NORDA Report 3

The Taxonomy and Distribution of Lanternfishes (Family Myctophidae) of the Eastern Pacific Ocean

NAVY OCEAN RESEARCH AND DEVELOPMENT ACTIVITY
Bay St. Louis, Mississippi

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ROBERT L. WISNER

University of California, San Diego
Scripps Institution of Oceanography

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PREFACE

This study of the lanternfishes (family Myctophidae) of the eastern Pacific Ocean is intended to meet the need for one publication in which the available information on their taxonomy, distribution, variation, and natural history (the latter information is meager) can be found. It also provides keys to their identification.

The study is admittedly a preliminary effort. It is also necessarily incomplete in regard to some genera, notably *Diaphus* and *Gymnoscopelus*. Further collection in the far southern and central Pacific and comparison with worldwide collections are needed before a definitive work on these two genera is accomplished. Similarly, the short-pectoral-fin species group of the genus *Lampanyctus* needs much more study in all oceans.

It is hoped that flaws in the keys and data of this work will be remedied by subsequent workers, and that the present effort will be perfected and expanded to include the entire Pacific Ocean, and perhaps all oceans.

This book was originally designated to be a technical report of the U.S. Naval Oceanographic Office. Intensive work was begun in 1968, and a date in 1970 was set for publication. This markedly later date of appearance is due to delays on my part and to the Oceanographic Office's problems in preparing and scheduling the work for publication.

Robert L. Wisner
Specialist, Marine Biology (Retired)
Scripps Institution of Oceanography
May 1, 1974

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The following also deserve special thanks. John C. Marr and Richard Shomura, formerly of the National Marine Fisheries Biological Laboratory, Honolulu, gave permission to examine a large series of collections from the central Pacific area. Thomas A. Clarke, University of Hawaii, provided specimens and unpublished data on vertical distributions of some species from Hawaiian waters; he and his co-workers offered valuable criticism of some keys to identification. C. Karrer, Zoologisches Museum, Berlin, provided type material of *Diaphus fulgens*. G. E. Maul, Museo Municipal do Funchal, Madeira, and Jorgen Nielsen, Universitetets Zoologiske Museum, Copenhagen, have kindly lent specimens from the Atlantic Ocean for comparative studies.

Dr. Nielsen made available a large unstudied collection of lanternfishes made by several Danish expeditions, principally the Galathea. Dr. P. A. Hulley, South African Museum, Cape Town, kindly permitted me to retain for study a large collection of lanternfishes taken in waters surrounding the tip of South Africa. The latter specimens and those of the Danish expeditions have been of great value as comparative material.

I also wish to thank Drs. E. H. Ahlstrom and G. H. Moser, and their coworkers at the National Marine Fisheries Service, Southwest Fisheries Center, La Jolla, California, for specimens, many discussions, and much testing of the various keys to identification. Michael Barnett has also tested many of the keys during preparation of his doctoral dissertation; his criticisms and suggestions are greatly appreciated.

Bernard J. Zahuranec contributed generously of his time and effort in guiding the manuscript through the technical details of Government publication. I am grateful to Betty N. Shor for her very considerable efforts in typing the original manuscript. Charmion B. McMillan typed and gave valuable help in proofreading the final manuscript. Carl L. Hubbs kindly gave advice on nomenclature.

Lastly, I am most grateful to the late Rolf L. Bolin, who, upon his retirement from active ichthyological work, very kindly presented to me his valuable files of notes and illustrations of type specimens, and of microfilms of old and difficult-to-obtain literature, compiled during his studies of type material of myctophid fishes in the various museums of the world. I have presented these to Dr. Basil G. Nafpaktitis, University of Southern California, Los Angeles.

CONTENTS

INTRODUCTION

This account of the taxonomy and distribution of the lanternfishes (family Myctophidae) is intended to include species that are known, or may reasonably be expected, to occur in the eastern Pacific Ocean, the Polar regions, and eastward of 160° longitude. This westward limit was imposed because of the paucity of collections from west of the Hawaiian Islands and also to avoid the high probability of encountering the poorly understood myctophid fauna of the Indo-Pacific region. Indeed, some species of that fauna were found in both the central and eastern Pacific sectors.

Even in this restricted area, a total of 31 genera (all those currently recognized in the family) and nearly 150 species are recognized as occurring. Some questionable species in the genera *Diaphus* and *Symbolophorus* may later be described as new. Such action is withheld at this time because knowledge of these fishes in the eastern and central Pacific area is incomplete. Also, several of the questionable species appear to be related to forms from the South Atlantic and Indian Oceans. Further comparative studies will be necessary before firm conclusions are warranted.

Prior to this work, few keys to myctophid fishes of the eastern Pacific have encompassed wide ranges of genera or species, and most have been constructed for use in rather restricted areas. This is the first attempt at a key for the entire area and for so many genera and species. A task of this magnitude could not be accomplished without substantial reliance on existing literature. I have drawn heavily from Andriashev's (1962) work on Antarctic myctophids for information on poorly known southern forms of the genera *Gymnoscopelus* and *Protomyctophum*, and on Becker's (1963) study of the latter genus, because of a lack of available study material. Also, as the genus *Lampadena* is poorly represented in the eastern Pacific, and in available study material, I have used keys, illustrations, and data from Nafpaktitis and Paxton (1968). I have used illustrations of other authors when I felt that redrawing would yield no significant improvement or when inadequate material left me no choice. I have restricted my investigation to adults and subadults, because during the earlier part of the study information on larval stages of myctophid fishes of the eastern Pacific was scant. For such information I refer the reader to the recent works of Moser and Ahlstrom (1970, 1972, and 1974). These authors are now completing a study on larval forms of lampanyctid species.

At present, the myctophid fauna from far southern waters of the eastern Pacific are poorly understood, and until very recently the central Pacific area was inadequately collected. Much of the early literature is inadequate or incorrect, particularly that regarding far southern fauna of the *Electronini* and the genus *Gymnoscopelus*. Most problems with these genera stem from a lack of specimens. In the near future, some of these difficulties may be resolved by study of collections gathered by cruises of the USNS *Eltanin* in far southern waters and now under investigation.

Although almost all species treated here are known to occur in the eastern Pacific Ocean, a few from other oceans are included, either because of questionable identification or because they are essential to a discussion of species that do occur in the western Pacific. This is particularly true of the genus *Loweina*; understanding the total problem requires extended discussion of early systematics and the designation and detailed description of lectotypes for two species known mainly from the Atlantic and Indian Oceans, *L. rara* and *L. interrupta*. A similar situation involves the species *Myctophum selenoides* from the Atlantic Ocean; type material of the Atlantic form is not discussed in detail.

Unfortunately, there is little information on the exact depths inhabited by most midwater fishes in the eastern Pacific Ocean; the vast majority of captures have been made with nets that fished open at all times, many fishing from the surface to 1000 m or more. (This range certainly contains most myctophid fishes.) Thus, the depths of capture given in this work are often necessarily imprecise. Also, many of the depths listed for earlier collections, particularly for the Isaacs-Kidd Midwater Trawl (IKMT), were derived from calculations based on wire angles measured at the surface (Clarke, 1963). The resulting depths range from near-surface to 4000 m or more, with the net fishing open at all times. Such records are uninformative of depths actually inhabited by a species, even if the maximum depths calculated are correct. Occasional captures with the opening-closing, paired zooplankton net (Bongo-net, McGowan and Brown, 1966) have given more precise information. However, this net has a much smaller mouth opening and requires a much slower towing speed than the IKMT, and captures consist mostly of the smaller specimens. In this report it is to be assumed, unless otherwise stated, that captures were made with nets that fished open at all times. Depths of capture are thus simply given as "To . . . . m" or "O . . . . m". If known, it is stated whether captures were in daylight or darkness. Data refer only to adults or young adults.

Some information on the approximate levels inhabited by lanternfishes in the eastern Pacific Ocean is offered by Paxton (1967) and Pearcy (1964). Paxton sampled to about 900 m in the San Pedro Basin, southern California, and Pearcy mostly to 200 m, with a few trawls to 1000 m. Unfortunately, both studies were made with nonclosing nets, and both areas have a rather sparse myctophid fauna.

The only major sampling effort with opening-closing trawls was made in the Atlantic Ocean near Bermuda, during the Ocean Acre Project. Gibbs, Goodyear, Keene, and Brown (1971) provide capture data for 52 species of lanternfishes collected with discrete-depth sampling gear.

The distribution charts are based mainly on material in the Marine Vertebrate Collection of the Scripps Institution of Oceanography. This is particularly true for species that are poorly known or easily confused with related forms. Distributional data from recent revisions have been accepted and credited to the authors.

Discussions of zoogeography are offered only in individual species accounts rather than in one formally designated section. Detailed discussions on this aspect of myctophid fishes of the Pacific Ocean have been presented by various Russian ichthyologists, principally Andriashev (1962), Parin (1968), and Becker (1964b).

The extensions of range of several species of the genus *Diaphus*, known previously only from the western Pacific and the Indo-Pacific areas, are reported for the first time; most of these new occurrences appear to be confined to tropical and subtropical regions of the central Pacific. In some instances too few collections were available to permit firm zoogeographical statements, or too few specimens to permit adequate assessment of specific relationships.

Perhaps the most interesting finding was the absence of certain species from a wide area of the extreme eastern Pacific between Baja California and central Chile. Some species were absent throughout this broad area but others from only the northern sector. These absences were evident only for species that are numerous around the periphery of the area but were not taken there despite considerable collecting effort. Thus far involved are the species *Diogenichthys atlanticus*, *Myctophum nitidulum*, the four species of *Centrobranchus*, *Bolinichthys photothorax* and *B. longipes*.

The reasons for these absences are not clear, and a solution or detailed discussion of the problem is beyond the scope of this publication. However, I am inclined to believe that the absences are related to the layer of oxygen-deficient water (containing 1.0 milliliter or less of oxygen per liter of water, ml/l) underlying a large part of the east-central Pacific Ocean, from about central Baja California to central Chile and extending in a narrowing wedge into the central tropical region. Austin (1960) delineated this oxygen minimum in the central area, to 170° W, and Wyrtki (1967) presented a detailed analysis for the eastern area. Wyrtki placed

the upper limit of the layer at depths ranging from 50 to 500 m and showed the thickness of the layer to vary from 200 to 1200 m.

This most interesting problem of interrupted distributions in apparent association with the oxygen minimum should be investigated by the use of depth-selective gear in conjunction with synoptic hydrological observations. Concurrent with that investigation, perhaps something could be learned of the ecology and physiology of those species that must certainly spend much of their lives in this oxygen-minimum layer.

I have arranged the list of genera and species in alphabetical order mainly for ease in finding the account of a particular species. However, in the text I have followed a phylogenetic arrangement so that illustrations and accounts of related forms could be more juxtaposed than would be possible in a strictly alphabetical order. In general, the phylogeny follows the system proposed by Bolin (1939) and further developed by Fraser-Brunner (1949)—a system based on an ancestor having one or more ventral series of photophores, some of which moved dorsally to form patterns of the modern myctophid while others were presumably lost. I have done so because this study is more concerned with aiding the student in ready identification of species than with following the most recent thought on the phylogeny of lanternfishes.

I wish to stress, however, that this action is in no way to be regarded as an intent to ignore or disparage the works of Paxton (1972) and of Moser and Ahlstrom (1970, 1972, and 1974), in which the arrangement employed by Fraser-Brunner (1949) was significantly altered. I agree generally with Paxton's division of the family into the subfamilies Myctophinae (tribes Myctophini and Gonichthini) and the subfamily Lampanyctinae (tribes Diaphini, Notolychnini, Lampanyctini, and Gymnoscopelini). Nor have I any quarrel with Moser and Ahlstrom (1974), who, although in essential agreement with Paxton's suprageneric categories, formulated a somewhat different arrangement based on the sequence of appearance of certain photophores in developing larvae.

Also, I readily accept the proposal by Moser and Ahlstrom (1972) to consider the species *Scopelopsis multipunctatus* Brauer (1906), a species with minute photophores on each scale pocket of head and body, as representing the ancestral form. These authors stated (p. 562): "Whatever were the adaptive forces that marshalled the light organs of myctophids into specific patterns, we believe that the ancestral myctophids had unspecialized photophores distributed over the head and body (one at the margin of each scale pocket) and that the specific patterns were derived by enhancement of some photophores and the concomitant deletion of others." These authors stated further (p. 563): "Such a mechanism for the evolution of photophore pattern seems much less cumbersome than the theory of upward migration of photophores from the ventral series."

Most certainly, as the knowledge of these fishes advances, the traditional phylogeny followed here must give way to a more coherent one encompassing larval development, general morphology, physiology, and ecology, as well as taxonomy.

METHODS

Except as noted, methods of measuring and counting followed those suggested by Hubbs and Lagler (1947). All measurements were made with dial calipers and recorded to the nearest tenth of a millimeter. All lengths refer to standard length unless otherwise stated. The count of dorsal and anal fin rays did not include the anteriormost, often difficult to perceive, small ray; the last ray of these fins was bifurcate to the base and was counted as one. The tiny, often nearly invisible lower rays of the pectoral fins were counted while immersed in water. Only the principal gill rakers were counted (on the upper and lower limbs of the outer arch only), except for the genus *Gonichthys*, in which the rakers became progressively shorter on the lower limb without the usual sudden decrease in size (to "nubs") anteriorly. Both sides were counted for pectoral rays and for anal (AO) photophores. Also, if only a few specimens were available, both sides were counted for gill rakers. In the tabular data on numbers of gill rakers, the central raker (at the juncture of the upper and lower limbs) was included in the count for lower rakers.

The depth of head was measured vertically through the end of the upper jaw, rather than vertically from the occiput. The distance the upper jaw extended beyond the orbit was derived by subtracting from the length of the upper jaw the distance from the tip of the upper jaw to the posteriormost margin of the orbit. The remainder was calculated as percent of upper jaw extending behind the orbit. This method yields a more precise value than the commonly used visual determination of a vertical from the rear margin of the orbit to the upper jaw, or a perpendicular from upper jaw to there. All measures of distance from tip of snout (upper jaw) to fins were made to origins of the fins, except for the adipose fin; in this case the end of the base of the fin, rather than the origin, was used as it afforded a more precise point than the often difficult to perceive (and often arbitrarily selected) origin of the gently rising "ramp" of this base. Thus, the values for "preadipose length" given in the various tables may be slightly greater than those given by other authors.

Unless otherwise stated, all values for body proportions, given in the various tables, are expressed as thousandths of standard length.

The location and terminology of the photophores and other luminous organs of head and body used in the identification of myctophid fishes are shown in Figs. 1, 78, and 84. In general,

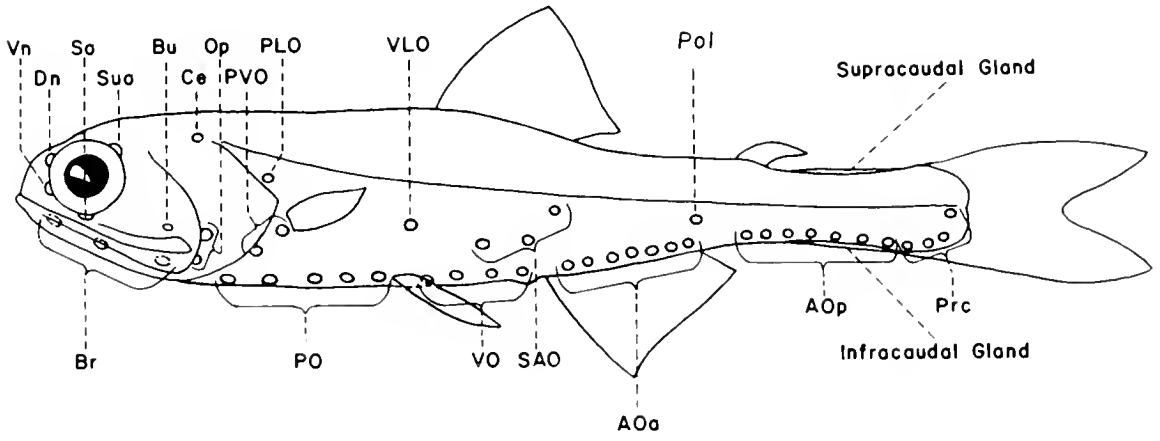


Fig. 1—Diagram of a myctophid fish showing the location and terminology of commonly occurring photophores. No one species will bear all the photophores shown.

only the symbol, e.g., SAO, is used, rather than a name, to denote a group of photophores or a single one, or other organs, but for convenience to the reader the following list of symbols and their commonly accepted names is offered (some alternate names are suggested):

Names of Luminous Organs

Symbol	*Commonly used names*	*Suggested alternate names*
Ant	Antorbital	
Dn	Dorsonasal	
Vn	Ventronasal	
So	Suborbital	
Suo	Supraorbital	
Br	Branchiostegal	
Bu	Buccal	
Ce	Cervical	
Op	Opercular	
PLO	Suprapectoral organ	Pectorolateral organ
PVO	Subpectoral organ	Pectoroventral organ
PO	Thoracic	
VLO	Supraventral	Ventrolateral organ
VO	Ventral organs	
SAO	Supralateral	Supraanal organs
AO	Anal organs (when in unbroken series)	
AOa	Anal organs, anterior	
AOp	Anal organs, posterior	

LIST OF GENERA AND SPECIES

An alphabetically arranged list of the genera and species of myctophid fishes recognized as occurring, or possibly occuring, in the eastern Pacific Ocean between the polar regions and 160° longitude; others, not known to occur in this area, are included for purposes of information and comparison, and for convenience to the student.

KEY TO GENERA OF FAMILY MYCTOPHIDAE

1a. Primary photophores small, usually indistinguishable from minute secondary ones present under each scale of head and body. Bases of dorsal and anal fins very long, about equal in length, their combined lengths contained about 1.75 times in SL.....*Scopelopsis*

1b. Primary photophores larger than and readily distinguishable from any minute secondary ones.....2

2a. No more than 2 Prc. PO_4 not elevated.....3

2b. More than 2 Prc. PO_4 elevated or not.....15

3a. Base of adipose fin far behind vertical from end of anal base. VLO, SAO_3, and Pol far above lateral line near dorsal profile. Upper Prc well above lateral line and about over the lower one. Prominent transparent dome covering pineal organ on top of head.....*Notolychnus*

3b. Base of adipose fin over or slightly before or behind vertical from end of anal base. No primary photophore above lateral line by more than about its diameter. Prc_2 always behind vertical from Prc_1.....4

4a. PLO far below origin of pectoral fin, about on level of base of lowest ray.....5

4b. PLO ranging from about level of pectoral origin to on or slightly above lateral line.....7

5a. Lateral line pores not visible. PLO and PVO_1 juxtaposed, nearly on same level and well below level of PVO_2. AO series in continuous, nearly straight line.....*Protomyctophum*

5b. Lateral line pores readily visible but the line incomplete in some genera.....6

6a. AO series undivided but often undulating near end of anal base, no distinct Pol. VO_2 not, or but slightly, elevated; VO series curved. PLO above PVO_1, about level with PVO_2, the three forming a right-angled triangle.....*Electrona*

6b. AO series divided into AOa and AOp. One or more distinct Pol. VO_2 notably elevated, the series not curved, VO_3 and VO_4 about level with VO_1.....*Metelectrona*

7a. Mouth subterminal, a fleshy snout protruding notably. PLO slightly below or above pectoral origin. Lateral line absent or partly to entirely complete.....8

7b. Mouth terminal.....11

8a. Lateral line absent. Gill rakers reduced to tiny nubs tipped with spinules.....*Centrobranchus*

8b. Lateral line present but incomplete in some genera.....9

9a. Least depth of caudal peduncle slightly greater than orbital diameter. Two to 4 VO (rarely 5); 5 PO (rarely 4 to 8); 2 or 3 SAO. Palatine teeth fanglike. Lateral line incomplete, only a few anteriormost scales perforated.....*Loweina*

9b. Least depth of caudal peduncle less than orbital diameter. Palatine teeth not fanglike.....10

10a. One Prc; 6 (5-9) PO; 6 VO. Lateral line poorly developed, only a few anterior scales perforated.....*Torletonbeania*

10b. Two Prc; 5 PO; 4 VO. Lateral line complete or nearly so, extending to at least near a vertical from adipose fin base.....*Gonichthys*

11a. Prc_2 at or near lateral line, far above level of Prc_1.....12

11b. Prc_2 close Prc_1, well below lateral line.....13

12a. Two Pol. PVO, well below level of PVO_2. VO series level. Both Dn and Vn present. Suo present, often indistinct. SAO series angulate.....*Hygophum*

12b. One Pol. PVO, and PVO_2 about on same level. VO_2 markedly elevated. Dn present, Vn and Suo absent. SAO series angulate.....*Benthosema*

13a. One Pol. PVO_1 and PVO_2 about on same level. VO_2 markedly elevated. Dn present, Vn absent. SAO series in straight line, or SAO_3 offset slightly behind a line through SAO_{1-2}. A few posterior teeth of jaws broad-based with hooked tips ..... *Diogenichthys*

13b. PVO_1 well below level of PVO_2. VO series level. One Pol. Dn and Vn present. No broad-based hooked teeth on jaws 14

14a. SAO series markedly angulate ..... *Symbolophorus*

14b. SAO series straight or slightly angulate ..... *Myctophum*

15a. Caudal luminous glands undivided, large, silvery, usually deeply set into vertical surfaces of caudal peduncle. PO_4 not elevated 16

15b. Caudal luminous glands, if present, divided into platelets or scales that often appear to be coalesced, not deeply set into vertical surface of caudal peduncle. PO_4 elevated or not 18

16a. Lateral line very indistinct or absent. Prominent crescent of whitish tissue on posterior half of iris. Photophores weakly developed, easily lost, apparently absent on one species ..... *Taaningichthys*

16b. Lateral line prominent. No crescent of whitish tissue on posterior half of iris. Photophores strongly to moderately developed 17

17a. Large, elongate luminous gland in front of adipose fin. Four or five Prc, one or two Prc far above lateral line and under dorsal procurrent caudal rays. Numerous minute secondary photophores on head, body, and proximal part of caudal fin ..... *Dorsadena*

17b. No luminous gland in front of adipose fin. No Prc above lateral line. No secondary photophores on body ..... *Lampadena*

18a. PO_4 elevated 19

18b. PO_4 not elevated 27

19a. First 3 VO in ascending straight line, subsequent VO on level of VO_1 20

19b. First 3 VO not in ascending straight line. VO_2 and VO_3 may be abruptly elevated, or the VO series curved 21

20a. Vn, Ant, and So absent. Dn present but often inconspicuous. Large supracaudal luminous gland in males, much smaller infracaudal gland in females. No luminous scale on PLO ..... *Lobianchia*

20b. Dn and Vn always present; So and Ant present in some species. No caudal luminous glands. More or less prominent luminous scale at PLO in nearly all species ..... *Diaphus*

21a. Small luminous scales at bases of rays of dorsal and anal fins, 5 VO 22

21b. No small luminous scales at bases of rays of dorsal and anal fins; 4 or 5 VO, the second and third elevated in some genera 24

22a. Five Prc closely spaced in continuous, nearly straight line. All upper photophores well below lateral line; 5 VO, the series curved. VO_2, VO_3, and VO_4 above level of VO_1 and VO_5 ..... *Lampanyctodes*

22b. Three or four Prc, the series angulate. Upper photophores immediately above or below lateral line; 5 VO, only VO_2 elevated, the rest on same level 23

23a. Three Prc. Crescent of whitish tissue on posterior half of iris. Upper photophores touching slightly below or above lateral line. SAO series only slightly angulate ..... *Bolinichthys*

23b. Four Prc. No crescent of whitish tissue on posterior half of iris. Upper photophores touching but not above lateral line. SAO series notably angulate ..... *Lepidophanes*

24a. SAO series in straight or very slightly angulate line; 3 to 4 Prc 25

24b. SAO series markedly angulate 26

25a. One Pol. All upper photophores several diameters below lateral line; 3 or 4 Prc, evenly spaced in curve ..... *Stenobrachius*

25b. Two Pol. All upper photophores touching or very near lateral line; 4 Prc, the series angulate, upper Prc widely separated from the rest ..... *Parvilux*

26a. Five VO, the second always, the third occasionally, elevated and displaced forward; 3 Prc evenly spaced and usually separate from AOp. Upper photophores touching lateral line either above or below it ..... *Triphoturus*

26b. Four VO, the second, but never the third, sometimes elevated and occasionally displaced forward. Upper photophores sometimes touching, but never above lateral line ..... *Lampanyctus*

27a. First AOa, and occasionally last, highly elevated 28

27b. First AOa never last occasionally, elevated 29

28a. Bases of dorsal fin notably longer than base of anal fin. Primary photophores large, indistinct. Scales of luminous tissue in rows along bases of rays of dorsal and anal fins, and elsewhere on body. No caudal luminous glands. SAO series forming straight, steeply oblique line; 2 Pol in nearly horizontal line; 3 to 6 Prc ..... *Hintonia*

28b. Base of dorsal fin variably slightly longer or shorter than base of anal fin. Primary photophores small but distinct. Scattered small scales of luminous tissue on body, often arranged in short rows. No caudal luminous glands. SAO in straight, nearly vertical line. One Pol; 4 to 9 Prc ..... *Gymnoscopelus*

29a. VO_2 and VO_3 elevated, the series curved. PV_2 below origin of pectoral fin and on line through PO_1 and PVO_1; 2 Pol in steeply oblique line. Luminous scales on dorsal midline before and behind, but not at base of, dorsal fin. Similar scales on ventral midline between origins of pelvic and anal fins, along base of anal fin, at bases of ventral procurrent caudal rays, between PO_1 and PVO_2, and near PLO. Infracaudal gland long, with 6-8 scales ..... *Ceratoscopelus*

29b. VO series level. PVO_2 above origin of pectoral fin and about directly over PVO_1; 2 or 3 Pol, at least 2 Pol in horizontal line 30

30a. Base of dorsal fin much longer than base of anal fin. No photophores on cheek. No minute secondary photophores on body; 2 or 3 Pol in a horizontal line; 3 Prc, the upper widely distant from the first two. A few small scales of luminous tissue randomly scattered over body, often in short rows above lateral line near head and below dorsal base and at bases of procurrent caudal rays. Supracaudal luminous gland large, infracaudal gland very small ..... *Notoscopelus*

30b. Base of dorsal fin slightly shorter than base of anal fin. Three to five photophores on cheek. Minute secondary photophore under each scale of body; 3 Pol, 2 near and parallel with lateral line, a third directly below the anteriormost of the upper two; 4 Prc. Small scales of luminous tissue scattered over body. Caudal luminous glands small and inconspicuous ..... *Lampichthys*

DISCUSSION OF GENERA AND SPECIES

Protomyctophum Fraser-Brunner, 1949

PLO before and nearly touching PVO_1, the two on about the same level and usually below level of PVO_2, the latter lying at bases of lower pectoral rays. Lateral line pores not visible. AO series undivided, no Pol. SAO series in a straight or slightly angulate line. Interorbital width as great or greater than width of expanded distal portion of upper jaw.

A subgenus, *Hierops* Fraser-Brunner (1949), is separable, in part, in that the interorbital width is seldom more than half (usually less) the expanded portion of upper jaw.

In the eastern Pacific Ocean most species of *Protomyctophum* occur in Antarctic waters and northward along the coast of Chile to about 30° S. Only three species (all of the subgenus *Hierops*) occur north of the equator; one of these, *P. (H.) beckeri*, is a tropical species which may occur on either side of the equator.

Since the circumglobal waters of the Antarctic are still poorly collected, it is not possible to give exact ranges for the species of this genus; it is assumed that all may be circumglobal in distribution. When known, an eastern Pacific range is given.

As a result of participation in several trans-Pacific cruises of the USNS *Eltanin* in antarctic and subantarctic waters, personnel of the University of Southern California obtained large collections of fishes of the tribe Electronini Wisner (1963b). These collections, now being studied, should further the understanding of these fishes.

The following species accounts and figures for *Protomyctophum* are taken largely from Andriashev (1962) and Becker (1963a), whose studies were the result of several cruises of Soviet vessels into far southern waters.

Key to species of *Protomyctophum*

1a. Interorbital width as great or greater (rarely slightly less) than greatest width of distal portion of upper jaw, the upper orbital margins converging anteriorly (subgenus *Protomyctophum*) 2

1b. Least interorbital width seldom more than half (usually less) than greatest width of distal portion of upper jaw, the upper orbital margins parallel (subgenus *Hierops*) 6

2a. Two SAO (rarely 3), the series very low on body and lying between verticals from VO_4 and AO_1. The 2 Prc separated by about half a photophore diameter ..... *P. (P.) anderssoni*

2b. Three SAO (rarely 4); SAO_1 about over VO_3 3

3a. SAO series distinctly angulate; SAO_{1-2} interspace greater than that of SAO_{2-3} 4

3b. SAO series in a straight line, evenly spaced 5

4a. SAO_1 slightly behind a vertical from VO_3. AO 17-19; 4 AO behind end of anal base ..... *P. (P.) tenisoni*

4b. SAO_1 over VO_3. AO 15-17; 3 AO behind end of anal base ..... *P. (P.) normani*

5a. SAO series in a flatly oblique line. AO 17-19 4 AO behind end of anal base. Gill rakers 5+1+15-16, total 21-22. The Prc separated by 1.0 to 1.5 photophore diameters ..... *P. (P.) bolini*

5b. SAO in a steeply oblique line. AO 16-17; 3 AO behind end of anal base. Gill rakers 4+1+14, total 19. Prc very close together. ..... *P. (P.) andriashevi*

6a. Interorbital width contained 2 to 3 times in width of distal portion of upper jaw 7
6b. Interorbital width very narrow, contained 5 to 7 times in width of distal portion of upper jaw 10
7a. SAO series angulate. SAO_{1-2} interspace greater than that of SAO_{2-3}; SAO_3 usually well above a line through SAO_{1-2}; SAO_1 over VO_3. AO 16 (15-17); 3 or 4 AO behind end of anal base .....*P. (H.) thompsoni*
7b. SAO series usually in an evenly spaced straight line; SAO_1 over or slightly before VO_4. AO usually 12-14 (rarely more); 2 or 3 AO behind end of anal base 8
8a. Gill rakers 4 +1+12 (11-13), total 17 (16-18).....*P. (H.) beckeri*
8b. Gill rakers 4-5 +1+15-17, total 20-23.....9
9a. Head and prepectoral lengths about 30-33% of SL. AO 13-14 (12-16); 2 or 3 AO behind end of anal base .....*P. (H.) crocker*
9b. Head length 37-38% of SL; prepectoral length 34-39% of Sl. AO 13 (12-14); 2 (rarely 1 or 3) AO behind end of anal base .....*P. (H.) chilense*
10a. Prc interspace equal to 1.0 to 1.5 photophore diameters. AO 14 (13-15), usually 3 AO behind end of anal base.....*P. (H.) subparallelum*
10b. Prc interspace equal to 3 to 4 photophore diameters, about equal to AO-Prc interspace. AO 17-19; 6 to 7 AO behind end of anal base .....*P. (H.) parallelum*

Protomyctophum (Protomyctophum) anderssoni
(Lönnberg, 1905)

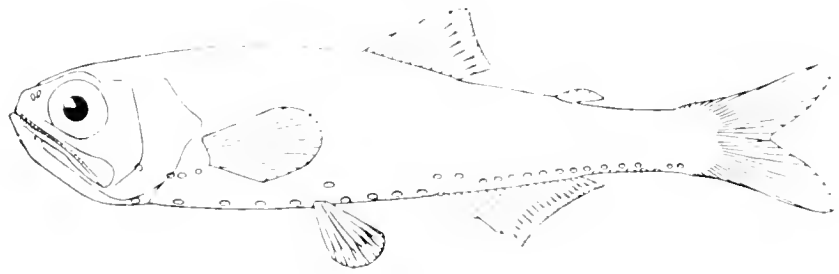


Fig. 2—*Protomyctophum (P.) anderssoni*, female, 68.0 mm. From Andriashev (1962, p. 227, fig. 6).

Description

D. 11-12; A. 18-19; P. 14-15; AO. 12-13; gill rakers 6-8 + 1 + 19-22, total 26-30; vertebrae 38 (37-39).

Two SAO (rarely 3) low on body, horizontal, over space between VO and AO series. Prc a little less than a photophore diameter apart. VLO low, a little above and behind pelvic origin. Four AO behind end of anal base. Greatest depth of body about 20% of SL.

Supracaudal luminous glands of males with 5 to 7 rounded, deeply set scales (Fig. 3). Infracaudal glands of females with to 3 to 5 weakly outlined spots. In either sex these glands do not form until 30 mm or larger.

Size: Females to 68 mm, males to 58 mm.
Least depth of capture: To 100 m.
Distribution: Circumglobal between about 40° S and 65° S.

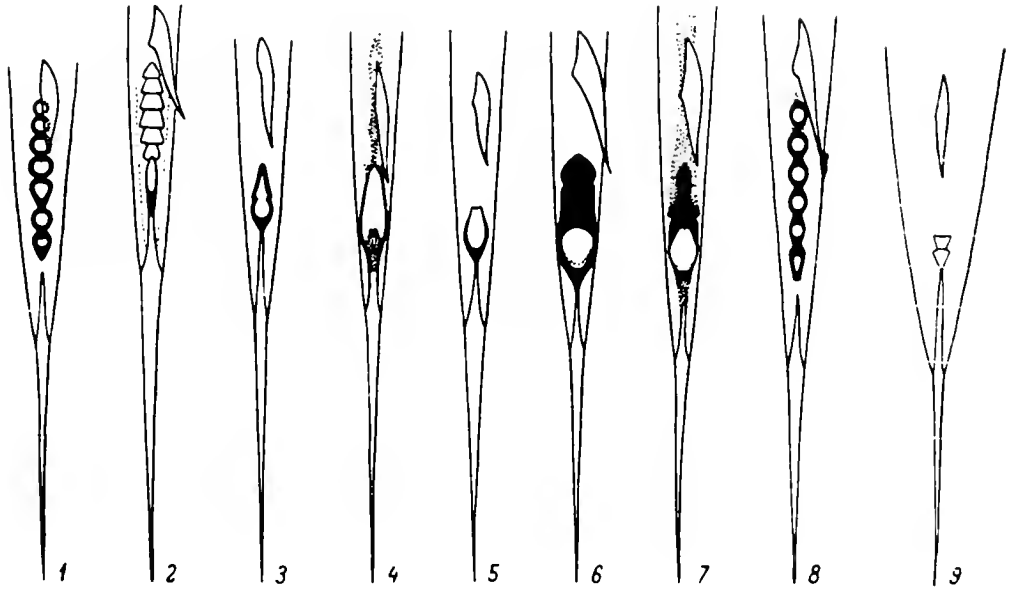


Fig. 3—Supracaudal luminous glands of males of certain species of the genera *Protomyctophum* and *Electrona*. (1) *Protomyctophum (Protomyctophum) anderssoni*, (2) *P. (P.) tenisoni*, (3) *P. (P.) bolini*, (4) *P. (Hierops) crockeri*, (5) *P. (H.) thompsoni*, (6) *P. (H.) subparallelum*, (7) *P. (H.) parallelum*, (8) *Electrona antarctica*, (9 *E. subaspera*. From Andriashev (1962, p. 217, fig. 1).

Protomyctophum (Protomyctophum) tenisoni
(Norman, 1930).

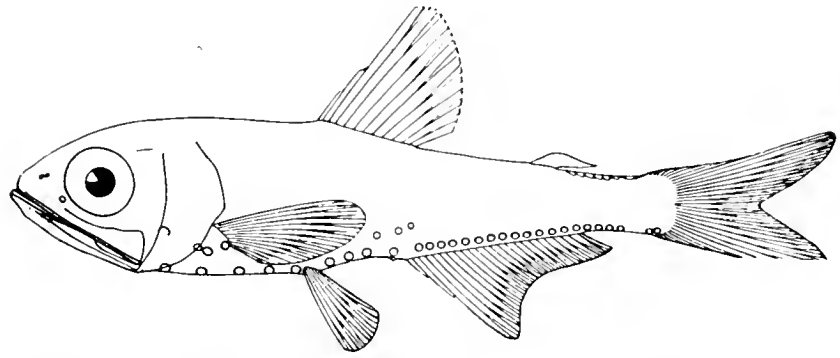


Fig. 4—*Protomyctophum (P.) tenisoni*, male, 39.0 mm. From Andriashev (1962, p. 229, fig. 8).

Description

D. 12-13; A. 22-23; P. 14-15; AO 17-19; gill rakers 6 + 1 + 17, total 24; vertebrae 40 (39).

Three SAO (seldom 4) in nearly straight, very slightly oblique line; SAO_{1-2} interspace a little greater than that of SAO_{2-3}. Prc juxtaposed. Photophores light, silvery. Greatest depth of body not more than 25% of SL, usually less.

Males with 6 to 7 supracaudal luminous glands, rather trapezoidal in shape (Fig. 3); females with 4 to 5 weakly outlined spots infracaudally.

Size: To about 70 mm (Norman, 1930).

Least depth of capture: To 77 m (Norman, 1930).

Distribution: Possibly circumglobal in Antarctic waters below 41° S; has been taken most often in the South Atlantic but also near Australia.

Protomyctophum (Protomyctophum) normani
(Tåning, 1932)

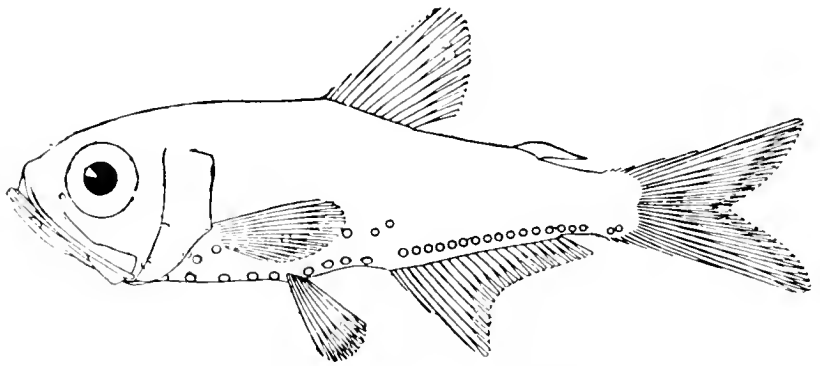


Fig. 5—*Protomyctophum (P.) normani*, sex unknown, 34.0 mm. From Andriashev (1962, p. 231, fig. 10).

Description

D. 13; A. 22-23; P. 14-15; AO 15-17; gill rakers 6 (5-7) + 1 + 16-19, total 24-25 (22-27); vertebrae 37-38.

SAO in a distinct, broadly obtuse angle; SAO_{1-2} interspace a little greater than that of SAO_{2-3}. Prc nearly touching each other. Usually 3 AO behind end of anal base. Eye large, over two-fifths of head length. Greatest depth of body 25-30% of SL.

Both supracaudal and infracaudal luminous glands may be present in each sex (definitely in females) from 25 mm and larger. Caudal glands of males are similar to those of *P. (H.) crockeri*; those of females are 2 to 4 small, overlapping, muddy-gray scales.

Size: To about 60 mm.

Least depth of capture: Andriashev (1962) listed 3 specimens taken with 4700 m of wire out.

Distribution: Probably circumglobal in sub-antarctic waters; known from near the Cape of Good Hope, from east of New Zealand, and from the southeastern Atlantic Ocean.

Discussion

This species is poorly known, and few specimens have been available for study. Becker (1963a) reported that 8 specimens from the southwestern Atlantic differed from 3 specimens from near New Zealand in having a blunter snout and fewer gill rakers (20-25 vs 25-26).

Protomyctophum (Protomyctophum) bolini
(Fraser-Brunner, 1949)

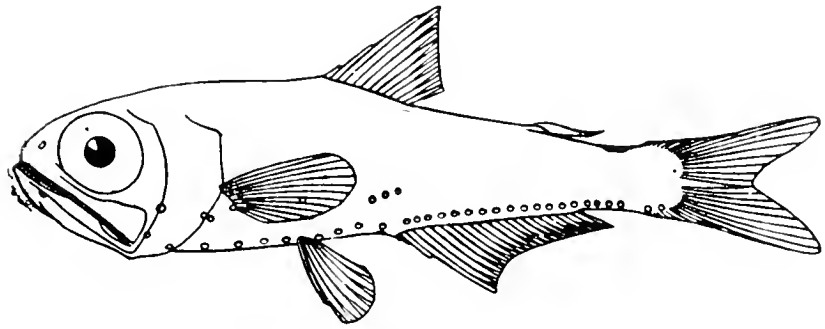


Fig. 6—*Protomyctophum (P.) bolini*, male, 52.5 mm. From Andriashev (1962, p. 233, fig. 11).

Description

D. 12-13; A. 24-25; P. 14-15; AO 17-19; gill rakers 5 + 1 + 15-16, total 21-22; vertebrae 39-40.

Three SAO (seldom 4), closely spaced in a very oblique, nearly horizontal, line. SAO_1 over VO_{3-4} interspace, usually nearer VO_3. Prc 1.0 to 1.5 photophore diameters apart. Usually 4 AO behind end of anal base. All photophores dull and dark in appearance.

Supracaudal glands of males (Fig. 3) a single (or coalesced double) small luminous patch just before first procurrent caudal ray; a constriction near the middle suggests two parts. The gland is rather prominently outlined with black pigment. Infracaudal glands of females usually with three small, weakly outlined spots.

Size: To about 55.0 mm.

Least depth of capture: To about 200 m.

Distribution: Apparently circumglobal between about 40° and 60° S.

Protomyctophum (Protomyctophum) andriashevi
Bekcer, 1963

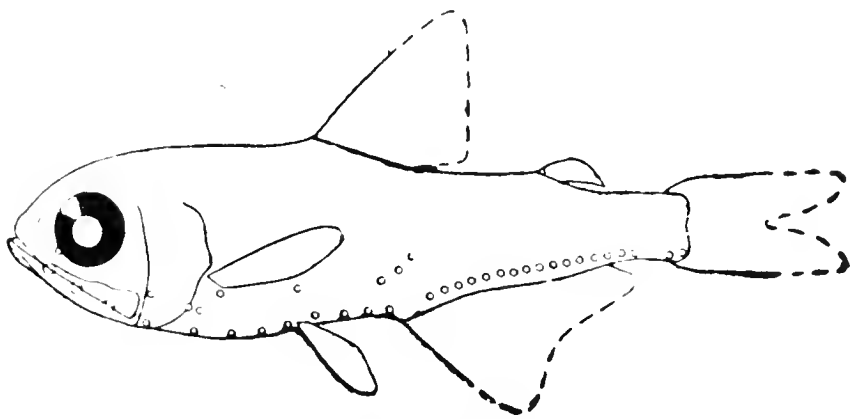


Fig. 7—*Protomyctophum (P.) andriashevi*, sex unknown, 29.7 mm. From Becker (1963a, p. 19, fig. 2).

Description

D. 12-13; A. 22-23; P. 16; AO 16-17; gill rakers 4 + 1 + 14, total 19; vertebrae 38-39.

SAO evenly spaced in a usually straight, oblique line that passes through VO_2. SAO_1 nearer VO_3 than to VO_4. Prc very close together, the last often slightly elevated. Snout obtuse, not steeply rounded.

Supracaudal glands of males described by Becker, from only two of six specimens, as a muddy-gray narrow band extending the length of the caudal peduncle. The caudal glands of females are unknown.

Size: To about 35 mm.

Least depth of capture: Recorded by Becker (1963a) as from 312 to 624 m.

Distribution: The species is known only from the southern Atlantic Ocean, at about 42° S, 39° W.

Subgenus Hierops
Fraser-Brunner, 1949

The subgenus *Hierops* is very similar to but differs from the subgenus *Protomyctophum* in that the interorbital space is generally less than half as great as the widest part of the expanded distal portion of the upper jaw, rather than equal to it or greater; the frontal bones over the orbit are nearly parallel, or are slightly closer together posteriorly than anteriorly, rather than considerably wider posteriorly and converging anteriorly, as in the subgenus *Protomyctophum*. In correlation with this narrowing of the frontal bones the eyes are canted inward toward the dorsal midline. Also, the dorsal portion of the iris is noticeably narrower than the ventral portion, and the lens is often directed more dorsally than laterally—a condition that has been referred to as "telescopic."

Fraser-Brunner (1949) divided the genus *Electrona* Goode and Bean (1896) into four subgenera, *Protomyctophum*, *Hierops*, *Electrona*, and *Elampa*. Bolin (1959) raised the first three to full generic status but did not discuss the subgenus *Elampa*; Wisner (1963b) referred the latter to the genus *Electrona*. Since its introduction the subgenus *Hierops* has been alternately accepted and rejected, both as a genus and subgenus.

Andriashev (1962) considered but two genera as valid, *Protomyctophum* and *Electrona*, and reduced *Hierops* to a subgenus of the first, stating that he had found at least one specimen of the subgenus with an interorbital width nearly as great as the width of the expanded distal portion of the upper jaw—a basic character separating *Protomyctophum* and *Hierops*. Becker (1963a and b), although appearing to agree with the subgenus status of *Hierops*, used only *Protomyctophum* as a generic term in dealing with primitive electronins from the North and South Pacific Oceans. More recent authors have been divided on the use of the subgeneric name *Hierops*. Nafpaktitis and Nafpaktitis (1969) retained it, but Moser and Ahlstrom (1970) at first did not and subsequently did (1974).

In an effort to determine the limits of variation of two basic characters that distinguish the subgenus *Hierops* (the very narrow interorbital space and asymmetrical iris), 351 specimens of *P. (H.) crockeri* (15 to 47 mm) and 207 specimens of *P. (H.) thompsoni* (16 to 51 mm) were examined. The interorbital space ranged from 21% to 86% of greatest width of upper jaw in *P. (H.) thompsoni*. In *P. (H.) crockeri* the interorbital space was half or less the greatest width of upper jaw in 89% of the specimens, and half or less in 76% of *P. (H.) thompsoni*. Of those specimens of *P. (H.) crockeri* with values below the 50% level 57% were in the 31%-45% bracket, whereas of those of *P. (H.) thompsoni* 50% were in this bracket.

In regard to the characters of asymmetrical iris and "telescopic eyes," of 270 specimens of *P. (H.) crockeri* with the eyes intact, 97.4% had asymmetrical irises but only 27.4% had the lens directed upward. Of 196 specimens of *P. (H.) thompsoni* with intact eyes, 79.6% had asymmetrical irises and only 23.5% had lenses directed upward ("telescopic eyes").

It may be that the dorsal displacement of the lens is an artifact of crowding in the net during capture, or of preservation; but the predominant asymmetry of the iris does not appear

to be an artifact and thus, along with the concomitant narrowed interorbit bones, offers justification for retaining *Hierops* as a subgenus of *Protomyctophum*.

Protomyctophum (Hierops) crockeri
(Bolin, 1939)

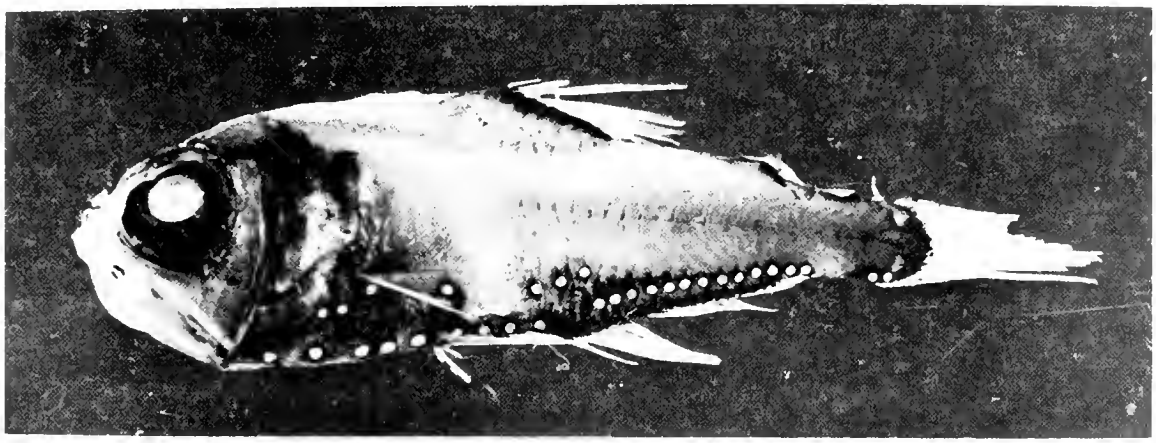


Fig. 8—*Protomyctophum (H.) crockeri*, male, 34.5 mm. (Photophores retouched).

Description

D. 11-13; A. 21-22 (19-24); P. 15-16 (13-17); AO 13-14 (12-16); gill rakers 4-5 (6) + 1 + 15 (13-17), total 20-22 (18-24) (see Table 1); vertebrae 36-37.

Three (rarely 4) SAO, usually equally spaced and in a straight, or nearly so, flatly oblique line; SAO_1 usually over or just before VO_4, rarely over midpoint of VO_{3-4} interspace. Interorbital width usually half or less than width of expanded end of upper jaw.

Supracaudal luminous glands of males (Fig. 3) begin to appear on specimens of about 25 mm and are single, prominent glands that protrude well above the dorsal profile of the caudal peduncle, just before the procurrent caudal rays, and extend somewhat down along the lateral surface of the peduncle. Infracaudal glands of females with 3 (rarely 2 or 4) small, oblong, juxtaposed spots embedded in the caudal peduncle.

Size: To about 46 mm.

Least depth of capture: Commonly taken at night above 100 m but apparently not at the surface; find no record of capture by surface nets.

Distribution: Across the North Pacific, primarily within the sub-arctic and California Current systems, to about 25° N (rarely beyond) (Fig. 9). At the seaward edge of these currents the species apparently occurs in the transition zone of the North-Central Water. The capture localities include those from Aron (1960), Becker (1963b), and Berry and Perkins (1966) and from many trawls by Scripps vessels. Only a relatively small part of these collections was immediately available for study.

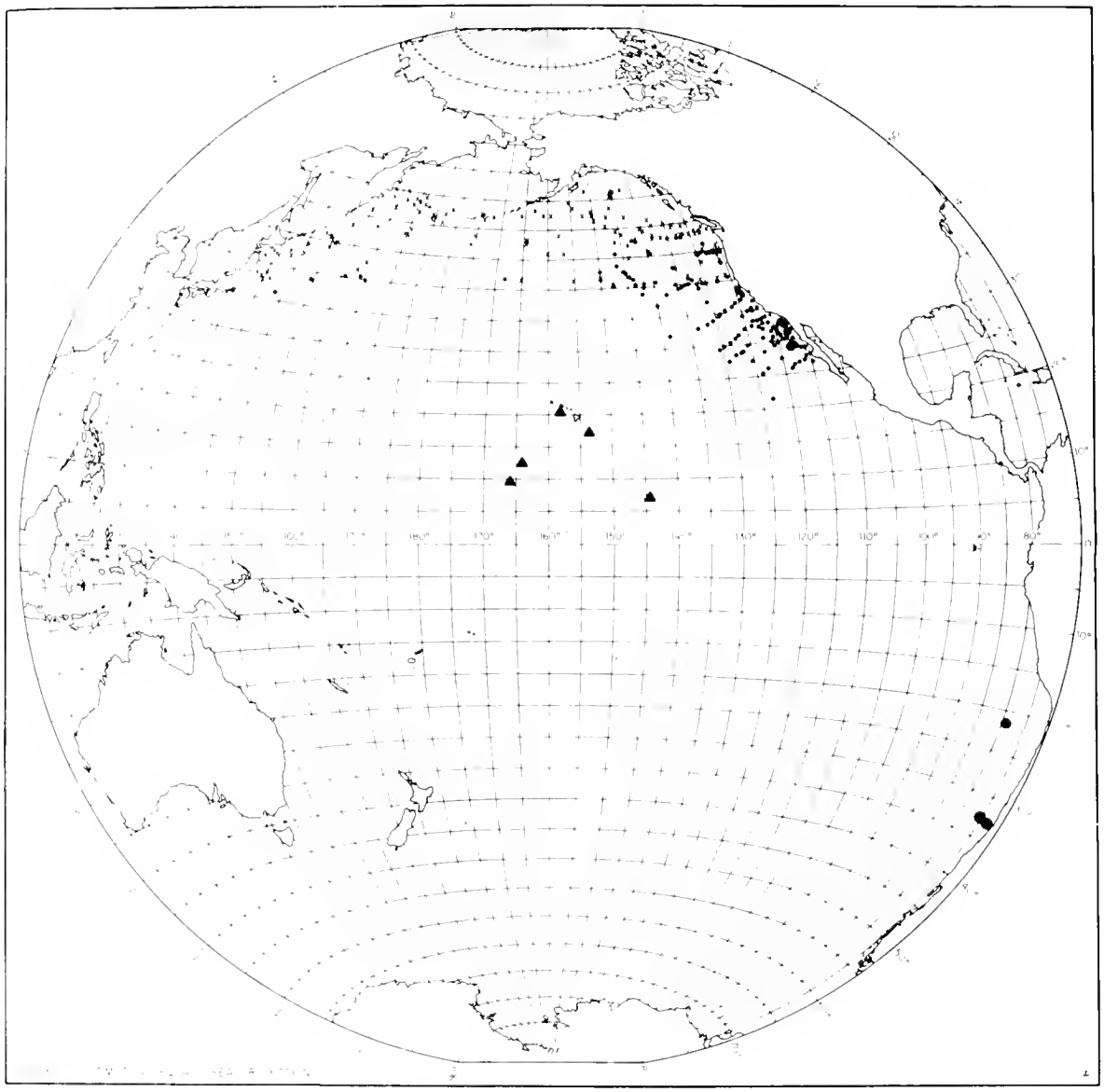


Fig. 9—Capture localities of *Protomycotphum (Hierops) crockeri* (small solid circles), *P. (H.) thompsoni* (X), *P. (H.) chilense* (large solid circles), *P. (H.) beckeri* (solid triangles).

Discussion

Becker (1963b) stated that, based primarily on meristic characters, within the total population of *P. (H.) crockeri* three areal groups were evident. He defined them broadly as: Western (coast of Honshu to 165° E), Eastern (coast of Oregon to 155° W), and Southeastern (coast of California). Becker concluded that despite an almost complete overlap in counts the numbers of pectoral and dorsal rays and gill rakers increased from west to east but that the number of AO photophores increased from east to west. Unfortunately, Becker had few specimens from the western and southeastern areas (no more than 13 counts and as few as 7) and from 34 to 52 counts from the eastern area.

No specimens were available to the present study from the western area, but a large number were available from the areas corresponding to the eastern and southeastern areas, as defined by Becker. Specimens from these areas were separated into the following four subareas (Table 1): 40° to 50° N, west of 130° W; coasts of Washington and Oregon; southern California

(San Diego Trough); Guadalupe Island, Mexico, and southward. Numbers of pectoral and anal rays, AO photophores, and gill rakers from these four areas are given in Table 1. Dorsal rays numbered 12 (11-13) and were virtually identical for all four areas.

TABLE 1. NUMBERS OF PECTORAL AND ANAL FIN RAYS, AO PHOTOPHORES, AND GILL RAKERS FOR *PROTOMYCTOPHUM (HIEROPS) CROCKERI* FROM FOUR AREAS OF THE NORTHEASTERN PACIFIC OCEAN

Area	Pectoral rays						
	13	14	15	16	17	N	Mean
40°-50° N, west of 130° W.	1	12	87	80	11	191	15.47
Near coasts of Washington and Oregon	—	5	35	33	3	76	15.45
Southern California (San Diego Trough)	—	16	48	36	3	103	15.25
Guadalupe Island and southward	—	5	27	57	1	90	15.60

	Anal rays							
	19	20	21	22	23	24	N	Mean
40°-50° N, west of 130° W.	—	—	5	19	23	1	48	22.42
Near coasts of Washington and Oregon	1	4	16	23	3	1	48	21.54
Southern California (San Diego Trough)	4	6	30	26	2	—	68	21.24
Guadalupe Island and southward	—	11	12	13	4	—	40	21.25

	AO photophores						
	12	13	14	15	16	N	Mean
40°-50° N, west of 130° W.	2	91	296	37	1	427	13.87
Near coasts of Washington and Oregon	1	35	66	6	—	108	13.71
Southern California (San Diego Trough)	6	112	103	6	2	229	13.50
Guadalupe Island and southward	5	61	36	2	—	104	13.34

	Upper gill rakers				
	4	5	6	N	Mean
40°-50° N, west of 130° W.	111	54	—	165	4.33
Near coasts of Washington and Oregon	63	37	—	100	4.37
Southern California (San Diego Trough)	39	94	—	133	4.71
Guadalupe Island and southward	—	91	8	99	5.08

	Lower gill rakers						
	14	15	16	17	18	N	Mean
40°-50° N, west of 130° W.	2	33	110	20	—	165	15.90
Near coasts of Washington and Oregon	—	17	63	20	—	100	16.03

TABLE 1 (CONTINUED)

Southern California (San Diego Trough)		—	10	71	46	6		133	16.36
Guadalupe Island and southward		—	2	11	57	29		99	17.11
	Total gill rakers								
	18	19	20	21	22	23	24	N	Mean
40°-50° N, west of 130° W.	2	26	80	47	10	—	—	165	20.22
Near coasts of Washington and Oregon	—	15	40	35	10	—	—	100	20.40
Southern California (San Diego Trough)	—	8	30	46	43	6	—	133	21.07
Guadalupe Island and southward	—	—	2	11	50	34	2	99	22.23

The data in Table 1 support Becker's conclusions in part. The numbers of anal rays and AO photophores increase slightly from south to north, but the reverse is true for pectoral rays and gill rakers. The greatest variation among the four areas of the eastern Pacific is in the numbers of gill rakers. There is an average difference of 2 total rakers between the northern and southern extremes of the total range, with both the upper and lower counts contributing to the difference.

Protomyctophum (Hierops) beckeri
Wisner, 1971

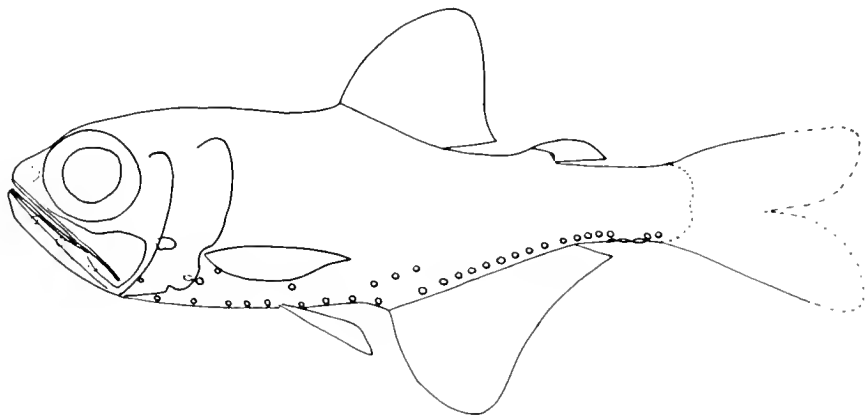


Fig. 10—*Protomyctophum (H.) beckeri*, female, 36.4 mm.

Description

D. 11-12; A. 21-23; P. 14-15: AO 14 (13-15); gill rakers 4 + 1 + 13 (12-14), total 18 (17-19); vertebrae 37 (4 specimens).

P. (H.) beckeri is superficially very similar to *P. (H.) crockeri* and *P. (H.) chilense* in having similar arrangements of photophores and precaudal luminous glands. It differs principally in having fewer total gill rakers (16-18) than the other two species (20-23) (Table 2). The relationships of these three species are discussed following the account of *P. (H.) chilense*.

Size: To about 37 mm.

Least depth of capture: To 326 m at night, near Hawaii. Becker (1963b) reported the capture of one specimen at the surface at night in the central tropical Pacific.

Distribution: Known only from the five localities indicated by solid triangles in Fig. 9.

TABLE 2. NUMBERS OF FIN RAYS, ANAL PHOTOPHORES (AO), AND GILL RAKERS FOR *PROTOMYCTOPHUM (HIEROPS) CHILENSE, P. (H.) CROCKERI,* AND *P. (H.) BECKERI**

Species	Dorsal rays			Anal rays			
	11	12	13	20	21	22	23
P. (H.) chilense	1	13	2	—	8	7	1
P. (H.) crockeri	2	19	5	2	12	11	1
P. (H.) beckeri	1	3	—	—	2	1	1

	Pectoral rays				AO photophores				
	14	15	16	17	12	13	14	15	16
P. (H.) chilense	—	12	16	4	7	29	2	—	—
P. (H.) crockeri	4	42	24	2	4	42	32	2	2
P. (H.) beckeri	1	7	—	—	—	2	7	1	—

	Gill rakers								
	Upper		Lower						
	4	5	12	13	14	15	16	17	18
P. (H.) chilense	—	38	—	—	—	—	23	15	—
P. (H.) crockeri	18	50	—	—	—	—	35	28	5
P. (H.) beckeri	10	—	1	8	1	—	—	—	—

	Total rakers							
	16	17	18	19	20	21	22	23
P. (H.) chilense	—	—	—	—	—	23	15	—
P. (H.) crockeri	—	—	—	—	15	23	25	5
P. (H.) beckeri	1	8	1	—	—	—	—	—

*Data for *P. (H.) crockeri* are taken only from specimens from the type locality, off San Diego, California

Protomyctophum (Hierops) chilense
Wisner, 1971

Fig. 11—*Protomyctophum (H.) chilense*, male, 38.0 mm.

Description

D. 12 (11-13); A. 21-22 (23); P. 16 (15-17); AO 13 (12-14); gill rakers 5 + 1 + 16-17 (18), total 21-22 (23); vertebrae 36 (35).

This species is closely related and superficially very similar to *P. (H.) crockeri* and *P. (H.) beckeri*, particularly in numbers and arrangements of photophores and precaudal glands. The relationships of these three species are discussed below.

Size: To 38 mm.

Least depth of capture: To 350 m at night.

Distribution: Known only from off Chile near Valparaiso northward to about Iquique and westward to about 79° W. Apparently does not occur northward of about 21° S for it was not recorded from north of that latitude by Bussing (1965); not taken on Cruise 12 of the R/V *Anton Bruun* off Peru in 1965, nor during the Scripps expedition Piquero in 1969, on the R/V *Thomas Washington*. Most captures lie well within the confines of the Peru-Chile Current.

Discussion

The preceding three species *Protomyctophum (Hierops) chilense, P. (H.) beckeri,* and *P. (H.) crockeri* are closely related and superficially very similar. They are separable by only a few of the characters listed in Tables 2 (counts) and 3 (body proportions). In each table, data for *P. (H.) crockeri* are only from specimens from the type locality, Cortes Bank, about 100 mi (160 km) west of San Diego, California. This restriction was imposed because of the existence of subpopulations throughout the range of the species, as demonstrated above.

TABLE 3. BODY PROPORTIONS FOR *PROTOMYCTOPHUM (HIEROPS) CHILENSE, P. (H.) BECKERI,* AND *P. (H.) CROCKERI*

Measurement	*P. (H.) chilense*		*P. (H.) beckeri*					*P. (H.) crockeri***	
	N = 15 (21-38 mm)		Holotype	Paratypes			Becker (1963b)*	N = 12 (25-41 mm)	
	Ave	Range	27.0 mm	36.5 mm	36.4 mm	34.0 mm	34.3 mm	Ave	Range
Head length	376	367-385	344	331	324	344	356	315	303-330
Head depth	302	289-325	288	280	280	294	—	299	289-310
Upper jaw length	244	234-261	234	219	223	230	—	217	206-237
Orbit length	148	137-160	133	126	126	—	—	135	122-144
Interorbital width	31	25-42	48	41	41	44	—	23	17-26
Prepectoral length	352	336-366	330	324	310	324	348	315	297-331
Prepelvic length	452	442-468	450	460	462	459	483	444	418-465
Predorsal length	532	517-547	511	520	495	533	526	511	501-520
Preanal length	588	562-620	589	590	590	586	643	587	561-615
Preadipose length	810	802-823	834	833	830	827	813	812	793-827
Dorsal origin to pelvic origin	320	306-340	319	324	324	318	354	307	291-318
Dorsal origin to anal origin	308	296-325	312	320	316	318	321	294	279-304
Anal base length	290	272-305	293	271	278	280	—	283	256-309
Dorsal base length	155	141-177	167	154	159	165	—	150	137-162
Caudal peduncle length	161	151-171	152	159	170	153	187	170	159-187
Caudal peduncle depth	98	89-105	96	110	102	106	105	96	85-112
Pectoral-fin length	232	217-245	222	214	220	209	—	197	186-221
Pelvic-fin length	176	157-191	—	165	126	109	—	159	130-173

*One specimen only.

**Data for *P. (H.) crockeri* are taken from specimens from near type locality, off San Diego, California.

The similarity of these three species is attested by the complete overlap in numbers of fin rays and AO photophores and in most body proportions. Only the numbers of lower and total gill rakers (Table 2) serve to separate *P. (H.) beckeri* from the other two species. Of the body proportions (Table 3) the head and prepectoral lengths are most useful in distinguishing the three species. The head of *P. (H.) chilense* averages 4% longer than that of *P. (H.) beckeri* and 6.1% longer than that of *P. (H.) crockeri*, with no overlap in values. The prepectoral length of *P. (H.) chilense* averages 2.2% greater than that of *P. (H.) beckeri* and 3.7% greater than that

of *P. (H.) crockeri*, again with no overlap in values. However, due to the paucity of specimens, it cannot now be said that the limits of variability of *P. (H.) beckeri* have been approximated.

Protomyctophum (Hierops) thompsoni
(Chapman, 1944)

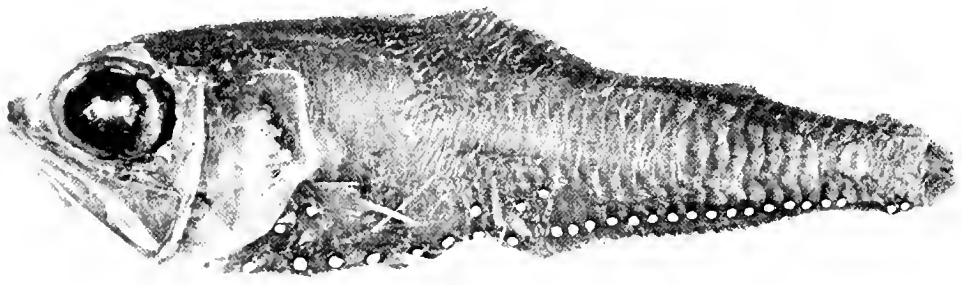


Fig. 12—*Protomyctophum (H.) thompsoni*, male, 47.5 mm. (Photophores retouched).

Description

D. 12 (11-13); A. 23 (21-25); P. 15 (14-17); AO 16 (15-17); gill rakers 4 (3) + 1 + 13 (12-15), total 18 (16-20); vertebrae 38 (37-39).

SAO in a distinct but very wide angle; SAO_3 slightly elevated above a line through SAO_{1-2}. SAO_1 usually before a vertical from VO_3, rarely at or behind this vertical. SAO_2 always nearer SAO_3 than to SAO_1, usually twice nearer. Interorbital width usually half or less the width of expanded distal portion of upper jaw.

Precaudal luminous glands very similar to those of *P. (H.) crockeri*; supracaudal glands of males average somewhat smaller (Fig. 3). Becker (1963b) stated that these glands begin to develop in specimens of about 25 mm, but are sometimes lacking at 33-36 mm.

Size: To about 52 mm.

Least depth of capture: 0 to 500 m at night.

Distribution: This species occurs across the North Pacific Ocean, usually north of 40° N (Fig. 9). It also occurs in the Bering Sea near the central Aleutian Islands, but is probably carried there by currents through the many interisland passes. It has not been taken elsewhere in the Bering Sea. No population structure is evident.

Protomyctophum (Hierops) subparallelum
(Tåning, 1932)

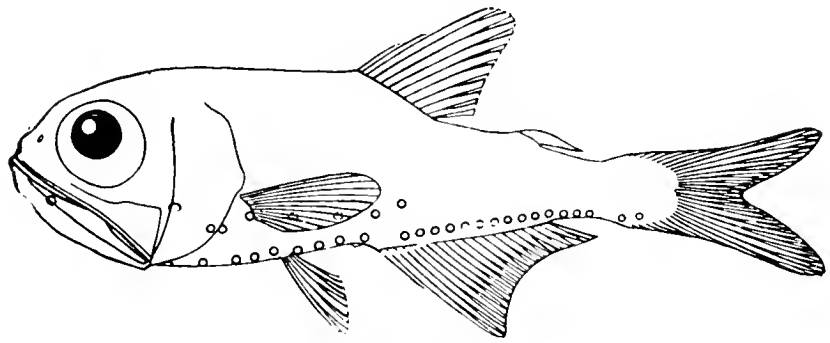


Fig. 13—*Protomyctophum (H.) subparallelum*, female, 29.0 mm. From Andriashev (1962, p. 235, fig. 14).

Description

D. 11-12; A. 20-21; AO 13-14 (rarely 15); gill rakers 3-4 + 1 + 13-14, total 17-19; vertebrae 36-37.

Prc_{1-2} interspace notably less than that of last AO-Prc_1; usually 3 AO behind end of anal base. Body depth greater than 25% of SL. PVO_2, VLO, SAO_{1-2} usually in a straight, nearly horizontal line, SAO_3 only slightly above this line. SAO_1 nearer VO_3 than to VO_4. SAO_{1-2} interspace only slightly greater than that of SAO_{2-3}.

Supracaudal glands of males single, prominent, heavily bordered with dark pigment (Fig. 3); infracaudal glands of females elongate, oval, lightly outlined in black.

Size: To about 40 mm.

Least depth of capture: To 100 m at night.

Distribution: Apparently circumglobal between about 45° and 50° S. In the eastern Pacific the species occurs off Chile, where it may be abundant. Craddock and Mead (1970) reported the capture of 376 specimens at 37 stations between about 30° and 35° S, 72° and 92° W.

Protomyctophum (Hierops) parallelum
(Lönnberg, 1905)

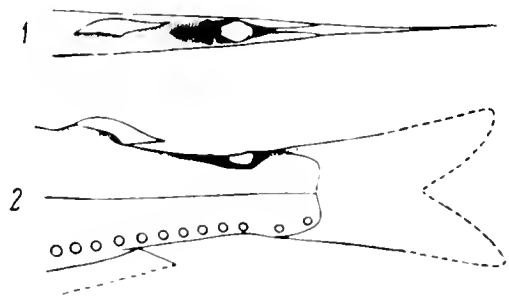


Fig. 14—Caudal region of *Protomyctophum (H.) parallelum*, male, 34.0 mm. (1) dorsal view, (2) lateral view. From Andriashev (1962, p. 238, fig. 16).

Description

D. 11-12; A. 24-25; P. 14-15; AO 17-19; gill rakers 3-4 + 1 + 12-13, total 16-18; vertebrae 40-41.

Prc_{1-2} interspace about equal to that between last AO and Prc_1; usually 6 AO behind end of anal base. Body depth slightly less than 25% of SL. PVO_2, VLO, SAO_{1-2} in a usually straight, nearly horizontal line, SAO_3 slightly above that line. SAO_1 usually nearer VO_2 than to VO_3. SAO_{1-2} interspace much greater than that of SAO_{2-3}.

Supracaudal glands of males single, small, heavily bordered with black (Fig. 3); infracaudal glands of females small, consisting of 2 or 3 rounded spots, lightly bordered with black.

Size: To about 35 mm.

Least depth of capture: At surface at night (Andriashev, 1962); the specimen off Chile was taken in a nighttime haul to 1,000 m.

Distribution: Poorly understood, but probably circumglobal between about 50° and 55° S. Like *P. (H.) subparallelum*, it occurs off Chile but possibly in smaller numbers; Craddock and Mead (1970) reported the capture of one specimen at 33° 31′ S, 77° 29′ W.

Electrona

Goode and Bean, 1896

Lateral line well developed. PLO and PVO_{1-2} form a nearly right-angled triangle. SAO series slightly to markedly angulate. Last few photophores behind end of anal base often below level of preceding ones.

The following key to species and illustrations of *Electrona* are taken largely from Andriashev, 1962.

Key to species of *Electrona*

1a. Body short, deep, its depth about 3 in its length. SAO series about equally spaced, straight or very slightly angulate. AO 12 (10-13) ..... *E. risso*

1b. Body relatively elongate, its depth much more than 3 in the length. SAO_{1-2} interspace distinctly greater than that of SAO_{2-3} 2

2a. So (posteriorly displaced Vn) present about under midorbit. SAO_3 nearer SAO_2 than to lateral line. Gill rakers 9-10 + 1 + 21-23, total 31-34. About 3 AO behind end of anal base ..... *E. carlsbergi*

2b. So present 3

3a. SAO series only moderately angulate. Exposed margins of all scales smooth. PO_5 not elevated. Four or 5 behind end of anal base. Gill rakers 4-5 + 1 + 12-14, total 17-20 ..... *E. antarctica*

3b. SAO series strongly angulate. Exposed margins of scales more or less crenulate. PO_5 slightly but distinctly elevated. One or 2 AO photophores over end of anal base, slightly but distinctly raised 4

4a. Exposed margins of all scales notably crenulate. Upper jaw barely reaching to a vertical from rear margin of orbit. Total gill rakers 29 (27-31) ..... *E. subaspera*

4b. Exposed margins of scales of lateral line only are notched at center, with weak crenulations above and below. Upper jaw reaching to well behind a vertical from rear margin of orbit. Total gill rakers 20-23 ..... *E. paucirastra*

Electrona carlsbergi

(Tåning, 1932)

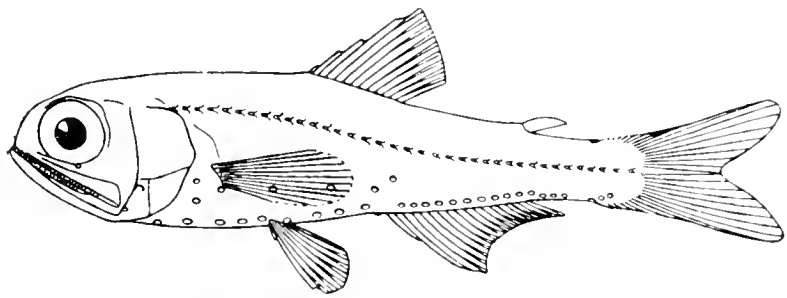


Fig. 15—*Electrona carlsbergi*, female, 72.5 mm. From Andriashev (1962, p. 244, fig. 20).

Description

D. 13-14; A. 19 (18-20); P. 11-13 (long, narrow, reaching to vent); AO 13-15; gill rakers 9-10 + 1 + 21-23, total 31-34; vertebrae 35-37.

Small suborbital organ (So) present below about midorbit (a greatly displaced Vn). SAO_3 nearer SAO_2 than to lateral line; 2 Prc half a diameter or less apart. More than 30 small

"fangs" on palatines. Three or 4 (rarely 5) AO behind anal base, the last few below level of preceding ones.

Both sexes bear single, small, scale-like supracaudal and infracaudal luminous glands.

Size: To about 100 mm.

Least depth of capture: Andriashev (1962) reported captures with wire lengths of 1000 to 4700 m.

Distribution: Between 40° and 68° S in the South Pacific.

Electrona antarctica
(Günther, 1878)

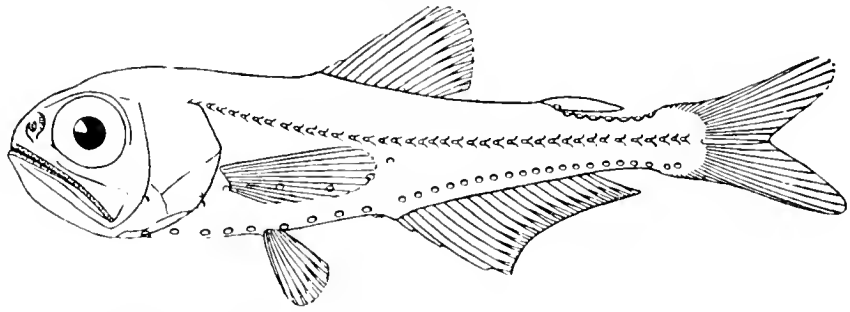


Fig. 16—*Electrona antarctica*, male, 66.5 mm. From Andriashev (1962, p. 241, fig. 18).

Description

D. 14 (13-15); A. 20-21 (22); P. 12-13; AO 17-18 (16-19); gill rakers 4-5 + 1 + 12-14, total 18 (17-20); vertebrae 40 (39-41). No So. SAO_3 nearer lateral line than to SAO_2. Prc usually separated by 1.0 to 1.5 diameters. Palatines bear 7 to 9 rather large, curved "fangs". Four (3-5) AO behind end of anal base.

Supracaudal glands of males with 6-7 (8) rounded spots ringed with dark pigment (Fig. 3); infracaudal glands of females with 1 to 3 weakly developed grayish spots, weakly outlined with dark pigment in adults; both glands are evident at about 40 mm.

Size: Males to 82 mm, females to 110 mm (Andriashev, 1962).

Least depth of capture: To 100 m.

Distribution: Circumglobal, usually south of the Antarctic Convergence; smaller specimens often range somewhat farther north. Reported to be the most common myctophid in Antarctic Waters.

Electrona subaspera
(Günther, 1864)

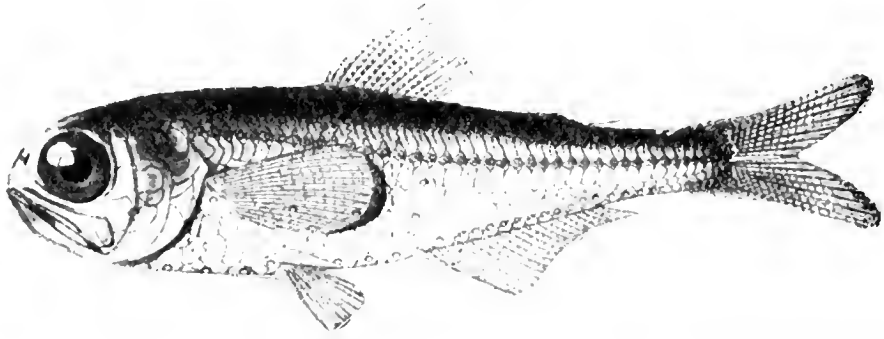


Fig. 17—*Electrona subaspera*, male, 92.0 mm. From Andriashev (1962, p. 246, fig. 21).

Description

D. 14 (13-15); A. 21 (20-22); P. 15-17; AO 16 (15-17); gill rakers 8-9 + 1 + 19-20, total 29 (28-30); vertebrae 38 (37-39).

Scale margins crenulate. Upper jaw short, barely extending beyond hind margin of orbit. SAO series sharply angulate, the angle only slightly greater than 90°. SAO_3 nearer lateral line than to SAO_2. Four (3-5) AO behind anal base. PO_5 slightly but distinctly elevated to level of base of outer pelvic ray.

Caudal luminous glands small, triangular, overlapping (Fig. 3), 2-3 supracaudally and 1-2 infracaudally. Andriashev (1962) reported that males had no infracaudal glands and that most females also had one supracaudal gland. In both sexes the glands are evident at about 60-65 mm.

Size: To about 110 mm.

Least depth of capture: At surface at night.

Distribution: Probably circumglobal above the Antarctic Convergence; apparently common in the southeastern Pacific Ocean.

Electrona paucirastra

Bolin (In: Becker, 1963)

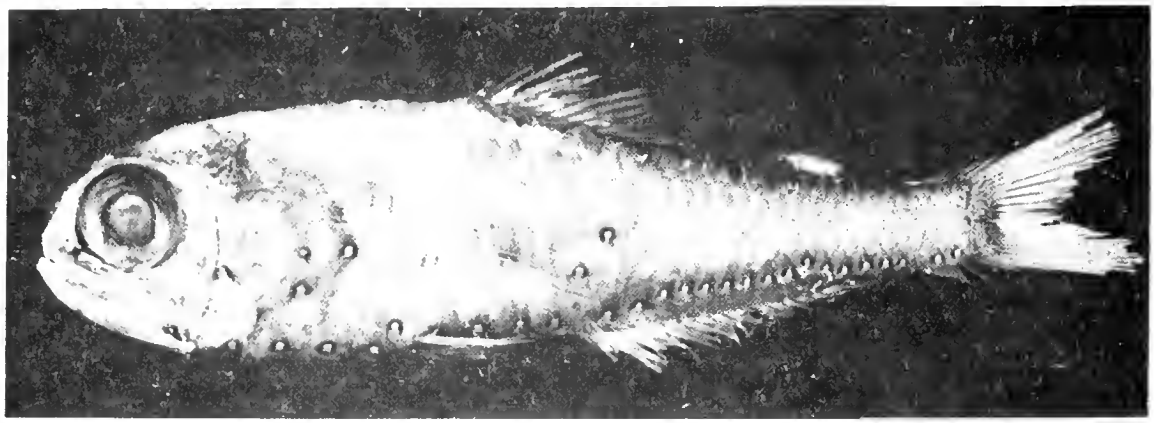


Fig. 18—*Electrona paucirastra*, male, 59.5 mm.

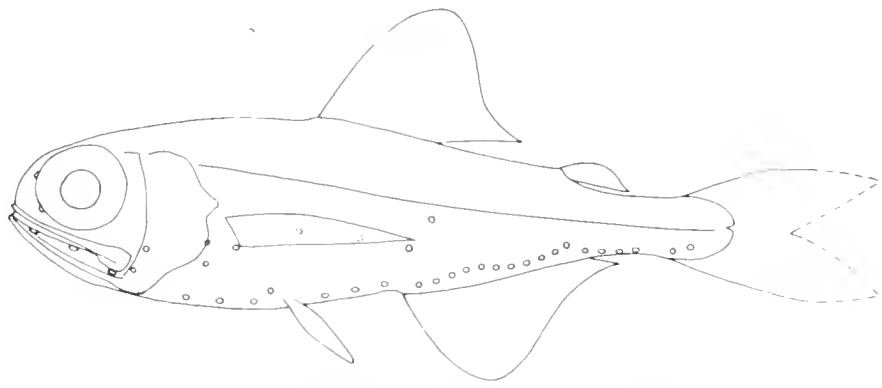


Fig. 19—*Electrona paucirastra*, sex unknown, 44.3 mm.

Description

D. 14 (15); A. 20 (19-21); P. 15 (14-16); AO 15 (14-16); gill rakers 6 (5-6) + 1 + 15 (14-16), total 22 (21-23); vertebrae 37-38.

PO_5 elevated to above level of pelvic base. VO series level. AO series in a very slightly curved and ascending line to about over end of anal base, where the last 4 or 5 photophores drop noticeably. Two Prc about a photophore diameter apart. Exposed margin of lateral line scales notched at center with weak crenulations above and below.

Supracaudal and infracaudal glands of one or two small, somewhat triangular luminous scales; none of the 12 specimens (58-69 mm) examined bore glands on both surfaces of the caudal peduncle.

Size: To 69 mm.

Distribution and depth of capture: Presently known from 39° 30′ S, 71° 15′ E, where 85 specimens were dipnetted at night, and 3 were taken between 0 and 1000 m (Becker, 1963a); 12 specimens dipnetted at 41° 01′ S, 75° 00′ E (R/V *Anton Bruun*, Sta. 308A).

Electrona risso
(Cocco, 1829)

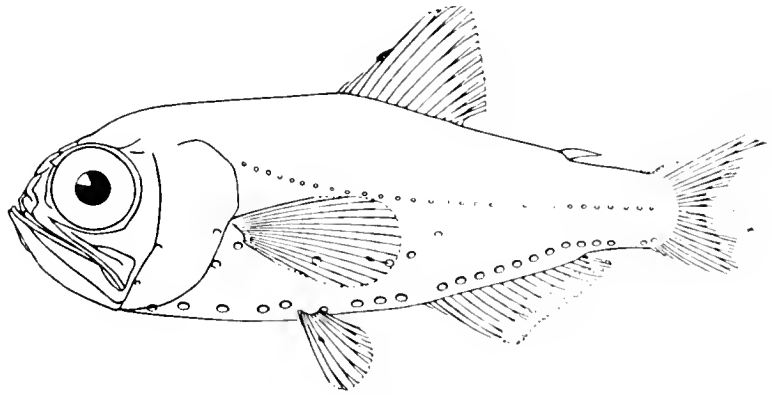


Fig. 20—*Electrona risso*, male, 64.5 mm. From Andriashev (1962, p. 248, fig. 23).

Description

D. 13-15; A. 19 (18-20); P. 13-16; AO 12 (10-13); gill rakers 8-9 + 1 + 17-20, total 26-30; vertebrae 33-34.

Body short and deep, its depth slightly greater than a third of SL; head short, about 3 in SL, and as deep as long. Upper jaw short, barely or not at all extending beyond hind margin of orbit. Caudal peduncle short and deep, with depth nearly equal to length. SAO series in a very broad, moderately steep angle, often in a nearly straight line. AO series slightly uundulating near end of anal base; usually 3 AO behind end of anal base.

Precaudal luminous glands unusual in electronin fishes; only the females bear these glands as tiny white spots on both surfaces of the caudal peduncle; males bear no glands (Brauer, 1906; Andriashev, 1962).

Size: To about 90 mm.

Least depth of capture: At surface at night in southeastern Pacific; to 170 m at night in northeastern Pacific (time not given).

Distribution: Northern Pacific Ocean, Mediterranean Sea, northwestern Atlantic Ocean, Gulf of Guinea, South Africa, tropical Indian Ocean, and near New Zealand. Kubota and

Uyeno (1972) reported nine specimens collected at Miho Beach in Suruga Bay in April and May, 1971 (the first records from the northwestern Pacific).

Discussion

Possibly two subspecies, or species, may be involved in this wide distribution. Whitley (1933) named *E. rissoi salubris* from near New Zealand. Bolin (personal communication) expressed the opinion that the northeastern Pacific form represents a new species. Two few specimens were available to me to provide data on variation. Unfortunately, *E. risso* is not taken in numbers and usually suffers considerable damage during capture; thus, the species is still poorly understood.

Metelectrona

Wisner, 1963

PLO and PVO photophores as in genus Electrona. PO_5 and VO_2 elevated by two or more diameters above adjacent ones. One or more AO photophores distinctly elevated as Pol, the elevation varying from slight to marked; the first or second Pol is randomly higher than the other. Prc_2 elevated its diameter or more above level of Prc_1.

Metelectrona ventralis

(Becker, 1963)

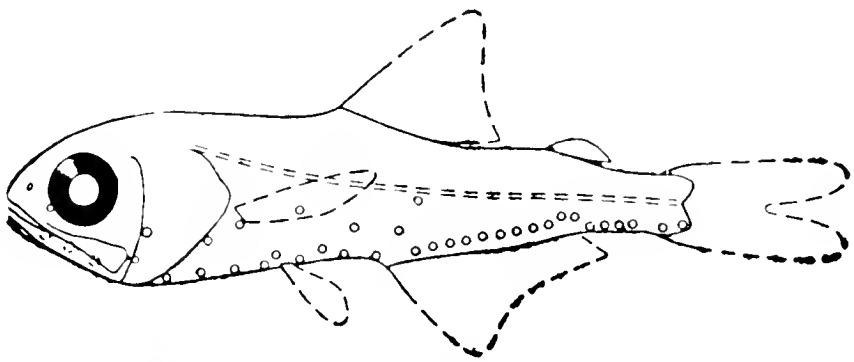


Fig. 21—*Metelectrona ventralis*, 26.2 mm. From Becker (1963a, p. 26, fig. 5).

