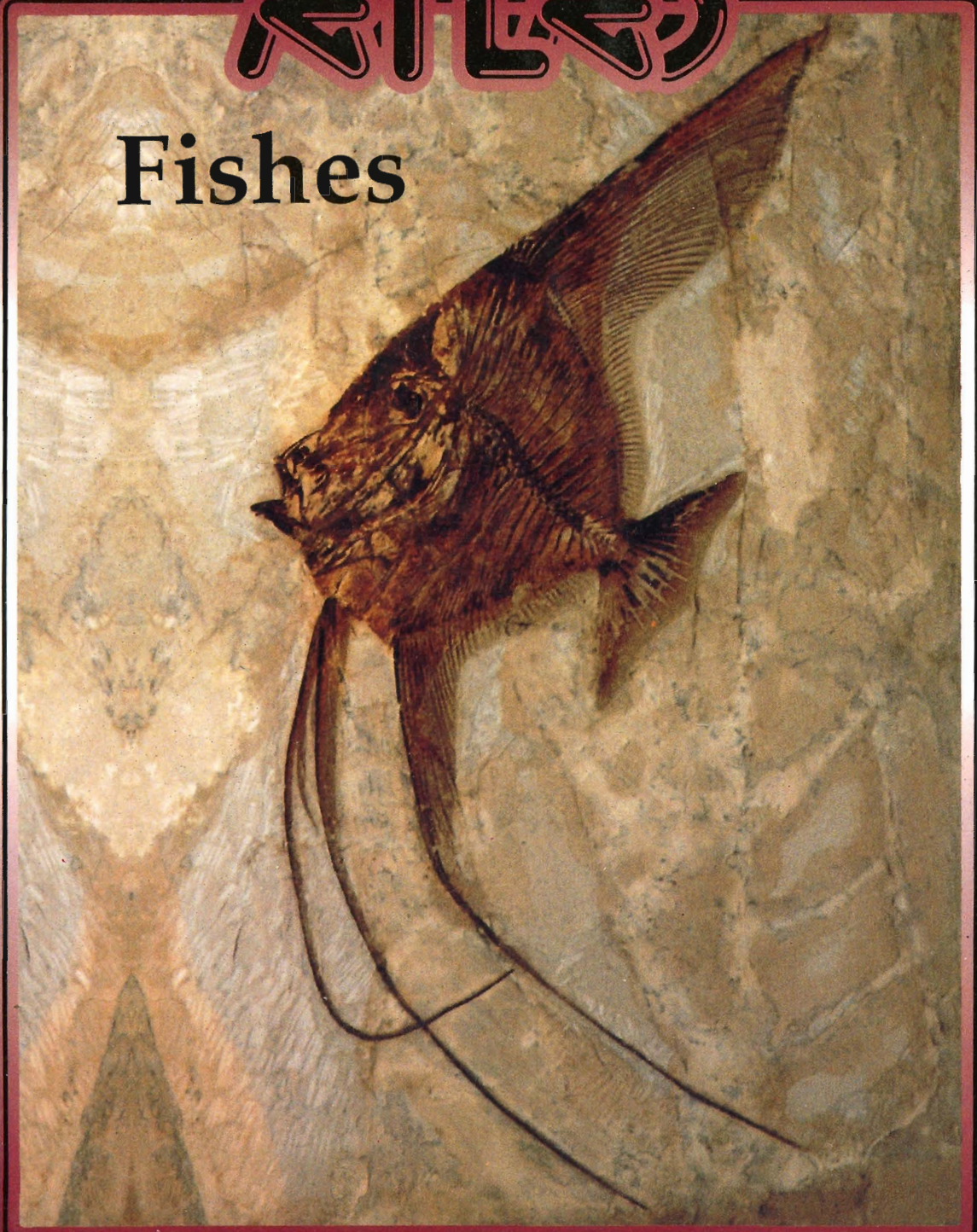
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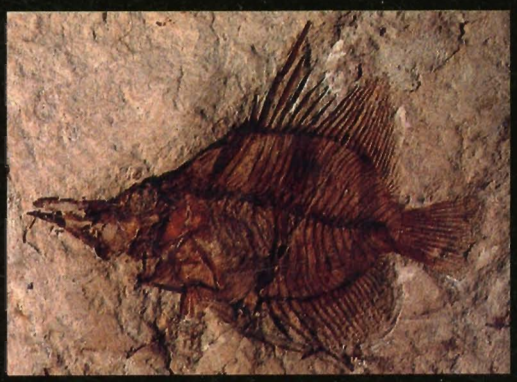
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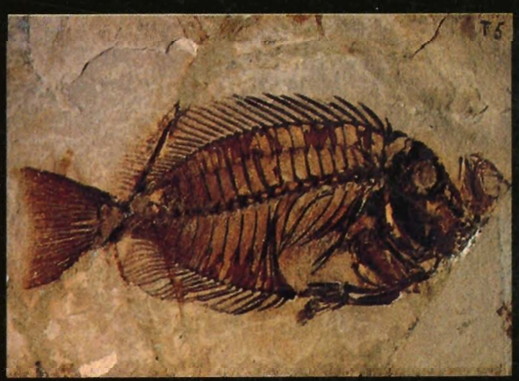


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FOSSIL ATLAS







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Approximately 420 million years ago (during the Silurian era), the first fishes appeared on our planet. They were quite clumsy, more benthic, and poor swimmers. Soon they were followed by placoderms, sharks, and finally, the first primitive bony fishes. Almost simultaneously the first lobe-finned fishes appeared. They ventured out onto land and evolved into amphibians and reptiles, eventually developing into vertebrates. Photos of 900 fossil fishes and over 200 recent descendants, plus several hundred line illustrations make this book an invaluable reference source for fish lovers, paleontologists, archaeologists, and fossilcollectors of all levels.

ISBN 1-56465-115-0

Photographs

Front of cover
Ceratoichthys pinnatiformis, Verona Museum.

Back of cover
Top Left: *Rhamphosus aculeatus*, Verona M.
Top Right: *Pygaeus gazolai*, Verona Museum.
Bottom Left: *Acanthura ovalis*, Verona Museum.

Title page (opposite)
Priscacara liops, Eocene, Wyoming, (50 million years), Baensch Collection.

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Preface

There is no lack of general literature on fossil invertebrates. Ammonites and trilobites, especially, have been very thoroughly treated in the last one hundred years and there are many texts available on faunas and particular systematic groups. Above all, there is the well known "Treatise on Invertebrate Paleontology"—an available work that leaves very little to be desired.

It is true that the last few years have given us "The Handbook of Palaeoichthyology" and "The Handbook of Palaeoherpetology". Unfortunately, however, neither work is complete and we may have to wait many years before all the volumes are available. Moreover, both are purely scientific works whose main objective is the diagnosis of genera. It is therefore understandable that they do not give as many figures as the editors and authors would no doubt have wished. Because of this, the readership is effectively restricted to scientific professionals and a few especially interested amateurs.

Apart from these two important works, little choice remains. The vertebrate literature must be gathered laboriously together and all-inclusive works hardly exist. As to fish, the last and only attempt to record all known fossil fishes, and illustrate them with masterly engravings, was made by Agassiz. He wrote 150 years ago, however. Only a few complete copies are left and they fetch an extremely high price—more a book lover's rarity than a practical work.

These considerations prompted me to produce the present work. It is a "picture book." I do not intend it to compete with more scientific works, since I knew from the start that it could be no more than a useful supplement to the specialised literature.

Nevertheless, it was no easy task. I have visited most of the important museums in the world and suffered a great deal of drudgery. I have searched through the collections for hours at a time, finally to photograph only those fishes still lacking. At first, everything went quickly, but once I had reached a certain level, it became more and more difficult to find anything new. Above all, I had set myself to photograph very well preserved specimens only. Thus I soon discovered that many of the 2500 genera so far described were based on incomplete specimens only, or even on single dorsal shields, teeth, spines or scales. No doubt there is

much good material to which I never had access or have overlooked. This, however, could only be true of a fraction of the genera shown in this book.

Another great difficulty was the nomenclature. In many collections I came across old specimens labelled with antique synonyms, or even undetermined material. I have made great efforts to bring everything into order; with the willing help of certain specialists, to whom I am very grateful. Nevertheless, I cannot guarantee absolute correctness in all cases. I sincerely ask that, if the reader finds a mistake, he tells me of it.

What readership is this book intended for? The scientific specialist may find in it a pictorial supplement to the technical literature. Besides that, he may be glad to know in what museum the fishes are kept which interest him. The museum curator will be able, using this book, to look over what is on offer and thus discover how his collections may sensibly be expanded. The student of palaeontology will be given a general view of most of the fossil fish fauna. The book will be of greatest interest to fossil collectors. Finally, I do not forget the amateur , whether angler or aquarist, who is interested in fishes. Up till now he has not had the chance to see what the ancestors of his fishes looked like, how they evolved nor how long they have already been on earth.

Autumn, 1994, Planegg.

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Collecting Fossils

Collecting can be seen as an instinctive drive of mankind, for otherwise we would not refer to a whole cultural stage as that of hunting and collecting. Something from that time must remain in many people, for very little is not collected, whether stamps, coins, beer mats or matchboxes, to name a few. Here the primitive hunting instinct is at work, since we rightly speak of hunting for the desired object before coming home with the loot.
Fossils have obviously always fascinated people although in early times nobody knew what they were. Thus in Stone Age deposits fossils have been found which had obviously been collected. Were they used as charms or ornaments? Was it only their strange shapes which attracted? Or did they have legends woven about them, as when the belemnites were called thunderbolts and seen as relics of the lightning thrown by Thor?
Later on, fossils were condemned by the Church as the work of the Devil or at best were supposed to be relics of Noah's Flood. This was why Scheuchzer saw the remains of a giant salamander found by him as those of a poor sinner drowned in the Flood. Nevertheless, he brought together an important collection, as was fashionable at the end of the 18th and, especially, in the early 19th century. At first it was noblemen and princely houses who were proud to maintain a cabinet of natural objects. However, there were always unpredictable incidents, like the famous example of Beringer, the Professor at Würzburg, who collected fossils with zeal but had forgeries passed off on him by his students. It was his bad luck that he did not recognize them in time. Indeed Beringer's "lying stones" have become world-famous.
In the end there were more and more people who concerned themselves with collecting these stony relics of a distant past. The present time has brought an awakening interest in Nature and there are many collectors who pursue this fascinating hobby with more or less devotion.
There are many ways of collecting. Some people, and they are probably the majority, collect only what they come across, whether accidentally or on purpose. They bring everything home that comes into their hands and, lacking standards of comparison, have no sense of quality. Over the years they pile up great heaps

of stone, often not even properly arranged. Sooner or later they, or perhaps their heirs, wish to sell this "collection". Then they cannot understand why they are paid, at most, a few Marks only. Others, again, make a local collection and have the ambition to possess all the fossils known from one locality. In the course of their lives they often acquire deep knowledge and thus achieve a remarkable contribution to science. Such collections always come, sooner or later, into the hands of a museum and thus finally reach the right place.

Others, again, collect only particular sorts of object, such as ammonites, trilobites or fishes. Commonly they are experts in their field and lay special value on complete specimens. Experience shows that such a collection will commonly finish in a museum after the owner's death, whether as a donation or at a reasonable price, as is only fair given the labour of amassing it.

Lastly, there are the aesthetes. They collect only what attracts the eye. Specimens can never be beautiful enough for them and they are ready to invest much time and money. In the course of their lives they bring collections together of which any museum could be proud. Indeed, museums are proud of them when, perhaps after several generations, such a collection comes on offer and is acquired. While such collectors live they have joy in their treasures every day. The clever ones among them see this pleasure as the "interest" earned by their often considerable "unemployed capital". When the values, or lack of value, of different ways of collecting are compared together, it is obvious that this last approach comes near the ideal. Nothing is more worthwhile than something which every day brings joy and in addition there is the pride of possessing something unique.

Unfortunately there are some museums today, and some scientists, who dislike the fact that private individuals are allowed to collect fossils. They would gladly claim a legal right to all such finds and would prefer to forbid private collecting entirely. But why should private initiative be suppressed? It is like the free market, without which nothing can prosper. Experience shows that every good collection lands, sooner or later, in a museum. It is only necessary to wait.

Many collectors try to photograph their treasures. Unfortunately this is less easy than it seems, for several factors must be considered. Thus the flash, otherwise so handy, must be forgotten, since illumination from in front leaves most fossils looking pale and flat and produces undesirable reflections. A side flash, however, may be useful in an emergency.

Best results are normally got under artificial light since only this form of illumination can be adapted to the requirements of the specimen. Even so, very bright light must, as a general rule, be avoided, for only a soft side light gives the desired results. This is particularly true of fossils that are hard to see, such as some insects. In such cases it is often important whether the light comes from left, right or above.

Furthermore the nature of the rock must be taken into account, because some rocks reflect light while others absorb it strongly. In this connection, automatic exposure meters often give wrong answers.

The photographic method used by me has aroused interest even among specialists. I work with a very simple trick—I use polarized light. The light source must have a polarizing filter, as likewise the lens of the camera. By rotating these polarizers, all reflections can be cut out. At the same time, the specimen grows darker and thus more brightly coloured. By turning the polarizers back slightly, a minimum of reflections can be brought back, giving a more lively picture.

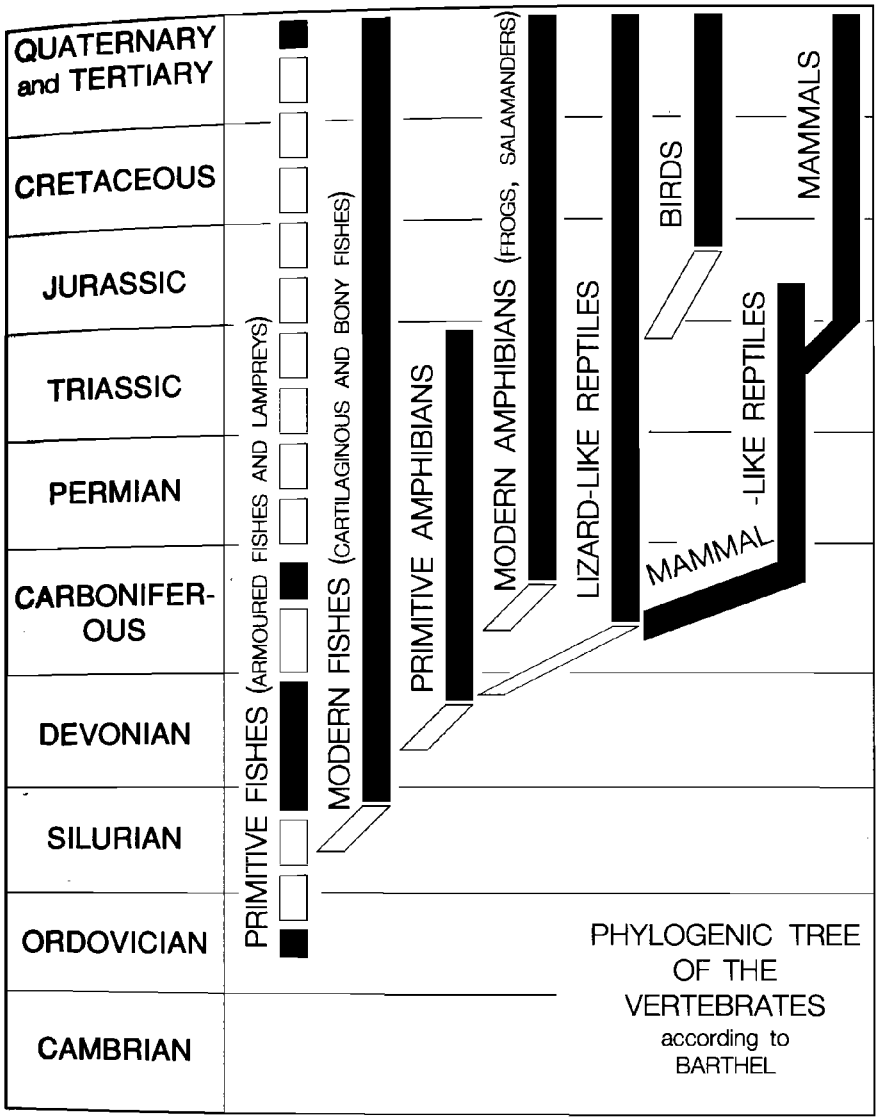
When using this method, all disturbing outside light should be excluded. Since this can hardly be done with incident daylight—except by photographing only at night—I use a blue filter over my light source. This allows me to employ daylight film with the benefit that the camera can quickly be used for other purposes. Film sensitivity should not be greater than 100-200 ASA (21-24 DIN). I use Ektachrome Professional film.

Unfortunately, even with a daylight filter, a slight trace of purple often intrudes which can be countered by using a weak green filter (Kodak Gelatine Filter G005). Using a light amber filter brings other advantages. Of course, by applying all these different filters I lose at least three stops. It is therefore necessary to use a stand. Exposure times of 1 second are attainable in almost all cases.

As to exposure time, I have already mentioned that the characteristics of the different rocks must be thought of. In this connection while black and red rocks need underexposure, grey rocks are, in general, neutral.
In the following table I give examples of how the exposure meter value should be modified in particular cases:

Bolca	normal
Brazil	1–2 stops more
Bundenbach	1 stop less
Holzmaden	1 stop less
Kupferschiefer	1–2 stops less
Lebanon	1–2 stops more
Messel	normal
Pfalz	normal
Red rocks	1–2 stops more
Scottish Old Red	normal
Solnhofen	1–2 stops more
Wyoming	1–2 stops more

These are only a few examples. Other rocks can be interpolated as appropriate.
And now for the camera itself. I recommend a small-frame camera with an interchangeable lens and a double draw tube. An extension ring allows me an image magnification of 1:1, which has turned out to be enough in all cases. If a higher image magnification were needed, a bellows could be inserted.
All this sounds rather complicated and is not cheap to buy. But the results are well worth the trouble and expense. There is a paradoxical rule of thumb—light-coloured rocks require overexposure.



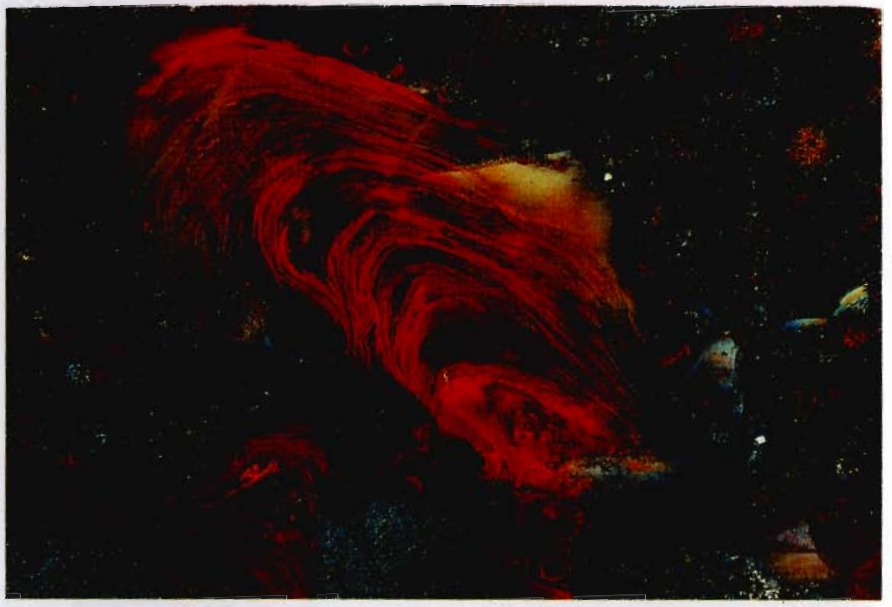
PHYLOGENIC TREE OF THE VERTEBRATES according to BARTHEL

Era	Period	Subdivisions (Epoch)	Years*	Animals and Plants
Cainozoic	Quarternary	Holocene (recent)	10,000	Pre-historic, historical and cultural evolution of man. The extinction of animal and plant species by man's activity begins and increases.
		Pleistocene (Ice Age) Wurm Glacial	50,000	
		Riss Glacial	200,000	
		Mindel Glacial	500,000	
		Gunz Glacial	700,000	The first true men. Climatic fluctuations caused by the ice ages change the fauna and flora.
		Pre-glacial	2 millon	
	Tertiary	Pliocene	7 million	Highest development of the mammals and the flowering plants (angiosperms). Primates appear. Towards the end the first man-like organisms originate.
		Miocene	26 million	
		Oligocene	38 million	
		Eocene	54 million	
		Palaeocene	65 million	
Mesozoic	Cretaceous	Upper Cretaceous	100 million	Evolution of reptiles up to enormous sizes (dinosaurs). The first advanced birds appear. Ammonites develop strange forms. The first flowering plants (angiosperms) appear. At the end of the period most reptiles die out, including the pterodactyls and ichthyosaurs. Ammonites and belemnites likewise disappear.
		Lower Cretaceous	136 million	
	Jurassic	Upper Jurassic	157 million	The acme of the reptiles, including especially the pterodactyls and the ichthyosaurs. Appearance of the primitive bird *Archaeopteryx*. Plants not much changed.
		Middle Jurassic	172 million	
		Lias	190 million	
	Triassic	Keuper	205 million	Origin of the first primitive reptiles. Further evolution of the reptiles and strong expansion of the gymnospermous plants.
		Muschelkalk	215 million	
		Bunter	225 million	

Paleozoic	Permian	Upper Permian	240 million	True bony fishes become numerous and mammal-like reptiles appear. Gymnosperms arise, including conifers, Ginkgo and others. Trilobites die out.
		Lower Permian	280 million	
	Carboniferous	Upper Carbiniferous (Pennsylvanian)	325 million	Appearance of the first reptiles. The highest evolution of ferns, lycopods and horsetails to form luxuriant forests giving rise to coal. Graptolites and armoured fishes die out.
		Lower Carboniferous (Mississippian)	345 million	
	Devonian	Upper Devonian	360 million	Origin of amphibians and occurrence of the first insects. Land plants develop further as psilophytes.
		Middle Devonian	370 million	
		Lower Devonian	395 million	
	Silurian		430 million	Expansion of corals. Armoured fishes and giant scorpions occupy the sea. The first primitive land plants.
	Ordovician		500 million	Appearance of fishes as the first vertebrates. Considerable further evolution of the ancestors of the ammonites. Crinoids and sea urchins, corals and graptolites appear for the first time.
	Cambrian	Upper Cambrian	515 million	Sudden appearance of invertebrate marine animals, especially trilobites. Further evolution of primitive algae.
		Middle Cambrian	540 million	
		Lower Cambrian	570 million	
Precambrian			1.0 billion	The beginning of animal life. Gradual evolution of multicellular organisms.
			3.4 billion	Beginning of plant life. Gradual evolution of algae.

* The numbers refer to the start of the period in question.

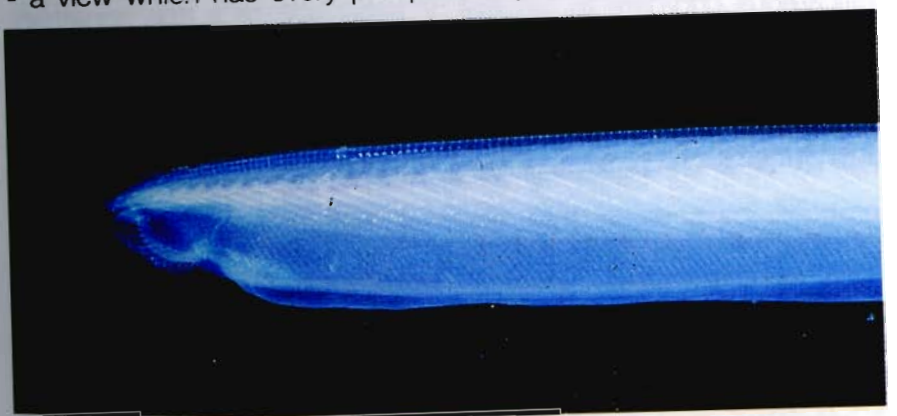
The Origin of Life and the Evolution of Fishes



Stromatolite from the Precambrian of Biwabik, U. S. A. Specimen and photograph: K. Götz, Munich.

The question as to when life began on this planet must be almost as old as paleontology itself. It is now supposed that plant life, in the form of bacteria and unicellular algae, started about 3.5 billion years ago, while animal life, in the form of unicellular flagellates, followed at about 1 billion years. This whole period, extending over billions of years, is called the Precambrian. Nobody should be surprised that fossil remains from this period are rare. Among the oldest are the stromatolites which are important both in the PRECAMBRIAN and in Lower Palaeozoic rocks. They are calcareous precipitates built mainly by green-blue algae. Stromatolites are among the most colourful fossils known and give a striking picture of the first organisms inhabiting this planet.
From the latest part of the PRECAMBRIAN a few finds of articulate animals (annelids, arthropods) are known and some jellyfish, but they are not very common.

The CAMBRIAN Period, which began about 570 million years ago, brought an explosive evolution of invertebrate animals and lower algae. This is when the ancestors of fishes must have existed, which would likewise be ancestral to all vertebrates and to man himself. When the first proven jawless fishes appeared in the ORDOVICIAN, and thus about 450 million years ago, they were already fully developed and must have had a long period of evolution behind them.
It is no surprise that the question of the ancestors of our fishes has been, or still is, the subject of lively discussion. Among recent animals there is an extremely primitive organism known as the lancelet or amphioxus (*Branchiostoma*). This little creature belongs to the *Acraniata*. Throughout the length of the body it has a notochord which is comparable with the human vertebral column and can be seen as its predecessor. The general shape of amphioxus is also what might be expected for an ancestor of the fishes.
There has been a recent unique fossil find. *Palaeobranchiostoma hamatotergum* has been discovered in the Permian of South Africa, which leads as to believe that *Acraniata* and fishes share a common ancestor. Additional supporting evidence are other chordates with their "calcareous skeleta", especially the *Calciochordata*. JEFFERIES believes them to be direct ancestors of the vertebrates - a view which has every prospect of prevailing.



Branchiostoma, also known as the lancelet or amphioxus. It suggests what the ancestors of fishes were like. (Photograph: Prof. Ax, Göttingen.)



Unnamed chordate from the Lower Carboniferous of Bear Gulch, Montana, U. S. A. Specimen: Adelphi University, Garden City, New Jersey, U. S. A.

But where do we go from there? It is a long way from such a calcareous chordate to lancelet or especially, to a true agnathan. We problably will never find all the links, though a beginning seems to have been made.

The fossil **Agnatha** differ considerably from the organisms that we now recognize as fishes. People still argue as to we should talk of them as fishes, or as fish-like. Their jawless mouth can probably be seen as their essential feature. At best they could suck or rasp, but never bite. Even their swimming ability may not have been very great, at least for most of them. Some of them reached lengths of 60-80 cm. Probably they lived mostly in fresh water. They reached their maximum in the Upper SILURIAN and finally disappeared in the Upper DEVONIAN.

A side branch of the agnathans, which differs in its anatomy in many ways from the classical representatives but shares the jawless mouth with them, still survives in the form of the hagfishes

and the lampreys. Three such cyclostomes have been found in the Lower Carboniferous, at a time when no other agnathans still existed. An evolutionary connection is therefore very likely.

In the Lower DEVONIAN another group besides the agnathans was widespread. These were the **placoderms** (PLACODERMI). From the evolutionary point of view they were more advanced. They had mobile jaws which gave them the advantage of leading a predatory mode of life. Their body was protected at back and belly by powerful armour so that they would scarcely need to fear enemies. They were still far from our usual picture of a fish—at first sight they could even be taken for turtles—and their swimming ability may also have been limited. In the Upper DEVONIAN they reached fearful sizes, up to eight metres long. These big forms had the armour confined to the head region and so could have swum considerably quicker than other placoderms. They must have terrorized the seas of the time but, nevertheless, did not prevail. They disappeared without issue, at the same time as the fossil agathans, in the Upper DEVONIAN.

The puzzling **acanthodians** (ACANTHODII) had already appeared in the Upper SILURIAN. As the name indicates (*acanthos* = spine) all the fins except the caudal fin carried a powerful spine. In some species the spines continued in a paired series between the pectoral and the pelvic fins. In their external features, the acanthodians were the first organisms with an undeniable resemblance to what we call fishes. Nevertheless, this class is completely isolated. It can neither be derived from the placoderms nor be assigned to the sharks. Unlike the latter, the acanthodians had bony tissue both in the internal and the external skeleton. The body was covered with small, tessellate, non-overlapping scales some of which extended onto the fin membranes. These scales consist of a bony base covered with a layer of dentine. The acanthodians lasted into the Lower PERMIAN but then died without issue. It is still controversial whether the acanthodians should be classified in front of the sharks or after them. It has even been suggested that the first primitive bony fishes are descended from them.

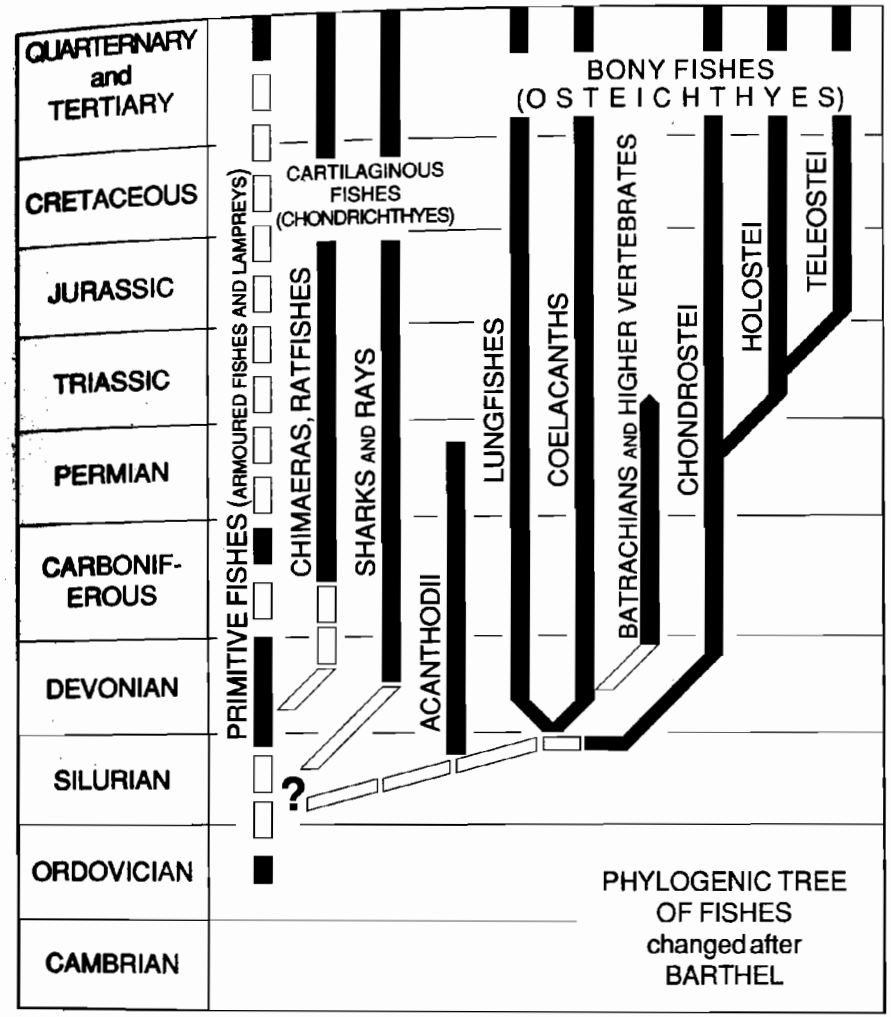
Perhaps it is not too daring to suppose that primitive, still unknown, ancestors of the acanthodians gave rise to all higher fishes.

The **cartilaginous fishes** (CHONDRICHTHYES) appeared considerably later, in the Upper DEVONIAN. As the name implies, they have no true bony tissue. The sharks belong to this group as do also the primitive but still surviving chimaeras. The sharks did not reach their maximum until the Upper Cretaceous, but there are still so many species today that the end of their evolution is by no means in sight. Ossification is often seen as an advanced feature and chondification as a primitive one. At least in this class, however, the opposite is true.

The first sharks lived in fresh water and were predators even then. Since the TRIASSIC, however, they have been able to live in the sea. The rays and skates, which are related to the sharks, are known first from the Upper Jurassic, but the beginning of their evolution may be considerably earlier.

Up till now, I have discussed three culs-de-sac of evolution and one successful branch road. Now, however, I come to the main route as followed by the **bony fishes** (OSTEICHTHYES). The most primitive representatives have been found in the Middle DEVONIAN, but their origins may lie considerably lower. At that time, the skeleton was not completely ossified, so at this evolutionary stage they are known as CHONDROSTEI. The scales were three-layered with the outer layer made of an enamel-like tissue **called ganoin**. The Lower CARBONIferous can be seen as the first maximum of the chondrosteans, but a second maximum followed in the Lower TRIASSIC. After that, they became very uncommon. In the recent fauna their only descendants are the sturgeons, the the lobe-finned pikes and the lobe-finned eel *Calamoichthys calabaricus* which arose from a side branch.

The next group, which is not truly self-contained, is the "**holosteans**" ("HOLOSTEI"). It separated off in the Upper PERMIAN. Their main common features are an increasing ossification of the internal skeleton and a reduction of the ganoin layer on the scales. This group reached a maximum in the Upper JURASSIC and were abundant even in the CRETACEOUS. Only in the TERTIARY did they lose importance. The only forms still existent are the garpike (*Lepisosteus*) and the bowfin (*Amia*).



Finally, in the Upper TRIASSIC, the ancestors should be sought **of the true bony fishes** (TELEOSTEI). This is a group of at least **25,000 species** and forms the majority of all living fishes. Most of **them** were small herring-like fishes that still retained a thin layer

of ganoin on the scales. In addition there were somewhat larger fishes, grouped into a total of four orders, which were the only true bony fishes during the whole of the JURASSIC and the greater part of the CRETACEOUS. Then eight new orders were added, while the Lower TERTIARY brought a further nine orders and the Middle TERTIARY another three. All the remaining, rather numerous, orders consist of recent fishes only. Thus about a third of all true bony fishes have only arisen recently. This suggests that the evolution of this, the most successful of all fish groups, is far from exhausted.

Which is descended from which can, in many cases, only be guessed. It is not even known with certainty whether we are dealing with a monophyletic or a polyphyletic group. Perhaps they can all be derived from the lineage of *Pholidophorus* and *Leptolepis*. Finally, however, the Pholidophoriformes may be split up into several branches and it may not be too outrageous to suppose that other ganoid fishes may also be involved.

All the **bony fishes** so far mentioned are placed in the subclass of the ACTINOPTERYGII. In these all the paired fins are carried by strong rays with a radial arrangement. There are, however, two further fish groups which are separated from them as **"flesh-finned"** (SARCOPTERYGII). These are the **lungfishes** (DIPNOI) and the **lobe-finned fishes** (CROSSOPTERYGII). Both of them are known since the Lower DEVONIAN.

There is evidence to suggest, however, that they separated off still earlier from the main branch which led to the bony fishes. Both possessed, at that time, the unusual ability to breathe air.

Lungfishes reached their maximum in the Upper DEVONIAN and still persist as a few genera today with an enormous geographical range including Africa, Australia and South America. They can survive droughts embedded in cocoons of mucus.

The maximum of the lobe-finned fishes was in the Middle DEVONIAN. No representative of this group of fishes has ever been found in the Tertiary and they were believed to have died out at the end of the Cretaceous. In 1938, however, the famous coelacanth *Latimeria chalumnae* was discovered. As a living fossil it showed that the lobe-finned fishes had survived to the present day.



Photograph of a live *Latimeria* at the coastal region of the Comoros Islands. Photo: Prof. Fricke, Seewiesen.

The original habitat of all lobe-finned fishes was in fresh water. The representatives of the order *Coelacanthiformes*, however, may from early times have preferred life in the sea. *Latimeria* itself belongs to this order. Among the other orders, included in the higher group *Rhipidistia*, those fishes must be sought which already attempted, at the end of the DEVONIAN, to conquer the land and which thus became, by way of the amphibians and the reptiles, the ultimate ancestors of all land-dwelling vertebrates.

Today we know that the last representatives of the lobe-finned fishes prefer to live at great depth in the lava cliffs off the Comores islands. They are active at night. The females are up to two metres long and viviparous. The number of still living animals is estimated at 250. Thus this living fossil, so recently discovered, is threatened with extinction. The fishermen of the Comoros catch a few every year and recently there have even been expeditions to try to catch living specimens for exhibition. Only the strictest conservation measures may call a halt and maintain the last lobe-finned fishes for the future.

The Fins

Fins are very important for fishes since they are the propulsive organs. Because of their very diverse structure they are often used for identification.

Basically there are two types of fin—paired and unpaired. The unpaired fins include the **dorsal** fin along the mid line of the back, the **anal** fin situated in the ventral mid line behind the anus and the **caudal** fin (tail fin) which forms the posterior end of the fish.

The paired fins are the **pectoral** and **pelvic**. The pectoral fins are always lateral and just behind the mouth. The pelvic fins, though always located ventrally, vary greatly in position. In evolutionary terms the pectoral and pelvic fins correspond to the fore and hind limbs of land vertebrates.

It is thought that the first ancestors of fishes had no fins and could move only by undulating their bodies. The predecessors of fins may have been almost undifferentiated stabilization keels. These may have arisen from an uninterrupted fold of tissue as found today in the larval stages of almost all fishes. Perhaps at first ridges of cartilage developed in these folds which later divided into a basal portion, transverse to the body, and a radial portion extending perpendicularly into the tissue fold. In any case, this is the type of fin still found in living agnathans, both hagfishes and lampreys. Since these represent the most primitive living fishes, the median fins may have arisen in this manner. The origin of the paired fins cannot be imagined so easily. Perhaps a fold running on left and right from the gill openings to the anal region may have played a role corresponding to the median fin fold. As yet, however, such a paired fold has been found only in the fossil agnathan *Jamoytius*.

In the sharks the supporting rays are further subdivided, although this cannot be seen from outside since they are covered by skin and muscle. The still-living sturgeon also has fins of primitive type. In these fishes the dorsal and anal fins have a muscular lobe at the base which surrounds rod-like structures in the body and rays in the externally visible parts of the lobes. Such fins are similar to typical shark fins but, unlike them, the outer part of the fin is supported by bony rays—the so-called

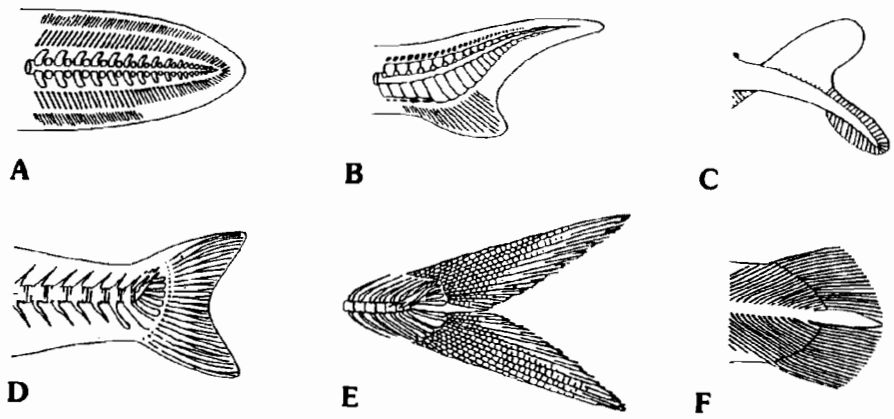
Lepidotrichia. Higher fishes lack this lobe at the base of the fin and the lepidotrichia, attached to little nodes in the body, have become the only support for the external part of the fin.

The supporting skeleton of the caudal fin is different, for modifications of the posterior part of the vertebral column are involved. If the vertebral column remains straight and the fin runs around it as a sort of fringe, we speak of a **protocercal** caudal fin. If the column bends upward and extends into a longer upper lobe, while the lower lobe remains shorter, then we have a **heterocercal** caudal fin. This type is found among all sharks and chondrosteans. The opposite case, when the vertebral column bends downwards and runs into the lower lobe, is called a **hypocercal** caudal fin. This type occurs in the agnathans and also in the ichthyosaurs. (These are not fishes but I mention them for the sake of completeness.) If the caudal fin is divided symmetrically into equal-sized upper and lower lobes, or is undivided, then the fin is **homocercal**. Externally this type of fin looks absolutely symmetrical but anatomy shows that here also, in the more primitive forms, the vertebral column turns upward at the end. This strongly indicates that the homocercal fin arose in evolution from the heterocercal fin. The homocercal fin is typical for most bony fishes. Finally there is the **diphycercal** caudal fin in which the vertebral column remains straight and the caudal fin is divided into two equal lobes. Perhaps this is the most primitive type of caudal fin. It is found in some of the lobe-finned fishes.

In general the caudal fin, like the dorsal and anal fin, is made up of simple rays and jointed rays which serve to support a thin membrane. Spines are never present.

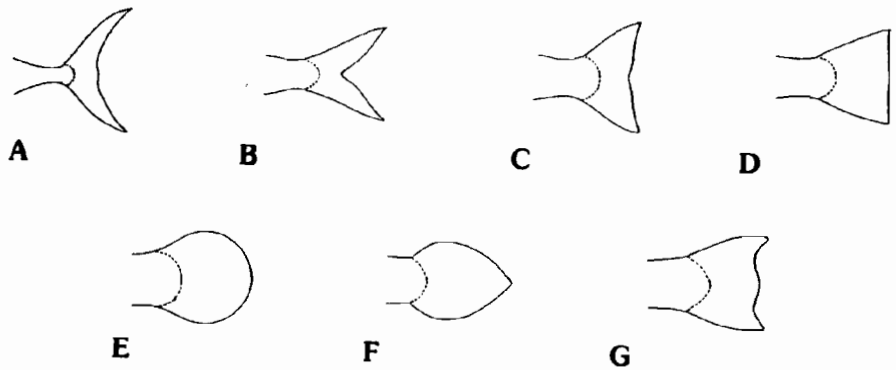
Finally, for completeness, I mention a type of fin which only occurs in the headfish *Mola*. This is the **gephyrocercal** caudal fin. It terminates the body by running as a fringe between the dorsal and anal fins.

Types of Caudal Fins



A = protocercal and diphycercal
B = heterocercal
C = hypocercal
D = homocercal (primitive type)
E = homocercal (more advanced type)
F = triphycercal

Shapes of Caudal Fins



A = sickle-shaped
B = forked
C = slightly forked
D = truncate
E = rounded
F = pointed
G = double-curved

Scales and Spines

The skin of fishes is fundamentally like that of other vertebrates. It consists of a very thin outer layer (epidermis) and a thicker layer beneath (dermis). The epidermis is made up of several layers of simple cells, the outermost layers being continually worn away by natural means and replaced. The dermis, on the other hand, is formed of a thick layer of connective tissue into which muscle fibres, nerves and blood vessels extend. The fine mucus which covers a fish and makes it slippery is secreted by special gland cells in the epidermis.

In addition to the skin, most fishes have another body covering i.e. the scales, which are sometimes referred to as an exoskeleton. In scaleless fishes the skin is always strengthened in some way. When it serves as a substrate for scales, however, it remains soft and also relatively thin.

Sharks and rays have dermal denticles which are also known as **placoid scales**. Each of these has a bone-like base embedded in the skin which at the surface bears a spine pointing backwards and covered with enamel. The rudiments of these denticles arise already in the skin of the embryo. Placoid scales, unlike the scales of bony fishes, do not enlarge as the fish grows. Rather do new placoid scales insert themselves between those already there, so that the growing body always remains covered. The shape of the dermal denticles varies with the genus and ranges from spine-like to wart-like. Some rays have even completely lost their denticles and retain only a smooth skin. Stingrays have a tail spine instead of the dorsal fin. This spine can be cast off if necessary and replaced by a new one. The chimaeras and their relatives (*Holocephali*) have largely a naked skin but there are places with little denticles almost like those of sharks.

In bony fishes the scales arise from the dermis. I start by describing **cosmoid scales** which are found in many lobe-finned fishes and fossil lungfishes. The individual scale is here made of four layers. The innermost layer consists of dense bone. Above this is a layer of porous bone, then a dentine-like cosmine layer and finally a thin superficial layer of enamel.

The chondrosteans have evolved another type of scale—the **ganoid scale**. In these the dentine layer is thinner and the bony layer correspondingly thicker. The most striking feature of this type of scale, however, is the thick layer of enamel which is referred to as

the ganoine layer. These layers are deposited concentrically around a tiny cosmoid scale. It is supposed that ganoid scales evolved earlier than cosmoid scales and that the latter originated by a reduction of the thick ganoin layer. Among still living fishes the primitive type of scale is found only in paddlefishes and in the African bichir and its relatives. In the "holosteans" a reduced type of ganoid scale occurs. It consists of only two layers and of these the enamel-like ganoine layer has become appreciably thinner. Such scales are found today only in the garpike *Lepisosteus* and are sometimes therefore referred to as the "lepisostoid" type of scale. Most ganoid scales are rhomboidal in outline.

All "ganoid" fishes were thus enclosed in a thick, rather inflexible armour which must have made them relatively immobile. On the other hand such scales offered a more or less effective defence against predators. Such fishes were therefore not adapted for rapid swimming and even the predators among them may have contented themselves with slow-moving or even sessile prey. Only with the gradual reduction and final loss of the enamel layer could modern types of fishes arise.

Among advanced recent fishes we have to distinguish between two basically different types of scale—**cycloid** and **ctenoid**. Cycloid scales are circular and overlap each other like tiles on a roof. They cover the whole body except for the fins and the head. The anterior end of each cycloid scale extends into a pocket in the dermis. Typical examples of cycloid scales are found in the carp. With ctenoid scales, on the other hand, the hinder edge of the scale has small tooth-like spines. These spines can be long and pointed, or rather soft and hair-like, or anything between. A typical example of a ctenoid scale is found in the perch. With a few exceptions it can be said that cycloid scales are mostly larger than ctenoid scales and that fish with only soft fins in general have cycloid scales while those with hard fin rays have ctenoid scales. There are some fishes, however, in which both types of scale occur.

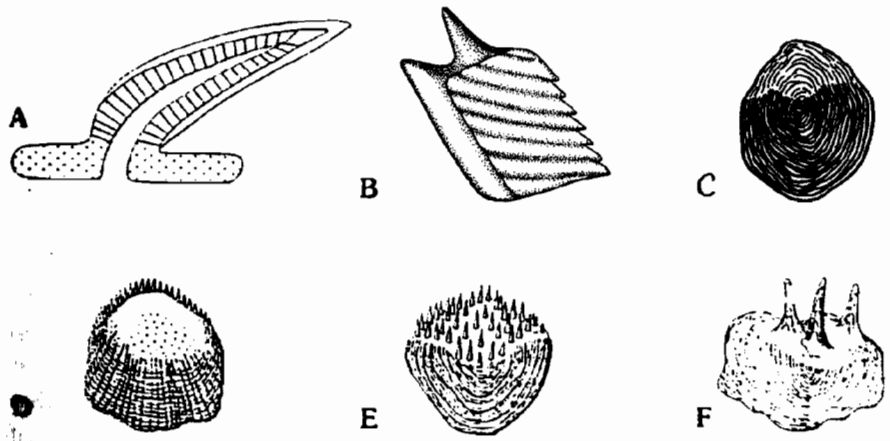
One particular exception must be mentioned. Among true bony fishes some retain a thin layer of enamel on the scales. These are the primitive true bony fishes e.g. *Pholidophorus*. Others evolved armour secondarily such as the snipefishes, sea-horses, stickle-backs, armoured catfishes and cofferfishes.

Some fishes have replaced their scales by spines. The best known example is the porcupinefish, in which the spines stick out at right

angles when the fish inflates itself. The same happens in some pufferfishes. The armour of many cofferfishes ends in sharp points and there are even some which have long spines extending from the head. The surgeonfishes have a lancet-shaped spine on either side of the tail base. These spines are normally enclosed in a fold of skin but in danger are protruded and can cause serious injury. The snipefishes have scales in the form of rhomb-shaped bony plates each of which extends posteriorly into a spine. Some armoured catfishes likewise show little spines on their bony plates which, like those of sharks, are formed of dentine and covered with enamel.

Among holosteans, as also among true bony fishes, there are some which have completely lost any scales and are content with a naked, though thickened, skin. In some superficially naked fishes, however, scales are present deeply embedded in the skin. This is a transitional condition to complete loss of scales. The best, and best known, example of a fish on the way to scalelessness is the European eel. Its tiny, almost buried scales are easily visible under the microscope.

Types of Scales



A = **placoid scale** (dermal denticle) of a shark
B = **ganoid scale** of a primitive bony fish
C = **cycloid scale** of a true bony fish
D–F = **ctenoid scales** of various types in true bony fishes.

Teeth

Teeth, and the type of dentition, give much information about the mode of feeding of different genera. There has been much modification in the course of evolution. Thus the oldest fishes had no true teeth. Lacking jaws, they would not have been able to grasp large prey with their teeth. In the mouth of the lamprey (*Petromyzon*) there are only conical structures and two horny plates with notched edges. The extendable tongue has other plates which serve to rasp away the surface of the prey fish. It is likely that fossil agnathans were similarly equipped.

Some placoderms had toothless cutting jaws while others had small or massive bony teeth. True teeth with dentine still did not exist. The sharks represent a great advance. Here teeth have arisen from placoid scales and are still, therefore, somewhat primitive. Each nevertheless consists of a bone-like substance called dentine covered by a layer of enamel. Enclosed by the dentine there is a pulp cavity which contains blood vessels and nerves. Such teeth are not fixed directly to the jaw but rest on a fibrous layer and are held in place additionally by the soft tissue of the gums. Sharks do not keep the same set of teeth throughout life. Whenever a tooth is lost, a replacement is ready to insert itself into the gap. Such continually self-renewing dentitions are called polyphyodont.

Sharks vary greatly in the size and shape of the teeth. They can be long and slender, or broadly triangular. There may be several types of tooth within a dentition. Even the forms of dentition are very variable. Sharks which swim freely in the water and live mainly on fishes have a typical predatory dentition which consists of two rows of sharp pointed teeth. Benthic sharks have a grasping dentition of small pointed teeth arranged in several rows one behind the other.

The chimaeras and many rays live on hard-shelled food and have crushing dentitions. These are pavement-like and consist of rounded or flat teeth or fused tooth-plates. The teeth of chondrichthyans are in general very characteristic and can therefore useful for identification.

Some acanthodians were toothless, some had teeth only in the lower jaw and a few had teeth in both jaws.

In the classes of fishes so far discussed, teeth are developed on the jaws only. In bony fishes, however, they can also be present on the tongue, on the palate and in the throat. Thus in many carp there are teeth in the throat but the jaws themselves are toothless. In general the teeth of bony fishes are more firmly fixed than in sharks. They vary greatly in shape, in correlation with the mode of feeding. Fish-eating fishes have especially strong sharp pointed teeth which are used for seizing prey but never for chewing it. Chewing occurs only in fishes with a pavement- or plate-like dentition. Some predatory fishes, such as the pike, have teeth also on the palate. These point backwards and can be pushed downwards in this direction to help prey to enter. They cannot be pushed forward, however, so that the prey, once in, cannot get out.

Other predatory fishes, such as the piranha, have very short upwardly directed jaws with razor-sharp teeth. This structure gives great strength to the bite so that pieces of flesh can be torn out of bigger animals. There are still other predatory fishes whose teeth are differentiated between long and short. They are especially long at the anterior end of the jaw where they are used as grasping teeth. Such teeth sink deep into the body of the prey and hold it in a powerful grip.

Fishes with a mixed diet, or which feed only on plants, mostly have blunt teeth, if any. Among other fishes, such as the puffers, the teeth fuse to form two sharp-edged plates in each jaw. Indeed, the porcupine fish has only one such plate in each jaw. Triggerfishes have chisel-like teeth with which they can make holes in hard-shelled bivalves. Finally, there are some rudderfishes (Stromateoidei), which only have tiny teeth but to compensate have a muscular, toothed feeding tube. The related form *Tetragonurus* has a similar feeding tube but lacks teeth.

All forms of systematics seem dry-as-dust at first sight and they frighten the layman off. Here I shall therefore try to explain the absolute necessity and, above all, the usefulness, of systematics.

A classification has the important task of inserting every species into a system so as to display its relationships as clearly as possible. Obviously, this is not always easy. Moreover a classification must change to take account of the latest researches. The more research advances, the more complicated the classification becomes.

Thus early classifications were simple. They were easy to understand but did not say very much. In particular it used to be customary to consider fossils separately from existent organisms, which at first sight seemed convenient. This simple approach, however, gave almost no indication of how fossils were related to recent organisms and scarcely suggested the course of evolution.

As regards fishes, the Russian ichthyologist L. S. Berg in 1940 was the first to unite fossils and recent organisms in one classification. This was a path-making act which soon stimulated others to move in the same direction. Thus in 1958, BERG's classification was extended by C. ARAMBOURG and L. BERTIN. Their interpretation, which naturally did not go uncontradicted, is still given in the text books. In contrast to this classification, in 1966 the ichthyologists GREENWOOD, ROSEN, WEITZMANN & MYERS set up a new system of subdivisions which was adopted in the latest edition of the standard work "Vertebrate Paleontology" by the brilliant paleontologist A. S. ROMER.

This classification, especially in mainland Europe, is still widely accepted.

In English-speaking countries, however, a new classification has been proposed which in part differs considerably from the one just mentioned. This is a cladistic interpretation, based on a theory of divergent evolution, but not yet generally accepted. It was proposed by LAUDER & LIEM in 1983 and radically revised by J. S. Nelson in 1984. The classification of fishes given by R. L. Carroll in his new successor-work to ROMER'S "Vertebrate Paleontology" is to a large extent based on this new system.

NELSON'S book "Fishes of the World" unfortunately deals mainly with recent fishes and only mentions fossil genera by way of example. In writing the present work, therefore, I could follow NELSON and CARROLL only with regard to the bony fishes (Osteichthys). For groups more primitive than them, however, and for the lobe-finned fishes, I had to compile a classification myself. This was necessary to produce a result even halfway up-to-date. Of course, I had the help of acknowledged experts and so I hope to have done the best possible.

I am sure that I shall not escape criticism, especially concerning a few arbitrary decisions (in my view unimportant) which I thought were necessary for clarity. Thus, for example, I adopt uniform terminations for all orders, all suborders and all superfamilies. Also, I did not have the courage to eliminate the old grouping "Holostei" before a suitable replacement is proposed. In the meantime I shall use the word in the systematic part in quotation marks, followed by the new subdivisions. The already cited A. S. Romer even said: "The difficulties of classifying the actinopterygians, and bringing them into a reasonable system, can drive the fish systematist to desperation. The task of giving even a passably coherent survey of the phylogeny of this group would be the death of me." It is likely that, even today, the last word has not been spoken on this subject.

After these introductory words, I wish to discuss the importance of systematics, especially with regard to the fishes. The subphylum *Vertebrata* (backboned animals) includes, besides the fishes, the amphibians, reptiles, birds and mammals. Thus the fishes are placed in the superclass *Pisces*. This includes everything from the agnathans to the rhipidistians. It is divided into individual classes called Agnatha, Placodermi, Chondrichthyes, Acanthodii and Osteichthyes. The agnathans are divided into three subclasses with a total of eight orders. The placoderms are divided into eight orders and four suborders. The chondrichthyans are divided into two subclasses, three superorders, 28 orders and 20 suborders. Finally the osteichthyans, which are by far the most diverse class, are divided into two subclasses, four infraclasses, three divisions, five subdivisions, five superorders, 66 orders and 62 suborders. Then come the families, genera and species.

All this only serves to show the interconnections and relationships clearly. If I try, not very successfully, to express the matter in human terms, then all members of the same class could be seen as more or less distant cousins. This relationship becomes closer, the farther we go downwards. Thus members of the same family could be seen as third cousins, and all members of a genus as second cousins. Accordingly the species must contain first cousins down to siblings with all possible combinations.
So how are a carp and a catfish related to each other? They both belong to the same suborder and are therefore fairly close "cousins". A carp and a pike form part only of the same subdivision. They are therefore rather distant "cousins". And how is it with a perch and a shark? They belong to different classes—the degree of relationship between them can be expressed only by saying that they are both "fishes".
The classification given below includes all fishes, fossil and recent, divided to the family level. A large number of fossil genera are included in the systematic part of this book and with each one it is stated whether connections exist with recent fishes. I have not attempted to list the relevant subfamilies and species.

CLASSIFICATION OF FISHES

103 orders
720 families

Of these
263 are only known fossil (†)
224 are known both fossil and recent
233 are only known recent (•)

CLASS AGNATHA — Agnathans
SUBCLASS MYXINI — Hagfishes or Myxinoids

Order MYXINIFORMES
†Family:Myxinidae (hagfishes)

SUBCLASS PTERASPIDOMORPHI

Order ASTRASPIDIFORMES
†Family: Arandaspididae
†Family: Astraspididae
†Family: Eriptychidae

Order PTERASPIDIFORMES
†Family: Cyathaspididae
†Family: Amphiaspididae
†Family: Corvaspididae
†Family: Traquairaspididae
†Family: Protopteraspididae
†Family: Pteraspididae
†Family: Cardipeltidae
†Family: Drepanaspididae

Order THELODONTIFORMES
- †Family: Katoporidae
- †Family: Loganiidae
- †Family: Turiniidae
- †Family: Apalolepididae
- †Family: Nikoliviidae

SUBCLASS CEPHALASPIDOMORPHI

Order CEPHALASPIDIFORMES
- †Family: Trematapididae
- †Family: Dartmuthiidae
- †Family: Ateleaspididae
- †Family: Sclerodontidae
- †Family: Cephalaspididae
- †Family: Kiaeraspididae

Order EUGALEASPIDIFORMES
- †Family: Hanyangaspididae
- †Family: Eugaleaspididae
- †Family: Nanpanaspididae
- †Family: Polybranchiaspididae
- †Family: Hunanaspididae
- †Family: Duyunolepididae
- †Family: Lungmenshanaspididae
- †Family: Tridensaspididae
- †Family: Dayongaspididae

Order ANASPIDIFORMES
- †Family: Jamoytiidae
- †Family: Birkeniidae
- †Family: Euphaneropsidae
- †Family: Endeiolepididae
- †Family: Lasaniidae

Order PETROMYZONTIFORMES — Lampreys
- •Family: Petromyzontidae (lampreys)
- †Family: Mayomyzontidae

CLASS PLACODERMI — Placoderms

Order STENSIOELLIFORMES
- †Family: Stensioellidae

Order PSEUDOPETALICHTHYIFORMES
- †Family: Paraplesiobatidae

Order RHENANIFORMES
- †Family: Asterosteidae

Order PTYCTODONTIFORMES
- †Family: Ptyctodontidae

Order ACANTHOTHORACIFORMES
- †Family: Palaeacanthaspididae
- †Family: Weejeraspididae

Order PETALICHTHYIFORMES
- †Family: Macropetalichthyidae

Order PHYLLOLEPIDIFORMES
- †Family: Antarctaspididae
- †Family: Phyllolepididae

Order ARTHRODIRIFORMES

Suborder Actinolepidoidei
- †Family: Actinolepididae

Suborder Wuttagoonaspidoidei
- †Family: Wuttagoonaspididae

Suborder Phlyctaenioidei
- †Family: Phlyctaeniidae
- †Family: Holonematidae
- †Family: Williamsaspididae

Suborder Heterosteoidei
- †Family: Heterosteidae

Suborder Coccosteoidei
Superfamily Buchanosteoidea
†Family: Buchanosteidae
†Family: Goodradigbeonidae
Superfamily: Gemuendenaspoidea
†Family: Gemuendenaspididae
SuperFamily: Homosteoidea
†Family: Homosteidae
Superfamily: Brachydeiroidea
†Family: Brachydeiridae
†Family: Leptosteidae
Superfamily: Coccosteoidea
†Family: Coccosteidae
†Family: Camuropiscidae
†Family: Pholidosteidae
†Family: Incisoscutidae
†Family: Rachiosteidae
Superfamily: Pachyostoidea
†Family: Dinichthyidae
†Family: Leiosteidae
†Family: Trematosteidae
†Family: Pachyosteidae
†Family: Mylostomatidae
†Family: Titanichthyidae
†Family: Bungartiidae

Order ANTIARCHIFORMES
†Family: Bothriolepididae
†Family: Asterolepididae
†Family: Sinolepididae

CLASS CHONDRICHTHYES — Cartilaginous Fishes
SUBCLASS ELASMOBRANCHII — Elasmobranchs

SUPERORDER UNNAMED

Order XENACANTHIFORMES
†Family: Diploselachidae
†Family: Xenacanthidae

Order CLADOSELACHIFORMES — Cladoselachian Sharks
†Family: Cladoselachidae

Order CORONODONTIFORMES
†Family: unnamed

Order SYMMORIIFORMES
†Family: Symmoriidae
†Family: Stethacanthidae

Order EUGENEODONTIFORMES
Superfamily: Caseodontoidea
†Family: Casiodontidae
†Family: Eugeneodontidae
Superfamily: Edestoidea
†Family: Agassizodontidae
†Family: Edestidae

Order ORODONTIFORMES
†Family: Orodontidae

Order PETALODONTIFORMES
†Family: Petalodontidae
†Family: Pristodontidae
†Family: Belantseidae

Order SQUATINACTIFORMES
†Family: Squatinactidae

SUPERORDER EUSELACHII

Order CTENACANTHIFORMES
Superfamily: Ctenacanthoidea
†Family: Ctenacanthidae
†Family: Bandringidae
†Family: Phoebodontidae

Superfamily: Hybodontoidea
†Family: Hybodontidae
Superfamily: Protacrodontoidea
†Family: Tamiobatidae

SUPERORDER NEOSELACHII

Order GALEIFORMES

†Family: Palaeospinacidae

Suborder Heterodontoidei
Family: Heterodontidae (horn sharks)

Suborder Orectoloboidei
Family: Orectolobidae (nurse sharks)
•Family: Rhincodontidae (whale sharks)
Family: Hemiscylliidae
†Family: Parascylliidae

Suborder Lamnoidei
Family: Carchariidae (cub sharks)
†Family: Cretoxyrhinidae
†Family: Otodontidae
Family: Lamnidae (mackerel sharks)
Family: Mitsukurinidae
Family: Cetorhinidae (basking sharks)
Family: Alopiidae (thresher sharks)
Family: Anacoracidae

Suborder Carcharhinoidei
Family: Scyliorhinidae (cat sharks)
Family: Pseudotriakidae
Family: Triakidae (hound sharks)
Family: Carcharhinidae (requin sharks)
Family: Sphyrnidae (hammerhead sharks)

Suborder Hexanchoidei
†Family: Orthacodontidae
Family: Hexanchidae (cow sharks)

Suborder Chlamydoselachoidei
Family: Chlamydoselachidae (frill sharks)

Order SQUALIFORMES

Suborder Squaloidei (angel and dogfish sharks)
Family: Squalidae (spiny dogfishes)
Family: Dalatiidae (sleeper sharks)
Family: Echinorhinidae (bramble sharks)

Suborder Pristiophoroidei
Family: Pristiophoridae (saw sharks)

Suborder Squatinoidei
Family: Squatinidae (angel sharks)

Order RAJIFORMES (Rays and Skates)

Suborder Rhinobatoidei
Family: Rhynchobatidae
Family: Rhinobatidae (guitarfishes)
†Family: Platyrhinidae

Suborder Rajoidei
Family: Rajidae (true rays and skates)
†Family: Cyclobatidae
•Family: Pseudorajidae
•Family: Anacanthobatidae

Suborder Sclerorhynchoidei
†Family: Sclerorhynchidae

Suborder Pristoidei (sawfishes)
Family: Pristidae

Suborder Torpedinoidei
Family: Torpedinidae (electric rays)
Family: Narcinidae
•Family: Temeridae

Suborder Myliobatoidei
Family: Dasyatidae (stingrays)
Family: Urolophidae (round rays)
Family: Potamotrygonidae (river stingrays)
Family: Gymnuridae (butterfly rays)
Family: Myliobatidae (eagle rays)
Family: Rhinopteridae (cow-nosed rays)
†Family: Rhombodontidae
Family: Mobulidae (devil rays)

SUBCLASS SUBTERBRANCHIALIA

SUPERORDER INIOPTERYGII

Order CHONDRENCHELYIFORMES
†Family: Chondrenchelyidae

Order INIOPTERYGIIFORMES
†Family: Iniopterygiidae
†Family: Sibyrhynchidae

SUPERORDER HOLOCEPHALI — Chimaeras

Order HELODONTIFORMES
†Family: Helodontidae

Order COPODONTIFORMES
†Family: Copodontidae

Order PSAMMODONTIFORMES
†Family: Psammodontidae

Order unnamed
Suborder Cochliodontoidei
†Family: Cochliodontidae
Suborder Menaspoidei
†Family: Menaspidae
Suborder Squalorajoidei
†Family: Squalorajidae
Suborder Myriacanthoidei
†Family: Acanthorhinidae
†Family: Chimaeropsidae
†Family: Myriacanthidae

Order CHIMAERIFORMES
Suborder Echinochimaeroidei
†Family: Echinochimaeridae
Suborder Chimaeroidei
Family: Chimaeridae (chimaeras)
Family: Rhinochimaeridae (longnose chimaeras)
Family: Callorhynchidae (ploughnose chimaeras)

CLASS ACANTHODII — Acanthodians

Order CLIMATIIFORMES
†Family: Climatiidae
†Family: Diplacanthidae
†Family: Gyracanthidae

Order ISCHNACANTHIFORMES
†Family: Ischnacanthidae

Order ACANTHODIFORMES
†Family: Acanthodidae

CLASS OSTEICHTHYES — Bony Fishes
SUBCLASS ACTINOPTERYGII — Ray-Finned Fishes
INFRACLASS CHONDROSTEI — Chondrosteans

Order POLYPTERIFORMES
Family: Polypteridae (bichirs)

Order PALAEONISCIFORMES
Suborder Palaeoniscoidei (palaeoniscoids)
†Family: Cheirolepididae
†Family: Stegotrachelidae

†Family: Tegeolepididae
†Family: Rhabdolepididae
†Family: Rhadinichthyidae
†Family: Carbovelidae
†Family: Canobiidae
†Family: Cornuboniscidae
†Family: Styracopteridae
†Family: Cryphiolepididae
†Family: Holuriidae
†Family: Cosmoptychiidae
†Family: Pygopteridae
†Family: Elonichthyidae
†Family: Acrolepididae
†Family: Coccocephalichthyidae
†Family: Amblypteridae
†Family: Aeduellidae
†Family: Platysellidae
†Family: Commentryidae
†Family: Palaeoniscidae
†Family: Dicellopygidae
†Family: Boreolepididae
†Family: Birgeriidae
†Family: Scanilepididae
†Family: Centrolepididae
†Family: Coccolepididae

Suborder Platysomoidei
†Family: Platysomidae
†Family: Chirodontidae
†Family: Bobasatraniidae

Order HAPLOLEPIFORMES
†Family: Haplolepididae

Order DORYPTERIFORMES
†Family: Dorypteridae

Order TARRASIIFORMES
†Family: Tarrasiidae

Order PTYCHOLEPIFORMES
†Family: Ptycholepididae

Order PHOLIDOPLEURIFORMES
†Family: Pholidopleuridae

Order LUGANOIIFORMES
†Family: Luganoiidae
†Family: Habroichthyidae
†Family: Thoracopteridae

Order REDFIELDIIFORMES
†Family: Redfieldiidae

Order PERLEIDIFORMES
†Family: Perleididae
†Family: Cleithrolepididae
†Family: Platysiagidae
†Family: Cephaloxenidae
†Family: Aetheodontidae

Order PELTOPLEURIFORMES
†Family: Peltopleuridae
†Family: Polzbergiidae

Order PHANERORHYNCHIFORMES
†Family: Phanerorhynchidae

Order SAURICHTHYIFORMES
†Family: Saurichthyidae

Order ACIPENSERIFORMES Sturgeons and Paddlefishes

Suborder Chondrosteoidei
†Family: Errolichthyidae
†Family: Chondrosteidae

Suborder Acipenseroidei (sturgeons)
Family: Acipenseridae (sturgeons)

Suborder Polyodontoidei (paddlefishes)
Family: Polyodontidae (paddlefishes)

SUBCLASS NEOPTERYGII — Neopterygians
DIVISION GINGLYMODI — Garpikes

Order LEPISOSTEIFORMES — Garpikes
Family: Lepisosteidae (gars)

DIVISION HALECOSTOMI

Order SEMIONOTIFORMES
†Family: Semionotidae

Order PYCNODONTIFORMES
†Family: Brembodontidae
†Family: Pycnodontidae

Order MACROSEMIIFORMES
†Family: Macrosemiidae
†Family: Uarbryichthyidae

SUBDIVISION HALECOMORPHI — Bowfins

Order AMIIFORMES — Bowfins
†Family: Parasemionotidae
†Family: Caturidae
Family: Amiidae (bowfins)
†Family: Tomognathidae

Order PACHYCORMIFORMES
†Family: Pachycormidae

Order ASPIDORHYNCHIFORMES
†Family: Aspidorhynchidae

SUBDIVISION TELEOSTEI — True Bony Fishes

Order PHOLIDOPHORIFORMES
†Family: Pholidophoridae
†Family: Ichthyokentemidae
†Family: Majokiidae
†Family: Ligulellidae
†Family: Pleuropholidae
†Family: Archaeomaenidae
†Family: Oligopleuridae

Order LEPTOLEPIFORMES
†Family: Leptolepididae

Order unnamed
†Family: Varasichthyidae

Order ICHTHYODECTIFORMES
†Family: Allothrissopidae
†Family: Ichthyodectidae
†Family: Saurodontidae
†Family: Thryptodontidae

Order unnamed
†Family: Tselfatiidae

INFRADIVISION OSTEOGLOSSOMORPHA — Bonytongues

Order OSTEOGLOSSIFORMES — Bonytongues
Suborder Osteoglossoidei
†Family: Singididae
Family: Osteoglossidae (bonytongues)
Family: Pantodontidae (butterflyfishes)
Suborder Notopteroidei (knifefishes and featherbacks)
†Family: Lycopteridae

Family: Hiodontidae (moon eyes)
Family: Notopteridae (knifefishes)

Suborder Mormyroidei (mormyrids)
Family: Mormyridae (elephantfishes)
•Family: Gymnarchidae

INFRADIVISION ELOPOMORPHA

Order ELOPIFORMES — Tarpons

Suborder unnamed
†Family: Anaethalionidae

Suborder Elopoidei
Family: Elopidae (tenpounders)
Family: Megalopidae (tarpons)

Suborder Albuloidei
†Family: Osmeroididae
Family: Pterothrissidae
Family: Albulidae (bonefishes)
†Family: Phyllodontidae (?)

Suborder Pachyrhizodontoidei
†Family: Crossognathidae
†Family: Pachyrhizodontidae
†Family: Notelopidae

Order NOTACANTHIFORMES — Spiny Eels and Halosaurid Eels

Family: Halosauridae (halosaurs)
Family: Notacanthidae (spiny eels)
•Family: Lipogenyidae
†Family: Protostomiatidae

Order ANGUILLIFORMES — Eels

†Family: Anguillavidae
Family: Anguillidae (true eels)
†Family: Paranguillidae
Family: Heterenchelyidae
•Family: Moringuidae (worm eels)
Family: Xenocongridae (false morays)

•Family: Myrocongridae
Family: Muraenidae (moray eels)
†Family: Proteomyridae
†Family: Anguilloididae
†Family: Milananguillidae
Family: Nemichthyidae (snipe eels)
•Family: Cyematidae
•Family: Synaphobranchidae (cutthroat eels)
•Family: Simenchelyidae (snubnose parasitic eels)
•Family: Dissomidae (mustard eels)
Family: Ophichthidae (snake eels)
•Family: Neenchelyidae
Family: Nettastomatidae (duckbilled eels)
•Family: Macrocephenchelyidae
Family: Congridae (congers)
Family: Muraenesocidae (pike eels)
•Family: Derichthyidae (longneck eels)
•Family: Nessorhamphidae
•Family: Serrivomeridae
†Family: Patavichthyidae
†Family: Urenchelyidae

Suborder Saccopharyngoidei (gulper eels)
•Family: Saccopharyngidae (swallowers)
•Family: Eupharyngidae (gulpers)
•Family: Monognathidae

INFRADIVISION CLUPEOMORPHA Herringlike Fishes

Order ELLIMMICHTHYIFORMES
†Family: Ellimmichthyidae

Order CLUPEIFORMES

Suborder Denticipitoidei
Family: Denticipitidae (denticle herrings)

Suborder Clupeoidei
Family: Clupeidae (herrings)
Family: Engraulididae (anchovies)
Family: Chirocentridae (wolf herrings)

INFRADIVISION EUTELEOSTEI Higher Teleosts

SUPERORDER OSTARIOPHYSI Carps and Catfishes

Order GONORHYNCHIFORMES

Suborder Chanoidei
Family: Chanidae (milkfishes)

Suborder Gonorhynchoidei
Family: Gonorhynchidae
†Family: Judeichthyidae

Suborder Knerioidei
•Family: Kneriidae
•Family: Phractolaemidae

Order CYPRINIFORMES Carps
Family: Cyprinidae (carps, tenches, minnows etc.)
•Family: Psilorhynchidae
•Family: Homalopteridae (torrentfishes)
Family: Cobitididae (loaches)
•Family: Gyrinocheilidae (algae eaters)
Family: Catostomidae (suckers)

Order CHARACIFORMES Characins
†Family: Clupavidae
•Family: Citharinidae (citharins)
Family: Hemiodontidae (hemiodids)
Family: Curimatidae (curimatas)
Family: Anastomidae (headstanders)
Family: Erythrinidae (trahiras)
•Family: Lebiasinidae (pencil fishes and pyrrhulinins)
•Family: Gasteropelecidae (freshwater hatchetfishes)
•Family: Ctenoluciidae (pike-characins)
•Family: Hepsetidae (Kafue pike)
Family: Characidae (true American characins)

Order SILURIFORMES Catfishes
•Family: Diplomystidae (diplomystid catfishes)
†Family: Hypsidoridae
Family: Ictaluridae (North American catfishes)
Family: Bagridae (bagrid catfishes)
•Family: Cranoglanididae (armorhead catfishes)
Family: Siluridae (Eurasian catfishes)
•Family: Schilbeidae (schilbeid catfishes)
Family: Pangasiidae (shark catfishes)
•Family: Amblycipitidae (Asiatic torrent catfishes)
•Family: Amphiliidae (African hillstream catfishes)
•Family: Akysidae (stream catfishes)
Family: Sisoridae (sisorid catfishes)
Family: Clariidae (airbreathing catfishes)
•Family: Heteropneustidae (airsac catfishes)
•Family: Chacidae (squarehead catfishes)
•Family: Olyridae (bannertail catfishes)
•Family: Malapteruridae (electric catfishes)
Family: Ariidae (sea catfishes)
Family: Plotosidae (catfish eels)
Family: Mochokidae (upside-down catfishes)
•Family: Doradidae (thorny catfishes)
•Family: Auchenipteridae (driftwood catfishes)
Family: Pimelodidae (antenna catfishes)
•Family: Ageneiosidae (barbel-less catfishes)
•Family: Helogenidae (marbled catfishes)
•Family: Cetopsidae (whale-like catfishes)
•Family: Hypophthalmidae (low-eyed catfishes)
•Family: Aspredinidae (banjo catfishes)
•Family: Trichomycteridae (parasitic catfishes)
Family: Callichthyidae (callichthyid armoured catf.)
•Family: Loricariidae (armoured catfishes)
•Family: Astroblepidae (S. American hillstream catf.)

Order GYMNOTIFORMES

Suborder Sternopygoidei
•Family: Sternopygidae
•Family: Rhamphichthyidae (knifefishes)
•Family: Hypopomidae
•Family: Apteronotidae (speckeled knifefishes)

Suborder Gymnotoidei
- •Family: Gymnotidae (knife eels)
- •Family: Electrophoridae (electric eels)

SUPERORDER PROTACANTHOPTERYGII

Order SALMONIFORMES

Suborder Esocoidei
- †Family: Palaeoesocidae e

Suborder Osmeroidei
- Family: Osmeridae (smelts)

Suborder Salmonoidei
- •Family: Salangidae (icefishes)
- •Family: Retropinnidae (New Zealand smelts)
- Family: Galaxiidae (galaxiids)
- Family: Salmonidae (salmonids)

SUPERORDER STENOPTERYGII

Order STOMIIFORMES

Suborder Gonostomatoidei
- Family: Gonostomatidae (bristlemouths)
- Family: Sternoptychidae (marine hatchetfishes)

Suborder Photichthyoidei
- Family: Photichthyidae
- •Family: Astronesthidae (snaggletooths)
- •Family: Melanostomiidae (scaleless black dragonfishes)
- •Family: Malacosteidae (loosejaws)
- •Family: Idiacanthidae (black dragonfishes)

SUPERORDER SCOPELOMORPHA

Order AULOPIFORMES

Suborder Enchodontoidei
- †Family: Enchodontidae
- †Family: Eurypholidae

Suborder Halecoidei
- †Family: Halecidae

Suborder Aulopoidei
- •Family: Aulopodidae (aulopus)
- •Family: Chlorophthalmidae (greeneyes)
- •Family: Scopelarchidae (pearleyes)
- •Family: Notosudidae

Suborder Alepisauroidei
- Family: Synodontidae (lizardfishes)
- •Family: Giganturidae (giganturids)
- Family: Paralepididae (barracudinas)
- •Family: Anotopteridae (daggertooth)
- •Family: Evermannellidae (sabretooth fishes)
- •Family: Omosudidae
- •Family: Alepisauridae (lancetfishes)
- •Family: Pseudotrichonotidae

Suborder Ichthyotringoidei
- †Family: Ichthyotringidae
- †Family: Cheirothricidae
- †Family: Dercetidae
- †Family: Cimolichthyidae
- †Family: Prionolepididae

Order MYCTOPHIFORMES
- †Family: Sardinoididae
- •Family: Neoscopelidae
- Family: Myctophidae (lanternfishes)

Order PATTERSONICHTHYIFORMES
- †Family: Pattersonichthyidae

Order CTENOTHRISSIFORMES
- †Family: Ctenothrissidae
- †Family: Aulolepidae

SUPERORDER PARACANTHOPTERYGII

- †Family: Mcconichthyidae

Order PERCOPSIFORMES

Suborder Sphenocephaloidei
- †Family: Sphenocephalidae

Suborder Percopsoidei
- Family: Percopsidae

Suborder Aphredoderoidei
- Family: Aphredoderidae (pirate perch)
- Family: Amblyopsidae (cavefishes)

Order GADIFORMES — Cods

Suborder Muraenolepidoidei
- •Family: Muraenolepididae (eel cods)

Suborder Gadoidei
- Family: Moridae (morid cod)
- •Family: Melanonidae (melanonids)
- Family: Bregmacerotidae (codlets)
- Family: Gadidae (cods)
- Family: Merlucciidae (merluccid hakes)

Suborder Macrouroidei
- Family: Macrouridae (grenadier fishes)

Order OPHIDIIFORMES
- Family: Ophidiidae (brotulas and cusk-eels)
- Family: Carapidae (carapids)

Order BATRACHOIDIFORMES
- Family: Batrachoididae (toadfishes)

Order LOPHIIFORMES — Anglerfishes

Suborder Lophioidei
- Family: Lophiidae (goosefishes)

Suborder Antennarioidei
- Family: Antennariidae (frogfishes)
- Family: Brachionichthyidae (warty anglers)
- •Family: Chaunacidae (sea toads)
- •Family: Ogcocephalidae (batfishes)

Suborder Ceratioidei
- •Family: Caulophrynidae
- •Family: Ceratiidae (sea devils)
- •Family: Gigantactinidae
- •Family: Neoceratiidae
- •Family: Linophrynidae
- •Family: Oneirodidae
- •Family: Thaumatichthyidae
- •Family: Centrophrynidae (deep-sea anglerfish)
- •Family: Diceratiidae
- •Family: Himantolophidae (footballfishes)
- •Family: Melanocetidae

SUPERORDER ACANTHOPTERYGII
SERIES ATHERINOMORPHA

Order CYPRINODONTIFORMES

Suborder Exocoetoidei
- Family: Exocoetidae (flying fishes)
- Family: Hemirhamphidae (halfbeaks)
- Family: Belonidae (needlefishes)
- Family: Scomberosocidae (sauries)
- †Family: Forficidae

Suborder Adrianichthyoidei
- Family: Adrianichthyidae (adrianichthyids)

Suborder Cyprinodontoidei
- •Family: Aplocheilidae (rivulines)
- Family: Cyprinodontidae (killifishes)

Family: Goodeidae (goodeids)
•Family: Anablepidae (four-eyed fishes)
•Family: Poeciliidae (livebearers)

Order ATHERINIFORMES
Family: Atherinidae (silversides)
•Family: Isonidae (surf sardines)
•Family: Melanotaeniidae (rainbowfishes)
•Family: Phallostethidae

SERIES PERCOMORPHA Perches

Order LAMPRIDIFORMES
Suborder Lampridoidei
Family: Lampridae (opah)
†Family: Turkmenidae
Suborder Veliferoidei
Family: Veliferidae
Suborder Trachipteroidei
Family: Lophotidae (crestfishes)
•Family: Trachipteridae (ribbonfishes)
•Family: Regalecidae (oarfishes)
Suborder Stylephoroidei
•Family: Stylephoridae (tube-eye)
Suborder Ateleopodoidei
•Family: Ateleopodidae
Suborder Mirapinnatoidei
•Family: Mirapinnidae (hairyfish)
•Family: Eutaeniophoridae (tapetails)
Suborder Megalomycteroidei
•Family: Megalomycteridae (largenose fishes)

Order BERYCIFORMES
Suborder Berycoidei
Family: Monocentrididae (pinecone fishes)
Family: Trachichthyidae (slimeheads)

•Family: Anomalopidae (lanterneye fishes)
•Family: Diretmidae (spinyfins)
•Family: Anoplogastridae (fangtooth)
Family: Berycidae (alfonsinos)
Family: Holocentridae (squirrelfishes)
Suborder Dinopterygoidei
†Family: Dinopterygidae
†Family: Aipichthyidae
†Family: Pycnosteroididae
†Family: Stichocentridae
†Family: Digoriidae
Suborder Polymixoidei
Family: Polymixiidae (beardfishes)
Suborder Stephanoberycoidei
•Family: Stephanoberycidae (pricklefishes)
Family: Melamphaidae (bigscale fishes)
•Family: Gibberichthyidae (gibberfish)
Suborder Araripichthoidei
†Family: Araripichthyidae

Order ZEIFORMES
•Family: Parazenidae (parazen)
•Family: Macrurocyttidae
Family: Zeidae (dories)
•Family: Oreosomatidae (oreos)
•Family: Grammicolepididae (grammicolepids)
Family: Caproidae (boarfishes)

Order GASTEROSTEIFORMES
•Family: Hypoptychidae (sand eels)
Family: Aulorhynchidae (tubesnouts)
Family: Gasterosteidae (sticklebacks)

Order INDOSTOMIFORMES
•Family: Indostomidae

Order PEGASIFORMES
Family: Pegasidae (seamoths)

Order SYNGNATHIFORMES

Suborder Aulostomoidei
Family: Aulostomidae (trumpetfishes)
†Family: Urosphenidae
Family: Fistulariidae (cornetfishes)
†Family: Parasynarcualidae
Family: Macrorhamphosidae (snipefishes)
Family: Centriscidae (shrimpfishes)
†Family: Paraeoliscidae

Suborder Syngnathoidei
Family: Solenostomidae (ghost pipefishes)
Family: Syngnathidae (pipefishes and seahorses)

Order DACTYLOPTERIFORMES
Family: Dactylopteridae (flying gurnards)

Order SYNBRANCHIFORMES
•Family: Synbranchidae (swamp-eels)

Order SCORPAENIFORMES

Suborder Scorpaenoidei
Family: Scorpaenidae (scorpionfishes)
•Family: Synanceiidae (synancejidae)
†Family: Pterygocephalidae
†Family: Rhamphosidae
•Family: Caracanthidae (orbicular velvetfishes)
•Family: Aploactinidae (velvetfishes)
•Family: Pataecidae
•Family: Congiopodidae (racehorses)
Family: Triglidae (searobins)

Suborder Platycephaloidei
Family: Platycephalidae (flatheads)
•Family: Hoplichthyidae (ghost flatheads)

Suborder Anoplopomatoidei
•Family: Anoplopomatidae (sablefishes)

Suborder Hexagrammoidei
Family: Hexagrammidae (greenlings)
•Family: Zaniolepididae (combfishes)

Suborder Cottoidei
•Family: Normanichthyidae
•Family: Ereuniidae
Family: Cottidae (sculpins)
•Family: Cottocomephoridae
•Family: Comephoridae (Baikal oilfishes)
•Family: Psychrolutidae
•Family: Agonidae (poachers)
Family: Cyclopteridae (lumpfishes and snailfishes)

Order PERCIFORMES

Suborder Percoidei
Family: Centropomidae (snooks)
Family: Percichthyidae (temperate basses)
Family: Serranidae (sea basses)
•Family: Grammistidae (soapfishes)
•Family: Pseudochromidae (dottybacks)
•Family: Grammidae (basslets)
•Family: Plesiopidae (roundheads)
•Family: Anisochromidae
•Family: Acanthoclinidae
•Family: Glaucosomatidae
•Family: Teraponidae (tigerperches)
•Family: Banjosidae
•Family: Kuhliidae (aholeholes)
Family: Centrarchidae (sunfishes)
Family: Percidae (perches)
Family: Priacanthidae (bigeyes)
Family: Apogonidae (cardinalfishes)
Family: Acropomatidae
Family: Sillaginidae (smelt-whitings)
Family: Malacanthidae
•Family: Labracoglossidae
Family: Lactariidae (false trevallies)
Family: Pomatomidae (bluefishes)
•Family: Rachycentridae (cobia)

Family: Echeneididae (remoras)
Family: Carangidae (jacks and pompanos)
•Family: Nematistiidae
•Family: Coryphaenidae (dolphins)
•Family: Apolectidae
Family: Menidae (moonfish)
Family: Leiognathidae (slimys, slipmouths or ponyfishes)
Family: Bramidae (pomfrets)
Family: Caristiidae (manefishes)
•Family: Arripidae (Australian salmon)
•Family: Emmelichthyidae (bonnetmouths)
Family: Lutjanidae (snappers)
•Family: Caesionidae
Family: Lobotidae (tripletails)
•Family: Gerreidae (mojarras)
Family: Haemulidae (grunts)
•Family: Inermiidae
Family: Sparidae (porgies)
•Family: Lethrinidae (scavengers or emperors)
•Family: Nemipteridae (threadfin breams)
Family: Sciaenidae (drums)
Family: Mullidae (goatfishes)
Family: Monodactylidae (fingerfishes)
•Family: Pempheridae (sweepers)
•Family: Leptobramidae (beachsalmon)
•Family: Bathyclupeidae
Family: Toxotidae (archerfishes)
•Family: Coracinidae (galjoen fishes)
•Family: Kyphosidae (sea chubs)
†Family: Amphistiidae
Family: Ephippidae (spadefishes)
Family: Platacidae
Family: Scatophagidae (scats)
•Family: Rhinoprenidae (threadfin scat)
Family: Chaetodontidae (butterflyfishes)
•Family: Pomacanthidae (angelfishes)
Family: Enoplosidae
•Family: Pentacerotidae (armourheads)
•Family: Nandidae (leaffishes)

Family: Oplegnathidae (knifejaws)
Family: Cichlidae (cichlids)
Family: Embiotocidae (surfperches)
Family: Pomacentridae (damselfishes)
†Family: Priscacaridae
•Family: Gadopsidae (blackfish)
•Family: Cirrhitidae (hawkfishes)
•Family: Chironemidae (kelpfishes)
•Family: Aplodactylidae
•Family: Cheilodactylidae (morwongs)
•Family: Latrididae (trumpeters)
Family: Owstoniidae
Family: Cepolidae (bandfishes)
Family: Dipterichthyidae (Twowingbasses)

†Family: Arambourgellidae

Suborder Mugiloidei
Family: Mugilidae (mullets)

Suborder Sphyraenoidei
Family: Sphyraenidae (barracudas)

Suborder Polynemoidei
Family: Polynemidae (threadfins)

Suborder Labroidei
Family: Labridae (wrasses)
•Family: Odacidae
Family: Scaridae (parrotfishes)

Suborder Zoarcoidei
•Family: Bathymasteridae (ronquils)
•Family: Zoarcidae (eelpouts)
Family: Stichaeidae (pricklebacks)
•Family: Cryptacanthodidae (wrymouths)
Family: Pholididae (gunnels)
Family: Anarhichadidae (wolffishes)
•Family: Ptilichthyidae (quillfish)
Family: Zaporidae (prowfish)
•Family: Scytalinidae (graveldiver)

Suborder Notothenoidei
- •Family: Bovichthyidae
- Family: Nototheniidae (cod icefishes)
- •Family: Harpagiferidae (plunderfish)
- •Family: Bathydraconidae (Antartic dragonfishes)
- •Family: Channichthyidae (crocodile icefishes)

Suborder Trachinoidei
- •Family: Opisthognathidae (jawfishes)
- •Family: Congrogadidae (eelblennies)
- Family: Chiasmodontidae
- •Family: Chamsodontidae
- •Family: Notograptidae
- •Family: Pholidichthyidae
- •Family: Trichodontidae(sandfishes)
- Family: Trachinidae (weeverfishes)
- •Family: Uranoscopidae (stargazers)
- •Family: Trichonotidae (sandfishes)
- •Family: Creediidae
- •Family: Leptoscopidae
- •Family: Percophidae
- Family: Mugiloididae (sandperches)
- •Family: Cheimarrhichthyidae

Suborder Blennioidei
- Family: Tripterygiidae (threefin blennies)
- •Family: Dactyloscopidae (sand stargazers)
- Family: Labrisomidae
- Family: Clinidae (clinids)
- •Family: Chaenopsidae
- Family: Blenniidae (combtooth blennies)

Suborder Icosteoidei
- •Family: Schindleriidae

Suborder Ammodytoidei
- Family: Ammodytidae (sand lances)

Suborder Callionymoidei
- Family: Callionymidae (dragonets)
- •Family: Draconettidae (dragonets)

Suborder Gobiesocoidei
- Family: Gobiesosocidae (clingfishes)

Suborder Gobioidei
- •Family: Rhyacichthyidae (loach gobies)
- •Family: Eleotrididae (sleepers)
- Family: Gobiidae (gobies)
- •Family: Gobioididae (eellike gobies)
- •Family: Tripauchenidae (burrowing gobies)
- •Family: Kraemeriidae (sand gobies)
- •Family: Microdesmidae (wormfishes)

Suborder Kurtoidei
- •Family: Kurtidae (nurseryfishes)

Suborder Acanthuroidei
- Family: Acanthuridae* (surgeonfishes)
- †Family: Caprovesposidae
- Family: Siganidae (rabbitfishes)
- †Family: Kushlukiidae

Suborder Scombroidei
- •Family: Scombrolabracidae
- Family: Gempylidae (snake mackerels)
- Family: Trichiuridae (cutlassfishes)
- Family: Scombridae (mackerels and tunas)
- Family: Xiphiidae (swordfish)
- •Family: Luvariidae (louvar)
- Family: Istiophoridae (billfishes)
- †Family: Palaeorhynchidae

Suborder Stromateoidei
- •Family: Amarsipidae
- •Family: Centrolophidae (medusafishes)
- Family: Nomeidae (driftfishes)
- •Family: Ariommatidae (amiommids)
- Family: Tetragonuridae (squaretails)
- Family: Stromateidae (butterfishes)

Suborder Anabantoidei
- Family: Anabantidae (climbing gouramies)
- •Family: Belontiidae (gouramies)
- •Family: Helostomatidae (kissing gourami)
- Family: Osphronemidae (giant gourami)

on places Zanclus in this family.

Suborder Luciocephaloidei
- •Family: Luciocephalidae (pikehead)

Suborder Channoidei
- Family: Channidae (snakeheads)

Suborder Mastacembeloidei
- •Family: Mastacembelidae (spiny eels)
- •Family: Chaudhuriidae

Order PLEURONECTIFORMES

Suborder Psettodoidei
- Family: Psettodidae (psettotids)

Suborder Pleuronectoidei
- Family: Citharidae (citharids)
- Family: Bothidae (lefteye flounders)
- Family: Pleuronectidae (righteye flounders)

Suborder Soleoidei
- Family: Cynoglossidae (tonguefishes)
- Family: Soleidae (soles)

Order TETRAODONTIFORMES

Suborder Balistoidei
- Family: Aracanidae
- Family: Triacanthodidae (spikefishes)
- Family: Triacanthidae (triplespines)
- Family: Balistidae (triggerfishes and filefishes)
- Family: Ostraciidae (boxfishes)

Suborder Tetraodontoidei
- •Family: Triodontidae (three-toothed puffer)
- Family: Tetraodontidae (puffers)
- Family: Diodontidae (porcupinefishes)
- Family: Molidae (molas)

SUBCLASS: SARCOPTERYGII — Sarcopterygians
INFRACLASS: CROSSOPTERYGII — Lobe-Finnned Fishes

Order COELACANTHIFORMES (Actinistia) — Coelacanths
- †Family: Diplocercidae
- †Family: Hadronectoridae
- †Family: Rhabdodermatidae
- †Family: Coelacanthidae
- †Family: Laugiidae
- •Family: Latimeriidae (gombessa)

Order ONYCHODONTIFORMES
- †Family: Onychodontidae

Order RHIPIDISTIIFORMES — (Rhipidistians)
- Superfamily: Holoptychoidea
  - †Family: Powichthyidae
  - †Family: Porolepididae
  - †Family: Holoptychidae
- Superfamily: Osteolepidoidea
  - †Family: Osteolepididae
  - †Family: Eusthenopteridae
  - †Family: Panderichthyidae
  - †Family: Rhizodontidae

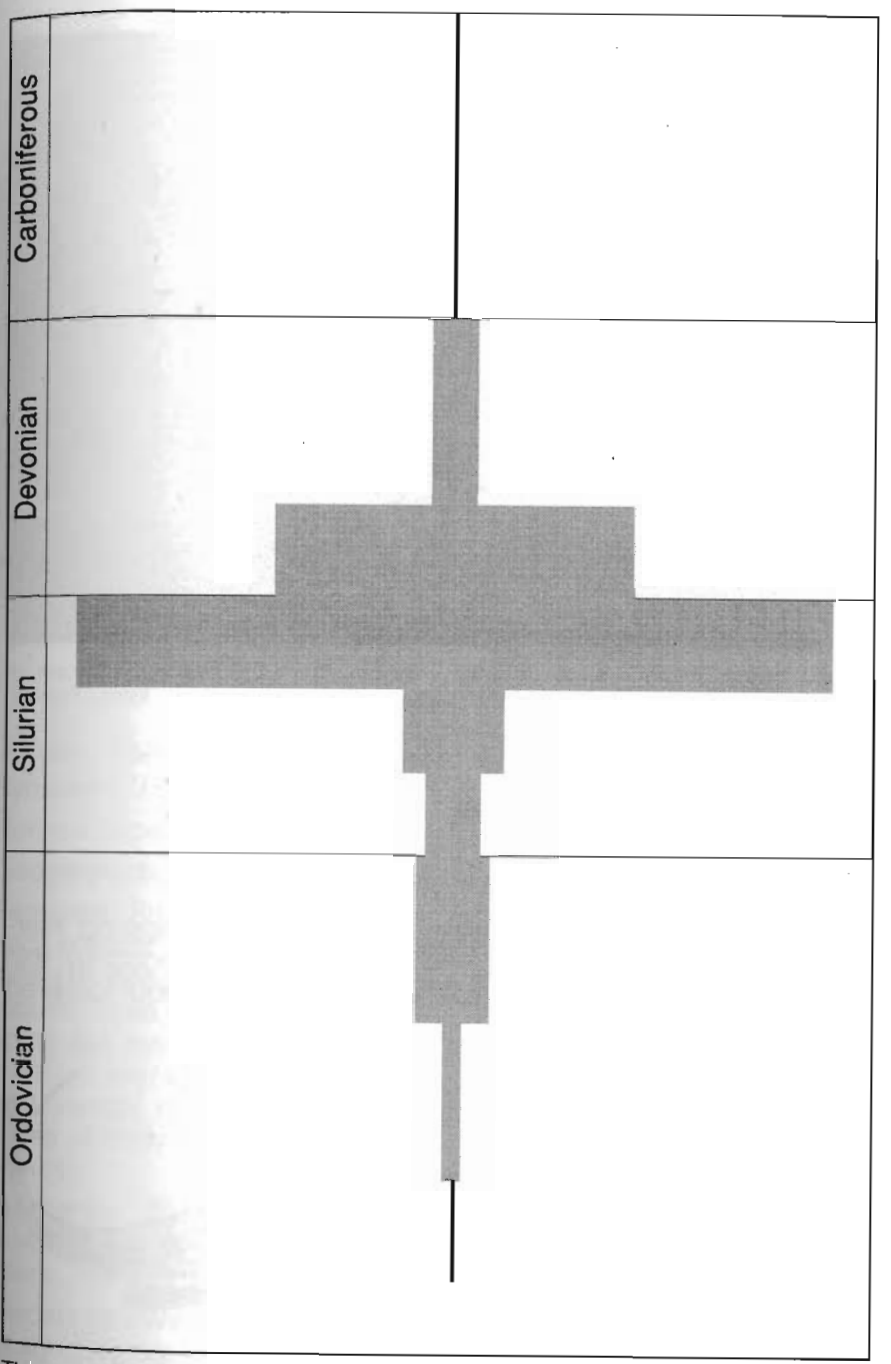
INFRACLASS: DIPNOI — Lungfishes
- †Family: Uranolophidae
- †Family: Dipnorhynchidae
- †Family: Dipteridae
- †Family: Rhynchodipteridae
- †Family: Phaneropleuridae
- †Family: Ctenodontidae
- †Family: Sagenodontidae
- †Family: Uronemidae
- †Family: Conchopomidae
- Family: Ceratodontidae (Australian lungfishes)
- Family: Lepidosirenidae (South American lungfishes)
- Family: Protopteridae (African lungfishes)

The first fish-like organisms to appear on earth were not much like our present concept of a typical fish. Most of them had a dorso-ventrally flattened body indicating a bottom-dwelling mode of life. They were probably weak swimmers. Their main common feature, from the evolutionary point of view, was the jawless mouth. They could not bite and therefore would not have been able to hunt for large swimming prey. Their circular mouths would allow them only to suck, or perhaps to rasp, so they would have fed mainly on small organisms and detritus. Their heads, and also the anterior parts of their bodies, were covered with thick bony armour which would have made an effective defence against enemies. Their eyes and nasal opening often lay close together and were directed upwards. The total size was usually small, though there were exceptions which reached a length of 60 cm or more.

Paired fins were usually developed only as pectorals. There are forms with one, or even two, dorsal fins while others lacked dorsal fins completely. The anal fin was sometimes present whereas the existence of pelvic fins is doubtful. The caudal fin was mostly heterocercal or hypocercal. The notochord (the evolutionary forerunner of the vertebral column) persisted throughout life. The order Anaspidiformes included some genera which looked truly fish-like. Instead of armour, they often had thick scales. A few of them had lost the scaly cover except for a few remnants. To judge by their shape, most members of this order would have been rather skillful swimmers in the open water.

Finally I must mention the hagfishes and lampreys which, except for the circular jawless mouth, were unlike other agnathans. They are known from the Upper Carboniferous onwards and still survive. They have scaleless eel-like bodies. They may represent a side branch which has survived from early times.

The **AGNATHA** first appeared in the Lower Ordovician, had their greatest maximum in the Upper Silurian and died out in the Upper Devonian except for the hagfishes and lampreys. About 200 fossil genera have been described, though most of them on the basis of isolated head shields and dorsal shields only. Complete agnathans are extremely rare.



The approximate distribution of the agnathans in geological time, changed after MÜLLER



Sacabambaspis janvieri GAGNIER (length c. 35 cm), from the Upper Ordovician of Sacabamba, Bolivia. Original: Muséum National d'Histoire Naturelle, Paris, France. Photo: Serette, Paris.

Genus: *Sacabambaspis* GAGNIER, 1986.

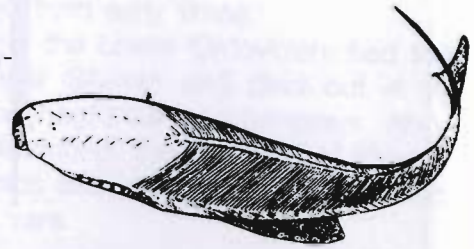
Horizon: Upper Ordovician.

Geographical distribution: South America.

Features: Large agnathans, wide at the front and tapering rearwards. The head and part of the trunk were surrounded by thin relatively primitive armour. The body behind the armour covered with rod-like sculptured scales in a diagonal arrangement. Maximum length up to 35 cm.

Remarks: Probably bottom-dwelling.

Recent relatives: None. Died out in the Ordovician.



Sacabambaspis, reconstruction after GAGNIER.



Anglaspis insignis KIAER & HEINTZ (length c. 5 cm) from the Lower Devonian of Spitzbergen. Original: Paleontologisk Museum, Oslo, Norway.

Genus: *Anglaspis* JAEKEL.

Synonym: *Fraenkelaspis*.

Horizon: Lower Devonian.

Geographical distribution: Europe, Spitzbergen.

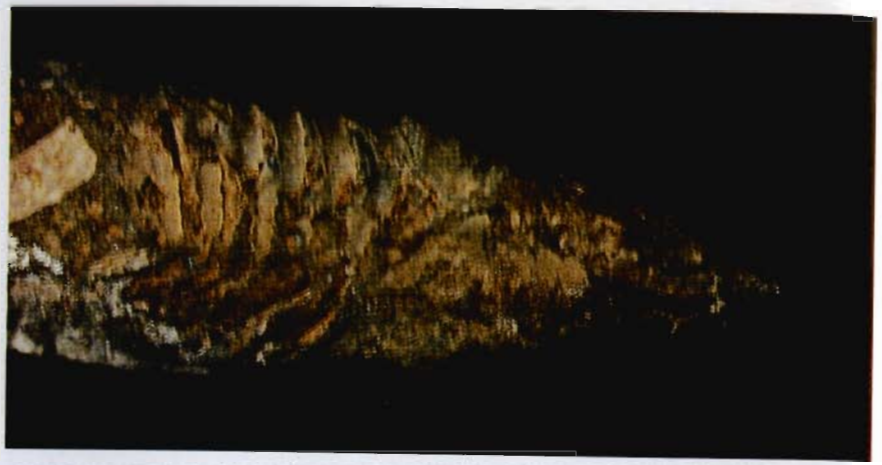
Features: Small agnathans, approximately torpedo-shaped. Head and anterior part of back enclosed in armour. Dorsal armour extends forward into small pointed rostrum which overhangs the mouth. Eyes lateral. No dorsal spine but overlapping rearward-pointing elements in the dorsal and ventral mid-lines of trunk. Sides of body covered with long plates.

Remarks: Probably bottom-dwelling and very weak swimmers.

Recent relatives: None. Died out in the Silurian.



Anglaspis, reconstruction after HEINTZ.



Irregulareaspis hoeli KIAER (length c. 6 cm) from the Lower Devonian of Spitzbergen. Original: Paleontologisk Museum, Oslo, Norway.

Genus: *Irregulareaspis* ZYCH, 1931.

Synonyms: *Dyctiaspidella*, *Dyctaspis*.

Horizon: Lower Devonian.

Geographical distribution: Europe, Spitzbergen.

Features: Middle-sized agnathans. Head and anterior part of the trunk enclosed in brief armour. Snout pointed. Mouth slightly ventral. Posterior part of trunk and rest of body heavily scaled. Scales large and elongate anteriorly but becoming smaller posteriorly. Caudal fin not subdivided. Eyes rather ventral. Maximum length c. 12 cm.

Remarks: Probably free-swimming.

Recent relatives: None. Died out in the Lower Devonian.



Irregulareaspis, reconstruction after BENDIX-ALMGREN.



Pionaspis sp. (length c. 17 cm) from the Lower Devonian of Grizzly Bear Lake, Alberta, Canada. Original: University of Alberta, Edmonton, Alberta, Canada.

Genus: *Pionaspis* STADELMANN, 1897.

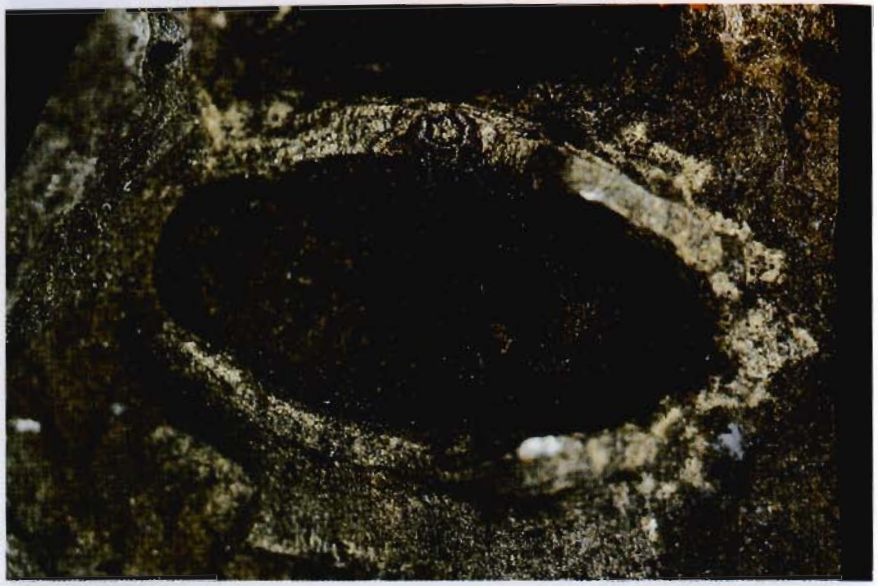
Horizon: Lower Devonian.

Geographical distribution: North America.

Features: Head and trunk enclosed above and beneath in armour. Plates elongate, oval and sculptured with little points. Eyes lateral. Mouth terminal or slightly ventral. Body behind armour covered with scales which are elongate anteriorly but become smaller posteriorly. Caudal fin hypocercal i.e. lower lobe larger than upper. Middle-sized agnathans. Maximum length c. 20 cm.

Remarks: Partly bottom-dwelling, partly free-swimming.

Recent relatives: None. Died out in the Lower Devonian.



Poraspis cylindrica KIAER & HEINTZ (length 4.5 cm) from the Lower Devonian of Bennevis, Spitzbergen. Original: Paleontologisk Museum, Oslo, Norway.

Genus: *Poraspis* KIAER, 1930.

Synonym: *Holaspis*.

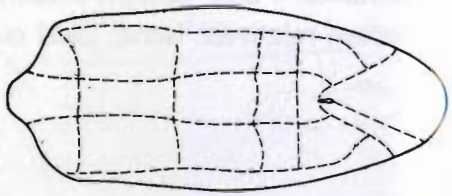
Horizon: Lower Devonian.

Geographical distribution: Europe, Spitzbergen, northern North America.

Features: Head and part of trunk enclosed in rather brief armour. Plates of armour sculptured with regularly arranged lines directed outwards to right and left. Behind the armour, lateral scales of body long and large. Dorsal and ventral mid lines of body bearing much smaller keel scales. Eyes lateral. Mouth somewhat ventral. Dorsal armour of head shield undivided.

Remarks: Probably more free-swimming than bottom-dwelling.

Recent relatives: None. Died out in the Lower Devonian.



Poraspis, reconstruction after BLIECK



Torpedaspis elongata BROAD & DINELEY (length c. 20 cm) from the Lower Devonian of Prince of Wales Island, Northwest Territories, Canada. Original: National Museum of Natural Sciences, Ottawa, Ontario, Canada.

Genus: *Torpedaspis* BROAD & DINELEY, 1973.

Horizon: Upper Silurian to Lower Devonian.

Geographical distribution: Northern North America.

Features: Head and trunk enclosed in unusually long narrow skeleton of armour. Scaly part of body considerably shorter than armoured part. Maximum length c. 25 cm.

Recent relatives: None. Died out in Lower Devonian.



Torpedaspis, reconstruction after DINELEY.



Athenaegis chattertoni SOEHN & WILSON (length c. 5 cm) from the Silurian of Avalanche Lake, Canada. Original: University of Alberta, Edmonton, Alberta, Canada.

Genus: *Atenaegis* SOEHN & WILSON, 1990.

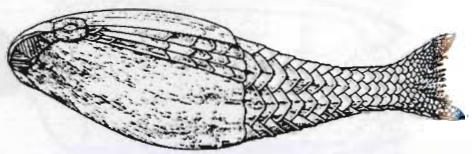
Horizon: Silurian.

Geographical distribution: North America.

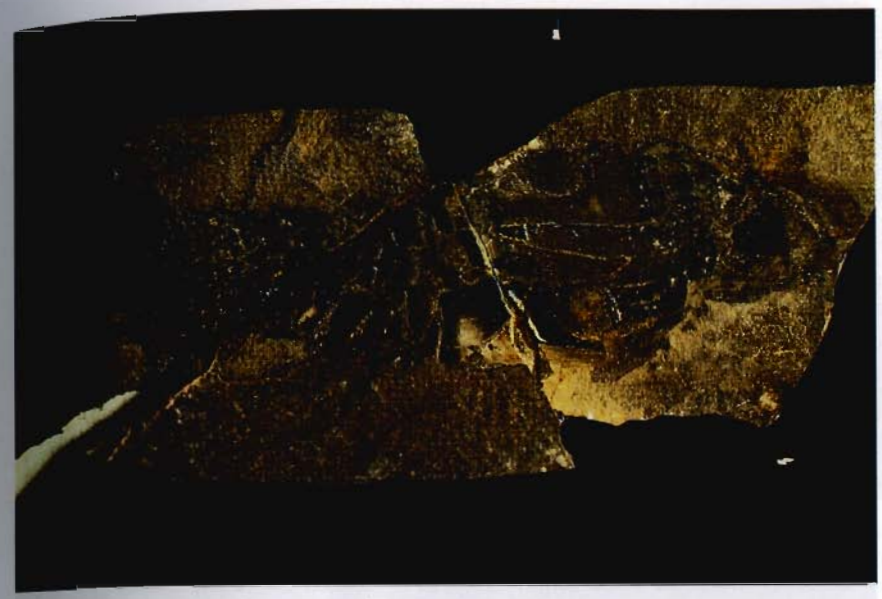
Features: Little agnathans. Head and trunk rather wide with armour above and beneath. Plates sculptured with elongate ridges. Eyes somewhat dorsal. Mouth terminal to ventral. Scales decreasing in size rearwards. Caudal fin divided, hypocercal. Maximum c. 6 cm.

Remarks: Probably bottom-dwelling.

Recent relatives: None. Died out in Silurian.



Athenaegis, reconstruction after SOEHN & WILSON.



Vernonaspis sp. (length c. 10 cm) from the Upper Silurian of Cornwallis Island, Northwest Territories, Canada. Original: Thorsteinsson Collection, Calgary, Alberta, Canada.

Genus: *Vernonaspis* FLOWER & WAYLAND-SMITH, 1952.

Synonyms: *Anatiftopsis*, *Eoarchegonaspis*.

Horizon: Upper Silurian to Lower Devonian.

Geographical distribution: Northern North America.

Features: Little agnathans. Head and trunk armoured above and below. Armour finely sculptured with a pattern of lines. Body behind armour covered with scales which become appreciably smaller posteriorly. Eyes lateral. Mouth terminal to ventral. Maximum length scarcely more than 10 cm.

Remarks: Probably partly bottom-dwelling, partly free-swimming.

Recent relatives: None. Died out in Lower Devonian.



Empedaspis inermis Novitskaya (length c. 7 cm) from the Lower Devonian of the Taimir Peninsula, Siberia, Russia. Original: Paleontologicheskii Muzei Russkoi Akademii Nauk, Moscow, Russia (Novitskaya Collection).

Genus: *Empedaspis* Novitskaya

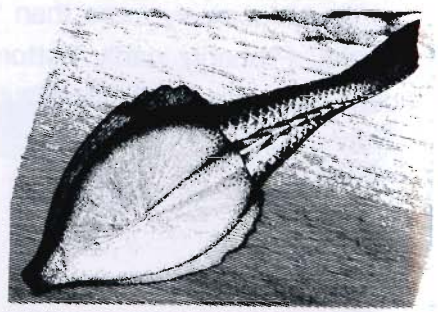
Horizon: Lower Devonian.

Geographical distribution: Northern Asia.

Remarks: Middle-sized agnathans with greatly enlarged head. The shield enclosing the whole head and the anterior part of the back is oval in outline, flattened posteriorly and with a rounded keel in the posterior mid line. Anteriorly it tapers to an almost quadrangular "nose". Here, close together, are the small eyes and also the ventral mouth.

Remarks: Probably bottom-dwellers and almost unable to swim.

Recent relatives: None. Died out in the Lower Devonian.



Empedaspis, reconstruction after Novitskaya.



Canadapteraspis sp. (length c. 6 cm) from the Lower Devonian of Prince of Wales Island, Northwest Territories, Canada. Original: Thorsteinsson Collection, Calgary, Alberta, Canada.

Genus: *Canadapteraspis* Dineley & Loeffler, 1976.

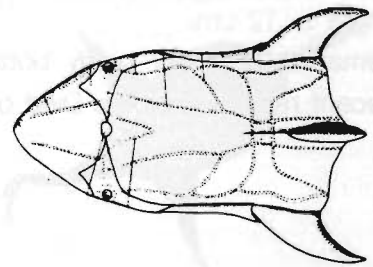
Horizon: Lower Devonian.

Geographical distribution: Northern North America.

Features: Middle-sized agnathans. Head and trunk armoured above and below. Snout region long and pointed. Dorsal armour with a strong, broad, posteriorly projecting spine in the dorsal mid line. Cornual plates paired, drawn into a point posteriorly. Eyes lateral. Mouth terminal to slightly ventral. Maximum size c. 12 cm.

Remarks: Partly bottom-dwelling, partly free-swimming.

Recent relatives: None. Died out in the Lower Devonian.



Canadapteraspis, reconstruction after Dineley & Loeffler.



Trygonaspis sp. (length c. 5 cm) from the Lower Devonian of Prince of Wales Island, Northwest Territories, Canada. Original: Thorsteinsson Collection, Calgary, Alberta, Canada.

Genus: *Trygonaspis* THORSTEINSSON

Horizon: Lower Devonian.

Geographical distribution: Northern North America.

Features: Middle-sized agnathans. Head and trunk armoured above and below, ventrally flattened. Armour ornamented with worm-like ridges with punctae between them. The dorsal armour with a rearward pointing spine in the mid line posteriorly. The paired cornual plates are expanded almost like fins and each ends in a point. Snout region pointed. Eyes lateral. Mouth ventral. maximum length c. 12 cm.

Remarks: Probably partly bottom-dwelling, partly free-swimming.

Recent relatives: None. Died out in the Lower Devonian.



Doryaspis nathorsti (LANKESTER) (length c. 15 cm) from the Lower Devonian of Lytka, Spitzbergen. Original: Paleontologisk Museum, Oslo, Norway.

Genus: *Doryaspis* WHITE, 1935.

Synonyms: *Lyktaspis*, *Scaphaspis*.

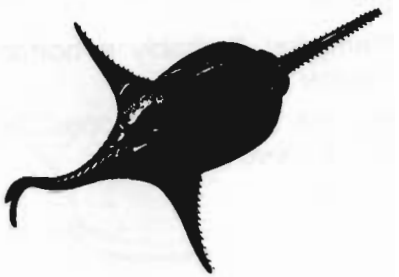
Horizon: Lower Devonian.

Geographical distribution: Spitzbergen.

Features: Head and anterior part of trunk enclosed in thick armour. The dorsal and ventral plates are the largest elements of the upper and lower sides. Armour with dentine ridges. The paired cornual plates at the posterior end of the armour stick out sideways and extend as spines. The snout part of the armour projects as a long rostrum. Beneath and behind it is the wide mouth. Proximal to the rostrum are the paired nasal openings. Maximum length up to 20 cm.

Remarks: Probably bottom-dwellers but certainly also in part free-swimming. The significance of the extended rostrum is unclear.

Recent relatives: None. Died out in the Lower Devonian.



Doryaspis, reconstruction after MACMILLAN.



Larnovaspis goujeti Blieck (length c. 10 cm) from the Lower Devonian of Spitzbergen. Original: Muséum National d'Histoire Naturelle, Paris, France. Photograph: Serette, Paris.

Genus: *Larnovaspis* Blieck, 1984.

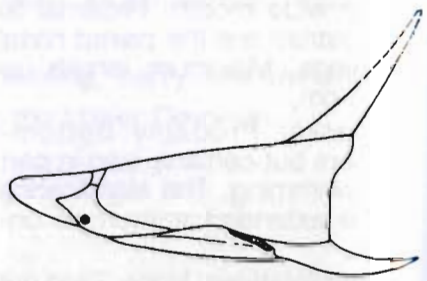
Horizon: Lower Devonian.

Geographical distribution: Europe, Spitzbergen.

Features: Middle-sized agnathans, probably with a spindle-shaped body. Head and anterior part of trunk enclosed above and below in thick armour. Eyes small. Snout broad at the base but extending into a pointed rostrum, beneath and behind which was the mouth. Total length perhaps 20 cm.

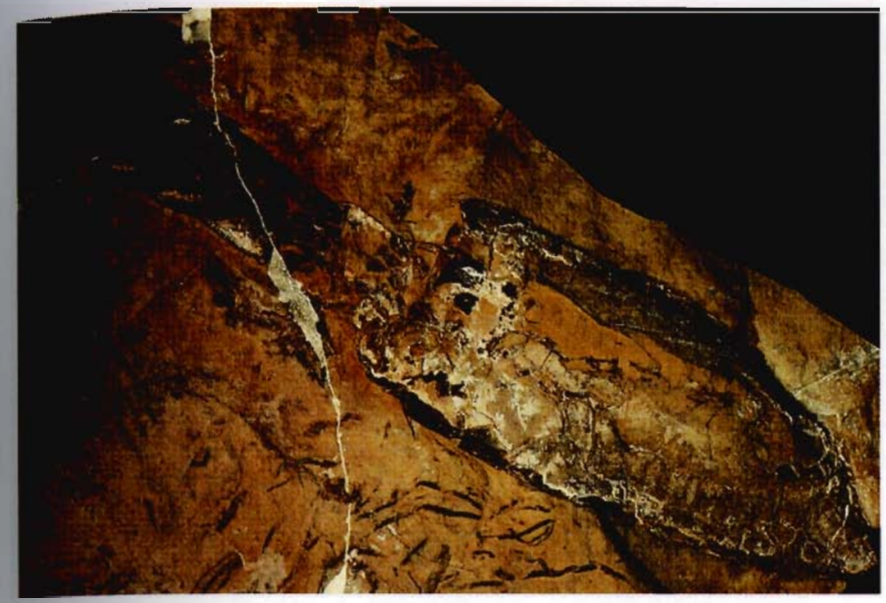
Remarks: Probably a bottom-dweller.

Recent relatives: None. Died out in Devonian.



Larnovaspis, reconstruction after Blieck.

AGNATHA
Order: Pteraspidiformes
Family: Pteraspididae
Jawless Fishes



Protaspis transversa Denison (length c. 26 cm) from the Lower Devonian of Big Horn County, Wyoming, U.S.A. Original: Field Museum of Natural History, Chicago, Illinois, U.S.A.

Genus: *Protaspis* Bryant, 1933.

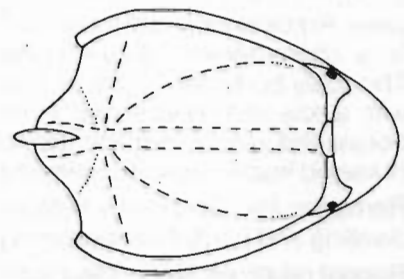
Horizon: Upper Silurian to Lower Devonian.

Geographical Distribution: Northern North America, Europe, Spitzbergen.

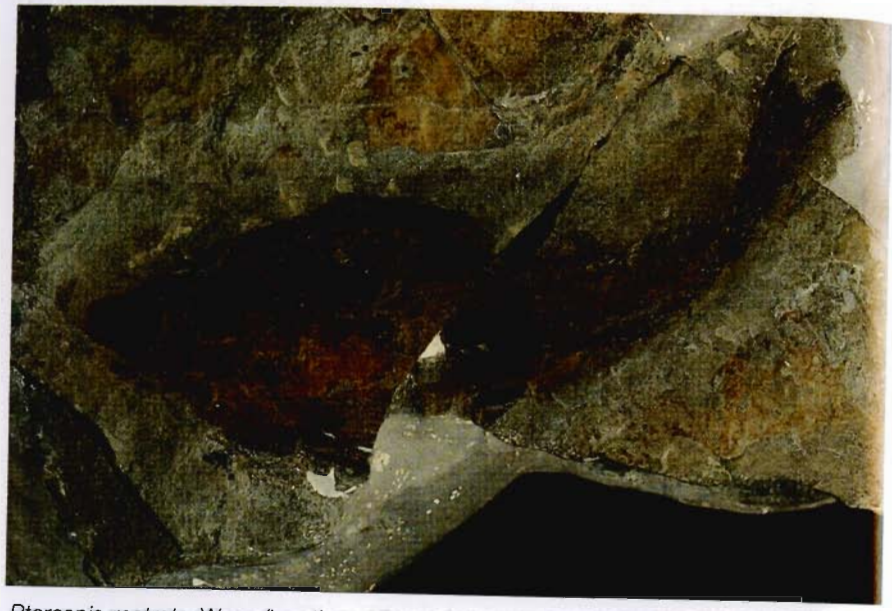
Features: Elongate agnathans. Narrow flat armour above and below. The central plate, both dorsally and ventrally, is slender and surrounded by mosaic-like smaller plates. Snout region extends into a small rostrum. Relatively long scaly body behind the armour. Tail fin hypocercal. Maximum length about 30 cm.

Remarks: Probably partly bottom-dwelling and partly free-swimming.

Recent relatives: None. Died out in the Lower Devonian.



Protaspis, reconstruction after Blieck.



Pteraspis rostrata WHITE (length c. 15 cm) from the Lower Devonian of Hereforeshire, England. Original: The Natural History Museum, London, U.K. (P16789).

Genus: *Pteraspis* KNER, 1847.

Synonyms: *Archaeoteuthis*, *Brachipteraspis*, *Lerichaspis*, *Palaeoteuthis*, *Parapteraspis*, *Plesiopteraspis*, *Pseudopteraspis*, *Simopteraspis*.

Horizon: Lower Devonian.

Geographical distribution: Western and eastern Europe, Spitzbergen, northern Asia, North America.

Features: Relatively slender, elongate agnathans. Head and trunk enclosed above and below in thick armour. The dorsal and ventral plates very large, forming almost all the dorsal and ventral armour respectively. Snout ends in a short rostrum directed slightly upwards and broad at the base. At posterior end of the armour is a characteristic dorsal spine. The scaly body behind the armour with a row of keeled scales in the dorsal and ventral mid line. Points of keeled scales directed rearward.

Remarks: Probably partly bottom-dwelling and partly free-swimming.

Recent relatives: None. Died out in the Lower Devonian.



Pteraspis, reconstruction after MACMILLAN.



Rhinopteraspis dunensis (ROEMER) (length c. 23 cm) from the Lower Devonian of Odenspiel, Rhineland, Germany. Original: Collection Brühn, Essen, Germany

Genus: *Rhinopteraspis* JAEKEL, 1919.

Synonym: *Belgicaspis*.

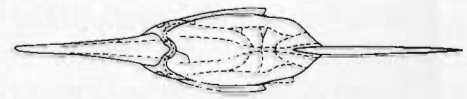
Horizon: Lower Devonian.

Geographical distribution: Western and Eastern Europe.

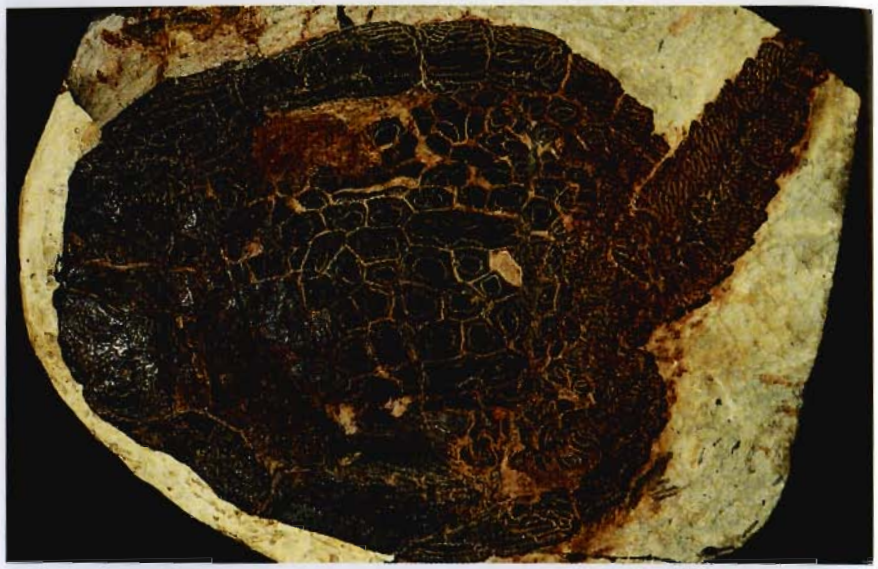
Features: Head and trunk enclosed above and below in thick armour. Snout extends into rostrum longer than the armour. Scaly body ends in a hypocercal caudal fin. Length, including rostrum, more than 30 cm.

Remarks: Probably bottom-dwelling and free-swimming. Significance of extended rostrum unclear.

Recent relatives: None. Died out in the Lower Devonian.



Rhinopteraspis, reconstruction after GROSS.



Cardipeltis bryanti DENISON (length c. 19 cm) from the Lower Devonian of Big Horn County, Wyoming, U.S.A. Original: Field Museum of Natural History, Chicago, Illinois, U.S.A.

Genus: *Cardipeltis* BRANSON & MEHL, 1931.

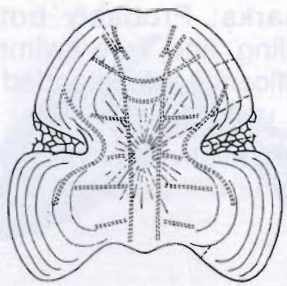
Horizon: Lower Devonian.

Geographical distribution: Spitzbergen, North America.

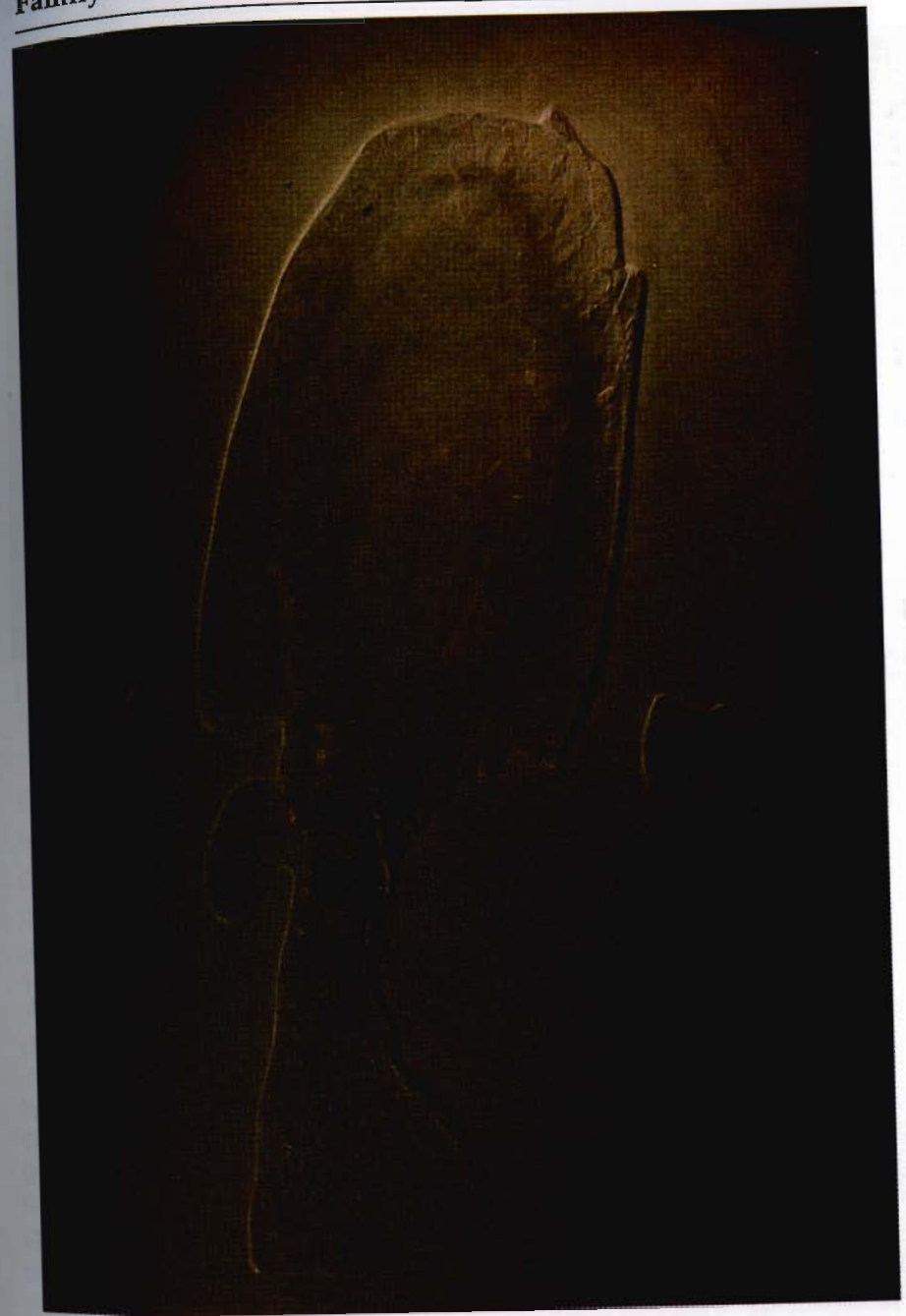
Features: Dorsal region oval but widening rearward and forming a heart-shaped embayment posteriorly. Further wide embayments at right and left received the external gill openings. Dorsal plates with a thin dentine layer but with worm-like ridges bearing flattened dentine pustules. Both the ridges and the pustules have smooth margins. Mouth somewhat ventral.

Remarks: Bottom-dwelling and probably not skillful swimmers.

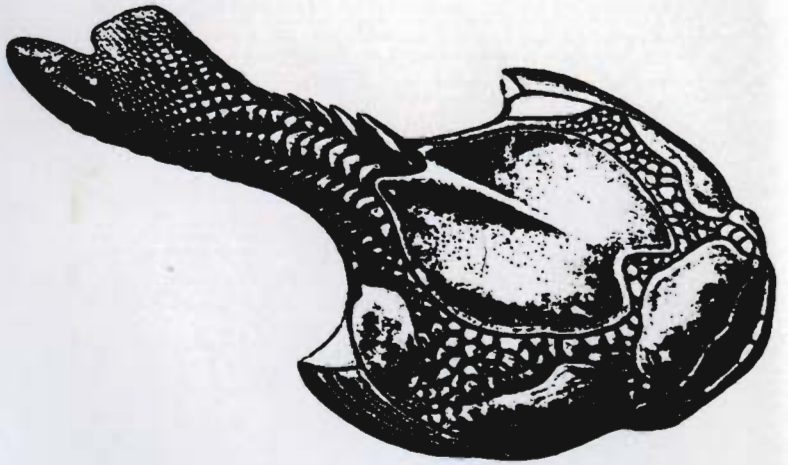
Recent relatives: None. Died out in Lower Devonian.



Cardipeltis, reconstruction after DENISON.



Drepanaspis gemuendensis SCHLÜTER (length c. 53 cm), from the Lower Devonian of Bundenbach, Rhineland, Germany. Original: Staatliches Museum für Naturkunde, Stuttgart, Germany.



Drepanaspis, reconstruction after MACMILLAN.

Genus: *Drepanaspis* SCHLÜTER, 1887.

Horizon: Lower Devonian.

Geographical distribution: Europe.

Features: Large agnathans which could reach a length of almost 1 m. Head and trunk half-oval in dorsal aspect, ending behind at a straight transverse line. The large plates of the armour surrounded by mosaic-like fields of scales. The tail with a row of keeled scales in the dorsal and ventral mid lines. Caudal fin hypocercal. Mouth terminal.

Remarks: Probably bottom-dwellers, though the terminal mouth suggests that prey could be taken, at least in part, during swimming.

Recent relatives: None. Died out in Lower Devonian.



Lanarkia horrida TRAQUAIR (length c. 7 cm) from the Upper Silurian of Segholm, Ayrshire, Scotland, U.K. Original: National Museum of Scotland, Edinburgh, U.K.

Genus: *Lanarkia* TRAQUAIR, 1899.

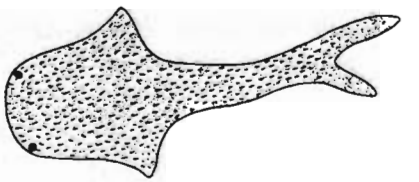
Horizon: Upper Silurian

Geographical distribution: Europe.

Features: Body extremely depressed dorso-ventrally and covered with strong thorn-like denticles. Length rarely greater than 10 cm. Dorsal and anal fins present. Mouth probably slit-like and somewhat ventral. Beneath the 9 "lateral fins" there were eight pairs of gill slits. Caudal fin a-symmetrical (hypocercal). Dentine of dermal denticles like that of Pteraspidiformes and suggests a relationship with that order.

Remarks: The shape suggests relatively slow-moving bottom-dwellers.

Recent relatives: None. Died out in the Upper Silurian.



Lanarkia, reconstruction after TRAQUAIR.



Phlebolepis elegans PANDER (length c. 6 cm) from the Upper Silurian of Oesel, Estonia. Original: American Museum of Natural History, New York, N.Y., U.S.A.

Genus: *Phlebolepis* PANDER, 1856.

Horizon: Upper Silurian.

Geographical distribution: Western and eastern Europe, northern North America.

Features: Shape "fish-like" (unlike *Thelodus* and *Lanarkia*). Maximum length 7–9 cm. Body covered with thin, uniform, scale-like elements. Dorsal, anal and pectoral fins present. Caudal fin hypocercal. Mouth terminal.

Remarks: Probably rather skilful free-swimmers.

Recent relatives: None. Died out in Upper Silurian.



Phlebolepis, reconstruction after RITCHIE.



Logania scotica (TRAQUAIR) (length c. 14 cm) from the Upper Silurian of Lanarkshire, Scotland. Original: National Museum of Scotland, Edinburgh U.K.

Genus: *Logania* DISTANT, 1884.

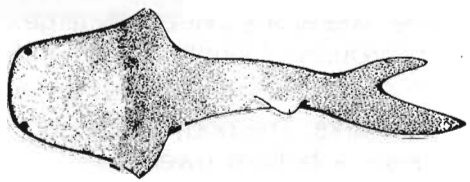
Horizon: Upper Silurian to Lower Devonian.

Geographical distribution: Western and eastern Europe, North America, central Asia.

Features: Ventro-dorsally compressed body much like *Thelodus* but with considerably smaller dermal denticles, especially in head. Relatively large—individuals of length 15 cm and more not uncommon. Mouth probably slit-like and ventral. One dorsal and one anal fin. Caudal fin hypocercal. Gill slits beneath the "lateral fins".

Remarks: Bottom-dwellers like *Thelodus* and *Lanarkia*.

Recent relatives: None. Died out in Lower Devonian.



Logania, reconstruction after TRAQUAIR.



Thelodus scoticus TRAQUAIR (length c. 15 cm) from the Upper Silurian of Lanarkshire, Scotland. Original: National Museum of Scotland, Edinburgh, U.K.

Genus: *Thelodus* AGASSIZ, 1838.

Synonyms: *Thelolepis*, *Thelolepoides*, *Thelyodus*.

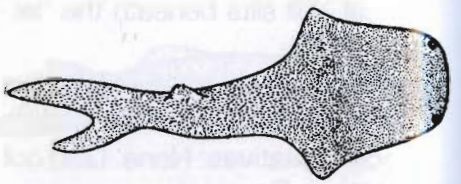
Horizon: Lower Silurian to Lower Devonian.

Geographical distribution: Western and eastern Europe, northern North America, Spitzbergen, central Asia.

Features: Body flattened. Head relatively large. Unlike *Lanarkia*, surface densely covered with fine dermal denticles. Dorsal and anal fin present. Mouth probably slit-shaped and slightly ventral. Eight gill slits beneath the "lateral fins". Relatively large. Individuals of length 15 cm and more are not unusual.

Remarks: The body shape suggests a bottom dweller.

Recent relatives: None. Died out in Lower Devonian.



Thelodus, reconstruction after TRAQUAIR.



Turinia pagei (POWRIE), (length c. 32 cm) from the Lower Devonian of Angus, Scotland. Original: National Museum of Scotland, Edinburgh, U.K.

Genus: *Turinia* TRAQUAIR, 1896.

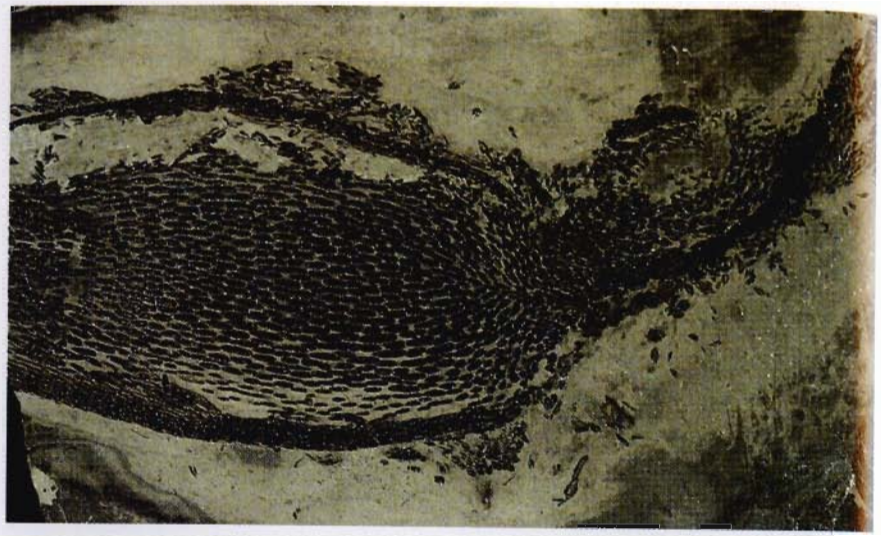
Horizon: Lower Devonian.

Geographical distribution: Western and eastern Europe, Spitzbergen, Australia, central Asia, northern Asia.

Features: All other thelodonts are at most 10-20 cm long but *Turinia* reaches a length of up to 40 cm. In outline it resembles *Thelodus* and *Lanarkia*, even in the presence of "lateral fins", but can always be distinguished by its greater size. The surface of the body is covered with very small synchronomorial scales. The mouth was probably slit-shaped. It was slightly ventral.

Remarks: The body shape suggests relatively slow-moving bottom-dwellers.

Recent relatives: None. Died out in the Lower Devonian.



Lepidaspis sp. (length c. 23 cm) from the Devonian of Grizzly Bear Lake, Canad: . Original: University of Alberta, Edmonton, Alberta, Canada.

Genus: *Lepidaspis* MacGillivray, 1921.

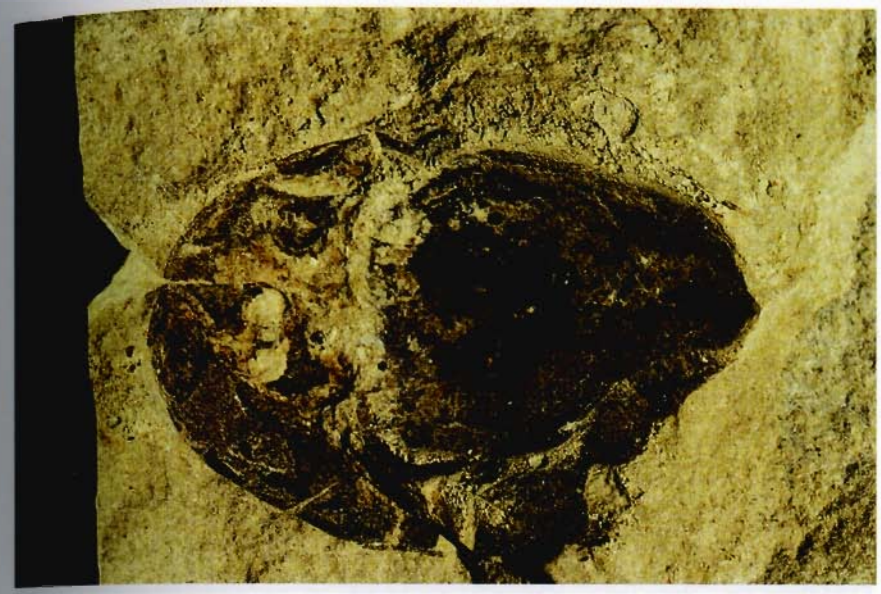
Horizon: Devonian.

Geographical distribution: North America.

Features: Middle-sized agnathans. Maximum length c. 25 cm. Body densely covered with short ridges. Tail strongly tapering. Caudal fin probably hypocercal. Dorsal fin present, and probably anal fin also. Mouth terminal to slightly ventral.

Remarks: Bottom-dwelling.

Recent relatives: None. Died out in Devonian.



Dartmuthia sp. (length c. 3.5 cm) from the Upper Silurian of Oesel, Estonia. Original: American Museum of Natural History, New York, N.Y., U.S.A.

Genus: *Dartmuthia* Patten, 1931.

Synonyms: *Lophosteus*.

Horizon: Upper Silurian.

Geographical distribution: Europe.

Features: Small slender agnathans, supposedly with a strikingly large head. Head and anterior part of back enclosed in pustulate armour with undulating posterior margin but rounded anteriorly. Eyes relatively large, close together and directed upwards.

Remarks: Probably bottom-dwellers and scarcely able to swim.

Recent relatives: None. Died out in Silurian.



Dartmuthia, reconstruction after Macmillan.



Tyriaspis whitei HEINTZ (length c. 9 cm) from the Upper Silurian of Ringerike, Norway. Original: Paleontologisk Museum, Oslo.

Genus: *Tyriaspis* HOPE, 1840.

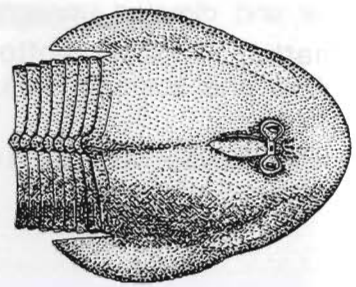
Horizon: Upper Silurian.

Geographical distribution: Europe.

Features. The rounded head and the anterior part of the trunk are enclosed in bony pustulate armour. Eyes on upper surface. Plump, scaly body tapers strongly towards tail. Mouth terminal to ventral. Maximum length about 10 cm.

Remarks: Bottom-dwellers, probably sluggish swimmers.

Recent relatives: None. Died out in Upper Silurian.



Tyriaspis, reconstruction after HEINTZ.



Aceraspis robustus KIAER (length c. 14 cm). Original: Paleontologisk Museum, Oslo, Norway.

Genus: *Aceraspis* KIAER, 1911.

Synonyms: *Hemiteleaspis*.

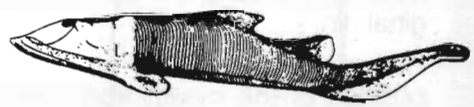
Horizon: Lower Devonian.

Geographical distribution: Europe.

Features: Shape elongate, flattened ventrally. The head and the anterior part of the body covered with bony armour. Eyes close together on the upper surface of the head armour. Nasal opening between the eyes. Gill slits circular. Body fish-like and covered with scales. Lobe-shaped, scaly pectoral fins. Two dorsal fins, the anterior halves of which are scaly. Caudal fin heterocercal, passing downwards into a marginal fin. Maximum length c. 15 cm.

Remarks: The flattened ventral surface and the position of the eyes suggest a bottom-dweller.

Recent relatives: None. Died out in Lower Devonian.



Aceraspis, reconstruction after STENSIÖ.



Hemicyclaspis murchisoni (EGERTON) (length c. 18 cm) from the Upper Silurian of Ledbury, Herefordshire, England, U.K. Original: The Natural History Museum, London, U.K. (P6023).

Genus: *Hemicyclaspis* LANKESTER, 1870.

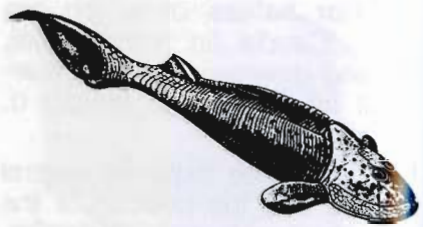
Horizon: Upper Silurian to Lower Devonian.

Geographical distribution: Europe, northern North America.

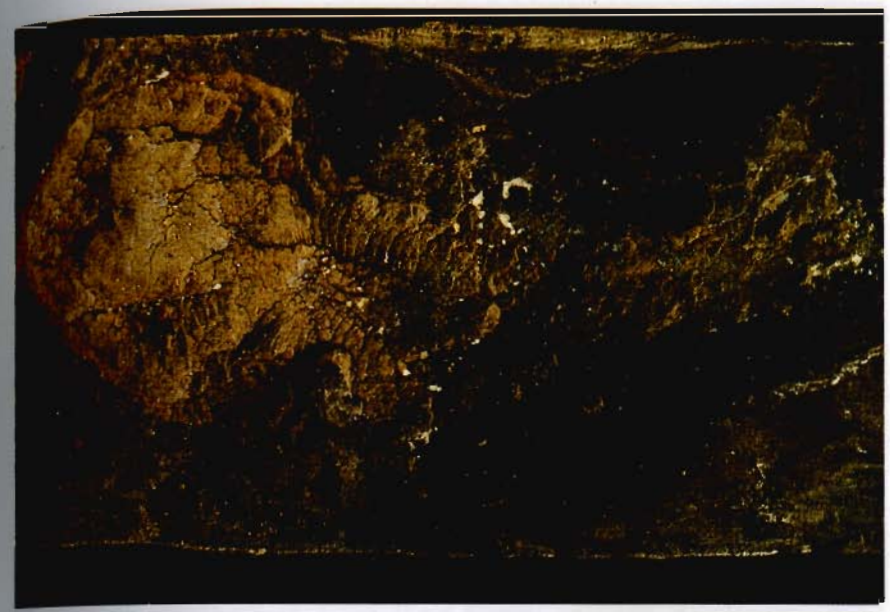
Features: Head and anterior part of body covered in bony armour. Mouth ventral. Pectoral fins lobe-shaped and scaly. Anterior dorsal fin present only as a projecting ridge. Fish-like, scaly, ventrally flattened body ends in a heterocercal caudal fin. The lower margin of the caudal fin runs into a short broad marginal fin.

Remarks: The shape and the position of the mouth and eyes suggest a bottom dweller.

Recent relatives: None. Died out in Lower Devonian.



Hemicyclaspis, reconstruction after MACMILLAN.



Hirella gracilis (KIAER) (length c. 7 cm) from the Upper Silurian of Ringerike, Norway. Original: Paleontologisk Museum, Oslo.

Genus: *Hirella* COSSMANN, 1920.

Synonyms: *Micraspis*.

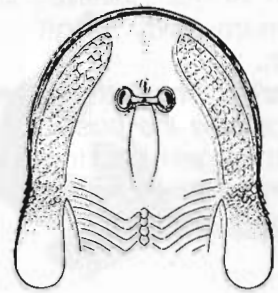
Horizon: Upper Silurian.

Geographical distribution: Europe.

Features: Little fishes, ventrally flattened. Head armour about as long as wide. No lateral horns to head armour. Mouth transversely elongate. Two dorsal fins. Pectoral fins present.

Remarks: Bottom dwellers.

Recent relatives: None. Died out in Upper Silurian.



Hirella, reconstruction after KIAER.



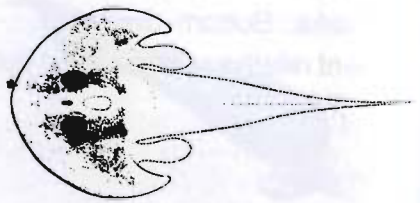
Alaspis microtuberculata ORVIG (length c. 31 cm) from the Upper Devonian of Miguasha, Gaspé Peninsula, Quebec, Canada. Original: Musée d'Histoire Naturelle, Miguasha.

Genus: *Alaspis* ORVIG, 1957.
Horizon: Upper Devonian.
Geographical distribution: North America.

Features: Head and anterior part of the body enclosed in armour. Head rounded in anterior outline in dorsal aspect. Prominent lateral horns. Eyes very close together and approximately in the middle of the armour. Nasal opening between the eyes. Ventral surface flattened. Scaled body slender and ending in a heterocercal tail. Mouth ventral. Relatively large - maximum body length up to 35 cm.

Remarks: The flattened ventral surface and the position of the mouth suggest a bottom dweller.

Recent relatives: None. Died out in Upper Devonian.



Alaspis, reconstruction after ORVIG.



Boreaspis puella WÄNGSJÖ (length c. 2 cm) from the Lower Devonian of Spitzbergen. Original: Naturhistoriska Riksmuséet, Stockholm, Sweden.

Genus: *Boreaspis* STENSIÖ.

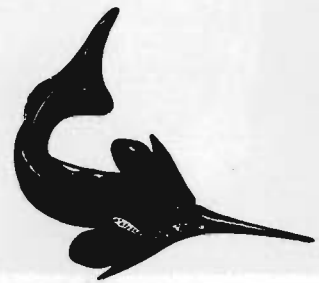
Horizon: Lower Devonian.

Geographical distribution: Northern Europe.

Features: Little agnathans of slender shape. Head and anterior part of the body enclosed in armour. Dorsal surface of armour extends into long narrow pointed rostrum. Lateral spines broad at base and acute-triangular in shape. Eyes small, on the upper surface.

Remarks: Probably bottom-dwelling and scarcely free-swimming.

Recent relatives: None. Died out in Lower Devonian.

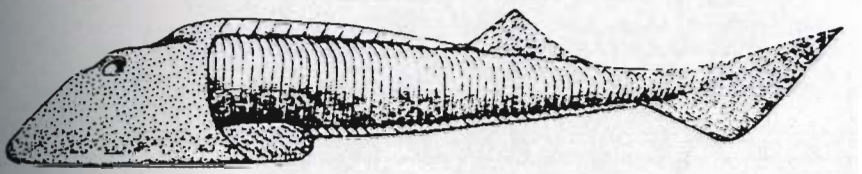


Boreaspis, reconstruction after MACMILLAN.



Cephalaspis powriei LANKESTER (length c. 12 cm) from the Lower Devonian of Angus, Scotland, U.K. Original: National Museum of Scotland, Edinburgh, U.K.

AGNATHA
Order: Cephalaspidiformes
Family: Cephalaspididae
Jawless Fishes



Cephalaspis, reconstruction after WOODWARD.

Genus: *Cephalaspis* AGASSIZ, 1835.

Synonyms: *Camptaspis*, *Escuminaspis*, *Eucephalaspis*, *Minestaspis*, *Pattenaspis*, *Scolenaspis*, *Zenaspis*.

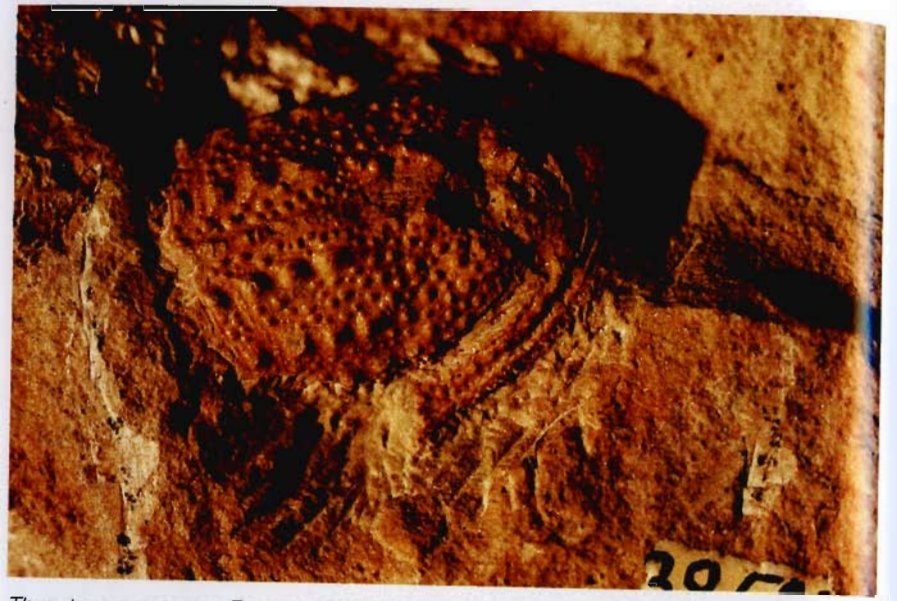
Horizon: Upper Silurian to Upper Devonian.

Geographical distribution: Europe, Spitzbergen, East Asia, North America.

Features: The head and the anterior part of the body enclosed in armour. Long lateral horns. Eyes facing upward, approximately in the middle of the head armour, very close together. Nasal opening between the eyes. Pectoral fins lobe-shaped. Dorsal fin in the posterior third of the body. Caudal fin heterocercal. Lower lobe broad. Body scaly. Mouth circular, ventral in position. Ventral surface flattened. General shape elongate. Maximum length up to 20 cm.

Remarks: The flattened belly and ventral mouth suggest a bottom dweller.

Recent relatives: None. Died out in Upper Devonian.



Thyestes verrucosus EICHWALD (length c. 2 cm) from the Upper Silurian of Saaremaa, Estonia. Original: Paleontologicheskii Muzei Russkoi Akademii Nauk, Moscow, Russia.

Genus: *Thyestes* EICHWALD, 1854.

Synonyms: *Auchenaspis*.

Horizon: Upper Silurian to Lower Devonian.

Geographical distribution: Europe.

Features: Little agnathans with oval, tuberculate shield. This encloses the whole head and the anterior part of the trunk. The lateral horns run parallel to the head but separated by a small gap. Eyes relatively large, close together and facing upwards. Mouth ventral.

Remarks: Probably bottom-dwellers and weak swimmers.

Recent relatives: None. Died out in Lower Devonian.



Thyestes, reconstruction after AFANASSIEVA.



Jamoytius kerwoodi WHITE (length c. 19 cm) from the Middle Silurian of Lanarkshire, Scotland, U.K. Original: The Natural History Museum, London U.K. (P47784).

Genus: *Jamoytius* WHITE, 1946.

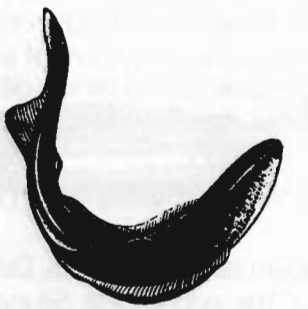
Horizon: Middle Silurian.

Geographical distribution: Europe.

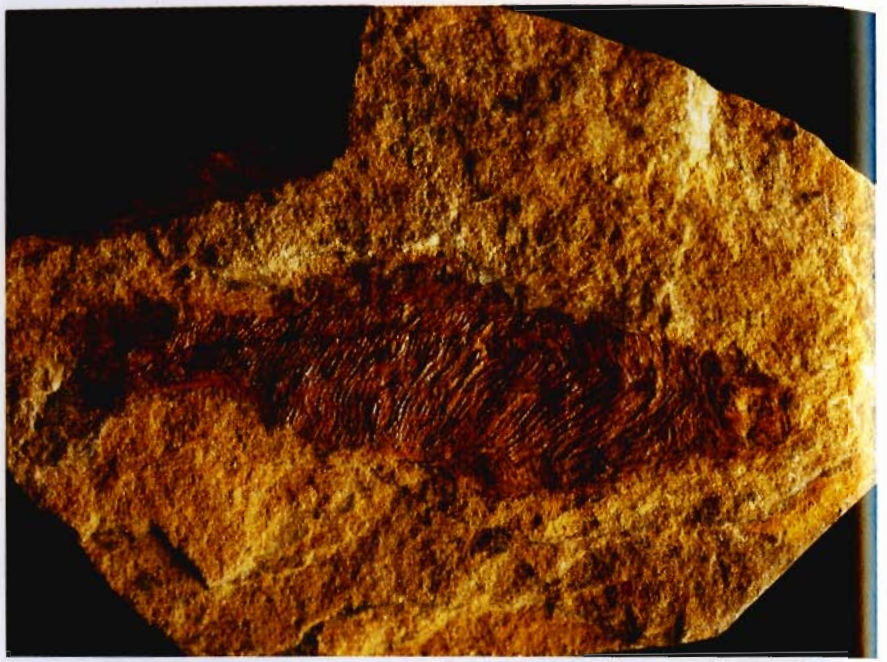
Features: Dorsal fin long and almost like a fin fold. Lateral fins likewise long and narrow, extending half length of body. Scales extremely weak and thin. Head naked. Eyes protected by sclerotic ring. Maximum length of long, spindle-shaped body perhaps 15 cm.

Remarks: Given the streamlined shape, possibly expert swimmers. Genus includes some of the oldest agnathans known.

Recent relatives: None. Died out in Middle Silurian.



Jamoytius, reconstruction after MACMILLAN.



Birkenia elegans TRAQUAIR (length c. 4 cm) from the Upper Silurian of Muirkirk, Scotland. Original: Frickhinger Collection, Munich.

Genus: *Birkenia* TRAQUAIR.

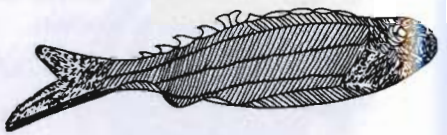
Horizon: Middle Silurian to lower Devonian.

Geographical distribution: Europe.

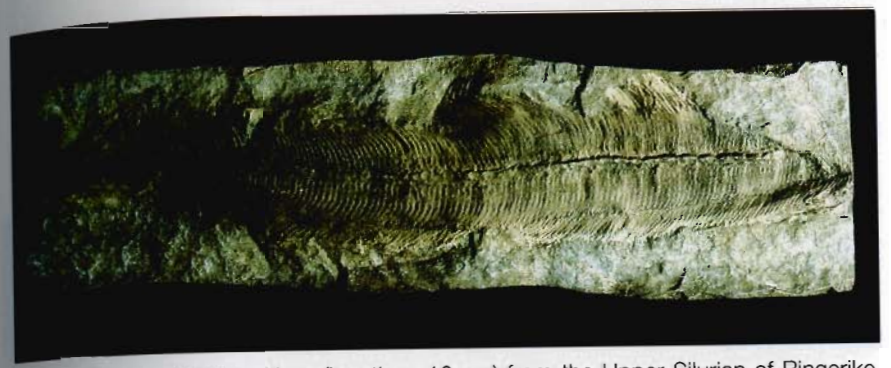
Features: Anterior part of dorsal mid line consists of large low keeled scales whereas posterior part is of spine-like structures. The two parts separated but a much taller structure whose two spikes point forward and back. The spindle-shaped body covered with overlapping rows of scales. Eight pairs of external gill slits. Caudal fin hypocercal. Length c. 10 cm.

Remarks: Probably expert swimmers.

Recent relatives: None. Died out near the end of the Silurian.



Birkenia, reconstruction after TRAQUAIR.



Pharyngolepis oblongus KIAER (length c. 16 cm) from the Upper Silurian of Ringerike, Norway. Original: National Museum of Scotland, Edinburgh, U.K.

Genus: *Pharyngolepis* KIAER, 1911.

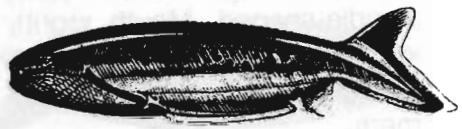
Horizon: Upper Silurian.

Geographical distribution: Europe.

Features: Streamlined shape. Greatest length up to 20 cm. Mouth terminal. Snout somewhat pointed. Eyes situated far forward on the head. The body passes into a hypocercal caudal fin. Along the dorsal mid line a row of small spines. 15 pairs of gill slits.

Remarks: Probably good swimmers.

Recent relatives: None. Died out in Upper Silurian.



Pharyngolepis, reconstruction after MACMILLAN.



Pterygolepis nitidus (KIAER) (length c. 7 cm) from the Upper Silurian of Ringerike, Norway. Original: Museum National d'Histoire Naturelle, Paris, France. Photograph: Serette, Paris.

Genus: *Pterygolepis* COSSMANN, 1920.

Synonyms: *Pterlepidops*, *Pterolepis*.

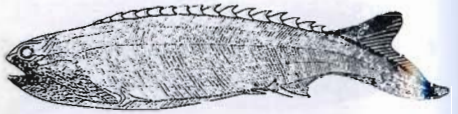
Horizon: Upper Silurian.

Geographical distribution: Europe.

Features: Mid-dorsal ridge of thorn-like scales, with points facing rearwards. Pectoral fins short. Body covered with five rows of overlapping scales. Ten pairs of gill slits. Caudal fin hypocercal. Maximum length 10 cm. Body spindle-shaped. Mouth slightly ventral.

Remarks: Probably expert swimmers.

Recent relatives: None. Died out in Upper Silurian.



Pterygolepis, reconstruction after ORLOV.



Rhyncholepis parvulus KIAER (length c. 6 cm) from the Lower Devonian of Ringerike, Norway. Original: Paleontologisk Museum, Oslo, Norway.

Genus: *Rhynocholepis* KIAER, 1911.

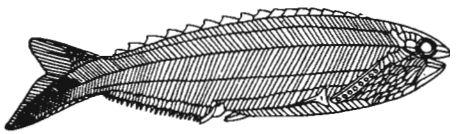
Horizon: Lower Devonian.

Geographical distribution: Europe.

Features: Mid-dorsal ridge of spine-like scales with points facing rearwards. Ventral fins short. Anal fin elongate with spine-like scales. Body covered in five rows of overlapping scales. Eight pairs of gill slits. Body broadly spindle-shaped. Length 6–7 cm.

Remarks: Somewhat plumper than other anaspids.

Recent relatives: None. Died out in Lower Devonian.



Rhyncholepis, reconstruction after KIAER.



Unnamed anaspid (length c. 15 cm) from the Middle Silurian of Cornwallis Island, Northwest Territories, Canada. Original: Thorsteinsson Collection, Calgary, Alberta, Canada.

Genus: Unnamed.

Horizon: Middle Silurian.

Geographical distribution: Northern North America.

Features: Relatively large anaspids. Greatest length 15 cm or more. A row of thorn-like structures in the dorsal mid-line. General shape broadly elongate. Head slightly pointed. Mouth somewhat ventral. Eyes far forward on head.

Remarks: Free-swimming.

Recent relatives: None. Died out in Middle Silurian.



Legendrelepis parenti ARSENAULT & JANVIER (length c. 8 cm) from the Upper Devonian of Miguasha, Gaspé Peninsula, Quebec, Canada. Original: Musée d'Histoire Naturelle, Miguasha, Quebec, Canada.

Genus: *Legendrelepis* ARSENAULT & JANVIER, 1991.

Horizon: Upper Devonian.

Geographical distribution: North America.

Features: Relatively small agathans. Greatest possible maximum length scarcely more than 10 cm. Streamlined shape. Mouth terminal. A row of thorns in the dorsal mid line with the points directed rearward. Caudal fin hypocercal with a strikingly long lower lobe. Body uniformly scaled.

Remarks: Probably clever swimmers.

Recent relatives: None. Died out in Upper Devonian.



Lasanius problematicus TRAQUAIR (length c. 5 cm) from the Upper Silurian of Ayrshire, Scotland. Original: Royal Museum of Scotland, Edinburgh, Scotland.

Genus: *Lasanius* TRAQUAIR, 1899.

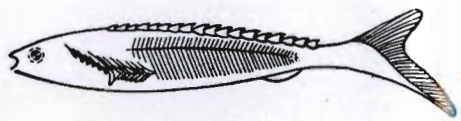
Horizon: Upper Silurian to Lower Devonian.

Geographical distribution: Europe.

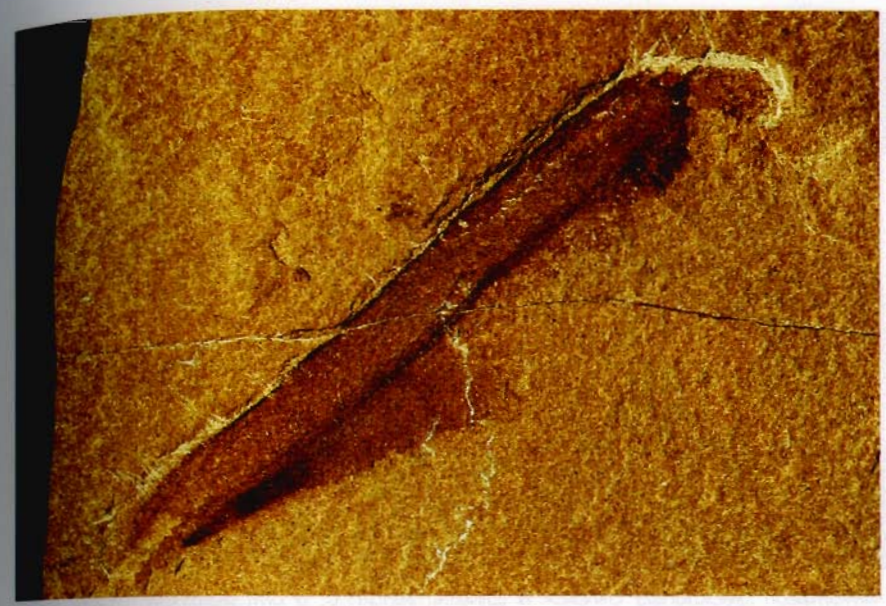
Features: Scales of mid-dorsal ridge thorn-like with the points facing rearwards. Scales of flanks very weak and scarcely recognizable. Gill slits probably six to eight pairs. Maximum length c. 8 cm. General form spindle-shaped.

