

STUDIES ON THE TRICHIUROID FISHES—3¹

A PRELIMINARY REVISION OF THE FAMILY TRICHIURIDAE

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SYNOPSIS

This paper presents a working classification of the Trichiuridae, based on a consideration of the literature of the family and examination of selected material, which has been prepared as a prelude to Reports on the "Dana" collections of Trichiuridae and Gempylidae. Three subfamilies are recognized: Aphanopodinae (genera *Diplospinus*, *Aphanopus*, *Benthodesmus*); Lepidopodinae (genera *Lepidopus*, *Evoxymetopon*, *Eupleurogrammus*, *Assurger*, *Tentoriceps*) and Trichiurinae (genera *Trichiurus*, *Lepturacanthus*). Keys, diagnoses and synonymies are presented and figures given of all species recognized. *Diplospinus* is considered to be the most primitive genus extant and grounds are given for relating it to the Gempylid *Nesiarchus*. The origin and radiation of the Trichiuridae are discussed.

¹ The previous papers in this series were: (1) The fishes of the genus *Benthodesmus* (Family Trichiuridae), *Proc. zool. Soc. Lond.* **123**: 171-197, 3 pls., 5 text-figs. (1953). (2) *Benthodesmus tenuis* (Günther) collected by the Expédition Océanographique Belge dans les eaux côtières de l'Atlantique Sud (1948-1949), with additional notes on the genus *Benthodesmus*, *Bull. Inst. roy. Sci. nat. Belg.* **31**, No. 64: 1-26, 1 pl., 11 text-figs. (1955).

INTRODUCTION

As I contemplated the mass of material which resulted from my rash acceptance of Dr. Anton Fr. Bruun's invitation to write reports on the young Trichiurid fishes collected by the "Dana" Expeditions, I realized the urgent need of some preliminary working classification with which to regulate the chaos that must ensue once these many thousands of specimens were released, like so many djinns, from their tubes and bottles.

The problem of the Gempylidae was immediately relieved by Matsubara and Iwai (1952) and by Mrs. Marion Grey (1953), but the case of the Trichiuridae remained desperate. There has been no comprehensive revision of this family since the end of the nineteenth century. The earlier synopses of Günther (1860), Gill (1863) and Goode and Bean (1895) are no longer adequate accounts even of the genera which they describe and, moreover, contain no attempt at a phyletic classification since they date from a period before the planting of family trees became fashionable. Later workers have had varying success in distinguishing the genera and species of limited regions. In this century a few new species and genera have been proposed, two of the latter without any of the inhibitions consequent upon an interest in the family or the possession of study-material.

The present draft revision assigns a place to every nominal genus and species and gives, as a minimum, the reference for the first publication of every name and name-combination, together with selected items from the remaining literature. It gives diagnoses and a phyletic classification of all sub-families, genera and species recognized and argues the case for synonymies with whatever detail the individual circumstances may immediately demand. Except for *Evoxymetopon*, *Assurger* and *Tentoriceps* (of which material or new published descriptions would be greatly appreciated), material of all genera and species has been examined, including a substantial number of type specimens.

The author of any "preliminary" contribution should justify his title. The amount of labour involved in preparing the present MS as a working tool has shown the need of such a tool and of certain small but critical contributions to the understanding of the Trichiuridae which those possessing rarer material may make. It will be some considerable time before the final "Dana" Reports on the Trichiuridae and Gempylidae can be completed and so, *faute-de-mieux*, a preliminary account appears likely to be useful, even though some of its conclusions may be subject to second thoughts.

I wish to express my thanks to Messrs. P. E. Purves and A. C. Wheeler of the British Museum (Natural History) for numerous radiographs which have been of very great assistance in this work.

THE CHARACTERS OF THE FAMILY TRICHIURIDAE

Regan (1909) allies the Trichiuridae with the Gempylidae as the Trichiuriformes, forming the first division of his suborder Scombroidei of the order Percomorphi. He characterises the Trichiuriformes as having:—

"Caudal fin-rays not deeply forked at the base, the hypural in great part

exposed. Praemaxillaries beak-like, free from the nasals; mouth toothed, with lateral cleft; strong anterior canines. Epiotics separated by supra-occipital. Gill-membranes free from the isthmus. Pectoral fins placed low."

With this diagnosis I have no present disagreement save to comment that hypurals are sometimes absent and to prefer the use of "fangs" or "caniniform teeth" rather than "canines" for fish teeth; the term "canine" is best restricted to certain reptiles and to the mammals, in which it is defined, not by form but by position and homology, as "the most anterior tooth of the maxilla, situated on or immediately behind the premaxillo-maxillary suture . . . or the tooth in the lower jaw which bites in front of the upper canine".

Regan's diagnosis of the family Trichiuridae follows:

"Body very elongate, strongly compressed; maxillary sheathed by the praeorbital; spinous dorsal, if distinct, not longer than the soft¹; anal with numerous short spines²; pelvic fins reduced to a pair of scale-like appendages or absent³; caudal small or absent. Dorsal and anal rays corresponding to the vertebrae⁴, each interneural or interhaemal attached to a neural or haemal spine; pelvic bones, if present, united to form a slender spicular bone connected with the cleithra by a long ligament⁵. Vertebrae numerous, 100(43 + 57) to 159(39 + 120) or more⁶; ribs feeble, sessile."

This description is evidently based primarily upon examinations of *Lepidopus*, *Aphanopus* and *Trichiurus* and requires several modifications and qualifications:

(1) The spinous dorsal is always distinct; it is longer than the soft in *Diplospinus* (discovered since Regan's time) and very slightly longer than the soft in occasional specimens of *Aphanopus*.

(2) Some, if not all, of the anal rays are split, soft and support a fin-membrane (*Diplospinus*, *Aphanopus*, *Benthodesmus*, *Lepidopus*, *Evoxymetopon*, *Assurger*); in *Trichiurus*, *Lepturacanthus* and *Eupleurogrammus*, however, the anal rays are much reduced spinules or entirely absent. At the origin of the anal fin, moreover, immediately behind the vent, are two spines (represented by the notation $i + I$ throughout the present paper); of these the anterior is a minute spinule while the second may be variously enlarged as a leaf-like or keeled scute, or as a stout spine.

(3) The pelvic fins in some genera (*Diplospinus*, *Aphanopus*, *Benthodesmus*, *Lepidopus*) and probably in all in which they are present, consist each of a scale-like spine and one rudimentary soft ray, the latter newly noticed.

(4) The dorsal spines and their basals and interneurals always correspond to the trunk vertebrae; the dorsal soft rays may be twice as numerous as the adjacent vertebrae (*Diplospinus*), slightly more numerous (*Aphanopus*, *Benthodesmus*) or as numerous (remaining genera).

(5) The pelvic bones form an imperfectly fused, fenestrated structure which is not always elongated.

(6) The vertebrae range from $34 + 24 = 58$ (*Diplospinus*) to $53 + 103 = 156$ (*Benthodesmus simonyi*) or $41 + 151 = 192$ (*Eupleurogrammus muticus*).

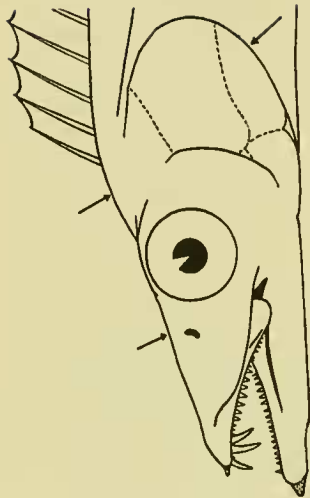


FIG. 2.—Types of Lepidopodine head (*Lepidopus*). The posterior confluence of the frontal ridges is elevated to form a sagittal crest, which is, in this form, however, confined to the nape. The free margin of the subopercular is convex.

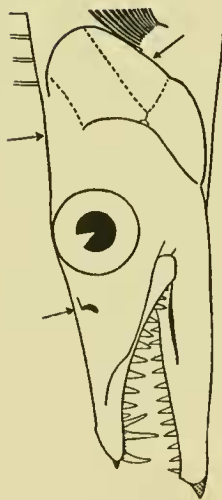


FIG. 1.—A typical Aphanopodine head (*Aphanopus*). There is no elevation of the ethmo-frontal region; the posterior confluence of the frontal ridges does not form a crest; the free margin of the subopercular is convex.

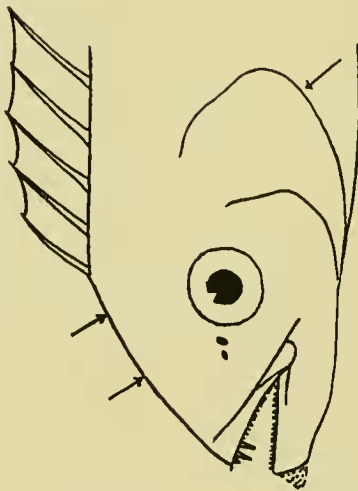


FIG. 3.—Types of Lepidopodine head: *Evoxymelopen* (re-drawn after Goode & Bean). The posterior confluence of the frontal ridges is elevated to form a sagittal crest, which is continued forward along the snout as an elevation of the entire ethmo-frontal region. The free edge of the subopercular is convex.



FIG. 4.—A typical Trichiurine head (*Trichiurus*). The posterior confluence of the frontal ridges is elevated to form a sagittal crest, which, in this subfamily, is confined to the nape. The free margin of the subopercular is concave.

A SHORT KEY TO THE SUBFAMILIES AND GENERA
OF THE FAMILY TRICHIURIDAE

- Frontal ridges not elevated, no sagittal crest. Profile of head rising very gently from snout tip to dorsal (cf. Text-fig. 1) APHANOPODINAE (p. 77)
- D.72-73. Spinous dorsal base twice as long as soft *Diplospinus* (p. 78)
- D.82-87. See "*Lepidopus xantusi*" (Lepidopodinae)
- D.91-95. Spinous and soft dorsal bases sub-equal *Aphanopus* (p. 81)
- D.120+ Spinous dorsal base half as long as soft *Benthodesmus* (p. 85)
- Posterior confluence of frontal ridges elevated, forming a prominent sagittal crest at the nape, which may or may not be continued forward as a ridge-like elevation of the ethmo-frontal region (cf. Text-figs. 2, 3 and 4).
- Ventral fins present. Lateral line descending gently from the shoulder and median or sub-median along the body, i.e. distance from lateral line to ventral profile at anus much more than half distance from lateral line to dorsal. Lower hind margin of operculum convex LEPIDOPODINAE (p. 89)
- Sagittal crest confined to nape. Interorbital concave. Caudal present *Lepidopus* (p. 90)
- Sagittal crest continuous from snout tip to dorsal. Interorbital convex
- Caudal present
- D.87-93. Body depth 12-13 in length *Evoxymetopon* (p. 97)
- D.120. Body-depth 20-28 in length *Assurger* (p. 106)
- Caudal absent.
- Body depth 14-18 in length *Eupleurogrammus* (p. 102)
- Body depth 20-24 in length *Tentoriceps* (p. 110)
- Ventral fins absent. Lateral line descending steeply from the shoulder and running near the ventral profile of the body, i.e. distance from lateral line to ventral profile at anus less than half distance from lateral line to dorsal. Lower hind margin of operculum more or less concave. Caudal always absent (cf. Text-fig. 4) TRICHIURINAE (p. 112)
- Post-anal scute small, less than the pupil. Soft anal rays not breaking through skin. Eye large, 5.0-7.0 in head *Trichiurus* (p. 113)
- Post-anal scute large, half the eye-diameter. Soft anal rays pungent spinules, breaking ventral profile. Eye small, 6.7-10.0 in head *Lepturacanthus* (p. 119)

SYSTEMATIC REVIEW

Subfamily APHANOPODINAE Gill

Aphanopodinae Gill, 1863, *Proc. Acad. nat. Sci. Philad.* 1863 : 225.

Type genus *Aphanopus* Lowe.

GENERA NOW RECOGNISED.—*Aphanopus* Lowe ; *Benthodesmus* Goode & Bean ; *Diplospinus* Maul.

DIAGNOSIS :

- A. Snout gently sloping ; orbits entering upper profile of head ; frontal ridges only slightly elevated, not contributing to a sagittal crest.
- B. A stout, conical, cartilaginous protuberance at the mandibular symphysis ; another, much smaller, at the tip of the snout.
- C. Lower hind margin of operculum markedly convex.

- D. Teeth of main series with double barbs (*Diplospinus*) or entirely without barbs (*Aphanopus*, *Benthodesmus*).
- E. Teeth on palatines in a linear series. (In *Aphanopus* only 1-2 posterior rudiments of the series present.)
- F. Lateral line descending gently from the shoulder and running in a median or sub-median position along the body, i.e. distance between lateral line and ventral profile much more than half distance between lateral line and dorsal.
- G. Spinous dorsal fin long, with 32-46 rays. Spinous and soft dorsals partly divided by a slight notch.
- H. Soft dorsal rays slightly more numerous than adjacent caudal vertebrae, or up to twice as many. Basal and interneural elements intercalated among the main series and unrelated to neural spines of vertebrae.
- I. Spinous anal $i + I$; anterior soft anal rays weak but (except in *Benthodesmus simonyi*) an external fin is continuous in some form or other from the vent nearly to the caudal; the properly developed fin may extend the whole length or be confined to the posterior 20-25 rays.
- J. Terminations of dorsal and anal fins sub-opposite.
- K. Caudal fin always present; small, normal, forked.
- L. Ventral fins always present (though reduced to internal rudiments in adult *Aphanopus*), composed each of a scale-like spine and one soft ray; in the adult fish inserted not more than 2-3 mm. before/behind anterior/posterior perpendiculars through the ends of the pectoral base.
- M. Pyloric caeca few (6-9); (not verified in *Diplospinus*).

Osteological Literature

- Günther, 1860, *Cat. Fish. B.M.* 2 : 342-344 (desc. osteology *Aphanopus*).
 Tucker, 1953, *Proc. zool. Soc. Lond.* 123 : 196-197, pls. 2-3 (figs. osteology of paired fins and anal fin of *Aphanopus* & *Benthodesmus*).
 — 1955, *Bull. Mus. Hist. nat. Belg* 31, No. 64 : 1-26 (figs. osteology of pelvic and anal fin of *Benthodesmus*).

Literature on young stages

- Maul, 1948, *Bol. Mus. Funchal* No. 3, Art 6 : 42, fig. 17 (young *Diplospinus*).
 Tucker, 1953, *op. cit.* : 187 (figs. young *Aphanopus* and *Benthodesmus*).

Genus *DIPLOSPINUS* Maul

Diplospinus Maul, 1948, *Bol. Mus. Funchal* No. 3, Art. 6 : 42.

Type species *Diplospinus multistriatus* Maul. Monotypic.

Synonyms

- Lepidopus* (non Gouan 1770) (part) Brauer, 1906.
Benthodesmus (non Goode & Bean 1882) (part) Goode & Bean, 1895; Fowler, 1938. (Refs. below.)

Diagnosis :

- (1) Body elongate, head length 6.6–6.9 in standard length 125–203 mm., body depth 18.5 in S.L.
- (2) Vent exactly in middle of S.L.
- (3) Vertebrae $34 + 24 = 58$. (Corresponds to $36 + 22 = 58$ in convention used for *Benthodesmus*.)
- (4) Spinous dorsal base twice as long as soft dorsal base.
- (5) Dorsal spines 32–33; dorsal soft rays 40.
- (6) Dorsal soft rays about twice as numerous as adjacent caudal vertebrae, so that alternate interneural elements do not articulate with neural spines.
- (7) Anal spines $i + I$, the former half the length of the latter in young stages; condition in the adult unknown; i is linear; I is dagger-shaped and V-shaped in transverse section.
- (8) Anal spines i and I articulate close together on a common basal, which is not enlarged or specially modified and which, except that it does not quite touch the corresponding haemal arch, does not show any difference in the size and relations of the interhaemal process from those which follow it. (Condition similar to *Lepidopus*.)
- (9) A complete external anal fin supported by 31 split but unbranched rays extending from the spinous anal nearly to the caudal. The soft rays and their basal elements are about twice as numerous as the adjacent caudal vertebrae, so that alternate basals have interhaemal processes which are unrelated to haemal arches.
- (10) Ventral fins inserted on perpendicular through anterior end of pectoral fin-base.
- (11) Ventral fin $I-1$; a narrow scale-like spine and an external split ray twice as long.
- (12) All principal teeth of the premaxillary and dentary series are strongly barbed (arrowhead-shaped), with thickened enamel caps.
- (13) Palatine teeth in a linear series, exposed.
- (14) Principal teeth on first gill-arch numerous.
- (15) Long intermuscular (pleurals and epipleurals) bones present, extending throughout trunk.
- (16) Melanophores distributed in parallel and narrow longitudinal rows along the body.

One species, *Diplospinus multistriatus* Maul, Atlantic and Indo-Pacific.

***Diplospinus multistriatus* Maul,**

(Text-fig. 5)

Benthodesmus atlanticus (part) Goode & Bean, 1895, *Oceanic Ichthyology*: 206 (the two small specimens mentioned, *vide* Dr. Carl L. Hubbs, *in litt.*).

Benthodesmus benjamini (part) Fowler, 1938, Proc. U.S. Nat. Mus. **85**: 45 (certain of the paratypes, *vide* Dr. Carl L. Hubbs, *in litt.*).

? *Lepidopus gracilis* Brauer, 1906, *Wiss. Ergeb. "Valdivia"* **15**: 291, Taf. XII, fig. 1 (not fig. 5 as erroneously stated in the text nor fig. 3 as stated in the legend to the plate).

Holotype in the Berlin Museum? Type locality West coast of S. Africa, St. 82, $21^{\circ} 53' S.$, $6^{\circ} 58' 6'' E.$



10 CM.
FIG. 5.—*Diplospinus multistriatus* Maul. Holotype, 203 mm. S.L.
(After Maul, 1948; altered.)

Diplospinus multistriatus Maul, 1948, *Bol. Mus. Funchal*, No. 3, Art 6: 42, fig. 17.

Holotype Museu Municipal do Funchal No. 3063. Type locality Madeira.

Paratypes Museu Municipal do Funchal Nos. 3064-5, 3067-9.

Paratype British Museum (Natural History) No. 1953.10.28.1. (Formerly 3066.)

Certain discrepancies will be noticed between the generic diagnosis given above and the otherwise accurate description and figure by Maul (1948); the corrected observations have been made on the paratype kindly presented by Mr. G. E. Maul. Each ventral fin includes a soft ray in addition to the spine; there is a single row of about a dozen teeth on each palatine ("no teeth on vomer or palatines"); there are traces of an apparent and highly probable lateral line ("no lateral line") though the present specimen is completely skinned; certain of the premaxillary fangs are represented by replacement teeth ("depressible teeth"). The number of branchiostegal rays is 7, as in other Trichiurids. The number of pyloric caeca cannot be determined owing to destruction of the thoracic region. There is a deep notch on the hinder margin of the opercular, as already observed by Maul, and this character proves to be rather important since it is confined to *Diplospinus*, the most primitive recent Trichiurid and to *Nesiarchus*, the nearest-related Gempylid (see p. 124).

Since Brauer's (1906) figure of *Lepidopus gracilis* bears the magnification 2/1 we may deduce a S.L. of 68 mm., i.e. about one-third the length of the type series of *Diplospinus multistriatus*. The head is 4.8 and the height 14.4 in the length; the eye goes 5 times in the head, and the ventral and anal spines are proportionately longer than in the types. All these differences are in the directions to be expected in a younger fish. The counts of D.65-67 and A.27 are slightly low, but not outside the probable range of variation or error. However, the eye is shown about a quarter its diameter *below* the dorsal profile of the head, the origin of the dorsal fin is a little retarded and the insertion of the ventral fins is below the posterior rather than the anterior end of the pectoral base ("Bauchflosse kurz hinter der Vertikale der Brustflosse"). These discrepancies must await a satisfactory explanation, which is likely to result in *Diplospinus gracilis* (Brauer) becoming the definitive name of the present species.

Genus *APHANOPUS* Lowe

Aphanopus Lowe, 1839, *Proc. zool. Soc. Lond.* 7: 79.

Type species *Aphanopus carbo* Lowe. Monotypic.

Synonyms

Lepidopus (non Gouan, 1770) Sim, 1898; Dons, 1921. (Refs. below).