Description

D. 13 (12-14); A. 19-20; P. 15-16; AOa 8 (9-10) + 4 (3-5), total 13-14 (12-15); gill rakers 5-6 + 1 + 16 (15-17), total 22-23; vertebrae 37 (36-38).

VLO about midway between lateral line and pelvic origin. The elevated VO_2 is about its diameter nearer VO_1 than to VO_3. SAO series in a broad angle of about 135°-145°. SAO_1 over VO_{3-4} interspace or a little nearer VO_4; SAO_2 well behind anal origin, and SAO_3 about over AOa_2; a line through SAO_{2-3} passes well behind VO_4. Origin of anal base under beginning of last third of dorsal base. AOa_{1-2} interspace about a photophore diameter greater than between the others. Elevation of Pol variable; 1 or 2 may be elevated and either higher than the other (Bussing, 1965). Palatine fangs large, 3 to 5 in number and preceded by 5 or 6 small teeth.

A small, roughly square luminous gland on both surfaces of caudal peduncle near the anterior procurrent caudal rays (Fig. 22). Sexual differences, or development of these glands with age of fish, are not known.

Size: To about 70 mm.

Least depth of capture: To 860 m.

Distribution: Probably circumglobal in southern temperature waters. It is known from near New Zealand, Valparaiso, Chile, and off South Africa.

Discussion

The genus *Metelectrona* has been relegated to the synonymy of *Elcctrona* by some authors, principally Becker (1967) and Paxton (1972). However I retain the genus principally because of the statement of Moser and Ahlstrom (1974, p. 395) that the larva of *Metelectrona* resembled larvae of the genus Hygophum in some features but had characters found in neither *Hygophum* nor *Electrona*, and stated that, ". . . the uniqueness of the larva strongly suggests the resurrection of *Metelectrona* as a valid genus."

Becker, 1963a, based the species *M. ventralis* on two small specimens (26.2 and 25.3 mm) that bore no luminous caudal glands. Wisner, 1963b, based *M. alhstromi* on a single adult that bore a small, roughly square luminous gland on each surface of the caudal peduncle near the first procurrent caudal ray. Counts and measurements of the two forms are very similar.

Dr. P. Alexander Hulley, South Africa Museum, Cape Town, has recently informed me that he had examined a large number of adults from the South Atlantic Ocean and found the caudal glands to be similar to those described and figured for *M. ahlstromi* and was satisfied that there was but one species. Publication of the name *ventralis* predates that of the name *ahlstromi* by about 38 days (February 21 vs March 30, 1963).

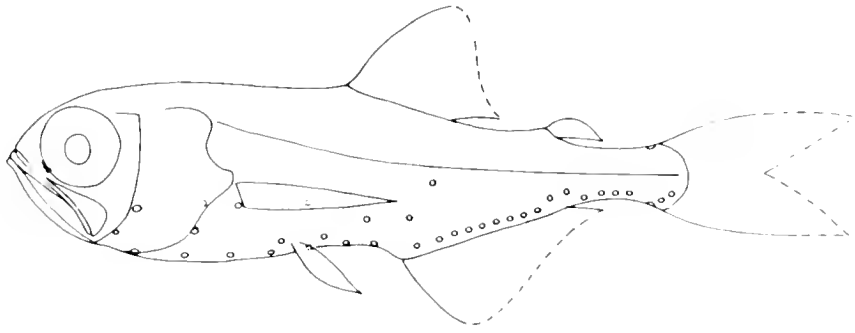


Fig. 22—*Metelectrona ahlstromi*, sex unknown, 66.3 mm.

Hygophum

Tåning (In: Bolin, 1939)

SAO markedly angulate. Two Pol; 2 Prc, widely separated, the upper usually near lateral line. VO level: PO usually level, PO_5 slightly elevated in one species. Upper jaw broadly expanded posteriorly, reaching little if at all past a vertical from posterior margin or orbit.

Key to species of *Hygophum*

1a. AOa series distinctly curved 2
1b. AOa series straight 3
2a. PO_5 slightly but distinctly elevated. A line through Pol passes through or before next to last AOa. VLO well below lateral line. AOa series moderately curved ..... *H. bruuni*
2b. PO_5 not elevated. A line through Pol passes through or before first AOa. VLO very near lateral line. AOa slightly curved ..... *H. hygomi*
3a. A line through SAO_{1-2} passes well below PVO_1. Origin of pectoral fin below level of center of eye. Greatest depth of body about 25% of SL. Upper jaw barely extends past hind margin of orbit ..... *H. proximum*
3b. A line through SAO_{1-2} passes through or above PVO_1. Origin of pectoral fin on or above level of center of eye. Greatest depth of body about 20% of SL 4

4a. Anal rays 19-20; total gill rakers 21 (19-22). Upper Pol under base of adipose fin; 2 or 3 AOp over anal base. Upper jaw extends well past hind margin of orbit.....*H. atratum*

4b. Anal rays 23 (21-25); total gill rakers 18 (17-20). Upper Pol well before base of adipose fin; 4 (3-5) AOp over anal base. Upper jaw extends only slightly past hind margin of orbit.....*H. reinhardtii*

Hygophum hygomi
(Lütken, 1892)

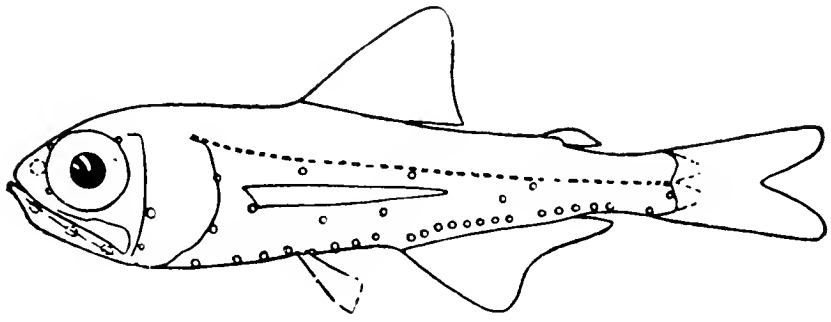


Fig. 23—*Hygophum hygomi*, male, 34.3 mm. From Becker (1965, p. 71, fig. 3).

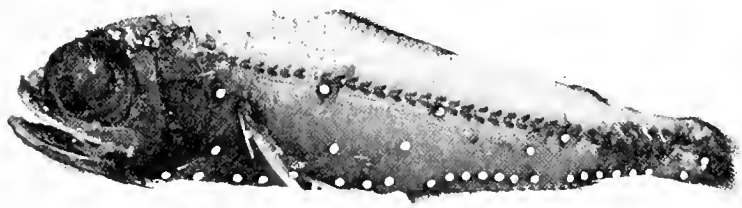


Fig. 24—*Hygophum hygomi*, female, 47.6 mm. (Photophores retouched).

Description

D. 14 (13-15); A. 21 (20-22); P. 15-16; AO 6-7 + 6-7, total 13 (12-14); gill rakers 5-6 + 1 + 15 (14-16), total 22 (21-23); vertebrae 36-37.

VLO, SAO_3, and upper Pol at or very near lateral line. Pol series in a flatly oblique line that passes through or before first AOa; SAO_1 over or before VO_2; 2 or 3 AOp over anal base.

Supracaudal glands of males small, undivided (2 mm long, 1 mm wide on a 49.5-mm male). The glands bifurcate posteriorly, with short projections along bases of first two procurrent caudal rays; bifurcation capped with darkly pigmented tissue. Infracaudal glands of females small, about half those of males of same size, more weakly developed and not bifurcate or pigment-capped posteriorly. Glands evident in each sex at about 35 mm.

Size: Females to about 60 mm, males to 50 mm.

Least depth of capture: At surface at night.

Distribution: H. hygomi is apparently circumglobal in southern waters and is also known from the North Atlantic Ocean and Mediterranean Sea. In the southeastern Pacific it has been taken off Chile between about 18°-34° S, 75°-95° W (Fig. 25).

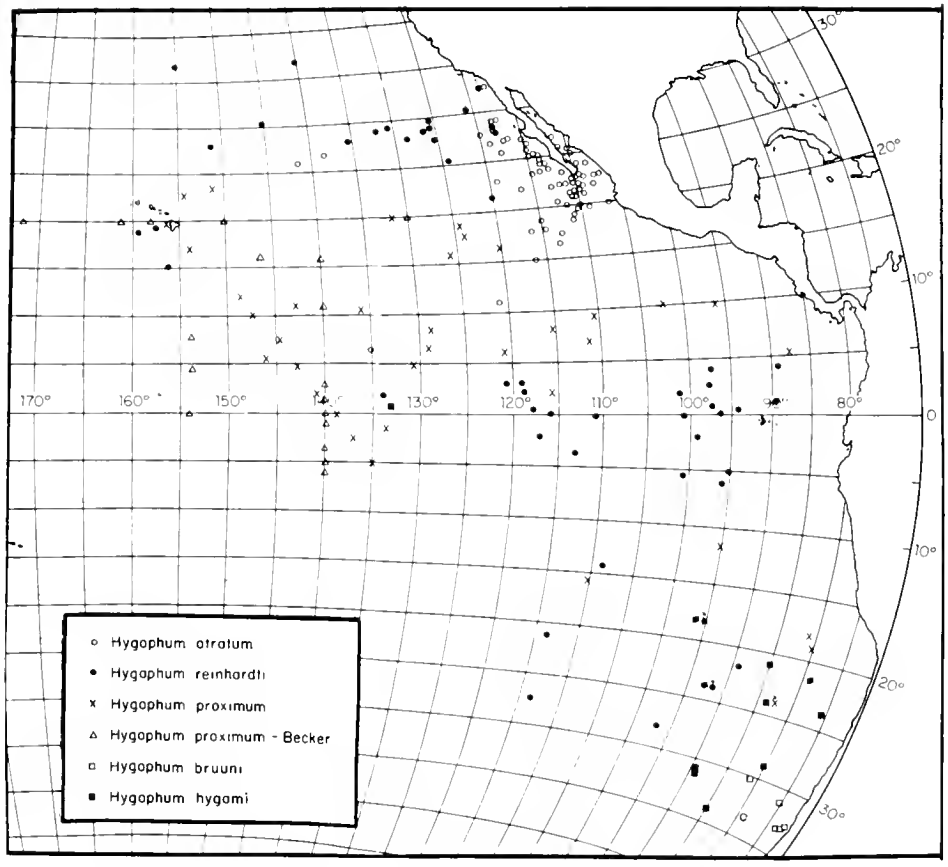


Fig. 25—Capture localities for species of *Hygophum* in the eastern Pacific Ocean.

Hygophum proximum
Becker, 1965

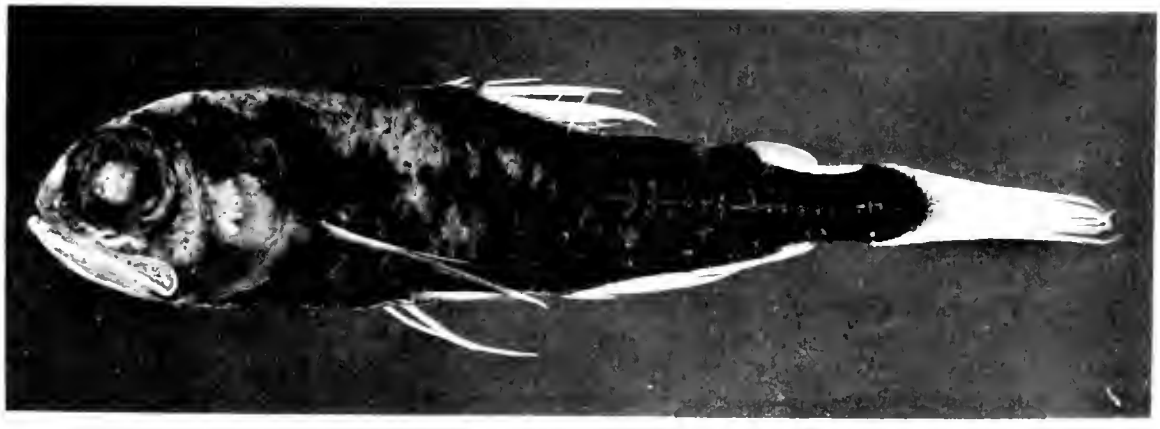


Fig. 26—*Hygophum proximum*, male, 42.2 mm.

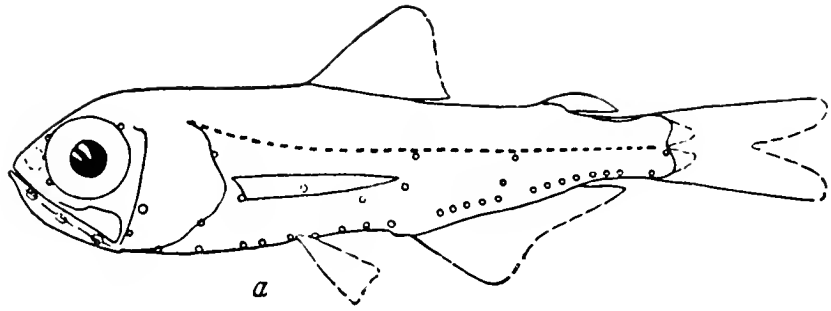


Fig. 27—*Hygophum proximum*, holotype, male, 37.8 mm. From Becker (1965, p. 82, fig. 7).

Description

D. 13 (12-14); A. 19-20 (18-21); P. 14 (13-15); AO 5-6 (4-7) + 6-7 (5-8), total 11-12 (10-14); gill rakers 4-5 +1 + 13 (11-14), total 18-19 (16-20); vertebrae 36 (35-37).

Pectoral origin below level of center of pupil. SAO_1 usually nearer VO_3 than to VO_2, but occasionally about midway between. Three or 4 AOp over anal base. Upper jaw short, barely reaching past hind margin of orbit. Body rather deep, about 4 in SL.

Supracaudal glands of males large, undivided, filling three-fourths or more of the supracaudal space (Figs. 26, 27). *H. proximum* has a larger supracaudal gland than any other species of the genus. Females bear a small, elongate infracaudal gland, consisting of 2 or 3 fused elements. The glands of both sexes are evident at about 25 mm.

Size: To about 50 mm.

Least depth of capture: At surface at night.

Distribution: This species is widespread in the warmer waters of the Pacific and Indian Oceans (Fig. 25). It has not been reported from the Atlantic Ocean.

Hygophum atratum
(Garman, 1899)

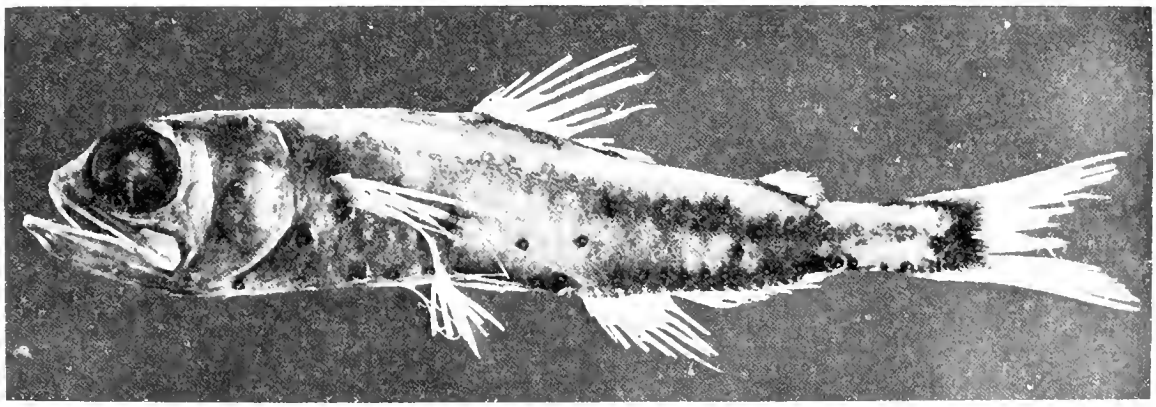


Fig. 28—*Hygophum atratum*, female, 55.0 mm.

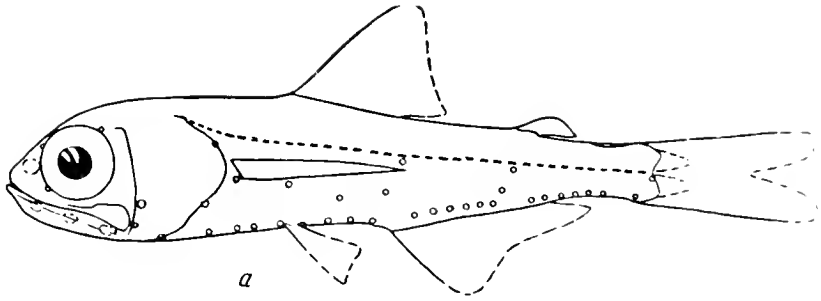


Fig. 29—*Hygophum atratum*, male, 41.6 mm. From Becker (1965, p. 88, fig. 8).

Description

D. 12 (11-14); A. 19-20 (18-21); P. 13-14 (12-15); AO 6 (5-7) + 5-6 (4-7), total 11 (10-13); gill rakers 4-5 (6) + 1 + 14-15 (13-16), total 20-21 (19-22); vertebrae 36 (37-35).

Body moderately slender, its greatest depth about 5 in SL. Origin of pectoral base high, about level with center of pupil. Two or 3 AOp over anal base. SAO_1 usually over midpoint of VO_{2-3} interspace but sometimes over VO_3. Upper jaw extends well behind hind margin of orbit. Upper Pol under adipose base.

Supracaudal glands of males undivided, short, extending over only about one-third of the supracaudal space (Fig. 29); infracaudal glands of females with 2 to 4 small, rounded scales lying between last AOp and first Prc (Fig. 28).

Size: To about 60 mm.

Least depth of capture: At surface at night.

Distribution: Hygophum atratum is confined to the eastern Pacific Ocean, primarily between 15° and 30° N and into the Gulf of California (Fig. 25). The westward range beyond 120° W is uncertain; the few captures may represent strays.

Hygophum reinhardtii
(Lütken, 1892)

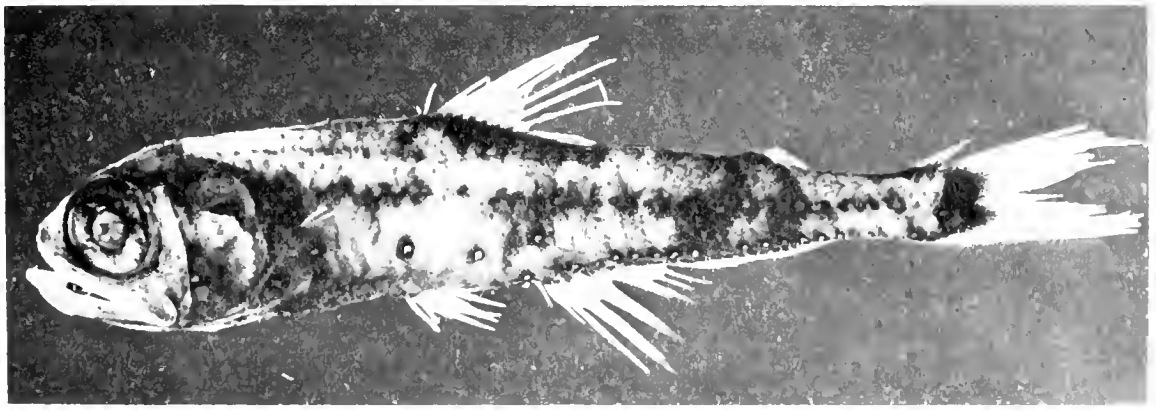


Fig. 30—*Hygophum reinhardtii*, female, 44.5 mm.

Description

D. 14 (13-15); A. 23 (21-25); P. 14 (13-15); AO 7 (5-8) + 7 (6-9), total 14 (11-16); gill rakers 4 (5) + 1 + 13 (12-14), total 18 (17-20); vertebrae 39 (38-40).

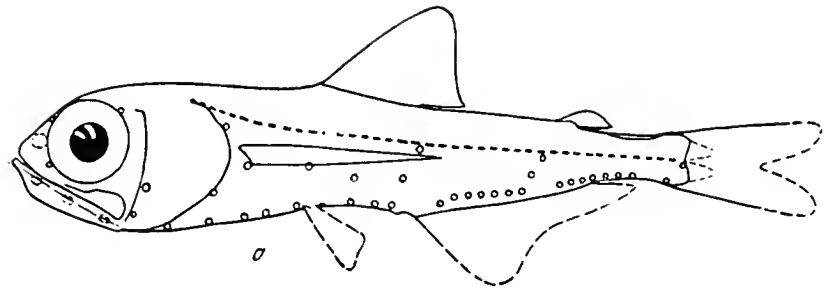


Fig. 31—*Hygophum reinhardtii*, male, 47.2 mm. From Becker (1965, p. 91, fig. 9).

Body generally more slender than in *H. atratum*, body depth about 4.0 to 4.5 times in SL. Four (3-5) AOp over anal base. Upper Pol noticeably before a vertical from adipose base. A narrow, pale, whitish crescent present on posterior margin of iris.

Supracaudal luminous glands of males undivided (Fig. 31), filling about half the supracaudal space; infracaudal glands of females of 3 or 4 coalesced or seldom separated spots (Fig. 30). The glands of males begin to appear before 25 mm, but those of females are not apparent until about 30 mm.

Size: To about 55 mm.

Least depth of capture: At surface at night.

Distribution: H. reinhardtii occupies the warmer waters of the eastern Pacific Ocean between about 30° N and 30° S, except for a hiatus of about 20° of latitude north of the eastern equatorial region (Fig. 25). In view of the collecting effort in that region and the finding of other species of the genus, it seems likely that this species is indeed absent or very uncommon there.

The lack of collections in the south-central Pacific precludes discussion of its occurrence there, but Becker (1965) reported it from the southwestern sector (northeast of New Zealand and Tasman Sea). *H. reinhardtii* is not known from the Indian Ocean. Becker (1965) questioned its reported occurrence in the South Atlantic.

Discussion

The apparent geographical separation of the two groups of *H. reinhardtii* in the eastern Pacific Ocean is supported by the occurrence of one more ray in the anal fin of the southern group than in that of the northern; the respective averages and ranges of counts are: 22.63 (21-25) vs 21.37 (20-23). All other meristic and morphometric characters for each group are very similar.

Hygophum bruuni
Wisner, 1971

Description

D. 11 (10-12); A. 21 (20-22); P. 15 (14-16); AO 5 (4-6) + 7 (6-8), total 12 (11-13); gill rakers 5 (4-6) + 1 + 15 (14-16), total 20 (19-21); vertebrae 36 (35).

PLO about midway between lateral line and origin of pectoral fin; VLO slightly above midway between lateral line and pelvic origin and about over the latter. SAO series in a wide angle varying from 130° to 160°. AOa series evenly and moderately curved, with AOa_2 seldom higher than AOa_3. Greatest body depth about 25% of SL.

Supracaudal luminous glands of males undivided, small but prominent, standing well above profile of caudal peduncle; infracaudal glands of females undivided, smaller than those

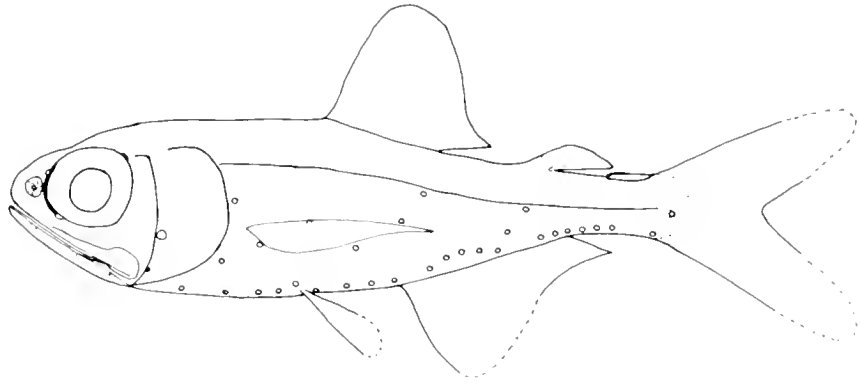


Fig. 32—*Hygophum bruuni*, holotype, male, 39.0 mm. From Wisner (1971, p. 41, fig. 2).

of males and not extending above the peduncular profile. These glands are visible on specimens of about 23 mm and appear to be fully formed at about 30 mm; a female (33.5 mm) bore both glands, each weakly but about equally developed.

Size: To 53 mm.

Least depth of capture: At surface at night.

Distribution: Known only from off Chile between about 30°-33° S, 72°-92° W. (Fig. 25). The species is apparently abundant and gregarious. Bussing (1965) reported the capture (as *H. hanseni*) of 236 specimens in three collections, and Craddock and Mead (1970) reported (as *H. hanseni*) a total of 9280 specimens from 45 collections, in surface and deeper hauls. Three of these hauls took 2000, 2500, and 3000 specimens, respectively.

Discussion

Hygophum bruuni is closely related to *H. hanseni* (Tåning, 1932) and has previously been so identified. Each has the AOa series notably curved, but in *H. bruuni* the series is less sharply curved and AOa_2 is less elevated than in *H. hanseni*. Meristic characters (Table 4) are very similar for the two species, except that the numbers of gill rakers average nearly three more total rakers in *H. bruuni*. Most body proportions are also very similar (Table 5). *H. bruuni* has a greater depth of body than does *H. hanseni*, with no overlap in values, and a somewhat greater depth of head, prepelvic, and preanal lengths, and distance from dorsal to anal origins, with but slight overlap.

Also, in *H. bruuni* the upper jaw usually extends farther beyond the rear margin of orbit than in *H. hanseni*, the respective values being 15.85% (10.1-22.4) for 30 specimens of *H. bruuni* and 10.1% (7.0-11.1) for 8 specimens of *H. hanseni* from off South Africa.

Differences were also observed in positions of some photophores; in 90% of a total of 50 specimens of *H. bruuni*, PLO was on a posteriorly oblique line with PVO_1 and PO_2; in the remaining 10%, PLO was distinctly, although slightly, behind this line, a condition found in 68.5% of the 8 South African specimens. In *H. bruuni* VLO was always about midway, or but slightly higher, between lateral line and pelvic base, rather than the higher position common to *H. hanseni*—three-fourths of this distance nearer the lateral line; this higher position of VLO was shown by Tåning (1932, p. 132, fig. 4) and both described and figured by Becker (1965, p. 96, fig. 11) and figured by Nafpaktitis and Nafpaktitis (1969, p. 20, fig. 18).

TABLE 4. NUMBERS OF FIN RAYS, AO PHOTOPHORES, AND GILL RAKERS FOR *HYGOPHUM BRUUII* AND *H. HANSENI**

Species	Dorsal rays (principal)**			Anal rays (total)				Pectoral rays (both sides)			
	10	11	12	19	20	21	22	14	15	16	17
H. bruuni	8	16	3	—	2	11	1	5	28	6	—
H. hanseni	1	10	3	5	18	3	2	5	9	—	2

	AO photophores									
	AOa			AOp			Total AO			
	4	5	6	6	7	8	11	12	13	14
H. bruuni	4	121	30	35	116	4	12	128	16	—
H. hanseni	—	28	30	2	30	24	2	6	39	5

	Gill rakers									
	Upper rakers						Lower rakers			
	4	5	6				13	14	15	16
H. bruuni	3	68	6				—	6	51	15
H. hanseni	30	—	—				23	7	—	—

	Total rakers				
	17	18	19	20	21
H. bruuni	—	—	9	47	16
H. hanseni	23	7	—	—	—

*Data for AO photophores of *H. hanseni* include those given by Becker (1965, p. 95, table 15) for specimens from the southwestern Atlantic Ocean.

**Two small anterior dorsal rays are not included in the count.

TABLE 5. BODY PROPORTIONS FOR *HYGOPHUM BRUUNI* AND *H. HANSENI*

Measurement	*Hygophum bruuni*		*Hygophum hanseni*				
	S.E. Pacific N = 16 SL—23-48 mm		South Africa N = 8 SL—27-41 mm		A* SL— 28.5 mm	B** SL— 39.9 mm	C† SL— 35.0 mm
	Ave.	Range	Ave.	Range			
Head length	322	298-334	293	271-308	312	251	282
Head depth	245	222-257	215	204-225	224	—	204
Upper jaw length	210	192-223	195	182-208	211	—	187
Orbit length	127	115-141	121	111-137	116	—	112
Interorbital width	85	69-98	83	80-86	95	—	80
Snout length	60	47-68	55	46-62	56	—	80
Prepectoral length	345	327-362	315	302-336	337	281	311
Prepelvic length	445	421-462	416	395-425	428	416	416
Predorsal length	492	477-510	472	460-486	495	454	453
Preanal length	609	591-632	580	565-597	603	577	563
Preadipose length	820	801-841	788	772-801	840	780	801
Dorsal origin to pelvic origins	236	222-249	208	192-232	221	—	221
Dorsal origin to anal origins	272	258-296	244	231-261	260	—	244
Dorsal base length	157	146-172	160	151-175	177	151	158
Anal base length	260	248-285	258	229-276	280	281	272
Caudal peduncle length	151	141-164	165	159-175	144	196	175
Caudal peduncle depth	78	69-85	71	62-81	77	83	71
Pectoral fin length	281	243-311	262	247-279	291	—	230

*From about 210 mi northwesterly from Tristan de Cunha.

**Data from Becker (1965, p. 96), based on one female; the capture locality was not given, but Becker reported one specimen from ca. 42° S, 159° E, and 15 specimens from the southwestern Atlantic Ocean.

†From the southern Indian Ocean, 41° 01′ S, 75° 00′ E.

Benthosema
Goode and Bean, 1896

Vn absent; Dn present. PVO series nearly horizontal. Five PO, none elevated; 5 VO, the second elevated and displaced forward. One Pol; 2 Prc, the upper one at lateral line and distant from the lower.

Key to species of *Benthosema*

1a. SAO series in a flatly oblique, straight or slightly angulate, line. VO_2 slightly but distinctly elevated and displaced forward by no more than its diameter ..... *B. glaciale*
1b. SAO series notably angulate. VO_2 highly elevated and displaced forward to nearly over VO_1 2
2a. Suborbital organ (So) present about under high margin of pupil. SAO_1 about on level of SAO_2. PLO nearer pectoral base than to lateral line. VLO about four of its diameters below lateral line, about on a line from PLO to SAO_2 ..... *B. suborbitale*
2b. So absent 3
3a. SAO_1 below level of SAO_2, far below a line through PLO, VLO and SAO_2. PLO about two, VLO two or three, diameters below lateral line. OP_2 only slightly above level of lower margin of orbit ..... *B. fibulatum*
3b. SAO_1 above level of SAO_2, the two on an ascending line with VLO and PLO. OP_2 high, about on level of pupil ..... *B. panamense*

Benthosema glaciale
(Reinhardt, 1837)

Fig. 33—*Benthosema glaciale*, sex unknown, 40.0 mm. From the Norwegian Sea.

Description

D. 13 (12-15); A. 18 (17-19); P. 11 (10-12); AO 6 (5-7) + 7 (5-8), total 13 (11-14); gill rakers 4 (4-5) + 1 + 11 (10-12), total 17 (15-18); vertebrae 36 (35-37).

VLO about midway between lateral line and pelvic base, about on level of PVO and SAO_{1-2}. VO_2 but little elevated, about over middle of VO_{1-3} interspace. PLO nearer pectoral base than to lateral line. SAO series in a flatly oblique, nearly horizontal and nearly straight angle; SAO_2 slightly below a line from SAO_{1-3}.

The supracaudal gland is small, translucent (in preservative), elongate, and heavily bordered with dark pigment, beginning just before first procurrent caudal ray. The infracaudal gland is smaller, of two coalesced parts, and also heavily bordered with dark pigment. Of the

material examined (14 specimens), the smallest male with glands was 59 mm, the smallest female 36 mm.

Size: To about 70 mm.

Least depth of capture: Has been taken at night with 100 m of wire out.

Distribution: Primarily from the North Atlantic and Arctic Oceans, and Mediterranean Sea. Included as a remotely possible item in the Pacific fauna on the basis of one specimen reported from the Arctic Ocean off Point Barrow, Alaska (Walters, 1955). Has not been reported from there since, and not at all from the Pacific Ocean.

Benthosema suborbitale
Gilbert, 1913

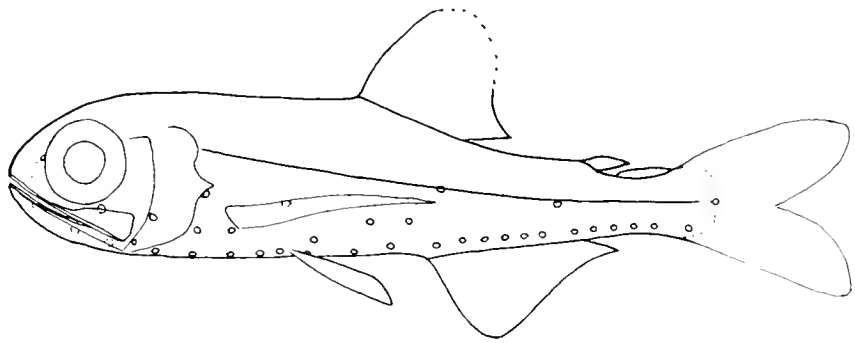


Fig. 34—*Benthosema suborbitale*, male, 30.3 mm.

Description

D. 13 (12-14); A. 17 (16-19); P. 14 (13-15); AO 6 (5-7) + 5 (4-6), total 11 (10-12); gill rakers 3 (3-4) + 1 + 10 (9-10), total 13-15; vertebrae 34 (33-35).

VLO high, near lateral line; VO_2 much elevated and displaced forward to nearly over VO_1, nearly on a line with PVO and SAO_{1-2}. PLO nearer pectoral base than to lateral line. So present below orbital margin about under posterior margin of pupil.

Supracaudal luminous gland single, large, extending from first procurrent caudal ray to over half the distance to base of adipose fin. Infracaudal gland of 2 or 3 luminous scales either lightly ringed with pigment or somewhat coalesced with slight indentations laterally.

Size: To about 30 mm.

Least depth of capture: Has been taken at night with 100 m of wire out.

Distribution: A warm water, apparently circumglobal, species. In the eastern Pacific it has been taken mostly in southern latitudes and from near Hawaii (Fig. 35). Two records, one from about 28° N, 126° W, and one outside the Gulf of Tehuantepec, Mexico, may be questionable; the specimens cannot now be found, and their capture localities lie far away from the others.

The only evidence of differentiation within this wide distribution is that specimens from the Pacific tend to have a more prominent, usually larger, suborbital photophore than those from the Atlantic Ocean.

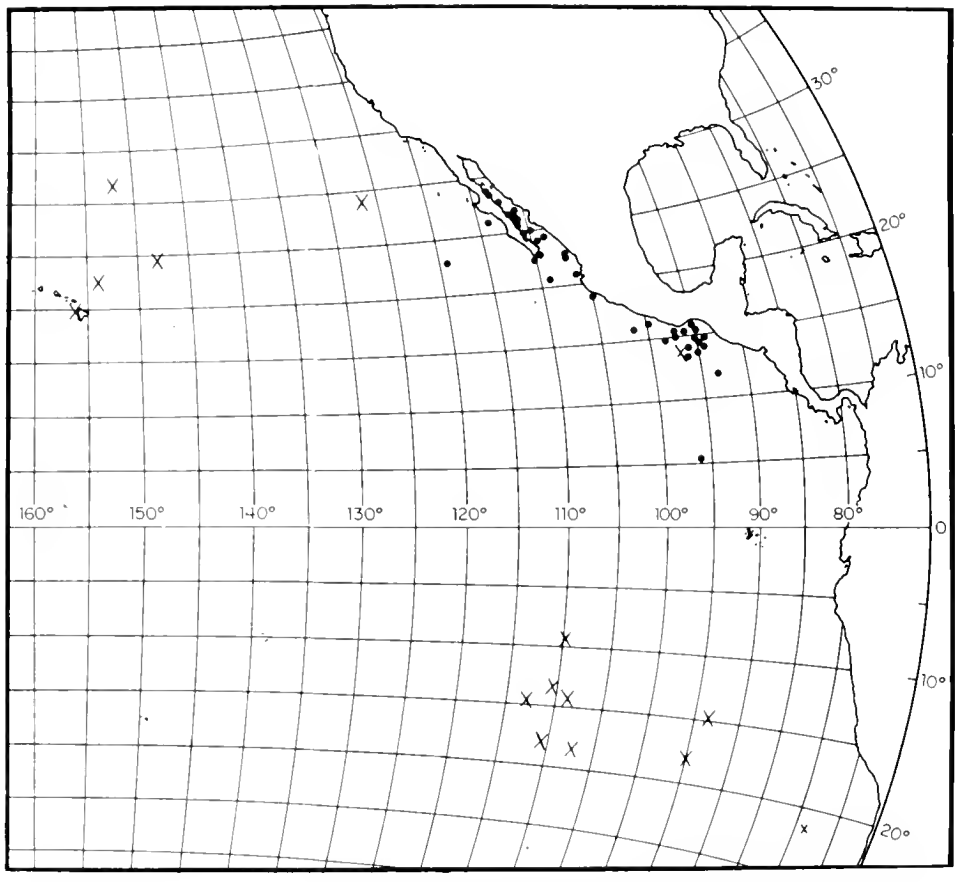


Fig. 35—Capture localities for *Benthosema panamense* (solid circles) and for *B. suborbitale* (Xs) in the eastern Pacific Ocean.

Benthosema fibulatum
(Gilbert and Cramer, 1897)

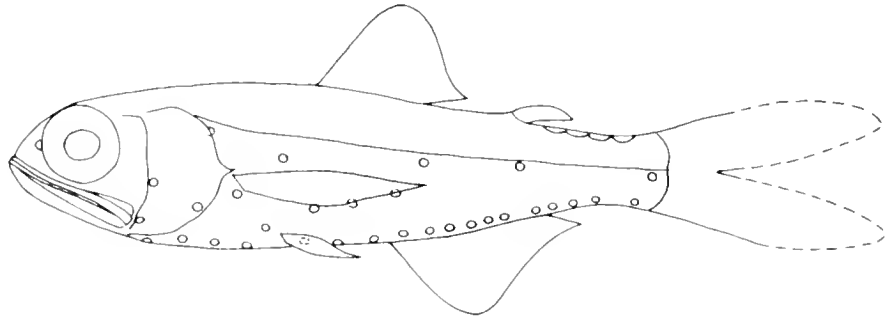


Fig. 36—*Benthosema fibulatum*, male, 62.6 mm.

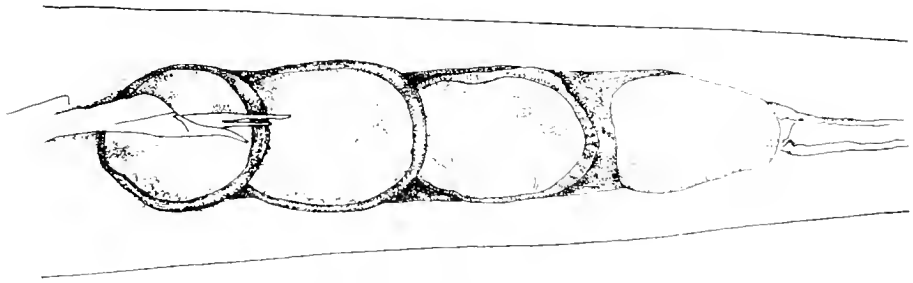


Fig. 37—Supracaudal gland of the male *B. fibulatum* shown in fig. 36.

Description

D. 13 (12-14); A. 19 (18-20); P. 16 (14-17); AO 6 (5-7) + 4 (3-5), total 10 (9-11); gill rakers 7 (6-7) + 1 + 15 (14-16), total 23 (21-24); vertebrae 32 (31-33).

VLO and PLO near lateral line. VO_2 notably elevated, lying over midpoint of VO_{1-3} interspace. Suboperculum produced into a short, bluntly pointed flap at level of pectoral origin.

Supracaudal glands of males (Fig. 37) are largest of the genus, and consist of 3 to 5 well-formed, translucent, luminous scales plus a posterior small, whitish patch at base of first procurrent caudal ray. The entire gland fills the supracaudal space. Apparently the translucent scales are easily lost, as many males of adequate size (sexed by dissection) bear no glands save the small white posterior patch. Females bear two small patches of luminous tissue, lying just before the first ventral procurrent ray, and often a tiny one ventrally a little before lower Prc.

Size: To about 90 mm.

Least depth of capture: To 122 m in early evening near Hawaii.

Distribution: Not well known. Taken in Hawaiian waters, north of New Guinea, off Japan, and from the Indian Ocean off South Africa. Presumably a warm water species.

Benthosema panamense
(Tåning, 1932)

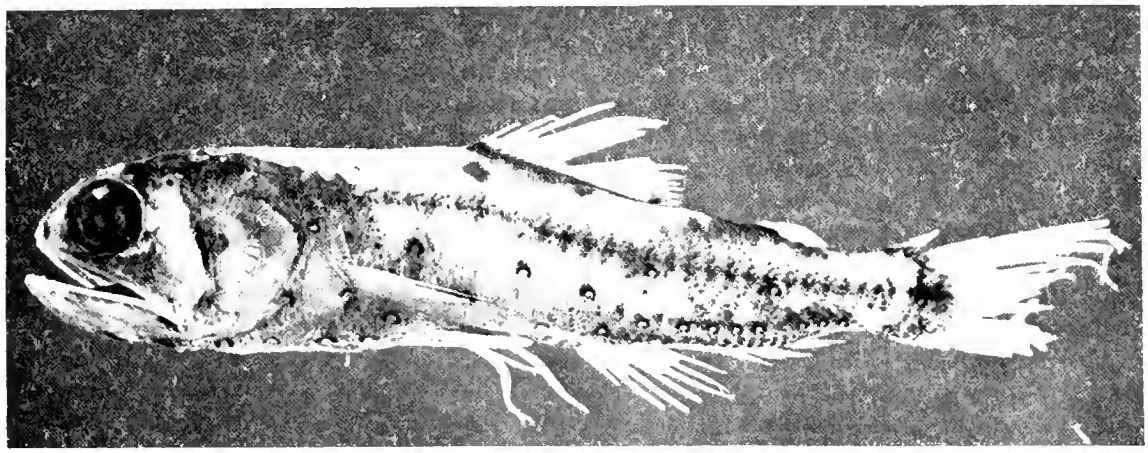


Fig. 38—*Benthosema panamense*, male, 40.6 mm.

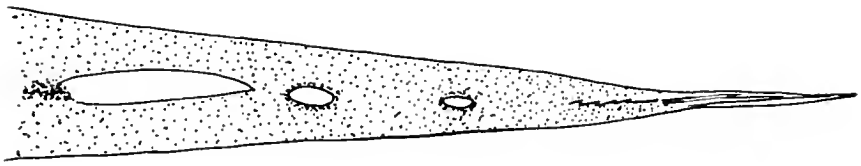


Fig. 39—Supracaudal luminous glands of *B. panamense*, female, 41.5 mm.

Description

D. 13 (12-13); A. 21 (20-22); P. 14 (13-15); AO 4 (3-4) + 6 (5-7), total 10 (9-11); gill rakers 9 (8-10) + 1 + 18 (16-20), total 28 (26-31); vertebrae 32 (31-33).

SAO_1 above level of SAO_2. OP_2 about on level of pupil. PLO nearer lateral line than to pectoral origin. PLO, VLO, and SAO_{1-2} from a straight line. Opercular margin laterally produced into a long, pointed flap.

The relationship of sex and caudal luminous glands in this species is uncommon in myctophid fishes. Dissection of 80 specimens with and 80 without supracaudal glands showed that only females bore these glands; males bore no glands, and no specimen bore an infracaudal gland. The supracaudal glands of females are usually two (rarely one or three) small, ovoid, weakly developed spots, lightly bordered with dark pigment (Fig. 39); these spots (easily lost) are evident on females of about 34 mm.

Size: To about 55 mm.

Least depth of capture: At surface at night. This species is the "Red-bait" reported by Alverson (1961) as forming dense "balls" at the surface in daylight, and being fed upon by yellowfin and skipjack tuna.

Distribution: B. panamense appears to be a relatively near-shore form confined to the eastern Pacific Ocean, principally between about 25° and 10° N, and to the Gulf of California to about 28° N (Fig. 35); the two localities shown outside the main body of collections may represent strays.

Discussion

In regard to caudal luminous glands, Bolin, (1939, fig. 13) stated: "One or two small, poorly developed, widely separated infracaudal luminous patches at vertical of AOp-Prc interspace on a few individuals, presumably females; 1 specimen with a very small indistinct supracaudal luminous patch at the same vertical is a male. In most specimens, even the largest ones, no caudal luminous patches are developed." At odds with my findings, Bolin's specimens were from Japan and Philippine waters and may represent *Benthosema pterotum* (Alcock, 1890), or a related form. Many authors of studies on eastern Pacific myctophids have used the name *pterotum* for this species.

Although quite closely related, it appears that *Benthosema panamense* from the eastern Pacific Ocean is distinct from its Indian Ocean relative, *B. pterotum*. As noted by Tåning (1932), the PLO and VLO are consistently somewhat higher and the eyes smaller in *B. panamense*. Tåning also reported the snout of the former to be more pointed, but this may be of limited taxonomic importance as it is not a consistent characteristic.

Body proportions (Table 6) for 12 specimens each of *B. panamense* from the eastern Pacific Ocean near the Gulf of California, and of *B. pterotum* from the northern Indian Ocean near the Gulf of Oman, indicate that only the lengths of orbit and pectoral fins differ appreciably, each being smaller in the eastern Pacific with little or no overlap.

TABLE 6. BODY PROPORTIONS FOR 12 SPECIMENS EACH OF *BENTHOSEMA PANAMENSE* (FROM THE EASTERN PACIFIC OCEAN) AND *B. PTEROTUM* (FROM THE NORTHERN INDIAN OCEAN)

Measurement	*B. panamense*		*B. pterotum*	
	SL—34.1-49.6 mm		SL—32.1-41.5 mm	
	Ave.	Range	Ave.	Range
Head length	367	354-385	374	356-393
Head depth	222	214-234	230	221-242
Orbit length	99	93-105	117	110-124
Upper jaw length	204	195-211	208	203-217
Prepectoral length	349	337-358	352	337-360
Prepelvic length	436	422-454	447	430-462
Predorsal length	489	465-510	491	480-505
Preanal length	600	584-623	618	599-632
Preadipose length	825	805-843	826	806-841
Dorsal origin to pelvic origin	227	215-236	242	234-252
Dorsal origin to anal origin	259	249-272	263	255-270
Caudal peduncle length	159	149-170	153	145-166
Caudal peduncle depth	92	85-99	86	81-89
Dorsal base length	174	161-188	161	150-171
Anal base length	272	258-287	272	265-283
Pectoral fin length	319	302-340	358	338-372

Tåning (1932) indicated that *B. panamense* had about two more anal fin rays than did *B. pterotum* (citing Norman (1929, p. 513) as authority); but it is possible that Norman had confused *B. fibulatum* with *B. pterotum*; the number of anal rays are 19 (18-20) in the *B. fibulatum* before me. It is also possible that *B. pterotum* from throughout the Indian Ocean is highly variable in this regard, for the counts given in Table 7 do not support the difference stated by Tåning.

The numbers of dorsal rays, AO photophores (AOa, AOp, and total), and vertebrae of *B. panamense* and *B. pterotum* overlap almost completely; the respective counts are as follows (those for *B. panamense* given first): dorsal rays 13 (12-14), 13 (12); AOa 6 (5-7) + 4 (3) for both species, total 10 (9-11), 10 (9); vertebrae 32 (31) for both species.

Thus, the two species are very much alike in counts and proportions. It may be that a study of abundant material of *B. pterotum* from throughout its presumed range (the Indo-

TABLE 7. NUMBERS OF ANAL AND PECTORAL FIN RAYS AND TOTAL GILL RAKERS FOR *BENTHOSEMA PANAMENSE* FROM THE EASTERN PACIFIC OCEAN AND FOR *B. PTEROTUM* FROM THE NORTHERN INDIAN OCEAN

Species	Anal rays				
	19	20	21	22	N
B. panamense	—	22	35	4	61
B. pterotum	3	14	3	1	21
	Pectoral rays				
	12	13	14	15	N
B. panamense	—	8	22	2	32
B. pterotum	7	15	9	—	31

	Total gill rakers							
	25	26	27	28	29	30	31	N
B. panamense	—	4	22	57	31	13	1	128
B. pterotum	7	19	9	5	2	—	—	42

Pacific area and much of the Indian Ocean) will show the above slight differences in morphometry and counts to be clinal and require the return of *B. panamense* to subspecific status or to synonymy with *B. pterotum*.

Diogenichthys
Bolin, 1939

SAO series in a steeply oblique line, usually with SAO_3 well behind a line through SAO_{1-2}. VO_2 elevated but not displaced forward. One Pol, at lateral line; 2 Prc, on same level. Dn present; Vn absent.

Key to species of *Diogenichthys*

1a. Upper jaw reaches well behind a vertical from hind margin of orbit. VLO no higher, usually noticeably less, than midway between lateral line and ventral profile of body. Prc interspace much less than that of AOp-Prc ..... *D. laternatus*

1b. Upper jaw scarcely reaches a vertical from hind margin of orbit. VLO no lower, usually noticeably higher, than midway between lateral line and ventral profile of body. Prc interspace as wide as that of AOp-Prc ..... *D. atlanticus*

Diogenichthys laternatus
(Garman, 1899)

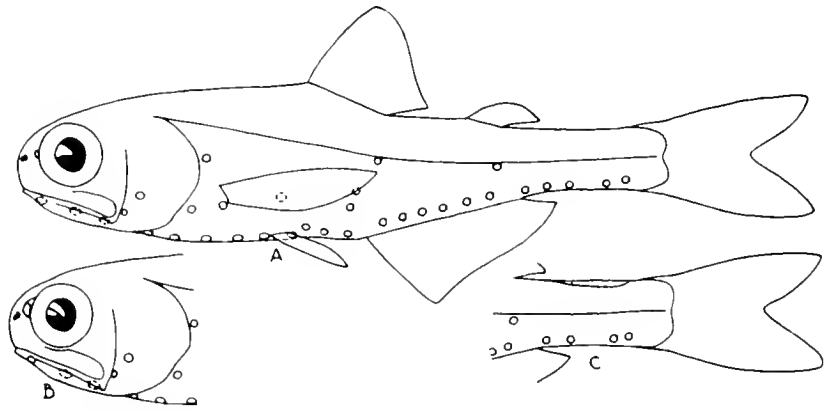


Fig. 40—*Diogenichthys laternatus*. From Bolin (1939, p. 120, fig. 15). (A) adult female, (B) head of adult male, (C) caudal peduncle of adult male.

Description

D. 11 (10-12); A. 16 (15-17); P. 11 (10-12); AO 6 (5-7) + 2-3, total 8-9 (7); gill rakers 3 (4) + 1 + 9-10, total 13-14; vertebrae 30 (29-31).

Upper jaw reaches well beyond a vertical from hind margin of orbit. VLO usually nearer pelvic base than to lateral line. SAO_1 over or slightly behind VO_1. SAO_3 usually well behind a line through SAO_{1-2}. Dn of males much larger than Dn of females.

Supracaudal glands of adult males (Fig. 40C) large, undivided, occupying over half the dorsal surface of caudal peduncle. Infracaudal glands of females (Fig. 40A) small, usually of two coalesced spots, beginning about under Prc_1 and extending halfway or slightly less to last AOp.

Size: To about 25 mm.

Least depth of capture: 0-100 m at night, 600-650 m in daylight.

Distribution: D. laternatus is found in warmer waters from off San Diego, California, to about 33° S, off Chile (Fig. 41). Occurrence in the coastal waters of Chile, which are normally quite cold, may be due to a tongue of submerged warm water present along the coast at a depth of about 300 m to as far as 40° S (Wooster and Gilmartin, 1961).

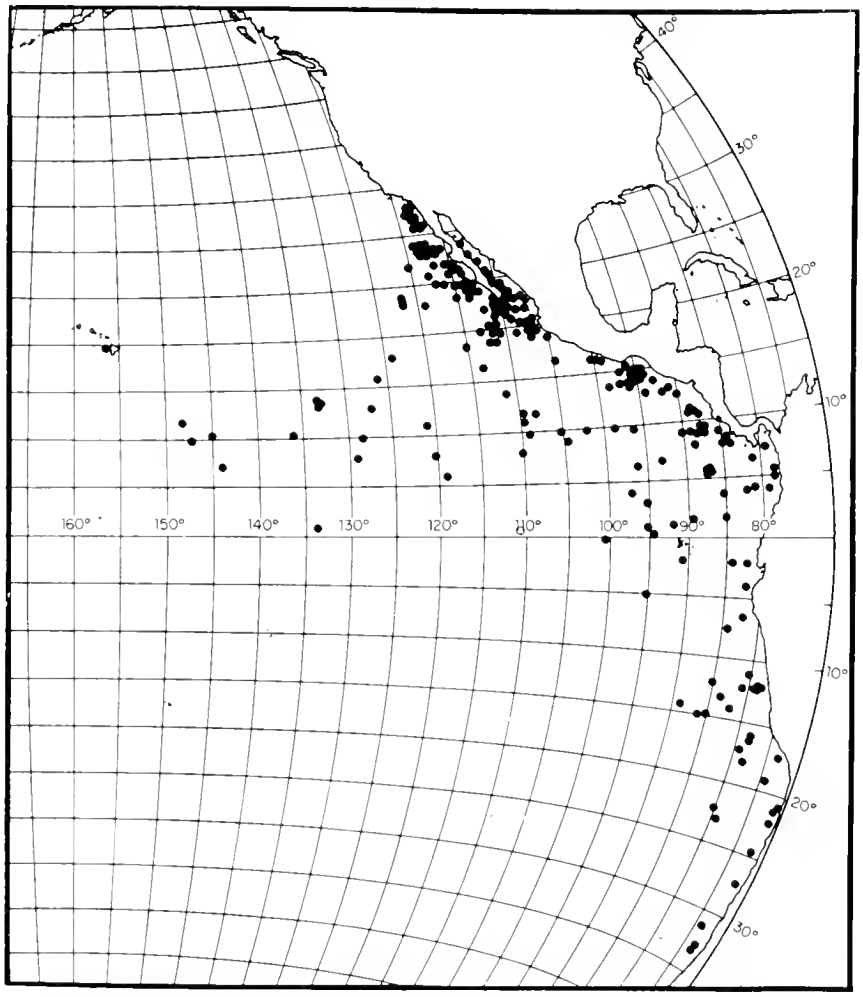


Fig. 41—Capture localities for *Diogenichthys laternatus* in the eastern Pacific Ocean.

Discussion

Diogenichthys panurgus Bolin (1946), a small species (to 23 mm) more related to *D. laternatus* than *D. atlanticus*, occurs in the Indian Ocean. A very similar form (possibly a new species) is known from the Indo-Pacific region and the far western Pacific but has not been reported from the central or eastern Pacific Ocean.

Diogenichthys atlanticus
(Tåning, 1928)

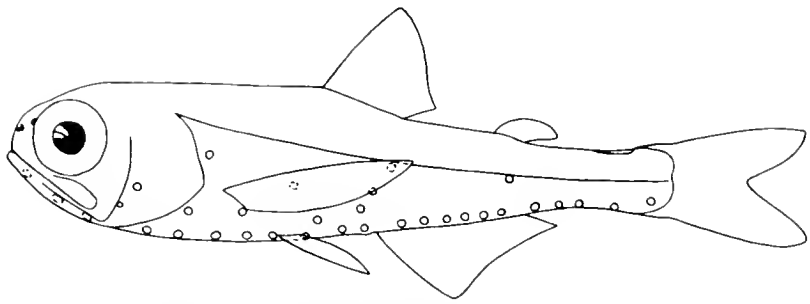


Fig. 42—*Diogenichthys atlanticus*, male. From Bolin (1939, p. 22, fig. 16) (as *D. scofieldi* n. sp.).

Description

D. 11 (10-12); A. 16 (14-17); P. 11 (10-12); AO 6 (5-7) + 3 (2-4), total 9 (8-10); gill rakers 2 + 1 + 11 (10-12), total 14 (13-15); vertebrae 33 (31-34).

Upper jaw barely reaches to a vertical from hind margin of orbit. VLO usually nearer lateral line than to ventral profile of body. SAO_1 over or slightly before VO_4; SAO series in a straight line on 30 of 41 sides, SAO_3 behind a line through SAO_{1-2} on 11 of 41 sides. Dn of males larger than in females, but contrast in size is much less than that between the sexes in *D. laternatus*.

Supracaudal luminous glands of males small, undivided, covering less than half the dorsal surface of caudal peduncle; infracaudal glands of females very similar to those of *D. laternatus*.

Size: To about 25 mm.

Least depth of capture: To 100 m at night, 600-650 m in daylight.

Distribution: D. atlanticus, unlike its congener *D. laternatus*, has a disjunct distribution in the eastern Pacific Ocean (Fig. 43). Although at the extremes of their ranges the two species are found together, *D. atlanticus* is absent from the vast eastern area wherein *D. laternatus* occurs commonly (Fig. 41). This hiatus in distribution coincides roughly with the area of low oxygen (1.0 ml/l and less) that dominates the subsurface waters of the eastern tropical Pacific, as delineated by Wyrtki (1967) for the area east of 140° W and by Austin (1960) for the central area.

Off Chile, *D. atlanticus* was not taken quite as close to shore as *D. laternatus*, except off Valparaiso; in this area Craddock and Mead (1970) reported the capture of 87 specimens from 18 stations between about 33°-34° S, 73°-90° W.

Discussion

The disjunct distribution of *D. atlanticus* suggests the possibility of a racial or population structure, but superficial examination of specimens from each of the three areas of occurrence (Fig. 43) indicated no obvious differentiation. A more detailed comparative study should be made.

Symbolophorus
Bolin and Wisner (In: Bolin, 1959)

SAO markedly angulate. One Pol; 2 Prc, about a photophore diameter apart, the last slightly elevated. Five PO, only the last slightly elevated. Four VO, none elevated.

The genus *Symbolophorus* is difficult taxonomically. Although species groups are readily separable, species within a group often show a remarkable degree of similarity in counts, body

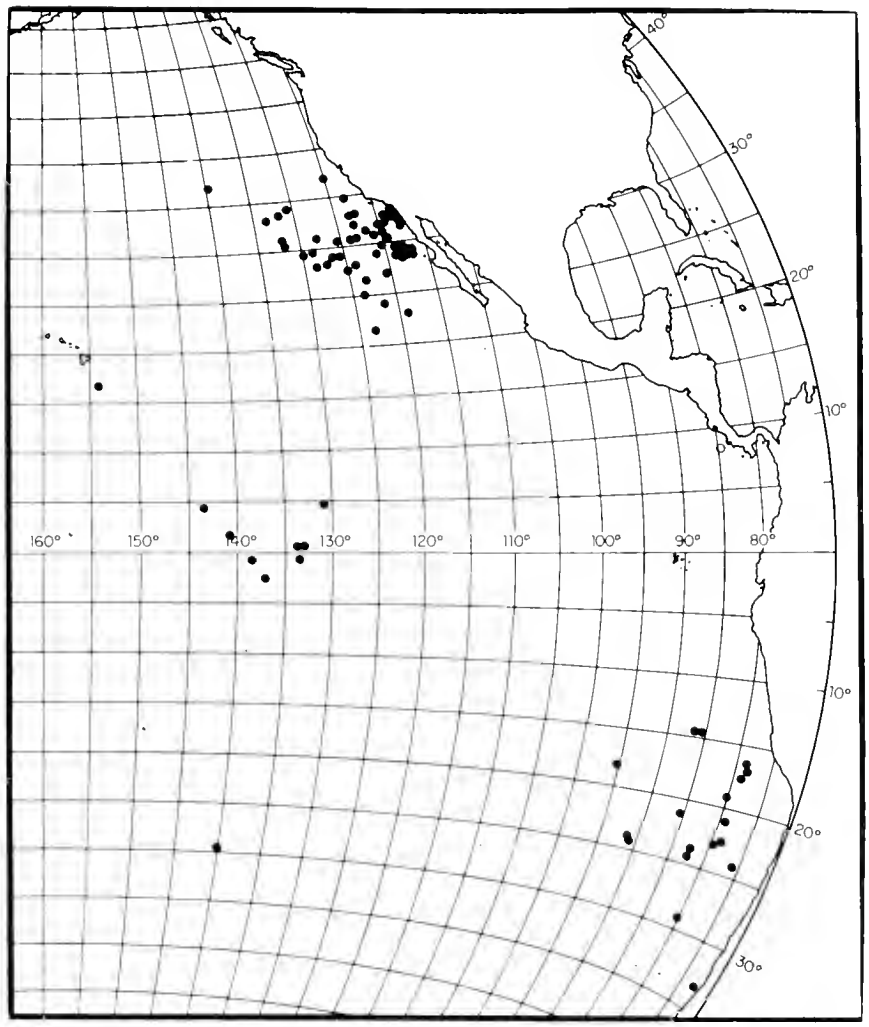


Fig. 43—Capture localities for *Diogenichthys atlanticus* in the eastern Pacific Ocean.

proportions, and photophore patterns. Mature males within a species group may be separated on the basis of appearance and structure of the supracaudal luminous glands, but the infracaudal glands of females are very similar throughout the genus. Immature specimens are almost impossible to determine specifically, especially where geographic ranges overlap.

The genus is worldwide in distribution. Although most species are essentially tropical, one (possibly two) is found to about 45° N in the northwestern Pacific, and one to at least 55° S in the southeastern Pacific (probably a new species).

In the entire eastern Pacific Ocean only three species have previously been recorded, *S. californiensis*, *S. evermanni*, and *S. boops*, but there may be five or six undescribed forms.

The following key will serve to segregate at least the species groups to be found in the eastern Pacific.

Key to species groups of *Symbolophorus*
in eastern Pacific

1a. Pol slightly before a vertical from end of base of adipose fin. Usually 1, seldom 2 (occasionally none) AOp over anal base. AOa series level.....*S. evermanni* species group
1b. Pol well before a vertical from end of base of adipose fin; 3 to 5 AOp over anal base.....2
2a. Palatine teeth in a narrow band, villiform, none enlarged. AOa series level.....*S. californiensis* species group
2b. Palatine teeth much enlarged, in a single row. AOa series distinctly curved.....*S. boops* (?) "southern" species group

Symbolophorus evermanni species group

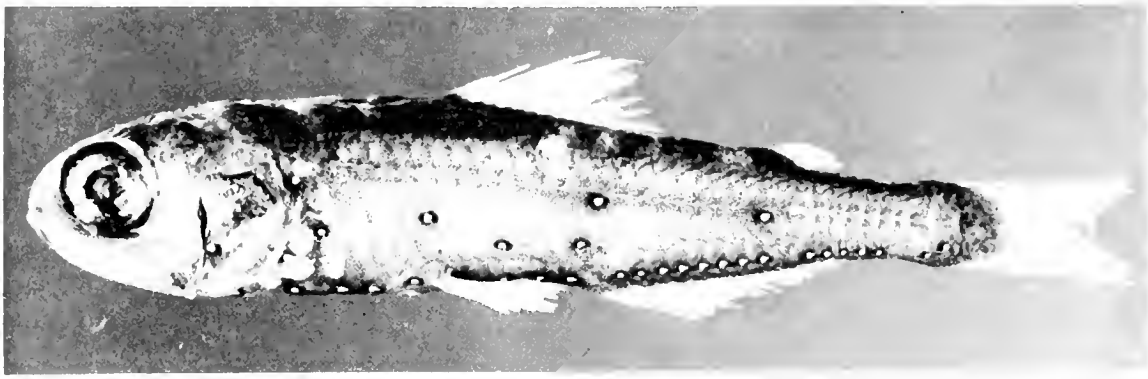


Fig. 44—*Symbolophorus* n. sp. (?) (short gland form), male, 65.0 mm. The pattern of photophores is characteristic of the *evermanni* species group.

Description

D. 15 (13-16); A. 20 (18-22); P. 15-16 (13-18); AO 8 (6-9) + 5 (4-7), total 13 (11-15); gill rakers 6 (5-7) + 1 + 14-15 (13-16), total 21-22 (19-23); vertebrae 37 (36-39).

At least three forms from the eastern Pacific may be involved in the *evermanni* species group. As the counts for all forms overlap completely, only one set is given above.

SAO_1 about over VO_2. SAO_{1-2} interspace greater than that of SAO_{2-3}. Palatine teeth in a narrow band, villiform, none enlarged. Adult males of three presently recognized forms have notably different types of supracaudal luminous glands (Fig. 45).

Size: To about 80 mm for all three forms.

Least depth of capture: At surface at night, all three forms.

Discussion and Distribution

The name *evermanni* has been applied to specimens taken in tropical waters of the Pacific and Indian Oceans. It is apparent, however, that several species occupy this wide area, with perhaps slight or only moderate overlap in ranges.

As presently understood, *S. evermanni* (sensu stricto), the form in which the concavities of the luminous scales of the supracaudal gland face forward (Fig. 45A), may be more or less restricted to the central and western tropical Pacific, with perhaps some penetration into the Indo-Pacific region. A few specimens with this type of supracaudal gland have been found in the extreme eastern Pacific from Panama to Ecuador; possibly these are migrants with the easterly flowing Equatorial Counter Current.

The "reverse-concavity" form, with the concavities of the luminous scales of the supracaudal gland facing posteriorly (Fig. 45 C), is very common in the eastern Pacific between 20° N and 20° S along the American continents. An occasional specimen is found near Hawaii, perhaps migrants with the westerly flowing North Equatorial Current.

The "short-gland" form (Fig. 45B) is known only from southeast of Hawaii near the equator.

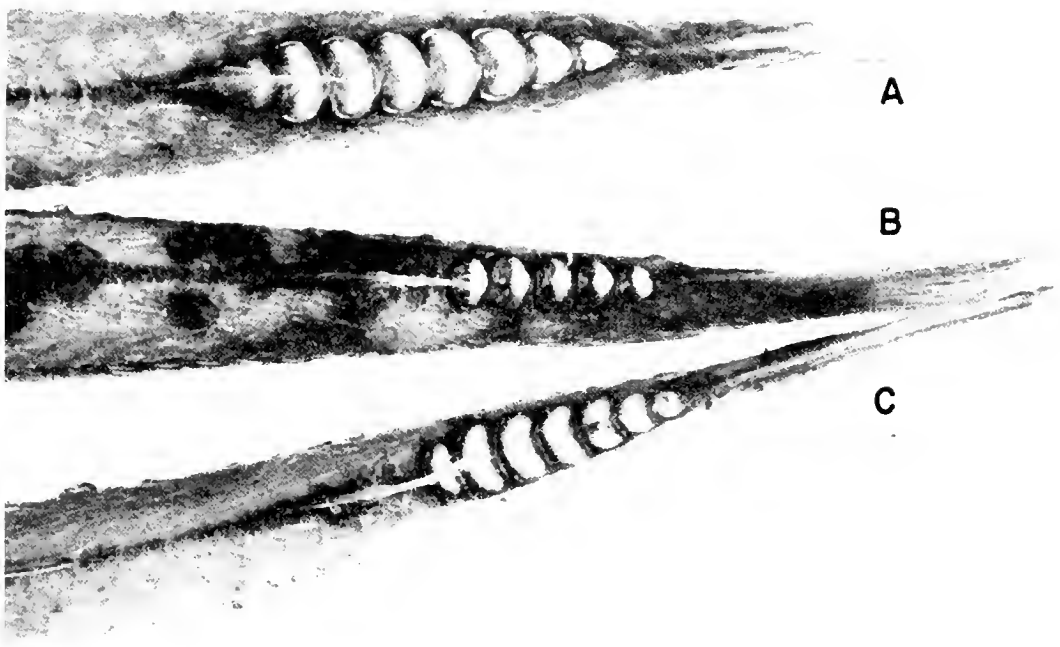


Fig. 45—Supracaudal luminous glands of males of three forms of the *Symbolophorus evermanni* species group.
A. *Symbolophorus evermanni* (sensu stricto) (Gilbert, 1905), 69.0 mm.
B. *Symbolophorus* n. sp. ? (short-gland form), 62.0 mm. Although basically like those of *S. evermanni*, the structure of the individual luminous scales differs notably.
C. *Symbolophorus* n. sp. ? (reversed-concavity form), 67.3 mm. Note the reversed position of the concave borders of the luminous scales, as compared to those of *S. evermanni*.

Symbolophorus boops (?), "Southern" species group

This category contains a group of poorly understood species found only in southern waters. Within the southeastern Pacific there are at least three forms whose relationships are by no means clear (Table 8). The principal differences known thus far are the structure and arrangement of the caudal luminous glands. On this character the three forms may be separated as follows (otherwise, in external appearance they are very similar to *S. californiensis*):

1. Both supracaudal and infracaudal luminous glands present just before the first procurrent caudal rays. Each gland composed of two small, closely spaced, but distinctly separate scales, beginning to form on specimens of about 40 mm. This form is known from off southern Peru and northern Chile. It is tentatively regarded as a new species.

2. Only a supracaudal gland present; this gland is large, with seven large plates nearly filling the space between adipose base and caudal fin. Only a few specimens are known, one from 44° S, 112° W, and two from Drake Passage near Cape Horn. These are also tentatively regarded as undescribed.

3. Andriashev (1962) reported on specimens taken from off Chile, to as far south as 55° S, and identified them as *Symbolophorus boops* (Richardson, 1844). The supracaudal glands are described and figured (Andriashev, 1962, p. 253, fig. 25) as small, separate, and located just before the procurrent caudal rays; these glands are similar to those described above from off Peru-Chile.

TABLE 8. SELECTED MERISTIC CHARACTERS FOR THREE FORMS OF *SYMBOLOPHORUS* FROM THE SOUTHEASTERN PACIFIC OCEAN

Character	*n. sp.* (Peru-Chile)	*n. sp.* (Large gland)	*S. boops* (Andriashev, 1962)
Dorsal rays	13-14	12	13-14
Anal rays	21-22	22	21-24
Pectoral rays	13-15	14	12-14
AO photophores	8 (7-9) + 8 (7-10)	8 + 9	7-9 + 6-10
Gill rakers	5 (4) + 1 + 1 + 11-13	6 + 1 + 15	5-6 + 1 + 13-15
Supracaudal glands	2	7	2
Infracaudal glands	2	0(?)	4-5

Andriashev indicated that those specimens (bearing both supracaudal and infracaudal glands) were males but prefaced the statement with "(?)." He stated (without a question mark) that the females bore only an infracaudal gland of 4 or 5 small juxtaposed scales lying about midway between the end of the anal base and the first procurrent caudal rays.

Symbolophorus californiensis
(Eigenmann and Eigenmann, 1889)

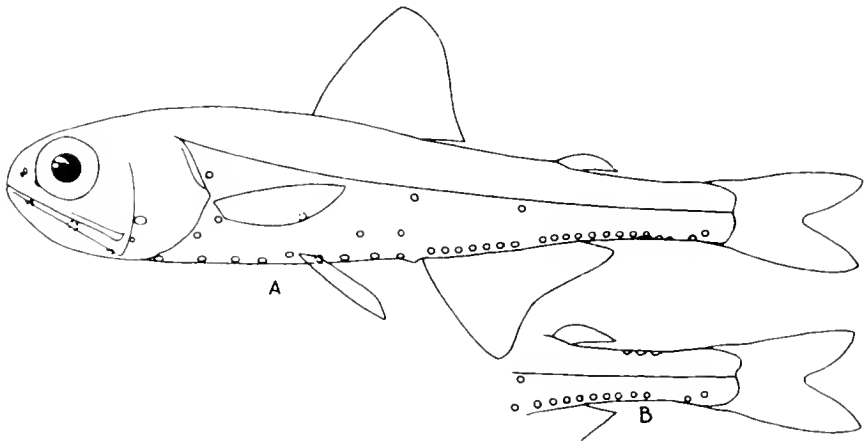


Fig. 46—*Symbolophorus californiensis*. From Bolin (1939, p. 106, fig. 9). (A.) Adult female, (B.) Caudal peduncle of adult male.

Description

D. 14 (13-15); A. 20 (19-21); P. 17 (15-19); AO 7 (6-8) + 9 (8-10), total 16 (14-17); gill rakers 6 (7) + 1 + 15 (14-16), total 22 (21-23); vertebrae 39 (38-40).

SAO interspaces about equal; SAO_1 midway between VO_{2-3}. Pol well before vertical from end of base of adipose fin; 4 (3-5) AOp over anal base.

Supracaudal glands of males with 6 (5-7) small, round or oval, nonoverlapping luminous scales; infracaudal glands of females with 4 (3-5) small, rounded, nonoverlapping spots. These luminous organs begin to appear on males of 55 to 60 mm and on females of 65 to 70 mm.

Size: To about 100 mm.

Least depth of capture: At surface at night.

Distribution: S. californiensis is apparently confined to the California Current from about 27° N to British Columbia and perhaps westward in the Subarctic Current to at least 155° W.

Some authors have placed the species off Japan, but, as discussed below, an undescribed form may occupy those waters.

Discussion

A probably new, closely related species occurs in the northwestern Pacific from Japan to at least 170° E. It differs from *S. californiensis* in having generally higher counts, with little or no overlap, and a shorter head and upper jaw. Due to inadequate collections from the north-central Pacific, it is not now possible to establish either a distinct break in distribution of the two forms or a cline in the respective characters.

Myctophum

Rafinesque, 1810

SAO series in a straight or slightly curved oblique line. SAO_1 well below level of SAO_2 and always behind a vertical from VO_3; 1 Pol; 2 Prc.

Key to species of *Myctophum*

1a. Pol behind a vertical from origin of base of adipose fin 2
1b. Pol on or before a vertical from origin of base of adipose fin 4
2a. Body short, deep, the greatest depth about 3 in SL. Least depth of caudal peduncle 2 or less in the length. Body scales markedly ctenoid. SAO in a straight or slightly curved line. SAO_1 behind a vertical from center of VO_4 ..... *M. selenoides*
2b. Greatest body depth 4 or more in SL. Least depth of caudal peduncle much more than 2 in the length. Body scales with smooth or weakly crenulated margins 3
3a. Posterodorsal margin of operculum markedly angulate, often recurved or hooked, very slightly or not at all striate or dentate. All body scales with smooth margins. SAO in a straight line that passes behind VO_3 ..... *M. nitidulum*
3b. Posterodorsal margin of operculum rounded; scales on anterolateral part of body weakly crenulate, all others with smooth margins. SAO curved. A line through SAO_{1-2} passes through or before VO_3 ..... *M. obtusirostrum*
4a. Upper Prc near lateral line, widely distant from lower Prc. Dorsolateral portion of opercle moderately enlarged, the margin notably striate and dentate. SAO series in a straight line that passes over VO_3. Pol far before origin of base of adipose fin. ..... *M. phengodes*
4b. Upper Prc far below lateral line, near lower Prc 5
5a. Body scales with smooth margins. Body slender, its greatest depth about 5.5 in SL. Posterodorsal margin of operculum notably striate and dentate, particularly in large specimens ..... *M. aurolaternatum*
5b. Body scales markedly ctenoid 6
6a. Scales over AO photophores with 1 to 3 elongate, sharp spines that project posteriorly 7
6b. Scales over AO photophores without elongate spines 8
7a. SAO series straight, or aberrantly and very slightly angulate, a line through the series passing through or very near VO_3. Greatest depth of body 4.0 or less in SL. Least depth of caudal peduncle about 3.2 (3.1-3.4) in the length ..... *M. lychnobium*
7b. SAO series always slightly angulate. A line through SAO_{1-2} passes before VO_3, often through VO_2. Greatest body depth 4.0 to 4.5 in SL. Least depth of caudal peduncle about 2.9 (2.8-3.0) in the length ..... *M. spinosum*
8a. Total gill rakers 14-17. A line through SAO_{1-2} passes variously between VO_1 and VO_2, or before VO_1 ..... *M. asperum*
8b. Total gill rakers 27-29. A line through SAO_{1-2} passes variously through or between VO_3 and VO_2 ..... *M. brachygnathum*

Myctophum aurolaternatum
Garman, 1899

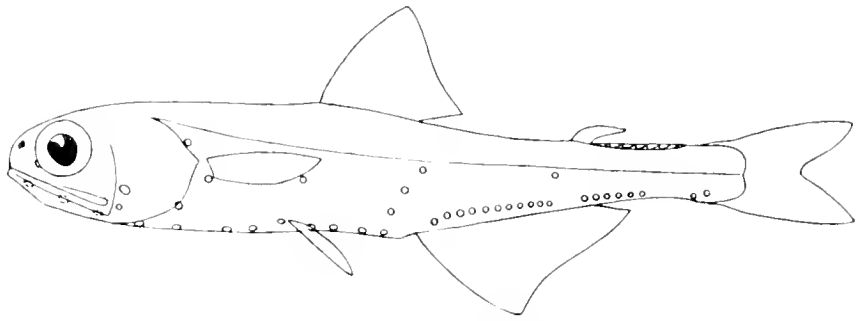


Fig. 47—Myctophum aurolaternatum, male.
From Bolin (1939, p. 108, fig. 10).

Description

Counts for *M. aurolaternatum* (Table 9) vary significantly between areas of its total range, particularly between three sectors of the eastern Pacific Ocean.

SAO series in a straight line; SAO_1 over or slightly behind VO_4. Pol well before base of adipose fin. Prc_2 only slightly elevated. Exposed margins of all scales smooth. Posterodorsal margin of operculum rounded, increasingly striate and serrate with size, beginning at about 30 mm. Usually 2 AOp over anal base.

Supracaudal luminous glands of males with 6 to 9 triangular, overlapping scales that begin to form at about 50 mm; infracaudal glands of females with 3 to 7 rounded, usually contiguous luminous scales, evident at 55 to 60 mm.

Size: To about 105 mm.

Least depth of capture: At surface at night.

Distribution: Widely distributed; commonly taken from about 25° N to 17° S in the extreme eastern Pacific Ocean (Fig. 48) but much less common in the central and far western Pacific, or these areas are inadequately collected. Also common in the Indo-Pacific region and Indian Ocean. The scarcity of captures in the far western Pacific may not be due entirely to a lack of collecting effort. V. E. Becker (personal communication) has stated that the expeditions of the *Vitiaz* did not find *M. aurolaternatum* between 180° and 150° E. Becker also stated that 206 specimens (from 73 stations) were taken in the Indian Ocean from Zanzibar and the Gulf of Aden to the Andaman Islands and Bali.

Discussion

The distribution of *M. aurolaternatum* in the eastern Pacific Ocean (Fig. 48) is similar to that reported by Wisner (1963a) for *Lampanyctus omostigma* and *L. parvicauda*; those distributions appeared to coincide with the pronounced oxygen-minimum layer which underlies much of the eastern tropical Pacific (Austin, 1960, Wyrtki, 1967). The latter two species were mostly taken at depth, but virtually all specimens of *M. aurolaternatum* were taken with dip net and surface light; possibly this species spends the daylight hours in or at least near the upper limits of the oxygen-minimum layer.

In the eastern sector, east of about 145° W, a pronounced racial or population structure is evident in specimens from between about 25° N and 17° S. Highly significant differences occur in nearly all meristic characters between three contiguous groups of specimens (24°29′ N to 11°30′ N, 11°29′ N to 00°30′ N, and 00°30′ S to 17°17′ S). These differences form a definite clinical trend in all characters, the counts averaging lower in the north and grading rather evenly into higher counts in the south. Differences in meristic characters are relatively slight in specimens from the remaining areas (the mid-Pacific and westward through the Indian

TABLE 9. NUMBERS OF TOTAL GILL RAKERS, TOTAL AO PHOTOPHORES, VERTEBRAE, AND FIN RAYS FOR *M. AUROLATERNATUM* FROM THE EASTERN AND MID-PACIFIC OCEAN, AND FROM THE INDO-PACIFIC AREA AND THE INDIAN OCEAN. DATA FOR THE EASTERN PACIFIC ARE ARRANGED IN THREE LATITUDINAL GROUPS.

Area	Total gill rakers								
	14	15	16	17	18	19	20	N	Mean
Eastern Pacific									
24° 29′-11° 30′ N	2	70	52	20	—	—	—	144	15.62
11° 29′-00° 30′ N	—	8	77	138	86	1	—	310	16.98
00°30′-17°17′ S	—	—	2	36	37	1	—	76	17.49
Mid-Pacific	—	1	2	11	32	5	—	51	17.75
Indo-Pacific	—	—	59	64	114	5	1	243	17.28
Indian Ocean	—	—	12	11	22	1	—	46	17.26
	Total AO photophores								
	13	14	15	16	17	18	19	N	Mean
Eastern Pacific									
24°29′-11°30′ N	—	—	41	75	25	3	—	144	15.93
11°29′-00°30′ N	—	1	25	111	135	36	—	308	16.58
00°30′-17°17′ S	—	—	—	9	37	28	2	76	17.30
Mid-Pacific	—	—	7	18	25	2	1	53	16.47
Indo-Pacific	1	4	18	116	105	12	1	257	16.40
Indian Ocean	—	2	3	19	26	—	—	50	16.38
	Vertebrae								
	42	43	44	45	46			N	Mean
Eastern Pacific									
24°29′-11°30′ N	14	37	10	—	—			61	42.93
11°29′-00°30′ N	2	49	79	30	—			160	43.86
00°30′-17°17′ S	1	1	19	16	1			38	44.39
Mid-Pacific	1	3	4	1	—			9	43.56
Indo-Pacific	3	26	64	13	—			106	43.82
Indian Ocean	—	11	11	—	—			22	43.50
	Principal dorsal rays								
	9	10	11	12				N	Mean
Eastern Pacific									
24°29′-11°30′ N	1	16	34	4				55	10.75
11°29′-00°30′ N	—	19	67	20				106	11.01
00°30′-17°17′ S	—	1	20	16				37	11.41
Mid-Pacific	—	—	10	1				11	11.09
Indo-Pacific	—	10	67	31				108	11.19
Indian Ocean	—	1	16	8				25	11.28
	Total anal rays								
	21	22	23	24	25	26	27	N	Mean
Eastern Pacific									
24°29′-11°30′ N	1	6	18	25	4	—	—	54	23.46
11°29′-00°30′ N	—	4	14	52	29	3	—	102	24.13
00°30′-17°17′ S	—	—	4	19	14	2	1	40	24.43
Mid-Pacific	—	1	2	6	2	—	—	11	23.82
Indo-Pacific	1	2	17	64	23	2	—	109	24.03
Indian Ocean	—	1	7	11	2	—	—	21	23.67
	Pectoral rays								
	12	13	14	15	16			N	Mean
Eastern Pacific									
24°29′-11°30′ N	2	64	33	—	—			99	13.13
11°29′-00°30′ N	4	44	130	23	—			201	13.86
00°30′-17°17′ S	—	4	31	35	2			72	14.49
Mid-Pacific	—	5	14	1	—			20	13.80
Indo-Pacific	—	3	23	99	32			157	14.02
Indian Ocean	—	2	31	10	—			43	14.19

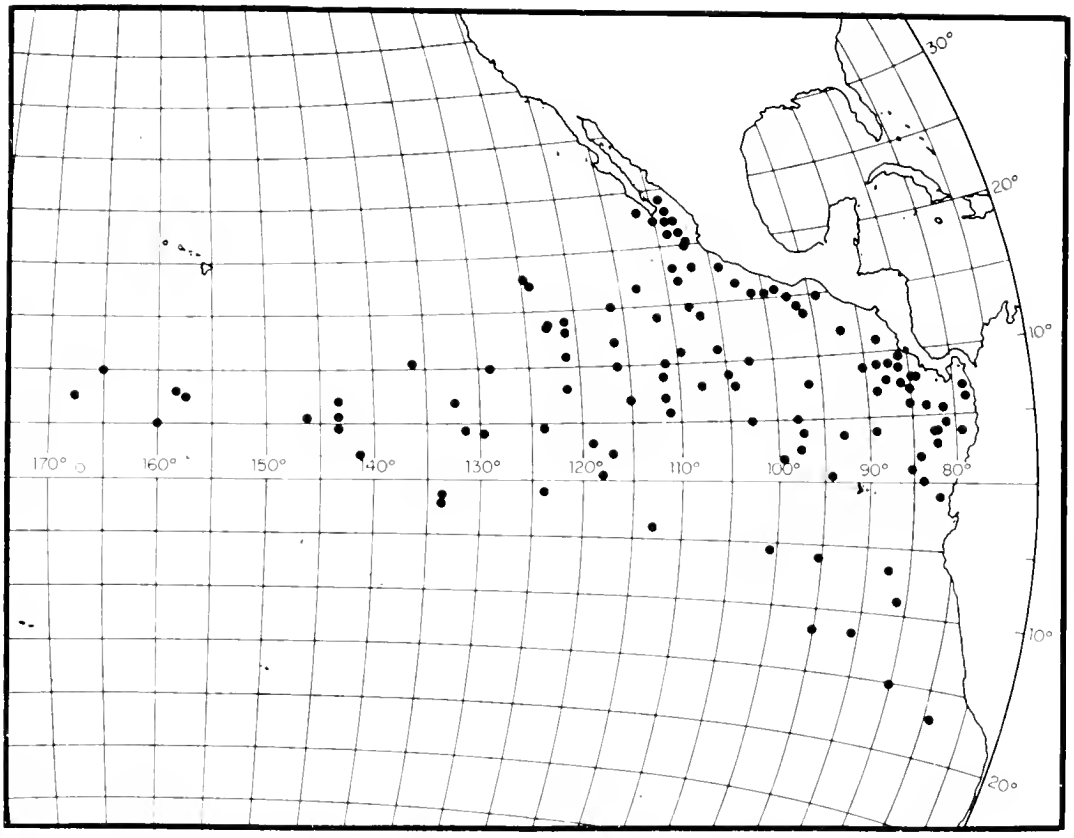


Fig. 48—Capture localities for *Myctophum aurolaternatum* in the eastern Pacific Ocean.

Ocean). Counts for total gill rakers, AO photophores, fin rays, and vertebrae are given in Table 9. No significant sexual dimorphism was demonstrated in meristic characters or body proportions in specimens from any of the geographical areas.

The most significant differences in counts occur in the extreme eastern Pacific sector of the range. Originally the data were arranged by each degree of latitude, north to south; the latitudinal groupings of data in Table 9 were derived from that arrangement and appear to represent natural breaks in the frequenty distributions of the various counts. These breaks also appear to coincide rather well with the boundaries of the major equatorial currents, as delineated by Wyrtki (1965).

Myctophum phengodes
(Lütken, 1892)

Description

D. 12-13; A. 21 (20-22); P. 15-16; AO 7 (6-8) + 8 (7-9), total 15 (14-16); gill rakers 7-8 + 1 + 17-18, total 26 (25-27); vertebrae 37 (36-38).

Upper Prc much elevated. Eye large, 1.5 in upper jaw. Usually 4 AOp over anal base. Upper margin of operculum markedly angulate and serrate in young and adults. SAO series straight; SAO_1 a little before a vertical from VO_1. AOa_1 often depressed below level of AOa_2.

