to Dr. G. Brown Goode
with the author's kind reg
BM. 12.1.88
A.G.

THE

VOYAGE OF H.M.S. CHALLENGER.

ZOOLOGY—VOL. XXII.

REPORT

ON THE

SCIENTIFIC RESULTS

OF THE

VOYAGE OF H.M.S. CHALLENGER

DURING THE YEARS 1873-76

UNDER THE COMMAND OF

CAPTAIN GEORGE S. NARES, R.N., F.R.S.

AND THE LATE

CAPTAIN FRANK TOURLE THOMSON, R.N.

PREPARED UNDER THE SUPERINTENDENCE OF

THE LATE

Sir C. WYVILLE THOMSON, Knt., F.R.S., &c.

REGIUS PROFESSOR OF NATURAL HISTORY IN THE UNIVERSITY OF EDINBURGH
DIRECTOR OF THE CIVILIAN SCIENTIFIC STAFF ON BOARD

AND NOW OF

JOHN MURRAY

ONE OF THE NATURALISTS OF THE EXPEDITION

ZOOLOGY—VOL. XXII.

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REPORT on the DEEP-SEA FISHES collected by H.M.S. CHALLENGER during the years 1873–1876.

By ALBERT GÜNTHER, M.A., M.D., Ph.D., F.R.S., Keeper of the Department of Zoology in the British Museum.

EDITORIAL NOTE.

THE Report on the DEEP-SEA FISHES, by Dr. Albert Günther, F.R.S., occupies the whole of the present Volume. This Report, which forms Part LVII. of the Zoological Series of Reports on the Scientific Results of the Expedition, extends to nearly 400 pages, with 73 Lithographic Plates and several woodcuts.

The Report comprises two Appendices, the first by Professor H. N. Moseley, F.R.S., on the structure of the PECULIAR ORGANS ON THE HEAD OF IPNOPS, the second by R. von Lendenfeld, Ph.D., on the structure of the PHOSPHORESCENT ORGANS OF FISHES.

With reference to the depths at which the specimens of Deep-Sea fish were captured I desire to repeat here a statement so frequently made in connection with these publications. During the cruise the naturalists recorded in each case, as faithfully as possible, the depth to which the dredge or trawl was sent down. The animals may have been captured at the bottom, or in any of the intermediate layers between surface and bottom; in many cases the structure, colour, or modifications of organs, and the contents of the stomach, furnish clear indications as to whether the animal lived at the bottom or on the surface, and on such matters the specialists in each group are the best judges. In this Report, therefore, the depths given for the specimens show that Dr. Günther regards the specimens, with a few exceptions which are mentioned in the body of his Report, as having been captured at the recorded depth.

This exceedingly valuable and comprehensive Report does not refer to the immature and larval specimens or pelagic fish captured at the surface of the sea during the Expedition. It is hoped that Dr. Günther may prepare a short Report on these forms during the coming year.

The Manuscript was received by me in instalments between the 9th September 1886 and the 28th June 1887.

JOHN MURRAY.

CHALLENGER OFFICE, 32 QUEEN STREET,
EDINBURGH, 1*st August* 1887.

THE

VOYAGE OF H.M.S. CHALLENGER.

ZOOLOGY.

REPORT on the DEEP-SEA FISHES collected by H.M.S. Challenger during the Years 1873-76. By Dr. ALBERT GÜNTHER, M.A., M.D., Ph.D., F.R.S., Keeper of the Department of Zoology in the British Museum.

PREFACE.

ALTHOUGH the collection of Deep-Sea Fishes which was made by the naturalists of H.M.S. Challenger was entrusted to me for investigation nearly ten years ago, the preparation of this Report was delayed by the pressure of other engagements, especially an increase of official duties. Only during the last two years I was able to steadily apply myself in my leisure hours to the work of re-examining the specimens and of preparing the present Report for press.

This delay appeared to be the less a matter of regret as it was known that deep-sea explorations were being actively carried on by two Institutions of the United States of America, and by the Norwegian, Italian and French Governments. As these expeditions had the great advantage of profiting by the experiences of the Challenger, and were likely to materially increase our knowledge of bathybial fishes, and to elucidate points which the Challenger with its initial apparatus had left obscure (such as the vertical range of pelagic forms), it seemed advantageous, in order to produce a complete account of the fish fauna of the deep sea, to await the publication of the results of those explorations. The hope, however, of utilizing those results for the present work became fainter, as in the succeeding years only more or less fragmentary and preliminary notices appeared, with one exception, viz., that of the valuable Report on the Fishes of the Norwegian North Atlantic Expedition.

One of the instructions given to me by the late Sir Wyville Thomson was, to include in my Report not only the species collected by the Challenger, but also those which from other sources are known to inhabit the deep sea. He agreed with me in the conclusion I arrived at from the materials then available, that a depth of 300 or 350 fathoms should be considered the boundary between the surface and deep-sea fishes, the fishes above that level belonging principally to littoral genera, whilst those specially organized for bathybial life appeared at or below that depth. Accordingly, almost all fishes captured by the Challenger at a less depth than 350 fathoms were included in my Report on the Shore Fishes.

However, the subsequent Norwegian and North American explorations brought to light instances of fishes with an unmistakably bathybial organisation occurring at a much shallower depth than the forms discovered by the Challenger, or, on the other hand, showed that certain littoral forms descend not only to 100, but even to beyond 300 fathoms.

It consequently seemed advisable to abandon the intention of limiting this Report to fishes occurring below 300 fathoms, and to adopt instead the 100-fathom line as the boundary at which, with the extinction of sun-light, the bathybial fauna commences, sporadically at first and largely mixed with surface forms. This line does not express a sharply defined boundary any more than any other depth, but it is chosen for the purposes of the present Report, in which a certain upper limit of the deep-sea fauna had to be fixed. In employing it I intend only to express the fact, that no fish not known at present to have occurred beyond the 100-fathom line, is admitted in the present Report; and, further, that no truly bathybial fish is known to live habitually above that line.

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[1] This fish was obtained at 360 fathoms, not at 3600 fathoms, as stated in the description.

INTRODUCTION.

The materials which form the subject of this Report consisted of 794 specimens, of which 610 were obtained during the voyage of the Challenger, 88 on the cruises of the "Knight Errant" and "Triton," and 96 from various other sources. These specimens are referred to 266 species, 177 falling to the share of the Challenger, and 14 being due to the exploration of the Færöe Channel. The number of new forms discovered by the Challenger amounts to 144, whilst by the deep-sea exploration of the Færöe Channel ten species were added to the fauna of the British Seas.

The latter possess, perhaps, the greatest interest to the student of the British marine fauna; they verified the supposition which had been entertained for some time, viz., that fishes distinct from those of the littoral fauna inhabit the depths of the ocean surrounding the British Islands. At a time when so much attention is paid to the investigation of the marine products of the British Seas, it may be hoped that the hitherto intermittent efforts of exploring the deeper parts of this ocean may be prosecuted in as systematic a manner as the explorations carried on on the American side of the Atlantic, where the United States Government has spared no expense to secure the rich harvest that was to be expected not only for the advancement of knowledge, but also for the direct benefit to the country.

The majority of the Challenger specimens were at least externally in a very good state of preservation; those fishes only which possess bones, integuments, or fin-rays of a soft or delicate texture, and thin deciduous scales, naturally suffered more or less through being dragged to the surface from a depth of 1000 and more fathoms. Such specimens can reach the surface in perfect condition only under exceptional circumstances. However, with few exceptions, even the specimens of delicate structure were sufficiently well preserved to enable us to recognise their original shape and the arrangement of their scales, and to reproduce them in what are believed to be tolerably accurate figures. Unfortunately the abdominal organs were only too frequently found to be destroyed, or had suffered too much by laceration and decomposition to admit of examination. This was especially the case in those provided with an air-bladder, which was almost invariably torn into mere shreds. The stomach was nearly always empty. This condition of the specimens, combined with the circumstance that many of the new types were represented only by one or two examples, which have to be kept intact for the use of future investigators, must account for the scanty information which I am able to give with regard to their internal structure.

In some of the specimens the so-called phosphorescent organs were well enough preserved for microscopical examination, and having always held the opinion that the function of all these organs was to produce light, an opinion which has been partly or wholly opposed by Leuckart, Ussow and Leydig, I was particularly anxious that as much as possible of the materials of the Challenger should be utilized for a thorough histological investigation of these organs by zoologists thoroughly versed in the method of histological research. Mr. Murray acceded without hesitation to this proposal, and it was hoped that Professor Moseley would undertake the whole of this investigation; but as he was compelled by other duties to limit himself to the examination of the remarkable organs in the genus *Ipnops*, the remainder were entrusted to Dr. von Lendenfeld. The reports of both these gentlemen will be found in the Appendices to the descriptive report.

My technical descriptions of the Challenger fishes will be found to be much more concise than those given by some recent writers on similar subjects, and will appear to some to be too short. In my own experience, the practice of circumstantially describing every minute detail of the surface of a fish, repeating every point of structure common to all the species of the genus or family, and indiscriminately mixing individual features with specific, not only renders the use of these lengthy descriptions a laborious and thankless task, but actually leads to misunderstandings not less frequently than insufficient short diagnoses prepared by inexperienced describers. In fact, in several instances I have found that the descriptions which I published some ten years ago as "preliminary diagnoses," express so fully the specific characters of the fishes as to render any additions to them superfluous.

HISTORY OF OUR KNOWLEDGE OF THE FISH-FAUNA OF THE DEEP SEA.

Isolated examples of Deep-Sea Fishes had fallen into the hands of zoologists at an early period of systematic ichthyology; thus, specimens of *Trachypterus*, *Regalecus*, *Saccopteryx*, *Stylophorus*, *Plagyodus*, and other genera were known to and described by zoologists of the last century. But, having been captured whilst floating on the surface or near to the coast, they were regarded merely as extremely scarce creatures, without any clear idea being entertained that they were stray individuals from the unknown depths of the ocean. RISSO was the first to distinguish a bathybial fish-fauna, assigning to it certain fishes and stating the depths at which they habitually live. In enumerating[1] the various regions of the Gulf of Genoa he states—"Les grands abimes de la mer ne sont fréquentés que par les alépocéphales, les pomatomes, les chimères et les lépidolèpres. Les profondeurs moindres sont la demeure habituelle des merlans, des molves, des phycis, des soldados, des citules, des serioles, des tétragonures, des castagnolles, etc." He states exactly the depths inhabited by several fishes: thus *Alepocephalus rostratus* occurs at a depth of 2000 feet or more (350 fathoms), *Trachyrhynchus trachyrhynchus* and *Macrurus cœlorhynchus* at a depth of 1500 or 1800 feet (250 or 300 fathoms) "ou parait constamment régner une température de dix degrés," *Uraleptus maraldi* at a depth of 1000 feet (170 fathoms), and *Gadus minutus* (*Morua capelanus*) at a depth of 300 metres (150 fathoms).

During his numerous and prolonged visits to the Island of Madeira the Rev. R. T. LOWE[2] paid special attention to the wonderful variety of the fishes of the sea surrounding that island. He discovered a number of new forms, the bathybial habits of which were ascertained, either by himself at the time of their discovery, or subsequently by others who studied the subject after him. In his History of the Fishes of Madeira, the five parts of which appeared at irregular intervals between the years 1843 and 1860, and which unfortunately remained unfinished, he gives the precise depths at which several species occur, viz., *Beryx splendens*, "which begins to be met with, of small size, at a depth of 150 or 200 fathoms, but is scarcely ever taken in full size and abundance, except with its congener, *Beryx decadactylus*, the Alfonsin a caste larga, at the enormous depth of from 300 to 400 fathoms, and from one to two leagues from shore"; *Scorpæna kuhlii*, the "Requeime," which is "caught with lines of from 100 to 250 fathoms"; *Thyrsites*

[1] Histoire naturelle des principales productions de l'Europe méridionale, vol. iii., Paris, 1826; Introduction, page x.

[2] He left England with his wife in April 1874 for his last journey to Madeira, which he never reached again. The steamer "Liberia," in which he had taken his passage, foundered in the Bay of Biscay, not a soul being saved of the passengers and crew. To him and to his successor in the field of Madeiran ichthyology, Mr. J. Y. Johnson, I owe a debt of gratitude for the encouragement and help they gave me at an early period of my ichthyological studies.

pretiosus, the "Escolar," which "is taken with an ordinary bait at a depth (the fishermen affirm) of from twelve to fourteen *linhas* (=300–400 fathoms), living habitually near the bottom, in company with the Cherne (*Polyprion cernium*), Cœlho (*Thyrsites prometheus* or *Prometheus atlanticus*), etc."; *Thyrsites prometheus*, which "lives habitually at the bottom, and is taken at most seasons in a depth of from 100 to 300 or 400 fathoms"; *Scorpæna dactyloptera*, from 250 to 400 fathoms. Especially instructive is Lowe's account of the capture and occurrence of *Polyprion cernium;* he says:—

"The Sherny in Madeira is only captured by the hook; and though shoals of small fishes, weighing from five to twenty pounds, and called Chernotta, are said to be often taken near the surface, in the neighbourhood of floating wreck or logs of wood, the proper habitat of the full-sized fish, weighing from thirty to one hundred pounds, is from one to two or three leagues from shore, and at the enormous depth of from twelve to fifteen or sixteen *linhas*, or from three hundred to four hundred fathoms. With a strong line[1] of this length, to the bottom of which is tied a stone (called the '*pendula*') of three or four pounds' weight, and having attached immediately above the stone, at intervals of eighteen inches, from twelve to fifteen strong hooks, baited with pieces of Cavallo [Mackerel] or Chicharro [Madeiran Horse-Mackerel], I have been frequently assisting at their capture. Coming up from these enormous depths, the fish becomes so distended with gas, expanding upon the removal of the vast pressure below, that it rises to the surface, not indeed entirely dead, but wholly powerless, and in a sort of rigid cataleptic spasm; the stomach is usually inverted, and protruded into the mouth; and the eyes in general are forced so completely from their sockets, sticking out often like two horns, that 'eyes like a Cherne' is a common phrase amongst the fishermen for a prominent-eyed person. Sometimes, from the same cause, it rises faster as it approaches the surface than the line can be hauled in, shooting quite out of the water at some distance from the boat upon its first emergence, like a cork or bladder, from the lightness caused by its great distension. The usual size of these was from two and a half to three and a half feet long, weighing from twenty-five to forty or fifty pounds."

The discovery that some fishes live, at an early period of their existence, at or near the surface, and in the course of their growth retire into the depths of the ocean, is due to Lowe.

The study of the fishes of Madeira was continued by Mr. J. Y. Johnson, who, between the years 1862 and 1866, made some of the most interesting additions to ichthyology; he discovered important bathybial types, such as *Chiasmodus*, *Melanocetus*, *Halosaurus*, *Synaphobranchus*, the *Saccopharynx* of Mitchell, and others, but he treated them like any other rare surface-fishes, without taking note of their pertinence to a distinct fauna.

[1] Each boat is generally furnished with two such lines, each worked by a single fisherman, who is, however, assisted by others in the labour of hauling in the line, which takes from twenty to thirty minutes.

Lowe as well as Johnson deposited their treasures in the British Museum, and from these materials chiefly I formed the idea of a special adaptation of the ichthyic type to bathybial life. The comparison of fishes so widely different as *Plagyodus* (*Alepidosaurus*), *Regalecus, Trachypterus, Stylophorus, Saccopharynx, Chiasmodus, Melanocetus,* showed nevertheless a singular agreement in important points of organisation, and even in the circumstances under which their capture took place. And having recognised that the diminished amount of earthy matter in the osseous system, the extreme thinness of the muscular layers of the trunk and tail, the easily ruptured connective ligaments and tissues of the muscles and bones, the increase in size or degradation of the organ of sight, the distensibility of the stomach, the shrinking of the gills, the development of the muciferous system with or without special organs of luminosity, the black coloration of the pharynx and peritoneum, were peculiarities which, either singly or combined, either by themselves or in connection with other evidence, indicated the bathybial nature of the fish, I relegated to the deep-sea fauna *Plagyodus* in 1860, the Trachypteridæ and Lophotidæ in 1861, *Halargyreus* and *Saccopharynx* in 1862, *Melamphaës, Melanocetus, Chiasmodus*, a part of the Sternoptychidæ, Scopelidæ and Stomiatidæ in 1864, the Halosauridæ in 1866, *Pseudophycis* in 1867, and *Synaphobranchus* in 1870.[1]

I had no definite information at the time with regard to the depth at which these types habitually live, but I thought it probable that some of them descend to much greater depths than were recorded hitherto, and that the degree of adaptation to a bathybial life increased with the depth reached by the fish; in fact, that the successive vertical zones of the deep sea were inhabited by fishes of a different and peculiar organisation. This last surmise has not been verified by the facts obtained during the Challenger and subsequent expeditions. But I ascertained, at a time previous to the British Deep-Sea expeditions,[2] that deep-sea fishes must have a wide horizontal range, and that consequently the physical conditions of the depths of the ocean must be the same or nearly the same over the whole globe,—a fact already recognised by Risso, though his observations were limited to the district of the Gulf of Genoa (*vide supra*, p. xix.).

The materials brought home by the Challenger laid a broad and sure foundation of our knowledge of the abyssal fish-fauna, and the preliminary notices of the new and remarkable forms which were published in the years 1877 and 1878[3] could not fail to draw the attention of the succeeding explorers of the deep sea to this class of animals.

1. Of the three Norwegian North Atlantic expeditions undertaken in the years 1876, 1877, and 1878, the last furnished much information as regards the deep-sea

[1] See Cat. Fish., under the headings of the genera enumerated; *Proc. Zool. Soc. Lond.*, 1864, p. 301 (*Melanocetus*); *Proc. Zool. Soc. Lond.*, 1866, p. 336 (*Ausonia*).

[2] Cat. Fish., vol. v. p. 420, 1864.

[3] *Ann. and Mag. Nat. Hist.*, 1877, vol. xx., and 1878, vol. ii.

fishes of the Polar Sea. The sea between Hammerfest and Varanger Fjord, that extending towards Novaja Zemlja and Jan Mayen, and northwards to the north-western extremity of Spitzbergen, were explored. The greatest depth reached by the trawl was nearly 1400 fathoms. About thirty species were collected, of which those of the genera *Lycodes* and *Liparis*, and the genus *Rhodichthys* are of particular interest. In an elaborate Report by Robert Collett these fishes are described in detail and well figured.[1]

2. Thanks to the exertions of Professor A. Agassiz and Dr. Spencer Baird, the Government of the United States provided, at first by the loan of ships, and later through the organisation of the U.S. Commission of Fish and Fisheries, for a systematic exploration of the depths of the Western Atlantic. Omitting the earliest operations, in which no special attention was paid to deep-sea fishes, we have to mention, in the first place, the successful trips of the U.S. steamer "Blake," under the command of Lieut.-Com. C. D. Sigsbee and Commander J. N. Bartlett, in the years 1878 to 1880, to the Gulf of Mexico and the Caribbean Sea. The dredging and trawling apparatus used by the Challenger was improved, and in order to ascertain the nature of the fauna at any given depth intermediate between the surface and bottom, Commander Sigsbee introduced an apparatus, which works in a vertical, instead of horizontal, direction, and which admits animals only at a desired depth. Whatever importance may be attached to the results obtained by it with regard to the distribution of the lower animals, the fact that this apparatus failed to capture any fishes in mid-water is evidence of but negative value. The investigation of the bottom revealed areas devoid of and others rich in animal life, and the causes of such abundance or poverty were approximately ascertained. The operations of the U.S. Fish Commission had to be conducted chiefly with the direct object of developing the commercial resources of the country, but as this object goes hand in hand with, and as its attainment is in great measure dependent on, strictly scientific research, the work of the Commission was carried on in both directions. From the year 1877 the Commission was enabled, by the possession of a suitable steamer, the "Fish-Hawk," to engage in deep-sea operations, chiefly in parts of the Atlantic north of the area surveyed by the "Blake," but occasionally extending southwards into the West Indian Sea, as, for instance, those of 1884 by the U.S. steamer "Albatross." These explorations, which were systematically carried out with sound judgment and intimate knowledge of the requirements for deep-sea operations, yielded adequate results; no other part of the ocean is now better known, with regard to its marine products, than the Atlantic coasts of the United States and the deep water outside the littoral zone. The contributions to the fauna of deep-sea fishes were numerous and of great interest, and have been described chiefly by Messrs. Brown Goode and

[1] Den Norske Nordhavs-Expedition, Zoologie. Fiske. Christiania, 1880, 4°.

Bean, whose publications will be duly referred to in the descriptive part of this Report. So far as the materials have been worked out, they show that fishes recorded by the Challenger from great depths live in much shallower water in other parts of the ocean, and that, on the other hand, many littoral forms descend to within the vertical limits of the deep-sea fauna. The greatest depth from which the capture of fishes is reported was 2900 fathoms, nearly the same as that stated by the Challenger.

3. By the explorations of the Færöe Channel, in H.M.SS. "Knight Errant" and "Triton," in the years 1880 and 1882, our knowledge of the deep-sea fishes between the British Islands and the Polar Sea was much advanced; in fact, nothing was known previously about this district. The trawl was used in from 200 to 640 fathoms.[1] All the species collected are embodied in the present Report; they proved to be partly identical with those collected by the Norwegian expedition, and partly closely allied to types which were previously known from the Mediterranean.

4. The deep-sea explorations undertaken by the French Government, and entrusted to a commission under the presidency of Professor Milne-Edwards, began in the year 1880. A vessel, "Le Travailleur," was employed for short periods in three consecutive years, and replaced by the larger "Talisman" in 1883. The field of operations was in the first years the Bay of Biscay, and extended to the Mediterranean and the Canary Islands, but still more work was done in the "Talisman," in which the expedition made a series of observations off the coast of Morocco southward to Cape Verde Islands and the Sargasso Sea, and westward to the Azores. From the general reports published it would appear that the materials collected contain important contributions to our knowledge of deep-sea fishes, but no authentic information has been published, with the exception of a supposed new genus, *Eurypharynx*.

5. The Italian Government despatched a ship of the Royal Navy, the "Washington," in three consecutive years (1881–3) for the exploration of the depths of the Mediterranean. With regard to abyssal fishes, these expeditions were somewhat barren in results.

[1] Staff Commander Tizard, R.N., and John Murray, Exploration of the Færöe Channel, during the summer of 1880 in H.M.'s hired ship "Knight Errant," *Proc. Roy. Soc. Edin.*, 1882.

CHARACTERISTICS OF DEEP-SEA FISHES.[1]

The physical conditions under which fishes live at a depth of 100 and more fathoms affect certain parts of their organisation. We know now, chiefly from the Norwegian and North America explorations, that many littoral fishes descend within the limits of the truly abyssal fauna. These descents, however, are not permanent removals from the littoral zone, but, at the most, periodical; and therefore no conspicuous change in any of the organs of these fishes has taken place. But already, in many fishes which permanently reside at from 80 to 120 fathoms, we find indications of their habitat in the black coloration of their pharynx and in the size of their eye, which is proportionally larger than in their representatives at the surface. In the true deep-sea fishes certain organs are so conspicuously modified that every one of these fishes may be recognised as a deep-sea fish, without accompanying positive evidence of its capture at a great depth; and *vice versa*, fishes reputed to have been obtained at a great depth, and not having any of the characteristics of the dwellers of the deep sea, must be regarded as surface fishes. The question whether the amount of modification is proportioned to the depth, must be negatived from the evidence at present available, inasmuch as deep-sea fishes caught at depths of between 300 and 400 fathoms may show a much more conspicuous development of abyssal peculiarities than those from 2000 and more fathoms.

The tremendous pressure under which deep-sea fishes live must be one of the primary causes affecting their organisation. The pressure of the atmosphere at the level of the sea amounts to fifteen pounds per square inch of the surface of the body of an animal; but below the surface of the ocean the pressure is increased to a ton weight for every 1000 fathoms of depth. In many deep-sea fishes we find, then, that the osseous or muscular systems, or both, are, as compared with the same parts of surface fishes, very feebly developed, as for instance in the Trachypteridæ, *Melanocetus, Chiasmodus, Plagyodus, Omosudis, Saccopharynx*. The bones have a fibrous, fissured and cavernous texture, are light, with scarcely any calcareous matter, so that the point of a fine needle will readily penetrate them without breaking. In some the primordial cartilage is persistent in a degree rarely met with in surface fishes, and the membrane bones remain more or less membranous or are reduced in extent, like the operculum, which frequently is too small to cover the gills. When the fish is brought to the surface, all the bones, and more particularly the vertebræ, are most loosely connected with one another. Likewise the muscles, especially the great lateral muscles of the trunk and tail, are thin; the fascicles can be readily separated or torn, the connective tissue being extremely loose and

[1] The contents of this chapter formed the subject of a lecture delivered at Cambridge in 1874, and of the notes published in Introduction to a Study of Fishes, 1880, p. 296.

feeble, so that the specimens require the most careful handling to prevent their breaking up into fragments. This condition appears to obtain in the highest degree in a fish allied to *Plagyodus*, and occurring in the Madeiran Sea, of which Lowe succeeded in obtaining fragments only. Specimens of this fish are sometimes caught on long lines at great depths, but before they can be hauled to the surface, the body breaks away, leaving fragments only on the hook.[1] We cannot assume that this loose connection of the osseous and muscular systems obtains whilst those fishes remain under the normal physical conditions of their abyssal abode. All are carnivorous, and some of them most rapacious creatures, which must be able to execute rapid and powerful movements to catch and overpower their prey; and for that object their muscular system, thin as its layers may be, must be as strong, and the chain of the segments of their vertebral column as firmly linked together, as in surface fishes. In coming to the surface their body has undergone a change which is merely due to their rapid withdrawal from the pressure under which they lived; it is a much aggravated form of the affection that is experienced by persons reaching great altitudes in a balloon, or by the ascent of a mountain. In every living organism with an intestinal tract there are accumulations of free gases; and, moreover, the blood and other fluids, which permeate every part of the body, contain gases in solution. Under greatly diminished pressure these gases expand, so that, if the withdrawal from a depth is not an extremely slow and gradual process, the various tissues must be distended, loosened and ruptured; and what is a vigorous fish at a depth of 500 or more fathoms, appears at the surface as a loosely-jointed body, which, if the skin is not of sufficient toughness, can only be kept together with difficulty. At great depths a fibrous osseous structure and a thin layer of muscles suffice to obtain the same results for which, at the surface, thickness of muscle and firm osseous tissue are necessary.

The singular circumstance that the first two specimens known of *Saccopteryx*, two of *Chiasmodus*, and one of *Omosudis* were picked up floating on the surface, dead or in a dying condition, with their stomach distended by a large recently swallowed prey, can be easily explained by the aid of those physiological facts. If, during the struggle which must take place between the attacking fish and its prey, the fishes are carried out of their depth into a somewhat higher stratum, the expansion of the gases will cause both to ascend towards the surface, especially if one of them be provided with an air-bladder, and the rate of speed of the ascent will increase the nearer they approach the surface, which they reach dead or in a dying condition, as witnessed and described by Lowe (*vide supra*, p. xx.). Occurrences of this kind must happen very often, as, of course, comparatively few can by accident fall under the observation of naturalists.

In a slight degree the phenomenon described is a matter of every day occurrence, well known to fishermen who fish at depths of from 40 to 80 fathoms. The fishes withdrawn from that depth come up more or less distended, if they possess a closed air-bladder.

[1] *Wiegm. Arch.*, 1860, p. 123.

By the expansion of the air-bladder the œsophagus and stomach are pressed out of the mouth and the eyes out of their sockets. Cod-fishers are therefore in the habit of puncturing the air-bladder, in order to keep the fish alive. Every larger collection possesses specimens showing the inverted stomach and œsophagus; and they may be safely assumed to have been captured at some distance from the surface.

We might expect that the air-bladder of deep-sea fishes would offer special modifications; and, indeed, there is sufficient evidence that in many a special muscular apparatus is developed for the compression or expansion of its contents, to enable the fish to rise into a higher, or descend into a lower stratum. But, unfortunately, in all the specimens examined by me the air-bladder was more or less ruptured and broken up, and destroyed by subsequent decomposition. One point only seems to be clearly made out, viz., that abyssal life has exercised no influence on the development of an air-bladder, that is, deep-sea fishes whose nearest surface-relations possess an air-bladder, are provided with this organ also, and *vice versa*. In none of the abyssal forms examined by me have I found an open communication between the air-bladder and the œsophagus, not even in those which are referred to the Physostomous division.

The branches of the muciferous system are dilated in many deep-sea fishes to an extraordinary degree. Sometimes it is only the lateral line which is conspicuously wider than in the allied surface forms (*Lepidopus tenuis*, many Scorpænidæ), but in many others, as in Berycidæ, Macruridæ, Ophidiidæ, and Scopelidæ, the branches on the head are enlarged into wide cavities, the walls of which are supported by high ridges of the superficial bones. Frequently the membranes investing these cavities are very thin and after the death of the fish liable to be destroyed, so as to leave bare the deeply sculptured surface of the skull; in other fishes the outer membranes collapse in consequence of the shrinking of the mucous contents of the cavities, so that the surface of the head appears to be extremely uneven; whilst again in others, as in the majority of the genus *Macrurus*, the integument is sufficiently tough to maintain the natural contours of the head. The arrangement of the cephalic branches is the same as in Teleosteous fishes generally: the rostral branches bifurcate into the frontal and infraorbital, and pass into the scapulary branch which is the commencement of the lateral line; and the mandibulary and præopercular branches are likewise invariably present. All these cavities and canals are filled with an immense quantity of mucus, which, in specimens that have not been too long preserved in spirits, swells by immersion in water, and can be pressed out of the apertures of the canals. These apertures may be wide slits, or more or less open, or minute pores with or without a tubule. The physiological use of this secretion, as, indeed, the function of the whole system, is not known. Whether it be regarded as an excretory or as a sensory organ, it is clear that its extraordinary development in so many deep-sea fishes must stand in relation to some one of the abyssal conditions under which they live; and it is very probable that some special function or functions are superadded to the original one which the muciferous system fulfils in the ordinary type of surface fishes. Considering that the majority of the localised and more highly specialised luminous organs are situated within the area of, and stand in relation to, the muciferous system, we may be justified in assuming that one of those additional functions is to surround the fish with luminosity, the more so as the mucus has been actually observed to have phosphorescent properties in newly caught specimens.

The so-called phosphorescent organs or luminous bodies have been noticed ever since the first species of *Scopelus* and other pelagic genera were described; but they were regarded as peculiar pigment spots or modified portions of the scales. Many species of *Scopelus* possess, beside the round mother-of-pearl-coloured spots, a pair of whitish gland-like bodies on the upper side of the snout; and it seems that Cocco was the first to assert that these bodies have phosphorescent properties. He mentions[1] these organs as "apparecchio lucido," and one of the species possessing them he named "*Nychtophus metopoclampus.*" Bonaparte copied Cocco's accounts, and Valenciennes[2] adopted his views as to the function of these organs. In 1864, when engaged in the systematic arrangement of the fishes of the families Sternoptychidæ, Scopelidæ, and Stomiatidæ, I ascribed phosphorescent properties to all these organs, whilst from their histological examinations Leuckart[3] and Ussow[4] declared them, or at least part of them, to be accessory eyes. Leydig[5] holds the opinion that they are "pseudo-electric" organs, which sometimes may have the function of emitting light; Emery[6] adopts the view of their phosphorescent nature in *Scopelus*. As these organs occur, not only in deep-sea fishes, but also in nocturnal pelagic forms, their function might have been expected to be readily ascertained by actual observation; however, so far as I am aware, this has been done twice only, viz., by myself, when I happened to notice distinct flashes of light to issue from a dying specimen of *Scopelus* floating on the surface in the British Channel; and by Dr. Guppy,[7] who examined some freshly caught specimens of the same genus.

During my examination of the Challenger fishes I found the luminous organs widely distributed over the various organs of the body, and discovered especially their presence, in a unique modification, in a genus of Alepocephalid fishes (*Xenodermichthys*), as well as in the Halosauridæ, in which their relation to the muciferous system is undeniable. Finally, Lütken[8] suggested that the white terminations of the dorsal tentacle of *Himantolophus reinhardti* may be phosphorescent during life, which undoubtedly they are.

Luminous organs are not equally distributed among the various families of deep-sea

[1] *Nuovi Ann. d. Sci. Nat.*, 1838, tom. ii. p. 184.
[2] Cuv. Val., vol. xxii. pp. 443, 444, 445.
[3] Ueber muthmassliche Nebenaugen bei einem Fische, *Bericht ü. d. Versamml. deutsch. Naturf.*, 1864.
[4] *Bull. Soc. imp. des Nat. Moscou*, 1879, vol. liv. p. 79.
[5] Die augenähnlichen Organe der Fische, 1881, 8°, Bonn.
[6] *Mittheil. Zool. Stat. Neapel*, vol. v., 1884, p. 471.
[7] *Ann. and Mag. Nat. Hist.*, vol. ix., 1882, p. 202.
[8] *Vidensk. Selsk. Skriv.*, vol. xi., 1878, p. 341.

fishes; and it is a remarkable fact that they are almost entirely absent in those which have the muciferous system most developed; thus, neither the Macruridæ nor the Ophidiidæ possess specialised luminous organs, probably because the mucus, which is so abundantly secreted, supplies a sufficient amount of luminosity. In the Berycidæ and Gadidæ we find only isolated instances, which remind us of the præocular or rostral organ of certain *Scopeli.* On the other hand, the Halosauri possess a wide lateral-line system with well differentiated luminous organs superimposed on it. In each of the families of Carangidæ and Alepocephalidæ one species only is provided with them. In the Pediculati luminous organs are of common occurrence and serve as lures to attract other fishes; they are most common in the Sternoptychidæ, Scopelidæ, and Stomiatidæ, in which they have principally the function of enabling these fishes to illuminate their surroundings, more rarely of alluring other fishes. In the Murænidæ no luminous organs have been found; but in some of them the muciferous system is enlarged.

The luminous organs present many modifications as regards their seat, appearance and structure.

1. In their most primitive condition they appear as innumerable minute tubercles more or less raised above the surface of the skin, and covering the sides of the body; they are crowded together in transverse bands corresponding to the segments of the muscular system. This form occurs in *Echiostoma, Opostomias, Pachystomias, Photonectes, Malacosteus.* I suppose that the pores scattered over the skin of some species of *Ceratias* (*Ceratias uranoscopus, Ceratias carunculatus*) are apertures of follicles in which luminous mucus is secreted.

2. Larger in size, less numerous and more projecting beyond the surface, are the small nodules in the skin of *Xenodermichthys;* they are distributed over the head as well as the body, and follow, on the former, the muciferous ducts, whilst they are arranged in a quincuncial fashion on the body, and are wanting along the tract of the lateral line.

3. More differentiated are the eye-like spots, of a white colour in preserved specimens, and red or green during life, which are arranged at regular intervals in two series on the lower side of the body of the fish, and which occur also on the head, at the base of the branchiostegals and on the gill-cover. Their arrangement is constant within the limits of a species, and to judge from their external appearance they gradually pass into the next form. They occur in numerous genera:—*Gonostoma* (some species), *Chauliodus, Astronesthes, Stomias, Echiostoma, Opostomias, Pachystomias, Photonectes,* and *Idiacanthus.*

4. Still more differentiated are large round flat organs of a peculiar mother-of-pearl brightness, arranged like the former in rows on the lower side of the body and head, with isolated ones on the sides and on the opercles, and frequently with the addition of a short dorsal and ventral series on the peduncle of the tail. They are found in the

families Sternoptychidæ and Scopelidæ only, viz., *Gonostoma* (*Gonostoma denudatum*), *Argyropelecus, Sternoptyx, Polyipnus, Photichthys, Scopelus* and *Nannobrachium.*

5. More or less diffuse patches of a white glandular substance of varying thickness are found.

a. On the side of the trunk in *Astronesthes.*

b. On the dorsal or ventral sides of the caudal peduncle in *Gonostoma* and *Nannobrachium.*

c. On or near the clavicle and more or less within the gill-cavity in *Sternoptyx, Opostomias* and *Halosaurus.*

d. Above the maxillary in the infraorbital region in *Gonostoma* and *Photichthys.*

e. On the top of the snout or in front of the eye in species of *Melamphaës, Melanonus* and *Scopelus.*

f. On barbels in *Linophryne, Stomias, Opostomias* and *Idiacanthus.*

g. On fin rays in *Melanocetus, Chaunax*, and *Himantolophus reinhardtii.*

6. In this group these large glandular masses are differentiated, forming a rounded, more or less oval mass lodged in a cavity of the infraorbital region (as in 5, *d*), viz., in *Anomalops, Echiostoma, Opostomias, Pachystomias, Photonectes, Malacosteus, Idiacanthus, Astronesthes.*

7. The luminous apparatus of the dorsal fin is differentiated, representing a cavity with an aperture from which a tentacle or filament may be exserted. This form is found in Pediculates only, such as *Himantolophus, Aegæonichthys*, some species of *Ceratias, Oneirodes* and *Linophryne.*

8. The luminous organs of *Halosaurus* differ from all those enumerated, inasmuch as they are arranged on the body in a single series which is lodged on the scales of the lateral line; on the head they follow the lower branches of the muciferous canals; in fact, they are situated in them. The organs have also a peculiar diamond-shape, and nearly all lie below, but free from, the semitransparent integument of the body.

9. The cephalic organ of *Ipnops*, the genetic relations of which are still obscure, although there can be no doubt as to its function.

The disposition of all these organs will be more fully noticed in the following pages, and a complete account of the histology of the more important forms will be given by Professor Moseley and Dr. von Lendenfeld in the Appendices at the end of the Report.

Light-producing organs are very generally distributed in the abyssal fauna, and those parts of the depths of the ocean in which phosphorescent animals are abundant must be sufficiently illuminated to enable such of them as are provided with well-developed eyes to perceive objects with as much distinctness as do the pelagic forms which sport at the surface at night, and are dependent on the light of the moon and stars and the general phosphorescent light around them. There is no doubt that fishes contribute a considerable amount of this luminosity of the abyssal depths; but the various degrees of differentiation of the luminous organs, as well as their location on very different parts of the fish, prove that the production of light is dependent on a variety of circumstances and subserves different purposes.

1. Light may be produced by the luminous organ to enable its possessor to see. In fishes which secrete merely a large quantity of luminous mucus without specially developed organs (Macruridæ), or in which innumerable minute organs are disseminated over the greater part of the body, the luminosity proceeds from the general surface of the fish whenever the animal is active, and probably ceases whilst it is asleep or at rest. But in those fishes in which the organs are highly developed and specialised, the production of light is evidently subject to the will of the fish. Only thus can the luminous apparatus be of advantage to the fish; if the production of light were constant, or could not be suppressed instantaneously, the fish would be a most conspicuous object and fall a ready prey to its enemies. The high degree of development of the luminous organs on the side of the head, in close proximity to the eye, as it is found in *Anomalops* and the Stomiatidæ, can be accounted for only by assuming that these fishes are able at will to shoot rays of light in the direction which they want to explore for the purpose of discovering their prey, or for some other object. In fact these organs are used by them as we would use a "bulls-eye." The circumstance that some of the organs are lodged below membranes or even in the cavities of the gills or within the mouth, cannot be regarded as an objection to this explanation of their function, as the membranes as well as the bones are semi-transparent, and would not much interfere with the effect. No doubt the intensity of light produced by the various organs is not the same, and it is probably least in those least specialised: perhaps no more than the glimmer produced by a number of minute particles of phosphorus; but the light which issues from the large pearly organs of the Scopelidæ, the infraorbital organs of the Stomiatidæ, and from the lenticular organs of the Halosauridæ, must be intense and penetrate to a considerable distance.

2. The luminous organs which are placed on barbels, filamentous fin-rays, or tentacles have evidently the function of attracting other animals and of serving as lures. It is a matter of common observation that aquatic animals are in the dark attracted by a light; and therefore these appendages will prove most efficient lures in the abyssal darkness, when, with one or several bright phosphorescent spots at the end of the tentacle, they are played about by the fish. Thus, whilst the appendages retain the original function which they have to perform in surface fishes like *Lophius*, *Antennarius*, etc., in which they simulate a worm or other similar creature, the means by which the final end is attained is changed in accordance with abyssal conditions. Their luminous property could not be of any other use to these fishes, many of which, as, for instance, the deep-sea Pediculates, have their eye in a most rudimentary condition.

I am also of opinion that the highly specialised organs which are placed on the dorsal and ventral sides of the caudal peduncle of many Scopelids and Sternoptychids, have the function of attracting prey, and not of enabling their possessors to see. Situated at the posterior extremity of the body, they would be in a most unfavourable position to throw the light within the area of vision by the eye. On the other hand, when we recollect the peculiar motion of a Scopelus, which darts rapidly in short curves to the right and left, upwards and downwards, we can understand that these posterior organs are of great assistance to the fish in picking up any creatures which, attracted by the gleam of light issuing from its tail, are lured into too near a proximity. The explanation that these caudal organs shoot out rays of light to frighten away a pursuer, does not seem to me a happy idea. They are, as I assume, subject to the will of the fish, which when pursued would simply extinguish its lantern and escape into darkness ; light would not frighten, but rather attract a pursuer.

Special organs of touch are not more generally developed in deep-sea fishes than in the littoral fauna. As such may be considered the ventral filaments of the Ophidiidæ, the more or less detached rays of the pectoral fin of *Pteroidonus*, *Microlene* and *Mixonus*, and especially of *Bathypterois* which possesses but rudimentary eyes, and the pectoral filaments of which remind one of those of the Polynemidæ. Indeed, the comparatively rare occurrence of special organs of touch in deep-sea fishes may be used as evidence that the majority depend on the sense of sight for the perception of surrounding objects, and that therefore a large amount of light must be distributed, at least locally, in depths to which the surface light does not penetrate.

The excessively elongate fin-rays of young Trachypteridæ are evidently not organs of touch ; it is difficult to explain their use in those young fishes ; it might be imagined that they would be rather disadvantageous to them by attracting other fishes of prey, unless they afford protection by their resemblance to delicate fronds of fucus floating in the water or gradually settling towards the bottom. Such delicate filaments can only be developed in fishes sojourning in water which is not subject to violent agitation.

In the subsequent descriptions of deep-sea fishes frequent mention is made of the reduction in size and length of the gill-laminæ. These organs appear short and shrunken ; it is possible that they are longer during life, ending in delicate points, and shrunken only in consequence of the action of the spirit, but the horny rods which support the plaits of the mucous membrane are also wanting in firmness, like the parts of the skeleton, and are much shorter than in the ordinary Teleostean type. The laminæ are also reduced in number, and the gill does not possess the same extent of respiratory surface, so that the intensity of the respiratory process seems to be more diminished than in surface fishes. We can hardly doubt that the sojourn in the low temperature of the abyssal depths must have some effect upon circulation, respiration, assimilation of food and secretion; but we cannot hazard a conjecture as to the manner and degree in which those physiological functions may differ from those of surface fishes.

I may here also shortly refer to a subject in regard to which very few facts are known, and which therefore offers wide scope for speculation. It is the fact that the spawn of some deep-sea fishes (as for instance *Polyprion cernium*), is developed at the surface, whilst mature individuals of the species reside at more or less considerable depths. It is not probable that these fishes rise to the surface at the season of propagation; we may rather suppose that the spawn is deposited at a depth of several hundred fathoms and gradually rises to the surface, the young fish, after a short pelagic surface existence, returning to the depths inhabited by their progenitors. This, however, is certainly not the case with all deep-sea fishes; of many the spawn will not only be deposited at the bottom of the ocean, but also remain there throughout the period of its development. But when we consider the immense difference of the conditions under which the development of the ova of these two kinds of fishes proceeds—the one under the accelerating influences of light, warmth, and a constant supply of oxygen, the other under the retarding conditions of darkness, cold, and a minimum amount of oxygen—we cannot help thinking that the one series supplies the deep sea with the forms which retain the organisation of the surface fishes, whilst the other develops into those degraded forms, of which the families Ophidiidæ and Murænidæ offer the most striking examples.

The colours of deep-sea fishes are extremely simple, their bodies being either black, pink, or silvery; however, some of the fishes which now are black are described as having been of a bluish colour when they were brought to the surface. In a few only are some filaments or the fin-rays of a bright scarlet colour; black spots on the fins or dark cross-bars on the body are of very rare occurrence. An extremely common, almost general characteristic of deep-sea fishes is the black coloration of some of the body-cavities; this is limited to the pharynx in many of the fishes which live about the 100-fathoms limit, but the colour is more intense, and spread all over the oral, branchial, and peritoneal cavities in strictly typical deep-sea forms. The highly specialised luminous organs on the head of the Stomiatidæ are green or pink during life, whilst they fade into white after the immersion of the fishes in spirit. Among the black-coloured deep-sea fishes albinos are not scarce.

VERTICAL AND HORIZONTAL DISTRIBUTION OF DEEP-SEA FISHES.

Before the voyage of the Challenger scarcely thirty deep-sea fishes were known; this number is now increased to about 370, if we include a few species which are, in fact, surface fishes, but descend occasionally or regularly to or even beyond the 100-fathoms limit. In a table appended to these introductory remarks, I have endeavoured to show in a graphic manner the bathymetrical range of each species, so far as it has been ascertained at present. Unfortunately, some uncertainty prevails as regards the depth at which certain specimens were obtained. I formerly assumed that the fishes of the open sea were living either near to the surface or at the bottom, but I think now that Mr. Murray is right in supposing that certain fishes live habitually in intermediate strata, without ever coming to the surface or descending to the bottom.[1] The function of the pneumatic apparatus with which many deep-sea fishes are provided is to regulate their specific gravity, so that a fish is able to maintain its position at a certain depth, which would vary only within certain limits, comparable to those which we observe in surface fishes. As the mouth of the dredges or trawls used by the Challenger was open during their descent or ascent, it is within the limits of probability that sometimes fishes were accidentally enclosed whilst the apparatus was traversing the strata intermediate between the surface and bottom. And this has actually happened more than once; for it is quite certain that common surface fishes, like *Sternoptyx* and *Astronesthes*, never ranged to the depth of 2500 fathoms, the depth to which the dredge had descended on the occasion of the capture of these specimens. On the other hand, many of the fishes obtained by the Challenger offer sufficient evidence, from their own organisation, that they live at the bottom, and are unable to maintain themselves suspended in the water; and, consequently, that they actually were obtained at the depth to which the dredge descended. Besides, the statements of the depths of the Challenger fishes have been confirmed in many instances by the observations made during the more recent deep-sea explorations.

However, it may be assumed that of those *mid-water fishes*, as the forms may be called which inhabit intermediate strata, comparatively much fewer specimens are captured than of the bottom fishes. It must be of rare occurrence that fishes accidentally enter the narrow mouth of the dredge whilst it is passing to the bottom or to the surface, and it is more likely to happen when the larger trawl is used. But such free-swimming fishes are much more agile in their movements, and escape more easily on perceiving the

[1] The habit of some fishes of living at a distance from the surface and bottom is a fact which has been known for a long time among fresh-water fishes. *Salmo lacustris*, of the Lake of Constance, has received its vernacular name from this habit; it is called "Schwebe-forelle," that is, the trout which is suspended in mid-water.

approach of the dredge than bottom fishes, which are generally of a more sluggish nature, and which, seeking safety by burying themselves in the ooze, would be readily enclosed in the dredge.

So far as the observations go at present, no distinct bathymetrical zones, characterised by peculiar forms, can be defined. As the transition from the organisation of the typical surface fish to that of the most highly specialised deep-sea form is gradual, so the passage from the littoral to the abyssal fauna is continuous and not marked by a sudden change. The limits between the two faunæ are still more obscured by the remarkable manner in which they overlap each other owing to the wide bathymetrical range of certain species of either fauna. I need only mention such common littoral forms as *Lophius piscatorius*, *Merluccius vulgaris*, and *Pleuronectes cynoglossus*, which descend to depths of from 300 to 700 fathoms, thus living in the same areas which are inhabited by the most highly specialised abyssal forms like *Chiasmodus*, *Trachypterus*, and *Alepocephalus*. Also the temperature of the water clearly interferes with a uniform bathymetrical distribution of fishes, as many species, which in low latitudes are found at considerable depths, often ascend into the cold surface strata of high latitudes.[1] Further, nocturnal pelagic surface fishes seek, during the day-time, the darkness of greater depths. The instances of the wide bathymetrical range of deep-sea species are numerous: some may range from a depth of some 300 fathoms down to one of 2000 fathoms; or, in other words, a fish which has once attained in its organisation to that modification by which it is enabled to exist under the pressure of half a ton, can easily accommodate itself to one of two tons or more.

But if there are serious obstacles to a division of the deep-sea fish-fauna into vertical zones characterised by the presence of peculiar forms, there are less objections to an attempt to show to what limits the families of fishes descend which are represented in the deep-sea by surface-forms or their modifications. As far as our present knowledge goes, we find—

1. That at a depth of 400 fathoms the Gobiidæ, Trachinidæ (with the exception of *Bathydraco*), Blenniidæ, Percidæ, Scorpænidæ, Trichiuridæ, Cyttidæ, Cataphracti, Bathythrissidæ cease to exist.

2. At a depth of 500 fathoms two important types, viz., the Sharks and Rays, and the Flat-fishes cease to flourish, only one isolated example of each descending beyond that limit.

3. At 700 fathoms several other families, which are characteristic forms of the littoral fauna of the cold and temperate zones disappear, viz., the Cottidæ, Discoboli, and Lycodidæ (with one exception); there is also no evidence of the Trachypteridæ and Myxine extending beyond this depth.

4 The depth of 1200 fathoms seems to be the limit of the Holocephali.

[1] This fact was first expressed in Introduction to the Study of Fishes, p. 305.

5. Beyond 2000 fathoms neither Gadidæ nor Salmonidæ nor Notacanthi have been found.

6. The families which descend to the greatest depth at which fishes have been obtained, viz., 2900 fathoms, are Berycidæ, Pediculati, Ophidiidæ, Macruridæ, Sternoptychidæ, Scopelidæ, Stomiatidæ, Murænidæ; also two families which have no representatives in the surface-fauna, viz., the Alepocephalidæ and Halosauridæ, extend to the same enormous depth; and there is no reason why all those deep-sea forms, which are known to live at a depth of nearly 3000 fathoms, should not occur in the greatest abyss of the ocean.

The abundance and variety of fish life decreases with the depth, as is obvious from the following table, which expresses our present knowledge of the subject. There have been found

between	100– 300	fathoms	232	species.
,,	300– 500	,,	142	,,
,,	500– 700	,,	76	,,
,,	700–1500	,,	56	,,
,,	1500–2000	,,	24	,,
,,	2000–2900	,,	23	,,

Of those found between 100 and 300 fathoms 108 also occur above the 100-fathoms limit.

This decrease in the number of species, as shown in this table, is no doubt partly owing to the difficulty of capturing fishes at great depths, a difficulty which increases in proportion to the depth at which the dredge is worked. But it must also be regarded as evidence of the actually diminished variety of fishes. Fishes may be, and no doubt are, locally abundant at the bottom of the ocean; but this abundance is probably one of individuals rather than of distinct forms. We may safely assume, that as the majority of deep-sea fishes are modifications and derivatives of surface forms, they are fewer in number than the latter, especially when we consider that the physical conditions of the abyss are of a very uniform character, and therefore cannot have given rise to the development of numerous specific and generic forms.

This uniformity of the physical character of the lowermost strata of the ocean is also the cause of the almost unlimited horizontal distribution of deep-sea fishes. Pelagic surface-fishes have already a wide range, but are more or less influenced in their distribution by climatic conditions. Deep-sea fishes are no longer subject to this cause of limitation when they have reached a depth of 500 fathoms, where the temperature of the water is as low as 40° F., and perfectly independent of that of the surface water. Therefore, the instances already known of the same genera, and even of the same species occurring in the depths of the eastern and western, northern and southern hemispheres are numerous, and will be still more increased by future investigations. A certain number of the species are no doubt more localised; those will be chiefly such as have been derived, and are not yet far removed in their organization, from littoral forms. Others, which may be supposed to have been derived from pelagic surface fish, may have been as widely distributed, almost from the beginning of their existence, as their ancestors. At present, however, our knowledge of the actual distribution of deep-sea fishes is much too imperfect to be used as a safe basis for further generalisations.

THE CONSTITUTION OF THE FISH-FAUNA OF THE DEEP SEA.

If, as has been done in the present Report, all species which hitherto have been found at a depth of 100 fathoms are included in the deep-sea fauna, so great an admixture of surface forms is admitted, that the characteristic features of abyssal fauna are obscured. We obtain a more correct idea of its constitution if we take into consideration only such forms as have been found from 300 fathoms downwards; eliminating from the total number of 385 species enumerated in this Report all which do not descend to 300 fathoms, 155 in number. This leaves 230 true abyssal forms.

Of this number the

Chondropterygians	furnish	8	species or	$3\frac{1}{2}$	per cent.
Holocephali	,,	2	,,	1	,,
Acanthopterygians	,,	64	,,	26	,,
Berycidæ	,,	24	,,	$10\frac{1}{2}$	,,
Pediculati	,,	7	,,		
Trachypteridæ	,,	7	,,		
Scorpænidæ	,,	5	,,		
Discoboli	,,	5	,,		
Percidæ	,,	4	,,		
Trichiuridæ	,,	4	,,		
Cottidæ	,,	3	,,		
Cataphracti	,,	2	,,		
Cyttidæ	,,	1	,,		
Trachinidæ	,,	1	,,		
Lophotidæ	,,	1	,,		
Anacanthini	,,	91	,,	40	,,
Lycodidæ	,,	13	,,		
Gadidæ	,,	19	,,	9	,,
Ophidiidæ	,,	20	,,	9	,,
Macruridæ	,,	37	,,	16	,,
Pleuronectidæ	,,	4	,,		
Physostomi	,,	63	,,	26	,,
Scopelidæ	,,	17	,,		
Murænidæ	,,	13	,,		
Stomiatidæ	,,	10	,,		
Alepocephalidæ	,,	9	,,		

Halosauridæ	furnish	5	species.	
Sternoptychidæ	,,	4	,,	
Salmonidæ	,,	2	,,	
Notacanthi	,,	2	,,	
Bathythrissidæ	,,	1	,,	
Cyclostomi	,,	2	,,	or 1 per cent.

As regards the abundance of individuals the Macruridæ seem to surpass all the other forms; then follow the Ophidiidæ and Gadidæ. Scopelidæ and Stomiatidæ are likewise numerous, much more so than the Berycidæ, although these latter are represented by a greater number of species.

Vertical Range of Distribution

	0–100	100–300	300–500	500–700	700–1000	
SHARKS—						
Scyllium canescens,	.	. .	—	. .	. . .	1
Pristiurus melanostomus,	—	—	. .	. .	. . .	2
Spinax spinax,	—	—	. .	. .	. . .	3
Spinax granulosus,	.	—	. .	. .	. . .	4
Centrophorus foliaceus,	.	. .	—	. .	. . .	5
Centrophorus cœlolepis,	.	. .	—	. .	. . .	6
Centrophorus squamulosus,	.	. .	—	. .	. . .	7
Centroscyllium fabricii,	—	—	. .	. .	. . .	8
Centroscyllium granulatum,	.	—	. .	. .	. . .	9
Læmargus borealis,	—	—	. .	. .	. . .	10
RAYS—						
Raja isotrachys,	.	. .	—	. .	. . .	11
Raja circularis,	—	—	—	. .	. . .	12
Raja radiata,	—	—	. .	. .	. . .	13
Raja hyperborea,	.	. .	—	—	. . .	14
Raja plutonia,	.	—	—	. .	. . .	15
Raja batis,	—	—	. .	. .	. . .	16
Raja vomer,	—	—	. .	. .	. . .	17
Raja fullonica,	—	—	. .	. .	. . .	18
Raja nidrosiensis,	.	—	. .	. .	. . .	19
Urolophus kaianus,	.	—	. .	. .	. . .	20
HOLOCEPHALA—						
Chimæra monstrosa,	- - -	—	—	—	. . .	21
Chimæra affinis,	.	—	—	—	—	22
ACANTHOPTERYGII—						
Percidæ—						
Anthias megalepis,	.	—	. .	. .	. . .	23
Centropristis pleurospilus,	.	—	. .	. .	. . .	24
Scombrops chilodipteroides,	.	- - -	—	. .	. . .	25
Acropoma philippinense,	—	—	. .	. .	. . .	26
Propoma roseum,	.	—	. .	. .	. . .	27

of Species, Genera, and Families.

	1000–1500	1500–2000	2000–2900
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Vertical Range of Distribution

	0–100	100–300	300–500	500–700	700–1000	
Malacichthys griscus, ...	- -	- - - - - - - - -	- - -	. .	. . .	28
Synagrops japonicus, ...	- -	- - - - - - - - -	- -	. .	. . .	29
Polyprion cernium, ...	———	———	———	. . .	. . .	30
Scorpænidæ—						
Scorpæna percoides, ...	———	———	———	. .	. . .	31
Scorpæna dactyloptera, ...	.	———	——	. .	. . .	32
Scorpæna kuhlii (see Lowe), ...	. -	———	. .	. .	. . .	33
Sebastes marinus, ...	———	——	. .	. .	. . .	34
Sebastes viviparus, ...	———	———	. .	. .	. . .	35
Sebastes macrochir, ...	.	. .	——	. .	. . .	36
Sebastes hexanema, ...	.	——	. .	. .	. . .	37
Sebastes oculatus, ...	———	———	—	. .	. . .	38
Setarches fidjiensis, ...	.	. .	—	. .	. . .	39
Setarches parmatus, ...	.	——	. .	. .	. . .	40
Setarches guntheri, ...	.	- - - - - - - - -	. .	. .	. . .	41
Bathysebastes albescens, ...	.	- - - - - - - - -	. .	. .	. . .	42
Lioscorpius longiceps, ...	.	—	. .	. .	. . .	43
Berycidæ—						
Hoplostethus mediterraneum, ...	.	- - - -	- - - -	. .	. . .	44
Trachichthys australis, ...	.	- - - -	- - - -	. .	. . .	45
Trachichthys jacksoniensis, ...	.	- - - -	- - - -	. .	. . .	46
Trachichthys elongatus, ...	.	- - - -	- - - -	. .	. . .	47
Trachichthys fernandezianus, ...	.	- - -	- - - -	. .	. . .	48
Trachichthys traillii, ...	.	- - -	- - -	. .	. . .	49
Trachichthys macleayi, ...	.	- - - -	- - - - -	. .	. . .	50
Trachichthys intermedius, ...	.	—	———	. .	. . .	51
Trachichthys darwinii, ...	.	- - - -	- - -	. .	. . .	52
Anoplogaster cornutus, ...	—- - -	. .	. .	. .	. . .	53
Caulolepis longidens, ...	.	. .	. .	. .	. . .	54
Melamphaës microps, ...	.	. .	. .	. .	. . .	55
Melamphaës typhlops	.	. .	. .	. .	- - - - - - -	56
Melamphaës megalops, ...	.	. .	. .	. .	- - - - - - -	57
Melamphaës crassiceps, ...	.	. .	. .	—	————	58

of Species, Genera, and Families.

	1000–1500	1500–2000	2000–2900
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Vertical Range of Distribution

	0–100	100–200	300–500	500–700	700–1000	
Melamphaës mizolepis,	.	. .	. .	. .	——	59
Melamphaës robustus,	.	. .	. .	. .	. . .	60
Melamphaës beanii,	.	. .	. .	. .	————	61
Melamphaës suborbitalis,	.	. .	. .	. .	. . .	62
Malacosarcus macrostoma,	.	. .	. .	. .	. . .	63
Stephanoberyx monæ,	.	. .	. .	. .	. . .	64
Beryx decadactylus,	.	—	——	. .	. . .	65
Beryx splendens,	.	———	——	. .	. . .	66
Polymixia nobilis,	.	. .	——	. .	. . .	67
Poromitra capito,	.	. .	. .	. .	. . .	68
Myripristis kaianus,	.	——	. .	. .	. . .	69
Trichiuridæ—						
Nealotus tripes,	- - - -	- - - -(?)	. .	. .	. . .	70
Aphanopus carbo,	- - - -	- -(?)	. .	. .	. . .	71
Nesiarchus nasutus,	- - -	- -(?)	. .	. .	. . .	72
Lepidopus caudatus,	—— - -	- - -	. .	. .	. . .	73
Lepidopus tenuis,	.	- - - -	——	. .	. . .	74
Lepidopus elongatus,	- - - -		. .	. .	. . .	75
Trichiurus lepturus,	———	————	——	. .	. . .	76
Euoxymetopon tæniatus,	- -	- - - -(?)	. .	. .	. . .	77
Euoxymetopon poeyi,	- -	- - - -(?)	. .	. .	. . .	78
Thyrsites pretiosus,	.	——	——	. .	. . .	79
Thyrsites prometheus,	—	————	——	. .	. . .	79*a*
Gempylus serpens,	- -	- - - - -(?)	. .	. .	. . .	80
Carangidæ—						
Anomalops palpebratus,	- -	- - - - -(?)	. .	. .	. . .	81
Cyttidæ—						
Cyttus abbreviatus,	.	. .	——	. .	. . .	82
Antigonia capros,	.	——	. .	. .	. . .	83
Coryphænidæ—						
Diretmus argenteus,	- - - -	- -(?)	. .	. .	. . .	84
Diretmus aureus,	- - -	- - - -(?)	. .	. .	. . .	85
Schedophilus medusophagus,	—— -	- - -	. .	. .	. . .	86

of Species, Genera, and Families.

	1000–1500	1500–2000	2000–2900
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79*a*			
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86			

Vertical Range of Distribution

	0–100	100–300	300–500	500–700	700–1000	
Schedophilus lockingtonii,	- -	- - -(?)				87
Schedophilus enigmaticus,	- -	- - - -(?)				88
Trachinidæ—						
Bathydraco antarcticus,						89
Aphritis gobio,	——	—				90
Acanthaphritis grandisquamis,		—				91
Champsodon vorax,	——	——				92
Uranoscopus kaianus,		——				93
Notothenia mizops,	- - -	—				93*a*
Pediculati—						
Lophius piscatorius,	——	———	—			94
Lophius naresii,		——				95
Himantolophus groenlandicus,	- - - -	-(?)				96
Himantolophus reinhardti,	- - - -	-(?)				97
Aegæonichthys appelii,	- -	- - -(?)				98
Ceratias bispinosus,			——			99
Ceratias holbolli,	- -	- - -(?)				100
Ceratias uranoscopus,						1
Ceratias carunculatus,			——			2
Oneirodes eschrichtii,	- -	- - -(?)				3
Melanocetus johnsonii,		- - - - -				4
Melanocetus murrayi,						5
Linophryne lucifer,		- - - - -(?)				6
Chaunax pictus,		——— -				7
Halieutæa senticosa,		——				8
Dibranchus atlanticus,			——			9
Cottidæ—						
Cottunculus microps,	——	———	———	——		10
Cottunculus thomsonii,			- - - - -	—		11
Cottus bathybius,			- - - - -	—		12
Centridermichthys uncinatus,	——	———				13
Icelus hamatus,	——	———				14
Triglops pingelii,	——	———				15

of Species, Genera, and Families.

	1000–1500	1500–2000	2000–2900
87			
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Vertical Range of Distribution

	0–100	100–300	300–500	500–700	700–1000	
Trigla leptacanthus,		——				116
Lepidotrigla spiloptera,		——				17
Cataphracti—						
Peristethus miniatum,		——				18
Peristethus moluccense,		——				19
Peristethus murrayi,		——				20
Peristethus liorhynchus,		——				21
Peristethus micronema,		- - - ——	——			22
Peristethus truncatum,		- - -	- - -			23
Agonus decagonus,	——	——				24
Discoboli—						
Cyclopterus spinosus,	——	-				25
Liparis fabricii,	——	-				26
Liparis micropus,				——		27
Liparis gelatinosus,	——	——	——	——		28
Paraliparis bathybius,				——		29
Paraliparis liparinus,			——			30
Paraliparis membranaceus,			——			31
Gobiidæ—						
Callionymus kaianus,		——				32
Callionymus calaurspomus,	——	——				33
Blenniidæ—						
Anarrhichas minor,	——	——				34
Anarrhichas latifrons,	——	——				35
Blenniops ascanii,	——	——				36
Trachypteridæ—						
Trachypterus,		- - -	——	- - -		37
Stylophorus,	(?)					38
Regalecus,		- - -	——	- - -		39
Lophotidæ—						
Lophotes,		- - -	——	- - -		40

of Species, Genera, and Families.

	1000–1500	1500–2000	2000–2900
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Vertical Range of Distribution

	0–100	100–300	300–500	500–700	700–1000	
PHARYNGOGNATHI—						
Heliastes roseus,	.	——	. .	. .	. . .	141
ANACANTHINI—						
Lycodidæ—						
Lycodes esmarkii,	.	——	——	——	. . .	42
Lycodes reticulatus,	——	——	——	——	. . .	43
Lycodes frigidus,	.	——	——	——	——	44
Lycodes pallidus,	——	——	——	. .	. . .	45
Lycodes seminudus,	——	——	. .	. .	. . .	46
Lycodes murænα,	.	. .	——	——	. . .	47
Lycodes sarsii,	——	——	. .	. .	. . .	48
Lycodes verrilli,	——	——	——	——	. . .	49
Lycodes paxillus,	.	. .	——	. .	. . .	50
Lycodes paxilloides,	.	. .	——	. .	. . .	51
Lycodonus mirabilis,	.	. .	——	. .	. . .	52
Gymnelis viridis,	——	——	. .	. .	. . .	53
Melanostigma gelatinosum,	——	——	——	. .	. . .	54
Gadidæ—						
Gadus morrhua,	——	——	. .	. .	. . .	55
Gadus poutassou,	——	——	. .	. .	. . .	56
Gadus argenteus,	——	——	. .	. .	. . .	57
Gadus minutus (see Risso),	——	——	. .	. .	. . .	58
Mora mediterranea,	.	. .	——	. .	. . .	59
Halargyreus johnsonii,	.	. .	- - - - -	. .	. . .	60
Melanonus gracilis,	.	. .	. .	. .	. . .	61
Merluccius vulgaris,	——	——	——	. .	. . .	62
Hypsicometes gobioides,	.	——	. .	. .	. . .	63
Lotella marginata,	.	——	——	.	. . .	64
Uraleptus maraldi (see Risso),	.	——	. .	. .	. . .	65
Physiculus dalwigkii,	.	- - -	- - -	. .	. . .	66
Physiculus kaupi,	- - -	- - - ——	——	. .	. . .	67
Physiculus peregrinus,	- - -	- - -	. .	. .	. . .	68
Phycis blennioides,	——	——	. .	. .	. . .	69

of Species, Genera, and Families.

	1000–1500	1500–2000	2000–2900
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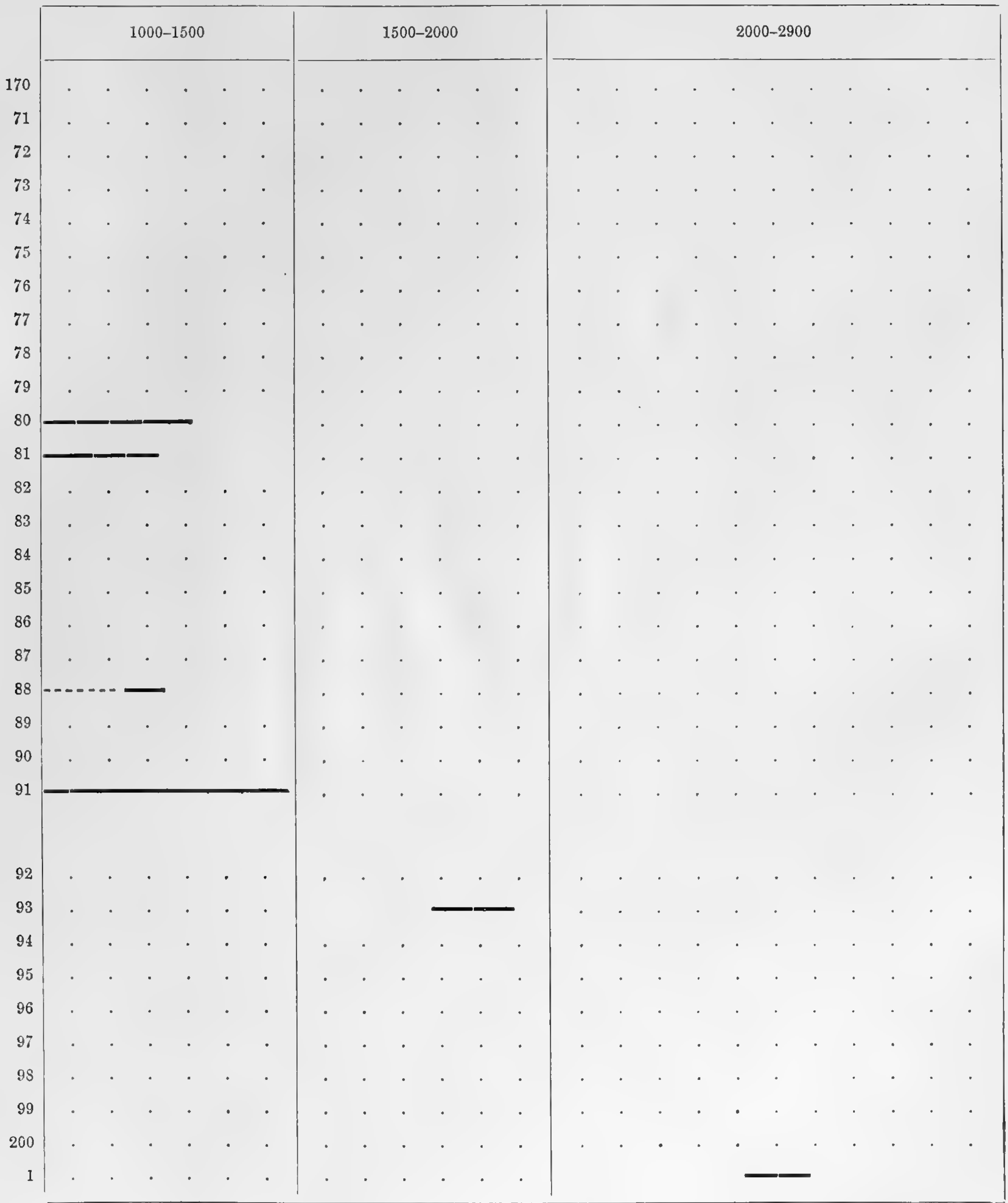
Vertical Range of Distribution

	0–100	100–300	300–500	500–700	700–1000	
Phycis chesteri,	.	—	. .	. .	. . .	170
Phycis regius,	—	—	. .	. .	. . .	71
Phycis americanus,	—	—	. .	. .	. . .	72
Phycis tenuis,	—	—	. .	. .	. . .	73
Læmonema barbatulum,	.	—	—	. .	. . .	74
Haloporphyrus guentheri,	.	- - -	- - -	. .	. . .	75
Haloporphyrus lepidion,	.	- - -	- - -	. .	. . .	76
Haloporphyrus eques,	.	. .	—	—	. . .	77
Haloporphyrus inosimæ,	.	. .	—	. .	. . .	78
Haloporphyrus ensiferus,	.	. .	. .	—	. . .	79
Antimora rostrata,	.	. .	. .	—	—	80
Antimora viola,	.	. .	—	—	—	81
Molva molva,	—	—	. .	. .	. . .	82
Molva abyssorum,	.	—	. .	. .	. . .	83
Onus macrophthalmus,	—	. .	. .	. .	. . .	84
Onus carpenteri,	.	—	. .	. .	. . .	85
Onus reinhardti,	—	—	—	—	. . .	86
Onus septentrionalis,	—	—	. .	. .	. . .	87
Onus ensis,	—	- - -	- - -	- - -	- - -	88
Onus cimbrius,	—	—	. .	. .	. . .	89
Brosmius brosme,	—	—	—	—	. . .	90
Chiasmodus niger,	.	. .	—	—	—	91
Ophidiidæ—						
Barathrodemus manatinus,	.	. .	. .	—	. . .	92
Neobythites grandis,	.	. .	. .	. .	. . .	93
Neobythites macrops,	.	. .	—	. .	. . .	94
Neobythites ocellatus,	.	. .	—	. .	. . .	95
Neobythites gillii,	.	—	. .	. .	. . .	96
Catætyx messieri,	.	. .	—	. .	. . .	97
Pteridium atrum,	.	- - -	. .	. .	. . .	98
Pteroidonus quinquarius,	.	. .	. .	—	. . .	99
Dicrolene intronigra,	.	. .	—	—	. . .	200
Mixonus laticeps,	.	. .	. .	. .	. . .	1

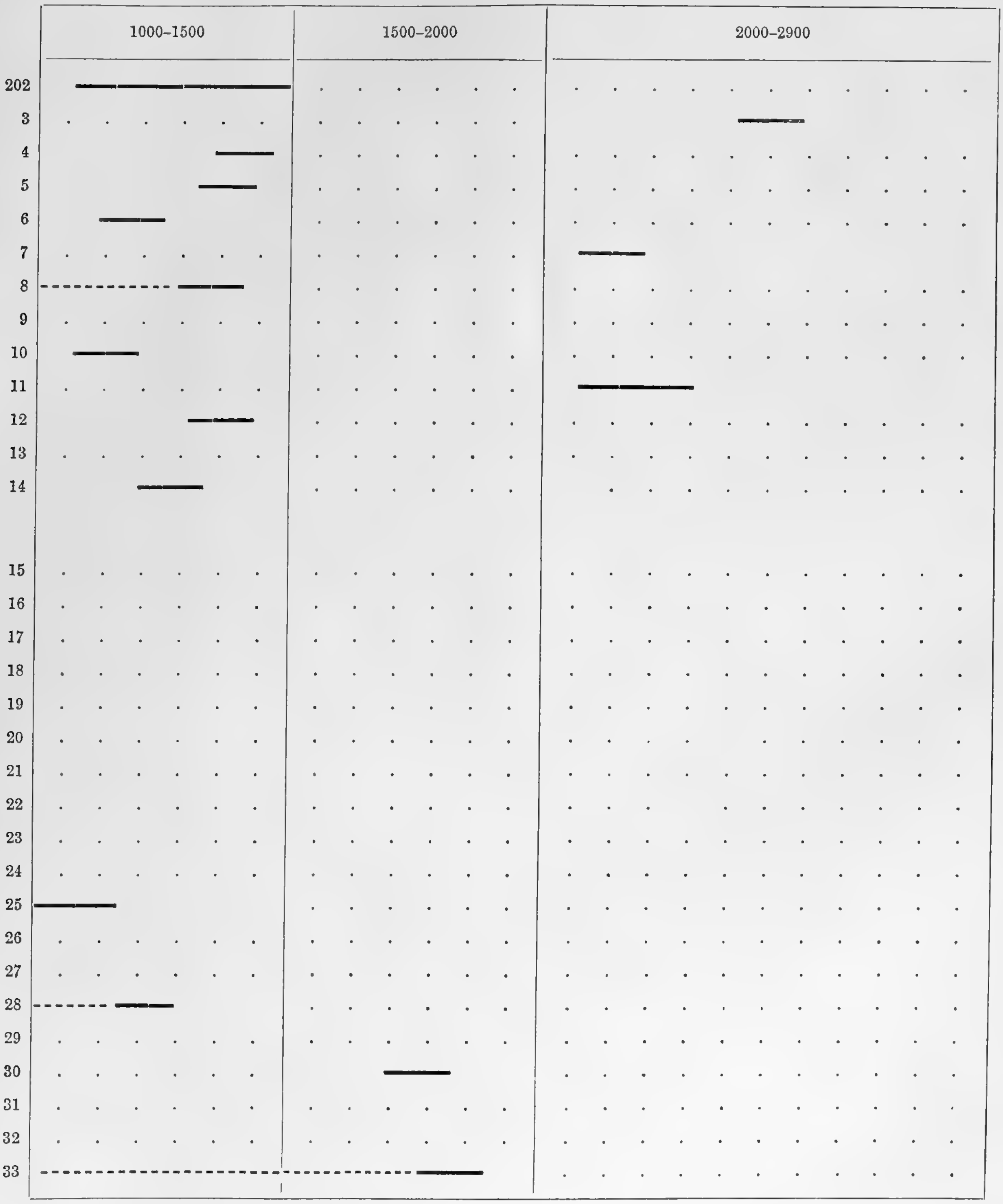
of Species, Genera, and Families.



Vertical Range of Distribution

	0–100	100–300	300–500	500–700	700–1000	
Bathyonus compressus,						202
Bathyonus tænia,						3
Bathyonus catena,						4
Porogadus gracilis,						5
Porogadus miles,						6
Porogadus rostratus,						7
Nematonus pectoralis,			—— - - -	- - -	- - -	8
Diplacanthopoma brachysoma,			——			9
Acanthonus armatus,						10
Typhlonus nasus,						11
Aphyonus gelatinosus,						12
Ophidium muræmolepis,		——				13
Rhodichthys regina,						14
Macruridæ—						
Macrurus parallelus,			——	——		15
Macrurus japonicus,			——			16
Macrurus australis,	——	- - -				17
Macrurus cœlorhynchus,		——				18
Macrurus carminatus,		——	——			19
Macrurus fasciatus,		——				20
Macrurus fabricii,	——	- - -				21
Macrurus rudis,				——		22
Macrurus nasutus,			——	——		23
Macrurus serrulatus,				——		24
Macrurus sclerorhynchus,				- - -	- - -	25
Macrurus æqualis,				——		26
Macrurus bairdii,		——	——	——	——	27
Macrurus goodii,			—— - - -	- - -	- - -	28
Macrurus holotrachys,				——		29
Macrurus asper,						30
Macrurus carinatus,			——			31
Macrurus rupestris,		- - - ——	——			32
Macrurus altipinnis,				—— - - -	- - -	33

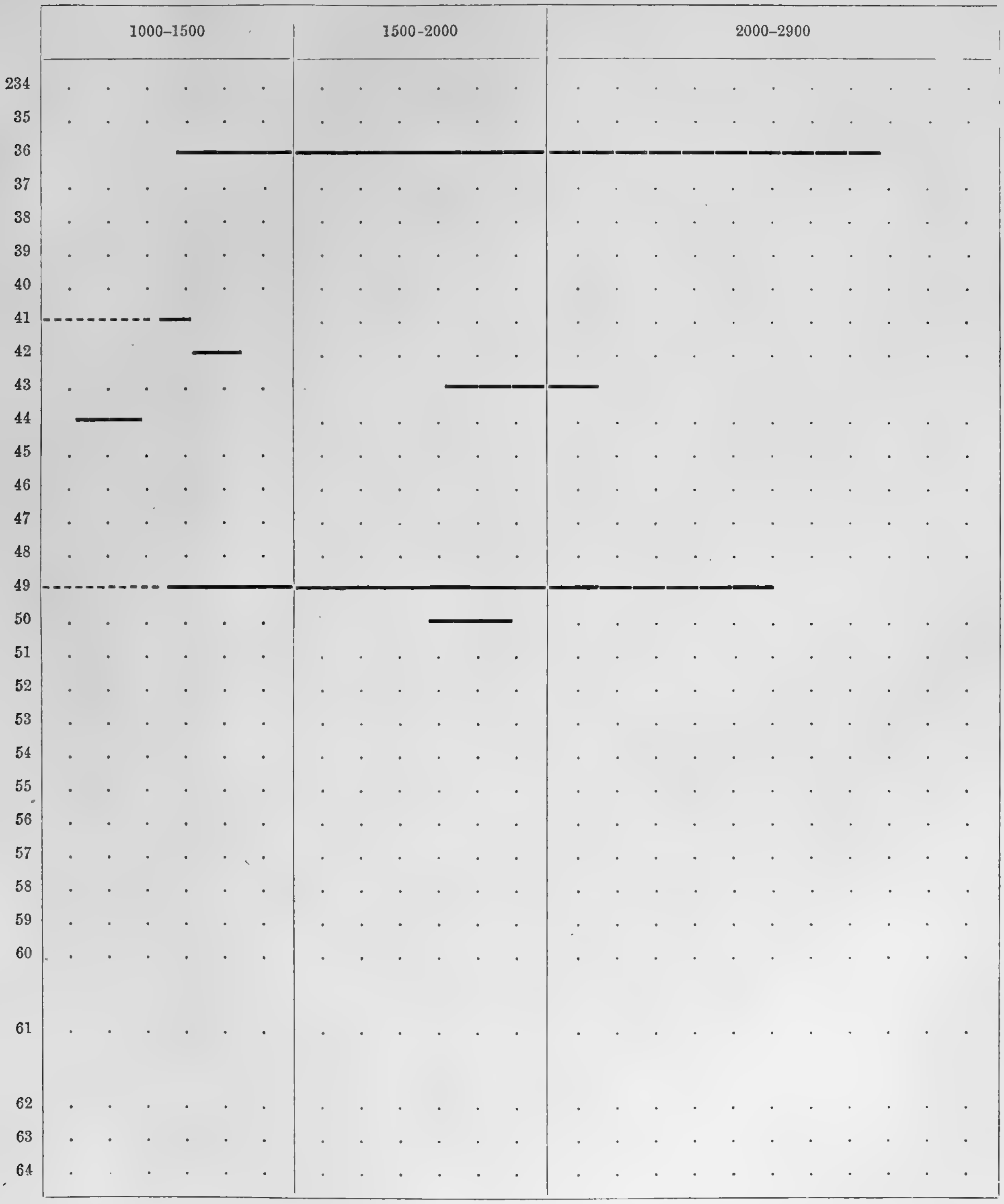
of Species, Genera, and Families.



Vertical Range of Distribution

	0–100	100–300	300–500	500–700	700–1000	
Macrurus longibarbis,			—			234
Macrurus italicus,		- - -				35
Macrurus filicauda,						36
Macrurus microlepis,			—			37
Macrurus villosus,			—			38
Macrurus crassiceps,				—		39
Macrurus leptolepis,			—			40
Macrurus simulus,			—	— - - -	- - -	41
Macrurus fernandezianus,						42
Macrurus liocephalus,						43
Macrurus murrayi,						44
Macrurus denticulatus,	—	—	—	—		45
Macrurus lævis,		—	—			46
Macrurus macrochir,			—			47
Macrurus sulcatus,			—			48
Macrurus armatus,			— - - -	- - -	- - -	49
Macrurus affinis,						50
Macrurus longifilis,				—		51
Trachyrhynchus trachyrhynchus,		—				52
Trachyrhynchus longirostris,				—		53
Trachyrhynchus murrayi,				—		54
Bathygadus cottoides,				—		55
Bathygadus multifilis,				—		56
Bathygadus cavernosus,			—			57
Bathygadus macrops,			—			58
Bathygadus longifilis,					—	59
Macruronus novæ-zelandiæ,	- - -	- - -				60
Ateleopodidæ—						
Ateleopus japonicus,		- - -	- - -(?)			61
Pleuronectidæ—						
Hippoglossus pinguis,	—	—	—			62
Hippoglossoides platessoides,	—	—				63
Poecilopsetta colorata,		—				64

of Species, Genera, and Families.



Vertical Range of Distribution

	0–100	100–300	300–500	500–700	700–1000	
Anticitharus polyspilus,		—				265
Samaris maculatus,		—				66
Lepidopsetta maculata,			—			67
Pseudorhombus hectoris,		—				68
Pseudorhombus boops,			—			69
Pseudorhombus oblongus,	—					70
Pseudorhombus ocellatus,		—				71
Monolene sessilicauda,		—				72
Citharichthys arctifrons,	—	—				73
Citharichthys unicornis,		—				74
Pleuronectes beanii,		—				75
Pleuronectes cynoglossus,	—	—	—	—	—	76
Nematops microstoma,		—				77
Solea kaiana,		—				78
Aphoristia nebulosa,		—				79
Physostomi—						
Sternoptychidæ—						
Argyropelecus hemigymnus,	—	- - -				80
Argyropelecus olfersii,	—	- - -				81
Sternoptyx diaphana,	—	- - -				82
Polyipnus spinosus,	- - -	- - - —				83
Gonostoma denudatum,	—	- - -				84
Gonostoma elongatum,		- - -	— - - -	- - -	- - - —	85
Gonostoma gracile,			— - - -	- - -	- - -	86
Gonostoma microdon,			—	—	—	87
Photichthys argenteus,		- - -				88
Chauliodus sloanii,		—	—	—	—	89
Scopelidæ—						
Saurus kaianus,		—				90
Harpodon microchir,		- - -	- - - (?)			91
Bathysaurus ferox,						92
Bathysaurus agassizii,				—		93
Bathysaurus mollis,						94

of Species, Genera, and Families.

	1000–1500	1500–2000	2000–2900
265			
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67			
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91			
92	——		
93			
94		———	————

Vertical Range of Distribution

	0–100	100–300	300–500	500–700	700–1000	
Bathypterois longifilis,				—		295
Bathypterois longipes,						96
Bathypterois longicauda,						97
Bathypterois quadrifilis,				—	—	98
Ipnops murrayi,						99
Chlorophthalmus agassizii,		—				300
Chlorophthalmus productus,			—			1
Chlorophthalmus nigripinnis,		—				2
Chlorophthalmus gracilis,						3
Scopelus macrolepidotus,				—		4
Scopelus glacialis,	—	—	—	—	—	5
Scopelus engraulis,		—				6
Scopelus dumerilii,		- - -	—			7
Nannobrachium nigrum,				—		8
Odontostomus hyalinus,		- - -				9
Omosudis lowii,			—			10
Plagyodus ferox,		- - -	- - -			11
Stomiatidæ—						
Astronesthes niger,	—	— - - -				12
Stomias boa,		- - — - -	- - -	- - -	- - -	13
Stomias affinis,			—			14
Stomias ferox,		- - -	—			15
Echiostoma barbatum,		- - -	- - -			16
Opostomias micripnus,						17
Pachystomias microdon,						18
Photonectes albipinnis,		- - -	- - - (?)			19
Malacosteus niger,			- - - (?)			20
Malacosteus indicus,			—			21
Bathophilus nigerrimus,		- - - (?)				22
Idiacanthus fasciola,	- - -	- (?)				23
Idiacanthus ferox,						24
Salmonidæ—						
Argentina silus,	—	—				25

of Species, Genera, and Families.

	1000–1500	1500–2000	2000–2900
295			
96			———
97			———
98			
99		———	———
300			
1			
2			
3	———		
4			
5	———		
6			
7			
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13	- - - - - -	- - - ———	
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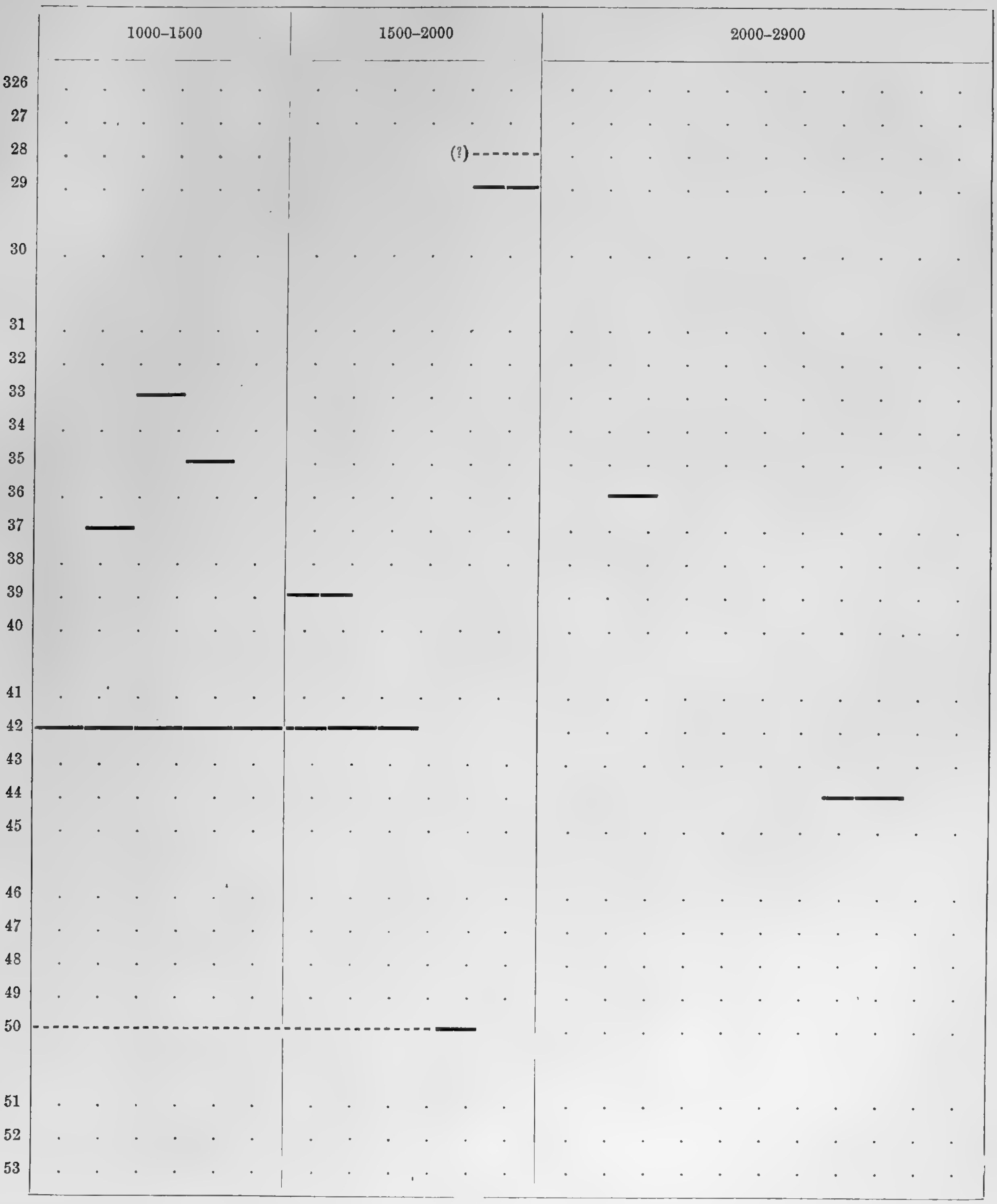
23			
24			———
25			

Vertical Range of Distribution

	0–100	100–300	300–500	500–700	700–1000	
Argentina lioglossa,		- - - - -				326
Argentina elongata,	- - - - -	-(?)				27
Bathylagus atlanticus,						28
Bathylagus antarcticus,						29
Bathythrissidæ—						
Bathythrissa dorsalis,		- - - - -	——			30
Alepocephalidæ—						
Alepocephalus rostratus,			——			31
Alepocephalus agassizii,					——	32
Alepocephalus productus,						33
Alepocephalus bairdii,		——				34
Alepocephalus niger,						35
Bathytroctes macrolepis,						36
Bathytroctes microlepis,						37
Bathytroctes rostratus,				——		38
Platytroctes apus,						39
Xenodermichthys nodulosus,			——			40
Halosauridæ—						
Halosaurus owenii,		- - - - -	- -			41
Halosaurus macrochir,				——	——————	42
Halosaurus mediorostris,					——	43
Halosaurus rostratus,						44
Halosaurus affinis,				——		45
Notacanthi—						
Notacanthus sexspinis,	- - -	- - -				46
Notacanthus nasus,	- - -	- - -				47
Notacanthus phasganorus,	- - -	- - -				48
Notacanthus bonapartii,			——			49
Notacanthus rissoanus,			- - - - -	- - - - -	- - - - -	50
Murænidæ—						
Congromuræna guttulata,			——			51
Simenchelys parasiticus,	——	——				52
Nettastoma melanurum,		- - - -	- - -			53

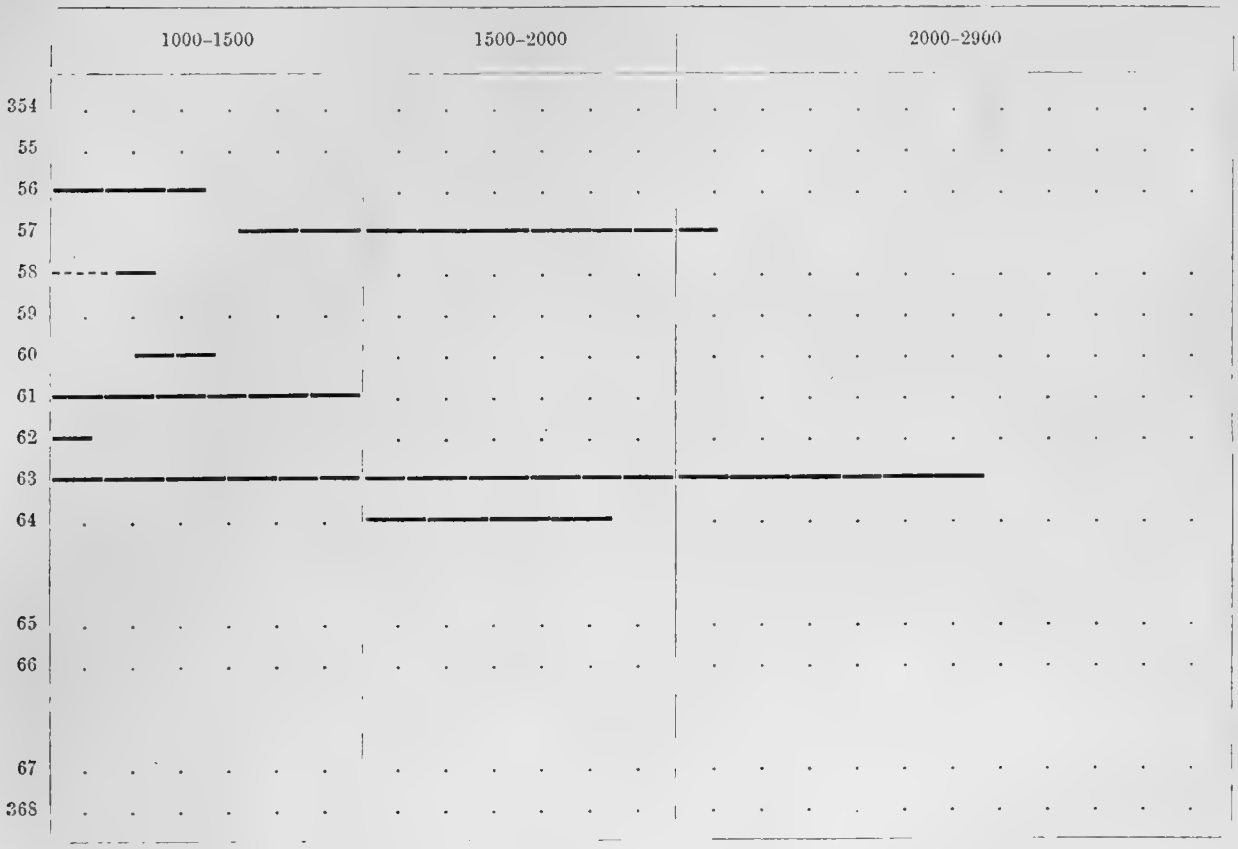
of Species, Genera, and Families.



Vertical Range of Distribution.

	0–100	100–300	300–500	500–700	700–1000	
Nettastoma parviceps,	.	. .	—	. .	. . .	354
Nettastoma procerum,	.	— - - -	- - - - -	- - - —	. . .	55
Synaphobranchus pinnatus,	.	—	—	—	—	56
Synaphobranchus bathybius,	.	. .	. .	. .	. . .	57
Synaphobranchus brevidorsalis,	.	. .	— - - -	- - - - -	- - - - -	58
Saccopharynx ampullaceus,	.	- -	- - - - -	. .	. . .	59
Saccopharynx pelecanoides,	.	. .	. .	. .	. . .	60
Saccopharynx bairdii,	.	. .	—	—	—	61
Nemichthys scolopacea,	.	. .	—	—	—	62
Nemichthys infans,	.	. .	. .	—	—	63
Cyema atrum,	.	. .	. .	. .	. . .	64
Plectognathi—						
Triacanthodes anomalus,	.	—	. .	. .	. . .	65
Monacanthus tessellatus,	.	—	. .	. .	. . .	66
Cyclostomata—						
Myxine glutinosa,	—	—	—	—	. . .	67
Myxine australis,	—	—	—	. .	. . .	368

of Species, Genera, and Families.



DESCRIPTION OF SPECIES.

PLAGIOSTOMATA.

SELACHOIDEI—SHARKS.

Family SCYLLIIDÆ.

Scyllium, M. and H.

The species of "Dog-fishes" hitherto known are strictly littoral, and, besides, have but a limited distribution. It is therefore a matter of some interest to find a species living at so great a depth as 400 fathoms, although there is nothing in its organisation which would have led us to suspect its bathybial habits.

Scyllium canescens (Pl. I. fig. A).

Scyllium canescens, Günth., Ann. and Mag. Nat. Hist., ser. 5, vol. ii. p. 18, 1878.

The nasal valves are separate from each other, the distance between them being less than the length of a nasal opening; each is provided with a cirrus. Length of the præoral portion of the snout much less than its width, or than the width of the mouth. Labial fold very short. Teeth very small, those of the lower jaw tricuspid, the cusps being subequal in length. Ventral fin with the posterior margin very oblique. The posterior dorsal slightly longer than the anterior. The anal terminates below the middle of the second dorsal, its base being longer than that of the latter fin, and equal to its distance from the caudal. The whole body rough from small spines. Uniform greyish; all the fins, except the caudal, tipped with white behind.

Habitat.—South-western coast of South America, Station 310; depth, 400 fathoms. One specimen, 11 inches long (young female).

Pristiurus, Bonaparte.

Pristiurus melanostomus, Rafinesque.

Collett[1] records the capture of this littoral species near Tromsö, at a depth of 250 fathoms.

Family NOTIDANIDÆ.

Chlamydoselache, Garman.

Chlamydoselache anguinea (Pls. LXIV., LXV.).

Chlamydoselachus anguineus, Garman, Bull. Mus. Comp. Zoöl., vol. xii. No. 1, 1885.

I am indebted to M. S. Tegima and A. Sanders, Esq., for three well-preserved examples of this shark, which hitherto was known from a single specimen only, a female without intestines, and with a mutilated tail. Our specimens were caught in deep water in Yeddo Bay, opposite Tokio. Two are males, of which the larger is 4 feet and 10 inches long, the tail measuring 2 feet; the third is a female, which had been eviscerated by the fishermen, from whom it was bought. I am able to supplement Mr. Garman's account by some remarks on the male claspers and other organs.

The membranous margin of the ventral fin of the male is attached to the outer and upper side of the clasper, leaving only the terminal third of the latter free, as is the case in the Notidanidæ generally, whilst in other sharks the fin and the clasper are separated by a more or less deep notch (Pl. LXIV. fig. C).

The skeleton of the clasper is extremely simple (Pl. LXIV. fig. D, D′). The principal cartilaginous rod (a) is attached to the basale (b) of the pelvic limb by three rudimentary and one larger intermediate cartilages (a'). The ventral side of its terminal third is longitudinally concave, forming a half-canal which in its middle is bridged over by a lobe-like expansion of the cartilage (l). A long calcified piece (t, t') with sharp cutting edge is movably attached to each side of the end of the semicanal. These two movable appendages can be approached to each other so as to complete or close the canal.

The structure is therefore very similar to that of *Acanthias* as figured by Gegenbaur.[2] The cartilaginous ray (r) nearest to the clasper (or *pterygopodium*, Petri) is much elongate, tapering, simple, occupying a position at about equal distance from the clasper and the ray next above it. This latter (r'), the penultimate of the series, is also elongate, and consists of two pieces subequal in length, with a minute terminal piece, the rudimentary condition of which leads me to suppose that it will not be found to be constant. The third ray (r'') is somewhat shorter than the second, consisting of two pieces, like the second, but without the rudimentary terminal. The following rays become successively shorter, are composed of three pieces, and arranged closely side by side, as in the female fish figured by Garman.

[1] *Nyt Mag. f. Naturvid*, xviii., 1884, p. 117.

[2] *Jenaische Zeitschr.*, v., Taf. xvi. figs. 15–17.

The *teeth* (Pl. LXIV. figs. A and B) are arranged with great regularity in series crossing the jaws obliquely. Each anterior series consists of six, and the posterior ones of five teeth, to which generally from one to three in an immature state of development are added. The series are separated from each other by a toothless space which becomes narrower between the posterior series; the latter are composed of much smaller and rudimentary teeth; in fact, the last two or three series are almost confluent, rendering the number of series somewhat uncertain, so that it may be given as twelve or thirteen on each side of the upper jaw. There is a broad toothless space in the middle of the upper jaw, and the two or three foremost series are bent outwards beyond the margin of the jaw, so that the two or three foremost teeth are entirely outside the buccal cavity. The lower jaw is armed with one unpaired additional series on the symphysis; in other respects, with regard to position, arrangement and number, the teeth of the lower jaw do not differ from those of the upper. Each tooth consists of an oblong base bearing on its anterior portion three long, divergent, pointed, spine-like cusps, with a pair of much smaller ones between. These cusps are directed backwards over the base of the tooth. On its lower side the base has anteriorly a pair of shallow grooves (*g*) to receive two short pointed processes (*p*) in which the base of the preceding tooth terminates; by these processes fitting into the grooves of the succeeding tooth, the union of the links of the dental chain is effected. In the rudimentary teeth of the posterior series the base of each tooth is very much abbreviated; the cusps also are much shorter and have a more erect position. In the teeth of the series which may be considered the last, the outer cusp is even entirely lost or quite rudimentary; in fact, these minute teeth differ very little from the enlarged papillæ of the surrounding skin.

The *stomach* is an extremely long cylindrical sac with thin walls; the short and narrow intestine, after having made a short and incomplete convolution, passes into the dilated portion which contains the spiral valve. This portion (Pl. LXV. figs. 5 and 6) has extremely strong muscular walls, from 3 to 4 mm. thick. The spiral valve makes thirty-five gyrations, this part of the intestine being six and a half inches long. A globular glandular body (fig. 3, *gl*) of the size of a large pea lies dorsad of the cloaca, into which it discharges its secretion by a short duct.

The *liver* consists of two extremely long lobes which reach backwards to the end of the abdominal cavity, and anteriorly receive the gall-bladder between them; this organ is of moderate size.

The *testicles* are narrow elongate bodies of nearly equal size, about 5 inches long and half an inch broad at the broadest part. Although our specimens seem to be sexually mature, I am uncertain whether they were captured during the season of propagation. The testicles reach close to the upper end of the abdominal cavity. In one of the males the arrangement of the urogenital organs and ducts, as well as of the external openings, is perfectly symmetrical and normal (fig. 1), whilst in the other the left side shows a much more developed condition than the right (figs. 2 and 3). In the latter specimen the left *vas deferens* (*vd*) is much wider than the right (*vd'*), and provided in its interior with low, circular, closely-set septa (fig. 4), of which only faint traces can be seen in the right duct. They are, however, limited to the lower 3 or 4 inches of the duct. The left *vas deferens* opens into the urinary bladder (fig. 3, *u*), if a bottle-shaped dilatation which terminates externally in a single small conical papilla (*ug'*) may be so called. The right *vas deferens* opens by a slit at the side of the papilla directly into the cloaca (figs. 2 and 3, *ug*). There is also in this specimen only one *porus abdominalis* in the median line (or very slightly to the left of it) immediately behind the cloaca (figs. 2 and 3, *po*).

The *conus arteriosus* (figs. 7 and 8) is of considerable length, slightly bent towards the right, and of nearly the same diameter throughout. No special valve separates it from the ventricle. I find the valves much more regularly arranged than would appear from the figure given by Garman. They form three longitudinal and six transverse rows (fig. 8). The largest are those of the distal transverse row, placed close to the end of the conus, and somewhat more distant from the next row than the five other rows are from each other. The next largest valves are those of the proximal row, those of the second and third being smaller, and those of the fourth still smaller, with only partially free anterior margins; the valves of the fifth row are quite rudimentary, and two of them merely indicated as raised papillæ, which are confluent with those of the fourth row. Finally, a fourth intermediate longitudinal series is indicated by two minute valves, belonging to the first and second transverse rows. The larger valves are provided with tendinous chordæ.

Family Spinacidæ.

Spinax, M. and H.

Spinax spinax, L.

The common European species is reported by Strom[1] to be common in Throndjhem Fjord, at a depth of from 70 to 300 fathoms.

Spinax granulosus.

Spinax granulosus, Günth., Report on the Shore Fishes, Zool. Chall. Exp., part vi. p. 19, pl. ii. 2, fig. C.

Habitat.—South-western coast of South America, Station 305A; depth, 125 fathoms. One specimen, $10\frac{1}{2}$ inches long.

Centrophorus, M. and H.

The two Japanese species here described live at about the same depth as the Atlantic species, all of which have been hitherto found in the Mediterranean, off Madeira, and on

[1] *Norsk. Vid. Selsk. Skrift.*, 1884, p. 44.

the coast of Portugal. With the exception of a specimen taken near Gloucester on the coast of Massachusetts, and of three very young examples obtained by Bleeker in the East Indian Archipelago, no other representative of this genus has been found in any other part of the globe; and therefore the distribution of this genus is an additional proof of the extraordinary resemblance of the Japanese and Madeiran marine faunas.

Centrophorus foliaceus, n. sp. (Pl. II. fig. A).

Snout much produced, the mouth being nearer to the first gill-opening than to the end of the snout. The distance between the nostrils is two-sevenths of the length of the præoral portion of the snout. The labial fold extends a little way along the margins of the mouth; the angle of the mouth being received into a deep longitudinal slit in the skin. The anterior teeth of the upper jaw triangular, erect, the lateral slightly oblique; they are arranged in two regular rows. No median tooth in the lower jaw. Pectoral short, with the lower angle rectangular, not produced. Dorsal spines strong, nearly as high as the fins. The first dorsal fin rather lower than the second, but with its base longer, the length of the base (without spine) being two-fifths of the distance between the two fins. Extremity of the ventral fin a little behind the dorsal spine. The scales are pedunculate, terminating in three spines, of which the middle is the longest, corresponding to a strong median keel on the scale. Uniform greyish.

Habitat.—Off Inosima, Japan, Station 232; depth, 345 fathoms. One specimen (young male), 16 inches long.

Centrophorus cœlolepis.

Centroscymnus cœlolepis, Bocage and Capello, Proc. Zool. Soc. Lond., 1864, p. 263, fig. 4; and Peix. Plagiost., p. 30, pl. ii. fig. 3.
,, ,, Wright, Ann. and Mag. Nat. Hist., 1868, vol. ii. p. 426.
Centrophorus cœlolepis, Günth., Fish., vol. viii. p. 423.

Probably all the European species of *Centrophorus* live at great depths, but the present is the only one of which we know this to be the case from actual observations, made by Dr. E. Percival Wright. He found the Portuguese fishermen fishing for them in 400 or 500 fathoms, with a line of some 600 fathoms in length. "The sharks caught were from three to four feet long; as they were hauled into the boat, they fell down into it as so many dead pigs. There could be no reasonable doubt that they were inhabitants of the same great depth as *Hyalonema*." This species is obtained off the coasts of Portugal and Madeira, and was once found off the coast of Massachusetts.

Centrophorus squamulosus, n. sp. (Pl. II. fig. B).

Snout much produced, the mouth being nearly midway between the first gill-opening and the end of the snout. The distance between the nostrils is two-fifths of the length of the præoral portion of the snout. The labial fold extends a little way along the margins of the mouth. Upper lip fringed. Pectoral short, with the lower angle rounded, not produced. The first dorsal fin small, its base (without spine) is shorter than that of the second, and nearly one-sixth of the distance between the two fins. Spines very small, scarcely projecting beyond the skin. Extremity of the ventral fins below the end of the second dorsal. The scales are tricuspid, with a median keel, and so minute as to give a velvety appearance to the skin. Uniform deep black.

Habitat.—Off Inosima, Japan, Station 232; depth, 345 fathoms. One specimen (adult female), 27 inches long.

The structure of the intestinal tract does not essentially differ from that of the ordinary littoral or pelagic Selachian type. The stomach consists of two portions; the anterior is much the larger, of an elongate form, narrowed towards its posterior extremity; it passes by an abrupt bend into the second reverted portion, which is the narrowest part of the intestinal tract. The commencement of the intestine is a wide diverticulum, separated from the stomach by the circular pyloric valve. The intestine proper is almost straight; the spiral valve commences on the level of the posterior extremity of the stomach, the spire being composed of fifteen transverse gyrations. Cæcal appendage worm-shaped, nearly an inch long, with a very narrow cavity. The intestinal tract contained nothing but the single beak of a cuttle-fish. The liver consists of two extremely long and flat lobes extending on the right as well as on the left side from the anterior to the posterior extremity of the abdominal cavity. Anteriorly they are connected by a short transverse strip not broader than the lateral portions, and having imbedded in its middle line a gall-bladder of moderate size. The ovaries are paired, containing mature ova, three in the right half and five in the left. In the oviducts no separate divisions can be distinguished, the whole of their cavity being coated with numerous longitudinal folds, the edges of which are beset with villi. They are confluent anteriorly, and attached in the median line to the ventral side of the abdominal cavity; their single opening is directed backwards towards the Fallopian tubes and surrounded by a thick swollen pad of soft membrane, the surface of which is finely transversely lamellated.

The valves of the conus arteriosus of the heart are arranged in five transverse series, each series consisting of three principal valves and as many intermediate smaller ones.

Centroscyllium, M. and H.

Centroscyllium fabricii, Reinhardt.

This Greenland shark has recently been discovered off the coast of Massachusetts, whence the British Museum received through the Smithsonian Institution a specimen captured in 250 fathoms.

Centroscyllium granulatum. n. sp.

The discovery of a specimen of this Arctic genus in the opposite hemisphere is highly interesting; unfortunately the specimen is in such a deteriorated condition, that we can ascertain from it scarcely anything beyond its generic characters. Specifically, it must be very closely allied to *Centroscyllium fabricii*, having the same disposition of the fins, size of teeth and dorsal spines, but the epidermoid productions of the head and body are much coarser, and in the form of granulations, whilst in *Centroscyllium fabricii* they are minute.

Habitat.—Port Stanley, Falkland Islands, Station 311; depth, 245 fathoms. One specimen, 11 inches long.

Læmargus, M. and H.

Læmargus borealis, Scoresby.

Common in the North Atlantic, and frequently found on the surface; but habitually living at a considerable depth (150 to 300 fathoms), at least on the coast of Norway.[1]

BATOIDEI—RAYS.

Raja, Cuv.

Raja isotrachys, n. sp. (Pl. III.).

Snout rather produced, the anterior margins meeting at nearly a right angle. The width of the interorbital space equals the length of the orbits. The distance between the outer margins of the nostrils equals their distance from the end of the snout. Teeth small, each with a point directed backwards towards the interior of the buccal cavity. Outer pectoral angle rounded, but the margins of the fin would meet at a right angle. Body and tail entirely covered on the upper surface with minute asperities, each with a stellate base. No spines on the superciliary margin. A single small spine in the middle of the back. A series of rather strong spines (eighteen) along the median line of the tail, none on the sides. Upper parts uniform, brownish-grey; lower parts smooth, brownish-black.

Distance between the snout and vent, ...	10	inches.
Length of the snout, ...	3	,,
Width of the body, ...	13	,,
Length of the tail, ...	12½	,,

[1] Strom, *Norsk. Vid. Selsk. Skrift.*, 1884, p. 44; Collett, *Nyt Mag. f. Naturvid.*, xviii., 1884, p. 117.

Habitat.—South of Japan, Station 235; depth, 365 fathoms. One specimen, female.

Raja circularis, Couch.

Of the Sandy Ray, only one specimen, a female, 15 inches long, was obtained on the cruise of the "Triton" in the Faröe Channel, at a depth of 516 fathoms (Station 10, August 24, 1882). Also Collett[1] reports its occurrence in 130 and 370 fathoms off the coast of Norway.

The Faröe specimen does not differ in its armature from specimens obtained on the south coast of England, only the spines on the upper side of the snout and the interorbital space are somewhat more developed, though in this respect littoral specimens show likewise some variation.

With regard to colour, it is notable that the spot on each side of the back which, in littoral specimens, is variegated with yellow, is much smaller in the deep-sea specimen, and uniformly black, without yellow. The lower parts are nearly uniform blackish-brown, which colour laps over to the upper side of the ventral fins. Tail with irregular brownish cross-bands.

Raja radiata, Donovan.

This species, which is widely distributed on the coasts of Northern Europe and North America, has been met with in the sea between Bear Island and Spitzbergen at depths of from 127 to 259 fathoms;[2] and in Throndhjem Fjord in 250 fathoms.[3]

Raja hyperborea (Pl. IV.).

Raja hyperborea, Collett, Forhandl. Vidensk. Selsk. Christ., 1878, p. 7; Norsk. Nordh. Exped. Zool. Fisk., p. 9, pl. i.

The margins of the snout form a right or a nearly right angle, its extremity being rounded; the margin of the body between the snout and the extremity of the pectoral fin is undulated. Width of the interorbital space considerably exceeding that of the orbit and spiracle; eye rather small, about as long as the spiracle. Distance between the nostrils a little more than their distance from the end of the snout. Teeth very slender, acutely pointed, widely set with narrow base. Outer pectoral angle nearly a right one.

Sides of the trunk nearly smooth, but the greater part of the pectorals and the margin

[1] *Forhandl. Vidensk. Selsk.*, 1880, p. 105, and *Nyt Mag. f. Naturvid.*, xviii., 1884, p. 119.
[2] Collett, Norsk. Nordh. Exped. Fisk., p. 14.
[3] Strom, *Norsk. Vid. Selsk. Skrift.*, 1881, p. 79; Collett, *Nyt Mag. f. Naturvid.*, xviii., 1884, p. 118.

of the head, also the snout and interorbital space, are studded with minute or very small spines resting upon a stellate base. A series of larger spines runs along the median line of the back and tail, commencing immediately behind the occiput. A group of three similar spines occupies each side of the shoulder; a short series composed of three or four spines along the supraorbital margin and above the spiracle. The spines along the ridges of the snout are also somewhat enlarged. Greyish-brown above with a trace of a darker spot on each side of the body. Lower parts white, with large sub-symmetrical brown patches. In very young specimens the lower parts are uniform white.

Habitat.—A large male specimen, $24\frac{1}{2}$ inches long, was obtained on the cruise of the "Knight Errant," at Station 9, on August 23 (1880), in 608 fathoms, together with three small ones, of which two are males $6\frac{1}{2}$ inches long, and one a female 8 inches long. A fourth very young male specimen was caught at Station 4 in about 400 fathoms.

The Norwegian expedition obtained one male only, at 115 kils. west of the Norsk Islands, Spitzbergen, at the depth of 459 fathoms.

Mr. Collett's description of this species is so detailed, that I need only refer to those points in which our specimens differ from his, or in which I can supplement his observations.

The most important difference between the specimens obtained by the Norwegian and British expeditions is the number of scapular spines, which in the former is only two, whilst four of our five specimens show three placed in a triangle.

In our old specimen the two dorsal fins are joined at the base, but a small spine intervenes between them in our young specimens. The young specimens are more uniformly covered with those minute spinelets described in the adult fish, but the larger spines are much more acute and prominent, longer and claw-like. The number of the median series varies: in the adult there are 8 + 19, in the three young males 6 + 10, 8 + 16, and 11 + 21; in the young female 7 + 17.

This deep-sea species of Ray shows some striking peculiarities. The teeth are remarkably slender, small, irregularly and widely set, different from those of other British Rays. In young specimens, at any rate, those of the male do not differ from those of the female. The mucous membrane behind the upper jaw forms a pad with a lobulated surface. The mucous cavities of the head are extremely wide; and finally, the accessory copulatory organs have a spongy appearance and are flexible, the cartilage by which they are supported being a simple slender rod. Fig. A represents the adult male three-sevenths of the natural size; fig. B, a young of the natural size; and fig. C is a separate view of the mouth of the adult specimen.

Raja plutonia.

Raja plutonia, Garman, Bull. Mus. Comp. Zoöl., vol. viii. No. 11, 1881, p. 236.

"Disk, including ventrals, broader than long, subquadrangular, broadly rounded in front and on the lateral angles; snout forming a very blunt angle; margin opposite the gill-openings nearly straight. Tail about one and one-half times the length of the disk, slender, depressed, with a cutaneous fold on each side near the extremity. Rostral cartilage short, not extending to the end of the snout. Mouth moderate, slightly curved, width equalling the distance between the outer angles of the nostrils, and contained twice in its distance from the end of the snout. Teeth about thirty-two series (a young specimen). Eyes large, longitudinal diameter of orbit greater than their distance apart. Interorbital space concave, narrow; width rather more than two and one-half times in the distance of the eyes from the end of the snout. Spiracles small. Anterior nasal valve tubular; posterior reaching the mouth, free on its outer margin. Hinder extremity of pectoral broad, rounded. Ventrals deeply notched, anterior portion narrow, extending farther from the middle of the pelvis than the posterior. . . . . .

"Back and tail covered with small, closely set, stellate-based scales, which bear elongate, slender, compressed, backward directed points. Larger spines form a supra-orbital row, and a single one stands on each side of the back of the head. The largest on the body form a close vertebral series on back and tail. On each side of the shoulder girdle there is an irregular series of five, and a short distance in front of each of these stands one or a pair. On each side of the tail there are two series, little smaller than those of the medial row. Smooth below. Very small specimens have not so many spines.

"Brown, grayish in small to purplish in the largest specimens at hand, with more or less irregular transverse series of distinctly defined spots of brown, often confluent into short bands, interspersed among which are spots of white of varying size and shapes. Tail with cross bands of light and of dark. Dorsals dark. Entire lower surface white."

This species was obtained during the cruise of the U.S. steamer "Blake," in from 229 to 333 fathoms, off the coast of Florida, in lat. 32° N., long. 78°.

Another deep-sea Ray from the North American coast of the Atlantic has been noticed by Goode and Bean[1] under the name of *Raja granulata* in the following terms: "A remarkable species with the back and ventral surface covered with minute sharp granular ossifications. Of the same type as *Raja lævis* (?), and having 30–31 teeth on each side; the back granulated and slate-coloured; the ventrals distinguished by reticulate markings and the claspers slender and scarcely expanded." Obtained on the Le Have Bank.

[1] *Bull. Essex Inst.*, vol. xi., 1879, p. 28.

Raja batis, L.

Raja batis, Strom, Norsk. Vidensk. Selsk. Skrift., 1881, p. 80; 1884, p. 46.
„ „ Collett, Nyt Mag. f. Naturvid., xviii., 1884, p. 119.

The common skate, which is generally found near the coast in rather shallow water, has been observed on the Norwegian coast to descend to 150 fathoms.

Raja vomer, Fries.

Raja vomer, Collett, Forhandl. Vidensk. Selsk. Christ., 1880, p. 106; Nyt Mag. f. Naturvid., 1884, xviii., p. 119.
„ „ Strom, *loc. cit.*, 1881, p. 81; 1884, p. 46.

Inhabiting deeper water than the common skate, not rare at a depth of 70 fathoms, and descending to, or even beyond, 150 fathoms.

Raja fullonica, L.

Raja fullonica, Collett, Forhandl. Vidensk. Selsk. Christ., 1880, p. 106; Nyt Mag. f. Naturvid., xviii. 1884, p. 119.

Reported by Collett to occur locally on the Norwegian coasts at depths of from 80 to 250 fathoms.

Raja nidrosiensis.

Raja nidrosiensis, Collett, Forhandl. Vidensk. Selsk. Christ., 1882, No. 7, p. 2, c. tab.; Nyt Mag. f. Naturvid., xviii., 1884, p. 121.
„ „ Strom, Norsk. Vidensk. Selsk. Skrift., 1881, p. 80; 1884, p. 47.

Snout long and pointed; the width of the interorbital space is contained about four times and one half in the length of the snout. Body above smooth, rough only on the snout and the upper margin of the eye, in some old specimens also along the front margin of the disk; the body below thickly covered with minute asperities. No larger spines on the disk. The tail in the males with a median series (containing about forty spines), but none on the sides; the old females with three series, the median series containing a varying number of spines, some of which are sometimes irregularly crowded together. Between the dorsals there are, as a rule, a few spines. The teeth form from forty-one to forty-four series in the upper, and from forty-one to forty-three in the lower jaw. Coloration dark greyish-brown above; the mucous pores marked with black vermicular spots. Lower surface blackish, without spots.

This species is locally not uncommon on the Norwegian coast, for instance in Throndhjem Fjord, at a depth of 150 to 200 fathoms. It is one of the larger skates, the specimens in the British Museum measuring from 38 to 46 inches in width.

Urolophus, M. and H.

Urolophus kaianus.

Urolophus kaianus, Günth., Report on the Shore Fishes, Zool. Chall. Exp., part. vi. p. 37.

Habitat.—Off the Ki Islands, Station 192, September 26, 1874; lat. 5° 49′ 15″ S., long. 132° 14′ 15″ E.; depth, 140 fathoms; bottom, blue mud.

HOLOCEPHALA.

Chimæra, L.

Chimæra monstrosa, L.

During the cruise of the "Knight Errant" a young male was obtained at the depth of 555 fathoms (Station 4). The length of its trunk is 5 inches. The specimens caught by the "Triton" are still younger; two, a male and a female, having the trunk $2\frac{1}{2}$ and 3 inches long, came from a depth of 516 fathoms (Station 10). Finally, a male, which does not appear to have been long hatched, has the trunk only $1\frac{1}{2}$ inches long; it came from 505 fathoms (Station 11).

These specimens are of considerable interest, as they show the gradual development of certain organs.

The youngest example has the caudal filament least developed, the length of the tail measured from the vent, being little more than 3 inches, or twice the length of the trunk. The tail is comparatively much longer in specimens of the next size, but as its extremity is broken off in both, the exact proportion cannot be ascertained. In the largest of these young specimens, with the trunk $4\frac{1}{2}$ inches long, the tail measures not less than 17 inches. Of the fins only the first dorsal with its spine is developed. Of the anal only a portion has appeared as a low ridge, but there is no trace of the second dorsal or of the caudal.

The development of the prehensile organ on the upper part of the snout, which is peculiar to the male sex in *Chimæra*, keeps pace with that of the claspers. This organ is visible in our youngest specimen, which evidently was hatched only a few days, as a narrow cartilage of whitish colour entirely covered by the skin, but visible through it. It has not made as great progress in the largest of the young specimens, and therefore does not seem to become detached from the head before the individual attains to sexual maturity.

The claspers are visible from the earliest stage, and although only 2 mm. long, show a distinct bifurcation.

The occurrence of these specimens shows that *Chimæra* is a deep-sea fish, and one which propagates its species in deep water. If the propagation of *Chimæra* really takes place in deep water only, this circumstance would account for the scarcity of young specimens in collections; and also the ova, which have been described as *Chimæroid*, seem to be rather those of *Callorhynchus* than of *Chimæra*, and, so far as I know, there is no well authenticated egg of the latter in any collection.

Chimæra affinis.

Chimæra affinis, Capello, Journ. Math. Phys. e. Nat. Lisb., iv. p. 314, pl. iii., 1868.
„ „ Jordan, Rep. Comm. Fish. for 1884 (1885).
„ *plumbea*, Gill, Bull. Phil. Soc. Washington, December 22, 1877.
„ *abbreviata*, Gill, Proc. U.S. Nat. Mus., vol. vi. p. 254, 1884.

Scarcely distinguished from *Chimæra monstrosa*. Has been found first on the coast of Portugal, and later on the North American side of the Atlantic, at depths varying from 200 to 1200 fathoms.

ACANTHOPTERYGII.

Family Percidæ.

Anthias, Cuv.

Anthias megalepis.

Anthias megalepis, Günth., Report on the Shore Fishes, Zool. Chall. Exp., part vi. p. 37, pl. xvi. fig. E.

Habitat.—Off the Ki Islands, Station 192; depth, 140 fathoms.

Centropristis, Cuv. Val.

Centropristis pleurospilus.

Centropristis pleurospilus, Günth., Report on the Shore Fishes, Zool. Chall. Exp., part vi. p. 37, pl. xvi. fig. D.

Habitat.—Off the Ki Islands, Station 192; depth, 140 fathoms.

Scombrops, Schlegel.

Scombrops chilodipteroides, Blkr.

This fish, which was originally described by Schlegel in the Fauna Japonica, seems to be scarce on the coast of Japan, as it is not distinguished by a vernacular name. The Challenger Expedition obtained one specimen only, 16 inches long, off Inosima, at a depth of 345 fathoms. Like other Japanese fish *Scombrops* reappears in the West Indies, Poey having described a closely allied species under the name of *Latebrus oculatus*.[1] The reason why I hesitate in specifically identifying the Cuban with the Japanese fish is the circumstance that Poey figures the strong teeth of the jaws as distinctly barbed, although he singularly enough does not allude to this peculiarity in the description. Differences in the statements of the number of the scales are of much less weight in regard to these fishes, because the transverse series are rather irregularly arranged and do not correspond with the number of scales along the lateral line. Poey also found only ten pyloric appendages in his specimen. He states that the fish is rare and an inhabitant of great depths.

FIG. 1.—*Scombrops chilodipteroides*. *st*, stomach; *i*, *i*, intestine; *p*, pyloric appendages; *p'*, pyloric appendage separated from the rest; *l*, liver, part of which has been removed; *g*, gall-bladder; *a*, end of ductus choledochus; *v*, vent; *o*, *o*, ovaries.

Scombrops shows some noteworthy peculiarities in the structure of its abdominal organs. The gall-bladder (*g*) is excessively prolonged, lying behind the lower intestine and extending to the end of the abdominal cavity. The stomach (*st*) is very short and small, but the pyloric appendages (*p*), of which there are eighteen, are very long and wide. Seventeen of them are convoluted and form a large bundle, whilst the eighteenth (*p'*) is straight, accompanying the anterior portion of the intestine. The intestine (*i*) makes only one entire convolution. The air-bladder is large, attached to the walls of the abdomen, with the ventral part of its outer tunic thickened and giving support to the much developed glandular red bodies.

[1] Mem. Hist. Nat. Cuba, ii., 1858, p. 168, Tab. xiii. figs. 11, 12; Tab. xiv. fig. 2.

Acropoma, Schlegel.

Acropoma philippinense.

Acropoma philippinense, Günth., Report on the Shore Fishes, Zool. Chall. Exp., part. vi. p. 51.

Habitat.—Philippine Islands, Station 201 ; depth, 82 to 102 fathoms.

Propoma, Gthr.

Propoma roseum.

Propoma roseum, Günth., Report on the Shore Fishes, Zool. Chall. Exp., part vi. p. 39, pl. xx. fig. B.

Habitat.—Off the Ki Islands, Station 192, September 26, 1874 ; lat. 5° 49′ 15″ S., long. 132° 14′ 15″ E.; depth, 140 fathoms ; bottom, blue mud.

Only two other bathybial Percoid fishes are known at present ; they were discovered in the Japanese sea by Döderlein, who characterises them thus :—

Malacichthys.

Malakichthys, Döderlein, Denkschr. d. k. Akad. d. Wiss. Wien, xlvii., 1883, p. 240.

Form of the body oval, similar to *Ambassis*. The two dorsals united by a low membrane ; anal with three spines. Præoperculum denticulated ; operculum with two feeble points. Bones of the head very thin, cavernous ; eye large. Very narrow bands of villiform teeth in the jaws, on the vomer and palatine bones, without canines. Head nearly entirely scaly. Mouth wide, oblique, with projecting mandible. Scales of moderate size, ctenoid, deciduous. Seven branchiostegals ; pseudobranchiæ. Lateral line complete. Pyloric appendages in small number (four). Air-bladder small. Abdominal cavity and pharynx black.

Malacichthys griseus.

Malakichthys griseus, Döderlein, *loc. cit.*, xlviii., Tab. ii. fig. 1.

D. $9\frac{1}{10}$, A. $\frac{3}{7}$, V. $\frac{1}{5}$, L. lat. 45, L. transv. $\frac{5}{11\text{-}12}$.

The height of the body is contained twice and three-fourths or twice and five-sixths, the length of the head twice and a half in the length of the body ; the diameter of the eye twice and two-thirds to twice and three-fourths, the width of the interorbital space rather more than five times, and the snout thrice and two-thirds in the length of the head. Dorsal spines rather strong, curved, the fourth the longest, its length being contained twice and one-third in that of the head. Mandible with two points at the chin. Coloration uniform.

Several examples were obtained from "great depths" at Tokio, where the fish is not rare. The largest example was 8 inches long.

Synagrops.

Melanostoma,[1] Döderlein, Denkschr. d. k. Akad. d. Wiss. Wien, xlviii., 1883, p. 5.

Shape of the body rather elongate. Upper side of the head with muciferous cavities. Præoperculum finely denticulated; operculum with two points. Two dorsal fins, the first with nine slender spines, the second rather short. A narrow band of villiform teeth in the jaws, on the vomer and palatine bones, with the addition of a pair of canine teeth in the upper jaw, and a series of similar teeth in the lower. Scales large, thin, and cycloid. Air-bladder present. Pyloric appendages in small number (six to seven). Pharynx and peritoneal cavity black.

Synagrops japonicus.

Melanostoma japonicum, Döderlein, *loc. cit.*, Taf. i. fig. 2.

B. 7, D. $9\frac{1}{10}$, A. $\frac{2}{8}$, P. $\frac{1}{15}$, V. $\frac{1}{5}$, L. lat. 31 (+5 caudal).

The height of the body is one-fourth, the length of the head nearly one-third of the total (without caudal). Eye longer than the snout, contained thrice and two-thirds in the length of the head. The mouth extends to below the middle of the eye, is rather oblique, with somewhat projecting lower jaw. Uniform blackish.

From "very great depths," and rare at Tokio; Döderlein obtained one example only, 9 inches long.

Family SCORPÆNIDÆ.

Scorpæna, Gthr.

On the distinctive characters of this genus and *Sebastes*, see Günther, Fisch. d. Südsee, p. 74.

[1] Preoccupied.—I may observe here that the fish described by Steindachner in the same paper, under the name of *Cypselichthys japonicus*, n. gen. et sp. (p. 14, pl. vii. fig. 1), is a species of the genus *Cubiceps*, and does not belong to the "*Maenini*," but to the family Nomeidæ.

Scorpæna percoides, Solander.

Scorpæna barathri, Hector, Trans. New Zeal. Inst., vol. vii. p. 245, pl. x., 1875; Ann. and Mag. Nat. Hist., vol. xv., 1875, p. 80.

This species, which is not uncommon along the coasts of Southern Australia, Tasmania, and New Zealand, descends to a depth of 400 fathoms, so far as is known at present. In the Report on the Shore Fishes of the Challenger Expedition, I have already recorded its occurrence at Twofold Bay in 120 fathoms. Another specimen, 4 inches long, was obtained in 275 fathoms at Station 166, in the neighbourhood of New Zealand. Finally, a very young specimen, 2 inches long, captured off Matuka, Fiji Islands (Station 173), in 215 fathoms, on July 24, 1874, belongs without doubt to the same species.

The specimen from which Dr. Hector drew up the description of his *Scorpæna barathri*, and which is said to have been obtained in 400 fathoms off Cape Farewell, is also identical with this species. The length of the third and fourth dorsal spines varies somewhat, being sometimes rather more, and at other times rather less than two-fifths of the length of the head.

I have now had an opportunity of examining a skeleton of *Scorpæna percoides*; its spine is composed of ten abdominal and fifteen caudal vertebræ, and therefore this species must be referred to *Scorpæna*, of which genus the vertebral formula $\frac{10}{14-15}$ is characteristic.

Scorpæna dactyloptera, de la Roche.

Sebastes dactylopterus, Günth., Fish., ii. p. 99.
" " Collett, Norges Fisk., p. 19.
" " Lilljeborg, Sveriges Fisk., p. 107.

This species, which has been known for many years from the Mediterranean and Madeira, occurs also on the coast of Norway, where it is not uncommon in depths of from 100 to 300 fathoms.

Other species of this genus also occur at considerable depths, but as it is not known to what depth they descend, they are omitted from the bathybial fauna at present.

Sebastes, Gthr.

Sebastes marinus.

Perca marina, Linné.
Sebastes norwegicus, Cuv. Val.
" " Collett, Norges Fisk., p. 19.
Sebastes marinus, Lütk., Vid. Meddel. nat. Foren. Kjøbenhavn, p. 358, 1876.
" " Collett, Norsk. Nordh. Exped., Fisk., p. 15; Vidensk. Selsk. Forhandl. Christ., 1880, No. 1, p. 7.
" " Goode, Proc. U.S. Nat. Mus., vol. iii. p. 480, 1881.
" " Lilljeborg, Sveriges Fisk., p. 92.

On the Norwegian expedition (1876) specimens were obtained at depths varying from 123 to 147 fathoms, and others on the American coast by the U.S. steamer "Fish

Hawk," at 155 fathoms. The observation which I have made on previous occasions, viz., that the young of many deep-sea fishes live on the surface, or much nearer to it than the adult, seems to be fully borne out by this species. Collett remarks that during the breeding season individuals are seldom taken at a depth less than 100 fathoms; the majority probably producing their young[1] in far greater depths. The fry rise towards the surface shortly or perhaps immediately after birth, choosing for their haunts the upper strata of the sea, and do not descend to any considerable depth till they have attained a length of about 50 or 60 mm.

Sebastes viviparus.

Sebastes viviparus, Kröyer, Nat. Hist. Tidsskr., 1844–45, p. 275; and in Gaimard, Voy. Scandin. Zool. Poiss. pl. vi.
" " Strom, Norsk. Vid. Selsk. Skrift., 1881, p. 73; 1884, p. 16.
" " Lilljeborg, Sveriges Fisk., p. 101.
" *regulus*, Fries och Ekstr., Skand. Fisk., pl. xlix.

Rather common on the coasts of Scandinavia, at a depth of from 50 to 300 fathoms.

Sebastes macrochir.

Sebastes macrochir, Günth., Report on the Shore Fishes, Zool. Chall. Exp., part vi. p. 65, pl. xxvii.

This fish was discovered off Inosima in 365 fathoms, and therefore is to be included among the deep-sea group. For the sake of comparison it was described in the Report on the Shore Fishes.

Sebastes hexanema.

Sebastes hexanema, Günth., Report on the Shore Fishes, Zool. Chall. Exp., part vi. p. 40.

Habitat.—Off the Ki Islands, Station 192; depth, 140 fathoms.

Sebastes oculatus, C. V.

Sebastes oculatus, Günth., Report on the Shore Fishes, Zool. Chall. Exp., part vi. p. 20.

Vert. $\frac{11}{16}$. Several specimens were obtained at Stations 306 and 307, near Magellan Strait, in 147 and 345 fathoms. This species, however, lives at certain times or localities much nearer to the surface, and is not uncommon along the Antarctic coasts of South America.

[1] This species is viviparous.

Setarches, Johnson.

Setarches fidjiensis, n. sp. (Pl. I. fig. C).[1]

$$\text{D. } 10 \mid \tfrac{1}{10}. \quad \text{A. } \tfrac{3}{5}. \quad \text{P. } 23.$$

The height of the body is one-third of the total length (without caudal); the length of the head two-fifths. Head scaleless, without prominent spines on the vertex and with parallel ridges; interorbital space flat, as wide as the eye, the diameter of which is two-ninths of the length of the head and two-thirds of that of the snout; upper jaw overlapping the lower, maxillary extending to below the middle of the eye; very narrow bands of villiform teeth in the jaws on the vomer and palatine bones. The largest spines of the head are three at the angle of the præoperculum; smaller ones are distributed on the præorbital, the lower præopercular margin, and the operculum. The fourth dorsal spine is the longest, two-fifths of the length of the head; the third anal spine is longer than the second. Pectoral extending to the anal fin. Body covered with minute cycloid scales. Lateral line wide. Body irregularly mottled with brown.

Habitat.—Off Matuku, Fiji Islands, Station 173; depth, 315 fathoms. One specimen, 3 in. long.

Only one species, represented by a single example from Madeira, was previously known of this genus, which is evidently a deep-sea modification of *Sebastes;* the Fiji species so much resembles the one from Madeira as to leave no doubt whatever with regard to their natural affinities. They are fishes inhabiting moderate depths, and I should say that they are not likely to descend below 500 fathoms.

Since the above lines were written, a third species has been described by Goode,[2] under the name of *Setarches parmatus.* Specimens were obtained off the southern coast of New England and in lat. 34° N., at depths of 120 and 178 fathoms. They are young, only 52 and 53 mm. long, possess only ten dorsal spines, small cycloid scales, and a deep body, the height of which is three-eighths of its length.

Bathysebastes.

Bathysebastes, Steindachner und Döderlein, Denkschr. d. k. Akad. d. Wiss. Wien, 1884, xlix. p. 207.

This genus is evidently closely allied to *Setarches* and *Lioscorpius*, with either of which it may have to be united; it has been characterised thus :—

[1] This specimen was accidentally destroyed by the artist to whom it had been entrusted for the purpose of being drawn. The figure was finished before the accident happened, but could not be compared by myself with the specimen.

[2] *Proc. U.S. Nat. Mus.*, 1881, p. 480.

The superficial bones of the skull with wide muciferous cavities. Cleft of the mouth unusually wide. Bands of villiform teeth in the jaws, on the vomer and palatine bones. Scales very small, cycloid; upper side of the head scaleless; [scales on the lateral parts of the head hidden under the skin].[1] Branchiostegals seven.

Otherwise resembling *Sebastes.*

Bathysebastes albescens.

Bathysebastes albescens, Steindachner u. Döderlein, Denkschr. d. k. Akad. d. Wiss. Wien, 1884, xlix. p. 207.

D. $\frac{12}{10}$. A. $\frac{3}{5}$. P. 21.

The posterior end of the maxillary is vertically a little in front of the hind-margin of the eye, which is contained five and two-fifths in the length of the head. The pectorals reach to the vent. Yellowish-white.

One specimen, 12 inches long, was obtained in the Sea of Japan, but nothing definite is known about the depth which it inhabits.

Lioscorpius, Gthr.

Lioscorpius longiceps.

Lioscorpius longiceps, Günth., Report on the Shore Fishes, Zool. Chall. Exp., part vi. p. 40, pl. xvii. fig. C.

Habitat.—Off the Ki Islands, Station 192; depth, 140 fathoms.

Family BERYCIDÆ.

Hoplostethus, C. V.

Body deep, compressed, covered with scales of moderate size and more or less distinct ctenoid structure, rather irregularly arranged, those of the lateral line being the largest. Head very large; the superficial bones being deeply sculptured to receive wide muciferous cavities which are covered by thin skin only. Mouth very wide, oblique; the jaws and palatine bones armed with villiform teeth, the vomer being toothless. Eye very large. Eight branchiostegals; gill-openings very wide, gill-laminæ very short. Præoperculum armed with a flat spine. Abdomen protected by dermal scutes which form a serrated edge. One dorsal fin, the anterior rays of which are spinous; ventrals with six soft rays; pectoral symmetrical; caudal deeply forked. Air-bladder simple; pyloric appendages numerous.

One species only is known.

[1] Useless for generic distinction.

Hoplostethus mediterraneum.

Hoplostethus mediterraneus, Cuv. et Val., iv. p. 469, pl. xcvii., *bis.*
" " Guichen, Explor. Algér. poiss., p. 42.
" " Günth., Fish., vol. i. p. 9; Ann and Mag. Nat. Hist., 1878, vol. i. p. 485.
" " Jordan and Gilbert, Synopsis, p. 458.
" " Steindachner, Denkschr. d. k. Akad. d. Wiss. Wien, 1883, xlvii. p. 218, tab. i.
Trachichthys pretiosus, Lowe, Proc. Zool. Soc. Lond., 1839, p. 77; Fish. Madeira, p. 55, pl. ix.
Hoplostethus japonicus, Hilgendorf, Sitzungsb. d. Gesellsch. naturf. Freunde, Berlin, 1879, p. 78.

D. $\frac{6}{13}$. A. $\frac{3}{9}$. V. $\frac{1}{6}$. L. lat. 28–29. Vert. $\frac{11}{15}$.

Specimens of this species have been discovered at distant intervals of time at considerable depth (the precise depth is not known) in the western parts of the Mediterranean, off Madeira, and recently also in the Sea of Japan. Dr. Hilgendorf was of opinion that he could specifically distinguish Japanese specimens by a somewhat larger number of abdominal scutes. This would have been a character insignificant enough, even if the Japanese specimens had not sometimes the same number of scutes as the Mediterranean. A more important difference seems to be the structure of the scales, which I find in Japanese specimens, on the whole, less strongly ctenoid than in Madeiran. But even in this respect there is no constancy in specimens from either of the two localities.

A specimen 3 inches long has lately been dredged by the U.S. Fish Commission, off Chesapeake Bay.

Trachichthys, Shaw.

Body compressed, more or less deep, covered with small ctenoid and generally rough scales, which are rather irregularly arranged. Abdomen protected by dermal scutes, which form a serrated edge. Head very large, the superficial bones being deeply sculptured to receive wide muciferous cavities which are covered by thin skin only. Mouth very wide, oblique; villiform teeth in the jaws and on the vomer and palatine bones. Eight branchiostegals; gill-openings very wide, gill-laminæ very short. Suprascapulary and angle of the præoperculum armed with a spine each. One dorsal fin, the anterior rays of which are spinous; ventrals with six soft rays; pectoral symmetrical; caudal deeply forked.

Lowe is right in stating that *Hoplostethus* is scarcely entitled to generic rank, the whole difference between it and *Trachichthys* being the absence or presence of vomerine teeth. The structure of the bones of the head, the development of large muciferous cavities, the large eye, the more or less intense black colour of the pharyngeal and branchial cavities, and finally the mode of occurrence, clearly indicate that the species of this genus belong to the deep-sea fauna, although the actual depth to which they may descend is known in one species only. The other species are known from one or two individuals only, which were picked up in an exhausted condition floating on the surface.