Remarks: Probably good swimmers.

Recent relatives: None. Died out in Lower Devonian.



Lasanius, reconstruction after ORLOV.



Hardistiella montanensis JANVIER & LUND (length c. 5 cm) from the Lower Carboniferous of Bear Gulch, Montana. Original: Adelphi University, Garden City, N.J., U.S.A.

Genus: *Hardistiella* JANVIER & LUND, 1983.

Horizon: Lower Carboniferous.

Geographical distribution: North America.

Features: Elongate, eel-like shape. Skin without scales. Skeleton not calcified. No bony tissue. Dorsal and caudal fins probably separate from caudal fin. Eyes dorso-lateral. Mouth terminal.

Remarks: Probably bottom dwellers. It is uncertain whether they fed on detritus and small organisms or were parasitic. At present only known as larval stage.

Recent relatives: Genus and family extinct. However, a close relationship to the lampreys (family Petromyzontidae) is suspected.



Hardistiella, reconstruction after LUND.



Mayomyzon pieckoensis BARDACK & ZANGERL (length c. 6 cm) from the Middle Carboniferous of Francis Creek, Illinois, U.S.A. Original: Field Museum of Natural History, Chicago, Illinois, U.S.A.

Genus: *Mayomyzon* BARDACK & ZANGERL, 1968.

Horizon: Middle Carboniferous.

Geographical distribution: North America.

Features: Eel-shaped agnathans, when adult very elongate. Skin without scales. Skeleton uncalcified. No bony tissue. Dorsal fin separated from dorsal fin by a shallow constriction. Eyes dorsolateral. Mouth terminal. Internal organs commonly visible as dark patches. Length of adult probably between 15 and 20 cm.

Remarks: Probably bottom dwellers, though also readily able to swim. It is uncertain whether these animals fed on detritus and small organisms or were parasitic.

Recent relatives: Genus and family extinct. Close relationship to the lampreys (family Petromyzontidae) is suspected.



Lampetra planeri, the recent brook lamprey.



Gilpichthys greenei BARDACK (length c. 6 cm) from the Upper Carboniferous of Essex, Illinois, U.S.A. Original: Henne Collection, Stuttgart, Germany.

Genus: *Gilpichthys* BARDACK, 1979.

Horizon: Upper Carboniferous.

Geographical distribution: North America.

Features: Slender eel-like shape. Skin without scales. Mouth terminal. No bony tissue. End of body pointed.

Remarks: Probably bottom-dwelling. Uncertain whether they fed on detritus and small organisms or were parasitic.

Recent relatives: Genus extinct. Relationships uncertain.



Gilpichthys, reconstruction after BARDACK & RICHARDSON.

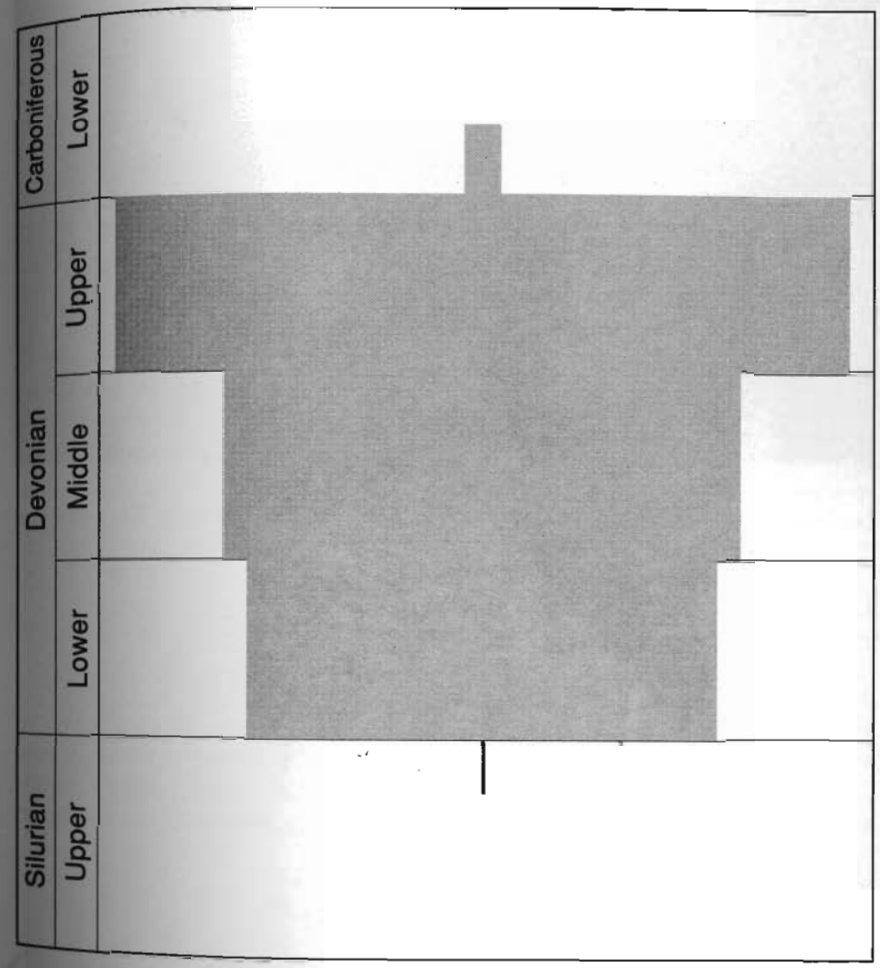
The placoderms evolved an extremely important feature, for they are the first fish with movable jaws. Thus they were adapted to a predatory mode of life. Most of them, however, had a dorso-ventrally flattened body which suggests that they were bottom-dwellers. Most of them probably had only a limited swimming ability.

The head and the anterior part of the trunk were covered with a multiplated armour of dermal bones and individual regions of the armour were often articulated to each other. The body behind this armour was naked or covered with scales. It tapered posteriorly and ended in a diphycercal or heterocercal caudal fin. The mouth was usually terminal but sometimes ventral.

Paired extensions in the region of pectoral fins also had an armour of bony plates. The dorsal head armour, together with these extensions, looks in some ways more like a turtle than a fish. In some species, pelvic and anal fins have also been found.

From the Middle Devonian on, some genera showed a tendency to a partial or complete loss of armour. The great majority of placoderms were small- to middle-sized animals. In the Upper Devonian, however, some were of very large size. In these same fishes, the armour was limited to the head region which gave them greater mobility. The largest forms, which were up to eight metres long, may, as dangerous predators, have played the role of Lords of the Sea. They certainly would have had no enemies.

Nevertheless, despite many advanced features, the placoderms were dominant only for a relatively short time. They appeared in the Lower Devonian and reached their maximum in the Upper Devonian. Whether they still existed in the Lower Carboniferous is doubtful. They had their widest distribution at the time when they died out. They had no descendants. Up to the present, some 200 genera have been described, mostly on the basis of isolated plates of the armour. Complete fishes are very rare.



The approximate distribution of placoderms in geological time, changed after MÜLLER



Stensioella heintzi Broili (length c. 26 cm) from the Lower Devonian of Bundenbach, Rhineland, Germany. Original: Bayerische Staatsammlung für Paläontologie, Munich, Germany.

Genus: *Stensioella* Broili, 1933.

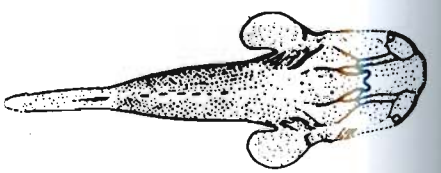
Horizon: Lower Devonian.

Geographical distribution: Europe.

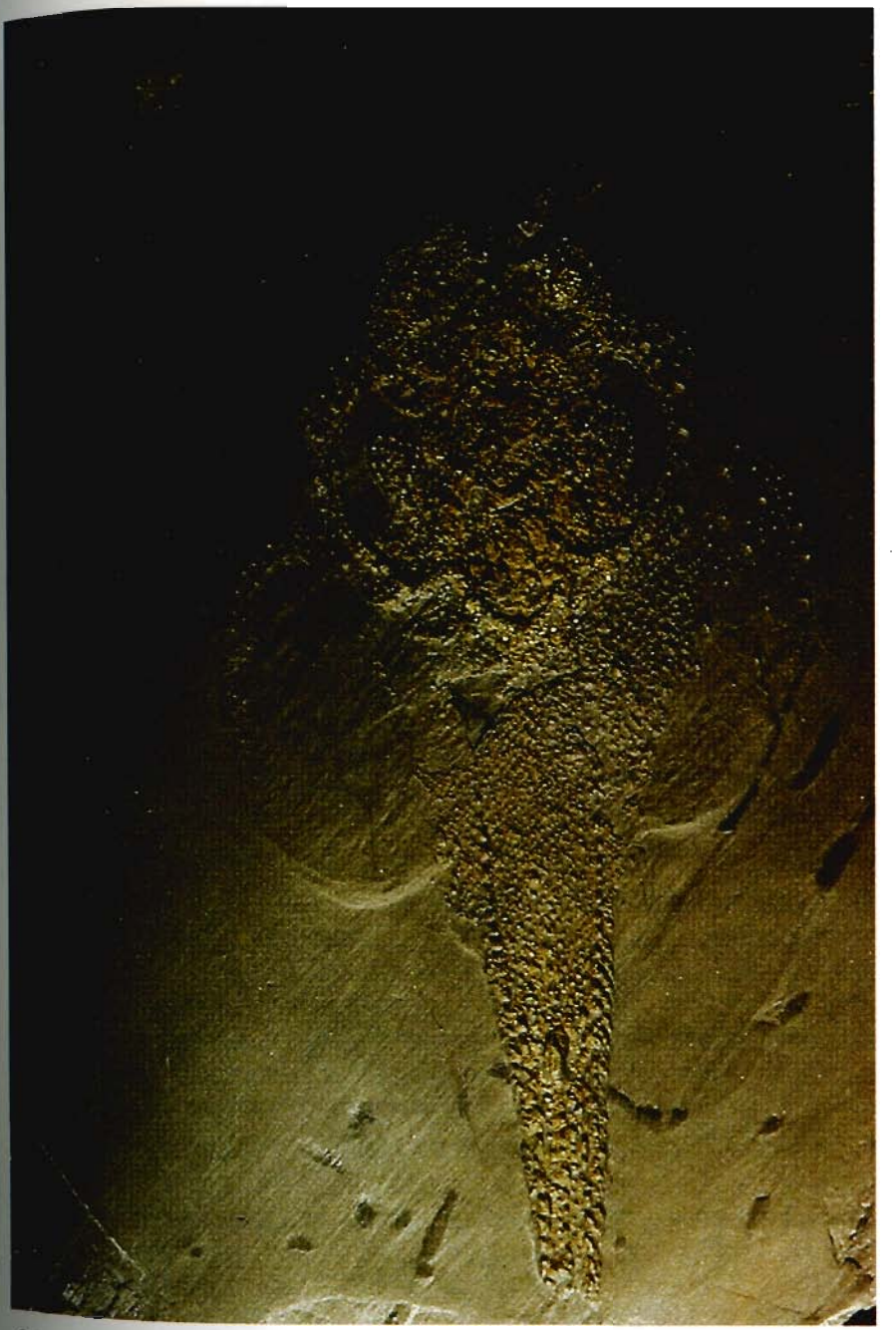
Features: Slender placoderms with extensive loss of exoskeleton. Head covered with bony plates and rigidly fused to the trunk. Pectoral fins large and without spines. Eyes small, widely separated from each other and protected by a sclerotic ring. Mouth ventral but far forward in the head. Lower jaw with tiny teeth. Paired fins well developed. Pelvic fins semi-circular. Dorsal fin small. A low ventral fin fold is present. Body covered with thin spiny scales.

Remarks: Bottom dwelling but also free-swimming.

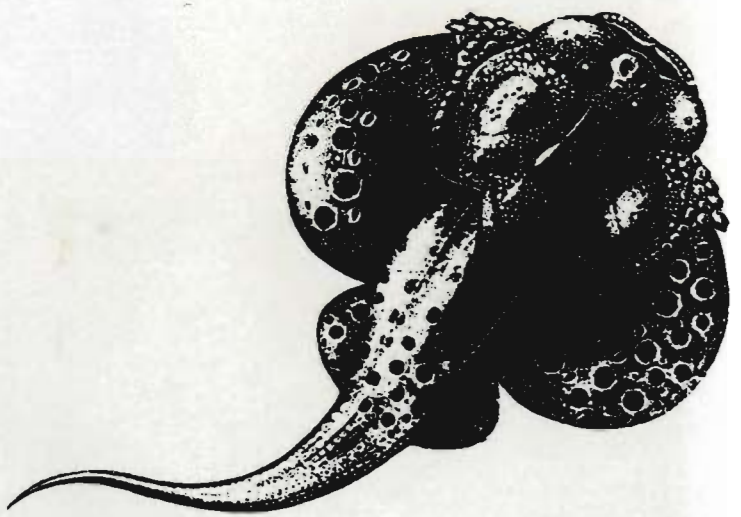
Recent relatives: None. Died out in Lower Devonian.



Stensioella, reconstruction after Broili.



Gemuendina stuertzii Traquair (length c. 15 cm) from the Lower Devonian of Bundenbach, Rhineland, Germany. Original: Bayerische Staatsammlung für Paläontologie, Munich, Germany.



Gemuendina, reconstruction after MACMILLAN.

Genus: *Gemuendina* TRAQUAIR, 1903.

Synonyms: *Broilina*.

Horizon: Lower Devonian.

Geographical distribution: Europe.

Features: Skate-like forms. Pectoral fins very large and semicircular. Tail tapers to point posteriorly, with a little spine at anterior end. Head flat, with eyes and nasal opening directed upwards. Mouth opening dorsally. Exoskeleton extensively reduced. Body mostly covered with scales and polygonal platelets. Normal length up to 25 cm but specimens 1 m long have been found.

Remarks: Probably partly bottom-dwelling and partly free-swimming.

Recent relatives: None. Died out in Lower Devonian. It is widely suspected that this form, together with *Ctenurella*, was a blind-ending side branch of the group of fishes which gave rise to the ancestors of the sharks.



Jagorina pandora JAEKEL (length c. 19 cm) from the Upper Devonian of Bad Wildungen, Hesse, Germany. Original: Museum für Naturkunde, Berlin, Germany.

Genus: *Jagorina* JAEKEL, 1921.

Horizon: Upper Devonian.

Geographical distribution: Europe.

Features: Middle-sized fishes with a broad semicircular skull, somewhat like that of rays. Bony plates on dorsal surface tuberculate. Internal surface of brain cavity ossified with a thin layer of bone. Eyes large. Nasal opening between the eyes. Jaws with loosely attached shark-like teeth. Pectoral fins probably extended along the body.

Remarks: Probably bottom-dwelling predatory fishes.

Recent relatives: None. Died out in Upper Devonian.



Ctenurella gladbachensis ORVIG (length c. 8 cm) from the Upper Devonian of Bombach, Bergisch Gladbach, Rhineland, Germany. Original: Naturmuseum Senckenberg, Frankfurt-am-Main, Germany.

Genus: *Ctenurella* ORVIG, 1960.

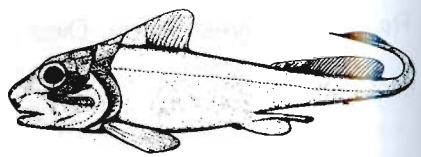
Horizon: Upper Devonian.

Geographical distribution: Europe, Australia.

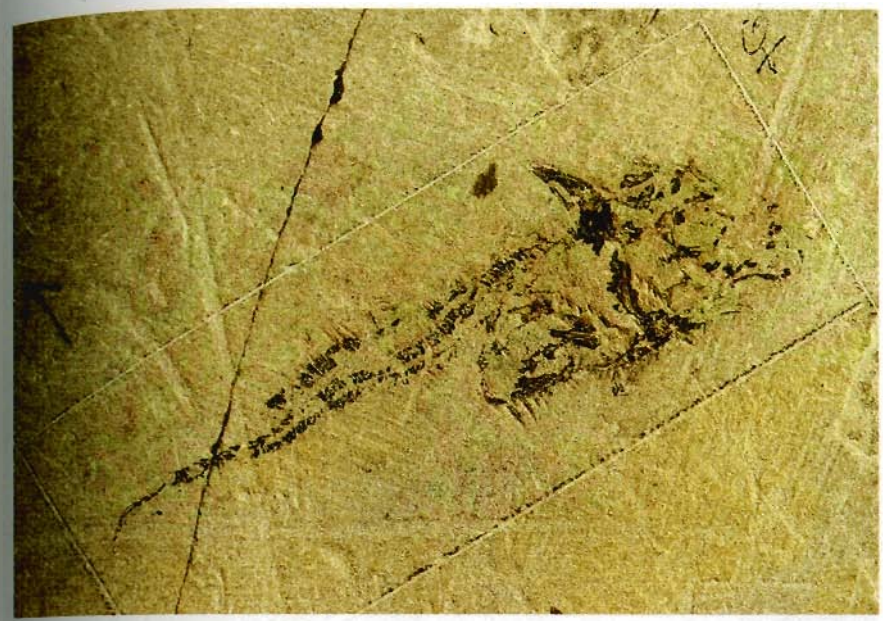
Features: Small fishes with a weakly developed exoskeleton. Head short and deep. Eyes directed upwards. Mouth somewhat ventral. A pair of tooth plates in both the upper and lower jaw. Two dorsal fins, the anterior short and the posterior elongate. Caudal fin small, heterocercal. Pectoral fins relatively large. Pelvic fins show sexual dimorphism. Those of the male have hook-shaped claspers. Body largely naked. Maximum length about 18 cm.

Remarks: Bottom-dwellers.

Recent relatives: None. Died out in Devonian. Certain similarities suggest that this is a blind-ending side branch of the group of fishes from which the chimaeras are descended.



Ctenurella, reconstruction after MACMILLAN.



Rhamphodopsis trispinatus WATSON (length c. 7 cm) from the Middle Devonian of Caithness, Scotland. Original: Australian Museum, Sydney, Australia.

Genus: *Rhamphodopsis* WATSON, 1934.

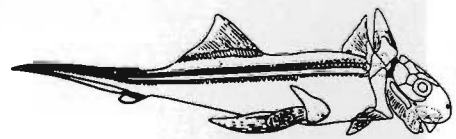
Horizon: Middle Devonian.

Geographical distribution: Europe.

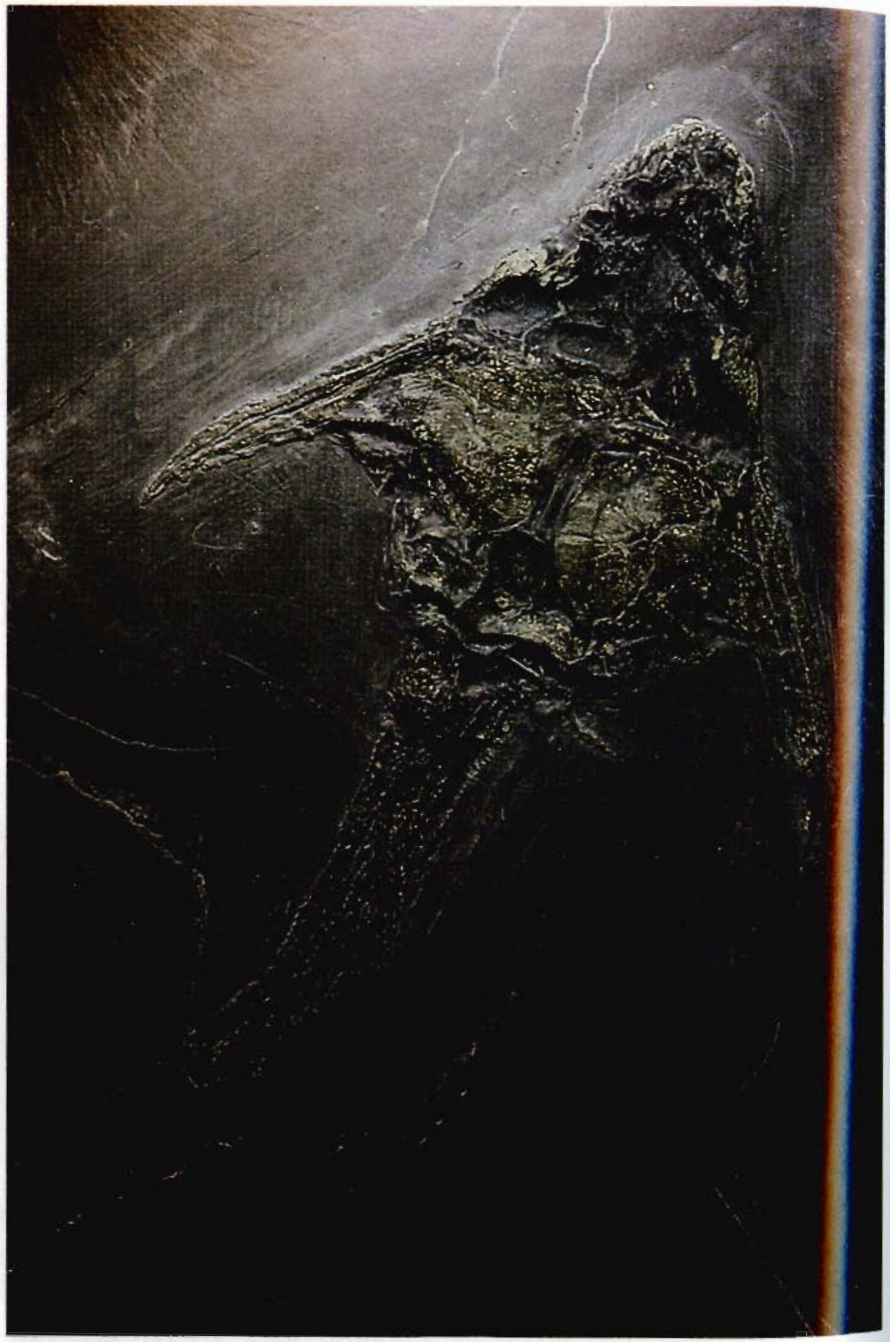
Features: Small fishes. Head relatively small. Eyes directed upwards. Mouth ventral. A pair of tooth plates on upper and lower jaw. The anterior part of the back has a posteriorly grooved spine. The posterior dorsal fin triangular and relatively large. Pelvic fins long, partly scaly in female and in the male with hook-shaped claspers. Maximum length c. 12 cm.

Remarks: Bottom-dwellers. Lived in fresh water.

Recent relatives: None. Died out in Middle Devonian.

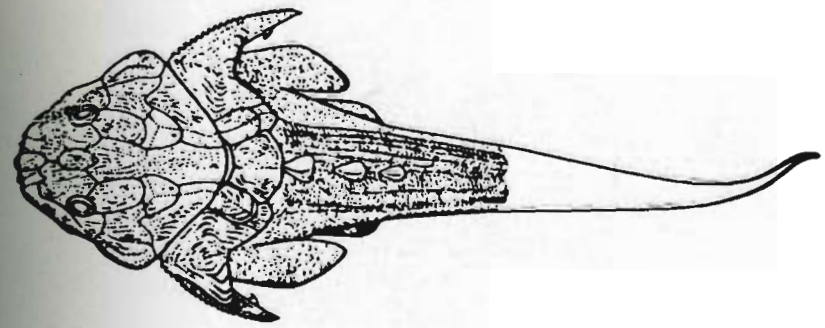


Rhamphodopsis, reconstruction after HOLMGREN.



Lunaspis broilii Gross (length c. 19 cm) from the Lower Devonian of Bundenbach, Rhineland, Germany. Original: Bayerische Staatsammlung für Paläontologie, Munich, Germany.

PLACODERMI
Order: Petalichthyiformes
Family: Macropetalichthyidae
Placoderms



Lunaspis, reconstruction after Stensiö.

Genus: *Lunaspis* Broili, 1929.

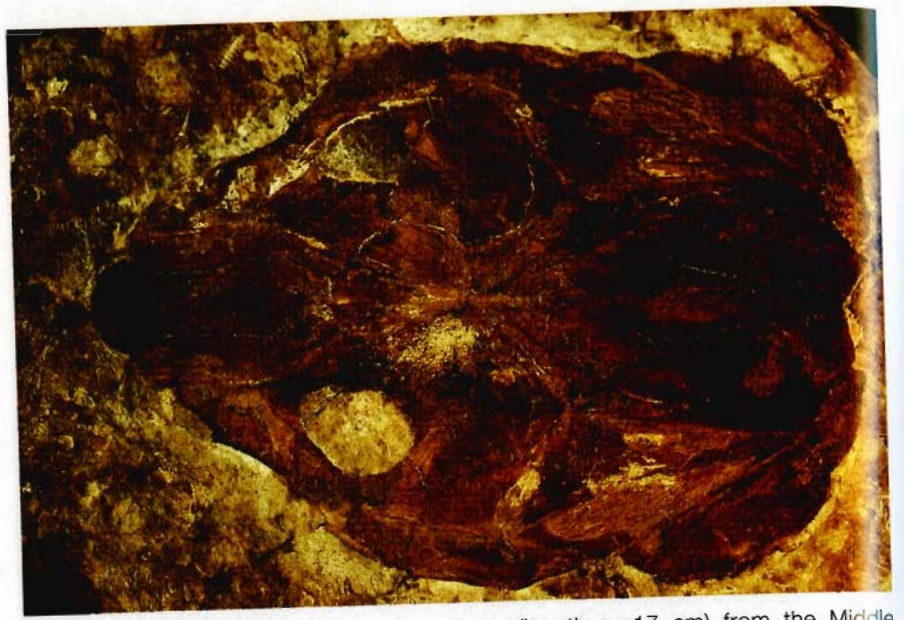
Horizon: Lower Devonian.

Geographical distribution: Europe.

Features: Middle-sized armoured fishes with a maximum length of c. 30 cm. Head armour and body armour not articulated to each other. Characteristic lateral spines with denticulate edges. Shape elongate. Tail tapering to point with diphycercal caudal fin. Other fins absent. Jaw never found. Body covered with thin scales. Three large keeled scales in the dorsal mid line.

Remarks: Bottom-dwelling.

Recent relatives: None. Died out in Lower Devonian.



Macropetalichthys sullivani NORWOOD & OWEN (length c. 17 cm) from the Middle Devonian of Sanusky, Ohio, U.S.A. Original: Peabody Museum of Natural History, New Haven, Connecticutt, U.S.A.

Genus: *Macropetalichthys* NORWOOD & OWEN, 1846.

Synonyms: *Acanthaspis*, *Agassichthys*, *Heintzaspis*, *Ohiodurolites*, *Physichthys*.

Horizon: Middle Devonian.

Geographical distribution: Europe, North America.

Features: Relatively large fishes. Roof of skull may reach length of 25 cm. Eyes directed upwards but somewhat laterally placed. Mouth slightly ventral. Jaws not yet found. Trunk armour relatively brief.

Remarks: Probably largely bottom-dwellers.

Recent relatives: None. Died out in Middle Devonian.



Macropetalichthys, reconstruction after BROILI.



Phyllolepis sp. (length c. 12 cm) from the Upper Devonian of East Greenlan. Original: Geologisk Museum, Copenhagen, Denmark.

Genus: *Phyllolepis* AGASSIZ, 1844.

Synonyms: *Pentagonolepis*.

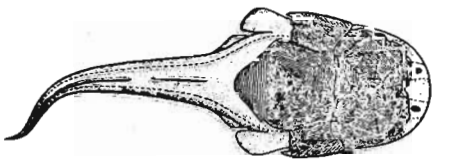
Horizon: Upper Devonian.

Geographical distribution: Western and Eastern Europe, Greenland, North America, Australia.

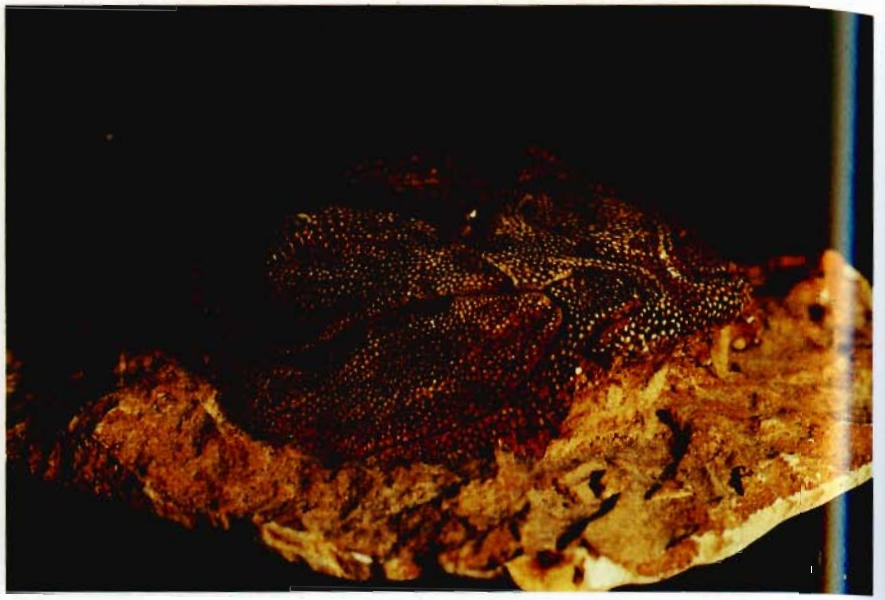
Features: Head shield broad and flat. Eyes small, antero-lateral in position. Dorsal and ventral shields likewise broad and flat. Lateral spines short. Pectoral fins narrow. Body behind armour slender and elongate, tapering to a point at end of tail. Maximum length, according to the species, 40 cm.

Remarks: Probably more bottom-dwelling than free-swimming.

Recent relatives: None. Died out in Upper Devonian.



Phyllolepis, reconstruction after STENSIÖ.



Wuttagoonaspis fletsheri RITCHIE (length c. 7 cm) from the Middle Devonian of Wuttagoona, New South Wales, Australia. Original: Australian Museum, Sydney, Australia.

Genus: *Wuttagoonaspis* RITCHIE, 1973.

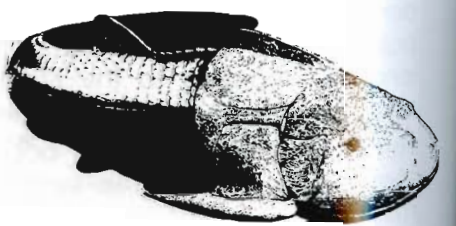
Horizon: Middle Devonian.

Geographical distribution: Australia.

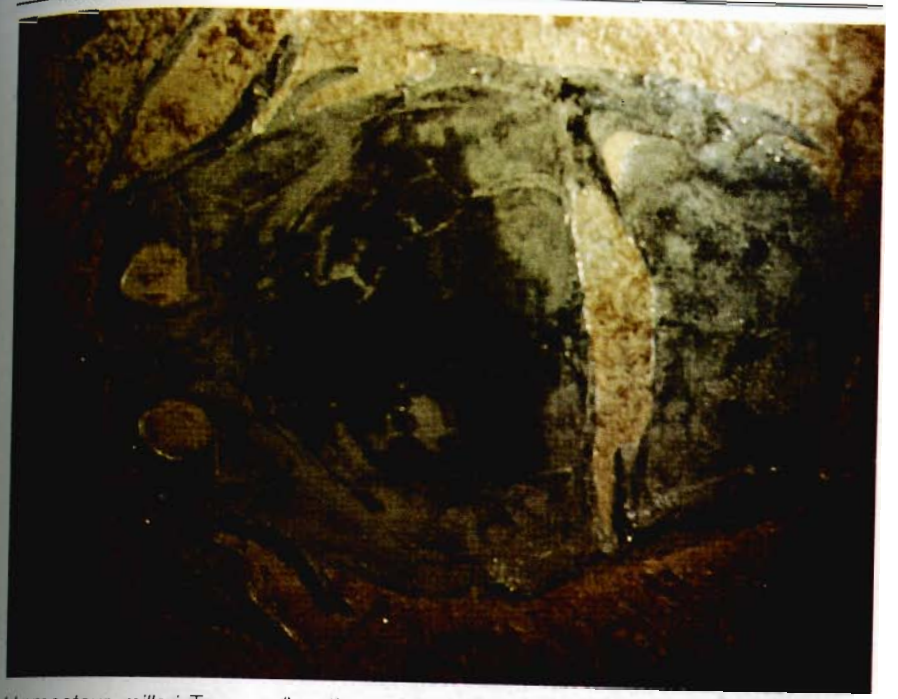
Features: Middle-sized fishes with beautifully sculptured armour. Head shield convex. Eyes displaced sideways and rearwards. Snout rounded. No differentiated hinge between head shield and trunk armour. Shortly behind the eyes there are slender lateral spines. Head shield up to 18 cm in length.

Remarks: Inhabited fresh-water.

Recent relatives: None. Died out in Middle Devonian.



Wuttagoonaspis, reconstruction after RITCHIE.



Homosteus milleri TRAQUAIR (length c. 42 cm) from the Middle Devonian of Caithness, Scotland, U.K. Original: National Museum of Scotland, Edinburgh, U.K.

Genus: *Homosteus* ASMUSS, 1856.

Synonyms: *Homostius*.

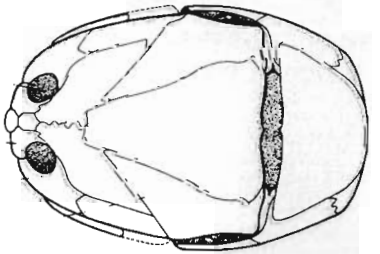
Horizon: Middle to Upper Devonian.

Geographical distribution: Western and Eastern Europe, Spitzbergen, Greenland, North America.

Features: Head and trunk arm form an ovoid. Eyes relatively large, anterior, close together and directed upwards. Trunk shield considerably smaller than head armour. Lateral spurs very small. Head and trunk armour together may reach a length of about 1 m in some species.

Remarks: The upward directed eyes suggest a bottom-dweller.

Recent relatives: None. Died out in Upper Devonian.



Homosteus, reconstruction after MILES.



Oxyosteus sp. (length c. 9 cm) from the Upper Devonian of Bad Wildungen, Hesse, Germany. Original: Naturhistoriska Riksmuseet, Stockholm, Sweden.

Genus: *Oxyosteus* JAEKEL, 1911.

Synonym: *Platyosteus*.

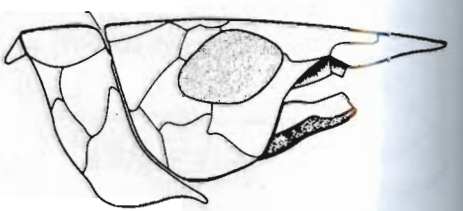
Horizon: Upper Devonian.

Geographical distribution: Western and Eastern Europe.

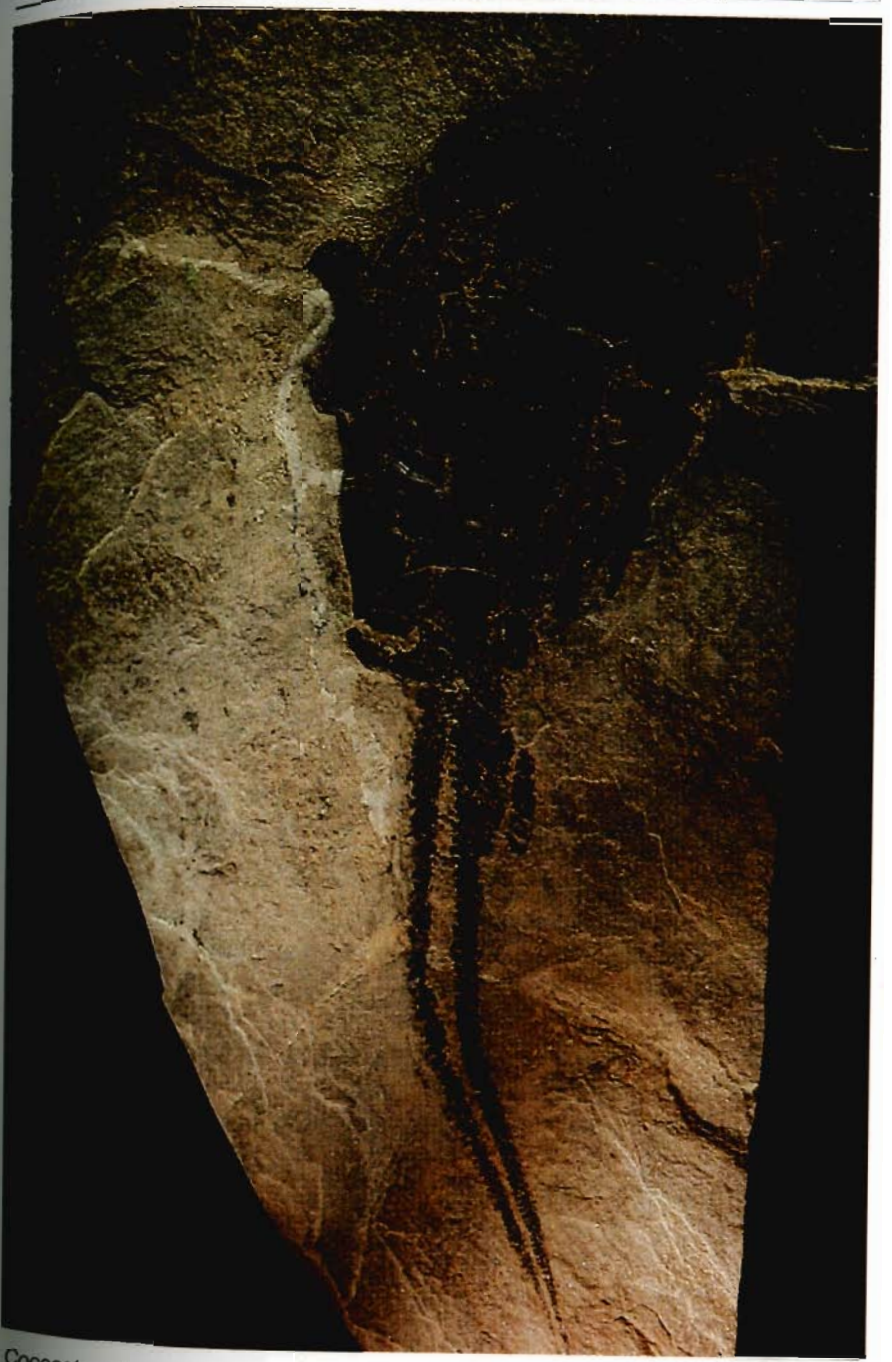
Features: Head and body narrow and deep. Anterior part of the head elongated to form pointed snout. Eyes large and lateral. Jaws toothless. In some species skull up to 20 cm long.

Remarks: Probably good swimmers.

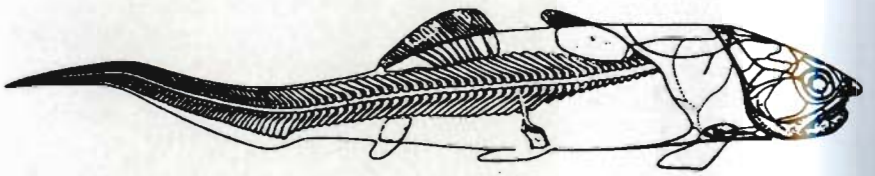
Recent relatives: None. Died out in Upper Devonian.



Oxyosteus, reconstruction after MILES.



Coccosteus cuspidatus MILLER (length c. 27 cm) from the Middle Devonian of Scotland. Original: Naturmuseum Senckenberg, Frankfurt-am-Main, Germany.



Coccosteus, reconstruction after STENSIÖ.

Genus: *Coccosteus* MILLER, 1841.

Horizon: Middle Devonian.

Geographical distribution: Western and Eastern Europe.

Features: Roof of skull relatively deep. Eyes of middle size and placed laterally. Pectoral fins roughly in the middle of the body. Dorsal fin present. Trunk armour broad. Body long and slender, ending in a pointed tail. Maximum length c. 40 cm.

Remarks: Probably good swimmers. The genus is known from both fresh-water and marine deposits.

Recent relatives: None. Died out in Middle Devonian.



Millerosteus minor (MILLER) (length c. 6 cm) from the Middle Devonian of Caithness, Scotland, U.K. Original: Field Museum of Natural History, Chicago, Illinois, U.S.A.

Genus: *Millerosteus* STENSIÖ, 1959.

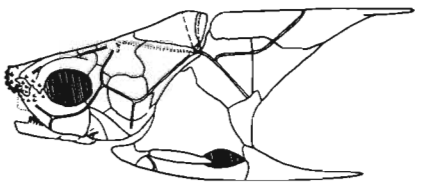
Horizon: Middle Devonian.

Geographical distribution: Western and Eastern Europe.

Features: Small placoderms. Length about 10 cm. Head shield rather deep. Eyes relatively large. Median dorsal shield long and slender with a spine at the end. Lateral spines also long and slender. One of the smallest placoderms.

Remarks: Bottom dwellers with moderate ability for free-swimming.

Recent relatives: None. Died out in Middle Devonian.



Millerosteus, reconstruction after DESMOND.



Watsonosteus fletti (WATSON) (length c. 58 cm) from the Middle Devonian of the Orkney Islands, Scotland, U.K. Copy: de Buisonje Collection, Amsterdam, Netherlands.

Genus: *Watsonosteus* MILES & WESTOLL, 1963.

Horizon: Middle Devonian.

Geographical distribution: Europe.

Features: Head shield moderately broad. Eyes middle-sized and lateral. Dorsal fin short and broad and located at anterior end of body behind armour. Tail long and ending in a point. Pectoral fins relatively large. Length about 60 cm.

Remarks: Probably good swimmers.

Recent relatives: None. Died out in Devonian.



Pholidosteus friedelti JAEKEL (length c. 17 cm) from the Upper Devonian of Bad Wildungen, Rhineland, Germany. Cast: American Museum of Natural History, New York, N.Y., U.S.A.

Genus: *Pholidosteus* JAEKEL, 1907.

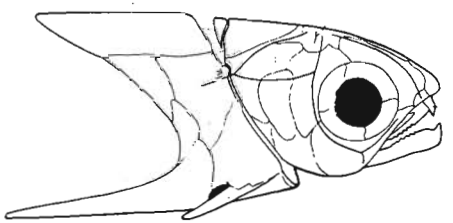
Horizon: Upper Devonian.

Geographical distribution: Europe.

Features: Middle-sized placoderms. Eyes extremely large, with sclerotic rings. Jaws toothed. Lateral spines short and narrow. Shape slender and elongate.

Remarks: Free-swimming.

Recent relatives: None. Died out in Upper Devonian.



Pholidosteus, reconstruction after GROSS.



Dunkleosteus terelli (NEWBERRY) (length c. 110 cm) from the Upper Devonian of Cleveland, Ohio, U.S.A. Original: Cleveland Museum of Natural History, Ohio, U.S.A.

Genus: *Dunkleosteus* LEHMAN, 1956.

Synonyms: *Dinichthys*.

Horizon: Upper Devonian.

Geographical distribution: Western and eastern Europe. North Africa, North America.

Features: Very large placoderms with massive skull. Maximum length about 6–8 m. Skull alone may be 65 cm long. Together with reduced body armour, may reach 110 cm. Enormous jaws toothless but strongly serrated. Eyes relatively small.

Remarks: Free-swimming, dangerous predators which need not even have feared sharks.

Recent relatives: None. Died out in Upper Devonian.



Dunkleosteus, reconstruction after MACMILLAN.

PLACODERMI
Order: Arthrodiriformes
Family: Dinichthyidae

Placoderms
Suborder: Coccosteoidei



Eastmanosteus calliaspis DENNIS-BRYAN (length c. 35 cm) from the Lower Devonian of Paddy's Springs, Western Australia. Original: Australian Museum, Sydney, Australia.

Genus: *Eastmanosteus* OBRUCHEV, 1964.

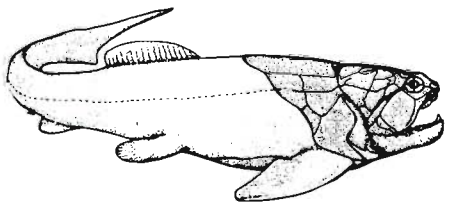
Horizon: Middle Devonian to Upper Devonian.

Geographical distribution: North Africa, North America, western and eastern Europe, southwest Asia.

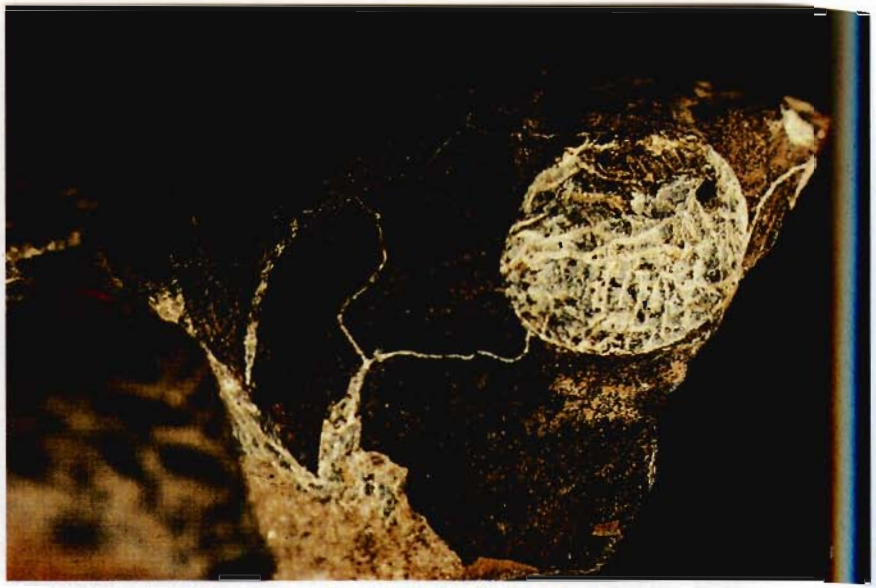
Features: Large skull. Reduced dorsal and lateral armour. Relatively small eyes. Length probably 2–3 m. Powerful serrated toothless jaws. Much like *Dunkleosteus* but in some ways more primitive.

Remarks: Free-swimming predators.

Recent relatives: None. Died out in Lower Devonian.



Eastmanosteus, reconstruction after West Australian Museum.



Brachyosteus dietrichi GROSS (length c. 5 cm) from the Upper Devonian of Bad Wildungen, Hesse, Germany. Original: Museum für Naturkunde, Berlin, Germany.

Genus: *Brachyosteus* JAEKEL, 1927.

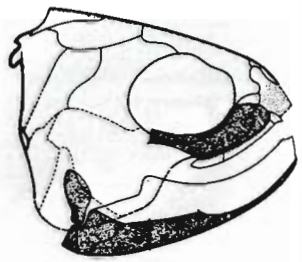
Horizon: Upper Devonian.

Geographical distribution: Europe.

Features: Small to medium-sized fishes with rather deep head. Central dorsal plate short and with a weak keel.

Remarks: Predatory fishes.

Recent relatives: None. Died out in Upper Devonian.



Brachyosteus, reconstruction after MILES.



Bothriolepis canadensis WHITEAVES (length c. 11 cm) from the Upper Devonian of Miguasha, Gaspé Peninsula, Quebec, Canada. Original: The Natural History Museum, London, U.K. (P56844).



Bothriolepis, reconstruction after West Australian Museum.

Genus: *Bothriolepis* EICHWALD, 1840

Synonyms: *Bothryolepis*, *Glyptosteus*, *Homothorax*, *Macrobrachius*, *Parmphractus*, *Phoebammon*, *Placothorax*, *Shurcabroma*, *Stanacanthus*.

Horizon: Middle to Upper Devonian.

Geographical distribution: Western and eastern Europe, Antarctica, North America, Greenland, central Asia, northern Asia, southwest Asia, Australia.

Features: Head shield short and deep. Body armour almost egg-shaped. Body ends in pointed caudal fin with a narrow fin fold above and a broad lobe beneath. Eyes close together and facing forward. Mouth terminal and relatively small. Two dorsal fins. Maximum length 40–50 cm.

Remarks: Free swimming.

Recent relatives: None. Died out in Upper Devonian.



Asterolepis maxima (AGASSIZ) (length c. 28 cm) from the Upper Devonian of Scotland, U.K. Original: National Museum of Scotland, Edinburgh, U.K.

Genus: *Asterolepis* EICHWALD, 1840.

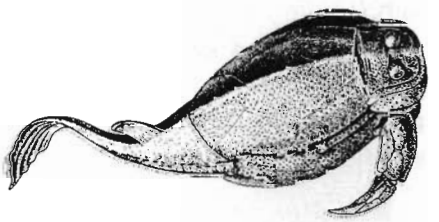
Horizon: Middle Devonian to Upper Devonian.

Geographical distribution: Western and Eastern Europe, North America, Greenland, Spitzbergen, eastern Asia, Australia.

Features: Head shield short and deep. Eyes close together. Body armour extending into a little point. Paired limbs reach back past the middle of the dorsal shield. A single dorsal fin. Body tapering in a point. Maximum length probably between 60 and 70 cm.

Remarks: Free-swimming.

Recent relatives: None. Died out in Upper Devonian.



Asterolepis, reconstruction after ORLOV.



Microbrachius dicki TRAQUAIR (length c. 3 cm) from the Middle Devonian of the Orkney Islands, Scotland, U.K. Original: National Museum of Scotland, Edinburgh, U.K.

Genus: *Microbrachius* TRAQUAIR, 1888.

Synonyms: *Microbrachium*.

Horizon: Middle Devonian.

Geographical distribution: Europe.

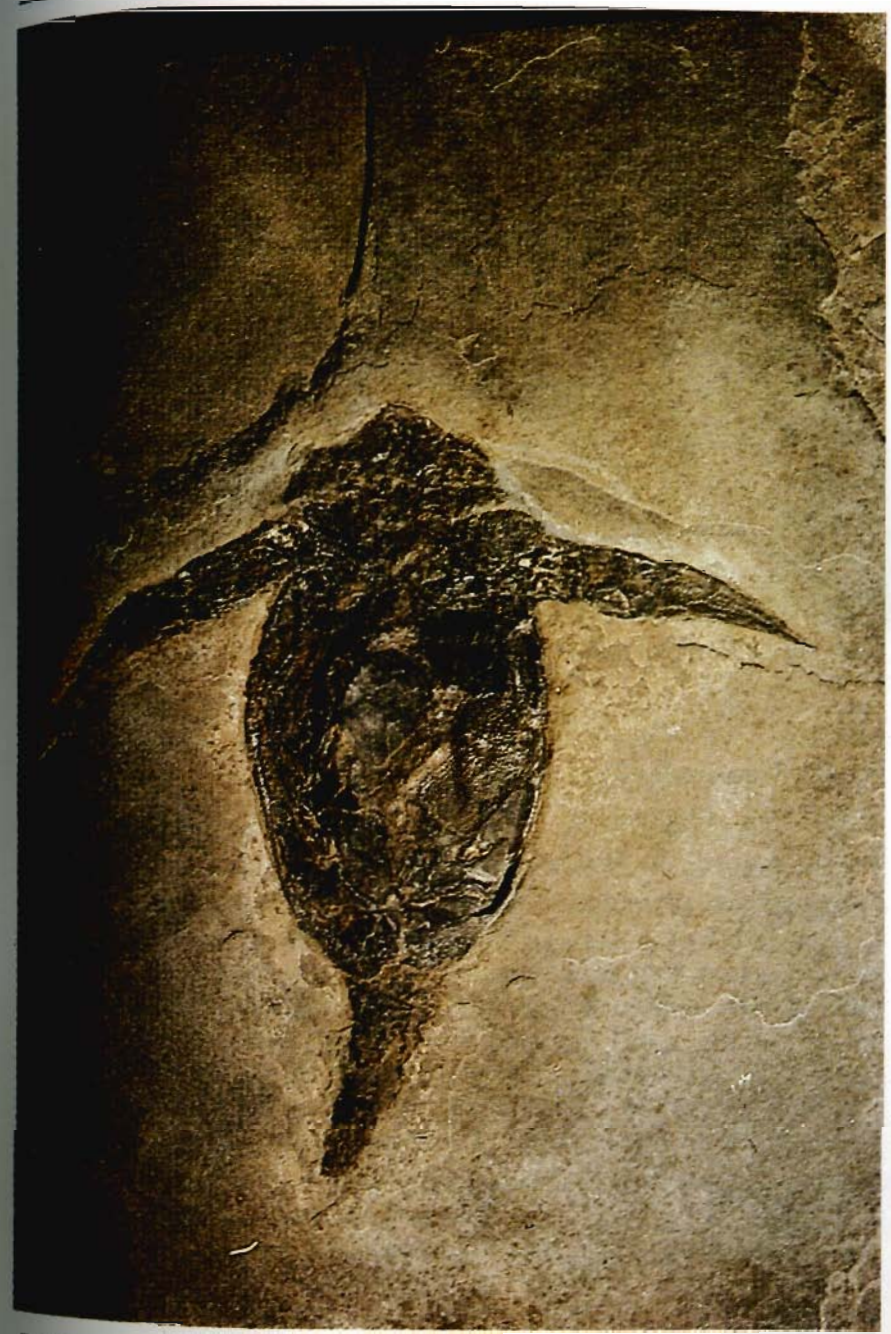
Features: A dwarf among placoderms. Length scarcely more than 6 cm. Relatively large head shield and relatively short and broad dorsal armour. The paired limbs scarcely extend beyond the half length of the dorsal armour. Systematic position still uncertain.

Remarks: Free swimmers, lived in fresh water.

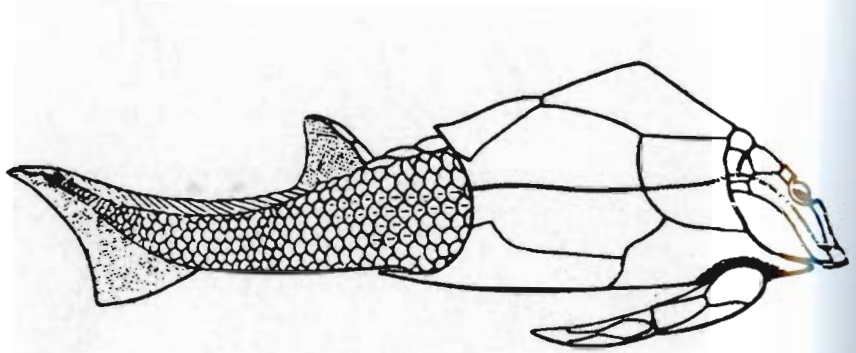
Recent relatives: None. Died out in Middle Devonian.



Microbrachius, reconstruction after TRAQUAIR.



Pterichthyodes milleri AGASSIZ (length c. 15 cm) from the Middle Devonian of Caithness, Scotland. Original: Frickhinger Collection, Munich, Germany.



Pterichthyodes, reconstruction after TRAQUAIR.

Genus: *Pterichthyodes* BLEEKER, 1859.

Synonyms: *Pterichthys*.

Horizon: Lower to Middle Devonian.

Geographical distribution: Europe, Australia.

Features: Head shield short and deep. Eyes facing forward and close together. Together with the nasal opening between them form a common orbito-nasal opening. Lower surface of head shield not armoured, carrying very delicate jaws and the mouth. Armoured paired limbs which extend back to two-thirds the length of the trunk armour. These limbs correspond functionally to the pectoral fins of higher fishes. Length c. 30 cm.

Remarks: Fresh-water fishes. Partly bottom-dwellers, partly free-swimming.

Recent relatives: None. Died out in Middle Devonian.



Remigolepis sp. (length c. 17 cm) from the Upper Devonian of Mount Smith Woodward, Greenland. Original: Geologisk Museum, Copenhagen, Denmark.

Genus: *Remigolepis* STENSIÖ, 1931.

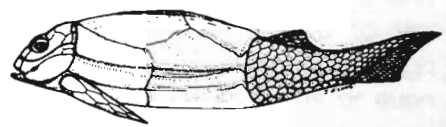
Horizon: Upper Devonian.

Geographical distribution: Europe, Greenland, Australia.

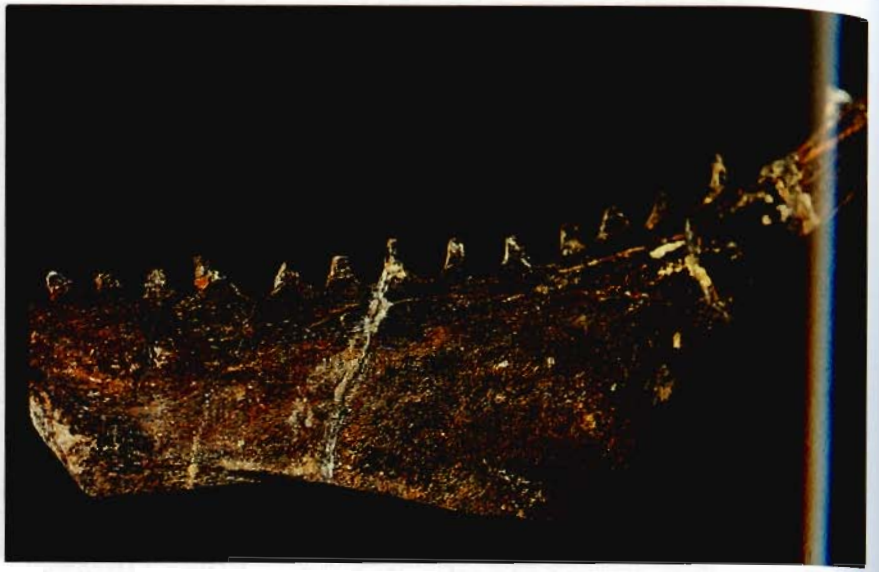
Features: Head shield short and deep. Body armour long, narrow and low. Paired limbs of a single piece (with no included articulation), reaching back to the posterior two-thirds of the body armour. The body behind the armour covered with rounded-rectangular scales. Caudal fin consists of lower lobe only. Length c. 40 cm.

Remarks: Bottom dwelling but free-swimming.

Recent relatives: None. Died out in Upper Devonian.



Remigolepis, reconstruction after West Australian Museum.



Diplognathus mirabilis NEWBERRY (length c. 18 cm) from the Upper Devonian of Cleveland, Ohio, U.S.A. Original: American Museum of Natural History, New York, N.Y., U.S.A.

Genus: *Diplognathus* NEWBERRY, 1878.

Horizon: Upper Devonian.

Geographical distribution: North America.

Features: Middle-sized placoderms with powerful jaws, which were probably up to 45 cm long and had a low sharp cutting edge and pointed teeth in the anterior part. In the posterior part the teeth are curved. Systematic position not yet resolved.

Remarks: Free-swimming predatory fishes.

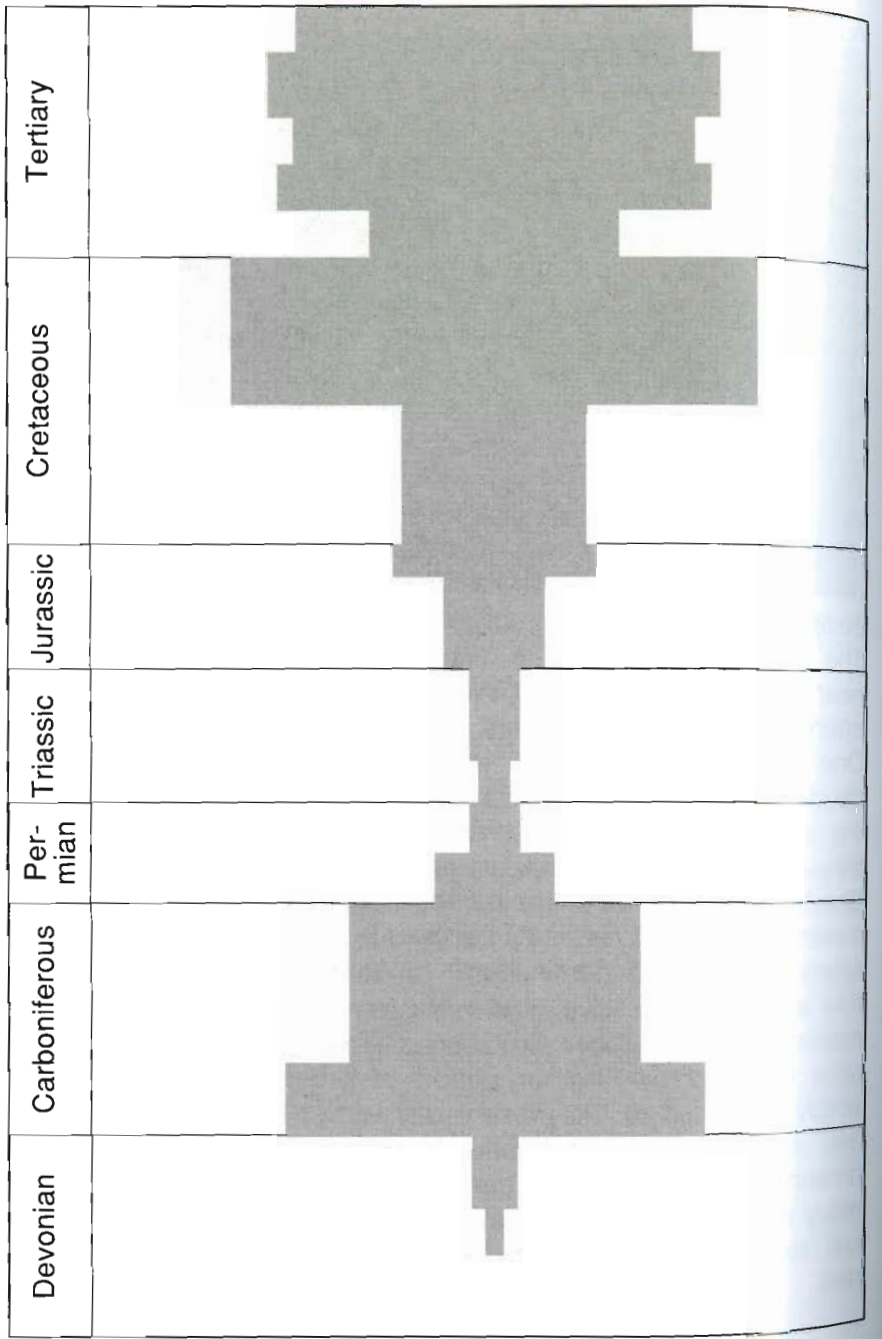
Recent relatives: None. Died out in Upper Devonian.

As the name implies, the endoskeleton may be calcified in these fishes but never contains true bony tissue. In an evolutionary sense, ossification is usually seen as more advanced than cartilage but in these fishes cartilaginisation seems to have been a success.

Cartilaginous fishes include the sharks, angel sharks, rays and chimaeras. The surface of the body is mostly covered with placoid scales which consist of a basal plate and a tooth-like upper part of various shapes. From the evolutionary point of view, the teeth can be seen as placoid scales which have migrated into the mouth. When worn away or lost, they can be replaced. The following types of dentition are distinguished: 1) the catching dentition comprising two rows of sharp teeth—this is typical for free-swimming sharks; 2) the grasping dentition of bottom-dwelling sharks—this consists of several rows of small pointed teeth lying one behind the other; and, finally, 3) the crushing dentitions of rays and chimaeras where the teeth are rounded, or form pavements or are developed as tooth plates.

The paired pectoral fins are mostly lateral in position and situated near the most posterior gill slits. The ventral fins are simpler and often bear hook-like claspers which facilitate internal fertilization. One or two dorsal fins may exist and an anal fin is present. The caudal fin is usually heterocercal with the vertebral column bending upwards into the larger upper lobe. The fin rays consist of thin, flexible unjointed rods named actinotricha.

Sharks first appear in the Middle Devonian. They had a brief maximum in the Lower Carboniferous and then the number of species decreased continuously up to the Lower Triassic. After this a new progressive phase began which led to an absolute maximum in the Upper Cretaceous. Then there was a new decline followed by another period of prosperity in the Eocene which continues to the present day with 100 recent genera and 340 species. The first sharks lived in fresh water. Up to the present, about 370 fossil genera have been described, though many of them only on the basis of incomplete specimens or even just teeth, fin spines etc. Complete fossil specimens are very rare.



The approximate distribution of cartilaginous fishes in geological time, changed after MÜLLER

Order: Palaeospondyliformes
Family: Palaeospondylidae



Palaeospondylus gunni TRAQUAIR (length c. 4 cm) from the Middle Devonian of Scotland. Original: Henne Collection, Stuttgart.

Genus: *Palaeospondylus* TRAQUAIR, 1890.

Horizon: Middle Devonian.

Geographical distribution: Europe.

Features: Little fishes scarcely 4 cm long. All trace of exoskeleton absent. Vertebral column of calcified ring-shaped centra. Skull relatively large. Pectoral and pelvic fins supposedly present.

Remarks: Systematic position unclear. Possibly larvae of larger fishes or dwarfed forms.

Recent relatives: None.



Palaeospondylus, reconstruction after MACMILLAN.



Expleuracanthus gaudryi HEYLER (length c. 58 cm) from the Upper Carboniferous of Commentry, France. Original: Muséum National d'Histoire Naturelle, Paris, France. Photograph: Serette, Paris.

Genus: *Expleuracanthus* BRONGNIART, 1888.

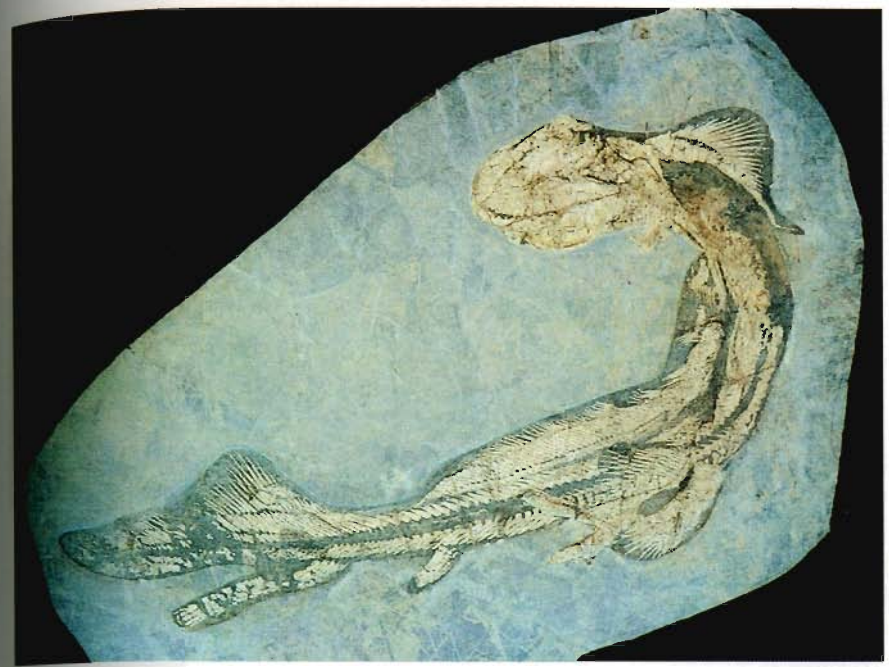
Horizon: Upper Carboniferous.

Geographical distribution: Europe.

Features: Slender Middle-sized sharks. Head deep and elongate. Eyes large. Mouth deeply incised and ventral. A long spine in the middle of the head. Dorsal fin low and fin-fold like. Begins shortly behind the head and extends back to the caudal fin. The latter surrounds the posterior end of the body and runs forward along the belly. Pelvic fins relatively broad. Pectoral fins narrow. Teeth very weak.

Remarks: *Expleuracanthus* has recently been considered as a synonym of *Triodus*.

Recent relatives: None. Died out in Carboniferous.



Orthacanthus senckenbergianus FRITSCH (length c. 220 cm) from the Lower Permian of Rockenhausen, Palatinate, Germany. Original: Naturmuseum Senckenberg, Frankfurt-am-Main, Germany.

Genus: *Orthacanthus* AGASSIZ, 1843.

Synonyms: *Aganodus*, *Compsacanthus*, *Diplodus*, *Dissodus*, *Eucompsacanthus*, *Ochlodus*, *Pternodus*.

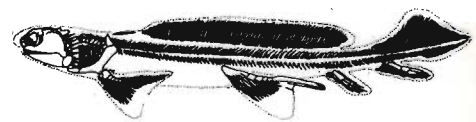
Horizon: Upper Carboniferous to Lower Permian.

Geographical distribution: Europe, North America, East Asia.

Features: Large sharks with an occipital spine situated immediately behind the head and attached to the shoulder girdle. This spine is long, pointed and oval or circular in section. Its posterior side ornamented with two parallel rows of thorns. Teeth relatively large, with two longer lateral cusps and a smaller central cusp. Pectoral fins long and pointed. Snout rounded. Mouth large.

Remarks: Predatory fish which were able to overpower even large prey.

Recent relatives: None. Died out in Permian.



Orthacanthus, reconstruction after HEIDTKE.



Triodus sesselis JORDAN (length c. 50 cm) from the Permian of Odernheim, Palatinate, Germany. Original: Interfoss, Munich, Germany.

Genus: *Triodus* JORDAN, 1849.

Synonyms: *Expleuracanthus*.

Horizon: Lower Permian.

Geographical distribution: Europe.

Features: Occipital spine like that of *Orthacanthus* but weaker. Teeth very small with two larger lateral cusps and a smaller middle cusp. Mouth large, slightly ventral. Fin extends from the neck region, over the pointed caudal end of the body forward to the posterior end of the belly. Pelvic and pectoral fins somewhat expanded.

Remarks: Predatory fishes.

Recent relatives: None. Died out in Lower Permian.



Xenacanthus meisenheimensis HAMPE (length c. 75 cm) from the Lower Permian of Meisenheim, Palatinate, Germany. Original: Interfoss, Munich, Germany.

Genus: *Xenacanthus* BEYRICH, 1848.

Synonyms: *Hypospondylus*.

Horizon: Lower Permian.

Geographical distribution: Europe.

Features: Middle-sized sharks with a long, slender body. Occipital spine long, relatively thin, of oval section. This spine has lateral thorns near the base. Teeth small, with two strong lateral cusps and an appreciably smaller middle cusp. End of tail bent slightly upwards. Caudal fin extends far forwards as a fin fold and separated from equally fold-like dorsal fin by a constriction. Pectoral and pelvic fins broad.

Remarks: Predatory fishes.

Recent relatives: None. Died out in Lower Permian.



Xenacanthus, reconstruction after FRITSCH.



Cladoselache clarki CLAYPOLE (length c. 60 cm) from the Devonian of Cleveland, Ohio, U.S.A. Original: Museum of Natural History, Cleveland, Ohio, U.S.A.

Genus: *Cladoselache* DEAN, 1894.

Synonyms: *Cladodus*.

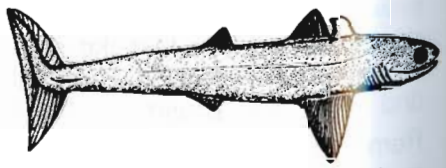
Horizon: Upper Devonian.

Geographical distribution: North America.

Features: Sharks with slim spindle-shaped body. Head with blunt snout. Two dorsal fins. Heterocercal forked caudal fin which nevertheless externally looks almost homocercal. Skin largely naked. Teeth with a large middle cusps and smaller lateral cusps (cladodont). Very large pectoral fins. A strong spine in front of the first dorsal fin. Maximum length c. 1 m.

Remarks: Probably rapid swimmers and formidable predators.

Recent relatives: None. Died out in Upper Devonian.



Cladoselache, reconstruction after HARRIS.



Diademodus hydei HARRIS (length c. 39 cm) from the Upper Devonian of Cleveland, Ohio, U.S.A. Original: Museum of Natural History, Cleveland, Ohio, U.S.A.

Genus: *Diademodus* HARRIS, 1951.

Synonyms: *Tiaradontus*.

Horizon: Upper Devonian.

Geographical distribution: North America.

Features: Small primitive sharks. Body covered with blunt dermal denticles. Teeth small, symmetrical. Two higher cusps in middle and a smaller one at each end. Probably only one dorsal fin. Male with claspers.

Remarks: Small sharks but nevertheless, in view of the sharp teeth, formidable predators.

Recent relatives: None. Died out in Upper Devonian.



Diademodus, reconstruction after HARRIS.



Symmorium reniforme COPE from the Upper Carboniferous of Indiana, U.S.A. Original: Field Museum of Natural History, Chicago, Illinois, U.S.A.

Genus: *Symmorium* COPE, 1839.

Synonyms: *Cladodus*.

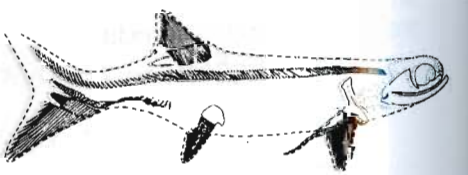
Horizon: Lower Carboniferous to Upper Carboniferous.

Geographical distribution: Europe, North America.

Features: Maximum length 3 m. Head relatively small. Lower jaw somewhat longer than upper jaw. Only one dorsal fin which lies in the posterior third of the body. Caudal fin slightly forked. Teeth cladodont (see *Cladoselache*). Body without spines.

Remarks: Predators with sharp teeth.

Recent relatives: None. Died out in Upper Carboniferous.



Symmorium, reconstruction after WILLIAMS.



Damocles serratus LUND (length c. 5 cm) from the Lower Carboniferous of Bear Gulch, Montana, U.S.A. Original: Adelphi University, Garden City, N.J., U.S.A.

Genus: *Damocles* LUND, 1986.

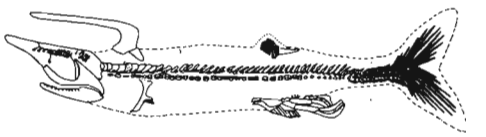
Horizon: Lower Carboniferous.

Geographical distribution: North America.

Features: Small slender sharks. Dorsal fin small and located in posterior third of body. Caudal fin forked. Upper part of head elongated to a point. Mouth displaced posteriorly. Characteristic recurved occipital spine stretched horizontally over head. Lower surface of this spine denticulate. Males with claspers in posterior third of ventral surface.

Remarks: Small predators.

Recent relatives: None. Died out in Lower Carboniferous.



Damocles, reconstruction after LUND.



Falcatus falcatus (St. John & Worthen) (length c. 15 cm) from the Lower Carboniferous of Bear Gulch, Montana, USA. Original: Staatliches Museum für Naturkunde, Karlsruhe, Germany.

Genus: *Falcatus* Lund, 1985.

Synonyms: *Physonemus.*

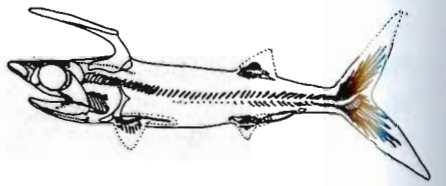
Horizon: Lower Carboniferous.

Geographical distribution: North America.

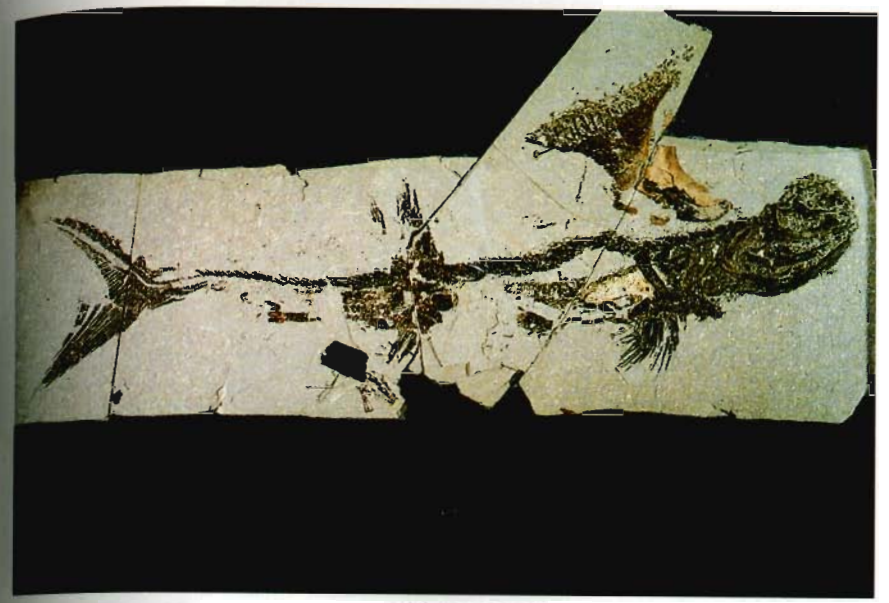
Features: Small slender fishes. Upper snout area very pointed. Mouth posterior. Eyes large. Caudal fin forked. Characteristic occipital spine pointed forward over head. It is relatively long and originates from a broad base.
The upper section is flattened.

Remarks: Small predators.

Recent relatives: None. Died out in Lower Carboniferous.



Falcatus, reconstruction after Lund



Stethacanthus sp. (length c. 70 cm) from the Upper Carboniferous of Bearsden, Glasgow, Scotland, U.K. Original: Hunterian Museum, Glasgow, U.K. Photograph: Hunterian Museum.

Genus: *Stethacanthus* Newberry, 1889.

Synonyms: *Cladodus*, *Lambdodus*, *Physonemus*.

Horizon: Upper Devonian to Upper Carboniferous.

Geographical distribution: Europe, North America.

Features: Middle-sized sharks with slender bodies. Head narrow. Snout pointed. In the dorsal mid line, immediately behind the head is a characteristic mushroom-shaped structure with a broad base. Upper margin of this structure expanded and with spines arranged to form a brush. Dorsal fin in the posterior half of the body, directly above the anal fin which is somewhat smaller. Pectoral fins narrow, each with a worm-like appendage arising from the base.

Remarks: Predatory fishes. The significance of the brush-like appendage uncertain.

Recent relatives: None. Died out in out in Upper Carboniferous.



Stethacanthus, reconstruction after Hunterian Museum.



Helicoprion bessonovi KARPINSKY (length c. 15 cm) from the Lower Permian of Russia. Original: Muséum National d'Histoire Naturelle, Paris, France. Photograph: Serette, Paris.

Genus: *Helicoprion* KARPINSKY, 1899.

Synonyms: *Lissoprion*.

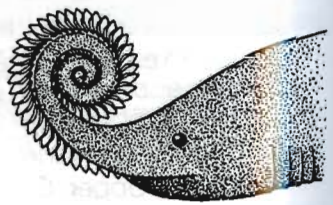
Horizon: Lower Permian.

Geographical distribution: Europe, eastern Asia, Australia, North America.

Features: Nothing known of this fish except the very striking teeth. These are laterally very compressed and form a tight spiral which, when adult, may comprise three whorls with a total of up to 180 teeth. Adult animals must have been more than 1 m long.

Remarks: Predatory mode of life.

Recent relatives: None. Died out in Permian.



Helicoprion, after LONG.



Edestus sp. (length c. 28 cm) from the Upper Devonian of St. Clair Co., Illinois, U.S.A. Original: Museum of Natural History, Lawrence, Kansas, U.S.A.

Genus: *Edestus* LEIDY, 1855.

Synonyms: *Edestes*, *Edestodus*, *Protospirata*.

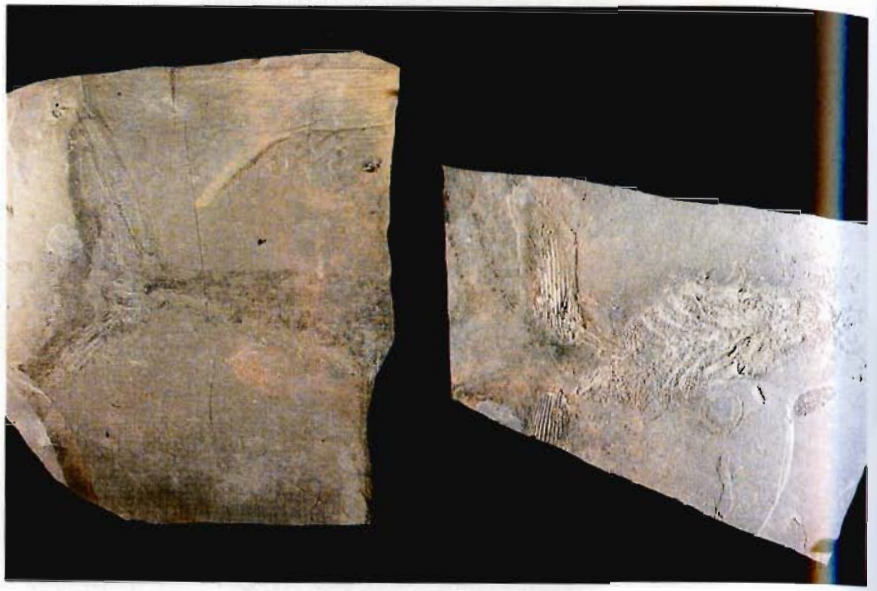
Horizon: Upper Carboniferous.

Geographical distribution: North America, western and eastern Europe.

Features: Relatively large sharks preserved only as their characteristic dentitions. The teeth are in characteristic whorls and usually broader than long. Both sides of the teeth are sharply serrated. Arrangement of teeth alternating.

Remarks: Predatory fishes. Their teeth suggest that they could overpower even large prey.

Recent relatives: None. Died out in Upper Carboniferous.



Unnamed shark (length c. 80 cm) from the Trias of Wapiti Lake, Canada. Original: Tyrell Museum of Paleontology, Drumheller, Alberta, Canada.

Genus: Unnamed.

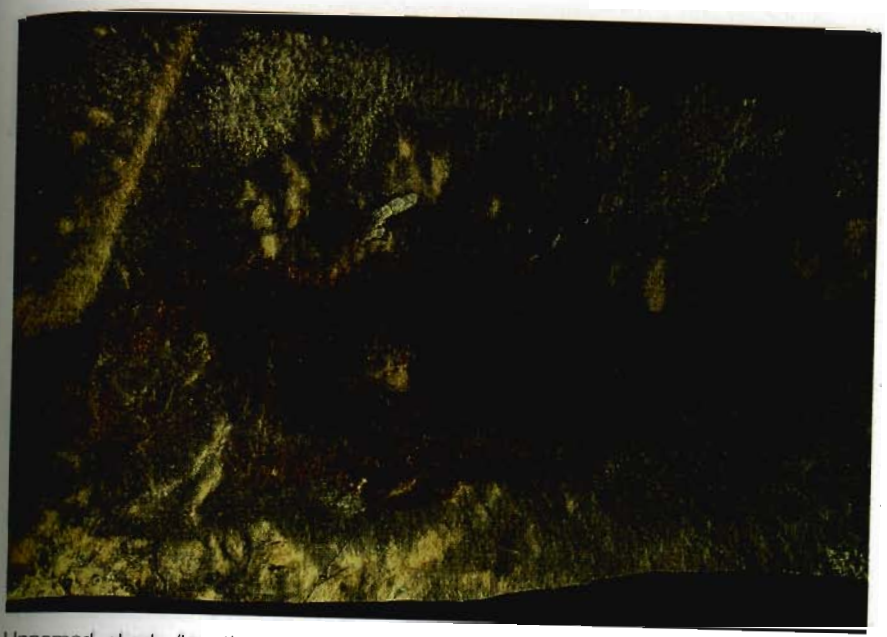
Horizon: Trias.

Geographical distribution: North America.

Features: A still undescribed edestid with the body well preserved. Skull long and narrow. Pectoral fins slender and very large. Caudal fin forked and unusually large. Body slender.

Remarks: Probably very rapid and skillful swimmers.

Recent relatives: None. Died out in Triassic.



Unnamed shark (length c. 12 cm) from the Lower Carboniferous of Bear Gulch, Montana, U.S.A. Original: Adelphi University, Garden City, N.J., U.S.A.

Genus: Not named.

Horizon: Lower Carboniferous.

Geographical distribution: North America.

Features: Genus not yet described. Evidently relatively small, plump sharks. Body laterally compressed. Head short. Fins small. Even the caudal fin has an "undeveloped" look.

Remarks: Probably more bottom-dwellers than free-swimming. Some members of the family Orodontidae, however, include members 3 m long.

Recent relatives: None. Died out in Lower Carboniferous.



Janassa bituminosa von SCHLOTHEIM (length c. 54 cm) from the Permian of Bad Sachsa, Lauterberg, Harz, Germany. Original: private Possession.

Genus: *Janassa* MÜNSTER, 1839.

Synonyms: *Acrodus*, *Byzenos*, *Climaxodus*, *Dictea*, *Ianassa*, *Peltodus*, *Strigilina*, *Thoracodus*, *Trilobites*.

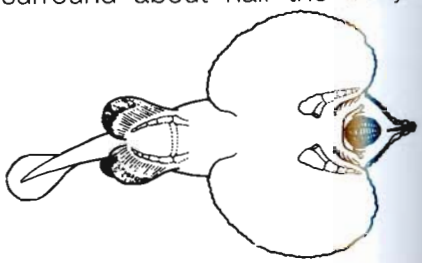
Horizon: Lower Carboniferous to Upper Permian.

Geographical distribution: Western and eastern Europe, North America, Greenland.

Features: Middle-sized fishes. Dorso-ventrally compressed and ray-like shape. Beak-like mouth on lower surface. Teeth arranged in longitudinal and transverse rows. Pectoral fins large, broad and semicircular. Anteriorly they surround about half the body. Small pelvic fins separated by a short distance from the pectoral fins. Dorsal fin situated above the pelvic fins. Body tapers to a point at the tail. Caudal fin rounded.

Remarks: Bottom-dwellers. Lived on hard food.

Recent relatives: None. Died out Upper Permian.



Janassa, reconstruction after SCHAUMBERG.



Belantsea montana LUND (length c. 27 cm) from the Lower Carboniferous of Bear Gulch, Montana, U.S.A. Original: Adelphi University, Garden City, N.J., U.S.A.

Genus: *Belantsea* LUND, 1989.

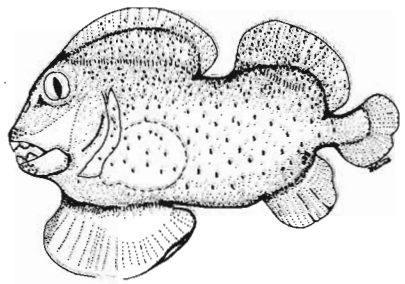
Horizon: Lower Carboniferous.

Geographical distribution: North America.

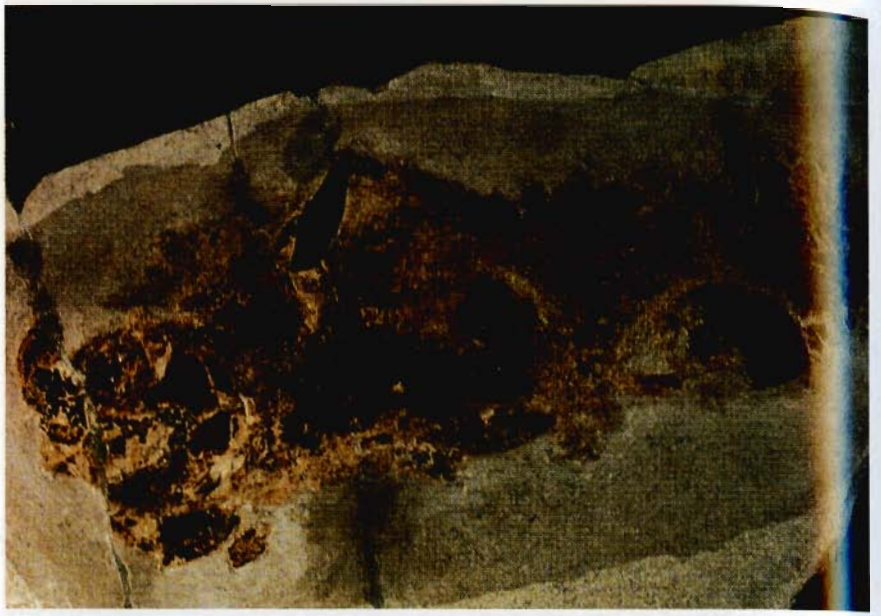
Features: Middle-sized fishes of laterally flattened shape. Head deep. Mouth relatively small with strong dentition. Dorsal mid line with two humps carrying the two dorsal fins. Pectoral fins small. Pelvic fins very large. Caudal fin rounded. All fins give impression of being veil-like. Body covered with small denticles.

Remarks: Free-swimming, but nevertheless could only have been very lethargic swimmers.

Recent relatives: None. Died out in Lower Carboniferous. Lower Carboniferous.



Belantsea, reconstruction after LUND.



Acronemus tuberculatus (Bassani) (length c. 29 cm) from the Triassic of Monte San Giorgio, Switzerland. Original: Paläontologisches Museum, Zürich, Switzerland.

Genus: *Acronemus* Rieppel, 1982.

Synonyms: *Acrodus*, *Adiapneustes*, *Psilacanthus*, *Sphenonchus*, *Thectodus*.

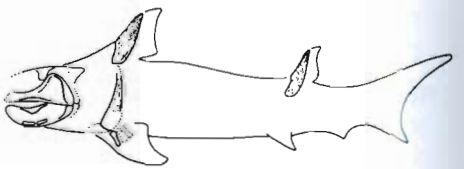
Horizon: Lower Triassic to Upper Cretaceous.

Geographical distribution: Europe, North America, South America, southern Asia, Spitzbergen.

Features: Small to middle-sized sharks. Head large. Body tapers moderately rearwards. Two dorsal fins, both carried by a powerful spine. Pectoral fins relatively large. Ventral and anal fins small. Another spine located above pectoral fins.

Remarks: Predatory fishes.

Recent relatives: None. Died out in Upper Cretaceous.



Acronemus, reconstruction after Rieppel.



Hamiltonichthys mapesi Maisey (length c. 28 cm) from the Upper Carboniferous of Greenwood County, Kansas, U.S.A. Original: Museum of Natural History, Lawrence, Kansas, U.S.A.

Genus: *Hamiltonichthys* Maisey, 1969.

Horizon: Upper Carboniferous.

Geographical distribution: North America.

Features: Small slim sharks. Body tapers to a pointed heterocercal caudal fin with a large lower lobe. Eyes small. Mouth slightly ventral. Teeth pointed and arranged spirally.

Remarks: Small predatory fish.

Recent relatives: None. Died out in Upper Carboniferous.



Hamiltonichthys, reconstruction after Maisey.



Hybodus hauffianus FRAAS (length c. 260 cm) from the Lower Jurassic of Holzmaden, Wurtemberg, Germany. Original: Staatliches Museum für Naturkunde, Stuttgart, Germany. Photograph: Lumpe, Stuttgart.

Genus: *Hybodus* AGASSIZ, 1837.

Synonyms: *Leiacanthus*, *Meristodon*, *Orthybodus*, *Parhybodus*, *Selachidea*.

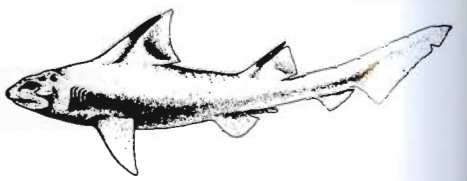
Horizon: Upper Permian to Upper Cretaceous.

Geographical distribution: Europe, Spitzbergen, Greenland, North America, Eastern Asia, Australia.

Features: Large sharks with big head and massive body. Caudal fin heterocercal with an elongate upper lobe. Lower lobe relatively small. Two dorsal fins, each supported by a powerful spine. Pectoral fins elongate. Teeth elongate at the base with a main cusp and several subsidiary cusps and with striated surface. The males have hook-shaped head spines behind the eyes.

Remarks: Predatory fish. However, they can be shown to have taken not only fishes but also belemnites.

Recent relatives: None. Died out in Upper Cretaceous.



Hybodus, reconstruction after MAISEY.



Wodnika striatula MÜNSTER (length c. 12 cm) from the Upper Permian of Richelsdorf, Hesse, Germany. Original: Bürger Collection, Bad Hersfeld, Germany.

Genus: *Wodnika* MÜNSTER, 1843.

Synonyms: *Radamas*.

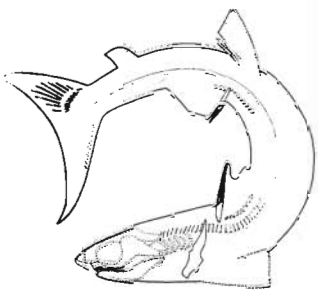
Horizon: Upper Permian.

Geographical distribution: Europe, North America.

Features: Middle-sized to large fishes, torpedo-shaped. Skull narrow. Snout pointed. Eyes relatively large. Mouth deeply incised. Lower jaw displaced rearwards. Both jaws set with bean-shaped teeth. Two dorsal fins, each supported by a furrowed spine. Anterior spine longer. Caudal fin with broad lower lobe. Anal fin small.

Remarks: The teeth suggest that these were not predators but that they fed on crustaceans and other invertebrates.

Recent relatives: None. Died out in Upper Permian.



Wodnika, reconstruction after SCHAUMBERG.



Heteropetalus elongatulus Lund (length c. 12 cm) from the Lower Carboniferous of Bear Gulch, Montana, U.S.A. Original: Carnegie Museum of Natural History, Pittsburgh, Penn., U.S.A.

Genus: *Heteropetalus* Lund, 1977.

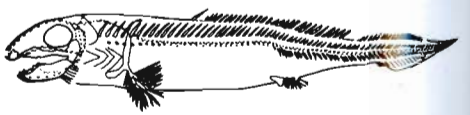
Horizon: Lower Carboniferous.

Geographical distribution: North America.

Features: Elongate shape. Snout elongate but truncate at end. Long, almost fin-fold-like dorsal fin extends almost from the middle of the body into the posterior third. In front of it is a weak spine. Body tapers towards the caudal fin which is diphycercal with a broad lower lobe. Mouth slightly ventral. Teeth small but powerful. Dermal denticles present only along the lateral line.

Remarks: The teeth suggest a durophagous diet of snails, bivalves and other hard-shelled organisms.

Recent relatives: None. Died out in Lower Carboniferous.



Heteropetalus, reconstruction after Lund.



Heterodontus falcifer (Wagner) (length c. 28 cm) from the Upper Jurassic of Solnhofen, (Eichstätt), Bavaria, Germany. Original: Jura-Museum, Eichstätt, Germany.

Genus: *Heterodontus* de Blainville, 1816.

Synonyms: *Cestracion*, *Drepanephorus*, *Gyropleurodus*, *Platyacrodus*, *Pseudacrodus*, *Tropidotus*.

Horizon: Upper Jurassic to recent.

Geographical distribution: Europe, South America, Africa, Australia, New Zealand.

Features: Relatively small slender sharks. Head relatively big. Two dorsal fins, each supported by a powerful spine. Spines smooth and smaller than the fins. Pectoral fins large. Caudal fin short with large lobes. Teeth pointed in anterior part of jaw but plate-like posteriorly.

Remarks: Small predatory fishes.

Recent relatives: Closely related to the recent bullhead shark *Heterodontus*.



Heterodontus sp., a recent bullhead shark.



Paracestracion zitteli (WAGNER) (length c. 15 cm) from the Upper Jurassic of Solnhofen, (Eichstätt), Bavaria, Germany. Original: Carnegie Museum of Natural History, Pittsburgh, Penn. U.S.A.

Genus: *Paracestracion* KOKEN, 1911.

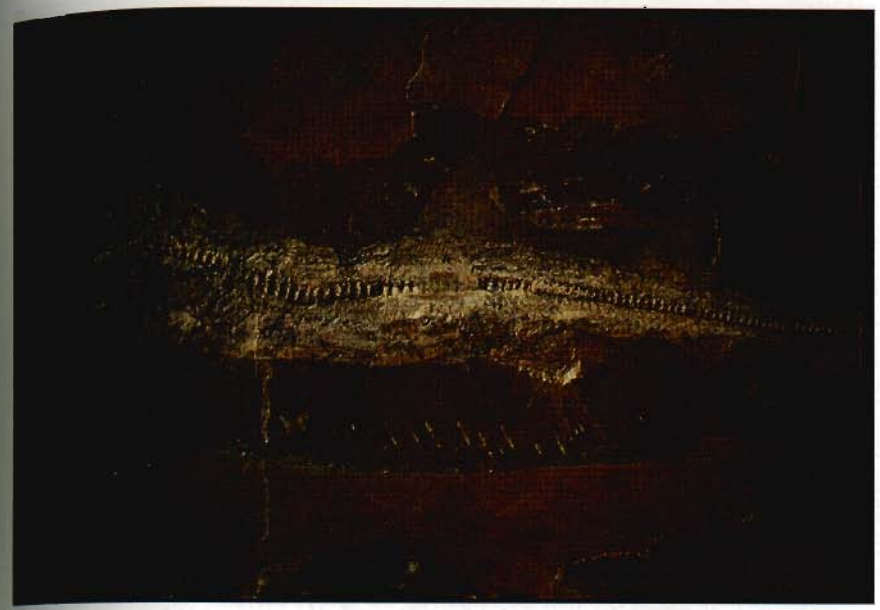
Horizon: Upper Jurassic.

Geographical distribution: Europe.

Features: *Paracestracion* differs from *Heterodontus* essentially in that the dorsal spines show a fine tuberculation on the sides. The teeth have a median keel.

Remarks: Some authors consider *Paracestracion* as a synonym of *Heterodontus*.

Recent relatives: Genus extinct. Distantly related to recent bullhead sharks of the family Heterodontidae which is represented in modern seas by one genus and eight species.



Corysodon cirinensis SAINT-SEINE from the Upper Jurassic of Cerin, France. Original: Musée Guimet d'Histoire Naturelle, Lyon, France. Photograph: Lyon Museum.

Genus: *Corysodon* SAINT-SEINE, 1949.

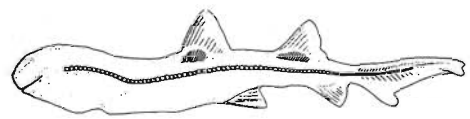
Horizon: Upper Jurassic.

Geographical distribution: Europe.

Features: Small sharks with two triangular dorsal fins, one approximately at middle of back and the other in the posterior third. Pelvic and anal fins obliquely beneath these. Teeth small and rather wide. Cutting edges not serrate.

Remarks: The genus *Corysodon* has recently been considered by some authors as a synonym of *Palaeoscyllium*.

Recent relatives: Genus extinct. Related to the recent nurse sharks.



Corysodon, reconstruction after SAINT-SEINE.



Orectolobus jurassicus WOODWARD (length c. 30 cm) from the Upper Jurassic of Solnhofen (Eichstätt), Bavaria, Germany. Original: Krauss Collection, Weissenburg, Germany.

Genus: *Orectolobus* BONAPARTE, 1838.

Geological range: Upper Jurassic to recent.

Geographical distribution: Europe.

Features: Small to middle-sized sharks. Body somewhat dorsoventrally flattened. The rounded pectoral fins smaller than in *Palaeocarcharias*. Snout blunt. Caudal fin with large lower lobe and small upper one.

Remarks: This genus has recently been taken as doubtful and assigned to *Phorcynis*.

Recent relatives: Supposed to be closely related to the recent nurse shark *Orectolobus*.



Orectolobus wardi, a recent nurse shark.



Palaeocarcharias stromeri BEAUMONT (length c. 86 cm) from the Upper Jurassic of Solnhofen (Eichstätt), Bavaria, Germany. Original: Jura-Museum, Eichstätt, Germany.

Genus: *Palaeocarcharias* de BEAUMONT, 1960.

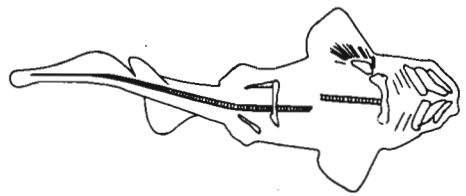
Geological range: Upper Jurassic.

Geographical distribution: Europe.

Features: Middle-sized sharks. Spindle-shaped bodies. Head short and rounded. Mouth almost terminal. Large triangular pectoral fins. Both dorsal fins and anal fin very posterior in position. Caudal fin long with rounded end. Teeth with broad bases, elongate and S-shaped if viewed from side.

Remarks: Predatory fishes.

Recent relatives: Genus extinct. Closely related to the recent nurse sharks of the family Orectolobidae which have 11 genera and about 28 species in recent seas.



Palaeocarcharias, reconstruction after BEAUMONT.



Phorcynis catulina THIOLLIÈRE from the Upper Jurassic of Cerin, France. Original: Musée Guimet d'Histoire Naturelle, Lyon, France.

Genus: *Phorcynis* THIOLLIÈRE, 1854.

Synonyms: *Crossorhinus*, *Crossorhinops*, *Palaeocrossorhinus*.

Geological range: Upper Jurassic.

Geographical distribution: Europe.

Features: Small sharks with broad rounded pectoral fins and two dorsal fins. Pelvic fin obliquely opposite posterior dorsal fin and near to the pectoral fins. Head deep and with a short snout. Teeth small and asymmetrical. Maximum length c. 40 cm.

Remarks: The placing of this genus in the Orectolobidae is disputed.

Recent relatives: Genus extinct. Supposedly related to the recent nurse sharks.



Phorcynis, reconstruction after SAINT-SEINE.



Mesiteia emiliae KRAMBERGER (length c. 27 cm) from the Upper Cretaceous of the Lebanon. Original: Henne Collection, Stuttgart, Germany.

Genus: *Mesiteia* KRAMBERGER, 1885.

Geological range: Upper Cretaceous.

Geographical distribution: Middle East.

Features: Small sharks with elongate slender bodies. Head short and deep. Nose pointed. Two well developed dorsal fins in posterior half of body, the first lying obliquely opposite ventral fins. Pectoral fins rounded. Anal fin fin-fold-like, beginning opposite the first dorsal fin and continuing to end of second dorsal fin. Caudal fin similarly developed as a fin-fold on both sides. Anterior teeth narrow with two lateral cusps. More posterior teeth asymmetrical.

Remarks: Small sharks which probably lived near the bottom but could swim well.

Recent relatives: None. Extinct in the Upper Cretaceous.



Carcharocles megalodon (AGASSIZ) from the Miocene. Original: Transvaal Museum, Pretoria, South Africa.

Genus: *Carcharocles* JORDAN & HANNIBAL, 1920.

Synonyms: *Carcharodon*, *Megaselachus*, *Procarcharodon*.

Geological range: Middle Eocene to Pliocene.

Geographical distribution: Europe, Africa, Australia, North America, southern Asia, South America, Indonesia, New Zealand.

Features: Known only from huge teeth which reach lengths of up to 15 cm. The crown is triangular, broad and high with finely serrate cutting edges.

Remarks: Judging by the teeth, *Carcharocles megalodon* may have reached a length of 30 m.

Recent relatives: None. Died out in the Pliocene.



Scapanorhynchus lewisii (DAVIS) (length c. 65 cm) from the Upper Cretaceous of the Lebanon. Original: Muséum National d'Histoire Naturelle, Paris, France. Photograph: Serette, Paris.

Genus: *Scapanorhynchus lewisii* WOODWARD, 1889.

Geological range: Lower Cretaceous to Recent.

Geographical distribution: Europe, southwestern Asia, Australia, New Zealand, Africa, South America.

Features: Middle-sized sharks of slender shape. Snout greatly elongated. Mouth ventral. Dorsal fins triangular and relatively small. Caudal fin very long. Pectoral fins narrow and pointed. Pelvic fins small and angular. Anal fin elongate.

Remarks: Predatory fishes.

Recent relatives: Closely related to the recent goblin shark *Scapanorhynchus* (=*Mitsukurina*) which occurs as a great rarity in northern seas.



Scapanorhynchus, reconstruction after MACMILLAN.



Squalicorax sp. (length c. 188 cm) from the Upper Cretaceous of Kansas, U.S.A. Original: National Museum of Natural History, Smithsonian Institution, Washington, D.C., U.S.A.

Genus: *Squalicorax* WHITLEY, 1939.

Synonyms: *Anacorax*, *Corax*, *Xenolamia*.

Geological range: Upper Cretaceous to Paleocene.

Geographical distribution: Europe, North America.

Features: Large sharks. Snout pointed. Pectoral fins triangular. Teeth small or large according to species. Asymmetrically triangular. Cutting edges strongly serrated.

Remarks: Predatory fishes.

Recent relatives: None. Died out in Paleocene.



Macrourogaleus hassei (WOODWARD) (length c. 12 cm) from the Upper Jurassic of Solnhofen (Eichstätt), Bavaria, Germany. Original: Bayerische Staatssammlung für Paläontologie, Munich, Germany.

Genus: *Macrourogaleus* FOWLER, 1947.

Synonyms: *Pristiurus*

Geological range: Upper Jurassic.

Geographical distribution: Europe.

Features: Very small representatives of the cat shark family which at present are only known to a length of about 12 cm. The head is long and blunt-ended. Probably two dorsal fins, the second one located far posteriorly, almost at beginning of caudal fin. Anal fin relatively long. Well developed caudal fin takes up almost one-third of the length of fish. Teeth unknown.

Remarks: Probably the oldest and most primitive representative of the cat sharks.

Recent relatives: Possibly related to the recent cat sharks of the family Scyliorhinidae.



Palaeoscyllium formosum WAGNER (length c. 60 cm) from the Upper Jurassic of Solnhofen (Eichstätt), Bavaria, Germany. Original: Perner Collection, Bad Homburg, Germany.

Genus: *Palaeoscyllium* von der MARCK, 1860.

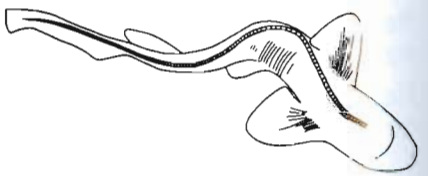
Geological range: Upper Jurassic to Upper Cretaceous.

Geographical distribution: Europe.

Features: Small slim sharks. Two triangular dorsal fins. Caudal fin elongate with the upper lobe larger. Mouth small. Teeth small, rather wide. Cutting edges not serrated.

Remarks: Like recent cat sharks, they may have fed mainly on bivalves and crustacea.

Recent relatives: Genus extinct. Distantly related to recent cat sharks of family Scylliorhinidae which are represented in modern seas by 17 genera and 86 species.



Palaeoscyllium, reconstruction after von der MARCK.



Scyliorhinus elongatus (DAVIS) (length c. 23 cm) from the Upper Cretaceous of the Lebanon. Original: Royal Museum of Scotland, Edinburgh, Scotland.

Genus: *Scyliorhingus* de BLAINVILLE, 1825.

Synonyms: *Scyllium*, *Thyellina*.

Geological range: Upper Cretaceous to recent.

Geographical distribution: Middle East, Africa, Europe.

Features: Small sharks. Body slim and elongate. Pectoral fins rounded. Two dorsal fins behind the middle of the body. Caudal fin long and narrow. Pelvic fins roughly in the middle of the body. Head long. Teeth pointed. Cutting edges not serrated.

Remarks: May have fed, like recent cat sharks, on crustacea, gastropods and bivalves.

Recent relatives: Closely related to the recent cat shark *Scyliorhinus*.



Scyliorhinus stellaris, a recent cat shark.



Unknown shark (length c. 87 cm) from the Upper Cretaceous of the Lebanon. Original: Staatliches Museum für Naturkunde, Karlsruhe, Germany.

Genus: Unnamed.

Geological range: Upper Cretaceous.

Geographical distribution: Middle East.

Features: This middle-sized shark may perhaps represent a still-undescribed genus. Form slender. Head long. Two triangular dorsal fins. Caudal fin with a short lower lobe. Teeth small and pointed with two lateral cusps.

Remarks: Judging by its shape, this fish may have hunted free-swimming prey.

Recent relatives: Distantly, or perhaps even closely, related to the recent cat sharks of the family Scyliorhinidae which is represented in recent seas by 17 genera and about 86 species.



Eogaleus bolcensis CAPETTA (length c. 110 cm) from the Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Eogaleus* CAPETTA, 1975.

Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Middle-sized shark with streamlined body. Head broad. Eyes small. Snout rounded. Mouth somewhat ventral. Gape long. Two pointed dorsal fins in the posterior third of the body. Caudal fin probably with the upper lobe larger. Pectoral fins long and pointed.

Remarks: Bottom-dwelling predatory fishes.

Recent relatives: Genus extinct. Possibly related to the recent cat sharks of the genus *Galeus*.



Galeus sp., a recent dog shark. Lithograph from COUGH.



Galeorhinus cuvieri (AGASSIZ) (length c. 78 cm) from the Middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Galeorhinus* de BLAINVILLE & PREVOST, 1818.

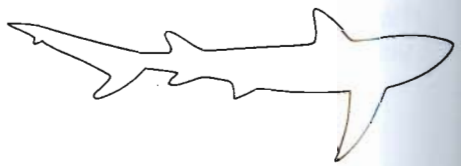
Geological range: Upper Cretaceous to Recent.

Geographical distribution: Europe, northern Africa, northern Asia.

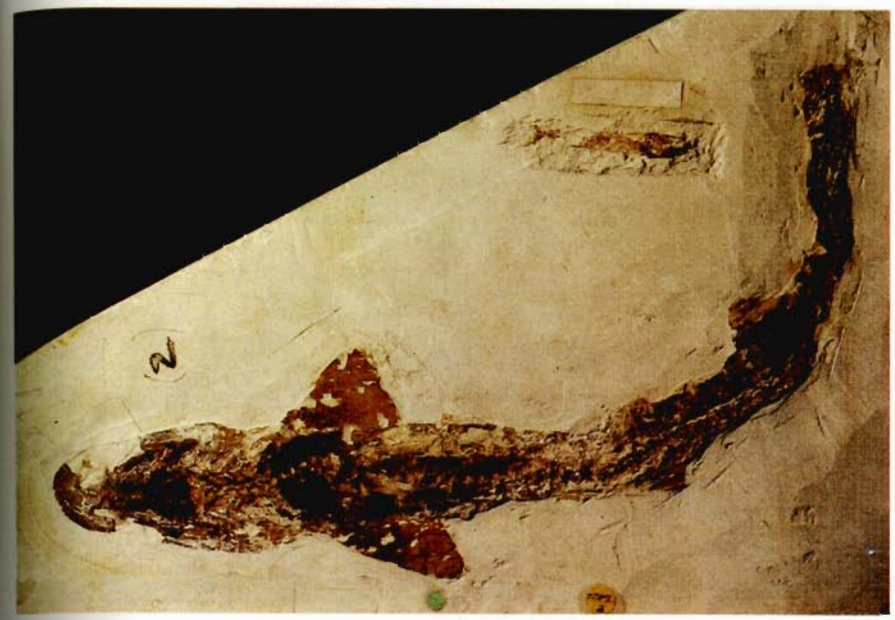
Features: Middle-sized slender sharks. Head long. Pectoral fins long and pointed. Two small dorsal fins. Long caudal fin with the upper lobe larger than the lower. Teeth short with the points directed rearwards. Lower part of posterior cutting edge coarsely serrated.

Remarks: Rapidly swimming predatory fishes.

Recent relatives: Closely related to recent representatives of the genus *Galeorhinus*.



Galeorhinus, reconstruction after CAPETTA.



Paratriakis curtirostris (DAVIS) (length c. 29 cm) from the Upper Cretaceous of the Lebanon. Original: The Natural History Museum, London, U.K.(P4022).

Genus: *Paratriakis* HERMAN, 1977.

Geological range: Upper Cretaceous.

Geographical distribution: Europe, Middle East.

Features: Small slender sharks. Head long. Snout somewhat pointed. Pectoral fins large, triangular. Caudal fin long, probably curved upward. Teeth small and pointed with the points directed rearwards. Cutting edges not serrated.

Remarks: Little predatory fishes which may mainly have fed on crustacea and other small organisms.

Recent relatives: Genus extinct. Closely related to the recent smooth dogfish *Triakis*.



Triakis semifasciatus, a recent smooth dogfish.



Hexanchus gracilis (Davis) (length c. 29 cm) from the Upper Cretaceous of the Lebanon. Original: National Museum of Scotland, Edinburgh, U.K.

Genus: *Hexanchus* Rafinesque, 1810.

Synonyms: *Notidanus*.

Geological range: Upper Jurassic to recent.

Geographical distribution: Middle East, Australia, Europe.

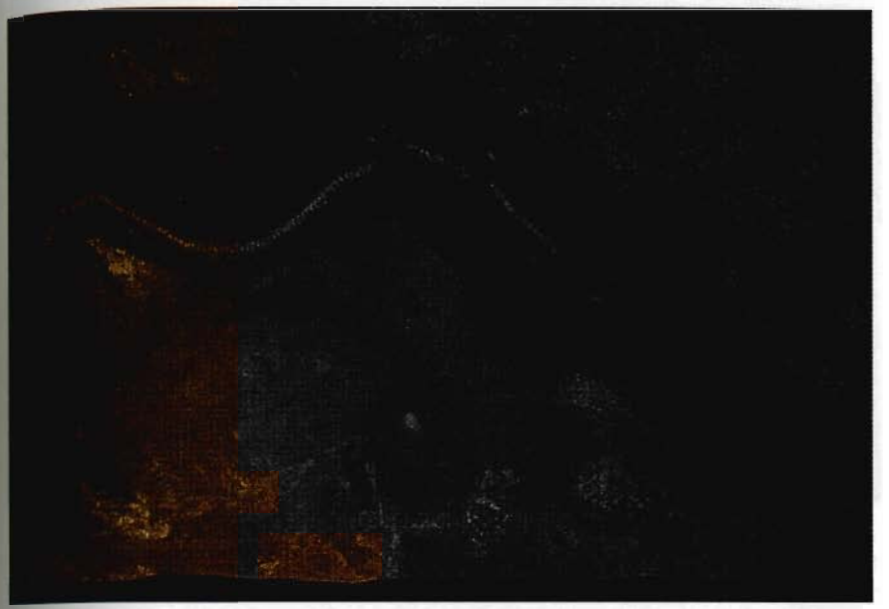
Features: Small to middle-sized sharks with relatively short rounded head. One dorsal fin, located posteriorly. Caudal fin long with upper lobe larger than the lower. Teeth broad with one large cusp and five small ones directed rearwards.

Remarks: Rapidly swimming predators.

Recent relatives: Closely related to recent cow sharks of the genus *Hexanchus*. The family is represented by three genera and four species in recent seas.



Hexanchus griseus, the recent sand shark.



Unnamed shark (length c. 67 cm) from the Lower Jurassic of Holzmaden, Württemberg, Germany. Original: Staatliches Museum für Naturkunde, Stuttgart, Germany.

Genus: Not named.

Geological range: Lower Jurassic.

Geographical distribution: Europe.

Features: Middle-sized fishes with a slender body. Head long and shallow passing into a rostrum broad at the base and tapering forward. Eyes small. Two short but powerful spines dorsally, each supporting a dorsal fin. Vertebral column calcified.

Remarks: Systematic position uncertain. A rostrum is unusual in a shark from the Lower Jurassic. The calcified vertebral column shows that it belongs to the modern sharks (Neoselachii).

Recent relatives: None. Died out in Lower Jurassic.



Centrophoroides latidens DAVIS (length c. 37 cm) from the Upper Cretaceous of the Lebanon. Original: The Natural History Museum, London, U.K. (P4021).

Genus: *Centrophoroides* DAVIS, 1887.

Geological range: Upper Cretaceous.

Geographical distribution: Middle East.

Features: Slender sharks with pointed snout. Two dorsal fins. The first is supported by a powerful spine which projects above the fin. The second small dorsal fin is associated with a spine whose length is at most one-third of the height of the fin. Pectoral fins large and triangular. Caudal fin relatively short. Teeth broad with a short cusp directed rearwards.

Remarks: Predatory fishes that fed not only on smaller fishes but perhaps also, or even mainly, on crustaceans and other invertebrates.

Recent relatives: Genus extinct. Distantly related to recent dogfishes of the family Squalidae.



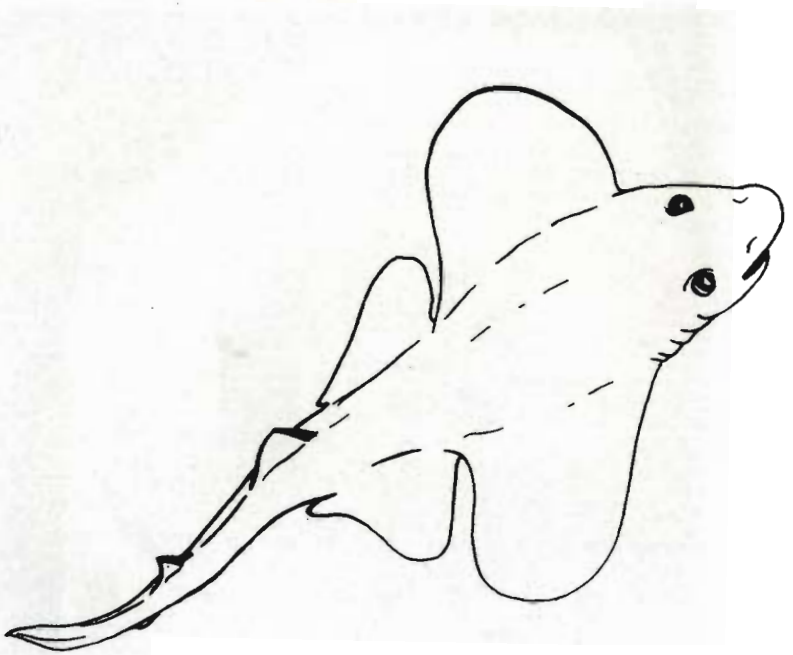
Squalus sp., a recent spiny dogfish. Lithograph from CUVIER.

CHONDRICHTHYES
Order: Squaliformes
Family: Squalidae

Cartilaginous Fishes
Suborder: Squaloidei
Spiny Dogfishes



Protospinax annectens WOODWARD (length c. 146 cm) from the Upper Jurassic of Solnhofen (Eichstätt), Bavaria, Germany. Original: Bayerische Staatssammlung für Paläontologie, Munich, Germany.



Protospinax, reconstruction after WOODWARD.

Genus: *Protospinax* WOODWARD, 1919.

Geological range: Upper Jurassic.

Geographical distribution: Europe.

Features: Middle-sized sharks with a dorso-ventrally flattened body. Head rounded. Gill slits latero-ventral. Very large pectoral fins. Pelvic fins also relatively large. Two small dorsal fins, each supported by a short spine. Caudal fin small and tapering to a point. Teeth broad and more or less flat.

Remarks: Probably more bottom-dwelling than free-swimming. Dentition suggests that they preferred shelly food.

Recent relatives: Genus extinct. Distantly related to recent dogfishes of the family Squalidae which are represented by 18 genera and 71 species in modern oceans.



Pseudorhina alifera (MÜNSTER) (length c. 96 cm) from the Upper Jurassic of Solnhofen (Eichstätt), Bavaria, Germany. Original: Interfoss, Munich, Germany.



Squatina australis, a recent angel shark.

Genus: *Pseudorhina* JAEKEL, 1898.

Synonyms: *Squatina*, *Rhina*, *Thaumas*, *Trigenodus*.

Geological range: Upper Jurassic to Pleistocene.

Geographical distribution: Europe, Middle East, northern Africa, Australia.

Features: Middle-sized ray-like sharks. Head rounded. Gill slits lateral. Mouth ventral but at front end of head. Pectoral and pelvic fins large. Two small dorsal fins situated at narrow end of tail. Caudal fin small. Teeth broader than tall.

Remarks: Bottom-dwelling sharks.

Recent relatives: Genus extinct. Closely related to the angel sharks of the genus *Squatina* which is represented by 11 species in modern seas.



Aellopos bugesiacus THIOLLIÈRE (length c. 110 cm) from the Upper Jurassic of Solnhofen (Eichstätt), Bavaria, Germany. Original: Museum Berger, Harthof bei Eichstätt, Germany.

Genus: *Aellopos* MÜNSTER, 1836.

Synonyms: *Euryarthra*, *Spathobatis*.

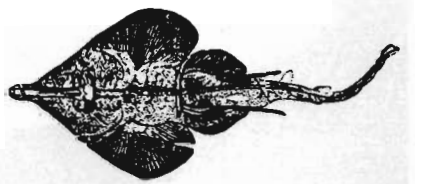
Geological range: Upper Jurassic.

Geographical distribution: Europe.

Features: Primitive rays, still somewhat like sharks in shape. Dorso-ventral body flattening is extreme only towards the pectoral fins. The latter are fused with the sides of the head and the mouth and gill slits are ventral, all of which are true ray characteristics. The long snout is a striking feature. Males with rod-like appendages on the pelvic fins. Teeth small, round and present in large numbers.

Remarks: Bottom-dwellers with durophagous diet.

Recent relatives: Genus extinct. Distantly related to recent guitarfishes of the family Rhinobatidae.



Aellopos, reconstruction after WOODWARD.



Asterodemus platypterus AGASSIZ (length c. 46 cm) from the Upper Jurassic of Solnhofen (Eichstätt), Bavaria, Germany. Original: Jura-Museum, Eichstätt.

CHONDRICHTHYES
Order: Rajiformes
Family: Rhinobatidae

Cartilaginous Fishes
Suborder: Rhinobatoidei
Guitarfishes



Aptychotrema vincentiana, a recent guitarfish.

Genus: *Asterodemus* AGASSIZ, 1843.

Geological range: Upper Jurassic.

Geographical distribution: Europe.

Features: Middle-sized rays. Like *Aellopos* but without the long snout. Pectoral fins broad. Pelvic fins rounded. Dorsal fins each with a small spine. Body not deep. Tail thin, with a small caudal fin. Skin covered with scales which carry star-shaped dermal denticles. Teeth not known.

Remarks: Bottom-dwellers.

Recent relatives: Genus extinct. Distantly related to recent guitarfishes of the family Rhinobatidae.



Belemnobatis sismondae THIOLLIÈRE (length c. 40 cm) from the Upper Jurassic of Cerin, France. Original: Naturhistoriska Riksmuseet, Stockholm, Sweden.

Genus: *Belemnobatis* THIOLLIÈRE, 1854.

Geological range: Upper Jurassic.

Geographical distribution: Europe.

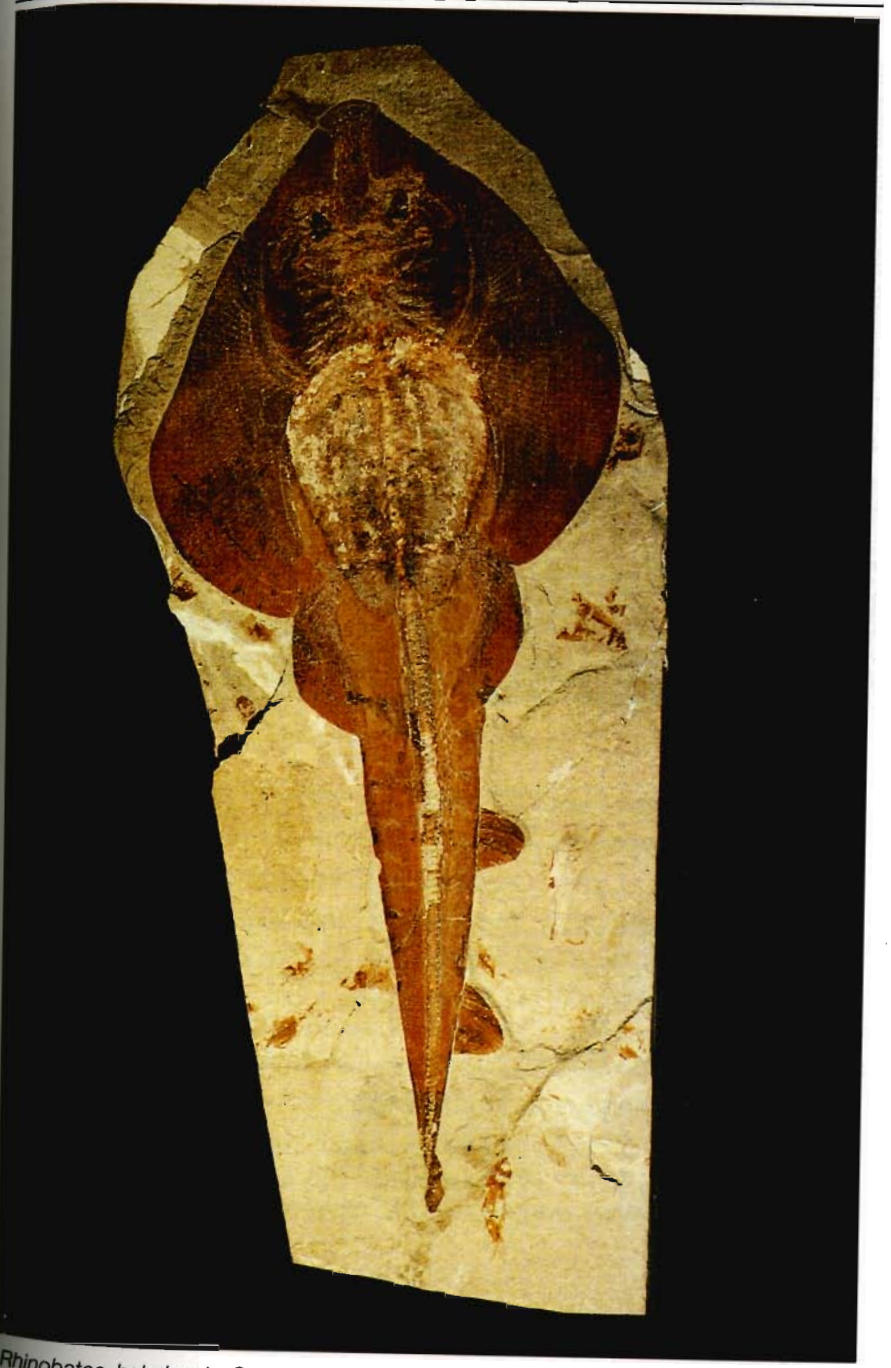
Features: Middle-sized rays. Disc wider than long. Pelvic fins long and rounded. Dorsal fins large, close together and with a protection of thorns. Tail (behind pelvic fins) shorter than rest of animal. Teeth wide with sharp crest.

Remarks: Bottom-dwellers.

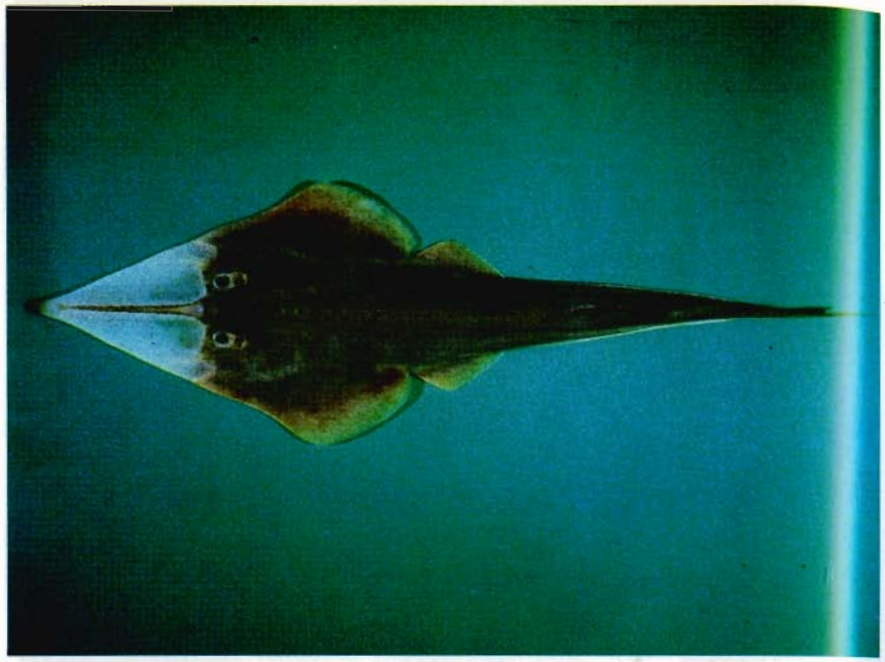
Recent relatives: Genus extinct. Distantly related to recent guitarfishes of the family Rhinobatidae.

CHONDRICHTHYES
Order: Rajiformes
Family: Rhinobatidae

Cartilaginous Fishes
Suborder: Rhinobatoidei
Guitarfishes



Rhinobatos hakelensis CAPETTA (length c. 28 cm) from the Upper Cretaceous of the Lebanon. Original: Staatliches Museum für Naturkunde, Stuttgart, Germany.



Rhinobatos granulatus, a recent guitarfish.

Genus: *Rhinobatos* LINCK, 1790.

Synonyms: *Rhinobatus*.

Geological range: Lower Cretaceous to recent.

Geographical distribution: Europe, northern Africa, Middle East.

Features: Middle-sized rays. Rostrum pointed. Dorsal fins located very posteriorly. Caudal fin lacks lower lobe. Skin covered with seed-like placoid scales. Teeth small, each with two lateral extensions, forming a pavement. Maximum length 2 m or more.

Remarks: Durophagous bottom-dweller.

Recent relatives: Closely related to recent members of the genus *Rhinobatos* of the family Rhinobatidae. The latter is represented in recent seas by seven genera and 45 species.



Rhombopterygia rajoides CAPETTA (length c. 42 cm) from the Upper Cretaceous of the Lebanon. Original: Interfoss, Munich, Germany.

Genus: *Rhombopterygia* CAPETTA, 1980.

Geological range: Upper Cretaceous.

Geographical distribution: Middle East.

Features: Small rays. Disc quadrilateral. Only slightly broader than long. Tail about as long as disc. Nasal capsule elliptical. Teeth with a stout crown.

Remarks: Durophagous bottom-dweller.

Recent relatives: Genus extinct. Distantly related to recent guitarfishes of the family Rhinobatidae.



Trigonorhina dezignii HECKEL (length c. 79 cm) from the Middle Eocene of Monte Bolca, Italy. Original: Naturhistorisches Museum, Vienna, Austria

Genus: *Trigonorhina* MÜLLER & HENLE, 1838.

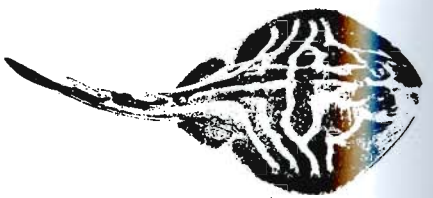
Geological range: Eocene to recent.

Geographical distribution: Europe.

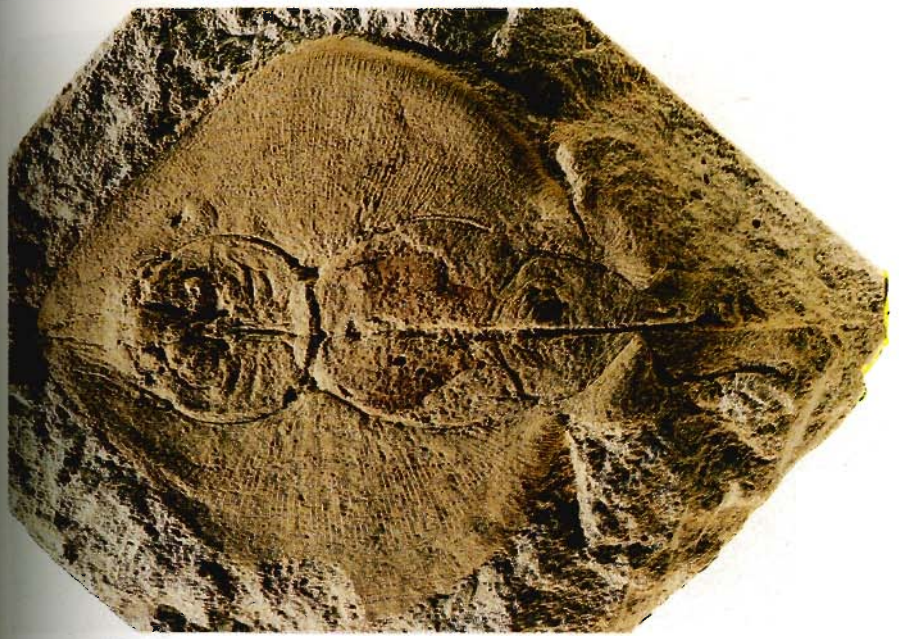
Features: Middle-sized rays. Disc oval, pointed anteriorly. Tail very powerful at base but pointed posteriorly, somewhat longer than the disc.

Remarks: Bottom-dwellers but probably also free-swimming.

Recent relatives: Closely related to recent members of the genus *Trigonorhina*.



Trigonorhina fasciata, a recent ray after WAITE.



Zapteryx bichuti SIG (length c. 47 cm) from the Eocene of St. Vaas les Mello, Oise, France. Original: Muséum National d'Histoire Naturelle, Paris, France. Photograph: Serette, Paris.

Genus: *Zapteryx* JORDAN & GILBERT, 1880.

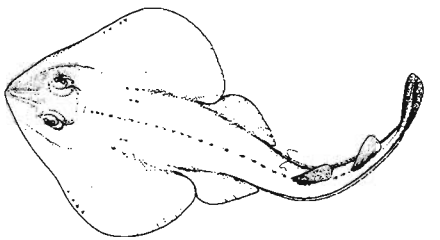
Geological range: Eocene to recent.

Geographical distribution: Europe.

Features: Middle-sized relatively primitive rays with a short pointed rostrum. Disc almost circular. Pelvic fins small and rounded. Tail relatively short. No spines. Probably two dorsal fins.

Remarks: Bottom-dwelling.

Recent relatives: Closely related to recent members of the genus *Zapteryx*.



Zapteryx brevirostris, a recent ray after BIGELOW.



Platyrhina egertoni de ZIGNO (length c. 55 cm) from the Middle Eocene of Mont Bolca, Italy. Original: Museo Civica di Storia Naturale, Verona, Italy.

Genus: *Platyrhina* MÜLLER & HENLE, 1838.

Geological range: Eocene to recent.

Geographical distribution: Europe.

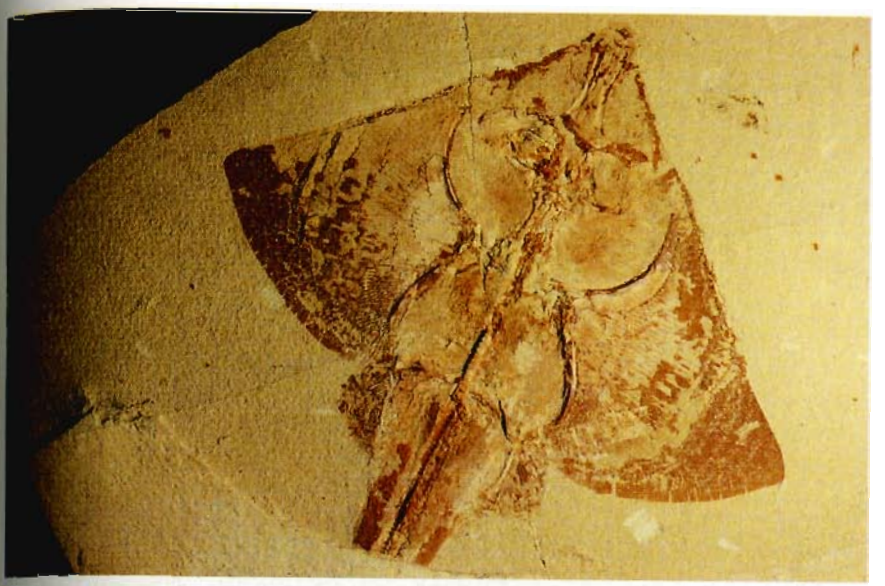
Features: Middle-sized rays. Disc large and round. Tail short, at most half as long as the disc. Two dorsal fins. Caudal fin small. Teeth unknown.

Remarks: Durophagous bottom-dweller.

Recent relatives: Closely related to recent members of the genus *Platyrhina*.



Platyrhina schoenleinii, a recent platyrhinid guitarfish.



Pararaja expansa (DAVIS) (c. 23 ∞ 23 cm) from the Upper Cretaceous of the Lebanon. Original: Siber & Siber Collection, Aathal, Switzerland.

Genus: *Pararaja* CAPETTA, 1980.

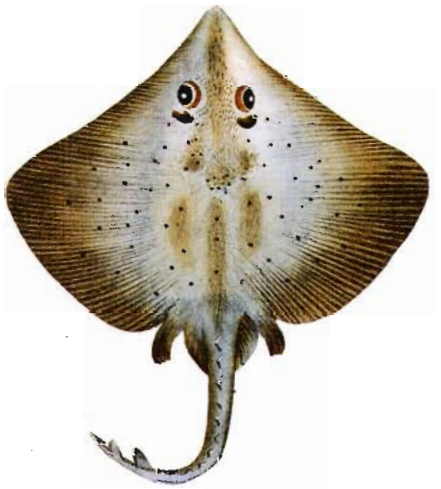
Geological range: Upper Cretaceous.

Geographical distribution: Middle East.

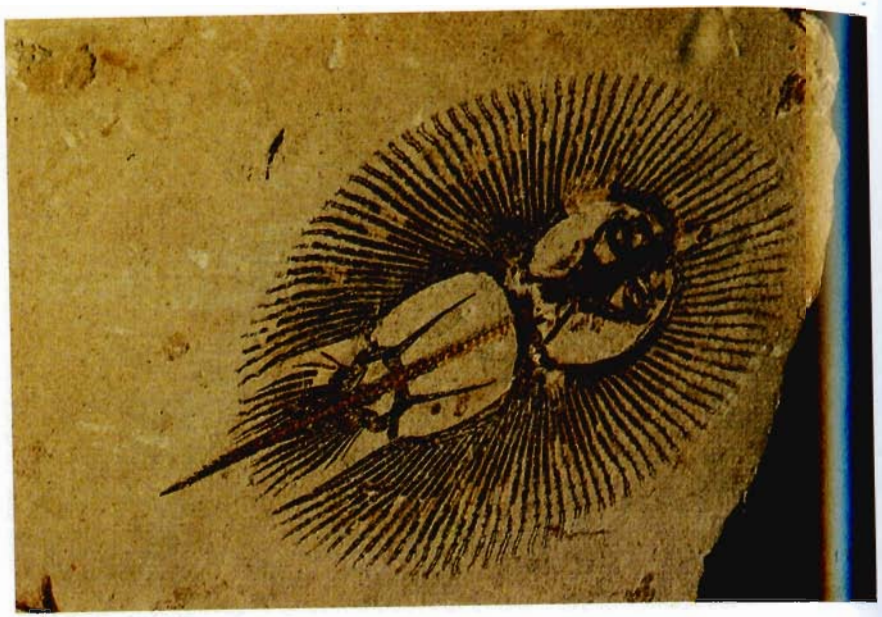
Features: Small skates. Disc broader than long. Tail shorter than disc. In males the pterygopodia (sexual appendages) almost as long as tail. Teeth small with flat crowns.

Remarks: Bottom-dwelling and free-swimming.

Recent relatives: Distant relatives of the recent skates (family Rajidae) which are represented in the oceans by 14 genera and about 190 species.



Raja batis, the recent common skate. Lithograph from BLOCH.



Cyclobatis major Davis (length c. 13 cm) from the Upper Cretaceous of the Lebanon. Original: Frickhinger Collection, Munich, Germany.

Genus: *Cyclobatis* Egerton, 1844.

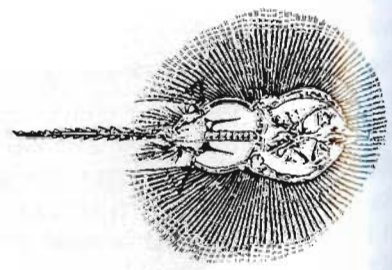
Geological range: Lower Cretaceous.

Geographical distribution: Middle East.

Features: Little skates with a circular disc. Tail of medium length to very short, carrying two or three rows of angular spines. In dorsal aspect the pelvic fins completely covered by pectoral fins. No dorsal fins on the tail. Numerous very small teeth.

Remarks: Durophagous bottom-dwellers.

Recent relatives: Genus extinct. Perhaps distantly related to the skates (Rajidae).



Cyclobatis, reconstruction after Arambourg & Bertin.



Micropristis solomonis (Hay) (length c. 53 cm) from the Upper Cretaceous of the Lebanon. Original: Staatliches Museum für Naturkunde, Stuttgart, Germany.

Genus: *Micropristis* Capetta, 1980.

Geological range: Upper Cretaceous.

Geographical distribution: Middle East.

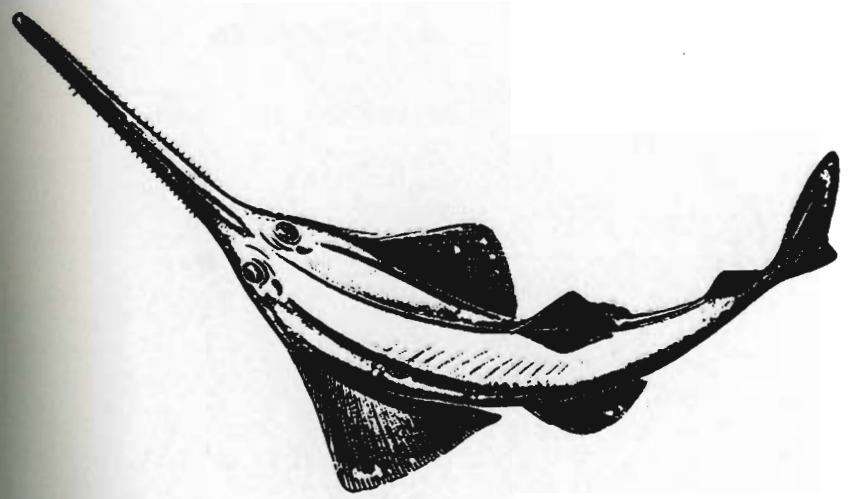
Features: Rostrum relatively short and blunt, carrying small teeth at the sides. Pectoral fins small, extending back to the pelvic fins. Tail broad at base but ending in a point. The anterior teeth are pointed and about 2.5 mm high while the posterior teeth are blunt.

Remarks: Probably bottom-dwelling and free-swimming.

Recent relatives: None. Died out in the Upper Cretaceous.



Sclerorhynchus atavus WOODWARD (length c. 68 cm) from the Upper Cretaceous of the Lebanon. Original: Staatliches Museum für Naturkunde, Karlsruhe, Germany.



Sclerorhynchus, reconstruction after MACMILLAN.

Genus: *Sclerorhynchus* WOODWARD, 1889.

Synonym: *Ganopristis*

Geological range: Upper Cretaceous to Paleocene.

Geographical distribution: Europe, Africa, Middle East.

Features: Maximum length c. 1 m. Rostrum narrow and blunt anteriorly, with numerous small teeth at the sides. Pectoral fins not especially large and extending back to the pelvic fins. Tail broad at base but ending in a point. Two dorsal fins, close together. Anterior teeth pointed, becoming blunter posteriorly.

Remarks: Bottom-dwelling and free-swimming.

Recent relatives: None. Died out in Paleocene.



Torpedo sp.? (length c. 38 cm) from the Eocene of Bolca, Italy. Original: Museum für Naturkunde, Berlin, Germany.

Genus: *Torpedo* HOUTTUYN, 1764.

Synonym: *Narcobatus*

Geological range: Middle Eocene to recent.

Geographical distribution: Europe.

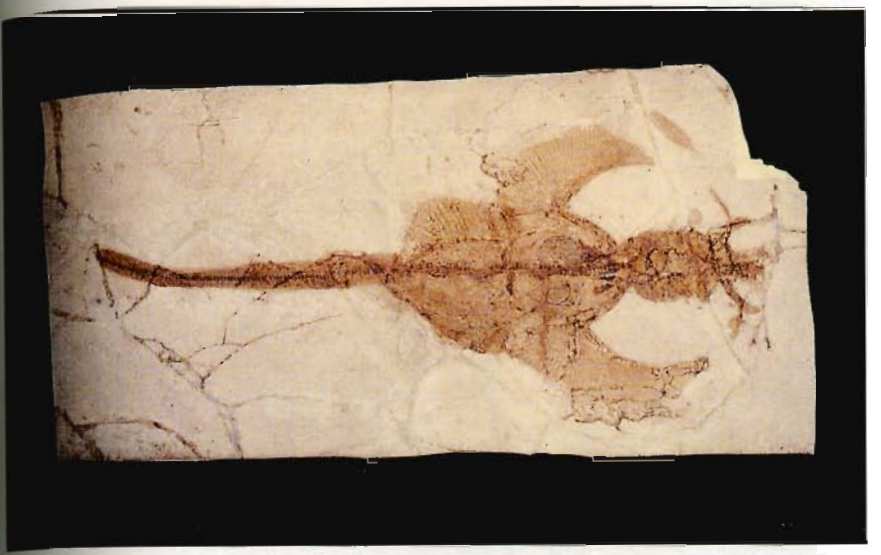
Features: Middle-sized fishes with strongly disc-shaped, anteriorly rounded bodies. Eyes small. Mouth ventral. Tail round in transverse section and relatively short. Two dorsal fins. Pectoral fins do not extend to the anterior end of the head. Skin naked. Teeth probably small.

Remarks: Bottom-dwelling genus with a predatory mode of life. Whether they already had an electric organ between the head and the pectoral fins is not established.

Recent relatives: Probably related to recent electric rays of the genus *Torpedo* which is represented by 13 species in modern seas.



Torpedo sp., a recent electric ray.



Narcine molini JAEKEL (length c. 90 cm) from the Middle Eocene of Bolca, Italy. Original: Università di Padova, Padua, Italy. Photograph: Università di Padova.

Genus: *Narcine* HENLE, 1834.

Geological range: Lower Eocene to recent.

Geographical distribution: Europe, northern and western Africa.

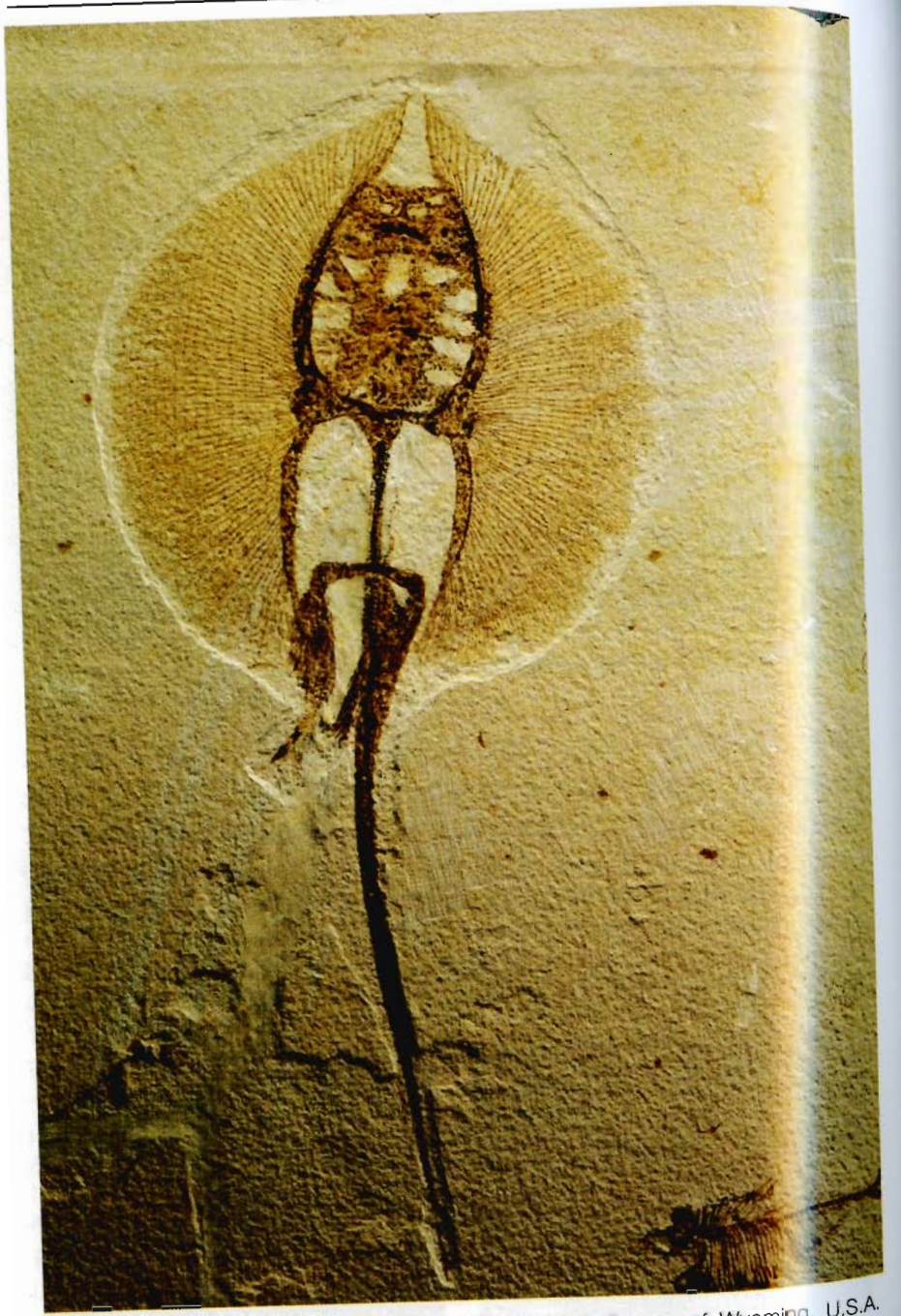
Features: Disc elongated. Well developed pelvic fins. Tail about as long as the rest of the body. One dorsal fin, approximately in middle of tail. Caudal fin narrow. Maximum length c. 1 m.

Remarks: Durophagous bottom-dweller.

Recent relatives: Closely related to the recent electric ray *Narcine*.



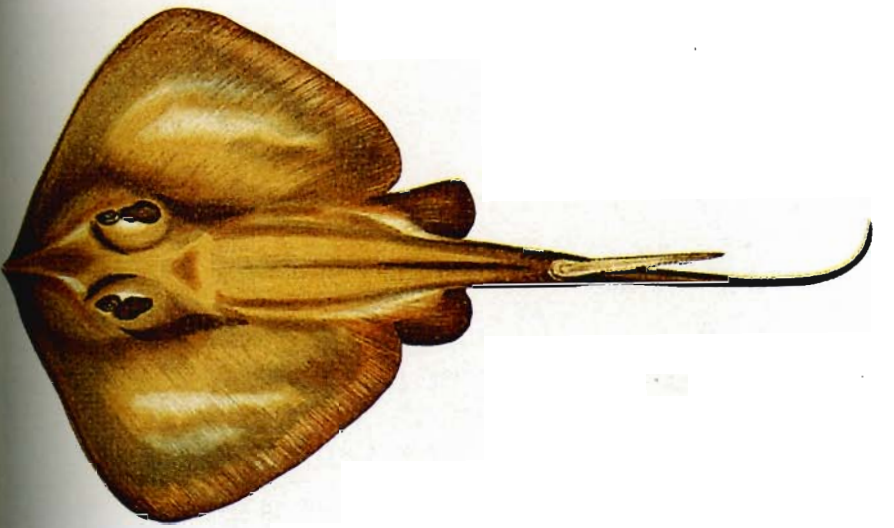
Narcine brunez, a recent electric ray.



Heliobatis radians MARSH (length c. 40 cm) from the Eocene of Wyoming, U.S.A. Original: Frickhinger Collection, Munich, Germany.

CHONDRICHTHYES
Order: Rajiformes
Family: Dasyatidae

Cartilaginous Fishes
Suborder: Myliobatoidei
Stingrays



Dasyatis sp., a recent stingray. Lithograph from COUGH.

Genus: *Heliobatis* MARSH, 1877.

Synonyms: *Dasybatis*, *Dasyatis*, *Palaeodasybatis*, *Xiphotrygus*.

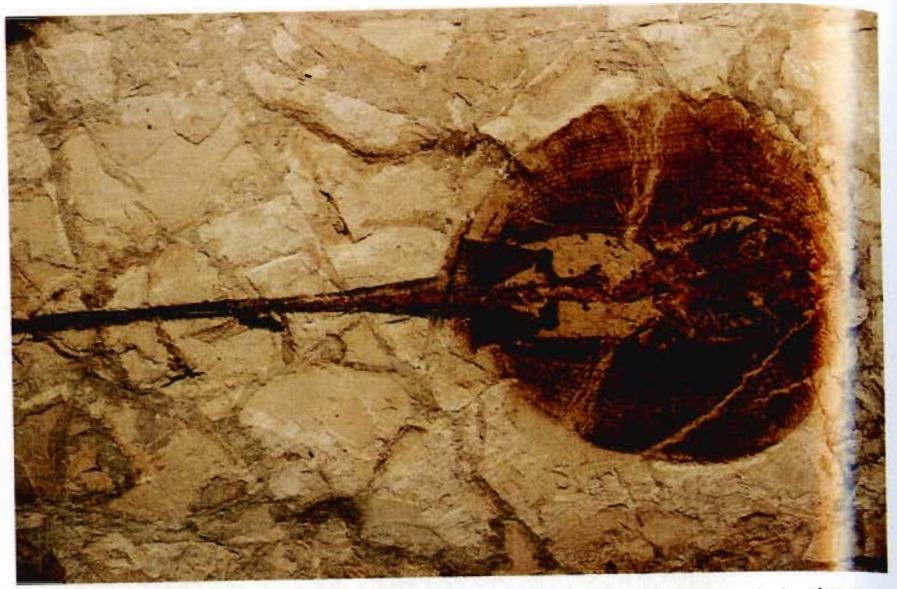
Geological range: Upper Cretaceous to Pleistocene.

Geographical distribution: Europe, North America, northern Africa, Asia, Australia, Indonesia.

Features: Disc approximately circular. Tail very long and whip-like. Many small thorn-like spines along the dorsal mid line. No rostrum. Approximately in the middle of the tail three long, finely serrated spines. Maximum length c. 1 m.

Remarks: Inhabit fresh water.

Recent relatives: Can be seen as forerunners of the stingrays (see *Trygon*).



Trygon muricata (VOLTA) (length c. 73 cm) from the Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Trygon* CUVIER, 1817.

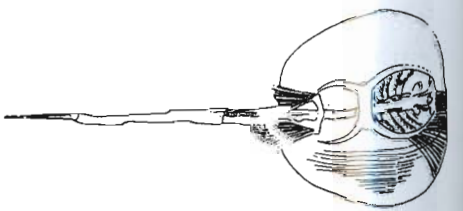
Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Disc approximately circular. No rostrum. Tail long and thin. Long spine at end of tail. In dorsal aspect pelvic fins covered by the pectorals. Teeth blunt.

Remarks: Marine fishes.

Recent relatives: Can be seen as forerunners of the sting rays which are assigned to the same family (Dasyatidae) represented by five recent genera and more than 50 recent species. Most live in the sea, but some belong exclusively in fresh water.



Trygon, reconstruction after JAEKEL.



Promyliobatis gazolae (de ZIGNO) (length c. 45 cm) from the Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Promyliobatis* JAEKEL, 1894.

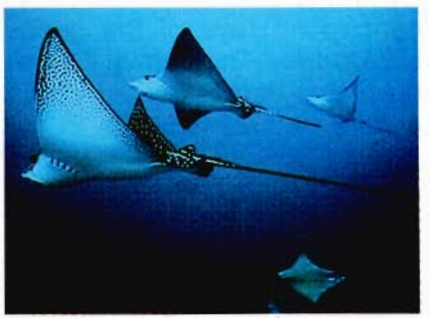
Geological range: Middle Eocene.

Geographical distribution: Europe.

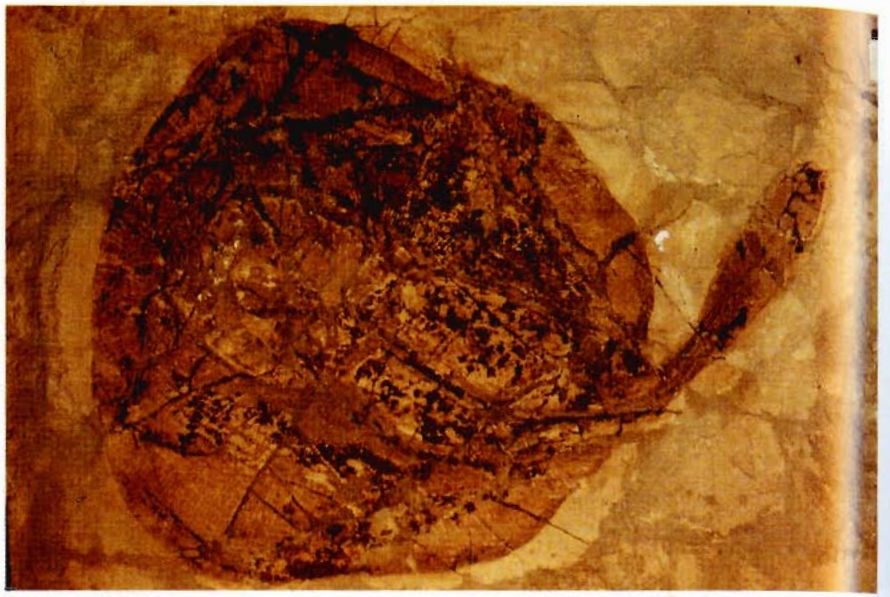
Features: Disc transversely rhombic. Pectoral fins extend to rostrum. One small dorsal fin. Teeth large, flat and hexagonal. Tail long and thin. Flat fin spine covered with denticles.

Remarks: Probably more free-swimming than bottom-dwelling.

Recent relatives: Can be seen as a forerunner of the eagle rays which, together with their closest relatives, have four genera and 24 species in recent seas.



Aetobatus sp., a recent eagle ray.



Urolophus crassicaudatus EASTMAN (length c. 80 cm) from the Middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Urolophus* MÜLLER & HENLE, 1838.

Geological range: Middle Eocene to recent.

Geographical distribution: Europe.

Features: Middle-sized rays. Disc circular, completely fused around the head. Eyes small. Mouth wide, situated on the lower surface. Tail stout and short. No dorsal fin. Caudal fin elongate and rounded.

Remarks: Bottom-dwelling fishes.

Recent relatives: Related to recent round rays of the genus *Urolophus*. The family Urolophidae is represented by two genera and 30 species in recent seas.



Urolophus halleri, a recent round ray.



Chondrenchelys problematica TRAQUAIR (length c. 12 cm) from the Lower Carboniferous of Eskdale, Scotland. Original: National Museum of Scotland, Edinburgh, U.K.

Genus: *Chondrenchelys* TRAQUAIR, 1888.

Geological range: Lower Carboniferous.

Geographical distribution: Europe.

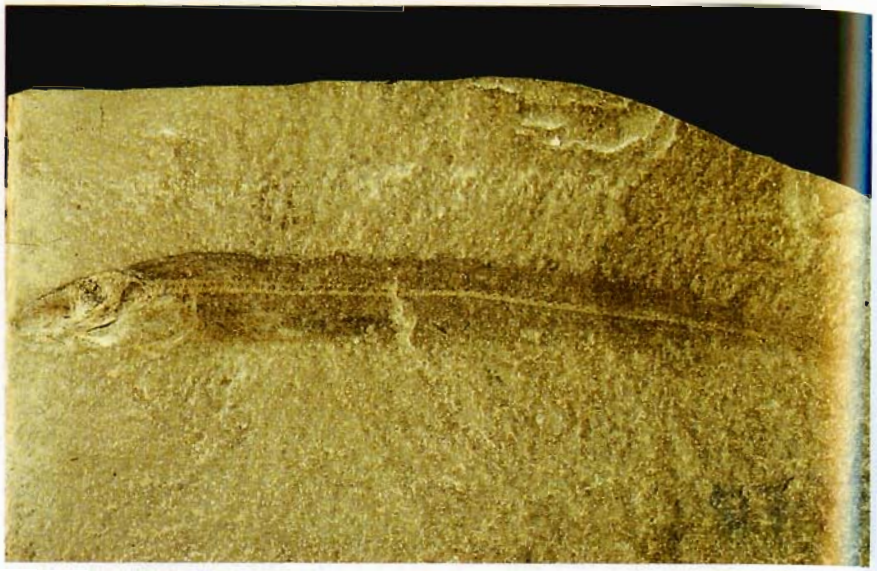
Features: Small cartilaginous fishes of elongate shape. Head elongate. Mouth slightly ventral. Eyes relatively large. Body tapers to a point posteriorly. Dorsal fin fin-fold-like, passes into the caudal fin which passes in turn into the anal fin. Pectoral fins biserial. Maximum length 15 cm.

Remarks: Probably free-swimming.

Recent relatives: None. Died out in Lower Carboniferous.



Chondrenchelys, reconstruction after ORLOV.



Harpagofututor volsellorhinus Lund (length c. 10 cm) from the Lower Carboniferous of Bear Gulch, Montana, U.S.A. Original: Carnegie Museum of Natural History, Pittsburgh, Penn., U.S.A.

Genus: *Harpagofututor* Lund, 1982.

Geological range: Lower Carboniferous.

Geographical distribution: North America.

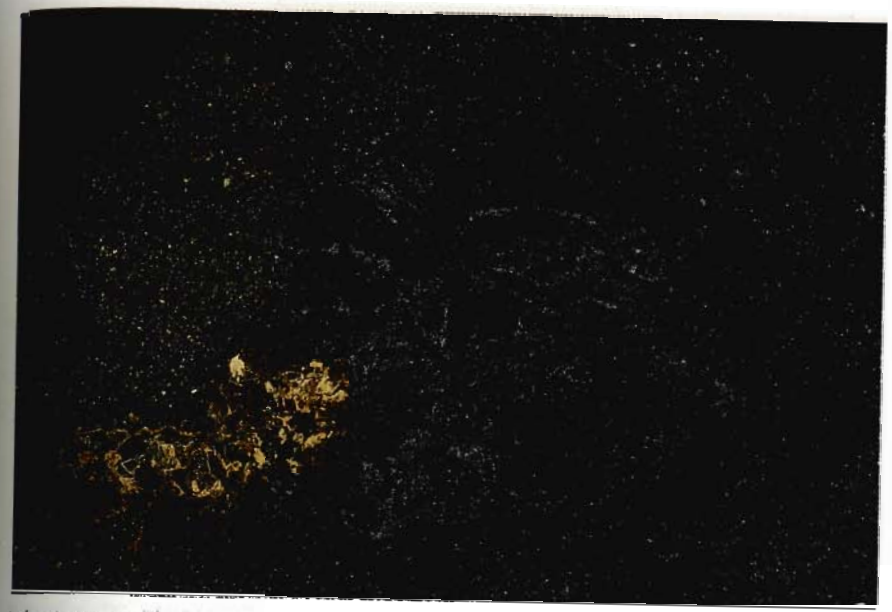
Features: Small chondrichthyans with slender body tapering to a point posteriorly. Head elongated with a beak-like curve of the upper jaw. Mouth somewhat ventral. Dentition with strong rounded teeth. Eyes relatively large. Pectoral fins biserial. Maximum length scarcely more than 10 cm.

Remarks: Dentition suggests a durophagous diet.

Recent relatives: None. Died out in the Lower Carboniferous.



Harpagofututor, reconstruction after Lund.



Iniopteryx rushlaui Zangerl & Case (length c. 24 cm) from the Upper Carboniferous of Nebraska, U.S.A. Original: American Museum of Natural History, New York, N.Y., U.S.A.

Genus: *Iniopteryx* Zangerl & Case, 1973.

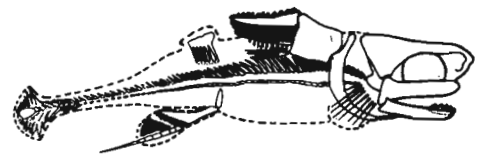
Geological range: Upper Carboniferous.

Geographical distribution: North America.

Features: Plump middle-sized fishes. Head relatively large and massive. Nose extended somewhat anteriorly. Eyes large. Simple conical teeth. Pectoral fins small with the first fin ray elongated in males. A row of powerful spines mid-dorsally behind the head. Dorsal fin small. Caudal fin rounded. Pelvic fins with a rod-like jointed appendage (pterygopodium).

Remarks: Bottom dwellers, but probably also capable of free-swimming.

Recent relatives: None. Died out in the Upper Carboniferous.



Iniopteryx, reconstruction after Zangerl & Case.



Iniopera richardsoni ZANGERL & CASE (length c. 24 cm) from the Upper Carboniferous of Pike County, Indiana, U.S.A. Original: Cleveland Museum of Natural History, Cleveland, Ohio, U.S.A.

Genus: *Iniopera* ZANGERL & CASE, 1973.

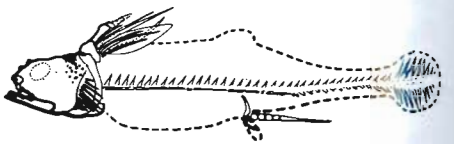
Geological range: Upper Carboniferous.

Geographical distribution: North America.

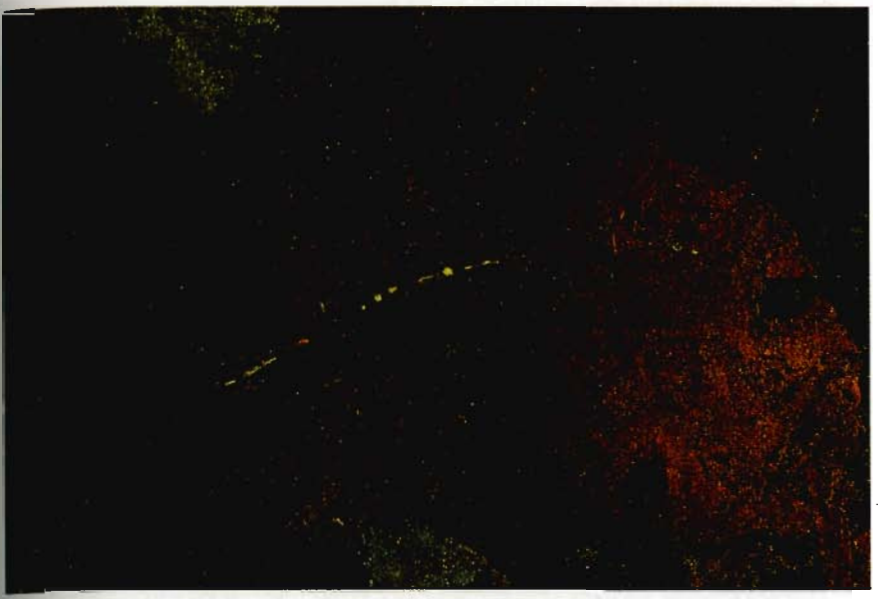
Features: Plump middle-sized fishes. Head small. Strong dentition of plate-like teeth. A row of pointed spines in the dorsal mid-line just behind the head. Dorsal fin small. Caudal fin probably rounded. Pelvic fin with a pointed rod-like posteriorly jointed appendage (pterygopodium).