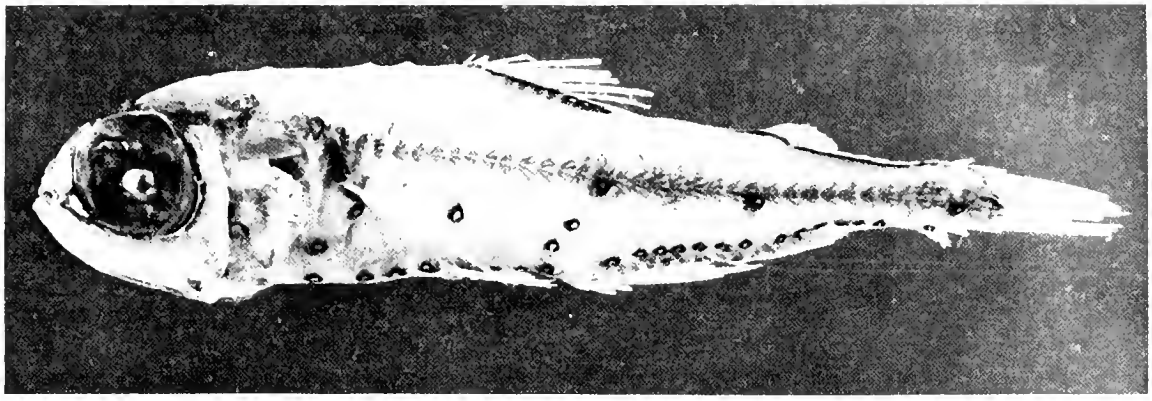


Fig. 49—*Myctophum phengodes*, male, 54.5 mm.

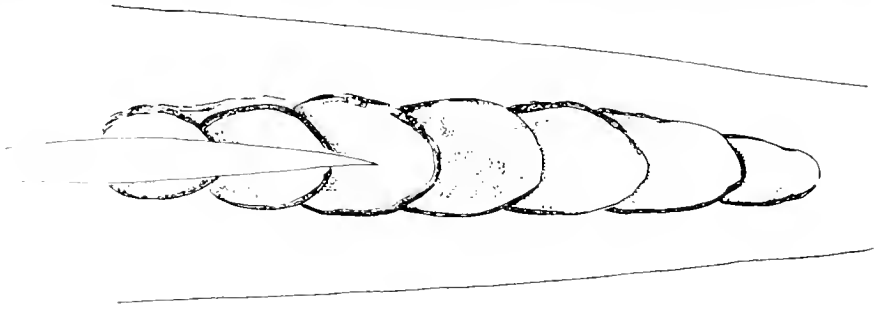


Fig. 50—Supracaudal gland of the male *M. phengodes* shown in fig. 49.

Six to 8 luminous scales in the supracaudal gland are evident at about 30 mm (Fig. 50); 3 or 4 luminous scales in the infracaudal gland. The limited material at my disposal does not permit an estimate of size at early development.

Size: To about 60 mm.

Least depth of capture: At surface at night. Craddock and Mead (1970) reported the capture of 614 specimens from the southeastern Pacific Ocean, off Chile, between about 30° and 34° S, 77° and 92° W; of this number, 320 were taken with surface nets at night, the rest by subsurface trawl.

Distribution: Apparently circumglobal only in southern oceans from about 25° to 50° S. Fowler (1901, p. 260) identified as *Myctophum phengodes* a specimen from 60° N, between Greenland and North America (the Labrador Sea). I have examined this specimen (ANSP 7987, 79.5 mm SL) and found it to be *Myctophum punctatum* Rafinesque, 1810, a very common species of the North Atlantic Ocean.

Discussion

Only 11 specimens were available to me for study: 4 from the southeastern Pacific Ocean, 6 from the Indian Ocean, and 1 from the southeastern Atlantic Ocean. Among these few specimens an interesting difference was observed in position of the Pol photophore relative to the base of the adipose fin. In the four specimens from the southeastern Pacific, Pol was under only the first or second lateral line pore before end of adipose base; in the six specimens from the Indian Ocean, Pol was under the third or fourth pore; and in the single specimen from the southeastern Atlantic, Pol was under the third pore. Both sides of each specimen were examined. Counts on these few specimens indicated no significant differences among the three areas.

Myctophum lychnobium
Bolin, 1946

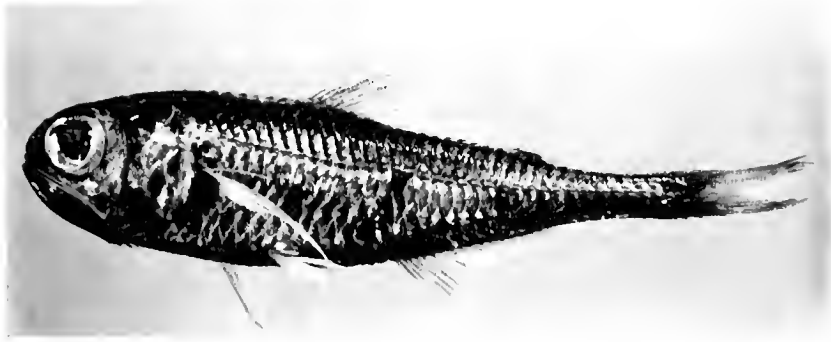


Fig. 51—*Myctophum lychnobium*, female, 98.0 mm.

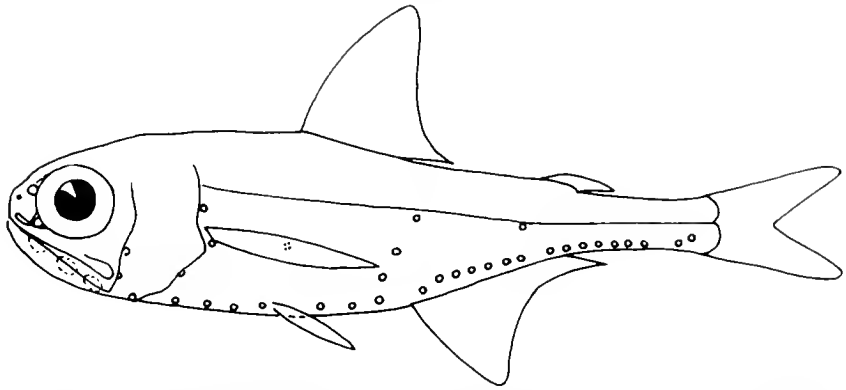


Fig. 52—*Myctophum lychnobium*. From Sarenas (1954, p. 411, fig. 9) (sex not stated.)

Description

D. 13 (12-14); A. 19 (17-20); P. 15-16 (14-17); AO 7 (6-8) + 7 (6-8), total 14 (12-16); gill rakers 6-7 (8) + 1 + 14-15 (13-17), total 22 (20-24); vertebrae 38 (37-39).

Exposed margins of scales strongly ctenoid. One to three serrations on the scales over the AO series, and often over ventral midline, are markedly elongated into spines which project posteriorly. Upper opercular margin serrate. One, rarely 2, AOp over anal base. SAO series usually straight and in a steep angle (about 60°). SAO_1 over VO_4. AOa_1 over fourth to sixth anal ray base; AOa_{1-2} interspace greater than those of remaining ones of series. Forebody deep, 4 in SL. Body color very dark brown or black in preservative. Males of about 60 mm begin to develop 6 to 8 luminous scales in the supracaudal gland and females of about 50 mm begin to develop from 1 to 4 scales in the infracaudal gland.

Size: To about 116 mm.

Least depth of capture: At surface at night.

Distribution: Known from tropical waters from eastern Pacific (Fig. 53) to Mozambique Channel, Indian Ocean.

Discussion

See *M. spinosum*.

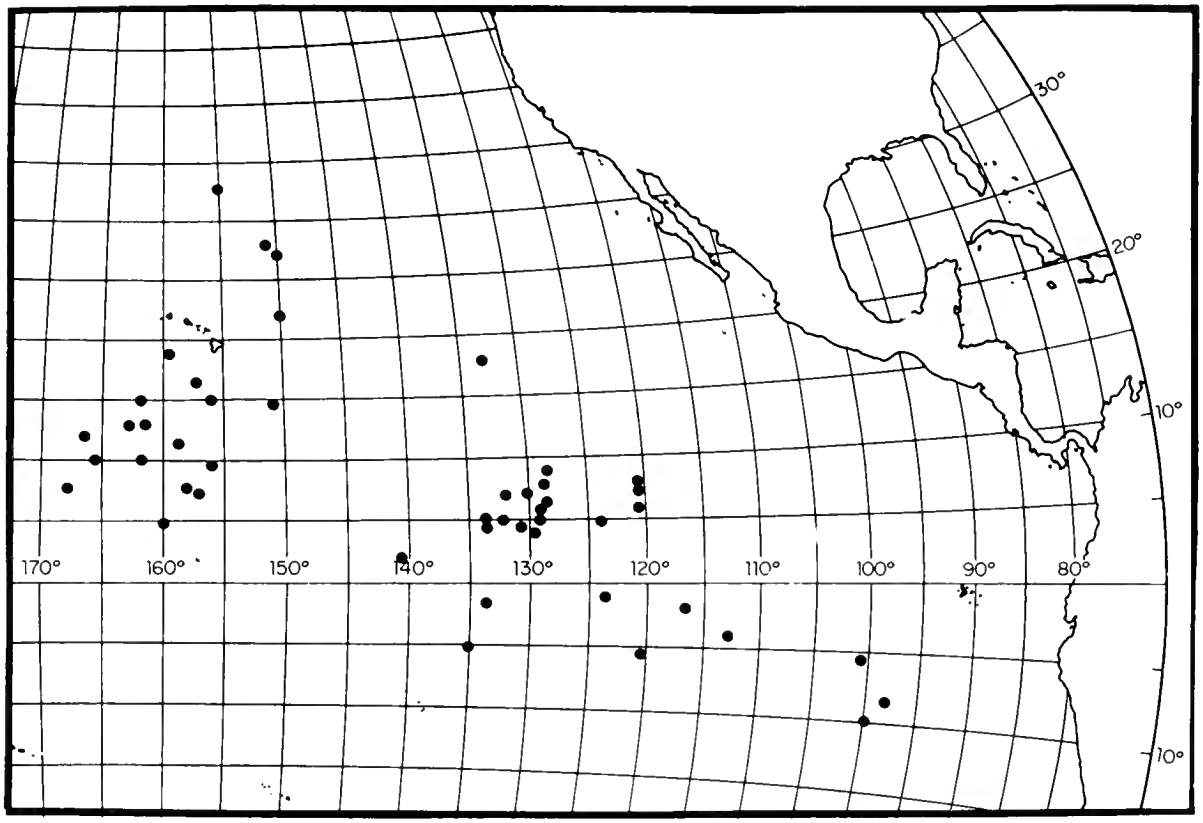


Fig. 53—Capture localities for *Myctophum lychnobium* in the eastern Pacific Ocean.

Myctophum spinosum
(Steindachner, 1867)

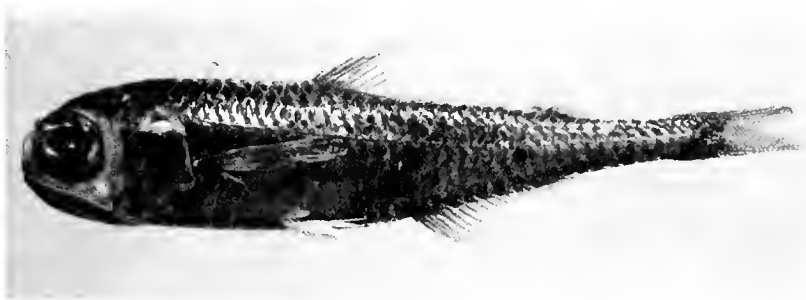


Fig. 54—*Myctophum spinosum*, male, 84.8 mm.

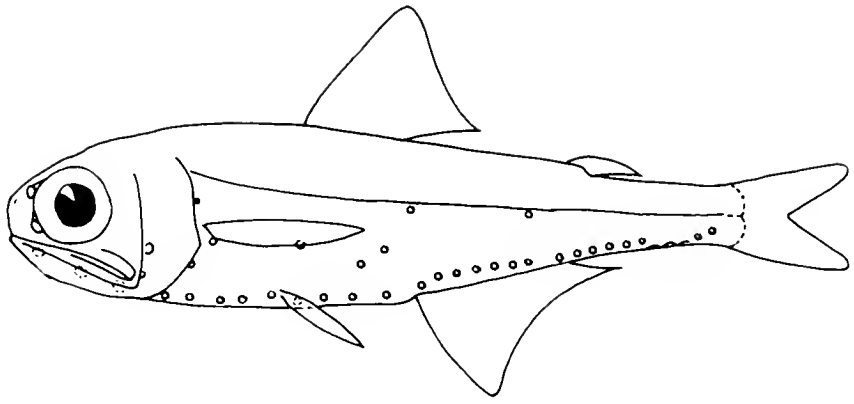


Fig. 55—*Myctophum spinosum*, female, From Sarenas (1954, p. 406, fig. 8).

Description

D. 13 (12-14); A. 19 (18-20); P. 14 (12-15); AO 7 (6-8) + 7 (5-8), total 14 (12-15); gill rakers 7 (6-8) + 1 + 16 (14-18), total 23 (21-25); vertebrae 39 (37-40).

Exposed margins of scales strongly ctenoid. As in *M. lychnobium*, 1 to 3 elongated spines project posteriorly from hind margins of scales overlying the AO series of photophores, and often on those over the ventral midline. SAO series slightly but distinctly angulate; SAO_1 over VO_{3-4} interspace, usually nearer to VO_3. AO_1 over second to fourth anal ray base; AOa_{1-2} interspace not greater than those of rest of series. Forebody only moderately deep, about 5 in SL. Body color light to warm brown in preservative.

From about 55 mm on, males bear 6 (5-7) luminous scales in the supracaudal gland, each with a black rim, and females bear 1 to 4 smaller scales in the infracaudal gland. Specimens from the South China Sea, Philippine, Sulu, and Celebes Seas show a high incidence of both supracaudal and infracaudal glands on one individual; of the 35 specimens used in this study, 14 (40%) bore both glands. In these cases the supracaudal luminous scales numbered from 1 to 3.

Size: To about 90 mm.

Least depth of capture: At surface at night.

Distribution: Tropical waters of Pacific, Indo-Pacific, Indian, and possibly Atlantic Oceans (Wisner, 1970a). Not found in the extreme eastern Pacific but has been reported from the Hawaiian region.

Discussion

Myctophum lychnobium is usually separable from *M. spinosum* by the more straight and steeply angled SAO series and the position of SAO_1 more nearly over VO_4. However, in the Hawaiian area some specimens presumed to be *M. lychnobium* have a more angulate SAO series and the first SOA about over a midpoint between VO_3 and $_4$, conditions approaching those characters presumed to be characteristic of *M. spinosum*. At present it is not known whether these are local variations or, possibly, the result of hybridization. Studies of adequate material from throughout the total range may show the existence of but one highly variable species.

Some authors have placed *M. lychnobium* in synonymy with *M. spinosum* but Moser and Ahlstrom (1974) show the larvae of these two species to be distinctively different.

Myctophum asperum (?)
(Richardson, 1844)

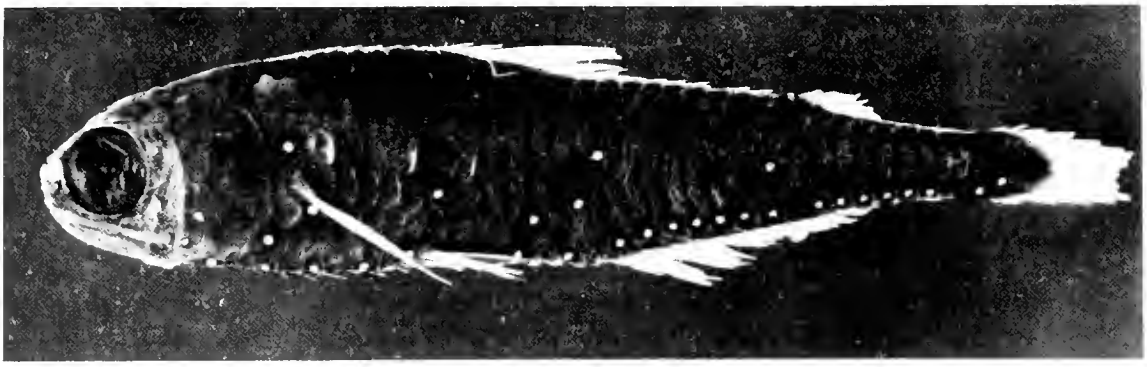


Fig. 56—*Myctophum asperum* (?), male 54.7 mm. From the central tropical Pacific Ocean. (Photophores retouched).

Description

D. 10-11; A. 17 (16); P. 14 (13-15); AO 6 (7-8) + 6 (4-7), total 13 (11-14); gill rakers 4 + 1 + 10 (9-12), total 15 (14-17); vertebrae 36 (35-38). (Counts given only for specimens from the eastern tropical Pacific Ocean.)

No elongate sharp spines on the strongly ctenoid exposed scale margins. SAO forming a moderate but distinct angle; SAO_1 over VO_{2-3} interspace. Males bear 4 to 6 luminous scales in the supracaudal gland which fill most of the space between end of adipose base and base of first procurrent caudal ray. Females bear 1 or 2 small ovate scales in the infracaudal gland.

Size: To about 70 mm.

Least depth of capture: At surface at night.

Distribution: Fishes corresponding to the diagnosis of *M. asperum* are known from the northwestern, eastern, central, and southwestern Pacific Ocean, and from the tropical Atlantic and Indian Oceans (Wisner, 1970a).

Discussion

Myctophum asperum forms a complex of at least two forms in the Pacific Ocean. The holotype has no recorded locality, merely, "habitat- - -?"; however, as the collecting vessels (HMS *EREBUS* and *TERROR*) collected primarily in southern seas, it may be assumed that the type locality lies there, but collections could have been made along the entire track (Richardson, 1844). Of the material used in this study, specimens from the east-central tropical Pacific (Fig. 56) appear to differ specifically from those of the tropical Atlantic and from the northwestern Pacific near Japan (Wisner, 1970a) in having fewer anal and pectoral rays, vertebrae, and AOp photophores. Also the two Pacific forms differ in at least 10 characters, with little or no overlap in percent of SL. Superficially, all forms key out to *M. asperum*, but at this time it is not possible to state which of the Pacific forms, if either, constitutes the true *Myctophum asperum*. More study on specimens from all oceans is needed.

Myctophum nitidulum
Garman, 1899

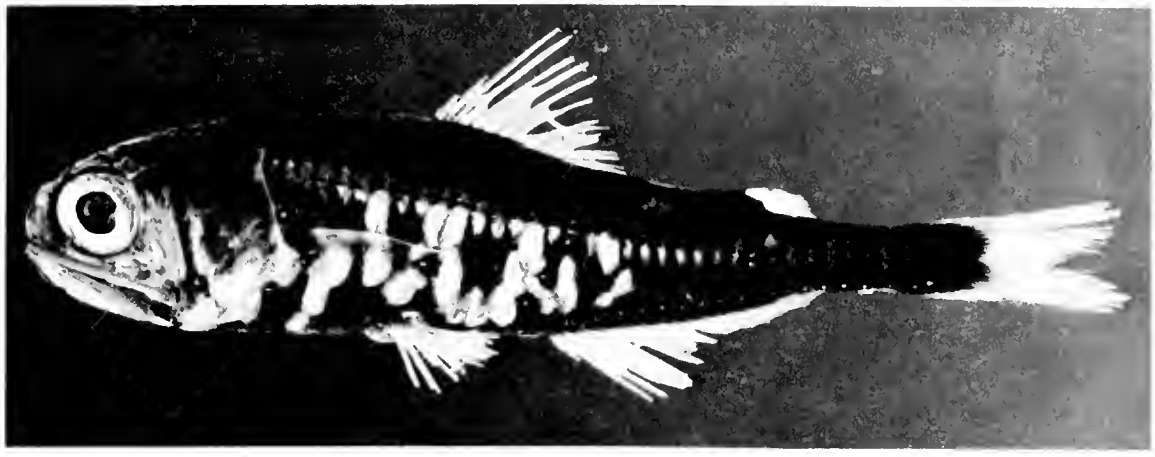


Fig. 57—*Myctophum nitidulum*, female, 68.5 mm.

Description

D. 13 (12-14); A. 19 (18-20); P. 14 (13-15); AO 8 (6-10) + 5 (4-7), total 13 -14 (10-17); gill rakers 6 (5-8) + 1 + 15 (12-18), total 20-22 (18-27—see discussion of variation); vertebrae 38 (37-39).

SAO series in an essentially straight, steeply oblique line; SAO_1 over or slightly behind VO_4. Pol nearly under or slightly before end of adipose base. Exposed margins of scales smooth; posterodorsal margin of operculum distinctly angulate, often more or less recurved; this angulation is discernible in specimens as small as 20 mm.

Supracaudal glands of males with 5 to 8 (3-6 in eastern tropical Pacific area) rather triangular, overlapping luminous scales; infracaudal glands of females with 2 to 6 small, round to oblong spots; in each sex the luminous scales are evident at about 35 mm.

Size: To about 75 mm.

Least depth of capture: At surface at night.

Distribution: Myctophum nitidulum is widespread throughout the warmer waters of the Pacific Ocean, and perhaps in the Atlantic and Indian Oceans. The localities shown in Fig. 58 represent only those specimens examined by me, for reasons discussed below. The southern parts of the Pacific are too poorly collected to warrant firm statements of occurrence of the species. Whitley (1968) did not include the species in his checklist of fishes from the New Zealand area. Craddock and Mead (1970) reported two adults taken off Chile, at 30°59′ S, 92°28′ W.

A hiatus in the distribution of *M. nitidulum* occurs in the eastern Pacific Ocean westward of the coasts of Mexico and Central America, from about 25°-05° N and about 120°-125° W (Fig. 58). This broad area has been repeatedly collected with surface and subsurface nets without taking the species. The area corresponds roughly with the region of very low oxygen concentrations (0.25 to 0.50 ml/l) as delineated by Wyrtki (1967).

Discussion

For at least the past 50 years the name *Myctophum affine* has been applied by most authors to the species herein referred to as *M. nitidulum*. The following brief account is intended as an aid in clarifying the current status of that name.

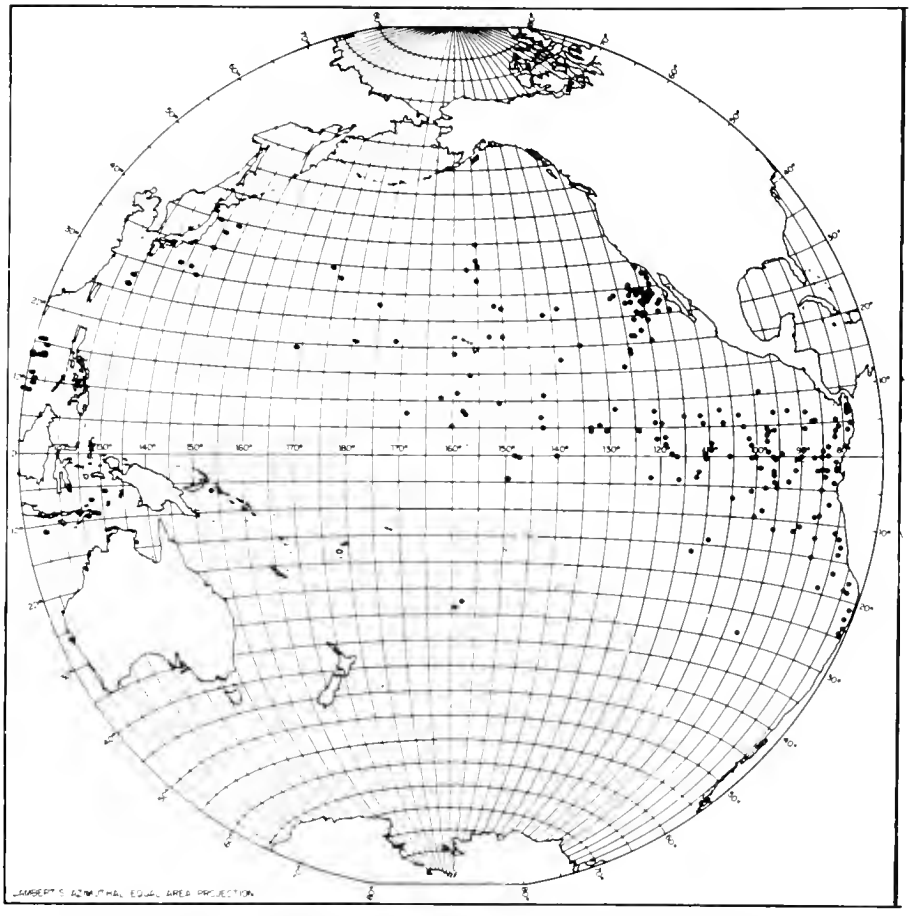


Fig. 58—Capture localities for *Myctophum nitidulum* in the Pacific Ocean.

Scopelus affinis (= *M. affine*) was described by Lütken (1892), based on 38 collections from the Atlantic and Indian Oceans. Garman (1899) described *Myctophum nitidulum* from the northeastern Pacific, type locality 27°50′ N, 145°45′ W. Gilbert (1905) described *M. margaritatum*, based on material from the Hawaiian area and from about 28°13′ N, 145°44′ W (the latter position is very near the type locality of *M. nitidulum*). Gilbert (1908) synonymized both these Pacific forms with *M. affine*.

Gibbs (1957), reporting on material from the northwestern Atlantic Ocean and the Gulf of Mexico, segregated two forms, each referrable to *M. affine* of Lütken. Gibbs characterized one form as having ctenoid scales and a rounded dorsal portion of the opercular margin, and the other form as having cycloid scales and a distinctly angulate posterodorsal margin of the operculum. On the advice of Bolin, Gibbs applied the name *M. affine* to the form having ctenoid scales and rounded opercular margin, and chose *M. nitidulum* as the earliest available name for the cycloid-scaled form with the angulate posterodorsal margin of the operculum.

Bolin (1959) reported that Lütken's original study material of *M. affine*, composed mostly of juveniles, contained at least two species, one being *M. asperum* (Richardson), the other the ctenoid-scaled, round-operculumed form reported by Gibbs (1957) as *M. affine*; Bolin designated a lectotype with the type locality in the Atlantic Ocean at 08° 44′ N, 21° W for this latter form. With some hesitation, Bolin accepted Gibbs' designation of the cycloid-scaled, angulate-operculumed form as *M. nitidulum*.

Based on the criteria provided by Gibbs and Bolin, I have found only *M. nitidulum* among hundreds of specimens from throughout the Pacific Ocean and from much of the Indian Ocean. Becker (1967b), however, reported one occurrence of *M. affine* from the southwestern Pacific, at Lord Howe Island, and at the same time indicated the occurrence of *M. nitidulum* in the tropical Pacific. As the south-central and southwestern Pacific Ocean is still rather inadequately collected or reported on, it is not certain that the true *M. affine* (as restricted by both Gibbs and Bolin) does not occur here, or perhaps elsewhere in the Pacific. For this reason the localities for *M. nitidulum* shown in Fig. 58 represent only specimens examined by me.

Variation: The numbers of total gill rakers (Table 10) indicate the existence of several populations (or one highly variable population) of *M. nitidulum* in the Pacific Ocean, and particularly the eastern equatorial area. Specimens from this area, bounded roughly by about 05° S to 10° N, 70° to 150° W, have significantly higher numbers of total gill rakers than those from other areas of the Pacific and from the Indian and Atlantic Oceans. Also, in the eastern equatorial region many specimens bear both supracaudal and infracaudal luminous glands, the scales in the supracaudal glands of all males from the area being fewer (3-5) than in other areas (5-9). Corollary to the higher numbers of gill rakers is an increase in numbers of AO photophores and vertebrae, but to a lesser degree of significance.

TABLE 10. NUMBERS OF TOTAL GILL RAKERS FOR *MYCTOPHUM NITIDULUM* FROM SELECTED AREAS OF THE PACIFIC OCEAN AND FROM THE INDIAN AND ATLANTIC OCEANS

Area	17	18	19	20	21	22	23	24	25	26	27	N	Mean
Pacific Ocean													
07°-28° S,													
Coast to 114° W	1	21	31	20	22	5	—	—	—	—	—	100	19.56
15°-33° N,													
Coast to 122° W	—	—	4	24	146	78	5	2	—	—	—	259	21.24
10°-40° N,													
135°-170° W	—	1	7	12	31	10	3	1	—	—	—	65	20.85
Japan area	—	2	36	154	27	1	—	—	—	—	—	220	19.95
Equatorial area													
05°-08° N													
75°-85° W	—	—	—	1	24	24	11	8	1	—	—	69	22.06
86°-99° W	—	—	—	1	4	16	52	72	29	2	2	178	23.66
100°-129° W	—	—	—	—	1	8	22	58	49	30	2	170	24.44
130°-150° W	—	—	—	2	20	8	—	—	—	—	—	30	21.20
South-Central Pacific													
27°-28° S,													
157°-159° W	3	5	3	—	—	—	—	—	—	—	—	11	18.00
Indian Ocean	—	—	1	7	42	20	—	—	—	—	—	70	21.16
Atlantic Ocean	—	18	31	12	8	—	—	—	—	—	—	69	19.14

Myctophum obtusirostrum
Tåning, 1928

Fig. 59—*Myctophum obtusirostrum*, male, 61.5 mm.

Description

D. 13 (12); A. 18 (17-19); P. 18 (17-19); AO 7 (6-8) + 4-5 (6), total 12 (11-13); gill rakers 7 (6-8) + 1 + 16-17 (15-18), total 25 (24-27); vertebrae 35.

Distance between hind margin of orbit and upper opercular margin greater than orbital diameter. Upper opercular margin straight and serrate in specimens of about 30 mm and larger. Scales weakly crenulate along forepart of body below lateral line. PLO nearer pectoral origin than to lateral line.

Males with 5 (4-6) luminous scales in the supracaudal gland, with pigmented margins, covering one-half to three-fourths of the upper surface of the peduncle; females with 2 (1-3) luminous scales in the infracaudal gland, smaller and less sharply outlined with pigment.

Size: To about 80 mm.

Least depth of capture: At surface at night.

Distribution: In central tropical Pacific waters, but eastward only to about 130° W; also found in the western Pacific and Indo-Pacific region and in the Indian and Atlantic Oceans.

Discussion

Recent action regarding the synonymy of this species is discussed under *M. brachygnathum*.

Myctophum brachygnathum
(Bleeker, 1856)

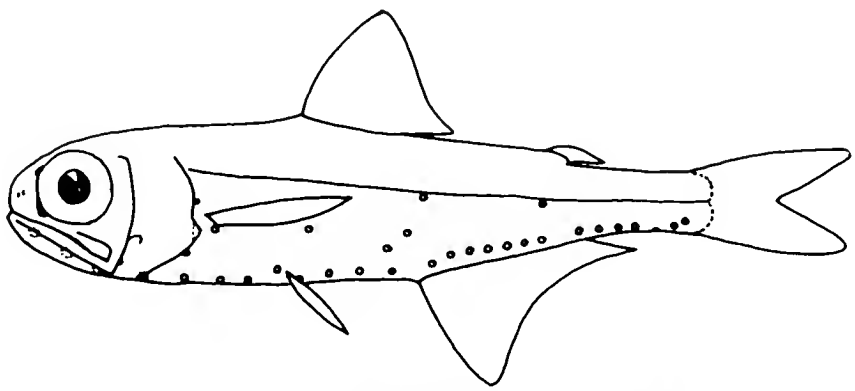


Fig. 60—*Myctophum brachygnathum*, female, From Sarenas, (1954, p. 403, fig. 7) (as *M. pristilepsis*).

Description

D. 13 (12); A. 18 (19); P. 17 (16-18); AO 7 (6-8) + 4 (3-5), total 11 (10-12); gill rakers 8 + 1 + 18 (17-19), total 26-28; vertebrae 35.

Distance from hind margin of orbit to upper opercular margin equal to or less than orbital diameter; upper opercular margin neither striate nor serrate. Exposed margins of scales distinctly ctenoid. PLO about midway between pectoral origin and lateral line.

Males have 2 (1-3) small supracaudal luminous glands, with rather heavily pigmented margins, lying about over AOp-Prc interspace. Females have 1 (2) smaller infracaudal glands with lightly pigmented margins, lying below the AOp-Prc interspace. The size at which these fishes first develop luminous caudal glands is not known.

Size: To about 65 mm.

Least depth of capture: At surface at night.

Distribution: Apparently similar to that of *M. obtusirostrum*.

Discussion

The three species, *Myctophum obtusirostrum*, *M. brachygnathum* and *M. pristilepis* (Gilbert and Cramer, 1897) have usually been confused, particularly the latter two. Fraser-Brunner (1949) placed *M. pristilepis* in the synonymy of *M. brachygnathum*, but Sarenas (1954) regarded the two as distinct. Sarenas stated that in *M. brachygnathum* the distance from hind margin of orbit to posterodorsal margin of operculum was greater than the length of orbit, whereas these two characters were of nearly equal length in *M. pristilepis*; he also stated that the scales of the latter were much more ctenoid than those of *M. brachygnathum*. In view of the synonymy of these two species (see below), it seems possible that Sarenas worked with misidentified material.

Nafpaktitis (1973), after examining Bleeker's and Tåning's type material and the holotype of *M. pristilepis*, concluded that in *M. obtusirostrum* the distance from hind margin of orbit to posterodorsal margin of operculum is greater than the length of orbit, but that these two characters were of nearly equal length in *M. brachygnathum*. Nafpaktitis agreed with Fraser-Brunner (1949) in placing *M. pristilepis* in the synonymy of *M. brachygnathum*. I have examined several adult specimens of *M. "pristilepis"* from the central Pacific and have found all body scales to be markedly ctenoid, whereas only a few weakly crenulate scales occur anterolaterally near the pectoral fins in *M. obtusirostrum*.

Myctophum selenoides
Wisner, 1971

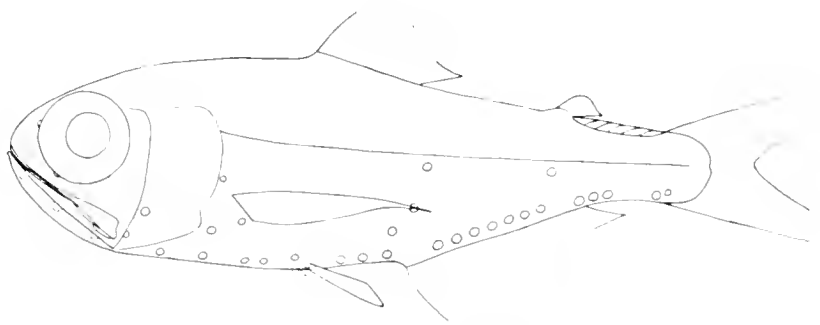


Fig. 61—*Myctophum selenoides*, holotype, male, 58.0 mm. From Wisner (1971, p. 43, fig. 8.)

Description

D. 13; A. 18 (17-19); P. 17 (16-18); AO 6-7 + 3 (4), total 9 (10); gill rakers 7 (6) + 1 + 15 (14-17), total 22 (20-24); vertebrae 35. Frequency distributions of the above meristics, except vertebrae, are given in Table 11.

Body and head deep, each about 31% of SL; head as deep as long. Caudal peduncle short, 6 in SL, and deep, 1.5 in its length. Exposed margins of body scales strongly ctenoid but without the elongated spines, on scales over the AO series, found in *Myctophum spinosum* and *M. lychnobium*. Three SAO in a straight or slightly angulate, steeply oblique line, at an angle of about 20° (17°-23°) from the vertical.

Only supracaudal glands occur in each sex; those of males strongly developed with 6 or 7 somewhat overlapping luminous scales that fill the supracaudal space (Fig. 61). The supracaudal glands of females have only 3 or 4 weakly developed, usually contiguous scales that fill about half the supracaudal space. No infracaudal luminous scales were found on any specimen.

Size: To about 60 mm.

Least depth of capture: To 20 m at night; this species is not yet reported as taken from the surface.

TABLE 11. NUMBERS OF FIN RAYS, AO PHOTOPHORES, AND GILL RAKERS FOR *MYCTOPHUM SELENOIDES* FROM THE CENTRAL PACIFIC OCEAN AND FOR *M. SELENOPS* FROM THE ATLANTIC AND PACIFIC OCEANS

	Dorsal rays		Anal rays			Pectoral rays		
Species and area	12	13	17	18	19	16	17	18
M. selenoides								
Near Hawaii	—	6	2	3	1	3	7	2
Near Equator	—	2	—	2	—	1	1	—
M. selenops								
Atlantic Ocean	1	7	1	5	1	4	11	1
Indian Ocean	—	1	—	1	—	—	2	—

	AO photophores							
	AOa			AOp			Total AO	
	6	7	8	2	3	4	9	10
M. selenoides								
Near Hawaii	3	9	—	—	11	1	2	10
Near Equator	—	4	—	—	4	—	—	4
M. selenops								
Atlantic Ocean	—	13	3	3	13	—	—	16
Indian Ocean	—	2	—	—	2	—	—	2

	Gill rakers										
	Upper		Lower				Total				
	6	7	14	15	16	17	20	21	22	23	24
M. selenoides											
Near Hawaii	6	8	5	9	—	—	4	3	7	—	—
Near Equator	—	4	—	—	2	2	—	—	—	2	2
M. selenops											
Atlantic Ocean	2	14	—	1	11	4	—	1	1	10	4
Indian Ocean	—	2	—	—	2	—	—	—	—	2	—

Distribution: Known only from a few specimens from near Hawaii and southward to near the equator (Fig. 62). Becker (1967b) recorded as *M. selenops* two specimens from the western Pacific (Fig. 62B) that may represent *M. selenoides*, but no descriptions or counts were given.

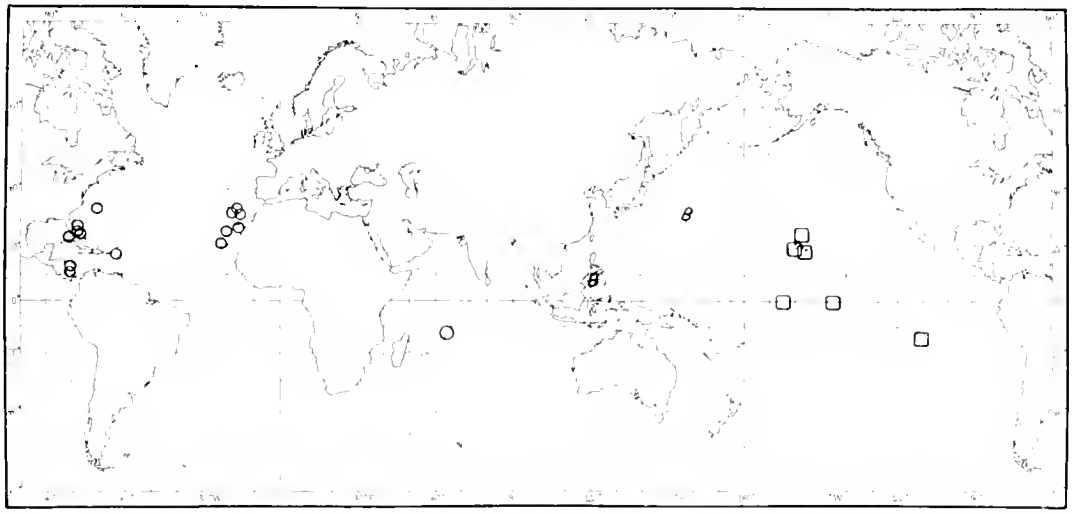


Fig. 62—Capture localities for *Myctophum selenoides* (open squares), and for *M. selenops* (open cirlces). "B" refers to localities given for "*M. selenops*" by Becker (1967b).

Discussion

Myctophum selenoides is closely related to *M. selenops* Tåning (1928), from the Atlantic Ocean (Fig. 63). It differs primarily in that the SAO series is at an angle of 20° (17°-23°) to the vertical axis of the body, rather than about 30° (28°-31°) as in *M. selenops*. Meristic data (Table 11) and body proportions (Table 12) are given for both species. Meristic characters appear to be essentially the same, but because of the few specimens involved it is probable that the limits of variation are not yet observed. The rather wide range in numbers of lower and total gill rakers (Table 11) among the two specimens from the equatorial region and the six from near Hawaii indicates a potential bimodality; however, in all other respects these two specimens are much more like those from Hawaii than like *M. selenops*.

Of the body proportions given in Table 12, only the orbit length differs notably between the two species, averaging 12% of SL vs 15% for *M. selenops*. The orbit averages 58% of upper jaw in *M. selenoides* vs 67% in *M. selenops*.

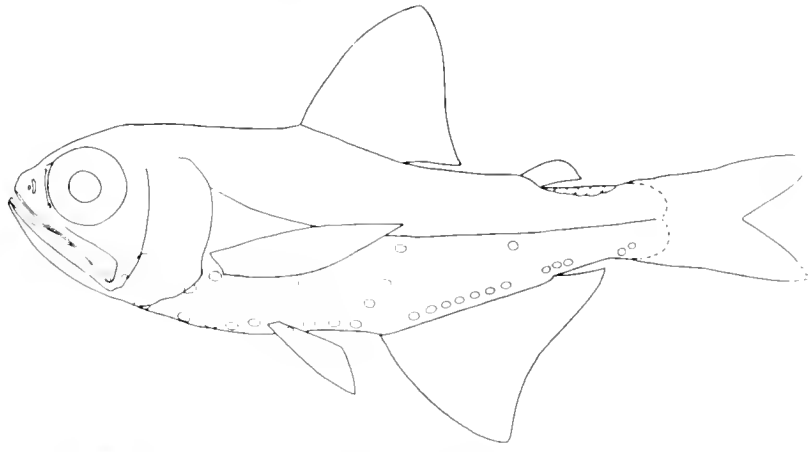


Fig. 63—*Myctophum selenops*, holotype, male, 51.6 mm. An unpublished drawing by Rolf L. Bolin.

TABLE 12. BODY PROPORTIONS FOR *MYCTOPHUM SELENOIDES* FROM THE PACIFIC OCEAN AND FOR *M. SELENOPS* FROM THE ATLANTIC AND INDIAN OCEANS

Measurement	*M. selenoides*			*M. selenops*		
	Central Pacific Ocean			Indian Ocean	Atlantic Ocean	
	Holotype	Paratypes N=7		N=1	N=7	
	SL—58.0 mm	SL—25.3-60.8 mm		SL—55.5 mm	SL—57.8-67.5 mm	
		Ave.	Range		Ave.	Range
Head length	317	307	298-320	317	318	312-329
Head depth	288	268	260-281	283	272	259-280
Upper jaw length	214	207	198-211	213	216	209-224
Orbit length	122	120	117-123	147	148	143-154
Prepectoral length	319	311	300-326	324	332	322-341
Prepelvic length	445	447	435-452	461	449	434-461
Predorsal length	497	480	479-488	472	485	468-487
Preanal length	597	606	592-626	613	614	602-627
Preadipose length	812	812	799-826	802	825	815-835
Dorsal origin to pelvic origin	323	315	306-324	315	304	282-314
Dorsal origin to anal origin	334	331	313-340	337	332	320-340
Dorsal base length	153	167	154-178	157	157	152-168
Anal base length	276	272	263-281	279	275	264-288
Caudal peduncle length	166	166	150-187	184	163	153-178
Caudal peduncle depth	114	100	95-106	99	97	83-111
Pectoral fin length	310	307	296-325	—	299	289-315
Pelvic fin length	150	148	137-156	—	147	134-161

The study material of *M. selenops* includes the specimen reported on by Maul (1952, p. 52, fig. 15); two discrepancies may be noted between this and Maul's report. The specimen (No. 3108, Museu Municipal do Funchal), taken from the stomach of an *Alepisaurus ferox* Lowe captured near Madeira, although in fair condition, has lost all scales and the last few lateral line pores on the left side. Maul recorded counts of 33 lateral line scales and 5 supracaudal luminous scales; because of damage to the caudal base and midbody, an accurate count cannot be made of either character on the left side. However, 37 lateral line pores are evident on the nearly intact right side. Also, as there is a fragment of whitish tissue in the area normally occupied by this scale, plus an indentation in the flesh having the characteristic shape of such a scale, the total number of supracaudal scales may be considered as 6 rather than 5. Also, for this specimen Maul stated "SAO 3, upper well separated from lateral line; Pol 1, well removed from lateral line." However, both the upper SAO and Pol nearly touch the lower border of the lateral line pore structure, a condition very like that shown for *M. selenops* (Fig. 63).

A discrepancy also exists between the two sets of data in regard to head length. Maul recorded the head as "5 1/3 in total length without caudal" for his specimen (No. 3108). This proportion must be regarded as in error, for the head is relatively undamaged on either side and its length is contained about 3.2 times in standard length (total length without caudal); this proportion is in agreement with those I have found for other specimens of *M. selenops*. All other proportions and counts are in agreement with those recorded by Maul.

The Dn organ of *M. selenops* has not previously been reported. Tåning (1928) mentioned no preorbital organs (species not figured). Fraser-Brunner (1949), in the first illustration of the species, may have attempted to illustrate the Vn and Dn, but the resulting print shows only faint indications, albeit in the proper locations; no mention of the organs was made. Maul (1952), offering the second published figure of *M. selenops* (of the specimen discussed above, No. 3108) figured neither the Dn nor Vn, although both are present, but stated "preorbital 1."

However, the seven undamaged specimens before me all have a well-developed, but often obscure, Dn.

Loweina

Fowler, 1925

Distance from snout to origin of dorsal base greater than that from dorsal origin to end of vertebral column. Deeply buried, often indistinct, Suo present behind posterior end of supraorbital bone, at about the level of Dn. PLO slightly below pectoral origin; 5 PO (rarely more); 2 to 4 VO; no PO or VO elevated. Two or 3 SAO in an oblique straight line that passes through or near VO_4; 1 Pol; 2 Prc closely spaced in a horizontal line. Lateral line incomplete, the external pores (perforated scales) seldom extending much beyond a vertical from pelvic origin. Supracaudal luminous gland of males single, large, filling half or more of the supracaudal space. Females bear no caudal luminous glands.

Key to species of *Loweina*

1a. Three SAO 2
1b. Two SAO, widely separate. PVO_1 behind a vertical from posterior margin of PO_2 3
2a. Four VO. PVO_1 behind a vertical from PO_2 ..... *L. terminata*
2b. Two VO (abnormally 3 but never 4), 1 near pelvic base, 1 near anus. PVO_1 before a vertical from PO_2 ..... *L. interrupta*
3a. Head length 29% (27-31) of SL; head depth 65% (61-69) of head length. Hind margin of operculum extends well past origin of pectoral fin ..... *L. laurae*
3b. Head length about 25% of SL; head depth about 73% of head length. Hind margin of operculum barely reaches to PLO, well short of pectoral origin ..... *L. rara*

Loweina terminata

Becker, 1964

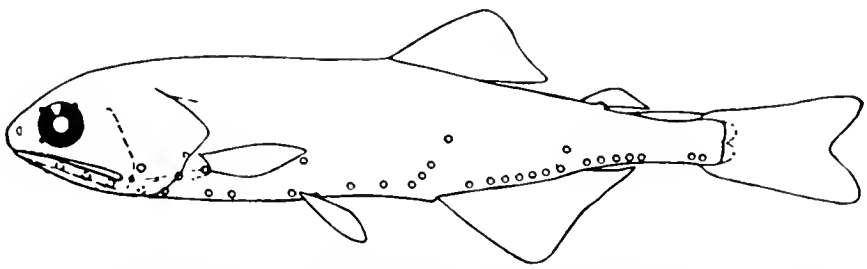


Fig. 64—*Loweina terminata*, holotype, male, 28.0 mm. From Becker (1964a, p. 19, fig. 2).

Description

D. 12 (11-13); A. 16 (15-17); P. 11 (9-12); AO 6 (5-8) + 5 (4-7), total 11 (10-13); gill rakers 2 + 1 + 6 (5-7), total 8-10; 38 (39-42) (sic) scales over lateral line—only the anteriormost 2 or 3 are perforated. (data from Becker, 1964a); vertebrae?

Three SAO in a steeply oblique, generally straight line and in series with VO_4. SAO_{2-3} interspace about twice that of SAO_{1-2}. AOa_{1-2} interspace but little greater than those of remaining AOa. Only 2 or 3 perforated lateral line scales.

A single, large undivided supracaudal gland, without a dark margin, extends from first procurrent caudal ray to end of base of adipose fin (Fig. 64).

Size: To about 30 mm.

Least depth of capture: At surface at night.

Distribution: Becker (1964a) stated: (translation by Edith Roden) "Although our material is scanty, its fortunate geographical distribution permits us to conclude that, within its entire range, *L. terminata* does not occur to the south of the North Tropical Convergence and that in its western part it does not touch the Kuroshio Convergence, nor in its central and eastern part the waters of the North Pacific Drift and the California Current. Thus, the range of *L. terminata* lies completely within the borders of the western and eastern North Pacific Central Water masses, at the northern boundary of the distribution of the tropical species of myctophids (Parin, 1961)."

Loweina laurae
Wisner, 1971*

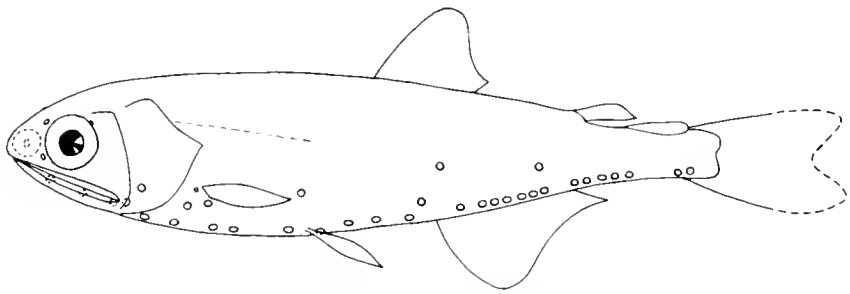


Fig. 65—*Loweina laurae*, holotype, male, 36.8 mm.

Description

D. 11-12 (10-13); A. 15 (13-17); P. 10-11 (9-13); AO 6 (4-7) + 5 (4-6), total 11 (8-13); gill rakers 2 (always) + 6 (4-7), total 9 (7-10); vertebrae 38 (37-39). Correlated counts of dorsal and anal fin rays and AO photophores are given in Table 13.

Two SAO, the lower over anus and about its diameter behind VO_4; the upper, one or two of its diameters below lateral midline. Four VO, the series curved, the VO_{1-2} interspace slightly greater than the others. Dorsal origin slightly behind midbody and about over midpoint between origins of pelvic and anal fins; anal origin under last third of dorsal base. Caudal peduncle short, about 5 in SL, and moderately deep, its depths about equal to orbit length. Lateral line incompletely developed, an average of 12 (2-19) perforated scales, at anterior end only (Table 14).

Supracaudal luminous gland large, undivided, filling about 70% (50%-85%) of supracaudal space. Females bear no caudal luminous glands.

Size: 36.8 mm, the largest of 93 specimens.

Least depth of capture: At surface at night.

*As stated in Copeia (1972: (1): 206—Erratum), fig. 4, p. 46, in Copeia, 1971 (1) is incorrectly stated to represent the holotype of *Loweina laurae*. Instead, it represents a specimen that was originally a syntype of *Scopelus (Rhinoscopelus) rarus* Lütken, 1892, and subsequently a syntype of *Myctophum interruptum* Tåning, 1928. This specimen has been selected and labeled as the lectotype of *Loweina interrupta* (Tåning) and is so designated below.

TABLE 13. CORRELATED COUNTS OF DORSAL AND ANAL RAYS, AND AO PHOTOPHORES FOR *LOWEINA LAURAE*

		Anal rays					
		13	14	15	16	17	Total
Dorsal rays	10	—	—	1	—	—	1
	11	1	6	25	9	—	41
	12	—	6	24	17	1	48
	13	—	—	1	1	—	2
	Total	1	12	51	27	1	92

		AOp			
		4	5	6	Total
AOa	4	1	—	1	12
	5	6	30	12	48
	6	12	73	38	123
	7	2	5	6	13
	Total	21	108	57	186

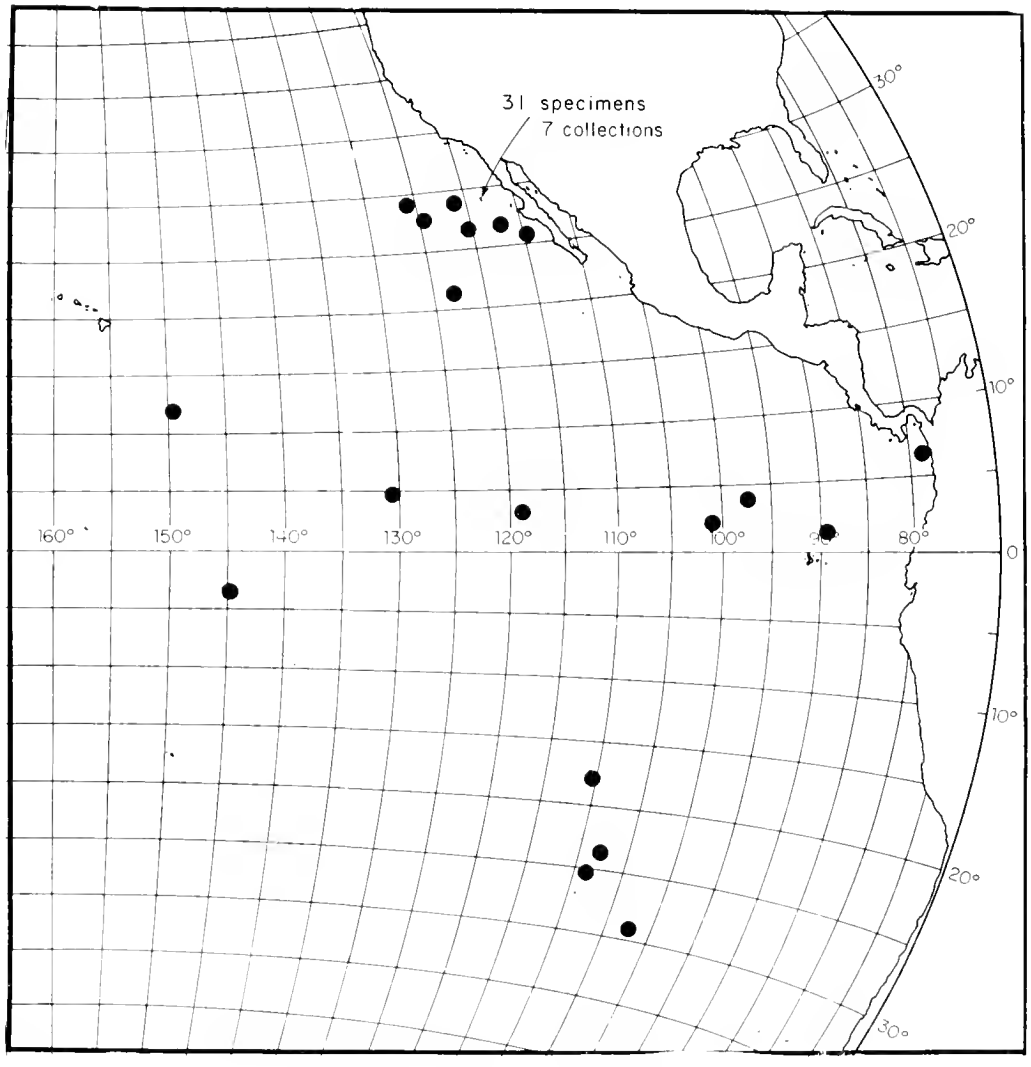
TABLE 14. NUMBERS OF PERFORATED SCALES IN THE LATERAL LINE OF *LOWEINA LAURAE* FROM FOUR AREAS OF THE EASTERN PACIFIC OCEAN

	Area			
Number of pores	Guadalupe Island	28°-21° N	11°-01° N	17°-29° S
2	—	—	—	4
3	—	—	—	1
4	—	—	—	3
5	—	—	—	1
6	—	—	—	1
7	2	—	—	—
8	1	—	3	—
9	4	—	1	—
10	6	10	6	—
11	8	4	8	—
12	9	5	10	—
13	5	11	14	—
14	2	9	17	—
15	—	6	4	—
16	—	—	2	—
17	—	2	—	—
N	37	47	65	10
Average	10.00	12.70	12.51	3.40

Distribution: *L. laurae* is known from the eastern Pacific Ocean between about 30° N and 30° S and westerly to 150° W (Fig. 66). Becker (1964a) reported as *L. rara* nine specimens from the west-central Pacific and southern tropical Indian Ocean; these specimens are herein provisionally assigned to *L. laurae*. The possible population structure in the eastern Pacific is discussed below.

Discussion

The presently known distribution of *Loweina laurae* in the eastern Pacific Ocean strongly suggests the existence of three discrete populations (Fig. 66). However, this apparent discreteness may be an artifact of sampling as most specimens were taken up with dip net and surface



66. Capture localities for *Loweina laurae*.

light, and the species is small and not readily visible under even slightly unfavorable conditions. Also, it is possible that no, or only minimal, netting effort was made in the regions lacking collections.

Meristic data for *L. laurae* from the eastern Pacific Ocean are arranged in four geographical units (Table 15). The northernmost group is divided into two units, one from Guadalupe Island, Mexico, the other from collections made elsewhere north of about 21° N (Fig. 66); this division was made as the specimens from Guadalupe Island (31 in 7 collections) were all taken in upwelled water close to shore while the vessels were at anchor, a circumstance suggesting endemism. A fifth group comprises data from Becker (1964a) for specimens designated as *L. rara*, from the west-central Pacific and southern tropical Indian Oceans.

TABLE 15. NUMBERS OF DORSAL, ANAL, AND PECTORAL FIN RAYS; AO PHOTOPHORES; AND TOTAL GILL RAKERS FOR *LOWEINA LAURAE* FROM FOUR AREAS OF THE EASTERN PACIFIC OCEAN, COMPARED WITH DATA ON *L. RARA* OF BECKER (1964A) FROM THE WESTERN PACIFIC, THE INDOPACIFIC AREA, AND INDIAN OCEAN

	Dorsal rays					
Area	10	11	12	13	N	Mean
Guadalupe Island	1	17	12	1	31	11.42
27°-21° N	—	10	11	—	21	11.52
06°-01° N	—	13	20	1	34	11.65
17°-29° S	—	—	5	—	5	—
Becker (1964a)	—	2	6	—	8	—

	Anal rays						
	13	14	15	16	17	N	Mean
Guadalupe Island	1	5	19	6	—	31	14.97
27°-21° N	—	6	14	1	—	21	14.76
06°-01° N	—	1	18	15	—	34	15.41
17°-29° S	—	—	—	4	1	5	—
Becker (1964a)	—	1	5	3	—	9	—

	Pectoral rays (both sides)					
	9	10	11	12	N	Mean
Guadalupe Island	3	23	29	7	62	10.65
27°-21° N	5	16	20	1	42	10.40
06°-01° N	8	32	23	2	65	10.23
17°-29° S	—	1	6	—	7	—
Becker (1964a)	6	8	4	—	18	9.89

	AOa photophores					
	4	5	6	7	N	Mean
Guadalupe Island	3	20	37	2	62	5.61
27°-21° N	—	16	23	3	42	5.69
06°-01° N	—	8	52	8	68	6.00
17°-29° S	—	2	8	—	10	5.80
Becker (1964a)	—	9	9	—	18	5.50

	AOp photophores				
	4	5	6	N	Mean
Guadalupe Island	6	31	25	62	5.31
27°-21° N	10	20	12	42	5.05
06°-01° N	3	46	19	68	5.24
17°-29° S	1	8	1	10	5.00
Becker (1964a)	2	13	3	18	5.06

	Total AO photophores							
	8	9	10	11	12	13	N	Mean
Guadalupe Island	1	1	23	17	20	—	62	10.87
27°-21° N	—	4	11	19	8	—	42	10.74
06°-01° N	—	—	9	40	13	6	68	11.24
17°-29° S	—	—	3	6	1	—	10	10.80
Becker (1964a)	—	—	9	8	1	—	18	10.56

	Total gill rakers					
	6	7	8	9	N	Mean
Guadalupe Island	—	—	39	23	62	8.37
27°-21° N	—	—	25	17	42	8.40
06°-01° N	—	3	22	43	68	8.59
17°-29° S	4	2	—	—	10	6.60
Becker (1964a)	6	2	—	—	8	—

No endemisim is indicated between specimens from Guadalupe Island and the adjacent group, 27°-21° N. In general, specimens from the central group (06°-01° N) have slightly higher counts than do those from Guadalupe Island and from 27°-21° N (Table 15). This tendency toward higher counts in southern specimens is supported in counts for the southernmost group (17°-29° S) only in numbers of dorsal and anal fin rays; the counts are near the upper limits found for the more northern groups. The numbers of total gill rakers in the southernmost group shown an interesting reduction of two rakers below the combined count for the northern groups.

No significant differences in body proportions were demonstrated between specimens from the four areas. These data are combined for all areas (Table 16) and are compared with similar data for *Loweina rara*, *L. interrupta*, and *L. terminata*.

The five specimens (four collections) comprising the southernmost group of *L. laurae* (17°-29° S, Fig. 66) show a very significant reduction in numbers of pores in the lateral line (Table 14). The more northern groups average 12 (7-17) pores, 149 sides counted, but the five southernmost specimens (10 sides) average about 3 (2-6) pores; in other respects, excepting the reduced numbers of gill rakers, these specimens are indistinguishable from those farther north. These very low counts appear valid, as there is no indication of damage to the anterior portions of the lateral line sufficient to have eradicated the pore structures. Becker (1964a, p. 19) reported 2 (2-4) developed pores in the lateral line of *L. terminata* (see above); this species is primarily distinguished from *L. laurae* by having 3 SAO rather than 2.

TABLE 16. BODY PROPORTIONS FOR THE FOUR SPECIES OF THE GENUS *LOWEINA*

Measurement	*L. laurae*				*L. rara*		*L. interrupta*	*L. terminata*	
	Eastern Pacific		Becker (1964a)					Becker (1964a)*	
	N = 15 (24.4-26.1 mm)		N = 9 (20.6-32.5 mm)		Lectotype (39.2 mm)	Paralectotype (36.2 mm)	Lectotype (37.2 mm)	Holotype (28.0 mm)	N = 10 Paratypes (23.7-29.5 mm)
	Ave.	Range	Ave.	Range					
Head length	290	273-307**	292	265-319	255	257	259	286	249-289
Head depth	181	168-197**	—	—	186	188	185	—	—
Snout length	50	47-57	—	—	38	44	45	—	—
Orbit length	80	71-88 **	—	—	66	69	79	—	—
Interorbital width	78	71-83	—	—	71	69	79	—	—
Upper jaw length	171	159-189**	—	—	163	163	159	—	—
Dorsal origin to anal origin	219	203-253	—	—	222	229	217	—	—
Dorsal origin to pelvic origin	241	217-264	—	—	255	260	238	—	—
Prepectoral length	280	265-299**	287	259-301	260	257	259	268	253-293
Prepelvic length	424	406-437	431	410-442	421	428	418	411	398-464
Predorsal length	536	510-562	539	512-571	548	552	532	542	524-577
Preanal length	604	590-618	606	593-623	621	625	611	619	579-621
Preadipose length	827	803-845	811	753-837	829	842	799	819	770-828
Greatest body depth	213	201-226	217	199-256	219	243	212	196	186-227
Caudal peduncle length	222	192-229**	215	208-221	182	184	222	196	172-200
Caudal peduncle depth	79	58-88	77	65-89	64	69	63	79	59-80
Dorsal base length	147	125-171	142	134-151	149	153	135	140	132-155
Anal base length	209	182-224	203	186-218	193	209	191	207	200-235
Pectoral fin length	139	122-156	137	126-144	126	127	108	146	132-157
Pelvic fin length	127	115-142	—	—	115	119	106	—	—
Supracaudal gland length	126	105-137	—	—	—	—	106	—	—

*Becker indicated that all specimens were males.

**From 31 to 33 specimens of *L. laurae* were measured for characters marked by a double asterisk.

In the five southernmost specimens before me there is no indication of the present or past occurrence of a third SAO; therefore, these specimens are assigned to *L. laurae*.

Aberrations in photophore patterns: The spacing of the first few photophores of the AOa series of *L. laurae* is inconsistent. In the most common pattern, the first two AOa are notably farther apart than the rest (Fig. 65). Of the 186 sides (93 specimens) examined, this wider space was lacking on both sides of 30 specimens, on the left side only of 8 specimens, and on the right only of 7 specimens. Aberrations in the PO series occurred in three instances and in four in the VO series. One specimen had an extra PO on the left side, equally spaced between PO_2 and PO_3; in another specimen PO_4 was missing on the left side; in still another specimen 8 equally spaced PO were present on the right side. Of the four aberrant VO series, 5 evenly spaced VO occurred on the right side of one specimen, another had but 3 VO on the right side (VO_1 missing), and another had 5 evenly spaced VO on both sides. Also, a specimen from the Indian Ocean had but 3 VO on both sides (VO_2 missing).

Becker (1964a) reported that a specimen of *L. "rara"* from the southern Indian Ocean had but one SAO on each side (the position corresponding to that of a normally placed SAO_1) and also had an extra PO (a total of 6) on the left side close behind PO_4. All specimens of *L. laurae* before me had two SAO.

Additional remarks: A discussion and redescription of *L. rara* (Lütken, 1892) and *L. interrupta* (Tåning, 1928), and designation of lectotypes for each:

Loweina laurae is very closely related to *L. rara* and to a lesser extent to *L. interrupta*. Although *L. rara* has only twice been reported from the Pacific Ocean (Beebe and Vander Pyl, 1944, and Becker, 1964a,—specimens now referred to *L. laurae*), and *L. interrupta* not at all, these two species are included in this report to clarify certain points of taxonomy (in the event they should be found). The two species, *L. rara* and *L. interrupta*, have often been confused by authors, perhaps because of a rather confusing action by Lütken in his original description of *L. rara* and because of a paucity of specimens by which his action could since have been evaluated. A translation of the original description by Lütken (1892, p. 246, fig. 4) is presented in an attempt to clarify the basic confusion. The following translation from the Danish was very kindly provided by Rolf L. Bolin:

> *Scopelus (Rhinoscopelus) rarus* n. sp. is represented by only a few specimens of 38-40 mm length (without caudal). The light snout protrudes very distinctly out over the mouth, but the edge of the opercle is as good as perpendicular. Body shape fairly short and plump; total length 40 mm, height 9 mm, head length 9½ mm, gape 6 mm, diameter of eye 2 mm. The anal fin is shorter than the previous species i.e. *Scopelus andreae* (ca. 15 rays). The scales are ribbed—3 or 4 ribs at the base. Lateral line scales high and narrow, ca. 39. There is as usual a light spot on the gill cover, 3 close in front of the pectoral base (the most posterior one directly under or behind the pectoral) and 5 in front of the ventrals; the distance between the fifth and fourth pair of these is almost twice as large as that between the more anterior pairs; the distance between the second and third pairs is also normally larger than between the others. In regard to the ventral light spots it is to be noted, that the two of the first pair always are pulled close together, while the distance between those of the second pair is distinctly larger, whereupon it decreases regularly between the following pairs. Of the supraanals there are normally only 2 (not so commonly 3), of which the lower one lies straight above the anus, the upper one a little farther back.[1] The count of the anal light spots is 12-13=6-7 + 6-7, in addition to which are the two closely approximated caudals. One of

[1]Two of the four specimens show the anomaly, that they lack the second and third pair of ventrals and have on one side 3 supraanals, in that there occurs 1 below and in front of that one, which above is designated as the lower one; in these is the space between the second and third pair of thoracics not either larger than between the others. (The silhouette sketch is made from one of these specimens.) Some of these are probably only individual anomalies, but that both lack the two pair of ventral light spots, can possibly signify a sexual difference? It is, therefore, a form which needs to be illuminated further on the basis of more material.

the specimens has behind the adipose fin a coalescent, oblong, shining spot, of which Capt. Andrea writes: "the white spot on the tail was golden."

Localities: 39° N Lat. (?); 20° N. Lat., 50°-48° W. Long.; 34°50′ S. Lat., 4°30′ W. Long.; 37°40′ S. Lat., 12° E. Long.

No doubt because of the paucity of the original material (four specimens), even those authors who were aware that Lütken had figured a specimen considered by him to be only an anomalous form of *L. rara*, briefly diagnosed in the footnote, were uncertain as to the limitations of the obvious variability. Tåning (1928), in a brief diagnostic key, gave the name *Myctophum interruptum* to the form described by Lütken in the footnote and illustrated in fig. 4. Since, however, the two species have often been confused, perhaps again due to a paucity of study material and the lack of detailed descriptions of the original type material.

The paucity of study material of the genus *Loweina* is illustrated by the few numbers of authors who have recorded the number of specimens studied (Table 17). It is of interest that despite the many expeditions conducted by various nations, including the recent extensive coverage of the world oceans by the various Soviet vessels, a total of only 54 specimens referable to the genus *Loweina* have been recorded by all authors from all oceans. It is then of great interest that a total of 93 specimens representing the new species *L. laurae* have been taken in the eastern Pacific Ocean.

Because of the basic similarity of *L. rara* and *L. laurae* and the lack of information on *L. interrupta*, and because of confusion in the early literature, it is now important that a type specimen be formally designated for both *L. rara* and *L. interrupta* and that detailed descriptions of each be provided.

TABLE 17. PREVIOUSLY REPORTED NUMBERS AND AREAS OF CAPTURE OF SPECIMENS OF GENUS *LOWEINA*

Author, Date, and Area of Capture	Species			
	L. rara	*L. interrupta*	*L. terminata*	*L. laurae*
Lütken, 1892				
N. Atlantic	2	—	—	—
Brauer, 1906				
N. Atlantic	4	9	—	—
Pappenheim, 1914				
S. Atlantic	—	1	—	—
Tåning, 1928				
N. Atlantic	—	2	—	—
Norman, 1930				
S. Atlantic	—	2	—	—
Beebe, 1937				
Bermuda	10*	—	—	—
Beebe and Vander Pyl,				
1944, S. E. Pacific	—	—	—	1
Maul, 1946				
Madeira	—	1	—	—
Nybelin, 1948				
N. Atlantic	—	1	—	—
Becker, 1964a				
W. Pacific and				
Indian Oceans	—	—	11	9 (?)
Nafpaktitis and				
Nafpaktitis, 1969,				
Indian Ocean	—	1	—	—
Totals	16	17	11	10

*Donn E. Rosen (personal communication) reported that these specimens are no longer at the American Museum of Natural History, and, as there is no record of their disposal, they are presumed to be lost.

Loweina rara
(Lütken, 1892)

Designation and Description of Lectotype

As stated above, Lütken's type material of *Scopelus rarus* consisted of four specimens. Due to the kindness of Dr. Jorgen Nielsen, Universitetets Zoologiske Museum, Copenhagen, I was privileged to examine these specimens. Two of them were labeled as *Myctophum rarum*, and two as *Myctophum interruptum*. Accompanying each of the four specimens (each in a separate vial) was a slip of paper bearing the single word "Type" printed in large bold letters. Thus, both specimens of both species have been regarded as types by some investigator, but without formal publication of the action.

Therefore, I hereby designate as lectotype of *Loweina rara* (Fig. 67), Number 223, a female (no caudal glands), 39.2 mm in standard length, deposited in the Universitetets Zoologiske Museum, Copenhagen, Denmark. The label bears the following data: "*Scopelus rarum* (sic) Ltk, 20° N.B. 48°-50° V.L., 10-9-1871, Iversen." I also designate as paralectotype of *Loweina rara* Number 224, of the same museum, a female (no caudal glands), 36.2 mm in standard length. The label bears only the following data: "*Scopelus rarum* (sic) Ltk. 33° N, 1863, Warming.

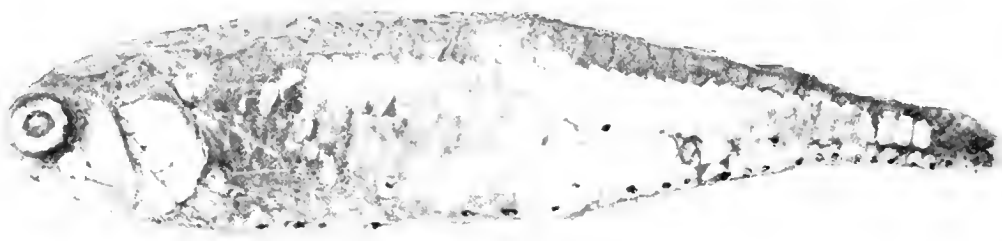


Fig. 67—*Loweina rara*, lectotype, female, 39.2 mm. (Photophores retouched).

In the following counts, those for the lectotype are given first and are followed by those for the paralectotype, in parentheses if different. D. 11 (12); A. 16; pectoral 11-11; pelvic 8-8; AO 7 + (6 + 6); gill rakers 2 + 1 + 6. The incomplete lateral line has 6 or 7 weakly expressed pores that extend to about over the end of the pectoral fin.

Body proportions for the lectotype and paralectotype of *L. rara*, and lectotype of *L. interrupta*, are given in Table 15 and are compared with those of *L. laurae* and *L. terminata*.

Dentition: Teeth of upper jaw in a single row of straight, alternately long and short, conical teeth that extend along entire outer margin to the slightly rounded expansion at end of upper jaw. The longer teeth are from two to three times longer than shorter ones, which in turn are rather typically cardiform. On the dentary, to its occlusion by the upper jaw, is a narrow band of cardiform teeth 2 or 3 teeth in width. An inner band of about 15 longer, backward curving, fanglike teeth extends from the symphysis to about under midorbit; posteriorly, these enlarged teeth become somewhat smaller, straight, and more closely set; those near the end of the gape tend to have a forward slant.

The palatine teeth occur in a row of about 10 widely spaced fangs, curved strongly backward, which extends continuously from the vomer heads (which bear a single fang each) to about under the hind orbital margin. No small teeth are evident on either vomer heads or palatines. The paralectotype has the palatines slightly damaged anteriorly, and some fangs

may be missing. Posteriorly, several smaller replacement (?) teeth are developing mesially to some of the principal fangs. In each of these two specimens the longest fangs are about half the width of the end of the premaxillary. The vomer heads bear a single fang similar to and continuous with those of the palatines. Teet of mesopterygoids comprise a narrow patch of small, backward-curving, fanglike teeth, beginning about under anterior margin of pupil and extending posteriorly to a little beyond hind margin of orbit. At the ends the patch is 2 to 3 teeth in width and increases to about 6 teeth near the middle.

Photophores: The following description of photophores pertains to the lectotype; any differences between it and the paralectotype are stated: Dn and Vn exposed, prominent; Dn before and slightly below level of upper orbital margin; Vn a little behind a vertical from Dn and slightly above level of lower orbital margin. A small Suo at posterodorsal margin of orbit, nearly on same level as Dn. OP_2 no larger than other body photophores; OP_1 a half smaller than OP_2, partially hidden by preoperculum, in line with and just behind end of jaw; OP_1 a little less than its diameter before a vertical from anterior margin of OP_2. PLO half the size of other body photophores, its diameter before, and its upper margin level with, pectoral origin. PVO_1 about three of its diameters below PLO and slightly before a vertical from center of PO_2; PVO_2 below and touching bases of lower pectoral rays. A line through anterior margins of PLO and PVO_1 passes through or behind center of PO_2; a line through PVO_2 and PVO_1 passes through PO_1; a line through PLO and PVO_2 passes through PO_4. Five PO, unequally spaced; the first pair close to ventral septum, the succeeding pairs very gradually diverging, the last just before origin of outer pelvic rays; PO_{1-2} interspace nearly a photophore diameter less than that of PO_{2-3} but about half a diameter greater than that of PO_{3-4} and slightly less than half of the interspace between PO_{4-5}. The PO spacing of the paralectotype differs in that the PO_{1-2} interspace is a full diameter less than that of PO_{3-4}, and the PO_{2-3} interspace is equal to that of PO_{4-5}.

VLO above and nearer to pelvic origin by about one-third the distance from there to lateral septum and about on level of midpoint between PLO and OP_2. Four VO, the first pair in contact at ventral septum and close to inner pelvic rays; the second pair is elevated about two of its diameters above the septum, the third and fourth pairs converging toward the anus, the fourth its diameter from the septum and before the anus; VO_{1-2} interspace a photophore diameter greater than those between the remaining pairs. Two SAO in steeply oblique line; line through their anterior margins touches the posterior margin of VO_4. SAO_1 two of its diameters above and one behind VO_4; SAO_2 at lower edge of lateral line scale and over base of first or second anal ray. In the paralectotype, SAO_1 is but half a diameter behind and about 1.5 diameters above VO_4; SAO_2 is farther forward, a little before base of first anal ray. SAO_{1-2} and VO_4 form a straight line.

AO 7 + 6, each side (6 + 6, each side, in paralectotype), the series straight. The first 2 AO are separated by a space equal to that between the AOa-AOp series. Pol its diameter behind a vertical from last AOa, a little higher than midway between there and lateral septum, and at the second lateral scale before end of adipose base. Two Prc, separated by nearly a photophore diameter. The interspaces between AOa_{1-2}, AOa-AOp, and AOp-Prc are equal. No luminous caudal organs present.

Loweina interrupta
(Täning, 1928)

Designation and Description of Lectotype

Although *Loweina interrupta* has been reported primarily from the Atlantic Ocean, and but once from the southern Indian Ocean, it may eventually be found in the Pacific Ocean. Regardless of its possible occurrence there, it appears fitting to deal with the species at this time.

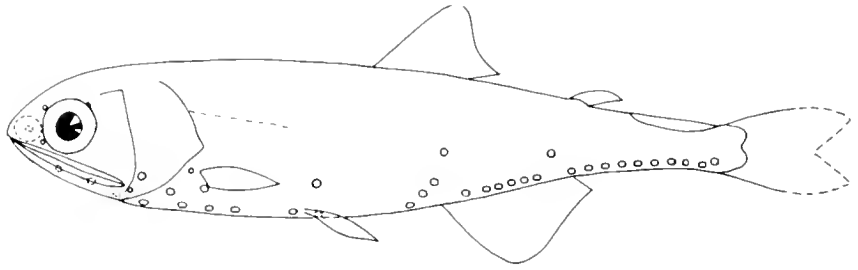


Fig. 68—*Loweina interrupta*, lectotype, male, 37.6 mm.

Much of the confusion of the species *L. rara* and *L. interrupta* appears to stem from Brauer's action in applying the name *"rarus"* to the specimen figured by Lütken (1892, fig. 4, p. 246) and briefly described in a footnote as an anomalous form (see above). According to more modern concepts of systematic procedure Brauer may have acted correctly, but to follow his action at this date would only serve to compound the existing confusion. I therefore retain the name *"interruptum,"* applied by Tåning (1928) to the species so figured by Lütken and described in the footnote; the name *"rara"* is then retained for the species described (but not figured) by Lütken in the body of the text.

Since no definite type specimen hsa been designated for, and as only a brief key furnished the original description of, *L. interrupta*, I hereby designate as lectotype of *Loweina interrupta* (Fig. 68) specimen Number 18, a male (supracaudal gland present), 37.6 mm in standard length, deposited in the Universitetets Zoologiske Museum, Copenhagen, Denmark. The specimen is in good condition except for some slight damage to the mouth; the lower jaw is split apart at the symphysis. The label bears the following data: *"Myctophum interruptum* Tåning (*Scopelus rarum* (sic) Ltk.). 37°40′ S.B. 12 0 L, 1864. Andrea." Also, I designate as paralectotype of *Loweina interrupta* specimen Number 225 of the same museum; the label bears this information: *"Myctophum interruptum* Tåning (*Scopelus rarum* (sic) Ltk.) 34°50′ S.B. 4°30′ V.L., 1864. Andrea."

The paralectotype is in poor condition. The forepart of the head is missing and only the gill arches, remnants of opercular bones, and a portion of the cranium are left. The rest of the body is relatively intact, except for slight damage to the caudal peduncle, but is quite soft and flaccid; however, most photophores are legible, and a few scales and a large supracaudal gland are retained. The length of the paralectotype, in its present condition, is about 33 mm, excluding the caudal fin; accurate standard length measurement is not possible.

Body proportions for the lectotype only are given in Table 16.

In the following counts, those for the lectotype are given first and are followed by those for the paralectotype in parentheses, if different. D. 12 (damaged), A. 15 (damaged), pectoral 10-9 (10-10), pelvic 8 + 8; AO 6 + 8 (7 + 8) gill rakers 3 + 1 + 10 (4 + 1 + 9, 3 + 1 + 10). There are about 8 very weakly developed lateral line pores that extend to about over the end of the pectoral fin.

Dentition: The dentition of *L. interrupta* is essentially like that of *L. laurae* and *L. rara*, but the teeth appear to be much smaller, particularly the fangs on the palatines and vomer heads. Also, the patch of teeth on the mesopterygoids is narrower than in the other two species.

Photophores: The photophores of the head of *L. interrupta* are very similar to those of *L. laurae* and *L. rara*. PVO_1 its diameter before a vertical from PLO and three diameters below it. PVO_2 below and touching bases of lower pectoral rays. A line through PLO and PVO_1 passes well forward of PO_2; a line through PLO and PVO_2 passes a little before PO_1. Five PO_1 unevenly spaced and in a straight row which diverges but little from the ventral septum. PO_1 is close to the septum, and PO_5 is but its diameter farther away and just before base of outer pelvic ray. PO_{1-2} interspace a photophore diameter greater than those of PO_{2-3} and PO_{3-4}; the interspace between PO_{2-4} is equal to that between PO_{4-5} and is two diameters greater than that of PO_{1-2}.

VLO low, directly above pelvic origin about one-third the distance from there to the lateral septum. Two VO; the first pair nearly touch the ventral septum just behind the inner pelvic rays; the second pair about two diameters before the anus and one distant from the ventral septum. Three SAO in a wide angle; SAO_1 about two diameters above and two behind VO_4; SAO_2 about two diameters above and two behind SAO_1, and about over the anus; SAO_3 high, on lower edge of the lateral line scale which lies over base of first anal ray; it is distant from SAO_2 by twice the SAO_{1-2} interspace. A line through the posterior margins of SAO_{1-2} touches the anterior margin of VO_4; a line through the anterior margins of SAO_3 and $_2$ touches the posterior margin of VO_4. On the right side of the paralectotype there are but two SAO, arranged much as in *L. rara*; it would appear that SAO_1 is missing, but there is no evidence of damage.

AO 6 + 8, each side (7 + 8 in paralectotype): AOa_{1-2} interspace about a photophore diameter greater than those of rest of series; this interspace is about half that between the AOa-AOp series. It is noteworthy that the present count of 8 AOp differs from that of 7 as shown by Lütken (1892, fig. 4) and as listed by Tåning (1928) when describing the species. The eighth photophore is not readily visible but is definitely present on each side. There is no enlarged space between the AOp and Prc series. Damage to the ventral margin of the posterior part of the peduncle in the paralectotype renders an accurate count of the AOp uncertain, but remaining pits and bits of luminous tissue indicate that 8 photophores were once present. One Pol, a diameter behind a vertical from posterior margin of last AOa and a little over halfway between there and lateral septum, and on the second scale row before a vertical from end of adipose base. Two Prc, low on caudal profile, are separated by about one and one-half diameters and are continuous with AOp; the first is well before, the second over, the first procurrent caudal ray; the second is elevated about one diameter above level of the first.

A large, massive supracaudal gland, beginning at first procurrent caudal ray, occupies three-fourths the distance from there to end of base of adipose fin. This gland extends above the dorsal profile and slightly down along the lateral surface of the peduncle; its width is about one-fourth its length. The paralectotype has a gland of almost identical proportions.

As in *Loweina laurae*, *L. rara*, and *L. terminata*, the numbers of photophores of *L. interrupta* may be variable within the respective patterns. Maul (1946, p. 26, fig. 9) reported a male (28.5 mm) of *L. interrupta*, caught alive at night in Funchal Harbor, that had 3 VO, "One close behind ventral base and two close together just before vent, leaving thus a long interval between them and the front one." This specimen also had 5 PO and 4 AOa on the left side, and 6 PO and AOa on the right side.

Tarletonbeania

Eigenmann and Eigenmann, 1890

One Prc; 1 Pol. Lateral line undeveloped externally, only the first 2 or 3 scales perforated. Suo present. PO 6-7; VO 5-7; 3 SAO, the series slightly angulate. Caudal luminous glands on males only.

Key to species of *Tarletonbeania*

1a. Supracaudal luminous gland of males long, slender, usually filling the supracaudal space; infracaudal gland of males, if present, is short, very weakly developed, and hidden under body scales ..... *T. crenularis*

1b. Males with short, bulky luminous glands on both surfaces of caudal peduncle..... *T. taylori*

Tarletonbeania crenularis
(Jordan and Gilbert, 1880)

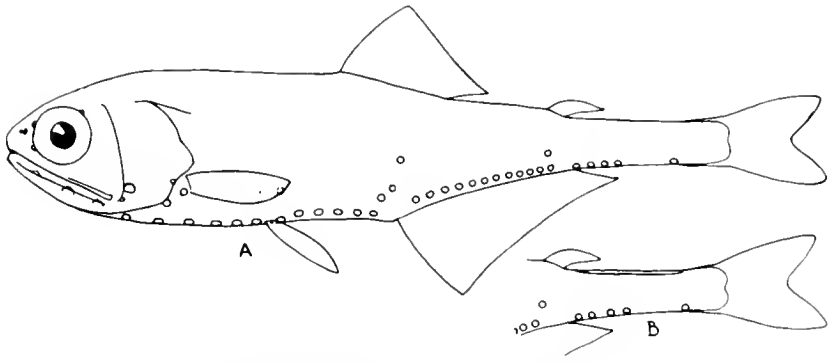


Fig. 69—*Tarletonbeania crenularis*. From Bolin (1939, p. 101, fig. 5). (A.) Adult female, (B.) Caudal peduncle of adult male.

D. 12 (11-14); A. 18 (17-20); P. 13 (11-15); AO 10 (9-11) + 4 (3-5), total 15 (13-16); gill rakers 5 (4-6) + 1 + 10 (9-11), total 16 (15-18); vertebrae 40-41.

Dorsal origin slightly before midpoint of body and about over a point midway between pelvic and anal origins. One undivided, long, thin supracaudal luminous gland and occasionally a very weakly developed, inconspicuous infracaudal gland, in males only. Females bear no caudal luminous glands.

Size: To about 70 mm.

Least depth of capture: At surface at night.

Distribution: Pacific coast of North America from about 50° to 30° N. The seaward range within these latitudes is not well delineated but probably lies within the California Current. Records of occurrences from above 45° N are unreliable unless based on males (see *T. taylori*).

Tarletonbeania taylori
Mead, 1953

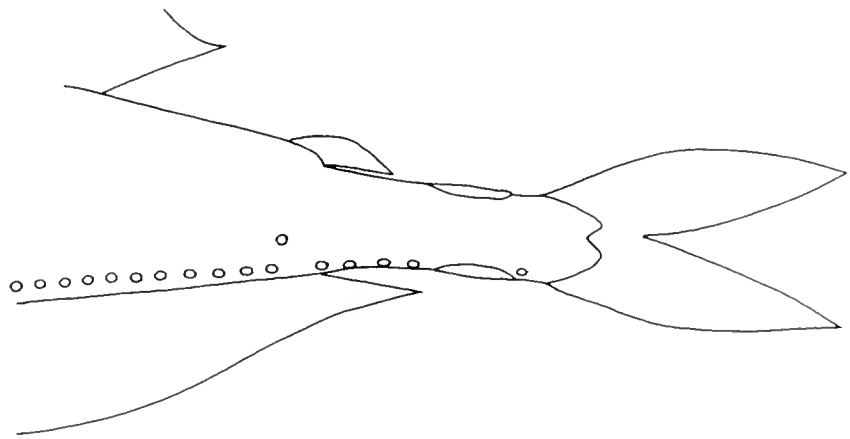


Fig. 70—Caudal peduncle of adult male of *Tarletonbeania taylori*, showing the short, bulky supracaudal and infracaudal glands.