The following are the species known of this genus :—

Trachichthys australis.

Trachichthys australis, Shaw, Nat. Misc., p. 378.
" " Günth., Fish., i. p. 10.

D. $\frac{3}{12}$. A. $\frac{2-3}{10}$.

Scales small and very rough; eight or nine abdominal scutes. The height of the body is a little more than one-half of its length, without caudal. Suprascapular spine longer than that of the angle of the præoperculum. A black band along each caudal lobe, the anterior rays of the dorsal and anal fins black.

Besides the dry typical specimen I have seen only one other, 2 inches long, which also is stated to have come from Australia.

Trachichthys jacksoniensis.

Trachichthys australis, Castelnau, Proc. Linn. Soc. N.S.W., 1879, vol. iii. p. 364.
" *jacksoniensis*, Macleay, *Ibid.*, vol. v. p. 511.

I fully agree with Mr. Macleay that the fish described by Castelnau as *Trachichthys australis* cannot be that species, provided that the characters are correctly stated. But it is somewhat unfortunate that Mr. Macleay himself has not confirmed the more important of Castelnau's statements. Castelnau states that his specimen had no teeth on the palate; if that be correct, the fish should be referred to *Hoplostethus.*

D. $\frac{4}{12}$. A. $\frac{2}{10}$.

Scales rough; abdominal scutes ten. The height of the body is rather more than one-half of its length, without caudal. Fins coloured as in *Trachichthys australis.*

One specimen, $5\frac{1}{2}$ inches long, was found in Port Jackson on the 19th of September 1877.

Trachichthys elongatus (Pl. V. fig. C).

Trachichthys elongatus, Günth., Fish., i. p. 10.

D. $\frac{4}{11}$. A. $\frac{3}{9}$. L. lat. ca. 65.

Eleven or twelve abdominal scutes; the height of the body is one-third of its length, without caudal; suprascapulary spine very small, much smaller than that of the præoperculum, which is also very short. A black band along each of the caudal lobes and another in front of the soft dorsal and anal fins.

The two typical specimens, of which one, 4 inches long, was found near the Great Barrier Island (New Zealand), seem still to be the only ones known.

Trachichthys fernandezianus, n. sp.

D. $\frac{5}{14}$, A. $\frac{3}{12}$, L. lat. ca. 85.[1]

The height of the body is contained twice and three-fourths in the total length, without caudal, the length of the head thrice. Bones of the head deeply sculptured as in the other species of the genus. Eye two-fifths of the length of the head. The suprascapulary spine is nearly of the same size as that of the præoperculum. Scales studded with minute spines. Abdominal scutes ten. Spines of the fins moderately strong; and also the rudimentary outer rays of the caudal fin are modified into spines. The dorsal spines increase in length posteriorly, the length of the last being two-sevenths of that of the head. Pectoral fin not extending to the anal. Body with a coppery tinge; fins yellowish.

Two specimens, preserved in a dry state, were contained in the series of Chilian fish in the London Exhibition of 1884, and presented by the Chilian Government to the British Museum. They were stated to have been captured at Juan Fernandez, and are 5 inches long.

Trachichthys traillii (Pl. LV. fig. A).

Trachichthys traillii, Hutton, Ann. and Mag. Nat. Hist., 1875, vol. xvi. p. 315; or Trans. New Zeal. Inst., vol. viii. p. 212.
„ „ Arthur, Trans. New Zeal. Inst., 1885, vol. xvii. p. 162, pl. xiv. fig. 2.

D. $\frac{5}{13}$. A. $\frac{3}{10}$. V. $\frac{1}{6}$. L. lat. 95 (118). Cœc. pyl. 11.

The height of the body is contained twice and one-third in the total length (without caudal), the length of the head thrice. The bones on the upper side of the head deeply sculptured, the anterior ridges terminating in a pair of small rostral spines projecting above the mouth. Eye one-third of the length of the head. Suprascapulary and opercular spines subequal in length. The four anterior dorsal spines are shorter than, and the fifth is nearly equal to, the diameter of the eye. Scales rough, ctenoid, irregularly arranged. Abdominal scutes eleven. The ventrals nearly reach as far back as the pectorals, which, however, do not reach the anal fin. Fins yellowish.

The specimen from Otago described and figured here, shows a very extraordinary, and probably abnormal position of the vent, which is placed between the ventral fins, in front (and not, as usual, behind) the series of abdominal scutes (fig. *a*).

[1] The exact number of the scales cannot be ascertained, both specimens being dried and thickly covered with varnish.

A specimen $7\frac{1}{2}$ inches long was found dead and floating on the surface of the water near Stewart Island; a second of the same length was caught in Otago Harbour, September 6, 1884; and a third smaller one since that date.

Trachichthys macleayi.

Trachichthys macleayi, Johnston, Pap. R. Soc. Tasman., 1880, p. 56.

This is probably the same species as the preceding, but described as having thirteen abdominal scutes. The scales of the lateral line are said to be about fifty in number, but as they are much larger than the other scales, no inference can be drawn from this statement as to the distinctness of the two species. This species was described from a specimen, $9\frac{1}{2}$ inches long, obtained at the mouth of the estuary of the Derwent.

Trachichthys intermedius (Pl. V. fig. D).

Trachichthys intermedius, Hector, Trans. New Zeal. Inst., vol. vii. p. 245, pl. xi. fig. 18A.

D. $\frac{6}{13}$. A. $\frac{3}{11}$. L. lat. 40.

The height of the body is contained twice and one-third in the total length, without caudal; the length of the head twice and one-half. Bones of the head sculptured in the same fashion as in the other species of the genus. Eye rather larger than one-third the length of the head. Suprascapulary spine smaller and shorter than that of the præoperculum. Scales thin, but with their surface studded with minute spines. Abdominal scutes nine. Spines of the fins rather strong; also the rudimentary outer rays of the caudal fin are modified into spines; the dorsal spines increase in length posteriorly, the length of the last being one-half of that of the head. Pectoral extending to the middle of the anal fin, ventral to the vent. Silvery, tips of the caudal lobes and top of the dorsal fin black.

Two specimens were collected by the Expedition; one, $3\frac{1}{3}$ inches long, on the east coast of New Zealand, at Station 166; depth, 275 fathoms.

The specimen described by Dr. Hector was only 2·7 inches long, and obtained off Cape Farewell in 400 fathoms.

Trachichthys darwinii.

Trachichthys darwinii, Johns., Proc. Zool. Soc. Lond., 1866, p. 311, pl. xxxii.
„ *japonicus*, Steindachner und Döderlein, Denkschr. d. k. Akad. d. Wiss. Wien, 1883, xlvii. p. 218, tab. ii.

D. $\frac{8}{14}$. A. $\frac{3}{12}$. Cœc. pyl. 13.

This species differs from the Antarctic in having the bones of the head more solid, narrower muciferous channels, a smaller eye, and the spinous dorsal fin more differentiated from the soft. The scales are small; abdominal scutes ten. The height of the body is less than one-half of the total length without caudal; the diameter of the eye two-ninths of the length of the head. No projecting suprascapulary spine. The third and fourth dorsal spines are the longest, and the seventh is shorter than the eighth.

Only one specimen, 19 inches long, was obtained off Madeira in the month of April. Mr. Johnson adds that from the protruded stomach and inflated membranes about the eyes it may be inferred that the fish came from a great depth. Like so many other Madeiran fishes, this species occurs also in Japan, where it was met with by Döderlein, who seems to have been unacquainted with Johnson's description.

Anoplogaster, Gthr.

Body compressed and deep, covered with minute asperities; abdomen without enlarged dermal scutes; head large, with thin bones deeply sculptured to receive wide muciferous cavities. Mouth very wide and oblique; jaws armed with bands of small teeth which are somewhat larger and of unequal size in the lower jaw; no teeth on the palate. Eight branchiostegals; gill-openings very wide. Suprascapulary and angle of the præoperculum armed with a spine. One dorsal fin, without spinous division; ventrals with six soft rays. Air-bladder small, pear-shaped.

Anoplogaster cornutus.

Hoplostethus cornutus, Cuv. Val., ix. p. 470.
Anoplogaster cornutus, Günth., Fish., i. p. 12.
„ „ Lütken, Oversigt K. D. Vid. Selsk. Forhandl., 1877, p. 181, tab. v. figs. 4–7 (fig. opt).

B. 8. D. 17. A. 9-10. V. (O) 7. C. pyl. 6. Vert. 26.

Of this singular fish only very few specimens are known, and, with the exception of one, all were taken from the stomachs of pelagic fish of prey, one in lat. 26°, three in lat. 31° N. and long. 40° W., and one in lat. 25° N. and long. 31° W.; all in the Atlantic. The largest of these specimens is only 77 mm. long. Lütken has made the interesting observation that in very young specimens (10 mm. long), no ventral fins are developed, and that the spines on the head are much elongate, forming a very effectual armature.

Caulolepis.

Caulolepis, Gill, Proc. U.S. Nat. Mus., 1884, vol. vi. p. 258.

Closely allied to *Anoplogaster*, which it also resembles in the form of the body. Body covered with pedunculated leaf-like scales. A pair of very long teeth in front of the upper jaw closing in front of the lower; a similar pair of still longer teeth in the lower jaw received in grooves of the palate. On the sides of each jaw two long teeth terminating in bulbous tips; a row of minute teeth on the posterior half of the maxillaries. Palate toothless.

Caulolepis longidens.

Caulolepis longidens, Gill, *loc. cit.*

D. $\frac{2}{17}$. A. $\frac{2}{8}$. Eyes small, black.

Habitat.—A single specimen of this interesting form (size not stated) was obtained by the U.S. steamer "Albatross," in the Atlantic; lat. 39° 27′ N., long. 69° 56′ W.; depth, 1346 fathoms.

Melamphaës.

Metopias, Lowe, Proc. Zool. Soc. Lond., 1843, p. 90.
Melamphaës, Günth., Cat. Fish., v. p. 433.

Head large and thick, with nearly all the superficial bones modified into wide muciferous channels. Cleft of the mouth of moderate width, obliquely descending backwards, with the jaws nearly equal in front. A narrow band of villiform teeth in both the jaws; palate toothless. Eight branchiostegals; pseudobranchiæ present; no barbels; opercles not armed. Scales large, cycloid, rather irregularly arranged. One dorsal; caudal forked; anal spines very feeble; ventrals with seven rays.

The formation of the head, the black colour of the body, together with the circumstances attending the capture of the three specimens first known, clearly indicate that the fishes of this genus are inhabitants of the depths of the ocean. Lowe's two specimens were picked up at the surface, near Madeira, evidently in an exhausted condition; whilst the specimen described by Lütken was found in the stomach of a dolphin. The discoveries by the Challenger, and by the United States S.S. "Albatross," have proved the surmise [1] of the bathybial nature of these fishes to be correct.

The following is a list of all the species known :—

Melamphaës microps.

Scopelus microps, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 186.

B. 8. D. $\frac{6}{15}$. A. $\frac{1}{9}$. P. 14. V. $\frac{1}{7}$. L. lat. 35.

The height of the body is one-fourth of the total length (without caudal), the length of the head one-third; eye one-seventh of the length of the head, and rather more

[1] Günther, *loc. cit.*

than one-half of that of the snout. Mouth oblique, with the lower jaw rather prominent, and with the maxillary extending to the vertical from the hind-margin of the eye. The teeth are very small, rather irregularly placed, so as to appear at places to form a double and at others a single series. The interior internasal space is occupied by a pair of muciferous cavities separated by a strip of striated skin, which is narrower than deep, and much narrower than in *Melamphaës typhlops.* Branchiostegals long and closely set. No spines on the neck.

The spines of the fins are very weak, not stronger than the rays. End of the dorsal fin opposite to the origin of the anal, the rays of which are shorter than those of the dorsal. Caudal fin very short, and covered with scales at the base. Pectoral not quite as long as the head, and not reaching to the vent. Ventrals much shorter. Black; mouth black; fins yellowish.

	Millims.
Total length,	120
Length of snout,	10
Length of eye,	$4\frac{1}{2}$
Length of head,	35
Length of pectoral fin,	29
Distance of snout from origin of dorsal,	41
Distance of snout from vent,	69

Habitat.—Between the Cape of Good Hope and Kerguelen Island, Station 146; depth, 1375 fathoms. One specimen.

Melamphaës typhlops (Pl. V. fig. A).

Metopias typhlops, Lowe, Proc. Zool. Soc. Lond., 1843, p. 90, and 1850, p. 125.
Melamphaës typhlops, Günth., Cat. Fish., v. p. 433.

B. 8. D. $\frac{6}{11}$. A. $\frac{2}{6}$. P. 15. V. $\frac{1}{7}$. L. lat. 25. L. transv. 7.

Eye small, one-sixth of the length of the head, and two-thirds of that of the snout. Ventral fins not quite as long as pectorals, not reaching to the vent. Black.

Habitat.—Atlantic, near Madeira.

Melamphaës megalops (Pl. V. fig. B).

Melamphaës megalops, Lütken, Oversigt K. D. Vid. Selsk. Forhandl., 1877, p. 176, tab. v. figs. 1–3,

B. 8. D. $\frac{3}{11}$. A. $\frac{1}{9}$. P. 10–11. V. $\frac{1}{7}$. L. lat. 34. L. transv. 9.

Eye rather large, more than one-fourth of the length of the head, and much longer than the snout. Ventral fins at least as long as pectorals, reaching beyond the vent. Black.

Habitat.—Atlantic, south of the Azores.

The single specimen known was taken from the stomach of a *Coryphæna;* and the skin covering the head and enclosing the muciferous cavities is destroyed by the action of the gastric juice so as to render the ridges of the skeleton of the head more conspicuous than they are in a living or well-preserved example.

Melamphaës crassiceps (Pl. VIII. fig. B).

Scopelus crassiceps, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 185.

D. $\frac{3}{12}$. A. $\frac{1}{8\text{-}9}$. P. 14. V. $\frac{1}{7}$. L. lat. 28.

The height of the body is one-fourth of the total length (without caudal); the length of the head one-third; the least depth of the tail is two-fifths of its free portion. Head very thick with short snout. Eye small, one-seventh of the length of the head, and one-half of that of the snout; posterior margin of the præoperculum descending obliquely backwards; lower jaw slightly prominent; cleft of the mouth rather oblique; the maxillary reaches to behind the eye, and is moderately dilated behind. Origin of the dorsal fin nearer to the extremity of the snout than to the caudal fin, and immediately behind the base of the ventrals; its last ray is above the anterior anal rays. Pectoral fin narrow, nearly as long as the head, reaching to or beyond the end of the anal fin. Black.

All the specimens are in an indifferent state of preservation; the bones are extremely soft, and the wide muciferous channels have collapsed, most of the covering membrane being destroyed. The scales are lost.

Habitat.—Mid-Atlantic, Station 107; depth, 1500 fathoms. One specimen, 2 inches long.

Off Pernambuco, Station 120; depth, 675 fathoms. One specimen, $2\frac{1}{2}$ inches long.

Midway between Cape of Good Hope and Kerguelen Island, Station 146; depth, 1375 fathoms. One specimen, $6\frac{3}{4}$ inches long.

North of New Guinea, Station 220; depth, 1100 fathoms. One specimen, $2\frac{3}{4}$ inches long.

Melamphaës mizolepis.

Scopelus mizolepis, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 185.

D. $\frac{3}{10}$. A. $\frac{1}{8}$. V. $\frac{1}{6}$.

Height of the body two-sevenths of the total length (without caudal); the length of the head rather less than two-fifths; the least depth of the tail is one-half of its free portion. Head very thick, with short snout; eye very small, about one-seventh of the length of the head, and one-half of that of the snout. Posterior margin of the præoperculum subvertical; lower jaw slightly prominent; cleft of the mouth rather oblique; the maxillary reaches to below the anterior portion of the eye, and is moderately dilated behind. Origin of the dorsal fin somewhat nearer to the extremity of the snout than to the caudal fin, and behind the base of the ventrals, which is below that of the pectorals; the last dorsal ray is above the middle of the anal. Pectoral fin long, extending at least to the middle of the anal fin. The scales, which are lost, appear to have been of unusually large size; there were, perhaps, not more than eighteen along the lateral line. Black.

Habitat.—South of New Guinea.

Off the Arrou Islands, Station 191; depth, 800 fathoms. One specimen, 3 inches long.

Melamphaës robustus, n. sp.

D. 13 (? $\frac{2}{11}$). A. $\frac{1}{9}$. V. $\frac{1}{7}$. L. lat. 33.

The height of the body is two-sevenths of the total length (without caudal); the length of the head a little less than two-fifths; the least depth of the tail is two-fifths of its free portion. Head thick, with the usual muciferous cavities; snout short; eye very small, about one-eighth of the length of the head and one-half of that of the snout. Posterior margin of the præoperculum subvertical; lower jaw slightly prominent; cleft of the mouth rather oblique, wide, extending beyond the eye. Maxillary dilated behind. Origin of the dorsal fin midway between the end of the snout and the root of the caudal, somewhat behind the base of the ventrals, which are distinctly thoracic. The last dorsal ray is opposite to the first of the anal. Upper pectoral rays elongate and reaching to the vent; ventrals rather short. Uniform black.

	Millims.
Total length, ...	53
Depth of the body, ...	$12\frac{1}{2}$
Length of the head, ...	17
Diameter of the orbit, ...	2
Length of the caudal fin, ...	8

Habitat.—Mid-Atlantic, south-west of Sierra Leone, Station 106; depth, 1850 fathoms. One specimen which has lost its scales, and has most of the fin-rays broken.

Melamphaës beanii, Gthr.

Plectromus crassiceps, Bean, Proc. U.S. Nat. Mus., 1885, p. 73.

D. $\frac{2}{11-12}$. A. $\frac{1}{8-9}$. V. 8. P. 15. L. lat. ca. 25.

The length of the head is one-third, the depth of the body two-sevenths of the total length, without caudal. The eye is about two-ninths of the length of the head.

The pectoral is as long as the head, and more than twice as long as the ventral, which does not quite reach to the vent. Black.

Habitat.—Four specimens are known to have been obtained in the Central Atlantic:—at a depthof 855 fathoms, in lat. 41° 40′ N., long. 65° 35′; at a depth of 1022 fathoms, in lat. 39° 44′ N., long. 71° 4′; at a depth of 1497 fathoms, in lat. 37° 41′ N., long. 73° 3′; and one at a depth of 2949 fathoms.

Melamphaës suborbitalis.

Plectromus suborbitalis, Gill, Proc. U.S. Nat. Mus., 1884, vol. vi. p. 258.

D. $\frac{3}{16}$. A. $\frac{1}{8}$.

Elongate like the two preceding species. Black.

Habitat.—One specimen is known from the Central Atlantic, obtained by the United States S.S. "Albatross," at a depth of 1735 fathoms, in lat. 38° 52′ N., long. 69° 24′.

Malacosarcus, n. gen.

Head large and thick, with the bones very thin, and with wide and deep muciferous cavities; also the canal along the lateral line is much distended. Cleft of the mouth wide, obliquely descending backwards, with the jaws nearly equal in front. A narrow band of villiform teeth in both jaws; palate toothless. Eight branchiostegals, pseudobranchiæ present. The edges of the præoperculum and the lower edge of the mandible with minute and distant spines. Scales extremely thin, not sculptured, deciduous, irregular, and of moderate size. One dorsal; caudal emarginate, with broad basal fold above and below; anal spines very feeble. Ventrals small, five-rayed, inserted at some distance behind the pectorals. Gills four; gill-laminæ short; gill-rakers long, needle-shaped.

Although this fish is only a degraded form of *Melamphaës*, it will be better to make it the type of a distinct genus, as otherwise the generic definition of *Melamphaës* would lose much in precision.

Malacosarcus macrostoma.

Scopelus macrostoma, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 186.

B. 8. D. 13. A. 13. P. 10. V. 5.

The body is highest where it joins the head, and rather rapidly becomes lower towards the tail; its greatest depth is rather more than one-fourth of the total length (without caudal), the length of the head one-third. Head thick, with the snout of moderate length, obtuse, and with the jaws equal in front; eye small, not quite one-sixth of the length of the head, and two-thirds of that of the snout. Posterior margin of the præoperculum oblique, rounded. Operculum narrow, membranaceous. Cleft of the mouth oblique, very wide, the maxillary reaching far behind the eye to the mandibulary joint. It is obliquely dilated behind. Origin of the dorsal fin but little nearer to the extremity of the snout than to the root of the caudal, and not much in advance of the vent; its last ray opposite to the last ray of the anal. Pectoral with narrow base, rather small, scarcely extending to the origin of the dorsal. Ventral very small, its root equidistant from the vent and the vertical from the base of the pectoral; the caudal rays extend a considerable distance forward on the upper as well as lower side of the tail, and are enclosed within the remains of the embryonic vertical fin. Gill-rakers of the first branchial arch twenty-seven in number, the longest nearly twice as long as the eye. Transparent; with the sides of the head and the abdomen black.

Habitat.—Mid-Pacific, Station 271; depth, 2425 fathoms. One specimen, 3½ inches long.

Near the Low Archipelago, Station 276; depth, 2350 fathoms. One specimen, 3½ inches long (in bad condition).

The specimen which has served for the description is not in a good state of preservation; in fact, the structure of the bones, integuments, and muscles of the fish is so soft that we can scarcely hope ever to obtain a perfect animal. The rays of the vertical fins are also much broken, so that it is impossible to distinguish in the dorsal fin between spines and rays. The soft condition of the parts, the embryonic condition of the caudal, the want of development of the ventral fins, the absence of colour, the short branchial laminæ, &c., indicate that this fish inhabits actually the great depth as recorded in the journal of the Challenger.

Stephanoberyx.

Stephanoberyx, Gill, Proc. U.S. Nat. Mus., 1884, vol vi. p. 258.

This genus is very imperfectly known at present, and said to be closely allied to *Melamphaës*, but with cycloid scales which are armed about the centre with one or two erect spines, and with only five soft rays in the ventral fin.

Stephanoberyx monæ (D. 14. A. 13. P. 10), is named from a single small specimen, obtained by the United States S.S. "Albatross," in the Atlantic, lat. 41° 9′ N., long. 65° 55′, at a depth of 1253 fathoms.

Beryx, Cuv.

Body compressed and deep, covered with ctenoid scales which are regularly arranged; abdomen compressed, trenchant, but without enlarged dermal scutes. Head rather large, with thin bones and high ridges, between which large muciferous cavities are lodged. Mouth very wide and oblique; villiform teeth in the jaws, on the vomer and palatine bones. Eye very large. Branchiostegals from seven to ten, gill-openings very wide. Præoperculum without spine. One dorsal fin with a few spines in front; ventrals with seven and more rays; pectoral asymmetrical; anal with four spines; caudal deeply forked, with the upper and lower rudimentary rays transformed into spines. Air-bladder simple; pyloric appendages from twenty to thirty.

Of the five species known of this genus two only are known to descend to such a depth as to justify their admission into the deep-sea fauna. The other species (which belong to the Australian fauna) seem to live habitually in shallower water, and not far from the coast, where they are captured not unfrequently by the ordinary means. The two deep-sea species are *Beryx decadactylus* and *Beryx splendens;* they were discovered first in the sea off Madeira, and more recently in the sea off Japan. Lowe says that "the latter species, the 'Alfonsin a casta cumprida' of the Madeiran fisherman, begins to be met with of small size at the depth of 150 or 200 fathoms, but is scarcely taken in full size and plenty except with its congener, *Beryx decadactylus,* the 'Alfonsin a casta larga,' at the depth of from 300 to 400 fathoms, and from one to two leagues from shore." The Challenger Expedition obtained specimens of *Beryx decadactylus* only, off Inosima, at a depth of 345 fathoms, whilst we are indebted to H. Batson Joyner, Esq., for specimens of *Beryx splendens,* which he obtained during his residence at Tokio.

Young specimens have been found in the open sea. A specimen, described by Cuvier and Valenciennes under the name of *Beryx delphini,* was taken from the stomach of a *Coryphæna* in the Western Indian Ocean, in lat. 32° S. and long. 51° E.

Remains of extinct species of *Beryx* are found in Cretaceous formations, but not all the species described as such belong to this genus or even family. The skeleton of *Beryx decadactylus,* of which a figure is given on Pl. VI., well illustrates the family characteristics.

On the whole the bones of the skeleton are solid and firmly built, but some of the bones of the head are dilated into thin lamellar ridges, between which the muciferous channels and cavities are lodged. This is particularly the case with the bones forming the roof of the skull, the infraorbital ring, and the lower part of the mandible. The canal running along the præopercular limbs is much less deeply excavated. The basal portion of the cranial cavity is comparatively short and deep, very much swollen to lodge the organ of hearing and especially a pair of very large otoliths. The bones forming this part of the skull are thin and perforated by an oblong opening between the alisphenoid and basisphenoid, as in *Myripristis.*[1]

The vertebral column consists of eleven abdominal and thirteen caudal vertebræ. The five anterior neural spines are remarkably stout and broad to support the anterior

[1] Cat. Fish., vol. i. p. 23.

spinous part of the dorsal fin. The three anterior interneurals have no direct connection with the dorsal fin, but terminate in the soft parts of the back. The remaining interneurals with which the dorsal rays articulate are feeble, one or two of the anterior and two or three of the posterior corresponding to the several neural spines. The hæmal spines of the caudal vertebræ are longer and stronger than the opposite processes. The hæmal of the eleventh vertebra, which forms the boundary between the abdominal cavity and the muscles of the tail, is exceedingly strong and long and anchylosed to the first interhæmal, the distal extremity of which is dilated into a vertical lamella. The remaining interhæmals are feeble, three being lodged between each pair of hæmals. There are not less than eight interhæmals abutting upon the first hæmal. The pubic bones are peculiarly shaped, somewhat resembling those of *Myripristis*; they are much higher in the vertical line than broad in the horizontal; anteriorly they are produced into a very long styliform process, stretching across the whole width of the shoulder-girdle to its front margin. Posteriorly they form a trihedral cavity with the entrance from beneath, and with a longitudinal ridge on the outer and inner surface.

Beryx decadactylus.

Beryx decadactylus, Cuv. Val., iii. p. 222.
" " Lowe, Fish. Madeira, p. 53.
" " Steindachner, Denkschr. d. k. Akad. d. Wiss. Wien, xlvii. p. 220.
" *splendens*, Lowe, Cambr. Phil. Trans., vol. vi. tab. 3 (no descript.).
" *borealis*, Düb. and Kor., K. Svensk. Vetensk. Akad. Handl., 1844, p. 33, pl. ii.
" " Collett, Vidensk. Selsk. Forhandl. Christ., 1884, No. 1, pl. i. (young).
" " Lilljeborg, Sverig. och Norg. Fisk., p. 76.

B. 8 (7). D. $\frac{4}{16-19}$. A. $\frac{3-4}{28-29}$. V. $\frac{1}{9-10}$. L. lat. 64–65. L. transv. 34–35.

The depth of the body exceeds the length of the head, and is two-fifths of the total length.

Habitat.—Off Inosima, Japan, Station 232; depth, 345 fathoms. Two specimens, 14 and 12 inches long.

Beryx splendens.

Beryx splendens, Lowe, Proc. Zool. Soc. Lond., 1833, p. 142; Cambr. Phil. Trans., vol. vi. p. 197. (not fig.); Fish. Madeira, p. 47, pl. viii.
" " Günth., Ann. and Mag. Nat. Hist., 1878, vol. i. p. 485.
" " Hilgendorf, Sitzungsber. d. Gesellsch. naturf. Freunde, Berlin, 1879, p. 78.
" " Steindachner, *loc. cit.*, p. 221.

B. 8 (9). D. $\frac{4}{13-15}$. A. $\frac{4}{26-29}$. V. $\frac{1}{10-13}$. L. lat. 71–76. L. transv. $\frac{8}{20}$.

The depth of the body is equal to the length of the head, and one-third or one-fourth of the total.

Polymixia, Lowe.

The fishes of this genus have about the same bathymetrical and horizontal distribution as *Beryx*.

Polymixia nobilis (Pl. I. fig. B).

Polymixia nobilis, Lowe, Cambr. Phil. Trans., 1838, vol. vi. p. 198.
„ „ Günth., Fish., i. p. 17.
Nemobrama webii, Valenc. in Webb and Berthel. Ichthyol. Iles Canar., p. 41, pl. viii.
Polymixia lowei, Günth., Fish., i. p. 17.
„ „ Poey, Report Cub., ii. p. 158.
Dinemus venustus, Poey, Mem. Cub., 1860, pp. 161, 352, pl. xiv. fig. 1.
Polymixia japonica, Günth., Ann. and Mag. Nat. Hist., 1877, vol. xx. p. 436.
„ „ Steindachner, Denkschr. d. k. Akad. d. Wiss. Wien, 1883, xlvii. p. 261, tab. iv. fig. 2 (barbels ?).

Specimens of this genus have been obtained at rare intervals in various parts of the tropical and subtropical Atlantic, namely, near Madeira, the Canary Islands, St. Helena and Cuba. The Challenger Expedition brought home specimens from the Sea of Japan, where they were captured off Inosima, at a depth of 345 fathoms; and quite recently I have received a specimen from the Mauritius, my correspondent informing me that it was the first specimen of its kind which the fishermen remembered to have seen. This deep-sea form has therefore a wide geographical range, although it probably does not descend to very great depth or extend beyond the tropical or subtropical zones. From comparison of all these materials I have also convinced myself that the differences on which I formerly separated individuals from distant localities are without specific importance. The specimen figured is one of the Challenger specimens from Inosima.

Habitat.—Off Inosima, Japan, Station 232; depth, 345 fathoms. Three specimens, $6\frac{1}{2}$ and $7\frac{1}{2}$ inches long.

Poromitra.

Poromitra, Goode and Bean, Bull. Mus. Comp. Zoöl., vol. x. No. 5, 1883, p. 214.

Body short, compressed, scopeliform, covered with thin cycloid scales. Head very large, nearly half the entire length of the fish to base of caudal, with scales upon cheeks, suboperculum, and probably elsewhere. No barbel. Mouth very large, the lower jaw projecting. Margin of upper jaw composed of a short intermaxillary and a long maxillary. Teeth cardiform, numerous, very small on the intermaxillaries and mandibles. None discovered on maxillaries, palatines or vomer. Opercular apparatus complete. Ventrals very small, inserted in advance of the pectoral. Dorsal fin in the middle of the body, its origin not far behind that of the ventrals, the spinous and soft portions subequal in length. Anal much shorter than dorsal, its middle under the end of the dorsal or nearly so. Pseudobranchiæ present. Gill-openings very wide, separate.

Poromitra capito.

Poromitra capito, Goode and Bean, *loc. cit.*, p. 215.

D. $\frac{7-8}{6}$. A. 9. V. 7 or 8. P. 12. L. lat. ca. 24. L. transv. ca. 10.

Of this fish two specimens only, $1\frac{1}{4}$ inches long, and in a dilapidated condition, were obtained in 1632 fathoms during the cruise of the U.S. steamer "Blake" off the American coast, in lat. 34° N. and long. 75° W.

Myripristis, Cuv.

Myripristis kaianus.

Myripristis kaianus, Günth., Report on the Shore Fishes, Zool. Chall. Exp., part vi. p. 39.

Habitat.—Off the Ki Islands, Station 192; depth, 140 fathoms.

Family TRICHIURIDÆ.

Nealotus, Johnson.

Body elongate, much compressed, incompletely covered with delicate scales. Small teeth in the jaws and on the palatine bones; none on the vomer. First dorsal composed of about twenty spines extending on to the second; finlets behind the dorsal and anal; a dagger-shaped spine behind the vent. Caudal fin well developed. Ventrals reduced to a spine each. No keel on the tail.

Nealotus tripes.

Nealotus tripes, Johnson, Proc. Zool. Soc. Lond., 1865, p. 434.

D. 21 | 19 + II. A. 18 + II. P. 13. V. 1.

This fish was known from a single example,[1] 10 inches long, obtained at Madeira in the month of December, and has been fully described by Johnson. The Challenger

[1] Mr. Johnson says (*loc. cit.*, p. 435) that this specimen has been deposited in the British Museum. Such was undoubtedly his intention at the time when he wrote his description, as before and afterwards he most liberally presented his ichthyological treasures to the National Institution. But this specimen was never received, and from later inquiries it would appear that this valuable type is lost.

collection contains a very young specimen, only 33 mm. long, which agrees so well with Johnson's description that it no doubt belongs to the same species. Only the dagger-shaped postanal spine is shorter than the ventral spines, and also the separation of distinct finlets cannot be clearly made out, as might be expected in so young an example. It was brought up in the dredge at Station 40, in lat. 34° 51′ N., long. 68° 30′ W., where the dredge had reached a depth of 2675 fathoms. However, no part of the organisation of these Trichiuroids indicates that they descend to so great a depth, whilst, on the other hand, young Trichiuroids are not rarely found near the surface. It is, therefore, much more probable that this small fish entered the dredge shortly before it came to the surface.

Aphanopus, Lowe.

Body much elongate, band-like, scaleless; head long, pointed; cleft of the mouth very wide, the jaws being armed with strong lanceolate teeth disposed in a single series and in a common alveolar grove; no teeth on the palate. Eye very large. The whole of the back is occupied by a dorsal fin which is divided into two subequal divisions. Anal spines numerous, very feeble; a strong dagger-shaped spine behind the vent. Caudal fin well developed, deeply cleft; pectoral fins of moderate length, rounded; ventral fins absent. Seven branchiostegals; air-bladder present. Pyloric appendages in small number.

Aphanopus carbo (Pl. VII. fig. A).

Aphanopus carbo, Lowe, Proc. Zool. Soc. Lond., 1839, p. 79.
" " Günth., Fish., vol. ii. p. 343.
" " Capello, Journ. Sci. Acad. Lisb., vol. i., t. iv. fig. 4.

We have no information as to the exact depth at which this fish lives, but there is no doubt that it belongs to the deep-sea fauna, as it is caught, and only very rarely, on the longest lines of the Madeiran fishermen; off the Portuguese coast it is similarly obtained on the tackle used by the Portuguese fishermen for the capture of deep-sea sharks. The large eye, the black colour of the body, the thinness of the bones of the head and of the vertebræ are additional evidence of the bathybial habits of the fish.

The length of the species is from 4 to 5 feet.

Nesiarchus, Johnson.

Body elongate, compressed, covered with small scales. Eye of moderate size. Several strong fangs in the jaws; palate toothless. First dorsal fin with about twenty spines, separate from the second. No detached finlets. Ventrals small, thoracic. Caudal fin present. A dagger-shaped spine behind the vent.

Nesiarchus nasutus.

Nesiarchus nasutus, Johnson, Proc. Zool. Soc. Lond. 1862, p. 173, pl. 22.
Prometheus paradoxus, Capello, Journ. Sc. Acad. Lisb., vol. iii. p. 260, pl. iv. fig. 5; and vol. vi. p. 154.

This is the only species of the genus; it is a large fish, known from a few specimens only which have been found in the sea off Madeira and the Portuguese coast. It is without doubt a deep-sea fish, which comes to the surface only by accident.

Lepidopus, Gouan.

Body much elongate, band-like, scaleless; head long and pointed; cleft of the mouth wide, the jaws being armed with strong lanceolate teeth in a single series; a series of small teeth on the palatine bones. Eyes large. The whole of the back is occupied by a single dorsal fin; anal spines numerous, but the majority are rudimentary or may disappear entirely; no postanal spine; caudal fin small. Ventral fins absent or rudimentary. Eight branchiostegals; air-bladder present. Pyloric appendages rather numerous.

Lepidopus caudatus (Euphrasen).

The Scabbard-fish or Frost-fish of New Zealand is probably an inhabitant of moderate depths, although no positive evidence has been forthcoming as to its vertical distribution. It is rather common in the Mediterranean and warmer parts of the Atlantic, at the Cape of Good Hope, in the seas around Tasmania and New Zealand, and on the coast of California. Lendenfeld has observed that the Frost-fish periodically appears on the coast of New Zealand in numbers, evidently rising from the depths which it inhabits in order to deposit its spawn.[1]

The skeleton has been described in the Catalogue of Fishes, vol. ii. p. 345, and the annexed figure represents the abdominal surface of the pelvic bones with the rudimentary scale-like ventral fins, twice the natural size.

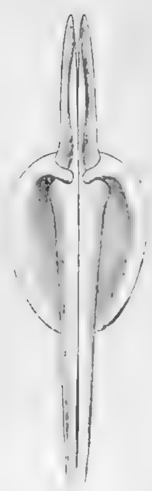


Fig. 2.—Pelvic bones of *Lepidopus caudatus*.

Lepidopus tenuis (Pl. VII. fig. B).

Lepidopus tenuis, Günth., Ann. and Mag. Nat. Hist., 1877, vol. xx. p. 437.

D. 126. A. 71.

This species is distinguished at the first glance by the extraordinary slenderness of the body, the depth of which is not much more than one-fourth of the length

[1] *Zool. Anzeiger*, 1883, p. 559.

of the head; the latter is two-fifths of the length of the trunk, and one-seventh of the total. The lateral teeth are comparatively stronger and fewer in number than in *Lepidopus caudatus.* The terminal portion of the tail becomes so slender that its entire depth is occupied by the mucous canal of the lateral line, which is very wide. Caudal fin very small. The anterior anal rays are not free, but hidden below the skin. Uniform silvery.

Habitat.—Off Inosima, Japan, Station 232; depth, 345 fathoms. One specimen, 24 inches long.

The above diagnosis requires scarcely any addition. The two pairs of large teeth which occupy the front of the upper jaw in *Lepidopus caudatus* are present also in this species, but happen to be broken off near the base in the present specimen. None of the teeth show a trace of being barbed near the apex. Gill-rakers minute and remote from each other. The inside of the mouth and pharynx is black, indicating, in conjunction with the wide lateral line, delicate structure of the skin, fin-rays and membranes, the bathybial habits of the fish. On the other hand, its eye is comparatively smaller than in *Lepidopus caudatus,* being contained seven and a half times in the length of the head, and three and a half times in that of the snout.

Lepidopus elongatus.

Lepidopus elongatus, Clarke, Trans. New Zeal. Inst., vol. xi., 1879, p. 294, pl. xiv.
Benthodesmus elongatus, Goode and Bean, Proc. U.S. Nat. Mus., vol. iv., 1882, p. 379.

D. 154–155. A. 25 (Clarke). 100 (G. and B.).

This fish is so closely allied to *Lepidopus tenuis* that I should have referred it to that species, but for the circumstance that both the descriptions agree in assigning to it twenty-eight or twenty-nine more dorsal rays than are found in the Japanese specimen. Also the dermal elements of the anal fin seem to be more numerous in *Lepidopus elongatus* than in *Lepidopus tenuis.* Clarke represents the caudal fin as distinctly forked, and so it may have been in the specimen of *Lepidopus tenuis,* in which this fin is much mutilated. He also counted of the anal rays those only which were connected by membrane, and it is quite possible that at an earlier age a similar connection existed between the posterior rays in *Lepidopus tenuis.*

The discoverer of this fish found eight or ten specimens washed ashore on the Hokitika Beach on October 12, 1874; the largest was $27\frac{1}{2}$ inches long. The example described by the North American ichthyologists was taken from the stomach of a Halibut, caught in 80 fathoms on the Grand Bank of Newfoundland.

Trichiurus, L.

Trichiurus lepturus, L.

Trichiurus lepturus, Günth., Report on the Shore Fishes, Zool. Chall. Exp., part vi. p. 66.

The Silvery Hairtail is a common surface-fish in the warmer parts of the Atlantic, the Indian Archipelago, in the Chinese and Japanese Seas, and in New Zealand. The Challenger Expedition obtained it off Inosima in 345 fathoms.

Euoxymetopon, Poey.

Body much elongate, band-shaped; head with the supraocular portion compressed into a trenchant edge, and the upper profile abruptly descending towards the end of the snout; eye of moderate size, much below the upper profile. Cleft of the mouth wide; teeth lanceolate, in single rows, with larger ones in front; a series of small teeth on the palatines. Fins as in *Lepidopus*.

Euoxymetopon tæniatus.

Euoxymetopon tæniatus, Poey, Proc. Acad. Nat. Sci. Philad., 1863, p. 228; An. Soc. Espan. Hist. Nat., 1873, p. 77, lam. 5.

B. 7. D. 87. A. $x+19$. P. 12.

The ventral fins are reduced to a pair of flat scales; the dorsal commences above the eye, the diameter of which is about one-sixth of the length of the head. Body with reddish longitudinal bands.

Of this fish only one specimen [1] is known to exist in collections, which was obtained by Professor Poey at Havannah, and is five feet long. The reference of this fish to the bathybial fauna is merely inferential at present, as nothing is known of the particular circumstances under which the typical specimen was captured. But it is most improbable that, if it came as frequently to the surface as *Lepidopus caudatus*, it should have escaped so long the observation of an indefatigable collector like Professor Poey.

Euoxymetopon poeyi, n. sp. (Pl. XLIII.).

A fish which I have received from the Mauritius, whilst this Report is passing through the press, agrees in all the principal characteristics so completely with the Cuban fish, that

[1] After having examined the original account given by Hoy in *Trans. Linn. Soc. Lond.*, vol. xi., 1815, p. 210, of two supposed specimens of *Trichiurus lepturus* from the Moray Firth, I concur with the view expressed by Fleming (*Ann. and Mag. Nat. Hist.*, vol. iv., 1831, p. 219) that the specimen captured in 1810 was a *Trachypterus*, and with Mr. F. Day (Fish. of Great Britain and Ireland, p. 222), who refers the second which was thrown ashore in 1812, to a species of *Regalecus*.

it is with great hesitation that I describe it as a second species, attaching to it the name of the discoverer of the genus. There are two points in which our specimen apparently differs from the Cuban specimen. First, it possesses an enormously large first dorsal spine; but then this spine is but loosely articulated with the interneural, and it is quite possible that it may have been lost, during or after the life of the fish, in Professor Poey's specimen. Secondly, the original description in the Proceedings of the Philadelphia Academy mentions a postanal spine at the commencement of the anal fin, which, however, is afterwards explained by Professor Poey to be hidden under the skin, and therefore not apparent in his figure. Neither should I have taken any notice of this spine in our specimen; it is entirely covered by skin, and consists of coalesced and flattened interhæmal elements, and cannot be properly called a spine. But in our specimen, a single oval scale slightly bent along the middle occupies the place at a short distance behind the vent; this scale is quite similar to the scales representing the ventral fins, but single, and of about the same size.

The specimen is a dry skin, 78 inches long, and in a good state of preservation; it was unknown to any of the fishermen at Port Louis, and the captor stated that he had obtained it at a depth of 70 fathoms.

D. 93. A. $x+20$. P. 12.

The greatest depth of the body is below the first dorsal spine, and one-thirteenth of the total length or even less; length of the head one-eighth of the total; orbit occupying the middle of the depth of the head, a little nearer to the end of the snout than to the end of the gill-cover, and one-fifth of the length of the head. Each jaw with a series of small, flat, and triangular teeth, but the upper jaw is armed besides with three large compressed fangs which stand inside the outer series of small teeth, and of which the two posterior are placed more closely together, and are somewhat larger than the anterior; in the lower jaw the foremost pair is very little larger than the others. The first dorsal spine is large, compressed, sword-shaped, finely ribbed, and in its mutilated condition not much shorter than the head. The lower pectoral rays are twice as long as the upper, and half as long as the head; vent somewhat in advance of the middle of the total length. A large scale marks the commencement of the anal fin, the rays of which begin to be free in the posterior third of its extent. Hind part of the tail very slender; caudal fin deeply forked. Coloration in the present state of the specimen uniform silvery.

I have given on Pl. XLIII. a view of the anterior part of the fish of the natural size, an outline figure, reduced in size, of the entire fish, and separate views of the pair of ventral scales (*a*) and of the single postanal scale (*b*).

Gempylus, Cuv. Val.

Body much elongate, compressed, almost scaleless. Eye large. The first dorsal continuous, with thirty and more spines, and extending on to the second. Six finlets behind the dorsal and anal; ventrals rudimentary. Several strong teeth in the jaws, and some small ones on the posterior part of the palatine bones.

The single species known, *Gempylus serpens*, figured by Cuvier and Valenciennes, on pl. ccxxi., and by myself in Fische d. Südsee, taf. lxviii. fig. B, has been rarely obtained at the Canary Islands, in the Caribbean Sea, and near the Society and Sandwich Islands. It is generally reported to be an inhabitant of great depths, but nothing positive is known as to its vertical range.

Very young specimens are not rarely found in the open sea; their changes during growth have been observed by Lütken.[1]

Family CARANGIDÆ.

Anomalops, Kner.

Body oblong, covered with small rough scales. Snout very short and convex, mouth very wide. Eyes very large; a glandular, elongate, partly free, luminous organ occupies a hollow of the infraorbital ring below the eyes. Villiform teeth in the jaws and on the palatine bones; vomer toothless. First dorsal short; second and anal moderately long; caudal forked.

Anomalops palpebratus.

Sparus palpebratus, Boddært, in Pallas N. Nord. Beitr., ii. p. 55, tab. iv. figs. 1–2.
Heterophthamus katoptron, Bleek., Act. Soc. Sc. Ind. Nederl., i.; Manado en Makass., p. 42.
Anomalops græffei, Kner, Sitzungsb. Akad. Wien, 1868, lviii. p. 294, tab. i. fig. 1.
Anomalops palpebratus, Günth., Fisch. d. Südsee, p. 142, taf. xci. fig. A.

D. 5 | 15-16. A. 13. V. $\frac{1}{5}$.

The height of the body equals the length of the head, and is two-sevenths of the total; the large eye is only two-fifths of the length of the head. The maxillary extends to behind the middle of the eye. Præoperculum finely denticulated. Nearly uniform blackish.

Of this singular fish only six specimens are known, viz., four from Amboina and Manado, one from the Fiji Islands, and one from the Paumoto Archipelago. The largest is 12 inches long. This fish lives evidently in great depths, and comes to the surface

[1] *K. Dansk. Vidensk. Selsk. Skriv.*, xii., 1880, p. 456, tab. iii. figs. 5–8.

at night or by accident only. The peculiar organ below the eyes is without doubt of the same nature and has the same function as similar structures on the side of the head of other deep-sea fishes; as in *Pachystomias*, it is partly free, as if it could be made to protrude out of the pit in which it lies.

Kner places this fish in the Berycidæ, from which family it is removed by the different structure of its fins. I have not been able to examine specimens.

Family CYTTIDÆ.

Cyttus, Gthr.

The two species of this genus which were previously known—one from Madeira, the other from the coast of South Australia—are large-eyed fishes which probably inhabit the same depth as our John Dory (*Zeus*), and which on the evidence extant cannot be included in the deep-sea fauna. The small fish, of which we here give a description, is reported to have been taken at 400 fathoms, and differs in some particulars from the diagnosis given for the genus, which differences, however, do not seem to me to call for a generic separation. There is nothing in its organisation which would lead one to suppose *a priori* that it comes from a greater depth than its congeners.

Cyttus abbreviatus (Pl. X. fig. B).

Platystethus abbreviatus, Hector, Trans. New Zeal. Inst., vol. vii., 1875, p. 247, tab. xi.
Cyttus abbreviatus, Hector, *loc. cit.*, vol. ix., 1876, p. 465.
Antigonia mülleri, Klunzinger, Sitzungsb. Akad. Wien, lxxx., 1880, p. 380, taf. v. fig. 3.

B. 6. D. 7/26. A. 2/26. P. 16. V. $\frac{1}{6}$.

Resembling the boar-fish in general appearance, the body being much compressed and elevated. The highest point of its upper profile is the root of the first dorsal spine, the greatest depth of the body being more than one-half of the total length, without caudal. The lower profile is also convex, but less so than the upper. The head participates in the general form of the body, and its length is more than two-fifths of the total, without caudal. Peduncle of the tail very slender, much longer than deep.

The eye lies immediately below the upper profile and is large, at least as long as the snout, and two-fifths of the length of the head. Snout pointed, with the lower jaw projecting and the mouth obliquely directed upwards. The distal portion of the maxillary is dilated, and terminates on its antero-inferior corner in a narrow process, which, when the mouth is half open, projects downwards like a moustache. The cleft of the mouth does not extend to below the eye; the mouth is very protractile, the posterior inter-maxillary processes sliding in the deeply excavated interorbital space, which is much narrower than the orbit. An angular projection of the parietals above the front margin of the orbit. Præopercular margin gently convex; the opercular pieces very short in the longitudinal axis of the head. The lower ridges of the mandible, præ- and sub-operculum finely serrate. Teeth in the jaws very minute, forming extremely narrow bands; palate toothless.

The first dorsal spine is short, the second very strong, compressed, scythe-shaped, as long as the orbit; the other spines are much more feeble, and gradually decrease in length. The rayed dorsal is only about half as high as the longest spine. The two anal spines are separate from the soft portion, the anterior and longer being one-third the length of the longest dorsal spine; the soft anal fin is similar to the opposite dorsal. Caudal fin as long as the orbit, truncated. The pectorals are inserted below the middle of the depth of the body, and are broad and much shorter than the ventrals. Ventrals with a strong, straight, compressed spine, shorter than the dorsal spine, the fins extending to the soft anal. The distance between the root of the ventrals and the anal spine is less than that between ventrals and pectorals, the vent occupying the middle. The projecting first interhæmal renders the short space between vent and anal trenchant, whilst the pelvic region is rather flattened, and there exists no groove for the reception of the ventrals.

The scales (fig. B[1]) leave the nape of the neck and a narrow strip below the dorsal profile naked. Those covering the side of the body are much deeper than long, the free portion, which shows the entire margin of a cycloid scale, and only a few concentric striæ, being less deep than the radical portion, which is more deeply striated, the striæ (all of which run parallel to the hind-margin of the scale) being more numerous. Along the base of the dorsal and anal fins a series of harder scales is firmly embedded in the skin, each being armed with a series of small spines. The lateral line follows the dorsal outline.

Silvery, with a blackish crescent behind the pectoral. Total length, 3 inches.

One specimen was obtained two hundred miles off Cape Farewell, in 400 fathoms. It is now in the British Museum.

Fig. B[1] of Pl. X. represents a scale from the middle of the side, much magnified; the free portion being on the left, and the radical on the right hand side of the reader.

Antigonia, Lowe.

Antigonia capros.

Antigonia capros, Lowe, Proc. Zool. Soc. Lond., 1843, p. 85.
" " Günth., Fish., vol. ii. p. 497.
" " Steindachner, Denkschr. d. k. Akad. d. Wiss. Wien, xlix., 1884, p. 187, pl. v.
Caprophonus aurora, Müll. and Trosch., Hor. ichth., iii. p. xxviii. taf. v. fig. 1.
Hypsinotus rubescens, Schleg., Faun. Jap. Poiss., p. 84, pl. lxii. fig. 2.
" " Günth., Report on the Shore Fishes, Zool. Chall. Exp., part vi. p. 44.

Steindachner observes that the height of the body decreases with age relatively to the length of the fish. This is true within the limits of more or less advanced age, but exactly the reverse is the case when young specimens are taken into consideration, as I have already mentioned in the Report on the Shore Fishes, and as will be seen from the following table, in which the total length is given with exclusion of the caudal fin :—

	Total length.	Height of body.
a. Ki Islands, ...	16 lines.	14 lines.
b. Ki Islands, ...	21 "	22 "
c. Ki Islands, ...	25 "	33 "
d. Manado, ...	27 "	35 "
e. Japan, ...	78 "	84 "
f. Barbados, ...	60 "	59 "
g. Madeira, ...	69 "	70 "

Probably the proportions of the body are also subject to some slight individual variation, as is also the case with respect to the length of the third and longest dorsal spine, which in old specimens is much shorter than the head, whilst it is comparatively more slender and longer in some of the younger specimens. At a certain age a blackish ocular band is visible, with traces of a second below the commencement of the dorsal fin. These bands are visible in specimen *b*, but not in *a* or *c*.

This fish is an inhabitant of moderate depths and has a wide distribution; it is therefore not very scarce. We have received specimens from Madeira, Barbados and Manado; several collectors have found it in Japan, and the Challenger obtained three specimens near the Ki Islands, from a depth of 129 fathoms.

Diretmus.

Diretmus, Johns., Proc. Zool. Soc. Lond., 1863, p. 403.
Discus, Campbell, Trans. New Zeal. Inst., vol. xi., 1879, p. 297.

Body much compressed, short and elevated, covered with small, coarsely spinous scales, on which no lateral line can be traced; abdomen prominent and keeled. Mouth wide, obliquely ascending, with projecting lower jaw. The jaws are armed with a very narrow band (which, posteriorly, becomes a single series) of small fine teeth of unequal size. The vomer and palatine bones are toothless. The maxillaries terminate at their upper and inner extremity in a pair of short pointed processes, which form peculiar fang-like projections in the inside of the mouth, in front of the vomer. Bones of the head thin, with wide muciferous cavities, the lower limb of the præoperculum denticulated. Eyes very large. Dorsal long, without spinous division; anal similar in form and composition; interradial membrane very fragile. Pectorals large; ventral fins thoracic, with more than five rays (?). Branchiostegals seven; pseudobranchiæ.

To judge from external characters we may place this genus provisionally near *Brama*.

Diretmus argenteus.

Diretmus argenteus, Johns., *loc. cit.*, pl. xxxvi. fig. 1.

D. 27. A. 22. P. 18.

The specimen from Madeira, described in detail and well figured by Johnson, is still the only one known. This author ascribes to it, although with doubt, ten ventral rays, but the rays are much confused, broken, and split down to the base, so that their exact number cannot be ascertained. The spine is enlarged into a thin scalpel-shaped lamella, and marked with numerous oblique striæ.

It is evident from the structure of the cranial bones, the immense eyes, the black colour of the cavity of the mouth and pharynx, and also from the extreme scarcity of the fish, that this species belongs to the deep-sea fauna.

Diretmus aureus.

Discus aureus, Campbell, *loc. cit.*

D. 26. A. 21. P. 17.

I should be inclined to refer this fish, which is known from four specimens, $2\frac{3}{4}$ inches long, cast up on Hokitika beach (New Zealand), to the same species as the Madeiran specimen, but for the seeming absence of the enlarged ventral spine. This, of course, might also be accounted for by the less advanced age of the specimens. All the other differences as they appear in the description would probably disappear on a direct comparison of the examples. The perforations of the interradial membrane of the dorsal and anal fins, which Campbell regards as an extraordinary character, may also be seen in the Madeiran type, and are due to the extremely delicate structure of the membrane.

Family Coryphænidæ.

Schedophilus, Cocco.

The species of this genus are pelagic; young examples, at least, are frequently captured in the surface-net in the open ocean. Some of the species, however, possess structural characters which indicate bathybial habits, for instance, a singular want of firmness of the tissues, especially of the bones.

Schedophilus medusophagus.

Schedophilus medusophagus, Cocco in Giorn. Innom. Mess. Ann., iii. No. 7, p. 57; Bonap. Faun. it. Pesc. c. fig.
„ „ Günth., Fish., vol. ii. p. 412; Fisch. d. Südsee, p. 149; Trans. Zool. Soc. Lond., vol. xi., 1882, p. 223, pl. 47.

Adult specimens have been obtained in the Mediterranean, one on the coast of Ireland, and another in the South-Sea near Samoa. Young examples are frequently observed on the surface of the Mid-Atlantic.

Schedophilus lockingtonii.

Icichthys lockingtonii, Jordan and Gilbert, Proc. U.S. Nat. Mus., vol. ii., 1881, p. 305; and Synopsis, p. 621.

D. 40. A. 28. V. $\frac{1}{5}$.

Lateral line composed of a hundred and twenty smooth scales. More slender than the typical *Schedophilus*, the depth of the body being one-fourth of the total length. Eye one-fourth the length of the head.

One specimen, $7\frac{1}{2}$ inches long, was obtained from deep water off San Francisco.

The fish is described as possessing very soft and flexible bones, and being without an air-bladder. But I fail to find in the description characters which would warrant a generic separation from *Schedophilus*, or the creation of a distinct family "Icosteidæ."

Schedophilus enigmaticus (Pl. XLIV.).

Icosteus enigmaticus, Lockington, Proc. U.S. Nat. Mus., vol. iii., 1881, p. ~~63.~~ 305
„ „ Jordan and Gilbert, Synopsis, p. 620.
„ „ Steindachner, Sitzungsb. Akad. Wiss. Wien, lxxxvi., 1882, p. 82.
Schedophilopsis spinosus, Steindachner, *loc. cit.*, lxxxiii., 1881, p. 396.

B. 6. D. 52–55. A. 37–40. V. $\frac{1}{4}$.

The greatest depth of the body is above the vent, and one-half of the total length, the head and caudal fin not included. The length of the head is contained four times and one-fourth in the total, without caudal. It is very broad above, the width of the interorbital space being two-fifths of the length of the head; eye rather small, one-seventh of the length of the head in adult specimens, but comparatively larger in young ones. Cleft of the mouth of moderate width, the maxillary extending to below the middle of the eye; jaws even in front. Nostrils small, close together, nearer to the end of the snout than to the eye. Teeth minute, in a single series. Præoperculum with several small spinous processes on the margin. Bones of the head generally soft and flexible.

The upper profile rises abruptly from the interorbital space and describes a gentle curve to the end of the dorsal fin. The anterior rays of the latter are short, but the rays gradually increase in length backwards, those inserted on the posterior descending part of the curve being the longest. Anal fin similar in shape to the opposite part of the dorsal fin. Caudal fin rounded, with a semicircular base. Caudal peduncle with a narrow fringe of the skin above and below. Pectoral broad, rounded, as long as the post-orbital portion of the head; ventrals much shorter, inserted immediately behind the vertical from the base of the pectoral fin. Vent nearly in the middle of the length of the body.

The skin is naked, groups of minute spines indicate the course of the lateral line; also the rays of all the fins are beset with minute spines.

The gills are well developed; the gill-rakers are thin, membranaceous, flexible papillæ, and as a broad membrane is stretched in the concavity of the arches, each branchial arch bears a series of gill-rakers inside as well as outside of the membrane. Pseudobranchiæ large, with a series of gill-rakers, similar to those of the branchial arches, along the base.

The fish is of a very light coloration, transparent below the dorsal and above the anal; its upper half is marked with large blackish spots, irregular in shape, smaller on the head and neck than on the rest of the body; they form a series along the base of the vertical fins, which are similarly spotted.

I have examined two specimens from California, of which one is 11 and the other 7 inches long.

Family TRACHINIDÆ.

Bathydraco.

Bathydraco, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 18.

Body elongate, subcylindrical; tail tapering and very attenuated behind; head depressed, with the snout much elongate, spatulate; mouth wide, horizontal, with the lower jaw prominent; eyes very large, vertical, close together. Scales very small, embedded in the skin. Lateral line rather wide, continuous. One dorsal fin; ventrals jugular; the lower pectoral rays branched. Teeth in the jaws in villiform bands; none on the vomer or the palatine bones. Opercles unarmed; ten branchiostegals; the gill-membranes free from the isthmus and but slightly united in front. Air-bladder none. Gills four; pseudobranchiæ none; gill-rakers short.

Bathydraco antarcticus (Pl. VIII. fig. A).

Bathydraco antarcticus, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 18.

D. 36. A. 31. P. 23. V. $\frac{1}{6}$.

The greatest depth of the body is only one-third of the length of the head, which is one-third of the total length (without caudal); the large eye occupies nearly the middle of the length of the head, and is about one-fourth of its length. The entire upper surface of the head is naked, but the cheeks and opercles are covered with small scales like the body. The dorsal fin commences at a distance from the occiput, which is considerably less than the distance of the occiput from the snout; this fin is highest in front and very low behind, terminating at some distance from the caudal fin. The origin of the anal is opposite to the tenth dorsal ray. Caudal truncated; pectoral fin very broad, with the hind margin truncated and extending to the origin of the anal. Light coloured above; lower parts and gill-apertures black.

This genus is clearly allied to *Chœnichthys;* its habitat at a great depth is evidenced by the diminished proportion of earthy matter in the bones of the skull; by its large eyes, wide muciferous channels, and coloration.

Habitat.—South of Heard Island, Station 152; depth, 1260 fathoms.

Total length,	120	lines
Length of head,	37	,,
Length of snout,	13	,,
Width of snout opposite nostrils,	$9\frac{1}{2}$	,,
Diameter of the eye,	$8\frac{1}{2}$	,,
Length of pectoral,	22	,,
Length of ventral,	15	,,
Length of caudal,	16	,,
Distance of snout from origin of dorsal,	48	,,
Distance of snout from vent,	55	,,
Depth of peduncle of tail,	$2\frac{2}{3}$	,,

Aphritis, C. V.

Aphritis gobio.

Aphritis gobio, Günth., Report on the Shore Fishes, Zool. Chall. Exp., pt. vi. p. 21, pl. ix.

Habitat.—Southern coasts of South America, from surface to 147 fathoms.

Near Magellan Strait, Station 307; depth, 140 fathoms. One specimen.

Acanthaphritis, Gthr.

One species only is known.

Acanthaphritis grandisquamis.

Acanthaphritis grandisquamis, Günth., Report on the Shore Fishes, Zool. Chall. Exp., pt. vi. p. 43, pl. xviii. fig. A.

Habitat.—Ki Islands, Station 192; depth, 140 fathoms.

Champsodon, Gthr.

Champsodon vorax.

Champsodon vorax, Günth., Report on the Shore Fishes, Zool. Chall. Exp., pt. vi. pp. 43, 52, pl. xxiii. fig. A.

Widely spread in the Chinese and Japanese Seas, off the Philippines and southwards into the Arafura Sea. The Challenger obtained numerous specimens at depths of 115 fathoms (Station 204B), 140 fathoms (Station 192), and 152 fathoms (Admiralty Islands).

Uranoscopus, L.

Uranoscopus kaianus.

Uranoscopus kaianus, Günth., Report on the Shore Fishes, Zool. Chall. Exp., pt. vi. p. 43, pl. xix. fig. A.

Habitat.—Arafura Sea, south of Papua, Station 188; depth, 28 fathoms.
Off the Ki Islands, Station 192; depth, 140 fathoms.

Family PEDICULATI.

Lophius, Art.

Lophius piscatorius, L.

According to Brown Goode [1] the Sea-devil descends to a considerable depth. It was taken off the coast of New England, a large specimen in 120, another in 142 fathoms, and finally one, 26 cm. long, in 365 fathoms.

Lophius naresii.

Lophius naresii, Günth., Report on the Shore Fishes, Zool. Chall. Exp., pt. vi. pp. 53, 56, pl. xxv.

All the specimens known are from deep water, viz., from 115 fathoms (Philippines, Station 204B), from 150 fathoms (North of New Guinea, Station 219), and from the Admiralty Islands.

[1] *Proc. U.S. Nat. Mus.*, vol. iii., 1881, p. 469.

The *Bathybial Sea-devils* which are noticed under the following genera, are degraded forms of *Lophius;* they descend to the greatest depths of the ocean. Their bones are of an extremely light and thin texture, and frequently other parts of their organisation, their integuments, muscles, and intestines are equally loose in texture when the specimens are brought to the surface. In their habits they probably do not differ in any degree from their surface representative, *Lophius.*

When the first individuals of this group were discovered, they seemed to be sufficiently distinct from one another to justify generic separation. However, the additions of recent years exhibit that variation in the shape of the body, head and mouth, in the specialised dorsal spines, and in the development of dermal scutes, which may be expected in such grotesquely formed creatures; and future discoveries may lead to a further reduction of genera, viz., to the union of the naked-skinned *Melanocetus* and *Oneirodes* with *Ceratias.*

The number of the dorsal spines is always reduced, and at the end of the series of these fishes only one spine remains, with a simple, very small lamella at the extremity (*Melanocetus johnsonii*, *Melanocetus murrayi*). In other forms sometimes a second cephalic spine, sometimes a spine on the back of the trunk, is preserved. The first cephalic spine always retains the original function of a lure for other marine creatures, but to render it more effective, a special luminous organ [1] is sometimes developed in connection with the filaments with which its extremity is provided (*Ceratias bispinosus*, *Oneirodes eschrichtii*). So far as is known at present, these complicated tentacles attain to the highest degree of development in *Himantolophus* and *Aegæonichthys.* In other species very peculiar dermal appendages are developed, either accompanying the spine on the back, or replacing it; they may be paired or form a group of three, are pear-shaped, covered with the common skin, and perforated at the top, a delicate tentacle sometimes issuing from the foramen.

Himantolophus, Rhdt.

Body, short, thick, moderately compressed; head very large. Eyes rudimentary. Mouth directed obliquely upwards, of moderate width, with projecting mandible. Jaws armed with several series of rasp-like depressible teeth of different lengths; palate toothless. Skin thick, with round scutes scattered over the body. The spinous dorsal reduced to a single filament; the soft dorsal and anal very short. Ventrals none. Gills two and two halves.

[1] Whose function was first suggested by Lütken.

Himantolophus groenlandicus.

Himantolophus groenlandicus, Reinh., K. dansk. Vidensk. Selsk. Afhandl., 1837, p. 74.
" " Lütken, K. dansk. Vidensk. Selsk. Skriv., 1880, p. 320, tab. ii. fig. 5 (end of dorsal filament).

B. 6. D. 1 | 9. P. 12.

The height of the body is two-fifths of the total length.

A single much injured specimen, 23 inches long, was obtained off the coast of Greenland.

Himantolophus reinhardti.

Himantolophus reinhardti, Lütken, *loc. cit.*, p. 309, tab. i., tab. ii. figs. 1–4.

B. 6. D. 1 | 5. A. 4. C. 9. P. 17.

The height of the body is three-fourths of the total length.

One specimen, 14 inches long, was likewise discovered off the coast of Greenland. Whether some young specimens obtained in Mid-Atlantic, and referred by Lütken to this species, belong to it or to some other species, cannot be decided from the materials at present available.

Aegæonichthys.

Aegæonichthys, Clarke, Trans. New Zeal. Inst., vol. x., 1878, p. 245.

Head excessively large and broad; body short. Eyes small. Mouth exceedingly wide and vertical. Jaws armed with bands of teeth unequal in size and depressible; palate toothless. Skin with scattered, large, round scutes, each ending in a spine. The spinous dorsal reduced to a single tentacle; the soft dorsal and anal very short. Ventrals none. Pectorals well developed. Gills?

Unfortunately nothing is known of the gills of this fish, which, as regards grotesqueness of form, surpasses the fishes of the preceding genus. It is evidently closely allied to *Himantolophus reinhardtii*, and I therefore suppose that it possesses the same number of gills. If this should prove to be the case, the question will arise whether it should be kept as the type of a distinct genus. According to the figure *Aegæonichthys* would appear to be much more depressed in shape than *Himantolophus*; however, we must remember that these flaccid deep-sea fishes may assume, or be made to assume, very different appearances.

Aegæonichthys appelii.

Aegæonichthys appelii, Clarke, *loc. cit.*, pl. vi.

D. 5. A. 4. C. 8. P. 17.

The cephalic spine consists of a tuft, one-sixth as long as the fish, with a swollen muscular base and a hemispherical head, from which spring three or four long branched tentacles; the shaft is covered with minute spines. Greyish, mottled with light and splashed with dark brown.

The hemispherical head of the cephalic spine is described as a capsular gland, the front of which is covered with a silvery or nacreous integument, with an aperture in the centre communicating with the interior and surrounded by a black ring. It is evidently the same structure which I have described in *Ceratias bispinosus*, and adapted for the same function. It is phosphorescent, and probably illuminates the play of the tentacles which serve to allure other creatures.

Ceratias, Kröyer.

Pediculates without ventral fins and with two gills and a half only; no pseudobranchiæ. Head very large; body and tail short; eyes small. Mouth large, with the mandible projecting. Jaws armed with a series or narrow band of depressible teeth of various lengths. Skin with dermal scutes or spinelets. The spinous dorsal fin reduced to one or two spines, which are generally modified into tentacles, and sometimes provided with an accessory luminous apparatus. The soft dorsal and anal short.

The species may be arranged in the following order:—

I. Two cephalic spines—*Ceratias* (*Diceratias*) *bispinosus*.

II. One cephalic spine.

- A. A second spine on the back, with lateral caruncles; no vomerine teeth—*Ceratias* (*Ceratias*) *holbölli*.
- B. No spine on the back; with caruncles.
  1. Caruncles placed at a distance from the soft dorsal.
     - *a.* Two caruncles only; no vomerine teeth—*Ceratias* (*Mancalias*) *uranoscopus*.
     - *b.* Three caruncles; vomerine teeth?—*Ceratias* (*Typhlopsaras*) *shufeldti*.
  2. Caruncles placed immediately in front of the soft dorsal.
     - *a.* Terminal cephalic joint very short—*Ceratias* (——) *carunculatus*.
     - *b.* Terminal cephalic joint long—*Ceratias* (*Cryptopsaras*) *couesii*.

Ceratias bispinosus, n. sp. (Pl. XI. fig. B).

D. 1 | 1 | 6. A. 4. C. 9. P. 14.

Similar in general appearance to *Ceratias johnsonii*, but the whole body covered with minute prickles, giving a velvety appearance to the skin. The dentition is also very similar, but the teeth in the upper jaw are less numerous and form a single series only. The vomerine teeth form also a transverse series, but the teeth are not implanted on an elevated ridge as in *Ceratias johnsonii*, and the series is interrupted in the middle. Eye small; a perforated nasal tube in front of the eye close to the base of the maxillary; each frontal bone is armed with a short conical spine situated above the eye. The upper surface of the head is concave, and in the interorbital groove there are implanted the two tentacles to which the anterior dorsal fin is reduced. The anterior is stout, half the length of the head, terminating in a fleshy lentil-shaped knob, which is fringed along its edges; the second spine is rudimentary, situated immediately behind the first. Dorsal and anal fins close to the caudal; caudal half as long as the remainder of the fish, composed of bifid rays, the rays of the other fins being simple. Base of the pectoral fin enveloped in skin; it is of moderate length, situated above the gill-opening. The whole fish is brownish-black, with the exception of the vertical fins, which are white.

Habitat.—Off Banda Island, Station 194A; depth, 360 fathoms. One specimen, $3\frac{1}{2}$ inches long.

Gills two and a half. The top of the knob at the end of the dorsal tentacle encloses a cavity which is covered by a smooth cornea-like membrane, very different from the velvety integument of the body of the knob. The membrane is perforated on the left side by a wide pore (fig. *b*).

Ceratias holboelli.

Ceratias holbölli, Kröyer, Nat. Hist. Tidsskr., 1874, i. p. 639; and in Gaimard, Voy. Skand. Poiss., pl. ix.

" " Lütken, K. dansk. Vidensk. Selsk. Skriv., 1878, xi. p. 326 (skel.).

D. 1 | 1 | 4. A. 4. C. 8. P. 19.

Body rather compressed, short. Mouth subvertical, of moderate width, with projecting mandible. Jaws armed with rasp-like depressible teeth of different lengths, in several series; palatines and vomer toothless. Cephalic spine very long, as long as the body, a short distal portion connected with the rest by a joint. A second long spine on the back, with a dermal caruncle on each side. Skin with small scutes which are separate from each other. Black.

Three specimens, from 18 to 28 inches long, were obtained off the coast of Greenland.

Ceratias uranoscopus (Pl. XI. fig. C).

Ceratias uranoscopus, Murray, in Wyv. Thomson, The Atlantic, vol. ii. p. 67.
Mancalias uranoscopus (Gill), Goode, Proc. U.S. Nat. Mus., vol. iii., 1881, p. 469.

D. 1 | 3–4. A. 4. C. 8. P. 10.

Body and head much compressed; skin finely granular, with scattered minute spinelets of equal size. Cleft of the mouth vertical. The upper end of the maxillary with a projecting triangular spine, pointing upwards and forwards. Small pores are scattered over the whole body. Eye rudimentary. The first dorsal spine extends to the end of the caudal fin, its distal portion being attached to the rest by a joint. No second dorsal spine between the pair of claviform tentacles. Gill-opening rather nearer to the end of the snout than to the end of the caudal fin. Uniform black.

Minute foramina or pores may be seen scattered over the body, together with extremely fine and soft tentacles of a white colour. These tentacles are so perishable that the slightest touch removes them, and they are preserved in our specimen only on some parts of the body. The specimen is not well enough preserved to make out whether they rise from the bottom or the circumference of the pore. I have noticed one, two, or three tentacles attached to one pore. I cannot detect terminal pores on the caruncles, although they are probably present.

Habitat.—North Atlantic, Station 89; depth, 2400 fathoms. One specimen, $3\frac{1}{4}$ inches long.

A much larger example ($9\frac{1}{2}$ inches long) was obtained by the U.S. Fish Commission on the south coast of New England, at a depth of 372 fathoms. It has not been described, which is to be regretted, as in so large an example many points might be cleared up which must remain obscure and uncertain in a small, indifferently preserved example, like that of the Challenger Expedition.

Ceratias shufeldti.

Typhlopsaras shufeldti (Gill) Jordan, Catal. Fish. N. Amer., p. 138.

D. 1 | 0 | 4. A. 4. C. 8. P. 4 or 5.

Trunk elongate, back rectilinear. Cephalic spine long, the basal shaft reaching the dorsal fin, and the knob of its distal joint the caudal; knob pear-shaped, without tentacles. A pair of dermal caruncles, with an intermediate single one at some distance in advance of the dorsal fin. Skin ? Vomerine teeth ?

No information is given as regards the length of the specimen, which was obtained in the Atlantic by the U.S. Fish Commission steamer "Albatross."

Ceratias carunculatus, n. sp. (Pl. XI. fig. D).

D. 1 | 0 | 4. A. 4. C. 8. P. 12.

This species is rather short, with the upper profile obliquely descending towards the front as well as the caudal fin. The branchial opening is midway between the end of the snout and the root of the caudal. Vent a little to the left of the median line of the abdomen. Eye rudimentary. Cleft of the mouth subvertical, not of excessive width. The skin is densely covered with minute prickles of equal size, and pores are scattered irregularly over the trunk and tail.

The first dorsal spine or tentacle is inserted between the eyes, directed forwards, and having suspended from a very short distal joint a comparatively large lemon-shaped body; this tentacle scarcely extends beyond the end of the snout. Instead of a second dorsal spine, a soft pear-shaped caruncle is developed, which differs from the two claviform appendages between which it is placed in size only, being about twice as large. Each of these three caruncles has a pore at its top. The other fins do not show any peculiarity. Uniform black.

Habitat.—South of Yeddo, Station 232; depth, 345 fathoms. One specimen, $1\frac{1}{2}$ inch long.

The specimen is figured of twice the natural size.

A fish shortly characterised in Jordan's Catalogue of the Fishes of North America, p. 138, is closely allied to this species, if not identical with it.

Cryptopsaras couesii (Gill). Trunk shortened, back longitudinally convex; basal joint of the anterior spine concealed and procumbent; terminal joint elongate, reaching backwards to the dorsal tubercles; the bulb is pyriform and surmounted by a long whitish filament. A large intermediate globular and a pair of subpedunculated lateral dorsal appendages near the front of the dorsal fin. D. 4. A. 4. p. 15. The specimen was obtained by the U.S. Fish Commission steamer "Albatross." The size is not stated.

Oneirodes, Lütken.

Head very large, body short and naked. Cleft of the mouth oblique, with depressible teeth, unequal in size, in the jaws. A cephalic and dorsal spine. The soft dorsal and anal fins short. Ventrals none. Gills two and a half.

Oneirodes eschrichtii.

Oneirodes eschrichtii, Lütken, Oversigt K. D. Vid. Selsk. Forhandl., 1871, p. 56, tab. ii.

D. 1 | 1 | 6. A. 4. C. 8.

Body short, with convex upper profile. Cleft of the mouth rather oblique;[1] teeth of moderate and unequal size, in a single series in the upper jaw; vomerine teeth. Cephalic spine about one-fourth of the total length (without caudal), with a knob at its extremity which (is luminous and) bears various short tentacles. A second thick and flaccid spine on the top of the back, rather longer than the first. A short conical spine above each eye, and another at the posterior end of the mandible. Black.

One specimen, 8 inches long, obtained off the coast of Greenland, has been described in detail by Lütken.

Melanocetus, Gthr.

Head and body rather compressed; head and cleft of the mouth enormous; trunk and tail comparatively short and small. Eyes very small. Mouth vertical, jaws armed with rasp-like depressible teeth of different lengths; vomer toothless or armed with similar teeth. Skin smooth, soft, and thin. The spinous dorsal is reduced to a single filament on the head. The soft dorsal and anal short. Ventrals none. Gills two and a half.

Two species are known:—

1. Vomerine teeth present—*M.* (*Melanocetus*) *johnsonii.*
2. Vomerine teeth absent—*M.* (*Liocetus*) *murrayi.*

Melanocetus johnsonii.

Melanocetus johnsonii, Günth., Proc. Zool. Soc. Lond., 1864, p. 301, pl. xxv.
" " Lütken, Oversigt K. D. Vid. Selsk. Forhandl., 1871, p. 74; or Ann. and Mag. Nat. Hist., 1872, vol. ix. p. 343.

B. 6. D. 1 | 14. A. 4. C. 8. P. 18.

Vomer armed with a transverse series of teeth similar to those of the jaws. Length of the maxillary at least one half of the total length, without caudal. Black.

One specimen only is known, $3\frac{8}{10}$ inches long; it was obtained by Mr. Johnson at Madeira, and had in its stomach, rolled up spirally into a ball, a Scopelus which measured $7\frac{1}{2}$ inches in length, and 1 inch in depth.

[1] Lütken describes it as horizontal, but it is evident from the figure that the lower jaw is turned upwards when the mouth is shut.

Melanocetus murrayi, n. sp. (Pl. XI. fig. A).

D. 1 | 13. A. 4. C. 9. P. 14.

Extremely similar to *Melanocetus johnsonii*, but, singularly, there is no trace of vomerine teeth, whilst there is no distinction between the two species as regards the dentition of the jaws. The posterior angle of the mandible projects more and forms a salient point. The mouth is comparatively less wide, and the maxillary considerably shorter, being about two-fifths of the total length, without caudal, whilst it is rather more than one-half in the Madeiran species. Eye rudimentary. One cephalic spine, which is shorter than the maxillary. The last dorsal ray is connected by a short and delicate membrane with the caudal fin; most of the caudal rays are bifid, the longest shorter than the maxillary. Pectoral fin as much developed as in *Melanocetus johnsonii*. Entirely black.

Total length,	44	lines.
Length of mandible,	14	„
Length of maxillary,	12	„
Length of caudal fin,	10½	„

Habitat.—Mid-Atlantic, Station 106; depth, 1850 fathoms. One specimen, 44 lines long.

Mid-Atlantic, Station 348; depth, 2450 fathoms. One specimen, 13 lines long.

In the young specimen the dorsal filament is already of the same relative length as in the old one.

Linophryne, Collett.

This genus differs from *Melanocetus* in possessing a long tentacle at the throat.

Linophryne lucifer.

Linophryne lucifer, Collett, Proc. Zool. Soc. Lond., 1886, p. 138, pl. xv.

D. 1 | 3. A. 2. C. 9. P. 14–15.

A spinous projection above each orbit. Cephalic tentacle black, with a large ovate bulb, the upper half of which is white; gular tentacle much longer, terminating in two tongue-like appendages, which are furnished on the upper edge with a row of round white papillæ.

One specimen, 1¾ inch long, was found floating on the surface off Madeira, in lat. 36° N., long. 20° W.

Chaunax, Lowe.

Head very large, depressed; cleft of the mouth wide, subvertical. Skin covered with minute spines. Jaws and palate armed with bands of small teeth. The spinous dorsal fin is reduced to a short spine above the snout. The soft dorsal of moderate length, anal short; ventrals developed. Gills two and a half; pseudobranchiæ none.

The fourth branchial arch does not bear a gill, but its integument is dilated, and forms a broad fold along its convex margin. The dorsal spine with the terminal tentacle can be entirely received into the grove behind it; the tentacle is fleshy, double-heart-shaped, and covered with delicate filaments of a white colour.

Chaunax pictus (Pl. X. fig. A).

Chaunax pictus, Lowe, Trans. Zool. Soc. Lond., vol. iii. p. 339, pl. li.
" " Günth., Fish., iii. p. 200.
" " Goode, Proc. U.S. Nat. Mus., vol. iii., 1881, p. 470.
" *fimbriatus*, Hilgendorf, Sitzungsb. Gesellsch. naturf. Freunde, 1879, p. 80.
" " Steindachner und Döderlein, Denkschr. d. k. Akad. d. Wiss. Wien, xlix., 1884, p. 194.

The specimens of this fish have been obtained at very distant localities. It was first discovered at Madeira by Mr. Lowe and subsequently by Mr. Johnson. A single specimen forms part of the Challenger collection, and was obtained near the Fiji Islands, at Station 173, from a depth of 315 fathoms. Hilgendorf and Döderlein record its existence in the Sea of Japan, considering the specimens to be a distinct species (*Chaunax fimbriatus*). Finally the U.S. steamer "Fish Hawk" obtained a single small specimen on the south coast of New England in 192 fathoms.

All these specimens I consider to belong to one and the same species. The specimen from the Fiji Islands differs only in the colour of the rostral tentacle and of the grove into which it is received; these parts are black in the Atlantic specimens, and of the same colour as the body in the Fiji Island example. The latter has, in common with the Japanese specimen, the lower parts of the muciferous ducts fimbriated with very delicate and short tentacles, of which only a few are to be observed in Madeiran specimens. With regard to other characters on which the Japanese species was separated, I have to observe that seven anal rays and round yellow spots occur also in Atlantic specimens, and that the width of the interorbital space is equal to two diameters of the eye, if the soft prickly non-transparent skin above the eye be taken as part of the interorbital space.

Habitat.—Off Matuku, Fiji Islands, Station 173; depth, 315 fathoms. One specimen $7\frac{3}{4}$ inches long.

Halieutæa, C. V.

The well-known species from China and Japan, *Halieutæa stellata*, is the only representative of this genus that was hitherto known. That a second species should be discovered in the Atlantic, can hardly excite any surprise in those who have paid attention to the distribution of the marine fishes of the Japanese Fauna. But we should not have expected to find that, while the Indo-Pacific species is evidently a littoral fish, or at least one which is readily obtained by the ordinary means of fishermen, its newly discovered Atlantic representative is an inhabitant of a depth of more than 200 fathoms. No special modification indicative of bathybial habits has been pointed out in the Atlantic species.

Halieutæa senticosa.

Halieutæa senticosa, Goode, Proc. U.S. Nat. Mus., vol. iii., 1881, p. 467.

D. 1 | 6. A. 4. C. 8. V. 5. P. 13–15.

The width of the mouth is equal to the distance between the centres of the eyes. Disk with a marginal series of closely set spines; outside of the marginal spines a row of five depressed, knife-like spines, each with a crown of three spinelets; these two rows coalesce on the front edge of the disk.

Five specimens, $2\frac{1}{2}$ to $5\frac{1}{2}$ inches long, were obtained by the U.S. Fish Commission on the south coast of New England, at depths varying from 225 to 238 fathoms.

Dibranchus, Ptrs.

Differs from *Halieutæa* by having only two gills.

Dibranchus atlanticus.

Dibranchus atlanticus, Peters, Monatsber. d. k. preuss. Akad. d. Wiss., Berlin, 1875, p. 738, c. Tab.

B. 6. D. 6–7. A. 4. C. 9. P. 10–14. V. $\frac{1}{5}$. Vert. $\frac{6}{12}$.

The larger tubercles with from seven to ten ridges. Brown above, whitish below.

Four specimens, $3\frac{1}{4}$ inches long, were obtained off the west coast of Africa in lat. 10° 12′ N., long 17° 25′ W., at a depth of 3600 fathoms.

Family COTTIDÆ.

Cottunculus, Collett.

The first species discovered of this genus, viz., *Cottunculus microps*, seemed to differ so much from *Cottus*, especially by its enormously developed head, that a generic separation appeared to be well justified. To the very aberrant shape of the head there were added some other distinctive characters, viz., the connection of the two dorsal fins by a broad membrane, and the slight development of the spines of the gill-covers, which do not penetrate the thick skin.

The combination of these characters is not maintained in the second species, *Cottus thomsonii*, which has united dorsals and small spines, but the typical Cottoid shape of the head and body. In fact it connects *Cottunculus* with *Cottus*, so that the former can only be retained as a group of the latter genus, characterised by the union of the dorsal fins and division of the vomerine teeth into two groups.

Cottunculus microps (Pl. IX. fig. A).

Cottunculus microps, Collett, Norges Fisk., p. 20; Forh. Vid. Selsk. Christian., 1880, p. 11; Norsk. Nordh. Exped. Fisk., p. 18, pl. i. figs. 5–6; Nyt Mag. f. Naturvid., vol. xviii., 1884, p. 53.
„ „ Strom, Norsk. Vid. Selsk. Skrift., 1880, p. 75.
„ „ Goode, Proc. U.S. Nat. Mus., vol. iii., 1881, p. 479; Bull. Mus. Comp. Zoöl., vol. x., 1883, p. 212.
„ „ Lilljeb., Sverig. och Norg. Fisk., p. 113.

This fish has been fully described by Collett, who examined specimens from the open sea, south and west of Spitzbergen, dredged at depths varying between 200 and 460 fathoms. The species occurs also on the coast of Norway at depths of from 80 to 200 fathoms. Specimens of various ages, the largest $9\frac{2}{3}$ inches long, were obtained during the exploration of the Faröe Channel by the "Knight Errant," at Stations 4, 8 and 9, at depths varying between 307 and 608 fathoms. The species seems to be also common in the western parts of the North Atlantic, off the coast of New England, where it was found in depths of from 238 to 372 fathoms. Our specimens show very little variation among themselves. The two occipital prominences are sometimes compressed and truncated, in other specimens more or less distinctly bicuspid. In an adult male the black bands are more clearly defined, and of a deeper colour, than in the female figured, or in the young. Also the caudal, anal and pectoral fins are black, with white margins.

Cottunculus thomsonii (Pl. IX. fig. B).

Cottus thomsonii, Günth., Proc. Roy. Soc. Edin., vol. xi., 1882, p. 679.
Cottunculus torvus, Goode, Bull. Mus. Comp. Zoöl., vol. x., 5, 1883, p. 212.

D. $\frac{5}{17}$. A. 13. P. 22.

Like the typical species of *Cottunculus*, the present has the two dorsal fins enveloped in a common and cutaneous fold, so that the division between them can be ascertained only by dissection. But the head is much more depressed (as in an ordinary *Cottus*), and the skin is apparently quite smooth and rather loose, minute granules being scattered over the back. The protuberances on the various bones of the head are arranged as in *Cottunculus microps*, those of the præoperculum slightly piercing the skin, whilst those on the top of the head are comparatively less developed. The head is much wider than deep, its greatest width being rather less than its length, which is contained twice and two-thirds in the total, without caudal. The eye equals the length of the snout, and is a little less than one-fourth of that of the head. The bony portion of the interorbital space is flat, less wide than the orbit; and the quadrangular space enclosed by lines connecting the four projections on the top of the head is nearly twice as long as broad.

Mouth wide, with projecting lower jaw, and with the maxillary not quite reaching to below the middle of the eye. Vomerine teeth separated in the middle, each half forming an elongate oval patch. Gill-membrane confluent with the isthmus opposite to the lowermost pectoral ray.

The dorsal fin commences above the gill-opening, and is rather low in its anterior portion; the soft rays are more distinct externally than the spinous, and much longer, this part of the fin being about as high as the body underneath is deep. The anal fin is much lower and commences at some distance behind the vent. Caudal fin narrow at the base, half as long as the head, subtruncated, with rounded corners. Pectorals extending nearly to the origin of the anal; ventrals small and not reaching to the vent.

The colour is now of that dirty whitish tint into which the pink hue of many fishes changes after death; and it is probable that this species is red during life; the fins have a greyish shade.

Total length, ...	86 lines.
Length of head, ...	26 „
Distance of snout from vent, ...	34 „
Distance of snout from anal fin, ...	42 „
Length of caudal fin, ...	$13\frac{1}{2}$ „
Length of ventral fin, ...	$8\frac{1}{2}$ „

Habitat.—Faröe Channel, Station 4 "Knight Errant," August 10, 1880; depth, 535 fathoms. One specimen, $7\frac{1}{4}$ inches long.

Cottus, Art.

Cottus bathybius (Pl. X. fig. C).

D. 5 | 10. A. 7. P. 17. V. 3.

The præoperculum is very strongly armed; there are two spines arising from the same root at the angle, one in front of the other, the posterior being longer than the eye; three other shorter spines along the lower edge of the præoperculum; operculum with a small spine at its antero-inferior angle. A pair of spines on the occiput behind a deep depression occupying nearly the whole of the vertex. Eyes longer than the snout, close together. Minute teeth on the vomer, but none on the palatine bones. Tail much attenuated. Pectoral fin extending beyond the origin of the anal; ventrals not reaching the vent. Second dorsal fin higher than first; length of the caudal two-fifths of that of the body (without head). Muciferous system much developed, opening by wide pores along the lower jaw, the præoperculum, the infraorbital ring and the lateral line. Greyish-brown; throat and all the fins black.

Habitat.—South of Yeddo, Japan, Station 235; depth, 565 fathoms. One specimen, $2\frac{1}{2}$ inches long.

It may appear matter for surprise to find a species of *Cottus* at so great a depth as 560 fathoms, and at first it did not seem to me improbable that the specimen accidentally entered the mouth of the dredge whilst it was near the surface. However, on further consideration these doubts disappeared, as it is not very likely that a fish living habitually at the bottom, as a *Cottus* must do, should be found floating far from land; moreover, the muciferous system is developed to an extraordinary degree, much more so than in the littoral species of the genus.

Centridermichthys, Richards.

Centridermichthys uncinatus.

Cottus uncinatus, Reinh., Vid. Selsk. Natur. och Math. Afhandl., 1833, p. xliv.
„ *bicornis*, Reinh., *loc. cit.*, viii. p. lxxv.
Centridermichthys uncinatus (Günth.), Collett, Norsk. Nordh. Exped., Fisk., p. 29, tab. i. fig. 7; Forh. Vid. Selsk. Christian., 1880, p. 14; Nyt Mag. f. Naturvid., xviii., 1884, p. 54.
„ „ Lütken, Kara-Havets Fisk. in Dijmphna-Togtet., p. 124.
„ „ Lilljeb., Sverig. och Norg. Fisk., p. 161.

An Arctic littoral species, more or less common in the sea between Greenland, Spitzbergen, Nova Zembla, and Norway, extending in the western part of its range southwards to the coast of New England. The Norwegian North Atlantic expedition has obtained specimens down to 223 fathoms (off Bear Island), and, therefore, the species is included in this Report. As bathybial characters, the width of the pores of the muciferous system and the relatively large eye may be mentioned.

Icelus, Kröy.

Icelus hamatus.

Icelus hamatus, Kröy., Nat. Hist. Tidsskr., 1844, i. p. 253.
" " Collett, Norges Fisk., p. 35; Forh. Vid. Selsk. Christian., 1880, p. 14; Norsk. Nordh. Exped. Fisk., p. 34, tab. i. fig. 8; Nyt Mag. f. Naturvid., xviii., 1884, p. 56.
" " Lütken, Kara-Havets Fisk. in Dijmphna-Togtet., p. 123.
" " Lilljeb., Sverig. och Norg. Fisk., p. 164.
" " Strom, Norsk. Vid. Selsk. Skrift., 1884, p. 18.
Icelus furciger, Malm, Förh. Skand. Naturf. 9 Möte., 1865, p. 410.

This common Arctic species is found at small depths; of late years it has been frequently found on the Norwegian Coast in 50–250 fathoms. Lütken examined numerous examples from 46 to 106 fathoms, obtained in the Kara Sea.

Triglops, Reinhardt.

Triglops pingelii.

Triglops pingelii, Reinh., Vid. Selsk. Natur. och Math. Afhandl., 1838, pp. 114, 118.
" " Günth., Proc. Zool. Soc. Lond., 1877, p. 475.
" " Collett, Norges Fisk., p. 36; Norsk. Nordh. Exped. Fisk., p. 38, pl. i. figs. 9, 10.
" " Lilljeb., Sverig. och Norg. Fisk., p. 168.
" *pleurostictus*, Cope, Proc. Acad. Nat. Sci. Philad., 1865, p. 81.

An Arctic species, not very common near the coast-lines of Greenland, Nova Zembla, Norway, and extending in the West Atlantic southwards to the latitudes of New England. It prefers water of about 20 fathoms, but descends to 263 fathoms.

Trigla, Art.

Trigla leptacanthus.

Trigla leptacanthus, Günth., Report on the Shore Fishes, Zool. Chall. Exp., part vi. p. 42, pl. xviii. fig. B.

Habitat.—Ki Islands, Station 192; depth, 140 fathoms. One specimen.

Lepidotrigla, Gthr.

Lepidotrigla spiloptera.

Lepidotrigla spiloptera, Günth., Report on the Shore Fishes, Zool. Chall. Exp., part vi. p. 42, pl. xviii. fig. C.

Habitat.—Ki Islands, Station 192; depth, 140 fathoms. One specimen.

Family Cataphracti.

Peristethus, Lacép.

The Mailed Gurnards are eminently bottom-fishes, which rise to the surface still more rarely than the true Gurnards. Some of the species have been lately discovered in deep water; probably all will be found to descend to considerable depths.

Peristethus miniatum.

Peristidium miniatum, Goode, Proc. U.S. Nat. Mus., vol. iii., 1881, pp. 349, 480; Bull. Mus. Comp. Zoöl., vol. x., 1883, p. 212.

D. 7–8/18. A. 17–18. L. lat. 27–28.

Very similar to, and with regard to armature agreeing with, the West Indian *Peristethus brevirostre*, but described as having four series of spiny plates on each side; the spines of the abdominal plates very weak posteriorly. The length of the præorbital processes is thrice and a half in the distance between their extremities and the anterior margin of the orbit. A single pair of spines on the upper surface of the snout. Interorbital space deeply concave. The ridge of the præoperculum terminates posteriorly in a depressed, short, sharply-pointed spine. Lower jaw with small tentacles on each side. The long tentacles at the angle of the mouth are fringed, and reach to the base of the pectorals. Crimson.

Several specimens were taken by the U.S. steamers between lat. 32° and 40° N., long. 70° and 79° W., in the Gulf Stream, at depths varying from 115 to 192 fathoms.

Peristethus moluccense, Blkr.

Found in various parts of the East Indian Archipelago, and discovered by the Challenger in 140 fathoms, at the Ki Islands, Station 192.

Peristethus murrayi.

Peristethus murrayi, Günth, Report on the Shore Fishes, Zool. Chall. Exp., part vi. p. 52, pl. xxxii. fig. A.

Discovered by the Challenger in the Sea of Banda, at a depth of 200 fathoms.

Peristethus liorhynchus.

Peristethus liorhynchus, Günth., Report on the Shore Fishes, Zool. Chall. Exp., part vi. p. 56.

First found at Manado, and rediscovered by the Challenger at the Admiralty Islands, in 152 fathoms.

Peristethus micronema.

Peristedion imberbe, Poey, Repert. Fis. Nat. Cuba, ii. pp. 158, 462.
Peristedion micronemus, Poey, Ann. Lyc. Nat. Hist. New York, ix. p. 321.

This species must inhabit the same depth as *Polymixia nobilis*, as Poey found it in the stomach of a specimen of that fish. He considers it as a distinct species characterised by the minute size of the mandibulary tentacles.

Peristethus truncatum.

Peristethus truncatum, Günth., Report on the Shore Fishes, Zool. Chall. Exp., part vi. p. 7.

In the Report on the Challenger Shore Fishes, p. 7, this species was described from the coast off Pernambuco; but it was stated to be uncertain whether the fish was caught in 30 or 350 fathoms.

Agonus, Bl. Schn.

Agonus decagonus.

Agonus decagonus, Bl. Schn., p. 105.
Aspidophorus spinosissimus, Kröyer, Nat. Hist. Tidsskr., i., 1844, p. 250; Gaimard, Voy. Scand., pl. v.
,, *malarmoides*, Deslongch., Mém. Soc. Linn. Norm., vol. ix., 1853, p. 167.
Agonus decagonus, Collett, Norges Fisk. p. 40; Norsk. Nordh. Exped. Fisk., p. 44, pl. ii. figs. 11–12.
,, ,, Lilljeb., Sverig. och Norg. Fisk., p. 193.

An Arctic littoral species, extending from the coasts of Greenland and Newfoundland to Iceland, Spitzbergen and Norway, and descending to a depth of 260 fathoms.

Family Discoboli.

Cyclopterus, Artedi.

The common Lump-sucker, *Cyclopterus lumpus*, is a shore fish, and has never been observed to go into deep water, whilst its more northern representative (*Cyclopterus spinosus*), like many other Arctic species, descends into the frigid strata of the deep sea.

Cycloptera spinosus.

Cyclopterus spinosus, Müll., Prodr., p. ix.
" " Gaimard, Voy. Scand. Poiss., pl. iv. fig. 2.
" " Günth., Fish., vol. iii. p. 157; Proc. Zool. Soc. Lond., 1877, p. 293 (fig. of young), and p. 475.
" " Jordan and Gilbert, Synopsis, p. 746.
Eumicrotremus spinosus (Gill), Collett, Norsk. Nordh. Exped. Fisk., p. 67, pl. ii. fig. 13.

This species extends from the southern coast of Greenland to lat. 82° N., and has been obtained by the North Atlantic Expedition at a depth of 129 fathoms. If Collett's supposition, that the number of dorsal rays varies in this species between nine and twelve, be confirmed by a more extensive series of examples, *Cyclopterus orbis*, from the North Pacific, would probably prove to be the same species.

Liparis, Art.

Liparis fabricii.

Liparis fabricii, Kröyer, Nat. Hist. Tidsskr., ii., 1847, p. 274.
" " Lütken, Kara-Havets Fisk. in Dijmphna-Togtet, p. 146, tab. xv. figs. 4–5.

The only record of the occurrence of this common Arctic littoral species beyond the 100 fathoms line is by Lütken, who states that he received a great number of specimens from the Kara Sea, where they were obtained at depths varying from 46 to 106 fathoms.

Liparis micropus, n. sp. (Pl. XII. fig. B).

D. 35–37. A. 35–36.

This species approaches in some respects the genus *Careproctus*, having the tail particularly attenuated, and the ventral disc of unusually small size. The head is large and thick, about one-fourth of the total length, the caudal included. The interorbital space equals in length the postorbital portion of the head. Eye entirely in the anterior half of the head and one-fifth of its length. Nostrils not tubulated. Cleft of the mouth not extending to the front margin of the eye. Teeth simple, unicuspid.

Vertical fins continuous, caudal very narrow and pointed. The origin of the anal is opposite to the eighth dorsal ray. Form of the pectoral typical, the foremost rays being opposite to the anterior margin of the ventral disc. Ventral disc circular, small, one-fourth of the length of the head, situated immediately behind the level of the eye. Vent very close to ventral disc. Colour light greyish or purplish.

Habitat.—"Knight Errant," 1882, Station 9; depth, 608 fathoms. Two specimens, 2 and 3½ inches long.

"Knight Errant," 1880, Station 8; depth, 540 fathoms. One specimen, 3½ inches long.

A specimen obtained on the cruise of the "Porcupine" in 180 fathoms, north of Shetland, was referred by me to *Liparis liparis*, to which it probably belongs; it is, however, in too bad a state of preservation to be identified with certainty.

Liparis gelatinosus.

Cyclopterus gelatinosus, Pall. Spicil., vii. p. 19, tab. iii.
Liparis gelatinosus (Cuv.), Reinh., Oversigt K. D. Vid. Selsk. Forhandl., 1843, p. lxxvii.
„ „ Günth., Fish., vol. iii. p. 163 (translat. Pall.).[1]
„ (*Careproctus*) *reinhardi*, Kröyer, Nat. Hist. Tidsskr., i., 1862, p. 252.
„ „ „ Collett, Norsk. Nordh. Exped. Fisk., p. 57, pl. ii. figs. 15–16.
„ „ „ Jordan and Gilbert, Synopsis, p. 740.
„ „ „ Lütken, Kara-Havets Fisk. in Dijmphna-Togtet, p. 152.

D. 54–55. A. 45–46. C. 11–14. P. 32–33. Vert. 64. Cocc. pyl. 48.

Tail very long and attenuated. Ventral disk very small, scarcely larger than the eye, immediately below the front part of which it is placed. Pectorals deeply notched, extending forwards to the mandibulary symphysis. Vent close to the disk. Skin glutinous; body semitransparent. Abdominal cavity black.

An Arctic circumpolar species, first described from the North Pacific (Behring's Strait), afterwards found on the Greenland coast, and recently discovered by the North Atlantic Expedition about Jan Mayen and Bear Island, and off Arendal, at depths varying between 263 and 658 fathoms; also found in the Kara Sea.

[1] This work has been referred to by Collett in a somewhat singular manner. As no specimen of *Liparis gelatinosus* was in the British Museum at the time of the publication of the third volume of the Catalogue, a literal translation of Pallas and Steller's account was given, and stated to be such. Yet Collett quotes the translation with the addition of a ? rather than the original authors! Jordan also adds a mark of interrogation to his quotation of the Catalogue, but this must have been an oversight, as his diagnosis is shaped after the one given in that work.

Paraliparis.

Paraliparis, Collett, Norsk. Nordh. Exped. Fisk., p. 53.
Monomitra, Goode, Proc. U.S. Nat. Mus., vol. vi., 1884, p. 109.

General shape of the body and head as in *Liparis*, the skin being very loose, thin, and easily torn. The peculiar posterior process of the infraorbital ring, the structure of the vertical fins, and the dentition are also the same as in *Liparis*. But the ventral fins are absent, and the lower rays of the pectoral fin are entirely detached from the others, or nearly so.

Paraliparis bathybius (Pl. XII. fig. C).

Liparis (*Paraliparis*) *bathybii*, Collett, Norsk. Nordh. Exped. Fisk., p. 52, pl. ii. fig. 15.

D. 60. A. 50. P. 12/3.

The specimen obtained by the "Knight-Errant" is of the same size and sex as the typical example, and also in a rather indifferent condition, nearly the whole body being denuded of skin. Fortunately those parts about which Collett's description leaves us in doubt, are well enough preserved to confirm his supposition that this fish is the type of a distinct genus. The ventral disc, or indeed any external trace of ventral fins, is absent, and the lower portion of the pectoral fin is separated from the upper by a smooth space without any of those intermediate filaments which are shown in Collett's figure. The three lower rays[1] are connected by membrane to their tips, and form a fin by themselves. The posterior part of the vertical fins is also less elevated, the rays being directed more backwards. The vent occupies a similarly advanced position as in *Liparis*. Our specimen is distended with apparently mature ova of the size of hemp-seed, as was the case in the type.

Habitat.—"Knight-Errant," Station 8, 1882; depth, 640 fathoms. One specimen, $7\frac{1}{2}$ inches long.

Collett's specimen was obtained in 658 fathoms, 108 kilometres west of Bear Island.

Paraliparis liparinus.

Amitra liparina, Goode, Proc. U.S. Nat. Mus., vol. iii., 1881, p. 478.
Monomitra liparina, Goode, *loc. cit.*, vol. vi., 1884, p. 109.

D. 67. A. 54. C. 6. P. 17/6.

Similar in form to *Paraliparis bathybius*, but with thick, lax, slimy skin. Teeth weak, paved. The dorsal fin begins over the end of the pectoral; and the anal under the eighth or tenth doral ray. Yellowish-white, dusky towards the tail and on the head.

[1] The number of fin-rays forming the detached portion of the pectoral fin is three only, and not more, as would appear from the figure, in which the artist has represented the external folds of the skin, which loosely envelops the three rays.

Two specimens were obtained, of which the larger is 7 inches long, by the U.S. Fish Commission, off the coast of New England, in 487 fathoms.

There are certain discrepancies between the description of this species and of the European specimens of the genus which made me long hesitate before referring them to the same genus. Goode says that pseudobranchiæ are present; Collett denies this, and in our specimen of *Paraliparis bathybius* they are certainly absent. The teeth are pointed in *Paraliparis bathybius*, and described as paved in *Paraliparis liparinus*. Finally, Goode does not remark upon the isolation of the lower pectoral rays which is so conspicuous in our specimen, although it should be remembered that Collett believes that he noticed intermediate rays in his example, which, without doubt, is of the same species as the one figured in this work. On the other hand, the agreement in the majority of the other essential points is great, so that I prefer at present to leave the fishes in the same genus. Probably the statement so distinctly made by Collett, viz., that the ventral fins had been accidentally lost, as well as the black colour which gives to the European species a very different appearance, has prevented Goode from comparing his specimens with *Paraliparis*.

Paraliparis membranaceus, n. sp. (Pl. XII. fig. D).

D. ca 70. A. ca 70.

The specimen from which the following description is taken is only 60 mm. long, and therefore presumably young; and it is uncertain whether it represents a species in which certain embryonic characters are persistent, or merely an early stage of development.

Its head is large, compressed, about as high as long, with the upper profile descending in a parabolic curve. The abdominal cavity, black and transparent through the integuments, is excessively short; the tail compressed and gradually tapering into a fine point. The whole of the integuments are colourless; with minute scattered points of pigment. A broad median dorsal fold rises from the top of the snout and is continued to the extremity of the tail, gradually disappearing as it approaches the caudal fin, which is represented by two or three extremely fine and rather long terminal filaments. The fold is highest above the posterior portion of the abdomen; there also fin-rays commence to be developed, which on the anterior half of the tail are distinct enough, but become more crowded posteriorly and almost indistinguishable. The anal has a similar structure; it also starts as a fold from the vent, which is far advanced, opposite to the hind margin of the orbit; rays are developed from the posterior end of the abdominal cavity, whence the fin is continued in the same manner as the dorsal.

Pectoral fin very large, with a very broad base, extending from the upper end of the gill-opening forward nearly to the hyoid bone; its principal portion consists of an extremely delicate membrane, in which rays are visible like fine striæ, and which on its hinder margin is provided with long fringes. The eight lower or anterior rays are quite free but not separated by an interspace from the remaining part of the fin. The bones of the head are extremely thin, forming cavities on the top and the snout. The eye is of moderate size, about two-sevenths of the length of the head, a little shorter than the snout, and considerably less than the width of the interorbital space, which is very convex. Jaws even in front, the maxillary extending nearly to the hind margin of the orbit.

As described by Goode in *Paraliparis liparinus*, the gill-openings are closed below, and restricted to small slits below the operculum.

One specimen, $2\frac{1}{4}$ inches long, was obtained off Cape St. Vincent, Station 310, at a depth of 400 fathoms.

Family Gobiidæ.

Callionymus, L.

Callionymus kaianus.

Callionymus kaianus, Günth., Report on the Shore Fishes, Zool. Chall. Exp., part vi. p. 44, pl. xix. fig. B.

Habitat.—Ki Islands, Station 192; depth, 140 fathoms. One specimen.

Callionymus calauropomus, Rich.

Callionymus calauropomus, Günth., Report on the Shore Fishes, Zool. Chall. Exp., part vi. p. 53.

Habitat.—Philippine Islands, Station 204B; depth, 115 fathoms. One specimen.

Family Blenniidæ.

Anarrhichas, Art.

The common European Wolf-fish, *Anarrhichas lupus*, is a littoral species which does not extend so far northwards, or reach so great a depth as the two following North Atlantic forms, which are considered to be specifically distinct by all Scandinavian and North American authors.

Anarrhichas minor, Olafsen.

Anarrhichas pantherinus, Zouiew.
Anarrhichas egerti, Steenstrup.
Anarrhichas minor, Collett, Forhandl. Vidensk. Selsk. Christ., 1880, p. 45.
" " Lilljeb., Sverig. och Norg. Fisk., p. 540.

An Arctic species which in southern latitudes descends into deep water, having been found on the north-west coast of Norway in 200 fathoms. The British Museum has received from the Smithsonian Institution a specimen, which was captured at the same depth in lat. 43° 52′ N., long. 59° W.

Anarrhichas latifrons, Steenstrup.

> *Anarrhichas latifrons*, Collett, Forhandl. Vidensk. Selsk. Christ., 1880, p. 46, pl. 2.
> „ „ Lilljeb., Sverig. och Norg. Fisk., p. 540.

Likewise an Arctic species, which has been caught off Finmarken in 100 fathoms; but the British Museum has received from the Smithsonian Institution a specimen, which was caught in 280 fathoms, in lat. 42° 27′ N., long. 64° 20′ W.

Blenniops, Nilss.

Blenniops ascanii.

> *Blennius ascanii*, Walbaum, Art. renov., iii. p. 173.
> *Blenniops ascanii*, Günth., Fish., vol. iii. p. 284; and Ann. Mag. Nat. Hist., 1874, vol. xiii. p. 139.
> *Carelophus ascanii*, Strom, Norsk. Vid. Selsk. Skr. 1881, p. 75.
> „ „ Collett, Nyt Mag. f. Naturvid. Christ., xviii. 1884, p. 68.

This Blenny was obtained during the cruise of the "Porcupine" between Shetland and Faröe in 180 fathoms, and is recorded by Strom from 140 fathoms in Throndhjem Fjord.

Family TRACHYPTERIDÆ.

Although Ribbon-fishes are spread over the whole area of the tropical and temperate zones,[1] and must be very abundant in the abyssal fauna, nothing is known of their habits and their vertical distribution. Of the expeditions in which the deep-sea dredge or trawl has been used, the Challenger Expedition is the only one which obtained a single example, and that of very small size. Large and long individuals, of course, would easily escape, but one might have expected the capture of a certain number of young examples. It is not improbable that such small specimens were actually caught, but destroyed during the ascent of the dredge, as the fragile condition of their body can hardly be expected to resist the force and pressure of the current passing through the net. Adult specimens probably pass a great portion of their life on the bottom, but the not uncommon occurrence of young *Trachypteri* near the surface seems to indicate that they live at any depth where the water ceases to be affected by the surface agitation.

[1] It is noteworthy that no instances have been recorded of their occurrence on the western coasts of the Atlantic.

Trachypterus, Gouan.

A considerable number of species have been described, some of which are without doubt merely stages of growth, while others were described by authors who had no opportunity of comparing them with well-authenticated specimens. On the other hand, in a genus which seems to comprise a plurality of species, but in which the distinctive specific characters are obscured by a variety of circumstances, it is difficult to arrive at a satisfactory conclusion with regard to the validity of the species described. One of the most common and best known is the Vagmær or Deal-fish, *Trachypterus arcticus*, from the North Atlantic, of which almost every year one or more specimens are secured on the Norwegian and British coasts after severe gales. From the Mediterranean and neighbouring parts of the Atlantic several species have been described, viz., *Trachypterus tænia* (Bl.), of which, according to Emery, *Trachypterus filicauda* (Costa), *Trachypterus iris* (Walb.), and *Trachypterus spinolæ* (C. and V.), are successive stages of growth; *Trachypterus gryphurus* (Lowe); *Trachypterus liopterus* (C. and V.), *Trachypterus rüppellii*[1] (Gthr.); *Trachypterus cristatus* (Bonelli); and *Trachypterus repandus* (Metaxa, Costa). From Cuba a species is described as *Trachypterus trachyurus* by Poey, and one from the East Indian Archipelago as *Trachypterus semiophorus* by Bleeker. The instances of the occurrence of this genus in the Pacific are very few, viz., *Trachypterus altivelis* (Kner.), from Valparaiso, *Trachypterus weychardti* (Philippi), also from the Chilian coasts, and *Trachypterus arawatæ* (Clarke), from the coast of New Zealand.

The example in the Challenger collection is only $1\frac{1}{2}$ inches long, and was obtained at Station 207, near the Philippine Islands, when the dredge was used at a depth of 700 fathoms; but as this extremely delicate specimen was preserved in a tolerably good condition, it is probable that it entered the dredge at no great distance from the surface. It is extremely similar to the small *Trachypterus* figured by Costa (Faun. napol., Tab. ix.), under the name of *Trachypterus repandus*. It has the same shape of body, the same elongate caudal fin, and the anterior dorsal rays and ventral fins are prolonged in an extraordinary manner. Also the tail and body are ornamented with transverse dark spots similarly arranged. But the prolonged fin-rays are shorter than in *Trachypterus repandus*, and lack lobes of skin.

It seems to me that both these small individuals represent the young stage of species of *Trachypterus*, which, when older, lose the extraordinary development of their fin-rays. Probably the fish from the Philippine Islands is a species distinct from that

[1] The specific distinctness of this fish has also been doubted; and, therefore, I beg again to draw attention to the position of the first lateral black spot, in which the specimen differs from the other Mediterranean specimens of the same size which are known to me.

figured by Costa, but it is impossible to say whether it is the young of a species already known or of one peculiar to that part of the Indian Ocean.[1]

Stylophorus, Shaw.

This extraordinary type is still known from the single example only (*Stylophorus chordatus*) which was found at the beginning of this century between Cuba and Martinique. Since I examined this fish in 1860, it has so much deteriorated, that no further information can be gleaned from it beyond that which I gave in the Catalogue of Fishes, vol. iii. p. 306. It has recently been transferred from the Royal College of Surgeons to the collection of the British Museum.

Regalecus, Brünn.

Oar-fishes have the same wide range in the depths of the sea as Deal-fishes, and like these, they have singularly not yet been observed on the American coasts of the Atlantic. They fall still more rarely into the hands of competent observers than the *Trachypteri*, and then generally in a more or less mutilated condition. The usual method subsequently adopted of preserving them dry or stuffed completes their destruction and renders them all but useless for future examination and comparison.[2] Hence, any attempt at distinguishing separate species is at present open to serious objections. With regard to the specimens found in the North Atlantic, Lütken,[3] and Collett,[4] have come to the conclusion that they are all the same species.

In the following list I have endeavoured to enumerate the specimens, the capture of which has been hitherto recorded; and it is noteworthy that by far the greater proportion of their captures fall into the stormy season, at any rate in the northern hemisphere. Thus, of those obtained on the British and Scandinavian coasts, we find four in the month of January, five in February, eight in March, two in April, one in May, June, and July each, two in August, one in September, and one in October. Of the six captured off the Cape of Good Hope and in New Zealand, one is recorded for each of the months of February, May, June, July, September, and October.

1 Since the above paragraph was written (1878), C. Emery has demonstrated by a series of young examples of *Trachypterus tænia*, that the fin-rays commence to grow when the young is about 6 mm. long, and continue to lengthen till the fish is about four times that size, after which period a shortening of the rays takes place. *Att. Accad. Linc.*, vol. iii., 1879, p. 390, *c.* figs. 1–6.

2 I would recommend to all who may happen to secure one of these valuable specimens, to cut the fish into convenient lengths and preserve them in the strongest spirit, each piece wrapped separately in muslin.

3 *Vid. Meddel. nat. Foren. Kjøbenhavn*, 1881, p. 190; *Oversigt K. D. Vid. Selsk. Forhandl.*, 1882, p. 206.

4 *Forhandl. Vidensk. Selsk. Christ.*, 1883, No. 16.

I. Scandinavia.[1]

1.	*Ophidium glesne.* Ascan,	Glesvær, near Bergen,	1740	Febr.
2.	,, ,,	,,	1766	
3.	*Regalecus glesne.* Ascan,	Væroe, near Glesvær,	1769	June
4.	,, ,,	Bergen,	1791	March
5.	*Gymnetrus grillii.* Lindr.,	Hitteren near Throndhjem,	1797	Aug.
6.	*Regalecus glesne.* Collett,	Sværholt (Finmarken),	1852	Febr.
7.	,, ,,	Nordfjord (Bergen Stift),	1855	
8.	,, ,,	Alstahoug (Norland),	1859	
9.	,, ,,	Molde,	1860	
10.	,, ,,	Jæderen,	1867	March
11.	,, ,,	Stavanger,	1881	April
12.	,, ,,	Langesund,	1882	May
13.	,, ,,	Tromsö,	1883	Febr.
14.	*Regalecus banksii.* Lütken,[2]	Faröe,	1852	

II. British Coasts.

1.		Whitby,	1759	Jan.
2.		Newlyn,	1788	Febr.
3.		Newcastle,	1794	March
4.		Filey,	1796	March
5.		Fern Islands,	1800	
6.		,,	1800	
7.		Crovie, near Macduff,	1844	March
8.		Alnmouth,	1845	Jan.
9.	*Gymnetrus banksii.* Hancock,	Cullercoats,	1849	March
10.	*Regalecus glesne.* Gray,	Redcar,	1850	Jan.
11.		Cromarty,	1851	Sept.
12.	*Gymnetrus banksii.* Hogg, Ann. and Mag. Nat. Hist., 1866, vol. xvii. p. 390; Tristram, Proc. Zool. Soc. Lond., 1866, p. 147,	Durham,	1866	March
13.	*Gymnetrus banksii.* Hogg, Ann. and Mag. Nat. Hist., 1866, vol. xviii. p. 136.	Whitby,	1866	April

[1] See Collett, Om de i vort Aarhundrede ved de norske Kyster strandede Exemplarer af Slægten Regalecus; *Forhandl. Vidensk. Selsk. Christ.*, 1883, No. 16.

[2] *Vid. Meddel. nat. Foren. Kjøbenhavn*, 1881, p. 205.

14.	. .	Yorkshire, . .	1870	Oct.
15.	. .	Amble, opp. Coquet Island,	1876	March
16.	. .	Dunnet Bay, Caithness, .	1877	July
17.	. .	St. Andrews, . .	1880	Aug.
18.	. .	Staithes, Yorkshire, .	1880	Jan.
19. "Scotsman," Febr. 11,	. .	Kinnaird Head Lighthouse,	1884	Febr.

III. Mediterranean.

About half a dozen specimens are known to have been observed on the coasts of the Mediterranean; those described by Risso and Valenciennes were captured near Nice, some in the month of May, but no record as regards the details of their capture seems to have been preserved.

1. *Gymnetrus gladius.* Jourdain, Comptes rendus, 1872, vol. 74, p. 58, .	Palavas, Hérault, . .	1871	April

IV. Bermudas.

1. J. M. Jones, Proc. Zool. Soc. Lond., 1860, p. 185, . . .	Hungry Bay, . .	1860	Jan.

V. Cape of Good Hope.

1. *Gymnetrus capensis*, C. V., vol. x. p. 376,	.	about 1834	
2. From a drawing in my possession, .	Simon's Bay, .	1865	Sept. 23
3. Layard, Proc. Zool. Soc. Lond., 1868, p. 319, ...	Table Bay, .	1868	Febr.

VI. Indian Ocean.

1. *Gymnetrus russellii.* Russell, vol. i. p. 40, ...	Vizagapatam, . .	1788	March

VII. New Zealand.

1. W. T. L. Travers, in Günth., Fish., vol. iii. p. 307, . . .	Nelson,[1] . . .	1860	Oct.
2. *Regalecus pacificus*, Haast, New Zeal. Trans., vol. x. p. 246, . .	New Brighton, . .	1876	May

[1] Fragments of this specimen are in the British Museum.

3. Haast, *loc. cit.*, p. 250, . .	Karamea District, . .	1877	July
4. Parker, *loc. cit.*, . . .	Moeraki, . .	about 1881	
5. *Regalecus argenteus*, Parker, New Zeal. Trans., vol. xvi. p. 284; and Trans. Zool. Soc., vol. xii. p. 5, .	Moeraki,[1] . . .	1883	June

Family LOPHOTIDÆ.

Of these singular fishes only a few specimens have fallen into the hands of naturalists, and have been referred to two species, *Lophotes cepedianus* and *Lophotes cristatus*.[2] They were obtained in the Mediterranean, off Madeira, and in the Sea of Japan. Most probably they are deep-sea fishes like the Trachypteridæ which they resemble in the general shape of the body, but their skeleton as well as their soft parts is of a firmer and more coherent texture.

ACANTHOPTERYGII PHARYNGOGNATHI.

Heliastes.

Heliastes roseus.

Heliastes roseus, Günth., Report on the Shore Fishes, Zool. Chall. Exp., part vi. p. 45, pl. xx. fig. D.

Habitat.—Ki Islands, Station 192; depth, 140 fathoms. One specimen.

ANACANTHINI.

Family LYCODIDÆ.

Lycodes, Reinh.

This genus is represented in the Southern as well as Northern Hemisphere, but it would appear from the present state of our knowledge that the Antarctic species do not descend to so great a depth as the Arctic. Probably all of the latter will be found to reach beyond the vertical limit of 100 fathoms, but up to the present time this has been ascertained of those species only which are enumerated here. Collett in his valuable contribution to the deep-sea fauna (Norsk. Nordh. Exped. Fisk.) has given a very complete bibliography of this genus.

[1] The skeleton of this specimen is now in the British Museum.
[2] Johns., *Proc. Zool. Soc. Lond.*, 1863.

Lycodes esmarkii.

Lycodes esmarkii, Collett, Norsk. Nordh. Exped. Fisk., p. 84, pl. ii. figs. 19–21, pl. iii. fig. 22; Nyt Mag. f. Naturvid. Christ., vol. xviii., 1884, p. 73.

This species, which has been distinguished from *Lycodes vahlii* by Collett on perhaps too indistinct characters, was found by the North Atlantic expedition off the Lofoten Islands and on the north west-coast of Spitzbergen in depths varying from 260 to 459 fathoms. During the cruise of the "Knight Errant" in the Faröe Channel, two specimens $10\frac{1}{2}$ inches long were obtained in 608 fathoms (Station 9, August 23, 1882). Individuals from the Varangerfjord, for which we are indebted to Hr. Collett, exceed 2 feet in length. According to him the species occurs also in the Western Atlantic, off the coast of Nova Scotia.

Lycodes reticulatus (Pl. XIII.).

Lycodes reticulatus, Reinh., K. dansk. Vidensk. Selsk. Afhandl, vii., 1838, p. 167, tab. vi.
„ „ Lütken, Vid. Meddel. nat. Foren. Kjøbenhavn, 1880, p. 318.
„ „ Collett, Norsk. Nordh. Exped. Fisk., p. 105.
Lycodes perspicillum, Kröy., K. dansk. Vidensk. Selsk. Afhandl, xi., 1845, p. ccxxxviii., Gaim., Voy. Scand. Poiss., pl. vii.; Nat. Hist. Tidsskr., 1862, p. 289 (young).
Lycodes rossii, Malmgren, Öfversigt k. Vetensk.-Akad. Förhandl., 1865, p. 516 (young) (Spitzbergen).
Lycodes gracilis, Sars, Forhandl. Vidensk. Selsk. Christ., 1866, p. 40, pl. i. figs. 1–3 (young) (Christiania Fjord).
Lycodes lütkenii, Collett, *loc. cit.*, p. 103, pl. iii. fig. 25.
„ „ Lütken, Kara-Havets Fisk. in Dijmphna-Togtet, tab. xvi.

The first specimens of this species were brought from the coast of Greenland; at a later period young specimens of apparently the same species were found at Spitzbergen and on the coast of Norway, and described under distinct names. Finally Hr. Collett is of opinion that an example, 14 inches long, obtained in the open sea, west of North Spitzbergen, in 459 fathoms, also represents a distinct species, though very closely allied to *Lycodes reticulatus*, which he named *Lycodes lütkenii*. On reading his somewhat lengthy description of this individual, I could not help entertaining some doubts as to the propriety of separating it from *Lycodes reticulatus*, and these doubts were increased by the examination of an example, 22 inches long, which the "Knight Errant" obtained in the Faröe Channel at Station No. 9, August 1882, in 608 fathoms. It might be referred to either *Lycodes reticulatus* or *Lycodes lütkenii*, or distinguished as a separate species, if no regard be paid to changes of form (to which very old examples must be subject), or no allowance be made for slight variation. In a paper on the fishes of the Kara Sea, received whilst this Report is passing through the press, I find that

Lütken retains the name proposed by Collett, for specimens which were obtained in that part of the Arctic Ocean.

The specimen is thickly covered with a stratum of coagulated mucus, which can be peeled off in large coherent flakes, filling the pits of the skin of the body and firmly adhering to the broad folds which are developed along the course of each anal ray. It seems to me evident from the appearance of this mucous layer that it is not merely a *port-mortem* result, but that the body was covered with it during life. The colour of the entire fish is a uniform dirty white.

The length of the head is equal to, or perhaps a little more than, its distance from the origin of the anal fin; the snout is produced and the mouth wide; the eye lies in the anterior half of the length of the head, and is distant from its fellow by only about one horizontal diameter; however, the general integument of the head passes so gradually into the transparent cornea, that it is difficult to define the exact dimensions of the eye. Nostril near the extremity of the snout, in a short tube. The maxillary extends just to the vertical from the hind margin of the orbit.

The skin of the head is naked, but with irregular pits on the lower parts of the cheeks, in which, however, no scales can be detected. The skin of the neck is likewise pitted, whilst a broad smooth stripe of skin runs along each side of the neck and for some distance along the back of the trunk. Sides of the body and tail pitted, each pit containing a rudimentary hyaline scale. The lower parts of the abdomen deeply pitted, without scales, the pits being filled with a deep layer of mucus which also covers the lower part of the head and the pectoral and anal fins. A single median lateral line; no trace of an abdominal line.

The dorsal fin commences above the commencement of the second third of the pectoral fin; it is enveloped in thick skin, which forms permanent folds running in the direction of the rays; anal similarly formed, but with the folds much higher; it is composed of seventy-two rays. Pectoral fin very broad, three-fifths as long as the head; ventrals very short and small. The specimen is a male and has several semidigested young specimens of its own species, or of a species closely allied to it, in its stomach.

Measurements:—

	Inches.	Lines.
Total length,	22	...
Total length without caudal rays,	21	2
Height below origin of dorsal,	4	...
Length of the head,	5	7
Distance of vent from end of snout,	10	...
Length of snout,	1	9
Length of eye,	...	6
Length of pectoral fin,	3	5
Length of ventral fin,	...	4
Distance of ventral fin from vent,	6	6

Lycodes frigidus.

Lycodes frigidus, Collett, Norsk. Nordh. Exped. Fisk., p. 96, pl. iii. figs. 23–24.

The specimens described by Collett under this name were obtained by the North Atlantic expedition in the tract of ocean surrounding Bear Island, Spitzbergen, and also on the banks of Heligoland and Lofoten. The depth varied from 260 to 1333 fathoms. The "Knight Errant" met with the same species in the Faröe Channel, capturing a great number of young and half-grown specimens on the 17th August 1880, at Station 8, in 540 fathoms, and in August 1882, at Stations 8 and 9, in 608 and 640 fathoms. Some of these specimens agree perfectly with the characters assigned to the species by Hr. Collett (who had the kindness to send to me one of his own specimens for comparison), but other specimens of the same size from the same haul, and possibly of the same brood, show variations in the development of the lateral line and in the extent of scaling, so that it would have been difficult, or rather impossible, to identify them from the descriptions only. And it seems to me very doubtful whether the lateral line and the scaling should be employed, in the fishes under consideration, so positively for specific distinction as has been attempted by Lütken and Collett.

Lycodes pallidus.

Lycodes pallidus, Collett, *loc. cit.*, p. 110, pl. iii. figs. 26, 27.
" " Lütken, Kara-Havet's Fisk. in Dijmphna-Togtet, p. 134, tab. xvii. figs. 1–3.

First known from two examples, $3\frac{1}{2}$ and $6\frac{1}{2}$ inches long, obtained off north-western Spitzbergen, in 260 and 459 fathoms, and lately recognised by Lütken in specimens from the Kara Sea, which were caught at a depth of between 46 and 106 fathoms.

Lycodes seminudus.

Lycodes seminudus, Reinh., Vid. Selsk. Naturv. Afhandl., vii., 1838, p. 221.
" " Lütken, Vid. Meddel. nat. Foren. Kjøbenhavn., 1880, p. 325.
" " Collett, Norsk. Nordh. Exped. Fisk., p. 113, pl. iv. fig. 28.

Known from two examples, one from Greenland, and the other from Spitzbergen (260 fathoms).

Lycodes murœna (Pl. XII. fig. A).

Lycodes murœna, Collett, Norsk. Nordh. Exped. Fisk., p. 116, pl. iv. figs. 29–31.

Of this interesting species many specimens were collected during the cruise of the "Knight Errant," viz., at Station 8 (August 17, 1880) in 540 fathoms, and at Station 9 (August 23, 1882) in 608 fathoms. The typical specimens came from banks lying off

Heligoland, and from the open sea, off Bear Island and Spitzbergen, from depths varying between 350 and 658 fathoms.

I have nothing to add to the long description given by Collett, except that our specimens, which vary in length from $2\frac{1}{2}$ to 9 inches, do not confirm his observation that the scales are most developed in examples of about 6 inches. The scales are equally rudimentary and irregularly developed on the different portions of the body. Generally they are present on the tail, but become only conspicuous when the specimen is allowed to dry. The number of anal rays varies from 87 to 100.

Lycodes sarsii.

Lycodes sarsii, Collett, Oversigt K. D. Vid. Selsk. Forhandl., 1872, p. 62, *c.* tab.; Norsk. Nordh. Exped. Fisk., p. 117; Nyt Mag. f. Naturvid. Christ., 1884, p. 78, pl. i. figs. 3–4.
Anguilla kieneri, Günth., Ann. and Mag. Nat. Hist., 1874, vol. xiii. p. 138.
Lycodes kieneri, Day, Proc. Zool. Soc. Lond., 1882, p. 536.

The knowledge of this species rests upon two young specimens, of which one, 43 mm. long, was caught in the Hardanger Fjord, at a depth of 100 to 150 fathoms, the other, 85 mm. long, in the North Atlantic, in 180 fathoms, during the cruise of H.M.S. "Porcupine."

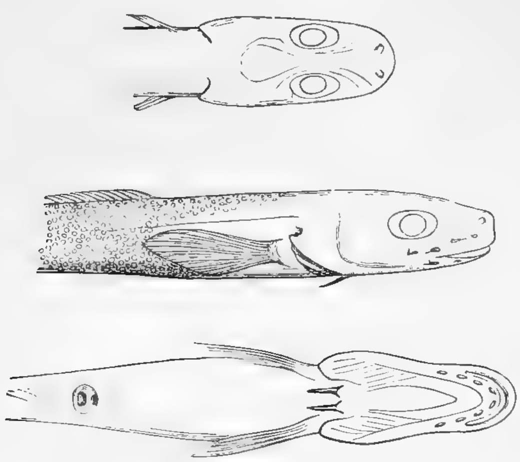


Fig. 3.—*Lycodes sarsii*, natural size.

This is a shorter species than *Lycodes murœna*, the vent being situated at the end of the anterior third of the total length, and the head occupying nearly one-half of the distance between the snout and vent. The pits, with their foramina, in the circumference of the upper and lower jaw are deep, but the skin covering the jaws is much less spongy than in *Lycodes murœna;* in fact, that of the upper jaw does not even form a labial fold. The snout is broad, obtuse, rounded, scarcely longer than the large eye. Ventrals very slender, two-rayed. Body with non-imbricate, minute, rudimentary scales, without any markings. Branchiostegals, five.

The specimen is too much shrunk to allow of the fin-rays being counted.

Lycodes verrilli.

Lycodes verrilli, Goode and Bean, Amer. Journ. Sci. and Arts, vol. xiv., 1878, p. 474; Bull. Mus. Comp. Zoöl., vol. x., 1883, p. 207.
" " Collett, Norsk. Nordh. Exped. Fisk., p. 118 (*c.* fig).
" " Goode, Proc. U.S. Nat. Mus., vol. iii., 1881, pp. 337, 477.

Coast of Massachusetts and northward, in from 90 to 603 fathoms.

Lycodes paxillus.

Lycodes paxillus, Goode and Bean, Proc. U.S. Nat. Mus., 1880, vol. ii. p. 44; 1881, p. 477.

Known at first from a single specimen, $14\frac{3}{8}$ inches long, which was caught on the Le Have Banks in about 300 fathoms, and subsequently from others obtained off the New England coast in 365 and 487 fathoms.

Lycodes paxilloides.

Lycodes paxilloides, Goode and Bean, Bull. Mus. Comp. Zoöl., 1883, vol. x. p. 207.

Obtained by the U.S. steamer "Blake" off the coast of Massachusetts in from 304 to 466 fathoms.

Lycodonus.

Lycodonus, Goode and Bean, Bull. Mus. Comp. Zoöl., vol. x., 1883, p. 208.

Form of a slender *Lycodes*. Body with rudimentary scales; each ray of the dorsal and anal supported laterally by a pair of sculptured scutes. Caudal distinct, not fully connate with the other vertical fins. Ventrals present. Gill-opening narrow; branchiostegal membranes broadly joined to the isthmus. Teeth as in *Lycodes*. Pseudobranchiæ apparently present. Gill-rakers present, in moderate number. Air-bladder and pyloric cœca apparently absent.

Lycodonus mirabilis.

Lycodonus mirabilis, Goode and Bean, Bull. Mus. Comp. Zoöl., vol. x., 1883, p. 208.

The eye is two-fifths of the length of the head; the maxillary reaches to the front of the pupil. The dorsal fin commences somewhat behind the base of the pectorals.

A single mutilated specimen, measuring $4\frac{1}{2}$ inches in its imperfect condition, was obtained by the U.S. steamer "Blake," in lat. 38° 20′ N., long. 73° 23′ W., at a depth of 470 fathoms.

Gymnelis, Reinh.

Two species[1] only are known: one from the Arctic Ocean, the other (*Gymnelis picta*) from the Straits of Magellan.

[1] I think Hr. Collett is in error when he identifies *Gymnelis picta* (Günth., Fish., vol. iv. p. 324 and *Proc. Zool. Soc. Lond.*, 1881, pl. ii. fig. B) with *Gymnelis viridis;* it is very likely an Antarctic species, well distinguished by the number of its fin-rays. The change of colour, which takes place during growth, seems to be common to *Gymnelis, Maynea*, and some species of *Lycodes*, and cannot be held as evidence of specific identity.

Gymnelis viridis.

Ophidium viride, Fabr., Faun. Grönl., p. 141.
Gymnelis viridis, Reinh., K. dansk. Vidensk. Selsk. Afhandl., vii., 1838, p. 131.
,, ,, Gaim., Voy. Scand. Poiss., pl. xv.
,, ,, Günth., Fish., vol. iv. p. 323.
,, ,, Collett, Norsk. Nordh. Exped. Fisk., p. 123, pl. iv. fig. 32.
,, ,, Kröyer, Nat. Hist. Tidsskr., 1862, i. p. 258.
,, ,, Lütken, Kara-Havets Fisk. in Dijmphna-Togtet, p. 125.

An Arctic circumpolar species, locally abundant near the shore, and found by the North Atlantic Expedition at Jan Mayen in 263 fathoms.

Melanostigma, Gthr.

One species only is known.

Melanostigma gelatinosum.

Melanostigma gelatinosum, Günth., Proc. Zool. Soc. Lond., 1881, p. 21, pl. ii. fig. A.
,, ,, Goode and Bean, Bull. Mus. Comp. Zoöl., 1883, p. 209.

The typical specimen, $5\frac{1}{2}$ inches long, was discovered by Dr. Coppinger in the Strait of Magellan, in 24 fathoms. Recently this fish has been found off the coast of Massachusetts in 395 fathoms, thus verifying the conclusion arrived at by the original describer from its organisation, viz., that it lives at a greater depth than that at which the typical specimen happened to be caught. But it is not probable that a fish so eminently specialised for bathybial life as *Melanostigma* becomes "a shore inhabitant in seas near the pole," as Messrs. Goode and Bean would have it.

Family GADIDÆ.

Gadus, Art.

Gadus morrhua, L.

Gadus callarias (L.), Lilljeb., Sverig. och Norg. Fisk., p. 31.

The Cod-fish retires during the summer months into deeper water, and Lilljeborg and other authors report that it is occasionally caught at a depth of 100 and more fathoms.

Gadus poutassou, Risso.

Gadus poutassou, Collett, Norg. Fisk., p. 110.
,, ,, Lilljeb., Sverig. och Norg. Fisk., p. 112.

This European species habitually lives in deeper water than the majority of its congeners, and is not rare at a depth of 100 fathoms on the coast of Scandinavia.

Gadus argenteus.

Gadiculus argenteus, Guichen., Explor. Alger. Poiss., p. 102, pl. vi. fig. 2.
Gadus argenteus, Günth., Ann. and Mag. Nat. Hist., 1874, xiii. p. 138.

Since this species was described from the Mediterranean, it seems to have been found only once again, viz., during the cruise of the "Porcupine," in lat. 54° 10′ N. and long. 10° 59′ W., in 183 fathoms. The single specimen obtained was 5½ inches long.

Mora, Risso.

Mora mediterranea, Risso.

Lowe[1] found this fish at a depth of 300 or 400 fathoms, off Magdalena at Madeira. The specimens collected by the Challenger were unfortunately destroyed on board ship.

Halargyreus, Gthr.

Halargyreus johnsonii.

Halargyreus johnsonii, Günth., Fish., vol. iv. p. 342.

The structure of the typical specimen, and the circumstances connected with its discovery at Madeira, are sufficient evidence that this fish belongs to the deep-sea fauna. Numerous examples of the same species, as it seems, appeared some years ago on the coast of New Zealand. A few specimens reached the British Museum, but unfortunately all are in a very bad state of preservation, so that we are unable to give a figure of this handsome fish. The caudal fin is separated from the other vertical fins by a free peduncle, and the numbers of the fin-rays, counted in three specimens, are—D. 7 | 57. A. 41; D. 7 | 55. A. 46; and D. 7 | 47. A. 41.

Melanonus.

Melanonus, Günth., Ann. and Mag. Nat. Hist., 1878, ii. p. 19.

Head and body rather compressed, covered with cycloid scales of moderate size, and terminating in a long tapering tail. Eye of moderate size; mouth wide, anterior and lateral; both jaws with narrow bands of villiform teeth; vomer and palatines with very narrow stripes of minute teeth. Barbel none. Dorsal fin with a short anterior and posterior division; the middle portion commences immediately behind the anterior, and has the anterior rays well developed; the posterior division is confluent with the extreme caudal rays and the posterior anal division. Anal like the dorsal, minus its anterior division. The outer gill-rakers of the first branchial arch strong and long, longer than

[1] *Proc. Zool. Soc. Lond.*, 1843, p. 91.

the gill-laminæ. Ventrals composed of several rays, slightly in advance of the pectorals, which are narrow. Bones flexible; mucous cavities of the head of moderate capacity. Pseudobranchiæ none.

Allied to *Strinsia*, but apparently with the dentition and fins modified.

Melanonus gracilis (Pl. XIV. fig. B).

Melanonus gracilis, Günth., Ann. and Mag. Nat. Hist., 1878, ii. p. 19.

B. 5. D. 6 | 67. A. 54. 3 D. + C. + 2 A. = 50. P. 10. V. 5.

The head bears, as regards form and general configuration, a striking resemblance to that of *Melamphaës;* it is of moderate length, equal to the distance of the root of the ventrals from the vent, rather broad, and with the snout obtuse and arched downwards. Only the operculum and præopercular limb are scaly; the remainder is covered with a soft skin, which is roughened by short, soft, keel-like prominences. The portion covering the front of the snout between the nostrils is of a lighter colour, with a network of low folds, and similar to the same organ in *Melamphaës typhlops.* The muciferous channels are of moderate extent, and open by small but very distinct pores in the usual manner. One pore, rather wider than the rest, opens in the centre of the upper surface of the head. The eye is of moderate size, two-ninths of the length of the head, and rather shorter than the snout. Interorbital space much wider than the eye, convex.

The mouth is wide, slightly oblique, and not reaching backwards to the hind margin of the orbit, the maxillary being but little dilated at its posterior extremity. The jaws are equal in front, or the mandible projects scarcely beyond the upper.

Gill-membranes united below the isthmus for some distance, supported by short branchiostegals.

The trunk is compressed, passing into the tail, which tapers into an exceedingly narrow extremity. Of the scales only a small portion has been preserved; they are thin, deciduous, marked with numerous concentric striæ, and of moderate size. There seem to be two and a half in a transverse series between the first dorsal and the lateral line. But the course of the latter cannot be traced, owing to the condition of the specimen.

The fin-rays are of very delicate structure, connected by a thin membrane, and the posterior are so closely packed and so fragile that to count them is a matter of some difficulty. All are more or less directed backwards, especially the posterior.

The first dorsal begins above the root of the pectoral, and is much lower than the body; its longest rays are longer than those of the second fin, which maintain nearly the same length to the end of the fin. The second fin commences immediately behind the first. A short break separates the second dorsal from the terminal fin which fringes a portion of the tail, and is equal to about half the length of the head; its upper and lower rays are short, much shorter than the few caudal rays proper. The anal fin commences immediately behind the vent, and is lower than the dorsal opposite. The break in its continuity is opposite to that of the dorsal.

Both the pectoral and ventral fins have a narrow base, and are slender; the length of the former equals that of the head, without snout, and is somewhat more than that of the ventrals, which have the second ray prolonged, but do not reach the vent.

The specimen is entirely black, with the exception of the patch of skin in front of the snout, which is of a brownish-grey colour. Fins transparent. Inside of the mouth black, but not the branchial cavity.

Only one example was obtained in the Antarctic Ocean at Station 156, in 1975 fathoms; it is 6 inches long.

The figures on Pl. XIV. represent this specimen of the natural size, also a side view of the head, and front view of the snout; finally, an enlarged view of a scale.

As mentioned above, *Strinsia tinca*, from the Mediterranean, must be closely allied to *Melanonus*, and probably should be included in the deep-sea series.

Merluccius, Cuv.