DIAGNOSIS:

- (1) Body elongate, head length 5.68-4.92 in standard length 102-1036 mm., body depth 21.7-11.23 in same.
- (2) Tail 48-49% of standard length.
- (3) Vertebrae 42-44 + 55-56 = 98-99.
- (4) Spinous and soft dorsal bases sub-equal, differing by at most $\pm 3\%$ of S.L.
- (5) Dorsal spines 38-41; dorsal soft rays 53-56; aggregate 91-95.
- (6) Dorsal soft rays practically corresponding with adjacent caudal vertebrae.

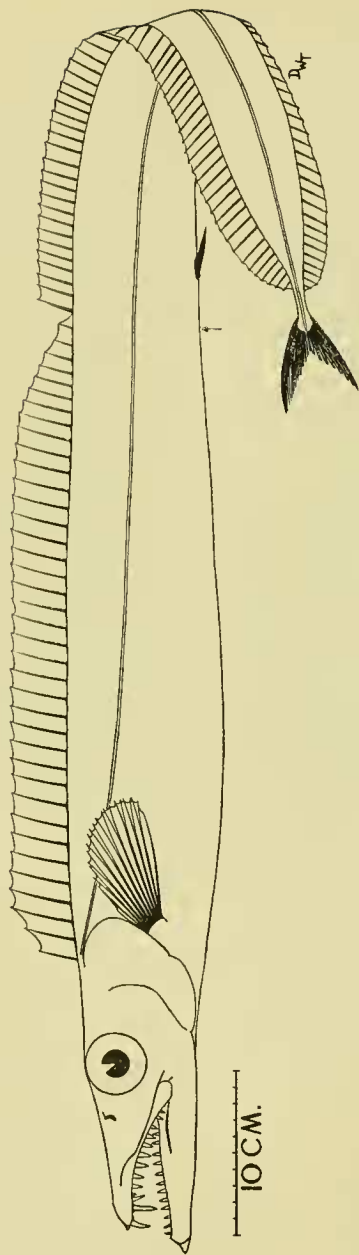


FIG. 6.—*Aphanopus carbo* Lowe. Holotype, 1,012 mm. S.L.

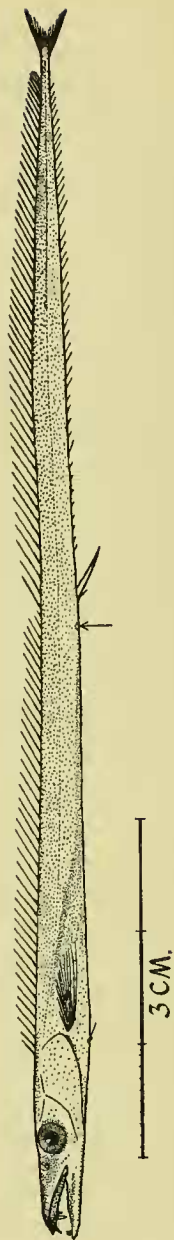


FIG. 7.—*Aphanopus carbo* Lowe, juvenile 102 mm. S.L. (Holotype of *A. acus* Maul, after Maul (1948), altered from the specimen.)

There are very few intercalated interneural elements which are unrelated to neural spines and these occur usually towards the beginning and end of the fin.

- (7) Anal spines $i + I$, the former about $1/5$ the length of the latter in the young stages but becoming disproportionately smaller in the adult, in which i becomes a minute sharp spinule, usually concealed beneath the skin and I is a stout dagger-shaped spine, triangular in cross-section.
- (8) Anal spine i articulates a short distance in advance of I . Their common basal element is a complex, greatly enlarged and strengthened to accommodate the hypertrophied I , and representing four or more fused elements. The compound interhaemal process is stout and does not touch the adjacent haemal arch. The horizontally directed component of the compound basal element occupies the length of three vertebral centra and the presumed anterior migration of the corresponding interhaemal processes leaves a space above it.
- (9) A complete external anal fin of 44-48 split but unbranched rays extending from the spinous anal nearly to the caudal. The anterior rays are very weak and the functional fin is effectively confined to the posterior 20-25 rays. The internal supporting skeleton is quite regular; there is a precise correspondence between rays, basal elements and caudal vertebrae, with a close association between interhaemal processes and haemal arches.
- (10) Ventral fins inserted immediately before perpendicular through anterior end of pectoral fin-base. External fins present only in the juvenile; fins and girdle reduced to an internal rudiment in the adult.
- (11) Ventral $I-I$ in the juvenile only; a narrow spine and an external split ray initially about 3 times as long.
- (12) Principal teeth of the premaxillary and dentary series without barbs: if these are sometimes present on the premaxillary fangs they are usually barely perceptible and confined to the hinder edges, without enamel thickening. The marginal teeth of the jaws are stout, triangular and have microscopically-serrated edges.
- (13) Palatine teeth reduced to 1-2 minute rudiments at hinder end of bone, very much concealed.
- (14) Principal teeth on first gill-arch very numerous.
- (15) Intermuscular bones (pleurals and epipleurals) weaker than in *Diplospinus*.
- (16) Pigmentation uniform, dense; fish uniform black when dead. Living fish coppery with iridescent reflexions.

One species, *Aphanopus carbo* Lowe, N. Atlantic and Gulf of Aden.

Aphanopus carbo Lowe

(Text-figs. 6 & 7).

Aphanopus carbo Lowe, 1839, *Proc. zool. Soc. Lond.* 7: 79.

Holotype B.M. (N.H.) No. 1851.11.29.6. Type locality Madeira.

Aphanopus minor Collett, 1886, *Chr. Vid.-Selsk. Forh.* 1886 No. 19: 1, fig. 1.

Holotype in Universitetets Zoologiske Museum, Oslo. Type locality Denmark Strait, E. of Greenland, 65° N., 31° W.

- Lepidopus caudatus* (non Euphrasen, 1788) Sim, 1898, *Ann. Scol. nat. Hist.* 1898 : 53.
Aphanopus schmidti Saemundsson, 1907, *Vid. Medd. naturh. Foren. Kbh.* 59 : 22, Pl. 1.
 Holotype in Náttfugurgripasafund, Reykjavik.
 Paratype B.M. (N.H.) No. 1925.7.23.4. Type locality Vestmann Is., S.W. of Iceland.
Lepidopus atlanticus (non Goode & Bean, 1895) Dons, 1921, *Tromsø Mus. Aarsh.* 43, No. 6 : 10,
 fig. 1.
 (Identification corrected to *Aphanopus schmidti* by Soot-Ryen, 1936, *Nytt. Mag. Naturv.*
 76 : 237.)
Aphanopus microphthalmus Norman, 1939, *Sci. Rep. John Murray Exped.* 7 No. 1 : 71, fig. 25.
 Holotype B.M. (N.H.) No. 1939.5.24.1322. Type locality Gulf of Aden.
Aphanopus acus Maul, 1948, *Bol. Mus. Funchal* No. 3, Art. 6 : 47, fig. 18.
 Holotype in Museu Municipal do Funchal. Type locality Madeira. (Withdrawn as
 young *A. carbo* by Maul, 1949, *Bol. Mus. Funchal*, No. 4, Art. 10 : 21.)
non Aphanopus simonyi Steindachner, 1891. (See under *Benthodesmus simonyi*.)
non Aphanopus carbo Norman, 1937. (Mediterranean records based on confusion with *Lepidopus*
caudatus, q.v.)

TABLE I.

Holotype.	Vertebrae.	Dorsal.	Anal.
<i>A. carbo</i>	42+56	XXXVIII, 56	i+I+48
<i>A. schmidti</i>	42+56	XXXVIII, 55	i+I+46
<i>A. minor</i>	44+?	XLI, ?	i+I+?
<i>A. microphthalmus</i>	44+55	XLI, 54	i+I+45

In the type of *A. minor* the tail has been broken off a short distance behind the vent and has subsequently healed over with some slight re-orientation of the soft dorsal and anal rays remaining. The remnant includes 25 caudal vertebrae, 28 soft dorsal rays, 21 anal elements.

Through the kindness of Dr. C. Støp-Bowitz (Oslo), Dr. Finnur Gudmundsson (Reykjavik) and Mr. G. E. Maul (Funchal) I have been able to examine the types of all the nominal species of *Aphanopus* and, by comparing these with a series of some thirty specimens from the type locality and as many more from the North Atlantic, to decide that they represent only one species, *A. carbo* Lowe.

A. acus Maul is a juvenile *A. carbo* and has already been adequately dealt with by Maul (1949). Meristic counts for the other nominal species are given in Table I. Ranges of vertebral counts for the long series are not yet available, but the variations now tabulated are small and well within the limits of those found in *Benthodesmus tenuis* (p. 88). Fin-ray counts on eighteen Madeiran specimens give ranges D.XXXVIII-XL, 53-55 (aggregate 91-95); A. i+I+44-48.

The validity of *A. schmidti* has been much debated, Saemundsson *pro*, Grieg and others *con*. The arguments will be dealt with in detail elsewhere; for the present it is sufficient to state that the two specimens of *A. schmidti* show no meristic differences from *A. carbo* nor any measurable differences in body proportions. The shorter dorsal rays noted by Saemundsson are merely broken; the intangible differences in the contour of the head are due to variations of desiccation and fixation, and may be observed in some of the fishes on the Funchal Market slabs; the colour described with poetic exactitude by Saemundsson is merely that of a living *A. carbo* and changes to a glossy black as a post-mortem effect.

A. minor Collett is founded on a wretched half-grown fish which had somehow contrived to survive the loss of its tail. I have compared the holotype with a Madeiran specimen of equivalent snout-vent length; there are no differences.

A. microphthalmus Norman has been checked against a similar-sized specimen from Madeira; there are no significant differences. The distension of the branchiostegal region of the holotype, adequately shown in Norman's figure, gives an exaggerated superficial impression of a deeper head and smaller eye.

Sim (1898) compares a Scottish fish with Day's description of *Lepidopus caudatus* and comments:

"Now in the specimen under notice there is not the slightest indication of such ventral scales, and what is considered a scale by the authors named takes the form of a strong, bayonet-shaped spine situated behind the vent, and is an inch long."

Sim clearly had an *Aphanopus carbo*, at that time unrecognised in the British fauna but since found to be common along the 100 fathom line, where it may sometimes be taken even by the hundred by vessels trawling for hake.

I have a monograph in preparation covering the anatomy and biology of this species.

Genus **BENTHODESMUS** Goode & Bean

Benthodesmus Goode & Bean, 1882, *Proc. U.S. Nat. Mus.* 4: 379.

Type species *Lepidopus elongatus* Clarke. Three species.

Goode & Bean erected this genus on the occasion of their describing a fish from Newfoundland which they believed to belong to Clarke's New Zealand species (the holotype of which they had not seen) and attributed characters to *Benthodesmus* additional or contrary to those in Clarke's description. In 1895 (*Oceanic Ichthyology*: 206) they erected a new species *B. atlanticus* on their Newfoundland specimen, leaving the situation that *Benthodesmus* was based on a species which they had not seen. Since the holotype of *L. elongatus* has been lost I propose to request the International Commission on Zoological Nomenclature to recognize *B. atlanticus* G. & B. as the type-species of *Benthodesmus*, which would at the same time provide a more convenient reference point and a more satisfactory indication of Goode & Bean's intentions. It is practically certain that the two nominal species will eventually be shown to be identical, but for the present I am retaining them both until New Zealand material shall be forthcoming. *B. atlanticus* is a junior synonym of *Aphanopus simonyi* Steindachner.

Synonyms

Lepidopus (non Gouan, 1770) } Numerous authors; for references see under synonymies
Aphanopus (non Lowe, 1839) } of species.

It has been suggested to me that *Benthodesmus* should be split and a new genus erected on *B. tenuis* (Günther). I am strongly opposed to any such action, being of the opinion that *B. tenuis* is the close ancestor of *B. elongatus* and that it would be improper to obscure this close relation in the way proposed.

In the event of a new genus being recognized there is some possibility of the name *Scarcina* Rafinesque (1810) being already available, with *S. argyrea* preceding *B. tenuis*. *Scarcina* has always been regarded as a junior synonym of *Lepidopus* Gouan (1770) and for reasons outlined on p. 94 I prefer to leave it so for the present.

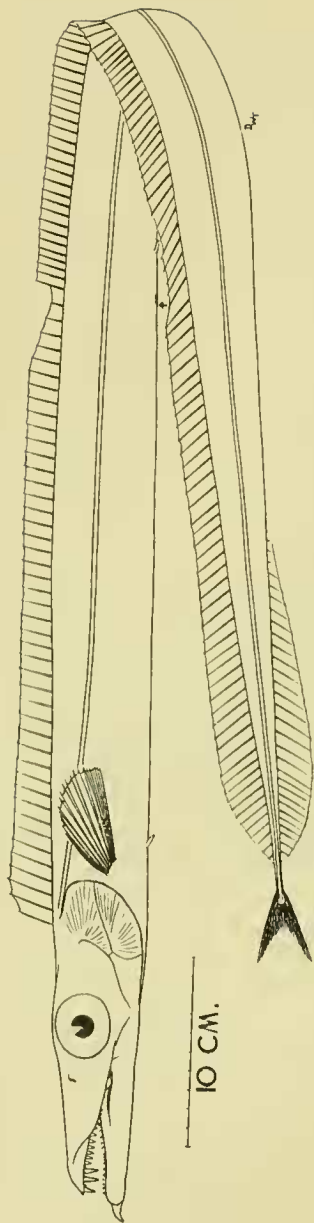


FIG. 8.—*Bentholesmus simonyi* (Steindachner). B.M. (N.H.) No. 1953. II. I. 283.
Madeira. 1,170 mm. S.L.

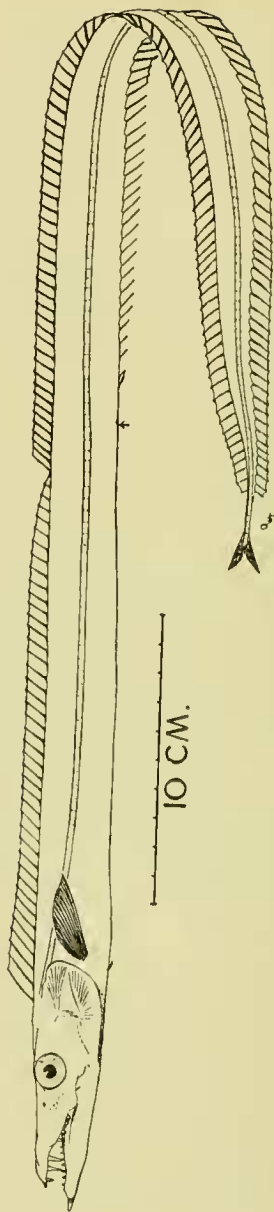


FIG. 9.—*Bentholesmus tenuis* (Günther). Holotype, 591 mm. S.L.
(Fins much reconstructed from other specimens.)

DIAGNOSIS :

- (1) Body very elongate ; head-length 7.0-7.6 in standard length 221-591 mm., body-depth 23.8-34.4 in same (*B. tenuis*) or head-length 6.8-7.8 in S.L. 910-1225 mm., body-depth 21.7-27.0 (*B. simonyi*).
- (2) Tail 55% (*B. tenuis*) or 60% (*B. simonyi*) of S.L.
- (3) Vertebrae 47-52 + 75-80 = 123-131 (*B. tenuis*) or 52-53 + 101-103 = 153-156 (*B. simonyi*).
- (4) Spinous dorsal base half as long as soft dorsal base.
- (5) Dorsal spines 39-42, dorsal soft rays 80-88 (*B. tenuis*) or dorsal spines 45-46, dorsal soft rays 102-108 (*B. simonyi*).
- (6) The number of soft dorsal rays is very close to that of the caudal vertebrae. There are very few intercalated interneural elements, which are usually toward the beginning or end of the fin.
- (7) Anal spines i + I, the former extremely minute and completely concealed in the adult. I is a delicate cardiform scute with a median keel projecting as a short point between the two rounded posterior lobes.
- (8) Anal spine i articulates a short distance in front of I. Their common basal element is a complex representing three or more fused elements. The interhaemal spine is a thin keel supported by three slender, tubular, cartilage-tipped spines (*B. tenuis*) or is completely wanting (*B. simonyi*). The horizontally-directed basal occupies the length of three vertebral centra.
- (9) A complete external anal fin of 70-76 split but unbranched rays extending from the anal spines nearly to the caudal (*B. tenuis*) or with the anterior rays wanting and the external fin posterior and reduced to about 25 rays (*B. simonyi*).
- (10) Ventral fins inserted immediately before perpendicular through anterior end of pectoral base (*B. tenuis*) or immediately behind perpendicular through posterior end of pectoral base (*B. simonyi*).
- (11) Ventral fin I, 1 (soft ray always present ?) ; a scale-like spine and an internal rudimentary soft ray shorter than the scale.
- (12) The principal teeth of the premaxillary and dentary series are without obvious barbs and without special enamel thickenings at the tips. When barbs are present, usually on the premaxillary fangs, they are barely perceptible and confined to the hinder edges. The margins of the teeth are smooth in both jaws.
- (13) Palatine teeth present in a linear series, exposed (*B. tenuis*) or concealed under mucosa (*B. simonyi*).
- (14) Principal teeth on first gill-arch few, teeth becoming progressively reduced on subsequent arches.
- (15) Intermuscular bones (pleurals and epipleurals) reduced.
- (16) Pigmentation uniform silver sprinkled black. Melanophores thinly distributed, except for denser aggregations along lateral line and along median dorsal and ventral lines. Dark spots at bases of dorsal and anal rays, preceded by large individual stellate melanophores in juveniles. Fins shaded with pastel colours.

Key to Species

Ventral fins inserted before anterior end of pectoral base.

Dorsal rays 120-133; anal elements i + I + 70-76 with external rays throughout; vertebrae 123-131; lateral line strongly developed (less than 15 times in height at pectoral)

Benthodesmus tenuis (Günther) E. Equatorial Atlantic; Gulf of Mexico; Indo-Pacific.

Ventral fins inserted behind posterior end of pectoral base.

Dorsal rays 147-155; anal elements i + I + 91-99 with external rays substantially confined to posterior third; vertebrae 153-158; lateral line less strongly developed (more than 20 times in height at pectoral)

Benthodesmus elongatus (Clarke) New Zealand; Australia; S. E. Africa (?)

Benthodesmus simonyi (Steindachner) N. Atlantic; N.E. Pacific

For full discussion and complete bibliographies see:—

Tucker, 1953, *Proc. zool. Soc. Lond.* **123**: 171-197, pls. and text-figs.

— 1955, *Bull. Mus. Hist. nat. Belg.* **31**, No 64: 1-26, 1 pl. and text figs.

Benthodesmus elongatus (Clarke)

Lepidopus caudatus (non Euphrasen, 1788) Hutton, 1872, *Fishes of New Zealand*: 13.

Lepidopus elongatus Clarke, 1879, *Trans. N.Z. Inst.* **11**: 294, pl. 14.

Holotype should be in the Dominion Museum, Wellington, N.Z., but cannot be found (*vide* Mr. J. Moreland *in litt.*). Type locality Hokitika Beach, W. coast of South Island, New Zealand.

Benthodesmus elongatus (part), Goode & Bean, 1882, *Proc. U.S. Nat. Mus.* **4**: 380.

Lepidopus (*Benthodesmus*) *elongatus* McCulloch, 1915, *Biol. Res.* "Endeavour," **3**: 152.

? *Benthodesmus atlanticus* (non Goode & Bean, 1895) Gilchrist & Von Bonde, 1924, *Rep. Fish. Mar. biol. Surv. S. Afr.* **3**, Spec. Rep. 7: 16.

? *Benthodesmus tenuis* (non Günther, 1877) J. L. B. Smith, 1949, *Sea Fishes S. Africa*: 312.

Benthodesmus simonyi (Steindachner)

(Text-fig. 8).

? *Lepidopus elongatus* Clarke, 1879, *Trans. N.Z. Inst.* **11**: 294, pl. 14. (See above.)

Benthodesmus elongatus (part), Goode & Bean, 1882, *Proc. U.S. Nat. Mus.* **4**: 381.

Aphanopus simonyi Steindachner, 1891, *S.B. Akad. Wiss. Wien* **100**: 356.