Description

D. 13 (12-14); A. 18 (17-20); P. 13 (11-15); AO 11 (10-13) + 5 (3-6), total 16 (14-18); gill rakers 5 (4-6) + 1 + 10 (9-11), total 16 (14-18); vertebrae 41 (40-42).

Basically, *T. taylori* is very similar in appearance to *T. crenularis*. It differs principally in the short, bulky supracaudal and infracaudal luminous glands of males that stand well above the peduncular profiles; this is in contrast to the thin, elongate band of *T. crenularis*, in which neither of the caudal glands are raised above the peduncular profiles. Females bear no caudal luminous glands.

Size: To about 70 mm.

Least depth of capture: At surface at night.

Distribution: Across the North Pacific from norther Honshu, Japan, to about 45° N along the North American coast.

Discussion

The existence of the infracaudal luminous gland of *T. crenularis* has been discussed by Wisner (1959) and Becker (1963c). Wisner stated that the males of *T. crenularis* bore only a pale, elongate area in the region usually occupied by the infracaudal gland of *T. taylori*. Becker interpreted this pale area as an infracaudal gland and reduced *T. taylori* to a subspecies of *T. crenularis*, despite the very notable differences in the appearance and size of both the supracaudal and infracaudal glands of each species. Subsequent examination has shown that a thin, fragile layer of apparently luminous tissue, coinciding with the pale infracaudal area, is present on some but not all males of *T. crenularis*; the overlying scales must be removed before this tissue is visible. In no way does this fragile tissue resemble in appearance the bulky infracaudal gland of males of *T. taylori* (Fig. 70). Also, in none of hundreds of specimens of *T. taylori* examined did the short and bulky supracaudal gland resemble the long and thin one of *T. crenularis*.

Although the females of the two species bear no caudal luminous glands, and they and the immature forms cannot now be separated as to species by reason of very similar counts and body proportions, the marked difference in the caudal glands of males appears to justify retention of *T. crenularis* and *T. taylori* as separate species until more detailed studies of these glands are made.

Gonicthys

Gistel, 1850

Supraorbital (Suo) photophore absent. Lateral line complete, or nearly so. PLO at level of origin of pectoral fin. SAO broadly angulate. Caudal peduncle long, slender, its least depth less than orbital length. Two Prc on same level, very low on caudal peduncle. Luminous scales in caudal glands separate or slightly overlapping.

The four presently recognized species of *Gonichthys* in the eastern Pacific Ocean are superficially very similar, and only the species *G. tenuiculus* is figured.

Key to species of *Gonichthys*

1a. Lateral line complete, all scales perforated 2
1b. Lateral line incomplete, at least a few of the posteriormost scales not perforated 3
2a. Anal rays 18 (17-20); pectoral rays 12-13; 3 to 5 AOp over anal base ..... *G. tenuiculus*
2b. Anal rays 22 (20-24); pectoral rays 16 (13-18); 5 to 7 AOp over anal base ..... *G. barnesi*
3a. Only the last 3 or 4 scales of lateral line unperforated; 5 to 6 (rarely 7) AOp over anal base ..... *G. venetus*
3b. Last perforated scale of lateral line under or before adipose-fin base; 4 to 6 AOp over anal base ..... *G. cocco*

Gonichthys tenuiculus
(Garman, 1899)

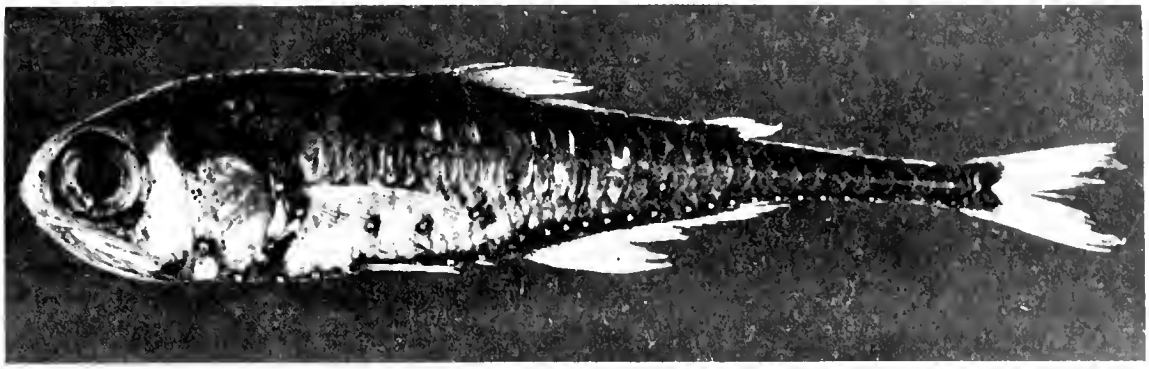


Fig. 71—*Gonichthys tenuiculus*, male, 52.5 mm.

Description

D. 11 (10-12); A. 18 (17-20); P. 12-13; AO 6 (5-7) + 11 (9-13), total 17 (15-19); gill rakers (all rudiments included) 5 (4-6) + 1 + 9 (7-11), total 14 (12-17); vertebrae 39-40 (38-41).

Only *G. tenuiculus* is illustrated, since all other species of the genus are superficially very similar.

Body elongate, slender, deepest anteriorly, tapering evenly from origin of dorsal fin to long, slender caudal peduncle. Pectoral fin reaches to over VO_4. SAO_1 over VO_{2-3} interspace, slightly nearer to VO_2. SAO_2 about over VO_4; SAO_3 about over, or a little before, first AOa. SAO_3 and Pol about two diameters below lateral line. VLO its diameter behind a vertical from origin of pelvic base and above it by a third, often slightly less, of the distance to lateral line, and usually slightly below, occasionally on, a line from PVO_2 to SAO_1. Usually 3 or 4 AOp over anal base north of, and 4 or 5 south of, the equator.

Size: To about 50 mm.

Least depth of capture: At surface at night.

Distribution: Found principally in tropical waters but also near the Americas to about 32° N and 22° S (Fig. 72). The lack of collections in the southeastern area, west of the Peru Current, precludes conjecture as to its occurrence there. I did not take the species in 1969 while working on a northeasterly course from Easter Island to about 90° W.

Discussion

Although *G. tenuiculus* has a wide north-south distribution, I have found no appreciably significant differences in meristic characters between specimens from the extremes of the range.

Gonichthys barnesi
Whitley, 1043)

Description

D. 12 (11-13); A. 22 (21-23, rarely 20 or 24); P. 16 (14-17, rarely 13 or 18); AO 7 (5-8) + 12 (10-14), total 19 (16-21); gill rakers (including all rudiments) 5 (4-6) + 1 + 8-9 (7-11), total 15 (12-18); vertebrae 40-41.

Gonichthys barnesi is basically similar to *G. tenuiculus*, differing primarily in having a shorter pectoral fin, reaching to about over VO_2 rather than to over VO_3, and Pol somewhat farther forward. Also, body proportions listed by Becker (1964a) indicate the anal base of *G. barnesi* to be somewhat longer than that of *G. tenuiculus:* (in percent of standard length) 28.1 (27.1-29.5) vs 24.3 (23.0-26.1). Five to 6, occasionally 7, AOp over anal base.

Size: To about 50 mm.

Least depth of capture: At surface at night.

Distribution: Probably circumglobal between 30° and 40° S. The localities of the few specimens examined in this study are shown in Fig. 72. Craddock and Mead (1970) reported (as questionable) 172 specimens (21-49 mm) from the southeastern Pacific Ocean between about 31° and 34° S, west of 77° W. I have seen one specimen (25 mm SL) from 25° S, 155° W.

Gonichthys venetus
Becker, 1964

Description

D. 11 (10-12); A. 20 (19-21); P. 14 (13-16); AO 5-6 (4-7) + 12 (10-14), total 18 (16-19); gill rakers (including rudiments) 4 (3-5) + 1 + 8 (6-9), total 13 (11-14); vertebrae 40-41.

Lateral line incomplete, the last 3 or 4 scales not perforated (see discussion below). Greatest body depth at vertical of pectoral origin, rather than at dorsal origin.

Size: To about 40 mm.

Least depth of capture: At surface at night.

Distribution: Known from northerly of New Zealand and from about 20°-30° S, 80°-110° W (Fig. 72). A possible subspecies (see below) occurs in equatorial waters south and southeasterly of Hawaii (designated by solid squares in Fig. 72).

Gonichthys cocco
(Cocco, 1829)

Description

D. 11-12; A. 20 (19-21); P. 13 (11-14); AO 6 (5-7) + 12-13 (11-14), total 18 (17-19); gill rakers (including all rudiments) 4-5 (6) + 1 + 7 (6), total 12 (11-13); vertebrae 40-41.

Lateral line incomplete, the last perforated scale lying under, or slightly before or behind, base of adipose fin. Five to 6 AOp over anal base.

Size: To 36 mm.

Least depth of capture: At surface at night.

Distribution and discussion: The placing of *G. cocco*, known primarily from the North Atlantic Ocean, in the southeastern Pacific Ocean is based principally on the finding of 36 specimens from five localities (Fig. 72) that have the first externally visible lateral line pore (and perforated scale) before a vertical from origin of adipose fin, a diagnostic character cited by Bolin (1959) and Becker (1964a). In general, the counts for the southeastern Pacific specimens agree well with those given by Bolin for the North Atlantic specimens, except that the numbers of rays in the anal fin average 2 less in the southeastern Pacific, and are similar to the count for *G. venetus* (see above).

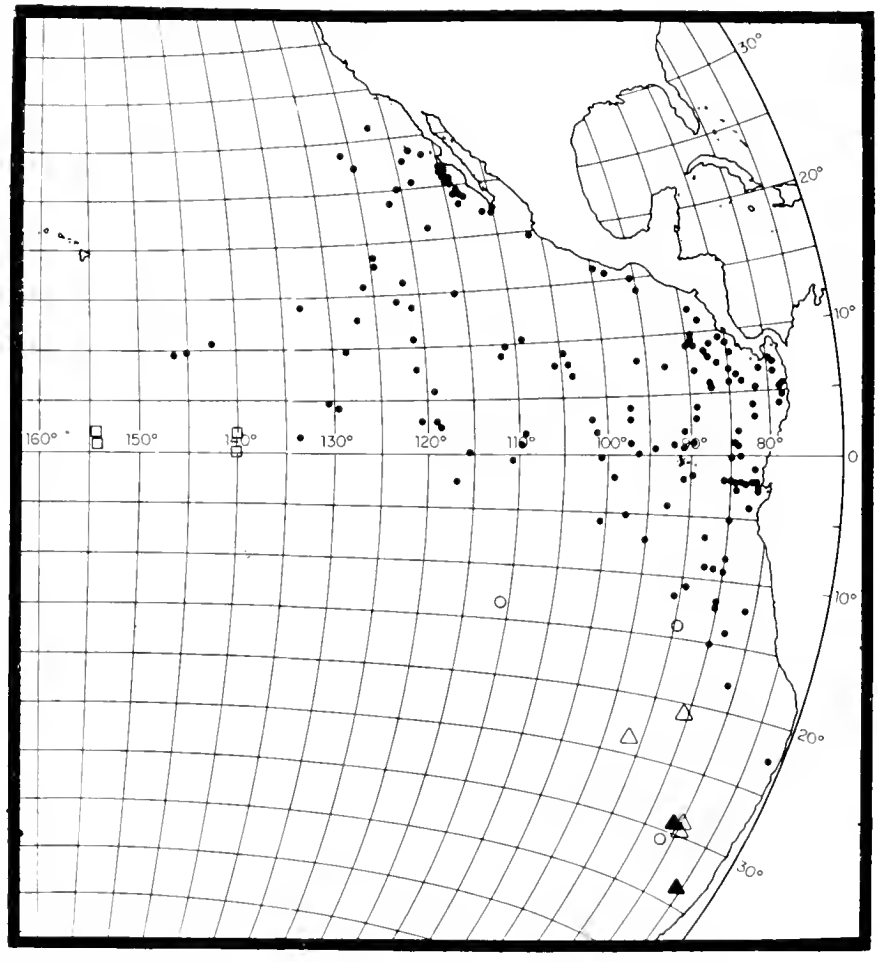


Fig. 72—Capture localities in the eastern Pacific Ocean for *Gonichthys tenuiculus* (small solid circles), *G. venetus* (large open circles), *G. venetus* s. sp. (open squares), *G. cocco* (open triangles), and *G. barnesi* (solid triangles).

Bolin (1959) stated that a form with an incomplete lateral line ranged westward from the coast of South America in a narrow band centered on 25° S; he further stated that it was uncertain whether these fishes represented an isolated population of *Gonichthys cocco* (Cocco, 1829) or an undescribed species. As suggested by Becker (1964a), it is probable that this form is referrable to *G. venetus*.

However, Becker stated that *G. venetus* is closely related to *G. cocco* and it may eventually be reduced to a subspecies. The principal character separating the two is that in *G. cocco* the last perforated scale of the lateral line lies under or in advance of the tip of the adipose fin (Bolin, 1959, key). Becker (1964a) gave a somewhat more anterior position for this scale, "beside a vertical from the origin of the adipose base," and stated that in *G. venetus* only the last 3 to 6 lateral line scales were unperforated.

Most of Becker's study material (124 specimens) of *G. venetus* was from the west-central Pacific Ocean, northerly of New Zealand, and formed the basis for diagnosis of the species; all these specimens apparently have the last 3 to 6 lateral line scales unperforated. Becker discussed as a possible subspecies seven specimens from near the equator between about 140° and 155° W (Fig. 72, solid squares) that differed from the rest of the material principally in having all the lateral line scales perforated. Becker also stated that these specimens had a

somewhat greater preanal and predorsal length, a slightly shorter caudal peduncle, and longer pectoral fins. This form was not found among the few specimens examined by me.

Based primarily on the above criterion, specimens answering well to both *G. venetus* and *G. cocco* were found in the southeastern Pacific (Fig. 72). However, in these specimens provisionally identified as *G. cocco*, the position of the last perforated scale generally was more in agreement with the criterion given by Bolin than that given by Becker, in that this scale was from 4 lateral line scales before to 2 behind a vertical from the tip of the adipose fin.

Centrobranchus
Fowler, 1904

Gill rakers poorly developed, reduced to a few small protuberances topped by slender spinules. Lateral line undeveloped, no perforated scales. One Pol; 2 Prc, close together on same level and widely separate from AOp.

The four currently recognized species of *Centrobranchus* have been delineated by Becker (1964a); the following key to species and data have been taken largely from that study.

Key to species of *Centrobranchus*

1a. SAO_1 usually slightly behind VO_4 ..... *C. andreae*
1b. SAO_1 over or before VO_3 (rarely slightly behind) 2
2a. Nasal rosette oval; snout length considerably greater than least depth of caudal peduncle. Four or 5 AOp over anal base ..... *C. choerocephalus*
2b. Nasal rosette round; snout short, about equal to least depth of caudal peduncle 3
3a. Snout short, equal to or less than least depth of caudal peduncle. Depth of body slightly less than 4 times in standard length. Three or 4 AOp over anal base ..... *C. brevirostris*
3b. Snout length equal to or slightly greater than least depth of caudal peduncle. Depth of body slightly greater than four times in standard length. Three (rarely 2 or 2) AOp over anal base ..... *C. nigroocellatus*

Centrobranchus andreae
(Lütken, 1892)

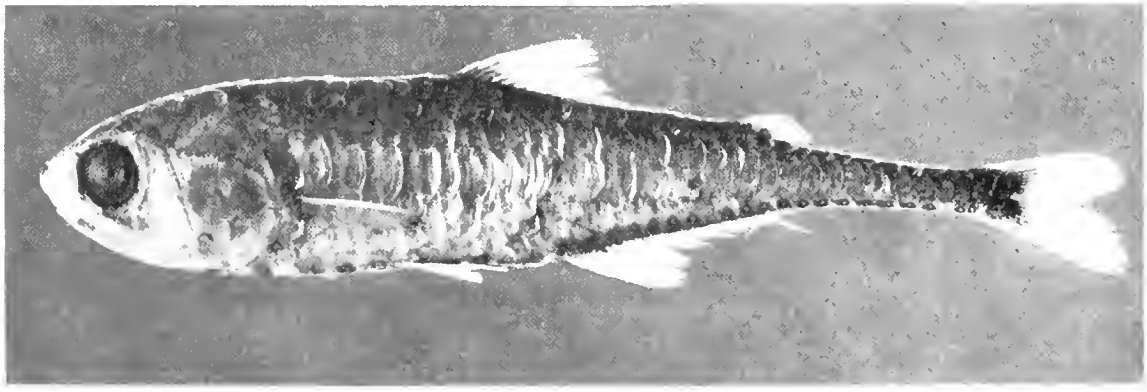


Fig. 73—*Centrobranchus andreae*, male, 62.4 mm.

Description

D. 11 (10-12); A. 18-19 (17-20); P. 12-13 (11-14); AO 6-7 (rarely 5-8) + 10-11 (rarely 7-12), total 17 (15-19); vertebrae 38 (37-39).

SAO in a straight, or nearly so, steeply oblique line that passes through or near VO_4. Nasal rosette always round. Three to 4 AOp over anal base. Five to 8 supracaudal and 4 to 7 infracaudal glands are evident on specimens of 22-25 mm.

Numbers of AO photophores for the four species of *Centrobranchus* are given in Table 18.

Size: To about 65 mm.

Least depth of capture: At surface at night.

Distribution: C. andreae may have a divided distribution, north and south of the equator, except in the east-central Pacific (Fig. 74). As yet not enough collections have been made to establish definite patterns of distribution.

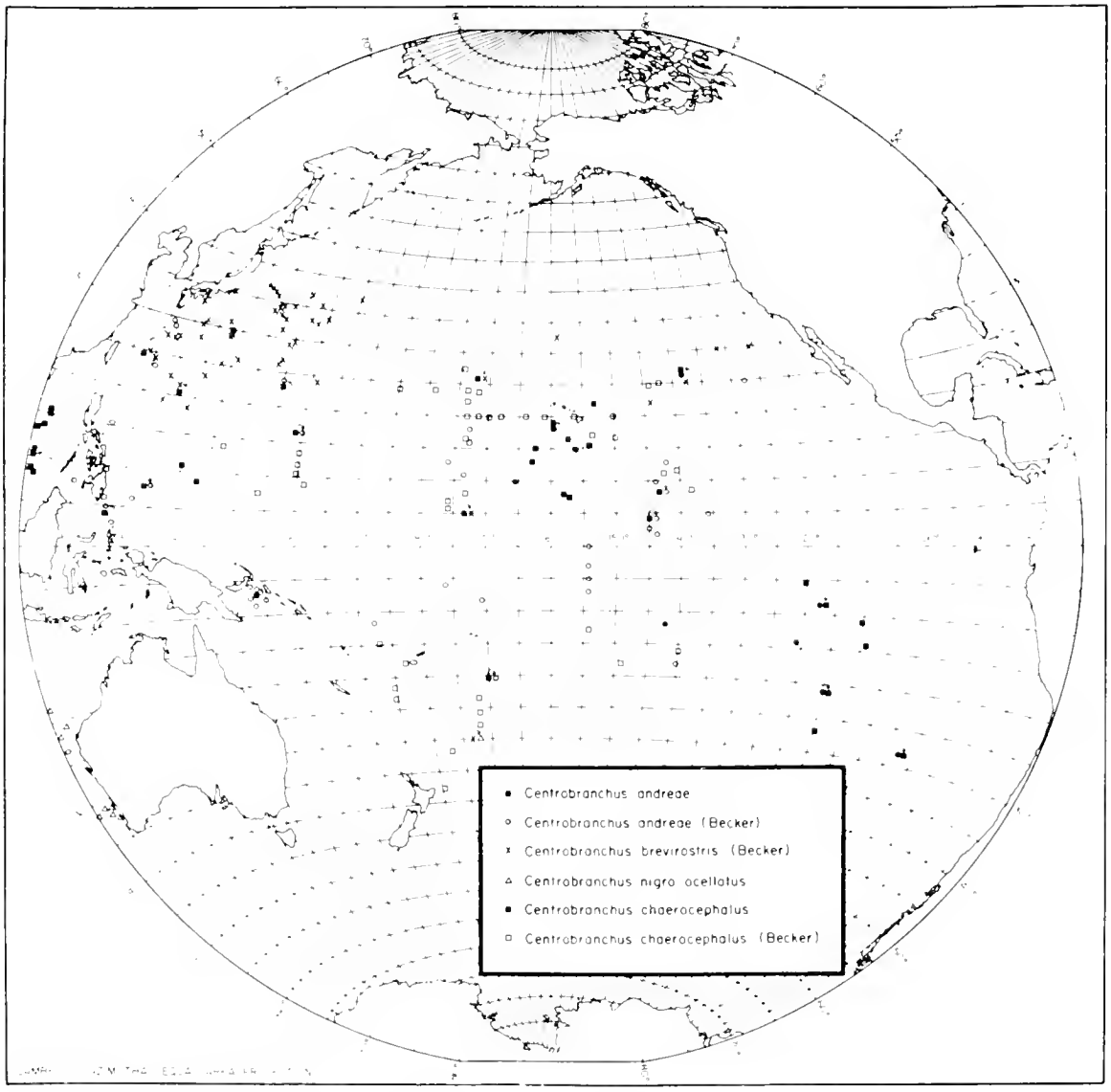


Fig. 74—Capture localities for species of the genus *Centrobranchus* in the Pacific Ocean and a portion of the Indo-Pacific region, including species listed by Becker, 1964a (as noted).

TABLE 18. NUMBERS OF AO PHOTOPHORES FOR SPECIES OF THE GENUS *CENTROBRANCHUS*

Species	AOa								
	4	5	6	7	8			N	Mean
*C. andreae**	—	7	177	230	17			431	6.60
*C. brevirostris**	30	309	81	—	—			420	5.12
C. nigroocellatus									
(Atlantic Ocean)	23	104	19	—	—			146	4.97
(Indian Ocean)*	11	131	51	9	—			202	5.29
C. choerocephalus									
(E. Pacific Ocean)	4	53	29	2	—			88	5.33

	AOp								
	6	7	8	9	10	11	12	N	Mean
*C. andreae**	—	1	1	45	272	105	7	431	10.16
*C. brevirostris**	—	—	23	243	150	4	—	420	9.32
C. nigroocellatus									
(Atlantic Ocean)	—	3	70	64	9	—	—	146	8.54
(Indian Ocean)*	—	—	3	111	79	9	—	202	9.47
C. choerocephalus									
(E. Pacific Ocean)	—	—	—	9	41	35	3	88	10.36

	Total AO photophores									
	12	13	14	15	16	17	18	19	N	Mean
*C. andreae**	—	—	—	13	123	252	42	1	431	16.76
*C. brevirostris**	—	7	229	175	9	—	—	—	420	14.44
C. nigroocellatus										
(Atlantic Ocean)	5	69	65	6	1	—	—	—	146	13.51
(Indian Ocean)*	—	6	72	92	30	2	—	—	202	14.75
C. choerocephalus										
(E. Pacific Ocean)	—	—	6	28	43	9	2	—	88	15.69

*Data taken from Beeker, 1964a.

Centrobranchus brevirostris
Becker, 1964

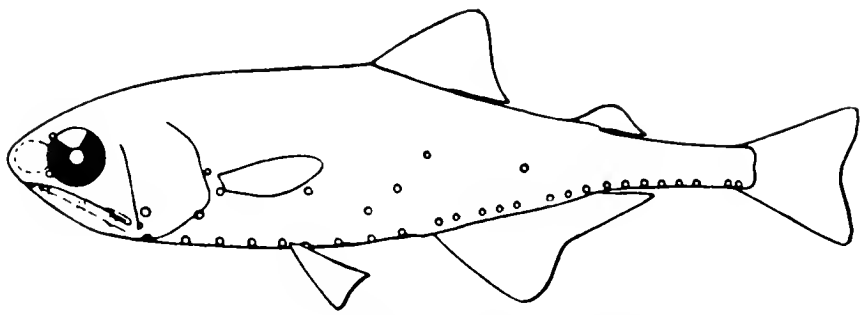


Fig. 75—*Centrobranchus brevirostris*. From Becker (1964a, p. 53, fig. 21).

Description

D. 11 (10-12); A. 17 (16-19); P. 15 (14-16); AO 5 (4-6) + 9 (8-11), total 14-15 (13-16); vertebrae 36-37.

SAO usually in a straight, or nearly so, moderately oblique line which passes through or near VO_2. Snout short, usually less than least depth of caudal peduncle. Body depth equal at

dorsal and pectoral origins and a little less than one-fourth of standard length. Nasal rosette round. Three (4) AOp over anal base.

Five to 7 supracaudal and 4 to 6 infracaudal luminous glands are evident on specimens of about 20 mm SL.

Size: To about 40 mm.

Least depth of capture: At surface at night.

Distribution: The range of *C. brevirostris*, known primarily from the northwestern Pacific, extends in a narrow band from about the North Tropical Convergence to the southern boundary of the North Pacific Drift (Fig. 74).

Discussion

C. brevirostris is so very similar to *C. nigroocellatus* of the North Atlantic Ocean that it may be at best only a subspecies. Until a more detailed comparison is made I feel it best to retain Becker's species.

Centrobranchus nigroocellatus

(Günther, 1873)

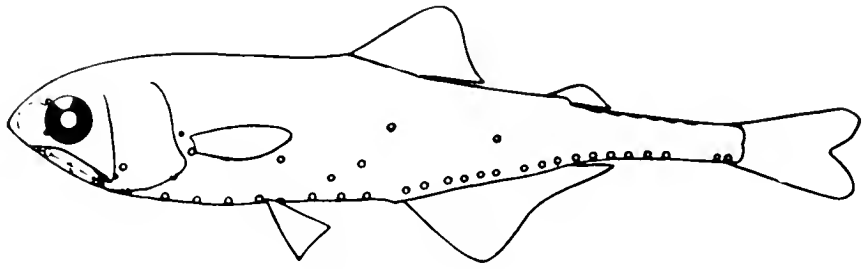


Fig. 76—*Centrobranchus nigroocellatus*. From Becker (1964a, p. 59, fig. 24).

Description

D. 10 (9-11); A. 18 (17-19); P. 15 (14-17); AO 5 (4-7) + 9 (8-11), total 15 (13-17); vertebrae 36 (35-37) (based on Atlantic specimens).

Snout length about equal to least depth of caudal peduncle, over half the orbital diameter. Greatest body depth a little less than one-fourth of standard length. Nasal rosette round. Three or 4 AOp over anal base.

Six (5-7) supracaudal and 5 (3-6) infracaudal luminous glands evident on specimens as small as 20 mm.

Size: To about 40 mm.

Least depth of capture: At surface at night.

Distribution: The range of *C. nigroocellatus* appears to lie in the Indian Ocean, with one occurrence noted in the southwestern Pacific at 29°52′ S, 172°00′ W (Becker, 1964a). It has not yet been reported from the eastern Pacific (Fig. 74).

Centrobranchus choerocephalus
Fowler, 1904

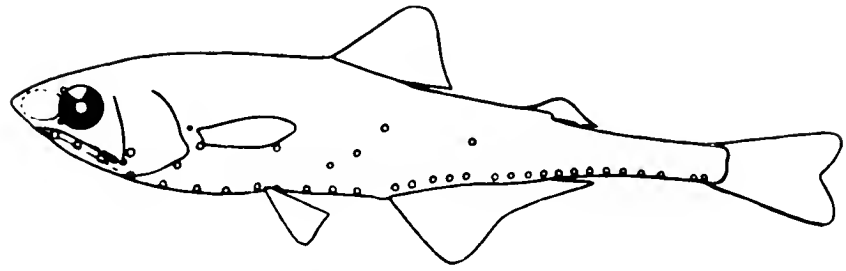


Fig. 77—*Centrobranchus choerocephalus*, From Becker (1964a, p. 62, fig. 25).

Description

D. 10 (9-11); A. 18 (17-19); P. 15 (14-17); AO 5-6 (4-7) + 10-11 (9-12), total 15-16 (13-18); vertebrae 38-39 (37-40).

Nasal rosette oval. Body slender; least depth of caudal peduncle considerably less than orbital diameter or snout length. At least 4 AOp over anal base.

Six to 7 supracaudal and 5 (4-6) infracaudal luminous glands evident on specimens of 20 to 25 mm.

Size: To about 40 mm.

Least depth of capture: At surface at night.

Distribution: Centrobranchus choerocephalus, the most abundant, or at least the most collected, species of the genus, appears to have at least two more or less segregated groups separated by about 10° of latitude at the equator, from about 05° N to at least 05° S (Fig. 74). This zone, at least in the eastern Pacific, has been rather well collected, and particularly so in the extreme eastern sector. Except for this break at the equator, the range of the species appears to extend between the North and South Tropical Convergences.

The Diaphid Fishes
Genera *Lobianchia* and *Diaphus*

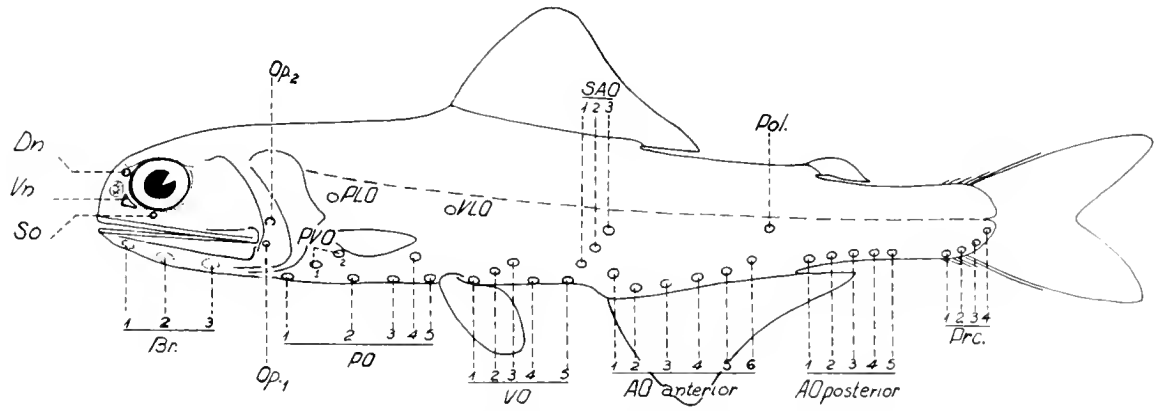


Fig. 78—Diagram of a fictitious diaphid fish showing the location and terminology of commonly occurring photophores. From Nafpaktitis (1968, p. 8, fig. 2).

The diaphid fishes, a rather difficult group taxonomically, are still not well understood throughout the world oceans. Although some species are quite distinctive, most are difficult to distinguish, a difficulty due in part to a very extensive overlap in many characters. The number of fin rays and anal photophores (AOa and AOp) are, with few exceptions, rather constant among species. The number of gill rakers and the positions of certain photophores (PLO, VLO, SAO_1 and SAO_3, Pol and Prc_4, and the AOa and AOp series) are of greatest use in separating species. However, there is variation in numbers of gill rakers within species, particularly among those of worldwide distribution, and there is some inconstancy in the positioning of the photophores named above. Seldom are the relative positions of the fins of taxonomic value.

If only adults or young adults in good condition are considered, the luminous organs of the head (variations of the Dn and Vn organs common to other genera of the family) will in most cases serve to delimit species groups, and some species. But, in some groups there are often distinct differences in these organs between adults and juveniles and between males and females. Unfortunately, these organs are tender and easily damaged or lost. However, despite these obstacles, it is possible to arrange the species into groups (albeit rather broad groups) on the basis of the kind and arrangement of the luminous organs of the head; the principal categories of the key to species used here are based on these arrangements (for adults and young adults only). This was attempted by Fraser-Brunner (1949), who employed four subgenera, *Hyperphotops* Fraser-Brunner, 1949; *Panthophos* Jordan and Hubbs, 1925; *Lamprossa* Jordan and Hubbs, 1925; and *Diaphus* Eigenmann and Eigenmann, 1890.

Bolin (1959) segregated into the genus *Lobianchia* some species formerly placed in subgenus *Hyperphotops*, primarily on the basis of the presence of supracaudal and infracaudal luminous glands—glands not present in other diaphid species. Also, Bolin, on the basis of dentition, placed the remaining species in two genera, *Aethoprora* Goode and Bean, 1896, and *Diaphus* Eigenmann and Eigenmann, 1890. The genus *Diaphus* was characterised as having an inner series of broad-based, sharply recurved teeth on the posterior part of the upper jaw. Teeth of the outer series of the upper jaw and dentary of genus *Aethoprora* were described as small and closely set, with those of the inner series somewhat enlarged and tending to be more widely spaced, particularly on the dentary.

The types of luminous organs of the head appear to coincide with the respective types of dentition in that the genus *Diaphus* (as restricted by Bolin) has the Dn and Vn widely separated and, in addition, a more or less prominent suborbital organ (So); the genus *Aethoprora* has a well-defined Dn and often has the Vn elongated and extending upward and contiguous or confluent with Dn, but has no So.

Moser and Ahlstrom (1974) supported the concept of three genera by demonstrating that the larvae of *Lobianchia, Aethoprora,* and *Diaphus* differ recognizably. However, they reported on the larvae of only one species each of the latter plus two genera—*Diaphus theta* and *D. pacificus* (*Aethoprora* group).

Nafpaktitis (1968) suggested that only the two genera *Lobianchia* and *Diaphus* be considered valid. His examination of large numbers of specimens of diaphid series revealed that the premaxillary teeth displayed a series of gradually changing shapes and that species with luminous organs of the head that differed considerably from those species assigned to genus *Diaphus* (as restricted by Bolin) had dentition closely resembling that of that genus. Nafpaktitis concluded, in addition, that although these luminous organs were generally useful in separating species groups, their structure, development, and considerable variation in appearance, plus certain instances of striking sexual dimorphism, were at present too poorly understood to warrant separation into genera.

I concur in this opinion. The finding of overlap in types of dentition, the incomplete knowledge of development of luminous organs of the head and transitional states of development between the two proposed genera, plus the as yet meager (although cogent) evidence of differences in larval types, indicate that more study is needed before adding more confusion to

a sufficiently difficult group. Therefore, only the genera *Lobianchia* and *Diaphus* are recognized herein.

The species of *Diaphus* treated herein are segregated more or less by the type of luminous organs of the head (see Fig. 83) only as a convenience to the student, and there is no intention to represent a truly phylogenetic relationship. I have seen only adult, or young adult, specimens, and information on the development with age of the head organs of the very young of most species must await further study.

It is important to remember that the species treated in the following key to identification may not represent the total actually occupying the eastern Pacific Ocean, since the south-central and western portions are still poorly collected. Many of the species were originally described and known only from the Atlantic Ocean, or from the Indo-Pacific region and from near New Zealand. Often these were represented by only a few specimens, frequently in poor condition, and it was not possible to compare specimens from widely separate localities. Thus, there was seldom an indication as to whether those found in the eastern Pacific were different or truly identical with those of distant waters, and, perhaps, were expatriates. An attempt has been made to include species which may conceivably occur in the eastern Pacific, largely because they are known to occur in water masses that impinge on those of the area of study.

Predictably, several taxonomic problems were encountered. One that I am presently unable to solve involves at least seven apparently distinct forms, or species. Four of these conform reasonably well to Brauer's (1906) description and figure of *Diaphus fulgens* (from the tropical Indian Ocean), and one may be that species; three other forms are very similar to *D. rafinesquii* (Cocco, 1838), presently known only from the Atlantic Ocean. Two species described by Gilbert (1908) and based on juveniles from near Nukuhiva, Marquesas, *Diaphus nanus* and *D. agassizi*, the types respectively 17 and 21 mm long, also present problems. One of the *fulgens*-like forms may represent *D. nanus*, but I cannot at all place *D. agassizi*.

Fraser-Brunner (1949) placed *D. agassizi* in the subgenus *Hyperphotops* (= *Lobianchia*), apparently because of the presence of only a Dn, as described and figured by Gilbert. But, as shown by Nafpaktitis (1968), very often diaphid fishes of about 20 mm or less have only the Dn visible, regardless of the ultimate development of other head organs. It is thus quite probable that *D. agassizi* should not be placed in that group having only a Dn, a character now considered as confined to the genus *Lobianchia*. Indeed, the patterns of body photophores are quite unlike that of *L. gemellarii, L. dofleini*, or *L. urolampa*, although they are basically more like those of the latter species. I have seen no large specimens bearing only a Dn that conform to the description and figure presented by Gilbert (1908) for the diminutive holotype of *D. agassizi*.

It is hoped that the obvious shortcomings and inadequacies of this effort on diaphid fishes of the eastern Pacific Ocean will induce others to undertake studies on this very interesting but quite exasperating group of fishes.

Lobianchia
Gatti, 1903

Five VO, the first 3 usually in an ascending oblique line (VO_2 raised to level of VO_3 in one species). Luminous organs of head limited to a small, inconspicuous Dn. No luminous scales at PLO. A long supracaudal luminous gland present in adult males; a shorter, rather inconspicuous infracaudal gland present in adult females. One Pol; 4 Prc.

Key to species of *Lobianchia*

1a. All upper photophores at or very near lateral line. First 3 VO not in a straight ascending series, VO_2 raised to level of VO_3. Only 2 SAO photophores. First AOa highly elevated ..... *L. urolampa*

1b. All photophores well below lateral line. First 3 VO in a straight, ascending series. Three SAO. First AOa not, or but little, elevated 2

2a. VLO about midway between pelvic origin and lateral line. Gill rakers 4 + 1 + 10 ..... (Near *L. gemellarii*)

2b. VLO markedly nearer pelvic base than to lateral line. Gill rakers 5 + 1 + 12-14 3

3a. Pol about midway between lateral line and anal base, usually lower. SAO series straight or slightly curved, the convexity directed anterodorsally. Prc evenly spaced, the last sometimes a little displaced posteriorly; Prc_{3-4} interspace always less than that between Prc_{1-3} ..... *L. gemellarii*

3b. Pol nearer lateral line than to anal base, the distance between the two two to two and one-half times that between Pol and lateral line. SAO in a gentle arc, the convexity directed posteroventrally. Prc_{3-4} interspace large, usually greater than, or at least equal to, that between Prc_{1-3} ..... *L. dofleini*

Lobianchia urolampa
(Gilbert and Cramer, 1897)

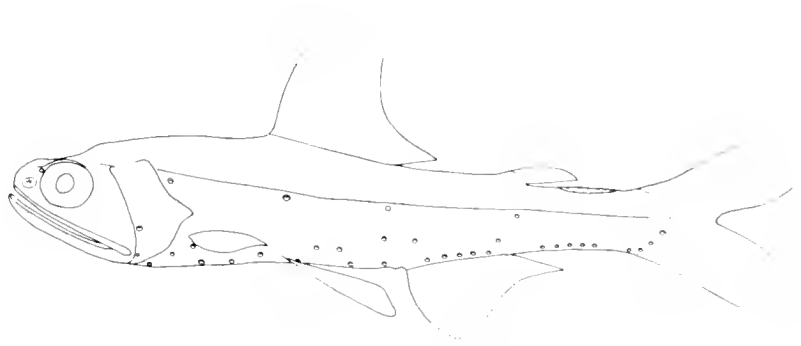


Fig. 79—*Lobianchia urolampa*, male, 84.0 mm.

Description

D. 15; A. 15; P. 14-15; AO 7 + 6; gill rakers 6 + 1 + 13-14, total 20-21; vertebrae 35 (5 specimens).

L. urolampa is readily distinguished from other species of the genus by the high positions of the PLO, VLO, SAO_3, and Pol, all at or near lateral line. Other equally distinctive characters are the high and nearly equally elevated VO_2 and VO_3, the highly elevated first and last AOa, and the presence (apparently) of but 2 SAO. None of these characters are present in any other known species of *Lobianchia*.

Supracaudal luminous gland rather short, filling half, or slightly more, of upper surface of caudal peduncle; this gland is shorter and much less robust than those of *L. gemellarii* or *L. dofleini*; the 5 to 7 individual luminous scales are poorly defined and not delimited by lines of pigment in the five males (69-87 mm) before me. I have seen no females and can offer no information concerning infracaudal luminous glands.

L. urolampa was originally figured as having only 2 SAO, but Fraser-Brunner (1949) figured 3. On the 10 sides before me there are but 2 SAO (Fig. 79). The first is almost directly over VO_5 and a little less than midway between there and lateral line; the second is at lateral line and slightly behind a line through VO_5 and SAO_1. Gilbert and Cramer (1897, Pl. 38, fig. 1) show this configuration, but in the text (p. 408) stated "Supraanals 3, forming nearly a right-angled triangle, with one of the spots above the hindmost ventral spot, the second immediately below the lateral line, and the third nearly above the first anterior anal spot." Such a configuration as these authors described is unknown in the family Myctophidae, and it would seem more reasonable to consider the posterior "spot" as an elevated AOa rather than a posteriorly displaced SAO.

Fraser-Brunner (1949) illustrated a third SAO (=SAO_1) as just above VO_5 and anterior to the middle SAO, the 3 organs closely spaced; an elevated first AOa and the 5 VO are shown in positions similar to those in Fig. 79 above. *L. urolampa* has no luminous scale at PLO—a finding in agreement with the original description. However, Fraser-Brunner figured this scale.

Size: Largest of the five specimens before me, 86 mm. Gilbert and Cramer (1897) listed "—a range for seven specimens of 2 1/2 to 4 1/2 inches."

Least depth of capture: Clarke (1973) stated that adults were taken in bottom trawls at depths between 124 and 190 m at night. Clarke also listed juveniles (25-26 mm) take at night from "100?" m, near Hawaii.

Distribution: Known principally from the immediate area of the Hawaiian Islands.

Lobianchia gemellarii
(Cocco, 1838)

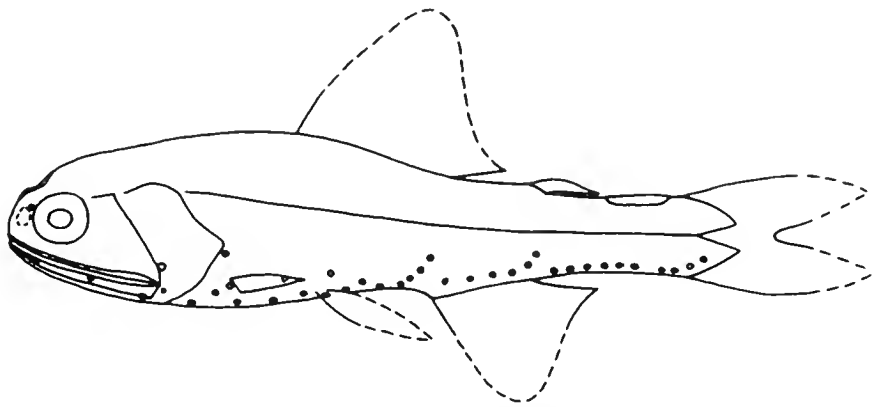


Fig. 80—*Lobianchia gemellarii*, male, 40.2 mm.

Description

D. 17 (16-18); A. 14 (13-15); P. 11-13; AO 4-5 + 6 (5), total 10-11; gill rakers 5 + 1 + 12 (11-14), total 18 (17-20); vertebrae 35 (34).

The characters given in the keys to *L. gemellarii* and *L. dofleini* (see above) are taken largely from Nafpaktitis (1968) and appear adequate for determining the species as found in the eastern Pacific Ocean, except for the following differences: In *L. gemellarii* from the eastern Pacific, PLO is as much as three times nearer pectoral origin than to lateral line; Pol is occasionally behind, rather than before or over end of anal base; and VLO ranges from about two times nearer pelvic base than to lateral line to about midway between.

There also may be a difference in the structure of the infracaudal luminous gland in that females in good condition from the eastern Pacific have but 2 or 3 scales that form a short and broad-armed "Y." Nafpaktitis (1969, p. 14, fig. 4A′) figured 6 scales for the North Atlantic form; it may be that some scales in the Pacific form have been lost, as there is some evidence of erosion, but there is no evidence of additional luminous scales on the better specimens. The supracaudal gland of a 30-mm specimen is evident but not fully formed.

Size: To about 70 mm (largest of nine specimens).

Least depth of capture: Clarke (1973) stated that in nighttime catches, only specimens 25 mm or less were taken above 100 m, those over 40 mm were taken from below 150 m, and substantial catches of larger fishes were made as deep as 300 m.

Distribution: The capture localities of *L. gemellarii* in the eastern Pacific indicate a widespread distribution (Fig. 81), although the captures appear to be sporadic—a circumstance not readily explained. The few occurrences in the southeastern sector (including a possible new form) are bolstered by the taking of 21 specimens (24-59 mm) identified as *L. gemellarii* in the area of 31°-34° S, 77°-91° W (Craddock and Mead, 1970).

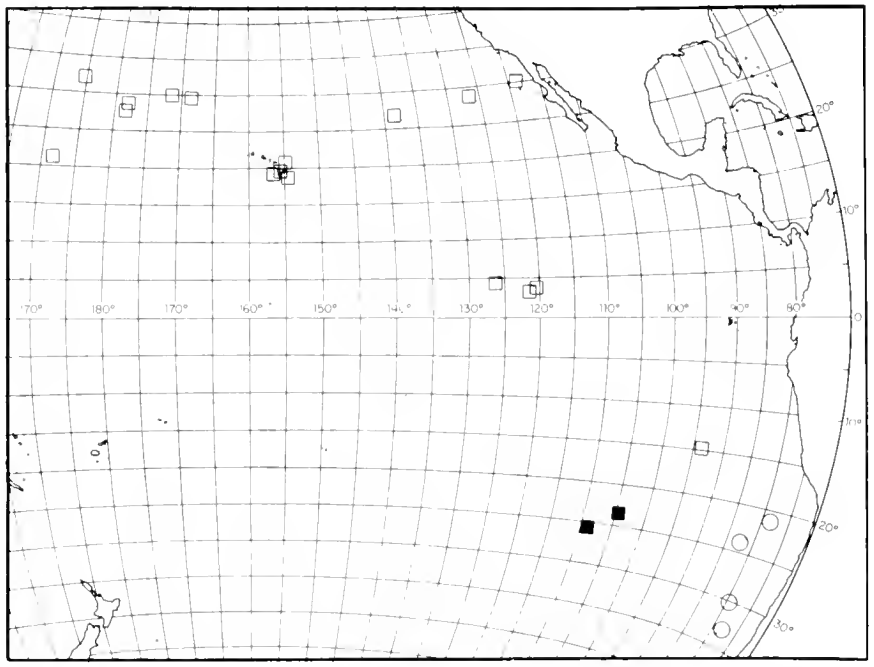


Fig. 81—Capture localities for *Lobianchia* n. sp. ? (solid squares), *L. gemellarii* (open squares), and *L. dofleini* (open circles).

Discussion

Three specimens, two males from the southeastern Pacific and one female from the Indian Ocean, differ from *L. gemellarii*, as described above, in having VLO midway between lateral line and pelvic base, rather than much nearer the latter, and having 4 + 1 + 10 gill rakers instead of 5 + 1 + 12 (11-14). The two specimens (48 and 60 mm) from the southeastern Pacific have the supracaudal luminous gland typical of males of *L. gemellarii*. The Indian Ocean specimen (59 mm) has an infracaudal gland similar to the "Y" of the female from the Pacific Ocean.

At present, inadequate material of *L. gemellarii*, in good condition, is available to determine the limits of variation in numbers of gill rakers and positions of PLO and VLO, or to state whether these specimens are variants or represent an undescribed form.

Lobianchia dofleini
(Zugmayer, 1911)

Description

D. 16; A. 13; P. 12-13; AO 5 (4-6), total 10 (9-11); gill rakers 5 + 1 + 13 (14), total 19 (20); vertebrae 33-34.

This species is basically very similar to *L. gemellarii*; Pol is nearer lateral line than to end of anal base and lies over or slightly before, but occasionally behind, that base. Last Prc far back on caudal rays.

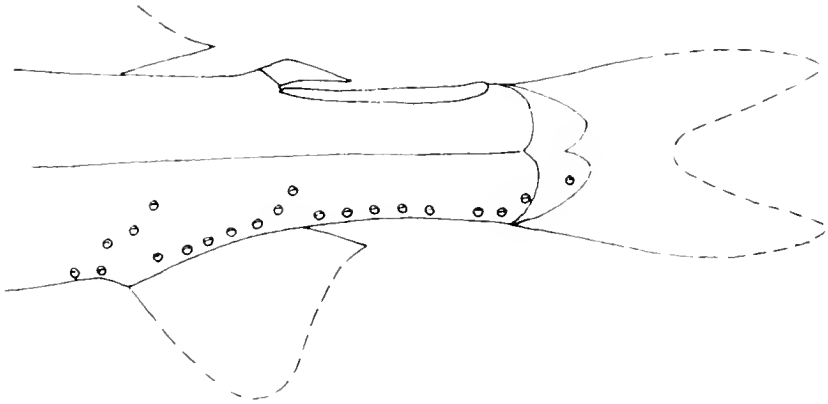


Fig. 82—Posterior region of *Lobianchia dofleini*, male, 35.0 mm.

Infracaudal luminous glands of females from the eastern Pacific appear to differ considerably from those of North Atlantic specimens. Those from the eastern Pacific bear no more than 4 small scales, 2 in line on each side of the median in the space between last AOp and first Prc; this pattern differs notably from the cluster of 7 scales shown for the North Atlantic form by Nafpaktitis (1968, p. 14, fig. 4A). The supracaudal glands of males from both oceans are quite similar.

Size: To 48 mm (largest of 60 specimens).

Least depth of capture: All specimens before me were taken in tows to 500 m or more.

Distribution: This species is apparently confined to the extreme southeastern Pacific Ocean (Fig. 81). I have seen no other specimen among thousands of diaphid fishes from other areas of the Pacific. Craddock and Mead (1970) reported the capture of 120 specimens in the southeastern area at about 31°-34° S, 88°-93° W.

Diaphus

Eigenmann and Eigenmann, 1890

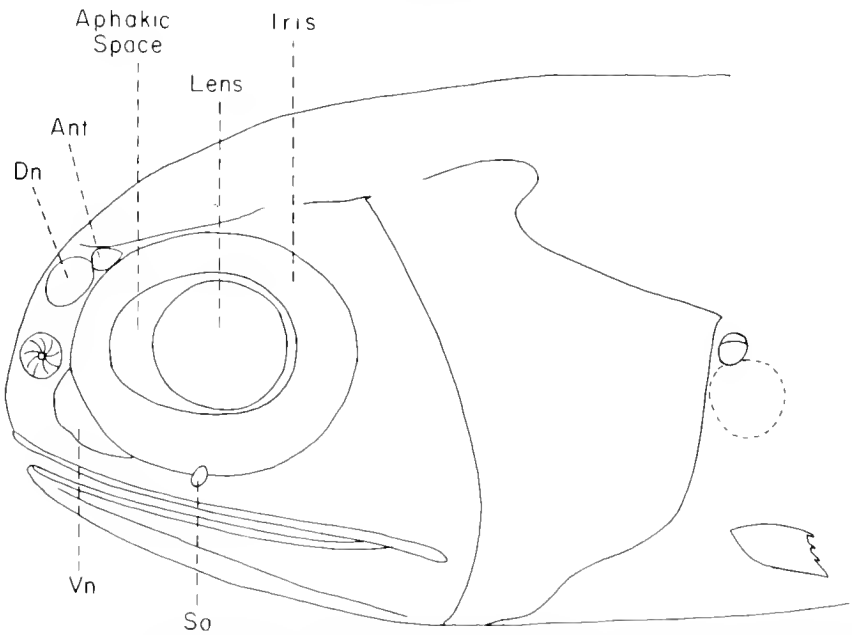


Fig. 83—Head of a diaphid fish showing locations and terminology of characters used in identification. No single species will bear all the characters shown.

Always more than 1 luminous organ at orbital margin; these organs are of varied size, shape, and arrangement, and are connected by a varyingly wide band of darkly pigmented tissue. Supracaudal and infracaudal luminous glands absent. A luminous scale of varied size and shape at PLO is present in most species. Five VO, the first 3 in ascending series; 4 Prc.

Key to species of *Diaphus* in the eastern Pacific Ocean

1a. So present (Fig. 84A). Ant absent. Inner series of teeth of posterior portion of upper jaw broad-based, the tips sharply recurved 2

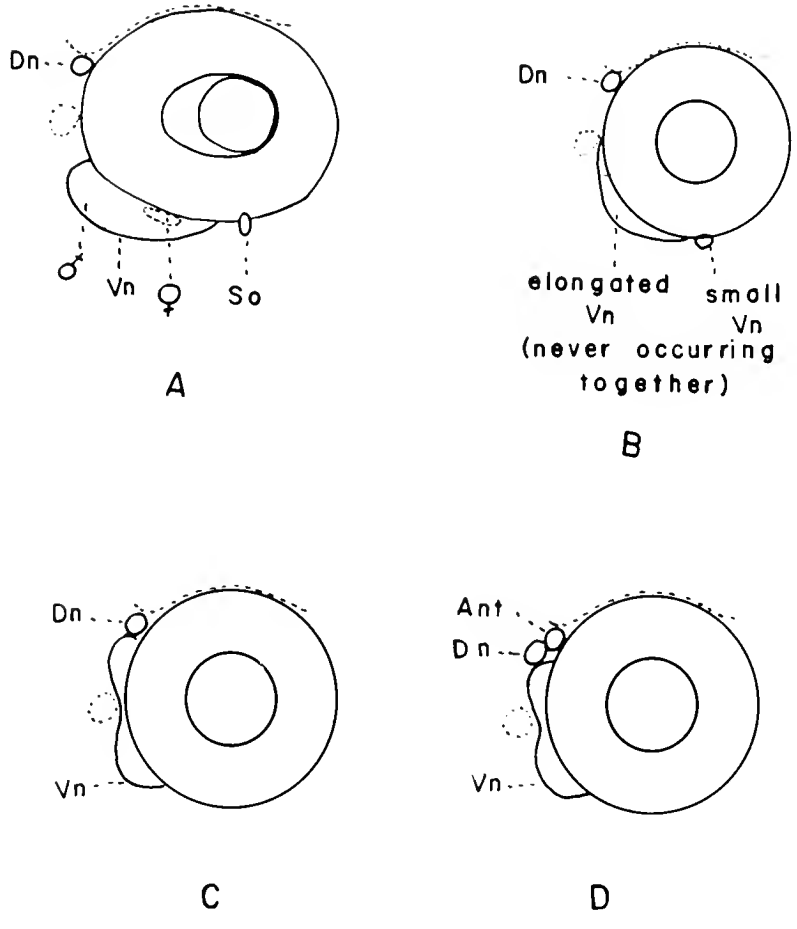


Fig. 84—Sketches of orbital regions of adult and young-adult diaphid fishes of the eastern Pacific Ocean, showing four combinations of luminous organs and their approximate locations.

1b. So absent. Ant absent or present (Fig. 84 B, C, D). Inner series of teeth of upper jaw straight or slightly curved. If (rarely) slightly broad-based and recurved, it is to a much lesser degree than in those species having an So 9

2a. Pupil essentially round, no prominent (aphakic) space between lens and iris. Luminous organs of head small, always well separated 3

2b. Pupil elongated horizontally or vertically, a prominent (aphakic) space usually present anteriorly between lens and pupil (Fig. 83). Luminous organs of head variable in size, not necessarily well separated 4

3a. Dn, Vn, and So small, about equal in size, connected by a thin strand of dark tissue. Body photophores large, very closely spaced, the upper series low on body. SAO series in an

oblique line with VO_5. Luminous scales at PLO large, the tissue in short wavy lines or convoluted ..... *D. anderseni*

3b. Dn small but prominent; Vn minute*. So larger than Dn or Vn, very much enlarged in males, wedge-shaped, the apex anteriorly, filling space between upper jaw and orbital margin and extending to about under hind margin of orbit; So of females much shorter than in males, elliptical. SAO_1 on level of last 2 VO. Luminous scale at PLO small and thin, the tissue appearing as vertical striations ..... *D. diadematus**

4a. First AOa not or but very slightly elevated. Posterodorsal margin of operculum moderately angulate 5

5a. So behind vertical from posterior margin of pupil. No luminous scale at PLO 6

5b. So before vertical of posterior margin of pupil. Pupil more or less elongated horizontally. Luminous scale at PLO 7

6a. Pupil vertically elongate; a notable space usually present ventrally between lens and iris. Orbit large, 58-60% of upper jaw. So surrounded by and separated from Vn by dark pigment. A large, profusely ramified melanophore immediately posteroventral to So. Body deep, robust, its depth about 34% of SL. Photophores of upper series very low on body. Caudal peduncle short, deep. Vn long, underlying most of orbit, narrow in females, much widened in males; So a small knob at end of Vn ..... *D. brachycephalus*

6b. Pupil round, no appreciable space ventrally between lens and iris. Orbit about 50% of upper jaw. So not surrounded by or separated from Vn by dark pigment. No large melanophore posteroventral to So. Very similar to *D. brachycephalus* (6a) but body less deep and robust, its depth about 22-24% of SL ..... *D. richardsoni*

7a. Caudal-peduncle length about 22-24% of SL, its depth 48% (44-51%) of its length. Luminous scale at PLO about half the pupil in size, the tissue in short, wavy lines radiating away from PLO ..... *D. theta*

7b. Caudal peduncle very short and deep, its length 12-13% of SL, its depth 68% (65-71%) of its length. Luminous scale at PLO half or less the size of pupil, the tissue in short, wavy, laterally directed lines ..... *D. longleyi*

8a. Posterodorsal margin of opercle notably angulate and recurved. Gill rakers 5-6 + 1 + 12-13; AO 5-6 + 3-4 (rarely 5). Luminous scale at PLO small, the tissue appearing convoluted or granular ..... *D. mollis*

8b. Posterodorsal margin of operculum only moderately angulate and very little if at all recurved. Gill rakers highly variable in number, totals ranging from 13 to 27. Luminous scale at PLO large and prominent; absent in one form ... *D. fulgens-rafinesquii* (a complex)

9a. Ant absent (a tiny photophore-like and pigment-ringed luminous dot, present in some species above and often in contact with Dn, is not to be interpreted as an Ant). Pupil essentially round 10

9b. Ant present. Dn and Vn contiguous 25

10a. Dn and Vn widely separated 11

10b. Dn and Vn contiguous or confluent 16

11a. Vn elongated. Dn and Vn widely separated (Fig. 84B) 12

11b. Vn small, not elongated. Dn and Vn widely separated (Fig. 84B) 13

12a. Vn smooth on dorsal surface. Vn very much enlarged in males, wedge-shaped, the apex anteriorly, filling space between upper jaw and orbital margin and extending to about under hind margin of orbit ..... *D. diadematus*

12b. Dorsal surface of Vn bearing 4 or 5 luminous dots embedded in a heavy streak of dark pigment and protruding into orbital rim. Vn long and slender in females, much more massive in males, extending under much of orbital rim. SAO_1 on level of last 2 VO.

D. diadematus may be more properly placed in that group having the Dn and Vn widely separated (couplet 11) and connected by a strand of dark tissue bearing one or more dots of luminous tissue. However, one of these dots is often enlarged and may be interpreted as a small Vn, and the larger posterior organ as an So.

Luminous scale at PLO about one and one-half to one and three-fourths the size of pupil, the tissue in intermittent, rather horizontal lines ..... *D. lütkeni*

13a. Dn and Vn both very small, inconspicuous; Vn at anteroventral margin of orbit. PLO near lateral line. AOa_1 not or but slightly elevated; last AOa often slightly elevated. SAO distinctly angulate; SAO_{1-2} interspace half or less that of SAO_{2-3}. Luminous scale at PLO about size of pupil, the tissue in more or less vertical lines ..... *D. dumerili*

13b. Dn and Vn small but conspicuous, Vn somewhat the larger, more or less rounded, occasionally protruding into orbital rim, a little before vertical from hind margin of orbit 14

14a. Vn rounded or horizontally elliptical. AOa_1 seldom elevated by more than half its diameter above level of AOa_2. PLO nearer pectoral origin than to lateral line; VLO midway or lower between pelvic origin and lateral line. SAO_3 and Pol two to four diameters below lateral line; SAO interspaces nearly equal. No luminous scales at any photophore other than PLO, this scale three to four times larger than PLO, the tissue in wavy, roughly vertical lines ..... *D. termophilus*

14b. Vn triangular. First AOa elevated to about level of SAO_2 15

15a. Small mounds of pigmented tissue protruding into ventral margin of orbit anterior to Vn. Luminous scales adjacent to PLO, VLO, SAO_3, Pol, and Prc_4. Total gill rakers 24-25 (22-26) ..... *D. trachops*

15b. No small mounds of pigmented tissue anterior to Vn. A luminous scale present only at PLO. Total gill rakers 22 (21-23) ..... *D. similis*

16a. One or more of the last few AOp elevated, the last usually the highest. PLO and VLO much nearer lateral line than to pectoral and pelvic bases. Prc interspaces increasingly wider. Luminous scale at PLO about the size of pupil, the tissue in short, somewhat vertical lines ..... *D. regani*

16b. Last few AOp photophores on same level as others 17

17a. Total gill rakers 13-14 (4 + 1 + 9 (8)). PLO below level of VLO and slightly nearer pectoral base than to lateral line; VLO slightly nearer lateral line than to pelvic base. SAO_3 well behind a line through the almost vertically placed SAO_{1-2}. Luminous scale at PLO small, 0.50 to 0.75 in pupil, the tissue in wavy or convoluted lines directed posteriorly ..... *D. problematicus*

17b. Total gill rakers 16 or more 18

18a. SAO_3 and Pol two or more of their diameters below lateral line 19

18b. SAO_3 and Pol at or very near lateral line 20

19a. VO_3 always below a line through PLO, VLO, and SAO_2. SAO_1 on same level as last 2 VO. Vn of males not extending up behind Dn and displacing it forward. Luminous scales at PLO roughly ovoid horizontally, slightly larger than pupil, the tissue in long, nearly vertical lines ..... *D. jenseni*

19b. VO_3 on a line through PLO, VLO, SAO_2, and AOa_1 (AOa_1 very rarely not elevated). SAO_1 its diameter above level of last 2 VO. Vn of males with an occasionally isolated lobe extending up behind Dn and displacing it forward; this lobe of Vn then resembles an Ant. Vn of females often not quite contiguous with Dn. Luminous scale at PLO as large as, often slightly larger than, pupil, the tissue in long, nearly vertical lines ..... *D. pacificus*

20a. Posterodorsal margin of operculum strongly lobed, recurved, weakly serrate in adults. Dn of both sexes large, half or more the vertical diameter of orbit. Body photophores notably small. Head deep, 80-85% of its length. Luminous scale at PLO slightly larger than pupil, the tissue convoluted ..... *D. lucidus*

20b. Posterodorsal margin of operculum not strongly lobed 21

21a. First 3 Prc closely and rather evenly spaced, the fourth widely separated 22

21b. All Prc separated by two or more diameters, the spacing often becoming progressively wider 23

22a. PLO nearer pectoral base than to lateral line; VLO usually nearer lateral line than to pelvic base, but sometimes midway between. SAO_2 and AOa_1 well below a line through PLO and VLO. Dn expanded to over nasal apparatus, particularly in males. Luminous

scale at PLO two or three times PLO in size, the tissue in short, irregular, somewhat vertical lines ..... *D. malayanus*

22b. PLO always, VLO usually, nearer lateral line than to pectoral and pelvic bases. SAO_2 and AOa_1 usually above, rarely on, a line through PLO and VLO. Dn of males much enlarged, that of females small. Luminous scale at PLO somewhat rectangular, about as large as pupil, the tissue convoluted ..... *D. garmani*

23a. PLO usually much nearer pectoral base than to lateral line; VLO always nearer lateral line than to pelvic base. A line through SAO_{1-2} usually passes before SAO_3. Dn not expanded to over nasal rosette. Anterior end of frontal supraorbital bone produced into a strong, forward-directed spine. Luminous scale at PLO somewhat triangular, half or more the size of orbit, the tissue convoluted near center but in closely spaced, more or less parallel lines near margin ..... *D. splendidus*

23b. PLO and VLO about on same level, both slightly nearer lateral line than to pectoral and pelvic bases, or about midway between. No AOp over anal base 24

24a. PLO and VLO much nearer lateral line than to pectoral and pelvic bases. AOa_1 often over AOa_2. Dn of males (only) expanded to over nasal rosette. Luminous scale at PLO slightly larger than pupil, the tissue in short, nearly vertical lines ..... *D. schmidti*

24b. PLO and VLO only slightly nearer lateral line than to pectoral and pelvic bases, or about midway between. AOa_1 usually over or distinctly behind AOa_2. Luminous scale at PLO triangular, slightly larger than pupil, the tissue in closely spaced, wavy lines radiating away from PLO ..... *D. signatus*

25a. Ant present. Inner row of teeth of lower jaw much enlarged, curved, rather widely and evenly spaced. PLO a little above level of VLO and nearer lateral line than to pectoral base. VLO slightly nearer pelvic base than to lateral line. SAO_3 and Pol at lateral line. Prc progressively more widely spaced. Luminous scale at PLO about half the size of pupil, the tissue in long, vertical lines ..... *D. fragilis*

25b. Inner row of teeth of lower jaw not notably enlarged 26

26a. Head considerably longer than deep 27

26b. Head short, about as deep as long 32

27a. Ant much elongated and narrow, extending back under supraorbital bone to near hind margin of pupil. Dn small; Vn separated from Dn and extending under orbital rim to about midpupil. PLO much nearer pectoral base than to lateral line. VLO about midway between pelvic base and lateral line. Luminous scale at PLO large, roughly triangular, nearly filling space between PLO and pectoral fin, the apex rounded, the tissue finely convoluted ..... *D. adenomus*

27b. Ant round or somewhat triangular 28

28a. SAO_3 and Pol two to three of their diameters below lateral line 29

28b. SAO_3 and Pol at lateral line 30

29a. Orbit about 3 in upper jaw. Dn small, not extending over nasal apparatus or to near median ethmoid crest. Gill rakers short and heavy, total rakers 19 (18-20). Luminous scale at PLO about half the pupil in size, the tissue convoluted ..... *D. coeruleus*

29b. Orbit about 2 in upper jaw. Dn large, extending over nasal apparatus nearly to median ethmoid crest. SAO_1 low, slightly above level of VO_5. First AOa elevated to above level of SAO_2. Gill rakers long and slender; total rakers 25-26 (24-27). Luminous scale at PLO no more than twice the size of PLO, the tissue in wavy lines radiating from a point on anterior margin of scale ..... *D. rolfbolini*

30a. Vn elongated posteriorly, extending below hind margin of pupil. PLO much nearer lateral line than to pectoral origin. Luminous scale at PLO about half the pupil in size, the tissue nearly horizontally striated, the scale thin and fragile ..... *D. chrysorhynchus*

30b. Vn not elongated posteriorly but barely extending under anterior margin of pupil. PLO about midway between lateral line and pectoral origin 31

31a. Least depth of caudal peduncle 54% (52-55%) of length of peduncle. Body rather robust, its depth at pectoral origin 24% (23-25) of SL. Total gill rakers 28 (26-29). Luminous scale

at PLO elliptical to triangular in shape, its length slightly greater than diameter of pupil, the tissue nearly vertically striated.....*D. elucens*

31b. Least depth of caudal peduncle 41% (40-42%) of length of peduncle. Body rather slender, its depth at pectoral origin 20% (19-21) of SL. Total gill rakers 25-26. Luminous scale at PLO vertically elliptical in shape, its length slightly greater than diameter of pupil, the tissue nearly horizontally striated .....*D. gigas*

32a. Vn not reaching to under orbital rim. SAO_3 and Pol several of their diameters below lateral line. PLO and VLO about midway between lateral line and pectoral and pelvic bases. Posterodorsal margin of operculum moderately lobed and recurved. Photophores notably small. Luminous scale at PLO nearly equal to vertical diameter of pupil, the tissue in short, vertical lines.....*D. ostenfeldi*

32b. Vn greatly elongated to under orbital rim and ending in a distinct knob about under hind margin of pupil. SAO_3 and Pol at lateral line. PLO and VLO much nearer lateral line than to pectoral and pelvic origins. Posterodorsal margin of operculum strongly lobed and recurved. Photophores notably small. Luminous scale at PLO about half the pupil in size, the tissue convoluted .....*D. metopoclampus*

Diaphus dumerilii
(Bleeker, 1856)

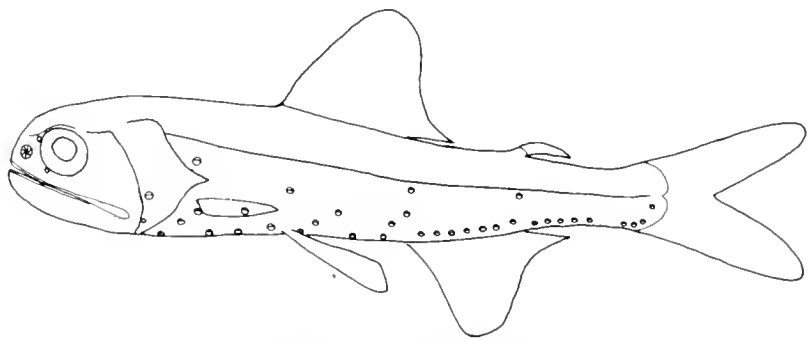


Fig. 85—*Diaphus dumerilii*, female, 58.0 mm.

Description

The following data are taken from specimens from off Cabo Corrientes, Cuba.

D. 14; A. 15 (16); P. 12-13; AO 7 (6) + 5 (6), total 12 (13); gill rakers 6 + 1 + 14 (six specimens); vertebrae 36 (35-37).

Dn and Vn of females small, inconspicuous. Dn of males much enlarged dorsally, and elongated, reaching to about lower margin of nasal apparatus; Vn of males tiny. PLO much nearer lateral line than to pectoral base; VLO about midway between pelvic base and lateral line. First AOa not elevated, last AOa but slightly so.

Size: To about 80 mm.

Least depth of capture: At surface at night.

Distribution: This species was not found among the extensive material examined for this study, and its occurrence in the eastern Pacific is doubtful, although Beebe and Vander Pyl (1944) reported it from off Acapulco, Mexico, and Fowler (1928) reported it from near Hawaii; the type locality is in the Malay Archipelago. Nafpaktitis (1968) reported the species as abundant in the tropical North Atlantic. *Diaphus dumerilii* is either very rarely taken in the eastern Pacific or the identifications from there are erroneous.

Diaphus termophilus
(Tåning, 1928)

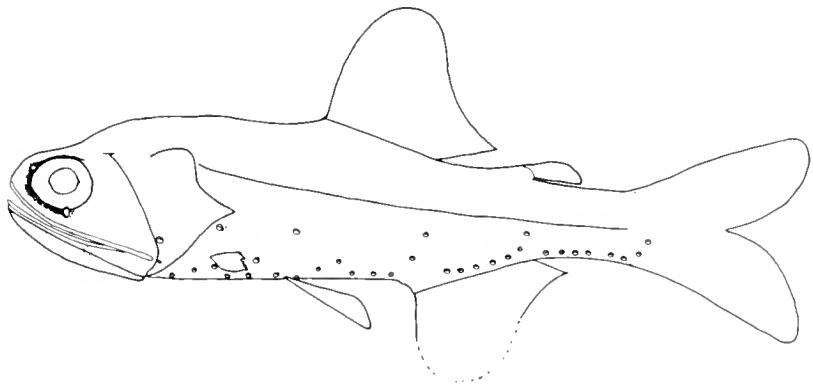


Fig. 86—*Diaphus termophilus*, female, 48.0 mm.

Description

D. 13-14; A. 15-16; P. 12-13; AO 5-6 + 4-5, total 10 (9-11); gill rakers 7 (6-8) + 1 + 12-13 (14), total 20-21 (19-22); vertebrae 35.

PLO about over pectoral origin, or slightly behind, and much nearer that origin than to lateral line. VLO variously over bases of inner pelvic rays or on a point between there and base of outer ray. SAO series usually straight, occasionally slightly curved or angulate, and evenly spaced; SAO_{2-3} interspace usually no more than a half (rarely a full) photophore diameter wider than that between SAO_{1-2}. SAO_1 about half its diameter above level of VO_5. First and last AOa elevated above level of adjacent AOa by about half their diameters, seldom by more.

Dn usually smaller than Vn, not deeply embedded. Vn variable in form (see *Discussion*); several tiny dots of luminous (?) tissue are lightly embedded in a thin streak of dark tissue anterior to Vn along anteroventral margin of orbit. Luminous scale at PLO small, somewhat elongate, weakly formed, the tissue in almost vertical, slightly wavy lines.

Size: To about 50 mm.

Least depth of capture: To 100 m at night.

Distribution: In the eastern Pacific Ocean *D. termophilus* appears to be confined to the equatorial region (Fig. 87). Clarke (1973) did not report the species from near Hawaii. Apparently *D. termophilus* occurs near Australia, for J. R. Paxton (personal communication) stated that specimens at the Sydney Museum were *D. termophilus* rather than the related species *D. trachops* and *D. similis*.

Discussion

Specimens of *Diaphus termophilus* from the eastern Pacific Ocean agree rather well with the diagnosis of the species given by Nafpaktitis (1968), based on North Atlantic material, except in numbers of gill rakers; that author listed 8 (rarely 9 or 7) + 15 (14-16), total 23-25 (rarely 26). The somewhat higher count of gill rakers for the North Atlantic material may indicate a specific difference, but until further studies are made, the name *termophilus* is retained for these specimens from the eastern Pacific Ocean.

In addition to the possible interocean differences, there is an interesting variation in structure of the Vn in Pacific specimens. Two basic forms of Vn occur: One (Fig. 88, Form A) is rather full bodied and horizontally elliptical, the tissue in rather coarse horizontal striations, the general aspect closely resembling the Vn shown by Nafpaktitis (1968, p. 56, fig. 32). A second type of Vn (Fig. 88, Form B) is vertically elliptical, finely striated horizontally, and does not fill the total space in the outline of the organ, the posterior area usually being covered with a thin layer of reflective tissue. Specimens with the Vn as in Form A were taken in the eastern

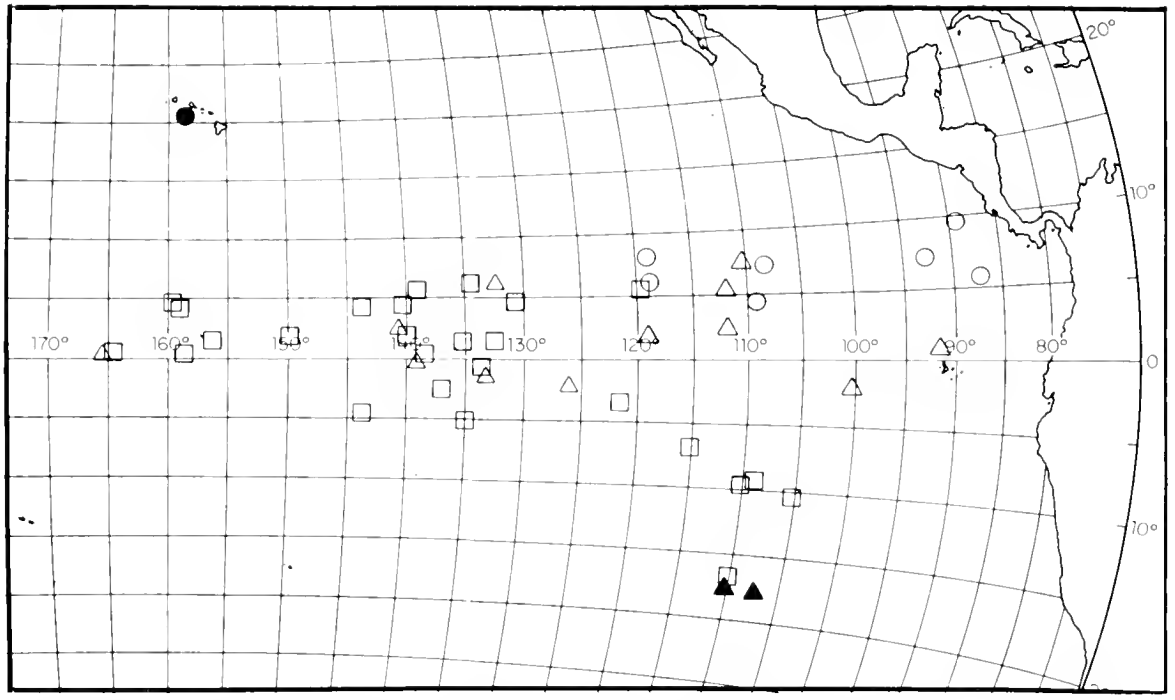


Fig. 87—Capture localities in the eastern Pacific Ocean for *Diaphus trachops* (solid circle), *D. simulis* (open circles), *D. termophilus* (open and solid triangles—see text), and *D. lutkeni* (open squares). A locality for *D. trachops*, near Monterey, California, is not shown.

equatorial area, and those of Form B in the more central portion. An insufficient number of specimens in good condition were available to resolve this intriguing problem.

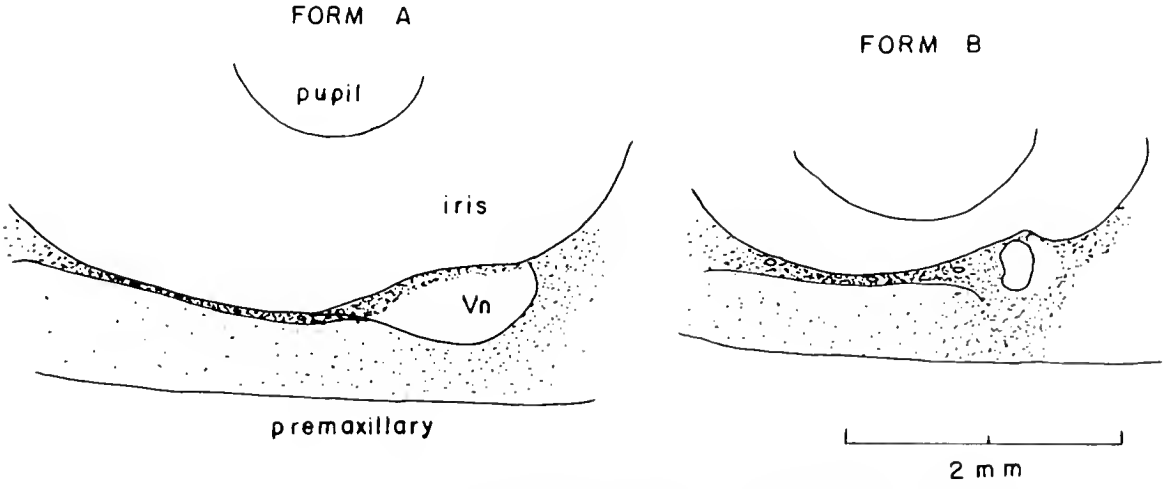


Fig. 88—Two forms of Vn of *Diaphus termophilus* found in the eastern Pacific Ocean.

Diaphus similis
Wisner, 1974

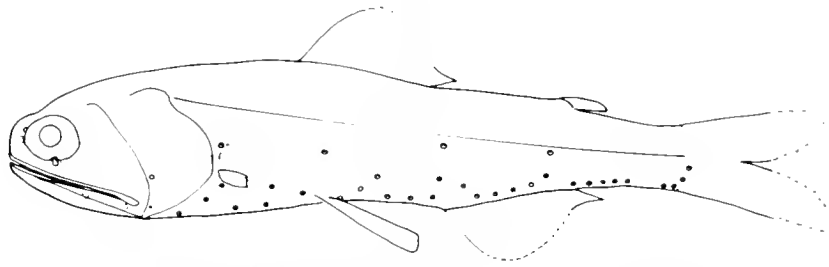


Fig. 89—*Diaphus similis*, holotype, 72.2 mm. From Wisner (1974, p. 7, fig. 4).

Description

D. 14; A. 15-16; P. 12-13 (14); AO 6 (5-7) + 5 (4), total 11 (10-12); gill rakers 7 (6-8) + 1 + 14 (13-15), total 22 (21-23); vertebrae 35 (34-36).

D. similis is very similar to *D. trachops*. It differs primarily in that Vn is more rounded or vertically elliptical (Fig. 90 B), and the streak of darkly pigmented tissue containing the

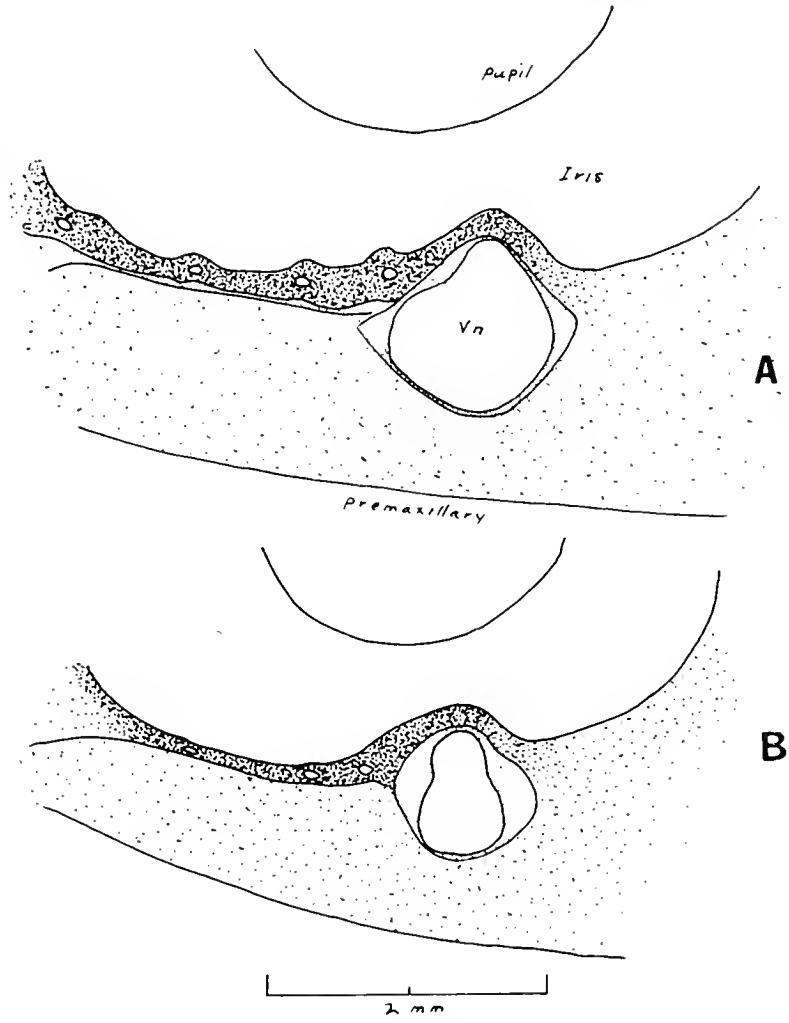


Fig. 90—Vn of (A) *Diaphus trachops* and (B) *D. similus*, and associated minute dots of whitish tissue embedded in the darkly pigmented tissue at ventral margin of orbit.

minute dots of whitish tissue anterior to Vn is not bulged upward above these dots, or at best any bulges are extremely minute and difficult to perceive. Also, *D. similis* has a scale of luminous tissue only at PLO, and has fewer gill rakers. AOa_1 is seldom elevated to the level of SAO_2, and the last AOa is somewhat less elevated than that of *D. trachops*.

Size: To about 72 mm.

Least depth of capture: To about 170 m at night.

Distribution: D. similis is known only from a small area of the eastern tropical Pacific Ocean bounded by about 04°-10° N, 87°-119° W (Fig. 88, open circles).

Diaphus trachops
Wisner, 1974

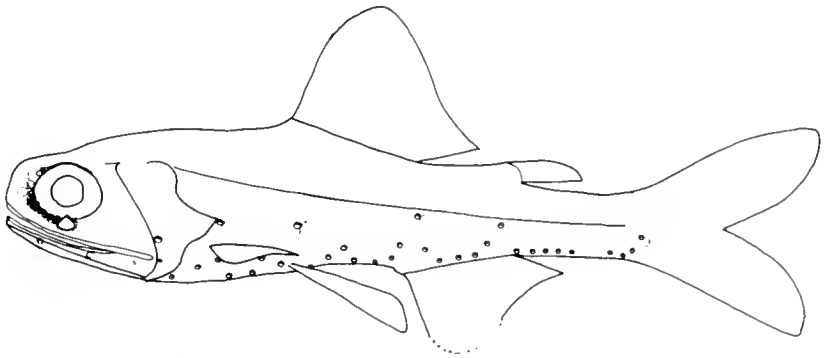


Fig. 91—*Diaphus trachops*, holotype, 63.5 mm. From Wisner (1974, p. 5, fig. 2).

Description

D. 14; A. 15 (14-16); P. 12 (11-13); AO 6 (5-7) + 5-6, total 11 (10-12); gill rakers 8 (7-9) + 1 + 15-16 (14-17), total 24-25 (22-26); vertebrae 34-35.

Dn small, round, deeply recessed. Vn prominent, triangular, about twice as large as Dn and protruding into orbital rim. The luminous tissue of Vn is vertically striated. Anterior to Vn, and embedded in a band of dark tissue, are 4 or 5 minute dots of whitish tissue (probably luminous); the pigmented tissue above these dots bulges upward in small domes that protrude slightly above orbital rim (Fig. 90 A) and are evident in specimens as small as 22 mm, but not in one of 15 mm. These protrusions, although much less prominent, resemble those that project notably from the Vn into the orbital rim of *Diaphus luetkeni*. AOa_1 elevated to level of SAO_2; last AOa elevated to a line through VO_3, SAO_2, and AOa_1. PLO slightly below midway between lateral line and pelvic origin. Small scales of luminous tissues immediately posterior to PLO, VLO, SAO_3, Pol, and Prc_4.

Size: To about 64 mm.

Least depth of capture: To 100 m at night.

Distribution: Most specimens have been taken near Oahu, Hawaii (Fig. 87, solid circles). One specimen known from near Monterey, California (not shown in Fig. 87), may be a stray.

Diaphus luetkeni
(Brauer, 1904)

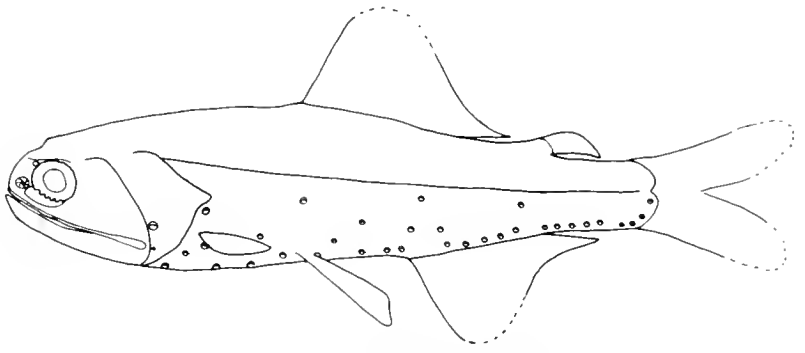


Fig. 92—*Diaphus lutkeni*, male, 54.6 mm.