Merluccius vulgaris (Flem.).

The Hake has been recorded from depths of 115 to 487 fathoms on the edge of the Gulf Stream off the southern New England coast.[1] The specimens caught were numerous, both old and young. Mr. Goode adds: "The adults appeared to be in the middle of the spawning season (September, 1880), the eggs being separated in the ovaries, and flowing easily in specimens taken at the depth of 250 and 487 fathoms. This phenomenon is of the greatest interest and importance, since it may serve to illustrate how other species common near the shores, such as the Menhaden and Bluefish (*Pomatomus saltatrix*) retreat to deep water to spawn."

Hypsicometes.

Hypsicometes, Goode, Proc. U.S. Nat. Mus., vol. iii., 1881, p. 347.

In introducing this fish into the literature, the author states that "a small specimen, much contracted and distorted from immersion in strong alcohol, is the only material upon which to base his description. Although not quite satisfied that the relations of this fish

[1] Goode, *Proc. U.S. Nat. Mus.*, vol. iii., 1881, pp. 337, 476; *Bull. Mus. Comp. Zoöl.*, vol. x., 1883, p. 207.

are most nearly with Merluciidæ, he ventures to assign it temporarily to a position in this family," and proceeds to characterise it thus :—

In general form closely resembling *Merlucius,* but with the elongate body covered with (comparatively) large scales. Mouth rather small. A separate caudal. Two dorsal fins, the first composed of a few long rays, the second with longer base. One elongate anal. Ventrals well developed, with broad base, composed of six rays. Teeth on the vomer and in the jaws in two or three rows, rather feeble. Eyes large, near together, looking upwards. No barbel.

Hypsicometes gobioides.

Hypsicometes gobioides, Goode, *loc. cit.,* p. 348.

D. 6 | 17. A. 16. V. 6. L. lat. 58.

The general appearance suggestive of a *Gobius.* Ventrals far apart, and far in advance of the pectorals. A large black blotch on the base of the upper caudal rays.

A single specimen, 2 inches long, was obtained by the U.S. Fish Commission, off the coast of Rhode Island, in 115 fathoms.

Lotella, Kaup.[1]

Lotella marginata (Pl. XIV. fig. A).

Lotella marginata, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 19.

B. 7. D. 7–8 | 65. A. 62. V. 5.

Head of moderate length, two-ninths of the total, the caudal fin not included. Eye very large, more than one-third of the length of the head, and equal to that of the postorbital portion; consequently the snout is short, though its length much exceeds the width of the interorbital space. The maxillary extends only to below the middle of the eye; jaws with an outer series of distinctly larger teeth. Barbel small.

Scales very small, about twelve or fourteen in a transverse series between the first dorsal fin and the lateral line.

The first dorsal commences above the root of the pectoral, and has none of the rays prolonged. The second dorsal and especially the anal is depressed in height along the middle of its length. Pectoral shorter than the head, without snout, directed upwards. The two outer ventral rays prolonged, the second (which is the longer)

[1] Under the name of "*Lotella maxillaris,* n. s.," Dr. Bean described a specimen, $2\frac{2}{5}$ inches long, obtained in 396 fathoms by the U.S. Fish Commission. It is an immature specimen, of which not even the genus or subgenus could be determined with certainty (*Proc. U.S. Nat. Mus.,* 1885, p. 241).

just reaching the vent. The distance between the vent and the root of the ventrals equals the length of the head, without snout.

Light-coloured, with black margins to the vertical fins.

Habitat.—Pacific coast of south-western South America.

Near Magellan Strait, Station 305A; depth, 125 fathoms. Two specimens, 5 and $6\frac{1}{4}$ inches long.

Near Magellan Strait, Station 306A; depth, 345 fathoms. One specimen, 6 inches long.

Messier Channel, Station 307; depth, 140 fathoms. One specimen, 9 inches long.

Near Magellan Strait, Station 308; depth, 175 fathoms. Four specimens, $5\frac{1}{2}$ to 7 inches long.

Measurements :—

Total length,	105	lines.
Length of the head,	22	,,
Diameter of the eye,	8	,,
Length of the pectoral fin,	15	,,
Distance of the vent from the ventrals,	16	,,
Depth of the caudal peduncle,	$2\frac{3}{4}$	,,

Uraleptus, Costa.

Uraleptus maraldi.

Gadus maraldi, Risso, Ichth. Nice, p. 123, pl. vi. fig. 13.
Uraleptus maraldi, Costa, Faun. Napolit. Pesc., pl. xxxviia.
,, ,, Günth., Fish., vol. iv. p. 349.
,, ,, Johnson, Ann. and Mag. Nat. Hist., 1863, vol. x. p. 164.

Not very rare in the Mediterranean and off Madeira, and apparently an inhabitant of no great depths.

Physiculus, Kaup.

Physiculus et *Pseudophycis*, Gthr.

In consequence of the discovery of several intermediate forms, a generic distinction between *Physiculus dalwigkii* and *Physiculus bacchus* cannot be maintained; and most probably the transition from the perfectly developed, many-rayed ventral fin, to the single filament of *Phycis* will be found to be so gradual, as to diminish the value of the structure of this fin as a taxonomic character in these fishes. Besides the species enumerated here, others have been described (*Physiculus breviusculus*, Rich. = *Physiculus bacchus*, Forst., *Physiculus barbatus*, Gthr. = *Physiculus palmatus*, Klunz.), but it is not known whether they descend to the same depths as their congeners.

Physiculus dalwigkii.

Physiculus dalwigkii, Kaup, in Wiegm. Arch., 1858, p. 88.
„ „ Günth., Fish., vol. iv. p. 348.
„ „ Jordan and Gilbert, Synopsis, p. 801.[1]

I have three specimens before me, from Madeira, all of which have an exceedingly narrow base to the ventral fin, which is composed of five rays only. The largest of these specimens is only 10 inches long, and it is not known at what depth they were caught.

Physiculus kaupi (Pl. XVII. fig. A).

Physiculus kaupi, Poey, Report Cub., 1865, p. 186.
„ *japonicus*, Hilgendorf, Sitzungsb. naturf. Freunde Berlin, 1879, p. 80.

This species has constantly (as far as is shown by our specimens) a broader base to the ventral fins than *Physiculus dalwigkii*, and they are formed of seven rays, of which the longest may or may not reach the anal fin. The fin rays vary within proportionate limits; they are D. 9–10 | 60–66. A. 60–70. There are thirteen series of scales between the anterior dorsal and the lateral line. The peduncle of the tail is shorter and less slender than in the Madeiran form, but otherwise the two species are so similar as to scarcely deserve specific separation.

Habitat.—Poey obtained a specimen at Cuba, and Melliss two at St. Helena. These differ in no respect from five examples found by the Challenger off Inosima in 345 fathoms, and 11 to 16 inches long.[2]

Physiculus peregrinus.

Pseudophycis peregrinus, Günth., Proc. Zool. Soc. Lond., 1871, p. 669.

With three rays in the ventral fins.

Since the discovery of the typical example at Manado no other specimens have been found. It has so much the characteristic appearance of a deep-sea fish that I cannot hesitate to admit it here.

Phycis, Cuv.

All the species of this genus seem to descend habitually beyond the hundred fathom line; at any rate, the following have been recorded from deep water.

[1] See, with regard to this reference, Jordan, Cat., p. 130.

[2] Hilgendorf states as one of the characteristics of the Japanese form, that the length of the head is *one-fifth* of the total length. This is not the case in our examples, in which the head forms nearly one-fourth of the total, as in *Physiculus dalwigkii*.

Phycis blennioides (Brünn.).

Phycis blennioides, Strom, Norsk. Vid. Selsk. Skr., 1881, p. 76; 1884, p. 35.
" " Collett, Nyt Mag. f. Naturvid., 1884, p. 83.

This species, which is not uncommon in the littoral parts of the European seas, is reported by Strom and Collett from a depth of from 70 to 200 fathoms, from the Norwegian coast.

Phycis chesteri.

Phycis chesteri, Goode and Bean, Proc. U.S. Nat. Mus., vol. i., 1879, p. 256.
" " Goode, *ibid.*, vol. iii., 1881, pp. 337, 476; Bull. Mus. Comp. Zoöl., vol. x., 1883, p. 204.

Known from numerous specimens, taken off the coasts of Massachusetts and New England, in from 110 to 306 fathoms; the largest is nearly 10 inches long.

Phycis regius (Walb.).

Phycis regius, Goode, Proc. U.S. Nat. Mus., vol. iii., 1881, pp. 337, 476; Bull. Mus. Comp. Zoöl., vol. x., 1883, p. 204.

A common species on the Atlantic coasts of North America, and recorded to have been taken in from 142 to 155 fathoms, off the southern New England coasts.

Phycis americanus (Bl. Schn.).

Phycis chuss (Walb.), Goode and Bean, Bull. Mus. Comp. Zoöl., vol. x., 1883, p. 203.

A common species on the Atlantic coasts of North America, and recorded to have been taken in 143 fathoms, off the coasts of Massachusetts.

Phycis tenuis (Mitch.).

Phycis tenuis, Goode and Bean, Bull. Mus. Comp. Zoöl., x., 1883, p. 203.

Abundant on the Northern Atlantic coast of the United States, and once recorded to have been taken in 304 fathoms, off the coast of Massachusetts.

Læmonema, Gthr.

This group scarcely deserves generic separation from *Phycis*; it was distinguished only in order that we might be consistent in the employment of certain technical characters, by which the Gadidæ have been divided. Of the four species known, *Læmonema yarrellii* and *Læmonema robustum* probably reach to or below the depth of 100 fathoms, but this is not sufficiently indicated by their organisation. *Læmonema brasiliense* (*Læmonema brefifile*, Gthr.) is a shore fish.

Læmonema barbatulum.

Læmonema barbatula, Goode and Bean, Bull. Mus. Comp. Zoöl., vol. x., 1883, p. 204.

B. 7. D. 5 | 63. A. 59. L. lat. 140. L. trans. $\frac{13}{31}$.

The diameter of the eye is one-third of the length of the head. Length of the head equal to the distance between the root of the ventrals and the anal.

Habitat.—Several specimens were obtained in lat. 32° and 38° N., long. 73° and 78° W., by the United States Survey steamers at depths of from 225 to 312 fathoms.

Haloporphyrus, Gthr.

All the species of this genus belong to the deep-sea fauna.

Haloporphyrus guentheri (Pl. XVIII. fig. A).

Haloporphyrus lepidion, Günth., Fish., vol. iv. p. 358.
" " Johns., Ann. and Mag. Nat. Hist., 1862, vol. x. p. 166.
" *güntheri*, Giglioli, Nature, 1880, Jan. 1.
" " Vinciguerra, Ann. Mus. Civ. Genoa, vol. xviii. p. 558.

B. 7. D. 4 | 52–56. A. 49–52. P. 21. V. 6. L. lat. 210. Cœc. phy. 15.

The diameter of the eye is one-sixth of the length of the head (in specimens 20 to 24 inches long). Caudal peduncle rather slender, its depth being two-thirds of the distance between dorsal and caudal fins. Fifteen or sixteen longitudinal series of scales between the anterior dorsal fin and the lateral line. The dorsal filament very thin, thread-like.

Habitat.—This species has been obtained off the coasts of Madeira and Portugal, and also in the Mediterranean.

The figure of the head is of the natural size and taken from a Madeiran specimen, 24 inches long.

Haloporphyrus lepidion.

Gadus lepidion, Risso, Ichth. Nice, p. 118, pl. xi. fig. 40.
Haloporphyrus lepidion, Giglioli, *loc. cit.*
" " Vinciguerra, *loc. cit.*, p. 554, Taf. iii.

D. (5)4 | 52. A. 46–48. V. 6. L. lat. 155–160. Cœc. pyl. 10.

Eye very large, thrice or thrice and a half in the length of the head. Maxillary extending beyond the middle of the orbit. Thirteen or fourteen series of scales between the first dorsal fin and the lateral line.

Habitat.—Mediterranean.

I have recently obtained for the collection of the British Museum a specimen 10 inches long from Nice, which is undoubtedly the true *Gadus lepidion.* As in the preceding and following species, so in this specimen the scales between the first dorsal fin and the lateral line are rather confused, but there are distinctly more than eleven series, which number is given by Vinciguerra as characteristic of this species.

Haloporphyrus eques, n. sp. (Pl. XVIII. fig. B).

B. 7(8). D 4 | 56–62. A. 49–54. V. 7. L. lat. 180. Cœc. pyl. 10–11.

The length of the head equals the distance between the root of the ventral fin and the anal, and is rather less than one-fourth of the total (without caudal). The eye is very large, one-third of the length of the head, longer than the snout, and nearly twice the width of the interorbital space. Snout of moderate length, obtuse, with an undulated series of pores in the præorbital region running towards the extremity of the snout. The mouth extends nearly to below the middle of the eye. Barbel half the length of the eye. The caudal peduncle very slender, its depth being two-fifths of the distance between dorsal and caudal fins. Fifteen or sixteen longitudinal series of scales between the anterior dorsal fin and the lateral line. The first long dorsal ray is compressed, moderately strong, extending backwards to the posterior fourth of the length of the dorsal fin. The middle of the anal fin very conspicuously depressed. Caudal fin rounded, with its basal rays extending for some distance along the peduncle. Pectoral fin as long as the head without snout. The filamentous ventral ray, which, in fact, consists of two rays free along their distal half, does not exceed in length the pectoral fin.

Brownish, with blackish fins; orbit with a black ring; the cavities of the mouth, gills and abdomen black. Specimens of a much lighter colour (probably albinos) are not scarce.

Young specimens (6 inches in length) do not differ essentially from older ones of twice the length, but their eye is relatively still larger and the dorsal filament somewhat smaller. Numerous specimens were obtained by the "Knight Errant" in the Faröe Channel, in 530 fathoms, the largest being 12 or 13 inches long, at Station 6, in August 1880, and Station 2, in August 1882.

I formerly believed that these specimens represented the younger stage of the large specimen from Madeira (the only one known to me at the time) which I referred in 1862 to Risso's fish; but examples received at a later period convinced me that the present species may be constantly, at all ages, distinguished by a comparatively larger eye and shorter head. However, the three European species, viz., *Haloporphyrus guentheri*, *Haloporphyrus lepidion*, and *Haloporphyrus eques* are most closely allied to each other.

Haloporphyrus inosimæ, n. sp. (Pl. XX. fig. B).

B. 7. D. 5 | 60. A. 52. Cœc. pyl. 13.

This species is also very similar to *Haloporphyrus lepidion*, but distinguished by much smaller scales. The length of the head is conspicuously less than the distance between the root of the ventral fin and the anal. Eye rather large, one-fourth of the length of the head, equal to the length of the snout and more than the width of the interorbital space. The rows of pores in the præorbital region are present as in *Haloporphyrus lepidion* and *Haloporphyrus eques*, but the pores are much smaller. The mouth scarcely extends to below the middle of the eye. Barbel nearly as long as the eye. The caudal peduncle is rather slender, its depth being two-thirds of the distance between dorsal and caudal fins. Scales very small, about twenty longitudinal series between the anterior dorsal fin and the lateral line. The first long dorsal ray is rather feeble, extending scarcely to the middle of the length of the dorsal fin. Middle of the anal fin but little depressed. Caudal fin subtruncated. Pectoral fin three-fifths as long as the head, equal in length to the filamentous ventral.

Brownish, with blackish fins; the cavities of the mouth, gills, and abdomen black.

Habitat.—Several specimens, from 8 to 12 inches long, were obtained by the Challenger at Inosima, in 345 fathoms.

Haloporphyrus ensiferus, n. sp. (Pl. XIX. fig. A).

B. 7. D. 5 | 52. A. 46. V. 8. Cœc. pyl. 10.

Distinguished by the very broad and compressed dorsal ray. The length of the head equals the distance between the root of the ventrals and the vent. Eye rather large, two-sevenths of the length of the head, a little longer than the snout, and in width much exceeding the interorbital space; pores of the præorbital region very small. Mouth comparatively narrow, only reaching beyond the anterior margin of the eye; barbel much shorter than the eye. Caudal peduncle rather slender, its depth being rather more than one-half of the distance between dorsal and caudal fins. Scales very small, rather irregularly arranged, about eighteen longitudinal series between the first dorsal fin and the lateral line. The long dorsal ray is strongly compressed, broad, shaped like a blade of grass, and extending backwards to the posterior third of the dorsal fin. It is so in three male specimens, but in a female the ray is much less developed, scarcely extending beyond the anterior third of the dorsal fin. Middle of the anal fin strongly depressed; caudal fin subtruncated; pectoral as long as the head without snout, much shorter than the filamentous ventral fin, which, however, does not reach the vent.

Brownish, fins blackish, the posterior dorsal and anal rays whitish; cavities of the mouth, gills, and abdomen black.

Habitat.—Four specimens, from 10 to 14 inches long, were obtained off the mouth of the Rio Plata, at Station 320, in 600 fathoms.

Antimora.

Antimora, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 18.

Body elongate, covered with small scales. Upper part of the snout produced into a pointed projection. A separate caudal; two dorsal fins, the first with four or five rays; one anal, with a deep depression along the middle. Ventrals narrow, composed of six rays. Jaws with bands of villiform teeth; vomerine teeth in a small roundish patch; none on the palatine bones. Muciferous channels on the side of the head well developed; bones of the cranium wanting in solidity. Vent at the end of the abdominal cavity. Chin with a barbel. Branchiostegals seven; pseudobranchiæ none. Pyloric appendages long, in moderate number.

Deep-sea fishes descending to greater depths than the allied genera of *Salilota* and *Haloporphyrus.*

Antimora rostrata (Pl. XVI. fig. A).

Haloporphyrus rostratus, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 18.

B. 7. D. 4 | 51–56. A. 38–39. V. 6. L. lat. 140. L. transv. ca. 10/x. Cœc. pyl. 13.

This species is readily distinguished by the peculiarly produced snout, which forms a short, triangular, pointed lamina, sharply keeled on the sides, and overhanging the cleft of the mouth.

The head is rather short, broad posteriorly, half as long as the distance between ventral and anal fins. Eye round, rather large, its diameter one-fourth of the length of the head, less than that of the snout, and nearly equal to the width of the flat interorbital space. Mouth wide, the maxillary extending nearly to below the hind margin of the eye. Teeth in both jaws in narrow villiform bands; a small group of teeth on the vomer. Posterior extremity of the maxillary not much dilated. Nostrils close together; the posterior are wide, semicircular openings, the anterior narrower and round. The vent is rather nearer to the end of the operculum than to the root of the caudal.

The entire head (even the gill-membrane and the foremost part of the snout) and the body are covered with small cycloid scales, of which only a few have been preserved; there are about ten in a transverse line between the first dorsal fin and the lateral line.

The greater part of the dorsal and anal fins are covered with scales. The first dorsal is subcontinuous with the second, and the first ray is produced into a filament about as long as the head. The second dorsal and anal fins are rather low; the latter so much depressed in the middle as to present the appearance of a double anal. The free portion of the tail is narrow, terminating in a comparatively small caudal fin, which is truncated behind. Pectoral pointed, the upper rays being the longest; it is as long as or longer than the head exclusive of the snout. The two outer ventral rays prolonged as two filaments; the second being twice as long as the first, and not extending as far back as the pectoral.

Black; cavity of the mouth, gills, and abdomen deep black.

Habitat.—Deep-sea, midway between the Cape of Good Hope and Kerguelen Island; east of the mouth of the Rio de la Plata.

Near Marion Island, Station 146; depth, 1375 fathoms. One specimen, $18\frac{1}{2}$ inches long.

Off Monte Video, Station 320; depth, 600 fathoms. One specimen, 24 inches long.

Antimora viola (Pl. XV.)

Haloporphyrus viola, Goode and Bean, Proc. U.S. Nat. Mus., vol. i., 1879, p. 257; vol. iii., 1881, p. 476; Bull Mus. Comp. Zoöl., vol. x., 1883, p. 206; Amer. Journ. Sci. and Arts, vol. xvii., 1879, p. 41.
Antimora viola, Jordan, Cat. Fish. N. Amer., p. 129.

This fish is very closely allied to *Antimora rostrata*, but clearly a distinct species, if the following characters should prove to be constant.

B. 7. D. 4–5 | 53–55. A. 40. V. 6. L. lat. 145. L. transv. $\frac{13}{x}$. Cœc. pyl. 16.

Head rather elongate and pointed, its length being much more than one-half of the distance between ventral and anal fins. Vent midway between the root of the caudal and the eye. Eye large, oval, its horizontal longest diameter being rather more than one-fourth of the length of the head, as long as the snout, and exceeding the width of the interorbital space. Violet.

The single specimen from which these characters are taken is 16 inches long, and was obtained by the U.S. Fish Commission in lat. 43° 41′ N., and long. 59° 15′ W.

But this species seems to be abundant in the deep sea off the Atlantic coasts of the United States, numerous examples having been taken in depths of from 306 to 1242 fathoms. Greatest length recorded, 18 inches.

Salilota.

Body oblong, covered with very small scales. Head thick, but rather compressed. A separate caudal; two dorsal fins and one anal. Ventrals with broad base, composed of several (eight) rays. Abdominal cavity extending far behind the vent. Villiform teeth of equal size in the jaws and on the vomer; none on the palatines. The first dorsal with about nine rays. Chin with a barbel. Pyloric appendages very long, of moderate number.

This fish differs so strikingly from the typical *Haloporphyrus,* with which I at first associated it, that its separation into a distinct genus seems to me justified. It forms a passage to *Lota,* from which it differs by an entirely different form of the head. It is not a deep-sea fish, and ought to have been included in the shore series.

Salilota australis (Pl. XVII. fig. B).

Halophorphyrus australis, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 19.

D. 9 | 50–52. A. 53. V. 8. Cœc. pyl. 17.

The length of the head is one-fourth of the total (without caudal), and about twice as long as the distance of the ventrals from the anal. The depth of the body is two-fifths of the total. Snout obtuse, rounded, with the upper jaw overlapping the lower, as long as, or rather longer than the eye, the diameter of which is one-fourth or two-ninths of the length of the head. The maxillary extends somewhat behind the middle of the eye. Teeth villiform, forming bands. A small semicircular patch of similar teeth in the middle of the head of the vomer. Barbel shorter than the eye. Interorbital space flat, wider than the eye. There are about eighteen longitudinal series of scales between the anterior dorsal and the lateral line. The first dorsal fin has no prolonged rays, and is not higher than the second, situated behind the root of the pectoral. The second dorsal and anal have the margin somewhat emarginate, and terminate close to the caudal. Vent situated below the first dorsal. Caudal slightly rounded. The length of the pectoral fin is two-thirds of that of the head. Outer ventral ray bifid, slightly prolonged, reaching to the vent. Uniform brown, vertical fins with a blackish margin.

Habitat.—Puerto Bueno; Magellan Strait.

Off Cape Virgins, Patagonia, Station 313; depth, 55 fathoms. One specimen, $18\frac{1}{2}$ inches long.

Puerto Bueno, 9th January 1876. One specimen, 11 inches long; one specimen, 12 inches long.

Between Cape Virgins and Falkland Islands, Station 314; depth, 70 fathoms. One specimen, 6 inches long.

Molva, Nilss.

Molva molva, L.

Molva vulgaris (Flem.), Collett, Nyt Mag. f. Naturvid., 1884, p. 84.
„ „ Lilljeb., Sverig. och Norg. Fisk., p. 131.

Collett states that on the Norwegian coast young examples of the Ling are rarely found at a less depth than 100 fathoms; and according to Lilljeborg the largest are caught at a depth of from 80 to 150 fathoms.

Molva abyssorum, Nilss.

Molva byrkelange (Walbaum), Strom, Norsk. Vid. Selsk. Skr., 1884, p. 35.
„ „ Collett, Nyt Mag. f. Naturvid., 1884, p. 84.
„ „ Lilljeb., Sverig. och Norg. Fisk., p. 139.

This species descends to a still greater depth than the Common Ling, and is abundant between 100 and 300 fathoms.

Onus, Risso.

This genus is represented in the North Atlantic from the shore-line to a depth exceeding 1000 fathoms.

Onus macrophthalmus.

Motella macrophthalma, Günth., Ann. and Mag. Nat. Hist., 1867, vol. xx. p. 288, pl. v. fig. B.

D. 55. A. 55. P. 17. V. 5.

Barbels three. The length of the head is one-fourth of the total (without caudal). The diameter of the eye is one-fourth of the length of the head, as long as the snout, and much longer than the interorbital space is wide. The maxillary reaches the hind margin of the orbit. Both jaws with teeth unequal in size, some being enlarged and canine-like.

Vent nearer to the snout than to the end of the anal. The anterior ray of the first dorsal about as long as the eye. Back with narrow brownish cross-bars.

This species is known only from a single example, 3 inches long, obtained in 80 or 90 fathoms, near the Hebrides. Dr. Lütken[1] gives it as his opinion that this represents the young of his *Motella mediterranea* (L.). But I have never seen a Mediterranean specimen of the same size and with equally large eyes. Also Hr. Collett[2] would refer it rather to a species which he characterises by 62 dorsal, 21 pectoral, and 8 ventral rays!

Onus carpenteri (Pl. XLII. fig. D).

Motella macrophthalma, Günth., Ann. and Mag. Nat. Hist., 1874, vol. xiii. p. 139 (not 1867).

D. 49. A. 45. P. 23. V. 6.

Barbels three. The length of the head is two-ninths of the total (without caudal); the diameter of the eye two-ninths of the length of the head, as long as the snout and longer than the interorbital space is wide. The maxillary reaches to a little behind the hind margin of the orbit. Both jaws with teeth unequal in size, some being enlarged and canine-like. Vent much nearer to the snout than to the end of the anal. The anterior ray of the first dorsal fin about as long as the eye. Coloration uniform.

One specimen only is known, 4½ inches long, obtained during the cruise of H.M.S. "Porcupine," in 180 fathoms, between Shetland and Faröe. I formerly regarded this specimen as representing a more advanced stage of growth of *Onus macrophthalmus*, an opinion fully in accord with the characters given above. But Dr. Lütken, in a recent paper on the species of this genus,[3] has drawn attention to differences in the paired fins which, if they are of specific value in this genus, indicate the distinctness of this specimen from all the species known to me or described by Dr. Lütken. It is named after Dr. Carpenter, whose memory will ever be associated with the "Porcupine" and the succeeding British Deep-Sea Expeditions.

Onus reinhardti (Pl. XIX. fig. B).

Motella reinhardi,[4] Collett, Forhandl. Vidensk. Selsk. Christ., 1878, p. 83.
" " Lütken, Vid. Meddel. nat. Foren. Kjøbenhavn, 1882, p. 236.
Onos reinhardi, Collett, Norsk. Nordh. Exped. Fisk., p. 131, pl. iv. fig. 34.

D. 53–59. A. 43–48. P. 22–24. V. 8.

Barbels three. The length of the head is contained four and one-fourth times in the total (without caudal), the diameter of the eye four times and two-thirds or five times in

[1] *Vid. Meddel. nat. Foren. Kjøbenhavn*, 1882, p. 244.
[2] *Nyt Mag. f. Naturvid.*, 1884, p. 93.
[3] *Vid. Meddel. nat. Foren. Kjøbenhavn*, 1882, p. 228.
[4] This fish remained undescribed, and the name merely a MS. term, until Collett undertook its examination in 1878.

the length of the head; it is shorter than the snout, equal to, or less in length than, the width of the interorbital space. The maxillary scarcely extends to the hind margin of the eye. Both jaws and the vomer with an outer series of larger teeth. Vent nearer to the root of the caudal than to the snout. The anterior ray of the first dorsal fin rather longer than the eye. Coloration uniform.

Habitat.—Several specimens, the longest of which is 12 inches long, were obtained by the "Knight Errant" in the Faröe Channel, at Station 8 (August 1880), in 540 fathoms, and at Stations 8 and 9 (August 1882), in 608 and 640 fathoms.[1] At a similar depth (658 fathoms) the species was found by the North Atlantic expedition in the open sea west of Bear Island. Other specimens came from the coast of Greenland.

Onus septentrionalis.

Motella septemtrionalis, Collett, Ann. and Mag. Nat. Hist., 1875, vol. xv. p. 82; Norg. Fisk., p. 117, pl. ii.; Forhandl. Vidensk. Selsk. Christ., 1880, p. 68.
Onus septemtrionalis, Collett, Norsk. Nordh. Exped., Fisk., p. 138, pl. iv. figs. 35, 36; Nyt Mag. f. Naturvid., vol. xviii., 1884, p. 86.
" " Strom, Norsk. Vidensk. Selsk. Skriv., 1881, p. 77.

From the coast of Norway in from 20 to 50 fathoms, and reported by Strom to have been found once in 150 fathoms; extending westwards to the coast of Greenland.

Onus ensis (Reinh.).

The typical specimens are from the coast of Greenland; and it would appear from a short note[2] that the same fish has been found at a depth of 1106 fathoms, by the U.S. Fish Commission, in lat. 39° 41′ N., long. 69° 20′ W.

Onus cimbrius, L.

Onus cimbrius, Goode and Bean, Proc. U.S. Nat. Mus., vol. iii., 1881, p. 476; Bull. Mus. Comp. Zoöl., vol. x., 1883, p. 207.

Not rare on the northern coasts of Europe and America, and reported from 178 fathoms by Brown Goode.

Brosmius, Cuv.

Brosmius brosme, Müll.

Brosmius brosme, Günth., Proc. Roy. Soc. Edin., 1882, p. 680.
" " Lilljeb., Sverig. och Norg. Fisk., vol. ii. p. 202.

The Torsk lives habitually in deep water, in from 30 to 120 fathoms; one adult example was obtained by the "Knight Errant" in the Faröe Channel (August 11, 1880), in 530 fathoms.

[1] These specimens were erroneously referred to *Motella macrophthalma* in *Proc. Roy. Soc. Edin.*, 1882, p. 680.
[2] Gill, *Proc. U.S. Nat. Mus.*, vol. vi., 1884, p. 259 (*Onus rufus*).

Chiasmodus, Johns.

One species only is known.

Chiasmodus niger.

Chiasmodus niger, Johns., Proc. Zool Soc. Lond., 1863, p. 408.
" " Günth., Fish., vol v. p. 435.
" " Carter, Proc. Zool. Soc. Lond., 1886, p. 35, pl. ii.[1]
" " Günth., *Ibid.*
" " Jordan and Gilbert, Synops. Fish. North Amer., p. 810.

The first specimen, only $2\frac{3}{4}$ inches long, was obtained at Magdalena (Madeira), at a depth of 312 fathoms, in the year 1850, by Lowe, who, however, omitted to give a description of it. The species was rediscovered twelve years later at the same locality by Johnson, who recognised it as the type of a distinct genus. The third specimen, $6\frac{1}{2}$ inches long, the largest known at present, was picked up from the surface, near the island of Dominica. A fourth example, $2\frac{1}{2}$ inches long, in no point differing from the preceding, except that it has lost the larger front teeth, was obtained by the Challenger, in Mid-Atlantic, at Station 107 (August 26, 1873), in 1500 fathoms. Finally, Jordan and Gilbert mention the capture of this fish off the coast of Massachusetts.

Family OPHIDIIDÆ.

Barathrodemus.

Barathrodemus, Goode and Bean, Bull. Mus. Comp. Zoöl., vol. x., 1883, p. 200.[2]

Caudal free from the other vertical fins. Pectoral without detached rays. Ventrals reduced each to a single bifid ray, close together, inserted under the middle of the operculum. Body elongate, much compressed, covered, like the head, with small thin scales. Head compressed; snout long, swollen, overlapping the jaws; mouth moderate. Villiform teeth in the jaws, on the vomer and palatines. Barbel none. Branchiostegals eight; pseudobranchiæ none. Lateral line indistinct.

One species is known.

[1] The specimen described in this paper was first submitted to me by Mr. Carter, who begged me to give him my opinion on it; the figure was also made under my direction.

[2] A specimen of some allied deep-sea fish, and noticed in *Proc. U.S. Nat. Mus.*, 1884, p. 259, under the name of *Bassozetus normalis*, is at present not better known than if it had escaped the dredge of the U.S. Fish Commission.

Barathrodemus manatinus.

Barathrodemus manatinus, Goode and Bean, *loc. cit.*

B. 8. D. 106. A. 86. C. 9. P. 18–20. V. $\frac{1}{1}$. L. transv. ca. 34 (above vent).

Habitat.—Two specimens, $6\frac{1}{4}$ inches long, were obtained by the U.S. steamer "Blake," in lat. 33° 35′ N., long. 76° 0′ W., at a depth of 647 fathoms.

Neobythites.

Neobythites, Goode and Bean, Proc. U.S. Nat. Mus., vol. viii., 1886, p. 600.

Body elongate, compressed, covered with small scales; lateral line indistinct. Head not compressed, covered with scales. Eye of moderate size. Vertical fins united; ventrals each reduced to a bifid filament, inserted behind the humeral symphysis, and somewhat distant from each other. Snout overlapping the mouth, without barbels. Bands of villiform teeth in the jaws, on the vomer and palatine bones. Operculum with a long spine. Eight branchiostegals; air-bladder present; pseudobranchiæ small. Pyloric appendages 0 to 20.

This genus has been distinguished by me for some time, but the manuscript name which I proposed for it, *Tetranematopus*, was unfortunately introduced by me into the literature without diagnosis, so that it has to give way to *Neobythites.* I failed to recognise the latter, as it was characterised by single-rayed ventral fins, until Mr. Goode, on inquiry, kindly informed me that the genus to which he had given this name has bifid ventral rays, as, indeed, he had stated in the description of the species.

Neobythites grandis (Pl. XXI. fig. A).

Sirembo grandis, Günth., Ann. and Mag. Nat. Hist., 1877, vol. xx. p. 437.

Head rather short and broad, with obtuse snout overlapping the lower jaw. Eye small, about one-third of the length of the snout and one-eleventh of that of the head. Mouth rather wide, the maxillary extending to behind the eye; barbels none. Teeth of the jaws, vomer, and palatine bones in villiform bands. The vomerine teeth form a triangular patch, much broader than long; the width of the palatine band exceeds that of the intermaxillary. A deep groove in the skin descends from the anterior nostril towards the maxillary, and reascends towards the median line of the extremity of the snout, cutting off an anterior lobe, as in some Sciænoids. Several pores, leading into the muciferous system, are hidden in the groove; a few small open pores near the symphysis of the mandible. Nostrils gaping, oval openings, of which the anterior is surrounded by a membranous wall. Præoperculum crescent-shaped, without any armature; operculum with a strong spine above. Distance of the vent from the root of the pectoral more than the length of the head.

Scales minute; also the entire head, even the space between the nostrils, covered with minute scales. Lateral line indistinct for the greater part of its course.

The dorsal fin is, like the anal, enveloped in a thick, scaly skin. It commences with short rays above the middle of the pectoral fin. The pectoral is rounded, broad, and remarkably short, about half as long as the head. Ventrals inserted below the angle of the præoperculum. Each ventral filament is bifid, the inner part being the longer.

Brown; darker behind, lighter in front. Fins blackish. Cavity of the mouth grey, peritoneum black.

Total length, $29\frac{1}{2}$ inches; length of the head, $5\frac{3}{4}$ inches; length of ventral filament, 3 inches; distance of the vent from the snout, $12\frac{1}{2}$ inches. This specimen is the largest deep-sea fish obtained by the Expedition.

Habitat.—South of Yedo, near Yokohama, Japan, Station 237; depth, 1875 fathoms. One specimen.

Without causing more injury to the unique specimen than is consistent with its preservation, the following points could be made out as regards its abdominal organs.

The œsophagus is provided with about ten deep, parallel folds, some of which coalesce where the œsophagus passes into the stomach, forming then only seven deep and broad folds. The stomach is short, without cæcal prolongation behind, simply bent towards the right at its posterior extremity, and passing immediately into the intestine. A duodenal division cannot be distinguished. The walls of the stomach are very thick, and strengthened by an outer stratum of longitudinal muscular fascicles. Externally the pylorus is marked by a slight constriction, pyloric appendages being absent. Internally the pyloric passage is indicated by a very low circular fold, on which the longitudinal folds of the mucous membrane of the stomach terminate, and behind which the villosities of the intestinal tube begin. I do not recollect any other fish in which the mucous membrane of the intestine shows an equally developed villous texture. The villosities are long, coarse, and densely packed, transversely lamellar or pointed, becoming lower in the vicinity of the rectum. Rectum short, separated by a deep circular valvular fold from the upper part of the intestine; its mucous membrane has a reticulated surface. The intestinal tract makes one and a half convolutions, and the mesenteric blood-vessels are singularly wide and thick-walled.

The liver is very large, occupying about one-third of the abdominal cavity, viz., the whole of its left side, extending nearly to its hinder end. Its anterior transverse portion bends over into a very short and narrow right lobe. The gall-bladder is large, entirely separate from the liver, sending a narrow duct into the intestine a considerable distance below the pylorus. Attached to its dorsal convexity is the spleen, which is a large, compact, kidney-shaped gland.

The ovary is enclosed in a sac of very firm texture, and situated between the rectum and the kidney. It was much contracted in our specimen, and without ova. A strong ligament extends from its anterior ventral end to the level of the anterior end of the gall-bladder, where it coalesces with the mesentery; another long ligament, starting more to the left of the ovarian sac, fixes the organ to the air-bladder.

The air-bladder is large, firmly attached to the dorsal wall of the abdomen. Externally it appears to be simple, but it consists of two divisions, one behind the other, separated by a complete elastic transverse septum. The anterior division is the shorter, and possesses thinner tunics, which collapse when divided by the knife. The inner silvery tunic, as well as the fibrous one of the posterior division, is much thicker. A large vaso-ganglion, covered by the inner tunic only, occupies the back of the cavity. The vessels of this *rete mirabile* unite into a bundle of the thickness of a goose's quill, which enters this division in about the middle of its length, and is loosely stretched, without other attachment, to the end of the bladder where it makes its exit.

Neobythites macrops, n. sp. (Pl. XX. fig. A).

Head oblong, as deep as broad, the obtusely rounded snout overlapping the lower jaw. Eye rather large, two-ninths of the length of the head, its long diameter being equal to the length of the snout and to the width of the flat, scaly, interorbital space. The maxillary extends somewhat behind the eye. Vomerine teeth in a triangular patch or $\wedge$-shaped band; palatine teeth in a long band, which tapers behind, and is in the middle as broad as the intermaxillary band. Præoperculum with two short spines; one at the angle, the other somewhat above it; both pointing backwards. Opercular spine rather strong, finely pointed. The upper part of the head is covered with small scales nearly to the extremity of the snout; similar small scales cover the skin between the two rami of the mandible. There are eight or nine scales in a transverse series between the first dorsal ray and the lateral line. The vertical fins are rather low, the dorsal beginning behind the root of the pectoral. The distance between the vent and root of the ventrals equals the length of the head. Pectoral fin as long as the postorbital portion of the head. The ventrals are bifid, the inner filament being the longer; they are inserted nearly opposite to the angle of the præoperculum, somewhat distant from each other, and do not extend so far backwards as the pectorals. Brownish-grey, irregularly spotted with brown; six or seven large deep-black blotches on the dorsal fin.

Habitat.—Off the Philippine Islands, Station 210; depth, 375 fathoms. One specimen, $8\frac{2}{3}$ inches long.

The firm structure of the bones of the skull, the moderate size of the eye, and the variegated coloration seem clearly to indicate that this fish is not an inhabitant of very great depths, and, perhaps, does not penetrate beyond the depth mentioned.

A second smaller specimen is so similar to the other, that no distinctive specific characters can be pointed out; it is not, however, in a good state of preservation. It is of a nearly uniform reddish colour, finely punctated with greyish on the back, and white below.

Habitat.—Off Matuku, Fiji Islands, Station 173A; depth, 310 fathoms. One specimen, 6½ inches long.

The stomach of this species is prolonged into a distinct cæcal sac; the pylorus is surrounded by a ring of extremely short appendages, and others equally short occupy in a double series the mesenteric line of the uppermost part of the intestine. These pyloric appendages are altogether twenty in number.

Neobythites ocellatus, n. sp. (Pl. XXI. fig. B).

Head compressed, deeper than broad, the obtusely rounded snout overlapping the lower jaw. Anterior part of the head with wide muciferous cavities. Eye rather large, as long as the snout, and one-fourth of the length of the head. Interorbital space convex. The maxillary extends somewhat behind the eye. Præoperculum with an obtuse spine above its angle, hidden below the skin. Opercular spine slender, very conspicuous. Vomerine teeth a subquadrangular patch, as broad as long, with the posterior corners produced. The upper part of the head is covered with small scales to between the eyes. Chin naked. Scales small and very thin, in seven or eight longitudinal series between the dorsal fin and lateral line. Vertical fins of moderate height, the dorsal beginning behind the root of the pectoral. The distance between the vent and root of the ventrals equals the length of the head. Pectorals rather longer than the postorbital portion of the head. The ventrals are inserted nearly opposite to the angle of the præoperculum a little distant from each other, and do not quite extend so far backwards as the pectorals; they are bifid, the inner filament being the longer. Body light brownish, marbled with darker. A large black white-edged ocellus anteriorly on the dorsal fin, a second larger one at some distance behind, a third is but slightly indicated.

Habitat.—Off Pernambuco, coast of Brazil, Station 122; depth, 350 fathoms. One specimen, 3¾ inches long.

Neobythites gillii.

Neobythites gillii, Goode and Bean, Proc. U.S. Nat. Mus., vol. viii., 1886, p. 600.

The eye is large, contained three and two-third times in the length of the head, and one and one-half times in that of the snout. Mouth large, extending to behind the eye; patch of vomerine teeth broadly V-shaped, with a circular bunch at the angle. Scales of moderate size, seven rows between the origin of the dorsal fin and the lateral line. Length of the pectoral fin equal to two-thirds of that of the head; ventral reaching nearly to the vent. The distance of the root of the ventral from the vent equals the length of the head. Coloration a light yellowish, with a series of irregular brown blotches above the lateral line, two being much darker, extending up on the dorsal fin, the largest about midway between head and tail.

Habitat.—A single specimen, $3\frac{1}{4}$ inches long, was obtained by the U.S. Fish Commission, in lat. 28° 36′ N., and long. 85° 33′ W., at a depth of 111 fathoms.

Catætyx, n. gen.

Body compressed, elongate, covered with very small and thin scales; lateral line indistinct, interrupted. Head oblong, with somewhat pointed snout, covered with very small scales, only the anterior part of the snout naked; bones of the head rather firm, but with the muciferous system well developed, the canals having wide openings along the infraorbital, and on the lower limb of the præoperculum. Eye rather small. Nostrils far apart, the posterior in front of the eye and the anterior at the extremity of the snout. Operculum with a spine behind, no other armature on the head. Snout not swollen, but the upper jaw slightly overlapping the lower; barbels none. Mouth wide. Bands of villiform teeth in the jaws, on the vomer and the palatine bones; a series of larger teeth along the sides of the lower jaw. The tail is not much attenuated. Vertical fins confluent; ventrals close together, reduced to a pair of fine simple filaments, and inserted somewhat behind the isthmus, below the middle of the operculum.

Gills four, with short broad gill-rakers and well-developed laminæ. Pseudobranchiæ none. Branchiostegals eight. Pyloric appendages.

Catætyx messieri (Pl. XXIII. fig. B).

Sirembo messieri, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 19.

D. 105. C. 12. A. 75. P. 24.

The height of the body below the origin of the dorsal fin is rather more than one-third of the distance of the extremity of the snout from the vent, the length of the head rather less than one-half, the vent being nearly equidistant from the snout and root of the caudal fin. Head deeper than broad. Eye without orbital fold, one-sixth of the length of the head, two-thirds of that of the snout and less than the width of the flat interorbital space. The maxillary is dilated behind, extending behind the eye; labial folds well developed. The vomerine teeth form an open V-shaped band and are stronger than those of the maxillary. The vertical fins are completely confluent, but as the termination of the tail is comparatively broad, the rays starting from the end may be regarded as the caudal portion. All the fin rays are thin and closely set, enveloped in a broad basal membrane, so that it is difficult to ascertain their number without dissection. Origin of the dorsal fin midway between occiput and vent. Anal fin commencing immediately behind the vent. Pectoral fin, with broad fleshy base, as long as the post-orbital portion of the head. The ventrals do not extend so far backwards as the pectorals, and the distance between their root and the vent is much more than the length of the head.

Uniform brown with black fins.

Habitat.—Off Middle Island, Messier Strait, Station 306A; depth, 345 fathoms. One specimen, 8 inches long.

Pteridium (Scopoli).

Head and body compressed, covered with very small scales, only the upper part of the head and the snout being naked. The body is moderately elongate, the tail but little attenuated. Snout obtuse, not swollen, with the jaws even in front, and with the mouth obliquely ascending. Bones of the head firm, the muciferous canals narrow. Eye small. Operculum with a short spine behind; præoperculum with two short projections near the angle. Barbels none. Bands of villiform teeth in the jaws and an open V-shaped band on the vomer; some slightly enlarged teeth along the inner series of the mandible and on the vomer; palatine teeth none. Vertical fins confluent; ventrals close together, reduced to a pair of fine simple filaments, and inserted somewhat behind the isthmus, below the middle of the operculum. Lateral line interrupted. Gills four; pseudobranchiæ none. Branchiostegals eight. Pyloric appendages two.

Only one species is known.

Pteridium atrum (Risso).

Very scarce in the Mediterranean, and admitted here for comparison with the allied bathybial genera. Probably it also is an inhabitant of considerable depths, but nothing is known on this point. Having now obtained a specimen $3\frac{1}{2}$ inches long, but in a somewhat desiccated condition, I am enabled to correct my former diagnosis,[1] which was drawn up from Filippi and Verany's description. The lateral line is rather indistinct, interrupted, and the fact that the ends of the two portions overlap each other, gave rise to the statement that the line was double along a portion of the tail.

[1] Fish., vol. iv. p. 375.

Pteroidonus, n. gen.

The lower pectoral rays are incompletely united with the upper part of the fin and are prolonged. Body elongate, compressed, covered with small scales; lateral line incomplete, close to the dorsal profile. Head oblong, thick, covered with scales. Eye small. Vertical fins united, but the narrow caudal projecting beyond the short anal and dorsal rays. Ventrals reduced to a simple filament, inserted behind the humeral symphysis, and somewhat distant from each other. Snout broad with rounded profile, including the lower jaw, without barbel. Mouth wide; bands of villiform teeth in the jaws, on the vomer and palatine bones. Operculum with a straight spine; præoperculum armed. Eight branchiostegals. Gill-laminæ rather short; gill-rakers rather long, lanceolate and widely set; pseudobranchiæ none.

A true deep-sea form.

Pteroidonus quinquarius, n. sp. (Pl. XXII. fig. B).

B. 8. D. 99. A. 87. C. 5. V. 1. P. 15 | 5. L. transv. ca. 35 (above vent).

Body elongate, compressed, its depth being less than the length of the head, which equals the distance between the vent and root of pectoral fin. The tail tapers almost to a point. Head not much deeper than broad, its depth being equal to the length of its postorbital portion; it is flat above, the interorbital space being more than twice as broad as the eye. Eye small, without orbital fold, much shorter than the snout, and about one-seventh of the length of the head; it is lateral, but situated immediately below the upper profile of the head. No spines about the orbit. Nostrils rather distant from each other, open; the posterior, the larger, immediately in front of the upper part of the eye, the anterior close to the end of the snout.

Snout broad, rather depressed, overlapping the lower jaw. Mouth wide, somewhat oblique, the much dilated posterior extremity of the maxillary extending backwards beyond the orbit. Præorbital region narrow; intermaxillary styliform. Teeth in villiform bands, the bands of the vomer and palatines very narrow; vomerine band ʌ-shaped. Præoperculum with a rounded angle which is armed with three very short and weak spines; opercular spine moderately strong and straight.

The bones of the head are thin, with shallow muciferous cavities. Nearly the entire head, even the dilated extremity of the maxillary and the glossohyal region, are covered with small scales. Gill-membranes entirely separate.

The dorsal fin commences at a short distance behind the root of the pectoral, is rather low, the rays being enclosed in a scaly skin at the base, and has its last and shortest rays connected with the caudal by membrane. The anal is very similar to the dorsal, but lower. The length of the very narrow caudal is two-fifths of that of the head.

The pectoral fin has a broad base, is elongate, with rounded posterior margin, and as long as the head without snout. The five detached rays are somewhat stronger than the other rays; they form at the base one continuous series with the remainder of the fin, and therefore do not seem to possess a separate action. The uppermost ray is the longest, not quite twice as long as the fin, the others gradually decreasing in length. The ventral fins are very feeble simple filaments, only half as long as the pectoral, somewhat distant from each other, and inserted opposite to the hind margin of the præoperculum.

The scales are small, thin, smooth, adherent. The lateral line is a continuous tract, not covered by scales, running parallel to, and close to, the dorsal profile, and disappearing in the posterior third of the tail; it is separated from the dorsal fin by about six series of scales.

The colour was probably pink, with black vertical fins; cavity of the mouth and gills black.

Habitat.—Japan, Station 235; depth, 565 fathoms. One specimen, 14½ inches long.

Dicrolene.

Dicrolene, Goode and Bean, Bull. Mus. Comp. Zoöl., vol. x., 1883, p. 202.

The lower pectoral rays are separate and much produced. Body elongate, moderately compressed, covered with small scales. Lateral line incomplete, close to the dorsal profile. Head somewhat compressed, covered with scales. Eye large. A small separate caudal fin much prolonged. Ventral fins close together, each composed of a single bifid ray. Snout short; jaws nearly equal in front; barbel none. Mouth and dentition as in *Pteroidonus.* Operculum with a straight spine. Seven branchiostegals. Gill-laminæ of moderate length; gill-rakers rather long, not numerous; pseudobranchiæ none. Pyloric cæca few, rudimentary.

One species is known.

Dicrolene intronigra.

Dicrolene introniger, Goode and Bean, *loc. cit.*

B. 7. D. 100. A. ca. 85. C. 6 or 7. V. 1 | 1. P. 19 | 7–8. L. transv. ca. 27 (above vent).

Head with supraorbital spines; several strong spines on the præoperculum. Eye one-fourth as long as the head and as wide as the interorbital space. Upper detached pectoral ray one-third of the length of the body, and about thrice as long as the fin.

Habitat.—Several specimens (the size is not stated) were obtained by the U.S. steamer "Blake"; in lat. 33° 40′ N., long. 76° 0′ W.; in 464 and 647 fathoms.

Mixonus, n. gen.

I have long hesitated to describe the following fish under a distinct generic name. The specimen is small, unique, and not in the best state of preservation, so that several of the characters assigned here to the genus may have to be amended when other specimens are discovered. Its pertinence to either *Pteroidonus* or *Dicrolene* seems to be doubtful on account of the difference in the shape of the head.

The lower pectoral rays are free, not united by membrane with, but inserted on the same base as the upper part of the fin; they are but slightly stronger than the other rays and prolonged. Body elongate, compressed, covered with small, very thin and deciduous scales. Head slightly compressed, broad and flat above, depressed in front, naked (with the exception of the parts between the mandibles, and, perhaps, of the cheeks). Bones thin, with the muciferous system moderately developed; only one small spine above on the operculum; præoperculum without spine. Eye small. Vertical fins united, but the narrow caudal projecting beyond the short dorsal and anal rays. Ventrals each reduced to a filament, which consists of two rays firmly bound together in their whole length; they are inserted behind the humeral symphysis and close together. Snout broad, rounded, scarcely overlapping the lower jaw. Mouth very wide; villiform teeth in the jaws, on the vomer and palatine bones. Gill-laminæ short; gill-rakers long, not very closely set. Pseudobranchiæ none.

Mixonus laticeps (Pl. XXV. fig. B).

Bathynectes laticeps, Günth., Ann. and Mag. Nat. Hist., vol. ii., 1878, p. 20.

The greatest depth of the body is below the origin of the dorsal fin, and one-third of the length of the trunk (including head). The distance of the vent from the snout is two-thirds of its distance from the extremity of the spinal column. The length of the head equals the remainder of the trunk. The crown of the head is remarkably convex, covered with an extremely thin and transparent skin, which, perhaps, in older examples is scaly. The interorbital space less convex, and equal in width to the length of the snout including the eye. Eye small, above the middle of the length of the maxillary, one-half of the length of the snout, and one-eighth of that of the head. Posterior nostrils wide, open, in front of the eye.

The distance of the vent from the ventrals exceeds the length of the head. Origin of the dorsal fin above the root of the pectorals, its rays of moderate length, but longer than those of the anal. Pectoral with a rather narrow base, as long as the head without snout; its rays are feeble, seventeen in number, of which the three or four lower ones are a little stouter, detached, and prolonged. The ventral filaments do not reach as far backwards as the pectoral.

Gill-rakers ten, much longer than the laminæ. Whitish, with the abdomen and gill-apparatus black.

Habitat.—One specimen, $5\frac{1}{2}$ inches long, was obtained in Mid-Atlantic (Station 104), at the enormous depth of 2500 fathoms.

Bathyonus.

Bathynectes sp., Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 20.
Bathyonus sp., Goode and Bean, Proc. U.S. Nat. Mus., vol. viii., 1886, p. 603.

Body compressed, with long tapering tail, covered with deciduous thin scales of moderate size. Bones of the head very soft and cavernous, the upper opercular spine very feeble, ridge-like; no other armature on the head. Head scaly, except the snout, which is obtusely rounded off, with the jaws equal or nearly equal in front. Mouth very wide; bands of villiform teeth in the jaws, on the vomer and palatine bones. Barbel none. Eyes small. The anterior nostril about midway between the posterior and the extremity of the snout. Vertical fins confluent; ventrals close together, reduced to a pair of simple filaments, and inserted below the rounded angle of the præoperculum.

Gills four, with short gill-laminæ, but with long stiff gill-rakers on the first branchial arch. Pseudobranchiæ none. Branchiostegals eight. Pyloric appendages none.

Bathyonus compressus (Pl. XXII. fig. A).

Bathynectes compressus, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 20.

D. 116. A. 92. P. 23. V. 1.

The greatest depth of the body is above the end of the gill-cover and about one-half of the length of the trunk, the vent being twice as distant from the extremity of the tail as from the snout; consequently, the tail is but moderately attenuated. Head compressed like the body, and about two-thirds of the length of the trunk; the superficial bones form large muciferous cavities which, when full, must give to the head a much more evenly rounded appearance than in the preserved state, when the supporting bony ridges project more or less from under the skin. The snout is slightly swollen, but the jaws are nearly even in front, the wide mouth slightly ascending forwards. The maxillary has the form usual in these Gadoid fishes, is dilated behind, and extends far behind the eye.

The eye is very small, one half of the length of the snout, and about one-eleventh of that of the head; it is placed high up on the side, and does not possess an orbital fold of the integument. The interorbital space rather convex and equal in width to three diameters of the eye.

All the teeth are very small and short, densely set, and form villiform bands. The broadest is that of the maxillary bone, and it is quite uncovered on the sides, no labial folds being developed. The palatine band is broader than the mandibulary, and the vomerine band Λ-shaped, each arm being bent with the convexity inwards.

Gill-opening and cavity very wide and of an intense black. The gill-rakers are much longer than the laminæ, fifteen in number on the anterior arch, besides some rudimentary ones above.

The dorsal fin commences above the upper end of the gill-opening, with short rays partly hidden in the skin; the rays become longer in the middle of the fin, but remain of moderate length, and the anal rays are still shorter. The pectoral has a rather narrow base, is quite free, and composed of feeble rays; its length is only half that of the head. Ventral rays very feeble, reaching somewhat beyond the root of the pectoral.

Only very few of the thin, cycloid scales have been preserved; they are of moderate size, there being about sixteen in a transverse series running from the vent to the dorsal fin. The lateral line, if it was developed, can no longer be traced.

Blackish, with the fins, head, and abdomen black.

Specimens of this very fine and truly bathybial fish were obtained at great depths on the south-east of New Guinea, off the Philippine Islands, and in the Mid-Atlantic.

Habitat.—Seventy-five miles east-south-east of Raine Island, Station 184; depth, 1400 fathoms. Two specimens, 17 and $4\frac{1}{2}$ inches long.

Philippine Islands, Station 205; depth, 1050 fathoms. One specimen, $5\frac{1}{2}$ inches long.

Mid-Atlantic, Station 107; depth, 1500 fathoms. One specimen, $5\frac{1}{2}$ inches long.

The young specimens are extremely similar to the old, but have a larger eye, which is only one-eighth of the length of the head. The specimen from Station 205 (Philippine Islands) has longer ventral filaments, extending nearly to the vent.

Bathyonus tænia (Pl. XXIII. fig. A).

D. 138. A. 115. P. 30. V. 1.

The greatest depth of the body is below the origin of the dorsal fin, and about one-third of the length of the trunk, the vent being not quite thrice as distant from the extremity of the tail as from the snout. Therefore the whole fish, and especially the tail, is much attenuated. Head not compressed, low and long, forming four-sevenths of the length of the trunk. Structure of the bones of the head as in *Bathyonus compressus*. Snout rather swollen and broad, the upper jaw but slightly overlapping the lower. Maxillary extending far behind the eye, which is very small, one-third of the length of the snout, about one-fourteenth of that of the head, and one-fourth of the width of the interorbital space. All the teeth are very small and short, densely set, forming narrow villiform bands; vomerine band open, Λ-shaped. Gill-cavity deep black; gill-rakers long and slender, sixteen in number, with some rudimentary ones in front and behind.

The dorsal fin commences above the upper end of the gill-opening, with short rays partly hidden in the skin; the rays become longer on the anterior third of the tail, but remain of moderate length, and the anal rays are still shorter. The pectoral has a broad base, is quite free, and composed of rather feeble rays; its length is equal to that of the postorbital portion of the head. Ventral rays very feeble, reaching nearly to the middle of the pectoral.

The scales must have been extremely thin, and rather small; there were probably about twenty in a transverse series running from the vent to the dorsal fin. The lateral line cannot be made out.

Light-coloured (possibly pink in life), with the head and abdomen black.

Habitat.—Only one specimen of this eminently bathybial fish was obtained in Mid-Atlantic (Station 104), at a depth of 2500 fathoms. Its total length is 10 inches.

Bathyonus catena.

Bathyonus catena, Goode and Bean, Proc. U.S. Nat. Mus., vol. viii., 1886, p. 603.

Tail much attenuated; height of the body two-thirds of the length of the head. Head not much compressed; width of the interorbital space equal to the diameter of the eye, about equal to the length of the snout, and one-fifth of that of the head. Gill-rakers long, about fifteen in number. Origin of the dorsal fin slightly behind the root of the pectoral; pectoral four-fifths as long as the head. The distance of the vent from the root of the ventral rather more than the length of the head. Brownish-yellow, head and abdomen blackish.

Habitat.—This species evidently belongs to the same genus as *Bathyonus compressus* and *Bathyonus tænia;* it is known from two specimens, 8 and 9 inches long, obtained by the U.S. Fish Commission in lat. 28° N., long. 87° 42′ W.; at a depth of 1467 fathoms.

Porogadus.

Porogadus, Goode and Bean, Proc. U.S. Nat. Mus., vol. viii., 1886, p. 602.

Body compressed, with long, tapering tail, covered with very thin, small, deciduous scales. Bones of the head soft, with the muciferous channels moderately developed. Operculum with a spine above; some of the other cranial bones project as spines. Snout rather depressed, with the jaws equal in front. Mouth very wide; bands of ivlliform teeth in the jaws, on the vomer and palatine bones. Barbel none. Eyes small. The anterior nostril much smaller than the posterior and about midway between the posterior and the extremity of the snout. Vertical fins confluent; ventrals close together, close to the humeral symphysis, each composed of two subequal filaments.

Gills four, with very short laminæ, but with long stiff gill-rakers on the first branchial arch. Pseudobranchiæ rudimentary.

Porogadus gracilis (Pl. XVI. fig. B).

Bathynectes gracilis, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 21.

Head and body low, rather compressed; tail produced into a long filament. The greatest depth of the body is on a level with the root of the pectoral, and is two-sevenths of the length of the trunk. The length of the head is nearly one-half of the same length. Eye of moderate size, its diameter five and a half times in the length of the head, and two-thirds of that of the snout and of the width of the interorbital space, which is somewhat convex. The posterior nostrils are very wide and separated from the eye by a small spinous projection of bone. The muciferous channel of the infra-orbital ring shows in its course five or six wide sinuses, that of the præoperculum four or five. The integument of the head being very thin, underlying projections of the bone appear in preserved specimens as small prominent spines above the posterior portion of the eye; on the shoulder there is a single short spine. Præoperculum without spines. Mouth very wide, extending far behind the eye, the extremity of the maxillary much dilated. The teeth form narrow bands, that of the vomer is Λ-shaped, with the two arms straight. The dorsal fin commences above the root of the pectoral, its rays being of moderate length, but longer than those of the anal. Pectoral with feeble rays, tapering, as long as the head exclusive of the snout. Each ventral is composed of a bifid filament, the longer part of which extends backwards as far as the pectoral.

Scales very thin, cycloid, small, with the exception of some (about seven), which form a series running from the upper end of the gill-opening towards the dorsal fin; these are about three times the size of the others. About twenty-four may be counted in a transverse series running from the vent to the dorsal fin.

Outer branchial arch with sixteen long and slender gill-rakers, the longest of which are about five times as long as the laminæ. Of pseudobranchiæ only two minute lobules can be distinguished.

Colour light brownish, head and abdomen black.

Habitat.—A single specimen, 9 inches long, was obtained at Station 184, south of New Guinea, at a depth of 1400 fathoms.

Porogadus miles.

Porogadus miles, Goode and Bean, Proc. U.S. Nat. Mus., vol. viii., 1886, p. 602.

Tail much attenuated, the length of the head being contained six and a half times in the total. Eye contained five and three-quarter times in the length of the head, and rather less than the width of the interorbital space. The maxillary extends far behind the eye. Head with numerous spines on the interorbital space, two pairs on the shoulders, one at the angle of the operculum, and a double series on the angle of the præoperculum; and with numerous mucous pores. Behind each posterior nostril a strong spine, projecting outwards and backwards. The distance between the root of the ventrals and the vent nearly equals the length of the head. Origin of the dorsal somewhat behind the vertical from the base of the pectoral. Blackish-brown.

Habitat.—A single specimen, 153 mm. long, was obtained by the U.S. Fish Commission in lat. 38° 27′ N., long. 73° 0′ W., at a depth of 1168 fathoms.

Porogadus rostratus, n. sp. (Pl. XXIV. fig. B).

B. 8. D. 120. A. 95 (?). P. 21. V. 2.

This species differs strikingly from the two preceding by its much shorter form, and by the peculiar shape of its snout.

The body is moderately compressed, the head depressed, especially in its rostral portion. The greatest depth of the former is about the middle of the abdomen, and two-fifths of the length of the trunk, of which the head forms a little more than one-half. The trunk (including the head) is fully two-thirds of the length of the tail, which rapidly tapers to a fine point.

Head as broad as high, its width being equal to the length of the postorbital portion; snout depressed, with its central portion slightly produced, overlapping the lower jaw. Mouth wide, extending to the hind margin of the orbit. Eye small, immediately below the upper profile, one-ninth of the length of the head, one-third of that of the snout, and two-fifths of the width of the flat interorbital space. The nostrils are somewhat remote from each other, the posterior being wide, round and open. The folds of the mucous membrane of the nasal cavity are arranged in two rows, forming together a longitudinal pad with a linear base.

The bones of the head are rather thin, and the superficial shaped into large sinuses. Spines are developed on the operculum, which is armed above with a short horizontal spine; on the præoperculum, the margin of which is irregularly crenulated; behind the supraciliary edge, where a short spine points backwards; and finally, behind the posterior nostril, which is separated from the orbit by a very short spinous projection. The muciferous channels are very wide, that of the frontal bone opens in front by a wide aperture on each side of the rostral projection; a longitudinal ridge runs along the infraorbital ring. Each mandibulary canal opens in front immediately behind the symphysis by a slit in the skin.

Teeth in villiform bands in the jaws, on the vomer and palatine bones, the vomerine band being Λ-shaped and much narrower than the palatine band.

The dorsal fin begins above the posterior third of the pectoral, and is composed of densely set, fine and rather short rays, which, however, are a little longer than those of the anal fin.[1] Pectoral with a narrow base and feeble rays, not quite half as long as the head. The ventral filaments are still shorter, very feeble, close together, and inserted opposite to the rounded angle of the præoperculum.

The scales are cycloid, not deciduous, and rather irregularly arranged. Traces of a lateral line can be distinguished at various parts of the body, but they are not continuous. About thirty scales can be counted in a transverse series running from the vent to the dorsal fin. The upper and lateral parts of the head, and also the rami of the mandible, are covered with small thin scales.

The gill-laminæ are short, shorter than the stiff and widely-set gill-rakers, which are eight or nine in number. Of pseudobranchiæ only two or three small lobes can be distinguished. Pyloric appendages none.

Uniform black.

Habitat.—Only one specimen, in an excellent state of preservation, 11½ inches long, was obtained North of Celebes (Station 198), at a depth of 2150 fathoms.

Nematonus, n. gen.

Bathyonus sp., Goode and Bean.

This genus differs from *Porogadus* merely by the absence of spines on the head.[2]

Nematonus pectoralis.

Bathyonus pectoralis, Goode and Bean, Proc. U.S. Nat. Mus., vol. viii., 1886, p. 604.

B. 8. D. 93. A. 73. P. 17. V. 2.

Tail moderately elongate. Eye rather small, one-seventh of the length of the head, and slightly less than that of the snout. Distance of the root of the ventrals from the vent rather more than the length of the head. The penultimate ray of the pectoral prolonged, nearly twice as long as the head. About twenty-three scales in a transverse series running from the vent to the dorsal fin. Eighteen long gill-rakers on the first arch. Brownish-yellow, head and abdomen blackish.

[1] In consequence of some injury during life, a small portion of the anal fin is lost.

[2] The operculum probably is armed with a small spine behind, as in the majority of the fishes of this group.

Habitat.—Two specimens were obtained by the U.S. Fish Commission; one $8\frac{1}{2}$ inches long in lat. 28° N., long. 87° 43′ W., at 1430 fathoms; the other, $2\frac{1}{2}$ inches long, off Dominica in 330 fathoms.

Diplacanthopoma, n. gen.

Body compressed, elongate, covered with small and thin scales; lateral line very indistinct; head rather depressed, naked, with thin bones and wide muciferous channels. Eye of moderate size. Nostrils far apart, the posterior widely open, in front of the eye, and the anterior at the extremity of the snout. Operculum with two spines, one pointing backwards, the other situated behind the angle of the præoperculum and pointing downwards; præoperculum unarmed. Snout not swollen, broad, depressed, the upper jaw slightly overlapping the lower; barbels none. Mouth of moderate width; bands of villiform teeth in the jaws, on the vomer and the palatine bones. Tail attenuated; vertical fins confluent; ventrals close together, reduced to a pair of simple filaments and inserted somewhat behind the isthmus below the middle of the operculum. Gills four, with lanceolate, widely-set gill-rakers, and well-developed laminæ. Pseudobranchiæ none.

Diplacanthopoma brachysoma, n. sp. (Pl. XXIII. fig. C).

The greatest depth of the body is below the origin of the dorsal fin, and contained twice and one-third in the distance of the extremity of the snout from the vent. The head is about as deep as broad, its length being equal to the distance of the vent from the root of the ventral fins, and more than one-half of the length of the body exclusive of the tail. The vent is nearer to the snout than to the root of the caudal. Eye of moderate size, without orbital fold, as long as the snout, one-fifth of the length of the head and equal to the width of the flat interorbital space. Mouth of moderate width, the maxillary extending somewhat behind the eye and being slightly dilated behind. All the teeth are in narrow villiform bands, that of the vomer being open and Λ-shaped. The superficial bones of the head are thin, and those of the infraorbital ring and of the mandible dilated for the reception of the wide mucous canals. Of the opercular spines the horizontal is remarkably long, much longer than the lower vertical one.

The vertical fins are completely united, and, owing to the great attenuation of the tail, no caudal portion can be distinguished. The rays are very thin, closely set, and of moderate length. Origin of the dorsal fin immediately behind the root of the pectoral, and that of the anal immediately behind the vent. Pectoral fins rather narrow, inserted on a short, broad, and partly free pedicle; they are longer than the postorbital portion of the head; ventrals half as long as the distance of their root from the vent.

The scales are rather small, thin, cycloid, and rather deciduous; if a lateral line is present, it is confined to the trunk.

Upper parts of a uniform light brownish colour; the lower parts and the fins colourless.

Habitat.—Off Pernambuco, coast of Brazil, Station 122; depth, 350 fathoms. One specimen, 4½ inches long.

Acanthonus.

Acanthonus, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 22.

Head excessively large and thick, armed in front and on the opercles with strong spines; trunk very short, the vent being below the pectoral; tail thin, strongly compressed, tapering, with the caudal distinct. Eye small. Mouth very wide, with the teeth in villiform bands in the jaws, on the vomer and palatine bones, and along the hyoid. Barbel none. Ventrals each reduced to a bifid filament, placed close together on the humeral symphysis. Gill-membranes not united. The gill-laminæ are remarkably short; the gill-rakers long, lanceolate, stiff. Scales extremely small. Bones of the head soft, the superficial supporting large cavities.

A true deep-sea form of extraordinary shape, but otherwise not differing from the typical Ophidiidæ.

The gills are four in number, a long slit being behind the fourth. The long gill-rakers (Pl. XXIV. figs. *a*, *a'*) are confined to the middle piece of the first branchial arch, about twenty in number, of which the hindmost are nearly ½ inch long. The gill-laminæ are very short, but it is possible that they were longer during life, and have shrunk by the action of the spirit; they are slender, like tentacles, free at their extremity. The air-bladder is lodged in a spacious cavity below the abdominal portion of the vertebral column; its membranes are thin where they are attached to the walls of the abdominal cavity, only that portion which separates the organ from the intestines being of a firmer texture. Its posterior portion does not extend to between the muscles of the tail, and is subdivided into several smaller cells by trabeculæ.

The stomach is elongate, externally distinguished from the intestine by a covering of black-coloured peritoneum; the peritoneal lamina, which covers the intestine, being colourless. It is, in the specimen examined, contracted, and does not appear to have been capable of that extraordinary degree of distension which is observed in other deep-sea forms. The intestine makes one and a half convolutions and is short. Liver small. Urinary bladder large; kidneys limited to the posterior part of the abdominal cavity. Testicles oblong.

The specimen dissected had two gland-like masses attached to the posterior edge of the liver and the lower portion of the intestine. They were enveloped in a dense membrane with polished, pearly surface. The contents consisted of more or less confluent cysts filled with a cheesy matter, probably the remains of perished parasitic worms.

Acanthonus armatus (Pl. XXIV. fig. A).

Acanthonus armatus, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 22.

B. 9. D. + C. + A. 100 + 3 + 88. C. 8. P. 18. V. 2.

The head of this remarkable fish appears of an extraordinary thickness, compared with the thin and compressed trunk and tail; it is very broad across the frontal regions and not much longer than high; the small eye being much nearer to the end of the snout than to the gill-opening. The snout would be truncated in front, but for its upper projecting portion which terminates in two short acute spines. The large mouth is slightly oblique, the maxillary extending backwards beyond the middle of the length of the head. The jaws are equal in front. Two sharp ridges run along each ramus of the mandible, to receive between them a wide muciferous channel.

The angle of the præoperculum is armed with four spines, three of which are placed on the outer edge of the bone; the upper is the longest and dagger-shaped, pointing backwards, the middle is shorter, broader, and points, like the third and smallest, downwards. The fourth is placed anteriorly to the first, arising from the anterior lamella of the bone, short and directed outwards. The longest spine of the head is part of the operculum, which otherwise is a very thin and narrow bone; this spine is nearly two-fifths the length of the head, styliform, deeply grooved above and below, and points backwards.

The nostrils are rather close together, and on the side of the snout; a large mucous aperture in front of them, below the rostral spines.

The entire head and body were covered with minute scales, thin and deciduous, and mostly lost in the specimens. The lateral line is represented by a series of small, distant black pores, running along the proximal ends of the interneural spines.

The length of the body and tail is not quite thrice that of the head; the vent placed immediately behind the root of the pectoral; its distance from the root of the ventrals is less than the length of the head.

The dorsal fin begins nearly above the root of the pectoral, but some rudimentary rays are more advanced and hidden under the skin. The rays are moderately long, longer than those of the anal fin, and gradually decrease in length as they approach the end of the tail; in one of the specimens the small caudal is distinctly free from the other fins. Pectoral fin with broad base, rounded edge and eighteen thin rays, the longest of which are two-fifths as long as the head. The ventral filaments are about half the length of their distance from the vent.

The entire fish is either black or of a reddish-white colour, with the exception of the jaws and abdomen, which, like the buccal and branchial cavities, are of a deep black, as is so often the case in deep-sea fishes.

Distance of the snout from the eye,	1 inch.	1 line.
Distance of the snout from the gill-opening,	3 „	4 „
Distance of the snout from the vent,	4 „	...
Total length,	13 „	...

Habitat.—Philippine Islands, Station 205; depth, 1050 fathoms. One specimen, 13 inches long.

North of New Guinea, Station 218; depth, 1070 fathoms. One specimen, $11\frac{1}{2}$ inches long.

Of the figures on Pl. XXIV. figure *a* represents the outer and figure *a′* the inner aspect of the first branchial arch.

Typhlonus.

Typhlonus, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 21.

Head large, compressed, with most of the bones in a cartilaginous condition; the superficial bones with enormous muciferous cavities, not armed. Snout a thick protuberance, projecting far beyond the mouth, which is rather small and inferior. Trunk very short, the vent being below the pectoral; tail excessively compressed, deep, tapering, without separate caudal. Eye not visible externally, reduced to a minute rudiment hidden below the skin. Bands of villiform teeth in the jaws, on the vomer and palatine bones. Barbel none. Ventrals reduced to simple filaments, placed close together on the humeral symphysis. Gill-openings very wide, the gill-membranes being but slightly united in front. Gills four; gill-laminæ very short, gill-rakers of moderate length. Scales thin, deciduous, small.

A true deep-sea form.

After removal of the extremely thin skin from the side of the head, a partly cartilaginous partly membranaceous layer is laid bare, which is formed by the greatly expanded dermal bones and the walls of the mucous cavities. The place of the orbital cavity is covered by this layer, underneath which a minute black globular body (smaller than a pin's head) represents the rudiment of an eye. The opercular bones are almost membranaceous, the sub- and interoperculum supported by fibrous rays. Vertebræ thin, but ossified. The abdominal cavity does not extend into the tail. Liver small. Stomach apparently not much distensible, covered by a lamina of the black peritoneum.

Intestine with two and a half convolutions. Air-bladder a simple, thin-walled sac. Kidneys large, extending far forwards. Ovaries enclosed in a membranous sac.

Mr. Murray[1] observes :—"This Ophidiid had a large, rounded, fleshy head; no trace of an eye could be seen other than a small dark spot a considerable distance underneath the skin. The fins were black, but the body of the fish was white; with the exception of one or two, all the scales had been rubbed off, and with them apparently a thin black skin, so that probably the fish when first caught by the trawl was of a uniform black colour; the mouth and gill-chambers were black."

Typhlonus nasus (Pl. XXV. fig. A).

Typhlonus nasus, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 21.

The head of this most remarkable form is somewhat compressed, deep, as thick in the rostral as in the opercular portion; its length is rather more than one-fourth of the total. Protuberances, formed by projecting portions of the cranium, occupy the upper and lateral surfaces of the head; and more especially one in front, and another on each side of the snout are very conspicuous.

The cavities between them are large, muciferous; during life, when these cavities are full, the whole head must be enveloped in mucus.[2] No apertures leading into them are visible anywhere. The snout is thick, projecting far beyond the mouth, which is rather small, horse-shoe-shaped and quite at the lower side of the head. A thin skin, covered with very small scales, envelops the whole head. The nostrils are close together situated on the lateral prominences of the snout.

The depth of the body is not quite equal to the length of the head. The scales appear to have been irregularly arranged, and no lateral line is visible. The dorsal fin commences above the root of the pectoral, and is composed of numerous feeble and rather short rays; it passes without interruption into the caudal and anal. The distance of the vent from the root of the ventral is only half the length of the head.

Pectoral rounded, composed of twenty-six feeble rays, reaching beyond the vent; ventral filaments beyond the extremity of the pectoral.

Light brownish, with black fins.

Habitat.—North-east of Australia, Station 181; depth, 2440 fathoms. One specimen, 10 inches long.

North of Celebes, Station 198; depth, 2150 fathoms. One specimen, 10 inches long.

[1] Narr. Chall. Exp., vol. i. p. 520.

[2] The external configuration of the head during life is evidently very different from the appearance which it presents in specimens preserved in strong spirits. After the specimen had been submerged in diluted alcohol for the purposes of dissection, the mucus still remaining in the cavities swelled into a gelatinous mass, distending the membranes, so that the contours of the head appeared rounded.

Aphyonus.

Aphyonus, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 22.

Head, body and tapering tail strongly compressed, enveloped in a thin, scaleless, loose skin. Vent far behind the pectoral in nearly the middle of the total length. Snout swollen, projecting beyond the mouth, which is wide. No teeth in the upper jaw; small conical teeth in the lower, pluriserial in front and uniserial on the side. Vomer with a few rudimentary teeth; palatine teeth none. Nostrils close together, small. No externally visible eye. Barbel none. Ventrals reduced to simple filaments, placed close together, and near to the humeral symphysis. Gill-membranes not united. Four branchial arches, the posterior without gill-laminæ; the anterior with very short gill-rakers and with rather short gill-laminæ. Head covered with a system of wide muciferous channels and sinuses, the dermal bones being almost membranaceous, whilst the others are in a semicartilaginous condition. Notochord persistent, but with a superficial indication of the vertebral segments (as in some Leptocephaline forms).

Although this fish resembles *Typhlonus* in so many points that one might be induced to regard it as an early stage of development of that fish, no such direct relation can obtain between them. The single individual obtained by the expedition has the ovaries fully developed, filling one-half of the abdominal cavity, the ova being apparently mature and ready for exclusion. It is, therefore, a persistent and independent type, the lowest of all Anacanths, so far as is known at present, which has remained stationary at an early stage of its development. The abdominal organs do not show any peculiarity, and are very similar to those of *Typhlonus*.

Aphyonus gelatinosus (Pl. XXVI. fig. A).

Aphyonus gelatinosus, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 22.

The head, in the preserved specimen, is compressed, rather deep, and enveloped in loose skin; especially on the upper side of its anterior half the skin forms a large loose bag, which, during life, is probably filled and distended with mucus.

The snout overlaps the wide mouth, the maxillary extending backwards nearly to the middle of the length of the head. A rudiment of the eye, in the shape of a minute black globular body, is hidden below the skin in a recess of the infraorbital mucous sinus, as in *Typhlonus*. Seen from above, the head appears convex, rather broad; its length is less than its distance from the vent and one-fourth of the total.

The body is strongly compressed and deep, its depth at the beginning of the dorsal fin being one-third of the distance of the vent from the snout; also the tail is deep and short, shorter than the rest of the body. The skin covering the muscular parts is not loose, very thin, transparent, so that the myocommas can be clearly seen through it.

The integument of the abdomen is loose, and forms a double fold in the median line, which, however, extends only to about the middle of the length of the abdomen. The vent and genital openings project as thick papillæ.

The vertical fin is continuous, and supported throughout by extremely numerous, densely set, fine cartilaginous rays; it commences immediately behind the vertical from the root of the pectoral, and is continued round the tail to the vent. Pectoral with a broad base, and thirty-three fine rays, rounded, more than half as long as the head. Ventral filaments stoutish, with a narrow fringe of skin, as long as the pectorals.

Transparent, colourless, like a *Leptocephalus*.

Habitat.—Between north-east Australia and New Guinea, Station 184; depth, 1400 fathoms. One specimen, 5½ inches long.

Mr. Murray[1] mentions that three specimens were obtained of this fish. However, on closer inspection, one only of these three specimens proved to be an *Aphyonus*, the two others belonging to different genera.

Rhodichthys.

Rhodichthys, Collett, Norsk. Nordh. Exped. Fisk., p. 153.

Head thick, body and tail strongly compressed, the latter tapering behind, enveloped in a thin, transparent, scaleless skin. Vent immediately behind the humeral symphysis. Snout swollen, overlapping the wide mouth. A few series of weak teeth in the jaws, none on the vomer or palate. Eye of moderate size. Ventrals reduced to two filaments, each bifid, and inserted on the hyoid. Vertical fins continuous, but with caudal rays differentiated. Gill-openings very wide. Pyloric appendages ten.

Rhodichthys regina.

Rhodichthys regina, Collett, Norsk. Nordh. Exped. Fisk., p. 154, pl. v.

Ventral filaments long. Uniform bright red during life.

Habitat.—A single example, nearly 12 inches long, was obtained by the Norwegian expedition in the sea between Bear Island, Jan Mayen, and Finmark, from a depth of 1280 fathoms.

[1] Narr. Chall. Exp., vol. i. p. 521.

Family Macruridæ.

Macrurus.

Head generally with large muciferous cavities, most developed in the suborbital ring, and continued into the præoperculum and into the snout, which frequently projects more or less beyond the mouth. The mouth may be inferior or subterminal and lateral, is armed with small teeth, and the palate is toothless. A barbel at the symphysis of the lower jaw. Scales sometimes typically ctenoid, sometimes cycloid; no scaleless fossa on the side of the nape. The second dorsal is always less developed than the anal, and its anterior rays, or all of them, are more or less rudimentary. Gill-membranes slightly united in front. Four gills with well-developed gill-laminæ; no pseudobranchiæ. A broad fold of the membrane of the gill-cavity stretches across to the terminal portions of the first branchial arch, and renders the slit between that arch and the wall of the gill-cavity much narrower than the slits between the arches. Gill-rakers of the first branchial arch broad, low, cartilaginous bodies, generally armed with curved spines.

Before the Challenger Expedition the known species of *Macrurus* were few in number, and they were but sparingly represented in museums. Thus, when I gave a general account of them in the year 1862, I knew from autopsy five only, and I believed I recognised in them the types of three genera, which I distinguished by the form of the snout and position of the mouth, by the size of the scales and modifications of the dentition.

The dredge of the Challenger secured more than one hundred and forty examples, referable to thirty species, and proved that this type of fishes is not only one of the most widely spread in the depths of all oceans, but also extremely abundant with regard to species and individuals. These materials afforded the further evidence that the characters on which I had relied for the generic groups of *Macrurus*, *Coryphænoides*, and *Malacocephalus*, did not possess the taxonomic value assigned to them, with the exception of the modifications of the dentition, which, however, were capable of more precise definition.

With regard to the form of the snout and position of the mouth, there exists every gradation, from the most specialised types, such as *Macrurus japonicus* and *Macrurus parallelus*, to *Macrurus longifilis*, which may be regarded as representing the original type whence the others were derived. Its head is compressed, well proportioned, formed by firm bones, the superficial of which enclose a muciferous system not more enlarged than we find it in many surface fishes; its snout is not more tumid or projecting than in the majority of surface Gadoids, and the wide mouth terminal and lateral. As the muciferous cavities increase in width, the bones are expanded into thin lamellæ and lose in firmness, those of the infraorbital ring cover more or less the side of the head, extend backwards to the angle of the præoperculum, and push the latter backwards. The snout becomes the receptacle of large or even enormously enlarged cavities, supported by thin osseous ridges, and projects more or less beyond the mouth, which is forced downwards to the lower surface of the head, like that of a shark. Thus, great as the dissimilarity is between the extreme forms of the snout in the species of *Macrurus*, there is no fundamental difference in structure; they merely represent different degrees of the same line of modification.

With regard to the scales, there is also every gradation from the small-scaled *Malacocephali* to the large-scaled *Macrurus longibarbis*. In very young specimens of all species the scales formed at first are always thin, without any armature, in fact cycloid. Spines appear only after some time, generally in the median line of the scale, singly and not in series; scales with fully developed armature are generally not found in specimens under 8 inches in length. In some species which normally possess strongly spiniferous scales, individuals may occur (especially such whose skin is wanting in pigment), in which the spines are much more feeble and scarcely visible. And finally, there are species in which the cycloid structure of the scales remains normally persistent. Thus, neither the size nor the structure of the scales can be safely used as a generic character.

The serrature or smoothness of the dorsal spine is a constant character,[1] the serrature but rarely becoming obsolete with age, and never disappearing altogether so far as my observations go. In very young specimens the barbs are comparatively further apart and less numerous than in older ones, in which the barbs of more recent growth are more adpressed to the body of the spine, more closely arranged, and more numerous at the base than towards the top.

The dentition is an infallible aid in the discrimination of the species, and therefore is used here as the main character in their arrangement.

I have generically separated from the *Macruri* those forms which do not possess the characteristic attachment of the first branchial arch to the outer wall of the gill-cavity; but with regard to the host of the other species, I do not think that they should be more widely separated than in the form of subgeneric groups; there is no doubt that many more species will come to light, which may lead to a different mode of arranging the species.

It is singular that, although the Macruridæ are represented in the deep-sea by such a great number of species and individuals, no young specimens in the *Krohnius*-stage[2] were obtained by the expedition.

[1] This character has also been used by Lütken in a synopsis of genera and species, *Vid. Meddel. nat. Foren. Kjøbenhavn*, 1872, p. 4.
[2] *Cf.* Emery, *N. Accad. d. Linc. Rom.*, vol. iii., 1879.

Systematic Arrangement of the Subgenera of Macrurus.[1]

I. Teeth in villiform bands above and below, that of the lower jaw always broadest near the symphysis, and sometimes tapering into a series on the side of the jaw.

A. Scales distinctly imbricate, without enlarged dorsal scales.

1. Scales spinigerous:—

a. Mouth entirely at the lower side of the head, a longitudinal ridge dividing the infraorbital region into a vertical and subhorizontal portion. Dorsal spine smooth, . . . *Cœlorhynchus.*

b. Mouth inferior; infraorbital ridge more or less distinct. Dorsal spine serrated, . . *Macrurus.*

c. Mouth wide and lateral. Dorsal spine serrated, *Coryphænoides.*

d. Mouth wide and lateral. Dorsal spine smooth, *Mystaconurus.*

2. Scales smooth, ... *Lionurus.*

B. Scales indistinct, the whole skin covered with villosities, *Trachonurus.*

C. A series of enlarged scales along the base of the dorsal and anal fins, ... *Cetonurus.*

II. Intermaxillary heterodont, with an outer series of strong widely-set teeth, and an inner villiform band; mandibulary teeth uniserial.

A. Dorsal spine serrated, ... *Chalinurus.*

B. Dorsal spine smooth, ... *Optonurus.*

III. Intermaxilliary teeth uni- or biserial; mandibulary teeth uniserial.

A. Dorsal spine smooth, ... *Malacocephalus.*

B. Dorsal spine serrated, ... *Nematonurus.*

[1] Owing to insufficient description no further notice can be taken here of the following species:—

1. *Macrurus macrolepidotus*, Kaup (*Archiv f. Naturgesch*, 1858, p. 91). Scales with fourteen to fifteen keels; twelve scales only from the anus upwards to the back.
2. *Macrurus acrolepis*, Bean (*Proc. U.S. Nat. Mus.*, vol. vi. p. 362). Washington Territory.
3. *Macrurus carribæus*, Goode and Bean (*Proc. U.S. Nat. Mus.*, 1886, p. 594), from the northern part of the Gulf of Mexico, depth 210 fathoms (belongs to the section *Cœlorhynchus*).
4. *Malacocephalus occidentalis*, Goode and Bean (*Proc. U.S. Nat. Mus.*, 1886, p. 597), from depths of 132 and 164 fathoms, in the western and central Atlantic (would seem to belong to the section *Nematonurus*).
5. *Macrurus occa*, Goode and Bean (*loc. cit.*, p. 595), from 335 fathoms in the western central Atlantic. The authors consider this a near relation to *Macrurus trachyrhynchus*, but as they do not mention either the large dorsal scales, or the temporal fossa, or the structures of the gills, it is quite as likely that it is one of the long-snouted species of true *Macruri*.

Subgenus *Cœlorhynchus.*

Cœlorhynchus, Giorna.

Macrurus parallelus (Pl. XXIX. fig. A).

Macrurus parallelus, Günth., Ann. and Mag. Nat. Hist., 1877, vol. xx. p. 439.

D. 10. A. 90. V. 7. P. 16. C. pyl. 12.

Snout much produced, subtrihedral, pointed, nearly twice as long as the large eye. *Scales* with five or even seven spiny ridges, which are nearly parallel to one another, and of which the middle one is the strongest, terminating in a more or less strongly projecting spine. Head covered all over with irregular, spiny, tubercle-like scales, of which those along the infraorbital crest and along two lines on each side of the crown of the head are the strongest. There are five scales in a transverse series between the first dorsal and lateral line. Outer ventral ray produced into a short filament. Cavity of the mouth and of the gills and abdomen black.

Habitat.—Off New Zealand; Station 169; depth, 700 fathoms. One specimen, 18½ inches long.

Off the Kermadec Islands, Station 170A; depth, 630 fathoms. Three specimens, 23, 12 and 7 inches long.

Off the Kermadec Islands, Station 171; depth, 600 fathoms. Two specimens, 2½ inches long.

Hyalonema-ground, off Inosima, Japan, Station 232; depth, 345 fathoms. Eight specimens, 12 to 17 inches long.

South of Japan, Station 235; depth, 565 fathoms. One specimen, 5½ inches long.

The length of the head is but little less than the distance between the barbel and vent, the snout being much produced, subtrihedral, depressed, acutely pointed in front, and nearly twice as long as the large eye. The horizontal diameter of the eye is much longer than its vertical, and equal to the width of the flat interorbital space in a specimen 23 inches long. The posterior nostril is twice as wide as the anterior; the flap which separates them is of a black colour. Angle of the præoperculum produced backwards into a short lobe; eye nearer to the point of the operculum than to the end of the snout, two-ninths of the length of the head. Pectoral rather small, equal in length to the post-orbital portion of the head, much longer than the ventrals. The first dorsal ray feeble, as long as the pectoral, inserted at a very short distance behind the vertical from the root of the pectoral. The relative length of the abdominal cavity is liable to change with the growth of the fish; in a specimen 23 inches long, the distance between vent and isthmus is two-thirds of the length of the head, whilst it is only one-half in an example of half that length.

The scales are somewhat differently sculptured on the different parts of the body of the fish, in individuals of different ages, and in specimens from different localities. In a specimen from the Kermadec Islands, 23 inches long, a scale (fig. a), taken from the middle of the fish above the lateral line, has from five to seven nearly parallel ridges, of which the middle one is the highest, ending behind in a strong spine. The other ridges are more or less faint, with small spines either at the end or in the middle. In the scales on the back (fig. a'), as well as on the abdominal region, the median spine projects strongly and is preceded by two or three smaller ones, which cover each other in an imbricate fashion. In the scales of the lateral line the median ridge is, as it were, longitudinally divided by the muciferous channel, forming above and below the line a series of imbricate spines, generally no other ridges being visible on these scales. On the head the scales are more or less modified into scutes, with serrated ridges, which form more or less regular stellate figures on each scute, rendering the whole surface of the head very rough; the largest scutes are those occupying the raised bony ridges which are found in every species of this genus. The course of the muciferous channels on the snout and other parts of the head can be easily traced by series of very small and short black tubules, by which the mucous secretion is discharged, and which are particularly numerous on the lower part of the snout.

In a specimen from the Kermadec Islands, which is only 12 inches long, all the spinous projections are comparatively weaker and the parallel ridges on the scales less distinct.

In a New Zealand specimen, $18\frac{1}{2}$ inches long, the dermal ossifications on the head are considerably smaller, so much so that they do not always touch each other; also on the body the spines project less, but the parallel arrangement of the ridges is much more conspicuous. On the other hand, in Japanese specimens the armature is much more developed, and there is not the same great difference in the size of the median and lateral spines.

In a young specimen $5\frac{1}{2}$ inches long from Japan (fig. A′) the snout has already the characteristic form and is nearly twice as long as the eye, the body is scaled, and on some of the scales (fig. a'') minute spines are arranged in two or three series, but not close enough to form continuous ridges. No scutes are visible on the head except along the osseous ridges found in nearly all the species of this genus.

Very young specimens (fig. A″), $2\frac{1}{2}$ inches long, are partially covered with extremely delicate scales (fig. a'''), those on the back being armed with a stronger median and sometimes an additional pair of weaker lateral spines. The ridges on the head are simply serrated and the snout is comparatively shorter, the eye being only two-thirds of its length.

Figures A of Pl. XXIX. represent the entire view of a specimen from the Kermadec Islands, and the lower view of its head, of nearly two-thirds of the natural size; A′, side view of the head of a young Japanese specimen ($5\frac{1}{2}$ inches long); A″, a very young specimen from the Kermadec Islands. *a* and *a′* are scales of specimen A, somewhat magnified, the former from the side, the latter from the back; *a″*, highly magnified scale of specimen A′; *a‴*, highly magnified scale of specimen A″.

Macrurus japonicus (Pl. XXIX. fig. C).

Macrurus japonicus, Schleg., Faun. Japon. Poiss., p. 256, pl. cxii. fig. 2.

D. 11 | 70. C. 6. A. 74. P. 18. V. 7.

Snout much produced, subtrihedral, pointed, nearly twice as long as the large eye, which is two-ninths of the length of the head. *Scales* with from three to five strong radiating keels, each keel terminating in a spine. Head covered all over with similar or spiny tubercle-like scales, of which those along the infraorbital ridge and along a line on each side of the crown of the head are the strongest. There are five scales in a transverse series between the first dorsal and lateral line. Outer ventral ray produced into a short filament. Length of abdomen equal to that of the head (without snout) in adult specimens (20 inches long).

Habitat.—South of Japan, *Hyalonema*-ground; off Inosima, Station 232; depth, 345 fathoms. One specimen, $21\frac{1}{2}$ inches long.

This species is very closely allied to *Macrurus parallelus*, but the keels on the scales diverge or radiate, whilst they are subparallel in the latter species. I see that the two heads which the British Museum [1] received under the name of the present species belong to a very distinct fish, evidently a new species, which may be described when more complete materials are available.

Macrurus australis.

Lepidoleprus australis, Richards, Proc. Zool. Soc. Lond., 1839, p. 100.
Macrurus australis, Günth., Fish., vol. iv. p. 391.

D. 12–13. A. 87–96. V. 7. P. 16.

Snout moderately produced, pointed, rather longer than the eye in old specimens, and rather shorter in younger ones. Each *scale* with from twelve to eighteen parallel keels, and with the margin more or less distinctly crenulated. Head covered entirely with rather irregularly shaped scales, of which those along the infraorbital crest and along two indistinct lines on each side of the crown of the head are particularly rough. There are four scales in a transverse series between the first dorsal fin and the lateral line. Dorsal spine smooth. Abdomen, that is, distance of the vent from the isthmus, equal to the distance of the end of the operculum from the anterior nostril in adult specimens.

[1] Cat. Fish., vol. iv. p. 395.

The typical specimen, which is nearly 17 inches long (head $3\frac{1}{2}$ inches) came from Port Arthur. But the species appears also on the New Zealand coast, whence I have received specimens 21 inches long, the head measuring $4\frac{1}{2}$ inches. These specimens offered evidence of the change of the form of the snout which the species of this genus undergo with age, the snout being comparatively longer in old specimens than in young ones, as may be seen from the following measurements:—

	Head.	Eye.	Snout.
a. Port Arthur, . .	42 lines	12 lines	11 lines
b. Wellington, . .	54 ,,	16 ,,	20 ,,

Several very young specimens, 4 to $4\frac{1}{2}$ inches long, were obtained by the Challenger at Station 166, in 275 fathoms. In these the snout is comparatively still shorter, and scales are developed only on the anterior part of the body. There is a fontanelle-like depression between the ventral fins, but it does not seem to persist throughout life in this species, as in *Macrurus cœlorhynchus.* Also in an example $5\frac{1}{2}$ inches long, from Cape Campbell, New Zealand, the ventral fontanelle is still present, but the whole body is clothed with hard and well-developed scales, which, however, show a structure different from that of the scale of the adult fish. Each scale is provided with five radiating keels, prominent, and projecting beyond the margin of the scale. Each keel, being in fact a series of imbricated spines, is serrated in its whole length.

Macrurus cœlorhynchus.

Lepidoleprus cœlorhynchus, Risso, Ichth. Nice, p. 200, pl. vii. fig. 22; Eur. mérid., iii., p. 244.
Macrourus cœlorhynchus, Bonap., Faun. Ital. Pesc. (pl., *Macrourus mysticetus*).
,, ,, Costa, Faun. Nap., pl. xxxix.
,, ,, Canestrini, Arch. Zool., ii. p. 374.
,, ,, Johns., Ann. and Mag. Nat. Hist., 1862, vol. x. p. 169.
,, ,, Vinciguerra, Ann. Mus. Genov., vol. xiv., 1879, p. 619; vol. xviii. 1882, p. 565.
Macrurus atlanticus, Lowe, Proc. Zool. Soc. Lond., 1839, p. 88.
,, ,, Günth., Fish., vol. iv. p. 392.

D. 10. A. 75–86. P. 20. V. 7.

Snout moderately produced, angular in front, a little shorter than or equal to the eye, the diameter of which is one-third of the length of the head. *Scales* of moderate size, covered with minute spines, giving a granular appearance to their surface. There are five or six scales in a transverse series, between the first dorsal fin and the lateral line. Dorsal spine smooth. Abdomen, that is, distance of the vent from the isthmus, equal to the length of the head without snout in specimens about 12 inches long. Outer ventral ray produced into a short filament.

All the six specimens which I have examined, from 11 to 13 inches long, have the abdominal region and the ventral fins of a black colour. In all specimens there is a scaleless elliptical depression between the ventral fins, covered by a thin, smooth membrane only.

This species has hitherto been found in the Mediterranean and near Madeira. Collett,[1] believes that a specimen, 260 mm. long, which he obtained from the stomach of a Codfish near Bergen, belongs to this species.

Macrurus carminatus (Pl. L. fig. B).

Macrurus carminatus, Goode, Proc. U.S. Nat. Mus., vol. iii., 1881, pp. 346, 475; Bull. Mus. Comp. Zoöl., vol. x., No. 5, p. 196.

D. 10. P. 18. V. 7.

This fish is very closely allied to *Macrurus cœlorhynchus*, having a similar naked space between the ventral fins, but the spines of the scales are conspicuously longer. Snout long, sharp, depressed, triangular, a little longer than the diameter of the eye, which is contained three and a quarter times in the length of the head, and more than the width of the interorbital space. Teeth small, conical, somewhat recurved, in villiform bands. Barbel very short. *Scales* densely covered with long depressed spines; five transverse rows above and twelve below the lateral line, counting from the vent obliquely backwards. Anterior dorsal spine smooth; pectoral fin more than half as long as the head. Outer ventral ray produced into a short filament. The distance between the two dorsal fins equals half the length of the head. Coloration uniform.

Habitat.—Specimens (9½ inches long) were obtained by the U.S. Fish Commission on the east coast of the United States, in depths varying from 115 to 464 fathoms. Our specimen, which is of the same length, was obtained in the vicinity of the Bahama Islands.

Macrurus fasciatus (Pl. XXVIII. fig. A).

Macrurus fasciatus, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 24.

D. 12. A. 62. P. 15. V. 7.

Snout not much produced, shorter than the eye, which is very large, two-fifths of the length of the head, its vertical diameter being considerably more than the width of the interorbital space. *Scales* with from eight to ten subparallel keels. Upper and lateral portions of the head covered with small, rough scales, lower naked. There are four scales in a transverse series between the first dorsal spine and lateral line; distance between the two dorsal fins equal to the length of the base of the first. Anterior

[1] Norges Fisk., p. 129.

dorsal spine smooth. Outer ventral ray produced into a filament. Distance between vent and isthmus shorter than the head, without snout. Barbel small. Whitish, with broad, irregular, blackish bands across the back.

Habitat.—East coast of the southern extremity of South America, Station 311; depth, 245 fathoms. Five specimens, 7 to 10 inches long (in bad condition).

East coast of the southern extremity of South America, Stations 309, 309A; depth, 40 to 140 fathoms Two specimens, 6½ and 10 inches long.

East coast of the southern extremity of South America, Station 305A; depth, 125 fathoms. One specimen, 7½ inches long.

This species is closely allied to *Macrurus australis*, but differs in having a narrower forehead, larger eye, and fewer keels on the scales. In the smaller and younger specimens the keels are fewer in number (five to six), and have a more divergent direction than in the largest example.

Subgenus *Macrurus*.

Macrurus, proposed by Bloch for *Macrurus fabricii*.

Macrurus fabricii (Sundevall).

Macrurus fabricii, Collett, Norges Fisk., p. 128.
" " Lilljeb., Sverig. och Norg. Fisk., p. 242.

D. 12 | 124.[1] A. 148.[1] P. 18–19. V. 8.

Snout short, subtrihedral, pointed in front, much shorter than the large eye, which is one-third or two-fifths of the length of the head in adult specimens. *Scales* with a prominent serrated ridge and more or less distinct lateral keels; there are six longitudinal series of scales between the first dorsal fin and the lateral line. The first dorsal spine indistinctly denticulated towards the point. Vent situated behind the origin of the second dorsal fin.

This species is not uncommon on the northern coasts of Scandinavia, and on the coasts of Greenland and North America southward to Massachusetts.

Of four specimens which I have before me, no two agree in certain not unimportant points, and it is possible that more than one species may be distinguished by other observers. They are all nearly of the same size, viz., about 24 inches long, one being from Finmarken, two from the coasts of Greenland, and the fourth from the New England coasts. One of the Greenland specimens has a conspicuously smaller eye, which is not quite one-third of the length of the head, or less than the distance between the orbit and the angle of the præoperculum. This specimen has also the interorbital

[1] These numbers are subject to great variation.

space of greater width and less concave than other specimens, the width being two-thirds of the diameter of the eye; the posterior limb of the præoperculum is much more oblique, whilst in the other specimens it is almost vertical. The scales of the Greenland specimens are much more smooth, and in one of them only a few of the scales show traces of the lateral keels. The scales are roughest in our specimens from Finmarken, and they scarcely possess a scale which does not show lateral keels or spines. The length of the pectoral fin is subject to great variation; in the Finmarken specimen it is short, contained twice and one-fourth in the length of the head; in the New England specimen long, and contained once and four-fifths in the length of the head, the Greenland specimens being intermediate in this respect.

Macrurus rudis (Pl. XXVII.).

Coryphænoides rudis, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 24.

D. 10 | 94. A. 96. P. 19. V. 10.

Snout obtusely conical, projecting beyond the mouth, which extends backwards to beyond the middle of the eye. The outer series contains stronger teeth in both jaws. Barbel about as long as the eye. The profile of the nape ascends very slightly towards the dorsal fin. *Scales* equally rough over the whole of their surface, the spinelets being subequal in size, densely packed, and not arranged in series. There are eight scales in a transverse series between the first dorsal and the lateral line. Anterior margin of the second dorsal spine armed with barbs placed at some distance from each other. The second dorsal fin commences at a distance behind the first scarcely inferior to the length of the base of the first. The outer ventral ray produced into a long filament.

Habitat.—Pacific, north of the Kermadec Islands, Station 171; depth, 600 fathoms. Three specimens, 3 inches, 11 inches, and 33 inches long.

Pacific, north of the Kermadec Islands, Station 170A; depth, 630 fathoms. Three specimens, 6 to 7 inches and 12 inches long.

Pacific, north of the Kermadec Islands, Station 170; depth, 520 fathoms. Two specimens, 3½ inches long.

As in other fishes, so in *Macrurus*, the eye is comparatively larger in young than in adult individuals. In our large example the head is 175 mm., the eye 25 mm., the snout 43 mm., and the width of the interorbital space 50 mm. These dimensions being in the smaller respectively 50, 16, 15, and 13 mm.

Also the serrature of the dorsal spine changes with age, the barbs being widely set and few in number (seven) in very young specimens 6 inches long (fig. *c*), much more numerous (twenty) in older examples 11 inches long (fig. *b*), and becoming rather obsolete in adult ones.

But the most extraordinary change takes place in the position of the vent. In young specimens (of 12 inches and less) the vent is placed between the ventrals (fig. *a*), immediately behind their roots at some distance from the origin of the anal, and the distance between vent and isthmus is only about half the length of the head. In the adult, in which the abdominal organs are fully developed, the external extent of the abdomen is also enlarged, the vent being moved backwards behind the ventrals immediately in front of the anal, and the distance between vent and isthmus has been much increased, being equal to the length of the head.

Macrurus nasutus (Pl. XXX. fig. B).

Coryphænoides nasutus, Günth., Ann. and Mag. Nat. Hist., 1877, vol. xx. p. 440.

Allied to *Macrurus rudis.*

D. 12 | 95. A. 110. B. 20. V. 10.

Snout obtusely conical, with a rather sharp upper edge, and with a more or less projecting knob in the middle. The snout projects beyond the mouth, the cleft of which does not reach to below the middle of the eye. The teeth of the outer series are scarcely stronger than the remainder. Barbel very small. The width of the interorbital space is not quite equal to the vertical diameter of the eye, which, in a specimen 14 inches long, is nearly one-fourth of the length of the head, and equal to that of the snout. The structure of the *scales* is almost identical with that in *Macrurus rudis.* They are equally rough over the whole of their surface, the spinelets being subequal in size, densely packed, and not arranged in series. The majority of these spinelets are strengthened by a strong longitudinal keel (fig. *b*). There are seven or eight scales in a transverse series between the first dorsal and the lateral line. Second dorsal spine somewhat produced, armed along its anterior edge with barbs pointing upwards and rather closely set. The second dorsal fin commences at a considerable distance behind the first, the distance being nearly equal to the length of the head. The outer ventral ray produced into a filament, shorter than the fin.

Habitat.—South of Yeddo, Station 235; depth, 565 fathoms. Five specimens, $14\frac{1}{2}$ and 14 inches long.

Hyalonema-ground, off Inosima, Japan, Station 232; depth, 345 fathoms. Six specimens, about 12 and 13 inches long.

The number of dorsal and anal rays must always be subject to considerable variation, because the end of the tail is not equally produced in all individuals. In several specimens the tail has been mutilated at an early stage of growth, and in such cases the truncated stump is surrounded by a rayed fin, very much of the same appearance as the caudal fin of the ordinary Teleostean type.

This species is also closely allied to *Macrurus serrulatus*, but has the dorsal spine differently serrated. Its eye is comparatively smaller, and the postorbital portion of the head, as well as the snout longer. Mouth small.

Macrurus serrulatus (Pl. XXX. fig. A).

Coryphænoides serrulatus, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 26.

D. 10. A. 108. P. 19. V. 7.

The projecting part of the snout is short, with an obtuse upper edge, and with a rough tubercle in the middle. The cleft of the mouth extends to below the middle of the eye, which is comparatively large. The teeth of the outer series are visibly stronger than the remainder. Barbel about as long as the eye. The interorbital space is flat, its width rather less than the diameter of the eye, which, in a specimen 16 inches long, is a little less than one-third of the length of the head, and more than that of the snout. The *scales* are equally rough over the whole of their surface, the spinelets being subequal in size, densely packed, closely adpressed to the scale, and not arranged in series. There are seven scales in a transverse series between the first dorsal and the lateral line. *Second dorsal spine finely and closely serrated in front.* The second dorsal fin commences at a considerable distance from the first, the distance being equal to the length of the head. The outer ventral ray produced into a filament.

Habitat.—North-east of New Zealand, Station 169; depth, 700 fathoms. Three specimens, 13, 15, and 16 inches long.

One of these specimens had had the tail mutilated at an early stage of growth; and the fin-rays which surround the mutilated portion are longer than those on the ventral edge of the extremity of the tail, simulating a caudal fin, as shown in fig. *a*.

Macrurus sclerorhynchus (Pl. XXXII. fig. A).

Macrurus sclerorhynchus, Valenc. in Webb and Berth., Iles Canar., p. 80, pl. xiv. fig. 1.
" " Vinciguerra, Ann. Mus. Genov., vol. xiv., 1879, p. 622, Tab. ii.

D. 11. A. 95. P. 17. V. 7.

Snout conically projecting beyond the mouth, with sharp and smooth canthus rostralis; a rough protuberance in front, and one on each side of the canthus. Mouth rather small, situated at the lower side of the snout; infraorbital ridge sharp, prominent in its whole length. The cleft of the mouth does not extend to below the centre of the eye. Teeth in villiform bands, in both jaws; those of the outer series of the upper jaw scarcely stronger than the others. Barbel short and slender. Interorbital space flat, its width being equal to the vertical diameter of the eye. The horizontal diameter of the eye equals the length of the snout, and is two-sevenths of that of the head.

The *scales* are covered with very small spinelets, which are arranged in about nine series, the middle series being sometimes more prominent than the others; only the terminal spinelet of the central series projects sometimes beyond the margin of the scale. There are six scales in a transverse series between the first dorsal spine and the lateral line. Second dorsal spine somewhat produced, armed in front with rather closely set barbs. The distance between the two dorsal fins equals the length of the head, the snout not included. The outer ventral ray produced into a filament. Brown.

Habitat.—Atlantic, between the Canary Islands and south of Portugal; Mediterranean.

Ninety miles south-east of Cape St. Vincent, Station V.; depth, 1090 fathoms. One specimen, 11 inches long.

The determination of this specimen is subject to some doubt; it does not show so strong a central keel on any of the scales as is represented by Valenciennes, though some scales have the central series of spinelets decidedly enlarged. This specimen is also closely allied to those which I have separated under the name of *Macrurus æqualis*. But the interorbital space is wider, and the spinelets of the scales are much more numerous than in the latter species.

Macrurus æqualis (Pl. XXXII. fig. C).

? *Macrourus serratus*, Lowe, Proc. Zool. Soc. Lond., 1843, p. 91.
Coryphænoides æqualis, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 25.

Allied to *Macrurus rudis*.

1 D. 12. A. 90–118. P. 17. V. 9.

Snout conically projecting beyond the mouth, with rather obtuse and rough upper edge; the cleft of the mouth extends nearly to below the centre of the eye. The teeth of the outer series are visibly stronger than the remainder. Barbel slender, but not so long as the eye. The upper profile rises rather suddenly towards the anterior dorsal spine. The interorbital space is flat, its width being considerably less than the diameter of the eye, which conspicuously exceeds the length of the snout, and is one-third or rather more than one-third of the length of the head. The *scales* are equally rough over the whole of their surface, the spinelets being subequal in size, densely packed, but arranged in from eight to twelve series, the middle series not being more prominent than the others (as is the case in *Macrurus sclerorhynchus*). The entire margin of the scale is spinous. There are eight scales in a transverse series between the first dorsal and the lateral line. Second dorsal spine somewhat produced, armed along its anterior edge with barbs pointing upwards and rather closely set. The second dorsal fin commences at a distance from the first which is less than the length of the head. The outer ventral ray not, or but slightly, produced. Lower part of the head and antero-superior portion of the first dorsal black.

Habitat.—South of Portugal, Station IV.; depth, 600 fathoms. Two specimens, 8 to 9 inches long.

This species is very closely allied to *Macrurus rudis*, from which it differs, however, in several minor points, such as the number of ventral rays, the size of the dorsal profile, &c. The interorbital space is conspicuously narrower, when specimens of the two species of nearly the same size are compared. In a specimen of *Macrurus æqualis*, 9 inches long, the greatest diameter of the eye is 13 mm. long, and the interorbital space only 9 mm. wide.

The type of *Macrourus serratus* of Lowe is lost, and the short diagnosis he has given of it does not enable us to decide which of the closely allied species—*Macrurus sclerorhynchus*, *Macrurus æqualis*, *Macrurus bairdii*, *Macrurus goodii*—he had before him. As he distinctly says that the ventral fin is produced into a filament, I cannot refer the specimens mentioned above to his species, as I should otherwise have been inclined to do.

One of the specimens has been mentioned and rudely figured by Sir Wyville Thomson,[1] under the name of *Coryphænoïdes serratus*.[2]

Macrurus bairdii (Pl. XXXII. fig. B).

Macrurus bairdii, Goode and Bean, Amer. Journ. Sci. and Arts, vol. xiv., 1877, p. 471; and vol. xvii., 1879, p. 40; Proc. U.S. Nat. Mus., vol. iii., 1881, p. 475; Bull. Mus. Comp. Zoöl., vol. x., No. 5, 1883, p. 195.

D. 12. A. 117. P. 18. V. 7.

This species is very closely allied to *Macrurus æqualis*, but distinguished from it by a distinctly longer snout, which is nearly equal to the diameter of the eye, and by the smaller number of ventral rays (seven).

Habitat.—Specimens were obtained by the American surveying vessels, at various localities off the coast of New England, in 160 to 740 fathoms.

[1] The Atlantic, vol. i. p. 118, fig. 3.

[2] Although the matter is of no importance, I must apologise to M. Vinciguerra for having inadvertently misinformed him in a letter as regards my determination of that specimen (see *Ann. Mus. Genov.*, vol. xviii. p. 566). I confounded the specimen with the one which I have referred to *Macrurus sclerorhynchus*.

Macrurus goodii.

Macrurus asper, Goode and Bean, Bull. Mus. Comp. Zoöl., vol. x., No. 5, 1883, p. 196.

D. 10–11. P. 20. V. 10.

Allied to *Macrurus bairdii*.[1] Width of the interorbital space a little greater than the horizontal diameter of the orbit, contained four and a quarter times in the length of the head, and equal to that of the snout. Cleft of the mouth extending to the hind margin of the orbit. Teeth "in the jaws" (upper jaw ?) in a very narrow, villiform band, the outer series slightly larger; those in the lower jaw apparently in a single series (?). Barbel shorter than the eye. *Scales* with the spines arranged in about seven rows, the middle not being keel-like, although the median marginal spine projects most strongly. Seven series of scales above the lateral line. Vent at a distance from the ventral considerably greater than the length of that fin. Outer ventral ray slightly produced. Reddish-brown.

Habitat.—Several specimens, the longest 12 inches long, were obtained by the U.S. steamer "Blake," between lat. 40° and 41° N., long. 65° and 68° W., at depths of 304 and 1242 fathoms.

Macrurus holotrachys (Pl. XXVIII. fig. B).

Macrurus holotrachys, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 24.

D. 11. A. 115. P. 21. V. 9.

Snout moderately produced, as long as the eye, which is large, one-third of the length of the head, its vertical diameter being considerably more than the width of the interorbital space. Anterior edge of the snout with three rough prominences, one in the middle, and one on each side. Mouth inferior, lower side of the head naked. Each *scale* with a median series of spinelets, and with two or more isolated spinelets besides; the median are the strongest, forming with their fellows continuous longitudinal lines on the body. Upper and lateral portions of the head covered with irregular, rough scales, lower naked. There are five scales in a transverse series between the first dorsal spine and lateral line. Teeth of the lower jaw in a very narrow band. Distance between the two dorsal fins scarcely equal to the length of the base of the first. Second dorsal spine with small barbs anteriorly; outer ventral ray produced into a short filament. Distance of the vent from the isthmus equal to the length of the head, without snout. Barbel very small. No bands or spots.

Habitat.—East of the mouth of the Rio de la Plata, Station 320; depth, 600 fathoms. One specimen, 9 inches long.

[1] Hence probably with a barbed dorsal spine, no mention being made by the authors of this character.

Macrurus asper (Pl. XXXVI. fig. A).

Coryphænoides asper, Günth., Ann. and Mag. Nat. Hist., 1877, vol. xx. p. 440.

D. 11. A. 89. P. 25. V. 10–11.

Snout short, slightly projecting beyond the mouth. Eye of moderate size, not much shorter than the snout, and two-ninths of the length of the head; interorbital space flat, wider than the eye. Mouth extending to below the middle of the eye. Teeth of the outer series in the upper jaw stronger than the remainder. Barbel rather shorter than the eye. Præoperculum with the hind margin not excised, and subvertical, and with both limbs densely scaly. *Scales* with five radiating series of long and slender spines. There are six scales in a transverse series between the first dorsal fin and the lateral line. Second dorsal spine considerably produced, armed in front with rather distant barbs. The second dorsal fin commences at a short distance behind the first. The outer ventral ray produced into a filament. Black.

Habitat.—South of Japan, Station 237; depth, 1875 fathoms. One specimen, 13 inches long.

Macrurus carinatus (Pl. XXXIII. fig. A).

Coryphænoides carinatus, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 28.

D. 12. P. 21. V. 8.

Snout obtusely conical, projecting beyond the mouth, the cleft of which reaches nearly to below the middle of the eye. Teeth of the upper jaw in a band, those of the lower likewise crowded in front and in a single series on the sides. Barbel well developed, but much shorter than the eye. Interorbital space flat, much narrower than the large eye, the diameter of which equals the length of the snout, and is only a little less than one-third of that of the head. The distance between vent and isthmus is nearly equal to the length of the head.

The *scales* are of moderate size and provided with a very strong median keel, terminating in a projecting spine, and with several short and low ridges which converge towards the median keel, or run nearly parallel to it. There are five scales in a transverse series between the first dorsal and the lateral line. Præoperculum with the hind margin undulated, and with the limbs scaly. The second dorsal spine is armed with rather small and somewhat closely set barbs. The distance between the two dorsal fins equals the length of the base of the first. Pectoral fin rather more than half as long as the head. Outer ventral ray produced into a very short filament. Brown.

Habitat.—Near Prince Edward Island, Station 145A; depth, 310 fathoms. One specimen, $21\frac{1}{2}$ inches long.

Subgenus *Coryphænoides.*

Coryphænoides, name proposed by Gunner for *Coryphænoides rupestris.*

Macrurus rupestris.

Coryphænoides rupestris, Gunner, Trondhj. Selsk. Skrift., vol. iii. p. 50, tab. iii. fig. 1.
" " Goode and Bean, Bull. Mus. Comp. Zoöl., vol. x., No. 5, 1883, p. 197.
" " Collett, Forhandl. Vidensk. Selsk. Christ., 1880, p. 70; and Nyt Mag. f. Naturvid., 1884, p. 95; Ström, Norsk. Vidensk. Selsk. Skrift., 1884, p. 37.
" " Lilljeb., Sverig. och Norg. Fisk., p. 259.
Macrurus norwegicus, Nilss., Skand. Faun. Fisk., p. 600.
Macrourus strömii, Reinh., K. dansk. Vidensk. Selsk. Afhandl., vol. vii. p. 129.
" " Gaim., Voy. Scand., Poiss., pl. xi.

D. 10. P. 19. V. 7.

Head short, rather compressed; snout short, obliquely truncated in front; cleft of the mouth wide, lateral, extending to beyond the centre of the eye; intermaxillary not much shorter than the maxillary. Teeth in villiform bands in both jaws; barbel very small. Interorbital space convex, its width being considerably more than the diameter of the eye, which, in a specimen three feet long, is equal to the length of the snout and one-fourth of that of the head. The *scales* are equally rough over the whole of their surface, all the spinelets being directed backwards; there are seven or eight scales in a transverse series between the first dorsal fin and the lateral line. Head entirely covered with small scales. Anterior dorsal spine armed with numerous small, closely set barbs; outer ventral ray produced into a long filament. Distance between the vent and isthmus two-thirds of the length of the head.

Habitat.—North Atlantic; a large specimen nearly three feet long, which has served principally for the above diagnosis, is from Sognefjord, Bergen, and several young specimens were obtained between Shetland and the Færöe Islands during the cruise of the "Porcupine" and "Knight Errant," in from 200 to 500 fathoms. The occurrence of this species on the east coast of the United States is reported from lat. 41° 32′ N., long. 65° 55′ W.; depth, 524 fathoms.[1]

Macrurus altipinnis (Pl. XXXIX. fig. A).

Coryphænoides altipinnis, Günth., Ann. and Mag. Nat. Hist., 1877, vol. xx. p. 439.

D. 12. P. 21. V. 9.

The snout is rather short, slightly projecting beyond the mouth, with a prominent tubercle in the middle. Orbit large, in a specimen 19 inches long, contained four and one-

[1] I am unable to place *Coryphænoides carapinus* (Goode and Bean, *Bull. Mus. Comp. Zoöl.*, vol. x., No. 5, 1883, p. 197), described from the east coast of the United States in connection with the above species, the authors having omitted to examine the dentition.

third times in the length of the head, and not much shorter than the snout or than the width of the interorbital space; eye surrounded by a broad orbital membrane. Mouth wide, lateral, extending beyond the middle of the eye. Teeth of the outer series in the upper jaw visibly stronger than the remainder. Barbel shorter than the eye. Præoperculum with the hind margin not excised, and with both limbs densely scaly.

Scales small and comparatively thin, but regularly arranged, with five radiating spiny ridges, the spines being very small. There are eleven or twelve scales in a transverse series between the first dorsal fin and the lateral line. Second dorsal spine considerably produced, armed in front with rather distant barbs, more conspicuous in the upper half of the spine. The second dorsal fin commences at a short distance behind the first. The outer ventral ray produced into a filament.

Habitat.—South of Yeddo, Station 237; depth, 1875 fathoms. One specimen, 19 inches long.

Off Japan, Station 235; depth, 565 fathoms. Two specimens, 6 inches long.

This is one of the species in which the characteristic physiognomy of the typical *Macruri* commences to be lost. The infraorbital ridge is still visible, but is not the boundary between the side and lower portion of the head; in fact, the space between the eye and mouth is vertical, and the cleft of the mouth is lateral, and inferior in front only. Also the cheeks and præoperculum are those of an ordinary Gadoid. The scales, although they are still ridged, are much less hard than in the typical *Macruri*.

Subgenus *Mystaconurus*.

Macrurus longibarbis (Pl. XVIII. fig. C).

B. 6. D. 10. P. 11. V. 8.

Snout short, obtuse, with the anterior profile descending in a parabolic curve; mouth terminal and lateral, wide, extending beyond the middle of the orbit. Eye very large, more than one-third of the length of the head, much more than that of the snout, and twice as wide as the interorbital space. Teeth in both jaws in narrow villiform bands. Barbel long, two-thirds as long as the head. Præoperculum with the hind margin not excised, without marginal denticulation, and scaleless, like the whole head.

The *scales* are very large, in two and a half series above the lateral line; and in eleven between the vent and the dorsal fin. In the young specimen described they are cycloid, but with minute spinelets now and then appearing on the surface. The dorsal spine is smooth. The pectoral fin has a very narrow base and is about two-thirds of the length of the head. The ventral with the outer ray produced into a longish filament, inserted in the middle of the length of the abdomen, which is slightly longer than the head.

The specimen is still colourless, except on the sides of the head and trunk and along the middle of the tail, which parts are covered with a silvery pigment. Abdomen and lower parts of the head black.

Habitat.—Off Matuku, Fiji Islands, Station 173; depth, 315 fathoms. One specimen, 5½ inches long.

Although the specimen is young, it is so unlike any other of the numerous young *Macruri* collected by the Challenger, that I cannot but consider it to be a very distinct form. It has long passed the larval or *Krohnius*-stage, and developed specific characters by which it may be recognised, viz., the long barbel, large scales, smooth dorsal spine, villiform dentition, large eye, parabolic snout, and narrow interorbital space. It possesses the gill-apparatus characteristic of the true *Macruri*. The scales of the adult may be supposed to be spiny.

Macrurus italicus.

Hymenocephalus italicus, Giglioli (*e* Issel), Pelagos, p. 228, *c.* fig. (without description).

D. 12. P. 16. V. 10.

Head deeper than broad, with vertical sides and wide muciferous cavities; snout obtuse, short, slightly projecting beyond the mouth, the cleft of which is oblique, anterior and lateral, and extending to behind the middle of the eye. Teeth in both jaws minute, of equal size, villiform, in narrow bands. Barbel small. Interorbital space as wide as the eye, the diameter of which is one-third of the length of the head, and exceeds the snout in length. *Scales* extremely thin, deciduous, spiny, of comparatively large size.[1] Præopercular margin not serrated. Anterior dorsal spine smooth, filamentous; the distance between the two dorsal fins is but little more than the length of the base of the former.[2] Pectoral fin about half as long as the head. Vent close to the root of the ventral fins which reach it, and the outer ray of which is produced into a filament. A triangular scaleless space between the ventral fins, nearly extending to the vent; a small round naked space, surrounded by spiny scales, in the middle of the præventral region. Distance between the vent and isthmus three-fourths of the length of the head. Body

[1] No scales whatever are preserved in our specimen on the tail and back, only slight traces of the scale pouches are visible; on the sides of the abdomen, which are silvery, no scales had yet been developed, whilst the lower side of the abdomen, with the exception of the naked spaces described, is covered with spiny scales, the spines being rather long and irregularly placed as in *Macrurus lævis*.

[2] In the woodcut given by Giglioli about thrice as long, but this figure evidently cannot claim great exactness in details.

and tail colourless; sides of the head and abdomen silvery; lower parts to the vent black.

I have examined a young specimen from Nice, 5½ inches long; Giglioli's specimen seems to have been of about the same size.

There can be no doubt that this is a juvenile form, and if it were not for the dentition I should not hesitate to refer it to *Macrurus lævis*, with which it agrees in several important characters. However, this relationship, if it does exist, cannot be proved at present without the evidence of a much more complete series than is at my disposal.

Subgenus *Lionurus*.

Macrurus filicauda (Pl. XXXIV. fig. B).

Coryphænoides filicauda, Günth., Ann. and Mag. Nat. Hist., 1878, vol. xx. p. 27.

D. 11. P. 20. V. 9. Cœc. pyl. 7.

Snout considerably projecting beyond the mouth, pointed in the middle; it is twice as long as the eye, which is unusually small, only half as wide as the interorbital space. Mouth rather wide, extending beyond the centre of the eye. Upper teeth villiform, in a very narrow band, those of the mandible very small, biserial. Barbel minute. Præoperculum with the angle produced backwards, broadly rounded and crenulated on the margin. The terminal portion of the tail is prolonged into a long filament, more slender than in any of the other species. Bones of the head soft.

Scales of moderate size, thin, *cycloid* and deciduous; six or seven in a transverse series between the first dorsal spine and the lateral line; snout and inferior half of the infraorbital region naked. The second dorsal spine slender, with the barbs in front very inconspicuous and sometimes entirely absent. The distance between the two dorsal fins is less than the length of the head. The outer ventral ray produced into a short filament. Distance between vent and isthmus less than the length of the head.

Head and trunk whitish, tail brownish, lower part of the head and gill-opening black.

Habitat.—Deep-sea on both sides of the South American Continent; Antarctic Ocean.

Station 325; depth, 2650 fathoms. Three specimens, 12, 10, and 6 inches long.
Station 323; depth, 1900 fathoms. One specimen, 13½ inches long.
Station 299; depth, 2160 fathoms. One specimen, 15 inches long.
Station 158; depth, 1800 fathoms. Two specimens, 13 inches long.
Station 157; depth, 1950 fathoms. Three specimens, 9½ inches long.
Station 146; depth, 1375 fathoms. Twelve specimens, 4 to 8 inches long.

This species is clearly one of those in this family which extend to the greatest depths. The decrease in the size of the eye, the very soft bones, the concomitant want of firmness in the structure of the scales, and the tail, which tapers into a very fine filament, indicate its abyssal abode. The scales are nearly all gone in all the specimens obtained. The species appears to be abundant in individuals, and has, like a true deep-sea fish, a wide distribution.

Macrurus microlepis.

Coryphænoides microlepis, Günth., Ann. and Mag. Nat. Hist., 1878, vol. xx. p. 26.

D. 12. V. 10.

Snout short, obliquely truncated, slightly projecting beyond the mouth; eye exceeding in length that of the snout and the width of the interorbital space. Head much compressed, high. The cleft of the mouth does not quite extend to below the middle of the eye. Teeth of the outer series visibly stronger than the remainder. Barbel as long as the eye.

Scales small, cycloid. There are thirteen scales in a transverse series between the first dorsal fin and the lateral line. Second dorsal spine armed in front with [distant] barbs; the distance between the two dorsal fins equals the length of the head, without snout. [Trunk very short.] Outer ventral ray slightly prolonged. [Head and body dotted with brown.]

Habitat.—Off Matuku, Fiji Islands, Station 173; depth, 315 fathoms. One specimen, 4 inches long.

Although it must appear hazardous to describe a Macruroid from a single young example, I can hardly hesitate to do so in the present instance, the species being well characterised by its compressed head, small scales, &c. Some of the characters mentioned are probably only signs of the immaturity of the individual, and have been enclosed within brackets.

Subgenus *Trachonurus.*

Macrurus villosus (Pl. XXXVI. fig. B).

Coryphænoides villosus, Günth., Ann. and Mag. Nat. Hist., 1877, vol. xx. p. 441.

D. 10. P. 13. V. 7.

Head compressed, with vertical sides. Snout compressed, very slightly projecting beyond the mouth, short, not longer than the eye, which is of moderate size, one-fourth of the length of the head. Interorbital space broader than the eye. Mouth rather small, lateral, not extending to below the centre of the eye. Infraorbital ridge obsolete. Teeth in villiform bands in both jaws. Barbel very small and slender. Angle of the præoperculum not produced backwards; hind margin crescent-shaped. The skin is densely studded with erect spines, which give to the body and head the appearance of being covered with short villosities. A series of stronger spines runs along each side of the base of the second dorsal and anal fins. The second dorsal spine is very slender, smooth, much shorter than the head; the second dorsal fin very low, commencing immediately behind the first. The ventral fin reaches to the anal; its outer ray produced into a very short filament. Space between ventral fins and vent scaleless; the distance between vent and isthmus less than the length of the head.

Habitat.—South of Yeddo, Station 232; depth, 345 fathoms. One specimen, 8 inches long.

South of the Philippine Islands, Station 214; depth, 500 fathoms. One specimen, 10 inches long.

Subgenus *Cetonurus*.

Macrurus crassiceps (Pl. XXXVII.).

Coryphænoides crassiceps, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 25.[1]

D. 10. P. 16. V. 10.

Head exceedingly large and thick, especially the anterior portion. Snout with an anterior naso-rostral canthus, excessively broad and high, short, but longer than the eye, which is small and not quite one-fifth of the length of the head. Mouth small, inferior, extending beyond the vertical from the centre of the eye. Teeth villiform, in very narrow bands in both jaws. Intermaxillaries short. Barbel minute.

Trunk of the body very short, the vent being immediately behind the vertical from the root of the pectoral. The trunk rapidly passes into the tail, the anterior portion of which is much contracted in width. The distance between the vent and isthmus equals the length of the postorbital portion of the head.

The *scales* are small, studded with long, very fine, curved spinelets, which give the body the appearance of being covered with short villosities. The entire head densely covered with villous scales. A series of larger scales runs along each side of the base of the second dorsal fin. The second dorsal spine is very slender, obscurely denticulated in front; the second dorsal fin commences at a very short distance behind the first. Pectoral fin with a narrow base, as long as the postorbital portion of the head. The outer ventral ray is but slightly produced. Brownish-grey, lower side of the trunk black.

Habitat.—North of the Kermadec Islands, Station 170; depth, 520 fathoms. One specimen, 13 inches long.

[1] A similar fish, probably identical with the one described above, is noticed under the name of *Macrurus globiceps* (L. Vaill.) in *Nature*, 1884, No. 560.

North of the Kermadec Islands, Station 171; depth, 600 fathoms. One specimen, 14 inches long.

In one of these specimens the tail tapers to a fine point, as is normal in Macruroids, and in the other the mutilated extremity bears a pseudo-caudal fin composed of several rays. As in all deep-sea fishes with large muciferous cavities and thin flexible bones, the form and outlines of the head are liable to shrinking in preserved specimens.

Subgenus *Chalinurus*.

Chalinura, Goode and Bean.

Macrurus leptolepis (Pl. XXXI.).

Coryphænoides leptolepis, Günth., Ann. and Mag. Nat. Hist., 1877, vol. xx. p. 441.

D. 19. P. 18. V. 9.

Head compressed. The snout is rather long, but its front portion projects but slightly beyond the mouth, which is almost anterior. The eye is comparatively small, rather more than one-half the length of the snout, or one-seventh of the length of the head and three-fifths of the width of the interorbital space. Mouth wide, lateral, extending to below the hind margin of the eye. The teeth of the outer series of the upper jaw are widely set and much stronger than those of the villiform band. Mandibulary teeth in a single series. Barbel as long as the eye. The præoperculum with the hind margin excised, and with the angle rounded and produced backwards, naked; its lower margin is not toothed.

Scales thin and deciduous; most with five or seven radiating keels, some, especially on the back, nearly or quite smooth. There are seven scales in a transverse series between the first dorsal and the lateral line. Those on the gill-cover and in front of the ventral fins are quite smooth; the front part of the snout and the lower half of the infraorbital region scaleless. Second dorsal spine slightly produced, with barbs in front, which are rather distantly arranged. The second dorsal fin commences at a short distance behind the first. The outer ventral ray produced into a long filament. Distance between vent and isthmus equal to the length of the head.

The single specimen is of a dirty whitish colour.

Habitat.—Off the coast of Brazil.

Off Pernambuco, Station 122; depth, 350 fathoms. One specimen,[1] 18 inches long.

[1] I formerly referred some specimens from the Pacific and Japan to the same species, but I think now that they can be specifically distinguished on account of the shorter snout.

Macrurus simulus.

Chalinura simula, Goode and Bean, Bull. Mus. Comp. Zoöl., vol. x., No. 5, p. 199.

D. 10. P. 20. V. 9.

Snout long, broad, truncate, not much produced; mouth subterminal, lateral, wide. The diameter of the eye is one-fifth of the length of the head, equal to that of the snout, and rather less than the width of the interorbital space. Barbel longer than the eye. Teeth in the upper jaw in a broad villiform band, with the outer series much enlarged; mandibulary teeth uniserial. *Scales* cycloid, without armature, but with indications of radiating striæ. Anterior dorsal spine serrated, the barbs closely adpressed. Outer ventral ray produced into a long filament.

Habitat.—Specimens were obtained by the U.S. steamer "Blake," between lat. 31° and 41° N., and long. 65° and 78° W., at depths of 333, 647, and 1242 fathoms, the largest being 18 inches long.

Macrurus fernandezianus, n. sp. (Pl. XXXVIII. fig. B).

D. 9. P. 18. V. 10.

Head moderately compressed, but with the sides vertical, the mouth being lateral and anterior; also the front margin of the snout is subvertical. Eye rather small, being contained five and a half times in the length of the head, two-thirds of that of the snout, and three-fifths of the width of the interorbital space. Mouth wide, extending nearly to below the hind margin of the eye; teeth as in *Macrurus leptolepis*. Præoperculum with the hind margin excised, and with the lower margin crenulated. *Scales* rather thin and deciduous, but with from three to five series of spines; also the scales on the head and in front of the ventral fins are rough; but the snout, nearly the whole of the infra-orbital region, and the limbs of the præoperculum are perfectly scaleless. The distance between the vent and isthmus equals the length of the head, without snout. Barbs of the dorsal spine widely set and few in number; outer ventral ray produced. Brownish; lower parts of the head, abdomen, buccal and branchial cavities black.

Habitat.—South of Juan Fernandez, Station 300; depth, 1375 fathoms. One specimen, 11 inches long.

Macrurus liocephalus, n. sp. (Pl. XXXVIII. fig. A).

D. 11. P. 20. V. 10.

Head compressed, snout moderately long, but slightly projecting beyond the mouth, which is almost anterior. Eye rather small, two-thirds of the length of the snout and of the width of the interorbital space, and one-sixth of the length of the head. Mouth wide, lateral, extending to below the hind margin of the eye; teeth as in *Macrurus leptolepis.* Præoperculum with the hind margin excised and with the lower margin crenulated. *Scales* thin and deciduous, without conspicuous keels; there are seven scales in a transverse series between the first dorsal and the lateral line. The scales on the sides of the head are quite smooth, but the foremost part of the snout, the lower portion of the infraorbital region, and the limbs of the præoperculum are perfectly scaleless. The distance between the vent and isthmus is less than the length of the head. Outer ventral ray produced into a long filament. Blackish; head, abdomen, buccal and branchial cavities deep black.

Habitat.—Near Yokohama, Japan, Station 237; depth, 1875 fathoms. One specimen, 16½ inches long.

Mid-Pacific, Station 246; depth, 2050 fathoms. Two specimens, 7½ inches long.

Macrurus murrayi (Pl. XXXIV. fig. A).

Coryphænoides murrayi, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 26.

D. 12. P. 20. V. 12.

Snout short, but longer than the eye, which is small, its width being much less than that of the interorbital space, and one-fifth of the length of the head. Canthus rostralis obtuse, without median tubercle. The cleft of the mouth is anterior and lateral, and extends to below the middle of the eye. Teeth of the outer series much stronger than the posterior villiform band. Mandibulary teeth uniserial. Barbel longer than the eye.

Scales with from five to seven crenulated radiating keels, some of which project beyond the rounded posterior margin of the scale. There are seven or eight scales in a transverse series between the first dorsal fin and the lateral line. Upper and lateral parts of the head, with the exception of the extremity of the snout, covered with small rough scales. Anterior dorsal spine slightly prolonged, armed with numerous distant barbs pointing upwards. The second dorsal fin commences at a considerable distance from the first, which, however, is rather less than the length of the head. The outer ventral ray produced into a filament. Distance between the vent and isthmus rather less than the length of the head.

Brownish; lower parts of the head, buccal and branchial cavities black.

Habitat.—Off New Zealand, Station 168; depth, 1100 fathoms. Five specimens, 3½, 7, and 15 inches long.

Four young examples, obtained at the same locality, probably belong to a distinct species, but they are too immature for identification; they seem to have the snout more pointed and longer. Their eye is as small as in the larger specimen.

Subgenus *Optonurus*.

Macrurus denticulatus.

Macrurus denticulatus, Rich., Voy. Ereb. and Terr., Fish., p. 53, pl. xxxii. figs. 1–3.
Coryphænoides denticulatus, Günth., Fish., vol. iv. p. 396.
„ „ Hutton, Fish. New. Zeal., p. 49, No. 80.

D. 13. P. 17. V. 9.

Head compressed, with the sides vertical; snout short, convex, but not overlapping the mouth, which has the jaws equal, is anterior and lateral, and extends backwards to below the middle of the eye. The intermaxillary is but little shorter than the maxillary. Eye very large, more than one-third of the length of the head, longer than the snout and much wider than the flat interorbital space. Teeth of the upper jaw in a villiform band, with an outer series of much larger teeth. Lower jaw with a single series of widely-set teeth on the sides; near the symphysis the teeth are more crowded, small, and of equal size. Barbel very short.

Scales of moderate size, densely covered with minute spinelets, which are directed backwards; there are six series between the dorsal fin and the lateral line; snout and the greater portion of the side of the head scaleless. Anterior dorsal spine smooth; pectoral fin as long as the head without snout; outer ventral ray not produced. The lower margin of the præoperculum is membranaceous and finely denticulated. Distance between the vent and isthmus rather more than the length of the head.

Greenish; sides silvery, lower parts of the head and abdomen black.

The slit between the outer branchial arch and the wall of the gill-cavity is much narrowed by a membrane attached to both ends of the arch; it is only about twice as wide as the slit behind the fourth arch. The gill-laminæ are short, separated from one another. Gill-rakers in a double series; those of the anterior series of the first arch are small tubercles, fourteen in number, those of the posterior series longer, and beset with fine bristles.

The specimens obtained by the Expedition are all of very small size and still destitute of scales, but the British Museum has received several examples from the Colonial Museum at Wellington, which are probably adult; they are 15 inches long and came from Cook's Straits. Hutton says that this fish is thrown up in immense quantities after heavy gales.

Habitat.—Off New Zealand, Station 166; depth, 275 fathoms. One specimen, 4½ inches long.

The Kermadec Islands, Station 170; depth, 520 fathoms. Five specimens, 3 to 4½ inches long.

Subgenus *Malacocephalus*.

Malacocephalus, Gthr.

Macrurus lævis (Pl. XXXIX. fig. B).

Macrurus lævis, Lowe, Proc. Zool. Soc. Lond., 1843, p. 92.
Malacocephalus lævis, Günth., Fish., vol. iv. p. 397.
" " Lütken, Vid. Meddel. nat. Foren. Kjøbenhavn, 1872, p. 1.

D. 13–14. P. 17. V. 9.

Head compressed, with vertical sides; muciferous cavities wide. Snout obtusely conical, slightly projecting beyond the mouth, the cleft of which is oblique, anterior and lateral, and extending somewhat behind the middle of the eye. Teeth of the upper jaw biserial, those of the outer series much stronger than the inner; mandibulary teeth uniserial. Barbel shorter than the eye. The interorbital space flat, its width being equal to, or less than the diameter of the eye, which is large, longer than the snout, and one-third or two-sevenths of the length of the head. *Scales* very small, much deeper than long, covered with short minute bristles. Præoperculum with the posterior margin slightly excised above the angle, and with the lower margin not serrated. The entire head is covered with minute rough scales. Anterior dorsal spine smooth. Pectoral fin about two-thirds of the length of the head. The vent (fig. *b*) is close to the root of the ventrals, which reach beyond it; it lies at the end of an oval scaleless depression, and there is another triangular scaleless space between the roots of the ventrals. Distance between the vent and isthmus two-thirds of the length of the head.

Brownish above, sides silvery; axil, ventrals and the region in front of them black; branchial cavity partly black, inside of the mouth white.

Habitat.—This fish has been hitherto found at Madeira and in the Mediterranean; and once on the coast of Denmark. The Challenger Expedition obtained a specimen, 17½ inches long, off the coast of Pernambuco (Station 122), in 350 fathoms.