Holotype should be in the Naturhistorisches Museum, Vienna, but cannot be found (*vide* Dr. D. Kähsbauer, *in litt.*). Type locality N.E. from S. Cruz de Tenerife, Canary Is.

Benthodesmus atlanticus (part) Goode & Bean, 1895, *Oceanic Ichthyology*: 206.

Holotype U.S. Nat. Mus. Washington No. 29116. Type locality W. edge Grand Bank of Newfoundland. (The two smaller specimens mentioned are *Diplospinus multistriatus* Maul, *vide* Dr. Carl L. Hubbs *in litt.*)

Lepidopus sp. Vieira, 1895, *Ann. Sci. nat. Porto* **1**: 165, upper figs. pl. 9 and 10.

Lepidopus atlanticus, Boulenger, 1899, *Ann. Mag. nat. Hist.* (7) **3**: 180.

Lepidopus (*Benthodesmus*) *atlanticus* Saemundsson, 1921, *Skýrsla um hild islonzka náttúrufrædisfélag* **1919-20**: 37.

Benthodesmus tenuis (non Günther, 1877) (part) J. L. B. Smith, 1949, *Sea Fishes S. Africa*: 312.

(Figure copy of *B. atlanticus* from G. & B. 1895.)

Benthodesmus simonyi Maul, 1953, *Proc. zool. Soc. Lond.* **123**: 167.

***Benthodesmus tenuis* (Günther)**

(Text-fig. 9)

Lepidopus tenuis Günther, 1877, *Ann. Mag. nat. Hist.* (4) 20 : 437.*Lepidopus tenuis* Günther, 1887, "Challenger" *Reps. Zool.* 22 : 37, pl. 7, fig. B.

Holotype B.M. (N.H.) No. 1879.5.14.297. Type locality "Challenger" St. 232, 35° 11' 0" N., 139° 28' 6" E., off Inosima, Sagami Bay, Japan.

Benthodesmus tenuis, Goode & Bean, 1895, *Oceanic Ichthyology* : 206.*Benthodesmus elongatus* (non Clarke, 1879) *idem. loc. cit.* (figure only, a reversed tracing from Günther, 1887).*Lepidopus aomori* Jordan & Snyder, 1901, *J. Coll. Sci. Tokyo*, 15 : 303.

Holotype in the Aomori Museum, Japan. Type locality Aomori Bay.

Benthodesmus benjamini (part) Fowler, 1938, *Proc. U.S. Nat. Mus.* 85 : 45, fig. 16.Holotype U.S. Nat. Mus. No. 98821. Paratypes 98822-5. Type locality "Albatross" St. D.5445, off Philippine Is. (The paratype material is contaminated with *Diplospinus multistriatus* Maul, *vide* Dr. Carl L. Hubbs, *in litt.*)*Benthodesmus atlanticus* (non Goode & Bean, 1895) Longley & Hildebrand, 1941, *Cat. Fish. Tortugas* : 73.? *Lepidopus argenteus* (non Bonnaterre, 1788) Brauer, 1906, *Wiss. Ergeb. "Valdivia,"* 15 : 292, taf. 12, fig. 3. (Fig. erroneously captioned *L. gracilis*.)***Benthodesmus sp. incertae sedis****Lepidopus tenuis* (? non Günther, 1877) Franz, 1910, *Abh. Bayer. Akad.* 4 Suppl. Bd. 1 : 56. (Locality Uraga Channel, Japan.)

On the information available this specimen cannot be assigned with certainty to either *B. simonyi* or *B. tenuis*. I do not believe it to be a new species, nor do I accept Franz's opinion that it justifies regarding this genus as containing one world-wide species.

Subfamily LEPIDOPODINAE Gill

Lepidopodinae Gill, 1863, *Proc. Acad. nat. Sci. Philad.* 1863 : 227.Type genus *Lepidopus* Gouan.

GENERA NOW RECOGNISED.—*Lepidopus* Gouan ; *Evoxymetopon* (Poey) Gill ; *Eupleurogrammus* Gill ; *Assurger* Whitley ; *Tentoriceps* Whitley.

DIAGNOSIS :

(Note.—Since there is considerable diversity among the genera of Lepidopodinae and since, through inadequate descriptions and lack of study-material, certain characters have not been verified in *Evoxymetopon*, *Assurger* and *Tentoriceps*, it is necessary to introduce qualifications into the following diagnosis. For this purpose the abbreviations *Lep.*, *Evox.*, *Eupl. Ass.*, & *Tent.* have been used for the generic names).

- A. Slope of snout variable, gentle to steep ; orbits barely entering upper profile of head (*Lep.*) or more or less remote from it (all other genera) ; posterior confluence of frontal ridges elevated to support a sagittal crest at the nape which (in all genera except *Lep.*) is continued forward along the snout as a ridge-like elevation of the entire ethmofrontal region.

- B. Cartilaginous protuberance at mandibular symphysis weak or absent ; a small, soft projection at the tip of the snout.
- C. Lower hind margin of operculum markedly convex.
- D. Teeth of main series without barbs. (*Lep.*, *Eupl.*, *Evox.*, *Tent. Ass.*). (Fangs slightly barbed in *Lep.*).
- E. Teeth on palatines in a linear series. (*Lep.*, *Evox.*, *Eupl.*)
- F. Lateral line descending gently from the shoulder and running in a median or sub-median position along the body, i.e. distance between lateral line and ventral profile at anus much more than half distance between lateral line and dorsal.
- G. Spinous dorsal fin short, with 10 (*Evox.*), 9 (*Lep.*) or 3 (*Eupl.*) rays. Spinous and soft dorsals continuous, without any intervening notch.
- H. Soft dorsal rays precisely corresponding to adjacent caudal vertebrae, each basal and interneural element being related to a neural spine. (*Lep.*, *Eupl.*)
- I. Spinous anal 1 (*Lep.*, *Eupl.*) + I (all genera) ; anterior soft anal rays not penetrating skin (*Lep. Eupl. Evox. Ass.*) and external and functional fin effectively confined to posterior *ca.* 20 rays, or (in *Eupl.*) absent.
- J. Terminations of dorsal and anal fins sub-opposite (*Lep.*, *Evox. Ass.*) or anal extending slightly beyond dorsal (*Eupl.*).
- K. Caudal fin present, small, normal, forked (*Lep.*, *Evox.*, *Ass.*) or absent (*Eupl.*, *Tent.*)
- L. Ventral fins always present, composed each of a scale-like spine and sometimes at least (*Lep.*) an internal rudimentary soft ray ; insertion retarded, 1 to 5 eye-diameters behind posterior end of pectoral base.
- M. Pyloric caeca *ca.* 24 (*Lep.*, *Eupl.*)

Osteological literature

Günther, 1860, *Cat. Fish. B.M.* 2 : 345-346 (short desc. *Lepidopus*).

Starks, 1911, *Stanford Univ. Publ.* 5 : 17-26, pl. (skull of *Lepidopus*).

Tucker, 1953, *Proc. zool. Soc. Lond.* 123 : 196, pls. (paired fins and anal of *Lepidopus*).

Literature on young stages

Delsman, 1927, *Treubia* 9, Livr. 4 : 338 (*Eupleurogrammus* eggs and larvae).

Regan, 1916, *Sci. Rep. Brit. Antarct. Exped. Zool.* 1 : 144, pl. 8 (young *Lepidopus*).

Strubberg, 1918, *Rep. Dan. Oceanogr. Exped.* 2 Biol. A. 6. II : 7-16 (life-history of *Lepidopus*).

Genus **LEPIDOPUS** Gouan

Lepidopus Gouan, 1770, *Hist. Piscium* : 107, 185, Tab. 1, fig. 4.

No type species designated. Two species.

The earliest available binomen is *L. argenteus* Bonnaterre, 1788, *Encycl. Méth. Zool. Ich.* : 58, pl. 87, fig. 364. Bonnaterre's figure is an accurate reversed tracing of Gouan's caricature, but *L. argenteus* is a synonym, and almost certainly a junior synonym, of *Trichiurus caudatus* Euphrasen, 1788, *Handl. K. Vetensk. Akad. Stockholm* 9 : 52, tab. 9, fig. 2.

Euphrasen's paper appears in the section of the *Handl. K. Vetensk. Akad.* for Jan., Feb., Mar., 1788, the sections having been issued quarterly with separate title-pages though paginated in annual volumes.

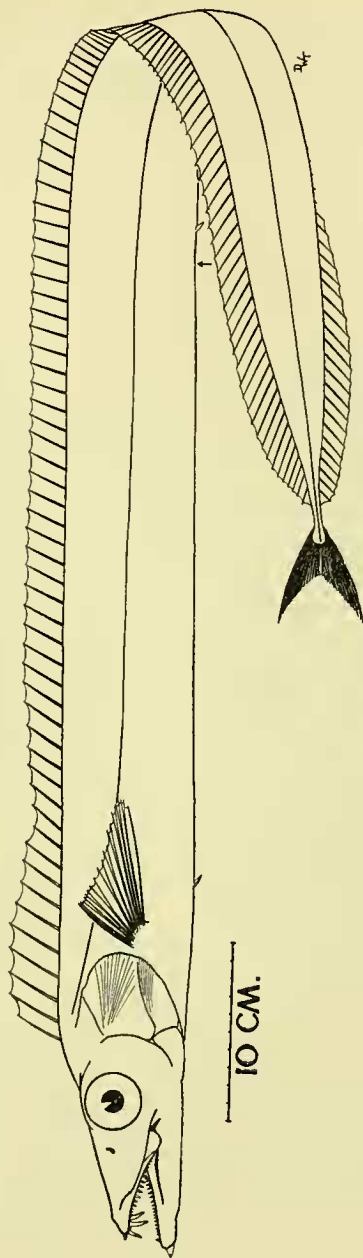


FIG. 10.—*Lepidopus caudatus* (Euphrasen). B.M. (N.H.) No. 1860.4.22.69.
Lisbon, 1,145 mm. S.L.

In their third and final attempt to establish the dates of publication of the parts of the *Encyclopédie Méthodique*, Sherborn & Woodward, 1906, *Ann. Mag. nat. Hist.* (7) 17: 578 could establish nothing more precise concerning Bonnaterre's *Ichthyologie* than that it appeared in livraison 28 of the *Encyclopédie* issued sometime in 1788. Since, however, the livraisons were issued in order and the date April, 1788, can be assigned to livraison 26 the balance of probability favours Euphrasen's publication as the earlier one. Following the nomenclatorial orgy at the earlier part of the nineteenth century Euphrasen's name has been the more generally used.

Synonyms

(The full references to the following are given in the synonymy of *Lepidopus caudatus*, p. 93).

Trichiurus (non Linnaeus, 1758) Vandelli, 1797; Holten, 1802.

Vandellius Shaw, 1803. Type species *Vandellius lusitanicus* Shaw (ex Vandelli MS.).

Ziphotheca Montagu, 1809. Type species *Ziphotheca tetradens* Montagu.

Xiphotheca
Xiphotheca } variant spellings by later authors.

(NON *Zyphotheca* Swainson, 1839.)

? *Scarcina* Rafinesque, 1810. Type species *Scarcina argyrea* Rafinesque.

DIAGNOSIS (based on *L. caudatus*):

- (1) Body elongate, head 5·8–7·1 in standard length, greatest depth 10·8–18·3 in standard length (57–1224 mm.)
- (2) Upper profile of head oblique-concave, rising at about 25° to the longitudinal axis from above the snout tip to behind the orbits and thereafter more steeply to the dorsal origin; straight before the orbits. Ethmo-frontal region not elevated, posterior confluence of frontal crests strongly elevated. Interorbital slightly concave with very low longitudinal ridges.
- (3) Orbit large, 4·9–5·6 in head, touching dorsal profile.
- (4) Dorsal IX, 90–96; aggregate 99–105. The first dorsal spine is not enlarged, save as a transient larval character.
- (5) Anal spines i + I; I is a small triangular scale 2 or more in the pupil.
- (6) Anal fin elements i + I + 61–64; anterior rays reduced or absent, posterior 20–24 rays supporting fin.
- (7) Posterior end of operculum a broadly rounded point, barely reaching to anterior end of pectoral base.
- (8) Ventral fins present, scale-like, inserted an eye-diameter behind the posterior end of the pectoral base.
- (9) Caudal fin present.
- (10) Vertebrae 41 + 70–73 = 111–113.

Key to Species

Dorsal rays 99–105; external anal fin reaching only half way to vent. D.IX, 90–96; anal elements i + I + 61–64 (the last 20–24 only being external fin-supporting rays); vertebrae 41 + 70–73.

Head 5·8–7·1 in standard length 57–1224 mm.; depth 14·4 (–18·3)–10·8 in same; eye 4·9–5·6 in head.

Ventral fins I-1 (I is an internal rudiment only 1 mm. long in the adult fish), inserted an eye-diameter behind the pectoral base; anal spine I is a small triangular scale, less than the pupil. Pyloric caeca 20+. Colour uniform silvery.

Lepidopus caudatus (Euphrasen).

Atlantic, Mediterranean, S. Indian Ocean, S. Pacific.

Dorsal rays 82-87; external anal fin reaching to vent.

Analysis of dorsal spines and rays not known; external anal $i + I + 45-58$; vertebrae unknown.

For body proportions see discussion.

Ventral fins I-1 inserted on or immediately behind perpendicular through posterior end of pectoral base; anal spine I is long, keeled, about three-quarters the diameter of the eye. Pyloric caeca unknown.

This compromise description, based on Jordan & Evermann (1898) and Brauer (1906), may include two species or one, of uncertain systematic position, and without valid name(s). The discussion on pp. 95-7 explains this unhappy situation.

"*Lepidopus Xantusi*" Goode & Bean
California, Gulf of Guinea.

Lepidopus caudatus (Euphrasen)

(Text-fig. 10).

Trichiurus caudatus Euphrasen, 1788, *Handl. K. Vetensk. Akad. Stockholm*, 9 : 52, tab. 9, fig. 2.

Holotype in Alströmrika Museum? Type locality Cape of Good Hope.

Lepidopus caudatus, White, 1851, *List Brit. Anim. B.M.* 8 Fish : 32.

Lepidopus argenteus Bonnaterre, 1788, *Encycl. Méth. Zool. Ichth.* : 58, pl. 87, fig. 364.

(Ex Gouan, 1770.) (See note under *Lepidopus* p. 90.) There is a partial confusion with *Lepturus argenteus* Linnaeus, 1754 (= *Trichiurus*) in the text.

Trichiurus ensiformis Vandelli, 1797, *Mém. Acad. Sci. Lisboa*, 1 : 70 (*nomen nudum*).

(*id. fide* Nobre, 1935, *Faun. Mar. Portugal*, 1 Vert. : 260).

Lepidopus ensiformis, Swainson, 1839, *Larv. Cab. Cycl. Fish.* 2 : 254.

Lepidopus gouanianus Lacépède, 1800, *Hist. nat. Poissons* 2 : 519.

(Ex Gouan, 1770.)

Lepidopus gouani Bloch & Schneider, 1801, *Syst. Ichth.* 1 : 239, tab. 53, lower fig.

(Ex Gouan, 1770.)

Trichiurus gladius Holten, 1802, *Skr. nat.-Selsk. Kbh.* 5, Heft 2 : 23, Tab. 2, fig. 1.

Holotype in Copenhagen Museum? Type locality Portugal. (I am doubtful whether this name should not perhaps be attributed to Abildgaard.)

Vandellius lusitanicus Shaw, 1803, *Gen. Zool. Pisc.* 4 (2) : 199.

(Ex Vandelli MS.)

Lepidopus lusitanicus, Leach, 1815, *Zool. Misc.* 2 : 7, pl. 62.

Ziphotheca tetradens Montagu, 1809, *Mem. Werner. N. H. Soc.* 1 : 81.

Holotype B.M. (N.H.) No. 1955.6.2.1. Type locality English Coast.

Lepidopus tetradens, Fleming, 1828, *Hist. Brit. Anim.* : 205.

Lepidopus peronii Risso, 1810, *Ichth. Nice* : 148, Pl. 5, fig. 18.

Type locality Nice.

? *Scarcina argyrea* Rafinesque, 1810, *Car. n. gen.* : 20, pl. 7, fig. 1.

Type locality Sicily.

? *Lepidopus argyreus*, Cuvier, 1829, *Règne Animal* 2 Ed. 2 : 217.

Lepidopus gouaniensis Risso, 1826, *Hist. Nat.* 3 : 290.

(Ex Gouan, 1770.)

Lepidopus lex Phillips, 1932, *N.Z. Journ. Tech.* 13 : 232.

Syntypes in Dominion Museum, Wellington? Type locality New Zealand. (*Lepidopus caudatus* of other New Zealand authors; non *L. caudatus* Hutton, 1872, *Fishes N.Z.* : 13, who had *Benthodesmus elongatus* (Clarke).)

Aphanopus carbo (non Lowe, 1839) (part) Norman, 1937, in Fraser and Norman, *Giant Fishes, Whales and Dolphins* : 140.

non *Lepidopus caudatus* Sim, 1898, *Ann. Scot. nat. Hist.* 1898 : 53 (mis-identification of *Aphanopus carbo* Lowe).

non *Lepidopus elongatus* Clarke (1879); McCulloch (1915) (see *Benthodesmus elongatus*).

non Lepidopus sp. Vieira (1895).
non Lepidopus atlanticus, Boulenger (1899); Saemundsson (1921) } (See *B. simonyi*).
non Lepidopus aomori Jordan & Snyder (1901) }
non Lepidopus argenteus Brauer (1906) } (See *Benthodesmus tenuis*.)

The nineteenth century synonyms listed above have been pretty generally accepted; I have verified each of them, so far as the accompanying data allow, and do not propose to attempt any individual justifications in the present short summary. Only *Scarcina argyrea* Rafinesque (1810) calls for any urgent comment. This name has been copied as a synonym of *Lepidopus caudatus* by many authors, but the figure shows a head and body-form very reminiscent of a *Benthodesmus* and the stated dorsal count (125) falls within the range of *B. tenuis* (Günther) and is well above the D.99-105 found in *L. caudatus*. The anal count of 15 and the anal fin as figured are, however, quite like *Lepidopus*. Since *Benthodesmus* is not yet known from the Mediterranean it is better to regard Rafinesque's as an inaccurate impression of *L. caudatus* for the present. Should *B. tenuis* be found in the Mediterranean *Scarcina argyrea* will have to be considered as a senior synonym and it may be thought desirable to invoke the Plenary Powers of the International Commission in order to suppress it. *Scarcina* would also precede *Benthodesmus*.

Norman (1937) mentions *Aphanopus carbo* as being "not uncommon in the fish markets of the Mediterranean". In an intensive study of *A. carbo* I have so far found nothing to confirm this statement, which may have been made through some confusion of vernacular names. Thus the Portuguese and Madeiran fishermen call *A. carbo* "O Peixe Espada preta" and *L. caudatus* "O Peixe Espada branca" (Black and White Scabbard-fishes, respectively), and in both cases "Peixe-espada" or "Espada" for short.

Phillipps (1932):

"examined several frost-fish and found consistent, though slight, differences between the New Zealand and Atlantic species . . . 3 to 4 less rays in the dorsal fin, 3 or 4 less anal rays, and a total length of head under 7 in total length. Goode and Bean's figure shows a species with a longer head, and no dorsal spines of greater length than the diameter of the eye. In the New Zealand fish the height of the sixth dorsal ray is 5 in the head while in the European fish the height of this ray is about 8 or more in the head. The tail of the New Zealand frost-fish is not so deeply emarginate and agrees more nearly with that of *Evoxymetopon taeniatus* figured by Goode and Bean."

Phillipps is presumably referring to Goode & Bean (1895) *Oceanic Ichthyology*, Plate 58, figs. 213 and 214. I have dealt in some detail with the identification of fig. 213 under "*Lepidopus Xantusi*" (p. 96 *q.v.*) and so for the present it is sufficient to state that this figure is a poorish figure of an apparent young *Lepidopus caudatus* and not a very satisfactory basis for any comparison. The head in Goode & Bean's figure goes about 7.5 in the total length and is therefore shorter, not longer as stated by Phillipps, and typical of a juvenile as opposed both to post-larval and adult specimens. The dorsal spines and tail of Goode & Bean's figure are useless as evidence.