Description

D. 16; A. 15 (16); P. 11; AO 6 (5-7) + 5 (4-6), total 11 (10-12); gill rakers 6-7 + 1 + 14 (13-15), total 22 (20-23); vertebrae 35 (34-36).

SAO in a straight or very slightly angulate line, the SAO_{2-3} interspace nearly twice that of SAO_{1-2}. First AOa elevated to about level of SAO_2. Dorsal and anal bases overlap considerably. The elongated Vn of females is much narrower than that of males (Fig. 92) but has distinct, though usually smaller, "knobs" protruding into the orbital rim.

Size: To about 60 mm.

Least depth of capture: To about 90 m at night.

Distribution: In the eastern Pacific, *D. luetkeni* is known only from a rather narrow sector of the tropical area (Fig. 87); it has not been taken in the extreme eastern sector despite considerable collecting effort.

Diaphus dilemmatus
Tåning, 1932

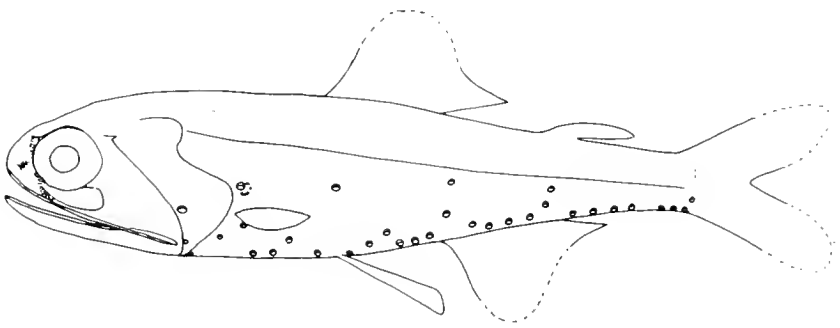


Fig. 93—*Diaphus dilemmatus*, male, 24.0 mm.

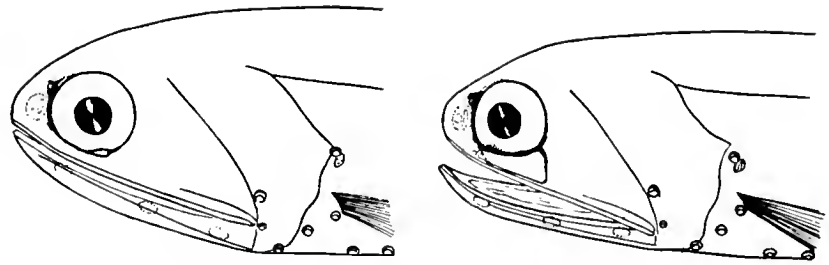


Fig. 94—*Diaphus dialematus*. (A.) Head of adult female, (B.) Head of adult male. Note pronounced sexual dimorphism. From Taning (1932, p. 137, fig. 9).

Description

D. 13-14; A. 13-14; P. 10-12; AO 5 + 5; gill rakers 5 (4) + 1 + 10 (9), total 16 (15); vertebrae 33 (34).

PLO a little nearer pectoral base than to lateral line and before a vertical from that base; VLO much nearer lateral line than to pelvic base. SAO_1 on level of last 2 VO; SAO spacing about equal. The first 3 Prc nearly on same level, the third sometimes slightly raised; Prc_4 usually well separated from the rest and nearer lateral line than to ventral profile of caudal peduncle. The very large Vn of males is immediately diagnostic (Fig. 94 B); the small Vn of females (Fig. 94 A) is ovate and under posterior half of orbit. A streak of dark tissue extends along margin of orbit between Dn and Vn and bears one or more tiny dots of luminous tissue, one of which may be enlarged to resemble a third organ; the posteriormost organ may then erroneously be interpreted as an So.

Size: To 33 mm, largest of 28 specimens; it may be a small species.

Least depth of capture: To 500 m at night.

Distribution: Probably circumglobal, mainly in southern waters. It is also known from the Atlantic and Indian Oceans near South Africa and from the Java Trench and Celebes Sea (06° N).

Discussion

The placement of *Diaphus dialematus* in the genus appears to depend on the degree of development and prominence of one of the luminous dots between the Dn and Vn. Fraser-Brunner (1949) considered such a dot to be a Vn and placed the species in that group having an So; he stated, "Posterior Vn larger than anterior one, the two separate from each other and from Dn." Of the 28 specimens before me, only five have this dot sufficiently developed to be readily visible and subject to misinterpretation; the dot is quite tiny and barely visible on the remaining specimens.

Regardless of the degree of development of this luminous dot, I believe the proper placement of the species to be nearer *Diaphus luetkeni* than to those species having a bona-fide So, because the elongated Vn of males of *D. dialematus* is more akin (albeit quite different) to that of *D. luetkeni*. Also, SAO_1 is on level of last 2 VO, a character common to *D. luetkeni, D. termophilus, D. trachops* and *D. similis*, but not found among those species having an So.

Diaphus garmani
Gilbert, 1906

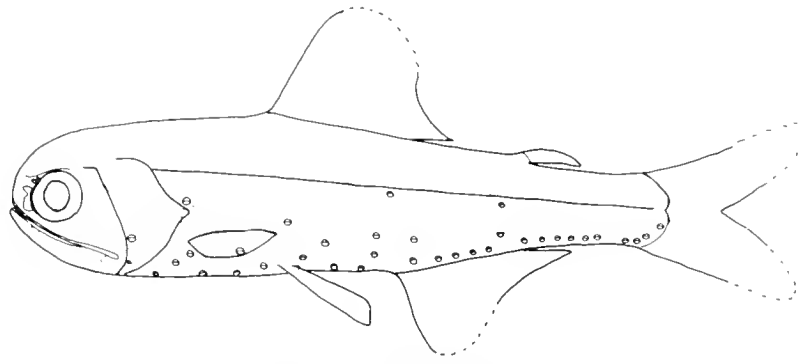


Fig. 95—*Diaphus garmani*, female, 51.6 mm.

Description

D. 15 (14-16); A. 16 (15-17); P. 11 (10-12); AO 7 (6-8) + 5 (4-6), total 12 (11-14); gill rakers 7 (6-8) + 1 + 13 (14), total 20 (19-21); vertebrae 35 (34-36).

Prc series not widely spaced; Prc_{3-4} interspace about twice those between Prc_{1-2} and Prc_{2-3}. A small, round luminous organ lies above and slightly behind Dn; this organ is found also in *D. problematicus* and *D. splendidus* (following). Dn of males larger and more clearly defined than Dn of females. Vn larger than Dn in females, but of equal size or smaller than Dn in males.

Size: To about 55 mm.

Least depth of capture: Readily dip-netted at night and taken at 250 m or less in daytime. Nakamura (1970) reported hundreds of thousands of *D. garmani* at the surface at night at Christmas Island.

Distribution: Known from about 30° S, 80° W, northerly to about Acapulco, Mexico, westerly to Hawaii, and toward Japan to about 35°-40° N, 165° E (Fig. 96).

Diaphus problematicus
Parr, 1928

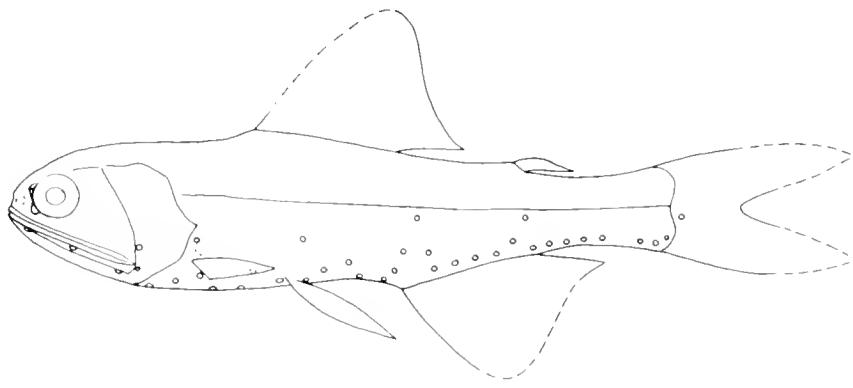


Fig. 96—*Diaphus problematicus*, male, 50.8 mm.

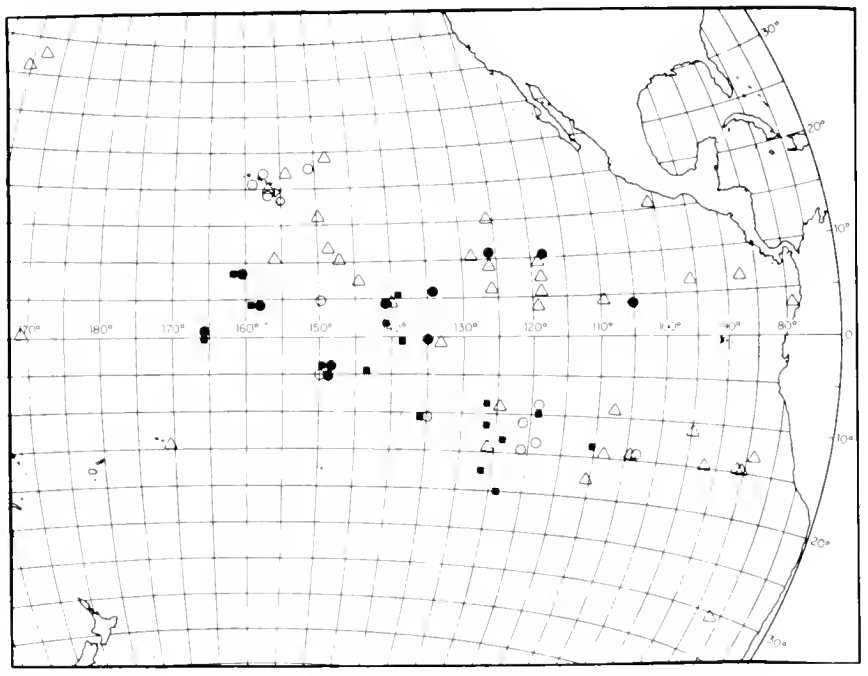


Fig. 97—Capture localities in the eastern Pacific Ocean for *Diaphus garmani* (open triangles), *D. schmidti* (open circles), *D. jenseni* (solid squares), and *D. malayanus* (solid circles).

Description

D. 16; A. 17; P. 12; AO 6 + 4-5; gill rakers 4 + 1 + 9 (8) (the lowest count of any known diaphid species); vertebrae 35.

Only four specimens were available for study; these all had the low gill raker count, but the PLO appears to be higher than that shown by Parr (1928) and by Nafpaktitis (1968) for specimens from the North Atlantic. One large and one small specimen had the SAO_2 set behind a line through $SAO_{1\text{-}2}$, a pattern similar to that found in *D. splendidus* and *D. coeruleus*. One AOp over anal base. Dn and Vn of about equal size and connected by a thin streak of luminous tissue close to orbital rim; Vn of males somewhat larger than that of females.

Size: To about 80 mm.

Least depth of capture: To 180 m at night.

Distribution: In the eastern Pacific this species is known only from about 06° N to 10° S along 135° W.

Diaphus splendidus
(Brauer, 1904)

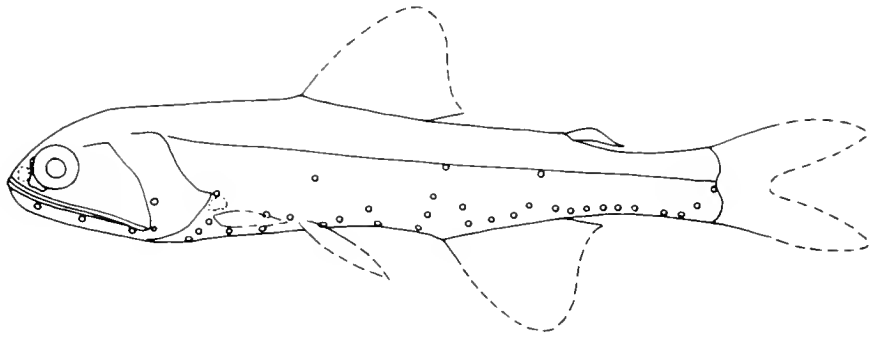


Fig. 98—*Diaphus splendidus*, male, 84.5 mm.

Description

D. 14-15; A. 16; P. 12-13; AO 6 (7) + 5-6 (4), total 11 (10-12); gill rakers 5 + 1 + 12 (11), total 18 (17); vertebrae 35-36.

Anterior end of supraorbital ridge produced into a prominent, sharp point, a development not known in other diaphid species. If these points are broken off, the blunt, somewhat ragged stubs are diagnostic. SAO_{1-2} interspace slightly less than that of SAO_{2-3}. Prc interspaces progressively wider. AOa_1 at least its diameter before second AOa and often elevated nearly to level of SAO_2. Dn and Vn of males a little larger than those of females.

Size: To 90 mm.

Least depth of capture: To 90 m at night.

Distribution: In the eastern Pacific this species is known only from a few specimens taken in an area from about 08° N to 12° S and 119° W to 162° W.

Diaphus schmidti
Tåning, 1932

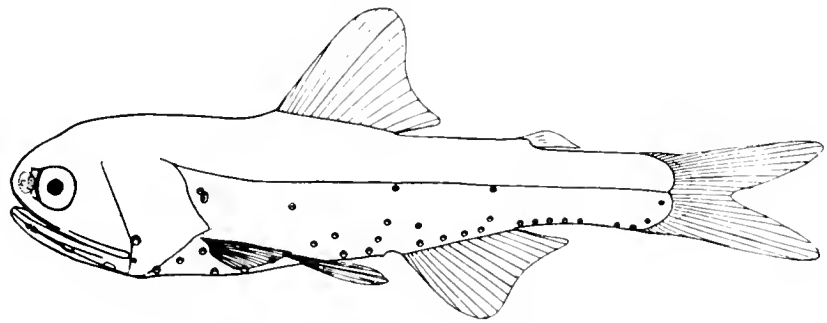


Fig. 99—*Diaphus schmidti*. From Taning (1932, p. 139, fig. 11).

Description

D. 15-16; A. 16; P. 10-11; AO 6 (5-7) + 5 (4-6), total 11 (10-12); gill rakers 5-6 + 1 + 12 (11-13), total 18-19 (17-20); vertebrae 35 (34-36).

SAO series slightly angulate; the first two SAO in a nearly straight line with VO_5; SAO_{2-3} interspace nearly twice that of SAO_{1-2}. A line through PLO-VLO usually passes above SAO_2 and AOa_1; a line through SAO_{1-2} passes through or a little behind VO_5. First AOa elevated to nearly over second AOa and about on level of SAO_2. Prc interspaces progressively wider. Dn

and Vn of females small, about equal in size, confluent behind nasal apparatus; both much enlarged in males, the Dn resembling that of *D. malayanus*. Eye small, about 5 in head.

Size: To about 40 mm.

Least depth of capture: To 100 m at night.

Distribution: In the central and eastern Pacific *Diaphus schmidti* has been taken in a rather narrow band extending from Hawaii southeasterly to about 15° S, 104° W (Fig. 97). Its pattern of capture localities is very similar to that of *Diaphus jenseni*. The type locality is north of Samoa.

Diaphus regani
Tåning, 1932

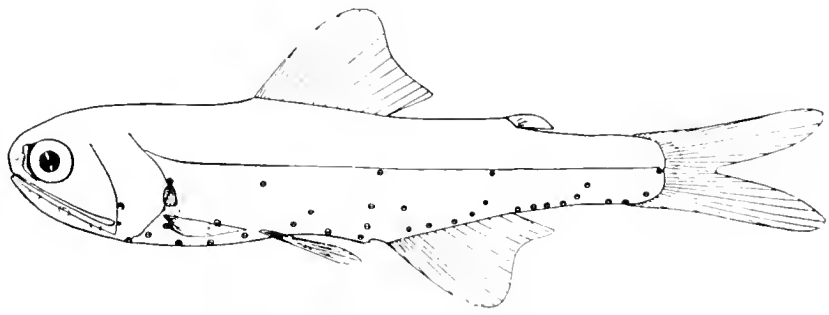


Fig. 100—*Diaphus regani*. From Tåning (1932, p. 140, fig. 12).

Description

D. 16 (15-17); A. 16-17; P. 10-11; AO 6 (5-7) + 5-6, total 12 (10-13); gill rakers 7 (8) + 1 + 13 (14), total 21 (22); vertebrae 36 (35-37).

The elevation of the last few AOp will immediately justify this species. Dn and Vn but little larger in adult males than in adult females. First AOa elevated nearly to level of SAO_2 and to nearly over second AOa. SAO series in a very steep line which passes slightly behind VO_5.

Size: To about 60 mm.

Least depth of capture: To 50 m at night.

Distribution: Type locality, New Caledonia. In the eastern Pacific, *D. regani* is known only from the equatorial region south of Hawaii between 150° and 160° W.

Diaphus jenseni
Tåning, 1932

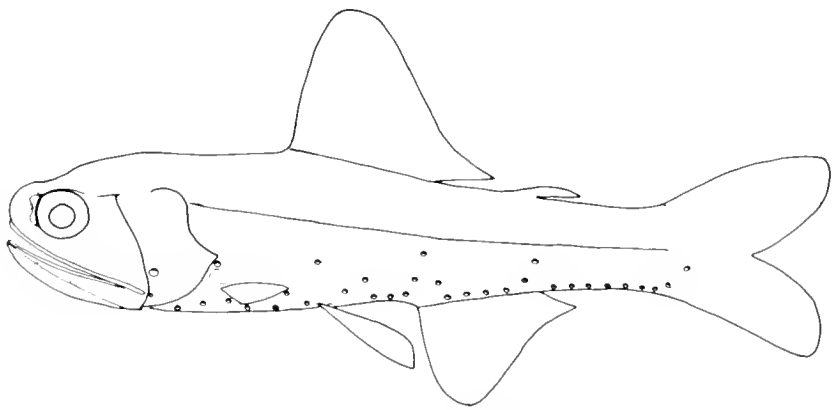


Fig. 101—*Diaphus jenseni*, male, 37.5 mm.

Description

D. 14-15; A. 14-15; P. 10-11; AO 6 (5-7) + 5 (4-6), total 11 (10-12); gill rakers 6 (5) + 1 + 13 (14), total 20 (19-21); vertebrae 35.

PLO much nearer pectoral base than to lateral line; VLO about midway between pelvic base and lateral line. SAO_3 one diameter, Pol and upper Prc two diameters, below lateral line. First 3 Prc low and closely spaced, the fourth widely separate and usually much farther back on base of caudal fin. Neither Dn or Vn much enlarged in males.

Size: To about 40 mm.

Least depth of capture: To 85 m at night.

Distribution: In the central and eastern Pacific *D. jenseni* has been taken only in a rather narrow band extending southeasterly from near the equator at about 165° to 110° W between 10° to 20° S (Fig. 97). Apparently it does not occur north or east of these limits. The type locality is north of New Guinea.

Diaphus malayanus
Weber, 1913

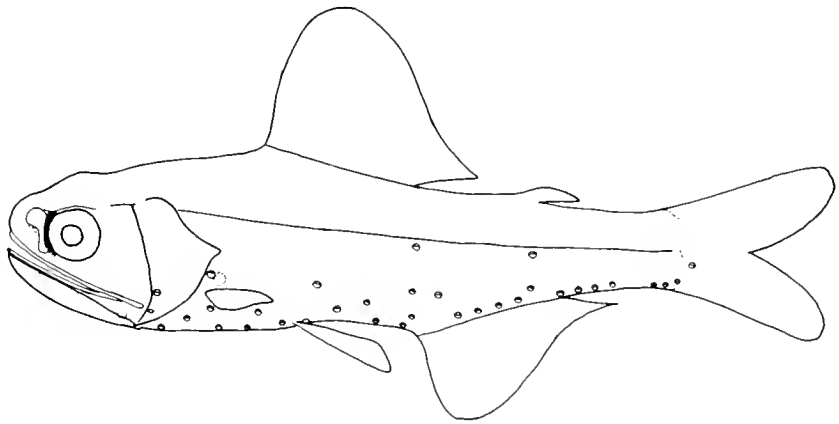


Fig. 102—*Diaphus malayanus*, male, 31.4 mm.

Description

D. 15 (14-16); A. 15; P. 11 (10-12); AO 6 (5-7) + 4 (5), total 10 (11); gill rakers 6 + 1 + 12 (13), total 19 (20); vertebrae 34 (35).

PLO and VLO much nearer pectoral and pelvic bases than to lateral line. SAO_3, Pol, and upper Prc at lateral line: Prc_{3-4} interspace equal to or greater than that between Prc_1 and Prc_3. SAO in a steeply oblique straight line. AOa_1 elevated to level of SAO_2.

Size: To 30 mm.

Least depth of capture: To 85 m at night.

Distribution: In the eastern Pacific, *D. malayanus* is infrequently taken in equatorial waters between about 105° and 165° W (Fig. 97). The type locality is in Banda Sea.

Diaphus pacificus
Parr, 1931

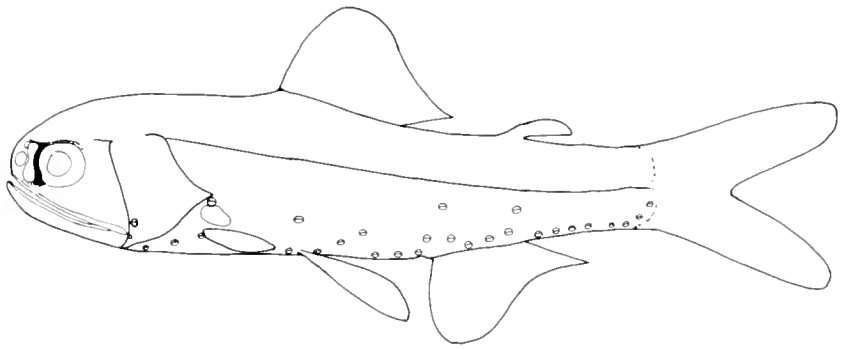


Fig. 103—*Diaphus pacificus*, male, 31.8 mm.

Description

D. 14 (13-15); A. 12 (11-13); P. 10 (9); AO 4-5 + 4 (5), total 8-9 (10); gill rakers 7 (6-8) + 1 + 13 (12-14), total 20 (19-22); vertebrae 32 (31-33).

PLO and VLO respectively much nearer pectoral and pelvic bases than to lateral line. SAO_3, Pol, and upper Prc two or three diameters below lateral line. First Aoa slightly elevated to about its diameter below level of SAO_2; last AOa often slightly elevated. Prc usually evenly spaced, but the Prc_{3-4} interspace may be a little greater than the rest. Vn larger than Dn, often with a dorsal lobe that extends up behind Dn, particularly in males; this lobe of Vn may then be misinterpreted as an Ant. Luminous scales at PLO large, nearly filling space between PLO and pectoral fin, the tissue in rather straight vertical lines.

Size: To about 35 mm.

Least depth of capture: To 90 m at night.

Distribution: Apparently confined to the eastern tropical Pacific (Fig. 104); it has not been taken elsewhere.

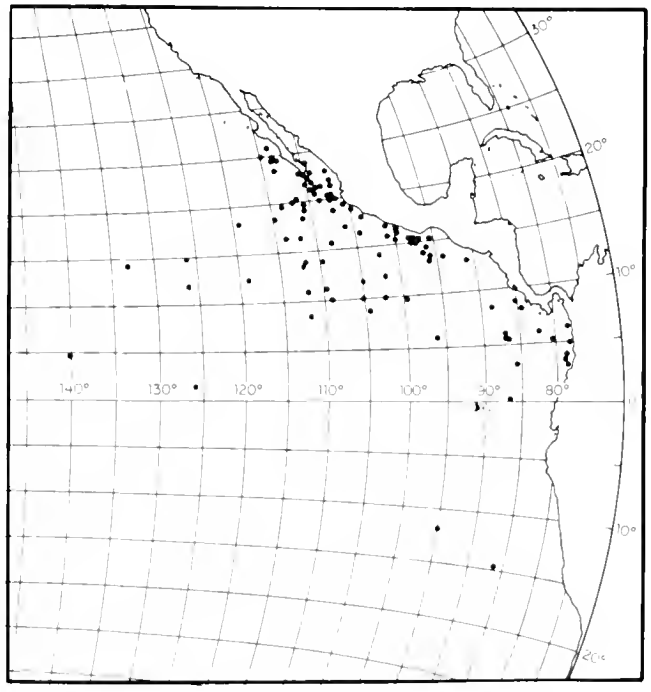


Fig.104—Capture localities for *Diaphus pacificus*.

Diaphus signatus
Gilbert, 1908

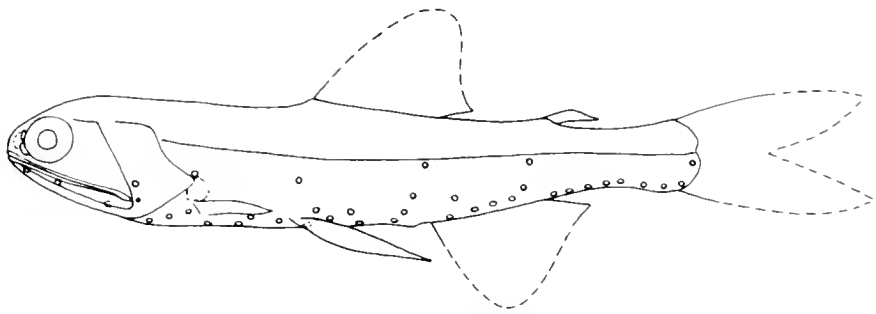


Fig. 105—*Diaphus signatus*, male, 49.5 mm.

Description

D. 15 (16); A. 15 (16); P. 11-12; AO 6 (7) + 4 (5); gill rakers 6 (7) + 1 + 14 (15); vertebrae 35-36.

Body elongate, its depth about 5.5 in SL. SAO_3, Pol, and upper Prc at or very near lateral line. SAO_{2-3} interspace twice that of SAO_{1-2}. SAO series usually straight, forming a line with VO_5. First AOa elevated to about over, often distinctly behind, the second. Prc interspaces progressively wider, in a flattened curve, the last nearly over bases of caudal fin rays.

Size: To about 60 mm.

Least depth of capture: To 90 m at night.

Distribution: In the central and eastern Pacific *Diaphus signatus* is known only from near the equator between about 165° and 134° W. One occurrence is known from about 11° S, 126° W. The type locality is Nukuhiva Island, Marquesas.

Diaphus lucidus
(Goode and Bean, 1896)

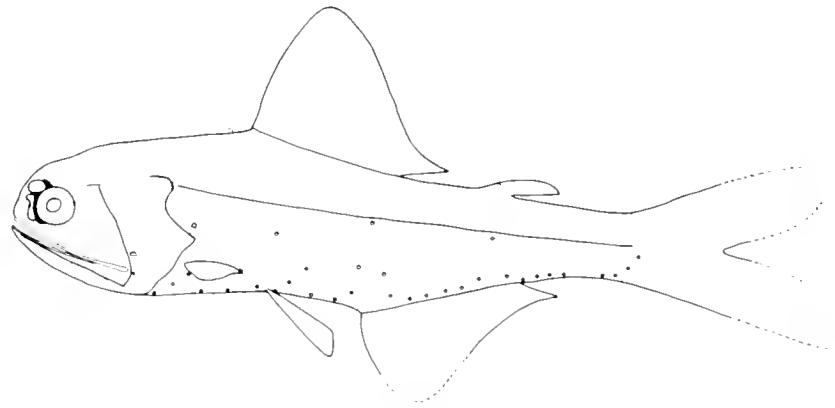


Fig. 106—*Diaphus lucidus*, male, 74.0 mm.

Description

D. 18 (17-19); A. 17-18; P. 11-12; AO 7 + 5 (4-6), total 12 (11-13); gill rakers 5-6 + 1 + 11 (10-12), total 18 (16-19); vertebrae 36 (35-37).

SAO_{2-3} interspace one and one-half to two times that of SAO_{1-2}; SAO series in a steeply oblique, usually straight line that passes well behind VO_5. AOa_1 elevated to about level of SAO_2; last AOa but little elevated. Prc interspaces progressively wider, the last 3 in a nearly straight, oblique line. Luminous scale at PLO about three-fourths the vertical diameter of orbit, the tissue convoluted. Dn large, expanded to ethmoidal crest and of about equal size in both sexes; Vn extending posteriorly to under orbital margin and upward to Dn behind nasal apparatus; much of the Vn is covered by a heavy band of dark pigment. Dorsal origin usually somewhat before pelvic origin; bases of dorsal and anal fins and of anal and adipose fins overlapping.

Size: To 78 mm in eastern Pacific. A 118-mm specimen has been taken in the southeastern Atlantic Ocean.

Least depth of capture: To 175 m at night.

Distribution: In the eastern Pacific eight specimens have been taken from an area from 01° S to 16° N and 130° to 137° W; one specimen known from 26° 14.0′ N, 141° 34.5′ W, and one from 03° 25′ N, 126° 00′ W. The type locality is in the northeastern Atlantic Ocean.

Diaphus fragilis
Tåning, 1928

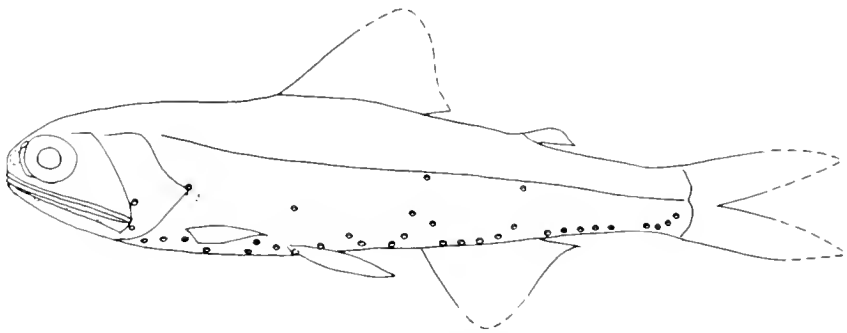


Fig. 107—*Diaphus fragilis*, male, 84.0 mm.

Description

D. 17-18; A. 17 (16-18); P. 11 (12); AO 6 + 5 (4), total 11 (10); gill rakers 5-6 + 1 + 12 (11-13), total 19 (18-21); vertebrae 35 (36).

Inner row of enlarged, rather widely spaced teeth on the lower jaw are immediately diagnostic of this species, even for specimens as small as 20 mm. PLO a little above midway between lateral line and pectoral origin; VLO about midway, occasionally slightly lower, between lateral line and pelvic origin. SAO_{2-3} interspace about one and one-half times that of SAO_{1-2}. SAO series in a nearly straight, steeply oblique line; SAO_3 and Pol at lateral line. First and last AOa elevated. VO_5 and SAO_{1-2} form gentle curve. Prc interspaces progressively wider. Opercular margin tapers to sharp point under PLO. Ant of males usually slightly larger and more sharply delineated than that of females.

Size: To about 90 mm.

Least depth of capture: To 100 m at night.

Distribution: Known in eastern Pacific Ocean from about 23° S, 91° W, to the Hawaiian Islands and south to the equator. I have seen two specimens from about 40° N, 164° W (Fig. 108).

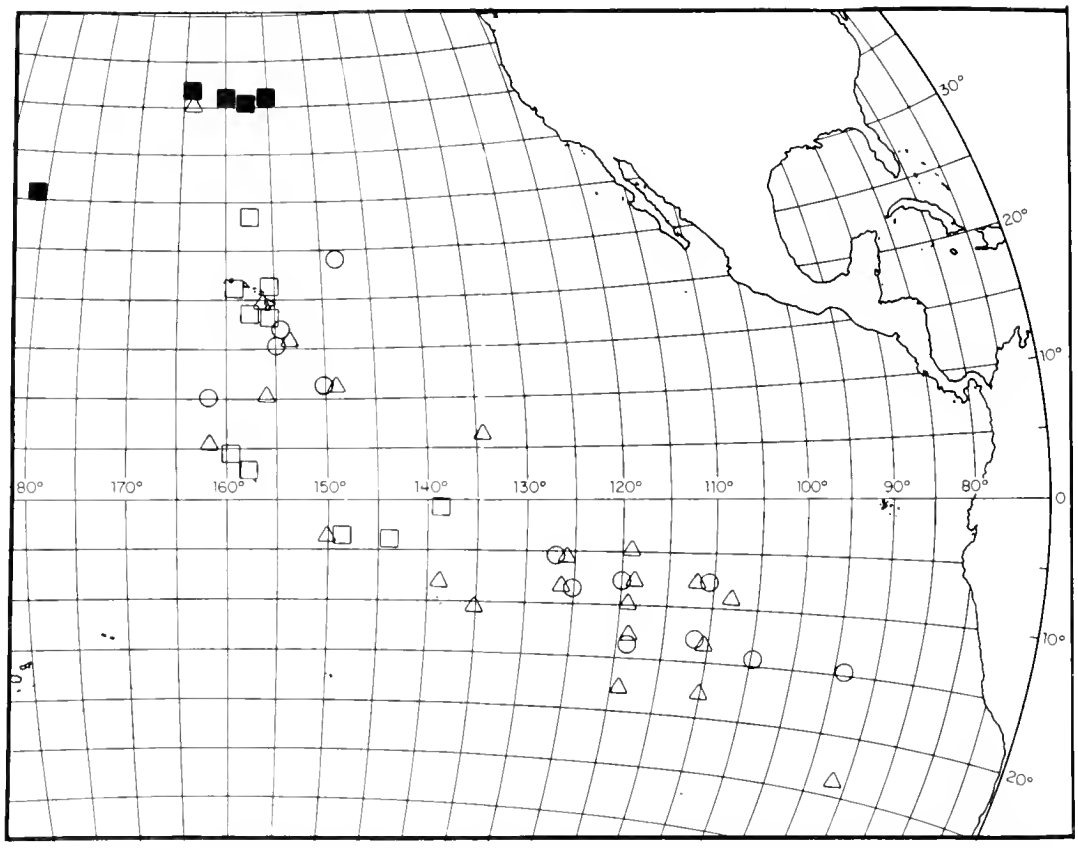


Fig. 108—Capture localities in the eastern Pacific Ocean for *Diaphus fragilis* (open triangles), *D. gigas* (solid squares), *D. elucens* (open squares), and *D. rolfbolini* (open circles).

Diaphus coeruleus
(Klunzinger, 1871)

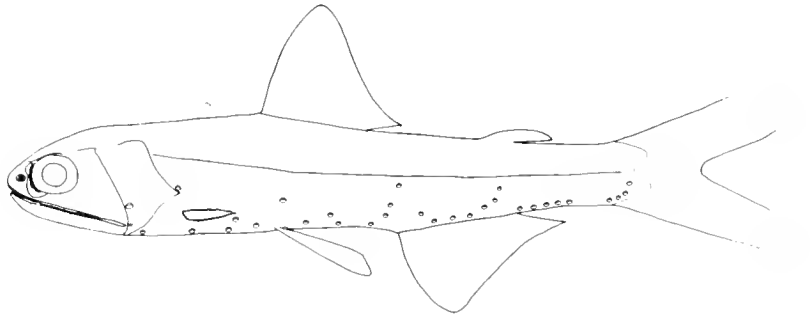


Fig. 109—*Diaphus coeruleus*, male, 94.0 mm.

Description

The only specimens available to me were off South Africa; these provided the following counts: D. 15-16; A. 15-16; P. 11; AO 6 + 5; gill rakers 5-6 + 1 + 12-13, total 19 (18-20); vertebrae 36.

Dn somewhat elongate, extending down to level of nasal apparatus; Ant close under the supraorbital ridge, about half the size of Dn; Vn long, extending from nearly under anterior margin of pupil up to and in contact with Dn; anteroventral portion of Vn enlarged, extending out to under the nasal apparatus. A prominent band of dark pigment separates Dn and Vn from the orbital rim.

Size: To 140 mm.

Least depth of capture: The South Africa specimens, from off Durban, were taken between 500 and 545 m in daylight (Galathea Sta. 197).

Distribution: Diaphus coeruleus has not yet been taken from the eastern Pacific Ocean. Known primarily from the Indo-Pacific and western Pacific region and is included here in case it may be taken in the poorly collected west-central portion of the eastern Pacific.

Diaphus chrysorhynchus
Gilbert and Cramer, 1897

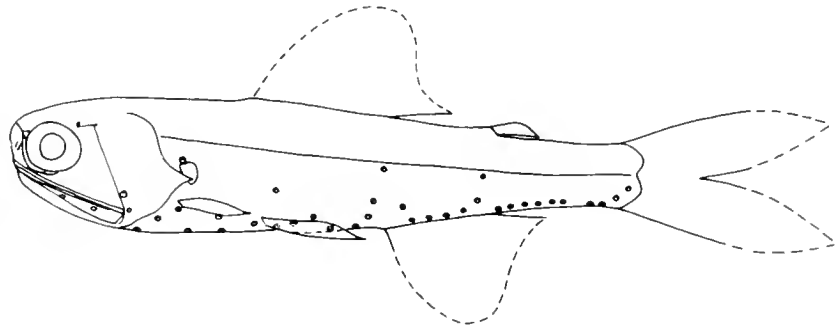


Fig. 110—*Diaphus chrysorhynchus*, male, 62.0 mm.

Description

D. 16-17; A. 16 (15-17); P. 12 (11); AO 6 (7) + 5 (4-6), total 11 (12); gill rakers 7 + 1 + 14 (five specimens); vertebrae 35 (34-36).

SAO in a steeply oblique line that passes a little behind VO_5. SAO_{2-3} interspace at least twice that of SAO_{1-2}; Prc interspaces progressively wider. The opercular margin tapers to sharp point below PLO. The adipose tissue covering the entire snout appears to be luminous. There is no information available on sexual dimorphism in the luminous organs of the head. All five specimens before me are males.

Size: To about 80 mm.

Least depth of capture: At surface at night, 500-600 m in daylight.

Distribution: Known only from immediate area of Hawaiian Islands, the type locality.

Diaphus adenomus
Gilbert, 1905

Description

D. 15 (14-16); A. 15; P. 11-12; AO 6 + 5-6, total 11-12; gill rakers 5 + 1 + 10-11, total 16-17 (Gilbert recorded 5+ 1 + 13 rakers for the holotype, but I found 5 + 1 + 11) vertebrae.

PLO and VLO slightly nearer lateral line than to pectoral and pelvic origins. First 3 VO in flatly oblique nearly horizontal line, VO_3 about on a line from PO_4 to SAO_1. Three SAO in steeply oblique, nearly straight line that passes a little behind VO_5. First AOa elevated to

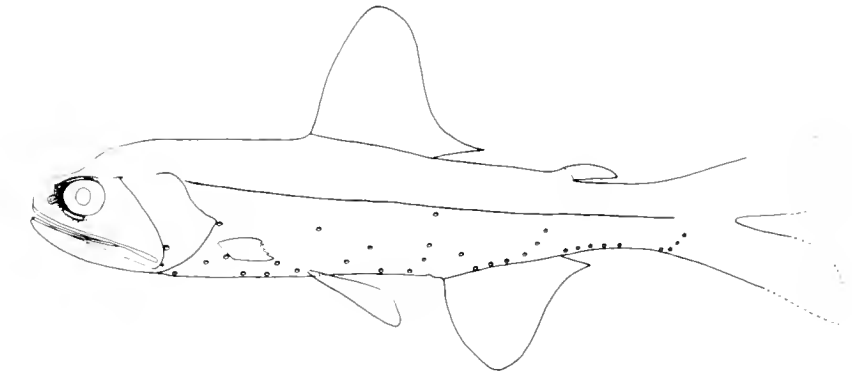


Fig. 111—*Diaphus adenomus*, male, 103.7 mm.

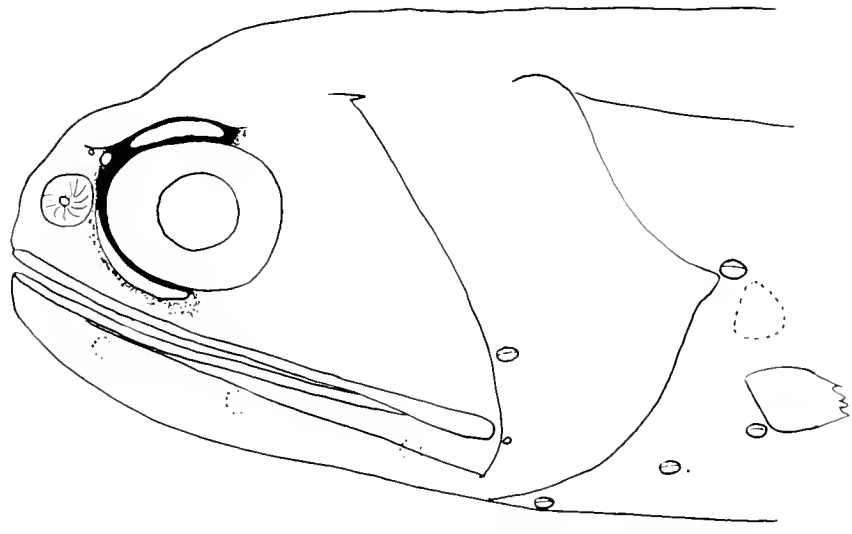


Fig. 112—*Diaphus adenomus*. Head of adult male, 107.5 mm, showing arrangement of luminous organs.

level midway between SAO_{1-2}. Last few AOa increasingly elevated toward, and about equally spaced with, Pol. Prc increasingly more widely spaced in a gentle arc, the chord of the arc slightly shorter than the AOp-Prc interspace.

Vn and Ant of *D. adenomus* are unique in that both are much elongated, the latter organ extending back over the orbital rim (Fig. 112); Dn rather small and not deeply recessed.

Size: To 131 mm (Gilbert recorded "16 cm"; this may refer to total length).

Least depth of capture: All specimens have been taken in hauls near the bottom from about 460 to 640 m.

Distribution: Known mainly from Pacific Ocean near Hawaii and off Japan. It has recently been taken in the Caribbean Sea and in the Atlantic area near the Bahamas and off Casablanca, Morocco (Nafpaktitis, 1974).

Discussion

Nafpaktitis (1974), after comparing the holotypes, placed *Diaphus anteorbitalis* Gilbert (1913) in synonymy with *D. adenomous*. I concur, having also compared the holotypes.

Diaphus gigas
Gilbert, 1913

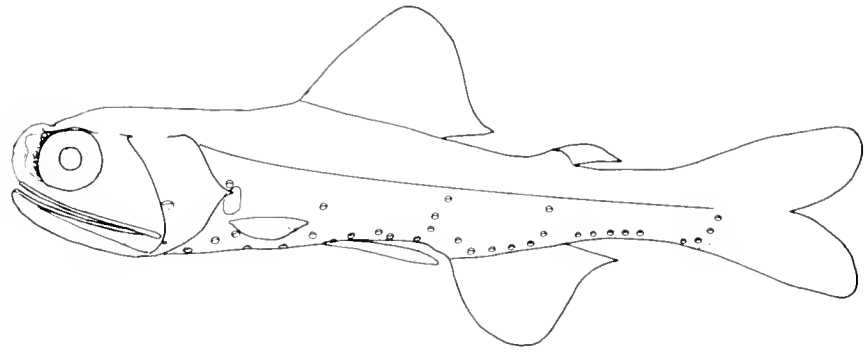


Fig. 113—Diaphus gigas, male, 44.9 mm.

Description

D. 16; A. 15; P. 12; AO 6 + 5, total 11; gill rakers 8 (7) + 1 + 16 (15-17), total 25 (23-26); vertebrae 35.

PLO below lateral line about one-third the distance between lateral line and pectoral origin; VLO two or three diameters behind a vertical from pelvic origin and about midway between lateral line and level of pelvic base. VLO low, two or more diameters below a line through VLO-SAO_2. SAO_1 its diameter above and behind VO_5; SAO_2 about two diameters above, and almost directly over SAO_1; SAO_3 its diameter behind a line through SAO_{1-2}, about two diameters below lateral line and separated from SAO_2 by a space about twice that between SAO_{1-2}. First AOa elevated to about its diameter below level of SAO_2; last AOa elevated by about two diameters above penultimate AOa, which is level with second, third, and fourth AOa. Pol at least its diameter below lateral line and under anterior position of base of adipose fin. Penultimate AOa-AOp_1 interspace about equal to that of AOp-Prc.

Size: The largest of scant study material from the central Pacific Ocean was 57 mm. Gilbert stated the holotype to be "172 mm. in total length, 140 mm. to base of caudal, —" and the largest of two cotypes from Sagami Bay, Japan, as "21 cm."

Least depth of capture: To 218 m at night.

Distribution: In the eastern Pacific Ocean, known from only four localities (Fig. 108). Type locality is Sagami Bay, Japan.

Discussion

Diaphus gigas is very closely related to *D. elucens* in that the SAO_3 and the Pol are close to the lateral line, and the preorbital luminous organs are much alike. However, the name *gigas* is applied here to the few specimens from the north-central Pacific (Fig. 108, solid squares) because they agree well in certain body proportions with the description, and in numbers of gill rakers (8 + 16) given by Gilbert. Body proportions for *D. gigas*, including those given by Gilbert, are given in Table 19, and are compared with similar data for *D. elucens* from the central Pacific and northern Atlantic Oceans. In general, *D. gigas* is more slender than *D. elucens* and has a shorter and less deep head and a smaller eye.

TABLE 19. BODY PROPORTIONS FOR *DIAPHUS GIGAS* AND *D. ELUCENS* FROM THE PACIFIC OCEAN, AND FOR *D. ELUCENS* FROM FROM THE NORTH ATLANTIC OCEAN

Measurement	*Diaphus gigas*			*Diaphus elucens*			
	North Pacific N = 3 (49-57 mm)		Holotype* 140 mm	Central Pacific N = 10 (43-56 mm)		North Atlantic** N = 44 (21-56 mm)	
	Av.	Range		Ave.	Range	Ave.	Range
Head length	289	272-301	290	322	315-332	333	310-353
Head depth	203	183-213	—	241	234-247	245	231-266
Upper jaw length	210	200-217	195	220	212-235	229	212-257
Orbit length	82	80-85	85	103	95-110	111	102-119
Prepectoral length	288	277-296	—	301	284-312	325	302-353
Prepelvic length	439	426-447	435	453	435-464	459	443-479
Predorsal length	411	389-426	420	425	415-442	432	412-460
Preanal length	626	624-629	635	650	635-666	642	626-664
Preadipose length	796	786-806	800	812	810-820	801	779-819
Caudal peduncle length	225	217-236	—	208	199-218	—	—
Caudal peduncle depth	94	90-99	85	112	108-116	118	111-129
Dorsal base length	215	197-225	—	229	221-236	232	220-242
Anal base length	179	172-183	—	168	162-179	180	165-192

*Data from Gilbert, 1913.
**Data from Nafpaktitis, 1968.

Discussion

Diaphus elucens may be conspecific with *Diaphus perspicillatus* (Ogilby, 1898), type locality 31° 33′ S, 159° 05′ E. This species has seldom been reported in the literature, and the available descriptions, including the original, are inadequate; two of the three extent figures (to my knowledge) of the species shown the preorbital organs as only vaguely resembling those of specimens of *D. elucens* before me, although the general aspect of the body and the arrangement of photophores are similar. *Diaphus danae* Tåning, 1932), type locality: north of New Zealand, was placed in synonymy with *D. perspicillatus* by Whitley (1933: 63, fig. 1) and by Fraser-Brunner (1949); although the photophore patterns of these two species are much like that of *D. elucens*, the preorbital organs, as delineated, bear only a vague resemblance to those of *D. elucens*. The preorbital organs shown by Brauer (1906: 220, fig. 140) for *D. elucens* also bear no resemblance to those of specimens I have seen, and none at all to those shown by the respective authors for *D. danae* and *D. perspicillatus*.

Munro (1967: 38, fig. 265) showed the preorbital organs of *D. perspicillatus* to be very similar to those of *D. elucens*; unfortunately, most body photophores are indistinct in the figure (a dark half-tone) but the overall pattern appears to be like that of *D. elucens*. Gilbert (1913: 93) indicated that the two species were synonymous, and these similarities lend some credence to that indication. But as the original descriptions of *D. perspicillatus* and *D. danae* did not include numbers of gill rakers, it is not here possible to make further comparisons with *D. elucens*, or to attempt a synonymy; therefore, until direct comparison of these species is made, the name *D. elucens* is retained.

Diaphus elucens
(Brauer, 1904)

Description

D. 16 (15-17); A. 15 (16); P. 10-11; AO 6 (5) + 5 (4), total 11 (10); gill rakers 10 (9) + 1 + 17 (16-19), total 28 (26-29); vertebrae 35 (34).

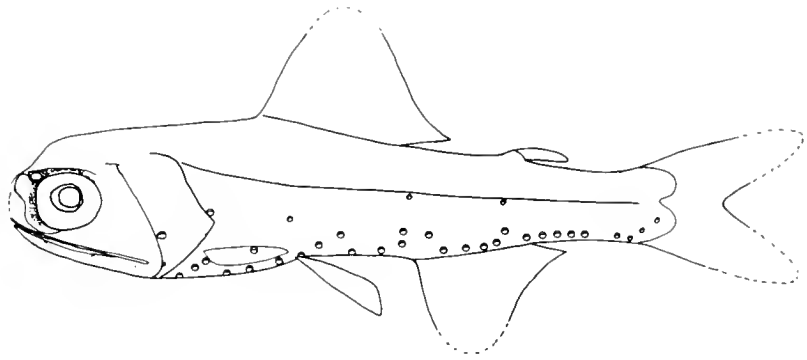


Fig. 114—*Diaphus elucens*, male, 44.0 mm.

SAO in a nearly perpendicular line that passes through or near the vent and far behind VO_5; SAO_3 occasionally slightly before a line through SAO_{1-2}. SAO_3 and Pol touch lateral line. VLO at least its diameter nearer pelvic base than to lateral line; PLO about two of its diameters nearer lateral line than to pectoral origin. Penultimate AOa-AOp_1 interspace greater than that of Prc-AOp. Prc interspaces progressively wider. Body proportions (Table 19) are given for *D. elucens* from the Central Pacific and North Atlantic Oceans.

Size: To about 60 mm.

Least depth of capture: To 85 m at night.

Distribution: In the eastern Pacific Ocean *D. elucens* is known only from the central region, near and south of Hawaii (Fig. 108).

Diaphus rolfbolini
Wisner, 1971

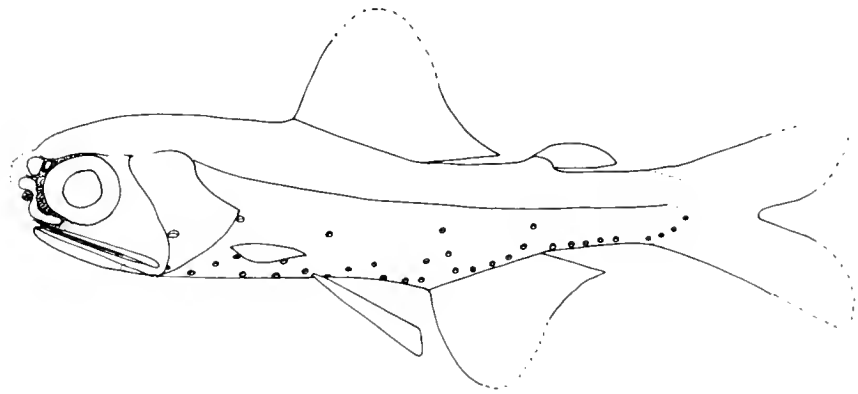


Fig. 115—*Diaphus rolfbolini*, holotype, 44.5 mm. From Wisner (1971, p. 48, fig. 5).

Description

D. 15 (14-16); A. 14-15 (16); P. 12 (11-13); AO 6 (5-7) + 5 (6), total 11 (10-12); gill rakers 8-9 (10) + 1 + 16 (15-17), total 25-26 (24-27); vertebrae 35 (34-36). Coordinated counts of AO photophores and gill rakers are given in Table 20.

All upper photophores well below lateral line. SAO series in a steeply oblique line that passes well behind VO_5. SAO_1 about two of its diameters behind a line through SAO_{1-2}; SAO_{2-3} interspace about twice that of SAO_{1-2}. First and last AOa slightly elevated. Last 3 Prc evenly spaced in a straight, rather flatly oblique (approaching horizontal) line.

TABLE 20. CORRELATED COUNTS (BOTH SIDES) OF AO PHOTOPHORES AND GILL RAKERS FOR *DIAPHUS ROLFBOLINI*

		AOp				Lower rakers (including central raker)		
		5	6			16	17	18
Aoa	5	8	4	Upper rakers	8	7	22	5
	6	59	4		9	3	16	3
	7	1	—		10	—	1	—

Preorbital area of holotype and several paratypes covered with a viscous, transparent substance that creates a domelike effect. Entire posterior surface of the preorbital area appears to have a highly reflective lining and no doubt glows when the luminous organs are active. There is no appreciable sexual dimorphism in these organs.

Size: To about 54 mm.

Least depth of capture: Between 50 and 200 m at night and 600 m in daytime (Clarke, 1973).

Distribution: Thus far known from the warmer waters of the central Pacific (Fig. 108) between about 14° S, 93° W and 17° N, 154° W and in the western Pacific and Indo-Pacific areas.

Discussion

Diaphus rolfbolini is closely related to *D. effulgens* (Goode and Bean, 1896). It differs primarily in having a total of 25-26 (24-27) gill rakers, rather than 20-21 (19-22). Also, it may be a smaller species, as the largest of 87 specimens available was 65 mm. A gravid female of 60 mm was found. Nafpaktitis (1968) reported that no gravid females were found among his study material of *D. effulgens* from the North Atlantic Ocean, and that "At best, female specimens of about 130 mm and males of 85 to 105 mm showed medium-sized, finely granular, flaccid ovaries and large, healthy looking testes, respectively. The species reaches a relatively large size (commonly 120 to 130 mm)."

Diaphus ostenfeldi
Tåning, 1932

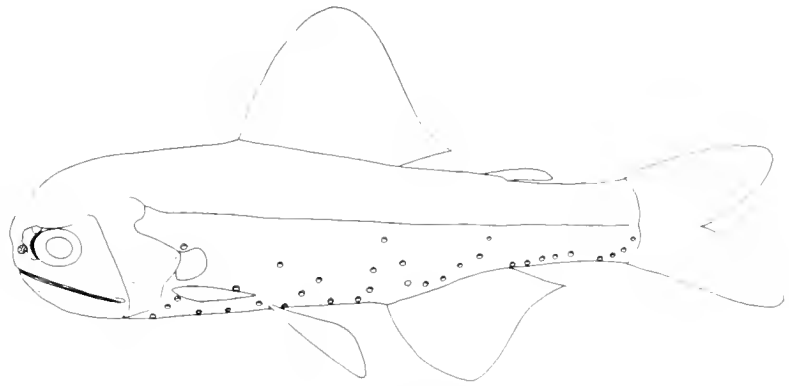


Fig. 116—*Diaphus ostenfeldi*, male, 99.3 mm.

Description

The following counts were taken from two specimens from off South Africa and one from the Indian Ocean (42° 03.8′ S, 70° 39.9′ E).

D. 16; A. 15-16; P. 11-12; AO 7 + 5; gill rakers 9 (8) + 1 + 16 (15), total 24-26; lateral line pores 37; vertebrae ?.

A large luminous scale at PLO fills the space between PLO and pectoral fin in a 99-mm specimen; about three-fourths of this space is filled in an 84-mm specimen. This luminous scale is composed of short, contiguous, vertically arranged fibers.

This distinctive species may be readily recognized (as adults) by the very large Dn, the short, deep head, the highly irregular opercular margin, and the very small photophores. The nearest related form is *D. metopoclampus*, but the two species are separable on the basis of a great difference in preorbital organs and the higher positions of the SAO_3 and Pol of *D. metopoclampus*, at or near the lateral line.

Size: To about 100 mm.

Least depth of capture: To 100 m at night in southeastern Pacific Ocean (Craddock and Mead, 1970).

Distribution: This species was not among the material examined in this study. Craddock and Mead (1970) reported the capture of 37 specimens (15-73 mm) from eight localities along about 34° S and between about 76° and 91° W. King and Iversen (1962) reported the species from the region of the Equatorial Countercurrent, but I have not been able to examine the specimen or to confirm the identification. Clarke (1973) did not list this species from the immediate area of Oahu, Hawaii.

Diaphus metopoclampus
(Cocco, 1829)

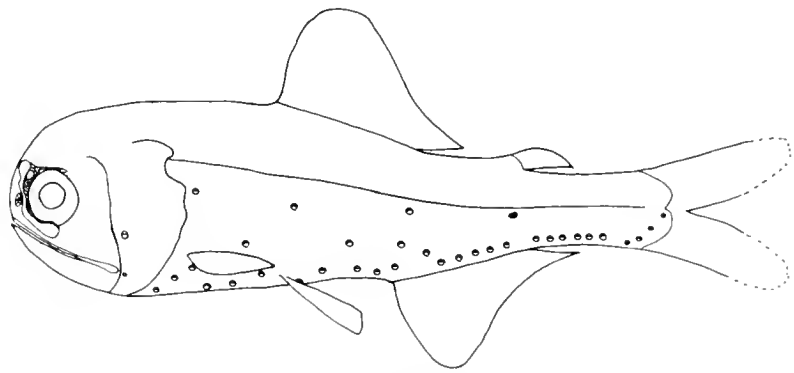


Fig. 117—*Diaphus metopoclampus*, male, 49.4 mm.

Description

The following data are taken mostly from South African specimens.

D. 15; A. 15; P. 10-11; AO 6 (5-7) + 6 (5-7), total 12 (11-13); gill rakers 8 (7-9) + 1 + 14 (13-15), total 23 (21-25); lateral line pores 36-37; vertebrae ?.

As in *D. ostenfeldi*, the body photophores are notably smaller than in most diaphid species. The short, deep head and the very distinctive preorbital organs, especially the posterior extension of the Vn and its ending in a prominent knob under the latter half of the iris, are like those of no other diaphid fish.

Size: To about 75 mm.

Least depth of capture: To about 600 m in daytime in the eastern Pacific Ocean and Indo-Pacific area.

Distribution: In the eastern Pacific a single specimen (46.3 mm), a male with moderately well-developed testes, is known from about 25° S, 155° W. The species is also known from the North Atlantic Ocean and is common off South Africa. I have examined specimens from the Indian Ocean (25° 24′ S, 35° 41′ E) and from the Indo-Pacific area (ca 13° N, 111° E). Whitley (1968) did not list the species in his checklist of New Zealand fishes.

The *Diaphus fulgens-rafinesquii* Species Complex in the Pacific Ocean

During this study I encountered eight apparently distinct diaphid species that correspond reasonably well to *Diaphus fulgens* Brauer (1904). One of these forms is almost certainly *Diaphus mollis* Tåning (1928), and three appear to be allied to *D. rafinesquii* (Cocco, 1838). I believe the remaining four to be most closely related to *D. fulgens*, but as I am unable to assign any of the four to Brauer's species, I diagnose them only as Forms A, B, C, and D. Similarly, I diagnose the three *D. rafinesquii*-like forms as Forms R-1, R-2, and R-3. The affinities of the seven presently unassignable forms to described species will be discussed after their diagnoses. The following key will aid in the identification of the Forms.

Key to the identification of Forms A, B, C, and D of the *Diaphus fulgens* complex and Forms R-1, R-2, and R-3 of the *D. rafinesquii* complex in the Pacific Ocean.

1a. Total gill rakers 21 or less (rarely 22). The *D. fulgens* complex 2
1b. Total gill rakers 22 or more. The *D. rafinesquii* complex 5
2a. Upper gill rakers 3 to 4 3
2b. Upper gill rakers 5 to 6 4
3a. Gill rakers 4 + 1 + 10 (9-11), total 15 (14-16). No luminous scale at PLO. Enlarged Vn of males in two parts, the anterior the largest ..... Form A
3b. Gill rakers 3-4 + 1 + 9 (8-10), total 14 (13-15). A large luminous scale present at PLO, the tissue in horizontal lines. Enlarged Vn of males undivided ..... Form B
4a. Gill rakers 6 (5) + 1 + 12-13 (14), total 19-20 (18-22). Luminous scale at PLO large, the tissue in straight lines slanting more or less posteroventrally. Enlarged Vn of males undivided. Body photophores small. VO_{2-3} interspace 72% (60-86%) of space between VLO and VO_2 ..... Form C
4b. Gill rakers 5 + 1 + 10-11 (12), total 16-17 (15-18). Luminous scale at PLO large, the tissue in steep, posteroventrally slanting, often nearly vertical lines. VO_{2-3} interspace 48% (39-55%) of space between VLO and VO_2 ..... Form D
5a. Length of orbit 51% (49-56%) of length of upper jaw. Length of anal base 84% (79-93%) of length of dorsal base. VO_{2-3} interspace 52% (40-60%) of space between VLO and VO_2 ..... Form R-2
5b. Length of orbit 46% to 48% (44-52%) of length of upper jaw 6
6a. Length of orbit 46% (44-48%) of length of upper jaw. Length of anal base 77% (74-80%) of length of dorsal base. VO_{2-3} interspace 61% (56-67%) of space between VLO and VO_2 ..... Form R-1
6b. Length of orbit 48% (45-52%) of length of upper jaw. Length of anal base 83% (75-91%) of length of upper jaw. VO_{2-3} interspace 57% (53-62%) of space between VLO and VO_2 (in young fish, 37 to 57 mm) ..... Form R-3

Meristic data for *Diaphus mollis*, Forms A, B, C and D of the *D. fulgens* species complex and Forms R-1, R-2 and R-3 of the *D. rafinesquii* species complex are given in the following tables: Numbers of gill rakers (Table 21); correlated counts of AO photophores (Table 22); body proportions for the four forms of the *D. fulgens* complex (Table 23); body proportions for the three forms of the *D. rafinesquii* complex from the North Pacific Ocean and for *D. rafinesquii* from the North Atlantic Ocean (Table 24).

TABLE 21. NUMBERS OF GILL RAKERS FOR *DIAPHUS MOLLIS* FROM THE PACIFIC OCEAN, FOR FORMS A, B, C, AND D OF THE *D. FULGENS* SPECIES COMPLEX IN THE EASTERN AND CENTRAL PACIFIC AND FOR FORMS R-1, R-2, AND R-3 OF THE *D. RAFINESQUII* SECIES COMPLEX IN THE NORTH-CENTRAL AND NORTHWESTERN PACIFIC OCEAN

Species or complex	Upper rakers						
	3	4	5	6	7	8	9
D. mollis	—	—	47	11	—	—	—
D. fulgens species complex							
Form A	—	31	—	—	—	—	—
Form B	2	16	—	—	—	—	—
Form C	—	—	8	61	—	—	—
Form D	—	—	24	—	—	—	—
D. rafinesquii species complex							
Form R-1	—	—	—	1	30	3	—
Form R-2	—	—	—	—	2	49	3
Form R-3	—	—	—	—	13	9	—

	Lower rakers (including central raker)										
	9	10	11	12	13	14	15	16	17	18	19
D. mollis	—	—	—	6	31	21	—	—	—	—	—
D. fulgens species complex											
Form A	—	2	27	2	—	—	—	—	—	—	—
Form B	1	15	2	—	—	—	—	—	—	—	—
Form C	—	—	—	—	33	27	9	—	—	—	—
Form D	—	—	10	12	1	—	—	—	—	—	—
D. rafinesquii species complex											
Form R-1	—	—	—	—	—	—	4	19	11	—	—
Form R-2	—	—	—	—	—	—	—	4	25	7	5
Form R-3	—	—	—	—	—	—	1	14	6	1	—

	Total rakers									
	13	14	15	16	17	18	19	20	21	22
D. mollis	—	—	—	—	7	28	26	8	—	—
D. fulgens species complex										
Form A	—	2	27	2	—	—	—	—	—	—
Form B	3	13	2	—	—	—	—	—	—	—
Form C	—	—	—	—	—	8	28	27	8	1
Form D	—	—	1	9	12	1	—	—	—	—

	Total rakers					
	22	23	24	25	26	27
D. rafinesquii species complex						
Form R-1	5	17	10	2	—	—
Form R-2	—	2	2	24	7	6
Form R-3	1	9	8	3	1	—

TABLE 22. CORRELATED COUNTS OF AO PHOTOPHORES FOR *DIAPHUS MOLLIS* FROM THE PACIFIC AND ATLANTIC OCEANS, FOR FORMS A, B, C, AND D OF THE *DIAPHUS FULGENS* SPECIES COMPLEX AND FOR FORMS R-1, R-2, AND R-3 OF THE *DIAPHUS RAFINESQUII* SPECIES COMPLEX IN THE EASTERN AND NORTHWESTERN PACIFIC OCEAN, AND FOR *D. RAFINESQUII* FROM THE ATLANTIC OCEAN

Diaphus mollis (Pacific Ocean)

		AOp		
		3	4	5
AOa	4	—	—	2
	5	—	36	—
	6	3	2	—

*Diaphus mollis** (Atlantic Ocean)

		AOp		
		3	4	5
AOa	4	—	2	—
	5	—	240	23
	6	4	8	—

Diaphus fulgens species complex, Pacific Ocean

Form A

		AOp		
		3	4	5
AOa	4	—	—	4
	5	5	65	12
	6	6	4	—

Form B

5 + 4

Both sides of 9 specimens

Form C

		AOp		
		4	5	6
AOa	4	—	3	4
	5	9	84	4
	6	5	1	—

Form D

		AOp		
		3	4	5
AOa	4	—	2	2
	5	4	46	7
	6	2	—	1

Diaphus rafinesquii species complex, central and northwestern Pacific Ocean

Form R-1

		AOp	
		4	5
AOa	5	24	9

Form R-2

		AOp	
		4	5
AOa	5	2	29
	6	3	—

Form R-3

		AOp	
		4	5
AOa	5	18	2
	6	2	—

*D. rafinesquii** (Atlantic Ocean)

		AOP		
		3	4	5
AOa	5	—	1	2
	6	4	121	7
	7	4	3	—

*Data from Nafpaktitis, 1968.

TABLE 23. BODY PROPORTIONS FOR FOUR FORMS OF THE *DIAPHUS FULGENS* SPECIES COMPLEX FROM THE PACIFIC OCEAN

Measurement	Form A N = 12 (23.8-33.0 mm)		Form B N = 9 17.7-30.6 mm)		Form C N = 12 (27.3-41.8 mm)		Form D N = 12 (25.2-35.9 mm)	
	Ave.	Range	Ave.	Range	Ave.	Range	Ave.	Range
Head length	288	284-295	295	284-300	283	269-300	320	303-336
Head depth	216	211-232	224	216-237	201	186-212	240	224-251
Upper jaw length	177	167-188	184	173-191	162	154-171	199	180-208
Orbit length	110	105-114	115	106-121	103	94-112	119	107-130
Dorsal origin to pelvic origin	228	212-236	228	220-239	210	187-227	240	226-257
Dorsal origin to anal origin	316	291-318	319	307-335	313	304-330	346	316-342
Prepectoral length	278	271-289	296	286-309	280	264-298	322	306-336
Prepelvic length	448	437-459	455	441-477	451	442-468	468	452-484
Preanal length	668	651-683	672	656-683	676	659-696	682	664-696
Predorsal length	484	461-505	467	450-477	463	439-477	487	478-500
Preadipose length	831	821-851	822	806-831	800	784-810	824	805-837
Dorsal base length	183	169-195	189	168-202	183	167-197	181	166-198
Anal base length	145	130-162	139	126-150	136	124-149	140	123-159
Caudal peduncle length	224	216-232	222	212-238	227	203-238	211	197-226
Caudal peduncle depth	108	102-116	106	90-122	102	96-108	109	103-122

TABLE 24. BODY PROPORTIONS FOR THREE FORMS OF A *DIAPHUS RAFINESQUII*-LIKE SPECIES COMPLEX FROM THE NORTHERN PACIFIC OCEAN AND FOR *DIAPHUS RAFINESQUII* FROM THE NORTH ATLANTIC OCEAN*

Measurement	*D. rafinesquii*-like forms, northern Pacific						*D. rafinesquii*, North Atlantic	
	Form R-1 N = 12 (39.2-60.2 mm)		Form R-2 N = 12 (55.8-80.3 mm)		Form R-3 N = 11 (37.1-94.0 mm)		N = 43 (30.0-73.9 mm)	
	Ave.	Range	Ave.	Range	Ave.	Range	Ave.	Range
Head length	300	289-310	304	289-311	309	296-324	314	306-325
Head depth	217	205-229	226	216-245	219	213-225	231	222-243
Upper jaw length	201	193-206	211	204-218	207	192-219	216	204-228
Orbit length	104	100-107	96	93-99	100	93-108	112	105-119
Dorsal origin to pelvic origin	213	198-223	230	221-240	223	213-232	—	—
Dorsal origin to anal origin	320	292-315	308	290-320	302	291-312	—	—
Prepectoral length	297	281-310	305	292-313	308	293-326	309	229-322
Prepelvic length	451	442-469	467	453-480	471	463-493	461	450-478
Preanal length	674	653-695	676	659-689	676	661-686	660	640-680
Predorsal length	472	455-489	466	450-475	466	450-489	475	463-489
Preadipose length	825	814-839	828	819-846	828	811-841	814	781-830
Dorsal base length	174	163-191	197	190-201	187	168-203	186	175-200
Anal base length	144	136-155	151	143-158	157	145-165	167	153-179
Caudal peduncle length	208	196-214	212	208-217	213	198-225	—	—
Caudal peduncle depth	99	92-105	104	99-112	103	96-109	111	104-123

*Data from Nafpaktitis, 1968, p. 82.

Diaphus mollis
Tåning, 1928

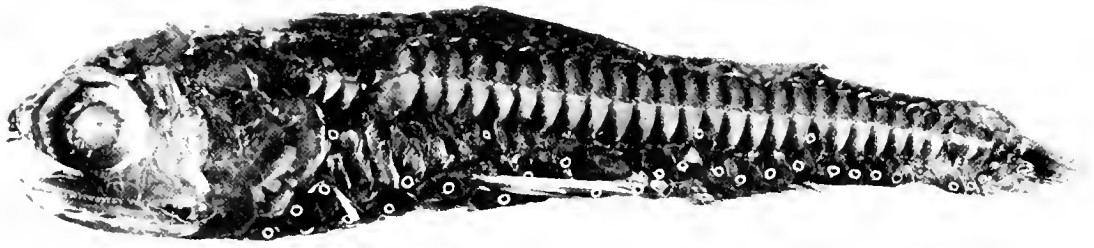


Fig. 118—*Diaphus mollis*, male, 55.4 mm. From about 27° N, 155° W. (Photophers retouched).

Description

D. 12-13; A. 12-13; P. 10-11; AO 5 (4-6) + 4 (3-5), total 9 (10); gill rakers 5-6 + 1 + 12-13 (11), total 18-19 (17-20); vertebrae 33. Numbers of gill rakers (Table 21) and AO photophores (Table 22) are compared with counts for Forms A, B, C, and D of the *Diaphus fulgens* species complex and for Forms R-1, R-2, and R-3 of the *D. rafinesquii* species complex of the Pacific Ocean.

Posterodorsal margin of operculum sharply angulate and recurved. Origin of dorsal fin about over pelvic origin. Origin of anal fin behind a vertical from end of dorsal base by about 0.75% of the orbital diameter. End of base of adipose fin usually slightly before, occasionally on, a vertical from end of anal base. Pelvic fins extend past anal origin by nearly the length of the pupil in undamaged specimens.

Body photophores rather small, often indistinct against the very dark integument normally found on freshly preserved and undamaged specimens. PLO on or very slightly behind a vertical from origin of pectoral fin and above that origin by 39% (35-43% of the distance from it to lateral line. VLO over bases of inner pelvic rays and nearer them by 45% (42-50%) of the distance to lateral line. VO_{2-3} interspace 53% (44-64%) of the space between VLO and VO_2 SAO_3, Pol, and Prc_4 lie about three of their respective diameters below lateral line. SAO series broadly angulate, a line through SAO_{1-2} passing through or a little before VO_3 and well behind SAO_3. SAO_{2-3} interspace 2.0 to 2.5 times that of SAO_{1-2}. First AOa elevated nearly to level of SAO_2 and from 1.5 to 2.0 times its diameter above second AOa. Last AOa seldom elevated by more than its diameter above next to last AOa. Pol about over base of last anal ray. Prc interspaces progressively wider.

Vn of males much enlarged and in two parts; a large anterior part of dense, fine-grained tissue, roughly triangular in shape, fills the space between anteroventral orbital margin, premaxillary and nasal apparatus. The posterior part is much smaller and oblong; it appears as a reflective layer thinly covered with luminous tissue; two parts are separated by a prominent darkly pigmented streak. The luminous tissue of both parts is easily eroded and lost. The small So barely intrudes into the orbital margin. Vn of females slender, elongate, entire, and also easily lost. Luminous scale at PLO small, two to three times the size of that organ; it is thin and weakly formed, the tissue appearing as granular or convoluted.

Size: To about 65 mm.

Least depth of capture: D. mollis has been dipnetted once in central Pacific waters; the least depth of tows taking the species is from 0 to 300 m.

Distribution: Probably common in warmer waters of Pacific Ocean. I have seen specimens from only one locality of the Indo-Pacific region, south of Mindanao, Philippines (Fig. 119).

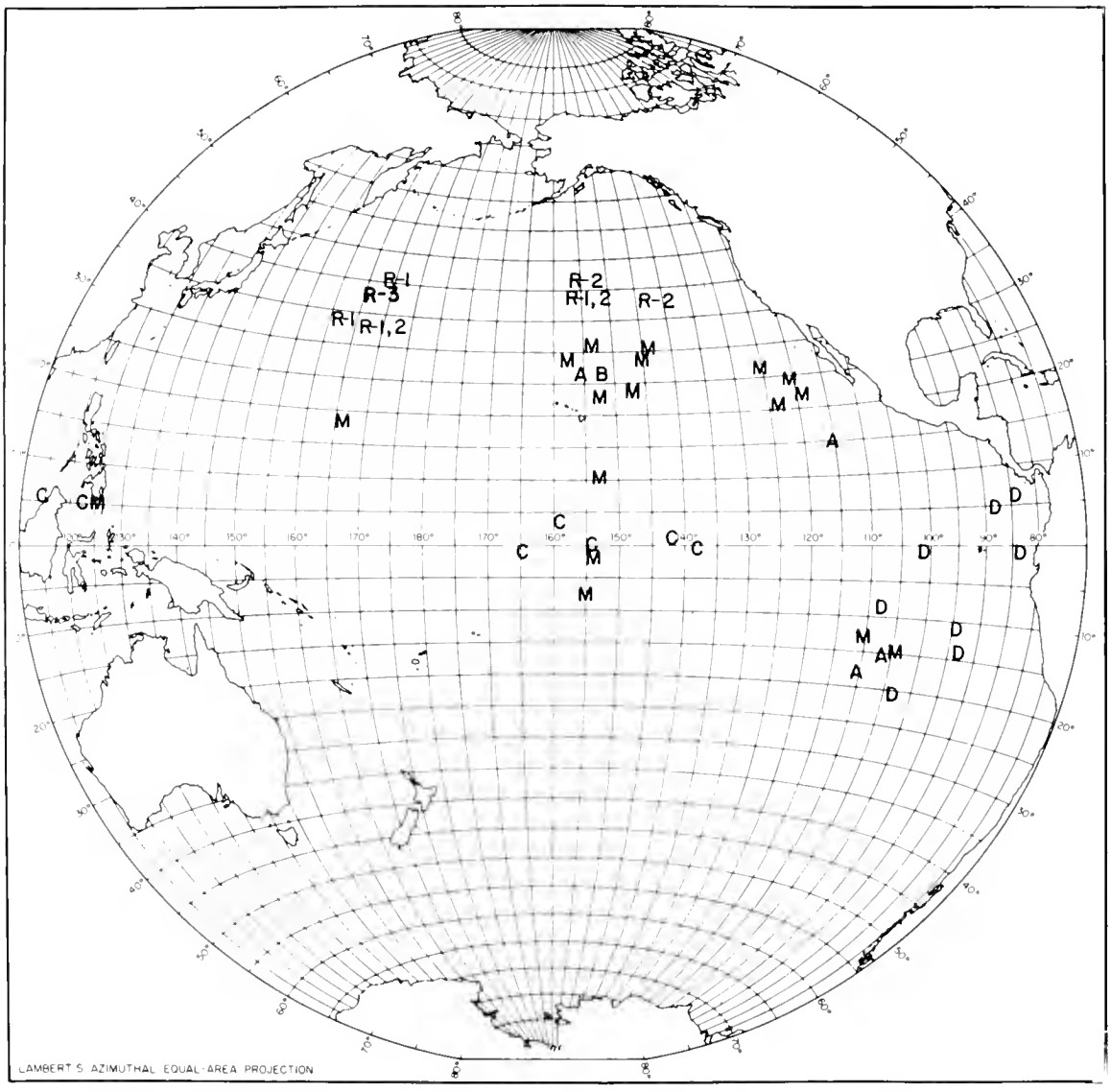


Fig. 119—Capture localities in the Pacific Ocean for *Diaphus mollis* (M), Forms A, B, C, and D of the *D. fulgens* species complex, and Forms R-1, R-2, and R-3 of the *D. rafinesquii* species complex.

Discussion

Although the type locality of *Diaphus mollis* is in the North Atlantic Ocean, north of the Cape Verde Islands, with some confidence I have applied the name to the Pacific Ocean specimens. The body proportions are extremely similar to those given by Nafpaktitis (1968) for the North Atlantic specimens, as also are the numbers of AO photophores (Table 22) and the general pattern of photophores. However, the total numbers of gill rakers (Table 21) average about 2 higher in the Pacific; Nafpaktitis listed 4-5 + 1 + 11 (10-12), total 16-17 (rarely 15 or 18) for the North Atlantic specimens. Also, Nafpaktitis (1968, fig. 56) described and figured the Vn of males as entire, although apparently of two contiguous or coalesced parts. Possibly direct comparison of large numbers of specimens from each ocean will show the Pacific form to be distinct.

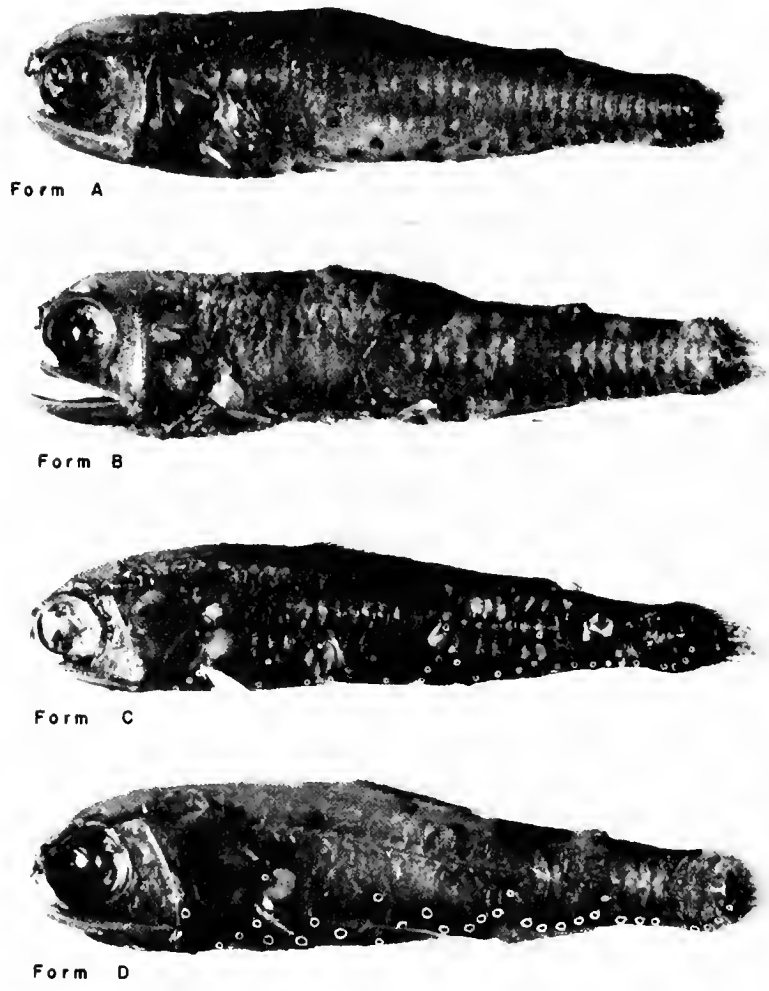


Fig. 120—Forms A, B, C, and D of the *Diaphus fulgens* species complex in the Pacific Ocean. (Photophores retouched in Forms C and D).

Form A of **Diaphus fulgens** species complex

Description

D. 14 (13); A. 11-12 (13); P. 10; AO 5 (4-6) + 4 (5), total 9-10; gill rakers 4 + 1 + 10-11, total 15-16, vertebrae 33 (32-34).

Posterodorsal margin of operculum smoothly rounded, not recurved.

No luminous scale at PLO; despite the very excellent condition of several of the larger specimens, no trace of this scale was found. Body photophores moderately large, those of the AO series separated by no more than their diameters, usually less. PLO about its diameter behind a vertical from origin of pectoral fin and variably above that origin by 33% (26-39% of the distance from it to lateral line. VLO over bases of inner pelvic rays and about 46% (41-52%) of the distance from them to lateral line. SAO_3, Pol, and Prc_4 below lateral line by about two of

their respective diameters. The VO_{2-3} interspace averages approximately half (53%) of that between VLO and VO_2 but varies from 44% to 64%. A line through SAO_1 and SAO_2 usually passes slightly before, occasionally through, VO_5 and well behind SAO_3. AOa_1 seldom elevated by more than its diameter (usually half) above AOa_2. Last AOa from 1.0 to 1.5 times its diameter above level of next to last AOa. Pol usually under middle of base of adipose fin. Prc interspaces increasingly wider.

The much enlarged Vn of males appears as two parts, the posterior part small and ovate to round and separated from a much larger anterior part by a whitish (in preservative) septum. The larger anterior part is rather egg-shaped, apex pointing posteriorly, and fills space between orbital rim, nasal apparatus, and premaxillary. Vn of females small, ovate, and often indistinct. So small and usually well covered with dark tissue and intruding sharply into orbital margin.

Teeth of premaxillary small, flattened laterally, and sharply recurved in a forward direction on the posterior portion, but less flattened and are curved posteriorly on the anterior position.

Size: To 31 mm. Form A may be a small species, as gravid females of 26 to 30 mm were found.

Least depth of capture: To 375 m at night.

Distribution: Form A is known only from three localities of the eastern Pacific Ocean (Fig. 119); most specimens were taken at about 27° N, 155° W.

Form B of **Diaphus fulgens** species complex

Description

D. 13-14; A. 12-13; P. 10-11; AO 5 + 4, total 9; gill rakers 4 (3) + 1 + 9-10, total 14 (13-15); vertebrae 33 (only eight specimens known).

Posterodorsal margin of operculum rounded and only slightly recurved.

Body photophores moderately large, those of AO series usually separated by less than their diameters. PLO over or slightly before a vertical from pectoral origin and above it by 35% (30-49%) of the distance from there to lateral line. VLO over bases of inner rays of pelvic fin and above them by about 44% (38-39%) of distance to lateral line. VO_{2-3} interspace 44% (38-54%) of space between VLO and VO_2. A line through SAO_{1-2} passes through or a little before VO_5 and well behind SAO_3. SAO_3, Pol, and Prc_4 below lateral line about three of their respective diameters. First and last AOa photophores about half their diameters above levels of adjacent ones; Pol under end of adipose base. Prc interspaces progressively wider.

Luminous scale at PLO large, extending from slightly above PLO nearly to pectoral fin, the tissue arranged in rather coarse horizontal lines. Vn of males large, undivided, somewhat triangular in shape with the apex posteriorly, and filling space between anteroventral margin of orbit, premaxillary, and nasal apparatus. Vn of females much smaller, elliptical, and often indistinct.

Teeth of upper and lower jaws similar to those of Form A. Palatine toothless, or one or two teeth present at anterior end. Mesopterygoids sparsely set with small elongate teeth.

Size: To 31 mm, largest of eight specimens. Apparently Form B is also a small species; a female of 22 mm was gravid.

Least depth of capture: To 580 m at night.

Distribution: All eight known specimens taken at about 27° N, 155° W (Fig. 119).

Description

D. 13-15; A. 12-13; P. 10-11; AO 5 (4-6) + 5 (4-6), total 10 (9-11); gill rakers 6 (5) + 1 + 13 (12-14), total 19-20 (18-22); vertebrae 34 (33-35).

Posterodorsal margin of operculum moderately angulate and recurved. All body photophores notably smaller than those of Forms A, B, and D; spaces between those of AO series equal to at least two diameters, often more. PLO slightly behind a vertical from base of upper pectoral ray and above it by 39% (35-46%) of the distance to lateral line. VLO nearly over bases of inner pelvic rays and about midway, 49% (44-53%), between pelvic base and lateral line. SAO_3, Pol, and Prc_4 1.0 to 1.5 of their diameters below lateral line. VO_{2-3} interspace 72% (60-86%) of distance from VLO to VO_2, this space notably wider that that of Forms A, B, and D. SAO series somewhat more angulate than in other forms; line through SAO_{1-2} passes through or slightly before VO_5 but far behind SAO_3. AOa_1 1.5 to 2.0 times its diameter above level of AOa_2 and very slightly below a line through VO_3 and SAO_2; last AOa about its diameter above level of the next to last AOa. Pol variably below middle to end of base of adipose fin.

Luminous scale at PLO large, about equal to space between PLO and pectoral origin, the tissue in somewhat coarse, straight lines that slant posteroventrally at an angle of 30° to 40° to the horizontal. Vn of males, large, undivided, broadly elliptical in shape but more robust anteriorly, filling space between posteroventral margin of orbit, premaxillary and nasal apparatus. Vn of females small, ovate, under anterior portion of pupil.

Teeth of upper and lower jaws similar to those of Forms A and B. Palatine teeth absent except for a small clump at anterior end. In adults, the mesopterygoids are sparsely set bucally with elongate teeth but with a narrow row of thick-set similar teeth mesially, the centers often naked or with a few scattered teeth. In sub-adults, the mesopterygoids tend to be more evenly set with small, conical teeth.

Size: To about 40 mm. Form C also appears to be a small species; a female of 34.5 mm was fully gravid and one of 28.0 mm had ovaries in an advanced stage of development.

Least depth of capture: To 85 m at night.

Distribution: Form C appears to be restricted to a narrow band of equatorial water between about 137° and 165° W, although little or no collecting has been done westerly of this area. It is also known from the Indo-Pacific area (Fig. 119).

Discussion

Form C has been taken in greater numbers than any of the other forms. Also, it may be more gregarious, for several tows captured from 20 to 68 specimens each, whereas of the other forms only one to four were taken per tow.

Form D of **Diaphus fulgens** species complex

Description

D. 13 (12-14); A. 12-13; P. 10-11; AO 5 (4-6) + 4 (3-5), total 9 (8-11); gill rakers 5 + 1 + 10-11 (12), total 16-17 (15-18); vertebrae 33.

Posterodorsal margin of operculum broadly angulate and slightly recurved.

Body phosphates moderately large, those of the AO series about one diameter apart. PLO over pectoral origin and nearer it by 35% (29-42%) of the distance from them to lateral line. VLO above bases of inner pelvic rays by 39% (36-42%) of the distance from there to lateral line.