Macrurus macrochir (Pl. XXIX. fig. B).

Macrurus macrochir, Günth., Ann. and Mag. Nat. Hist., 1877, vol. xx. p. 438.

D. 11. P. 18. V. 7.

Head rather compressed, elongate, with vertical sides. Snout produced, tetrahedral, rather longer than the large eye. Interorbital space nearly flat, its width being somewhat more than the diameter of the eye, which is contained four and one-third times in the length of the head. Infraorbital ridge low. Mouth rather wide, lateral, the intermaxillary shorter than the maxillary. Barbel very small. Teeth coarsely villiform in a narrow band in the upper jaw, and in a single series in the lower. The two limbs of the præoperculum meet at a somewhat acute angle which is produced backwards.

The second dorsal spine is smooth and slender; and the second dorsal fin commences at a distance behind the first, which is about one-half of the length of the head. Pectoral fin remarkably long, extending to the origin of the second dorsal, and equal in length to the head, the snout not included. The outer ventral ray not produced.

Scales rather thin, with from eight to ten finely crenulated radiating ridges, which do not project beyond the margin of the scale. There are five scales in a transverse series between the first dorsal fin and the lateral line. The head is covered with similar radiated scales, which, however, are irregular as regards size and arrangement; snout and lower limb of the præoperculum scaly.

Brownish-black.

Habitat.—*Hyalonema*-ground, off Inosima, Station 232; depth, 345 fathoms. One specimen, 27½ inches long.

A very remarkable species, which may be at once recognised by its large head and long pectoral fin. The figures marked B on Pl. XXIX. represent the entire fish from the side, of half the natural size, and the lower side of the snout. The figure of the scale is magnified four times.

Macrurus sulcatus.

Coryphænoides sulcatus, Goode and Bean, Proc. U.S. Nat. Mus., vol. viii., 1886, p. 596.

D. 10–11. P. 13. V. 7.

Snout short, obtuse, scarcely overhanging the mouth, shorter than the eye, which is contained thrice and two-thirds in the length of the head, and equal to the width of the interorbital space. The maxillary reaches to below the middle of the orbit. Dorsal spine smooth. Vent about midway between the root of the ventrals and the anal. *Scales* each with eight or ten spinelets irregularly placed, and less numerous in young individuals, which feel bristly to the touch, separated by wide deep furrows (hence the specific name). Seven scales in a series between the origin of the dorsal fin and the lateral line. Teeth in the upper jaw in two series, the outer series somewhat enlarged; mandibulary teeth uniserial. Pectoral fin about half as long as the head. Brown; lower parts of the head and abdomen blackish.

Habitat.—Two specimens, 9 and 18 inches long, were obtained by the U.S. Fish Commission in lat. 28° 30′ N., long. 86° 50′ W., and off Martinique, at depths of 340 and 472 fathoms.

Subgenus *Nematonurus.*

Macrurus armatus (Pl. XL. fig. A).

Macrurus armatus, Hector, Ann. and Mag. Nat. Hist., 1875, vol. xv. p. 81.
Coryphænoides variabilis, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 27.

D. 11. P. 18–20. V. 9–10.[1]

Snout obtusely conical, projecting beyond the mouth, the cleft of which extends behind the middle of the eye. Teeth of both jaws in a single series. Barbel nearly as long as the eye. The interorbital space is flat, its width being much more than the diameter of the eye, which is comparatively small, and in specimens 11 to 20 inches long shorter than the snout, and contained five and a half times in the length of the head.

The *scales* are provided with five ridges, each ridge composed of several spines, and the central ridge being the strongest. There are eight scales in a transverse series between the first dorsal fin and the lateral line. Lower limb of the præoperculum scaleless. Second dorsal spine armed with barbs in front, which are rather distantly set. The second dorsal fin commences at a distance from the first, which is less than the length of the head. The distance between the vent and isthmus is equal to, or more than, the length of the head. The outer ventral ray produced into a long filament.

Habitat.—Midway between the Cape of Good Hope and Kerguelen Island, Station 147; depth, 1600 fathoms. Three specimens, 5, 10½, and 22 inches long.

South Pacific, Station 146; depth, 1375 fathoms. Six specimens, 10 inches long.

South Pacific, Station 157; depth, 1950 fathoms. One specimen, 10 inches long.

South Pacific, Station 158; depth, 1800 fathoms. Eleven specimens, 5 to 18 inches long.

Mid-Pacific, Station 246; depth, 2050 fathoms. Three specimens, 7 and 17 inches long.

Mid-Pacific, Station 271; depth, 2425 fathoms. One specimen, 15 inches long.

Two hundred miles east of Cape Farewell; depth, 400 fathoms. One specimen, 8¾ inches long. Type of *Macrurus armatus.*

This species has a wide range in the southern hemisphere, and is subject to some variation, the variation occurring in individuals from the same locality, and affecting the form of the head, length of dorsal spine, &c. The most striking deviation from the typical form is a kind of albino, not quite white, but of a much lighter colour than the ordinary specimens. In these albinos the scales (fig. *a′*) are much thinner, the ridges sometimes scarcely visible, and if developed, they are merely keels without spines. The spines are in some specimens more projecting than in others; the specimen from Station 271 having them most prominent.

[1] Not seven as stated by Hector.

Macrurus affinis (Pl. XL. fig. B).

Coryphænoides affinis, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 27.

D. 11. P. 19. V. 10.

Closely allied to *Coryphænoides armatus.*

Snout obtusely conical, projecting beyond the mouth, the cleft of which extends behind the middle of the eye. Teeth of the upper jaw biserial, those of the outer series much stronger than the inner; mandibulary teeth uniserial. Barbel shorter than the eye. The interorbital space is flat, its width being equal to the diameter of the eye, which is comparatively large, as long as the snout, and one-fourth of the length of the head. The *scales* are provided with five (or three) radiating ridges, each ridge composed of several small spines, and the central ridge being the strongest. There are seven scales in a transverse series between the anterior dorsal spine and the lateral line. Præoperculum with the posterior margin slightly excised above the angle, and with the lower margin crenulated; the lower limb of the præoperculum is covered with small scales in the larger specimen, and naked in the young one. The second dorsal spine is armed with barbs which are rather closely set. The second dorsal fin commences at a distance from the first, which is rather more than one-half of the length of the head. Distance between the vent and isthmus much more than the length of the head in the larger specimen, and equal to it in the younger one. Outer ventral ray produced into a filament. Brownish-black.

Habitat.—East of the mouth of the Rio de la Plata, Station 323; depth, 1900 fathoms. Two specimens, 10 and 13 inches long.

Macrurus longifilis (Pl. XXXV.).

Coryphænoides longifilis, Günth., Ann. and Mag. Nat. Hist., 1877, vol. xx. p. 439.

D. 13. P. 18. V. 9.

Head compressed, oblong, with the muciferous canals not enlarged. Snout, as in a *Gadus*, swollen, obtuse, not projecting beyond the mouth, the jaws being equal. Eye rather large, one-fifth of the length of the head, shorter than the snout, the length of which equals the width of the flat interorbital space. Mouth very wide, anterior and lateral, extending nearly to below the hind margin of the eye. Upper teeth biserial, those of the outer series much stronger than the others, those of the lower strong, in a single series. Barbel minute. Præoperculum with the hind margin excised, with the angle rounded, and both limbs scaly.

Scales rather thin and small, with about five feeble radiating keels. There are thirteen or fourteen scales in a transverse series between the first dorsal fin and the lateral line. The second dorsal spine is feeble, somewhat produced, obscurely denticulated in front. The second dorsal fin commences immediately behind the first. Pectoral much prolonged, as long as the head. The outer ventral ray produced into an exceedingly long stiff filament. The distance between vent and isthmus rather less than the length of the head. Brownish-black.

Habitat.—South of Yedo, Japan, Station 235; depth, 565 fathoms. One specimen, 28 inches long.

This species in the structure of its head and in its physiognomy approaches to the ordinary Gadoid type.

Trachyrhynchus.

Trachyrhynchus, Giorna.

Snout produced into a long depressed process, sharply pointed in front, and with a rather sharp lateral edge, which is continued in a straight line across the infraorbital region. Mouth horse-shoe-shaped, situated at the lower side of the head. Teeth in both jaws in villiform bands. A barbel. A scaleless fossa on each side of the nape. The second dorsal fin well developed from its beginning. Scales of moderate size, more or less spinigerous; a series of larger scales, each armed with a projecting ridge along each side of the base of the anterior portions of the dorsal and anal fins. Of the gill-covers the operculum is particularly small. Gill membranes scarcely united in front. Four gills with well-developed gill-laminæ. The first branchial arch is free and provided with short styliform gill-rakers.

Trachyrhynchus trachyrhynchus (Pl. XLI. fig. C).

Lepidoleprus trachyrhynchus, Risso, Ichth. Nice, p. 197, pl. vii. fig. 21.
,, ,, Canestr., Arch. per la Zool., 1864, p. 371, pl. xii. fig. 2.
,, ,, Vinciguerra, Ann. Mus. Genov., vol. xiv. p. 617; vol. xviii. p. 564.

D. 10–11. P. 20–21. V. 7.

Snout not quite twice as long as the eye, the horizontal diameter of which is much greater than the vertical, about one-fourth of the length of the head, and equal to the width of the interorbital space above the centre of the orbit. Scales very rough, each with three or four acute and prominent spines; four series between the first dorsal fin and the lateral line; the crests of many of the enlarged dorsal scales are coarsely denticulated. The entire abdomen covered with scales. Distance of vent from the isthmus equal to that of the hind margin of the eye from the extremity of the snout. Barbel very small. Ventrals small, inserted in front of the pectoral fin, with the outer ray produced into a short filament. Anterior branchial arch with twenty-two very short, styliform gill-rakers.

This is a Mediterranean species, of which I have examined three specimens from Nice, from 15 to 17 inches long.

Of the two figures, the lower is a magnified view of a scale taken from the middle of the side, the upper is a dorsal scute, likewise magnified.

Trachyrhynchus longirostris (Pl. XLI. fig. B).

Macrurus longirostris, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 23.

D. 10. P. 21. V. 6.

The snout is produced into a long flattened process, pointed anteriorly, and not quite twice as long as the large eye. Horizontal diameter of the eye about twice as long as vertical, more than one-fourth of the length of the head, and equal to the width of the interorbital space above the centre of the orbit. Head covered with short, linear, serrated asperities. Scales of the body with smooth surface, but with from three to seven spinelets on the margin. They are rather irregularly arranged, there being four in a transverse series between the lateral line and dorsal fin. A series of projecting triangular spines along each side of the neck and the base of the anterior portion of the dorsal fin; a similar series along each side of the base of the anal extends much farther backwards than the dorsal series, and anteriorly is lost on the side of the abdomen. These spines have smooth edges (not denticulated, as in *Macrurus trachyrhynchus*). The entire abdomen covered with scales. Outer ventral ray produced into a short filament. Anterior branchial arch with about twenty short gill-rakers.

Habitat.—North-east of New Zealand, Station 169; depth, 700 fathoms. Two specimens, 20 inches long.

These specimens were caught on the 10th of July, which, although mid-winter in that southern latitude, seems to be the season of propagation. The ovaries are closed sacs, the ova of the size of millet-seed.

The lower figure represents a scale from the middle of the side, the upper a dorsal scute; both magnified.

Trachyrhynchus murrayi, n. sp. (Pl. XLI. fig. A).

D. 9. P. 23. V. 7.

The large orbit is oval in shape, nearly one-fourth of the length of the head, contained once and two-thirds in the length of the snout, and equal to the width of the interorbital space above the middle of the orbit. Scales almost smooth, having one, two, or three small spines developed on their hind margin; they are rather irregularly arranged, in four series between the dorsal fin and the lateral line; crests of the dorsal scales simple, triangular, spines directed backwards, without denticulation. The abdomen between the vent and the roots of the ventral fins scaleless. The distance of the vent from the isthmus nearly equal to that of the hind margin of the eye from the extremity of the snout. Barbel minute. Ventral fin very small, scarcely in front of the pectoral, with the outer ray produced into a filament, which does not reach the vent. Pectoral as long as the postorbital portion of the head. Anterior branchial arch with twenty-two very short styliform gill-rakers.

Light yellowish (in spirits): vertical fins, ventral filament, interior of the mouth and branchial cavity black.

This species was discovered by Mr. John Murray during the cruise of the "Knight Errant" in the Faröe Channel, at a depth of 555 fathoms (Station 4, August 10, 1880). Four specimens were obtained; the two larger are 14 and 15 inches long, and the two smaller ones 8 and 10 inches. The latter, being the younger, differ from the former, as usual, by a relatively somewhat larger eye and a somewhat shorter abdomen.

Bathygadus.

Bathygadus, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 23.

Head short, thick. Snout not projecting beyond the mouth; jaws even in front. Mouth wide, anterior and lateral. Eye small. Teeth in both jaws villiform, in narrow bands, which occupy the whole length of the jaws. Barbels present or absent. The two dorsal fins are almost continuous, and the anterior rays of the second are not shortened, but gradually diminish in length in the narrow posterior portion of the tail. Anal rays feeble. Bones of the head cavernous, soft, without prominent ridges. Scales small, cycloid, deciduous. Three and a half gills only, there being no slit behind the fourth arch; gill-laminæ very short. The first branchial arch quite free, with numerous long, setiform gill-rakers.

Bathygadus cottoides (Pl. XLII. fig. A).

Bathygadus cottoides, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 23.

D. 8. P. 10. V. 8–9.

The head is large, thick, and in the nuchal region of considerable depth. Nothing can be said of its integuments, which are lost, leaving the bones and cavities bare. The muciferous channels are of great width, formed of very thin bone. The eye is small, situated anterior to the middle of the length of the head, about one-sixth of its length, one-half of the length of the snout and of the width of the interorbital space. Snout broad, with the mouth oblique, opening anteriorly, and extending backwards to below or beyond the middle of the eye. Gill-openings very wide, the gill-membranes being united for a short distance only, leaving the greater part of the isthmus uncovered. Branchiostegals six. Barbel none. The margin of the præoperculum is much dilated, forming a semicircular disk, and, like the other bones of the gill-apparatus, membranaceous.

The first dorsal fin commences immediately above the root of the pectoral; its rays are very thin and fragile, not much longer than the anterior of the second dorsal, which commences immediately behind the first. The rays of the second dorsal are throughout much more developed than those of the anal. Base of the pectoral narrow; its rays being extremely thin and delicate, and the upper prolonged into long filaments, the longest of which extends to the anal. Ventral fins below the pectoral.

The distance between the vent and base of the ventral equals about half the length of the head. Nearly all the scales are gone, but the few which remain show that they were cycloid. There appear to have been six in a transverse line between the first dorsal fin and the lateral line.

Brownish-black. Head, abdomen, and inside of mouth, deep black. First branchial arch with 6 + 17 long, setiform gill-rakers (see figure).

Habitat.—Deep-sea, between New Zealand and the Kermadec Islands, Station 169; depth, 700 fathoms. One specimen, 8 inches long.

Near the Kermadec Islands, Stations 170, 170A; depth, 520 and 630 fathoms. Seven specimens, 4 to 7 inches long.

Near the Kermadec Islands, Station 171; depth, 600 fathoms. Six specimens, 2 to $2\frac{1}{2}$ inches long.

All the specimens of this interesting new form of Macruridæ were unfortunately much damaged by the trawl.

Bathygadus multifilis (Pl. XLII. fig. B).

D. 8. P. 15. V. 8.

The head is compressed, and rather elongate; the nuchal region not being elevated. The muciferous channels are less capacious, and the bones are generally firmer than in *Bathygadus cottoides.* Eye of moderate size, oval, much longer than deep, its longest diameter being two-ninths of the length of the head, equal to the length of the snout and to the width of the interorbital space. Snout rather obtuse, with the mouth very wide, oblique, opening anteriorly, and extending backwards to behind the eye. Gill-openings as in *Bathygadus cottoides.* Barbel long, half the length of the head. The margin of the præoperculum is but slightly dilated, with the angle rounded.

The first dorsal fin commences above the root of the pectoral, the second ray, as well as the first of the pectoral, and the outer of the ventral, is feeble, but produced into very long filaments. The rays of the second dorsal, which commences immediately behind the first, are throughout much more developed than those of the anal. Base of the pectoral narrow, not broader than that of the ventrals. Ventral fins below the pectoral. The distance between the vent and base of the ventral equals about half the length of the head.

Nearly all the scales are lost, but there appear to have been six in a transverse line, between the first dorsal fin and the lateral line. Gill-rakers 5 + 24, long, slender, setiform.

Brownish, with the lower part of the head and the inside of the mouth deep black.

Habitat.—South of the Philippine Islands, Station 214; depth, 500 fathoms. One specimen, 5 inches long.

Bathygadus cavernosus.

Bathygadus cavernosus, Goode and Bean, Proc. U.S. Nat. Mus., 1886, vol. viii. p. 598.

D. 12. P. ? V. 11.

The eye is much longer than the snout, more than one-third of the length of the head, and equal to the width of the interorbital space. Barbel not quite half as long as the eye. Pectoral about two-thirds of the length of the head. Outer ventral ray produced, and reaching beyond the origin of the anal.

The single specimen obtained is quite young, and only $6\frac{1}{2}$ inches long. As its gill-rakers are described as "very short, minute, and rather numerous," and the second dorsal fin as "almost rudimentary" and composed of "remarkably short rays," it is very improbable that this fish belongs to *Bathygadus*. It was caught by the U.S. Fish Commission in the North Atlantic; lat. 28° 45′ N., long. 86° 26′ W.

Bathygadus macrops.

Bathygadus macrops, Goode and Bean, Proc. U.S. Nat. Mus., vol. viii., 1886, p. 598.

D. 10. P. ? V. 8.

The eye is much longer than the snout, exceeds the width of the interorbital space, and is more than one-third of the length of the head. Maxillary extending to below the hind margin of the eye. Barbel minute. The longest dorsal spine is not quite half as long as the head; anterior rays of the second dorsal well developed, and longest. Pectoral fin as long as the head, without snout; ventral reaching nearly to the vent. Gill-rakers lanceolate, elongate, 7 + 26. Yellowish-grey.

The scales were lost, but about twenty-five rows could be counted in an oblique line from the vent to the dorsal fin.

Habitat.—A specimen, 12 inches long, was taken by the U.S. Fish Commission in lat. 28° 34′ N., long. 86° 48′ W., at a depth of 335 fathoms.

Bathygadus longifilis.

Bathygadus longifilis, Goode and Bean, Proc. U.S. Nat. Mus., vol. viii., 1886, p. 599.

D. 10–11. P. 13. V. 8.

The eye is one-fourth of the length of the head, equal to that of the snout, and rather less than the width of the interorbital space. Maxillary extending somewhat behind the eye. Barbel longer than the eye by one-half. The anterior dorsal spine, the upper pectoral ray, and the outer ventral ray produced into long filaments. About twenty-five scales in a row from the vent upwards and forwards to the dorsal fin. Gill-rakers very long and slender, 7 + 28. Yellowish-grey; abdomen bluish.

Evidently closely allied to *Bathygadus multifilis.*

Habitat.—Specimens were obtained by the U.S. Fish Commission in lat. 28° 47′ N., long. 87° 27′ W., at a depth of 724 fathoms; they were 8 inches long.

Macruronus.

Macruronus, Günth., Zool. Record, vol. viii., 1873, p. 103.

Head and body compressed, covered with cycloid scales; trunk not abbreviated. Bones of the head rather firm, with narrow cavities. Eye large; snout rather pointed; mouth wide, lateral. Teeth in the upper jaw biserial, those of the outer series and those of the single mandibulary series strong. Gill-membrane slightly united in front; seven branchiostegals; four gills with the gill-laminæ well developed; the first branchial arch free, with long lanceolate gill-rakers. Rays of the second dorsal well developed throughout its length. Barbel none.[1]

Macruronus novæ-zelandiæ.

Coryphænoides novæ-zelandiæ, Hector, Trans. New Zeal. Inst., vol. iii. p. 136, pl. xviii. fig. 1; Hutton, Fish. N. Z., p. 49.

Of this fish I have examined specimens from New Zealand, Tasmania, and the Messier Channel, the largest being nearly 2 feet long. All of them seem to have been caught near the surface and at no great distance from the shore, and it is not probable that it descends to the same great depth as the other *Macruri*. Like *Lepidopus*, it seems to live for the greater part of the year at a small depth, and to periodically approach the shore at certain seasons. Hutton says that it is thrown up in large quantities on the shores of Cook Straits after heavy gales.

[1] Both Hector and Hutton describe or figure this fish with a barbel, whilst I cannot detect a trace of it in our specimens. Some misunderstanding by the artist must have occurred, as, at any rate, the bifid barbel could not be at the place where he has drawn it.

Family Lyconidæ.

Body terminating in a long compressed tapering tail, covered with small scales. A continuous dorsal fin occupies the back to the extremity of the tail, but a division into two portions may be considered to be indicated by the prolongation of some of the anterior dorsal rays; anal long, extending from the vent to the end of the tail; no caudal; ventrals thoracic, composed of several rays. Pseudobranchiæ present; four gills; seven branchiostegals.

I am obliged to propose a distinct family for the new genus described below, as it differs in certain characters from the Macruridæ, by which this latter family has hitherto seemed to be well defined. It may be considered to be a more generalised type than the Macruridæ.

Lyconus, n. gen.

Head and body compressed, the former composed of thin bones, but with narrow muciferous channels, except on the top between the eyes; trunk as long as or longer than the head; eye large; snout short; cleft of the mouth wide, terminal, both jaws armed with a series of widely set teeth unequal in size; two in front of the upper jaw being canine-like but not so large as those of the lower jaw; vomer with a single canine-like tooth on each side. Scales very small, cycloid, deciduous. Gill-membranes not united. Barbel none.

Lyconus pinnatus, n. sp. (Pl. XLII. fig. C).

Head compressed, as deep as it is long, without snout. The interorbital space is rather flat, narrower than the round eye, which lies immediately below the upper profile; its diameter is one-third of the length of the head and rather longer than the snout. The mouth ascends obliquely forwards, and extends behind the middle of the orbit; the jaws are even in front. The teeth are but few in number, and besides the two long lateral fangs there are only three shorter ones developed in the lower jaw. Opercular bones very thin, and the infraorbitals narrow, separating the maxilla from the eye by a narrow space only.

The distance of the vent from the root of the ventrals is rather more than the length of the head. The tail tapers into an exceedingly fine filament.

The dorsal fin commences above the base of the pectoral, and is composed of very delicate simple rays; there is no break in its continuity, but some of its anterior rays, perhaps three or four, are much prolonged, but as this portion is injured, no more precise information can be given. The anal fin commences immediately behind the vent, and its rays are considerably shorter than those of the dorsal. The pectoral has a narrow base, and is obliquely directed upwards; it consists of thirteen rays, and is exceedingly elongate, the middle rays extending far beyond the vent.

The ventral fins are mutilated; they are composed of ten rays and situated below the base of the pectoral.

Scales very small, thin and deciduous.

The total length of the specimen is 59 lines, of which the head takes 7, and the head and trunk together 17.

The single specimen was acquired for the British Museum in 1876 from the Godeffroy Museum, but I deferred its description, in the hope that the Challenger collection might supply some additional materials. But as it has remained unique, it seems that it is an extremely rare species. The specimen was picked up in mid-ocean in the South Atlantic, in the depths of which adult examples will be probably discovered at some future time. It is not likely that the principal characters given here will be found to undergo essential changes with age.

Family Ateleopodidæ.

Ateleopus, Schleg.

Body and tail compressed, scaleless, the latter much elongate, band-shaped; head oblong, with rather long and broad snout, the end of which overlaps the mouth; maxillaries protractile in a downward direction. Bones of the head and body soft, semicartilaginous, those of the snout enclosed in a thick, mucigerous skin. One short-rayed dorsal fin on the trunk, a narrow, skinny, rayless fringe occupying the remainder of the back. A long anal begins behind the vent, and is continuous with the caudal. Ventral fins reduced to filaments, and inserted immediately behind the symphysis of the clavicles. Eyes of moderate size, with small horizontal pupil. Teeth villiform, in narrow bands; none on the palate. Trunk as long as the head. Gills four, separate; pseudobranchiæ none.

One species only is known.

Ateleopus japonicus (Pl. L. fig. A).

Ateleopus, Schleg., Faun. Japon. Poiss., p. 255, pl. cxii. fig. 1.
Ateleopus japonicus, Bleek., Verhandl. Batav. Genootsch., vol. xxv. Nalez. Japan., p. 19.
" " Günth., Fish., vol. iv. p. 398.

B. 9. D. 8. A + C. 110. P. 12. V. 2.

The length of the head equals that of the trunk, and is one-seventh of the total. The head is rather thick, low and oblong, with broad, flat, slightly declivous upper surface. The eye is a little nearer to the extremity of the snout than to the end of the gill-cover, immediately below the upper profile, about half the length of the snout. The entire head is enveloped in soft skin, which is thickest and mucigerous on the snout; no foramina leading into the muciferous system can be distinguished. The nostrils lie immediately in front of the eye.

The thick end of the snout overlaps the mouth, which is horse-shoe-shaped, its lateral cleft extending to the front margin of the eye. Barbel none.

The branchial cleft extends from the upper end of the gill-cover far forwards, the branchiostegous membranes being free from each other. Gill-laminæ well developed; gill-rakers rather short, soft, lanceolate.

All the fins are long-rayed. The dorsal fin has a rather broad base, the length of which is about one-third of its distance from the end of the snout; it is very high, its longest rays being much longer than the head, and even exceeding the pectoral fin. As regards the anal fin, the rays of its anterior portion are about equal to the depth of the tail, but the posterior increase in length, and exceed much the gradually decreasing depth of the tail. The pectorals have a narrow base, are longer than the head, and extend backwards to the origin of the anal. The ventrals consist of two rays each, of which the longer is bifid at the end, and nearly reaches the vent; the shorter and inner is rudimentary.

The fish is nearly transparent, with a brownish tint; dorsal and pectoral fins and a broad margin of the anal black.

I am indebted to M. Tegima of the Tokio Museum for a specimen of this extremely rare fish, which does not seem to have been observed since it was described in the Fauna Japonica. It is 9 inches long, and in a good state of preservation, except for a certain degree of desiccation, which it has undergone in consequence of the action of the spirit on the mucous layer with which it is covered. Our specimen differs in the shape of the fins from the figure given by Schlegel. Perhaps this is due to age, as the specimen of the Dutch naturalist was considerably larger.

Family Pleuronectidæ.[1]

As far as our present knowledge goes, Flat-fishes are, unlike the Gadoids and Ophidioids, but sparsely represented in the deep sea, and have not yet reached to a depth of

[1] For the sake of completeness I mention here a small Flat-fish, 72 mm. long, which was obtained by the U.S. Fish Commission at depths of 86 and 115 fathoms, in lat. 40° 0′ N., long. 70° 23′ W., and which has been described by Mr. Brown Goode under the name of *Thyris* or *Delothyris pellucidus* (*Proc. U.S. Nat. Mus.*, vol. iii. p. 344, 1880; and p. 110, 1884), and which both he and Mr. Jordan regard as a larval form. As generic diagnosis the following description is given:—" A genus of heterosome fishes, with soft, transparent, elongate body. Head very short (in the single species contained about 5½ times in total length of body). Mouth small, toothless. Eyes upon left side, close together, the lower slightly in advance of the upper. Pectoral fin upon blind side shorter and with fewer rays than upon coloured side. Ventrals crowded together upon median keel of body, their bases prolonged upon this keel. Dorsal fin commences in front of the eye upon the snout. Dorsal and anal rays simple. Caudal fin subsessile, almost confluent with dorsal and anal. Scales very small, thin, easily detached. Dorsal line marked, straight. Body translucent, colourless (except for three longitudinal stripes in the single species). The vertebræ can almost be counted through the flesh when the fish is held up to the light, and the arrangement of the gills is clearly visible through the opercular bones."

800 fathoms. Neither does this family offer a striking instance of bathybial organisation, for although the majority of the species are distinct from the surface forms, their distinctive characters are such as may be also observed among the latter. The number of Flat-fishes of which we have certain indications of their living or occurring beyond 100 fathoms, is only nineteen; and four of them are identical with species which have been long known as littoral inhabitants; one of them descends to 100, the second to 220, a third to 447, and the fourth (*Pleuronectes cynoglossus*) to 732 fathoms, the furthest limit of the vertical distribution of the Pleuronectoid type. The other fifteen species are either generically or specifically distinct from surface forms, ten having been found between 100 and 200 fathoms, two between 200 and 300 fathoms, and three between 300 and 400 fathoms.

Hippoglossus, Cuv.

Hippoglossus pinguis, Fabr.

Hippoglossus pinguis, Collett, Norges Fisk, p. 135.
Platysomatichthys hippoglossoides (Walb.), Goode and Bean, Bull. Ess. Inst., vol. xi. p. 7, 1879.
" " Collett, Norsk. Nordh. Exped. Fisk., p. 142.
Hippoglossus grœnlandicus, Günth., Fish., vol. iv. p. 404.

An Arctic species, extending southwards to the deep water off the coast of Massachusetts, in the Western Atlantic; found in a single young example by the North Atlantic Expedition, south-west of Bear Island, in 447 fathoms, and occasionally obtained from deep water on the coast of Norway.

Hippoglossoides, Gottsche.

Hippoglossoides platessoides (Fabr.).

Hippoglossoides platessoides, Collett, Norsk. Nordh. Exped. Fisk., p. 145.
" " Goode, Proc. U.S. Nat. Mus., vol. iii. p. 471.

An inhabitant of the northern seas, from the coast of Scandinavia to that of North America, southwards to New England, and living in shallow water in the vicinity of land. Collett reports its occurrence at depths of from 120 to 220 fathoms south of Spitzbergen and Bear Island. Goode states that it is not unusual in deep water off Southern Massachusetts and Rhode Island.

Pœcilopsetta, Gthr.

Only one species is known.

Pœcilopsetta colorata.

Pœcilopsetta colorata, Günth., Report on the Shore Fishes, Zool. Chall. Exp., pt. vi. p. 48, pl. xxii. fig. B.

Habitat.—Ki Islands, Station 192; depth, 129 fathoms. Two specimens.

Anticitharus, Gthr.

One species only is known.

Anticitharus polyspilus.

Anticitharus polyspilus, Günth., Report on the Shore Fishes, Zool. Chall. Exp., pt. vi. p. 48, pl. xxii. fig. A.

Habitat.—Ki Islands, Station 192; depth, 140 fathoms. Two specimens, 7 and $8\frac{1}{2}$ inches long.

Samaris, Gray.

Two species are known, of which one occurs in the Chinese Seas, and is probably littoral; the other is—

Samaris maculatus.

Samaris maculatus, Günth., Report on the Shore Fishes, Zool. Chall. Exp., pt. vi. p. 47, pl. xxi. fig. A.

Habitat.—Ki Islands, Station 192; depth, 140 fathoms. One specimen, 4 inches long.

Lepidopsetta, Gthr.

Known from a single specimen only.

Lepidopsetta maculata.

Lepidopsetta maculata, Günth., Report on the Shore Fishes, Zool. Chall. Exp., pt. vi. p. 18, pl. xxx. fig. C.

Habitat.—Off Prince Edward Island, Station 145A; depth, 310 fathoms. One specimen, $5\frac{1}{4}$ inches long.

Pseudorhombus, Blkr.

Dr. Hector has kindly sent to me the specimen from 400 fathoms which was given him by Sir Wyville Thomson for description, and which served as a type of his *Pseudorhombus boops*. On comparing it with the second specimen from 150 fathoms, brought home by the expedition as a "co-type" of that species, and consequently described by me under the same name in Shore Fishes, p. 26, I find considerable differences in the proportions of various parts of the head; differences which are quite in accordance with the depths at which the two specimens were found, and which are sufficiently developed to call for specific distinction. I give here comparative descriptions and figures of the heads of both specimens, from which it will be seen how far the development of bathybial characters has proceeded in the specimen from the greater depth.

Pseudorhombus hectoris.

Pseudorhombus boops, Günth., Report on the Shore Fishes, Zool. Chall. Exp., pt. vi. p. 26 (not Hector).

D. 117. A. 89. P. 12. L. lat. 78.

The dorsal fin commences above the nostrils. The height of the body is two-fifths of the total length (without caudal), the length of the head nearly one-fourth. Scales ciliated; those on the head and on the anterior part of the body smaller than those on

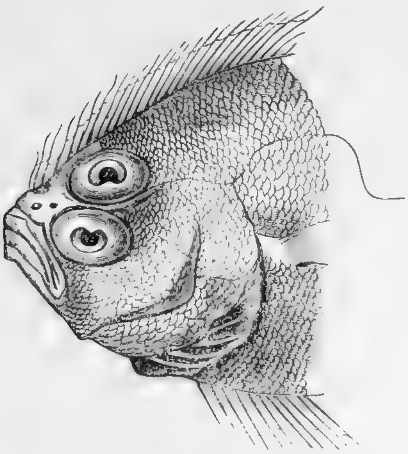


Fig. 4.—Head of *Pseudorhombus hectoris*.

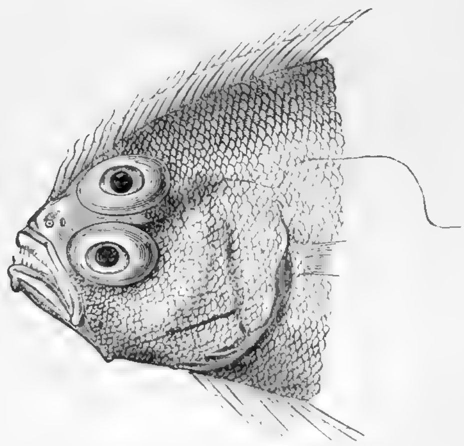


Fig. 5.—Head of *Pseudorhombus boops*.

the tail. Interorbital ridge very narrow and naked. No spines or tubercles along the lateral line or the base of the fins. The curve of the lateral line is strong, but flat above. Snout rather shorter than the eye, the diameter of which is two-sevenths of the length of the head. Lower jaw scarcely prominent when the mouth is shut. The maxillary extends beyond the front margin of the eye, and is two-fifths of the length of the head. Lower eye considerably in advance of the upper. Lower limb of the præoperculum half as long as the head. Vertical fins of moderate height, extending nearly to the root of the caudal. Left pectoral fin more developed than the right, and rather more than one-half of the length of the head. Brownish; fin-rays indistinctly punctulated with brown.

Habitat.—Off the coast of New Zealand, Station 167; depth, 150 fathoms. One specimen, 6 inches long.

Pseudorhombus boops.

Pseudorhombus boops, Hector, Trans. New. Zeal. Inst., vol. vii. p. 249, pl. xi.

D. 111. A. 92. P. 13. L. lat. 80.

The dorsal fin commences above the nostrils. The height of the body is contained twice and three-fourths in the total length (without caudal), the length of the head thrice and three-fifths. Scales indistinctly ciliated; those on the head and on the anterior part of the body smaller than those on the tail. Interorbital ridge very narrow and naked. No spines or tubercles along the lateral line or the base of the fins. The curve of the lateral line is strong, but flat above. Snout two-thirds of the length of the eye, the diameter of which is two-sevenths of the length of the head. Lower jaw prominent. The maxillary extends nearly to below the middle of the eye and is two-fifths of the length of the head. Lower eye considerably in advance of the upper. Lower limb of the præoperculum rather more than half as long as the head. Vertical fins of moderate height, extending nearly to the root of the caudal. Left pectoral fin more developed than the right and somewhat more than one-half of the length of the head. Uniform yellowish-white.

Habitat.—Two hundred miles off Cape Farewell; depth, 400 fathoms. One specimen, 6 inches long.

Pseudorhombus oblongus (Mitch.).

Paralichthys oblongus, Goode, Proc. U.S. Nat. Mus., vol. iii. p. 472.

A littoral species, off the United States, taken in 100 fathoms, on the south coast of New England.

Pseudorhombus ocellatus.

Pseudorhombus ocellatus, Günth., Report on the Shore Fishes, Zool. Chall. Exp., pt. vi. p. 56, pl. xxiv. figs. A, B.

Habitat.—Admiralty Islands; depth, 152 fathoms. One specimen, $5\frac{1}{2}$ inches long.

Rhomboidichthys, Blkr.

This genus includes littoral species of the Tropical and Subtropical seas, and there is also some uncertainty as to the depth at which the following species was obtained.

Rhomboidichthys cornutus.

Rhomboidichthys cornutus, Günth., Report on the Shore Fishes, Zool. Chall. Exp., pt. vi. p. 7, pl. ii. fig. B.

Habitat.—Coast of Brazil, Stations 122 to 122B; depth, 32 to 350 fathoms. One specimen, 3½ inches long.

Monolene.

Monolene, Goode, Proc. U.S. Nat. Mus., vol. iii., 1881, p. 338.

This genus seems to differ from *Arnoglossus* by having a narrower mouth, the length of the maxillary being less than one-third of that of the head, by the total absence of the pectoral fin on the blind side, and by feeble gill-rakers in small number.

Monolene sessilicauda.

Monolene sessilicauda, Goode, Proc. U.S. Nat. Mus., vol. iii., 1881, pp. 338, 472; Bull. Mus. Comp. Zoöl., vol. x., 1883, p. 194.

D. 99–103. A. 79–84. L. lat. 92 (?).

Several specimens, from 4 to 6 inches long, were obtained by the U.S. Survey steamers, in lat. 40° 0′ N., long. 70° 22′ W.; and in lat. 32° 31′ N., long. 78° 44′ W.; at depths from 115 to 155 fathoms.

Citharichthys, Blkr.

The species of this genus are littoral forms, from the Tropical Atlantic and California, but the following have descended to moderate depths within the same oceanic area.

Citharichthys arctifrons.

Citharichthys arctifrons, Goode, Proc. U.S. Nat. Mus., vol. iii., 1881, pp. 341, 472; Bull. Mus. Comp. Zoöl., ser. 5, vol. x., 1843, p. 194.

Numerous specimens, from 3½ to 5½ inches long, were obtained by the U.S. Fish Commission, at lat. 40° 0′ N., long. 70° 23′ W.; in from 86 to 155 fathoms; and by the U.S. steamer "Blake," in the same area down to 197 fathoms.

Citharichthys unicornis.

Citharichthys unicornis, Goode, Proc. U.S. Nat. Mus., vol. iii., 1881, p. 342.

Specimens, $2\frac{3}{4}$ inches long, were obtained by the U.S. Fish Commission, in lat. 40° 0′ N., long. 70° 22′ W., in 115 and 155 fathoms.

Pleuronectes, Gthr.

Pleuronectes beanii.

Limanda beanii, Goode, Proc. U.S. Nat. Mus., vol. iii., 1880, p. 473.

Two specimens, 5 inches long, were obtained by the U.S. Fish Commission, in lat. 40° 0′ N., long. 70° 23′ W., at depths varying from 120 to 126 fathoms.

Pleuronectes cynoglossus, Linn.

Glyptocephalus cynoglossus, Goode, Proc. U.S. Nat. Mus., vol. iii., 1880, p. 475; Bull. Mus. Comp. Zoöl. ser. 5, vol. x., 1883, p. 195.
„ „ Collett, Norsk. Nordh. Exped., Fisk., p. 150; Forhandl. Vidensk. Selsk. Christ., 1880, p. 82.
„ „ Strom, Norsk. Vidensk. Selsk. Skriv., 1884, p. 39.

The occurrence of this littoral species at considerable depths is a very remarkable fact. The U.S. Fish Commission and the U.S. steamer "Blake" found specimens between lat. 34° and 39° N., and between long. 70° and 75° W.; at depths of 120, 263, 395, 603 and 732 fathoms; and the North Atlantic Expedition met with the species near Lofoten and Finmark, at 125 to 150 fathoms. Strom has caught it in Trondhjem Fjord to a depth of 200 fathoms.

Nematops, Gthr.

Known from the following species only :—

Nematops microstoma.

Nematops microstoma, Günth., Report on the Shore Fishes, Zool. Chall. Exp., pt. vi. p. 57, pl. xxiv. fig. C.

Habitat.—Admiralty Islands; depth, 152 fathoms. One specimen, $3\frac{3}{4}$ inches long.

Solea, Gthr.

Of the numerous species of Soles one species only is at present known to descend beyond a depth of 100 fathoms, viz. :—

Solea kaiana.

Solea kaiana, Günth., Report on the Shore Fishes, Zool. Chall. Exp., pt. vi. p. 49, pl. xxi. fig. C.

Habitat.—Ki Islands, Station 192; depth, 140 fathoms. One specimen, 4½ inches long.

Aphoristia, Kaup.

Aphoristia nebulosa.

Aphoristia nebulosa, Goode and Bean, Bull. Mus. Comp. Zoöl., ser. 5, vol. x., 1883, p. 192.

Habitat.—One specimen, 3½ inches long, was obtained by the U.S. steamer "Blake," in lat. 32° N., long. 78° 37′ W.; at a depth of 229 fathoms.

PHYSOSTOMI.

Family STERNOPTYCHIDÆ.[1]

Argyropelecus, Cocco.

Argyropelecus hemigymnus, Cocco.

Common in the Mediterranean and neighbouring parts of the Atlantic, and frequently caught at night in the surface net. During the cruise of the "Porcupine" an adult example was obtained between Shetland and Faröe, at a depth of 180 fathoms. It would therefore appear that this fish is of nocturnal habits, living during the day at a depth from the surface, which varies according to circumstances.

It is also reported by Messrs. Goode and Bean among the fishes obtained by the U.S. steamers "Blake" and "Fish Hawk," at depths of 225 and 245 fathoms.[2]

Argyropelecus olfersii, Cuv.

This species, like its congeners, has been hitherto considered to be a pelagic species of the Atlantic, which now and then is found as far north as the coast of Norway. But the naturalists of the Challenger obtained a specimen, 2¼ inches long, at Station I. (off Cape Finisterre), by the dredge, which had reached a depth of 1125 fathoms.

[1] If Mr. Jordan (Cat. Fish. N. Amer., p. 45) takes exception to the expression which I have used (Cat. Fish., vol. v. p. 384) in the diagnosis of this family, "a rudimentary spinous dorsal fin," and explains that "this appearance is due to the projection of one or more of the several spines beyond the muscles, and is in no proper sense a rudiment of a fin,"—he should have added that this explanation of the term used was first given by myself (*loc. cit.*, p. 385). In the diagnosis of the genus *Argyropelecus*, which he copies from my work, he has introduced (probably by a slip of the pen) a misleading error in describing the gill-opening as "very short," whilst, in fact, it is "very wide."

[2] *Bull. Mus. Comp. Zoöl.*, vol. x., 1883, p. 220.

The question arises whether the fish was really captured at this great depth, or whether it entered the dredge during its passage through the surface strata; and I am very much inclined to think that the latter took place. We have very little positive information as to the habits of these fishes, but we know that they are commonly obtained near the surface in mid-ocean; and from their structure we may infer that, like all deep, compressed fishes, they are slow swimmers, and that they can with ease maintain a free position in the water, without the necessity of a support, remaining as it were suspended at a certain distance from the surface. This may be observed in a fish of our own seas with a similarly elevated body, viz., the John Dory, in which, however, a rapid undulatory movement of the soft dorsal fin is almost unceasing. The great development of the luminous organs, combined with the large eyes, indicates the nocturnal habits of the fish, which would induce it to descend to a greater depth during daytime. Also the firm structure of the bones disproves the bathybial habits of *Argyropelecus*.

Sternoptyx (Herm.).

Body much elevated and compressed, passing abruptly into a short and compressed tail; the angle made by the hind margin of the trunk and the lower edge of the tail being filled up by a broad fold of the integument, of peculiar transparent appearance, resembling thin cartilage. This fold bears the anal fin and is supported by interhæmal rays. The greater portion of the body is scaleless, and covered with a silvery pigment. A series of luminous spots runs along the lower edge of the abdomen, and is separated from that of the other side by a cartilaginous fold occupying the median line of the abdomen; another series runs on each side of the isthmus; a row of three above and behind the root of the ventrals, and another row of three above the vent. The luminous organs on the lower part of the tail consist anteriorly of a row of four, of which the first is prolonged towards the back as a narrow band, terminating about the middle of the depth of the body in a globular black spot with a white centre; posteriorly in front of the caudal rays there is another row of four small spots.

Head short, compressed, deep, with extremely short snout and a wide subvertical mouth. Bones of the head firm, some of them terminating in short spines, namely, the angle of the præoperculum, the postero-inferior angle of the mandible, and the symphysis of the humeral bones. The margin of the upper jaw is formed by the maxillary and intermaxillary, the latter being very short; both these bones have a sharp edge which is armed with a series of very small teeth, somewhat unequal in size; lower jaw with a similar dentition; vomer and palatine bones toothless. Eyes large, lateral.

Pectorals well developed, close to the lower profile; ventrals small; pelvic bone with a bifid spine in front pointing forwards. The dorsal fin occupies the middle of the back and consists of a triangular bony lamella, very thin in front, but strengthened along its hind margin, and followed by several rays. Adipose fin absent, or represented by a very low membranous fringe of the dorsal margin of the tail. The anal fin is incompletely developed, extending from the vent to the root of the caudal fin, its rays being rudimentary, widely set, and scarcely free. Caudal fin broad and forked. Gill-opening very wide, the gill-membrane being attached to the isthmus. A luminous organ occupies the inner side of the operculum close to its lower end; another is placed at the anterior end of the ceratohyal, and, finally, a very large glandular mass is lodged on the upper edge of the anterior end of the clavicle. Gills four; the branchial arches are long, not angularly bent, the branchial slits being closed by a membrane in their upper portion. Only a few of the gill-rakers are prolonged, needle-shaped, and widely set, the others being quite rudimentary. Pseudobranchia present.

Sternoptyx diaphana (Herm.) (Pl. XLV. figs. D, D′).

D. 10 to 12. A. 12. P. 10. V. 3.

The numerous specimens collected by the Challenger differ not inconsiderably in the shape of the body, which in some specimens is much more oblique than in others; in the width of the upper surface of the head and neck, and, finally, in the size of the eye, which in a specimen 50 mm. long is 8 mm. wide, and in another specimen of the same length only 7 mm. Also the relative position of the luminous organs which are congregated in groups, is subject to unimportant variations.

Two forms may be distinguished.

1. In the first and more common (fig. D), the eye is comparatively larger and its diameter more than the depth of the triangular space, which is formed by the margins of the præoperculum, of the jaws, and of the orbit; the upper part of the mouth is also conspicuously above the level of the lower margin of the orbit.

2. In the second form (fig. D′), the diameter of the eye is not longer than the depth of the triangular space described, and the upper part of the cleft of the mouth is on a level with the lower margin of the orbit.

Both forms occur in the Indo-Pacific as well as Atlantic, and seem sometimes to have been obtained on the same occasion; and as, moreover, intermediate forms occur which might be assigned to either of the two forms, it is evident that the differences mentioned are not of specific value.

Very young specimens of 15 mm. in length already possess all the characteristics of the adult.

As will be seen from the following list of specimens obtained during the voyage, this species would appear to inhabit all depths from the surface downwards. This is extremely improbable, and its frequent capture is only a proof of its abundance in all tropical seas, and of the slowness of its movements, which prevent it from getting out of the way of the dredge or net. Like *Argyropelecus* it is a pelagic fish, which probably lives in shoals, as sometimes more than one example were obtained in the same haul. Possibly it may descend to or beyond the 100 fathoms line during the day-time.

Messrs. Goode and Bean have included this species in their Report on the "Blake" collection, from depths of 229 and 457 fathoms.[1]

Habitat.—Between Tenerife and St. Thomas; surface. Two specimens, $\frac{2}{3}$ and 1 inch long.

Off Sierra Leone, Station 101; depth, 2500 fathoms. One specimen, $\frac{1}{2}$ inch long.

Mid Atlantic, Station 106; depth, 1850 fathoms. One specimen, $1\frac{3}{4}$ inches long.

Mid Atlantic, Station 107; depth, 1500 fathoms. Two specimens, $\frac{3}{4}$ and $1\frac{1}{2}$ inches long.

South of Australia, Station 159; depth, 2150 fathoms. One specimen, $1\frac{1}{2}$ inches long.

Kermadec Islands, Station 171; depth, 600 fathoms. Two specimens, $1\frac{1}{4}$ and 2 inches long.

Philippine Islands, Station 214; depth, 500 fathoms. Six specimens, $1\frac{1}{2}$ and 1 inch long.

North of New Guinea, Station 218; depth, 1075 fathoms. One specimen, 2 inches long.

South of Yedo, Station 235; depth, 565 fathoms. One specimen, 2 inches long.

Polyipnus, n. gen.

This genus differs from *Sternoptyx* in having the body covered with large, very thin and deciduous scales, and in lacking the anterior spinous dilatation of the dorsal fin.

Habitat.—Philippine Islands.

Polyipnus spinosus, n. sp.

D. 12. A. 15.

Occiput terminating in a pair of horizontal spines pointing backwards.

Habitat.—Between the Philippine Islands and Borneo, Station 200; depth, 250 fathoms. One specimen, $2\frac{1}{4}$ inches long.

This fish differs from *Sternoptyx* in having the body of a more regular shape, there being no deep indentation by which the tail is separated from the trunk. The form of its outline is oval, its greatest depth being contained once and two-thirds in the total

[1] *Bull. Mus. Comp. Zoöl.*, vol. x., 1883, p. 220.

length, without caudal. The head is much higher than long, its length one-third of the total; eye large, two-fifths of the length of the head. Mouth vertical, snout extremely short. Intermaxillary narrow, and, although it does not entirely form the margin of the upper jaw, it reaches as far as the cleft of the mouth, when the gape is open to its fullest extent. The maxillary is a broad lamelliform bone; the lower two-fifths of its anterior margin remain free from the intermaxillary, and show a very obscure and rudimentary denticulation. The teeth in both jaws are minute, and appear to form anteriorly an extremely narrow band, and laterally a single series; vomerine teeth present, and similar.

The upper part of the head is much compressed, narrow, hollow, and bordered on each side by a serrated ridge. The two ridges slightly converge behind, and are continued as a pair of humeral ridges, which terminate behind in a strong and acute spine. On the side of the head the ridges of the præoperculum are very distinct, the posterior and inferior meeting at a right angle, and the angle being armed with a slender claw-like spine, which points downwards. Also the lower margin of the mandible is finely serrated, and terminates behind in a short and obtuse spine.

Nostrils in front of the upper part of the eye, separated by a very narrow bridge of skin, the posterior being much wider than the anterior.

Branchiostegals five. The gill-membranes overlapping the isthmus free. Gill-rakers rather numerous, closely set, long and slender; pseudobranchiæ present.

The dorsal fin is preceded by a minute forked spine, and composed of eleven soft rays. A well-developed adipose fin, which is about half as long as the rayed dorsal, occupies the middle of the space between dorsal and caudal. Anal fin with fourteen rays. Caudal fin composed of some thirty-five rays, some of which occupy the upper and lower edges of the tail. Pectoral inserted low down on the side, composed of about fourteen very slender rays, and pointing forwards, not backwards. The lower edge of the abdomen is convex and denticulated, the ventrals being inserted in front of the vent, close together, and in a vertical position. None of the scales have been preserved, but to judge from the pouches, which are distinctly visible, they must have been large, and numbering perhaps thirty-two, in a series along the middle of the side.

The luminous organs have reached in this fish an extraordinary degree of development as regards size and number:—

1. A series of six, pearl-coloured, oblong organs runs on each side of the isthmus to the root of the pectoral fin.

2. A series of ten along each side of the ventral edge, from the humeral symphysis to the ventral fin.

3. A series of five, which are rather irregularly arranged, occupies a position higher up the side above the level of the pectoral.

4. Two isolated organs are placed still higher up the side of the trunk, but below the middle line.

5. A series of five on each side of the abdomen, somewhat above the lower profile.

6. A series of seventeen along each side of the lower profile of the tail; these are smaller than the preceding, and the series is slightly interrupted behind the anal fin.

7. The organs on the head are all placed in its lower half; a series of six occupies the roots of the branchiostegals.

8. A very large one is placed above the lower rim of the præoperculum.

9. A small one occupies the suboperculum where it joins the operculum.

10. Finally, two of the smallest are placed, one in front of, the other behind the eye.

Gonostoma, Rafin.[1]

As far as it is possible to make out the anatomical structure from a specimen of *Gonostoma denudatum* which has been preserved in spirits for some time, the conditions are the following:—

The œsophagus is continued into a very long, tapering cæcal stomach, the pyloric portion of which is surrounded by seven short pyloric appendages. The intestine is narrow throughout, attached in its upper portion along the cæcal sac of the stomach, and continued in a straight line to the vent.

The air-bladder is not only present but of large size, extending from one end of the abdomen to the other. Its dorsal wall, as well as its posterior extremity, is rather thick, whilst the membrane on its ventral aspect is very thin. I am unable to find any communication between it and the œsophagus. A narrow muscular band starts from each side of its anterior third, and is attached to the intermuscular ligaments of the fore part of the trunk. The posterior end of the bladder is obtusely rounded, and has a conical, muscular body attached to its ventral side. This muscular body is hollow in its interior, and seems to communicate with the cavity of the bladder; the broad end of the cone rests upon the coalescent mass of the kidneys, and is suspended by a tendinous ligament from the vertebral column.

Ovaries large, elongate, lamellated; ova minute.

Gonostoma denudatum, Raf.

D. 14–15. A. 30–31. P. 11–12. V. 8. L. lat. 36.

The height of the body is contained five and a half times in the total length (without caudal), the length of the head four times. Jaws heterodont, the intermaxillary being

[1] A fish, mentioned under the name of *Sigmops stigmaticus* (*Proc. U.S. Nat. Mus.*, 1884, p. 256), is not recognisable from the notes accompanying this binomial term.

A fish, mentioned and rudely figured in *La Nature*, 1884, p. 184, under the name of *Neostoma bathyphillum* [? *bathyphilum*], L. Vaill., from a depth of 2220 metres in the Eastern Atlantic, seems to belong to *Gonostoma*.

armed with two, the maxillary with about twelve large distant teeth, the spaces between them being filled with very small teeth; lower jaw similarly armed with ten or eleven large teeth. The entire cheek is covered with the enormously enlarged infraorbital.

Common in the Mediterranean and neighbouring parts of the Atlantic, attaining a length of 7 inches; evidently a species which comes to the surface at night.

Gonostoma elongatum (Pl. XLV. fig. B).

Gonostoma elongatum, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 187.

B. 11. D. 13. A. 29. P. 11. V. 7.

The cheek is not entirely covered by the infraorbital. Dentition as in *Gonostoma denudatum*. The height of the body is one-seventh of the total length (without caudal), the length of the head two-ninths.

Habitat.—Indian Ocean, south of New Guinea, Station 191; depth, 800 fathoms. One specimen, 6⅔ inches long.

Off Banda, Station 194A; depth, 360 fathoms. One specimen, 4½ inches long.

The height of the body is one-seventh of the total length, without caudal, the length of the head two-ninths. Vent midway between the root of the caudal fin and the eye. Eye rather small, two-thirds of the length of the snout, about one-eighth of the length of the head, and narrower than the width of the interorbital space. Cleft of the mouth exceedingly wide, the maxillary extending to the posterior angle of the præoperculum; it is armed with about twelve large distant teeth, the interspaces being filled with small teeth, the intermaxillary with two, and the mandible with about ten large teeth. The infraorbital bone is dilated into a large very thin lamella, which extends backwards along the upper margin of the maxillary, but covers only about one-half of the cheek. Opercular bones very thin, like the rest of the bones of the head.

The whole of the gill apparatus reminds one very much of that of an anchovy. The gill-laminæ are very short, the gill-rakers long and needle-shaped. Branchiostegals eleven, very short.

The dorsal fin commences a little behind the vertical from the vent, and is higher than the body underneath. Of the anal fin the anterior portion is much higher than the middle and posterior; it terminates at a short distance in front of the caudal. Caudal fin forked. Pectoral narrow, low down on the side of the body, composed of eleven rays, two-thirds as long as the head. Ventral fins nearly twice as distant from the pectorals as from the vent, which they do not reach.

Nothing can be said about the scales, as not only they are lost (if they were present), but also the greater part of the skin. There are traces of scale pouches on the tail of the larger specimen, but it would appear as if the greater part of the trunk had been scaleless. At any rate, no trace of the existence of scales is visible on such parts of the trunk of the smaller specimen as have the skin preserved. The coloration was uniform black.

The luminous organs are apparently less developed than in *Gonostoma denudatum*, but their arrangement is essentially the same. Two rows run near to the lower edge of the abdomen; the lowermost series containing four in front of the pectoral, ten between pectoral and ventral, four between ventral and vent, and twenty-two between the vent and caudal fin. The upper abdominal series is composed of twelve organs, but does not extend to the tail. A short series of oblong glandular masses occupies the root of the upper and lower rudimentary caudal rays. Another similar mass is imbedded behind the upper portion of the maxillary bone. A luminous organ also occupies the root of each of the branchiostegals, as in *Gonostoma denudatum*, but none of the opercular organs are preserved, if they were present at all.

Gonostoma gracile (Pl. XLV. fig. C).

Gonostoma gracile, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 187.

D. 10. A. 26. P. 11. V. 6.

Apparently scaleless. The cheek is not entirely covered by the infraorbital. The larger teeth in the upper jaw rather numerous. The height of the body is one-ninth of the total length, the length of the head one-fifth. Tail very slender and narrow. Adipose fin absent.

Habitat.—South of Japan, Station 232; depth 345 fathoms. One specimen, $4\frac{3}{4}$ inches long.

South of Japan, Station 230; depth 2425 fathoms. One specimen, $2\frac{1}{2}$ inches long.

The height of the body is one-ninth of the total length, without caudal, the length of the head one-fifth. Vent midway between the root of the caudal and the end of the snout. Eye rather small, two-thirds of the length of the snout, about one-seventh of the length of the head, and but little narrower than the width of the interorbital space. Cleft of the mouth exceedingly wide, the maxillary extending to the posterior angle of the præoperculum; lower jaw very prominent in front. The maxillary is armed with about thirteen larger teeth, which are not very remote from each other, the interspaces being occupied with small teeth. Intermaxillary with two or three, mandible with about eleven larger teeth, the latter being much smaller than those of the upper jaw. The infraorbital bone is dilated into a very thin lamella, which extends backwards along the upper half of the maxillary, and leaves the greater portion of the cheek uncovered. Gill apparatus as in *Gonostoma elongatum;* branchiostegals ten.

The dorsal fin commences at some distance behind the origin of the anal and is higher than the body underneath. Form of the anal fin as in *Gonostoma elongatum;* it terminates at some distance from the caudal, the caudal peduncle being long and slender. Caudal fin forked. Pectoral very narrow, nearly one-half as long as the head. Ventral fins likewise very narrow, they reach to the vent, and their distance from the latter is only two-fifths of that from the root of the pectorals.

This fish is evidently scaleless, and uniform deep black; the fins transparent.

The luminous organs are still less developed than in *Gonostoma elongatum,* but their arrangement is essentially the same. Two rows run near to the lower edge of the abdomen; the lowermost series containing four very small ones in front of the pectoral, five between the pectoral and ventral, three between the ventral and anal, and very small ones, whose number cannot be made out, along the base of the anal fin. The upper abdominal series is represented only by a single organ at about the middle of the trunk. The majority of the organs on the trunk consist of two parts, namely, a larger, circular, glandular disk and a superimposed small eye-like spot, with a black margin and white pupil. An oblong glandular mass occupies the lower margin of the tail on each side of the root of the rudimentary caudal rays, but is absent, or present in a rudimentary condition only, on the corresponding part of the upper side of the tail. Another similar mass is embedded behind the upper portion of the maxillary bone, and is likewise accompanied by an eye-like spot above. A small organ occupies the middle of the hind margin of the præoperculum. The organs which occupy the roots of each of the branchiostegals are small and eye-like, and similar minute structures are scattered in an irregular fashion along the middle, and also on the sides, of the abdomen.

Gonostoma microdon.

Gonostoma microdon, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 188.
Cyclothone lusca, Goode and Bean, Bull. Mus. Comp. Zoöl., vol. x., 1883, p. 221.

D. 13. A. 18–21. P. 9. V. 7. L. lat. 26 (?).

Cheek naked. Teeth in the upper jaw very fine and numerous, with some larger ones placed at regular intervals. Eye small.

Habitat.—Atlantic and Pacific (500 to 2900 fathoms).

North-east of Bermuda, Station 60; depth, 2575 fathoms. Eight specimens, 1 to $2\frac{1}{2}$ inches long.

North-east of Bermuda, Station 61; depth, 2850 fathoms. Three specimens, $1\frac{1}{4}$ inches long.

North-west of Bermuda, Station 40; depth, 2675 fathoms. Two specimens, $1\frac{1}{2}$ inches long.

South of Sombrero Island, Station 23; depth, 450 fathoms. Seven specimens, 1 to $1\frac{1}{2}$ inches long.

South of Sombrero Island, Station 101; depth, 2500 fathoms. Two specimens, $1\frac{1}{2}$ inches long.

Mid Atlantic, Station 106; depth, 1850 fathoms. Two specimens, 1 to $1\frac{1}{4}$ inches long.

Off Pernambuco, Station 120; depth, 675 fathoms. Twenty-five specimens, $1\frac{1}{2}$ to $2\frac{1}{2}$ inches long.

South Atlantic, Station 137; depth, 2550 fathoms. One specimen, $1\frac{1}{2}$ inches long.

South Atlantic, Station 337; depth, 1240 fathoms. One specimen, $2\frac{1}{2}$ inches long.

South Pacific, Station 286; depth, 2335 fathoms. One specimen, 3 inches long.

The Kermadec Islands, Station 171; depth, 600 fathoms. One specimen, 2 inches long.

The Kermadec Islands, Station 170; depth, 520 fathoms. Two specimens, 2 inches long.

Mid-Pacific, Station 169; depth, 700 fathoms. Five specimens, 2 to $2\frac{1}{2}$ inches long.

Mid-Pacific, Station 265; depth, 2900 fathoms. One specimen, 2 inch long.

Off New South Wales, June 13, 1874. One specimen, $1\frac{1}{3}$ inches long.

South of Australia, Station 158; depth, 1800 fathoms. Two specimens, $2\frac{1}{2}$ inches long.

Antarctic Ocean, Station 156; depth, 1975 fathoms. One specimen, $2\frac{1}{2}$ inches long.

North of New Guinea, Station 218; depth, 1070 fathoms. One specimen, $1\frac{1}{4}$ inches long.

North of New Guinea, Station 220; depth, 1100 fathoms. One specimen, $2\frac{1}{2}$ inches long.

North of New Guinea, Station 223; depth, 2325 fathoms. Two specimens, $2\frac{1}{2}$ inches long.

Off Amboina, Station 196; depth, 825 fathoms. One specimen, 2 inches long.

West Pacific, Station 226; depth, 2300 fathoms. One specimen, $2\frac{2}{3}$ inches long.

South of Japan, Station 230; depth, 2425 fathoms. One specimen, $1\frac{1}{2}$ inches long.

South of Yedo, Station 237; depth, 1875 fathoms. Eight specimens, $1\frac{1}{3}$ to $2\frac{1}{2}$ inches long.

Coast of Japan, June 1875. Two specimens, $1\frac{1}{2}$ to $2\frac{1}{3}$ inches long.

Unfortunately all the specimens of this species are in a more or less injured condition; it is quite evident they were dragged for some considerable distance through the water, and it is therefore very probable that the majority of them were actually obtained at the depths indicated by the soundings.

The height of the body is contained eight and a half times in the total length, without caudal, the length of the head five times. Vent nearly midway between the root of the caudal and the end of the snout. Eye very small; cleft of the mouth exceedingly wide, the maxillary extending to the posterior end of the præoperculum; lower jaw very prominent in front. The maxillary is armed with a single series of numerous teeth which gradually increase in size towards its posterior extremity; in the posterior half of the bone some of the teeth (placed at regular intervals) are larger than the others, but the difference between them is much less than in the other species of this genus. Intermaxillary with one or two larger and several small teeth. Mandibulary teeth extremely numerous and closely set, decreasing in size towards the front; but near to the symphysis the bone is armed with a single long fang which appears to be easily lost, as it is present only in a few of the specimens; infraorbital bone not dilated, leaving the whole of the cheek uncovered. Branchiostegals nine.

The dorsal fin commences opposite to the origin of the anal, and is as high as the body underneath. Form of the anal as in the other species; it terminates at a short distance from the caudal, the caudal peduncle being not much longer than deep. Caudal fin forked. Pectoral fin extremely narrow; ventral fin extending beyond the vent.

Some of the specimens are still provided with very large and deciduous scales, there being only about five in a vertical series between the origins of the dorsal and anal fins. But in the majority of the specimens the skin is quite scaleless, and does not show even traces of pouches. The colour of all the specimens is black.

Luminous organs are present as very small eye-like spots; they are arranged in two series along each side of the abdomen, and in a single series along each side of the tail. The branchiostegal series is likewise present, as well as an organ below the small eye, but the glandular mass on the back of the tail is only rudimentary.

Photichthys.

Phosichthys, Hutton, Cat. New Zeal. Fish., p. 55.

This genus is closely allied to *Gonostoma*, from which it differs in the following points:—

Both jaws are armed with a single series of teeth; those of the maxillary being small and equal in size. The intermaxillary is armed with two large fangs besides the small teeth; mandible with seven large equidistant teeth, the spaces between them being filled up with very small denticles. Vomer with a fang on each side of its head; palatine with strong, curved teeth, which gradually decrease in size backwards. The dorsal fin corresponds in position to the space between ventrals and anal; adipose fin small. Air-bladder present as a long simple sac with thick walls.

As the specimens available are very much deteriorated, it appeared rather hazardous to enter upon the examination of some points of their anatomical structure. On the whole, it resembles much that of *Gonostoma*. The stomach is cæcal; when empty, its walls appear thick and the mucous membrane laid into deep folds. Pyloric appendages present, short, and in small number. Air-bladder long, thick-walled dorsally, but thin and elastic along its ventral aspect. Towards the posterior extremity of the bladder, which is subcylindrical and pointed, its wall is very thick, and of an almost cartilaginous consistency behind; its end is open, the circular aperture being thickened and closed by what appears as a conical muscular mass, which, after it has penetrated into the interior of the bladder, spreads out and forms a layer on the inside of its posterior portion. An examination of fresh specimens will show the real condition of this singular apparatus, the function of which is most likely connected with the compression or expansion of the gas contained in the bladder.

Photichthys argenteus (Pl. XLV. fig. A).

Phosichthys argenteus, Hutton, *loc. cit.*, p. 56; and vol. v., pl. xv. fig. 90.

B. 21. D. 13. A. 26. P. 9. V. 7. L. lat. 50?

The height of the body is contained six and a half times in the total length, without caudal, the length of the head four and a half times. The vent is nearly twice as distant from the eye as from the root of the caudal. Eye of moderate size, one-fifth of the length of the head, a little shorter than the snout, but as wide as the interorbital space. Cleft of the mouth exceedingly wide, the maxillary extending to the posterior angle of the præoperculum; lower jaw somewhat projecting beyond the upper. There is only one infraorbital bone, but it is succeeded behind by two long and very thin supplementary bones, which are attached along the upper margin of the maxillary. Cheek uncovered either by scales or by bone.

The branchiostegals are very short, shorter than the eye. Four branchial arches, which bear extremely short gill-laminæ, much shorter than the opposite gill-rakers. On the outer branchial arch there are eleven of these slender, needle-shaped, and distantly placed gill-rakers in its lower portion, and five in its upper. Pseudobranchiæ absent.

The origin of the dorsal fin is somewhat nearer to the root of the caudal than to the extremity of the snout, and the fin is nearer to the ventrals than to the anal. The adipose fin is a very small and narrow lobe, which may be easily overlooked, or it may be entirely absent. Anal fin much higher in front than behind, and terminating at some distance from the caudal, the peduncle being long and deep. Caudal fin forked. Pectorals narrow. Ventrals well developed, their root being equidistant from the vent and the base of the pectorals; they terminate at a long distance from the vent.

I am unable to state anything about the scales, as only the traces of some of the scale-pouches on the tail have been preserved. The isthmus is deep and much compressed, and the scales on each side are so arranged that one corresponds to and covers each of the luminous organs of this region.

Not one of the specimens which I received from the Colonial Museum at Wellington is in a tolerable state of preservation, so that I am not certain whether the following list of luminous organs is exhaustive. There is one organ placed at the base of each branchiostegal ray; a series of seven larger ones runs along each side of the isthmus and is continued as an abdominal series which consists of seventeen organs to the ventral fin, and of as many from the ventral to the anal; seventeen may also be counted along the base of the anal to the caudal. As in *Gonostoma* a second series, situated higher up the sides, accompanies this series on the trunk. A single luminous organ is situated in front of the eye and covered by the præorbital, and another under the transparent sub-operculum. To judge from outward appearance, all these organs seem to possess the same structure and to differ only in size.

This fish exceeds the allied forms in size, one of the specimens being 12 inches long.

According to Hutton, the specimens were found in Cook's Strait, thrown ashore after severe gales.

Chauliodus, Bl. Schn.

Chauliodus sloanii, Bl. Schn.

The following specimens of this well-known bathybial genus were obtained by the Challenger. Previously it was known from the Mediterranean and Atlantic only.

Habitat.—South of New Guinea, Station 191; depth, 800 fathoms. One specimen, $8\frac{1}{2}$ inches long.

North of New Guinea, Station 216A; depth, 2000 fathoms. One specimen, $2\frac{3}{4}$ inches long.

South of Japan, Station 235; depth, 565 fathoms. One specimen, $5\frac{1}{2}$ inches long.

Mid-Atlantic, Station 104; depth, 2500 fathoms. One specimen, $7\frac{1}{2}$ inches long.

North-east of Bermuda, Station 60; depth, 2575 fathoms. One specimen, 3 inches long.

Family Scopelidæ.

Saurus, C. V.

Besides the species mentioned here, probably others descend to similarly moderate depths, as, for instance, *Saurus atlanticus*, *Saurus intermedius*, &c.

Saurus kaianus.

Saurus kaianus, Günth., Report on the Shore Fishes, Zool. Chall. Exp., pt. vi. p. 50, pl. xxiii. fig. C.

Habitat.—Ki Islands, Station 192; depth, 140 fathoms. One specimen, $5\frac{1}{2}$ inches long.

Harpodon, Les.

Harpodon microchir (Pl. XLVII. fig. A).

Harpodon microchir, Günth., Ann. and Mag. Nat. Hist., 1878, vol. i. p. 487.

B. 17. D. 14. A. 14. P. 12. V. 9.

Body elongate, compressed; its greatest depth is below the origin of the dorsal fin, and contained seven and a half times in the total length, without caudal. The caudal peduncle is long and its least depth only one-third of that of the body. Vent situated far backwards, its distance from the root of the caudal being only one-half of that from the head. Head small, more compressed behind than anteriorly, the flat interorbital space being one-fourth of the length of the head. The latter constitutes one-sixth of the total length, without caudal. Snout very short, the diameter of the small eye being two-fifths of its length and about one-eleventh of the length of the head. Bones of the head thin and more or less flexible; mandible extremely long, projecting in front, and nearly three-fourths of the length of the head.

Cleft of the mouth extremely wide, armed with numerous slender, more or less curved teeth of unequal size, all of which are movable and depressible towards the median line of the mouth. The maxillary is armed with a narrow band, of which the inner series contains the larger teeth; mandible armed with a similar band, but the larger teeth are nearly three times the size of those of the upper jaw, and terminate distinctly in an arrow-head-shaped point. Palatine teeth irregularly biserial and extending far backwards; the anterior are the strongest and strongly curved. There is inside this long band of teeth a second much shorter one. The hyoid bone and the concave margins of all the branchial arches above and below are armed with clusters and bands of teeth, and considering the great distensibility of the mouth, this fish must be able to seize and to retain fishes of very considerable bulk.

The branchial apertures are exceedingly wide, the isthmus is narrow and compressed. Gills four, pseudobranchiæ very distinct; gill-laminæ rather short.

The dorsal fin occupies a position midway between the eye and the root of the caudal fin; it is not quite so high as long, and rather lower than the body underneath. The small adipose fin is a little nearer to the caudal than to the dorsal, and opposite to the middle of the anal fin, which is of a similar shape to the dorsal but lower. Caudal fin deeply emarginate. The pectoral fin is very small, about one-fourth of the length of the head, and situated rather above the middle of the side. Ventral fins broad and generally well developed, as long as the postorbital portion of the head, and inserted opposite to the anterior dorsal rays.

The head and trunk are without scales, only one series of long lanceolate scales follows the course of the lateral line. The tail is covered with small and extremely thin cycloid scales, rather irregular in outline.

Sides silvery, back and fins blackish, buccal and branchial cavities black.

This species is known from a single specimen only, 27 inches long, and obtained at Tokio, Japan. Although it is not known at what depth the fish was obtained, it is evident from its organisation that it should be referred to the deep-sea fauna.

Bathysaurus.

Bathysaurus, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 181.

Shape of the body similar to that of *Saurus*, subcylindrical, elongate, covered with small scales. Head depressed with the snout produced, flat above. Cleft of the mouth very wide, with the lower jaw projecting; intermaxillary very long, styliform, tapering, not movable. Teeth in the jaws in broad bands, not covered by the lips, curved, unequal in size and barbed at the end. A series of similar teeth runs along the whole length of each side of the palate; a few teeth on the tongue, and groups of small ones on the hyoid. Eye of moderate size, lateral. Pectoral of moderate length. Ventral eight-rayed, inserted immediately behind the pectoral. Dorsal fin in the middle of the length of the body, with about eighteen rays. Adipose fin absent or present. Anal of moderate length. Caudal emarginate. Gill-openings very wide, the gill-membranes being separate from each other and from the isthmus. Eleven or twelve branchiostegals. Gill-laminæ well developed, separate; gill-rakers tubercular; pseudobranchiæ well developed. Air-bladder absent.

Bathysaurus ferox (Pl. XLVI. fig. A).

Bathysaurus ferox, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 182.

D. 18. A. 11. P. 15. V. 8. L. lat. ca. 120.[1]

Adipose fin absent.

Habitat.—East coast of New Zealand. Station 168; depth, 1100 fathoms. One specimen, 20 inches long.

[1] This is the number of transverse series of scales; the number of the large scales of the lateral line is only about 74.

The form of this fish is very elongate, depressed from the neck forwards, somewhat cylindrical about the middle and rather compressed behind. The greatest depth of the body, below the origin of the dorsal fin, is about twice the depth of the caudal peduncle, and one-ninth of the total length, without caudal. The head is greatly depressed behind, twice as broad as deep, its length being contained three times and three-fourths in the total length, without caudal. Snout depressed and long, the hind margin of the eye being in the middle of the length of the head; eye rather large, one-seventh of the length of the head, partly directed upwards, and separated from the intermaxillary by the exceedingly narrow chain of infraorbital bones. The mouth is exceedingly wide, the length of the mandible being nearly three-fourths of that of the head; and the jaws are powerful, especially the lower, which is greatly expanded on the lower aspect of the head.

Teeth numerous, unequal in size, generally curved, and with a more or less distinctly barbed point (see fig. A‴). Almost all are depressible in the longitudinal axis of the head. In the upper jaw they form a broad band with the largest teeth along the inner margin (fig. A′). The mandibulary band is still broader (fig. A″); in fact, it consists of two narrower bands between which the intermaxillary teeth are received. The vomerine and palatine teeth form one continuous biserial row, close and parallel to the intermaxillary. These teeth slightly exceed those of the jaws in size, at least anteriorly, but gradually decrease in length backwards. The row consists of two series, those of the outer series being shorter and fixed. Also the basibranchials are armed with small curved teeth, uniserial in front and biserial behind. Patches of small teeth take the place of gill-rakers.

The upper side of the head, the snout, and the branchiostegal membrane are naked, the cheeks and the gill-cover scaly. The nostrils are a pair of small openings, close together, but separated by a short flap; they are about midway between the eye and the end of the snout, and quite at the upper side of the head. The muciferous channels are narrow with small but distinct openings.

Branchiostegals long and flexible; the gill-openings extremely wide, extending from the upper end of the gill-cover near to the symphysis of the lower jaw; the left branchiostegal membrane overlaps the right in front.

The dorsal fin is higher anteriorly than posteriorly, and higher than the body underneath, the length of the second ray being more than one-half of that of the head; this fin occupies the middle of the length of the fish, its distance from the root of the caudal being equal to that from the end of the snout. The anal fin commences shortly behind the vertical from the last dorsal ray, and is higher in front than behind. Caudal fin emarginate, with a great part of its basal portion covered with scales. Pectoral long, extending to the ninth dorsal ray; its base is narrow, and when in use this fin assumes a horizontal position much like the ventral. Ventral fin strong, broad, horizontal, as in bottom fish generally; it is inserted so that its inner ray corresponds to the anterior dorsal ray.

Scales rather small and cycloid; there are about ten series between the origin of the dorsal fin and the lateral line, and about eight between the lateral line and the anal. The lateral line is broad and very distinctly marked; its scales correspond only to about every second transverse series; they have their hind margin raised and free, and two small but distinct pores open above and below each scale.

Colour brownish, lower parts of the head and abdomen black; buccal and branchial cavities black. A stripe between each pair of dorsal rays; the membrane between the three middle caudal rays, the anal fin, the outer (respectively lower) sides of the pectoral and ventral fins blackish.

The œsophagus passes into a long and wide cæcal sac, which, however, does not reach backwards to the middle of the length of the abdominal cavity. The pylorus is on the same level as the cardiac end of the stomach; two short and wide pyloric appendages are placed opposite to each other. The intestine runs straight backwards without any lateral bend, and is separated from the short rectum by a circular fold, the course of which is also visible externally. The mucous membrane of the intestine is densely and deeply folded, the folds being raised in a reticulated fashion. The liver consists of a right and a left lobe, connected by a thin transverse bridge. The left lobe is broad and flat, extending somewhat further backwards than the stomach. The right lobe is far more bulky, extending nearly to the end of the abdominal cavity, and hollowed out on one side for the reception of the intestinal tract. This lobe is connected with the transverse portion of the liver by a long and thin strip of the substance of the liver. Gall-bladder of moderate size. Air-bladder absent.

The ovaries are closed cylindrical sacs, and attached to each other along their whole length; they did not contain ova.

Bathysaurus agassizii, Goode and Bean,[1] described from a specimen 21 inches long, and obtained at a depth of 647 fathoms in the Atlantic, lat. 33° 35′ N., long. 76° 0′ W., is probably not specifically distinct from the Pacific specimen. It seems to be a fish with a somewhat deeper body, but, then, it was ascertained to be a "female, full of nearly mature eggs."

Bathysaurus mollis (Pl. XLVI. figs. B, B′).

Bathysaurus mollis, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 182.

D. 15. A. 11. P. 15. V. 8.

Adipose fin present. Rays of the fins, especially the front rays of the dorsal, rather elongate.

[1] *Bull. Mus. Comp. Zoöl.*, vol. x., 1883, p. 215.

Habitat.—Off Yedo, Station 237; depth, 1875 fathoms. One specimen, 19 inches long.

Middle of South Pacific, Station 281; depth, 2385 fathoms. One specimen, 7½ inches long.

This fish is highly interesting, inasmuch as the points in which it differs from *Bathysaurus ferox* indicate that it is merely an abyssal modification of that species; or, if the present form were not known to attain to nearly the same size as *Bathysaurus ferox*, it might have been taken for an earlier stage of the development of the latter.

The fish is of a whitish colour, the buccal and branchial cavities and the lower parts of the body being black. The bones of the head are less firm than in *Bathysaurus ferox*, the scales extremely thin and deciduous (only a few are preserved), some parts of the body, as the gill-cover and the præventral portion of the body, being naked. All the fin rays are prolonged, and a short but high adipose fin is present, as also a broad fold at the root of the caudal fin above as well as below. The greatest depth of the body is below the origin of the dorsal fin and more than twice the depth of the caudal peduncle, one-ninth of the total length, without caudal. The head is less broad than in *Bathysaurus ferox*, about one-third broader than deep, and its length is two-ninths of the total, without caudal. Snout depressed and of moderate length; eye of moderate size, one-half of the length of the snout, one-seventh of that of the head, and two-thirds of the width of the interorbital space.

Otherwise the configuration of the head as well as the dentition are as in *Bathysaurus ferox*. The position of the nostrils is likewise similar, but they are separated by a rather long and pointed tentacle, and there is another aperture in front of the nostrils which leads into one of the superficial mucous channels.

The anterior dorsal rays are much higher than the body underneath, their length being equal to that of the head without snout; but the position of the fin is the same as in *Bathysaurus ferox*. The adipose fin occupies a position behind the last anal ray; the caudal fin is very broad, deeply emarginate, and without scales on its base. Pectoral with a very narrow base, lateral, subhorizontal, with the middle ray longest, nearly as long as the head. Ventral fin very strong and broad, and with the outer ray enveloped in thick skin; it is inserted in front of the dorsal and is not much shorter than the pectoral.

In the young specimen the body and tail are ornamented with fourteen narrow vertical bars, composed of minute pigment spots, and reaching across the whole depth of the body. In the interspaces between them there is a shorter bar which does not extend upwards beyond the lateral line. A pattern of coloration of this kind is of extremely rare occurence in deep-sea fishes.

The structure of the lateral line is the same as in *Bathysaurus ferox*.

This species differs internally from its congener more than one might expect in two species which are so closely allied. The stomach has the same form, but the pylorus is furnished with one appendage only, and the intestine makes in its lower course four bends, two to the right and two to the left. The network of the mucous membrane is less close and the folds are lower. The liver consists only of the left lobe and the transverse bridge, but the bulky right lobe, which in *Bathysaurus ferox* forms the greater part of the liver, is entirely absent in this species. The specimen described is a male possessing a narrow tape-like testicle on each side of the posterior half of the abdominal cavity.

Bathypterois.

Bathypterois, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 183.

Shape of the body like that of an *Aulopus*. Head of moderate size, depressed in front, with the snout projecting, the large mandible very prominent beyond the upper jaw. Cleft of the mouth wide; maxillary much developed, very movable, much dilated behind. Teeth in narrow villiform bands in the jaws. On each side of the broad vomer a small patch of similar teeth; none on the palatines or on the tongue. Eye very small. Scales cycloid, adherent, of moderate size. Rays of the pectoral fin much elongated; some of the upper being separate from the rest and forming a distinct division. Ventral fins abdominal, with the outer rays prolonged, eight-rayed. Dorsal fin inserted in the middle of the body, above or immediately behind the root of the ventral, of moderate length. Adipose fin present or absent. Anal short. Caudal forked. Gill-openings very wide; gill-laminæ well developed, separate from each other; gill-rakers long. Pseudobranchiæ absent.

Mr. Murray[1] observes about these fishes (*Bathypterois longipes*):—"When taken from the trawl they were always dead, and the long pectoral rays were erected like an arch over the head, requiring considerable pressure to make them lie along the side of the body; when erected they resembled Pennatulids like *Umbellula*." If we had any evidence of some deep-sea fish feeding on Pennatulids, we might suppose that the function of those rays consisted in attracting other fishes. But in the absence of such evidence, I am inclined to regard them as organs of touch.

Bathypterois longifilis (Pl. XLVII. fig. B; Pl. XLVIII. fig. B).

Bathypterois longifilis, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 183.

B. 12. D. 13. A. 9. P. 3 | 13. V. 8. L. lat. 61. L. transv. 6 | 10.

The uppermost pectoral ray is the strongest, longer than the whole fish, bifid towards its extremity. Outer ventral rays with dilated extremities. Dorsal fin inserted immediately behind the root of the ventrals. An adipose fin.

[1] Narr. Chall. Exp., vol. i. p. 218.

Habitat.—Near the Kermadec Islands, Stations 170, 170A; depths, 520 and 630 fathoms. Two specimens, 13 inches long.

The form of the body of this singular type of fishes is somewhat elongate, moderately compressed; its greatest depth is below the origin of the dorsal fin and equals one-sixth of the total length, without caudal. The head is broad, composed of solid bones, about as deep as wide, and terminates in a long, depressed, wedge-shaped snout. The eye is minute, two-thirds as distant from the extremity of the snout as from the hind margin of the gill-cover. Interorbital space very broad, osseous, convex, with a width equal to the length of the snout.

The bones composing the jaws are very powerful and firm, thus compensating for the weakness of the dentition, which consists merely of a narrow band of villiform asperities in the jaws and of a similar patch on each side of the vomer. The intermaxillary alone is toothed, styliform, tapering and closely fitting into the front margin of the maxillary; the latter is toothless, about half as long as the head, and its hinder portion, which extends beyond the intermaxillary, is dilated into a broad and oblong lamella. When the mouth is closed, the maxillary occupies a horizontal position in about the middle of the depth of the head, and extends beyond the middle of its length. The lower jaw is extremely broad, its halves touching each other below, when the mouth is shut. Its symphyseal portion forms a strong and large projection.

Branchial apertures very wide, extending forwards to the end of the isthmus, the gill-cover remaining entirely free. There are four gills with well-developed gill-laminæ. All the branchial arches are provided with gill-rakers, but those of the outer arch are the longest and those of the inner the shortest. The outer arch has thirty gill-rakers in its lower branch and twelve in its upper; they are slender, needle-shaped, the longest about one-fourth of the length of the head.

The dorsal fin occupies exactly the middle between the extremity of the upper jaw and the root of the caudal fin; it is much higher in front than behind, the anterior rays being rather higher than the body underneath. Adipose fin narrow, nearly midway between the dorsal and caudal. Anal fin opposite to the space between the dorsal and adipose. Caudal fin emarginate. Pectoral fin lateral, placed in the middle of the height of the trunk, and composed of exceedingly elongate and simple rays, which are quite free, not connected by membrane; the longest reach to the end of the anal fin. An exceedingly long and compressed ray is detached from the fin and articulated at the upper end of the clavicle, opposite to the upper margin of the gill-cover. It extends far beyond the caudal fin and is bifid in its posterior half; it is accompanied below by two other rays, which are much shorter and connected by a membrane with the long ray. By a separate set of muscles (Pl. XLVIII. fig. B′) it can be moved outwards or upwards (*c*) so as to form nearly a right angle with the longitudinal axis of the body, whilst another muscle (*b*) draws it downwards into a line with the other pectoral rays.

The large ventrals are inserted immediately in front of the origin of the dorsal fin. Its two outer rays are simple, the others broad and dichotomously split. The extremities of the two outer ones and of the outer branches of the third are modified into soft, swollen, long, lamelliform pads. These singular appendages extend backwards to the end of the anal fin and remind us of similar structures in certain Cyprinodonts, in which the appendages are sexual and peculiar to the male sex. Both the specimens of the present species are females.

The scales are of moderate size, rather irregular in shape, and cycloid. The lateral line runs along the middle of the side.

Colour light greenish with narrow black margins to the scales; sides of the head, the abdomen, and the buccal and abdominal cavities black. Vertical and ventral fins black, with lighter margins; pectoral fins without colour.

The structure of the pectoral arch (Pl. XLVIII. fig. B) shows some noteworthy peculiarities. The clavicle (*cl*) consists of a narrow subvertical branch which is slightly bent in the form of a knee; the shorter part above the knee is connected with the skull by two supraclavicles (*scl′*, *scl″*), of which the upper is two-pronged as usual and partially excavated into a muciferous tube. The portion below the knee is posteriorly dilated into a broad, thin, and slightly convex lamella (*cl′*). Although separated from the narrow vertical part by a shallow groove, this lamella is in perfect continuity with the clavicle, and, therefore, cannot be the coracoid bone, for which it might be taken.

The cartilaginous lamella which intervenes between the clavicle and the pectoral fin is broad and thin with four comparatively small ossifications.

The lower ossification (*co*) represents the coracoid; it is of an oval shape with a notch in its upper margin. The scapula (*sc*) occupies the upper portion of the cartilage, and surrounds the large vacuity which generally distinguishes this bone; it bears the long upper pectoral rays without any intervening basalia. A large space (*ca*) between the three bones described remains cartilaginous; but there are behind this cartilaginous area two other flat and thin bones (*b′*, *b″*) which may be taken either as basalia or as detached portions of the coracoid and scapula. A vacuity is left between them, and another between the lower and the coracoid. The lower pectoral rays are thus articulated directly to the narrow cartilaginous border of the coracoid and some to the lower basale.

The *stomach* terminates behind in a very short cæcal sac, its pyloric portion being much shorter and narrower than the cardiac. Its walls are rather thick, and its mucous membrane is deeply folded longitudinally. Pyloric appendages are absent. The commencement of the intestine has a much greater circumference than the pyloric portion of the stomach, and its interior is densely beset with long villi. The succeeding part of the intestine is but slightly convoluted, possesses very thin walls, the mucous membrane being without villi, but forming numerous circular, low, transverse folds. The liver is small with a short lobe on the right side. Gall-bladder small, detached from the liver. Air-bladder absent. Ovaries elongate closed sacs, without ova in our specimens.

Bathypterois longipes (Pl. XLVIII. fig. A).

Bathypterois longipes, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 184.

B. 12. D. 13. A. 10. P. 2 | 7–8. V. 8. L. lat. 55. L. transv. 6 | 8.

The uppermost pectoral ray is the strongest, about as long as the whole fish, bifid towards its extremity. Outer ventral rays much prolonged, strong, but not dilated at the extremity. Dorsal fin inserted at some distance behind the root of the ventrals. Adipose fin present or absent.

Habitat.—Off the east coast of South America, Station 325; depth, 2650 fathoms. Two specimens, 9 inches long.

This species is very similar to *Bathypterois longifilis*, from which it differs only in the following points. Eye minute. The dorsal fin is placed further backwards, its origin being nearly midway between the end of the snout and the root of the caudal; consequently the root of the ventral is some distance in advance of the dorsal, and the end of the dorsal is vertically opposite to the fifth anal ray. One specimen possesses, the other lacks the adipose fin. Caudal fin deeply forked, with the outer rays much produced. Of the two branches into which the posterior third of the long pectoral ray is split, one is much shorter and weaker than the other. The two outer ventral rays are closely adpressed from the root to the end, and much stouter and longer than the other rays; they are articulated to the end and without the soft pads described in the preceding species. These fin rays extend beyond the end of the anal fin.

Colour black, with white fins.

Bathypterois longicauda (Pl. XXVI. fig. B).

Bathypterois longicauda, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 184.

D. 12. A. 9. P. 2 | 9. V. 8. L. lat. 55. L. transv. 6 | 8.

The uppermost pectoral ray is the strongest, longer than the whole fish, bifid from the middle of its length. The outer ventral rays much prolonged, filiform. Dorsal fin inserted at a considerable distance behind the root of the ventrals, and extending to above the anal. Caudal deeply forked with the lobes prolonged. Adipose fin present.

Habitat.—Middle of Southern Pacific, Station 289, October 23, 1875; depth, 2550 fathoms. One specimen, 3 inches long.

This fish represents the young condition of *Bathypterois;* possibly it may be merely the young of *Bathypterois longipes*, but this, of course, is at present subject to doubt, as that species has hitherto been found in the Atlantic only. The body of the only specimen available is much twisted and would seem to be much narrower than the head, but it is impossible to say how much of this is due to contraction caused by the preserving fluid. The position of the fins is as in *Bathypterois longipes*, but all the fin rays are much more elongate. The distance between the dorsal fin and the occiput is scarcely equal to the length of the head. This fin as well as the anal are very high. Adipose fin present. Caudal broad and deeply cleft. The long upper pectoral ray is cleft, less than one-half of its length being simple, and one branch being much shorter than the other. The longest of the lower pectoral rays reaches nearly to the caudal fin, and the two outer ventral rays extend still further back, being more than twice as long as the longest branched ray.

Sides of the head and the lower part of the abdomen black; tail and fins transparent.

Bathypterois quadrifilis (Pl. XXXIII. fig. B).

Bathypterois quadrifilis, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 184.

B. 12. D. 14. A. 9. P. 2 | 9. V. 9. L. lat. 59. L. transv. 6 | 8.

The uppermost and lowermost of the pectoral rays are filiform, the former bifid for more than two-thirds of its length; the latter simple. Outer ventral rays much prolonged, strong, not dilated at the extremity. Dorsal fin inserted close behind the root of the ventrals. Adipose fin present.

Habitat.—Off the coast of Brazil, Station 126; depth, 770 fathoms. Two specimens, 8½ inches long.

Off the coast of Brazil, Station 121; depth, 500 fathoms. One specimen, 5½ inches long.

This species differs somewhat more from the preceding than these do among themselves. The greatest depth of the body is one-seventh of the total length, without caudal, the length of the head nearly one-fifth. The head is remarkably flat above, and the width of the interorbital space exceeds the length of the snout. The eye is small, but larger than in the two preceding species, about one-third of the length of the snout, and one-fifth or one-sixth of the length of the postorbital portion of the head.

The dentition and branchial apparatus do not offer any noteworthy peculiarity.

The dorsal fin occupies the middle between the extremity of the upper jaw and the root of the caudal fin. A narrow adipose fin is present and midway between the dorsal and caudal. The anal fin commences immediately behind the dorsal, its origin being equidistant from the roots of the pectoral and caudal. Caudal fin emarginate.

The principal distinctive feature of this species is that it possesses not only the long detached upper pectoral ray, but also an equally long lower ray, which, however, is not removed from the remainder of the fin. The upper ray becomes bifid in its proximate third, and is accompanied by an extremely short rudimentary second ray; it scarcely reaches to the caudal fin and is shorter than the lowermost ray, which may reach to the end of the caudal and is split only at its very extremity.

The structure of the ventral fins is the same as in *Bathypterois longipes*, but the strong outer rays are somewhat curved and do not reach the end of the anal.

The scales are cycloid as in the other species, but those behind the basal portion of the pectoral fin are deeply pectinated, provided with from five to ten long and narrow teeth, of which the middle ones are the longest (see figures).

Colour blackish or black; pectoral filaments whitish.

Ipnops.

Ipnops, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 187.

Body elongate, subcylindrical, covered with large thin deciduous scales, and without luminous organs. Head depressed, with broad, long, spatulate snout, the whole upper surface of which is occupied by a pair of large transparent lamelliform membrane bones which cover a luminous organ longitudinally divided into two symmetrical halves. Eyes absent; nostril reduced to a minute opening in front of each lamina. Bones of the lower and lateral parts of the head well ossified. Mouth wide, with the lower jaw projecting; maxillary dilated behind. Both jaws with narrow bands of villiform teeth; palate toothless. Pectoral and ventral fins well developed, and, owing to the shortness of the trunk, close together. Dorsal fin at a short distance behind the vent; adipose fin absent; anal fin moderately long; caudal subtruncated. Pseudobranchiæ absent; air-bladder absent; pyloric appendages absent.

This genus is closely allied to *Bathypterois*, not only in its external characters, but also in the structure of its abdominal organs. Professor Moseley has kindly acceded to my request to make a histological examination of the remarkable organ on the upper surface of the head. The results of his examination are given in Appendix A and Pls. LXVII., LXVIII.

Ever since the discovery of this fish much uncertainty has prevailed with regard to the nature and function of the extraordinary apparatus on the upper side of the head; but from Professor Moseley's examination it seems to be almost beyond doubt, that it is a special form of phosphorescent organ. The power of producing light, and thereby attracting other creatures, must be of great use to a fish, which, deprived of organs of sight and touch, would be unable to procure its food.

The question of the homology of the luminous organ and its covering lamellæ is still obscure; and no other specimen can be sacrificed to investigate the osteology of the skull. If, as Professor Moseley's investigations seem to prove, the luminous organ is not a modification of the eye, as Mr Murray and myself supposed at first, and if the organ of vision with the optic nerve has disappeared, the luminous organ is probably the homologue of that which is found in some Scopelids between the eye and nostril, and the covering plates would be the homologues of the præorbital membrane bones. With the abortion of the eyes the luminous organs with their præorbitals would have moved from their usual lateral position to the top of the head.

Ipnops murrayi (Pl. XLIX. fig. B).

Ipnops murrayi, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 187.

B. 12. D. 10. A. 13. P. 14. V. 8. L. lat. 55.

Body elongate, cylindrical, tail compressed behind, head depressed. The depth of the trunk diminishes but little backwards, and is contained thirteen and a half times in the total length, without caudal; the length of the head is one-sixth of the total. Head broad, much broader than deep, its greatest depth being two-thirds of its length. Snout broad, much depressed, with obtusely rounded anterior profile; cleft of the mouth very wide, the maxillary moderately dilated behind and extending beyond the middle of the length of the head. Mandible projecting beyond the upper jaw, broad, but owing to the depressed form of the snout its outer surface is nearly entirely at the lower side of the snout. Infraorbital chain of bones very narrow, wedged in between the transparent lamina and the maxillary, with four very distinct apertures leading into the mucous duct. The upper surface of the head, including the snout, is wholly covered by the two cornea-like laminæ of the luminous apparatus. They are closely attached to each other along the median line, each being divided by a shallow transverse ridge into a larger anterior and a smaller posterior portion. The ridge turns forward near and parallel to, the median line, and marks the course of a superficial mucous duct.

The gill-laminæ are well developed and the gill-rakers long, needle-shaped, closely set, about twenty-two in number on the outer branchial arch.

The vent is nearly twice as distant from the root of the caudal fin as from the end of the snout, and rather more than the length of the head from the gill-opening; it is placed between the ventral fins.

The dorsal fin commences immediately behind the vertical from the vent; it is short, but its longest rays are twice as high as the body. Origin of the anal midway between the vent and the root of the caudal, composed of rays which are still more slender and shorter than those of the dorsal. Caudal fin narrow, subtruncated, more than half as long as the head. Pectorals rather feeble, lateral, as long as the caudal, and extending to the ventrals. Ventrals composed of stronger rays, horizontally placed and somewhat distant from each other, as is frequently found in fishes habitually moving on the bottom; they slightly exceed the pectorals in length.

The scales are large, thin, deciduous, forming only six longitudinal series on each side of the trunk. Lateral line faintly indicated along the middle of the body; the muciferous channels on the head are also narrow, with small apertures.

Brown, with colourless fins. Buccal and branchial cavities and the lower side of the head black.

Habitat.—South Atlantic and Indian Ocean.

Coast of Brazil, Station 124; depth, 1600 fathoms. One specimen, 4½ inches long.

Near Tristan da Cunha, Station 133; depth, 1900 fathoms. Two specimens, 5½ inches long.

North of Celebes, Station 198; depth, 2150 fathoms. One specimen, 4 inches long.

Chlorophthalmus, Bonap.

Hyphalonedrus, Goode, Proc. U.S. Nat. Mus., 1881, p. 483.

The only point in which Dr. Goode's diagnosis apparently differs from that given by me in Fish., vol. v. p. 403, is that he denies the presence of lingual teeth. However, these teeth are so minute in *Chlorophthalmus agassizii* as to require a magnifying glass to find them, and therefore may easily be overlooked. But even if a species without these rudimentary structures should be found, their absence could not justify a generic separation. The sheaths in which the scales are lodged show, especially after the loss of the scales, a very conspicuous arrangement of straight parallel oblique lines, very characteristic of the two first species of this genus. The following species are known at present.

Chlorophthalmus agassizii (Pl. L. fig. C).

Chlorophthalmus agassizii, Bonap., Faun. it. Pesc. c. fig.
" " Günth., Fish., vol. v. p. 404.
Hyphalonedrus chalybeius, Goode, *loc. cit.*, p. 484; and Bull. Mus. Comp. Zoöl., vol. x., 1883, p. 223.

B. 10. D. 11–12. A. 9. P. 16–18. V. 9. L. lat. 52–53. L. trans. 7 | 6.[1]

The length of the head is contained thrice and three-fourths in the total (without caudal); eye scarcely more than one-third of the length of the head, a little longer than the snout, which is moderately produced, and equal to the postorbital por-

[1] Not 4 | 6 as stated by me in Fish., vol. v. p. 404.

tion of the head. Body with large brownish blotches which are subquincuncially disposed.

Gill-laminæ rather shorter than the longest gill-rakers, which are very slender, needle-shaped, and 5 + 18 in number. Pseudobranchiæ large.

Attains a length of about 4 inches. Not rare in the Mediterranean, it has been more recently found by the U.S. Fish Commission off the coast of Rhode Island, and southward to about lat. 38° 30′ N., in 120 and 156 fathoms.

Chlorophthalmus productus, n. sp. (Pl. L. fig. D).

Closely allied to *Chlorophthalmus agassizii*, but with longer snout, and more numerous scales.

B. 8. D. 11. A. 10. P. 16. V. 9. L. lat. 58. L. trans. 8 | 9.

The length of the head is contained thrice and one-third or thrice and one-fourth in the total (without caudal); eye a little more than one-third of the length of the head, slightly exceeding the snout in length, and equal to the postorbital portion of the head. Snout produced. Coloration uniform.

Lingual teeth minute and few in number. Gill-laminæ rather short, shorter than the slender gill-rakers, of which there are 2 + 15; the longest gill-rakers about one-third as long as the eye. Pseudobranchiæ large.

Habitat.—Off Matuku, Fiji Islands, Station 173; depth, 315 fathoms. Two specimens, 3 and 5 inches long.

Chlorophthalmus nigripinnis (Pl. LI. fig. A).

Chlorophthalmus nigripinnis, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 182.

B. 7. D. 11. A. 9. P. 16. V. 9. L. lat. 50. L. transv. $4\frac{1}{2}$ | 5.

Similar to *Chlorophthalmus agassizii.* The length of the head is contained thrice and three-fourths in the total length (without caudal); the eye is large, two-fifths of the length of the head and three times the width of the interorbital space. The distance of the adipose fin from the dorsal equals that between the latter and the front margin of the eye. Teeth in the jaws, on the vomer and palatine bones, in very narrow bands. Pectoral rather shorter than the ventral, which extends far beyond the vent; the vent being much nearer to the ventral than to the anal. Silvery, with some very indistinct darker spots on the side of the body; top of the dorsal and extremity of each caudal lobe deep black.

Habitat.—Off Twofold Bay; depth, 120 fathoms. Two specimens, $5\frac{1}{2}$ and 6 inches long.

The snout is less produced and depressed than in *Chlorophthalmus agassizii;* the jaws are generally weaker and the maxillary extends beyond the anterior margin of the eye.

Four gills, with pseudobranchiæ. The gill-rakers of the anterior arch are slender, the longest not quite as long as the half of the eye, twenty-five in number, of which the five uppermost are quite rudimentary.

Peduncle of the tail not compressed, nearly as broad as high; the dorsal region of the trunk and tail is also broad. Scales thin and cycloid, with very minute concentric striæ and lacerated posterior margins.

The terminal portion of the three outer ventral rays is thickened and covered with a thick mucous layer, a peculiarity which we shall find still more developed in the following species.

The dorsal fin is high, the anterior rays being much higher than the body underneath, and more than twice as long as the anterior anal rays.

Uniformly silvery, with the top of the dorsal fin and the extremity of the caudal lobes black; the mouth and gill-cavity are not coloured.

This fish shows nothing to indicate its bathybial life beyond the excessively large eye; and it is not likely that it descends to any more considerable depth than that from which it was obtained.

Chlorophthalmus gracilis, (Pl. XLIX. fig. A).

Chlorophthalmus gracilis, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 182.

B. 10. D. 11. A. 11. P. 22. V. 8. L. lat. 60. L. transv. 6 | 7.

The length of the head is one-fourth of the total length, without caudal. The tail being slender, the distance between the end of the anal and root of the caudal is not very much less than the length of the head. Distance of the adipose fin from the dorsal equal to that between the latter and the front margin of the eye. Snout depressed, flat, with the lower jaw prominent. Interorbital space rather broad, more than the vertical diameter of the eye. Eye large, its horizontal diameter being two-ninths of the length of the head, and two-thirds of that of the snout. Teeth in the jaws in coarsely villiform bands, those on the vomer and palatine bones in a single series; the vomerine series being interrupted in the middle. Only a few minute teeth on the tongue. The intermaxillary is toothed along the whole of its length, and extends nearly as far back as the maxillary, the extremity of which reaches to behind the eye. Pectoral considerably longer than the ventral, which does not extend to the vent, the vent being a little nearer to the anal than to the ventral. Origin of the dorsal fin immediately behind the root of the ventral. Scales cycloid; those of the lateral line and between the ventral fins larger than the rest. Uniformly brownish-black; fins of a lighter colour.

Habitat.—Off the eastern coast of New Zealand, Station 168; depth, 1100 fathoms. One specimen, 8 inches long.

Middle of South Atlantic, Station 300; depth, 1375 fathoms. Three specimens, $9\frac{1}{2}$ inches long.

Off Juan Fernandez, Station 335; depth, 1425 fathoms. One specimen, 4 inches long.

The body is but slightly compressed in the middle, gradually passing into the head which is depressed, and into the more compressed caudal peduncle. The greatest depth is below the origin of the dorsal fin, about one-half of the length of the head, and contained seven and a half times in the total length, without caudal. Snout depressed, broad, with the lower jaw projecting. Mandible dilated on its ventral aspect and much longer than one-half of the length of the head; bones of the head generally rather thin, leaving wide round vacuities in the course of the muciferous channels, which are well developed.

The gill-rakers of the first branchial arch are needle-shaped, closely set, the longest being as long as the eye.

Dorsal fin much higher than the body underneath, its anterior rays being much longer than those of the anal fin. Caudal fin emarginate, with the upper lobe rather longer than the lower. Pectoral fin elongate, with a rounded posterior margin, shorter than the head, but extending beyond the dorsal fin. The ventral fins are horizontal, rather broad, and show sometimes a modification of the distal half of the three or four outer rays. This is seen only in the two larger specimens from Station 300, but not in the one from Station 168 or in the young specimen. The degree to which these rays are thickened is not the same in the two specimens which show this peculiarity; in one, which is slightly the smaller, the integument at the lower side is merely thickened (fig. *a'*), but in the larger the rays themselves are stouter, bent outwards and covered below with a white and callous cushion-like enlargement of the skin (fig. *a*). All the specimens are females.

Scales cycloid, regularly arranged; lateral line straight, running along the middle of the body and tail.

The stomach is short and cæcal; the intestine makes first one bend to the left and then another to the right, is short and of moderate width. Two short pyloric appendages opposite to each other behind the pylorus. Ovaries closed and elongate sacs. Ova of the size of hemp seed. A long spindle-shaped urinary bladder lies above and on the left side of the intestine. Air-bladder absent.

Scopelus, Gthr.

The numerous species which I refer to this genus, are, as far as we know of their habits, nocturnal pelagic surface fishes, which are frequently caught at night in the surface net, but disappear during the daytime, when they evidently descend to a depth to which only a moderate amount of light penetrates. A few, like *Scopelus macrolepidotus*, and, perhaps, *Scopelus glacialis*, undoubtedly belong to the bathybial fauna, but with regard to the other species admitted in this Report, I consider it equally probable that they accidentally entered the dredge during its ascent. Only a few specimens were captured in this manner, much fewer than of *Argyropelecus*, a fact which is no doubt due to their greater activity, by which they are enabled to make their escape on perceiving the approach of the net.

Scopelus macrolepidotus (Johnson).

Of this fine and large species, which hitherto was known from Madeira, six specimens, from 6½ to 8 inches long, were obtained at the Kermadec Islands, Stations 170 and 170A, in 520 and 630 fathoms.

Scopelus glacialis.

Scopelus glacialis, Reinh., Nilss., Kröy.
Scopelus mülleri[1] (Gmel.) Collett, Norges Fisk., p. 152; Norsk. Nordh. Exped. Fisk., p. 158.
„ „ Goode and Bean, Bull. Mus. Comp. Zoöl., vol. x., 1883, p. 222.

This species, which has been not rarely observed as a surface fish in the northern seas, is stated by Collett to have been obtained by the North Atlantic Expedition in a dredge, which was worked at a depth of 1110 fathoms. The U.S. steamers took it frequently at depths of 300, 400 and 600 fathoms off the southern shores of New England and off the coast of South Carolina. All the specimens were in a more or less injured condition, as if they had been dragged a long way through the water, and as Collett found in their stomach an Ostracod (*Concœcia borealis*) which is not found at a less depth than 300 fathoms, it is highly probable that this species is bathybial.

Scopelus antarcticus (Pl. LI. fig. D).

Scopelus antarcticus, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 184.

D. 15. A. 20. P. 13. V. 9. L. lat. 38.

The height of the body is two-ninths of the total length (without caudal); the length of the head is contained thrice and two-thirds in it, the depth of the head equals its length without snout. The diameter of the eye is somewhat more than one-third of the length of the head; distance between the posterior margin of the orbit and the præopercular edge one-third of the diameter of the eye. Snout short, obtuse, with its upper

[1] There is no advantage to be gained in abandoning a well established specific name for an uncertain nomenclature. Our best thanks are due to Hr. Collett for having unravelled the confused history of the first knowledge of these northern *Scopeli*, but, even if no confusion had taken place in Ström's account, I should hesitate to supersede a name given by an original observer like Reinhardt, by another which is proposed by a mere compiler.

profile descending in a strong curve and with the jaws nearly equal anteriorly. The maxillary reaches to below the posterior margin of the eye, and is strongly dilated behind. Cleft of the mouth oblique. The origin of the dorsal fin is nearer to the end of the snout than to the root of the caudal, behind the base of the ventrals; its last ray is in the vertical from the fourth or fifth anal ray. The pectoral fin extends to the middle of the ventral, the ventral to the vent. Scales smooth, deciduous. There are seven round pearly-looking patches between the adipose fin and the caudal.

The phosphorescent organs are arranged in the following manner:—Two behind the præopercular margin opposite to the extremity of the maxillary; a straight series of five between the isthmus and the root of the ventral, continued behind the ventrals to the vent as a series of four; somewhat higher up the side another series begins in front of the root of the ventrals; it consists of seven spots, the two last of which are above the vent; two in front of the root of pectoral; and an isolated one below the lateral line, about the middle of the body; a series of twenty runs along each side of the anal fin and the lower edge of the tail, the last two occupying the base of the rudimentary caudal rays and being separated from those more anterior by a short interspace. A single series of six or seven large pearl-coloured spots occupies the back of the tail behind the adipose fin. None of these spots have a black septum, and it is also to be remarked that one or the other which is present on one side may be rudimentary or entirely absent on the other. In specimens which have lost a portion of their scaly integuments, some of the organs are generally lost also.

Habitat.—Antarctic Ocean, Station 156; depth, 1975. One specimen, $3\frac{3}{8}$ inches long.
Antarctic Ocean, Station 157; depth, 1950 fathoms. One specimen, $2\frac{1}{2}$ inches long.

This species has so much the appearance of a surface *Scopelus*, that I strongly suspect that it did not actually come from the immense depth to which the dredge descended on the occasion of the capture of the specimens, but that these entered the dredge whilst it was being hauled to the surface.

Scopelus engraulis, n. sp. (Pl. LI. fig. C).

D. 14. A. 14–15. P. 12. V. 9. L. lat. 38. L. trans. 3 | 5.

Habit rather slender, the height of the body being nearly one-fifth of the total length (without caudal); the length of the head is contained thrice and two-thirds in the same. The shape of the head reminds one of many species of *Engraulis*, the eye being situated near to the extremity of the very short snout. The diameter of the eye is one-fifth of the length of the head, and longer than the snout. Interorbital space wider than the orbit. Posterior margin of the præoperculum oblique. Operculum thin, narrow, scarcely covering the gill-aperture. Mouth oblique, very wide, the upper jaw overlapping the lower; the maxillary extends back to the mandibulary joint and is not dilated behind.

The origin of the dorsal fin is midway between the extremity of the snout and the adipose fin, a little in advance of the root of the ventral; its last ray is in advance of the vent. Pectoral fin short, not extending to the ventrals. Scales perfectly smooth, those of the lateral line not larger than the others. Lateral luminous spots at some distance below the lateral line.

Black; mandibles whitish, with a black cross-band below the eyes.

The phosphorescent organs are arranged in the following manner:—One on the præoperculum, near to its lower angle; three between the root of the pectoral and the isthmus; one above the pectoral; three in a series on each side of the median line of the abdomen in front of the ventrals, and an isolated one higher up on the side; three on each side of the median line of the abdomen between the ventrals and the vent, and two or three others higher up the sides; three in an oblique series running from the vent towards the lateral line; a series of eleven along the base of the anal and on each side of the lower part of the tail; one higher up the side opposite to a break in the series last described; and four on the root of the lower caudal rays. All these eye-like pearl-coloured organs are divided into two by a septum of black pigment. A large whitish, gland-like organ occupies the place in front of the eye below the nostrils.

Habitat.—Philippine Islands, Station 200; depth, 250 fathoms. One specimen, 6½ inches long.

Scopelus dumerilii.

Scopelus dumerilii, Bleek., Act. Soc. Sci. Indo-Neerl., i., Manado en Makassar, p. 66.

D. 14–15. A. 14–15. P. 10. V. 9. L. lat. 37.

This species is closely allied to *Scopelus engraulis*, and for some time I was inclined to refer the following specimen to that species, taking the larger size of the eye merely as a sign of its immaturity, but the difference in the position of the lateral phoshorescent organs seems to indicate specific distinctness.

The diameter of the eye is two-sevenths of the length of the head, equal to the width of the interorbital space and much more than the length of the snout. The origin of the dorsal fin is rather nearer to the adipose than to the end of the snout. Pectoral fin reaching somewhat beyond the root of the ventral, and the latter beyond the anterior anal rays. The phosphorescent spots are arranged as in *Scopelus engraulis*, but the four which are placed on the sides are not at a distance below the lateral line, but almost on it, one corresponding to the root of the pectoral, the second to that of the ventral, the third to the origin, and the fourth to the end of the anal fin. None of the organs have a black septum in this species.

Habitat.—Off Matuku, Fiji Islands, Station 173; depth, 315 fathoms. One specimen, 3 inches long.

Nannobrachium, n. gen.

Head and body rather elongate and compressed, covered with deciduous scales of rather large size. Cleft of the mouth very wide; maxillary well developed, not dilated behind. Teeth minute, in narrow bands, in the jaws, on the vomer, the palatine bones, and the tongue. Eye rather small. Pectoral fins rudimentary; ventral fins well developed, eight-rayed, inserted at some distance behind the pectorals; dorsal fin in the middle of the length of the body with fourteen rays, its origin being between the ventrals and the anal; adipose fin small; anal of moderate length; caudal forked. Gill-opening very wide; pseudobranchiæ small. Series of phosphorescent organs along the lower side of the head, body and tail; a gland-like luminous organ on the upper and lower sides of the caudal peduncle.

Habitat.—Indian Ocean.

Nannobrachium nigrum, n. sp. (Pl. LII. fig. B).

D. 14. A. 19. L. lat. ca. 34.

The single specimen in the collection has suffered much at the time of capture and has lost a great portion of its integuments.

This fish is closely allied to *Scopelus*, and bears in its physiognomy and general form of body a great resemblance to *Scopelus engraulis*. The depth of the body is contained five and a half times in the total length, without caudal, the length of the head three times and two-thirds. A great portion of the skull is cartilaginous, the superficial bones being extremely thin and modified for the reception of the wide muciferous cavities. The eye is rather small, about one-fifth of the length of the head and equal to that of the snout. Mouth extremely wide, rather oblique, with the lower jaw somewhat projecting, extending backwards to the end of the præoperculum. Intermaxillary as long as maxillary, toothed throughout its whole length, both bones being very narrow and rod-shaped. Hind margin of the præoperculum very oblique.

Gill-laminæ very short; gill-rakers long, needle-shaped, eighteen on the outer branchial arch, the longest as long as the eye.

The origin of the dorsal fin is nearer to the extremity of the snout than to the root of the caudal, and its last ray opposite to the eighth of the anal fin. Adipose fin narrow, opposite to the end of the anal. The origin of the anal is opposite to the eighth ray of the dorsal fin. Caudal emarginate.

The pectoral fin is reduced to three or four small and extremely delicate filaments.

The ventral fin is inserted consipcuously in front of the dorsal and extends backwards to the vent.

The eye-like phosphorescent organs are small and arranged very much in the same manner as in *Scopelus engraulis*, but owing to the condition of the specimen no exact description of their number can be given. A long, linear, glandular organ of white colour occupies the back and opposite side of the posterior half of the caudal peduncle.

Coloration uniform black.

Habitat.—South of Philippine Islands, Station 214; depth, 500 fathoms. One specimen, 4½ inches long.

Odontostomus, Cocco.

Body oblong, compressed, naked; head compressed, snout short; cleft of the mouth very wide; intermaxillary and maxillary bones slender, the former with a series of small teeth of equal size which have their points directed backwards; the lower jaw, the vomer and the palatine bones armed with a few very large curved and lanceolate teeth, which are barbed at the tip, curved, and depressible backwards. Eye very large, with the orbital cavity expanded downwards, so that the eye can be turned either upwards or towards the side of the head. Pectoral and ventral fins well developed, the latter are inserted below the dorsal at some distance behind the pectoral. Dorsal fin in the middle of the length of the body; adipose fin small, placed far backwards; anal fin long; caudal forked. Branchiostegals eight; pseudobranchiæ well developed, gills four; the outer branchial arch with small gill-laminæ and without gill-rakers.

Odontostomus hyalinus, Cocco (Pl. LII. fig. A).

D. 12. A. 34. P. 12. V. 9.

The height of the body is contained six times and one-third in the total length, without caudal, the length of the head four times and a half. The wide cleft of the mouth, which is oblique, extends far beyond the eye, but does not reach the angle of the præoperculum. The mandible is broad, not attenuated in front, and projects beyond the mouth. The large fangs can be depressed backwards, and are always depressed when the mouth is closed; they are very much compressed and sharp-edged in front and behind. The longest of the palate have their extremities curiously bent forward.

The form and structure of the orbit is quite unique; it is, in fact, turned upwards, separated from its fellow by an extremely narrow interorbital space; its lateral wall is formed by a transparent membrane so that the fish by rotating the eye-ball behind this membrane outwards for 90°, can place the eye in the usual position on the side of the head, and thus see either sidewards or upwards. The infraorbital ring is very narrow, bent in a strong curve, within which the transparent orbital membrane is extended.

The eye is large, but shorter than the snout and less than one-fourth of the length of the head.

Origin of the dorsal fin a little nearer to the extremity of the snout than to the root of the caudal; it is higher than long. The anal fin commences at some distance behind the vent, which occupies a position midway between the ventrals and the anal, and somewhat behind the vertical from the last dorsal ray. The anal fin is lower than the dorsal and terminates close to the anterior rudimentary rays of the caudal fin. The adipose fin is a small narrow lobe. Pectoral fin inserted close to the ventral profile, truncated behind, and terminating at some distance from the ventral fin. Ventral fins inserted somewhat behind the vertical from the origin of the dorsal fin, shorter than the pectorals, and extending to the vent.

This fish is colourless in spirits, but covered all over with brown pigment spots.

The description is taken from a specimen, $6\frac{1}{2}$ inches long, obtained near Nice.

Omosudis, n. gen.

Body oblong, compressed, naked; head compressed, snout of moderate length, cleft of the mouth very wide, intermaxillary and maxillary bones slender, the former with a series of very small teeth of equal size, only one or two anterior ones being somewhat enlarged; the lower jaw, the vomer and palatine bones with a few very large and lanceolate teeth. Lower jaw broad, and like the rest of the head formed of very thin bone. The supraclavicle and postclavicles form a long rod extending from the occiput on each side downwards to the abdomen, and partly free, not covered by skin. Ventral fins inserted far behind the pectorals below the origin of the dorsal. Dorsal fin behind the middle of the length of the body; adipose fin very small; anal fin long. Stomach very distensible. Branchiostegals eight; pseudobranchiæ well developed; gills four, with broad gill-laminæ and very short gill-rakers.

Omosudis lowii, n. sp. (Pl. LII. figs. C, C′).

B. 8. D. 9. A. 14. P. 12. V. 6. (?)

The length of the head is two-sevenths of the total length, without caudal; the greatest depth of the body immediately behind the head is one-fifth of the total length. The head is strongly compressed, with rather flat upper surface; snout somewhat pointed, rather longer than the eye, the diameter of which is one-third of the length of the head. The bones of the head are extremely thin, the operculum being smaller than the suboperculum and supported by two or three ridges. The infraorbital ring is nearly membranaceous. Præoperculum terminating below in a forked point. Cleft of the mouth extending backwards to the angle of the præoperculum.

The dentition is truly formidable for so small a fish; the longest tooth is one anteriorly on the side of the mandible; in both our specimens only one is present either on the right or left of the jaw; its length is nearly one-third of that of the head. The next largest are those on the palate, where there are two on each side, beside several smaller ones. Smaller teeth are also implanted on the hinder part of the dentary bone. All the large teeth can be laid backwards.

A semicircular scale-like osseous lamella of extreme thinness covers the lower part of the cheek and is marked by very shallow concentric striæ.

The singular bone which supports the side of the anterior part of the abdomen is styliform, slightly curved backwards. It starts from the top of the occiput and descends towards the median line of the abdomen, which it reaches behind the pectoral fin. It is composed of the two-pronged supraclavicle (*scl*) which is fixed by ligaments to the occiput, and of three slender and needle-shaped postclavicles (*pcl*); the uppermost post-clavicle is suspended by ligaments from the supraclavicle, as is also the clavicle (*cl*). The rod lies immediately below the thin integument and its lower portion is quite free.

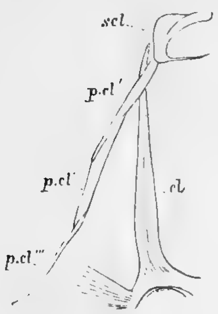


Fig. 6.—Scapular arch of *Omosudis* (enlarged).

The dorsal fin commences midway between the root of the caudal and the eye, and is composed of very feeble rays; the anal commences at some distance behind the dorsal and terminates not very far from the caudal. Caudal fin small, with a considerable number of basal rays above and below. Pectoral fins quite at the lower side of the body; ventral fins very small and partly coalescent.

Light brownish on the back with numerous brown pigment spots on the sides; abdomen black.

One of the two specimens (fig. C′) has the abdomen excessively distended, having swallowed a *Sternoptyx* equal in bulk to its destroyer, and with a body the width of which is about twice that of the *Omosudis*. In the other specimen the abdominal integuments are longitudinally folded.

One specimen, 3¼ inches long, was obtained south of the Philippine Islands, at Station 214, in a depth of 500 fathoms. But the existence of this singular form has been known to me since 1868, in which year I received from my late friend, the Rev. R. T. Lowe, a somewhat smaller example, which he had obtained at his favourite station, Magdalena, in the year previous. That specimen had its abdomen distended by the contents of its stomach, and was probably killed by the dorsal spike of the *Sternoptyx* penetrating the walls of the abdomen. Not only the head but also the hind part of the body were so much distorted and injured that it did not seem to me advisable to describe the genus from this specimen.

Plagyodus, Steller.

No specimen of this characteristic deep-sea type was obtained during the Challenger Expedition; indeed, no example is known to have been captured by means of the dredge or trawl. The Madeiran species is rarely caught on the deep-sea lines of the fishermen, whilst the other species seem to be known from examples that were found floating on the surface or thrown ashore. The following species are known:—

Plagyodus ferox.

Alepisaurus ferox, Lowe.

Known from the depths of the Atlantic only; a fragmentary skull from Tasmania indicates the presence of this species in the South Pacific.

Plagyodus æsculapius.

Alepisaurus æsculapius, Bean, Proc. U.S. Nat. Mus., 1883, p. 661.

Alaska.

Plagyodus altivelis.

Alepisaurus altivelis, Poey, Mem. Cub., vol. ii. 302.

Cuba.

Plagyodus borealis.

Caulopus borealis, Gill, Proc. Acad. Nat. Sci. Philad., 1862, p. 128.

Pacific Coast of North America.

Family STOMIATIDÆ.

Astronesthes, Rich.

Astronesthes niger, Rich.

Habitat.—Near Sierra Leone, Station 101; depth, 2500 fathoms. Two specimens, $1\frac{1}{2}$ inches long.

West Coast of Africa, April 28, 1876. One specimen, $1\frac{1}{3}$ inches long.

This little fish is one of the most common of pelagic forms in the Atlantic as well as in the Indian Ocean, and therefore is caught on almost every voyage on which the tow-net is used. From the development of its luminous organs, which cover in great number not only the lower but also the lateral parts of the body, we may infer that its habits are nocturnal. It is not known to what depth it descends during the daytime, but it is very improbable that the two specimens from Station 101 were caught at the depth of 2500 fathoms.

No more is known about the habits of the other species of the genus which have been described, viz., *Astronesthes richardsonii* (Poey), *Astronesthes barbatus* (Kner),[1] *Astronesthes martensii* (Klunz.), *Astronesthes chrysophekadion* (Blkr.).[2]

Stomias, Cuv.

Stomias boa.

Esox boa, Risso.
Stomias boa, Cuv. Val., vol. xviii. p. 368, fig. 545.
„ *barbatus*, Cuv., Règne animal.
„ „ Bonap., Faun. ital. Pesc. (*c. fig. mala*).

I refer to this species a specimen obtained south of Australia, Station 158, in 1800 fathoms, as it agrees with the only detailed and reliable description and figure which have hitherto been given of the Mediterranean fish, viz., by Valenciennes. Peters[3] also states that he has not found any difference between a specimen from Nice and one from the Pacific, caught in lat. 42° 56′ S., and long. 149° 26′ W. However, I must not omit to mention that none of the authors referred to have given the number of luminous spots along the abdomen, and that, not having a specimen from the Mediterranean, I am consequently unable to assert the agreement of our fish in this respect; also that Valenciennes has counted seventy-two scales along the side of the body, whilst our Antarctic specimen possesses eighty-eight. Ussow,[4] in his valuable contribution to our knowledge of the structure of the luminous spots, states that *Stomias barbatus* and *Stomias anguilliformis*[5] possess fifteen luminous spots in a series from the caudal fin to the anal, thirty-five from the anal to the ventral, and twenty-two from the ventral to the pectoral. But these numbers differ so much from my own observations that I cannot help thinking that by some error the numbers were confused in his table.

As a full description has been given of *Stomias* elsewhere, I append here only a diagnosis taken from the Antarctic specimen.

[1] = *Stomias leucopterus*, Eyd. and Soul., Voy. Bonite. Zool., tom. i. p. 193, pl. vii. fig. 4.

[2] A fish mentioned and figured in *La Nature*, 1884, p. 185, under the name of "*Eustomias obscurus* (N. S. N. S., L. Vaill.)," is not characterised, but the figure represents it with a long barbel terminating in a phosphorescent button-like swelling; it was captured in the Atlantic during the voyage of the "Talisman" at a depth of 2700 metres.

[3] *Monatsber. d. k. preuss. Akad. d. Wiss. Berlin*, 1876, p. 846.

[4] *Bull. Soc. imp. des Nat. Moscou*, 1879, p. 108.

[5] A name for which I have unsuccessfully searched ichthyological literature.

D. 18. A. 18. P. 6. V. 5. L. lat. 88.

The height of the body is contained twelve and a half times in the total length, without caudal, the length of the head nine and one-third times. Barbel as long as the head, terminating in three filaments. Pectoral and ventral fins very narrow and elongate. Each of the median abdominal series of luminous spots contains fifty-four between pectoral and ventral fins, fourteen between ventral and anal, and fifteen between the origin of the anal and caudal.

Stomias affinis, n. sp. (Pl. LIV. fig. A).

D. 17. A. 20. P. 6. V. 5.

Scaleless, but with the hexagonal divisions of the skin distinct. The height of the body is one-twelfth of the total length, without caudal, the length of the head one-eighth. Teeth fixed. The barbel is about as long as the head, and terminates in three filaments (fig. *a*); the end of the stem of the barbel white, with a black pigment-spot, and probably luminous. Pectoral and ventral fins narrow and elongate, especially the latter, which taper into a filament and extend beyond the anterior anal rays. Anal fin higher than dorsal. Each of the abdominal series of luminous spots contains forty-three between the pectoral and ventral fins, six between ventrals and anal, and fifteen (sixteen) between the origin of the anal and caudal; another parallel series runs below, and a third above the middle of the side of the body. Fins white, dorsal, anal and ventrals with black margins.

Habitat.—South of Sombrero Island, Station 23; depth, 450 fathoms. One specimen, 5 inches long.

Stomias ferox (Reinh.).

D. 17. A. 21. P. 6. V. 6.

The height of the body is about one-twelfth of the total length, the length of the head one-tenth. The barbel is longer than the head, tapering and not fringed at its extremity. Neither the pectorals nor the ventrals are produced.

Discovered first in the sea off the coast of Greenland; other specimens were recently obtained further southward, viz., in lat. 40° 0′ to 41° 30′ N., long. 65° 0′ to 68° 0′ W.; at depths of 304 and 524 fathoms.

Echiostoma, Lowe.[1]

Echiostoma barbatum (Pl. LIII. fig. B).

Echiostoma barbatum, Lowe. Proc. Zool. Soc. Lond., 1843, p. 88.
„ „ Günth., Fish., vol. v. p. 427.
„ „ Goode and Bean, Bull. Essex Instit., vol. xi. p. 128.

B. 12. D. 12–15. A. 16–18. P. 3–5. V. 8.

The head and body of this fish are compressed, scaleless; its greatest depth is one-eighth of the total length, the length of the head nearly one-seventh. The upper part of the head is short, the cleft of the mouth very wide, extending to the angle of the præoperculum, the hind margin of which consequently descends backwards in a strongly oblique direction. The opercular portion is very narrow, and the whole gill-cover formed by thin, almost membranous plates. The width of the interorbital space much exceeds that of the orbit, the diameter of which is one-sixth of the length of the head, and a little less than that of the snout. Lower jaw but slightly projecting beyond the upper. Nostrils, two round openings on each side, situated in a cavity on the upper side of the snout, and separated from the orbit by a slight crenulated projection; also the median ridges on the upper side of the head are indistinctly crenulated.

The formidable dentition consists of pointed teeth unequal in size, chiefly arranged uniserially, all the larger ones being depressible backwards or inwards. The two large front teeth of the upper jaw leave a wide space for the reception of the lower teeth. When complete, the intermaxillary dentition consists of ten teeth, of which the first is the smallest and readily lost, the third and sixth the largest. The maxillary dentition is peculiar, inasmuch as its proximal third consists of six teeth of moderate size, while the two distal thirds are formed by uniformly small teeth, there being no gradual transition from the larger to the smaller teeth. The mandibulary teeth are uniserial in front, biserial behind; the seven anterior teeth are larger than the rest, and the third and sixth exceed the others. Vomer with a fang on each side; palatine with a series of small teeth. Two pairs of fangs, strongly curved backwards, on the tongue. Also the upper pharyngeals bear some teeth of rather small size.

The gill-laminæ are well developed, except on the hinder part of the horizontal

[1] This genus seems to have been re-named *Hyperchoristus* (Gill, *Proc. U.S. Nat. Mus.*, vol. vi. 1884, p. 256); its dentition is described thus:—"Teeth on the jaws nearly uniserial, but in several groups, of which the successive teeth (about four) rapidly increase in size backwards, and teeth on the palate enlarged, one on each side of the vomer, and several on the palatines." A single specimen, named *Hyperchoristus tanneri*, of which the size is not stated, was obtained by the U.S. Fish Commission in the North Atlantic (lat. 40° 26′ N., long 66° 58′ W.), at a depth of 956 fathoms; but as the specimen is said to have been "so lively when brought to the surface that it twisted itself round in its attempt to bite the commander of the vessel," it is more likely to have been captured much nearer to the surface of the water.

branch of the outer branchial arch, where they are remarkably short; gill-rakers in quite a rudimentary condition.

The barbel is of nearly uniform thickness, and scarcely more than half as long as the head; it is inserted somewhat behind the anterior extremity of the hyoid bone, and seems to have terminated in a short, small, black lobe.

The vent is placed very far backwards, its distance from the root of the caudal not much exceeding that between the pectoral fin and the end of the snout. The anal commences immediately behind the vent, and its depth, as well as that of the dorsal, is less than that of the tail between these two fins. The dorsal fin is shorter than the anal, commencing a little behind, and terminating in front of, the anal. Caudal short, cleft with pointed lobes. Pectoral very narrow, its upper ray is separate from the remainder of the fin, and produced into a very long and exceedingly fine filament, which nearly reaches the ventral. Ventrals very narrow, pointed, and somewhat longer than the head; the distance of their base from the end of the caudal equals that from the root of the pectoral.

The luminous organs[1] are arranged thus:—

a. A series of rather small, but distinctly developed eye-like bodies begins on the isthmus, and runs along each side of the abdomen to the commencement of the anal fin; it consists of eight in front of the pectoral, twenty-nine between pectoral and ventral, and fifteen between ventral and anal.

b. A parallel series, beginning above the root of the pectoral, and running below the median line of the side of the body along the base of the anal to the root of the caudal. The position of the organs corresponds to that in series *a*; but there are twelve additional posterior ones, from the commencement of the anal to the root of the caudal.

c. A series of similar organs along the base of the branchiostegals.

d. Innumerable smaller, and partly quite rudimentary, organs are scattered between the principal series; they extend upwards on the sides to the back, but they are there more regularly arranged, a biserial row corresponding to each myocomma. A great number of rudimentary organs, like raised pigment-spots, are scattered all over the head.

e. An isolated eye-like organ, larger than any of the others hitherto described, occupies the suture between operculum and suboperculum.

f. The principal luminous organ, situated behind the eye, along the maxillary, is of a narrow cuneiform shape, pointed behind, and longer than the eye; it is said to be rose-coloured during life.

Colour, uniform black.

Habitat.—Very rare at Madeira, where the only specimen I have seen was obtained; it is 9 inches long. Another example is reported to have been taken off the coast of Massachusetts.

[1] The result of their histological examination will be given in Appendix B.

Opostomias, n. gen.

This genus differs from *Echiostoma* by its dentition, the long teeth not being depressible, but received in grooves or hollows of the opposite jaw. Maxillary and palatine teeth absent. A barbel.

Opostomias micripnus (Pl. LIII. fig. A).

Echiostoma micripnus, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 180; Narr. Chall. Exp., vol. i. p. 412.

B. 15. D. 21. A. 23. P. 1 | 3. V. 7.

The length of the head is nearly one-ninth of the total (with the caudal). Barbel much longer than the head and fringed at its extremity; the anterior pectoral ray filamentous and distinctly separated from the others. Root of the ventral rather nearer to the extremity of the snout than to the root of the caudal. Black; luminous organ above the maxillary small, round, like a rudimentary eye.

Habitat.—South of Australia, Station 159; depth, 2150 fathoms. One specimen, $15\frac{1}{2}$ inches long.

The height of the body is one-eighth of the total length, the length of the head two-ninths. Head moderately compressed; interorbital space convex, broad, its width being contained twice and two-thirds in the length of the head. Cleft of the mouth wide, but not quite extending to the angle of the præoperculum, the posterior margin of which is vertical. Gill-cover completely covering the gill-cavity, narrow. Eye small, half as long as the snout and one-sixth or one-seventh[1] of the length of the head.

Jaws armed with very strong teeth, few in number and not depressible. About one-half of the length of the upper jaw is formed by the intermaxillary and the other half by the maxillary. The intermaxillary bears four teeth, of which the second is by far the strongest and received in a shallow impression behind the large fang of the mandible. The three other teeth are subequal and of rather small size. Maxillary toothless. Mandible broad and deep, armed anteriorly with two large and pointed fangs, which are distant from each other and are received in a deep hollow of the upper jaw. This large mandibulary fang is succeeded by three teeth only, which are remote from each other and somewhat larger than the opposite teeth of the upper jaw. Vomer with a small fang on each side. Palatines toothless; upper pharyngeals with some small fangs.

Pupil of the eye vertical. Nostrils close together, above the eye, on the upper surface

[1] The eyes are not exactly of the same size on each side.

of the snout. The barbel is inserted in front of the extremity of the hyoid bone; it is much longer than the head and terminates in a luminous organ, from which a short terminal filament arises.

Gills four, well developed, the laminæ on the posterior part of the horizontal branch of the outer branchial arch being shorter than the others. Gill-rakers in the shape of short spiny tubercles.

The distance of the vent from the root of the caudal is twice the length of the head. The anal fin commences immediately behind it, and terminates so close to the caudal that the extremities of some of its posterior rays touch it. The dorsal is coterminal with the anal in front, but does not extend quite so far backwards; both fins are about equal in height and lower than the tail between them. Caudal fin short, cleft, the lower lobe being the stronger. The upper pectoral ray is separated from the remainder of the fin by a short interspace; it is about as long as the head and has the terminal portion covered with a white luminous substance. The pectoral fin proper is extremely narrow, short, and in fact rudimentary. Ventrals much more developed, as long as the head; their root is nearer to the extremity of the snout than to the root of the caudal, but rather nearer to the vent than to the gill-opening.

The skin is naked, with conspicuous mucous openings on the top of the head, and a great number of luminous organs [1] which are arranged as follows:—

a. A series of small eye-like organs, which commences on the isthmus and runs along each side of the abdomen to the root of the caudal fin. It consists of five very small organs on the isthmus, thirty between the pectoral region and the ventral fin, twenty-two between the ventral fin and the vent, and about sixteen between the vent and the root of the caudal. Of these latter posterior organs some may be occasionally missing, all being very small.

b. The upper lateral series consists of eye-like organs, which in size and position generally correspond to those of the former series, but there is now and then a break in the series by one or more of the organs being absent. This series disappears altogether opposite to the anal fin.

c. A series of similar organs along the base of the branchiostegals.

d. An eye-like organ, isolated and somewhat larger than those described, between the operculum and suboperculum.

e. A still larger organ, between the upper jaw and the eye, so closely simulating an eye, that, from its external appearance, a cornea, iris, and pupil might be distinguished.

f. A great number of minute organs, some with a lighter centre, others being merely raised pigment-spots, scattered over the whole body and head.

g. It has been already mentioned that the terminal portions of the barbel and pectoral filaments are covered and slightly thickened by a layer of white luminous

[2] The histology of these organs is described in Appendix B.

substance; and it appears that there is a large patch of similar substance in the gill-cavity on and in front of the clavicle.

The entire specimen is black, the vertical fins of a somewhat lighter colour; the upper central rays of the caudal black. Ventrals whitish, the hind part of the three inner rays black.

Mr. Murray[1] observes:—"The end of the barbel, which was thickened, was flesh colour with a rose tint, there was also a rose tint on the dorsal and anal fins. The rest of the animal was of a dark colour with a perceptible slate-coloured tint. The phosphorescent spots along the belly and lateral line were red, as was also that below the eye."

Pachystomias, n. gen.

This genus differs from *Echiostoma* by the absence of a separate pectoral ray; also by a much less developed dentition, vomerine and maxillary teeth being absent.

Pachystomias microdon (Pl. LIII. fig. C).

Echiostoma microdon, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 180.

D. 24. A. 29. P. 3. V. 7.

The length of the head is more than one-fifth of the total (with the caudal). No separate pectoral ray; root of the ventral considerably nearer to the base of the caudal than to the extremity of the snout. All the teeth rather small, a few only in the middle of the palatine bone. Black; two luminous organs below the eye, a narrow elongate one above the maxillary, and a small short one nearer to the eye.

Habitat.—North-West of Australia, Station 181; depth, 2440 fathoms. One specimen, 9 inches long.

This fish is a much shorter and heavier fish than *Echiostoma barbatum*, somewhat approaching *Malacosteus* in its physiognomy. The head and body are compressed; the greatest depth, immediately behind the head, is one-fifth of the total length, the length of the head two-ninths. The head is enveloped in rather thick skin, like the body, well hiding the underlying parts. Upper part of the head rather short, cleft of the mouth exceedingly wide, extending backwards nearly to the margin of the gill-opening; the præopercular edge is therefore very oblique. Interorbital space convex, but with a depression along the middle caused by two longitudinal ridges; its width equals the diameter of the eye, which is as long as the snout, and one-fourth of that of the head. Nostrils close together, round, lateral, in front of the eye. Snout rounded,

[1] Narr. Chall. Exp., vol. i. p. 412.

with a parabolic anterior profile; mandible tapering in front and not longer than the upper jaw.

The dentition in the upper as well as in the lower jaws consists of a single series of rather small teeth, not very closely set, fixed, not depressible, subequal in size, only two pairs in front of the lower jaw being somewhat larger and strongly curved. Only the intermaxillary is toothed. The teeth on the palate are reduced to a short series of five small closely set teeth, which are depressed inwards and backwards.

The gill-cover is so narrow as to leave a considerable portion of the gills uncovered. The gill-laminæ are developed, except on the hinder part of the horizontal branch of the outer branchial arch, where they are remarkably short; gill-rakers absent.

A narrow bridge of skin behind the symphysis stretches from one mandible to the other. Barbel small, tapering, about one-third of the length of the head, suspended from the hyoid.

The vent is placed very far backwards, its distance from the root of the caudal being a little less than the length of the head. The anal fin extends nearly to the caudal, a little further backwards than the dorsal, the origin of which is opposite to that of the anal. Behind these fins the tail is suddenly narrowed and terminates in a small bilobed caudal fin. Pectoral fin rudimentary, its short rays being free at the tip. Ventrals twice as distant from the eye as from the vent; they are well developed, have a moderately broad base, and are half as long as the head.