Remarks: Bottom-dwellers, probably scarcely capable of free swimming.

Recent relatives: None. Died out in Upper Carboniferous.



Iniopera, reconstruction after ZANGERL & CASE.



Sibirhynchus denisoni ZANGERL & CASE (length c. 20 cm) from the Upper Carboniferous of Pike County, Indiana, U.S.A. Original: Cleveland Museum of Natural History, Cleveland, Ohio, U.S.A.

Genus: *Sibirhynchus* ZANGERL & CASE, 1973.

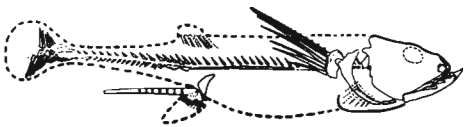
Geological range: Upper Carboniferous.

Geographical distribution: North America.

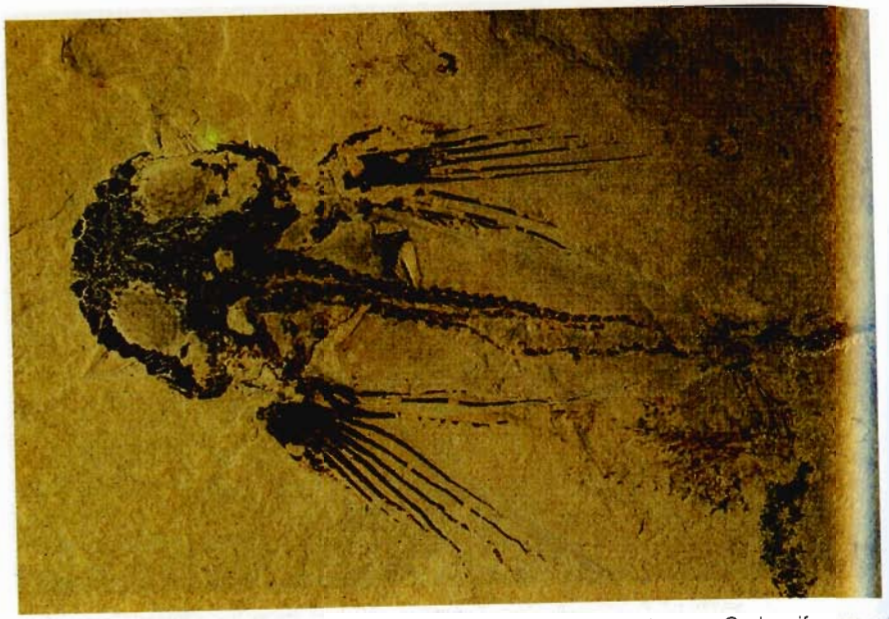
Features: Plump middle-sized fishes. Head small. Lower jaw with a pointed anterior process. Dorsal fin small. Caudal fin probably rounded. Pectoral fins supported by spines of which the first is particularly strong and bears thorns on its upper surface. Pelvic fin small, with a rod-like jointed appendage (pterygopodium).

Remarks: Bottom dwellers, probably scarcely capable of free swimming.

Recent relatives: None. Died out in Upper Carboniferous.



Sibirhynchus, reconstruction after ZANGERL & CASE



Unnamed iniopterygiiform fish (length c. 10 cm) from the Lower Carboniferous of Bear Gulch, Montana, U.S.A. Original: Adelphi University, Garden City, N.J., U.S.A.

Genus: Unnamed.

Geological range: Lower Carboniferous.

Geographical distribution: North America.

Features: Small, still undescribed fishes. Head large, rounded anteriorly. Eyes very large, directed upwards. Pectoral fins unusually long, each with eight strong rays.

Remarks: The upward directed eyes suggest a bottom dweller.

Recent relatives: None. Died out in Lower Carboniferous.



Unnamed iniopterygiiform fish (length c.10 cm) from the Lower Carboniferous of Bear Gulch, Montana. Original: Adelphi University, Garden City, N.J., U.S.A.

Genus: Unnamed.

Geological range: Lower Carboniferous.

Geographical distribution: North America.

Features: Small, still undescribed fishes. Body plump, drawn out into a point posteriorly. Head short. Just behind head, in mid-dorsal line, a branched antler-like outgrowth. One dorsal fin and small pelvic fins present.

Remarks: Probably free-swimming, but certainly not expert swimmers.

Recent relatives: None. Died out in Lower Carboniferous.



Unnamed cochliodontoid fish (length c. 14 cm) from the Lower Carboniferous of Bear Gulch, Montana, U.S.A. Original: Adelphi University, Garden City, N.J., U.S.A.

Genus: Unnamed.

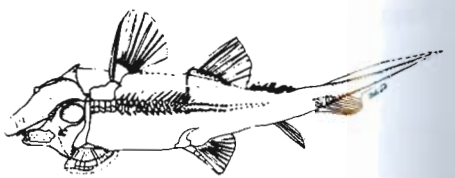
Geological range: Lower Carboniferous.

Geographical distribution: North America.

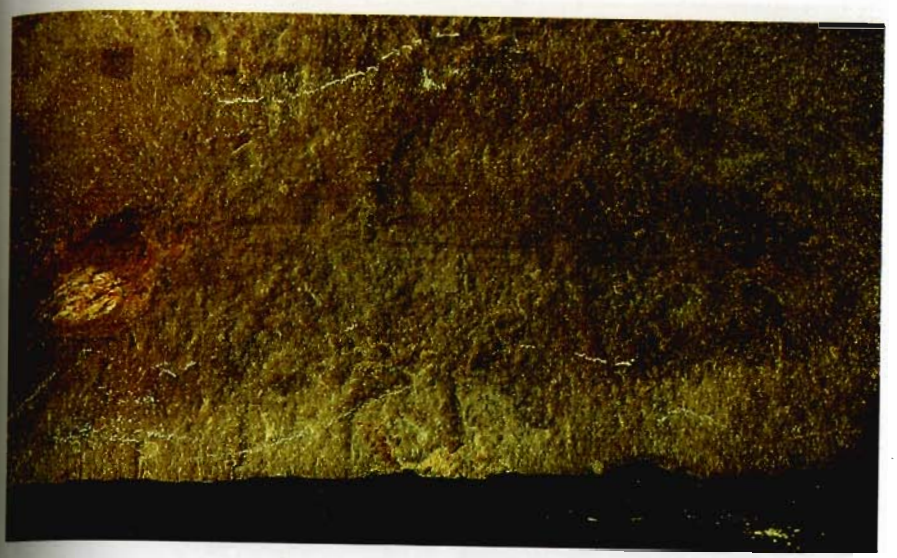
Features: Small, still undescribed fishes. Head small, snout pointed. Strong dentition. Eyes large. Two strong dorsal fins. The first with a long thorn anteriorly. Body pointed posteriorly. Males have a copulation hook on the ventral fin. Anal fin narrow and long.

Remarks: The strong dentition indicates a durophagous diet.

Recent relatives: None. Died out in Lower Carboniferous.



Reconstruction after Lund



Unnamed cochliodontoid fish (length c. 11 cm) from the Lower Carboniferous of Bear Gulch, Montana, U.S.A. Original: Adelphi University, Garden City, N.J., U.S.A.

Genus: Unnamed.

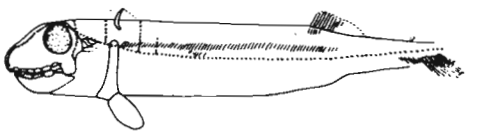
Geological range: Lower Carboniferous.

Geographical distribution: North America.

Features: Small, still undescribed fishes. Head small with large eyes and strong dentition. Body rather plump. Short thorn in the nape. One dorsal fin very posterior.

Remarks: The strong dentition indicates a durophagous diet.

Recent relatives: None. Died out in Lower Carboniferous.



Reconstruction after Lund.



Unnamed cochliodontoid fish (length c. 10 cm) from the Lower Carboniferous of Bear Gulch, Montana, U.S.A. Original: Adelphi University, Garden City, N.J., U.S.A

Genus: Unnamed.

Geological range: Lower Carboniferous.

Geographical distribution: North America.

Features: Small, still undescribed fishes. Head elongate. Snout pointed. Strong dentition. Two nasal spines. Many occipital spines, curved, directed rearwards and ending in sharp points.

Remarks: Probably free-swimming.

Recent relatives: None. Died out in Carboniferous.



Unnamed cochliodontoid fish (length c. 9 cm) from the Lower Carboniferous of Bear Gulch, Montana, U.S.A. Original: Adelphi University, Garden City, N.J., U.S.A.

Genus: Unnamed.

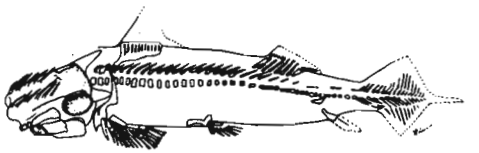
Geological range: Lower Carboniferous.

Geographical distribution: North America.

Features: Small, still undescribed fish. Body rather plump. Head small. Snout flattened. Mouth ventral. Strong dentition. Two rows of pointed spines on the dorsal surface of the body. Probably two dorsal fins, with a weak spine at front of first one. Caudal fin with upper and lower lobes similar to each other and triangular. Male with claspers on pelvic fins.

Remarks: Probably free-swimming.

Recent relatives: None. Died out in Carboniferous.



Reconstruction after LUND.



Deltoptychius sp. (length c. 50 cm) from the Upper Carboniferous of Bearsden, Glasgow, Scotland, U.K. Original: The Natural History Museum, London, U.K.(P62092). Photograph: Hunterian Museum, Glasgow, U.K.

Genus: *Deltoptychius* Morris & Roberts, 1862.

Synonyms: *Listracanthus*, *Pnigeacanthus*, *Platacanthus*, *Platycanthus*, *Streblodus*.

Geological range: Lower to Upper Carboniferous.

Geographical distribution: Europe, North America.

Features: Middle-sized menaspoid fishes. Body wide anteriorly but tapering behind into the tail. Head narrow. Snout broadly pointed. On the dorsal surface anteriorly are two rows posteriorly pointing spines. More posteriorly is another row, in the dorsal mid line. The upper part of the end of the tail has a fin-fold-like fin. Pectoral fins rounded elongate and very large.

Remarks: Probably living near the bottom with a durophagous diet.

Recent relatives: None. Died out in Upper Carboniferous.



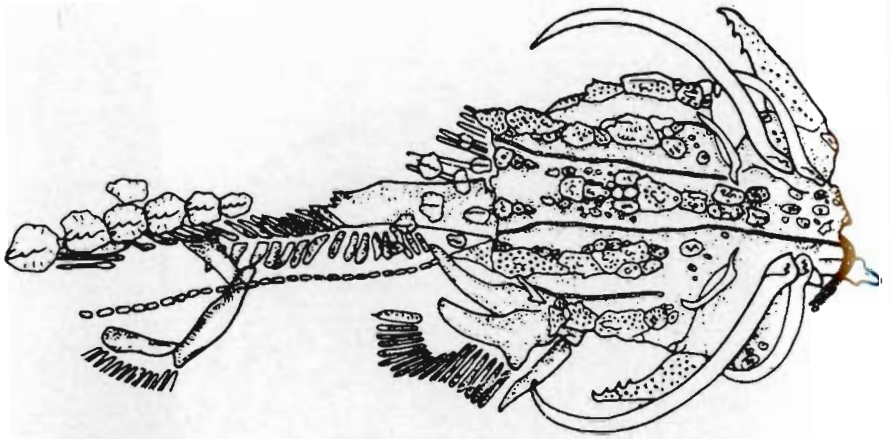
Deltoptychius, reconstruction after the Hunterian Museum.

CHONDRICHTHYES
Order: Unnamed
Family: Menaspidae

Cartilaginous Fishes
Suborder: Menaspoidei



Menaspis armata Eichwald (length c. 16 cm) from the Upper Permian of Eisleben, Germany. Original: Museum für Naturkunde, Berlin, Germany.



Menaspis, reconstruction after Moy-Thomas & Miles.

Genus: *Menaspis* Eichwald, 1848.

Synonyms: *Asima*, *Radamus*.

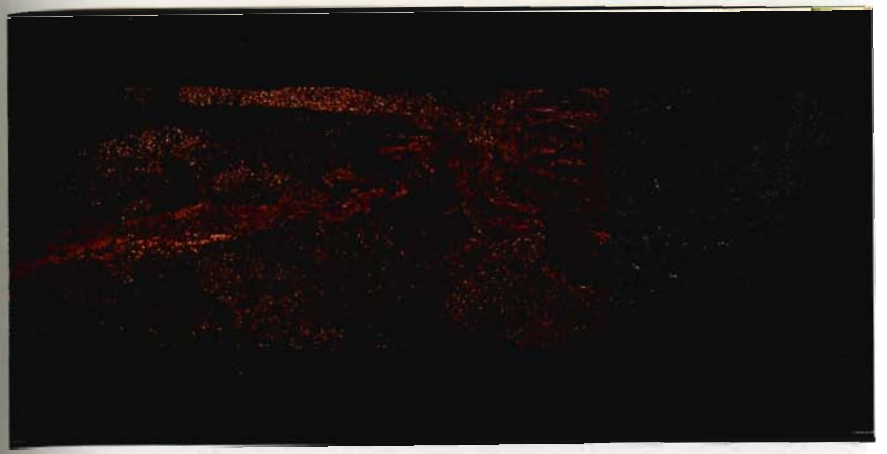
Geological range: Upper Permian.

Geographical distribution: Europe.

Features: Elongate body. On each side of the head a short thick triangular spine with a tuberculate surface. Behind come three thinner curved smooth spines, of which the second one is considerably longer than the two others. Head and trunk covered with longitudinally directed placoid scales which are partly covered with thorns or keeled and partly are seed-like. Dentition of small plates.

Remarks: Durophagous bottom dwellers.

Recent relatives: None. Died out in Upper Permian.



Acanthorhina jaekeli Fraas (length c. 50 cm) from the Lower Jurassic of Holzmaden, Württemberg, Germany. Original: Staatliches Museum für Naturkunde, Stuttgart, Germany. Photograph: Lumpe, Stuttgart.

Genus: *Acanthorhina* Fraas, 1911.

Geological range: Lower Jurassic.

Geographical distribution: Europe.

Features: Head tapering anteriorly to a long pointed rostral cartilage. Male with a small frontal spine. Strong fin spine in front of the first dorsal fin. Dentition is a pair of flat, undulating tooth plates in the upper jaw and three pairs in the lower jaw.

Remarks: Bottom-dwelling with durophagous diet.

Recent relatives: None. Died out in Lower Jurassic.



Acanthorhina, reconstruction after Fraas.



Echinochimaera meltoni LUND (length c. 8 cm) from the Lower Carboniferous of Bear Gulch, Montana, U.S.A. Original: Carnegie Museum of Natural History, Pittsburgh, Penn., U.S.A.

Genus: *Echinochimaera* LUND, 1977.

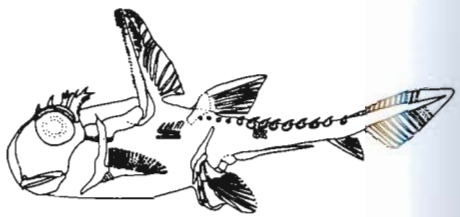
Geological range: Lower Carboniferous.

Geographical distribution: North America.

Features: Dwarf chimaeras of depressed shape with long pointed tail. Head short. Eyes large. Mouth slightly ventral. On the dorsal surface of the head a few spines, some of them branched. Two dorsal fins, of which the first is upright and supported by a long, anteriorly serrated spine. On the tail is a row of rearward pointing thorns.

Remarks: Free-swimming, durophagous in diet.

Recent relatives: None. Died out in Lower Carboniferous.



Echinochimaera, reconstruction after LUND.



Ischyodus quenstedti WAGNER (length c. 142 cm) from the Upper Jurassic of Solnhofen (Eichstätt), Bavaria, Germany. Original: Bayerische Staatssammlung für Paläontologie, Munich, Germany.

Genus: *Ischyodus* EGERTON, 1843.

Synonyms: *Auluxacanthus*, *Chimaeracanthus*.

Geological range: Middle Jurassic to Paleocene.

Geographical distribution: Europe, New Zealand.

Features: Large chimaeras with greatly elongate body tapering rearwards to a point. Head large. Nose probably pointed. Mouth slightly ventral. Lower jaw with two rhombic tooth plates. Palatal teeth small. Pectoral fins very large. First dorsal fin large and triangular, supported by a long projecting with denticles on the posterior surface. Second dorsal fin low and very long. The male has a short, slightly curved spine on the head.

Remarks: Probably bottom-dwellers but sometimes free-swimming. Durophagous diet.

Recent relatives: Genus extinct. Related to the recent chimaeras which are represented by six genera and about 30 species in the seas of the world.



Chimaera monstrosa, a recent chimaera. Lithograph from BLOCH.



Delphyodontos dacriformis LUND (length c. 11 cm) from the Lower Carboniferous of Bear Gulch, Montana, U.S.A. Original: Adelphi University, Garden City, N.J., U.S.A.

Genus: *Delphyodontos* LUND, 1980.

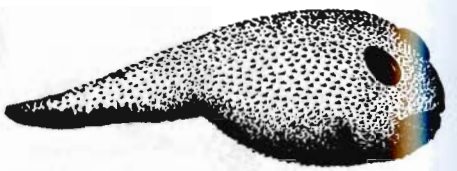
Geological range: Lower Carboniferous.

Geographical distribution: North America.

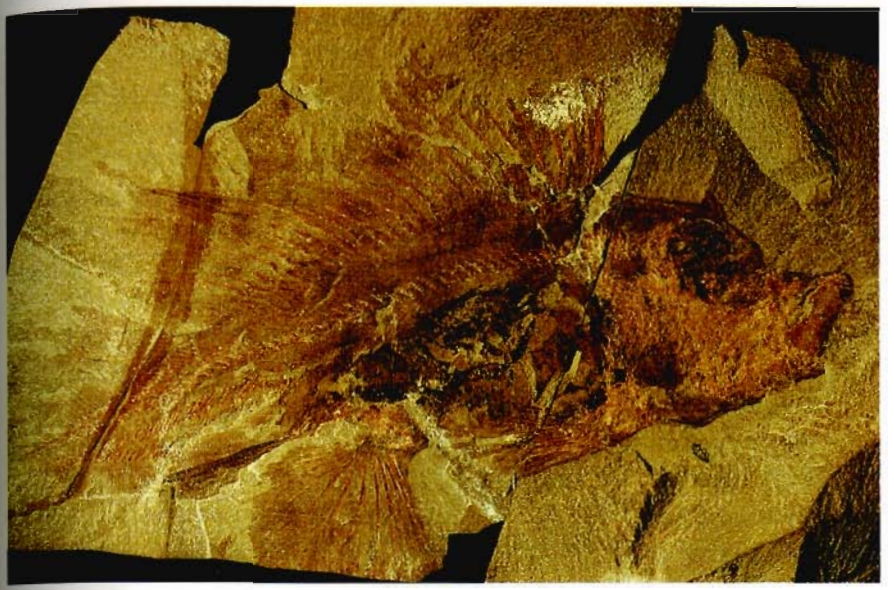
Features: Small chimaeras of variable appearance. Plump in shape. Head large and not visibly distinct from the body. Eyes relatively large and pointing forwards. Mouth terminal. Tail end of body pointed. Skin covered with short spines.

Remarks: Bottom-dwelling and possibly clumsily free-swimming.

Recent relatives: None. Died out in Lower Carboniferous.



Delphyodontos, reconstruction after LUND.



Unnamed chondrichthyan (length c. 18 cm) from the Lower Carboniferous of Bear Gulch, Montana, U.S.A. Original: Adelphi University, Garden City, N.J., U.S.A

Genus: Unnamed.

Geological range: Lower Carboniferous.

Geographical distribution: North America.

Features: Small fishes of somewhat laterally compressed shape. Head deep. Eyes large. Snout elongate and pointed. Mouth probably large. Dorsal fin tall, beginning behind the head and continuing along the whole back as a fringe. Anal fins large and fan-shaped. Pectoral fins narrow. Caudal fin pointed, probably low and fringe-like.

Remarks: Lethargic fishes with a predatory mode of life.

Recent relatives: None. Died out in Carboniferous.

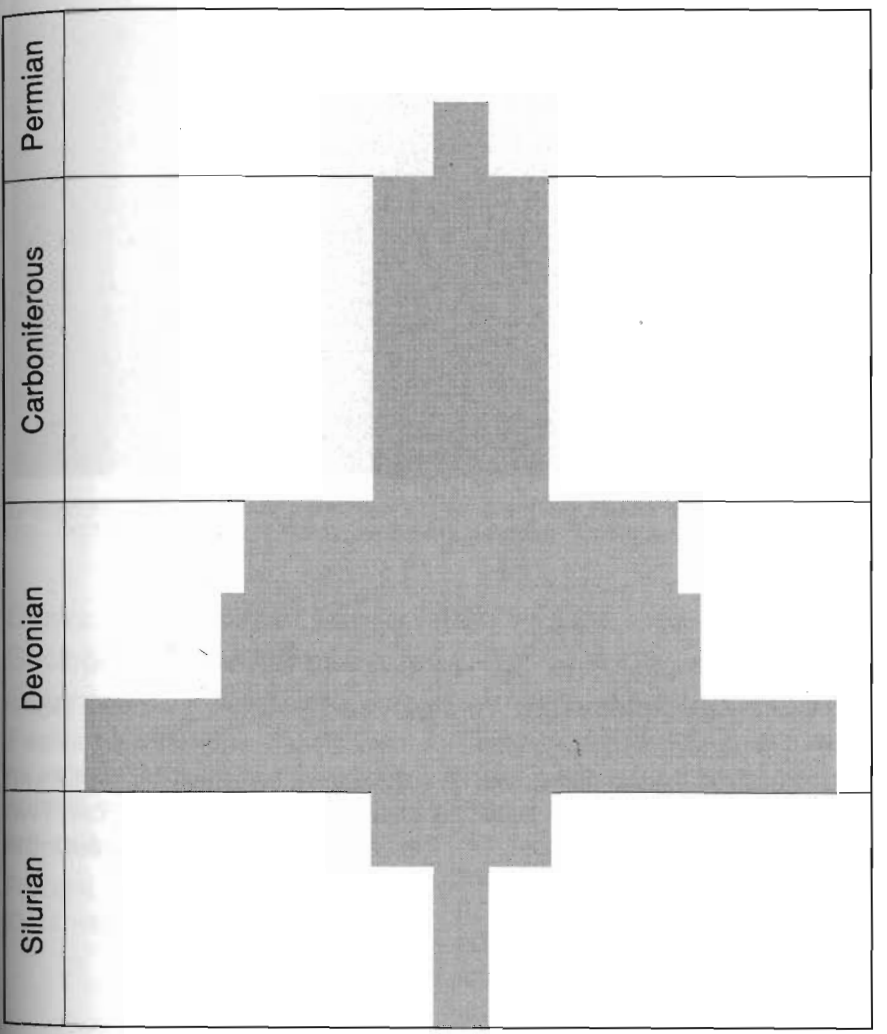
The acanthodians are jaw-bearing fishes (Gnathostomata) but there is still no final agreement on their systematic position. They have a highly advanced, spindle-like body shape very similar to the normal conception of a fish. In general they are small, between 20 and 50 cm in length, but there are some real giants which reach up to 2.5 metres. Bony tissue occurs both in the exoskeleton and the endoskeleton. The body was covered with small scales arranged like a mosaic and, at least externally, these resemble those of "ganoid" fishes. Sometimes the scales continue onto the skin of the fins. From the evolutionary point of view, these scales are not dermal denticles, as in the sharks, for they have a bony base covered with dentine. This is why they recall the scales of "ganoids."

The snout region of the skull is strikingly small. The eyes are large and face laterally and the nostrils are high in the skull. Usually the little teeth are confined to the lower jaw, though in some species they are present on the upper jaw also. Other species are toothless.

A feature common to all of them is that every fin, except the caudal fin, is supported by a massive spine formed of dentine. This sometimes projects far beyond the fin. On the ventral surface, the series of spines may be continuous between the pectoral and pelvic fins consisting of one or several pairs of free spines. Perhaps these are vestiges of additional paired fins. The caudal fin is always heterocercal.

The acanthodians probably represent a blind side-branch whose ancestors gave rise to all other jaw-bearing fishes.

The acanthodians have been shown to exist in the Middle and Upper Silurian. They reached a maximum in the Lower Devonian and then the number of species continually declined. They died out in the Lower Permian without leaving any descendants. About 65 genera have been described and some of them are extremely well preserved.



The approximate distribution of acanthodians in geological time, changed after MÜLLER



Climatius reticulatus AGASSIZ (length c. 14 cm) from the Lower Devonian of Scotland. Original: National Museum of Scotland, Edinburgh, U.K.

Genus: *Climatius* AGASSIZ, 1845.

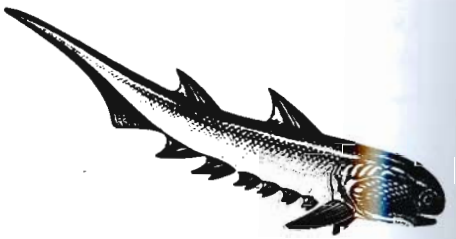
Geological range: Upper Silurian to Lower Devonian.

Geographical distribution: Western and eastern Europe, North America.

Features: Elongated fishes with a rounded head. Eyes large. Mouth slightly ventral. Caudal fin tapering to a point in the upper lobe. Two short strong dorsal spines. On the ventral surface, between the pectoral and pelvic fins are four pairs of smaller spines which increase in size posteriorly. The teeth are flat, each one with a main cusp and two lateral cusps.

Remarks: Rapid swimmers.

Recent relatives: None. Died out in Lower Devonian.



Climatius, reconstruction after MACMILLAN.

ACANTHODII
Order: Climatiiformes
Family: Climatiidae
Acanthodians



Euthacanthus macnicolli POWRIE (length c. 14 cm) from the Lower Devonian of Angus, Scotland. Original: National Museum of Scotland, Edinburgh, U.K.

Genus: *Euthacanthus* POWRIE, 1864.

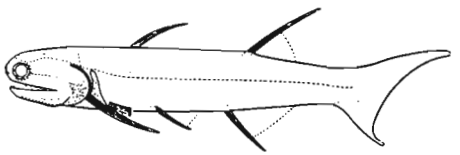
Geological range: Lower Devonian.

Geographical distribution: Europe.

Features: Elongate fishes with a relatively short caudal fin. Head rounded. Mouth slightly ventral. Five pairs of powerful ventral spines which become larger posteriorly. No teeth.

Remarks: Rapid swimmers.

Recent relatives: None. Died out in Lower Devonian.



Euthacanthus, reconstruction after WATSON.



Parexus falcatus POWRIE (length c. 14 cm) from the Lower Devonian of Angus, Scotland. Original: National Museum of Scotland, Edinburgh, U.K.

Genus: *Parexus* AGASSIZ, 1845.

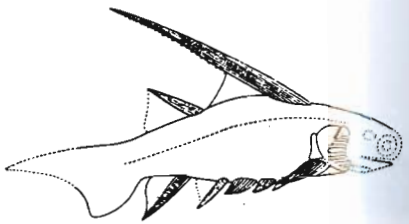
Geological range: Lower Devonian.

Geographical distribution: Europe.

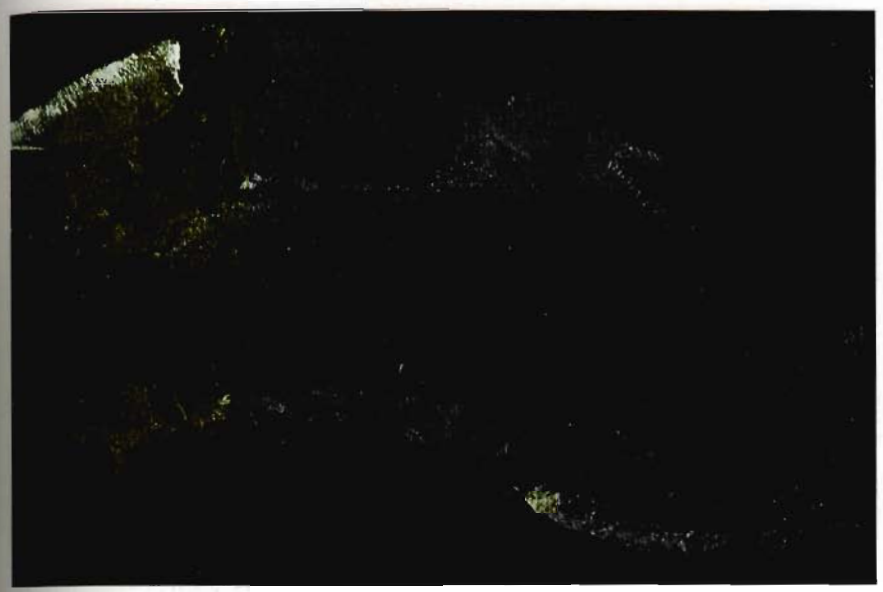
Features: Fishes with laterally compressed body shape. Head rounded. Mouth slightly ventral. Caudal fin relatively short and broad. Long teeth with a single point. Eyes large. Two dorsal spines, the first being extremely long. Posteriorly with two rows of denticle-like structures. On the ventral surface, between the pectoral and pelvic fins, there are three pairs of powerful spines which increase in size posteriorly.

Remarks: Probably somewhat clumsy swimmers.

Recent relatives: None. Died out in Lower Devonian.



Parexus, reconstruction after WATSON.



Vernicomacanthus uncinatus (POWRIE) (length c. 8 cm) from the Lower Devonian of Forfar, Scotland, U.K. Original: National Museum of Scotland, Edinburgh, U.K.

Genus: *Vernicomacanthus* MILES, 1973.

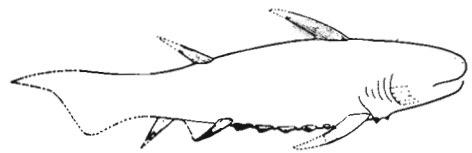
Geological range: Lower Devonian.

Geographical distribution: Europe.

Features: Relatively small fishes with a somewhat laterally compressed body. Eyes large. Mouth ventral. Teeth flat. Two dorsal fins with powerful spines, the anterior spine being longer than the posterior. Four pairs of free ventral spines. Maximum length scarcely more than 15 cm.

Remarks: Nimble swimmers.

Recent relatives: None. Died out in Lower Devonian.



Vernicomacanthus, reconstruction after MILES.



Diplacanthus striatus AGASSIZ (length c. 5 cm) from the Devonian of Achanarras, Caithness, Scotland, U.K. Original: The Natural History Museum, London, U.K. (P22199).

Genus: *Diplacanthus* AGASSIZ, 1844.

Synonym: *Rhadinacanthus*

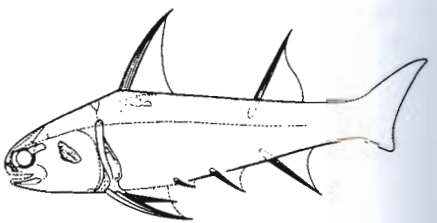
Geological range: Middle to Upper Devonian.

Geographical distribution: Western and eastern Europe, North America.

Features: Little fishes with somewhat laterally compressed body shape. Caudal fin relatively short. Mouth ventral. No teeth. Fin spines long and powerful. First dorsal fin very anterior in position. One pair of spines between the pectoral and pelvic fins.

Remarks: Probably not very good swimmers.

Recent relatives: None. Died out in Upper Devonian.



Diplacanthus, reconstruction after WATSON.



Rhadinacanthus longispinus TRAQUAIR (length c. 16 cm) from the Middle Devonian of Caithness, Scotland, U.K. Original: Tischlinger Collection, Stammham, Germany.

Genus: *Rhadinacanthus* TRAQUAIR, 1888.

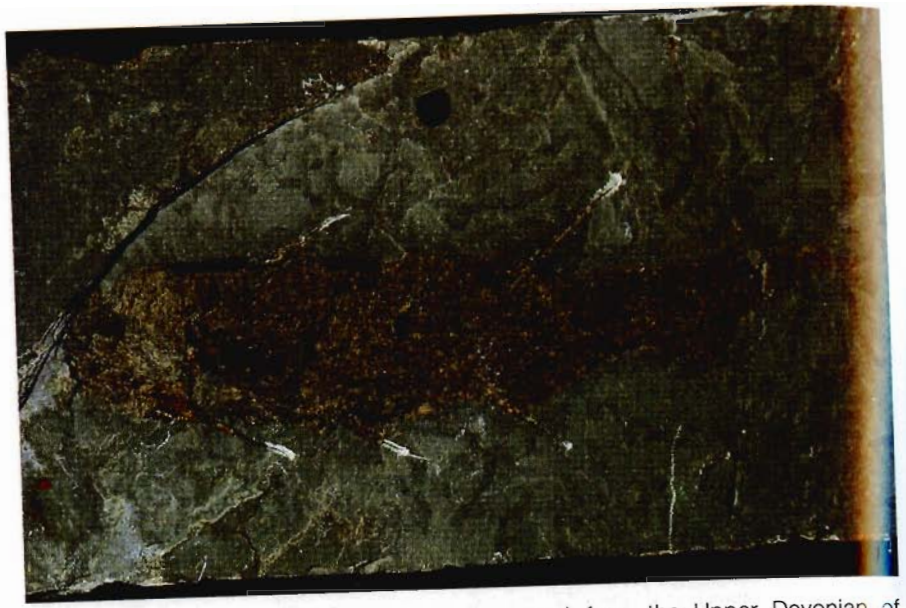
Geological range: Middle Devonian.

Geographical distribution: Europe.

Features: Small to middle-sized, somewhat plump fishes. Head rounded. Eyes large. Mouth ventral. No teeth. Fin spines powerful and long. The first dorsal fin very anterior with a shorter, slightly curved spine. The second dorsal fin with a longer straight spine. One pair of spines between the pectoral and pelvic fins.

Remarks: The genus *Rhadinacanthus* is sometimes seen as a synonym of *Diplacanthus*.

Recent relatives: None. Died out in Devonian.



Ischnacanthus gracilis EGERTON (length c. 10 cm) from the Upper Devonian of Forfarshire, Scotland, U.K. Original: The Natural History Museum, London, U.K. (P132).

Genus: *Ischnacanthus* POWRIE, 1864.

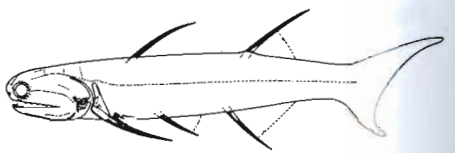
Geological range: Lower Devonian.

Geographical distribution: Europe, North America.

Features: Elongate fishes with middle-sized caudal fin. Head rounded. Mouth slightly ventral. Eyes large. Two dorsal fins, each with a slender spine. First spine smaller and slightly curved. No free ventral spines. Teeth with broadly conical points. Maximum length scarcely more than 10 cm.

Remarks: Nimble swimmers.

Recent relatives: None. Died out in Upper Devonian.



Ischnacanthus, reconstruction after WATSON.



Acanthodes bronni AGASSIZ (length c. 40 cm) from the Permian of Niederkirchen, Palatinate, Germany. Original: Staatliches Museum für Naturkunde, Stuttgart, Germany.

Genus: *Acanthodes* AGASSIZ, 1833.

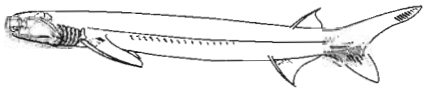
Geological range: Upper Carboniferous to Lower Permian.

Geographical distribution: Europe, North America, Australia, South Africa, eastern Asia.

Features: Relatively large fishes, sometimes reaching a length of more than 50 cm. Laterally compressed body. Caudal fin clearly divided into an upper and a lower lobe. Head bluntly rounded. Eyes large. Mouth opening slightly ventral. No teeth. Only one dorsal fin, with a powerful spine which does not exceed the fin in height.

Remarks: Nimble swimmers.

Recent relatives: None. Died out in Lower Permian.



Acanthodes, after HEIDTKE.



Cheiracanthus latus EGERTON (length c. 14 cm) from the Upper Devonian of Banffshire, Scotland, U.K. Original: The Natural History Museum, London, U.K. (P15286).

Genus: *Cheiracanthus* AGASSIZ, 1835.

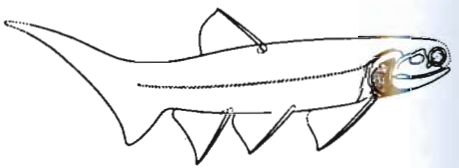
Geological range: Upper Devonian.

Geographical distribution: Western and eastern Europe.

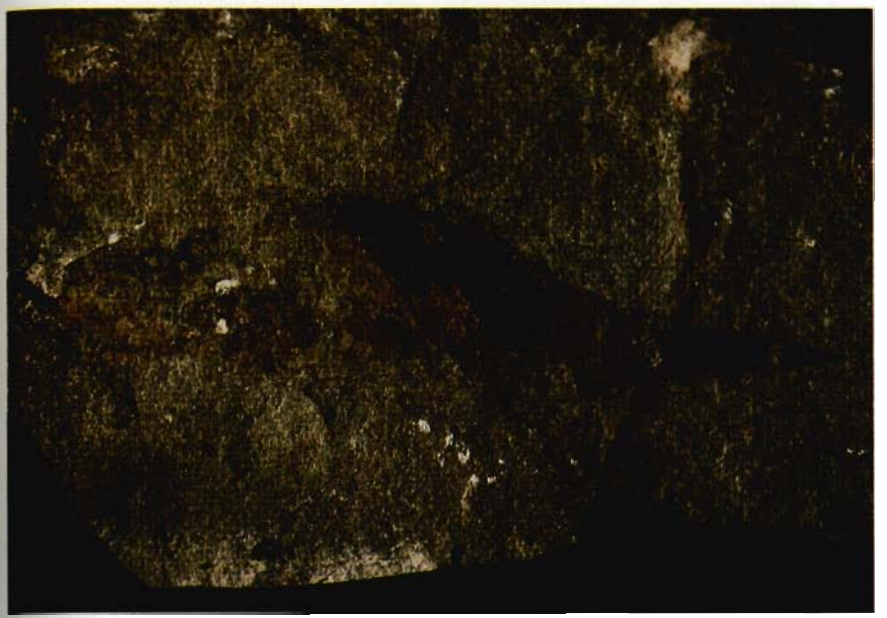
Features: Rather large fishes with a somewhat laterally compressed body which may reach a length of about 30 cm. Caudal fin with greatly elongate upper lobe. Head rounded. Mouth somewhat ventral. Eyes large. No free ventral spines. Only one dorsal fin with a short spine which does not project beyond fin.

Remarks: Nimble swimmer.

Recent relatives: None. Died out in Upper Devonian.



Cheiracanthus, reconstruction after WATSON.



Homalacanthus concinnus (WHITEAVES) (length c. 8 cm) from the Upper Devonian of Miguasha, Gaspé Peninsula, Quebec, Canada. Original: Naturhistoriska Riksmuseet, Stockholm, Sweden.

Genus: *Homalacanthus* RUSSEL, 1951.

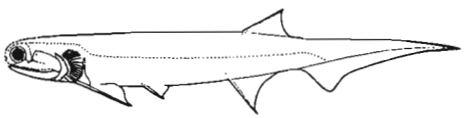
Geological range: Upper Devonian to Lower Carboniferous.

Geographical distribution: North America, eastern Europe.

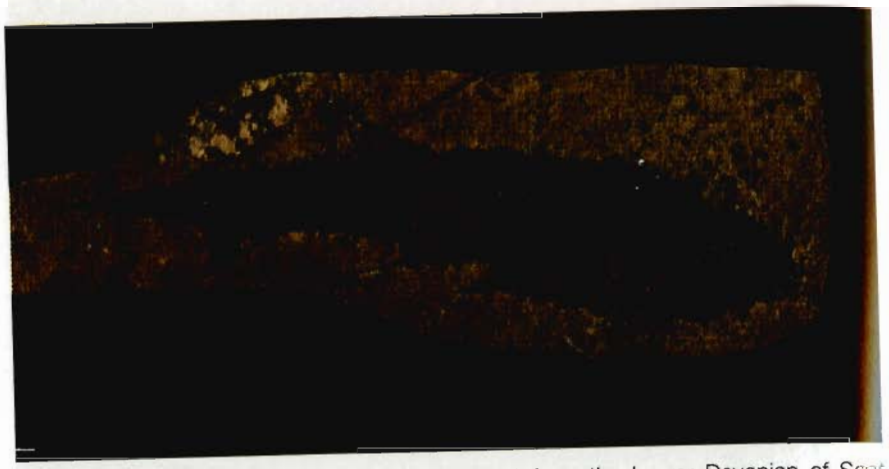
Features: Middle-sized fishes with a long slender body. Caudal fin extending into a point and with a long lower lobe. A single dorsal fin with a delicate short spine. Head rounded. Mouth slightly ventral. Eyes large. No free ventral spines. No teeth. Length scarcely more than 15 cm.

Remarks: Nimble swimmers.

Recent relatives: None. Died out in Lower Carboniferous.



Homalacanthus, reconstruction after MILES.



Mesacanthus mitchelli EGERTON (length c. 6 cm) from the Lower Devonian of Scotland, U.K. Original: National Museum of Scotland, Edinburgh, U.K.

Genus: *Mesacanthus* TRAQUAIR, 1888.

Geological range: Lower Devonian to Middle Devonian.

Geographical distribution: Europe.

Features: Small fishes with a slender body. Head rounded. Mouth slightly ventral. Eyes large. Caudal fin relatively short. One pair of free ventral spines. No teeth. Only one dorsal fin, very posterior in position and supported by a spine which projects far above the fin. Length scarcely more than 15 cm.

Remarks: Nimble swimmers.

Recent relatives: None. Died out in Middle Devonian.



Mesacanthus, reconstruction after WATSON.



Traquairichthys pygmaeus (FRITSCH) (length c. 6 cm) from the Lower Permian of Nursava, Czechoslovakia. Original: Naturhistorisches Museum, Vienna, Austria.

Genus: *Traquairichthys* WHITLEY, 1933.

Geological range: Upper Carboniferous to Lower Permian.

Geographical distribution: Europe, North America.

Features: Small, very slender fishes. The body ends in a caudal fin whose termination is curved slightly downwards. Head pointed. Eyes small. No teeth. Only one dorsal fin, located very posteriorly just in front of the caudal fin. No free ventral spines. No pelvic fins. Maximum length scarcely more than 10 cm.

Remarks: Nimble swimmers.

Recent relatives: None. Died out in Lower Permian.



Traquairichthys, reconstruction after FRITSCH.



Triazeugacanthus affinis (WHITEAVES) (length c. 3 cm) from the Upper Devonian of Miguasha, Gaspé Peninsula, Quebec, Canada. Original: Musée d'Histoire Naturelle, Miguasha, Canada.

Genus: *Triazeugacanthus* MILES, 1966.

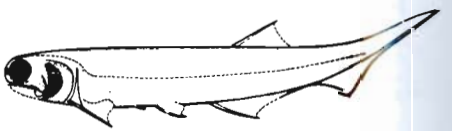
Geological range: Upper Devonian.

Geographical distribution: North America.

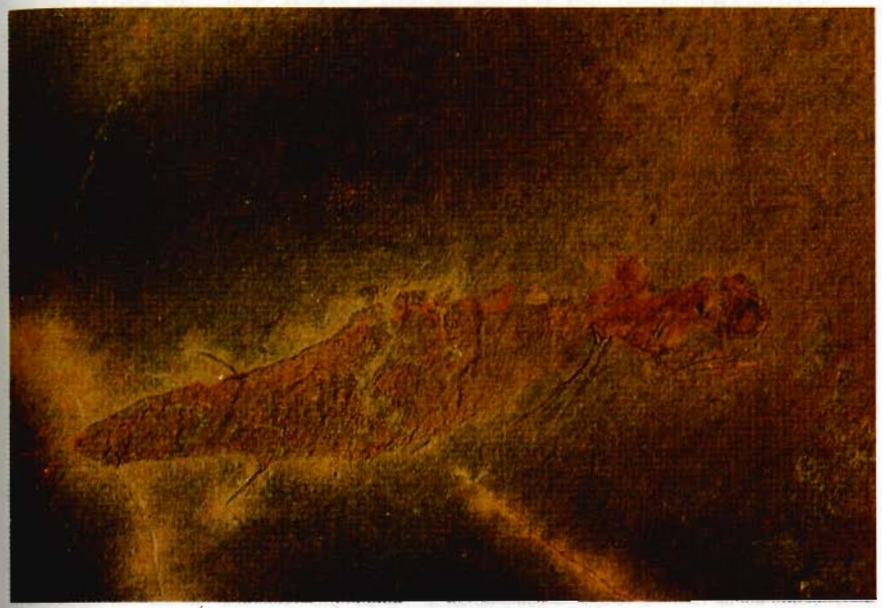
Features: Small fishes with a very slender body. This ends in a caudal fin with the upper lobe tapering to a point and directed upwards. Head rounded. Eyes large. Mouth slightly ventral. No teeth. One pair of free ventral spines. Only one dorsal fin, with a delicate spine which does not project beyond the fin. Maximum length scarcely more than 10 cm.

Remarks: Nimble swimmers.

Recent relatives: None. Died out in Upper Devonian.



Triazeugacanthus, reconstruction after MILES.



Utahacanthus guntheri SCHULTZE (length c. 6 cm) from the Upper Carboniferous of Utah, U.S.A. Original: Brigham Young University, Provo, Utah, U.S.A.

Genus: *Utahacanthus* SCHULTZE, 1990.

Geological range: Upper Carboniferous.

Geographical distribution: North America.

Features: Very small fishes with a slender body. Head rounded. Eyes small. Mouth slightly ventral. Only one dorsal fin, posteriorly located with a delicate spine. Probably no teeth and no free ventral spines. Maximum length scarcely more than 10 cm.

Remarks: Nimble swimmers.

Recent relatives: None. Died out in Upper Carboniferous.



Utahacanthus, reconstruction after SCHULTZE.

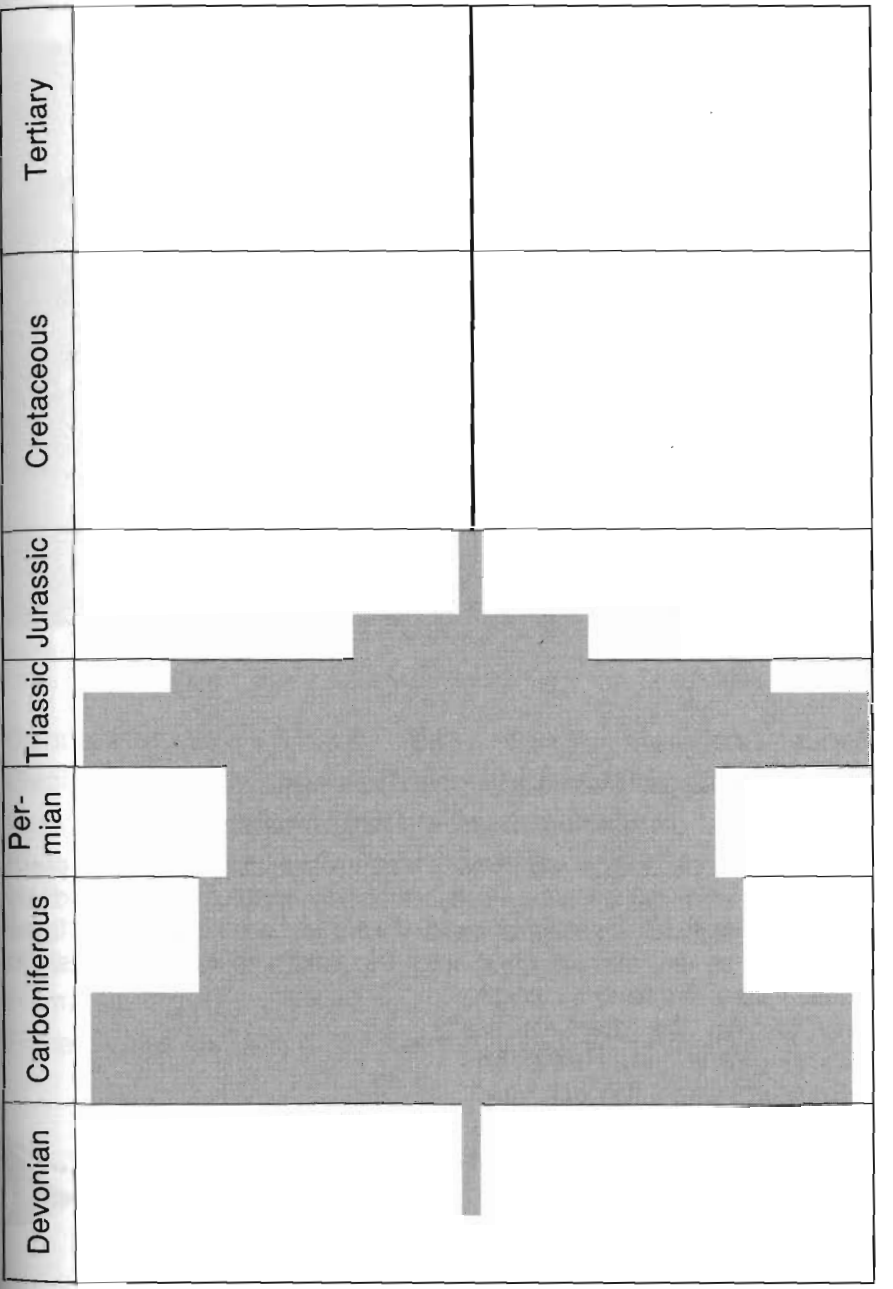
Actinopterygians, or ray-finned fishes, include the true bony fishes or teleosts among others. They are characterized by paired fins supported by strong, radially arranged rays. The most primitive actinopterygians are referred to as chondrosteans (Chondrostei). The chondrosteans still have much cartilage in the endoskeleton —for example the centra of the vertebrae are not ossified. Moreover, with a few exceptions, the upper jaw and palate are rigidly attached to the anterior cover of the operculum, so that only the lower jaw is moveable. The eyes, which are usually large, are nearly always protected by a four-part sclerotic ring.

There is always only a single dorsal fin. With a few exceptions, the caudal fin is heterocercal. In the older representatives of this group, this fin is generally covered with scales up to the tip but in the course of evolution the scale-covered surface decreases.

Rhombic ganoid scales are the commonest type. They consist of ganoine, cosmine and bony tissue with the ganoine layer reaching a considerable thickness. Ganoine is very similar to tooth enamel and so these scales are referred to as enamel scales. The ganoine and cosmine layers, however, become more and more reduced in the course of evolution and in some cases the scales are almost completely lost. V-shaped keeled scales, called fulcral scales, commonly occur on the dorsal margins of the dorsal and anal fins and also on the anterior margin of the dorsal lobe of the caudal fin.

At first most chondrosteans may have lived in fresh water. Nevertheless, by the end of the Triassic almost all of them had taken to salt water. This fresh-water ancestry may be the reason why, as a sort of folk memory, some bony fishes live in the sea but return to fresh water to lay their eggs.

The first sparse occurrence of chondrosteans can be traced back to the Middle Devonian. They reached their first maximum in the Lower Carboniferous, then suffered a slight retreat to reach a second maximum in the Lower Triassic. In the Upper Jurassic they had already become very scarce and the only surviving fishes which are kin to them are the sturgeons and garpikes. More than 200 fossil genera have so far been described. They are often extremely well preserved.



The approximate distribution of chondrosteans in geological time, changed after MÜLLER



Cheirolepis trailli AGASSIZ (length c. 25 cm) from the Middle Devonian of Nairnshire, Scotland, U.K. Original: The Natural History Museum, London, U.K. (P453).

Genus: *Cheirolepis* AGASSIZ, 1835.

Geological range: Middle to Upper Devonian.

Geographical distribution: Europe, North America.

Features: Body shape elongate. Head rather deep. Pointed teeth on upper and lower jaws. Eyes relatively small, surrounded by sclerotic rings. Scales small and rhombic, with the bony layer projecting as an obtuse cone into the cosmine layer. Dorsal fin located very posteriorly, beginning behind the start of the opposing anal fin. Pelvic fins with a strikingly broad base. Pectoral fins with narrow lobes. Tail fin heterocercal with an axial lobe.

Remarks: Middle-sized predators.

Recent relatives: None. Died out in Upper Devonian.



Cheirolepis, reconstruction after LEHMAN.



Kentuckia hlavini DUNKLE (length c. 10 cm) from the Upper Devonian of Cleveland, Ohio, U.S.A. Original: Museum of Natural History, Cleveland, Ohio, U.S.A.

Genus: *Kentuckia* RAYNER, 1951.

Geological range: Upper Devonian to Lower Carboniferous.

Geographical distribution: North America.

Features: Small to middle-sized fishes of spindle-like shape. Head large, somewhat elongate. Snout blunt. Mouth relatively wide. Teeth small, pointed. Scales thick and elongate. Dorsal fin in the posterior third of the body.

Remarks: Predatory fishes.

Recent relatives: None. Died out in Lower Carboniferous.



Moythomasia nitida Gross (length c. 7 cm) from the Middle Devonian of Bergisch Gladbach, Westphalia, Germany. Original: Geologisch-Paläontologisches Museum, Münster, Germany.

Genus: *Moythomasia* Gross, 1950.

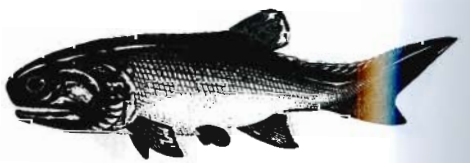
Geological range: Middle to Upper Devonian.

Geographical distribution: Europe, Australia.

Features: Slender fishes. Head relatively short with a blunt snout. Upper and lower jaws with pointed teeth. Eyes strikingly large. Dorsal fin in the posterior half of the body, opposite the anal fin. Caudal fin heterocercal with an elongate upper lobe.

Remarks: Small predators.

Recent relatives: None. Died out in Upper Devonian.



Moythomasia, reconstruction after MacMillan.



Stegotrachelys finlayi (Woodward & White) (length c. 9 cm) from the Middle Devonian of Exnaboe, Shetland Islands, Scotland. Original: The Natural History Museum, London, U.K. (P 13408-9)

Genus: *Stegotrachelys* Woodward & White, 1926.

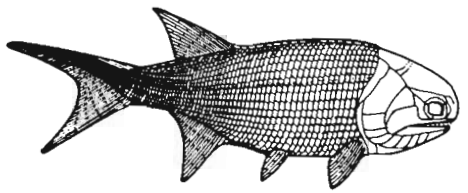
Geological range: Lower to Middle Devonian.

Geographical distribution: Europe, North America.

Features: Small fishes of somewhat laterally compressed shape. Dorsal fin pointed triangular, opposite the anal fin and equal in size. Caudal fin heterocercal. Upper lobe only slightly elongate. Pectoral and pelvic fins narrow. Scales square to rectangular.

Remarks: Small predators.

Recent relatives: None. Died out in Middle Devonian.



Stegotrachelys, reconstruction after White.



Apateolepis australis WOODWARD (length c. 14 cm) from the Middle Triassic of Gosford, New South Wales, Australia. Original: The Natural History Museum, London, U.K. (P6268).

Genus: *Apateolepis* WOODWARD, 1890.

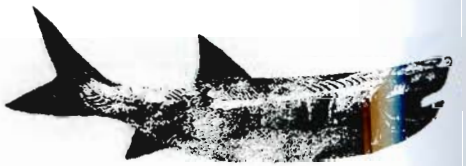
Geological range: Middle Triassic.

Geographical distribution: Australia.

Features: Small to middle-sized fishes with elongate, spindle-shaped bodies. Snout blunt. Scales small and thin. Dorsal fin located very posteriorly. Pectoral fins relatively broad with unsegmented bony fin rays (lepidotrichia).

Remarks: Predators.

Recent relatives: None. Died out in Middle Triassic.



Apateolepis, reconstruction after WOODWARD.



Megapteriscus longicaudatus WADE (length c. 6 cm) from the Middle Triassic of Brookvale, New South Wales, Australia. Original: The Natural History Museum, London, U.K. (P16827)

Genus: *Megapteriscus* WADE, 1935.

Geological range: Middle Triassic.

Geographical distribution: Australia.

Features: Small fishes with spindle-shaped elongate bodies. Snout blunt. Dorsal fin very posterior. Strikingly broad pectoral and pelvic fins. Scales small and thin.

Remarks: Small fishes, probably predatory.

Recent relatives: None. Died out in Middle Triassic.



Rhabdolepis macropterus BRONN (length c. 25 cm) from the Lower Permian of the Palatinate, Germany. Original: Henne Collection, Stuttgart, Germany.

Genus: *Rhabdolepis* TROSCHEL, 1857.

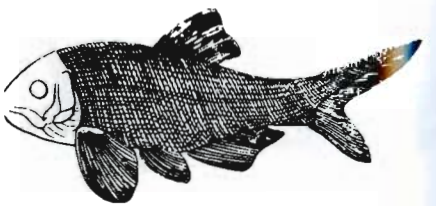
Geological range: Lower Permian.

Geographical distribution: Europe.

Features: Small fishes with slender elongate bodies. Eyes relatively large. Dorsal fin in posterior half of the body. Anal fin large and triangular. Scales scalloped and divided by diagonal ridges. Upper and lower jaws with powerful conical teeth.

Remarks: Predators.

Recent relatives: None. Died out in Lower Permian.



Rhabdolepis, after AGASSIZ.

CHONDROSTEI
Order: Palaeonisciformes
Family: Rhabdolepididae

Chondrosteans
Suborder: Palaeoniscoidei



Aetheretmon valentiacum WHITE (length c. 6 cm) from the Lower Carboniferous of Berwickshire, Scotland, U.K. Original: The Natural History Museum, London, U.K. (P 13145)

Genus: *Aetheretmon* WHITE, 1927.

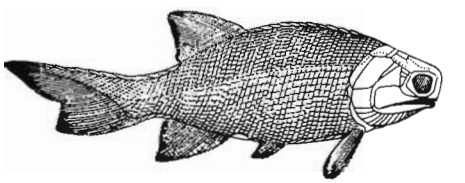
Geological range: Lower Carboniferous.

Geographical distribution: Europe.

Features: Small fishes of somewhat laterally compressed shape. Head relatively large with blunt snout. Eyes large. Dorsal fin in the posterior half of the body. Caudal fin heterocercal with elongate upper lobe. Pectoral fins narrow. Pelvic fins small. Anal fin of same size as dorsal fin. Scales square in the dorsal part of the body, elongate rectangular more ventrally, arranged in diagonal series.

Remarks: Small predators.

Recent relatives: None. Died out in Lower Carboniferous.



Aetheretmon, reconstruction after PIVETEAU.



Mentzichthys walshi JUBB (length c. 9 cm) from the Upper Devonian of Witteberg, South Africa. Original: Albany Museum, Grahamstown, South Africa.

Genus: *Mentzichthys* JUBB, 1965.

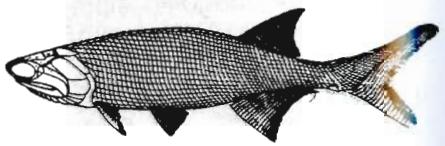
Geological range: Upper Devonian.

Geographical distribution: South Africa.

Features: Small slender fishes. Head narrow. Snout pointed. Eyes large. Dorsal fin located posteriorly, almost opposite the equally large anal fin. Caudal fin heterocercal with upper and lower lobes almost equal. Scales square and very small.

Remarks: Small predators.

Recent relatives: None. Died out in Upper Devonian.



Mentzichthys, reconstruction after GARDINER.



Rhadinichthys carinatus (length c. 11 cm) from the Lower Carboniferous of Edinburgh, Scotland, U.K. Original: Henne Collection, Stuttgart, Germany.

Genus: *Rhadinichthys* TRAQUAIR, 1877.

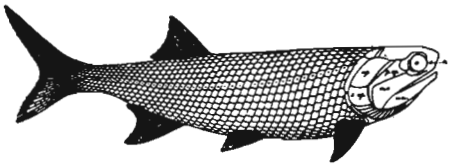
Geological range: Upper Devonian to Upper Carboniferous.

Geographical distribution: Europe, South America, Africa, northern Asia.

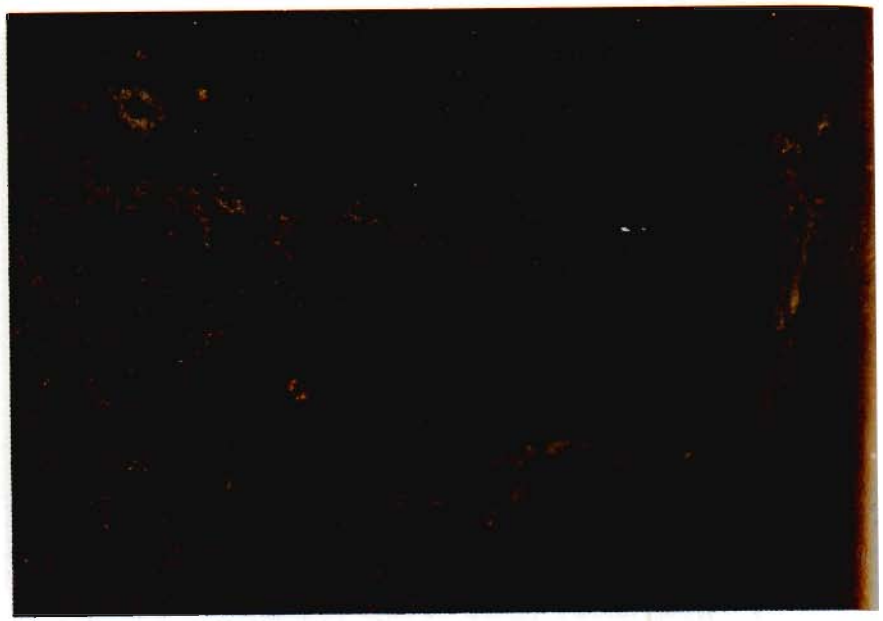
Features: Small fishes with slender spindle-shaped bodies. Head elongate. Snout blunt. Dorsal fin in the posterior half of the body, obliquely opposite the almost equally large anal fin. Caudal fin heterocercal, with the upper lobe only slightly longer than the lower lobe. Scales square to rectangular, arranged in diagonal rows.

Remarks: Small predators.

Recent relatives: None. Died out in Upper Carboniferous.



Rhadinichthys, reconstruction after GARDINER.



Phanerosteon pauper FRITSCH (length c. 6 cm) from the Lower Permian of Kostalov, Czechoslovakia. Original: Naturhistorisches Museum, Vienna, Austria.

Genus: *Phanerosteon* TRAQUAIR, 1881.

Synonyms: *Gymnoniscus*, *Sceletophorus*.

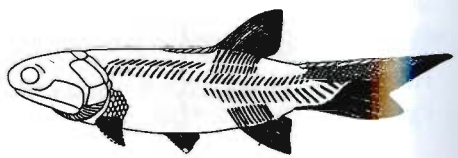
Geological range: Lower Carboniferous to Lower Permian.

Geographical distribution: Europe, North America.

Features: Small slender fishes. Head shallow. Snout rounded. Dorsal fin in the posterior half of the body, only slightly in front of the anal fin. Caudal fin heterocercal with long upper lobe. Pectoral and pelvic fins small.

Remarks: Small predatos.

Recent relatives: None. Died out in Lower Permian



Phanerosteon, reconstruction after WHITE.



Canobius ramsayi TRAQUAIR (length c. 6 cm) from the Lower Carboniferous of Dumfriesshire, Scotland, U.K. Original: Royal Museum of Scotland, Edinburgh, U.K.

Genus: *Canobius* TRAQUAIR, 1881.

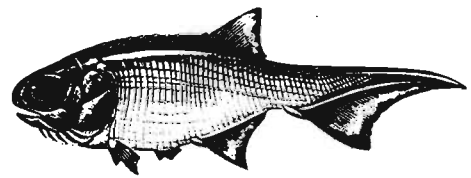
Geological range: Lower Carboniferous.

Geographical distribution: Europe.

Features: Small fishes of somewhat laterally compressed shape. Head relatively deep. Snout rounded. Dorsal fin pointed triangular, situated in the posterior third of the body. Anal fin likewise triangular, slightly anterior to the dorsal fin. Pectoral and pelvic fins small.

Remarks: Small predators.

Recent relatives: None. Died out in Lower Carboniferous.



Canobius, reconstruction after MACMILLAN.



Mesopoma politum TRAQUAIR (length c. 7 cm) from the Lower Carboniferous of Eskdale, Scotland, U.K. Original: The Natural History Museum, London, U.K. (P 4070a)

Genus: *Mesopoma* TRAQUAIR, 1890.

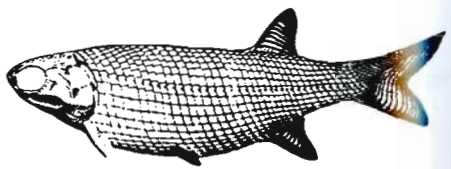
Geological range: Lower Carboniferous.

Geographical distribution: Europe.

Features: Small fishes of somewhat laterally compressed body shape. Head small, deep, with somewhat pointed snout. Eyes large. Dorsal fin in the posterior third of the body, opposite the anal fin. Scales square in the dorsal part of the body, rectangular more ventrally, arranged in diagonal rows.

Remarks: Small predators.

Recent relatives: None. Died out in Lower Carboniferous.



Mesopoma, reconstruction after the Hunterian Museum.

CHONDROSTEI
Order: Palaeonisciformes
Family: Canobiidae

Chondrosteans
Suborder: Palaeoniscoidei



Sundayichthys elegantulus GARDINER (length c. 25 cm) from the Upper Devonian of Witteberg, South Africa. Original: Albany Museum, Grahamstown, South Africa.

Genus: *Sundayichthys* GARDINER, 1969.

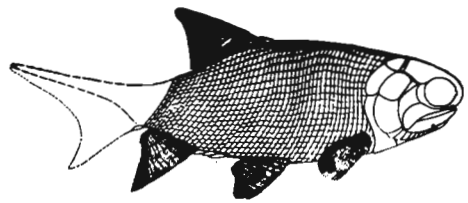
Geological range: Upper Devonian.

Geographical distribution: South Africa.

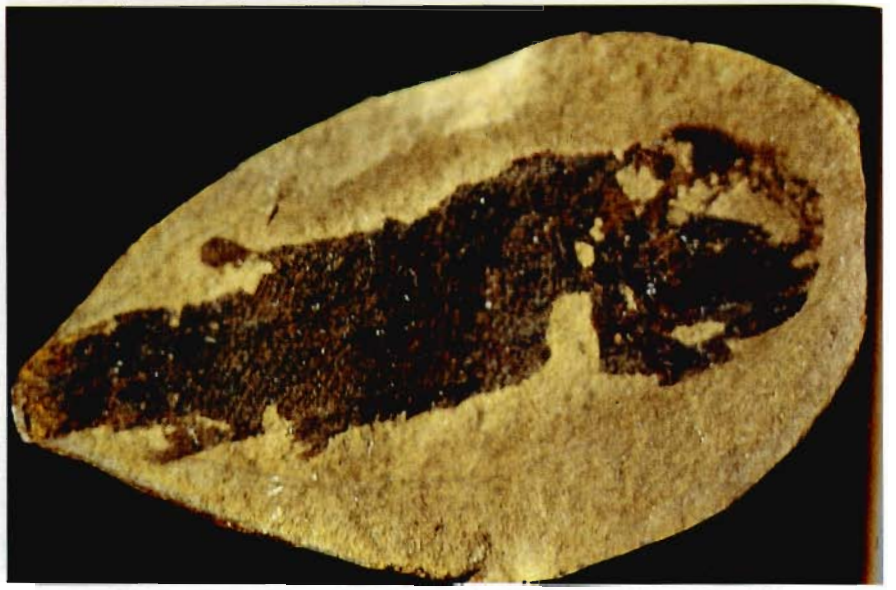
Features: Middle-sized fishes of somewhat compressed shape. Head deep with somewhat rounded snout. Eyes large. Dorsal fin relatively large and pointed, situated in the posterior half of the body. Anal fin very posterior. Caudal fin heterocercal, with the upper lobe longer than the lower. Pectoral and pelvic fins relatively broad. Scales square to rectangular.

Remarks: Middle-sized predators.

Recent relatives: None. Died out in Upper Devonian.



Sundayichthys, reconstruction after GARDINER.



Cornuboniscus budensis WHITE (length c. 3 cm) from the Lower Carboniferous of Bude, Cornwall, England, U.K. Original: Geologisch Museum, Amsterdam, Netherlands.

Genus: *Cornuboniscus* WHITE, 1939.

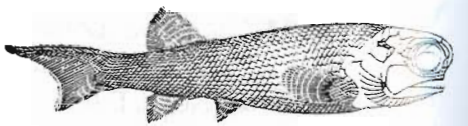
Geological range: Lower Carboniferous.

Geographical distribution: Europe.

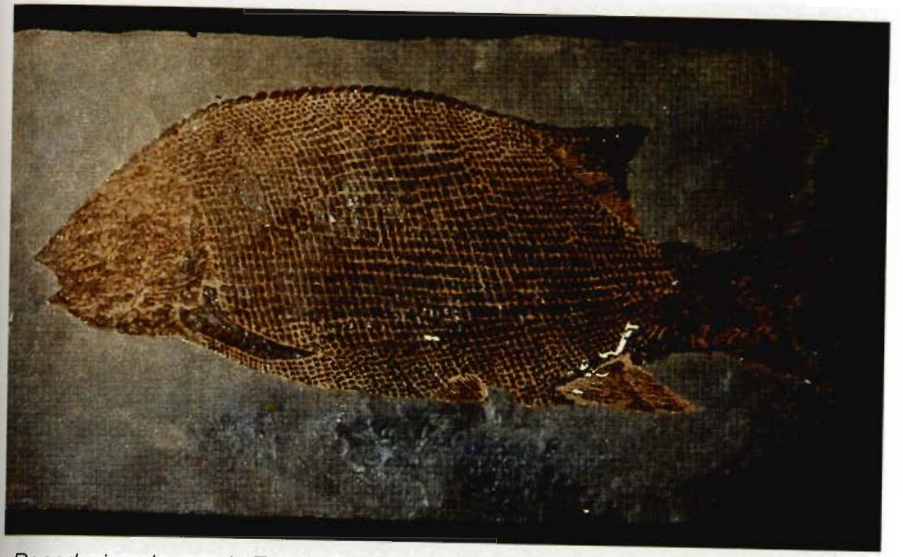
Features: Very small slender fishes with elongate head and rounded snout. Eyes large. Dorsal fin very posterior, opposite the smaller anal fin. Caudal fin heterocercal with projecting upper lobe. Pelvic fins small and pointed. Scales rectangular, arranged in diagonal rows.

Remarks: Very small predatory fishes.

Recent relatives: None. Died out in Lower Carboniferous.



Cornuboniscus, reconstruction after WHITE.



Benedenius deneensis TRAQUAIR (length c. 22 cm) from the Lower Carboniferous of Denée, Belgium. Original: The Natural History Museum, London, U.K.

Genus: *Benedenius* TRAQUAIR, 1878.

Synonym: *Benedenichthys*

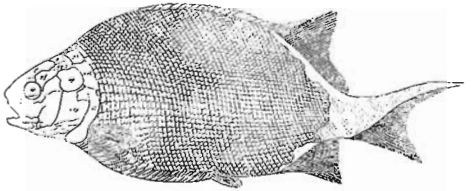
Geological range: Lower Carboniferous.

Geographical distribution: Europe.

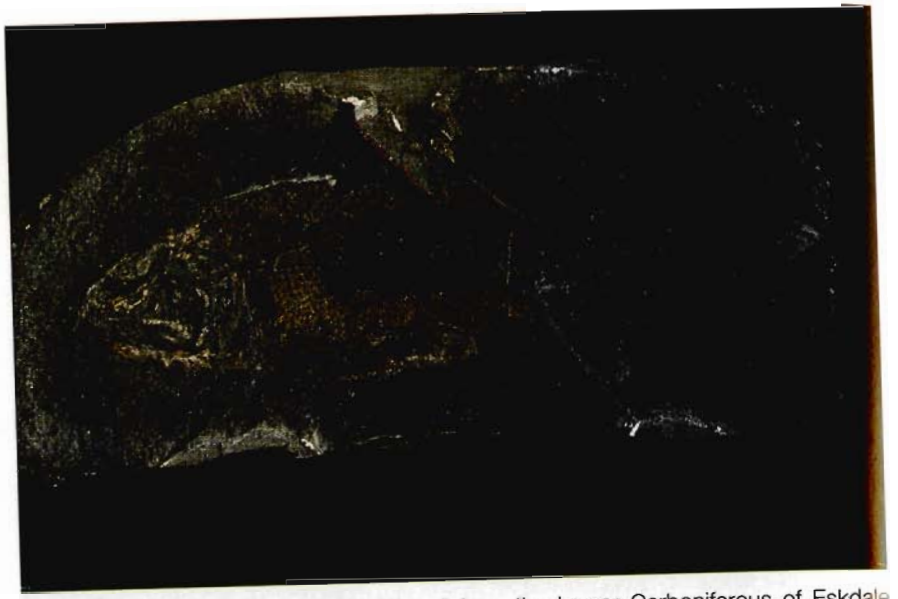
Features: Middle-sized fishes of rather plump body shape. Head small and deep. Snout pointed. Eyes relatively small. Dorsal fin very posterior, almost at the beginning of the caudal fin, opposite the anal fin. Pectoral fins long and narrow. Pelvic fins very small. Scales small but thick.

Remarks: Probably relatively lethargic fishes.

Recent relatives: None. Died out in Lower Carboniferous.



Benedenius, reconstruction after TRAQUAIR.



Holurus parki TRAQUAIR (length c. 12 cm) from the Lower Carboniferous of Eskdale, Scotland, U.K. Original: Royal Museum of Scotland, Edinburgh, U.K.

Genus: *Holurus* TRAQUAIR, 1881.

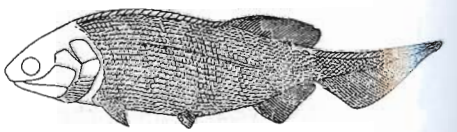
Geological range: Lower Carboniferous.

Geographical distribution: Europe.

Features: Small fishes of somewhat laterally compressed body shape. Head elongate. Snout pointed. Eyes small. Dorsal fin broad and low, very posterior in position, opposite the smaller anal fin. Caudal fin not divided. Pectoral and pelvic fins small. Scales almost square, arranged in curved diagonal rows.

Remarks: Small predators.

Recent relatives: None. Died out in Lower Carboniferous.



Holurus, reconstruction after TRAQUAIR.



Nematoptychius greenocki (AGASSIZ) (length c. 45 cm) from the Lower Carboniferous of Edinburgh, Scotland, U.K. Original: Henne Collection, Stuttgart, Germany.

Genus: *Nematoptychius* TRAQUAIR, 1875.

Geological range: Lower Carboniferous.

Geographical distribution: Europe.

Features: Relatively large fishes with slender streamlined bodies. Head elongate. Snout pointed. Eyes large. Dorsal fin pointed, opposite the likewise pointed anal fin. Caudal fin heterocercal with very elongate narrow lobes. Scales small and thin.

Remarks: Large predators.

Recent relatives: None. Died out in Lower Carboniferous.



Pygopterus humboldti AGASSIZ (length c. 48 cm) from the Upper Permian of Richelsdorf, Hesse, Germany. Original: Perner Collection, Bad Homburg, Germany.

Genus: *Pygopterus* AGASSIZ, 1833.

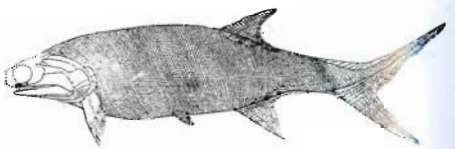
Geological range: Middle Permian to Lower Triassic.

Geographical distribution: Europe, Greenland, South Africa.

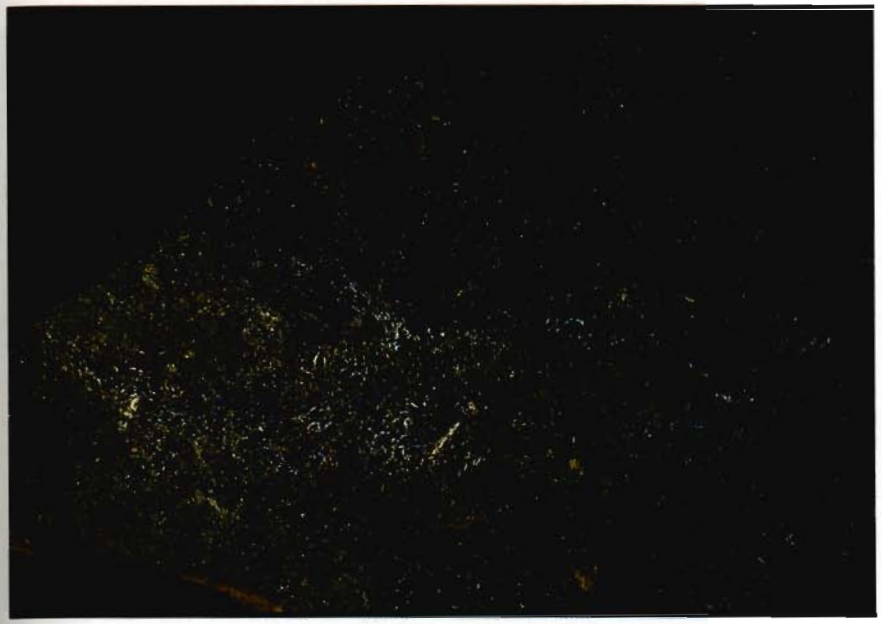
Features: Relatively large fishes with slender streamlined bodies. Head elongate. Snout pointed. Eyes large. Dorsal fin pointed, situated in the posterior half of the body, almost opposite the likewise pointed anal fin. Caudal fin heterocercal with long narrow lobes. Pectoral fins narrow. Pelvic fins small and pointed. Scales small and thin.

Remarks: Large predators.

Recent relatives: None. Died out in Lower Triassic.



Pygopterus, reconstruction after ALDINGER.



Drydenius insignis TRAQUAIR (length c. 10 cm) from the Lower Carboniferous of Edinburgh, Scotland, U.K. Original: National Museum of Scotland, Edinburgh, U.K.

Genus: *Drydenius* TRAQUAIR, 1890.

Geological range: Lower Carboniferous to Permian.

Geographical distribution: Europe.

Features: Small slender fishes. Head small and elongate. Snout pointed. Eyes small. Caudal fin heterocercal with narrow pointed lobes. Scales thick and rhombic.

Remarks: Small predators.

Recent relatives: None. Died out in Permian.



Elonichthys punctatus ALDINGER (length c. 8 cm) from the Lower Permian of Palatinate, Germany. Original: Henne Collection, Stuttgart, Germany.

Genus: *Elonichthys* GIEBEL, 1848.

Synonyms: *Ganocrodus*, *Propalaeoniscus*.

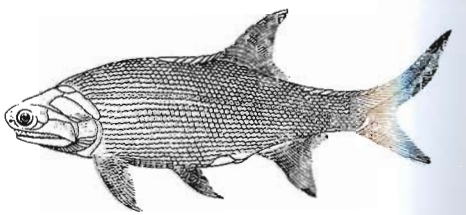
Geological range: Lower Carboniferous to Upper Triassic.

Geographical distribution: South America, western Africa.

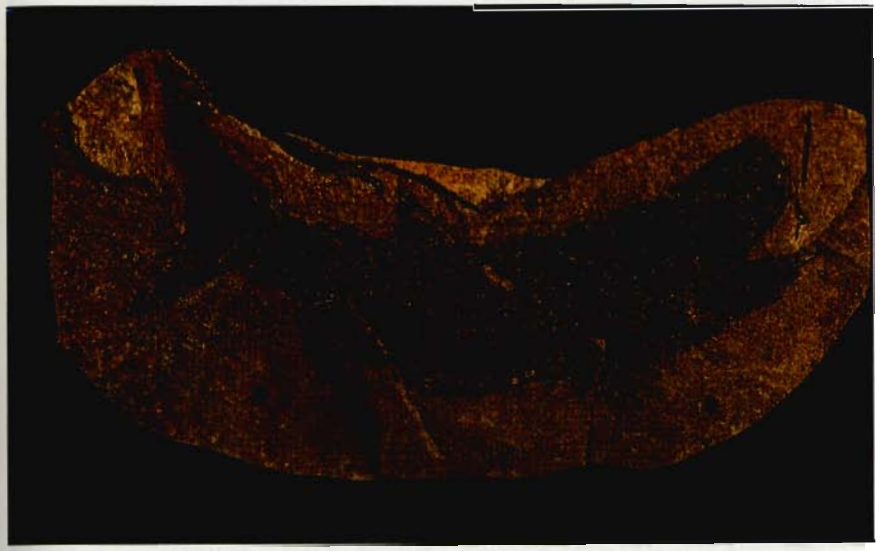
Features: Small to middle-sized fishes with somewhat laterally compressed bodies. Head elongate with slightly pointed snout. Eyes relatively small. Dorsal fin pointed triangular, in the posterior half of the body. Anal fin almost equal in size and somewhat more posterior. Pectoral and pelvic fins pointed and rather large. Scales square, arranged in diagonal rows.

Remarks: Predators. The species *punctatus* is not clear.

Recent relatives: None. Died out in Upper Triassic.



Elonichthys, after TRAQUAIR.



Ganolepis gracilis WOODWARD (length c. 7 cm) from the Permian of Siberia, Russia, C.I.S. Original: Paleontologicheskii Muzei Russkoi Akademii Nauk, Moscow, Russia.

Genus: *Ganolepis* WOODWARD, 1893.

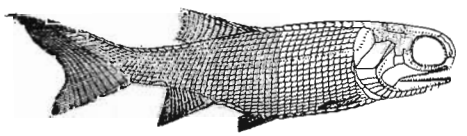
Geological range: Permian.

Geographical distribution: Northern Asia.

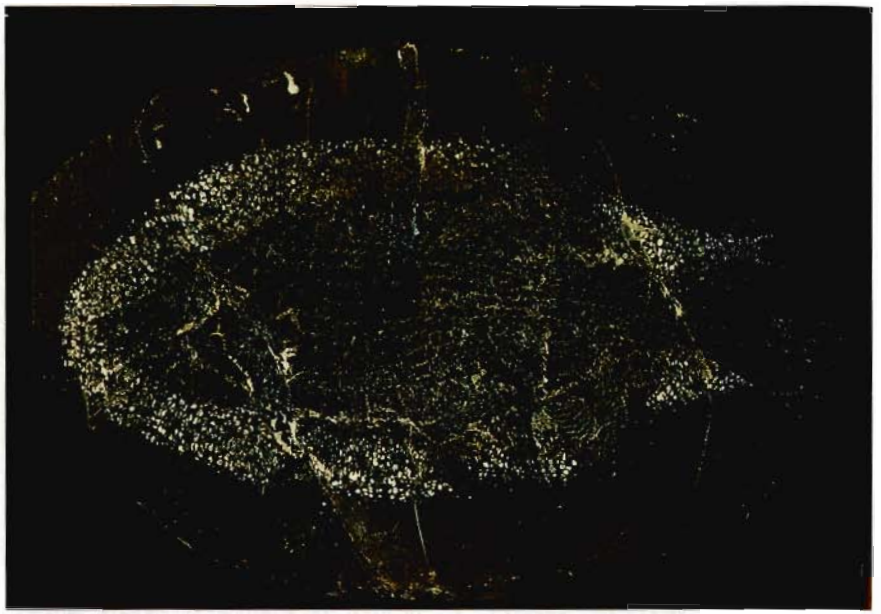
Features: Small fishes with slender elongate bodies. Head elongate. Snout rounded. Eyes large. Dorsal fin obtuse-triangular, situated in the posterior half of the body. Anal fin somewhat behind the dorsal fin. Pectoral and pelvic fins small. Scales square, arranged in regular rows.

Remarks: Predators.

Recent relatives: None. Died out in Permian.



Ganolepis, reconstruction after ORLOV.



Gonatodus punctatus AGASSIZ (length c. 17 cm) from the Lower Carboniferous of Edinburgh, Scotland, U.K. Original: National Museum of Scotland, Edinburgh, U.K.

Genus: *Gonatodus* TRAQUAIR, 1877.

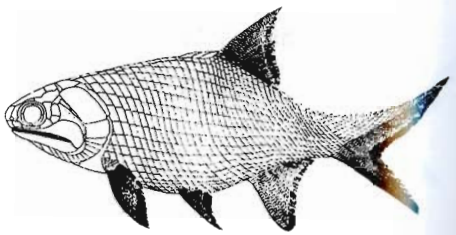
Geological range: Lower to Upper Carboniferous.

Geographical distribution: Europe, North America.

Features: Middle-sized fishes with laterally compressed bodies. Head elongate. Snout rounded. Eyes large. Dorsal fin relatively large and pointed triangular, obliquely opposite the anal fin. Caudal fin heterocercal with almost equal-sized lobes. Pectoral and pelvic fins elongate and pointed. Scales rectangular, arranged in regular rows.

Remarks: Predatory fishes, probably with a somewhat lethargic mode of life.

Recent relatives: None. Died out



Gonatodus, reconstruction after GARDINER.

CHONDROSTEI
Order: Palaeonisciformes
Family: Elonichthyidae

Chondrosteans
Suborder: Palaeoniscoidei



Acrolepis ortholepis TRAQUAIR (length c. 30 cm) from the Lower Carboniferous of Eskdale, Scotland, U.K. Original: The Natural History Museum, London, U.K. (P4081).

Genus: *Acrolepis* AGASSIZ, 1833.

Geological range: Lower Carboniferous to Upper Permian.

Geographical distribution: Europe, North America, South America, northern Asia, Australia.

Features: Relatively large fishes with slender bodies. Head elongate. Snout rounded. Dorsal fin in the posterior half of the body. Pectoral, pelvic and anal fins large. Scales rhombic, overlapping.

Remarks: Large predatory fishes.

Recent relatives: None. Died out in Permian.



Acropholis stensioei ALDINGER (length c. 65 cm) from the Permian of Cape Stosch, Greenland. Original: Geologisk Museum, Copenhagen, Denmark.

Genus: *Acropholis* ALDINGER, 1935.

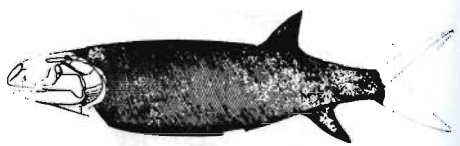
Geological range: Upper Permian.

Geographical distribution: Greenland.

Features: Large predatory fishes with elongate streamlined bodies. Head elongate. Snout pointed. Dorsal fin pointed triangular, very posterior in position, obliquely opposite the anal fin which is even more posterior. Caudal fin heterocercal, probably with narrow lobes of almost equal length. Scales very small and overlapping.

Remarks: Large predatory fishes.

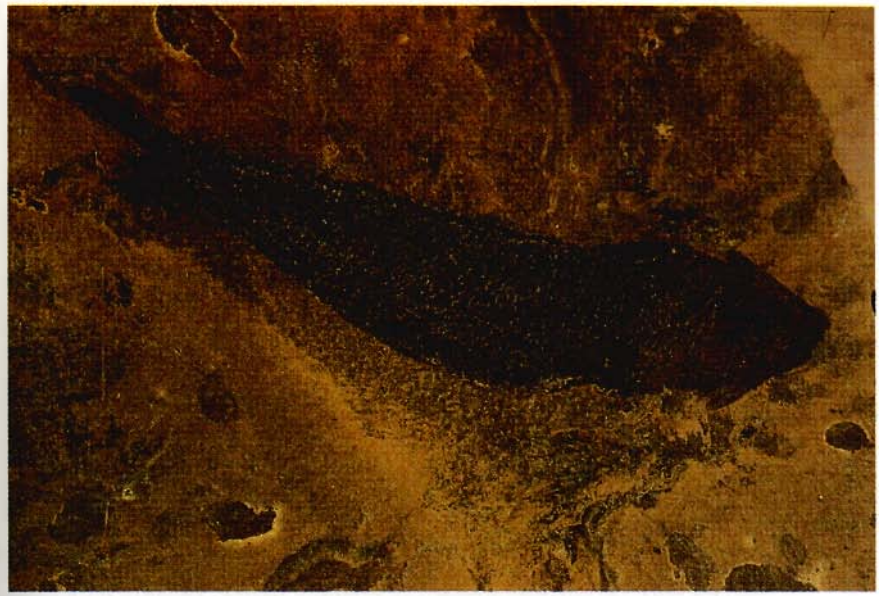
Recent relatives: None. Died out in Upper Permian.



Acropholis, reconstruction after ALDINGER.

CHONDROSTEI
Order: Palaeonisciformes
Family: Acrolepididae

Chondrosteans
Suborder: Palaeoniscoidei



Boreosomus sp. (length c. 13 cm) from the Lower Triassic of Wapiti Lake, Canada. Original: Tyrell Museum of Paleontology, Drumheller, Alberta, Canada.

Genus: *Boreosomus* STENSIÖ, 1921.

Synonyms: *Diaphorognathus*

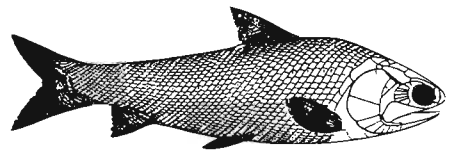
Geological range: Lower to Upper Triassic.

Geographical distribution: Greenland, Spitzbergen, Madagascar, North America.

Features: Small to middle-sized fishes with slender elongate bodies. Head deep. Snout pointed. Eyes relatively large. Dorsal fin at the hinder end of the anterior half of the body. Caudal fin heterocercal, with broad pointed lobes of equal length. Pectoral fins large and broad. Pelvic fins small. Anal fin triangular. Scales small, rectangular, arranged in diagonal rows.

Remarks: Predators.

Recent relatives: None. Died out in Upper Triassic.



Boreosomus, reconstruction after LEHMAN.



Mesembroniscus longisquamosus WADE (length c. 8 cm) from the Middle Triassic of Brookvale, New South Wales, Australia. Original: The Natural History Museum, London, U.K.

Genus: *Mesembroniscus* WADE, 1935.

Geological range: Middle Triassic.

Geographical distribution: Australia.

Features: Small fishes with elongate slender bodies. Head elongate. Snout rounded. Dorsal fin pointed triangular, situated in the posterior half of the body, obliquely opposite the more posterior anal fin. Caudal fin heterocercal with a long upper lobe. Scales small, rectangular.

Remarks: Small predators.

Recent relatives: None. Died out in Middle Triassic.

CHONDROSTEI
Order: Palaeonisciformes
Family: Acrolepididae

Chondrosteans
Suborder: Palaeoniscoidei



Reticulepis exsculpta (KURTZE) (length c. 57 cm) from the Upper Permian of Richelsdorf, Hesse, Germany. Original: Naturkundemuseum in Ottoneum, Kassel, Germany.

Genus: *Reticulepis* WESTOLL, 1934.

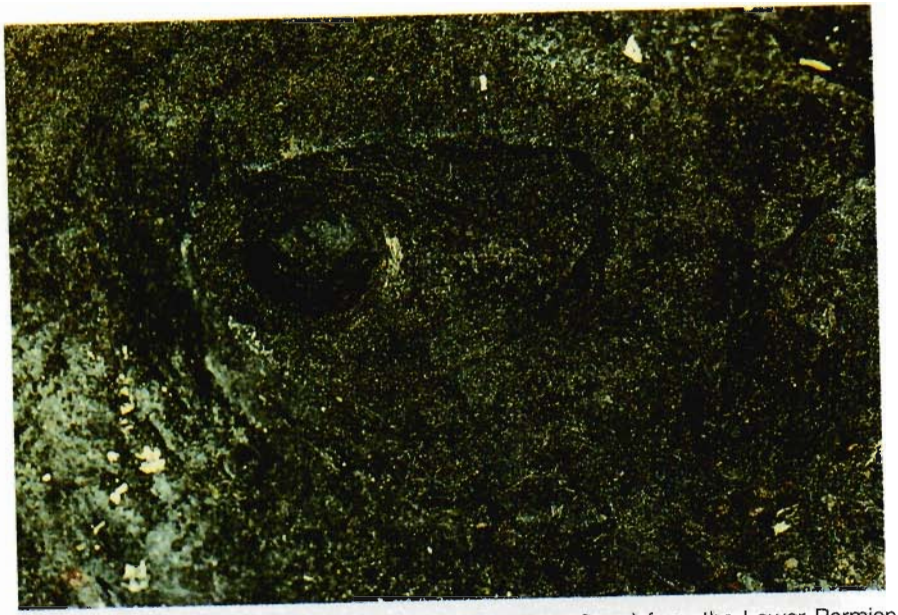
Geological range: Upper Permian.

Geographical distribution: Europe.

Features: Middle-sized fishes with slender bodies. Head relatively shallow. Snout probably rounded. Jaws set with pointed teeth. Dorsal fin triangular, in the posterior half of the body, obliquely opposite the smaller anal fin. Caudal fin heterocercal, with narrow pointed lobes of almost equal length. Scales finely sculptured. In the posterior part this sculpture appears reticulate because of transverse ridges.

Remarks: Predators.

Recent relatives: None. Died out in Upper Permian.



Tholonotus brasiliensis DUNKLE & SCHAEFFER (length c. 6 cm) from the Lower Permian of Brazil. Original: American Museum of Natural History, New York, N.Y., U.S.A.

Genus: *Tholonotus* DUNKLE & SCHAEFFER, 1956.

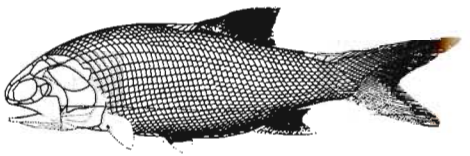
Geological range: Lower Permian.

Geographical distribution: South America.

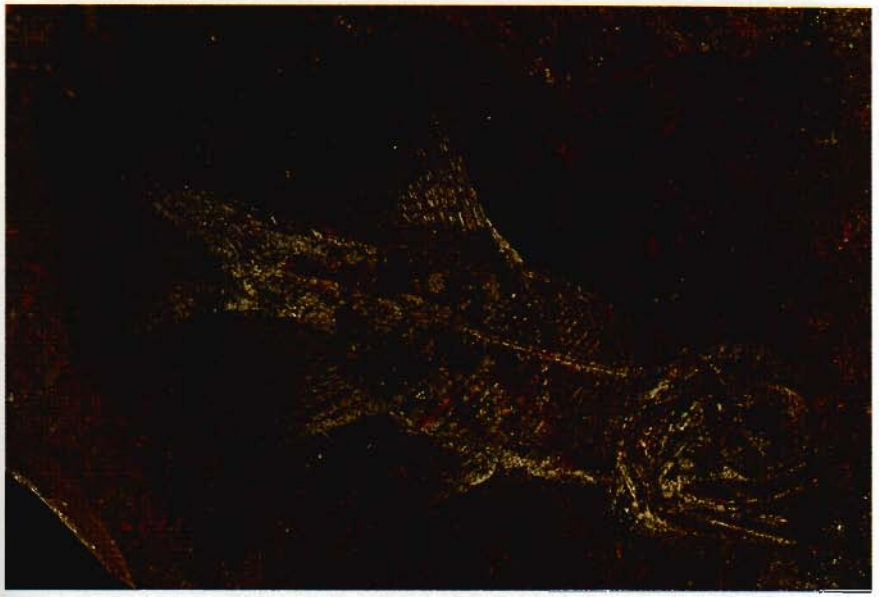
Features: Small to middle-sized fishes. Head deep. Snout rounded. Eyes large. Scales thick and rhombic. Teeth small and pointed.

Remarks: Small to medium-sized predatory fishes.

Recent relatives: None. Died out in Lower Permian.



Tholonotus, reconstruction after DUNKLE & SCHAEFFER.



Amblypterus macropterus AGASSIZ (length c. 7 cm) from the Lower Permian of the Saar region, Germany. Original: Naturhistorisches Museum, Vienna, Austria.

Genus: *Amblypterus* AGASSIZ, 1833.

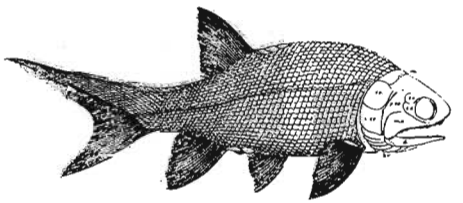
Geological range: Lower to Upper Permian.

Geographical distribution: Europe, North America.

Features: Small fishes with laterally compressed bodies. Head deep. Snout blunt. Eyes large. Dorsal fin relatively large, pointed triangular, situated in the posterior half of the body, obliquely opposite the likewise relatively large anal fin. Pectoral pelvic fins broadly pointed. Scales square to rectangular, arranged in diagonal rows.

Remarks: Small predators. Now reclassified Linto the genus *Paramblypterus.*

Recent relatives: None. Died out in Upper Permian.



Amblypterus, after AGASSIZ.



Lawnia sp. (length c. 14 cm) from the Lower Permian of Baylor County, Texas. Original: University of Alberta, Edmonton, Canada.

Genus: *Lawnia* WILSON, 1953.

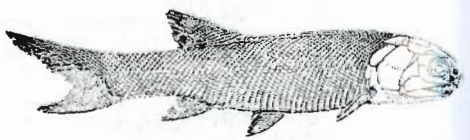
Geological range: Lower Permian.

Geographical distribution: North America.

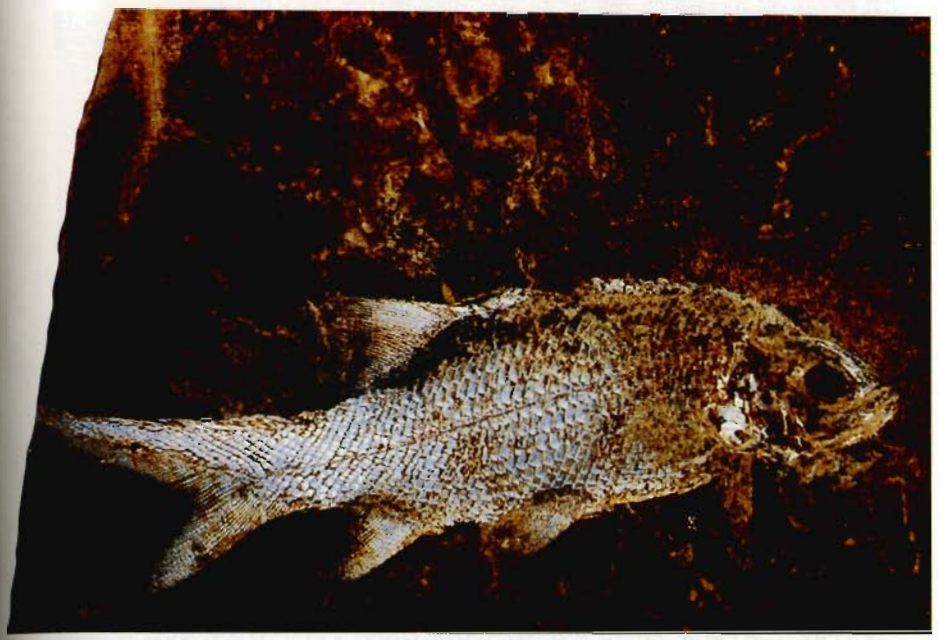
Features: Middle-sized fishes with elongate very slender bodies. Head elongate. Snout rounded. Eyes small. Dorsal fin triangular, situated in the posterior half of the body, opposite the smaller, but likewise triangular, anal fin. Pectoral fins elongate and narrow. Pelvic fins triangular. Scales thick and rectangular, arranged in diagonal rows.

Remarks: Middle-sized predators.

Recent relatives: None. Died out in Middle Permian.



Lawnia, reconstruction after WILSON.



Aeduella blainvillei (AGASSIZ) (length c. 13 cm) from the Lower Permian of Palatinate, Germany. Original: Henne Collection, Stuttgart, Germany.

Genus: *Aeduella* WESTOLL, 1937.

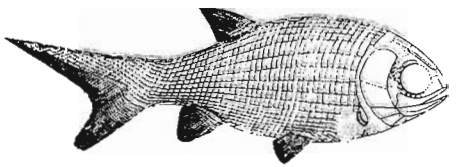
Geological range: Lower Permian.

Geographical distribution: Europe.

Features: Middle-sized fishes with laterally compressed bodies. Head deep. Snout slightly pointed. Eyes unusually large. Dorsal fin pointed triangular, situated in the posterior half of the body, obliquely opposite the obtusely triangular anal fin. Pectoral fins small. Pelvic fins broad. Scales rectangular, arranged in regular rows.

Remarks: Middle-sized predators. The species *blainvillei* is still controversial.

Recent relatives: None. Died out in Lower Permian.



Aeduella, after PIVETEAU.



Bourbonella guilloti HEYLER (length c. 15 cm) from the Lower Permian of L'Archambault, France. Original: The Natural History Museum, London, U.K. (P 61120)

Genus: *Bourbonella* HEYLER, 1967.

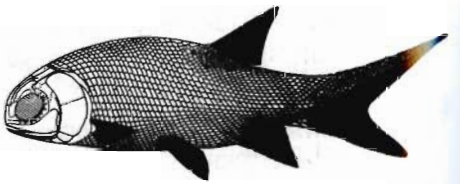
Geological range: Lower Permian.

Geographical distribution: Europe.

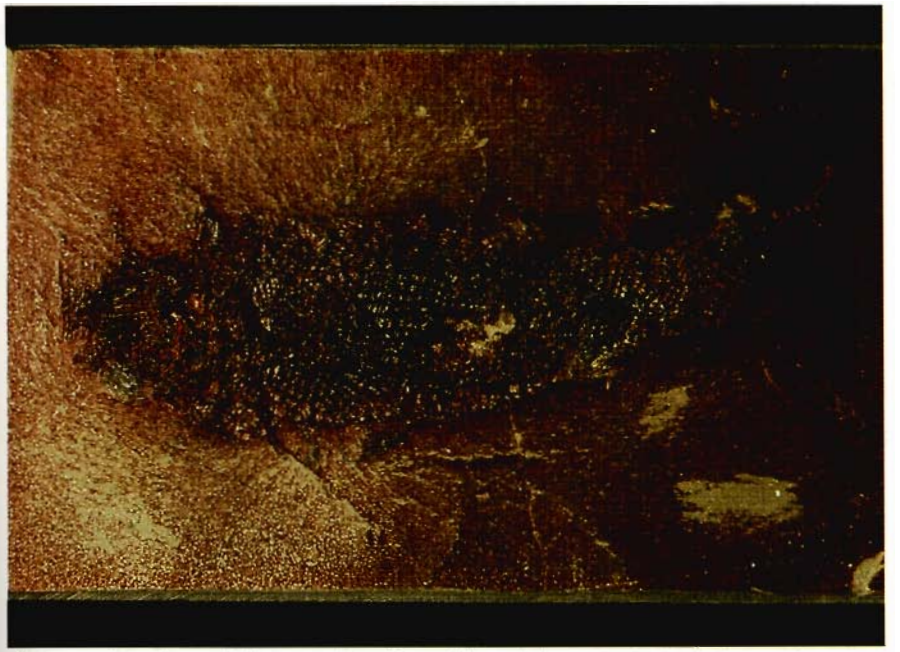
Features: Middle-sized fishes with laterally compressed bodies. Head deep. Snout rounded. Eyes strikingly large. Dorsal fin pointed and elongate, situated in the posterior half of the body, obliquely opposite the anal fin which is likewise pointed. Pectoral fins small and triangular. Pelvic fins relatively long and broad. Scales square to rectangular, arranged in diagonal rows.

Remarks: Middle-sized predators.

Recent relatives: None. Died out in Lower Permian.



Bourbonella, reconstruction after HEYLER.



Commentrya traquairi SAUVAGE (length c. 13 cm) from the Upper Carboniferous of Commentry, France. Original: The Natural History Museum, London, U.K. (P995).

Genus: *Commentrya* SAUVAGE, 1888.

Synonyms: *Elaveria*

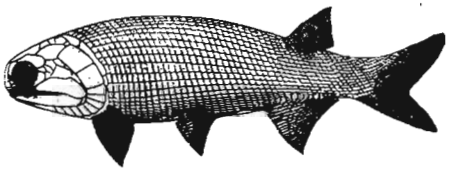
Geological range: Upper Carboniferous.

Geographical distribution: Europe.

Features: Small to middle-sized fishes with somewhat laterally compressed bodies. Head deep. Snout rounded. Eyes relatively large. Dorsal fin triangular, very posterior in position, opposite the considerably larger anal fin. Pectoral and pelvic fins relatively large. Scales square to rectangular, arranged in regular rows.

Remarks: Predators.

Recent relatives: None. Died out in Upper Carboniferous.



Commentrya, reconstruction after PIVETEAU.



Paramblypterus gelberti (GOLDFUSS) (length c. 20 cm) from the Lower Permian of Odernheim, Palatinate, Germany. Original: Interfoss, Munich, Germany.

Genus: *Paramblypterus* SAUVAGE, 1888.

Synonyms: *Amblypterops*, *Cosmopoma*, *Dipteroma*.

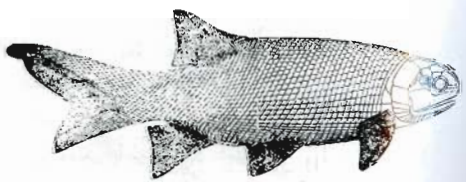
Geological range: Lower Permian.

Geographical distribution: Europe.

Features: Middle-sized fishes with somewhat laterally compressed bodies. Head deep. Snout rounded. Eyes small. Dorsal fin triangular and pointed, posterior in position, obliquely opposite the equally pointed anal fin. Caudal fin heterocercal with the upper lobe longer than the lower. Pectoral fins elongate and pointed. Pelvic fins triangular. Scales rectangular to rhombic, arranged in diagonal rows.

Remarks: Predators.

Recent relatives: None. Died out in Lower Permian.



Paramblypterus, reconstruction after BIOTT.



Gyrolepis albertii AGASSIZ (length c. 25 cm) from the Middle Triassic of Nußloch, Baden, Germany. Original: Staatliches Museum für Naturkunde, Karlsruhe, Germany.

Genus: *Gyrolepis* AGASSIZ, 1833.

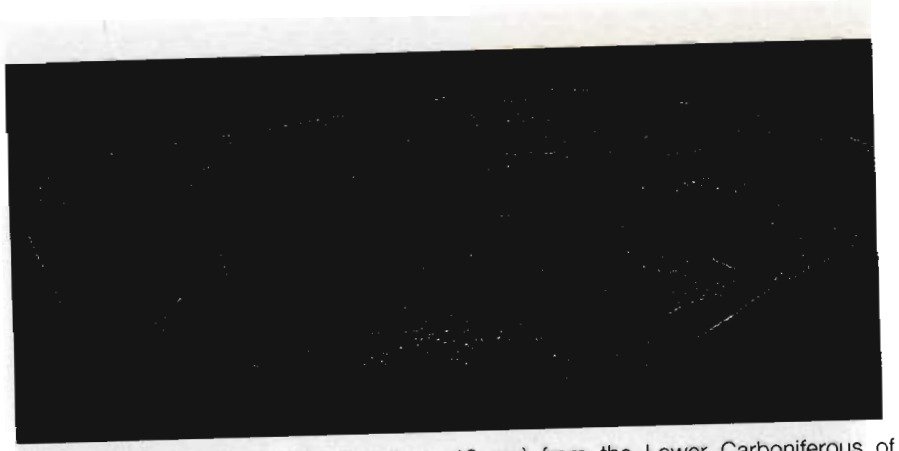
Geological range: Lower to Upper Triassic.

Geographical distribution: Europe, North America, eastern Asia.

Features: Middle-sized fishes with slender bodies. Head shallow and elongate. Snout pointed. Dorsal fin pointed triangular, situated in the posterior half of the body, opposite the anal fin. Caudal fin heterocercal with narrow pointed lobes. Pectoral fins long and narrow. Pelvic fins triangular. Scales rhombic, arranged in diagonal rows.

Remarks: Predatory fishes.

Recent relatives: None. Died out in Upper Triassic.



Howqualepis rostridens LONG (length c. 19 cm) from the Lower Carboniferous of Mansfield, Australia. Original: Bureau of Mineral Resources, Canberra, Australia.

Genus: *Howqualepis* LONG, 1988.

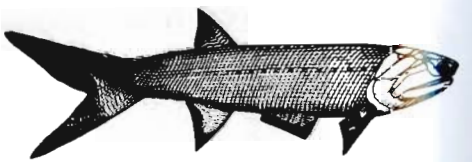
Geological range: Lower Carboniferous.

Geographical distribution: Australia.

Features: Middle-sized fishes with slender elongate bodies. Head elongate. Snout blunt. Eyes small. Dorsal fin triangular, situated in the posterior half of the body, opposite the likewise triangular anal fin. Caudal fin relatively large, heterocercal, with upper and lower lobes of almost equal length. Pectoral fins pointed. Pelvic fins broad at the base. Scales small, arranged in regular rows.

Remarks: Predatory fishes.

Recent relatives: None. Died out in Lower Carboniferous.



Howqualepis, after LONG.



Myriolepis clarki EGERTON (length c. 18 cm) from the Lower Triassic of Gosford, New South Wales, Australia. Original: The Natural History Museum, London, U.K. (P18069)

Genus: *Myriolepis* EGERTON, 1864.

Geological range: Lower Triassic.

Geographical distribution: Australia.

Features: Middle-sized fishes with slender elongate bodies. Head shallow and elongate. Snout pointed. Eyes small. Dorsal fin triangular, in the posterior half of the body. Anal fin lies considerably farther behind. Scales strong and dense.

Remarks: Predatory fishes.

Recent relatives: None. Died out in Lower Triassic.



Palaeoniscum freieslebeni de BLAINVILLE (length c. 28 cm) from the Upper Permian of Richelsdorf, Hesse, Germany. Original: Perner Collection, Bad Homburg, Germany.

Genus: *Palaeoniscum* de BLAINVILLE, 1818.

Synonyms: *Eupalaeouiscus, Palaeoniscus, Geomichthys, Palaeothrissum*

Geological range: Lower Permian to Upper Triassic.

Geographical distribution: Europe, North America, Greenland, Spitzbergen, Australia.

Features: Middle-sized fishes with elongate bodies. Head shallow and elongate. Snout blunt. Eyes large. Dorsal fin small and pointed. Pectoral fins also small. Scales small, arranged in regular rows.

Remarks: Predators.

Recent relatives: None. Died out in Upper Triassic.



Palaeoniscum, reconstruction after TRAQUAIR.



Pteronisculus cicatrosus WHITE (length c. 7 cm) from the Lower Triassic of Madagascar. Original: Interfoss, Munich, Germany.

Genus: *Pteronisculus* WHITE, 1933.

Synonym: *Glaucolepis*.

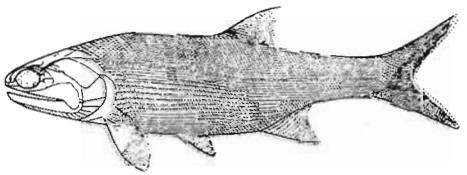
Geological range: Lower Triassic.

Geographical distribution: Spitzbergen, Greenland, Madagascar, Australia.

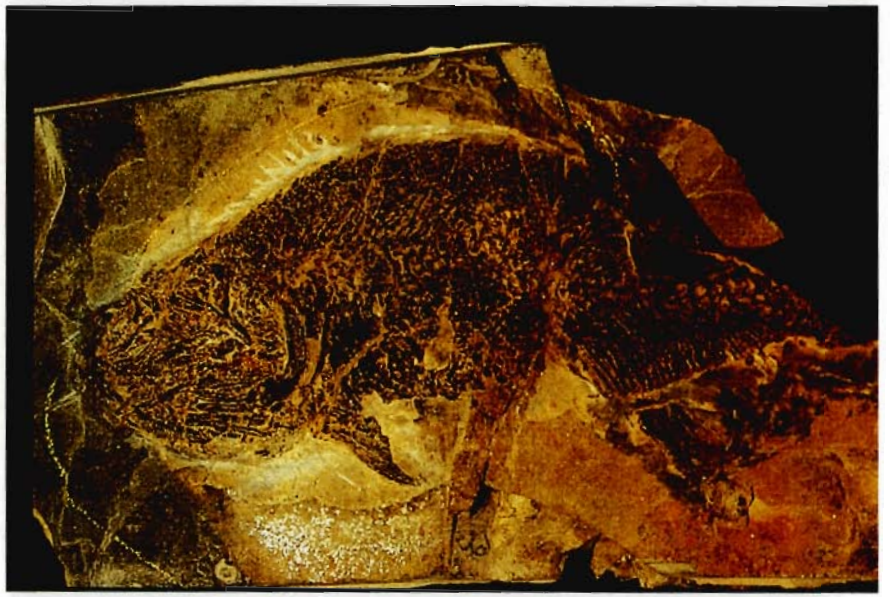
Features: Small fishes with somewhat laterally compressed bodies and elongate head. Snout pointed. Eyes large. Dorsal fin relatively small and triangular, obliquely opposite the more posteriorly placed anal fin. Pectoral fins long and broad. Pelvic fins small and pointed. Scales small and arranged in regular rows.

Remarks: Predators.

Recent relatives: None. Died out in Lower Triassic.



Pteronisculus, reconstruction after LEHMAN.



Turseodus acutus LEIDY (length c. 19 cm) from the Upper Triassic of Firestone, U.S.A. Original: Peabody Museum of Natural History, New Haven, Connecticut, U.S.A.

Genus: *Turseodus* LEIDY, 1857.

Synonyms: *Eurecana*, *Gwynnedichthys*.

Geological range: Upper Triassic.

Geographical distribution: North America.

Features: Middle-sized fishes with somewhat laterally compressed bodies. Head elongate. Snout rounded. Dorsal fin in the posterior half of the body. Caudal fin heterocercal with the upper lobe longer. Pectoral fins small and pointed. Scales small, arranged in regular rows.

Remarks: Probably predators.

Recent relatives: None. Died out in Upper Triassic.



Turseodus, reconstruction after SCHAEFFER.



Dicellopyge draperi (WOODWARD) (length c. 13 cm) from the Lower Triassic of Rouxville, South Africa. Original: The Natural History Museum, London, U.K. (P 6084)

Genus: *Dicellopyge* BROUGH, 1931.

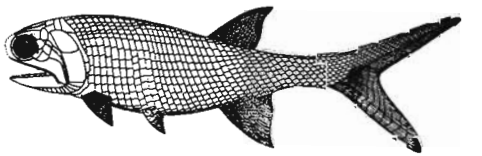
Geological range: Lower Triassic.

Geographical distribution: South Africa.

Features: Middle-sized fishes with slender elongate bodies. Head deep. Snout rounded. Eyes large. Dorsal fin triangular, in the posterior half of the body, opposite the likewise triangular anal fin. Caudal fin heterocercal, deeply forked with relatively long, almost equal-sized lobes. Pectoral and pelvic fins small and pointed. Scales rectangular, arranged in diagonal rows.

Remarks: Predators.

Recent relatives: None. Died out in Lower Triassic.



Dicellopyge, reconstruction after BROUGH.



Birgeria acuminata (AGASSIZ) (length c. 79 cm) from the Upper Triassic of Zogno, Bergamo, Italy. Original: Museo Civico Naturali Caffi, Bergamo, Italy.

Genus: *Birgeria* STENSIÖ, 1919.

Synonym: *Xenestes*.

Geological range: Lower to Upper Triassic.

Geographical distribution: Europe, Spitzbergen, Greenland, North America.

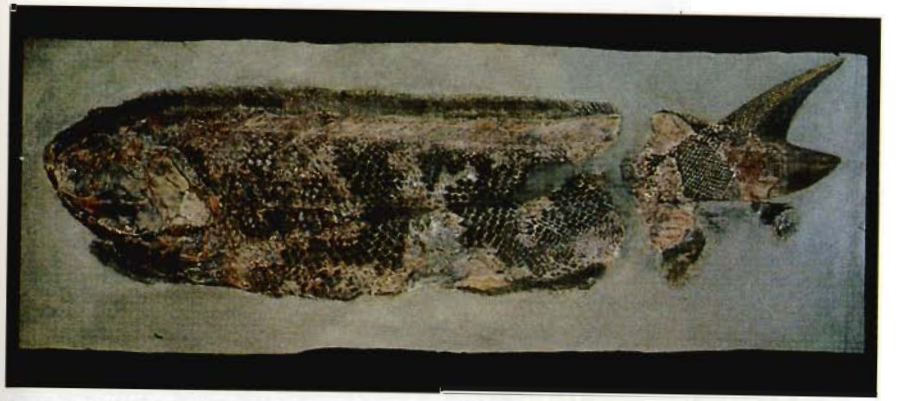
Features: Relatively large fishes with slender, elongate bodies. Head long and shallow. Snout blunt. Eyes small. Gape long. Dorsal fin triangular, very posterior in position, opposite the likewise triangular anal fin. Pectoral fins broad and pointed. Pelvic fins small. Scales sparse and thin.

Remarks: Predatory fishes.

Recent relatives: Some authors see the genus *Birgeria* as related to the order Acipenseriformes and thus as a forerunner of fossil sturgeons.



Birgeria, reconstruction after PIVETEAU.



Scanilepis dubia ALDINGER (length c. 65 cm) from the Triassic of Scania, Sweden. Original: Naturhistoriska Riksmuseet, Stockholm, Sweden.

Genus: *Scanilepis* ALDINGER, 1937.

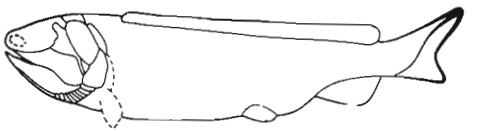
Geological range: Lower to Upper Triassic.

Geographical distribution: Europe, Spitzbergen.

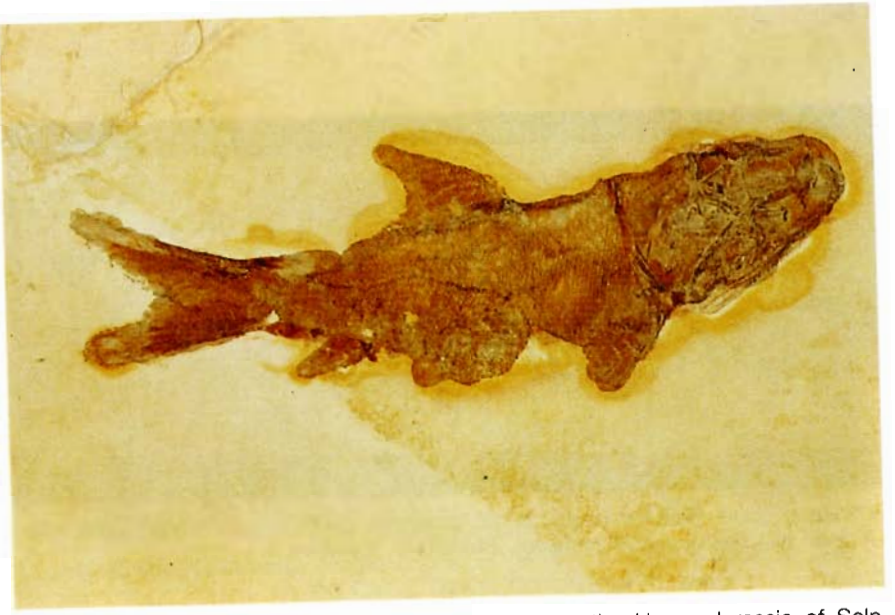
Features: Relatively large fishes with somewhat laterally compressed bodies. Skull deep. Snout blunt. Eyes small. Dorsal fin fringe-like, stretching along almost the whole of the back. Anal fin broad-based. Caudal fin heterocercal with narrow upper and broad lower lobes. Pectoral and pelvic fins small. Scales square to rectangular, arranged in diagonal rows.

Remarks: Large predators.

Recent relatives: None. Died out in Upper Triassic.



Scanilepis, reconstruction after LEHMAN.



Coccolepis bucklandi AGASSIZ (length c. 10 cm) from the Upper Jurassic of Solnhofen (Eichstätt), Bavaria, Germany. Original: Jura-Museum, Eichstätt, Germany.

Genus: *Coccolepis* AGASSIZ, 1874.

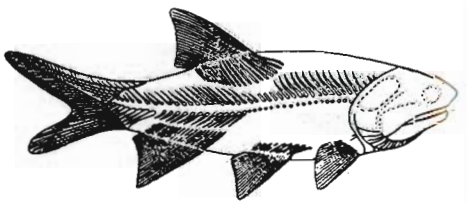
Geological range: Lower Jurassic to Lower Cretaceous.

Geographical distribution: Europe, Asia, Australia.

Features: Small fishes with somewhat laterally compressed bodies. Head deep. Snout rather blunt. Eyes small. Dorsal fin triangular, relatively large, situated in the posterior half of the body, obliquely opposite the anal fin. Caudal fin heterocercal with the upper lobe somewhat larger than the lower. Pelvic fins large and pectoral fins somewhat smaller. Scales round and delicate.

Remarks: The only chondrosteans in the Lithographic Stone of Solnhofen.

Recent relatives: None. Died out in Lower Cretaceous.



Coccolepis, reconstruction after TRAQUAIR



Acanthoniscus cracens LOWNEY (length c. 11 cm) from the Lower Carboniferous of Bear Gulch, Montana, U.S.A. Original: Field Museum of Natural History, Chicago, Illinois, U.S.A.

Genus: *Acanthoniscus* LOWNEY, 1980.

Geological range: Lower Carboniferous.

Geographical distribution: North America.

Features: Small fishes with slender elongate bodies. Head elongate. Snout pointed. Eyes small. Dorsal fin pointed, very posterior in position, almost opposite the relatively large anal fin. Pelvic fins small. Scales elongate, arranged in diagonal rows.

Remarks: Predators.

Recent relatives: None. Died out in Lower Carboniferous.



Atherstonia minor WOODWARD (length c. 14 cm) from the Permian of Plaatjesfontein, South Africa. Original: Albany Museum, Grahamstown, South Africa.

Genus: *Atherstonia* WOODWARD, 1889.

Synonym: *Hypterus*

Geological range: Upper Permian to Lower Triassic.

Geographical distribution: Europe, South Africa, Madagascar, North America.

Features: Middle-sized fishes with slender elongate bodies. Head elongate. Snout blunt. Eyes large. Dorsal fin with a broad base, posterior in position, obliquely opposite the anal fin. Pectoral fins elongate. Pelvic fins broad. Scales square to rectangular, arranged in diagonal rows.

Remarks: Predators.

Recent relatives: None. Died out in Lower Triassic.



Atherstonia, reconstruction after ORLOV.

CHONDROSTEI
Order: Palaeonisciformes
Family: Unnamed

Chondrosteans
Suborder: Palaeoniscoidei



Atracauda lundi LOWNEY (length c. 13 cm) from the Lower Carboniferous of Bear Gulch, Montana, U.S.A. Original: Tyrell Museum of Paleontology, Drumheller, Alberta, Canada.

Genus: *Atracauda* LOWNEY, 1980.

Geological range: Lower Carboniferous.

Geographical distribution: North America.

Features: Small to middle-sized fishes with slender elongate bodies. Head deep. Snout blunt. Dorsal fin relatively small, situated in the posterior half of the body, obliquely opposite the likewise small anal fin. Caudal fin heterocercal, deeply forked, upper lobe somewhat longer than the lower. Scales rhombic, arranged in diagonal rows.

Remarks: Predatory fishes.

Recent relatives: None. Died out in Lower Carboniferous.



Belichthys minimus WADE (length c. 5 cm) from the Middle Triassic of Brookvale, New South Wales, Australia. Original: The Natural History Museum, London, U.K. (P 24708-9)

Genus: *Belichthys* WADE, 1935.

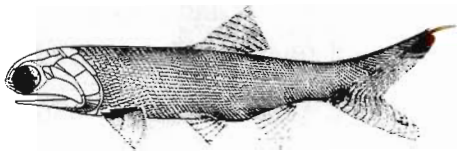
Geological range: Middle Triassic.

Geographical distribution: Australia.

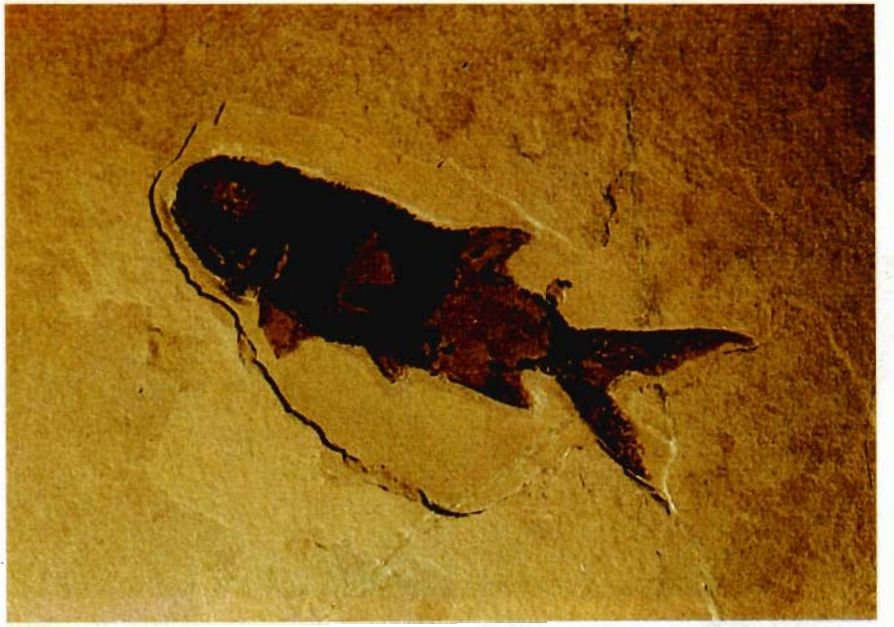
Features: Small fishes with slender elongate bodies. Head elongate. Snout rounded. Eyes large. Dorsal fin pointed, approximately in the middle of the body, opposite the small pelvic fins. Caudal fin heterocercal with narrow pointed lobes, the upper being longer than the lower. Scales small and rhombic.

Remarks: Small predators.

Recent relatives: None. Died out in Middle Triassic.



Belichthys, reconstruction after HUTCHINSON.



Fubarichthys prolatus (length c. 10 cm) from the Lower Carboniferous of Bear Gulch, Montana, U.S.A. Original: Staatliches Museum für Naturkunde, Karlsruhe, Germany.

Genus: *Fubarichthys* LOWNEY

Geological range: Lower Carboniferous.

Geographical distribution: North America.

Features: Small fishes with somewhat laterally compressed bodies. Head deep. Snout rounded. Eyes large. Gape very long. Dorsal fin behind the middle of the body, obliquely opposite the pelvic fins. Caudal fin heterocercal, deeply forked, upper lobe somewhat longer than the lower. Anal fin pointed. Pelvic fins small. Pectoral fins somewhat broader. Scales small and square, arranged in diagonal rows.

Remarks: Small predators.

Recent relatives: None. Died out in Lower Carboniferous.



Gardineria akolkensis KAZANTSEVA (length c. 18 cm) from the Permian of eastern Europe. Original: Paleontologicheskii Muzei Russkoi Akademii Nauk, Moscow, Russia.

Genus: *Gardineria* KAZANTSEVA-SELENTEVA, 1981.

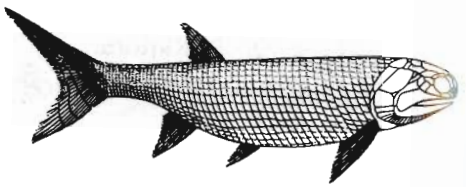
Geological range: Permian.

Geographical distribution: Eastern Europe.

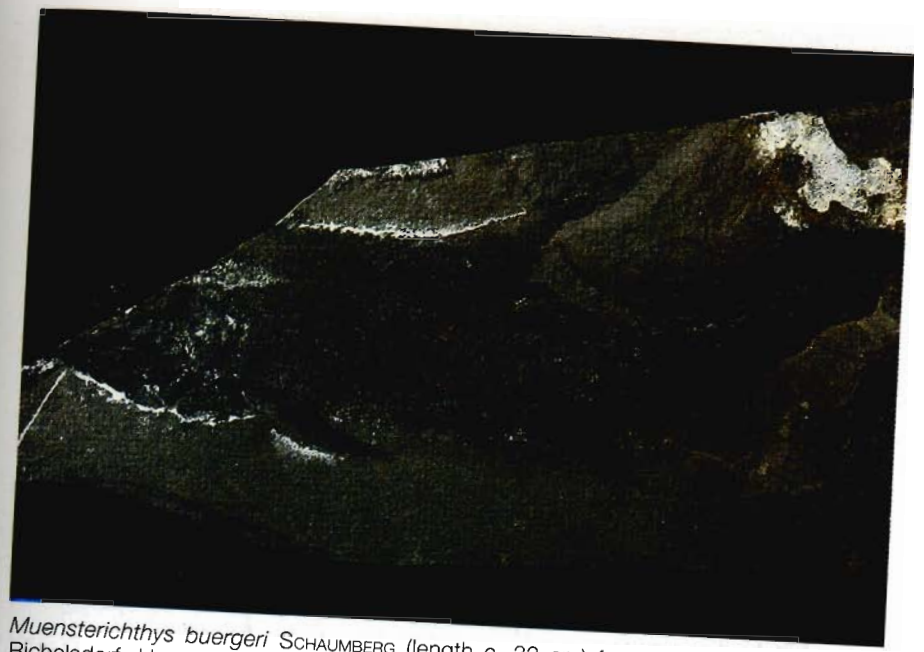
Features: Slender, middle-sized fishes. Head narrow. Eyes small. Gape long. Dorsal fin pointed triangular, situated in the posterior third of the body, opposite the somewhat broader anal fin. Pelvic fins small. Scales arranged in diagonal rows.

Remarks: Small predators.

Recent relatives: None. Died out in Permian.



Gardineria, reconstruction after Akademia Nauk, Moscow.



Muensterichthys buergeri SCHAUMBERG (length c. 32 cm) from the Upper Permian of Richelsdorf, Hesse, Germany. Original: Bürger Collection, Bad Hersfeld, Germany.

Genus: *Muensterichthys* SCHAUMBERG, 1989.

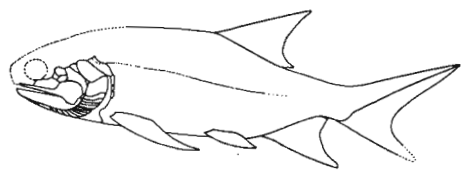
Geological range: Upper Permian.

Geographical distribution: Europe.

Features: Middle-sized spindle-shaped fishes. Head deep. Snout rounded. Eyes large. Gape long. Lower jaw set posteriorly. Dorsal fin large, triangular, situated in the posterior half of the body. Anal fin obliquely opposite, of the same shape but somewhat smaller. Caudal fin heterocercal, with the lower lobe shorter. Pectoral fins long, narrow and drawn out into a point. Pelvic fins short and pointed. Scales small.

Remarks: Probably predatory fishes.

Recent relatives: None. Died out in Upper Permian.



Muensterichthys, reconstruction after SCHAUMBERG.



Pteroniscus sp. (length c. 6 cm) from the Upper Jurassic of Karatau, Central Asia. Original: Museum für Geologie und Paläontologie, Tübingen, Germany.

Genus: *Pteroniscus* CHEKKER, 1848.

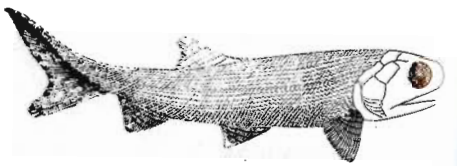
Geological range: Upper Jurassic.

Geographical distribution: Western and central Asia.

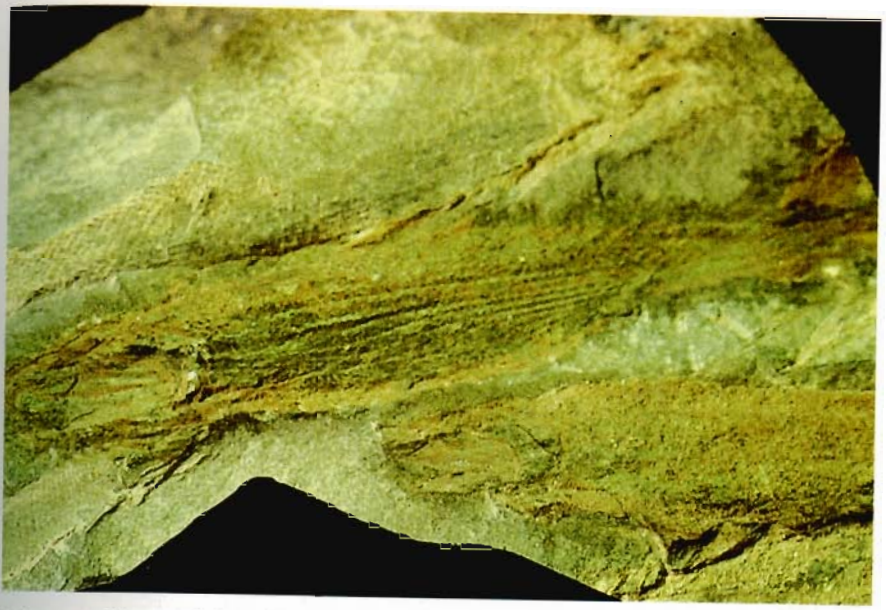
Features: Small fishes with slender elongate bodies. Head deep. Snout rounded. Eyes large. Dorsal fin broad at the base, obliquely opposite the posteriorly placed, likewise triangular, anal fins. Pectoral fins broad and pointed. Pelvic fins broad at the base. Scales small, arranged in regular rows.

Remarks: Small predators.

Recent relatives: None. Died out in Upper Jurassic.



Pteroniscus, reconstruction after ORLOV.



Willomorichthys striatulus GARDINER (length c. 15 cm) from the Upper Devonian of Witteberg, South Africa. Original: Albany Museum, Grahamstown, South Africa.

Genus: *Willomorichthys* GARDINER, 1969.

Geological range: Upper Devonian.

Geographical distribution: South Africa.

Features: Middle-sized fishes. Head narrow. Snout blunt. Dorsal fin very posterior in position, almost opposite the anal fin. Pectoral fins narrow. Scales small, arranged in regular rows.

Remarks: Predatory fishes.

Recent relatives: None. Died out in Upper Devonian.



Yogoniscus gulo LOWNEY (length c. 27 cm) from the Lower Carboniferous of Bear Gulch, Montana, U.S.A. Original: Adelphi University, Garden City, N.J., U.S.A.

Genus: *Yogoniscus* LOWNEY, 1980.

Geological range: Lower Carboniferous.

Geographical distribution: North America.

Features: Middle-sized fishes with elongated bodies. Head elongate. Snout pointed. Eyes large. Dorsal fin, triangular, pointed, situated in the posterior half of the body, obliquely opposite the anal fin which is likewise pointed. Caudal fin heterocercal, deeply forked with the upper lobe somewhat longer than the lower. Scales rhombic, arranged in diagonal rows.

Remarks: Predatory fishes.

Recent relatives: None. Died out in Lower Carboniferous.



Enzichthys aizenvergi SELEZNEVA (length c. 3.5 cm) from the Middle Carboniferous of the Donbass, Ukraine. Original: Paleontologicheskii Muzei Russkoi Akademii Nauk, Moscow, Russia.

Genus: *Enzichthys* SELEZNEVA, 1988.

Geological range: Middle Carboniferous.

Geographical distribution: Eastern Europe.

Features: Very small fishes of rounded rhombic outline. Head deep. Eyes large. Gape rather long. Dorsal fin pointed, situated behind the middle of the body opposite the anal fin. Caudal fin stalked, deeply divided, with narrow lobes. Scales in ventral part of body rod-shaped.

Remarks: Lived in still water and possibly fed on plants.

Recent relatives: None. Died out in Carboniferous.



Mesolepis scalaris TRAQUAIR (length c. 15 cm) from the Upper Carboniferous of Staffordshire, England, U.K. Original: The Natural History Museum, London, U.K. (P 8046)

Genus: *Mesolepis* YOUNG, 1866.

Synonyms: *Pododus*

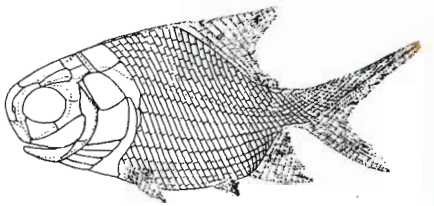
Geological range: Lower to Upper Carboniferous.

Geographical distribution: Europe.

Features: Middle-sized, laterally compressed fishes with rhombic body outline. Head deep. Snout blunt. Dorsal fin pointed and elongate and fold-like posteriorly. Anal fin with a broad base, low, fold-like but passing into a narrow point. Pectoral and pelvic fins small. Scales rod-like ventrally.

Remarks: Probably lived in still water. Possibly fed, at least partly, on plants.

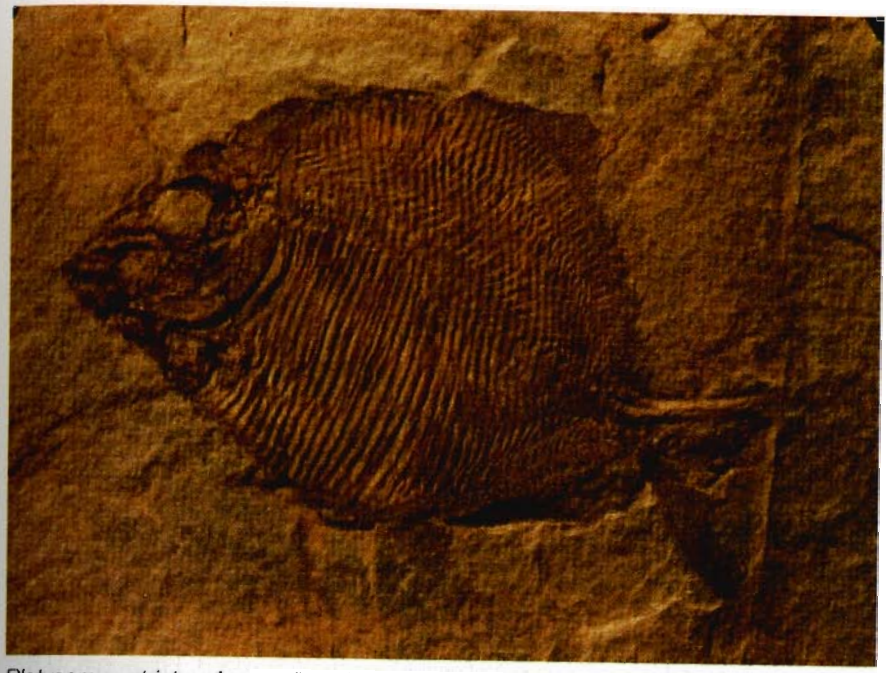
Recent relatives: None. Died out in Upper Carboniferous.



Mesolepis, reconstruction after MOY-THOMAS.

CHONDROSTEI
Order: Palaeonisciformes
Family: Platysomidae

Chondrosteans
Suborder: Platysomoidei



Platysomus striatus AGASSIZ (length c. 22 cm) from the Upper Permian of Richelsdorf, Hesse, Germany. Original: Interfoss, Munich, Germany.

Genus: *Platysomus* AGASSIZ, 1833.

Synonym: *Uropteryx*.

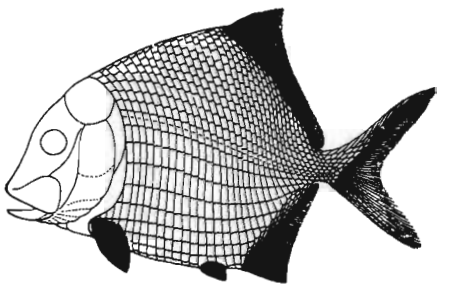
Geological range: Lower Carboniferous to Upper Triassic.

Geographical distribution: Europe, North America, Greenland, Spitzbergen, Australia.

Features: Middle-sized fishes with laterally compressed bodies and a rhombic outline. Head deep. Snout flattened. Dorsal fin anteriorly short and pointed, passing posteriorly into a low fringe-like fin. Anal fin of similar shape. Pectoral fins narrow and pointed. Pelvic fins very small. Scales rectangular, becoming more elongate ventrally, arranged in diagonal rows.

Remarks: Probably lived in still water. Perhaps fed, at least partly, on plants.

Recent relatives: None. Died out in Upper Triassic.



Platysomus, reconstruction after TRAQUAIR.



Eurynothus crenatus AGASSIZ (length c. 17 cm) from the Lower Carboniferous of Edinburgh, Scotland, U.K. Original: National Museum of Scotland, Edinburgh, U.K.

Genus: *Eurynothus* AGASSIZ, 1834.

Synonyms: *Eurynotus Plectrolepis*

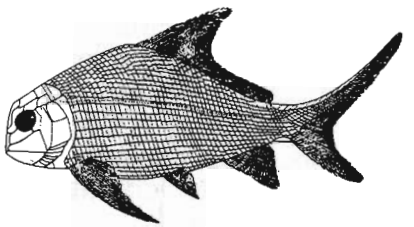
Geological range: Lower to Upper Carboniferous.

Geographical distribution: Europe, North America, northern Asia.

Features: Middle-sized, laterally compressed fishes of elongate oval outline. Head deep. Snout blunt. Eyes large. Dorsal fin large and pointed, running posteriorly into a low, fringe-like fin. Anal fin without a fringe. Pectoral fins narrowly elongate and ending in points. Pelvic fins small and pointed. Scales rectangular, arranged in regular rows.

Remarks: Lived in still water. Fed, at least partly, on plants.

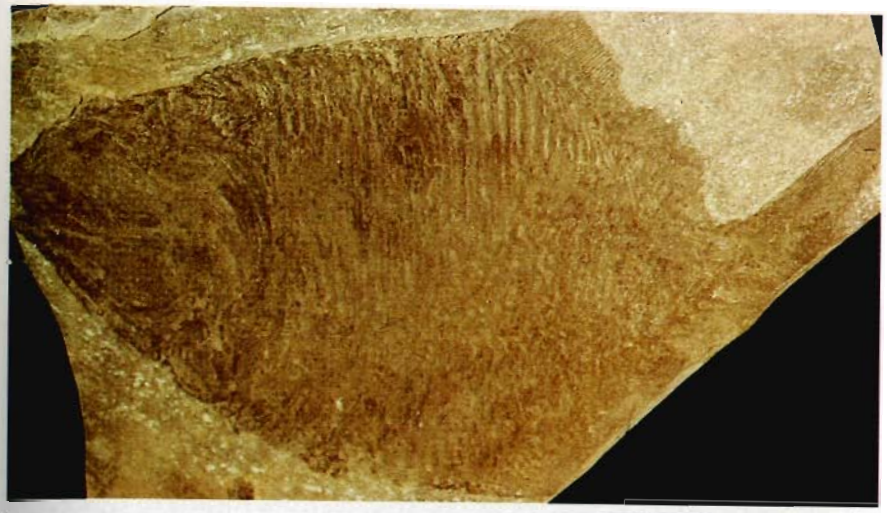
Recent relatives: None. Died out in Upper Carboniferous.



Eurynothus, reconstruction after TRAQUAIR.

CHONDROSTEI
Order: Palaeonisciformes
Family: Chirodontidae

Chondrosteans
Suborder: Platysomoidei



Eurysomus macrurus AGASSIZ (length c. 23 cm) from the Upper Permian of Richelsdorf, Hesse, Germany. Original: National Museum of Natural History, Smithsonian Institution, Washington, D.C., U.S.A.

Genus: *Eurysomus* YOUNG, 1866.

Synonym: *Globulodus*.

Geological range: Upper Permian.

Geographical distribution: Europe.

Features: Middle-sized, laterally compressed fishes, of rhombic outline. Head deep. Snout pointed. Dorsal fin short and pointed, running into a low fin fold. Anal fin of same shape. Pelvic fins very small. Scales rod-like, becoming longer ventrally. Teeth hemispherical (crushing dentition).

Remarks: Still-water fishes of durophagous diet.

Recent relatives: None. Died out in Upper Permian.



Eurysomus. Lithograph after DINKEL.



Cheirodopsis geitziei TRAQUAIR (length c. 7 cm) from the Lower Carboniferous of Eskdale, Scotland, U.K. Original: The Natural History Museum, London, U.K. (P20221)

Genus: *Cheirodopsis* TRAQUAIR, 1881.

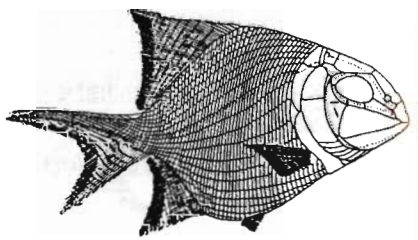
Geological range: Lower Carboniferous.

Geographical distribution: Europe.

Features: Small, laterally compressed fishes of rhombic body outline. Head deep. Snout flattened. Dorsal fin with a broad base and pointed, resembling the anal fin on the opposite side. Pectoral fins with a narrow base but expanding outwards and ending in a point. Pelvic fins very small. Scales rectangular and elongate.

Remarks: Still-water fishes. Probably fed, at least partly, on plants.

Recent relatives: None. Died out in Lower Carboniferous.



Cheirodopsis, reconstruction after MOY-THOMAS & DYNE.



Chirodus sp. (length c. 9 cm) from the Upper Carboniferous of Springfield, Nebraska, U.S.A. Original: Henne Collection, Stuttgart, Germany.

Genus: *Chirodus* M'COY, 1848.

Synonyms: *Amphicentrum*, *Cheirodus*, *Hemicladodus*.

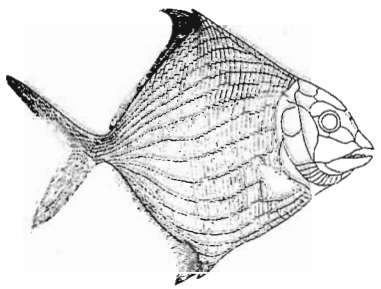
Geological range: Lower to Upper Carboniferous.

Geographical distribution: Europe, North America.

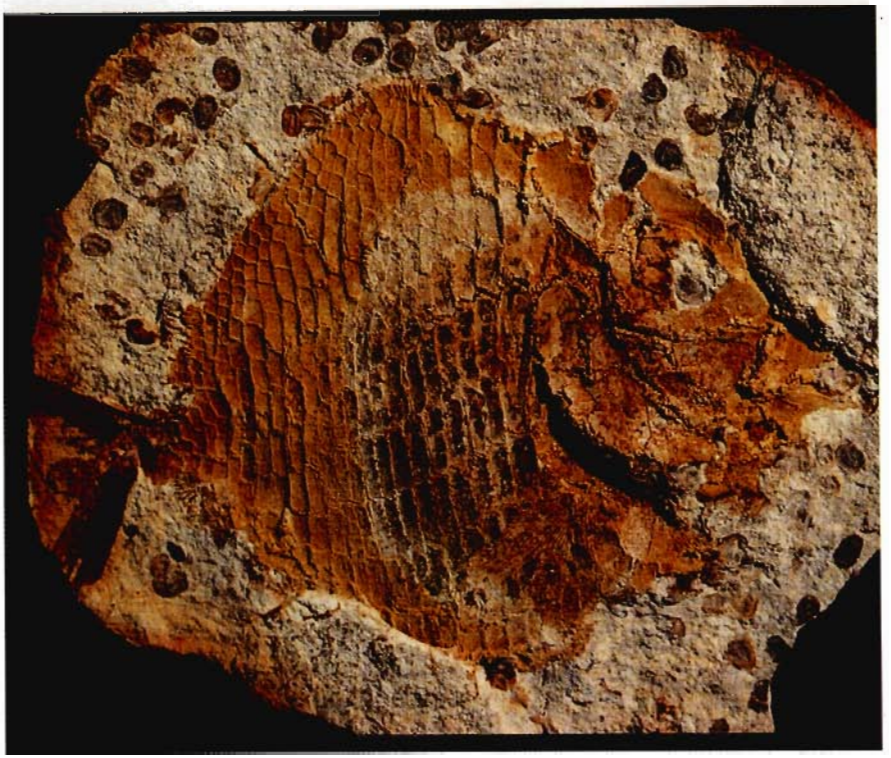
Features: Small to middle-sized fishes, laterally compressed with rhombic body outline. Head deep. Snout pointed. Eyes large. Dorsal fin pointed, running into an elongate fin fold. Anal fin similar in shape. In front of the dorsal and anal fins there is a characteristic pointed apex on the body. Pectoral fins small. Pelvic fins absent. Scales elongate rectangular, arranged in curved rows.

Remarks: Still-water fishes. Probably fed, at least partly, on plants.

Recent relatives: None. Died out in Upper Carboniferous.



Chirodus, reconstruction after TRAQUAIR.



Bobasatrania mahavavica WHITE (length c. 6 cm) from the Lower Triassic of Madagascar. Original: Frickhinger Collection, Munich, Germany.

Genus: *Bobasatrania* WHITE, 1932.

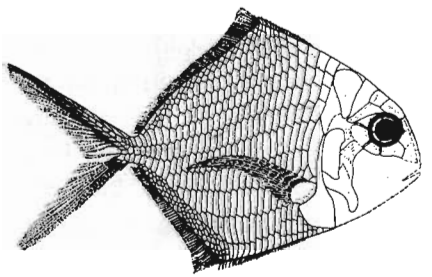
Geological range: Lower Triassic.

Geographical distribution: Madagascar, North America, Spitzbergen, Greenland.

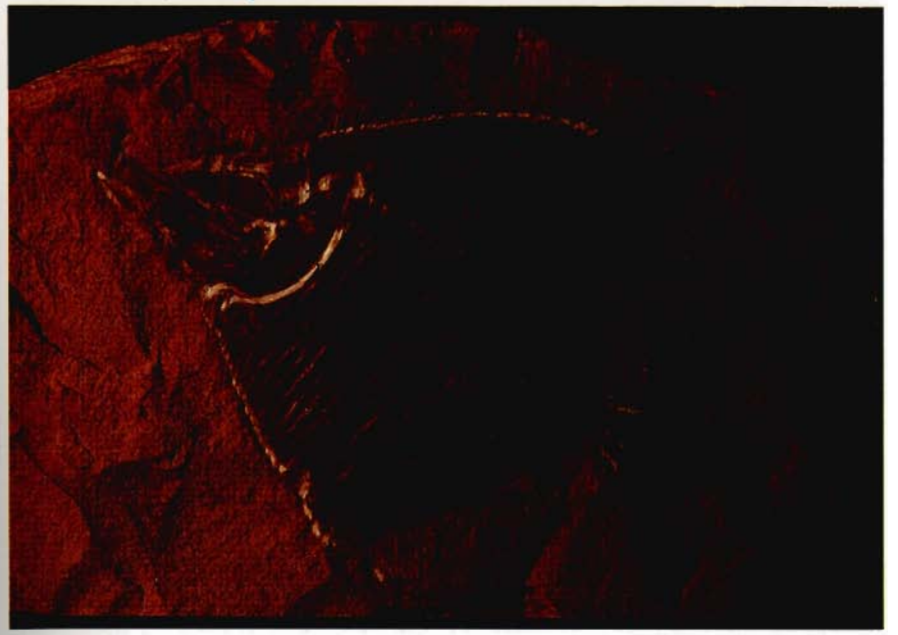
Features: Small, laterally compressed fishes of rhombic body outline. Head deep. Snout blunt. Eyes large. Dorsal fin begins anteriorly with a little apex which passes into a low fringe. Pectoral fins narrow and pointed. Pelvic fins absent. Scales rhombic, becoming longer ventrally.

Remarks: Still-water fishes. Probably fed, at least partly, on plants.

Recent relatives: None. Died out in Lower Triassic.



Bobasatrania, reconstruction after STENSIÖ.



Ebenaqua ritchiei CAMPBELL (length c. 12 cm) from the Upper Permian of Queensland, Australia. Original: Interfoss, Munich, Germany.

Genus: *Ebenaqua* CAMPBELL & LE DUY PHUOC, 1983.

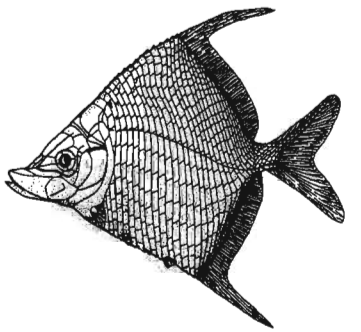
Geological range: Upper Permian.

Geographical distribution: Australia.

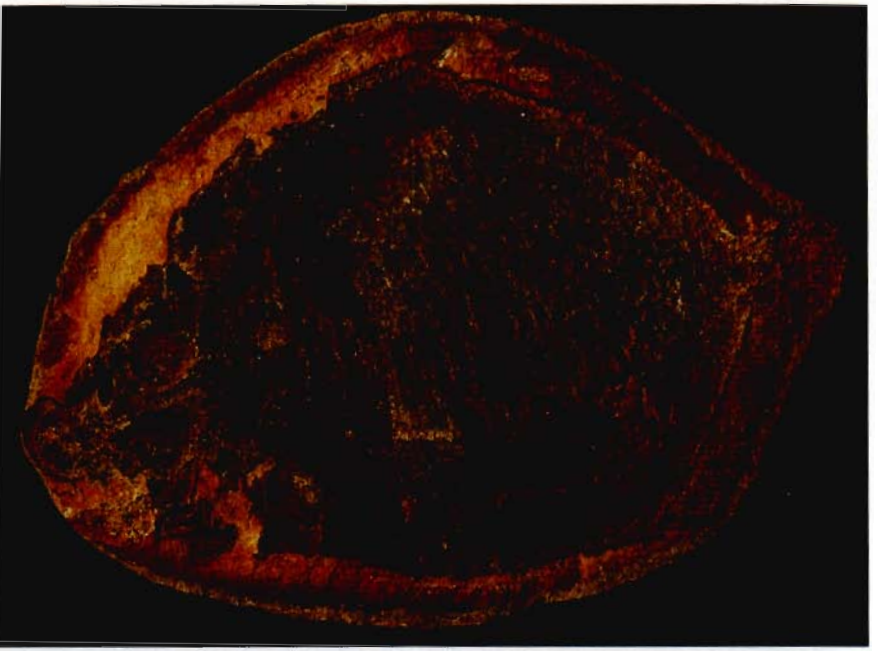
Features: Small to middle-sized, laterally compressed fishes of rhombic body outline. Head deep. Snout strongly pointed. Eyes large. Dorsal fin beginning with a long narrow point which passes into a fringe-like fin. Anal fin similar in shape. Scales long and rod-like ventrally.

Remarks: Still-water fishes. Probably fed, at least partly, on plants.

Recent relatives: None. Died out in Upper Permian.



Ebenaqua, reconstruction after LONG.



Ecrinesomus dixoni WOODWARD (length c. 12 cm) from the Lower Triassic of Madagascar. Original: Naturhistorisches Museum, Vienna, Austria.

Genus: *Ecrinesomus* WOODWARD, 1910.

Geological range: Lower Triassic.

Geographical distribution: Madagascar.

Features: Small to middle-sized, laterally compressed fishes of rhombic body outline. Head deep. Snout blunt. Eyes large. Dorsal fin with only a slight point at the anterior end, passing into a low fin fold. Anal fin of similar shape. Lepidotrichia (bony fin rays) packed densely together. Scales rhombic in shape, becoming longer ventrally.

Remarks: Still-water fishes. Probably fed, at least partly, on plants.

Recent relatives: None. Died out in Lower Triassic.



Guildayichthys carnegiei LUND (length c. 6 cm) from the Lower Carboniferous of Bear Gulch, Montana, U.S.A. Original: Adelphi University, Garden City, N.J., U.S.A.

Genus: *Guildayichthys* LUND.

Geological range: Lower Carboniferous.

Geographical distribution: North America.

Features: Small, high-backed fishes with an oval body outline. Head deep. Snout pointed. Eyes large. Dorsal fin elongate, beginning somewhat anterior to the middle of the body and extending far posteriorly. Caudal fin not forked. Anal fin with a broad base. Pelvic fins elongate. Scales rod-shaped in the ventral part of the body, arranged in diagonal rows.

Remarks: Probably lethargic fishes, perhaps even living on plant food.

Recent relatives: None. Died out in Lower Carboniferous.



Discoserra pectinodon LUND (length c. 7 cm) from the Lower Carboniferous of Bear Gulch, Montana, U.S.A. Original: Adelphi University, Garden City, N.J., U.S.A.

Genus: *Discoserra* LUND.

Geological range: Lower Carboniferous.

Geographical distribution: North America.

Features: Small fishes of almost circular outline. Head deep. Snout pointed. Eyes large. Dorsal fin elongate, beginning in the middle of the body and reaching far posteriorly. Saw-like ridge scales on the anterior part of the back, on the mid line. Caudal fin not forked. Anal fin broad-based. Rod-like scales on ventral surface.

Remarks: Probably lethargic fishes, perhaps even living on plant food.

Recent relatives: None. Died out in Lower Carboniferous.



Haywardia jordani TANNER (length c. 11 cm) from the Upper Triassic of Bear Lake Co., Idaho, U.S.A. Original: Field Museum of Natural History, Chicago, Illinois, U.S.A.

Genus: *Haywardia* TANNER, 1936.

Geological range: Upper Triassic.

Geographical distribution: North America.

Features: Small to middle-sized fishes with elongate bodies. Head elongate. Snout pointed. Eyes small. Scales strikingly rod-like on the ventral surface of body.

Remarks: Not yet placed systematically.

Recent relatives: None. Died out in Upper Triassic.



Urosthenes latus WOODWARD (length c. 27 cm) from the Lower Permian of New South Wales, Australia. Original: The Natural History Museum, London, U.K.

Genus: *Urosthenes* DANA, 1848.

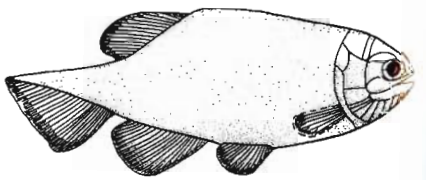
Geological range: Lower Permian.

Geographical distribution: Australia.

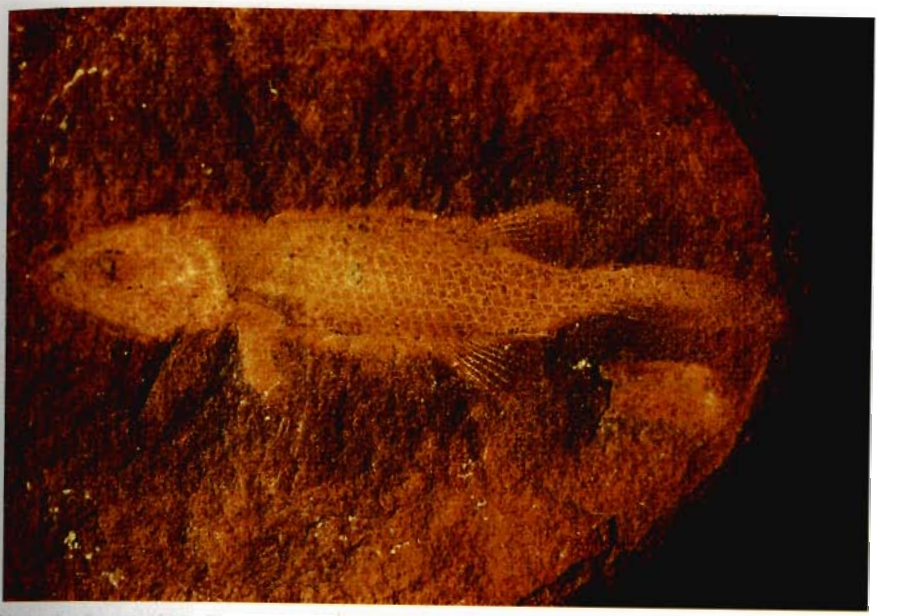
Features: Middle-sized fishes with laterally compressed bodies. Dorsal fin veil-like with a broad base, resembling the anal fin opposite. Pelvic fins elongate but expanded near the ends. Scales weak.

Remarks: Probably lethargic fishes, perhaps even feeding on plants.

Recent relatives: None. Died out in Lower Permian.



Urosthenes, after LE DUY PHUOC.



Haplolepis sp. (length c. 4 cm) from the Upper Carboniferous of Mazon Creek, Illinois, U.S.A. Original: Field Museum of Natural History, Chicago, Illinois, U.S.A. P (22164)

Genus: *Haplolepis* MILLER, 1982.

Synonyms: *Eurylepis*, *Mecolepis*, *Mekolepis*, *Parahaplolepis*.

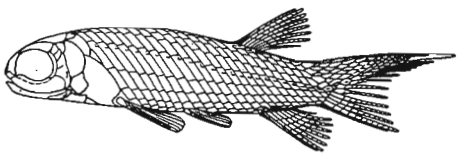
Geological range: Upper Carboniferous.

Geographical distribution: North America.

Features: Small fishes with elongate slender bodies. Head deep. Snout rounded. Eyes very large. Dorsal fin long and narrow, in the posterior third of the body, almost opposite the very similar anal fin. Pelvic fins small. Pectoral fins somewhat longer and very narrow. Scales rectangular, appreciably longer than elsewhere along the longitudinal axis of the body, arranged in regular rows.

Remarks: Probably gregarious.

Recent relatives: None. Died out in Upper Carboniferous.



Haplolepis, reconstruction after WESTOLL.



Microhaplolepis tuberculata LOWNEY (length c. 3 cm) from the Upper Carboniferous of Linton, Ohio, U.S.A. Original: Carnegie Museum of Natural History, Pittsburgh, Pennsylvania, U.S.A.

Genus: *Microhaplepis* LOWNEY, 1980.

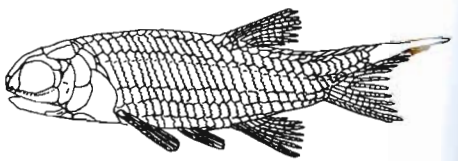
Geological range: Upper Carboniferous.

Geographical distribution: North America.

Features: Very small fishes with slender bodies. Head massive. Snout rounded. Eyes very large. Dorsal fin very posterior in position, obliquely opposite the anal fin. Pectoral fins narrow. Scales rod-like.

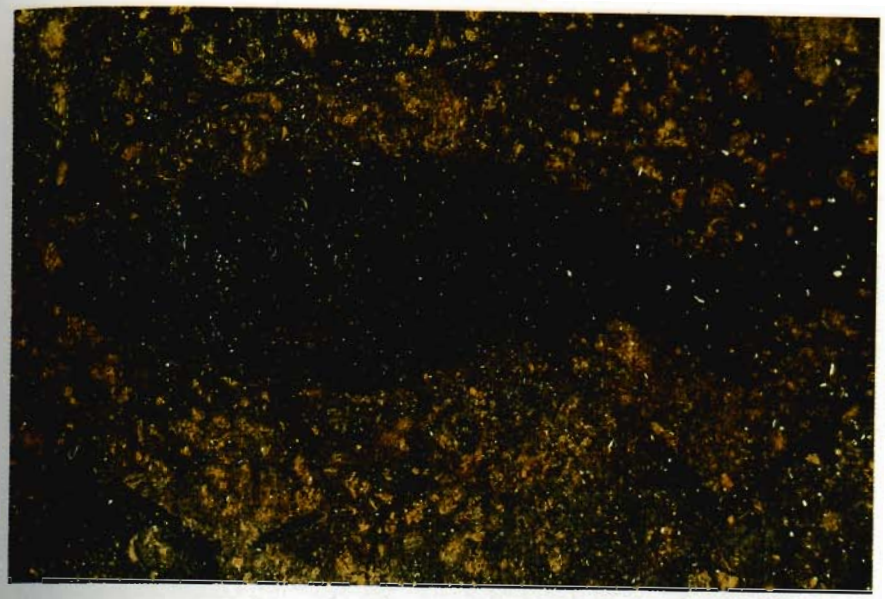
Remarks: Probably gregarious.

Recent relatives: None. Died out in Upper Carboniferous.



Microhaplolepis, reconstruction after LOWNEY.

CHONDROSTEI
Order: Haplolepiformes
Family: Haplolepididae
Chondrosteans



Pyritocephalus sculptus FRITSCH (length c. 5 cm) from the Lower Permian of Nursava, Czechoslovakia. Original: Geologisk Museum, Copenhagen, Denmark.

Genus: *Pyritocephalus* FRITSCH, 1894.

Synonym: *Teleopterina*.

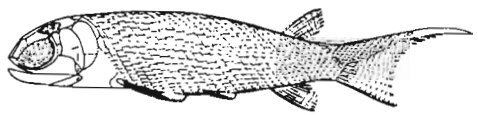
Geological range: Upper Carboniferous to Lower Permian.

Geographical distribution: Europe, North America.

Features: Small fishes with elongate slender bodies. Head laterally compressed. Snout rounded. Dorsal fin very narrow, very posterior in position, opposite the somewhat broader anal fin. Caudal fin heterocercal. Posterior end of the vertebral column slightly curved. Pelvic fins small and narrow. Pectoral fins also narrow, but longer. Scales rectangular, arranged in diagonal rows.

Remarks: Probably gregarious.

Recent relatives: None. Died out in Lower Permian.



Pyritocephalus, reconstruction after WESTOLL.



Dorypterus hoffmanni GERMAR (length c. 12 cm) from the Upper Permian of Richelsdorf, Hesse, Germany. Original: Munk Collection, Karlsruhe, Germany.