SAO_3, Pol, and Prc_4, respectively, two to three of their diameters below lateral line. VO_{2-3} interspace 48% (39-55%) of the space between VLO and VO_2. SAO series angulate, a line through SAO_{1-2} usually passing through VO_5, occasionally before, but well behind SAO_3. AOa_1 from 1.0 to 1.5 diameters above level of AOa_2, the succeeding AOa in a straight line ascending dorsally at a slight angle; last AOa nearly its diameter above next to last. Pol about its diameter before a vertical from end of base of adipose fin. Prc interspaces progressively wider.

Luminous scale at PLO large, broadly lunate, its length greater than distance from PLO to pectoral origin, the luminous tissue in more or less straight lines that slant posteroventrally at a steep angle, often vertically. Vn of males large, undivided, filling space between posteroventral margin of orbit, premaxillary and nasal apparatus; an intrusion of non-luminous tissue extends ventrally from orbital rim at about mid-Vn so that the organ may appear divided. Vn of females much smaller and broadly ovate.

Teeth of both jaws similar to those of Forms A, B, and C. Palatines toothless except for 1 or 2 occasional small teeth at anterior end. Mesopterygoids sparsely set with small, conical teeth, the centers often toothless.

Size: To 38 mm. Form D also appears to be a small species; gravid females were found at lengths of 28 and 32 mm.

Least depth of capture: To 50 m at night.

Distribution: Form D is known only from the tropical eastern Pacific (Fig. 119).

Diaphus rafinesquii species complex in the North Pacific Ocean

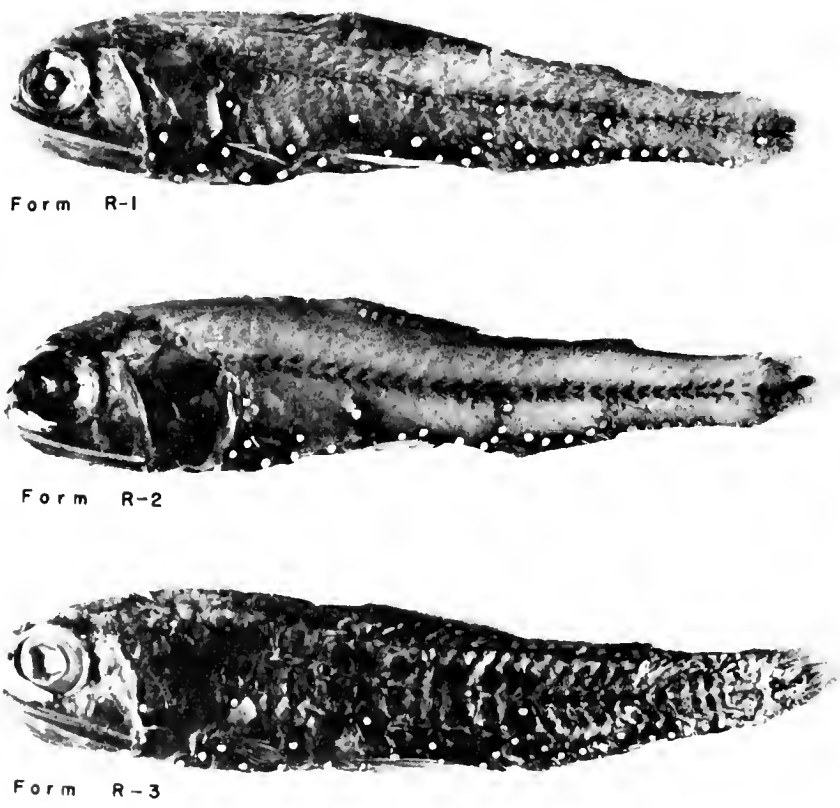


Fig. 121—Forms R-1, R-2, and R-3 of the *Diaphus rafinesquii* species complex in the North Pacific Ocean.

Form R-1 of the **Diaphus rafinesquii** species complex in the North Pacific Ocean

Description

D. 12-13; A. 12-13 (11); AO 5 + 4 (5), total 9-10; gill rakers 7 (6-8) + 1 + 15 (14-16), total 23-24 (22-25); vertebrae 33-34.

Posterodorsal angle of operculum sharply rounded and slightly but distinctly recurved. Dorsal origin over pelvic origin. Anal origin slightly behind vertical from end of dorsal base. Base of adipose fin over end of anal base.

PLO over pectoral origin and about midway between it and lateral line. VLO over bases of inner pelvic rays and midway, or slightly less, from there to lateral line. VO_{2-3} interspace about 61% (57-67%) of space between VLO and VO_2. SAO series in a nearly straight, steeply oblique line; SAO_{2-3} interspace about twice that between SAO_{1-2}. SAO_3, Pol, and Prc_4 below lateral line by slightly more than their diameters. First and last AOa elevated about two of their diameters above level of adjacent AOa. Pol about under end of base of adipose fin. Prc interspaces progressively wider, the Prc_{3-4} interspace nearly as wide as that of Prc_{1-3}.

Vn of males enlarged, somewhat wedge-shaped, the apex posteriorly. A small intrusion of luminous tissue extends slightly into orbital rim. The apex of Vn in larger males is nearly confluent with the small So. Vn of females small, narrow, well separated from the So. Luminous scale at PLO small, weakly formed, scarcely larger than PLO, the tissue convoluted.

Teeth of jaws typical of diaphid species bearing an So organ. Palatines with small teeth on only the anterior two-thirds, the posterior third toothless; no enlarged teeth at tips. Vomer heads naked or with very few asperities. Mesopterygoids thickly set with small, sharp teeth.

Size: To 65 mm.

Least depth of capture: To 200 m at night.

Distribution: Form R-1 is known only from a narrow region of the North Pacific Ocean, about 30° to 40° N, 155° W to 165° E (Fig. 119).

Form R-2 of the **Diaphus rafinesquii** species complex in the North Pacific Ocean

Description

D. 12; A. 12; P. 11-12; AO 5 (6) + 5 (4), total 10 (9); gill rakers 8 (7-9) + 1 + 16 (15-17), total 25 (23-27); vertebrae 34.

Posterodorsal angle of operculum rounded, not recurved. Dorsal origin slightly before a vertical from pelvic organ. Anal origin behind a vertical from end of dorsal base by slightly more than half the length of anal base. End of base of adipose fin distinctly behind a vertical from end of anal base.

PLO and VLO respectively a little below midway between origins of pectoral and pelvic fins. SAO_3, Pol, and Prc_4 usually about two of their diameters below lateral line. SAO series in a slight but distinct angle, a line through anterior margins of SAO_{1-2} passing slightly behind SAO_3; SAO_{2-3} interspace at least twice that of SAO_{1-2}. First AOa elevated one to one and one-half times its diameter above level of second AOa; last AOa elevated by a similar amount. Pol about over base of next to last anal ray and under anterior end of base of adipose fin. Prc interspaces progressively wider.

Vn of males enlarged, nearly filling space between orbital rim, premaxillary and nasal apparatus, and almost confluent with So. Vn of females much smaller, elongate, not reaching to So. Luminous scale at PLO large, its length equal to or slightly greater than distance between PLO and pectoral origin, the tissue convoluted.

Teeth of jaws as in Form R-1. Palatines very sparsely toothed except for a patch of small teeth at anterior end, these teeth becoming increasingly larger toward the tip. Vomer heads naked. Mesoptergoids thickly set with small, sharp teeth.

Size: To 85 mm.

Least depth of capture: To 360 m at night.

Distribution: Form R-2 is known only from a narrow region of North Pacific Ocean, about 30° to 43° N, 140° W to 170° E. This distribution is very similar to that of Form R-1, and the two have twice been taken sympatrically (Fig. 119).

Form R-3 of the **Diaphus rafinesquii** species complex in the North Pacific Ocean

Description

D. 13 (12); A. 12-13; P. 11; AO 5 (6) + 4 (5), total 9 (10); gill rakers 7-8 + 1 + 15-16 (14-17); vertebrae 33-34.

Posterodorsal angle of operculum rounded, not recurved. Dorsal origin on or slightly behind a vertical from pelvic origin. Anal origin behind a vertical from end of dorsal base by a distance equal to about half the length of anal base. Base of adipose fin distinctly behind a vertical from end of anal base.

PLO usually behind, rarely over, pectoral origin and nearer that origin than to lateral line by about three of its diameters. VLO over bases of inner pelvic rays and about midway between them and lateral line. PLO, VLO, and SAO_2 on a straight line. VO_{2-3} interspace about 57% (48-66%) of space between VLO and VO_2. SAO_3, Pol, and upper Prc from one to three of their diameters below lateral line. SAO series moderately angulate, a line through SAO_{1-2} passing through or slightly before VO_3 and well behind SAO_3. First and last AOa elevated by one to two of their diameters above adjacent AOa. Pol variably under middle to anterior end of base of adipose fin. Prc_4 distant from Prc_3 by a space nearly equal to that between Prc_1 and Prc_3.

Vn of males enlarged, undivided, extending from nasal apparatus to and confluent with So in a 94-mm specimen; in a 58-mm specimen the Vn and So are not quite confluent. In smaller males Vn incompletely formed and falling well short of the So. Vn of females elongate and narrow, but no females over 45 mm (based on structure of Vn) were available. Luminous scale at PLO large, about equal in length to distance between PLO and pectoral origin in the largest specimen (94 mm) but about half that length in the 58-mm specimen, the tissue finely convoluted.

Teeth of jaws as in Forms R-1 and R-2. Palatines almost naked except for shorter anterior portion bearing enlarged, backward-curving teeth; a few small teeth scattered sparsely along posterior portion of palatines. Vomer heads naked. Mesopterygoids with a few randomly scattered sharp teeth.

In young specimens (37-55 mm) the anterior portion of the palatine, and the entire surface of the mesopterygoids, are densely set with minute teeth.

Size: To 94 mm.

Least depth of capture: The single capture was from 0-880 m at night.

Distribution: Form R-3 is known from only one locality in the North Pacific Ocean (Fig. 119). It is probably sympatric with Forms R-1 and R-2.

Discussion

The difficulty is definitely assigning any of Forms A, B, C, and D to the species described by Brauer (1904, p. 402, fig. 4) and further delineated by Brauer (1906, p. 224, fig. 146) as *Myctophum (Nyctophus) fulgens* lies in the fact that the species is at present undefinable. Dr. C. Karrer, Zoological Museum, Humboldt University, Berlin, has informed me that the 3.9-cm specimen figured by Brauer is not among the specimens cataloged in that Museum (personal communication). Dr. Karrer kindly provided me with two specimens cataloged as *Myctophum (Nyctophus) fulgens*, each designated as "Typen." One specimen, 10.0 mm SL, ZMB 17606, from Valdivia Station 228, is of a circumglobal species complex related to *Diaphus theta* Eigenmann and Eigenmann (1890); the second specimen, 22.0 mm SL (Fig. 122), ZMB 17605, from Valdivia Station 226, probably a female (based on appearance of Vn), is not of the same species described and figured by Brauer. Instead, I believe it may be the same as Form C, diagnosed above in that the VO_{2-3} interspace is about 60% of the space between VLO and VO_2, a value similar to that found for Form C, and higher than for Forms A, B, and D. Also, the numbers of gill rakers, 5 + 1 + 12, agree with the count for Form C (Table 21), as does the count of AO photophores, 5 + 5 (Table 22).

Also in agreement with the counts for the "Type" of *D. fulgens* are those given for *Diaphus nanus* Gilbert (1908, p. 224, pl. 2) described from nera Nukuhiva, Marquesas, 5 + 5 (6) AO and 5 + 13 gill rakers, including all rudiments. Unfortunately, the holotype of *D. nanus* is only "17 mm long"; Gilbert recorded four paratypes from the same region and stated that "All are smaller than the type." It is possible that Form C, *D. nanus* and the "Type" of *D. fulgens* (ZMB 17605) are conspecific. But, if the latter specimen is not of the same species as that described and figured by Brauer, the name *fulgens* is not available and must remain in doubt until the 3.9-cm specimen is reexamined. The solution to that dilemma is not within the scope of this publication.

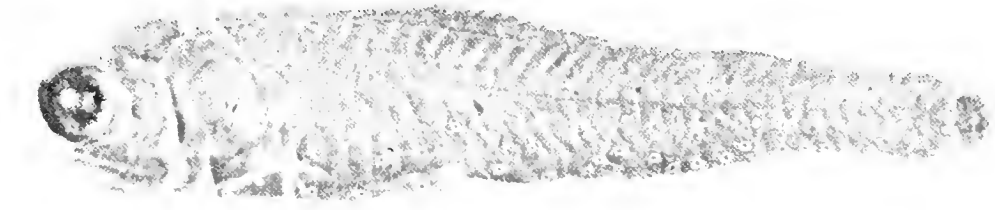


Fig. 122—A specimen, 22.0 mm, ZMB 17065, labeled as "Type" of *Myctophum (Nyctophus) fulgens* Brauer, 1904. (Photophores retouched).

Form A may be related to *Diaphus parri* Tåning (1932) primarily because of the lack of a luminous scale at PLO, although Tåning stated "PLO with a very diminutive luminous scale, sometimes not to be seen." This scale was not discussed or illustrated by Nafpaktitis (1973) in his redescription of *D. parri*. The slight elevation of the first AOa is also similar in Form A and in *D. parri*, but apparently this organ has a consistently higher position in Form A. Nafpaktitis (1973) described the first AOa of *D. parri* as being very slightly, if at all, raised, whereas in Form A it is at least a half, often a full, diameter above the level of the second AOa. The numbers of AO photophores and gill rakers are very similar in both species.

Forms B and D do not readily conform to any known species, or it may be that inadequate data on variation in characters is available for a known related species. The very low numbers of gill rakers of Form B, totalling 14 (13-15) is to my knowledge the lowest of any diaphid species other than the quite unrelated *D. problematicus* Parr (1928). Form D differs from the other three forms primarily in the very steeply slanting, almost vertical lines of the tissue in the large luminous scale at PLO, a structure unlike that of any other diaphid species I have seen.

Two other species, *Diaphus aliciae* and *D. kendalli*, described by Fowler (1934) from near the Philippines, should also be compared with the Forms A, B, C, and D, and with the *fulgens*" of Brauer. However, because of Fowler's inadequate descriptions and illustrations, comparisons are difficult, but the patterns of the SAO series of Fowler's two species are similar to these forms and to that of *fulgens*, as delineated by Brauer.

Both *D. aliciae* and *D. kendalli* are described and figured as having a large Vn. *D. aliciae* is shown to have a large luminous scale at PLO, but *D. kendalli* is not; this apparent lack of luminous scale at PLO is a character shared with Form A, but the latter appears to be a much smaller species. Fowler reported a length of 69 mm for the holotype of *D. kendalli*, but I found the length to be 59.5 mm SL; both lengths are far in excess of the maximum length found for the diminutive Form A (31 mm). Also, the numbers of gill rakers for *D. kendalli* are much higher (6 + 1 + 13) than that of Form A (4 + 1 + 10 (9-11)). Fowler recorded 8 + 14 rakers for *D. kendalli*.

Diaphus aliciae and Form C may be conspecific, primarily because of a similarity in numbers of gill rakers and sizes of luminous scales at PLO. I found the gill raker count for the holotype of *D. aliciae* to be 6 + 1 + 12 plus 1 "nub" on lower limb, but Fowler recorded 7 + 17. Fowler also reported a length of 53 mm, but I found it to be 42.0 mm SL.

I have related Forms R-1, R-2, and R-3 to the Atlantic Ocean species *Diaphus rafinesquii* (Cocco, 1838) rather than to the *D. fulgens* complex, because of several similarities. First, the expanded Vn of males and the So organ are very close together, occasionally confluent; this condition is not found in the *D. fulgens* group. Also, AO photophores (Table 22) and body proportions (Table 24) are very similar. Nafpaktitis (1968) listed the number of gill rakers for *D. rafinesquii* as 7-8 + 1 + 14-15, total 22-24, a count very similar to those of the three Pacific forms (Table 21), although the latter have somewhat higher counts. Also, they attain a similar size (70 to 94 mm), although these Pacific forms may reach a larger size than *D. rafinesquii*. Becker (1967) recorded a specimen of 79.5 mm, the largest I have found recorded in the literature, and much larger than the Forms of the *Diaphus fulgens* complex.

Although quite alike in counts and superficial aspect, *D. rafinesquii* is distinct from these Pacific forms in having a somewhat smaller and differently shaped enlarged Vn in males. Also, the SAO series is straight or but very slightly angulate in *D. rafinesquii*, and a line through the anterior margins of SAO_1 and SAO_2 touches or passes very near the posterior margin of SAO_3; in the Pacific forms this condition is approached only in Form R-1.

Forms R-1, R-2, and R-3 are also basically similar to *Diaphus theta* Eigenmann and Eigenmann (1890) and may occur sympatrically. However, *D. theta* is easily separable because of the very low position of the first AOa, usually on the level of adjacent the AOA or, rarely, elevated above that level by more than its diameter, usually only half. Also, the SAO series is almost evenly spaced and in a straight line in *D. theta*, whereas the SAO_{2-3} interspace is always notably greater than that of SAO_{1-2} in the three forms in question.

Diaphus longleyi (?)
Fowler, 1934

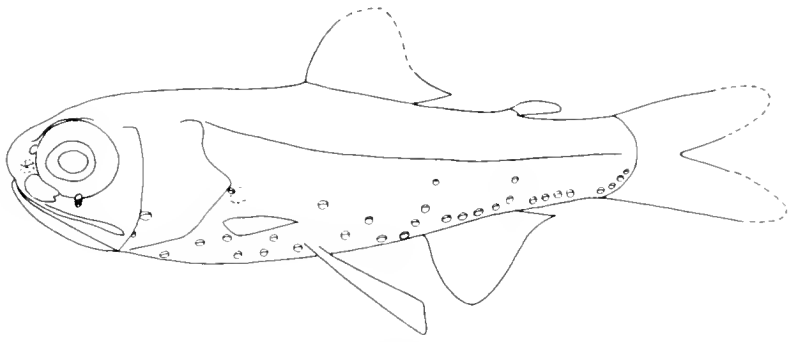


Fig. 123—*Diaphus longleyi* (?), male, 55.8 mm.

Description

D. 13 (14); A. 13; P. 10-11; AO 5 (6) + 4 (5), total 9 (10); gill rakers 6 (5-7) + 1 + 12-13 (11-14), total 19-20 (18-22); vertebrae 33 (32).

Body robust, deepest at pectoral origin. Caudal peduncle short, deep, its depth about 68% of its length. Photophores moderately large, those of AO series averaging about a diameter apart. First AOa not, or but little, elevated; last AOa elevated to about its diameter (often less) above level of penultimate AOa. PLO and VLO a little nearer pectoral and pelvic bases than to lateral line: SAO_3, Pol, and upper Prc three to four diameters below lateral line. SAO_{2-3} interspace no more than 1.5 times that of SAO_{1-2}. Posterodorsal margin of operculum markedly angulate, often slightly recurved; operculum produced into blunt point at about PLO. Vn of males much expanded anteriorly, reaching to nasal apparatus.

Size: To about 55 mm.

Least depth of capture: To 200 m at night.

Distribution: This species, although described from the Philippines region, has been taken primarily in the southeastern and central Pacific Ocean (Fig. 124).

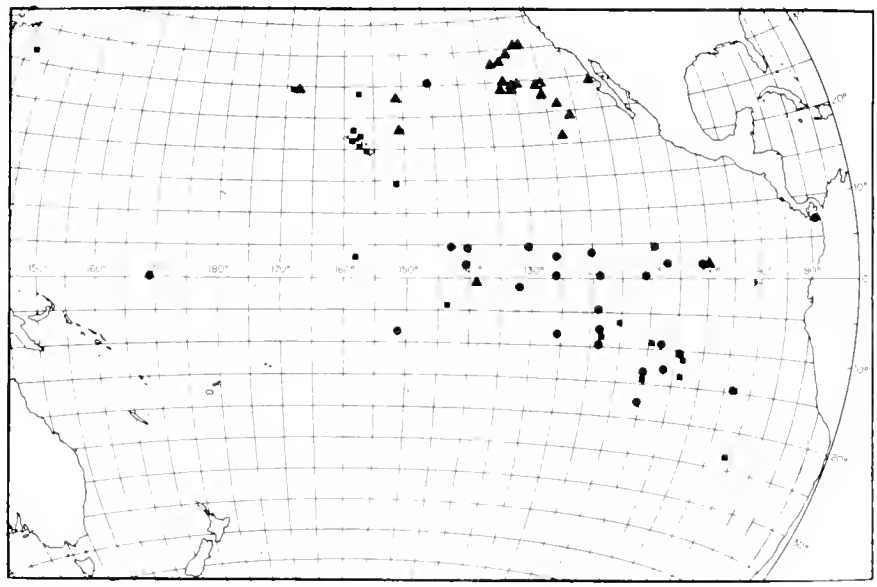


Fig. 124—Capture localities in the eastern and central Pacific Ocean for *Diaphus longleyi*, (solid circles), *D. brachycephalus* (solid squares) and *D. anderseni* (solid triangles).

Discussion

The species is provisionally listed as *D. longleyi* since it compares well with measurements and notes made by me of the holotype (USNM 92320). Unfortunately, Fowler's unsatisfactory figure and description are of little use in distinguishing his form from any closely related one. The pattern of distribution suggests that the name *longleyi* may not apply to these specimens, unless that species is widespread. However, the far western Pacific has been very inadequately collected, and the one capture locality at 170° E on the equator (Fig. 124) strengthens the possibility that the specimens in question may be *D. longleyi*.

Diaphus theta

A species complex

Eigenmann and Eigenmann, 1890

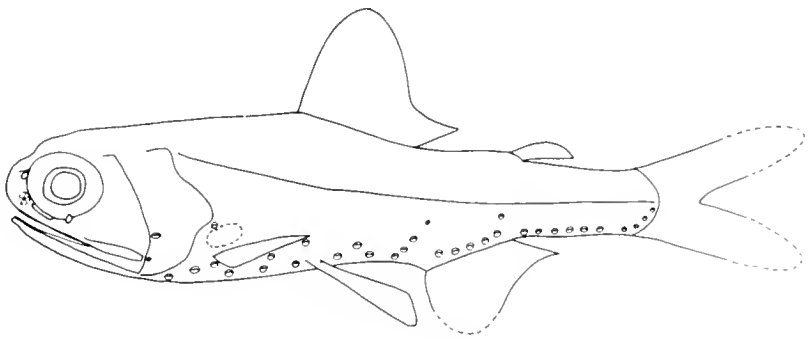


Fig. 125—*Diaphus theta*, male, 52.0 mm.

Description

The counts below were taken from specimens from off San Diego, California (the type locality). This was done in order to confine the counts to specimens that unquestionably are *D. theta* (see *Discussion*).

D. 13 (12-14); A. 13 (14); P. 10 (11); AO 5-6 + 6 (5); total 11 (10) (12 once in 70 sides); gill rakers 6-7 + 1 + 14 (13-15), total 21-22 (19-23); vertebrae 35 (34-36).

PLO and VLO much nearer pectoral and pelvic bases than to lateral line. SAO, Pol, and upper Prc, two to three diameters below lateral line. SAO series usually equally spaced and in line with VO_5; SAO_2 often a little behind a line through $SAO_{1\text{-}3}$; $SAO_{2\text{-}3}$ interspace infrequently slightly greater than that of $SAO_{1\text{-}2}$. First AOa usually on level of adjacent ones but occasionally slightly elevated, though seldom by a full diameter; last 1 or 2 AOa elevated to form a curve with Pol. Pol and last AOa interspace usually a little larger than those between the other AOa.

Size: To about 90 mm.

Least depth of capture: To 10 m at night, 400 m in daylight.

Distribution: This species ranges into the north-central Pacific (Fig. 126), and the numbers of total gill rakers increase with increasing latitudes; also, the species appears to reach a larger size in northern waters, a 50-mm specimen being uncommon off southern California.

Discussion

The larger specimens from the northeastern Pacific, with higher total gill raker counts on the average (about one raker), appear to represent the form on which Gilbert (1891) based his description of *D. protoculus*, herein considered a synonym of *D. theta*.

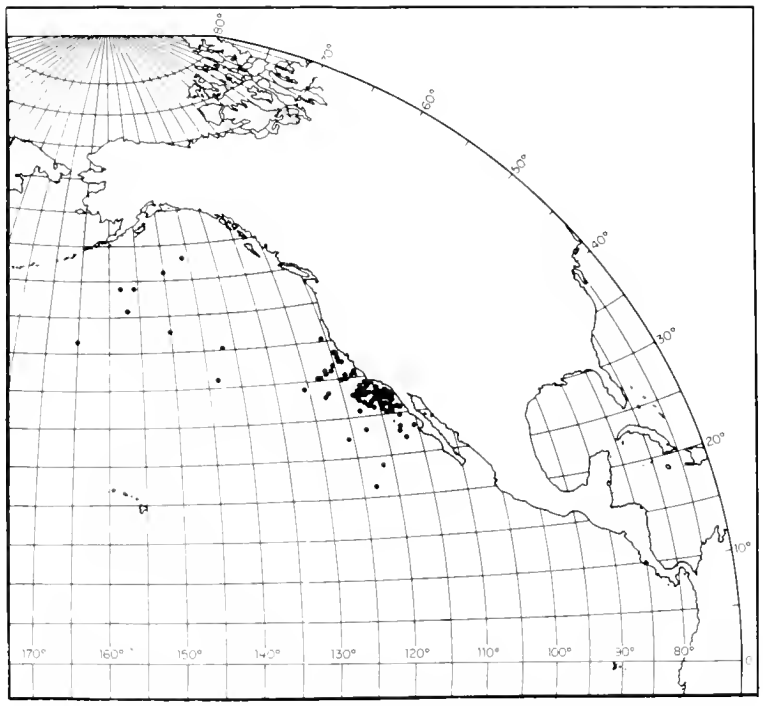


Fig. 126—Capture localities for *Diaphus theta* in the northeastern Pacific Ocean.

Although the name *Diaphus theta* may properly apply only to specimens from off Southern California, the name has also been applied to specimens from the eastern Pacific, off Chile (Bussing, 1965). Recently Craddock and Mead (1970) reported the capture of 54 specimens, in 19 collections off Chile from an area roughly bounded by 31°-34° S, 72°-92° W (not included in Fig. 126). These authors correctly placed these specimens in a "*Diaphus theta*-complex." This southern complex probably extends across the southern Atlantic; I have seen a few specimens from the central Pacific and from off South Africa.

These southern specimens may represent one or more undescribed species. They differ slightly from those from the type locality of *D. theta* in having somewhat longer and deeper heads and deeper bodies. They have 11 to 12 pectoral rays rather than the 10 (rarely 11) of *D. theta*, and the AO photophores more commonly number 5 + 5 (rarely 4 or 6), total 10 (rarely 11), rather than the 5 (4-6) + 6 (5), total 11 (10-12), of *D. theta*. Also, there may be differences in size and structure of the luminous scale at PLO; this scale appears to be markedly smaller in the few undamaged southern specimens before me, and the tissue is much more finely convoluted than in *D. theta*. I have studied too few specimens from the southern Atlantic Ocean to now attempt a solution to this problem.

Diaphus brachycephalus
Tåning, 1928

Description

D. 12-13; A. 12-13; P. 11-12 (10); AO 5 (4) + 4 (5), total 9; gill rakers 6 (5-7) + 1 + 13 (12-15); total 20-21 (17-23); vertebrae 33 (32-34) (10 specimens).

Photophores large, closely spaced, those of the AOp series much less than half a diameter apart and often nearly in contact. VO_5, SAO_1, and SAO_2 form a flatly oblique, nearly horizontal, straight line that passes slightly behind SAO_3; $SAO_{1\text{-}2}$ interspace about half that of

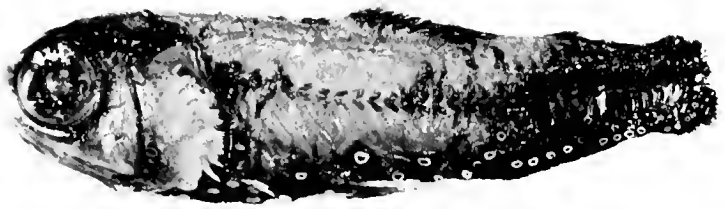


Fig. 127—*Diaphus brachycephalus*, male, 51.2 mm. (Photophores retouched).

SAO_{2-3}. Prc closely spaced in a moderate curve, the Prc_{3-4} interspace a little wider than the others. Opercular margin irregular, the lateral portion produced into a blunt point above PLO.

Size: To about 45 mm.

Least depth of capture: To about 150 m at night.

Distribution: Apparently the species is confined to warm waters of both the North Atlantic and Pacific Oceans (Fig. 124). I have seen two specimens from the South Atlantic Ocean (33° 47′ S, 15° 47′ W).

Discussion

The 10 specimens before me answer well to the description and figure offered by Nafpaktitis (1968) for specimens from the North Atlantic (the type locality). This species is closely related to *D. richardsoni* but differs slightly in some body proportions (Table 25) as well as in certain luminous organs, as stated above.

TABLE 25. BODY PROPORTIONS FOR *DIAPHUS RICHARDSONI* AND *D. BRACHYCEPHALUS*.

Measurement	*D. richardsoni*				*D. brachycephalus*				
	Java Trench SL-50.0mm	S. China Sea SL-37.5mm	Sulu Sea SL-46.5mm	South Africa SL-44.0mm	South Eastern Pacific SL-39.6mm	SL-34.2mm	SL-38.1mm	North Atlantic* 31 (21.3-51.4mm)	
Head length	320	317	327	311	346	351	342	353	342-368
Head depth	234	221	219	220	260	264	267	266	252-282
Upper jaw length	212	205	219	207	220	232	226	232	222-239
Orbit length	112	107	106	109	134	133	131	138	130-149
Snout length	56	48	49	55	40	42	47	—	
Prepectoral length	312	315	327	298	334	339	334	350	337-362
Prepelvic length	500	476	495	479	487	481	467	510	496-521
Preanal length	700	688	697	675	685	692	683	699	680-723
Predorsal length	500	507	516	515	548	536	525	516	503-531
Preadipose length	842	845	845	850	852	835	838	831	800-844
Dorsal origin to pelvic origin	230	237	219	218	266	269	263	—	
Dorsal origin to anal origin	320	304	314	298	336	342	334	—	
Caudal peduncle length	220	189	187	200	189	181	192	—	
Caudal peduncle depth	118	128	120	102	134	140	131	145	135-158
Dorsal base length	174	176	172	168	194	197	186	195	186-213
Anal base length	166	165	159	155	157	163	152	168	158-181

*Data from Nafpaktitis (1968).

Diaphus richardsoni
Tåning, 1932

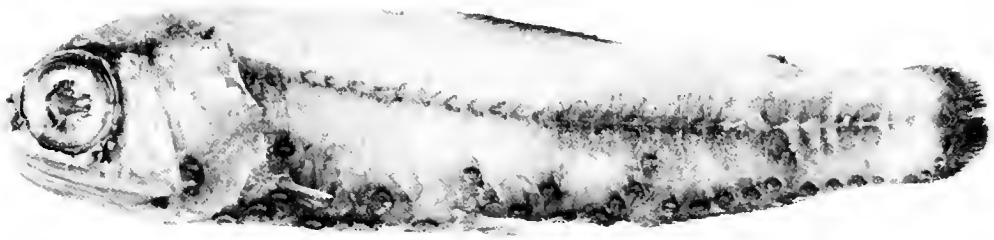


Fig. 128—*Diaphus richardsoni*, male, 50.0 mm. From the Java Trench.

Description

The following data are taken from four specimens, one each from Java Trench, South China Sea, Sulu Sea, and off Durban, South Africa.

D. 12-13; A. 13; P. 10 (11); AO 5 + 3-4, total 8-9; gill rakers 6 + 1 + 13-14, total 20-21; vertebrae 32.

PLO above pectoral origin by about one-third the distance from there to lateral line. VO_4 elevated to about level of pectoral origin. VLO slightly behind pelvic origin and nearer to it by about one-third the distance to lateral line. VLO about half its diameter above level of VO_3, a line through these 2 organs passing well above PLO. SAO series very slightly angulate; a line through SAO_{1-2} passes a little before VO_5 and behind SAO_3. First AOs not elevated; ultimate AOa elevated by about its diameter above penultimate AOa. SAO_3 and Pol below lateral line by two to three times their diameters.

Diaphus richardsoni is closely related to *D. brachycephalus*. It differs primarily in having no heavily pigmented area around the So, and the Vn of males is much less massive anteriorly than in *D. brachycephalus*; the Vn of females is similar in the two species. Also, *D. richardsoni* appears to have the external pore structure of the lateral line less strongly developed. It has a more slender body, as indicated in the body proportions in Table 25.

Size: To 57 mm (Holotype).

Least depth of capture: To about 200 m at night.

Distribution: This species has not yet been reported from the eastern Pacific Ocean, but since the type locality is north of new Guinea (02° 00′ N, 138° 22′ E), it may occur in the poorly collected southwestern section.

Diaphus anderseni
Tåning, 1932

Description

D. 13; A. 11-12; P. 10-11 (9); AO 4 (3-5) + 5, total 9 (8-10); gill rakers 5-6 (4) + 1 + 12 (11-13), total 18-20; vertebrae 33 (32-34).

Body photophores large, those of SAO and AO series less than half a diameter apart. PLO before pectoral origin and somewhat nearer it than to lateral line; VLO only two or three of its diameters above pelvic base. Prc closely spaced, in a moderately flat curve.

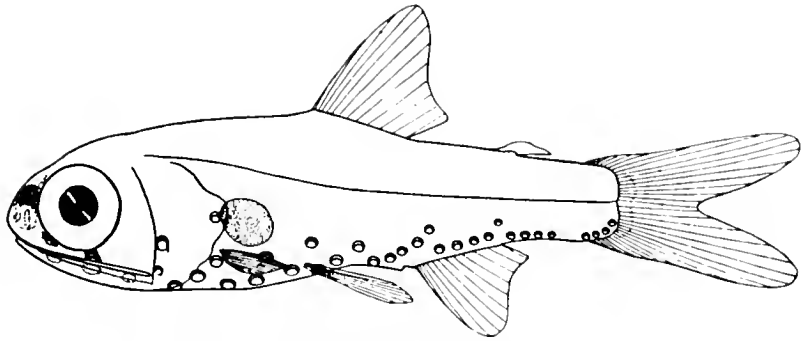


Fig. 129—*Diaphus anderseni*. From Tåning (1932, p. 134, fig. 6).

Size: To about 35 mm.

Least depth of capture: To about 24 m at night.

Distribution: Although the type locality is southwest of Fiji, the species is very common in the northeastern Pacific Ocean (Fig. 124).

Notolychnus Fraser-Brunner, 1949

Frontal bones expanded into a small, but conspicuous, median, transparent dome into which the pineal organ extends. Adipose fin far behind end of anal base. Two Prc arranged vertically. Five PO, the third notably, the fourth markedly, elevated. Four VO, the first elevated. VLO, SAO_3, and upper Pol very high, near dorsal profile. Dn present; no Vn. A single deeply set translucent supracaudal luminous gland present in both sexes; no infracaudal glands. Males have a much larger eye and supracaudal gland than do females. Lateral line obsolete.

Photophores are easily lost on this diminutive species, but the supracaudal gland, or a portion of it, usually remains. If this gland is also lost, the far-back portion of the adipose fin is diagnostic, as are the low number of pelvic rays (6).

A single species is recognized.

Notolychnus valdiviae
(Brauer, 1904)

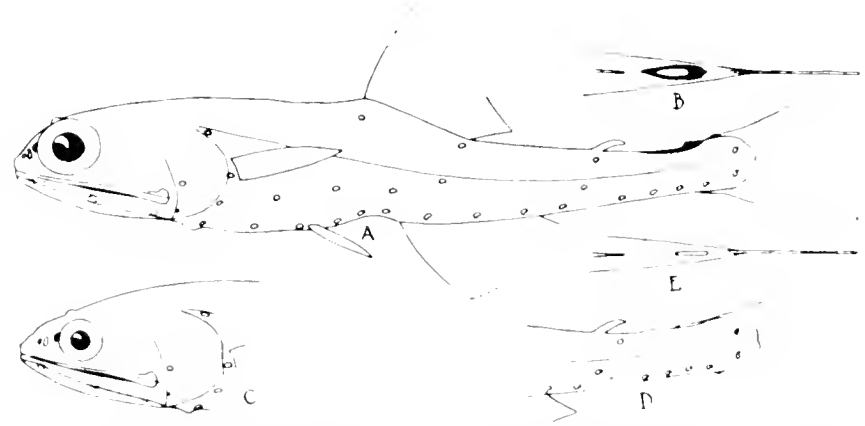


Fig. 130—*Notolychnus valdiviae* (Brauer, 1904). (A.) Adult male (note large eye), (B.) Dorsal view of male caudal peduncle, (C.) Head of adult female, (D.) Caudal peduncle of adult female, (E). Dorsal view of female caudal peduncle. From Bolin (1946, p. 147, fig. 9).

Description

D. 11 (10-12); A. 13 (12-14); P. 13 (12-14); AO 4-5 + 3-4; gill rakers 2 + 1 + 7; vertebrae 29 (27-31).

Size: To about 25 mm.

Least depth of capture: Clarke (1973) reported that night tows between 80 and 100 m took specimens of less than 15 mm almost entirely, but specimens of 20 mm or more between 115 and 145 m.

Distribution: Circumglobal in tropical and temperate waters.

Discussion

Although Bolin (1946) described and figured an infracaudal gland for females from the Indian Ocean (Fig. 130 E), I have been unable to detect a definite gland on any specimen from the eastern Pacific Ocean. However, as this is a very fragile species, it may be that the gland is easily lost. The figure from Bolin was used because no intact specimen was available to me; none had the full complement of photophores, and few had the supracaudal gland intact.

Taaningichthys Bolin, 1959

Lateral line poorly developed or obsolete. Snout short and blunt, less than half the orbital diameter; orbit large, usually less than 3.0 in head. A large, opaque, whitish crescent on posterior half of iris. Photophores weakly developed or entirely absent, often lost with the fragile, easily eroded integument. PO 5-7; VO 3-10. A large, pearly white luminous organ set deeply into upper and lower surfaces of the caudal peduncle of both sexes. Three Prc, the first 2 low and closely spaced, the third at lateral line and widely separated from the others.

Key to species of *Taaningichthys*

1a. Distance from anal origin to end of hypural less than distance from anal origin to upper end of pectoral base. Pectoral fin extending well beyond pelvic base. Five PO; VO 8-10; only 1 SAO, near lateral septum; AO 5-8 + 3-5. Supracaudal luminous gland usually less than half the length of infracaudal gland. Scales small, 40-41 along lateral septum; vertebrae 49 (39-41) ..... *T. minimus*

1b. Distance from anal origin to end of hypural greater than distance from anal origin to upper end of pectoral base 2

2a. Supracaudal and infracaudal luminous glands about equal in length. Pectoral fin not reaching to pelvic base. Five to 7 PO; VO 2-5; only 1 SAO, high, near lateral septum; AO 2-3 + 1-2. Scales large, 35-36 along lateral septum; vertebrae 35-36 ..... *T. bathyphilus*

2b. Supracaudal luminous gland half or less the length of infracaudal gland. Pectoral fin reaching to about pelvic base. No photophores on head or body ..... *T. paurolychnus*

Taaningichthys bathyphilus
(Tåning, 1928)

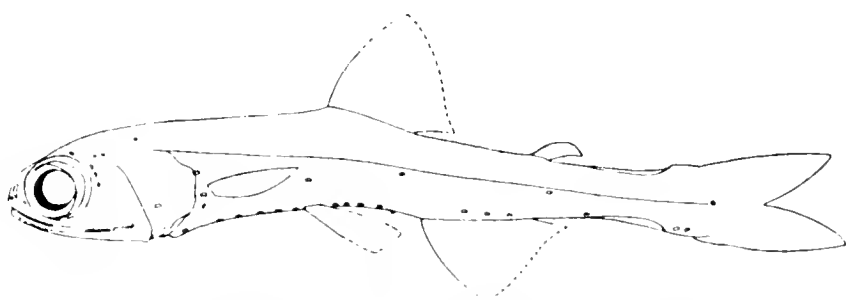


Fig. 131—*Taaningichthys bathyphilus*. From Bolin (1959, p. 26, fig. 6).

Description

D. 13 (12-14); A. 13; P. 13 (12-15); AO 2-3 + 1-2; PO 5-7; VO 2-5; gill rakers 3 + 1 + 7 (6-8), total 11 (10-12); vertebrae 35-36.

PVO_{1-2} in nearly vertical line. VLO much nearer lateral line than to pelvic base. Prc_{1-2} interspace small, equal to about one photophore diameter.

Size: To 68 mm.

Least depth of capture: Clarke (1973, p. 415) reported that *T. bathyphilus* was taken regularly between 600 and 1000 m and occasionally deeper both day and night. Greatest catches were between 700 and 800 m. It was the only myctophid which definitely did not migrate.

Distribution: This species is known from all oceans, but is not common; seldom are more than four taken in one haul. In the eastern Pacific Ocean it has not been taken in the wide area between the tip of Baja California and about 15° S (Fig. 132), perhaps due to the thick layer of oxygen-deficient water underlying the area.

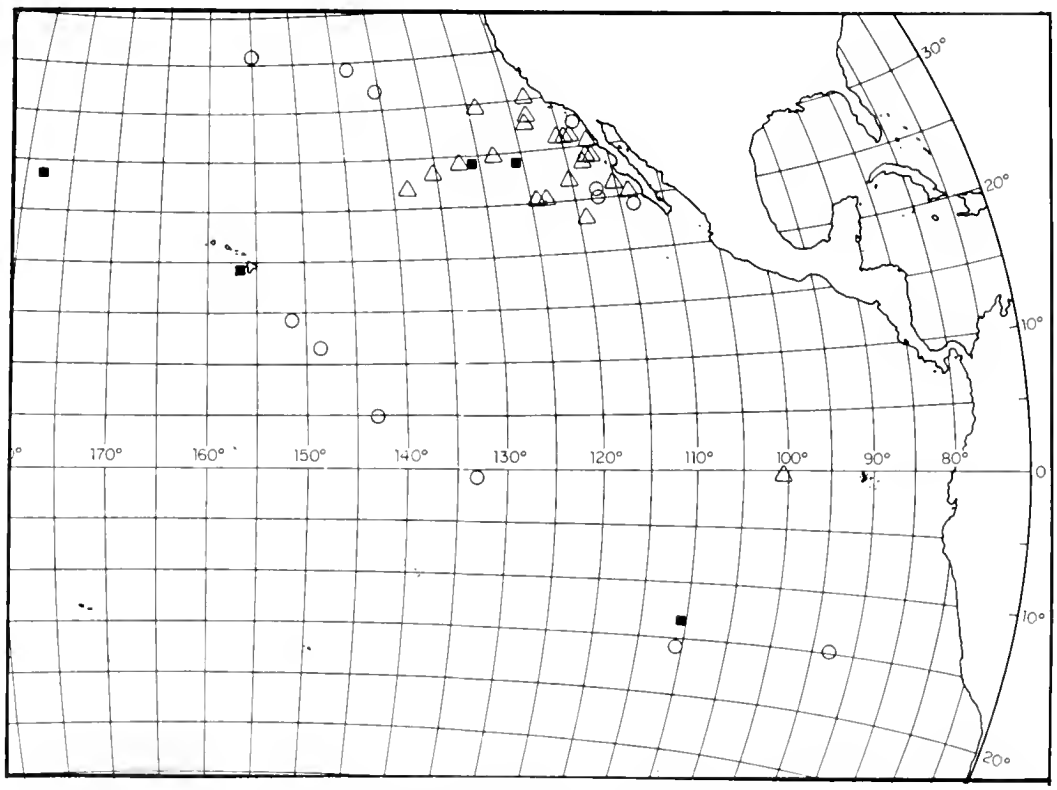


Fig. 132—Capture localities in the eastern Pacific Ocean for *Tanningichthys bathyphilus* (open circles), *T. minimus* (closed squares) and *T. paurolychnus* (open triangles).

Taaningichthys minimus
(Tåning, 1928)

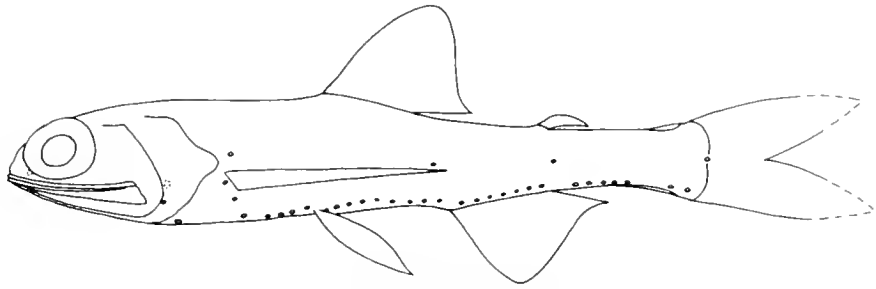


Fig. 133—*Taaningichthys minimus*, 51.8 mm.

Description

D. 12 (11-13); A. 13 (12-14); P. 16-17; AO 7 (5-7) + 4 (3-6); PO 5-6; VO 9-10; gill rakers 4-5 + 1 + 11-12 (10-13), total 16-17 (15-18); vertebrae 40 (39-41).

PVO_1 well behind a vertical from PVO_2. VLO midway between pelvic base and lateral line, or slightly nearer the latter. Prc_{1-2} interspace equal to at least two photophore diameters.

Size: To about 60 mm.

Least depth of capture: Between 0 and 400 m at night, 0 to 800 m in daylight in Hawaiian waters. Clarke (1973) states "Other reports, e.g., Davy (1972), have stated that *T. minimus* does not migrate, but all night catches in this study were well above the day depth range. Individuals 20-30 mm long were caught between 150 and 250 m at night and larger fish between 200 and 400 m. None were taken in night tows below 475 m."

Distribution: As with *T. bathyphilus*, *T. minimus* is known from all oceans but is even less frequently taken. In the eastern Pacific it is the least commonly taken of the three species (Fig. 132).

Taaningichthys paurolychnus
Davy, 1972

Fig. 134—*Taaningichthys paurolychnus*, male, 64.5 mm.

Description

D. 12-13; A. 13 (12-14); P. 14 (13-15); no AO photophores; gill rakers 3-4 + 1 + 10-11 (9-12), total 14-15 (13-16); vertebrae 35 (36).

No luminous organs or photophores on head or body, other than large supracaudal and infracaudal luminous glands; although species of the genus *Taaningichthys* are notable for

extreme fragility of the photophores, the very excellent condition of several specimens of *T. paurolychnus* leaves not doubt as to their absence.

Size: To 95 mm.

Least depth of capture: Between 0 and 1000 m at night. Davy (1972) reported that this species had not been taken above 900 m and that it did not appear to perform daily vertical migrations.

Distributions: In the eastern Pacific Ocean (Fig. 132) this species is commonly taken but not in large numbers, no more than two having been taken in one haul. Davy (1972) reported this species from the warmer waters of all oceans.

Discussion

Aside from the lack of head and body photophores, another striking feature of *T. paurolychnus* is the presence of a pair of nearly transparent, bony, broad-based, and strongly recurved teeth projecting forward from the tip of each premaxillary (Fig. 135). Similar teeth rarely occur in the species *T. bathyphilus* and *T. minimus*, but only a few specimens of each species have been found with one or more teeth remaining, either relatively intact or as stubs. If an entire tooth is missing a pit in the bone will indicate its former presence. The highly vulnerable position of these teeth, at the very tips of the premaxillaries, and their sharply pointed and recurved structure, render them easily snagged and broken by the meshes of nets, or by contact with other organisms during capture.

The probably luminous crescent of whitish opaque tissue on the posterior position of the iris (a differentiating character of the genus *Taaningichthys*) is more pronounced in this species than in others of the genus (Fig. 136). This crescent is barely or not at all visible in

Fig. 135—Ventral view of premaxillary teeth of *Taaningichthys paurolychnus*. Paired teeth occur at anteriormost margin of each premaxillary bone. The tooth at left center is intact; the tips of the remaining teeth are missing. The entire tooth is missing on the extreme right (left side of specimen).

Figure 136—Head of *Taaningichthys paurolychnus*, 69.0 mm, showing extent of whitish crescent on posterior portion of iris.

fresh material, most specimens requiring nearly two hours in preservative (10% formalin) before attaining the maximum state of whiteness.

On specimens of *T. paurolychnus* in excellent condition there is often a domed covering of a transparent, viscous substance over both the supra- and infracaudal luminous glands (Fig. 137). Either this dome is quite fragile or the viscous substance is readily dissolved in preserving fluids (10% formlin followed by 40% isopropyl alcohol) for in several specimens that originally had this structure it is now collapsed.

Lampadena Goode and Bean, 1896

Large, very silvery, undivided luminous glands, usually set rather deeply into vertical surfaces of caudal peduncle in both sexes. No crescent of luminous tissue on iris. Vn small, inconspicuous; Dn absent. PO series linear, except in one species in which PO_4 is highly elevated. Usually 5 VO, but variably 4 to 6, none markedly elevated. SAO in a steep, slightly angulate line, usually in series with last VO. One Pol; 3 Prc, the upper at end of lateral line. Dorsal and anal fin bases not overlapping; base of adipose fin over or slightly behind end of anal base. Procurrent caudal rays stiff, spine-like.

Nafpaktitis and Paxton (1968) presented a review of the genus *Lampadena* from all oceans and included a key to identification of seven species, one new; of these, five are known to occur in the eastern Pacific Ocean, and the other two may eventually be found in the poorly

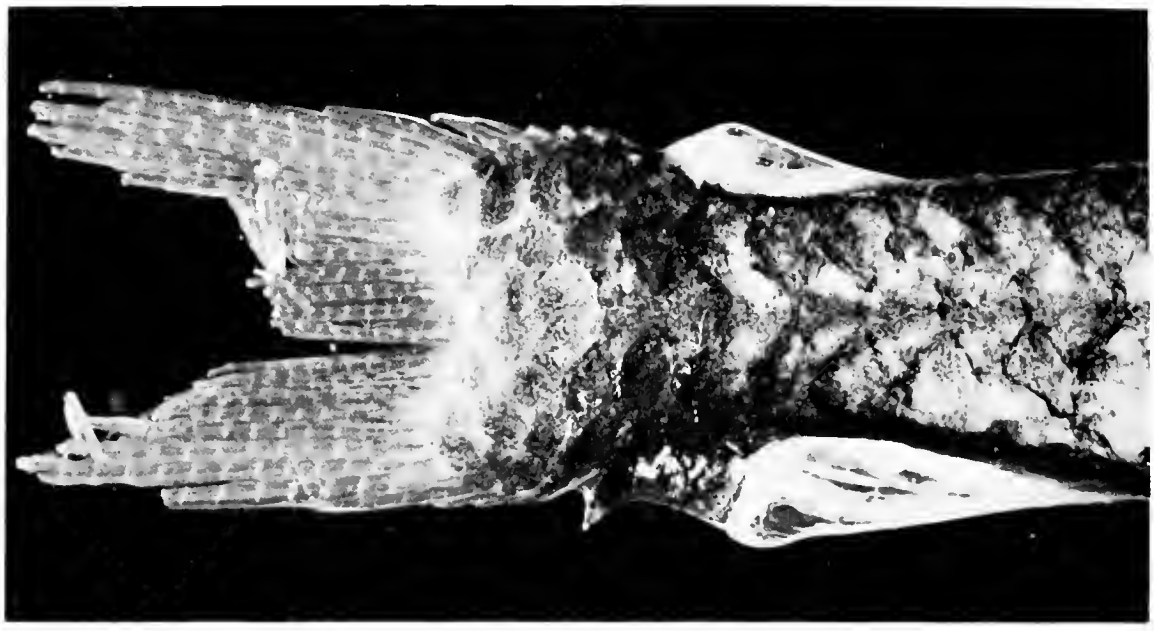


Fig. 137—Caudal region of *Taaningichthys paurolychnus*, 69.0 mm, showing domed covering of the caudal luminous glands. Supracaudal gland is the shorter one.

collected southern portion. Krefft (1970), dealing only with Atlantic Ocean material, described a new species, *L. pontifex*, from the vicinity of Cape Verde Islands, and provided a detailed description and a figure of *L. anomala* (see Fig. 145).

As stated by Nafpaktitis and Paxton (1968), "The genus as a whole is rather uncommon. Examination of many more collections around the world will probably result in an increase in the number of know species in the genus and further elucidate individual patterns of distribution." With this statement in mind it is deemed reasonable to present their key, including all seven species, in anticipation that further collecting effort will indeed show them to occur in the eastern Pacific Ocean.

Key to species of *Lampadena*

1a. PO_4 abruptly and highly elevated to over or slightly before or behind PO_3 and about on level of PVO_1, or slightly higher ..... *L. luminosa*

1b. None of the PO abruptly or highly elevated 2

2a. VO plus SAO equals 5 to 6; AOa 3 to 4. Caudal luminous glands rather weakly developed and not set deeply into vertical surfaces of caudal peduncle ..... *L. anomala*

2b. VO plus SAO equals 7 to 9; AOa 5 to 7. Caudal luminous glands strongly developed and set deeply into vertical surfaces of caudal peduncle 3

3a. Prc_{1-2} interspace equal to, or greater than, three times the diameter of a photophore of this series 4

3b. Prc_{1-2} interspace much shorter than three times the diameter of a photophore of this series 5

4a. Last 2 (sometimes 3) AOa entirely behind base of anal fin; 2 AOp; infracaudal luminous gland very long, at least 1.5 times as long as least depth of caudal peduncle, almost twice as long as diameter of eye; crescent-shaped patch of whitish tissue on iris above pupil; pterotic spine directed posteriorly ..... *L. chavesi*

4b. No AOa behind base of anal fin; 4 to 5 AOp (rarely 3); infracaudal luminous gland shorter than 1.5 times the least depth of caudal peduncle an about 1.5 times as long as diameter of eye; no crescent-shaped patch of whitish tissue on iris above pupil; pterotic spine directed downward and forward (in specimens longer than about 30 mm) ..... *L. dea*

5a. Gill rakers 6-8 + 1 + 12-17; supracaudal gland shorter than infracaudal gland; mesopterygoid teeth uniformly small 6

5b. Gill rakers 3-5 + 1 + 8-10; supracaudal gland equal in length to or somewhat longer than infracaudal gland; posterior mesopterygoid noticeably enlarged ..... *L. urophaos*

6a. Distance between posterior end of base of anal fin and anterior margin of infracaudal gland equal to, or slightly greater than, length of this gland. Photophores small; those of the AOa series about one diameter apart (about two diameters in specimens of less than 30 mm). First and usually second AOp in front of infracaudal gland; AOa level; gill rakers 6-7 + 1 + 12-14, total 19-22 ..... *L. speculigera*

6b. Distance between posterior end of base of anal fin and anterior margin of infracaudal gland equal to about one-fourth of length of this gland; photophores large. AOa interspaces about 1.5 times the diameter of a photophore (less than one diameter in specimens less than 30 mm). All AOp well over infracaudal gland; last AOa usually distinctly raised above level of rest of organs of same series; gill rakers 7-8 + 1 + 16-17, total 24-26 ..... *L. notialis*

Lampadena luminosa

(Garman, 1899)

Fig. 138—*Lampadena luminosa*, 67.4 mm. From Nafpaktitis and Paxton (1968, p. 5, fig. 1).

Description

D. 15; A. 14 (13-14); P. 16 (15-17); AO 5-6 (7) + 2; Prc 2 + 1; gill rakers 4 + 1 + 9 (8-10), total 14 (13-15); PO 5; VO 4-5; vertebrae 36 (37) (8 specimens); lateral line scales 35-37.

Pterotic spine prominent, directed posteriorly. Supracaudal and infracaudal luminous glands of about equal length, slightly less than orbital diameter; distance between anterior end of infracaudal gland and posterior end of anal base about equal to or slightly less than length of gland.

Size: To 150 mm (off Japan).

Least depth of capture: To 60 mm at night and to 555 m in daylight. Clarke (1973) reported "large" fish taken mostly between 150-250 m at night but between 650-750 m in daylight in Hawaiian waters.

Distribution: This species has been reported primarily from the warmer waters of the Atlantic and Indian Oceans; one specimen is known to me from the eastern Pacific, 04°56′ N, 142°54′ W.

Lampadena urophaos
Paxton, 1963

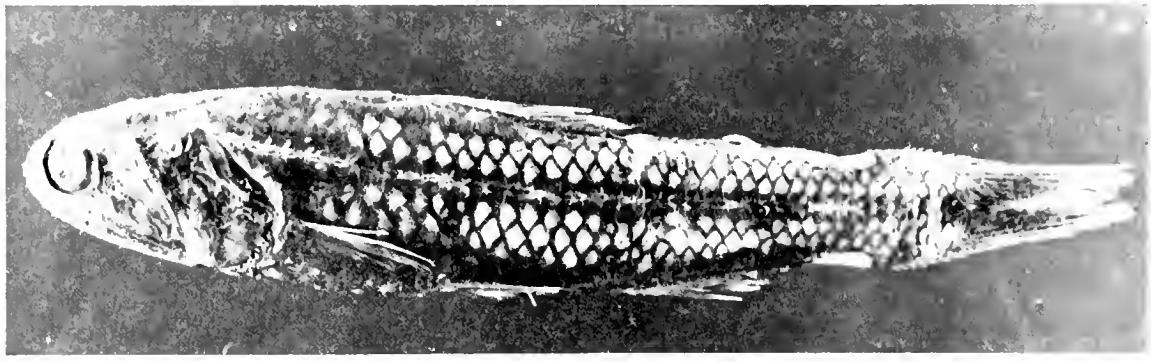


Fig. 139—*Lampadena urophaos*, male, 112-0 mm.

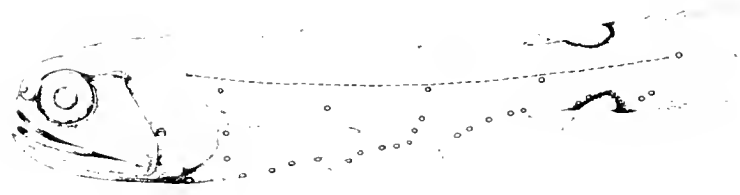


Fig. 140—*Lampadena urophaos*, 56-0 mm. From Nafpaktitis and Paxton (1968, p. 8, fig. 2).

Description

D. 15 (14-16); A. 14 (13); P. 16 (15-17); AO 5 (6) + 2 (3), total 7 (8-9); gill rakers 4 (3-5) + 1 + 8-9 (10), total 13-14 (16); PO 5; VO 5 (4-6); Prc 2 + 1; vertebrae 36 (35).

Pterotic spine strong, directed posteriorly and slightly ventrally. Caudal luminous glands about of equal size in small specimens, but supracaudal gland slightly larger in those over 50 mm. Distance from anterior end of infracaudal gland to end of base of anal fin 1.0 to 0.75 times the length of the gland.

Size: To 104 mm.

Least depth of capture: To 130 m at night.

Distribution: L. urophaos occurs between about 25° and 42° N in the eastern Pacific and westward to Hawaii. A possible subspecies occurs in the North Atlantic Ocean.

Discussion

Maul (1969) described a new subspecies, *L. urophaos atlanticus*, from the northeastern Atlantic Ocean. He based the distinction on a more posterior position of PVO_1 (slightly behind, rather than on, a vertical from PVO_2); also, the 2 caudal luminous glands were described as equal in length at all sizes of specimens, whereas in the Pacific form the supracaudal gland was somewhat larger in specimens over 50 mm.

Photographs of an otolith of *L. urophaos* (Nafpaktitis and Paxton, 1968) and of *L. u. atlanticus* (Kotthaus, 1972) show striking dissimilarities that approach the familial level and indicate a possible aberrance in formation or an error.

Nafpaktitis (personal communication) has found the more posterior position of PVO_1 to be inconstant, a significant number of specimens having PVO_1 directly below PVO_2. Thus, in view of this inconstancy, the apparently excessive difference in shapes of otoliths, and an only slight difference in lengths of supracaudal luminous gland with size of fish, more study is needed, particularly on otoliths, to validate the subspecific distinction. Pending this study, I retain *L. urophaos* at the full species level.

Lampadena speculigera
Goode and Bean, 1896

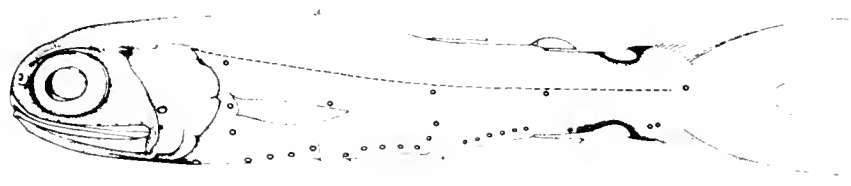


Fig. 141—*Lampadena speculigera*, 66.0 mm. From Nafpaktitis and Paxton (1968, p. 11, fig. 3).

Description

D. 14 (13-15); A. 14 (15); P. 14 (15); AO 6-7 + 3-4 (5); Prc 2 + 1; PO 5 (6); VO 5 (4-6); gill rakers 6-7 + 1 + 12-14, total 19-22; lateral line scales 39-41; vertebrae 38-39 (40) (five specimens).

Eye large, 2.7 to 3.2 in head. Opercular margin not pointed but with a shallow indentation about at level of pectoral origin. Pterotic spine strong, straight, directed posterolaterally.

Supracaudal luminous gland one-half to two-thirds the length of infracaudal; posterior margin of supracaudal distinctly notched. Distance from end of anal base to anterior end of infracaudal 1 to 1.5 times the length of the gland.

Size: To 130 mm.

Least depth of capture: To 60 m at night and 100-700 m in daylight.

Distribution: In southeastern Pacific off Chile at about 34° S, 73° 30′ W. Also known from North Atlantic and southern Indian Oceans, and off New Zealand.

Lampadena notialis
Nafpaktitis and Paxton, 1968

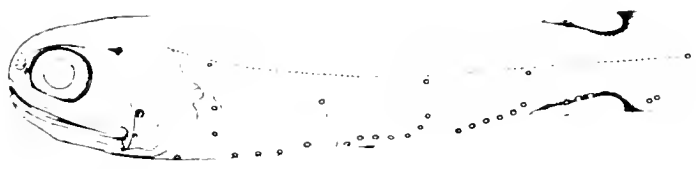


Fig. 142—*Lampadena notialis*, holotype, 66.3 mm. From Nafpaktitis and Paxton (1968, p. 14, fig. 5).

Description

D. 14; A. 14; P. 14; AO 6 + 3; Prc 2 + 1; PO 5; VO 5 (6); gill rakers 7-8 + 1 + 16-17, total 24-26; lateral line scales 38-39; vertebrae 37-38 (two specimens).

Eye large, 2.8 to 3.0 in head. Opercular margin produced into two rounded lobes separated by triangular indentation about at level of PVO_2. Pterotic spine directed posterolaterally in young (66 mm) and posteroventrally in mature specimen (105 mm).

Supracaudal luminous gland about 0.75 times the length of infraucaudal; infracaudal gland length equal to (in small specimens) or greater than (in large specimens) diameter of eye. Distance between end of anal base and anterior end of infracaudal gland about 0.25 of that gland.

Size: To 105 mm.

Least depth of capture: To 60 mm at night (28-mm specimen) and to 715 m in daylight (128-mm specimen).

Distribution: Known from near New Zealand and Australia, and from Indian Ocean and off the Cape region of South Africa between 40° and 50° S.

Lampadena dea
Fraser-Brunner, 1949

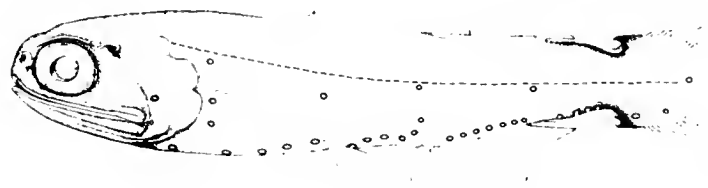


Fig. 143—*Lampadena dea*, 59.0 mm. From Nafpaktitis and Paxton (1968, p. 17, fig. 6).

Description

D. 14; A. 14 (15); P. 14 (15); AO 6-7 (5) + 4-5 (3); Prc 2 + 1; PO 5; VO 5 (4-6); gill rakers 6 (7) + 1 + 14 (15), total 21 (22-23); lateral line scales 37-38; vertebrae 37-38 (three specimens).

Eye large, 2.9 to 3.3 in head. Opercular margin with a very distinct triangular indentation at level of pectoral origin. Pterotic spine very strong, curved downward and forward in larger specimens, posterolaterally in smaller specimens.

Supracaudal luminous gland about 0.66 of infracaudal; posterior margin of supracaudal slightly to distinctly notched. Distance between end of anal base and anterior end of infracaudal gland less than 0.25 the length of that gland.

Size: To 63.5 mm.

Least depth of capture: To 150 m at night (21-mm specimen) and between 350 and 2390 m in daylight (64-mm specimen).

Distribution: In southern parts of all three oceans between about 20° and 50° S.

Lampadena chavesi
Collett, 1905

Fig. 144—Lampadena chavesi, 54.5 mm. From Nafpaktitis and Paxton (1968, p. 18, fig.7).

Description

D. 14; A. 13-14 (12); P. 16-17; AO 7 (8) + 2; Prc 2 + 1; VO 5 (6); gill rakers 6-7 + 1 + 13, total 20-21; lateral line scales 38 (39); vertebrae 37-38 (two specimens).

Eye large, 2.6 to 3.3 in head. Opercular margin with slight indentation opposite middle of pectoral base. Pterotic spine strong, directed posteriorly.

Caudal glands largest and most distinctive of the genus *Lampadena*; supracaudal gland bifurcate posteriorly; infracaudal flat in cross section, limited to ventral surface, and not extending down much on sides of peduncle, tapering posteriorly rather than anteriorly (in contrast to all other species of this genus). Distance between end of anal base and anterior margin of infracaudal gland very short, about twice a photophore diameter.

Size: To 60 mm.

Least depth of capture: To 50 m at night (22 to 24-mm specimens).

Distribution: Apparently antitropical; it occurs in North Atlantic and in southern Indian and Pacific Oceans between about 30° and 40° S. Craddock and Mead (1970) reported eight specimens from west of Valparaiso, Chile, between about 88° and 93° W.

Lampadena anomala
Parr, 1928

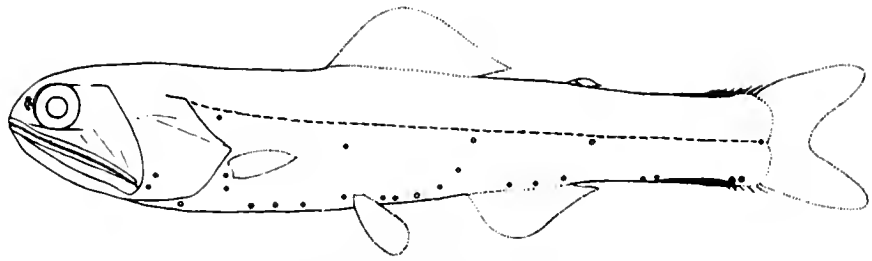


Fig. 145—*Lampadena anomala*, 149.7 mm. From Krefft (1970, p. 282, fig. 4).

Description

D. 16; A. 13-14; P. 16-18; AO 3-4 + 2; gill rakers 5 + 1 + 11 (10-12), total 17 (16-18); vertebrae 36-38.

The following data and description are taken from Nafpaktitis and Paxton (1968) and from Krefft (1970).

Photophores smaller than in other species of the genus. VLO nearer lateral line than to pelvic base. Three VO; 3 SAO; 3 AOa, widely separated; 2 AOp, the last over anterior margin of infracaudal luminous gland. Three Prc, the first 2 very close together, the third far distant at end of lateral line. SAO_3 and Pol about their diameters below lateral line. Supracaudal luminous gland slightly shorter than infracaudal, its length about equal to distance between end of anal base and anterior margin of infracaudal gland.

Size: To about 150 mm.

Least depth of capture: To 170-330 m at night (Krefft, 1970).

Distribution: L. anomala is known primarily from the Atlantic Ocean. Nafpaktitis and Nafpaktitis (1969) reported a single, damaged specimen from the western Indian Ocean. A badly damaged specimen, apparently of this species, was taken in the east-central Pacific Ocean at about 05° S, 135° W.

Discussion

The occurrence of this species in the eastern Pacific Ocean is somewhat questionable. It is based on a badly damaged specimen (ca. 48 mm) that conforms well to the diagnoses given by Nafpaktitis and Paxton (1968) and by Krefft (1970), except for somewhat fewer gill rakers (4 + 1 + 9-10, total 14-15). All photophores, except the AO series, are missing in the Pacific specimen, but the weakly formed caudal luminous glands, and the general similarity in counts, indicate at least a close relationship to *L. anomala*.

Dorsadena Coleman and Nafpaktitis, 1972

Basically similar to genus *Lampadena* in body structure, arrangement of photophores, and size and positions of caudal luminous glands. It differs principally in having an elongate luminous gland covering the dorsal midline immediately in front of the adipose fin; this gland is in addition to the supracaudal and infracaudal glands. Also head, body, anterior portion of caudal fin, and scale pockets along lateral line bear many tiny secondary photophores. Four or 5 Prc, 1 or 2 far above lateral line near bases of dorsal procurrent caudal rays.

A single species is known.

Dorsadena yaquinae
Coleman and Nafpaktitis, 1972

Fig. 146—*Dorsadena yaquinae*, holotype, 77.0 mm. From Coleman and Nafpaktitis (1972, p. 3, fig. 1).

Description

As I have seen no study material of this species, the following data are taken entirely from Coleman and Nafpaktitis, 1972.

D. 14-15; A. 12-14; P. 15-16; AO 5-7 + 3-5, total 9-11; gill rakers (4) 5 + 1 + 11, total 17 (16); vertebrae—no data.

Dn absent; Vn very small, poorly developed. Body photophores generally small and not well defined (in preserved specimens). PLO slightly before a vertical from pectoral origin. PVO_1 and PVO_2 in a near vertical line; PVO_2 close to middle of pectoral base. PLO, VLO, SAO_3, and Pol respectively about their diameters below lateral line. Six to 8 PO, variably spaced in a wavy line; 3 to 5 (usually 4) VO, none elevated. SAO series in very wide angle, a line through SAO_1 and SAO_2 passing behind SAO_3 and near vent. First and last AOa interspaces occasionally enlarged; first or last AOa, or both, slightly elevated. Pol under base of adipose fin. Prc_{1-2} interspace less than a photophore diameter; Prc_1 slightly lower than Prc_2; Prc_3 well behind a vertical from Prc_2 and at or near end of lateral line; 1 or 2 additional Prc near dorsal procurrent caudal rays.

Supracaudal and infracaudal luminous glands small, undivided, equal in size, and apposed, their length 1.6 to 2.0 times in orbital length. Each gland framed in dark tissue; most of the luminous tissue is covered posteriorly by a darkly pigmented hood. Next to the dorsally displaced Prc, the most definitive character is an undivided luminous gland about equal to the orbital length, extending from anterior end of base of adipose fin to nearly midway to end of base of dorsal fin, the gland outlined by black pigment with luminous tissue bulging dorsally. Many minute secondary photophores on head, body, and anterior part of caudal fin, and in rather regular vertical patterns on scale pockets along lateral line.

Size: To about 100 mm.

Least depth of capture: To 180 m at night.

Distribution: Only five specimens known, taken from a small area of the North Pacific Ocean bounded by about 44° to 45° N, 134° to 139° W.

Lampanyctodes Fraser-Brunner, 1949

The 8 to 10 procurrent caudal rays are stiff and spine-like. Dn, if present, modified into a thin, elongate patch of luminous tissue between anterior portion of supraorbital bone and orbital margin and extending downward nearly to nasal rosette; Vn round, deeply embedded. PVO_1 before and nearly level with PVO_2—a condition similar to that found in the primitive

Electronini subgenera *Protomyctophum* and *Hierops*, and in genera *Benthosema* and *Diogenichthys*. Five PO, the third and fifth slightly but distinctly elevated. Five VO, the first 3 successively elevated in a pattern similar to those of the genera *Lobianchia* and *Diaphus*; last 2 VO essentially on the same level and well below VO_3.

One species is recognized.

Lampanyctodes hectoris (Günther, 1876)

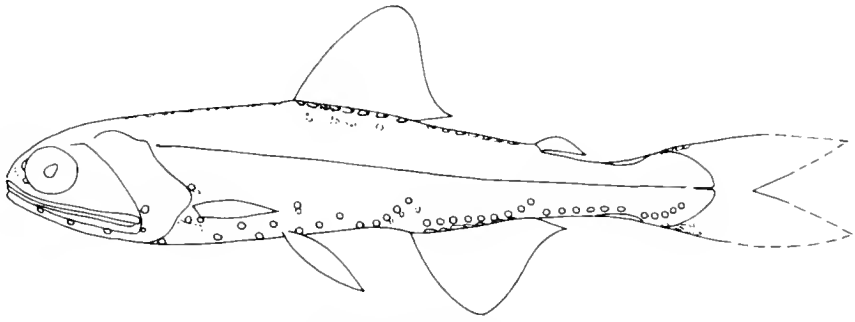


Fig. 147—*Lampanyctodes hectoris*, male, 60.5 mm.

Description

D. 13-14; A. 15-16 (14-17); P. 13 (12-14); AO 8 (7-9) + 6 (4-7), total 13-14 (12-15); gill rakers 10-11 + 1 + 20-21 (19-22), total 30-31 (29-33); vertebrae 37 (36-39).

Three SAO in a straight, equally spaced line about in series with VO_5. No AOa elevated; 1 Pol; 5 (4-6) Prc; all photophores well below lateral line. Dorsal and anal bases about equal in length. Pupil very small, less than diameter of lens.

Size: To about 70 mm.

Least depth of capture: To 220 m at night off South Africa.

Distribution: This species is known from off South Africa, New Zealand, and Australia, and is probably circumglobal near the southern boundary of the Subtropical Convergence; it has not yet been reported from the eastern Pacific Ocean.

Discussion

Lampanyctodes hectoris, an infrequently reported species, is poorly described. The description of the type is inadequate in that neither photophores nor luminous glands are mentioned (Günther, 1876: 471). Gilchrist (1905), in describing this species as *Scopelus argenteus* from off South Africa, presented a more complete description. Fraser-Brunner (1949), in characterizing the genus *Lampanyctodes*, added further details but erred in stating that the procurrent caudal rays were "soft" and spine-like when they are distinctly stiff. He further erred in stating that aside from the small supracaudal and infracaudal luminous glands no luminous glands appeared elsewhere.

In addition to the three or four small luminous scales of the caudal glands, weakly developed, small and fragile, luminous scales are below PVO_1, posteroventrad to PLO, below VLO, and below most if not all AOa photophores, but apparently not below those of the AOp series. There are also one or two rows of very small luminous scales under most of the Prc photophores. Similar scales are present at bases of most dorsal procurrent caudal rays behind the supracaudal gland, possibly on each scale pocket between end of dorsal base and origin of adipose base, between origin of dorsal base and occipital region of head, and at bases of most dorsal fin rays.

Since detailed counts and measurements for *L. hectoris* are not available in the literature, correlated counts for dorsal and anal fin rays, AO photophores, and gill rakers (Table 26), and a list of body proportions are offered, based on material from near South Africa.

TABLE 26. CORRELATED COUNTS OF ANAL AND DORSAL FIN RAYS, AO PHOTOPHORES, AND GILL RAKERS FOR *LAMPANYCTODES HECTORIS* FROM NEAR SOUTH AFRICA

		Anal rays			
		14	15	16	17
Dorsal rays	13	2	5	4	2
	14	—	18	13	1

		AOp			
		4	5	6	7
AO_a	7	—	3	59	8
	8	1	47	112	3
	9	—	7	6	—

		Lower rakers (including central raker)			
		19	20	21	22
Upper rakers	10	4	27	17	—
	11	—	5	14	5

The following body proportion of *Lampanyctodes hectoris* are based on 15 to 17 specimens, 37.5 to 61.9 mm in length. Averages are given first, followed by the range of values in parentheses.

Head length 308 (293-326); head depth (on a vertical through angle of jaw) 199 (191-208); orbital diameter 90 (81-99); upper-jaw length 236 (223-251); prepectoral length 320 (302-338); prepelvic length 447 (429-466); preanal length 631 (612-655); predorsal length 449 (432-466); preadipose length 814 (797-828); dorsal origin to pelvic origin 191 (176-204); dorsal origin to anal origin 276 (262-293); caudal peduncle length 201 (187-213); caudal peduncle depth 83 (76-88); dorsal base length 177 (165-187); anal base length 197 (180-208).

Stenobrachius Eigenmann and Eigenmann, 1890

Vn present, no Dn. SAO in relatively straight line, in line, or nearly so, with last VO. One Pol. PO_4 much elevated; VO level. Supracaudal and infracaudal glands present in both sexes.

Key to species of *Stenobrachius*

1a. Usually 4 (3-5) VO, the VO_{1-2} interspace larger than the rest. Usually 4 (3-5) Prc, in even curve. Numbers of SAO variable, usually counted as 3, but 2 or 4 not uncommon. Supracaudal gland with 5-8 luminous scales; infracaudal with 7-9 scales, filling entire space. Body moderately robust ..... *S. leucopsarus*

1b. Usually 5, rarely 4, VO; usually 3, rarely 4, Prc. Supracaudal luminous glands 2-4; infracaudal glands 5-6, filling only about three-fourths of infracaudal space. Body slender, elongate ..... *S. nannochir nannochir*

Stenobrachius leucopsarus
(Eigenmann and Eigenmann, 1890)

Description

D. 14 (13-15); A. 15 (14-16); P. 9 (8-10); AO 6 (5-7) + 7 (6-8), total 13 (12-14); gill rakers 5 (6) + 1 + 12 (11-13), total 18 (17-19); vertebrae 36 (35-37).

Descriptive data, other than that in key to species, is given below in a discussion of differences between *S. leucopsarus* and its congener *S. nannochir*.

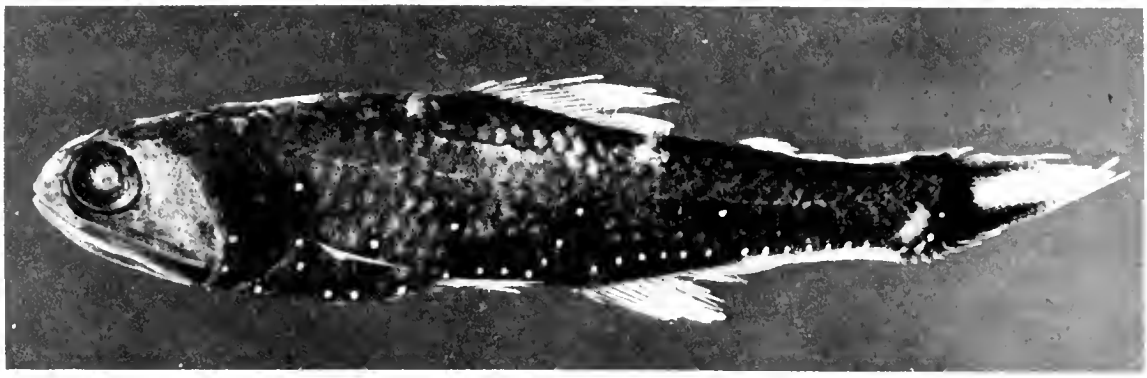


Fig. 148—*Stenobrachius leucopsarus*, male, 77.0 mm.

Size: To about 90 mm.

Least depth of capture: Rarely dipnetted, but commonly taken above 30 m at night.

Distribution: S. leucopsarus is confined to the North Pacific cold water areas. It occurs from off Baja California, Mexico (about 29° N, 115° W) northward into Gulf of Alaska and Bering Sea and west to Kamchatka and Kurile Islands (Fig. 149). Capture data from Aron, (1960, Fig. 149, dotted lines) indicate that the species is abundant in northern waters; the solid line enclosing near-shore water off southern California, indicates an area in which hundreds of specimens have been taken. Paucity of capture localities in northwestern Pacific may reflect minimal collecting effort.

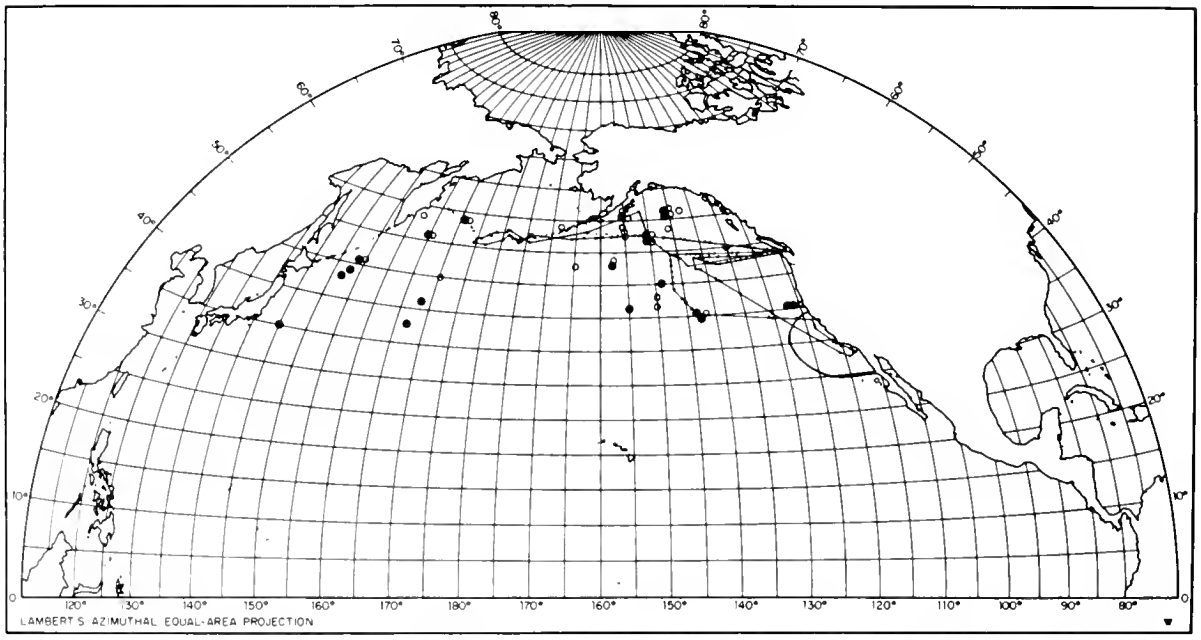


Fig. 149—Capture localities for *Stenobrachius n. nannochir* (large solid circles) and *S. leucopsarus*. For this latter species, the heavy curved line off southern California and northern Baja California, Mexico, encloses an area in which many collections (hundreds of specimens) were made. The thin, straight lines indicate the cruise tracks of expeditions reported by Aron (1960), each dot representing at least one capture of this species. The open circles indicate additional captures of *S. leucopsarus*.

Stenobrachius nannochir nannochir
(Gilbert, 1890)

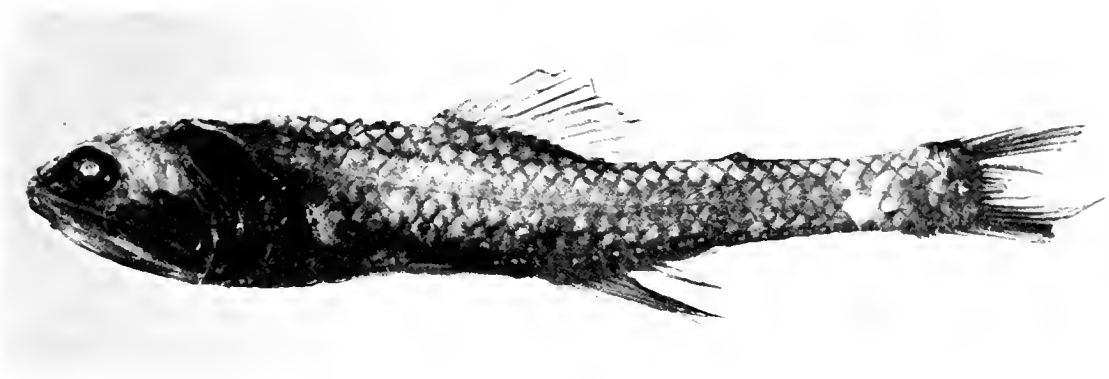


Fig. 150—*Stenobrachius n. nannochir*, female, 107.0 mm.

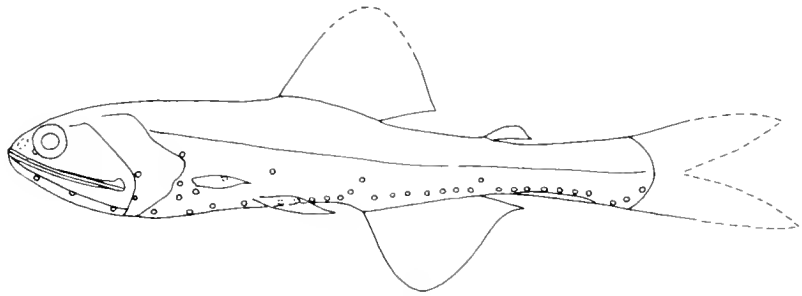


Fig. 151—*Stenobrachius n. nannochir*, drawing of specimen in Fig. 150.

Description

D. 14 (13); A. 15 (14-16); P. 9 (10); AO 7 (6-8); total 13-14 (15); gill rakers 5-6 + 1 + 12 (11-13), total 18-19 (17-20); vertebrae 37 (36-38).

Size: To about 110 mm.

Least depth of capture: To 300 m in daylight (See Discussion).

Distribution: In the eastern Pacific this is a more northern form than *S. leucopsarus*. Off California it is not taken south of about 40° N; it ranges north into Gulf of Alaska and across the North Pacific (Fig. 149). A subspecies, *S. n. laticauda* Kulikova (1960), occurs in Okhotsk Sea, but the eastern range of this subspecies, or any overlap in distribution of the two forms, is not known.

Discussion

S. n. nannochir and its congener *S. leucopsarus* are somewhat similar and have been confused although they are readily separable. In addition to the principal characters given in the key to species, the following may be of aid in distinguishing between the two: In general, *S. leucopsarus* has a more robust body; the depth at pectoral origin is 21% of SL, *vs* about 19% in *S. n. nannochir*. The eye is slightly smaller and the upper jaw distinctly longer in *S. n. nannochir*, such that the eye is 30% (28-33%) of upper jaw *vs* 38% (34-41%) in *S. leucopsarus*. Also, the caudal peduncle is more slender in *S. n. nannochir*, its least depth being 30% (28-33%) of its length *vs* 36% (33-40%) in *S. leucopsarus*.

In life, and persisting for some time in preservative, the photophores of *S. leucopsarus* are yellowish-green in color, and those of *S. n. nannochir* claret.

S. n. nannochir is apparently a deeper-living form than *S. leucopsarus*. Aron (1960) reported many captures of the latter species, but none of the first, in the North Pacific Ocean; most of Aron's sampling was at depths above 225 m at night, with but few to 400 m. Pearcy (1964) reported 2 specimens of *S. n. nannochir* from 23 tows taken between 0 and 500 m, and 39 specimens from 24 tows taken between 0 and 1000 m, all about 50 mi (80 km) off Newport, Oregon.