The skin is rather tough, scaleless, but rhombic lines are visible, especially on the side of the back, indicating the first commencement of the development of scales. The luminous organs[1] are arranged thus:—

a. A series of three or four minute eye-like spots on each side of the isthmus. After a short interruption this series is continued along the abdomen by three similar organs in front of the pectoral, by sixteen between the pectoral and ventral, and by fourteen or sixteen between the ventral and anal.

b. The lateral ventral series consists of similar organs, but still more minute in size, and more or less disappearing at the level of the anal fin.

c. A vertical series of three much larger eye-like organs on the gill-cover; they do not possess the white centre of those described hitherto, but appear through a rather opaque round cornea-like membrane.

d. The large subocular organ which consists of two portions, one being elongate, as long as the eye and lying close to the intermaxillary; the other much shorter, between the anterior end of the former and the front margin of the eye. Each of these organs is of a pure white colour, has free margins all round, and lies in a hollow of the skin of corresponding shape.

Colour uniform deep black.

[1] The histology of these organs is described in Appendix B.

Mr. Murray[1] observes:—"The new species of *Echiostoma* showed signs of life when taken out of the trawl, so that probably it had not come from any great depth. It had one club-shaped spot of a rose colour directly below the eye, and another, about half the size, directly in front of this, of the same colour; these spots turned yellow in spirit. The two rows of probably phosphorescent dots along the body were red, surrounded by a circle of pale violet; these dots turned white in spirit."

Photonectes.

Lucifer,[2] Döderlein, Wiegm. Archiv f. Naturgesch, 1882, p. 26.

Body compressed, rather long, scaleless; vent far behind the middle of the length. Head compressed, with short snout and exceedingly wide mouth. Teeth in the jaws small, unequal in size, in single series; vomer and palatine with a small group of teeth on each side. Eye small. Opercular portion of the head very narrow. A long hyoid barbel. The dorsal fin opposite to the anal, which commences behind the vent. Pectorals none. Ventrals inserted behind the middle of the length. A small suborbital phosphorescent organ, and two series of luminous dots along the lower part of the sides, with numerous rudimentary similar organs scattered over the skin of the body.

Photonectes albipinnis.

Lucifer albipennis, Döderlein, *loc. cit.*, pl. iii.

D. 13. A. 15. P. 0. V. 7.

Black, with white fins.

Known from a single example from Inosima, 9 inches long.

Malacosteus, Ayres.

This form is one of the most extraordinary types of deep-sea fishes, reminding us in certain respects of the Bathybial Pediculates and Gadoids (*Chiasmodus*). Resembling a Stomiatid in its principal characters and general appearance of the body, *Malacosteus* possesses an osseous framework of a very soft, semicartilaginous or membranous structure; its integuments and fins are extremely fragile and loosely connected. The whole of its cranial bones are remarkably reduced in size and development, with the exception of those required for seizing and holding its prey. The snout is so short as to remind us of those monstrosities of carps or trout, in which the anterior facial portion of the cranium is missing; whilst the jaw-bones and the præoperculum are greatly prolonged, forming

[1] Narr. Chall. Exp., vol. i. p. 521.

[2] Preoccupied for a genus of Crustacea.

an enormous gape which extends backwards beyond the base of the pectoral fins. On the other hand, the gill-cover is still more reduced than in the other Stomiatids, and quite rudimentary.

A perfectly unique structure is a thin, cylindrical, muscular band which connects the back part of the mandibulary symphysis with the extremity of the hyoid bone. It is probably the homologue of a muscular band which in other Stomiatids stretches on each side from the mandible to the side of the hyoid, the two bands coalescing into an unpaired one in *Malacosteus.* It is, in the present state of preservation, much elongate, like a barbel, but during life it is probably contractile and serves to give to the extremity of the mandible the requisite power of resistance when the fish has seized its prey, as without such a contrivance, so long and slender a bone would yield to the force of its struggling victim. This structure is so unique, and the band so similar to a barbel that, before having become acquainted with it by autopsy, I imagined that its original describer, Dr. Ayres, had misunderstood its character, and that he had only seen a barbel like that of *Stomias* or *Echiostoma.* Dr. Ayres had not made any suggestion as to its probable function.

Being provided with a mouth which allows of the passage of fishes much exceeding in size its own bulk, *Malacosteus* must have as distensible a stomach as *Chiasmodus* or *Omosudis.* Both the specimens which are known had the stomach empty, but in our example the integuments of the abdomen are so distinctly longitudinally folded that there can be no doubt on this point; and probably *Stomias* and *Pachystomias* are likewise able to swallow large fishes, though this peculiarity is less developed in them than in *Malacosteus.*

The eye is comparatively large; and it would be quite inconceivable that a fish living at a depth to which no ray of the sun can penetrate, should be provided with an organ of sight so much developed, unless light be produced from some other source or by the fish itself. In *Malacosteus* the subocular luminous organ[1] is broken up into two bodies imbedded in the muscular substance; the anterior is the larger, pear-shaped, with the narrow end directed forwards and wedged into the narrow space between the eye and intermaxillary; the posterior is situated somewhat further back, above the maxillary, smaller and of a more rounded form. Both are now of the colour of a crystalline lens after immersion in spirit, and surrounded by a very narrow pearly ring.

Small eye-like organs are arranged in longitudinal series along the lower part of the side, and scattered between the series; others are scattered over the upper parts, but owing to the state of the specimen I am unable to trace the series in their whole course or to ascertain their number.

The gills are four in number with very short laminæ, and without gill-rakers; of branchiostegals I counted eight, all extremely short, rod-like and cartilaginous.

[1] Its histological structure will be described in Appendix B.

Malacosteus niger (Pl. LIV. fig. C).

Malacosteus niger, Ayres, Journ. Bost. Soc. Nat. Hist., 1849, p. 53, pl. v.

D. 19. A. 20. P. 5. V. 6.

The specimen of which Dr. Ayres has given an excellent description and figure, was 8½ inches long, and picked up at sea in the Atlantic in lat. 42° N., long. 50° W. Its mandible is armed with a series of slender, more or less curved teeth unequal in size; the largest occupy the anterior half of the bone and are four in number, a few smaller ones being placed between them in an irregular fashion; also the extremity of the mandible is armed with a longer curved tooth, but shorter than the lateral large ones. The caudal peduncle is very narrow behind, about two-thirds as long as the base of the dorsal fin. Base of the ventral fin midway between the caudal and the posterior luminous organ.

These are the principal characters by which this fish seems to specifically differ from its congener from the Indian Ocean.

The figure of the dentition is copied from Dr. Ayres' original drawing.

Malacosteus indicus (Pl. LIV. fig. B).

Malacosteus indicus, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 181.

D. 18. A. 20. P. 2. V. 6.

The fang on the extremity of the mandible is as strong as any of the lateral teeth, more strongly bent, and directed forwards and outwards. Of the lateral mandibulary teeth two exceed the others in length and strength; the anterior is at no great distance from the terminal fang, and the space between them is filled up by three or four smaller teeth which decrease in size forwards. The posterior large fang is more remote from the anterior and separated from it by smaller teeth varying in size. The caudal peduncle is less narrow than in the Atlantic species, and its length less than one-half of the length of the dorsal fin. Base of the ventral fin nearer to the caudal than to the posterior suborbital luminous organ. Caudal fin emarginate. Deep black.

One specimen, 4½ inches long, was obtained near the Philippine Islands (Station 214), in 500 fathoms. It is extremely similar to *Malacosteus niger*, and a detailed description is therefore rendered unnecessary by the excellent account which Ayres has given of that species.

Mr. Murray[1] observes:—This fish "had between the maxilla and the eye on either side two spots, the posterior one round and of a beautiful light yellowish-green colour, the anterior one larger, club-shaped (the head of the club pointing back), and of a dull red colour. The specimen was . . . . entirely black, with minute dots over the surface."

[1] Narr. Chall. Exp., vol. i. p. 669.

Bathophilus.

Bathophilus, Giglioli, Pelagos, p. 261.

Body compressed, rather short, scaleless, minutely granulated; vent far behind the middle of the length. Head compressed; cleft of the mouth very wide; teeth stout. Eye small. Barbel none. Dorsal fin opposite to the anal, which commences behind the vent. Pectoral fins long, ventrals narrow, inserted high upon the side of the trunk. No luminous organs (?).

Bathophilus nigerrimus.

Bathophilus nigerrimus, Giglioli, *loc. cit.*, *c.* fig.

D. 14. A. 13. P. 29. V. 11.

Known from a single specimen only, found at Messina, $2\frac{3}{4}$ inches long.

Idiacanthus.

Idiacanthus, Peters, Monatsber. d. k. preuss. Acad. d. Wiss. Berlin, 1876, p. 846.
Bathyophis, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 181.

Body extremely narrow and elongate, snake-like, naked. Vent far behind the middle of the length of the body. Head large, compressed, with the snout of moderate length, and with the cleft of the mouth as long as the head. Teeth in the jaws extremely large, numerous, of unequal size, depressible. Similar teeth on the tongue and on each side of the vomer and palatines. Eye rather small. Opercular portion of the head narrow. A long barbel anteriorly on the hyoid. The dorsal commences above or in front of the ventrals and extends nearly to the caudal; the anal is also long, commencing behind the vent. Pectorals none. Ventrals inserted in front of the middle of the length of the body. A small phosphorescent organ above the middle of the upper jaw, and series of small luminous dots along each side of the abdomen and along the outer ventral ray. Similar organs on the tail. Gill-opening extremely wide; branchiostegals short, numerous. Gills four; no pseudobranchiæ.

Idiacanthus fasciola.

Idiacanthus fasciola, Peters, *loc. cit.*, p. 847.

B. 18. D. ca. 70. A. 41. V. 6. C. | 13 |.

Vent situated anterior to the seventh twelfth of the total length. Commencement of the dorsal fin rather nearer to the head than to the ventrals. Black.

Known from two specimens in the Berlin Museum; the larger, about 5 inches long, was obtained north of Australia in long. 117° E., the smaller, 2 inches long, north of New Guinea in lat. 1° 4′, long. 136° E., both at the surface.

Idiacanthus ferox (Pl. LII. fig. D).

Bathyophis ferox, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 181.

D. 60. A. 45. V. 6. Vert. ca. 69.

Vent situated at the sixth eighth of the total length. Commencement of the dorsal fin opposite to the root of the ventrals. Black.

Habitat.—Middle of North Atlantic, Station 63; depth, 2750 fathoms. One specimen, 8 inches long.

The body of this extraordinary form is extremely elongate, band-shaped, with the muscular system so little developed, that in its present preserved state the vertebral column appears to be merely covered by the skin, with the outlines of the vertebræ clearly visible. It is one of those deep-sea fishes in which the stomach and the walls of the abdomen are capable of extreme distention, to receive the prey which the fish is able to seize, and to hold with its large and formidably armed jaws. The vent lies at the commencement of the sixth eighth of the total length, the tail being therefore rather short.

The head is high, compressed, the large jaws forming nearly one-half of its lateral area; its length is contained thrice and two-thirds in its distance from the ventral fins, or is one-fourteenth of the total length. Eye rather small, not quite twice as distant from the posterior end of the head as from the anterior. Cleft of the mouth extremely wide, extending backwards to the end of the head, slightly oblique, with the lower jaw prominent. The dentition is more complete on the right side than on the left, and consists in the upper jaw of seventeen long and pointed teeth, of which the fourth and the eighth are the longest. The teeth of the lower jaw are still longer, twenty on each side, the fourth and eleventh being very long, whilst the hindmost are very short.

These teeth when erect prevent the jaws from shutting, but all of them can be depressed to the level of the jaws. Vomer with one or two small teeth on each side, placed at considerable distance from each other; palatine with a series of three or four small teeth, slightly increasing in length backwards; tongue with three pairs of teeth. Gill-opening very wide, with a very narrow and membranaceous gill-cover. Barbel long, about twice as long as the head, with the terminal portion slightly dilated by a narrow fold running along each side, but the end of the appendage tapers again into a delicate filament (fig. *d*).

The dorsal fin commences opposite to the ventrals, and is composed of widely set, extremely fine and partly free, simple rays, their number corresponding to that of the vertebræ; each ray starts behind a minute curved spine-like projection of the vertebra (see fig. *d'*). Anal fin of similar structure, commencing immediately behind the vent, and terminating, like the dorsal, at a short distance from the caudal. Caudal fin very narrow and apparently forked. Ventral fins very narrow, pointed, not quite so long as the head, composed of six very feeble rays; their root is about midway between the vent and the head.

A phosphorescent eye-like organ is situated behind the eye, above the middle of the upper jaw. Similar but smaller organs are disposed along the lower side of the abdomen in a double series, which becomes single behind the ventral fins, and is continued on the tail. About twenty-three may be counted in a series in front of the ventral fins, and seventeen between the ventrals and the vent; those on the tail become very inconspicuous behind. Another series of minute organs occupies the base of the branchiostegals.

Colour entirely black; the lateral folds of the dilated portion of the barbel white.

The number of vertebræ appears to be twenty-two in front of the ventrals, seventeen between the ventrals and the vent, and thirty in the tail.

Family SALMONIDÆ.

Argentina, Art.

The three Atlantic species known are very similar to each other in their organisation, and, therefore, we may infer that they agree very much in their habits. They live at a considerable depth, but probably at some distance from the bottom, as they have never been captured by the dredge or trawl during any of the deep-sea expeditions.

Argentina silus, Cuv.

Argentina silus, Collett, Norg. Fisk., p. 173; Nyt Mag. f. Naturvid., vol. xviii., 1884, p. 109.
Argentina syrtensium, Goode and Bean, Proc. U.S. Nat. Mus., vol. i., 1879, p. 261.

Known chiefly from specimens obtained off the coast of Norway; Collett reports its occurrence at 80 and 100 fathoms. The specimen described as *Argentina syrtensium* was taken from the stomach of a *Phycis* hooked on a line that had been set in 200 fathoms on Sable Island Bank, off the coast of Nova Scotia.

Argentina sphyræna, L.

Osmerus hebridicus, Yarrell.
Argentina sphyræna, Collett, Norg. Fisk., p. 171; Forhandl. Vidensk. Selsk. Christ., 1880, p. 92.
Argentina decagon, Clarke, Trans. New Zeal. Inst., vol. xi., 1879, p. 295.

Known from the Mediterranean as well as the North Atlantic; and not rarely found in deep water on the Norwegian coast. Collett, who showed that the *Osmerus hebridicus* should not be separated from this species, gives 200 fathoms as the depth at which specimens were secured, and they were taken from the stomach of a *Molva vulgaris*.

This species seems to occur also on the coast of New Zealand; at least, I am unable to distinguish from it the *Argentina decagon* of Clarke, described from a specimen found at Hokitika.

Argentina lioglossa, Cuv. Val.

From the Mediterranean. This fish has not been found again since the discovery of the typical specimens.

Argentina elongata (Pl. LV. fig. B).

Argentina elongata, Hutton, Ann. and Mag. Nat. Hist., 1879, vol. iii. p. 53.

This Antarctic species is known from a single young example only, not in a good state of preservation, 3½ inches long, and obtained at Port Campbell, New Zealand. It is evidently distinct from the Atlantic species, and characterised by a narrow and prolonged head.

D. 10. A. 11. P. 15. V. 12. L. lat. ca. 50.

Head and body low, slightly compressed; the length of the former is contained thrice and one-fifth in the total (without caudal), the depth of the body eight times. The diameter of the eye is scarcely more than one-fourth of the length of the head, and much shorter than the long and pointed snout. Tongue with a series of curved teeth on each side. The origin of the dorsal fin is somewhat nearer to the end of the snout than to the root of the caudal; ventrals opposite to the last dorsal rays. Scales without denticulations (only a few on the tail are preserved). Body with a silvery longitudinal band.

Microstoma, Cuv.

The evidence as to the bathybial habits of these small fishes is merely circumstantial. They seem to have the same vertical range as *Argentina*, but are much more rarely seen in collections, as the small size of their slender cylindrical body renders their capture very difficult. The majority of the specimens come from the Mediterranean (*Microstoma rotundatum*, Risso), and a somewhat allied form has been observed in the Greenland sea (*Microstoma groenlandicum*, Rnhrdt.).

Bathylagus.

Bathylagus, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 248.

Body oblong, compressed, covered with thin deciduous scales of moderate size. No phosphorescent organs. Head short, rather compressed, with thin membranaceous bones. Mouth very narrow, transverse, anterior. The margin of the upper jaw is formed by the intermaxillary and maxillary, which is very short, dilated. Teeth in the intermaxillary rudimentary; those of the lower jaw extremely small, implanted on the edge of the bone, forming a minute serrature; a series of minute teeth across the vomer and along the palatine. Eye very large. Pectoral and ventral fins developed, the latter eight-rayed, and inserted opposite to the dorsal, at a considerable distance from the pectoral. Dorsal fin in the middle of the length of the body; adipose fin small, not very far from the caudal. Anal fin of moderate length or many-rayed. Gill-opening narrowed, commencing opposite to the root of the pectoral, and extending across the isthmus, the gill-membranes being united and not attached to the isthmus. Gill-rakers lanceolate, rather long; gills small; pseudobranchiæ well developed.

The nearest ally to this genus is *Microstoma*. The thinness of the bones, the fragility of the fin-rays, the delicacy of the skin and scales, and the enormously large eyes, seem to be sufficient evidence that these fishes are actually inhabitants of very great depths, although there may be reasonable doubts as regards the exact depth at which *Bathylagus atlanticus* was obtained. These fishes must therefore be entirely dependent for vision on the phosphorescent light which is produced by other abyssal creatures. Not being fish of prey themselves, or only to a slight degree, they would be attracted by the light issuing from the Pediculates and Stomiatids of the deep, and thus fall an easy prey to these fishes.

Bathylagus atlanticus.

Bathylagus atlanticus, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 248.

B. 3. D. 9. A. 13. P 7. V. 8. L. lat. 40.

The height of the body is a little less than the length of the head, which is one-fourth of the total (without caudal); the eye one-half of the length of the head. The width of the interorbital space is only two-thirds of that of the eye. Snout very short with steep anterior profile and transverse anterior mouth, the cleft of the mouth being nearly on the same level as the lower margin of the eye. All the bones of the head are very thin, semicartilaginous; the head seems to have been scaleless. The gill-cavity is closed behind, the gill-opening beginning opposite to the root of the pectoral fin, and the gill-membrane forming a broad bridge across the isthmus. This membranous bridge is not attached to the isthmus, and contains a layer of transverse muscular fascicles by which the gill-covers can be simultaneously firmly closed. The branchiostegals are extremely thin and short and hidden in the membrane. The dorsal fin commences nearly midway between snout and caudal; it is short and composed of feeble rays. Vent placed far backwards, the length of the tail not being much more than that of the head. Anal fin likewise composed of feeble rays, terminating at a short distance from the caudal. (The caudal fin is too much injured to ascertain its shape.) Pectoral fin narrow, close to the lower profile. Ventrals opposite to the hind part of the dorsal fin.

All the scales being lost, their size and number can be given only approximately from the remaining scale pouches; they must have been very thin, and the lateral line seems to have run along the middle of the side of the body.

Also of the colour nothing can be stated, except that the scale pouches have a distinct black margin.

Habitat.—One specimen, in very bad condition and 6½ inches long, was obtained in the South Atlantic, at Station 318 (depth, 2040 fathoms).

Mr. Murray[1] has made a very important observation on the circumstances attending the capture of this fish, which has a direct bearing on the question as to the bathybial range of many of the fishes captured by the deep-sea trawl. At this station the trawl was over the side for seven hours, but it never seemed to touch the bottom. Yet it contained, beside the specimen of *Bathylagus*, several large Medusæ, several bright scarlet Shrimps, and other animals. "It is impossible to say how near the trawl may have been to the bottom, but Mr. Murray considers it quite certain that most, if not all, of the animals above mentioned were captured in the intermediate water, between a depth of 100 fathoms from the surface, and a short distance from the bottom."

Bathylagus antarcticus.

Bathylagus antarcticus, Günth., Ann. and. Mag. Nat. Hist., 1878, vol. ii. p. 248.

D. 10. A. 22. P. 9. V. 8.

This species is closely allied to the preceding, but readily distinguished by the greater number of anal rays. The height of the body is rather less than the length of the head,

[1] Narr. Chall. Exp., vol. i. p. 903.

which is nearly two-ninths of the total length, without caudal; eye one-half of the length of the head; interorbital space flat, about two-thirds as wide as the eye; snout short, with rather oblique upper profile. Mouth narrow, hardly lateral, its cleft being above the level of the lower margin of the eye. Gill-opening as in *Bathylagus atlanticus*, but the branchiostegal membrane is not so muscular across the isthmus as in that species. The origin of the dorsal fin is nearer to the end of the snout than to the end of the caudal fin. All the fins are composed of feeble rays. The vent is situated at the beginning of the posterior third of the total length and the anal commences immediately behind it. Pectorals rather narrow, close to the lower profile. Ventrals opposite to the middle of the dorsal fin.

Otherwise the specimen is so much damaged, that I can only add that its scales and coloration seem to have been very much the same as in the Atlantic species; and that it is altogether a rather more slender fish.

Habitat.—One specimen, 4½ inches long, was obtained in the Antarctic Ocean, Station 157, at a depth of 1950 fathoms.

Pter:

Family ~~BATHY~~THRISSIDÆ.

Body oblong, with rounded abdomen, covered with cycloid scales; head naked; barbels none. Margin of the upper jaw formed by the intermaxillaries mesially, and by the maxillaries laterally. Opercular apparatus complete. Adipose fin absent; dorsal fin much elongate, many-rayed; anal fin short. Stomach with a blind sac; pyloric appendages numerous. Gill-apparatus well-developed; pseudobranchiæ; gill-openings wide; an air-bladder. Ova very small; ovaries without duct.

The fish for which I propose this new family differs from the Clupeidæ and allied forms chiefly in the development of the dorsal fin.

Bathythrissa.

Bathythrissa, Günth. Ann. and Mag. Nat. Hist., vol. xx., 1877, p. 443.
Pterothrissus, Hilgendorf, Act. Soc. Leop. Carol., xiii. p. 127.[1]

Body covered with scales of moderate size; head narrow, oblong, with the muciferous channels much developed, Eye large. Mouth narrow, Coregonoid, with bands of minute

[1] Dr. Hilgendorf seems to claim priority for the name proposed by him. To this I must demur, until he brings forward more satisfactory evidence as to the date of *publication* of the sheet of the Leopoldina, which contains his first notice of this fish. That sheet, indeed, bears "August" on the first page (p. 113), but as the Manuscript of it was finished only on the 31st of that month (see p. 128), it is evident that it could not have been printed, much less published in that month. Neither the German nor the English reporters on the ichthyological literature of the year 1877 mention Dr. Hilgendorf's paper, which would hardly have escaped their notice if that part of the Leopoldina had been actually issued. The exact date of the publication of *Bathythrissa* is November 1.

teeth imbedded in the thick lips; maxillary with a marginal row of very small teeth. Caudal fin forked, with a dense layer of small scales. Air-bladder with very thick walls, terminating in two short horns in front, pointed behind.

Bathythrissa dorsalis (Pl. LVI. fig. A).

Bathythrissa dorsalis, Günth., *loc. cit.*.
Pterothrissus gissu, Hilgendorf, *loc. cit.*; Sitzungsb. naturf. Freunde Berlin, 1878, p. 156.

B. 6. D. 56. A. 12. V. 9. L. lat. 112. L. transv. $\frac{8}{13}$. Cœc. pylor. 14.

The general aspect of this remarkable fish is that of a much elongated *Coregonus*, its greatest depth being one-fifth of the length of the body (without caudal). The head is low, elongate, one-fourth of that length; the large eye, the diameter of which is rather more than one-fourth of the length of the head, occupies nearly the middle of its length, slightly encroaching upon the upper profile. The width of the bony interorbital space is much less than the diameter of the eye. Snout projecting beyond the mouth as in *Coregonus;* mouth laterally extending to below the anterior nostril; the labial fold of the mandible does not extend across the symphysis. Nostrils close together, separated by a membrane only. The muciferous channel of the infraorbital is longitudinally divided by a straight ridge; angle of the præoperculum somewhat produced backwards; operculum small; sub- and inter-operculum narrow.

Scales very regularly arranged; lateral line straight, running along the middle of the tail.

The vent is situated far backwards, its distance from the caudal being less than the length of the head.

The dorsal fin is low, but the anterior rays are somewhat the longest; it commences above the middle of the pectoral, and terminates above the middle of the anal. Also the anal rays are short, the anterior being the longest. The caudal fin is deeply forked, densely covered with scales. The pectorals are more and the ventrals less than half as long as the head. Ventrals inserted midway between the anal and the head.

Upper parts brownish, shining silvery, lower parts silvery, minutely dotted with brown.

Habitat.—Off Inosima; purchased from Japanese fishermen; depth, (?) 345 fathoms. One specimen, 15 inches long.

Family ALEPOCEPHALIDÆ.

Alepocephalus, Risso.

All the four or five species of this genus which have been described hitherto, are bathybial.

Alepocephalus rostratus.

Alepocephalus rostratus, Risso, Mem. Acad. Sci. Torin., xxv., 1820, p. 291, pl. x. fig. 4.
" " Cuv. Val., vol. xix. p. 172, pl. dlxvi.
" " Günth., Fish., vol. vii. p. 477.
" " Gegenbaur, Morphol. Jahrb., iv., Suppl., p. 1, pls. i.–ii. (skull).

B. 6. D. 16–17. A. 18–19. P. 13. V. 8. L. lat. 55. Cœc. pyl. 12.

The height of the body is a little more than one-fifth of the total length (without caudal); the length of the head a little less than one-third. Diameter of the eye contained thrice and one-fourth in the length of the head, and longer than the snout. Scales much longer than wide, with the anterior (radical) margin truncated. Origin of the dorsal fin opposite to the vent. Pectoral fin longer than orbit. Distance of ventral fin from the head three-fifths the length of the latter. Uniform deep black.

Habitat.—Mediterranean.

Alepocephalus agassizii.

Alepocephalus agassizii, Goode and Bean, Bull. Mus. Comp. Zoöl., vol. x., 1883, p. 218.

D. 15. A. 17. P. 11. V. 6 (?). L. lat. 90. L. transv. 10 | 12.

The height of the body is one-fifth of the total length (without caudal); the length of the head one-third. Diameter of the eye two-sevenths of the length of the head, and exceeding that of the snout, which is conically elongate, with the lower jaw slightly produced. Teeth on the intermaxillaries, mandible and palatines. Scales apparently ovate-lanceolate, parchment-like. Origin of the dorsal fin immediately above the vent, that of the anal under the second dorsal ray. Pectoral as long as orbit. Distance of ventral fin from the snout considerably less than twice the length of the head. Colour dark, head and fins nearly black.

Habitat.—A specimen, $10\frac{1}{2}$ inches long, was found by the U.S. steamer "Blake," in 922 fathoms in the Central Atlantic; lat. 38° 19′ N., long. 73° 18′ W.

Alepocephalus productus.

Alepocephalus productus, Gill, Proc. U.S. Nat. Mus., vol. vi., 1884, p. 256.

A specimen of an *Alepocephalus* from 1362 fathoms in the Central Atlantic (lat. 39° 26′ N., long. 70° W.) is characterised thus:—"Agrees closely with *Alepocephalus agassizii*, but the eye is considerably smaller, its diameter equalling less than a quarter of the head's length, while the snout is half as long again as in *Alepocephalus agassizii*, and forms little less than a third of the length of the head." The size is not stated.

Alepocephalus bairdii.

Alepocephalus bairdi, Goode and Bean, Proc. U.S. Nat. Mus., vol. ii., 1880, p. 55.

B. 6. D. 22. A. 25. P. 12. V. 10. L. lat. 65. L. transv. 7 | 12. Cœc. pyl. 15.

The height of the body is contained five and one-third times in the total length (without caudal); the length of the head four times and one-third. Snout equal to the width of the orbit, which is one-fourth of the length of the head. Snout sub-conical, with the lower jaw included within the upper. Scales large, thin, oblong, triangular at the free end. Teeth on the intermaxillaries, mandible and palatines. Uniform indigo-blue.

Habitat.—One specimen, 23 inches long, was obtained on the Grand Banks, Newfoundland, in 200 fathoms.

Alepocephalus niger (Pl. LVI. fig. B).

Alepocephalus niger, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 248.

B. 6. D. 21. A. 27. P. 10. V. 6. L. lat. 140.

Scales small. The length of the head is rather less than one-third of the total (without caudal); snout projecting beyond the mouth. Black.

Habitat.—North of Australia, 75 miles east-south-east of Raine Island, Station 184; depth, 1400 fathoms. One specimen, 13 inches long.

The depth of the body is one-sixth of the total length without caudal; the length of the head rather less than one-third. Head scaleless, flat above, the least width of the interorbital space being two-ninths of the length of the head. Eye of moderate size, one-sixth of the length of the head, and rather more than one-half of that of the snout. The snout is depressed, broad, the intermaxillary occupying a transverse position with a sharp upper edge which penetrates through the skin. The side of the mouth is formed by the maxillary, which extends backwards a little beyond the front margin of the eye.[1]

Intermaxillary and mandible armed with a single series of small acute teeth; a transverse series of similar but smaller teeth stretches across the fore-part of the palate; it is interrupted in the middle, opposite to the head of the vomer, which is toothless.

As in *Alepocephalus rostratus* the bones of the head are very thin and fragile, the gill-cavity being covered by a membrane, which is supported by radiating bony ridges of the operculum and suboperculum, not unlike the branchiostegals which are included in the same membrane.

Gills four, the laminæ being short in the upper part of each branchial arch and thicker isolated and vermiform in the lower part. Gill-rakers stout, pointed, rather widely set; fourteen on the outer branchial arch.

[1] The nasal region is so much injured, that the form of the nostrils cannot be ascertained.

Vent nearly midway between the upper end of the gill-opening and the root of the caudal fin. The anal fin commences almost immediately behind it in front of the vertical from the origin of the dorsal. The caudal fin is still more injured than the two other vertical fins, and therefore nothing can be said about its form, but it is continued along the upper and lower edges of the caudal peduncle as a broad fold, which extends almost to the dorsal and anal and contains well-developed rays, the posterior of which are articulated and branched. Pectoral fin lateral, inserted opposite to the lower half of the gill-opening. Root of the ventral midway between that of the pectoral and the origin of the anal.

Scales simple, cycloid, considerably longer than deep, deeply implanted in the skin. The lateral line is straight, running above the middle of the depth of the body, and is composed of tubiform scales with rather wide mucous openings.

Colour now uniform deep black, but Mr. Murray [1] informs us that "the whole animal was of a light blue colour, of a deeper tint about the fins and gill-covers."

Form of the stomach siphonal; pyloric appendages short, wide, four in number.

Bathytroctes.

Bathytroctes, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 249.

Body rather elongate, compressed, covered with scales of moderate size. Cleft of the mouth rather wide; the maxillary extending to below the middle of the large eye. Both intermaxillary and maxillary armed with a series of minute teeth, as is also the mandible. Vomer and palatine bones with similar teeth. No teeth on the tongue. Eye very large. Dorsal and anal fins moderately long, the former behind the ventrals; adipose fin absent; caudal forked. Gills very narrow; pseudobranchiæ present. Gill-rakers long, lanceolate. Pyloric appendages in moderate number. Ova rather small.

Bathytroctes macrolepis, n. sp. (Pl. LVII. fig. B).

B. 7. D. 15. A. 11. V. 8. L. lat. 42.

The maxillary extends to below the posterior third of the orbit.

Habitat.—North of Celebes, Station 198; depth, 2150 fathoms. One specimen, 9 inches long (without caudal).

The height of the body is two-elevenths of the total length (without caudal), the length of the head a little more than one-third. Bones of the head extremely thin; membranous, especially the opercular bones which, as in *Alepocephalus*, are enclosed in the same membrane with the branchiostegals, forming a large flap extending from the

[1] Narr. Chall. Exp., vol. i. p. 521.

scapulary to the hyoid region. Head low and elongate, scaleless, broad across the occipital region, but tapering towards the front. Its upper surface is deeply concave longitudinally, the least width of the interorbital space being about one-half of the longitudinal diameter of the eye. The eye is very large, longer than deep, rather longer than the snout, and contained thrice and a quarter in the length of the head. Snout rather pointed, with the jaws equal in front and with the cleft of the mouth rather wide, the maxillary extending beyond the centre of the eye. The dentition is feeble; teeth small, pointed, of equal size, uniserial. The intermaxillary and the foremost part of the maxillary are toothless; vomerine series divided into two groups, each with three teeth. Palatine series short, consisting of about nine teeth.

Branchiostegals very slender, rod-shaped. The infraorbital ring consists of very narrow bones hollowed out for the muciferous channel.

Gills four, with very short gill-laminæ. Gill-rakers long, lanceolate, rather widely set, twenty-two on the outer branchial arch.

Vent nearly midway between the gill-opening and the root of the caudal fin. Origin of the dorsal somewhat in advance of the vent, its last ray being opposite to the fourth of the anal fin. Both dorsal and anal rather high in front, their longest rays being equal in length to the depth of this portion of the body. (The caudal fin is nearly entirely destroyed.) Pectoral fin lateral, inserted opposite to the lower half of the gill-opening; ventrals with broad base, covering the vent, but not extending to the anal; their base is midway between the root of the pectoral and the end of the anal, immediately in advance of the dorsal.

Only a few of the scales have been preserved; they are simple, cycloid. The lateral line is straight, running along the middle of the tail, with wide mucous apertures.

Colour, uniform black.

The specimen is not in a sufficiently good state to be figured entire.

Bathytroctes microlepis (Pl. LVII. fig. A).

Bathytroctes microlepis, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 249.

B. 7. D. 16. A. 17. V. 8. L. lat. ca. 70.

The maxillary extends to below the posterior third of the orbit.

Habitat.—Atlantic, south-east of Cape St Vincent, Station V.; depth, 1090 fathoms. One specimen, 10 inches long.

The height of the body is contained five times and one-fourth in the total length (without caudal), the length of the head thrice and three-fifths. Bones of the head thin as in *Bathytroctes macrolepis*. Head rather compressed, moderately deep, its depth at the occiput being two-thirds of its length; its upper surface is concave, the width of the interorbital space being one-half of the longitudinal diameter of the eye. Eye very large, rather longer than deep, one-third of the length of the head and considerably longer than the snout. Infraorbital ring very narrow, the broad maxillary being separated from the orbit by a very narrow strip of bone. Snout somewhat wedge-shaped, with the upper profile declivous, with the jaws equal in front and with the maxillary extending to the posterior third of the orbit. Dentition feeble; all the teeth being equally minute and uniserial; the intermaxillary and maxillary are toothed throughout their whole extent; vomerine series transverse and straight, slightly interrupted in the middle; palatine series nearly as long as vomerine series.

Branchiostegals slender, rod-shaped. Gills four; that of the fourth arch being short and reduced to a horizontal series of laminæ, which is only one-third of the horizontal series of the outer branchial arch. Gill-laminæ very short, especially on the convex portion of the arches; gill-rakers long, lanceolate, closely set, 24 + 11 on the outer branchial arch.

Vent considerably nearer to the root of the caudal fin than to the gill-opening, whilst the origin of the dorsal fin is somewhat nearer to the latter point. Dorsal fin longer than high, its anterior rays increasing in length to the fifth or sixth ray. Origin of the anal behind the vertical from the middle of the dorsal fin, which this fin resembles in shape. Caudal fin deeply emarginate. Pectoral inserted a short way above the lower profile; it has a moderately broad base, is three-fifths of the length of the head, and does not extend to the ventral. Ventrals close together, scarcely extending to the vent, their root being midway between the root of the caudal and the anterior margin of the orbit.

Scales deciduous, cycloid, with numerous fine concentric and radiating striæ; there were probably nine scales in a transverse series between the lateral line and the origin of the dorsal fin, and twelve between the lateral line and ventral fin. Lateral line straight, running from the upper end of the gill-opening along the middle of the tail, with rather narrow mucous apertures.

Colour, uniform black.

Stomach with a short cœcal sac. Thirteen short pyloric appendages fringe the intestine behind the pylorus. Intestine short, scarcely convoluted. The ovaries, which are laminated and open on their costal surface, contain an immense number of minute immature eggs, between which a few larger ones of the size of millet seed are embedded.

Bathytroctes rostratus (Pl. LVIII. fig. B).

Bathytroctes rostratus, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 250.

D. 20. A. 17. V. 9. P. 16. L. lat. ca. 100.

The maxillary reaches to below the hind margin of the orbit; intermaxillary terminating in front in a short projection.

Habitat.—Off Pernambuco, Station 120; depth, 675 fathoms. One specimen, $6\frac{1}{2}$ inches long.

The height of the body is nearly one-fifth of the total length (without caudal); the length of the head one-third. Bones of the head very thin and very easily ruptured, like all the other parts of the body. Head compressed, moderately deep, its depth at the occiput being three-fifths of its length; its upper surface longitudinally concave, the width of the interorbital space being more than one-half of the longitudinal diameter of the eye. Eye large, a little longer than deep, contained thrice and two-thirds in the length of the head and equal to that of the snout. Infraorbital ring narrow, the broad and large maxillary being separated from the orbit by a narrow strip of bone. Snout wedge-shaped, with a pair of short and flat projections in front, each being formed by the intermaxillary and toothed at its extremity. The cleft of the mouth is wide, the maxillary extending to below the hind margin of the orbit. Dentition very feeble, all the teeth being minute and uniserial. The intermaxillary and maxillary are toothed throughout their whole extent; the teeth of the mandible are particularly minute, and the series is interrupted close to the symphysis, the symphysial portion being external to the lateral portion, which is implanted on the upper edge of the bone. The vomerine teeth are reduced to a pair of very small teeth in the middle of the bone. Palatine teeth none, or reduced to a single tooth-like projection.

Branchiostegals long, narrow, slender. Gills as in *Bathytroctes macrolepis.* Gill-rakers long, lanceolate, closely set, 20 + 7 on the outer branchial arch.

Vent nearer to the gill-opening than to the root of the caudal. Origin of the dorsal fin somewhat in advance of the vent; it is much longer than high, the length of the anterior rays increasing to the sixth or seventh ray. Origin of the anal fin below the anterior half of the dorsal, which it resembles in shape. Caudal fin deeply emarginate. Pectoral inserted a short way above the lower profile, rather short and broad, about as long as the eye. Ventrals broad, extending to the vent, their root being rather nearer to the base of the caudal than to the extremity of the snout.

Scales simple, cycloid, in about twelve longitudinal series above and below the lateral line, between the dorsal and the ventral fins. Lateral line straight, running from the upper end of the gill-opening along the middle of the tail, with rather small mucous apertures.

Colour, uniform black.

A very small pointed osseous projection in front of the clavicular symphysis reminds us of a similar peculiarity in the following genus, *Platytroctes.*

Platytroctes.

Platytroctes, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 249.

Body rather abbreviated, much compressed, and covered with small keeled scales. Mouth of moderate width; the maxillary, intermaxillary, and mandible armed with a single series of small teeth. Palate nearly smooth. Eye rather large. The dorsal and anal fins opposite to each other, on the tail, moderately long. Adipose fin absent. Caudal forked. Pectoral small. Ventrals none. Each clavicle terminates below in a long, projecting, acute spine, the two spines coalescent. Gill-opening wide; six branchiostegals. Gills very narrow, pseudobranchiæ present; gill-rakers long, lanceolate. Pyloric appendages rudimentary.

Platytroctes apus (Pl. LVIII. fig. A).

Platytroctes apus, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 249.

D. 18. A. 17. P. 20. L. lat. ca. 100.

The height of the body is more than one-third of the total length (without caudal); the diameter of the eye one-third of the length of the head. The maxillary does not extend to below the middle of the eye.

Habitat.—Mid-Atlantic, Station 107; depth, 1500 fathoms. One specimen, $5\frac{1}{2}$ inches long.

The body of this fish is much compressed and deep, but, singularly, the convex portions on the dorsal and ventral halves are merely a fold of the skin, into which neither the muscles nor the abdominal organs enter. The greatest depth of the body is at about the middle of its length, and contained in it twice and three-fourths, not including the caudal. The head is likewise compressed, of moderate dimensions, two-sevenths of the length of the body. Head longitudinally concave above, the concavity being bordered on each side by a perforated muciferous canal, and broadest behind, but tapering to a point between the nostrils. The bones of the head are rather thin, but less so than in *Bathytroctes*. Eye large, one-third of the length of the head, as long as the snout, and situated immediately below the upper profile. Infraorbital ring incomplete, the muciferous canal not being prolonged beyond the præorbital. Mouth rather small, with the lower jaw projecting when the mouth is open. Maxillary broad, short, extending to the front margin of the eye. Dentition very feeble; teeth uniserial, uniformly minute, occupying the whole extent of the intermaxillary and maxillary, but confined to the front part of the mandible; only a few rudimentary teeth are visible on the side of the mandible. Vomer with a minute tooth on each side; palatines toothless.

Branchiostegals extremely slender, curved. Gills four, the inner one very short;

gill laminæ short, especially on the convex portion of the arches; gill-rakers long, lanceolate, closely set, 20 + 10 on the outer branchial arch.

The bones of the shoulder-girdle project at the symphysis as two rather long pointed spikes.

The vent is much nearer to the root of the caudal than to the gill-opening. The dorsal fin commences immediately above it, the anal behind; both fins are very similar in shape and of moderate height. Caudal peduncle more than half as deep as long, its depth being increased by a fold of the integument between the vertical fins. Caudal fin rather short and forked. Pectoral fin very short, only half as long as the eye and directed towards the back.

Scales small, cycloid, each with a longitudinal keel which is not composed of spines as in *Macrurus*, but simple as in the keeled scales of a snake; the striations, instead of continuously crossing the scale, are interrupted by the raised median line. Head entirely scaleless. Lateral line straight, running along the middle of the body and tail, and composed of very small pores.

Brown; head, pectoral region, the vent and fringes of the caudal peduncle black.

Xenodermichthys.

Xenodermichthys, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 250.

Body rather elongate, compressed, without true scales. The skin is rather tough, finely wrinkled longitudinally, with numerous small nodules, regularly arranged, which possess the structure and probably the function of luminous organs. Minute, rudimentary, scale-like productions are embedded in the skin, especially on the trunk. Mouth very small, with feeble jaws and rudimentary teeth in the intermaxillary and mandible, and a few in the maxillary. Palate toothless. Dorsal and anal fins equal in length. Caudal forked. Gill-opening wide, but not extending much above the level of the pectoral fins. Gills well-developed; pseudobranchiæ. Gill-rakers long.

Xenodermichthys nodulosus (Pl. LVIII. fig. C).

Xenodermichthys nodulosus, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 250.

D. 33. A. 33. P. 6. V. 5.

The height of the body is nearly one-seventh of the total length, without caudal; the length of the head two-elevenths. Eye of moderate size, its diameter being more than the width of the interorbital space. Uniform black.

Habitat.—South of Yedo, Station 232; depth, 345 fathoms. One specimen, 8 inches long.

The form of the body of this extremely interesting type is compressed and elongate, in fact it simulates in some respects the Stomiatid type. The depth of its body is nearly uniform between the head and vent, and contained six and a half times in the total length (without caudal); the length of the head, which is compressed and much longer than deep, five times and one-third. The length of the upper surface of the head only half the length of its side; snout extremely short and obtuse, with its anterior profile parabolic. Mouth small, provided with extremely small teeth on the intermaxillary and on the anterior portion of the mandible. The maxillary is short, broad, very thin, extending somewhat beyond the anterior margin of the eye. Eye well developed, immediately below the upper profile, wider than the interorbital space, and two-ninths of the length of the head; it is much longer than the snout.

The gill-opening is closed above, and begins from opposite the root of the pectoral fin. Branchiostegals slender, six in number. Four gills, with well-developed laminæ; gill-rakers rather long, stout, lanceolate, twenty-five on the outer branchial arch. The opercles and branchiostegals are enveloped in a common thick skin, so as to be indistinguishable without dissection.

Vent midway between the roots of the caudal and pectoral. The dorsal fin commences immediately above, and the anal behind the vent; both fins low, coterminal; peduncle of the tail not quite twice as long as deep. The caudal fin is deeply forked, each lobe produced into a short filament; the upper and lower rudimentary rays are numerous and extend forwards for more than one-half of the length of the peduncle. Pectoral fin inserted low down the sides, with a very narrow base, rather pointed behind, and three-fifths of the length of the head. The ventral fins are likewise narrow, half as long as the head and extending to the vent.

The skin is tough and leathery, finely wrinkled longitudinally, with minute scale-like productions irregularly scattered over the body. The lateral line is a broad continuous straight canal, which arises close behind the eye and runs along the middle of the body and tail. Very small raised nodules [1] with whitish centre are distributed over the body. They are arranged in subquincuncial order, and even extend on to the rays of all the fins except the caudal. On the head they form series, one series following the infraorbital ring, two others the lower limb of the præoperculum, and the fourth the margin of the gill-opening. I consider these organs to possess luminous properties.

Fig. *c* on Pl. LVIII. represents a piece of skin slightly magnified, with four luminous nodules and a number of minute scattered scales.

[1] Their histological structure will be described in Appendix B.

Family HALOSAURIDÆ.

Halosaurus, Johns.

Body elongate, compressed, terminating in an exceedingly long tapering tail; abdomen rounded. Snout much projecting beyond the mouth, which is inferior, of moderate width. Facial bones with large muciferous cavities; a series of luminous organs is generally developed in the course of the mucous canal system. Suboperculum large; præoperculum rudimentary; interoperculum membranous. Eye large. Teeth in villiform bands in the jaws, on the rudimentary palatines, and pterygoids; none on the vomer. A band of hyoid teeth. Dorsal fin short, opposite to the space between ventrals and vent. Anal fin exceedingly long, occupying the entire length of the tail; no caudal fin. Lateral line running near to the lower profile, and composed of larger scales which bear the luminous organs. Gill-membranes entirely separate, with numerous branchiostegals.

Of this family which hitherto was known from a single example only, four species were discovered by the Challenger, showing that it is widely and abundantly represented in the deep sea.

The following observations have been made on a specimen of *Halosaurus macrochir*.

The œsophagus, the inside of which is longitudinally folded, passes into the short pear-shaped stomach, which is cæcal, rather thin walled, and beset with short villi in its interior. The pyloric portion of the intestine is provided with a series of ten appendages which are not longer than the stomach. The intestine is nearly straight but wide, its mucous membrane being raised in numerous low annular folds which become distinct at a short distance behind the last pyloric appendage.

The liver embraces the lower part of the œsophagus; it possesses only one lobe, that on the left side, which does not extend so far backwards as the stomach.

The air-bladder is nearly destroyed. It is simple, occupying the posterior half of the abdominal cavity. A thick nacreous stratum intervenes between the thin inner and outer membranes. At its anterior extremity it is suddenly contracted into a narrow tapering tube, which ends in a thread-like ligament attached to the dorsal side of the lower part of the œsophagus. An open communication between the œsophagus and the air-bladder does not seem to exist. The tube is surrounded by a muscular ring at the place where it enters the air-bladder, and a thick muscular fascicle starts from this ring to each side of the body of the bladder, gradually losing itself on its surface.

The ovaries are two bands extending forwards beyond the stomach. They are transversely laminated on their costal surface, the ova falling into the abdominal cavity.[1] Singularly the right ovary is interrupted in the middle, thus consisting of an anterior and posterior portion which are separated by a space equal in length to one of the portions. Peritoneum deep black in the anterior part of the abdominal cavity, but gradually losing the pigmentation behind.

The kidneys are confluent, and occupy the hindmost part of the abdominal cavity; their secretion is collected in a wide tube which lies between them and the intestine; it contained three large specimens of a *Distoma*.[2]

The stomach contained shrimp-like Crustaceans.

After removal of the dermal ossifications and the visceral portions of the skull, the cranium (Pl. LX. figs. 3, 5, 7) proper appears as the much depressed brain-capsule with the anterior facial part greatly elongate and narrowed. The whole of the upper surface is flat, horizontal, the sides of the brain-capsule sloping inwards towards the basal median line. The occipital region is vertical with scarcely any protuberances, but with a low exoccipital crest. Also the sloping sides are remarkably smooth. The facial portion terminates in front in a broad, diamond-shaped *rostrale* (*r*), composed of a bilamellate very thin bone which is the main support of the rostral prolongation of the snout.

The primordial cartilage persists as a thin layer in the otic and occipital regions, but has entirely disappeared in the roof of the brain-capsule and in the sphenotic region; it reappears as a thin thread along the front part of the interorbital septum, expands in front of the orbit in a lateral præorbital process (fig. 5, *cp*), is thickest along the narrow snout, and terminates in a long tapering point which is wedged in between the two halves of the rostrale (fig. 4, *ec*).

The bones which cover the primordial cartilage are of extreme thinness, yet firmer and more elastic than in many other deep-sea fishes. Only the basi-occipital and basal bones are somewhat thicker than the rest. In the occipital region the basi-occipital (fig. 8, *bo*) occupies the greater part of the area, covering also the infero-posterior portion of the side of the brain-capsule; its conical excavation for the articulation with the vertebral column is large and deep. A subquadrangular supraoccipital (*spo*) is wedged in between the pair of well-formed paroccipitals (*paro*).

The side of the brain-capsule gives the appearance of continuous cartilage owing to the thinness and transparency of the superficial ossifications, the largest of which is the alisphenoid or prootic (figs. 5, 7, *po*), with the large foramen for the fifth nerve in advance of its centre. It is joined to the exoccipital (*exo*) by a faint sutural line; this lamella

[1] In the definition of this family (Fish., vol. vii. p. 482), the ovaries are described as "closed"; and, indeed, the appearance of the ovaries of the only specimen then available, which are so much distended by the mature ova that the lamination has entirely disappeared, seemed to warrant this view, although already Mr. Johnson (*Proc. Zool. Soc. Lond.*, 1863, p. 408), in the original description of *Halosaurus owenii*, states that these organs are "uncovered with a sac."

[2] *Distomum halosauri*, Bell, *Ann. and Mag. Nat. Hist.*, 1887.

extends upwards towards the paroccipital, from which it is separated by a linear strip of cartilage. The articular facet (*a*) for the hyomandibular extends a long way above the alisphenoid and exoccipital immediately below the upper edge of the cranium. Finally a small quadrangular ossification (*pt*) occupies the postero-lateral corner of the brain-capsule; it is so thin that it can be easily pressed into the ear-cavity; perhaps Parker's name *pterotic* may be applied to it.

The base of the skull is occupied, as usual, by the very large basale (*b*).

The membrane bones on the upper surface offer the peculiarity that the *parietals* (fig. 3, *p*) are joined by a long median suture, and not separated by a process of the supra-occipital; they are bordered on each side by a squamosal (*sq*) oblong in form. The frontals (*f*) are large and long, each longitudinally divided by a groove into a median and supraocular portion. The narrow part of the snout is occupied by a long unpaired bone, the *ethmoidale medium* (*em*), which in front is expanded into a short lateral process (fig. 4, *em'*). This process is folded downwards to the lower side of the snout, where it forms on each side a semicylindrical groove (fig. 6, *e*) for the reception of a nerve (olfactory ?) and blood-vessels. The two canals are separated by a narrow bony prominence, on each side of which there is a foramen for the passage of the nerve. There lie on each side of the median ethmoid two dermal bones, connected with it only by the intervening skin; they are two nasalia, of which the posterior (fig. 3, *n*) is oblong in shape, and the anterior (*an*) linear with a very thin lobe in the middle.

The lower side of the snout is covered by the long *vomer* (figs. 5, 6, *v*) longitudinally hollowed out, and bordered in front by a high horse-shoe-shaped ridge which does not bear any teeth. It is suturally connected with the basale, but touches only partly the ethmoidale medium, part of the ethmoidal cartilage being unprotected by bone on the side of the snout.

The terminal *rostrale* (*r*) with the termination of the ethmoid cartilage (*ec*) has been mentioned above.

The palato-quadrate arch (fig. 2) also represents peculiarities in the absence or rudimentary condition of some of its component parts.

The hyomandibulare (*hm*) is a subquadrangular lamella with a deep groove and wide foramen in its anterior half; its greater portion is cartilage, which, however, is entirely covered with an ossified superficial stratum. It is joined to the cranium by the whole length of the upper side of the quadrangle; the angle between the two posterior sides offers the base for the articulation of the operculum; the lower angle is slightly produced downwards, and has the thin styliform cartilaginous symplectic (*sy*) attached to it. Its anterior side is partly free, partly suturally connected with the metapterygoid.

The metapterygoid (*mp*) is a fan-like bone with the angle of the fan directed backwards and overlapping the lower corner of the hyomandibulare; one half of its convexity forms a connection with the quadrate, the other half with the entopterygoid (*ep*).

The quadrate (*q*) is similar in shape to the metapterygoid, the handle of the fan being formed by the condyle for the articulation of the mandible; it is intercalated between and forms broad sutures with the pterygoid bones.

Very remarkable is the præoperculum (*pr*), which is reduced to a short small bone situated at the lower side of the quadrate bone. The ectopterygoid (*ecp*) is a long and slender bone, thin and lamelliform in its posterior half, and subtrihedral anteriorly, the trihedral portion being cartilaginous. Viewed from the inside of the mouth the greater part of its surface is covered with minute toothlets and asperities, but the surface of the trihedral portion is smooth, giving attachment to a small membranous lamella which is covered with teeth and represents a rudimentary palatine bone (*pal*). The ectopterygoid is articulated to a condyle-like process of the ethmoid cartilage (fig. 3, *ecp'*).

The hyoid arch does not show any noteworthy peculiarity.

The intermaxillary (fig. 1, *im*) occupies an obliquely transverse position at the lower side of the rostrum; its lateral terminal third is in juxtaposition with the maxillary, its inner portion is somewhat dilated, and not provided with ascending processes; consequently it is fixed and not capable of any sliding downward or forward motion. The maxillary (*m*) is rather short, sword-shaped, constricted behind its articulatory end, and proximally terminating in a styliform curved process which leans against the ethmoid cartilage behind the ethmoid process (*em'* or *e* of figs. 4 and 6); its dental margin is slightly thickened, and its posterior margin crescent-shaped; it bears a lanceolate single supramaxillary behind.

The mandible (fig. 2) is a very thin bone, rather broad, longitudinally concave below, and slightly convex on the side. No separate angular can be observed, but the articular is curved upwards as a small hook behind the joint. The tooth-bearing portion of the dentary is separated from the upper margin of the articular by a long and wide slit which is closed by a fibrous membrane. Meckel's cartilage is very thin and slender.

The dermal and membrane bones on the side of the head (fig. 1) are semimembranous. The operculum (*o*) is thin, subtriangular, with radiating folds; it is noteworthy that the cartilaginous substance of its articulatory facet extends a little way in the direction of the folds. The suboperculum (*so*) is much dilated, twice the size of the operculum, striated, with a frayed margin. The interoperculum (*io*) is small, and consists of an anterior dilated and posterior styliform portion. The chain of infraorbitals is quite straight, and extends from the tip of the snout to the hind margin of the suboperculum. They are almost membranous, and being reverted along the upper edge, form the framework of a wide muciferous canal. The anterior which surround the rostrale are very irregular in shape, and much reduced in size, whilst the hindmost, which overlies the suboperculum, is merely a skinny lobe lacerated behind.

Externally the segmentation of the vertebral column would appear to be complete;

however, sections made in various parts show that the notochord is continuous and persistent, and that the centra of the vertebræ are only very thin rings of bone. The abdominal vertebræ are short, deeply pitted, sixty in number; they are provided with very short zygapophyses, feeble neural spines, and, below, with rudimentary ribs which can scarcely be distinguished from fibrous ligaments. The caudal vertebræ are very similar to those of the trunk, and provided with very feeble, needle-like neural and hæmal spines. Those constituting the extremity of the tail are very narrow and elongate, and consist of a centrum only. The first interneural is a broad lamella with a pair of diverging ridges, and attached to the neural spines of the thirty-first, thirty-second, and thirty-third vertebræ. Interhæmal spines rather short and feeble.

The scapulary arch (fig. 2) is very simple and weak. The clavicle (*cl*) is a narrow, slightly curved, sword-shaped bone, tapering at the symphysis, and terminating in a short point at its junction with the supraclavicle. It is suspended from the skull by two supraclavicles, of which the upper (*scl*) is the shorter, and slightly dilated at its distal end. The scapula (*sc*) and coracoid (*co*) form an extremely thin lamina, subcircular in shape. The pectoral rays are joined to four minute basalia. A postclavicle is absent.

The pubic bones are also very weak, consisting of a thin semicartilaginous rod, dilated inwards into a very thin and weak, bony lamella; their base is swollen for the insertion of the fin-rays and cartilaginous.

Halosaurus owenii.

Halosaurus owenii, Johns., Proc. Zool. Soc. Lond., 1863, p. 406, pl. xxxvi. fig. 2.
„ „ Günth., Fish., vol. vii. p. 482.

B. 14. D. 11. P. 11. V. 10. L. transv. 14 | 6.

Snout produced; its præoral portion being nearly one half of its length. Eye rather large, the length of its diameter being two-fifths of the postocular portion of the head, and much more than the width of the interorbital space. The maxillary reaches the vertical from the front margin of the eye. The length of the head is more than its distance from the ventral fin, the base of which is entirely in front of, and somewhat remote from the base of the dorsal. Pectoral fin with narrow base, very long, extending nearly to the root of the ventral. Scales of the lateral line scarcely larger than the others, without phosphorescent organs being visible in the only specimen known. Anterior portion of the dorsal fin covered with small scales; anal fin scaleless. Brownish, silvery on the abdomen; gill-cover blackish.

The typical specimen from Madeira, 17½ inches long, is still the only individual known of this species.

Halosaurus macrochir (Pl. LIX. fig. A).

Halosaurus macrochir, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 251.
„ „ Goode and Bean, Bull. Mus. Comp. Zoöl., vol. x., 1883, p. 219.
Halosaurus goodei, Gill, Proc. U.S. Nat. Mus., vol. vi., 1881, p. 257.

B. 12. D. 13. V. 10. P. 11–13. L. transv. 14 | 5.

Snout moderately produced, the præoral portion forming only one-third of its length. Eye rather small, one-fourth of the postocular portion of the head and one-half of the width of the interorbital space. Maxillary reaching to the front margin of the eye. The length of the head is more than its distance from the root of the ventral, the origin of which is immediately in front of that of the dorsal. Pectoral fin with narrow base, very long, extending nearly to the root of the ventral. Scales of the lateral line larger than the others, more or less hidden in a pouch of black skin, with a phosphorescent organ at the base of the free portion. These large scales are continued for some length on the tail and cover the base of the anal fin, which, like the dorsal, is covered in its basal half with small scales. Uniform black.

Distance of the snout from the mouth, . .	...	5 lines
Distance of the snout from the eye, . .	1 inch	4 „
Distance of the snout from the root of the pectoral fin,	3 „	1 „
Distance of the snout from the root of the ventral, .	5 „	6 „
Distance of the snout from the origin of the dorsal, .	5 „	9 „
Distance of the snout from the vent, . .	7 „	11 „
Total length, ...	21 „	6 „

Habitat.—Midway between the Cape of Good Hope and Kerguelen Island. Common in the central parts of the Atlantic, where it was first discovered by the Challenger, and more recently by the U.S. survey ships, in from 647 to 1730 fathoms.

Off the Strait of Gibraltar, Station V.; depth, 1090 fathoms. One specimen, 21½ inches long.

Near Marion Island, Station 146; depth, 1375 fathoms. Four specimens, 18 to 20 inches long.

The entire head is naked, only the upper portions of the gill-cover and of the cheek are covered with scales similar to those of the body.

The band of intermaxillary teeth is broader than the maxillary band. Palatine teeth in two separate patches, each being of an oval shape, with the pointed end directed forwards; pterygoid teeth in a very narrow band which extends far backwards in the cavity of the mouth; basibranchials with a long and broad band.

Four well-developed gills. Outer branchial arch with fourteen widely set gill-rakers, of which the middle ones are slender and as long as the eye, the others becoming shorter towards the ends of the series.

In this species luminous organs are more developed than in the other species known, and the evidence that these organs are developed from the muciferous system, at least in the present genus, seems to me undeniable; in fact, the principal series of luminous organs is borne by the scales of the lateral line. It runs along the lower part of the side, from the gill-opening along a great portion of the base of the anal fin, and is separated from the ventral fin by a single series of scales only. The scales of this series are much larger than the others, carrying at the base of their exposed portion a vertical narrow subovate patch of glandular matter, which is covered by but visible through the cuticular pouches which entirely envelop the scales. When divested of the soft surroundings, these scales show a subvertical raised ridge, which divides them into an anterior and a smaller posterior portion, the gland-like substance being deposited on the latter.

The arrangement of the cuticular coverings of the lateral line is not easy to understand, chiefly owing to the lacerated state of the outer covering, the lacerations being most irregular and partly caused after the capture of the specimens, partly, however, an evidently normal condition of the living fish. The artist who drew the figure on Pl. LIX. found it quite impossible to reproduce this covering so as to give a correct idea of its appearance.

The series of large scales of the lateral line is covered in its entire length by a broad membrane of deep black colour, which is thicker at certain intervals, and thinner and more readily torn in the intermediate portions, the thin portions corresponding in position to the luminous organs. This membrane is fixed along its upper margin to the nearest longitudinal series of scales, and has numerous but irregular attachments along its lower margin to the integument protruding between the neighbouring ventral series of scales. Normally a pair of slits, an upper and a lower one, in the membrane corresponds to each of the larger scales. Thus, if we imagine the membrane to be quite intact, a wide canal would exist along the whole series of enlarged scales, the inner wall of which would be formed by the scales (with their investing thin membrane), the outer by the membrane; and the canal would possess two longitudinal series of apertures and slits, an upper and a lower, through which water would be admitted into its interior or through which the mucus secreted would be discharged. The function of the luminous organs would not be impaired by the covering, as it is thin and transparent at regular intervals.

This normal state of things is preserved in various short portions of the lateral line, but at intervals the membrane is ruptured or torn across, generally in its thin parts, between the slits or at some distance from them, leaving a greater or lesser extent of the interior of the canal, and frequently the luminous organ itself uncovered. The lacerated floating margins of the membrane are most irregular in shape and direction.

The accompanying woodcut may assist in rendering this structure intelligible; it represents diagrammatically a longitudinal section made along the median line of four scales; *sc* are the scales, which overlap each other only to a slight extent, the overlapping ends being closely adpressed (not apart as shown in the diagram for the sake of clearness). Each scale possesses a transverse ridge (*r*), behind which the gland-like white substance of the luminous organ (*l*) is lodged. A membrane (*i*) investing the greater part of the transverse ridge (*r*), and extends forwards covering the preceding scale until it

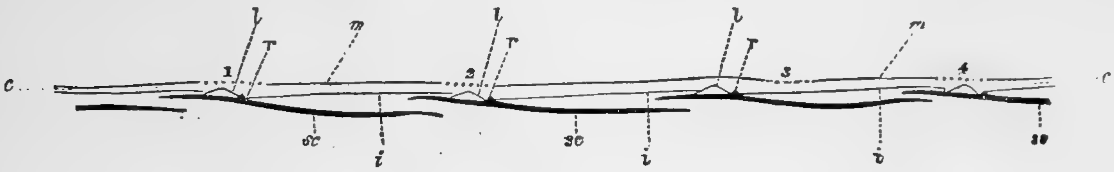


Fig. 7.

arrives at the luminous organ, where it terminates in a free margin closely surrounding the luminous organ. All these structures form the inner side of the canal (*c*), its outer wall being formed by the outer membrane (*m*), which is irregularly interrupted at the places marked 1, 2, 3, and 4.

There are twenty-six luminous spots between the gill-opening and the vent, and about as many behind the vent along the base of the anal fin. In order to show the arrangement of the luminous organs on the head, it is necessary to remove the integument which covers the muciferous bones. They then represent the disposition shown in figs. a' and a''. The organs are of the same shape and structure as on the lateral line, about nine in number in the infraorbital canal. In the continuation of this canal on the rostral process of the snout, three other pairs of luminous organs are developed, and visible on the lower side of the rostrum after removal of the skin.

The mandibulary canal contains five luminous organs, and is continued along the lower portion of the much enlarged suboperculum. A large patch of a white substance, which does not differ from that of the luminous organs described, is deposited in this as well as the other species (with the exception of *Halosaurus owenii*) in the upper part of the gill-cavity, between the gills and the upper part of the supraclavicle. When this substance is detached from the skin, the surface of the latter is seen to be covered with a great number of minute papillæ.[1]

Halosaurus mediorostris, n. sp. (Pl. LIX. fig. C).

B. 11. D. 11. V. 8. P. 8. L. transv. 11 | ?.

Allied to *Halosaurus macrochir* and with the same comparatively short snout, but with a shorter pectoral fin. The length of the præoral portion is not quite one-third

[1] An account of the histology of these luminous organs will be found in Appendix B.

of that of the snout. Eye rather small, one-fourth of the postocular portion of the head, and two-thirds of the width of the interorbital space. Maxillary reaching to the front margin of the eye. The length of the head is nearly twice its distance from the root of the ventral, which is situated almost entirely in advance of the dorsal. Pectoral fin with very narrow base, extending nearly to the root of the ventral. Nearly all the scales are lost, but those of and below the lateral line are much larger than the others, each bearing a luminous organ.

Distance of the snout from the mouth, . .	...	4 lines.
Distance of the snout from the eye, . .	1 inch.	...
Distance of the snout from the root of the pectoral fin,	2 „	8 „
Distance of the snout from the root of the ventral,	4 „	2 „
Distance of the snout from the origin of the dorsal fin,	4 „	11 „
Distance of the snout from the vent, . .	6 „	9 „
Total length, ...	17 „	6 „

Habitat.—West of the Philippine Islands, Station 207; depth, 700 fathoms. One specimen, 17½ inches long.

The entire head is naked, only the uppermost portion of the gill-cover and the upper half of the cheek are covered with scales similar to those of the body; the bones of the head are very thin, especially the gill-covers, which are nearly membranaceous, the operculum folded and the other parts striated. The lower half of the side of the head from the snout to the gill-opening is occupied by two exceedingly wide muciferous channels, of which one takes its origin on the præorbital, the other on the mandible. The nostrils are small openings, close together in front of the eye.

The dentition is very much like that of *Halosaurus macrochir*, but the pterygoid band is rather broader. Also the branchial apparatus does not differ from that in the species named.

The luminous organs are constructed and arranged as in *Halosaurus macrochir;* the glandular patch being narrower and much deeper, occupying the whole width of the scales, and being pointed above and below. These scales are very large, twice the size of the others and somewhat distantly placed. There are probably no more than eighteen between the gill-opening and the vent. This species is rather light coloured, but the deep black of the buccal and branchial cavities shines through the thin integuments; also the posterior part of the anal fin is black.

Halosaurus rostratus (Pl. LIX. fig. D).

Halosaurus rostratus, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 252.

B. 9. D. 10. V. 9, 10. L. transv. 13 | 6.

The length of the head much exceeds the height of the body. The snout very much produced, spatulate, its præoral portion being more than one-half of its length. Eye of moderate size, its length being one-third of the postocular portion of the head, and considerably less than the width of the interorbital space. Maxillary scarcely reaching the front margin of the eye. The length of the head is a little more than its distance from the root of the ventral, which is nearly entirely situated before the dorsal. Nearly all the scales are lost, but some of the lateral line remain; they are much larger than the other scales; and on the tail, where the lateral line approaches the lower profile, these larger scales fill up all the space between the lateral line and the anal fin.

Distance of the snout from the mouth, . .	...	$8\frac{1}{2}$ lines.
Distance of the snout from the eye, ...	1 inch.	3 „
Distance of the snout from the root of the pectoral,	2 „	7 „
Distance of the snout from the root of the ventral,	4 „	10 „
Distance of the snout from the origin of the dorsal,	5 „	8 „
Distance of the snout from the vent, . .	6 „	11 „
Total length, ...	20 „	...

Habitat.—Mid-Atlantic, Station 63; depth, 2750 fathoms. One specimen, 20 inches long.

Bones of the head very thin; operculum smooth, covered with a very fine membrane. The lower part of the side of the head is occupied from the snout to the gill-opening by two exceedingly wide muciferous channels, of which one takes its origin on the præorbital, the other on the mandible, and which open behind at the gill-opening by a common and very wide aperture. Branchial apparatus as in the other species.

The dentition is very similar to that of *Halosaurus macrochir*, but the palatine patches are crescent-shaped and rather widely separated from the pterygoid band.

The scales of the lateral line are about three times the size of the others, and about twenty-four in number between the gill-opening and the vent. Each bears a luminous organ, vertically elongated and rhombic, but not extending to the upper or lower margins of the scale. Light coloured, the lower part of the head and the gill-cover black; abdominal region blackish.

Halosaurus affinis (Pl. LIX. fig. B).

Halosaurus affinis, Günth., Ann. and Mag. Nat. Hist., 1877, vol. xx. p. 444.

Snout much produced, but less so than in *Halosaurus rostratus*; its præoral portion being scarcely one-half of its length. Eye of moderate size, one-third of the postocular portion of the head and equal to the width of the interorbital space. Maxillary not reaching to the front margin of the eye. The length of the head equals its distance from the root of the ventral, the origin of which is but slightly in advance of that of the dorsal. Nearly all the scales are lost, only some of the lateral line remain. They are much larger than the other scales; and on the tail, where the lateral line approaches the lower profile, these larger scales are separated from the anal fin by one series of small scales only. Otherwise, there is the greatest similarity between this species and *Halosaurus rostratus*.

Distance of the snout from the mouth,	...	$5\frac{1}{2}$ lines.
Distance of the snout from the eye,	1 inch.	...
Distance of the snout from the root of the pectoral fin,	2 ,,	4 ,,
Distance of the snout from the root of the ventral,	4 ,,	6 ,,
Distance of the snout from the origin of the dorsal,	4 ,,	9 ,,
Distance of the snout from the vent,	6 ,,	10 ,,
Total length,	16 ,,	6 ,,

Habitat.—South of Japan, Station 235; depth, 565 fathoms. Two specimens, $16\frac{1}{2}$ inches long.

This species is so closely allied to the preceding that it would appear to be sufficient to refer to the following points only: the band of palatine teeth is not broader than that of the intermaxillary, only slightly separated from that of the other side, and somewhat distant from the pterygoid teeth. The scales of the lateral line are about three times the size of the others, and twenty-nine in number between the gill-opening and the vent. They seem to have been provided with a luminous organ, but it must have been very thin and much less developed than in the other species, as only traces of it remain on the few scales which have been preserved.

The body of the fish is light-coloured; the head, vent, and hind part of the tail black.

Family NOTACANTHI.

In placing the Notacanths in the present work between the Halosauridæ and Murænidæ I do not intend to convey the impression that I consider them to be specially allied to either of these Physostomous families. There is no other type of Acanthopterygians by which they would be connected with that order, whilst the truly abdominal position of their many-rayed ventral fins offers sufficient grounds for removing them to the Physostomi. On the other hand, there does not seem to be an open communication between the air-bladder and the œsophagus, at least in *Notacanthus sexspinis*. As I already stated in 1861,[1] these fishes will, no doubt, have to be placed in a distinct order; but it would be premature to establish this order before its characters can be defined from a detailed examination of several of the species.

Notacanthus, Bloch.

Body elongate, terminating in a band-like, tapering tail. A dorsal fin is represented by a series of short spines, entirely, or very nearly replacing the soft rays. The whole of the tail is fringed by an anal fin, the anterior elements of which are transformed into spines. Ventrals abdominal, with more than five soft rays. Snout protruding beyond the mouth, which is inferior, shark-like. Palatine bones movable; armed with a series of closely-set teeth like the jaws. Shoulder-girdle loosely suspended from the skull by ligaments. Air-bladder present, without open pneumatic duct. Gills four; pseudobranchiæ absent. Ovaries without oviducts.

This genus may be divided thus:—

a. Dorsal spines in small number (six to eleven); teeth in the upper jaw compressed, obliquely triangular:—*Notacanthus.*

β. Dorsal spines more than thirty; teeth in the upper jaw but little compressed, and erect:—*Polyacanthonotus.*[2]

a. Notacanthus.

Notacanthus sexspinis ((Pl. LX. figs. 9–15; Pl. LXI. fig. A).

Notacanthus sexspinis, Richards, Voy. Ereb. and Ter., Fish., p. 54, pl. xxxii. figs. 4–11.

B. 9. D. 6–8 | 1. A. 13–15 | 160. P. 12. V. 7–8. Cæc. pyl. 5.

Gill-membranes united across the isthmus, emarginate in the middle. Teeth in single series, twenty-eight on each intermaxillary. Ventral fins completely united.

The body is compressed, terminating in a band-shaped tapering tail, the length of which is a little variable. The vent is placed at a distance from the head, equal to one and two-thirds or twice the length of the latter. Head rather narrow and compressed, its depth being one-half or less than one-half of its length; it is produced into an obtusely pointed snout, supported by the narrow rostral cartilage, on each side of which are subcutaneous cavities, filled with a large quantity of mucus. The eye, which is covered by a semitransparent skin and lacks an orbital fold, is one-sixth the length of the head, and occupies a position in the middle of the depth of the head and in the anterior half of its length. Nostril in front of the upper margin of the eye with two openings, which are close together, situated in a common depression. The projection of the snout is

[1] Fish., vol. iii. p. 544.

[2] This name was first proposed by Bleeker, though on insufficient grounds.

less than two diameters of the eye. The subsemicircular mouth is entirely at its lower side, the bones of the upper jaw being covered by the general integument which leaves only the extremity of the maxillary free, without forming labial folds. On the other hand, the mandible possesses a distinct fold on each side. The end of the maxillary is opposite to the middle of the eye.

Each jaw and the palate are armed with a series of small lancet-shaped teeth which are arranged with beautiful regularity. Those of the upper jaw are twenty-eight in number on each side, and have their sharp and acute points obliquely directed outwards. Those of the lower jaw are somewhat smaller, more erect, and twenty-five in number on each side. The palatine series is parallel to the intermaxillary series, and consists of fifty-four teeth. This bone is more movable than the upper jaw, opposed to the mandible, and evidently performs the function of a jaw.

The broad flexible gill-cover with its integument joins that of the other side, forming a broad bridge across the isthmus, from which it is entirely free. The supporting bones are so thin that none of them can be distinguished externally under the firm thick integument. There are four gills, but no pseudobranchia. The gill-rakers are moderately long, soft, and remote from each other, the anterior arch bearing about eighteen.

Dorsal spines short, distant from each other ; among a series of seven specimens I count six in one, seven in four, and eight in two ; a minute soft ray is generally visible behind the last dorsal spine. The anal fin commences immediately behind the vent and opposite to the space between the second and third dorsal spines (in a specimen with seven dorsal spines); the anal spines gradually increase in length behind, the last being two-ninths of the length of the head ; there are thirteen in three examples, fourteen in three, and fifteen in one. The soft rays are all simple, and about one hundred and sixty in number ; the extremities of the last are attached to the base of the extremely narrow caudal fin. The longest are at about the middle of the length of the fin and two-sevenths of the length of the head. Pectoral composed of twelve rays, of which the longest are in the upper half of the fin ; its base is narrow and its length half of that of the head. Ventral fins far back, but not reaching to the vent ; each consists of one spine and six or seven rays, of which the inner and outer one are simple, the latter being frequently transformed into a spine ; the other rays are dichotomous. The two ventrals are broad, close together, and united by the interradial membrane, which stretches across from one fin to the other. The scales are very thin and small, cycloid, suboval in shape, and cover almost every part of the body and head. Lateral line well developed, running a little above the middle of the depth and disappearing about the middle of the length of the tail.

Colour brown, inside of cavities black. Length, 18 to 20 inches.

Not rare in the deep water off the coasts of South Australia and New Zealand.

The abdominal organs are in all our specimens much decomposed, so that the following observations only could be made :—

The intestinal tract above the pylorus is distinguished from the remainder by its deep black colour, which is spread over the interior as well as the exterior surfaces, and in fact through the whole tissue of the œsophagus and stomach. The cardiac portion of the œsophagus is beset with rather long villii which are replaced by longitudinal folds in the stomach. Form of the stomach siphonal. Five pyloric appendages of moderate length. The remainder of the intestine very little convoluted and narrow. Liver not divided into lobes. Gall-bladder with rather firm walls.

The air-bladder is of an oval shape, and occupies the posterior half of the abdominal cavity; anteriorly it is divided into two short cornua. Its peritoneal coating is very firm; its proper membrane consists of a thick pearl-coloured substance, the inside of which is coated with a delicate vascular membrane which can easily be detached from the pearly portion. In one of the cornua this membrane passes into a pair of thick muscle-like pads, but the specimen is in too bad a condition to ascertain their nature. A pneumatic duct can be traced for a short distance from the end of the left cornu, but is soon lost, and does not appear to reach the œsophagus. The kidneys are confluent into one short body, the foremost portion of which extends into the abdominal cavity behind the thick peritoneal covering, whilst the larger portion is situated between the muscles of the tail.

The osseous framework of this fish is so much wanting in the characteristic peculiarities of bathybial fishes, as to throw serious doubts upon the statement that this species at least of *Notacanthus* lives at a great depth. The ossifications of the skull (Pl. LX. figs. 9–15) are very firm, so that the sutures between some of the cranial bones are obscure or have disappeared altogether. The cranium proper (figs. 10, 11, 12, 14) consists of the short and compressed brain-capsule, which is connected with the small and narrow facial portion by the extremely narrow frontal and basal bones; the orbit being a wide suboval vacuity, bordered in front by a vertical strip of the ethmoidal cartilage. The upper surface of the brain-capsule is smooth and rather convex; the sides slope inwards, with an uneven surface crossed by two subparallel ridges in the epiotic region, the articular facet for the hyomandibular being below the lower ridge; the basis cranii shows a projecting V-like ridge, open behind (fig. 12); the occipital region (fig. 14) is subvertical, bordered above with a slight ridge, with a low swelling above the foramen occipitale, and another on each side; the orbito-sphenoid region is entirely membranous.

The primordial cartilage has entirely disappeared in this part of the skull, and owing to the obscurity of the sutures the outlines of the following bones only can be distinguished. The basioccipital (figs. 12, 14, *bo*) is large, with a rather shallow articulatory excavation which is enlarged by a smaller depression on each side; the suture between this bone and the upper occipital is distinct, but the paroccipitals seem to have coalesced with the supraoccipital (*spo*). The latter bone penetrates between, but does not entirely separate the parietals (*p*). The bones on the side of the cranium are coalesced. The basale (figs. 10, 12, *b*) has a singular shape; it is dilated into a pair of lateral wings closing part of the side of the cranium, and separated from the frontal by the intercalated alisphenoid (*po*); at the base of the skull it forms the pair of strong ridges already mentioned, convergent anteriorly, where the bone is narrowed into a styliform slightly curved process which supports the membranous interorbital septum, and extends forwards to the rostral process. The frontals (figs. 10, 11, *f*) are very narrow, especially above the orbit, and taper into fine points in front. The *ethmoidale medium* (*em*) is a narrow long single bone situated above the remains of the ethmoidal cartilage (*ec*).

The foremost part of the snout (figs. 10, 15) is formed by a cartilage, the lower part of which is ossified, whilst the upper projects free as a flexible rostral appendage (*r'*). The ossified portion (*r*) is wedged in between the ascending processes of the intermaxillary, which are firmly attached to it, so that this latter bone is not capable of being moved in any direction. It almost entirely excludes the maxillary (*m*) from the margin of the jaw. The maxillary is firmly tied to the intermaxillary, and therefore also not capable of free motion; its distal extremity is bifid, the lower end being bent downwards beyond the extremity of the intermaxillary, and the upper modified into an acute spine.

A singular nodule of cartilage (fig. 10, *n*) which has no direct connection with the rostral cartilage, and can be moved independently, is lodged in the fibrous tissue filling the angle between the intermaxillary and basale.

Of the suspensorium the hyomandibulare (fig. 13, *hm*) is the largest bone; in fact it is of unusual size, subtriangular, narrowest below, and provided with a raised strong, obtuse ridge. Three bones are joined to its lower edge, the entopterygoid (*ep*), the symplectic (*sy*), which is almost entirely cartilaginous, and the stylohyal (*st*). The quadrate (*q*) is narrow, produced to a point in front of and behind the mandibulary joint, and forming a long suture with the ectopterygoid (*ecp*). A rather large vacuity exists between the quadrate and entopterygoid.

The ectopterygoid (*ecp*) extends forwards nearly to the end of the palato-pterygoid arch, has a subvertical position, and is provided above, near its anterior end, with a pair of small protuberances for the attachment of ligaments and muscles. To its lower edge are attached rather loosely the palatal bones (*pal*) which together form an arch joining in the median line, and which are armed with a series of teeth like the jaws. There is no vomer.

The palatal series of teeth is opposed to that of the lower jaw, as in sharks; and the entire front part of the palatal arch can be moved in a vertical direction, thus assuming the function of the immovable upper jaw.

The mandible is short and deep, with a very thin rudiment of Meckelian cartilage; only a dentary and articulary can be distinguished.

The præoperculum (fig. 9, *pr*) consists of a narrow vertical, and similar horizontal limb, both meeting at a right angle. The operculum (*o*) is membranous, rayed, frayed on the edge; the suboperculum (*so*) of similar structure, narrow; the interoperculum (*io*) smooth and firmer, attached to the lower limb of the præoperculum.

Infraorbital bones are absent.

The hyoid and branchial arches do not offer any noteworthy peculiarity, except that the nine slender branchiostegals are crowded together on the epihyal and the cartilaginous end of the ceratohyal, being enclosed in the same membrane as the operculum and suboperculum.

The scapulary arch (fig. 10) is very simple, and suspended from the cranium by loose and easily detached ligaments. The clavicle (*cl*) is narrow and curved, the single supraclavicle (*scl*) not much smaller and single. As usual a urohyal (*uh*) is attached to the symphysis of the clavicle. The scapula (*sc*) and coracoid (*co*) form an extremely thin lamina, of which a great portion remains cartilaginous. Basalia minute. Post-clavicle absent.

The centra of the *vertebræ* are deeply biconcave, perforated in the middle, rather short and broad, with deeply pitted outer surface, the abdominal surface of those of the trunk being remarkably flat. The caudal vertebræ, whilst retaining their short longitudinal axis, are more and more compressed towards the end of the tail, and those of the extremity of the vertebral column are more elongate, and finally become quite rudimentary.

The articulation of the first vertebra with the skull is not effected merely by a simple circular concavity, but there is a distinct median osseous projection on the upper margin of the centrum of the vertebra, whilst the opposite part on its lower margin recedes further backwards than the lateral portions of the joint.

There are forty-two vertebræ in front of the one which supports the first interneural, and forty-nine may be reckoned as belonging to the abdominal portion of the column.

The neural arches of the abdominal vertebræ are broad and solid, terminating in short and much depressed neural spines. Posteriorly the neural spines become longer, slender, needle-shaped, and disappear on the rudimentary vertebræ at the extremity of the column.

The interneural spines are broad lamellæ, which assume a very oblique position, each being provided with a strong longitudinal ridge, at the top of which the dorsal spine is joined.

The parapophyses of the abdominal vertebræ are short, placed on each side of the lower surface of the vertebræ, thus enlarging the abdominal surface of the column. They are lengthened on the first three or four caudal vertebræ, and then those of each vertebra coalesce at their distal extremities, forming a wide hæmal canal which disappears in the posterior fifth of the length of the tail. The interhæmals of the anal spines are strong, corresponding in length to the exterior spines; only the anterior are somewhat dilated, the remainder being rod-shaped, and gradually passing into the interhæmals of the anal rays; with regard to the numbers, the interhæmals correspond to the anal rays, and the hæmals nearly to the interhæmals.

A short separate bone is horizontally intercalated between the distal extremities of every two interhæmal spines, each taking part in the articulation of an anal spine.

Ribs begin to be developed on the fourth vertebra, being inserted immediately below the neural arch; they are extremely slender, and become gradually longer on the posterior abdominal vertebræ where each coalesces with a floating rib, the ribs thus having the appearance of consisting of two roots (one being fixed to the vertebra and the other free), and of a simple distal portion. Of the caudal vertebræ only the anterior possess ribs.

The pubic is a simple feeble bone, with a transversely swollen, cartilaginous base for the articulation of the ventral rays; it is a thin lamella tapering in a fine point in front, and with a lamellar longitudinal ridge at its ventral surface.

Notacanthus nasus.

Notacanthus nasus, Bloch, Fisch., vol. xii. p. 113, tab. 431.
„ „ Cuvier, vol. viii. p. 467, pl. ccxli.
„ „ Gaimard, Voy. Isl. et Grönl. Zool. Poiss., pl. xi.
„ „ Lütken, Vid. Meddel. nat. Foren. Kjøbenhavn, 1878, p. 145.

B. 8 (9 ?). D. 9–10. A. 13–17 | 116 (ca.). P. 14–16. V. 3 | 6–7.

Gill-openings reaching forwards to below the posterior margin of the orbit. Intermaxillary teeth compressed with the point directed outwards, forty on each side; the mandibulary and palatine teeth smaller, more erect, and anteriorly in a double or triple series. Ventral fins scarcely united (*vix conjunctæ*, Lütken).

Only a few specimens are known from the deep-sea off the coasts of Southern Greenland and Iceland.[1]

[1] In the absence of all information as regards the dentition, and even of the size of the specimen, it is impossible to form an opinion as to the distinctness of a *Notacanthus* obtained by the U.S. Fish Commission in the Gulf Stream (lat. 40°) in 547 fathoms. It is characterised thus:—*Notacanthus analis*, Gill (*Proc. U.S. Nat. Mus.*, vol. vi., 1884, p. 255): D. 11 | 1. A. 18 | ? "The length of the snout and diameter of the orbit subequal, and greater than the interorbital area, and the snout projecting about one-third of its own length beyond the mouth."

Notacanthus phasganorus.

Notacanthus phasganorus, Goode, Proc. U.S. Nat. Mus., vol. iii., 1881, p. 535.

D. 10. A. 19 | ca. 130. P. 17. V. 2 | 8–9.

Teeth in the upper jaw blunt, acicular, set side by side like the teeth of a comb, about thirty-two on each side. In the lower jaw they are shorter and more slender and in double rows. Villiform teeth upon the palatines, in about two series. The height of the body is contained once and one-fifth in the length of the head, which is contained twice and one-third in its distance from the vent. Diameter of the eye one-eighth of the length of the head, and nearly one-half of that of the snout. Ventrals broad, with peduncle-like bases thickly covered with scales; closely adjacent, separated by a narrow groove (Goode).

One specimen, nearly three feet long, was taken from the stomach of a *Læmargus borealis* on the Grand Bank of Newfoundland.

Notacanthus bonapartii (Pl. LXI. fig. C).

Notacanthus bonapartii, Risso, Wiegm. Archiv f. Naturgesch., 1840, p. 376 (not fig.).
" " Filippi and Vérany, Mem. Acc. Sci. Torino, xviii. p. 190.

D. 8 (–9). A. (15–) 18 | x(150). C. 3. P. 9. V. 1 | 7. Cæc. pyl. 5.

The greatest depth of the body is opposite to the ventral fin, and contained twice and two-thirds in the distance of the vent from the end of the snout; the length of the compressed oblong head is contained twice and one-third in the same length. The snout is thick, swollen, much produced beyond the narrow transverse mouth, which is opposite to the front margin of the orbit, and quite at the lower side of the head. Twenty teeth on each side of the upper jaw. The eye is close to the upper profile, two-thirds of the length of the snout, one-fifth of that of the head, and less than the width of the interorbital space. Gill-opening of moderate width, the gill-membranes being confluent in the vertical from the upper end of the gill-opening, and not attached to the isthmus.

The whole body and head are covered with minute, smooth, imbricate, and adherent scales.

All the dorsal spines are short, the anterior very short, the second opposite to the vent. The anal spines commence immediately behind the vent, and increase in length posteriorly, passing into the flexible rays, which are of varying and indefinite number. The pectoral is inserted at the usual distance from the gill-opening, and has the base of moderate width. Ventrals united and extending to the vent.

Total length,	290 mm.
Length of the head,	45 ,,
Depth of the body,	30 ,,
Length of the tail,	182 ,,

Habitat.—South-Western Coast of South America, Station 310; depth, 400 fathoms. One specimen, $11\frac{1}{2}$ inches long.

Mediterranean.

As Risso correctly states, the number of maxillary ("mandibule," Risso) teeth is from twenty to twenty-two on each side, that of the mandible ("machoire," Risso) twenty, and that of the palate twenty-four. The posterior part of the paired fins and the lower of the anal are black. Cavity of the mouth and gills black. Structure of the air-bladder as in *Notacanthus sexspinis.*

Filippi and Vérany[1] have shown that Risso, in figuring and describing his *Notacanthus bonapartii*, has confounded two species. The name ought to be retained for the specimen described, without reference to the figure which itself is evidently very faulty.

B. *Polyacanthonotus.*

Notacanthus rissoanus (Pl. LXI. fig. B).

Notacanthus rissoanus, Filippi and Vérany, Mem. Acc. Sci. Torino, xviii. p. 190.

B. 9. D. 34. A. 54 | x (79). C. 6. P. 11. V. 1 | 9.

The greatest depth of the body is opposite the vent, and one-fifth of the distance of the vent from the end of the snout; the length of the narrow, long, compressed head is one-third of the same length. The snout is compressed, pointed, much produced beyond the narrow mouth, the cleft of which laterally extends to below the posterior nostril. Each jaw is armed with a series of fixed minute teeth; a similar palatine series within the intermaxillary series; the mandibulary series fits between the upper two rows. The eye is close to the upper profile, and distant two diameters from the end of the snout, and four from the extremity of the opercle; its diameter exceeds the width of the interorbital space. The gill-opening is wide; the gill-membranes are supported by very slender branchiostegals, confluent in front, and not attached to the isthmus.

The whole body and head are covered by minute, smooth, imbricate, and adherent scales.

All the dorsal spines are short, distant from one another, the first being above the

[1] *Mem. Acc. Sc. Torin.*, xviii., 1859, p. 188.

root of the pectoral, the last behind the middle of the length of the tail. The anal spines commence immediately behind the vent, and very gradually and but slightly increase in length behind, passing finally into flexible rays of varying and indefinite number. The pectoral is inserted at some distance behind the gill-opening, and has a very narrow base. Ventrals close to, but not extending to the vent, entirely separate.

Colour uniform light brown, blackish about the gills and on the soft anal fin.

Total length, ...	396 mm.
Length of head, ...	52 ,,
Depth of the body, ...	32 ,,
Length of the tail, ...	236 ,,

Habitat.—South of Yedo, Station 237 ; depth, 1875 fathoms. One specimen, 16 inches long.

Mediterranean.

The teeth are minute, those of the upper jaw scarcely different in size or shape from those of the lower. There are thirty-one on each side of the upper and twenty-three on each side of the lower jaw; each half of the palatine series contains twenty-one teeth. Each ramus of the mandible with a series of pores which is continued on the præoperculum. The union of the gill-membranes takes place opposite to the middle of the distance between orbit and occiput. Orbit without circular fold. Gill-cavity and peritoneal sac with a thin layer of black pigment.

The air-bladder is much smaller than in *Notacanthus sexspinis*, occupying a small portion of the middle of the abdominal cavity; anteriorly on the left side it is prolonged into a narrow cylindrical horn about two-thirds of the length of its body; there is no open communication between it and the intestinal duct. The ovaries are a pair of band-like bodies, transversely plaited and without oviduct. The intestine makes only one convolution; pyloric appendages are represented by three short diverticula only. Kidneys confluent into one short body which is situated between the muscles of the tail behind the vent.

The description by Filippi and Vérany is so short as to leave the identification of the Japanese with the Mediterranean fish in some uncertainty; on the other hand, it applies sufficiently well to our specimen. And as a number of Mediterranean fishes are identical with Japanese, and as at least one other species of *Notacanthus* (*Notacanthus bonapartii*) shows a wide geographical range, I should not feel justified in giving a distinct name to the fish described.

Family Muræнidæ.

Group Anguillina, Gthr.

Congromuræna, Kaup.

Congromuræna guttulata, n. sp.

Allied to *Congromuræna habenata*, but with a comparatively longer tail; the length of the body being contained once and two-thirds in that of the tail. Eye rather large, two-thirds of the length of the snout. Lips somewhat swollen, a wide muciferous cavity being lodged on the side of the snout; upper jaw projecting beyond the lower. Anterior nostril at the extremity of the snout, posterior in front of the middle of the eye; a wide pore on the margin of the upper lip. Cleft of the mouth extending to below the middle of the eye; teeth very small, somewhat unequal in size, forming extremely narrow bands; vomer with a few teeth anteriorly. Length of the head two-thirds of that of the trunk. Dorsal fin rather low, beginning immediately behind the root of the pectoral fin. Whitish, with a series of extremely minute black dots above and another below the lateral line.

A single specimen $7\frac{1}{2}$ inches long was obtained at Station 173, off the island of Matuku, Fiji Group, at a depth of 315 fathoms.

Simenchelys.

Simenchelys, Goode and Bean, Bull. Essex Inst., vol. xi., 1879, p 27.

One species only is known.

Simenchelys parasiticus.

Simenchelys parasiticus, Goode and Bean, *loc. cit.*
,, ,, Jordan and Gilbert, Synops. Fish. N. Amer., p. 363.

Abundant on the off-shore banks, south of Newfoundland (80 to 200 fathoms); individuals have been found burrowing in the flesh of the Halibut.

Group Murænesocina, Gthr.

Nettastoma, Rafinesque.

Three species are known.

Nettastoma melanurum, Raf.

Not uncommon in the Mediterranean, and most probably descending to depths similar to those of its congeners.

Nettastoma parviceps (Pl. LXIII. fig. A).

Nettastoma parviceps, Günth., Ann. and Mag. Nat. Hist., 1877, vol. xx. p. 446.

Head small, its length being two-fifths of the distance between the gill-opening and vent (more than one-half in *Nettastoma melanurum*). Dorsal fin commencing in advance of the gill-opening. In other respects similar to the Mediterranean species.

Habitat.—South of Yedo, Station 232; depth, 345 fathoms. One specimen, 26½ inches long.

Nettastoma procerum.

Nettastoma procerum, Goode and Bean, Bull. Mus. Comp. Zoöl., vol. x. 1883, p. 224.

Distinguished by a long filamentous rostral tip, the length of which is equal to twice the diameter of the eye. Tail twice as long as trunk and head.

Three specimens, from 16 to 26 inches long, were obtained by the U.S. steamer "Blake," in lat. 33° 35′ to 40° 0′ N., long. 76° 0′ W.; at depths of 178 and 647 fathoms.

Group Synaphobranchina, Gthr.

Synaphobranchus, Johns.

Synaphobranchus pinnatus (Pl. LXII. fig. A).

Muræna pinnata, Gronov., Syst. ed. Gray, p. 19.
Synaphobranchus kaupii, Johnson, Proc. Zool. Soc. Lond., 1862, p. 169.
,, *pinnatus*, Günth., Fish., vol. viii. p. 23.
,, ,, Goode and Bean, Bull. Essex Inst., vol. xi., 1879, p. 26; Bull. Mus. Comp. Zoöl., vol. x., 1883, p. 223.
,, *affinis*, Günth., Ann. and Mag. Nat. Hist., 1877, vol. xx. p. 445.

The eye is one-half or a little less than one-half of the length of the snout; the length of the body is contained twice or twice and a third in that of the tail. The dorsal fin commences above or at a very short distance behind the vent. Root of the pectoral midway between the extremity of the snout and the vent. Length of the pectoral fin half that of the head. Scales rudimentary, lanceolate, oblique; cheeks scaly. Dorsal and anal fins low, especially the former. The dentition of the jaws consists in each of a narrow band of villiform teeth, the inside series containing larger pointed ones. The largest teeth are on the intermaxillary, where they are grouped together in an oval-shaped patch, longer than broad. At some distance behind this group the vomerine series of small teeth commences, running backwards along the median line of the palate. Coloration black or brown.

Habitat.—Madeira; coasts of the United States (200 to 740 fathoms).

Coast of Brazil, Station 125; depth, 1200 fathoms. One specimen, 18 inches long.

South of Japan, Station 235; depth, 565 fathoms. Four specimens, 20 to 27 inches long.

Hyalonema ground, off Inosima, Station 232; depth, 345 fathoms. Eleven specimens, 14½ to 22 inches long (type of *Synaphobranchus affinis*).

South of Philippine Islands, Station 214; depth, 500 fathoms. Two specimens, 15½ and 21 inches long.

Philippine Islands, Station 210; depth, 375 fathoms. One specimen, 13 inches long.

Synaphobranchus bathybius (Pl. LXII. fig. B).

Synaphobranchus bathybius, Günth., Ann. and Mag. Nat. Hist., 1877, vol. xx. p. 445.

Mouth and dentition as in *Synaphobranchus pinnatus*. Eye one-half or two-thirds of the length of the snout. The length of the body is contained only once and one-fourth in that of the tail. The dorsal fin commences above or immediately behind the pectoral, which is only one-third the length of the head. Scales quite rudimentary, lanceolate, imbedded in the skin; cheeks naked. Dorsal and anal fins low, especially the former. Uniformly black.

Habitat.—Middle of North Pacific, Station 246; depth, 2050 fathoms. One specimen, 24½ inches long.

South of Yedo, Station 237; depth, 1875 fathoms. Nine specimens, 14 to 22 inches long.

Midway between Cape of Good Hope and Kerguelen Island, Station 146; depth, 1375 fathoms. One specimen, 14 inches long (albino).

Synaphobranchus infernalis.

Histiobranchus infernalis, Gill, Proc. U.S. Nat. Mus., vol. vi., 1884, p. 255.

Possibly identical with *Synaphobranchus bathybius*. "An isolated small patch of teeth on the vomer, behind that on its head." "The dorsal fin commences little behind the root of the pectoral, while the anal arises not much nearer the snout than the end of the tail. The pectorals are considerably shorter than the snout."

One specimen, the size of which is not stated, was obtained by the U.S. steamer "Albatross" in the Atlantic; lat. 38° 30′ N., long. 69° 0′ W.

Synaphobranchus brevidorsalis, n. sp. (Pl. LXIII. fig. C).

Mouth and dentition as in *Synaphobranchus pinnatus*. Gill-openings in a single slit, in advance of the pectoral fins. Eye of moderate size, one-half the length of the pointed snout. The length of the body is less than one-half of that of the tail; root of the pectoral fin much nearer to the end of the snout than to the vent. The dorsal fin commences so far behind the vent, that the distance between its origin from the vent equals the length of the head. Pectoral of moderate length, two-fifths of the length of the head. Scales rudimentary, rounded, imbedded in the skin, extending over the cheeks. Anal higher than dorsal. Dark brown.

Habitat.—North of New Guinea, Station 218; depth, 1070 fathoms. One specimen, 23 inches long.

Hyalonema ground, off Japan, Station 232; depth, 345 fathoms. One specimen, 17½ inches long.

Group Saccopharyngina, Gthr.

Saccopharynx.

Saccopharynx, Mitchill, Ann. Lyc. Nat. Hist. New York, vol. i., 1824, p. 82.
" Günth., Fish., vol. viii. p. 22.
Ophiognathus, Harwood, Phil. Trans., 1827, p. 277.
Eurypharynx, Vaillant, Comptes rendus, 1882, vol. xcv. p. 1226.
Gastrostomus, Gill and Ryder, Proc. U.S. Nat. Mus., vol. vi., 1884, p. 271.

Deep-sea eels, characterised as such by a combination of the Muræenoid characters with a specifically bathybial modification of the osseous and muscular systems, of which the former is wanting in inorganic matter, whilst the latter is but very feebly developed, except in the parts which have to perform the function of deglutition. To enable them to seize upon prey more powerful than themselves, certain organs have undergone a degree of specialisation, as is observed in bathybial members of other families with a similar mode of life; the jaws are exceedingly elongate, and the whole gape, the pharynx and stomach capable of extraordinary distension. The head is of enormous size, with short cranial portion; the trunk of moderate extent, with the vent at its end; the tail exceedingly elongate, band-shaped, and tapering into a point. Snout very short, pointed, flexible; one nostril in front of the small lateral eye.

Maxillary and mandible slender, armed with feeble teeth, in one or two more or less complete series; palate toothless. Gill-openings at some distance behind the head, close together, at the lower part of the side; branchial arches five; very short gills, extremely small. Dorsal and anal fins low, more or less rudimentary; pectorals very small.

The specimens observed are few in number, and to judge from the descriptions, referable to three species.

Saccopharynx ampullaceus (Pl. LXVI.).

Saccopharynx sp., Mitchill, Ann. Lyc. Nat. Hist. New York, vol. i., 1824, p. 82.
Ophiognathus ampullaceus, Harwood, Phil. Trans., 1827, p. 52, pl. vii.
Saccopharynx flagellum, Cuv.,[1] R. an., 1829, vol. ii. p. 355.
" " Günth., Fish., vol. viii. p. 22.
" *ampullaceus*, Johnson, Ann. and Mag. Nat. Hist., 1862, vol. x. p. 277.

Both jaws are armed with slender, curved, widely-set teeth, irregularly uni- or bi-serial, their points being directed inwards. The length of the jaws is from one-third to one-seventh of the length of the body, that is, the distance from the vent to the extremity of the snout. The dorsal fin commences a long way behind the head, and a short distance in front of the vent; like the anal it may or may not reach the end of the tail, which terminates into an extremely delicate and thin filament. The small pectoral fin with some thirty very thin rays. Gill-opening an elongate slit. A bluish-white line runs on the back along each side of the base of the dorsal fin, and a similar line is sometimes distinct along the anal fin.

Of this species four specimens are known to have been captured :—

1. The fish described by Mitchill in 1824, which was taken in lat. 52° N. and long. 30° W.; it was discovered afloat in a helpless condition, having swallowed a fish 10 inches long. The body of this specimen was 14 and the tail 58 inches long. It does not seem to have been preserved.

2. The fish described by Harwood in 1827, which was taken in lat. 62° N. and long. 57° W.; it was discovered afloat in a helpless condition, "almost worn out by unavailing efforts to gorge a fish of about 7 inches in circumference." This is the largest of the specimens known, its body having been about 20 and the tail 34 inches long. It does not seem to have been preserved.

3. The fish described by Johnson in 1862, which was taken off Madeira, under what circumstances Johnson could not learn, but probably also floating on the surface;

[1] Cuvier ascribes this specific name to Mitchill, as he speaks of the "*Saccopharynx flagellum de Mitchill*," or of the "*Ophiognathus ampullaceus de Harwood*."

it had swallowed another deep-sea fish about 9 inches long (*Halargyreus johnsonii*), the stomach of which was forced up into the mouth by the distended air-bladder, showing how rapidly both fishes must have ascended to the surface. The body of this specimen is $8\frac{1}{2}$ and the tail 23 inches long. It is preserved in the British Museum.

4. A young specimen in the British Museum, the history of which is unknown; its body is 3, its tail $8\frac{1}{2}$ inches long. It is much shrivelled, having been preserved for a long time, but supplies some valuable information on points in which the larger is imperfect.

I first give a detailed description of the Madeiran specimen.

The figure of the fish on Pl. LXVI. will give a better idea of its general appearance than could be supplied by a description; it represents the specimen with its victim *in situ;* when the stomach is empty the abdominal integuments are contracted, yet protrude as a wrinkled bag, which, however, does not extend beyond the vent.

The whole fish is covered with a thin, jet-black skin, which is easily ruptured. In a lateral view of the head the sides are nearly vertical, occupied chiefly by the broad and long mass of muscle, which is situated between the suspensory and palato-pterygoid bone. This portion of the head extends far backwards and obliquely downwards, and is bordered below by the slender and slightly curved maxillary. External to the anterior extremity of the maxillary lies the small eye which is somewhat obscured by the skin, and situated so that the fish can discern objects approaching from the side, from the front and from below. In front of the eye there is only the short, triangular, flexible rostral appendage, which, at least in this specimen, is bent downwards. The mandible is as slender and simple a bone as the maxillary, and curved in such a manner that it can be closely fitted to the latter. When the mouth is shut, the mandibulary forms an acute angle with the suspensory and with its fellow. However, the joints at the opposite ends of the mandible are so loose, that the fish had the power of throwing down the lower jaw until "it was almost in a line with the upper"; and even now the two rami of the mandible can be so far drawn apart, as to form a right angle at the symphysis. The posterior end of the palato-pterygoid projects free out of the muscle, and covered with skin only, leans against the maxillary at a distance of half an inch in advance of the mandibulary joint.

Viewed from above, the cranium appears extremely short and broad, slightly convex longitudinally as well as transversely; it is broadest vertically above the hind margin of the eye, where the side of the cranium projects outwards; its transverse diameter at this place is half an inch, but little less than the length of the cranial portion to the end of the rostral appendage. Thick occipital or nuchal muscles are inserted immediately behind the line between the lateral projections of the skull, and hide the occipital portion of the cranium, the backward extent of which cannot be ascertained without dissection.

Passing to the lower side of the head, we find the space between the mandibulary rami occupied only by elastic skin, which, when the rami are closely approximated to each other, projects as a broad fold on the inside of the gape; it is more or less wrinkled on its inner surface, especially posteriorly, where it passes into the pharynx. Its inner membrane, backwards to the end of the stomach, is deep black like the outside. There is no tongue; if any rudiments of hyoid elements exist, they would be displaced together with the branchial apparatus a long way behind the head.

The "small, sharp, delicate teeth" which Johnson saw in his specimen were rather loosely attached to the jaw-bones, and have now almost entirely disappeared; and if we had not his testimony, confirmed by the dentition of another example, the dentition in the present condition of the specimen might have been described as "granulations" in the upper jaw, and as almost absent in the lower. The dentition has been restored in the figure from the remaining teeth or traces of teeth in the specimen figured, with the aid of the perfect dentition in our young specimen.

The smaller example in the British Museum shows that the teeth are very slender, of two sizes, the longest strongly curved, with the point directed towards the inside of the mouth; the largest is $2\frac{1}{2}$ mm. long; the majority are 2 mm., and the smaller sized ones only 1 mm. long. Those of the lower jaw are generally smaller than those of the upper, and so much directed inwards as to be entirely hidden by the fold of the skin which covers the inside of the jaws. The largest teeth, from ten to twelve in number in each jaw, are widely set and placed in the same line; the interspaces between them are occupied by the smaller teeth, which may be inserted also in the same line, or somewhat external to it.

This dentition is much too feeble to be capable of injuring or holding any of those large and powerful fishes which, as we know, are attacked by the species of *Saccopharynx*, therefore they cannot afford the same amount of assistance in overpowering the prey as the dentition of *Omosudis* and others, or even of *Chiasmodus*. But they are sufficiently strong to enable the *Saccopharynx* to fasten itself to and retain its hold on another fish, which may drag its enemy a long way before its strength is played out, and before the *Saccopharynx* commences to draw itself over its victim similarly to an *Actinia* which has captured a large fish or crab. There is not the slightest reason for supposing that the mode of feeding differs in any of the species of this genus. And so far from its being "probable that they may derive their food from the water which is received into the pouch, by a process of selection of the small or minute organisms therein contained," the absence of any kind of straining apparatus should have afforded a sufficient caution against such a proposition, even if no evidence of the actual mode of feeding had been extant.

The trunk terminates with the vent, which is distant eight and a half inches from the extremity of the snout. It is compressed, and its anterior part which lies between the lateral suspensory enlargements of the head is rather muscular. But the muscles become attenuated further behind, forming a thin band on each side of the vertebral column. A large abdominal bag, formed by the external integuments and the membranes of the stomach, is suspended from the trunk, and may be so much distended that the contents of the stomach are clearly visible through the walls of the bag.

The trunk passes into the compressed tail, on which the muscles form only a very thin layer. Gradually the depth of the tail diminishes, the last five inches being as thin as a thread, in which at first elongate vertebral centra are still distinguishable, whilst the last two and a half inches are a simple filament without segmentation.

Fishes with the organs of locomotion so feebly developed, and with a long caudal appendage which must be an impediment rather than a help in locomotion, may be justly supposed to be sluggish in their movements, habitually lying on the bottom of the sea, more or less concealed in the ooze. They patiently wait for the approach of their prey, the size of which will compensate for the rarity of the occasions on which a fish comes within their reach.

The rupture of the abdominal sac has afforded an opportunity of examining some of the vertebræ in the middle of the trunk. The fibrous ligaments connecting the vertebræ are extremely thin, and as easily ruptured as in a well-macerated skeleton. The centra of these vertebræ (fig. *v*) are $5\frac{1}{2}$ mm. long, hour-glass-shaped, with deep and spacious concavities which are connected by a very narrow canal. A pair of short, acute divergent spines start from the neural surface of the most constricted portion of the centrum; they project at a right angle from the longitudinal axis of the vertebra. On the hæmal side another pair of spines project, but they are directed backwards, and start from behind the middle of the vertebra. The caudal vertebræ are shorter, as may be seen through the skin, and become elongate again towards the narrowest portion of the tail.

It is difficult in our specimen to fix the exact position and shape of the gill-openings. They are longitudinal slits, eight or nine lines long, close together at the lower side of the abdominal bag, and about one inch behind the angle of the lower jaw. There is no separate gill-cavity; a large body passing through the pharynx can be seen through the gill-opening, which in consequence of the distension of these parts, would be a wide open aperture. Three of the branchial arches stretch across the gill-opening, and are more or less visible from the outside; they are extremely slender, merely thin cartilaginous rods with an indistinct knee-shaped bend, and with the gill-laminæ less developed than I have seen in any fish. The second branchial arch is hidden below the skin, and still smaller than the posterior, the first being quite rudimentary, without any gill.

The dorsal and anal fins are in a rudimentary condition. The former commences in front of the vent, but its anterior rays become visible only by dissection, and with the aid of a magnifying glass; the longest rays are about the middle of the tail, where they are about two lines long, free, and extremely delicate; they disappear at some distance from the end of the tail. The structure of the anal fin is similar, but the rays are on the whole longer and somewhat less delicate. The number of these rays is independent of that of the vertebræ; two or three may be reckoned to each vertebra.

The pectoral fins are minute, placed immediately behind, and a little above, the gill-openings; they have a comparatively broad base and a rounded margin, and are composed of about thirty closely approximate, very thin rays.

A pair of narrow bluish-white lines commence on the nape and accompanies the dorsal fin, one on each side, until it disappears on the tail. The base of the fin itself runs on a whitish median line which is separated from the lines on the side by a deep black line. Also the anterior part of the anal runs on such a light coloured line, but the lateral lines are very indistinct.

I cannot see a trace of these lines in our young specimen, which agrees in every respect with the larger one, except in some unimportant points to be mentioned hereafter.

Taking into consideration certain discrepancies in the descriptions given by Mitchill and Harwood, Cuvier as well as Johnson suspected that these authors possibly had distinct species of the same genus before them. However, if no more than due allowance is made for the difficulty in making out the exact proportions and structure of these fragile and more or less distorted and injured objects; for individual variations, such as the length of the hair-like posterior part of the tail; for the changes dependent on growth; and finally for the imperfect observations which in Mitchill's, and still more in Harwood's descriptions are manifest,[1] those discrepancies will be taken at their true value.

1. Cuvier draws attention to Mitchill's statement that the lower jaw of his fish was toothless. This may have actually been the case, as the teeth are loosely attached to the jaw and readily come off; or they may have been overlooked by Mitchill, as in our larger specimen such teeth as are still preserved, point inwards, and are hidden under the fold of the skin which runs along the inner margin of the jaw. The mandibulary teeth are decidedly smaller than those of the upper jaw, as is best seen in our smaller example which has them fully preserved.

2. The relative length of the jaws and of the body, that is, the distance between the snout and vent, seems to undergo a change with growth; at least so it would appear

[1] Even in Mr. Johnson's description an observation occurs which, without the type specimen, might have been readily misinterpreted and misused. He says: "What is very remarkable about these (gill-) apertures is that, within the lips of each, the opposite sides are connected by three narrow cutaneous bands, two near the anterior end of the aperture, and one near the posterior end." These three "cutaneous bands" are the third, fourth, and fifth branchial arches which are exposed in the gill-opening.

from the information which is available at present, and which may be tabulated thus :—

	Length of jaws.	Length of body.	Proportion.
In the smallest specimen, . . .	$13\frac{1}{2}$ lines.	36 lines.	nearly 1 : 3.
In Johnson's specimen, ...	$2\frac{1}{2}$ inches.	$8\frac{1}{2}$ inches.	nearly 1 : $3\frac{1}{2}$.
In Mitchill's specimen, ...	3 inches.	14 inches.	nearly 1 : 5.
In Harwood's specimen,[1] . . .	...	20 inches.	about 1 : 7.

3. Mitchill describes the white lines along the dorsal and anal fins, whilst Harwood says nothing about them. Johnson's specimen, which without any doubt is identical with Harwood's fish, has the dorsal lines very distinct, and traces of the anal lines barely visible; it, therefore, agrees in this singular point with Mitchill's fish.

4. The length of the tail would be naturally subject to great variation, its posterior portion being as delicate as the most slender fin-filament; and specimens in which this part is mutilated must be as common as those in which it is intact; probably it is readily reproduced. For this reason I cannot attach any weight to the various statements with regard to the extent to which the dorsal and anal fins are continued towards the extremity of the tail. The longest and perhaps the most perfect tail was observed in Mitchill's specimen, in which it was four times the length of the body, with the dorsal and anal fins continued to its extremity. In the three other specimens the tail is respectively only one and a half times, two and a half times, and thrice as long as the body, and every trace of the dorsal and anal is lost at a greater or lesser distance from its extremity.

5. Mr. Johnson lays particular stress upon a series of free filaments apparently starting from the skin of the back, and described by Mitchill as accompanying the dorsal fin for a considerable distance; they were about one inch in length and some fifty in number. These filaments are certainly not to be seen in the Madeiran fish, but were present in Harwood's specimen, as he mentions them, and some are clearly shown in his figure. As Mr. Johnson nevertheless justly considers his fish to be identical with Harwood's, he should not have relied upon this character as indicating the specific distinctness of his and Mitchill's specimens.

6. All four specimens agree in the dorsal fin commencing at a considerable distance behind the head, and at a short distance in front of the vent.

These considerations led me some twenty-four years ago to the conclusion that there is no sufficient evidence of these specimens being representatives of distinct species; and as no fresh light has been thrown upon this question by the recent discoveries of either the French or the North American surveying vessels, I see no reason to abandon the view then expressed.

[1] Harwood does not give the measurements; the proportion has been ascertained from the figure, allowing for the foreshortening of the curved jaws.

Saccopharynx pelecanoides.

Eurypharynx pelecanoides, Vaillant, Comptes rendus, 1882, vol. xcv. p. 1226.[1]

Both jaws possess merely feeble dental granulations, but the lower jaw is armed in front with a pair of slender curved teeth (2 mm. long). The length of the jaws is about one-half of that of the body. The origin of the dorsal fin is nearer to the end of the snout than to the vent; neither the dorsal nor the anal fin reach the end of the tail (which terminates in a small skinny lobe). Gill-opening a very small round opening. No bluish-white line along the back.

Known from a specimen, 18½ inches long, of which the body takes about 6 inches; it was captured during the cruise of the French surveying vessel "Travailleur," on the coast of Morocco, at a depth of 2300 meters. The tail has much the appearance of having been mutilated during the life of the fish.[2]

Saccopharynx bairdii.

Saccopharynx flagellum, Goode and Bean, Bull. Mus. Comp. Zoöl., vol. x., 1883, p. 223; Proc. U.S. Nat. Mus., vol. vii., 1885, p. 65.
Gastrostomus bairdii, Gill and Ryder, Proc. U.S. Nat. Mus., vol. vii., 1885, p. 271.

Jaws with minute acute conical teeth, depressed inwards in a very narrow band, without fangs at the extremity of the lower jaw. The length of the jaws is more than one-half of that of the body (distance of the snout from the anal fin). The origin of the dorsal fin is nearer to the end of the snout than to the origin of the anal; neither the dorsal nor the anal fin reach the end of the tail. Gill-openings narrow. No bluish-white line along the back.

This form is based on four specimens obtained by the North American surveying vessels between lat. 35° and 40° N., and long. 65° and 74° W., at depths of 389, 898, 1309, and 1467 fathoms. One of these specimens is 18½ inches long, of which the body apparently takes 6½ inches. It is uncertain whether these specimens are specifically distinct from *Saccopharynx pelecanoides;* indeed, Mr. Jordan,[3] in referring to the fishes of this genus says with very good reason "the species are little known and possibly all forms of a single one."

[1] The typical specimen has been figured in a woodcut in "*La Nature*," 1883.

[2] Whilst this sheet is passing through the press, we learn from Perrier, Les Explorations Sous-Marines, Paris, 1886, 8vo, p. 56, that a second specimen was discovered by the naturalists of the "Talisman" off Mogador. No mention is made of any differences which may exist between the two specimens.

[3] Catalogue of the Fishes known to inhabit the Waters of North America, 1885, p. 57.

Group Nemichthyina, Gthr.

Nemichthys, Richards.[1]

Nemichthys scolopacea.

Nemichthys scolopacea, Richards, Voy. Samar. Fish., p. 25, pl. x. figs. 1–3.
„ „ Günth., Fish., p. 21.
„ „ Jordan and Gilbert, Synops. Fish. N. Amer., p. 366.
„ „ Goode and Bean, Bull. Mus. Comp. Zoöl., vol. x., 1883, p. 225.
Leptorhynchus leuchtenbergii, Lowe, Mém. Savans Étrang. St. Petersb., vol. vii., 1854, p. 171.
Belonopsis leuchtenbergii, Brandt, *ibid.*, p. 174, c. fig.

The dorsal fin commences immediately behind the occiput, and the anal behind the vent. Vent below the middle of the pectoral fin. The diameter of the eye is two-fifths, and the greatest depth of the head two-thirds of the length of the postorbital portion of the head.

The larger of the two specimens in the British Museum, which is probably the type of Lowe's description, is 33 inches long, and was caught at Madeira. The U.S. Fish Commission has obtained many specimens by means of the trawl off New England, in depths of from 304 to 1047 fathoms.

Nemichthys avocetta.

Nemichthys avocetta, Jordan and Gilbert, Proc. U.S. Nat. Mus., vol. iii., 1881, p. 409; Synops. Fish. N. Amer., p. 367.

This species, which is perhaps not specifically distinct from *Nemichthys scolopacea*, is characterised thus:—"Head slenderer, its depth one-ninth its greatest length. Eye large, one-third the head, without snout. Length of pectoral scarcely greater than height of anal, which is scarcely less than the greatest depth of the body, and more than the greatest depth of the head. Translucent; belly with close-set dark spots, its lower edge and anal fin black, the back abruptly white and unspotted."

One specimen, 22 inches long, was captured at the surface in Puget's Sound; its movements in the water are said to have been extremely active.

[1] Some fishes obtained by the U.S. Fish Commission, off the coast of New England, belong to this or perhaps an allied genus, but are, at present, too imperfectly described to deserve more than a passing notice, viz., *Serrivomer beanii*, stated to be "the stoutest of the family, and with much shorter jaws than any other, and with a very formidable vomerine armature"; 21 inches long, from 855 fathoms. *Spinivomer goodei*, name given to a young specimen 130 mm. long, from 2361 fathoms. *Labichthys carinatus* and *Labichthys elongatus*, with "the tail abruptly truncated," about 16 and 20 inches long, from respectively 906 and 1628 fathoms. Gill, *Proc. U.S. Nat. Mus.*, vol. vi., 1884, pp. 260–262.

Nemichthys infans (Pl. LXIII. fig. B).

Nemichthys infans, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 251.

Body much less elongate and eye much smaller than in *Nemichthys scolopacea*. Vent twice or thrice as distant from the root of the pectorals as is the latter from the eye.

Habitat.—Mid-Atlantic, Station 101; depth, 2500 fathoms. One specimen, 11 inches long.

Off Pernambuco, Station 121; depth, 500 fathoms. One specimen, $7\frac{1}{2}$ inches long.

Besides these two specimens the British Museum has received a third from the Mona Channel in the West Indies, which was found attached to an old telegraph cable that had been laid at the depth of 814 fathoms; it is 14 inches long, but had a great part of its body mutilated during life. This specimen, which is better preserved than the two others, will be referred to as specimen C in the following description.

The body, although compressed, is rather fleshy, in its anterior portion lower and narrower than the head, but becoming broader and wider behind, the terminal portion tapering again, but retaining a thin muscular covering to the very end (fig. B‴). In specimen C (which is figured) the body was mutilated during life at a short distance behind the point where it attained its greatest depth, and the mutilated part is surrounded by a rather broad fin, in which a number of branched fin-rays have been developed.

The hind part of the head is subquadrangular, nearly as deep as broad. Eye without circular fold, of moderate size, its diameter being about one-third of its distance from the pectoral fin, and about twice the width of the interorbital space. The snout is produced into the same long slender bill as in *Nemichthys scolopacea*. The extremities of the upper and lower jaws terminate in two small swollen knobs (fig. B″) in the two smaller specimens, which are not observable in specimen C. The asperities with which the beak is armed in its entire length, are in the form of minute imbricate scale-like denticles, the points of which are directed backwards (fig. B′). The cleft of the mouth extends a little behind the eye.

The gill-openings are nearly as wide as the orbit, obliquely directed towards the median line of the belly and rather close together. In specimen C the vent is nearly three times as distant from the pectoral fin as this latter is from the eye, but the distance is comparatively less in the two smaller specimens.

The dorsal fin commences immediately behind the pectoral, and is throughout composed of extremely delicate rays; of these only the anterior are distinctly connected by membrane, all the others are free and probably non-erectile. The anal fin commences immediately behind the vent, and is more developed than the dorsal, its rays being stronger and longer; only its anterior rays are delicate and rudimentary like those of the dorsal fin. Pectoral fin well developed, with broad base, as long as the body is high, its point being directed upwards. The lateral line runs along the middle of the side and is composed of conspicuous and rather widely-set pores. It can be traced to the extremity of the tail.

Coloration black; jaws, pectoral fin, and lower part of the abdomen of a lighter colour.

One of the specimens had in its stomach the remains of two large shrimps.

The figure of the entire specimen is of the natural size, that of the head twice the natural size. B′ is an enlarged view of a portion of the dentition of the upper jaw; B″ the end of the upper jaw of one of the small specimens, much magnified; B‴ end of tail of the same specimen, slightly enlarged.

Cyema.

Cyema, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 251.

This genus combines the form of the snout of a *Nemichthys* with the soft short body of a *Leptocephalus;* but the gill-openings are very narrow, and close together on the abdominal surface. Vent in about the middle of the length of the body; vertical fin well developed, confined to and interrupted at the extremity of the tail. Pectoral fins well developed. Eye very small.

Cyema atrum (Pl. LIV. fig. D).

Cyema atrum, Günth., Ann. and Mag. Nat. Hist., 1878, vol. ii. p. 251.

The cleft of the mouth extends backwards to the end of the head. Black.

Habitat.—South Pacific, Station 295; depth, 1500 fathoms. One specimen, $4\frac{1}{2}$ inches long.

Antarctic Ocean, Station 158; depth, 1800 fathoms. One specimen, $4\frac{2}{3}$ inches long.

The body is compressed, band-shaped, soft like that of a *Leptocephalus*, but, for an eel, short, its depth being one-twelfth of its length, the head not included; it is nearly of uniform depth throughout its length, except close to the end where it gradually becomes narrower, the end itself being rounded. The postorbital part of the head is compressed like the body; in front of the eye, which is minute, the snout tapers into the very long and slender beak, both jaws being armed with a broad band of asperities or teeth. The upper jaw shows at about half its length a distinct swelling, in front of which the jaws coalesce into the tapering simple extremity of the beak; the dentiferous parts of the jaw diverge behind the swelling, leaving a depression between them in which a narrow band of asperities runs well backwards along the median line (fig. *d*). The asperities are subimbricate and arranged in transverse series (fig. *d′*); those of the median band being rather lanceolate in shape. Cleft of the mouth extending to the end of the head, the jaws being toothed to their posterior extremity.

Nostrils, two minute openings in front of the eyes; gill-openings very small, close together at the lower surface of the body, immediately in front of the base of the pectoral but at some distance from the angle of the lower jaw (fig. d'').

Vent midway between the angle of the lower jaw and the extremity of the tail; the vertical fin is well developed, but does not surround the extremity of the tail, showing a distinct break between the neural and hæmal portions. The dorsal fin commences opposite to the vent and is composed of numerous closely set delicate but very distinct rays. The rays are longest on the narrow portion of the tail, but rapidly decrease in length backwards. The anal is entirely similar to the dorsal as regards structure and extent. Pectoral well developed, composed of about twelve rays, its distance from the eye being two-fifths of that from the vent.

Lateral line inconspicuous, running along the middle of the tail.

Coloration uniform black.

This form is extremely interesting, inasmuch as it is still nearer to the Leptocephalid condition than *Nemichthys infans*. In fact, I had to consider the possibility of its being a less advanced stage of development of that species; however, the minute size of the eye disposes of the idea of genetic affinity. Possibly some of the long forms of *Leptocephalus* are the offspring of this and the preceding genus.

PLECTOGNATHI.

The fishes of this order are littoral and a few only pelagic forms; none show in any part of their organisation special adaptation for a bathybial existence. All are bad swimmers. It is therefore not improbable that of the following two species, at least the *Monacanthus* was caught near to the surface.

Triacanthodes, Blkr.

One species only is known.

Triacanthodes anomalus, Schleg.

Triacanthodes anomalus, Günth., Report on the Shore Fishes, Zool. Chall. Exp., pt. vi. p. 50.

This species was hitherto known from Japan only. Specimens were obtained at Ki Island, Station 192, where the trawl brought up a great number of new and interesting forms from a depth of 140 fathoms.

Monacanthus, Cuv.

None of the numerous species of this genus, which is spread all over the tropical and subtropical seas, have ever been recorded from deep water, with the exception of the following.

Monacanthus tessellatus.

Monacanthus tessellatus, Günth., Report on the Shore Fishes, Zool. Chall. Exp., pt. vi. p. 54, pl. xxiii. fig. B.

One specimen, 5 inches long, was obtained at the Philippine Islands, Station 204, where the trawl descended to a depth of 115 fathoms.

CYCLOSTOMATA.

Myxine, L.

The habits and vertical distribution of all the Myxinidæ are probably the same, but we possess positive information on these points in the case of two species only.

Myxine glutinosa, L.

The common North Atlantic species is locally abundant at small depths, as, for instance, in the Norwegian Fjords, at 70 fathoms. Messrs. Goode and Bean have found it in the collections made on the Atlantic coast of North America, at depths of from 172 to 524 fathoms.[1]

Myxine australis (Jenyns).

This species, which is common on the coast of the southern extremity of the American continent, occurs also in the Japanese Sea, half a dozen specimens from 9 to 20 inches long having been taken on the *Hyalonema* ground at a depth of 345 fathoms (Station 232). I also believe that *Heptatrema cirrhatum* of Schlegel, should be referred to the same species. The three foremost teeth of the inner series are invariably confluent at the base, but in adult specimens they are neither longer nor stouter than the next succeeding. The branchial apertures are subject to some variation, a specimen from Magellan Strait having two on the left side and one on the right. Also the pores of the lateral line may be sometimes very distinct, sometimes scarcely conspicuous; and it appears to me that the smaller foramina represented in Schlegel's figure of *Heptatrema cirrhatum* are nothing else but those of the lateral line, which in the specimen figured were unusually conspicuous, as I have also seen them in specimens from Magellan Strait.

Finally, a Lamprey has also once been obtained at a depth of 547 fathoms in the Atlantic, lat. 40° 0′ N., long. 68° 50′ W., and noted as *Petromyzon* (*Bathymyzon*) *bairdii*, which is said to be distinguished from other Lampreys by the obsolescence of the cusps of the dental laminæ. No indication is given as regards the size of the specimens.[2]

[1] *Bull. Mus. Comp. Zoöl.*, vol. x., 1883, p. 226; and *Proc. U.S. Nat. Mus.*, vol. iii., 1881, p. 486.
[2] Gill, *Proc. U.S. Nat. Mus.*, vol. vi., 1884, p. 254.

ADDENDA.

On page 15 add :— *Polyprion*, Cuv.

Polyprion cernium, Val.

Polyprion cernium, Lowe, Fish. Madeira, p. 183.

Not rare in the Mediterranean, and the neighbouring parts of the Atlantic. Young specimens live near the surface, but the largest occur at Madeira in depths of from 300 to 400 fathoms.

On page 41 add :— *Thyrsites*, C. V.

Thyrsites pretiosus, Cocco.

Aplurus simplex, Lowe, Fish. Madeira, p. 121.

The "Escolar," one of the best food-fishes of Madeira and the West Indies, lives habitually at moderate depths, and is taken with the line by Madeiran fishermen at a depth of 300 or 400 fathoms.

Thyrsites prometheus, C. V.

Prometheus atlanticus, Lowe, Fish. Madeira, p. 141.

Not uncommon at moderate depths at Madeira and St. Helena; frequently taken at the former island at depths varying from 100 to 400 fathoms.

On page 49 add :— *Notothenia*, Richards.

Notothenia mizops.

Notothenia mizops, Günth., Report on the Shore Fishes, Zool. Chall. Exp., pt. vi. p. 16, pl. viii. fig. D.

Several specimens, from $1\frac{1}{2}$ to 6 inches long were caught in 120 fathoms off Kerguelen Island.

On page 121 add :— *Ophidium*, Cuv.

Ophidium murænolepis.

Ophidium murænolepis, Günth., Report on the Shore Fishes, Zool. Chall. Exp., pt. 6, p. 46, pl. xx. fig. A.

One specimen, 7 inches long, was obtained at Ki Island, Station 192, in 140 fathoms.

APPENDIX A.

REPORT on the STRUCTURE of the PECULIAR ORGANS on the HEAD of IPNOPS. By Professor H. N. MOSELEY, F.R.S. (Pls. LXVII., LXVIII.).

IN the General Report on the Scientific Results of the Voyage of H.M.S. Challenger,[1] some account is given of the structure of the peculiar organs existing on the head of *Ipnops murrayi*. As there stated, Mr. John Murray was the first to examine these organs by means of sections, and point out their remarkable peculiarities. He concluded that the organs were organs of luminosity, and Dr. Günther formed the same opinion from his examinations of the specimens. Mr. Murray kindly placed his sections at my disposal; they did not show any structure very clearly, and being misled by an unlabelled slide placed with the rest and containing a section of the retina of some ordinary teleostean fish, and which I attributed to *Ipnops*, I formed the opinion that the peculiar organs of that fish were essentially retinal in structure, and hence arrived at the conclusion that the organs must be regarded as modified organs of vision.

Mr. Murray's preparations not being sufficient for any definite conclusions as to the structure and relations of the peculiar organs, Dr. Günther kindly placed a perfect specimen of *Ipnops* at my disposal for a detailed examination, and on making a complete series of sections of the head I found no trace of any retina-like organ and soon realised my mistake. The peculiar organs have in reality no connection with organs of vision. The eyes, as well as the optic nerves, are entirely aborted in the fish, and the organs are apparently not sensory at all, but most probably phosphorescent, as Dr. Günther and Mr. Murray at first concluded. I have to express my thanks to Sir Henry Acland, K.C.B., Librarian of the Radcliffe Library, for permitting me to publish the drawing reproduced on Pl. LXVII. by the artist of the Library.

I shall term the organs the phosphorescent organs, for the purposes of description here.

The organs are paired expanses completely symmetrical in outline, placed on either side of the median line of the upper flattened surface of the head of the fish, and extending from a line a little posterior to the nasal capsules nearly to a point above the posterior extremity of the cranial cavity. They are covered by the upper wall of the

[1] Narr. Chall. Exp., vol. i., part i., p. 239.

skull, which is extremely thin and completely transparent in the region lying over them. This upper wall consists of membrane and membrane bone, but I was unable to ascertain the exact extension of the latter, since I had no macerated specimen to refer to and was obliged to decalcify the one used for sections. Where the bony matter is thinnest it appears as a more or less open network of very fine spicules embedded in the membrane. The margins of the phosphorescent organs are extremely clearly defined, because they bear at their edge a special band of dark pigment (Pl. LXVII.).

The organs rest in a pair of elongate cavities, one on either side of skull. These cavities are separated from one another by a longitudinal median septum, which in their anterior region is composed of a vertical plate of cartilage continuous with a horizontal plate of cartilage which forms the roof of the mouth cavity. The floors of the cavities are nearly flat, but owing to the rising in height of the septum and roof of the skull posteriorly, the cavities there become deeper, and are deepest in the region indicated by the letter *a* (Pl. LXVIII. fig. 1) immediately on either side of the base of the median septum. Probably these regions represent the former position of the orbital cavities, and the septum the interorbital septum, although all trace of eyes has disappeared. The skull-roof lying immediately over these areas forms a pair of convex cornea-like prominences (Pl. LXVIII. fig. 1, *a*). Beyond these anteriorly and laterally it is flattened, and shows concentrically disposed striæ (*Ibid.*, fig. 1, *b*). On either side of the median septum the skull-wall is traversed by a long closed canal (fig. 1, *T*). These canals are seen in section in fig. 2, and contain organs which in spirit are opaque, white, apparently mucous canals, and also transmit a nerve on each side to the nasal capsule, no doubt the nasal branch of the fifth nerve. The canals are continued outwards obliquely from a point coinciding nearly with the commencement of the cranial cavity and brain, and thus mark off a posterior region (*d*) of the phosphorescent organs.

The phosphorescent organs form membranous structures about 0·04 mm. in thickness, which are stretched over the entire floors of the two cavities described. They probably, in the recent state of the animal, lie close to the floors of the cavities. They rise vertically up the sides of the median septum as they extend inwards towards the middle line on either hand, and thus present their free edges to view on either side of the septum when viewed through the skull-roof from above. Their edges are similarly turned up to the surface all along their margins, and lie all round immediately in contact with the transparent skull-roof (Pl. LXVIII. fig. 2, *W. V.*).

The view of the phosphorescent organs is completely obstructed by the bony canals (fig. 1, *T*) and thus on either side of the median septum there appear to be isolated strips of the organ. The posterior areas of the phosphorescent organs (fig. 1, *d*) appear somewhat isolated as they lie immediately above the roof of the cranial region of the skull, and thus very near to the surface. In contrast with them the immediately adjoining regions of the organs which occupy the floors of the orbital (?) cavities (fig. 1, *a*) lie so deep as to be almost or quite invisible from the surface. It is only in the regions where the phosphorescent organs lie very near the skull-roof, that their component hexagonal bodies can be seen with a microscope in the uninjured condition of the fish.

The phosphorescent organ is of identical structure throughout its extent, and no difference in its composition could be detected in its various regions. When it is viewed from above it is seen to be marked over its entire upper surface with a series of hexagonal areas of about 0·04 mm. in diameter. When its surface is viewed by reflected light, the appearance is of a number of glistening, white, isolated, short columns, hexagonal in outline, standing up in relief from its basal membrane (Pl. LXVIII. fig. 3). The organ forms a continuous membranous expanse about 0·04 mm. in thickness, excluding the connective tissue and vascular layer. It is composed of the hexagonal columnar masses arranged with considerable regularity in rows, and resting inferiorly on a pigmented connective tissue layer. Each hexagonal column is composed of a number (about thirty or forty) of transparent rods disposed side by side at right angles to the outer surface of the organ, and with their bases applied against the concave surface of a large hexagonal pigment-cell, one of which forms the base of each hexagonal column. The basal pigment-cells (figs. 10, 14) are hexagonal in outline and are cup-like, concavo-convex in form and of the same breadth as the hexagonal columns. The under surface of the phosphorescent organ is thus covered with a series of hexagonal areas each presenting a rounded convex prominence (fig. 5, *c*). The outer extremity of each rod is surmounted by a hexagonal nucleated cell (Pl. LXVIII. figs. 5, 6, 7).

In stained sections (fig. 5) each phosphorescent organ is seen to be composed of three strata; the superficial layer of cells (*e*) deeply stained, the layer of rods very little stained and the layer of pigmented-cells (*c*) conspicuous by its dark brown colour.

The superficial layer is composed of cells all alike, of hexagonal outline, each with a large nucleus filled with fine granules. The protoplasm of the cells also contains granules. These cells are present in exactly the same number as the rods, and each when *in situ* forms the summit of the rod beneath it. The cells of this layer are closely connected together and the layer composed of them is frequently found in microscopic sections separated as a continuous sheet from large areas of the organ, leaving the ends of the rods exposed.

The rods (figs. 6, 7) are more or less regularly hexagonal in section apparently perfectly clear, hyaline and transparent in structure. They appear to taper slightly towards their lower extremities where they rest on the concave surfaces of the hexagonal pigment-cells. In some few preparations I have seen a highly stained small oval nucleus present in the lower extremities of certain rods, but have failed to detect such in the large majority of instances (fig. 8).

The basal hexagonal pigment-cells have each a well-marked nucleus. Their substance is full of fine brown pigment granules (fig. 6, *d*). They form an apparently continuous pigmented layer at the base of the phosphorescent organ, but the lines of separation of the margins of the cells can be clearly detected with a high power of the microscope (fig. 6).

The phosphorescent organs are traversed by small blood-vessels (figs. 4, 6), in abundance. These vessels may be seen ramifying in the organs when viewed by a strong light in the uninjured fish. They appear to be more or less correspondingly arranged on the organs of opposite sides. The capillary vessels appear to traverse the organs superficially to the pigment-cells and amongst the bases of the rods, since the tips of the rods may be detected as present above them by careful focussing when an organ is viewed from the surface.

When a portion of a phosphorescent organ is examined with a deep focus from the surface, a network of ramifying pigmented strings and fibres is observed, which lies just above the hexagonal pigment-cells and includes the hexagonal columns in its meshes (figs. 6, 12, 13, 14). The pigmented strings follow mostly the lines of junction of the margins of the hexagonal pigment-cells and thus surround the bases of the hexagonal columns, but they also form long main stems extending for considerable distances in a definite direction, and give off numerous connecting offsets which may directly cross the hexagonal areas. They also send vertical offsets up between the columns which give off fine ramifications and form partial networks at the surface of the phosphorescent organs, amongst or just below the superficial cells. The strings are very deeply coloured by the presence of dark brown pigment-granules. They show enlargements at their points of junction, and these enlargements contain in their interior small masses of pigment darker than the general pigment.

Beneath the components of the phosphorescent organs already described is a layer of connective tissue, which contains numerous large ramified pigment-cells such as occur commonly in the pigmented tissues of other fishes, and which is also traversed by nerves and blood-vessels (figs. 15, 16). I am uncertain whether in the recent condition this connective tissue layer is always in close relation with the under surface of the phosphorescent organ. It is frequently found widely separated from it in my sections, but I think it most probable that, in the recent condition of the animal, it lies closely applied to the floor and against the walls of the phosphorescent organ cavity, with the under surface of the phosphorescent organ closely applied to and in contact with it. It is shown in fig. 2 as seen in an actual section, where it is detached both from the phosphorescent organ and the floor of its cavity, excepting towards the outer margin of the latter. It is attached towards the middle line to the sides of the ethmoid septum where the latter unites with the ridge of the roof of the skull. No doubt it supplies nerves and blood-vessels to the phosphorescent organs. Blood-vessels are frequently seen in sections attached to the under surface of the phosphorescent organ by parts of the connective-tissue layer, as shown in fig. 6. In some instances these blood-vessels are seen to give off branches to join the capillaries within the substance of the phosphorescent organ. I have also traced nerve-fibres from the connective-tissue layer to the region of the pigmented hexagonal cells, but have not been able to observe any satisfactory connection between them and the elements of the organ.

The phosphorescent organs receive a specially rich blood supply, in the form of a pair of large vertically directed branches of the main blood-stems traversing the base of the skull, apparently the carotids.

I have not found any distinguishable traces of rudimentary eyes or of optic nerves in the *Ipnops* examined. The Gasserian ganglia are specially large and well developed, composed of numerous large multipolar ganglion cells, and although no distinct nerve connection has been traced, there appears to be little doubt that the nerves passing to the phosphorescent organ from the connective tissue layer originate from the fifth nerve. No trace has been found of any other source of nerve supply for the organ. It is just possible that the network of pigmented strings may have some connection with the nerve-system.

The phosphorescent organs can hardly be sense-organs since they appear to be supplied with no special nerves but only by ordinary nerves. They are certainly not modified eyes.

The richness of their blood supply is in favour of their being phosphorescent organs, as is also the extreme transparency of the portion of the roof of the skull covering them.

They can scarcely be electric, since there is an entire absence of the definite connective-tissue walls of insulation between the hexagonal bodies so characteristic of electric organs. No olfactory nerve was found in the sections of *Ipnops*, and apparently the nasal organs are in a condition of abeyance of function. No olfactory membrane was detected in them.

The auditory nerve is well developed.

The interstices between the muscular fibres of the specimen examined are everywhere crowded with parasitic psorosperms (spores of Myxosporidia) of pseudonavicellar shape, showing that fish are not free from the attacks of Sporozoa at great depths.

Comparison of the Phosphorescent Organs of Ipnops with allied Organs of other Scopelids.

The phosphorescent organs of *Ipnops* show in certain points of structure a close affinity with the so-called " eye-like bodies " of other Scopelids, as described by Ussow, Leydig[1] and other authors, whilst in others they differ from them most remarkably. Moreover, in some points of structure they resemble the organs of one genus of Scopelids, in others those of other genera, thus combining the peculiarities of several.