Genus: *Dorypterus* GERMAR, 1842.

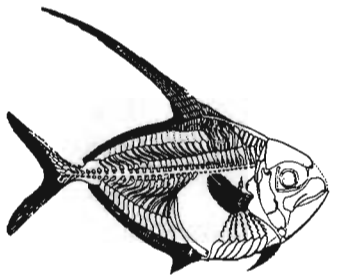
Geological range: Lower to Upper Permian.

Geographical distribution: Europe, eastern Asia.

Features: Middle-sized laterally compressed fishes with oval body outline. Head deep. Snout rounded. Eyes large. Jaws toothless. Dorsal fin begins somewhat in front of the middle of the body with a narrow sail-like prolongation and continues as a fringe extending to the caudal fin. Anal fin similar but with a short point instead of the long sail. Pelvic fins small, unusually anterior in position. Body almost without scales.

Remarks: The toothless jaws suggest a peaceable disposition.

Recent relatives: None. Died out in Upper Permian.



Dorypterus, reconstruction after WESTOLL.



Apholidotos ossna LUND (length c. 8 cm) from the Lower Carboniferous of Bear Gulch, Montana, U.S.A. Original: Tyrrell Museum of Paleontology, Drumheller, Alberta, Canada.

Genus: *Apholidotos* LUND.

Geological range: Lower Carboniferous.

Geographical distribution: North America.

Features: Small fishes with elongate lancet-shaped bodies. Head very small. Snout rounded. Fins probably joined into a fringe as in *Paratarrasius*. Scales sparse.

Remarks: Probably lived in crevices or burrowed into the sand.

Recent relatives: None. Died out in Lower Carboniferous.



Paratarrasius hibbardi Lund & Melton (length c.12 cm) from the Lower Carboniferous of Bear Gulch, Montana, U.S.A. Original: Adelphi University, Garden City, N.J., U.S.A.

Genus: *Paratarrasius* Lund & Melton, 1982.

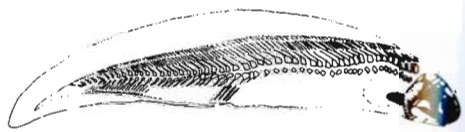
Geological range: Lower Carboniferous.

Geographical distribution: North America.

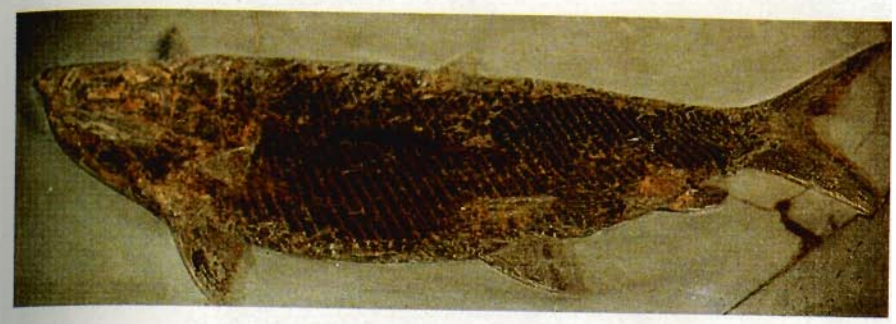
Features: Elongate lancet-shaped fishes. Head small. Snout rounded. Eyes relatively large. Dorsal fin in the form of a low fringe which begins behind the head and probably continues, *via* the pointed termination of the body, to the middle of the ventral surface. Scales delicate.

Remarks: Probably lived in crevices or burrowed into the sand.

Recent relatives: None. Died out in Lower Carboniferous.



Paratarrasius, reconstruction after Lund.



Ptycholepis bollensis Agassiz (length c. 32 cm) from the Lower Jurassic of Holzmaden, Württemberg, Germany. Original: Bayerische Staatssammlung für Paläontologie, Munich, Germany.

Genus: *Ptycholepis* Agassiz, 1833.

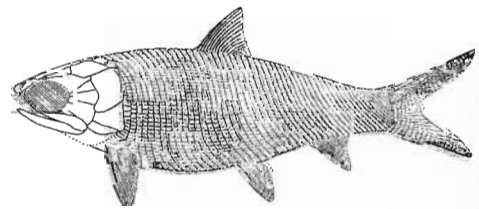
Geological range: Middle Triassic to Lower Jurassic.

Geographical distribution: Europe, North America.

Features: Middle-sized fishes with slender bodies. Head elongate. Snout pointed. Lower jaw strikingly long. Eyes large. Dorsal fin in the middle of the body. Caudal fin heterocercal, with the lower lobe somewhat shorter and broader than the upper lobe. Pectoral fins elongate. Anal and pelvic fins small. Scales denticulate at posterior edge of scale and with transverse furrows.

Remarks: Rapid swimmers.

Recent relatives: None. Died out in Lower Jurassic.



Ptycholepis, reconstruction after Brough.



Australosomus merlei PRIEM (length c. 8 cm) from the Lower Triassic of Madagascar. Original: Museo Civico di Storia Naturale, Milan, Italy.

Genus: *Australosomus* PIVETEAU, 1930.

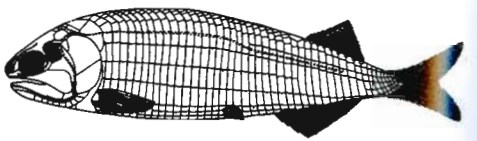
Geological range: Lower to Middle Triassic.

Geographical distribution: Africa, Madagascar, Greenland, Spitzbergen.

Features: Small to middle-sized fishes with elongate bodies. Head relatively less deep than the body. Snout blunt. Eyes large. Dorsal fin obtusely pointed. The anal fin opposite is broad-based. Caudal fin somewhat forked with two almost equal-sized lobes. Pectoral fins elongate and pointed. Pelvic fins very small. Scales long and rod-like, arranged in regular rows.

Remarks: Probably predators.

Recent relatives: None. Died out in Middle Triassic.



Australosomus, after LEHMAN.

CHONDROSTEI
Order: Pholidopleuriformes
Family: Pholidopleuridae
Chondrosteans



Macroaethes brookvalei WADE (length c. 30 cm) from the Middle Triassic of Hornsby Heights, Australia. Original: Australian Museum, Sydney, Australia.

Genus: *Macroaethes* WADE, 1932.

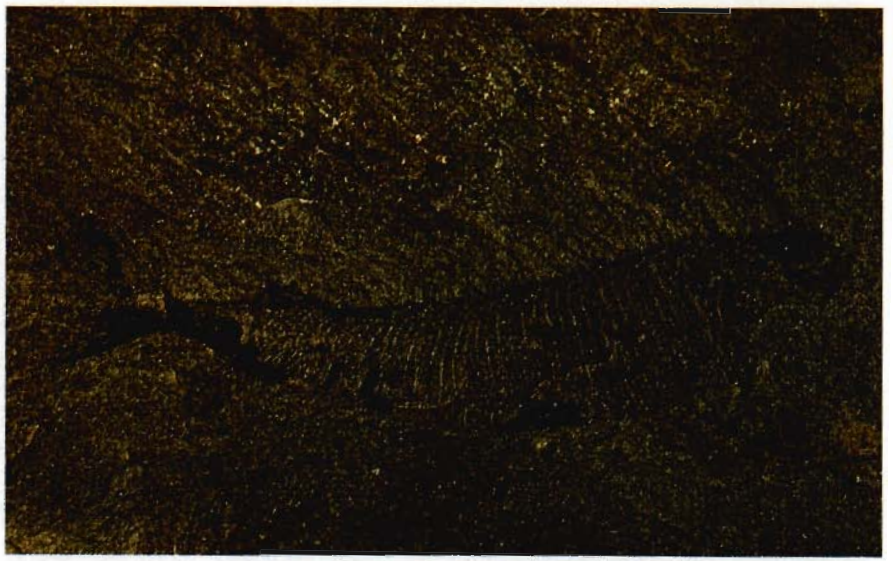
Geological range: Middle Triassic.

Geographical distribution: Australia.

Features: Middle-sized fishes with elongate streamlined bodies. Head shallow. Snout pointed. Eyes small. Dorsal fin small and pointed, very posterior in position, passing behind into a low fringe. Anal fin similar. Pelvic fins small. Long rod-like scales on the flanks.

Remarks: Probably very rapid swimmers.

Recent relatives: None. Died out in Middle Triassic.



Pholidopleurus typus BRONN (length c. 9 cm) from the Middle Triassic of Carinthia, Austria. Original: The Natural History Museum, London, U.K. P (1099c)

Genus: *Pholidopleurus* BRONN, 1858.

Geological range: Middle to Upper Triassic.

Geographical distribution: Europe.

Features: Small fishes with elongate bodies. Head small. Snout blunt. Dorsal fin small, very posterior in position, passing into a low fringe. Anal fin similar in shape. Pectoral fins narrow and pointed. Characteristic long rod-shaped scales on the flanks.

Remarks: Probably gregarious.

Recent relatives: None. Died out in Upper Triassic.



Pholidopleurus, reconstruction after KNER.



Habroichthys sp. (length c. 3 cm) from the Middle Triassic of Perledo, Italy. Original: Paläontologisches Museum, Zürich, Switzerland.

Genus: *Habroichthys* BROUGH, 1939.

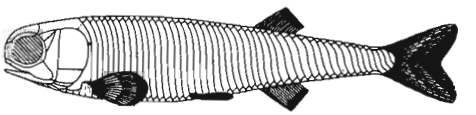
Geological range: Middle Triassic.

Geographical distribution: Europe.

Features: Small slender fishes. Head shallow. Snout pointed. Eyes large. Dorsal fin pointed, situated in the posterior half of the body, obliquely opposite the anal fin. Scales thick and shiny, rhombic on the dorsal surface and rod-like on flanks.

Remarks: Probably lethargic swimmers and gregarious.

Recent relatives: None. Died out in Middle Triassic.



Habroichthys, reconstruction after GRIFFITH.



Nannolepis elegans GRIFFITH (length c. 7 cm) from the Upper Triassic of Polzberg, Lunz, Austria. Original: Naturhistorisches Museum, Vienna, Austria.

Genus: *Nannolepis* GRIFFITH, 1977.

Geological range: Upper Triassic.

Geographical distribution: Europe.

Features: Small slender fishes. Head relatively deep. Snout blunt. Dorsal fin very posterior in position, opposite the anal fin. Caudal fin forked, with almost equal-sized lobes. Pelvic fins small. Scales rhombic on the dorsal surface and rod-like on the anterior part of the flanks.

Remarks: Probably not very clever swimmers.

Recent relatives: None. Died out in Upper Triassic.



Thoracopterus magnificus TINTORI (length c. 6 cm) from the Upper Triassic of Cene, Bergamo, Italy. Original: Naturmuseum Senckenberg, Frankfurt-am-Main, Germany.

Genus: *Thoracopterus* BRONN, 1858.

Synonyms: *Pterygopterus*.

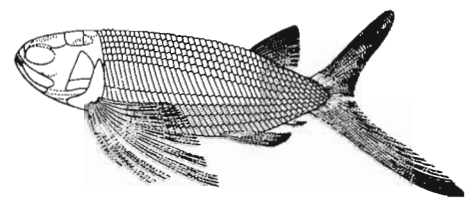
Geological range: Lower to Upper Triassic.

Geographical distribution: Europe, North America, Australia.

Features: Small to middle-sized fishes with slender bodies. Head shallow. Snout pointed. Teeth small. Dorsal fin very small, very posterior in position. Anal fin even smaller than the dorsal fin. Caudal fin deeply forked, with the lower lobe longer than the upper. Pectoral fins greatly enlarged. Pelvic fins long and pointed. Scales square to rectangular, elongate on the flanks in the anterior part of the body.

Remarks: "Flying" fishes.

Recent relatives: None. Died out in Upper Triassic.



Thoracopterus, reconstruction after LEHMAN.



Besania sp. (length c. 5 cm) from the Middle Triassic of Monte San Giorgio, Switzerland. Original: Paläontologisches Museum, Zürich.

Genus: *Besania* Brough, 1939.

Geological range: Middle to Upper Triassic.

Geographical distribution: Europe.

Features: Small fishes with slender bodies. Head small. Snout pointed. Eyes large. Scales thick, rhombic on the dorsal surface of the body, rod-like on the flanks.

Remarks: Probably gregarious little fishes but their thick "scale armour" suggests that they would not have been rapid swimmers.

Recent relatives: None. Died out in Upper Triassic.



Luganoia lepidosteoides Brough (length c. 6 cm) from the Middle Triassic of Monte San Giorgio, Switzerland. Original: Paläontologisches Museum, Zürich, Switzerland.

Genus: *Luganoia* Brough, 1939.

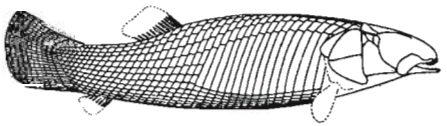
Geological range: Middle to Upper Triassic.

Geographical distribution: Europe.

Features: Small fishes with slender bodies. Head shallow. Snout pointed. Teeth small. Dorsal fin in the posterior third of the body, obliquely opposite the anal fin. Pectoral fins probably narrow and rounded. Scales square to rectangular, elongate and rod-like on the anterior part of the flanks.

Remarks: Probably not rapid swimmers, in view of the thick "scale armour".

Recent relatives: None. Died out in Upper Triassic.



Luganoia, reconstruction after Brough.



Atopocephala watsoni BROUGH (length c. 5 cm) from the Lower Triassic of Rouxville, South Africa. Original: The Natural History Museum, London, U.K. (P 16079)

Genus: *Atopocephala* BROUGH, 1934.

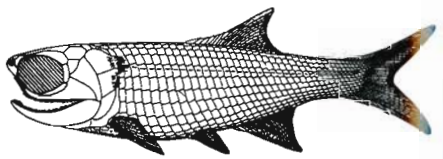
Geological range: Lower Triassic.

Geographical distribution: South Africa.

Features: Small fishes with a large head and very large eyes. Nose pointed. Gape very long. Upper and lower jaws set with small pointed teeth. Dorsal fin broad-based, shortly behind the middle of the body. Anal fin obliquely opposite. Pelvic fins small and pointed. Pectoral fins likewise pointed.
Scales rhombic, arranged in regular rows.

Remarks: Probably gregarious.

Recent relatives: None. Died out in Lower Triassic.



Atopocephala, reconstruction after PIVETEAU.



Beaconia spinosa WADE (length c. 5 cm) from the Middle Triassic of New South Wales, Australia. Original: American Museum of Natural History, N.Y., U.S.A.

Genus: *Beaconia* WADE, 1935.

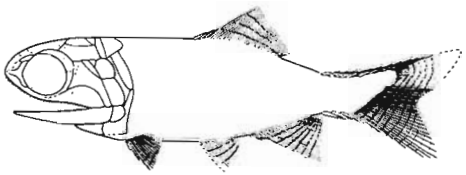
Geological range: Middle Triassic.

Geographical distribution: Australia.

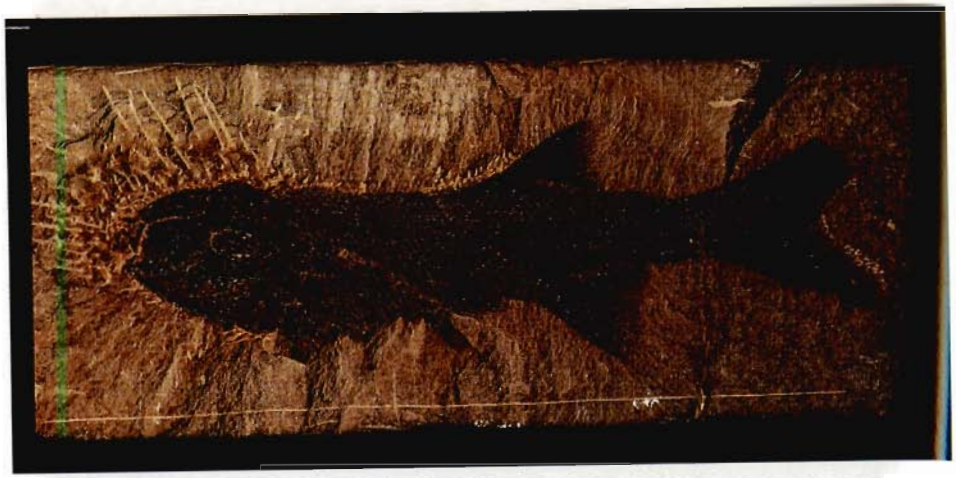
Features: Small slender fishes. Head elongate. Eyes large. Dorsal fin in the posterior half of the body. Anal fin obliquely opposite. Dorsal and ventral mid lines carry a row of pointed spines in front of the caudal fin. Dorsal and anal fins both with two spines anteriorly. Caudal fin not strongly forked.

Remarks: By some authors the genus *Beaconia* is assigned to *Brookvalia*.

Recent relatives: None. Died out in Middle Triassic.



Beaconia, reconstruction after HUTCHINSON.



Brookvalia gracilis WADE (length c. 9 cm) from the Middle Triassic of Brookvale, New South Wales, Australia. Original: The Natural History Museum, London, U.K. (P 15799-800)

Genus: *Brookvalia* WADE, 1935.

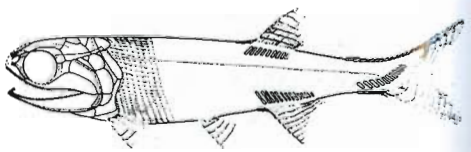
Geological range: Middle Triassic.

Geographical distribution: Australia.

Features: Small very slender fishes. Head elongate. Eyes very large. Gape very long. Small pointed teeth. Dorsal fin in the posterior half of the body, opposite the anal fin. Pointed spines in front of the caudal fin dorsally and ventrally, and also in front of the dorsal and anal fins. Pectoral and pelvic fins small. Scales square to rhombic.

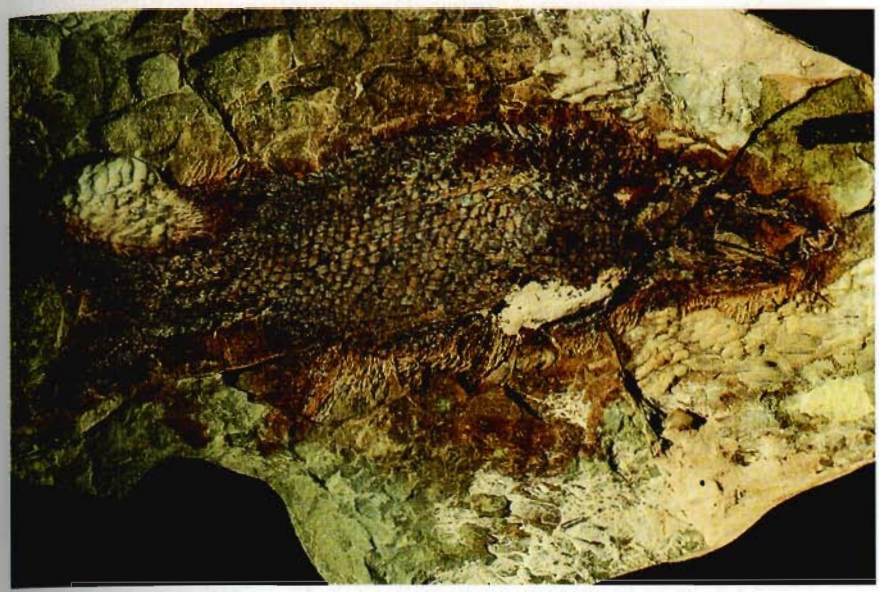
Remarks: Probably rapidly swimming and gregarious.

Recent relatives: None. Died out in Middle Triassic.



Brookvalia, reconstruction after HUTCHINSON.

CHONDROSTEI
Order: Redfieldiiformes
Family: Redfieldiidae
Chondrosteans



Cionichthys dunklei SCHAEFFER (length c. 15 cm) from the Upper Triassic of Montrose, Utah, U.S.A. Original: National Museum of Natural History, Smithsonian Institution, Washington, D.C., U.S.A.

Genus: *Cionichthys* SCHAEFFER, 1967.

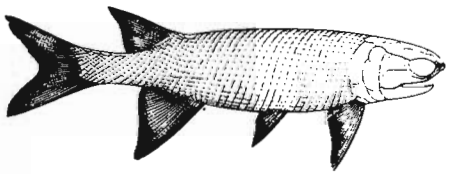
Geological range: Upper Triassic.

Geographical distribution: North America.

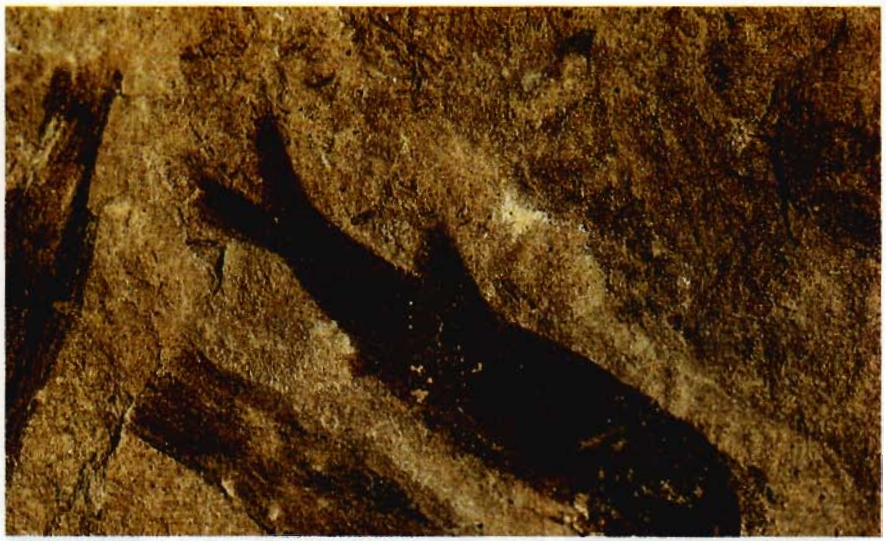
Features: Middle-sized slender fishes. Head elongate. Snout somewhat pointed. Dorsal fin in the posterior half of the body, obliquely opposite the anal fin. Caudal fin relatively large, deeply forked. Scales rhombic, arranged in diagonal rows.

Remarks: Probably predators.

Recent relatives: None. Died out in Upper Triassic.



Cionichthys, reconstruction after SCHAEFFER.



Dictyopyge illustrans WOODWARD (length c. 6 cm) from the Lower Triassic of Gosford, New South Wales. Original: The Natural History Museum, London, U.K. (P6269)

Genus: *Dictyopyge* EGERTON, 1847.

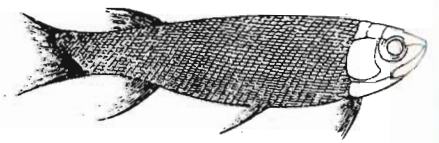
Geological range: Lower Triassic.

Geographical distribution: Australia.

Features: Small slender fishes. Head elongate. Snout pointed. Dorsal fin very posterior in position, opposite the longer anal fin. Pectoral and pelvic fins likewise relatively long. Scales rectangular, arranged in diagonal rows.

Remarks: Probably predators.

Recent relatives: None. Died out in Lower Triassic.



Dictyopyge, reconstruction after STRUVER.



Helichthys browni BROOM (length c. 7) from the Lower Triassic of Rouxville, South Africa. Original: Museum für Geologie und Paläontologie, Tübingen, Germany.

Genus: *Helichthys* BROOM, 1909.

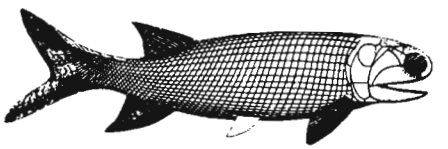
Geological range: Lower Triassic.

Geographical distribution: South Africa.

Features: Small slender fishes. Head elongate. Snout rounded. Eyes large. Jaws set with very small teeth. Dorsal fin triangular, pointed, very posterior in position, obliquely opposite the anal fin which is likewise triangular. Scales square to rhombic, arranged in diagonal rows.

Remarks: Probably gregarious.

Recent relatives: None. Died out in Lower Triassic.



Helichthys, reconstruction after BROUGH.



Ischnolepis bancrofti HAUGHTON (length c. 7 cm) from the Upper Triassic of Zimbabwe. Original: South African Museum, Cape Town, South Africa.

Genus: *Ischnolepis* HAUGHTON, 1934.

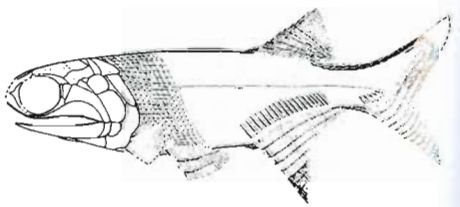
Geological range: Upper Triassic.

Geographical distribution: South Africa.

Features: Small slender fishes. Head elongate. Eyes very large. Gape very long. Upper and lower jaws set with small pointed teeth. Dorsal fin very posterior in position, opposite the broad-based anal fin. In front of the bases of every fin are one or several pointed spines. Scales rhombic, arranged in diagonal rows.

Remarks: Probably gregarious.

Recent relatives: None. Died out in Upper Triassic.



Ischnolepis, reconstruction after HUTCHINSON.



Lasalichthys hillsi SCHAEFFER (length c. 9 cm) from the Upper Triassic of Little Valley, Utah, U.S.A. Original: American Museum of Natural History, New York, N.Y., U.S.A.

Genus: *Lasalichthys* SCHAEFFER, 1967.

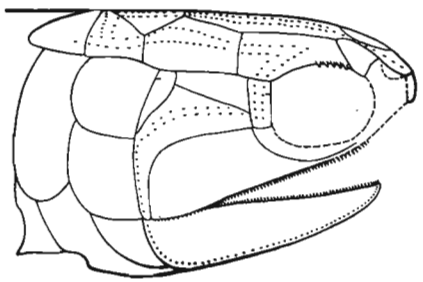
Geological range: Upper Triassic.

Geographical distribution: North America.

Features: Middle-sized slender fishes. Head elongate. Snout pointed. Pectoral fins triangular, strikingly large. Scales rhombic, arranged in diagonal rows.

Remarks: The large pectoral fins suggest that these fishes could "fly" for short distances.

Recent relatives: None. Died out in Upper Triassic.



Lasalichthys, reconstruction after SCHAEFFER.



Molybdichthys junior WADE (length c. 13 cm) from the Middle Triassic of Brookvale, New South Wales, Australia. Original: Australian Museum, Sydney, Australia.

Genus: *Molybdichthys* WADE, 1935.

Geological range: Middle Triassic.

Geographical distribution: Australia.

Features: Small to middle-sized slender fishes. Head elongate. Eyes very large. Dorsal fin very posterior in position, opposite the anal fin. Caudal fin only slightly divided. Pectoral fins small. Scales almost square, arranged in diagonal rows.

Remarks: Probably predators.

Recent relatives: None. Died out in Middle Triassic.



Molybdichthys, reconstruction after HUTCHINSON.



Phlyctaenichthys pectinatus WADE (length c. 14 cm) from the Middle Triassic of Brookvale, New South Wales, Australia. Original: Australian Museum, Sydney, Australia.

Genus: *Phlyctaenichthys* WADE, 1935.

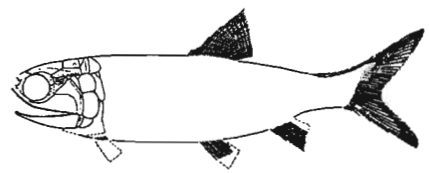
Geological range: Middle Triassic.

Geographical distribution: Australia.

Features: Middle-sized slender fishes. Head elongate. Snout rounded. Eyes very large. Gape very long. Dorsal fin in the posterior half of the body, almost opposite the small pelvic fins. In the dorsal mid line, in front of the beginning of the caudal fin, is a row of pointed spines. Scales arranged in diagonal rows.

Remarks: Probably gregarious.

Recent relatives: None. Died out in Middle Triassic.



Phlyctaenichthys, reconstruction after WADE.



Redfieldius gracilis (REDFIELD) (length c. 14 cm) from the Lower Triassic of Durham, Connecticut, U.S.A. Original: Carnegie Museum of Natural History, Pittsburgh, Pennsylvania, U.S.A.

Genus: *Redfieldius* HAY, 1899.

Synonyms: *Catopterus.*

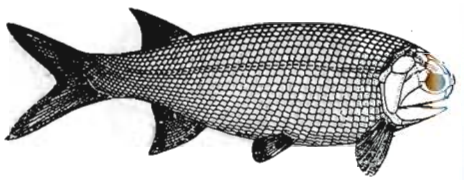
Geological range: Lower Triassic.

Geographical distribution: North America.

Features: Medium-sized fishes with a somewhat stout body. Head broad. Snout rounded. Eyes large. Mandible with small teeth. Dorsal fin pointed, triangular, very posterior, almost opposite to the slightly larger anal fin. Ventral fins small. Pectoral fins somewhat broadened. Scales rectangular with sinuate fringes, arranged in diagonal rows.

Remarks: Predatory fishes.

Recent relatives: None. Died out in the Middle Triassic.



Redfieldius, reconstruction after BROUGH



Schizurichthys pulcher WADE (length c. 20 cm) from the Middle Triassic of Brookvale, New South Wales, Australia. Original: Australian Museum, Sydney, Australia.

Genus: *Schizurichthys* WADE, 1935.

Geological range: Middle Triassic.

Geographical distribution: Australia.

Features: Medium-sized slender fishes. Head elongate. Snout pointed. Eyes large. Gape very long. Mandible with very small teeth. Dorsal fin on the posterior half of the body at a slant opposite to the broad anal fin. Pectoral and anal fins small. Scales thin.

Remarks: Predators.

Recent relatives: None. Died out in Middle Triassic.



Schizurichthys, reconstruction after HUTCHINSON



Synorichthys stewartii SCHAEFFER (length c. 17 cm) from the Upper Triassic of the U.S.A. Original: Peabody Museum of Natural History, New Haven, Connecticut, U.S.A.

Genus: *Synorichthys* SCHAEFFER, 1967.

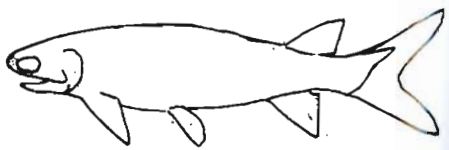
Geological range: Upper Triassic.

Geographical distribution: North America.

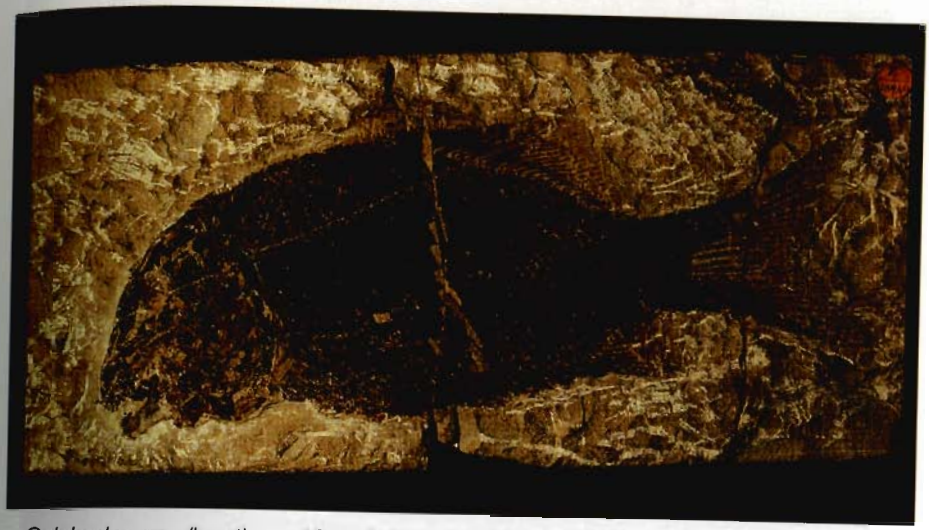
Features: Middle-sized slender fishes. Head elongate. Snout rounded. Eyes large. Dorsal fin triangular, pointed, very posterior in position, opposite the somewhat larger but likewise triangular anal fin. Pectoral fins somewhat expanded. Pelvic fins small. Scales thick.

Remarks: Predatory fishes.

Recent relatives: None. Died out in Upper Triassic.



Synorichthys, reconstruction after SCHAEFFER.



Colobodus sp. (length c. 16 cm) from the Upper Triassic of Hirtenstein, Austria. Original: The Natural History Museum, London, U.K. (P 10944)

Genus: *Colobodus* AGASSIZ, 1844.

Synonyms: *Asterodon*, *Euplorodus*.

Geological range: Lower to Upper Triassic.

Geographical distribution: Europe, South Africa, eastern Africa, Australia, northern Asia.

Features: Middle-sized, broad-bodied fishes. Head deep. Snout pointed. Dorsal fin broad-based, situated in the posterior descending part of the dorsal mid line, obliquely opposite the small anal fin. Pectoral fins fan-like. Scales denticulate at posterior margin and ornamented with parallel ribs on the external surface. Teeth hemispherical, forming a pavement dentition.

Remarks: The dentition suggests a durophagous diet.

Recent relatives: None. Died out in Upper Triassic.



Manlietta crassa WADE (length c. 7 cm) from the Middle Triassic of Brookvale, New South Wales, Australia. Original: Australian Museum, Sydney, Australia.

Genus: *Manlietta* WADE, 1935.

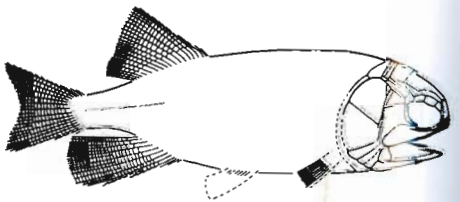
Geological range: Middle Triassic.

Geographical distribution: Australia.

Features: Small fishes of somewhat compressed shape. Head elongate. Eyes large. Jaws set with small conical teeth. Mouth not deeply incised. Dorsal fin in the posterior third of the body, obliquely opposite the long broad anal fin. Caudal fin with a slightly concave posterior margin. Pectoral and pelvic fins small. Scales rhombic.

Remarks: Probably fed on crustacea and other small animals.

Recent relatives: None. Died out in Middle Triassic.



Manlietta, reconstruction after HUTCHINSON.

CHONDROSTEI
Order: Perleidiformes
Family: Perleididae
Chondrosteans



Meidiichthys browni (BROOM) (length c. 10 cm) from the Lower Triassic of Rouxville, South Africa. Original: The Natural History Museum, London, U.K. (P16073)

Genus: *Meidiichthys* BROUGH, 1931.

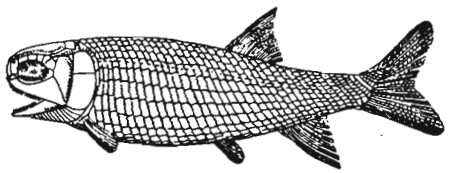
Geological range: Lower Triassic.

Geographical distribution: South Africa.

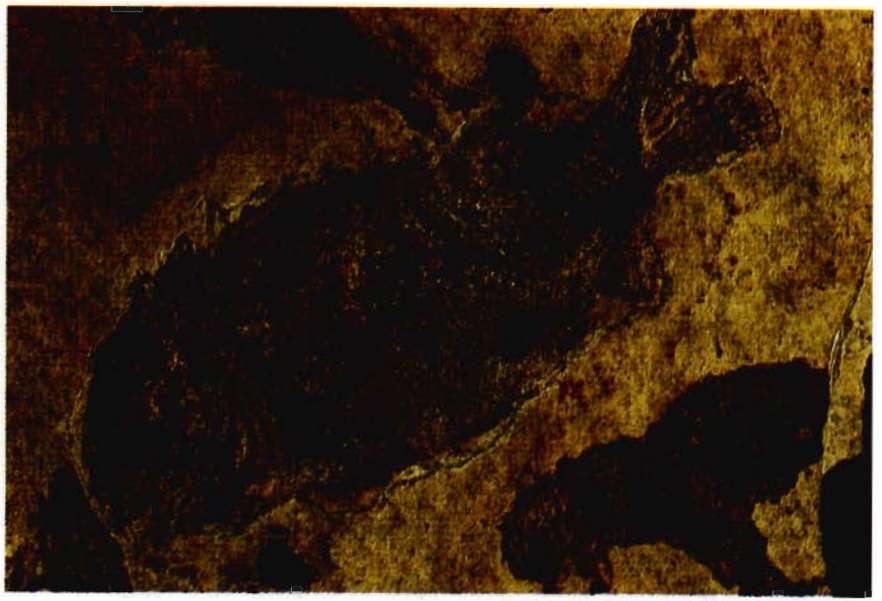
Features: Small slender fishes. Head deep. Eyes large. Gape not very long. Jaws set with conical teeth. Dorsal fin just behind the middle of the body, obliquely opposite the pointed anal fin. Pectoral and pelvic fins small. Scales square, with scalloped margins, arranged in diagonal rows.

Remarks: Probably fed on crustaceans and other small animals.

Recent relatives: None. Died out in Lower Triassic.



Meidiichthys, reconstruction after BROUGH.



Mendocinichthys brevis BORDAS (length c. 5 cm) from the Middle Triassic of Mendoza, Argentina. Original: American Museum of Natural History, New York, N.Y., U.S.A.

Genus: *Mendocinichthys* WHITLEY, 1953.

Synonym: *Mendocinia*.

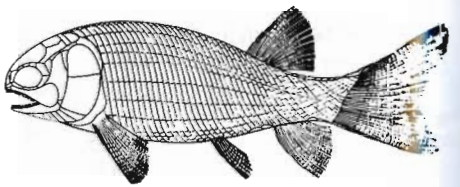
Geological range: Middle Triassic.

Geographical distribution: South America.

Features: Small plump fishes. Head deep. Snout rounded. Jaws set with conical teeth. Dorsal fin very posterior in position, opposite the triangular anal fin. Scales square to rectangular, arranged in diagonal rows.

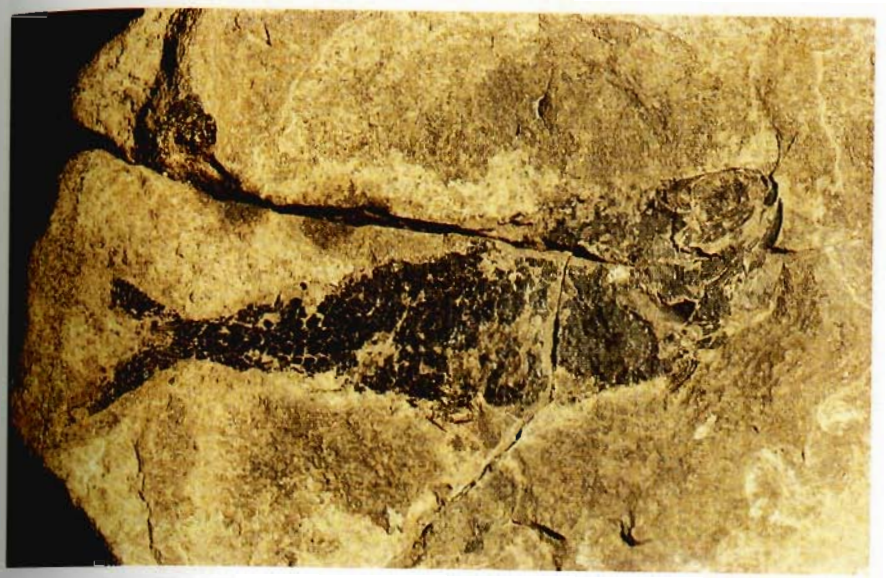
Remarks: Probably fed on crustaceans and other small animals.

Recent relatives: None. Died out in Middle Triassic.



Mendocinichthys, reconstruction after SCHAEFFER.

CHONDROSTEI
Order: Perleidiformes
Family: Perleididae
Chondrosteans



Meridensia meridensis de ALESSANDRI (length c. 10 cm) from the Middle Triassic of Monte San Gorgio, Switzerland. Original: Paläontologisches Museum, Zürich, Switzerland.

Genus: *Meridensia* ANDERSSON, 1916.

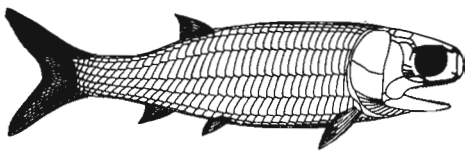
Geological range: Middle to Upper Triassic.

Geographical distribution: Europe.

Features: Small elongate fishes. Head elongate. Snout pointed. Eyes large. Gape moderately long. Teeth small. Dorsal fin small, in the posterior third of the body, obliquely opposite the anal fin which is likewise small. Pectoral and pelvic fins pointed. Scales elongate, rounded.

Remarks: Probably gregarious.

Recent relatives: None. Died out in Upper Triassic.



Meridensia, reconstruction after BROUGH.



Perleidus madagascariensis LEHMAN (length c. 23 cm) from the Lower Triassic of Madagascar. Original: Staatliches Museum für Naturkunde, Karlsruhe, Germany.

Genus: *Perleidus* de ALESSANDRI, 1910.

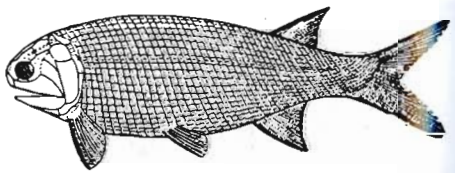
Geological range: Lower Triassic.

Geographical distribution: Madagascar.

Features: Middle-sized fishes with somewhat laterally compressed bodies. Head deep. Eyes large. Gape moderately long. Dorsal fin in the posterior third of the body, obliquely opposite the anal fin. Pectoral fins rounded. Pelvic fins small. Scales square to rectangular with scalloped edges, arranged in regular diagonal rows.

Remarks: Diet probably durophagous.

Recent relatives: None. Died out in Upper Triassic.



Perleidus, reconstruction after LEHMANN.



Pristisomus latus WOODWARD (length c. 11 cm) from the Lower Triassic of Gosford, New South Wales, Australia. Original: The Natural History Museum, London, U.K. (P 6274)

Genus: *Pristisomus* WOODWARD, 1890.

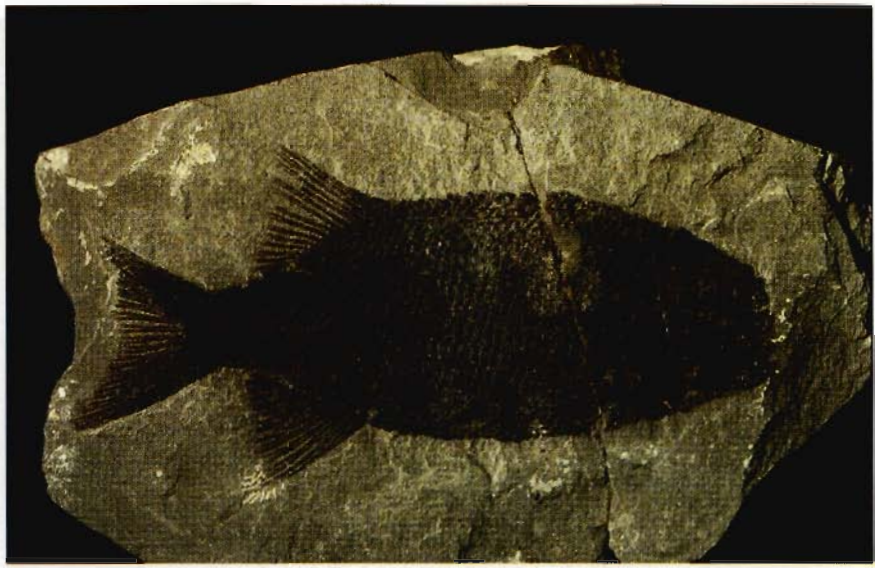
Geological range: Lower Triassic.

Geographical distribution: Australia, Madagascar.

Features: Small to middle-sized fishes of oval outline. Head deep. Dorsal fin in the posterior third of the body, opposite the somewhat larger anal fin. Caudal fin scarcely forked. Scales rod-shaped.

Remarks: Probably durophagous.

Recent relatives: None. Died out in Lower Triassic.



Procheirichthys ferox WADE (length c. 16 cm) from the Middle Triassic of Brookvale, New South Wales, Australia. Original: Australian Museum, Sydney, Australia.

Genus: *Procheirichthys* WADE, 1935.

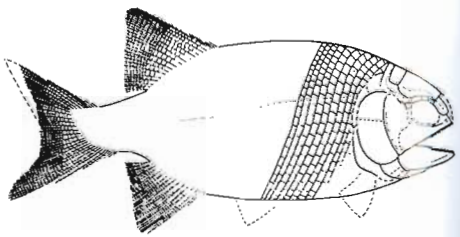
Geological range: Middle Triassic.

Geographical distribution: Australia.

Features: Small slender fishes with laterally compressed bodies. Head deep. Snout rounded. Eyes large. Gape rather long. Teeth small. Dorsal fin large, situated in posterior third of the body, obliquely opposite the anal fin. Pectoral and pelvic fins small. Scales rectangular with smooth edges, arranged in diagonal rows.

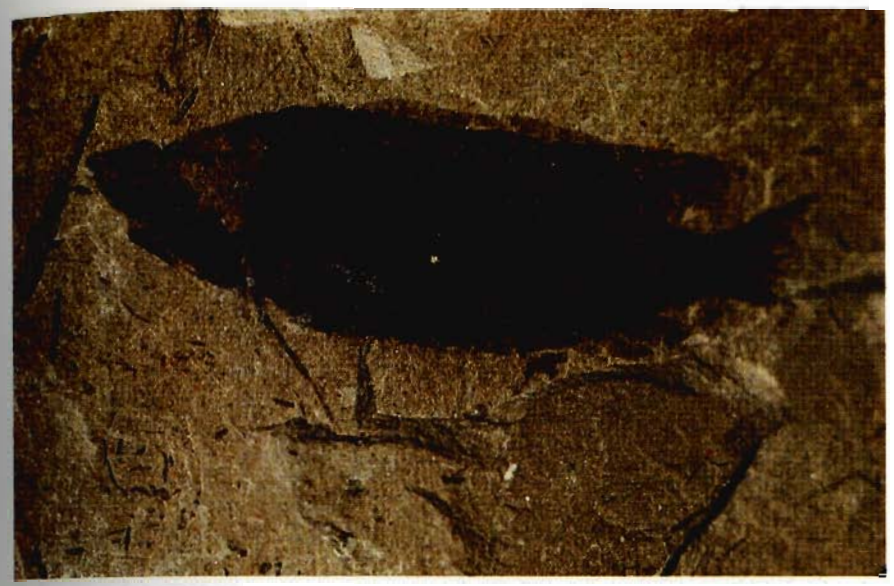
Remarks: Probably fed on crustacea and other small animals.

Recent relatives: None. Died out in Middle Triassic.



Procheirichthys, reconstruction after HUTCHINSON.

CHONDROSTEI
Order: Perleidiformes
Family: Perleididae
Chondrosteans



Tripelta dubia Woodward (length c. 6 cm) from the Lower Triassic of Gosford, New South Wales, Australia. Original: The Natural History Museum, London, U.K. (P 6274 c)

Genus: *Tripelta* WADE, 1940.

Geological range: Lower Triassic.

Geographical distribution: Australia.

Features: Small slender fishes. Head elongate. Snout pointed. Dorsal fin very posterior in position, opposite the larger anal fin. Scales rectangular to rhombic.

Remarks: Probably fed on crustacea and other small animals.

Recent relatives: None. Died out in Lower Triassic.



Cleithrolepidina extoni (WOODWARD) (length c. 10 cm) from the Lower Triassic of Rouxville, South Africa. Original: National Museum, Bloemfontein, South Africa

Genus: *Cleithrolepidina* BERG, 1940.

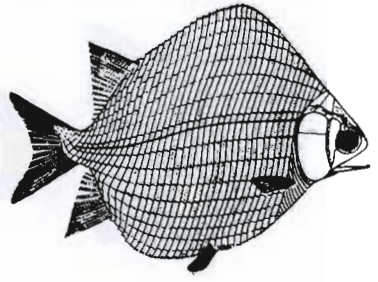
Geological range: Lower Triassic.

Geographical distribution: South Africa.

Features: Small fishes, deep in the belly and with a sharp dorsal mid line. Head deep. Eyes large. Gape rather long. Jaws toothless. Dorsal and anal fins triangular, near the posterior end of the body. Pectoral and pelvic fins small. Scales elongate, each one curved to form a half-cylinder.

Remarks: The toothless jaws suggest a partly herbivorous diet.

Recent relatives: None. Died out in Lower Triassic.



Cleithrolepidina, reconstruction after JUBB & GARDINER.



Cleithrolepis granulatus EGERTON (length c. 10 cm) from the Lower Triassic of Gosford, New South Wales. Original: The Natural History Museum, London, U.K. (P 1862)

Genus: *Cleithrolepis* EGERTON, 1864.

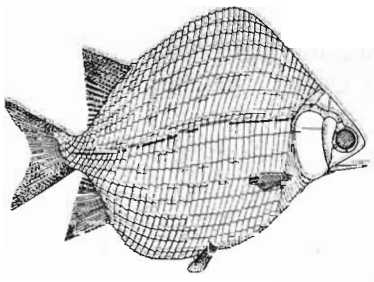
Geological range: Lower to Upper Triassic.

Geographical distribution: Europe, South Africa, Australia, South America.

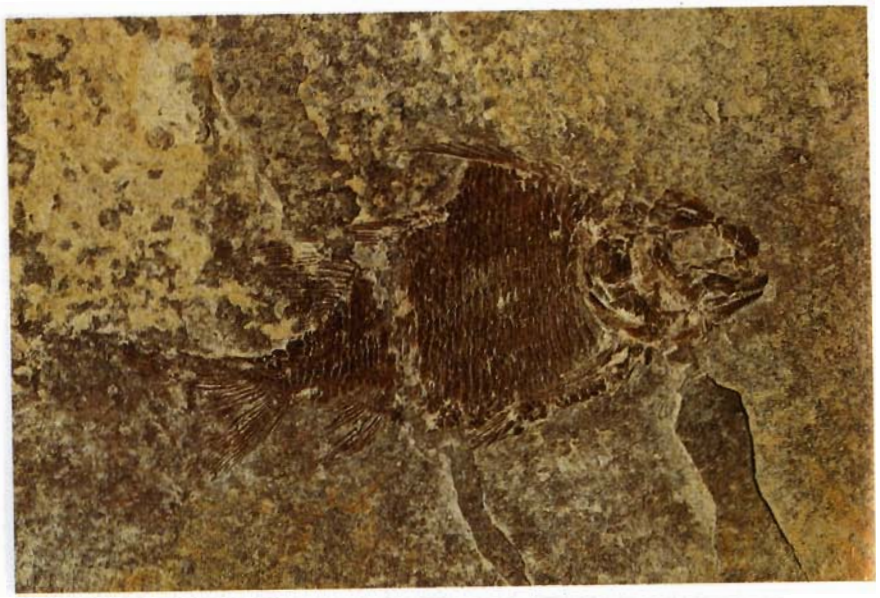
Features: Small deep-bellied fishes with a sharp dorsal mid line. Laterally compressed. Head deep. Snout pointed. Eyes large. Gape rather long. Jaws toothless. Dorsal and anal fin very posterior in position. Pectoral and pelvic fins small. Scales elongate, rectangular, arranged in undulating diagonal rows.

Remarks: Probably partly herbivorous.

Recent relatives: None. Died out in Upper Triassic.



Cleithrolepis, reconstruction after BROUGH.



Dipteronotus olgiatii TINTORI (length c. 7 cm) from the Middle Triassic of Ca'del Frate, Varese, Italy. Original: Museo Civico di Scienze Naturali d'Induno Olona, Varese, Italy.

Genus: *Dipteronotus* EGERTON, 1854.

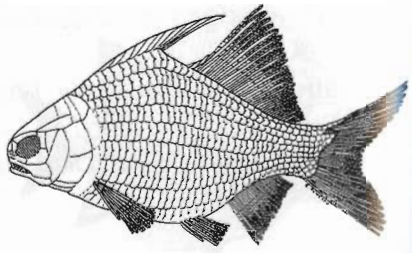
Geological range: Middle Triassic.

Geographical distribution: Europe.

Features: Small fishes of approximately oval outline with sharp dorsal mid line. Head elongate. Snout rounded. Eyes large. Dorsal fin fringe-like. Anal fin with long rays. Pectoral and pelvic fins small. Scales elongate rhombic.

Remarks: Probably still-water fishes, partly herbivorous in diet.

Recent relatives: None. Died out in Upper Triassic.



Dipteronotus, reconstruction after TINTORI.



Aetheodontus besanensis BROUGH (length c. 5 cm) from the Middle Triassic of Monte San Giorgio, Switzerland. Original: Paläontologisches Museum, Zürich, Switzerland.

Genus: *Aetheodontus* BROUGH, 1939.

Geological range: Middle to Upper Triassic.

Geographical distribution: Europe.

Features: Small slender fishes. Head deep. Snout rounded. Eyes large. Dorsal fin in the posterior half of the body. Scales thick, rectangular to rhombic, arranged in diagonal rows.

Remarks: Probably fed on crustaceans and other small animals.

Recent relatives: None. Died out in Upper Triassic.



Peltopleurus kneri WOODWARD (length c. 5 cm) from the Middle Triassic of Carinthia, Austria. Original: The Natural History Museum, London, U.K. (P1099a).

Genus: *Peltopleurus* KNER, 1866.

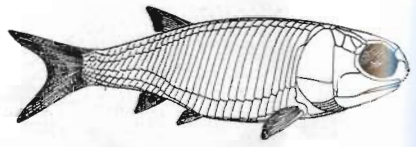
Geological range: Middle to Upper Triassic.

Geographical distribution: Europe, eastern Asia.

Features: Small slender fishes. Head deep. Eyes very large. Dorsal fin in the posterior third of the body, obliquely opposite the small anal fin. Pectoral and pelvic fins also small. Scales very thick, rod-like on the flanks but otherwise rectangular or square.

Remarks: Probably lived on crustaceans and other small animals.

Recent relatives: None. Died out in Upper Triassic.



Peltopleurus, reconstruction after BROUGH.



Placopleurus besanensis BROUGH (length c. 4 cm) from the Middle Triassic of Monte San Giorgio, Switzerland. Original: Paläontologisches Museum, Zürich, Switzerland.

Genus: *Placopleurus* BROUGH, 1939.

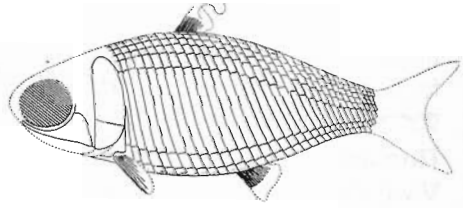
Geological range: Middle to Upper Triassic.

Geographical distribution: Europe.

Features: Small fishes of laterally compressed shape. Head deep. Snout rounded. Eyes very large. Dorsal fin small, situated in the middle of the body. Caudal fin deeply divided. Pectoral and pelvic fins small. Scales very thick, rod-like on the flanks, otherwise square or rectangular.

Remarks: Probably fed on crustaceans and other small animals.

Recent relatives: None. Died out in Upper Triassic.



Placopleurus, reconstruction after BROUGH.



Saurichthys sp. (length c. 35 cm) from the Middle Triassic of Monte San Giorgio, Switzerland. Original: Interfoss, Munich, Germany.

Genus: *Saurichthys* AGASSIZ, 1834.

Synonyms: *Acidorhynchus*, *Belonorhynchus*, *Gymnosaurichthys*, *Ichthyorhynchus*.

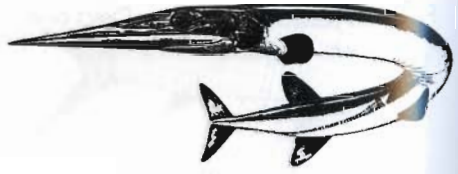
Geological range: Lower to Upper Triassic.

Geographical distribution: Western and eastern Europe, North America, Spitzbergen, Madagascar, Australia, Greenland, South Africa, southern, eastern and central Asia.

Features: Middle-sized fishes with elongate streamlined bodies. Head elongate, ending in a rostrum equally formed from upper and lower jaws which were of the same length. Dorsal fin almost at the posterior end of the body, opposite the fan-shaped anal fin. Pectoral and pelvic fins relatively small. Scales arranged in four longitudinal rows - dorsal, ventral and along each flank.

Remarks: Pike-like predators. Viviparous.

Recent relatives: None. Died out in Middle Triassic.



Saurichthys, after MACMILLAN.



Saurorhynchus brevirostris WOODWARD (length c. 36 cm) from the Lower Jurassic of Holzmaden, Württemberg, Germany. Original: Staatliches Museum für Naturkunde, Stuttgart, Germany.

Genus: *Saurorhynchus* REIS, 1892.

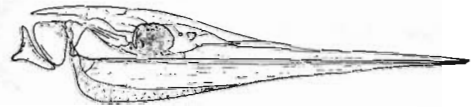
Geological range: Lower Jurassic.

Geographical distribution: Europe.

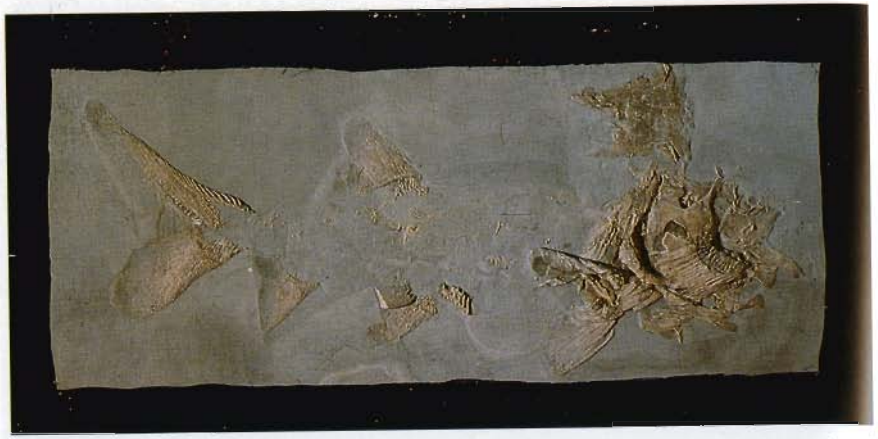
Features: Middle-sized fishes of elongate streamlined shape. Head elongate, ending in a rostrum formed equally from upper and lower jaws. Teeth pointed conical. Caudal fin homocercal. Body almost scaleless.

Remarks: Eel-like predators.

Recent relatives: None. Died out in Lower Jurassic.



Saurorhynchus, reconstruction after GARDINER.



Chondrosteus hindenburgi (HENNIG) (length c. 300 cm) from the Lower Jurassic of Holzmaden, Württemberg, Germany. Original: Museum für Geologie und Paläontologie, Tübingen, Germany.

Genus: *Chondrosteus* EGERTON, 1858.

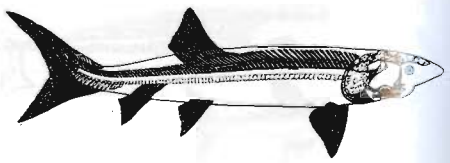
Geological range: Lower Jurassic.

Geographical distribution: Europe.

Features: Very large, rather plump fishes. Head deep. Snout pointed. Mouth ventral. Dorsal fin in the posterior third of the body, obliquely opposite the anal fin. Pectoral fins large. Pelvic fins pointed. Body largely scaleless.

Remarks: Marine.

Recent relatives: Genus and family extinct. Distantly related to the recent family Acipenseridae. Can be seen as forerunners of the true sturgeons.



Chondrosteus, reconstruction after WOODWARD.



Stichopterus popovi YAKOVLEV (length c. 56 cm) from the Lower Cretaceous of Mongolia. Original: Paleontologicheskii Musei Russkoi Akademii Nauk, Moscow, Russia.

Genus: *Stichopterus* YAKOVLEV, 1986.

Geological range: Lower Cretaceous.

Geographical distribution: Central Asia.

Features: Middle-sized fishes of rather laterally compressed shape. Head deep. Snout somewhat elongate. Dorsal fin triangular, obliquely opposite the anal fin. Body scaleless except for the axis of the caudal fin. Caudal fin heterocercal. The lower lobe concave in outline and considerably bigger than the upper, which carries ganoid scales.

Remarks: Predatory fishes.

Recent relatives: Genus and family extinct. Distantly related to recent sturgeons.



Acipenser sturio, a recent sturgeon. Lithograph from BLOCH.

CHONDROSTEI — Chondrosteans

Order: Acipenseriformes
Family: Polyodontidae



Crossopholis magnicaudatus Cope (length c. 39 cm) from the Eocene of Wyoming, U.S.A. Original: Field Museum of Natural History, Chicago, Illinois, U.S.A.

Genus: *Crossopholis* Cope, 1883.

Geological range: Eocene.

Geographical distribution: North America.

Features: Large fishes, laterally compressed. Head shallow, ending in a long rostrum formed from both upper and lower jaws. Dorsal fin relatively small, situated in the posterior third of the body, obliquely opposite the somewhat larger anal fin. Caudal fin heterocercal, lower lobe larger than the upper. Pectoral and pelvic fins triangular.

Remarks: Lived in fresh water.

Recent relatives: Genus extinct. Family still extant. Probably to be seen as forerunners of the paddlefish *Polyodon*.



Polyodon spathula, the recent paddlefish.

"HOLOSTEI" — Holosteans

The term "Holostei" is no longer used in modern systematics because the common features of this transitional group between the Chondrostei and the Teleostei are not enough to make a natural group. The few fishes that belong here are split into the divisions Ginglymodi and Halecostomi and the subdivision Halecomorphi. For clarity's sake I use the word "Holostei" in quotation marks.

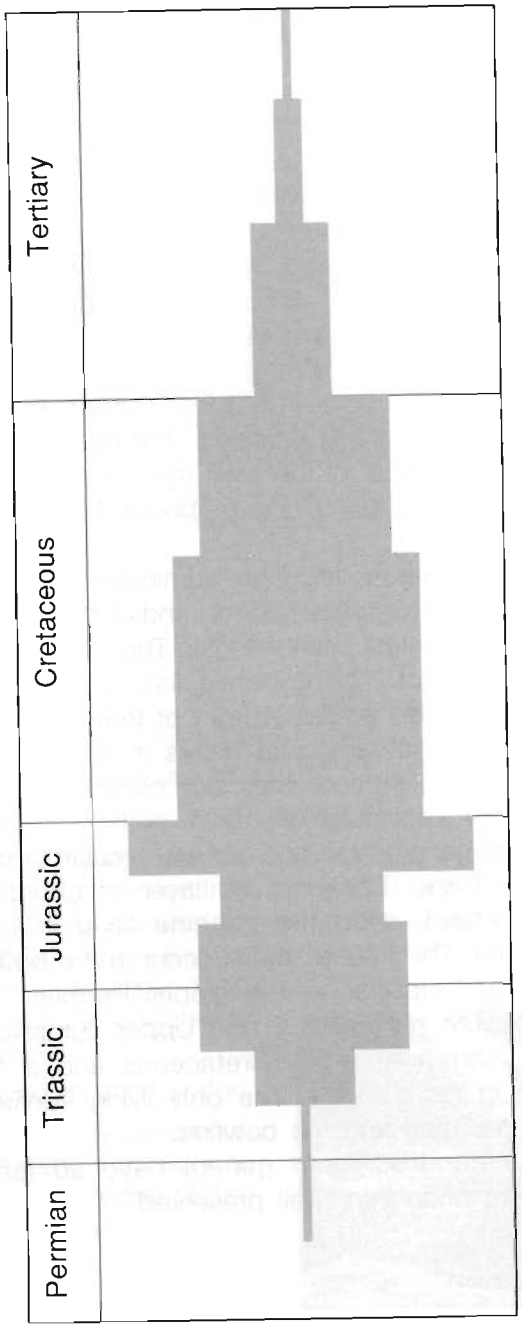
Many skeletal parts represented by cartilage in the chondrosteans are ossified in the holosteans. The rigid contacts of the bones in the head are here lost so that the upper jaw becomes mobile relative to the skull. Teeth are usually present on upper as well as lower jaws. In semionotids and pycnodontids they are hemispherical and form a grinding dentition. The orbits of the eyes are more posterior and higher in the skull than in chondrosteans and generally are protected by a ring of bone. The gape is usually shorter.

There is only one dorsal fin. The hemiheterocercal caudal fin shortens, to a greater or lesser extent, and in the more advanced forms is externally almost symmetrical. The scaly upper lobe is usually greatly reduced. The unpaired fins, as in the chondrosteans, have bony keeled scales in front of them called fulcra. The ossification of the vertebral centra differs in different genera and is usually incomplete. Indeed, they are completely ossified only in the gars (family Lepisosteidae).

The scales are of ganoid type but can be circular or rhombic and sometimes very thick. The cosmine layer of chondrosteans is here lacking. Indeed, even the ganoine layer in many cases tends to reduction. Thin round scales occur in the bowfins (*Amia*).

The first "holostei" appear in the Upper Permian. The group reached its absolute maximum in the Upper Jurassic. Its members were still common in the Cretaceous and a few genera remained even in the Tertiary. The only living survivors among holosteans are the gars and the bowfins.

More than one hundred fossil genera have so far been described. They are often very well preserved.



The approximate distribution of holosteans in geological time, changed after MÜLLER.



Atractosteus strausi (KINKELIN) (length c. 25 cm) from the Eocene of Messel, Germany. Original: Frickhinger Collection, Munich, Germany.

Genus: *Atractosteus* RAFINESQUE, 1820.

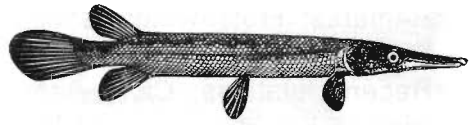
Geological range: Upper Cretaceous to recent.

Geographical distribution: Europe, North America, western Africa.

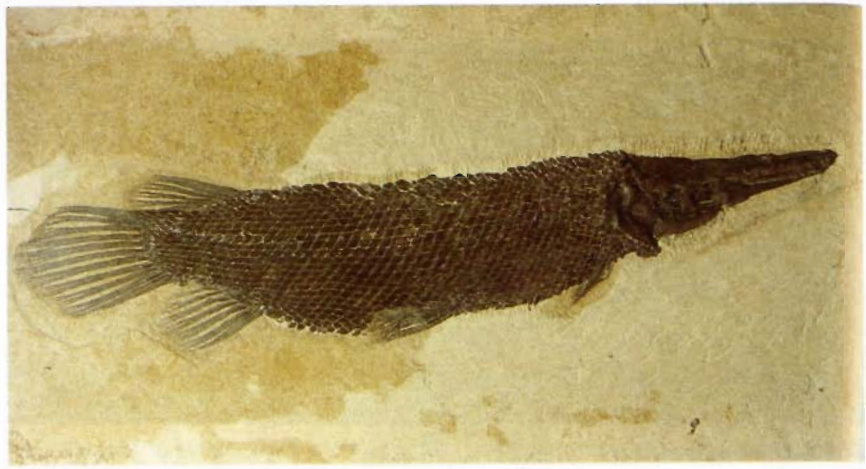
Features: Middle-sized fishes with elongate slender bodies. Head narrow, ending in a rostrum formed from both upper and lower jaws. Teeth pointed. Eyes small. Dorsal fin very posterior in position, opposite the anal fin. Caudal fin not forked, rounded. Pectoral and pelvic fins small. Body covered with massive ganoid scales.

Remarks: Fresh-water fishes like their recent relatives.

Recent relatives: Closely related to the recent gars of the genus *Atractosteus* which occur in North America, Central America and Cuba.



Atractosteus spatula, a recent gar, after Yale University.



Lepisosteus cuneatus (COPE) (length c. 65 cm) from the Eocene of Wyoming, U.S.A. Original: Field Museum of Natural History, Chicago, Illinois, U.S.A.

Genus: *Lepisosteus* de LACÉPÈDE, 1803.

Geological range: Upper Cretaceous to recent.

Geographical distribution: North America, southern Asia.

Features: Middle-sized to large fishes with elongate slender bodies. Head elongate, ending in a rostrum formed of upper and lower jaws which are nearly of equal length. Teeth pointed. Eyes small. Dorsal fin very posterior in position, opposite the large anal fin. Caudal fin not divided, rounded. Pectoral fins small and narrow. Pelvic fins somewhat broader. Body covered with thick ganoid scales.

Remarks: Fresh-water fishes, like their recent relatives.

Recent relatives: Closely related to the recent gars of the genus *Lepisosteus* which occur in North America, Central America and Cuba.



Lepisosteus osseus, the recent longnose gar.



Acentrophorus varians KIRKBY (length c. 7 cm) from the Upper Permian of Durham, England. Original: The Natural History Museum, London, U.K. (P3481c).

Genus: *Acentrophorus* TRAQUAIR, 1877.

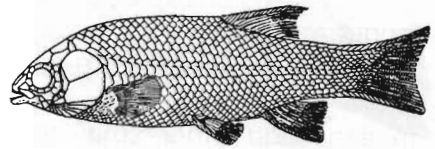
Geological range: Upper Permian to Upper Triassic.

Geographical distribution: Europe, North America.

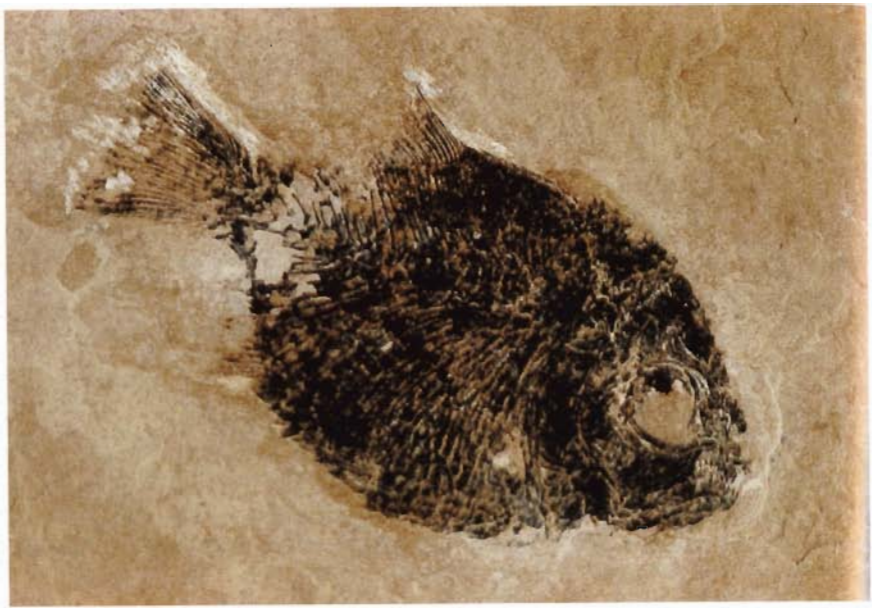
Features: Small fishes with somewhat laterally compressed bodies. Head deep. Snout pointed. Eyes large. Teeth small and pointed. Dorsal fin attached behind the middle of the body, obliquely opposite the anal fin. Pectoral and pelvic fins broad. Body covered with rectangular ganoid scales.

Remarks: Probably herbivorous.

Recent relatives: None. Died out in Upper Triassic.



Acentrophorus, reconstruction after GILL.



Dandya ovalis GORJANOVIC - KRAMBERGER (length c. 5 cm) from the Upper Triassic of Cene, Bergamo, Italy. Original: Museo Civico di Scienze Naturali Caffi, Bergamo, Italy.

Genus: *Dandya* WHITE & MOY-THOMAS, 1940.

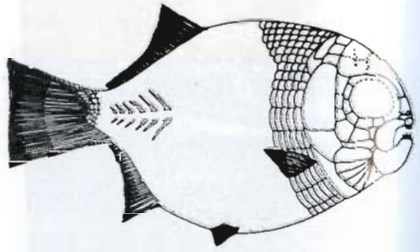
Geological range: Upper Triassic.

Geographical distribution: Europe.

Features: Small fishes with oval bodies. Head deep. Snout blunt. Eyes large. Teeth conical. Dorsal fin in the posterior half of the body, beginning with a point and continuing as a fringe. Anal fin similar in shape, opposite in position. Pectoral fins placed high on the body. Pelvic fins small. Scales thick, becoming longer ventrally.

Remarks: Still-water fishes which probably lived on crustaceans and other small animals.

Recent relatives: None. Died out in Upper Triassic.



Dandya, after TINTORI.



Dapedium punctatum AGASSIZ (length c. 34 cm) from the Lower Jurassic of Holzmaden, Württemberg, Germany. Original: Urweltmuseum Hauff, Holzmaden, Germany.

Genus: *Dapedium* LEACH, 1832.

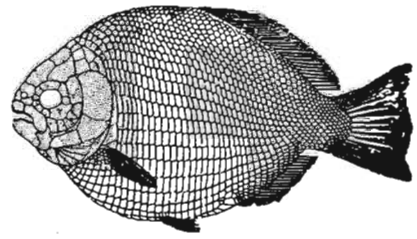
Synonyms: *Aeschmodus*, *Amblyurus*, *Dapedius*, *Omalopleurus*, *Pholidotus*.

Geological range: Upper Triassic to Lower Jurassic.

Geographical distribution: Europe, southern Asia.

Features: Middle-sized fishes of oval outline. Head deep. Snout rounded. Dorsal fin begins approximately in the middle of the body and reaches as a fringe to the base of the caudal fin. Anal fin likewise fringe-like but somewhat shorter. Pectoral and pelvic fins small. Teeth clavate. Thick ganoid scales, on the flanks longer than wide.

Remarks: Still-water herbivores that also fed on small animals.



Dapedium, after WOODWARD.

Recent relatives: None. Died out in Lower Jurassic.



Enigmaichthys attenuatus WADE (length c. 5 cm) from the Middle Triassic of Hornsby, Sydney, Australia. Original: Australian Museum, Sydney, Australia.

Genus: *Enigmaichthys* WADE, 1935.

Geological range: Middle Triassic.

Geographical distribution: Australia.

Features: Small fishes of elongate fusiform shape. Head elongate. Snout pointed. Dorsal fin in posterior third of the body, opposite the anal fin. Caudal fin not forked. Pectoral and pelvic fins small. Body covered in ganoid scales.

Remarks: Probably fed on crustaceans and other small animals.

Recent relatives: None. Died out in Middle Triassic.

"HOLOSTEI" Halecostomi Holosteans
Order: Semionotiformes
Family: Semionotidae



Eosemionotus sp. (length c. 5 cm) from the Middle Triassic of Monte San Gorgio, Switzerland. Original: Paläontologisches Museum, Zürich, Switzerland.

Genus: *Eosemionotus* STOLLEY, 1920.

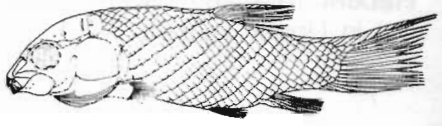
Geological range: Lower to Middle Triassic.

Geographical distribution: Europe.

Features: Small fishes with somewhat laterally compressed bodies. Head deep. Snout rather pointed. Dorsal fin just behind the middle of the body. Posterior margin of caudal fin slightly concave. Anal fin, pectoral fins and pelvic fins relatively small. Body covered with large, more or less rhombic, scales.

Remarks: Probably gregarious.

Recent relatives: None. Died out in Middle Triassic.



Eosemionotus, reconstruction after SCHULTZE.



Hemicalypterus weiri SCHAEFFER (length c. 9 cm) from the Upper Triassic of San Juan County, Utah, U.S.A. Original: Museum of Natural History, Lawrence, Kansas, U.S.A.

Genus: *Hemicalypterus* SCHAEFFER, 1967.

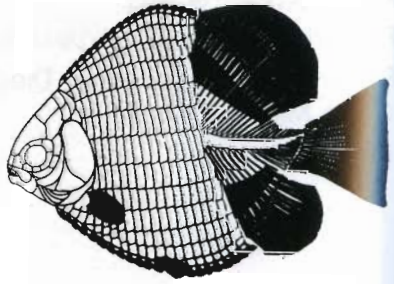
Geological range: Upper Triassic.

Geographical distribution: North America.

Features: Small fishes of oval outline. Head deep. Snout blunt. Eyes relatively large. Dorsal fin tall, fringe-like, opposite the similarly shaped anal fin. Caudal fin not forked. Body covered with elongate to rod-shaped Scales.

Remarks: Still-water fishes which probably fed on crustaceans and other small animals.

Recent relatives: None. Died out in Upper Triassic.



Hemicalypterus, reconstruction after SCHAEFFER.



Heterostrophus latus WAGNER (length c. 40 cm) from the Upper Jurassic of Solnhofen (Blumenberg), Bavaria, Germany. Original: Jura-Museum, Eichstätt, Germany.

Genus: *Heterostrophus* WAGNER, 1859.

Geological range: Upper Jurassic.

Geographical distribution: Europe.

Features: Middle-sized fishes of oval outline. Head deep. Snout rather pointed. Eyes relatively large. Dorsal fin in the posterior half of the body, with a point anteriorly but continuing posteriorly as a low fringe, opposite the anal fin which is also fringe-like. Pectoral and pelvic fins small. Scales square to rectangular, arranged in diagonal rows.

Remarks: This very rare fish is sometimes cited under the incorrect name of *Tetragonolepis*. Wagner's holotype has disappeared.

Recent relatives: None. Died out in Upper Jurassic.



Lepidotes elvensis (de BLAINVILLE) (length c. 47 cm) from the Lower Jurassic of Holzmaden, Württemberg, Germany. Original: Interfoss, Munich, Germany.

Genus: *Lepidotes* AGASSIZ, 1832.

Synonyms: *Lepidotus*, *Plesiodus*, *Prolepidotus*, *Scrobodus*, *Sphaerodus*.

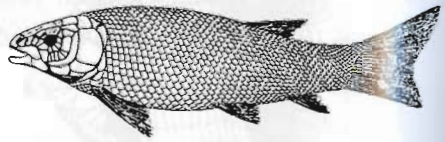
Geological range: Upper Triassic to Lower Cretaceous.

Geographical distribution: Europe, Africa, North America, Asia, South America, Madagascar.

Features: Middle-sized to large fishes with laterally compressed bodies. Head elongate. Snout pointed. Eyes small. Teeth peg-shaped with rounded ends. Dorsal fin small and pointed, in the posterior half of the body. Anal fin more posterior. Posterior margin of caudal fin only moderately concave. Pelvic fins small. Pectoral fins somewhat larger. Scales very thick, rectangular, arranged in diagonal rows.

Remarks: Lethargic swimmers with durophagous diet.

Recent relatives: None. Died out in Lower Cretaceous.



Lepidotes, reconstruction after JAEKEL.



Paracentrophorus madagascariensis PIVETEAU (length c. 8 cm) from the Lower Triassic of Madagascar. Original: The Natural History Museum, London, U.K.

Genus: *Paracentrophorus* PIVETEAU, 1941.

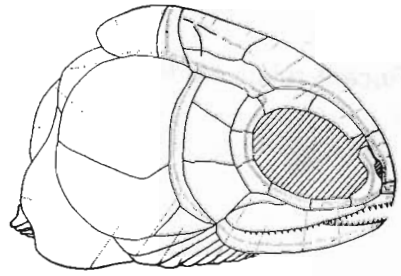
Geological range: Lower Triassic.

Geographical distribution: Madagascar.

Features: Small fishes with laterally compressed bodies. Head deep. Snout rounded. Dorsal fin in the posterior third of the body, opposite the anal fin. Pectoral and pelvic fins small. Scales large, rectangular, arranged in diagonal rows.

Remarks: Probably of durophagous diet.

Recent relatives: None. Died out in Lower Triassic.



Paracentrophorus, reconstruction after GARDINER.



Paralepidotus ornatus (AGASSIZ) (length c. 53 cm) from the Upper Triassic of Zogno, Bergamo, Italy. Original: Museo Brembano di Scienze Naturali, San Pellegrino, Bergamo, Italy.

Genus: *Paralepidotus* STOLLEY, 1920.

Geological range: Upper Permian to Upper Triassic.

Geographical distribution: Europe.

Features: Middle-sized to large fishes with somewhat corpulent bodies. Head elongate. Snout pointed. Eyes large. Dorsal fin relatively large, with a broad base, situated in the posterior half of the body. Anal fin opposite, considerably smaller. Caudal fin moderately concave behind. Scales thick and rectangular, arranged in diagonal rows.

Remarks: Still-water fishes with durophagous diet.

Recent relatives: None. Died out in Upper Triassic.



Pericentrophorus minimus JÖRG (length c. 3 cm) from the Lower Triassic of Durlach, Baden, Germany. Original: Staatliches Museum für Naturkunde, Karlsruhe, Germany.

Genus: *Pericentrophorus* JÖRG, 1969.

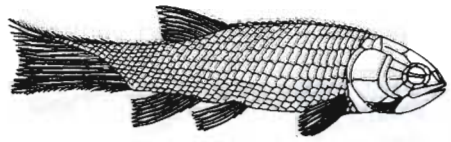
Geological range: Lower Triassic.

Geographical distribution: Europe.

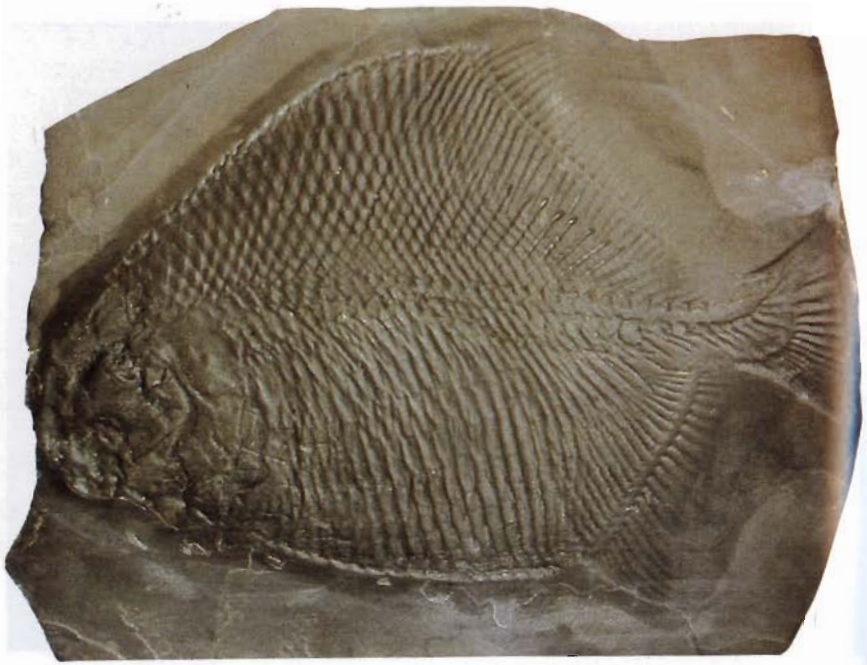
Features: Very small slender fishes. Head elongate. Snout pointed. Teeth small. Dorsal fin pointed, triangular, broad-based, situated in the posterior half of the body, obliquely opposite the broadly elongate anal fin. Pectoral and pelvic fins relatively large. Scales quadrangular, becoming longer on the flanks.

Remarks: Probably fed on crustaceans and other small animals.

Recent relatives: None. Died out in Lower Triassic.



Pericentrophorus, reconstruction after JÖRG.



Sargodon tomicus PLIENINGER (length c. 33 cm) from the Upper Triassic of Berbenno, Bergamo, Italy. Original: Museo Civico di Scienze Naturali Caffi, Bergamo, Italy.

Genus: *Sargodon* PLIENINGER, 1847.

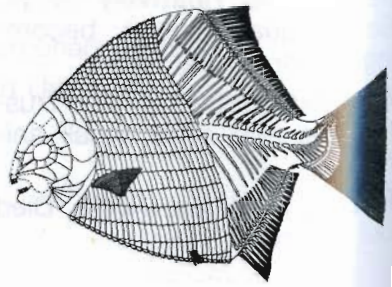
Geological range: Upper Triassic.

Geographical distribution: Europe.

Features: Middle-sized fishes, broadly rhombic in outline. Head deep. Snout rounded. Teeth rod-like with rounded ends. Dorsal fin begins with a point at the place where the dorsal mid line turns downwards and continues as a fringe. Anal fin opposite and similar but shorter. Pectoral fins very high in the body. Pelvic fins very small. Scales square in the dorsal half of the body, becoming rod-shaped ventrally.

Remarks: Still-water fishes, probably with durophagous diet.

Recent relatives: None. Died out in Upper Triassic.



Sargodon, after TINTORI.



Semionotus bergeri AGASSIZ (length c. 17 cm) from the Upper Triassic of Weißenbrunn, Coburg, Bavaria, Germany. Original: Bayerische Staatssammlung für Paläontologie, Munich, Germany.

Genus: *Semionotus* AGASSIZ, 1832.

Synonyms: *Archaeosemionotus*, *Ischypterus*.

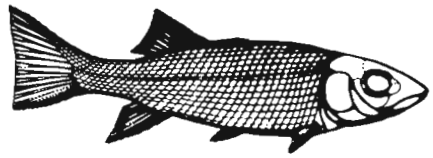
Geological range: Lower to Upper Triassic.

Geographical distribution: Europe, South Africa, Australia, North America, South America.

Features: Middle-sized slender fishes. Head elongate. Snout pointed. Dorsal fin relatively large, beginning with a row of keeled scales. Anal fin somewhat more posterior. Posterior margin of caudal fin straight to slightly concave. Pectoral and pelvic fins elongate. Teeth rod-like with rounded ends. Scales rhombic.

Remarks: Probably durophagous.

Recent relatives: None. Died out in Upper Triassic.



Semionotus, reconstruction after JUBB & GARDINER.

Order: Semionotiformes
Family: Semionotidae



Tetragonolepis semicinctus (BRONN) (length c. 9 cm) from the Lower Jurassic of Sulzkirchen, Bavaria, Germany. Original: Tischlinger Collection, Stammham, Germany. Photograph: Tischlinger.

Genus: *Tetragonolepis* BRONN, 1830.

Synonyms: *Homoeolepis*, *Pleurolepis*.

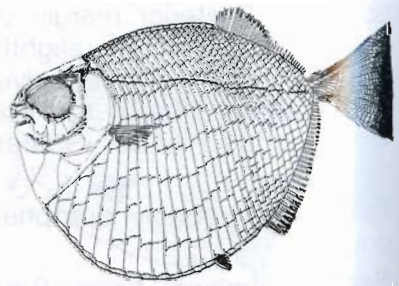
Geological range: Lower Jurassic.

Geographical distribution: Europe, Asia.

Features: Small fishes with rounded oval outline and deep bellies. Laterally flattened. Head deep. Snout rounded. Dorsal fin beginning approximately in the middle of the body and continuing rearwards as a fringe. Anal fin similar. Posterior margin of caudal fin straight. Pectoral fins set high on the body. Scales rod-like, becoming longer ventrally.

Remarks: Still-water herbivores that also fed on small animals.

Recent relatives: None. Died out in Lower Jurassic.



Tetragonolepis, after THIES.

Order: Pycnodontiformes
Family: Brembodontidae



Brembodus ridens TINTORI (length c. 14 cm) from the Upper Triassic of Zogno, Bergamo, Italy. Original: Museo Civico di Scienze Naturali Caffi, Bergamo, Italy.

Genus: *Brembodus* TINTORI, 1980.

Geological range: Upper Triassic.

Geographical distribution: Europe.

Features: Small fishes of inflated-oval outline and laterally compressed bodies. Snout blunt. Eyes small. Gape directed downwards. Small rounded teeth. Dorsal mid line raised into a point in the anterior part of the body. Dorsal fin fringe-like, extending over the whole posterior half of the body. Anal fin considerably smaller. Caudal fin not forked.

Remarks: Probably durophagous.

Recent relatives: None. Died out in Upper Triassic.

Order: Pycnodontiformes
Family: Brembodontidae



Gibbodon cenensis Tintori (length c. 6 cm) from the Upper Triassic of Cene, Bergamo, Italy. Original: Museo Civico di Scienze Naturali Caffi, Bergamo, Italy.

Genus: *Gibbodon* Tintori, 1980.

Geological range: Upper Triassic.

Geographical distribution: Europe.

Features: Small fishes of inflated-oval outline, laterally compressed. Head deep. Eyes relatively large. Gape directed downwards. Teeth rod-like with rounded ends. Anterior part of the dorsal mid line pointed. Dorsal fin low, with a very broad base, opposite the smaller anal fin. Caudal fin not subdivided. Scales massive.

Remarks: Probably durophagous.

Recent relatives: None. Died out in Upper Triassic.

Order: Pycnodontiformes
Family: Pycnodontidae



Arduafrons prominoris Böss (length c. 29 cm) from the Upper Jurassic of Solnhofen, Bavaria, Germany. Original: Bürgermeister Müller Museum, Solnhofen, Germany.

Genus: *Arduafrons* Böss.

Geological range: Upper Jurassic.

Geographical distribution: Europe.

Features: Middle-sized fishes with circular outline, laterally compressed. Head deep and narrow, with a relatively steep "forehead". Snout pointed. Gape short. Powerful rounded teeth. Anterior part of dorsal mid line pointed. Dorsal fin low, broad-based, very posterior, opposite the smaller anal fin which is drawn into a point at its anterior end. Caudal fin fan-shaped, not forked.

Remarks: Probably durophagous.

Recent relatives: None. Died out in Upper Jurassic.



Coccodus insignis PICTET (length c. 12 cm) from the Upper Cretaceous of Lebanon. Original: Staatliches Museum für Naturkunde, Karlsruhe, Germany.

Genus: *Coccodus* PICTET, 1851.

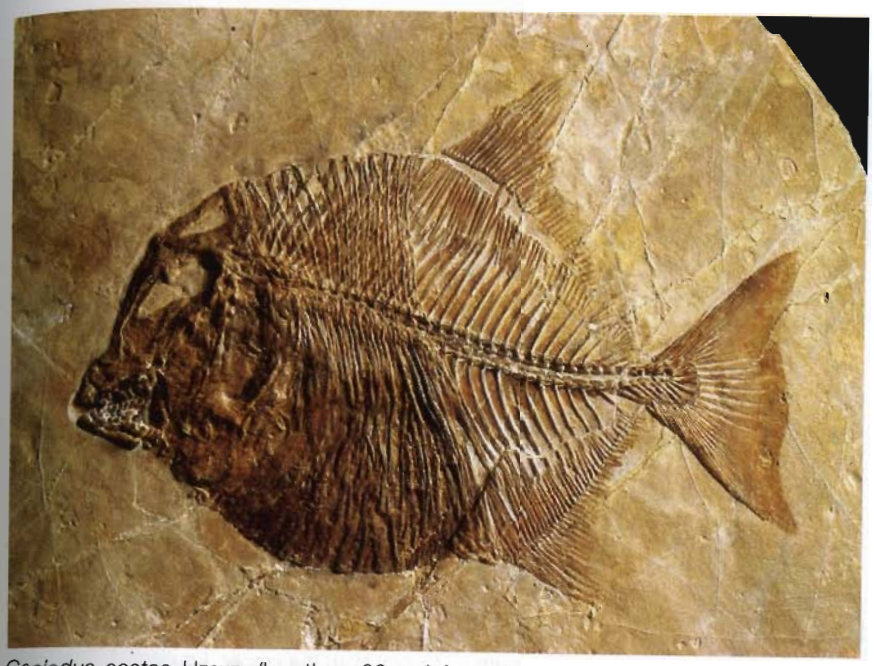
Geological range: Upper Cretaceous.

Geographical distribution: Middle East.

Features: Small slender fishes with elongate oval bodies. Head elongate. Gape long. Mouth with strong hemispherical but laterally flattened teeth. There is a powerful dorsal spine and on left and right a thorn-shaped spike divided distally into two points.

Remarks: Durophagous.

Recent relatives: None. Died out in Upper Cretaceous.



Coelodus costae HECKEL (length c. 36 cm) from the Lower Cretaceous of Pietraroia, Italy. Original: Interfoss, Munich.

Genus: *Coelodus* HECKEL, 1836.

Synonyms: *Anomiophthalmus*, *Cosmodus*, *Glossodus*.

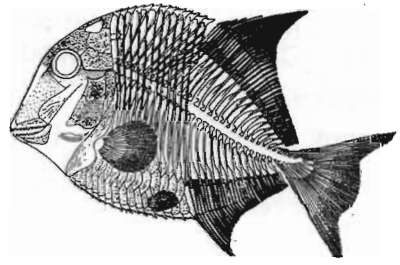
Geological range: Upper Jurassic to Eocene.

Geographical distribution: Europe, North America, Madagascar, Asia.

Features: Middle-sized fishes with oval outline and laterally flattened bodies. Head deep. Snout pointed. Gape short. Mouth with rounded teeth. Dorsal fin in the posterior half of the body, broad-based and rising to a point near the anterior end. Anal fin opposite, similar in shape but much smaller. Caudal fin fan-shaped, with scalloped posterior margin.

Remarks: Durophagous.

Recent relatives: None. Died out in Eocene.



Coelodus, reconstruction after WOODWARD.



Eomesodon gibbosus (WAGNER) (length c. 42 cm) from the Upper Jurassic of Solnhofen (Birkhof), Bavaria, Germany. Original: Jura-Museum, Eichstätt, Germany.

Genus: *Eomesodon* WOODWARD, 1918.

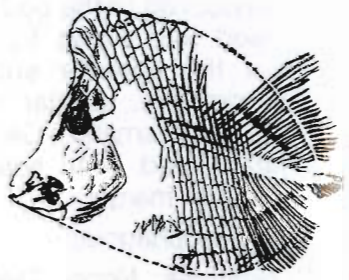
Geological range: Upper Triassic to Upper Jurassic.

Geographical distribution: Europe.

Features: Middle-sized fishes with oval outline, laterally compressed. Head deep. Gape directed downwards. Mouth with strong hemispherical teeth. "Forehead" steep. Dorsal mid line pointed in the anterior part. Dorsal fin in the posterior part of the dorsal mid line, broad-based and almost semicircular. Anal fin opposite, considerably smaller. Caudal fin not forked.

Remarks: Durophagous.

Recent relatives: None. Died out in Upper Jurassic.



Eomesodon, reconstruction after WOODWARD.



Gyrodus hexagonus de BLAINVILLE (length c. 22 cm) from the Upper Jurassic of Solnhofen (Eichstätt), Bavaria, Germany. Original: Krauss Collection, Weißenburg, Germany.

Genus: *Gyrodus* AGASSIZ, 1833.

Synonym: *Strematodus*.

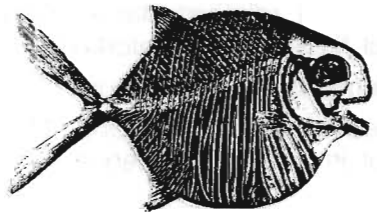
Geological range: Middle Jurassic to Upper Cretaceous.

Geographical distribution: Europe, Africa, Cuba.

Features: Body oval or almost circular in outline. Snout vertical. Rounded oval teeth with an obvious margin. In juvenile specimens the teeth pointed in the middle. Caudal fin large relative to the body, deeply forked with relatively narrow lobes. Dorsal fin narrow, almost opposite smaller anal fin. Maximum body length up to two metres.

Remarks: Fed on hard-shelled prey, possibly also on corals.

Recent relatives: None. Died out at end of Cretaceous.



Gyrodus, reconstruction after ZITTEL.



Gyronchus macropterus (WAGNER) (length c. 10 cm) from the Upper Jurassic of Solnhofen (Eichstätt), Bavaria, Germany. Original: Interfoss, Munich, Germany.

Genus: *Gyronchus* AGASSIZ, 1839.

Synonyms: *Mesodon*, *Macromesodon*, *Scaphozus*, *Typodus*.

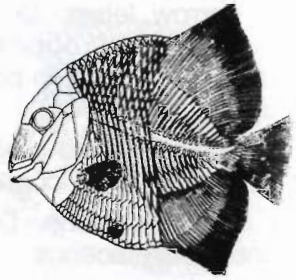
Geological range: Middle Jurassic to Lower Cretaceous.

Geographical distribution: Europe.

Features: Small fishes with circular outline, laterally compressed. Head deep. Snout pointed. Eyes small. Gape directed downwards. Dorsal fin in the posterior half of the body, broad-based, with a point anteriorly. Anal fin opposite, of similar shape and likewise relatively large. Caudal fin short and unforked.

Remarks: Durophagous.

Recent relatives: None. Died out in Lower Cretaceous.



Gyronchys, reconstruction after WOODWARD.



Ichthyoceros spinosus GAYET (length c. 7 cm) from the Upper Cretaceous of the Lebanon. Original: Staatliches Museum für Naturkunde, Karlsruhe, Germany.

Genus: *Ichthyoceros* GAYET, 1984.

Geological range: Upper Cretaceous.

Geographical distribution: Middle East.

Features: Small fishes resembling coffer fishes in shape. Head deep, with a long and pointed snout. Teeth rod-like. Eyes large. Characteristic broad-based spine at the posterior end of the head. Dorsal fin fringe-like, situated in the posterior half of the body. Caudal fin with a stem-like base, unforked and rounded.

Remarks: Durophagous.

Recent relatives: None. Died out in Upper Cretaceous.

Mesturus, reconstruction after LEHMAN.



Mesturus verrocosus WAGNER (length c. 28 cm) from the Upper Jurassic of Solnhofen (Eichstätt), Bavaria, Germany. Original: Krauss Collection, Weißenburg.

Genus: *Mesturus* WAGNER, 1859.

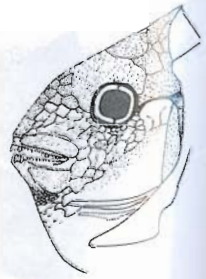
Geological range: Upper Jurassic.

Geographical distribution: Europe.

Features: Middle-sized fishes with oval outline, laterally compressed. Head deep. Snout pointed. Eyes large. Gape long with rounded teeth. Cheeks covered with a mosaic of bony plates. Dorsal fin low, broad-based. Anal fin opposite and similarly shaped. Caudal fin fan-shaped, not forked, with a concave posterior margin.

Remarks: Probably durophagous.

Recent relatives: None. Died out in Upper Jurassic.



Mesturus, reconstruction after LEHMANN



Neoproseinets penalvai (SILVA SANTOS), length c. 37 cm, from the Lower Cretaceous of Ceará, Brazil. Original: Frickhinger Collection, Munich, Germany.

Genus: *Neoproscinetes* FIGUEIREDO & SILVA SANTOS, 1987

Synonym: *Microdon, Polysephus*.

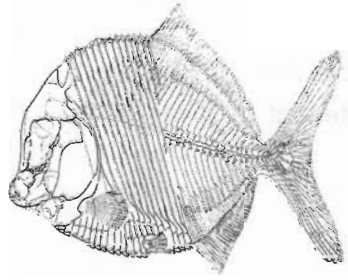
Geological range: Lower Cretaceous.

Geographical distribution: South America.

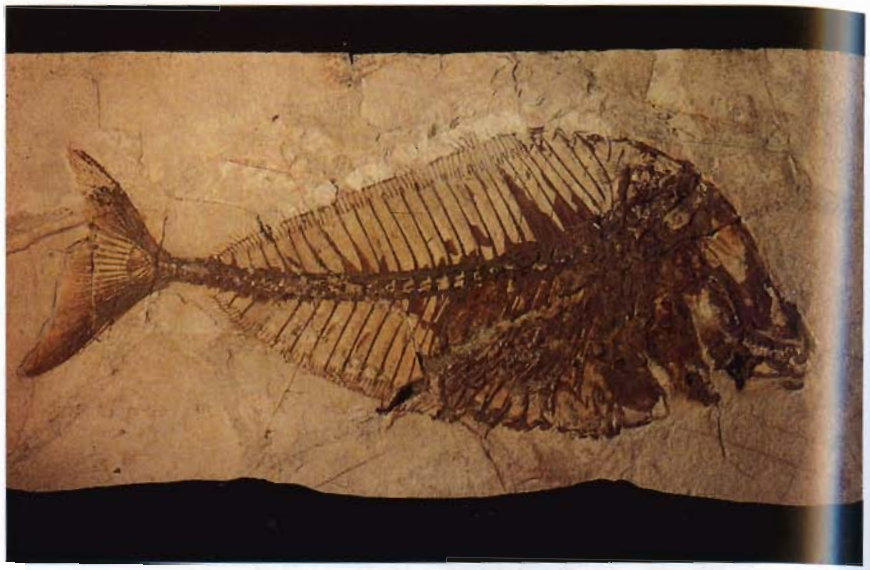
Features: Middle-sized fishes of disc-shaped outline, laterally compressed. Head deep. Snout pointed and directed slightly downwards. Eyes large. Jaws with strong hemispherical teeth. Dorsal fin probably pointed, situated in the posterior third of the body, opposite the anal fin. Caudal fin very large, deeply forked, with narrow lobes.

Remarks: Fishes of durophagous diet.

Recent relatives: None. Died out in Lower Cretaceous.



Neoproscinetes penalvai, after MAISEY



Nursallia veronae BLOT (length c. 31 cm) from the Middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Nursallia* BLOT, 1987.

Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Middle-sized fishes with elongate oval outline, laterally compressed. Head deep. Snout pointed. Eyes large. Gape rather long. Upper and lower jaws with a pavement of spherical teeth. Dorsal fin behind the highest point of the body. Caudal fin stalked, broadly expanded with pointed ends, the posterior margin concave but scalloped.

Remarks: Durophagous. Possibly bit pieces off corals. Possibly *Nursallia* is a synonym for *Pycnodus*.

Recent relatives: None. Died out in Eocene.



Palaeobalistum goedeli HECKEL (length c. 20 cm) from the Upper Cretaceous of Lebanon. Original: Frickhinger Collection, Munich, Germany.

Genus: *Palaeobalistum* de BLAINVILLE, 1818.

Synonyms: *Palaeobalistes*.

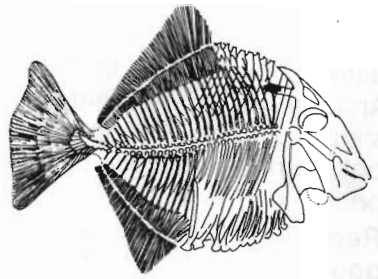
Geological range: Upper Cretaceous to Eocene.

Geographical distribution: Middle East, South America, Europe, Africa.

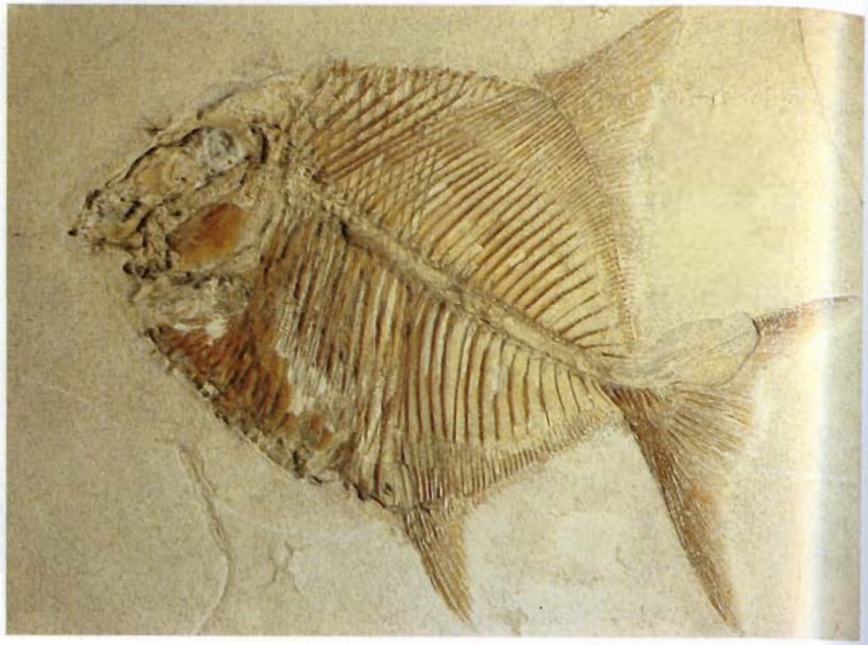
Features: Middle-sized fishes with rounded oval outline, laterally compressed. Head deep. Gape directed downwards. Eyes small. Dorsal fin in the posterior half of the body, begins with a narrow point and passes into a low fringe. Anal fin opposite and similar in shape. Tail fin stalked, narrowly fan-shaped, with broadly scalloped posterior margin.

Remarks: Durophagous.

Recent relatives: None. Died out in Eocene.



Palaeobalistum, reconstruction after HECKEL.



Proscinetes elegans AGASSIZ (length c. 24 cm) from the Upper Jurassic of Solnhofen, Bavaria, Germany. Original: Bayerische Staatssammlung für Paläontologie, Munich, Germany.

Genus: *Proscinetes* GISTL, 1848.

Synonyms: *Microdon*, *Polysephis*.

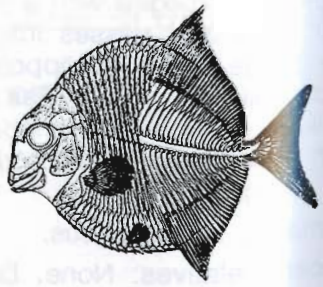
Geological range: Middle Jurassic to Lower Cretaceous.

Geographical distribution: Europe, Central America, South America, North America.

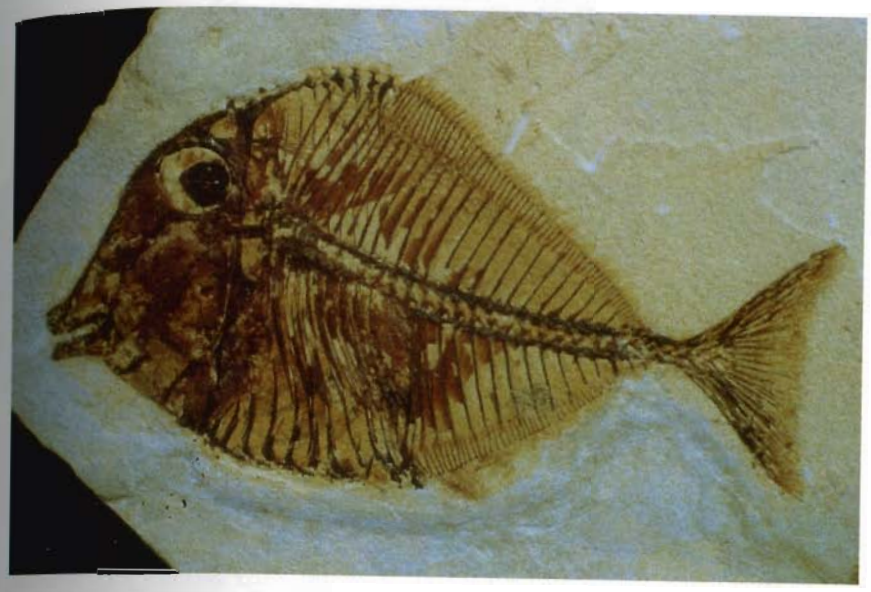
Features: Middle-sized fishes with circular outline, laterally compressed. Head deep. Gape directed downwards. Strong rounded teeth. Dorsal fin in the posterior half of the body, broad-based, beginning with a point but becoming lower posteriorly. Anal fin opposite, similar in shape. Caudal fin not forked but with a strongly concave posterior margin.

Remarks: Probably durophagous.

Recent relatives: None. Died out in Lower Cretaceous.



Proscinetes, reconstruction after WOODWARD.



Pycnodus platessus (de BLAINVILLE) (length c. 11 cm) from the Middle Eocene of Bolca, Italy. Original: Interfoss, Munich, Germany.

Genus: *Pycnodus* AGASSIZ, 1833.

Synonyms: *Periodus*, *Pychnodus*.

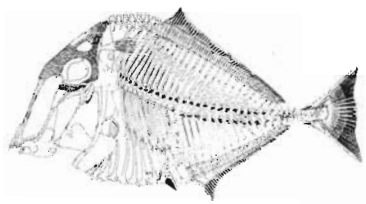
Geological range: Middle Jurassic to Eocene.

Geographical distribution: Europe, West Indies, Australia, North America, Africa, Asia.

Features: Small to middle-sized fishes with oval outline, laterally compressed. Head deep, with gape directed downwards. Rounded teeth. Eyes large. The dorsal mid line carries a small hump anteriorly. Behind this is the dorsal fin which has a point anteriorly but passes behind into a low fringe. Anal fin opposite and similarly shaped. Caudal fin stalked, with a concave posterior margin.

Remarks: Durophagous.

Recent relatives: None. Died out in Eocene.



Pycnodus, reconstruction after BLOT.

Order: Pycnodontiformes
Family: Pycnodontidae



Stemmatodus rhombus (AGASSIZ) (length c. 6 cm) from the Lower Cretaceous of Castellamare, Italy. Original: Frickhinger Collection, Munich, Germany.

Genus: *Stemmatodus* HECKEL, 1854.

Geological range: Upper Jurassic to Lower Cretaceous.

Geographical distribution: Europe.

Features: Small fishes with rounded oval outline, laterally compressed. Head deep. Snout pointed. Eyes large. Gape directed slightly downwards. Teeth small, rounded. Dorsal fin beginning behind the middle of the body, low, fringe-like. Anal fin opposite, similarly shaped. Caudal fin relatively small, deeply forked.

Remarks: Durophagous.

Recent relatives: None. Died out in Lower Cretaceous.

Order: Macrosemiiformes
Family: Macrosemiidae



Aphanepygus dorsalis DAVIS (length c. 7 cm) from the Upper Cretaceous of the Lebanon. Original: The Natural History Museum, London, U.K.

Genus: *Aphanepygus* BASSANI, 1879.

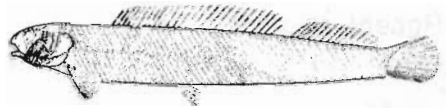
Geological range: Upper Cretaceous.

Geographical distribution: Middle East.

Features: Small fishes with elongate slender bodies. Head shallow. Gape short. Mouth terminal. Dorsal fin extends as a long low fringe along almost all of the back. Caudal fin not forked. Scales arranged in diagonal rows.

Remarks: *Aphanepygus* is often assigned to the genus *Petalopteryx*.

Recent relatives: None. Died out in Upper Cretaceous.



Aphanepygus, reconstruction after BARTRAM.



Dischicholepis dumortieri THIOLLIERE (length c. 15 cm) from the Upper Jurassic of Cerin, France. Original: Musée Guimet d'Histoire Naturelle, Lyon, France.

Genus: *Dischicholepis* THIOLLIERE, 1873.

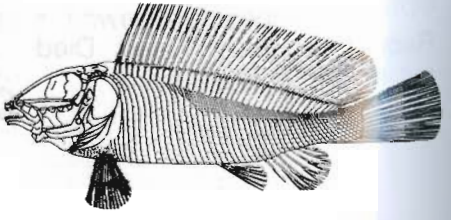
Geological range: Upper Jurassic.

Geographical distribution: Europe.

Features: Small fishes with slender bodies. Head long and shallow. Snout pointed. Mouth terminal. Dorsal fin stretches like a sail along the whole of the back. Anal fin rounded. Caudal fin not forked. Pectoral fins rounded. Pelvic fins small.

Remarks: The genus *Dischicholepis* is considered by some authors as a synonym of *Macrosemius*.

Recent relatives: None. Died out in Upper Jurassic.



Dischicholepis, reconstruction after BARTRAM.



Histionotus oberndorferi WAGNER (length c. 13 cm) from the Upper Jurassic of Solnhofen (Eichstätt), Bavaria, Germany. Original: Museum Berger, Harthof bei Eichstätt, Germany.

Genus: *Histionotus* EGERTON, 1854.

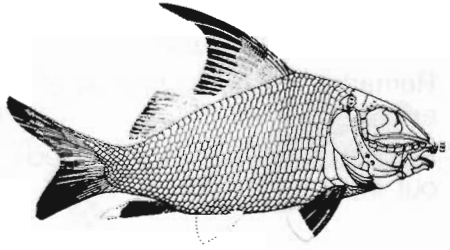
Geological range: Upper Jurassic to Lower Cretaceous.

Geographical distribution: Europe.

Features: Small fishes with somewhat laterally compressed bodies. Head deep. Mouth terminal. Two dorsal fins, the first sail-like, high and pointed, the second starting immediately behind the first, low triangular. Anal, pectoral and pelvic fins small. Caudal fin forked. Scales elongate rectangular to rhombic.

Remarks: Probably reef dwellers.

Recent relatives: None. Died out in Lower Cretaceous.



Histionotus, reconstruction after BARTRAM.



Legnonotus krambergeri BARTRAM (length c. 9 cm) from the Upper Triassic of Cene, Bergamo, Italy. Original: Museo Civico di Scienze Naturali Caffi, Bergamo, Italy.

Genus: *Legnonotus* EGERTON, 1854.

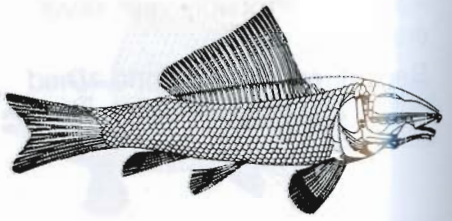
Geological range: Upper Triassic.

Geographical distribution: Europe.

Features: Small slender fishes. Head elongate and shallow. Mouth terminal. Dorsal fin broad-based, approximately in the middle of the body, anteriorly tall and sail-like but decreasing in height posteriorly. Anal and pelvic fins small. Caudal fin small and moderately forked. Pectoral fins somewhat broader than the pelvic fins. Scales small and elongate rectangular.

Remarks: Probably reef dwellers.

Recent relatives: None. Died out in Upper Triassic.



Legnonotus, reconstruction after BARTRAM.



Macrosemius rostratus AGASSIZ (length c. 12 cm) from the Upper Jurassic of Solnhofen (Eichstätt), Bavaria, Germany. Original: Krauss Collection, Weißenburg, Germany.

Genus: *Macrosemius* AGASSIZ, 1844.

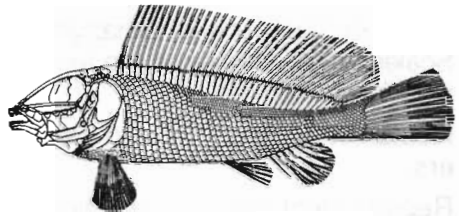
Geological range: Upper Jurassic.

Geographical distribution: Europe, western Africa.

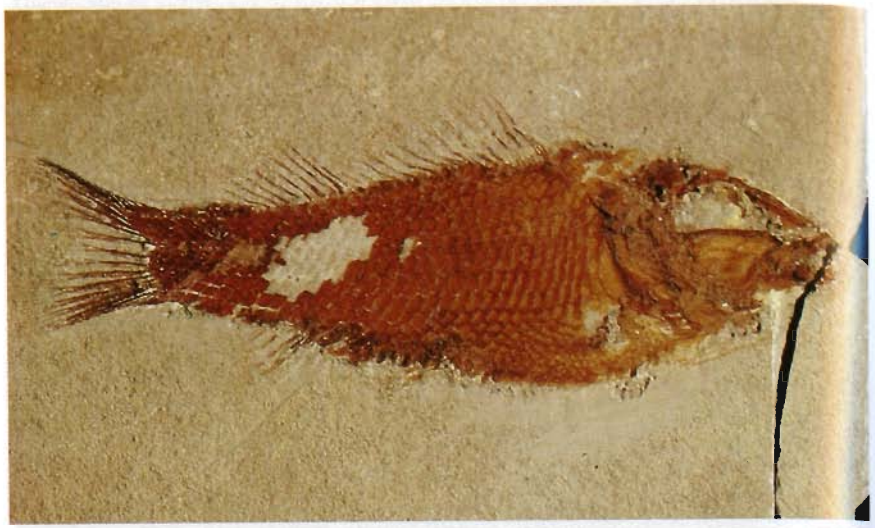
Features: Small to middle-sized fishes with elongate bodies. Head relatively large. Mouth small and terminal. Dorsal fin very broad-based, extending almost the whole length of the back. Caudal fin not forked, narrow and rounded. Anal fin rounded. Pectoral fins fan-like. Pelvic fins small. Scales small.

Remarks: Probably reef dwellers.

Recent relatives: None. Died out in Upper Jurassic.



Macrosemius, reconstruction after BARTRAM.



Notagogus denticulatus AGASSIZ (length c. 9 cm) from the Upper Jurassic of Solnhofen (Kelheim), Bavaria, Germany. Original: Bayerische Staatssammlung für Paläontologie, Munich, Germany.

Genus: *Notagogus* AGASSIZ, 1835.

Synonyms: *Blenniomogius*, *Callignathus*.

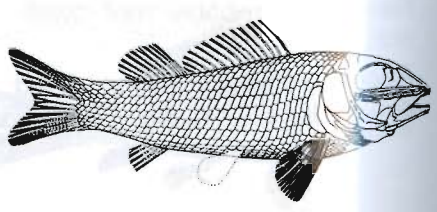
Geological range: Upper Jurassic to Lower Cretaceous.

Geographical distribution: Europe.

Features: Small fishes with elongate bodies. Head relatively large. Snout pointed. Gape not very long. Two dorsal fins, the first tall anteriorly and decreasing in height posteriorly, the second small and approximately quadrilateral. Caudal fin moderately forked. Anal fin and pelvic fins small. Pectoral fins fan-shaped. Scales small, serrate at the longitudinal margins.

Remarks: Probably reef dwellers.

Recent relatives: None. Died out in Lower Cretaceous.



Notagogus, reconstruction after BARTRAM.

"HOLOSTEI" Halecostomi Holosteans
Order: Macrosemiiformes
Family: Macrosemiidae



Petalopteryxs syriacus PICTET (length c. 24 cm) from the Upper Cretaceous of the Lebanon. Original: Naturmuseum Senckenberg, Frankfurt-am-Main, Germany.

Genus: *Petalopteryx* PICTET, 1851.

Geological range: Lower to Upper Cretaceous.

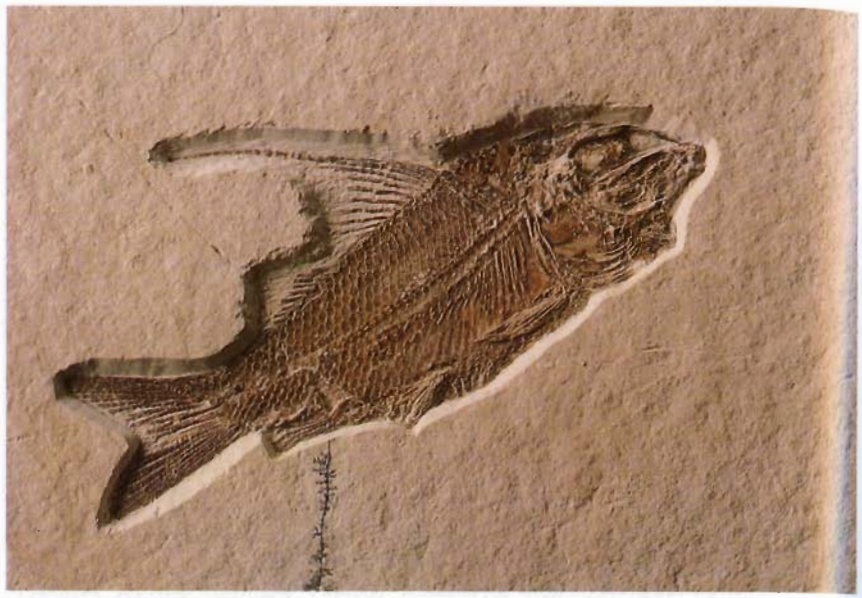
Geographical distribution: Europe, Middle East.

Features: Middle-sized fishes with elongate bodies. Head relatively large. Gape moderately long. Two dorsal fins—the first begins in the anterior part of the body and is anteriorly tall and pointed, becoming lower posteriorly with a concave upper margin; the second is in the posterior third of the body and triangular. Anal fin and pelvic fins small and pointed. Pectoral fins fan-shaped. Caudal fin forked. Scales thick and quadrangular.

Remarks: Rapid swimmers, probably living near reefs.

Recent relatives: None. Died out in Upper Cretaceous.

Order: Macrosemiiformes
Family: Macrosemiidae



Propterus microstomus AGASSIZ (length c. 10 cm) from the Upper Jurassic of Solnhofen (Eichstätt), Bavaria, Germany. Original: Krauss Collection, Weißenburg, Germany.

Genus: *Propterus* AGASSIZ, 1834.

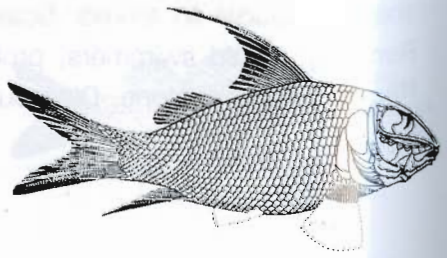
Geological range: Upper Jurassic to Lower Cretaceous.

Geographical distribution: Europe.

Features: Small fishes with somewhat laterally compressed bodies. Head deep. Mouth very small. Two dorsal fins—the first, in the anterior half of the body, is tall and pointed, with the first fin ray forming a long spine; the second is low and small. Anal fin pointed. Pelvic fins small. Pectoral fins fan-shaped. Caudal fin deeply forked. Scales weakly serrated along the longitudinal margins.

Remarks: Probably reef dwellers.

Recent relatives: None. Died out in the Lower Cretaceous.



Propterus, reconstruction after BARTRAM.

Order: Macrosemiiformes
Family: Uarbryichthyidae



Uarbryichthys latus WADE (length c. 32 cm) from the Lower Jurassic of Talbragar, New South Wales, Australia. Original: Australian Museum, Sydney, Australia.

Genus: *Uarbryichthys* WADE, 1941.

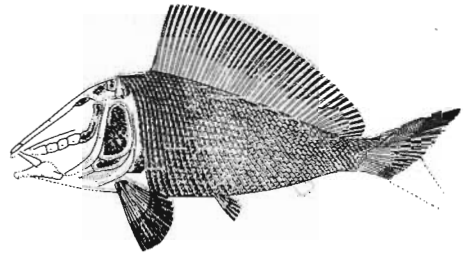
Geological range: Lower Jurassic.

Geographical distribution: Australia.

Features: Middle-sized fishes with somewhat laterally compressed bodies. Head large. Snout pointed. Mouth terminal. Gape not very long. Dorsal fin extending like a sail over almost the whole of the back, very tall anteriorly, becoming lower posteriorly. Anal and pelvic fins small. Pectoral fins fan-shaped. Caudal fin forked. Scales small.

Remarks: Still-water herbivores that also fed on small animals.

Recent relatives: None. Died out in Lower Jurassic.



Uarbryichthys, after BARTRAM.



Ophiopsis procera AGASSIZ (length c. 26 cm) from the Upper Jurassic of Solnhofen (Eichstätt), Bavaria, Germany. Original: Schwegler Museum, Langenaltheim near Solnhofen, Germany.

Genus: *Ophiopsis* AGASSIZ, 1834.

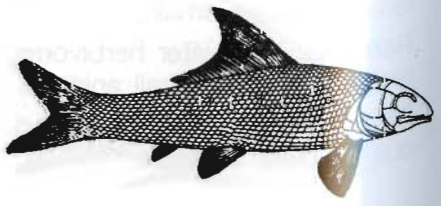
Geological range: Middle Triassic to Lower Cretaceous.

Geographical distribution: Europe, western Africa.

Features: Middle-sized fishes with slender elongate bodies. Head shallow. Snout pointed. Gape rather long. Dorsal fin broad-based, begins in the anterior half of the body and anteriorly is tall and pointed but decreases in height posteriorly, with a concave upper margin. Anal fin small. Pelvic fins somewhat larger. Pectoral fins fan-shaped. Thick quadrangular scales.

Remarks: Probably lived near reefs.

Recent relatives: None. Died out in Lower Cretaceous.



Ophiopsis, reconstruction after WOODWARD.



Albertonia cupidinia (LAMBE) (length c. 36 cm) from the Lower Triassic of Wapiti Lake, Alberta, Canada. Original: Bayerische Staatssammlung für Paläontologie, Munich, Germany.

Genus: *Albertonia* GARDINER, 1966.

Geological range: Lower Triassic.

Geographical distribution: North America.

Features: Middle-sized fishes with laterally compressed bodies. Head elongate. Snout rounded. Gape rather long. Eyes small. Dorsal fin very large, flag- or veil-like and situated in the posterior third of the body, opposite the rounded anal fin. Pelvic fins small. Pectoral fins strikingly long and veil-like. Scales strong and quadrangular.

Remarks: Still-water fishes that probably fed on plants.

Recent relatives: None. Died out in Lower Triassic.



Jacobulus novus LEHMAN (length c. 8 cm) from the Lower Triassic of Madagascar. Original: Muséum National d'Histoire Naturelle, Paris, France. Photograph: Serette Paris.

Genus: *Jacobulus* LEHMAN, 1952.

Geological range: Lower Triassic.

Geographical distribution: Madagascar.

Features: Small fishes with rather deep bodies. Head deep. Snout rounded. Eyes small. Gape long. Mouth with powerful dentition. Dorsal fin triangular, situated in the posterior half of the body. Pectoral fins narrow. Pelvic fins fan-like. Caudal fin probably emarginate of slightly forked. Scales quadrangular, sometimes rectangular.

Remarks: Probably predators.

Recent relatives: None. Died out in Triassic.

"HOLOSTEI" Halecomorphi Holosteans
Order: Amiiformes
Family: Parasemionotidae



Parasemiontus labordei PIVETEAU (length c. 13 cm) from the Lower Triassic of Madagascar. Original: Hennlye Collection, Stuttgart, Germany.

Genus: *Parasemionotus* PIVETEAU, 1929.

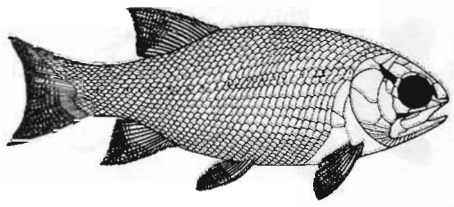
Geological range: Lower Triassic.

Geographical distribution: Madagascar, Greenland.

Features: Small to middle-sized fishes with rather laterally compressed bodies. Head deep. Snout rounded. Eyes large. Mouth small. Dorsal fin triangular, very posterior in position. Anal fin likewise triangular. Pelvic and pectoral fins narrow. Caudal fin slightly concave posteriorly.
Scales square to rectangular, arranged in diagonal rows.

Remarks: Probably fed on crustaceans and other small animals.

Recent relatives: None. Died out in Lower Triassic.



Parasemionotus, reconstruction after LEHMAN.



Phaidrosoma lunzensis GRIFFITH (length c. 12 cm) from the Upper Triassic of Polzberg, Austria. Original: Naturhistorisches Museum, Vienna, Austria.

Genus: *Phaidrosoma* GRIFFITH, 1977.

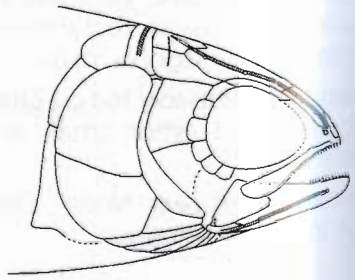
Geological range: Upper Triassic.

Geographical distribution: Europe,.

Features: Small fishes with elongate fusiform bodies. Head elongate. Snout pointed. Dorsal fin acute triangular, located in the posterior third of the body. Anal and pelvic fins elongate. Caudal fin deeply forked. Pectoral fins.

Remarks: Probably fed on crustaceans and other small animals. Has been reclassed into the genus *Dipteronotus.*

Recent relatives: None. Died out in Upper Triassic.



Phaidrosoma, reconstruction after GRIFFITH



Praesemionotus sp. (length c. 3 cm) from the Lower Triassic of Durlach, Baden, Germany. Original: Staatliches Museum für Naturkunde, Karlsruhe, Germany.

Genus: *Praesemionotus* JÖRG, 1969.

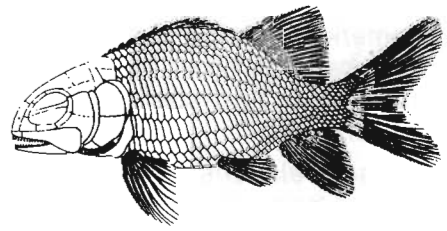
Geological range: Lower Triassic.

Geographical distribution: Europe.

Features: Very small fishes with somewhat laterally compressed bodies. Head relatively large. Snout rounded. Gape rather long. Small pointed teeth. Eyes relatively large. Dorsal fin triangular, located very posteriorly. Anal fin long and narrow. Pelvic fins elongate. Pectoral fins similar and inserted very low on the body. Caudal fin large, deeply forked.

Remarks: Probably fed on crustaceans and other small animals. Has been reclassified into the genus *Dipteronotus*.

Recent relatives: None. Died out in Lower Triassic.



Praesemionotus, after JÖRG.



Promecosomina beaconensis WADE (length c. 26 cm) from the Middle Triassic of Gosford, New South Wales, Australia. Original: Australian Museum, Sydney, Australia.

Genus: *Promecosomina* WADE, 1935.

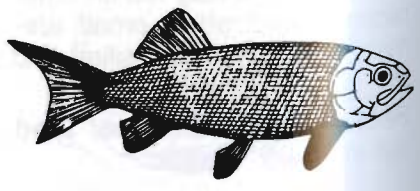
Geological range: Middle to Upper Triassic.

Geographical distribution: Australia.

Features: Middle-sized fishes with rather laterally compressed bodies. Head elongate. Snout pointed. Gape short. Eyes small. Dorsal fin broad-based, situated in the posterior third of the body, opposite the anal fin. Anal fin, pelvic fins and pectoral fins narrow. Caudal fin strongly concave posteriorly. Scales arranged in diagonal rows.

Remarks: Probably fed on crustaceans and other small animals and perhaps also on plants.

Recent relatives: None. Died out in Upper Triassic.



Promecosomina, after WADE.



Watsonulus eugnathoides (PIVETEAU) (length c. 11 cm) from the Upper Triassic of Madagascar. Original: Carnegie Museum of Natural History, Pittsburgh, Pennsylvania, U.S.A.

Genus: *Watsonulus* BROUGH, 1939.

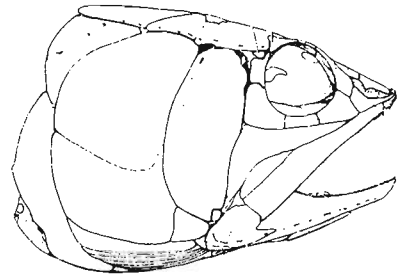
Geological range: Lower Triassic.

Geographical distribution: Madagascar, North America.

Features: Small to middle-sized fishes with rather laterally compressed bodies. Head deep. Snout rounded. Eyes small. Gape rather long. Dorsal fin in the posterior third of the body, opposite the anal fin. Pelvic and pectoral fins elongate. Caudal fin concave posteriorly. Scales arranged in diagonal rows.

Remarks: Probably fed on crustaceans and other small animals and perhaps also on plants.

Recent relatives: None. Died out in Upper Triassic.



Watsonulus, reconstruction after OLSEN.

Order: Amiiformes
Family: Parasemionotidae?



Unnamed fish (length c. 32 cm) from the Triassic of Wapiti Lake, British Columbia, Canada. Original: Staatliches Museum für Naturkunde, Karlsruhe, Germany.

Genus: Not named.

Geological range: Lower Triassic.

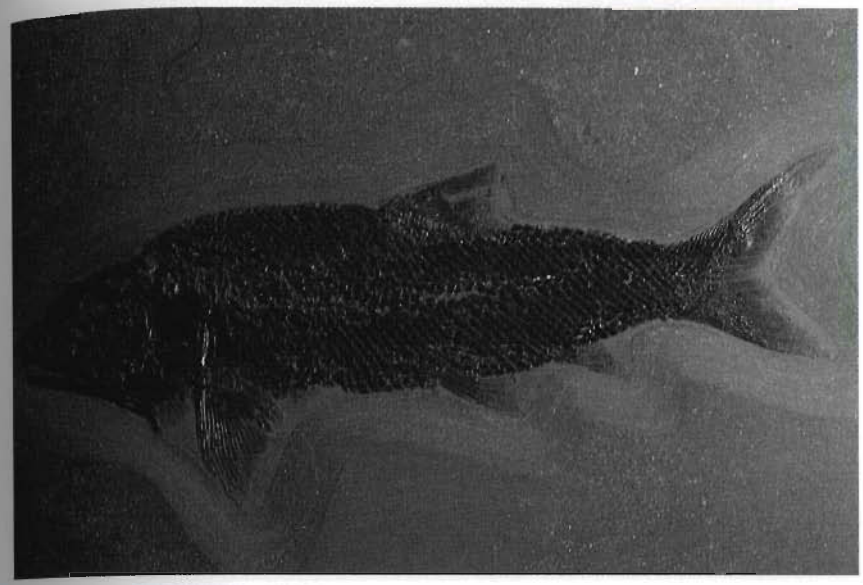
Geographical distribution: North America.

Features: Middle-sized fishes with streamlined bodies. Head shallow. Snout rounded. Small pointed teeth. Dorsal fin just behind the middle of the body, obliquely opposite the anal fin. Pectoral fins strikingly long, almost veil-like. Caudal fin deeply forked. Scales circular.

Remarks: This fish has not yet been described. Possibly a new species of the genus *Albertonia* or perhaps some other genus.

Recent relatives: None. Died out in Lower Triassic.

Order: Amiiformes?
Family: Parasemionotidae?



Unnamed fish (length c. 50 cm) from the Lower Jurassic of Holzmaden. Original: Urweltmuseum Hauff, Holzmaden, Württemberg, Germany.

Genus: Unknown.

Geological range: Lower Jurassic.

Geographical distribution: Europe.

Features: Middle-sized fishes of slender shape. Head deep. Snout pointed. Gape long. Upper and lower jaws set with pointed teeth. Dorsal fin triangular, located just behind the middle of the body, opposite the narrow pectoral fins. Anal fin small. Pectoral fins large, fan-shaped. Caudal fin heterocercal, with a narrow upper and a broad lower lobe. Body covered with thick, diagonally arranged scales.

Remarks: Predators.

Recent relatives: None. Probably died out in Lower Jurassic.



Caturus furcatus AGASSIZ (length c. 28 cm) from the Upper Jurassic of Solnhofen (Eichstätt), Bavaria, Germany. Original: Interfoss, Munich, Germany.

Genus: *Caturus* AGASSIZ, 1834.

Synonyms: *Conocus*, *Ditaxiodus*, *Endactis*, *Thlattodus*, *Uraeus*.

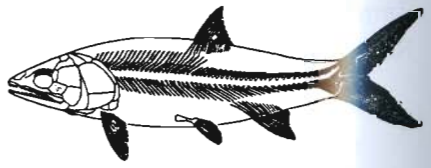
Geological range: Lower Jurassic to Lower Cretaceous.

Geographical distribution: Europe, west Africa.

Features: Middle-sized fishes of slender salmon-like shape. Head short, with powerful, strongly toothed jaws. Eyes relatively small. Dorsal fin pointed, located shortly behind the middle of the body. Anal fin likewise pointed, attached more posteriorly. Pelvic and pectoral fins narrow. Caudal fin large, deeply forked. Scales small, rounded, almost cycloid. Vertebral column incompletely ossified.

Remarks: Rapidly swimming predators.

Recent relatives: None. Died out in Lower Cretaceous.



Caturus, reconstruction after WOODWARD.

"HOLOSTEI" Halecomorphi Holosteans
Order: Amiiformes
Family: Caturidae



Eoeugnathus megalepis BROUGH (length c. 9 cm) from the Middle Triassic of Monte San Giorgio, Switzerland. Original: Paläontologisches Museum, Zürich, Switzerland.

Genus: *Eoeugnathus* BROUGH, 1939.

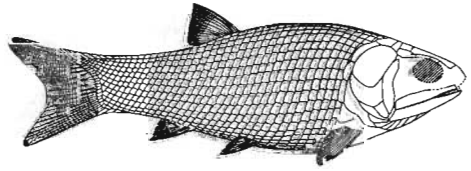
Geological range: Middle to Upper Triassic.

Geographical distribution: Europe.

Features: Small fishes of rather laterally compressed shape. Head deep. Snout rounded. Gape rather long. Jaws with small pointed teeth. Eyes large. Dorsal fin triangular, shortly behind the anterior half of the body, obliquely opposite the anal fin which is smaller but likewise triangular. Pelvic fins small and pointed. Pectoral fins rounded. Caudal fin posteriorly strongly concave. Scales relatively thick.

Remarks: Predators.

Recent relatives: None. Died out in Upper Triassic.



Eoeugnathus, reconstruction after BROUGH.



Amblysemius bellicianus THIOLLIERE (length c. 23 cm) from the Upper Jurassic of Solnhofen (Zandt), Bavaria, Germany. Original: Bayerische Staatssammlung für Paläontologie, Munich, Germany.

Genus: *Amblysemius* AGASSIZ, 1844.

Geological range: Upper Jurassic.

Geographical distribution: Europe.

Features: Middle-sized fishes with elongate slender bodies. Head elongate and shallow. Snout somewhat rounded. Gape long. Mouth with powerful jaws and very strong dentition. Dorsal fin triangular, located in the posterior third of the body. Anal fin likewise triangular but located more posteriorly. Pectoral fins narrow and somewhat fan-like. Caudal fin deeply forked.

Remarks: Rapidly swimming predators.

Recent relatives: None. Died out in Upper Jurassic.



Furo longimanus (AGASSIZ) (length c. 15 cm) from the Upper Jurassic of Solnhofen, Bavaria, Germany. Original: Bürgermeister Müller Museum, Solnhofen, Germany.

Genus: *Furo* GISTL, 1848.

Synonyms: *Isopholis*, *Lissolepis*.

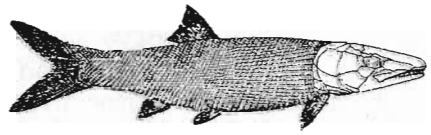
Geological range: Upper Jurassic.

Geographical distribution: Europe, Asia.

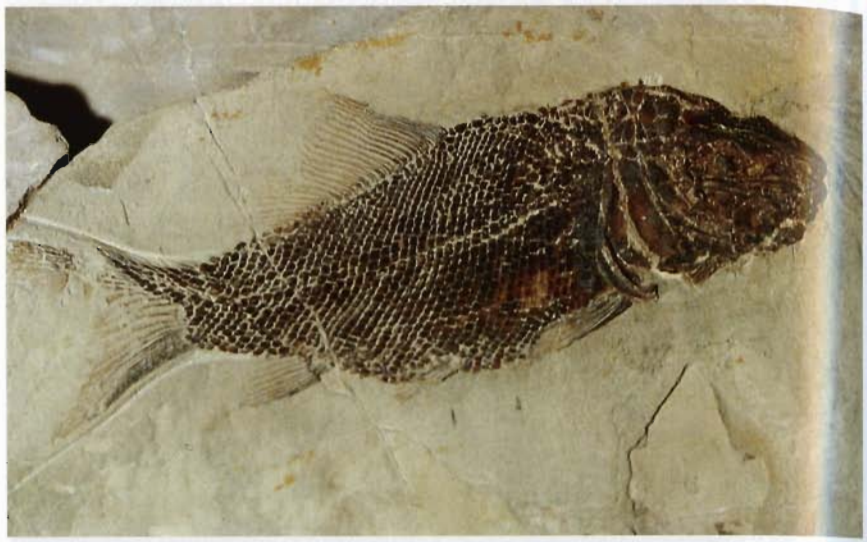
Features: Small to middle-sized fishes with elongate slender bodies. Head elongate and shallow. Gape long. Mouth powerful jaws and strong teeth. Dorsal fin acutely triangular, located shortly behind the middle of the body. Anal fin small and triangular, situated more posteriorly. Pelvic and pectoral fins narrow. Scales quadrangular, relatively thick.

Remarks: Rapidly swimming predators.

Recent relatives: None. Died out in Upper Jurassic.



Furo, reconstruction after WOODWARD.



Heterolepidotus dorsalis KNER (length c. 17 cm) from the Upper Triassic of Adnet, Hallein, Austria. Original: Bayerische Staatssammlung für Paläontologie, Munich, Germany.

Genus: *Heterolepidotus* EGERTON, 1872.

Synonyms: *Brachyichthys*, *Eulepidotus*.

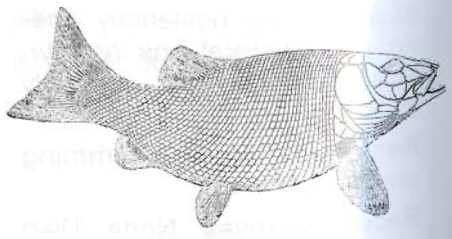
Geological range: Upper Triassic to Upper Jurassic.

Geographical distribution: Europe, Central Asia.

Features: Small to middle-sized fishes with rather laterally compressed bodies. Head elongate and shallow. Snout pointed. Gape rather long. Jaws with small pointed teeth. Dorsal fin rounded, located in the posterior third of the body, obliquely opposite the smaller anal fin. Pelvic fins elongate and rounded. Pectoral fins similar, but considerably larger. Caudal fin only slightly forked, with broad lobes. Scales thick and quadrangular.

Remarks: Predators.

Recent relatives: None. Died out in Upper Jurassic.



Heterolepidotus, reconstruction after BROUGH.



Macrepistius arenatus COPE (length c. 11 cm) from the Lower Cretaceous of Glen Rose, Texas. Original: American Museum of Natural History, New York, N.Y., U.S.A.

Genus: *Macrepistius* COPE, 1895.

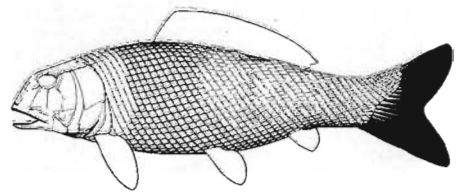
Geological range: Lower Cretaceous.

Geographical distribution: North America.

Features: Middle-sized to large fishes with slender bodies. Head deep. Snout pointed. Gape rather long. Jaws with powerful peg-shaped teeth. Eyes relatively large. Scales quadrangular, thick and shiny. Very similar to fishes of the order Semionotiformes.

Remarks: The teeth suggest a durophagous diet.

Recent relatives: None. Died out in Lower Cretaceous.



Macrepistius, reconstruction after SCHAEFFER.



Strobilodus giganteus WAGNER (length c. 177 cm) from the Upper Jurassic of Solnhofen (Eichstätt), Bavaria, Germany. Original: Jura-Museum, Eichstätt, Germany.

Genus: *Strobilodus* WAGNER, 1851.

Geological range: Upper Jurassic.

Geographical distribution: Europe.

Features: Large fishes with slender bodies. Head short. Snout pointed. Eyes relatively small. Jaws very powerful and strongly toothed. Dorsal fin narrow and pointed, located shortly behind the middle of the body. Anal fin acutely triangular. Pelvic and pectoral fins narrow. Caudal fin very large, deeply forked.

Remarks: Large predators, often placed in the genus *Caturus*.

Recent relatives: None. Died out in Upper Jurassic.



Amia kehreri ANDREAE (length c. 25 cm) from the Eocene of Messel, Hesse, Germany. Original: Frickhinger Collection, Munich, Germany.

Genus: *Amia* LINNAEUS, 1766.

Synonyms: *Amiatus*, *Paramiatus*, *Protamia*.

Geological range: Upper Cretaceous to Recent.

Geographical distribution: Europe, North America, Asia, Spitzbergen.

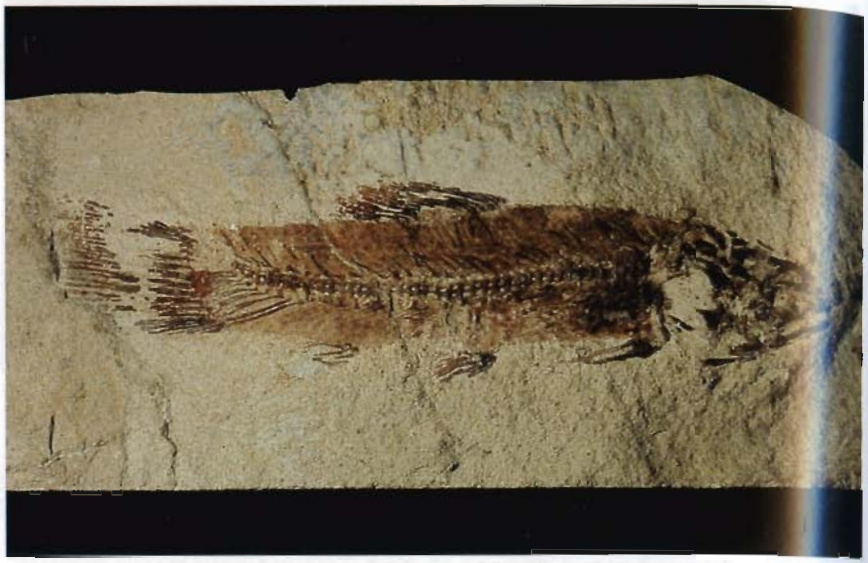
Features: Middle-sized to large fishes of deep but elongate shape. Head elongate. Snout pointed. Eyes small. Teeth small and pointed. Dorsal fin extended like a fringe, long and low. Anal fin broadly elongate and rounded. Pelvic and pectoral fins relatively small. Caudal fin rounded. Scales thin, overlapping, without a ganoin layer and approaching the cycloid type.

Remarks: Freshwater fishes. Probably cryptic predators.

Recent relatives: The genus is recent. This fossil fish is closely related to the recent bowfin *Amia calva*.



Amia calva, the recent bowfin.



Amiopsis dolloi TRAQUAIR (length c. 14 cm) from the Lower Cretaceous of Bernissart, Belgium. Original: Musée Royale des Sciences Naturelles de Belgique, Brussels, Belgium.

Genus: *Amiopsis* KNER, 1863.

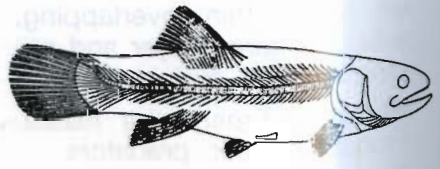
Geological range: Upper Jurassic to Lower Cretaceous.

Geographical distribution: Europe.

Features: Small fishes with somewhat laterally compressed bodies. Head elongate. Snout pointed. Gape long. Eyes small. Dorsal fin triangular, located in the posterior half of the body, opposite the narrow elongate anal fin. Pelvic and pectoral fins small. Caudal fin forked, rounded.

Remarks: Probably cryptic predators.

Recent relatives: Genus extinct. Family recent. Closely related to the recent bowfin *Amia calva*.



Amiopsis, reconstruction after WOODWARD.



Calamopleurus cylindricus AGASSIZ (length c. 84 cm) from the Cretaceous of Ceará, Brazil. Original: Frickhinger Collection, Munich, Germany.

Genus: *Calamopleurus* AGASSIZ, 1841.

Synonyms: *Enneles*

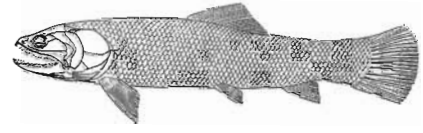
Geological range: Lower Cretaceous.

Geographical distribution: South America.

Features: Middle-sized to large fishes of elongate shape. Head elongate. Snout somewhat rounded. Eyes small. Gape long. Jaws powerful, with long pointed teeth. Dorsal fin triangular, located shortly behind the middle of the body, obliquely opposite the elongate anal fin. Pelvic and pectoral fins small. Caudal fin not forked, rounded. Large and thick quadrangular scales.

Remarks: Predators living in salt water.

Recent relatives: Genus extinct. Family recent. Closely related to the recent bowfin *Amia calva*.



Calamapleurus, reconstruction after MAISEY.



Liodesmus sprattiformis WAGNER (length c. 12 cm) from the Upper Jurassic of Solnhofen (Schernfeld), Bavaria, Germany. Original: Jura-Museum, Eichstätt, Bavaria, Germany.

Genus: *Liodesmus* WAGNER, 1859.

Synonyms: *Lophiurus*.

Geological range: Upper Jurassic.

Geographical distribution: Europe.

Features: Small fishes of elongate shape which, at first sight, are not obvious members of the Amiidae. Head elongate. Snout slightly pointed. Dorsal fin triangular, situated just behind the anterior half of the body, obliquely opposite the anal fin which is likewise triangular. Pelvic fins small. Pectoral fins elongate and broad. Caudal fin forked, with broad lobes. Scales thin.

Remarks: Small marine predators.

Recent relatives: None. Died out in Upper Jurassic.

"HOLOSTEI" Halecomorphi Holosteans
Order: Amiiformes
Family: Amiidae Bowfins



Sinamia zdanskyi STENSIÖ (length 4.5 cm) from the Lower Cretaceous of Ning-Khia-Kou, Shantung Province, China. Original: Paleontologiska Museet, Uppsala, Sweden.

Genus: *Sinamia* STENSIÖ, 1936.

Geological range: Lower Cretaceous.

Geographical distribution: Eastern Asia.

Features: Middle-sized fishes with slender elongate bodies. Head elongate. Snout rounded. Eyes large. Gape long. Upper and lower jaws bearing teeth. Overall structure very similar to *Amia*. Scales rhombic and covered with ganoin.

Remarks: Freshwater fishes.

Recent relatives: Genus extinct. Closely related to the recent bowfin *Amia* which lives in fresh-water in North America.



Sinamia, after LIN.



Urocles altivelus WAGNER (length c. 44 cm) from the Upper Jurassic of Solnhofen (Eichstätt), Bavaria, Germany. Original: Interfoss, Munich.

Genus: *Urocles* JORDAN, 1919.

Synonyms: *Megalurus*, *Synergus*.

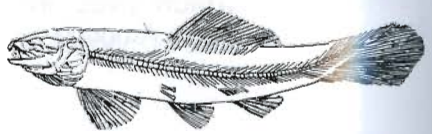
Geological range: Upper Jurassic.

Geographical distribution: Europe.

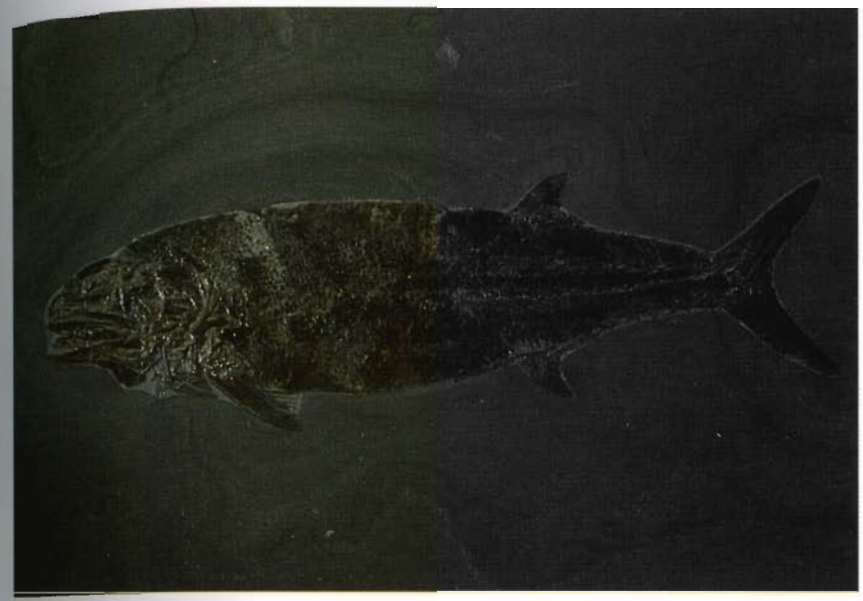
Features: Middle-sized fishes of rather deep-bodied but elongate shape. Head elongate. Snout slightly rounded. Gape long. Jaws with pointed teeth. Dorsal fin broad-based, beginning tall and approximately in the middle of the body and diminishing in height posteriorly. The small anal fin lies opposite. Pelvic fins also small. Pectoral fins fan-like. Caudal fin not forked, convex behind.

Remarks: Marine predatory fishes.

Recent relatives: Genus extinct. Family recent. Closely related to the bowfin *Amia calva*.



Urocles, reconstruction after WOODWARD.



Unnamed fish (length c. 50 cm) from the Lower Jurassic of Holzmaden, Württemberg, Germany. Original: Urweltmuseum Hauff, Holzmaden, Germany.

Genus: Not named.

Geological range: Lower Jurassic.

Geographical distribution: Europe.

Features: Middle-sized fishes with elongate streamlined bodies. Head deep. Snout slightly protrusive. Eyes small. Upper and lower jaws with teeth. Dorsal fin small, located in the posterior third of the body, opposite the anal fin which is likewise small. Pectoral fins elongate and fan-shaped. Caudal fin deeply forked, with narrow lobes.

Remarks: Predators.

Recent relatives: None. Probably died out in Lower Jurassic.



Asthenocormus titanicus (WAGNER) (length c. 216 cm) from the Upper Jurassic of Solnhofen (Eichstätt) Bavaria, Germany. Original: Jura-Museum, Eichstätt, Germany.

Genus: *Asthenocormus* WOODWARD, 1895.

Synonyms: *Agassizia*.

Geological range: Upper Jurassic.

Geographical distribution: Europe.

Features: Large to very large fishes with elongate bodies. Head long and shallow. Snout pointed. Eyes small. Caudal fin very large, forked even at the base, with almost vertically diverging long narrow lobes. Pelvic fins absent. Pectoral fins unusually long. Vertebral centra almost unossified.

Remarks: Rapidly swimming predators which probably lived in the open sea.

Recent relatives: None. Died out in Upper Jurassic.

"HOLOSTEI" Halecomorphi Holosteans
Order: Pachycormiformes
Family: Pachycormidae



Euthynotus intermedius (AGASSIZ) (length c. 31 cm) from the Lower Jurassic of Werther, Westphalia, Germany. Original: Bayerische Staatssammlung für Paläontologie, Munich, Germany.

Genus: *Euthynotus* WAGNER, 1860.

Synonyms: *Cyclospondylus*, *Heterothrissops*, *Parathrissops*, *Pseudothrissops*.

Geological range: Lower Jurassic.

Geographical distribution: Europe.

Features: Middle-sized fishes of elongate slender shape. Head long and shallow. Snout slightly pointed. Eyes large. Gape long. Dorsal fin very small, located in the posterior third of the body. Anal and pelvic fins also small. Pectoral fins pointed, somewhat larger. Caudal fin relatively short, moderately forked. Scales small.

Remarks: Rapidly swimming predators.

Recent relatives: None. Died out in Lower Jurassic.



Euthynotus, reconstruction after WENZ.



Hypsocormus insignis WAGNER (length c. 70 cm) from the Upper Jurassic of Solnhofen (Eichstätt), Bavaria, Germany. Original: Staatliches Museum für Naturkunde, Stuttgart, Germany.

Genus: *Hypsocormus* WAGNER, 1860.

Geological range: Upper Triassic to Upper Jurassic.

Geographical distribution: Europe.

Features: Middle-sized to large fishes with slender bodies somewhat deepened anteriorly. Head long and shallow. Snout slightly pointed. Gape long. Jaws with pointed teeth. Dorsal fin in the posterior half of the body, anteriorly with a point but decreasing in height posteriorly with a concave upper margin. Anal fin obliquely opposite with a broad base. Pelvic fins small. Pectoral fins long and narrow. Caudal fin deeply forked, with long narrow lobes.

Remarks: Rapidly swimming predators, probably living in coastal regions.

Recent relatives: None. Died out in Upper Jurassic.



Hypsocormus, reconstruction after WOODWARD.



Orthocormus cornutus WEITZEL (length c. 113 cm) from the Upper Jurassic of Solnhofen (Eichstätt), Bavaria, Germany. Original: Jura-Museum, Eichstätt.

Genus: *Orthocormus* WEITZEL, 1930.

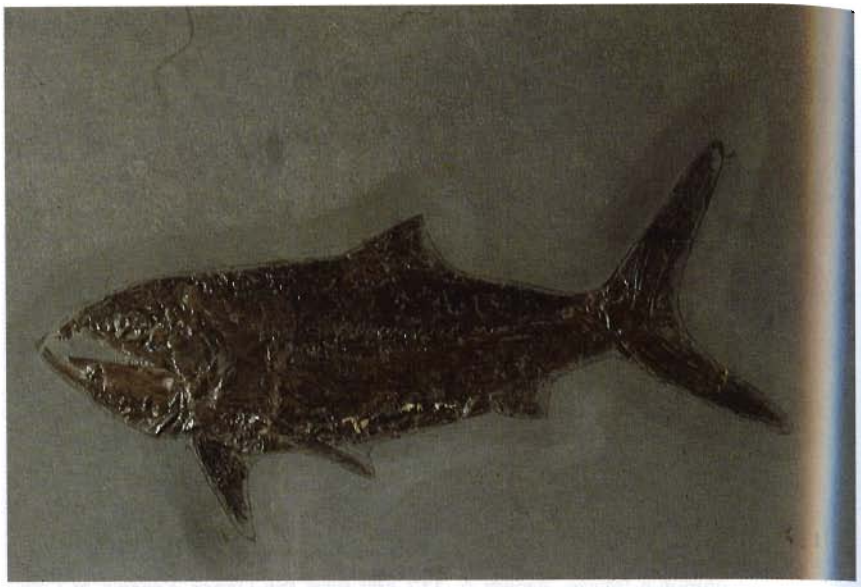
Geological range: Upper Jurassic.

Geographical distribution: Europe.

Features: Middle-sized to large fishes with elongate slender bodies. Head long and shallow. Snout slightly pointed. Gape long. Jaws with pointed teeth. Dorsal fin behind the middle of the body, narrow and pointed, obliquely opposite the narrow anal fin. Pelvic and pectoral fins likewise long and narrow. Caudal fin deeply divided, with narrow lobes diverging almost vertically from each other.

Remarks: Rapidly swimming predators which probably lived in coastal regions or in the open ocean.

Recent relatives: None. Died out in Upper Jurassic.



Pachycormus curtus AGASSIZ (length c. 30 cm) from the Lower Jurassic of Holzmaden, Württemberg, Germany. Original: Urwelt-Museum Hauff, Holzmaden, Germany.

Genus: *Pachycormus* AGASSIZ, 1833.

Synonyms: *Cephenoplosus*.

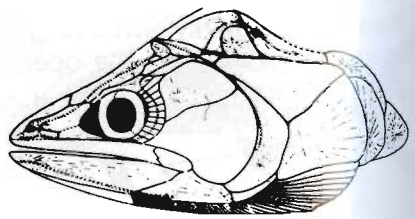
Geological range: Lower Jurassic.

Geographical distribution: Europe.

Features: Middle-sized fishes with rather laterally compressed bodies. Head deep. Snout pointed. Eyes small. Jaws with pointed teeth. Dorsal fin only slightly behind the middle of the body, small and triangular. Anal fin likewise small and triangular, located more posteriorly. Pectoral fins pointed and relatively long. Caudal fin large, deeply forked, with strongly divergent narrow lobes.

Remarks: Rapidly swimming predators.

Recent relatives: None. Died out in Lower Jurassic.



Pachycormus, reconstruction after LEHMAN.



Protosphyraena sp. (length c. 47 cm) from the Upper Cretaceous of Kansas, U.S.A. Original: Sternberg Memorial Museum, Fort Hays, Kansas, U.S.A. Photograph: Bennett, Lawrence, Kansas, U.S.A.

Genus: *Protosphyraena* LEIDY, 1857.

Synonyms: *Erisichthe*, *Pelecopterus*.

Geological range: Upper Cretaceous.

Geographical distribution: Europe, Asia, North America, South America.

Features: Large fishes with long shallow skulls extending into a strong very elongate rostrum. Gape very long. Mouth with strong forward-directed teeth which are exceptionally long in the anterior parts of the jaws. Eyes relatively large. Pectoral fins large and very narrow, their anterior margins set with tooth-like processes.

Remarks: Obviously dangerous predators which could overpower even large prey. The significance of the rostrum is uncertain.

Recent relatives: None. Died out in Upper Cretaceous.



Sauropsis longimanus AGASSIZ (length c. 32 cm) from the Upper Jurassic of Solnhofen (Eichstätt), Bavaria, Germany. Original: Bayerische Staatssammlung für Paläontologie, Munich, Germany.

Genus: *Sauropsis* AGASSIZ, 1832.

Synonyms: *Diplolepis*.

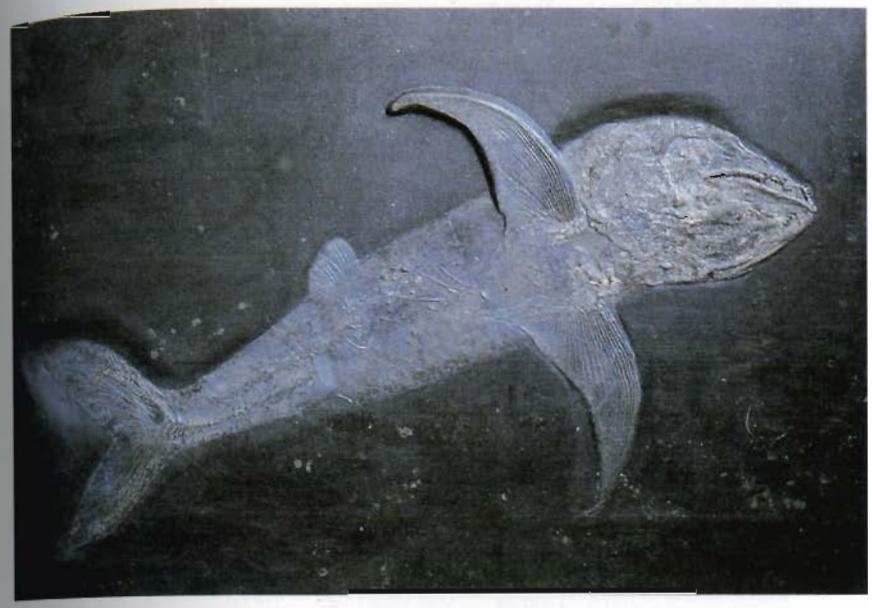
Geological range: Lower to Upper Jurassic.

Geographical distribution: Europe, North America.

Features: Middle-sized fishes with somewhat compressed bodies. Head large and deep. Snout rounded. Gape long. Jaws with powerful teeth. Dorsal fin behind the middle of the body, narrow and pointed. Anal fin opposite, of similar shape. Pectoral fins long and narrow. Caudal fin deeply forked, with narrow lobes.

Remarks: Rapidly swimming predators.

Recent relatives: None. Died out in Upper Jurassic.



Saurostomus esocinus AGASSIZ (length c. 94 cm) from the Lower Jurassic of Holzmaden, Württemberg, Germany. Original: Interfoss, Munich, Germany.

Genus: *Saurostomus* AGASSIZ, 1833.

Synonyms: *Pachycormus*, *Protosauropsis*, *Prosauropsis*.

Geological range: Lower Jurassic.

Geographical distribution: Europe.

Features: Middle-sized to large fishes with rather laterally compressed bodies. Head deep. Snout slightly pointed. Gape long. Jaws with pointed teeth. Dorsal fin shortly behind the middle of the body, very small. Anal fin likewise very small, somewhat more posterior. Pectoral fins strikingly large, almost wing-like. Caudal fin deeply forked, with relatively broad lobes. Scales small and rhombic.

Remarks: Rapidly swimming predators which probably lived in the open sea.

Recent relatives: None. Died out in Lower Jurassic.



Aspidorhynchus acutirostris (de BLAINVILLE) (length c. 60 cm) from the Upper Jurassic of Solnhofen (Eichstätt), Bavaria, Germany. Original: Interfoss, Munich, Germany.

Genus: *Aspidorhynchus* AGASSIZ, 1833.

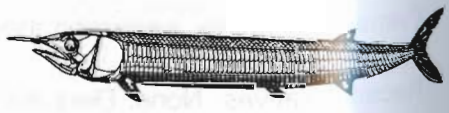
Geological range: Upper Jurassic to Upper Cretaceous.

Geographical distribution: Europe, North America, Asia, Australia, north Africa.

Features: Middle-sized, very slender, elongate pike-like fishes. Head elongate. Snout with a long and pointed rostrum formed from the upper jaw. Eyes large. Jaws with small pointed teeth. Dorsal fin small, situated in the posterior third of the body, opposite the small triangular anal fin. Pelvic fins very small. Pectoral fins somewhat longer. Caudal fin deeply forked, with narrow lobes. Characteristic rod-like scales on the flanks.

Remarks: Rapidly swimming predators. The rostrum probably served for deflecting gregarious fishes and hitting prey from the side.

Recent relatives: None. Died out in Upper Cretaceous.



Aspidorhynchus, after ASSMANN.



Belonostomus tenuirostris AGASSIZ (length c. 34 cm) from the Upper Jurassic of Solnhofen (Zandt), Bavaria, Germany. Original: Bayerische Staatssammlung für Paläontologie, Munich, Bavaria, Germany.

Genus: *Belonostomus* AGASSIZ, 1834.
Synonyms: *Belonostmus*, *Dichelospondylus*, *Hemirhynchus*, *Ophirachis*.
Geological range: Upper Jurassic to Upper Cretaceous.
Geographical distribution: Europe, North America, Middle East, Australia.
Features: Middle-sized fishes but smaller than *Aspidorhynchus*. Of slender almost eel-like shape. Head shallow. Snout pointed, with a rostrum formed from upper and lower jaws—the lower jaw extending into the rostrum is only slightly shorter than the upper. Teeth pointed. Dorsal fin small, opposite the anal fin which is likewise small. Caudal fin forked, with narrow but powerful lobes. Characteristic rod-like scales on the flanks.
Remarks: Predators. The rostrum probably had the same significance as in *Aspidorhynchus*.
Recent relatives: None. Died out in Upper Cretaceous.



Belonostomus, after SAINT-SEINE.

Order: Aspidorhynchiformes
Family: Aspidorhynchidae



Vinctifer comptoni AGASSIZ (length c. 80 cm) from the Lower Cretaceous of Ceará, Brazil. Original: Frickhinger Collection, Munich, Germany.

Genus: *Vinctifer* JORDAN, 1920.

Synonyms: *Aspidorhynchus*, *Belonostomus*.