Parvilux Hubbs and Wisner, 1964

Body elongate, slender, moderately compressed, the musculature rather weak and flaccid as in deep-living lampanyctids. Caudal peduncle moderately deep, about half the greatest depth of body. SOA in straight or slightly angulate oblique line. Procurrent caudal rays stiff and spinelike. Body photophores very small. PO_4 highly, PO_3 slightly, elevated. Upper Prc at lateral line and widely separated from the rest. Pectoral fins very weak and short.

Key to species of *Parvilux*

1a. Supracaudal and infracaudal glands short, of about 4 luminous scales each. VLO nearer lateral line than to ventral profile. SAO_3 over or before a vertical from anal origin ..... *P. ingens*

1b. Supracaudal and infracaudal glands longer, of about 6 or 7 luminous scales each. VLO nearer ventral profile than to lateral line. SAO_3 well behind a vertical from anal origin ..... *P. boschmai*

Parvilux ingens
Hubbs and Wisner, 1964

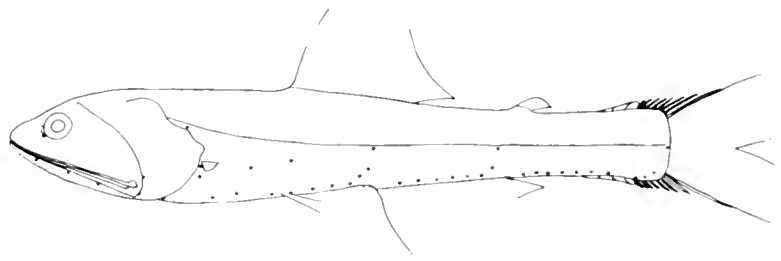


Fig. 152—Parvilux ingens, holotype, 160.0 mm. From Hubbs and Wisner 1964, p. 459, fig. 4).

Description

D. 14-17; A. 15-18; P. 10-13; AO 6 (5-7)+ 7 (6-8), total 13 (11-15); gill rakers 5 (4-6)+ 1+ 12 (11-14), total 17 (15-19); vertebrae 37 (36-38).

PO_4 elevated to about level of PVO_2; PO_3 elevated by about its diameter above level of PO_2 and PO_5. VLO below lateral line by about one-third of distance from VLO to ventral profile and about over VO_1; 3 to 6 VO (usually 4). SAO series slightly angulate, first 2 in line with VO_5, uppermost at lateral line and about over anal origin. AOa series level. AOp and Prc series not continuous.

Size: To about 200 mm.

Least depth of capture: To 155 m at night.

Distribution: This species is apparently confined to northeastern Pacific Ocean. It is presently known from between about 28° and 40° N and seaward to about 130° W (one specimen known from near 41° N, 146° W). It is mostly confined to the California Current.

Parvilux boschmai
Hubbs and Wisner, 1964

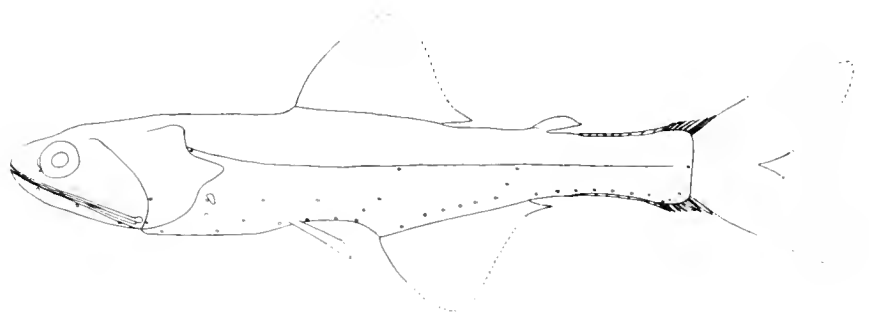


Fig. 153—*Parvilux boschmai*, holotype, 113.0 mm. From Hubbs and Wisner (1964, p. 458, fig. 5).

Description

D. 16-17; A. 17 (16-18); P. 12 (11-13); AO 6 (5-7)+ 7 (6-8), total 13 (12-14); gill rakers (4)5 + 1 + (10) 11-12, total 17-18 (one specimen had 4 + 1 + 10, each side); vertebrae 36-37 (35-38).

The species *Parvilux boschmai* was based on the holotype and only known specimen, but 12 additional specimens (101-126 mm) were available for the present study.

PLO, SAO_3, upper Pol, and Prc touch or are very near lateral line. PO_4 high, about on level of pectoral origin and slightly below, rarely on, level of VLO; PO_4 usually nearer a vertical from PO_3 than from PO_5 but occasionally midway between. VLO midway between, often slightly nearer, lateral line than level of VO_1 (nearer VO_1 in one specimen) and usually nearer a vertical from VO_1 than from VO_2. Four VO (holotype has only 3 VO) about equally spaced. SAO series slightly to moderately angulate; SAO_1 on or a little behind, rarely slightly before, a vertical from VO_5; SAO_2 variously somewhat before, on, or behind a vertical from first AOa. First AOa depressed, AOa_{1-2} interspace wider than those of remaining AOa. AOp and Prc series usually continuous; Prc_4 widely distant from Prc_3.

Dn apparently absent; in the original description it was suggested that the Dn, if present, was represented merely by a streak of silvery tissue, but study of the new material shows this streak to be connective tissue. Vn prominent but often well covered with darkly pigmented tissue.

Perhaps the most significant changes in the original description of *P. boschmai* are an increase from 3 VO to 4 (although holotype has but 3 equally spaced VO) and reduction in length of supracaudal gland; in holotype this gland was 14.2% of standard length but only 8.9% (7.1-11.6%) in the 12 new specimens.

Certain body proportions are given below, including those for the holotype; the average value is given first, followed by range in parentheses:

Head length 289 (273-310); head depth 155 (151-169); length of orbit 52 (48-60); length of upper jaw 200 (190-210); prepectoral length 288 (274-304); prepelvic length 401 (388-421); preanal length 545 (528-582); predorsal length 440 (414-464); preadipose length 791 (778-811); dorsal origin to pelvic origin 169 (147-176); dorsal origin to anal origin 206 (190-223); length of

dorsal base 208 (191-223); length of anal base 215 (206-232); length of caudal peduncle 252 (224-270); depth of caudal peduncle 80 (71-88); length of supracaudal luminous gland 89 (71-116); length of infracaudal luminous gland 134 (109-159).

Size: To 126 mm.

Least depth of capture: To 370 m at night.

Distribution: P. boschmai is presently known only from the following five localities in the eastern Pacific Ocean: 02° 09′ N, 84° 53′ W (holotype), 08° 57′ S, 107° 44′ 107° 44′ W (one specimen), 14° 46′ S, 93° 37′ W (one specimen), 20° 00′ N, 129° 00′ W (one specimen) and 11° 49′ N, 144° 51′ W (nine specimens).

Triphoturus Fraser-Brunner, 1949

Five VO, 1 or more highly elevated and displaced forward. SAO markedly angulate. Two Pol. PLO, VLO, SAO_3, and Pol on or a little above lateral line; upper Prc well above and behind end of lateral line. Usually only 3 Prc, separate from AOp. Vn present, Dn absent. Pectoral fins tiny.

Key to species of *Triphoturus* in eastern Pacific Ocean

1a. VO_1 and VO_2 highly elevated and displaced forward to before verticals from VO_2 and VO_3, respectively. PVO_1 well before vertical from PVO_2 ..... *T. mexicanus* (a complex)

1b. Only VO_1 elevated and displaced forward to before VO_2. PVO_1 almost directly below PVO_2 ..... *T. nigrescens*

Triphoturus mexicanus species complex (Gilbert, 1890)

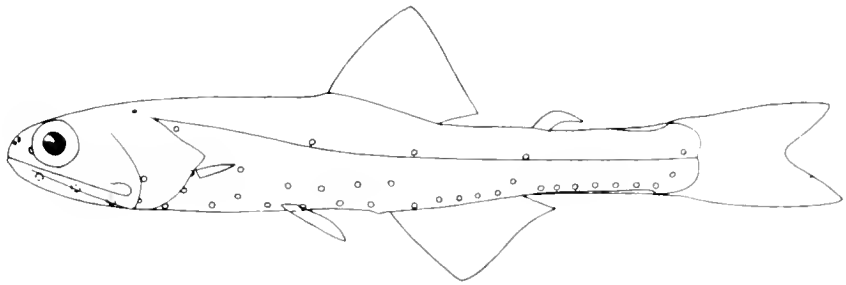


Fig. 154—*Triphoturus mexicanus*. From Bolin (1939, p. 136, fig. 21).

Description

PLO below but nearly touching lateral line; all other upper photophores a little above lateral line. PO_4 and SAO_{1-2} about on a straight line that passes well above VO_2 and VO_3. SAO_1 well behind a vertical from VO_4. Infracaudal luminous gland long, reaching to, or nearly to, end of anal base.

The outline sketch (Fig. 154) is representative of all forms, since all are superficially very similar.

In the eastern Pacific, two species and a probable subspecies are found, based primarily on numbers of gill rakers and vertebrae (Table 27). Moser and Ahlstrom (1970, p. 114) stated that, based on distinctiveness of the larvae, the southern form is referrable to *Triphoturus oculeus* (Garman, 1899).

Size: To about 70 mm.

Least depth of capture: To about 50 m (rarely less) at night.

Distribution: The species comples of *T. mexicanus* extends from about 38°N to 35°S, from off San Francisco, California, to a little south of Valparaiso, Chile (Fig. 156). As indicated (Table 27), the Gulf of California harbors a population that differs significantly from that of the open ocean, extending from near the tip of Baja California Peninsula northward.

Moser and Ahlstrom (1970, p. 114) stated that *T. oculeus* ranged from Panama to Peru. However, *T. oculeus* ranges somewhat farther to the north and much father south (Fig. 155). Bussing (1965) reported the species from near Valparaiso, Chile, and Craddock and Mead (1970) reported it from there and westward to about 76°W, between about 31° and 35°S.

TABLE 27. SOME MERISTIC CHARACTERS OF THE TWO FORMS OF *TRIPHOTURUS MEXICANUS* AND FOR *T. OCULEUS*.

	T. mexicanus		*T. oculeus*
Character	Oceanic form (ca 20° to 30° N)	Gulf of California	S.E. Pacific (ca 13° N to 35° S)
Total gill rakers	17 (15-18)	18 (16-20)	14 (11-16)
Vertebrae	34 (32-36)	32 (30-33)	34 (32-35)
Total AO photophores	10 (9-11)	9 (8-10)	10 (8-12)
Dorsal rays	14 (13-16)	13 (12-15)	14 (12-15)
Anal rays	15 (14-17)	15 (13-16)	15 (14-16)
Pectoral rays	9 (8-10) for all three forms.		

Triphoturus nigrescens
(Brauer, 1904)

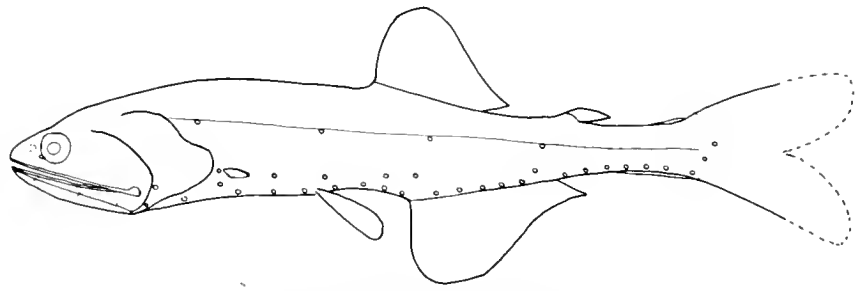


Fig. 155—*Triphoturus nigrescens*, 34.8 mm.

Description

D. 14 (13-15); A. 17 (16-18); P. 9 (8-10); AO 5 (4) + 6 (5), total 11 (10); gill rakers 3 (2-4) + 1 + 8 (7-10), total 12 (10-14); vertebrae 33-34.

Only upper Prc is above lateral line, all other upper photophores below but touching that line. VO_2 about on line through PVO_2, PO_4, and SAO_{1-2}. Infracaudal luminous gland short, ending far behind end of anal base.

Size: To about 40 mm.

Least depth of capture: To 24 m at night.

Distribution: In eastern Pacific Ocean *T. nigrescens* appears to be widely spread between about 30° N and 30° S. It is a warm water species, not taken in California Current system, but rather common in central water masses. It occurs across the Pacific and into the Indo-Pacific

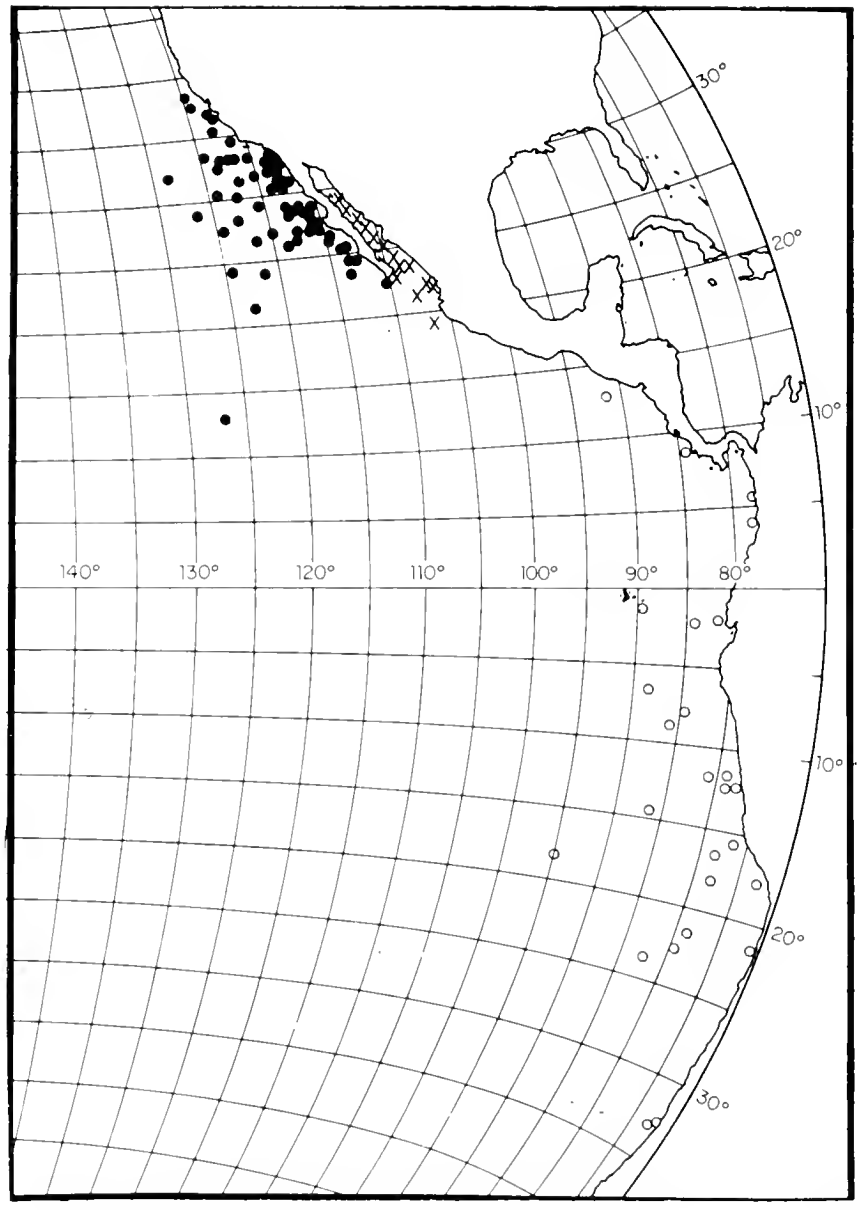


Fig. 156—Capture localities for *Triphoturus mexicanus* (solid circles) and *T. oculeus* (open circles).

and Indian Ocean areas. The exact distribution is open to some question because of taxonomic confusion (see *Discussion*).

Discussion

The name *T. microchir* Gilbert (1913) is herein synonymized with *T. nigrescens* (Brauer, 1904) as I cannot find any differences that warrant retention of Gilbert's species. I find that all characters overlap completely.

These two species appear to have been confused primarily because of Fraser-Brunner's illustrations showing the PO_4 to be well above the origin of the pectoral fin in *T. nigrescens*, as

also shown by Brauer, (1906, p. 241, fig. 158), and below that origin in *T. microchir*, as described, without figure, by Gilbert (1913, p. 101-103). In a total of 150 specimens from the southeastern Pacific and the Indo-Pacific area and South China Sea, I found no PO_4 above the level of the pectoral origin; in fact, many were below the level of the bases of lower pectoral rays, or between there and the first ray. Nafpaktitis and Nafpaktitis (1968, p. 57, fig. 70, as *T. microchir*) showed the PO_4 to be no higher than the pectoral origin.

Another species, *T. micropterus*, placed in the genus *Triphoturus* by Fraser-Brunner (1949), may also be discussed here. It was described and figured by Brauer (1906, p. 239-240, fig. 157) as *M. (Lampanyctus) micropterum*). Brauer's study material was from the Atlantic Ocean (Gulf of Guinea) and the Indian Ocean (from near Sumatra to near the Seychelles). Brauer gave some body proportions for two specimens, for example 3.1 and 7.2 cm "körperlänge," and stated that the largest specimen was 7.4 cm and the smallest 1.5 cm. It is quite probable that Brauer based his species on a mixed material, for of the large material of the genus *Triphoturus* before me (excluding species of the *mexicanus* complex) the largest specimen is but 4.0 cm SL. Also, the genus *Triphoturus* has not been since reported from the Atlantic Ocean. Bolin (1959) did not list the genus from the large Michael Sars collection from the North Atlantic, nor did Becker (1967a) from the large material gathered by the R/V PETR LEVEDEV from throughout the Atlantic Ocean.

Bolin (unpublished notes) examined a 15.2-mm specimen (Berlin Mus. no. 19375), determined by Brauer to be *micropterum*, and stated that the specimen differed in several respects from Brauer's figure and description, notably in having only "13½" anal rays. Other differences listed by Bolin are: the AOa forms a light arc anteriorly; there are 4 Prc in an even arc with the last interspace markedly enlarged; the AOa-Prc interspace is equal to about half the depth of the caudal peduncle; and there are 5 dorsal and 5 ventral luminous scales before procurrent caudal rays. Bolin further stated that the specimen was in poor condition, and he added a note that the broadness of the pectoral base indicated that it might possibly be a somewhat aberrant juvenile (*Lampanyctus*) *macropterus*.

In view of Bolin's findings, and the quite large size of at least two specimens of Brauer's type material (72-74 mm), the species *micropterus* is in some doubt. Holotypes of Gilbert's *T. microchir* and Brauer's *T. nigrescens* and *T. micropterus* must be compared before the taxonomy of these forms is fully understood.

Meanwhile it seems best to apply the name *nigrescens* to at least eastern Pacific material.

Lampanyctus Bonaparte, 1840

Upper jaw long, slender, slightly but abruptly expanded posteriorly. No Dn; Vn small; PVO_1 always well below PVO_2. Five PO, the fourth elevated. 4 VO, the second elevated in some species. Two Pol. Four Prc. Scale-like luminous glands on both dorsal and ventral surfaces of caudal peduncle; some species bear a few similar scales on base of adipose fin. No luminous scales at bases of dorsal, anal, or pectoral fins. One or more primary photophores on cheeks and minute secondary ones on head and body in some species.

In the eastern Pacific Ocean, the genus *Lampanyctus* is reasonably well understood, except for a few troublesome species groups. One group involves *L. tenuiformis* (Brauer, 1906), *L. festivus* Tåning, 1928, and possibly *L. steinbecki* Bolin, 1939; the first two species were described respectively from the Indian and Atlantic oceans, but study material is scant and very few specimens have been reported on in detail. *L. steinbecki*, described from off southern California, is well represented in collections and is herein considered a valid species; however, adequate material of the first two species must be compared with the latter before firm conclusions as to synonymy are warranted. A second group involves *L. niger* (Günther, 1887) and *L. ater* Tåning, 1928; these species are very similar and are poorly understood in the world oceans. Also, *L. achirus* Andriashev is quite variable and involves two or more species.

In addition to these troublesome groups, there are a few specimens before me, in poor condition, that bear such abnormalities as 5 VO, or the SAO_1 well behind a vertical from VO_4. These specimens, not discussed further, cannot now be properly assigned, because other useful characters are too often eroded away. Also, many specimens, obviously Lampanyctids, are unidentifiable because of severe damage to head and body, or complete denudation—conditions common in the more fragile species.

Key to species of *Lampanyctus*

1a. Pectoral fin short, weak, narrow-based, or entirely absent. If present, width of the base equal to or less than shortest distance between lower orbital margin and toothed margin of upper jaw. No prominent photophore on cheek, but a small Bu may be present posteroventrally just above margin of upper jaw. No luminous gland at base of adipose fin; no minute secondary photophores under scales of body and head 2

1b. Pectoral fin long, broad-based; width of base greater than shortest distance between lower orbital margin and toothed margin of upper jaw. Some species bear 1 or more prominent photophores on cheek, a luminous gland at base of adipose fin, and minute secondary photophores under scales of body and head 7

2a. VLO well below lateral line 3

2b. VLO at or near lateral line 6

3a. SAO_1 over or slightly before VO_4. SAO_2 well behind, SAO_3 far behind, origin of anal base. Bu present ..... *L. idostigma*

3b. SAO_1 about over VO_3. SAO_2 over or slightly before origin of anal base. Bu present 4

4a. Photophores notably small. SAO_2 and SAO_3 both before anal origin. VLO well above a line from SAO_{1-2}. Bu present ..... *L. regalis*

4b. Photophores not notably small 5

5a. SAO_2 about over, SAO_3 slightly behind, anal origin. VLO on a line from SAO_{1-2}. Bu present. Infracaudal gland with 6 (5-7) luminous scales filling three-fourths or less of infracaudal space ..... *L. ritteri*

5b. SAO_2 well before, SAO_3 well behind, anal origin. VLO slighly above line from SAO_{1-2}. VO_2 slightly but distinctly elevated. Bu present; 8-9 (7-10) luminous scales in infracaudal gland filling, or nearly so, infracaudal space ..... *L. fernae*

6a. Infracaudal gland with 7 to 9 luminous scales. Pectoral fin absent or reduced to a few filamentous rays. SAO_3 above third or fourth anal ray. Upper Pol on or slightly behind vertical from base of last anal ray ..... *L. achirus* (A complex)

6b. Infracaudal gland with 3 to 5 luminous scales. Pectoral fin usually present but small and fragile. SAO_3 over origin of anal base. Upper Pol before vertical from base of last anal ray ..... *L. niger*

7a. No photophores on cheek; no luminous scale at base of adipose fin; no minute secondary photophores on body 8

7b. One or more photophores on cheek; 1 or more luminous scales at base of adipose fin (absent in one species); minute secondary photophores present and more or less prominent 17

8a. First 3 Prc in a slightly curved, nearly horizontal line; Prc_4 usually widely separate from the rest 9

8b. First 3 Prc not on a nearly horizontal line, last 3 about equally spaced on an oblique, usually straight line; Prc_4 not widely separate from the rest 12

9a. Nine to 11 procurrent caudal rays. VO_2 elevated but not displaced forward, VO series curved and about equally spaced. AOa series curved. Seven to 8 luminous scales in infracaudal gland ..... *L. acanthurus*

9b. No more than 8 ventral procurrent caudal rays 10

10a. VO and AOa series distinctly curved. VO_2 elevated but not displaced forward, VO series about evenly spaced. VLO nearer lateral line than to pelvic base. SAO_1 slightly above level of SAO_2; a line through them passes slightly below VLO and far below PLO. Seven to 9 luminous scales in infracaudal gland ..... *L. festivus*

10b. VO and AOa series in straight or very slightly curved line 11

11a. SAO_1 above level of SAO_2. VLO much nearer lateral line than to pelvic base. Line through SAO_2, SAO_1, and VLO passes near PLO. Five to 6 luminous scales in infracaudal gland ..... *L. steinbecki*

11b. SAO_1 on or below level of SAO_2. VLO about midway between lateral line and pelvic base. Line through SAO_2, SAO_1, and VLO passes far below PLO. Six luminous scales in infracaudal gland ..... *L. tenuiformis*

12a. VO_2 moderately elevated but not displaced forward. VLO about midway between lateral line and pelvic base, slightly above or on a line from PLO to SAO_1. SAO_1 distinctly below level of SAO_2. Prc_4 usually notably well back on bases of caudal rays; Prc_{3-4} interspace somewhat greater than that between the others ..... *L. nobilis*

12b. VO_2 markedly elevated and displaced forward to near VO_1 13

13a. VO_2 elevated and displaced forward to before vertical from VO_1. VLO at lateral line. Prc_2 offset posteriorly to below Prc_3. First, third, and fourth Prc form a straight, steeply oblique line. Three or 4 AOp over anal base ..... *L. hubbsi*

13b. VO_2 elevated and displaced forward to slightly behind vertical from VO_1. VLO several of its diameters below lateral line 14

14a. Prc_2 slightly offset to under or behind Prc_3; first 2 Prc often smaller than last 2. One, rarely 2, AOp over anal base. Seven to 8 luminous scales in infracaudal gland ..... *L. macropterus*

14b. Prc_2 not offset posteriorly, but forms a steeply oblique line with Prc_3 and Prc_4 15

15a. PVO_1 over or slightly before a vertical from PVO_2. Prc_2 not offset posteriorly. Two or 3 AOp over anal base. Seven to 9 luminous scales in infracaudal gland ..... *L. omostigma*

15b. PVO_1 well behind vertical from PVO_2. Infracaudal gland short, with 5 or 6 (4-7) luminous scales, filling no more than 75% (usually much less) of infracaudal space ..... *L. parvicauda*

16a. AOa series abruptly angulate, not evenly curved. Extra PLO close above and behind origin of pectoral fin 17

16b. AOa series straight or evenly curves; AOa_2 and/or AOa_3 may be slightly depressed. No extra PLO 18

17a. Second to fourth AOa variously and abruptly elevated; first, fifth, and succeeding ones never elevated. Extra PLO near pectoral origin strongly developed. Secondary photophores weakly developed, persistant only near lateral line ..... *L. jordani*

17b. Only AOa_2 and AOa_3 abruptly elevated (often only slightly so). Extra PLO well developed. Secondary photophores very weakly developed ..... *L. simulator*

18a. Three to 5 luminous scales in infracaudal gland 19

18b. Seven to 9 luminous scales in infracaudal gland 20

19a. No luminous scale at base of adipose fin. VLO about midway between lateral line and pelvic base. AOa series slightly curved. Secondary photophores well developed. Pectoral fin reaching to about AOa_1 ..... *L. pusillus*

19b. Luminous scale present at base of adipose fin 21

20a. Gill rakers 3-4 + 1 + 8-9. VLO at lateral line. One cheek photophore; secondary photophores prominent. SAO_1 about over VO_3. Pectoral fin long, reaching to Pol ..... *L. alatus*

20b. Gill rakers 5-7 + 1 + 12-14 ..... *L. australis*

21a. Gill rakers 6-8 + 1 + 14-18. VLO about midway between lateral line and pelvic base, and behind vertical from VO_3. Secondary photophores weakly developed, persistent only near Lateral line ..... *L. macdonaldi*

21b. Gill rakers 4-5 + 1 + 9-12. VLO about over midpoint of VO_{2-3} interspace. One or 2 cheek photophores 22

22a. AOa series in a slighly arched line; AOa_{1-2} interspace wider than others of the series. VLO no higher than midway between pelvic base and lateral line. VLO, SAO_1, and SAO_2 in nearly straight, horizontal line. Pectoral fin short, reaching to about pelvic base; width of pectoral base 28% (24-31%) of length of orbit. Two photophores on cheek. Secondary photophores well developed. 7 (8-9) luminous scales in infracaudal gland .....*L. iselinoides*

22b. VLO above level of SAO_1 23

23a. Width of pectoral base 55% (50-60%) of length of orbit. Pectoral fin reaching to between AOa_2 and AOa_5. SAO_1 above level of SAO_2, the 2 usually forming straight line with VLO. AOa_2, and often AOa_3, usually depressed below level of adjacent AOa. Two, rarely 1, cheek photophore. Body photophores not unusually small; secondary photophores weakly developed, persistent only near lateral line ..... *L. intricarius*

23b. Width of pectoral base 39% (35-42%) of length of orbit. Pectoral fin reaching to between VO_2 and VO_3. SAO_1 below level of SAO_2, line through them passing far below VLO. AOa_2 and AOa_3 occasionally depressed below level of adjacent AOa. One, rarely 2, cheek photophores. Body photophores very small; secondary photophores well developed, persistent over entire body .....*L. lepidolychnus*

Lampanyctus ritteri
Gilbert, 1915

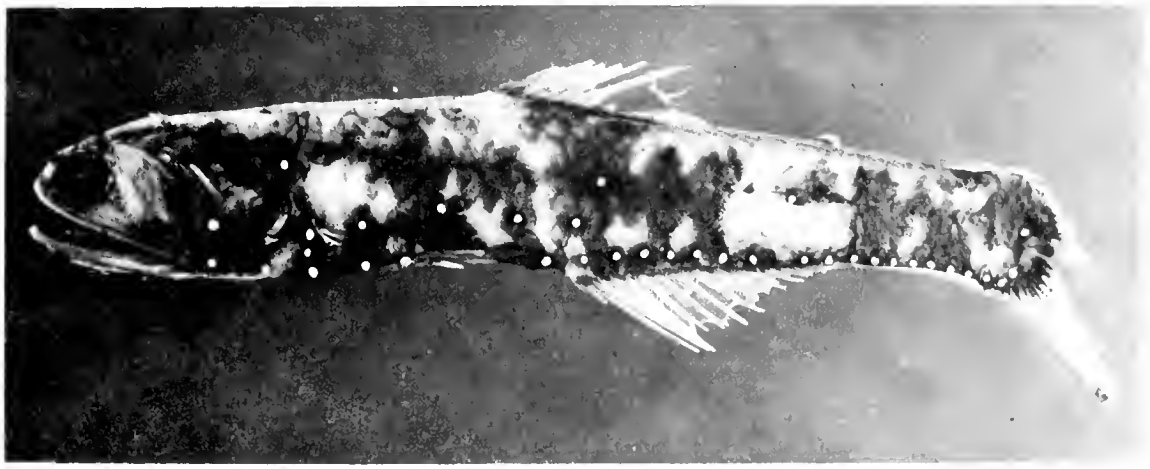


Fig. 157—*Lampanyctus ritteri*, male, 108.0 mm.

Description

D.13 (13-15); A. 18 (17-19); P. 11 (11-12); AO 7 (6-8) + 8 (9), total 15 (14-17); gill rakers 4 + 1 + 9 (8-10), total 14 (13-15); vertebrae 36 (35-38).

Body moderately robust, its depth at pelvic origin about 18% of SL; caudal peduncle deep, about 10% of SL. Infracaudal luminous gland covering no more than three-fourths (usually less) of the ventral surface of the caudal peduncle. VO_2 not elevated. VLO on line through SAO_1 and SAO_2 and a little below midway between lateral line and pelvic base. SAO_3 well behind from anal origin. Prc_4 slightly behind vertical from Prc_3.

Size: To about 120 mm.

Least depth of capture: To about 20 m at night.

Distribution: Apparently confined to colder waters of the northeastern Pacific (Fig. 158). It ranges from about 25° N off Baja, California, Mexico, to about 46° N off Vancouver Island, Canada. Aron (1960) reported captures as far west as about 146° W. Solitary captures of what

appear to be *L. ritteri* have been made to 153° W at about 37° N. The species has not been reported from outside these limits.

Discussion

L. ritteri appears to be most closely related to *L. fernae*. It differs, in part, in certain meristic characters (Table 28) and in having a shorter infracaudal luminous gland and a generally more robust body (Table 29).

TABLE 28. CORRELATED COUNTS OF DORSAL AND ANAL FIN RAYS, AO PHOTOPHORES, AND GILL RAKERS FOR *LAMPANYCTUS FERNAE* AND *L. RITTERI* (COUNTS UNDERLINED).

		Anal fin rays				
		16	17	18	19	20
Dorsal fin rays	12	1	2	—	—	—
	13	3 <u>1</u>	8 <u>5</u>	2 <u>4</u>	—	<u>1</u>
	14	<u>1</u>	4 <u>14</u>	1 <u>15</u>	<u>4</u>	—
	15	—	<u>3</u>	<u>6</u>	—	—
		AOp				
		7	8	9	10	
AOa	5	—	1	6	4	
	6	—	22 <u>7</u>	21 <u>9</u>	3	
	7	2	2 <u>57</u>	1 <u>20</u>	—	
	8	<u>1</u>	<u>2</u>	—	—	
		Lower rakers (including central raker)				
		9	10	11	12	13
Upper rakers	4	<u>4</u>	<u>81</u>	7 <u>3</u>	39	2
	5	—	<u>1</u>	—	7	1

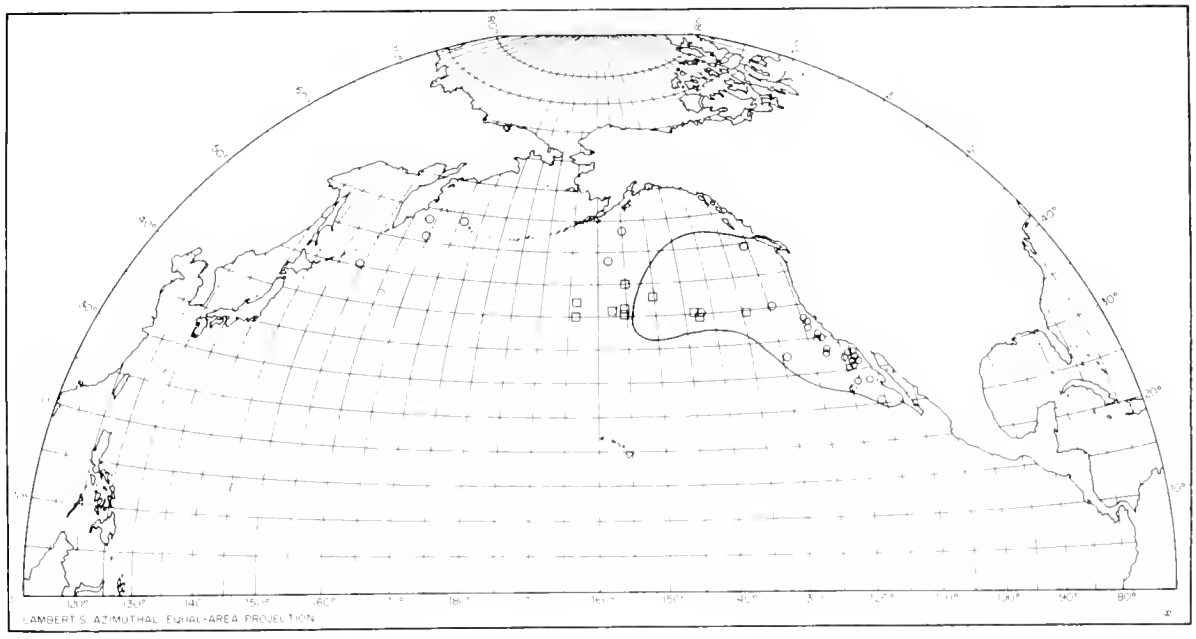


Fig. 158—Capture localities for *Lampanyctus ritteri* (many eastward of curved line), *L. fernae* (open squares) and *L. regalis* (open circles).

TABLE 29. BODY PROPORTIONS FOR *LAMPANYCTUS FERNAE* AND *L. RITTERI*.

Measurement	*L. fernae*			*L. ritteri*	
	Holotype* SL-76.3mm	Paratypes N= 20 SL-41-90mm		N= 18 SL-47-98mm	
		Ave.	Range	Ave.	Range
Head length	257	250	235-264	286	272-300
Head depth	149	146	130-159	173	162-180
Orbit length	62	61	57-66	65	59-73
Upper jaw length	181	174	154-187	202	194-212
Prepectoral length	266	263	254-275	298	280-312
Prepelvic length	389	387	371-408	413	391-429
Predorsal length	470	461	445-481	475	454-495
Preanal length	539	548	538-562	555	544-566
Preadipose length	786	782	758-806	800	782-813
Dorsal origin to pelvic origin	179	169	159-180	186	169-202
Dorsal origin to anal origin	199	191	176-201	213	190-226
Dorsal base length	149	152	140-164	167	152-187
Anal base length	214	215	198-229	233	223-255
Caudal peduncle length	245	259	242-280	224	211-245
Caudal peduncle depth	88	84	69-99	105	85-115
Supracaudal gland length	79	80	66-96	55	42-72
Infracaudal gland length	207	207	182-232	126	77-145

*Data from Wisner, 1971.

Lampanyctus fernae
Wisner, 1971

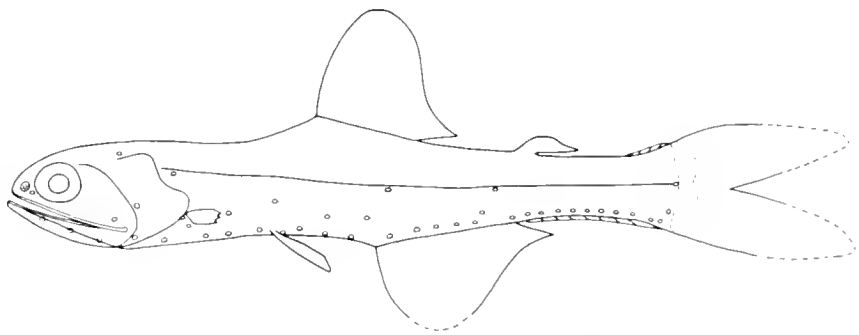


Fig. 159—*Lampanyctus fernae*, holotype, 76.3 mm. From Wisner (1971, p. 50, fig. 6).

Description

D. 13 (12-14); A. 17 (16-18); P. 13 (12-14); AO 6 (5-7)+ 8-9 (7-10), total 14-15 (13-16); gill rakers 4 (5)+ 1+ 11 (10-13), total 16 (15-18); vertebrae 37 (36-38).

Correlated counts of dorsal and anal fin rays, AO photophores and gill rakers (Table 28), and body proportions (Table 29) are given for *L. fernae* and are compared with similar data for *L. ritteri*.

Size: To about 90 mm.

Least depth of capture: To 200 m at night.

Distribution: Presently known from a rather restricted area of the North Pacific Ocean, about 40° to 45° N, 135 to 165° W (Fig. 158).

Discussion

Lampanyctus fernae is basically similar to *L. ritteri* (Fig. 157) and has been found so misidentified in some collections of that species. It differs from *L. ritteri* in having more gill rakers, more scales in the infracaudal luminous gland (this gland longer and reaching to end of anal base instead of but one-half to three-fourths that distance, as in *L. ritteri*), a shorter and less deep head, and a generally more slender body. Also, the VO_2 is slightly but distinctly elevated, although not displaced forward, and the VLO is notably higher. Prc_1 lies well behind rather than over or a little before a vertical from Prc_3.

Lampanyctus regalis

(Gilbert, 1891)

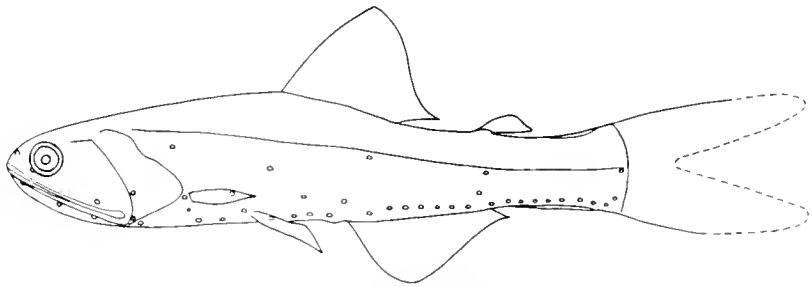


Fig. 160—*Lampanyctus regalis*, male, 155.0 mm.

Description

D. 15 (14-16); A. 17 (18); P. 13 (14); AO 6 (7)– 8 (7), total 14 (13-15); gill rakers 4+ 1+ 9 (8), total 12 (13); vertebrae 37 (36-39).

Body moderately robust, very similar to that of *L. ritteri*. SAO_3 about over anal origin; VLO much nearer lateral line than to pelvic base; line through VLO and SAO_1 passes far below SAO_3. AOa series often slightly curves. In specimens in excellent condition tiny secondary photophores can be seen at the posterior border of some scale pockets.

Size: To about 165 mm (see Discussion).

Least depth of capture: To about 50 m at night.

Distribution: From south of Magdalena Bay, Baja California, to off Japan, in the colder waters of the northeastern Pacific (Fig. 158). The density of occurrence in the California area is no doubt the result of a greater number of hauls.

Discussion

A possible new form, closely related to *L. regalis*, occurs in near-shore waters off Oregon and perhaps off northern California. Apparently it is a large species, reaching at least 170 mm. It differs from *L. regalis* in having the following features: D. 17 (16); A. 19 (18); P. 14 (rarely 12 or 13); AO 7 (8) + 8(7), total 15 (14-16); gill rakers 4 (5) + 1 + 10 (11), total 15 (14-16).

SAO_3 lies over base of third anal ray rather than over anal origin; AOa_1 is not followed by an enlarged interspace. Only a few specimens have been examined thus far, and more must be studied to determine if these differences are more than just clinal.

Lampanyctus idostigma

Parr, 1931

Description

D. 13 (12); A. 17 (16-18); P. 11-12; AO 5-6 + 6 (5-7), total 11 (10-13); gill rakers 4 (5) + 1 + 10 (9-11), total 15 (14-17); vertebrae 32 (31-33).

SAO_3 far behind anal origin, over or a little behind AOa_2; SAO_1 over or a little before VO_4; SAO_2 about over AOa_1. VLO about midway between lateral line and pelvic origin. Prc interspaces progressively wider; Prc_1 about over Prc_3. Two or 3 luminous scales in supracaudal

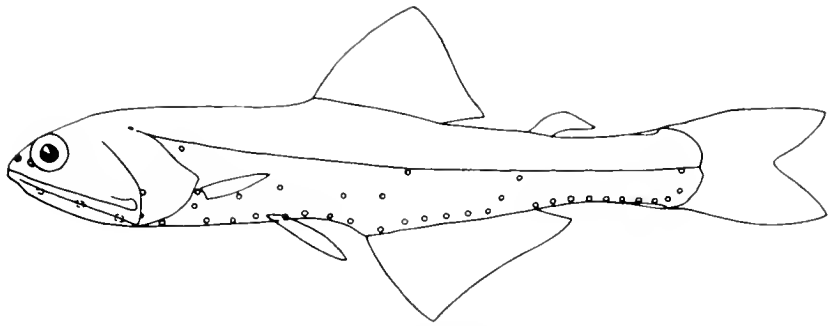


Fig. 161—*Lampanyctus idostigma*, 82.5 mm.

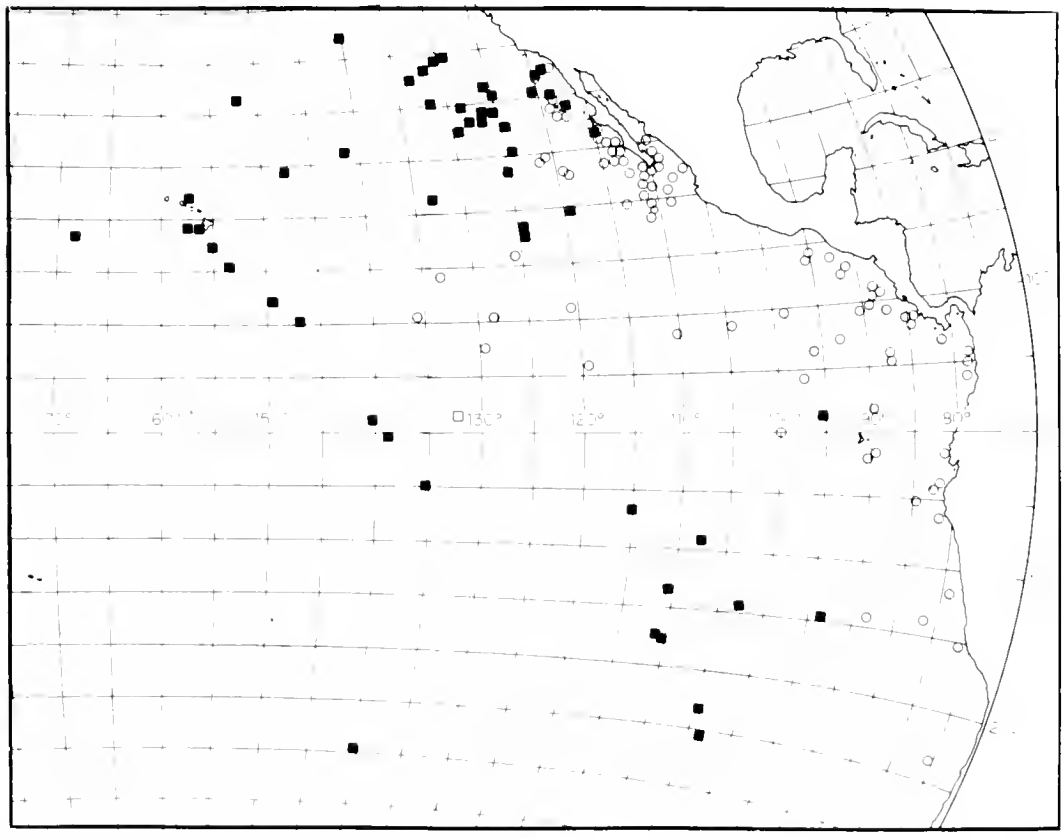


Fig. 162—Capture localities for *Lampanyctus idostigma* (open circles) and *L. steinbecki* (solid squares); this latter distribution represents only captures in the eastern Pacific Ocean.

gland and no more than 3 in infracaudal gland. AOa series level; AOp and Prc series usually continuous.

Size: To about 90 mm.

Least depth of capture: All tows taking the species were from 0 to 300 m and more.

Distribution: Apparently confined to the east of about 135° W. It has a very large north-south range, but no significant differences could be found between specimens from the extremes of this wide range (some 3300 miles between San Diego, California, and Antofogasta, Chile).

Lampanyctus niger
(Günther, 1887)

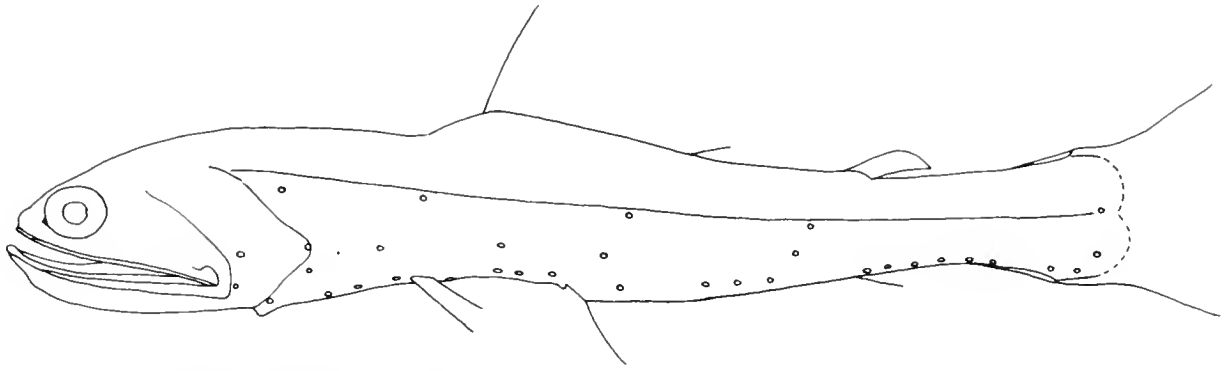


Fig. 163—*Lampanyctus niger*, holotype, 102.8 mm. BMNH 1887.12.7.219. (An unpublished drawing by Rolf L. Bolin).

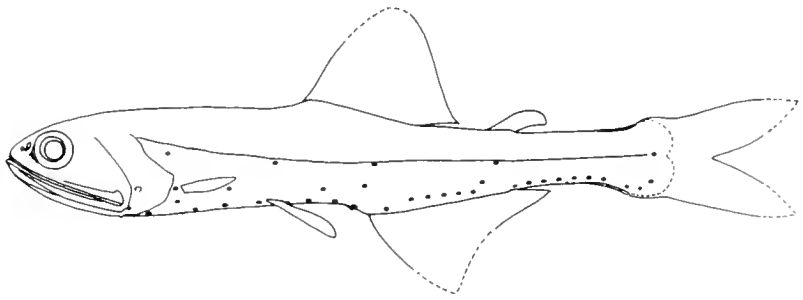


Fig. 164—*Lampanyctus ater* Tåning, 1928, holotype, 89.0 mm. From Dana Station 1152 I. (An unpublished drawing by Rolf L. Bolin).

Description

D. 13-14; A. 16 (15-17); P. 10-11; AO 6 (5-7) + 6-7, total 11-12 (14); gill rakers 4-5 + 1 + 10 (9-11), total 15-16 (14-17); vertebrae 35 (34-36).

The nominal species *L. niger*, of worldwide distribution, apparently constitutes a complex of closely related forms, subspecies or species (see *Discussion*). The following data are taken from specimens from north of Hawaii, that conform reasonably well to the inadequate description and figure provided by Günther and to the above outline sketch by Bolin. Two forms may occur near Hawaii: one form apparently reaches a maximum size of about 80 mm (apparently sexually mature at about 70 mm), the other (based on a very few specimens) reaches about 140 mm.

PLO about three times nearer lateral line than to pectoral origin and well forward of vertical from that origin. PO_4, SAO_1, and SAO_2 on a nearly straight, level line. VLO varies from near lateral line to four of its diameters below lateral line and over or slightly behind VO_1. Four VO, equally spaced. SAO series strongly angulate; SAO_1 over a point variously nearer VO_2 or VO_3; SAO_2 about over anal origin; SAO_3 nearly touching lateral line over a point midway between anal origin and first AOa. AOa series level, the AO_{1-2} interspace often wider than those between remaining AOa. First Pol well behind last AOa; a line through the 2 Pol passes variously through origin or end of base of adipose fin. Prc_1 and Prc_2 very closely spaced and nearly on same level; Prc_3 above and behind Prc_2 and distant from it by a space three times wider than that of Prc_1 and Prc_2. Prc_4 on or slightly above lateral line, over, or its diameter behind, vertical from Prc_3 and distant from it by twice the Prc_{2-3} interspace.

Supracaudal luminous gland short and weak, of 2 or 3 coalesced scales; infracaudal gland more robust, of 3 to 5 overlapping and coalesced scales, its length about equal to or slightly greater than least depth of caudal peduncle.

Size: To about 90 mm (see Discussion).

Least depth of capture: To about 1000 m at night.

Distribution: The nominal species *L. niger* is worldwide, but at present there is considerable doubt as to the correctness of identification. Until a definitive study is made of all forms concerned, the distribution of *L. niger* (sensu stricto) must remain in question.

Discussion

Günther's description of "*Nannobrachium nigrum*," based on a single damaged specimen, applies to several lampanyctid species in that the body structures received the most discussion. Photophores are described in the following terms: "The eye-like phosphorescent organs are small and arranged very much in the same manner as in *Scopelus engraulis*, but owing to the condition of the specimens no exact description of their number can be given. A long, linear, glandular organ of white colour occupies the back and opposite side of the posterior half of the caudal peduncle." Unfortunately, this account of the photophores is useless in defining *L. niger*, because *Sopelus engraulis* belongs to the genus *Diaphus*, as shown by the description and figure provided by Günther (1963 reprint: p. 197, pl. LI, fig. C).

Tåning (1928) described *Lampanyctus ater* as new; Bolin (1959) expressed doubt that *L. ater* was specifically distinct from *L. niger* and stated that fishes of this group were variable in the numbers of infracaudal glands, those from the southern hemisphere and East Indian region having fewer glands than those from the North Atlantic Ocean.

It is of interest that Bolin's figure (above) of the holotype of *L. niger* differs from that shown by Günther (Plate LII, fig. b, Report on the deep-sea fishes) in that Bolin shows SAO_1 to be nearly over VO_2 rather than over VO_3, as shown in Günther's and subsequent illustrations of the species. (Bolin had included with the drawing the statement "no trace of pectorals left"). Possibly this discrepancy was due to the poor condition of the specimen, but in his personal notes Bolin has stated that in specimens from the South Atlantic Ocean VLO was more nearly over VO_2 than over VO_3.

At least two forms of this *niger-ater* (?) complex are found in the eastern and central Pacific Ocean. Aside from the probable difference in maximum sizes, the smaller form has VLO very near lateral line and a gill raker count of 5 + 1 + 11-13; in the larger form VLO is several of its diameters below lateral line, and the rakers number 4 + 1 + 9-10.

Much more study on specimens in good condition from all oceans, and a careful examination of the holotype of *L. niger* must be accomplished before this problem is solved.

Lampanyctus achirus
Andriashev, 1962
Species Complex

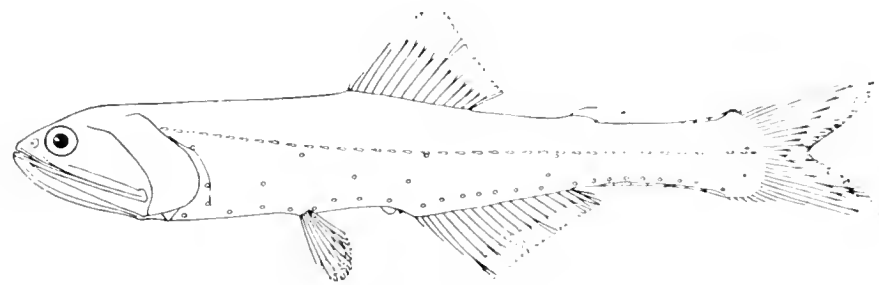


Fig. 165—*Lampanyctus achirus*, holotype, 124.0 mm. From Andriashev (1962, p. 257, fig. 27).

Fig. 166—(A.) *Lampanyctus achirus* (?), From 12°15′ S, 77°48′ W; (B.) *Lampanytus achirus* (n.sp. ?), 48.0 mm. From about 27° N, 155° W.

Description

Counts for specimens basically referrable to *L. achirus* from four areas of the eastern Pacific Ocean and from off South Africa are presented in the following tables: Dorsal and anal fin rays (Table 30), AO photophores (Table 31), gill rakers (Table 32), and vertebrae (Table 33).

TABLE 30. NUMBERS OF DORSAL AND ANAL FIN RAYS OF THE *LAMPANYCTUS ACHIRUS* SPECIES COMPLEX FROM FOUR AREAS OF THE EASTERN PACIFIC OCEAN AND FROM NEAR SOUTH AFRICA.

Area	Dorsal fin rays					Anal fin rays					
	13	14	15	16	17	15	16	17	18	19	20
Southeastern Pacific											
64°-46° S	4	20	19	6	—	—	—	8	13	6	—
34°-03° S	—	3	16	33	2	—	—	5	16	20	2
Northeastern Pacific											
19°32° N, 118°-133° W	12	15	1	—	—	3	8	16	3	—	—
19°-26° N, ca 155° W	4	26	3	—	—	—	6	11	15	3	—
Near South Africa	—	3	6	—	—	—	—	—	9	1	—

TABLE 31. NUMBERS OF AO PHOTOPHORES OF THE *LAMPANYCTUS ACHIRUS* SPECIES COMPLEX FROM FOUR AREAS OF THE EASTERN PACIFIC OCEAN AND FROM NEAR SOUTH AFRICA.

Area	AOa photophores				AOp photophores				
	5	6	7	8	5	6	7	8	9
Southeastern Pacific									
64°-46° S*	—	2	56	8	—	—	5	72	10
34°-03° S*	—	4	27	6	1	20	23	1	—

Northeastern Pacific									
19°-32° N, 118°-133° W	18	6	—	—	—	3	18	3	—
19°-26° N, ca 155° W	28	38	—	—	—	26	34	4	—
Near South Africa	—	4	13	—	—	—	11	7	—

	Total AO photophores					
	11	12	13	14	15	16
Southeastern Pacific						
64°-46° S*	—	—	—	6	46	14
34°-03° S*	—	2	15	17	3	—
Northeastern Pacific						
19°-32° N, 118°-133° W	3	18	3	—	—	—
19°-26° N, ca 155° W	6	49	18	2	—	—
Near South Africa	—	—	4	7	7	—

*Counts for AOp photophores include those of Bussing (1965).

TABLE 32. NUMBERS OF GILL RAKERS OF THE *LAMPANYCTUS ACHIRUS* SPECIES COMPLEX FROM FOUR AREAS OF THE EASTERN PACIFIC OCEAN AND FROM NEAR SOUTH AFRICA.

Area	Upper rakers			Lower rakers (central raker included)				
	4	5	6	10	11	12	13	14
Southeastern Pacific								
64°-46° S*	—	18	46	—	8	31	43	9
34°-03° S*	—	95	3	3	32	77	3	—
Northeastern Pacific								
19°-32° N, 118°-133° W	48	2	—	—	50	—	—	—
19°-26° N, ca 155° W	61	1	—	2	57	3	—	—
Near South Africa	11	8	1	—	1	11	6	2

	Total gill rakers						
	14	15	16	17	18	19	20
Southeastern Pacific							
64°-46° S	—	—	—	7	17	31	9
34°-03° S	—	1	18	73	6	—	—
Northeastern Pacific							
19°-32° N, 118°-133° W	—	48	2	—	—	—	—
19°-26° N, ca 155° W	1	28	4	—	—	—	—
Near South Africa	—	1	10	1	6	1	1

*Counts for lower gill rakers include those of Bussing (1965).

TABLE 33. NUMBERS OF VERTEBRAE OF THE *LAMPANYCTUS ACHIRUS* SPECIES COMPLEX FROM THE EASTERN PACIFIC OCEAN AND FROM NEAR SOUTH AFRICA.

	Vertebrae				
	33	34	35	36	37
Southeastern Pacific					
64°-46° S*	—	—	1	18	8
34°-03° S*	—	27	28	18	—
Northeastern Pacific					
19°-32° N, 118°-133° W	12	10	1	—	—
19°-26° N, ca 155° W	4	12	2	—	—
Near South Africa	—	—	6	15	2

*Counts include those of Bussing (1965).

Pectoral fins usually absent, or when present are reduced to a few extremely vestigial rays. PLO and VLO two or three of their diameters below lateral line. PLO well forward of a line through the two vertically arranged PVO. PVO_{1-2} interspace from 0.75 to 1.0 in vertical diameter of orbit; the highly elevated PO_4 and upper PVO about on same level. PO_4 on or slightly behind vertical from PO_3 SAO series in obtuse angle of about 140°, SAI_1 on or a little above level of SAO_2, the latter over or slightly before origin of anal fin or variously father back to over bases of second to fifth anal rays (see *Discussion*). SAO_{1-2} interspace from 1.5 to 2.0 times that of SAO_{2-3}. Upper Pol and SAO_3 on or very near lateral line. Prc_4 about on or slightly above lateral line and on, before, or behind vertical from Prc_3 (see *Discussion*).

Supracaudal luminous gland short (2 to 5 scales); infracaudal gland variable in numbers of scales, with 7 to 10 in far southern waters but only 3 to 5 off Chile and Peru (34° to 03° S) and in northeastern Pacific.

Size: To about 155 mm in the southeastern, to about 70 mm in the northeastern, Pacific Ocean.

Least depth of capture: To about 300 m at night in northeastern area. All captures in southeastern area, and off South Africa, were from tows with open nets to deeper than 300 m.

Distribution: Probably circumglobal in far southern seas. Andriashev's type material of *L. achirus* (12 specimens) was taken in an area of the southeastern Pacific and southwestern Atlantic Ocean from 58° to 64° S, 61° to 135° W. Specimens conforming well to the diagnosis of *L. achirus* have been taken off Chile and Peru and in the northeastern Pacific between 19° and 32° N, 118° and 133° W, and in the north-central Pacific between 19° and 27° N, along about 155° W. The species also occurs off South Africa and in the southeastern Atlantic at about 30° S, 05° W. There are no records of capture in the eastern Pacific between about 03° S and 19° N; also no captures are recorded from between the two northeastern areas.

Discussion

In the eastern Pacific Ocean throughout the nearly 5800-mile south-to-north range of these fishes without pectoral fins there are some interesting variations in meristic characters and body proportions that may indicate possible speciation. Meristic characters are invariably somewhat higher in far southern waters but grade more or less smoothly to lower in the north; this is apparent in numbers of dorsal and anal fin rays (Table 30), AO photophores (Table 31), gill rakers (Table 32), and vertebrae (Table 33). Variability also occurs in the general robustness of the body; specimens from between 64° and 46° S, and from the northeastern Pacific, have a somewhat more slender body form than those from between 34° S and 03° S, as illustrated by Bussing (1965, p. 204, fig. 7). This difference in body form between the Peruvian and northeastern specimens is also shown in Figures 165 and 166, above.

TABLE 34. BODY PROPORTIONS FOR THE *LAMPANYCTUS ACHIRUS* SPECIES COMPLEX FROM OFF SOUTH AFRICA AND FROM THE SOUTHEASTERN AND NORTHEASTERN PACIFIC OCEAN.

Measurement	South Africa N= 10 (58-140 mm)		Southeastern Pacific N= 20 (84-145 mm)		Northeastern Pacific N= 27 (42-68 mm)	
	Ave.	Range	Ave.	Range	Ave.	Range
Head length	265	253-284	274	261-289	277	265-286
Head depth	168	156-182	175	162-184	162	152-176
Upper jaw length	201	186-216	201	188-211	205	197-215
Orbit length	55	49-61	51	44-61	64	49-74
Prepelvic length	412	399-423	403	389-418	407	398-417
Preanal length	561	530-581	534	521-550	563	541-582
Predorsal length	500	462-533	460	437-477	483	457-505
Preadipose length	815	789-837	803	790-820	817	797-832
Dorsal origin to pelvic origin	169	146-191	197	178-218	178	160-193
Dorsal origin to anal origin	184	173-199	222	214-226	198	174-215
Dorsal base length	189	176-203	199	181-216	189	180-198
Anal base length	231	206-247	247	229-265	243	229-259
Caudal peduncle length	214	199-241	218	201-233	216	192-239
Caudal peduncle depth	79	66-85	98	90-104	76	68-90
Supracaudal gland length	154	142-181	137	105-195	76	62-87

Body proportions (Table 34) are given for specimens of the *L. achirus* complex from near South Africa and from the southwestern and northeastern Pacific Ocean.

Lampanyctus achirus was described and figured as having SAO_2 slightly before a vertical from origin of anal fin but this character is highly variable througout the range. In 83% of the legible specimens (a total of 70 sides) from between 64° S and 46° S, SAO_2 was beofre or on a vertical from origin of anal fin, and over bases of second or third anal ray in 17% of the sides. In specimens from between 34° S and 03° S, SAO_2 was somewhat more posteriorly placed; of 56 sides only about 12% of SAO_2 were before or over anal origin, but 68% were over bases of second or third rays, and 20% were over bases of fourth or fifth rays. On 51 sides from the northeastern Pacific, SAO_2 had, on the average, an even more posterior position; SAO_2 was not observed to occur before a vertical from anal origin and was over that origin in only 6% of the sides; SAO_2 was over bases of second or third rays in 34% of the sides, and over bases of fourth or fifth rays in 60%. In the few legible specimens from off South Africa (15 sides) SAO_2 was over or slightly before anal origin in 66% of the sides, and over bases of second or third rays in 34%.

The position of Prc_4 relative to Prc_3 also is variable throughout the range of the *L. achirus* complex. In specimens from 64° to 46° S, Prc_4 is predominantly on (few slightly before or behind) a vertical from Prc_3; in specimens from 34° to 03° S, Prc_4 is before, rarely on or behind, a vertical from Prc_3. In specimens from the northeastern Pacific, Prc_4 is nearly always behind, often by at least two diameters, the vertical from Prc_3 and is rarely on or before it.

Since the *achirus*-like form was first reported from the northeastern Pacific (Berry and Perkins, 1966), it has been thought to be specifically distinct. But as the above data indicate, the intergrading of the various meristic characters between the southeastern and northeastern forms and the variability in positions of SAO_2 and Prc_4 suggests caution in regarding the northeastern form as a separate species. However, I believe it may prove to be distinct because of the consistently more posterior position of Prc_4 and the much smaller size. Examination of ovaries of specimens 58 to 65 mm revealed well developed, though still immature, ova, an indication that this northeastern form may be fully adult at the largest known size of about 70 mm.

Lampanyctus steinbecki
Bolin, 1939

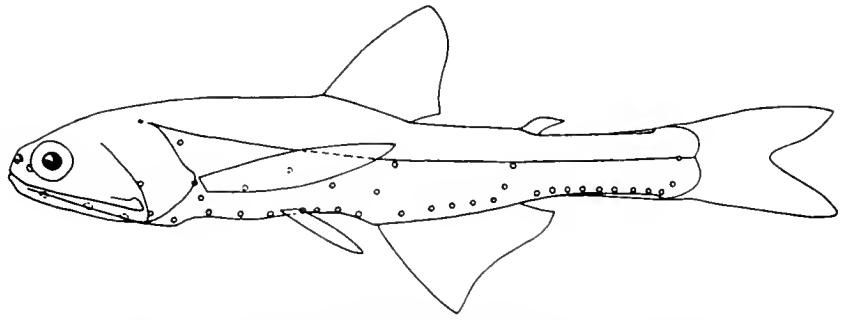


Fig. 167—*Lampanyctus steinbecki*, holotype, 35.5. mm. From Bolin (1939, p. 140, fig. 23).

Description

D. 12-13 (14); A. 17-18 (16-19); P. 14 (13-15); AO 6(5-7) + 7 (6-8), total 12-13 (14); gill rakers 3-4 + 1 + 9 (8-10), total 13 (12-14); vertebrae 35 (34-36).

SAO_1 well above level of SAO_2, a line through them passing through or near VLO and PLO. VLO below lateral line by about one-third the distance from there to pelvic base. VO_2 often slightly elevated by about half its diameter above the rest. AOa series usually slightly curved. Deviations of VO_2 and AOa are not always evident in smaller specimens (30 mm and less). Infracaudal gland with 5 or 6 luminous scales covering about three-fourths ventral surface of caudal peduncle.

Size: To 80 mm.

Least depth of capture: To about 300 m at night.

Distribution: Apparently widespread in eastern Pacific Ocean (Fig. 162). Insufficient collecting has been done westerly and southwesterly of the depicted range to be certain of its occurrence in those areas. Whitley (1968) did not include the species in his list of fishes from New Zealand. *L. steinbecki* has been reported from the Indian Ocean (see *Discussion*).

Discussion

Nafpaktitis and Nafpaktitis (1969) applied the name *L. steinbecki* to specimens from the western Indian Ocean, stating that they agreed very well with Bolin's original description. However, these authors listed counts that differ somewhat from those of eastern Pacific specimens: D. 12; A. 16 (15-17); P. 13-14; AO 4-5 (6) + 5-6 (7), total 9-11 (12); gill rakers 3 + 1 + 8 (7). Also, these authors showed the VLO to be somewhat nearer lateral line than in eastern Pacific specimens.

These differences indicate a probability that two distinct species may be involved. However, at present there are insufficient data to warrant specific separation.

Lampanyctus tenuiformis-festivus species complex

Bolin (1959), in a discussion of *Lampanyctus festivus* (Tåning, 1928) from the North Atlantic Ocean, stated that the species was possibly conspecific with *L. tenuiformis* (Brauer, 1906), *L. bensoni* (Fowler, 1934), and *L. steinbecki* Bolin (1939), but offered neither illustrations nor criteria for separating the forms. Nafpaktitis and Nafpaktitis (1969) discussed and illustrated all except *L. bensoni* and offered a few characters for distinguishing between *L. tenuiformis* and *L. festivus*; Bolin (personal communication) also provided characters for separating the latter two species. Data from these investigators are combined in Table 35 and are compared with similar data from specimens provisionally identified as *L. tenuiformis* from

TABLE 35. SOME CHARACTERS REPORTED AS USEFUL IN DISTINGUISHING BETWEEN *LAMPANYCTUS TENUIFORMIS* AND *L. FESTIVUS* FROM THE INDIAN AND ATLANTIC OCEANS COMPARED WITH A FORM PROVISIONALLY IDENTIFIED AS *L. TENUIFORMIS* FROM THE PACIFIC OCEAN.

*L. tenuiformis** (Indian Ocean) A. 18 P. 14 AO 6 + 7	*L. festivus*** (Atlantic Ocean) A. 19-20 P. 16 (15-17) AO 7 + 8-9	*L. tenuiformis* (?) (Pacific Ocean) A. 17-18 P. 14 (13-15) AO 6 + 7
6 scales in infracaudal gland, filling four-fifths of infracaudal space	8 (7-10) scales in infracaudal gland, filling all the space	5-8 scales in infracaudal gland, filling two-thirds to all the space
VO series in a straight line	VO series curved	VO series usually curved, often straight in specimens of less than 50 mm
AOa series in a straight line	AOa series slightly curved	AOa series slightly curved
SAO_1 and SAO_2 on same level	SAO_1 below level of SAO_2	SAO_1 on or below level of SAO_2
SAO_1 before vertical from VO_3	SAO_1 directly over VO_3	SAO_1 before vertical from VO_3
PO_4 slightly above level of lower end of Pectoral base	PO_4 about on level of upper end of pectoral base	PO_4 slightly above level of lower end of pectoral base
Line SAO_{1-2} passes slightly below pectoral base	Line SAO_{1-2} passes slightly above pectoral base	Line SAO_{1-2} passes variously near upper and lower ends of pectoral base

* Data from one specimen (85 mm) reported by Nafpaktitis and Nafpaktitis, 1969.

** Data from holotype (101 mm) reported by Nafpaktitis and Nafpaktitis, 1969, and from three specimens (35-68 mm) reported by Bolin, 1959.

the Pacific Ocean. *L. steinbecki* is herein regarded as a valid species; *L. bensoni* is not discussed.

The following key will be of aid in separating *L. steinbecki* (from the eastern Pacific Ocean) from *L. tenuiformis* and *L. festivus*.

1a. A line through SAO_{1-2} passes through or near VLO and/or PLO. SAO_1 over VO_3 and well above level of SAO_2. VO and AOa series slightly but distinctly curved, often nearly straight in specimens of 25 mm or less ..... *L. steinbecki*

1b. A line through SAO_{1-2} passes variously near upper or lower ends of pectoral base 2

2a. VO and AOa series not curved. SAO_1 slightly below level of SAO_2 and directly over VO_3. A line through SAO_{1-2} passes near lower end of pectoral base ..... *L. tenuiformis*

2b. VO and AOa series slightly but distinctly curved. SAO_1 about on level of SAO_2 and before vertical from VO_3. A line through SAO_{1-2} passes through or slightly above upper end of pectoral base ..... *L. festivus*

Lampanyctus tenuiformis (?)
(Brauer, 1906)

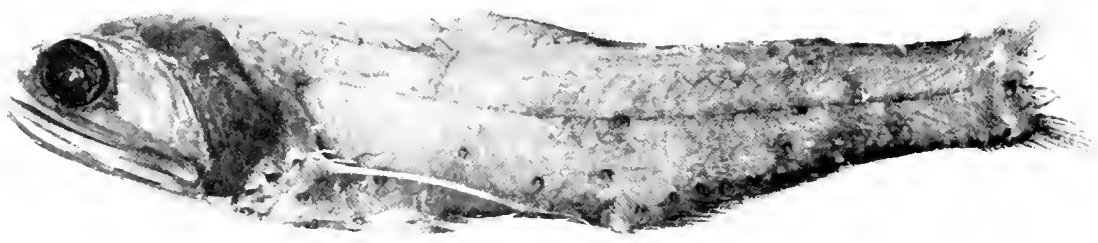


Fig. 168—*Lampanyctus tenuiformis* (?), female, 110.0 mm. From the southeastern Pacific Ocean, 02°31′ S, 137°04′ W.

Description

D. 13-14; A. 17-18; P. 14 (13-15); AO 6-7 + 6-7, total 13 (12-14); gill rakers 4 (5) + 1 + 9 (10-11), total (see discussion); vertebrae 36 (37).

PLO two to three of its diameters below lateral line; SAO_3, Pol, and Prc_4 touching lateral line. VLO about over base of inner pelvic ray and slightly nearer lateral line than to pelvic base. Line through PLO and VLO passes through or very near SAO_1. Line through SAO_3 and SAO_2 passes through or slightly behind VO_4.

Size: To 115 mm.

Least depth of capture: To 300 m at night.

Distribution: Apparently widespread in the eastern Pacific Ocean (Fig. 169) but, as few specimens have been taken, it may be either uncommon or somehow unavailable to capture gear.

Discussion

Two possibly distinct forms of the provisional species are evident. Eight of the eleven specimens showed little variation in numbers of gill rakers, all having 4 + 1 + 9, except one which had 5 + 1 + 9 on the right side. Also, in these specimens the Prc_{3-4} interspace was notably greater than that between $Prc_1$and Prc_3. Three of the eleven specimens (in three collections from the northeastern Pacific, enclosed by dashed line in Fig. 169) differed in that the Prc_{3-4} interspace was equal to or slightly les than that of Prc_{1-3}. The number of gill rakers was also higher, 5 + 1 + 10-11; one specimen (of two), totally denuded, had 4 + 1 + 9 rakers, whereas the other (all photophores present) had 5 + 1 + 10; the respective sizes were 38 and 48 mm.

Based on criteria given in Table 35 and in the foregoing key, specimens conforming strictly to either *L. tenuiformis* or *L. festivus* were not found in the eastern Pacific Ocean; however, 11 specimens (9 collections) in good condition, from widely scattered areas of the Pacific (Fig. 169), have characters that are presumed to differentiate *L. tenuiformis* and *L. festivus* (Table 35). It may be that these Pacific specimens represent a new species, but because of the paucity of information on either *L. tenuiformis* or *L. festivus* they may also merely reflect an unknown variation in these species. Therefore, until further study the older name, *tenuiformis*, is provisionally applied to the Pacific forms.

However, as the western and southern areas of the eastern Pacific Ocean are inadequately collected it is possible that the forms from the Indian Ocean, identified as *L. tenuiformis* and *L. festivus* by Nafpaktitis and Nafpaktitis (1969, p. 48, figs. 57, 58) may eventually be found in these marginal areas. Therefore, the figures provided by these authors for the two species are reproduced here (Figs. 170 and 171).

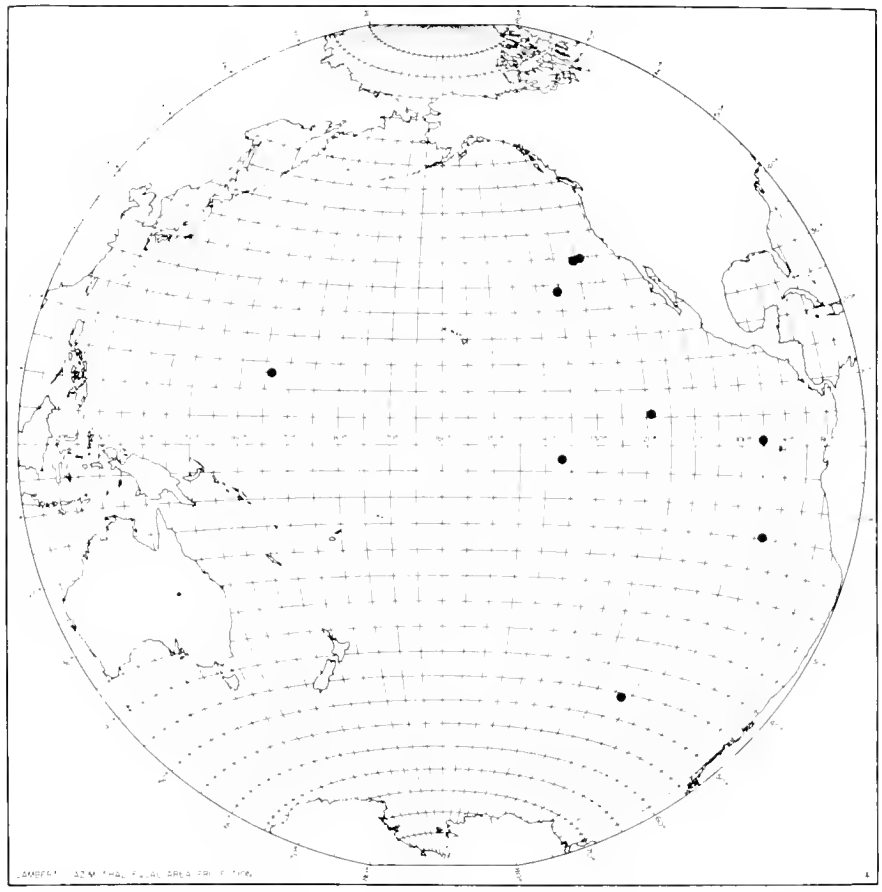


Fig. 169—Capture localities for specimens tentatively assigned to *Lampanyctus tenuiformis* but having characters reported as useful in separating the nominal species *L. tenuiformis* and *L. festivus*.

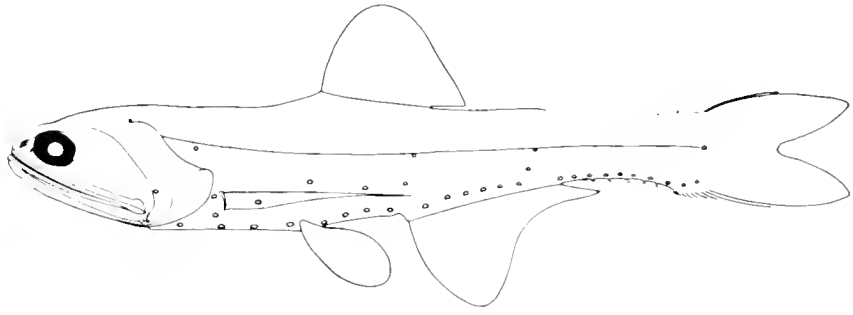


Fig. 170—*Lampanyctus tenuiformis*, 85.0 mm. From Nafpaktitis and Nafpaktitis (1969, p. 48, fig. 57).

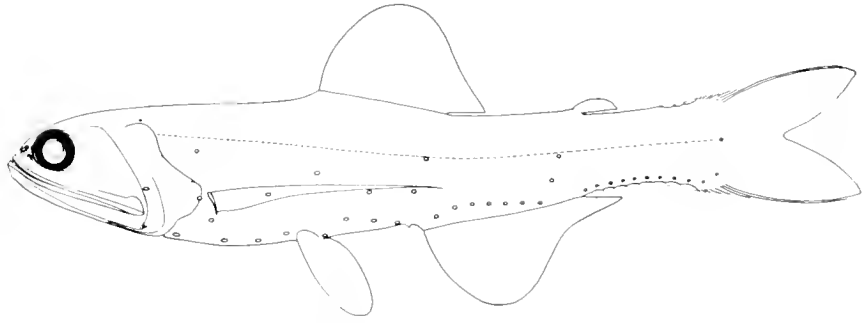


Fig. 171—*Lampanyctus festivus*, holotype, 101.0 mm. From Nafpaktitis and Nafpaktitis (1969, p. 58, fig. 48).

Lampanyctus acanthurus
Wisner, 1974

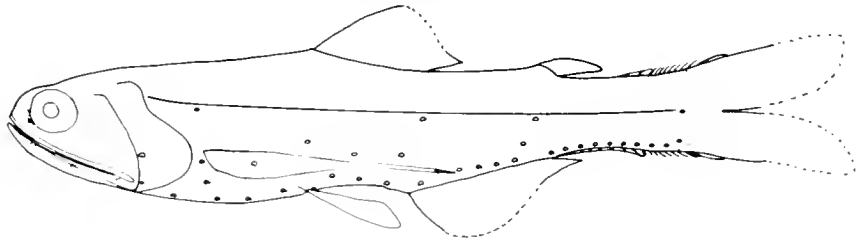


Fig. 172—*Lapmanyctus acanthurus*, holotype, male, 93.3 mm. From Wisner (1974, p. 37, fig. 8).

Description

D. 13 (14); A. 17 (16-18); AO 6 (5) + 7 (8), total 13 (12-14); gill rakers 5 (6) + 1 + 10 (9-11), total 16 (15-18); vertebrae 36.

Particularly diagnostic of this species is the high number of procurrent caudal rays, 9 (8-10) above and 10 (11) below, a number higher than found in any other species of the genus.

PLO, SAO_3, upper Pol, and Prc one or two of their diameters below lateral line; PLO about three of its diameters before a vertical from origin of pectoral fin. VLO slightly nearer lateral line than to base of pelvic fin and on or very near a line from PLO to SAO_1. VO series curved; VO_2 elevated at least its diameter above levels of VO_1 and VO_3. SAO_1 usually above level of SAO_2 and on or a little before vertical from VO_3; SAO_2 about over anal origin; SAO_3 slightly behind vertical from first AOa; a line through SAO_3 and SAO_2 passes through or a little behind VO_4. AOa series curved, AOa_1 depressed and AOa_2 raised by about three diameters. All AOp behind anal base; AOp and Prc series continuous. Prc_{3-4} interspace about equal to that between Prc_{1-3}; Prc_4 slightly behind vertical from Prc_3.

Supracaudal luminous gland very short, of about 2 coalesced scales; infracaudal gland long, of 7 (6-8) overlapping, noncoalesced scales.

Size: To 112 mm (largest of 21 specimens).

Least depth of capture: To 800 m at night.

Distribution: Most specimens were taken about 600 mi (960 km) north of Hawaii (27° to 31° N, 155° W); two specimens known from about 350 mi (560 km) west of Point Conception, California.

Discussion

L. acanthurus appears to be most closely related to the poorly understood nominal species *L. tenuiformis* and *L. festivus*, discussed above.

Lampanyctus nobilis
Tåning, 1928

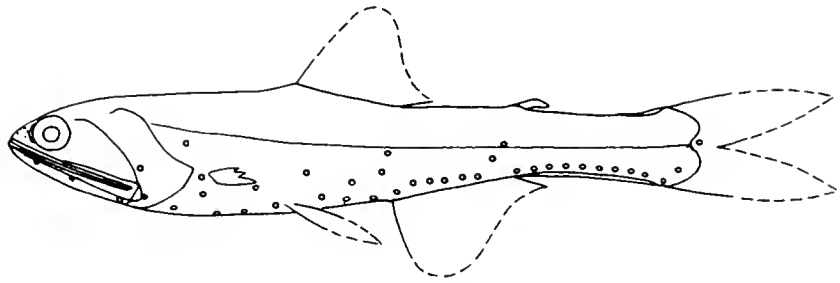


Fig. 173—*Lampanyctus nobilis*, 86.2 mm.

Description

D. 14-15; A. 18 (17-19); P. 14 (13); AO 6 (5-7) + 9 (8-10), total 15 (14-16); gill rakers 3 (4) + 1 + 9 (8-10), total 13 (12-14); vertebrae 38 (37-39).

This species may be easily recognized by the rather far back position of last Prc, over bases of caudal rays, and by the slightly but distinctly elevated VO_2, which is not displaced forward toward VO_1, the VO series remaining about equally spaced. In general, a line through SAO_2 and SAO_3 passes a little before VO_4, and PVO_1 and PVO_2 are in oblique line with PO_2. The Prc-AOp interspace is either distinct or not present (this character appears variable).

Supracaudal gland has 4 to 5, infracaudal gland 10 to 11, well developed luminous scales, the latter filling the infracaudal space.

Size: To about 100 mm.

Least depth of capture: Between 100 and 200 m at night.

Distribution: In the eastern Pacific this species is known only from the Hawaiian area. It appears to occur in warm waters of all oceans.

Lampanyctus macropterus
(Brauer, 1904)

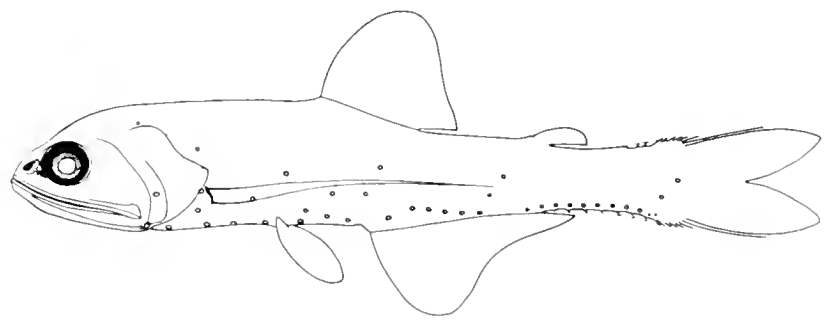


Fig. 174—*Lampanyctus macropterus*, 45.0 mm. From Nafpaktitis and Nafpaktitis (1969, p. 50, fig. 61).

Description

D. 13-15; A. 18-19; P. 14 (13-15); AO 6 (5-7) + 9 (8-10), total 15 (13-16); gill rakers 3 + 1 + 9 (8-10), total 13 (12-14); vertebrae 38 (37-39).

VO_2 elevated and displaced forward to about its diameter behind vertical from posterior margin of VO_1, but never to over or before VO_1. AOa series notably curved; AOa_{1-2} interspace about twice as large as others. First 2 Prc often closely spaced and slightly smaller than last 2;

second, third, and last Prc form a slight curve, the concavity facing posteriorly (Fig. 174). Supracaudal gland with 3 to 4, infracaudal gland with 6 to 8, small but well developed luminous scales, the latter filling at least three-fourths of ventral surface of caudal peduncle (Fig. 174).

Size: To about 60 mm.

Least depth of capture: To 70 m at night.

Distribution: All known eastern Pacific specimens are from near Hawaii.

Discussion

The *Lampanyctus macropterus*-like forms from the eastern-central Pacific Ocean apparently represent a species complex, or the species is highly variable in its arrangement of Prc photophores. Although basically similar to the pattern of Prc shown in Fig. 174, the first two Prc of the few central Pacific specimens available to me are much larger and more widely spaced. In most respects I can find no differences between the specimens before me and the figure and descriptions offered by Nafpaktitis and Nafpaktitis (1969, p. 50, fig. 61). All have the VLO well below instead of at the lateral line; most of the AOa series appeared to be arched. Because of the position of VO_2 behind VO_1, and not before it as in *L. hubbsi*, the name *macropterus* is given to these specimens. Unfortunately, the specimens are not in good condition. Several have the Prc arranged as in *L. hubbsi*, but with the VO_2 elevated as in *L. macropterus*. Much more study is needed for this species group.

Because the species *L. macropterus* (Brauer, 1904) and *L. nobilis* Tåning, 1928, have been confused, the following nomenclatorial history of the two is offered. Brauer (1904, p. 404, fig. 5) described and figured *Myctophum (Lampanyctus) macropterum*. Brauer (1906, p. 249, textfigs. 166-167) offered a more detailed account (with two figures) of this species, but apparently he had mixed material. Brauer reproduced the 1904 figure of *L. macropterus* (1906, p. 250, textfig. 166) again under that name, but he also showed what he presumed to be variations in the position of the VO_2 and of Prc patterns in textfig. 167. In this figure the VO_2 is shown to be directly over the VO_2 and the second Prc offset posteriorly so that instead of Prc_2, Prc_3, and Prc_4, Prc_1, Prc_3, and Prc_4 are in an oblique line as in textfig. 166. The VLO is not shown in textfig. 167. Brauer's textfig. 166 shows the VLO to be well below the lateral line but much nearer it than to the pelvic origin, and the VO_2 as distinctly elevated but displaced forward only to about its diameter behind a vertical from the VO_1; the AOa series is markedly curved, and the AOp-Prc series is continuous. Nafpaktitis and Nafpaktitis (1969, p. 50, fig. 61) offered a figure (Fig. 174) for *L. macropterus* that is basically similar to that of Brauer's textfig. 166 but has the Prc series much like that shown by Brauer's in textfig. 167, except that the first two Prc are shown to be very small and close together.