Thus the rod layer in *Ipnops* is closely similar in general appearance to the unbroken

[1] Die augenähnlichen Organe der Fische, Bonn, 1881.

layer of narrow transparent rods present in the accessory eye of *Stomias anguilliformis* as figured by Ussow[1] (Tab. ii. fig. 10, *b*); but the component rods here, as in all allied organs of fishes as yet described, have no hexagonal terminal nucleated cells attached to their extremities. Moreover, the hexagonal cells (?) forming the layer beneath the rods are in *Stomias* filled with iridescent rod bodies ("Flitterchen" of Leydig), forming what Ussow, who holds the organs to be eyes, calls a tapetum; whilst in the case of the organs of *Ipnops* no such iridescent layer is present, but only in its place a layer of hexagonal pigmented nucleated cells exactly like that occupying a similar position in the corresponding organ of *Chauliodus sloani* (Ussow, *loc. cit.*, Tab. ii. fig. 8). In this organ of *Chauliodus*, however, the rod-like bodies bear scarcely any resemblance to those of *Ipnops*, being immensely long, with one extremity club-shaped and the other drawn out into a fine filament. A still more important difference is the absence of any trace of the lens-like bodies present in the organs both of *Chauliodus* and *Stomias*. There seems to be no trace at all of the iridescent structures in *Ipnops*. Leydig appears to question the accuracy of Ussow's determination of the polygonal pigmented objects as cells in every instance,[2] but there can be no doubt that the bodies forming the layer beneath the rod layer in the organs of *Ipnops* are cells, since they have a well-defined nucleus, which may be well stained with carmine. On the whole, though the organs of *Ipnops* show to some extent corresponding structure to the "augenähnliche Organen" of Leydig it is evidently rather with the two other groups of his classification (Leydig, *loc. cit.*, pp. 64, 70, 73), the "Glasperlen-ähnlichen Organe" and the "Leuchtorgane," that they are most closely allied. The former are described as slight plate-like depressions of the outer skin surface with a dome-like transparent roof, with the following structure in all species. An outer brown pigmented capsule, a layer with a metallic iridescence, a connective tissue gelatinous body, nerves and blood-vessels. In many species there is present besides a spindle-shaped string or plate of homogeneous granular constitution.

The organ in *Ipnops* possesses the nerves though apparently not so richly developed, the blood-vessels and the brown pigmented capsule, and a representative of the layer with the metallic glance, in the hexagonal pigmented cells devoid of such glance. It has no trace of a gelatinous body, but the spindle-shaped string or plate may be represented in it by the rod layer. In the glass-bead-like organs of *Scopelus rissoi*, the plate shows a striate arrangement of its component granules (Leydig, *loc. cit.*, p. 45).

Leydig examined the two pairs of phosphorescent organs on the head of *Scopelus rafinesquii*, but unfortunately for lack of material was unable to make out a complete account of their histology; he, however, convinced himself that their structure is

[1] M. Ussow, Ueber den Bau der sogenannten augenähnlichen Flecken einiger Knochenfische, *Bull. Soc. des Naturalistes de Moscou*, 1879.

[2] Leydig, Die augenähnlichen Organe der Fische, Bonn, 1881, pp. 71, 72.

closely like that of the pearl spot on the tail of *Scopelus humboldtii*. These phosphorescent organs or "Leuchtorgane" differ from the glass-bead organs in having no gelatinous refractive media. They have the pigment capsule, the blood-vessels, and the layer of polygonal elements, with metallic glance, like the glass-bead organs, and inside this layer a layer of substance which is to be regarded (Leydig, *loc. cit.*, p. 73) as a specialisation and expansion of the spindle-shaped plate of the glass-bead organs.

This inner substance ought to be homologous with the rod layer in *Ipnops*, but unfortunately its structure as described is very indefinite, probably from the imperfection of the material used. In the phosphorescent organs of *Scopelus rafinesquii* it is stated to be a grey layer of a peculiar transparent homogeneous fine granular substance. In the pearl spot organ on the back of the tail of *Scopelus humboldtii*, it is said not to be composed of cell elements, but made of very finely granular material traversed by channels through which the blood-vessels pass. Nevertheless, on side view, an appearance is seen as if it were composed of pear-shaped elements (Leydig, *loc. cit.*, pp. 53, 54). From the figure given of the microscopical structure of this layer (Leydig, *loc., cit.*, Taf. x. fig. 61), and the description of its peculiarities, it seems possible that it may eventually prove to be made up of fine rods something like those composing the rod layer in *Ipnops*. The small blood-vessels traverse the layer just as in the case of the rod layer of *Ipnops*. Leydig describes the cell elements lying next to the tapetum in the eye-like organs of some fishes as approaching in form and power of refraction the crystalline rods of Arthropoda; these must surely be identical with the rod bodies of *Ipnops* (Leydig, *loc. cit.*, p. 80).

On the whole, it seems not unlikely that the remarkable head organs of *Ipnops* are to be regarded as highly specialised and enormously enlarged representatives of the phosphorescent organs on the heads of such allied Scopelidæ as *Scopelus rafinesquii* and *Scopelus metopoclampus* (Leydig, *loc. cit.*, Taf. x. figs. 55, 56). It may be conceived that in *Ipnops* the supra-nasal and subocular phosphorescent organ of these species on either side have united and become one, with the result of the total obliteration of the eye. In *Scopelus metopoclampus* there is a notch which nearly separates the subocular organ into two parts. In the organs of *Ipnops* there is a similar notch due to an incursion inwards of their pigmented borders on either side (see Pl. LXVII.), but it lies on the outer, not on the inner margin of each organ.

The phosphorescent organs in *Ipnops* lie entirely outside the cavity of the cranium, although they sink over part of their anterior region into two cavities on either side of the median septum of the skull. Posteriorly they lie quite close to the skin surface on the top of the cranial wall. The margins of the rod layer and pigment layers are everywhere superficial. The exact extent to which the transparent roof of the organ is ossified was not made out, as no specimen was available for maceration. The organs are bounded interiorly by the connective tissue pigment-bearing layer, no doubt of dermic origin, as in the organs of the Scopelidæ.

The most important point in which the organs of *Ipnops* appear to differ from the group of allied organs in fishes generally as yet described seems to be the nature of the rod layer. The rods in *Ipnops* are hexagonal in section and show no tendency to taper to fine filaments at either end. At the free end directed towards the exterior and the light, they are capped by very definite and distinct hexagonal nucleated cells, which easily become detached from them as a continuous membranous sheet. At their opposite extremities the rods abut on the concave surfaces of the hexagonal pigment-cells by broad hexagonal bases, as may be seen by viewing their ends through the substance of these cells. No arrangement of rods such as this has been described in any phosphorescent or allied organ from a fish. The absence of tapetal plates is a matter of less importance. They seem to be represented by the hexagonal pigmented cells. The brown pigmented network described as traversing the basal regions of the rod layer in *Ipnops*, and sending up fine branches which ramify at its surface, apparently corresponds with the "Fachwerk" traversing the grey body in the eye-like bodies of other fishes (Leydig, *loc. cit.*, p. 68). This network is the only structure which I have found in *Ipnops* which would in any way correspond with the structures figured by Ussow as ganglion cells in what he terms the retina of the eye-like bodies of *Chauliodus sloani* (Ussow, *loc. cit.*, Taf. ii. fig. 7).

APPENDIX B.

REPORT on the STRUCTURE of the PHOSPHORESCENT ORGANS of FISHES. By R. VON LENDENFELD, Ph.D., F.L.S., Assistant and Demonstrator in the Biological Laboratory of University College, London.

PREFACE.

MOST of the deep-sea fishes and also some pelagic surface fishes of nocturnal habits collected during the voyage of H.M.S. Challenger, possess certain organs which appear to have the function of producing light—in the case of deep-sea forms—to illuminate the eternally dark abysses of the ocean.

Dr. Günther, whilst engaged in the examination of the fishes collected by H.M.S. Challenger, intrusted me with the histological investigation of these organs in such specimens as could be spared for this object, and the results of these researches will be found in the following pages. It is my pleasant duty here to express my thanks to Dr. Günther for his great kindness in assisting me to bring these studies to a successful issue.

Although the specimens examined by me are for the most part remarkably well preserved, still the most minute histological details would have remained doubtful on some points, if I had not had other material, specially preserved for histological purposes, to compare with the Challenger specimens. Where it was necessary I have embodied in this Report the descriptions of the structure of the phosphorescent organs in such specimens. I must express my thanks to Professor Ray Lankester who placed some excellent material for this work at my disposal, and in whose laboratory the necessary series of sections were prepared.

The phosphorescent organs were studied principally by means of series of sections, cut in the usual manner after embedding in paraffin; they were stained with Kleinenberg's hæmatoxylin, borax-carmine, alum-carmine, or picrocarmine. The last named produced the best results.

CONTENTS.

I. HISTORICAL INTRODUCTION.

Before entering into the results of this research it may be advantageous to bring to the recollection of the reader the investigations on this subject published by other authors. In doing so I shall strictly confine myself to the papers on the Histology of these organs.

The first who paid special attention to the histology of these organs was R. Leuckart,[1] who called them "accessorische Augen."

Afterwards, Ussow[2] published a short account of these organs. He examined *Chauliodus, Stomias, Scopelus,* and *Argyropelecus,* and came to the conclusion that in these genera the organs in question were, as Leuckart had assumed, accessory and segmentally grouped eyes. Their structure is compared with that of the so-called composite organs with a simple cornea.

Ussow compares them directly with the ocellar segmentally distributed accessory eyes of *Euphausia*.[3]

Afterwards, Ussow studied these structures in some other species, and published a very detailed account[4] of his researches, which were made on the organs of the following species:—

Astronesthes martensii.
Stomias anguilliformis.
Stomias barbatus.
Chauliodus sloani.
Chauliodus setinotus.
Scopelus rissoi.
Maurolicus amethystina-punctatus.
Gonostoma denudatum.
Argyropelecus hemigymnus.

It appears that he only examined those organs which are designated ocellar organs in this Report. He did not extend his investigations to those found chiefly on the head, which I call glandular organs. He comes to the conclusion that those which are more simple in their structure are glandular in function, although they have no external opening. I can endorse Ussow's descriptions and figures of these organs.

The more complicated organs, which are incised near the middle, and which are designated below as "composite ocellar," are considered by Ussow as eyes.

His descriptions and figures of these are not in accordance with the results obtained by Leydig and myself.

[1] R. Leuckart, Ueber muthmassliche Nebenaugen bei einem Fische, *Bericht ü. d. Versamml. deutsch. Naturf.*, 1864.

[2] M. Ussow, *Arbeiten d. Gesellsch. d. Naturf. St. Petersb.*, Bd. v. p. 70, 1874.

[3] According to G. O. Sars (Report on the Schizopoda collected by H.M.S. Challenger, Zool. Chall. Exp., part xxxvii.) these are not eyes but phosphorescent organs.

[4] M. Ussow, Ueber den Bau der sogenannten augenähnlichen Flecken einiger Knochenfische, *Bull. Soc. imp. des Nat. Moscou*, t. liv. No. 1, p. 79, 1879.

The most important work on this subject has been published by Leydig,[1] who examined the following species :—

Gonostoma denudatum.	*Scopelus humboldtii.*
Ichthyococcus ovatus.	*Scopelus benoiti.*
Ichthyoccocus palmeriæ.	*Scopelus bonapartii.*
Argyropelecus hemigymnus.	*Scopelus rafinesquii.*
Scopelus rissoi.	*Scopelus metopoclampus.*

Leydig divides the organs examined by him and described by previous authors into three groups :—" Augenähnliche Organe," " Glasperlenähnliche Organe," and " Leucht-organe."

The meaning of these terms as compared with those used by Ussow and myself will be explained below.

The description given of the microscopic structure of these organs I am able to endorse ; but minute details are not described, and most of the material at Leydig's disposal was not in very good condition.

Leydig considers these organs as " electric or pseudoelectric." This positive statement appears rather vague, but his negative assertions, however, are very decisive. He combats the view held by Ussow (*loc. cit.*) particularly, that these organs are accessory eyes, and he decides with equal emphasis that they are not glandular.

He acknowledges that they may emit light, but he thinks that this is not their primary or principal function. He considers them as pseudoelectric apparatus which may in some cases emit light.

From this it appears that the physiological results are not at all in proportion to the excellence and extent of the facts and observations on the subject hitherto ascertained.

Emery[2] has published a description of the minute structure of the phosphorescent organs of *Scopelus*. He gives a correct figure, but has failed to observe the cells described below, which appear so very peculiar, and which, being found in all these organs, may be considered as their principal constituents.

He considers the reflector at the back of the organ to be an inverted scale, and says that the organ is covered by another scale, which has been converted into a lens. He considers these organs to be phosphorescent.

I shall now enter on the results of my own studies on this subject, postponing the consideration of their physiological and general results to the end of this Report.

Although these organs appear to be of uniform histological structure in different groups of fishes, they nevertheless present such differences in shape, distribution, and origin in the different groups that it appears advantageous to dwell on the different forms separately.

[1] F. Leydig, Die augenähnlichen Organe der Fische, 10 pls., Bonn (E. Strauss), 1881.
[2] E. Emery, *Mittheil. d. zool. Station zu Neapel*, Bd. v.

II. THE DIVERSITY OF THE PHOSPHORESCENT ORGANS.

The following species were examined by me :—

Opostomias micripnus.
Echiostoma barbatum.
Pachystomias microdon.
Malacosteus indicus.
Astronesthes niger.
Argyropelecus hemigymnus.
Sternoptyx diaphana.
Scopelus benoiti.
Xenodermichthys nodulosus.
Halosaurus macrochir.
Halosaurus rostratus.

In these fishes a great many different kinds of phosphorescent organs are met with, and all the various forms described by Ussow, Leydig and Emery, are represented in one or more of them.

I distinguish twelve different kinds of phosphorescent organs in these fishes, which may be divided into two main groups.

Scattered more or less regularly in segmental distribution over the ventral side or the whole of the body, small, regular, bulbous organs sunk into the body are met with, which have been designated by Ussow as "augenähnliche Organe" and by Leydig as "augenähnliche" and "glasperlenähnliche" organs.

I term these "regular ocellar phosphorescent organs." They may be "simple" or "compound." The former correspond to those organs which are described as glandular by Ussow and partly also to the "augenähnlichen Organe" of Leydig. The latter, the compound regular ocellar phosphorescent organs, are particularly the ones considered as "augenähnliche" and "glasperlenähnliche" organs by the authors mentioned.

The simple ocellar organ is more or less spherical, closed on all sides and generally partly invested by a pigment coat; its internal structure appears radial.

The composite ocellar organ is divided into two parts, an interior closed spherical portion divided by an annular incision from the cup-shaped external portion. Sometimes several of these composite organs stand close together, and then their spherical basal portions may coalesce so as to form a canal or tube, to one side of which the cup-shaped outer portions of the joined organs are attached.

The simple ocellar organs may or may not have a pigment coat.

The composite organs always have a pigment coat, but they may or may not be provided with a layer of threads or spicules, which shine like silver, refract the light strongly, and act as reflectors. The composite ocellar organs with reflectors are identical with Leydig's "glasperlenähnliche" organs. They are always very oblique to the surface, whilst those which are destitute of a light-reflecting layer appear generally more or less perpendicular to the outer surface.

Exceptionally also simple ocellar organs are found attached to the outer surface of the body and appear as spherical projections.

The lateral line may be converted into a series of ocellar phosphorescent organs, every one of the scales which cover the lateral slime-canal bearing on its outer surface a phosphorescent organ connected with the tissue below by a central perforation of the scale.

We have, therefore, the following six kinds of regular ocellar phosphorescent organs :—

1. Regular ocellar simple phosphorescent organs sunk in the body, without pigment coat and without reflector.
2. Regular ocellar simple phosphorescent organs sunk in the body, with pigment coat and without reflector.
3. Regular ocellar composite phosphorescent organs sunk in the body, without reflector.
4. Regular ocellar composite phosphorescent organs sunk in the body, with reflector.
5. Regular ocellar simple phosphorescent organs attached outside to the body.
6. Regular ocellar organs attached to the differentiated lateral line.

The irregular glandular phosphorescent organs are always found on the head, and besides, sometimes also on the sides of the body (*Astronesthes*), on the tail (some species of *Scopelus*, Leydig), and on specially differentiated barbels (*Opostomias micripnus*, *Malacosteus indicus*).

These have not been taken notice of by Ussow; they are designated by Leydig as "Leuchtorgane."

Six kinds of glandular organs are met with :—

1. Glandular organs scattered irregularly.
2. Glandular organs on the lower jaw.
3. Glandular organs on the barbels.
4. Glandular organs under the gill-cover.
5. Suborbital, highly differentiated glandular phosphorescent organs without reflectors, and
6. With reflectors.

These may accordingly be with or without reflectors. A pigment coat is, however, invariably present in all the different kinds of irregular glandular phosphorescent organs.

The following table shows how these various kinds of phosphorescent organs are distributed in the species examined by me :—

					Opostomias micripnus.	*Echiostoma barbatum.*	*Pachystomias microdon.*	*Malacosteus indicus.*	*Astronesthes niger.*	*Argyropelecus hemigymnus.*	*Sternoptyx diaphana.*	*Scopelus benoiti.*	*Halosaurus macrochir*	*Halosaurus rostratus.*	*Xenodermichthys nodulosus.*
Phosphorescent Organs.	Regular ocellar.	On scales of lateral line, simple, . . .		without pigment,									×	×	
		Sunk, .	simple,	without pigment,	×										
				with pigment,	×	×	×	×	×						
			composite,	without reflector, vertical,	×	×	×		×						
				with reflector, oblique,						×	×	×			
		Projecting,	simple,	with pigment,											×
	Irregular glandular.	Scattered, .	irregularly, . .						×						
			on lower jaw, . .							×	×				
		On barbels, ...			×			×							
		Under gill-cover, ...											×		
		Suborbital,	without reflector, .		×				×						
			with reflector, . .			×	×	×				×			

III. SPECIAL DESCRIPTION OF THE DIFFERENT KINDS OF PHOSPHORESCENT ORGANS.

A. Regular Ocellar Organs.

1. Simple ocellar organs without pigment coat, sunk in the body.

a. Distribution.

These organs have hitherto only been found in one species, *Opostomias micripnus*; and have not been observed by previous authors. In *Opostomias micripnus* they appear as very small white spots scattered very abundantly on the sides and back of the otherwise dark-coloured fish, and when magnified present the appearance of circular patches from 0·1 to 0·3 mm. in diameter. They are not uniformly scattered over the back of the fish, but appear in groups of from fifty to one hundred, and these groups take the shape of transverse bands, which are about 3 mm. broad, and divided from each other by darker zones in which the white organs are scarce. Within the bands the phosphorescent organs are on an average 0·7 mm. apart (from centre to centre).

Towards the ventral side these organs diminish in number and stand further and further apart, until they disappear altogether below the line formed by the upper row of composite phosphorescent organs on the side.

b. Structure.

Surface views and section-series reveal the structure of these organs (Pl. LXXII. figs. 34, 35, 37). They are mostly lens-shaped, flat and extended, and sunk into the skin of the fish for about half their height (figs. 34, 35). In other cases (fig. 37) they appear nearly hemispherical, are not sunk into the skin at all, their hemispherical surface projecting beyond the surrounding surface. The lower lens-shaped forms likewise project beyond the surface, but not so much (fig. 34). They are from 0·1 to 0·2 mm. high, and generally project about 0·07 mm. The flat lens-shaped form is predominant; the high forms being rare and intermediate shapes by no means common.

The circumference is usually spherical, sometimes slightly irregular, never elliptical.

These organs do not seem to possess any special membrane, the common cuticle passing *over* them, and the capillaries of the skin appear aggregated at the base of the organ, whence bloodvessels extend up into the organ itself. These are on an average 0·02 mm. apart, and converge towards the centre of the organ at right angles to the convex base. Between them radial tubes, rounded and closed at the distal ends, are situated, and these are filled with small granular spherical cells similar to those described by Ussow[1] in the gland tubes of the simple ocellar organs of *Gonostoma denudatum*. There is no difference between these cells and the homologous ones in the simple ocellar organs with pigment coat.

The tubes in which these granular elements are contained are polygonal pyramids, with their points cut off, and consequently their narrow converging ends, which are situated near the centre, are open. The broader rounded distal ends are attached to the tissue which is situated below the organ.

The walls of the tubes are thin membranes of connective tissue into which capillaries and nerves extend. The nerves are medullated, the sheath disappearing apparently at the points where the branches of these nerves enter the mass of granular cells.

In the material at my disposal the extreme nerve ends cannot be traced. Near the centre of the organ, above the terminations of these pyramidal tubes, there is an empty space extending right across the organ; it has a shape somewhat similar to that of the

[1] M. Ussow, Ueber den Bau der sogenannten augenähnlichen Flecken einiger Knochenfische, *Bull. Soc. imp. des Nat. Moscou*, t. liv. p. 98, pl. iii. fig. 11.

organ itself, and is only lower and flatter in proportion. This space is not altogether "empty" as the expression "empty space" might imply, for it appears filled by a finely granular mass, evidently the secretion of the tubes containing the granular cells; it is, however, destitute of cells. Above this space, very narrow, slender and long cells are situated which are perpendicular to the outer convex surface of the organ, and extend between it and the central cavity, above referred to. These cells are spindle-shaped, tapering to fine points at each end, and have elongated, oval nuclei, and in consequence of their shape and position give to this part of the organ a radially striped appearance. Just below the outer surface there is a granular zone about 0·01 mm. wide, with spherical nuclei, but in this zone the radial structure is rather obscured by the granules. The whole structure is exceedingly transparent and possesses—in spirit—that peculiar white colour which is so characteristic of all these organs.

c. *Innervation.*

The medullary nerves found in the walls of the pyramidal tubes originate from fibres which extend along the lower surface of the organ; the latter form a kind of plexus in that locality, which is connected with nerves belonging to the system of the spinal nerves. The plexus and the branches which connect it with the spinal system are modified dermal nerves.

d. *Function.*

From these facts we may conclude that these organs are composed of a gland, consisting of closely packed and therefore flattened and polygonal tubes, on the lower side, and a special phosphorescent apparatus above, which produces light at the volition of the fish by using up or burning the secretion supplied by the gland and stored in the space below. This phosphorescent apparatus is innervated from above, where a layer of ganglion cells—the granular layer with the spherical nuclei—is found.

The state of preservation of these organs is not sufficiently good to allow of a more detailed description, but the whole structure is so similar to that of some other organs to be described, which I was able to study by means of excellent material, that I consider myself justified in referring for further details to the descriptions of the phosphorescent apparatus in the suborbital organs of *Opostomias micripnus*, and the composite ocellar organs in *Scopelus benoiti*.

At the first glance these organs, scattered in dense crowds over the fish, remind one of the chromatophores of Cephalopods, and they are in all probability defensive arrangements to frighten away fish of prey, which may attack them from above. Probably the fish, by simultaneously exciting certain groups of these organs, is able to emit light from these areas. As the organs in different regions of the surface are successively incited to phosphorescence, clouds of light pass over the body. This may be compared to the changing of the colour in *Sepia*, where the different hues travel over the body like shadows of clouds.

e. Development.

Remarkable structures, like those represented in Pl. LXXII. fig. 35, are occasionally met with, which seem to indicate that these organs multiply by division. As the fish grows in size, and the area to be occupied by these organs extends, it appears that they multiply, and that they are not formed spontaneously in the skin of the adult fish at all. No indications of a spontaneous formation of these organs have been observed.

From which organs in the skin these phosphorescent apparatus were originally developed phylogenetically it is difficult to say. It appears most probable that they were developed from small slime-glands of the skin, such as are found in all fish. The slime of some Batrachians is luminous, and so the slime produced by the small glands in the skin of some fishes may have *by chance* become slightly phosphorescent. This may at a certain time, particularly when the fish in question took up its abode in great depths, have become advantageous to them, and with the demand for a luminous slime the glands would naturally have been modified in the course of time, so as to produce slime more and more luminous, and afterwards, the duct leading from the gland outwards may have been closed and the luminous slime retained. The slender cells forming the upper stratum of these organs are newly formed coenogenetic structures, and indicate that these organs are already very highly differentiated.

These regular, ocellar, simple phosphorescent organs without a pigment coat are of particular interest, as from them all the other forms may be supposed to have developed. There is no doubt that these organs are by far the simplest of their kind hitherto observed, and they appear to have retained the original character, which has been much changed and further modified in the cases of the other kinds of regular ocellar phosphorescent organs.

Their phylogenetic position is elucidated in the following table :—

Regular ocellar phosphorescent organs.
- Composite, with reflector.
- Composite, without reflector.
- Simple, with pigment coat.
- Simple, without pigment.
- Small slime-glands of the skin.

2. Simple, regular, ocellar phosphorescent organs with pigment coat, sunk in the body.

a. Distribution.

These organs have been found by me in *Opostomias micripnus* and *Pachystomias microdon*, scattered all over the body at intervals of from 1 to 3 mm. In *Echiostoma barbatum* they occur in double transverse rows on the dorsal and ventral sides of the body, while in *Malacosteus indicus* and in *Astronesthes niger* they are found on the ventral side only. In these species their extent is laterally limited by the lower row of composite phosphorescent organs.

Organs which belong to this group have been found by Ussow in *Gonostoma denudatum*,[1] *Maurolicus amethystinopunctatus*,[2] and *Scopelus rissoi*,[3] and their position corresponds, according to Ussow, with that of the composite phosphorescent organs in other fishes. He seems to think that they replace the composite organs, without being aware that usually (except in *Sternoptyx* and *Argyropelecus*) they are present in great numbers together with the composite organs. Leydig has found such organs apparently in *Gonostoma denudatum*, according to the figure.[4] He describes them, however, as having a reflector.

Ussow considers that these organs have a glandular nature and terms them "drüsenartige Organe." He considers them to be homologous to those which he believes to be accessory eyes. It seems rather difficult to understand how two similar and homologous organs should be so different as Ussow would make out in this case. Some of the "augenähnlichen Organe" of Leydig, those namely which are not composite, likewise belong to this group.

These authors, however, have paid much less attention to these structures than to the much more complicated and differentiated composite organs, particularly those with a reflector, and, consequently, the great and fundamental difference between the simple and composite organs has escaped their notice. Both seem to have considered the presence or absence of the reflector to be of paramount importance, and did not consider that some organs without reflectors were constructed on quite the same principle as others which possess a reflector.

b. Structure.

The structure of these organs has been described by Ussow,[5] and his figure (pl. iii. fig. 11) gives a fair representation of the internal structure. Such differences

[1] M. Ussow, Ueber den Bau der sogenannten augenähnlichen Flecken einiger Knochenfische, *Mém. Soc. imp. des Nat. Moscou*, t. liv. pp. 97, 98, pl. iii. fig. 11.

[2] M. Ussow, *loc. cit.*, p. 101, pl. iii. fig. 12.

[3] M. Ussow, *loc. cit.*, pp. 99–100, pl. iii. fig. 13.

[4] F. Leydig, Die augenähnlichen Organe der Fische, p. 15, pl. i. fig. 6.

[5] M. Ussow, *loc. cit.*

as Ussow found in different species certainly do not exist between these organs of the various species examined by myself. The differences in Ussow's figures (pl. iii. figs. 11, 12, 13), might be accounted for by his having studied sections made in different directions.

The only form of this organ seen by me is the following :—

A sac is attached to the cuticle, which is about as deep as wide, cylindrical, rounded below, and opening outwards by a circular aperture, which is covered by a continuation of the cuticle as in the case of the simple organs without a pigment coat described above (Pl. LXIX. figs. 2, *b*, 5, 10; Pl. LXXII. fig. 38).

These sac-shaped organs measure 0·3 to 0·5 mm. in diameter. The sac (Pl. LXIX. fig. 5; Pl. LXXII. fig. 38) is formed of a dense layer of pigment, similar to the pigment found in the skin in other localities, and to the naked eye these organs therefore appear as *dark spots* scattered over the skin.

These pigment-sacs, which appear very striking and prominent in sections, are generally slightly expanded at the base and contracted near the mouth (Pl. LXIX. fig. 5), with their axis sometimes perpendicular to the surface of the skin (Pl. LXIX. fig. 5) as in *Astronesthes*, and sometimes oblique (Pl. LXXII. fig. 38), as in *Echiostoma barbatum*. The thickness of the pigment-layer forming this sac is 0·02 mm. The sac is surrounded by a loose plexus of bloodvessels[1] and nerves, from both of which branches arise and penetrate the pigment-layer. The cornea-like continuation of the cuticle which closes the sac is convex, watch-glass-shaped (see figures).

The internal structure appears to be very similar to that of the simple organs without a pigment coat. The lower, proximal part of the sac is occupied by radially placed pyramidal gland-tubes, closely packed, and, therefore, flattened against each other. Their wide distal ends are rounded, and nerves and bloodvessels radiate upwards between the tubes. The membranes forming the tubes are very fine, and the tubes have an average width of 0·04 mm. at the base and 0·02 mm. at the distal, open end.

These tubes are *filled* with spherical or slightly irregular granular cells, which are very similar to those attached to the wall of the gland-tube. The cells have an average diameter of 0·01 mm.; Ussow[2] has given a good representation of them. In the centre of the organ, within the terminations of the gland-tubes, there is a space 0·06 mm wide, which is filled with a granular secretion.

The portion of the organ underlying the cuticle is also granular, but it is easy to perceive that this portion of the gland is occupied by cells. In Ussow's[3] figure (pl. iii. fig. 13), these cells are represented (*Scopelus rissoi*), but I have never observed them nearly so distinct. The spherical nuclei in the outermost layer, with a diameter of 0·002 mm. (which are not so large as represented in Ussow's figure, *loc. cit.*), become

[1] Compare F. Leydig, Die augenähnlichen Organe der Fische, pl. i. fig. 6.
[2] M. Ussow, *loc. cit.*
[3] M. Ussow, *loc. cit.*

clearly visible after staining. The limits of the cells, however, remain indistinct. Below this outermost layer of indistinct cells, which has a thickness of 0·026 mm., and which appears to consist of a single layer of these cells, a striated structure is met with. This fills the interval between the central cavity and the outer layer of cells. The striæ are vertical to the outer surface, and indicate that this part of the organ is composed of the same narrow slender cells described above as forming the homologous part of the simple glands without pigment coat. There is a single layer of them; they are 0·03 to 0·05 mm. long, and in the thickened centre, where the elongate nucleus is situated, 0·0015 mm. thick.

It appears from this that the only structural difference between these organs and the regular, ocellar, simple phosphorescent organs without pigment coat is the absence of the pigment coat in the one, and the presence of it in the other kind.

c. *Innervation.*

The nervous plexus which surrounds these organs is connected with branches of the spinal nerves in the same way as has been described above in the case of the organs without pigment coat.

d. *Function.*

It appears that the radial tubes in the proximal portion of the organ, which are filled with granular cells, are true gland-tubes. These glands are comparable to the milk glands in mammals, inasmuch as the secretion which is formed does not appear as a segregation of the cells, but the whole of the cell is bodily converted into the substance of the secretion. The cell is pushed from the wall of the gland-tube which is always occupied by the youngest generation of cells; and when disconnected from the capillaries in the membrane of the gland-tube the cell undergoes a change. It loses its nucleus[1] and finally also its individuality, its substance joining that of other similarly degenerated cells. In this way the secretion which occupies the centre of the organ appears to be formed.

At the expense of this secretion or fuel, the slender cells above it may produce light. The outermost layer of indistinct cells with the highly colourable nuclei I consider to be a nervous layer composed chiefly of irregular ganglion cells; the slender cells appear to be innervated from them.

The fish can probably produce light in these organs at will. They do not emit light under ordinary circumstances when not excited to phosphorescence by the fish itself.

[1] Ussow (*loc. cit.*) figures nuclei in the detached cells occupying the interior of the gland-tubes. I have not seen nuclei in the detached cells in *my* sections.

Like the organs without pigment coat, these are probably incited to action in groups and not singly, although there may be more individuality in their performance than in that of the less highly differentiated organs without pigment coat.

The function of the pigment coat is probably to shade the light at the sides, and to concentrate it in one direction, which, of course, would be of advantage to the fish. Possibly the pigment is only to be considered as a residue of the chemical reactions which go on in the organ.

e. Development.

I do not doubt that these organs have been developed from the simple phosphorescent organs without pigment coat, and that they in this way represent the second stage in the development of the ocellar phosphorescent organs of fishes. Not only does their structure indicate a much greater differentiation, but also their distribution over the surface of the fish is more sharply defined and not so irregular as in the case of the former organs.

3. Composite, ocellar, regular phosphorescent organs, without reflector.

a. Distribution.

Organs of this kind have been found by me in *Opostomias micripnus, Echiostoma barbatum, Astronesthes niger*, and *Pachystomias microdon.*

These organs invariably appear in two rows on each side of the body, one lateral and one ventral. The rows extend forwards on the lower side of the head, a row on the projecting crest of a fold below the operculum being especially conspicuous.

Ussow [1] has described the distribution of these organs over the body very carefully. The organs in one row are from 2·5 to 5 mm. apart according to the size of the species. Large specimens possess a much greater number of them than small ones.

The organs which Ussow calls "augenähnliche Organe" in *Astronesthes martensii*,[2] *Stomias barbatus*,[3] and *Chauliodus sloani*,[4] belong to this group.

Some of Leydig's "augenähnliche Organe," which he found in *Ichthyococcus ovatus* [5] and in *Ichthyococcus palmeriæ*,[6] likewise belong to this group.

In all the fishes in which these organs have been found, they are distributed over the surface of the body in the same way, always occupying four lines.

In this respect the composite organs differ much from the two preceding kinds, which are scattered much more irregularly over the surface and which never occur in distinct rows.

[1] M. Ussow, *loc. cit.*, pp. 108, 109.
[2] M. Ussow, *loc. cit.*, p. 89, pl. ii. fig. 9.
[3] M. Ussow, *loc. cit.*, p. 91, pl. ii. fig. 10.
[4] M. Ussow, *loc. cit.*, p. 93, pl. ii. figs. 6, 7.
[5] F. Leydig, Die augenähnlichen Organe der Fische, p. 22, pl. vi. fig. 33.
[6] F. Leydig, *loc. cit.*, p. 25.

b. Structure.

The structure of these organs has been carefully studied by Ussow,[1] but I cannot here give a review of all his statements. The main results, however, of his examination of *Chauliodus*, *Astronesthes* and *Stomias*, are the following:—

The organ consists of two parts, divided from each other by a constriction of the wall. The outer portion is filled by a structureless liquid, the function of which is to protect the tender structures below from the pressure of water. A complicated lens which is composed of cells is situated in the constriction. It is convex in front and drawn out into a cylindrical process behind.

The lower or internal chamber, which is designated as an *eye*, is occupied by radial "Krystall Kegel." The spherical base is occupied by ganglion cells and the whole is enclosed by a pigment coat.

Leydig[2] describes these organs in *Ichthyococcus* very differently indeed. According to this author both the chambers of the composite organ are occupied by radial gland-tubes filled with the well-known spherical granular cells. In the centre, near the constriction, there is a space filled with a granular mass which is in connection with a stout nerve entering the organ from without.

My own observations made on those of the four species mentioned above, are in accordance with Leydig's (*loc. cit.*) results. I have not seen anything like the structures described by Ussow in any of the species examined by me.

Seen from the surface with the naked eye, the organs appear as dark spots with whitish centres. With a magnifying glass circular and oval patches of this kind can be distinguished. In section series we observe the following structure.

The whole organ evidently consists of two parts (Pl. LXIX. figs. 2, *a*, 3, 4; Pl. LXXI. fig. 32), an interior regularly spherical and an exterior cup-shaped part. The whole is exceedingly regular and appears as a rotation body round an axis, the leading lines of which form three-quarters of a circle for the interior part and a parabola for the external cup-shaped part.

The axis of this organ is mostly vertical to the surface as in *Astronesthes* (Pl. LXIX. fig. 3), or oblique and inclined to the surface at an angle of 30° as in *Opostomias micripnus*.

In the latter case the cup-shaped part, which is a rotation-paraboloid, appears cut off obliquely.

In the first case the organ appears, when seen from the surface, circular, in the second elliptical, otherwise there is no difference between the vertical and oblique composite phosphorescent organs.

These organs are of pretty uniform size. Usually those at the anterior ends of the

[1] M. Ussow, *loc. cit.* [2] F. Leydig, Die augenähnlichen Organe der Fische, pp. 22–24.

rows, on the head, &c., are slightly larger and more conspicuous than the others. The average measurements are :—

Radius of spherical portion,	0·15 mm.
Radius of stricture,	0·08 ,,
Depth of cup,	0·4 ,,
Radius of orifice of cup,	0·25 ,,
Focal length of the paraboloid reflector,	0·08 ,,

They are accordingly larger than the simple organs, yet much smaller than the much more highly differentiated composite phosphorescent organs, with reflectors, found in *Argyropelecus*, *Scopelus* and *Sternoptyx.* They are intermediate between these two kinds in size and differentiation of structure. The whole organ is covered, with the exception of the exposed outer surface, by a dense layer of pigment very similar to that described above as forming the sacs which enclose the simple phosphorescent organs. This layer is about 0·02 mm. thick, and it is most dense at the stricture; round the lower spherical part its thickness is greater than in the wall of the cup. Towards the margin (Pl. LXIX. fig. 3) it becomes very much thinner. This pigment is the same as that in other parts of the skin. There is a layer of pigment just below the outer surface and there are thin layers of it parallel to the *outer* surface further down which join the pigment coat of the phosphorescent organ. The nerves and bloodvessels penetrate the pigment coat. A thin but very distinct membrane (Pl. LXIX. fig. 3, *m*) is found within it, which clothes the whole of the inner surface of this coat. It is very thin, being only 0·0015 mm. in thickness, but it is conspicuous in sections in consequence of its high refractive power; it replaces functionally the complicated reflectors observed in the more highly differentiated phosphorescent organs.

The outer surface is closed by a continuation of the ordinary cuticle, which is convex (Pl. LXIX. fig. 3, *b*) and appears as an immovable cornea. Below this, *two* other thin membranes are found, the outer one of which is structureless like the cuticle, whilst the inner one consists of cells (Pl. LXIX. fig. 3). In the specimens at my disposal, these membranes were generally folded and appear collapsed, but it seemed to me that in the living state the space between the innermost and intermediate membrane (Pl. LXIX. fig. 3, *d*) is probably filled with a kind of corpus vitreum, traces of which have been observed by me in some of the sections. In that case this structure would be a *lens.* Its development, however, seems subject to specific variations. Ussow[1] in his figure of the organ in *Stomias anguilliformis* indicates a structure corresponding to that observed by me particularly in *Astronesthes niger.* I am not prepared to say to what extent the differences between these structures in different species may be due to differences in the state of preservation of the various specimens.

[1] M. Ussow, *loc. cit*, pl. ii. fig. 10B.

The cellular membrane below this supposed lens is 0·008 mm. thick, and composed of one layer of polygonal cells. This membrane extends, like the two preceding ones, beyond the orifice of the cup on every side for some distance down its sides; nuclei can be discerned in it after staining.

The light-reflecting membrane which divides the internal portion from the pigment coat is continued over the outer surface in the shape of a very fine, circular, watch-glass-shaped membrane, apparently dividing the thick cellular membrane from the interior of the phosphorescent organ.

It appears from this that—at least in *Astronesthes*—there are four membranes outside the phosphorescent organs, as follows:—

Outermost, continuation of cuticle.

Second, convex structureless membrane.

Third, cellular membrane divided by a large space from the former, which is supposed to be occupied by a corpus vitreum in the living state.

Fourth, continuation of the special membrane of the organ.

The supposed lens would be concavo-convex, the convex surface having a shorter focus than the concave one. The action of it on light would therefore be equal to the action of a plano-convex or biconvex lens with a focal length equal to the difference of the focal lengths of the two surfaces of this structure.

The internal part, invested on all sides by the thin special membrane, is of a very complicated structure. I have referred above to the results of the studies of Ussow and Leydig on this subject, but as my own results differ from these very much in some respects, it will be necessary to describe these structures, as seen by me, in detail.

The internal spherical portion is occupied by radial, pyramidal, closely-packed and flattened gland-tubes, and in the centre of this part there is a space, as in the similar simple organs, into which the gland-tubes open.

The gland-tubes correspond to Ussow's "Kristallstäbchen," and the empty space in the interior to the lower extension of his "lens"[1] of *Chauliodus sloanei*.

Leydig's representation of the organ of *Ichthyococcus ovatus*[2] corresponds well with my own results, and in the four species possessing such organs examined by me this structure is identical.

The gland-tubes are formed of very fine membranes into which blood-vessels extend, and are 0·02 mm. wide at the base. The central space—the lumen of the gland—is about 0·1 mm. wide, and extended in a plane parallel to the surface.

The gland-tubes are filled with spherical granular cells similar to those described above from the gland-tubes of the simple phosphorescent organs.

The gland-tubes are closed at their distal ends by convex membranes projecting

[1] M. Ussow, *loc. cit.*, pl. ii. fig. 6.
[2] F. Leydig, Die augenähnlichen Organe der Fische, pl. vi. fig. 33.

centrifugally, but these do not reach to the investing membrane. They are, moreover, divided from it by a layer of cells and fibres 0·024 mm. in thickness.

There is a single layer of irregular cells with an average diameter of 0·01 mm. (Pl. LXXI. fig. 33, *c*) lying close to the inner surface of the membrane (*b*). Their nuclei are conspicuous, spherical, and can be readily stained. Between and over these cells, which are divided by small intervals, fine fibres running in all directions (Pl. LXXI. fig. 33), are found together with numerous bloodvessels. These fibres extend up into the partitions dividing the lower portions of the centrifugal parts of the gland-tubes from each other.

With a low power this layer of cells and fibres appears as a granular zone (Pl. LXXI. fig. 32). It corresponds to that of *Chauliodus sloanei* figured by Ussow (*loc. cit.*) in fig. 7, pl. ii. Above the central space or lumen of the gland, which is usually occupied by the granular non-transparent secretion, a disc, which deserves particular attention, is situated, and occupies the whole of the constriction, and in this way completely divides the contents of the spherical from those of the cup-shaped part of the organ. It is 0·16 mm. broad, circular, expanded in a plane vertical to the axis of the organ, and 0·1 mm. thick. The upper external surface is flat, whilst the lower surface, looking towards the interior of the spherical part, appears slightly convex and projecting in the centre into the lumen of the gland (Pl. LXIX. fig. 3).

This disc is divided by a kind of diaphragm, which is not very distinct, into two portions, an external and an internal. The diaphragm appears as a continuation of the inner membrane, stretched out within the projecting ring of the incision which divides the cup-shaped from the spherical portion of the organ.

The whole of the disc is composed of large irregular cells, which readily become stained and contain large spherical nuclei, 0·008 mm. in diameter, which then appear exceedingly prominent. Although the contours of the cells are not very distinct, I have been able to see them in the organs of all the specimens examined by me.

This double disc of large cells is very conspicuous; it corresponds, as far as its position is concerned, with Ussow's[1] "lens." Leydig[2] represents it as a portion of the granular secretion occupying the lumen of the gland.

The space above this disc—the cup—is filled with a somewhat granular substance in which radial lines are very clearly visible with a low power (Pl. LXXII. fig. 32). A similar radial structure has been observed in this part of the organ by Ussow[3] and Leydig[4]; but while the former supposes it to be caused by irregular threads pervading the structureless substance filling the cup, the latter sees in it the expression of radial gland-tubes similar to those found in the lower spherical portion of the organ.

[1] M. Ussow, *loc. cit.*, pl. ii. fig. 6 *k*, *l*.
[2] F. Leydig, *loc. cit.*, pl. vi. fig. 33.
[3] M. Ussow, *loc. cit.*, pl. ii. fig. 6, *x*.
[4] F. Leydig, *loc. cit.*, pl. vi. fig. 33.

There can be no doubt that these structures in the species examined by me are in no way similar to those described by Ussow; I find, however, a difference between them and the gland-tubes of the internal spherical part, which has not been noticed by Leydig.

At first sight it appears that the radial lines in the part occupying the cup are much closer together than in the interior of the sperical portion of the phosphorescent organs. Spherical cells, as in the latter part, cannot be distinguished so readily in the cup, and the substance also seems to be more transparent and less granular. The radial stripes are much closer together in *Echiostoma* than in *Astronesthes*.

The structure of this part of the organ is the following:—

From the disc of large granular cells, situated at the constriction, fibres originate, which extend upwards in a vertical direction towards and nearly to the outer surface, terminating 0·04 mm. below it.

They extend below to a trumpet-shaped, thickened base, and become more and more slender distally. They are in direct connection with the substance of the basal disc, and interspersed with granular spindle-shaped cells which appear more abundant in the basal than in the distal part of the fibres. These spindle-shaped cells have spherical nuclei identical with the nuclei in the cells of the disc. The bulk of the fibres seem to be composed of nerves; bloodvessels have not been observed in them.

The fibres are on an average 0·025 mm. apart. Their structure is very transparent and they appear closer than they really are in longitudinal sections, because one generally sees several layers of them, but transverse sections show their true distance.

Attached to each of these fibres are cells, generally long and slender but sometimes also stout and spindle-shaped, in such a way that one layer of them encloses each fibre. These cells appear to be attached to the fibres by one of their ends and they project from the fibres like the hairs on the tail of a squirrel. Sometimes, particularly when the cells are very slender, they extend nearly parallel to the fibres and produce the closely striated appearance of this structure which is observed in some cases (Pl. LXXI. fig. 33). Sometimes, particularly where the cells are stout, they radiate from the fibres in an oblique direction, never exceeding an angle of 45°, and they invariably point outwards.

These cells are very tender and transparent, their nuclei easily escape observation in specimens not specially preserved, and their contours can only be distinguished by means of very fine sections and good lenses. Under ordinary circumstances this whole mass appears structureless and granular.

If we now compare this description with the statements of Ussow and Leydig, mentioned above, we find that although the differences are great, still the observations are not altogether incompatible.

Ussow's observation of the organ in the fresh state in *Chauliodus* shows us that there is a transparent substance with radial lines in this part of it.

It appears highly probable that the whole structure is very transparent in the fresh state, and that the delicate cells, which appear granular in spirit specimens, are then difficult to distinguish. Perhaps Ussow has failed to see their contours and nuclei. The radial fibres described by him entirely correspond to the fibres observed by me.

Leydig represents this structure in his figures as consisting of radial tubes, which he considers as glandular.

Between the squirrel-tail-like columns of cells with the central fibre, very slender membranes, likewise containing nerves as well as capillaries, are found. These membranes coalesce with the watch-glass-shaped external portion of the membrane and are thickened near their base. They divide the fibres with their cell columns completely, as may be observed in longitudinal, but much better in transverse sections which are properly stained.

These polygonal tubes are identical with the tubes observed by Leydig and are not so distinct as the gland-tubes of the spherical part, but similar to them.

Ussow has not observed them, whilst Leydig and myself have found them without exception. According to Leydig, however, they are filled with spherical granular cells, similar to those in the proximal spherical portion of the phosphorescent organ. Leydig's material was not very good and this statement must therefore be accepted with caution.

c. *Innervation.*

Leydig[1] has discovered the mode of innervation of these organs. According to him, a thick nerve enters it by penetrating the pigment coat and intima, *near the central constriction*, which divides the spherical from the cup-shaped portion. It then spreads out and joins the granular mass in the centre.

To these observations, which I can corroborate, I have to add that the nerve is a branch of a spinal nerve, and where there are two composite organs on each side of each segment, the nerves supplying them join a little way above the upper organ of the two. They are the thickest branches of the spinal nerves, and all other branches originate from them in such a way as clearly to indicate that they form the stem of the distal two-thirds of the spinal nerve. The two composite phosphorescent organs appear to be situated at the terminations of the two main branches into which the spinal nerve divides.

I have mentioned above that Leydig's "central granular mass" is identical with the granular secretion in the centre of the spherical glandular portion, *together with* the disc of large granular cells situated in the constriction. The nerves of course terminate *in the disc*, and not in the secretion. Here they become non-medullated. Other, but very much smaller and quite insignificant nerve-fibres are also found attached to the spherical

[1] F. Leydig, Die augenähnlichen Organe der Fische.

part. There are generally two or three such nerves, which apparently have nothing to do with the large nerve supplying the central disc.

Ussow's representation of the innervation of the organs in *Stomias anguilliformis*, where a single nerve is said to enter at the back of the spherical part, does not coincide with Leydig's observations or my own.

The innervation of these organs corresponds to that of the simple phosphorescent organs above described, and in every case the nerves supplying them are branches of *spinal* nerves.

d. Function.

It is not very difficult to perceive the functions of the different parts of these organs. The pigment coat prevents the light from issuing in any other direction than that indicated by the axis of the organ.

The membrane which reflects the light produced within the organ is, in consequence of its shape, very well adapted for the purpose of concentrating the light in one cone.

The optical action of this reflecting membrane is illustrated in Pl. LXIX. fig. 4. The spherical part reflects all the rays of light which are thrown in a centripetal direction, until they pass from it into the cup-shaped portion. As the cup has the shape of a rotation-paraboloid, all the light which issues from the focus of the parabola will be reflected parallel to the axis of the optical system, whilst light coming from other points in the neighbourhood of the focus will be reflected in a more or less similar direction, so that *all* the light produced within the organ issues from it in the shape of a cone, the axis of which is the continuation of the axis of the optical system. The light passing through the concavo-convex lens is further concentrated and may be emitted from the fish as an intense flash in the direction of the axis.

There are muscles surrounding these phosphorescent organs, but it is doubtful whether the organs are movable. If they were, the fish could of course throw flashes of light from them in any desired direction, and by setting the axes of all the organs of one side in the same direction, might produce a "broadside" of light-flashes sufficient to illuminate objects at some distance.

There can hardly be any doubt that the spherical part of the organ is filled with a glandular structure. The cells of the layer found just within the membrana propria are probably ganglion cells in connection with the nerves which supply this part of the organ. The gland-tubes are morphologically very similar to those in the simple organs, and produce a granular secretion by the same process of direct conversion of cell-substance into secretion. The secretion accumulates in the space below the disc, and the disc itself is evidently composed of ganglion cells, which are in connection with the large nerve, to be designated after its discoverer, Leydig's nerve.

The really phosphorescent apparatus is to be sought in the cells which occupy the cavity of the cup, and which are evidently connected with the ganglion-cells by means of the radial fibres issuing from the disc.

The structure is intermediate between the simple form in the simple ocellar phosphorescent organs and the more complicated structure of the composite organs with special reflector, to be described below.

The fish can at its option incite the organ, which under ordinary circumstances is non-luminous, to phosphorescence. The voluntary impulse is transmitted by the thick nerve of Leydig to the disc of ganglion cells, which excite the phosphorescent cells in the cup to action by means of the radial nerve-fibres.

The phosphorescence of the latter requires, however, the secretion of the gland in the sphere as fuel, in a manner similar to that which has been described in the simple organs.

The secretion passes through the disc and the radial fibres to its destination, where it is consumed to produce light.

e. Development.

Although no transitional forms have been observed by me, I do not doubt that these composite phosphorescent organs have been developed from the simple ones by continued differentiation of the parts. During this progress of development the shape, which is very variable in the simple organs, has been determined. Their number has been reduced and likewise determined, together with their position. From a great number of undifferentiated organs scattered irregularly over the surface of the body, a small number of more highly differentiated organs, with a definite position, has been evolved.

4. Composite ocellar organs, with special reflector.

a. Distribution.

These most highly differentiated phosphorescent organs have been found by me in *Argyropelecus hemigymnus*, *Sternoptyx diaphana*, and *Scopelus benoiti*, whilst Ussow[1] has seen them in *Argyropelecus hemigymnus* and designates them as "drüsenähnliche Organe." Leydig,[2] who designates them as "glasperlenartige Organe," has found them in *Gonostoma denudatum*, *Argyropelecus hemigymnus*, *Scopelus rissoi*, *Scopelus humboldtii*, *Scopelus benoiti*, *Scopelus bonapartii*, *Scopelus rafinesquii*, and *Scopelus metopoclampus*.

The number of these organs and their distribution on the body are very regular, and

[1] M. Ussow, *loc. cit.*, p. 108. [2] M. Ussow, *loc. cit.*

as they are large and striking in appearance, they strongly characterise the species which possess them.

In the different species they are distributed as follows:—

Argyropelecus hemigymnus.—A row of six anterior to the pectoral fin, a row of twelve ventral, close to the median plane of the body, and three groups on the sides, in the vicinity of the anal fin. The groups are formed by the breaking up of the two lateral rows of phosphorescent organs observed in other fishes, the upper row furnishing three, and the lower two groups. All the organs point downwards.

Sternoptyx diaphana.—A row of nine large organs on the ventral side, close to the median plane, representing the lower row, and two groups of three organs in each, above, on the side, representing the upper row (Pl. LXX. figs. 15, 17). All point downwards.

Scopelus benoiti.—One organ in the middle of the back, behind the dorsal fin, pointing backwards. The organs of the lateral rows have retained their original shape and distribution.

Scopelus, other species.—I cannot give an account of the distribution of these organs in other species, as Leydig does not specially mention these peculiar unpaired organs behind the dorsal fin which are so characteristic of *Scopelus.* Sometimes there are more organs than one in that locality, in some species as many as five, one behind the other, and they always point backwards.

Gonostoma denudatum.—In two lateral rows like the composite organs without reflectors (Leydig).

b. Structure.

a. General.

The structure of these organs is more complicated than that of the organs without reflectors, and there are very essential differences between the two, although they are similar to a certain extent in shape, and formed on the same principle. They may be single and isolated, as for instance the organs on the back of *Scopelus benoiti,* here designated "stern-chasers"; the rule, however, is that several are placed together, with their sides in contact, and that their spherical interior portions coalesce to a certain extent. Such a coalescence of course produces a canal, from the outer side of which the cup-shaped portions of the organs project (Pl. LXX. figs. 17, 18, 20). Such structures are never produced by the union of phosphorescent composite organs without reflectors. These organs with reflectors are always very oblique, so much so that the axis is inclined towards the surface of the fish at an angle, never exceeding 10°. Generally this angle is smaller and the axis often appears nearly parallel to the surface. The spherical portion is more elliptical than in the organs above described, and appears sac-shaped.

The paraboloid cups are in a very slanting position. And as they meet the surface very obliquely, the outline which is the intersection of the cup, and the surface appears as a very elongate ellipse. The ventral organs which lie at the extremity of the body in the median line have a circular outline, because they are situated close to the ventral margin of the laterally compressed body.

These ellipses are very conspicuous; they appear surrounded by a dark line of pigment, whilst they shine with a brilliant silvery lustre in the centre. They measure 1 to 2 by 3 to 6 mm. in diameter. A dark mass—the pigment coat of the sac-shaped portion—is attached to one end and looms through the semitransparent skin of the fish.

The two rows of ventral organs of *Argyropelecus* and also of *Sternoptyx* approach each other so closely in the median line of the body that they are nearly in contact (Pl. LXX. fig. 17). Their orifices (Pl. LXX. fig. 19), therefore, appear nearly square, the cups becoming by mutual compression prismatically four-sided in their outer portions.

In external appearance there is a great difference in these organs, although the internal structure is the same in all. Four varieties may be distinguished.

(1) *The organs of Gonostoma.*

These have been studied by Leydig.[1] I have not seen any specimens of this genus; but they do *not* coalesce like the other varieties and resemble more the composite phosphorescent organs without reflectors. They are smaller than the other varieties and not so oblique. Leydig gives no detailed description of their shape.

(2) *The dorsal organs or "stern-chasers" of Scopelus.*

The sac-shaped portions do not coalesce, and the constriction dividing the sac-shaped and cup-shaped portion is very conspicuous, it is circular and has a diameter of 0·3 mm. The axis is nearly parallel to the surface. The cup-shaped portion is a rotation-paraboloid with very small focal length, about 0·1 mm. The cup terminates on the surface with a very elongate, elliptical contour measuring 1 by 4 mm., and the posterior margin approaches the constriction to within 0·2 mm. The sac-shaped proximal part of the organ is elongate, conical, tapering towards the rounded end, and widest just below the constriction, where it has a width of nearly 1 mm. It is 2·5 mm. long.

The sizes vary according to the species; the more numerous these stern-chasers are, the smaller they appear to be. The largest are possessed by those species which have only a single one.

The proportions are always as indicated by the above numbers, and the shape of the organ is constant.

[1] F. Leydig, *loc. cit.*, p. 12.

(3) *The groups of lateral organs in Argyropelecus and Sternoptyx.*

These groups consist of from three to five organs, the sacs of which coalesce. Generally there are three (Pl. LXX. figs. 22, 23, 24). The constriction is circular and has a diameter of 0·1 mm., and the plane in which it lies is perpendicular to the axis. The axis is nearly parallel to the surface. The cup-shaped portions are rotation-paraboloids, and the line with which they terminate on the surface of the fish is a very elongate ellipse measuring 1·5 by 5 mm. This circumference touches the constriction, that is to say, only one side of the cup, namely the lower, is developed (Pl. LXX. fig. 23). The focal length of the paraboloid is 0·1 mm.

The sac-shaped portions of the organs coalesce to form an irregular flattened sac, with from three to five circular apertures on one side, the original strictures of the organs.

Seen from the surface this combined sac is in the triplex organ of *Sternoptyx* nearly semicircular (Pl. LXX. fig. 22). In sections its flattened shape becomes apparent (Pl. LXX. fig. 23). It measures 0·3 mm. in height and 1·2 mm. in length. The width of course depends on the number of cups attached to it. In the triplex organ it is about 1·2 mm., in the quinqueplex 2 mm. In the interior of it crests or ridges can be discerned which are the remnants of the partitions between the adjacent phosphorescent organs, the internal portions of which have coalesced.

(4) *The ventral rows of Argyropelecus and Sternoptyx.*

Wherever composite ocellar phosphorescent organs are observed, they invariably form, as stated above, two lateral lines or rows on each side of the body. The groups of triplex and quinqueplex organs of *Sternoptyx* and *Argyropelecus* mentioned above, belong to the upper of the two rows which is split up to form groups along the side of the fish.

The *lower* rows, however, remain unbroken and continuous. They approach each other very closely (Pl. LXX. fig. 17). The lower portions of the organs on both sides coalesce to form *one* large ventral canal lying in the median line of the body, from the lower side of which two rows of cups project (Pl. LXX. fig. 20). The optical axes of all the cups are parallel, and so the rays of light from all these cups are concentrated in one direction.

β *Histology.*

The histological structure of the different organs belonging to this group is pretty much the same, so that it can be dealt with in a summary manner.

The composite ocellar organ with reflector consists of three distinct layers; an outer layer of pigment, an inner coating of light-reflecting threads or spicules, and a transparent soft mass in the interior.

The pigment layer encloses the proximal portion and also extends distally with undiminished thickness to the margin of the cup (compare Pl. LXX. figs. 17–24; and Pl. LXXII. fig. 44). It consists of dark brown or black pigment-granules closely packed in the connective tissue.

The reflecting layer, which is perforated and traversed by bloodvessels and nerves leading into the interior of the organ, is very thick and hard. In some cases pigment-granules are found in the course of the bloodvessels and nerves in the perforations through this layer. Such are figured by Emery,[1] and have also been found by me in some cases, and Leydig[2] records them in the case of *Scopelus*.

The light-reflecting layer is composed of calcareous spicules which vary exceedingly in size. They are generally very thin, and may be very long and filiform, or shorter, only about fifteen times as long as thick and abruptly pointed at each end, as in *Argyropelecus*. They are closely packed, generally parallel, and are disposed longitudinally, extending from the base of the cup to the margin in meridional lines. The spicules are not round, cylindrical, but prismatic, with plane surfaces and accurately apposed to one another, there being hardly room for any substance between them. This intervening substance forming the thin sheaths of the spicules appears as connective tissue. The optical effect of this structure is very remarkable, its lustre being very brilliant in consequence of the flatness of the surfaces of the spicules.

The structure which occupies the interior of these organs, however, demands our special attention. In the proximal sacs of the complex and the solitary organs, and also in the large ventral canal of *Sternoptyx*, a glandular structure is met with. This consists of tubes which extend more or less longitudinally throughout the ventral canal of *Sternoptyx* (Pl. LXX. fig. 20), and which appear radially situated in the other cases mentioned above. In these (Pl. LXX. fig. 23) the gland-tubes are conical, attached to the wall of the sac by their broad base, and opening at the narrow end which lies just below the mouth of the sac.

These tubes are formed of a fine membrane into which bloodvessels and nerves extend, and are lined by a single layer of highly granular gland-cells, which appear about as broad as high. The lumen is generally occupied by a granular substance which may be stained very readily, and which appears to be mucus, precipitated by the action of spirit. The gland-tubes in the ventral canal of *Sternoptyx* seem to open below the bases of the cups in the corresponding position. These gland-tubes do not occupy the whole of the sac, there being an empty space just below the mouth of the sac into which

[1] E. Emery, *Mittheil. aus d. zool. Station zu Neapel*, Bd. v.
[2] F. Leydig, Die augenähnlichen Organe der Fische, pl. x. fig. 60

they pour their secretion. Here large and conspicuous spherical bodies (nuclei ?) which very readily become stained are found, surrounded by the secretion of the gland-tubes (Pl. LXX. fig. 23, *c*).

It appears from this that these structures are very similar to those described above from the proximal sac of the regular, vertical, composite organs without reflector.

The structure of the substance which occupies the distal portion of the organ or the cup, is very different and complicated.

The bloodvessels and nerves which pass through the spicule-layer extend perpendicularly to the surface. They are straight and sometimes supported by a slender cartilaginous rod, and end just below the outer surface (Pl. LXXII. fig. 44). Leydig[1] and Emery[2] describe and figure these vessels as irregularly curved and branched, but in all the specimens examined by me they were quite straight. From these vertical columns slender cells radiate, which are about half as long as the vertical bloodvessels are apart. They extend tangentially from their lower portion and radiate from the upper end in every direction, and since they are closely packed they surround the vertical vessels on all sides. In this way cylindrical or prismatic structures, rounded at their distal ends, are produced, which measure about 0·2 mm. in diameter and are 0·8 mm. high. These cylinders do not occupy the whole of the space, and do not touch each other, but appear to be separated by a substance which forms narrow partitions between the cylinders and which covers their rounded distal ends. This substance is granular and contains round nuclei which stain very readily. Outside there are one or more layers of very flat epithelial cells covering the whole organ.

The elements which compose the cylinders are of particular interest (Pl. LXXII. figs. 43, 44). There are two kinds of cells in the radiating mass which surrounds the vertical pillars, the greater number being faintly visible and indifferently spindle-shaped or cylindrical (Pl. LXXII. fig. 43, *a*). Other very peculiar club-shaped elements are found between them (Pl. LXXII. fig. 43, *b*), these widen towards the distal end and taper proximally to form a very long and comparatively slender peduncle which is about one-fourth as thick as the club-shaped end. In the latter an oval highly refracting body (Pl. LXXII. fig. 43, *c*) is situated, which apparently consists of a cavity, with a very fine wall, containing fluid. This vesicle occupies the greater part of the club-shaped end of the cell and is surrounded by a thin film of protoplasm only. Just below it the oval nucleus is situated. The protoplasm of these cells as well as the nucleus stains very readily.

The appearance of thin sections renders it probable that the proximal peduncles of these cells are in direct connection with the nerves, which extend upwards in the central pillars of the cylinders.

[1] F. Leydig, Die augenähnlichen Organe der Fische, pl. x. fig. 60.
[2] E. Emery, *Mittheil. aus d. zool. Station zu Neapel*, Bd. v.

I think that these cells are the special phosphorescent elements. I have found the same cells in a good many other kinds of phosphorescent organs of fishes, but not in all of them.

c. Innervation.

According to Leydig[1] thick nerves extend through the superficial tissue of the fish below these organs, and give off stout branches, which enter the proximal, sac-shaped, glandular portion from the side.

According to my own observations the nerve enters at the incision between the sac-shaped and distal cup-shaped parts and extends principally *below the spicule-layer underlying the latter;* there the nerve fibres form a very conspicuous plexus (Pl. LXXII. fig. 44, *g*) which occupies the space between the continuous pigment-layer and the light-reflecting spicule-layer.

From this plexus nerves are given off which, together with bloodvessels, traverse the organ perpendicularly from the bottom to the roof, extending upwards in the central pillars of the cylinders of radiating cells described above. They are, as stated, probably in direct communication with the typical phosphorescent clavate cells.

According to Leydig[2] the nerves form a plexus *within* the phosphorescent tissue in the organs of *Scopelus humboldtii.*

d. Function.

Regarding the function of these organs, we are in a more fortunate position than in regard to most of the other structures described in this Appendix, inasmuch as direct observation has shown that these organs actually emit light, so that there can be no doubt about their phosphorescent nature.

Willemoes Suhm[3] says that a *Scopelus* brought up by the trawl at night "shone like a star in the net." Guppy[4] and Günther have made similar observations. Guppy particularly was able to observe that the light is emitted *from these organs.*

It seems not improbable that the glands in the sac-shaped proximal portion of these organs produce a secretion which is poured out into the cup-shaped distal part, and there a mutual chemical action between this slime, in which also cells and nuclei are found, and the typical phosphorescent clavate cells may take place at the will of the fish, and a certain amount of light may be produced, which is reflected by the parabolic spicule-layer, and thrown out as a strong flash.

The ventral organs can illuminate the dark water below the fish for any purpose,

[1] F. Leydig, Die augenähnlichen Organe der Fische.
[2] F. Leydig, *loc. cit.*, pl. x. fig. 60.
[3] Willemoes Suhm, Challenger-Briefe, *Zeitschr. f. wiss. Zool.*, Bd. xxiv.
[4] Guppy, *Ann. and Mag. Nat. Hist.*, ser. 5, vol. ix.

whilst the dorsal stern-chasers or the solitary dorsal stern-chaser, which are invariably directed backwards, probably serve for purposes of defence, inasmuch as a strong ray of light shot forth from the stern-chaser may dazzle and frighten an enemy which is in hot pursuit of a *Scopelus*.

c. Development.

According to Emery[1] these organs are enclosed between two scales, one forming the light-reflecting layer of spicules below the cup-shaped portion, and the other a lens on the surface above it.

All these organs examined by me are destitute of a lens, and only covered by a very thin epithelium.

As these organs, with the exception of the dorsal stern-chasers, are always found in two more or less continuous lateral rows, they seem to be in some way connected with the slime-canal system.

It may be supposed that the stern-chasers have been developed in the skin independently of the lateral slime-canal.

The development of the complex organs with coalesced proximal portions from isolated ones, has been referred to above.

5. Regular ocellar projecting organs.

a. Distribution.

These organs have been only found in *Xenodermichthys nodulosus*.

They differ in a remarkable manner from all other forms, and no organs similar to these have been previously described.

They are found segmentally placed in rows on the sides of this fish.

b. Structure.

These organs appear as oval bodies, attached to the fish only by a small portion of their base, and they project freely beyond the surface, differing in this respect from all other analogous organs. Each organ is oval, about two and a half times as long as high, slightly flattened, and broader than high. One end is slightly wider and covered by a thick layer of pigment. This is directed dorsad, and is accordingly under ordinary circumstances turned upwards, while the other end is slightly narrower and looks downwards, being situated ventrally. This end is only covered by a thin transparent epithelium. The organ is about 2 mm. long and 1 mm. wide; it is attached (Pl. LXXIII. fig. 50) to the surface of the fish by a peduncle near its upper end, and apparently pendent from the base of attachment.

[1] C. Emery, *Mittheil. aus d. zool. Station zu Neapel*, Bd. v.

Externally the organ in its dorsal portion is, as mentioned above, covered by a thickly pigmented shell, which possesses a crest, projecting inwards and dividing the contents of the organ into a proximal and distal portion. In this respect this organ appears as a transition between the simple and composite ocellar organs. The side which touches the fish below the base of attachment likewise possesses a thick layer of pigment (Pl. LXXIII. fig. 50, *g*). In the lower end a few superficially situated patches of pigment are found (Pl. LXXIII. fig. 50, *k*). The proximal portion, which corresponds to the sac-shaped part of the composite ocellar organs, is occupied by a mass, which is readily stained, and which contains numerous conspicuous nuclei. The distal portion is filled with elongated cells, which extend parallel to the long axis of the organ, and accordingly point downwards; these cells are very similar to those of the cup-shaped portion of the composite ocellar organs described above. We find, namely, slender spindle-shaped cells (Pl. LXXIII. fig. 51), and the typical phosphorescent clavate cells (Pl. LXXIII. figs. 52, 53, 50, *i*), the club-shaped ends of which are situated distally. They do not form one single regular layer, but are scattered throughout the whole of the distal portion of the organ. The vesicle which reflects the light sometimes appears to be divided into two portions (Pl. LXXIII. fig. 53), but generally it is simple and oval, like the vesicles described above.

c. *Innervation.*

A very stout nerve enters the organ at the base of attachment and extends into the proximal portion (Pl. LXXIII. fig. 50, *f*, *h*). A direct connection of this nerve with the typical clavate cells is highly probable.

d. *Function.*

Within this organ no glandular portion can be discerned, but it seems not improbable that the secretion of the slime-canal system may pass into the organ. There can be no doubt that the typical clavate phosphorescent cells are the light-producing elements of the organ.

e. *Development.*

It appears that these organs are developed in a similar manner to those sunk in the body, which have been described above. The peculiar structures of the same fish, which are described below, may throw some light on the origin of these organs from the slime-canal system.

f. Doubtful structures in the skin.

On the sides of the body, in close proximity to the organs described above, we find thickenings of the fibrous dermal layer, which lies outside the thick pigment-stratum of the skin (Pl. LXXIII. fig. 49). Ducts leading from the slime-canals of the skin to the outer surface pass through it, and form loops in the fibrous tissue, which is apparently quite transparent. It seems not improbable that the contents of these ducts are luminous.

6. Regular ocellar covered organs.

a. Distribution.

These organs are found in *Halosaurus macrochir* and other species of *Halosaurus*. They invariably form one single row on each side of the body, overlying the large lateral slime-canal. The scales of the lateral line are, in these fishes, much larger than the rest and form a conspicuous row on each side. They are covered by membranes. Each scale bears a transverse vertical ridge on its outer side, and behind this ridge a conspicuous spindle-shaped whitish organ is situated, which is 1 mm. broad and from 2 mm. to 3 mm. long. The ends are extended to form fine points. The long axis of the organ is vertical.

b. Structure.

a. General.

The large scales of the lateral line overlap about one-third or less, and appear slightly curved, S-shaped in longitudinal section. Outside, the row of scales is covered by two membranes, the outer one of which appears pretty continuous and attached particularly above, and loose only partially on the lower margin. The inner one extends from ridge to ridge of the successive scales (Pl. LXXIII. fig. 61, *r*). The lateral slime-canal is situated below these scales and sends branches up between them, which extend on the outer side of the proximal, anterior portion of each scale (Pl. LXXIII. fig. 61, *e*). The space between the slime-canal and the scales is filled with a peculiar tissue (Pl. LXXIII. fig. 63, *c*), and this extends outwards so as to fill the spaces between the scales; this tissue will be described below. At the sides of the slime-canal meandriform gland-tubes are met with (Pl. LXXIII. figs. 50, *b*, 59). The whole of the immersed portion of the scale is covered by a pigmented membrane (Pl. LXXIII. fig. 61, *m*). Between the pigment coat and the tissue underlying the scales a highly refracting membrane is observed. Just behind the transverse ridge a peculiar, apparently phosphorescent organ is attached outside to the middle of the scale; this is spindle-shaped and upright, and measures 1 mm. in width and 2 to 3 mm. in length in the vertical direction, being about 0·4 mm. high (in spirit specimens). Below this phosphorescent organ the scale is perforated by a conical canal leading outwards and backwards (Pl. LXXIII. fig. 61, *t*). The nerves and bloodvessels which supply the organ pass through this canal. The phosphorescent organ itself has a radiating structure.

β. *Histology.*

(1) *The scales.*

The scales have been described by Dr. Günther elsewhere in this Report, they do not show any peculiarity so far as their histological structure is concerned.

(2) *The pigmented membranes.*

The pigment does not form a perfectly continuous layer, but appears in patches, which lie pretty close together so that these membranes have a dotted appearance. They surround the scales on all sides (Pl. LXXIII. figs. 61, *l*, *m*, 62, *c*, *f*).

(3) *The light-reflecting membrane.*

The outermost layer of the scales is a very thin light-reflecting membrane, which appears in sections as a narrow dark line only, it is closely attached to the pigment-membrane below it (Pl. LXXIII. figs. 61, *n*, 62, *b*, *f*). When seen from the surface (Pl. LXXIII. fig. 54) it appears to be composed of two systems of very fine parallel threads crossing each other nearly at right angles. This structure is exceedingly minute and becomes apparent only under a very high power, and it seems probable that the silvery lustre which these membranes exhibit is produced by this structure.

(4) *The phosphorescent organ.*

The elongate spindle-shaped phosphorescent organ above mentioned appears to be connected with the tissue below by a comparatively slender canal, which passes through an oblique perforation in the scale. It is rich in bloodvessels and consists essentially of two parts. In the lower portion we find numerous and large bloodvessels, whilst between these and outside of them very elongate radially extending cells are situated, which reach from the base of the organ to the surface. Here they are curved so that their distal portion extends tangentially. These cells are mostly spindle-shaped, granular, and contain a nucleus in the centre, and between them comparatively wide transparent spaces are observed. It seems that these spindle-shaped cells are not in contact, but divided from each other by a hyaline substance. The outermost layer of the organs is as usual more granular than the remainder. In the middle of the organ these spindle-cells are vertical to the surface, but near the margin they curve outwards. At the base of the spindle-cell layer irregular ganglion cells are found. The whole organ is raised above the surface of the scale, but it is covered and protected from the outside by the above mentioned membranes.

(5) *The slime-canal and its branches.*

Below the lateral line the slime-canal is situated, and it extends in the usual way from the head to the tail. It is about 0·75 mm. wide and regularly cylindrical, with a more or less circular transverse section. Below the base of each scale it is widened, the upper side of it forming a low conical extension, from the summit of which a branch, which extends along the upper surface of the proximal part of the scale, originates. The lumen of the slime-canal is more or less circular in transverse section, and lies excentrically very close to the outer surface of the cylindrical structure. It is about one-third to one-half as wide as the whole organ (Pl. LXXIII. fig. 55, *e*); at the bases of the scales where the canal is extended, the lumen also extends (Pl. LXXIII. fig. 61, *d*). I have not observed a continuation of the lumen into the branches. The lumen of the slime-canal is more or less filled with a granular mucin-precipitate, produced by the action of the spirit, and it is surrounded by the cells of the slime-canal. Here two distinct kinds of cells are met with. Firstly, irregular, granular bi-, tri-, or multipolar cells with large, readily stainable nuclei (Pl. LXXIII. figs. 56, 57), and secondly, short cylindrical elements, with a regularly circular transverse section, transparent contents, a thick and conspicuous cell-wall, and a small shining nucleus. The former are particularly abundant in close proximity to the lumen, whilst the latter, which form by far the greater bulk of the whole structure, do not exclusively occur towards the surface, but are also met with close to the lumen, intermixed with the granular cells (Pl. LXXIII. figs. 58, 62, *g*). I consider the former to be nervous and the latter glandular. No such structures as those described by F. E. Schulze[1] were observed by me, probably because the specimens at my disposal were not sufficiently well preserved.

The branches which extend along the scales (Pl. LXXIII. figs. 61, *e*, 62, *g*) are composed of both these kinds of cells, the glandular elements being apparently very prevalent. The branches extend tangentially and coalesce to form a *flat expanded continuous layer just above the light-reflecting membrane* over the base of each scale (Pl. LXXIII. fig. 62, *g*).

(6) *The tissue overlying the slime-canal.*

The whole of the space between the slime-canal and the scales is occupied (Pl. LXXIII. figs. 61, *f*, *g*, 55, *a*, 63, *c*, 60, 62, *a*, *h*, *i*) by a peculiar structure, which consists of lenticular bodies of varying size but of uniform shape, interwoven with a tissue composed of very fine threads. These lenticular bodies are very large and numerous; they extend tangentially and appear spindle-shaped in section (Pl. LXXIII. figs. 55, 60, 61) because their margin is very thin and tangentially extended. They attain a width

[1] F. E. Schulze, Ueber die Sinnesorgane der Seitenlinie bei Fischen und Amphibien, *Archiv f. mikrosk. Anat.*, Bd. vi., 1870.

of 0·2 and a height of 0·06 mm., appearing perfectly structureless, and being formed of a solid *unstainable yellow* substance, which may perhaps be a secretion poured into these spaces.

The fibrous tissue which separates the lenticular yellow bodies from each other consists chiefly of slender spindle-shaped elements, with oval, highly stainable nuclei. There seems to exist a very fine cuticular membrane surrounding each of the lenticular bodies.

The volume of the fibrous tissue is about as great as that of the yellow substance in the lenticular bodies.

(7) *The meandriform gland-tubes.*

At the sides of the slime-canal (Pl. LXXIII. fig. 55, *b*) large and conspicuous highly stainable glands (Pl. LXXIII. fig. 59), which consist of meandriform tubes of circular transverse section and uniform width, are met with. These gland-tubes, which do not appear to open into the slime-canal, are completely filled with round cells each of which has a very distinct cell-wall, a small nucleus, and transparent hyaline contents. They are very similar to the short oval or cylindrical elements, with circular transverse section, which are found in the slime-canal (Pl. LXXIII. fig. 58).

c. *Innervation.*

I have mentioned above that I look upon the granular cells in the slime-canal as ganglion-cells. They are connected by a fine plexus, which extends up along the scales and supplies the fibrous tissue between the lenticular bodies with nerves. A large bundle of nerve-fibres, similar to that observed in other cases, is found in these organs in *Halosaurus*, in the canal leading from the chamber through the scale into the phosphorescent organ.

d. *Function.*

According to F. E. Schulze,[1] the slime-canal is to be regarded as a sense-organ, adapted to perceive vibrations of the water with wave lengths too great to be perceptible by the ear. In other words the slime-canal is a supplement to the ear, and any further development of it should, one would think, be organs of sense of a similar kind. In the abysses of the sea, where light is scanty, this organ would be particularly valuable and so we might assume that here we have a case before us, where the slime-canal sense-organ has been further developed and complicated.

The peculiar whitish colour of the organ and the light reflecting membrane which clothes the chambers might, on the other hand, lead one to assume that these organs really

[1] *Loc. cit.*

are, as is here supposed, phosphorescent; yet it seems by no means improbable that they are sense-organs. However problematical the function of this part of the organ may be, there can be no doubt that the small spindle-shaped organ attached outside to the scale is phosphorescent. It appears very similar to the suborbital organ of *Opostomias micripnus.*

In many of the phosphorescent organs of fishes, glands appear combined with slender spindle- or club-shaped elements which produce light with the aid of the secretion of the gland, in which they are immersed.

The membranes covering these phosphorescent organs in *Halosaurus* make it appear probable that we have here a similar case. The secretion of the glands observed at the sides and over the slime-canal, and probably also the slime produced in the latter itself, are stored in the lens-shaped spaces of the tissue between the scales and the slime-canal, are then poured into the pockets between the membrane and the scales, and surround the projecting phosphorescent organs, the spindle-cells of which may by the aid of the secretion produce light. The abundance of bloodvessels at the base of the organ and their great size indicate that some very energetic function goes on within it, and we may assume that this function is the production of light.

c. *Development.*

In the various species of *Halosaurus* the development of this organ from an ordinary lateral line can easily be traced. It is not indicated in *Halosaurus oweni,* and is most highly developed in *Halosaurus macrochir.*

This organ is therefore to be regarded as a further development or differentiation of that portion of the lateral slime-canal, with which it remains permanently connected.

B. Irregular Glandular Organs.

These are to be distinguished from the preceding group of regular ocellar organs by their larger size, their irregular shape, and particularly by their distribution over the surface of the body, which is never segmental.

7. Glandular organs of irregular position.

a. *Distribution.*

Such organs occur only in *Astronesthes niger,* and their histology has not been previously investigated.

On the sides of the body irregular whitish patches are observed, one usually occurring on each side over the pectoral fin (Pl. LXIX. fig. 1, *c*). The two patches on the two sides are generally not exactly opposite but are of uniform shape and size—a circumstance which proves the inconstancy of their position.

b. Structure.

In transverse sections (Pl. LXIX. figs. 6, 7, 8) the patch appears as a tangentially extended whitish mass attached outside to the highly pigmented skin. Conical threads of pigment extend upwards from the pigmented base about halfway through the organs. The proximal portion consists of a series of parallel gland-tubes placed vertically to the surface, and between these blood-vessels extend upwards, the largest of which are followed for some distance by the pigment of the skin. In this manner the dark vertical threads are formed.

The gland-tubes are filled with the usual spherical gland-cells.

The distal portion of the organ consists, in the spirit specimens at my disposal, of coagulated slime (Pl. LXIX. fig. 8) in which I have not detected any nuclei.

c. Function.

The colour of this organ is very similar to that of those phosphorescent organs described above, as to the nature of which there cannot be any doubt, whilst its structure resembles that of some of them pretty closely. Their phosphorescent or non-phosphorescent character must, however, for the present remain undetermined.

8. Glandular organ on the lower jaw.

a. Distribution.

This organ, which is situated on the lower jaw, has been found in *Sternoptyx diaphana* and *Argyropelecus hemigymnus* (Pl. LXX. figs. 15, *e*, 16).

b. Structure.

This organ consists of two different parts, an upper and a lower, the latter being much the larger. Both are situated in the median line of the fish and are symmetrical. The upper one is divided by a cartilaginous crest into a right and a left half, the lower one is undivided (*Sternoptyx*). The upper anterior margin of both organs is continuous and semicircular, but the posterior margins in both have four lobes.

The organ rests on a light-reflecting spicule-layer and consists of long straight gland-tubes, which are sac-shaped, and which commence on the posterior lobate margin and run forwards, converging at the same time to a point in the median line near the anterior margin. These tubes are filled with the ordinary spherical gland-cells.

c. Function.

The light-reflecting spicule-layer renders it sufficiently certain that this organ is phosphorescent. It illuminates the water in front of and below the fish.

9. Differentiated barbels and fin-rays.

a. Distribution.

The extraordinary barbels of *Opostomias micripnus* (Pl. LXXII. fig. 39) and *Pachystomias microdon*, which are either attached to the mouth or developed from the first ray of the pectoral fin, bear on their distal portion the organ to be described below.

b. Structure.

This organ is attached to one side of the barbel only. It consists of gland-tubes which appear closed on all sides, and which are straight and conical, tapering proximally (Pl. LXXII. fig. 36). These tubes are perpendicular to the surface of the barbel. As the central gland-tubes are the longest, the whole structure has a very oblong, oval transverse section. They are covered by a granular layer which forms a kind of sheath to the whole organ, and which extends beyond the base of it, so as to enclose the opposite side of the barbel with a thin film (Pl. LXXII. fig. 36).

c. Function.

The gland-tubes are in every respect very similar to those found in some of the undoubtedly phosphorescent organs of fishes and it may therefore be assumed that they emit light. The only use to which they might be put would be to act as lures to attract other animals.

10. Glandular organs under the gill-covers.

a. Distribution.

These organs are only found in *Halosaurus macrochir*, where they form a conspicuous white patch just behind the last gill-arch in the clavicular region on each side of the fish.

b. Structure.

The patch is about 3 mm. long, and 2 mm. broad, with a slightly irregular lobate outline. Structurally it resembles very closely the irregular organs on the sides of the body of *Astronesthes.* It consists (in the only specimen which I was able to examine) of a granular mass containing very many small nuclei which stain deeply (Pl. LXXIII. fig. 46, *a*). Outside, the organ is covered by a thin epithelium (Pl. LXXIII fig. 46, *e*). In the granular mass of the organ a few comparatively large, irregular cells, with two or more processes, are found, and these contain larger nuclei than those scattered in such abundance throughout the whole of the mass (Pl. LXXIII. figs. 47, 48). The organ is traversed by threads placed perpendicularly to the surface (Pl. LXXIII. figs. 45, *b*, 46, *b*). These threads are attached to the flat base by broad trumpet-shaped extensions, and taper towards the upper end, which lies just below the surface. They consist chiefly of a tough cartilaginous supporting rod and a large bloodvessel; nerve fibres are also found in them. The floor of the organ consists of a thick structureless cuticle (Pl. LXXIII. fig. 46, *c*) overlying the ordinary superficial pigment layer of the skin (Pl. LXXIII. fig. 46, *d*). This structureless cuticle is continued, rapidly becoming thinner, some distance up the vertical threads which penetrate into the organ.

c. Function.

The state of preservation of the specimens at my disposal does not permit me to draw any very definite conclusion from the structure in regard to the function of the organ. In colour and general appearance it resembles very closely other undoubtedly phosphorescent organs of fishes.

11. Suborbital glandular organs, without reflector.

a. Distribution.

These organs are found in *Astronesthes niger* and *Opostomias micripnus*, in both of which they occupy the same position, being situated on the upper jaw just below the eye. As, however, they structurally differ very much in these two species, it will be best to describe them separately.

b. Structure.

(1) *Astronesthes niger.*—In this species we find five phosphorescent patches of an irregular glandular nature on the head, one (Pl. LXIX. figs. 1, *d*, 11, *a*) being situated in the median line between the eyes. The other four (Pl. LXIX. figs. 1, *e*, *e′*, 11, *b*, *c*)

appear as two pairs of suborbital organs, an anterior and a posterior. The anterior patches are about twice as large as the posterior, and their outline is irregularly lobate. With a magnifying-glass a radial structure can be detected in the patches (Pl. LXIX. fig. 11). In sections we see that the whole organ is composed of cylindrical gland-tubes of uniform width, which commence at the anterior margin and extend to the posterior end, which is slightly drawn out. The organ is sunk in the surface, so that its upper side lies at the same level as the surrounding surface (Pl. LXIX. figs. 12, 13). Near the anterior margin it has the greatest depth, and from this region the floor rises gradually towards the posterior margin (Pl. LXIX. fig. 13). It is covered on the outer side by a thin, transparent epithelium, whilst the gland-tubes, which extend from the broad to the narrow end of the wedge-shaped organ, have an inner coating of cells which are about as high as broad (Pl. LXIX. fig. 14, *b*). A narrow lumen is left in the centre of the gland-tube, and this is filled by the slimy secretion, precipitated in granular form by the action of the spirit (Pl. LXIX. fig. 14, *c*). A special membrane can be observed enclosing each gland-tube (Pl. LXIX. fig. 14, *a*). Between the gland-tubes bloodvessels and nerves, extending mainly in a longitudinal direction, parallel to the tubes, are found.

The number of gland-tubes in the thick anterior portion is much greater than in the narrow posterior part, where they lie side by side, forming a single layer (Pl. LXIX. fig. 12). The floor of the organ is formed by a thin, light-reflecting membrane backed by the usual pigment layer, but as in the organs described above from the sides of the body of *Astronesthes*, the lower jaw of *Sternoptyx*, the gills of *Halosaurus*, and the barbels of *Opostomias* and other fishes, no typical phosphorescent gland-cells have been observed.

(2) *Opostomias micripnus.*—In this species a single phosphorescent organ is found on each side of the head just below and a little behind the eye. It appears, when seen from the surface, as a slit (Pl. LXXII. fig. 39, *d*) commencing below the eye and extending backwards and slightly downwards. This slit is 12 mm. long and in the centre 2 mm. wide. In the anterior quarter of it a small white patch—an aperture—is seen in the gray, pigmented, soft membrane which covers the slit. It appears that this membrane is movable, the underlying phosphorescent organ emitting its light through the aperture. The margin of the gray membrane adjoining the pore is soft and movable, covering the underlying organ more or less like a lid. The aperture may be contracted, so as to screen that organ partially or entirely, or on the other hand dilated and opened wide, leaving a large aperture through which it becomes visible. In Pl. LXXII. fig. 39 this aperture is drawn, as it appears in the spirit specimen, in a very much contracted condition.

The phosphorescent organ which lies below this membrane is a very remarkable structure (Pl. LXXII. fig. 40). It consists of a lamella abruptly folded in the middle so that the two parts enclose an angle of 80°. One portion lies tangentially and occupies the space just below the gray sphincter membrane, and the other extends downwards into the interior of the orbital fossa. The whole organ lies loose in a cavity surrounded by a light-reflecting membrane backed by the usual pigment layer. The wall of this sac or cavity is perforated in one place only—where the nerve and the bloodvessels enter the organ.

The organ itself consists of two distinct structures; firstly, meandriform gland-tubes surrounded and divided from each other by fibrous tissue containing nerves and bloodvessels, of which the whole of the inverted and the central portion of the tangential lobe are composed; secondly, a high cylinder-epithelium on the surface of the tangential lobe. The gland-tubes contain a coating of ordinary gland-cells and their lumen is partly filled with similar cells and partly with a slimy secretion, but they present no striking peculiarity. The cylinder-epithelium on the other hand is a most complex and interesting structure.

Of all the Challenger fish examined by me, this one is the best preserved, so well in fact that the most minute detail in the structure of this organ could be studied in very fine longitudinal sections (Pl. LXXII. figs. 40, 41).

The superficial part of the tangential lobe rests on the ordinary fibrous tissue covering the central gland-tubes (Pl. LXXII. fig. 41, *b*), and the nerves contained in this tissue extend upwards into it. It consists of two layers. Below, attached to the floor, we find a layer of ganglion cells (Pl. LXXII. fig. 41, *c*), which are irregularly roundish, highly granular, non-transparent, and measure 0·006 mm. in diameter, their nuclei being spherical, highly stainable and conspicuous. From their upper surface the ganglion cells send forth stout processes, which are in direct connection with club-shaped typical phosphorescent cells found in the upper layer (Pl. LXXII. fig. 41, *d*).

The upper layer is structurally very similar to the tissue described above from the cup-shaped portion of the composite phosphorescent organs in *Scopelus*.

It is chiefly composed of slender, vertical, indifferent, transparent, spindle-shaped cells with small nuclei, and between them, rising directly from the ganglion cells below, the typical phosphorescent clavate-cells are situated. These are shorter and stouter than in *Scopelus* and *Xenodermichthys*, and are scattered somewhat irregularly, resembling in this respect the corresponding structure in *Xenodermichthys*. They are 0·01 to 0·02 mm. high, the club-shaped end is 0·002 mm. thick.

The light-refracting vesicle is always single, forming an oval body with a vertical longitudinal axis. It is situated in the club-shaped end of the cell, 0·0024 mm. long and about half as broad. The protoplasm is highly stainable, but singularly enough I did not observe nuclei in these cells. Neither have I observed any pavement epithelium on the surface as in other similar organs.

c. Innervation.

The innervation is similar to that of the suborbital organs with reflectors to be described below. A stout nerve enters the inverted lobe of the organ (Pl. LXXII. fig. 40, *d*), and ramifies within it, its branches extending between the gland-tubes. From the fibrous layer, which separates the glandular from the epithelial portion of the tangential lobe, nerves extend into the epithelial layer and are joined to the ganglion cells at its base, which are in direct connection with the typical clavate cells.

d. Function.

The discovery of the clavate cells removes all doubt as to the phosphorescent nature of these organs. The gray sphincter membrane, which is non-transparent and movable, plays the part of a lamp shade, and acts like the iris of an eye. The fish can shoot forth a ray of light, modify its brilliancy, and illuminate such objects as are in the line of vision, but this ray may be immediately intercepted when the fish finds it advantageous to pursue its way in darkness. The phosphorescent organ has the same position as the eye, the optical axis of the two being parallel.

The organs of *Astronesthes*, on the other hand, are not nearly so highly developed, being only glandular; yet their appearance would lead one to suppose that here also the secretion of the gland-tubes is either constantly luminous or may be incited to phosphorescence at the will of the fish.

e. Development.

The position, and to a certain extent the glandular nature, of these organs render it probable that they have been developed from that portion of the slime-canal system which is situated in the suborbital region.

12. Suborbital organs with reflector.

The phosphorescent organs belonging to this category are the largest and most highly developed known.

a. Distribution.

As the name implies, they are found in the suborbital region, a larger and a smaller one generally occurring on each side. They have been found by me in

Scopelus benoiti, Pachystomias microdon, Opostomias barbatum, and *Malacosteus indicus.*

Leydig[1] mentions organs which belong to this group in several species of *Scopelus* besides *Scopelus benoiti.*

b. Structure.

(1) *General.*

The organs are glandular and generally surrounded by an exceedingly thick light-reflecting spicule-layer, but the pigment layer is often not very highly developed.

There is a tangential lobe and an extension reaching down into the interior of the orbital fossa as in *Opostomias micripnus.* The latter is generally larger than the former, spherical in shape and connected with the tangential portion by a comparatively narrow neck. On the surface which looks outwards, vertical striations are found, which in fine sections can be resolved under high powers into elements similar to those of *Opostomias micripnus* above described. The distinction between the interior glandular and external epithelial portion is, however, not clearly marked, and the whole structure is much less regular than in that fish.

(2) *Special description of the suborbital organs in Pachystomias microdon.*

α. General appearance.—Seen from the outside the suborbital organs in this fish appear as two very conspicuous white masses below the eye (Pl. LXXI. fig. 25). The anterior one, which lies below and in front of the eye, is oval, and its upper margin is slightly concave. The anterior end extends forwards and slightly upwards. It is 3 mm. long and 1·5 mm. wide. The posterior organ is sausage-shaped, being 1·5 mm. wide and 17 mm. long. Its anterior end lies just below the posterior end of the smaller anterior organ (Pl. LXXI. fig. 25, *b*), and it extends backwards and slightly downwards. The posterior end is slightly turned up.

On dissection it appears that the orbital cavity in the skeleton of the head is greatly extended downwards and backwards (Pl. LXXI. fig. 26), and in the lower portion of this extended orbital cavity the two phosphorescent organs are situated. The nerves which supply them come from the angle between the anterior and internal walls of the large cavity (Pl. LXXI. fig. 26), and to each of the organs an extensive spherical mass appears to be attached internally, which, of course, is not visible from the surface before dissection.

β. The smaller anterior organ.—The non-transparent and soft membrane which covers the portion of the orbital cavity below the eye, is perforated so as to allow

[1] Leydig, Die augenähnlichen Organe der Fische.

the phosphorescent organs situated below to be visible from the outside. The anterior perforation corresponds to the smaller anterior phosphorescent organ. This membrane extends over the phosphorescent organ for some distance (Pl. LXXI. fig. 27, *e*), the margin of the perforation being drawn out to form a kind of iris which is probably a movable sphincter membrane as in *Opostomias micripnus*. The whole organ lies pretty loose in a sac, which is divided about halfway down by a constriction into a proximal and a distal portion. Below the surface of the distal portion a pigment layer is observed, which is not continued downwards below the constriction as a continuous layer, but exists there only in the shape of scattered patches of pigment. The phosphorescent organ is situated in the sac, and consists essentially of three layers. There is firstly the innermost gland with reticulate structure (Pl. LXXI. fig. 27, *b*), forming a superficial layer of considerable thickness; it has the shape of a pouch, and is in contact with the inner surface of the proximal pouch-shaped portion of the cavity in which the phosphorescent organ is situated. The margin of this reticulate layer reaches up to the constriction. There is, secondly, a thick layer of light-reflecting spicules, perforated at regular intervals; and thirdly, the radial glandular contents of the pouch-shaped spicule-layer, which expands above to form the tangential or superficial portion of the organ (Pl. LXXI. fig. 27, *d*).

The basal reticulate structure is very peculiar, and nothing similar has been observed in any other fish. The reticulation is produced by a very regular network of pigment-threads (Pl. LXXI. fig. 30) which are associated with fibrous tissue, bloodvessels and nerves. The meshes are occupied by very irregular gland-tubes, which consist of a thin membrana limitans and one layer of ordinary gland-cells, which are about as high as broad. The lumina of these tubes were empty in the specimen examined by me. The thickness of this reticulate layer is greatest below in the fundus of the pouch, where it measures nearly 1 mm., and from this point its thickness decreases uniformly towards the margin. A stout nerve enters this structure from behind.

The spicule-layer (Pl. LXXI. fig. 29) presents a very curious appearance when seen from the surface, being perforated by oval holes of uniform shape and size, which are distributed over the surface in a perfectly regular manner. This layer is 0·1 mm. thick in the fundus of the pouch and thins out towards the margin, which coincides with the margin of the reticular layer and the constriction of the cavity in which the phosphorescent organ lies embedded. Through the perforations, which are 0·07 mm. long, 0·04 mm. broad, and 0·2 mm. apart, the secretion prepared in the reticular layer is poured into the upper portion of the organ, and also nerves and bloodvessels pass through them. The third layer, which forms the central and upper part of the organ, possesses a radial structure, particularly in its proximal part, which occupies the spicule-layer pouch (Pl. LXXI. fig. 27, *d*). The superficial portion shows vertical striations, the outermost layer appearing more granular than the rest. The state of preservation of the specimen does not allow of the minute structural details being made out, but it appears not improbable that the vertical striation of the superficial layer is the expression of a structure somewhat similar to that described above in *Opostomias micripnus.*

γ. *The larger posterior organs.*—These organs are similar to the foregoing, but the reticulate glandular layer is absent. The light-reflecting spicule-layer encloses the proximal, immersed, spherical portion of the organ (Pl. LXXI. fig. 28, *c*) and does not extend beyond the constriction, which is more conspicuous and deeper than in the smaller anterior organ. Here the spicule-layer, which is 0·4 mm. thick in the fundus, terminates in a thin margin. This proximal portion of the organ has the shape and size of a pea, and lies below the posterior end of the superficial portion. The spicule layer is perforated by very numerous, slightly branched, more or less oblique canals, which have a circular transverse section and are on an average only 0·01 mm. wide (Pl. LXXI. fig. 31). These are occupied by nerves and bloodvessels. The contents of the proximal portion, that is to say, the part surrounded by the spicule-layer, is a large, somewhat irregular gland. The gland-tubes, which are comparatively wide, having an average diameter of 0·05 mm., appear to commence in an irregular tangential position close to the spicule-layer, and they converge in the interior towards the narrow neck, where the proximal and distal portions of the organ are joined (Pl. LXXI. figs. 28, *d*, 31). Between the gland-tubes comparatively thick layers of fibrous tissue are met with, which contain nerves and large bloodvessels. The superficial portion of the organ shows the same vertical striation which has been described above in the smaller anterior organ. In this case also the indifferent state of preservation precludes a precise account of the minute structure being given.

c. *Innervation.*

(1) *In general.*—As mentioned above, the nerves which are found in these organs enter them in the shape of a stout bundle. They spread out to form a nervous plexus, which either appears as a film on the outer side of the spicule-layer in the posterior organs, or sends its branches along the threads in the reticulate portion of the organ below the spicule-layer in the anterior organ. Fine branches of the nerve penetrate the spicule-layer and enter the distal portion of the organ, where they can be traced for some distance in the fibrous tissue which surrounds the gland-tubes. The superficial portion of the larger posterior organ of *Pachystomias microdon* is supplied by a special nerve (Pl. LXXI. fig. 28).

(2) *The brain of Echiostoma barbatum.*—In this species the suborbital phosphorescent organs are highly developed. I have dissected the brain of this species to ascertain what nerve supplies the suborbital organs. The brain (Pl. LXXII. fig. 42) exhibits for the most part no striking peculiarity. The Nervi Olfactorii (*i*) are dilated

at the base near their junction with the olfactory lobes. The optic lobe is of the usual size. On the lower surface on each side, between the bases of the Nervus Opticus and Trigeminus, a special lobe, not found in ordinary fishes, is met with (*m*). From this lobe a very stout nerve (*g*), which is thicker than any other cerebral nerve, originates, and extending downwards and slightly backwards and outwards, divides into two equally stout branches, which are bent abruptly on entering the orbital cavity and which pass backwards. Ramifications of these nerves supply the two suborbital organs. I name this nerve Nervus phosphorius, and the lobe from which it originates Lobus phosphorius. Morphologically, this nerve is to be considered as a highly developed, modified anterior branch of the Trigeminus, and it thus appears homologous with the electric nerve of *Torpedo*.

d. Function.

The spicule-layer of these organs and their general structure establish their phosphorescent nature with sufficient certainty. It is an extraordinary and remarkable fact, that the light-reflecting spicule layer is found surrounding the immersed proximal portions of these organs only, and does not extend so as to form a reflector also for the superficial portion. It has been suggested by Dr. Günther that the suborbital organs can be projected partially, and that they then extend far beyond the surface of the fish. There is no reason why this should not be possible; but it has not been observed in any of the specimens at my disposal. The light, which is presumably emitted from these organs, is thrown in such a direction, that it illuminates the field of vision of the fish; they thus enable the fish to see, and must be considered as aggressive organs.

e. Development.

The structure and position of the organs indicate that they, like those described above, have been developed from a portion of the slime-canal system.

CONCLUSION.

a. Comparison of the Different Phosphorescent Organs of Fishes.

All the organs which have been described above, have, however different they may be in other respects, one thing in common, namely, that either the whole of the organ or part of it is glandular. In the latter case the glandular portion is always proximally situated and other structures of a special nature are added to it, which are always found in the distal part of the organ. We may, therefore, assume that the original form of the phosphorescent organs of fishes was that of a gland, which produced luminous slime, and that to these glandular structures other more highly differentiated elements were added in the course of development. It may be assumed that the glands which produce luminous slime are, like other glands, supplied with nerves, and that their secretion is subject to nervous influences. These nervous elements do not seem to undergo any particular modification, even in the most highly developed phosphorescent organs, except that they increase in size. The phosphorescent gland was originally, as the lowest forms show, attached outside to the skin, and the dermis, or the scale which underlies it, may be further developed, so as to form a reflector. The lower portion of the gland, like the nerves which supply it, remains unchanged, but the superficial portion is sometimes highly modified, and here the typical phosphorescent cells are developed, and the nerves which supply them become modified, special ganglion cells being often developed in their course. Leydig comes to the conclusion that these organs have nothing to do with the slime-canal system. The various suborbital organs above described, and also the ocellar organs on the lateral line of *Halosaurus*, show clearly that in these cases at least, the organs in question have been developed in connection with the slime-canal system.[1] The histological facts ascertained are not in all cases sufficient to allow of a conclusion regarding the function of these organs, but it is quite certain that some of them are phosphorescent, and there are good reasons for assuming that the remainder are so likewise. It is quite certain that none of them are eyes. Most of the organs seem to be defensive, inasmuch as their position precludes their illuminating anything that lies within the field of vision of the fish, so that their only use can be to frighten away its enemies. This particularly applies to the metameric organs on the body. The organs on the barbels may have the function of luring other fish, whilst the large and formidable suborbital organs may be regarded as aggressive, inasmuch as they are used for the purpose of illuminating the field of vision and facilitating the capture of the prey. The large eyes of many deep-sea fishes show that there must be some light in the depths inhabited by them, the source of which can only be sought for in phosphorescent organs.

b. The Typical Phosphorescent Cells.

The clavate cells with their highly refracting oval vesicle may be regarded as the most highly differentiated elements to be found in the phosphorescent organs of fishes. I am not aware that cells of this kind have been described before, although the luminous elements of *Phylliroë bucephala*, discovered by Panceri,[2] resemble them to

[1] Dr. Günther arrived at the same conclusion from a general consideration of the distribution of the luminous organs.

[2] Paolo Panceri, *Atti Accad. Sci. Fis. e Mat. Napoli*, vol. v. No. 14.

a certain extent. These elements are evidently modified gland-cells, and the shining vesicle represents the secretion. Although such cells are produced, the ordinary undifferentiated gland-cell is not dispensed with. These typical clavate cells are always found in connection with undifferentiated glands.

The slender cells which support these clavate cells may have been derived from the fibrous layer surrounding the gland-tubes.

The light reflecting spicule layer is apparently a modified inverted scale.[1]

The glands themselves are not to any extent different from other slime-glands found in fishes.

The only doubtful structures which remain are the yellow bodies in *Halosaurus*, and these may with great probability be regarded as a secretion. We may, therefore, sum up as follows:—

1. *The phosphorescent organs of fishes are more or less modified glands, which have partly been developed from simple slime-glands in the skin, and partly in connection with the slime-canal system.*
2. *The typical clavate cells are modified gland-cells.*
3. *The accessory reflectors and sphincters are developed from the skin around and below the gland.*
4. *The large suborbital organs are innervated by a modified branch of the Trigeminus, and the other organs by the ordinary superficial nerves.*

c. The Phosphorescent Organs of Fishes compared with those of some Other Animals.

Among Cœlenterates, particularly the higher species, there are a great number of forms which are known to produce light. Among Sponges no such observations have been recorded, but in the other groups such instances are numerous. Special organs are not, however, developed for phosphorescent purposes, but the *ordinary slime* produced by the gland-cells in the epithelia is luminous, the light being apparently emitted independently of the will of the animal. This is the lowest form of phosphorescence hitherto observed among Enterozoa.

A higher form is represented by *Phyllirhoë bucephala*,[2] where a great number of spherical cells scattered throughout the body emit light. These cells, which contain an oval, flattened nucleus and a large spherical vesicle filled with a highly refracting substance, have been compared above to the clavate cells in fishes. They are scattered and isolated and are attached by granular threads to ganglion cells. The organs are under

[1] According to C. Emery, *Mittheil. aus d. zool. Station zu Neapel*, vol. v.

[2] Paolo Panceri, *Atti Accad. Sci. Fis. e Mat. Napoli*, vol. v. No. 14. E. Müller, Bau der Phyllirhöe, *Zeitschr. f. wiss. Zool.*, 1854.

the control of the animal, and may singly or in groups emit light apparently at the will of the *Phylliroë*.

A still higher form of phosphorescent organ is met with in *Pyrosoma*.[1] Here we find groups of cells which are spherical and destitute of nuclei (?). These groups of cells are in connection with a stout nerve and are glandular, secreting a fatty substance which, under the influence of nervous stimulation, is burnt, and emits a brilliant light. It is obvious that these organs of *Pyrosoma* are in every respect similar to the "simple ocellar phosphorescent organs" described above from *Opostomias micripnus*.

Further stages in the development of phosphorescent organs are found in fishes, where also their development reaches to the highest point among aquatic animals.

The ocellar phosphorescent organs are comparable to the elements in *Euphausia* which have been considered as accessory eyes by Claus,[2] but which according to Sars[3] are not sense-organs at all, but phosphorescent. They are spherical, and divided by a stout ring situated in the surface tangentially in the outer third, into two portions, an outer and an inner one. The outer is occupied by a transparent cellular structure, and covered by a watch-glass-shaped cuticle. The lower portion is surrounded by a layer of red pigment, and filled with roundish cells similar to those in the phosphorescent organ of *Pyrosoma*. In the centre of the proximal portion a bundle of vertical threads is found, and a lens is situated between the two portions.

No organs comparable to the highly differentiated phosphorescent apparatus with reflectors in fishes have been found in other animals.

The phosphorescent organs of insects are not comparable in any way to those of fishes.

The mode of development of the phosphorescent organs in aquatic animals, as represented by those of living adult forms, is shown in the annexed scheme.

[1] Paolo Panceri, Gli organi luminosi e la luce dei Pirosomi e delle Foladi, *Atti Accad. Sci. Fis. e Mat.*, vol. v. No. 13, 3 pls.; also Panceri, Gli organi luminosi e la luce dei Pirosomi, *Rendiconti Accad. fis. e math.*, xi., fasc. 2, 1872, p. 43.

[2] C. Claus, Ueber einige Schizopoden und niedrige Malacostraken, *Zeitschr. f. wiss. Zool.*, Bd. xiii. p. 446.

[3] G. O. Sars, Report on the Schizopoda of the Challenger Expedition, Zool. Chall. Exp., pt. xxxvii. p. 70, pl. xi.

Scheme of the Development of Phosphorescent Organs.

Pachystomias.
With superficial typical clavate cells, with reflector.

Halosaurus.
Phosphorescent organs along the lateral line.
(?)

Xenodermichthys.
Projecting, with clavate cells, without reflector.

Sternoptyx.
Immersed, with reflector and clavate cells.

Opostomias.
With superficial typical clavate cells, without reflector.

Euphausia.
A hemispherical mass of gland-cells with a lens at the top, simple.

Astronesthes.
Without lens and reflector, immersed. Composite, with superficial clavate cells.

Opostomias.
On barbels.

Astronesthes.
In suborbital region.

Halosaurus.
Under gill-cover.

Sternoptyx.
On lower jaw.

Astronesthes.
Regular groups of undifferentiated radially arranged gland-cells, with pigment coat.

Astronesthes.
Irregular glandular patches on the surface.

Echiostoma.
Regular groups of radially arranged undifferentiated gland-cells, without pigment coat.

Pyrosoma.
Irregular groups of undifferentiated gland-cells, without pigment coat.

Phylliroë.
Isolated cells containing a vesicle and connected with special ganglion cells.

Pelagia.
Isolated gland-cells producing phosphorescent slime.

EXPLANATION OF PLATES.

KEY TO THE FIGURES ON THE PLATES.

Plate LXIX. figs. 1–14.
Plate LXX. figs. 15–24.
Plate LXXI. figs. 25–33.
Plate LXXII. figs. 34–44.
Plate LXXIII. figs. 45–63.

Phosphorescent Organs.

1. Regular, ocellar, simple, sunk, without pigment.
   Opostomias micripnus, . Figs. 34, 35, 37.

2. Regular, ocellar, simple, sunk, with pigment.
   Opostomias micripnus, .
   Echiostoma barbatum, . .
   Pachystomias microdon, .
   Malacosteus indicus, . .
   Astronesthes niger, . .
   } Figs. 1, 2, 5, 10, 38, 39.

3. Regular, ocellar, composite, sunk, without reflector.
   Opostomias micripnus, .
   Echiostoma barbatum, . .
   Pachystomias microdon, .
   Astronesthes niger, . .
   } Figs. 1, 2, 3, 4, 32, 33.

4. Regular, ocellar, composite, sunk, with reflector.
   Argyropelecus hemigymnus, .
   Sternoptyx diaphana, . .
   Scopelus benoiti, . .
   } Figs. 15, 17, 18, 19, 20, 21, 22, 23, 24, 43, 44.

5. Regular, ocellar, projecting.
   Xenodermichthys nodulosus, . Figs. 49, 50, 51, 52, 53.

6. Regular, ocellar, covered organs attached to the lateral line.
   Halosaurus macrochir, .
   Halosaurus rostratus, . .
   } Figs. 54, 55, 56, 57, 58, 59, 60, 61, 62, 63.

7. Glandular, irregularly scattered.

Astronesthes niger, . .	Figs. 1, 6, 7, 8, 9.

8. Glandular, on lower jaw.

Argyropelecus hemigymnus, . *Sternoptyx diaphana*, .	Figs. 15, 16.

9. Glandular, on barbels.

Opostomias micripnus, . . *Pachystomias microdon*, .	Figs. 36, 39.

10. Glandular, under gill-cover.

Halosaurus macrochir, .	Figs. 45, 46, 47, 48.

11. Suborbital, glandular, without reflector.

Opostomias micripnus, . . *Astronesthes niger*, . .	Figs. 1, 11, 12, 13, 14, 39, 40, 41.

12. Suborbital, glandular, with reflector.

Echiostoma barbatum, . . *Pachystomias microdon*, . *Malacosteus indicus*, . . *Scopelus benoiti*, . .	Figs. 25, 26, 27, 28, 29, 30, 31, 42.

ALPHABETICAL INDEX.

PLATE I.

PLATE I.[1]

Fig. A. *Scyllium canescens* (page 1).

South-Western Coast of South America, Station 310; depth, 400 fathoms.

Fig. B. *Polymixia nobilis* (page 34).

Off Inosima, Japan, Station 232; depth, 345 fathoms.

Fig. C. *Setarches fidjiensis* (page 19).

Off Matuku, Fiji Islands, Station 173; depth, 315 fathoms.

[1] The figures on all the plates are of the natural size, unless stated otherwise.

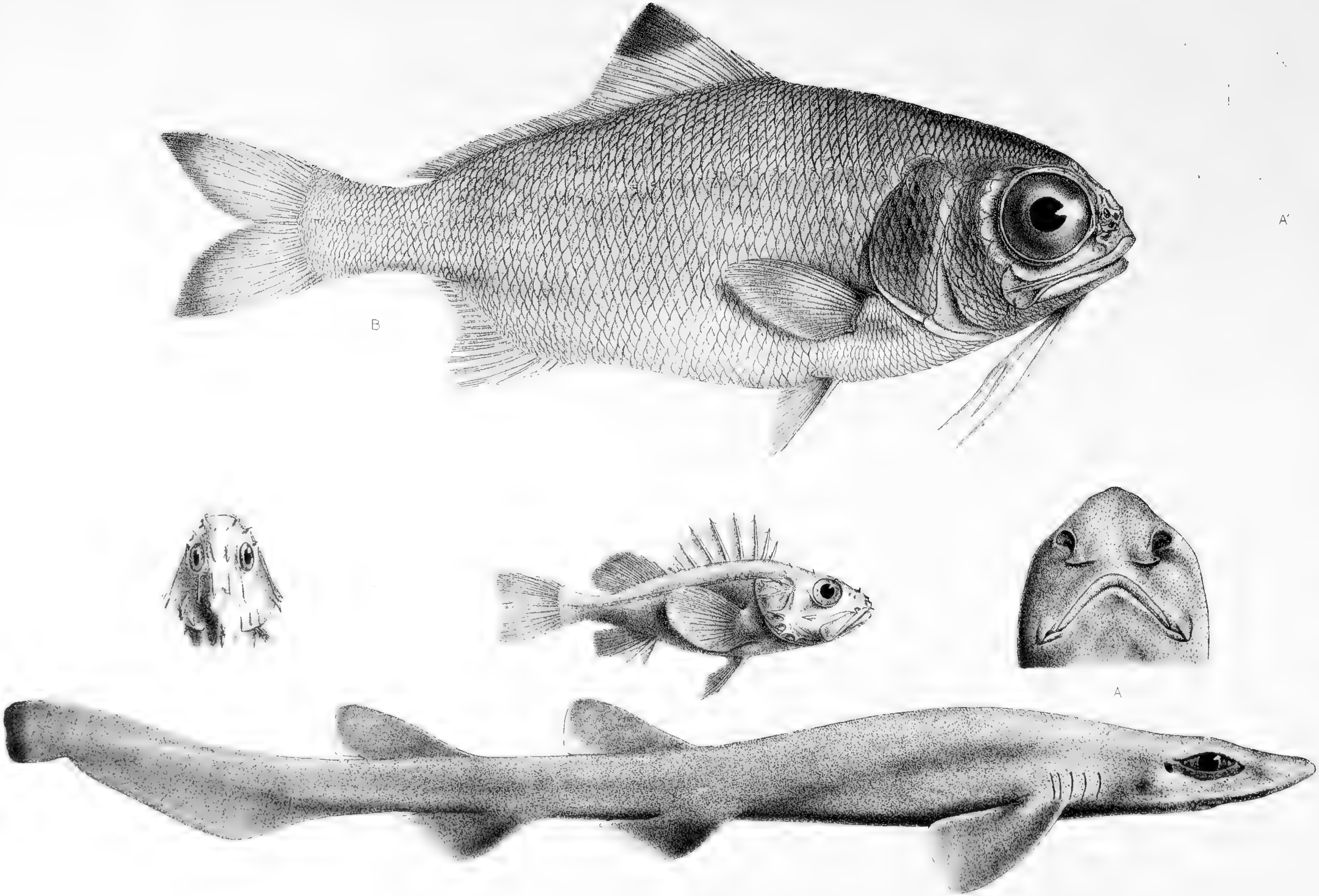


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PLATE II.

PLATE II.

Fig. A. *Centrophorus foliaceus* (page 5).

Fig. B. *Centrophorus squamulosus* (page 5).

Both these sharks were obtained off Inosima, Japan, Station 232; depth, 345 fathoms. Figures reduced in size; separate views of the dentition and scales, magnified.

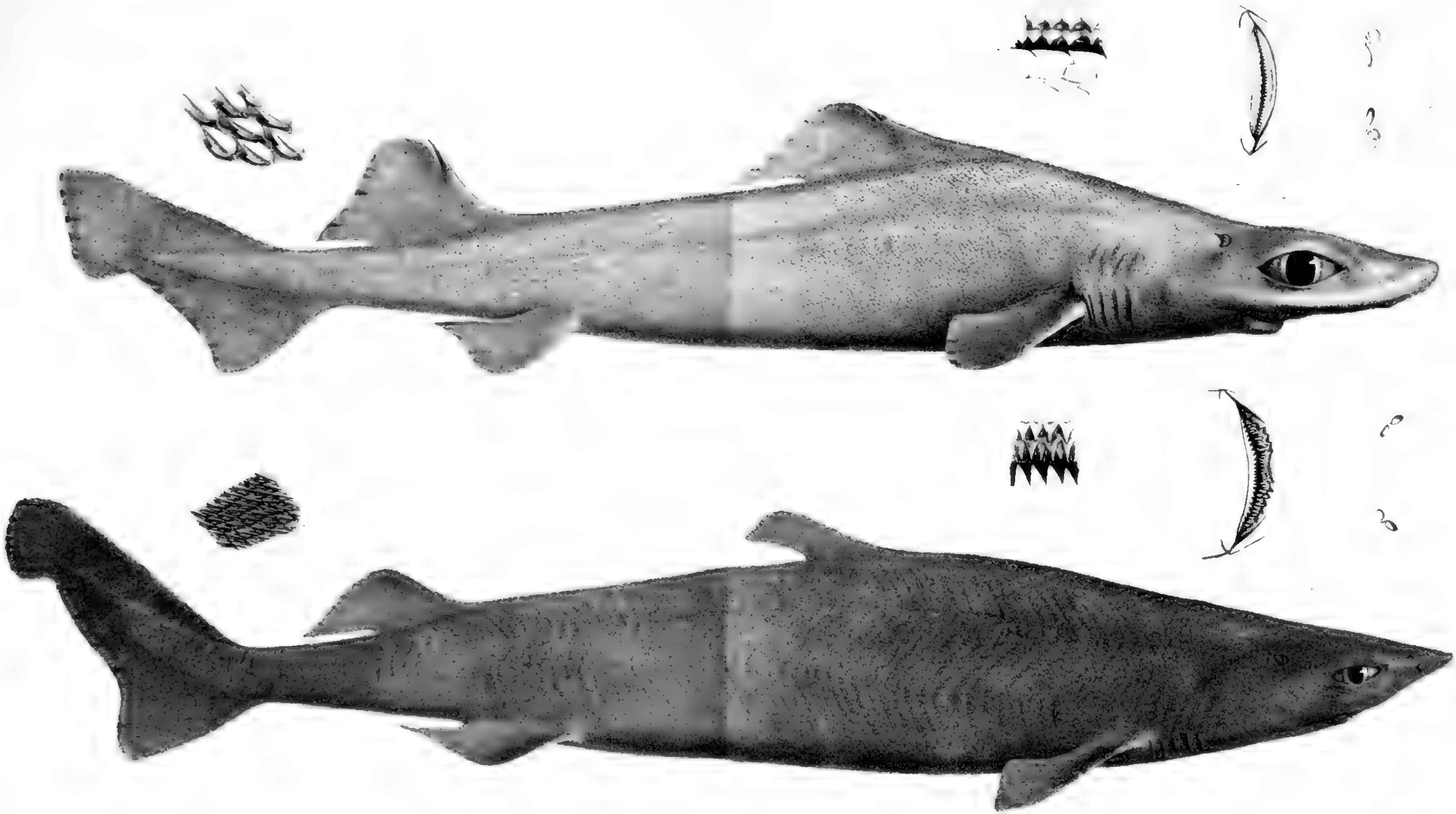
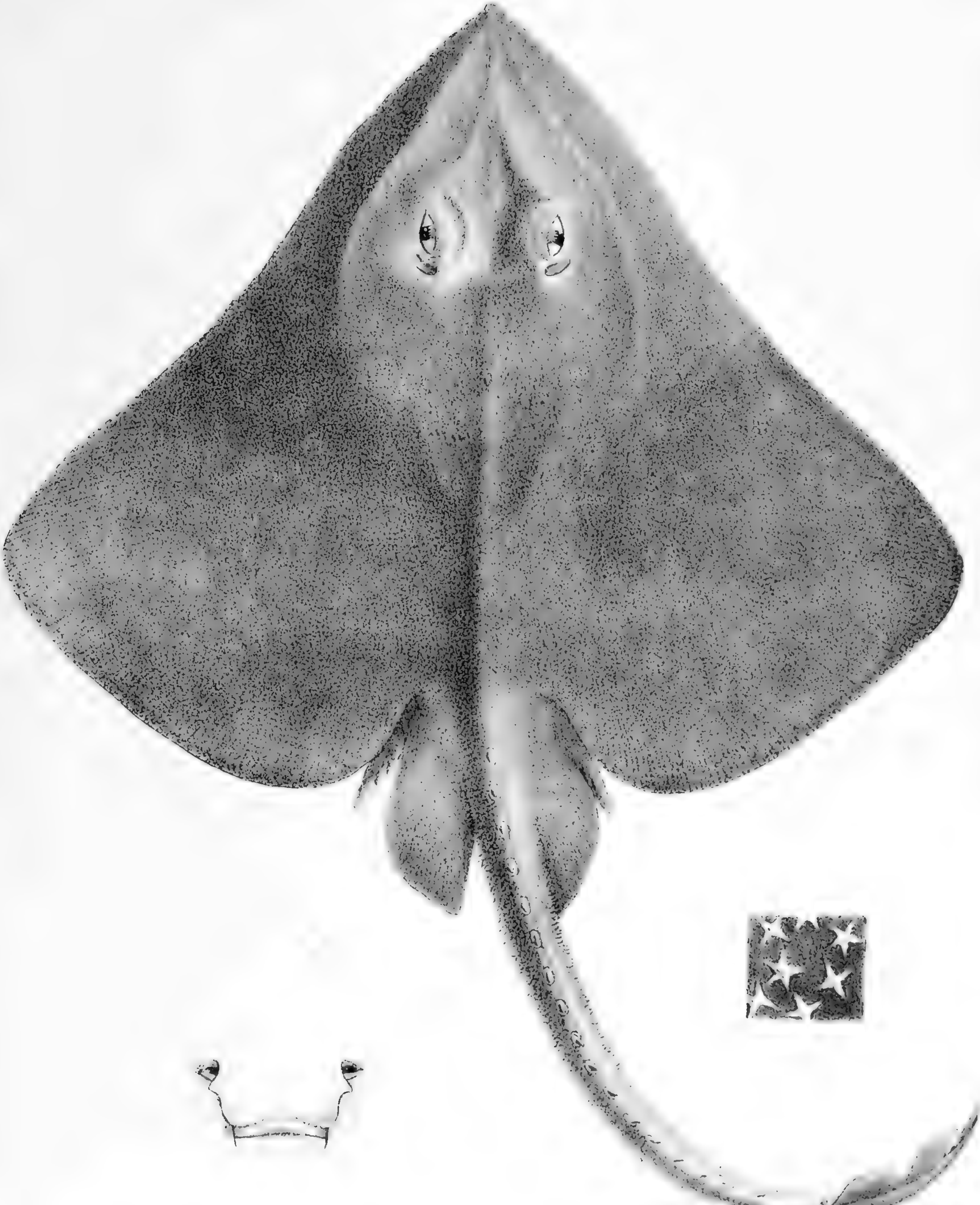


PLATE III.

PLATE III.

Raja isotrachys (page 7).

South of Japan, Station 235; depth, 365 fathoms. Portion of the skin, magnified.



R. Mintern del. et lith.

Mintern Bros. imp.

PLATE IV.

PLATE IV.

Raja hyperborea (page 8).

Faröe Channel; depth, 400 to 608 fathoms.

Fig. A. Upper and lower views of male; three-sevenths of natural size.

Fig. B. Young; natural size.

Fig. C. Separate view of mouth; natural size.

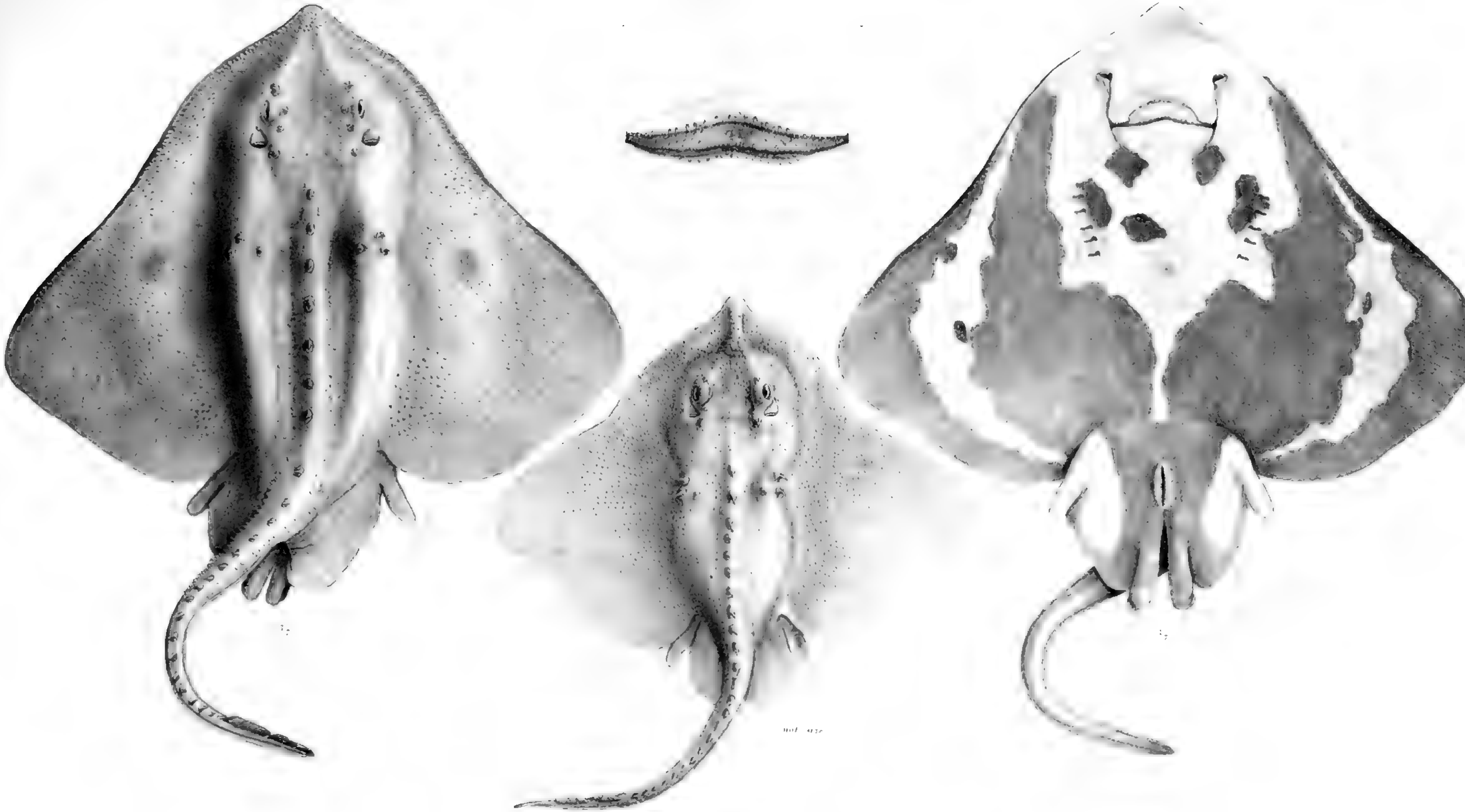


PLATE V.

PLATE V.

Fig. A. *Melamphaës typhlops* (page 27).

Atlantic, near Madeira.

Fig. B. *Melamphaës megalops* (page 27).

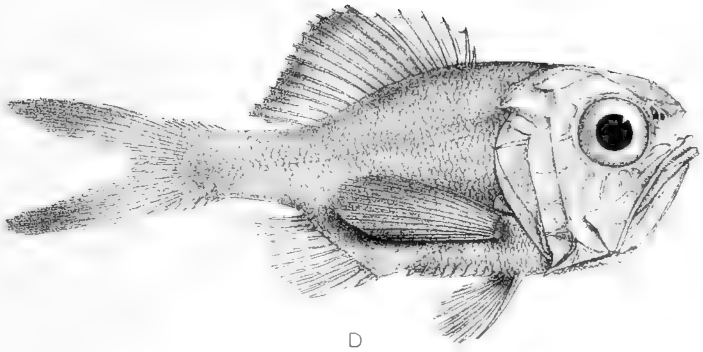
Atlantic, south of the Azores. Figure copied from Lütken.

Fig. C. *Trachichthys elongatus* (page 22).

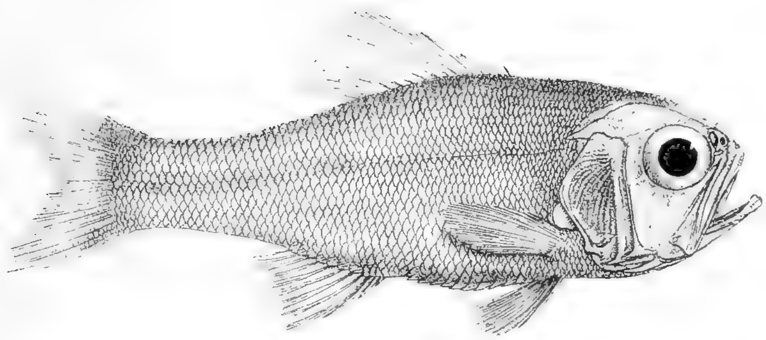
Off the Great Barrier Island, New Zealand.

Fig. D. *Trachichthys intermedius* (page 24).

Coast of New Zealand, Station 166; depth, 275 fathoms.



D



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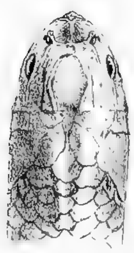
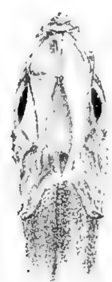


A'.



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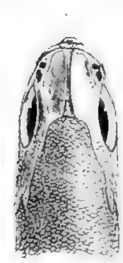
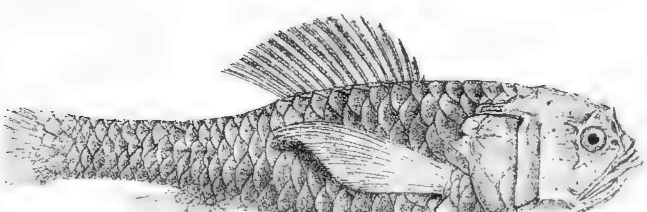
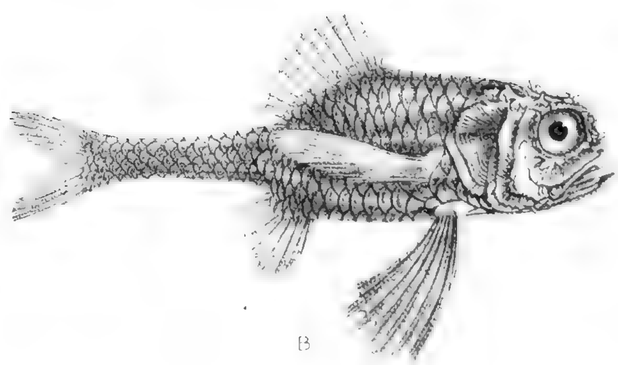




A



B

R. Mintern del et lith

Mintern Bros imp.

A. MELAMPHAËS TYPHLOPS. B. MELAMPHAËS MEGALOPS.
C. TRACHICHTHYS ELONGATUS. D. TRACHICHTHYS INTERMEDIUS.

PLATE VI.

PLATE VI.

Skeleton of *Beryx decadactylus* (page 32).

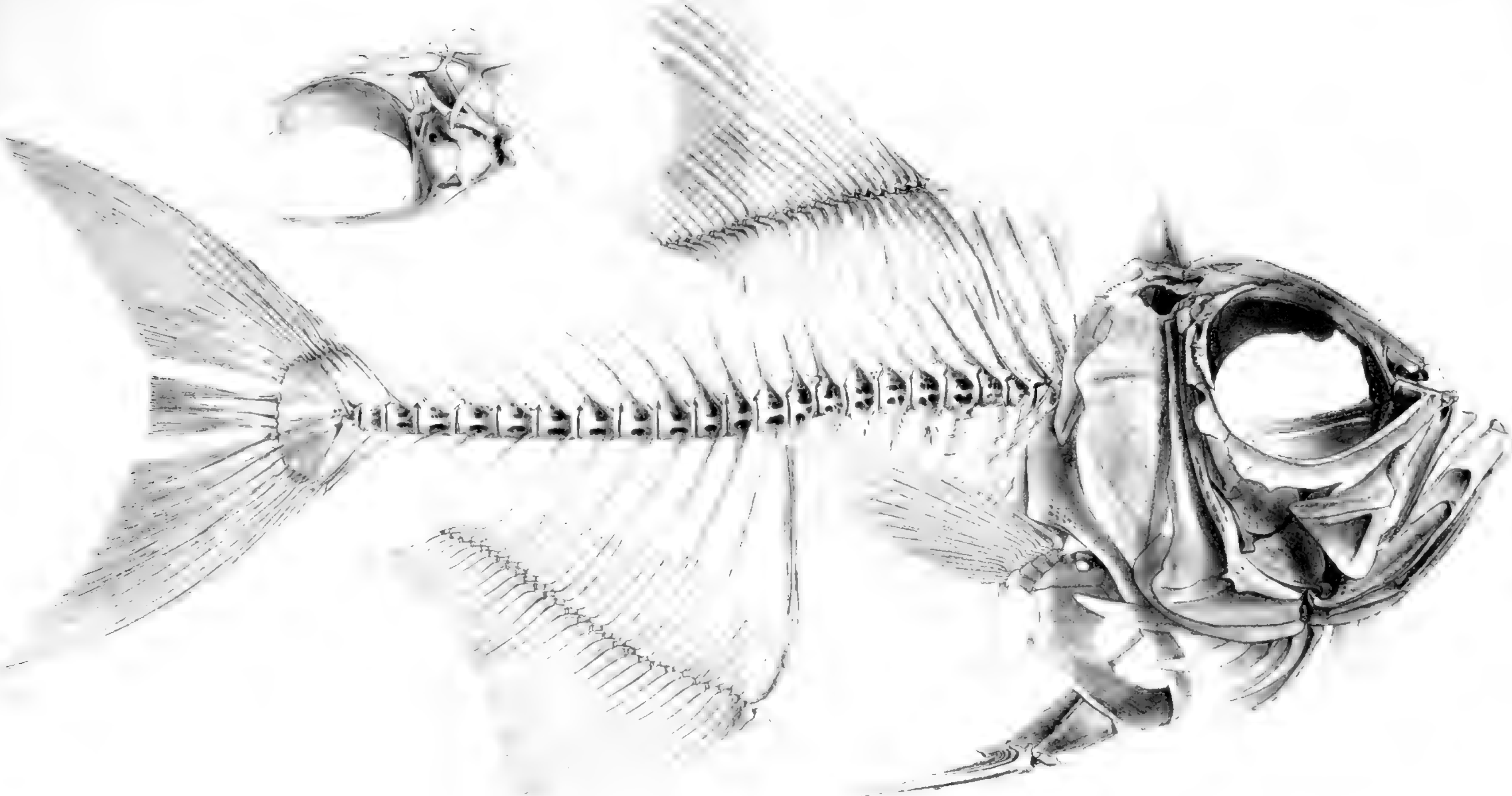


PLATE VII.

PLATE VII.

Fig. A. *Aphanopus carbo* (page 36).

Deep sea off Madeira and off the coast of Portugal (one-half the natural size).

Fig. B. *Lepidopus tenuis* (page 37).

Off Inosima, Japan, Station 232; depth, 345 fathoms.

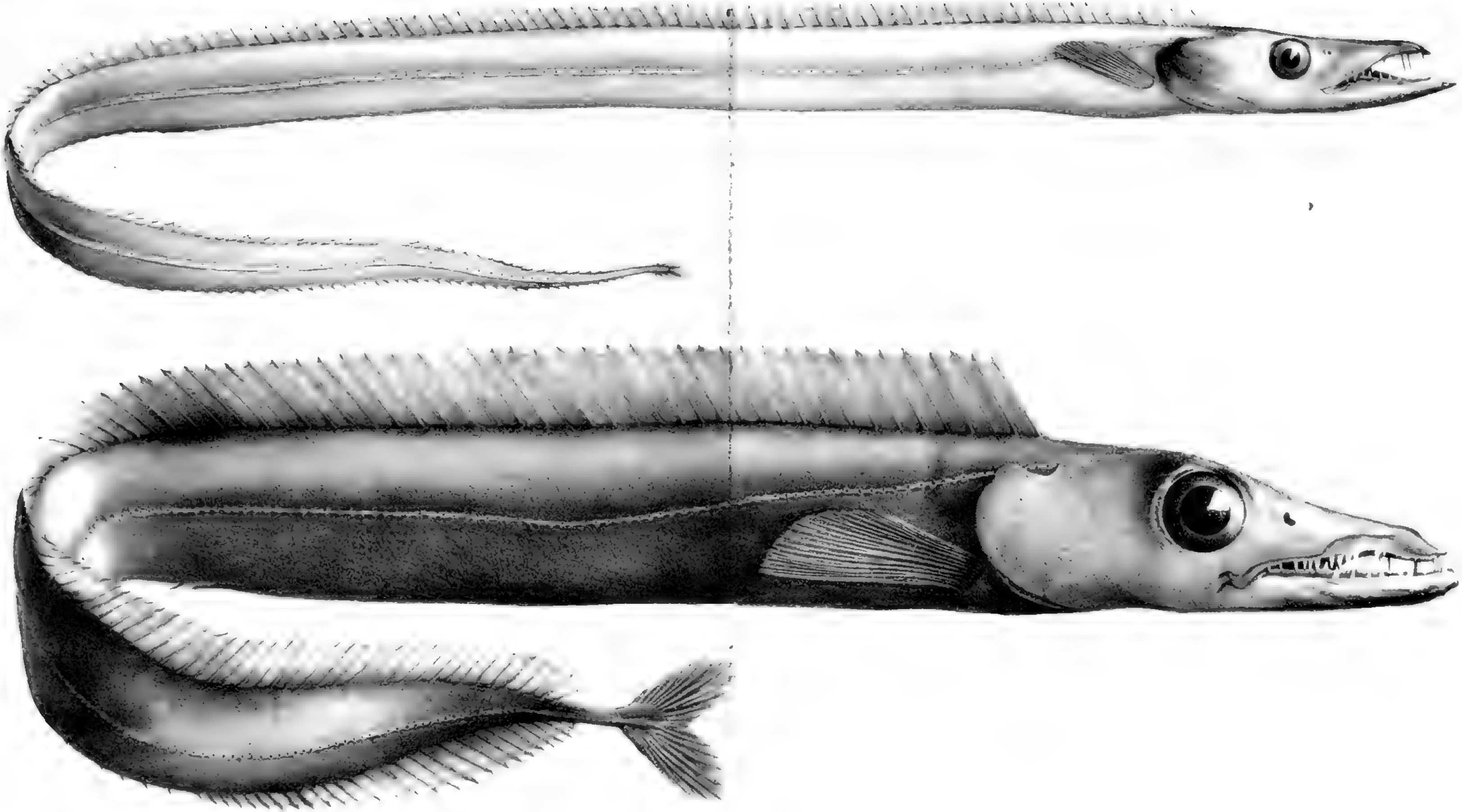


PLATE VIII.

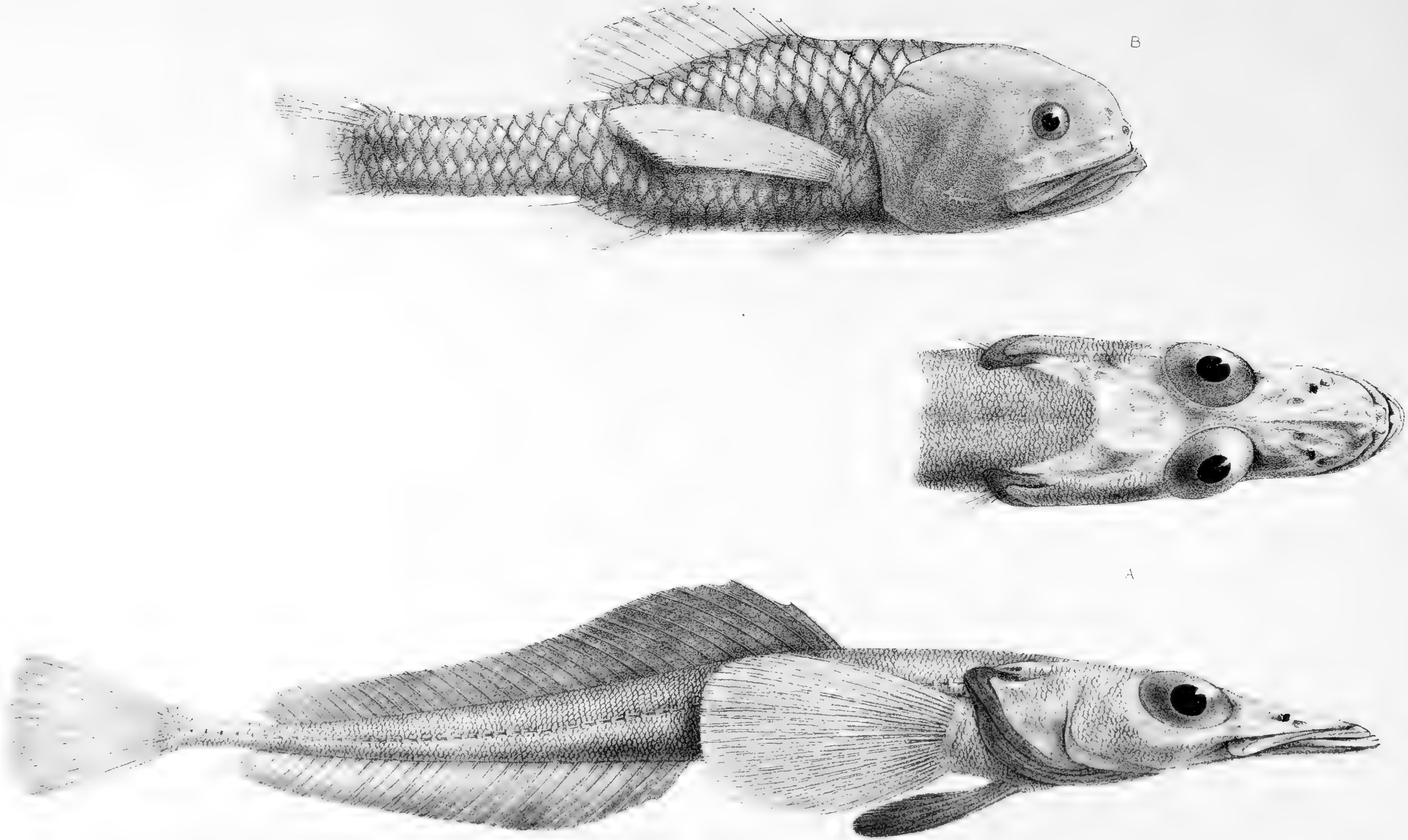
PLATE VIII.