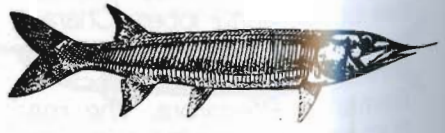
Geological range: Lower Cretaceous.

Geographical distribution: South America.

Features: Middle-sized fishes with slender, elongate, pike-like bodies. Head long and shallow. Upper jaw projecting to form a long narrow rostrum. Teeth probably small. Dorsal fin located very posteriorly opposite the small anal fin. Pelvic fins very small, pectoral fins somewhat larger. Caudal fin deeply forked, with strong lobes. Characteristic rod-like scales on the flanks.

Remarks: Rapidly swimming predators that probably hunted small gregarious fishes.

Recent relatives: None. Died out in Lower Cretaceous.



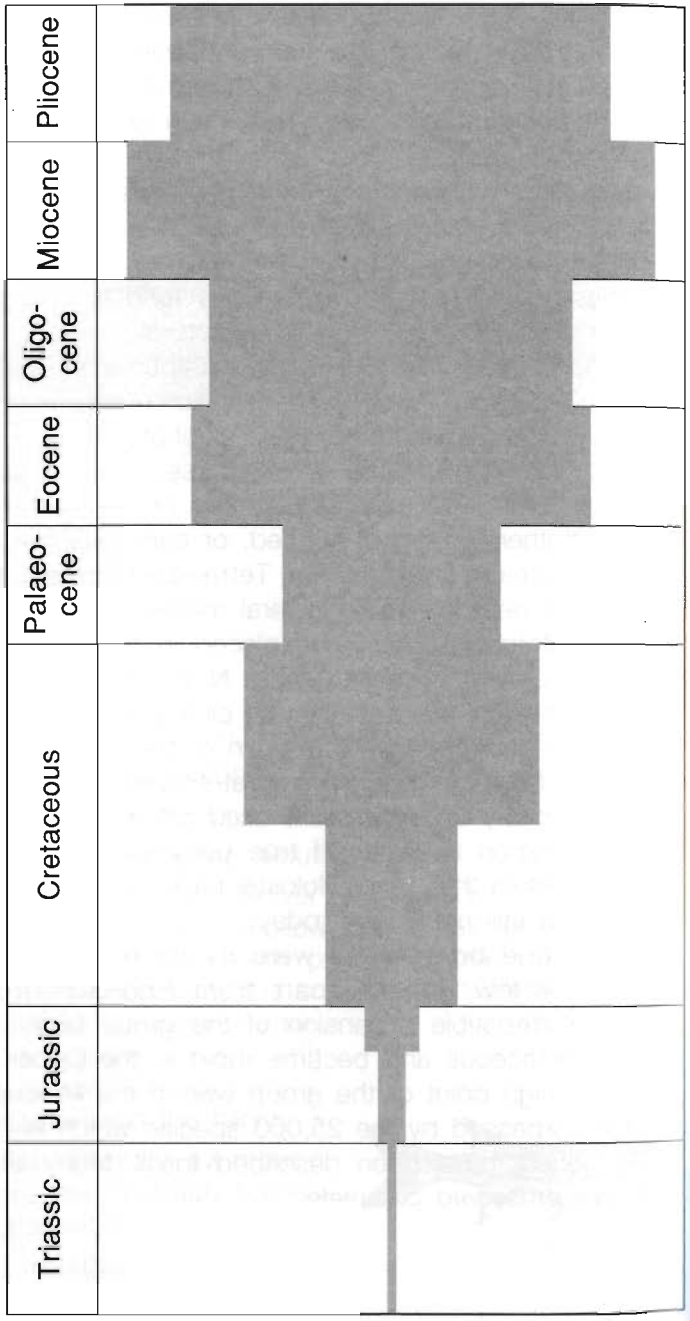
Vinctifer, reconstruction after SILVA SANTOS.

The first teleosts retain some primitive features, such as a thin ganoin layer on the scales or the vertebral column bent strongly upwards near the caudal fin. Such features no longer occur in the advanced teleosts (Euteleostei). These two groups are treated separately in what follows.

The internal skeleton of teleosts is completely ossified. The scales are mostly cycloid (with rounded posterior margins) or ctenoid (with denticulate posterior margins). Some fishes, however, have lost the scales completely. The pelvic fins tend to migrate forwards and so are sometimes sited in a pectoral position, or even under the throat or the chin. With a few exceptions the caudal fin is homocercal. There may be one, two, or sometimes even three, dorsal fins. In some genera there is an additional adipose fin on the back. It lacks fin rays and is, of course, very seldom preserved in fossils. The jaws may be toothless or the teeth may be of any type, whether small and pointed, or carnassial-like tearing teeth or the crushing teeth of the Tetraodontiformes. Length varies from a few centimetres to several metres.

The Pholidophoriformes used to be placed in the "Holostei" on account of their enamel-covered scales. Now, however, they are put at the beginning of the Teleostei as clearly indicated by their head skeleton. In consequence the origin of the true bony fishes goes back to the Lower Triassic. The sprat-shaped *Leptolepis* also has great evolutionary importance. It used often to be regarded as the latest common ancestor of true bony fishes. Now, however, it seems certain that other Holostei have contributed to this evolution which is still continuing today.

In the Jurassic true bony fishes were by no means common. There were very few genera apart from *Pholidophorus* and *Leptolepis*. The irresistible expansion of the group began slowly in the Lower Cretaceous and became rapid in the Upper Cretaceous. The first high point of the group was in the Miocene, but this has been surpassed by the 25,000 species which live today. About 1100 genera have been described fossil. Many of them, but not all, are preserved complete.



The approximate stratigraphical distribution of bony fishes, changed after MÜLLER.

Order: Pholidophoriformes
Family: Pholidophoridae



Baleiichthys sp. (length c. 6.5 cm) from the Jurassic of Balei, Siberia, Russia. Original: Museum für Naturkunde, Berlin, Germany.

Genus: *Baleiichthus* ROHON, 1890.

Geological range: Jurassic.

Geographical distribution: East Asia.

Features: Small fishes with very slender elongate bodies. Head shallow. Eyes small. Gape rather long. Dorsal fin approximately in the middle of the body, obliquely opposite the small triangular anal fin. Pectoral fins small and rather fan-like. Caudal fin rather deeply forked. Body covered with diagonally arranged, relatively thick scales.

Remarks: Predators.

Recent relatives: None. Died out in Jurassic.



Eurycormus speciosus WAGNER (length c. 30 cm) from the Upper Jurassic of Solnhofen (Eichstätt), Bavaria, Germany. Original: Jura-Museum, Eichstätt, Germany.

Genus: *Eurycormus* WAGNER, 1859.

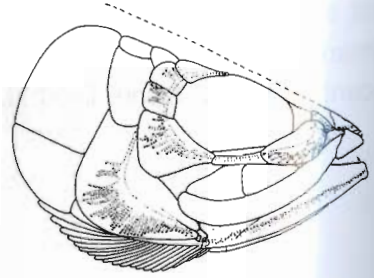
Geological range: Upper Jurassic.

Geographical distribution: Europe.

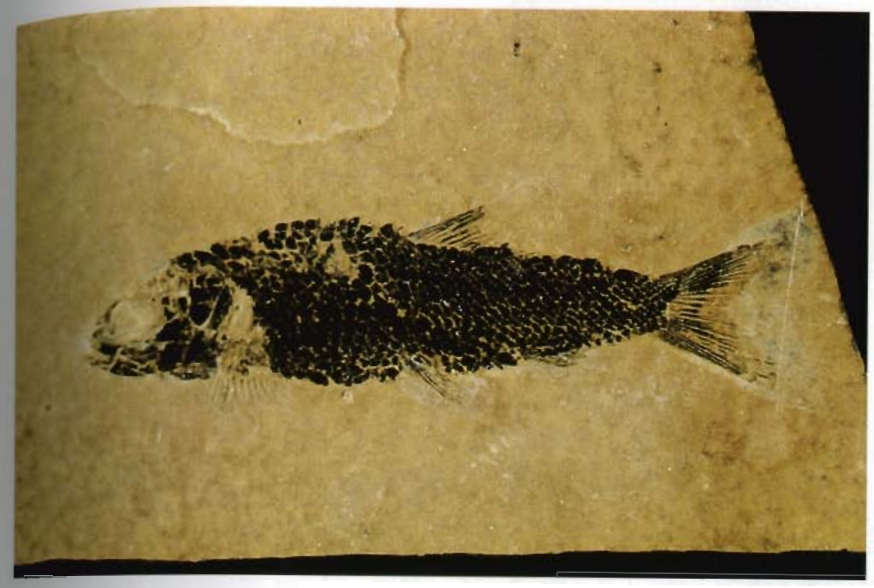
Features: Middle-sized fishes with rather laterally compressed bodies. Head deep. Snout pointed. Eyes strikingly large. Mouth rather long. Dorsal fin small, behind the middle of the body. Caudal fin deeply forked, with narrow lobes. Scales thin.

Remarks: Probably predators.

Recent relatives: None. Died out in Upper Jurassic.



Eurycormus, reconstruction after PATTERSON



Parapholidophorus caffii (AIRAGHI) (length c. 6 cm) from the Upper Triassic of San Pellegrino, Italy. Original: Museo Civico Scienze Naturali Caffi, Bergamo, Italy.

Genus: *Parapholidophorus* ZAMBELLI, 1975.

Geological range: Upper Triassic.

Geographical distribution: Europe.

Features: Small fishes of slender shape. Head elongate. Snout pointed. Eyes large. Gape rather long. Dorsal fin small, approximately in the middle of the body, opposite the elongate pelvic fins. Anal fin small. Pectoral fins fan-shaped. Caudal fin moderately forked, with lobes broad at the base and pointed at the ends. Scales thick.

Remarks: Probably gregarious.

Recent relatives: None. Died out in Upper Triassic.



Pholidoctenus serianus Zambelli (length c. 9 cm) from the Upper Triassic of Cene, Bergamo, Italy. Original: Museo Civico Scienze Naturali Caffi, Bergamo, Italy.

Genus: *Pholidoctenus* Zambelli, 1977.

Geological range: Upper Triassic.

Geographical distribution: Europe.

Features: Small fishes of rather laterally compressed shape. Head short and large. Snout rounded. Eyes large. Dorsal fin pointed, located approximately in the middle of the body. Pectoral fins fan-shaped. Caudal fin forked, with narrow pointed lobes. Thick scales arranged in diagonal rows.

Remarks: Probably gregarious.

Recent relatives: None. Died out in Upper Triassic.



Pholidolepis dorsetensis Nybelin (length c. 11 cm) from the Lower Jurassic of Lyme Regis, England, U.K. Original: The Natural History Museum, London, U.K. (P 39862)

Genus: *Pholidolepis* Nybelin, 1966.

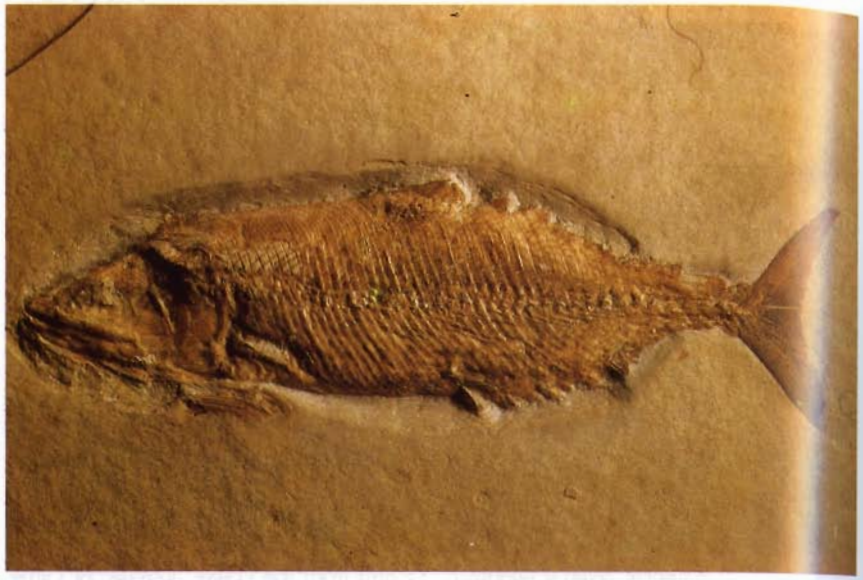
Geological range: Lower Jurassic.

Geographical distribution: Europe.

Features: Small fishes of elongate, generally slender shape. Head elongate. Snout pointed. Dorsal fin pointed, located approximately in the middle of the body. Pectoral fins narrow. Caudal fin moderately forked, with narrow lobes.

Remarks: Probably gregarious.

Recent relatives: None. Died out in Lower Jurassic.



Pholidophorus macrocephalus AGASSIZ (length c. 33 cm) from the Upper Jurassic of Solnhofen (Eichstätt), Bavaria, Germany. Original: Bayerische Staatssammlung für Paläontologie, Munich, Bavaria, Germany.

Genus: *Pholidophorus* AGASSIZ, 1832.

Synonyms: *Phelidophorus*.

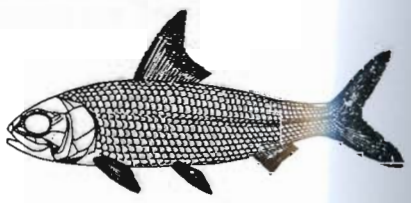
Geological range: Lower Triassic to Upper Jurassic.

Geographical distribution: Europe, North America, South America, west Africa, Asia.

Features: Middle-sized fishes of slender shape. Head deep. Snout rather pointed. Eyes large. Gape rather long. Dorsal fin with a tall point anteriorly, decreasing in height posteriorly and with the upper margin concave, opposite the pelvic fins. Anal fin located more posteriorly. Caudal fin rather forked, with broad lobes. Scales thin and with a thin ganoin layer.

Remarks: Swift fishes, probably predatory.

Recent relatives: The order Pholidophoriformes shows the first definite steps in the direction of the true bony fishes. Distantly related to the Leptolepiformes but also to the Osteoglossiformes and to the tarpons.



Pholidophorus, after WOODWARD.



Pholidorhynchodon malzanni ZAMBELLI (length c. 7 cm) from the Upper Triassic of Cene, Bergamo, Italy. Original: Museo Civico Scienze Naturali Caffi, Bergamo, Italy.

Genus: *Pholidorhynchodon* ZAMBELLI, 1980.

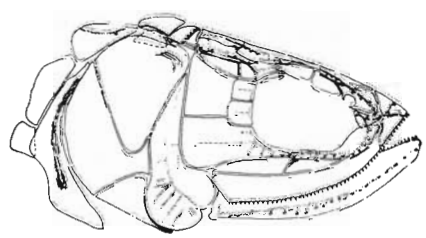
Geological range: Upper Triassic.

Geographical distribution: Europe.

Features: Small fishes with rather laterally compressed bodies. Head elongate. Snout pointed. Eyes large. Gape long. Dorsal fin small, approximately in the middle of the body, opposite the pelvic fins. Anal fin located more posteriorly. Pectoral fins fan-shaped. Caudal fin forked, with narrow lobes. Scales thick.

Remarks: Probably gregarious.

Recent relatives: None. Died out in Upper Triassic.



Pholidorhynchodon, reconstruction after ZAMBELLI.



Prohalecites porroi BELOTTI (length c. 3 cm) from the Middle Triassic of ca del Frate, Varese, Italy. Original: Museo Civico Scienze Naturali, Induno Olona, Varese, Italy.

Genus: *Prohalecites* DEECKE, 1889.

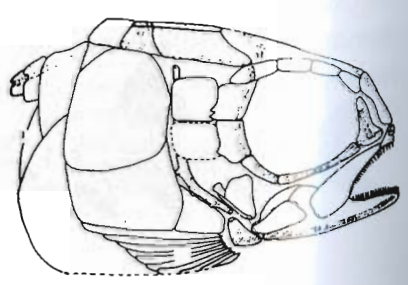
Geological range: Middle to Upper Triassic.

Geographical distribution: Europe.

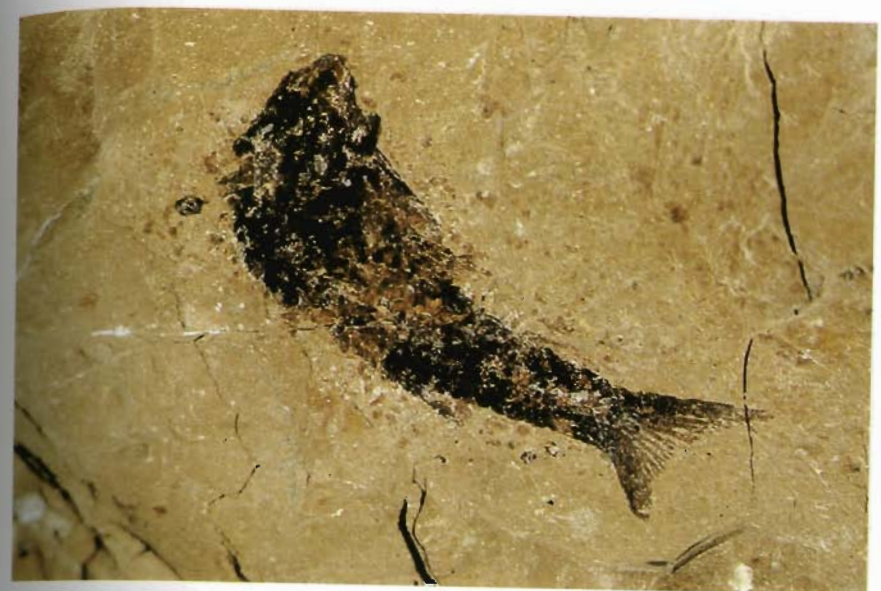
Features: Very small fishes of slender shape. Head large. Gape long. Jaws with small pointed teeth. Dorsal fin in the posterior third of the body, opposite the anal fin. Pelvic fins small, pectoral fins somewhat longer. Caudal fin posteriorly concave rather than forked.

Remarks: Probably gregarious.

Recent relatives: None. Died out in Upper Triassic.



Prohalecites, after TINTORI.



Catervariolus hornemani SAINT SEINE (length c. 6 cm) from the Upper Jurassic of Zaire. Original: Rijksmuseum van Geologie en Mineralogie, Leiden, Netherlands.

Genus: *Catervariolus* SAINT SEINE, 1955.

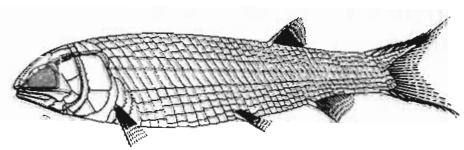
Geological range: Upper Jurassic.

Geographical distribution: West Africa.

Features: Small fishes of slender shape. Head shallow. Snout rounded. Eyes small. Dorsal fin in the posterior half of the body, obliquely opposite the anal fin. Caudal fin strongly concave posteriorly, with pointed lobes. Scales thick.

Remarks: Probably gregarious.

Recent relatives: None. Died out in Upper Jurassic.



Catervariolus, reconstruction after SAINT SEINE.



Ichthyokentema purbeckensis DAVIES (length c. 4 cm) from the Upper Jurassic of Wiltshire, England, U.K. Original: The Natural History Museum, London, U.K. (P7640).

Genus: *Ichthyokentema* WOODWARD, 1941.

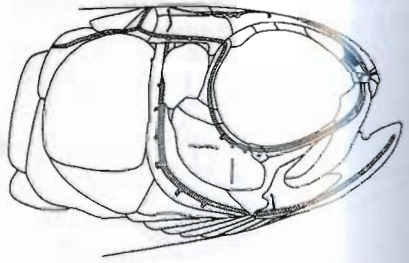
Geological range: Upper Jurassic.

Geographical distribution: Europe.

Features: Very small fishes of slender shape. Head elongate. Snout somewhat pointed. Eyes large. Dorsal fin pointed, shortly behind the middle of the body, obliquely opposite the somewhat more posterior anal fin. Caudal fin divided. Scales very thick, quadrangular, almost rod-shaped on the anterior part of the flanks.

Remarks: Probably gregarious.

Recent relatives: None. Died out in Upper Jurassic.



Ichthyokentema, after PATTERSON



Pleuropholis laevissimus AGASSIZ (length c. 6 cm) from the Upper Jurassic of Solnhofen (Kelheim), Bavaria, Germany. Original: The Natural History Museum, London, U.K. (P1100)

Genus: *Pleuropholis* EGERTON, 1858.

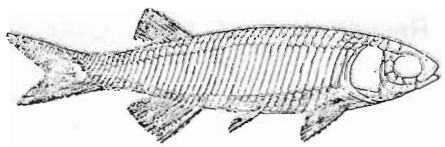
Geological range: Upper Triassic to Lower Cretaceous.

Geographical distribution: Europe, western Africa.

Features: Small fishes of slender shape. Head elongate. Snout rounded. Eyes large. Gape moderately long. Dorsal fin in the posterior third of the body, opposite the anal fin. Pelvic fins small. Pectoral fins elongate. Caudal fin forked, with broad lobes. Scales with serrated margins, quadrangular on the back and belly, but strikingly rod-shaped on the flanks.

Remarks: Probably predators.

Recent relatives: None. Died out in Lower Cretaceous.



Pleuropholis, reconstruction after WOODWARD.



Aphnelepis sp. (length c. 8 cm) from the Lower Jurassic of Talbragar, New South Wales, Australia. Original: Australian Museum, Sydney, Australia.

Genus: *Aphnelepis* WOODWARD, 1895.

Geological range: Lower Jurassic.

Geographical distribution: Australia.

Features: Small fishes of slender shape. Head elongate. Snout pointed. Eyes large. Gape long. Dorsal fin in the posterior half of the body, anteriorly with a point but decreasing in height posteriorly and with a concave dorsal margin, obliquely opposite the anal fin. Pectoral fins narrow. Caudal fin slightly forked, with relatively broad lobes.

Remarks: Probably gregarious.

Recent relatives: None. Died out in Lower Jurassic.



Archaeomaene tenuis WOODWARD (length c. 12 cm) from the Lower Jurassic of Talbragar, NSW. Original: The Natural History Museum, London, U.K. (P40498).

Genus: *Archaeomene* WOODWARD, 1895.

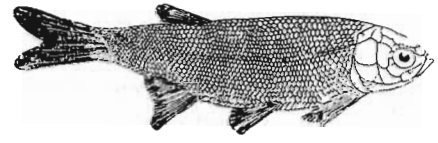
Geological range: Lower Jurassic.

Geographical distribution: Australia.

Features: Small fishes of elongate shape. Head short and deep. Snout rounded. Eyes large. Gape rather long. Dorsal fin small, located very posteriorly, obliquely opposite the larger anal fin. Pelvic fins elongate, rounded at the ends. Pectoral fins narrow. Caudal fin small, forked, with broad lobes. Scales rounded.

Remarks: Probably gregarious.

Recent relatives: None. Died out in Lower Jurassic.



Archaeomenae, after WADE.



Wadeichthys oxyops WALDMAN (length c. 16 cm) from the Lower Cretaceous of Australia. Original: Field Museum of Natural History, Chicago, Illinois, U.S.A.

Genus: *Wadeichthys* WALDMAN, 1971.

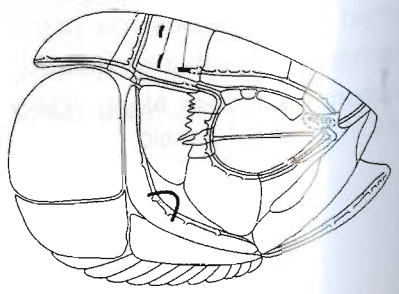
Geological range: Lower Cretaceous.

Geographical distribution: Australia.

Features: Small fishes with elongate bodies. Head short and deep. Snout rounded. Gape long, with the lower jaw projecting. Eyes small. Dorsal fin behind the middle of the body, obliquely opposite the triangular anal fin. Pelvic fins small. Pectoral fins somewhat longer. Caudal fin forked, with relatively broad lobes. Scales arranged in diagonal rows.

Remarks: Probably predators.

Recent relatives: None. Died out in Lower Cretaceous.



Wadeichthys, reconstruction after WADE.



Callopterus agassizi THIOLLIÈRE (length c. 55 cm) from the Upper Jurassic of Solnhofen (Eichstätt), Bavaria, Germany. Original: Jura-Museum, Eichstätt, Bavaria, Germany.

Genus: *Callopterus* THIOLLIÈRE, 1854.

Geological range: Upper Jurassic.

Geographical distribution: Europe.

Features: Middle-sized fishes of slender, rather laterally compressed shape. Head short and deep. Snout rounded. Gape relatively long. Eyes large. Dorsal fin located very posteriorly, large and triangular, obliquely opposite the anal fin which is also triangular. Pectoral fins fan-like. Caudal fin large, strongly concave posteriorly.

Remarks: Probably predatory fishes.

Recent relatives: None. Died out in Upper Jurassic.



Ionoscopus cyprinoides WAGNER (length c. 44 cm) from the Upper Jurassic of Solnhofen (Eichstätt), Bavaria, Germany. Original: Kraus Collection, Weißenburg, Germany.

Genus: *Ionoscopus* COSTA, 1853.

Synonyms: *Opsigonus*.

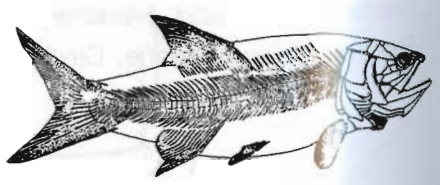
Geological range: Upper Jurassic to Lower Cretaceous.

Geographical distribution: Europe.

Features: Middle-sized fishes of rather laterally compressed shape. Head elongate. Snout pointed. Gape long. Jaws with pointed teeth. Dorsal fin acute triangular, situated behind the middle of the body, obliquely opposite the anal fin which is likewise an acute triangle. Pectoral fins elongate. Caudal fin rather deeply forked, with lobes broad at the base and pointed at the ends.

Remarks: Probably predators.

Recent relatives: None. Died out in Lower Cretaceous.



Ionoscopus, reconstruction after WAGNER.



Oshunia brevis WENZ & KELLNER (length c. 40 cm) from the Lower Cretaceous of Ceará, Brazil. Original: American Museum of Natural History, New York, N.Y., U.S.A.

Genus: *Oshunia* WENZ & KELLNER, 1986.

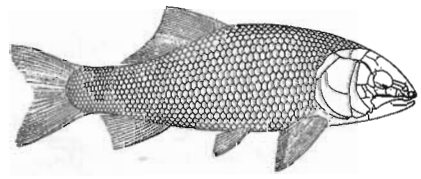
Geological range: Lower Cretaceous.

Geographical distribution: South America.

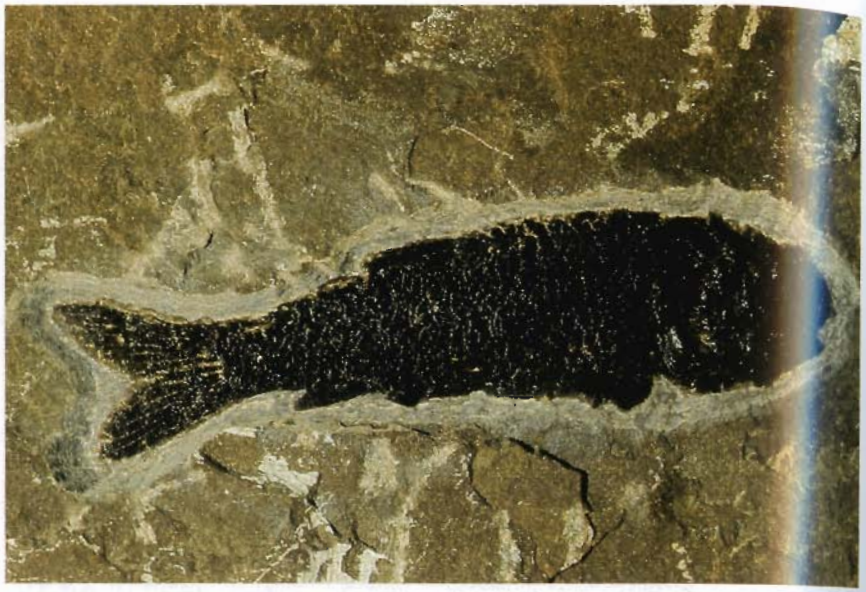
Features: Middle-sized fishes with deep bodies and a convex dorsal margin. Head shallow. Snout pointed. Gape long with powerful teeth. Eyes small. Dorsal fin behind the middle of the body, almost opposite the pelvic fins. Pectoral fins small. Scales thick.

Remarks: Still-water predatory fishes.

Recent relatives: None. Died out in Lower Cretaceous.



Oshunia, after MAISEY



Hulettia americana EASTMAN (length c. 10 cm) from the Lower Jurassic of New Mexico, U.S.A. Original: Frickhinger Collection, Munich, Germany.

Genus: *Hulettia* SCHAEFFER & PATTERSON, 1984.

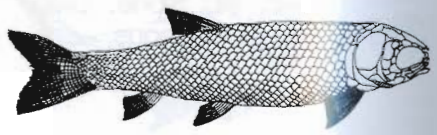
Geological range: Lower Jurassic.

Geographical distribution: North America.

Features: Small fishes of slender shape. Head deep. Snout rounded. Gape rather long. Dorsal fin in the posterior third of the body. Anal fin pointed, located more posteriorly. Pelvic and pectoral fins small. Caudal fin forked, with broad lobes. Scales thick and shiny.

Remarks: Probably predatory fishes.

Recent relatives: None. Died out in Lower Jurassic.



Hulettia, reconstruction after SCHAEFFER & PATTERSON.



Ascalabos voithii MÜNSTER (length c. 10 cm) from the Upper Jurassic of Solnhofen (Eichstätt), Bavaria, Germany. Original: Museum of Natural History, Lawrence, Kansas, U.S.A.

Genus: *Ascalabos* MUNSTER, 1839.

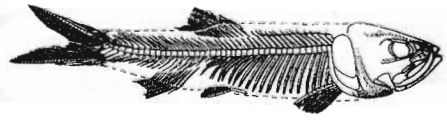
Geological range: Upper Jurassic.

Geographical distribution: Europe.

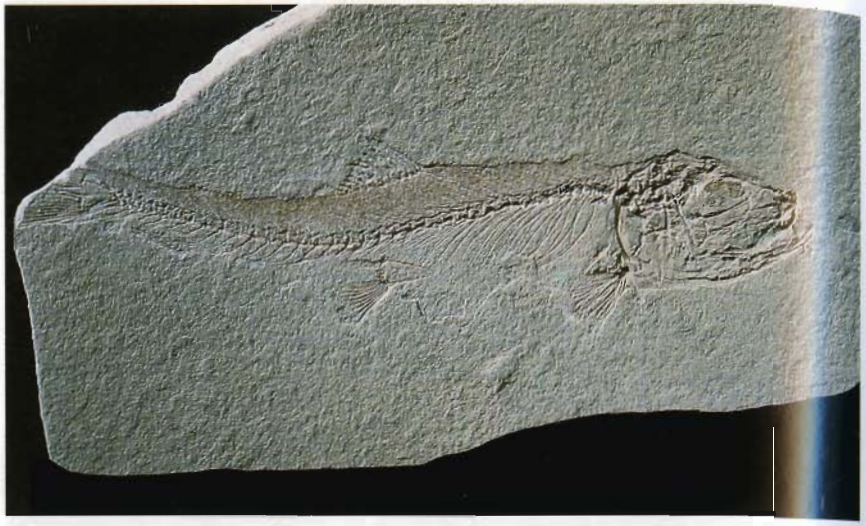
Features: Small fishes of slender shape. Head elongate. Snout pointed. Eyes strikingly large. Dorsal fin opposite the pelvic fins. Anal fin small. Pectoral fins narrow, fan-shaped. Caudal fin. Fewer vertebral centra than *Leptolepides*.

Remarks: Probably gregarious fishes.

Recent relatives: None. Died out in Upper Jurassic.



Ascalabos, reconstruction after TAVERNE.



Clupavus neocomiensis (Bassani) (length c. 6 cm) from the Lower Cretaceous of Tselfat, Morocco. Original: Muséum National d'Histoire Naturelle, Paris, France. Photograph: Serette, Paris.

Genus: *Clupavus* Arambourg, 1950.

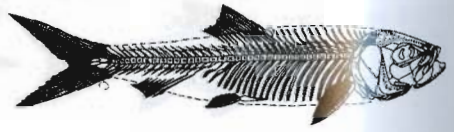
Geological range: Upper Jurassic to Lower Cretaceous.

Geographical distribution: Europe, northern Africa, North America.

Features: Small fishes with slender elongate bodies. Head elongate. Snout pointed. Gape long. Eyes large. Dorsal fin small, triangular, attached at the anterior end of the posterior half of the body. Anal fin small and elongate. Pelvic and pectoral fins fan-like. Pelvic fins opposite the dorsal fin. Caudal fin forked.

Remarks: Gregarious fishes.

Recent relatives: None. Died out in the Cretaceous.



Clupavus, reconstruction after Taverne.



Leptolepides sprattiformis (Agassiz) (length c. 8 cm) from the Upper Jurassic of Solnhofen, Bavaria, Germany. Original: Frickhinger Collection, Munich, Germany.

Genus: *Leptolepides* Nybelin, 1974.

Synonyms: *Leptolepis*.

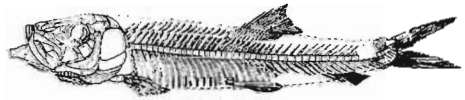
Geological range: Upper Jurassic.

Geographical distribution: Europe.

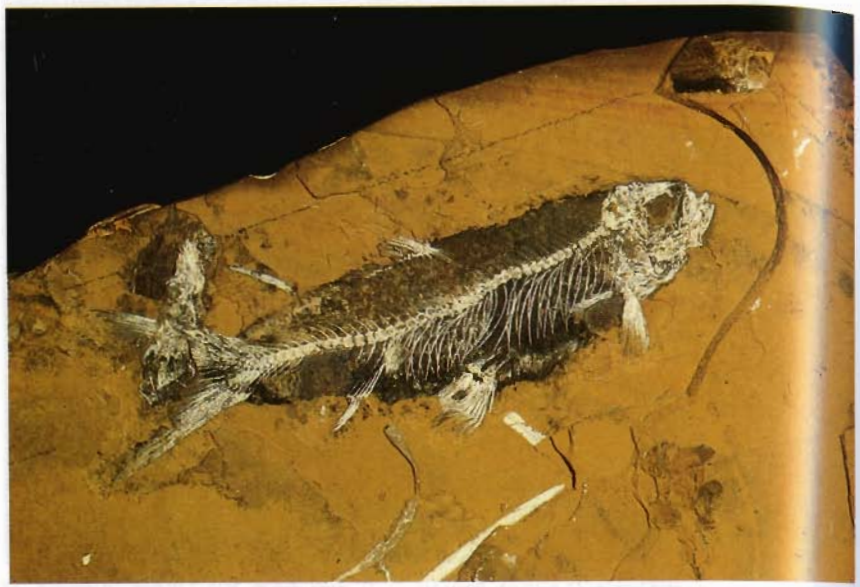
Features: Small fishes with slender bodies. Head shallow. Snout slightly pointed. Jaws with minute teeth. Dorsal fin approximately in the middle of the body, opposite the pelvic fins. Anal fin small. Caudal fin forked. Scales thin, cycloid and overlapping, with a thin ganoin layer.

Remarks: Gregarious fishes which occurred in huge numbers and served as food for many other fishes in the Jurassic seas.

Recent relatives: The genus *Leptolepides* and other genera of the Leptolepiformes already show predominantly the features of true bony fishes. They may represent early stages on the route towards herrings (Clupeiformes).



Leptolepides, reconstruction after Taverne.



Leptolepis talbragarensis WOODWARD (length c. 12 cm) from the Lower Jurassic of Talbragar, New South Wales, Australia. Original: Australian Museum, Sydney, Australia.

Genus: *Leptolepis* AGASSIZ, 1832.

Synonyms: *Liassolepis*, *Megastoma*, *Sarginites*.

Geological range: Lower Jurassic to Lower Cretaceous.

Geographical distribution: Europe, North America, Spitzbergen, Australia, Asia, South America, Africa.

Features: Small fishes of rather laterally compressed shape. Head shallow. Snout slightly truncate. Eyes relatively large. Dorsal fin opposite the relatively large pelvic fins. Pectoral fins narrow, fan-shaped. Caudal fin forked.

Remarks: Probably gregarious fishes.

Recent relatives: None. Died out in Lower Cretaceous.



Orthogonikleithrus leichi ARRATIA (length c. 6 cm) from the Upper Jurassic of Solnhofen, Bavaria, Germany. Original: Field Museum of Natural History, Chicago, Ill., U.S.A.

Genus: *Orthogonikleithrus* ARRATIA, 1987.

Geological range: Upper Jurassic.

Geographical distribution: Europe.

Features: Small to very small fishes of slender elongate shape. Head elongate. Snout pointed. Eyes large. Dorsal fin approximately in the middle of the body, opposite the pelvic fins. Caudal fin forked, with the lobes broad at the base and narrow terminally. Scales thin.

Remarks: Probably gregarious.

Recent relatives: None. Died out in Upper Jurassic.



Proleptolepis elongata NYBELIN (length c. 12 cm) from the Lower Jurassic of Lyme Regis, England, U.K. Original: The Natural History Museum, London, U.K. (P 7801)

Genus: *Proleptolepis* NYBELIN, 1974.

Geological range: Lower Jurassic.

Geographical distribution: Europe.

Features: Small fishes with very slender elongate bodies. Head shallow. Snout rounded. Eyes small. Dorsal fin opposite the pelvic fins. Caudal fin forked.

Remarks: Probably gregarious.

Recent relatives: None. Died out in Lower Jurassic.



Tharsis dubius (de BLAINVILLE) (length c. 20 cm) from the Upper Jurassic of Solnhofen (Eichtstätt), Bavaria, Germany. Original: Interfoss, Munich, Germany

Genus: *Tharsis* GIEBEL, 1847.

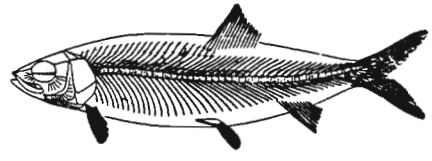
Geological range: Upper Jurassic.

Geographical distribution: Europe.

Features: Middle-sized fishes with slender, rather laterally compressed bodies. Head elongate. Snout pointed. Eyes relatively large. Dorsal fin behind the middle of the body, opposite the small narrow pelvic fins. Caudal fin forked with narrow lobes.

Remarks: Probably gregarious.

Recent relatives: None. Died out in Upper Jurassic.



Tharsis, after WOODWARD.



Tharrhias araripis JORDAN & BRANNER (length c. 30 cm) from the Lower Cretaceous of Ceará, Brazil. Original: Frickhinger Collection, Munich, Germany.

Genus: *Tarrhias* JORDAN & BRANNER, 1908.

Geological range: Lower Cretaceous.

Geographical distribution: South America.

Features: Middle-sized fishes with slender bodies. Head elongate. Snout pointed. Eyes small. Dorsal fin opposite the pelvic fins. Anal fin triangular. Caudal fin forked, with broad lobes. Scales quadrangular.

Remarks: Probably gregarious.

Recent relatives: None. Died out in Lower Cretaceous.



Tharrhias araripis, reconstruction after MAISEY.



Todiltia schoewi (DUNKLE) (length c. 6 cm) from the Lower Jurassic of New Mexico, U.S.A. Original: Museum of Natural History, Lawrence, Kansas, U.S.A.

Genus: *Todiltia* SCHAEFFER & PATTERSON, 1981.

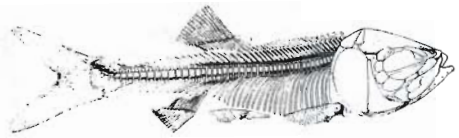
Geological range: Lower Jurassic.

Geographical distribution: North America.

Features: Small or very small fishes with slender bodies. Head short and deep. Snout truncate. Eyes relatively large. Dorsal fin in the posterior half of the body, obliquely opposite the pelvic fins. Caudal fin deeply forked. Scales somewhat thicker than in related forms.

Remarks: Probably gregarious.

Recent relatives: None. Died out in Lower Jurassic.



Todiltia, reconstruction after SCHAEFFER & PATTERSON.



Varasichthys ariasi ARRATIA (length c. 19 cm) from the Upper Jurassic of northern Chile. Original: Universidad de Chile, Santiago, Chile.

Genus: *Varasichthys* ARRATIA, 1981.

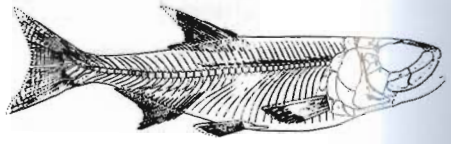
Geological range: Upper Jurassic.

Geographical distribution: South America.

Features: Small fishes to middle-sized fishes with slender elongate bodies. Head elongate. Snout somewhat rounded. Eyes relatively small. Dorsal fin approximately in the middle of the body, obliquely opposite the pelvic fins. Caudal fin forked.

Remarks: Probably gregarious.

Recent relatives: None. Died out in Upper Jurassic.



Varasichthys, reconstruction after ARRATIA.



Allothrissops salmoneus (de BLAINVILLE) (length c. 28 cm) from the Upper Jurassic of Solnhofen (Eichstätt), Bavaria, Germany. Original: Bayerische Staatssammlung für Paläontologie, Munich, Germany.

Genus: *Allothrissops* NYBELIN, 1964.

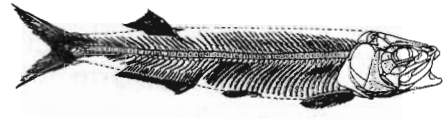
Geological range: Upper Jurassic to Lower Cretaceous.

Geographical distribution: Europe.

Features: Middle-sized fishes with very slender elongate bodies. Head small. Gape rather long. Eyes middle-sized. Dorsal fin small, situated very posteriorly, opposite the anal fin. Pelvic fins very small. Pectoral fins narrow and somewhat longer. Caudal fin small, moderately forked, with short lobes.

Remarks: Rapidly swimming predators.

Recent relatives: None. Died out in Lower Cretaceous.



Allothrissops, reconstruction after TAVERNE.



Chirocentrites coroninii HECKEL (length c. 33 cm) from the Lower Cretaceous of Komen, Jugoslavia. Original: Naturhistorisches Museum, Vienna, Austria.

Genus: *Chirocentrites* HECKEL, 1849.

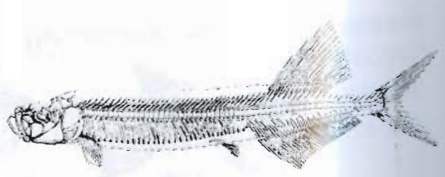
Geological range: Lower Cretaceous.

Geographical distribution: Europe.

Features: Middle-sized fishes with slender elongate bodies. Head shallow. Gape long and directed upwards. Eyes large. Dorsal fin located very posteriorly, obliquely opposite the anal fin. Pelvic fins very small. Pectoral fins narrow and somewhat longer. Caudal fin deeply forked, with long narrow lobes.

Remarks: Rapidly swimming predators.

Recent relatives: Genus extinct. Perhaps closely related to the wolf herrings of the genus *Chirocentrus*.



Chirocentrites, reconstruction after HECKEL.



Cladocyclus GARDNERI AGASSIZ (length c. 125 cm) from the Lower Cretaceous of Ceará, Brazil. Original: Interfoss, Munich, Germany.

Genus: *Cladocyclus* AGASSIZ, 1841.

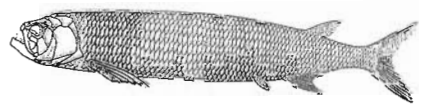
Geological range: Lower Cretaceous.

Geographical distribution: South America.

Features: Middle-sized to large fishes with slender elongate bodies. Head long and shallow. Gape long and directed upward. Eyes middle-sized. Jaws with powerful teeth. Dorsal fin relatively small, located very posteriorly, obliquely opposite the narrow anal fin. Pelvic fins small and narrow. Pectoral fins somewhat longer. Caudal fin deeply forked with long narrow lobes.

Remarks: Predatory fishes.

Recent relatives: Genus and family extinct. Perhaps distantly related to the wolf herrings of the family Chirocentridae.



Cladocyclus, after MAISEY.



Cooyoo australis Bartholomai & Lees (length c. 16 cm) from the Lower Cretaceous of Richmond, Queensland, Australia. Original: Queensland Museum, Brisbane, Queensland, Australia.

Genus: *Cooyoo* Bartholomai & Lees, 1987.

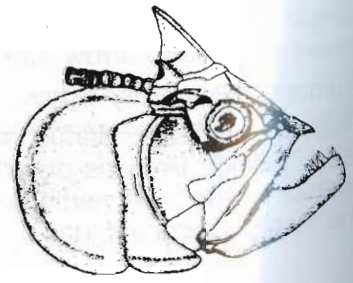
Geological range: Lower Cretaceous.

Geographical distribution: Australia.

Features: Middle-sized to large fishes with a big deep head. Snout rounded. Gape long and directed upward. Eyes large. Jaws with pointed teeth of differing shapes, anteriorly developed as grasping teeth. Characteristic horn-shaped process on the head.

Remarks: Formidable predators.

Recent relatives: None. Died out in Lower Cretaceous.



Cooyoo, reconstruction after Bartholomai & Lees.



Eubiodectes libanicus (Pictet & Humbert) (length c. 58 cm) from the Upper Cretaceous of the Lebanon. Original: Interfoss, Munich, Germany

Genus: *Eubiodectes* Hay, 1903.

Geological range: Upper Cretaceous.

Geographical distribution: Middle East.

Features: Middle-sized fishes of slender elongate shape. Head shallow. Gape long and directed upwards. Eyes relatively large. Jaws with pointed teeth. Dorsal fin small, located in the posterior third of the body, opposite the pelvic fins which are likewise small. Pectoral fins narrow and somewhat longer. Caudal fin deeply forked with slender lobes.

Remarks: Predators.

Recent relatives: Genus extinct. Perhaps related to wolf herrings of the family Chirocentridae.



Gillicus arcuatus (Cope) (length c. 157 cm) from the Upper Cretaceous of Kansas, U.S.A. Original: Siber & Siber Collection, Aathal, Switzerland.

Genus: *Gillicus* Hay, 1898.

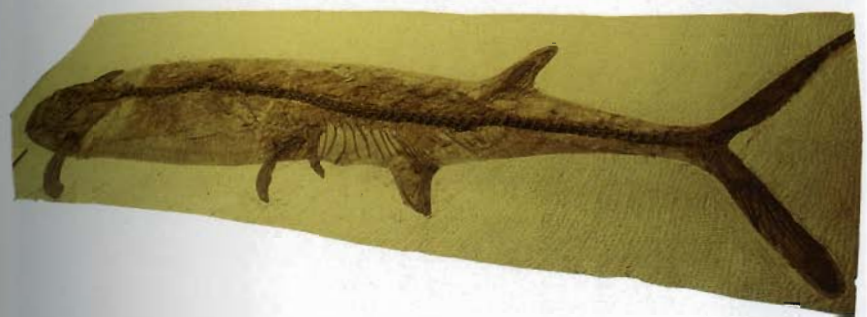
Geological range: Lower to Upper Cretaceous.

Geographical distribution: Europe, North America.

Features: Large fishes with elongate bodies. Head long and shallow. Gape long and directed upwards. Eyes relatively small. Jaws with pointed teeth. Dorsal fin pointed, located very posteriorly, opposite the anal fin which is likewise pointed. Pelvic fins small and narrow. Pectoral fins strikingly long and pointed. Caudal fin large, deeply forked, with long narrow lobes.

Remarks: Large predators.

Recent relatives: None. Died out in Upper Cretaceous.



Ichthyodectes ctenodon Cope (length c. 220 cm) from the Upper Cretaceous of Kansas, U.S.A. Original: Museum of Natural History, Lawrence, Kansas, U.S.A.

Genus: *Ichthyodectes* Cope, 1870.

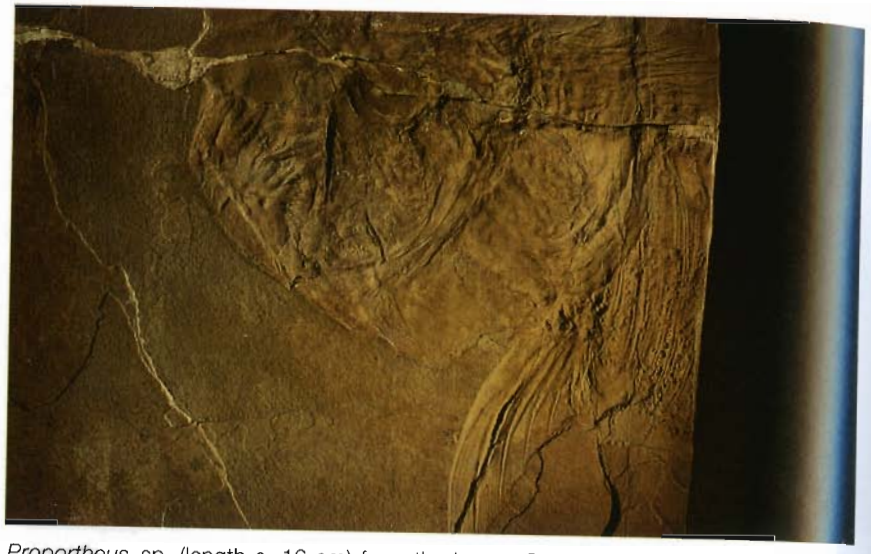
Geological range: Lower to Upper Cretaceous.

Geographical distribution: Europe, North America.

Features: Large fishes with slender elongate bodies. Head relatively small. Gape long. Dorsal fin small, in the posterior half of the body, opposite the somewhat larger anal fin. Pelvic fins small and narrow. Pectoral fins narrow and somewhat longer. Caudal fin very large, deeply forked, with long narrow lobes.

Remarks: Large predators.

Recent relatives: None. Died out in Upper Cretaceous.



Proportheus sp. (length c. 16 cm) from the Lower Cretaceous of Lesina, Yugoslavia. Original: Museum für Naturkunde, Berlin.

Genus: *Proportheus* JAEKEL, 1909.

Geological range: Lower Cretaceous.

Geographical distribution: Europe.

Features: Middle-sized fishes with massive heads. Eyes relatively small. Gape long and directed upwards. Upper and lower jaws with long pointed teeth of varying sizes, the anterior ones developed as grasping teeth. Pectoral fins very long and pointed.

Remarks: Dangerous predators.

Recent relatives: None. Died out in Lower Cretaceous.



Prymnites longiventer COPE (length c. 52 cm) from the Tertiary of Chiapas, Mexico. Original: National Museum of Natural History, Smithsonian Institution, Washington D.C., U.S.A.

Genus: *Prymnites* COPE, 1871.

Geological range: Tertiary.

Geographical distribution: Central America.

Features: Middle-sized fishes with slender elongate bodies. Head deep. Snout slightly rounded. Eyes relatively large. Dorsal fin small, located very posteriorly. Anal fin small and narrow. Pectoral fins long and narrow. Caudal fin forked.

Remarks: Predators.

Recent relatives: Genus extinct. Perhaps distantly related to wolf herrings of the family Chirocentridae.



Thrissops formosus AGASSIZ (length c. 28 cm) from the Upper Jurassic of Solnhofen (Schernfeld) Bavaria, Germany. Original: Jura-Museum, Eichstätt, Germany.

Genus: *Thrissops* AGASSIZ, 1883.

Geological range: Upper Jurassic to Upper Cretaceous.

Geographical distribution: Europe.

Features: Middle-sized fishes with rather laterally compressed bodies. Head small. Gape rather long. Jaws with small pointed teeth. Dorsal fin small and triangular, in the posterior third of the body, opposite the anal fin which is anteriorly pointed but more posteriorly forms a fringe. Pelvic fins very small. Pectoral fins long and narrow. Caudal fin large, deeply forked, with long narrow lobes.

Remarks: Rapidly swimming predators.

Recent relatives: Genus extinct, perhaps distantly related to wolf herrings of the family Chirocentridae.



Thrissops, reconstruction after TAVERNE.



Xiphactinus audax LEIDY (length c. 430 cm) from the Upper Cretaceous of Kansas, U.S.A. Cast: Tetra-Werke, Melle, Germany.

Genus: *Xiphactinus* LEIDY, 1870.

Synonyms: *Portheus*.

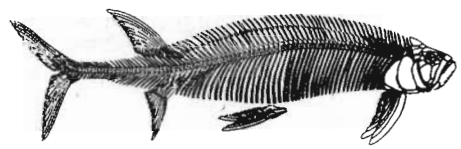
Geological range: Lower to Upper Cretaceous.

Geographical distribution: North America, Australia, Europe.

Features: Very large fishes with elongate bodies. Head elongate and shallow, with a horn-like process. Gape long, directed upwards, with long pointed teeth of various shapes, the anterior ones being developed as grasping teeth. Dorsal fin relatively small, somewhat behind the middle of the body. Anal and pelvic fins likewise small. Pectoral fins long, carried by a strong bony ray. Caudal fin very large, deeply forked, with the lobes broad at the base and pointed at the ends.

Remarks: Formidable predators.

Recent relatives: None. Died out in Lower Cretaceous.



Xiphactinus, reconstruction after OSBORN.



Saurodon leanus HAYS (length c. 20 cm) from the Upper Cretaceous of Kansas, U.S.A. Original: Field Museum of Natural History, Chicago, Illinois, U.S.A.

Genus: *Saurodon* HAYS, 1829.

Synonyms: *Daptinus*.

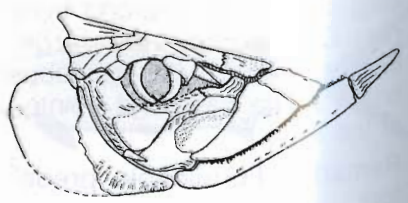
Geological range: Upper Cretaceous.

Geographical distribution: North America, Europe.

Features: Middle-sized fishes with shallow elongate heads. Snout elongate and somewhat rounded. Gape very long, with many pointed conical teeth. Lower jaw projecting.

Remarks: Formidable predators.

Recent relatives: None. Died out in Upper Cretaceous.



Saurodon, reconstruction after BARDACK.



Bananogmius evolutus (COPE) (length c. 76 cm) from the Upper Cretaceous of Kansas, U.S.A. Original: Museum of Natural History, Lawrence, Kansas, U.S.A.

Genus: *Bananogmius* WHITLEY, 1940.

Synonyms: *Ananogmius*, *Anogmius*.

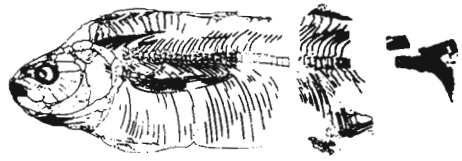
Geological range: Upper Cretaceous.

Geographical distribution: North America, Europe.

Features: Large fishes with elongate, relatively shallow heads. Snout rounded. Gape rather long. Eyes middle-sized. Jaws with small teeth. Dorsal fin small, located shortly behind the head.

Remarks: Probably sluggish swimmers.

Recent relatives: None. Died out in Upper Cretaceous.



Bananogmius, reconstruction after HAY.



Zanclites xenurus JORDAN (length c. 60 cm) from the Upper Cretaceous of Kansas. Original: Museum of Natural History, Lawrence, Kansas, U.S.A.

Genus: *Zanclites* JORDAN, 1925.

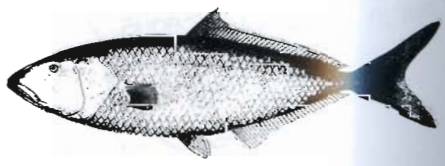
Geological range: Upper Cretaceous.

Geographical distribution: North America.

Features: Middle-sized fishes of elliptical outline. Head long and shallow. Snout pointed. Dorsal fin in the middle of the body, anteriorly with a point but running rearwards as a fringe, obliquely opposite the anal fin which is likewise fringe-like. Pelvic fins small. Pectoral fins located high on the body. Caudal fin large, deeply forked, with long lobes.

Remarks: Predators.

Recent relatives: None. Died out in the Upper Cretaceous.



Zanclites, reconstruction after JORDAN.



Unnamed fish (length c. 95 cm) from the Upper Jurassic of Solnhofen (Langenaltheim), Bavaria, Germany. Original: Bayerische Staatssammlung für Paläontologie, Munich, Germany.

Genus: Not named.

Geological range: Upper Jurassic.

Geographical distribution: Europe.

Features: Middle-sized to large fishes of elongate but nevertheless somewhat plump shape. Head relatively small and shallow. Snout pointed. Gape long and directed upwards. Powerful teeth. Dorsal fin small, located very posteriorly, obliquely opposite the anal fin which is also small. Pelvic fins narrow and pointed. Pectoral fins strikingly long and narrow.

Remarks: This fish may belong to the family Pachycormidae.

Recent relatives: None. Died out in Upper Jurassic.



Protobrama avus WOODWARD (length c. 7 cm) from the Upper Cretaceous of the Lebanon. Original: Naturhistoriska Riksmuseet, Stockholm, Sweden.

Genus: *Protobrama* WOODWARD, 1942.

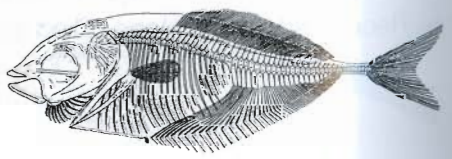
Geological range: Upper Cretaceous.

Geographical distribution: Middle East.

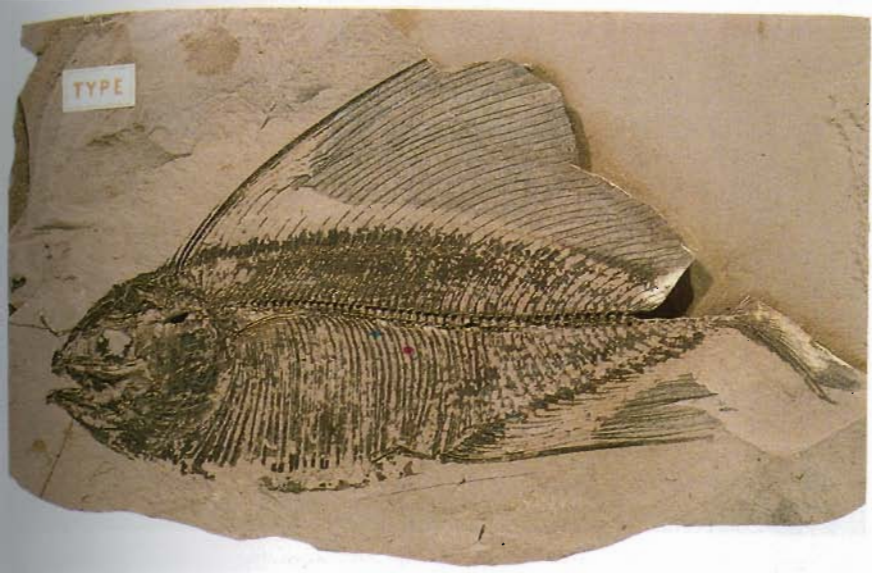
Features: Small fishes of approximately elliptical outline. Head shallow. Snout pointed. Eyes large. Dorsal fin low, beginning anteriorly in front of the middle of the body and running rearwards as a fringe, opposite the anal fin which is similarly constructed. Pectoral fins rounded elongate and set high on the body. Caudal fin stalked, deeply concave posteriorly with broad lobes.

Remarks: Probably rather sluggish fishes, perhaps plant-eating.

Recent relatives: None. Died out in Upper Cretaceous.



Protobrama, reconstruction after PATTERSON.



Tselfatia formosa ARAMBOURG (length c. 13 cm) from the Lower Cretaceous of Tselfat, Morocco. Original: Muséum National d'Histoire Naturelle, Paris, France. Photograph: Serette, Paris.

Genus: *Tselfatia* ARAMBOURG, 1958.

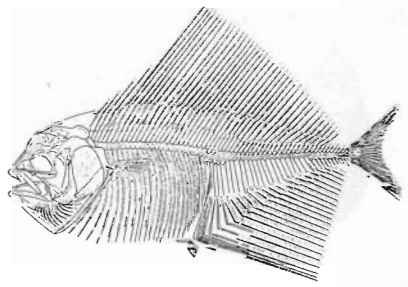
Geological range: Lower Cretaceous.

Geographical distribution: North Africa.

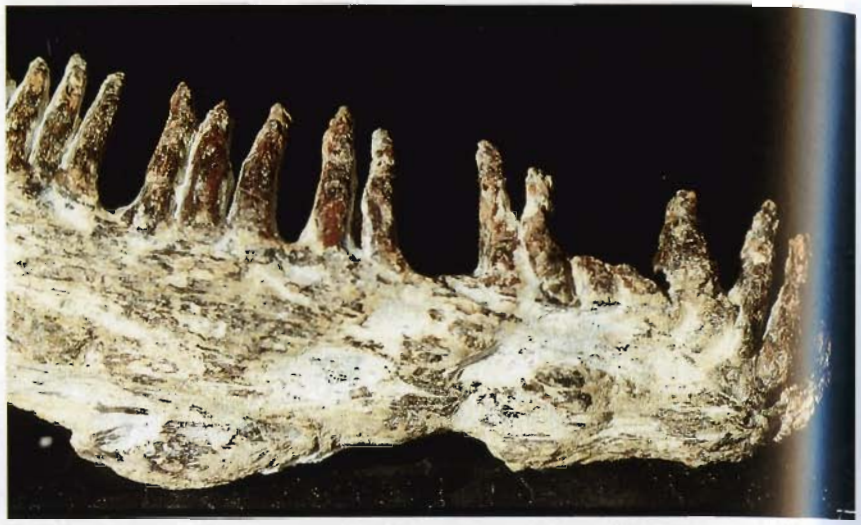
Features: Small to middle-sized fishes with bodies deep anteriorly and tapering strongly behind. Head rounded. Eyes large. Gape rather long. Dorsal fin beginning just behind the head, anteriorly increasing strongly in height and then decreasing to the end of the body. Anal fin very large and similar in shape to the dorsal fin. Pelvic and pectoral fins very small. Caudal fin relatively small and forked.

Remarks: Probably not aggressive fishes.

Recent relatives: None. Died out in Cretaceous.



Tselfatia, reconstruction after PATTERSON.



Brychaetus muelleri WOODWARD (length c. 19 cm) from the Eocene of Maryland, U.S.A. Original: National Museum of Natural History, Smithsonian Institution, Washington, D.C., U.S.A.

Genus: *Brychaetus* AGASSIZ, 1845.

Synonyms: *Platops*, *Pomphractus*.

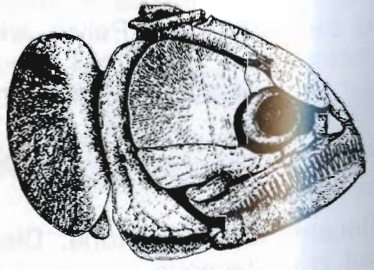
Geological range: Upper Cretaceous to Paleocene.

Geographical distribution: Europe, North America, North Africa.

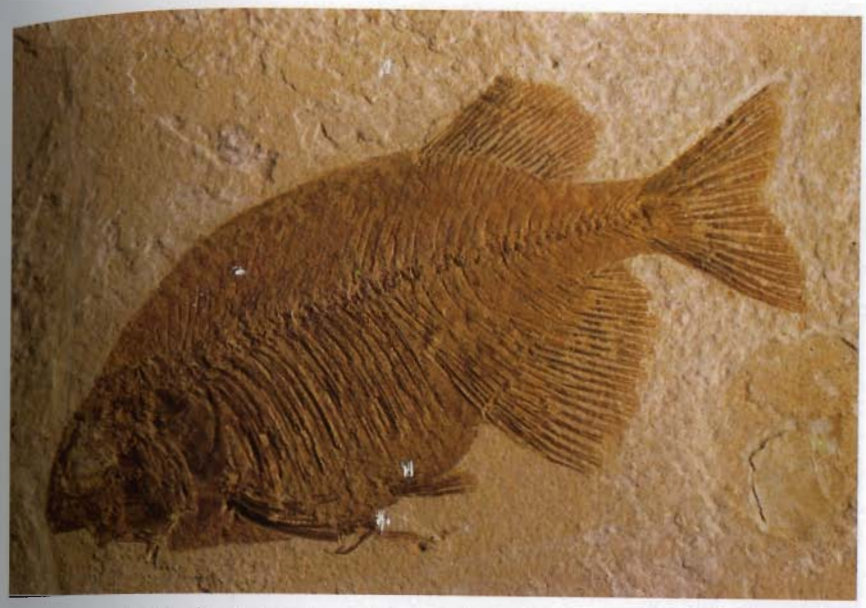
Features: Middle-sized to large fishes with powerful jaws. Teeth extremely long and not very pointed.

Remarks: Fresh-water fishes, probably predators.

Recent relatives: None. Died out in Paleocene.



Brychaetus, reconstruction after TAVERNE.



Phareodus testis (COPE) (length c. 31 cm) from the Eocene of Wyoming, U.S.A. Original: Frickhinger Collection, Munich, Germany.

Genus: *Phareodus* LEIDY, 1873.

Synonyms: *Dapedoglossus*.

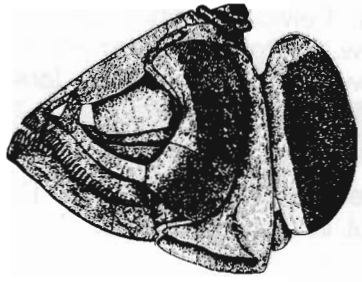
Geological range: Middle Eocene to Oligocene.

Geographical distribution: North America, Australia.

Features: Middle-sized fishes of oval outline. Head small. Snout slightly pointed. Gape rather long. Eyes relatively large. Dorsal fin broad at the base, posterior in position, opposite the anal fin which is larger. Pelvic fins small. Pectoral fins longer and narrow. Caudal fin slightly forked, with broad lobes.

Remarks: Fresh-water fishes.

Recent relatives: Genus extinct. Related to recent bony tongues of the family Osteoglossidae, such as *Arapaima* and *Osteoglossum*. The butterfly fish *Pantodon* is also a distant relative.



Phareodus, reconstruction after TAVERNE.



Lycoptera davidi SAUVAGE (length c. 8 cm) from the Upper Jurassic of Manchuria. Original: Staatliches Museum für Naturkunde, Stuttgart, Germany.

Genus: *Lycoptera* MÜLLER, 1848.

Synonyms: *Asiatolepis*.

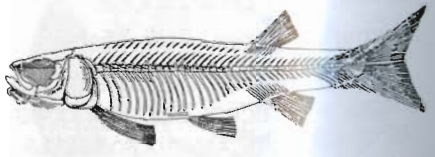
Geological range: Upper Jurassic.

Geographical distribution: East Asia.

Features: Small fishes with slender elongate bodies. Head shallow. Snout rounded. Gape rather long and directed upwards. Dorsal fin in the posterior half of the body, opposite the anal fin. Pelvic fins short and narrow. Pectoral fins long and narrow. Caudal fin slightly forked with pointed lobes.

Remarks: Probably gregarious.

Recent relatives: None. Died out in Upper Jurassic.



Lycoptera, reconstruction after REIS.



Eohiodon falcatus GRANDE (length c. 17 cm) from the Eocene of Wyoming, U.S.A. Original: Field Museum of Natural History, Chicago, Illinois.

Genus: *Eohiodon* CAVENDER, 1966.

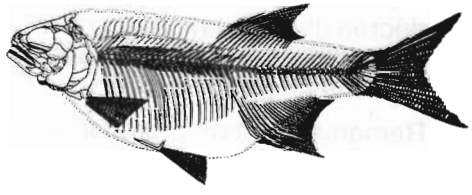
Geological range: Paleocene to Eocene.

Geographical distribution: North America.

Features: Small to middle-sized fishes of rather laterally compressed shape. Head short and deep. Snout rounded. Gape rather long, with small pointed teeth. Eyes very large. Dorsal fin shortly behind the middle of the body, anteriorly pointed but decreasing in height posteriorly with a concave postero-dorsal margin, obliquely opposite the anal fin which is similar in shape but broader. Pelvic fins small. Pectoral fins somewhat larger. Caudal fin strongly forked with pointed lobes.

Remarks: Fresh-water fishes.

Recent relatives: Genus extinct. Closely related to the recent genus *Hiodon* and more distantly related to knife fishes of the family Notopteridae.



Eohiodon, reconstruction after GRANDE.



Anaethalion knorri (de BLAINVILLE) (length c. 17 cm) from the Upper Jurassic of Solnhofen (Eichstätt), Bavaria, Germany. Original: Tischlinger Collection, Stammham, Germany. Photo: Tischlinger

Genus: *Anaethalion* WHITE, 1938.

Synonyms: *Aethalion*.

Geological range: Upper Jurassic to Lower Cretaceous.

Geographical distribution: Europe.

Features: Small to middle-sized fishes of slender shape. Head elongate and relatively shallow. Snout pointed. Gape rather long. Eyes large. Dorsal fin pointed, approximately in the middle of the body, opposite the very narrow pelvic fins. Pectoral fins likewise narrow. Anal fin anteriorly with a point but broad-based and decreasing in height posteriorly. Caudal fin deeply forked with rather broad lobes.

Remarks: Probably gregarious.

Recent relatives: Genus extinct. Related to the tenpounders and probably also to the herrings.



Anaethalion, after FOREY.



Apsopelix agilis (STEWART) (length c. 31 cm) from the Upper Cretaceous of Kansas, U.S.A. Original: The Natural History Museum, London, U.K. (P 9184)

Genus: *Apsopelix* COPE, 1871.

Synonyms: *Helmintholepis*, *Leptichthys*, *Palaeoclupea*, *Pelecorapis*, *Syllaemus*.

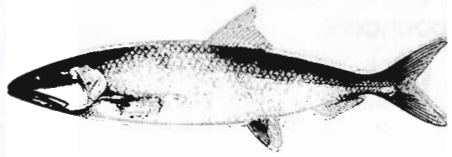
Geological range: Upper Cretaceous.

Geographical distribution: Europe, North America.

Features: Middle-sized fishes of slender shape. Head long and shallow. Snout pointed. Eyes small. Dorsal fin triangular, opposite the pointed pelvic fins. Anal fin low, broad-based. Pectoral fins long and narrow. Caudal fin forked, with broad lobes. Scales rhombic.

Remarks: Probably gregarious.

Recent relatives: Genus extinct. Probably related to recent tarpons.



Apsopelix, reconstruction after JORDAN.



Crossognathus sabaudianus PICTET (length c. 22 cm) from the Lower Cretaceous of Westphalia, Germany. Original: Museum für Geologie und Paläontologie, Tübingen, Germany.

Genus: *Crossognathus* PICTET, 1858.

Geological range: Lower Cretaceous.

Geographical distribution: Europe.

Features: Middle-sized fishes of slender shape. Head long and shallow. Snout pointed. Gape relatively long. Dorsal fin slightly in front of the middle of the body. Caudal fin deeply forked, with narrow lobes.

Remarks: Probably gregarious.

Recent relatives: Genus extinct. Possibly related to recent tenpounders.



Crossognathus, reconstruction after TAVERNE.



Brannerion vestitum JORDAN & BRANNER (length c. 33 cm) from the Lower Cretaceous of Ceará, Brazil. Original: Interfoss, Munich, Germany.

Genus: *Brannerion* JORDAN, 1919.

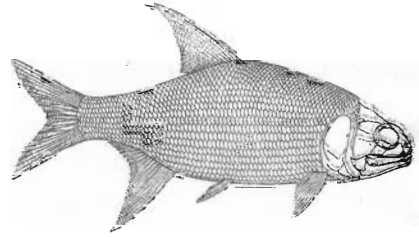
Geological range: Lower Cretaceous.

Geographical distribution: South America.

Features: Middle-sized fishes with somewhat compressed bodies. Head deep. Snout rounded. Dorsal fin tall and pointed, in the posterior half of the body, opposite the anal fin which is likewise pointed. Pectoral fins long and narrow. Caudal fin forked, with broad lobes.

Remarks: Probably fed partly on plants.

Recent relatives: None. Died out in Lower Cretaceous.



Brannerion, reconstruction after MAISEY.



Dastilbe elongatus Silva Santos (length c. 6 cm) from the Lower Cretaceous of Ceará, Brazil. Original: American Museum of Natural History, New York, N.Y., U.S.A.

Genus: *Dastilbe* Jordan, 1910.

Geological range: Lower Cretaceous.

Geographical distribution: South America.

Features: Small to very small fishes with slender elongate bodies. Head shallow. Snout pointed. Eyes middle-sized. Dorsal fin approximately in the middle of the body, opposite the pelvic fins. Caudal fin deeply forked, with relatively broad lobes.

Remarks: Gregarious.

Recent relatives: None. Died out in Lower Cretaceous.



Dastile, after Maisey



Davichthys gardneri Forey (length c. 9 cm) from the Upper Cretaceous of Lebanon. Original: Field Museum of Natural History, Chicago, Illinois, U.S.A.

Genus: *Davichthys* Forey, 1973.

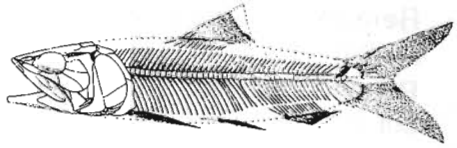
Geological range: Upper Cretaceous.

Geographical distribution: Middle East.

Features: Small fishes with slender bodies. Head deep. Gape rather long. Dorsal fin long and pointed, somewhat behind the middle of the body, obliquely opposite the very small pelvic fins. Anal fin small and pectoral fins narrow. Caudal fin forked, with relatively broad lobes.

Remarks: Probably gregarious.

Recent relatives: Genus extinct. Distantly related to recent tenpounders of the family Elopidae.



Davichthys, reconstruction after Forey.



Paraelops cearensis Silva Santos (length c. 70 cm) from the Lower Cretaceous of Ceará, Brazil. Original: Kandler collection, Augsburg, Germany.

Genus: *Paraelops* Silva Santos, 1971.

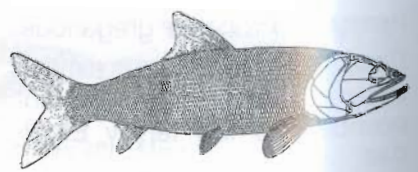
Geological range: Lower Cretaceous.

Geographical distribution: South America.

Features: Middle-sized to large fishes with slender elongate bodies. Head shallow. Snout slightly pointed. Gape rather long. Eyes middle-sized. Dorsal fin in the posterior half of the body, obtusely triangular, scaly, approximately opposite the small pelvic fins. Anal fin likewise obtusely triangular. Caudal fin deeply forked, with broad lobes.

Remarks: Rapidly swimming predators.

Recent relatives: None. Died out in Lower Cretaceous.



Paraelops, after Maisey.



Parasyllaemus gracilis Sternberg (length c. 31 cm) from the Upper Cretaceous of Manitoba, Canada. Original: Royal Ontario Museum, Toronto, Canada.

Genus: *Parasyllaemus*.

Geological range: Upper Cretaceous.

Geographical distribution: North America.

Features: Middle-sized fishes with slender elongate bodies. Head long and shallow. Gape long. Eyes large. Dorsal fin approximately in the middle of the body, opposite the pelvic fins. Anal fin pointed. Pectoral fins long and narrow. Caudal fin deeply divided with narrow lobes. Scales rounded.

Remarks: The pointed mouth suggests that it fed on worms and other burrowing animals.

Recent relatives: Genus extinct. Possibly distantly related to tenpounders of the family Elopidae.



Spaniodon elongatus PICTET (length c. 18 cm) from the Upper Cretaceous of the Lebanon. Original: Field Museum of Natural History, Chicago, Illinois, U.S.A.

Genus: *Spaniodon* PICTET, 1851.

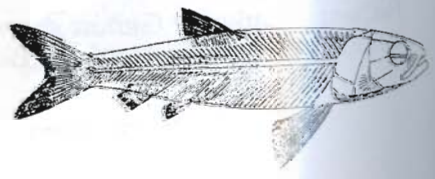
Geological range: Upper Cretaceous.

Geographical distribution: Middle East.

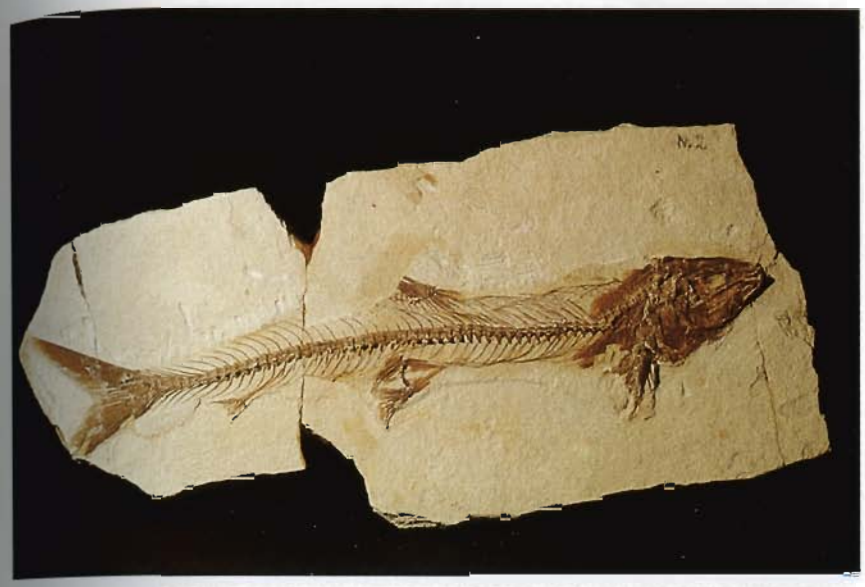
Features: Small to middle-sized fishes with slender bodies. Head long and shallow. Snout somewhat rounded. Gape rather long. Eyes large. Dorsal fin triangular, slightly behind the middle of the body, obliquely opposite the very small pelvic fins. Anal fin somewhat larger. Pectoral fins fan-shaped. Caudal fin divided with broad lobes.

Remarks: Probably gregarious.

Recent relatives: Genus extinct. Possibly related to recent tenpounders of the family Elopidae.



Spaniodon, reconstruction after WOODWARD.



Unnamed fish (length c. 21 cm) from the Cretaceous of Nardo, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: Unnamed.

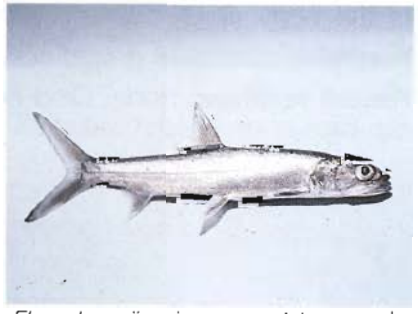
Geological range: Cretaceous.

Geographical distribution: Europe.

Features: Small to middle-sized fishes of slender shape. Head long and shallow. Snout pointed. Gape relatively long. Eyes small. Jaws with pointed teeth. Dorsal fin pointed, somewhat anterior to the middle of the body, opposite the small fan-shaped pelvic fins. Anal fin very small. Caudal fin deeply forked, with the lobes broad at the base and narrow towards the tips.

Remarks: Probably gregarious.

Recent relatives: Genus extinct. Possibly related to recent tenpounders of the genus *Elops*.



Elops hawaiiensis, a recent tenpounder.



Daitingichthys tischlingeri ARRATIA (length c. 30 cm) from the Upper Jurassic of Solnhofen (Daiting), Bavaria, Germany. Original: Tischlinger Collection, Stammham, Germany.

Genus: *Daitingichthys* ARRATIA, 1987.

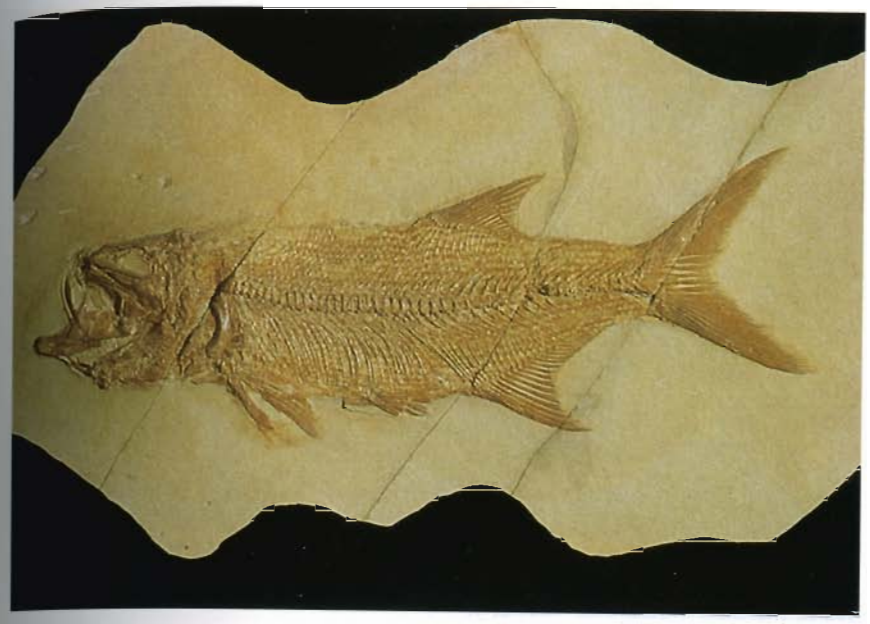
Geological range: Upper Jurassic.

Geographical distribution: Europe.

Features: Slender fishes with elongate bodies. Head shallow. Gape rather long. Eyes small. Dorsal fin triangular, in the posterior half of the body. Anal fin likewise small and somewhat more posterior. Pelvic fins very small and approximately in the middle of the body. Body covered with relatively large cycloid scales.

Remarks: Probably gregarious.

Recent relatives: None. Died out in Jurassic.



Pachythrissops propterus WAGNER (length c. 38 cm) from the Upper Jurassic of Solnhofen (Painten), Bavaria, Germany. Original: Bayerische Staatssammlung für Paläontologie, Munich, Germany.

Genus: *Pachythrissops* WOODWARD, 1919.

Geological range: Upper Jurassic to Lower Cretaceous.

Geographical distribution: Europe.

Features: Middle-sized fishes with rather laterally compressed bodies. Head deep. Gape rather long. Dorsal fin acute-triangular, somewhat behind the middle of the body, opposite small pelvic fins. Anal fin likewise acute-triangular. Pectoral fins narrow. Caudal fin deeply forked with relatively broad lobes.

Remarks: Probably rather slow swimmers which fed partly on plants.

Recent relatives: Genus extinct. Possibly related to recent tarpons of the family Megalopidae.



Sendenhorstia granulata (von der MARCK) (length c. 9 cm) from the Upper Cretaceous of Sendenhorst, Westphalia, Germany. Original: Geologisch-Paläontologisches Museum, Münster, Westphalia, Germany.

Genus: *Sendenhorstia* WHITE & MOY-THOMAS, 1941.

Synonyms: *Microcoelia*.

Geological range: Upper Cretaceous.

Geographical distribution: Europe.

Features: Small fishes with somewhat laterally compressed bodies. Head large and deep. Gape rather long. Dorsal fin triangular, approximately in the middle of the body. Anal fin likewise triangular. Pelvic fins small. Pectoral fins narrow. Caudal fin forked with broad lobes.

Remarks: Probably gregarious.

Recent relatives: Genus extinct. Related to tarpons of the family Megalopidae.



Megalops cyprinoides, a recent tarpon.



Osmeroides sardinoides PICTET (length c. 8 cm) from the Upper Cretaceous of the Lebanon. Original: Naturmuseum Senckenberg, Frankfurt-am-Main, Germany.

Genus: *Osmeroides* AGASSIZ, 1834.

Synonym: *Dermatoptychus*.

Geological range: Lower to Upper Cretaceous.

Geographical distribution: Europe, Middle East.

Features: Small fishes with elongate streamlined bodies. Head long and shallow. Snout pointed. Eyes large. Dorsal fin triangular, approximately in the middle of the body, opposite the short and narrow pelvic fins. Anal fin small. Pectoral fins narrow. Caudal fin forked, lobes broad at the base and pointed at the ends. Scales rounded.

Remarks: Probably gregarious.

Recent relatives: Genus extinct. Perhaps distantly related to recent bonefishes of the family Albulidae.



Osmeroides, reconstruction after ARAMBOURG.



Hajulia multidens WOODWARD (length c. 7 cm) from the Upper Cretaceous of the Lebanon. Original: The Natural History Museum, London, U.K. (P 13906)

Genus: *Hajulia* WOODWARD, 1942.

Geological range: Upper Cretaceous.

Geographical distribution: Middle East.

Features: Small fishes with slender bodies. Head long and shallow. Snout pointed. Gape long. Dorsal fin approximately in the middle of the body, opposite the pelvic fins. Anal fin short. Caudal fin forked, with relatively broad lobes.

Remarks: Probably fed on worms and other small animals.

Recent relatives: Genus extinct. Possibly related to the recent genus *Pterothrissus*.



Istieus macrocephalus AGASSIZ (length c. 33 cm) from the Upper Cretaceous of Sendenhorst, Westphalia, Germany. Original: Geologisch-Paläontologisches Museum, Münster, Germany.

Genus: *Istieus* AGASSIZ, 1844.

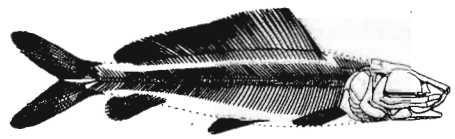
Geological range: Upper Cretaceous.

Geographical distribution: Europe.

Features: Middle-sized fishes with slender elongate bodies. Head long and shallow. Gape short. Eyes large. Dorsal fin elongate and fringe-like, beginning in the anterior third of the body and decreasing in height posteriorly. Anal fin elongate and rounded. Pelvic fins small. Pectoral fins narrow. Caudal fin deeply forked, with broad lobes.

Remarks: These fishes, like their recent relatives, may have fed mainly on worms snails and other small animals.

Recent relatives: Genus extinct. Related to the recent genus *Pterothrissus*.



Istieus, reconstruction after FOREY.



Thrissopteroides elongatus von der MARCK (length c. 20 cm) from the Upper Cretaceous of Sendenhorst, Westphalia, Germany. Original: Geologisch-Paläontologisches Museum, Münster, Westphalia, Germany.

Genus: *Thrissipteroides* WOODWARD, 1898.

Geological range: Upper Cretaceous.

Geographical distribution: Europe, Middle East.

Features: Small to middle-sized fishes with elongate, very slender bodies. Head shallow and elongate. Snout pointed. Dorsal fin in the posterior half of the body, opposite the narrow pelvic fins. Anal fin likewise narrow. Caudal fin deeply forked, with very narrow lobes.

Remarks: Probably fed on worms and other small animals living in the sea bottom.

Recent relatives: None. Died out in the Upper Cretaceous.



Lebonichthys lewisi (DAVIS) (length c. 30 cm.) from the Upper Cretaceous of the Lebanon. Original: The Natural History Museum, London, U.K. (P 6024)

Genus: *Lebonichthys* FOREY, 1973.

Geological range: Upper Cretaceous.

Geographical distribution: Middle East.

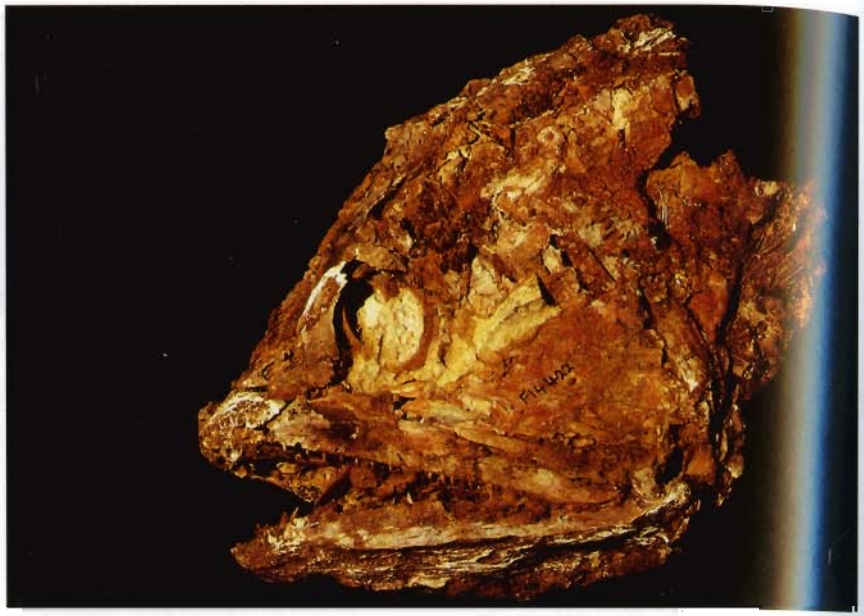
Features: Small to middle-sized fishes of very slender elongate outline. Head long and shallow. Snout pointed. Gape rather long. Eyes large. Dorsal fin broad-based, beginning in the anterior half of the body and decreasing in height posteriorly, opposite the very narrow pelvic fins. Anal fin triangular. Pectoral fins long and narrow. Caudal fin forked with relatively broad lobes.

Remarks: Probably gregarious.

Recent relatives: Genus extinct. Possibly related to recent bonefishes of the family Albulidae.



Albula sp., a recent bonefish. Lithograph from CUVIER.



Pachyrhizodus marathonensis (ETHERIDGE) (length c. 22 cm) from the Lower Cretaceous of Queensland, Australia. Original: Queensland Museum, Brisbane, Australia.

Genus: *Pachyrhizodus* AGASSIZ, 1850.

Synonym: *Thrissopater*.

Geological range: Lower Cretaceous.

Geographical distribution: Europe, North America, Australia.

Features: Middle-sized to large fishes with deep heads. Snout pointed. Gape long, with pointed teeth. Eyes large.

Remarks: Predators.

Recent relatives: None. Died out in Lower Cretaceous.



Rhacolepis buccalis AGASSIZ (length c. 14 cm) from the Lower Cretaceous of Ceará, Brazil. Original: Frickhinger Collection, Munich, Germany.

Genus: *Rhacolepis* AGASSIZ, 1841.

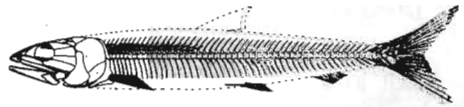
Geological range: Lower Cretaceous.

Geographical distribution: South America.

Features: Small to middle-sized fishes with slender, very streamlined bodies. Head long and shallow. Snout pointed. Gape long. Eyes relatively large. Dorsal fin in the posterior half of the body. Anal fin small. Pelvic fins very small. Pectoral fins narrow and somewhat longer. Caudal fin deeply forked, with narrow pointed lobes. Scales rhombic.

Remarks: Probably gregarious.

Recent relatives: None. Died out in Lower Cretaceous.



Rhacolepis, reconstruction after FOREY.



Notelops brama AGASSIZ (length c. 73 cm) from the Lower Cretaceous of Ceará, Brazil. Original: Frickhinger Collection, Munich, Germany.

Genus: *Notelops* WOODWARD, 1901.

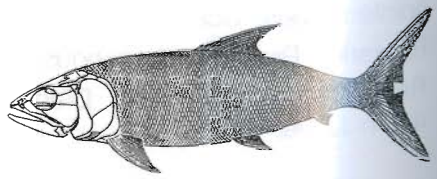
Geological range: Lower Cretaceous.

Geographical distribution: South America.

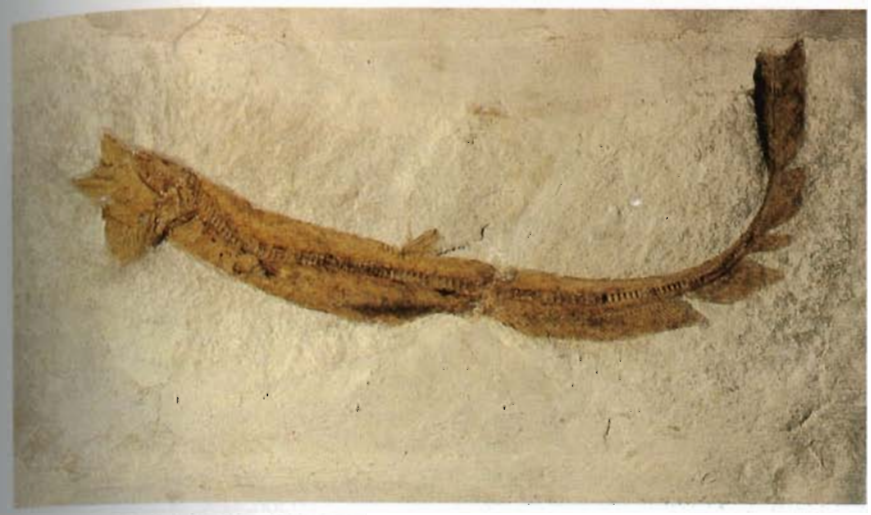
Features: Middle-sized fishes with elongate streamlined bodies. Head elongate and shallow. Snout pointed. Gape very long. Eyes large. Dorsal fin relatively tall, probably ending distally in a point, obliquely opposite the narrow anal fin. Pelvic fins very small. Pectoral fins long and narrow. Caudal fin strikingly large, deeply forked, with narrow, strongly divergent lobes.

Remarks: Rapidly swimming predators.

Recent relatives: None. Died out in Lower Cretaceous.



Notelops, after MAISEY.



Echidnocephalus troscheli (von der MARCK) (length c. 30 cm) from the Upper Cretaceous of Sendenhorst, Westphalia, Germany. Original: Geologisch-Paläontologisches Museum, Münster, Westphalia, Germany.

Genus: *Echidnocephalus* von der MARCK, 1858.

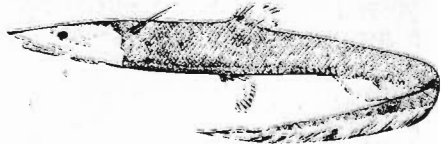
Geological range: Upper Cretaceous.

Geographical distribution: Europe, North Africa.

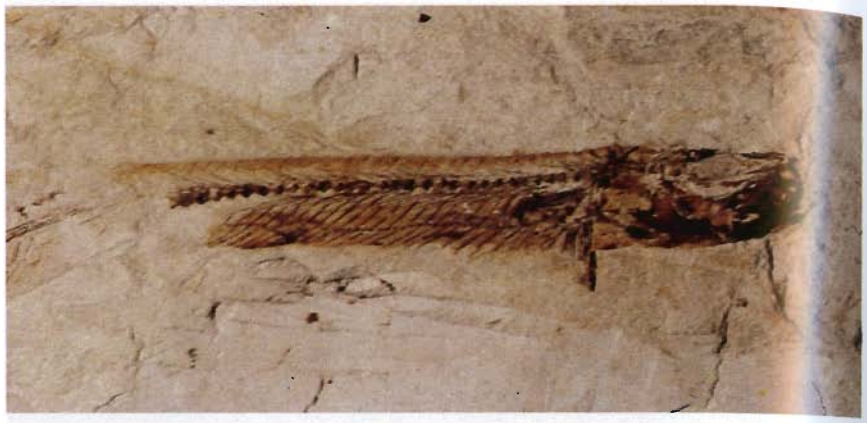
Features: Middle-sized very slender fishes of eel-like shape. Head long and shallow. Dorsal fin very small, somewhat in front of the middle of the body. Anal fin fringe-like, reaching from the point of the tail to the middle of the body. Fins without spines.

Remarks: Predators.

Recent relatives: Genus extinct. Related to recent halosaurs of the family Halosauridae.



Halosauropsis macrochir, a recent halosaur (after SMITH).



Pronotacanthus sahelalmae Davis (length c. 14 cm) from the Upper Cretaceous of the Lebanon. Original: The Natural History Museum, London, U.K. (49542)

Genus: *Pronotacanthus* Woodward, 1900.

Geological range: Upper Cretaceous to Oligocene.

Geographical distribution: Europe, Middle East.

Features: Small to middle-sized fishes of elongate eel-like shape. Body ending posteriorly in a point. Head long and shallow. Snout rounded. Gape directed downwards. Eyes large. Dorsal fin replaced by a row of disconnected spines. Anal fin fringe-like.

Remarks: Predators.

Recent relatives: Genus extinct. Related to the recent spiny eel *Notacanthus*, now found living in the deep sea.



Notacanthus sp., a recent spiny eel. Lithograph from Bloch.



Anguilla pachyura Agassiz (length c. 87 cm) from the Miocene of Öhningen, Württemberg, Germany. Original: Teylers Museum, Haarlem, Netherlands.

Genus: *Anguilla* Shaw, 1803.

Geological range: Miocene to recent.

Geographical distribution: Europe.

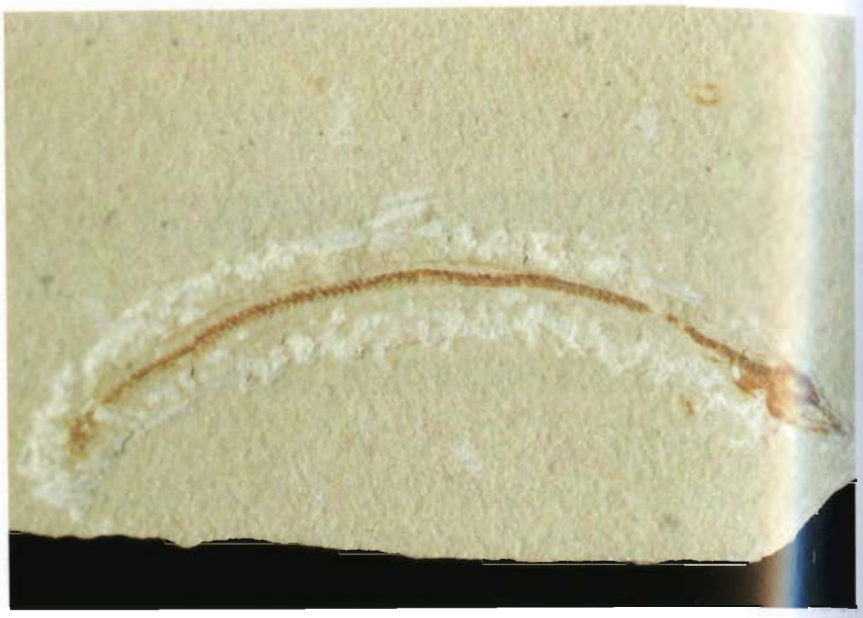
Features: Middle-sized to large fishes with powerful eel-like bodies. Head shallow. Snout pointed. Eyes small. Dorsal and anal fins fused to form a fringe which reaches to the posterior pointed end of the body. Pectoral fins small and rounded.

Remarks: Predators.

Recent relatives: Closely related to recent eels of the genus *Anguilla*.



Anguilla anguilla, the European eel.



Anguillavus quadripinnis HAY (length c. 6.5 cm) from the Upper Cretaceous of the Lebanon. Original: American Museum of Natural History, New York, N.Y., U.S.A.

Genus: *Anguillavus* HAY, 1903.

Geological range: Upper Cretaceous.

Geographical distribution: Middle East.

Features: Small fishes with narrow eel-like bodies. Head shallow. Snout pointed. Eyes small. Dorsal and anal fins joined to form a low fringe running to the pointed posterior end of the body. Pectoral fins with eight rays.

Remarks: Probably fed on worms, crustaceans and other small animals.

Recent relatives: One of the earliest eels. Genus extinct. Perhaps nevertheless distantly related to recent eels.



Dalpiaziella brevicauda CADROBBI (length c. 30 cm) from the Middle Eocene of Bolca, Italy. Original: Università di Padova, Padua, Italy.

Genus: *Dalpiaziella* CADROBBI, 1962.

Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Middle-sized to large fishes with elongate moray-eel-like bodies. Head shallow. Gape very long. Eyes small. Dorsal fin begins just behind the head and runs around the posterior end of the body into the anal fin which reaches to the middle of the ventral surface. Pectoral fins small.

Remarks: Predators. Probably lived like moray eels.

Recent relatives: None. Died out in the Eocene.



Dalpiazielliya, reconstruction after BLOT.



Paranguilla tigrina (Agassiz) (length c. 30 cm) from the Middle Eocene of Bolca, Italy. Original: Bayerische Staatssammlung für Paläontologie, Munich, Germany.

Genus: *Paranguilla* Bleeker, 1864.

Geological range: Middle Eocene.

Geographical distribution: Europe.

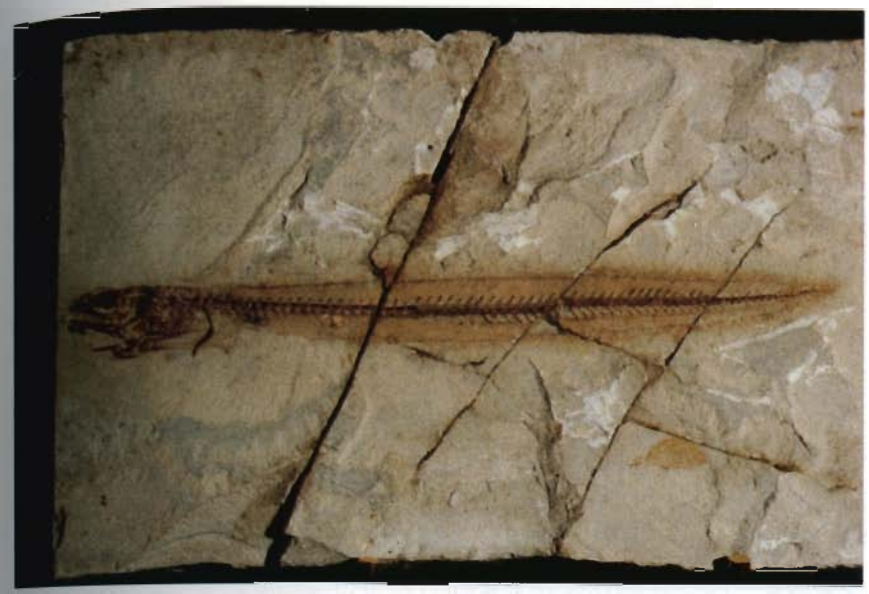
Features: Middle-sized fishes with rather broad eel-shaped bodies. Head deep. Snout pointed. Eyes small. Dorsal and anal fins joined to form a relatively tall fringe which begins immediately behind the head and runs to the pointed posterior end of the body. Pectoral fins small and rounded, located somewhat behind the beginning of the fringing fin.

Remarks: Predators.

Recent relatives: Genus extinct. Perhaps distantly related to recent moray eels.



Muraena helena, the Mediterranean moray eel.



Eomyrophis latispinus Agassiz (length c. 18 cm) from the Middle Eocene of Bolca, Italy. Original: Bayerische Staatssammlung für Paläontologie, Munich, Germany.

Genus: *Eomyrophis* Whitley, 1950.

Synonyms: *Eomyrus*.

Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Small to middle-sized fishes with slender eel-like bodies. Head shallow. Snout pointed. Eyes small. Dorsal fin and anal fins run together to form a low fringe which begins shortly behind the head and extends to the pointed posterior end of the body. Pectoral fins small.

Remarks: Probably fed on crustaceans and other small animals.

Recent relatives: Genus extinct. Probably related to recent false morays of the family Xenocongridae.



Kaupichthys sp., a recent false moray.



Mylomyrus frangens WOODWARD (length c. 31 cm) from the Eocene of Tura, Egypt. Original: The Natural History Museum, London, U.K. (P14484).

Genus: *Mylomyrus* WOODWARD, 1910.

Geological range: Eocene.

Geographical distribution: Northern Africa.

Features: Middle-sized fishes with slender elongate eel-shaped bodies. Head shallow. Snout pointed. Eyes small. Dorsal and anal fins run together as a fringe which is broad anteriorly but becomes narrower towards the pointed posterior end of the body. Jaws with obvious teeth. Pectoral fins small.

Remarks: Probably fed on worms, crustaceans and other small animals.

Recent relatives: Genus extinct. Possibly related to recent false morays.



Whitapodus breviculus (AGASSIZ) (length c. 7 cm) from the Middle Eocene of Bolca, Italy. Original: The Natural History Museum, London, U.K. (P24406a).

Genus: *Whitapodus* BLOT, 1980.

Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Small fishes of narrow eel-like shape. Head shallow. Snout pointed. Eyes small. Dorsal and anal fins join to form a fringe which is low anteriorly, broadens posteriorly, and then tapers again toward the pointed posterior end of the body.

Remarks: Probably fed on worms, crustaceans and other small animals.

Recent relatives: Genus extinct. Probably related to recent false morays.



Whitapodus, reconstruction after BLOT.



Proteomyris ventralis (Agassiz) (length c. 20 cm) from the Middle Eocene of Bolca, Italy. Original: Teylers Museum, Haarlem, Netherlands.

Genus: *Proteomyris* Cadrobbi, 1962.

Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Small to fishes with very slender, elongate, eel-shaped bodies. Head shallow. Snout pointed. Eyes small. Dorsal and anal fins run together as a low fringe which begins shortly behind the head and runs to the pointed posterior end of the body. Pectoral fins very small, located just beneath the anterior end of the fringe.

Remarks: Probably fed on worms, crustaceans and other small animals.

Recent relatives: None. Died out in Eocene.



Proteomyrus, reconstruction after Blot.



Anguilloides branchiostegalis (Eastman) (length c. 38 cm) from the Middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Anguilloides* Cadrobbi, 1962.

Geological range: Middle Eocene.

Geographical distribution: Europe.

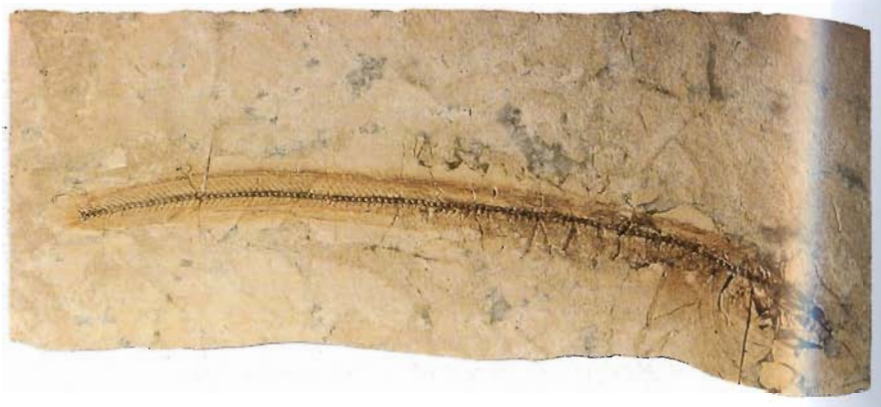
Features: Middle-sized fishes with narrow eel-shaped bodies. Head shallow. Snout pointed. Eyes small. Dorsal and anal fins run together as a low fringe which begins shortly behind the head and runs to the pointed posterior end of the body. Pectoral fins very small and rounded.

Remarks: Probably fed on worms, crustaceans and other small animals.

Recent relatives: None. Died out in Middle Eocene.



Anguilloides, reconstruction after Blot.



Veronanguilla ruffoi Blot (length c. 30 cm) from the Middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Veronanguilla* Blot, 1978.

Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Small to middle-sized fishes with very slender eel-shaped bodies. Head shallow. Snout pointed. Gape long. Dorsal fin low and fringe-like, begins in front of the middle of the body and continuous with the caudal and anal fins. Ventrally the fringe begins approximately in the middle of the body. Pelvic fins absent. Pectoral fins small.

Remarks: Predators.

Recent relatives: None. Died out in Eocene.



Veronanguilla, reconstruction after Blot.



Milananguilla lehmani Blot (length c. 15 cm) from the Middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Milananguilla* Blot, 1978.

Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Small fishes with very slender eel-shaped bodies. Head shallow. Snout pointed. Eyes small. Dorsal, caudal and anal fins form a continuous fringe. End of body pointed.

Remarks: Probably fed on worms, crustaceans and other small animals.

Recent relatives: None. Died out in Middle Eocene.



Milananguilla, reconstruction after Blot.



Goslinophis acuticaudus (AGASSIZ) (length c. 32 cm) from the Middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Goslinophis* BLOT, 1980.

Synonyms: *Ophisurus*, *Ophichthys*.

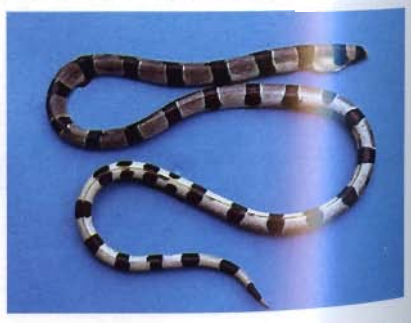
Geological range: Middle Eocene.

Geographical distribution: Bolca, Italy.

Features: Middle-sized, extremely slender, eel-like fishes. Head shallow. Snout pointed. Eyes small. Dorsal and anal fins run together as a low fringe which begins shortly behind the head and runs to the pointed posterior end of the body. Pectoral fins very small.

Remarks: Probably fed on worms, crustaceans and other small animals.

Recent relatives: Genus extinct. Related to recent snake eels of the family Ophichthidae.



Myrichthys colubrinus, a recent snake eel.



Bolcyrus bajai BLOT (length c. 24 cm) from the Middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Bolcyrus* BLOT, 1978.

Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Middle-sized fishes of slender eel-like shape. Head shallow. Snout pointed. Eyes small. Dorsal and anal fins run together as a low fringe to the pointed posterior end of the body. Pectoral fins very small and rounded.

Remarks: Probably predators.

Recent relatives: Genus extinct. Closely related to recent congers of the family Congridae.



Bolcyrus, reconstruction after BLOT.



Conger sp. (length c. 30 cm) from the Pliocene of Fiume Marecchia, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Conger* OKEN, 1817.

Geological range: Eocene to recent.

Geographical distribution: Europe, North America, New Zealand.

Features: Middle-sized fishes of very slender eel-like shape. Head shallow. Snout pointed. Gape rather long. Eyes small. Dorsal, caudal and anal fins form a continuous fringe which begins just behind the head and ends ventrally near the middle of the body. Pectoral fins small. Skin without scales.

Remarks: Predators.

Recent relatives: Closely related to recent congers of the genus *Conger* which occur in almost all oceans of the world.



Conger sp., a recent conger eel. Lithograph from BLOCH.



Enchelion montium HAY (length c. 13 cm) from the Upper Cretaceous of Lebanon. Original: Siber & Siber Collection, Aathal, Switzerland.

Genus: *Enchelion* HAY, 1903.

Geological range: Upper Cretaceous.

Geographical distribution: Middle East.

Features: Small fishes with extremely slender bodies. Head small. Snout pointed. Fins probably formed a fringe.

Remarks: Probably fed on worms, crustaceans and other small animals.

Recent relatives: None. Died out in Upper Cretaceous.



Pavelichthys daniltschenkoi Bannikov & Fedotov (length c. 9 cm) from the Lower Oligocene of the northern Caucasus. Original: Paleontologicheskii Musei Russkoi Akademii Nauk, Moscow, Russia.

Genus: *Pavelichthys* Bannikov & Fedotov, 1984.

Geological range: Lower Oligocene.

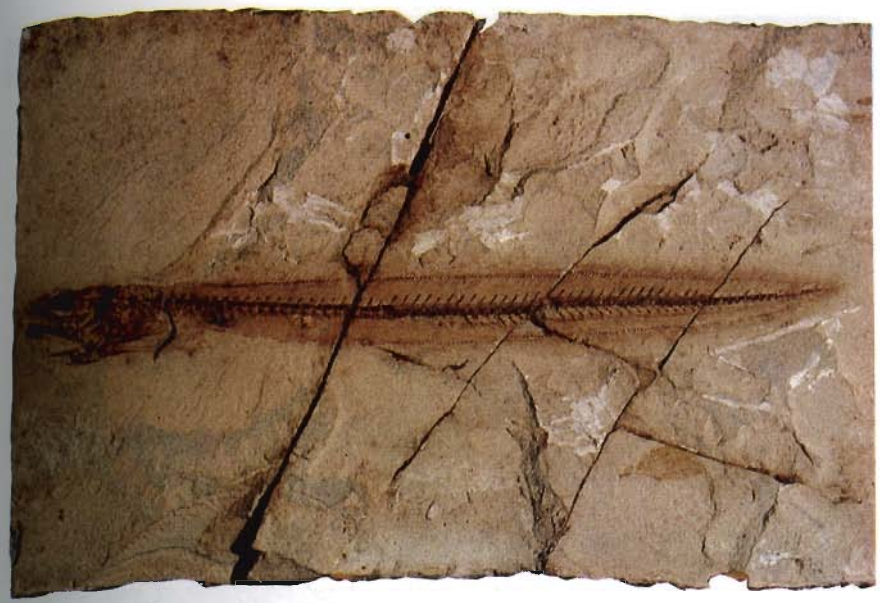
Geographical distribution: Eastern Europe.

Features: Small fishes with very slender elongate bodies. Head shallow. Snout pointed. Gape long. Eyes small. Dorsal caudal and anal fins continuous as a fringe which begins in the second third of the body and ends ventrally in the middle of the body. Skin without scales.

Remarks: Predators.

Recent relatives: None. Died out in Oligocene.

TELEOSTEI
Order: Anguilliformes
Family: Congridae
True Bony Fishes
Suborder: Anguilloidei
Conger Eels



Voltaconger latispinus (Agassiz) (length c. 25 cm) from the Middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Voltaconger* Blot, 1978.

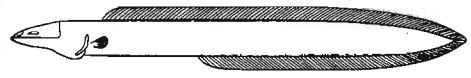
Geological range: Middle Eocene.

Geographical distribution: Europe.

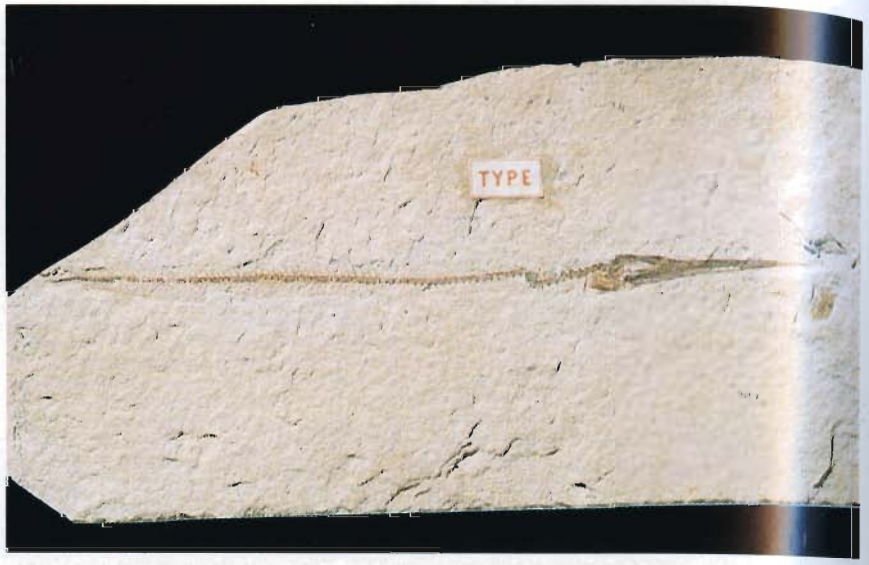
Features: Middle-sized fishes of rather broad eel-like shape. Snout pointed. Eyes small. Dorsal, caudal and anal fins form a continuous fringe.

Remarks: Predators.

Recent relatives: Genus extinct. Closely related to recent congers of the family Congridae.



Voltaconger, reconstruction after Blot.



Proserrivomer mecquenemi (Priem) from the Lower Oligocene of Iran. Original: Muséum National d'Histoire Naturelle, Paris, France. Photograph: Serette, Paris.

Genus: *Proserrivomer* Arambourg, 1939.

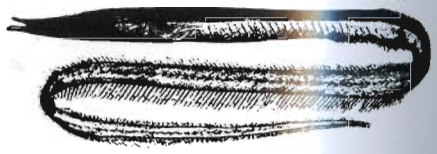
Geological range: Oligocene.

Geographical distribution: Middle East.

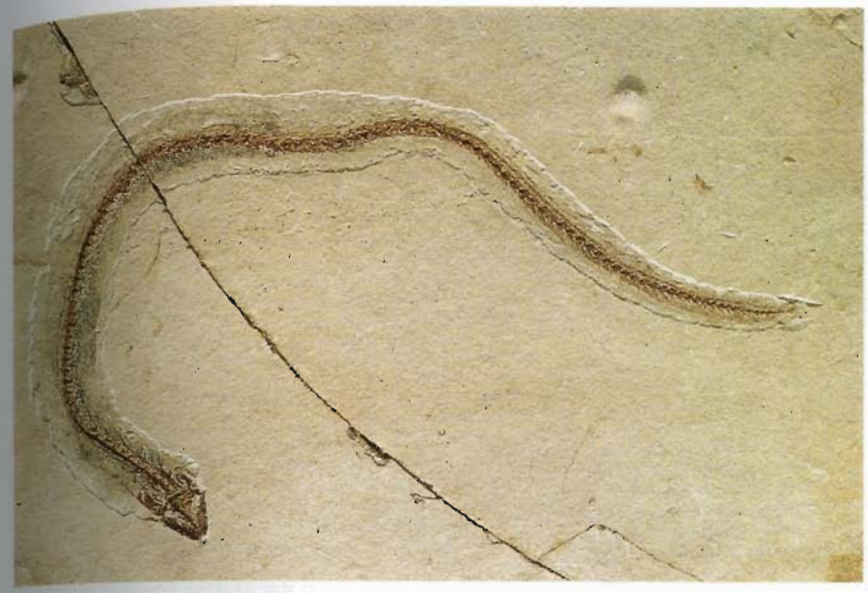
Features: Small fishes with very slender eel-like bodies. Head shallow. Eyes large. Both jaws elongated to form a rostrum. Dorsal, caudal and anal fins form a continuous low fringe which begins dorsally in the second third of the body and extends ventrally to the anterior third of the body. Pectoral fins very small.

Remarks: Bottom-dwelling predators.

Recent relatives: Genus extinct. Perhaps related to recent eels of the genus *Serrivomer*.



Serrivomer beanii. A recent serrivomerid eel.



Bolcanguilla brachycephala Blot (length c. 26 cm) from the Middle Eocene of Bolca, Italy. Original: Muséum National d'Histoire Naturelle, Paris, France. Photograph: Serette, France.

Genus: *Bolcanguilla* Blot, 1980.

Geological range: Eocene.

Geographical distribution: Europe.

Features: Middle-sized fishes with slender eel-like bodies. Head deep. Snout pointed-triangular. Dorsal, caudal and anal fins united to form a continuous fringe which reaches to the middle of the ventral surface. Pectoral fins very small.

Remarks: Predators feeding on small organisms.

Recent relatives: None. Died out in Eocene.



Bolcanguilla, reconstruction after Blot.



Patavichthys bolcensis (Bassani) (length c. 13 cm) from the Middle Eocene of Bolca, Italy. Original: Università di Padova, Padua, Italy. Photograph: Università di Padova.

Genus: *Patavichthys* Blot, 1980.

Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Small fishes with slender elongate bodies. Head shallow, ending in a rostrum formed from upper and lower jaws with the ends of both slightly divergent. Dorsal fin fringe-like, extending from the middle of the body to shortly before the pointed posterior end of the body. Anal fin similar but begins more posteriorly. Pectoral fins very small.

Remarks: Bottom-dwellers. Probably fed on worms and other animals living in the bottom.

Recent relatives: None. Died out in Eocene.



Patavichthys, reconstruction after Blot.



Urenchelys germanus Hay (length c. 16 cm) from the Upper Cretaceous of Lebanon. Original: Frickhinger Collection, Munich, Germany.

Genus: *Urenchelys* Woodward, 1900.

Geological range: Upper Cretaceous.

Geographical distribution: Europe, North Africa, Middle East.

Features: Fishes with slender eel-like bodies. Head shallow. Snout pointed. Dorsal and anal fins probably fringe-like, but the caudal fin is nevertheless clearly distinct.

Remarks: Probably predators.

Recent relatives: One of the earliest eels. Perhaps distantly related to recent eels.



Unnamed eel (length c. 45 cm) from the Miocene of St. Margarethen, Austria. Original: Weiss Collection, Vienna, Austria. Photograph: Weiss, Vienna.

Genus: Not named.

Geological range: Middle Miocene.

Geographical distribution: Europe.

Features: Middle-sized fishes with slender eel-like bodies. Head small. Gape rather long. Eyes small. Jaws with very small, pointed, backwardly curved teeth. Dorsal, caudal and anal fins form a continuous fringe which begins dorsally shortly behind the head and extends ventrally over the posterior third of the body.

Remarks: Predators.

Recent relatives: Probably related to recent eels.



Diplomystus dentatus COPE (length c. 28 cm) from the Eocene of Wyoming, U.S.A. Original: Frickhinger Collection, Munich, Germany.

Genus: *Diplomystus* COPE, 1877.

Synonyms: *Copeichthys*, *Histiurus*, *Hyperlophus*.

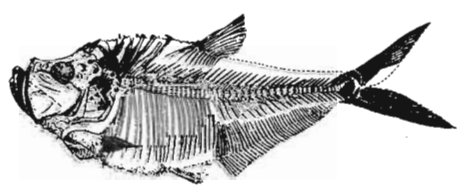
Geological range: Upper Cretaceous to Miocene.

Geographical distribution: Europe, South America, Africa.

Features: Middle-sized fishes with laterally compressed bodies and moderately deep bellies. Ventral keel with saw-tooth-like scales. Head short and deep. Snout slightly pointed. Gape rather long, directed upwards. Dorsal fin approximately in the middle of the body, small and pointed. Anal fin fringe-like. Caudal fin deeply divided.

Remarks: Fresh-water fishes feeding at least partly on plants.

Recent relatives: None. Died out in Miocene.



Diplomystus, reconstruction after JORDAN.



Ellimma branneri JORDAN (length c. 9 cm) from the Upper Eocene of Alagos, Brazil. Original: American Museum of Natural History, New York, N.Y., U.S.A.

Genus: *Ellimma* JORDAN, 1913.

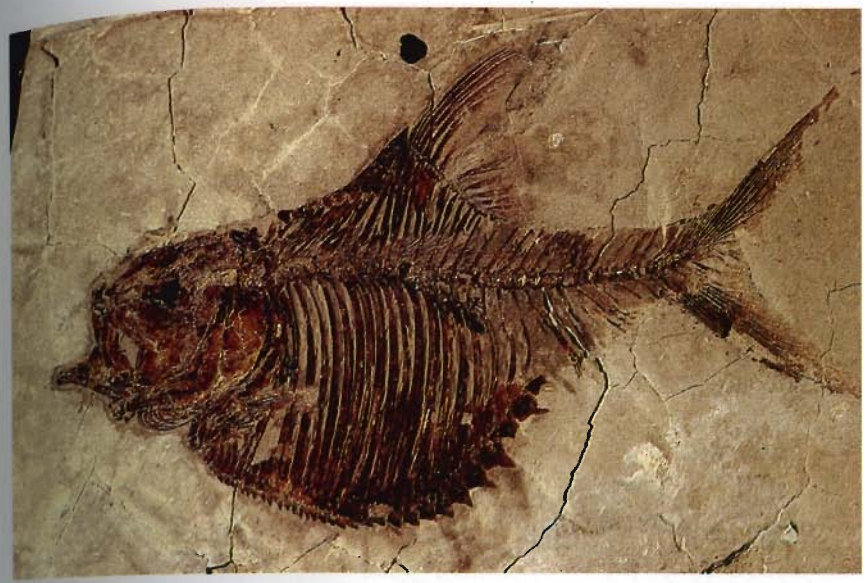
Geological range: Upper Eocene.

Geographical distribution: South America.

Features: Small fishes with laterally compressed bodies and deep bellies. Head deep. Snout somewhat pointed. Dorsal fin approximately in the middle of the body, small and pointed. Anal fin likewise small, more posterior. Small saw-tooth-like scales on the ventral keel. Caudal fin deeply divided with narrow lobes.

Remarks: Still-water fishes. Probably fed, at least partly, on plants.

Recent relatives: None. Died out in Upper Eocene.



Ellimmichthys longicostatus (COPE) (length c. 15 cm) from the Lower Cretaceous of Itacaranha, Brazil. Original: The Natural History Museum, London, U.K. (P 7109)

Genus: *Ellimmichthys* JORDAN, 1919.

Geological range: Lower Cretaceous.

Geographical distribution: South America.

Features: Small fishes of laterally compressed shape, with a deep belly. Head short and deep. Snout rounded. Eyes small. The body rises to a point in the dorsal mid line and has saw-tooth-like scales on the ventral keel. Dorsal fin immediately behind the dorsal apex, tall and pointed. Caudal fin deeply forked, with narrow lobes.

Remarks: Probably still-water fishes which fed, at least partly, on plants.

Recent relatives: None. Died out in Lower Cretaceous.



Unnamed fish (length c. 8.5 cm) from the Upper Cretaceous of Lebanon. Original: The Natural History Museum, London, U.K.

Genus: Not named.

Geological range: Upper Cretaceous.

Geographical distribution: Middle East.

Features: Small fishes with deep belly. Head short and deep. Eyes large. Dorsal fin tall and pointed. Caudal fin very large, deeply forked with narrow lobes. Anal fin low and fringe-like. Saw-tooth-like scales on the ventral keel and on the posterior part of the dorsal mid line.

Remarks: Probably still-water fishes.

Recent relatives: None. Died out in Upper Cretaceous.



Unnamed fish (length c. 10 cm) from the Upper Cretaceous of Bethel, Israel. Original: Staatliches Museum für Naturkunde, Karlsruhe, Germany.

Genus: Not named.

Geological range: Upper Cretaceous.

Geographical distribution: Middle East.

Features: Small fishes with very deep bellies. Dorsal mid line rises to an obtuse point. Head deep and short. Eyes large. Dorsal fin with a tall point anteriorly, but steeply decreasing in height and passing into a low fringe. Caudal fin divided with narrow lobes. Saw-tooth-like scales on the ventral keel.

Remarks: Probably still-water fishes.

Recent relatives: None. Died out in Upper Cretaceous.



Palaeodenticeps tanganyikae GREENWOOD (length c. 3 cm) from the Miocene of Zingida, Tanzania. Original: The Natural History Museum, London, U.K. (P42616).

Genus: *Palaeodenticeps* GREENWOOD, 1960.

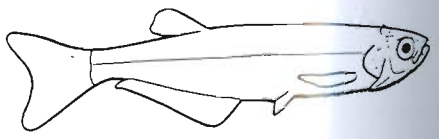
Geological range: Miocene.

Geographical distribution: Eastern Africa.

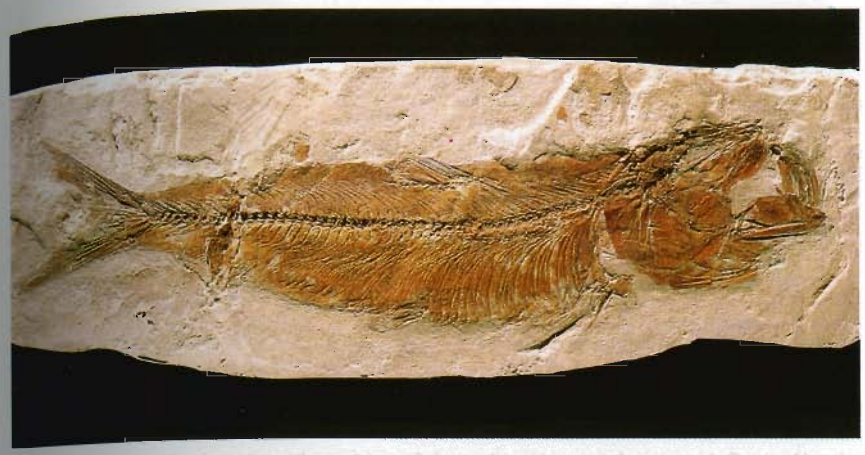
Features: Very small fishes of elongate slender shape. Head long and shallow. Eyes large. Dorsal fin in the posterior half of the body. Pectoral fins narrow. Caudal fin with concave posterior margin. Anal fin fringe-like. Spines on some scales and on the head.

Remarks: Gregarious freshwater fishes.

Recent relatives: Genus extinct. Related to recent denticle herrings of the genus *Denticeps*.



Denticeps clupeoides, the recent denticle herring (after NELSON).



Alosa elongata AGASSIZ (length c. 31 cm) from the Upper Miocene of Oran, Algeria. Original: Muséum National d'Histoire Naturelle, Paris, France. Photograph: Serette, Paris.

Genus: *Alosa* LINCK, 1790.

Synonyms: *Alausa*, *Caspiolus*, *Clupeonella*.

Geological range: Miocene to recent.

Geographical distribution: Europe, northern Africa, western Asia.

Features: Middle-sized fishes of slender shape. Head short and deep. Gape short. Eyes small. Dorsal fin approximately in the middle of the body. Pectoral fins pointed. Pelvic fins very small. Caudal fin forked, with relatively broad lobes.

Remarks: *Alosa* has recently been considered as a synonym of *Pomolobus*.

Recent relatives: Closely related to fishes of the recent genus *Alosa*.



Alosa sp., the recent blueback.



Clupea humilis MEYER (length c. 8 cm) from the Upper Miocene of Unterkirchberg, Württemberg, Germany. Original: Staatliches Museum für Naturkunde, Stuttgart, Germany.

Genus: *Clupea* LINNAEUS, 1758.

Synonyms: *Alonsina*, *Clupeops*, *Sahelinia*.

Geological range: Eocene to recent.

Geographical distribution: Europe, South America, western Asia, East Indies, northern Africa.

Features: Small fishes of slender elongate shape. Head shallow and elongate. Gape rather long. Eyes large. Dorsal fin approximately in the middle of the body, opposite the small pelvic fins. Anal fin low and fringe-like. Caudal fin forked with broad lobes.

Remarks: This fish has recently been assigned to the genus *Clupeonella*.

Recent relatives: Closely related to the recent herring *Clupea harengus*.



Clupea harengus, the herring. Lithograph from BLOCH.



Domeykos profetaensis ARRATIA & SCHULTZE (length c. 13 cm) from the Upper Jurassic of northern Chile. Original: Universitad de Chile, Santiago, Chile.

Genus: *Domeykos* ARRATIA & SCHULTZE, 1985.

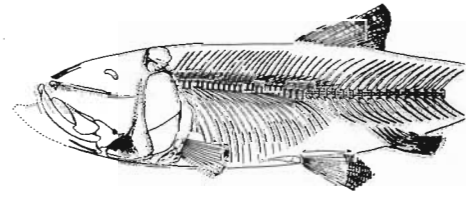
Geological range: Upper Jurassic.

Geographical distribution: South America.

Features: Small fishes with slender elongate bodies. Head shallow and elongate. Dorsal fin approximately in the middle of the body, opposite the small fan-shaped pelvic fins. Caudal fin forked.

Remarks: Probably gregarious.

Recent relatives: None. Died out in Upper Jurassic.



Domeykos, reconstruction after ARRATIA.



Erichalcis arcta FOREY (length c. 11 cm) from the Cretaceous of Hay River, Canada. Original: University of Alberta, Edmonton, Alberta, Canada.

Genus: *Erichalcis* FOREY, 1975.

Geological range: Cretaceous.

Geographical distribution: North America.

Features: Small fishes with slender bodies. Head long and shallow. Snout rounded. Dorsal fin opposite the pelvic fins. Caudal fin forked.

Remarks: Probably gregarious.

Recent relatives: None. Died out in Cretaceous. Belongs among the oldest known herrings.



Etrumeus teres (de KAY) (length c. 14 cm) from the Pliocene of Fiume Marecchia, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Etrumeus* BLEEKER, 1853.

Synonyms: *Halecula*, *Parahalecula*.

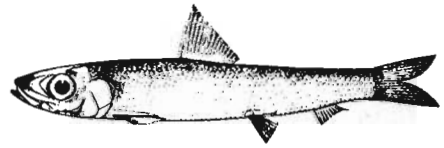
Geological range: Oligocene to recent.

Geographical distribution: Western Asia, Europe, northern Africa.

Features: Small to middle-sized fishes of slender shape, but somewhat protruding ventrally. Head shallow. Gape rather long. Eyes large. Dorsal fin in the middle of the body, opposite the small pelvic fins. Anal fin low, broad-based. Pectoral fins narrow. Caudal fin deeply forked.

Remarks: Gregarious.

Recent relatives: Closely related to recent round herrings of the genus *Etrumeus*.



Etrumeus teres, a recent round herring, after SMITH.



Gosiutichthys parvus GRANDE (length c. 5 cm) from the Eocene of Wyoming, U.S.A. Original: Frickhinger Collection, Munich, Germany.

Genus: *Gosiutichthys* GRANDE, 1982.

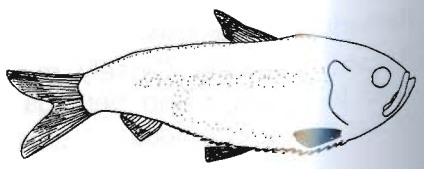
Geological range: Eocene.

Geographical distribution: North America.

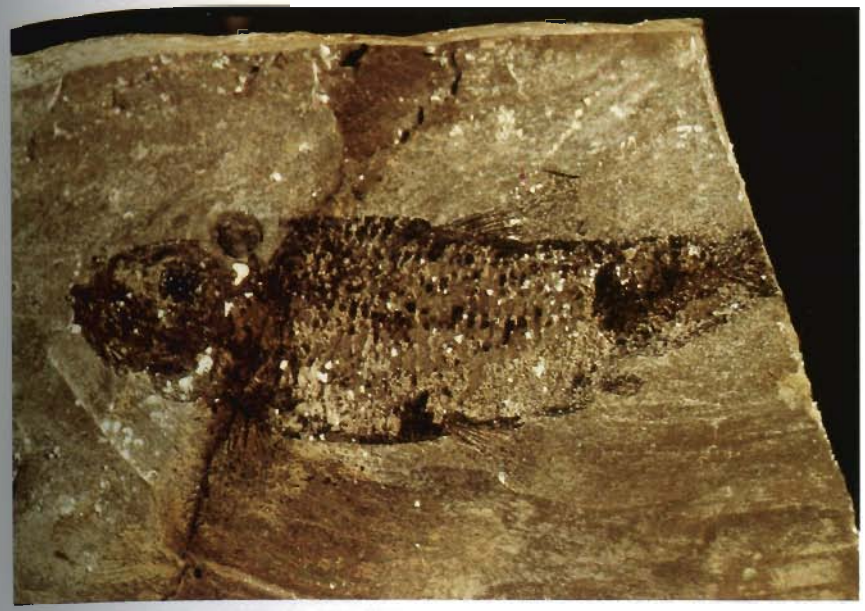
Features: Small to very small fishes with short, laterally compressed bodies. Head short and deep. Gape rather long and directed upwards. Eyes large. Dorsal fin pointed, somewhat anterior to the middle of the body, opposite the small pelvic fins. Anal fin rather broader at the base. Caudal fin divided with broad lobes.

Remarks: Gregarious freshwater fishes.

Recent relatives: None. Died out in Eocene.



Gosiutichthys, reconstruction after GRANDE.



Hilsa sp. (length c. 16 cm) from the Lower Pliocene of Transcaucasia. Original: Paleontologicheskii Muzei Russkoi Akademii Nauk, Moscow, Russia.

Genus: *Hilsa* REGAN, 1917.

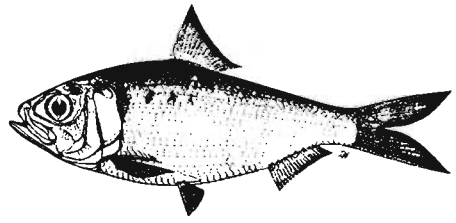
Geological range: Lower Pliocene to recent.

Geographical distribution: Western Asia.

Features: Small to middle-sized fishes with elongate but nevertheless somewhat laterally compressed shape. Head shallow. Eyes moderately large. Snout rounded. Dorsal fin narrow, approximately in the middle of the body, obliquely opposite the small anal fin. Pelvic fins small. Pectoral fins somewhat fan-shaped. Caudal fin sharply forked.

Remarks: Probably gregarious. Lived in coastal areas and probably also in the fresh water of large rivers.

Recent relatives: Closely related to recent shads of the genus *Hilsa*.



Hilsa kelee, a recent shad. After SMITH.



Histiothrissa macrodactyla (von der MARCK) (length c. 25 cm) from the Upper Cretaceous of Sendenhorst, Westphalia, Germany. Original: Geologisch-Paläontologisches Museum, Münster, Germany.

Genus: *Histiothrissa* WOODWARD, 1901.

Geological range: Upper Cretaceous.

Geographical distribution: Europe, Middle East.

Features: Middle-sized fishes with relatively broad bodies. Head deep and elongate. Snout rounded. Dorsal fin large, triangular, opposite the pelvic fins which are likewise triangular. Anal fin low triangular. Pectoral fins very large, fan-shaped. Caudal fin forked, with broad lobes.

Remarks: Probably still-water fishes.

Recent relatives: None. Died out in Upper Cretaceous.



Histiothrissa, reconstruction after von der MARCK.



Knightia alta (LEIDY) (length c. cm) from the Eocene of Wyoming, U.S.A. Original: Frickhinger Collection, Munich, Germany.

Genus: *Knightia* JORDAN, 1907.

Synonyms: *Ellimma*, *Ellipos*.

Geological range: Eocene.

Geographical distribution: North America, South America.

Features: Small to middle-sized fishes with slender, somewhat laterally compressed bodies. Head deep and short. Gape rather long. Dorsal fin triangular, approximately in the middle of the body, opposite the pelvic fins which are likewise triangular. Anal fin low triangular. Caudal fin forked, with broad lobes.

Remarks: Gregarious fresh-water fishes.

Recent relatives: None. Died out in Eocene.



Ornategulum sardinioides (PICTET) (length c. 17 cm) from the Upper Cretaceous of Lebanon. Original: Field Museum of Natural History, Chicago, Illinois, U.S.A..

Genus: *Ornategulum* FOREY, 1973.

Geological range: Upper Cretaceous.

Geographical distribution: Middle East.

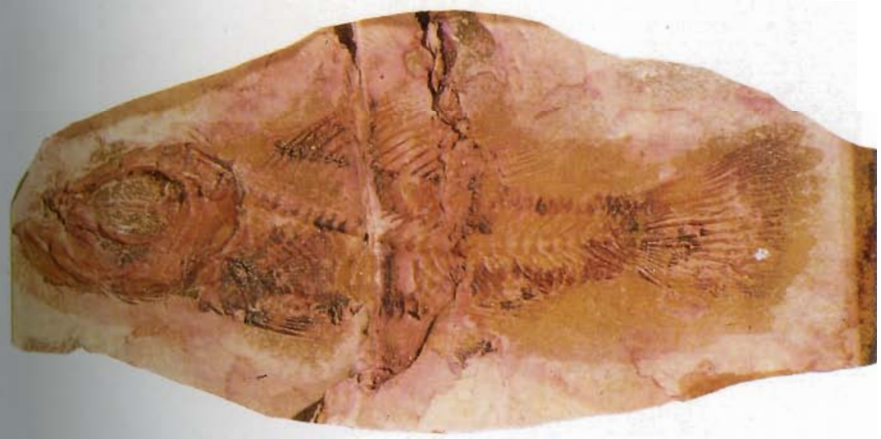
Features: Middle-sized fishes with slender elongate bodies. Head long and shallow. Gape rather long. Dorsal fin opposite the small pelvic fins. Pectoral fins narrow.

Remarks: The assignment to the family Clupeidae is uncertain.

Recent relatives: None. Died out in Upper Cretaceous.



Ornategulum, reconstruction after FOREY.



Pateroperca libanica GAUDANT (length c. 10 cm) from the Upper Cretaceous of the Lebanon. Original: Muséum National d'Histoire Naturelle, Paris, France. Photograph: Serette, Paris.

Genus: *Pateroperca* WOODWARD, 1942.

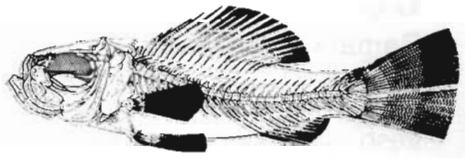
Geological range: Upper Cretaceous.

Geographical distribution: Middle East.

Features: Small to middle-sized fishes with rather slender bodies. Head deep. Snout rounded. Gape short. Eyes large. Dorsal fin tall, sail-like, in the middle of the body. Anal fin small, obliquely opposite the end of the dorsal fin. Pelvic fins long and narrow, almost opposite the pelvic fins which are likewise narrow but somewhat broader. Caudal fin broad, not forked.

Remarks: Probably not aggressive.

Recent relatives: None. Died out in Cretaceous.



Pateroperca, reconstruction after GAYET.



Pomolobus antiquus (SMIRNOV) (length c. 6 cm) from the Lower Oligocene of the Caucasus, C.I.S. Original: Paleontologicheskii Musei Russkoi Akademii Nauk, Moscow, Russia (Bannikov Collection).

Genus: *Pomolobus* RAFINESQUE, 1820.

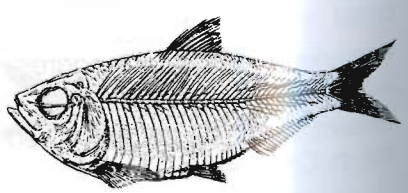
Geological range: Miocene to recent.

Geographical distribution: Western and eastern Europe.

Features: Small fishes with elongate bodies, somewhat deeper anteriorly. Head deep. Snout rounded. Eyes small. Dorsal fin narrow, slightly anterior to the middle of the body, obliquely opposite the broad and ventrally located anal fin. Pelvic fins small. Pectoral fins somewhat longer. Caudal fin forked.

Remarks: Gregarious fishes which lived in the sea but probably sometimes entered the fresh water of large rivers.

Recent relatives: Closely related to recent river herrings of the genus *Pomolobus*.



Pomolobus, reconstruction after Akademia Nauk, Moscow.



Protoclupea chilensis ARRATIA, CHANG & CHONG (length c. 11 cm) from the Upper Jurassic of northern Chile. Original: Universidad de Chile, Santiago, Chile.

Genus: *Protoclupea* ARRATIA, CHANG & CHONG, 1975.

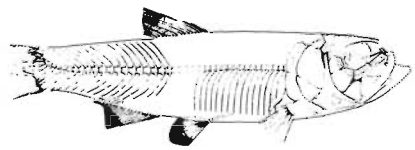
Geological range: Upper Jurassic.

Geographical distribution: South America.

Features: Small fishes of slender elongate shape. Head long and shallow. Eyes large. Dorsal fin approximately in the middle of the body, opposite the fan-like pelvic fins. Pectoral fins likewise fan-shaped. Caudal fin forked.

Remarks: Probably gregarious.

Recent relatives: None. Died out in Upper Jurassic. Belongs among the oldest herrings yet known.



Protoclupea, reconstruction after ARRATIA & SCHULTZE.



Pseudoberyx syriacus PICTET & HUMBERT (length c. 5.5 cm) from the Upper Cretaceous of Lebanon. Original: Museum für Naturkunde, Berlin, Germany.

Genus: *Pseudoberyx* PICTET & HUMBERT, 1866.

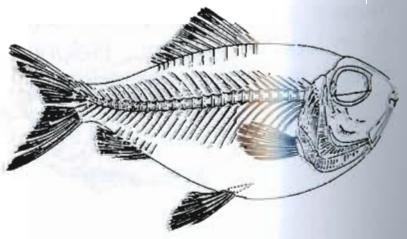
Geological range: Upper Cretaceous.

Geographical distribution: Middle East.

Features: Very small to small fishes with somewhat laterally compressed bodies. Head deep and short. Snout pointed. Eyes large. Dorsal fin opposite the pelvic fins. Caudal fin forked. Scales elongate rhombic and thick.

Remarks: Gregarious.

Recent relatives: None. Died out in Upper Cretaceous.



Pseudoberyx, reconstruction after PICTET & HUMBERT.



Sardina pilchardus (WALBAUM) (length c. 13 cm) from the Pliocene of Fiume Marecchia, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Sardina* ANTIPA, 1906.

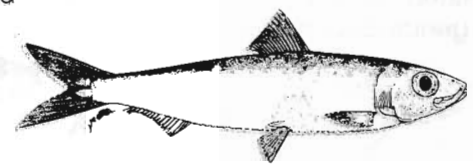
Geological range: Pliocene to recent.

Geographical distribution: Europe.

Features: Small fishes of slender outline but ventrally slightly protruding. Head shallow. Gape rather long. Eyes large. Dorsal fin in the middle of the body, opposite the small pelvic fins. Anal fin low, broad-based. Pectoral fins narrow. Caudal fin deeply forked.

Remarks: Gregarious.

Recent relatives: The fossil and recent species are identical.



Sardina pilchardus. A recent sardine, after WHITEHEAD.



Sardinella sardinites (HECKEL) (length c. 8 cm) from the Middle Oligocene of the Caucasus, C.I.S. Original: Paleontologicheskii Musei Russkoi Akademii Nauk, Moscow, Russia.

Genus: *Sardinella* VALENCIENNES, 1847.

Geological range: Miocene to recent.

Geographical distribution: Western and eastern Europe.

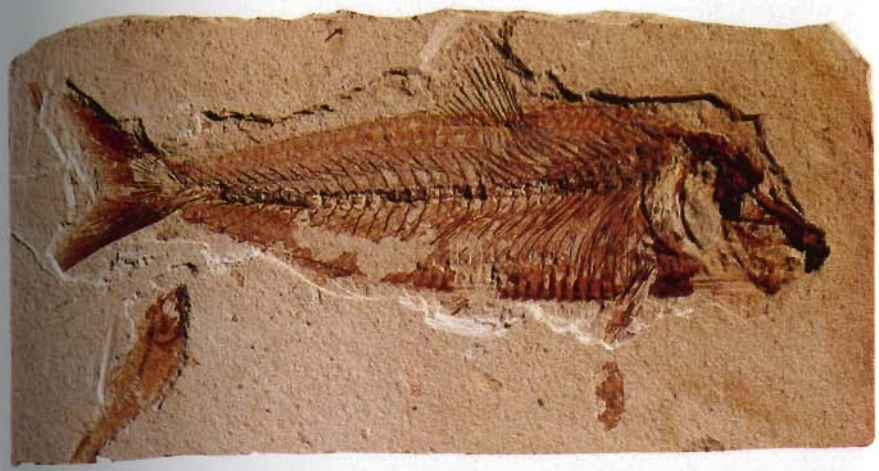
Features: Small fishes with slender elongate bodies. Head shallow. Snout slightly pointed. Gape rather long. Eyes large. Dorsal fin small, in the middle of the body, opposite the pelvic fins which are likewise small. Pectoral fins fan-shaped. Caudal fin forked.

Remarks: Gregarious.

Recent relatives: Closely related to recent sardines of the genus *Sardinella*.



Sardinella sp., a recent sardine. Lithograph from CUVIER.



Scombroclupea macrophthalma HECKEL (length c. 12 cm) from the Upper Cretaceous of Lebanon. Original: Staatliches Museum für Naturkunde, Stuttgart, Germany.

Genus: *Scombroclupea* KNER, 1863.

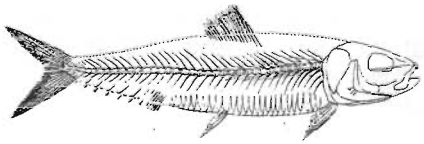
Geological range: Upper Cretaceous.

Geographical distribution: Middle East.

Features: Small fishes with laterally compressed, elongate bodies. Head elongate. Snout pointed. Eyes large. Dorsal fin in the middle of the body, opposite the pelvic fins. Caudal fin rather deeply divided with lobes broad at the base and pointed at the ends.

Remarks: Probably gregarious.

Recent relatives: None. Died out in Upper Cretaceous.



Scombroclupea, reconstruction after PIVETEAU.



Spratelloides gracilis SCHLEGEL (length c. 6.5 cm) from the Pliocene of Fiume Marecchia, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Spratelloides* de LACÉPÈDE, 1803.

Synonym: *Stolephorus*.

Geological range: Miocene to recent.

Geographical distribution: Europe, northern Africa, North America.

Features: Small fishes of slender shape. Head shallow. Gape rather long. Eyes large. Dorsal fin in the middle of the body, opposite the small pelvic fins. Anal fin low and broad-based. Caudal fin deeply forked.

Remarks: Gregarious.

Recent relatives: Closely related to recent round herrings of the genus *Spratelloides*.



Spratelloides sp., a recent sprat. Lithograph after CUVIER.



Sprattus crenatus (length c. 9 cm) from the Oligocene of Flörsheim, Hesse, Germany. Original: Naturmuseum Senckenberg, Frankfurt-am-Main, Germany.

Genus: *Sprattus* GIRGENSOHN, 1846.

Synonym: *Meletta*.

Geological range: Oligocene to recent.

Geographical distribution: Europe.

Features: Small fishes with slender elongate bodies. Head long and shallow. Eyes large. Dorsal fin approximately in the middle of the body, opposite the small pelvic fins. Pectoral fins narrow. Caudal fin forked. Scales rounded.

Remarks: Gregarious.

Recent relatives: Closely related to recent sprats of the genus *Sprattus*.



Sprattus sprattus, the sprat. Lithograph from BLOCH.



Xyne grex JORDAN & GILBERT (length c. 16 cm) from the Miocene of Lompoc, California, U.S.A. Original: Field Museum of Natural History, Chicago, Illinois, U.S.A.

Genus: *Xyne* JORDAN & GILBERT, 1919.

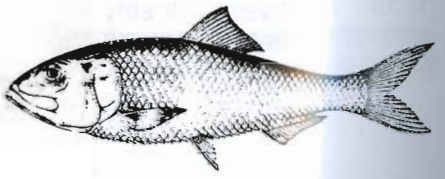
Geological range: Miocene.

Geographical distribution: North America.

Features: Middle-sized fishes of slender elongate shape. Head shallow. Dorsal fin opposite the small pelvic fins. Caudal fin forked.

Remarks: Probably gregarious.

Recent relatives: None. Died out in Miocene.



Xyne, reconstruction after JORDAN.



Engraulis tethensis GRANDE & NELSON (length c. 7 cm) from the Miocene of Lyssie, Cyprus. Original: The Natural History Museum, London, U.K. (P61224b).

Genus: *Engraulis* CUVIER, 1817.

Geological range: Miocene to recent.

Geographical distribution: Europe.

Features: Small fishes with slender elongate bodies. Head shallow and elongate. Gape long. Eyes large. Dorsal fin somewhat anterior to the middle of the body, opposite the pelvic fins. Pectoral fins narrow. Caudal fin forked, with broad lobes.

Remarks: Gregarious.

Recent relatives: Closely related to the recent anchovy *Engraulis*.



Engraulis encrasicholus, the European anchovy. Lithograph from BLOCH.



Platinx catulli HECKEL (length c. 90 cm) from the Middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Platinx* AGASSIZ, 1835.

Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Middle-sized to large fishes with elongate streamlined bodies. Head shallow. Gape long. Eyes large. Dorsal fin in the posterior third of the body, opposite the anal fin. Pectoral fins strikingly long and narrow.

Remarks: Rapidly swimming predators.

Recent relatives: Genus extinct. Perhaps distantly related to recent wolf herrings of the genus *Chirocentrus*.



Chirocentrus dorab, the wolf herring. Lithograph from BLEEKER.



Chanos zignii KNER & STEINDACHNER (length c. 39 cm) from the Oligocene of Chiavon, Italy. Original: Naturhistorisches Museum, Vienna, Austria. Photograph: Serette, Paris.

Genus: *Chanos* de LACÉPÈDE, 1803.

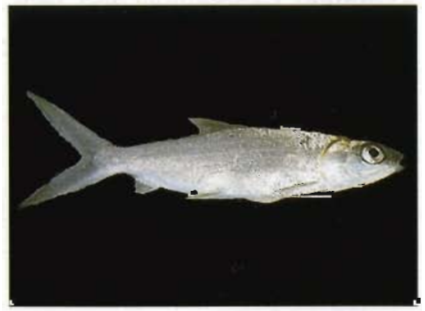
Geological range: Eocene to recent.

Geographical distribution: Europe.

Features: Middle-sized fishes with herring-shaped bodies. Head shallow. Snout slightly pointed. Eyes relatively large. Dorsal fin pointed, approximately in the middle of the body, opposite the small pelvic fins. Pectoral fins fan-shaped. Caudal fin large, deeply forked.

Remarks: Gregarious and probably herbivorous like their recent relatives.

Recent relatives: Closely related to the recent milk fish *Chanos*.



Chanos chanos, the milkfish.



Parachanos aethiopicus WEILER (length c. 22 cm) from the Upper Cretaceous of Gabon, Africa. Original: Muséum National d'Histoire Naturelle, Paris, France.

Genus: *Parachanos* ARAMBOURG, 1935.

Geological range: Lower to Upper Cretaceous.

Geographical distribution: Africa, South America, Europe.

Features: Small to middle-sized fishes of slender shape. Head deep. Snout pointed. Mouth small. Eyes small. Dorsal fin narrow, approximately in the middle of the body. Anal, pelvic and pectoral fins likewise small.

Remarks: Gregarious and probably plant eaters.

Recent relatives: Genus extinct. Distantly related to other milk fishes of the family Chanidae.



Chanoides macropoma WOODWARD (length c. 12 cm) from the Middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Chanoides* WOODWARD, 1901.

Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Small fishes with slender herring-shaped bodies. Head shallow and elongate. Snout rather pointed. Eyes large. Dorsal fin pointed triangular, approximately in the middle of the body. Caudal fin forked.

Remarks: Probably gregarious.

Recent relatives: Genus extinct. Systematic position unclear. Sometimes assigned to the family Albulidae.



Charitosomus hakelensis Davis (length c. 14 cm) from the Upper Cretaceous of Lebanon. Original: Museum für Geologie und Paläontologie, Tübingen, Germany.

Genus: *Charitosomus* von der Marck, 1885.

Synonym: *Solenognathus*.

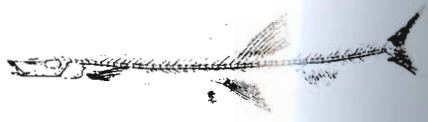
Geological range: Upper Cretaceous.

Geographical distribution: Europe, Middle East, North America.

Features: Small fishes with very slender elongate bodies. Head shallow and elongate. Gape rather long, directed slightly downwards. Dorsal fin small, approximately in the middle of the body, opposite the pelvic fins which are also small. Pectoral fins fan-shaped. Caudal fin only slightly forked.

Remarks: Probably bottom dwellers which fed on prey animals living in the sand.

Recent relatives: Genus extinct. Perhaps distantly related to recent members of the family Goniorhynchidae.



Charitosomus, reconstruction after Pictet & Humbert.



Notogoneus osculus Cope (length c. 58 cm) from the Eocene of Wyoming, U.S.A. Original: Pabst Collection, Zürich, Switzerland.

Genus: *Notogoneus* Cope, 1885.

Synonyms: *Colpopholis*, *Phalacropholis*, *Protocarostomus*, *Sphenolepis*.

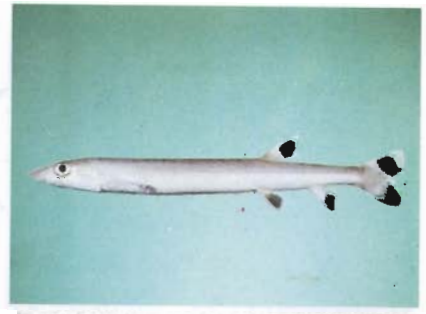
Geological range: Paleocene to Oligocene.

Geographical distribution: Europe, North America, Australia.

Features: Middle-sized fishes of slender elongate shape. Head shallow. Mouth opening ventrally. Eyes large. Dorsal fin small, somewhat behind the middle of the body, opposite the pelvic fins which are likewise small and rather fan-shaped. Anal fin elongate. Pectoral fins rounded and somewhat broader. Caudal fin slightly concave posteriorly.

Remarks: Fed on prey animals living in sand. Unlike their recent relatives, they inhabited fresh-water.

Recent relatives: Distantly related to recent members of the family Gonorhynchidae.



Gonorhynchus, a recent gonorhynchid.



Aethalionopsis robusta (TRAQUAIR) (length c. 17 cm) from the Cretaceous of Bernissart, Belgium. Original: Musée Royal des Sciences Naturelles de Belgique, Brussels, Belgium.

Genus: *Aethalionopsis* GAUDANT, 1966.

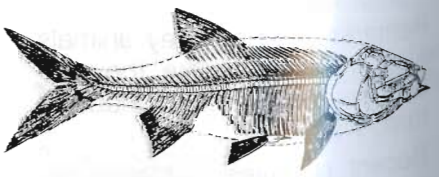
Geological range: Cretaceous.

Geographical distribution: Europe.

Features: Small fishes with a somewhat stout body. Head short. Snout area slightly pointed. Eyes small. Dorsal fin pointed, slightly behind the midpoint of the body. Anal and ventral fins small. Pectoral fins slightly fan-shaped. Caudal fin moderately forked.

Remarks: Probably schooling fishes.

Recent relatives: None, became extinct in the Cretaceous.



Aethalionopsis, reconstruction after TAVERNE



Aspius gracilis AGASSIZ (length c. 8 cm) from the Miocene of Öhningen, Württemberg, Germany. Original: Paläontologisches Museum, Zürich, Switzerland.

Genus: *Aspius* AGASSIZ, 1832.

Geological range: Miocene to recent.

Geographical distribution: Europe.

Features: Small fishes of slender shape. Head elongate. Eyes large. Dorsal fin somewhat behind the anterior half of the body, opposite the small pelvic fins. Anal fin rather broader-based. Caudal fin moderately forked.

Remarks: Fossil fishes assigned to the genus *Aspius* have recently been considered as juveniles of the genus *Leuciscus*.

Recent relatives: Perhaps closely related to recent members of the genus *Aspius*.



Aspius aspius, the recent asp.



Cyprinus priscus MEYER (length c. 17 cm) from the Miocene of Unterkirchberg, Allgäu, Germany. Original: Staatliches Museum für Naturkunde, Stuttgart, Germany.

Genus: *Cyprinus* LINNAEUS, 1758.

Geological range: Miocene to recent.

Geographical distribution: Europe.

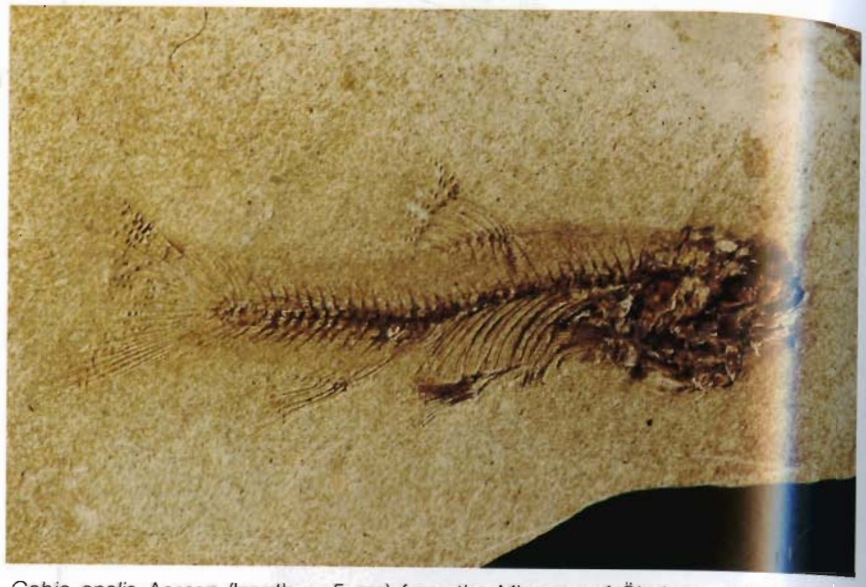
Features: Middle-sized fishes with arched backs. Head short and deep. Dorsal fin behind the anterior convexity of the back, opposite the small pelvic fins. Anal fin narrow and fan-shaped. Caudal fin moderately forked.

Remarks: Lived in stagnant fresh water.

Recent relatives: Closely related to recent carps.



Cyprinus carpio, the carp. Lithograph from BLOCH (next page).



Gobio analis AGASSIZ (length c. 5 cm) from the Miocene of Öhningen, Württemberg, Germany. Original: Teyler's Museum, Haarlem, Netherlands.

Genus: *Gobio* CUVIER, 1792.

Geological range: Miocene to recent.

Geographical distribution: Europe.

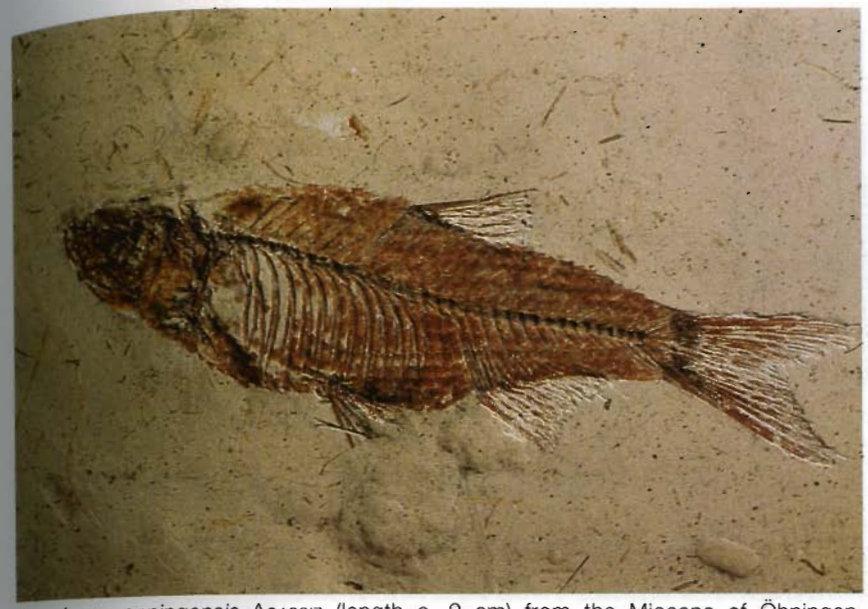
Features: Small fishes of slender shape. Head short. Eyes small. Dorsal fin triangular, somewhat behind the middle of the body, opposite the small pelvic fins. Anal fin likewise triangular. Caudal fin moderately forked.

Remarks: Fresh-water fishes. It has recently been suggested that fossil fishes of the genus *Gobio* are juveniles of the genus *Tinca*.

Recent relatives: Perhaps closely related to recent gudgeons of the genus *Gobio*.



Gobio gobio, a recent gudgeon.



Leuciscus oeningensis AGASSIZ (length c. 9 cm) from the Miocene of Öhningen, Württemberg, Germany. Original: Staatliches Museum für Naturkunde, Stuttgart, Germany.

Genus: *Leuciscus* CUVIER, 1817.

Geological range: Oligocene to recent.

Geographical distribution: Europe.

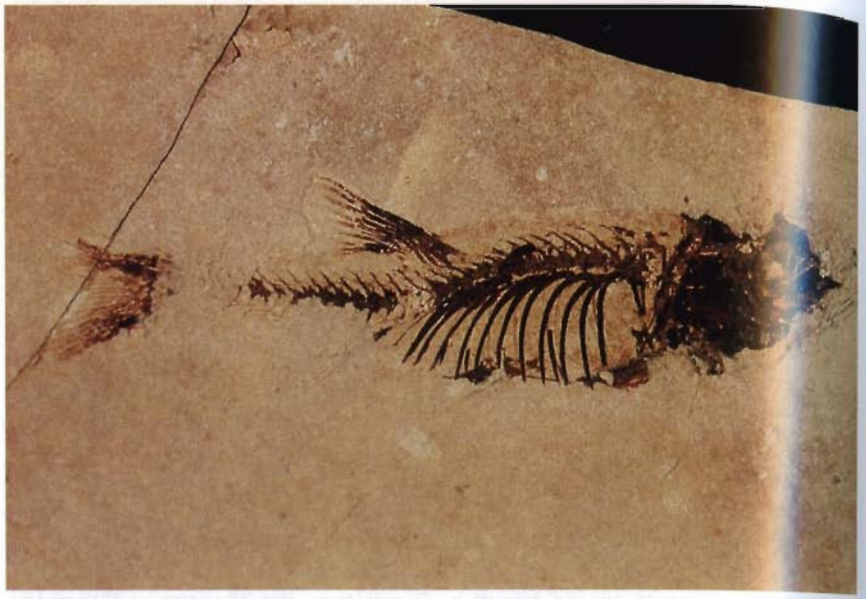
Features: Small fishes of slender shape. Head elongate and flat. Gape relatively long. Dorsal fin triangular, approximately in the middle of the body, opposite the small pelvic fins. Anal fin triangular, broad-based. Caudal fin moderately forked.

Remarks: Fresh-water fishes.

Recent relatives: Genus extinct. Closely related to recent bitterling of the genus *Leuciscus*.



Leuciscus idus, the recent ide.



Pseudorasbora macrocephala YOUNG & CHANG (length c. 4 cm) from the Miocene of Shantung, China. Original: The Natural History Museum, London, U.K. (P20972).

Genus: *Pseudorasbora* BLEEKER, 1860.

Geological range: Miocene to recent.

Geographical distribution: Asia.

Features: Small fishes with slender bodies. Head shallow and elongate. Dorsal fin in the posterior half of the body, opposite the narrow anal fin. Caudal fin forked.

Remarks: Fresh-water fishes.

Recent relatives: Genus extinct. Closely related to recent false rasboras of the genus *Pseudorasbora*.



Pseudorasbora parva, a recent barb.



Rhodeus elongatus (length c. 5 cm) from the Miocene of Öhningen, Württemberg, Germany. Original: Paläontologisches Museum, Zürich, Switzerland.

Genus: *Rhodeus* AGASSIZ, 1832.

Geological range: Miocene to recent.

Geographical distribution: Europe.