Comparing specimens of as nearly equivalent size as possible I obtain the following results :

TABLE II.

	<i>Lepidopus caudatus.</i>	
	Lisbon.	New Zealand.
	No. 1860.4.22.69.	No. 1903.4.30.29.
Standard length	1142 mm.	1224 mm.
Head in S.L.	7.13	6.65
Depth in S.L.	15.43	10.83
Eye in head length	4.92	5.41
6th dorsal spine in H.L. . . .	5.33	5.25
Dorsal count	D.IX, 96	D.IX, 90
Anal count	A.i+I+40+24	A.i+I+41+20

Apart from the greater depth of the body, in part attributable to age, the New Zealand specimen appears to show only the trivial differences to be expected in material of a widely ranging pelagic fish taken from the extreme limits of its distribution. The variations are no greater than those found in Trichiurid species, of which I have been able to study substantial samples and accordingly I am not at present prepared to accept *Lepidopus lex* Phillipps as distinct from *L. caudatus* (Euphrasen).

If, however, the separation of *L. lex* should be considered justified an interesting situation arises. Since the type locality of *L. caudatus* is the Cape of Good Hope it is likely that the antipodal forms will be conspecific but distinct from those of the E. Atlantic and Mediterranean. *L. lex* would therefore still fall as a synonym of *L. caudatus*, but *L. argentens* Bonnaterre (1788) would have to be revived. A further complication would arise in that the *Lepidopus caudatus* figured by Goode & Bean (1895) and uncertainly associated with the holotype of *L. xantusi* G. & B. appears to have the lower dorsal count of *L. lex* also. (Further discussion under *L. xantusi*, p. 96).

"*Lepidopus xantusi*" Goode & Bean

Lepidopus caudatus (? non Euphrasen) Jordan & Gilbert, 1882, *Proc. U.S. Nat. Mus.* 5 : 358.

Lepidopus caudatus (? non Euphrasen) (part) Goode & Bean, 1895, *Oceanic Ichth.* : 203, (?) fig. 213.

Lepidopus caudatus (? non Euphrasen) Jordan & Evermann, 1896, *Bull. U.S. Nat. Mus.* No. 47 : 886.

Lepidopus caudatus (? non Euphrasen) Jordan & Evermann, 1900, *Bull. U.S. Nat. Mus.* No. 47, (?) pl. 136, fig. 373.

Lepidopus xantusi Goode & Bean, 1895, *Oceanic Ichth.* : 519.

Holotype U.S. Nat. Mus. No. 10115. Type locality Cape San Lucas, California.

Lepidopus xantusi Jordan & Evermann, 1898, *Bull. U.S. Nat. Mus.* No. 47 : 2843.

Lepidopus xantusi Jordan & McGregor, 1899, *Rep. U.S. Fish. Comm.* 24 (1898) : 276.

Lepidopus xantusi ? Brauer, 1906, *Wiss. Ergeb.* "Valdivia," 15 : 291, taf. 12, fig. 2.

The circumstances surrounding the publication of this species are so wretchedly unsatisfactory that a new name will have to be found for it by the first worker able to re-describe it from material.

Jordan & Gilbert (1882) list U.S. Nat. Mus. No. 10115, "One specimen, 10 inches long, in poor condition" as "*Lepidopus caudatus* (Euphr.) White" in a catalogue of

the fishes collected by one John Xantus at Cape San Lucas, California. (The reader should beware confusion with the Joanne Xantus whose Asian collections were published by Karoli.)

Goode & Bean (1895 : 203) give a description of *L. caudatus* evidently taken from Günther whose name is, in fact, cited. They then refer to a Xantus specimen and on p. 13 of the accompanying *Atlas* of plates they state that their figure of *L. caudatus* is drawn from U.S. Nat. Mus. No. 10115, collected by John Xantus, off Cape St. Lucas. On p. 519 of an appendix to the main text, however, this specimen becomes the type of a new species with the brief remark :

“ The specific identity of the fish found at St. Lucas by Xantus is so doubtful that we prefer to refer to it as *L. Xantusi*, new specific name.”

We are left to consider whether Article 21 of the *International Rules* has been complied with ; on the text alone *L. Xantusi* is a *nomen nudum* and may be saved only by the figure, to be discussed presently.

Jordan & Evermann (1896) give the Günther-Goode & Bean version of *L. caudatus* (with an addition of pure Günther) and conclude by assigning the Xantus specimen once again to *L. caudatus*. Jordan & Evermann (1898) have realized that *L. Xantusi* exists and that somebody should give a description of it, but instead of describing it from the holotype (10 inches S.L.) they elect to do so from a second Cape San Lucas specimen which is more portable (5½ inches S.L.). Jordan & Evermann (1900), however, continue to publish Goode & Bean's original figure of the supposed holotype of *L. Xantusi* still with the legend “ *L. caudatus* ”.

The figure published by Goode & Bean has no scale of magnification nor do these authors anywhere state the size of their specimen ; for that we have to return to Jordan & Gilbert (1882). Moreover the drawing has the tail nicely curved, an effective obstruction to accurate measurement of standard length. I derive the following data :

Radial Formula D.99 ; A. (external) 18,	(mm.)
Measured distance from snout tip to D.30	125
Estimated distance from D.30 to D.70 (taken as 4 × mean distance)	
D.20-30 and D.70-80)	120
Measured distance from D.70 to tip caudal peduncle	79
Whence Estimated standard length of figure	324

Head in S.L. 7.3 ; depth in S.L. 18.6 ; eye in head 5.7 ; snout in head 3.1

Insertion of ventral fins an eye-diameter behind pectoral base.

But these are the counts found in *Lepidopus caudatus* (Euphrasen) and these the body-proportions of a young fish of that species ! We are therefore driven to one of two conclusions :

Either (1) The figure is drawn, by some accident, from a specimen other than the holotype of *L. Xantusi* Goode & Bean. In this case the name *L. xantusi* Goode & Bean falls as a synonym of *L. caudatus* (Euphrasen) ; whatever the

identity of the *Xantus specimen*, no "definition or description" have been published, nor any figure of that specimen. Further, although Jordan & Evermann (1898) and Brauer (1906) give adequate characterisations of a species distinct from *L. caudatus* (Euphrasen) under the name *L. Xantusi*, their name must fall as a homonym of *L. Xantusi* Goode & Bean under Article 35 of the Rules.

or (2) The figure is drawn from U.S. Nat. Mus. No. 10115 as stated and represents the holotype of *L. Xantusi* G. & B. In this case *L. Xantusi* again falls as a synonym of *L. caudatus* (Euphrasen) and *L. Xantusi* Jordan & Evermann and *L. Xantusi* Brauer again fall, as homonyms, under Article 35 of the Rules.

The description by Jordan & Evermann (1898) is repeated *verbatim* by Jordan & McGregor (1899). I give the complete text:

"Head $4 \frac{2}{3}$ in body; depth 3 in head; eye $5 \frac{1}{3}$; interorbital space 8 $\frac{1}{3}$; snout 3; maxillary $3 \frac{1}{3}$. D.82; A.II, 45. Jaws with long, sharp teeth in front, followed by single rows of weaker ones, arranged in groups of twos and threes. Height of dorsal, near middle of body, 3 in head. Anal preceded by 2 scutes, the first minute, the second wide, strongly keeled, its length $\frac{3}{4}$ the diameter of eye. Pectorals of 12 rays, length 2 in head. Each ventral consists of a flat keeled spine followed by a minute ray. This species is known from 2 small mutilated specimens, both found on the beach near San Jose del Cabo, Cape San Lucas. The type was taken by John Xantus, about 1860, and recorded by Jordan & Gilbert as *Lepidopus caudatus*. The second, of about the same size ($5\frac{1}{2}$ inches), was taken by Richard C. McGregor, in 1897. From the latter the above account was taken. The species differs from *Lepidopus caudatus* in the much shorter dorsal and longer anal. D.103; A. 24. (Named for John Xantus de Vesey)."

Additional data, not provided above, are now needed to decide whether this fish may remain in *Lepidopus* when a new name shall be assigned to it; at present it could as well belong to an *Aphanopodine* genus as to *Lepidopus* and may even represent a new genus connecting *Diplospinus* and *Lepidopus*.

Brauer (1906) gives a description and figure of "*L. Xantusi*" from the Gulf of Guinea and discusses the difficulties of his identification in face of the above description. The size is not given, but since a scale of magnification is given for some of the other figures on the same plate (though not for this) we may assume XI, hence 151 mm. S.L. Brauer gives D.87; A.58; head 5.5 in S.L.; depth 15 in S.L.; eye $5\frac{1}{2}$ in head. It would help if Jordan & Evermann meant "Head $4 \frac{2}{3}$ in body (less head)", i.e. $5 \frac{2}{3}$ in S.L., which would also give depth 17 in S.L. instead of 14. The discrepancies between the fin-ray counts are obvious. The figure shows a head about intermediate in form between *Aphanopus* and *Lepidopus* and ventrals inserted barely behind the pectorals, not quite so far retarded as in *L. caudatus*. Clearly we should know more about these specimens.

Genus *EVOXYMETOPON* (Poey) Gill.

Evoxymetopon Poey, in Gill, 1863, *Proc. Acad. nat. Sci. Philad.* 1863: 227.

Type species *Evoxymetopon taeniatus* (Poey) Gill. Monotypic, or two species.

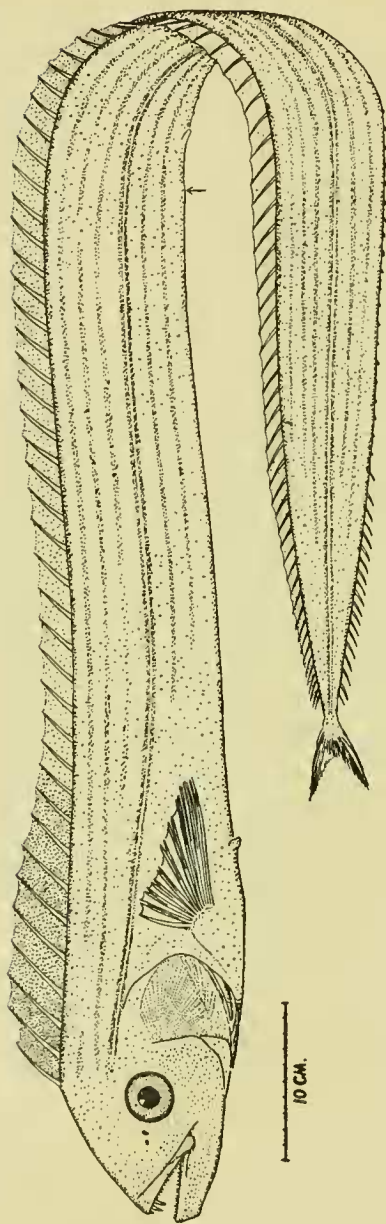


FIG. 11.—*Euxymetopon taeniatus* (Poey) Gill. Holotype, 1,410 mm. T. L.
(Re-drawn, from Goode & Bean; scale added.)

DIAGNOSIS :

- (1) Body elongate, head 8 in total length, greatest depth 12-13 in total length. (1410-1980 mm.)
- (2) Upper profile of head convex, a steep continuous curve from the tip of the snout to the origin of the dorsal set at about 45° to the longitudinal axis; slightly convex before the orbits. Structure of cranial crest unknown, but evidently the ethmo-frontal region and the posterior confluence of the frontal crests are both elevated. Interorbital strongly convex.
- (3) Orbit large, 5-6 in head length, an eye-diameter \pm below the dorsal profile.
- (4) Dorsal X, 77; aggregate 87. The first dorsal spine may be enlarged, nearly as long as the head.
- (5) Anal spines i(?) + I; I is a keeled scale.
- (6) Analysis of anal fin elements unknown; the anterior rays, if present, appear barely to penetrate the skin while the posterior *ca.* 20 only are fin-supporting rays.
- (7) Posterior end of operculum a broadly rounded point falling less than a pectoral base short of the pectoral base.
- (8) Ventral fins present, scale-like, inserted an eye-diameter behind the posterior end of the pectoral base.
- (9) Caudal fin present.
- (10) Analysis of vertebrae unknown.

Evoxymetopon taeniatus (Poey) Gill

(Text-figs. 11 12 13)

Evoxymetopon taeniatus Poey, in Gill, 1863, *Proc. Acad. nat. Sci. Philad.* 1863 : 228.

Holotype U.S. Nat. Mus. No. 5735. Type locality Havana, Cuba.

Evoxymetopon taeniatus Poey, 1873, *Ann. Soc. Esp. Hist. nat. Madrid*, 2 : 77, pl. 5.*Evoxymetopon taeniatus* Goode & Bean, 1895, *Oceanic Ichthyology* : 204, fig. 214.? *Evoxymetopon poeyi* Günther, 1887, " *Challenger* " *Reps. Zool.* 22 : 39, pl. 43.

Disposal of holotype unknown. Type locality Mauritius.

(For *Evoxymetopon anzac* Alexander see under *Assurger*, p. 106.)

It is curious that Poey should have waited ten years before publishing his own description and first figure of this species. Goode & Bean give a new figure of the holotype but their description appears to be derived entirely from Gill and their only original contribution is to confuse Gill's percentages with millimetres and so to mislead others into believing that the specimen is only one-fourteenth of its true length.

Evoxymetopon poeyi, described " with great hesitation . . . as a second species " was based on a dry skin which Günther received from Mauritius while his " *Challenger* " Report was passing through the press. The ownership and ultimate destination of this specimen are unstated and unknown; there is certainly no evidence that it ever became part of the permanent collections of the British Museum (Natural History).

The salient characters of these two fishes, as compiled from the literature, are given in Table III, from which it is apparent that there is a large measure of agreement between them and that the differences are readily attributable to age or sex, damage or misinterpretation.

The elongated first dorsal spine noted in *E. poeyi* is a striking feature and apparently unique among adult Trichiurids; though it occurs in the young stages of *Lepidopus* it does so only as a transitory condition and one to be regarded, like the disproportionate ventral fins, as a flotation device, paralleled among many other young Teleosts and without phyletic significance. *E. taeniatus* and *E. poeyi* may be female and male of

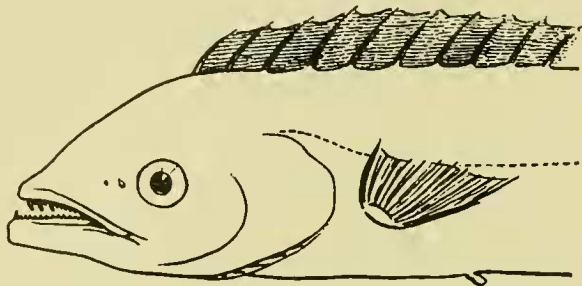


FIG. 12.—*Evoxymetopon taeniatus* (Poey) Gill. Head of holotype, 1,410 mm. T.L. (from Poey).

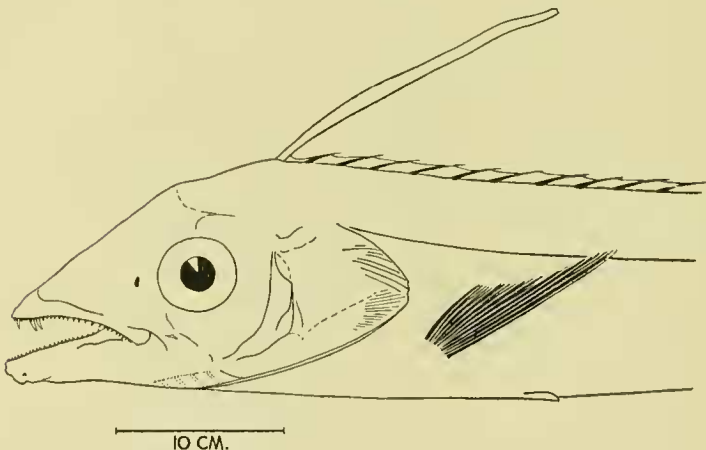


FIG. 13.—*Evoxymetopon poeyi* Günther. Head of holotype, 1,980 mm. S.L. (re-drawn, after Günther; scale added).

one species (c.f. *Anthias*) or there may be growth changes between 1410 and 1981 mm. length, but a quite likely explanation is that the Cuban specimen may be damaged.

The homologies of the parts in other Trichiuridae studied indicate that the post-anal structures probably comprise the usual minute spinule (so far overlooked) and a

broad scale having a median depression or keel, the pair articulating with a simple or compound basal structure. Experience with damaged *Benthodesmus* material provides a ready explanation of how the discrepancies between the accounts of Gill, Poey and Günther may have arisen.

TABLE III.

	<i>Evoxymetopon taeniatus</i> (Poey) Gill.	<i>Evoxy metopon poeyi</i> Günther.
Total length . . .	1410 mm. (Poey)	78 inches (Günther) (ca. 1981 mm.)
Greatest height/T.L. . .	1/12 (Gill)	1/13 or less (Günther)
Head length/T.L. . .	1/8 (Gill)	1/8 (Günther)
Orbit/head . . .	1/6 (Gill)	1/5 (Günther)
Dorsal rays . . .	X, 77 (D.87. "The first ten dorsal spines are undivided; the rest split."—Gill.)	D.93 (Günther)
First dorsal spine . . .	No special mention in either Gill or Poey.	" . . . large, compressed, sword-shaped . . . not much shorter than the head . . . loosely articulated with the interneural " (Günther).
Anal rays . . .	A.19. "Anal spines numerous . . . mostly minute, free, pos- teriorly enlarged, connected by the membrane and forming a fin " (Gill). Upwards of 30 small spines figured anterior to the fin proper (Goode & Bean).	x + 20 (Günther) " . . . anal fin, the rays of which begin to be free in the posterior third of its extent " (Günther).
Post-anal scute . . .	"Dagger-shaped spine behind the anus " (Gill). "A corta distancia posterior del ano la pequeña escama trian- gular y movediza senelada por Cuvier en el Lepidopo" (Poey).	(Gill's spine) "is entirely cover- ed by skin, and consists of coalesced and flattened inter- haemal elements . . . a single oval scale slightly bent along the middle occupies the space at a short distance behind the vent " (Günther).
Ventral insertions . . .	About 1½ times the head length from the tip of the snout (17½ : 12—Gill).	About 1¼ times the head length from the tip of the snout (313 : 240—Günther's fig.).
Vent . . .	"Submedian " (Gill).	"Somewhat in advance of the middle of the total length " (Günther).
Coloration . . .	"Silvery, with about six narrow reddish bands most distinct behind, the first on the ridge of the back and the fifth along the lateral line " (Gill).	"Uniform silvery " (Günther).

The upper profile of the head in *E. poeyi* does not rise quite as steeply as in *E. taeniatus* (a condition apparently related to allometric growth of the jaws) and the whole head is less plump in appearance. Here, again, one recalls post-mortem changes witnessed in freshly caught *Aphanopus carbo* off Madeira, as well as the fact that *E. poeyi* is figured from a dry skin, and accordingly one discounts the differences.

Gill (1863) alludes to a Scottish specimen referred by Hoy to *Trichiurus lepturus* (there were actually two) and suggests that it may have been an *Evoxymetopon*. *Evoxymetopon* has never been taken in British waters and Hoy's specimens must be referred probably to *Trachypterus* or *Regalecus*.

Although the osteology of *Evoxymetopon* is unknown it is certain that the ethmo-frontal region of the skull, together with the posterior confluence of the frontal ridges must be elevated in much the same way as in *Eupleurogrammus*, but to a greater extent. This character apart *Evoxymetopon* stands fairly close to *Lepidopus* and is very near to the ancestor of *Eupleurogrammus*.

Genus *EUPLEUROGRAMMUS* Gill

Eupleurogrammus Gill, 1863, *Proc. Acad. nat. Sci. Philad.* 1863 : 226.

Type-species *Trichiurus muticus* Gray. Two species.

Trichiurus (part). Many authors, from Linnaeus (1758), whose type material of *Trichiurus lepturus* was contaminated with this genus. (See note under *Trichiurus*, p. 114).

Enchelyopus (part) Bleeker, 1872, *Ned. Tijdschr. Dierk.* 4 (1872) : 131.