Fig. A. *Bathydraco antarcticus* (page 48).

South of Heard Island, Station 152; depth, 1260 fathoms.

Fig. B. *Melamphaës crassiceps* (page 28).

Mid and South Atlantic, Antarctic and South-Western Pacific Oceans; depths, 675 to 1500 fathoms. The specimen figured is from Station 146; depth, 1375 fathoms.



(Faths. 1260)

(Fathms. 1875)

Mintern Bros. imp.

PLATE IX.

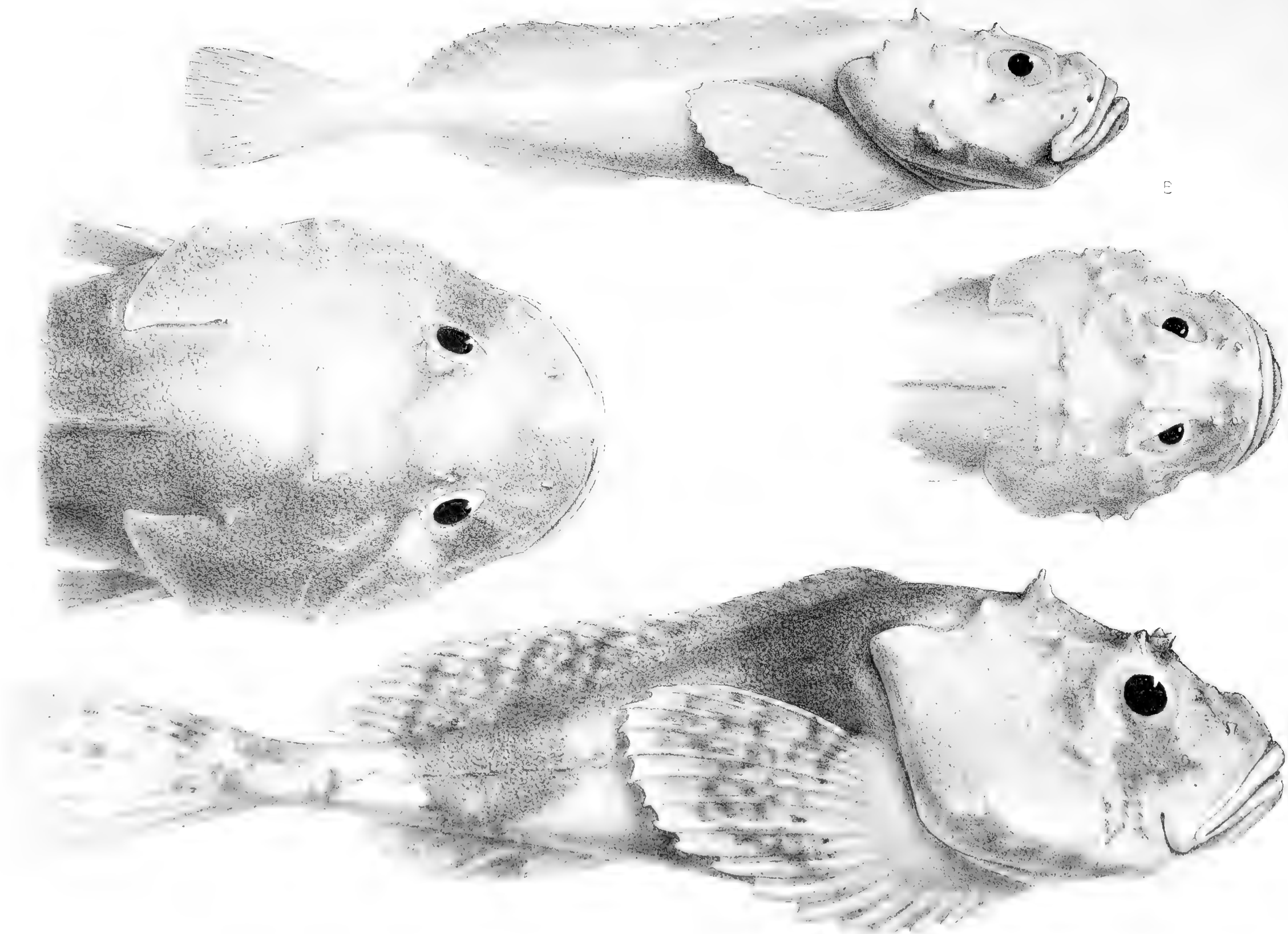
PLATE IX.

Fig. A. *Cottunculus microps* (page 60).

North Atlantic, Faröe Channel; depth, 307 to 608 fathoms.

Fig. B. *Cottunculus thomsonii* (page 61).

North Atlantic, Faröe Channel; depth, 535 fathoms.



G. Mintern del et lith

Mintern Bros. imp

A COTTUNCULUS MICROPS
(Faroe, fath. 397-608)

B COTTUNCULUS THOMSONII
(Faroe, fath. 555)

PLATE X.

PLATE X.

Fig. A. *Chaunax pictus* (page 58).

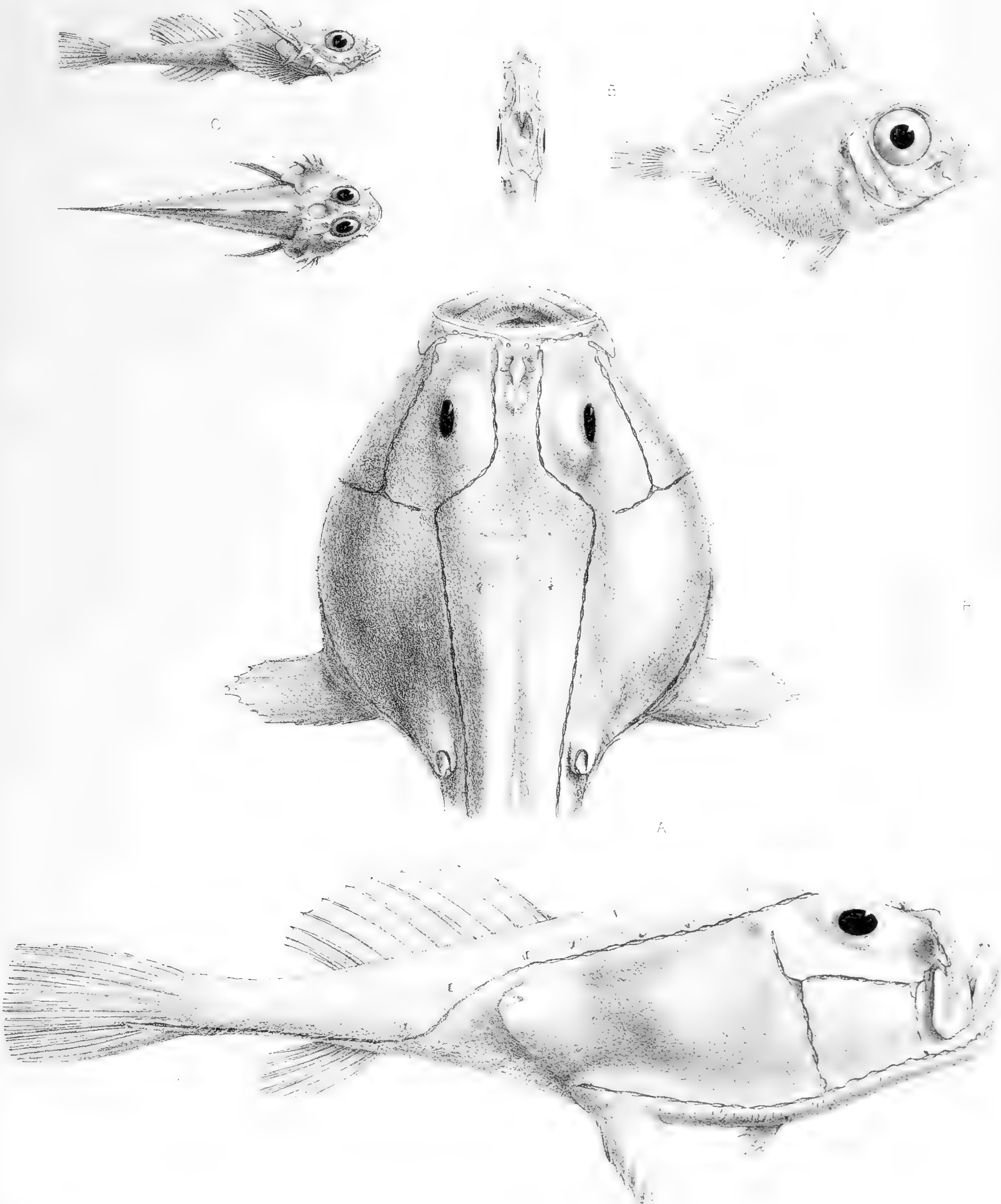
Mid Atlantic, Japan and Polynesia. The specimen figured is from Matuku, Fiji Islands, Station 173; depth, 315 fathoms.

Fig. B. *Cyttus abbreviatus* (page 42).

Off Cape Farewell; depth, 400 fathoms. B′ is a magnified view of a scale.

Fig. C. *Cottus bathybius* (page 62).

South of Yedo, Japan, Station 235; depth, 565 fathoms.



R. Mintern del et lith.

Mintern Bros. imp.

A. CHAUNAX PICTUS (Faths. 215) B. CYTTUS ABBREVIATUS. (Faths. 400) C. COTTUS B. (Faths. 5.)

PLATE XI.

PLATE XI.

Fig. A. *Melanocetus murrayi* (page 57).

Mid Atlantic, Station 106; depth, 1850 fathoms.

Fig. B. *Ceratias bispinosus* (page 53).

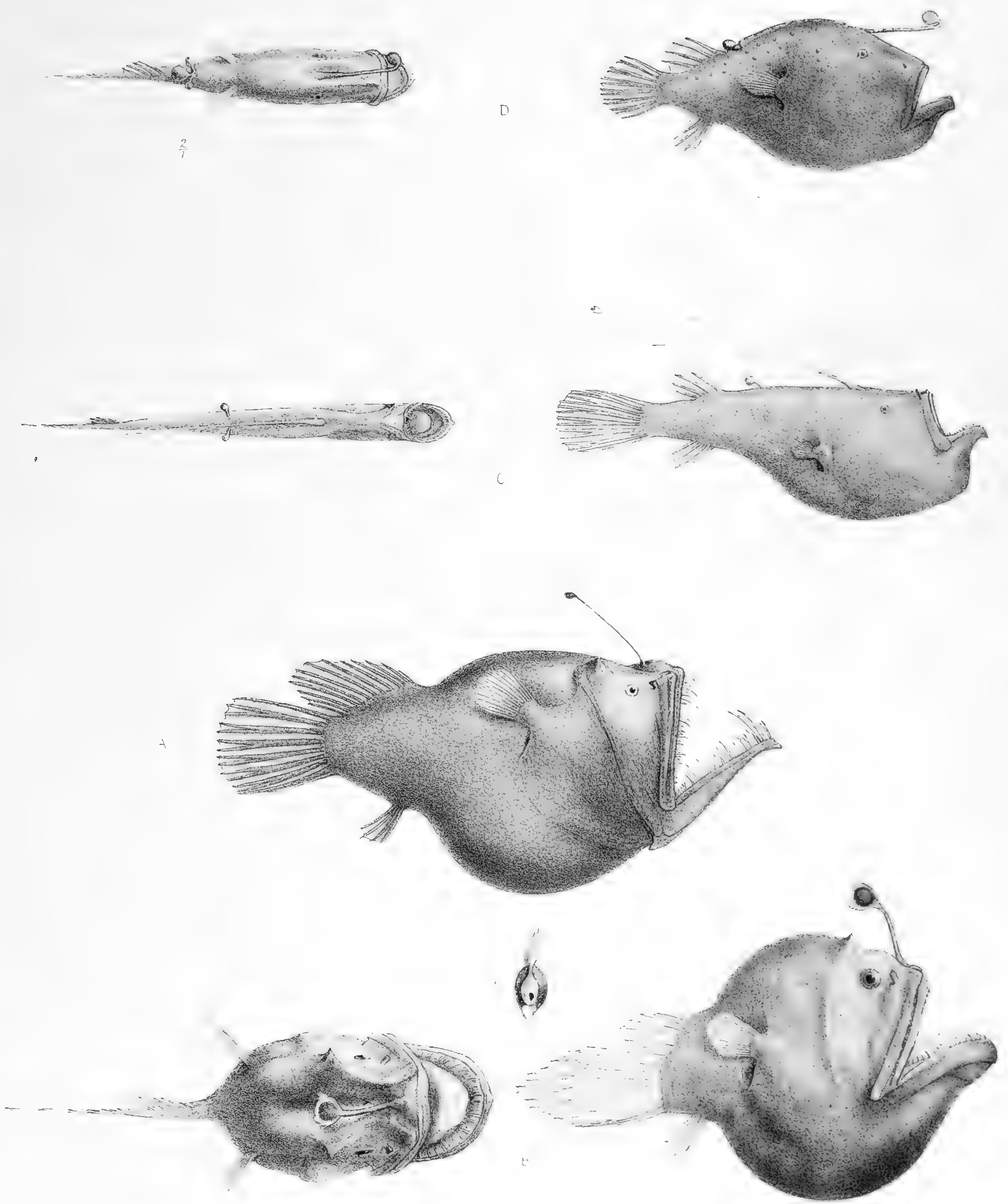
Off Banda Island, Station 194A; depth, 360 fathoms. *b.* Upper view of the knob-like termination of the cephalic spine, magnified.

Fig. C. *Ceratias uranoscopus* (page 54).

North Atlantic, Station 89; depth, 2400 fathoms.

Fig. D. *Ceratias carunculatus* (page 55).

South of Yedo, Station 232; depth, 345 fathoms. Twice the natural size.



R Mintern del et lith. Mintern Bros. imp.

A. MELANOCETUS MURRAYI.
(Faths. 1850–2450)

B. CERATIAS BISPINOSUS. (Faths 360) C. CERATIAS URANOSCOPUS. (Faths 2400.) D. CERATIAS CARUNCULATUS. (Faths. 345.)

PLATE XII.

PLATE XII.

Fig. A. *Lycodes muræna* (page 79).

North Atlantic. This species was obtained during the cruise of the "Knight Errant" in the Faröe Channel; depth, 540 to 640 fathoms.

Fig. B. *Liparis micropus* (page 66).

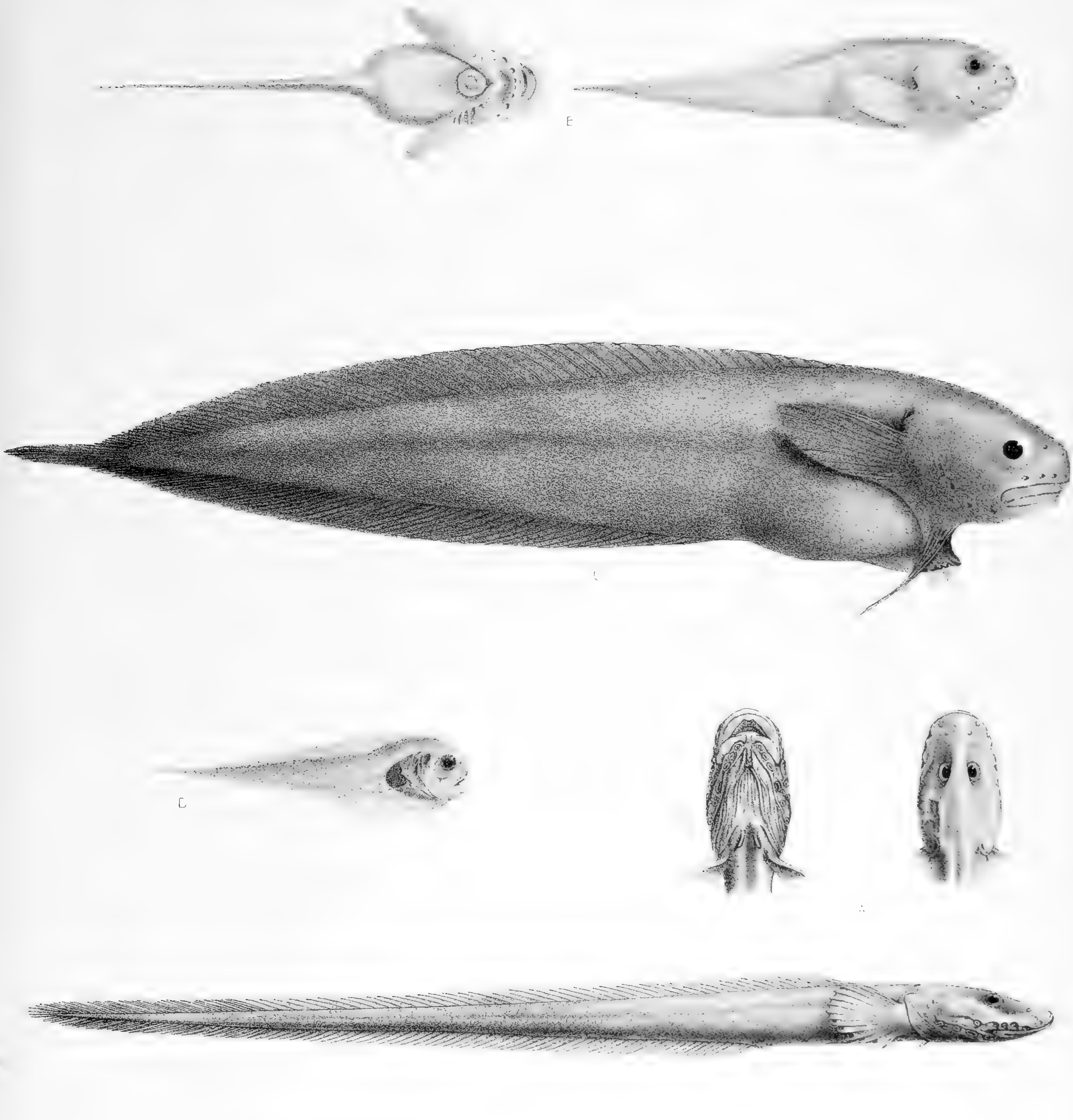
North Atlantic. This species was obtained during the cruise of the "Knight Errant" in the Faröe Channel; depth, 540 to 608 fathoms.

Fig. C. *Paraliparis bathybius* (page 68).

North Atlantic. This species was obtained during the cruise of the "Knight Errant" in the Faröe Channel; depth, 640 fathoms.

Fig. D. *Paraliparis membranaceus* (page 69).

Off Cape St. Vincent, Station 310; depth, 400 fathoms.



R. Mintern del. et lith.

Mintern Bros. imp.

A. LYCODES MURŒNA. B. LIPARIS MICROPUS. C. PARALIPARIS BATHYBIUS.
(Faroe Channel. Faths. 540–640.)
D. PARALIPARIS MEMBRANACEUS
(Faths. 400.)

PLATE XIII.

PLATE XIII.

Lycodes reticulatus, adult (page 77).

North Atlantic. This specimen was obtained by the "Knight Errant" in the Faröe Channel; depth, 608 fathoms.

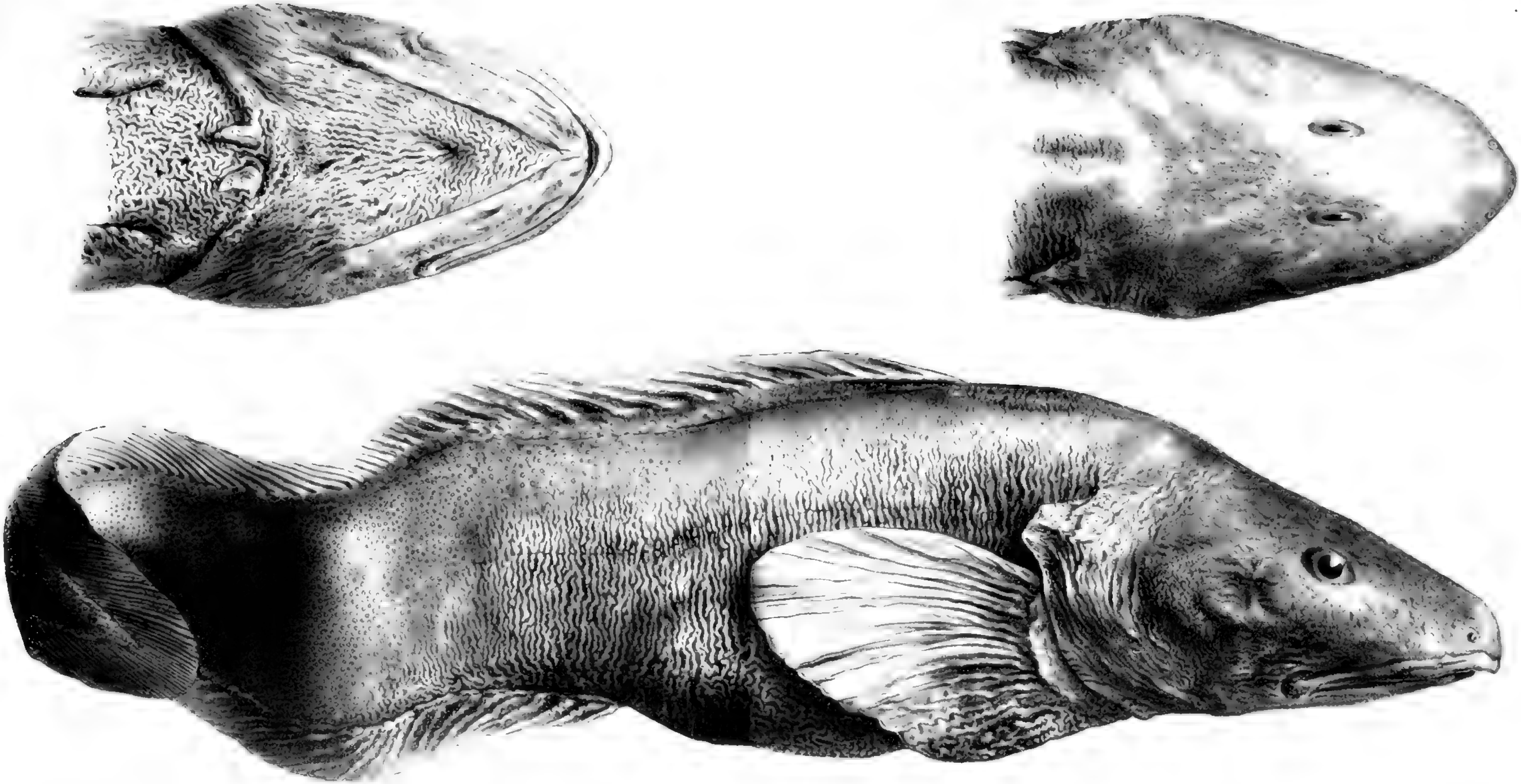


PLATE XIV.

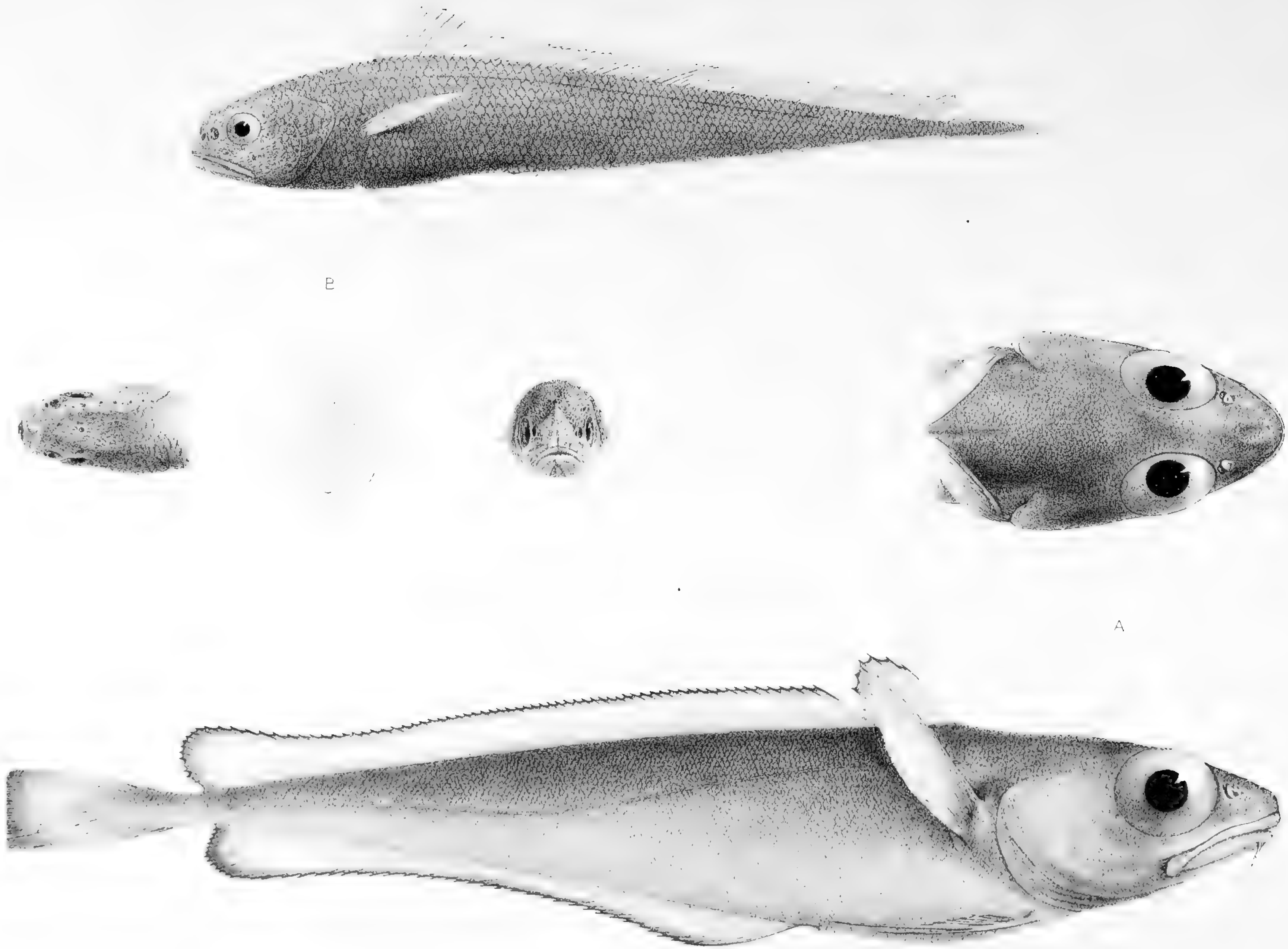
PLATE XIV.

Fig. A. *Lotella marginata* (page 86).

Pacific Coast of South-Western South America, Station 307; depth, 147 fathoms.

Fig. B. *Melanonus gracilis* (page 84).

Antarctic Ocean, Station 156; depth, 1975 fathoms. Besides the entire figure, a side view of the head and front view of the snout, also an enlarged view of a scale are given.



R.Mintern del et lith.
Mintern Bros. imp.

A. LOTELLA MARGINATA. (Faths 147.) B. MELANONUS GRACILIS (Faths 1975.)

PLATE XV.

PLATE XV.

Antimora viola (page 94).

Off the Atlantic coasts of North America; depth, 300 to 1200 fathoms.

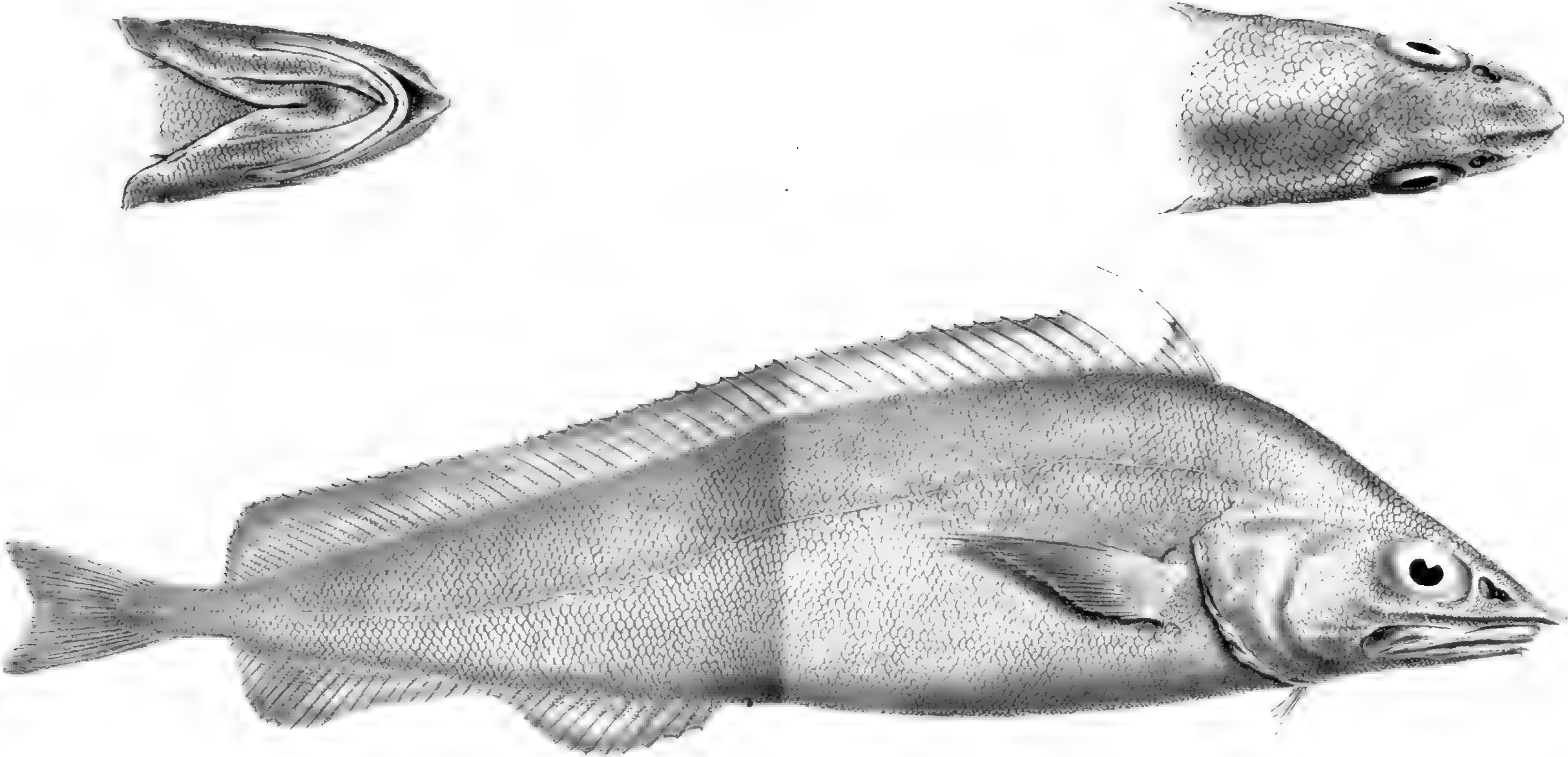


PLATE XVI.

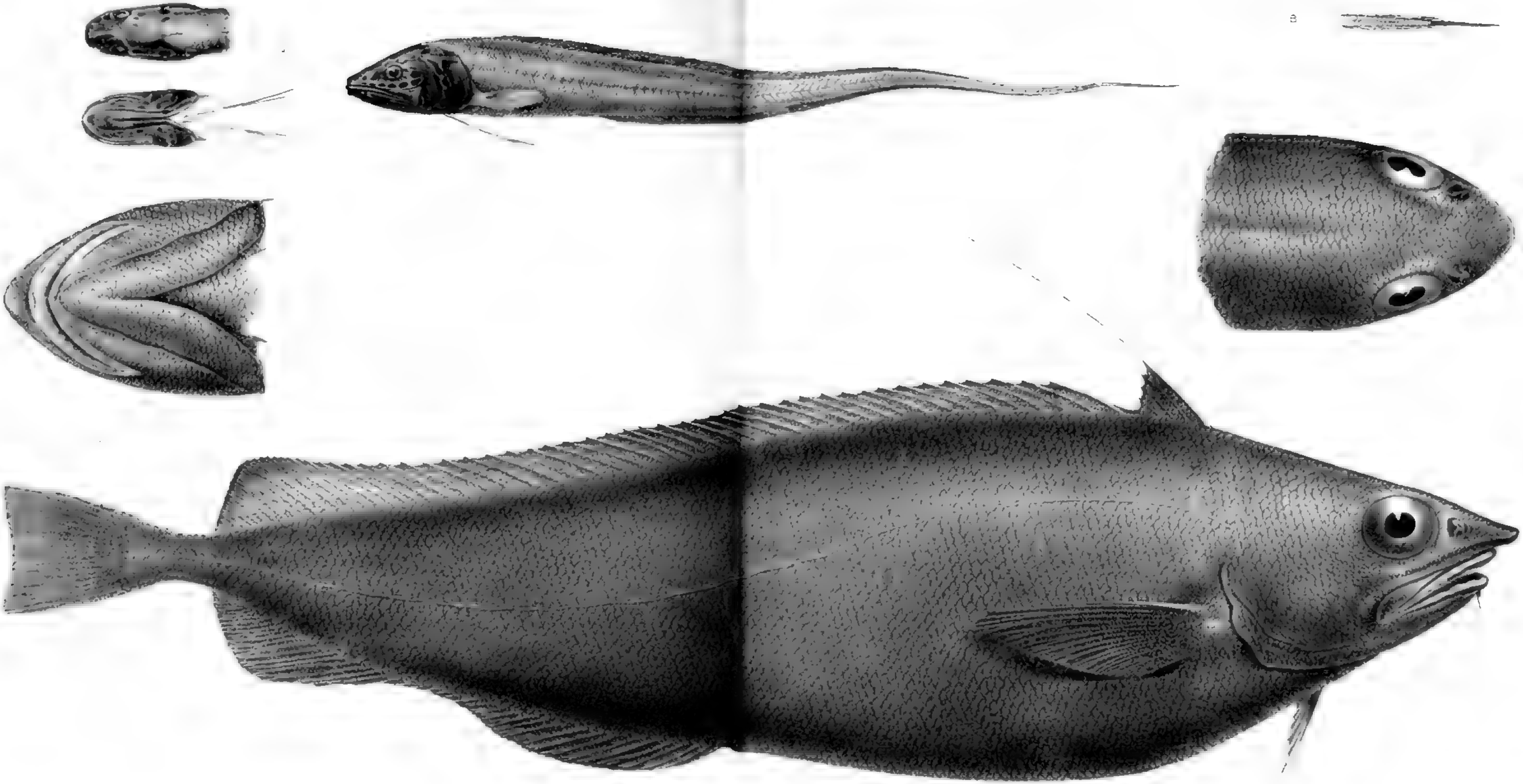
PLATE XVI.

Fig. A. *Antimora rostrata* (page 93).

South Atlantic and Antarctic Oceans, Station 320; depth, 600 fathoms. The figure is two-thirds of the natural size.

Fig. B. *Porogadus gracilis* (page 112).

South of New Guinea, Station 184; depth, 1400 fathoms. With separate view of the termination of the tail, enlarged.



Mintern Bros. imp.

PLATE XVII.

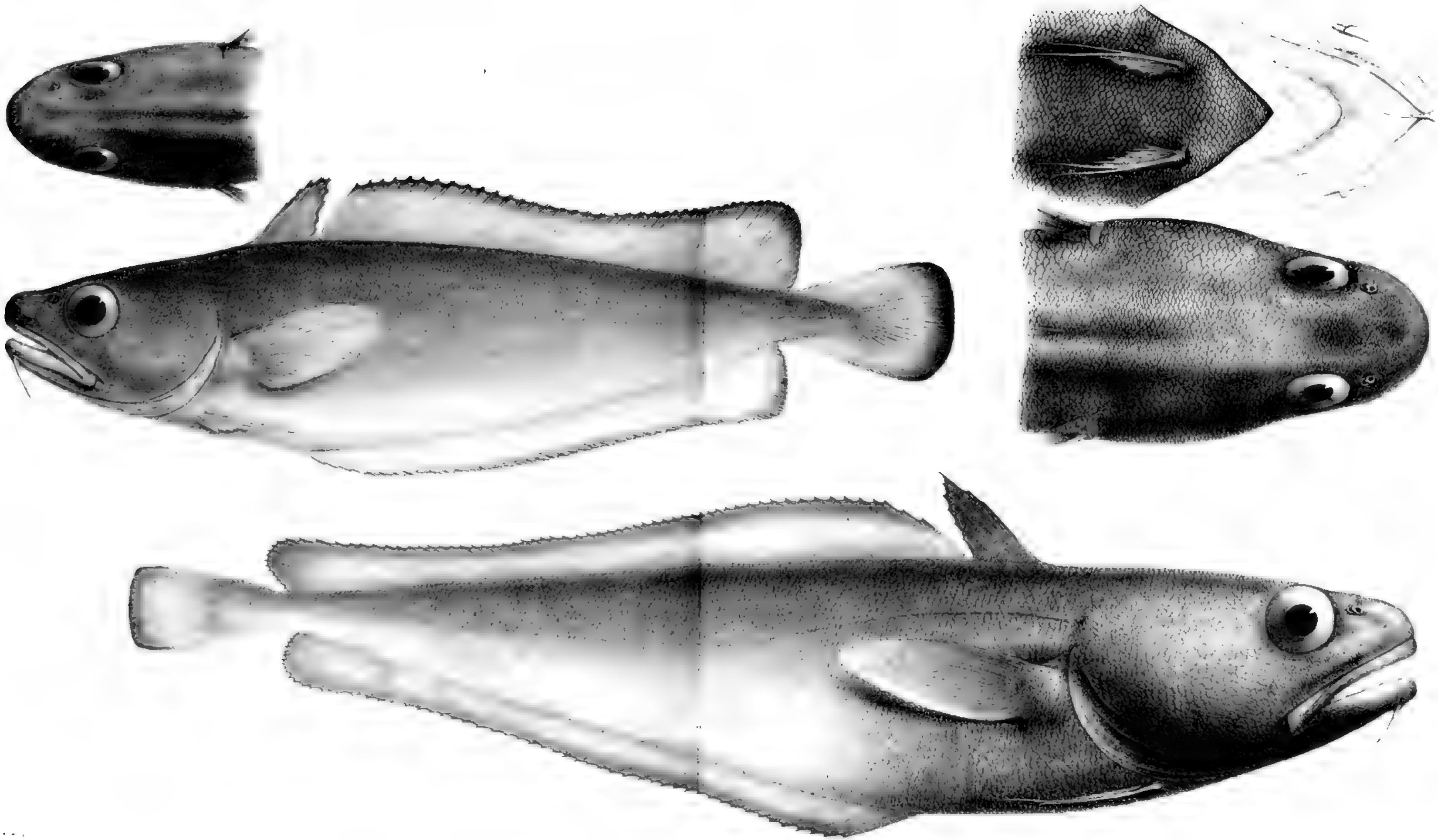
PLATE XVII.

Fig. A. *Physiculus kaupi* (page 88).

Tropical Atlantic and Japan. The specimen figured is from Inosima; depth, 345 fathoms.

Fig. B. *Salilota australis* (page 95).

Strait of Magellan and Coast of Patagonia; depth 55 to 70 fathoms.



Mintern Bros

PLATE XVIII.

PLATE XVIII.

Fig. A. *Haloporphyrus guentheri* (page 90).

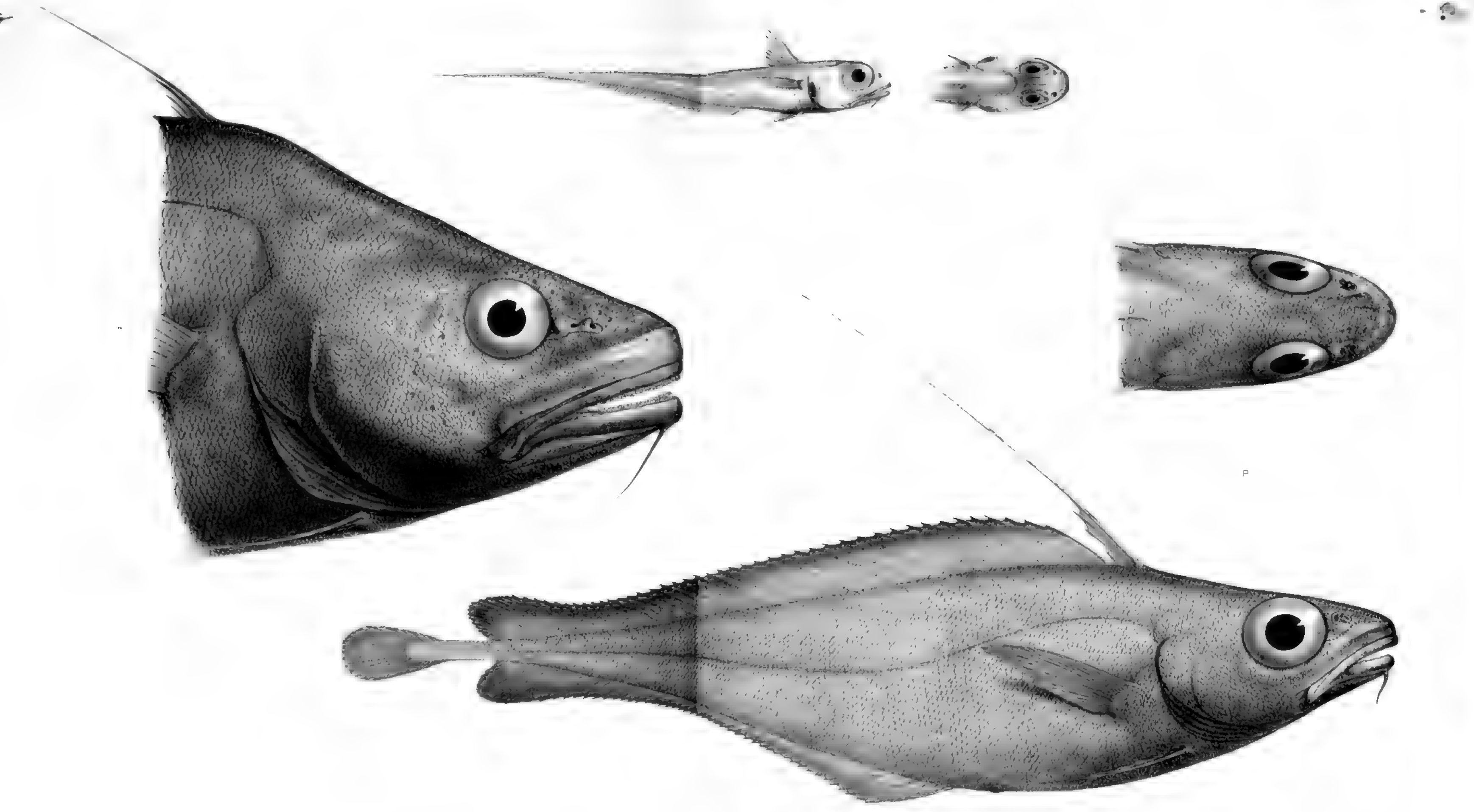
Coast of Portugal and Madeira, Mediterranean. The figure is taken from a Madeiran specimen.

Fig. B. *Haloporphyrus eques* (page 91).

Faröe Channel; depth, 530 fathoms.

Fig. C. *Macrurus longibarbis* (page 139).

Off Matuku, Fiji Islands, Station 173; depth, 315 fathoms.



Mintern Bros. imp.

PLATE XIX.

PLATE XIX.

Fig. A. *Haloporphyrus ensiferus* (page 92).
Off the mouth of the Rio Plata, Station 320 ; depth, 600 fathoms.

Fig. B. *Onus reinhardti* (page 97).
North Atlantic, Faröe Channel ; in 540 to 640 fathoms.

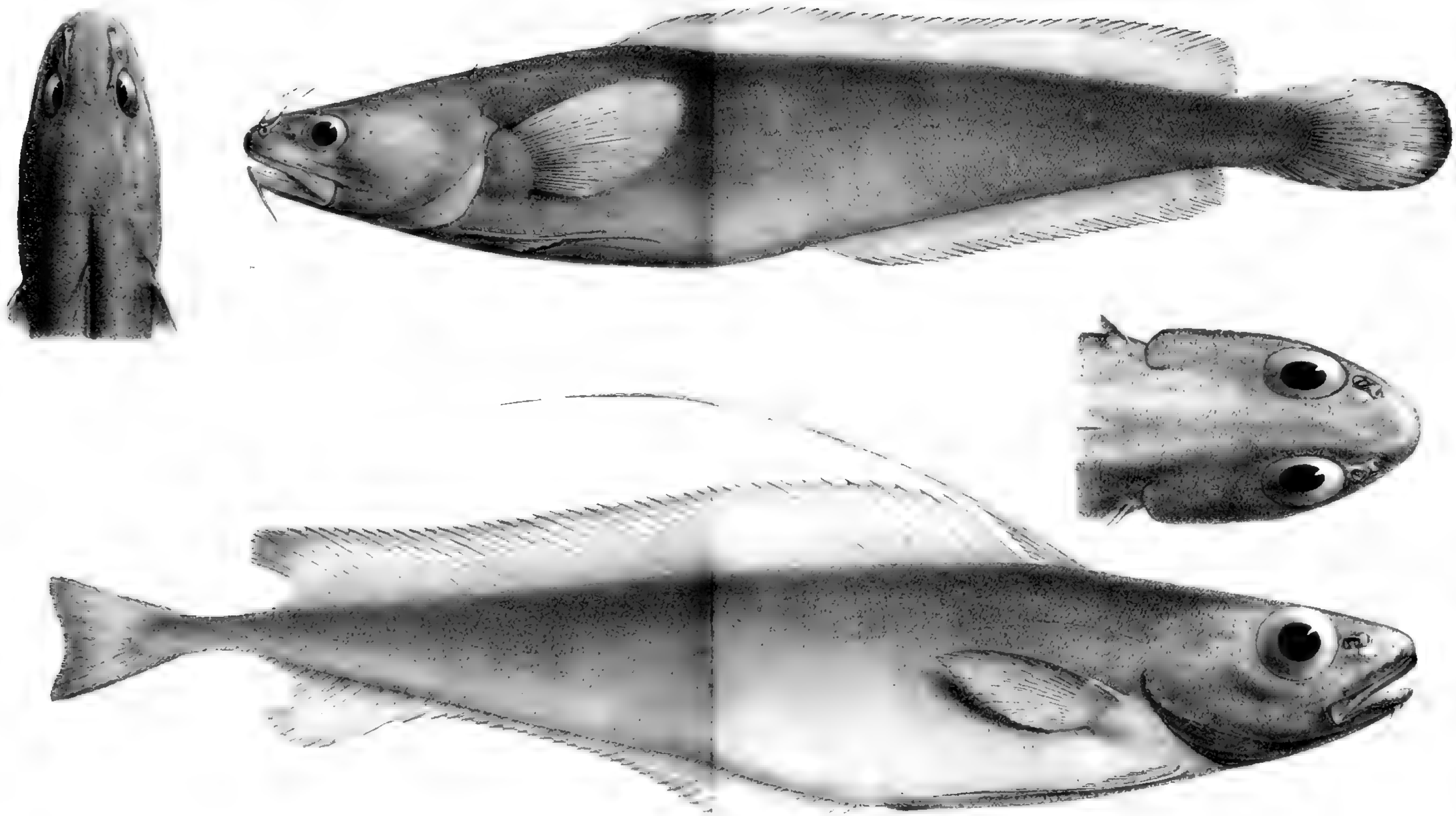


PLATE XX.

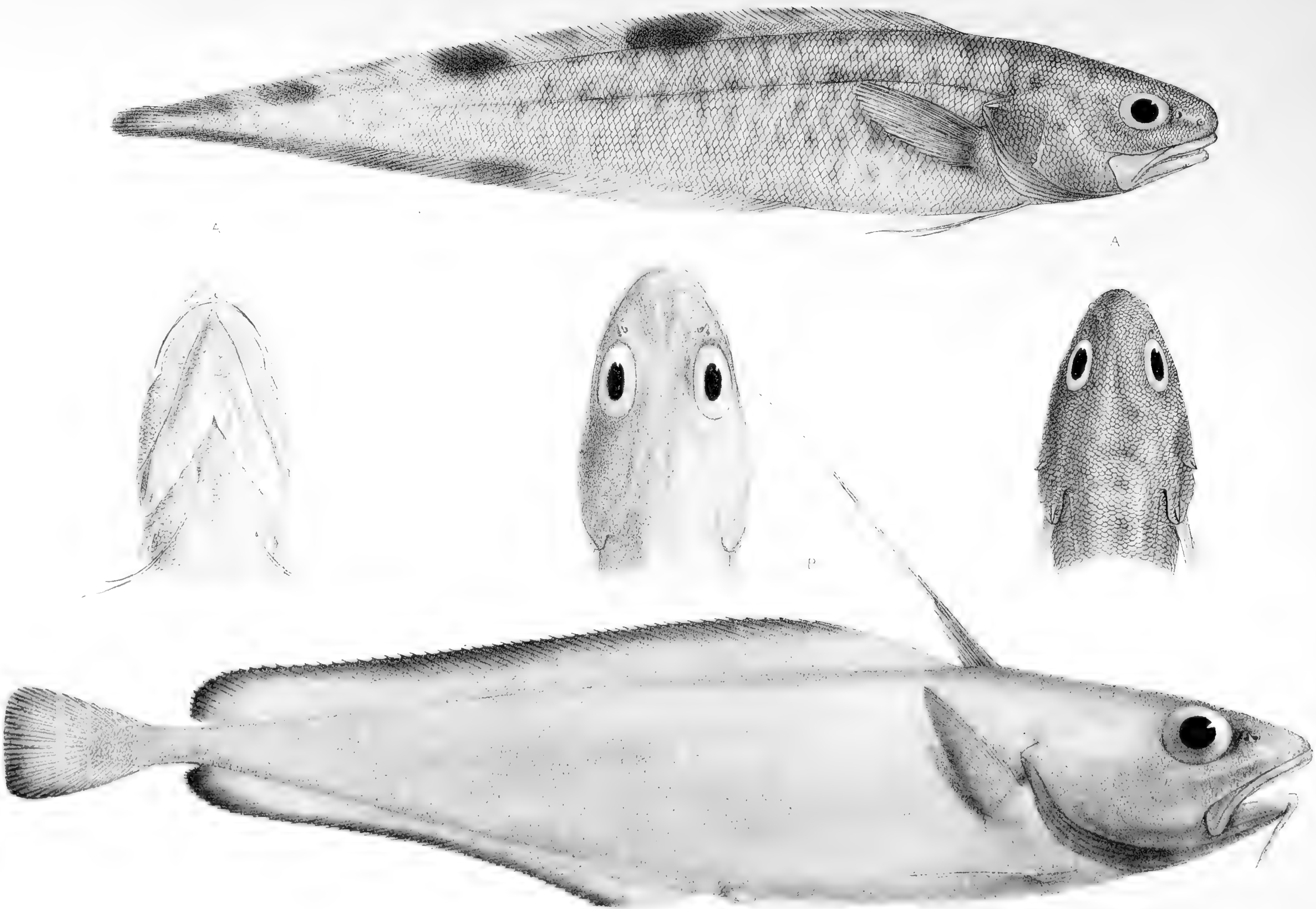
PLATE XX.

Fig. A. *Neobythites macrops* (page 102).

Off Matuku, Fiji Islands, Station 173A; depth, 310 fathoms.

Fig. B. *Haloporphyrus inosimæ* (page 92).

Inosima, Japan; in 345 fathoms.



R. Mintern del et lith.

Mintern Bros imp.

A NEOBYTHITES MACR
(Faths. 375)

B HALOPORPHYRUS NOSIMŒ
(Faths. 345)

PLATE XXI.

PLATE XXI.

Fig. A. *Neobythites grandis* (page 100).

South of Yedo, Station 237 ; depth, 1875 fathoms. Anterior part of the body and lower view of the head ; of natural size.

Fig. B. *Neobythites ocellatus* (page 103).

Off Pernambuco, Station 122 ; depth, 350 fathoms.

PLATE XXII.

PLATE XXII.

Fig. A. *Bathyonus compressus* (page 109).

Indo-Pacific and Atlantic. The specimen figured is from Station 184; depth, 1400 fathoms. The majority of the scales are restored.

Fig. B. *Pteroidonus quinquarius* (page 106).

Japan, Station 235; depth, 565 fathoms.

Fig. C. *Malacosarcus macrostoma* (page 30).

Mid Pacific, Station 271; depth, 2425 fathoms.

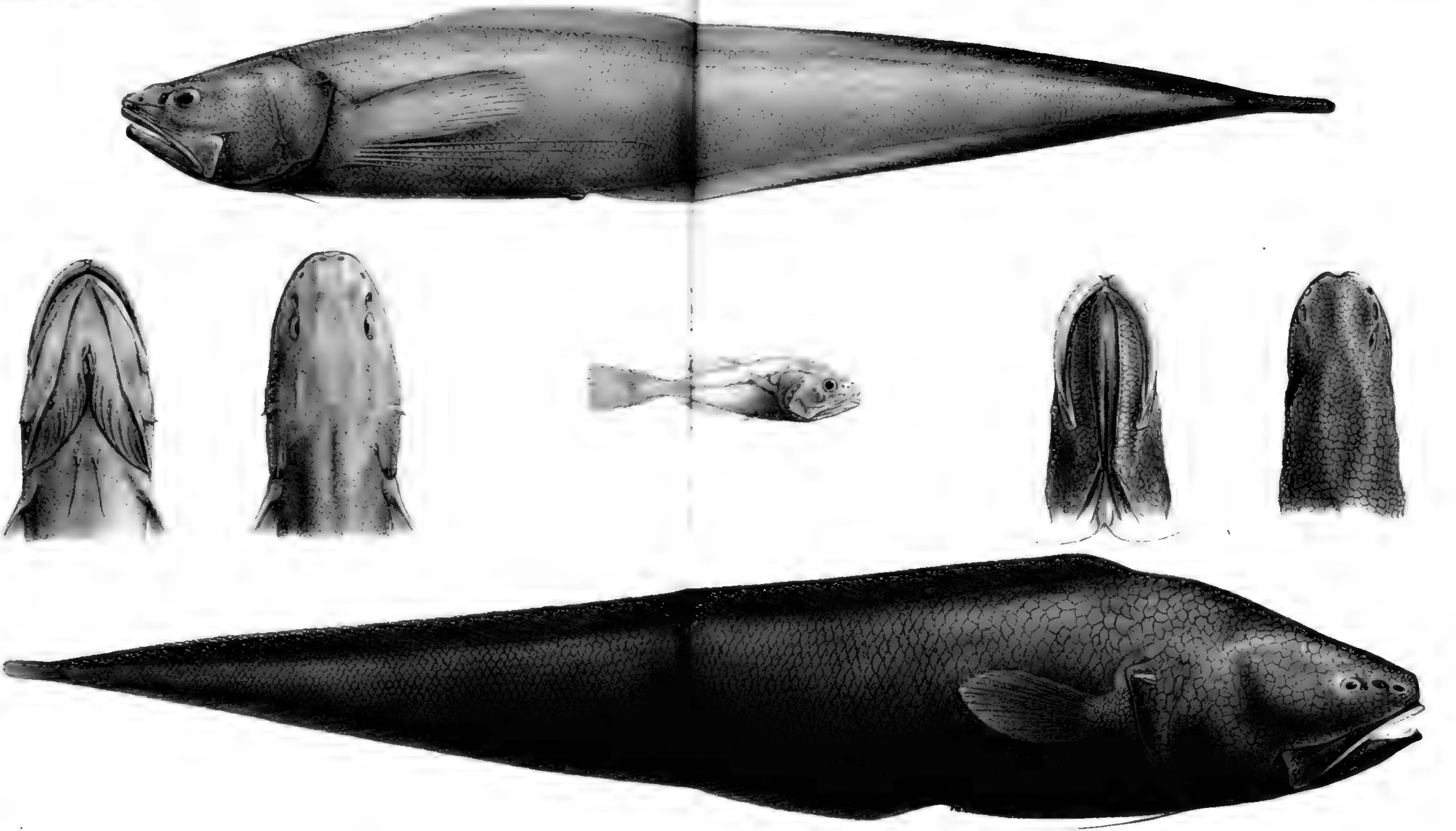


PLATE XXIII.

PLATE XXIII.

Fig. A. *Bathyonus tænia* (page 110).

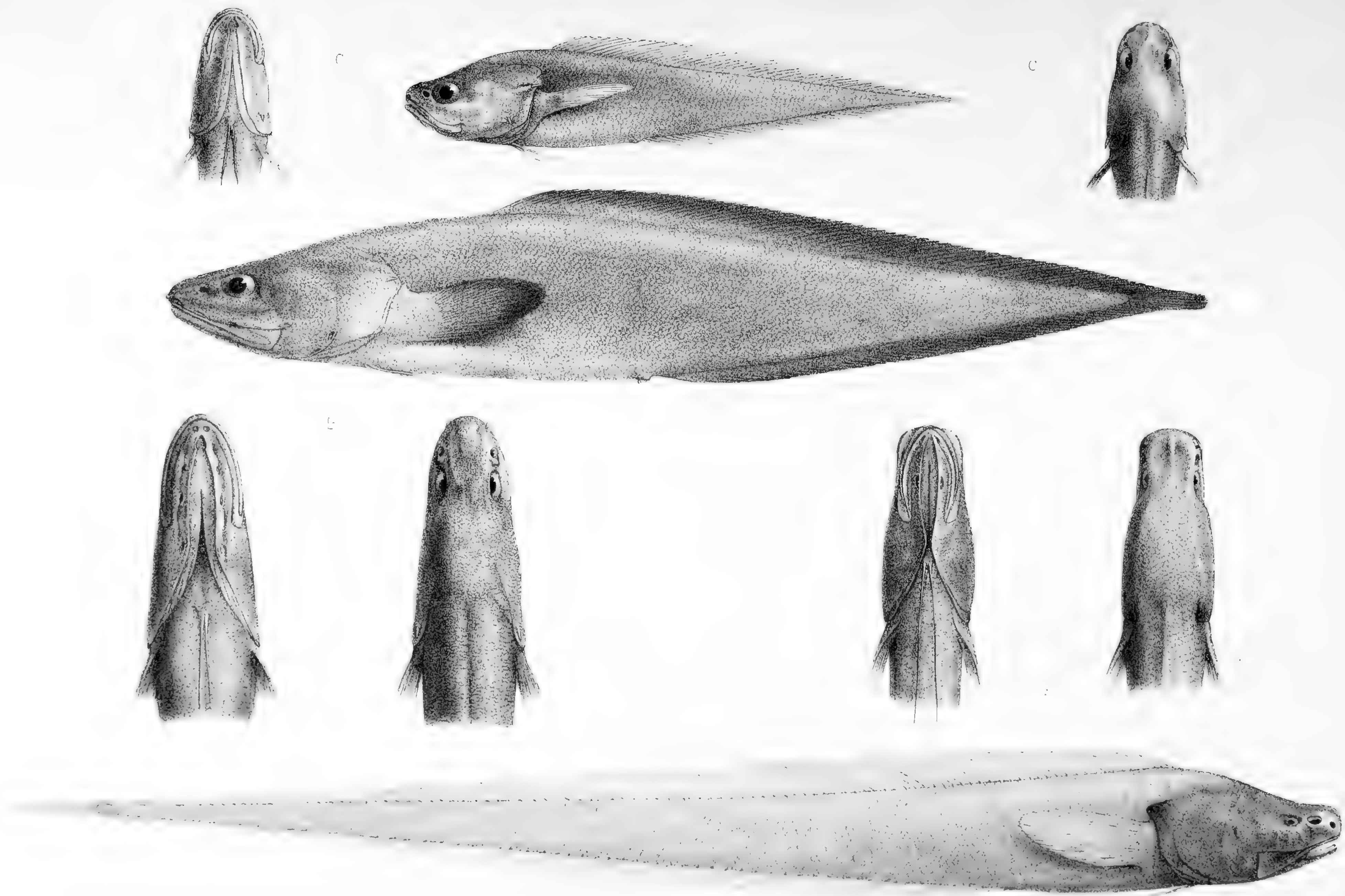
Mid Atlantic, Station 104; depth, 2500 fathoms. Scales restored.

Fig. B. *Catætyx messieri* (page 104).

Messier Strait, Station 306A; depth, 345 fathoms.

Fig. C. *Diplacanthopoma brachysoma* (page 115).

Off Pernambuco, Station 122; depth, 350 fathoms.



R. Mintern del et lith.

Mintern Bros. imp.

A BATHYONUS TÆNIA. (Fath. 2500)

B CATÆTYX MESSIERI (Fath. 345)

C DIPLACANTHOPOMA BRACHYSOMA. (Fath. 350)

PLATE XXIV.

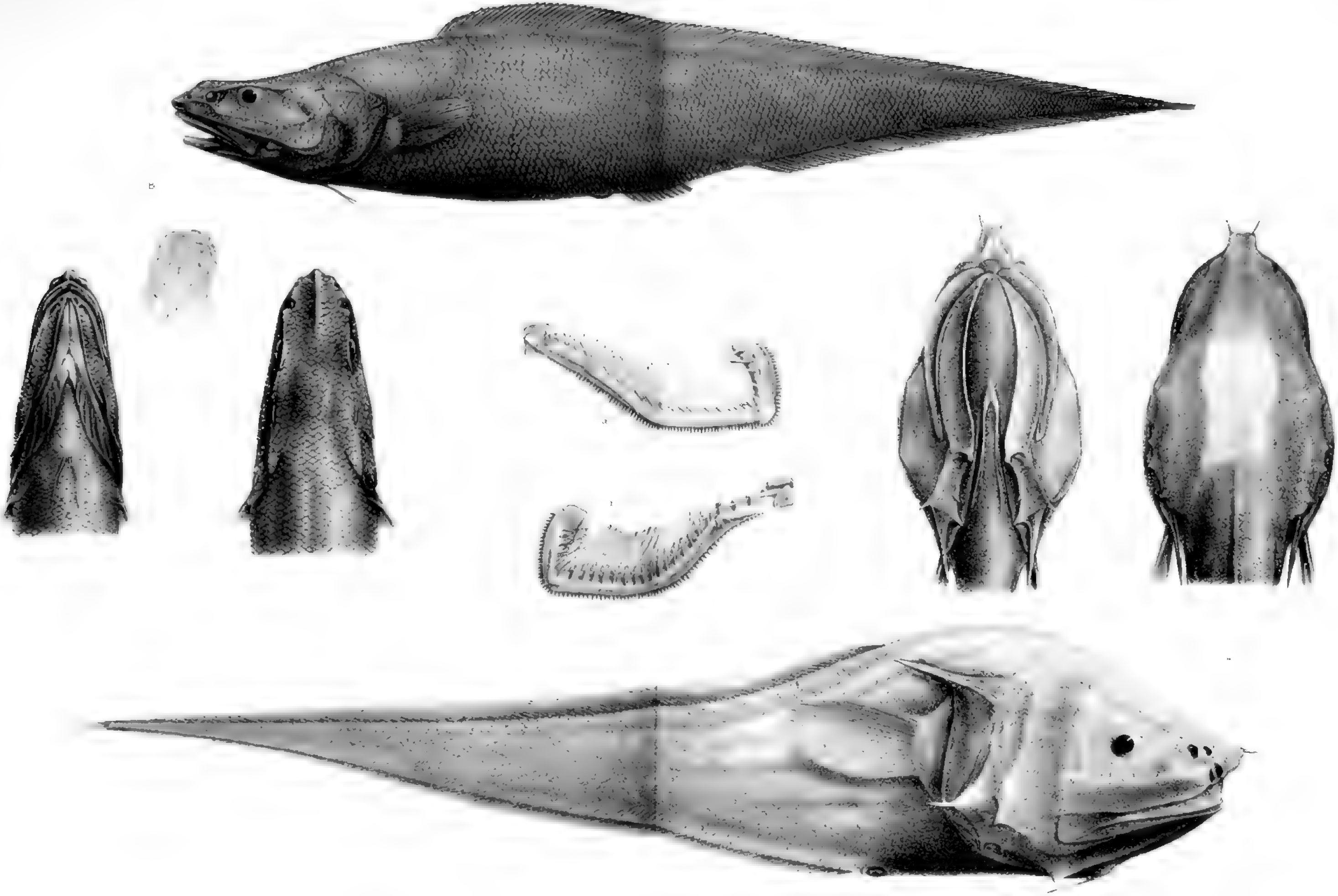
PLATE XXIV.

Fig. A. *Acanthonus armatus* (page 117).

Indo-Pacific Ocean; the specimen figured is from north of New Guinea, Station 218; depth, 1070 fathoms. *a*, outer; *a′*, inner aspect of first branchial arch.

Fig. B. *Porogadus rostratus* (page 113).

North of Celebes, Station 198; depth, 2150 fathoms. A magnified view of a scale is added.



Mintern Bros. imp.

PLATE XXV.

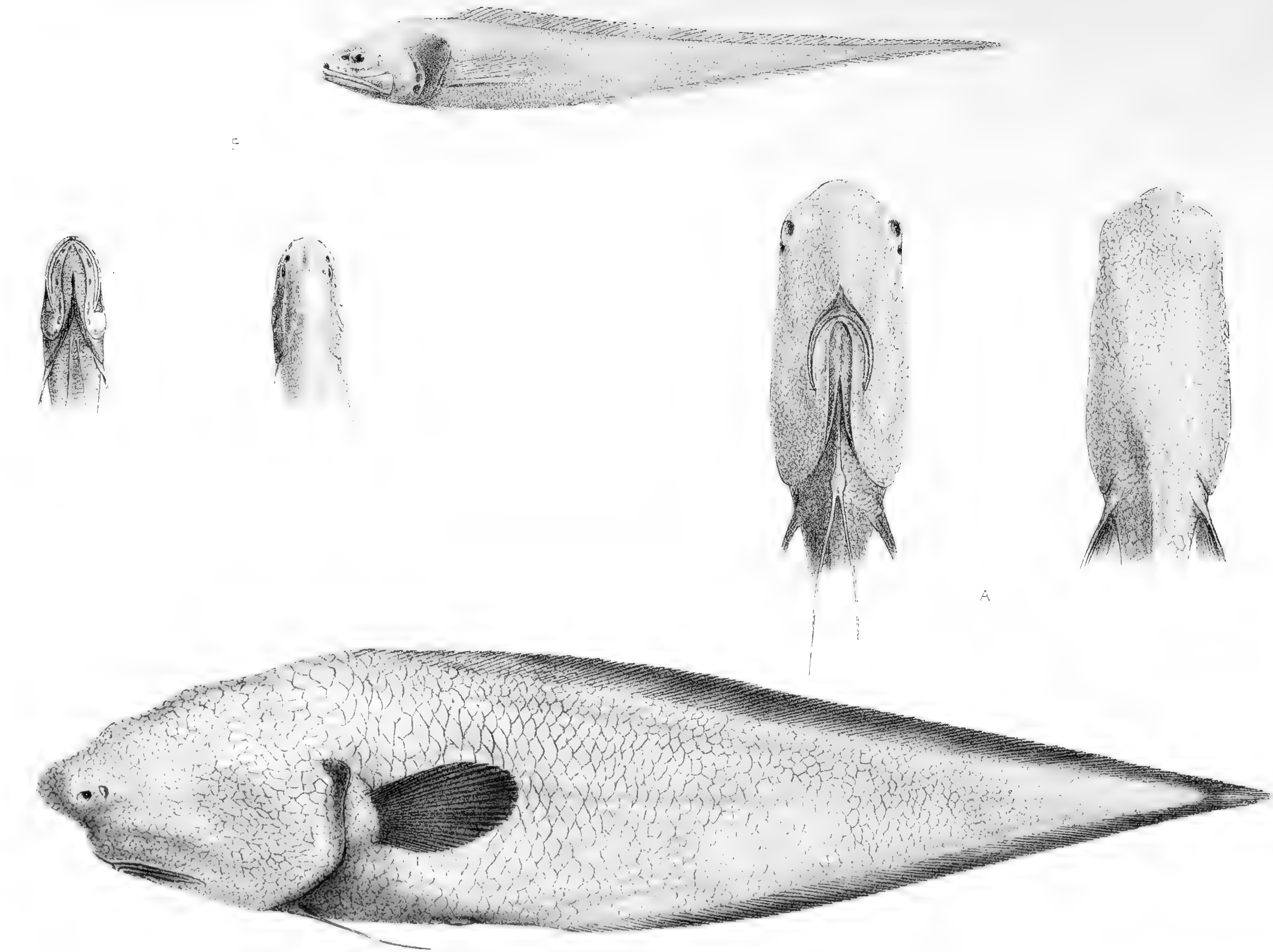
PLATE XXV.

Fig. A. *Typhlonus nasus* (page 119).

Indo-Pacific. The specimen figured is from Station 181, north-east of Australia; depth, 2440 fathoms.

Fig. B. *Mixonus laticeps* (page 108).

Mid Atlantic, Station 104; depth, 2500 fathoms.



J. Mintern del et lith.

Mintern Bros. imp.

A. TYPHLONUS NASUS.   B. MIXONUS LATICEPS.

PLATE XXVI.

PLATE XXVI.

Fig. A. *Aphyonus gelatinosus* (page 120).

Obtained between north-east of Australia and New Guinea at Station 184; depth 1400 fathoms.

Fig. B. *Bathypterois longicauda* (page 188).

South Pacific, Station 289; depth, 2550 fathoms. Figure twice the natural size.

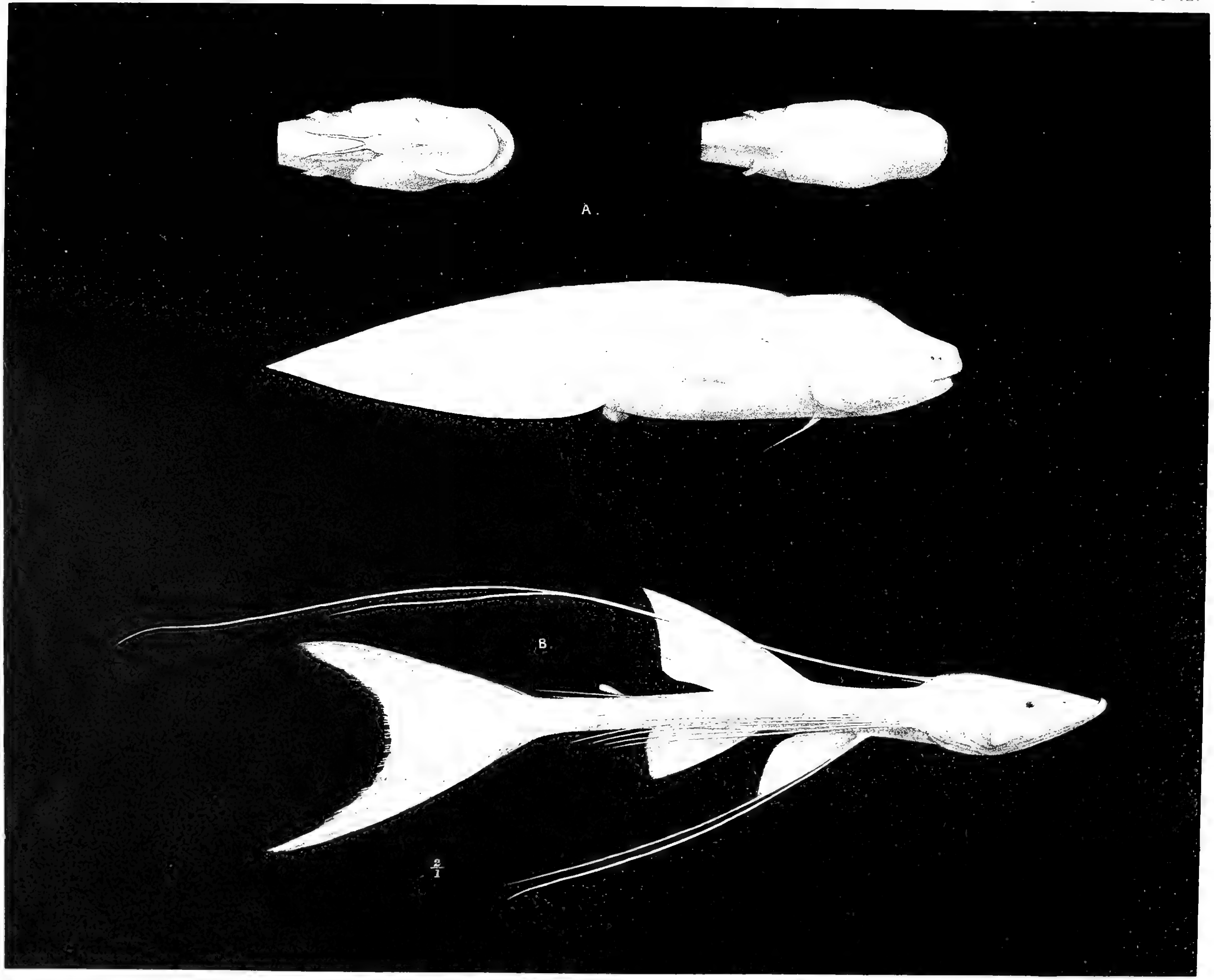

A.
B.
2/1

PLATE XXVII.

PLATE XXVII.

Macrurus rudis (page 131).

North of Kermadec Islands, Stations 170, 170A, 171; depth, 520 to 630 fathoms. *a*, Ventral aspect of a specimen 11 inches long, to show position of vent; *b*, Dorsal spine of a specimen of 11, and *c*, of one of 6 inches in length. Also an enlarged view of a scale.

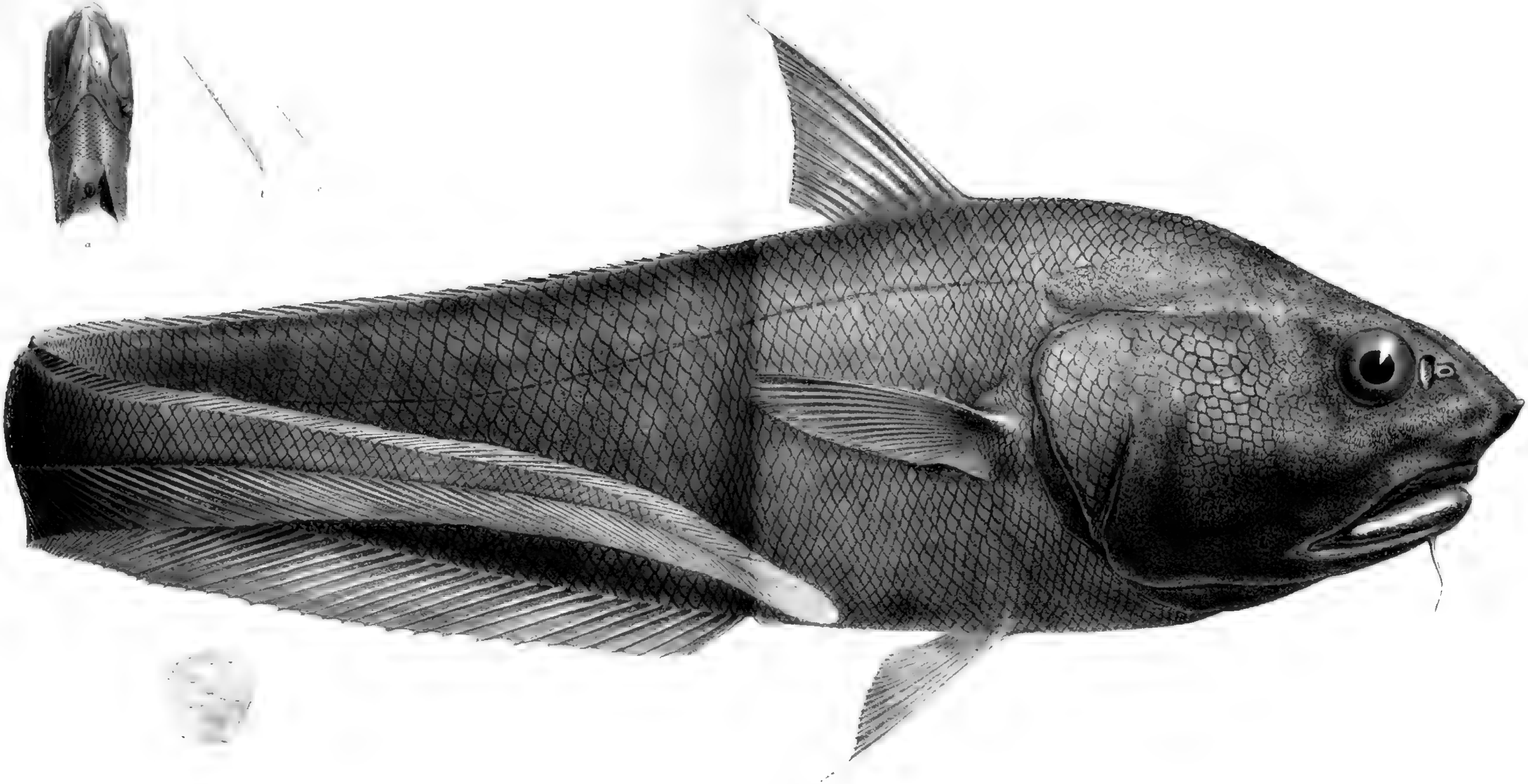


PLATE XXVIII.

PLATE XXVIII.

Fig. A. *Macrurus fasciatus* (page 129).

East coast of the southern extremity of South America, Station 309A; depth, 140 fathoms.

Fig. B. *Macrurus holotrachys* (page 136).

Mouth of the Rio de la Plata, Station 320; depth, 600 fathoms.

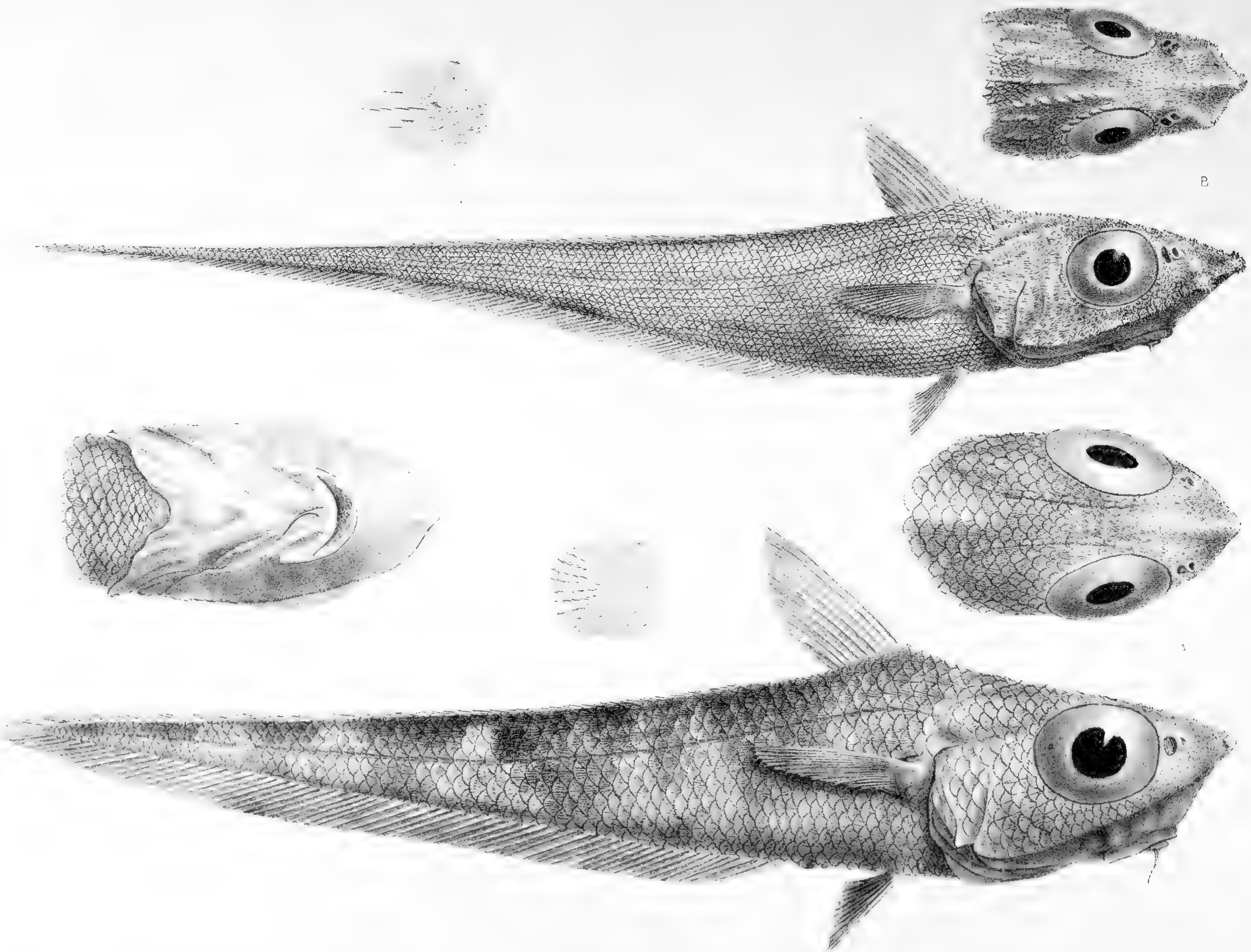

B
Mintern Bros. imp.

PLATE XXIX.

PLATE XXIX.

Fig. A. *Macrurus parallelus* (page 125) (two-thirds of natural size).

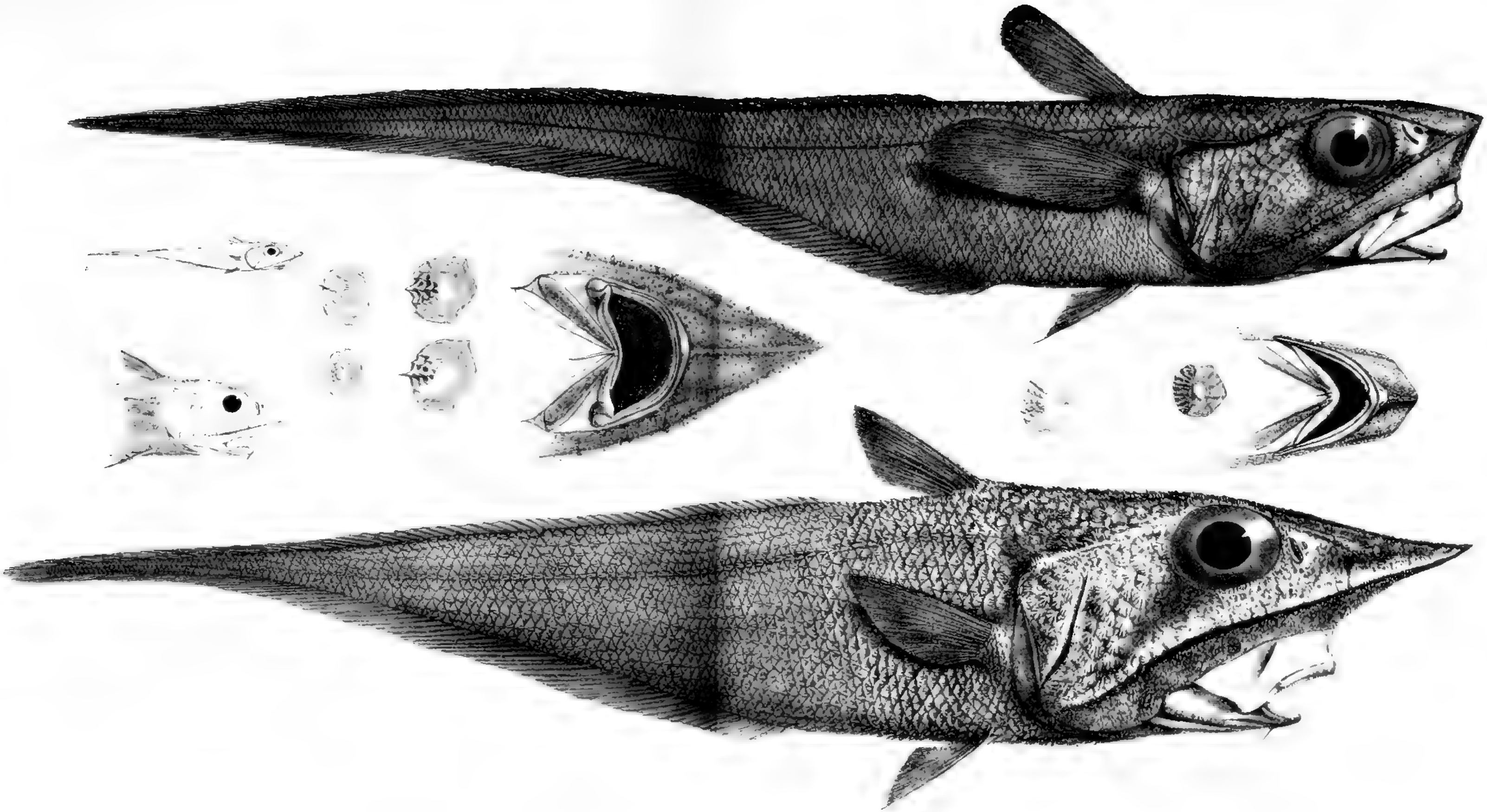
Pacific; the specimen figured is from Kermadec Island, Station 170A; depth, 630 fathoms. A′, young, $5\frac{1}{2}$ inches long; A″, very young, natural size; a, scale from middle of fish, above the lateral line; a', scale from the back; a'', scale of young specimen, $5\frac{1}{2}$ inches long; a''', scale of very young specimen (A″).

Fig. B. *Macrurus macrochir* (page 148) (one-half natural size).

Off Inosima, Station 232; depth, 345 fathoms. With enlarged view of scale.

Fig. C. *Macrurus japonicus* (page 127).

Scale only, magnified four times.



MACR RUS PARALLE...

PLATE XXX.

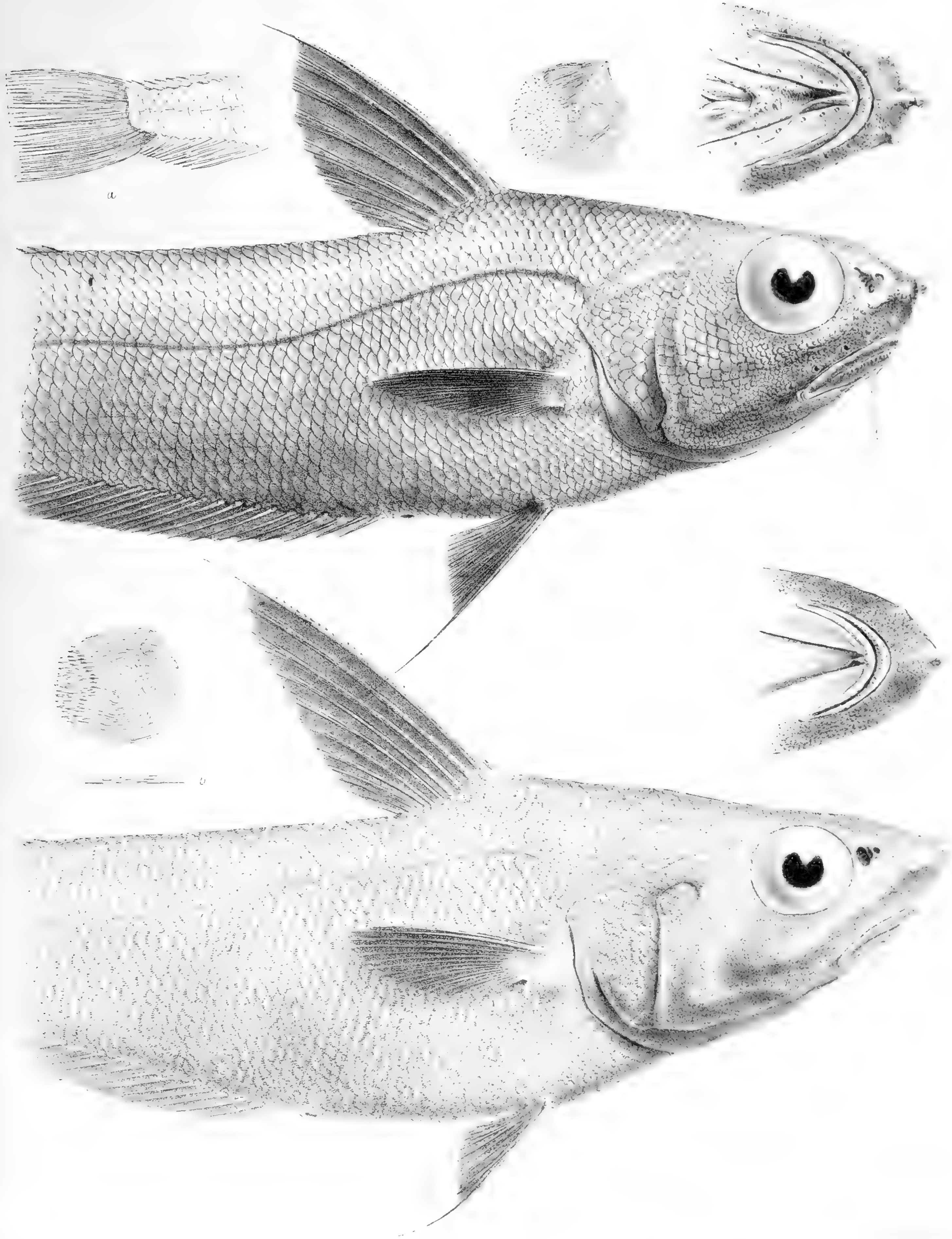
PLATE XXX.

Fig. A. *Macrurus serrulatus* (page 133).

North-East of New Zealand, Station 169; depth, 700 fathoms. *a*, End of mutilated tail, simulating a caudal fin.

Fig. B. *Macrurus nasutus* (page 132).

Sea of Japan, Station 235; depth, 565 fathoms. With enlarged figure of a scale, and with *b*, a spinelet from the surface of the scale, highly magnified, to show the longitudinal ridge.



P. Smit del. et lith.

A. MACRURUS SERRULATUS
Faths 700

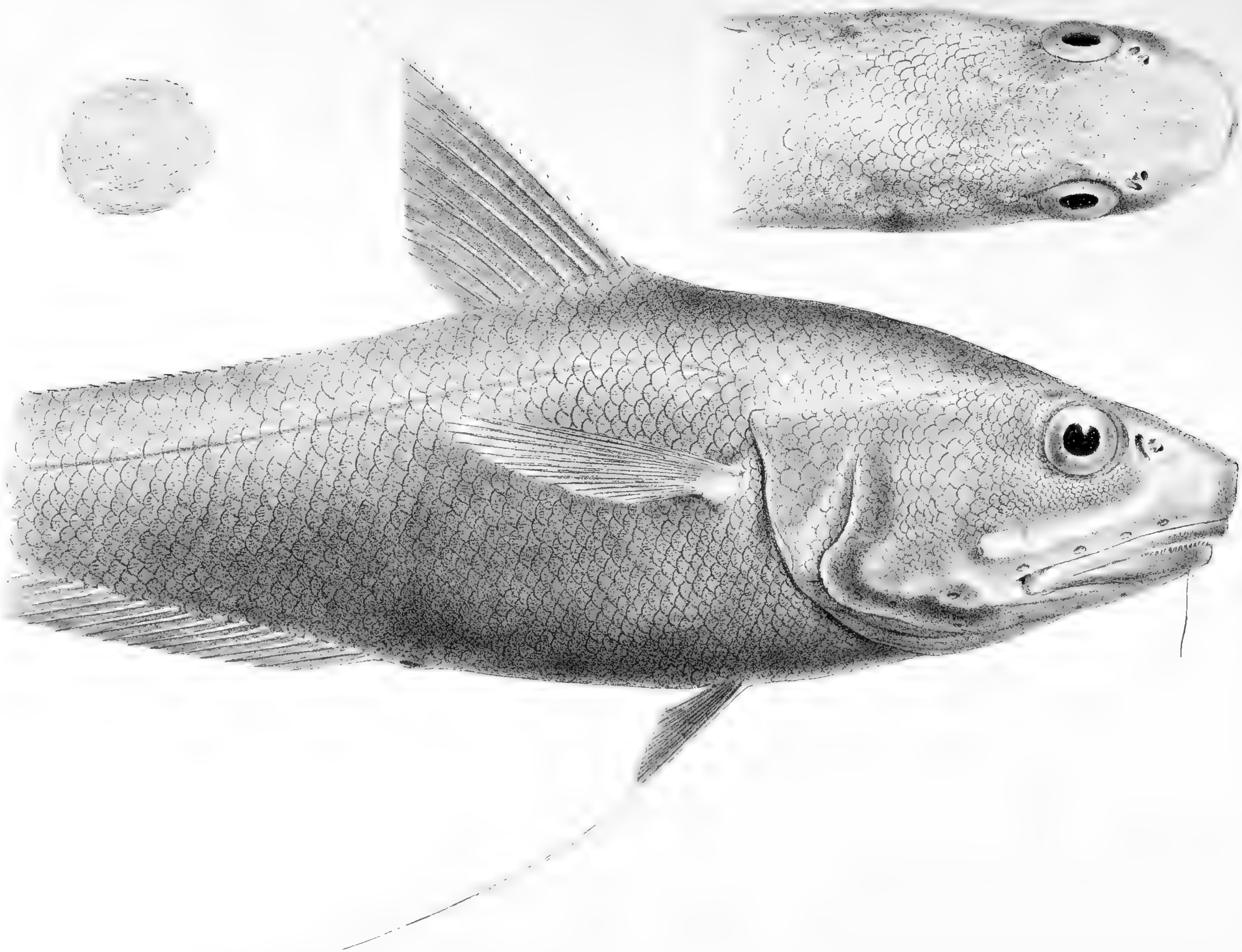
...45-51

PLATE XXXI.

PLATE XXXI.

Macrurus leptolepis (page 144).

Off the coast of Brazil, Station 122; depth, 350 fathoms.



P. Smit del. et lith.

Mintern Bros. imp.

PLATE XXXII.

PLATE XXXII.

Fig. A. *Macrurus sclerorhynchus* (page 133).

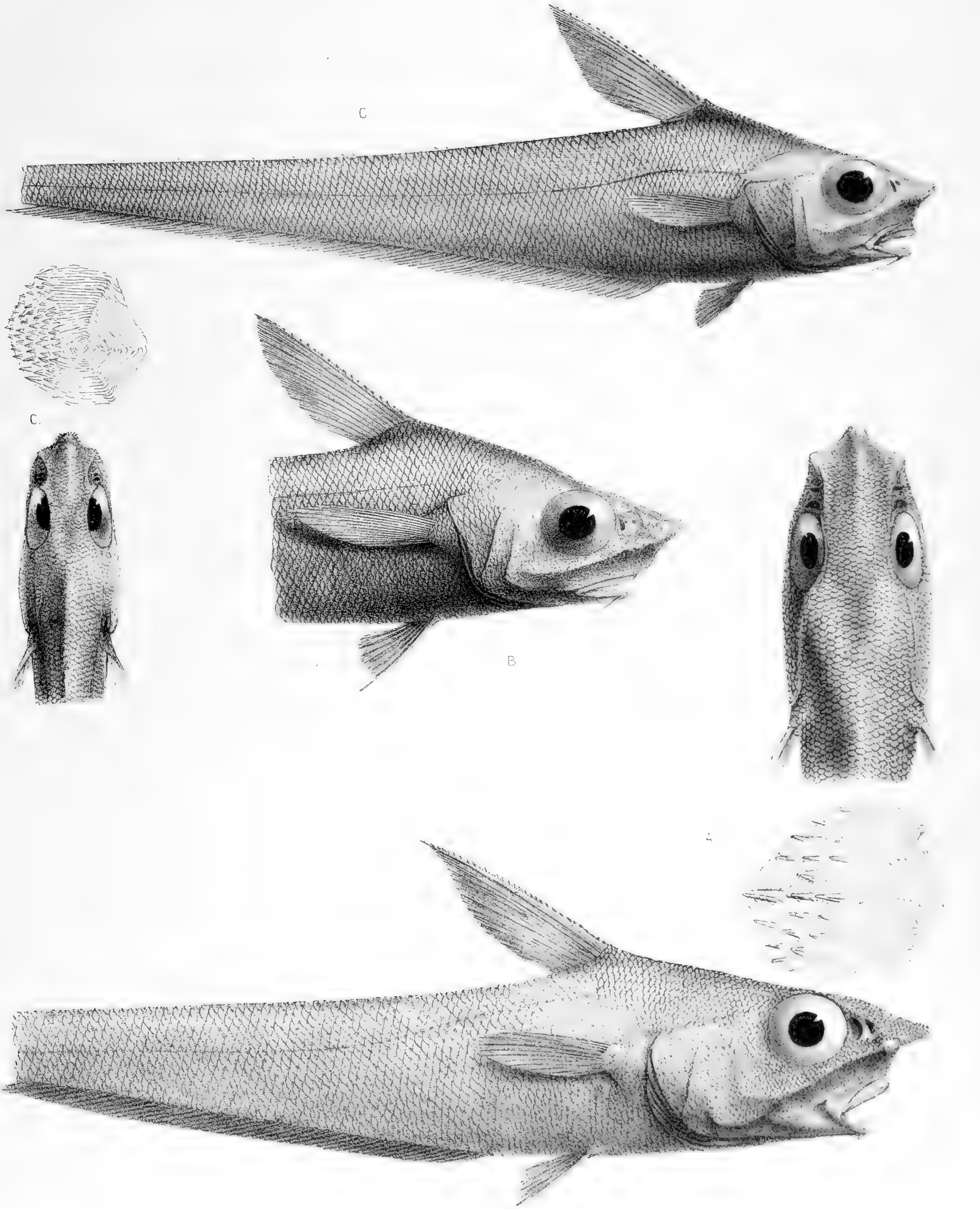
Eastern Atlantic, Station V.; depth, 1090 fathoms. An upper view of the head, and a much magnified view of a scale are added.

Fig. B. *Macrurus bairdii* (page 135).

Western Atlantic; depth 160 to 740 fathoms. Only a side view of the head and trunk is given.

Fig. C. *Macrurus æqualis* (page 134).

South of Portugal, Station IV.; depth, 600 fathoms. An upper view of the head and an enlarged view of a scale are added.



R. Mintern del et lith

Mintern Bros imp.

A. MACRURUS SCLERORHYNCHUS. (Faths 1090.) B. MACRURUS BAIRDII (Faths 160—740) C. MACRURUS ÆQUALIS. (Faths 300)

PLATE XXXIII.

PLATE XXXIII.

Fig. A. *Macrurus carinatus* (page 137).

Near Prince Edward Island, Station 145A; depth, 310 fathoms (not 500 as stated on plate).

Fig. B. *Bathypterois quadrifilis* (page 189).

Off the coast of Brazil, Stations 121 and 126; depth 500 to 770 fathoms. With separate views of the upper side of the head, and of the ventral fins; also enlarged views to two scales, one taken from the middle of the side, and the other, which is pectinated, from the post-pectoral region.

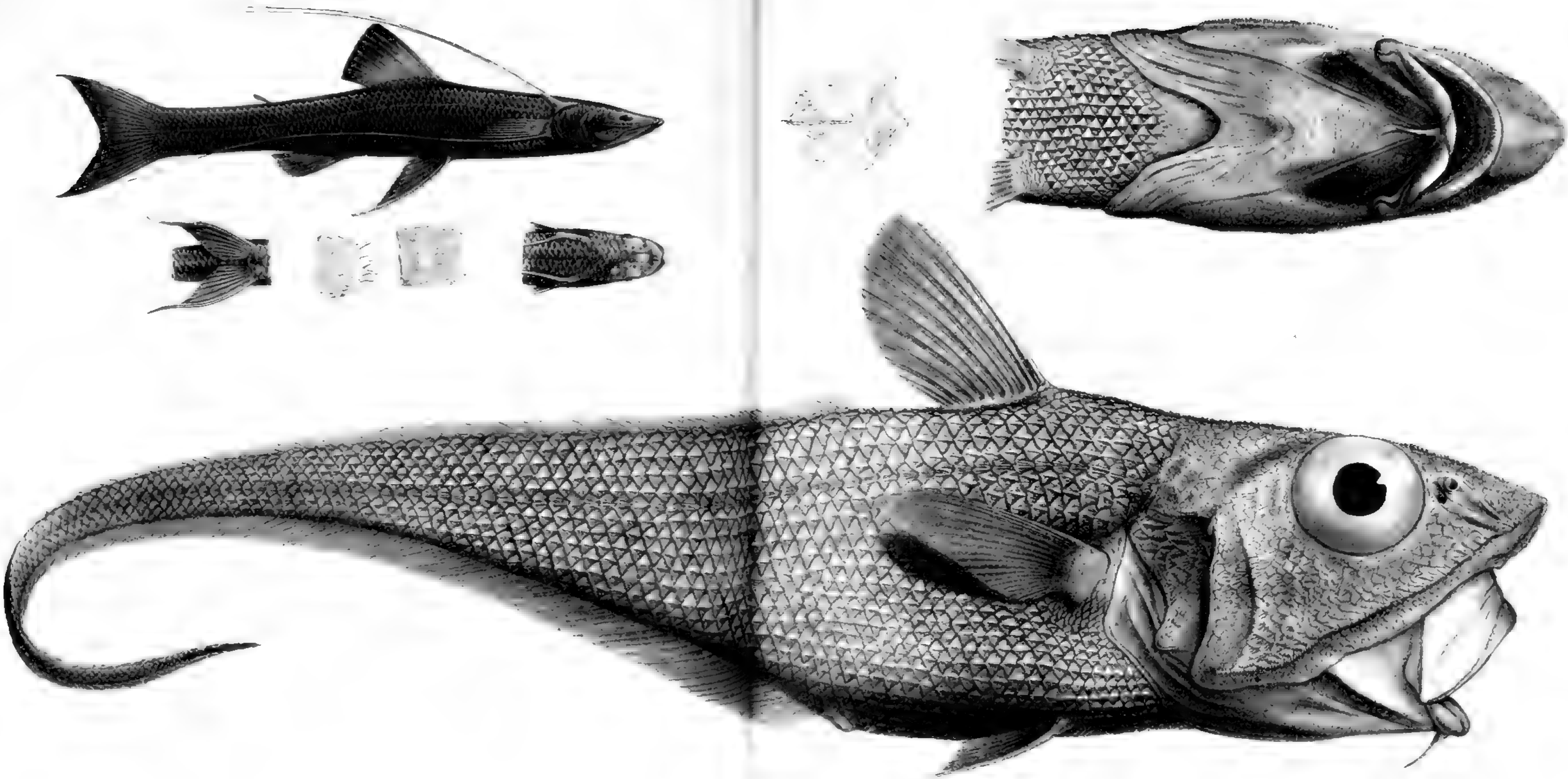


PLATE XXXIV.

PLATE XXXIV.

Fig. A. *Macrurus murrayi* (page 146).

Off New Zealand, Station 168; depth, 1100 fathoms.

Fig. B. *Macrurus filicauda* (page 141).

Deep-sea on both sides of the South American Continent and Antarctic Ocean, at a depth of 1375 to 2650 fathoms. The specimen figured is from Station 299. The majority of the scales were lost, and have been restored in the figure.

PLATE XXXV.

PLATE XXXV.

Macrurus longifilis (page 151).

South of Yedo, Station 235; depth, 565 fathoms.

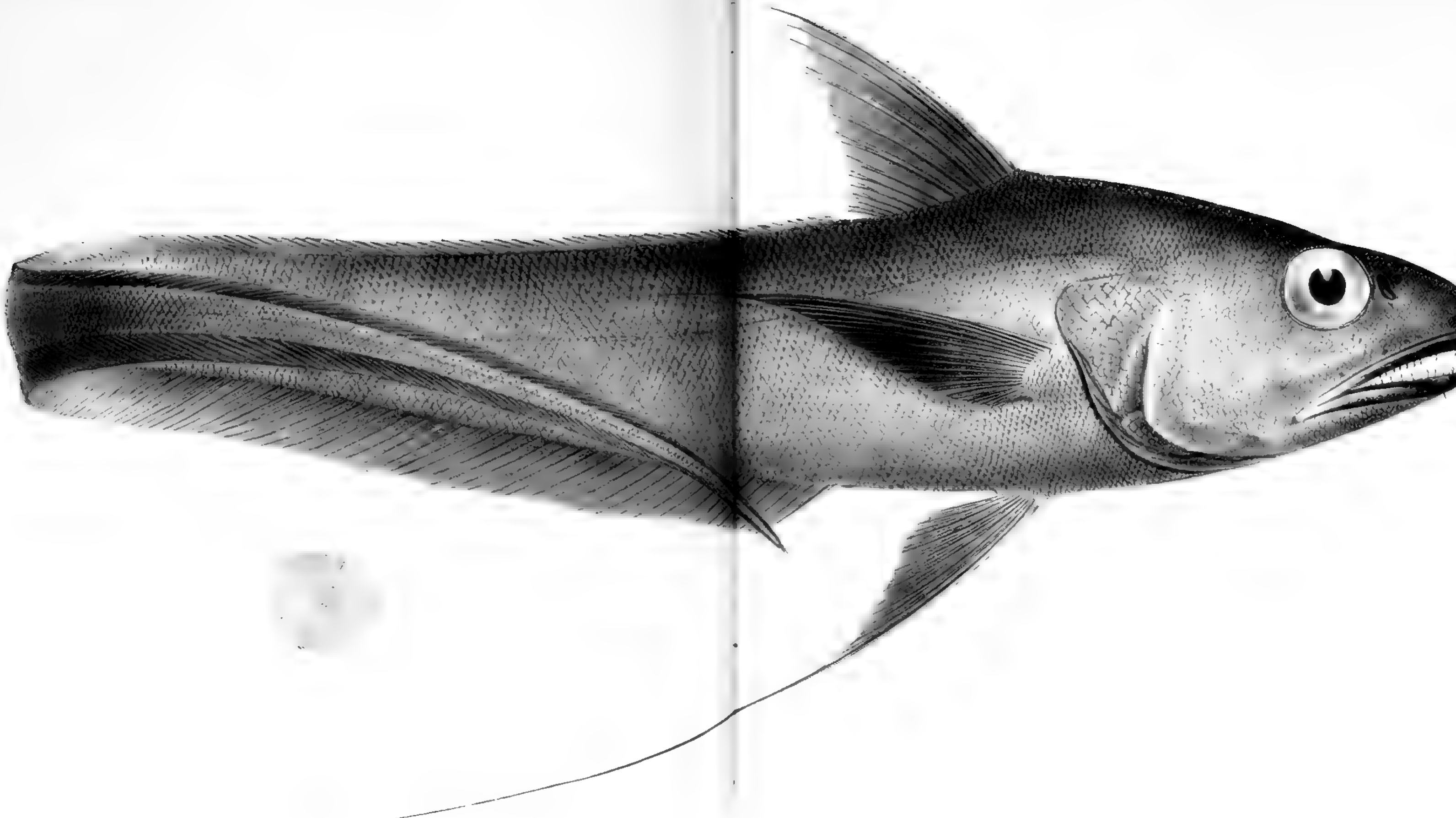


PLATE XXXVI.

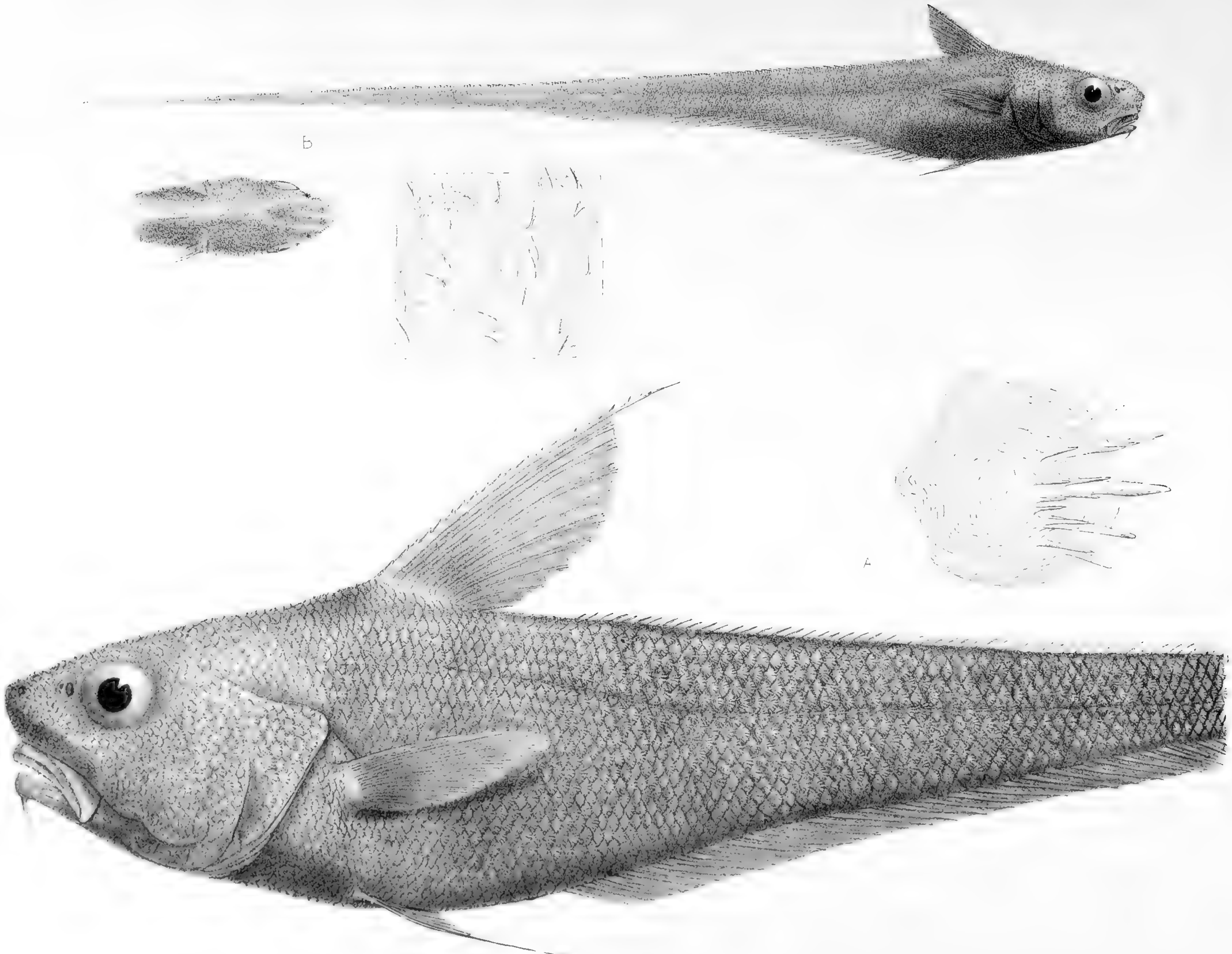
PLATE XXXVI.

Fig. A. *Macrurus asper* (page 137).

South of Japan, Station 237; depth, 1875 fathoms. With enlarged view of a scale.

Fig. B. *Macrurus villosus* (page 142).

Sea of Japan and the Philippine Islands, Station 214; depth, 500 fathoms. With enlarged view of a piece of the integument.



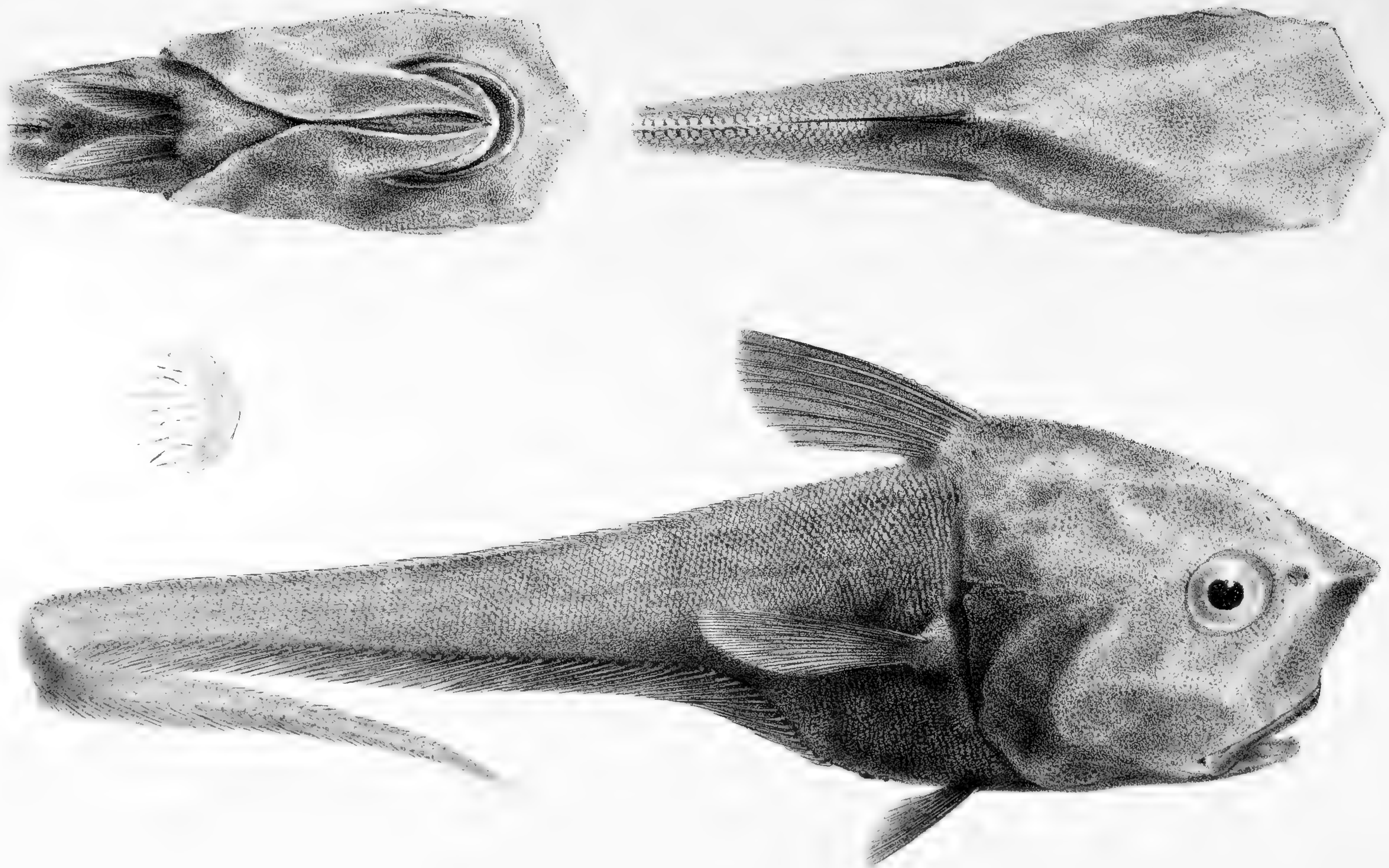
Mintern Bros. imp.

PLATE XXXVII.

PLATE XXXVII.

Macrurus crassiceps (page 143).

North of Kermadec Islands, Station 170; depth, 520 fathoms.



Mintern Bros.

PLATE XXXVIII.

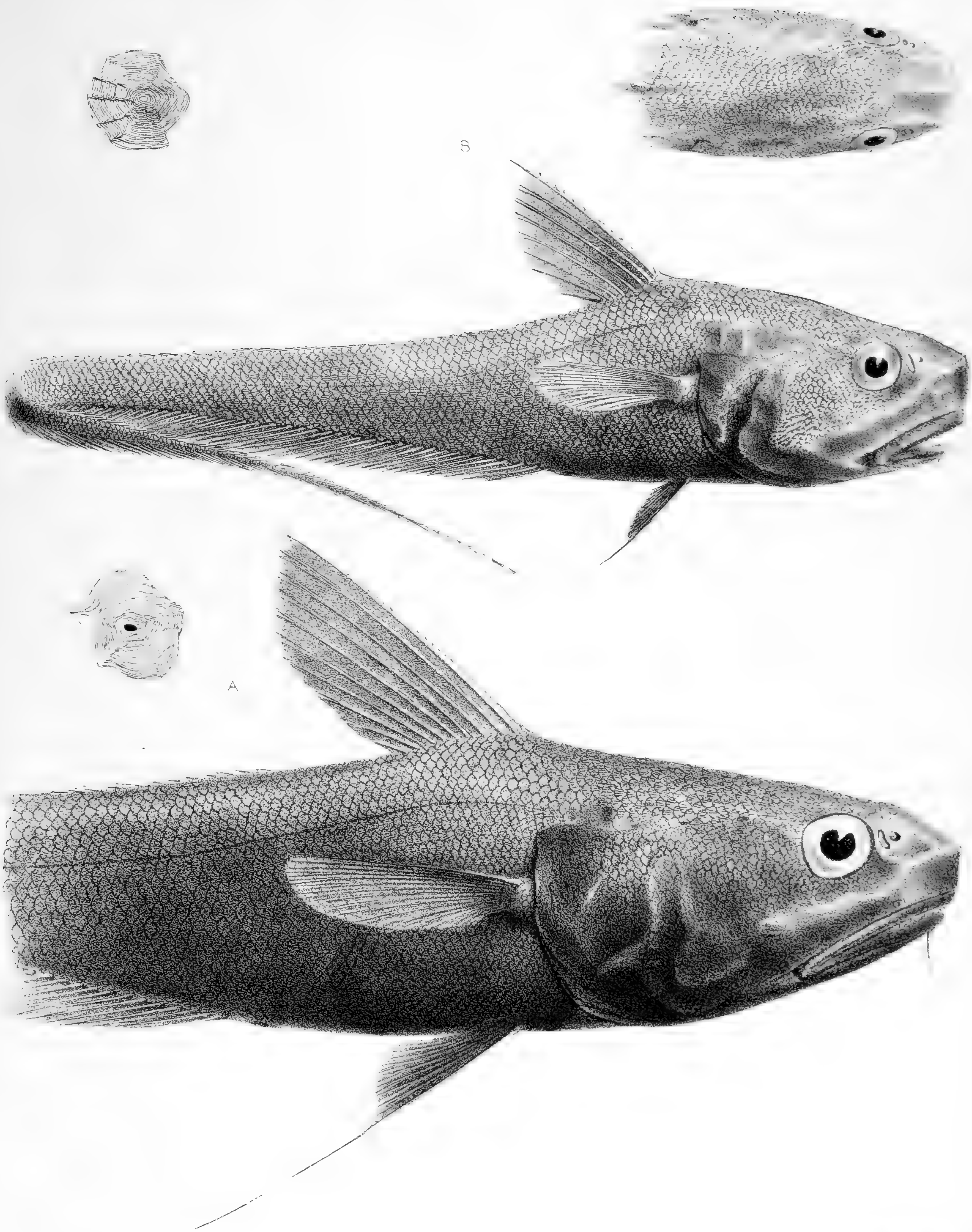
PLATE XXXVIII.

Fig. A. *Macrurus liocephalus* (page 145).

Pacific. The specimen figured is from Yokohama, Station 237; depth, 1875 fathoms.

Fig. B. *Macrurus fernandezianus* (page 145).

South of Juan Fernandez, Station 300; depth, 1375 fathoms.



P. Smit del et lith.

A. MA[illegible]URUS [illegible]EFHALU[illegible]
(Eathis 1875)

PLATE XXXIX.

PLATE XXXIX.

Fig. A. *Macrurus altipinnis* (page 138).

Japanese Sea, Station 237; depth, 1875 fathoms.

Fig. B. *Macrurus lævis* (page 148).

Atlantic. The figure is taken from a South Atlantic specimen, Station 122; depth, 350 fathoms. Fig. *b* represents the abdomen, with vent and the two scaleless depressions.

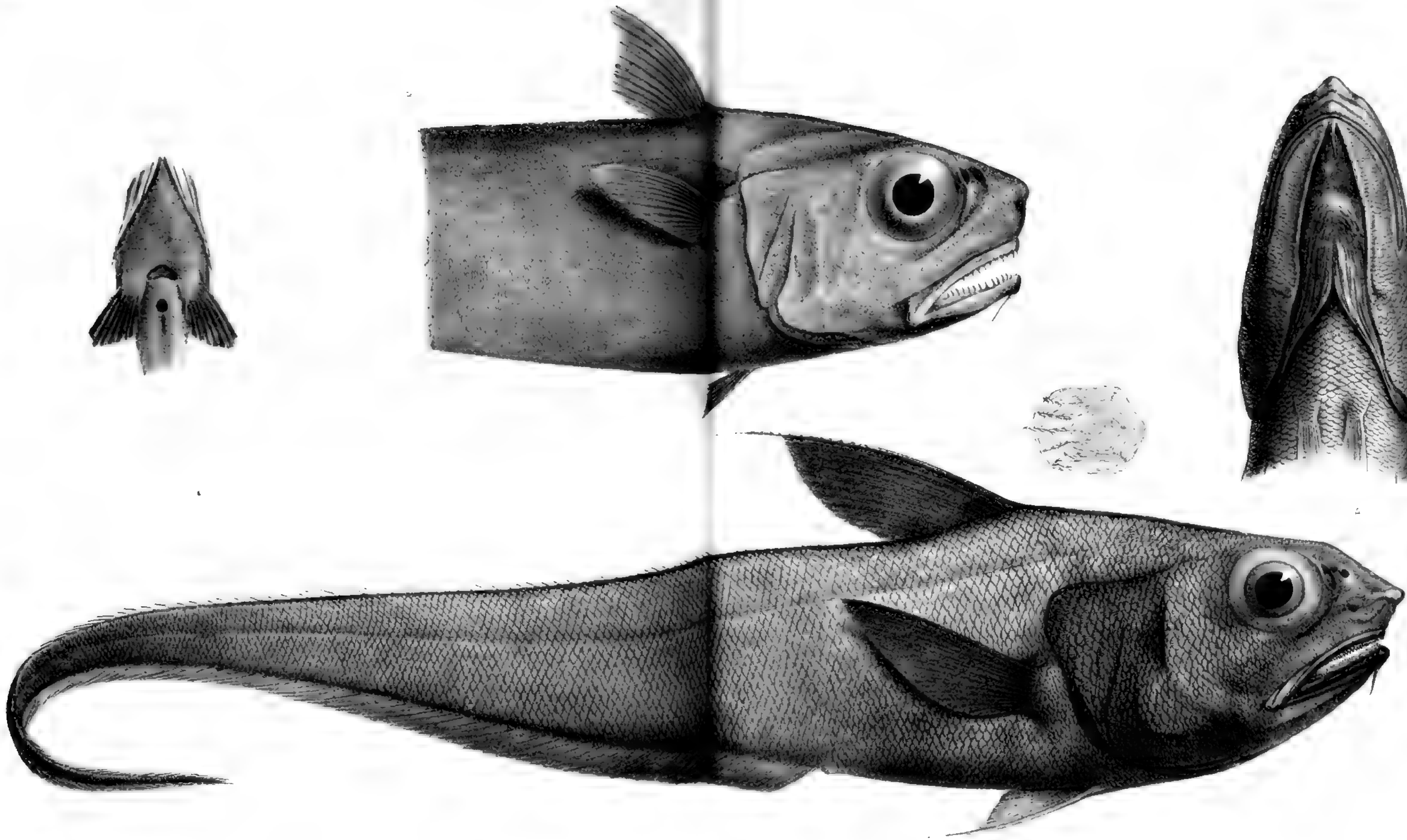


PLATE XL.

PLATE XL.

Fig. A. *Macrurus armatus* (page 150).

South Pacific, in 400 to 2425 fathoms. The figure is taken from a specimen from Station 147; depth, 1600 fathoms. *a* represents a magnified scale of a normal specimen, *a'* that of an albino.

Fig. B. *Macrurus affinis* (page 151).

Mouth of the Rio de la Plata, Station 323; depth, 1900 fathoms. *b*, magnified view of a scale.

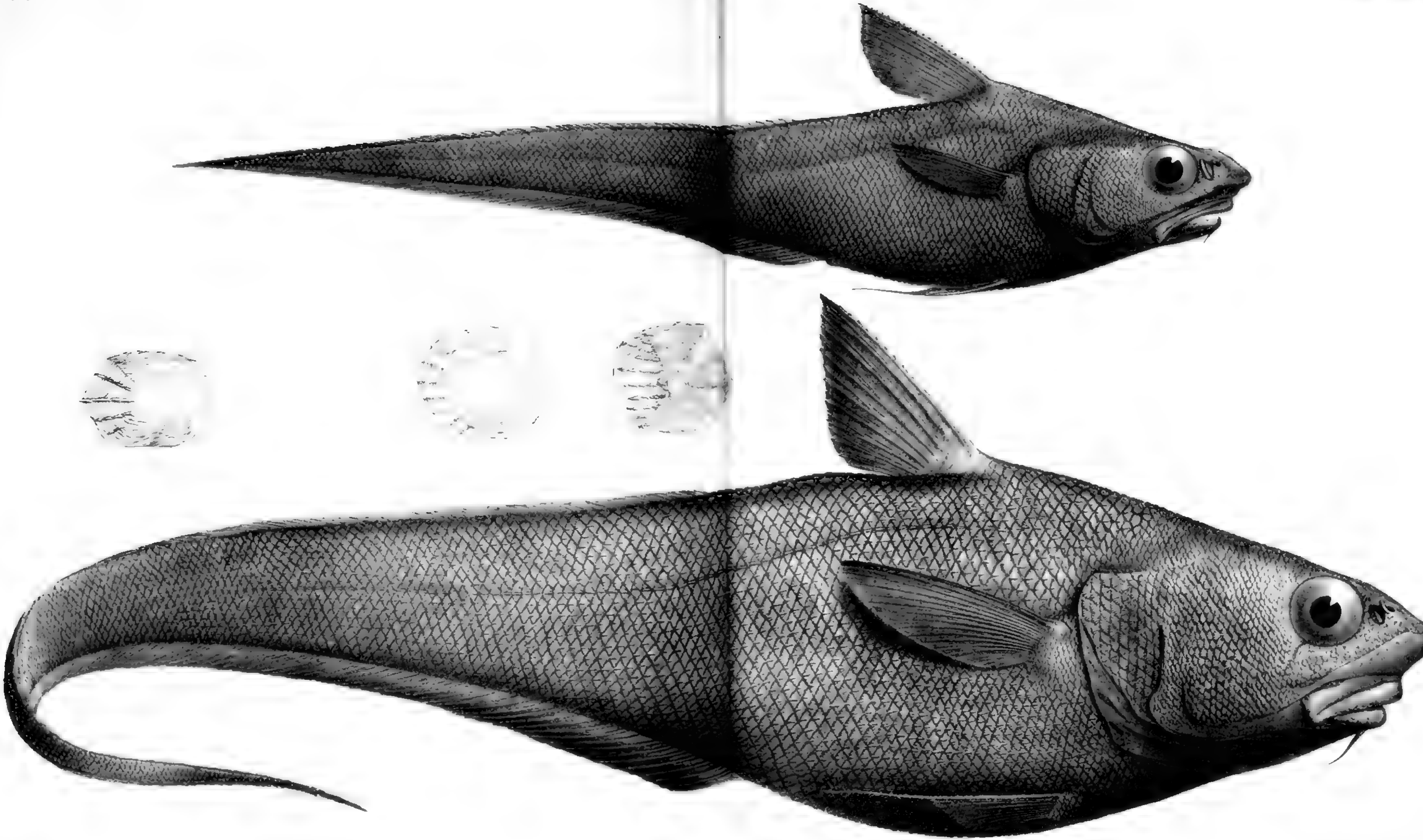


PLATE XLI.

PLATE XLI.

Fig. A. *Trachyrhynchus murrayi* (page 153).

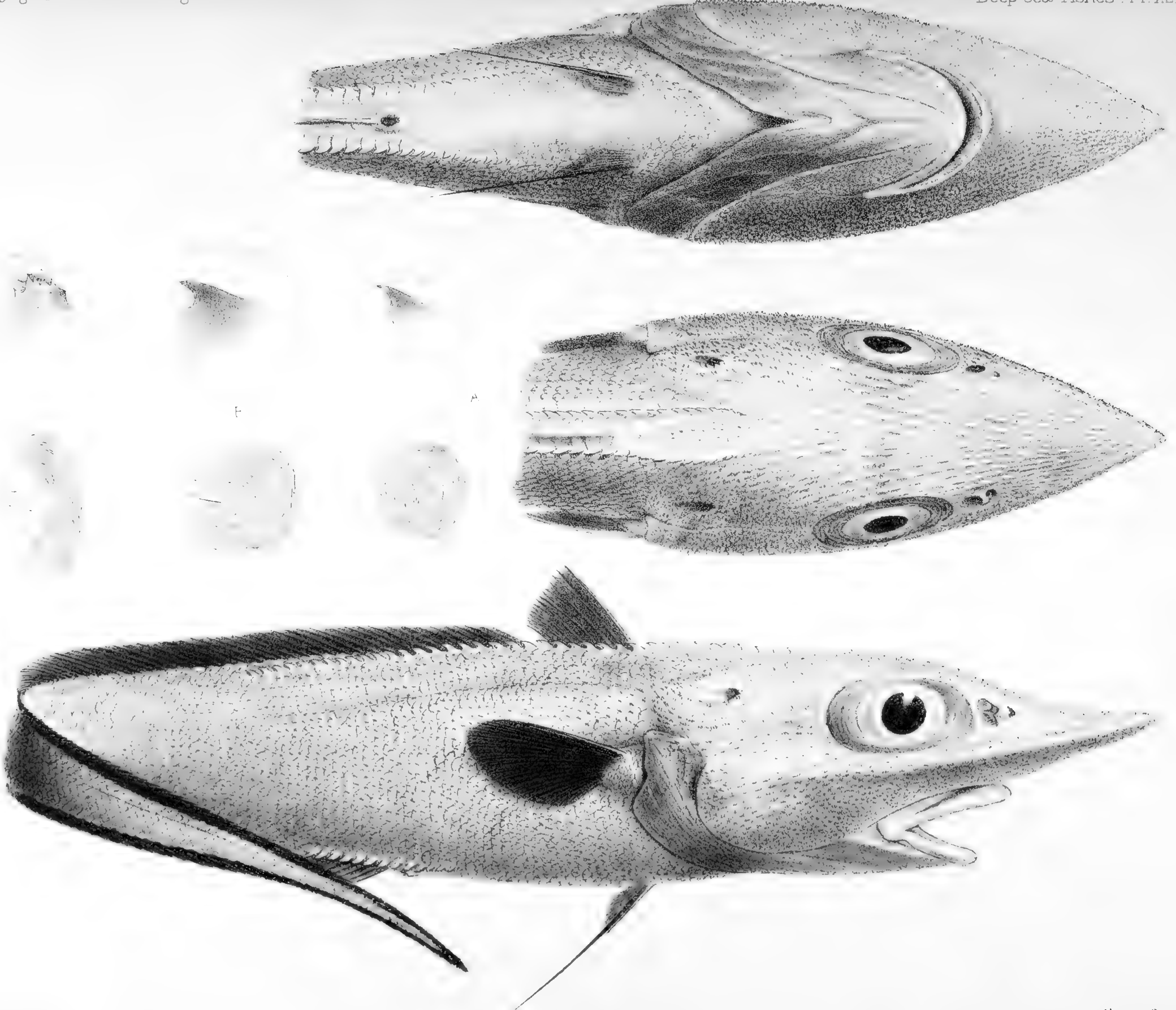
Faröe Channel; depth, 555 fathoms. Three views of the natural size are given, with magnified views of two scales, the lower taken from the middle of the side of the body, the upper being a dorsal scute.

Fig. B. *Trachyrhynchus longirostris* (page 153).

Only two magnified views of scales are given, for comparison with the corresponding parts in the other two species.

Fig. C. *Trachyrhynchus trachyrhynchus* (page 152).

Only two magnified views of scales are given, for comparison with the corresponding parts in the other two species.



P. Smit del. et lith.

Mintern Bros. imp.

A. TRACHYRHYNCHUS MURRAYI (Faroe Channel; Faths. 555.) B. TRACHYRHYNCHUS LONGIROSTRIS C. TRACHYRHYNCHUS TRACHYRHYNCHUS

PLATE XLII.

PLATE XLII.

Fig. A. *Bathygadus cottoides* (page 154).

Kermadec Islands, Station 169; depth, 700 fathoms. In the principal figure the majority of the scales are restored; also a view of the outer branchial arch, twice the natural size, is given.

Fig. B. *Bathygadus multifilis* (page 155).

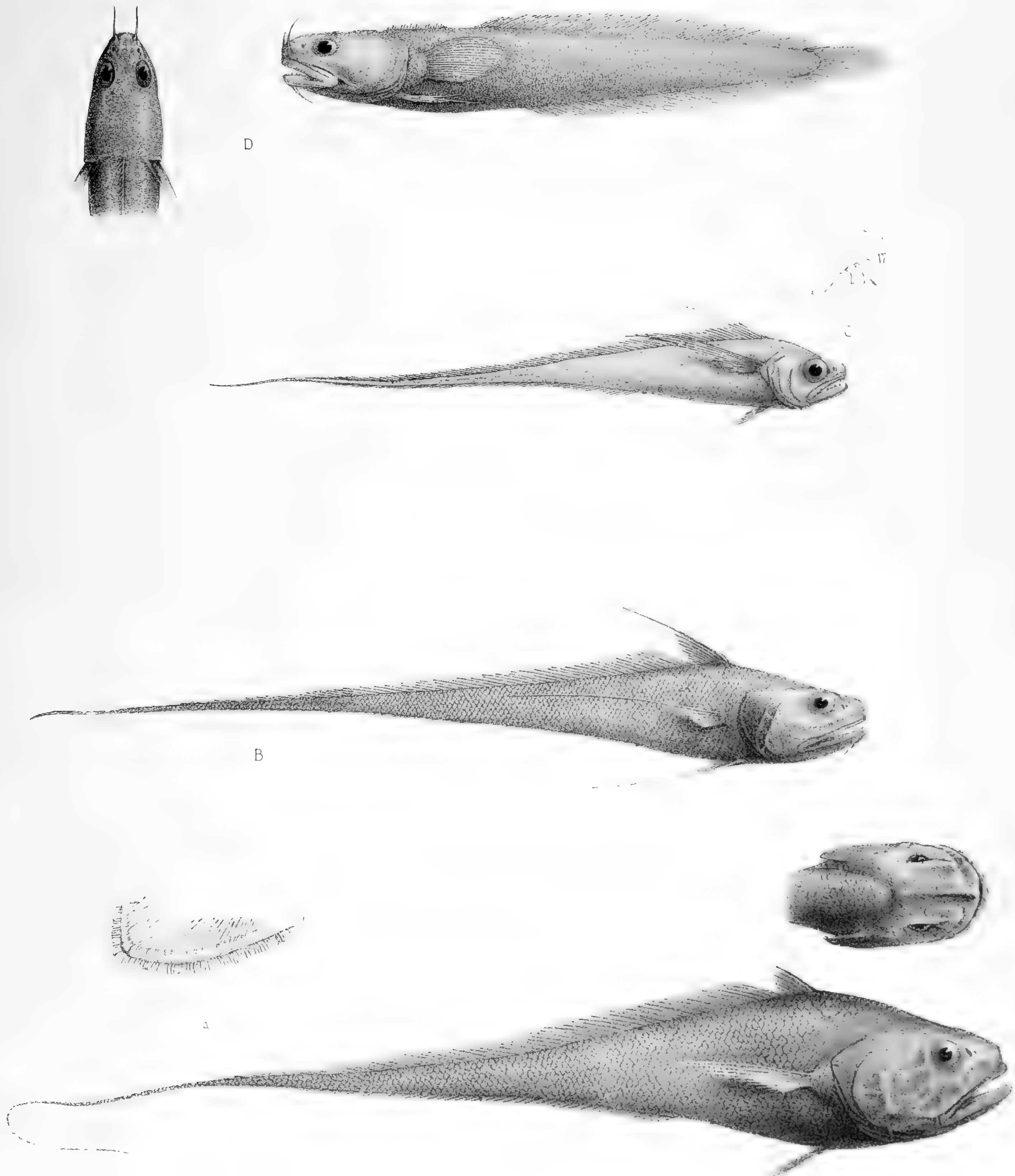
South of the Philippine Islands, Station 214; depth, 500 fathoms. The majority of the scales are restored.

Fig. C. *Lyconus pinnatus* (page 158).

South Atlantic. With a separate view of the mouth, enlarged.

Fig. D. *Onus carpenteri* (page 97).

Between Shetland and Faröe; depth, 180 fathoms.



R. Mintern del et lith.

Mintern Bros. imp.

A. BATHYGADUS COTTOIDES. (Faths. 700.) B. BATHYGADUS MULTIFILIS. (Faths. 500.) C. LYCONUS PINNATUS.

D. ONUS CARPENTERI. (Faths. 180)

PLATE XLIII.

PLATE XLIII.

Euoxymetapon poeyi (page 39).

Mauritius. The lower figure represents the anterior part of the body of this fish of the natural size, the upper the entire fish in outline and reduced. *a*, ventral scales; *b*, post-anal scale (natural size).