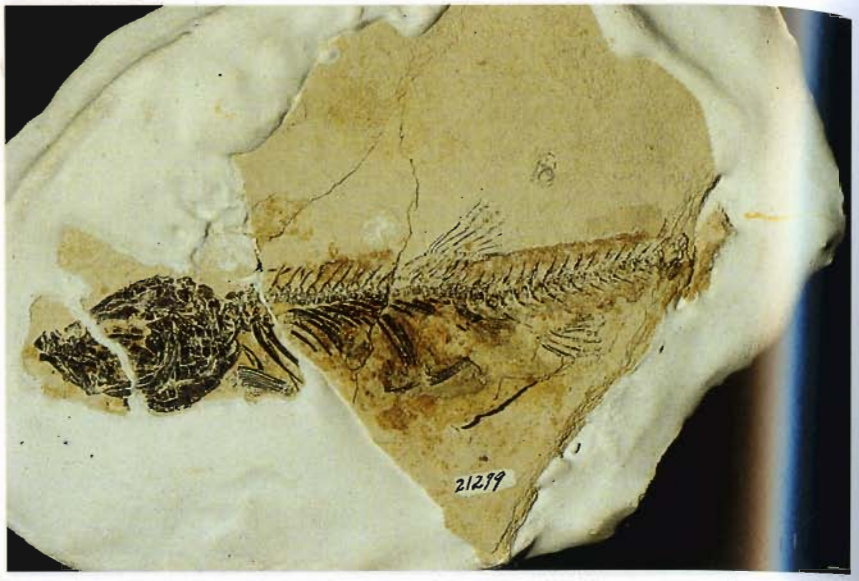
Features: Small fishes with somewhat laterally compressed bodies. Head short and deep. Dorsal fin in the posterior half of the body, approximately opposite the anal fin. Pectoral and pelvic fins small. Caudal fin moderately forked.

Remarks: Fresh-water fishes. A new interpretation is that the fossil genus *Rhodius* may represent juveniles of the genus *Leuciscus*.

Recent relatives: Perhaps closely related to the bitterling *Rhodeus sericeus amarus*.



Rhodeus sericeus amarus, the recent bitterling.



Richardsonius turneri (LUCAS) (length c. 9 cm) from the Pliocene of the U.S.A. Original: National Museum of Natural History, The Smithsonian Institution, Washington, D.C., U.S.A.

Genus: *Richardsonius* STEINDACHNER, 1866.

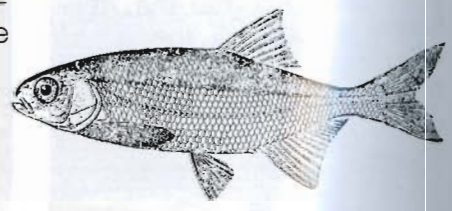
Geological range: Pliocene to recent.

Geographical distribution: North America.

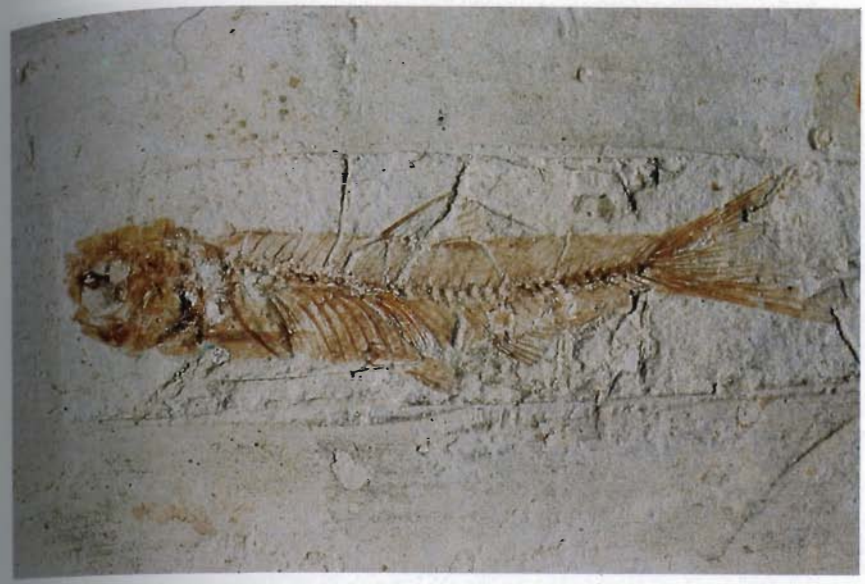
Features: Small fishes with slender bodies. Head elongate. Snout pointed. Gape rather long. Dorsal fin in the middle of the body, approximately opposite the pelvic fins. Pectoral fins small and narrow. Anal fin somewhat broader.

Remarks: Fresh-water fishes.

Recent relatives: Closely related to recent members of the genus *Richardsonius*.



Recent *Richardsonius*, after JORDAN.



Rutilus rubilio (BP) (length c. 5 cm) from the Pleistocene of Riano, Italy. Original: The Natural History Museum, London, U.K. (P44671).

Genus: *Rutilus* RAFINESQUE, 1820.

Geological range: Eocene to recent.

Geographical distribution: Europe.

Features: Small fishes with elongate bodies. Head deep. Gape rather long. Dorsal fin low triangular, opposite the small pelvic fins. Caudal fin forked.

Remarks: Fresh-water fishes.

Recent relatives: Closely related to recent roaches of genus *Rutilus*.



Rutilus rutilus, the recent roach.



Thynnichthys amblystoma (von der MARCK) (length c. 14 cm) from the Tertiary of Panchung, Sumatra. Original: The Natural History Museum, London, U.K. (47522).

Genus: *Thynnichthys* GIGLIOLI, 1880.

Geological range: Tertiary.

Geographical distribution: Indonesia.

Features: Small to middle-sized fishes with slender bodies. Head deep. Snout slightly rounded. Gape relatively long, directed somewhat upwards. Dorsal fin approximately in the middle of the body, opposite the small and narrow pelvic fins. Caudal fin forked.

Remarks: Probably predators.

Recent relatives: Closely related to recent members of the genus *Thynnichthys*.



Recent *Thynnichthys thynnoides*, after WEBER.



Tinca micropygoptera AGASSIZ (length c. 18 cm) from the Upper Miocene of Steinheim, Württemberg, Germany. Original: Staatliches Museum für Naturkunde, Stuttgart, Germany.

Genus: *Tinca* CUVIER, 1817.

Synonyms: *Tarsichthys*.

Geological range: Oligocene to recent.

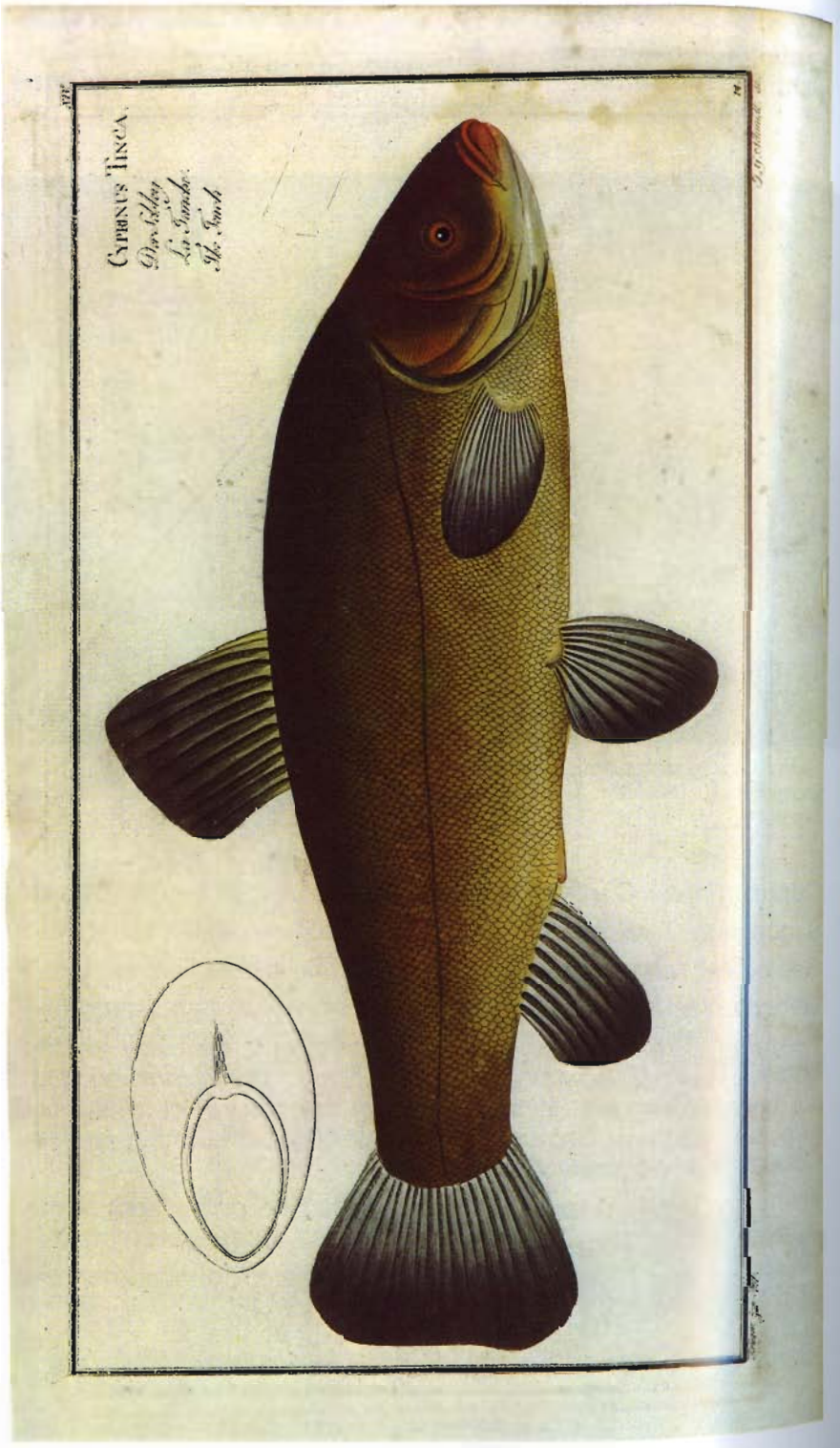
Geographical distribution: Europe.

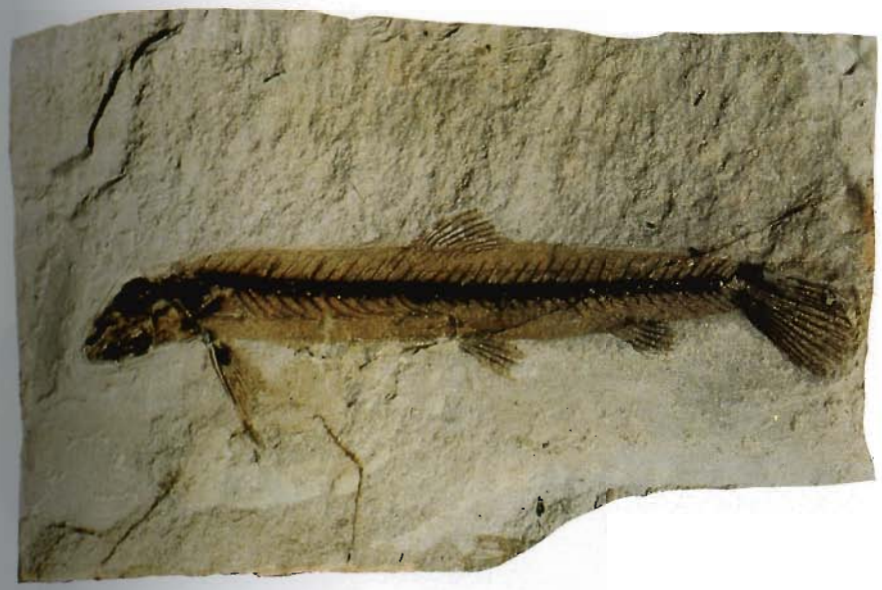
Features: Small to middle-sized fishes with relatively slender bodies. Head shallow and elongate. Snout slightly pointed. Dorsal fin approximately in the middle of the body. Pelvic fins and anal fin rounded. Pectoral fins small and somewhat narrower. Caudal fin moderately forked.

Remarks: Fresh-water fishes. Probably fed on plants and invertebrates.

Recent relatives: Genus extinct. Closely related to recent tenches of the genus *Tinca*.

Tinca tinca, the tench. Lithograph after BLOCH (see next page).





Cobitis centrochir AGASSIZ (length c. 10 cm) from the Miocene of Öhningen, Württemberg, Germany. Original: Teylers Museum, Haarlem, Netherlands.

Genus: *Cobitis* LINNAEUS, 1758.

Synonyms: *Acanthopsis*.

Geological range: Oligocene to recent.

Geographical distribution: Europe.

Features: Small fishes with very slender elongate bodies. Head shallow and elongate. Mouth opening downwards. Eyes small. Dorsal fin approximately in the middle of the body, opposite the pelvic fins. Anal fin small and rounded. Pectoral fins long and somewhat fan-shaped. Caudal fin rounded.

Remarks: Bottom-dwelling fresh-water fishes.

Recent relatives: Closely related to recent loaches of the genus *Cobitis*.



Cobitis taenia, a recent loach.



Nemacheilus musceli Pauca (length c. 5 cm) from the Oligocene of Muscel, Romania. Original: The Natural History Museum, London, U.K. (P16793).

Genus: *Nemacheilus* van Hasselt, 1823.

Geological range: Oligocene to recent.

Geographical distribution: Europe.

Features: Small fishes with exceedingly slender bodies. Head long and narrow. Eyes small. Mouth opening downwards. Dorsal fin rounded, slightly behind the middle of the body, opposite the elongate pelvic fins. Caudal fin forked.

Remarks: Bottom dwellers.

Recent relatives: Closely related to recent loaches of the genus *Nemacheilus*.



Nemacheilus barbatulus, the recent brook loach.



Amyzon aggregatum Wilson (length c. 22 cm) from the Middle Eocene of British Columbia, Canada. Original: Royal Ontario Museum, Toronto, Ontario, Canada

Genus: *Amyzon* Cope, 1872.

Geological range: Eocene to Oligocene.

Geographical distribution: North America.

Features: Middle-sized fishes with laterally compressed carp-like bodies. Head deep and short. Dorsal fin with a point anteriorly, running rearwards into a fringe. Pectoral fins slightly rounded, like the pelvic fins. Anal fin somewhat broader. Caudal fin large, somewhat concave behind.

Remarks: Probably fed on plants and invertebrates. Freshwater fishes.

Recent relatives: Genus extinct. Nevertheless related to recent suckers of the family Catostomidae.



Catostomus commersonii, a recent sucker.



Lusitanichthys sp. (length c. 5 cm) from the Cretaceous of Nardo, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Lusitanichthys* GAYET, 1981.

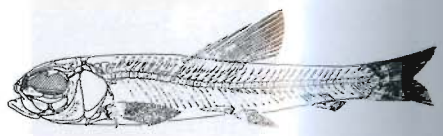
Geological range: Cretaceous.

Geographical distribution: Europe.

Features: Small fishes of slender, streamlined shape. Head relatively deep. Eyes large. Gape rather long. Snout rounded. Dorsal fin narrow, approximately in the middle of the body, opposite the pelvic fins which are likewise narrow. Anal fin short. Pectoral fins long and narrow. Caudal fin forked.

Remarks: Probably gregarious.

Recent relatives: None. Died out in the Cretaceous.



Lusitanichthys, reconstruction after GAYET.



Brycon avus WOODWARD (length c. 11 cm) from the Miocene of Taubaté, Brazil. Original: The Natural History Museum, London, U.K. (P9224).

Genus: *Brycon* MÜLLER & TROSCHEL, 1844.

Geological range: Oligocene to recent.

Geographical distribution: South America.

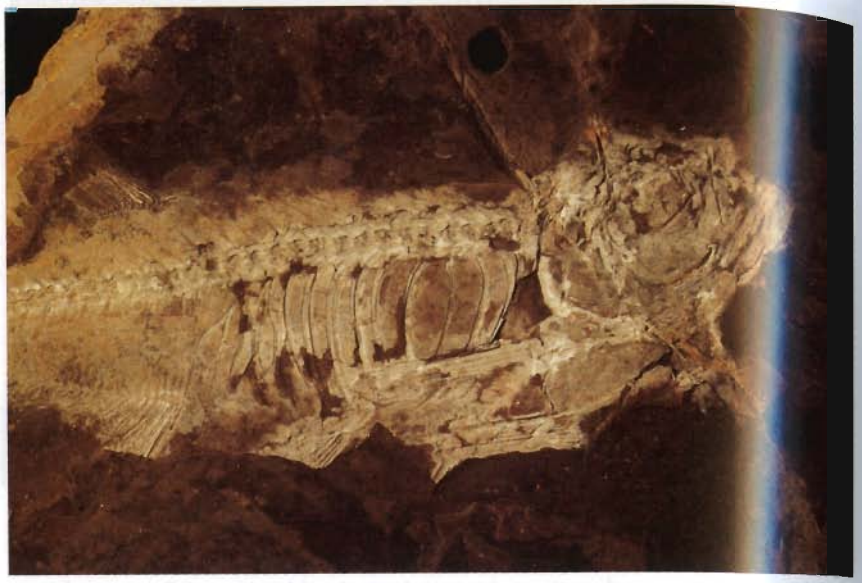
Features: Small fishes of slender shape. Head shallow. Dorsal fin relatively tall, approximately in the middle of the body, opposite the small pelvic fins. Pectoral fins narrow. Anal fin running off into a fringe. Caudal fin forked.

Remarks: Fresh-water fishes.

Recent relatives: Closely related to recent members of the genus *Brycon* and to other characins of the subfamily Bryconinae.



Brycon falcatus, a recent characin.



Tetragonopterus sp. (length c. 11 cm) from the Miocene of Taubaté, Brazil. Original: Naturhistorisches Museum Vienna, Austria.

Genus: *Tetragonopterus* CUVIER, 1817.

Geological range: Miocene to recent.

Geographical distribution: South America.

Features: Small fishes with slender bodies. Head elongate. Dorsal fin shortly behind the middle of the body, opposite the somewhat fringe-like anal fin. Pelvic fins small. Pectoral fins elongate. Caudal fin forked.

Remarks: Fresh-water fishes.

Recent relatives: Closely related to recent members of the genus *Tetragonopterus* and to many characins of the subfamily Tetragonopterinae.



Tetragonopterus argenteus, the recent silver tetra.



Triportheus ligniticus (WOODWARD) (length c. 9 cm) from the Miocene of Taubaté, Brazil. Original: The Natural History Museum, London, U.K. (P25001).

Genus: *Triportheus* COPE, 1872.

Synonym: *Lignobrycon*

Geological range: Miocene to recent.

Geographical distribution: South America.

Features: Small fishes of slender, almost herring-like shape. Head shallow. Dorsal fin shortly behind the anterior half of the body, opposite the small pelvic fins. Pectoral fins very long and very powerful. Caudal fin forked.

Remarks: Fresh-water fishes. In view of their powerful pectoral fins, they could presumably "fly" like their recent relatives.

Recent relatives: Closely related to the recent members of the genus *Triportheus* and to other characins of the subfamily Tryconinae.



Triportheus angulatus, the recent narrow hatchetfish.



Hypsidoris farsonensis Lundberg & Case (length c. 26 cm) from the Eocene of Wyoming, U.S.A. Original: Field Museum of Natural History, Chicago, Illinois, U.S.A.

Genus: *Hypsidoris* Lundberg & Case, 1970.

Geological range: Eocene.

Geographical distribution: North America.

Features: Middle-sized fishes with laterally compressed bodies, ventrally slightly flattened. Head broad and flat. Dorsal fin immediately behind the head, carried by a powerful spine. Pelvic fins small. Pectoral fins elongate. Anal fin broad-based. Caudal fin slightly concave posteriorly.

Remarks: Fresh-water fishes, mainly bottom-dwelling but partly also free-swimming.

Recent relatives: Distantly related to recent catfishes of the family Ictaluridae.



Ictalurus melas, a recent catfish.



Ameiurus vespertinus Miller & Smith (length c. 17 cm) from the Miocene of Idaho, U.S.A. Original: Field Museum of Natural History, Chicago, Illinois, U.S.A.

Genus: *Ameiurus* Rafinesque, 1820.

Synonym: *Ictalurus*.

Geological range: Oligocene to recent.

Geographical distribution: Asia, North America.

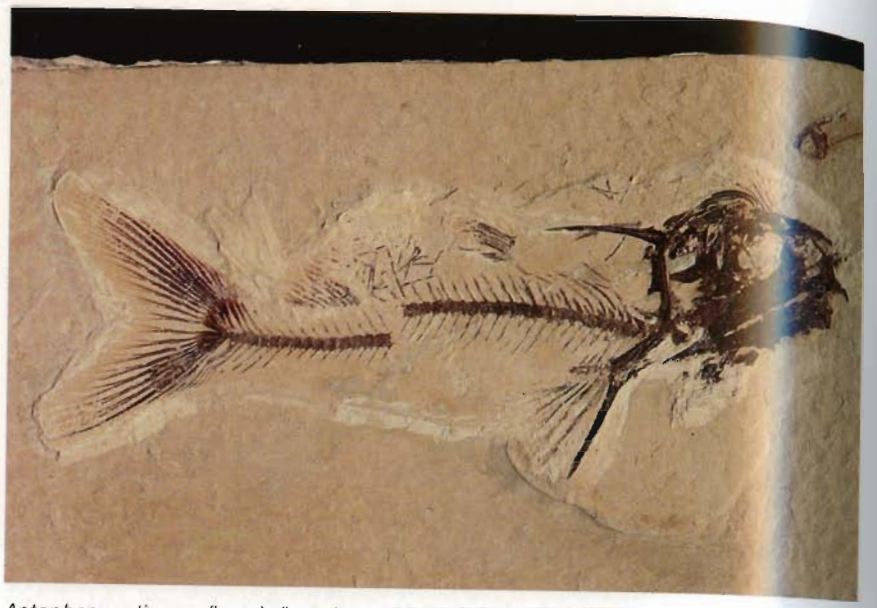
Features: Middle-sized fishes with laterally compressed bodies. Head powerful and broad. In the neck region, immediately behind the head, is a powerful spine carrying the dorsal fin. Caudal fin deeply concave posteriorly.

Remarks: Fresh-water fishes, mainly bottom-dwelling but sometimes also free-swimming.

Recent relatives: Closely related to North American fresh-water catfishes of the genus *Ameirus*.



Ictalurus (*Ameiurus*) *nebulosus*, the recent brown bullhead.



Astephas antiquus (LEIDY) (length c. 14 cm) from the Eocene of Wyoming, U.S.A. Original: Field Museum of Natural History, Chicago, Illinois, U.S.A.

Genus: *Astephas* COPE, 1873.

Synonym: *Rhineastes*.

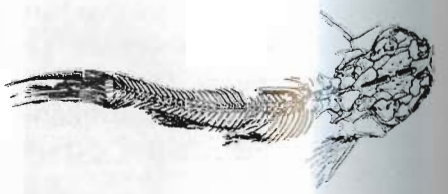
Geological range: Eocene to recent.

Geographical distribution: North America.

Features: Small to middle-sized fishes with cylindrical bodies. Head large, broad and flat. Gape long and broad. Dorsal fin and pectoral fins each borne by a powerful spine. Caudal fin deeply forked.

Remarks: Fresh-water fishes, mostly bottom-dwelling but sometimes free-swimming.

Recent relatives: Related to recent cat fishes of the family Ictaluridae.



Astephas, reconstruction after GRANDE.



Aoria saropteryx (von der MARCK) (length c. 28 cm) from the Oligocene of Sipang, Sumatra. Original: Museum für Geologie und Paläontologie, Tübingen, Germany.

Genus: *Aoria* JORDAN, 1919.

Geological range: Oligocene.

Geographical distribution: Southeastern Asia.

Features: Middle-sized fishes with laterally compressed bodies. Head large and broad. A powerful spine in the neck region carries the dorsal fin. Pectoral fins also with spines. Caudal fin forked.

Remarks: Fresh-water fishes, bottom-dwelling and free-swimming.

Recent relatives: Related to recent spiny catfishes of the family Bagridae.



Bagrus sp., a recent bagrid catfish. Lithograph from BLOCH.



Pangasius indicus (von der MARCK) (length c. 35 cm) from the Oligocene of Sipang, Sumatra. Original: Museum für Geologie und Paläontologie, Tübingen, Germany.

Genus: *Pangasius* BLEEKER, 1846.

Geological range: Oligocene to recent.

Geographical distribution: Southeastern Asia.

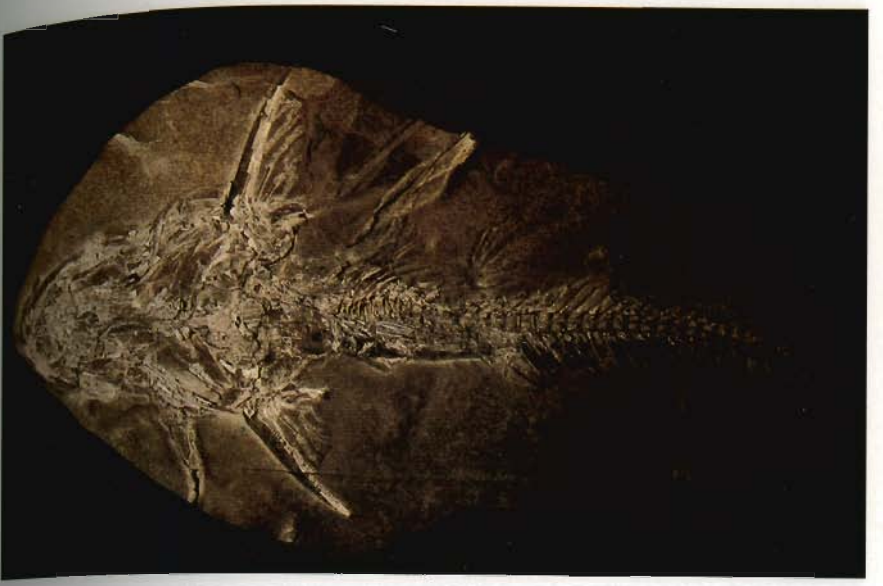
Features: Middle-sized fishes with elongate bodies, approximately circular in section. Head large and broad, flattened towards the snout. A powerful spine in the rear part of the head. Dorsal fin approximately in the middle of the body. Caudal fin strongly forked.

Remarks: Bottom-dwelling and free-swimming. Perhaps ate plants, like many of its recent relatives.

Recent relatives: Closely related to recent pangasiid catfishes of the genus *Pangasius*.



Pangasius sutchi, a recent shark catfish.



Pimelodus sp. (length c. 27 cm) from the Miocene of Taubaté, Brazil. Original: The Natural History Museum, London, U.K. (P9010).

Genus: *Pimelodus* de LACÉPÈDE, 1803.

Geological range: Miocene to recent.

Geographical distribution: South America, Africa.

Features: Middle-sized fishes with laterally compressed but ventrally flattened bodies. Head broad and flat. Pectoral fins small, with a spine. Dorsal fin approximately in the middle of the body. Pelvic fins very small. Caudal fin moderately forked.

Remarks: Bottom-dwelling fresh-water fishes.

Recent relatives: Closely related to the recent antenna catfish *Pimelodus*.



Pimelodus, a recent antenna catfish.



Corydoras revelatus COCKERELL (length c. 3 cm) from the Miocene of Sunchal, Argentina. Original: The Natural History Museum, London, U.K. (P136179).

Genus: *Corydoras* de LACÉPÈDE, 1803.

Geological range: Miocene to recent.

Geographical distribution: South America.

Features: Small fishes with laterally compressed but ventrally flattened bodies. Dorsal surface armoured with V-shaped plates of bone. Ventral surface unarmoured. Head short and deep. Eyes small. In the nape region there is a powerful spine which carries the dorsal fin. Caudal fin relatively large, moderately forked.

Remarks: Bottom-dwelling fresh-water fishes.

Recent relatives: Closely related to the recent corycats of the genus *Corydoras*.



Corydoras arcuatus, a recent armoured catfish.



Pharmacichthys venenifer WOODWARD (length c. 4 cm) from the Upper Cretaceous of Lebanon. Original: The Natural History Museum, London, U.K.

Genus: *Pharmacichthys* WOODWARD, 1942.

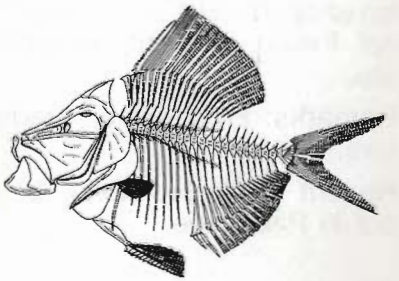
Geological range: Upper Cretaceous.

Geographical distribution: Middle East.

Features: Small fishes with broadly oval outline, laterally compressed. Head deep. Snout slightly pointed. On the highest point of the body is a long thin spine which probably carried the very tall dorsal fin. Pelvic and pectoral fins small. Anal fin. Caudal fin strongly forked.

Remarks: Probably still-water fishes. The name suggests a poisonous fish, referring to the first ray of the dorsal fin. The poisonous nature of this spine, however, is not proven. Systematic position uncertain.

Recent relatives: None. Died out in Upper Cretaceous.



Pharmacichthys, reconstruction after PATTERSON.



Boltyshia brevicauda Sytchevskaya & Daniltchenko (length c. 8 cm) from the Upper Paleocene of C.I.S. Original: Paleontologicheskii Muzei Russkoi Akademii Nauk, Moscow, Russia.

Genus: *Boltyshia* Sytchevskaya & Daniltchenko, 1975.

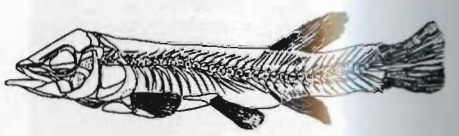
Geological range: Upper Palaeocene.

Geographical distribution: Eastern Europe.

Features: Small fishes with slender elongate bodies. Head shallow. Eyes small. Snout very pointed. Gape long. Dorsal fin pointed, in the posterior third of the body, opposite the anal fin. Pelvic fins small. Pectoral fins somewhat fan-shaped. Anal fin. Caudal fin not forked, probably emarginate.

Remarks: Fresh-water predators.

Recent relatives: None. Died out in Paleocene.



Boltyshia, reconstruction after Akademia Nauk, Moscow.



Esox lepidotus Agassiz (length c. 70 cm) from the Miocene of Öhningen, Württemberg, Germany. Original: Staatliches Museum für Naturkunde, Karlsruhe, Germany.

Genus: *Esox* Linnaeus, 1758.

Synonyms: *Trematina*.

Geological range: Paleocene to recent.

Geographical distribution: Europe, Asia, North America.

Features: Middle-sized fishes with slender streamlined bodies. Head elongate. Snout flattened. Eyes small. Dorsal fin very posterior, opposite the anal fin which is of the same size. Pelvic fins small. Pectoral fins obliquely fan-shaped. Caudal fin strongly forked.

Remarks: Fresh-water predators.

Recent relatives: Closely related to the recent pike.

Esox lucius, the pike. Lithograph from Bloch (see next page).





Umbra perpusilla (Agassiz) (length c. 3 cm) from the Miocene of Öhningen, Württemberg, Germany. Original: Teylers Museum, Haarlem, Netherlands.

Genus: *Umbra* Gronov, 1763.

Geological range: Oligocene to recent.

Geographical distribution: Europe.

Features: Very small fishes of slender shape. Head shallow. Snout pointed. Eyes small. Mouth opening downwards. Dorsal fin rounded, very posterior, opposite the elongate anal fin. Caudal fin with a convex margin.

Remarks: Fresh-water fishes which fed on small animals.

Recent relatives: Closely related to the recent mud minnows.



Umbra pygmaea, the recent mud minnow.



Unnamed fish (length c. 7.5 cm) from the Eocene of Fuur, Denmark. Original: Paleontologiska Muséet, Uppsala, Sweden.

Genus: Not named.

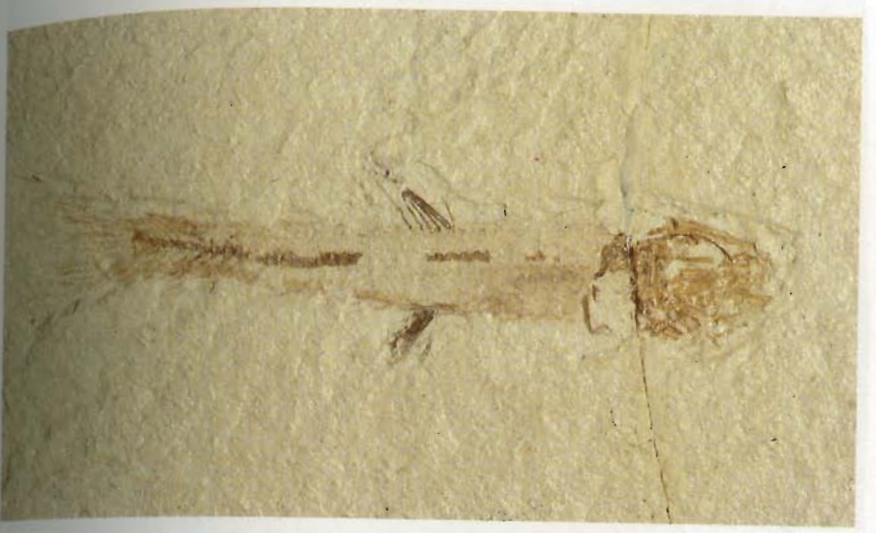
Geological range: Eocene.

Geographical distribution: Europe.

Features: Small, very slender fishes with streamlined bodies. Head shallow. Eyes large. Snout pointed. Dorsal fin small and pointed, opposite the fan-shaped pelvic fins. Caudal fin deeply forked, with narrow lobes.

Remarks: Gregarious.

Recent relatives: Genus probably extinct. Perhaps closely related to recent herring smelts of the family Argentinidae.



Bathylagus angelensis JORDAN & GILBERT (length c. 8 cm) from the Miocene of California, U.S.A. Original: Siber & Siber Collection, Aathal, Switzerland.

Genus: *Bathylagus* GÜNTHER, 1878.

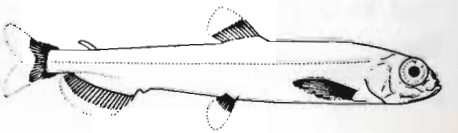
Geological range: Miocene to recent.

Geographical distribution: North America.

Features: Small fishes of slender elongate shape. Head shallow. Eyes large. Gape rather long. Dorsal fin pointed, approximately in the middle of the body, opposite the elongate pelvic fins. Anal fin rounded. Caudal fin slightly forked.

Remarks: Probably lived in the upper layers of the sea.

Recent relatives: Closely related to recent deep sea smelts of the genus *Bathylagus*.



Bathylagus berycoides, a recent deep sea smelt, after NORMAN.



Gaudryella gaudryi (PICTET & HUMBERT) (length c. 11 cm) from the Upper Cretaceous of Lebanon. Original: Henne Collection, Stuttgart, Germany.

Genus: *Gaudryella* PATTERSON, 1970.

Synonyms: *Eoclupea*.

Geological range: Upper Cretaceous.

Geographical distribution: Middle East.

Features: Small fishes with elongate bodies. Head elongate. Snout pointed. Gape long. Dorsal fin in the anterior half of the body. Caudal fin deeply forked.

Remarks: Probably gregarious.

Recent relatives: None. Died out in Upper Cretaceous.



Gaudryella, reconstruction after PICTET & HUMBERT.



Humbertia operta PATTERSON (length c. 10 cm) from the Eocene of Bolca, Italy. Original: American Museum of Natural History, New York, N.Y., U.S.A..

Genus: *Humbertia* PATTERSON, 1970.

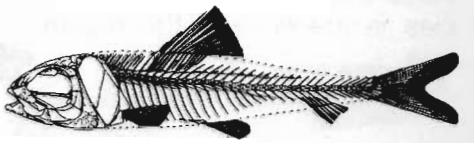
Geological range: Upper Cretaceous to Eocene.

Geographical distribution: Europe, Middle East.

Features: Small fishes of elongate shape. Head elongate. Eyes large. Dorsal fin somewhat anterior to the middle of the body. Pectoral fins fan-shaped. Caudal fin forked.

Remarks: Probably gregarious.

Recent relatives: None. Died out in Eocene.



Humbertia, reconstruction after PATTERSON.



Mallotus villosus CUVIER (length c. 12 cm) from the Pleistocene of Canada. Original: The Natural History Museum, London, U.K. (P58863a, b).

Genus: *Mallotus* CUVIER, 1829.

Geological range: Pleistocene to recent.

Geographical distribution: Europe, North America, Greenland.

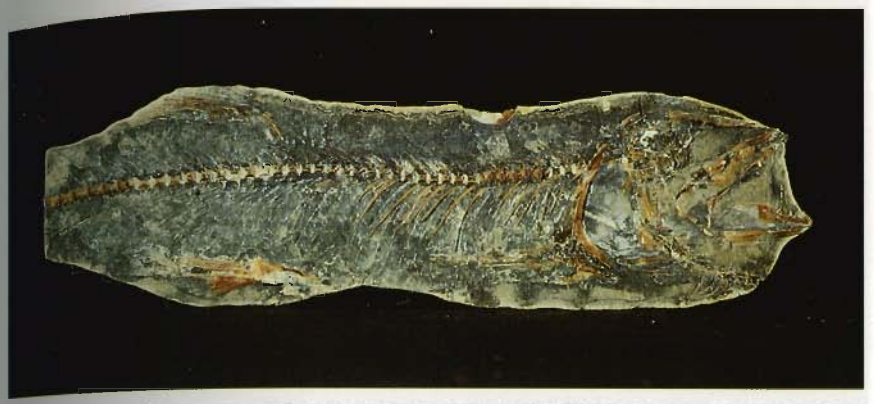
Features: Small fishes of slender streamlined shape. Head shallow. Snout slightly rounded. Gape rather long. Dorsal fin approximately in the middle of the body, opposite the small pelvic fins. Pectoral fins elongate. Anal fin broad-based, almost fringe-like. Caudal fin forked.

Remarks: Gregarious.

Recent relatives: The fossil species is identical to the recent one.



Mallotus villosus, the recent capelin. Lithograph from CUVIER.



Osmerus mordax (MITCHILL) (length c. 14 cm) from the Pleistocene of Canada. Original: National Museum of Natural Sciences, Ottawa, Canada.

Genus: *Osmerus* FORSKÅL, 1775.

Geological range: Miocene to recent.

Geographical distribution: Europe, North America.

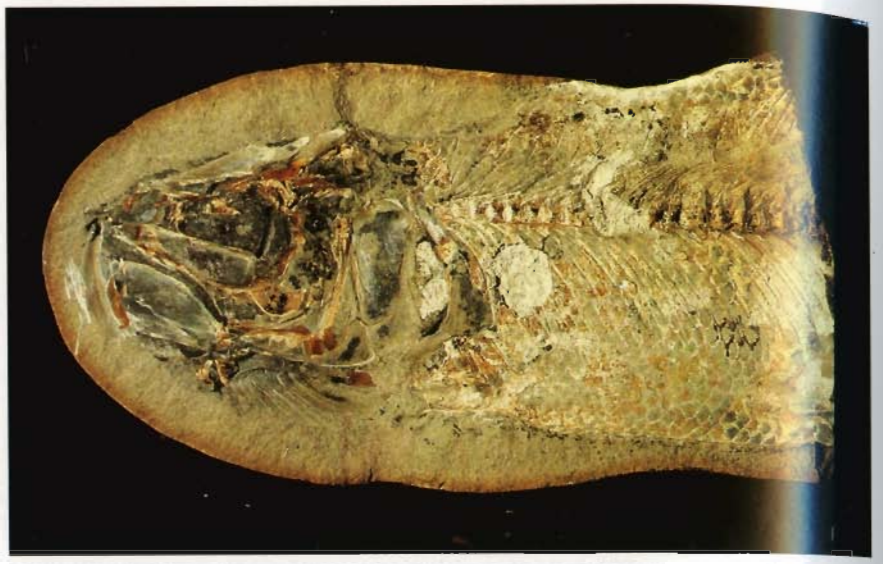
Features: Small fishes with elongate bodies. Head elongate. Eyes large. Gape long. Jaws set with small teeth. Dorsal fin approximately in the middle of the body, opposite the small fan-shaped pelvic fins. Anal fin broad-based. Caudal fin slightly forked, with broad lobes.

Remarks: Gregarious.

Recent relatives: Closely related to recent smelts of the genus *Osmerus*.



Osmerus eperlanus, the recent stint. Lithograph from BLOCH.



Coregonus artedii LESUEUR (length c. 6 cm) from the Pleistocene of Canada. Original: National Museum of Natural Sciences, Ottawa, Canada.

Genus: *Coregonus* de LACÉPÈDE, 1803.

Geological range: Pleistocene to recent.

Geographical distribution: Europe, North America.

Features: Small fishes of slender streamlined shape. Head elongate. Eyes large. Snout pointed. Gape long. Jaws with small teeth. Dorsal fin pointed, approximately in the middle of the body. Pectoral and pelvic fins elongate. Anal fin broad-based. Caudal fin rather deeply forked.

Remarks: Probably gregarious.

Recent relatives: Closely related to recent whitefishes and ciscos.



Coregonus sp., a recent whitefish. Lithograph from CUVIER.



Eosalmo driftwoodensis WILSON (length c. 18 cm) from the Middle Eocene of Driftwood Creek, Canada. Original: University of Alberta, Edmonton, Canada.

Genus: *Eosalmo* WILSON, 1977.

Geological range: Middle Eocene.

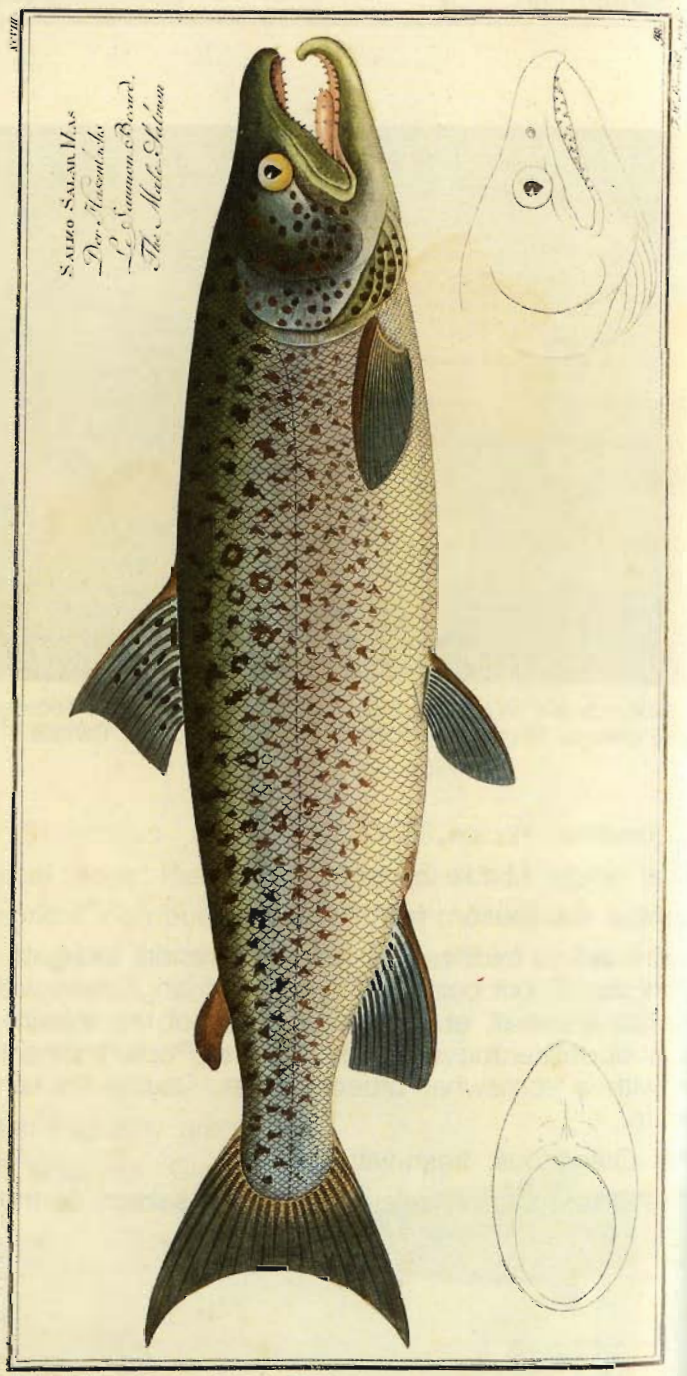
Geographical distribution: North America.

Features: Small to middle-sized fishes of slender elongate shape. Head elongate. Snout pointed. Gape rather long. Jaws with small teeth. Dorsal fin small, at the posterior end of the anterior half of the body, opposite the small pelvic fins. Pectoral fins narrow. Anal fin with a somewhat broader base. Caudal fin somewhat emarginate.

Remarks: Gregarious, fresh-water fishes.

Recent relatives: Closely related to recent salmon of the genus *Salmo*.

Salmo salar, the recent salmon. Lithograph from BLOCH (see next page).





Thaumaturus intermedius WEITZEL (length c. 6 cm) from the Middle Eocene of Messel, Hesse, Germany. Original: Frickhinger Collection, Munich, Germany.

Genus: *Thaumaturus* REUSS, 1844.

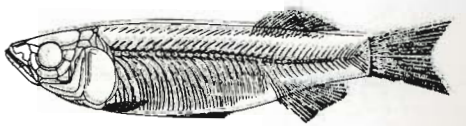
Geological range: Middle Eocene to Lower Miocene.

Geographical distribution: Europe.

Features: Small fishes with elongate bodies. Head shallow. Eyes large. Snout pointed. Jaws with small teeth. Dorsal fin low, broad-based, very posterior in position. Pectoral and pelvic fins small. Anal fin opposite the dorsal fin, likewise broad-based. Caudal fin rather emarginate.

Remarks: Small fresh-water predators.

Recent relatives: Distantly related to recent salmon.



Thaumaturus, reconstruction after WEITZEL.



Gharbouria libanica GAYET (length c. 3.5 cm) from the Upper Cretaceous of Lebanon. Original: Muséum National d'Histoire Naturelle, Paris, France. Photograph: Serette, Paris.

Genus: *Gharbouria* GAYET, 1988.

Geological range: Upper Cretaceous.

Geographical distribution: Middle East.

Features: Very small fishes of slender shape. Head shallow. Eyes large. Snout pointed. Gape rather long. Dorsal fin small, approximately in the middle of the body, opposite the narrow pelvic fins. Pectoral fins small and fan-shaped. Caudal fin forked.

Remarks: Probably gregarious.

Recent relatives: None. Died out in Cretaceous.



Cyclothone sp. (length c. 4 cm) from the Upper Miocene of California, U.S.A. Original: Peabody Museum of Natural History, New Haven, Connecticut, U.S.A.

Genus: *Cyclothone* GOODE & BEAN, 1883.

Synonyms: *Regenius*.

Geological range: Miocene to recent.

Geographical distribution: North America.

Features: Very small fishes with slender elongate bodies. Head elongate. Eyes large. Snout pointed. Jaws with sharp teeth. Dorsal fin in the posterior half of the body. Caudal fin deeply forked.

Remarks: Probably gregarious.

Recent relatives: Closely related to recent bristlemouths of the genus *Cyclothone*. This has twelve species in modern seas and is perhaps the most abundant genus of all fishes.



Cyclothone, a recent bristlemouth, after BADCOCK.



Gonostoma albyi SAUVAGE (length c. 9 cm) from the Upper Miocene of Licata, Sicily, Italy. Original: Muséum National d'Histoire Naturelle, Paris, France. Photograph: Serette, Paris.

Genus: *Gonostoma* RAFINESQUE, 1810.

Geological range: Miocene to recent.

Geographical distribution: Europe, North Africa.

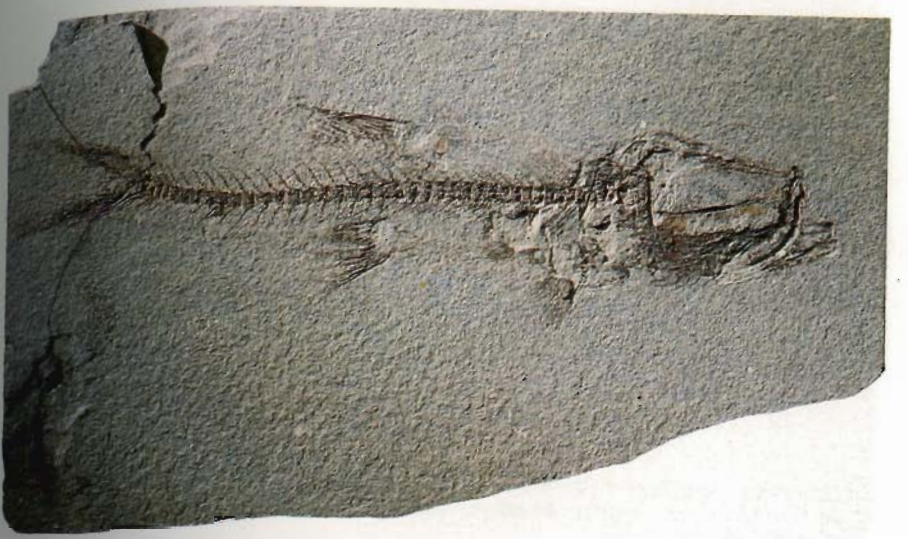
Features: Small fishes with slender elongate bodies. Head relatively large. Eyes small. Snout pointed. Gape long. Dorsal fin approximately in the middle of the body. Anal fin begins opposite the dorsal fin. Pectoral and pelvic fins small.

Remarks: Predators. The group probably had light organs even at that early date.

Recent relatives: Closely related to recent bristlemouths of the genus *Gonostoma*.



Gonostoma sp., a recent bristlemouth, after NELSON.



Idrissia jubae ARAMBOURG (length c. 6 cm) from the Lower Cretaceous of Tselfat, Morocco. Original: Muséum National d'Histoire Naturelle, Paris, France. Photograph: Serette, Paris.

Genus: *Idrissia* ARAMBOURG, 1954.

Geological range: Lower Cretaceous.

Geographical distribution: Northern Africa.

Features: Small fishes of slender shape, tapering rearwards. Head large. Eyes large. Snout slightly pointed. Gape long. Dorsal fin approximately in the middle of the body, opposite the pelvic fins. Pectoral fins small. Caudal fin deeply forked.

Remarks: Probably bottom-dwelling.

Recent relatives: None. Died out in Cretaceous.



Protostomias maroccanus ARAMBOURG (length c. 17 cm) from the Lower Cretaceous of Tselfat, Morocco. Original: Muséum National d'Histoire Naturelle, Paris, France. Photograph: Serette, Paris.

Genus: *Protostomias* ARAMBOURG, 1943.

Geological range: Lower Cretaceous.

Geographical distribution: Northern Africa.

Features: Small fishes with slender elongate, anteriorly deepened bodies. Head relatively large. Eyes small. Snout rounded. Gape long. Dorsal fin probably in the posterior half of the body. Caudal fin relatively small and deeply forked.

Remarks: Probably bottom dwellers.

Recent relatives: None. Died out in the Cretaceous.



Scopeloides glarisianus AGASSIZ (length c. 7 cm) from Middle Eocene of Litencice, Czechoslovakia. Original: Frickhinger Collection, Munich, Germany.

Genus: *Scopeloides* WETTSTEIN, 1887.

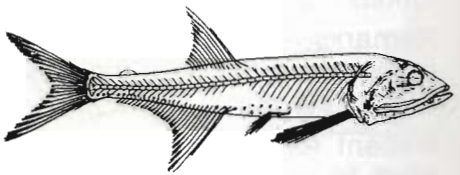
Geological range: Middle Eocene to Miocene.

Geographical distribution: Europe, western Asia.

Features: Small fishes with elongated bodies. Head shallow. Eyes large. Snout pointed. Gape long. Dorsal fin pointed, behind the middle of the body. Pectoral fins elongate. Pelvic fins small. Anal fin pointed, with a fringe-like posterior extension. Caudal fin deeply forked. Light organs on the flanks of the body.

Remarks: Probably deep-sea fishes.

Recent relatives: Genus extinct. Distantly related to extant bristlemouths of the family Gonostomatidae.



Scopeloides, reconstruction after DANILCHENKO.



Argyropelecus sp. (length c. 5 cm) from the Miocene of California, U.S.A. Original: Peabody Museum of Natural History, New Haven, Connecticut, U.S.A.

Genus: *Argyropelecus* Cocco, 1829.

Geological range: Oligocene to recent.

Geographical distribution: Europe, northern Africa, North America.

Features: Small fishes of almost circular outline, laterally compressed and deep-bellied. Head deep. Eyes large. Gape rather long, directed upwards. Dorsal fin somewhat behind the middle of the body, divided into two parts. Pectoral fins obliquely fan-shaped. Anal fin rounded. Pelvic fins small. Caudal fin not forked.

Remarks: Probably still-water fishes which fed near the surface of the water.

Recent relatives: Closely related to recent hatchet fishes of the genus *Argyropelecus*, which are ubiquitous in the pelagic waters of the oceans.



Argyropelecus aculeatus, a recent hatchetfish.



Maurolicus muelleri Gmelin (length c. 4 cm) from the Pliocene of Fiume Marecchia, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Maurolicus* Cocco, 1838.

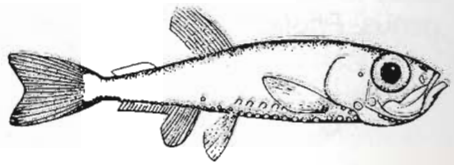
Geological range: Pliocene to recent.

Geographical distribution: Europe.

Features: Very small fishes of slender shape. Head shallow. Eyes large. Snout pointed. Gape directed upwards. Dorsal fin behind the middle of the body, obliquely opposite the narrow pelvic fins. Anal fin is tall anteriorly, but low in its posterior continuation. Caudal fin rather deeply forked.

Remarks: Probably had light organs even at that time.

Recent relatives: The fossil species is identical with the recent one.



Maurolicus muelleri, a recent lightfish.



Photichthys larteti SAUVAGE (length c. 19 cm) from the Upper Miocene of Licata, Sicily, Italy. Original: Muséum National d'Histoire Naturelle, Paris, France. Photograph: Serette, Paris.

Genus: *Photichthys* HUTTON & HECTOR, 1872.

Geological range: Miocene to recent.

Geographical distribution: Europe.

Features: Small to middle-sized fishes of slender shape. Head relatively large, elongate. Eyes small. Snout pointed. Dorsal fin narrow, shortly in front of the middle of the body. Anal fin broad-based. Pectoral fins elongate.

Remarks: Possess light organs.

Recent relatives: Closely related to recent lightfishes of the genus *Photichthys*.



Photichthys argenteus, a recent lightfish.



Vinciguerria sp. (length c. 6 cm) from the Pliocene of Fiume Marecchia, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Vinciguerria* JORDAN & EVERMANN, 1896.

Synonym: *Zalarges*.

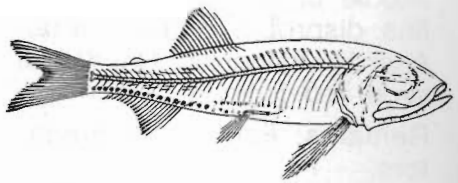
Geological range: Oligocene to recent.

Geographical distribution: Europe.

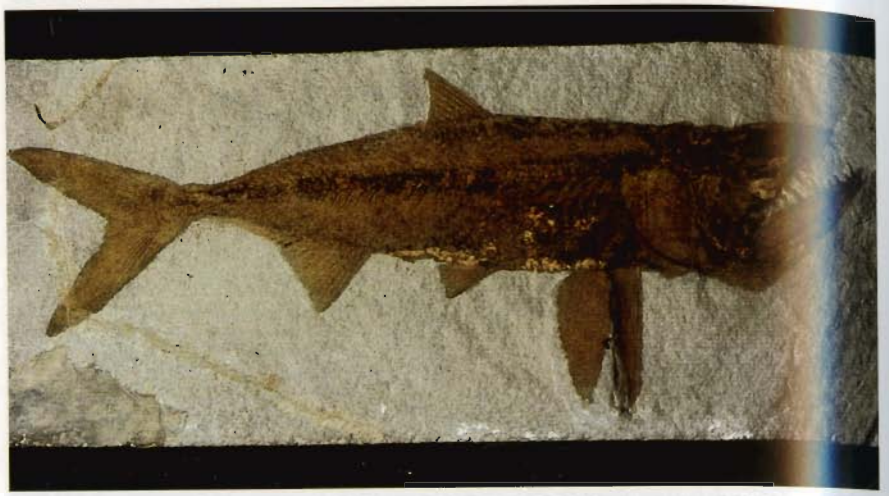
Features: Small fishes with slender bodies. Head shallow. Eyes large. Snout pointed. Dorsal fin triangular, very posterior in position, obliquely opposite the anal fin which is likewise triangular. Pelvic fins small. Pectoral fins elongate. Caudal fin forked. Light organs in the ventral part of the posterior part of the body.

Remarks: Probably pelagic even at that period.

Recent relatives: Closely related to recent lightfishes of the genus *Vinciguerria*.



Vinciguerria, reconstruction after ORLOV.



Enchodus macropterus von der Marck (length c. 23 cm) from the Upper Cretaceous of Sendenhorst, Westphalia, Germany. Original: Geologisch-Paläontologisches Museum, Münster, Germany.

Genus: *Enchodus* Agassiz, 1835.

Synonyms: *Eurygnathus*, *Holcodon*, *Ischyrecephalus*, *Isodon*, *Solenodon*, *Tetheodus*.

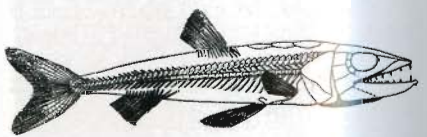
Geological range: Upper Cretaceous to Eocene.

Geographical distribution: Middle East, North America, Europe, Africa, South America.

Features: Middle-sized fishes with somewhat laterally compressed bodies. Head large and deep. Gape long, directed upwards. Predatory dentition. Dorsal fin triangular, approximately in the middle of the body. Pectoral fins disproportionately large. Anal fin triangular. Caudal fin large and forked.

Remarks: Formidable predators.

Recent relatives: None. Died out in Eocene.



Enchodus, reconstruction after Goody.



Leptecodon rectus Williston (length c. 23 cm) from the Upper Cretaceous of Kansas, U.S.A. Original: Museum of Natural History, Lawrence, Kansas, U.S.A.

Genus: *Leptecodon* Williston, 1899.

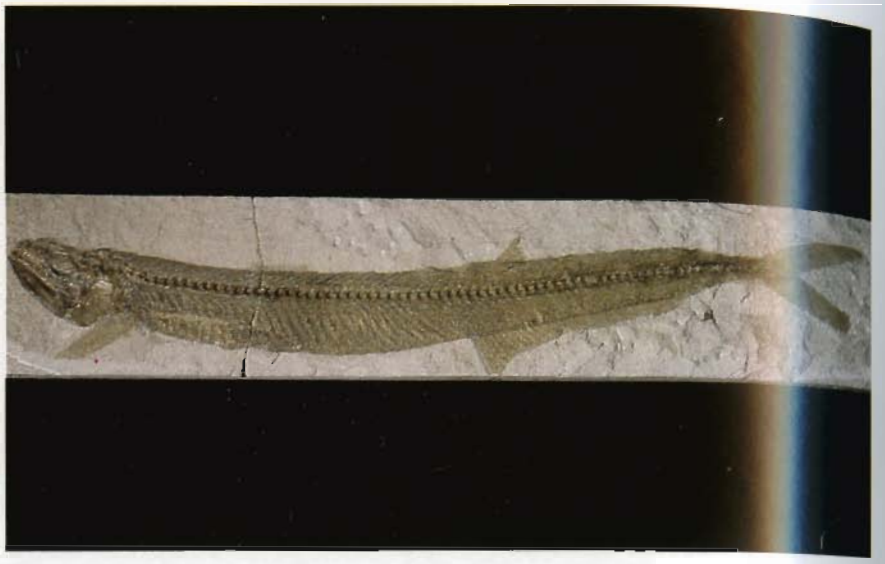
Geological range: Upper Cretaceous.

Geographical distribution: North America.

Features: Middle-sized fishes of slender shape. Head shallow with projecting snout running into a point. Eyes large. Jaws set with sharp teeth. Body covered with bony plates arranged in rows.

Remarks: Predators.

Recent relatives: None. Died out in Upper Cretaceous.



Palaeolycus dregenensis von der MARCK (length c. 40 cm) from the Upper Cretaceous of Sendenhorst, Westphalia, Germany. Original: Geologisch-Paläontologisches Museum, Münster, Germany.

Genus: *Palaeolycus* von der MARCK, 1863.

Geological range: Upper Cretaceous.

Geographical distribution: Europe.

Features: Middle-sized fishes of very slender eel-like shape. Head elongate. Jaws with powerful teeth. Eyes large. Dorsal fin strikingly small, shortly behind the middle of the body. Pectoral fins fan-shaped. Anal fin begins anteriorly opposite the dorsal fin and runs rearwards, as a fringe, almost to the caudal fin. Caudal fin forked.

Remarks: Predators.

Recent relatives: None. Died out in Upper Cretaceous.



Palaeolycus, reconstruction after GOODY.



Eurypholis boissieri PICTET (length c. 21 cm) from the Upper Cretaceous of Lebanon. Original: Frickhinger Collection, Munich, Germany.

Genus: *Eurypholis* PICTET, 1831.

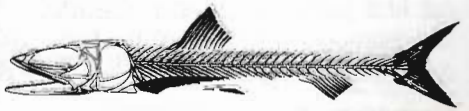
Geological range: Upper Cretaceous.

Geographical distribution: Europe, northern Africa, Middle East.

Features: Middle-sized fishes of slender shape. Head large, and broad in dorsal aspect. Eyes large. Snout pointed. Gape long. Dorsal fin pointed triangular, in the anterior half of the body. Caudal fin deeply forked. The dorsal mid-line and the flanks each carry a row of large bony scales.

Remarks: Predators.

Recent relatives: None. Died out in the Upper Cretaceous.



Eurypholis, reconstruction after ORLOV.



Halec microlepis (Davis) (length c. 18 cm) from the Upper Cretaceous of Lebanon. Original: Muséum National d'Histoire Naturelle, Paris, France. Photograph: Serette, Paris.

Genus: *Halec* Agassiz, 1834.

Synonyms: *Archaeogadus*, *Pomognathus*.

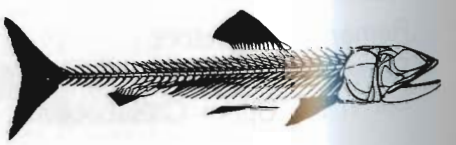
Geological range: Upper Cretaceous.

Geographical distribution: Europe, Middle East.

Features: Small to middle-sized fishes with slender elongate or somewhat broadened bodies. Head shallow. Eyes large. Snout pointed. Gape long. Dorsal fin in the anterior half of the body, opposite the small pelvic fins. Anal fin likewise small. Pectoral fins rather widened. Caudal fin relatively large, slightly forked.

Remarks: Rapid swimmer.

Recent relatives: None. Died out in the Cretaceous.



Halec, reconstruction after Goody.



Hemisaurida hakelensis Goody (length c. 5 cm) from the Upper Cretaceous of Lebanon. Original: Field Museum of Natural History, Chicago, Illinois, U.S.A.

Genus: *Hemisaurida* Kner, 1867.

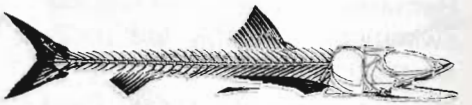
Geological range: Upper Cretaceous.

Geographical distribution: Europe, Middle East.

Features: Small fishes of slender shape. Head long and shallow. Eyes large. Snout pointed. Gape long. Dorsal fin small, in the anterior half of the body, opposite the pelvic fins. Caudal fin moderately forked, with narrow lobes.

Remarks: Probably gregarious.

Recent relatives: None. Died out in the Upper Cretaceous.



Hemisaurida, reconstruction after Goody.



Phylactocephalus microlepis DAVIS (length c. 15 cm) from the Upper Cretaceous of Lebanon. Original: Naturmuseum Senckenberg, Frankfurt-am-Main, Germany.

Genus: *Phylactocephalus* DAVIS, 1887.

Geological range: Upper Cretaceous.

Geographical distribution: Middle East.

Features: Middle-sized fishes with somewhat laterally compressed bodies. Head deep. Gape long, directed upwards. Dorsal fin triangular, in the anterior half of the body. Pectoral fins long and narrow. Pelvic and anal fins small. Caudal fin moderately forked. Strong scales.

Remarks: Certainly rather slow swimmers. Probably fed partly on plants.

Recent relatives: None. Died out in the Upper Cretaceous.



Phylactocephalus, reconstruction after GOODY.



Sardinius cordieri AGASSIZ (length c. 14 cm) from the Upper Cretaceous of Baumberge, Westphalia, Germany. Original: Geologisches-Paläontologisches Museum, Münster, Germany.

Genus: *Sardinius* von der MARCK, 1858.

Geological range: Upper Cretaceous.

Geographical distribution: Europe.

Features: Small to middle-sized fishes of rather laterally compressed shape. Head short and deep. Gape long, directed upwards. Dorsal fin triangular, approximately in the middle of the body. Pectoral fins broadly fan-shaped. Pelvic fins likewise broad. Anal fin with a point near the anterior end but becoming lower posteriorly. Caudal fin forked.

Remarks: Probably gregarious.

Recent relatives: Distantly related to recent lizard fishes of the family Synodontidae.



Sardinius, reconstruction after von der MARCK.



Synodus saurus (length c. 5 cm) from the Pliocene of Fiume Marecchia, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Synodus* Gronov, 1763.

Synonyms: *Xystodus*.

Geological range: Pliocene to recent.

Geographical distribution: Europe.

Features: Small fishes of elongate outline. Head elongate. Snout pointed. Dorsal fin pointed triangular, in the anterior half of the body. Pectoral fins narrow. Points on the ventral surface of the body were probably light organs.

Remarks: Probably solitary fishes which, like their recent relatives, lurked for prey supporting themselves on their pectoral fins.

Recent relatives: Related to recent lizard fishes of the genus *Synodus*.



Synodus sp., a lizardfish.



Lestidiops sphyraenoides Risso (length c. 17 cm) from the Pliocene of Fiume Marecchia, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Lestidiops* Hubbs, 1916.

Geological range: Pliocene to recent.

Geographical distribution: Europe.

Features: Middle-sized fishes of slender streamlined outline. Head shallow and elongate. Dorsal fin very posterior in position. Pectoral fins elongate and expanding forwards. Pelvic fins small. Caudal fin forked.

Remarks: Predators.

Recent relatives: Closely related to recent barracudinas of the genus *Lestidiops*.



Lestidiops similis, a recent barracudina, after Smith.



Paralepis albyi (SAUVAGE) (length c. 23 cm) from the Oligocene of southern France. Original: Interfoss, Munich, Germany.

Genus: *Paralepis* CUVIER, 1817.

Synonyms: *Anapterus*, *Tydeus*.

Geological range: Oligocene to recent.

Geographical distribution: Europe, northern Africa.

Features: Small to middle-sized fishes of very slender elongate shape. Head long and shallow. Eyes relatively large. Snout elongated to form a short pike-like rostrum. Gape long. Dorsal fin small, in the posterior half of the body, opposite the small pelvic fins. Pectoral fins narrow. Caudal fin small, deeply forked.

Remarks: Rapidly swimming predators.

Recent relatives: Closely related to recent barracudinas of the genus *Paralepis*.



Paralepis sp., a recent barracudina. Lithograph from CUVIER.



Parascopelus lacertosus SAUVAGE (length c. 22 cm) from the Upper Miocene of Licata, Sicily, Italy. Original: Muséum National d'Histoire Naturelle, Paris, France. Photograph: Serette, Paris.

Genus: *Parascopelus* SAUVAGE, 1873.

Geological range: Miocene to Pliocene.

Geographical distribution: Europe.

Features: Middle-sized fishes with slender streamlined bodies. Head elongate. Eyes small. Snout pointed. Gape long. Dorsal fin small, approximately in the middle of the body. Caudal fin likewise relatively small and moderately deeply forked.

Remarks: Predators.

Recent relatives: None. Died out in the Pliocene.



Sudis sphecodes (SAUVAGE) (length c. 19 cm) from the Upper Miocene of Licata, Sicily, Italy. Original: Muséum National d'Histoire Naturelle, Paris, France. Photo: Serette, Paris, France.

Genus: *Sudis* RAFINESQUE, 1810.

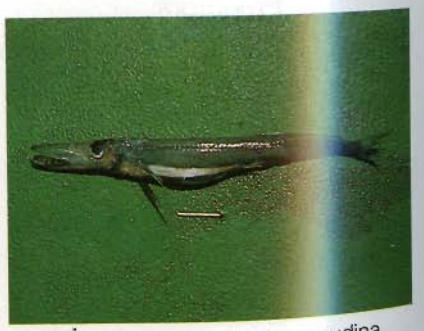
Geological range: Miocene to recent.

Geographical distribution: Europe, northern Africa.

Features: Middle-sized fishes with elongate streamlined bodies. Head elongate. Eyes small. Snout pointed. Dorsal fin behind the middle of the body. Pectoral fins fan-shaped. Anal fin elongate. Pelvic fins small.

Remarks: Predators.

Recent relatives: Closely related to recent members of the genus *Sudis*.



Sudis hyalina, a recent barracudina.



Apateopholis laniatus (DAVIS) (length c. 31 cm) from the Upper Cretaceous of Lebanon. Original: Staatliches Museum für Naturkunde, Karlsruhe, Germany.

Genus: *Apateopholis* WOODWARD, 1890.

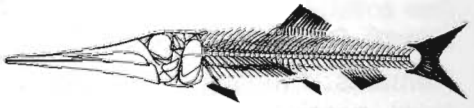
Geological range: Upper Cretaceous.

Geographical distribution: Middle East.

Features: Middle-sized fishes of slender outline. Head elongate and shallow. Upper and lower jaws set with small teeth and elongated to form a rostrum. Eyes large. Dorsal fin low, broad-based. Caudal fin deeply forked, with broad lobes.

Remarks: Predators. The rostrum was presumably used to strike prey from the side.

Recent relatives: None. Died out in the Upper Cretaceous.



Apateopholis, reconstruction after GOODY.



Ichthyotringa furcata (AGASSIZ) (length c. 15 cm) from the Upper Cretaceous of Bethel, Israel. Original: Staatliches Museum für Naturkunde, Karlsruhe, Germany.

Genus: *Ichthyotringa* COPE, 1878.

Synonym: *Rhinellus*.

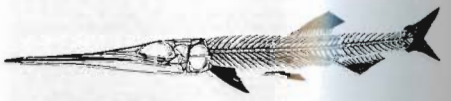
Geological range: Upper Cretaceous.

Geographical distribution: Europe, Middle East, North America, northern Africa.

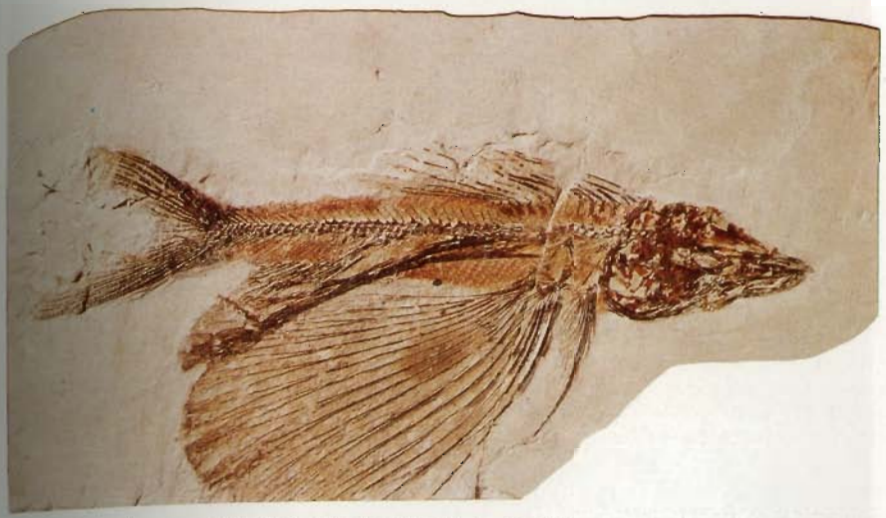
Features: Small to middle-sized fishes of slender shape. Head shallow and elongate. Upper and lower jaws extended to form a rostrum. Eyes large. Dorsal fin approximately in the middle of the body. Pectoral fins narrow, obliquely fan-shaped. Pelvic fins small. Anal fin low, broad-based. Caudal fin forked.

Remarks: Predators. The rostrum presumably served to strike prey from the side.

Recent relatives: None. Died out in the Upper Cretaceous.



Ichthyotringa, reconstruction after GOODY.



Cheirothrix libanicus PICTET & HUMBERT (length c. 15 cm) from the Upper Cretaceous of the Lebanon. Original: Muséum National d'Histoire Naturelle, Paris, France. Photo: Serette, Paris.

Genus: *Cheirothrix* PICTET & HUMBERT, 1866.

Synonyms: *Chirothrix*, *Megapus*, *Megistopuspholis*.

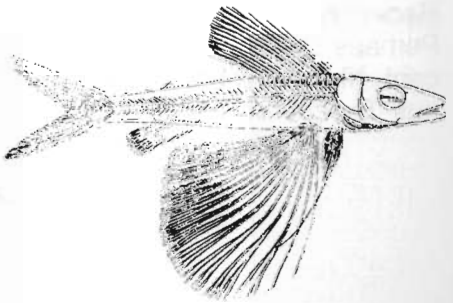
Geological range: Upper Cretaceous.

Geographical distribution: Middle East, Europe.

Features: Small fishes with slender bodies. Head elongate and shallow. Eyes large. Gape rather long. Pelvic fins broad and extremely elongate, wing-shaped. Dorsal fin narrow and long, very anterior, opposite the pelvic fins. Caudal fin forked.

Remarks: "Flying" fishes.

Recent relatives: None. Died out in the Upper Cretaceous.



Cheirothrix, reconstruction after WOODWARD.



Exocoetoides minor Davis (length c. 5 cm) from the Upper Cretaceous of Lebanon. Original: Frickhinger Collection, Munich, Germany.

Genus: *Exocoetoides* Davis, 1887.

Geological range: Upper Cretaceous.

Geographical distribution: Middle East.

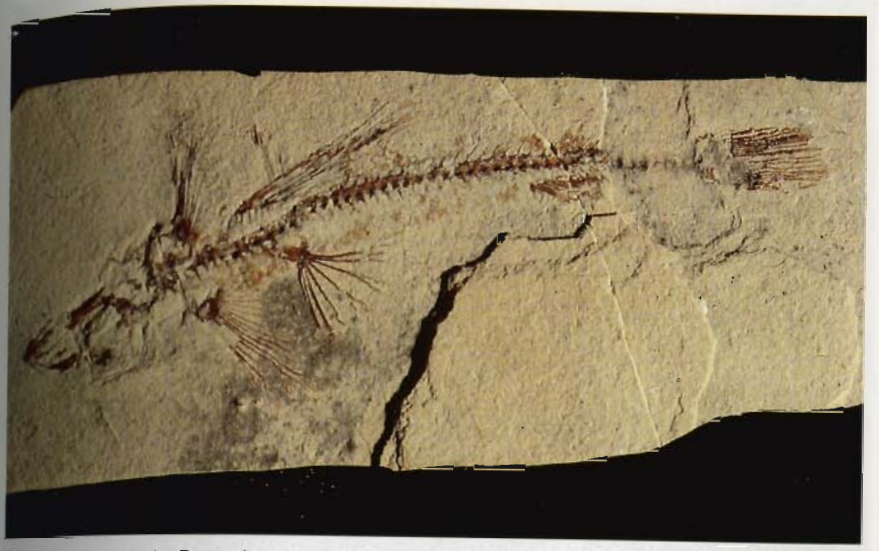
Features: Small fishes with slender bodies. Head elongate and shallow. Snout pointed. Pectoral fins narrow and very elongate. Pelvic fins rounded and expanded.

Remarks: "Flying" fishes.

Recent relatives: Genus extinct. Perhaps distantly related to recent "flying fishes" of the genus *Exocoetes*.



Exocoetus volitans, a flying fish. Lithograph from Bloch.



Telepholis tenuis Davis (length c. 15 cm) from the Upper Cretaceous of Lebanon. Original: Field Museum of Natural History, Chicago, Illinois, U.S.A.

Genus: *Telepholis* von der Marck, 1868.

Geological range: Upper Cretaceous.

Geographical distribution: Europe, Middle East.

Features: Small to middle-sized fishes of slender shape. Head elongate and shallow. Snout slightly pointed. Pectoral fins greatly expanded. Dorsal fin very posterior, opposite the low anal fin.

Remarks: Could probably "fly" short distances.

Recent relatives: None. Died out in the Upper Cretaceous.



Unnamed fish (length c. 18 cm) from the Lower Cretaceous of Hughenden, Queensland, Australia. Original: Queensland Museum, Brisbane, Australia.

Genus: Not named.

Geological range: Lower Cretaceous.

Geographical distribution: Australia.

Features: Small fishes of slender shape. Head elongate and shallow. Pectoral fins strongly expanded into "wings". Pelvic fins very small.

Remarks: "Flying" fishes.



Dercetis triqueter Pictet (length c. 27 cm) from the Upper Cretaceous of Lebanon. Original: National Museum of Scotland, Edinburgh, U.K.

Genus: *Dercetis* Agassiz, 1834.

Synonyms: *Leptotrachelus*, *Benthesikyme*.

Geological range: Upper Cretaceous.

Geographical distribution: Europe, Middle East.

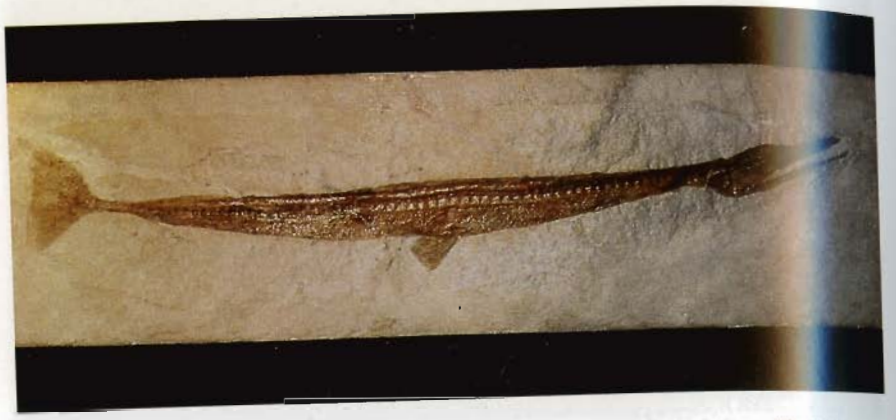
Features: Middle-sized fishes with very slender elongate bodies. Head elongate and very shallow. Eyes large. Upper and lower jaws produced to form a short rostrum. Dorsal fin low, broad-based, approximately in the middle of the body. Pectoral and pelvic fins narrow. Caudal fin moderately forked. Bony shields arranged in rows on the body.

Remarks: Predators.

Recent relatives: None. Died out in the Upper Cretaceous.



Dercetis, reconstruction after Goody.



Pelargorhynchus dercetiformis von der MARCK (length c. 48 cm) from the Upper Cretaceous of Sendenhorst, Westphalia. Original: Geologisch-Paläontologisches Museum, Münster, Germany.

Genus: *Pelargorhynchus* von der MARCK, 1858.

Geological range: Upper Cretaceous.

Geographical distribution: Europe.

Features: Middle-sized fishes with elongate, very narrow bodies. Head elongate and shallow. Upper and lower jaws lengthened to form a rostrum. Dorsal fin approximately in the middle of the body. Caudal fin stalked and unforked. Bony shields arranged in rows on the body.

Remarks: Predators.

Recent relatives: None. Died out in the Upper Cretaceous.



Rhynchodercetis hakelensis PICTET & HUMBERT (length c. 32 cm) from the Upper Cretaceous of Lebanon. Original: Naturhistorisches Museum, Vienna, Austria.

Genus: *Rhynchodercetis* ARAMBOURG, 1944.

Geological range: Upper Cretaceous.

Geographical distribution: Europe, Middle East.

Features: Middle-sized fishes of very slender shape. Head elongate and shallow. Upper and lower jaws lengthened to form a rostrum, with upper jaw projecting only slightly beyond the lower. Dorsal fin in the anterior half of the body, opposite the small pelvic fins. Anal fin likewise small. Caudal fin forked, with relatively narrow lobes.

Remarks: Predators.

Recent relatives: None. Died out in the Upper Cretaceous.



Rhynchodercetis, reconstruction after GOODY.



Cimolichthys nepaholica (COPE) (length c. 147 cm) from the Upper Cretaceous of Kansas, U.S.A. Original: Museum of Natural History, Lawrence, Kansas, U.S.A.

Genus: *Cimolichthys* LEIDY, 1857.

Synonym: *Empo*.

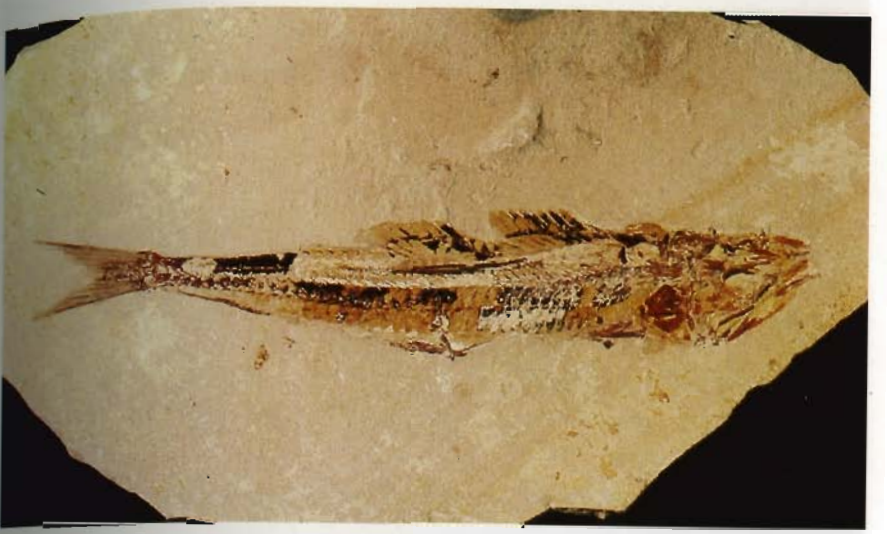
Geological range: Upper Cretaceous to Paleocene.

Geographical distribution: North America, South America, Europe, northern Africa.

Features: Large fishes of slender streamlined shape. Head shallow and relatively long. Snout pointed. Upper and lower jaws set with sharp teeth. On the back a row of large bony shields extends from the head to the dorsal fin. Smaller bony shields along the lateral line. Caudal fin disproportionately large, deeply forked, with narrow lobes.

Remarks: Predators.

Recent relatives: None. Died out in the Paleocene.



Prionolepis cataphractus (PICTET & HUMBERT) (length c. 21 cm) from the Upper Cretaceous of Lebanon. Original: Frickhinger Collection, Munich, Germany.

Genus: *Prionolepis* EGERTON, 1850.

Synonym: *Aspidopleurus*.

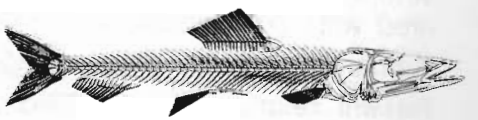
Geological range: Upper Cretaceous.

Geographical distribution: Europe, Middle East.

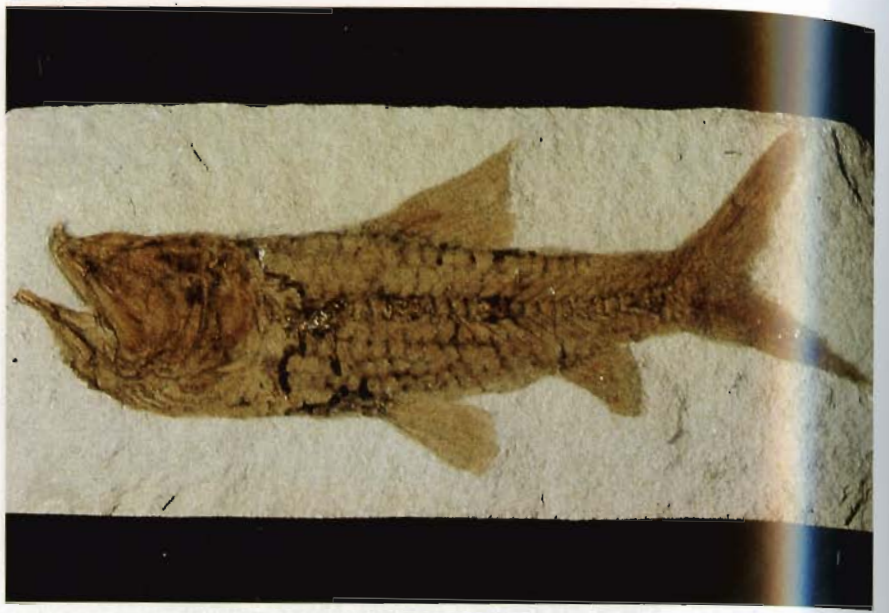
Features: Middle-sized fishes of slender shape. Head elongate and shallow. Gape rather long. Dorsal fin broad-based, in the anterior half of the body. Anal fin likewise broad-based. Caudal fin forked. Serrated scales arranged in rows.

Remarks: Probably predators.

Recent relatives: None. Died out in the Upper Cretaceous.



Prionolepis, reconstruction after GOODY.



Sardinioides monasterii Agassiz (length c. 18 cm) from the Upper Cretaceous of Sendenhorst, Westphalia, Germany. Original: Geologisch-Paläontologisches Museum, Münster, Westphalia, Germany.

Genus: *Sardinioides* von der Marck, 1858.

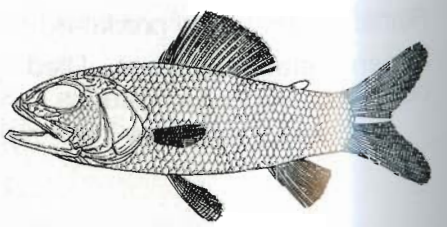
Geological range: Upper Cretaceous.

Geographical distribution: Europe, Middle East.

Features: Small to middle-sized fishes with rather laterally compressed bodies. Head short and deep. Eyes large. Gape long, directed upwards. Dorsal fin in the middle of the body. Pelvic fins very anterior in position, almost vertically beneath the small pectoral fins. Caudal fin forked, with broad lobes. Body covered with large scales.

Remarks: Probably predators.

Recent relatives: None. Died out in the Upper Cretaceous.



Sardinioides, reconstruction after Patterson.



Ceratoscopelus maderensis Lowe (length c. 8 cm) from the Pliocene of Fiume Marecchia, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Ceratoscopelus* Günther 1864.

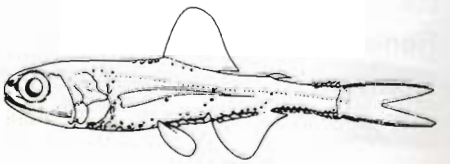
Geological range: Pliocene to recent.

Geographical distribution: Europe.

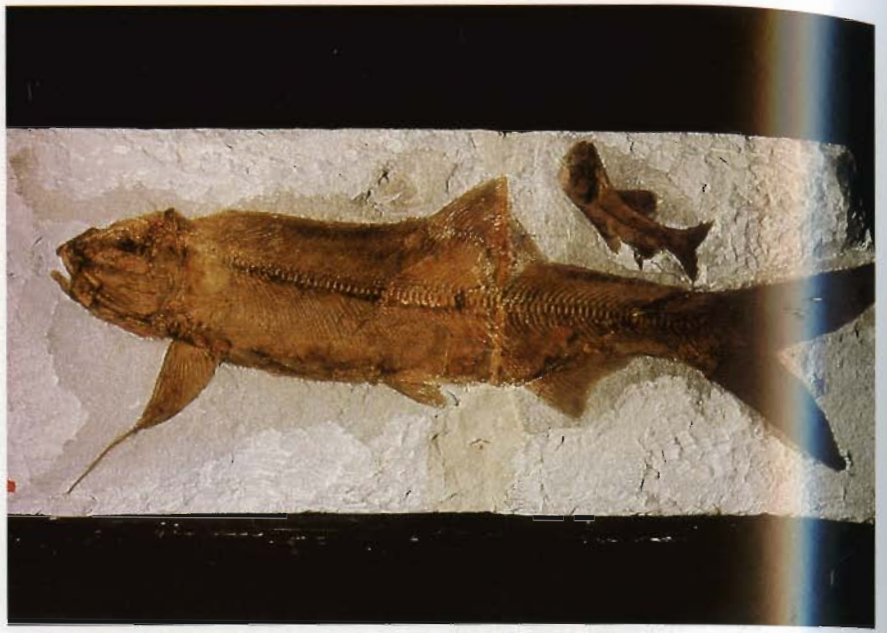
Features: Small fishes of slender shape. Head deep. Eyes large. Gape long, directed upwards. Dorsal fin in the middle of the body, opposite the small and narrow pelvic fins. Anal fin broad-based. Pectoral fins narrow. Caudal fin deeply forked.

Remarks: Probably already possessed light organs.

Recent relatives: Closely related to recent lantern fishes of the genus *Ceratoscopelus*.



Ceratoscopelus warmingii, a recent lanternfish (after Smith).



Dactylopogon grandis von der MARCK (length c. 44 cm) from the Upper Cretaceous of Sendenhorst, Westphalia, Germany. Original: Geologisch-Paläontologisches Museum, Münster, Germany.

Genus: *Dactylopogon* von der MARCK, 1868.

Geological range: Upper Cretaceous.

Geographical distribution: Europe.

Features: Middle-sized fishes with rather laterally compressed bodies. Head short and deep. Gape long, directed upwards. Dorsal fin triangular, approximately in the middle of the body. Pectoral fins unusually large, long and narrow. Pelvic fins small. Anal fin with a point anteriorly, becoming lower posteriorly. Caudal fin forked, with relatively narrow lobes.

Remarks: Probably predators.

Recent relatives: None. Died out in the Upper Cretaceous.



Eomyctophum koraense DANILTCHENKO (length c. 5 cm) from the Oligocene of Georgia. Original: Paleontologicheskii Muzei Russkoi Akademii Nauk, Moscow, Russia.

Genus: *Eomyctophum* DANILTCHENKO 1947.

Geological range: Oligocene to Miocene.

Geographical distribution: Western and eastern Europe, western Asia.

Features: Small sized fishes of somewhat laterally compressed shape. Head short and relatively deep. Snout rounded. Gape long. Dorsal fin approximately in the middle of the body. Pectoral and pelvic fins small. Anal fin larger. Light organs probably present.

Remarks: Probably fed on small organisms.

Recent relatives: Genus extinct. Closely related to recent lantern fishes of the genus *Myctophum*.



Myctophum sp. a recent lanternfish. Lithograph from BLEEKER.



Hakelia laticauda (PICTET) (length c. 9 cm) from the Upper Cretaceous of Lebanon. Original: American Museum of Natural History, New York, N.Y., U.S.A.

Genus: *Hakelia* WOODWARD, 1942.

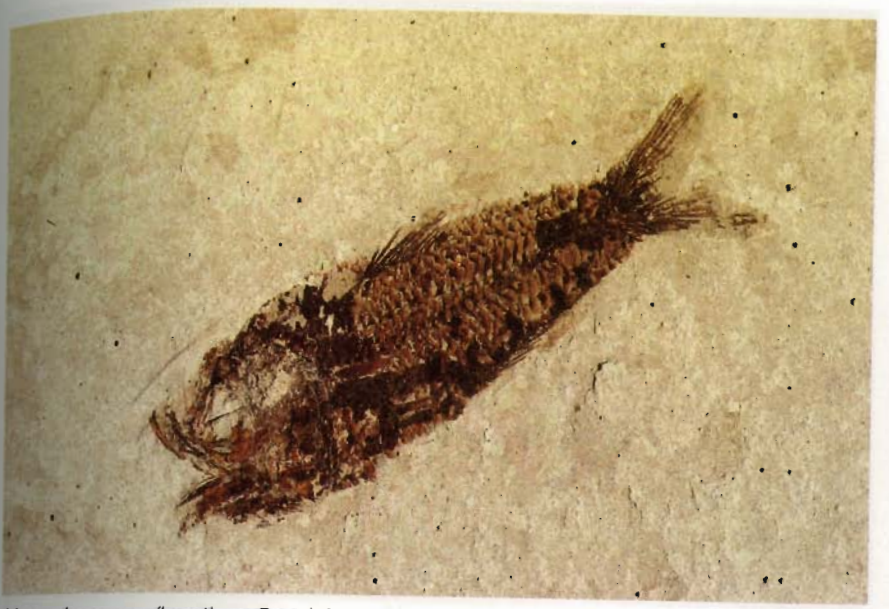
Geological range: Upper Cretaceous.

Geographical distribution: Middle East.

Features: Small fishes with slender bodies. Head elongate. Snout pointed. Gape long, directed upwards. Dorsal fin small, approximately in the middle of the body. Caudal fin unusually large, deeply forked.

Remarks: Probably fed on small organisms.

Recent relatives: Genus extinct. Distantly related to other lantern fishes of the family Myctophidae.



Hygophum sp. (length c. 5 cm) from the Pliocene of Fiume Marecchia, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Hygophum* BOLIN, 1939.

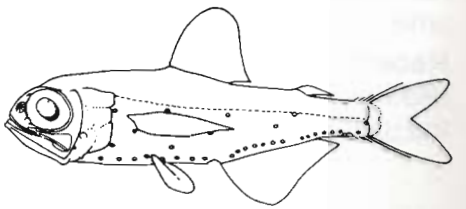
Geological range: Pliocene.

Geographical distribution: Europe.

Features: Small fishes of slender shape. Head deep. Eyes relatively large. Snout produced, pointed. Gape rather long, directed upwards. Dorsal fin approximately in the middle of the body. Caudal fin forked.

Remarks: Probably predators.

Recent relatives: Closely related to recent lantern fishes of the genus *Hygophum*.



Hygophum hygomii, a recent lanternfish, after SMITH.



Lampanyctus sp. (length c. 6 cm) from the Miocene of California, U.S.A. Original: American Museum of Natural History, New York, N.Y., U.S.A.

Genus: *Lampanyctus* BONAPARTE, 1840.

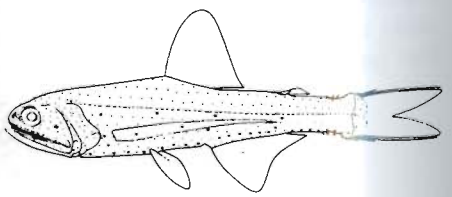
Geological range: Miocene to recent.

Geographical distribution: New Zealand, North America, Europe.

Features: Small fishes of slender shape. Head short and deep. Eyes large. Gape long. Dorsal fin in the middle of the body, obliquely opposite the somewhat larger and probably rather fringe-like anal fin.

Remarks: Probably fed on small organisms.

Recent relatives: Closely related to recent lantern fishes of the genus *Lampanyctus*.



Lampanyctus alatus, a recent lantern-fish, after SMITH.



Leptosomus elongatus von der MARCK (length c. 8 cm) from the Upper Cretaceous of Sendenhorst, Westphalia, Germany. Original: Geologisch-Paläontologisches Museum, Münster, Germany.

Genus: *Leptosomus* AGASSIZ, 1846.

Synonym: *Cassandra*.

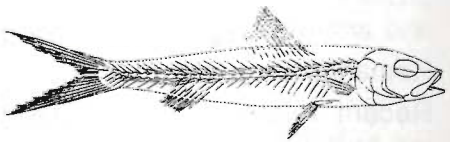
Geological range: Upper Cretaceous.

Geographical distribution: Europe, Asia.

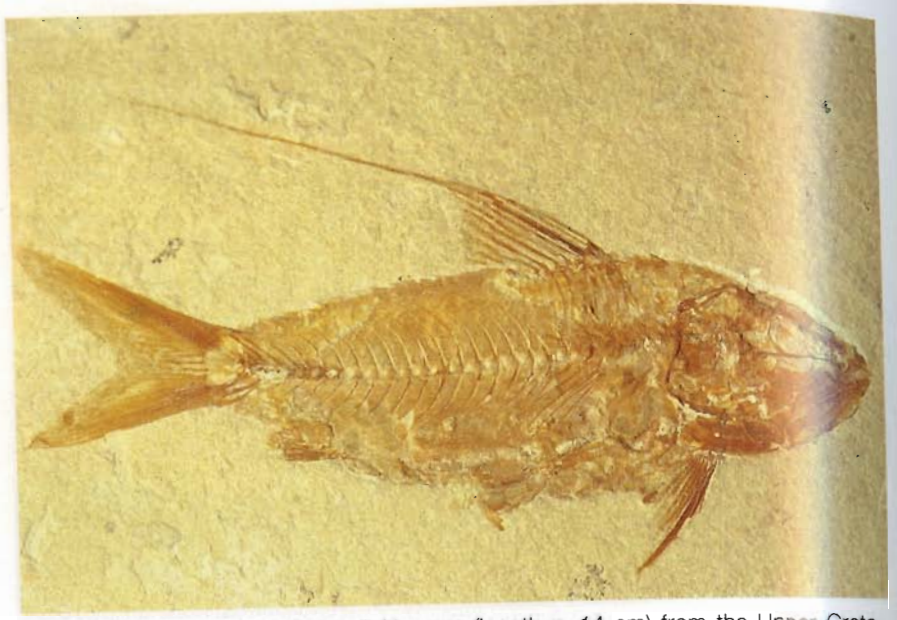
Features: Small fishes of slender shape. Head elongate. Snout pointed. Gape long. Dorsal fin triangular, in the anterior half of the body. Pectoral and pelvic fins small, set close together. Anal fin low. Caudal fin deeply forked.

Remarks: Predators.

Recent relatives: Genus extinct. Closely related to recent lantern fishes of the family Myctophidae.



Leptosomus, reconstruction after PICTET & HUMBERT.



Nematonotus longispinus PICTET & HUMBERT (length c. 14 cm) from the Upper Cretaceous of Lebanon. Original: Frickhinger Collection, Munich, Germany.

Genus: *Nematonotus* WOODWARD, 1899.

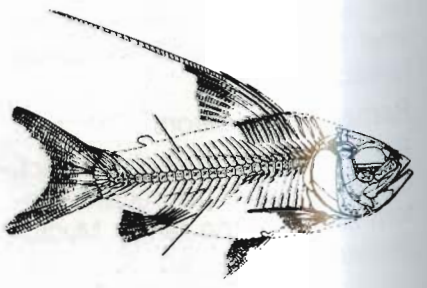
Geological range: Upper Cretaceous.

Geographical distribution: Middle East.

Features: Small to middle-sized fishes with rather laterally compressed bodies. Head short and deep. Eyes large. Gape long, directed upwards. Dorsal fin slightly anterior to the middle of the body, with the first fin ray elongated to form a spine. Pectoral fins elongate, likewise with a projecting first fin ray. Pelvic and anal fins small.

Remarks: Predators.

Recent relatives: None. Died out in the Upper Cretaceous.



Nematonotus, reconstruction after ROSEN & PATTERSON.



Nyctophus vexillifer (length c. 4 cm) from the Miocene of Forli, Italy. Original: Museo Civico di Storia Naturale, Milan, Italy.

Genus: *Nyctophus* COCCO, 1829.

Geological range: Miocene to Pliocene.

Geographical distribution: Europe, northern Africa.

Features: Small fishes of slender shape. Head elongate. Snout rounded. Dorsal fin in the middle of the body, opposite the pelvic fins. Caudal fin forked.

Remarks: Probably fed on small organisms.

Recent relatives: Distantly related to recent lantern fishes of the family Myctophidae.



Opistopteryx gracilis Pictet & Humbert (length c. 12 cm) from the Upper Cretaceous of Lebanon. Original: National Museum of Natural History, Smithsonian Institution, Washington, D.C., U.S.A.

Genus: *Opistopteryx* Woodward, 1901.

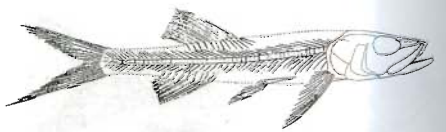
Geological range: Upper Cretaceous.

Geographical distribution: Middle East.

Features: Small fishes of very slender shape. Head elongate. Eyes large. Gape rather long. Dorsal fin approximately in the middle of the body. Pelvic and pectoral fins long and narrow. Anal fin broad-based. Caudal fin deeply forked, with narrow lobes.

Remarks: Probably predators.

Recent relatives: Genus extinct. Distantly related to recent lantern fishes of the family Myctophidae.



Opistopteryx, reconstruction after Pictet & Humbert.



Tachynectes longipes von der Marck (length c. 27 cm) from the Upper Cretaceous of Sendenhorst, Westphalia, Germany. Original: Geologisch-Paläontologisches Museum, Münster, Germany.

Genus: *Tachynectes* von der Marck, 1863.

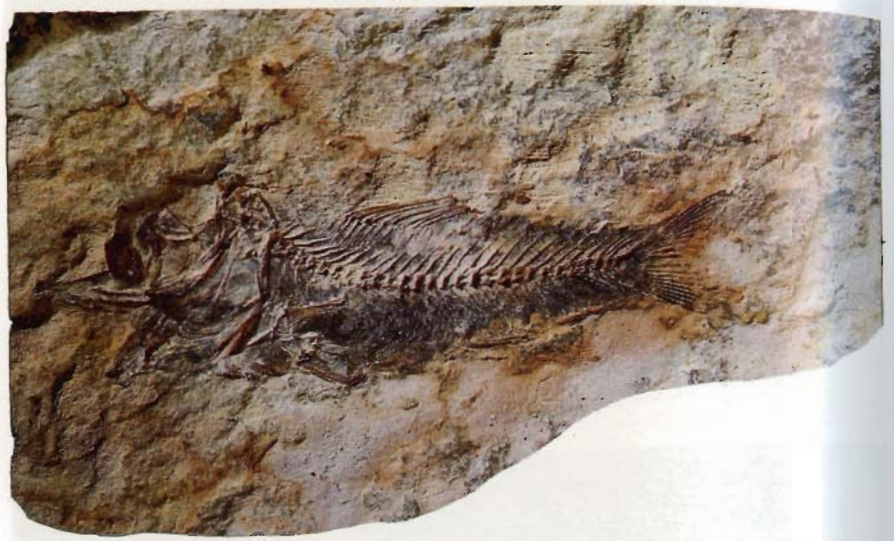
Geological range: Upper Cretaceous.

Geographical distribution: Europe.

Features: Middle-sized fishes of slender shape. Head elongate. Snout rounded like a pike. Dorsal fin approximately in the middle of the body. Pectoral fins unusually large, broad and rounded. Caudal fin forked.

Remarks: Probably bottom-dwelling fishes which lurked, waiting for prey, supported on their pectoral fins.

Recent relatives: None. Died out in the Upper Cretaceous.



Humilichthys orientalis GAUDANT (length c. 4.5 cm) from the Upper Cretaceous of Lebanon. Original: Muséum National d'Histoire Naturelle, Paris, France. Photograph: Serette, Paris.

Genus: *Humilichthys* GAUDANT, 1978.

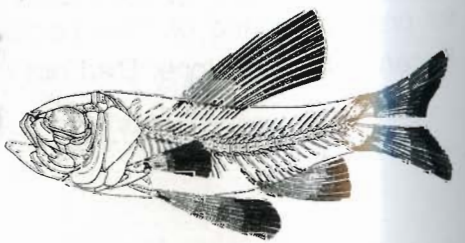
Geological range: Upper Cretaceous.

Geographical distribution: Middle East.

Features: Very small fishes with slender bodies. Head elongate. Eyes large. Dorsal fin approximately in the middle of the body, narrow and strikingly long, obliquely opposite the anal fin. Pectoral fins fan-shaped. Pelvic fins long and likewise fan-shaped. Caudal fin slightly forked, with broad lobes.

Remarks: Probably coral-reef fishes.

Recent relatives: None. Died out in the Cretaceous.



Humilichthys, reconstruction after GAUDANT.



Pattersonichthys delicatus GOODY (length c. 4 cm) from the Upper Cretaceous of Lebanon. Original: American Museum of Natural History, New York, N.Y., U.S.A.

Genus: *Pattersonichthys* GOODY, 1969.

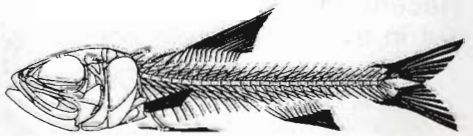
Geological range: Upper Cretaceous.

Geographical distribution: Middle East.

Features: Small fishes with slender bodies. Head elongate. Eyes large. Gape long. Dorsal fin in the anterior half of the body, pointed triangular. Pectoral fins narrow, with the very narrow pelvic fins immediately behind them. Anal fin triangular. Caudal fin forked.

Remarks: Probably coral-reef fishes.

Recent relatives: None. Died out in the Upper Cretaceous.



Pattersonichthys, reconstruction after GOODY.



Phoenicolepis arcuatus GAUDANT (length c. 5 cm) from the Upper Cretaceous of Lebanon. Original: Muséum National d'Histoire Naturelle, Paris, France. Photograph: Serette, Paris.

Genus: *Phoenicolepis* GAUDANT, 1978.

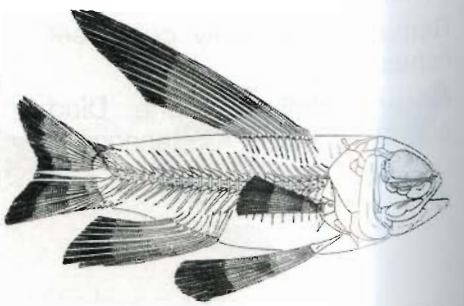
Geological range: Upper Cretaceous.

Geographical distribution: Middle East.

Features: Small fishes of squat shape. Head deep. Eyes large. Snout rounded. Gape rather long. Dorsal fin inserted anterior to the middle of the body, narrow and strikingly long. Pectoral and pelvic fins small. Anal fin somewhat longer. Caudal fin forked.

Remarks: Probably coral-reef fishes.

Recent relatives: None. Died out in the Upper Cretaceous.



Phoenicolepis, reconstruction after GAYET.



Ctenothrissa vexillifer PICTET (length c. 9 cm) from the Upper Cretaceous of Lebanon. Original: Frickhinger Collection, Munich, Germany.

Genus: *Ctenothrissa* WOODWARD, 1899.

Synonym: *Aeothrissa*.

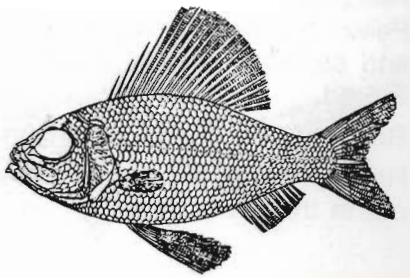
Geological range: Upper Cretaceous.

Geographical distribution: Europe, Middle East.

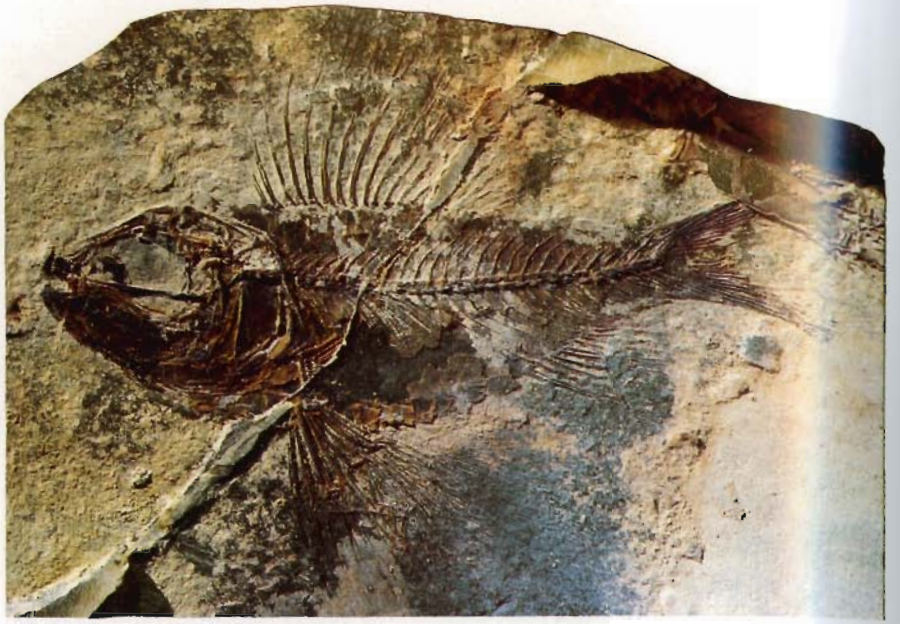
Features: Small fishes of laterally compressed shape. Head deep. Eyes large. Snout pointed. Dorsal fin in the middle of the body, very broad-based, expanded like a fan. Pectoral fins very small. Pelvic fins long and narrow. Anal fin broad and low. Caudal fin rather deeply forked.

Remarks: Probably coral-reef fishes.

Recent relatives: None. Died out in the Upper Cretaceous.



Ctenothrissa, reconstruction after PATTERSON.



Heterothrissa signeuxae GAUDANT (length c. 5.5 cm) from the Upper Cretaceous of Lebanon. Original: Muséum National d'Histoire Naturelle, Paris, France. Photograph: Serette, Paris.

Genus: *Heterothrissa* GAUDANT, 1978.

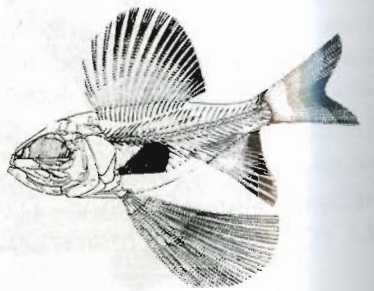
Geological range: Upper Cretaceous.

Geographical distribution: Middle East.

Features: Small fishes with bodies deeper anteriorly than posteriorly. Head deep. Eyes large. Gape short. Dorsal fin beginning slightly anterior to the middle of the body, tall and arcuate. Anal fin large, pointed triangular. Pectoral fins small, fan-shaped. Pelvic fins likewise fan-shaped and strikingly large. Caudal fin forked.

Remarks: Probably gregarious.

Recent relatives: None. Died out in the Cretaceous.



Heterothrissa, reconstruction after GAYET.



Mcconichthys longipinnis GRANDE (length c. 33 cm) from the Paleocene of Montana, U.S.A. Original: Field Museum of Natural History, Chicago, Illinois, U.S.A.

Genus: *Mcconichthys* GRANDE, 1988.

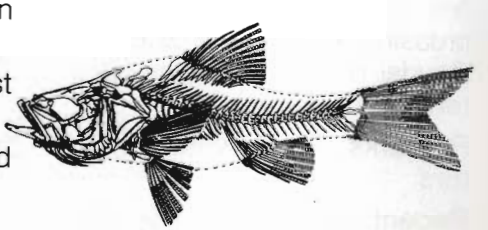
Geological range: Paleocene.

Geographical distribution: North America.

Features: Middle-sized fishes of slender shape. Head shallow. Eyes large. Snout pointed. Gape rather long. Dorsal fin low triangular, in the middle of the body, immediately behind the highest point of the back. Pelvic and pectoral fins close together. Anal fin rounded. Caudal fin rather deeply forked.

Remarks: Probably fed, at least partly, on plants.

Recent relatives: None. Died out in the Paleocene.



Mcconichthys, reconstruction after GRANDE.



Sphenocephalus fissicaudus (AGASSIZ) (length c. 11 cm) from the Upper Cretaceous of Baumberge, Westphalia, Germany. Original: Bayerische Staatssammlung für Paläontologie, Munich, Germany.

Genus: *Sphenocephalus* AGASSIZ, 1838.

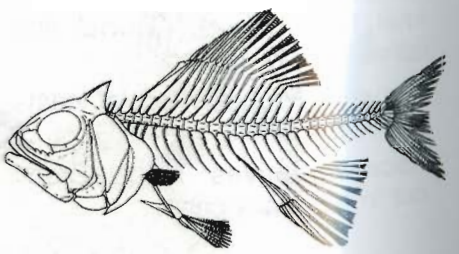
Geological range: Upper Cretaceous.

Geographical distribution: Europe.

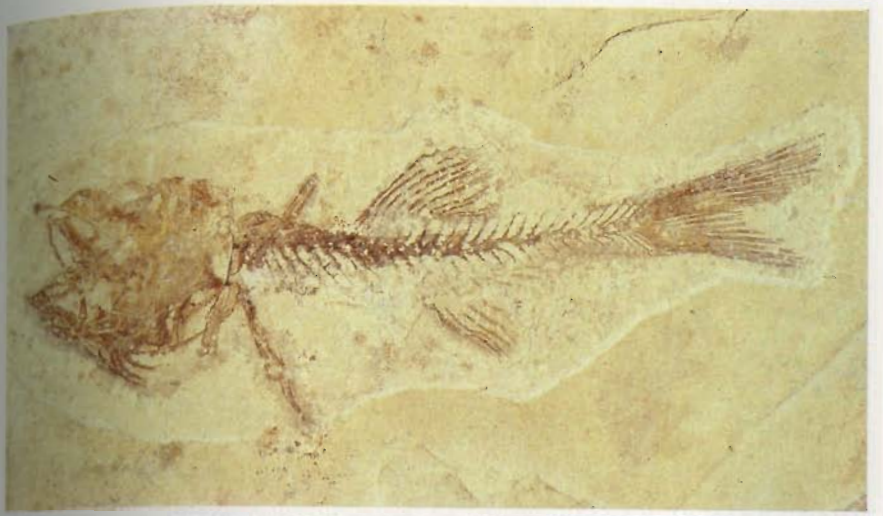
Features: Small fishes of laterally compressed shape. Head deep. Eyes large. Gape rather long. A horn-like spine mid-dorsally at the posterior end of the head. Dorsal fin approximately in the middle of the body, tall anteriorly but decreasing in height posteriorly. Pectoral fins very small, close to the fan-shaped pelvic fins. Anal fin broad-based, decreasing in height posteriorly. Caudal fin rather concave posteriorly.

Remarks: Fresh-water predators.

Recent relatives: None. Died out in the Eocene.



Spnenocephalus, reconstruction after PATTERSON.



Libotonius pearsoni WILSON (length c. 3 cm) from the Eocene of Washington State, U.S.A. Original: University of Alberta, Edmonton, Alberta, Canada.

Genus: *Libotonius* WILSON, 1977.

Geological range: Eocene.

Geographical distribution: North America.

Features: Very small fishes of slender shape. Head rather deep. Gape not very long. Dorsal fin obtusely triangular, slightly anterior to the middle of the body. Pectoral and pelvic fins close together. Anal fin triangular, obliquely opposite the dorsal fin.

Remarks: Fresh-water fishes.

Recent relatives: None. Died out in Eocene.



Amphiplaga brachyptera COPE (length c. 7 cm) from the Eocene of Wyoming, U.S.A. Original: The Natural History Museum, London, U.K. (P61236).

Genus: *Amphiplaga* COPE, 1877.

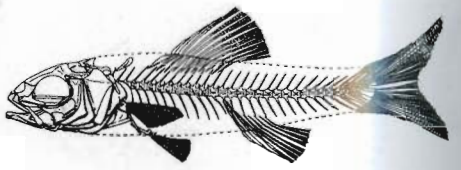
Geological range: Middle Eocene.

Geographical distribution: North America.

Features: Small fishes of slender shape. Head elongate. Eyes large. Gape rather long. Dorsal fin slightly anterior to the middle of the body, relatively tall and rounded. Pectoral and pelvic fins close together. Anal fin long and rounded. Caudal fin deeply emarginate.

Remarks: Fresh-water fishes.

Recent relatives: None. Died out in Eocene.



Amphiplaga, reconstruction after GRANDE.



Asineops squamifrons COPE (length c. 13 cm) from the Middle Eocene of Wyoming, U.S.A. Original: Frickhinger Collection, Munich, Germany.

Genus: *Asineops* COPE, 1870.

Geological range: Middle Eocene.

Geographical distribution: North America.

Features: Small fishes with laterally compressed bodies. Head deep. Eyes large. Gape rather long. Dorsal fin rounded, with nine spines anterior to it. Anal fin broad and rounded. Pectoral and pelvic fins close together. Caudal fin not forked, rounded.

Remarks: Fresh-water fishes.

Recent relatives: Genus extinct. Probably related to the recent pirate perch *Aphredoderus*.



Aphredoderus sayanus, the recent pirate perch.



Erismatopterus levatus (COPE) (length c. 7 cm) from the Eocene of Wyoming, U.S.A. Original: Field Museum of Natural History, Chicago, Illinois, U.S.A.

Genus: *Erismatopterus* COPE, 1871.

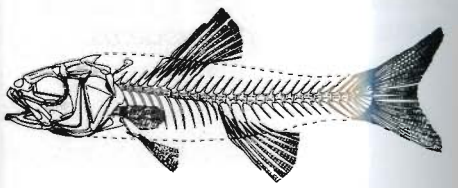
Geological range: Middle Eocene.

Geographical distribution: North America.

Features: Small fishes of slender shape. Head elongate. Eyes large. Snout pointed. Dorsal fin slightly anterior to the middle of the body, relatively tall and rounded. Anal fin broad and rounded. Pectoral and pelvic fins close together. Caudal fin deeply forked.

Remarks: Fresh-water fishes.

Recent relatives: None. Died out in Eocene.



Erismatopterus, reconstruction after ROSEN & PATTERSON.



Trichophanes foliarum (COPE) (length c. 11 cm) from the Oligocene of Florissant, Colorado, U.S.A. Original: Field Museum of Natural History, Chicago, Illinois, U.S.A.

Genus: *Trichophanes* COPE, 1872.

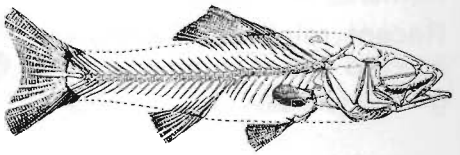
Geological range: Oligocene to Miocene.

Geographical distribution: North America.

Features: Small fishes of slender shape. Head elongate. Gape rather long. Dorsal fin obtusely triangular, approximately in the middle of the body. Anal fin small. Pectoral and pelvic fins close together. Caudal fin emarginate.

Remarks: Fresh-water fishes.

Recent relatives: None. Died out in the Miocene.



Trichophanes, reconstruction after ROSEN & PATTERSON.



Gadella sp. (length c. 10 cm) from the Pliocene of Fiume Marecchia, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Gadella* LOWE, 1843.

Geological range: Pliocene to recent.

Geographical distribution: Europe.

Features: Small fishes of slender shape. Head deep. Eyes large. Snout rounded. Gape rather long. Three dorsal fins, the most posterior of which is somewhat fringe-like, resembling the bipartite anal fin opposite. Pelvic fins situated on the throat. Pectoral fins narrow. Caudal fin slightly forked.

Remarks: Gregarious.

Recent relatives: Closely related to recent members of the genus *Gadella*.



Gadella sp., a recent codlet. Lithograph from BLOCH.



Bregmaceros albyi (SAUVAGE) (length c. 7 cm) from the Pliocene of Fiume Marecchia, Italy. Original: Frickhinger Collection, Munich, Germany.

Genus: *Bregmaceros* THOMPSON, 1840.

Synonym: *Podopteryx*.

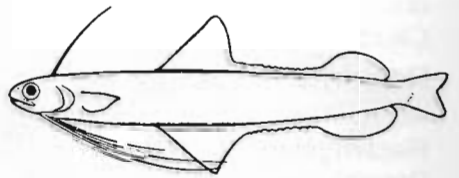
Geological range: Eocene to recent.

Geographical distribution: New Zealand, North America, Europe, western Asia, northern Africa.

Features: Small fishes of slender shape. Head shallow. Eyes large. Snout pointed. Anterior dorsal fin consists of one ray on the posterior part of the head. Posterior dorsal fin fringe-like. Pectoral fins very long. Caudal fin not forked, rounded.

Remarks: Fed on small organisms.

Recent relatives: Closely related to recent codlets of the genus *Bregmaceros*.



Bregmaceros atlanticus, the recent antenna codlet, after NELSON.



Bregmacerina antiqua (SMIRNOV) (length c. 11 cm) from the Lower Miocene of the northern Caucasus, C.I.S. Original: Paleontologicheskii Muzei Russkoi Akademii Nauk, Moscow, Russia.

Genus: *Bregmacerina* DANILTCHENKO, 1957.

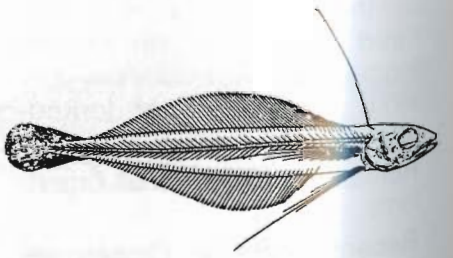
Geological range: Miocene.

Geographical distribution: Western and eastern Europe.

Features: Small fishes of slender shape. Head shallow. Eyes large. Snout pointed. Posterior dorsal fin an upwardly arcuate fringe extending almost the whole length of the back. Anterior dorsal fin a single ray on the posterior part of the head. Anal fin fringe-like and similar to the posterior dorsal fin. Pectoral and pelvic fins relatively long. Caudal fin not forked, rounded.

Remarks: Probably fed on small organisms.

Recent relatives: Genus extinct. Possibly related to recent codlets of the genus *Bregmaceros*.



Bregmacerina, reconstruction after DANILCHENKO.



Gadus sp. (length c. 18 cm) from the Pliocene of Fiume Marecchia, Italy. Original: Royal Ontario Museum, Toronto, Canada.

Genus: *Gadus* LINNAEUS, 1758.

Synonym: *Morhus*.

Geological range: Paleocene to recent.

Geographical distribution: Europe, Australia, Greenland.

Features: Middle-sized fishes of slender shape. Head shallow, conical. Eyes large. Snout pointed. Three dorsal fins, the first being pointed and the other two low and rounded. Two anal fins. Pectoral and pelvic fins small, close together. Caudal fin slightly forked.

Remarks: Predators.

Recent relatives: Closely related to recent cods of the genus *Gadus*.



Gadus morhua, the cod. Lithograph from BLOCH.



Lota sp. (length c. 25 cm) from the Pleistocene of Münster-Brehloh, Lower Saxony, Germany. Original: Stöbener Collection, Staufenberg, Germany.

Genus: *Lota* Oken, 1817.

Geological range: Pliocene to recent.

Geographical distribution: Europe.

Features: Middle-sized fishes of elongate slender shape. Head long and shallow. Eyes small. Gape long. First dorsal fin small. Second dorsal fin fringe-like. Anal fin likewise fringe-like. Pectoral fins rounded. Pelvic fins fan-shaped, anterior to the pectoral fins. Caudal fin rounded.

Remarks: Predators.

Recent relatives: Related to the recent burbot *Lota lota*.



Lota lota, the recent burbot. Lithograph from Bloch.



Micromesistius poutassou Risso (length c. 12 cm) from the Pliocene of Fiume Marecchia, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Micromesistius* Gill, 1864.

Geological range: Pliocene to recent.

Geographical distribution: Europe.

Features: Middle-sized fishes of slender shape. Head shallow. Eyes large. Snout pointed. Gape long. First and second dorsal fins acute-triangular. Third dorsal fin rounded, like the anal fin opposite whose second part has a broad base. Pelvic fins much reduced, located on the throat. Pectoral fins pointed. Caudal fin emarginate.

Remarks: Gregarious.

Recent relatives: Closely related to the recent cods of the genus *Micromesistius*, which lives in enormous shoals in northern seas.



Micromesistius poutassou, a cod.



Nemopteryx crassus (AGASSIZ) (length c. 27 cm) from the Lower Oligocene of Glarus, Switzerland. Original: British Museum (Natural History), London, U.K.(P15361).

Genus: *Nemopteryx* RATH, 1859.

Synonyms: *Lotimorpha, Megalolepis, Palaeobrosmius*

Geological range: Eocene to Miocene.

Geographical distribution: Europe, western Asia.

Features: Middle-sized fishes of slender shape. Head shallow. Snout pointed. Dorsal fin fringe-like. Pectoral and pelvic fins relatively long. Anal fin likewise fringe-like. Pectoral and pelvic fins close together. Caudal fin not forked, rounded.

Remarks: *Nemopteryx* is sometimes considered a synonym of *Palaeogadus*.

Recent relatives: Genus extinct. Distantly related to recent cods.



Onobrosmius oligocenicus (BOGATCHOV) (length c. 5 cm) from the Lower Miocene of the northern Caucasus, C.I.S. Original: Paleontologicheskii Muzei Russkoi Akademii Nauk, Moscow, Russia.

Genus: *Onobrosmius* BOGATCHOV, 1938.

Geological range: Miocene to Pliocene.

Geographical distribution: Western and eastern Europe, western Asia.

Features: Small fishes of slender shape. Head rather deep. Snout pointed. Gape not very long. Eyes large. Dorsal fin a low fringe beginning in the anterior half of the body. Caudal fin not forked.

Remarks: Probably fed on small organisms.

Recent relatives: None. Died out in the Pliocene.



Palaeogadus intergerinus DANILTCHENKO (length c. 18 cm) from the Lower Oligocene of the northern Caucasus,C.I.S. Original: Paleontologicheskii Muzei Rucckoi Akademii Nauk, Moscow, Russia.

Genus: *Palaeogadus* RATH, 1859.

Synonyms: *Lotimorpha*, *Megalolepis*, *Palaeobrosmius*, *Pseudolota*, *Ruppelianus*.

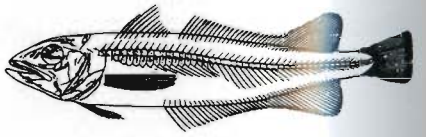
Geological range: Eocene to Oligocene.

Geographical distribution: Western and eastern Europe.

Features: Small to middle-sized fishes. Head shallow. Eyes large. Snout pointed. Anterior dorsal fin short. Posterior dorsal fin fringe-like. Anal fin likewise fringe-like. Caudal fin elongate, not forked.

Remarks: Probably fed on small organisms.

Recent relatives: Genus extinct. Related to recent cods of the genus *Gadus*.



Palaeogadus, reconstruction after DANILTCHENKO.



Palaeomolva monstrata FEDOTOV (length c. 6 cm) from the Lower Miocene of the Caucasus. Original: Paleontologicheskii Muzei Russkoi Academii Nauk, Moscow, Russia (Bannikov Collection).

Genus: *Palaeomolva* DANILTCHENKO, 1947.

Geological range: Lower Miocene.

Geographical distribution: Western and eastern Europe.

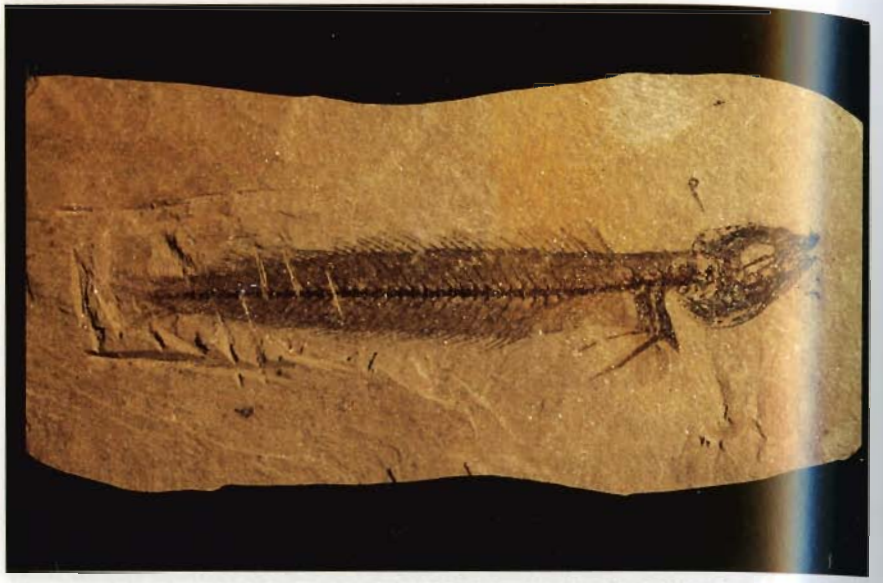
Features: Small fishes of slender shape. Head shallow. Snout pointed. Dorsal fin in two parts, fringe-like. Anal fin likewise fringe-like. Caudal fin not forked, rounded.

Remarks: Probably fed on small organisms.

Recent relatives: Genus extinct. Nevertheless related to recent hakes of the genus *Molva*.



Molva molva, a recent hake. Lithograph from BLOCH.



Pseudoraniceps sagus FEDOTOV (length c. 8.5 cm) from the Upper Oligocene of the northern Caucasus, C.I.S. Original: Paleontologicheskii Muzei Russkoi Akademii Nauk, Moscow, Russia (Bannikov Collection).

Genus: *Pseudoraniceps* FEDOTOV, 1974.

Geological range: Upper Oligocene.

Geographical distribution: Eastern Europe.

Features: Small fishes of slender shape. Head shallow. Eyes large. Snout pointed. Dorsal fin fringe-like. Pectoral fins small. Pelvic fins modified as feelers. Anal fin likewise fringe-like. Caudal fin not forked, rounded.

Remarks: Probably fed on small organisms. *Pseudoraniceps* is occasionally considered a synonym of *Onobrosmius*.

Recent relatives: Genus extinct. Perhaps distantly related to recent hakes of the genus *Raniceps*.



Raniceps sp., a recent hake. Lithograph from COUGH.



Merluccius errans (SMIRNOV) (length c. 19 cm) from the Oligocene of the Caucasus. Original: The Natural History Museum, London, U.K. (P22036).

Genus: *Merluccius* RAFINESQUE, 1810.

Synonym: *Spinogadus*.

Geological range: Eocene to recent.

Geographical distribution: Europe, Australia, New Zealand.

Features: Middle-sized fishes of slender shape. Head shallow. Snout pointed. The anterior dorsal fin short and pointed. Posterior dorsal fin fringe-like but dorsally concave, opposite the anal fin which is fringe-like and ventrally concave. Pectoral and pelvic fins narrow and close together. Caudal fin not forked, slightly emarginate.

Remarks: Predators.

Recent relatives: Closely related to recent merluccid hakes of the genus *Merluccius*.



Merluccius sp., a recent merlucoid hake.



Eolamprogrammus senectus DANILTCHENKO (length c. 5 cm) from the Lower Eocene of Turkmenistan, C.I.S. Original: Paleontologicheskii Muzei Russkoi Akademii Nauk, Moscow, Russia (Bannikov Collection).

Genus: *Eolamprogrammus* DANILTCHENKO, 1968.

Geological range: Lower Eocene.

Geographical distribution: Western Asia.

Features: Small fishes of slender shape. Head deep. Eyes small. Gape rather long. Dorsal fin soft-rayed, extending as a fringe over two-thirds of the back. Anal fin somewhat shorter, likewise fringe-like. Pelvic fins very narrow, on the throat. Pectoral fins small, rounded. Caudal fin fused with the dorsal and anal fins as a fringe.

Remarks: Probably fed on small organisms.

Recent relatives: Genus died out in Eocene. Distantly related to recent cusk eels of the family Ophidiidae.



Ophidion voltianum MASSALONGO (length c. 17 cm) from the Middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Ophidion* LINNAEUS, 1758.

Synonym: *Ophidium*.

Geological range: Paleocene to recent.

Geographical distribution: Europe, West Indies, Australia.

Features: Small fishes with slender bodies. Head shallow. Eyes small. Snout slightly pointed. Mouth small. Dorsal fin begins shortly behind the head and continues as a fringe, running into the caudal and anal fins and ending in the middle of the ventral surface. Pectoral fins small. Pelvic fins on the throat. Probably scaleless.

Remarks: Probably fed on small organisms.

Recent relatives: Probably related to recent cusk-eels of the genus *Ophidion*.



Ophidion barbatum, the recent cusk eel. Lithograph from BLOCH.



Propteridium douvillei Arambourg (length c. 14 cm) from the Lower Oligocene of Iran. Original: Muséum National d'Histoire Naturelle, Paris, France. Photograph: Serette, Paris.

Genus: *Propteridium* Priem, 1908.

Geological range: Lower Oligocene.

Geographical distribution: Middle East.

Features: Small fishes with very slender elongate bodies. Head elongate. Eyes small. Snout pointed. Gape short. Dorsal fin low, beginning shortly behind the head and running as a fringe which continues into the caudal and anal fin to end in the middle of the ventral surface. Pectoral fins small.

Remarks: Bottom-dwellers.

Recent relatives: None. Died out in the Oligocene.



Batrachoides didactylus Bloch & Schneider (length c. 18 cm) from the Miocene of Oran, Algeria. Original: Muséum National d'Histoire Naturelle, Paris, France. Photograph: Serette, Paris.

Genus: *Batrachoides* de Lacépède, 1798.

Geological range: Miocene to recent.

Geographical distribution: Northern Africa.

Features: Small to middle-sized fishes of plump shape. Head flat and broad. Mouth terminal and very large. Jaws with strong pointed teeth. Gill cover spiny. Anterior dorsal fin reduced to a few spines. Posterior dorsal fin elongate and soft-rayed, like the anal fin. Pelvic fins on the throat. Caudal fin not forked.

Remarks: Predators.

Recent relatives: Closely related to recent toadfishes of the genus *Batrachoides*.



Batrachoides sp., a recent toadfish. Lithograph from Cuvier.



Lophius brachysomus Agassiz (length c. 15 cm) from the Middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Lophius* Linnaeus, 1758.

Geological range: Eocene to recent.

Geographical distribution: Europe.

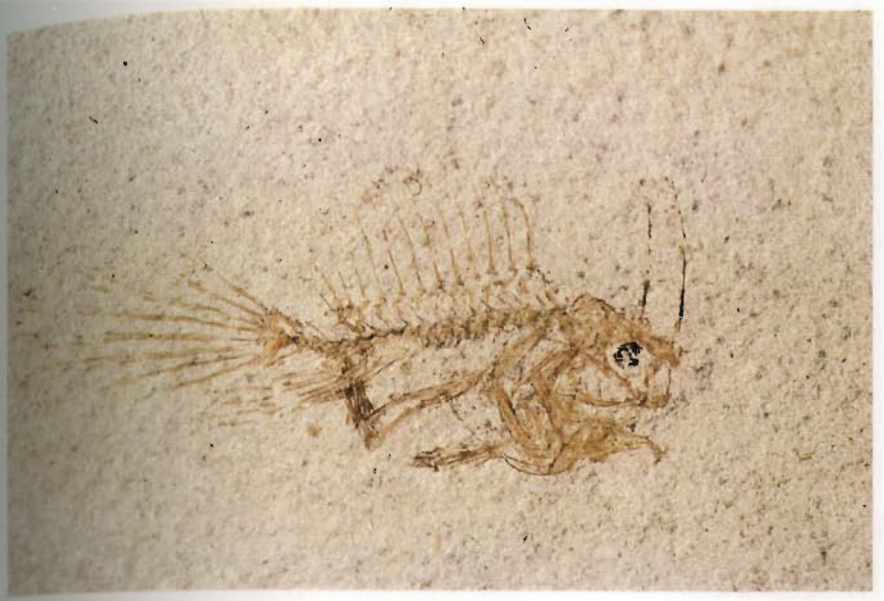
Features: Small to middle-sized fishes of plump, dorso-ventrally flattened shape, becoming narrower posteriorly. Head disproportionately large, with strongly toothed mouth. The first ray of the dorsal fin modified to form a lure on the head. Pectoral fins very broad and rounded. Caudal fin not forked, rounded.

Remarks: Bottom-dwelling fishes which, like their recent relatives, attracted prey by means of their lure.

Recent relatives: Closely related to recent angler fishes of the genus *Lophius*.



Lophius piscatorius, the recent anglerfish. Lithograph from Bloch.



Histionotophorus bassani (de Zigno) (length c. 3 cm) from the Middle Eocene of Bolca, Italy. Original: The Natural History Museum, London, U.K. (P19060-1).

Genus: *Histionotophorus* Eastman, 1904.

Synonym: *Histiocephalus*.

Geological range: Middle Eocene.

Geographical distribution: Europe.

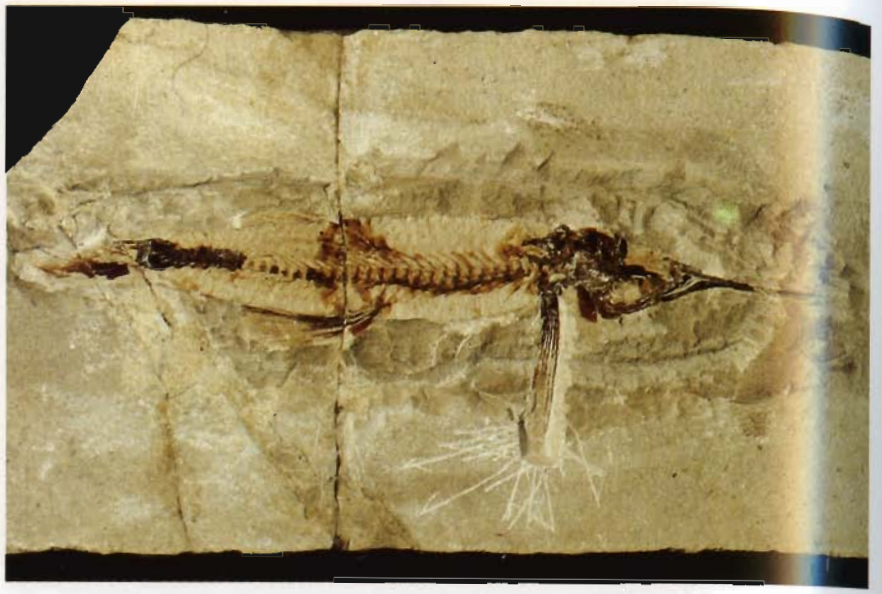
Features: Small fishes of laterally compressed shape. Head deep. Eyes large. Mouth very large. Two lures on the head. The dorsal fin hard-rayed and running along the whole of the back. Anal fin broadly elongate. Caudal fin not forked.

Remarks: Bottom-dwelling fishes which attracted prey by means of their lures, as their recent relatives still do.

Recent relatives: Genus extinct. Distantly related to recent anglerfishes of the family Antennariidae.



Antennarius moluccensis, a recent anglerfish.



Rhamphexocoetus volans Bannikov et al. (length c. 15 cm) from the Middle Eocene of Bolca, Italy. Museo Civico di Storia Naturale, Milan, Italy.

Genus: *Rhamphexocoetus* Bannikov, Parin & Pinna, 1985.

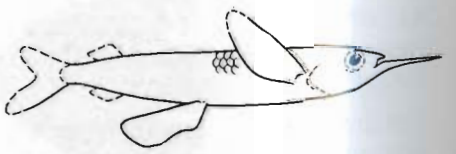
Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Small to middle-sized fishes of slender shape. Head shallow. Upper jaw short. Lower jaw produced to form a pointed rostrum. Pectoral fins long and wing-like. Pelvic fins broad and long, with a narrow base. Dorsal fin very small, very posterior in position, opposite the anal fin which is likewise very small.

Remarks: Probably had the ability to fly for short distances.

Recent relatives: Perhaps distantly related to recent flying fishes.



Rhamphexocoetus, after Bannikov.



Cobitopsis acutus (length c. 7 cm) from the Oligocene of Puy de Dome, France. Original: The Natural History Museum, London, U.K. (P61500).

Genus: *Cobitopsis* Pomel, 1853.

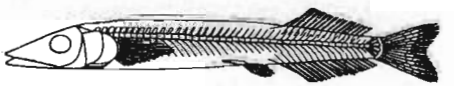
Geological range: Upper Cretaceous to Oligocene.

Geographical distribution: Europe, Middle East.

Features: Small fishes of very slender shape. Head elongate. Eyes large. Both jaws elongated to form a short rostrum. Dorsal fin in the posterior third of the body, opposite the considerably larger anal fin. Pectoral and pelvic fins small. Caudal fin emarginate.

Remarks: Fresh-water fishes.

Recent relatives: Genus extinct. Distantly related to recent halfbeaks of the family Hemirhamphidae.



Cobitopsis, reconstruction after Woodward.



"Brachyrhamphus" bolcensis de ZIGNO (length c. 6 cm) from the Middle Eocene of Bolca, Italy. Original: Università di Padova, Padua, Italy.

Genus: *Brachyrhamphus*.

Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Small fishes of slender shape. Head shallow. Eyes middle-sized. Both jaws elongated to form a pointed rostrum, with the lower jaw slightly shorter than the upper. Dorsal fin broad-based, relatively tall, carried by strong rays. Pectoral fins narrow.

Remarks: The name *Rhamphyrhynchus* is invalid and must be replaced since it is pre-occupied by a bird and an insect.

Recent relatives: None. Died out in Eocene.



Hemirhamphus edwardsi BASSANI (length c. 7 cm) from the Middle Eocene of Bolca, Italy. Original: Carnegie Museum of Natural History, Pittsburgh, Pennsylvania, U.S.A.

Genus: *Hemirhamphus* VOIGT, 1832.

Geological range: Middle Eocene to recent.

Geographical distribution: Europe.

Features: Small fishes of slender shape. Head shallow. Eyes large. Lower jaw elongated to form a long and pointed rostrum. Dorsal fin very posterior, opposite the anal fin. Caudal fin not forked, rounded.

Remarks: Marine fishes. Even today some halfbeaks live in fresh water and others in sea water.

Recent relatives: Closely related to recent halfbeaks of the genus *Hemirhamphus*.



Hemirhamphus brasiliensis, a halfbeak. Lithograph from BLOCH.



Hyporhamphus sp. (length c. 13 cm) from the Pliocene of Fiume Marecchia, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Hyporhamphus* GILL, 1859.

Synonym: *Reporhamphus*.

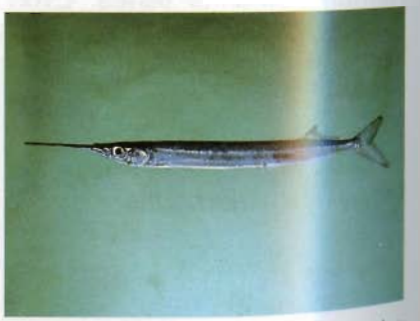
Geological range: Pliocene to recent.

Geographical distribution: Europe.

Features: Small fishes of slender shape. Head shallow. Eyes large. Snout elongated to form a rostrum with the lower jaw much longer than the upper. Dorsal fin in the posterior third of the body, opposite the similarly shaped anal fin. Pectoral and pelvic fins small. Caudal fin rather deeply forked.

Remarks: Probably fed mainly on floating foods.

Recent relatives: Genus extinct. Closely related to recent marine halfbeaks of the genus *Hyporhamphus*.



Hyporhamphus acutus, a recent marine halfbeak.



Belone sp. (length c. 25 cm) from the Pliocene of Fiume Marecchia, Italy. Original: Staatliches Museum für Naturkunde, Karlsruhe, Germany.

Genus: *Belone* CUVIER, 1817.

Geological range: Miocene to recent.

Geographical distribution: Europe, northern Africa.

Features: Middle-sized fishes with very slender bodies. Head elongate. Eyes large. Both jaws elongated to an equal extent to form a rostrum set with small pointed teeth. Dorsal fin in the posterior third of the body, Opposite the anal fin. Pectoral and pelvic fins small. Caudal fin forked.

Remarks: Predators. The rostrum served to deflect the prey and to strike it from the side.

Recent relatives: Closely related to recent needlefishes of the genus *Belone*.



Belone belone, the recent needlefish. Lithograph from BLOCH.



Aphanius crassicaudus (AGASSIZ) (length c. 4 cm) from the Pliocene of Castellaro, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Aphanius* NARDO, 1827.

Geological range: Miocene to recent.

Geographical distribution: Europe.

Features: Very small fishes of laterally compressed shape. Head short. Eyes large. Gape short. Dorsal fin in the posterior third of the body, opposite the rounded anal fin. Pelvic fins narrow. Pectoral fins broader. Caudal fin not forked, rounded.

Remarks: Probably lived in brackish water and fed on plants.

Recent relatives: Closely related to recent killifishes of the genus *Aphanius*.



Aphanius sirhani, a recent killifish.



Brachylebias persicus PRIEM (length c. 4 cm) from the Miocene of northwestern Iran. Original: The Natural History Museum, London, U.K. (P47944/5).

Genus: *Brachylebias* PRIEM, 1908.

Geological range: Miocene.

Geographical distribution: Western Asia.

Features: Very small fishes with rather laterally compressed bodies. Head short. Eyes large. Dorsal fin in the posterior half of the body, opposite the anal fin. Pectoral and pelvic fins small. Caudal fin small, not forked, rounded.

Remarks: Fresh-water fishes.

Recent relatives: Genus extinct. Related to recent killifishes of the family Cyprinodontidae.



Carrionellus diumortuus WHITE (length c. 5 cm) from the Miocene of Loja, Ecuador. Original: The Natural History Museum, London, U.K. (P47944/5).

Genus: *Carrionellus* WHITE, 1927.

Geological range: Lower Miocene.

Geographical distribution: South America.

Features: Small fishes with rather deep bodies anteriorly, becoming shallower behind. Head deep. Eyes large. Gape short. Dorsal fin in the posterior half of the body, opposite the larger anal fin.

Remarks: Fresh-water fishes.

Recent relatives: Genus extinct. Related to recent killifishes of the family Cyprinodontidae.



Cyprinodon variegatus, a recent killifish



Fundulus sp. (length c. 6 cm) from the Pliocene of Kansas, U.S.A. Original: Museum of Natural History, Cleveland, Ohio, U.S.A.

Genus: *Fundulus* de LACÉPÈDE, 1803.

Synonyms: *Gephyrura*, *Parafundulus*.

Geological range: Pliocene to recent.

Geographical distribution: North America.

Features: Small fishes of slender shape. Head elongate. Eyes large. Gape short. Dorsal fin in the posterior third of the body, opposite the larger anal fin. Pelvic fins narrow. Pectoral fins fan-shaped. Caudal fin not forked.

Remarks: Fresh-water fishes.

Recent relatives: Genus extinct. Closely related to recent killifishes of the genus *Fundulus*.



Fundulus pulvereus, a recent killifish.



Lebias perpusillus (AGASSIZ) (length c. 5 cm) from the Miocene of Öhningen, Württemberg, Germany. Original: Paläontologisches Museum, Zürich, Switzerland.

Genus: *Lebias* OKEN, 1817.

Geological range: Miocene.

Geographical distribution: Europe.

Features: Very small fishes with somewhat laterally compressed bodies. Head short. Eyes large. Gape short. Dorsal fin approximately in the middle of the body. Caudal fin slightly emarginate.

Remarks: Fresh-water fishes. There is some doubt whether this fish is a killifish.

Recent relatives: Genus extinct. Perhaps related to recent killifishes of the family Cyprinodontidae.



Lebias, reconstruction after ZITTEL.



Lithofundulus brouweri de BEAUFORT (length c. 6 cm) from the Miocene of Gimpoe, Celebes. Original: Geologisch Museum, Amsterdam, Netherlands.

Genus: *Lithofundulus*.

Geological range: Miocene.

Geographical distribution: Indonesia.

Features: Small fishes of slender shape. Head elongate. Eyes large. Snout somewhat pointed. Dorsal fin small, in the posterior half of the body, opposite the considerably larger anal fin.

Remarks: Fresh-water fishes.

Recent relatives: Genus extinct. Related to recent killifishes of the family Cyprinodontidae.



Pachylebias crassicaudus (AGASSIZ) (length c. 8 cm) from the Miocene of San Vittorio d'Alba, Italy. Original: Interfoss, Munich, Germany.

Genus: *Pachylebias* WOODWARD, 1901.

Synonyms: *Anelia*, *Physocephalus*.

Geological range: Oligocene to Miocene.

Geographical distribution: Europe.

Features: Small fishes of slender shape. Head short. Eyes large. Gape very short. Dorsal fin behind the middle of the body, obliquely opposite the anal fin. Pelvic fins small. Pectoral fins fan-shaped. Caudal fin not forked, elongate and rounded.

Remarks: Fresh-water fishes.

Recent relatives: Genus extinct. Related to recent killifishes of the family Cyprinodontidae.



Pachylebias, reconstruction after GAUDANT.



Prolebias cephalotus AGASSIZ (length c. 3 cm) from the Oligocene of Aix-en-Provence, France. Original: The Natural History Museum, London, U.K.

Genus: *Prolebias* SAUVAGE, 1874.

Synonyms: *Ismene*, *Pachystetus*.

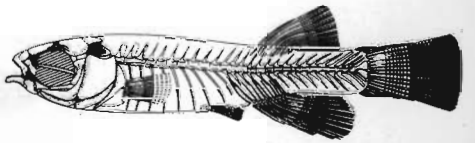
Geological range: Oligocene to Miocene.

Geographical distribution: Europe.

Features: Very small fishes with somewhat laterally compressed bodies. Head short and relatively deep. Eyes large. Gape short. Dorsal fin small, in the posterior half of the body, opposite the considerably larger anal fin.
Caudal fin not forked, rounded.

Remarks: Fresh-water fishes.

Recent relatives: Genus extinct. Related to recent killifishes of the family Cyprinodontidae.



Prolebias, reconstruction after GAUDANT.



Atherina verdonis SAUVAGE (length c. 8 cm) from the Oligocene of Gard, France. Original: Royal Ontario Museum, Toronto, Canada.

Genus: *Atherina* LINNAEUS, 1758.

Geological range: Middle Eocene to recent.

Geographical distribution: Europe, Asia, North America.

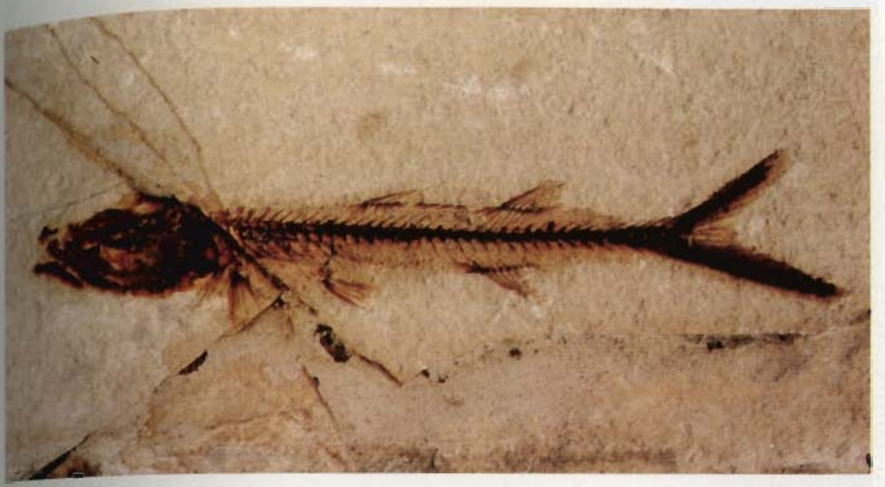
Features: Small fishes with slender bodies. Head shallow. Eyes large. Gape long. Two dorsal fins, the posterior one opposite the anal fin. Caudal fin rather forked.

Remarks: Fresh-water fishes.

Recent relatives: Closely related to recent silversides of the family Atherinidae.



Atherina sp., a recent silverside. Lithograph from BLOCH.



Rhamphognathus sphyraenoides (AGASSIZ) (length c. 12 cm) from the Middle Eocene of Bolca, Italy. Original: The Natural History Museum, London, U.K.

Genus: *Rhamphognathus* AGASSIZ, 1835.

Synonym: *Mesogaster*.

Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Small to middle-sized fishes of very slender shape. Head shallow and elongate. Eyes large. Gape relatively long. Two dorsal fins, the posterior opposite the anal fin. Pectoral fins small and fan-shaped. Caudal fin large and deeply forked.

Remarks: Predators.

Recent relatives: Genus extinct. Related to recent silversides of the family Atherinidae.



Bajaichthys elegans SORBINI (length c. 4 cm) from the Middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Bajaichthys* SORBINI, 1983.

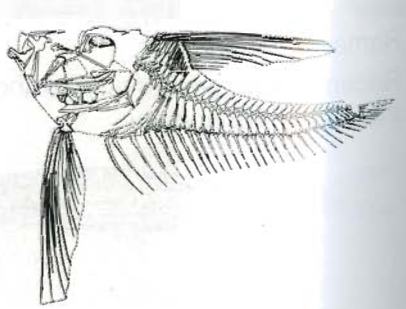
Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Very small fishes with bodies deep anteriorly and becoming less deep posteriorly. Head deep. Eyes large. Snout pointed. Gape short. Dorsal fin narrow, greatly elongated, situated just behind the head. Pectoral fins very long and narrow. Pelvic fins broad-based. Anal fin small.

Remarks: Probably coral-reef fishes.

Recent relatives: None. Died out in Eocene.



Bajaichthys, reconstruction after SORBINI.



Analectis pala DANILTCHENKO (length c. 5 cm) from the Lower Oligocene of northern Caucasus. Original: Paleontologicheskii Muzei Russkoi Akademii Nauk, Moscow, Russia.

Genus: *Analectis* DANILTCHENKO, 1980.

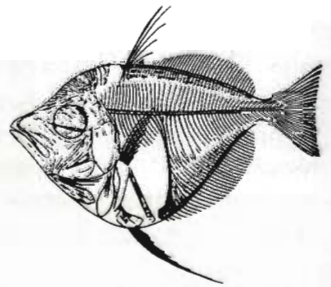
Geological range: Lower Oligocene.

Geographical distribution: Eastern Europe.

Features: Small fishes with a deep belly. Head deep. Eyes large. Snout pointed. Dorsal fin very posterior, shortly in front of the caudal fin. Anal fin opposite, fringe-like, broad-based and rather rounded. Pelvic fins narrow, attached to the lowest part of the body. Pectoral fins immediately above them, fan-shaped. Caudal fin broad, not forked.

Remarks: Fresh-water fishes, probably predators.

Recent relatives: Genus extinct. Perhaps related to the recent opah *Lampris*.



Analectis, reconstruction after Akademia Nauk, Moscow.



Turkmene finitimus DANILTCHENKO (length c. 11 cm) from the Lower Eocene of Turkmenistan. Original: Paleontologicheskii Muzei Russkoi Akademii Nauk, Moscow, Russia (Bannikov Collection).

Genus: *Turkmene* DANILTCHENKO, 1968.

Geological range: Lower Eocene.

Geographical distribution: Western Asia.

Features: Small fishes of oval outline, laterally flattened. Head small. Eyes large. Gape short. Dorsal fin tall and hard-rayed anteriorly but continuing posteriorly as a fringe. Anal fin similar. Pelvic fins long and narrow. Caudal fin forked.

Remarks: Probably fed on crustaceans and small organisms.

Recent relatives: Genus extinct in Eocene. Distantly related to the recent opah *Lampris regius* which lives in the oceans as the only species of its suborder.



Lampris regius, the recent opah. Lithograph from CUVIER.



Protolophotus elami (ARAMBOURG) (length c. 42 cm) from the Lower Oligocene of Iran. Original: Muséum National d'Histoire Naturelle, Paris, France. Photograph: Serette, Paris.

Genus: *Protolophotus* WALTERS, 1957.

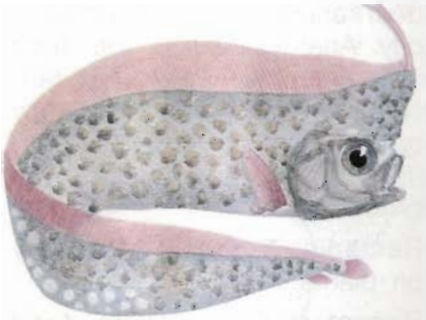
Geological range: Oligocene.

Geographical distribution: Middle East.

Features: Middle-sized fishes of somewhat laterally compressed shape. Head deep. Eyes small. A comb-like outgrowth on the upper part of the head. Dorsal fin begins shortly behind the head and runs as a fringe which includes the caudal and anal fins and reaches to the middle of the belly.

Remarks: Predators.

Recent relatives: Distantly related to recent crestfishes of the genus *Lophotus*.



Lophotus cepedianus, a recent crestfish. Lithograph from CUVIER.



Acrogaster heckeli (PICTET) (length c. 7 cm) from the Upper Cretaceous of Lebanon. Original: Staatliches Museum für Naturkunde, Stuttgart, Germany.

Genus: *Acrogaster* AGASSIZ, 1834.

Synonyms: *Acanthophoria*.

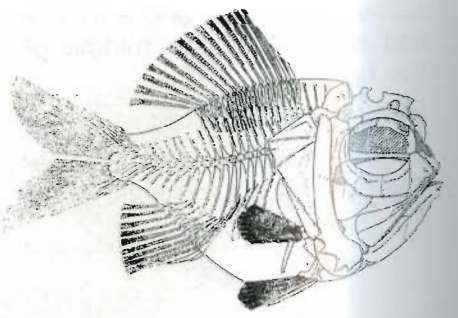
Geological range: Upper Cretaceous.

Geographical distribution: Middle East.

Features: Small fishes of almost disc-shaped outline, laterally flattened. Head disproportionately deep. Eyes large. Gape rather long. Dorsal fin with low hard rays anteriorly but rounded and decreasing in height posteriorly. Anal fin likewise with hard rays anteriorly. Pelvic fins fan-shaped, attached immediately opposite the pectoral fins. Caudal fin somewhat forked, with broad lobes.

Remarks: Probably fed partly on plants.

Recent relatives: None. Died out in Upper Cretaceous.



Acrogaster, reconstruction after PATTERSON.



Gephyroberyx robustus (BOGACHOV) (length c. 6 cm) from the Lower Oligocene of northern Caucasus, C.I.S. Original: Paleontologicheskii Muzei Russkoi Akademii Nauk, Moscow, Russia (Bannikov Collection).

Genus: *Gephyroberyx* BOULENGER, 1902.

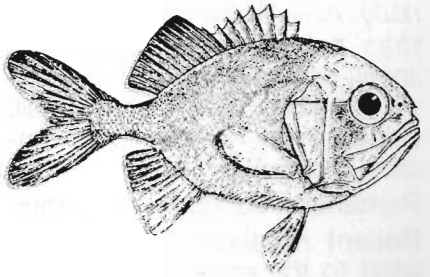
Geological range: Lower Oligocene to recent.

Geographical distribution: Eastern Europe.

Features: Small fishes with deep oval outline, laterally flattened. Head deep. Eyes large. Gape long. Dorsal fin begins approximately in the middle of the body and runs far posteriorly. Anal fin obliquely opposite, likewise broad. Pelvic and pectoral fins narrow, opposite each other. Caudal fin rather deeply forked.

Remarks: Probably predators.

Recent relatives: Closely related to recent slimeheads of the genus *Gephyroberyx*.



Gephyroberyx orbiculatus, a recent slimehead, after SMITH.



Hoplopteryx antiquus (AGASSIZ) (length c. 13 cm) from the Upper Cretaceous of Baumberge, Westphalia, Germany. Original: Bayerische Staatssammlung für Paläontologie, Munich, Germany.

Genus: *Hoplopteryx* AGASSIZ, 1838.

Synonyms: *Goniolepis*, *Hemicyclolepis*, *Hemigonolepis*, *Priconolepis*.

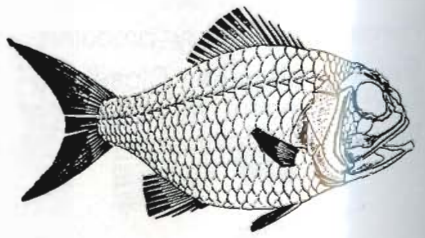
Geological range: Upper Cretaceous.

Geographical distribution: Europe, Middle East, northern Africa, North America.

Features: Small to middle-sized fishes with oval outline, laterally flattened. Head deep. Eyes large. Gape rather long. Dorsal fin with hard rays anteriorly, decreasing in height more posteriorly. Anal fin likewise with hard rays anteriorly. Pectoral fins small, vertically above the pelvic fins which are likewise small. Caudal fin of great height, concave posteriorly.

Remarks: Fed partly on plants.

Recent relatives: Possibly related to the recent genus *Centroberyx* (= *Hoplopteryx*).



Hoplopteryx, reconstruction after WOODWARD.



Libanoberyx spinosus GAYET (length c. 5.5 cm) from the Upper Cretaceous of Lebanon. Original: Muséum National d'Histoire Naturelle, Paris. Photograph: Serette, Paris.

Genus: *Libanoberyx* GAYET, 1980.

Geological range: Upper Cretaceous.

Geographical distribution: Middle East.

Features: Small fishes with oval outline, laterally flattened. Head deep. Eyes large. Gape long. Dorsal fin in the posterior half of the body, hard-rayed anteriorly. Anal fin similar. Pectoral fins fan-shaped. Pelvic fins vertically below them, carried by a spine-like thick ray. Caudal fin slightly forked, with broad lobes.

Remarks: Probably predators.

Recent relatives: None. Died out in the Cretaceous.



Lissoberyx arambourgi GAUDANT (length c. 6 cm) from the Upper Cretaceous of Lebanon. Original: Muséum National d'Histoire Naturelle, Paris, France. Photograph: Serette, Paris.

Genus: *Lissoberyx* PATTERSON, 1967.

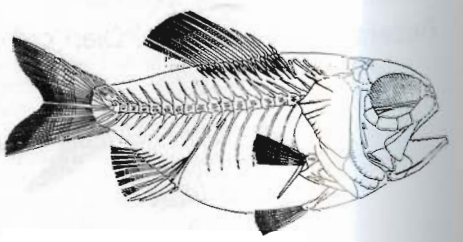
Geological range: Lower to Upper Cretaceous.

Geographical distribution: North Africa, Middle East.

Features: Small to middle-sized fishes with plump bodies. Head deep. Eyes large. Gape rather long. Dorsal fin approximately in the middle of the body, obliquely opposite the anal fin. Both dorsal and anal fins hard-rayed anteriorly and soft-rayed more posteriorly. Pelvic and pectoral fins fan-shaped, close together. Caudal fin forked, with broad lobes.

Remarks: Probably fed at least partly on plants.

Recent relatives: None. Died out in the Cretaceous.



Lissoberyx, reconstruction after GAYET.



Stichopteryx lewisi (DAVIS) (length c. 7 cm) from the Upper Cretaceous of Lebanon. Original: The Natural History Museum, London, U.K.

Genus: *Stichopteryx* GAUDANT, 1969.

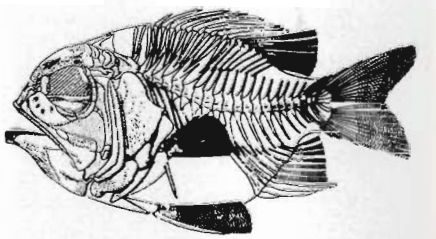
Geological range: Upper Cretaceous.

Geographical distribution: Middle East.

Features: Small fishes with oval outline, laterally flattened. Head deep. Eyes large. Gape rather long. Dorsal fin with hard rays anteriorly and ending rather tall near the root of the tail. Pelvic fins small, vertically beneath the fan-shaped pectoral fins. Caudal fin moderately forked, with broad lobes.

Remarks: Probably predators.

Recent relatives: None. Died out in the Cretaceous.



Stichopteryx, reconstruction after GAYET.



Tubantia cataphractus von der MARCK (length c. 16 cm) from the Upper Cretaceous of Baumberge, Westphalia. Original: The Natural History Museum, London, U.K. (P21984).

Genus: *Tubantia* PATTERSON, 1964.

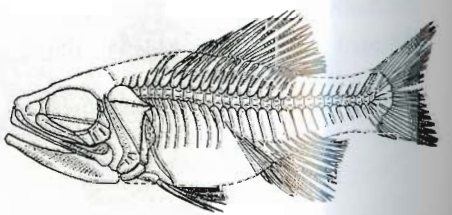
Geological range: Upper Cretaceous.

Geographical distribution: Europe.

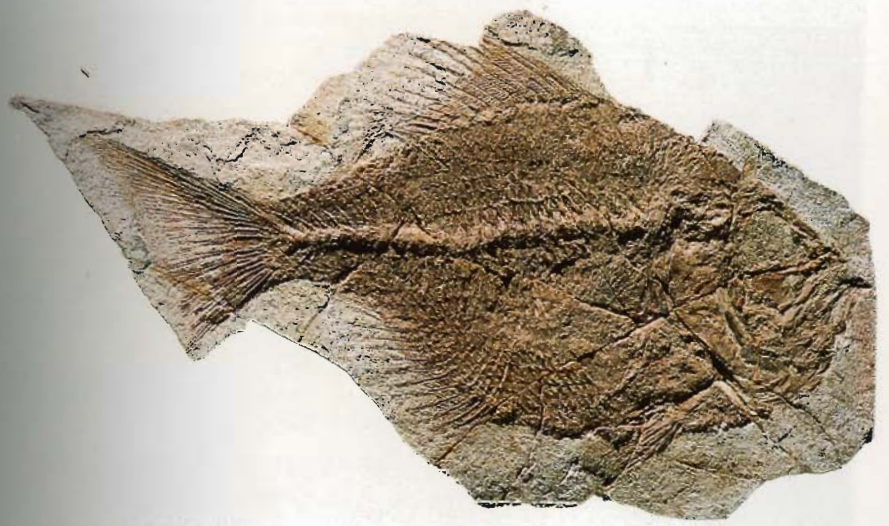
Features: Middle-sized fishes with elongate, somewhat laterally compressed bodies. Head deep. Eyes large. Gape long. Dorsal fin approximately in the middle of the body, tall and with hard rays anteriorly and decreasing in height more posteriorly. Anal fin likewise with hard rays anteriorly. Pelvic fins fan-shaped. Caudal fin emarginate.

Remarks: Predators.

Recent relatives: None. Died out in the Upper Cretaceous.



Tubantia, reconstruction after PATTERSON.



Berycomorus firdoussi ARAMBOURG (length c. 12 cm) from the Lower Oligocene of Iran. Original: Muséum National d'Histoire Naturelle, Paris, France. Photograph: Serette.

Genus: *Berycomorus* ARAMBOURG, 1939.

Geological range: Oligocene.

Geographical distribution: Middle East.