DIAGNOSIS :

- (1) Body very elongate, head 9.4–11.2 in total length, greatest depth (in region of vent) 14.7–17.6 in total length (273–617 mm.)
- (2) Upper profile of head oblique to very slightly concave, rising from the tip of the snout in a line set at about 30° to the longitudinal axis and quite straight before the orbits. Cranial crest formed by elevation of ethmo-frontal region and of the posterior confluence of the frontal crests. Inter-orbital strongly convex.
- (3) Orbit small, 6.0–7.8 in head, $\frac{1}{2}$ to $\frac{1}{4}$ an eye-diameter below the dorsal profile.
- (4) Dorsal III, 123–131 or III, 143–147; aggregate 126–150. First dorsal spine not enlarged.
- (5) Anal spines $\dot{i} + I$; I is a small triangular scale.
- (6) Anal fin elements $\dot{i} + I + 114$ – 121 ; the external fin is entirely suppressed and the ventral profile smooth.
- (7) Posterior end of operculum a rounded point, overlying middle of pectoral fin and base.
- (8) Ventral fins present, scale-like, inserted about 5 eye-diameters behind the posterior end of the pectoral base.
- (9) Caudal fin absent.
- (10) Vertebrae 32 – $35 + 125$ – $128 = 157$ – 162 or $41 + 150$ – $151 = 191$ – 192 .

Key to *Species*.

Anal origin below D.33-37

D.III, 123-131; Vertebrae 32-35 + 125-128 = 157-162

Eupleurogrammus intermedius (Gray)
Indo-Pacific.

Anal origin below D.41-42

D.III, 143-147; Vertebrae 41 + 150-151 = 191-192

Eupleurogrammus muticus (Gray)
Indo-Pacific.*Eupleurogrammus intermedius* (Gray)

(Text-fig. 14)

Trichiurus intermedius Gray, 1831, *Zoo. Misc.* 1 : 10.

Syn-types (3) B.M. (N.H.) No. 1869.3.19.76. Type locality Chusan.

Trichiurus muticus (non Gray) numerous authors. (Incorrect deductions from Gray's original description or from following Günther, 1860, *Cat. Fish. B.M.* 2 : 348; no new material involved.)*Trichiurus medius* Griffith, 1834, Cuvier's *Anim. Kingd.* Pisces : 349 (nom. emend. from Gray).*Trichiurus savala* (non Cuvier, 1829) (part) Bleeker, 1852, *Verh. Bat. Gen.* 24 Makr. : 41. (Determination altered to *T. glossodon* by Bleeker, see below.)*Trichiurus glossodon* Bleeker, 1860, *Acta. Soc. Indo-Neerl.* 8. Dertiende Bijdr. Visch. Borneo : 38.

? Syn-types, in Leiden Museum and in British Museum (Natural History), B.M. (N.H.)

No. 1880.4.21.119. Type localities Java, Sumatra, Singapore, Bintang, Borneo.

Trichiurus glossodon De Beaufort, 1951, *Fish. Indo-Austr. Archip.* 9 : 190. (Bleeker's material re-examined.)*Trichiurus glossodon* Delsman, 1927, *Treubia* 9, livr. 4 : 338.

Günther (1860) regarded *Trichiurus intermedius* Gray as a synonym of *T. muticus* Gray. This error of judgment not only led almost every subsequent worker astray; it also had the practical result that Gray's types in the British Museum (Natural History) were not properly recognized and segregated. There is, however, one jar, Reg. No. 1860.19.76, containing three specimens and bearing (among others) a label in an old hand stating :

" *Trichiurus intermedius*
Chusan. E. I. Company."

A second label, written in ink on paint, changes the identification to *Trichiurus muticus* and a third, overlying both, adds the Register number and changes the source to "Dr. Cantor's Colln." It is not possible to reconcile this material with any entry in Günther (1860), but there seems no doubt that these are the syntypes of *T. intermedius* Gray, both from their apparent history and their study.

Accordingly *T. intermedius* provides one of the major nomenclatorial surprises of the present paper. Even as a synonym of *T. muticus* it would, of course, have passed over into *Eupleurogrammus*, but, as shown in the key and in Table IV, *T. intermedius* proves to be a perfectly valid species. Further, on the evidence of a probable syntype of *T. glossodon* Bleeker and on De Beaufort's (1951) re-description of other presumed type-material of *T. glossodon* at Leiden, it becomes apparent that the more widely-recognized *T. glossodon* is only a synonym of *T. intermedius*, as

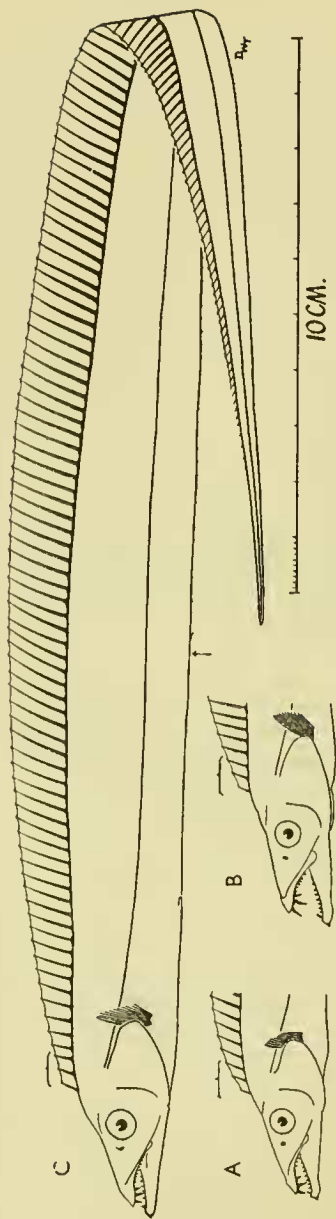


FIG. 14.—*Eupleurogrammus intermedius* (Gray). Syntypes. A., B., heads of specimens of 273, 308 mm. S.L., C., specimen of 335 mm. S.L.

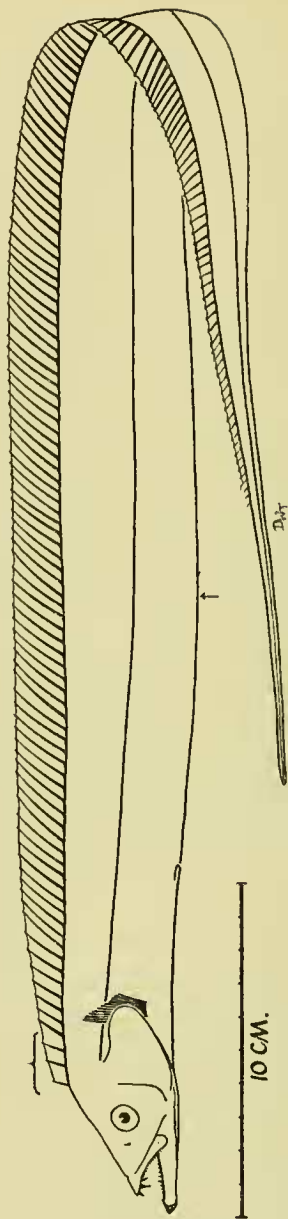


FIG. 15.—*Eupleurogrammus muticus* (Gray). Specimen of 617 mm. S.L. (not the holotype). No locality data.

TABLE IV.

	Standard Length (mm.)	Head in S.L.	Depth in S.L.	Eye in head.	Fin-ray counts :		A. origin below D.	Vertebral counts.
					D.	A.		
<i>Eupleurogrammus intermedius</i> :								
<i>Trichiurus intermedius</i> Gray								
Syn-types : Chusan : East India Co. Reg. No. B.M. (N.H.) 1860.3.19.76	{ 273 308 336	. 10.11 . 9.77 . 10.29	. 17.61 . 17.11 . 16.39	. 6.00 . 6.56 . 6.56	. III, 130 . III, 128 . III, 131	i+I+120 . i+I+116 . i+I+114	. 35-6 . 37 . 35	. 34+128=162 . 35+127=162 . 32+127=159
<i>Trichiurus glossodon</i> Bleeker								
? Syn-type : No. loc. : Bleeker Coll. Reg. No. B.M. (N.H.) 1880.4.21.119	. 427	. 9.47	. 15.00	. 6.42	. III, 123	i+I+114	. 33	. 32+125=157
<i>Eupleurogrammus muticus</i> :								
<i>Trichiurus muticus</i> Gray								
Holotype : India : Hardwicke, Reg. No. B.M. (N.H.) 1955.5.13.2	. 426	. ca.	. 14.69	. ca. 7.0	. III, 143	i+I+120	. 41	. 41+151=192
<i>Eupleurogrammus muticus</i> (Gray)								
No data. Reg. No. B.M. (N.H.) 1955.6.4.1	. 617	. 11.21	. 15.42	. 7.85	. III, 147	i+I+121	. 42	. 41+150=191

Bleeker (1860) himself suspected, and Delsman (1927). Delsman goes far towards recognizing the different vertebral counts in *T. muticus* and *T. glossodon*, but in the former case he appears to have had the misfortune to select a specimen with a broken tail and gives 40-115 = 155. De Beaufort comprehends the affinities of *T. muticus* and *T. glossodon*, as he shows in his key, but, apparently not having heard of *Eupleurogrammus*, he retains both species among *Trichiurus* and gives no *Eupleurogrammus* combinations in his synonymies.

De Beaufort's counts on the type material of *T. glossodon* (D.115-120. A. about 90.) seem a little on the low side though, in the nature of the material, not disturbingly so.

Discussion of the relationships of the two species of *Eupleurogrammus* and of their systematic position is continued under the following species.

Eupleurogrammus muticus (Gray)

(Text-fig. 15)

Trichiurus lepturus (part) Linnaeus, 1758, *Syst. Nat.* Ed. 10 : 246 (*vide* Lönnberg *et al.*, 1896, K. *Svensk. Vet.-Akad. Handl.* 22 : 40. See note under *Trichiurus*, p. 114.)

Trichiurus muticus Gray, 1831, *Zool. Misc.* 1 : 10.

Holotype B.M. (N.H.) No. 1955.5.13.2. Type locality India.

Eupleurogrammus muticus, Gill, 1863, *Proc. Acad. nat. Sci. Philad.* 1863 : 226.

Enchelyopus muticus, Bleeker, 1872, *Ned. Tijdschr.* 4 : 131.

non Trichiurus intermedius Gray, 1831, *Zool. Misc.* 1 : 10.

The taxonomy of *Eupleurogrammus muticus* requires very little comment, except a further emphasis on the fact that *T. intermedius* Gray is *not* a synonym of it as Günther has led too many to suppose. I have examined the types of both nominal species and give the results in Table IV. The holotype of *E. muticus* has the gill-covers partly damaged, but another and better specimen has been available also.

It has been discussed whether the distinction holds that *E. muticus* is "burnished silver" and *E. intermedius* "purely silvery"; Delsman and Day *pro*, De Beaufort *con.* De Beaufort appears to clinch the matter when he says:

"My specimens" (of *muticus*) "do not differ in colour from specimens of *glossodon* '(= *intermedius*)' collected in the same locality and preserved in the same jar."

The type of silver coloration is, in fact, quite variable in any one species of Trichiurid, depending on age, on fixative and preservative, on the amount of oil in the tissues (which can impart a golden tinge to the silver) and on the fine or coarse grain of the guanine itself.

Despite the superficial resemblance and absence of a caudal fin it seems surprising that these two species should ever have been placed in *Trichiurus* and still more so that Gill (1863) should have been content to recognize *Eupleurogrammus* without removing it to the *Lepidopodinae*. The typically Lepidopodine palatine teeth and median lateral line are fundamentally different from those of the Trichiurinae; to these characters are allied a rounded operculum and the presence of ventral fins. Further, though the development of the cranial crests is unlike that of *Lepidopus* as of the Trichiurinae, it is very like that of *Evoxymetopon*, a Lepidopodine which Gill had in his hands and classified as such. The dentition of the main series is finer than that of any other genus of the Trichiuridae.

Authors have regarded the ecaudate genera as "degenerate" simply because of their lack of a caudal fin. This is a very hasty and unwise opinion: in fact *Eupleurogrammus* is one of the most advanced. Not only does it display the culminations of a number of progressive trends (see pp. 125-8); in appearance and structure it has the most elegantly streamlined form. The sides of the head and operculum are smoothly curved, with none of that chunkiness which occurs in the more primitive genera; the upper and lower profiles of the body are both gently convex; the dorsal is arched and the always untidy anal entirely suppressed; the point of greatest depth has moved back toward the vent; and a comparison of a radiograph of the skeleton with that of, say *Nesiarchus* or *Diplospinus*, is like a comparison between the mechanism of a high-grade chronometer and of a cheap alarm-clock.

Genus **ASSURGER** Whitley

Assurger Whitley, 1933, *Rec. Aust. Mus.* 19: 84.

Type species *Evoxymetopon anzac* Alexander. Monotypic, Indo-Pacific.

DIAGNOSIS:

- (1) Body extremely elongate, head 12 in total length, greatest depth 28 in total length (ca. 1415 mm.)
- (2) Upper profile of head oblique, rising continuously from the tip of the snout in a straight line set at about 25° to the longitudinal axis and quite straight before the orbits. Structure of cranial crest unknown, but evidently the ethmo-frontal region and the posterior confluence of the frontal crests are both elevated. Interorbital strongly convex.
- (3) Orbit small, 8 in head length, $\frac{1}{3}$ an eye-diameter below the dorsal profile

- (4) Analysis of dorsal spines and soft rays unknown; aggregate *ca.* 120. First dorsal spine not enlarged.
- (5) Anal spines $i(?) + I$; I is a large oval scale.
- (6) Analysis of anal fin elements unknown; only the posterior 14-15 appear to be external fin-supporting rays.
- (7) Posterior end of operculum a rounded rectangle, falling about a pectoral base-length short of the pectoral base.
- (8) Ventral fins present, scale-like, inserted about $1\frac{1}{2}$ eye-diameters behind the posterior end of pectoral base.
- (9) Caudal fin present.
- (10) Analysis of vertebrae unknown.

Assurger anzac (Alexander)

(Text-fig. 16 and Pl. 10).

Evoxymetopon anzac Alexander, 1916, *J. Roy. Soc. W. Aust.* 2: 104, pl. 7.

Holotype in the Western Australian Museum, Perth. Type locality North Fremantle, Western Australia.

Evoxymetopon anzac Kamohara, 1952, *Sci. Rep. Kôchi Univ.* No. 3: 31, fig. 26.

Assurger alexanderi ("nom. emend., as *Anzac* is not permissible") Whitley, 1933, *Rec. Aust. Mus.* 19: 84.

(Whitley's emendation is quite unnecessary since a "Recommendation" at the end of Article 14 of the "International Rules of Zoological Nomenclature" expressly states: "Latinized Greek words or barbarous words may, however, be used. Examples . . . *zizac* . . .")

This species is known from Alexander's original and incomplete description and figure, the latter a photograph showing the head and the trunk back to the level of about the tenth dorsal ray. Whitley, in a general paper of miscellaneous studies, erected *Assurger* apparently on Alexander's account alone and without examination of the specimen which, though remote from Sydney, must surely have been more easily accessible to Mr. Whitley than to any worker outside Australia.

The following are all the data that can be extracted from Alexander:

"B. 7; D. *circa* 120; A. 14 +; C. 17; P. 12.

Total length 1415 mm., length of head 120 mm., greatest height 50 mm., diameter of orbit 15 mm.

"Unfortunately the fins are a good deal broken, and it is impossible to count the rays of either the dorsal or anal with accuracy, no doubt these breakages occurred when it was washed ashore, and if the large spine at the commencement of the dorsal found in *E. poeyi* was ever present it has disappeared. In other respects the example agrees in its structural features with Günther's description, the postanal spine is exposed evidently owing to the abrasion of the skin in that region and just behind it there is a large oval scale similar to that described and figured by Günther. There is no trace of the six narrow reddish bands which Poey describes in *E. taeniatus* and if one may judge from Goode and Bean's figure, the ridge on the forehead is not nearly so high as in that species, but agrees with that of *E. poeyi*." ". . . a bright silvery colour."

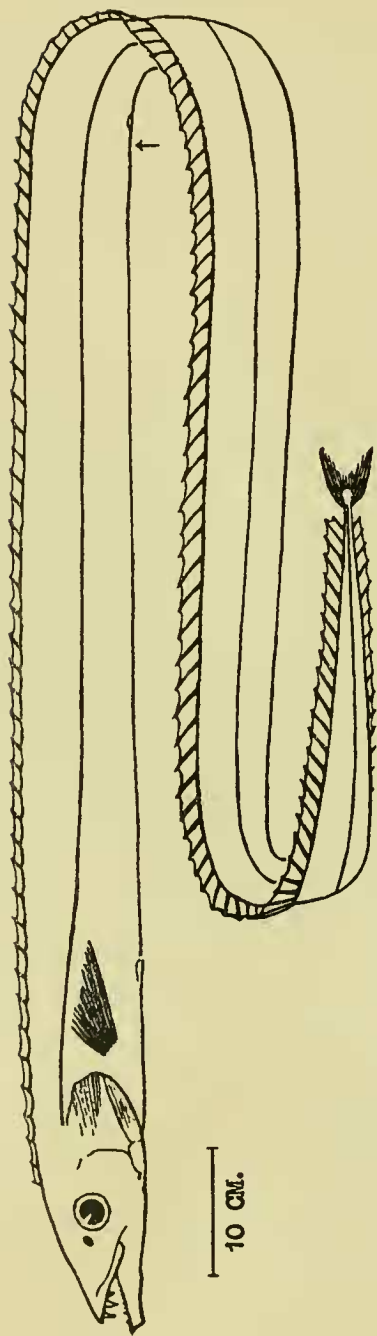


FIG. 16.—*Assinger anzac* (Alexander). Specimen of 2,250 mm. S. L. Japan.
(After Kamohara (1952), heavily re-touched.)

Alexander's references are to Poey (1873) and Goode & Bean (1895) (given with other *Evoxymetopon* references on p. 99). Although his discussion mentions Gill (1863) and Günther (1887) also, there is internal evidence in his paper that he cannot have examined them all. Gill clearly states that the type of *E. taeniatus* is nearly five feet long (in which he is followed by Günther) and Poey gives 1410 mm. total length, yet Alexander follows the mistake of Goode & Bean, who copy Gill's percentage proportions of total length as millimetres, and gives 100 mm. as the total length. When, therefore, Alexander denounces Goode & Bean's "very poor figure" of *E. taeniatus* he is complaining of a figure of a fish which he has not seen and which he has not compared with Poey's independent drawing of the same specimen.

Alexander's figure shows the profile of the head rising in practically a straight line from the tip of the snout to behind the eye, the slope (with the mouth open) being about 25° to the longitudinal axis of the body. The eye lies half its diameter from the dorsal profile. The hinder end of the operculum falls about a pectoral base-length short of the pectoral fin. The ventral fins are not mentioned; the photograph shows a nondescript median projection before the level of the end of the operculum, certainly irrelevant, and a slight indentation, about an eye-diameter behind the pectoral base, which is a likely position for the ventrals but quite inconclusive.

Dr. L. Glauert, Director of the West Australian Museum, has kindly done what he could to amplify Alexander's account. He has provided the original photographic print from which Alexander's plate was made and this is reproduced, I hope with greater clarity than before, as Plate 10 of the present paper. One point which this print does clarify is the fact that there are no barbs on the teeth; Alexander's plate may seem to indicate a barb on one of the premaxillary fangs, but this is an artifact due to indistinct reproduction of a piece of rubbish on the tooth in question. Dr. Glauert gives the eye-diameter as 16 mm. and the length of the head (measured from the snout-tip) as 113 mm., whence the ratio eye/head-length must be $1/7$ instead of $1/8$ as given by Alexander. Dr. Glauert is unable to add precision to Alexander's account of the dorsal fin: ". . . a University Undergraduate, interested in fishes, made an attempt and counted only 127, whereas all those others who made the attempt gave from 135 to 142. The explanation is that the dorsal fin was very much damaged when the fish reached the Museum".

Kamohara (1952) reports one specimen of 2250 mm. from Kôchi Market, Japan, and gives a small figure but no description. The illustration shows the fish bent into an S which prevents measurements of the body proportions and a count of the dorsal fin rays, but the general picture agrees with Alexander's description and figure. One new fact emerges: the ventral fins are inserted about $1\frac{1}{2}$ eye-diameters behind the pectoral base.