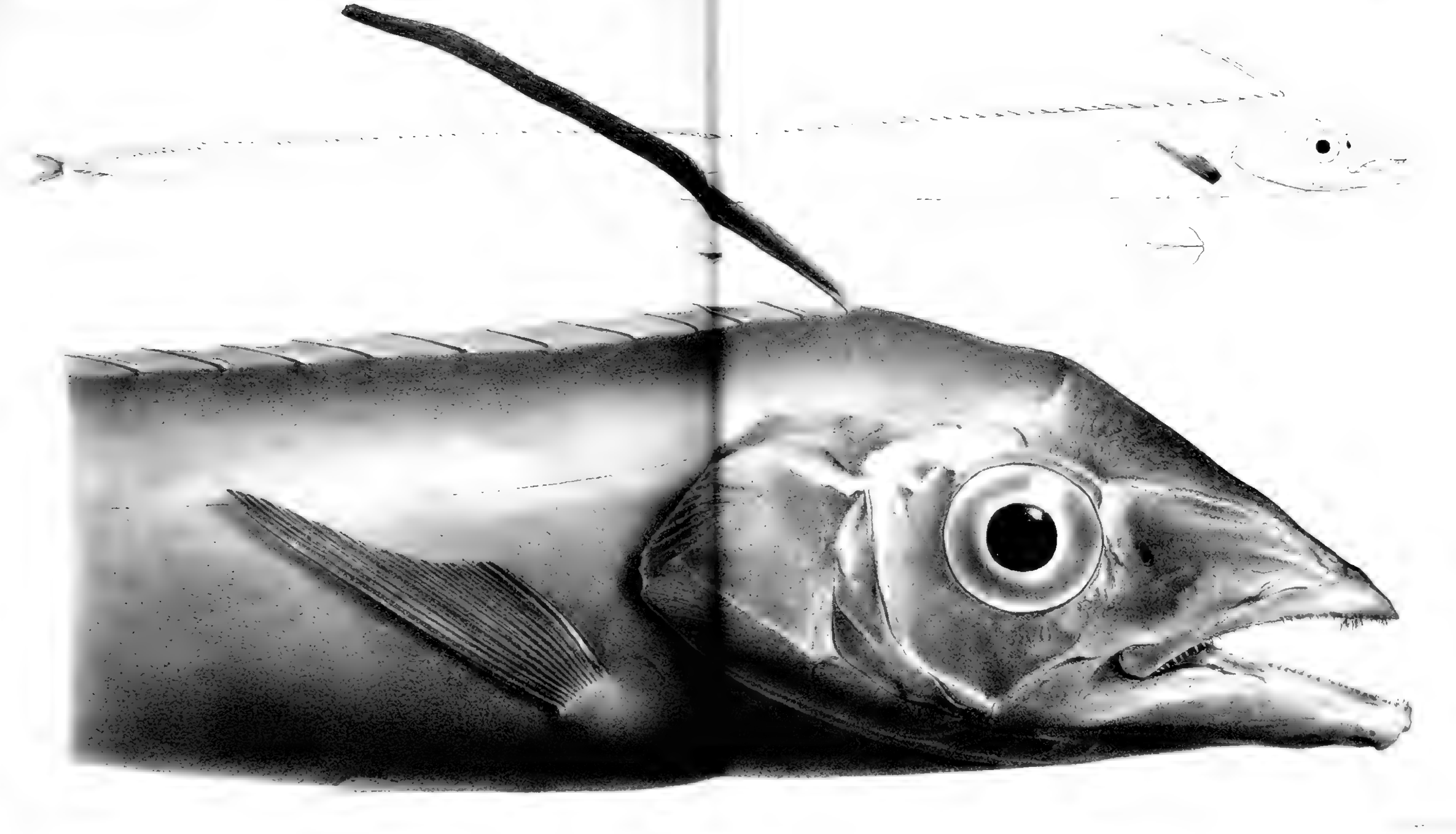
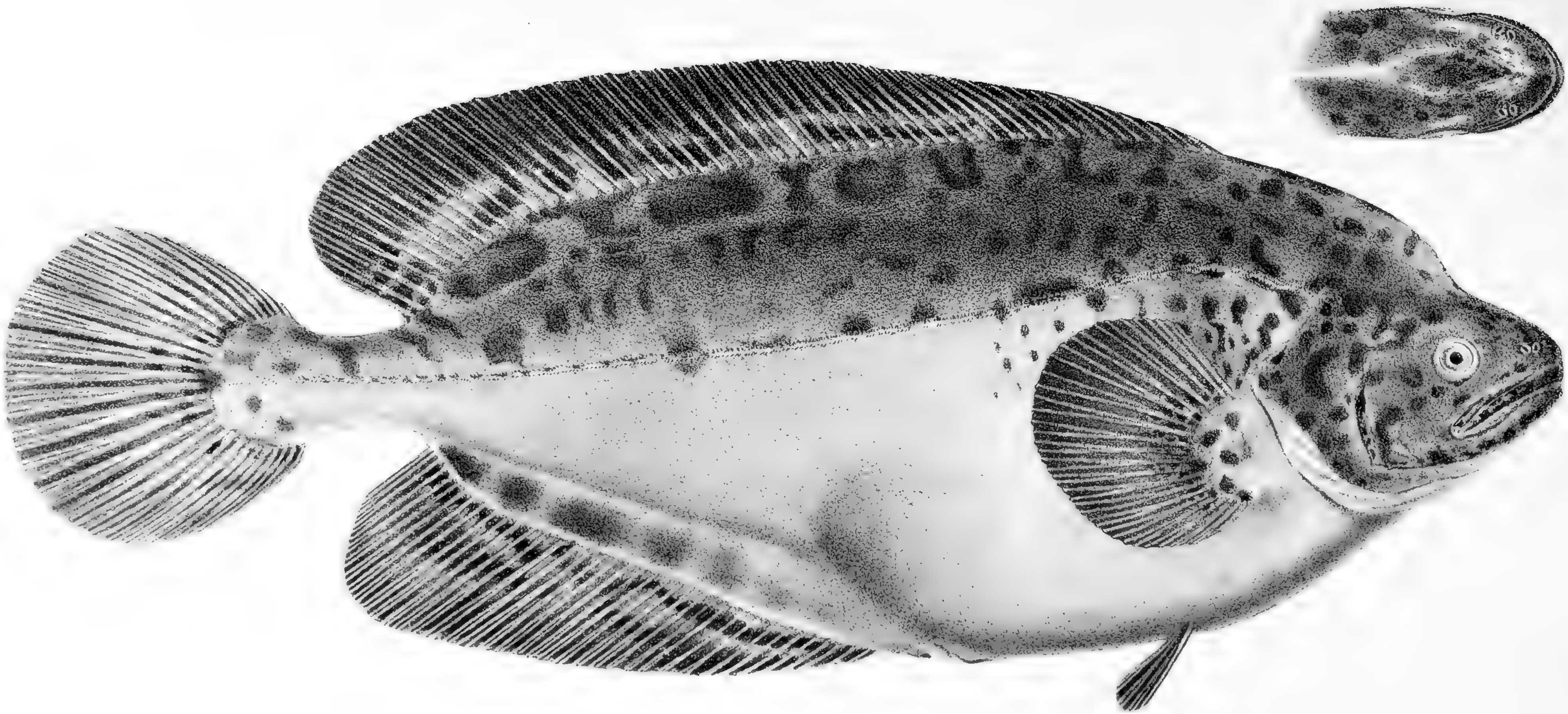


PLATE XLIV.

PLATE XLIV.

Schedophilus enigmaticus (page 46).
Pacific coast of North America.



del et lith

Mintern Bros. imp.

SCHEDOPHILUS ENIGMATICUS.

PLATE XLV.

PLATE XLV.

Fig. A. *Photichthys argenteus* (page 178).

Cook's Strait. Figure two-thirds natural size; the scales are restored.

Fig. B. *Gonostoma elongatum* (page 173).

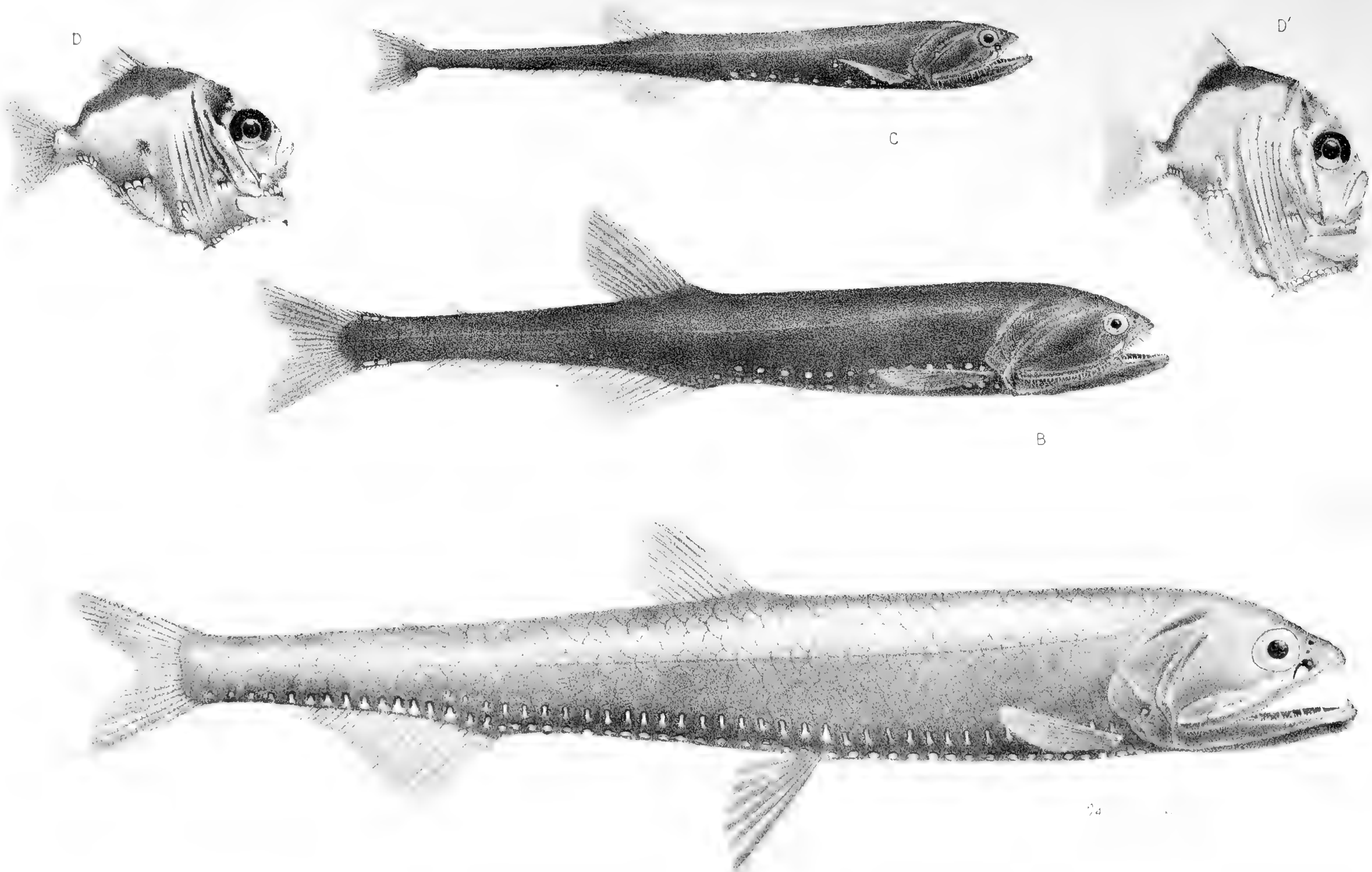
Indian Ocean, Station 191; depth, 800 fathoms.

Fig. C. *Gonostoma gracile* (page 174).

South of Japan, Stations 230 and 232; depth, 365 to 2425 fathoms.

Figs. D, D′. *Sternoptyx diaphana* (page 169).

Indo-Pacific and Atlantic Oceans. D, large-eyed, and D′, small-eyed form.



A. PHOTICHTHYS ARGENTEUS. B. GONOSTOMA ELONGATUM (*Faths. 800.*) C. GONOSTOMA GRACILE. (*Faths. 365.*)
D, D′. STERNOPTYX DIAPHANA.

PLATE XLVI.

PLATE XLVI.

Fig. A. *Bathysaurus ferox* (page 181).

East coast of New Zealand, Station 168 ; depth, 1100 fathoms.

Figs. B, B′. *Bathysaurus mollis* (page 183).

Pacific. Fig. B represents the adult, from the sea of Yedo, Station 237 ; depth, 1875 fathoms. Fig. B′, the young, from Station 281 ; depth, 2385 fathoms.

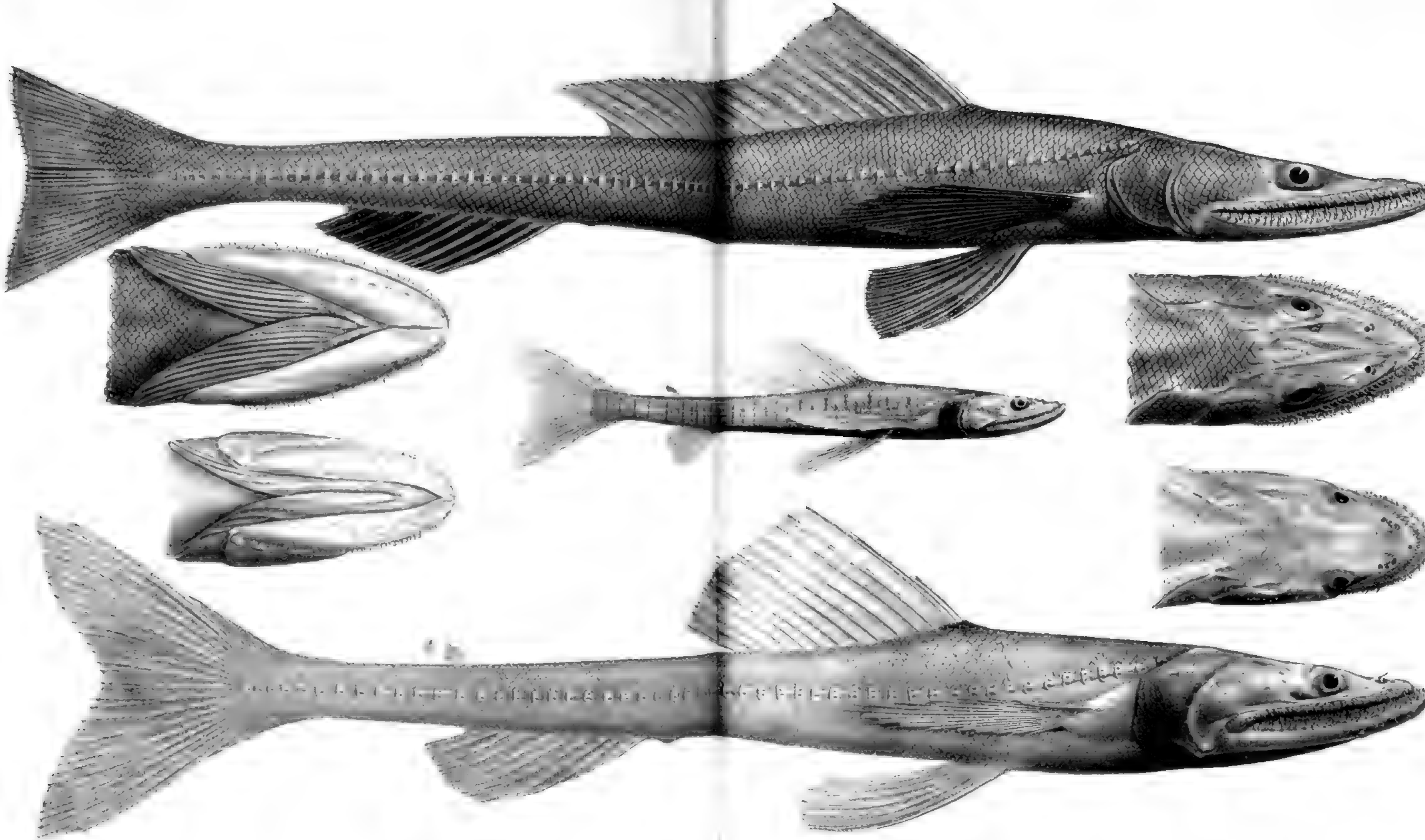


PLATE XLVII.

PLATE XLVII.

Fig. A. *Harpodon microchir* (page 180).

Tokio. The principal figure is two-thirds the natural size. A′, dentition of the upper jaw; A″, of the lower jaw, hyoid, and branchial bones; A‴, separate and enlarged views of one of the largest teeth.

Fig. B. *Bathypterois longifilis* (page 185).

Kermadec Islands, Station 170A; depth, 630 fathoms. Two separate views of the head and one of the left ventral fin are added.

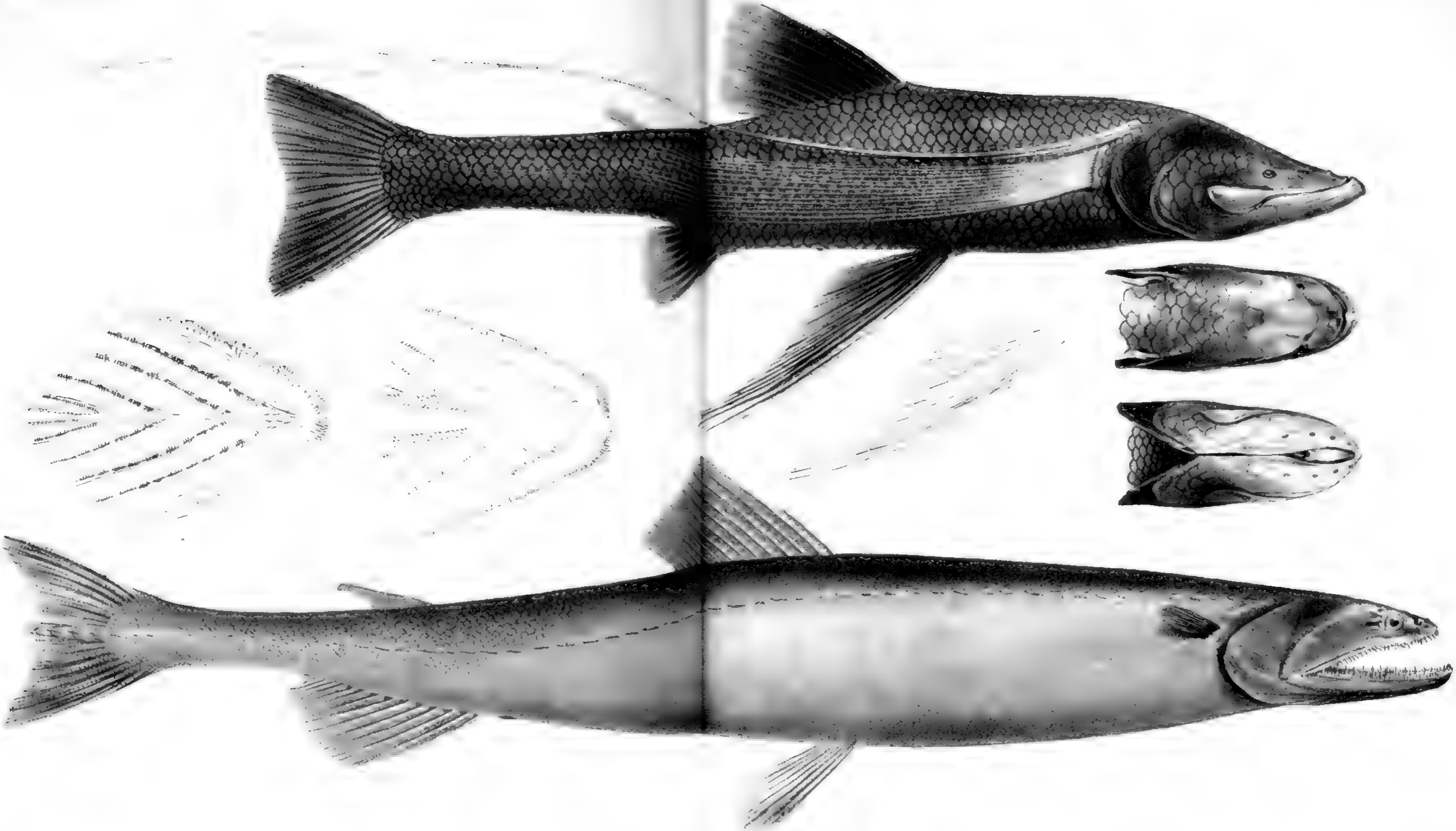


PLATE XLVIII.

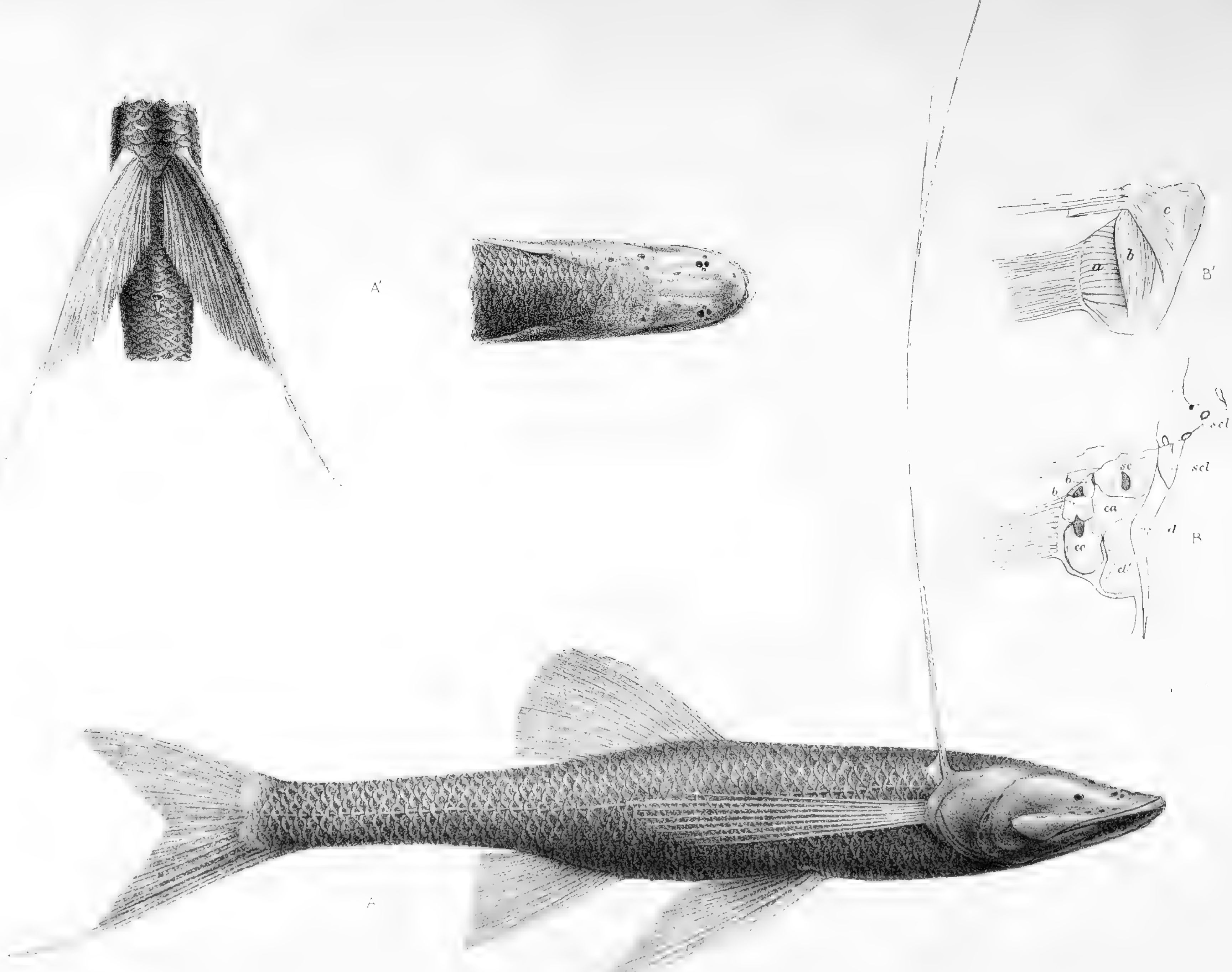
PLATE XLVIII.

Figs. A, A′. *Bachypterois longipes* (page 188).

East coast of South America, Station 325 ; depth, 2650 fathoms.

Figs. B, B′. Scapular arch of *Bathypterois longifilis* (page 187).

cl, Clavicle, with its posterior dilatation *cl′*; *scl′*, *scl″*, the two supraclavicles ; *co*, coracoid; *sc*, scapula, with the primordial cartilage *ca*; *b′*, *b″*, basalia. Fig. B′, Muscles moving the pectoral fin and ray ; *a*, muscles drawing the pectoral fin outwards ; *b*, muscle drawing the pectoral ray downwards ; and *c*, outwards and upwards.



Mintern del et lith.

Mintern Bros. imp.

BATHYPTEROIS LONGIPES   B. BATHYPTEROIS LONGIFILIS

PLATE XLIX.

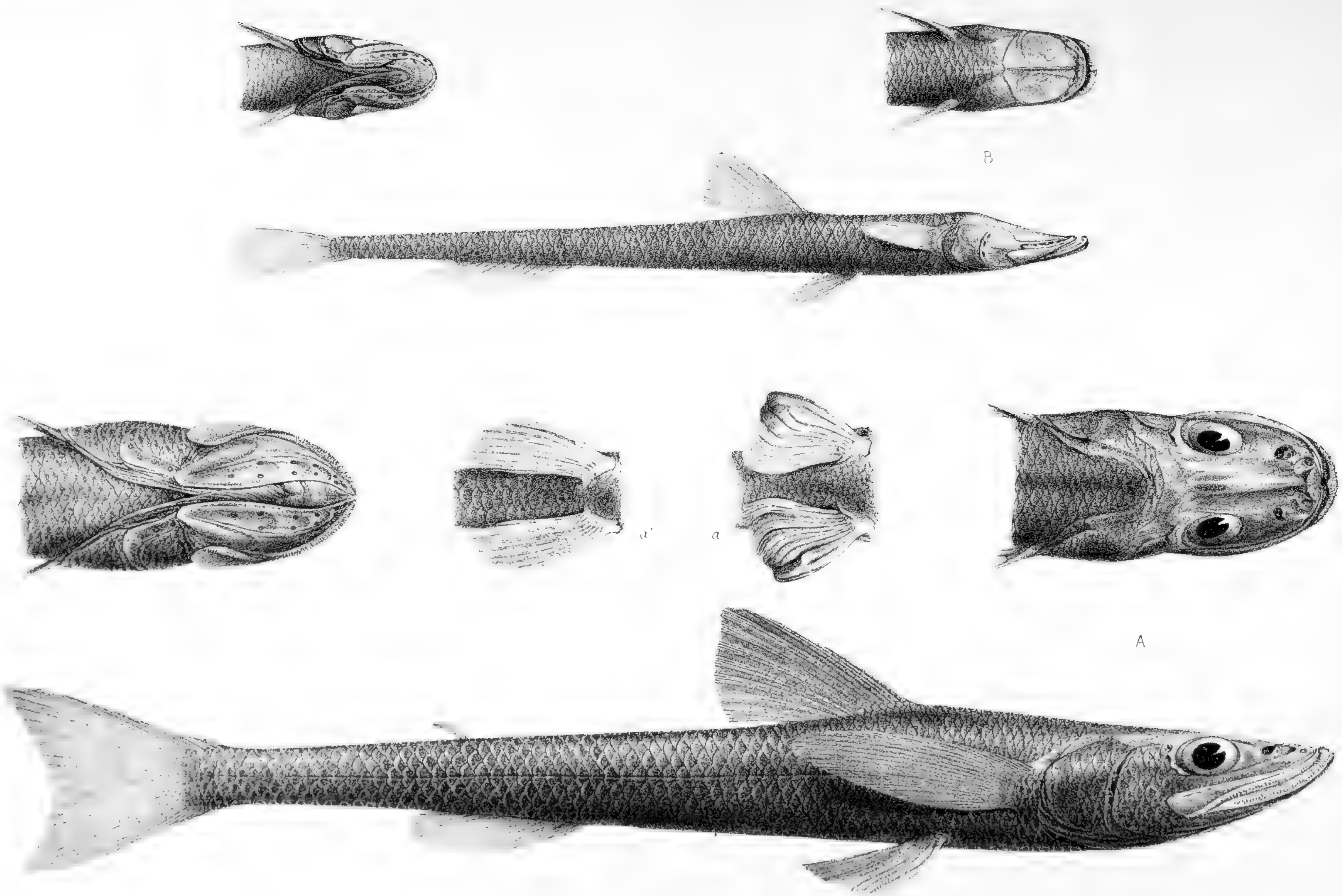
PLATE XLIX.

Fig. A. *Chlorophthalmus gracilis* (page 194).

South Atlantic and South Pacific. The specimen figured is from Station 300; depth, 1375 fathoms. *a*, ventral fin with callous, and *b*, with slightly thickened rays.

Fig. B. *Ipnops murrayi* (page 191).

South Atlantic and Indian Ocean; depth, 1600 to 2150 fathoms. The specimen figured is from Tristan da Cunha, Station 133.



R. Mintern del. et lith.
Mintern Bros. imp.

A. CHLOROPHTHALMUS GRACILIS. (Faths. 1375.) B. IPNOPS MURRAYI (Faths. 1900.)

PLATE L.

PLATE L.

Fig. A. *Atelcopus japonicus* (page 159).

Japan.

Fig. B. *Macrurus carminatus* (page 129).

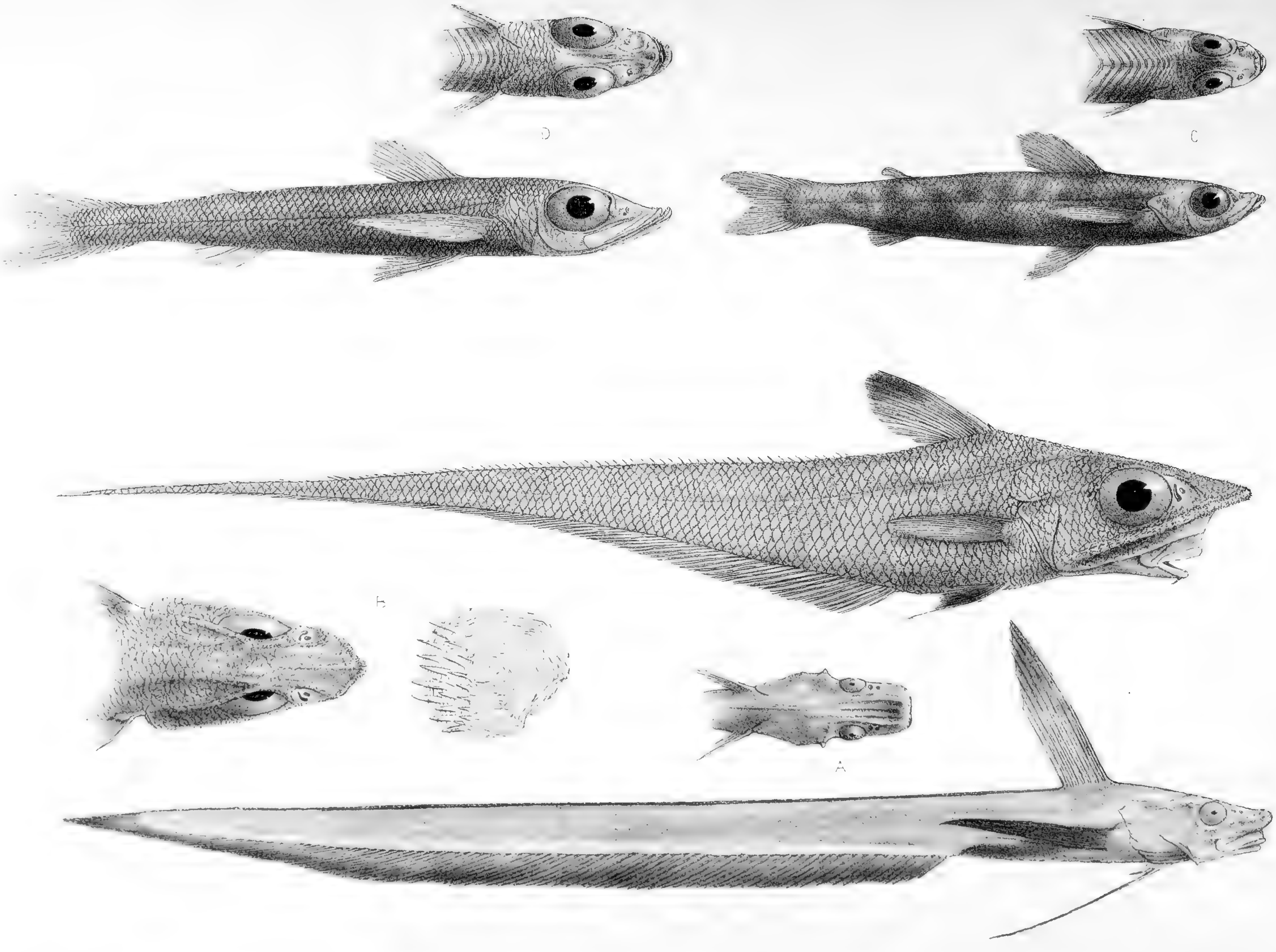
Atlantic, in from 115 to 464 fathoms. The specimen figured is from the vicinity of the Bahama Islands.

Fig. C. *Chlorophthalmus agassizii* (page 192).

Mediterranean and Atlantic; depth, 120 to 156 fathoms.

Fig. D. *Chlorophthalmus productus* (page 193).

Off Matuku, Fiji Islands, Station 173; depth, 315 fathoms.



Mintern Bros. imp.

[illegible] C. CHLOROPHTHALMUS AGASSIZII
(Faths. 100-400.) (Faths. 150)
D. CHLOROPHTHALMUS PRODUCTUS
[illegible]

PLATE LI.

PLATE LI.

Fig. A. *Chlorophthalmus nigripinnis* (page 193).

Off Twofold Bay; depth, 120 fathoms. With separate views of the head and ventral fins.

Fig. B. *Polyipnus spinosus* (page 170).

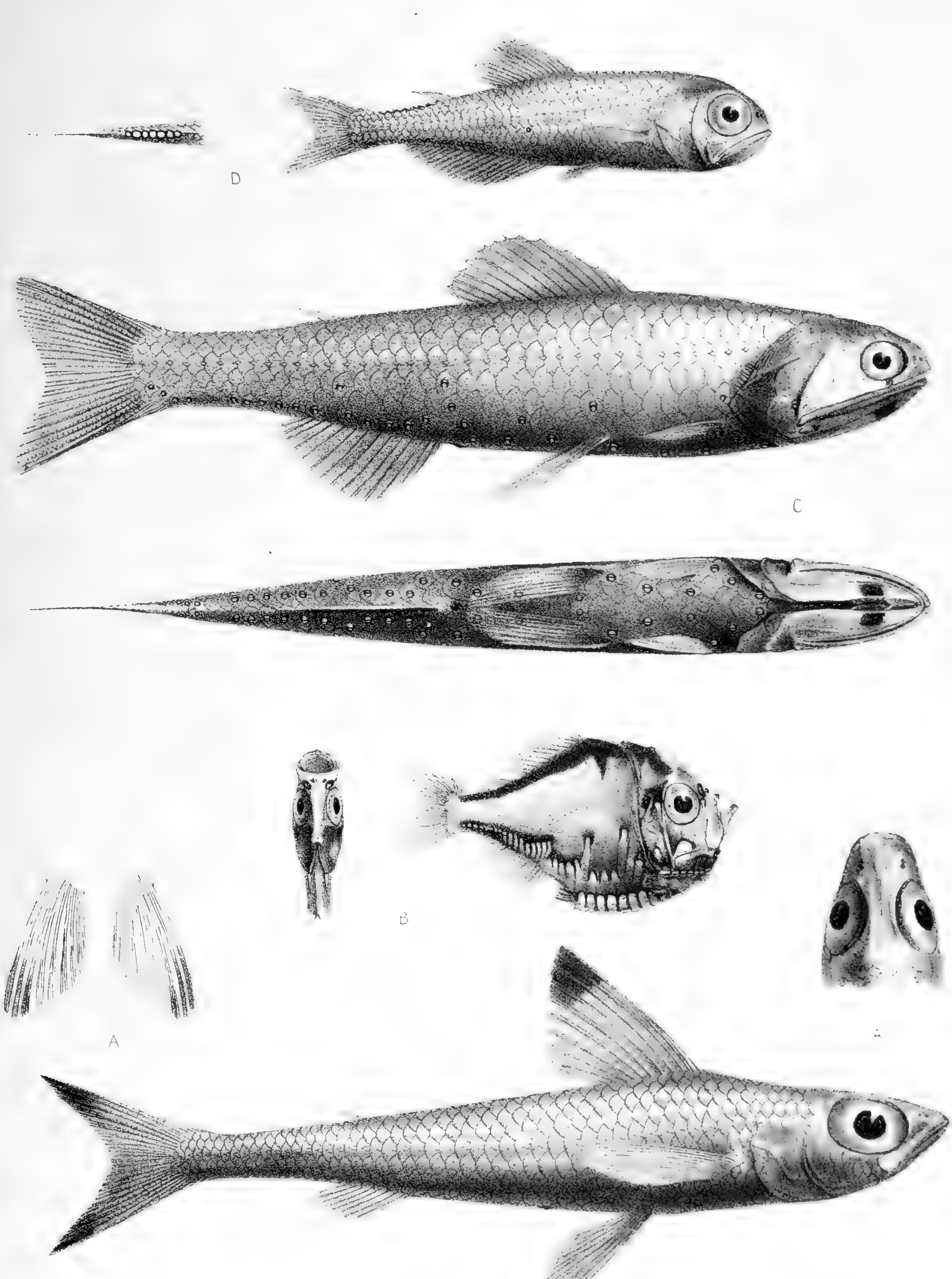
Indian Ocean, Station 200; depth, 250 fathoms.

Fig. C. *Scopelus engraulis* (page 197).

Philippine Islands, Station 200; depth, 250 fathoms.

Fig. D. *Scopelus antarcticus* (page 196).

Antarctic Ocean, Station 156; depth, 1975 fathoms (?). With a separate view of the luminous organs on the back of the tail.



P. Smit del et lith.

Mintern Bros. imp.

A. CHLOROPHTHALMUS NIGRIPINNIS B. POLYIPNUS SPINOSUS
(Faths 120.) [illegible]
C. SCOPELUS ENGRAULIS. D. SCOPE[illegible] [illegible]TARCTICUS
(Faths. 255) [illegible]

PLATE LII.

PLATE LII.

Fig. A. *Odontostomus hyalinus* (page 200).

Mediterranean. With an upper view of the head, the eyes being directed upwards.

Fig. B. *Nannobrachium nigrum* (page 199).

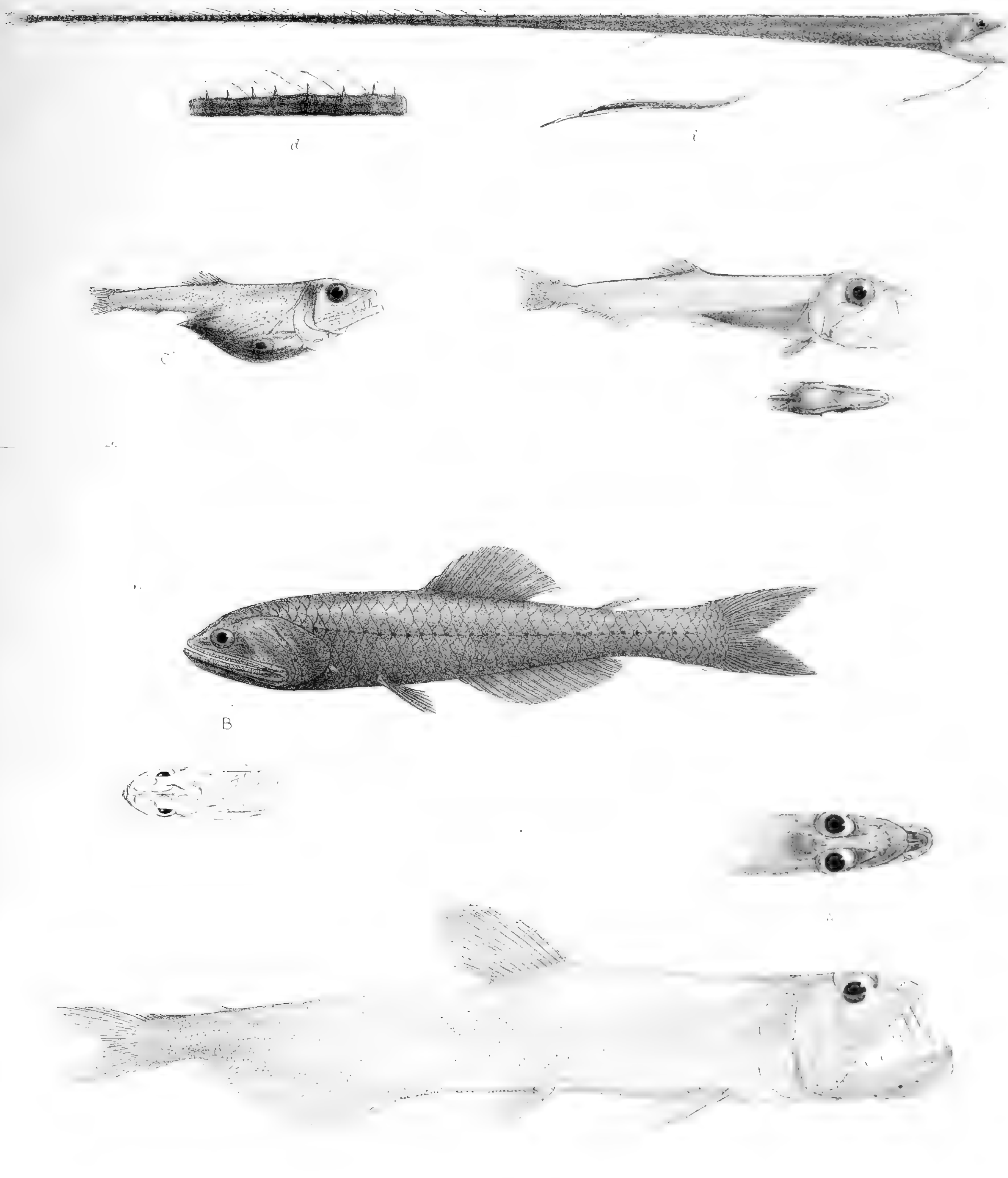
Indian Ocean, Station 214; depth, 500 fathoms.

Fig. C, C′. *Omosudis lowii* (page 201).

Fig. C represents the specimen from the Philippine Islands, Station 214; depth, 500 fathoms. Fig. C′, the specimen from Madeira, with the abdomen much distended, having swallowed a *Sternoptyx*.

Fig. D. *Idiacanthus ferox* (page 216).

North Atlantic, Station 63; depth, 2750 fathoms. *d*, enlarged view of distal portion of barbel; *d′*, enlarged view of part of the trunk, to show the processes of the vertebræ.



R. Mintern del et lith.

A ODONTOSTOMUS HYALINUS. B NANNOBRACHIUM NIGRUM (Faths 500) C, C' OMOSUDIS LOW (Faths 5[illegible])

D IDIACANTHUS FEROX. (Faths 2[illegible])

PLATE LIII.

PLATE LIII.

Fig. A. *Opostomias micripnus* (page 208).

South of Australia, Station 159; depth, 2150 fathoms.

Fig. B. *Echiostoma barbatum* (page 206).

Madeira.

Fig. C. *Pachystomias microdon* (page 210).

North-west of Australia, Station 181; depth, 2440 fathoms.

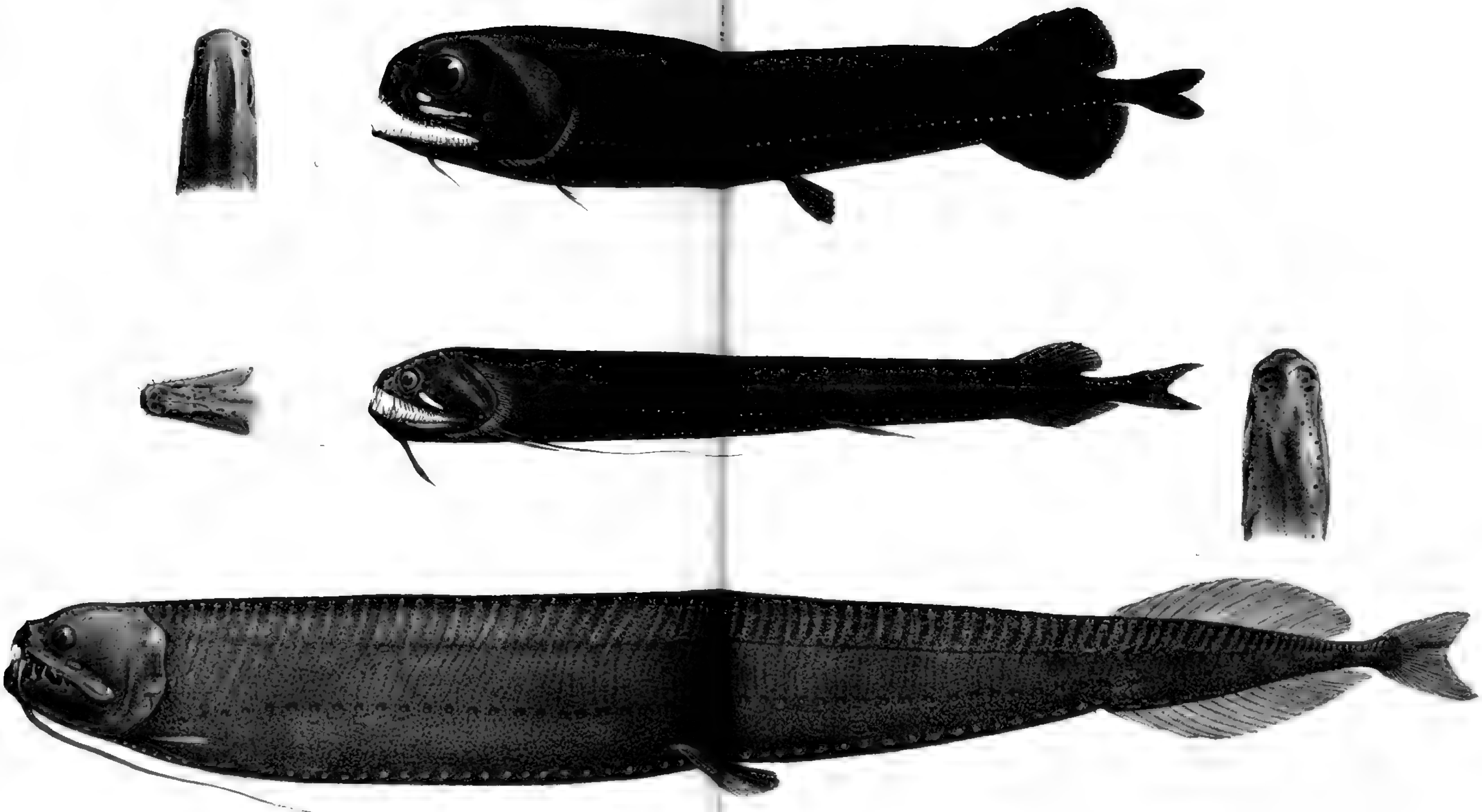


PLATE LIV.

PLATE LIV.

Fig. A. *Stomias affinis* (page 205).

South of Sombrero Island, Station 23; depth, 450 fathoms. *a*, distal portion of the barbel, enlarged.

Fig. B. *Malacosteus indicus* (page 214).

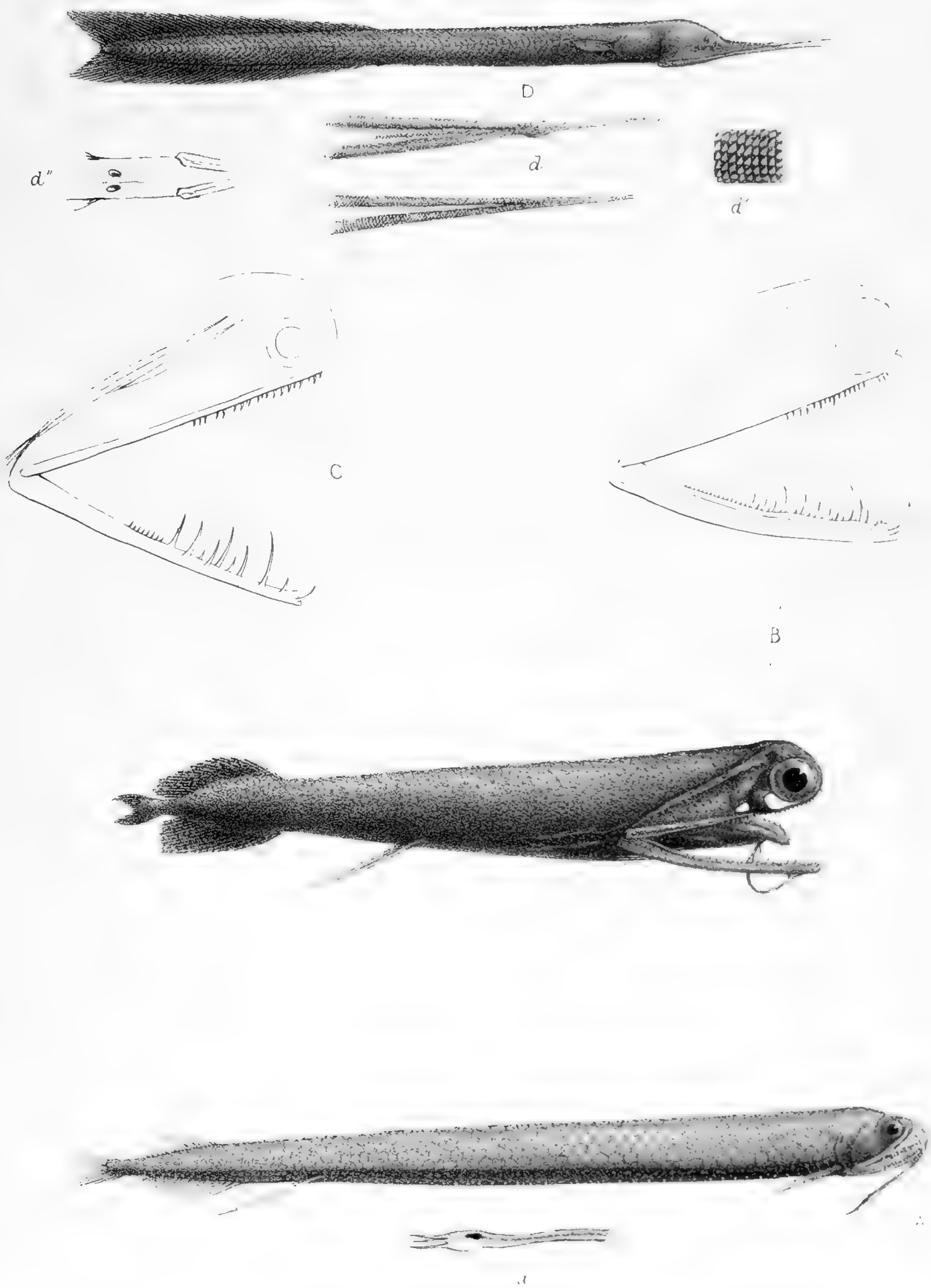
Philippine Islands, Station 214; depth, 500 fathoms. With enlarged view of the dentition.

Fig. C. Dentition of *Malacosteus niger* (page 214).

Copied from Ayres.

Fig. D. *Cyema atrum* (page 265).

Antarctic Ocean, Stations 158 and 295; depth, 1500 to 1800 fathoms, *d*, upper and lower jaws enlarged; *d′*, portion of the dentition, much magnified; *d″*, lower view to show the position of the gill-openings.



R. Mintern del et lith.

Mintern Bros. imp.

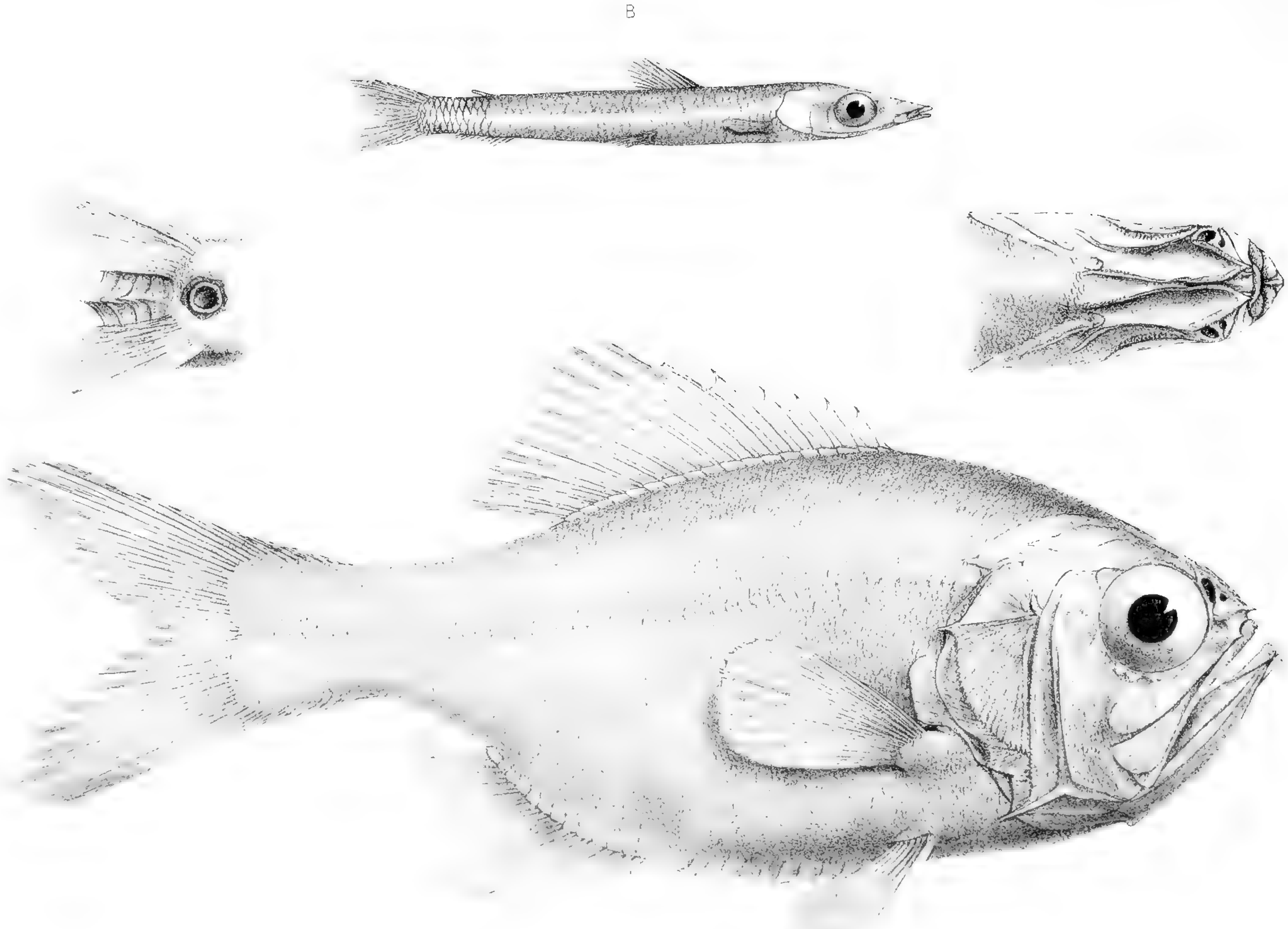
A STOMIAS AFFINIS (Faths. 450.) B MALACOSTEUS INDICUS (Faths 500.) C. MALACOSTEUS NIGER D CYEMA ATRUM (Faths. 1500 – 1800)

PLATE LV.

PLATE LV.

Fig. A. *Trachichthys traillii* (page 23).
New Zealand.

Fig. B. *Argentina elongata* (page 218).
New Zealand.



Mintern Bros. imp.

A. TRACHICHTHYS TRAILLII. B. ARGENTINA ELONGATA.

PLATE LVI.

PLATE LVI.

Fig. A. *Bathythrissa dorsalis* (page 222).
Sea of Japan, off Inosima.

Fig. B. *Alepocephalus niger* (page 224).
North of Australia, Station 184; depth, 1400 fathoms.

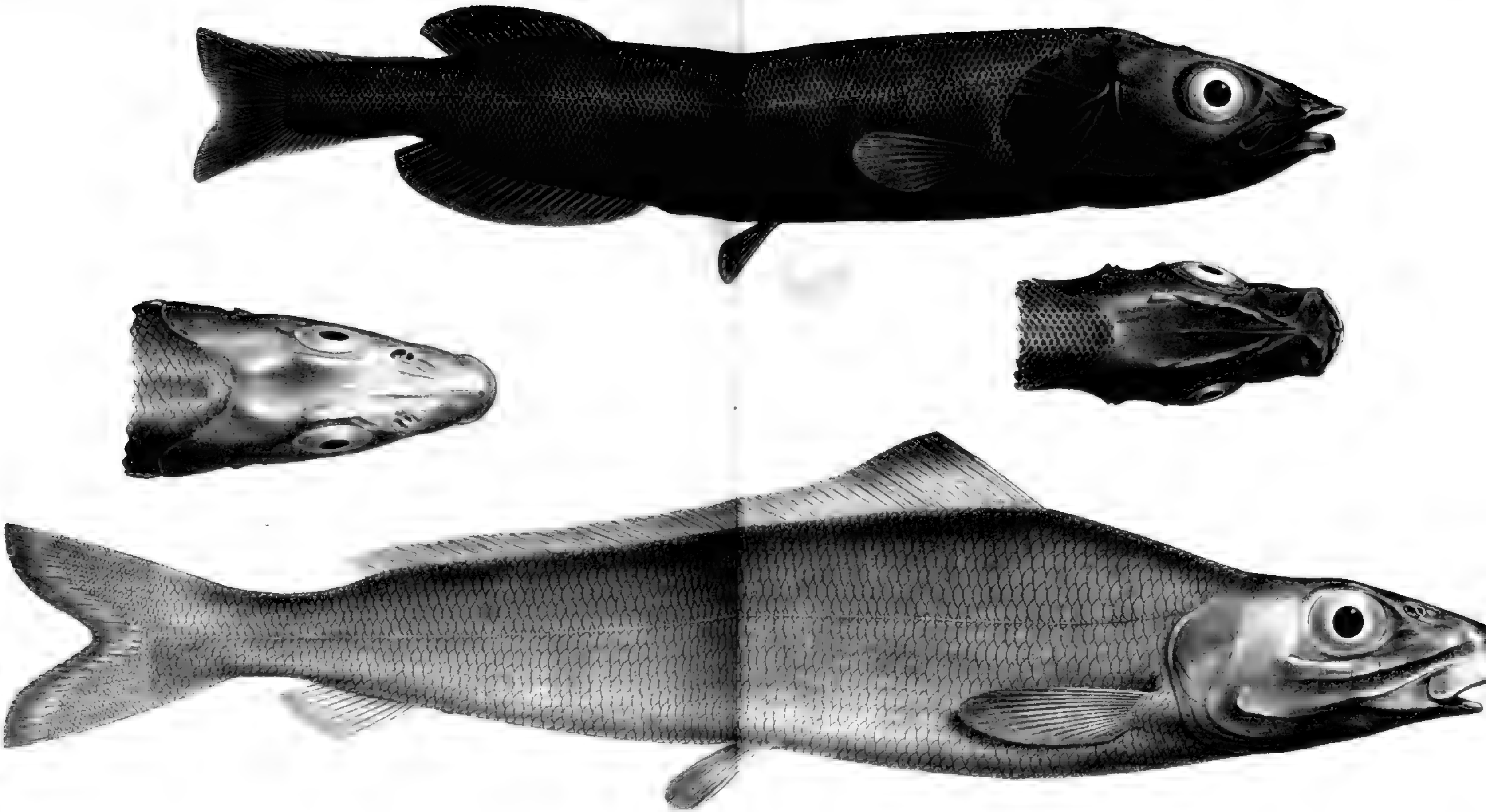


PLATE LVII.

PLATE LVII.

Fig. A. *Bathytroctes microlepis* (page 226).

Atlantic, Station V.; depth, 1090 fathoms.

Fig. B. *Bathytroctes macrolepis* (page 225).

North of Celebes, Station 198; depth, 2150 fathoms. Two views of the head.

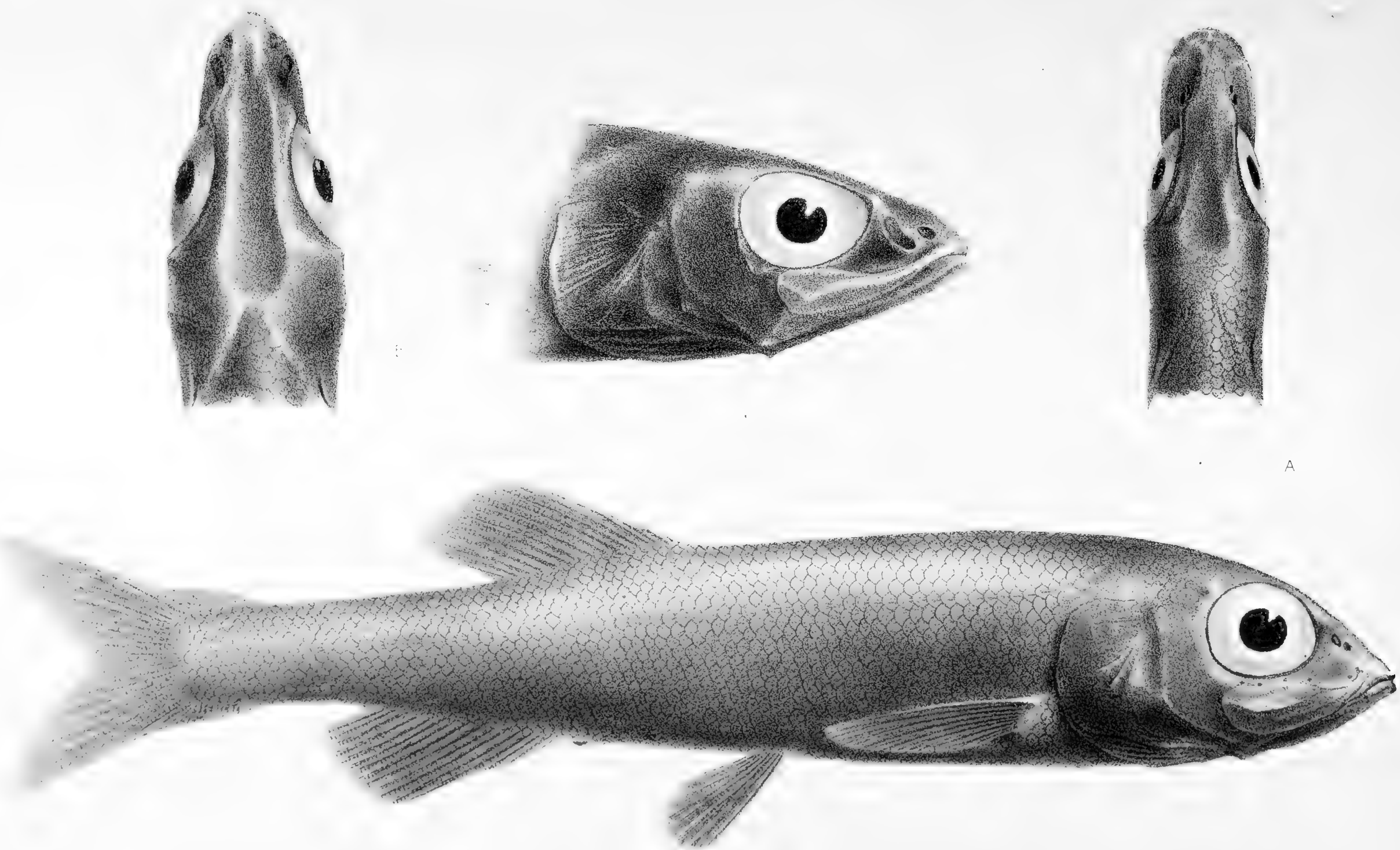

A

PLATE LVIII.

PLATE LVIII.

Fig. A. *Platytroctes apus* (page 229).

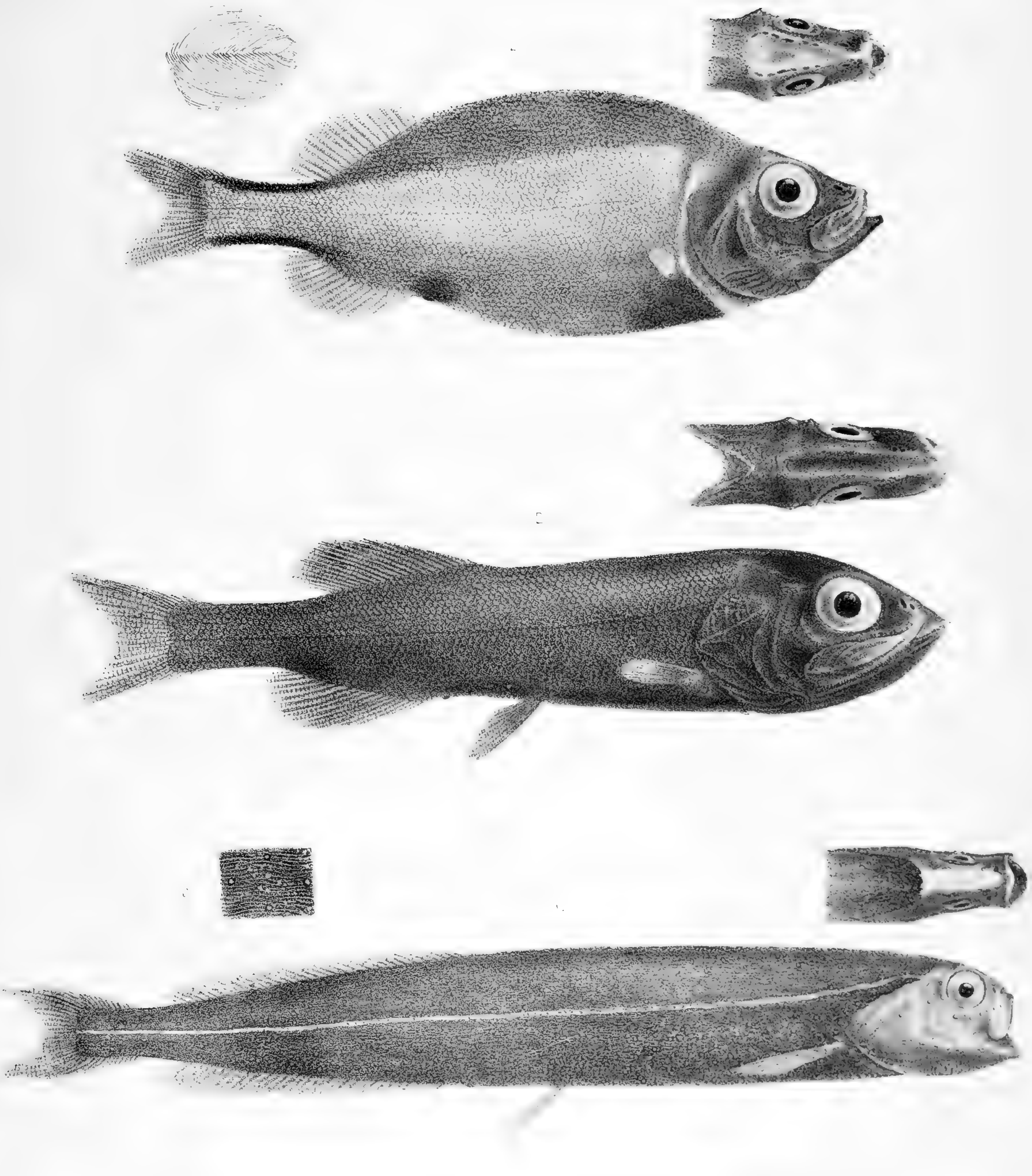
Mid Atlantic, Station 107; depth, 1500 fathoms.

Fig. B. *Bathytroctes rostratus* (page 227).

Off Pernambuco, Station 120; depth, 675 fathoms. With enlarged view of scale.

Fig. C. *Xenodermichthys nodulosus* (page 230).

South of Yedo, Station 232; depth, 345 fathoms. *c*, a piece of the skin, slightly magnified, with four luminous nodules.



P. Smit del et lith.

A. PLATYTROCTES AP

Faths 1500.

PLATE LIX.

PLATE LIX.

Fig. A. *Halosaurus macrochir* (page 237).

Atlantic and Antarctic Oceans, Station V.; depth, 1090 fathoms. *a*, upper side of head; *a′*, *a″*, two views of the head with the integuments of the lower parts and of the infraorbital ring removed to show the luminous organs. Scale magnified.

Fig. B. *Halosaurus affinis* (page 241).

South of Japan, Station 235; depth, 565 fathoms. *b*, upper side of head.

Fig. C. *Halosaurus mediorostris* (page 239).

West of the Philippine Islands, Station 207; depth, 700 fathoms. *c*, upper side of head.

Fig. D. *Halosaurus rostratus* (page 241).

Mid Atlantic, Station 63; depth, 2750 fathoms. *d*, upper side of head.

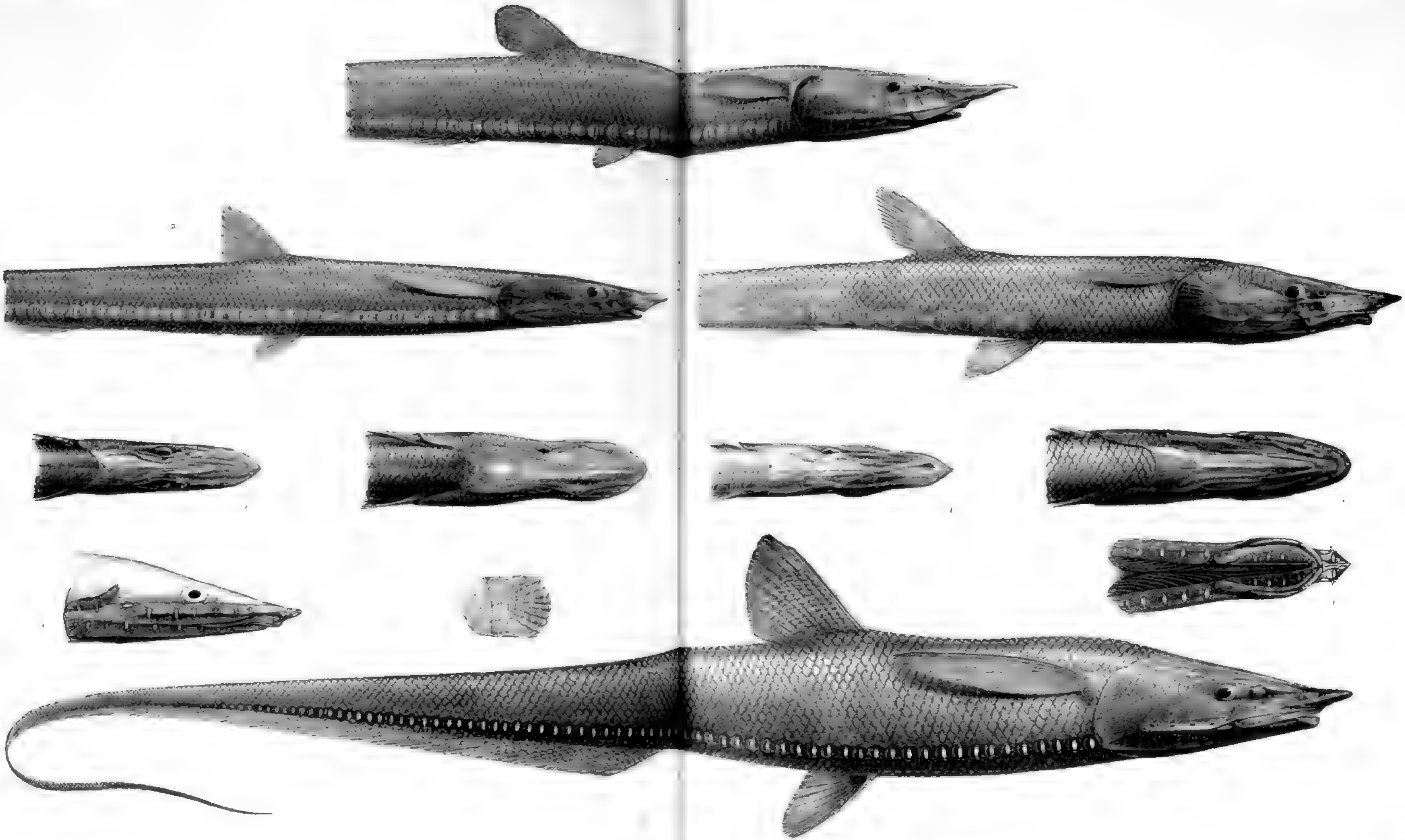


PLATE LX.

PLATE LX.

Figs. 1–8. Skull of *Halosaurus macrochir* (page 233).

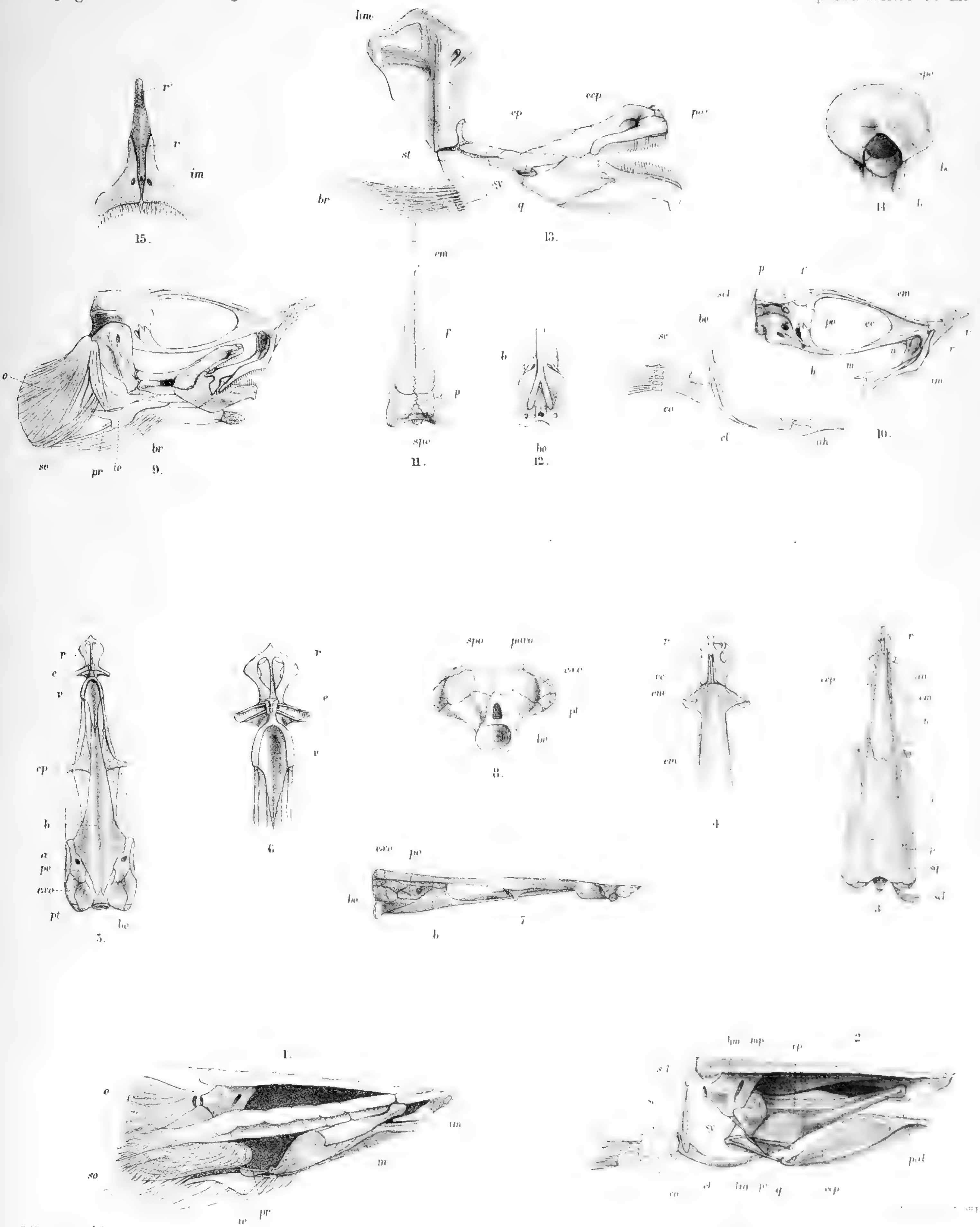
Fig. 1. Lateral view of the skull with the infraorbital chain and other superficial bones.
Fig. 2. Lateral view of the skull with the superficial bones removed.
Fig. 3. Upper view of the skull, with the lateral membrane bones removed on the left side.
Fig. 4. Anterior part of the snout, upper view; twice natural size.
Fig. 5. Lower view of the cranium.
Fig. 6. Anterior part of the snout, lower view; twice natural size.
Fig. 7. Side view of the cranium.
Fig. 8. Occipital view; enlarged.

a. Facet for the articulation of hyomandibular.
an. Anterior nasal.
b. Basal.
bo. Basioccipital.
cl. Clavicle.
co. Coracoid.
cp. Lateral præorbital process of primordial cartilage.
e. Groove of the transverse process of the ethmoidale medium.
ec. Anterior termination of ethmoid cartilage.
ecp. Ectopterygoid.
ecp'. Condyle of the ethmoid cartilage for the articulation of the ectopterygoid.
em, em'. Ethmoidale medium.
ep. Entopterygoid.
exo. Exoccipital.
hm. Hyomandibular.
f. Frontal.
im. Intermaxillary.
io. Interoperculum.
lig. Ligament between the ectopterygoid and lower jaw.
m. Maxillary.
mp. Metapterygoid.
n. Nasal.
o. Operculum.
p. Parietal.
pal. Palatine.
paro. Paroccipital.
po. Alisphenoid.
pr. Præoperculum
pt. Pterotic.
q. Quadrate.
r. Rostrale.
sc. Scapula.
scl. Supraclavicle.
so. Suboperculum.
spo. Supraoccipital
sq. Squamosal.
sy. Symplectic.
v. Vomer.

Figs. 9–15. Skull of *Notacanthus sexspinis*

Fig. 9. Lateral view of the skull.
Fig. 10. Lateral view of the cranium.
Fig. 11. Upper view of the cranium.
Fig. 12. Lower view of the cranium.
Fig. 13. Palatal arch with suspensorium and lower jaw; twice natural size.
Fig. 14. Back view of cranium; twice natural size.
Fig. 15. Front view of snout; twice natural size.

b. Basal.
bo. Basioccipital.
br. Branchiostegals.
cl. Clavicle.
co. Coracoid.
ec. Ethmoidal cartilage.
ecp. Ectopterygoid.
em. Ethmoidale medium.
ep. Entopterygoid.
f. Frontal.
hm. Hyomandibulare.
im. Intermaxillary.
io. Interoperculum.
m. Maxillary.
n. Nodule of cartilage.
o. Operculum.
p. Parietal.
pal. Palatine.
po. Alisphenoid.
pr. Præoperculum.
q. Quadrate.
r. Rostrale, with *r'* its cartilaginous portion.
sc. Scapula.
scl. Supraclavicle.
so. Suboperculum.
spo. Supraoccipital.
st. Stylohyal.
sy. Symplectic.
uh. Urohyal.



R. Mintern del. et lith.

1–8. HALOSAURUS MACROCHIR.

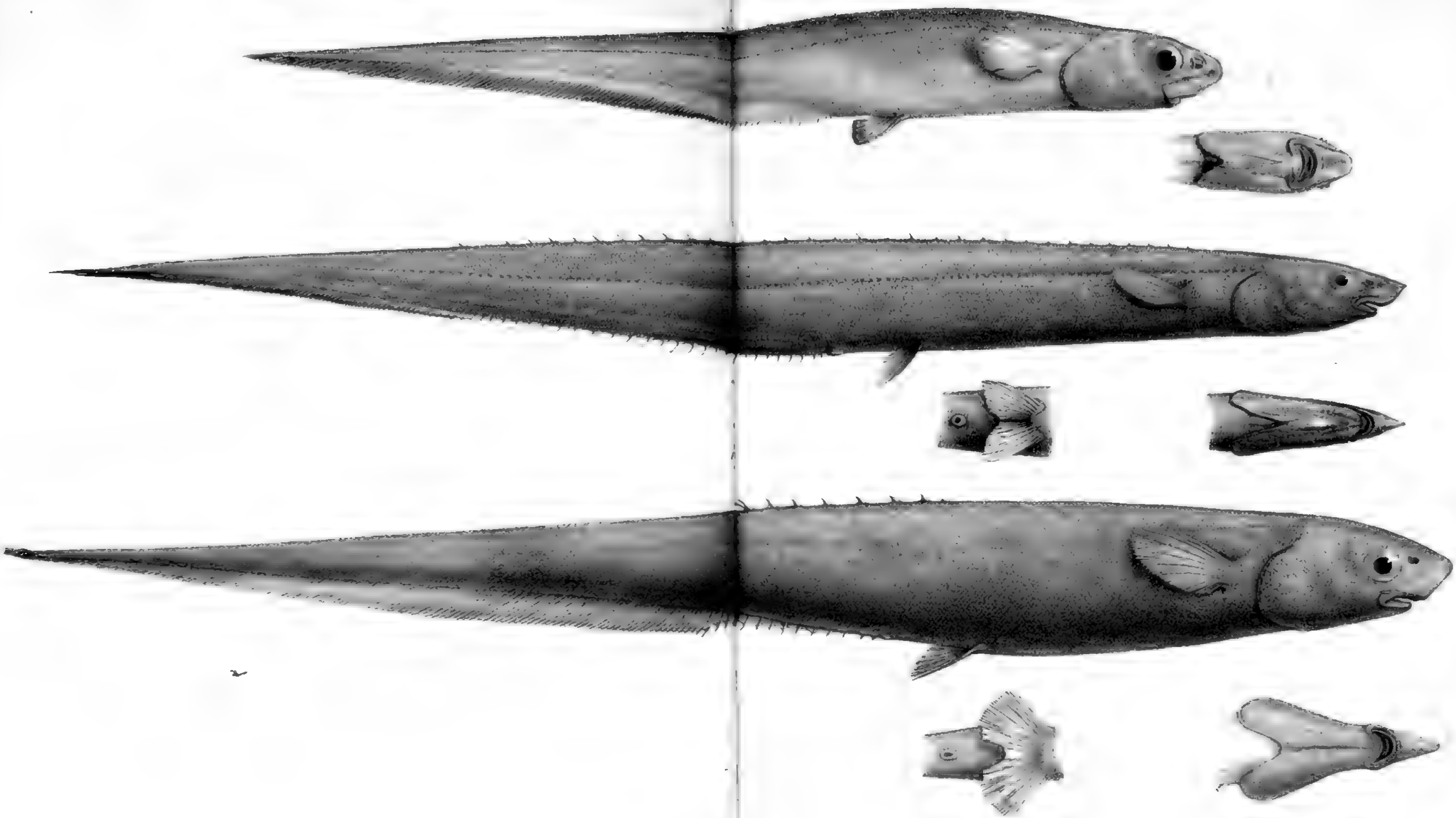
PLATE LXI.

PLATE LXI.

Fig. A. *Notocanthus sexspinis* (page 243).
Coast of New Zealand.

Fig. B. *Notacanthus rissoanus* (page 250).
Mediterranean, Japan, Station 237; depth, 1875 fathoms.

Fig. C. *Notacanthus bonapartii* (page 249).
Atlantic, Station 310; depth, 400 fathoms.



R. Mintern del et lith.

Mintern Bros. imp.

ACANTHUS SEXSPINIS

PLATE LXII.

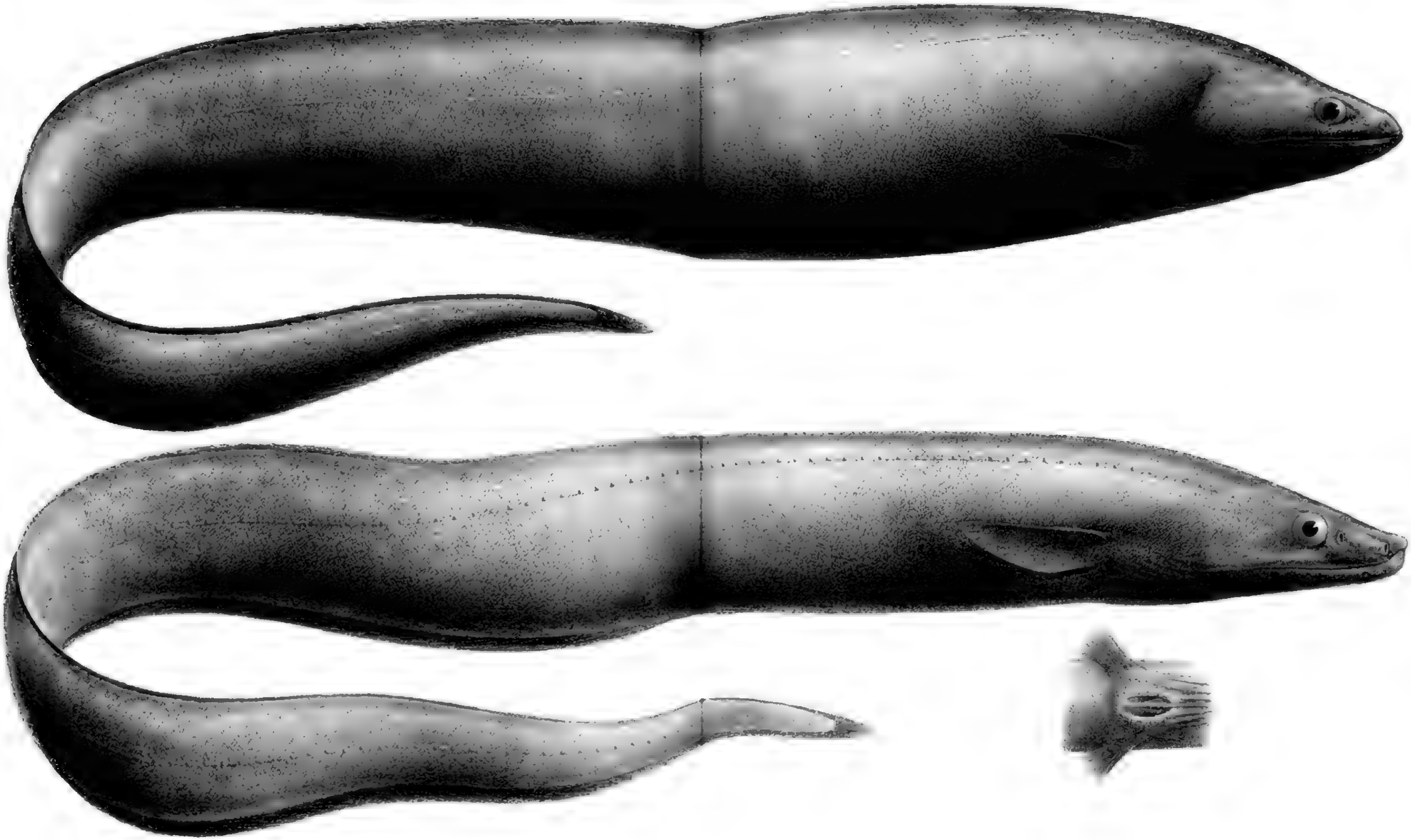
PLATE LXII.

Fig. A. *Synaphobranchus pinnatus* (page 253).

Atlantic; deep sea off Japan and the Philippine Islands. The specimen figured is from Station 235; depth, 565 fathoms. Separate view of the confluent gill-openings.

Fig. B. *Synaphobranchus bathybius* (page 254).

Pacific, at a depth of from 1375 to 2050 fathoms. The specimen figured is from Station 246; depth, 2050 fathoms.



Mintern Bros. imp.

PLATE LXIII.

PLATE LXIII.

Fig. A. *Nettastoma parviceps* (page 253).

South of Yedo, Station 232; depth, 345 fathoms.

Fig. B. *Nemichthys infans* (page 264).

Mid Atlantic; depth, 500 to 2500 fathoms. With separate view of head, twice natural size. B′, dentition of the upper jaw of the same specimen, four times natural size; B″, terminal portion of the upper jaw of a specimen, showing the knob-like termination, six times natural size; B‴, normal termination of tail.

Fig. C. *Synaphobranchus brevidorsalis* (page 255).

Pacific, Station 218; depth, 1075 fathoms.

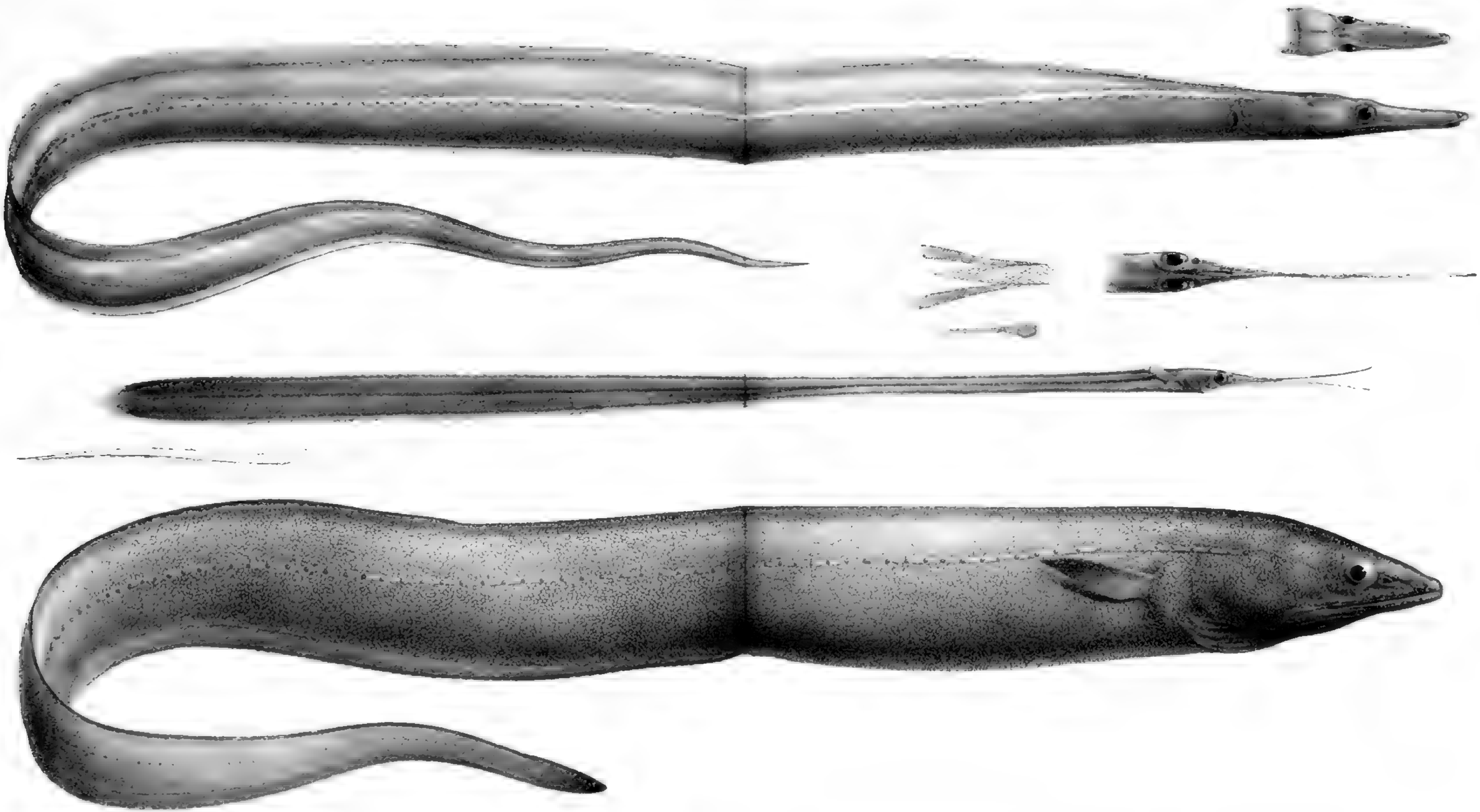
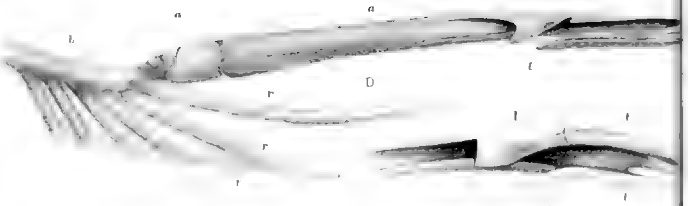


PLATE LXIV.

PLATE LXIV.

Chlamydoselache anguinea (page 2).

Japan. The entire figure is one-half the natural size. A. Outer view of a chain of teeth of the upper jaw, of the natural size, with a detached tooth somewhat magnified. B. View of the basal side of the same chain of teeth; *g*, grooves to receive the processes *p* of the preceding tooth. C. Ventral fins and claspers, one-half the natural size. D, D′, Skeleton of the claspers; *a*, principal cartilage; *a*′, intermediate cartilages; *b*, basals of ventral fin; *l*, lobe-like expansion of cartilage *a*; *r*, *r*′, *r*″, rays of ventral fin; *t*, *t*′, movable calcified terminal pieces, by which the canal can be opened or closed.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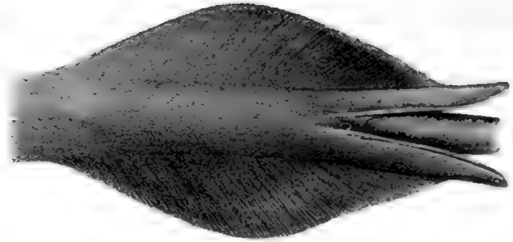


PLATE LXV.

PLATE LXV.

Chlamydoselache anguinea (page 3).

Fig. 1. External view of the abdominal apertures in a normally developed male. *cl*, cloaca; *v*, vent; *ug*, urogenital openings; *po*, porus abdominalis.

Fig. 2. External view of the abdominal apertures in a male, in which the ducts of the right side are less developed than those of the left.

Fig. 3. Side view of the vasa deferentia of the same specimen. *po*, porus abdominalis; *vd*, left, and *vd'*, right vas deferens; *u*, urinary bladder; *ug*, right, and *ug'*, left urogenital opening; *r*, kidney; *i*, rectum opened; *gl*, gland.

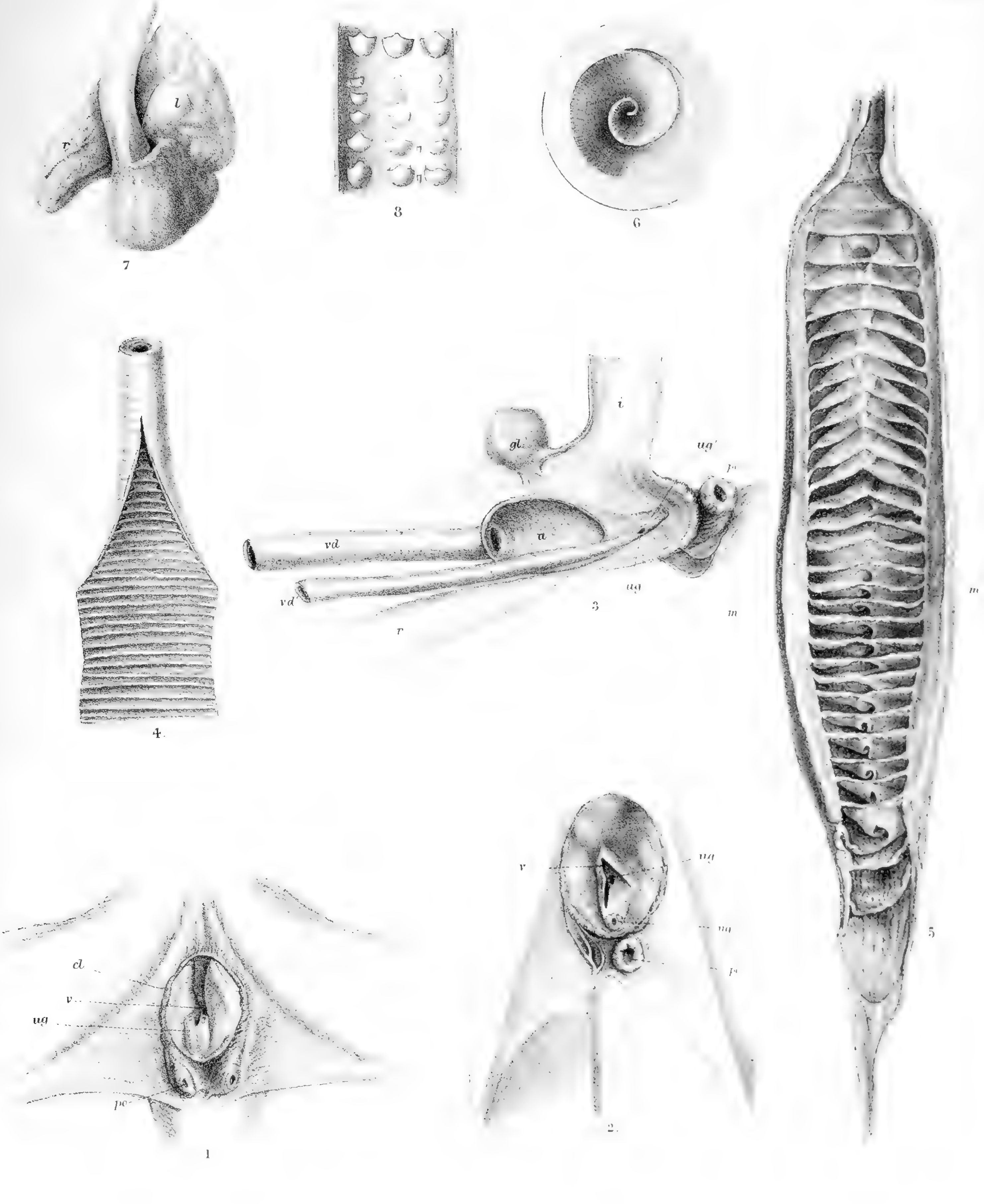
Fig. 4. Lower part of the left vas deferens, longitudinally slit open to show the annular folds.

Fig. 5. Valvular portion of the intestine slit open to show the spiral valve and the thick muscular wall (*m*).

Fig. 6. Transverse section through the middle of the valve.

Fig. 7. Heart (*r*, right, and *l*, left side).

Fig. 8. Conus arteriosus longitudinally opened to show the arrangement of the valves.



R. Mintern del. et lith.

Mintern Bros. imp.

CHLAMYDOSELACHE ANGUINEA

PLATE LXVI.

PLATE LXVI.

Saccopharynx ampullaceus (page 256).

Madeira. The specimen has swallowed a large fish, the outlines of which are visible through the integuments, and a portion of which can be seen in the distended gill-opening. *v*, *v′*, represent a lateral and ventral view of two abdominal vertebræ, twice natural size.

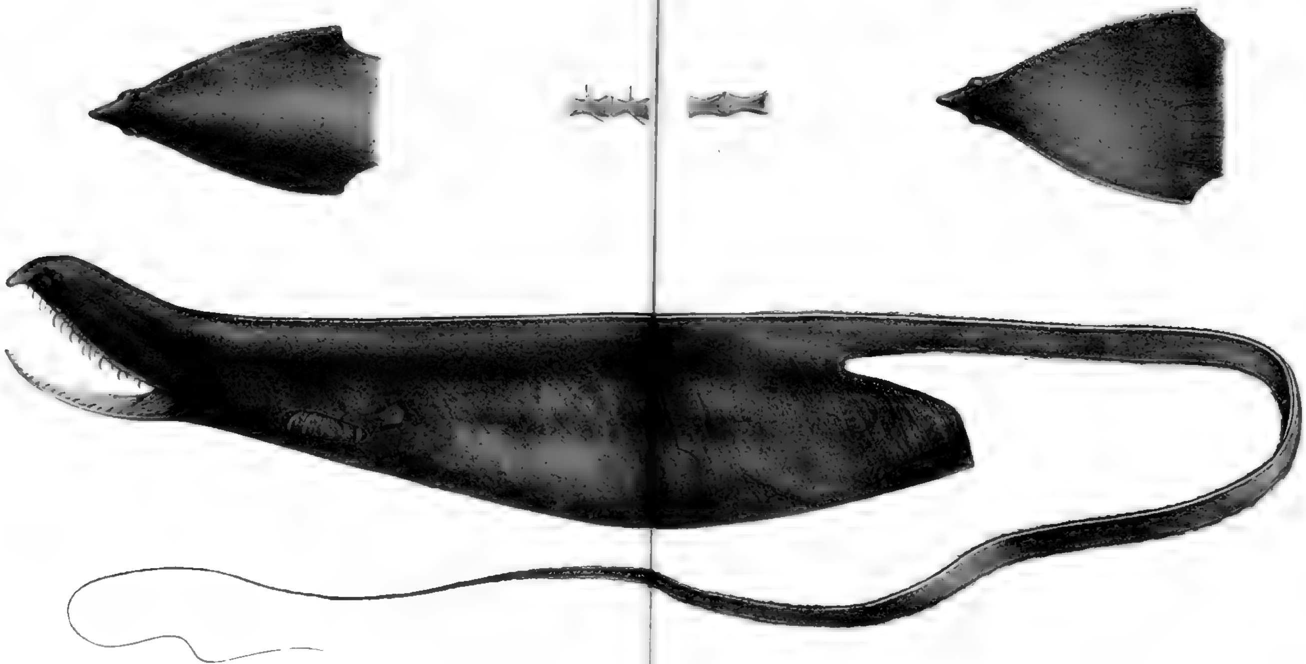


PLATE LXVII.

PLATE LXVII.

Drawing of the upper surface of the anterior extremity of a specimen of *Ipnops murrayi* preserved in spirits, much enlarged. Drawn from the specimen by Mr. Charles Drummond, artist to the Radcliffe Library, Oxford. The two phosphorescent organs occupy nearly the entire upper surface of the skull, extending from just behind the nasal region to almost the posterior extremity of the cranial cavity. They are seen through the transparent thin bony upper walls of the skull. Their upturned margins being deeply pigmented show clearly the exact extent of their area. The right organ and its coverings are represented as seen comparatively superficially, the left organ as viewed with a deep focus of the lens. Hence the curved convex orbital area of the skull-roof and its flattened concentrically striate area are seen on the right hand, whilst on the left the hexagonal bodies of which the organ itself is composed are indicated in two places, as seen through the skull-roof. A pair of bony canals traverse the skull surface on either side of the median septum antero-posteriorly. They transmit the two nasal branches of the fifth nerve, which are seen passing to the nasal capsules, but are mainly occupied by large mucous canals which are of a glistening opaque white owing to the action of spirit.

C. Drummond del.

PLATE LXVIII.

PLATE LXVIII.

Fig. 1. Diagrammatic sketch of the head of *Ipnops* to show the relation of the various structures. *S*, crest of cartilaginous median septum of skull; *E*, pigmented margin of phosphorescent organ; *T*, bony longitudinal canal; *a*, orbital (?) convex area of skull-roof; *b*, flattened concentrically striate area of same; *d*, posterior region of phosphorescent organ lying over the cranial roof; *c*, region of phosphorescent organ lying between the bony longitudinal canal and the septum.

Fig. 2. Vertical transverse section across the snout of *Ipnops*, about on a level with the point indicated by the letter *T* in fig. 1. Lower jaw removed. *S*, horizontal plate and median septum of hyaline cartilage, shaded dark *P*, transparent roof of skull; *T*, longitudinal canal on surface of skull-roof in section; *M*, its contained mucous canal; *N*, nasal branch of fifth nerve in section; *O*, plate of connective tissue completing the median septum; *R*, phosphorescent organ; *X*, connective tissue layer beneath the organ; *W*, section of internal margin of phosphorescent organ; *V*, section of external margin of the same. Each margin shows a thickening of pigment.

Fig. 3. A portion of the phosphorescent organ viewed from above by reflected light. Ten of the hexagonal columns remain *in situ*.

Fig. 4. A portion of the same viewed by transmitted light. *a*, ramifications of capillary blood-vessels.

Fig. 5. Vertical section of the phosphorescent organ, showing the rounded bases of the hexagonal columns. The under surface is partly seen in perspective; *e*, surface layer of cells; *b*, rods; *c*, hexagonal pigment-cells.

Fig. 6. Vertical section of phosphorescent organ through three hexagonal columns, very highly magnified. *a*, blood-corpuscles in a small blood-vessel seen in section. The blood-vessel is held *in situ* by part of the connective tissue layer lying beneath the phosphorescent organ, in which lies a large ramified pigment-cell, *b*; *c*, hexagonal pigment-cell forming base of a hexagonal column seen in section; *d*, its nucleus; *e*, superficial cells of phosphorescent organ; *f*, rods; *h*, bracket embracing the rods belonging to a single hexagonal column; *g*, pigmented ramifying string seen in section.

Fig. 7. Two of the rods with their corresponding cells, very highly magnified. Only about two-thirds of the length of the rods is shown.

Fig. 8. Two rods, less magnified, with nuclei near their inferior extremities.

Fig. 9. The cells of the superficial cell-layer of the phosphorescent organ viewed from above.

Fig. 10. Hexagonal pigment-cells viewed from the under surface of the phosphorescent organ. Also one of these from above, showing its cup-like form.

Fig. 11. One of the hexagonal columns viewed from above, so that the component rods are seen in optical section.

Fig. 12. View of the phosphorescent organ from above by transmitted light, showing the ramified network of pigmented strings.

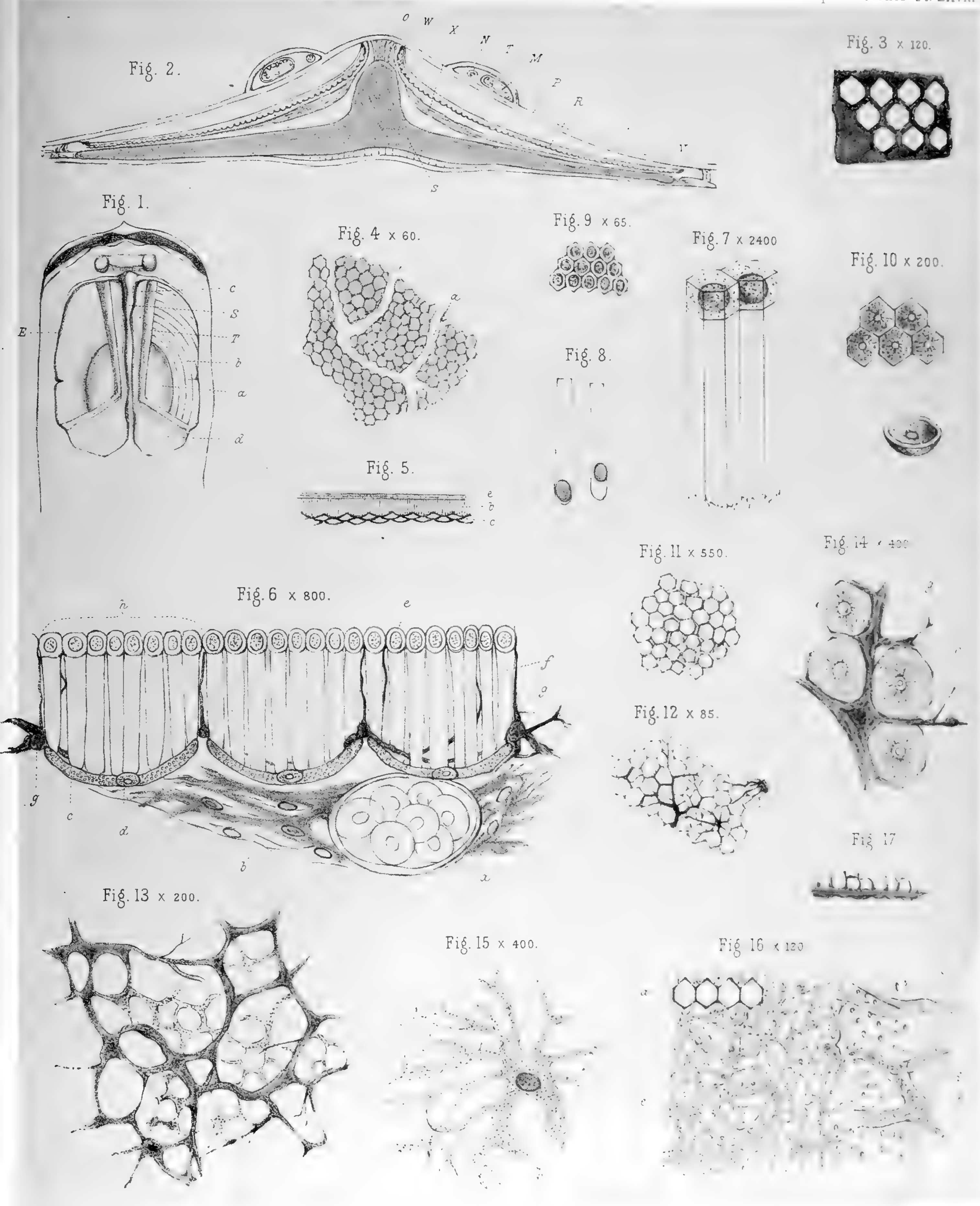
Fig. 13. The pigmented network much more enlarged.

Fig. 14. The same still more enlarged, showing its relation to the hexagonal pigmented cells. *g*, pigmented strings; *c*, hexagonal pigmented cells.

Fig. 15. Ramified pigment-cell from the connective tissue layer beneath the phosphorescent organ.

Fig. 16. Structure of the connective tissue layer beneath the phosphorescent organ; *a*, a few hexagonal columns left standing on the layer; *b*, connective tissue and other elements; *c*, nerve; *d*, blood-vessel; *e*, ramified pigment-cells. For purpose of clearness the other elements are omitted where the pigment-cells are represented.

Fig. 17. Special arrangement of pigment at the margin of the phosphorescent organ.



H.N. Moseley del.

PHOSPHORESCENT ORGAN OF IPNOPS MURRAYI

PLATE LXIX.

PLATE LXIX.

Astronesthes niger.

Fig. 1. Lateral view, showing the disposition of the luminous organs; natural size, from a spirit specimen.

a, a, Compound organs; *b*, simple organs; *c*, luminous patch on the side; *d*, on the forehead; *e, e'*, on the upper jaw.

Fig. 2. Transverse section through the ventral side. × 10.

a, Compound luminous organ; *b*, simple luminous organ; *I*, intestine; *a*, cartilage; *V*, blood-vessel.

Fig. 3. Compound luminous organ, from ventral side. Longitudinal section. × 100.

b, cornea-shaped transparent part of skin over the organ; *c*, transparent membrane outside the lens-shaped body; *d*, lens-shaped body; *e*, gland-tubes of the spherical part; *f*, pigment-layers; *g, g'*, pigment coating of the outer and inner parts of the luminous body; *h*, gland-tubes in the outer part of the luminous organ; *k*, granular mass of secretion and cells, inner portion belonging to the glands of the inner part of the organ; *l*, granular mass of secretion and cells, outer part; *m*, shining membrane within the pigment-mantle of the organ; *n*, ganglion cells in the granular central disc.

Fig. 4. Diagrammatic section through the axis of the compound luminous organ. × 100.

a_1, a_2, a_3, a_4, b_1, b_2, b_3, b_4, Rays of light emitted from the central part of the organ (*k*) and reflected in the lower spherical portion of the organ; c_1, c_2, c_3, d_1, d_2, d_3, e_1, e_2, e_3, f_1, f_2, f_3, rays of light emitted from the central part of the organ (*k*), in a centrifugal direction, reflected from the sides of the outer parabolic portion of the organ and refracted by passing through the outer surface of the cornea-like layer (*g*); *Ax*, axis of the optical system; *g*, cornea; *h*, phosphorescent tissue of the outer parabolic part; *i*, glands of the inner spherical part.

Fig. 5. Longitudinal section of a simple luminous organ. × 150.

a, Mass of granular secretion and cells; *b*, radial gland-tubes; *c*, pigment-mantle; *d*, cornea; *e*, reflecting membrane.

Fig. 6. Section of a lateral luminous patch (*c*, fig. 1). × 40.

a, Pigmented skin of the fish; *b*, vertical gland-tubes.

Fig. 7. Section of a lateral luminous organ. × 4.

a, Phosphorescent gland.

Fig. 8. Vertical section of a lateral luminous organ. × 150.

a, Granular secretion with cells; *b*, gland-tubes vertical to the skin; *c*, pigment-layer; *d*, lamellæ of pigment, extending upwards between the gland-tubes.

Fig. 9. Section through outer portion of simple luminous organ. × 300.

Fig. 10. Simple luminous organ, seen from without, × 30.

Fig. 11. Head in profile. × 4.

a, Frontal phosphorescent gland; *b*, anterior, *c*, posterior infraorbital phosphorescent glands; *d*, ocellar phosphorescent organs.

Fig 12. Transverse section of narrow posterior end of anterior infraorbital phosphorescent gland. × 150.

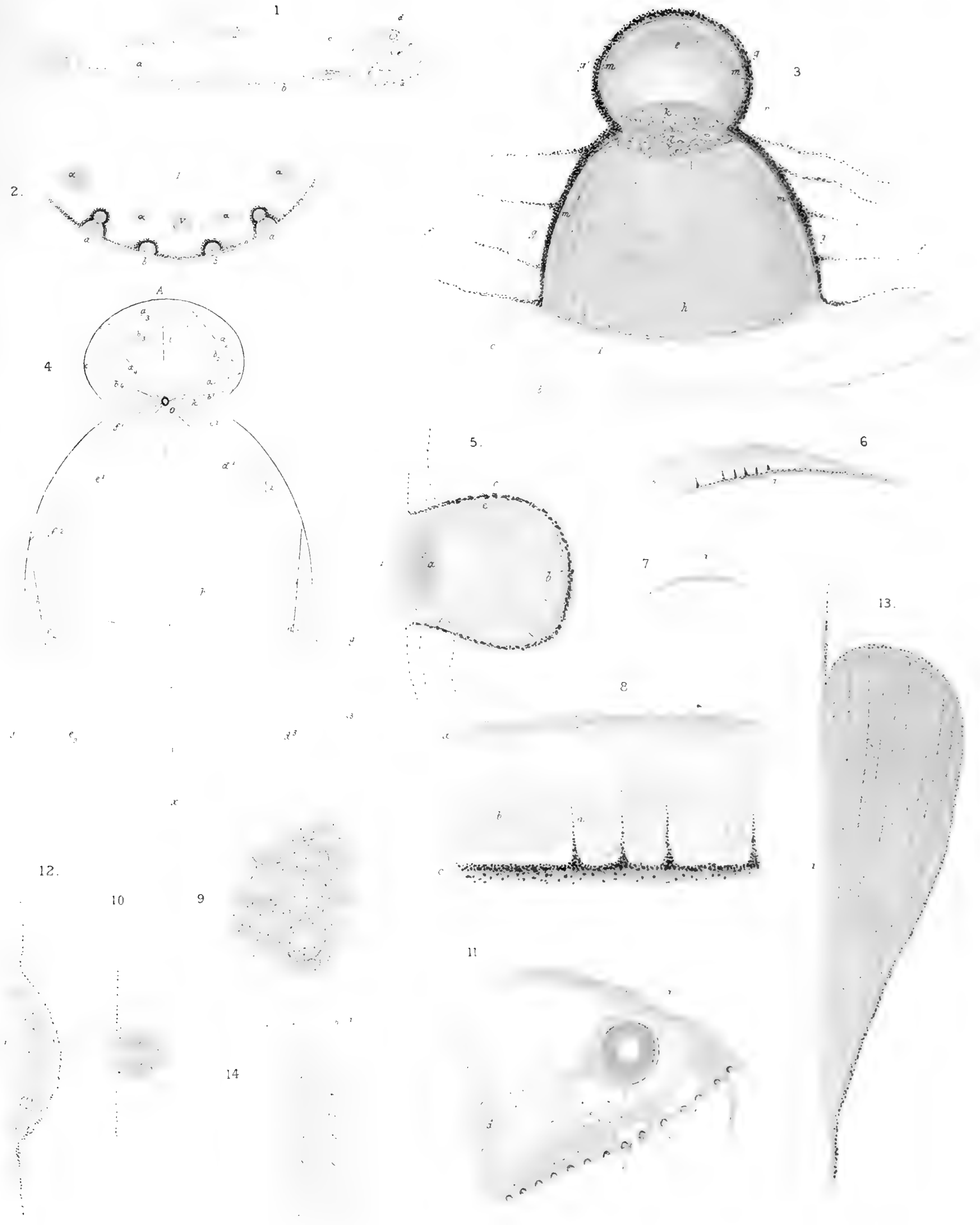
a, Transparent outer skin.

Fig. 13. Longitudinal section of anterior infraorbital gland. × 100.

a, Transparent outer skin.

Fig. 14. Portion of the section figured in fig. 13, showing a gland-tube. × 500.

a, Membrane of the gland-tube; *b*, gland-cells; *c*, lumen of the gland-tube, filled with secretion; *d*, a thread of cartilage.



R. v. Lendenfeld del.

F Huth Lith Edin^r

ASTRONESTHES NIGER

PLATE LXX.

PLATE LXX.

Sternoptyx diaphana.

Fig. 15. The fish seen from the side, natural size; drawn from a spirit specimen.

a, Ventral luminous organ; *b*, anterior, *c*, posterior lateral luminous organs; *d*, anal membrane; *e*, submaxillary phosphorescent gland.

Fig. 16. Submaxillary phosphorescent gland, seen *en face*. × 4.

a, Mouth.

Fig. 17. Ventral luminous organ, seen from below. × 2.

a, Ventral fins.

Fig. 18. Ventral luminous organ, longitudinal section, parallel to the median plane of the fish to the side of the mid rib. × 2.

a, Central canal; *b*, parabolic cups.

Fig. 19. Ventral luminous organ, outer surface. × 20.

a, Projecting mid rib; *b*, pigment-mantle.

Fig. 20. Transverse section of the anterior end of the ventral luminous organ. × 100.

a, Projecting cartilaginous mid rib; *b*, cartilage thread; *c*, crystalline spicules arranged longitudinally so as to reflect the light; *d*, pigment-mantle; *e*, main canal; *f*, parabolic, paired organs, the apertures of which are covered by a transparent cornea-like membrane; *g*, transparent connective tissue surrounding the phosphorescent tissue.

Fig. 21. Transverse section through the anterior end of the ventral luminous organ. × 50.

a, Pigment-mantle; *b*, light-reflecting layer of spicules; *c*, transparent connective tissue; *d*, phosphorescent tissue; *e*, transparent outer skin.

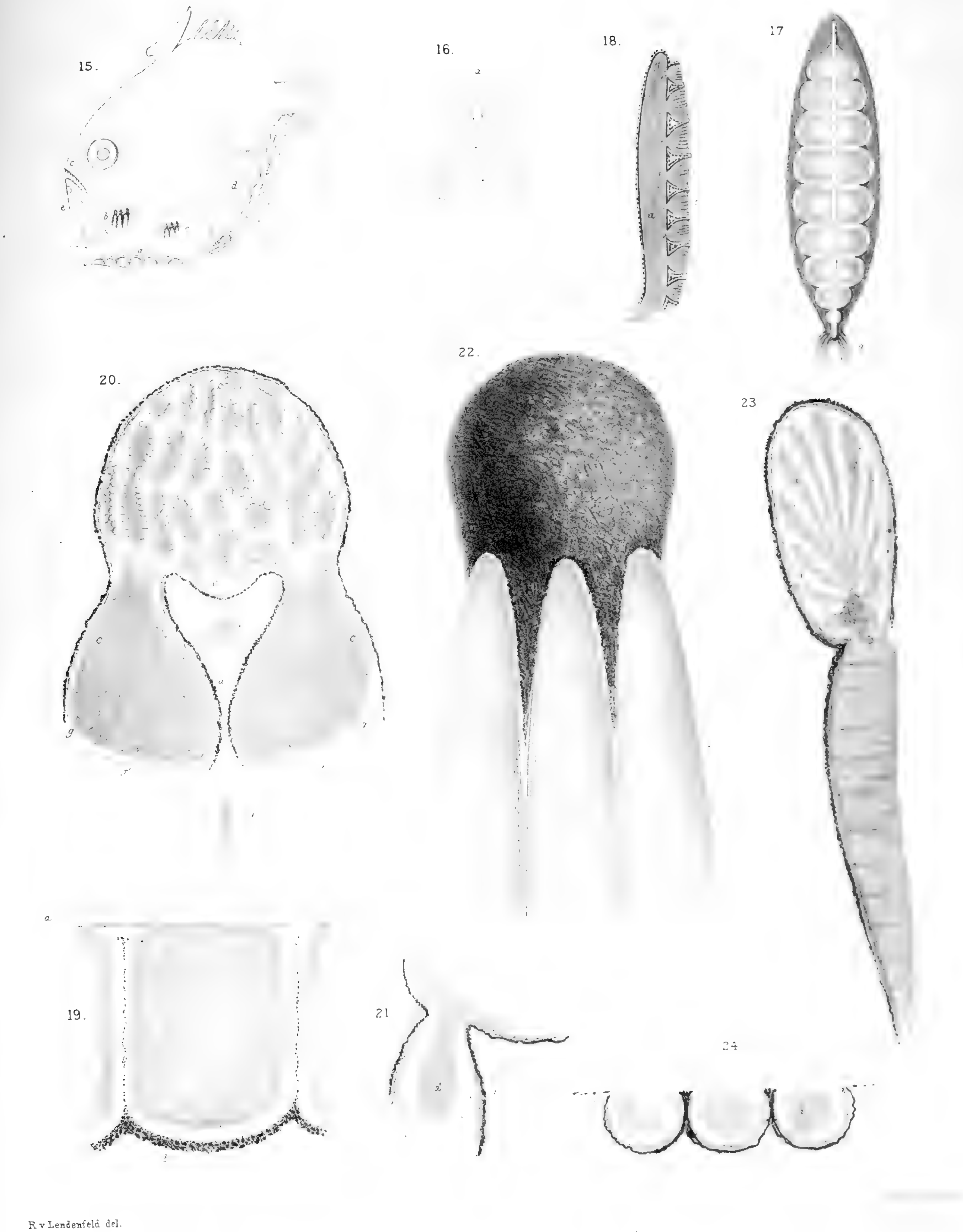
Fig. 22. Postero-lateral luminous organ, seen from the outside. × 30.

Fig. 23. Longitudinal section of the postero-lateral luminous organ. × 50.

a, Spicules forming a light-reflecting layer; *b*, pigment-mantle; *c*, large highly stainable cells at the entrance of the luminous sac; *d*, gland-tubes.

Fig. 24. Transverse section through the hemiparabolic reflectors of the postero-lateral luminous organ. × 50.

a, Spicules forming a light-reflecting layer; *b*, pigment-mantle; *c*, transparent connective tissue; *d*, gland-tubes.



R v Lendenfeld del.

STERNOPTYX DIAPHANA.

PLATE LXXI.

PLATE LXXI.

Pachystomias microdon.

Fig. 25. Head in profile, natural size, drawn from a spirit specimen.

a, Anterior suborbital phosphorescent organ; *b*, posterior suborbital phosphorescent organ.

Fig. 26. Suborbital phosphorescent organs *in situ*. × 2.

a, Anterior; *b*, posterior suborbital phosphorescent organ.

Fig. 27. Vertical section of the anterior suborbital phosphorescent organ. × 20.

a, Pigment coat; *b*, reticulate gland; *c*, layer of light-reflecting spicules; *d*, radial gland-tubes; *e*, outer skin, the margins of which can be drawn some distance over the surface of the phosphorescent organ.

Fig. 28. Vertical section of the posterior suborbital phosphorescent organ. × 25.

a, Granular outer surface; *b*, nervus phosphorius; *c*, layer of light-reflecting spicules; *d*, radial gland-tubes; *e*, outer skin, the margins of which can be drawn some distance over the phosphorescent organ.

Fig. 29. Anterior suborbital phosphorescent organ. × 50.

Light-reflecting layer of spicules seen from the surface. The external reticulate part of the gland communicates by these oval holes with the internal radial part.

Fig. 30. Section of the anterior suborbital organ shown in fig. 27. × 350.

a, Pigmented partition-membranes; *b*, gland-tubes.

Fig. 31. Section of the posterior suborbital phosphorescent organ shown in fig. 28. × 200.

a, Nervus phosphorius; *b*, light-reflecting layer of spicules traversed by numerous nerves and blood-vessels; *c*, termini of the radial gland-tubes; α, thick partition membranes with nerves and blood-vessel; β, gland-tubes.

Fig. 32. Longitudinal section of a compound phosphorescent organ from the lateral row. × 40.

Fig. 33. Section of the compound phosphorescent organ shown in fig. 32. × 400.

a, Pigment coat; *b*, light-reflecting membrane; *c*, granular layer with large cells in it (ganglion cells); *d*, radial gland-tubes.

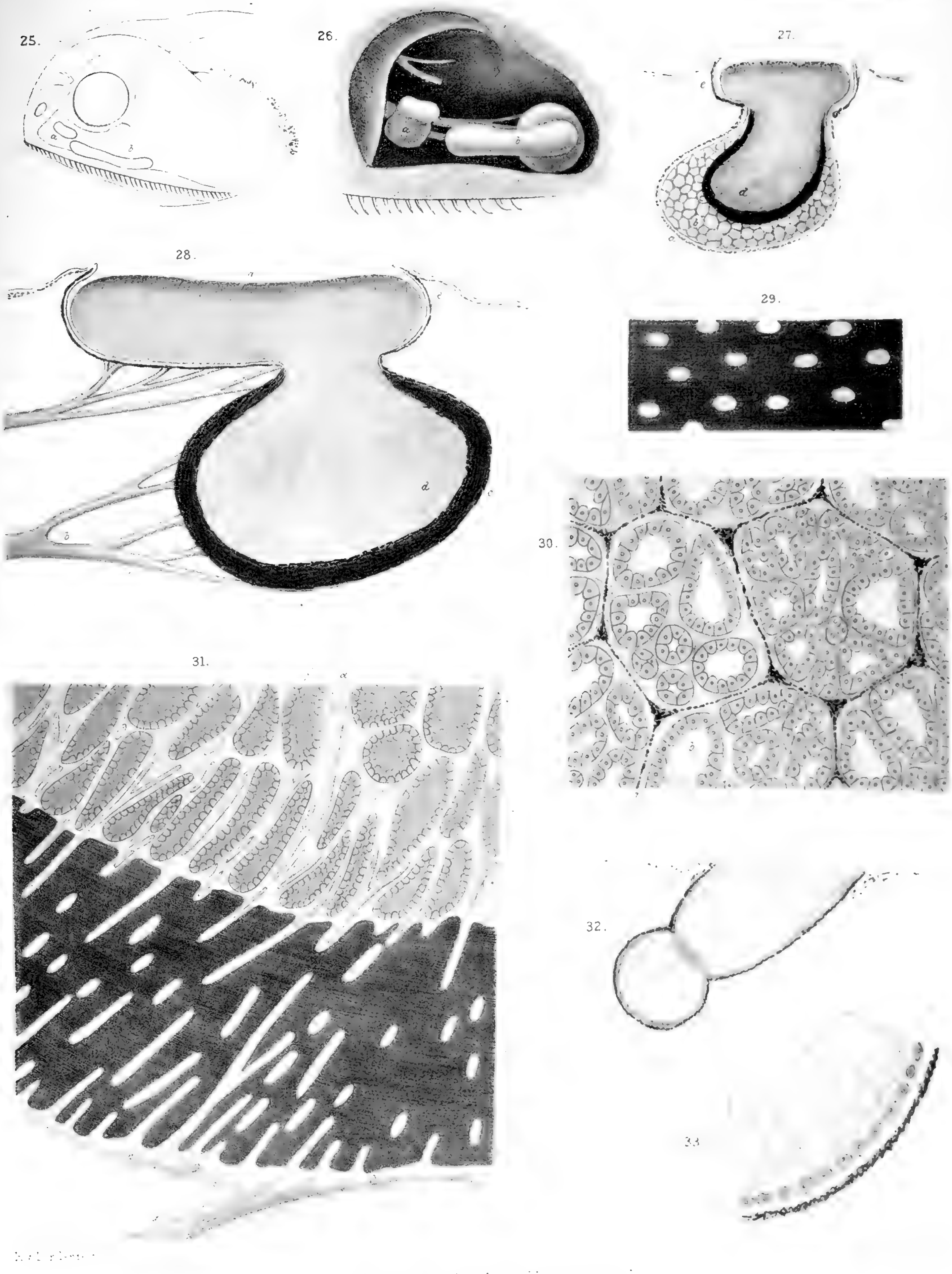

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PLATE LXXII.

PLATE LXXII.

Figs. 34–41. *Opostomias micripnus.*

Fig. 34. Median section of a lenticular white dorsal phosphorescent organ. × 80.

Fig. 35. Median section of another lenticular organ, showing incipient fission. × 80.

Fig. 36. Transverse section of the distal part of the anterior ray of the pectoral fin, which is prolonged to form a barbel. × 100.

Fig. 37. Median section of a hemispherical white dorsal phosphorescent organ. × 80.

Fig. 38. Median section of a black dorsal phosphorescent organ. × 80.

Fig. 39. Head in profile, from a spirit specimen; natural size.

a, Dorsal phosphorescent organs (simple); *b*, superior lateral line of compound phosphorescent organs; *c*, inferior lateral line of compound phosphorescent organs; *d*, suborbital phosphorescent organ; *e*, barbel attached to lower jaw; *f*, barbels formed by the first ray of the pectoral fins.

Fig. 40. Longitudinal section of the suborbital phosphorescent organ. × 100.

a, Outer skin; *b*, external radially striped part; *c*, gland-tubes; *d*, nervus phosphorius.

Fig. 41. Section of the suborbital phosphorescent organ. Portion of the external radially striped part, shown in fig. 40. × 800.

a, Gland-tubes of the interior; *b*, membrane dividing the outer layer from the inner glandular part; *c*, layer of ganglion cells; *d*, phosphorescent cells: *e*, long and slender cylindrical supporting cells between them; *f*, outer surface.

Fig. 42. *Echiostoma barbatum.*

Fig. 42. The brain in profile. × 4.

a, Spinal cord; *b*, and *c*, cerebral nerves; *d*, nervus acusticus; *e*, nervus trigeminus; *f*, nervus facialis *g*, nervus phosphorus (part of the trigeminus); *h*, nervus oculomotorius; *h'*, nervus opticus; *i*, nervus olfactorius; *k*, cerebellum; *l*, lobus opticus; *m*, lobus phosphorius.

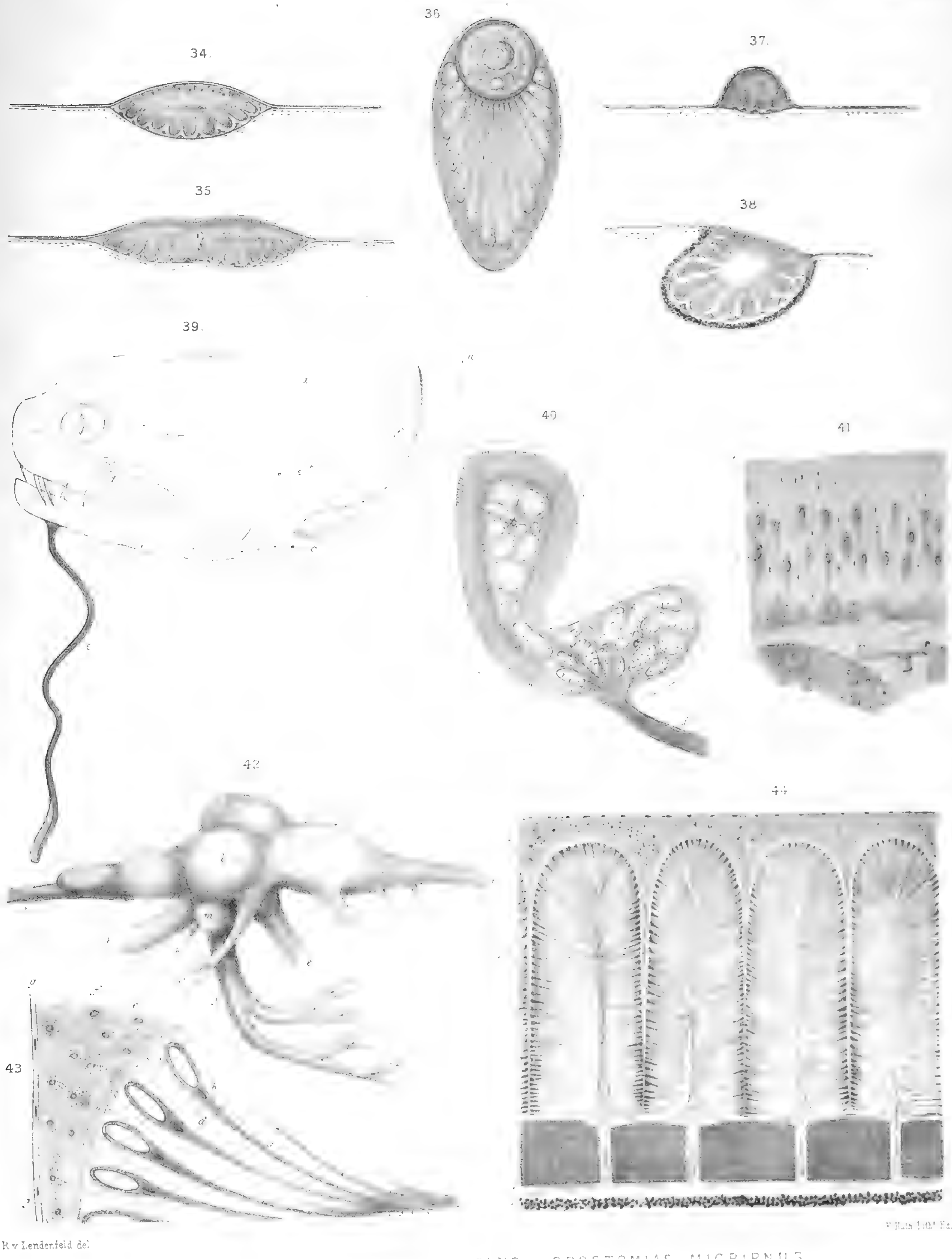
Figs. 43, 44. *Scopelus benoiti.*

Fig. 43. Vertical section of the single compound dorsal phosphorescent organ shown in fig. 44. × 1000.

a, Long and slender peduncle of the phosphorescent cell; *b*, nucleus of the phosphorescent cell; *c*, large oval vacuole outside the nucleus; *d*, slender cylindrical supporting cells; *e*, granular cells with indistinct outlines (ganglion cells); *f*, very distinct nuclei of the ganglion cells; *g*, outer surface clothed with flat epithelium.

Fig. 44. Vertical section of the exposed part of the single compound dorsal phosphorescent organ. × 80.

a, Outer surface with flat epithelial cells; *b*, granular mass of ganglion cells, with distinct nuclei; *c*, phosphorescent cells; *d*, reflecting layer of spicules; *e*, blood-vessels extending up into the masses of phosphorescent cells; *f*, nerves extending downwards from the external ganglion cell layer; *g*, layer of tissue with numerous blood-vessels; *h*, pigment coat.



R. v. Lendenfeld del.

ECHIOSTOMA BARBATUM. SCOPELUS. OPOSTOMIAS MICRIPNUS.

PLATE LXXIII.

PLATE LXXIII.

Figs. 45–48. *Halosaurus macrochir.*

Fig. 45. Transverse vertical section of the glandular phosphorescent organ below the gill-cover. × 15.
a, Granular substance; *b*, vertical threads; *c*, structureless reflecting cuticular membrane; *d*, pigment-layer.

Fig. 46. Transverse vertical section of the same organ. × 250.
a, Granular substance; *b*, vertical threads, consisting of blood-vessels, nerves, and a cartilaginous support; *c*, structureless reflecting cuticular basal membrane; *d*, pigment-layer; *e*, outer pavement epithelium.

Fig. 47. Tripolar cell from the granular substance. × 600.

Fig. 48. Bipolar cell from the same. × 600.

Figs. 49–53. *Xenodermichthys nodulosus.*

Fig. 49. Transverse vertical section of the ducts of the slime-glands in the sides of the body. × 100.
a, Outer pavement epithelium with scattered pigment; *b*, proximal end of efferent duct; *c*, thick pigment-layer of the dermis; *d*, transparent fibrous tissue.

Fig. 50. Axial section of a projecting ocellar phosphorescent organ, from the side of the body. × 100.
a, Thick pigment-layer of the dermis; *b*, outer pavement epithelium, with scattered pigment; *c*, thick pigment-layer covering the upper proximal portion of the organ; *d*, internal crest dividing the organ into a proximal and a distal portion; *e*, limit of the pigment cover; *f*, nerve passing into the organ; *g*, thick pigment-layer on the proximal side; *h*, proximal granular portion, with large nuclei; *i*, typical phosphorescent clavate cells; *k*, pigment patches; *l*, transparent epithelium.

Fig. 51. Bipolar cell from the distal portion of the same organ. × 800.

Fig. 52. Typical phosphorescent clavate cells, from the same. × 800.
a, Light-refracting vesicle; *b*, nucleus; *c*, peduncle.

Fig. 53. A similar clavate cell with abnormal refractive vesicle, from the same. × 800.
a, Two light-refracting vesicles; *b*, nucleus; *c*, peduncle.

Figs. 54–64. *Halosaurus macrochir.*

Fig. 54. Surface view of the reflecting membrane, clothing the spaces between the modified scales of the lateral line. × 1400.

Fig. 55. Transverse section of the large lateral slime-canal. × 150.
a, Phosphorescent tissue overlying the slime-canal; *b*, gland-tubes; *c*, short cylindrical longitudinally situated cells, with well-defined cell-wall, occupying the lower portions of the slime-canal; *d*, irregular cells surrounding the lumen of the slime-canal; *e*, lumen of the slime-canal; *f*, muscular fibres.

Fig. 56. Tripolar cell, from the slime-canal; adjacent to the lumen. × 400.

Fig. 57. Bipolar cell, from the same situation. × 400.

Fig. 58. Group of cells, from the slime-canal; adjacent to the outer wall, in transverse section. × 500.

Fig. 59. Coiled gland-tubes, from the vicinity of the slime-canal. × 300.

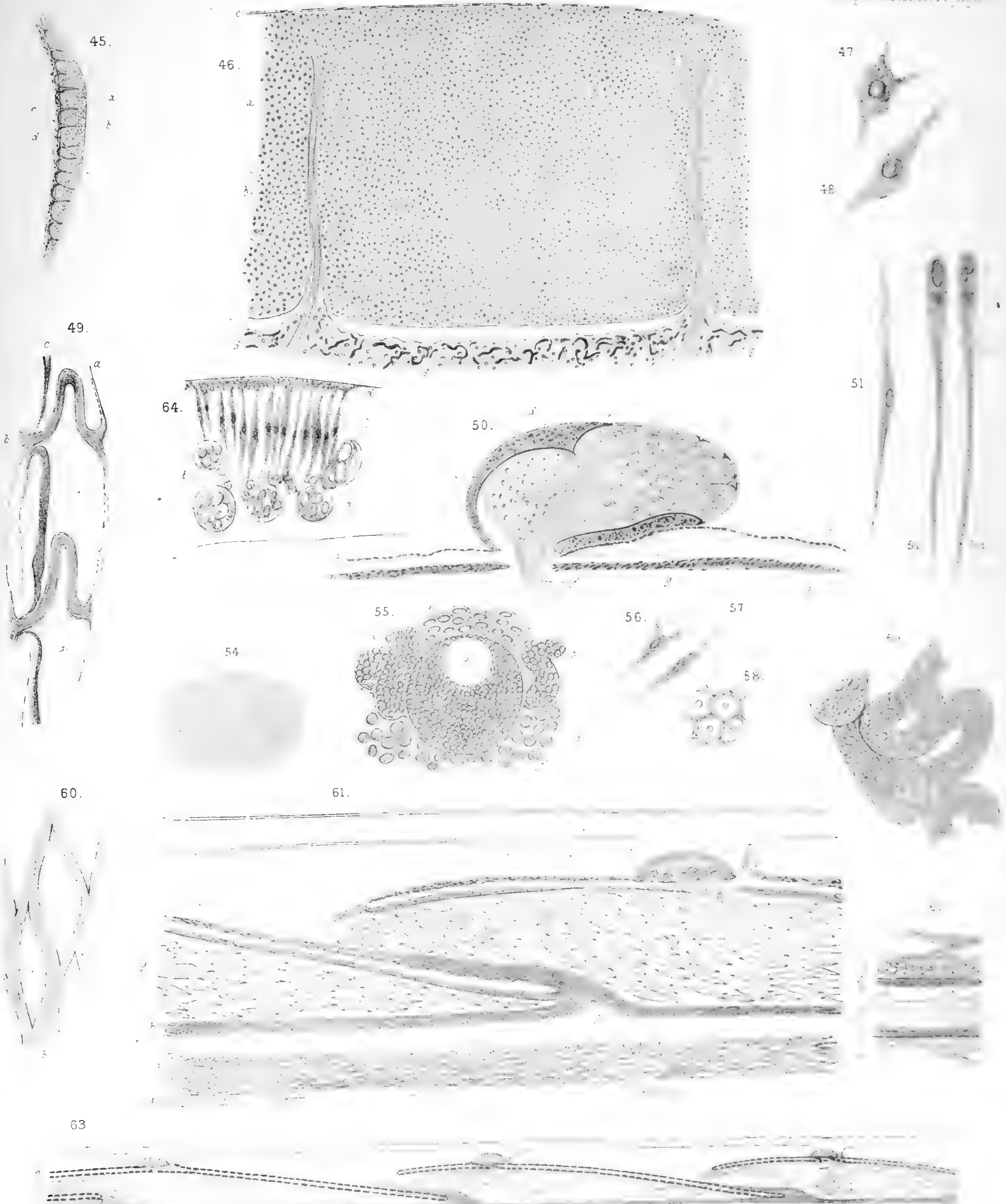
Fig. 60. Longitudinal section of the tissue occupying the spaces below the large modified scales of the lateral line. × 500.
a, Lenticular yellow bodies; *b*, intervening fibrous tissue.

Fig. 61. Longitudinal section through the slime-canal, showing the phosphorescent organs, in the modified lateral line. × 150.
a, Muscular fibres; *b*, inner portion of the tissue filling the slime-canal; *c*, lumen of the slime-canal; *d*, extensions of the lumen below the inner margin of each scale; *e*, extension of the roof of the slime-canal along the outer side of the proximal portion of each modified scale; *f*, tissue covering the slime-canal; *g*, tissue between the modified scales of the lateral line; *h*, roof of the slime-canal; *i*, modified scales of the lateral line; *k*, posterior margin of the scale; *l*, pigmented membrane covering the outer surface of the modified scales; *m*, pigmented membrane covering the inner surface of the modified scales; *n*, reflecting membrane on the inner side of the modified scales; *o*, reflecting membrane on the outer side of the modified scales; *p*, phosphorescent organ on the outer side of the scale; *q*, transverse ridge of the scale; *r*, inner membrane; *s*, outer membrane; *t*, canal passing through the scale and leading to the phosphorescent organ.

Fig. 62. Longitudinal section of a portion of the lateral line, near the proximal end of one of the modified scales. × 400.
a, Phosphorescent tissue overlying the slime-canal; *b*, reflecting membrane; *c*, pigmented membrane below the scale; *d*, scale; *e*, pigmented membrane; *f*, reflecting membrane above the scale; *g*, extension of the roof of the slime-canal along the outer side of the proximal portion of the scale; *h*, fibrous tissue; *i*, lenticular yellow bodies of the tissue between the scales.

Fig. 63. Longitudinal section of the slime-canal, showing the phosphorescent organs in the modified lateral line. × 60.
a, Lumen of the slime-canal; *b*, tissue of the slime-canal; *c*, tissue between adjacent modified scales; *d*, scales and their membranes (compare fig. 62).

Fig. 64. Transverse section of a phosphorescent organ attached to the outer side of the scale. × 400.
a, Blood-vessels; *b*, ganglion cells; *c*, phosphorescent spindle cells; *d*, granular superficial layer.



R.v.Lendenfeld del.

HALOSAURUS. XENODERMICHTHYS.