Features: Small to middle-sized fishes with oval outline, laterally flattened. Head deep. Eyes large. Snout rounded. Gape rather long. Dorsal fin hard-rayed, pointed, approximately in the middle of the body. Anal fin with a broader base. Pectoral fins fan-shaped. Caudal fin rather forked.

Remarks: Probably predators.

Recent relatives: Genus extinct. Perhaps related to recent slimeheads of the family Berycidae.



Beryx decadactylus, a recent slimehead.



Berybolcensis leptacanthus (Agassiz) (length c. 13 cm) from the Middle Eocene of Bolca, Italy. Original: Bayerische Staatssammlung für Paläontologie, Munich, Germany.

Genus: *Berybolcensis* Sorbini, 1979.

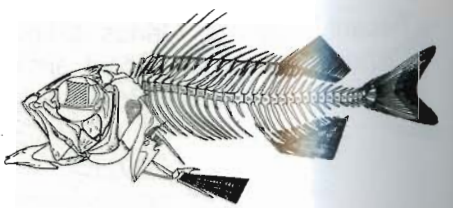
Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Small fishes with rather laterally compressed bodies. Head deep. Eyes large. Gape long. Two Dorsal fins, the posterior being triangular and the anterior one supported by strong rays. Anal fin triangular, with a broad base. Pectoral fins small, pelvic fins vertically beneath them, fan-shaped. Caudal fin rather deeply forked.

Remarks: Gregarious predators.

Recent relatives: None. Died out in the Eocene.



Berybolcensis, reconstruction after Sorbini.



Ctenocephalichthys loreti Gaudant (length c. 5 cm) from the Upper Cretaceous of Lebanon. Original: Muséum National d'Histoire Naturelle, Paris, France. Photograph: Serette, Paris.

Genus: *Ctenocephalichthys* Gaudant, 1969.

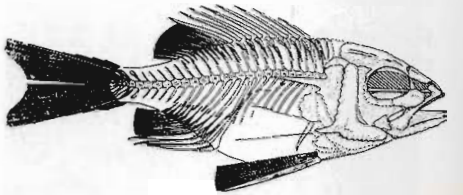
Geological range: Upper Cretaceous.

Geographical distribution: Middle East.

Features: Small fishes with rather broad bodies. Head deep. Eyes large. Gape rather long. Snout rather pointed. Anterior portion of dorsal fin hard-rayed and beginning anterior to the middle of the body. Posterior portion of fin soft-rayed, arcuate dorsally and declining in height rearwards. Anal fin likewise hard-rayed anteriorly and soft-rayed more posteriorly. Pectoral fins long and narrow. Caudal fin deeply emarginate.

Remarks: Probably fed, at least partly, on plants.

Recent relatives: Genus extinct. Perhaps distantly related to other squirrelfishes of the family Holocentridae.



Ctenocephalichthys, reconstruction after Gayet.



Eoholocentrum macrocephalum (de Blainville) (length c. 11 cm) from the Middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Eoholocentrum* Sorbini & Tirapelle, 1974.

Geological range: Middle Eocene.

Geographical distribution: Europa.

Features: Small fishes with slenderly oval bodies. Head deep. Eyes large. Gape rather long. Two dorsal fins, the posterior triangular, the anterior supported by strong rays. Anal fin likewise triangular. Pectoral fins vertically above pelvic fins. Caudal fin forked, with rounded lobes.

Remarks: Gregarious predators.

Recent relatives: Genus extinct. Related to recent squirrelfishes of the genus *Holocentrus*.



Eoholocentrum, reconstruction after Sorbini & Tirapelle.



Unknown *Holocentrid* (length c. 18 cm) from the Middle Eocene of Bolca, Italy. Original: Paleontologiska Muséet, Uppsala, Sweden.

Genus: *Holocentrus* Scopoli, 1777.

Geological range: Eocene to recent.

Geographical distribution: Europe.

Features: Small to middle-sized fishes with elongate oval, laterally flattened bodies. Head deep. Eyes large. Gape rather long. Dorsal fin begins with hard rays in the anterior half of the body and probably rises to a tall point just anterior to the root of the tail. Anal fin opposite the posterior portion of the dorsal fin. Pelvic in the anterior third of the body. Pectoral fins narrow. Caudal fin on a stalk, deeply forked.

Remarks: Probably gregarious.

Recent relatives: Closely related to recent squirrelfishes of the genus *Holocentrus*.



Holocentrus rufus, a recent squirrelfish.



Myripristis homopterygius AGASSIZ (length c. 11 cm) from the Middle Eocene of Bolca, Italy. Original: Staatliches Museum für Naturkunde, Karlsruhe, Germany.

Genus: *Myripristis* CUVIER, 1827.

Geological range: Eocene to Miocene.

Geographical distribution: Europe.

Features: Small fishes with slender, somewhat laterally compressed bodies. Head deep. Eyes large. Gape long. Two dorsal fins , the anterior hard-rayed, the posterior low and fringe-like, opposite the anal fin. Pectoral fins almost vertically above the pelvic fins. Caudal fin forked.

Remarks: Gregarious predators. Possibly the fossiled fish belongs to the genus *Berybolcensis*.

Recent relatives: Closely related to recent squirrelfishes of the genus *Myripristis*.



Myripristis murdjan, a recent squirrelfish.



Paraspinus cupulus GAYET (length c. 16 cm) from the Upper Cretaceous of Lebanon. Original: Muséum National d'Histoire Naturelle, Paris, France. Photograph: Serette, Paris.

Genus: *Paraspinus* GAYET, 1981.

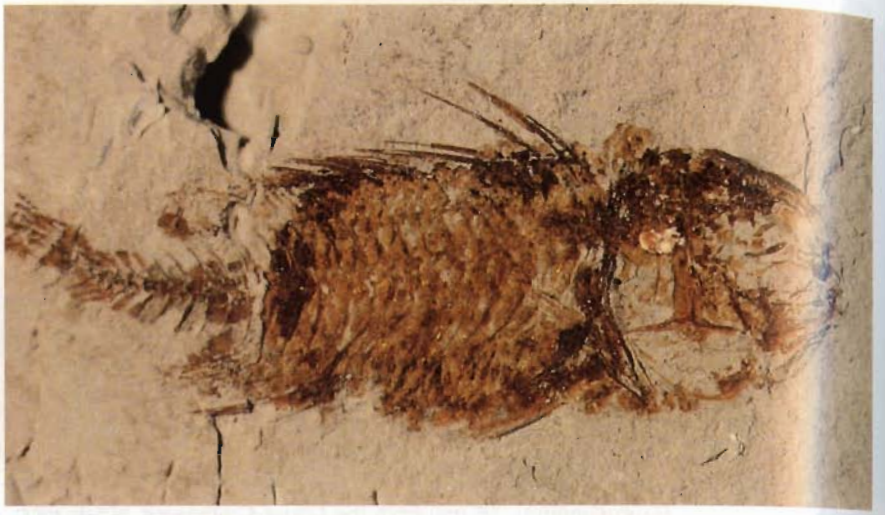
Geological range: Upper Cretaceous.

Geographical distribution: Middle East.

Features: Middle-sized fishes with elongate oval, laterally flattened bodies. Head deep, somewhat elongate. Eyes large. Gape long. Jaws set with sharp teeth. Snout slightly pointed. Dorsal fin hard-rayed anteriorly, soft-rayed posteriorly, begins approximately in the middle of the body. Anal fin begins anteriorly with a spine-like hard ray, as also do the pelvic fins. Pectoral fins fan-shaped. Caudal fin slightly forked, with broad lobes.

Remarks: Probably predators.

Recent relatives: None. Died out in the Cretaceous.



Sargocentron rubrum FORSKÅL (length c. 3.5 cm) from the Pliocene of Fiume Marecchia, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Sargocentron* FOWLER, 1904.

Synonym: *Sargocentrum*.

Geological range: Pliocene to recent.

Geographical distribution: Europe.

Features: Small fishes with rather laterally compressed bodies. Head deep. Eyes large. Gape rather long. Two dorsal fins. The anterior one hard-rayed and tall anteriorly, decreasing in height posteriorly. The more posterior soft-rayed and opposite the anal fin, which is likewise hard-rayed anteriorly and soft-rayed posteriorly. Pelvic fins vertically beneath the pectoral fins. Caudal fin forked.

Remarks: Gregarious.

Recent relatives: Closely related to recent squirrlefishes of the genus *Sargocentrum*.



Sargocentrum diadema, a recent squirrelfish.



Stichoberyx polydesmus (ARAMBOURG) (length c. 8 cm) from the Lower Cretaceous of Tselfat, Morocco. Original: Museum National d'Histoire Naturelle, Paris, France. Photograph: Serette, Paris.

Genus: *Stichoberyx* GAUDANT, 1978.

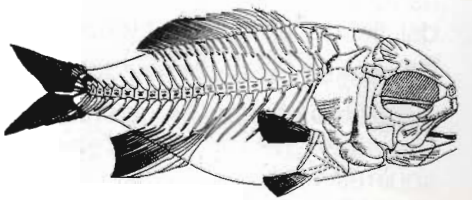
Geological range: Lower Cretaceous.

Geographical distribution: Northern Africa.

Features: Small to middle-sized fishes with rather plump, laterally flattened bodies. Head deep. Eyes large. Dorsal fins broad-based, begins just anterior to the middle of the body and consists of hard rays anteriorly and soft rays posteriorly. Anal fin opposite the posterior end of the dorsal fin. Pectoral fins fan-shaped, vertically above the pelvic fins which are likewise fan-shaped. Caudal fin forked, with relatively broad lobes.

Remarks: Probably predators.

Recent relatives: None. Died out in the Cretaceous.



Stichoberyx, reconstruction after GAYET.



Tenuicentrum lanceolatum (Bassani) (length c. 14 cm) from the Middle Eocene of Bolca, Italy. Original: The Natural History Museum, London, U.K. (P19063).

Genus: *Tenuicentrum* Sorbini, 1975.

Geological range: Middle Eocene.

Geographical distribution: Europe.

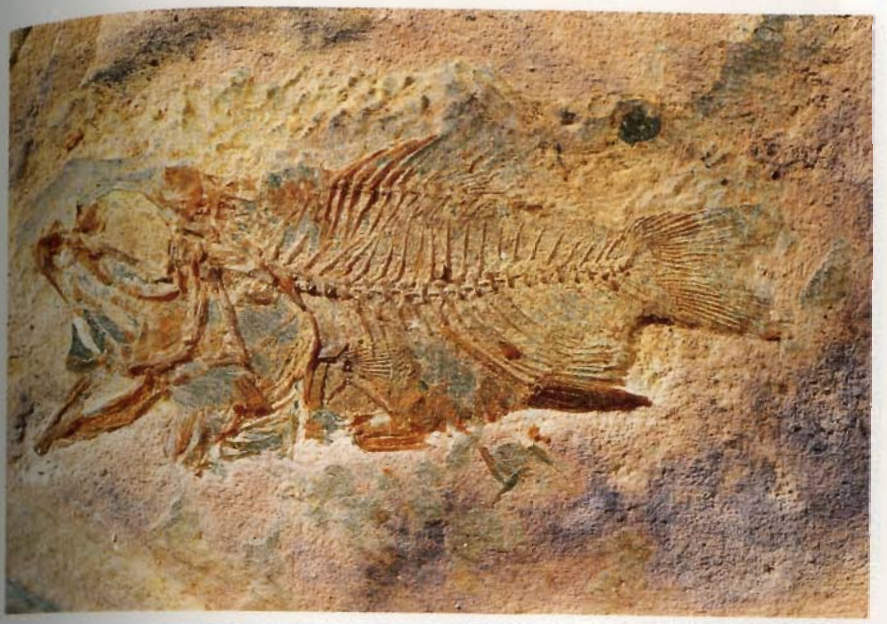
Features: Small to middle-sized fishes with oval bodies. Head deep. Eyes large. Gape rather long. Two dorsal fins, the posterior being triangular and the anterior hard-rayed. Anal fin tall anteriorly, but then decreasing in height and forming a fringe. Pectoral fins rounded. Pelvic fins vertically beneath them, narrow and relatively long. Caudal fin rather deeply forked.

Remarks: Probably predators.

Recent relatives: Genus extinct. Possibly related to recent squirrelfish of the family Holocentridae.



Tenuicentrum, reconstruction after Sorbini.



Cryptoberyx minimus Gaudant (length c. 3 cm) from the Upper Cretaceous of Lebanon. Original: Muséum National d'Histoire Naturelle, Paris, France. Photograph: Serette, Paris.

Genus: *Cryptoberyx* Gaudant, 1978.

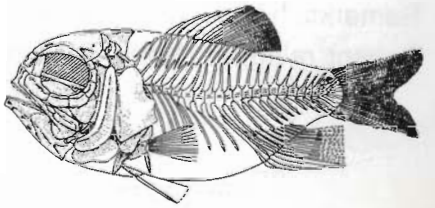
Geological range: Upper Cretaceous.

Geographical distribution: Middle East.

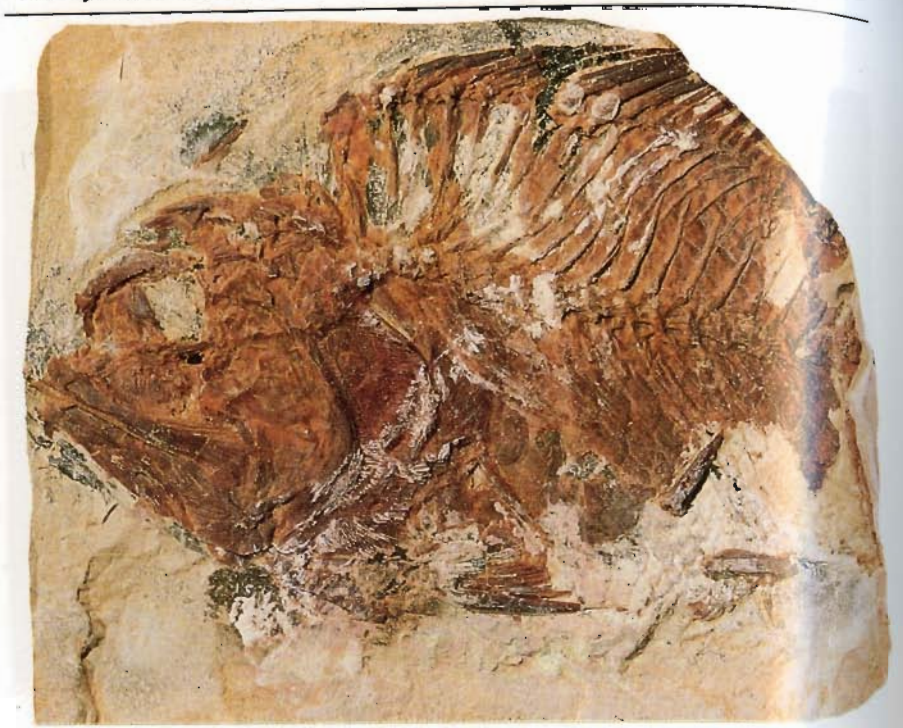
Features: Small fishes of rather plump shape. Head deep. Eyes large. Gape rather long. Dorsal fin begins shortly in front of the middle of the body, hard-rayed anteriorly and soft-rayed posteriorly. Anal fin similar but shorter. Pectoral fins small, fan-shaped. Pelvic fins almost vertically below. Caudal fin slightly forked.

Remarks: Probably gregarious.

Recent relatives: None. Died out in the Cretaceous.



Cryptoberyx, reconstruction after Gayet.



Plesioberyx maximus GAYET (length c. 9 cm) from the Upper Cretaceous of Lebanon. Original: Muséum National d'Histoire Naturelle, Paris, France. Photograph: Serette Paris.

Genus: *Plesioberyx* GAYET, 1980.

Geological range: Upper Cretaceous.

Geographical distribution: Middle East.

Features: Small fishes with oval, laterally flattened bodies. Head deep. Eyes large. Gape long. Snout slightly pointed. Dorsal fin begins shortly behind the head with hard rays. Anal and pelvic fins likewise carried by hard rays. Pectoral fins small and fan-shaped. Caudal fin slightly forked, with relatively broad lobes.

Remarks: Probably predators.

Recent relatives: None. Died out in the Cretaceous.



Dinopteryx spinosus DAVIS (length c. 14 cm) from the Upper Cretaceous of Lebanon. Original: The Natural History Museum, London, U.K. (P4761).

Genus: *Dinopteryx* WOODWARD, 1901.

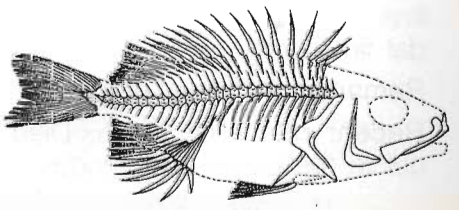
Geological range: Upper Cretaceous.

Geographical distribution: Middle East.

Features: Middle-sized fishes with deep bodies which taper sharply toward the tail root. Head shallow. Eyes large. Snout slightly pointed. Dorsal fin with numerous strong rays anteriorly, extending over the whole back. Anal fin similar but smaller. Pelvic fins narrow, fan-shaped. Pectoral fins. Caudal fin emarginate.

Remarks: Probably predators.

Recent relatives: None. Died out in the Upper Cretaceous.



Dinopteryx, reconstruction after PATTERSON.



Aipichthys velifer WOODWARD (length c. 8 cm) from the Upper Cretaceous of Lebanon. Original: Frickhinger Collection, Munich, Germany.

Genus: *Aipichthys* STEINDACHNER, 1859.

Geological range: Upper Cretaceous.

Geographical distribution: Middle East.

Features: Small fishes with almost circular, laterally flattened bodies. Head deep. Eyes small. Gape rather long, directed upwards. Snout slightly pointed. Dorsal fin begins anteriorly with a tall point, but decreases in height posteriorly, with an arcuate upper margin. Anal fin fringe-like. Pectoral fins small. Pelvic fins elongate and pointed. Caudal fin forked.

Remarks: Probably predators.

Recent relatives: None. Died out in the Upper Cretaceous.



Aipichthys, reconstruction after WOODWARD.



Pycnosteroides laevispinosus (HAY) (length c. 7 cm) from the Upper Cretaceous of Lebanon. Original: Field Museum of Natural History, Chicago, Illinois, U.S.A.

Genus: *Pycnosteroides* WOODWARD, 1942.

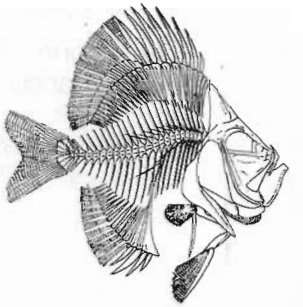
Geological range: Upper Cretaceous.

Geographical distribution: Middle East.

Features: Small fishes with circular, laterally flattened bodies. Head deep. Eyes large. Gape rather long. Dorsal fins with hard rays anteriorly but continuing as a tall fringe to the root of the tail. Anal fin similar but smaller. Pectoral fins small. Pelvic fins obliquely fan-shaped. Caudal fin strongly emarginate.

Remarks: Probably fed partly on plants.

Recent relatives: None. Died out in the Cretaceous.



Pycnosteroides, reconstruction after PATTERSON.



Stichocentrus livatus PATTERSON (length c. 6 cm) from the Upper Cretaceous of Lebanon. Original: The Natural History Museum, London, U.K. (P5/681).

Genus: *Stichocentrus* PATTERSON, 1967.

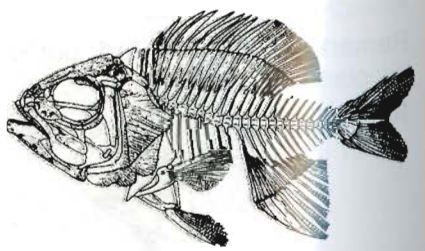
Geological range: Upper Cretaceous.

Geographical distribution: Middle East.

Features: Small fishes with oval, laterally flattened bodies. Head deep. Eyes large. Gape rather long. Dorsal fins with hard rays anteriorly and then decreasing in height towards the tail root. Anal fin likewise with hard rays anteriorly. Pelvic fins fan-shaped. Caudal fin rather deeply forked.

Remarks: Probably predators.

Recent relatives: None. Died out in the Upper Cretaceous.



Stichocentrus, reconstruction after PATTERSON.



Digoria ambigua DANILTCHENKO (length c. 7 cm) from the Lower Oligocene of northern Caucases. Original: Paleontologicheskii Muzei Russkoi Akademii Nauk, Moscow, Russia.

Genus: *Digoria* DANILTCHENKO, 1980.

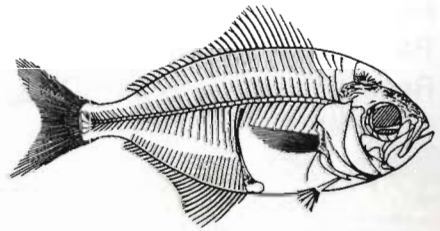
Geological range: Lower Oligocene.

Geographical distribution: Eastern Europe.

Features: Small fishes with rather laterally compressed bodies. Head deep. Eyes large. Gape rather long. Dorsal fin hard-rayed and rather tall anteriorly, lower and soft-rayed posteriorly. Anal fin low, broad-based. Pelvic fins small. Pectoral fins fan-shaped. Caudal fin deeply forked.

Remarks: Probably predators.

Recent relatives: None. Died out in Oligocene.



Digoria, reconstruction after Akademia Nauk, Moscow.



Omosoma sahelalmae (COSTA) (length c. 8 cm) from the Upper Cretaceous of Lebanon. Original: The Natural History Museum, London, U.K. (P 4862)

Genus: *Omosoma* COSTA, 1857.

Geological range: Upper Cretaceous.

Geographical distribution: Europe, North Africa, Middle East.

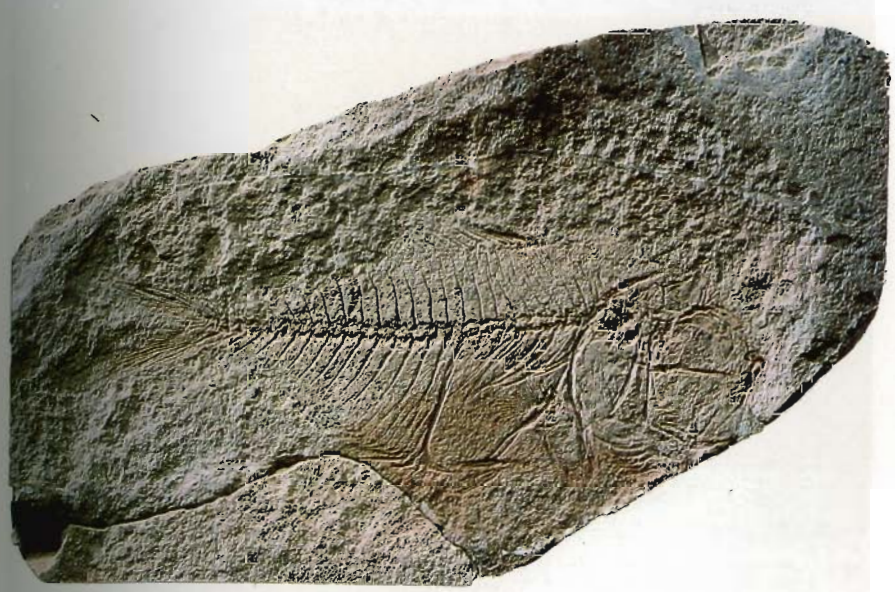
Features: Small fishes with laterally compressed bodies. Head deep. Eyes large. Gape rather long. Dorsal fin begins anterior to the middle of the body, fringe-like, decreasing in height posteriorly. Anal fin similar but smaller. Pelvic and pectoral fins small. Caudal fin forked, with relatively narrow lobes.

Remarks: Probably predators.

Recent relatives: None. Died out in the Upper Cretaceous.



Omosoma, reconstruction after PATTERSON.



Omosomopsis simum (ARAMBOURG) (length c. 6 cm) from the Lower Cretaceous of Tselfat, Morocco. Original: Muséum National d'Histoire Naturelle, Paris, France. Photograph: Serette, Paris.

Genus: *Omosomopsis* GAUDANT, 1978.

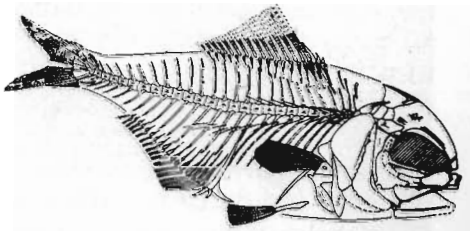
Geological range: Lower Cretaceous.

Geographical distribution: Northern Africa.

Features: Small to middle-sized fishes with rather plump bodies. Head deep. Eyes large. Gape rather long. Snout rounded. Dorsal fin approximately in the middle of the body, opposite the low, broad-based anal fin. Pelvic fins small, fan-shaped. Pectoral fins elongate, rounded. Caudal fin small, deeply forked, with narrow lobes.

Remarks: Probably fed at least partly on plants.

Recent relatives: None. Died out in the Cretaceous.

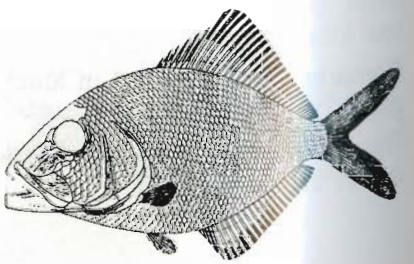


Omosomopsis, reconstruction after GAYET.



Platycormus germanus AGASSIZ (length c. 20 cm) from the Upper Cretaceous of Baumberge, Westphalia, Germany. Original: Geologisch-Paläontologisches Museum, Münster, Germany.

Genus: *Platycormus* von der MARCK, 1858.
Synonym: *Berycopsis*.
Geological range: Upper Cretaceous.
Geographical distribution: Europe.
Features: Middle-sized fishes with almost disc-shaped, laterally flattened bodies. Head deep. Eyes large. Gape rather long. Snout slightly pointed. Dorsal fin beginning in the middle of the body with a few hard rays, rising to a point in the anterior part and then decreasing in height towards the root of the tail. Anal fin fringe-like. Pelvic and pectoral fins small. Caudal fin deeply forked, with narrow lobes.
Remarks: Still-water fishes. Probably fed partly on plants.
Recent relatives: None. Died out in the Upper Cretaceous.



Platycormus, reconstruction after WOODWARD.



Pycnosterinx russeggeri HECKEL (length c. 5 cm) from the Upper Cretaceous of Lebanon. Original: National Museum of Scotland, Edinburgh, U.K.

Genus: *Pycnosterinx* HECKEL, 1849.
Geological range: Upper Cretaceous.
Geographical distribution: Middle East.
Features: Small fishes with broad bodies. Head deep. Eyes large. Gape rather long. Dorsal fin begins in the middle of the body, opposite the somewhat smaller anal fin. Pelvic and pectoral fins small. Caudal fin forked, with relatively narrow lobes.
Remarks: Probably predators.
Recent relatives: Genus extinct. Possibly related to the recent genus *Polymixia*.



Polymixia berndti, a recent beardfish.



Araripichthys castilhoi Silva Santos (length c. 42 cm) from the Lower Cretaceous of Ceará, Brazil. Original: Herrmann Collection, Büchenbach, Germany.

Genus: *Araripichthys* Silva Santos, 1985.

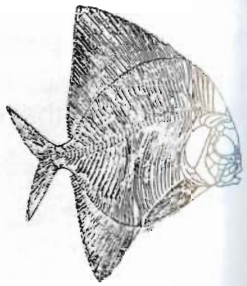
Geological range: Lower Cretaceous.

Geographical distribution: South America.

Features: Middle-sized fishes with disc-shaped, laterally flattened bodies. Head deep. Eyes large. Gape rather long. Dorsal fin in the middle of the body, rising to a point, partly covered with scales. Anal fin likewise partly covered with scales. Caudal fin deeply forked, with narrow lobes.

Remarks: Still-water fishes.

Recent relatives: None. Died out in the Lower Cretaceous.



Araripichthys, reconstruction after Silva Santos.



Unnamed fish (length c. 12 cm) from the Upper Cretaceous of Lebanon. Original: Beyrouthy Collection, Toulouse, France.

Genus: Not named.

Geological range: Upper Cretaceous.

Geographical distribution: Middle East.

Features: Middle-sized fishes with disc-shaped, laterally flattened bodies. Head deep. Eyes large. Gape rather long. Dorsal fin beginning anterior to the middle of the body, tall and pointed. It is obliquely opposite to the anal fin which is likewise tall anteriorly but then decreases in height and becomes fringe-like. Pectoral fins long and fan-shaped. Caudal fin rather deeply forked.

Remarks: Still-water fishes which probably fed partly on plants.

Recent relatives: None. Died out in the Upper Cretaceous.



Unnamed fish (length c. 9 cm) from the Upper Cretaceous of Lebanon. Original: Beyrouthy Collection, Toulouse, France.

Genus: Not named.

Geological range: Upper Cretaceous.

Geographical distribution: Middle East.

Features: Small fishes with disc-shaped outline, laterally flattened. Head deep. Eyes small. Gape rather long. Dorsal fin in the middle of the body, long and flag-like. Anal fin tall anteriorly, but running back into a low fringe. Pelvic fins very anterior in position, long and narrow. Caudal fin rather deeply forked, with slightly rounded lobes.

Remarks: Still-water fishes which probably fed partly on plants.

Recent relatives: None. Died out in the Upper Cretaceous.



Unnamed fish (length c. 8 cm) from the Upper Cretaceous of Lebanon. Original: Beyrouthy Collection, Toulouse, France.

Genus: Not named.

Geological range: Upper Cretaceous.

Geographical distribution: Middle East.

Features: Small fishes with deeply oval outline, laterally flattened. Head deep. Eyes large. Gape long. Dorsal fin begins shortly behind the head and runs as a tall fringe along the whole of the back, borne by hard thick spines which become thinner posteriorly. Anal fin triangular. Caudal fin moderately forked, with broad lobes.

Remarks: Probably predators.

Recent relatives: None. Died out in the Upper Cretaceous.



Zenopsis clarus DANILTCHENKO (length c. 9 cm) from the Lower Oligocene of the northern Caucasus. Original: Paleontologicheskii Muzei Russkoi Akademii Nauk, Moscow, Russia.

Genus: *Zenopsis* GILL, 1862.

Geological range: Oligocene to recent.

Geographical distribution: Western and eastern Europe.

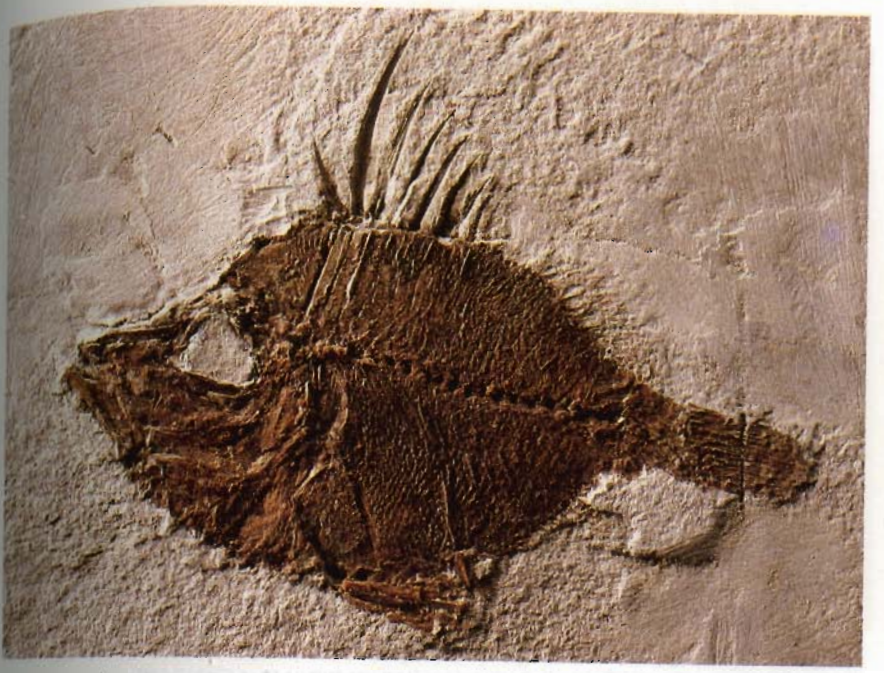
Features: Small fishes with almost circular outline, laterally flattened. Head deep. Gape long, directed upwards. Snout pointed. Dorsal fin approximately in the middle of the body, carried by hard rays. Anal fin broad-based. Pectoral fins small. Pelvic fins very anterior in position. Caudal fin not forked. Jaws set with small teeth.

Remarks: Open-water predators.

Recent relatives: Closely related to recent dories of the genus *Zenopsis*.



Zenopsis conchifer, a recent dory.



Zeus sp. (length c. 9 cm) from the Pliocene of Fiume Marecchia, Italy. Original: Interfoss, Munich, Germany.

Genus: *Zeus* LINNAEUS, 1758.

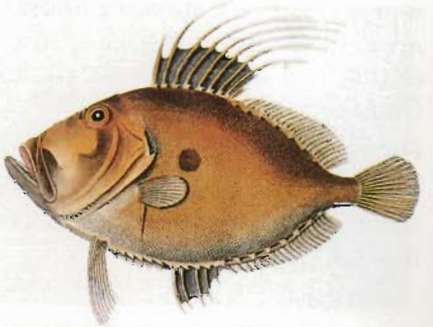
Geological range: Oligocene to recent.

Geographical distribution: Europe, North Africa.

Features: Small to middle-sized fishes with oval outline, laterally flattened. Head deep. Eyes large. Gape long, directed upwards. Snout pointed. Dorsal fin approximately in the middle of the body, anteriorly with strong, elongate rays but continuing posteriorly as a fringe. Anal fin similar. Pelvic fins elongate, very anterior in position. Pectoral fins small. Caudal fin not forked.

Remarks: Probably open-water predators.

Recent relatives: Closely related to recent dories of the genus *Zeus*.



Zeus faber, the recent John dory. Lithograph from BLOCH.



Antigonia veronensis SORBINI (length c. 3 cm) from the Middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Antigonia* LOWE, 1843.

Geological range: Middle Eocene to recent.

Geographical distribution: Europe.

Features: Small to middle-sized fishes with rounded lozenge-shaped outline, laterally flattened. Head deep. Eyes large. Snout pointed. Dorsal fin begins at the highest point of the body, hard-rayed anteriorly but continuing rearward as a soft-rayed fringe. Anal fin similar. Pelvic fins very anterior. Pectoral fins small. Caudal fin not forked.

Remarks: Predators.

Recent relatives: Closely related to recent boarfishes of the genus *Antigonia*.



Antigonia steindachneri, a recent boarfish.



Capros radobojanus (KRAMBERGER) (length c. 3 cm) from the Oligocene of Wiesloch, Baden, Germany. Original: Staatliches Museum für Naturkunde, Karlsruhe, Germany.

Genus: *Capros* de LACÉPÈDE, 1802.

Synonyms: *Glyphisoma*, *Metapomichthys*, *Proantigonia*.

Geological range: Oligocene to recent.

Geographical distribution: Western and eastern Europe, North Africa.

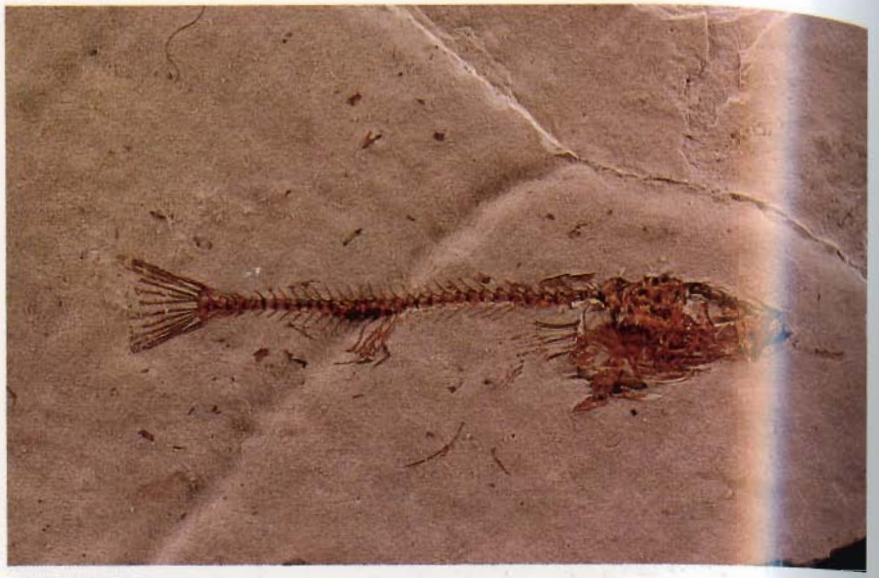
Features: Very small fishes with almost circular outline, laterally flattened. Head deep. Eyes large. Dorsal fin begins with hard rays just behind the head and continues rearwards as a soft-rayed fringe. Anal fin similar. Pelvic fins very anterior in position. Pectoral fins small. Caudal fin not forked.

Remarks: Predators.

Recent relatives: Closely related to recent boarfishes of the genus *Capros*.



Capros aper, a recent boarfish.



Gasterosteus doryssus JORDAN (length c. 6 cm) from the Miocene of California, U.S.A. Original: National Museum of Natural History, Smithsonian Institution, Washington, D.C., U.S.A.

Genus: *Gasterosteus* LINNAEUS, 1758.

Synonym: *Meriamella*.

Geological range: Upper Miocene to recent.

Geographical distribution: North America, Europe, Asia, North Africa.

Features: Small fishes of slender shape. Head shallow. Eyes large. Snout pointed. Dorsal fin with spines anteriorly, continuing rearwards as a fringe decreasing in height. Pectoral fins large. Pelvic fins consist of a powerful and obvious spine. Caudal fin slightly emarginate. Flanks of body armoured with bony plates.

Remarks: Fresh-water predators.

Recent relatives: Closely related to recent sticklebacks of the genus *Gasterosteus*.



Gasterosteus aculeatus, a recent stickleback.



Pegasus volans VOLTA (length c. 8 cm) from the Middle Eocene of Bolca, Italy. Original: Muséum National d'Histoire Naturelle, Paris, France. Photograph: Serette, Paris.

Genus: *Pegasus* LINNAEUS, 1758.

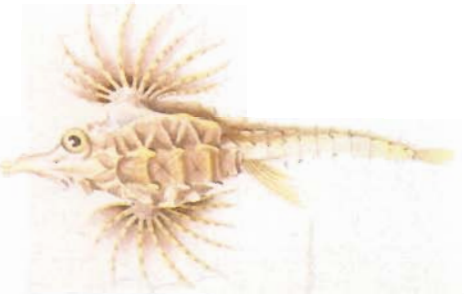
Geological range: Eocene.

Geographical distribution: Europe.

Features: Small fishes of unusual shape. Head small. Eyes small. Gape long. Snout produced as a broad rostrum. Mouth toothless. Pectoral fins transformed into long many-rayed "wings".

Remarks: Fed on small free-swimming organisms.

Recent relatives: Probably related to seamoths of the genus *Pegasus*.



Pegasus volans, a recent seamoth. Lithograph from CUVIER.



Aulostomoides tyleri BLOT (length c. 7 cm) from the Middle Eocene of Bolca, Italy. Original: Muséum National d'Histoire Naturelle, Paris, France. Photograph: Serette, Paris.

Genus: *Aulostomoides* BLOT, 1980.

Geological range: Eocene.

Geographical distribution: Europe.

Features: Small fishes with elongate, very slender bodies. Head shallow. Eyes relatively large. Snout produced to form a tube-shaped rostrum. Dorsal fin very posterior.

Remarks: Fed on free-swimming organisms.

Recent relatives: None. Died out in Eocene.



Eoaulostomus bolcensis (AGASSIZ) (length c. 10 cm) from the Middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Eoaulostomus* BLOT, 1980.

Synonym: *Aulostoma*.

Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Small fishes with elongate, very thin bodies. Head shallow. Eyes large. A powerful, rather long, tube-shaped snout with a terminal mouth. Caudal fin small and not forked.

Remarks: Fed on microscopic organisms.

Recent relatives: Related to recent trumpetfishes of the genus *Aulostomus*.



Aulostomus sinensis, a recent trumpetfish.



Macraulostomus veronensis BLOT (length c. 18 cm) from the Middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Macraulostomus* BLOT, 1980.

Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Small fishes with elongate slender bodies. Head shallow. Eyes relatively large. Upper and lower jaws fused to form a rather long tube. Mouth relatively large. Dorsal fin in the posterior third of the body, opposite the anal fin. Pectoral fins small. Caudal fin not forked, rounded. Body covered with small ctenoid scales.

Remarks: Fed on microscopic prey.

Recent relatives: Genus extinct. Perhaps distantly related to recent trumpetfishes of the genus *Aulostomus*.



Urosphen dubia (BLAINVILLE) (length c. 18 cm) from the Middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Urosphen* AGASSIZ, 1835.

Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Small fishes with thin, very slender bodies. Head shallow. Eyes large. Snout elongated to form a narrow tube. Mouth opening very small, terminal. Dorsal fin in the posterior third of the body, opposite the anal fin. Caudal fin not forked, rounded.

Remarks: In view of the small mouth, fed only on microscopic organisms.

Recent relatives: None. Died out in Oligocene.



Urosphenopsis sagitta DANILTCHENKO (length c. 16 cm) from the Eocene of Turkmenistan, C.I.S. Original: Paleontologicheskii Muzei Akademii Nauk Russkoi Akademii Nauk, Moscow, Russia, C.I.S.

Genus: *Urospehopsis* DANILTCHENKO, 1968.

Geological range: Lower Eocene.

Geographical distribution: Western Asia.

Features: Small fishes with very narrow, elongate bodies. Head shallow. Eyes small. Massive tubular snout with terminal mouth. Body covered with bony armour.

Remarks: Fed on microscopic organisms.

Recent relatives: None. Died out in Eocene.



Urosphenopsis, reconstruction after Akademia Nauk, Moscow.



Fistularioides veronensis BLOT (length c. 21 cm) from the Middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Fistularioides* BLOT, 1980.

Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Small to middle-sized fishes with elongate very thin bodies. Head shallow. Eyes small. Snout rather long, massive and tube-shaped with a small terminal mouth. Dorsal fin opposite anal fin. Caudal fin forked, with a filamentous appendage.

Remarks: Fed on microscopic organisms.

Recent relatives: Related to recent cornetfishes of the genus *Fistularia*.



Fistularia tabaccaria, a recent cornetfish. Lithograph from BLOCH.



Parasynarcualis longirostris (de BLAINVILLE) (length c. 22 cm) from the Middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Parasynarcualis* BLOT, 1980.

Synonym: *Fistularia*.

Geological range: Middle Eocene.

Geographical distribution: Europe.

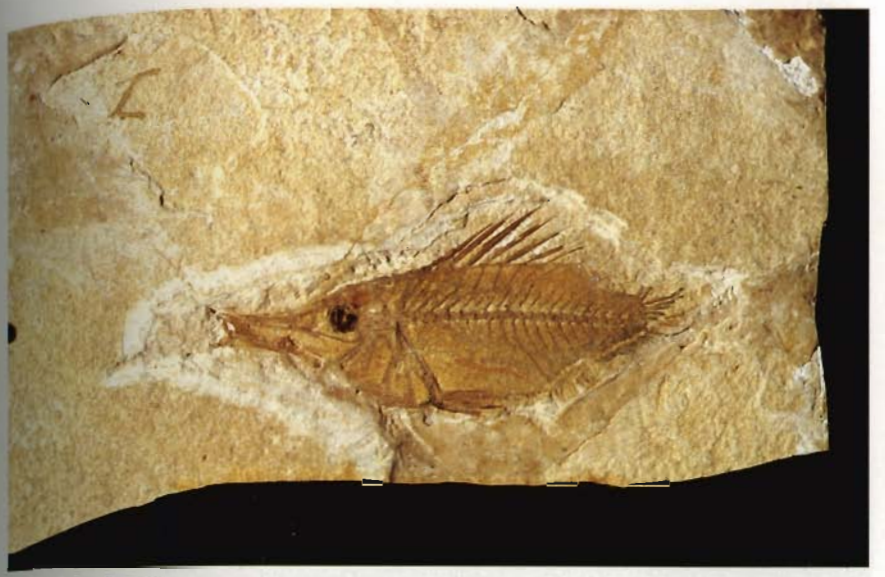
Features: Small to middle-sized fishes with elongate, very narrow bodies. Head shallow. Eyes large. Snout powerful, rather long and tubular with a terminal mouth. Dorsal fin bipartite. Anal fin fringe-like. Caudal fin not forked.

Remarks: Fed on microscopic organisms.

Recent relatives: Genus extinct. Possibly related to recent cornetfishes of the family Fistulariidae.



Parasynarcualis, reconstruction after Akademia Nauk, Moscow.



Aulorhamphus bolcensis (STEINDACHNER) (length c. 6 cm) from the Middle Eocene of Bolca, Italy. Original: Naturhistorisches Museum, Vienna, Austria.

Genus: *Aulorhamphus* de ZIGNO, 1890.

Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Small fishes with relatively deep, laterally flattened bodies. Head shallow. Eyes small. Snout short and tubular, with a small terminal mouth. Dorsal fin with hard rays anteriorly. Anal fin broad-based. Caudal fin not forked, rounded.

Remarks: Fed on microscopic animals.

Recent relatives: Possible related to recent snipefishes of the family Macrorhamphosidae.



Macrorhamphosus scolopax, a recent snipefish.



Gasterorhamphosus zuppichini SORBINI (length c. 6 cm) from the Upper Cretaceous of Nardo, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Gasterorhamphosus* SORBINI, 1981.

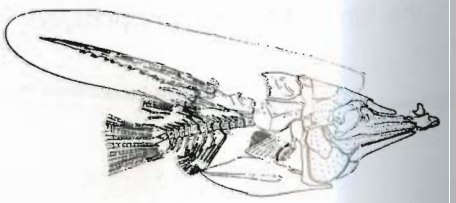
Geological range: Upper Cretaceous.

Geographical distribution: Europe.

Features: Small fishes with laterally flattened, relatively deep bodies. Head shallow. Eyes large. Snout tubular. Body partly armoured. Dorsal fin very posterior, the first ray very thick, denticulate on the dorsal surface and very long, projecting far behind the body. Anal fin small. Caudal fin not forked.

Remarks: Fed on microorganisms.

Recent relatives: Genus extinct. Related to recent snipefishes of the genus *Macrorhamphosus*.



Gasterorhamphosus, reconstruction after SORBINI.



Aeoliscus apsheronicus (LEDNEV) (length c. 10 cm) from the northern Caucasus, C.I.S. Original: Paleontologicheskii Muzei Russkoi Akademii Nauk, Moscow, Russia.

Genus: *Aeoliscus* JORDAN & STARKS, 1902.

Geological range: Oligocene to recent.

Geographical distribution: Western and eastern Europe.

Features: Small fishes with elongate, very laterally compressed bodies. Head shallow. Snout long and tubular, with small terminal mouth. Body covered with bony armour. Mid-ventral line sharp. Trunk extends rearwards into a long powerful spine. Tail region bent downwards. Caudal fin anterior to the spine, which represents the posterior end of the animal.

Remarks: Probably swam head-downwards, like their recent relatives.

Recent relatives: Related to recent shrimpfishes of the genus *Aeoliscus*.



Aeoliscus, reconstruction after ORLOV.



Centriscus strigatus GÜNTHER (length c. 14 cm) from the Pliocene of Fiume Marecchia, Italy. Original: Frickhinger Collection, Munich, Germany.

Genus: *Centriscus* LINNAEUS, 1758.

Synonym: *Amphisile*.

Geological range: Oligocene to recent.

Geographical distribution: Western Asia, Europe.

Features: Small fishes with slender, laterally very compressed bodies and sharp ventral edge. Head shallow. Eyes large. Rather long tubular snout with small terminal mouth. A long rearward-pointing spine projects beyond the posterior end of the body. Caudal fin small, rounded and turned downwards.

Remarks: Fed on microorganisms.

Recent relatives: Closely related to recent shrimpfishes of the genus *Centriscus*.



Centriscus scutatus, a recent shrimpfish. Lithograph from BLOCH.



Paramphisile weileri BLOT (length c. 7 cm) from the Middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Paramphisile* BLOT, 1980.

Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Small fishes with slender, laterally very compressed bodies with sharp ventral edge. Head shallow. Eyes large. Snout long, tubular, with small terminal mouth. Powerful spine projects beyond the posterior end of the body. Caudal fin small, rounded and turned downwards.

Remarks: Fed on microorganisms.

Recent relatives: Genus extinct. Distantly related to recent shrimpfishes of the genus *Centriscus*.



Aeoliscoides longirostris (Agassiz) (c. 4 cm) from the middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Aeoliscoides* Blot, 1980.

Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Small fishes with slender, compressed bodies. Sharp ventral edge. Snout elongated into a slender, tubular rostrum. Mouth small and terminal. The posterior end of the body terminates in a spine.

Remarks: Due to the small mouth these fishes could only feed on the smallest prey organisms.

Recent relatives: Genus extinct. There is a possible relation to recent shrimpfishes of the genus *Aeoliscus*.



Paraeoliscus robinetae Blot (length c. 10 cm) from the Middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Paraeoliscus* Blot, 1980.

Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Small fishes with narrow, very laterally compressed bodies. Head slender. Eyes large. Long tubular snout with small terminal mouth. A spine points posteriorly, extending far beyond the posterior end of the body which turns downwards, together with the caudal fin.

Remarks: Fed on microorganisms.

Recent relatives: Genus extinct. Related to recent shrimpfishes of the genus *Aeoliscus*.



Aeoliscus punctulatus, a recent shrimpfish.



Calamostoma breviculum AGASSIZ (length c. 12 cm) from the Middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Calamostoma* AGASSIZ, 1833.

Geological range: Middle Eocene.

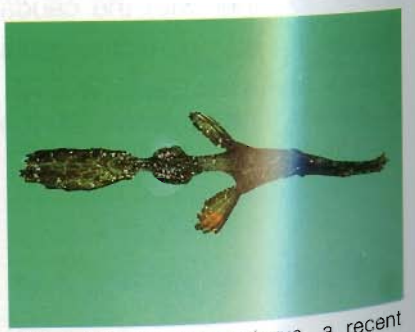
Geographical distribution: Europe.

Features: Small fishes of slender shape. Head shallow. Eyes relatively large. Snout extended to form a tube.

Mouth small. Two dorsal fins. Anal fin and pelvic fins small. Pectoral fins somewhat larger. Caudal fin relatively large, not forked. Body armoured with bony plates.

Remarks: Could only have fed on very small organisms in view of the narrow tubular mouth.

Recent relatives: Genus extinct. Perhaps distantly related to the recent genus *Solenostomus*.



Solenostomus cyanopterus, a recent ghost pipefish.



Prosolenostomus lessinii BLOT (length c. 4 cm) from the Middle Eocene of Bolca, Italy. Original: Carnegie Museum of Natural History, Pittsburgh, Penn., U.S.A.

Genus: *Prosolenostomus* BLOT, 1980.

Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Very small fishes of narrow elongate shape. Head shallow. Eyes small. Short tubular snout. Body armoured with quadrangular plates arranged in rows. Caudal fin not forked, rounded.

Remarks: Fed on microorganisms.

Recent relatives: Genus extinct. Related to recent ghost pipefishes of the family Solenostomidae.



Hippocampus ramulosus LEACH (length c. 5 cm) from the Pliocene of Fiume Marecchia, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.



Hippocampus cuda, a recent seahorse.

Genus: *Hippocampus* RAFINESQUE, 1810.

Geological range: Pliocene to recent.

Geographical distribution: Europe.

Features: Small fishes with elongate, angularly curved bodies, scaleless and surrounded by bony dermal shields. Head shallow. Eyes small. Rather long tubular snout with small terminal mouth. Dorsal fin shortly anterior to the beginning of the tail. Pectoral fins fan-shaped. Caudal fin absent.

Remarks: Fed on microorganisms.

Recent relatives: Closely related to recent seahorses of the genus *Hippocampus*.



Pseudosyngnathus opisthopterus (AGASSIZ) (length c. 30 cm) from the Middle Eocene of Bolca, Italy. Original: Muséum National d'Histoire Naturelle, Paris, France. Photograph: Serette, Paris.

Genus: *Pseudosyngnathus* KNER, 1863.

Geological range: Eocene.

Geographical distribution: Europe.

Features: Middle-sized fishes with very slender elongate bodies. Head small and elongate. Eyes small. Snout produced to form a long thin tubular rostrum. Dorsal fin small, very posterior. Caudal fin elongate, not forked, with a rounded end.

Remarks: Fed on free-swimming microorganisms.

Recent relatives: None. Died out in Eocene.



Syngnathus heckeli de ZIGNO (length c. 9 cm) from the Middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Syngnathus* LINNAEUS, 1758.

Synonym: *Siphonostoma*

Geological range: Middle Eocene to recent.

Geographical distribution: Europe, North America, northern Africa.

Features: Small to middle-sized fishes with elongate, very narrow bodies. Head shallow. Eyes small. Short tubular snout with small terminal mouth. Body covered with bony quadrangular plates arranged in rows. Caudal fin not forked, rounded.

Remarks: Fed on microorganisms.

Recent relatives: Genus extinct. Closely related to recent pipefishes of the genus *Syngnathus*.



Syngnathus sp., a recent pipefish.



Unnamed fish (length c. 22 cm) from the Pliocene of Fiume Marecchia, Italy. Original: Frickhinger Collection, Munich, Germany.

Genus: Not named.

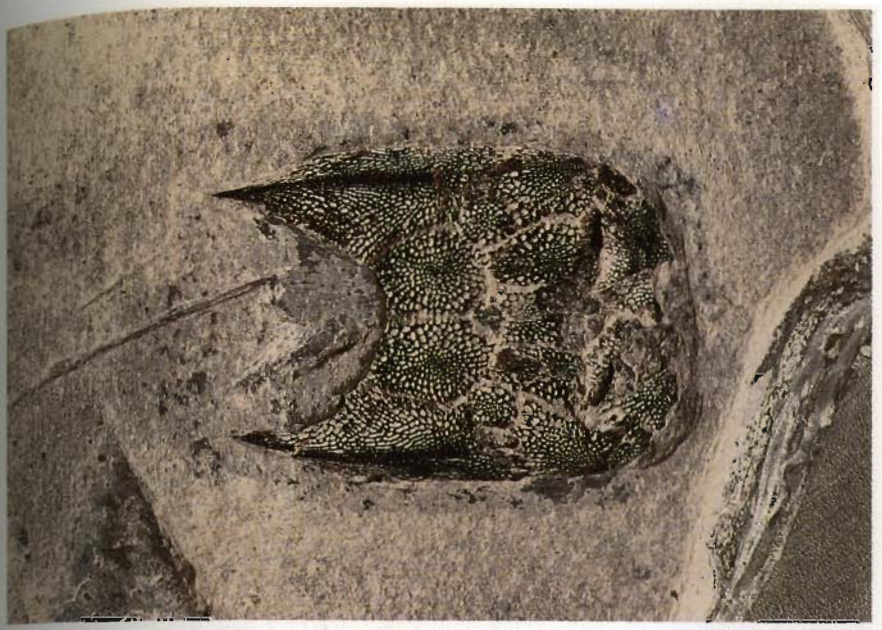
Geological range: Pliocene.

Geographical distribution: Europe.

Features: Middle-sized fishes with elongate, very narrow bodies. Head shallow. Eyes large. Rather long tubular snout with small terminal mouth. Body armoured with rounded plates of bone. Body tapers to a much narrower tail stem with a small unforked caudal fin.

Remarks: Fed on microorganisms.

Recent relatives: Related to recent pipefishes.



Dactylopterus volitans (LINNAEUS) (length c. 3.5cm) from the Pliocene of Fiume Marecchia, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Dactylopterus* de LACÉPÈDE, 1801.

Geological range: Pliocene to recent.

Geographical distribution: Europe.

Features: Small to middle-sized fishes with slender bodies. Head broad. Eyes large. Upper surface of skull flat, fused with the first three vertebrae, armoured with bony plates. Snout falling away steeply. First dorsal fin hard-rayed, shorter than the soft-rayed second dorsal fin. Pectoral fins on the throat. Caudal fin not forked. Scales fused firmly together.

Remarks: Probably bottom-dwelling fishes. Their "flying ability" is greatly in doubt.

Recent relatives: Closely related to recent flying gurnards of the genus *Dactylopterus*.



Dactylopterus sp., a recent flying gurnard.



Scorpaena prior HECKEL (length c. 19 cm) from the Miocene of St. Margarethen, Austria. Original: Weiss Collection, Vienna, Austria. Photograph: Weiss, Vienna.

Genus: *Scorpaena* LINNAEUS, 1758.

Geological range: Miocene to recent.

Geographical distribution: Europe.

Features: Small to middle-sized fishes of plump shape. Head large. Eyes large. Gape very long. Anterior part of the dorsal fin carried by hard rays, the posterior part soft-rayed. Anal fin opposite the posterior part. Pelvic fins under the broad pectoral fins. Caudal fin not forked, rounded.

Remarks: Bottom-dwelling predators. Even at that time the hard fin rays were probably poisonous.

Recent relatives: Closely related to recent scorpionfishes of the genus *Scorpaena*.



Scorpaena notata, a recent scorpionfish.



Pterygocephalus paradoxus AGASSIZ (length c. 5 cm) from the Middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Pterygocephalus* AGASSIZ, 1835.

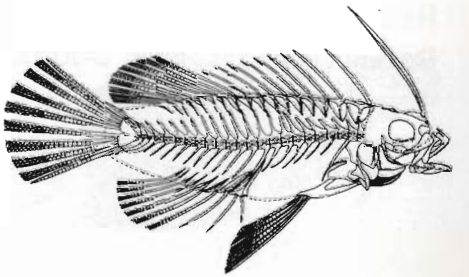
Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Small fishes of rather broad shape. Head shallow. Eyes large. Gape rather long. First head spine longer than second. First dorsal fin of powerful spines. Second dorsal fin rounded, opposite the anal fin which likewise begins with spines. Pectoral fins relatively large. Caudal fin large, not forked, rounded.

Remarks: Predators.

Recent relatives: None. Died out in Eocene



Pterygocephalus, reconstruction after BLOT.



Rhamphosus aculeatus (de BLAINVILLE) (length c. 6 cm) from the Middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Rhamphosus* AGASSIZ, 1835.

Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Small fishes of slender shape. Head shallow. Eyes small. Snout produced to form a pointed rostrum. Long, posteriorly directed spine approximately in the middle of the body. Dorsal fin very posterior, opposite the anal fin. Caudal fin not forked.

Remarks: Probably fed on microorganisms.

Recent relatives: None. Died out in Eocene.



Trigla licatae SAUVAGE (length c. 7 cm) from the Upper Miocene of Licata, Sicily, Italy. Original: Muséum National d'Histoire Naturelle, Paris, France. Photograph: Serette, Paris.

Genus: *Trigla* LINNAEUS, 1758.

Geological range: Eocene to recent.

Geographical distribution: Europe, western Asia, North America, northern Africa.

Features: Small fishes of rather plump shape. Head large. Eyes large. Snout pointed. Gape long. Two dorsal fins, the anterior hard-rayed. Anal fin broad-based. Pectoral fins greatly enlarged. Caudal fin slightly emarginate.

Remarks: Bottom-dwellers.

Recent relatives: Closely related to recent searobins of the genus *Trigla*.



Trigla sp., a recent searobin. Lithograph from BLOCH.



Cottopsis gaudryi (PRIEM) (length c. 10 cm) from the Lower Oligocene of Iran. Original: Muséum National d'Histoire Naturelle, Paris, France. Photograph: Serette, Paris.

Genus: *Cottopsis* PRIEM, 1908.

Geological range: Oligocene.

Geographical distribution: Middle East.

Features: Small fishes of rather laterally compressed shape. Head large. Eyes large. Two dorsal fins, the first in anterior half of body and the second in posterior half. The pectoral fins obliquely opposite the first dorsal fin. The broad-based anal fin opposite the second dorsal fin. Pelvic fins beneath the pectoral fins. Caudal fin forked.

Remarks: Bottom-dwelling predators.

Recent relatives: Genus extinct. Perhaps distantly related to recent sculpins of the family Cottidae.



Cottus brevis AGASSIZ (length c. 5 cm) from the Upper Miocene of Unterkirchberg, Württemberg, Germany. Original: Frickhinger Collection, Munich, Germany.

Genus: *Cottus* LINNAEUS, 1758.

Geological range: Oligocene to recent.

Geographical distribution: Asia, New Zealand, Europe, North America.

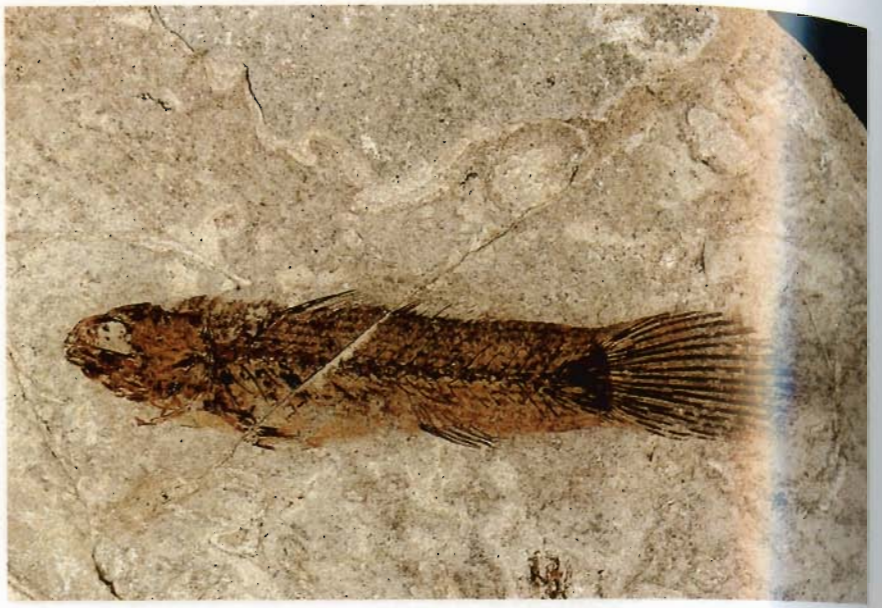
Features: Small fishes with rather laterally compressed shape. Head relatively wide. Two dorsal fins, the anterior being shorter than the posterior. Anal fin opposite the posterior dorsal fin. Pectoral fins large. Caudal fin not forked, rounded.

Remarks: Bottom-dwelling predators.

Recent relatives: Genus extinct. Closely related to recent sculpins of the genus *Cottus*.



Cottus gobio, a recent sculpin.



Eocottus veronensis VOLTA (length c. 9 cm) from the Middle Eocene of Bolca, Italy. Original: The Natural History Museum, London, U.K., (P16131).

Genus: *Eocottus* WOODWARD, 1901.

Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Small fishes of slender outline. Head shallow. Eyes large. Gape long. Two dorsal fins with the anal fin opposite the more posterior. Caudal fin large, not forked, rounded.

Remarks: Probably bottom-dwelling predators.

Recent relatives: Genus extinct. Related to recent sculpins of the genus *Cottus*.



Lepidocottus aries (AGASSIZ) (length c. 8 cm) from the Lower Oligocene of Aix en Provence, France. Original: The Natural History Museum, London, U.K. (P27442).

Genus: *Lepidocottus* SAUVAGE, 1875.

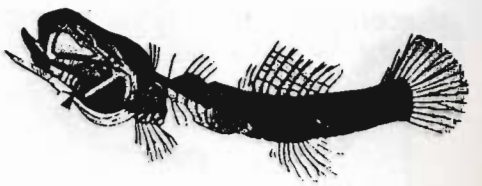
Geological range: Lower Oligocene.

Geographical distribution: Europe.

Features: Small fishes of elongate shape. Head shallow. Eyes large. Snout pointed. Gape long, directed upwards. Two dorsal fins, the first in the anterior and the second in the posterior half of the body. Anal fin opposite the second dorsal fin. Pectoral fins relatively broad. Caudal fin not forked, rounded.

Remarks: Bottom-dwelling predators.

Recent relatives: Genus extinct. Related to recent sculpins of the family Cottidae.



Lepidocottus, reconstruction after ZITTEL.



Unnamed fish (length c. 3.5 cm) from the Eocene of Fuur, Denmark. Original: Paleontologiska Muséet, Uppsala, Sweden.

Genus: Not named.

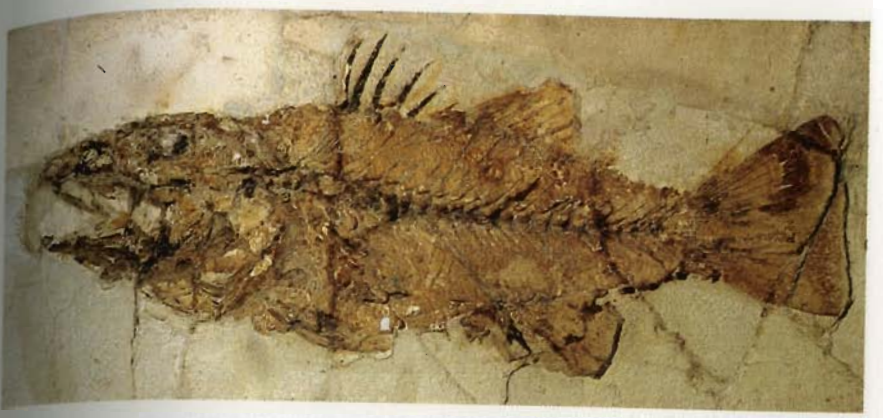
Geological range: Eocene.

Geographical distribution: Europe.

Features: Small fishes of slender shape. Head shallow. Eyes large. Gape long. Upper and lower jaws set with small pointed teeth. Dorsal fin beginning shortly behind the head. Pectoral fins fan-shaped. Pelvic fins opposite them and preceded by free spines. Caudal fin not forked, rounded. A few barbels on the chin.

Remarks: Probably bottom-dwellers.

Recent relatives: Genus presumably extinct. Possibly related to recent fishes of the order Scorpaeniformes.



Cyclopoma gigas AGASSIZ (length c. 40 cm) from the Middle Eocene of Bolca, Italy. Original: Rijksmuseum van Geologie en Mineralogie, Leiden, Netherlands.

Genus: *Cyclopoma* AGASSIZ, 1833.

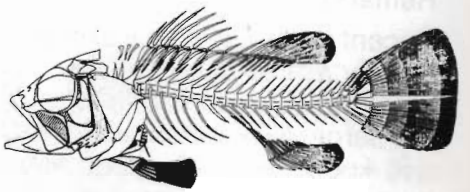
Geological range: Middle Eocene.

Geographical distribution: Europe.

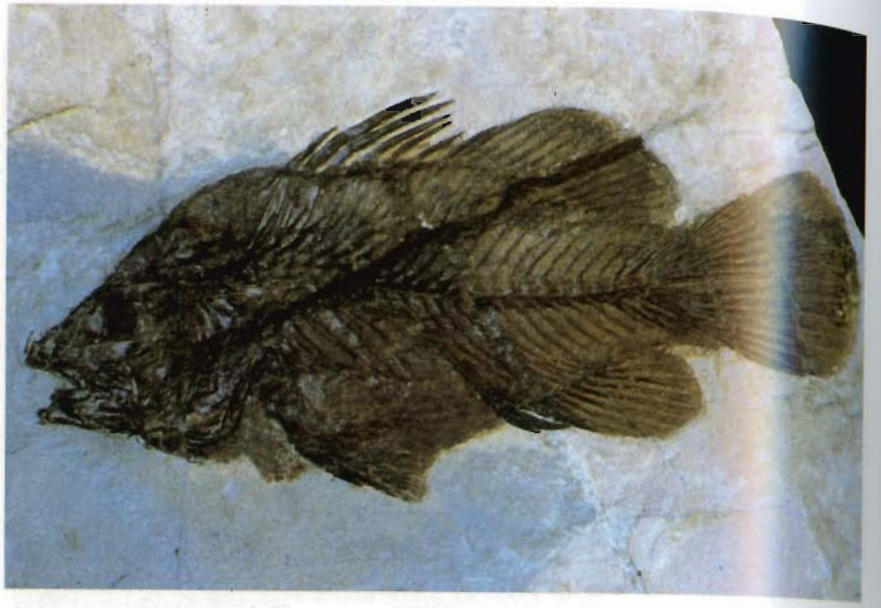
Features: Middle-sized fishes of rather laterally compressed shape. Head shallow. Eyes small. Snout pointed. Gape rather long. Two dorsal fins, the anterior consisting of a few hard rays, the posterior rounded and soft-rayed. Anal fin with three hard rays anteriorly, continuing posteriorly with an elongate, rounded soft-rayed portion. Pelvic fins fan-shaped. Caudal fin, large, rounded, not forked.

Remarks: Predators.

Recent relatives: None. Died out in Eocene.



Cyclopoma, reconstruction after SORBINI.



Eolates gracilis (Agassiz) (length c. 16 cm) from the Middle Eocene of Bolca, Italy. Original: Krauss Collection, Weißenburg, Germany.

Genus: *Eolates* Sorbini, 1970.

Geological range: Eocene.

Geographical distribution: Europe, Africa.

Features: Middle-sized fishes, very laterally compressed in shape. Head shallow. Anterior dorsal fin of hard rays. Second dorsal fin tall, rounded and soft-rayed. Anal fin with a few hard rays anteriorly, continuing posteriorly as an elongate, rounded, soft-rayed portion. Pectoral fins fan-shaped. Caudal fin large, rounded, not forked.

Remarks: Predators.

Recent relatives: Genus extinct. Closely related to recent perches of the genus *Lates*, to which the large Nile perch and the well known Australian food fish barramundi belong. Seven species of this genus live in fresh water and one in the sea.



Lates calcarifer, the barramundi.



Blotichthys coleanus (Agassiz) (length c. 4 cm) from the Middle Eocene of Bolca, Italy. Original: The Natural History Museum, London, U.K. (P5513921).

Genus: *Blotichthys* Sorbini, 1979.

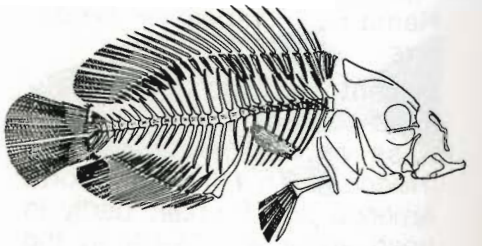
Geological range: Middle Eocene.

Geographical distribution: Europe.

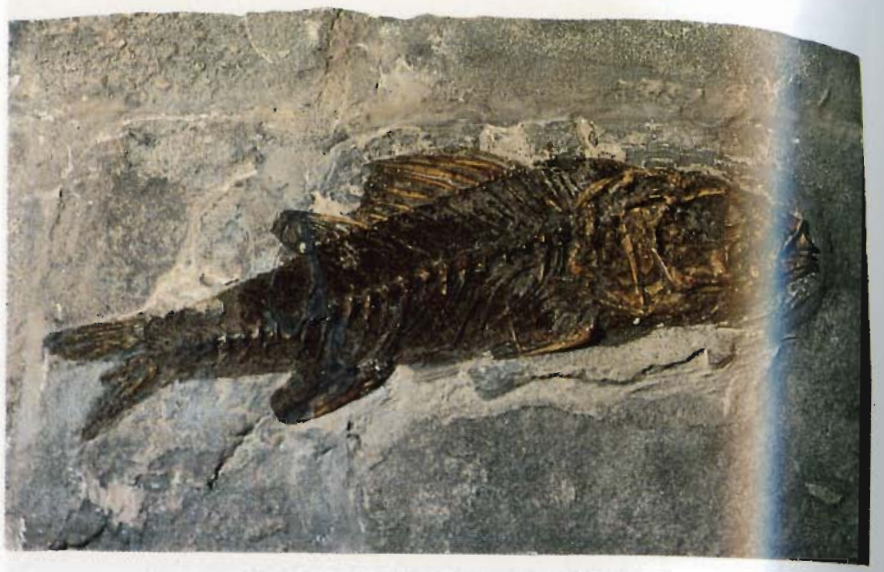
Features: Very small fishes of oval outline, laterally flattened. Head deep. Eyes large. Snout somewhat pointed. Dorsal fins with short hard rays anteriorly, becoming taller and soft-rayed posteriorly. Anal fin shorter but otherwise similar. Pectoral fins small. Pelvic fins rather elongate. Caudal fin rounded, not forked.

Remarks: Predators living in littoral zones.

Recent relatives: None. Died out in Eocene.



Blotichthys, reconstruction after Sorbini.



Morone sp. (length c. 23 cm) from the Oligocene of Wiesbaden, Hesse, Germany. Original: Bürger Collection, Bad Hersfeld, Germany.

Genus: *Morone* Mitchill, 1814.

Geological range: Oligocene to recent.

Geographical distribution: Europe, North America.

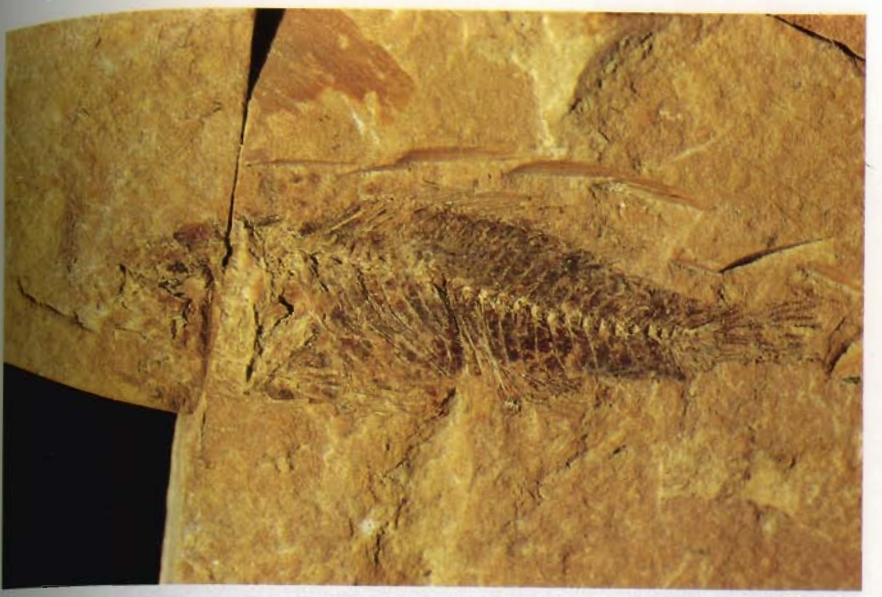
Features: Small to middle-sized fishes of slender shape. Head shallow. Eyes relatively small. Snout slightly pointed. Gape rather long. Anterior dorsal fin consisting of hard-rays, beginning approximately in the middle of the body. Posterior dorsal fin considerably smaller, soft-rayed. Anal fin opposite the posterior dorsal fin, elongate and rounded, with hard rays anteriorly. Pelvic fins beneath the pectoral fins. Caudal fin deeply forked.

Remarks: Fresh-water predators.

Recent relatives: Closely related to recent perches and bass of the genus *Morone* (*Roccus*). This lives in North America and Europe, partly in fresh water and partly in the sea, but it always seeks fresh water to lay its eggs.



Morone americana, the recent white perch.



Percalates sp. (length c. 5 cm) from the Eocene of Queensland, Australia. Original: Queensland Museum, Brisbane, Australia.

Genus: *Percalates* Ramsay & Ogilby, 1887.

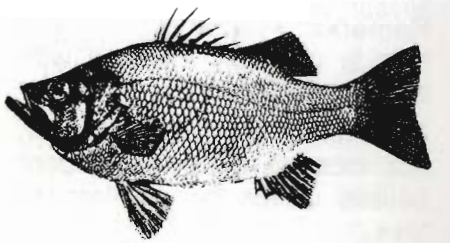
Geological range: Eocene to recent.

Geographical distribution: Australia.

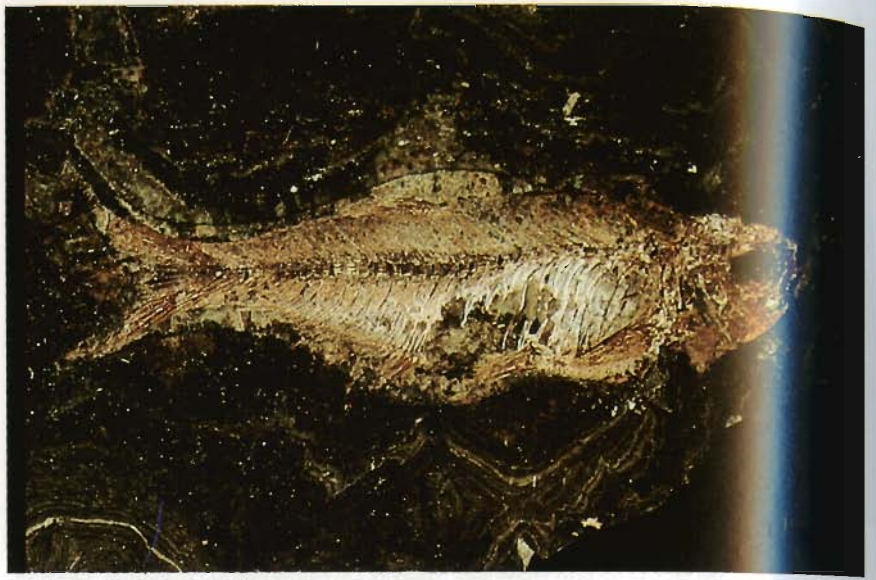
Features: Very small fishes with rather laterally compressed bodies. Head shallow. Eyes small. Snout pointed. Dorsal fin hard-rayed anteriorly, soft-rayed posteriorly. Anal fin similarly with hard rays anteriorly. Pelvic fins vertically beneath the pectoral fins. Caudal fin not forked, slightly emarginate.

Remarks: Bottom-dwellers.

Recent relatives: Genus extinct. Closely related to the recent genus *Percalates* which lives in Australia.



Percalates colonorum, a recent bass.



Percichthys antiquus (length c. 8 cm) from the Miocene of Taubaté, Brazil. Original: Interfoss, Munich, Germany.

Genus: *Percichthys* GIRARD, 1834.

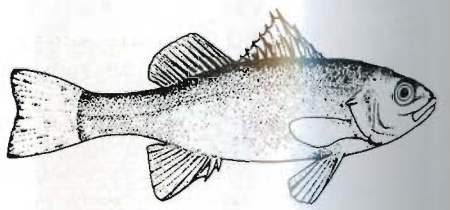
Geological range: Paleocene to recent.

Geographical distribution: South America.

Features: Small fishes with rather laterally compressed bodies. Head deep. Eyes large. Gape rather long. Dorsal fin in the middle of the body, with hard rays anteriorly and soft rays posteriorly. Obliquely opposite the anal fin, which likewise has hard rays anteriorly. Pectoral and pelvic fins small.

Remarks: Predators. *Percichthys* is probably identical with the genus *Santosius*.

Recent relatives: Genus extinct, but closely related to recent basses of the genus *Percichthys*.



Percichthys trucha, a recent bass after ARRATIA.



Santosius antiquus WOODWARD (length c. 12 cm) from the Miocene of Taubaté, Brazil. Original: Naturmuseum Senckenberg, Frankfurt-am-Main, Germany.

Genus: *Santosius* ARRATIA, 1982.

Geological range: Miocene.

Geographical distribution: South America.

Features: Small fishes of slender shape. Head shallow. Eyes large. Snout pointed. Dorsal fin with hard rays anteriorly and posteriorly continuing as a soft-rayed fringe. Pectoral fins very small. Pelvic and anal fins somewhat larger. Caudal fin not forked.

Remarks: Fresh-water predators.

Recent relatives: Genus extinct. Perhaps related to recent basses of the *Percichthys* which live in South America.



Acanus gracilis AGASSIZ (length c. 18 cm) from the Lower Oligocene of Glarus, Switzerland. Original: Tischlinger Collection, Stammham, Germany. Photo: Tischlinger.

Genus: *Acanus* AGASSIZ, 1834.

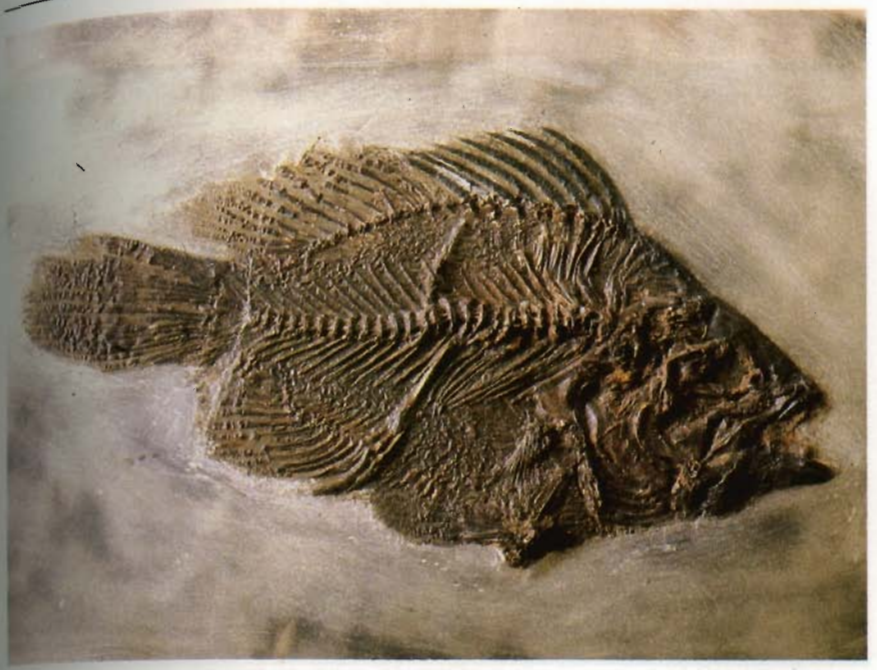
Geological range: Oligocene.

Geographical distribution: Europe.

Features: Small fishes of oval outline, laterally flattened. Head deep. Eyes very large. Snout rather pointed. Gape rather long. Dorsal fin hard-rayed anteriorly and soft-rayed posteriorly. Anal fin likewise with hard rays anteriorly. Pectoral fins small. Pelvic fins somewhat elongate. Caudal fin not forked.

Remarks: Predators. Probably lived in the littoral zones. Recently assigned to the genus *Priacanthus*.

Recent relatives: None. Died out in Oligocene.



Amphiperca multiformis WEITZEL (length c. 20 cm) from the Eocene of Messel, Germany. Original: Frickhinger Collection, Munich, Germany.

Genus: *Amphiperca* WEITZEL, 1933.

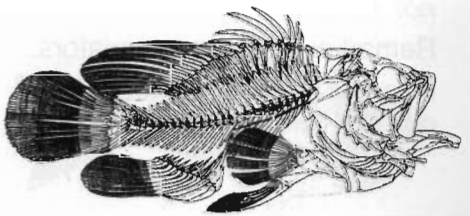
Geological range: Eocene to Miocene.

Geographical distribution: Europe.

Features: Middle-sized fishes with deep, laterally compressed bodies. Head short and deep. Eyes large. Snout pointed. Gape rather long. Anterior dorsal fin consisting of hard rays. Posterior dorsal fin soft-rayed. Anal fin shorter, likewise hard-rayed anteriorly and soft-rayed posteriorly. Pectoral fins small. Pelvic fins vertically beneath and rather broader. Caudal fin rounded, elongate, not forked.

Remarks: Fresh-water predators.

Recent relatives: None. Died out in Miocene.



Amphiperca, reconstruction after MICKLICH.



Blabe crawleyi WHITE (length c. 5 cm) from the Miocene of Tourah, Egypt. Original: The Natural History Museum, London, U.K. (P14486).

Genus: *Blabe* WHITE, 1936.

Geological range: Miocene.

Geographical distribution: Northern Africa.

Features: Very small fishes with oval outline, laterally flattened. Head deep. Eyes large. Snout somewhat pointed. Gape rather long. Dorsal fin with hard rays anteriorly, continuing as a soft-rayed fringe posteriorly. Anal fin shorter, but otherwise similar. Pectoral fins small. Pelvic fins elongate. Caudal fin rounded, not forked.

Remarks: Probably predators.

Recent relatives: None. Died out in Miocene.



Blabe, reconstruction after WHITE.



Dapalis macrurus (AGASSIZ) (length c. 21 cm) from the Oligocene of Cereste, France. Original: Frickhinger Collection, Munich, Germany.

Genus: *Dapalis* GISTLY, 1848.

Synonym: *Smerdis*.

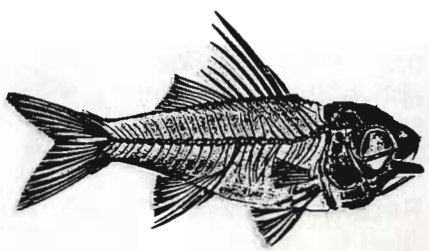
Geological range: Paleocene to Miocene.

Geographical distribution: Europe, northern Africa.

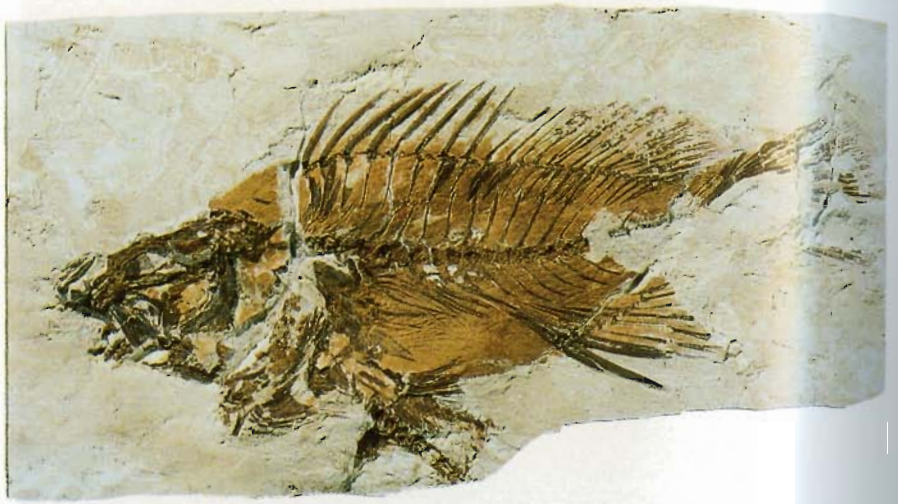
Features: Middle-sized fishes of rather laterally compressed shape. Head deep. Eyes large. Gape rather long. Anterior dorsal fin tall, hard-rayed. Posterior dorsal fin low, triangular and soft-rayed. Anal and pelvic fins triangular. Pectoral fins small. Caudal fin rather deeply forked, with broad lobes.

Remarks: Fresh-water predators.

Recent relatives: None. Died out in Miocene.



Dapalis, reconstruction after WOODWARD.



Epinephelus sp. (length c. 21 cm) from the Miocene of Oran, Algeria. Original: Muséum National d'Histoire Naturelle, Paris, France. Photograph: Serette, Paris.

Genus: *Epinephelus* Bloch, 1793.

Synonym: *Emmachaere*.

Geological range: Miocene to recent.

Geographical distribution: Northern Africa.

Features: Small fishes with rather deep bodies anteriorly, becoming less deep rearwards. Head elongate. Eyes small. Gape rather long. Dorsal fin begins just behind head with hard rays and continues, with soft rays, to near the end of the body. Anal fin likewise hard-rayed anteriorly. Pectoral fins vertically above the pelvic fins. Caudal fin not forked.

Remarks: Predators.

Recent relatives: Closely related to recent groupers of the genus *Epinephelus*.



Epinephelus sp., a recent grouper. Lithograph from Bloch.



Palaeoperca proxima Micklich (length c. 21 cm) from the Eocene of Messel, Hesse, Germany. Original: Staatliches Museum für Naturkunde, Karlsruhe, Germany.

Genus: *Palaeoperca* Micklich, 1978.

Geological range: Eocene.

Geographical distribution: Europe.

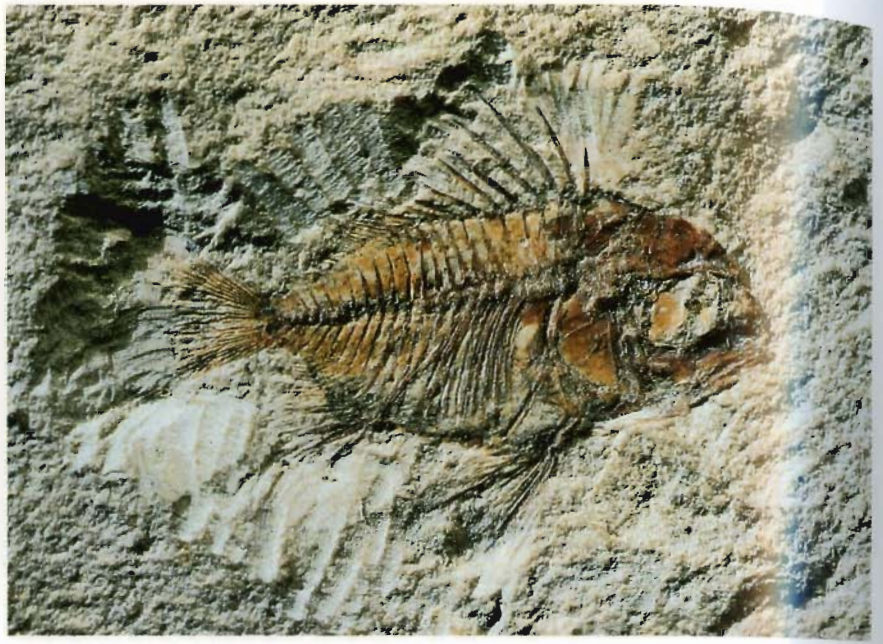
Features: Middle-sized fishes of rather laterally compressed shape. Head deep. Eyes small. Snout pointed. Gape long. Anterior dorsal fin hard-rayed. Posterior dorsal fin triangular and soft-rayed. Anal fin with hard rays anteriorly and soft rays posteriorly. Caudal fin not forked, slightly emarginate.

Remarks: Fresh-water predators.

Recent relatives: None. Died out in Eocene.



Palaeoperca, reconstruction after Micklich.



Priacanthopsis crassispinus ARAMBOURG (length c. 2 cm) from the Lower Oligocene of Iran. Original: Muséum National d'Histoire Naturelle, Paris, France. Photograph: Serette, Paris.

Genus: *Priacanthopsis* ARAMBOURG, 1967.

Geological range: Lower Oligocene to recent.

Geographical distribution: Middle East.

Features: Very small fishes with oval bodies. Head deep. Eyes large. Snout slightly pointed. Gape rather long. Dorsal fin tall and hard-rayed anteriorly, but posteriorly low and soft-rayed. Anal fin similar. Pelvic fins long and narrow. Caudal fin not forked.

Remarks: Probably predators.

Recent relatives: None. Died out in Oligocene.



Prolates heberti GERVAIS (length c. 6 cm) from the Upper Cretaceous of Monte Aimée, France. Original: The Natural History Museum, London, U.K.

Genus: *Prolates* PRIEM, 1899.

Synonym: *Pseudolates*.

Geological range: Upper Cretaceous to Paleocene.

Geographical distribution: Europe.

Features: Small fishes of rather laterally compressed shape. Head shallow. Eyes large. Gape rather long. Dorsal fin hard-rayed anteriorly and soft-rayed posteriorly. Anal fin similar. Pelvic fins likewise with hard rays. Caudal fin rounded, not forked.

Remarks: Predators.

Recent relatives: None. Died out in Paleocene.



Properca angusta (length c. 17 cm) from the Middle Miocene of Puy de Dome, France. Original: The Natural History Museum, London, U.K. (P27736).

Genus: *Properca* SAUVAGE, 1880.

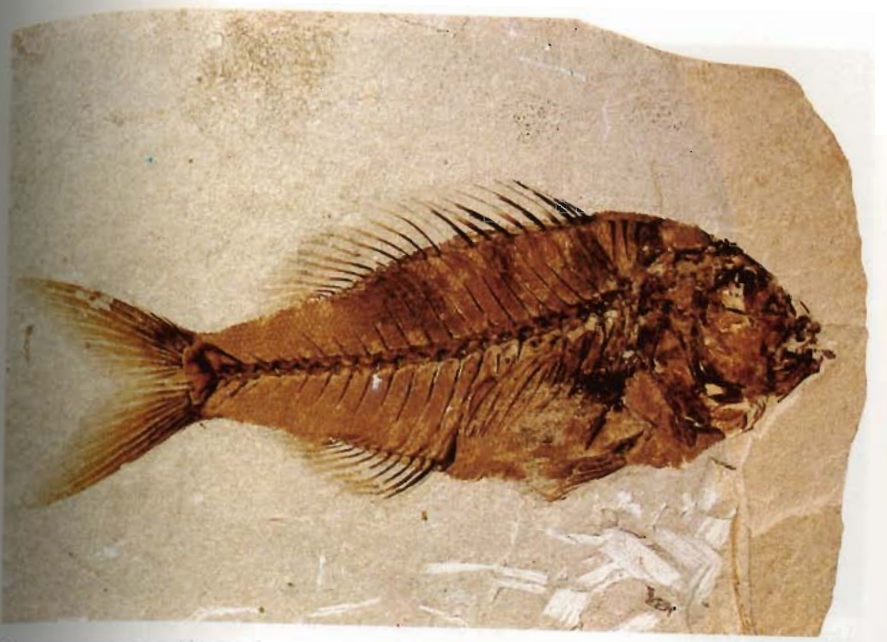
Geological range: Eocene to Miocene.

Geographical distribution: Europe.

Features: Middle-sized fishes with rather laterally compressed bodies. Head shallow. Eyes small. Gape rather long. Dorsal fin low and hard-rayed anteriorly, triangular and soft-rayed posteriorly. Anal fin opposite the posterior part of the dorsal fin. Pelvic fins rounded. Caudal fin not forked, slightly emarginate.

Remarks: Fresh-water fishes.

Recent relatives: None. Died out in Miocene.



Serranus rugosus HECKEL (length c. 14 cm) from the Middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Serranus* CUVIER, 1817.

Geological range: Middle Eocene to recent.

Geographical distribution: Europe, northern Africa.

Features: Small fishes of somewhat laterally compressed shape. Anterior dorsal fin hard-rayed. Posterior dorsal fin rounded, soft-rayed. Anal fin with a few hard rays. Pectoral and pelvic fins rounded. Pelvic fins vertically beneath pectorals. Caudal fin forked.

Remarks: Predators.

Recent relatives: Closely related to recent sea basses of the genus *Serranus*.



Serranus baldwini, a recent sea bass.



Unnamed bass (length c. 3 cm) from the Eocene of Mors, Denmark. Original: Paleontologiska Muséet, Uppsala, Sweden.

Genus: Not named.

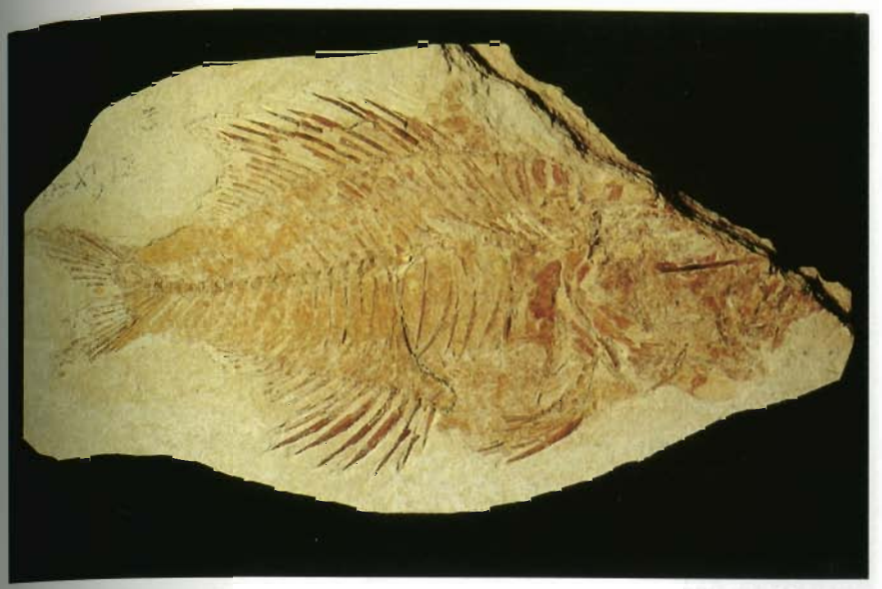
Geological range: Eocene.

Geographical distribution: Europe.

Features: Very small fishes of elongate oval outline, laterally flattened. Head deep. Eyes large. Gape short. Anterior dorsal fin hard-rayed, approximately in the middle of the body. Posterior dorsal fin soft-rayed, in the posterior third of the body, opposite the broad-based anal fin. Pectoral fins narrow. Caudal fin slightly emarginate.

Remarks: Fed on small animals.

Recent relatives: Genus presumably extinct. Possibly related to recent basses of the family Serranidae.



Boreocentrarchus sp. (length c. 13 cm) from the Miocene of Nevada, U.S.A. Original: Field Museum of Natural History, Chicago, Illinois, U.S.A.

Genus: *Boreocentrarchus* SCHLAIKJER, 1937.

Geological range: Miocene.

Geographical distribution: North America.

Features: Small fishes with deep, laterally flattened bodies. Head deep. Eyes large. Gape rather long. Dorsal fin hard-rayed anteriorly but low and soft-rayed posteriorly. Anal fin similar. Pelvic fins vertically beneath pectoral fins. Caudal fin rather deeply forked.

Remarks: Fresh-water fishes.

Recent relatives: Genus extinct. Possibly related to other sunfishes, living in North America, of the family Centrarchidae.



Chaenobryttus kansasensis HIBBARD (length c. 8 cm) from the Miocene of Kansas, U.S.A. Original: Museum of Natural History, Lawrence, Kansas, U.S.A.

Genus: *Chaenobryttus* COPE, 1865.

Geological range: Miocene to recent.

Geographical distribution: North America.

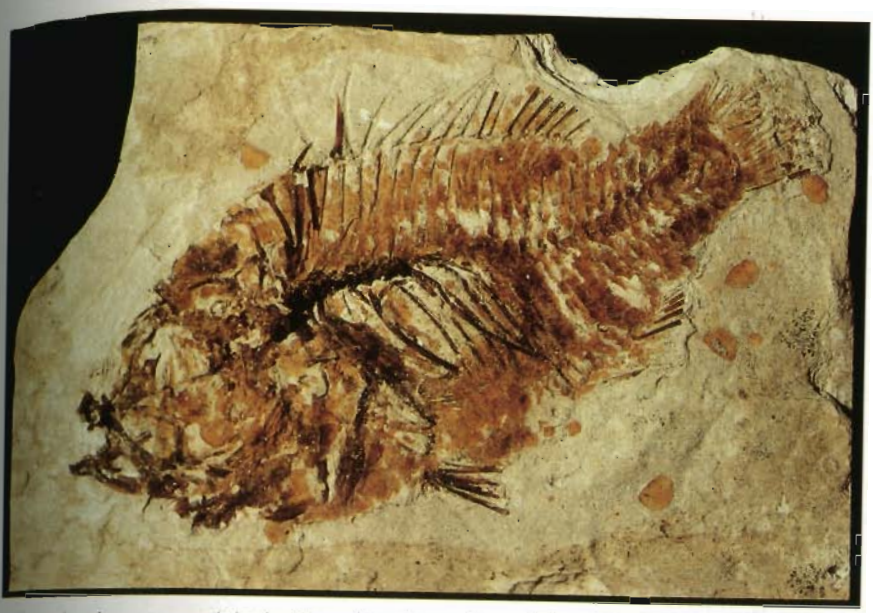
Features: Small fishes of rather laterally compressed shape. Head shallow. Eyes large. Gape rather long. Dorsal fin hard-rayed anteriorly, soft-rayed posteriorly. Anal fin similar. Pelvic fins short, lying vertically beneath the likewise short pectoral fins. Caudal fin not forked, emarginate.

Remarks: Fresh-water fishes.

Recent relatives: Related to recent sunfishes of the genus *Chaenobryttus*.



Chaenobryttus gulosus, a recent sunfish.



Oligoplarchus squamipinnis COPE (length c. 9 cm) from the Oligocene of South Dakota, U.S.A. Original: National Museum of Natural History, Smithsonian Institution, Washington, D.C., U.S.A.

Genus: *Oligoplarchus* COPE, 1891.

Synonym: *Lepomis*.

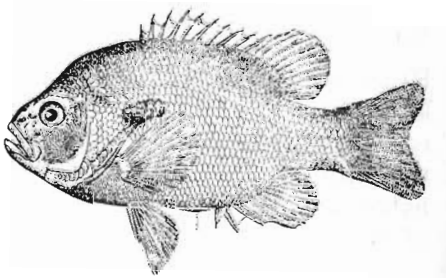
Geological range: Oligocene.

Geographical distribution: North America.

Features: Small fishes of oval outline, laterally flattened. Head deep. Eyes large. Gape rather long. Dorsal fin hard-rayed anteriorly and soft-rayed posteriorly. Anal fin similar. Pelvic and pectoral fins small. Caudal fin not forked.

Remarks: Fresh-water fishes.

Recent relatives: None. Died out in Oligocene.



Oligoplarchus, reconstruction after JORDAN.



Pomoxis lanei HIBBARD (length c. 5 cm) from the Miocene of Kansas, U.S.A. Original: Museum of Natural History, Lawrence, Kansas, U.S.A.

Genus: *Pomoxis* RAFINESQUE, 1818.

Geological range: Miocene to recent.

Geographical distribution: North America.

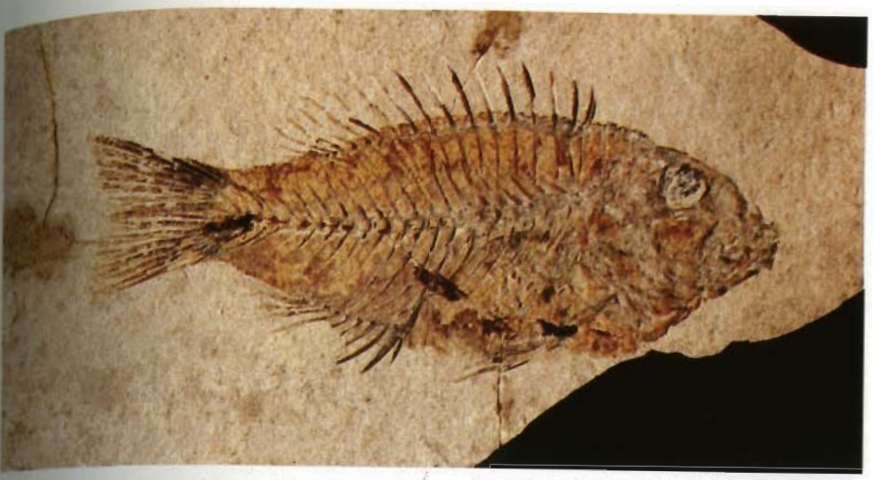
Features: Very small fishes of rather laterally compressed shape. Head deep. Eyes large. Gape short. Anterior dorsal fin hard-rayed. Posterior dorsal fin soft-rayed. Anal fin similar. Pelvic fins small, vertically beneath the pectoral fins which are likewise small. Caudal fin not forked, emarginate.

Remarks: Fresh-water fishes.

Recent relatives: Closely related to the recent sunfishes named crappies and placed in the genus *Pomoxis*. These fishes live in the fresh waters of North America.



Pomoxis nigromaculatus, a recent sunfish.



Dules temnopterus AGASSIZ (length c. 11 cm) from the Middle Eocene of Bolca, Italy. Original: Rijksmuseum van Geologie en Mineralogie, Leiden, Netherlands.

Genus: *Dules* AGASSIZ, 1844.

Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Small fishes of rather laterally compressed shape. Head deep. Eyes large. Gape rather long. Dorsal fin begins shortly behind the head and continues posteriorly as a fringe. Anal fin considerably shorter, but likewise fringe-like. Caudal fin short and broad, not forked, slightly emarginate.

Remarks: Probably predators.

Recent relatives: None. Died out in Eocene.



Mioplosus labracoides Cope (length c. 27 cm) from the Eocene of Wyoming, U.S.A. Original: Interfoss, Munich, Germany.

Genus: *Mioplosus* Cope, 1877.

Geological range: Eocene.

Geographical distribution: North America.

Features: Middle-sized fishes of slender shape. Head shallow. Eyes large. Gape long. Anterior dorsal fin hard-rayed. Posterior dorsal fin soft-rayed, triangular, opposite the anal fin which is likewise triangular. Caudal fin deeply emarginate.

Remarks: Fresh-water predators.

Recent relatives: Genus extinct. Perhaps distantly related to recent pike perches of the genus *Stizostedion*.



Stizostedion lucioperca, the recent pike perch. Lithograph from Bloch (see next page).



Perca fluviatilis LINNAEUS (length c. 21 cm) from the Upper Pliocene of Willershausen, Lower Saxony, Germany. Original: Staatliches Museum für Naturkunde, Stuttgart, Germany.

Genus: *Perca* LINNAEUS, 1758.

Synonyms: *Coeloperca*, *Eoperca*, *Percostoma*.

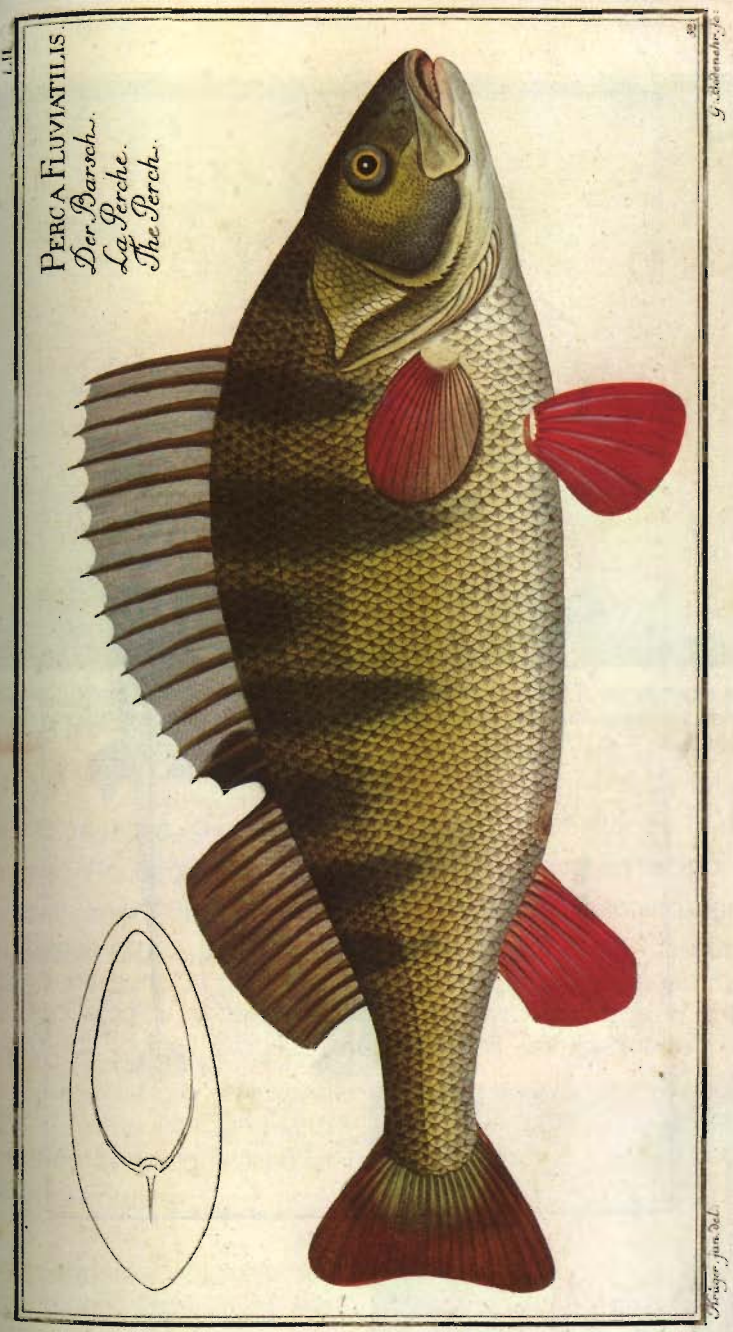
Geological range: Eocene to recent.

Geographical distribution: Europe, North America, western Asia.

Features: Small to middle-sized fishes of slender shape. Head shallow. Eyes large. Gape long. Anterior dorsal fin hard-rayed, arcuate. Posterior dorsal fin soft-rayed. Anal fin narrow. Pectoral fins rounded. Pelvic fins elongate. Caudal fin deeply emarginate.

Remarks: Predators.

Recent relatives: The fossil species is identical to the recent one.



Perca fluviatilis, the recent perch. Lithograph from BLOCH (see next page).



Plioplarchus whitei Cope (length c. 7 cm) from the Oligocene of North Dakota, U.S.A. Original: National Museum of Natural History, Smithsonian Institution, Washington, D.C., U.S.A.

Genus: *Plioplarchus* Cope, 1883.

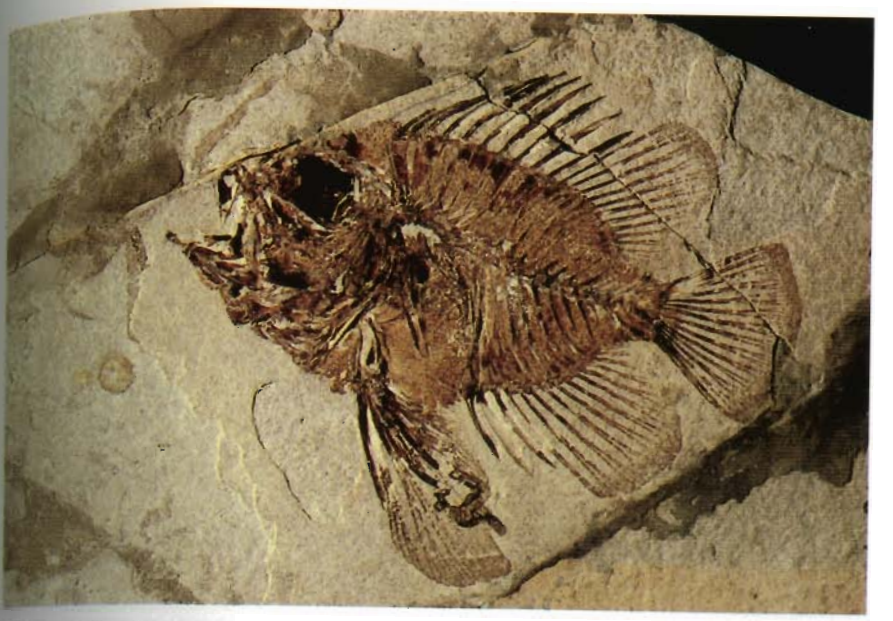
Geological range: Eocene to recent.

Geographical distribution: Europe, North America.

Features: Small fishes with rather laterally compressed bodies. Head deep. Eyes large. Gape rather long. Dorsal fin hard-rayed anteriorly and soft-rayed posteriorly. Anal fin similar but shorter. Pelvic and pectoral fins elongate. Caudal fin not forked, rather emarginate.

Remarks: Predators.

Recent relatives: Closely related to recent perches of the genus *Plioplarchus*.



Pristigenys substriatus Eastman (length c. 6 cm) from the Middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Pristigenys* Agassiz, 1835.

Synonyms: *Pseudopriacanthos*

Geological range: Eocene to recent.

Geographical distribution: Europe.

Features: Small fishes of oval outline, laterally flattened. Head deep. Eyes large. Gape rather long. Dorsal and anal fins very large, hard-rayed anteriorly and soft-rayed posteriorly. Pectoral fins small. Pelvic fins long and narrow. Caudal fin not forked.

Remarks: Probably lived near reefs.

Recent relatives: Closely related to recent bigeyes of the genus *Pristigenys* which live in modern oceans.



Pristigenys altus, a recent bigeye.



Apogon spinosus Agassiz (length c. 4 cm) from the Middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Apogon* de Lacépède, 1802.

Synonym: *Eretima*.

Geological range: Middle Eocene to recent.

Geographical distribution: Europe, North America.

Features: Small fishes of rather laterally compressed shape. Head deep. Eyes large. Gape rather long. Anterior dorsal fin hard-rayed. Posterior dorsal fin soft-rayed. Both relatively tall. Anal fin expanded on a narrow base. Rounded pectoral and pelvic fins. Caudal fin not forked.

Remarks: Lived in coral reefs like their recent relatives.

Recent relatives: None. Died out in Miocene. Genus extinct. Closely related to cardinalfishes of the genus *Apogon*.



Apogon maculatus, a recent cardinalfish.



Eosphaeramia margaritae Sorbini (length c. 4 cm) from the Middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Eosphaeramia* Sorbini, 1983.

Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Small fishes of oval outline, laterally flattened. Head deep. Eyes large. Gape rather long. Anterior dorsal fin very tall, hard-rayed. Posterior dorsal fin considerably lower, soft-rayed. Anal fin hard-rayed anteriorly and soft-rayed posteriorly. Pectoral fins small. Pelvic fins very long. Caudal fin forked with broad lobes.

Remarks: Reef-dwellers.

Recent relatives: Genus extinct. Possibly related to recent cardinalfishes of the genus *Apogon*.



Apogon nematopterus, a recent cardinalfish.



Acropoma lepidotus (Agassiz) (length c. 3 cm) from the Middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Acropoma* Temminck & Schlegel, 1843.

Synonym: *Labrax*.

Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Very small fishes of oval outline, rather rounded in transverse section. Head deep. Eyes large. Gape short. Two dorsal fins, the posterior one opposite the anal fin. Caudal fin rather deeply forked, with broad lobes.

Remarks: The genus *Acropoma* is placed by some authors in the family Percichthyidae.

Recent relatives: Closely related to recent members of the genus *Acropoma*.



Acropoma sp., a recent representative.



Lednevia oligocenica (Smirnov) (length c. 5 cm) from the Lower Miocene of the northern Caucasus, C.I.S. Original: Paleontologicheskii Muzei Russkoi Akademii Nauk, Moscow, Russia (Bannikov Collection).

Genus: *Lednevia* Daniltchenko, 1960.

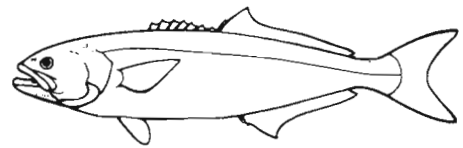
Geological range: Miocene.

Geographical distribution: Western and eastern Europe.

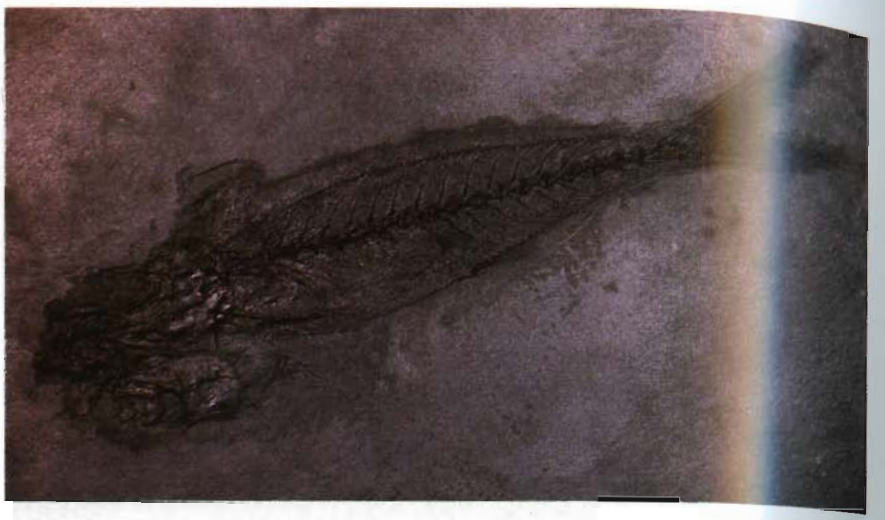
Features: Small fishes of slender shape. Head deep. Eyes large. Gape long, directed slightly upwards. Dorsal fins begin approximately in the middle of the body, the first being hard-rayed and the second soft-rayed. Anal fin opposite the second dorsal fin. Caudal fin relatively large, emarginate.

Remarks: Predators.

Recent relatives: Genus died out in Miocene. Perhaps related to recent bluefishes of the family Pomatomidae.



Pomatomus saltatrix, a recent bluefish, after Nelson.



Echineis glaronensis WETTSTEIN (length c. 28 cm) from the Lower Oligocene of Glarus, Switzerland. Original: Paläontologisches Museum, Zürich, Switzerland.

Genus: *Echineis* LINNAEUS, 1758.

Geological range: Oligocene to recent.

Geographical distribution: Europe.

Features: Middle-sized fishes of slender elongate shape. Head shallow. Eyes small. Gape rather long. A characteristic oval sucker on the head. Dorsal fin in the posterior half of the body, fringe-like. Anal fin likewise fringe-like. Caudal fin rather deeply forked.

Remarks: Probably attached itself to larger fishes, even at that time.

Recent relatives: Closely related to recent remoras of the genus *Echineis* which live nowadays in the oceans.



Echineis sp., a recent remora.



Archaeus sp. (length c. 7 cm) from the Oligocene of Wiesloch, Baden, Germany. Original: Staatliches Museum für Naturkunde, Karlsruhe, Germany.

Genus: *Archaeus* AGASSIZ, 1834.

Synonym: *Archaeoides*.

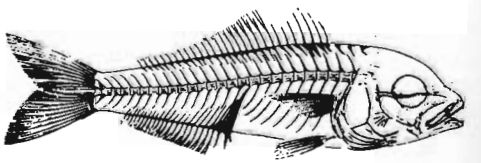
Geological range: Oligocene to Miocene.

Geographical distribution: Europe.

Features: Small fishes of elongate oval outline, laterally flattened. Head deep. Eyes large. Gape rather long. Anterior dorsal fin hard-rayed. Posterior dorsal fin soft-rayed. Anal fin low and fringe-like. Caudal fin rather deeply forked.

Remarks: Probably gregarious.

Recent relatives: None. Died out in Miocene.



Archaeus, reconstruction after Akademia Nauk, Moscow.



Carangopsis dorsalis AGASSIZ (length c. 32 cm) from the Middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Carangopsis* AGASSIZ, 1844.

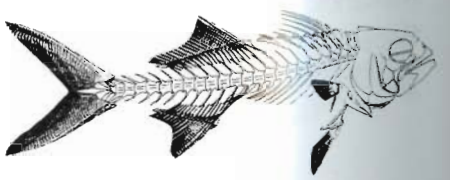
Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Small fishes with slender outline, deeper anteriorly than posteriorly. Head shallow. Eyes small. Gape rather long. Anterior dorsal fin hard-rayed. Posterior dorsal fin soft-rayed, rather fringe-like. Pectoral fins pointed. Caudal deeply forked, with narrow lobes.

Remarks: Predators.

Recent relatives: None. Died out in Eocene.



Carangopsis, reconstruction after BLOT.



Caranx ovalis HECKEL (length c. 11 cm) from the Oligocene of Chiavon, Italy. Original: Naturhistorisches Museum, Vienna, Austria.

Genus: *Caranx* de LACÉPÈDE, 1802.

Synonyms: *Citula*, *Perequula*.

Geological range: Middle Eocene to recent.

Geographical distribution: Europe, North America, northern Africa.

Features: Small fishes of oval outline, laterally flattened. Head deep. Eyes large. Gape rather long. Dorsal fins small, the first hard-rayed and the second soft-rayed. Anal fin low and fringe-like. Caudal fin forked, with narrow lobes.

Remarks: Probably gregarious.

Recent relatives: Closely related to recent jacks of the genus *Caranx*, the most important of which is the yellow jack.



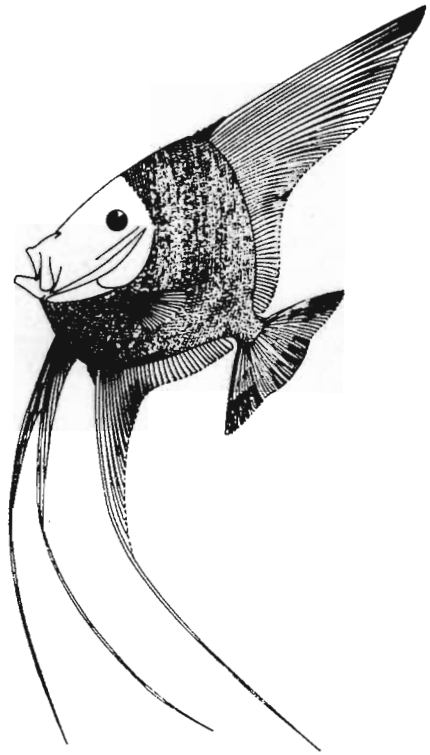
Caranx bartholomaei, the recent yellow jack.



Ceratoichthys pinnatiformis de BLAINVILLE (length c. 50 cm) from the Middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

EUTELEOSTEI
Order: Perciformes
Family: Carangidae

Higher Bony Fishes
Suborder: Percoidei
Jacks and Pompanos



Ceratoichthys, reconstruction after BLOT.

Genus: *Ceratoichthys* BLOT, 1969.

Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Middle-sized fishes, broadly oval in outline and laterally flattened. Head deep. Eyes small. Gape short. Dorsal fin begins with a few hard rays and rises steeply to a high point, then decreases in height with a posteriorly convex curve and continues rearwards as a low fringe. Anal fin with a long first ray, but then becoming rapidly less tall in a posteriorly concave curve and likewise passing into a low fringe. Pelvic fins drawn out into two long filaments. Pectoral fins small. Caudal fin not forked, with an undulating posterior margin.

Remarks: Probably open-water fishes.

Recent relatives: None. Died out in Eocene.



Ductor vestenae VOLTA (length c. 11 cm) from the Middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Ductor* AGASSIZ, 1844.

Geological range: Middle Eocene.

Geographical distribution: Europe.

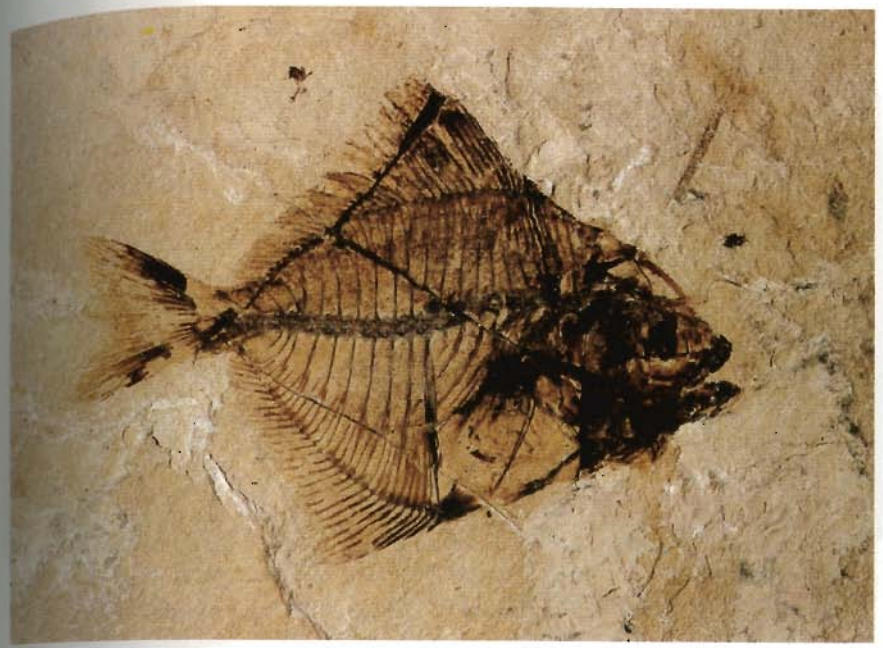
Features: Small fishes of slender elongate shape. Head shallow. Eyes small. Snout pointed. Gape rather long. Jaws set with small teeth. Anterior dorsal fin of a few hard rays. Posterior dorsal fin soft-rayed and fairly high, running off into a fringe. Anal fin similar. Pectoral and pelvic fins narrow, set close together. Caudal fin rather deeply forked, with broad lobes.

Remarks: Gregarious.

Recent relatives: None. Died out in Eocene.



Ductor, reconstruction after BLOT.



Paratrachinotus tenuiceps AGASSIZ (length c. 9 cm) from the Middle Eocene of Bolca, Italy. Original: Bayerisches Staatssammlung für Paläontologie, Munich, Germany.

Genus: *Paratrachinotus* BLOT, 1969.

Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Small fishes of approximately lozenge-shaped outline, laterally flattened. Head deep. Eyes large. Gape rather long. Dorsal fin with a few hard rays anteriorly, rises to a point approximately in the middle of the body and then continues rearwards as a low fringe. Anal fin similarly constructed and of same length. Pectoral fins rounded. Caudal fin rather deeply forked.

Remarks: Probably fed partly on plants.

Recent relatives: Related to recent pompanos of the genus *Trachinotus*.



Trachinotus carolinus, the recent Florida pompano.



Seriola prisca AGASSIZ (length c. 22 cm) from the Middle Eocene of Bolca, Italy. Original: Interfoss, Munich, Germany.

Genus: *Seriola* CUVIER, 1817.

Synonyms: *Carangopsis*, *Lichia*, *Micropteryx*.

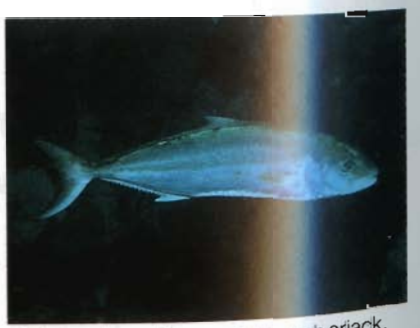
Geological range: Middle Eocene to recent.

Geographical distribution: Europe, North America, northern Africa.

Features: Middle-sized fishes of slender elongate shape. Head elongate. Eyes small. Gape rather long. Dorsal fin begins shortly behind the head with hard rays, but more posteriorly is soft-rayed, at first rising to a point and then continuing as a low fringe. Anal fin likewise fringe-like. Pectoral and pelvic fins elongate and pointed. Caudal fin forked, with broad lobes.

Remarks: Gregarious.

Recent relatives: Closely related to recent amberjacks of the genus *Seriola*.



Seriola dumerilii, a recent amberjack.



Trachurus primaevus EASTMAN (length c. 7 cm) from the Middle Eocene of Bolca, Italy. Original: The Natural History Museum, London, U.K. (P 17493)

Genus: *Trachyurus* de LACÉPÈDE, 1802.

Geological range: Middle Eocene.

Geographical distribution: Europe, northern Africa.

Features: Small fishes with elongate, rather laterally compressed bodies. Head shallow. Eyes small. Snout pointed. Gape rather long. Dorsal fin hard-rayed anteriorly and soft-rayed posteriorly. Pelvic fins small and fan-shaped. Caudal fin rather deeply forked.

Remarks: Predators. Has been reclassified into the genus *Eastmanalepes*.

Recent relatives: Closely related to recent jack mackerels of the genus *Trachurus*.



Trachurus trachurus, a recent jack mackerel. Lithograph from BLOCH.



Vomeropsis triurus VOLTA (length c. 20 cm) from the Middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Vomeropsis* HECKEL, 1854.

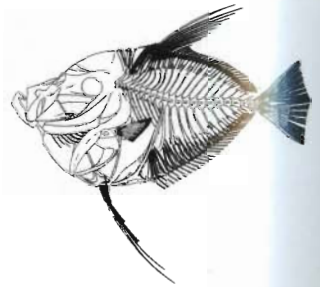
Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Middle-sized fishes of oval outline, laterally flattened. Head deep. Eyes small. Gape rather long. Dorsal fin begins approximately in the middle of the body at a tall point and continues posteriorly as a low fringe. Anal fin likewise low and fringe-like. Pectoral fins small, obliquely fan-shaped. Pelvic fins with long and short hard rays. Caudal fin broad, not forked, with an obtuse point in the middle and emarginate above and below the point.

Remarks: Probably durophagous.

Recent relatives: None. Died out in Eocene.



Vomeropsis, reconstruction after BLOT.



Mene rhombea VOLTA (length c. 31 cm) from the Middle Eocene of Bolca, Italy. Original: Interfoss, Munich, Germany.



Mene maculata, a recent moonfish. Lithograph from CUVIER.

Genus: *Mene* de LACÉPÈDE, 1803.

Synonym: *Gasteronemus.*

Geological range: Paleocene to recent.

Geographical distribution: Europe, northern Africa.

Features: Middle-sized fishes of rounded, deep-bellied outline, laterally flattened. Head deep. Eyes large. Gape rather long. Dorsal fin begins with a point at the highest part of the body and continues rearwards as a very low fringe. Pectoral fins narrow. Pelvic fins transformed into two long filaments. Caudal fin narrow, not forked, very slightly emarginate.

Remarks: Probably open-water fishes.

Recent relatives: Closely related to the recent of *Mene maculata*, which lives today as a pelagic fish in the Pacific Ocean.



Leiognathus altapinnus (WEILER) (length c. 9 cm) from the Lower Oligocene of northern Caucasus C.I.S. Original: Paleontologicheskii Muzei Russkoi Akademii Nauk, Moscow, Russia.

Genus: *Leiognathus* de LACÉPÈDE, 1803.

Synonym: *Equula*.

Geological range: Oligocene to recent.

Geographical distribution: Western and eastern Europe.

Features: Small fishes with rather high-backed bodies. Head short and deep. Eyes large. Anterior dorsal fin beginning at the highest point of the body, hard-rayed. Posterior dorsal fin soft-rayed, almost fringe-like, opposite the anal fin which is likewise hard-rayed anteriorly. Caudal fin large, deeply forked.

Remarks: Predators.

Recent relatives: Closely related to recent slipmouths of the genus *Leiognathus*.



Leiognathus sp., a recent slipmouth.



Brama sp. (length c. 19 cm) from the Pliocene of Fiume Marecchia, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Brama* Bloch & Schneider, 1801.

Geological range: Pliocene to recent.

Geographical distribution: Europe.

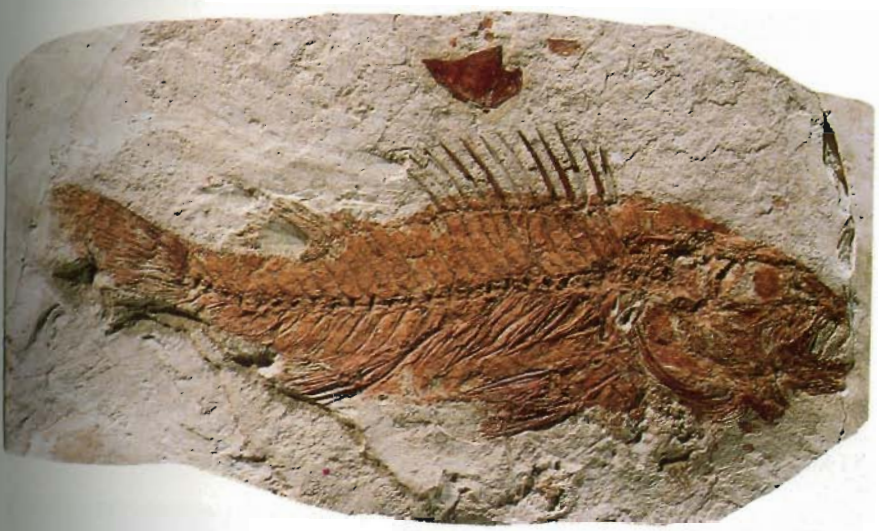
Features: Middle-sized fishes of rounded outline, laterally flattened. Head deep. Eyes large. Snout pointed. Gape short. Dorsal fin hard-rayed anteriorly and rising to a point, continuing posteriorly as a low fringe. Anal fin similar. Pectoral fins long and narrow. Caudal fin forked.

Remarks: Fed on plants.

Recent relatives: Closely related to recent pomfrets of the genus *Brama*.



Brama sp., a recent pomfret. Lithograph from Bloch.



Parapristipoma prohumile Arambourg (length c. 20 cm) from the Miocene of Oran, Algeria. Original: Muséum National d'Histoire Naturelle, Paris, France. Photograph: Serette, Paris.

Genus: *Parapristipoma* Bleeker, 1872.

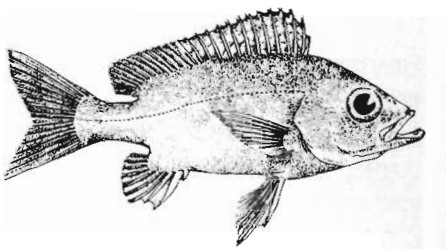
Geological range: Miocene to recent.

Geographical distribution: Northern Africa.

Features: Small fishes with rather deep bodies anteriorly. Head deep. Eyes large. Gape rather long. Dorsal fin beginning shortly behind the head, hard-rayed anteriorly, soft-rayed posteriorly and continuing almost to the end of the body. Anal fin opposite the posterior end of the dorsal fin. Pectoral fins elongate. Pelvic fins hard-rayed. Caudal fin forked.

Remarks: Predators.

Recent relatives: Closely related to recent grunts of the genus *Parapristipoma*.



Parapristipoma pumile, a recent grunt, after Whitehead.



Pomadasys furcatus (Agassiz) (length c. 10 cm) from the Middle Eocene of Bolca, Italy. Original: Naturhistorisches Museum, Vienna, Austria.

Genus: *Pomadasys* de Lacépède, 1802.

Synonym: *Pristipoma*.

Geological range: Eocene to recent.

Geographical distribution: Europe, northern Africa.

Features: Small fishes with oval outline, laterally flattened. Head deep. Eyes large. Gape rather long. Jaws set with pointed teeth. Dorsal fin hard-rayed anteriorly, soft-rayed and fringe-like posteriorly. Anal fin similar, but smaller. Caudal fin broad, not forked.

Remarks: Probably gregarious.

Recent relatives: Closely related to recent grunts of the genus *Pomadasys*, which now live in the oceans.



Pomadasys kaakan, a recent grunt.



Boops sp. (length c. 12 cm) from the Pliocene of Fiume Marecchia, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Boops* Cuvier, 1814.

Synonym: *Box*.

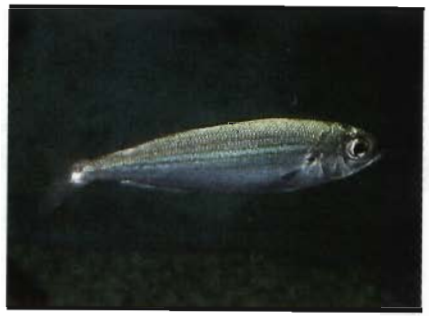
Geological range: Pliocene to recent.

Geographical distribution: Europe.

Features: Middle-sized fishes of elongate outline but rather plump. Head deep. Eyes large. Snout rounded. Gape short. Dorsal fin hard-rayed anteriorly, soft-rayed posteriorly. Anal fin similar, but considerably smaller. Pelvic fins vertically beneath the narrow pectoral fins. Caudal fin deeply forked.

Remarks: Probably fed essentially on plants.

Recent relatives: None. Died out in Miocene. Genus extinct. Closely related to recent porgies of the genus *Boops*.



Boops boops, a recent porgy.



Ctenodentex laekeniensis (van Beneden) (length c. 30 cm) from the Upper Eocene of Heembeek, Belgium. Original: Musée Royal des Sciences Naturelles de Belgique, Brussels, Belgium.

Genus: *Ctenodentex* Storms, 1897.

Geological range: Eocene.

Geographical distribution: Europe, northern Africa.

Features: Middle-sized fishes of high-backed outline, laterally flattened. Head short and deep. Eyes large. Snout pointed. Gape rather long. Jaws set with powerful teeth. Dorsal fin low, hard-rayed anteriorly and soft-rayed and fringe-like posteriorly. Anal fin similar but shorter. Pelvic fins long and pointed. Caudal fin somewhat forked, with broad lobes.

Remarks: Probably gregarious.

Recent relatives: None. Died out in Eocene.



Dentex microdon Agassiz (length c. 16 cm) from the Middle Eocene of Bolca, Italy. Original: Bayerische Staatssammlung für Paläontologie, Munich, Germany.

Genus: *Dentex* Cuvier, 1815.

Geological range: Eocene to recent.

Geographical distribution: Europe, northern Africa, New Zealand.

Features: Small to middle-sized fishes with laterally compressed bodies. Head deep. Eyes large. Gape rather long. Jaws set with powerful teeth. Dorsal fin hard-rayed anteriorly, soft-rayed and fringe-like posteriorly. Anal fin similar but smaller. Pectoral fins long and fan-shaped. Caudal fin deeply forked, with broad lobes.

Remarks: Probably gregarious.

Recent relatives: None. Died out in Miocene. Genus extinct. Closely related to recent porgies of the genus *Dentex*.



Dentex sp., a recent porgy. Lithograph from Bloch.



Diplodus oranensis (Woodward) (length c. 14 cm) from the Miocene of Oran, Algeria. Original: Muséum National d'Histoire Naturelle, Paris, France. Photograph: Serette, Paris.

Genus: *Diplodus* Rafinesque, 1810.

Synonym: *Sargus*.

Geological range: Eocene to recent.

Geographical distribution: Europe, northern Africa, Australia, North America.

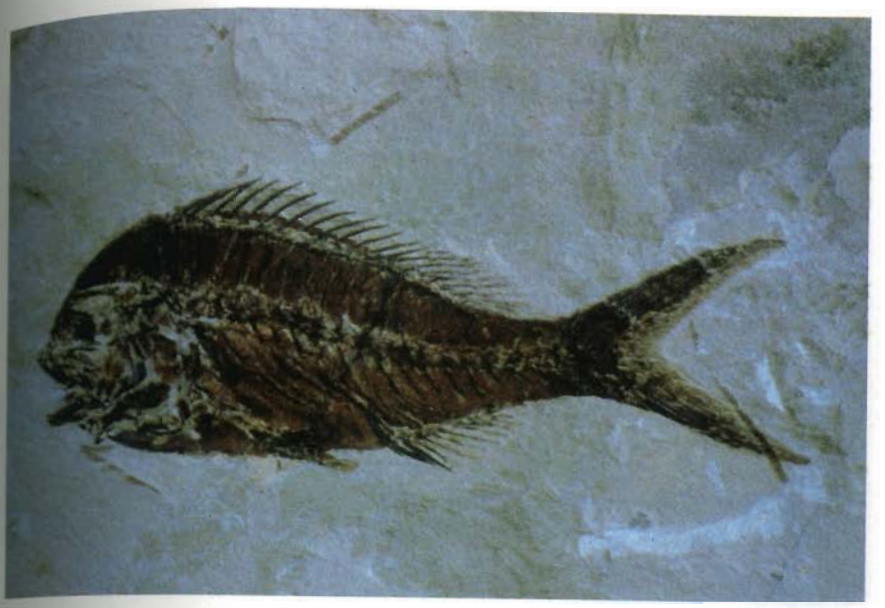
Features: Small to middle-sized fishes of broadly oval outline, laterally flattened. Head deep. Eyes small. Gape rather long. Jaws with teeth. Snout slightly pointed. Dorsal fin begins shortly behind the head, hard-rayed anteriorly, soft-rayed posteriorly and continuing almost to the end of the body. Most anterior ray of the anal fin spine-like. Pectoral fins elongate. Pelvic fins small. Caudal fin forked.

Remarks: Gregarious.

Recent relatives: Closely related to recent porgies of the genus *Diplodus*.



Diplodus sargus, a recent porgy.



Pagellus microdon Agassiz (length c. 24 cm) from the Middle Eocene of Bolca, Italy. Original: Interfoss, Munich, Germany.

Genus: *Pagellus* Griffith & Smith, 1834.

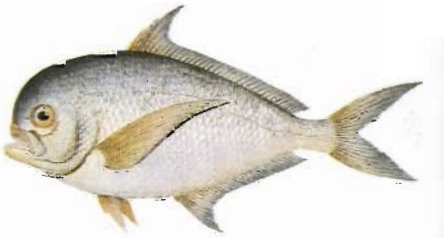
Geological range: Paleocene to recent.

Geographical distribution: Europe, New Zealand.

Features: Middle-sized fishes with rather laterally compressed bodies. Head deep. Eyes large. Gape rather long. Dorsal fin begins at the highest point of the body, hard-rayed anteriorly, soft-rayed posteriorly. Anal fin likewise hard-rayed anteriorly. Pelvic fins small. Pectoral fins long and narrow. Caudal fin deeply forked, with narrow lobes.

Remarks: Gregarious.

Recent relatives: Closely related to recent porgies of the genus *Pagellus* which live in the oceans.



Pagellus sp., a recent porgy. Lithograph from Bloch.



Pagrus mauretanicus ARAMBOURG (length c. 33 cm) from the Miocene of Oran, Algeria. Original: Muséum National d'Histoire Naturelle, Paris, France. Photograph: Serette, Paris.

Genus: *Pagrus* CUVIER, 1817.

Geological range: Paleocene to recent.

Geographical distribution: Europe, northern Africa.

Features: Middle-sized fishes of elongate oval outline, laterally flattened. Head deep. Eyes large. Snout pointed. Jaws set with conical teeth. Anal fin small. Pelvic fins elongate. Pectoral fins fan-shaped. Caudal fin forked, with broad lobes.

Remarks: Gregarious.

Recent relatives: Closely related to recent porgies of the genus *Pagrus*.



Pagrus sp., a recent porgy. Lithograph from BLOCH.



Rythmias starrii JORDAN & GILBERT (length c. 18 cm) from the Miocene of California, U.S.A. Original: National Museum of Natural History, Smithsonian Institution, Washington, D.C., U.S.A.

Genus: *Rythmias* JORDAN & GILBERT, 1920.

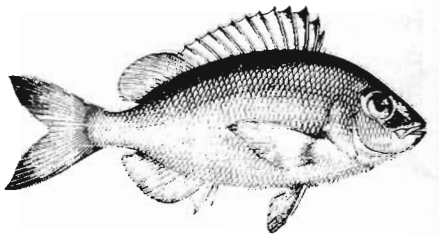
Geological range: Miocene.

Geographical distribution: North America.

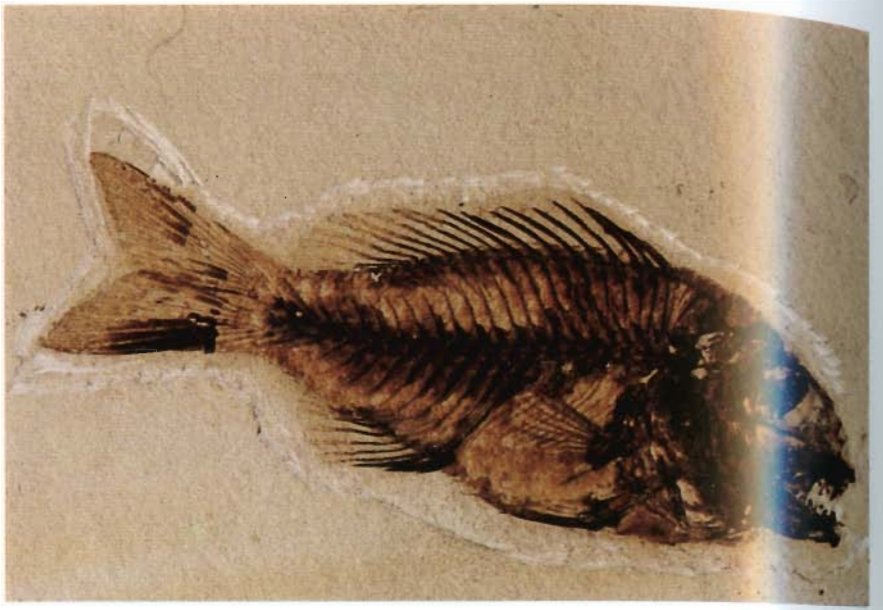
Features: Small to middle-sized fishes of laterally compressed shape. Head deep. Eyes large. Dorsal fin hard-rayed anteriorly and soft-rayed posteriorly. Anal fin similar. Pectoral fins long and pointed. Caudal fin rather deeply forked.

Remarks: Probably gregarious.

Recent relatives: None. Died out in Miocene.



Rhythmias, reconstruction after JORDAN.



Sparnodus vulgaris Agassiz (length c. 14 cm) from the Middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Sparnodus* Agassiz, 1835.

Geological range: Eocene to Miocene.

Geographical distribution: Europe.

Features: Small to middle-sized fishes of rather laterally compressed shape. Head deep. Eyes large. Gape short. Jaws set with powerful teeth. Dorsal fin low, hard-rayed anteriorly, soft-rayed and fringe-like posteriorly. Anal fin similar, but considerably shorter. Pectoral fins fan-shaped. Caudal fin rather deeply forked with broad lobes.

Remarks: Probably gregarious.

Recent relatives: Genus extinct. Related to porgies of the family Sparidae.



Sparus sp. (length c. 43 cm) from the Miocene of Overland Corner, South Australia. Original: South Australian Museum, Adelaide, Australia.

Genus: *Sparus* Linnaeus, 1758.

Synonyms: *Aurata*, *Chrysophrys*.

Geological range: Eocene to recent.

Geographical distribution: West Indies, Europe, northern Africa, Australia.

Features: Middle-sized fishes with rather laterally compressed bodies. Head deep. Eyes large. Gape short. Dorsal fin hard-rayed anteriorly, low and soft-rayed anteriorly. Pectoral fins long and pointed. Caudal fin rather forked, with relatively broad lobes.

Remarks: Gregarious.

Recent relatives: Related to recent porgies of the genus *Sparus* which live in oceans.



Sparus auratus, the recent golden porgy. Lithograph from Bloch.



Lompoquia retropes JORDAN & GILBERT (length c. 27 cm) from the Miocene of California, U.S.A. Original: National Museum of Natural History, Smithsonian Institution, Washington, D.C., U.S.A.

Genus: *Lompoquia* JORDAN & GILBERT, 1919.

Geological range: Miocene.

Geographical distribution: North America.

Features: Middle-sized fishes of elongate slender shape. Head shallow. Eyes small. Snout pointed. Anterior dorsal fin hard-rayed. Posterior dorsal fin soft-rayed, opposite the anal fin. Pelvic and pectoral fins elongate. Caudal fin slightly emarginate.

Remarks: Gregarious.

Recent relatives: Genus extinct. Possibly related to recent croakers of the family Sciaenidae.



Lompoquia, reconstruction after JORDAN.



Sciaena knyrkoi DANILTCHENKO (length c. 14 cm) from the Upper Miocene of the northern Caucasus, C.I.S. Original: Paleontologicheskii Muzei Russkoi Akademii Nauk, Moscow, Russia (Bannikov Collection).

Genus: *Sciaena* LINNAEUS, 1758.

Synonym: *Sciaenops*.

Geological range: Upper Miocene to recent.

Geographical distribution: Western and eastern Europe, North America.

Features: Middle-sized fishes of slender outline, rather deeper in middle of body. Head shallow. Snout slightly pointed. Gape rather long. Anterior dorsal fin low and hard-rayed. Posterior dorsal fin soft-rayed and likewise low. Anal fin small, opposite the posterior dorsal fin. Caudal fin, not forked, rhombic.

Remarks: Predators.

Recent relatives: Related to recent croakers of the genus *Sciaena*.



Sciaena sp., a recent croaker. Lithograph from BLOCH.



Mullus moldavicus SVITCHENSKAYA (length c. 8 cm) from the Upper Miocene of Moldavia, C.I.S. Original: Paleontologicheskii Muzei Russkoi Akademii Nauk, Moscow, Russia (Bannikov Collection).

Genus: *Mullus* LINNAEUS, 1758.

Geological range: Miocene to recent.

Geographical distribution: Europe, western Asia.

Features: Small fishes of slender elongate shape. Head shallow. Eyes large. Snout pointed. Anterior dorsal fin hard-rayed, situated in the anterior half of the body. Posterior dorsal fin soft-rayed, opposite the anal fin. Pectoral and pelvic fins narrow. Caudal fin rather deeply forked.

Remarks: Gregarious.

Recent relatives: Related to recent goatfishes of the genus *Mullus* which live in the oceans.



Mullus surmuletus, a recent goatfish.



Pasaichthys pleuronectiformes BLOT (length c. 6 cm) from the Middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Pasaichthys* BLOT, 1969.

Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Small fishes of rounded oval outline, laterally compressed. Head deep. Eyes large. Gape short. Dorsal fin begins in the anterior half of the body, increases gently in height and then passes rearwards into a fringe which extends to the root of the tail. Anal fin similar, but shorter. Pectoral fins rounded. Pelvic fins small. Caudal fin large, not forked, posterior margin regularly concave.

Remarks: Fed partly on plants.

Recent relatives: Genus extinct. Perhaps related to recent fingerfishes of the family Monodactylidae which are represented by three genera and five species in modern oceans.



Monodactylus argenteus, the recent mono.



Psettopsis subarcuatus de BLAINVILLE (length c. 45 cm) from the Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Psettopsis* BLOT, 1969.

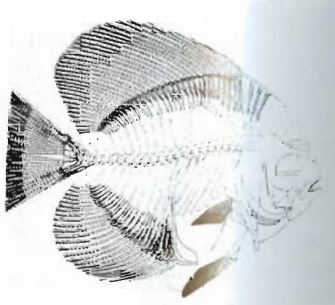
Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Middle-sized fishes of rounded oval outline, laterally flattened. Head deep. Eyes large. Gape short. Dorsal fin tall, extending in an arc over the whole of the back. Anal fin likewise tall and arcuate. Caudal fin large, triangular and not forked.

Remarks: Fed at least partly on plants.

Recent relatives: Genus extinct. Perhaps related to recent fingerfishes of the family Monodactylidae which are represented by three genera and about five species in modern oceans.



Psettopsis, reconstruction after BLOT.



Toxotes antiquus (AGASSIZ) (length c. 11 cm) from the Middle Eocene of Bolca, Italy. Original: Naturhistorisches Museum, Vienna, Austria.

Genus: *Toxotes* EASTMAN, 1914.

Geological range: Middle Eocene.

Geographical distribution: Europe.

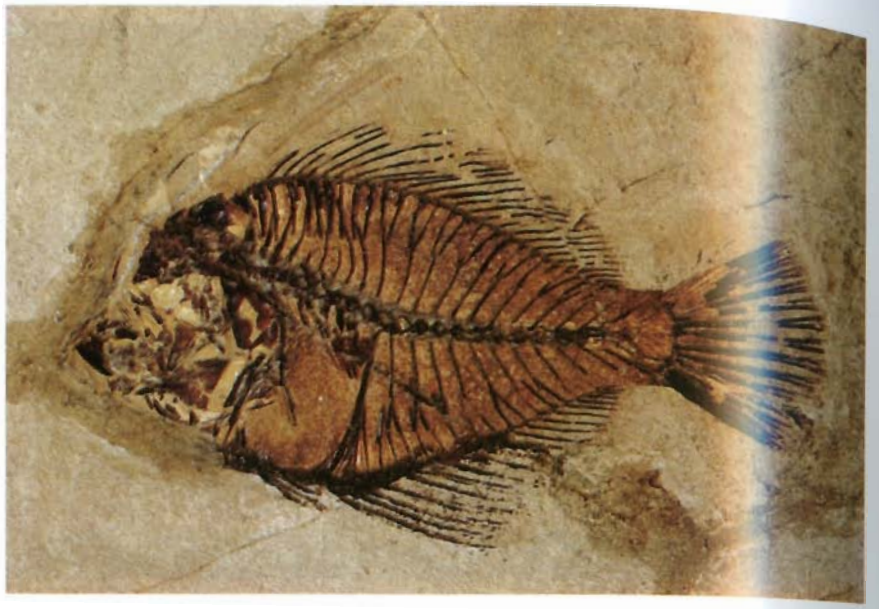
Features: Small fishes of elongate oval outline. Head deep. Eyes large. Snout pointed. Gape long. Dorsal fin approximately in the middle of the body, hard-rayed anteriorly. Soft-rayed part lower, opposite the anal fin. Caudal fin somewhat forked, with broad lobes.

Remarks: The generic name *Toxotes* is disputed, but the ascription to the family Toxotidae nevertheless seems certain.

Recent relatives: Perhaps related to recent archerfishes of the genus *Toxotes* which is represented by six species, mainly in warm brackish waters.



Toxotes jaculatrix, a recent archerfish.



Amphistium paradoxum AGASSIZ (length c. 6 cm) from the Middle Eocene of Bolca, Italy. Original: Interfoss, Munich, Germany.

Genus: *Amphistium* AGASSIZ, 1844.

Synonyms: *Macrostoma*, *Woodwardichthys*.

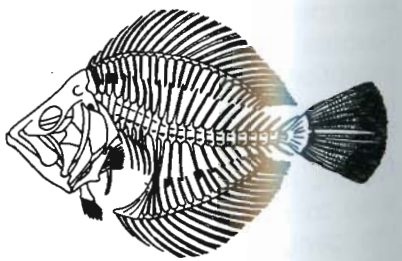
Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Small fishes of rounded oval outline, laterally flattened. Head deep. Eyes small. Snout pointed. Dorsal fin extending in an arc over the whole of the back. Anal fin similar. Pelvic and pectoral fins very small. Caudal fin large, elongate, unforked and rounded.

Remarks: Probably predators.

Recent relatives: None. Died out in Eocene.



Amphistium, reconstruction after EASTMAN.



Archaephippus asper VOLTA (length c. 38 cm) from the Middle Eocene of Bolca, Italy. Original: Naturhistorisches Museum, Vienna, Austria.

Genus: *Archaephippus* BLOT, 1969.

Synonym: *Ephippus*.

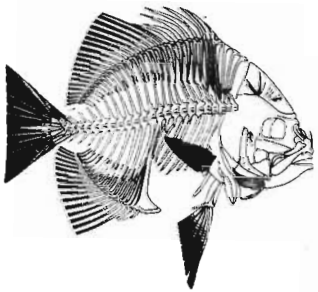
Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Middle-sized fishes of rounded oval outline, laterally flattened. Head deep. Eyes large. Gape short. Anterior dorsal fin hard-rayed. Posterior dorsal fin soft-rayed, at first increasing in height and then decreasing in a gentle curve. Anal fin similar to the posterior dorsal fin and opposite. Pectoral fins narrow and pointed. Pelvic fins long and pointed. Caudal fin not forked.

Remarks: Fed at least partly on plants.

Recent relatives: Genus extinct. Perhaps related to recent spadefishes of the family Ephippidae which is represented by three genera and twelve species in modern oceans.



Archaephippus, reconstruction after BLOT.



Ephippus longipennis AGASSIZ (length c. 11 cm) from the Middle Eocene of Bolca, Italy. Original: Bayerische Staatssammlung für Paläontologie, Munich, Germany.

Genus: *Ephippus* CUVIER, 1817.

Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Small fishes of almost circular outline, laterally flattened. Head deep. Eyes small. Gape short. Anterior dorsal fin hard-rayed. Posterior dorsal fin soft-rayed, in its anterior part taller than the anterior dorsal fin. Anal fin opposite, with hard spines. Caudal fin not forked.

Remarks: Predators.

Recent relatives: Related to recent spadefishes of the genus *Ephippus* which live in warm seas.



Ephippus faber, a recent spadefish.



Exellia velifer (VOLTA) (length c. 14 cm) from the Middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Exellia* WHITE & MOY-THOMAS, 1941.

Synonym: *Semiophorus*.

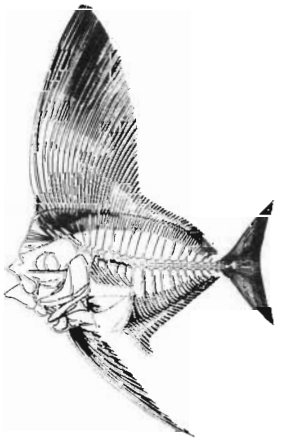
Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Middle-sized fishes of oval outline, laterally flattened. Head deep. Eyes large. Gape short. Dorsal fin begins anteriorly with a few hard rays, becomes rapidly taller and flag-like, reaching double the height of the body, then sharply decreases again in height, extending as a fringe to the root of the tail. Anal fin fringe-like, with a short point anteriorly. Pectoral fins small. Pelvic fins long, narrow and tapering to a point. Caudal fin not forked, narrow and slightly emarginate.

Remarks: Fed, at least partly, on plants.

Recent relatives: None. Died out in Eocene.



Exellia, reconstruction after BLOT.



Eoplatax papilio (VOLTA) (length c. 62 cm) from the Middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.



Platax orbicularis, the recent orbiculate batfish.

Genus: *Eoplatax* BLOT, 1969.

Synonym: *Platax*.

Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Middle-sized fishes almost circular in outline, laterally flattened. Head deep. Eyes small. Gape short. Dorsal fin begins with short hard rays, increases in height to more than the height of the body, then decreases steeply in height to near the root of the tail. Anal fin similar in size and shape. Pelvic and pectoral fins small. Caudal fin small, not forked, somewhat rounded.

Remarks: Open-water predators.

Recent relatives: Genus extinct. Related to recent batfishes of the genus *Platax*, three species of which live in warm seas.



Scatophagus frontalis Agassiz (length c. 12 cm) from the Middle Eocene of Bolca, Italy. Original: Interfoss, Munich, Germany.

Genus: *Scatophagus* Cuvier & Valenciennes, 1830.

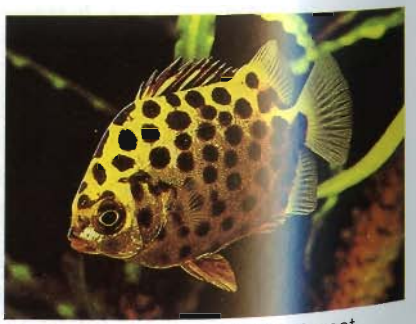
Geological range: Eocene to recent.

Geographical distribution: Europe.

Features: Small high-backed fishes, laterally flattened. Head deep and short. Eyes large. Anterior dorsal fin begins at highest point of the body, hard-rayed. Posterior dorsal fin soft-rayed, opposite the anal fin which has hard rays anterior to it. Pectoral fins rounded. Pelvic fins small, with two hard rays.

Remarks: Probably already lived partly on live prey and partly on detritus.

Recent relatives: Closely related to recent scats of the genus *Scatophagus* which live in warm seas and brackish water.



Scatophagus argus, a recent scat.



Chaetodon ficheuri Arambourg (length c. 18 cm) from the Upper Miocene of Oran, Algeria. Original: Muséum National d'Histoire Naturelle, Paris, France. Photograph: Serette, Paris.

Genus: *Chaetodon* Linnaeus, 1758.

Geological range: Oligocene to recent.

Geographical distribution: Europe.

Features: Small fishes of oval outline, laterally flattened. Head short and deep. Eyes small. Snout pointed. Gape rather long. Dorsal fin fringe-like, with hard rays anteriorly and soft rays posteriorly. Anal fin similar but shorter. Pelvic and pectoral fins small. Caudal fin not forked.

Remarks: The systematic position of this fish in the family Chaetodontidae is disputed.

Recent relatives: Perhaps closely related to recent butterflyfishes.



Chaetodon semilarvatus, a recent butterflyfish.



Pygaeus gazolai (Massalongo) (length c. 8 cm) from the Middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Pygaeus* Agassiz, 1838.

Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Small fishes of circular outline, laterally flattened. Head deep. Eyes large. Upper and lower jaws produced to form an obvious rostrum. Anterior dorsal fin begins at the highest part of the body with a point formed from hard rays, contiguous with the posterior dorsal fin which is soft-rayed and likewise pointed. Anal fin with hard rays anteriorly, running off into a soft-rayed fringe. Pectoral fins small. Pelvic fins elongate. Caudal fin not forked.

Remarks: Probably fed on corals and associated small organisms.

Recent relatives: None. Died out in Eocene.



Enoplosus pygopterus Agassiz (length c. 4 cm) from the Middle Eocene of Bolca, Italy. Original: Museum National d'Histoire Naturelle, Paris, France. Photograph: Serette, Paris, France.

Genus: *Enoplosus* de Lacépède, 1803.

Geological range: Eocene to recent.

Geographical distribution: Europe.

Features: Small fishes with rather laterally compressed bodies. Head deep. Eyes large. Snout slightly pointed. Gape rather long. Two separate dorsal fins, the first hard-rayed entirely and the second hard-rayed anteriorly. Anal fin broad-based. Pelvic fins fan-shaped. Pectoral fins rounded. Caudal fin broad, slightly forked.

Remarks: Probably fed mainly on plants.

Recent relatives: Related to recent fishes of the genus *Enoplosus*.



Enoplosus armatus, the oldwife fish.



Pentaceros sakhalinicus GRETCHINA (length c. 8 cm) from the Miocene of Sakhalin, Siberia, C.I.S. Original: Paleontologicheskii Muzei Russkoi Akademii Nauk, Moscow, Russia.

Genus: *Pentaceros* CUVIER, 1829.

Geological range: Miocene to recent.

Geographical distribution: Eastern Asia.

Features: Small fishes of rounded oval outline, laterally flattened. Head deep. Eyes large. Snout pointed. Anterior dorsal fin tall, hard-rayed. Posterior dorsal fin soft-rayed, rounded. Anal fin likewise accompanied by hard rays.

Remarks: Predators.

Recent relatives: Closely related to recent armourheads of the genus *Pentaceros*.



Pentaceros sp., a recent armourhead. Lithograph from CUVIER.



Geophagus priscus (WOODWARD) (length c. 12 cm) from the Miocene of Maranhao, Brazil. Original: The Natural History Museum, London, U.K. (P25258).

Genus: *Geophagus* HECKEL, 1840.

Synonym: *Macracara*.

Geological range: Miocene.

Geographical distribution: South America, northern Africa.

Features: Small fishes with rather laterally compressed bodies. Head deep. Eyes small. Snout pointed. Dorsal fin anteriorly tall and fringe-like, more posteriorly projecting into a point. Anal fin large, with the middle ray elongated. Pectoral and pelvic fins long and narrow. Caudal fin not forked or weakly emarginate.

Remarks: Like their recent relatives, probably chewed through the bottom mud looking for food.

Recent relatives: Closely related to recent members of the genus *Geophagus*.



Geophagus sp., a recent "earth eater".



Tilapia fossilis WHITE (length c. 10 cm) from the Pleistocene of Askati, Kenya. Original: The Natural History Museum, London, U.K. (P19089-4).

Genus: *Tilapia* SMITH, 1840.

Geological range: Pliocene to recent.

Geographical distribution: Africa.

Features: Small fishes with laterally compressed bodies. Head large. Eyes large. Gape short. Dorsal fin low and fringe-like anteriorly but becoming taller posteriorly. Anal fin likewise decreasing in height posteriorly. Pectoral fins narrow. Caudal fin not forked.

Remarks: Probably fed on plants.

Recent relatives: Closely related to the recent African cichlids of the genus *Tilapia*.



Tilapia buttikoferi, the recent zebra tilapia.



Unnamed cichlid (length c. 8 cm) from the Pliocene of Castellaro, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: Not named.

Geological range: Pliocene.

Geographical distribution: Europe.

Features: Small fishes of oval outline, laterally flattened. Head deep. Eyes large. Snout rounded. Gape short. Dorsal fin hard-rayed anteriorly, soft-rayed posteriorly. Anal fin similar but shorter. Pelvic fins narrow, vertically beneath the broader pectoral fins. Caudal fin rounded, not forked.

Remarks: Probably lived in brackish water and fed on plants.

Recent relatives: Related to recent members of the family Cichlidae.



Unnamed fish (length c. 16 cm) from the Eocene of Vicenza, Italy. Original: Leonhardt Interfoss, Munich, Germany.

Genus: Not named.

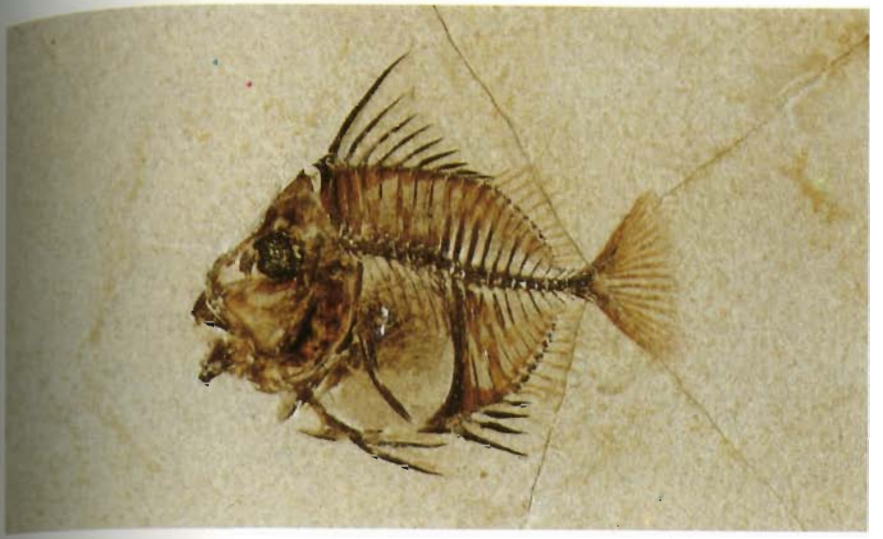
Geological range: Eocene.

Geographical distribution: Europe.

Features: Small to middle-sized fishes of oval outline, laterally flattened. Head deep. Eyes small. Gape short. Dorsal fin begins shortly behind the head, hard-rayed anteriorly, soft-rayed posteriorly. Anal fin large and rounded. Pelvic fins narrow. Pectoral fins small. Caudal fin broad, not forked.

Remarks: Probably fed on plants.

Recent relatives: None. Died out in Eocene.



Odonteus pygmaeus de Zigno (length c. 5 cm) from the Middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Odonteus* Agassiz, 1835.

Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Small fishes of circular outline, laterally flattened. Head deep. Eyes large. Gape rather long. Anterior dorsal fin of powerful spines, the first one being disproportionately long. Posterior dorsal fin soft-rayed and fringe-like. Anal fin likewise accompanied by powerful spines. Caudal fin, not forked, slightly rounded.

Remarks: Lived in coral reefs and probably fed on small animals.