Since it is evident that the structure of the ethmoid and frontal region of the head must be similar to that in *Eupleurogrammus* and *Evoxymetopon* I place this fish among the Lepidopodinae, among which it may be considered to parallel *Benthodesmus* among the Aphanopodinae. It is at once separable from *Eupleurogrammus* and *Tentoriceps* by its possession of a caudal fin and from *Lepidopus* by the form of the head and of the elongate body. It differs from *Evoxymetopon* in the gentler slope of the snout, smaller eye ($1/7$: $1/6$ of the head), elongate body (height $1/28$: $1/12$, head

1/12 : 1/8 of total length) and higher dorsal count (*ca.* 120+ : 87). These comparisons are between holotypes of practically identical size (*Assurger anzac* 1415 mm., *Evoxymetopon taeniatus* 1410 mm. total length).

Genus *TENTORICEPS* Whitley

Tentoriceps Whitley, 1948, *Rec. Aust. Mus.* 22 : 94.

Type species *Trichiurus cristatus* Klunzinger. Monotypic.

DIAGNOSIS :

- (1) Body extremely elongate, head 9 in total length, greatest depth 20–24 in total length (*ca.* 418 mm.)
- (2) Upper profile of head convex, a continuous curve rising from the tip of the snout at about 30° to the longitudinal axis and markedly convex before the orbits. Structure of cranial crest unknown, but evidently the ethmo-frontal region and the posterior confluence of the frontal crests are both elevated, the former perhaps disproportionately so. Interorbital convex.
- (3) Orbit large, 5 in head length (Klunzinger description) or 6 (Klunzinger figure), 2/3 of an eye-diameter below the dorsal profile.
- (4) Analysis of dorsal spines and soft rays unknown; aggregate *ca.* 120. First dorsal spine not enlarged.
- (5) Analysis of anal fin elements unknown : “ mit rudimentären, kaum sicht-
- (6) baren Stachelchen ”.
- (7) Posterior end of operculum acutely elliptical, reaching to middle of, but not concealing, pectoral base.
- (8) Ventral fins present, scale-like, but insertion unknown.
- (9) *Caudal fin absent.*
- (10) Analysis of vertebrae unknown.

Tentoriceps cristatus (Klunzinger)

(Text-fig. 17).

Trichiurus cristatus Klunzinger, 1884, *Fische Rothen Meeres* 1 : 120, Taf. 13, fig. 5a.

Syntypes retained in Klunzinger's private collection, Stuttgart; eventual disposal unknown. Type locality Kosseir, Red Sea coast of Egypt.

Tentoriceps cristatus, Whitley, 1948, *Rec. Aust. Mus.* 22 : 94.

All that is known of this species is contained in Klunzinger's original description and figure. I give the complete text :

“ Kopfprofil convex, gratartig, scharf : eine hohe blattartige, bogige Crista zieht vom Beginn der Rückenflosse an über Stirn und Schnauze ; den vorderen Theil der letztern indess nicht mehr schärfend. Das Auge liegt daher weit unter der Profillinie. Bauchflossen wie beim vorigen in Form eines Schuppenpaares wie bei b.” (b. is *Trichiurus muticus* Gray, type-species of *Eupleurogrammus*.) “ Die Seitenlinie senkt sich sehr allmählig abwärts und läuft etwas über dem unteren Körperdrittel. Afterflosse nur mit rudimentären, kaum sichtbaren Stachelchen. Auge gross, 5 in der Kopflänge, Schnauze von doppelter Länge

des Auges, Kopf mässig lang, $2\frac{3}{4}$ mal so lang als der Körper hoch, 9 in der Gesamtlänge. Körperhöhe 20–24 (letzteres bei Aelteren) in der Gesamtlänge, Körper also sehr gestreckt. Rückenstrahlen $1\frac{1}{4}$ in der Körperhöhe, $3\frac{1}{2}$ in der Kopfänge, also ziemlich nieder. Brustflossen kurz, 7 in der Kopfänge, (wenn nicht abgebrochen?). Peitsche kurz, nur von $\frac{1}{2}$ Kopfänge. Vordere Zähne einfach ohne Ansatz. D. c. 120 (?). Neue Art vom Rothen Meer."

" Von dieser neuen und durch die scharfe, blattartige Kopfgräte gut charakterisirten Art (siehe obige Uebersicht) bekam ich 3 Exemplare bei Koseir, ebenfalls aus dem inneren Meer. Farbe silbrig, Ruckenflosse hyalin "

The lengths of the three specimens are not given. The head, however, figured " in natürlicher Grösse " is 46.5 mm. in length, (measured from the snout tip) and this multiplied by 9 gives ca. 418.5 mm. for the total length of the specimen which is likely to have been the largest of the three.

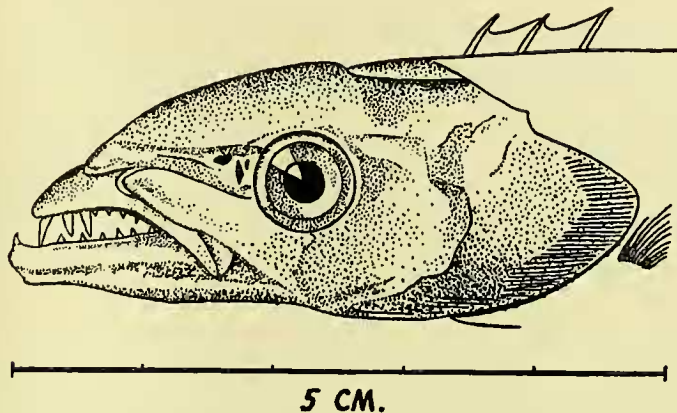


FIG. 17.—*Tentoriceps cristatus* (Klunzinger). Head of syntype ca 418 mm. S.L. (re-drawn after Klunzinger (1884), scale added). Some confusion is evident in the representation of the nostrils.

Klunzinger's figure shows only the head, pectoral fin and trunk back to the third dorsal ray. Even so the evidence available appears adequate to justify the recognition of a distinct species and genus, provided it is all accurately related and represented; relatively small divergences from the published account would involve consideration of possible *Assurger* or *Eupleurogrammus* spp. Klunzinger's careful consideration of the whole genus may justify confidence in his present data.

It is obvious at the outset that *T. cristatus* has very little in common with the Aphanopodinae. It is likewise certain that, despite its ecaudate condition, it differs from the Trichiurinae in the general shape of the head, in the presence of ventral fins, in the median position of the lateral line and the absence of barbs from the teeth. (Elsewhere Klunzinger properly characterises the barbed teeth and falling lateral line in *Trichiurus muticus*).

Considered now as a possible Lepidopodine species *T. cristatus* is quite unlike *Lepidopus*. The form of the upper profile of the head is intermediate between *Evoxymetoſon* and *Assurger*, from both of which our species differs in lacking a caudal fin. From Klunzinger's figure it seems that the elevation of the ethmo-frontal region has proceeded further than that of the posterior confluence of the frontal ridges giving an almost teratological appearance which is quite the reverse of the condition in the ecaudate *Eupleurogrammus*. The hind end of the operculum is a rounded point with an extension in relation to the pectoral base intermediate between that in the Aphanopodinae and Trichiurinae and unlike the other Lepidopodines. The number of dorsal rays (*ca.* 120) is similar to that in *Assurger*, but the elongation of the body, though considerable, is slightly less (depth 20–24 : 28 in length). The number of dorsal spines is unknown, likewise the position of the ventral fin-insertions, the condition of the post-anal structures and the number of vertebrae ; nevertheless I find it possible to accept *Tentoriceps cristatus* (Klunzinger) as a valid species and genus arising from a Lepidopodine offshoot a little before *Assurger*.

Whitley (1948) proposes *Tentoriceps* with no more than a translation of Klunzinger's original description of *Trichiurus cristatus*, without any indication of the supposed discriminant characters and with no reference to his own earlier proposal of *Assurger*. He proposes it in a portmanteau paper of "Studies in Ichthyology" having no direct concern with the Red Sea fauna, no special interest in the Trichiuridae nor any Australian material of that family requiring comment. *Tentoriceps* is but another of Mr. Whitley's foundlings, casually discovered, capriciously re-baptized and callously abandoned, in the hope of adoption or decent interment, on the cold doorsteps of systematic ichthyology.

Subfamily TRICHIURINAE Swainson

Trichiurinae (evident misprint for *Trichiurinae*) Swainson, 1839, *Nat. Hist. Fish. Amphib. Rept.* 2 : 254.

Type genus *Trichiurus* Linnaeus.

Lepturinae Gill, 1863, *Proc. Acad. nat. Sci. Philad.* 1863 : 225.

Type genus *Lepturus* Artedi (= *Trichiurus* L.).

GENERA NOW RECOGNISED : *Trichiurus* Linnaeus ; *Lepturacanthus* Fowler.

DIAGNOSIS :

- A. Slope of snout moderate ; orbits barely entering upper profile of head ; posterior confluence of frontal ridges elevated as a sagittal crest at the nape.
- B. Cartilaginous protuberance at mandibular symphysis weak ; a small, soft projection at the tip of the snout.
- C. Lower hind margin of operculum more or less concave.
- D. Teeth of main series with barbs.
- E. Palatine teeth minute, in a villiform band.
- F. Lateral line descending steeply from the shoulder and running nearer the ventral surface of the body, i.e. distance between lateral line and ventral profile at anus slightly less than half distance between lateral line and dorsal.

- G. Spinous dorsal fin very short, with 3 or 4 rays. Spinous and soft dorsals continuous, without any intervening notch.
- H. Soft dorsal rays precisely corresponding with adjacent caudal vertebrae, each basal and interneural element being related to a neural spine.
- I. Spinous anal $i + I$; soft anal rays reduced to internal rudiments or wanting (*Trichiurus*) or taking the form of minute pungent spines which definitely break the ventral profile (*Lepturacanthus*).
- J. Anal fin (i.e., basal elements of anal—see I above) extending well beyond dorsal.
- K. Caudal fin and hypurals entirely absent.
- L. Ventral fins and girdle entirely absent.
- M. Pyloric caeca 24, perhaps more.

Osteological literature

- Günther, 1860, *Cat. Fish. B.M.* 2 : 343-344. (desc. osteology of *Trichiurus*).
- Starks, 1911, *Stanford Univ. Pubs.* No. 5 : 25-26 (desc. general osteology of *Trichiurus*, comp. with *Lepidopus*).
- Gregory, 1933, *Trans. Amer. Phil. Soc.* 23 : 316, fig. 195 (skull of *Trichiurus*).

Literature on young stages

- Delsman, 1927, *Treubia* 9 : 338.
- Lütken, 1880, *K. Dansk. Selsk. Skrift.* 12 : 409.
- Nair, 1952, *Proc. Indian. Acad. Sci.* 35B : 225.
- Tang & Wu, 1936, *Lingnan Sci. J.* 15 : 651.

Genus *TRICHIURUS* Linnaeus

Trichiurus Linnaeus, 1758, *Syst. Nat. Ed.* 10 : 246.

Type species *Trichiurus lepturus* Linnaeus *ex* Artedi (see note under *T. lepturus*). Probably monotypic.

Enchelyopus Klein, 1744, *Hist. Piscium* : 51.

Enchelyopus Bleeker, 1862, *Versl. Akad. Amsterdam* 14 : 109.

Type species *Clupea haumela* Forskäl. (Also spelt *Encheliopus* by authors. *Non Enchelyopus* Gronovius, 1763).

Gymnogaster Gronovius, 1754, *Mus. Ichth.* 1 : 17.

Type species *Anguilla Jamaicensis* Sloane.

Lepturus Artedi, 1738, *Desc. Spec. Pisc.* : 111.

Type species *Lepturus argenteus* Artedi.

Lepturus Gill, 1863, *Proc. Acad. nat. Sci. Philad.* 1863 : 225.

(*Non Lepturus* Moehring, 1758 ; Brisson, 1760.)

? *Diepinotus* Rafinesque, 1815, *Analyse Nat.* : 91 (*nom. nud.*). (Also spelt *Dipinotus* by authors.)

? *Symphocles* Rafinesque, 1815, *Analyse Nat.* : 91 (*nom. nud.*).

? *Nemachirus* Rafinesque, 1815, *Analyse Nat.* : 91 (*nom. nud.*).

DIAGNOSIS :

- (1) Body-proportions highly variable : Head 7.0-9.4 in length, depth 14.4-21.0 in length.
- (2) Eye relatively large, 5.0-7.0 in head.

- (3) Dorsal spines III ; D.III, 137 in three specimens of three nominal species radiographed. (Published aggregate ranges D.120-140).
- (4) A. i + I + 105-108.
- (5) Post-anal scute (= anal spine I) not enlarged ; a small, triangular scale, less than the pupil.
- (6) First basal element of anal fin slightly enlarged, presumably a compound of 2, its interhaemal spine lengthened and slightly thickened. There follows a gap of 1 in the series of interhaemal spines, leaving 1 free haemal arch.
- (7) "Soft anal" elements minute spinules which usually do not break the skin and which are occasionally absent. The first *ca.* 60 are directed backwards, the last *ca.* 40 are directed forwards.
- (8) Vertebrae 39-40 + 123-128 = 162-168.

Probably only one variable species, *Trichiurus lepturus* L., world-wide except in colder regions.

Trichiurus lepturus Linnaeus

(Text-fig. 18).

Trichiurus lepturus (part) Linnaeus (ex Artedi), 1758, *Syst. Nat.* Ed. 10 : 246.

Type in the Museum of the Royal University of Upsala. Type locality South Carolina.

Note.—Lönnberg *et al.*, 1896, *K. Svensk. Vet.-Akad. Handl.* 22 : 40, state that the Linnaean types of "*T. lepturus*" at Upsala include material of the species now known as *Eupleurogrammus muticus* (Gray). The suggestion that *T. lepturus* should consequently be replaced by *T. argenteus* Linnaeus, 1754, *Mus. Ad. Frid.* : 76, pl. 26, fig. 2 is, of course, illegal, nor is it really necessary since the situation has never created any practical difficulty.

Günther, 1898, *Proc. Linn. Soc. Lond.* 1898-9 : 29, satisfied himself that the Linnaean material in the possession of the Linnaean Society of London is, in fact, *T. lepturus*, which is rendered doubly certain by the fact that it came from Garden's South Carolina collections, consignment of 1761. (See also *id. ib.* : 25.)

Trichiurus lepturus J. L. B. Smith, 1949, *Sea Fish South Africa* : 313 ; Okada, 1955, *Fishes of Japan* : 155.

Trichiurus argenteus Shaw, 1803, *Gen. Zool.* 4 : 90, pl. 12 (apparently *ex* Linnaeus, 1754).

Clupea haumela Forskål, 1775, *Descr. Anim.* : 72.

Type *not* in Herbarium Ichthyologicum Forskål, Copenhagen (*vide* N. B. Marshall, personal communication). Type locality Red Sea.

Trichiurus hamvela Schneider, 1801, *Syst. Ichth.* : 518 (*nom. err.*).

Trichiurus lepturus japonicus Temminck & Schlegel, 1844, *Faun. Jap. Pisc.* : 102, pl. 54.

Type Leiden Museum No. 2040. Type locality Japan.

Trichiurus lepturus japonicus Boeseman, 1947, *Zool. Meded.* 28 : 06 (for Temminck co-author p. 2).

Trichiurus japonicus Bleeker, 1857, *Verh. Bat. Gen.* 26 : 98.

Trichiurus japonicus Lin, 1936, *Bull. Chekiang Fish. Sta.* 2 (5) : 2.

Trichiurus lajor Bleeker, 1854, *Nat. Tijdschr. Ned. Indie* 7 : 248.

Type in Leiden Museum. Type locality Manado, Celebes. (Re-examined by De Beaufort, 1951, *Fish. Indo-Austr. Archip.* 9 : 196.)

Trichiurus malabaricus Day, 1865, *Proc. zool. Soc. Lond.* 1865 : 20.

Holotype B.M. (N.H.) No. 1867.5.30.2. Type locality Madras. (Withdrawn as *T. haumela* by Day, 1876, *Fish. India* : 201.)

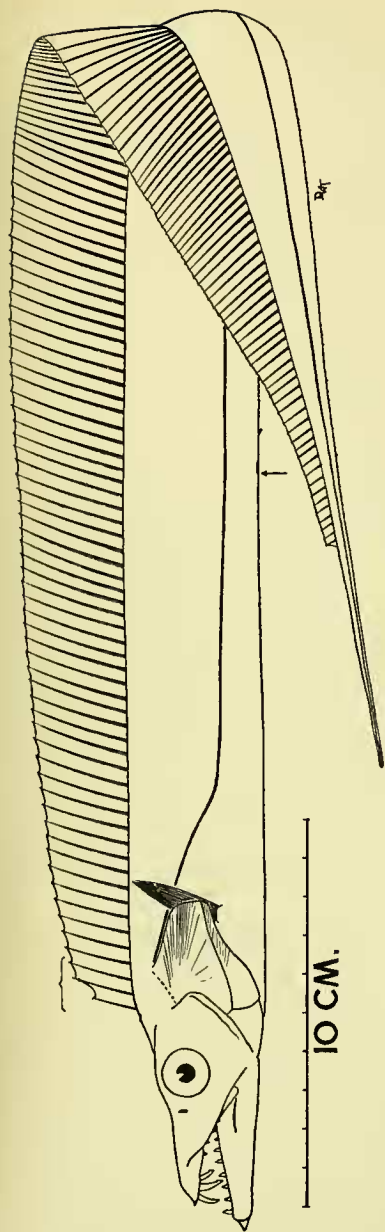


FIG. 18.—*Trichiurus lepturus* Linnaeus. B.M. (N.H.) No. 1948.8.6.795.
Texas. 545 mm. S.L.

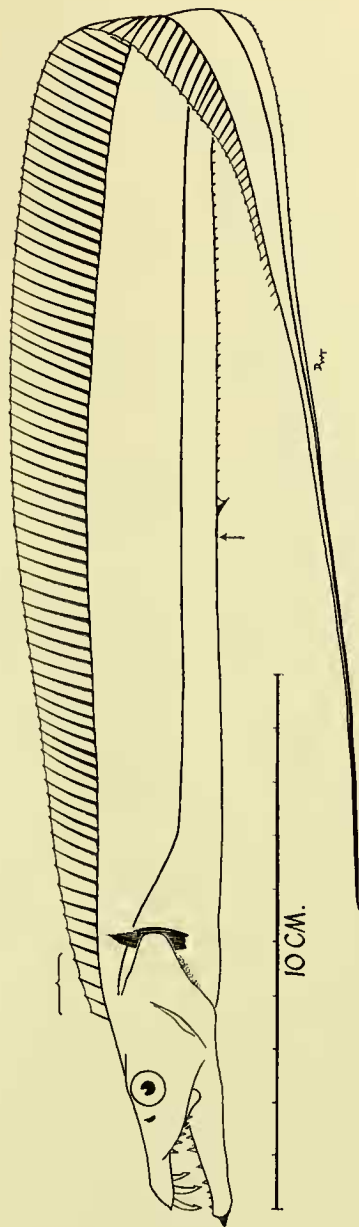


FIG. 19.—*Lepturacanthus savala* (Cuvier). 466 mm. S.L.
(Holotype of *Trichiurus armatus* Gray.)

Trichiurus auriga Klunzinger, 1884, *Fische Rothen Meeres* 1 : 120, Pl. 12, fig. 1.

Type retained in Klunzinger's private collection, Stuttgart. Now at Stuttgart, Berlin or Vienna? Type locality Kosseir, Red Sea coast of Egypt.

Trichiurus auriga Weber, 1913, *Siboga Fische* : 406.

Trichiurus auriga De Beaufort, 1951, *op. cit.* : 196.

Trichiurus coxii Ramsay & Ogilby, 1887, *Proc. Linn. Soc. N.S.W.* 1887 2 (2) : 562.

Holotype Australian Museum, Sydney No. 1.1342. Type locality Broken Bay, N.S.W.

? *Trichiurus nitens* Garman, 1899, *Mem. Mus. comp. Zool. Harv.* 26 : 69.

Syntypes (2) in U.S. N.M.? Type locality coast of Peru.

? *Trichiurus nitens* Hubbs & Hubbs, 1941, *Calif. Fish Game* 27 : 29.

? *Trichiurus nitens* Breder, 1936, *Bull. Bingham Ocean. Coll.* 2 Art. 3 : 12.

non *Trichiurus lepturus* Mohr, 1786, *Forsøg til en islandsk Naturh. Kjob.* : 63.

non *Trichiurus lepturus* Sveinn Palsson, 179+, *J. Naturforsk. Reise Island 1791-97* 2.

(Mis-identifications of *Trachypterus* sp. Refs. fide Saemundsson, 1926, *Fiskamir* : 155. Reykjavik).

non *Trichiurus lepturus* Hoy, 1815, *Trans. Linn. Soc. Lond.* 11 : 210-212.

(Mis-identification of *Trachypterus* or *Regalecus* spp.)

non *Trichiurus trimaculatus* Giovene, 1829, *Mém. Soc. Ital.* 20 Pt. 1 : 25.

(Mis-identification of *Trachypterus* sp.)

At the commencement of the present paper *Trichiurus* seemed likely to give the most difficulty; that promise has been abundantly fulfilled. *Trichiurus* is a common pelagic fish of world-wide distribution, occurring in all but the coldest seas and assuming some economic importance in certain areas; as a consequence it possesses a literature as large as that of the rest of the family put together. Much of this work is uncritical: species have been recognized on supposed differences of body-proportions unrelated to possible ontogenetic changes, geographic variation, or environmental effects, or on small differences in fin-ray counts which are difficult to establish with any accuracy except in radiographs. Vertebral counts have hardly ever been employed. Very often it is found that where a worker has characterised a pair of species to his own satisfaction another will reverse the discriminant characters in the same pair.

In dealing with all this intractable material it has seemed useful to take as a working hypothesis the theory that we are dealing with one highly variable species. If the evolutionary behaviour of the other recent Trichiuridae affords any precedent it is one pointing to the evolution of monotypic genera, or of pairs of species having sharply discontinuous ranges of meristic counts, not to the subtle distinctions which the would-be splitters of *Trichiurus* postulate. Geographic variation and the increasing evidence of environmental effects upon meristic characters must also be taken into account.

The first problem is the identity or distinctness of the Atlantic and Indo-Pacific populations; currently recognized as *T. lepturus* L. and *T. haumela* (Forskål) respectively. The results of the examination of two specimens taken at random from the collections of the British Museum (Natural History) are given in Table V. They show a precisely coincident dorsal count and anal/vertebral counts differing by only 3/2 rays/vertebrae respectively. The differences in body proportions are no greater than may be explained by the difference in age. These two specimens show that similar *Trichiurus* occur off Texas and Shanghai almost as well as population samples treated with all the apparatus of statistical necromancy.

TABLE V.

	<i>Trichiurus lepturus</i> . Aransas Bay, Texas. No. 1948.8.6.795.	<i>Trichiurus "haumela."</i> Shanghai. No. 1862.11.1.260.	<i>Trichiurus "japonicus."</i> Yenting, Chekiang. No. 1925.4.23.5.
Dorsal rays	D.III, 137	D.III, 137	D.III, 137
Anal rays	A.i+I+105	A.i+I+108	A.i+I+107
Vertebrae	39+123=162	40+124=164	40+128=168
Standard length	545 mm.	838 mm.	926 mm.
Head in S.L.	7.07	7.83	9.17
Depth in S.L.	16.03	16.43	17.47
Snout-vent in S.L.	2.79	3.07	3.07
Head in S-V.	2.53	2.55	2.98
Depth in S-V.	5.73	5.35	5.68
Eye in head	5.92	6.68	6.12
Snout in head	2.80	2.77	2.52
Mx. in head	2.48	2.46	2.29

A modern re-assessment of *Trichiurus japonicus* Temminck & Schlegel, a second Pacific form, is given by Boeseman (1947):

"The differences between *Trichiurus japonicus* T. & S. and *T. lepturus* L. as stated by Temminck & Schlegel and Bleeker (*l.c.*) do not exist in our material. A comparison, however, with several specimens of *lepturus* in our collection (all Atlantic) showed a very distinct and constant difference; the head in all these specimens of *lepturus* is larger, about 7-7.5 in length, while in our specimens of *japonicus* it is 8.1-8.6 in length, consequently considerably smaller. On account of this I want to discriminate both species and regard the Japanese specimens as the type material of a separate species, *Trichiurus japonicus* T. & S. Specimen no. 2040 I regard as type."

In opposition to this stands the work of Lin (1936) who comments that:

"Several authors . . . used to distinguish *T. japonicus* from *T. haumela* by the shorter head and the smaller eyes, but the series of intermediate forms lying between them is so continuous that no clear line can be drawn to separate them into two distinct species."

Lin gives a table of data covering a series of 12 Chinese *T. japonicus* of 424-1,290 mm. S.L., with the following ranges: depth in length 14.4-21; head in length 7-9.4; depth in head 1.9-2.3; eye in head 5.4-6.4; D.136-140. He notes the difficulties which arise through the loss of the tip of the tail and advocates the substitution of snout-vent length for the calculation of body-proportions. Oddly enough Lin does not take the logical step of substituting the earlier name *haumela* for *japonicus*.

"In reviewing the recorded distribution of *T. japonicus* and *T. haumela*, it is found that the former species inhabits the Chinese and Japanese coastal waters and is neither known to live beyond the Asiatic continental shelf nor

southward to the East Indian seas, while the latter is found from the Japanese and Chinese seas to the Philippines and Indian Ocean and Archipelago."

A specimen of *T. japonicus* (Table V), being duly radiographed, shows a dorsal count identical with that of the two specimens of the other two nominal species, an intermediate anal count and an increment in caudal vertebrae altogether less than the head/body proportion would lead one to expect. I suggest that *T. japonicus* is, in the light of the evidence, no more than an ecotypic form of *T. haumela* (= *lepturus*).

T. lajor Bleeker and *T. malabaricus* Day have been adequately dealt with by De Beaufort (1951) and by Day himself (1876) and as synonyms of *T. haumela* now need no further comment.

T. auriga Klunzinger, placed very close to *T. haumela* by Klunzinger (1884) himself and founded on a very young specimen (250 mm. S.L.) is probably no more than a juvenile of the latter species, though the published illustration contains peculiar features at variance with the description. The only serious difficulty is the definitely stated absence of barbs from the teeth. *T. auriga* has been reported only once more, a specimen of 320 mm. from the Timor Sea having been described by Weber (1913) and De Beaufort (1951).

T. coxii Ramsay & Ogilby (1887) contains, on the published account, no differences from *T. haumela* and its authors do not attempt to indicate those characters in which they consider it to be divergent.

Only in the case of *T. nitens* Garmen (1899) has there been argued any very cogent case for specific separation, by Breder (1936) and by Hubbs & Hubbs (1941). Breder's conclusions, summarized in the form of a key are:

- A. Dorsal rays never less than 126, usually about 133; maxillary 2.2 to 2.5 in head, usually about 2.3 (11 specimens, D.126-137, mean 132.9) *lepturus* Atlantic
- AA. Dorsal rays never more than 128, usually about 122; maxillary 2.5 to 2.8 in head, usually about 2.6 (36+ specimens, D.120-128, mean ca. 122.3
nitens California, Galapagos

These results must obviously be treated with respect, though not with absolute acquiescence. The variation in the maxillary should be stated in relation to the size of the fish, for there is some allometry with age. The differences in mean dorsal counts are considerable, but if the two samples are drawn from a continuous hypothetical population of one species, having its origin somewhere in the Indian Ocean and extending westwards to the Western Atlantic and eastwards to the Pacific coast of America we still have no more than the variation we should expect at the limits of that wide range. The satisfactory establishment of *T. nitens* requires, not comparison with Atlantic material, but demonstration of a non-cline discontinuity across the Pacific.

Having regard therefore to the known variation in the Trichiuridae and to the growing literature concerning environmental effects upon fishes, I am more inclined to "lump" *Trichiurus* as one variable species than to "split" and thereby make assumptions concerning the genetic distinctness of populations which present precedents and evidences of variation do not appear to justify. Such modern authors as J. L. B. Smith (1949) and Okada (1955) have apparently arrived at the same conclusion, though they do not submit any evidence to support their decisions.

Genus **LEPTURACANTHUS** Fowler

Lepturacanthus (sub-genus of *Trichiurus* L.) Fowler, 1905, *Proc. Acad. nat. Sci. Philad.* 1904 : 770.

Type species *Trichiurus savala* Cuvier. Monotypic.

Trichiurus (part) many earlier authors.

DIAGNOSIS :

- (1) Body-proportions highly variable : Head 7.4-10.5 in length, depth 14.8-19.8 in length.
- (2) Eye relatively small, 6.7-10.0 in head.
- (3) Dorsal spines IV ; D.IV, III in two specimens radiographed, including holotype of *Trichiurus armatus* Gray. (Published aggregate ranges D.105-134).
- (4) A.i + I + 72.
- (5) Post-anal scute (= anal spine I) enlarged, as in *Aphanopus* ; a dagger-like spike half the diameter of the eye.
- (6) First basal element of anal fin markedly enlarged, as in *Aphanopus*, presumably a compound of 3, its interhaemal spine likewise lengthened and thickened. There follows a gap of 2 in the series of interhaemal spines, leaving 2 free haemal arches.
- (7) "Soft anal" elements pungent spinules, definitely breaking the ventral profile throughout the length of the fin and all directed backwards.
- (8) Vertebrae 32-35 + 124-130 = 159-162.

One species, *Lepturacanthus savala* (Cuvier). Indo-Pacific.

Lepturacanthus savala (Cuvier)

(Text-fig. 19).

Trichiurus savala Cuvier, 1829, *Règne Animal* 2 Ed. 2 : 219.

Syntypes in Paris Museum, Reg. No. a.5357-5358. Type locality "Mer des Indes" (= Bombay & Malabar).

Trichiurus (Lepturacanthus) savala Fowler, 1905, *Proc. Acad. nat. Sci. Philad.* 1904 : 770.

Trichiurus armatus Gray, 1831, *Zool Misc.* 1 : 9 ; Gray, 1835, *Illust. Ind. Zool.*, pl. 93, fig. 1.

Holotype B.M. (N.H.) No. 1955.5.13.1. Type locality India.

Trichiurus Roelandti Bleeker, 1860, *Acta Soc. Indo-Neer.* 8 (4) : 30.

Holotype in Leiden Museum. Type locality Sunda Strait. (Re-examined by De Beaufort, 1951, *Fish. Indo-Austr. Archip.* 9 : 194.)

Trichiurus armatus Gray has for long, and, for once, correctly, been regarded as a synonym of this species. De Beaufort has adequately dealt with *T. Roelandti* Bleeker and so the taxonomic situation in this newly-promoted genus *Lepturacanthus* is mercifully straightforward.

Lepturacanthus is obviously closely related to *Trichiurus* and as widely separated from the other Trichiuridae : any attempt at a natural classification must adequately express this situation. In a wide classification Fowler's erection of *Lepturacanthus* as a sub-genus of *Trichiurus* very adequately did so, but with the exposure of *Eupleurogrammus* and its removal to the Lepidopodinae the Trichiurinae are left as a very

small group. Within this group the divergence between *Lepturacanthus savala* and *Trichiurus lepturus* is very comparable to that between *Aphanopus* and *Benthodesmus* and accordingly consistency requires the elevation of *Lepturacanthus* to full generic status.

THE ORIGIN, EVOLUTION AND CLASSIFICATION
OF THE TRICHIURIDAE

Summary of earlier work

Before summarizing previous opinions on the classification of the Trichiuridae it may be useful to indicate the sequence of recognition of the genera now accepted :

<i>Trichiurus</i>	Linnaeus,	1758.
<i>Lepidopus</i>	Gouan,	1770.
<i>Aphanopus</i>	Lowe,	1839.
<i>Evoxymetopon</i>	(Poey) Gill,	1863.
<i>Eupleurogrammus</i>	Gill,	1863.
<i>Benthodesmus</i>	Goode & Bean,	1882.
<i>Lepturacanthus</i>	Fowler,	1905.
<i>Assurger</i>	Whitley,	1933.
<i>Diplospinus</i>	Maul,	1948.
<i>Tentoriceps</i> ,	Whitley,	1948.

Classification commences, and commences remarkably well, with Cuvier & Valenciennes (1831) who recognize the Scombroids as a natural group (Scombéroides) containing all the Trichiurids and Gempylids so far known (Lépidopes, Trichiures ; Thyrsites, Gempyles) as well as the Tunnies, etc. Their key runs :

“ Tous ou une grande partie des rayons de l'anale réduits à de très-petites épines.
Dents des thyrsites et des gempyles.

LÉPIDOPES. Une petite écaille au lieu de chaque ventrale ; une caudale.

TRICHIURES. Point de ventrales ; point de caudale.”

These authors grasp so early the essential relationships of the Trichiuridae and Gempylidae :

“ Il est impossible de ne pas placer à la suite des gempyles et des thyrsites deux genres de poissons qui leur ressemblent presque en toutes choses, si ce n'est qu'ils manquent entièrement de fausses nageoires et même de rayons mous à leur dorsale ; ce sont les lépidopes et les trichiures, poissons très-remarquables d'ailleurs par leur éclat et par leurs formes singulières.

“ Leur tête, leurs dents, leur peau, leur squelette, rappellent de tout point les genres auxquels nous les associons, et la longueur même de leur corps en ruban, qui les avait fait rapprocher des cépoloïdes, est déjà annoncée par la forme de plusieurs gempyles.”

Swainson (1839) was the first to erect a higher taxon for the Trichiurid fishes, though he takes a step backwards, making *Ammodytes* as well as *Trichiurus* and *Gempylus* members of a sub-family Trichiurinae of the family Coryphaenidae.

Günther (1860) attempts no subdivision of his family Trichiuridae, which includes not only *Aphanopus*, *Lepidopus* and *Trichiurus* but also the Gempylids *Epinnula*, *Dicrotus*, *Thyrsites* and *Gempylus*.

Gill (1863) gives a classification recognizably approaching that now advocated, though based on inadequate and in part inaccurate premises :

" I. Dorsal fin undivided.

- | | |
|------------------------------------------------------------|--------------------------|
| A. Tail filiform and finless | LEPTURINAE. |
| Lateral line near the abdomen | <i>Lepturus</i> . |
| Lateral line median | <i>Eupleurogrammus</i> . |
| B. Tail with a normally developed and forked fin | LEPIDOPODINAE. |
| Profile rectilinear and forehead depressed | <i>Lepidopus</i> . |
| Profile high, trenchant and boldly declining | <i>Evoxymetopon</i> . |

- | | |
|---------------------------------------|--------------------|
| II. Dorsal fin double | APHANOPODINAE. |
| Teeth of the palate wanting | <i>Aphanopus</i> . |

Johnson (1865) describes a number of Gempylids as Trichiuridae.

Capello (1868) takes a view of the Trichiuridae equivalent to the Trichiuriformes of later authors and recognizes three sub-families :

TRICHIURINA	{ <i>Trichiurus</i> , <i>Eupleurogrammus</i> . <i>Lepidopus</i> , <i>Evoxmyetopon</i> . <i>Aphanopus</i> .
GEMPYLINA	
THYRSITINA	
	<i>Gempylus</i> , <i>Prometheus</i> , <i>Epinnula</i> . <i>Thyrsites</i> , <i>Dicrotus</i> .

A division of the Trichiurina similar to Gill's is implicit in the key given. Time, on the whole, has dealt more kindly with Capello than did Günther in the *Zoological Record*.

Goode & Bean (1895) limit the Trichiuridae to *Trichiurus*, of which *Eupleurogrammus* is merely " a Chinese form . . . with a single species " ! They erect a separate family, the Lepidopidae, with two sub-families :

- " I. Dorsal continuous. Teeth on palatines. Ventrals present, scale-like, rudimentary.
 No post-anal spine LEPIDOPINAE.
 (Genera *Lepidopus*, *Evoxymetopon*, *Benthodesmus*.)
- II. Dorsal in two subequal portions, closely contiguous. No teeth on palatines.
 Ventrals absent. A dagger-like post-anal spine APHANOPINAE.
 (Genus *Aphanopus*.)

This pastiche of half-truth and etymological abomination is preceded by one of Goode & Bean's self-contradictions (Lepidopidae have " No teeth on palatines " ; Lepidopinae have " Teeth on palatines ").

Boulenger (1904) and Goodrich (1909) include both Trichiurids and Gempylids in a family Trichiuridae without subdivisions. This grouping becomes the Scombroid Division Trichiuriformes of Regan (1909), with two undivided families Trichiuridae and Gempylidae in the generally accepted modern sense, as later followed by Jordan (1923) and by Berg (1940).

Starks (1911), in a classic paper concerned only with the osteology of three genera, defines families Gempylidae (*Promethichthys*), Lepidopidae (*Lepidopus*) and Trichi-

uridae (*Trichiurus*). He comments that "the descent of the family Trichiuridae from the Gempylidae was long ago pointed out" and compares the structure of *Lepidopus* with that of *Promethichthys*, which latter he rightly regards as too specialized to be an ancestral form. He concludes: "This ancestor may have been *Gempylus*, a form which I have been unable to obtain, but showing a development towards the elongate forms of *Lepidopus* and *Trichiurus*."

Roule (1927) introduces a little light relief by attempting to place the Iniomous *Anotopterus* among the Trichiuridae.

Gregory (1933) figures a museum exhibit showing in pictorial form the evolution of the Scombroid fishes. *Ruvettus*, *Epinnula*, *Gempylus* and *Trichiurus* are shown as consecutive stages in a linear series, with *Lepidopus* emerging as a sideshoot between *Epinnula* and *Gempylus*. In these circumstances the presence of a number of apparently undecided fishes swimming in the background to this exhibit occasions no surprise.

Tucker (1953), though not attempting a full classification, draws attention to the affinities between *Aphanopus* and *Benthodesmus* as contrasted with *Lepidopus*. He shows that *Benthodesmus* has a differentiated and partly divided dorsal fin like that of *Aphanopus* and demonstrates the significance of the ventral fin-insertions and post-anal structures, but, fails to realize that the dorsal fin is differentiated throughout the entire family. The error arose through an undue reliance on previous literature of the non-Aphanopodinae and a brief study of *Lepidopus* and *Trichiurus* from radiographs which, for reasons of economy, were fragmentary. Dr. Carl L. Hubbs, *in litt.* kindly drew attention to this mistake.

Nesiarchus-Diplospinus: *the Gempylid-Trichiurid bridge*

Regan (1909) gives the following diagnosis of the Gempylidae which may still serve as a basis for comparison with the Trichiuridae (p. 74):

"Body oblong or elongate, compressed; maxillary exposed; spinous dorsal longer than the soft; anal with 3 spines, similar to the soft dorsal; each pelvic fin of a spine and 5 soft rays or reduced to a spine only; caudal fin present. Rays of the spinous dorsal equal in number to the vertebrae below them, each interneural usually attached to a neural spine; rays of soft dorsal and anal more crowded (except the isolated finlets, when present), about twice as numerous as the corresponding vertebrae; pelvic bones separate, anteriorly extending forward to the cleithra and firmly imbedded in the ligament between them. Vertebrae 31(15 + 16) to 53(28 + 25); anterior praecaudals without parapophyses, with sessile ribs; posterior praecaudals with ribs attached at the extremities of closed haemal arches; epipleurals attached to the centra."

Closely related to the Scombridae, from which, however, they may be descended by more than one line, the Gempylidae are quite a varied group of fishes. As Mrs. Grey (1953) notes:

"There is a puzzling scattering of such characters as the presence of a free dagger-shaped spine preceding the anal fin, of dorsal and anal finlets, double or single lateral lines; and the presence, absence, or reduction of ventral fins."

A goodly proportion of the genera are well-illustrated in the paper by Matsubara & Iwai (1952).

The ancestors of the Trichiuridae must undoubtedly be sought among the Gempylinae (*Gempylus* Cuvier, *Nesiarchus* Johnson, *Mimasea* Kamohara), Gempylidae which possess an especially elongate body, the head and trunk in particular being reminiscent of those of the Trichiurids although the tail seems greatly telescoped by comparison and curiously unfinished. In these three genera alone appear the conical cartilaginous processes at the tip of the snout and mandibular symphysis which are found in the Aphanopodinae; their skulls are long and low, without prominent crests; they have, like other Gempylids, the typical Trichiurid dentition with the three pairs of prominent premaxillary fangs; their squamation is, at the most, vestigial, leading directly to the naked bodies of the Trichiuridae.