Recent relatives: Related to recent damselfishes of the family Pomacentridae which are represented by 28 genera and about 335 species in the reefs of tropical seas.



Dascyllus melanurus, a recent damselfish.



Priscacara liops Cope (length c. 13 cm) from the Eocene of Wyoming, U.S.A. Original: Pabst Collection, Zürich, Switzerland.

Genus: *Priscacara* Cope, 1877.

Geological range: Eocene.

Geographical distribution: North America.

Features: Small to middle-sized fishes of oval outline, laterally flattened. Head deep. Eyes large. Gape rather long. Anterior dorsal fin hard-rayed. Posterior dorsal fin soft-rayed and rounded. Anal fin rounded, associated with hard rays. Caudal fin not forked, slightly rounded.

Remarks: The genus *Priscacara* is placed by some authors in the family Percichthyidae and by others in the family Cichlidae. They were fresh-water fishes.

Recent relatives: None. Died out in Miocene. Genus extinct. Perhaps related to cichlids (family Cichlidae).



Dipterichthys leptosomus Arambourg (length c. 11 cm) from the Lower Oligocene of Iran. Original: Muséum National d'Histoire Naturelle, Paris, France. Photograph: Serette, Paris.

Genus: *Dipterichthys* Arambourg, 1939.

Geological range: Oligocene.

Geographical distribution: Middle East.

Features: Small fishes of elongate slender outline. Head shallow and elongate. Eyes large. Snout pointed. Gape long. The two dorsal fins relatively far apart from each other. Anal fin opposite the posterior dorsal fin. Pectoral fin narrow, almost vertically above the pelvic fins. Caudal fin forked.

Remarks: Predators.

Recent relatives: None. Died out in Oligocene.



Arambourgella cephala (HECKEL) (length c. 16 cm) from the Middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Arambourgella* BLOT, 1981.

Synonym: *Carangodes*.

Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Small to middle-sized fishes with laterally compressed bodies. Head large. Eyes large. Gape long. Dorsal fin with steep anterior slope and rounded posterior slope. Anal fin and pectoral fins large. Caudal fin stalked and deeply forked, with relatively broad lobes.

Remarks: Predators.

Recent relatives: None. Died out in Eocene.



Ottaviania mariae SORBINI (length c. 14 cm) from the Middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Ottaviania* SORBINI, 1983.

Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Small fishes with slender bodies. Head deep. Eyes rather large. Gape long. Anterior dorsal fin begins just behind the head, fringe-like, consisting of powerful spines. Posterior dorsal fin small, soft-rayed. Caudal fin deeply forked, with narrow lobes.

Remarks: Predators.

Recent relatives: None. Died out in Eocene.



Ruffoichthys spinosus SORBINI (length c. 6 cm) from the Middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Ruffoichthys* SORBINI, 1983.

Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Small fishes of slender outline, rather deep in the middle of the body but less so posteriorly. Head shallow. Eyes small. Gape rather long. Anterior dorsal fin consisting of well separated hard spines. Posterior dorsal fin small and soft-rayed. Caudal fin stalked.

Remarks: Predators.

Recent relatives: None. Died out in Eocene.



Unnamed fish (length c. 9 cm) from the Middle Eocene of Bolca, Italy. Original: Paläontologisches Museum Zürich, Switzerland.

Picture on the previous page.

Genus: Not named.

Geological range: Eocene to recent.

Geographical distribution: Europe.

Features: Small fishes of almost lozenge-shaped outline, laterally flattened. Head deep. Eyes large. Snout pointed. First ray of the dorsal fin disproportionately elongate, as also the first ray of the pelvic fins. Caudal fin stalked, triangular, slightly forked.

Remarks: Probably still-water predators.

Recent relatives: None. Died out in Eocene.



Mugil princeps Agassiz (length c. 8 cm) from the Oligocene of Sodom, Israel. Original: Naturhistoriska Riksmuseet, Stockholm, Sweden.

Genus: *Mugil* Linnaeus, 1758.

Geological range: Eocene to recent.

Geographical distribution: Europe, northern Africa, western Asia.

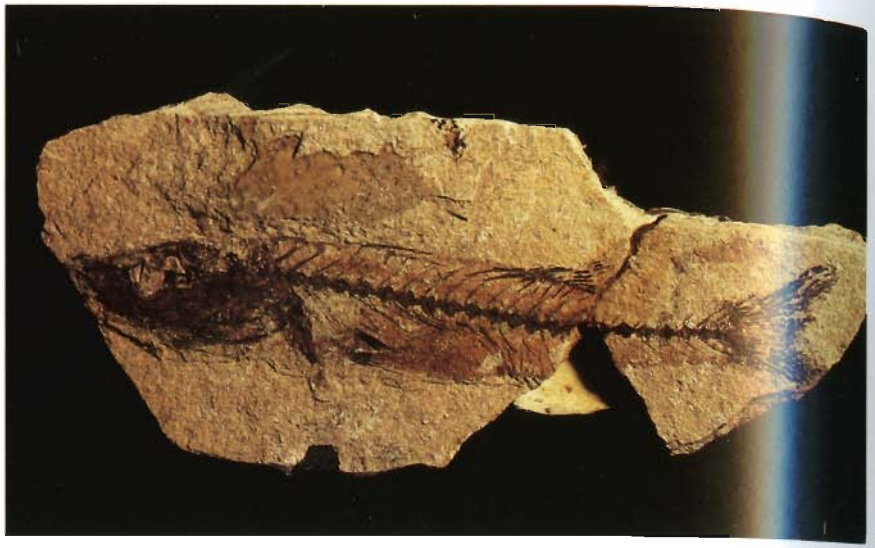
Features: Small fishes of elongate, but nevertheless rather plump, shape. Head shallow. Eyes small. Snout pointed. Anterior dorsal fin pointed, hard-rayed. Posterior dorsal fin soft-rayed, approximately triangular. Pelvic fins elongate and broad. Pectoral fins pointed. Caudal fin deeply forked.

Remarks: Gregarious.

Recent relatives: Closely related to recent mullets of the genus *Mugil*.



Mugil cephalus, a recent mullet. Lithograph from Bloch.



Parasphyraena apsheronica SVITCHENSKA (length c. 11 cm) from the Upper Miocene of Azerbaijan, C.I.S. Original: Paleontologicheskii Muzei Russkoi Akademii Nauk, Moscow, Russia.

Genus: *Parasphyraena* SVITCHENSKA, 1968.

Geological range: Upper Miocene.

Geographical distribution: Western Asia.

Features: Small to middle-sized fishes of slender streamlined shape. Head shallow. Eyes small. Snout pointed. Two relatively small dorsal fins. Anterior dorsal fin hard-rayed, in the anterior half of the body. Posterior dorsal fin soft-rayed, in the posterior half of the body, opposite the similarly shaped anal fin. Pelvic fins very small. Caudal fin forked.

Remarks: Predators.

Recent relatives: Genus extinct but nevertheless related to recent barracudas of the genus *Sphyraena* which is represented by 18 species in tropical seas.



Parasphyraena, reconstruction after Akademia Nauk, Moscow.



Sphyraena bolcensis AGASSIZ (length c. 18 cm) from the Middle Eocene of Bolca, Italy. Original: Interfoss, Munich, Germany.

Genus: *Sphyraena* ARTEDI, 1792.

Geological range: Eocene to recent.

Geographical distribution: Europe, Africa, Indonesia, Asia, North America.

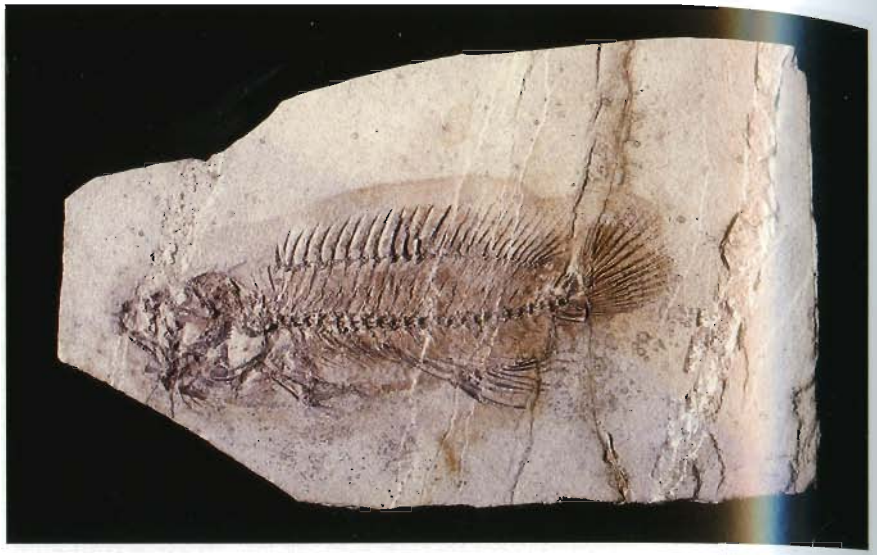
Features: Middle-sized fishes of slender streamlined shape. Head shallow. Eyes small. Upper and lower jaws set with powerful teeth and elongated to form a broad rostrum. Two relatively small dorsal fins. Anterior dorsal fin hard-rayed. Posterior dorsal fin soft-rayed, opposite the similarly shaped anal fin. Pectoral and pelvic fins small. Caudal fin deeply forked, with narrow lobes.

Remarks: Predators.

Recent relatives: Closely related to recent barracudas of the genus *Sphyraena*, represented by 18 species in tropical seas.



Sphyraena barracuda, a recent barracuda. Lithograph from BLOCH.



Eolabroides szajnochae (de ZIGNO) (length c. 10 cm) from the Middle Eocene of Bolca, Italy. Original: Università di Padova, Padua, Italy.

Genus: *Eolabroides* EASTMAN, 1914.

Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Small fishes with elongate bodies. Head relatively shallow. Eyes small. Dorsal fin extends over almost the whole length of the back, divided into a long hard-rayed and a short soft-rayed portion. Anal fin with a few hard rays anteriorly, soft-rayed more posteriorly. Caudal fin rounded, not forked.

Remarks: Fed on small animals and also on bivalves and snails.

Recent relatives: Genus extinct. Nevertheless related to recent wrasses.



Labrus agassizi MÜNSTER (length c. 17 cm) from the Miocene of St. Margarethen, Austria. Original: Naturhistorisches Museum, Vienna, Austria.

Genus: *Labrus* LINNAEUS, 1758.

Geological range: Eocene to recent.

Geographical distribution: Europe.

Features: Small to middle-sized fishes with rather laterally compressed bodies. Head shallow. Eyes relatively small. Gape short. Dorsal fin divided into a long hard-rayed and a short soft-rayed portion. Caudal fin strongly emarginate.

Remarks: Fed on small animals and also on bivalves and snails.

Recent relatives: Closely related to recent wrasses of the genus *Labrus*.



Labrus sp., a recent wrasse.



Pseudovomer minutus SAUVAGE (length c. 5 cm) from the Upper Miocene of Licata, Sicily, Italy. Original: Muséum National d'Histoire Naturelle, Paris, France. Photograph: Serette, Paris.

Genus: *Pseudovomer* SAUVAGE, 1873.

Geological range: Miocene to Pliocene.

Geographical distribution: Europe.

Features: Small fishes of oval outline, laterally flattened. Head deep. Eyes large. Snout somewhat protruding. Dorsal fin beginning shortly behind the head with hard rays. Pectoral fins fan-shaped. Anal fin with a spine-like first ray. Pelvic fins narrow.

Remarks: Fed on small animals.

Recent relatives: None. Died out in Pliocene.



Symphodus salvus BANNIKOV (length c. 9 cm) from the Upper Miocene of Moldavia, C.I.S. Original: Paleontologicheskii Muzei Russkoi Akademii Nauk, Moscow, Russia (Bannikov Collection).

Genus: *Symphodus* RAFINESQUE, 1810.

Geological range: Miocene to Pliocene.

Geographical distribution: Western and eastern Europe, northern Africa.

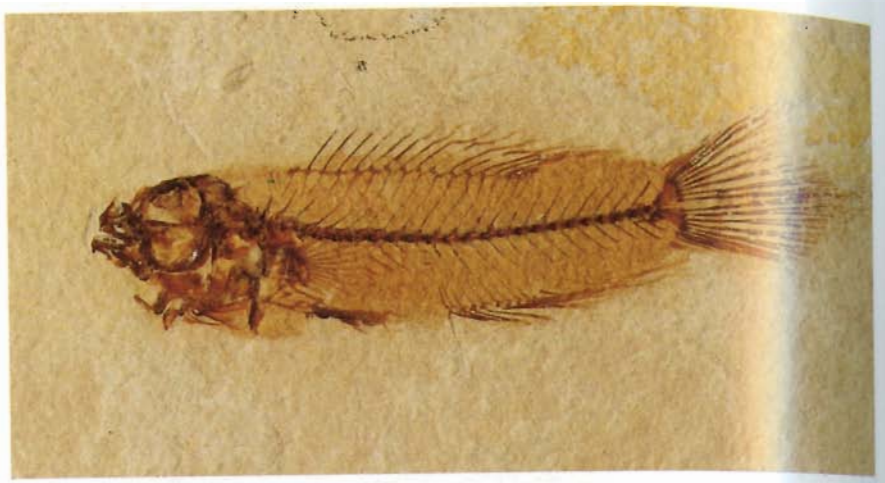
Features: Small fishes of elongate oval outline. Head short and deep. Eyes large. Dorsal fin beginning just behind the head, anteriorly hard-rayed but with a soft-rayed, posteriorly arcuate portion. Anal fin with a few hard rays anteriorly, soft-rayed posteriorly. Caudal fin not forked.

Remarks: Probably fed mainly on small animals but also on bivalves and snails.

Recent relatives: Closely related to recent wrasses the genus *Symphodus*.



Symphodus melops, the mermaid.



Tortonesia esilis SORBINI (length c. 7 cm) from the Middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Tortonesia* SORBINI, 1983.

Geological range: Middle Eocene.

Geographical distribution: Europe.

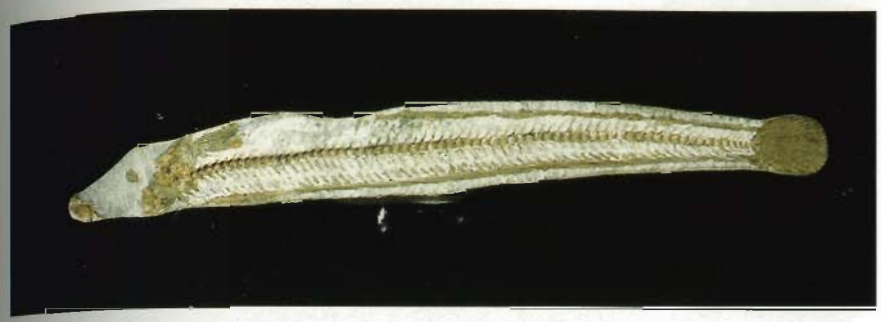
Features: Small fishes with elongate slender bodies. Head shallow. Snout pointed. Dorsal fin broad-based, divided into a long hard-rayed and a short soft-rayed portion. Anal fin relatively long. Pectoral fins rounded. Caudal fin not forked, with a rounded end.

Remarks: Fed mainly on small animals but also on bivalves and snails.

Recent relatives: Related to recent wrasses of the family Labridae which is represented by 57 genera and about 500 species in warm seas.



Bodianus izuensis, a recent wrasse.



Pholis gunellus LINNAEUS (length c. 12 cm) from the Pleistocene of Greenland. Original: Naturhistoriska Riksmuseet, Stockholm, Sweden.

Genus: *Pholis* GRONOV, 1760.

Geological range: Pleistocene to recent.

Geographical distribution: Greenland.

Features: Small fishes with elongate slender, laterally compressed bodies. Head shallow. Eyes small. Gape short, directed upwards. Dorsal fin long, hard-rayed. Caudal fin rounded, not forked.

Remarks: Fed on small animals.

Recent relatives: The fossil species is identical to the recent one. The genus *Pholis* is represented by ten species in northern seas.



Pholis gunellus, a recent gunnel. Lithograph from BLOCH.



Callipterys speciosus AGASSIZ (length c. 36 cm) from the Middle Eocene of Bolca, Italy. Original: Field Museum of Natural History, Chicago, Illinois, U.S.A.

Genus: *Callipterys* AGASSIZ, 1835.

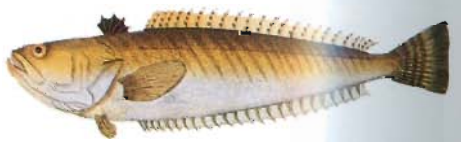
Geological range: Middle Eocene.

Geographical distribution: Europe.

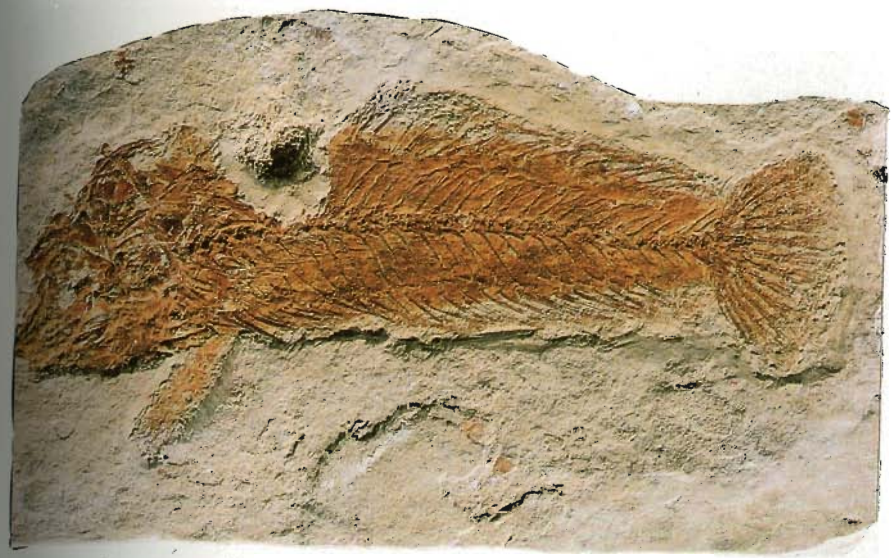
Features: Middle-sized fishes with elongate, rather laterally compressed bodies. Head shallow. Snout pointed. Dorsal fin divided into a short, relatively hard-rayed and a long soft-rayed portion. Anal fin fringe-like, beginning in the middle of the body. Caudal fin elongate, rounded posteriorly.

Remarks: Probably lived mainly near the bottom.

Recent relatives: Genus extinct. Perhaps distantly related to weeverfishes of the genus *Trachinus*, represented by four species in the Mediterranean and other temperate seas.



Trachinus draco, the recent greater weever. Lithograph from BLOCH.



Neopercis mesogea ARAMBOURG (length c. 18 cm) from the Miocene of Oran, Algeria. Original: Muséum National d'Histoire Naturelle, Paris, France. Photograph: Serette, Paris.

Genus: *Neopercis* STEINDACHNER, 1884.

Synonym: *Parapercis*.

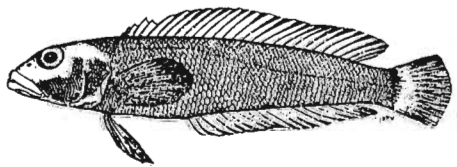
Geological range: Miocene to recent.

Geographical distribution: Northern Africa.

Features: Small, rather plump fishes. Head deep. Eyes small. Snout pointed. Gape long. Dorsal fin begins just behind the head and runs as a fringe to near the posterior end of the body. Anal fin likewise fringe-like. Pectoral fins small. Pelvic fins vertically beneath the pectorals and very elongate. Caudal fin not forked, rounded.

Remarks: Lived near the bottom.

Recent relatives: Closely related to recent sandperches of the genus *Neopercis (Parapercis)*.



Parapercis multifasciata, a recent sandperch. (After SMITH).



Clinitrachus gratus BANNIKOV (length c. 4.5 cm) from the Upper Miocene of Moldavia, C.I.S. Original: Paleontologicheskii Muzei Russkoi Akademii Nauk, Moscow, Russia (Bannikov Collection).

Genus: *Clinitrachus* SWAINSON, 1839.

Geological range: Upper Miocene to recent.

Geographical distribution: Eastern Europe.

Features: Very Small fishes of slender shape. Head short and deep. Eyes small. Gape short. Dorsal fin extending over the whole of the back. Anal fin fringe-like. Pectoral fins broad. Pelvic fins small. Caudal fin rounded, not forked.

Remarks: Fed on small organisms and lived near the bottom.

Recent relatives: Closely related to recent clinids of the genus *Clinitrachus* which live in the Mediterranean.



Clinitrachus, reconstruction after BANNIKOV.



Clinus gracilis STEINDACHNER (length c. 7 cm) from the Upper Miocene of Hernals, near Vienna, Austria. Original: Naturhistorisches Museum, Vienna, Austria.

Genus: *Clinus* CUVIER, 1817.

Geological range: Miocene to recent.

Geographical distribution: Europe, norther Africa.

Features: Small fishes with elongate slender bodies. Head shallow. Eyes small. Snout pointed. Dorsal fin extends as a fringe over the whole of the back. Anal fin likewise fringe-like. Caudal fin not forked, rounded.

Remarks: Fed on small organisms and lived near the bottom.

Recent relatives: Closely related to recent clinids of the genus *Clinus* which live in temperate eastern seas.



Clinus sp., a clinid. Lithograph from CUVIER.



Ammodytes antipai PAUCA (length c. 4 cm) from the Middle Oligocene of Rumania. Original: Naturhistorisches Museum, Vienna, Austria.

Genus: *Ammodytes* LINNAEUS, 1758.

Geological range: Oligocene to recent.

Geographical distribution: Europe.

Features: Very small fishes with elongate eel-like bodies. Head long and shallow. Snout pointed. Dorsal fin low, extending over almost the whole of the back. Anal fin likewise low, but considerably shorter. Caudal fin rather deeply forked.

Remarks: Fed on small organisms and lived on a sandy bottom.

Recent relatives: Closely related to recent sandlances of the genus *Ammodytes* which live in the oceans.



Ammodytes sp. a recent sand lance. Lithograph from BLOCH.



Gobius microcephalus AGASSIZ (length c. 5 cm) from the Middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Gobius* LINNAEUS, 1758.

Geological range: Middle Eocene to recent.

Geographical distribution: Europe, North America, western Asia, northern Africa.

Features: Very small fishes with laterally compressed bodies. Head deep. Eyes large. Gape short. Two dorsal fins, the anterior short, the posterior broad-based. Anal fin opposite the second dorsal fin. Pelvic fins small. Pectoral fins relatively broad. Caudal fin rounded, not forked.

Remarks: Fed on small organisms and lived near the bottom.

Recent relatives: Closely related to recent gobies of the genus *Gobius*.



Gobius sp., a recent goby. Lithograph from CUVIER.



Acanthonemus subaureus (de BLAINVILLE) (length c. 14 cm) from the Middle Eocene of Bolca, Italy. Original: The Natural History Museum, London, U.K. (P16201).

Genus: *Acanthonemus* AGASSIZ, 1834.

Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Small fishes of oval outline and laterally flattened bodies. Head short and deep. Eyes small. Anterior dorsal fin hard rayed, very tall and prominent. Posterior dorsal fin soft-rayed, low and extending to the root of the tail. Anal fin likewise with long hard rays anteriorly and soft rays posteriorly. Pectoral fins short and pointed. Pelvic fins somewhat longer and tapering. Caudal fin broad, not forked.

Remarks: Probably fed at least partly on plants.

Recent relatives: None. Died out in Eocene.



Acanthonemus, reconstruction after de BLAINVILLE.



Acanthurus ovalis AGASSIZ (length c. 14 cm) from the Middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Acanthurus* FORSKÅL, 1775.

Geological range: Middle Eocene to recent.

Geographical distribution: Europe.

Features: Middle-sized fishes of oval outline, laterally flattened. Head short and deep. Eyes large. Snout slightly pointed. Dorsal fin begins shortly behind the head with hard rays and continues as a soft-rayed fringe to the root of the tail. Anal fin similar and fringe-like. Pectoral and pelvid fins small. Caudal fin not forked, emarginate.

Remarks: Fed at least partly on plants. Has been reclassified into the genus *Proacanthurus*

Recent relatives: Closely related to recent surgeonfishes of the genus *Acanthurus* which live in all tropical seas.



Acanthurus leucosternon, the powder-blue surgeonfish.



Eozanclus brevirostris AGASSIZ (length c. 12 cm) from the Middle Eocene of Bolca, Italy. Original: Museum National d'Histoire Naturelle, Paris, France. Photograph: Serette, Paris.

Genus: *Eozanclus* BLOT & VORUZ, 1974.

Geological range: Middle Eocene.

Geographical distribution: Europe.

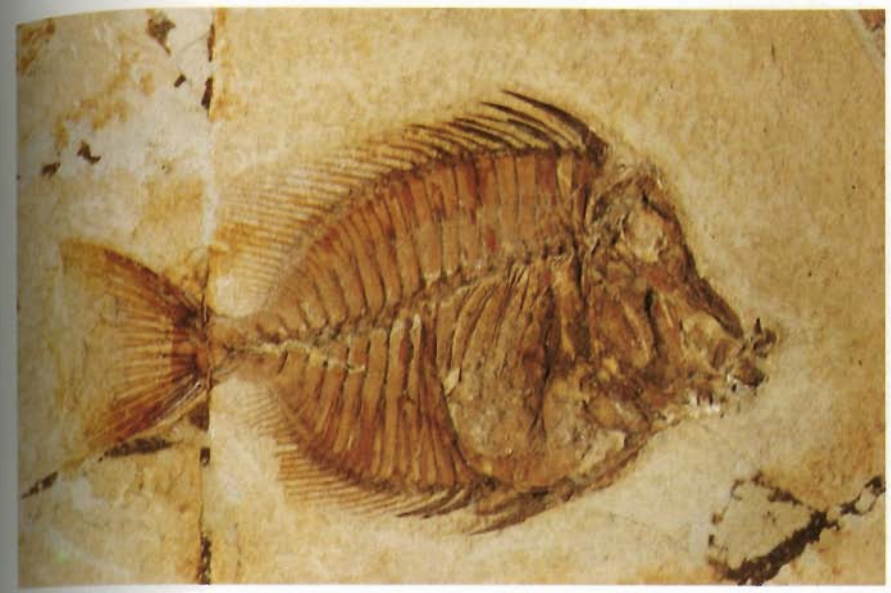
Features: Small fishes of almost circular outline, laterally flattened. Head deep. Eyes small. Snout somewhat produced. Dorsal fin hard-rayed anteriorly, projects upward from the highest part of the body and ends in a tall point, then descends in a curve and extends as a fringe to the root of the tail. Anal fin similarly fringe-like and beginning with a few hard rays. Pectoral fins small. Pelvic fins pointed. Caudal fin rounded, not forked.

Remarks: Probably fed, at least partly, on plants.

Recent relatives: Closely related to recent surgeonfishes of the genus *Zanclus*, represented by a few species in tropical seas.



Zanclus cornutus, the recent Moorish idol.



Naseus rectifrons AGASSIZ (length c. 10 cm) from the Middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Naseus* de LACÉPÈDE, 1802.

Synonym: *Naso*.

Geological range: Middle Eocene to recent.

Geographical distribution: Europe.

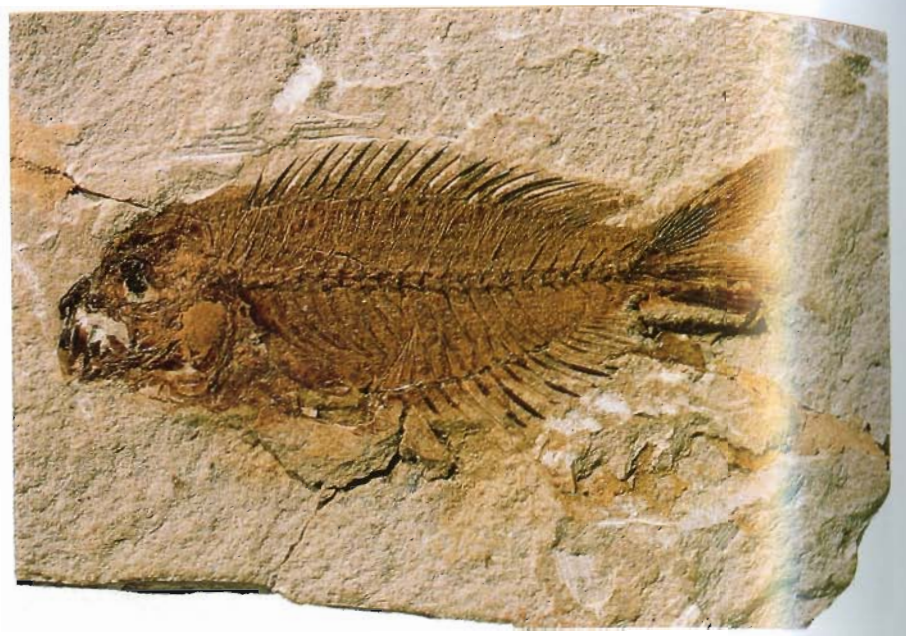
Features: Small fishes of rounded outline, laterally flattened. Head short and deep. Upper and lower jaws form a projecting snout. Dorsal fin begins at the highest part of the body, is hard-rayed anteriorly and continues as a soft-rayed portion rounded posteriorly. Anal fin similar and extending as a fringe to the root of the tail. Pectoral fins small. Pelvic fins hard-rayed. Caudal fin, not forked, emarginate.

Remarks: Fed partly on plants. Has been reclassified into the genus *Eorandallius*.

Recent relatives: Closely related to recent unicornfishes of the genus *Naso* which live in tropical seas.



Naso lituratus, a recent unicornfish.



Parapygaeus polyacanthus PELLEGRIN (length c. 7 cm) from the Middle Eocene of Bolca, Italy. Original: Muséum National d'Histoire Naturelle, Paris, France. Photograph: Serette, Paris.

Genus: *Parapygaeus* PELLEGRIN, 1907.

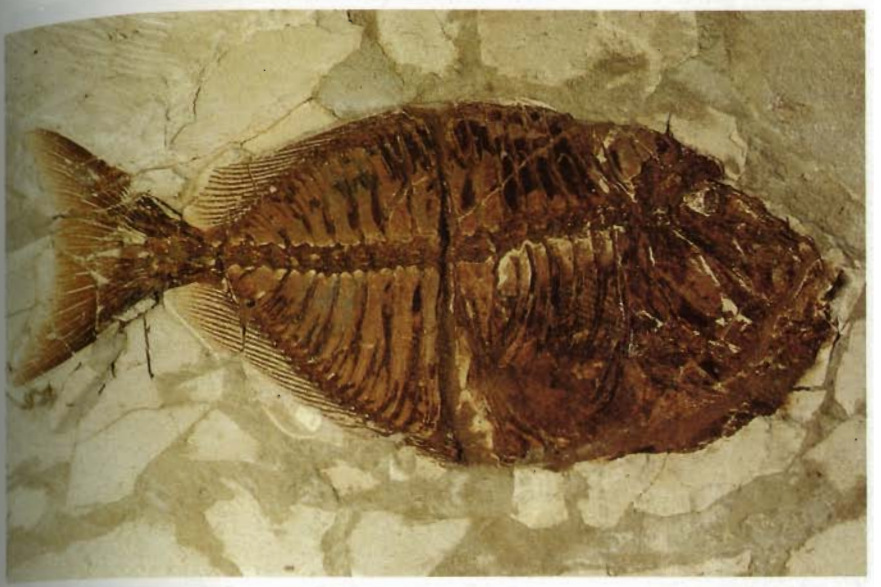
Geological range: Eocene.

Geographical distribution: Europe.

Features: Small fishes of elongate oval outline, laterally flattened. Head deep. Eyes large. Snout somewhat produced. Dorsal fin hard-rayed anteriorly and fringe-like and soft-rayed posteriorly. Anal fin similar but shorter. Pelvic and pectoral fins small.

Remarks: Predators.

Recent relatives: None. Died out in Eocene.



Tylerichthys nuchalis (AGASSIZ) (length c. 21 cm) from the Middle Eocene of Bolca, Italy. Original: Field Museum of Natural History, Chicago, Illinois, U.S.A.

Genus: *Tylerichthys* BLOT, 1980.

Synonym: *Naseus*.

Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Middle-sized fishes of oval outline, laterally flattened. Head deep. Eyes small. Gape rather long. Dorsal fin in the posterior half of the body, anteriorly with a few hard rays, posteriorly soft-rayed. Anal fin opposite, fringe-like. Caudal fin not forked, deeply emarginate.

Remarks: Probably lived partly on hard-shelled food.

Recent relatives: None. Died out in Eocene.



Caprovesposus parvus DANILTCHENKO (length c. 3 cm) from the Lower Oligocene of northern Caucasus, C.I.S. Original: Paleontologicheskii Muzei Russkoi Akademii Nauk, Moscow, Russia.

Genus: *Caprovesposus* DANILTCHENKO, 1960.

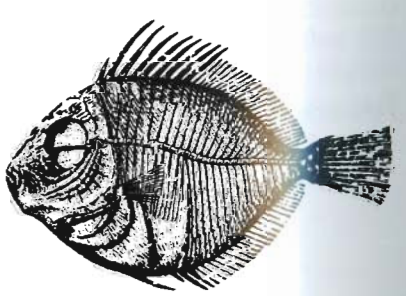
Geological range: Oligocene to Miocene.

Geographical distribution: Western and eastern Europe.

Features: Small fishes of oval outline, laterally flattened. Head deep. Eyes large. Snout pointed. Dorsal fin begins shortly behind the head, hard-rayed anteriorly, soft-rayed posteriorly, extending as a fringe almost the whole length of the back. Pectoral fins small. Pelvic fins close to the pectorals. Tail fin not forked.

Remarks: Predators.

Recent relatives: None. Died out in Oligocene.



Caprovesposus, reconstruction after Akademia Nauk, Moscow.



Kushlukia permira DANILTCHENKO (length c. 17 cm) from the Lower Eocene of Turkmenistan, C.I.S. Original: Paleontologicheskii Muzei Russkoi Akademii Nauk, Moscow, Russia.

Genus: *Kushlukia* DANILTCHENKO, 1968.

Geological range: Lower Eocene.

Geographical distribution: Western Asia.

Features: Middle-sized fishes of oval outline, deep anteriorly and strongly decreasing in height posteriorly. Head deep. Eyes large. Snout pointed. Gape rather long. Anterior dorsal fin tall, hard-rayed. Posterior dorsal fin soft-rayed, fringe-like. Caudal fin not forked.

Remarks: Predators.

Recent relatives: Genus extinct. Nevertheless perhaps related to recent rabbitfishes.



Siganus guttatus, a recent rabbitfish.



Epinnula cancellata ARAMBOURG (length c. 5 cm) from the Lower Oligocene of Iran. Original: Muséum National d'Histoire Naturelle, Paris, France. Photograph: Serette, Paris.

Genus: *Epinnula* POEY, 1854.

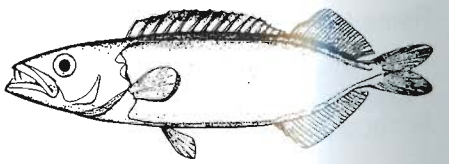
Geological range: Oligocene to recent.

Geographical distribution: Middle East.

Features: Small fishes with very slender elongate bodies. Head relatively large. Eyes small. Snout strongly pointed. Gape long. Anterior dorsal fin elongate, hard-rayed. Posterior dorsal fin soft-rayed. Pectoral fins pointed. Pelvic fins vertically beneath pectorals and very small. Anal fin triangular. Caudal fin forked.

Remarks: Gregarious.

Recent relatives: Closely related to recent fishes of the genus *Epinnula*.



Epinnula orientalis, a recent fish of the family Gempylidae.



Hemithyrsites maicopicus DANILTCHENKO (length c. 6 cm) from the Lower Miocene of Azerbaijan, C.I.S. Original: Paleontologicheskii Muzei Russkoi Akademii Nauk, Moscow, Russia.

Genus: *Hemithyrsites* SAUVAGE, 1873.

Geological range: Miocene.

Geographical distribution: Western and eastern Europe, northern Africa.

Features: Small fishes with very slender elongate bodies. Head shallow. Eyes large. Snout pointed. Dorsal fin fringe-like, hard-rayed. Anal fin small, like the pectoral and pelvic fins. Caudal fin forked.

Remarks: Probably gregarious predators.

Recent relatives: Genus extinct. Nevertheless distantly related to recent snake mackerels of the genus *Thyrsites*.



Thyrsites atun, a recent snake mackerel. Lithograph from CUVIER.



Eutrichiurides delheidi LERICHE (length c. 8 cm) from the Oligocene of Wiesloch, Baden, Germany. Original: Staatliches Museum für Naturkunde, Karlsruhe, Germany.

Genus: *Eutrichiurides* CASIER, 1944.

Geological range: Paleocene to Oligocene.

Geographical distribution: Europe, Africa.

Features: Small fishes with slender, laterally flattened bodies. Head shallow. Eyes large. Snout pointed. Gape rather long. Dorsal fin low and fringe-like. Caudal fin very small, forked.

Remarks: Predators.

Recent relatives: Perhaps related to recent cutlassfishes of the genus *Trichiurs* which live in the oceans.



Trichiurus lepturus, a recent cutlassfish. Lithograph from BLOCH.



Lepidopus sp. (length c. 24 cm) from the Pliocene of Licata, Sicily, Italy. Original: Siber & Siber Collection, Aathal, Switzerland.

Genus: *Lepidopus* GOUAN.

Synonyms: *Acanthonotus*, *Anenchelum*, *Lepidopides*.

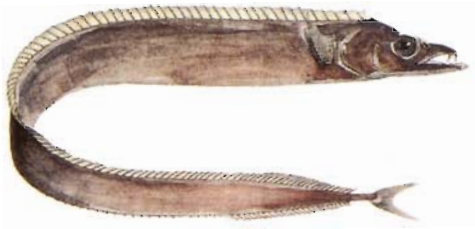
Geological range: Eocene to recent.

Geographical distribution: Europe, South America, western and northern Africa.

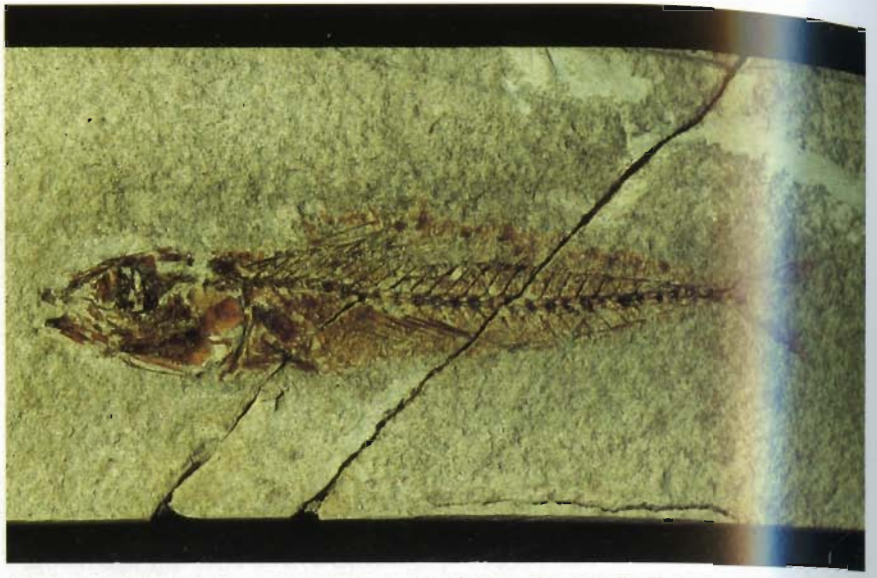
Features: Middle-sized fishes with very slender elongate, laterally flattened bodies. Head shallow. Eyes large. Snout pointed. Gape long. Dorsal fin low, extending along the whole body. Anal fin likewise low and fringe-like, but nevertheless considerably shorter. Pelvic fins completely lost. Caudal fin very small, forked.

Remarks: Predators.

Recent relatives: Closely related to recent scabbardfishes of the genus *Lepidopus* which live in the oceans.



Lepidopus sp., a recent scabbardfish. Lithograph from CUVIER.



Auxis propterygius (AGASSIZ) (length c. 7 cm) from the Middle Eocene of Bolca, Italy. Original: National Museum of Natural History, Smithsonian Institution, Washington, D.C., U.S.A.

Genus: *Auxis* CUVIER, 1829.

Geological range: Eocene to recent.

Geographical distribution: Europe.

Features: Small fishes of slender shape. Head shallow. Eyes large. Snout somewhat produced, pointed. Two small dorsal fins. Caudal fin deeply forked.

Remarks: Predators.

Recent relatives: Closely related to recent bullet mackerels of the genus *Auxis* which are placed among the smaller tunas.



Auxis sp., a bullet mackerel. Lithograph from CUVIER.



Grammatorcynus scomberoides ARAMBOURG (length c. 15 cm) from the Lower Oligocene of Iran. Original: Muséum National d'Histoire Naturelle, Paris, France. Photograph: Serette, Paris.

Genus: *Grammatorcynus* GILL, 1862.

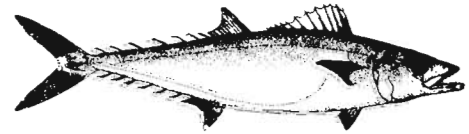
Geological range: Oligocene to recent.

Geographical distribution: Middle East.

Features: Small to middle-sized fishes, outline becoming deeper anteriorly. Head elongate. Eyes small. Snout pointed. Gape rather long. Anterior dorsal fin hard-rayed, posterior dorsal fin soft-rayed. Anal fin opposite the posterior dorsal fin. Pelvic fins vertically beneath the pectoral fins.
Caudal fin forked.

Remarks: Gregarious.

Recent relatives: Closely related to recent mackerels of the genus *Grammatocynus*.



Grammatorcynus bicarinatus, the recent double-lined mackerel, after WEBER.



Isurichthys orientalis WOODWARD (length c. 9 cm) from the Oligocene of Shuster, Iran. Original: The Natural History Museum, London, U.K. (P7130).

Genus: *Isurichthys* WOODWARD, 1901.

Geological range: Oligocene.

Geographical distribution: Europe, western Asia.

Features: Small fishes of slender shape. Head shallow. Eyes large. Snout pointed. Dorsal fin fringe-like. Anal fin likewise fringe-like and very low. Caudal fin deeply forked, with narrow lobes.

Remarks: Predators.

Recent relatives: None. Died out in Oligocene.



Palimphyes longirostratus DANILTCHENKO (length c. 11 cm) from the Lower Oligocene of the Caucasus, C.I.S. Original: Paleontologicheskii Muzei Russkoi Akademii Nauk, Moscow, Russia (Bannikov Collection).

Genus: *Palimphyes* AGASSIZ, 1844.

Synonym: *Krambergeria*.

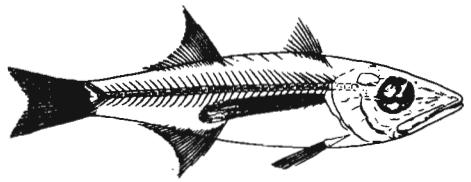
Geological range: Oligocene.

Geographical distribution: Europe.

Features: Small to middle-sized fishes of slender shape. Head shallow. Eyes relatively large. Snout pointed. Two dorsal fins, respectively opposite the pelvic fins and the anal fin. Pectoral fins narrow. Caudal fin deeply forked.

Remarks: Gregarious.

Recent relatives: None. Died out in Oligocene.



Palimphyes, reconstruction after Akademia Nauk, Moscow.



Sarda rara Bannikov (length c. 7.5 cm) from the Lower Oligocene of the northern Caucasus, C.I.S. Original: Paleontologicheskii Muzei Russkoi Akademii Nauk, Moscow, Russia (Bannikov Collection).

Genus: *Sarda* Cuvier, 1829.

Synonym: *Pelamys*.

Geological range: Paleocene to recent.

Geographical distribution: Europe, North America, northern Africa.

Features: Small fishes of slender shape. Head narrow. Eyes large. Snout pointed. Gape deep. Dorsal fin on a broad base, beginning about body center. Anal, pectoral and ventral fins small. Caudal fin deeply forked.

Remarks: Schooling fishes.

Recent relatives: Closely related to recent fishes of the genus *Sarda*.



Sarda australis, a recent bonito



Scomber sujedanus Steindachner (length c. 33 cm) from the Oligocene of Radoboj, Yugoslavia. Original: Naturhistorisches Museum, Vienna, Austria.

Genus: *Scomber* Linnaeus, 1758.

Synonym: *Pneumatophorus*.

Geological range: Eocene to recent.

Geographical distribution: Europe, Africa, North America, eastern Asia.

Features: Middle-sized fishes of slender elongate shape. Head shallow. Snout pointed. Two dorsal fins, respectively opposite the pelvic fins and the anal fin. Pectoral fins narrow. Caudal fin deeply forked.

Remarks: Gregarious.

Recent relatives: Closely related to recent mackerels of the genus *Scomber* which live in great schools in tropical and subtropical seas.



Scomber scomber, a recent mackerel. Lithograph from Bloch.



Scomberomorus speciosus AGASSIZ (length c. 40 cm) from the Middle Eocene of Bolca, Italy. Original: Rijksmuseum van Geologie en Mineralogie, Leiden, Netherlands.

Genus: *Scomberomorus* de LACÉPÈDE, 1802.

Synonym: *Cybium*.

Geological range: Paleocene to recent.

Geographical distribution: Europe, Africa, Middle East.

Features: Small fishes of slender outline, but somewhat deeper in the middle of the body. Head shallow. Eyes small. Snout pointed. Gape long. Two dorsal fins, respectively opposite the pelvic fins and the anal fin. Caudal deeply forked.

Remarks: Gregarious.

Recent relatives: Closely related to recent Spanish mackerels of the genus *Scomberomorus* which belong among the tunas and occur in huge schools in the Atlantic and Pacific.



Scomberomorus queenslandicus, a mackerel.



Scombrosarda cernerurae (CIOBANU) (length c. 21 cm) from the Lower Oligocene of the northern Caucasus, C.I.S. Original: Paleontologicheskii Muzei russkoi Akademii Nauk, Moscow, Russia.

Genus: *Scombrosarda* DANILTCHENKO, 1962.

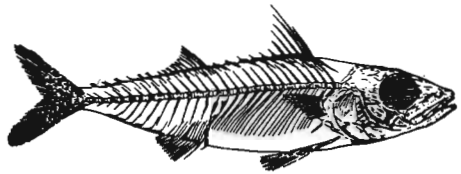
Geological range: Eocene to Oligocene.

Geographical distribution: Western and eastern Europe.

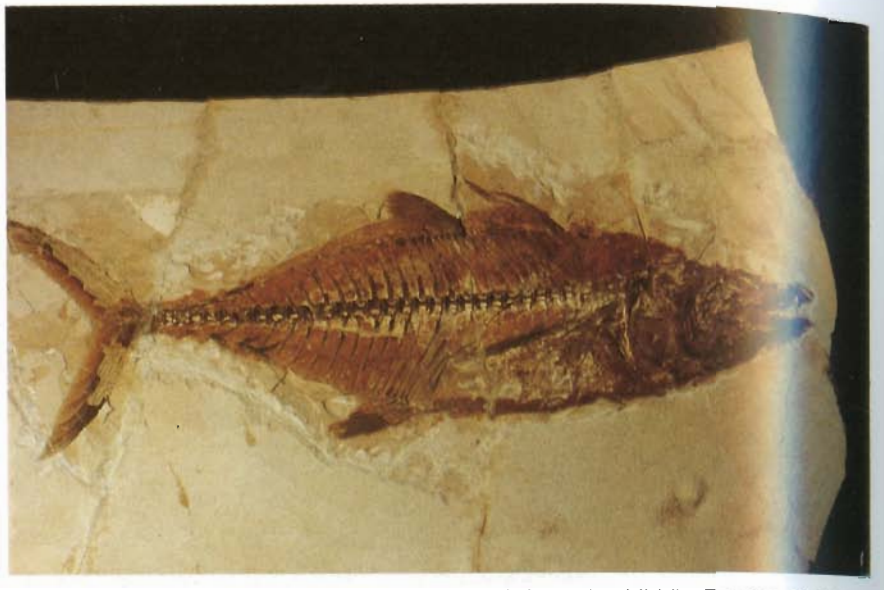
Features: Middle-sized fishes of slender shape. Head shallow. Eyes large. Snout pointed. Gape long. Two small dorsal fins. Anal fin triangular. Pelvic and pectoral fins small. Caudal fin rather deeply forked.

Remarks: Gregarious.

Recent relatives: Genus extinct. Possibly related to recent mackerels.



Scombrosarda, reconstruction after Akademia Nauk, Moscow.



Thunnus lanceolatus (AGASSIZ) (length c. 33 cm) from the Middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Thunnus* SOUTH, 1845.

Synonyms: *Orcinus*, *Thynnus*.

Geological range: Eocene to recent.

Geographical distribution: Europe, North America, Africa.

Features: Small fishes of slender outline, but deepest in the middle of the body and tapering towards the caudal fin. Head shallow. Eyes small. Snout pointed. Two dorsal fins, respectively opposite the pelvic fins and the anal fin. Pectoral fins narrow and relatively long. Caudal fin deeply forked and sickle-shaped.

Remarks: Gregarious.

Recent relatives: Closely related to recent tunas of the genus *Thunnus* which live in huge swarms in warm and temperate seas.



Thunnus thynnus, the recent tuna. Lithograph from BLOCH.



Turio wilburi (GILBERT & JORDAN) (length c. 30 cm) from the Miocene of California, U.S.A. Original: National Museum of Natural History, Smithsonian Institution, Washington, D.C., U.S.A.

Genus: *Turio* GILBERT & JORDAN, 1920.

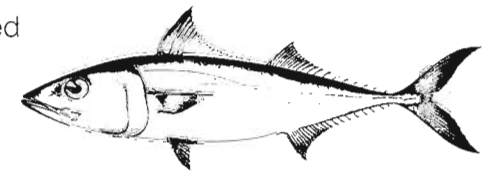
Geological range: Miocene.

Geographical distribution: North America.

Features: Middle-sized fishes of slender elongate outline. Head shallow. Eyes large. Snout pointed. Pelvic fins small. Caudal fin deeply forked.

Remarks: Predators. *Turio* is occasionally considered a synonym of *Scomber*.

Recent relatives: None. Died out in Miocene.



Turio, reconstruction after JORDAN.



Xiphopterus falcatus (VOLTA) (length c. 55 cm) from the Middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Xiphopterus* AGASSIZ, 1835.

Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Middle-sized fishes of very slender elongate outline. Head shallow. Eyes small. Upper and lower jaws produced to a point, the upper being shorter. Two small dorsal fins, the posterior being opposite the anal fin and the anterior opposite the pelvic fins. Caudal fin deeply forked.

Remarks: Rapidly swimming predators.

Recent relatives: None. Died out in Eocene.



Blochius longirostris VOLTA (length c. 60 cm) from the Middle Eocene of Bolca, Italy. Original: Interfoss, Munich, Germany.

Genus: *Blochius* VOLTA, 1800.

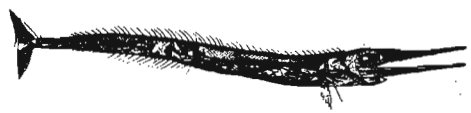
Geological range: Middle Eocene.

Geographical distribution: Europe.

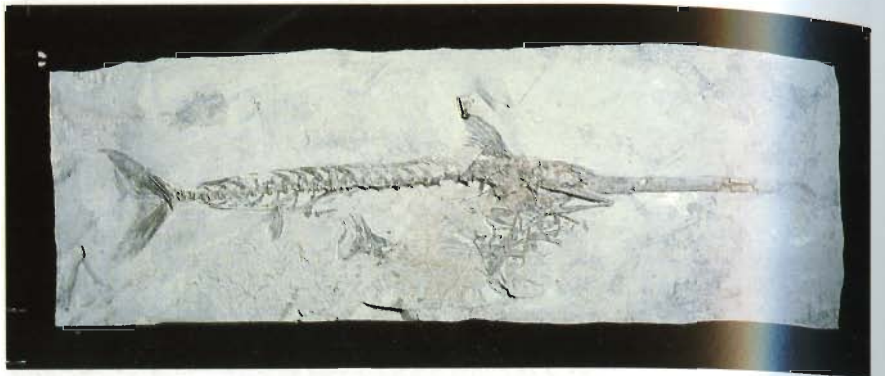
Features: Middle-sized fishes of very slender elongate outline. Head shallow. Eyes large. Upper and lower jaws set with pointed teeth and extended to form an unusually long rostrum. Dorsal fin fringe-like and extending over the whole length of the body. Anal fin likewise fringe-like, but beginning only in the middle of the body. Pelvic and pectoral fins small, fan-shaped. Caudal fin deeply forked.

Remarks: Predators. The rostrum probably served to deflect the prey and strike it from the side.

Recent relatives: None. Died out in Eocene.



Blochius, reconstruction after ZITTEL.



Xiphias gladius LINNAEUS (length c. 134 cm) from the Pliocene of Fiume Marecchia, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Xiphias* LINNAEUS, 1758.

Geological range: Eocene to recent.

Geographical distribution: Europe, western and northern Africa.

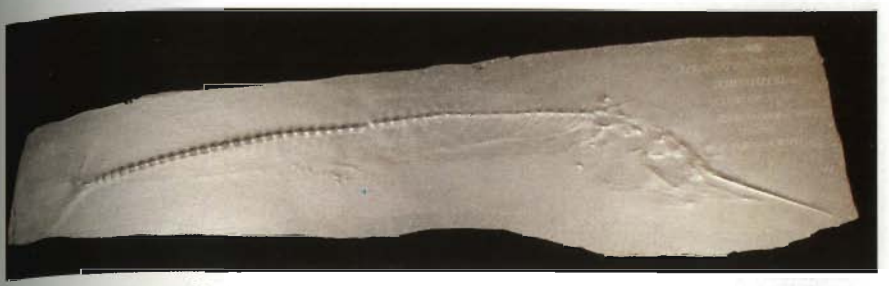
Features: Large to very large fishes of streamlined shape. Head shallow. Eyes large. Upper and lower jaws produced to form a sword-like rostrum, with the lower jaw considerably shorter than the upper. Anterior dorsal fin tall, immediately behind the head. Posterior dorsal fin small, shortly in front of the end of the body. Anal fin large. Pelvic fins very anterior in position. Pectoral fins long and pointed, placed rather ventrally. Caudal fin large, sickle-shaped.

Remarks: Pelagic predators.

Recent relatives: The fossil species is identical to the recent one. The swordfish *Xiphias gladius* lives in all the world's oceans.



Xiphias gladius, the recent swordfish. Lithograph from BLOCH.



Homorhynchus colei (AGASSIZ) (length c. 81 cm) from the Lower Oligocene of Glarus, Switzerland. Original: Teylers Museum, Haarlem, Netherlands.

Genus: *Homorhynchus* van BENEDEN, 1873.

Synonym: *Hemirhynchus*.

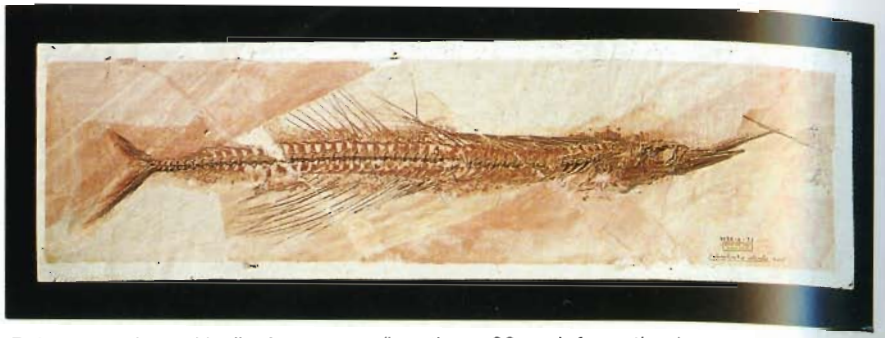
Geological range: Eocene to Miocene.

Geographical distribution: Europe.

Features: Middle-sized fishes of very slender elongate outline. Head shallow. Eyes large. Upper and lower jaws produced to form a rostrum, with the lower jaw considerably shorter than the upper. Dorsal and anal fins fringe-like. Caudal fin deeply forked.

Remarks: Predators.

Recent relatives: None. Died out in Miocene.



Palaeorhynchus altivelis ARAMBOURG (length c. 60 cm) from the Lower Oligocene of Iran. Original: Muséum National d'Histoire Naturelle, Paris, France. Photograph: Serette, Paris.

Genus: *Palaeorhynchus* de BLAINVILLE, 1818.

Geological range: Eocene to Miocene.

Geographical distribution: Europe, Middle East.

Features: Middle-sized fishes of slender elongate outline. Head shallow, elongate. Eyes large. Upper and lower jaw produced to form a rostrum. Dorsal fin extending over the whole body, arcuate upwards. Anal fin similar, but only half as long. Pectoral fins very small. Pelvic fins elongate. Caudal fin relatively small, deeply forked.

Remarks: Predators.

Recent relatives: None. Died out in Miocene.



Palaeorhynchus, reconstruction after ORLOV.



Carangodes cephalus HECKEL (length c. 16 cm) from the Middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Carangodes* HECKEL, 1856.

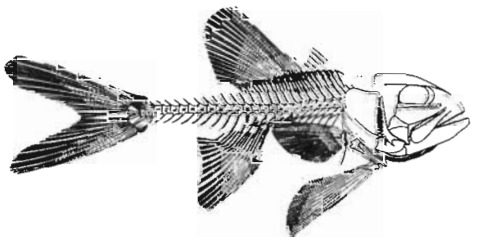
Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Small fishes of slender outline. Head deep. Eyes large. Gape long. Anterior dorsal fin small, consisting of a few hard rays. Posterior dorsal fin long, arcuate behind. Anal fin large, triangular. Pectoral fins large, rounded. Pelvic fins likewise large, elongate. Caudal fin deeply forked.

Remarks: Perhaps even at that time there was a sort of symbiosis between these fishes and large jellyfishes.

Recent relatives: Perhaps related to recent driftfishes of the family Nomeidae which is represented in tropical and subtropical seas by three genera and about 15 species.



Carangodes, reconstruction after BLOT.



Psenicubiceps alatus DANILTCHENKO (length c. 12 cm) from the Lower Oligocene of northern Caucasus, C.I.S. Original: Paleontologicheskii Muzei Russkoi Akademii Nauk, Moscow, Russia (Bannikov Collection).

Genus: *Psenicubiceps* DANILTCHENKO, 1980.

Geological range: Lower Oligocene.

Geographical distribution: Eastern Europe.

Features: Small fishes of elongate oval outline. Head relatively deep. Eyes large. Gape short. Anterior dorsal fin tall, hard-rayed. Posterior dorsal fin soft-rayed. Pectoral fins broad. Pelvic fins narrow. Caudal fin deeply forked.

Remarks: Perhaps even at that time these fishes live in symbiosis with large jellyfishes.

Recent relatives: Genus extinct. Probably related to recent driftfishes of the family Nomeidae and to their close relatives the Ariommidae.



Ariomma indica, a recent ariommid.



Tetragonurus sp. (length c. 18 cm) from the Pliocene of Fiume Marecchia, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Tetragonurus* RISSO, 1810.

Geological range: Pliocene to recent.

Geographical distribution: Europe.

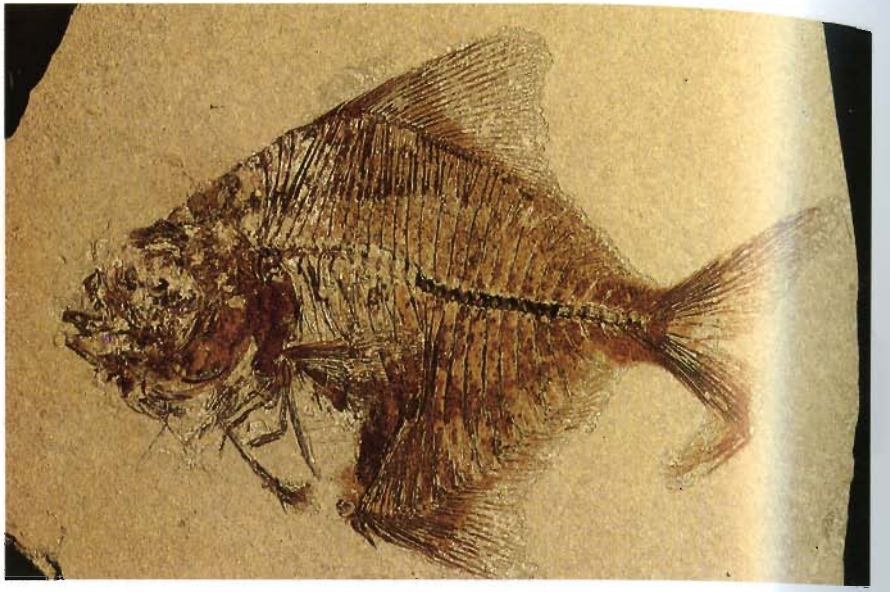
Features: Middle-sized fishes with elongate, torpedo-shaped bodies. Head shallow. Eyes large. Snout rounded. Gape short. Dorsal fin anteriorly hard-rayed and very low, passing posteriorly into a rounded soft-rayed portion which lies opposite the anal fin. Pelvic fins very small, vertically beneath the pectoral fins which are considerably larger. Caudal fin arcuate above and below, emarginate posteriorly, heart-shaped in outline. Keeled rhombic scales arranged in transverse rows.

Remarks: Probably fed on jellyfishes.

Recent relatives: Closely related to recent squaretails of the genus *Tetragonurus*.



Tetragonurus cuvieri, a recent squaretail. Lithograph from CUVIER.



Pinichthys pulcher BANNIKOV (length c. 11 cm) from the Lower Oligocene of northern Caucasus, C.I.S. Original: Paleontologicheskii Muzei Russkoi Akademii Nauk, Moscow, Russia (Bannikov Collection).

Genus: *Pinnichthys* BANNIKOV, 1985.

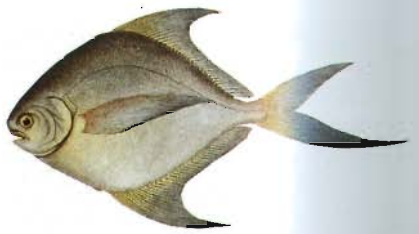
Geological range: Lower Oligocene.

Geographical distribution: Eastern Europe.

Features: Small fishes of rhombic outline, laterally flattened. Head small in relation to the total body size. Eyes small. Gape short. Dorsal fin begins at the highest part of the body, tall anteriorly but continuing posteriorly as a low fringe. Anal fin similar. Pelvic fins probably absent. Pectoral fins rounded. Caudal fin deeply forked, with rather broad lobes.

Remarks: Probably fed on small animals.

Recent relatives: Genus extinct. Distantly related to recent butterfishes of the family Stromateidae.



Stromateus flatola, a recent butterfish. Lithograph from BLOCH.



Unnamed butterfish (length c. 13 cm) from the Eocene of Mors, Denmark. Original: Paleontologiska Muséet, Uppsala, Sweden.

Genus: Not named.

Geological range: Eocene.

Geographical distribution: Europe.

Features: Fishes with oval outline, laterally flattened. Head deep. Eyes large. Gape short. Dorsal fin narrow, beginning in the anterior third of the body and running rearwards to a raised arcuate end near the caudal fin. Anal fin large, triangular. Pelvic fins narrow. Pectoral fins small, fan-shaped. Caudal fin large, slightly emarginate.

Remarks: Probably lived in open water near the coast.

Recent relatives: Genus probably extinct. Perhaps related to recent butterfishes of the family Stromateidae.



Arnoglossus distinctus SVITCHENSKA (length c. 4.5 cm) from the Lower Miocene of northern Caucasus, C.I.S. Original: Paleontologicheskii Muzei Russkoi Akademii Nauk, Moscow, Russia.

Genus: *Arnoglossus* BLEEKER, 1862.

Geological range: Miocene to recent.

Geographical distribution: Western and eastern Europe.

Features: Very small fishes of oval outline with strongly flattened, asymmetrical bodies. Eyes small, both on the right side of the body. Dorsal and anal fins fringe-like. Pectoral fins small. Caudal fin not forked.

Remarks: Predators lying on the bottom.

Recent relatives: Closely related to recent scaldfishes of the genus *Arnoglossus*.



Arnoglossus sp., a recent scaldfish. Lithograph from COUGH.



Bothus sp. (length c. 7 cm) from the Pliocene of Fiume Marecchia, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Bothus* BONAPARTE, 1841.

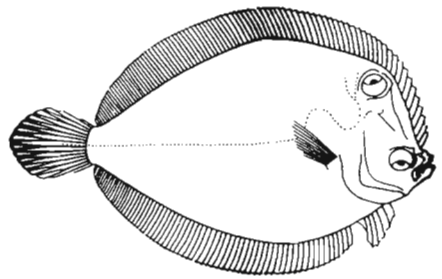
Geological range: Oligocene to recent.

Geographical distribution: Europe.

Features: Small fishes of rounded oval outline with strongly flattened asymmetrical bodies. Eyes small. Both on the right side. Snout slightly pointed. Dorsal and anal fins fringe-like. Pectoral fins small. Caudal fin not forked.

Remarks: Predators lying on the bottom.

Recent relatives: Closely related to recent lefteye flounders of the genus *Bothus*.



Bothus podas, a recent flounder, after WHITEHEAD.



Eobothus minimus (AGASSIZ) (length c. 6 cm) from the Middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Eobothus* EASTMAN, 1914.

Synonym: *Rhombus*

Geological range: Middle Eocene.

Geographical distribution: Europe, Asia.

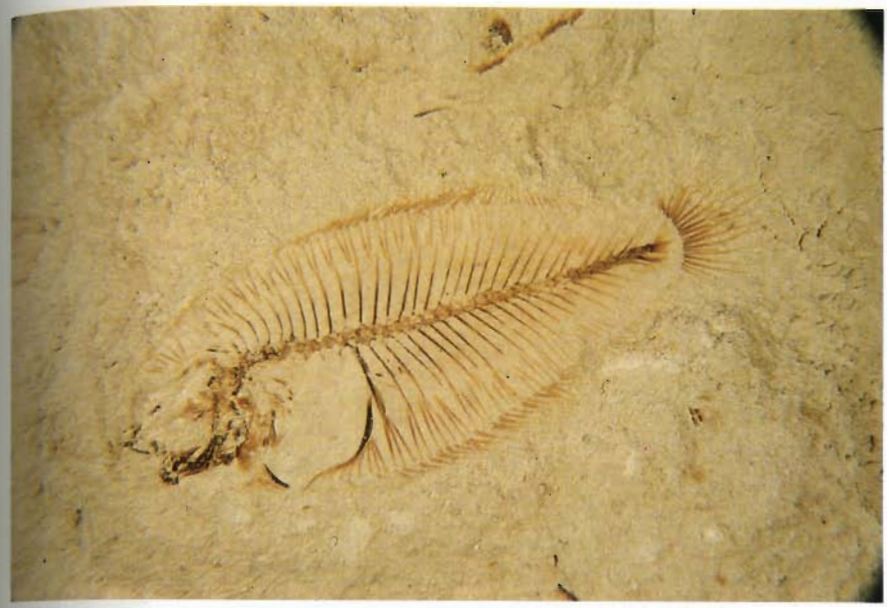
Features: Small fishes of rounded oval outline with very flattened asymmetrical bodies. Eyes small, both on the right side. Dorsal and anal fins fringe-like. Pectoral fins small, fan-shaped. Caudal fin not forked, rounded.

Remarks: Bottom-dwelling predators.

Recent relatives: Related to recent flounders of the genus *Bothus*.



Eobothus, reconstruction after MAC-MILLAN.



Scophthalmus heckeli (KNER) (length c. 6 cm) from the Middle Miocene of St. Margarethen, Austria. Original: Weiss Collection, Vienna, Austria.

Genus: *Scophthalmus* RAFINESQUE, 1810.

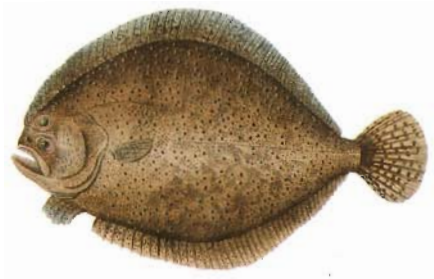
Geological range: Miocene to recent.

Geographical distribution: Europe.

Features: Small fishes of rounded oval outline, with strongly flattened asymmetrical bodies. Eyes small, both on the left side. Snout pointed. Dorsal fin and anal fin fringe-like. Pectoral fins small and narrow. Caudal fin not forked.

Remarks: Bottom-dwelling predators.

Recent relatives: Closely related to the recent brill (*Scophthalmus rhombus*) and other turbots.



Scophthalmus maximus, the recent turbot. Lithograph from BLOCH.



Liopsetta sp. (length c. 11 cm) from the Pliocene of Sakhalin, Siberia, C.I.S. Original: Paleontologicheskii Muzei Russkoi Akademii Nauk, Moscow, Russia.

Genus: *Liopsetta* GILL, 1864.

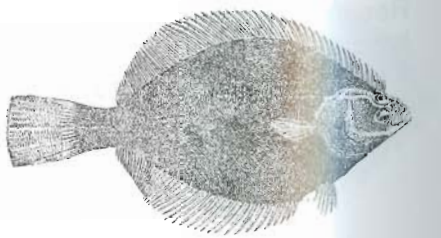
Geological range: Pliocene to recent.

Geographical distribution: Eastern Asia.

Features: Small fishes with greatly flattened asymmetrical bodies. Eyes small, both on the right side. Dorsal and anal fins fringe-like. Pectoral fins small and fan-shaped. Caudal fin rounded, not forked.

Remarks: Bottom-dwelling predators.

Recent relatives: Closely related to recent arctic flounders of the genus *Liopsetta* which live off arctic coasts.



Liopsetta glacialis, the recent arctic flounder. From JORDAN.



Solea kirchbergeana MEYER (length c. 7 cm) from the Miocene of Unterkirchberg, Württemberg, Germany. Original: Bayerische Staatssammlung für Paläontologie, Munich, Germany.

Genus: *Solea* GOUAN, 1770.

Geological range: Paleocene to recent.

Geographical distribution: Europe, northern Africa, western Asia.

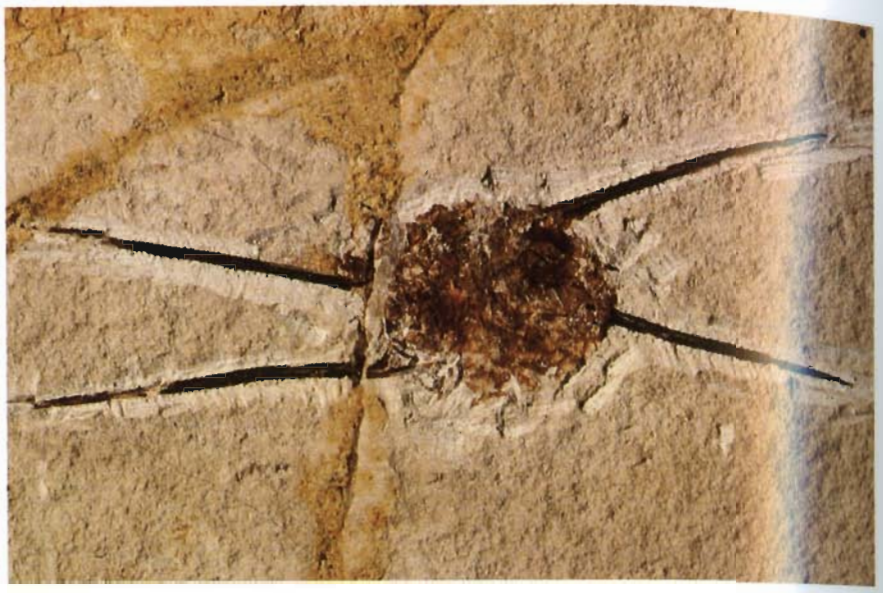
Features: Small fishes of oval outline with greatly flattened, asymmetrical bodies. Eyes small. Both on the right side of the body. Snout rather rounded. Dorsal fin and anal fins fringe-like. Pectoral fins pointed. Caudal fin not forked, rounded.

Remarks: Bottom-dwelling predators.

Recent relatives: Closely related to recent soles of the genus *Solea*.



Solea solea, the recent sole. Lithograph from BLOCH.



Eolactoria sorbinii TYLER (length c. 5 cm) from the Middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Eolactoria* TYLER, 1975.

Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Small fishes with rounded bodies, almost entirely armoured with bony plates - only the snout and the stalk of the tail are free. Eyes large. Snout rounded. Mouth small. Upper and lower jaws with teeth. All fins small. The forehead region and the posterior ventral part of the body each carry a pair of spines with small thorn-like outgrowths. Two small broad spines at the horizontal level of the eyes.

Remarks: Lived on small organisms.

Recent relatives: Genus extinct. Distantly related to recent cowfishes of the genus *Lactoria*.



Lactoria fornasini, the thornback cowfish.



Plectocretacicus clarae SORBINI (length c. 2 cm) from the Upper Cretaceous of Lebanon. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Plectocretacicus* SORBINI, 1979.

Geological range: Upper Cretaceous.

Geographical distribution: Middle East.

Features: Very small fishes of almost circular outline. Head small. Eyes large. Gape rather long. Head and body enclosed in an armour of bony plates with only the stalk of the caudal fin and the bases of the other fins free of it.

Remarks: Counts as the oldest known boxfish. Probably fed on small organisms taken from the bottom.

Recent relatives: Genus extinct. Distantly related to recent boxfishes.



Proaracana dubia (de BLAINVILLE) (length c. 4 cm) from the Middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Proaracana* TYLER, 1975.

Synonym: *Ostracion*.

Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Very small fishes with rounded outline and laterally rather flattened bodies. Head deep. Eyes large. Gape short. Head and body enclosed in an armour of hexagonal bony plates, except for the stalk of the tail and the bases of the fins. First dorsal fin pointed, at the highest part of the body. Second dorsal fin soft-rayed, opposite the anal fin. Caudal fin elongate, not forked, rounded.

Remarks: Probably preferred hard-shelled food.

Recent relatives: Related to recent cowfishes of the genus *Aracana*.



Proaracana, reconstruction after TYLER.



Eoplectus bloti TYLER (length c. 10 cm) from the Middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Eoplectus* TYLER, 1973.

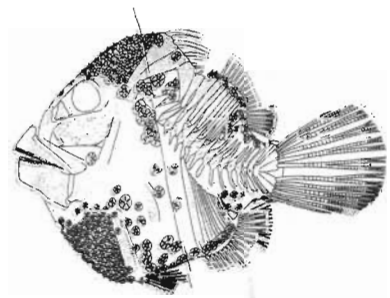
Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Small fishes of circular outline, rather laterally flattened. Head short and deep. Eyes large. Gape short, rather produced. First dorsal fin hard-rayed. Second dorsal fin soft-rayed, opposite the anal fin. Pelvic fins small. Caudal fin on a thick peduncle, elongate, rounded, not forked.

Remarks: Probably preferred hard-shelled food.

Recent relatives: None. Died out in Eocene.



Eoplectus, reconstruction after TYLER.



Spinacanthus imperialis (MASSALONGO) (length c. 66 cm) from the Middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy. Photograph: G. Bonato, Verona.

Genus: *Spinacanthus* AGASSIZ, 1835.

Synonym: *Protobalistum*.

Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Middle-sized to large fishes of oval outline, laterally flattened. Head deep. Eyes large. Gape somewhat anterior. First dorsal fin carried by five strong hard rays which decrease in length posteriorly. Second dorsal fin small, soft-rayed. Anal fin opposite the second dorsal fin, rather larger. Caudal fin pedunculated, not forked, rounded.

Remarks: Free-swimming predators which certainly also took hard-shelled prey.

Recent relatives: None. Died out in Eocene.



Zignoichthys oblongus (de ZIGNO) (length c. 18 cm) from the Middle Eocene of Bolca, Italy. Original: Università di Padova, Padua, Italy. Photograph: Università di Padova.

Genus: *Zignoichthys* TYLER, 1975.

Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Middle-sized fishes of oval outline, laterally compressed. Head deep. Eyes small. Snout somewhat produced. First dorsal fin borne by three hard rays. Second dorsal fin soft-rayed, short and fringe-like, like the anal fin opposite. Caudal fin not forked.

Remarks: Probably fed on bivalves, gastropods, crabs and also corals.

Recent relatives: Genus extinct. Nevertheless related to recent triggerfishes.



Balistoides conspicillum, the clown triggerfish.



Protacanthodes ombonii de Zigno (length c. 16 cm) from the Middle Eocene of Bolca, Italy. Original: Università di Padova, Padua, Italy.

Genus: *Protacanthodes* Gill, 1888.

Geological range: Middle Eocene.

Geographical distribution: Europe.

Features: Middle-sized fishes in outline deep in the middle of the body and tapering rearwards. Head deep. Eyes large. Snout pointed. Gape short. Jaws set with powerful teeth. First dorsal fin with a long powerful ray and three smaller rays. Second dorsal fin soft-rayed, broad-based. Anal fin considerably smaller. Pectoral fins likewise small. Pelvic fins each with one long hard ray. Caudal fin elongate and rounded.

Remarks: Probably fed mostly on hard-shelled prey.

Recent relatives: Genus extinct. Nevertheless related to recent spikefishes of the family Triacanthodidae.



Triacanthus biaculeatus, the common tripodfish.



Alutera sp. (length c. 3 cm) from the Pliocene of Fiume Marecchia, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Alutera* Oken, 1817.

Geological range: Pliocene to recent.

Geographical distribution: Europe.

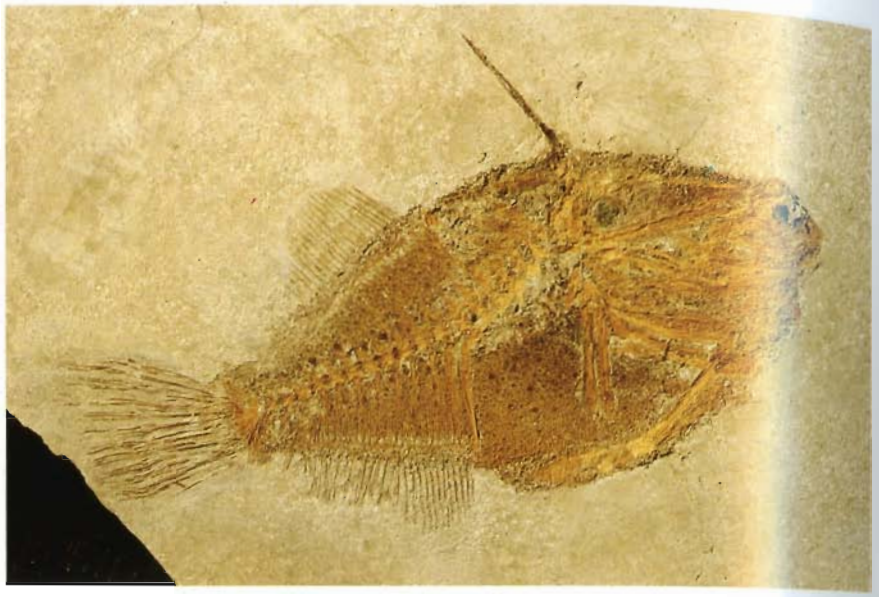
Features: Small to middle-sized fishes of elongate, laterally flattened shape. Head deep but with a long produced snout. Mouth small. First ray of the first dorsal fin elongated as a spine and with thorn-like outgrowths. Second dorsal fin short, fringe-like and soft-rayed. Pelvic fins absent. An obvious ventral keel begins at the throat. Tail fin not forked.

Remarks: Fed on plants.

Recent relatives: Related to recent filefishes of the genus *Alutera*.



Alutera scripta, the scribbled filefish.



Monacanthus sp. (length c. 14.5 cm) from the Pliocene of Fiume Marecchia, Italy. Original: Staatliches Museum für Naturkunde, Karlsruhe, Germany.

Genus: *Monacanthus* Oken, 1817.

Geological range: Pliocene to recent.

Geographical distribution: Europe.

Features: Small fishes of elongate oval outline. Head deep. Eyes relatively small. Mouth produced somewhat forward, very small. First ray of the first dorsal fin very long and powerful. Second dorsal fin very posterior, short and fringe-like, opposite the anal fin. Belly with an obvious keel. Pelvic fins absent. Caudal fin not forked, rounded.

Remarks: Fed on small organisms and probably also on plants.

Recent relatives: Closely related to recent filefishes of the subfamily Monacanthinae.



Monacanthus hispidus, the recent planehead filefish.



Oligobalistes robustus Daniltchenko (length c. 9 cm) from the Lower Oligocene of the northern Caucasus, C.I.S. Original: Paleontologicheskii Muzei Russkoi Akademii Nauk, Moscow, Russia.

Genus: *Oligobalistes* Daniltchenko, 1960.

Geological range: Lower Oligocene.

Geographical distribution: Eastern Europe.

Features: Small fishes of oval outline, laterally flattened. Head deep. Eyes small. Snout somewhat produced. First dorsal fin with three hard rays, the first being considerably stronger and longer than the two others. Second dorsal fin fringe-like like the anal fin. Caudal fin not forked, rounded.

Remarks: Fed on bivalves and snails, crabs and possibly also corals.

Recent relatives: Closely related to recent triggerfishes of the family Balistidae.



Pseudobalistes fuscus, the recent blue-and-gold triggerfish.



Unnamed fish (length c. 38 cm) from Fiume Marecchia, Italy. Original: Staatliches Museum für Naturkunde, Karlsruhe, Germany.

Genus: Not named.

Geological range: Pliocene to recent?

Geographical distribution: Europe.

Features: Middle-sized fishes of elongate oval outline, laterally flattened. Eyes large. Gape very small. First ray of the first dorsal fin elongate, powerful and anteriorly serrated. Second dorsal fin very posterior, short and fringe-like, opposite the similar anal fin. Caudal fin elongate, not forked, rounded. Belly keeled.

Remarks: Fed on small organisms and perhaps also on plants.

Recent relatives: Closely related to recent filefishes of the subfamily Monacanthinae.



Monacanthus melanocephalus, the recent redtail filefish.



Eotetraodon pygmaeus TYLER (length c. 2 cm) from the Middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Eotetraodon* TYLER, 1980.

Geological range: Eocene.

Geographical distribution: Europe.

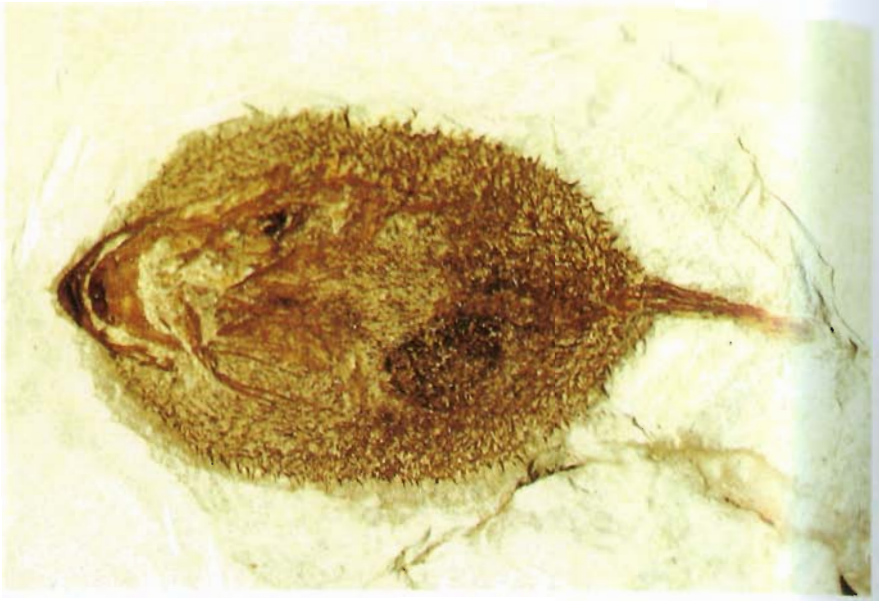
Features: Small to very small fishes with rounded plump bodies. Head large. Eyes large. Mouth small, somewhat produced. Teeth fused to form beak-like plates. First dorsal fin absent, as also are the pelvic fins. Second dorsal fin opposite the anal fin. Caudal fin stalked, not forked.

Remarks: Fed preferably on hard-shelled prey. Perhaps even then were able to inflate themselves.

Recent relatives: Closely related to recent puffers which live in tropical and subtropical seas but also occur in brackish and fresh water.



Arothron hispidus, the recent stars and stripes puffer.



Diodon tenuispinus Agassiz (length c. 7 cm) from the Middle Eocene of Bolca, Italy. Original: Museo Civico di Storia Naturale, Verona, Italy.

Genus: *Diodon* Linnaeus, 1758.

Synonyms: *Heptadiodon*, *Megalurites*.

Geological range: Eocene to recent.

Geographical distribution: Europe, Asia, Africa, North America, Indonesian Archipelago, Caribbean, Australia.

Features: Small fishes with plump oval bodies. Skin set with short powerful spines. Head small. Mouth relatively large. Mouth beak-like. Fused dental ridges. Dorsal and anal fins small, opposite each other, near the root of the tail. Caudal fin on a stalk, not forked, rounded.

Remarks: Fed mainly on hard-shelled prey. Could probably already inflate themselves.

Recent relatives: Closely related to recent porcupine fishes of the genus *Diodon* which live in warm seas.



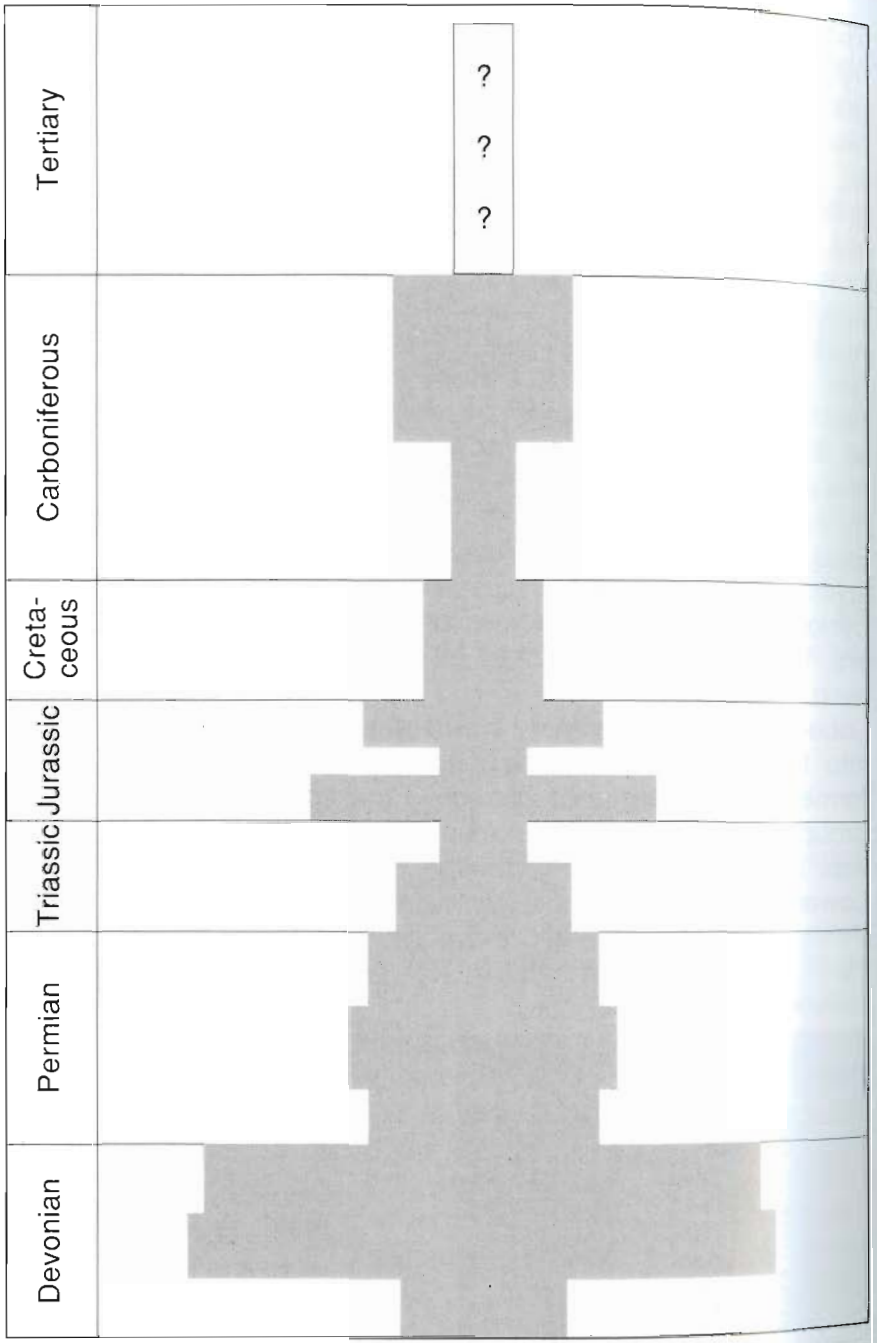
Diodon hystrix, a recent porcupinefish.

The lobe-finned fishes are assigned to the Osteichthyes. They differ from other bony fishes, however, in possessing true nostrils and choanae (ducts leading from the nostrils into the mouth). The skull is extensively ossified in the older forms, but incompletely so in the Coelacanthiformes. The eyes are protected by bony sclerotic rings consisting of more than four elements. The jaws are set with more or less longitudinally ribbed teeth. The vertebrae are only partly ossified. Pelvic and pectoral fins arise from a quadripartite base. The caudal fin is heterocercal in the older representatives, with a small upper lobe. In the course of evolution, however, this lobe became gradually bigger and finally reached the size of the lower lobe. Later forms have a third lobe at the end of the vertebral column. There are usually two dorsal fins and an anal fin separate from the caudal fin.

In the primitive members of the group the body is covered by thick rhombic scales with a cosmine layer and a thin shiny ganoine layer. In later forms these cosmine scales tend to transform into cycloid scales by gradual loss of the cosmine and ganoine layers. The length of these fishes varies from 20 cm to 2.5 metres or even more.

Lobe-finned fishes originally lived in fresh water. Later they moved into the sea, especially the members of the order Coelacanthiformes. The oldest ones appear in the Lower Devonian and the group reached its first maximum in the Middle Devonian. There was a second maximum, though only of short duration, in the Lower Triassic. After some oscillations they came to be uniformly distributed in the Upper Cretaceous. After that time, in the Tertiary, no fossil lobe-fins have ever been found, and they were believed to have died out.

In 1938, however, the famous *Latimeria* was discovered living in the depths of the ocean around the Comores Islands so the lobe-fins had survived after all. About 90 fossil genera have so far been described. Many of these are based on fragments though others are very well preserved. The particular importance of lobe-fins lies in the fact that they are seen as the immediate ancestors of all terrestrial vertebrates.



The approximate stratigraphical distribution of the crossopterygians, changed after MÜLLER.

Order: Coelacanthiformes
Family: Diplocercidae



Chagrinia sp. (length c. 10 cm) from the Upper Devonian of the U.S.A. Original: American Museum of Natural History, New York, N.Y., U.S.A.

Genus: *Chagrinia* SCHAEFFER, 1962.

Geological range: Upper Devonian.

Geographical distribution: North America.

Features: Small fishes of slender shape. Head shallow. Eyes large. Snout pointed. Gape rather long. First dorsal fin anterior to the middle of the body. Second dorsal fin in the posterior third of the body. Anal fin small. Pectoral fins relatively large. An obvious ventral keel begins at the throat. Caudal fin three-lobed with the middle lobe brush-like.

Remarks: Predators.

Recent relatives: None. Died out in Upper Devonian.



Lochmocercus aciculiodontus Lund & Lund (length c. 11 cm) from the Lower Carboniferous (Mississippian) of Bear Gulch, Montana, U.S.A. Original: Adelphi University, Garden City, N.Y., U.S.A.

Genus: *Lochmocercus* Lund & Lund, 1984.

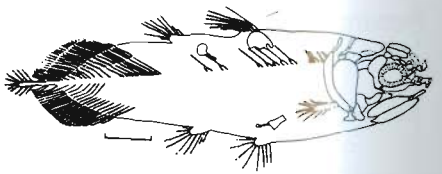
Geological range: Lower Carboniferous (Mississippian).

Geographical distribution: North America.

Features: Small fishes with laterally compressed bodies. Head deep. Eyes large. Gape rather long. Two small dorsal fins, the first being approximately in the middle of the body and the second in the posterior third of the body. The pelvic and anal fins are likewise small and lie obliquely opposite the first and second dorsal fins respectively. Caudal fin rounded, three-lobed, with a prominent brush-like middle lobe.

Remarks: Predators.

Recent relatives: None. Died out in Lower Carboniferous.



Lochmocercus, reconstruction after Lund.



Allenypterus montanus Melton (length c. 14 cm) from the Lower Carboniferous (Mississippian) of Bear Gulch, Montana, U.S.A. Original: Field Museum of Natural History, Chicago, Illinois, U.S.A.

Genus: *Allenypterus* Melton, 1969.

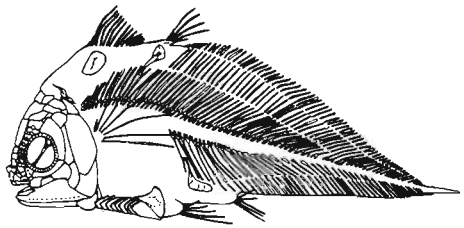
Geological range: Lower Carboniferous (Mississippian).

Geographical distribution: North America.

Features: Small fishes, approximately half-pear-shaped in outline. Head deep. Eyes large. Gape rather long. First dorsal fin at the highest part of the body. Second dorsal fin begins shortly behind the first and extends rearwards as a fringe. Anal fin and pelvic fins small. Pectoral fins considerably larger. Caudal fin consists only of a small extension of the vertebral axis.

Remarks: Predators.

Recent relatives: None. Died out in Lower Carboniferous.



Allenypterus, reconstruction after Lund.



Hadronector donbairdi Lund & Lund (length c. 9 cm) from the Lower Carboniferous (Mississippian) of Bear Gulch, Montana, U.S.A. Original: Carnegie Museum of Natural History, Pittsburgh, Penna., U.S.A.

Genus: *Hadronector* Lund & Lund, 1984.

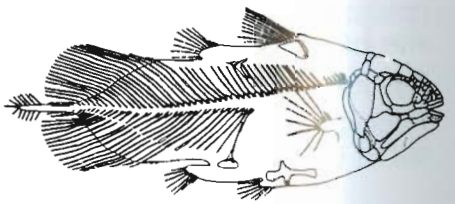
Geological range: Lower Carboniferous (Mississippian).

Geographical distribution: North America.

Features: Small fishes with laterally compressed bodies, deepest in the middle. Head deep. Eyes large. Gape rather long. First dorsal fin approximately in the middle of the body, the second dorsal fin in the posterior third. Pelvic and anal fins opposite the two dorsal fins, small. Pectoral fins somewhat larger. Caudal fin broad, three-lobed, the middle lobe prominent and brush-like.

Remarks: Predators.

Recent relatives: None. Died out in Lower Carboniferous.



Hadronector, reconstruction after Lund.



Polyosteorhynchus simplex Lund & Lund (length c. 12 cm) from the Lower Carboniferous (Mississippian) of Bear Gulch, Montana, U.S.A. Original: Adelphi University, Garden City, N.Y., U.S.A.

Genus: *Polyosteorhynchus* Lund & Lund, 1984.

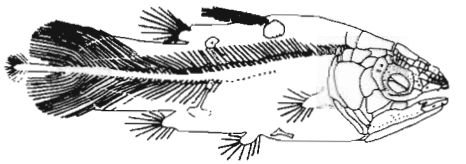
Geological range: Lower Carboniferous (Mississippian).

Geographical distribution: North America.

Features: Small fishes with laterally compressed bodies. Head deep. Eyes large. Gape rather long. Two small dorsal fins, the first being at the highest part of the body, the second in the posterior third. Pelvic, pectoral and anal fins small. Caudal fin three-lobed, the middle lobe promingent and brush-like.

Remarks: Predators.

Recent relatives: None. Died out in Lower Carboniferous.



Polyosteorhynchus, reconstruction after Lund.



Caridosuctor populosum LUND & LUND (length c. 19 cm) from the Lower Carboniferous (Mississippian) of Bear Gulch, Montana, U.S.A. Original: Bayerische Staatssammlung für Paläontologie, Munich, Germany.

Genus: *Caridosuctor* LUND & LUND, 1984.

Geological range: Lower Carboniferous (Mississippian).

Geographical distribution: North America.

Features: Small to middle-sized fishes of slender shape. Head shallow. Eyes large. Snout slightly rounded. Gape rather long. First dorsal fin approximately in the middle of the body. Second dorsal fin in the posterior third of the body. Pelvic and anal fins small, opposite the dorsal fins. Pectoral fins rounded. Caudal fin elongate, three-lobed, the middle lobe greatly extended and brush-like.

Remarks: Predators.

Recent relatives: None. Died out in Lower Carboniferous.



Caridosuctor, reconstruction after LUND.



Coelacanthopsis curta TRAQUAIR (length c. 9 cm) from the Lower Carboniferous of Eskdale, U.K. Original: National Museum of Scotland, Edinburgh, U.K.

Genus: *Coelacanthopsis* TRAQUAIR, 1901.

Synonym: *Dumfregia*.

Geological range: Lower Carboniferous (Mississippian).

Geographical distribution: Europe.

Features: Small fishes with slender bodies. Head shallow. Eyes large. Snout rounded. Gape rather long. First dorsal fin shortly behind the middle of the body. Second dorsal fin just in front of the root of the tail. Pelvic and anal fins opposite the dorsal fins. Caudal fin three-lobed, the middle lobe brush-like.

Remarks: Predators. Now reclassified into the genus *Rhabdoderma*.

Recent relatives: None. Died out in Lower Carboniferous.



Rhabdoderma elegans (NEWBERRY) (length c. 14 cm) from the Lower Carboniferous of Scotland, U.K. Original: The Natural History Museum, London. (P 5379)

Genus: *Rhabdoderma* REIS, 1888.

Synonyms: *Conchiopsis*, *Holopygus*.

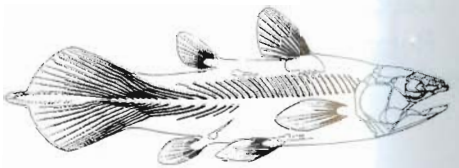
Geological range: Lower to Upper Carboniferous.

Geographical distribution: Western and eastern Europe, North America, northern Africa.

Features: Small to middle-sized fishes of slender shape. Head shallow. Eyes large. Snout rounded. Gape rather long. Both dorsal fins small, the first approximately in the middle of the body, the second in the posterior third. Caudal fin three-lobed, the middle lobe brush-like.

Remarks: Predators.

Recent relatives: None. Died out in Upper Carboniferous.



Rhabdoderma, reconstruction after FOREY.



Axelrodichthys araripensis MAISEY (length c. 42 cm) from the Lower Cretaceous of Ceará, Brazil. Original: Staatliches Museum für Naturkunde, Karlsruhe, Germany.

Genus: *Axelrodichthys* MAISEY, 1986.

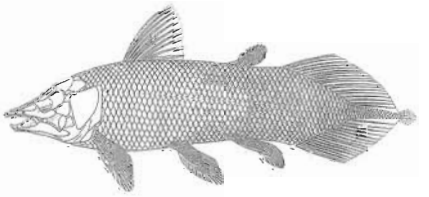
Geological range: Lower Cretaceous.

Geographical distribution: South America.

Features: Middle-sized fishes with laterally compressed bodies. Head shallow. Eyes small. Gape long. First dorsal fin in the anterior third of the body. Second dorsal fin probably smaller, in the posterior part of the body. Pelvic and anal fins elongate. Pectoral fins broad, fan-shaped. Caudal fin very large, probably three-lobed.

Remarks: Predators.

Recent relatives: None. Died out in Lower Cretaceous.



Axelrodichthys araripensis, reconstruction after MAISEY.



Coccoderma nudum Reis (length c. 17 cm) from the Upper Jurassic of Solnhofen (Kelheim), Bavaria, Germany. Original: Bayerische Staatssammlung für Paläontologie, Munich, Germany.

Genus: *Coccoderma* Zittel, 1887.

Synonym: *Dokkoderma*.

Geological range: Upper Jurassic.

Geographical distribution: Europe.

Features: Small to middle-sized fishes of slender shape. Head shallow. Eyes large. Snout somewhat pointed. Gape rather long. First dorsal fin anterior to the middle of the body. Second dorsal fin in the posterior half of the body. Pelvic and anal fins opposite the respective dorsal fins. Pectoral fins rounded. Caudal fin approximately lozenge-shaped, three-lobed, the middle lobe prominent and brush-like. Scales with granular surface.

Remarks: Predators.

Recent relatives: None. Died out in Upper Jurassic.



Coelacanthus granulatus Agassiz (length c. 32 cm) from the Permian of Bad Sachsa, Hesse, Germany. Original: Interfoss, Munich, Germany.

Genus: *Coelacanthus* Agassiz, 1836.

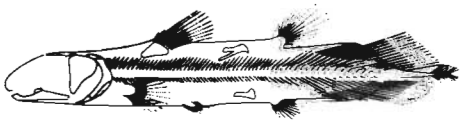
Geological range: Upper Carboniferous to Lower Triassic.

Geographical distribution: Europe, Madagascar, North America.

Features: Small to middle-sized fishes of slender shape. Head shallow. Eyes large. Snout rounded. Gape rather long. First dorsal fin in anterior third of body. Second dorsal fin in posterior third of body. Pelvic fins small. Anal and pectoral fins rounded. Caudal fin three-lobed, the middle lobe brush-like.

Remarks: Predators.

Recent relatives: None. Died out in Lower Triassic.



Coelacanthus, reconstruction after Moy-Thomas.



Diplurus newarki BRYANT (length c. 10 cm) from the Upper Triassic of Newark, N.J., U.S.A. Original: Interfoss, Munich, Germany.

Genus: *Diplurus* NEWBERRY, 1878.

Synonyms: *Osteoplurus*, *Holophagoides*, *Pariostegus*, *Rhabdiolepis*.

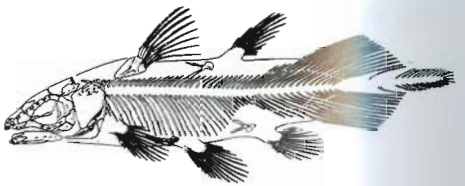
Geological range: Upper Triassic.

Geographical distribution: North America.

Features: Small fishes of slender outline. Head shallow. Eyes large. Snout pointed. First dorsal fin anterior to the middle of the body. Second dorsal fin somewhat larger, in the posterior half of the body. Pelvic and anal fins obliquely opposite the respective dorsal fins. Caudal fin three-lobed, the middle lobe prominent and brush-like.

Remarks: Predators.

Recent relatives: None. Died out in Upper Triassic.



Diplurus, after SCHÄFFER.



Libys superbus ZITTEL & REIS (length c. 42 cm) from the Upper Jurassic of Solnhofen (Eichstätt), Bavaria, Germany. Original: Bayrische Staatssammlung für Paläontologie, Munich, Germany.

Genus: *Libys* MÜNSTER, 1842.

Geological range: Upper Jurassic.

Geographical distribution: Europe.

Features: Middle-sized fishes of laterally compressed shape. Head deep. Eyes large. Snout somewhat produced. Gape rather long. Both dorsal fins relatively large, the first anterior to the middle of the body, the second in the posterior third. Pelvic and anal fins rounded and slightly pointed. Caudal fin very large, three-lobed, the middle lobe prominent and brush-like.

Remarks: Predators.

Recent relatives: None. Died out in Lower Carboniferous.



Macropomoides orientalis WOODWARD (length c. 8 cm) from the Upper Cretaceous of Lebanon. Original: Henne Collection, Stuttgart, Germany.

Genus: *Macropomoides* WOODWARD, 1942.

Geological range: Upper Cretaceous.

Geographical distribution: Middle East.

Features: Small fishes with rather laterally compressed bodies. Head deep. Eyes large. Snout produced. Gape rather long. First dorsal fin shortly behind the middle of the body. Second dorsal fin much more posterior. Pelvic and anal fins rounded. Caudal fin three-lobed, the middle lobe prominently brush-like.

Remarks: One of the last lobe-fins before the discovery of *Latimeria*.

Recent relatives: Possibly related to the recent genus *Latimeria*.



Latimeria chalumnae. The only recent lobe-fin.



Miguashaia bureaui SCHULTZE (length c. 7.5 cm) from the Upper Devonian of Miguasha, Gaspé Peninsula, Quebec, Canada. Original: Musée de Géology, University Laval, Quebec, Canada.

Genus: *Miguashaia* SCHULTZE, 1973.

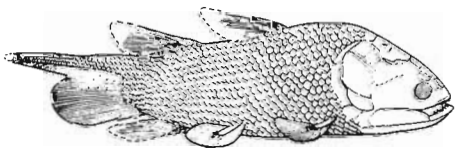
Geological range: Upper Devonian.

Geographical distribution: North America.

Features: Small fishes of slender shape. Head deep. Eyes rather large. Snout somewhat produced. First dorsal fin approximately in the middle of the body. Second dorsal fin very posterior. Caudal fin three-lobed, the middle lobe brush-like.

Remarks: Predators.

Recent relatives: None. Died out in Upper Devonian.



Miguashaia, reconstruction after SCHULTZE.



Piveteauia madagascariensis LEHMAN (length c. 12 cm) from the Lower Triassic of Madagascar. Original: Muséum National d'Histoire Naturelle, Paris, France. Photograph: Serette, Paris.

Genus: *Piveteauia* LEHMAN, 1952.

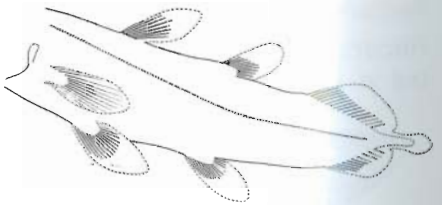
Geological range: Lower Triassic.

Geographical distribution: Madagascar.

Features: Small fishes of slender shape. Head deep. Snout pointed. Gape rather long. First dorsal fin narrow, in the anterior third of the body. Second dorsal fin with a rather broader base. Pectoral and pelvic fins narrow, obliquely opposite each other. Caudal fin three-lobed, the middle lobe prominently brush-like.

Remarks: Probably predators.

Recent relatives: None. Died out in Triassic.



Piveteauia, reconstruction after LEHMAN



Whiteia woodwardi MOY-THOMAS (length c. 26 cm) from the Lower Triassic of Madagascar. Original: Staatliches Museum für Naturkunde, Karlsruhe, Germany.

Genus: *Whiteia* MOY-THOMAS, 1935.

Geological range: Lower to Upper Triassic.

Geographical distribution: Madagascar, Greenland, North America.

Features: Middle-sized fishes of rather laterally compressed shape. Head shallow. Eyes large. Snout elongate and pointed. Gape rather long. First dorsal fin long and narrow. Second dorsal fin in the posterior third of the body, rounded. Anal, pelvic and pectoral fins likewise rounded. Caudal fin three-lobed, the middle lobe prominently brush-like.

Remarks: Predators.

Recent relatives: None. Died out in Upper Triassic.



Whiteia, reconstruction after LEHMAN.



Unnamed fish (length c. 67 cm) from the Lower Triassic of Wapiti Lake, Canada. Original: Staatliches Museum für Naturkunde, Karlsruhe, Germany.

Genus: Not named.

Geological range: Lower Triassic.

Geographical distribution: North America.

Features: Middle-sized fishes with rather laterally compressed bodies. Head elongate. Eyes small. Snout slightly produced. Gape rather long. First dorsal fin in the anterior third of the body. Second dorsal fin in the posterior third of the body, opposite the larger anal fin. Pectoral fins long, narrow and pointed. Caudal fin very large, the upper and lower lobes arcuate anteriorly, produced into a point posteriorly, the middle lobe brush-like.

Remarks: Predators.

Recent relatives: None. Probably died out in the Triassic.



Holophagus sp. (length c. 25 cm) from the Upper Triassic of Zogno, Bergamo, Italy. Original: Museo Civico dei Scienze Naturali Caffi, Bergamo, Italy.

Genus: *Holophagus* EGERTON, 1861.

Synonym: *Trachymetopon*.

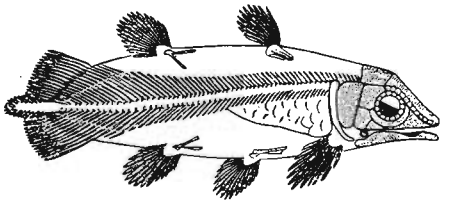
Geological range: Upper Triassic.

Geographical distribution: Europe, Australia.

Features: Middle-sized fishes of rather laterally compressed shape. Head shallow. Eyes large. Snout pointed. Gape rather long. Dorsal fins rounded, the first in the middle of the body, the second very posterior. Anal and pelvic fins likewise rounded. Pectoral fins long and rounded. Caudal fin three-lobed, the middle lobe prominently brush-like.

Remarks: Predators.

Recent relatives: None. Died out in Upper Triassic.



Holophagus, reconstruction after WOODWARD.



Laugia groenlandica STENSIO (length c. 17 cm) from the Lower Triassic of Greenland. Original: The Natural History Museum, London, U.K. (P2641-2).

Genus: *Laugia* STENSIÖ, 1932.

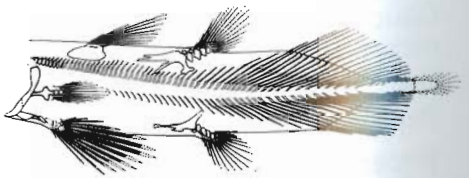
Geological range: Lower Triassic.

Geographical distribution: Greenland.

Features: Middle-sized fishes of slender shape. Head shallow. Eyes large. Gape rather long. First dorsal fin slightly anterior to the middle of the body. Second dorsal fin in the posterior third, opposite the relatively long anal fin. Caudal fin long and narrow, three-lobed, the middle lobe prominently brush-like.

Remarks: Predators.

Recent relatives: None. Died out in Lower Triassic.



Laugia, reconstruction after STENSIÖ.



Undina penicillata MÜNSTER (length c. 32 cm) from the Upper Jurassic of Solnhofen (Eichstätt), Bavaria, Germany. Original: Interfoss, Munich, Germany.

Genus: *Undina* MÜNSTER, 1834.

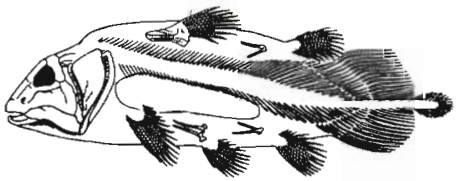
Geological range: Upper Jurassic.

Geographical distribution: Europe.

Features: Middle-sized fishes of rather laterally compressed shape. Head deep. Eyes large. Gape rather long. First dorsal fin approximately in the middle of the body, the second very posterior. Pelvic and anal fins rounded. Pectoral fins elongate. Caudal fin broad, three-lobed, the middle lobe prominently brush-like.

Remarks: Predators. *Undina* is occasionally considered a synonym of *Holophagus*.

Recent relatives: None. Died out in Upper Jurassic.



Undina, reconstruction after NORMAN.



Callistiopterus clappi ROMER (length c. 7 cm) from the Upper Devonian of Miguasha, Gaspé Peninsula, Quebec, Canada. Original: Museum for Comparative Zoology, Harvard University, Cambridge, Mass., U.S.A.

Genus: *Callistiopterus* THOMSON & HAHN, 1968.

Geological range: Upper Devonian.

Geographical distribution: North America.

Features: Small fishes with very slender elongate bodies. Head shallow. Eyes small. Gape long. The two dorsal fins very posterior in position, respectively opposite the anal and pelvic fins. Caudal fin heterocercal with large lower lobe. Rounded scales. The taxonomic classification of this specimen is disputed.

Remarks: Predators. The taxonomic classification of this specimen is disputed.

Recent relatives: None. Died out in Upper Devonian.



Callistiopterus, reconstruction after SCHULTZE.



Quebecius quebecensis (WHITEAVES) (length c. 6 cm) from the Upper Devonian of Miguasha, Gaspé Peninsula, Quebec, Canada. Original: Museum of Natural History, Lawrence, Kansas, U.S.A.

Genus: *Quebecius* SCHULTZE, 1973.

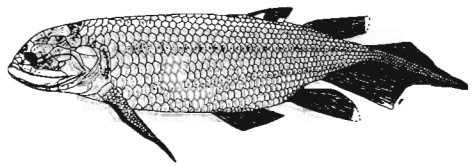
Geological range: Upper Devonian.

Geographical distribution: North America.

Features: Small fishes with rather laterally compressed bodies. Head deep. Eyes small. Gape very long. Two dorsal fins, the first smaller, both very posterior in position. Anal fin elongate, rounded. Pelvic fins broad-based. Pectoral fins long and very narrow. Caudal fin directed downwards, heterocercal, with the lower lobe bigger than the upper. Rounded, strongly overlapping scales.

Remarks: Predators. Now reclassified into the genus *Holoptychiidae*.

Recent relatives: None. Died out in Upper Devonian.



Quebecius, reconstruction after SCHULTZE.



Porolepis brevis JARVIK (length c. 20 cm) from the Middle Devonian of Spitzbergen. Original: Muséum National d'Histoire Naturelle, Paris, France. Photograph: Serette, Paris.

Genus: *Porolepis* WOODWARD, 1891.

Synonym: *Gyrolepis*.

Geological range: Lower to Middle Devonian.

Geographical distribution: Europe, Spitzbergen, northern Asia.

Features: Small to middle-sized fishes of rather laterally compressed shape. Head deep. Eyes relatively large. Snout rounded. Two pairs of nostrils. Body covered with thick rhombic scales. Paired fins probably long and pointed, with fleshy lobes.

Remarks: Probably predators.

Recent relatives: None. Died out in Devonian.



Glyptolepis paucidens AGASSIZ (length c. 62 cm) from the Middle Devonian of Caithness, Scotland. Original: National Museum of Scotland, Edinburgh, U.K.

Genus: *Glyptolepis* AGASSIZ, 1841.

Synonyms: *Hamodus*, *Phlyphlepis*, *Sclerolepis*.

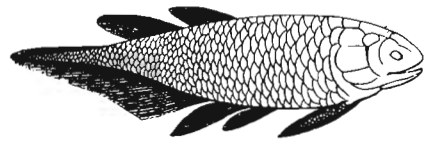
Geological range: Middle to Upper Devonian.

Geographical distribution: Western and eastern Europe, Spitzbergen, Greenland.

Features: Middle-sized to large fishes with rather laterally compressed bodies tapering strongly rearwards. Head rather deep. Eyes small. Gape long. Two dorsal fins, both of them narrow and gently pointed and situated very posteriorly. Pelvic and anal fins obliquely opposite the respective dorsal fins. Pectoral fins very long and narrow. Caudal fin heterocercal, with the lower lobe considerably larger and almost fringe-like. Rounded, overlapping scales.

Remarks: Predators.

Recent relatives: None. Died out in Upper Devonian.



Glyptolepis, reconstruction after ZITTEL.



Holoptychius quebecensis (WHITEAVES) (length c. 45 cm) from the Middle Devonian of Scaumenac Bay, Canada. Original: American Museum of Natural History, New York, N.Y., U.S.A.

Genus: *Holoptychius* EGERTON, 1837.

Synonyms: *Apedodus*, *Apendulus*, *Dendrodus*, *Lamnodus*.

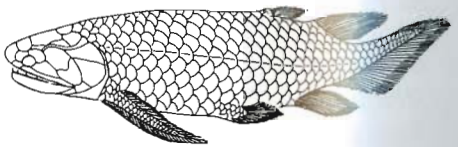
Geological range: Middle Devonian to Lower Carboniferous.

Geographical distribution: Europe, North America, Greenland, Australia, Antarctic, northern Asia.

Features: Middle-sized fishes with rather laterally compressed bodies. Head shallow. Eyes small. Gape long. First dorsal fin very small, second considerably larger, both very posterior. Pelvic fins small, rather pointed, opposite the first dorsal fin. Anal fin somewhat larger. Pectoral fins unusually long and narrow. Caudal fin heterocercal with the lower lobe larger. Rounded overlapping scales.

Remarks: Predators.

Recent relatives: None. Died out in Lower Carboniferous.



Holoptychius, reconstruction after TRAQUAIR.



Ectosteorhachis sp. (length c. 40 cm) from the Lower Permian of Texas, U.S.A. Original: American Museum of Natural History, New York, N.Y., U.S.A.

Genus: *Ectosteorhachis* COPE, 1880.

Geological range: Lower Permian.

Geographical distribution: North America.

Features: Middle-sized fishes with long narrow bodies. Head broad. Eyes small. Gape long. Dorsal fins very posterior. Pectoral fins rounded. The whole body covered with thick rhombic scales.

Remarks: Predators.

Recent relatives: None. Died out in Lower Permian.



Gyroptychius agassizi TRAILL (length c. 30 cm) from the Middle Devonian of the Orkney Islands, U.K. Original: Bayerische Staatssammlung für Paläontologie, Munich, Germany.

Genus: *Gyroptychius* McCOY, 1848.

Synonyms: *Diplopterax*, *Diplopterus*, *Diptopterus*.

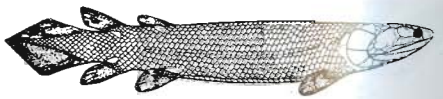
Geological range: Middle to Upper Devonian.

Geographical distribution: Europe, Greenland.

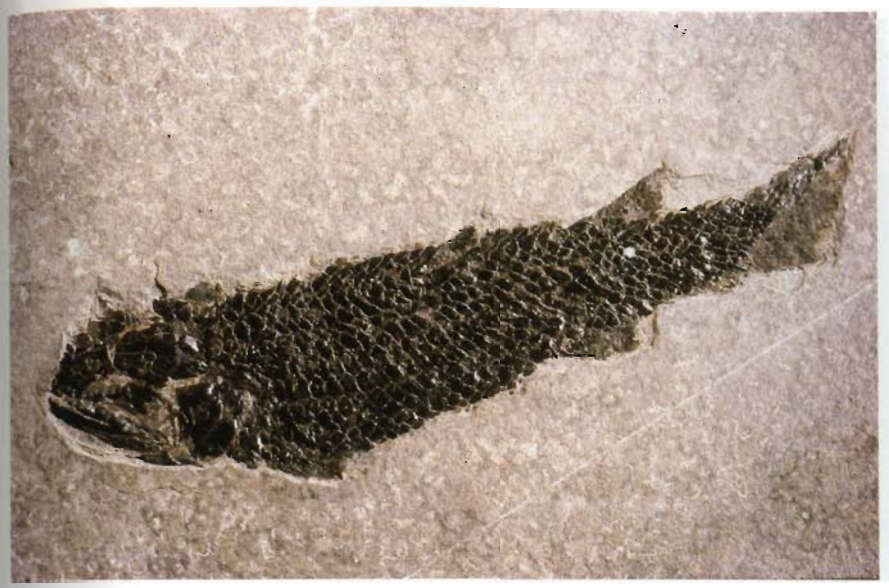
Features: Middle-sized fishes with elongate slender bodies. Head shallow. Eyes small. The two dorsal fins very posterior, with the first smaller than the second. Anal and pelvic fins opposite the respective dorsal fins. Caudal fin rhombic in shape, pointed posteriorly. Body covered with rectangular, diagonally arranged scales.

Remarks: Predators.

Recent relatives: None. Died out in Upper Devonian.



Gyroptychius, reconstruction after JARVIK.



Osteolepis macrolepidotus AGASSIZ (length c. 18 cm) from the Middle Devonian of the Orkney Islands, U.K. Original: Frickhinger Collection, Munich, Germany.

Genus: *Osteolepis* VALENCIENNES, 1829.

Synonyms: *Pleiopterus*, *Pliopterus*, *Triplopterus*, *Tripterus*.

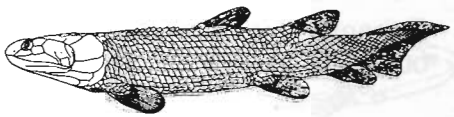
Geological range: Middle to Upper Devonian.

Geographical distribution: Europe, northern Asia, Antarctica.

Features: Small to middle-sized fishes with slender elongate bodies. Head shallow. Eyes small. Gape long. The two dorsal fins small, rounded, very posterior in position. Anal and pelvic fins obliquely opposite the respective dorsal fins. Pectoral fins likewise rounded. Caudal fin heterocercal with the lower lobe larger. Scales rectangular, arranged in diagonal rows.

Remarks: Predators.

Recent relatives: None. Died out in Upper Devonian.



Osteolepis, reconstruction after JARVIK.



Thursius pholidotus TRAQUAIR (length c. 19 cm) from the Middle Devonian of Caithness, Scotland, U.K. Original: Bayerische Staatssammlung für Paläontologie, Munich, Germany.

Genus: *Thursius* TRAQUAIR, 1888.

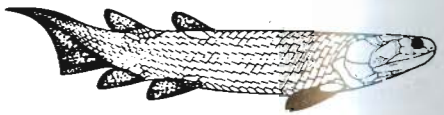
Geological range: Middle Devonian.

Geographical distribution: Europe.

Features: Small to middle-sized fishes with slender elongate bodies. Head shallow. Eyes small. Gape long. Both dorsal fins rounded, very posterior. Pelvic and anal fins opposite the respective dorsal fins. Pectoral fins elongate and narrow. Caudal fin heterocercal with lower lobe considerably larger. Body covered with rectangular, diagonally arranged scales.

Remarks: Predators.

Recent relatives: None. Died out in Middle Devonian.



Thursius, reconstruction after JARVIK.



Eustenopteron foordi WHITEAVES (length c. 31 cm) from the Upper Devonian of Miguasha, Gaspé Peninsula, Quebec, Canada. Original: Musée d'Histoire Naturelle, Miguasha, Quebec, Canada.

Genus: *Eusthenopteron* WHITEAVES, 1881.

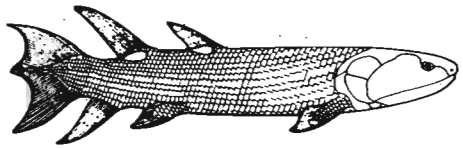
Geological range: Upper Devonian.

Geographical distribution: Europe, North America.

Features: Middle-sized fishes with long, anteriorly dorso-ventrally flattened bodies. Head shallow. Eyes small. Gape long. Two elongate and pointed dorsal fins, both of them very posterior. Pelvic and anal fins opposite the respective dorsal fins and somewhat broader. Pectoral fins elongate, rounded. Caudal fin with three lobes, the middle one extending beyond the two others. Scales round and thin, overlapping.

Remarks: Commonly seen as the most typical example of the lobe-fins which first moved onto land.

Recent relatives: None. Died out in Upper Devonian.



Eusthenopteron, reconstruction after WHITEAVES.



Tristichopterus alatus EGERTON (length c. 28 cm) from the Middle Devonian of the Orkney Islands, U.K. Original: National Museum of Scotland, Edinburgh, U.K.

Genus: *Tristichopterus* Egerton, 1861.

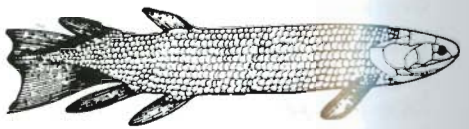
Geological range: Middle Devonian.

Geographical distribution: Europe.

Features: Middle-sized fishes with slender elongate bodies. Head shallow. Eyes small. Gape long. Two narrow dorsal fins, both very posterior. Anal and pelvic fins opposite the respective dorsal fins, somewhat longer and pointed. Pectoral fins long and narrow, somewhat fan-shaped. Caudal fin tripartite, with all three lobes of about the same length. Rounded, overlapping scales.

Remarks: Predators.

Recent relatives: None. Died out in Middle Devonian.



Tristichopterus, reconstruction after WATSON.



Elpistostege watsoni WESTOLL (length c. 17 cm) from the Upper Devonian of Miguasha, Gaspé Peninsula, Quebec, Canada. Original: Musée d'Histoire Naturelle, Miguasha, Quebec, Canada.

Genus: *Elpistostege* WESTOLL, 1938.

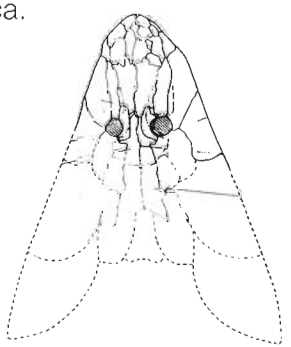
Geological range: Upper Devonian.

Geographical distribution: North America.

Features: Middle-sized to large fishes with head deep behind and tapering forwards. Snout rounded. Eyes small and close together. Gape long.

Remarks: Already has a very amphibian-like head and therefore may have played an important role in evolution.

Recent relatives: None. Died out in Upper Devonian.



Elpistostege, reconstruction after SCHULTZE.

Order: Rhipidistiiformes
Family: Rhizodontidae



Canowindra grossi THOMSON (length c. 52 cm) from the Devonian of Canowindra, New South Wales, Australia. Cast: Tyrell Museum of Natural History, Drumheller, Alberta, Canada.

Genus: *Canowindra* THOMSON, 1973.

Geological range: Upper Devonian.

Geographical distribution: Australia.

Features: Middle-sized fishes with slender elongate bodies. Head shallow. Eyes small. Gape long. First dorsal fin smaller than the second, both very posterior. Pelvic and anal fins similar. Pectoral fins small and pointed. Caudal fin heterocercal with the lower lobe larger. Body covered with round overlapping scales.

Remarks: Predators.

Recent relatives: None. Died out in Upper Devonian.

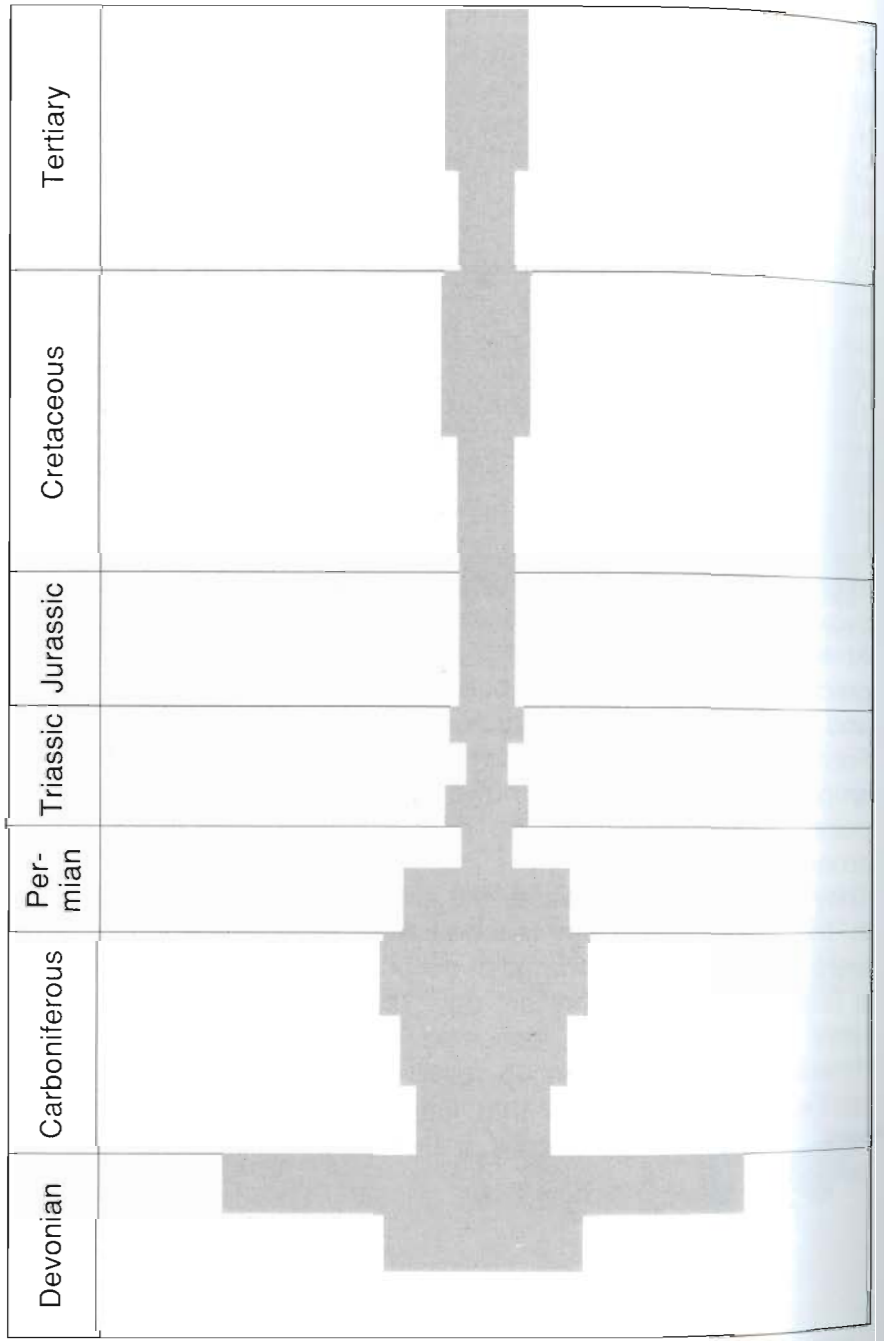


Canowindra, reconstruction after West Australian Museum.

Lungfishes are bony fishes with a lung branching ventrally from the esophagus. The lung is a primitive organ comparable to that of other primitive teleosts and amphibians. External gills form in the larval stages but are later lost. In the earliest stages there is bone in the skull, but cartilage predominates later. Most lungfishes have massive tooth plates which have arisen by the fusion of primitive tooth rows. There are usually two tooth plates on the palate and one on the lower jaw. Some Devonian genera have remarkable flange-like bones on the upper and lower jaws which have been interpreted as gripping tools helping in the capture of food. The internal skeleton is partly bony and partly cartilaginous. The paired fins are narrow-based and consist of a jointed main ray and numerous side rays. The caudal fin is primitively heterocercal but tends to become diphycercal. The first dorsal fin tends to be lost, while in the course of evolution the second dorsal fin fuses with the caudal and anal fin. Primitively there are thick cosmoid scales, but in younger genera these become thinner cycloid scales with the loss of the cosmine and ganoine layers. At the same time the scales increase in size. Lungfishes feed predominantly on molluscs but also on plants. All lungfishes live, and always have lived, in fresh water.

Formerly the lungfishes were seen as the forerunners of the amphibians. It turns out, however, that, from the phylogenetic point of view, they must be regarded as a side branch of the crossopterygians.

They first appeared towards the end of the Lower Devonian and in the Upper Devonian reached their all-time maximum. They were never so common again, although they have persisted, with a few genera, to the present day. These recent forms are distributed over a wide area, occurring in Africa, Australia and South America. Not more than 45 fossil genera have so far been described which indicates that lungfishes were always relatively rare. The smaller specimens are often extremely well preserved as fossils.



The approximate stratigraphical distribution of lungfishes, changed after MÜLLER.



Uranolophus wyomingensis DENISON (length c. 30 cm) from the Lower Devonian of Wyoming, U.S.A. Original: Field Museum of Natural History, Chicago, Illinois, U.S.A.

Genus: *Uranolophus* DENISON, 1967.

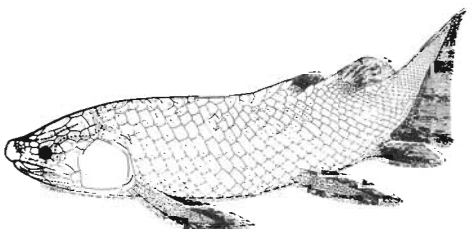
Geological range: Lower Devonian.

Geographical distribution: North America.

Features: Middle-sized fishes with laterally bodies but rather broader in the middle. Head deep. Body covered with very thick rhombic scales. Both dorsal fins low. Caudal fin broad and short.

Remarks: Fresh-water predators.

Recent relatives: None. Died out in Lower Devonian.



Uranolophus, reconstruction after SCHULTZE.



Dipnorhynchus suessmilchi (ETHERIDGE) (length c. 12 cm) from the Lower Devonian of Taemas, New South Wales, Australia. Original: Australian National University, Canberra, Australia.

Genus: *Dipnorhynchus* JAEKEL, 1927.

Geological range: Lower Devonian.

Geographical distribution: Europe, Australia.

Features: Middle-sized fishes of slender shape. Head shallow and flat. Eyes small. Snout rounded. Gape rather long. Two dorsal fins. Anal fin small. Pelvic and pectoral fins long and pointed. Caudal fin with a lower lobe. Body covered with rounded overlapping scales.

Remarks: Fresh-water predators.

Recent relatives: None. Died out in Lower Devonian.



Dipnorhynchus, reconstruction after MACMILLAN.



Griphognathus sculpta SCHULTZE (length c. 25 cm) from the Upper Devonian of Bergisch Gladbach, Rhineland, Germany. Original: Naturhistoriska Riksmuseet, Stockholm, Sweden.

Genus: *Griphognathus* GROSS, 1956.

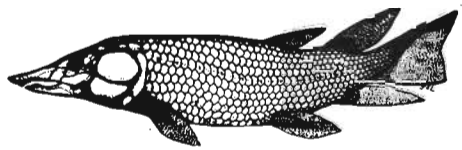
Geological range: Upper Devonian.

Geographical distribution: Europe, Australia.

Features: Middle-sized fishes with rather laterally compressed bodies. Head shallow. Eyes small. Snout produced to form a sort of beak. Gape long. Two dorsal fins in the posterior third of the body, the first being small and pointed and the second considerably larger. First dorsal fin. Second dorsal fin. Anal, pectoral and pelvic fins elongate, narrow and pointed. Caudal fin with a lower lobe. Body covered with rounded, overlapping scales.

Remarks: Fresh-water predators.

Recent relatives: None. Died out in Upper Devonian.



Griphognathus, reconstruction after SCHULTZE.



Holodipterus gogoensis MILES (length c. 8 cm) from the Upper Devonian of Paddy's Springs, Western Australia, Australia. Original: Australian National University, Canberra, Australia.

Genus: *Holodipterus* WHITE & MOY-THOMAS, 1940.

Synonyms: *Archaeotylus*, *Holodus*.

Geological range: Upper Devonian.

Geographical distribution: Europe, Australia.

Features: Middle-sized fishes. Head shallow. Snout produced into a sort of beak. Lower jaw extends further than upper jaw. Strong intermeshing tooth plates.

Remarks: Fresh-water predators.

Recent relatives: None. Died out in Upper Devonian.



Chirodipterus australis MILES (length c. 12 cm) from the Upper Devonian of Paddy's Springs, Western Australia, Australia. Original: Australian National University, Canberra, Australia.

Genus: *Chirodipterus* GROSS, 1933.

Geological range: Upper Devonian.

Geographical distribution: Europe, Australia.

Features: Middle-sized fishes. Head shallow. Eyes large. Snout slightly produced, rounded. Lower jaw placed rather posteriorly, acting against the upper jaw as in a parrot's beak. Body covered with rounded scales.

Remarks: Fresh-water predators.

Recent relatives: None. Died out in Upper Devonian.



Dipterus valenciennesi SEDGWICK & MURCHISON (length c. 12 cm) from the Middle Devonian of Caithness, Scotland, U.K. Original: Naturmuseum Senckenberg, Frankfurt-am-Main, Germany.

Genus: *Dipterus* SEDGWICK & MURCHISON, 1829.

Synonyms: *Catopterus*, *Eoctenodus*, *Paradipterus*, *Polyphractus*.

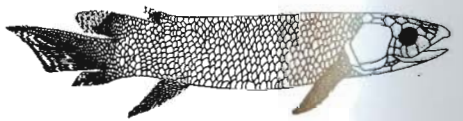
Geological range: Lower to Upper Devonian.

Geographical distribution: Europe, North America, northern Asia, Australia.

Features: Small fishes of slender shape. Head shallow. Eyes relatively large. Snout produced, pointed. Gape long. Two dorsal fins, the first very small, the second elongate and broad. Caudal fin with lower lobe. Pelvic and pectoral fins elongate, narrow and pointed. Body covered with round overlapping scales.

Remarks: Fresh-water predators.

Recent relatives: None. Died out in Upper Devonian.



Dipterus, reconstruction after FORSTER-COOPER.



Pentlandia macroptera (TRAQUAIR) (length c. 12 cm) from the Middle Devonian of the Orkney Islands, U.K. Original: National Museum of Scotland, Edinburgh, U.K.

Genus: *Pentlandia* WATSON & DAY, 1916.

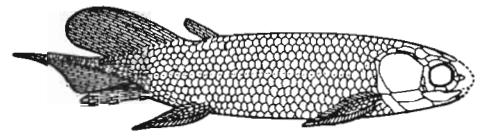
Geological range: Middle Devonian.

Geographical distribution: Europe.

Features: Small fishes with slender bodies. Head rather deep. Eyes large. Snout rounded. Two dorsal fins near the posterior end of the body. First dorsal fin very small. Second dorsal fin considerably larger and rounded at the end. Caudal fin with lower lobe only. Anal fin just separate from the caudal fin, elongate and narrow. Pelvic and pectoral fins elongate and pointed. Caudal fin heterocercal. Round overlapping scales.

Remarks: Fresh-water predators.

Recent relatives: None. Died out in Middle Devonian.



Pentlandia, reconstruction after Watson.



Rhinodipterus sp. (length c. 11 cm) from the Upper Devonian of Bergisch-Gladbach, Rhineland, Germany. Original: Naturhistoriska Riksmuseet, Stockholm, Sweden.

Genus: *Rhinodipterus* Gross, 1956.

Geological range: Middle to Upper Devonian.

Geographical distribution: Europe.

Features: Small fishes of slender shape. Head shallow. Eyes relatively large. Snout produced. Gape long. Two dorsal fins, close together at the posterior end of the body. First dorsal fin considerably smaller than the second. Caudal fin with lower lobe only. Anal, pelvic and pectoral fins elongate and pointed. Body covered with round overlapping scales.

Remarks: Fresh-water predators.

Recent relatives: None. Died out in Upper Devonian.



Fleurantia denticulata Graham-Smith & Westoll (length c. 21 cm) from the Upper Devonian of Bonaventura County, Canada. Original: The Natural History Museum, London, U.K. (P24745-6).

Genus: *Fleurantia* Graham-Smith & Westoll, 1937.

Geological range: Upper Devonian.

Geographical distribution: North America.

Features: Middle-sized fishes with rather laterally compressed bodies, deepest out in the middle. Head shallow. Eyes relatively large. Snout produced to form a sort of beak. Gape long. Teeth pointed. First dorsal fin very small. Second dorsal fin broad. Caudal fin with lower lobe only. Anal, pelvic and pectoral fins elongate and pointed. Body covered with thin round scales.

Remarks: Fresh-water predators.

Recent relatives: None. Died out in Upper Devonian.



Fleurantia, reconstruction after Graham-Smith & Westoll.



Phaneropleuron andersoni HUXLEY (length c. 33 cm) from the Upper Devonian of Fife, Scotland, U.K. Original: National Museum of Scotland, Edinburgh, U.K.

Genus: *Phaneropleuron* HUXLEY, 1859.

Geological range: Upper Devonian.

Geographical distribution: Europe.

Features: Middle-sized fishes of slender shape. Head shallow. Eyes small. Snout somewhat produced, pointed. Gape rather long. Dorsal fin fused with the caudal fin to form a fringe which begins in the anterior third of the body and becomes rather taller posteriorly. Anal fin separate from the caudal fin. Pelvic and pectoral fins elongate and pointed. Thin overlapping scales.

Remarks: Fresh-water predators.

Recent relatives: None. Died out in Upper Devonian.



Phaneropleuron, reconstruction after DOLLO.



Scaumenacia curta (WHITEAVES) (length c. 25 cm) from the Upper Devonian of Miguasha, Gaspé Peninsula, Quebec, Canada. Original: American Museum of Natural History, New York, N.Y., U.S.A.

Genus: *Scaumenacia* TRAQUAIR, 1893.

Synonym: *Canadipterus*.

Geological range: Upper Devonian.

Geographical distribution: North America.

Features: Middle-sized fishes of laterally compressed, high-backed shape. Head shallow. Eyes small. Snout somewhat produced, pointed. First dorsal fin beginning at the highest part of the body and forming a very blow fringe. Second dorsal broad, rounded posteriorly. Caudal fin with the lower lobe considerably larger than upper. Anal, pelvic fins and pectoral fins elongate and pointed. Body covered with round scales.

Remarks: Fresh-water predators.

Recent relatives: None. Died out in Upper Devonian.



Scaumenacia, reconstruction after PIVETEAU.



Ctenodus tardus Fritsch (length c. 45 cm) from the Permian of Kostalov, Czechoslovakia. Original: American Museum of Natural History, New York, N.Y., U.S.A.

Genus: *Ctenodus* Agassiz, 1838.

Synonyms: *Campylopleuron*, *Proctenodus*, *Rhadamista*.

Geological range: Lower Carboniferous to Permian.

Geographical distribution: Europe, Australia, North America.

Features: Middle-sized fishes with slender, laterally flattened bodies. Head shallow. Eyes small. Snout somewhat produced, pointed. Gape rather long. Dorsal and anal fins fused with caudal fin to form a narrow fringe. Body covered with thin round scales.

Remarks: Fresh-water predators.

Recent relatives: None. Died out in Permian.



Sagenodus copeanus Williston (length c. 34 cm) from the Upper Carboniferous of Kansas, U.S.A. Original: Museum of Natural History, Lawrence, Kansas, U.S.A.

Genus: *Sagenodus* Owen, 1867.

Synonyms: *Petalodopsis*, *Yonodus*.

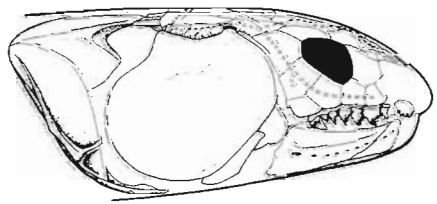
Geological range: Lower Carboniferous to Lower Permian.

Geographical distribution: Europe, North America.

Features: Middle-sized fishes with slender, laterally flattened bodies. Head shallow. Eyes small. Snout rounded. Dorsal and anal fins fused with the caudal fin to form a low fringe. Body covered with round scales.

Remarks: Fresh-water predators.

Recent relatives: None. Died out in Upper Permian.



Sagenodus, reconstruction after Watson & Gill.



Uronemus lobatus Traquair (length c. 13 cm) from the Lower Carboniferous of Edinburgh, Scotland, U.K. Original: National Museum of Scotland, Edinburgh, U.K.

Genus: *Uronemus* Agassiz, 1844.

Synonym: *Ganopristodus*.

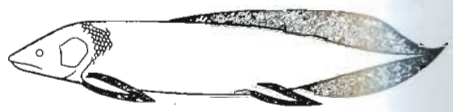
Geological range: Lower Carboniferous.

Geographical distribution: Europe.

Features: Small fishes of slender shape. Head shallow. Eyes small. Snout somewhat produced and pointed. Gape rather long. Dorsal fin and anal fins fused with the caudal fin to produce a narrow fringe which begins dorsally in the anterior third of the body and reaches ventrally almost to the pelvic fins. Pelvic and pectoral fins elongate, pointed. Body covered with round scales.

Remarks: Fresh-water predators.

Recent relatives: None. Died out in Lower Carboniferous.



Uronemus, reconstruction after Forster-Cooper.



Conchopoma edesi Denison (length c. 10 cm) from the Upper Devonian of Francis Creek, Illinois, U.S.A. Original: Field Museum of Natural History, Chicago, Illinois, U.S.A.

Genus: *Conchopoma* Kner, 1868.

Synonyms: *Conchiopsis*, *Peplorhina*.

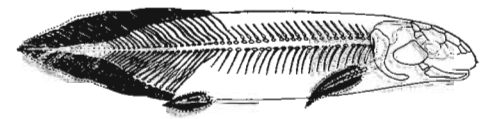
Geological range: Upper Carboniferous to Lower Permian.

Geographical distribution: Europe, North America.

Features: Small to middle-sized fishes of slender shape. Head shallow. Eyes small. Snout rounded. Gape rather long. Lower jaw somewhat posterior in position. Dorsal and anal fins fused with the caudal fin to form a low fringe tapering rearwards. Anal fins small, pointed oval in outline. Pectoral fins considerably bigger, elongate and pointed. Body covered with round scales.

Remarks: Fresh-water predators.

Recent relatives: None. Died out in Lower Permian.



Conchopoma, reconstruction after Weitzel.



Gosfordia truncata WOODWARD (length c. 27 cm) from the Lower Triassic of Gosford, Australia. Original: Australian Museum, Sydney, Australia.

Genus: *Gosfordia* WOODWARD, 1890.

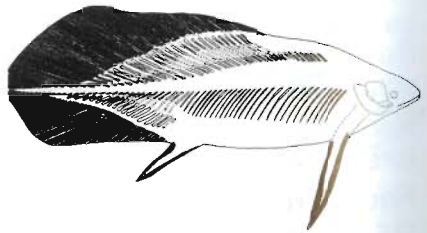
Geological range: Lower Triassic.

Geographical distribution: Australia.

Features: Middle-sized fishes with laterally compressed bodies. Head deep. Eyes small. Snout produced and pointed. Gape rather long. Dorsal fins fused with caudal fin and anal fin to form a broad fringe. Pelvic fins very narrow and elongate. Pectoral fins likewise very narrow but considerably longer.

Remarks: Fresh-water predators.

Recent relatives: Related to recent Australian lungfishes of the genus *Neoceratodus*.



Gosfordia, reconstruction after RITCHIE.



Paraceratodus germaini LEHMAN (length c. 110 cm) from the Lower Triassic of Madagascar. Original: Muséum National d'Histoire Naturelle, Paris, France. Photograph: Serette, Paris.

Genus: *Paraceratodus* LEHMAN, 1959.

Geological range: Lower Triassic.

Geographical distribution: Madagascar.

Features: Middle-sized to large fishes with slender bodies tapering rearwards. Head shallow and elongate. Eyes small. Snout pointed. Dorsal fin beginning approximately in the middle of the body, probably joined to form a fringe with the caudal and anal fins. Pelvic and pectoral fins probably elongate.

Remarks: Had a durophagous diet.

Recent relatives: Genus extinct. Perhaps related to the Australian lungfish *Neoceratodus*.



Neoceratodus forsteri, the Australian lungfish.



Esconichthys apopyris BARDACK (length c. 5 cm) from the Upper Carboniferous (Pennsylvanian) of Mazon Creek, Illinois, U.S.A. Original: Field Museum of Natural History, Chicago, Illinois, U.S.A.

Genus: *Esconichthys* BARDACK, 1974.

Geological range: Upper Carboniferous (Pennsylvanian).

Geographical distribution: North America.

Features: Small fishes with slender bodies. Head shallow. Eyes small. Snout rounded. Pectoral fins very narrow and strikingly long. This fish represents a larval stage.

Remarks: Adult specimens not known.

Recent relatives: None. Presumably died out in Carboniferous.



The Bolca fishes came from this cliff. It seems clear, unfortunately, that the locality will be exhausted in the foreseeable future.

For reasons of space, this bibliography is essentially confined to works on morphology, systematics or phylogeny. Further references can be found in the bibliographies of all major paleontological works.

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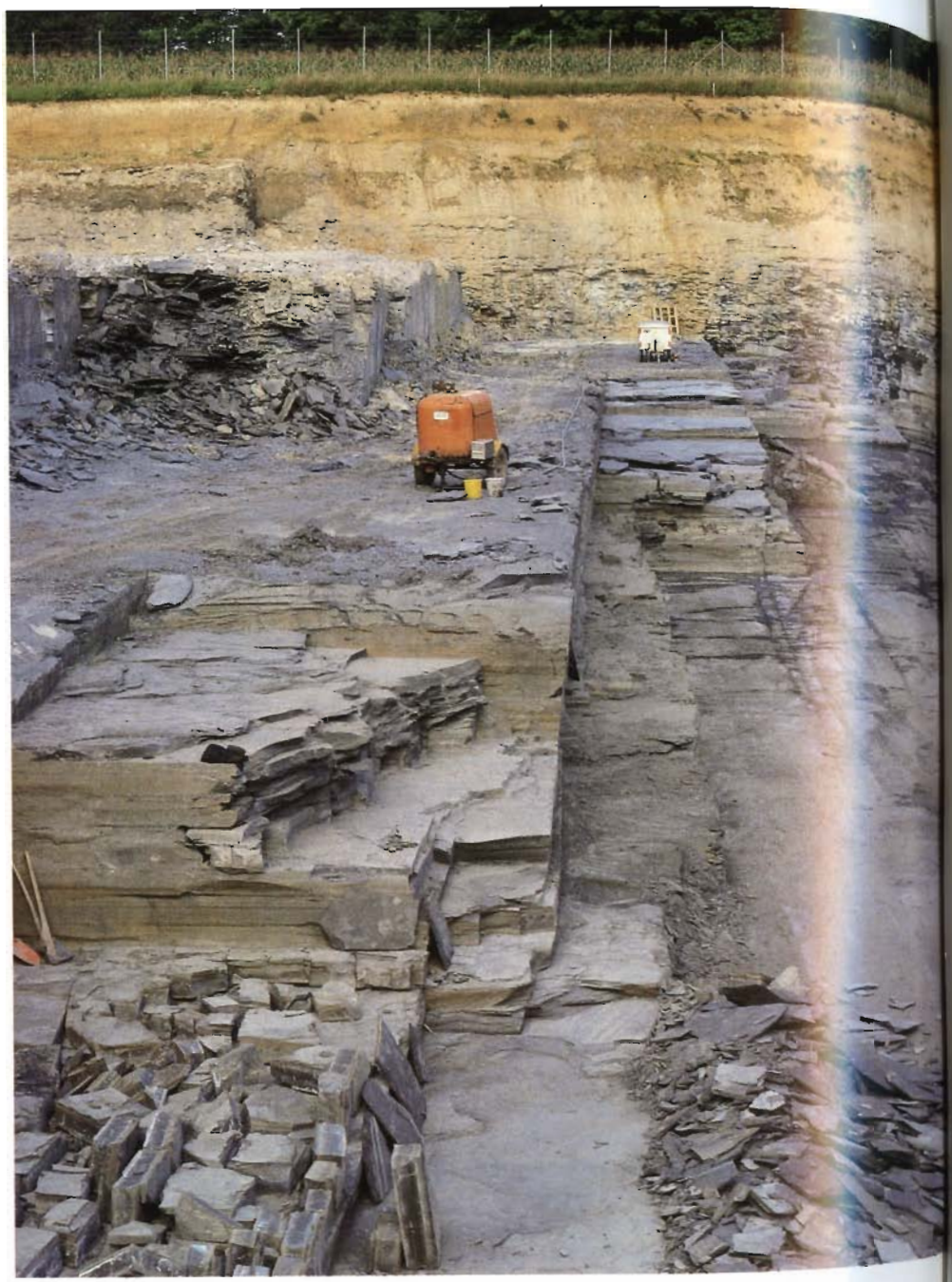
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This is a quarry in the famous Posidonia Shales of the Lias of southern Germany at Holzmaden in Württenberg. As well as interesting fishes, many ichthyosaurs have been found here. Photo: Staatliches Museum für Naturkunde

Index of Genera and Synonyms

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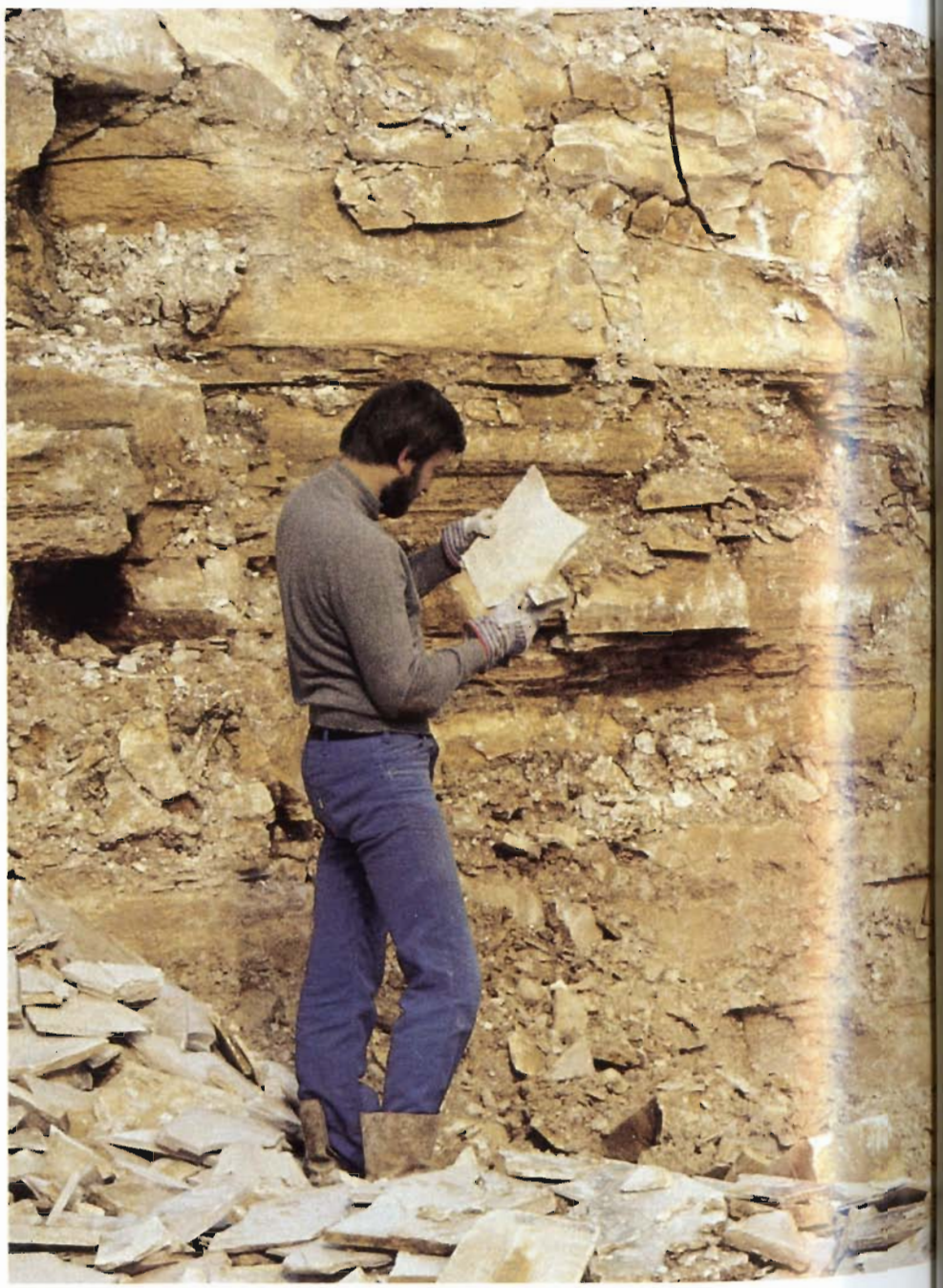
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This is a quarry in the famous Lithographic Limestone of the upper Jurassic of southern Germany, at Daiting, near Solenhofen, Bavaria. Unfortunately not all beds are rich in fossils. Good luck is required to find anything.

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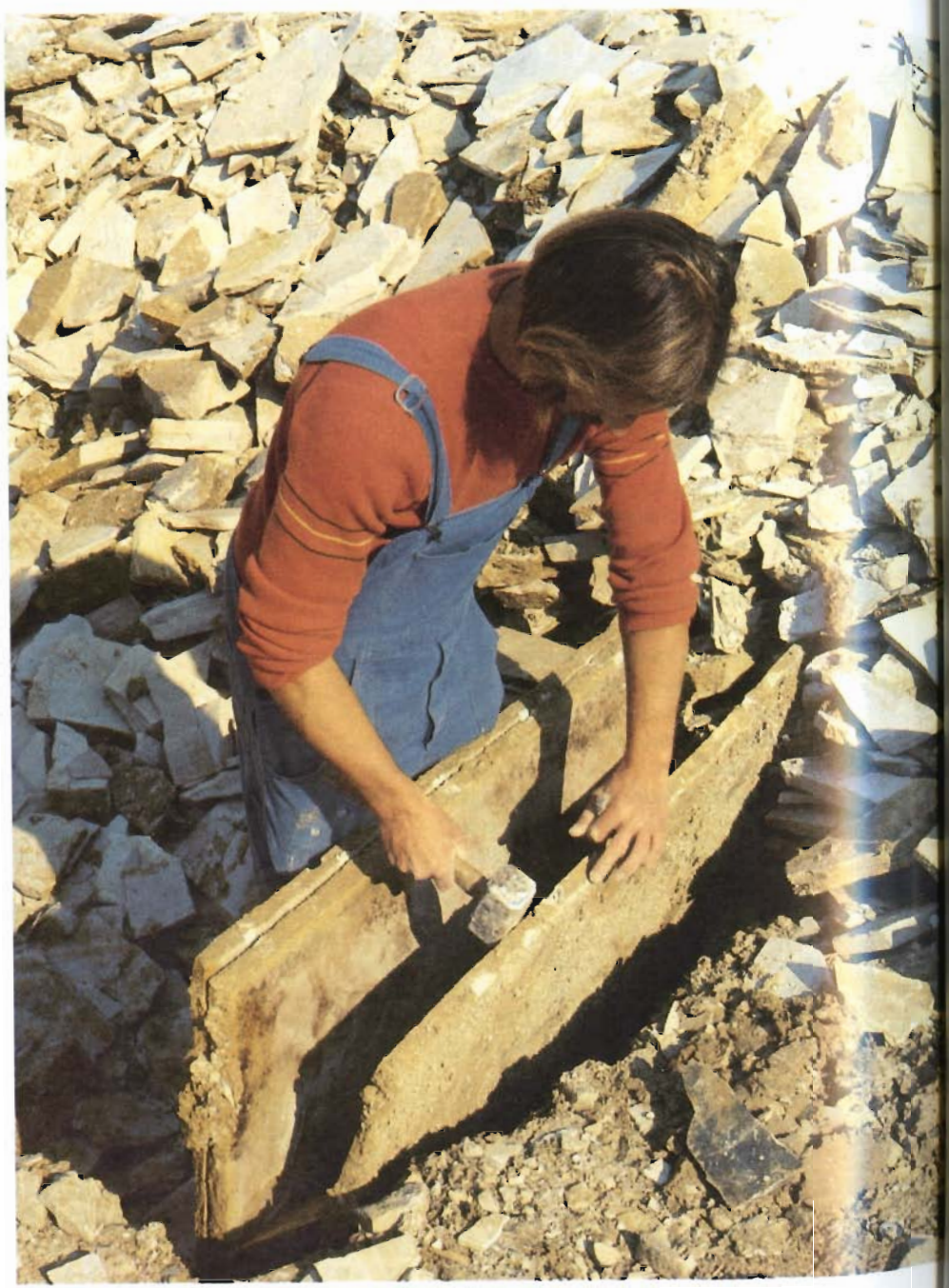
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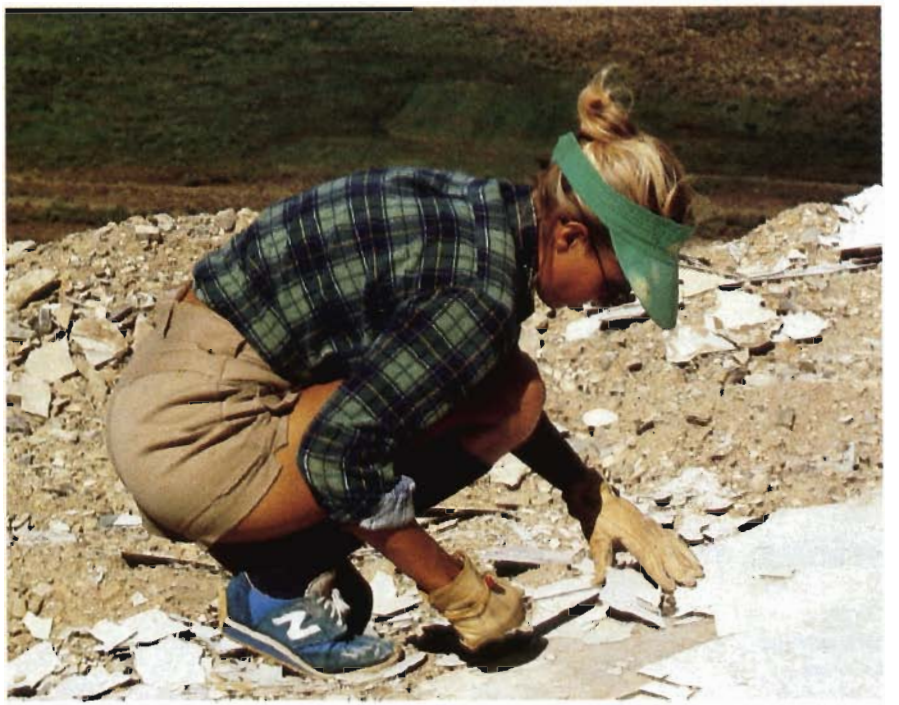
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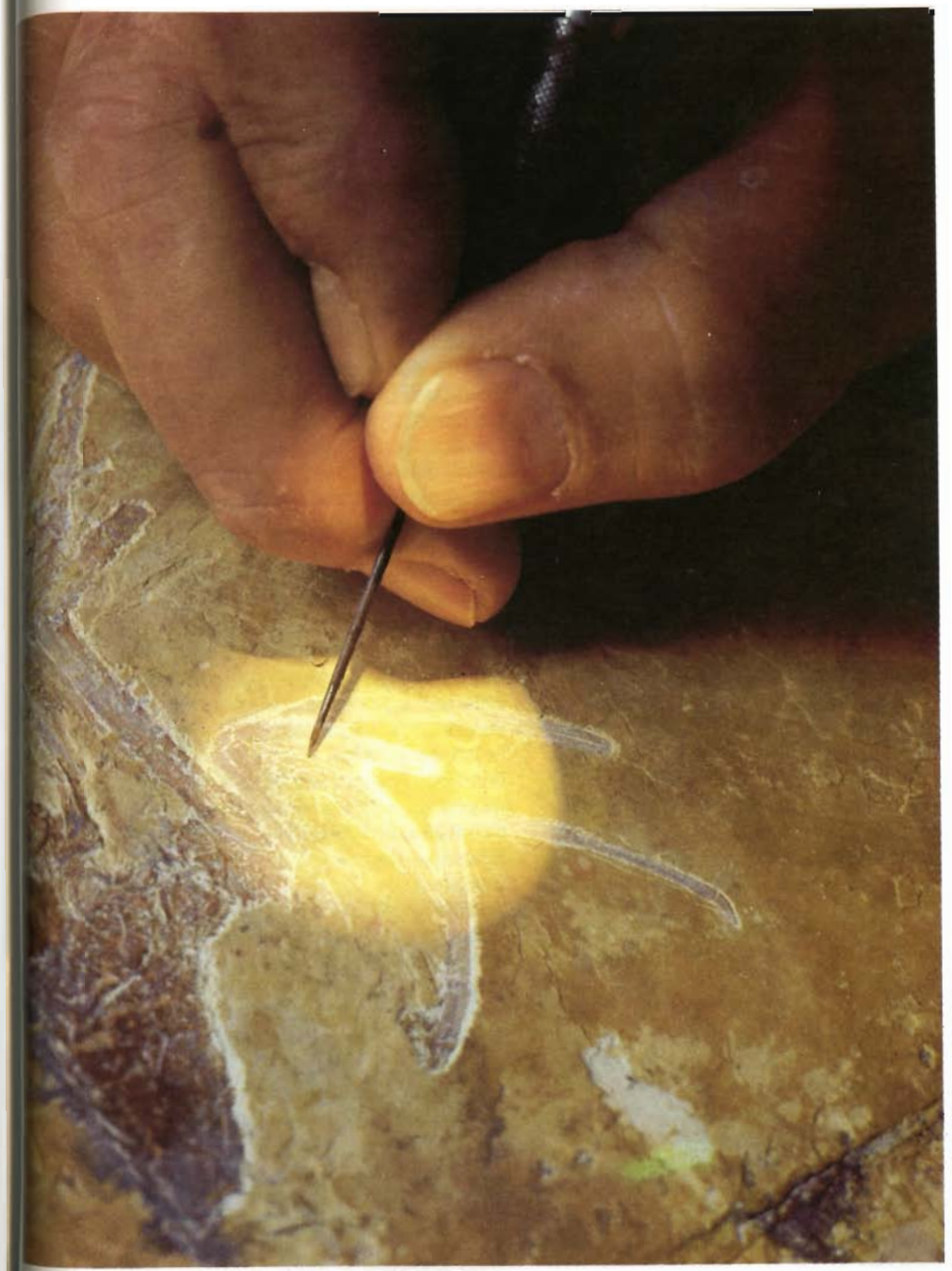
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Reclaiming a fossil demands utmost care. The smallest tools are used under a dissecting scope to clean a fossil—here a crustacean. Photo: K. Götz.

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Karl Albert Frickhinger was born in 1924. Science always interested him so that, even as a boy, he was an enthusiastic fossil collector. This, however, was only an episode. Coming from an old family of pharmacists, he was predestined to study pharmacy. At the same time he took an interest in botany and finally opened his own pharmaceutical shop in Munich. Here, for the first time, he had an opportunity to spend some of this time on scientific research and turned his attention to fish parasitology. He invented several preparations for the prevention of fish diseases in the aquarium and, after a few years, founded the firm Zoomedica to market his products worldwide. He sold the firm in 1977 and so, at last, had time to pursue his old hobby of paleontology. By methodical acquisition, guided by evolutionary considerations, he built up an impressive collection. Since, however, he had always been under the Sign of the Fish, it is no surprise that finally he specialized entirely on fishes. This gave him the determination needed to produce this book.

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