A single row of teeth is present on the palatine in *Nesiarchus* (personal observation) and in *Gempylus* (Matsubara & Iwai), though *Mimasea* is said to have none.

Of these three Gempyline genera *Mimasea* (Text-fig. 20) is specialized in having a double lateral line and a ventral fin-insertion behind the pectoral base; primitive in that the ventral fin is quite well developed, with five soft rays. Despite low median fin-ray counts and presumably low vertebral counts therefore, it does not seem a likely ancestor to the Aphanopodine Trichiurids.

Gempylus (Text-fig. 21) has rather less well-developed ventrals, allied, however, to a double lateral line and a series of widely-spaced dorsal and anal finlets. The proportion of soft dorsal rays to aggregate vertebrae in this genus is very low (18 : 53) in comparison with *Diplospinus*, the most primitive recent Trichiurid (40 : 58) and, since the early history of the Trichiurids appears to show soft dorsal rays multiplying much faster than the caudal vertebrae, we may feel that the transition from 53 to 58 vertebrae represents a smaller change than is likely to admit the necessary concomitant structural changes (Table VI).

Nesiarchus, (Text-fig. 22) however, seems to stand very close to the primitive Trichiuridae. It has a total of vertebrae (35) near to the minimum of its family (31 in *Epinnula*), allied to a higher number of soft dorsal rays than in *Gempylus* (21-23 : 18) and without detached finlets. The ventral fins are inserted on the perpendicular through the posterior end of the pectoral base and consist each of a spine with four smaller soft rays. The skull is well figured by Steindachner (1867); apart from a broad general resemblance to the skulls of the Aphanopodinae there is a striking similarity in the deep opercular notch, nowhere as marked in the other Gempylidae and found in only one Trichiurid—the primitive *Diplospinus*. The post-anal spines appear superficially “wrong”; the first is much larger. But internally there is a rudiment of yet another before the first; there are three well-developed spines in *Epinnula* and it becomes evident that of these the first is to become the minute spinule of *Nesiarchus* and the Trichiuridae (i), the second will become the larger spine of *Nesiarchus* and the principal spine or scute of the Trichiuridae (I), and the third, though disappearing, is to signify its claim by a space in the anal fin and will contribute to the compound and reinforced anterior basal structure whenever this is developed.

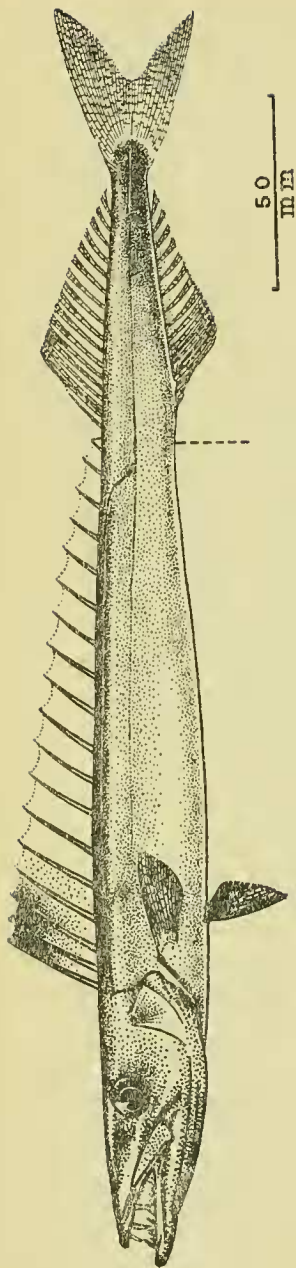


FIG. 20.—*Mimasea taeniosoma* Kamohara. 280 mm. S.L. Japan (from Matsubara & Iwai, 1952).

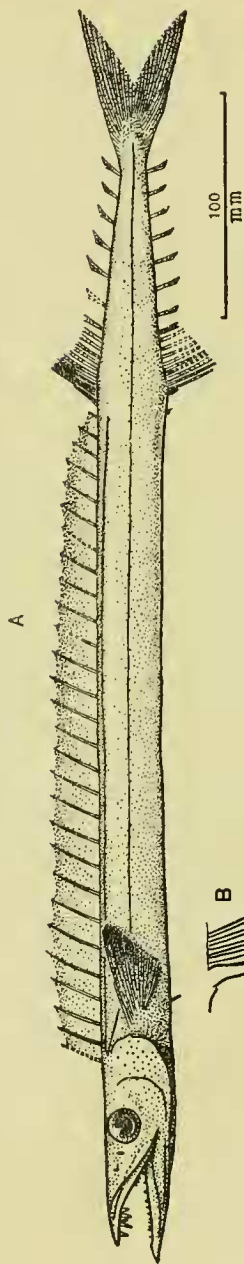


FIG. 21.—*Gempyllus seypens* Cuvier. A. Specimen of 488 mm. S.L. Japan. B. Detail of ventral fin of same (from Matsubara & Iwai, 1952).

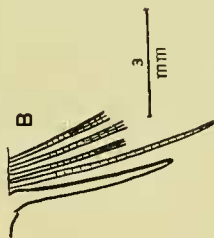
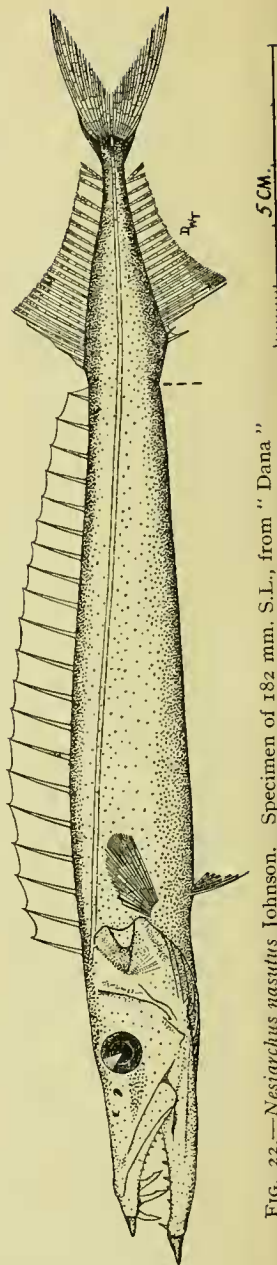


FIG. 22.—*Nesiarchus nasutus* Johnson. Specimen of 182 mm. S.L., from "Dana" St. 1186V., 17° 54' N., 64° 54' W., 1,000 m. wire.



The body of *Nesiarchus* is quite naked; the lateral line is single and descends gently to a mid-lateral course along the caudal. The number of pyloric caeca (7) is similar to that in the Aphanopodinae.

Nesiarchus differs from *Diplospinus* in the lower meristic counts, in having the maxillary exposed, in having barbs on the teeth confined to the premaxillary fangs and in the external (though not in the internal) structure of the spinous anal fin. But the indications from a study of the subsequent evolution of the Trichiuridae are that during the addition of 18 vertebrae *Nesiarchus* would have had plenty of time to undergo the modifications needed to produce a *Diplospinus*. This is the view expressed in Text-fig. 23.

Nesiarchus and *Diplospinus* therefore may be regarded as the approaches to the Gempylid-Trichiurid bridge. Whether the Trichiurinae crossed by the same bridge or by a parallel bridge further downstream is still debatable. It is tempting to regard the low lateral line in the Trichiurinae as representing the lower limb of the fork in another Gempylid ancestor; but unfortunately, although *Trichiurus* has a longitudinal groove which would serve for an upper limb, no recent Gempylid has a lower limb which falls in quite the same way. If, however, the "toothless" palatines in *Mimasea* should, on further examination, prove to be provided with a villiform band of teeth, the discovery would be a significant indication of a possible relationship and therefore of a diphyletic descent of the Trichiuridae. In this connexion it is interesting to observe that the concave lower hind margin of the operculum, characteristic of the Trichiurinae (though not of *Nesiarchus*, the Aphanopodinae or the Lepidopodinae), makes sporadic appearances among the primitive Gempylidae in *Epinnula* and *Neoeppinnula*.

Evolutionary trends in the Trichiuridae

Evolution in the Trichiuridae has resulted from the action, at various rates, of the following trends:

(1) Elongation of the caudal region of the body, least in the stem-forms at any level (*Diplospinus*, *Lepidopus*) and greatest in the most divergent side-shoots (*Benthodesmus*, *Assurger*, *Tentoriceps*).

(2) Multiplication of the soft dorsal and anal rays, initially at a greater rate than that of the adjacent vertebrae. This development, already incipient throughout the Gempylidae, is seen proceeding at its greatest rate in *Diplospinus* and is practically in harmony with the multiplying vertebrae in the other Aphanopodinae.

(3) Multiplication of the caudal vertebrae until eventually (except at the caudal tip) each vertebra has one corresponding soft dorsal and anal ray with their associated basal elements. This process is nearly complete in *Aphanopus* and *Benthodesmus*, in which, however, there are usually a very few rays, mainly towards the beginning and end of the soft fins, which are not directly related to vertebrae. Except possibly in "*Lepidopus xantusi*" further additions of vertebrae and fin rays proceed in unison in the Lepidopodinae and Trichiurinae.

(4) A slower increase in the number of trunk vertebrae. (See Table VI in conjunction with Text-fig. 23).

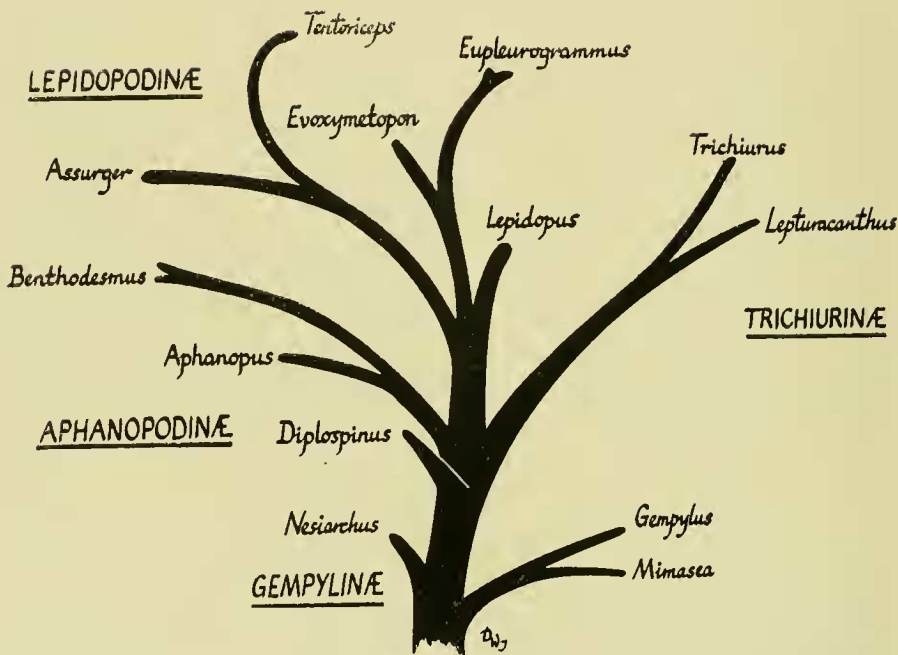


FIG. 23.—Suggested relationships of the genera of the Gempylid subfamily Gempylinae and of the subfamilies and genera of the family Trichiuridae.

TABLE VI.

	Dorsal.		Vertebrae.
	Spines.	Soft rays.	
GEMPYLIDAE			
Gempylinae :			
<i>Nesiarchus nasutus</i> . . .	19-21	21-23	23 + 12 = 35
<i>Mimasea taeniosoma</i> . . .	18	16-18	—
<i>Gempylus serpens</i> . . .	29-32	18	53
TRICHIURIDAE			
Aphanopodinae :			
<i>Diplospinus multistriatus</i> . . .	32-33	40	34 + 24 = 58
<i>Aphanopus carbo</i> . . .	38-41	53-56	42-44 + 55-56 = 98-99
<i>Benthodesmus tenuis</i> . . .	39-42	80-88	47-52 + 75-80 = 123-131
<i>Benthodesmus simonyi</i> . . .	45-46	102-108	52-53 + 101-103 = 153-156
Lepidopodinae :			
" <i>Lepidopus xantusi</i> " . . .	(82)		—
<i>Lepidopus caudatus</i> . . .	9	90-97	41 + 70-73 = 111-113
<i>Assurger anzac</i> . . .	(ca. 120)		—
<i>Tentoriceps cristatus</i> . . .	(ca. 120)		—
<i>Evoxyetopon taeniatus</i> . . .	10	77	—
<i>Eupleurogrammus intermedius</i> . . .	3	123-131	32-35 + 125-128 = 157-162
<i>Eupleurogrammus muticus</i> . . .	3	143-147	41 + 150-151 = 191-192
Trichiurinae :			
<i>Trichiurus lepturus</i> . . .	3	137	39-40 + 123-128 = 162-168
<i>Lepturacanthus savala</i> . . .	4	111	32-35 + 124-130 = 159-162

Data for *Nesiarchus* (part), *Mimasea* & *Gempylus* taken from Matsubara & Iwai (1952) and Grey (1953); for "*Lepidopus xantusi*" from Jordan & McGregor (1899); for *Assurger anzac* from Alexander (1916); for *Tentoriceps cristatus* from Klunzinger (1884); for *Evoxyetopon taeniatus* from Gill (1863). Remainder original.

(5) Progressive reduction of the number of dorsal spines in the higher forms and their replacement by soft rays.

(6) Backward migration of the ventral fins. In the Gempylidae the pelvic girdle is embedded in the ligament between the cleithra, and the primitive position of the ventral fin-insertions in the Trichiuridae is likewise closely before or behind the level of the pectoral base. In *Benthodesmus simonyi* they are already further back than in *B. tenuis*, while among the Lepidopodinae the migration continues: an eye-diameter behind the pectoral base in *Lepidopus* and *Evoxyetopon*, an eye-diameter and a half in *Assurger* and finally five eye-diameters in *Eupleurogrammus*, but all the while a ligamentous connection between the pelvic girdle-rudiment and the symphysis is maintained. This situation has been discussed by Regan (1909: 67).

(7) Hypertrophy of the dorsal musculature, with consequent elevation of the posterior confluence of the frontal ridges of the skull into a distinct sagittal crest (*Lepidopus*, *Trichiurus*) followed at a later stage by an adjacent elevation of the ethmo-frontal region continuing this crest forward along the snout (*Evoxyetopon*, *Assurger*, *Eupleurogrammus*, *Tentoriceps*).

(8) Increase in the number of pyloric caeca. In the Aphanopodinae, as in the

Gempylinae, the number lies within the range 6-9 (6-8 in 30 *Aphanopus* counted) ; in *Lepidopus* it is over 20 and may be much higher in *Trichiurus* (which needs to be studied from fresh material).

(9) Reduction of the soft anal fin from before backwards. In *Diplospinus* the soft anal extends nearly to the vent, so also in *Benthodesmus tenuis*. In *Aphanopus* and in *B. simonyi* the anterior rays are weak and probably of no functional consequence in the fin ; in *Lepidopus* and others only the last 20 rays or so form the true fin. In *Lepturacanthus* and in *Trichiurus* the whole fin is reduced to a series of minute spinules, while in *Eupleurogrammus* the fin as such has ceased to exist and only the basal and interhaemal elements remain, firmly interlocking with the haemal arches to form a continuous mid-ventral keel.

(10) Loss of the caudal fin and hypural bones, independently in *Trichiurus*, *Lepturacanthus*, *Eupleurogrammus* and *Tentoriceps*.

(11) Reduction in the extent of the intermuscular (pleural and epipleural) bones. In *Diplospinus* these long bones are a prominent feature in the skeleton and form a complete basket surrounding the abdominal cavity, but in all the other genera the space which they contain becomes a much smaller portion of the whole. In *Eupleurogrammus* a small "basket" supported by 14 rather smaller vertebrae is pushed to the anterior end of the trunk and is followed by 18-25 vertebrae without epipleurals.

Pari-passu with the major trends outlined above come sporadic tendencies, repeated at different levels :

(a) Excessive elongation of the body, a possible symptom of evolutionary inertia (*Benthodesmus*, *Assurgcr*, *Tentoriceps*).

(b) Hypertrophy of the second anal spine, with correlated condensation of the anterior basal and interhaemal elements into an enlarged supporting structure. (*Aphanopus*, *Lepturacanthus*).

(c) Reduction of the pelvic girdle and fins to an internal rudiment (*Aphanopus*) or their complete loss (*Trichiurus*, *Lepturacanthus*).

Classification of the Trichiuridae

The Aphanopodinae as now recognised comprise Gill's group (*Aphanopus*) with the addition of *Benthodesmus* and *Diplospinus*, genera recognized since Gill's time. They are forms in which the major changes from the Gempylina condition have been accomplished but in which the evolution of the Trichiurid caudal may still be seen proceeding. The discriminant characters of the primitive *Diplospinus* have already been noted ; it is a satisfactory ancestral form except possibly in the advanced barbing of the teeth, a character which, if not merely adaptive, may indicate an affinity with the ancestors of the Trichiurinae rather than with the *Nesiarchus-Aphanopus* line. *Aphanopus* is a secondarily specialized bathypelagic form having an enlarged postanal spine and associated endoskeleton. *Benthodesmus* is an attenuate type which has gone some way with *Aphanopus* (as evidenced by the endoskeleton of the anterior anal fin) and then stopped. *B. simonyi*, evidently derived from *B. tenuis*, shows several evolutionary trends in action in the same genus.

The Lepidopodinae are equivalent again to Gill's group (*Lepidopus*, *Evoxyrmetopon*) with the addition of *Eupleurogrammus* (removed from Gill's *Lepturinae* =

Trichiurinae) and of other genera subsequently recognised—*Assurger*, *Tentoriceps*, *Lepidopus* (as represented by *L. caudatus*) shows a great reduction in the spinous dorsal and the early stages in the uplift of the cranial crest and in the backward progress of the ventral fins; at the same time it has attained equilibrium in the development of vertebrae and soft fin-rays, and is well on the way towards losing its anal fin. The so-called "*Lepidopus xantusi*" of unhappy memory is inadequately known, but would appear to be more primitive than *L. caudatus* and may even deserve generic status in a position between *Lepidopus* and *Diplospinus* in the main stem. In my opinion *L. caudatus* represents the termination of a very old line and its close similarity of skull to *Trichiurus* is the result of parallelism and not of any closer relationship. The remaining Lepidopodine genera—*Evoxymetopon*, *Assurger*, *Tentoriceps*, *Eupleurogrammus*—have in common an elevation of the ethmo-frontal region to continue the sagittal crest forward from the nape to the snout; in *Eupleurogrammus*, the only one of this quartet which I have been able to handle, the homologies in relation to *Lepidopus* are easily discernible and, together with published figures, give sufficient indication of the likely condition in the other three. *Evoxy-metopon* is probably the most primitive of this group, in its shorter body and lower median fin-ray counts and in the position of the ventrals and presence of a caudal fin, but has a rather steep profile. The ecaudate and highly perfected *Eupleurogrammus* may have been descended from this line, sharing with the Lepidopodines (and not with *Trichiurus*, with which it was formerly classified) the uniseriate palatine teeth, median lateral line, ethmo-frontal elevation, ventral fins and rounded operculum. The elongate, caudate *Assurger* and the ecaudate *Tentoriceps* form another like pair.

The Trichiurinae are now restricted to *Trichiurus* and *Lepturacanthus*, the latter Fowler's sub-genus upgraded to full generic rank. They are unique among the Trichiuridae, not for their loss of a tail (which has occurred elsewhere and independently), but in having a band of villiform teeth on each palatine rather than a single series, in having lost the last vestige of a pelvic girdle and fins and in having a low-descending lateral line. Other differences assume greater significance in relation to these. It is therefore likely that the fundamental cleavage between the Trichiurinae and the other two sub-families goes deeper than has previously been supposed.

It is interesting to observe, in conclusion, that although there has been such a great reduction in the number of nominal species formerly placed in *Trichiurus* the residue are now distributed through five genera—*Lepidopus*, *Trichiurus*, *Lepturacanthus*, *Eupleurogrammus* and *Tentoriceps*.

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