The confusion of *L. macropterus* with *L. nobilis* is largely the result of two actions by Parr (1928, p. 111, fig. 20) in which he published a figure as *L. macropterus* that closely resembled Brauer's (1906) textfig. 166, the major difference being a lesser elevation of the VO_2 with no forward displacement. Then Parr (1931, p. 29, fig. 11) offered a figure of *L. nobilis* that differed from his figure of *L. macropterus* partly in that the AOa series was shown to be level. He stated that this figure was verified by Tåning to be that of *nobilis* by direct comparison with the type. Without mention of depicted difference in curvature of the AOa series, Parr (1931) placed his 1928 version of *L. macropterus* in the synonymy of *L. nobilis*. Nafpaktitis and Nafpaktitis (1969, p. 49, fig. 59) presented a figure of the holotype of *L. nobilis* (53.5 mm, DANA Station 1185 XI, 17° 41′ N, 60° 58′ W) showing the AOa series to be markedly curved anteriorly. Thus, this figure is more similar to Parr's 1928 illustration of *L. macropterus* than to his 1931 illustration of *L. nobilis*.

Lampanyctus parvicauda
Parr, 1931

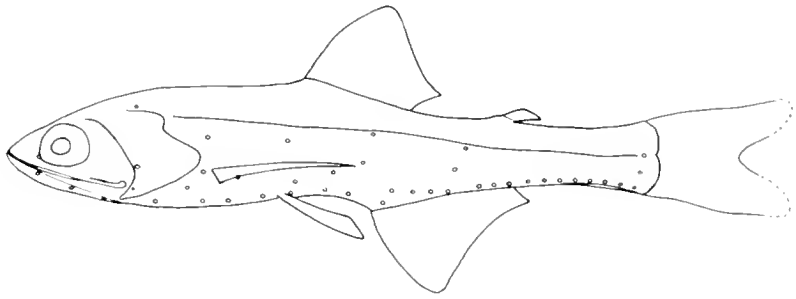


Fig. 175—*Lampanyctus parvicauda*, 62.1 mm. From Wisner (1963a, p. 17, fig. 3).

Description

D. 14 (13-15); A. 18 (17-20); P. 13 (12-15); AO 5 (4-6) + 9 (7-11), total 13-14 (12-16); gill rakers 3 (4) + 1 + 9 (8-10), total 13 (12-14); vertebrae 36-37 (35-38).

PLO and VLO slightly below, SAO_3 and upper Pol touching, lateral line. VO_2 elevated and displaced forward to just behind vertical from VO_1, but never to over or before it. AOa series strongly curved, the photophores about evenly spaced. Last 3 Prc evenly spaced in straight, steeply oblique line. Usually 3 AOp over anal base. Infracaudal gland short, with about 5 (4-7) luminous scales. Pectoral fin short, barely reaching to vent.

Size: To about 110 mm.

Least depth of capture: At surface at night.

Distribution: May be confined to warmer waters of eastern Pacific Ocean between about 20° N and 15° S (Fig. 176). It has been taken in southern part of Gulf of California. It is not

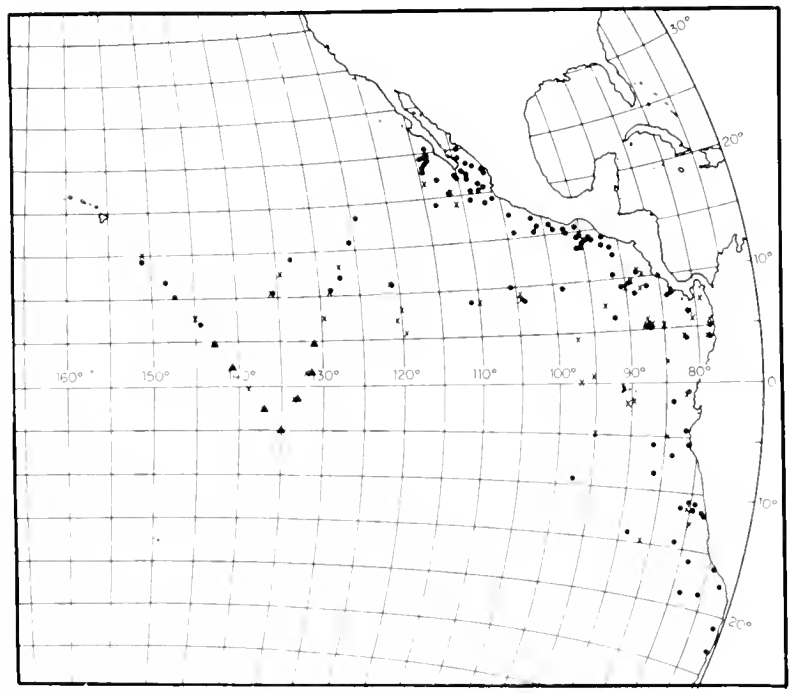


Fig. 176—Capture localities for *Lampanyctus* omostigma (X), *L. parvicauda* (solid circles) and *L. hubbsi* (solid triangles).

commonly taken in eastern central Pacific west of 150° W, but whether because of nonoccurrence or lack of collecting effort is not known.

Lampanyctus omostigma
Gilbert, 1908

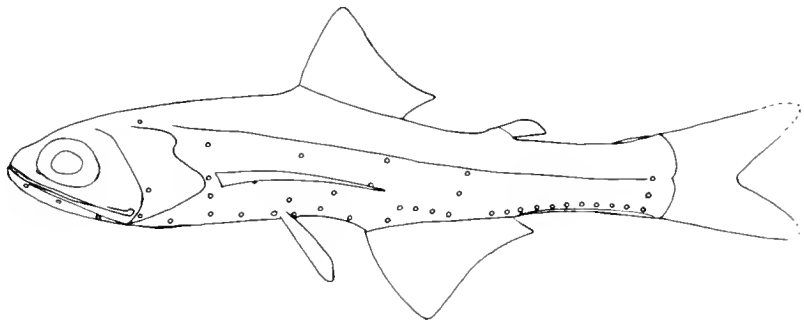


Fig. 177—*Lampanyctus omostigma*, 60.0 mm. From Wisner (1963a, p. 17, fig. 2).

Description

D. 14 (13-15); A. 18 (16-20); P. 13 (12-14); AO 5 (4)6 + 8-9 (7-10), total 13-14 (12-15); gill rakers 4 (3-5) + 1 + 10-11 (9-12), total 15-16 (13-18); vertebrae 36 (35-38).

PLO and VLO slightly below, SAO_3 and upper Pol touching, lateral line. VO_2 elevated and displaced forward to at least its diameter before a vertical from VO_1. AOa series about evenly spaced, markedly curved. Last 3 Prc evenly spaced in a straight, steeply oblique line. Two or three AOp over anal base. Pectoral fin usually reaches to about middle of AOa series. Infracaudal gland with 8 (7-9) luminous scales, nearly filling infracaudal space.

Size: To about 65 mm.

Least depth of capture: At surface at night.

Distribution: L. omostigma appears to have distribution very similar to that of *L. parvicauda* (Fig. 176). It is sparsely collected in the central Pacific, but the reason for the paucity of occurrence is not clear.

Lampanyctus hubbsi
Wisner, 1963

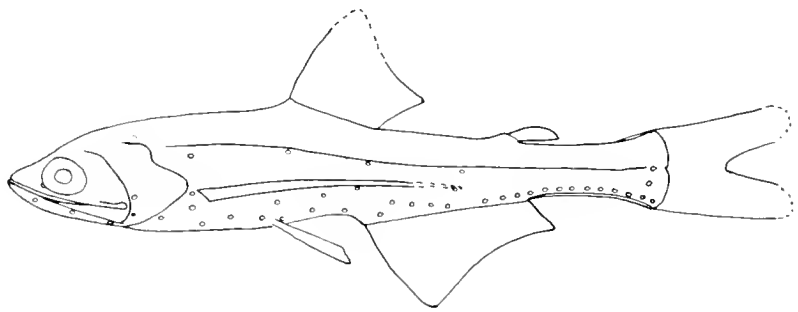


Fig. 178—*Lampanyctus hubbsi*, holotype, 54.0 mm. From Wisner (1963a, p. 17, fig. 1).

Description

D. 14 (21-15); A. 20 (18-21); P. 13-14 (12-15); AO 5 (4-6) + 11 (9-12), total 15-16 (14-17); gill rakers 4 (3-5) + 1 + 10-11 (9-12), total 16 (15-17); vertebrae 37-38 (39).

PLO several of its diameters below lateral line; VLO, SAO_3, and upper Pol and Prc at lateral line. VO_2 elevated and displaced forward to about its diameter before VO_1. AOa evently spaced in marked curve. Prc_2 notably offset behind line through Prc_1, Prc_3, and Prc_4. Usually 4 AOp over anal base. Infracaudal gland with 8 (7-9) luminous scales, nearly filling infracaudal space. Pectoral fin reaches to Pol.

Size: To about 80 mm.

Least depth of capture: Taken only in hauls from 0-2000 m.

Distribution: L. hubbsi may be confined to the east-central portion of the equatorial region of the Pacific Ocean (Fig. 176). The pattern of distribution reflects the track of the expedition that captured the study specimens. The species is infrequently taken, with no more than eight specimens in one haul.

Lampanyctus jordani
Gilbert, 1913

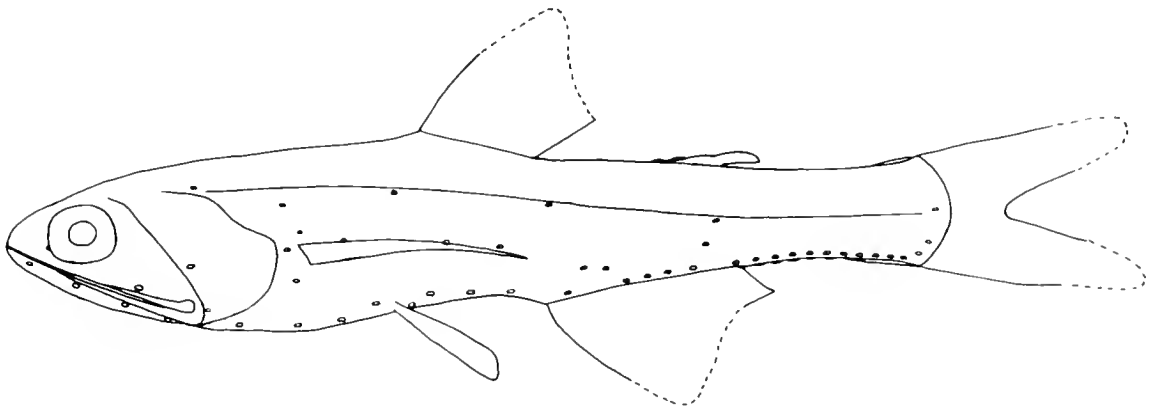


Fig. 179—*Lampanyctus jordani*, 113.0 mm. From Wisner (1970b, p. 421, fig. 1).

Description

Principal dorsal rays 11 (10-12); A. 18 (17-20); P. 16 (14-17); AO 7 (6-8) + 9 (7-10), total 16 (14-18); gill rakers 6 (5-7) + 1 + 14-15 (13-16), total 22-23 (20-24); vertebrae 39 (38-40).

The abruptly elevated AOa_2, AOa_3, and often AOa_4 (Fig. 179), and the extra photophore close above pectoral origin, will, in combination, immediately identify this species. Also, the pectoral fins are not as long or broad-based as in most of the species having tiny secondary body photophores. PO_4 elevated high, about on line through PVO_1, VLO, and SAO_{1-2}.

Size: To about 115 mm in northeastern Pacific; lengths of 140 mm reported from Okhotsk Sea.

Least depth of capture: To 200 m at night. It has been taken at surface at night once, by dipnet and surface light.

Distribution: All known capture localities of *L. jordani* are shown in Fig. 180 (solid circles). The one occurrence off Santa Catalina Island, Southern California (an adult, 116 mm) no doubt represents a stray. The species has not before been taken to the east or south of the depicted range. Localities shown in Fig. 180 (solid circles) include those of various authors, as listed by Wisner (1970b, fig. 2).

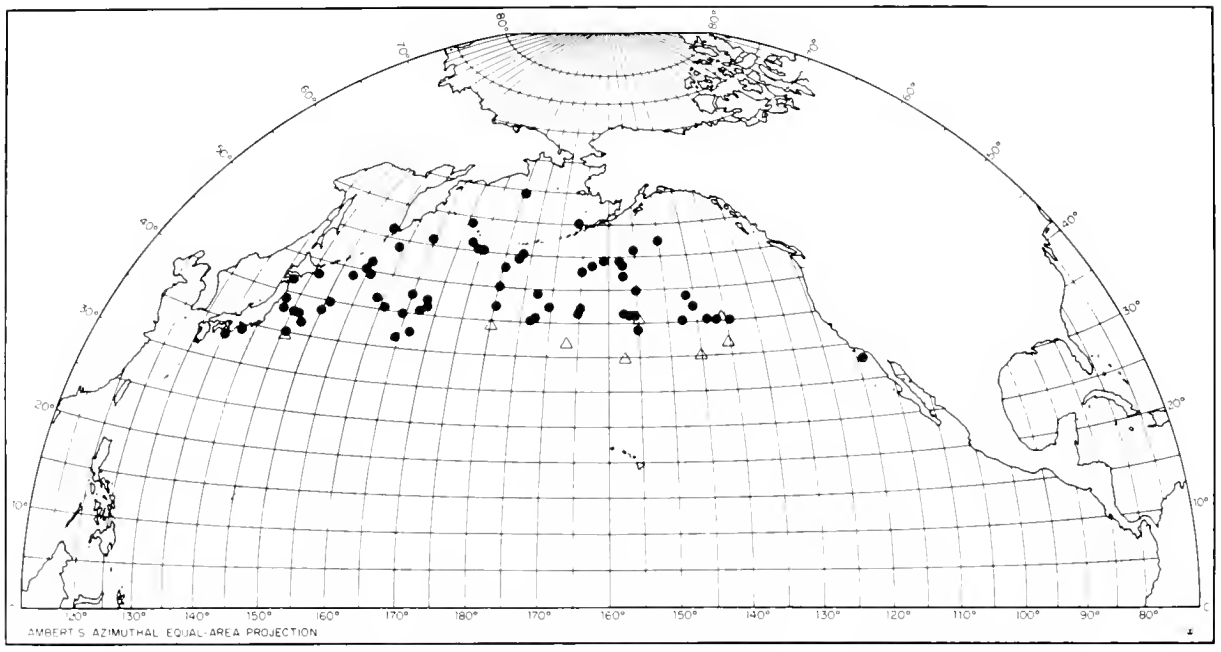


Fig. 180—Capture localities for *Lampanyctus jordani* (solid circles) and *L. simulator* (open triangles).

Lampanyctus simulator
Wisner, 1971

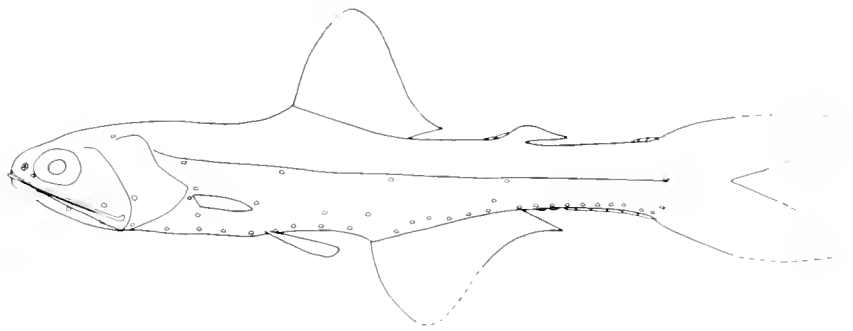


Fig. 181—*Lampanyctus simulator*, holotype, female, 73.3 mm. From Wisner (1971, p. 52, fig. 7).

Description

D. 13 (12-14); A. 18 (17); P. 12-13; AO 6 (5-7) + 8 (7), total 14 (13-15); gill rakers 5 (4) + 1 + 11-12, total 17-18 (16); vertebrae 36 (35-37). Correlated counts of AO photophores and of gill rakers are given in Table 36 and are compared with similar counts for *L. jordani*.

Lampanyctus simulator is similar to *L. jordani*, primarily because of the extra-pectoral photophore just above and behind origin of pectoral base (an organ previously thought unique to *L. jordani*). Also, the second and third AOa photophores are often slightly elevated in a weak imitation of the much greater elevation of these two organs in *L. jordani*, as delineated by Wisner (1970b). Other similarities and differences are discussed below.

Size: To about 95 mm.

Least depth of capture: To 200 m at night.

Distribution: L. simulator is thus far known from only 13 specimens from a restricted area

TABLE 36. CORRELATED COUNTS OF AO PHOTOPHORES AND GILL RAKERS FOR *LAMPANYCTUS JORDANI* AND *L. SIMULATOR* (COUNTS UNDERLINED).

		AOp			
		7	8	9	10
AOa	5	—	3	—	—
	6	2	14	10	9
	7	2	11 1	93	41
	8	—	8	14	2

		Lower gill rakers (including raker at angle)					
		12	13	14	15	16	17
Upper gill rakers	4	1	1	—	—	—	—
	5	8	12	—	1	—	—
	6	—	—	15	21	4	—
	7	—	—	8	45	40	3

of the North Pacific Ocean between about 35° and 40° N (Fig. 180). The distribution is similar to that of *L. fernae* (Fig. 158) but appears to extend farther westward; one specimen was taken near Japan.

Discussion

Although *L. simulator* is superficially similar to *L. jordani*, the two species differ notably in numbers of gill rakers (Table 36) and in several body proportions (Table 37), the former being a more slender fish. *L. simulator* has a higher number of both upper and lower gill rakers, with little or no overlap. In nearly all the body proportions given in Table 37, those of

TABLE 37. BODY PROPORTIONS FOR *LAMPANYCTUS SIMULATOR* AND *L. JORDANI*.

	L. simulator			*L. jordani**	
Measurement	Holotype SL—73.3 mm	Paratypes N= 12 SL—41-94 mm		N= 22 SL—52-108 mm	
Head length	267	271	257-288	290	272-309
Head depth	154	155	152-167	181	166-191
Orbit length	59	61	56-67	66	580-80
Interorbital width	79	71	66-82	86	78-95
Upper jaw length	190	182	186-203	215	204-231
Body depth at pelvic origin	161	164	144-176	190	175-210
Prepectoral length	281	283	275-295	308	290-325
Prepelvic length	396	397	378-412	427	402-463
Predorsal length	453	457	442-469	464	437-494
Preanal length	565	554	541-590	590	561-615
Preadipose length	787	787	776-800	798	785-818
Dorsal origin to pelvic origin	199	185	169-200	205	186-223
Dorsal origin to anal origin	229	213	201-229	243	226-260
Dorsal base length	171	152	141-171	151	134-171
Anal base length	237	230	222-251	214	197-237
Pectoral fin length	105	106	89-120	281	259-300
Pelvic fin length	—	141	128-154	173	159-188
Caudal peduncle length	221	232	217-245	228	210-248
Caudal peduncle depth	105	95	85-105	104	96-119
Infracaudal gland length	162	174	166-189	177	163-182

*These data are from a combination of specimens from the northeastern and northwestern Pacific Ocean (Wisner, 1970b).

L. jordani have higher values than those of *L. simulator*, although often with considerable overlap; those proportions showing no overlap are the upper-jaw length and pectoral and pelvic-fin lengths.

Lampanyctus australis
Tåning, 1932

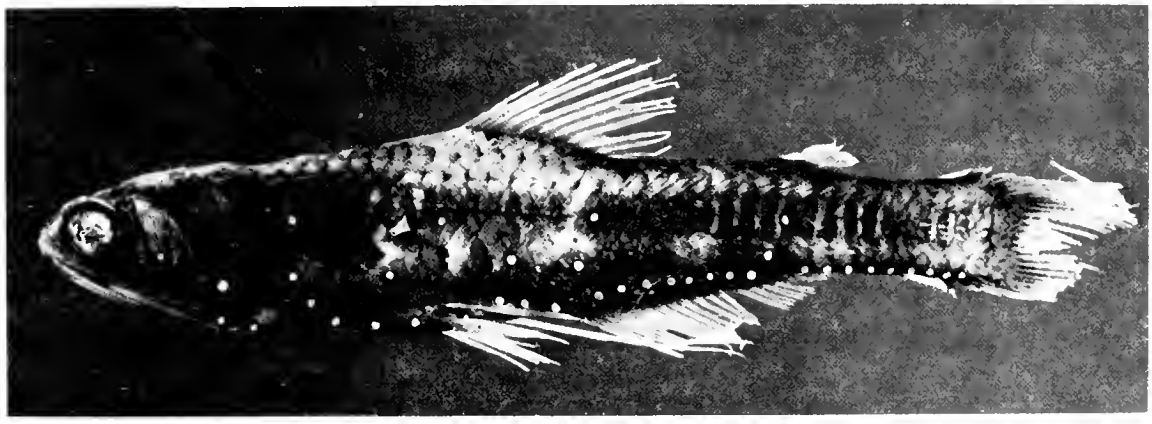


Fig. 182—*Lampanyctus australis*, 99.0 mm. (Photophores retouched).

Description

D. 13; A. 17-18; P. 14 (13-15); AO 7 (7-8) + 7-8, total 14 (15); gill rakers 6 (5) + 1 + 13 (14) total 20 (19-21); vertebrae 36 (35).

This species is easily distinguished by the single, prominent cheek photophore, by the VLO close to lateral line, by the very long pectoral fin which reaches nearly to the Pol, and by the very few (3-5) luminous scales in the infracaudal gland. Upper Prc over or slightly before vertical from next lowest; Prc and AOp continuous.

Size: To 102 mm.

Least depth of capture: To 100 m at night.

Distribution: L. australis is common and circumglobal in the southern hemisphere. In the eastern Pacific, it is known from off Chile (30° to 45° S, 72° to 80° W) (Craddock and Mead, 1970; Bussing, 1965).

Discussion

A related species, *Lampanyctus alatus* Goode and Bean, 1896, is superficially very similar to *L. australis* and the two have been confused by various authors. *L. alatus* is a smaller species, seldom attaining 50 mm SL and it differs further in having fewer gill rakers (3-4 + 1 + 8-10, total 12-15). In the Pacific Ocean *L. alatus* is known only from the northern Indo-Pacific region and from near Taiwan. It is common in the Atlantic, Indian and western Pacific Oceans between latitudes of about 36° N and 37° S (Bolin, 1959).

Lampanyctus pusillus
(Johnson, 1890)

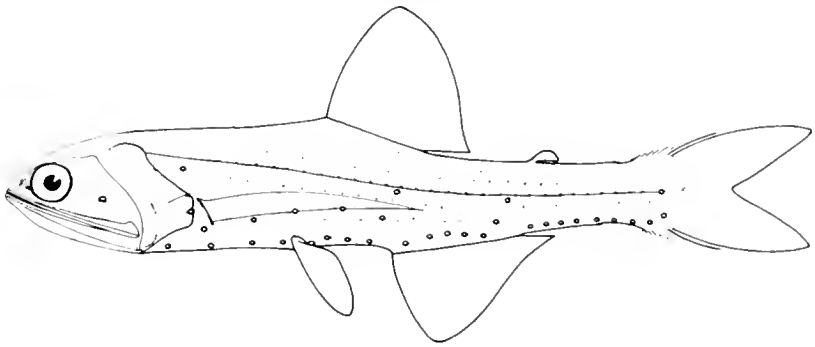


Fig. 183—*Lampanyctus pusillus*, 34.5 mm. From Nafpaktitis and Nafpaktitis (1969, p. 54, fig. 66).

Description

D. 12-13; A. 14-15; P. 13-14; AO 5 (4) + 5-6, total 10 (9-11); gill rakers 3 + 1 + 8 (9), total 12 (13).

AOa but slightly curved; the space between first 2 AOa notably wider than these between the rest. Prc_4 distinctly before vertical from Prc_3. Caudal luminous glands small and weakly formed, with 2 to 4 scales in supracaudal and 3 to 5 in infracaudal glands.

Size: To about 40 mm.

Least depth of capture: To 70 m at night.

Distribution: In the eastern Pacific, it is known only from off Chile (Bussing, 1965; Craddock and Mead, 1970) between about 29° and 34° S, 73° and 93° W. It is also known from the southern Indian and North and South Atlantic Oceans.

Discussion

This species is superficially similar to both *L. alatus* and *L. australis* but is readily separable by the absence of a luminous scale at the base of the adipose fin and by the low position of VLO, about midway between base of pelvic fin and lateral line.

Lampanyctus iselinoides
Bussing, 1965

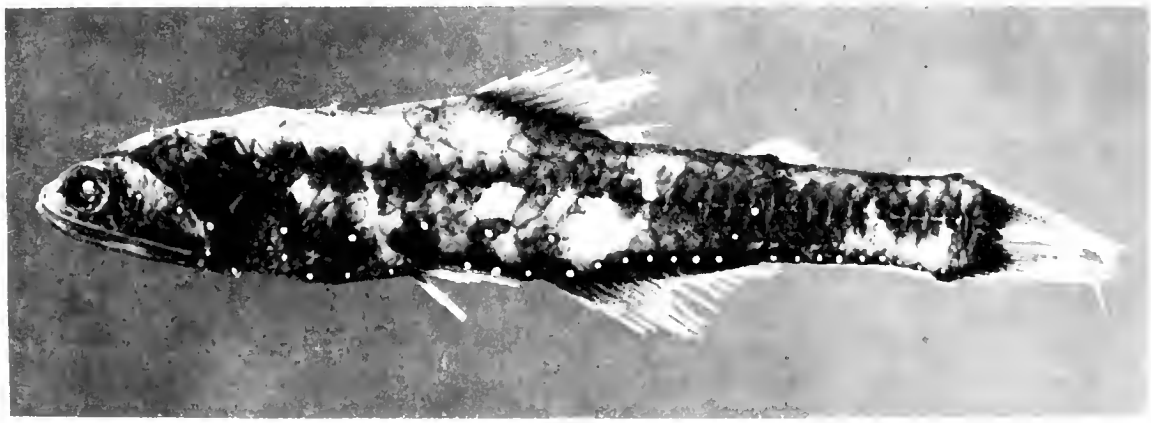


Fig. 184—*Lampanyctus iselinoides*, 97.2 mm. (Photophores retouched).

Description

D. 13 (12-14); A. 17 (16-18); P. 11 (10-12); AO 7 (6-8) + 7 (8), total 14 (13-16); gill rakers 4 (5) + 1 + 11 (10-12), total 16 (15-18); vertebrae 36 (35-37).

Two prominent photophores on middle of cheek, well separated and on a line about parallel with upper jaw. Anal origin about under beginning of last third of dorsal base. Prominent secondary photophores on each scale pocket. Last 3 Prc in oblique line, the last (uppermost) on level of lateral line at bases of caudal rays; Prc_{3-4} interspace slightly greater than the rest; Prc and AOp continuous. AOa level, the space between the first 2 notably greater than those between the rest. Infracaudal gland with 7 (8-9) luminous scales filling ventral surface of caudal peduncle; supracaudal gland small, the scales varying in number from 3 to 4. Luminous gland at base of adipose fin with 1 to 4 luminous scales.

Size: To about 100 mm.

Least depth of capture: To 70 m at night.

Distribution: Known only from the southeastern Pacific Ocean off Chile, from about 21° to 48° S, 71° to 82°W.

Lampanyctus intricarius
Tåning, 1928

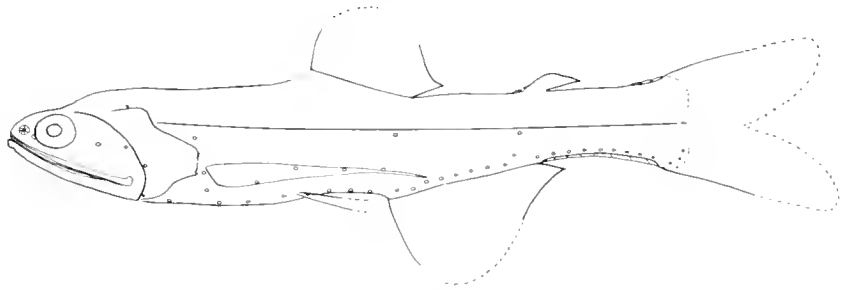


Fig. 185—*Lampanyctus intricarius*, male, 107.5 mm. From the southeastern Pacific Ocean, near Valparaiso, Chile.

Description

D. 14-15; A. 18-19; P. 14 (13-15); AO 8-9 (10) + 8-9 (10), total 17 (16-19); gill rakers 4 + 1 + 9 (10), total 14 (15); vertebrae 39 (38-40). Body proportions are given in Table 38 and are compared with similar data for a related species, *L. lepidolychnus*.

PLO below lateral line, about one-third the distance from there to pectoral origin. PVO_{1-2} interspace about half that of PLO-PVO_2. PLO and PVO_{1-2} form straight, posteriorly slanting line that passes slightly before PO_2. PO_4 elevated to about level of middle of pectoral base, or slightly lower, and to almost directly over PO_3. VLO over or slightly behind pelvic origin and slightly above midway between that origin and lateral line. SAO_1 on level of or slightly higher than SAO_2 and about over midpoint between VO_{2-3} interspace. SAO_{1-2} interspace nearly one and one-half times that of SAO_{2-3}. A line through SAO_{1-2} passes slightly behind VO_4. SAO_2 about over anus; SAO_3 slightly before or behind vertical from AOa_1. The 2 Pol and last AOa form line that passes variously through, before, or slightly behind end of base of adipose fin. AOa-AOp interspace equal to about half least depth of caudal peduncle and considerably greater than space between Prc_{3-4}. First 3 Prc equally spaced in curve; Prc_4 at end of lateral line and separate from Prc_3 by space only little less than that between Prc_1 and Prc_3.

Size: To about 155 mm.

Least depth of capture: To 70 m at night, off Chile.

TABLE 38. BODY PROPORTIONS FOR *LAMPANYCTUS INTRICARIUS*, FROM OFF THE PACIFIC COAST OF CHILE, AND FOR *L. LEPIDOLYCHNUS*, FROM THE SOUTHERN OCEANS.

Measurement	*L. intricarius* N = 25 (63-170 mm)		*L. lepidolychnus** N = 20 (58-115 mm)	
	Ave.	Range	Ave.	Range
Head length	287	278-297	259	247-271
Head depth	164	153-177	145	139-157
Orbit length	62	56-68	59	50-67
Upper jaw length	207	212-218	184	178-196
Prepectoral length	303	293-315	278	271-288
Prepelvic length	418	402-430	396	380-409
Preanal length	566	548-580	560	552-578
Predorsal length	465	451-475	462	452-473
Preadipose length	791	777-804	802	787-809
Dorsal origin to pelvic origin	183	163-198	190	174-200
Dorsal origin to anal origin	220	210-233	223	215-235
Caudal peduncle length	222	213-237	214	204-225
Caudal peduncle depth	96	82-111	106	100-114
Dorsal base length	157	146-165	176	171-184
Anal base length	226	209-245	246	231-252

*Of the 20 specimens of *L. lepidolychnus*, 10 were from off South Africa, 3 each from the southwestern Atlantic and south-central Pacific Oceans, and 4 from the southern Indian Ocean.

Distribution: In the eastern Pacific Ocean, *L. intricarius* is known primarily from off Valparaiso, Chile (Bussing, 1965, and Craddock and Mead, 1970), and northward to 21°16′ S, 71°09′ W. I have seen one specimen (142 mm) from between New Zealand and Chatham Island. It is also known from the North Atlantic and southern Indian Oceans.

Discussion

Lampanyctus intricarius is very similar to *L. lepidolychnus*; this relationship will be discussed in the following account of that species.

Lampanyctus lepidolychnus
Becker, 1967

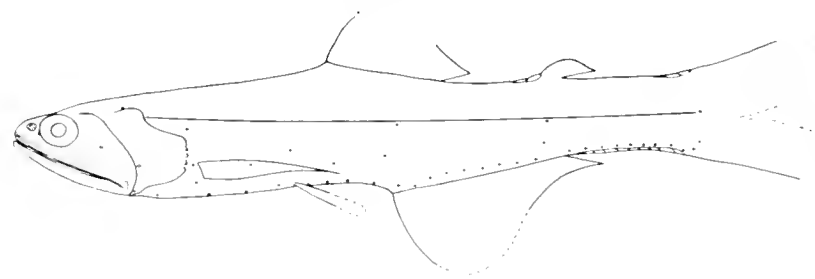


Fig. 186—*Lampanyctus lepidolychnus*, female, 103.0 mm. From the southeastern Atlantic Ocean, 36°51′ S, 12°43′ E.

Description

D. 15 (14-16); A. 19-20; P. 12 (11-13); AO 9 (8-10) + 8 (7-9), total 16)17 (18); gill rakers 4 (3) + 1 + 10 (9-11), total 15 (14-16); vertebrae 37-38. Body proportions are given in Table 38 and are compared with similar data for a related species, *L. intricarius*.

PLO below lateral line by one-third to one-fourth the distance from there to pectoral origin. PVO_{1-2} interspace about half that of PLO-VPO_2. PLO and PVO_{1-2} form straight, posteriorly slanting line that passes slightly before PO_2. PO_4 elevated to about level of middle of pectoral base, or somewhat lower, and to its diameter behind a vertical from PO_3. VLO about midway between lateral line and pelvic base and about over middle of that base. SAO_1 below level of SAO_2 and about over midpoint of VO_{2-3} interspace, often slightly nearer to VO_3. SAO_{1-2} interspace about one and one-half times that of SAO_{2-3}. A line through SAO_{1-2} passes through or below PO_4; a line through SAO_{2-3} passes slightly behind VO_4. SAO_2 about over anus; SAO_3 slightly behind vertical from AOa_1 and over bases of third or fourth anal rays. A line through the 2 Pol passes slightly behind last AOa. AOa-AOp interspace slightly less than half least depth of caudal peduncle and about equal to that between Prc_{1-3}. AOp continuous with Prc. First 3 Prc equally spaced in curve; Prc_4 at or above lateral line and separate from Prc_3 by a space about a third greater than that between Prc_1 and Prc_3.

Size: To 110 mm.

Least depth of capture: To 200 m at night off South Africa.

Distribution: L. lepidolychnus appears to occur circumglobally in southern waters, probably below 30° S. It is known from off South Africa and Argentina and from south-central Pacific and Indian Oceans. It has not yet been reported from the southeastern Pacific, off Chile, where the related species, *L. intricarius*, is moderately abundant.

Discussion

Lampanyctus lepidolychnus and *L. intricarius* are very similar. They may be confused primarily because of the similarity in positions of the depressed AOa_2 photophores. However, in addition to those characters given above, and the few differences in body proportions (Table 38), the two species differ somewhat in the percentage values of depth to length of the caudal peduncle: 49% (45-57%) for *L. lepidolychnus*, vs 43% (36-48%) for *L. intricarius*. Also, the color (in preservative) of the latter species is a light to medium brown, whereas the former is very dark.

Other characters useful in distinguishing between *L. lepidolychnus* and *L. intricarius* are given in Table 39.

TABLE 39. SOME CHARACTERS USEFUL IN DISTINGUISHING BETWEEN *LAMPANYCTUS LEPIDOLYCHNUS* AND *L. INTRICARIUS*.

L. lepidolychnus	*L. intricarius*
SAO_1 below level of SAO_2	SAO_1 on or above level of SAO_2
AOa-AOp interspace slightly less than half least depth of caudal peduncle and about equal to that of Prc_{3-4}	AOa-AOp interspace about as in *L. lepidolychnus* but much greater than that of Prc_{3-4}
Prc_{3-4} interspace slightly less than that of Prc_{1-3}	Prc_{3-4} interspace about one-third greater than that of Prc_{1-3}
Least depth of caudal peduncle 49% (45-57%) of length of peduncle	Least depth of caudal peduncle 43% (36-48%) of length of peduncle
Color in preservative very dark	Color in preservative light to medium brown.

L. lepidolychnus is also somewhat similar to *L. iselinoides* but differs in part in that the pectoral fin of the latter is much shorter (scarcely reaching to pelvic origin), and the length of the pectoral base averages 28% (24-31%) of the length of the orbit. The percentage values for depth to length of caudal peduncle are higher in *L. iselinoides*—43% (40-46%). Also, this latter species has 2 cheek photophores, rather than 1, and the last 3 Prc are in a straight, oblique line, rather than in a curve as in *L. intricarius*.

Lampanyctus macdonaldi
(Goode and Bean, 1896)

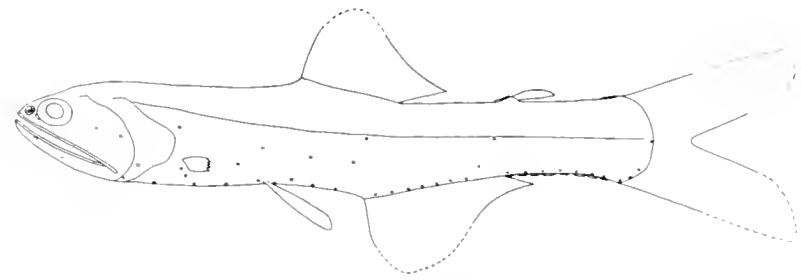


Fig. 187—*Lampanyctus macdonaldi*, female, 117.0 mm.

Description

D. 14-15; A. 18; P. 12 (11); AO 7 (6-8) + 7 (6-8), total 14 (13-15); gill rakers 8 (9) + 1 + 17 (16-18), total 26 (25-27); vertebrae 36 (seven specimens).

PLO below lateral line about a third the distance to pectoral origin; VLO usually slightly nearer lateral line than to pelvic origin and slightly before vertical from that origin. Line through SAO_{1-2} and VLO passes through or somewhat below PLO; SAO_1 slightly behind vertical from VO_3 and usually slightly above level of SAO_2. AOa series evenly spaced and occasionally very slightly curved, or AOa_1 slightly depressed. No AOp over anal base. Prc and AOp often continuous; upper Prc at end of lateral line and distant from closely spaced first 3. The luminous scale before adipose base is weakly developed and easily lost; 2 to 4 weak luminous scales in supracaudal gland, 7 to 9 in infracaudal, the latter usually extending to near base of last anal ray.

Size: To 117 mm in eastern Pacific; Bolin (1959) listed 135 mm for a specimen from the North Atlantic.

Least depth of capture: To 1200 m at night off Chile. Bolin reported captures with 1000 m of wire out in the North Atlantic.

Distribution: Probably circumglobal in southern seas. It is also known from the North Atlantic Ocean, but has not been reported from the South Atlantic. In the South Pacific Ocean, it is known from off Valparaiso, Chile (Craddock and Mead, 1970), to Kermedec Islands and southeast of South Island, New Zealand. I have seen one specimen (115 mm) from about 42° S, 71° E in the Indian Ocean.

Discussion

L. macdonaldi is superficially similar to *L. iselinoides* (see above) but differs in having no secondary body photophores and in having about 10 more total gill rakers, 26 (25-27) vs 16 (15-18).

At present there is no distributional evidence to link the North Atlantic population of *L. macdonaldi* (reported by Bolin, 1959) with that of the southern oceans. Data from the seven specimens available to me from the South Pacific agree well with that given by Bolin, except, perhaps, in numbers of gill rakers; Bolin reported 7 (6-8) + 1 + 16 (14-18), total 24 (21-26) (about 2 fewer rakers).

Bolinichthys Paxton, 1972

Body moderately robust, head rather short and deep. PO_3 slightly, PO_4 highly, elevated, the remaining 3 in more or less straight, descending series. SAO series moderately angulate. 3 Prc, first 2 near ventral caudal rays, third above lateral line and well behind vertical from second. PLO, SAO_3, upper Pol, and Prc_3 above lateral line. Crescent of whitish tissue on

posterior half of iris. Small scales of luminous tissue at bases of dorsal, anal, and pelvic fins, and near base of pectoral fin in one species.

Key to species of *Bolinichthys* in the eastern Pacific Ocean

1a. VLO far below lateral line, only slightly above midway between there and pelvic base. VO_2 only slightly elevated, far below level of lower end of pectoral base. No luminous tissue on head or at bases of dorsal and pelvic fins.....*B. supralateralis*

1b. VLO touching or very near lateral line. VO_2 much elevated, about on level of lower end of pectoral base. Luminous tissue on head and at pelvic base.....2

2a. Luminous patches present above pectoral origin and below PVO_1; 2 to 5 luminous scales at bases of anterior rays of dorsal and anal fins. Infracaudal luminous gland reaches to or beyond last AOp. VLO two or three of its diameters below lateral line .....*B. photothorax*

2b. No luminous patches above pectoral origin or below PVO_1. One (usually) or 2 (rarely 3) luminous scales at bases of dorsal and anal rays. Infracaudal luminous gland seldom reaches to (never beyond) last AOp. VLO on lateral line.....*B. longipes*

The genus *Bolinichthys* was separated from the genus *Lepidophanes* Fraser-Brunner, (1949) by Paxton (1972) primarily on the basis of characters stated in the "Key to Genera of Family Myctophidae." Paxton's justifiable action restricted the genus *Lepidophanes* to two known species, *L. guntheri* (Goode and Bean, 1896) and *L. gaussi* (Brauer, 1906); neither has been reported from the Pacific Ocean.

Bolin (1959) reduced all species now referrable to the genus *Bolinichthys* to synonyms of *Bolinichthys pyrsobolus* (Alcock, 1890). However, the time-honored name *pyrsobolus* will not be used here for any of the eastern Pacific species of the genus *Bolinichthys* for a number of reasons. Alcock described *Scopelus pyrsobolus* from the Indian Ocean, based on a single, damaged female. The inadequate description and figure pertain in part to all subsequently described species of *Bolinichthys*. No luminous organs were shown in the figure, and Alcock stated only that, "The luminous organs have been too much damaged for description: two series, traversing the ventral half of the body on each side, still remain; two long luminous organs occupy respectively the mid-dorsal and mid-ventral line close to the base of the caudal." The "long" caudal organs may have been only a subjective interpretation by Alcock, for the accompanying outline sketch shows the gland is short and much more like that of *Bolinichthys* than of *Lepidophanes* (the latter genus having long supracaudal glands). Despite these inadequacies in description by Alcock, all eastern Pacific specimens have heretofore been referred to *"pyrsobolus."*

Nafpaktitis and Nafpaktitis (1969), reporting on western Indian Ocean material, could not reconcile any of their specimens with Alcock's description and figure and chose to refer them to two species more adequately described and illustrated, *Bolinichthys longipes* (Brauer, 1906) and *B. photothorax* (Parr, 1928), and to describe a new species, *"Lepidophanes" indicus*. This choice is followed herein.

Bolinichthys supralateralis
(Parr, 1928)

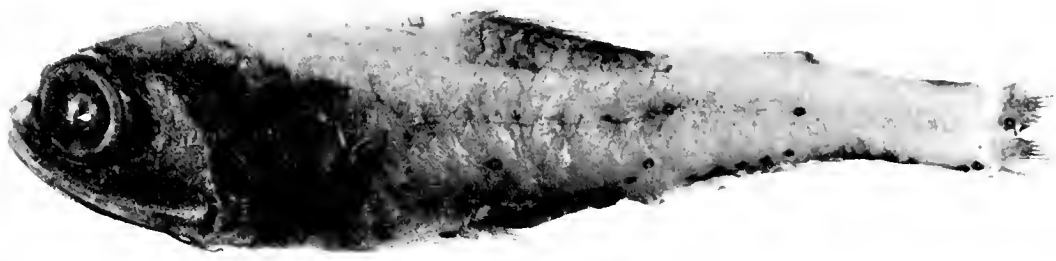


Fig. 188—*Bolinichthys supralateralis*, female, 60.2 mm. From near Hawaii.

Description

D. 13 (12); A. 14 (13-15); P. 12-13; AO 5-6 + 4 (3-5), total 9-10; gill rakers 5 (6) + 1 + 11 (10-12), total 16 (15-17); vertebrae 34 (rarely 33). Frequency distributions for the above characters are given in Table 40 and are compared with those for *B. photothorax* and *B. longipes*.

TABLE 40. NUMBERS OF FIN RAYS, AO PHOTOPHORES, GILL RAKERS, AND VERTEBRAE FOR *BOLINICHTHYS SUPRALATERALIS*, *B. PHOTOTHORAX*, AND *B. LONGIPES* FROM THE EASTERN PACIFIC OCEAN.

	Dorsal rays					
Species	11	12	13	14	15	
B. supralateralis	—	1	20	—	—	
B. photothorax	—	—	23	3	—	
B. longipes	3	17	—	—	—	
	Anal rays					
	11	12	13	14	15	
B. supralateralis	—	—	8	21	1	
B. photothorax	—	—	2	21	1	
B. longipes	—	—	11	8	1	
	Pectoral rays					
	11	12	13	14	15	
B. supralateralis	—	5	10	—	—	
B. photothorax	—	—	12	21	7	
B. longipes	—	8	23	8	—	
	AOa photophores					
	2	3	4	5	6	7
B. supralateralis	—	—	—	8	20	—
B. photothorax	—	4	53	10	2	—
B. longipes	7	130	131	6	—	—
	AOp photophores					
	2	3	4	5	6	7
B. supralateralis	—	6	18	4	—	—
B photothorax	—	—	—	13	45	11
B longipes	—	—	21	225	28	—

(Table 40 cont'd.)

	Total AO photophores						
	7	8	9	10	11		
B. supralateralis	—	—	10	18	—		
B. photothorax	—	—	4	53	12		
B. longipes	17	111	132	14	—		
	Upper gill rakers						
	4	5	6				
B. supralateralis	—	23	3				
B. photothorax	1	32	25				
B. longipes	9	57	—				
	Lower gill rakers						
	11	12	13	14	15	16	17
B. supralateralis	2	19	5	—	—	—	—
B. photothorax	—	2	19	16	14	7	1
B. longipes	3	24	34	5	—	—	—
	Total gill rakers						
	16	17	18	19	20	21	22
B. supralateralis	2	16	8	—	—	—	—
B. photothorax	—	3	14	16	7	12	6
B. longipes	7	25	29	5	—	—	—
	Vertebrae						
	32	33	34	35	36		
B. supralateralis	—	2	12	—	—		
B. photothorax	—	1	4	20	5		
B. longipes	10	61	34	4	—		

PLO, SAO_3, Pol, and Prc_3 distinctly above lateral line. PVO_{1-2} often form a straight, nearly vertical line that passes through or slightly behind PO_2. PO_4 elevated to about level of PVO_1. VO_2 and VO_3 nearly on same level. VLO slightly above midway between pelvic base and lateral line. VO_5, SAO_1, and SAO_2 in an oblique, nearly straight line that passes well behind SAO_3.

Small photophores behind orbital rim and tiny ones on scale pockets, present in the other two species of *Bolinichthys* in the eastern Pacific Ocean, are either absent or very weakly developed; on only 1 of 15 specimens was a very small postorbital organ present, but on no specimen was a tiny organ evident on any scale pocket. However, the integument of all specimens was somewhat eroded.

No luminous tissue below PVO_1, between pectoral origin and lateral line or at bases of dorsal and pelvic fins; 3 or 4 small luminous scales present anteriorly on base of anal fin, beginning at about fourth ray. Supracaudal luminous gland short, of 2 (rarely 3) scales; infracaudal gland of 3 to 5 scales that reach to below last or next to last AOp. Pectoral fins all broken in specimens at hand, but Parr (1928) reported this fin to be "very long, reaching beyond middle of anal fin."

Body proportions are given in Table 41 and are compared with similar data for *B. photothorax* and *B. longipes*.

Size: To 84 mm.

Least depth of capture: Clarke (1973, Table 1) listed depths of 95 to 225 m at night and 490 to 690 m in daytime tows near Hawaii.

Distribution: In the eastern Pacific Ocean, the species is known only from near Hawaii. I have also examined specimens from off the northeastern tip of Luzon, Philippines, and from about 10° N, 96° E in the Indian Ocean.

TABLE 41. BODY PROPORTIONS FOR 10 SPECIMENS EACH OF *BOLINICHTHYS SUPRALATERALIS*, *B. PHOTOTHORAX*, AND *B. LONGIPES* FROM THE EASTERN PACIFIC OCEAN.

Measurement	*B. supralateralis* SL—45.2-84.6 mm		*B. photothorax* SL—35.2-66.8 mm		*B. longipes* SL—33.1-47.1 mm	
	Ave.	Range	Ave.	Range	Ave.	Range
Head length	355	346-364	328	308-338	334	320-346
Head depth	239	226-255	203	192-214	220	202-230
Orbit length	111	106-113	114	105-120	111	103-121
Upper jaw length	228	216-238	199	191-208	197	188-214
Prepectoral length	349	338-361	335	332-339	337	321-349
Prepelvic length	464	450-480	447	435-461	467	449-484
Predorsal length	483	467-489	472	462-486	486	472-500
Preanal length	646	626-655	636	620-645	652	646-660
Preadipose length	823	813-843	800	785-816	822	813-839
Dorsal origin to pelvic origin	230	222-239	202	189-223	219	204-237
Dorsal origin to anal origin	279	273-287	274	264-288	281	264-296
Dorsal base length	148	140-154	154	140-160	155	144-164
Anal base length	176	163-184	182	160-207	181	175-189
Caudal peduncle length	197	189-206	205	189-221	191	176-204
Caudal peduncle depth	90	86-94	96	86-106	93	85-100

Discussion

Dr. R. K. Johnson, Chicago Natural History Museum, has evidence (personal communication) that specimens referable to *B. supralateralis* from the central and western Pacific Ocean and Indo-pacific areas may represent an undescribed species.

Bolinichthys photothorax
(Parr, 1928)

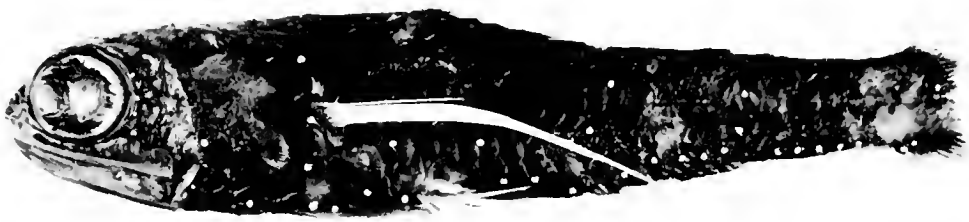


Fig. 189—*Bolinichthhys photothorax*, female, 67.0 mm. From the central tropical Pacific Ocean. (Photophores retouched).

Description

D. 13 (12-14); A. 14 (15); P. 14 (13-15, rarely 16); AO 6 (5-7) + 4 (3-6), total 10 (9-11); gill rakers 5 (4-6) + 1 + 13-15 (12-16), total 18-20 (17-22); vertebrae 35 (34-36). Frequency distribution for the above characters are given in Table 40 and are compared with those for *B. supralateralis* and *B. longipes*.

Pectoral fin long, fragile, reaching to Pol. PO_4 elevated to about level of base of lower pectoral ray; PO_3 elevated to at least its diameter above a line through upper margins of PO_2 and PO_5. VO_4 elevated to about level of PO_4 and SAO_1, the remaining VO in descending series.

Supracaudal luminous glands with 2 or 3 scales; infracaudal gland with 3 or 4, the latter extending to below (usually slightly beyond) the last, and occasionally to next to last AOp. Patterns of luminous organs of the head in eastern Pacific forms (Fig. 190) are quite similar to those shown by Nafpaktitis and Nafpaktitis (1969, p. 61, fig. 73A) for Indian Ocean specimens.

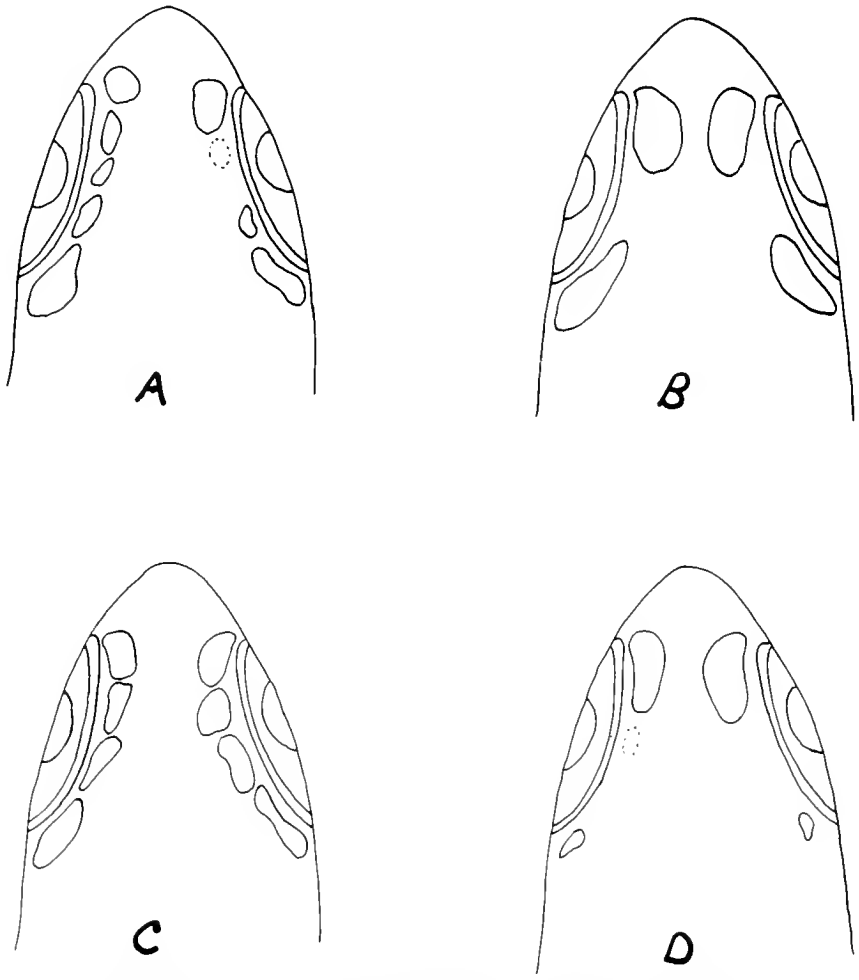


Fig. 190—Luminous gland on heads of *Bolinichthys photothorax*: (A) male, 48.0 mm, (B) female, 52.0 mm; and of *B. longipes*: (C) male, 34.0 mm, (D) female, 33.0 mm.

Body proportions are given in Table 41 and are compared with similar data for *B. supralateralis* and *B. longipes*.

Size: To 68 mm.

Depth of capture and distribution will be discussed under *B. longipes*.

Bolinichthys longipes
(Brauer, 1906)

Fig. 191—*Bolinichthys longipes*, male, 45.0 mm. From the eastern tropical Pacific Ocean. (photophores retouched).

Description

D. 12-13 (rarely 11); A. 14 (13-15); P. 12-13; AO 5 (4-6) + 3-4 (2-5), total 8-9 (7-10); gill rakers 5 (4) + 1 + 12-13 (11-14), total 17-18 (16-19); vertebrae 33-34 (32-35). Frequency distributions of the above characters are given in Table 40 and are compared with those for *B. supralateralis* and *B. photothorax*.

Bolinichthys longipes is basically similar to *B. photothorax*, differing primarily as stated in key to species. Also, the pectoral fins may not reach quite as great a length, the longest (apparently intact) reaching to about AOa_3 rather than to Pol. In general, depth of head and body is somewhat greater in *B. longipes*. Body proportions are given in Table 41 and are compared with similar date for *B. supralateralis* and *B. photothorax*.

The pattern of luminous organs of the head (Fig. 190) is similar to that shown for this species from the western Indian Ocean by Nafpaktitis and Nafpaktitis (1969), particularly in males; these authors stated that only traces of luminous tissue were found on females from that area, but in females from the eastern Pacific Ocean these patches were very well developed anteriorly but to a lesser degree posteriorly.

Size: To 49 mm.

Least depth of capture: Clarke (1973, Table 1) listed depths of 50 to 150 m in nighttime, and 525 to 725 m in daytime tows (few specimens taken at less than 625 m).

Distribution: In the eastern Pacific Ocean *B. longipes* and *B. photothorax* occupy the same waters, but for reasons not clear the latter is not commonly taken; both species are occasionally taken in one haul. Their distribution appears to be limited to warmer waters, for much collecting has been done north and southeast of the area shown in Fig. 192 without taking either species. Insufficient collecting has been done west and southwest of the area to permit firm statements as to their occurrence there. Whitley (1968) did not list any species of *Bolinichthys* in his checklist of New Zealand fishes.

Discussion

On the basis of size alone, it is probable that either *B. supralateralis* or *B. photothorax* are synonymous with Alcock's *pyrsobolus*. Alcock (1890) stated the size of the holotype of *pyrsobolus* to be "3½ inches without caudal" (about 78 mm). The 10 specimens of *B. supralateralis* from the Indian Ocean examined by me ranged from 51 to 64 mm. Of the three species from the Indian Ocean discussed by Nafpaktitis and Nafpaktitis (1969), the largest of 60 specimens of *B. photothorax* was 60 mm, the largest of 1267 *B. longipes* was 45 mm, and of 18 *B. indicus*, 37.5 mm. In the eastern Pacific area, the largest of 15 *B. supralateralis* was 84 mm, and of 103 *B. photothorax*, 68 mm; of hundreds of *B. longipes* none exceeded 47 mm. Thus, only *B. supralateralis* and *B. photothorax* (or *B. blacki* (Fowler, 1934, "length 80 mm"), an Indo-Pacific form not considered here) approach the size (ca 78 mm) recorded for the holotype of *B. pyrsobolus*.

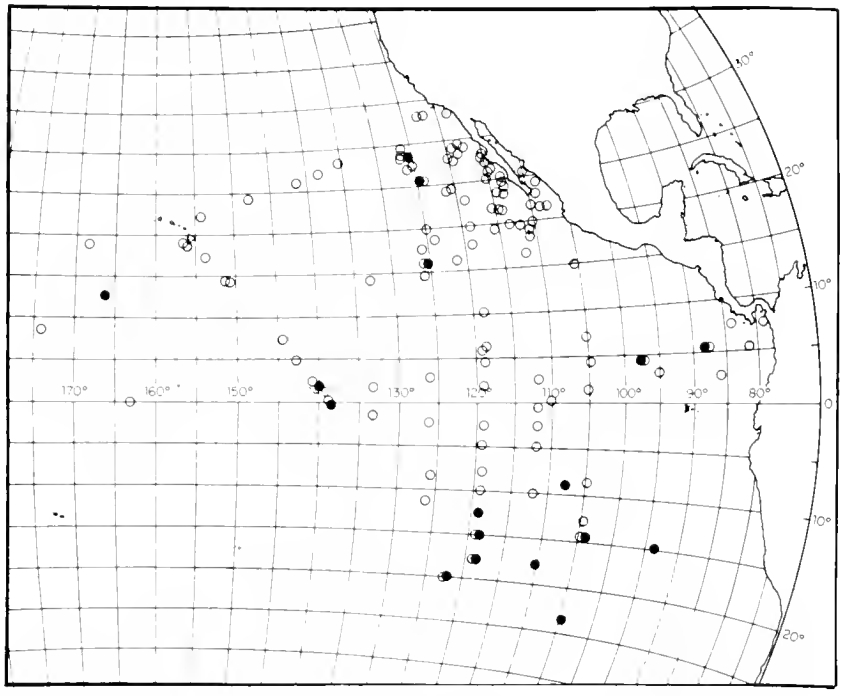


Fig. 192—Capture localities in the eastern Pacific Ocean for *Bolinichthys photothorax* (solid circles) and *B. longipes* (open circles).

Ceratoscopelus Günther, 1864

Very similar to genus *Bolinichthys* but first 4 PO on same level; only PO_5 elevated. Five VO, not on same level. Palatine teeth in single series, the anterior few slightly enlarged. No Dn; Vn small, rounded. PLO, SAO_3, upper Pol and Prc below but touching lateral line; VLO about midway between pelvic origin and lateral line. Numerous patches of luminous tissue (scales) occur along dorsal and ventral midlines and on other parts of the body but are easily lost; most persistent is the Y-shaped series of scales between pelvic and anal fins and those along base of anal fin and in caudal luminous glands.

There are at least two forms in the eastern and central Pacific Ocean that conform to the above diagnosis. As presently understood, these forms are separable only by the presence or absence of some luminous scales on head and body, and, possibly, the extension of these scales along the secondary (procurrent) caudal rays. Unfortunately, as some luminous scales are easily lost, only specimens in good condition may be properly allocated; given such specimens, the following key will aid in determining two basic forms.

Key to species of *Ceratoscopelus*

1a. Prominent patches of luminous tissue over each eye (supraorbital luminous gland). Pectoral fin seldom reaching past AOa_2. No luminous scales between PVO_{1-2} and PO_{2-3} over PO_4, or over anus. Luminous scales on caudal peduncle usually not extending beyond vertical from Prc_2 ..... *C. townsendi*

1b. No supraorbital luminous gland. Pectoral fin usually reaching AOa_3 or AOa_4. Luminous scales present between PVO_{1-2} and PO_{2-3}, over PO_4, and over anus. Luminous scales on caudal peduncle extending to or beyond a vertical from Prc_3 or Prc_4 ..... *C. warmingii*

Ceratoscopelus townsendi
(Eigenmann and Eigenmann, 1889)

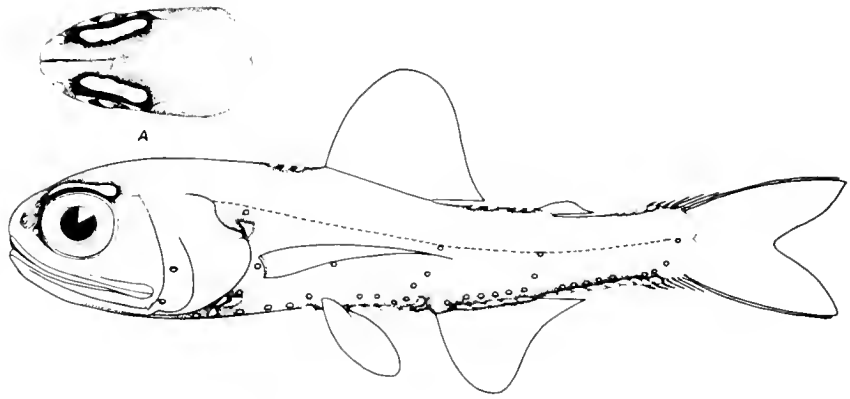


Fig. 193—*Ceratoscopelus townsendi*, male, 43.0 mm. From Nafpaktitis and Nafpaktitis (1969, p. 67, fig. 78).

Description

D. 14 (13-15); A. 13-14; P. 13-14; AO 6 (5-7) + 6 (5), total 11 (10-12); gill rakers 4 (5) + 1 + 10 (9-11), total 15 (14-16); vertebrae 36 (35-38).

SAO series in a very slight angle, often nearly straight; anterior margin of SAO_2 usually touches a line through posterior margins of SAO_{1-2}. A line through SAO_{2-3} passes through or slightly before VO_5, occasionally through VO_4. AOa_1 usually below level of others; AOa_{1-2} interspace often slightly greater than others of series. Last AOa often slightly elevated and appearing in series with Pol. Lower Pol over or slightly before end of anal base. All AOp behind end of anal base. First 3 Prc closely spaced, their interspaces slightly but progressively wider, the space between Prc_{3-4} nearly as great as that between Prc_{1-3}.

A large and easily lost supraorbital luminous organ lies over each eye (Fig. 193), more massive and robust in males. A small luminous scale present between PLO and pectoral origin, and 2 or 3 scale in area between PO_{1-2} and PVO_1. A row of several luminous scales occurs before dorsal fin, on each side of the fin, and between end of dorsal fin and origin of adipose fin; these scales are also easily lost.

Size: To about 60 mm.

Least depth of capture: Paxton (1967a) reported captures between 0 and 20 m at night and 500 and 800 m in daylight in the San Pedro Basin, southern California.

Distribution: C. townsendi may be restricted to northeastern Pacific Ocean (Fig. 194), but see discussion of its systematic and spatial relationships to *C. warmingii*.

Ceratoscopelus warmingii
(Lütken, 1892)

Description

D. 14 (13-15); A. 14 (13-16); P. 14 (13-15); AO 6 (5-7) + 5 (4-6), total 11 (10-13); gill rakers 4 (5) + 1 + 10 (9-11), total 15 (14-16); vertebrae 36 (35-38).

C. warmingii very similar to *C. townsendi*, differing principally as diagnosed in the key to species. In addition, in *C. warmingii* angulation of SAO series is often such that a line through SAO_{1-2} passes well before VO_4 rather than well behind or (rarely) through. SAO_3 appears to be more often slightly behind vertical from origin of anal fin rather than over or slightly before that origin as in *C. townsendi*. However, there is considerable variation and slight overlap in these characters within and between the two species.

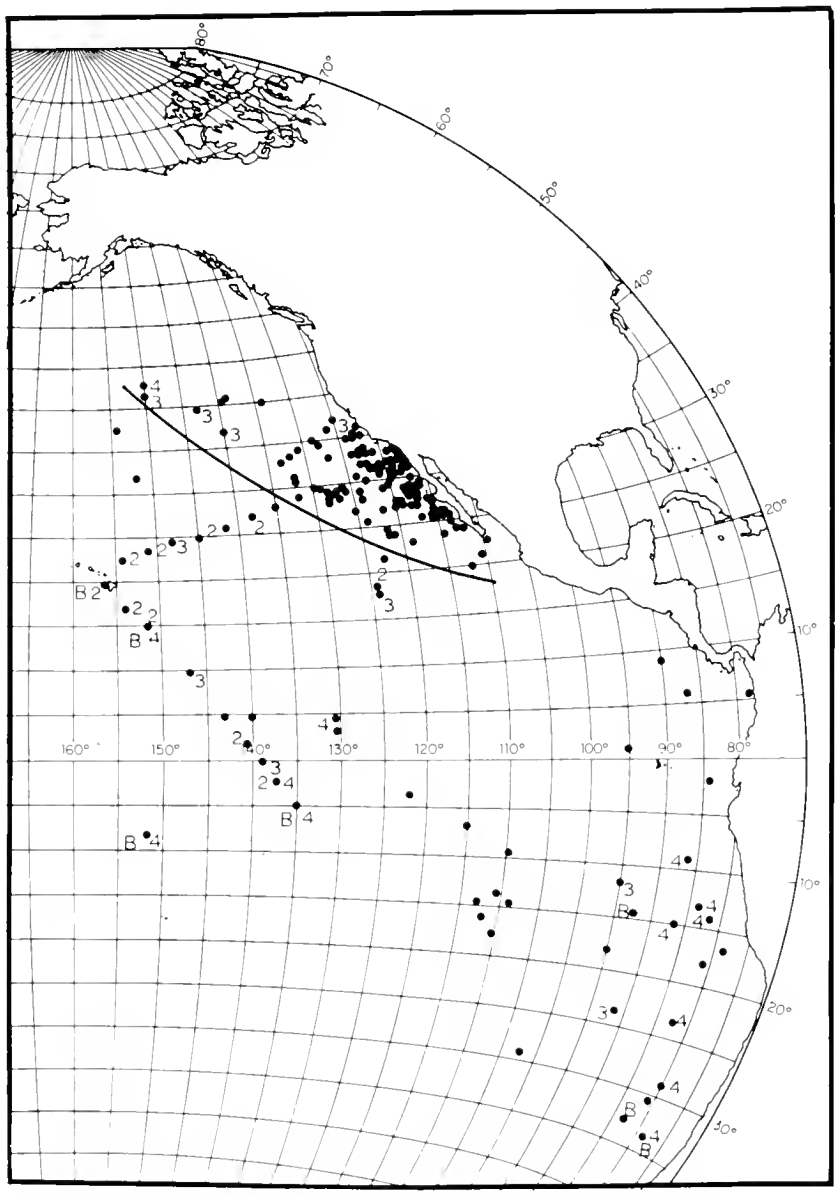


Fig. 194—Capture localities in the eastern Pacific Ocean for the *Ceratoscopelus townsendi-warmingii* species complex. The heavy line indicates the probable western limit of *C. townsendi*. The solid circles south and west of the heavy line indicate specimens not completely representative of either *C. warmingii* or *C. townsendi*. The numberals at certain localities indicate the Prc photophore to which luminous scales extend. The letter B indicates specimens found to have black pigment at tips of one or more luminous scales of the body.

Size: Commonly to 75 mm in east-central Pacific; Craddock and Mead (1970) reported a 93-mm specimen (as *C. townsendi* from off Chile at about 34° S, 85° W.

Least depth of capture: To 100 m at night.

Distribution: C. warmingii may be widely distributed in the Atlantic, Indian, and perhaps Pacific Oceans (Fig. 194). Additional specimens, determined as *C. townsendi*, have been reported by the following authors: Andriashev (1962) reported a juvenile taken at 64° 36′ S, 108° 52′ W, and a 79.5-mm specimen at 600 m (960 km) south of Easter Island. This latter specimen, as figured by Andriashev (p. 261, fig. 28) agrees well with the figure of *C. warmingii* by

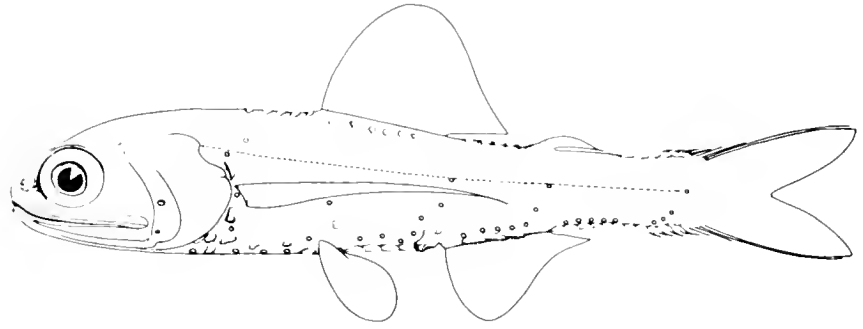


Fig. 195—*Ceratoscopelus warmingii*, female, 58.0 mm. From Nafpaktitis and Nafpaktitis (1969, p. 64, fig. 76).

Nafpaktitis and Nafpaktitis (1969) (Fig. 195). Craddock and Mead (1970) reported capture of 163 specimens (21-93 mm) from west of Valparaiso, Chile, in the area of about 31°-33° S, 77°-92° W (16 collections).

As noted for other myctophid fishes, individuals of *Ceratoscopelus* appear to avoid, or are rarely taken, in the eastern tropical Pacific over much of the area of oxygen-deficient water (Fig. 194).

Discussion

C. warmingii described from the North Atlantic Ocean, has been regarded by most authors as a synonym of *C. townsendi*, described from Cortez Bank, near San Diego, California, in the northeastern Pacific Ocean. Nafpaktitis and Nafpaktitis (1969) reported the capture of many specimens of the genus *Ceratoscopelus* from the western Indian Ocean, and stated that these specimens were generally very similar to specimens of *C. warmingii* from the North Atlantic and that a direct comparison of the two forms with *C. townsendi* from the northeastern Pacific Ocean revealed the principal differences stated in the above key to species. They further stated, "Prior to the development of the supraorbital gland (individuals smaller than about 27 mm), or in cases of poorly preserved specimens (supraorbital glands rubbed off), it is difficult to distinguish *C. townsendi* from *C. warmingii*. Minor differences which, considered together, may help distinguish the young and poorly preserved adults of the two species include: series of luminous scales along the bases of the caudal procurrent rays often extending to vertical through Prc_4 in *C. warmingii* (the character does not apply to populations from equatorial Atlantic waters), not reaching vertical through Prc_3 in *C. townsendi*; pectoral fin extending to the fourth AOa in *C. warmingii*, not reaching the second AOa in *C. townsendi*; absence of luminous tissue between PVO_1 and PVO_2, anterodorsad to PO_3 and PO_4, above the base of ventral fin and over the origin of the anal fin in *C. townsendi*."

On the basis of the presence or absence of the supraorbital tissue these authors concluded that *C. townsendi* was limited to the northeastern Pacific (Fig. 194), and that *C. warmingii* was widely distributed in the Atlantic, Indian, and probably South Pacific Oceans. In regard to this sole criterion, it would seem that these authors were correct. I have found specimens having supraorbital luminous patches only among those captured at localities east of the heavy line shown in Fig. 194, draw roughly parallel to the coast of North America. No supraorbital luminous tissue was found on any specimen from elsewhere in the Pacific Ocean; many were in such excellent condition that it could only be concluded that such tissue was never present.

However, the other critera offered by Nafpaktitis and Nafpaktitis (1969) for separating the two species appear to be of questionable value. In the northernmost portion of the area of *C. townsendi*, off North America (Fig. 194), I found some specimens bearing supraorbital luminous tissue to have pectoral fins reaching to or beyond AOa_3, and luminous scales reaching to under or beyond Prc_3. Also, an occasional specimen had luminous scales in the areas of

the PO and PVO_{1-2}, as shown for *C. warmingii* (Fig. 194). The criteria were also quite variable in specimens from other parts of the eastern Pacific—specimens in excellent condition and without supraorbital luminous tissue. In many, the pectoral fins reached no further than to AOa_2, but in others to AOa_4; also, particularly in the Hawaiian area, the luminous scales under the Prc reached only to Prc_2 and Prc_3, but on an occasionaly specimen to Prc_4.

A previously unreported character was found in specimens from the central and southeastern Pacific Ocean. A cap of black pigment covered the posterior portions of the luminous scales above the pectoral fin, at PVO_1 and PVO_2, at PO_3 and PO_4, above the pelvic origin, at the posterior ends of the ventral "Y," above the anus, and at least on the last few scales below the Prc series. These black-tipped luminous scales have thus far been found only on males from near Juan Fernandez Island, Chile, and between there and Hawaii (indicated by "B" in Fig. 194); none of these specimens, all in excellent condition, bore supraorbital luminous tissue, and on most the luminous scales extended to under Prc_4.

Thus, from the above findings, it is possible that *C. townsendi* is confined to the extreme northeastern Pacific Ocean. Whether or not only *C. warmingii* or one or more closely related species, occupies the rest of the eastern Pacific, or the entire ocean, must await detailed studies on extensive material in good condition. As no very highly significant differences in counts and body proportions were found between the two species, any valid differences may well depend on number and kind of luminous scales on the body.

Becker and Borodulina (1968) placed *C. warmingii* in the synonymy of *C. townsendi* and concluded that the world population of the latter was variable. They also reported that only specimens from the northeastern Pacific Ocean bore luminous tissue interorbitally.

Gymnoscopelus Günther, 1873

Body elongate, moderately deep. Dn and Vn well developed. PO 5 or 6; PO_4 not elevated. 5 or 6 VO. First AOa always strongly elevated. No supracaudal or infracaudal luminous glands. Body with variously arranged specks and small irregularly shaped patches of luminous tissue, all highly deciduous, often in longitudinal rows. Prc varying in number from 4 to 9. Both PVO below pectoral origin, except in subgenus *Nasolychnus*.

Smith (1933) erected the subgenus *Nasolychnus* to contain at least two species of *Gymnoscopelus* which had the upper PVO well above the pectoral origin.

Andriashev (1962) revised the genus *Gymnoscopelus*, largely from material collected by the Russian vessels OBJ and SLAVA in far southern seas. The following key, data, and illustrations are derived mainly from that revision. The portion for the subgenus *Nasolychnus* was communicated to Andriashev by Rolf L. Bolin.

Key to species of *Gymnoscopelus*

1a. Upper PVO below level of pectoral origin. Lower PVO always behind vertical from upper PVO ..... Subgenus *Gymnoscopelus* 2

1b. Upper PVO well above level of pectoral origin. Lower PVO almost vertically below upper PVO ..... Subgenus *Nasolychnus* 5

2a. PLO midway between lateral line and pectoral origin 3

2b. PLO nearer lateral line than to pectoral origin 4

3a. Caudal peduncle longer than upper jaw. VLO nearer pelvic origin than to lateral line. Six to 9 Prc, the series usually continuous with AOp ..... *G. (G.) nicholsi*

3b. Caudal peduncle shorter than upper jaw. VLO about midway between lateral line and pelvic origin. Four to 5 Prc, the series continuous with AOp ..... *G. (G.) opisthopterus*

4a. Prc 7, the series not continuous with AOp. Total AO 17-19; total gill rakers 21-24 ..... *G. (G.) bolini*

4b. Prc 4 to 5, the series continuous with AOp. Total AO 18-21; total gill rakers 23-25 (22-26) ..... *G. (G.) braueri*

5a. Dorsal rays 16-18, always fewer rays than in anal; A. 20; P. 13; AO 11+ 7; gill rakers 7-9 + 1 + 17-19, total 26-28; Prc 3 + 1, the upper widely separate and elevated; Prc separate from AOp. Scale margins with a few blunt projections ..... *G. (N.) fraseri*

5b. Dorsal rays 18-20, always with more rays than in anal; A. 18; P. 13-14; AO 8-9 + 8-9; gill rakers 9-10 + 1 + 19-22, total 29-33; vertebrae 42. Prc 5 (4?), the last widely separate and elevated; Prc separate from AOp ..... *G. (N.) piabilis*

Gymnoscopelus (Gymnoscopelus) nicholsi
(Gilbert, 1911)

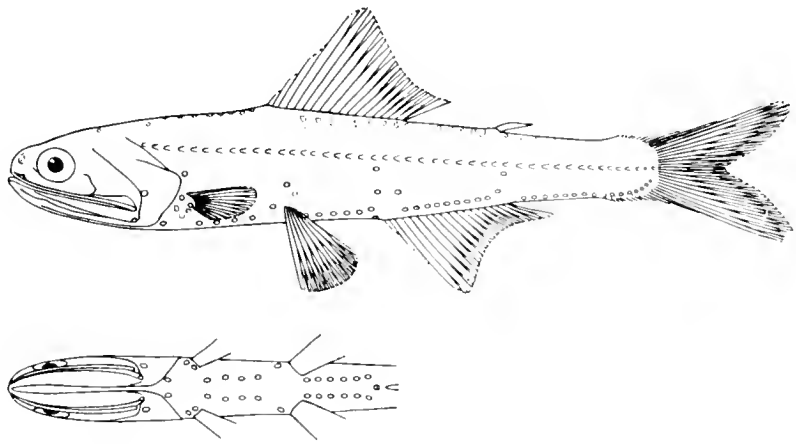


Fig. 196—*Gymoscopelus (G.) nicholsi*, 141.0 mm. From Andriashev (1962, p. 270, fig. 32).

Description

D. 18 (17-19); A. 19-20; P. 13-14; AO 10 (9-11) + 7 (6-9), total 17-18 (19); gill rakers 10-11 + 1 + 21-24, total 32-36; vertebrae 43-44 (42-45).

Photophores relatively large, light in color. PLO about midway between lateral line and pectoral origin; VLO 1.0 to 1.5 times nearer pelvic origin than to lateral line. A line through PVO_{1-2} passes well behind PO_2, nearly through PO_3. Six PO, the last notably elevated, the rest on same level; 5 (4 or 6) VO, none elevated. SAO series straight or in slightly obtuse angle. SAO_{1-2} interspace slightly less than that of SAO_{2-3}. SAO_1 nearly on level of last VO. AOp-Prc series usually continuous, except when 9 Prc are present.

Size: To 148 mm.

Least depth of capture: No information.

Distribution: Antarctic waters of Pacific and Indian Oceans (about 62° to 70° S).

Gymnoscopelus (Gymnoscopelus) bolini
Andriashev, 1962

Description

Two specimens reported by Andriashev (1962, p. 272), the holotype (46.0 mm) and paratype (33.0 mm). The counts are given in that order.

D. 19, 21; A. 21, 21; P. about 13; AO 10 + 7-6, 12-10 + 7 (6?); gill rakers 6 + 1 + 14, 7 + 1 + 16, total 21-24; vertebrae 43.

PLO nearer lateral line than to pectoral origin; VLO midway between lateral line and pelvic origin. A line through PVO_{1-2} passes through PO_2. Five PO, the last elevated. Five VO,

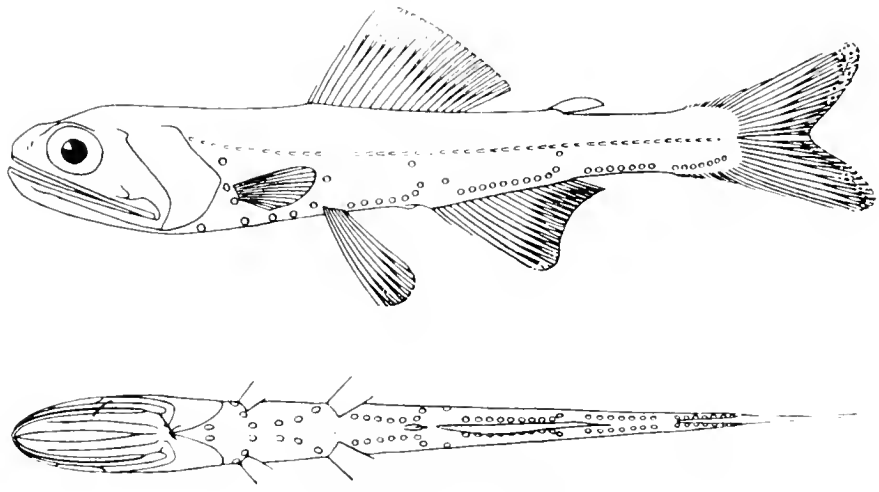


Fig. 197—*Gymnoscopelus (G.) bolini*, holotype, 46.0 mm. From Andriashev (1962, p. 273, fig. 34).

none elevated. SAO series in nearly vertical, straight or slightly angulate line; SAO_{1-2} interspace about half that of SAO_{2-3}. AOp-Prc series well separated; 7 Prc, equally spaced in very slight curve, nearly horizontal.

Size: To 46 mm, largest of two specimens.

Least depth of capture: The two specimens taken with 4700 and 4200 m of wire out, respectively.

Distribution: The holotype was taken at 47°21′ S, 160°05′ W, paratype at 53°01′ S, 109°30′ W.

Gymnoscopelus (Gymnoscopelus) braueri
(Lönnberg, 1905)

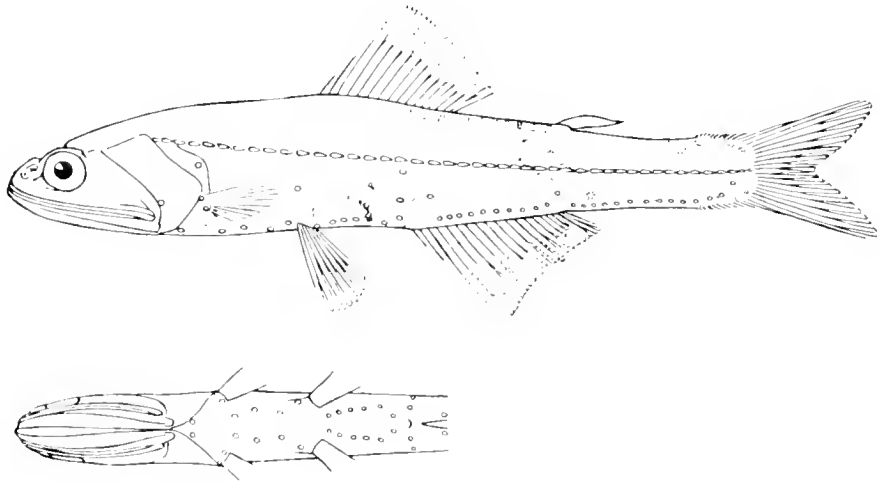


Fig. 198—*Gymnoscopelus (G.) braueri*, 110.0 mm. From Andriashev (1962, p. 265, fig. 29).

Description

D. 16 (14-17); A. 18 (17-19); P. 13-14; AO 10 (9-11) + 9-10 (8-11), total 19-20 (18-21); gill rakers 6-7 + 1 + 15-17 (18), total 23-24 (22-26); vertebrae 42-43 (41-44).

PLO nearer lateral line than to pectoral origin; VLO midway between lateral line and pelvic origin. A line through PVO_{1-2} passes through PO_2. PO_3 and PO_5 slightly elevated, the rest on same level. SAO series in nearly straight, vertical line; SAO_1 over anus; SAO_3 its diameter below lateral line. SAO_{1-2} interspace a little smaller than that of SAO_{2-3}. AOp-Prc series usually continuous. Prc pattern 3 + 1 or 4 + 1, rarely 2 + 1 or 5 + 1.

Size: To 133 mm. (Norman, 1937).

Least depth of capture: Andriashev recorded a capture at not over 100-150 m at negative temperatures (time not stated).

Distribution: Known from Drake Strait and southern Pacific and Indian Oceans south of the Antarctic Convergence.

Gymnoscopelus (Gymnoscopelus) opisthopterus
Fraser-Brunner, 1949

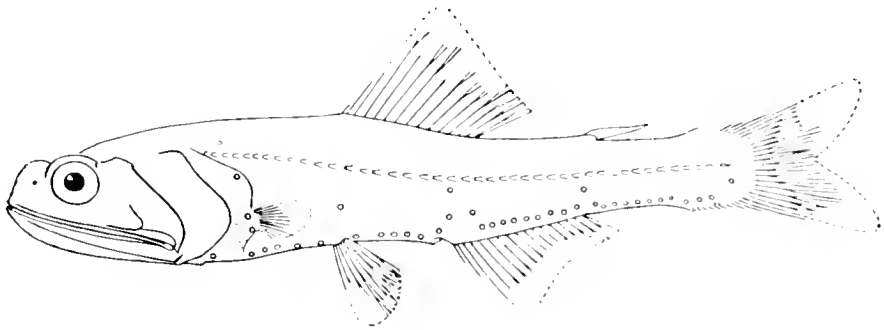


Fig. 199—*Gymnoscopelus (G.) opisthopterus*, 111.0 mm. From Andriashev (1962, p. 269, fig. 31).

Description

Counts from two specimens, holotype included.

D. 15; A. 16-17; P. 14-15; AO 9-10 + 7-8; total 17-18; gill rakers 8 + 1 + 19, total 28; vertebrae 43.

Photophores small, dim, often difficult to distinguish from small specks of luminous tissue on body. PLO about midway between lateral line and pectoral origin; VLO about midway between pelvic origin and lateral line. A line through PVO_{1-2} passes through or slightly behind PO_2. Six PO, nearly on same level; 5 VO, the middle 3 slightly raised above level of first and last. SAO series in a very obtuse angle; SAO_1 over anus and its diameter above level of last VO. SAO_3 1.0 to 1.5 times its diameter below lateral line. SAO_{2-3} interspace nearly twice that of SAO_{1-2}. AOp-Prc series continuous; Prc pattern 3 + 1 or 5 in a continuous curve (the only available specimen was damaged caudally).

Size: To 111.0 mm.

Least depth of capture: 0 to 500 and 900 m (two captures).

Distribution: Presently known only from southern Indian Ocean (60°-50° S).

Gymnoscopelus (Nasolychnus) fraseri
Fraser-Brunner, 1931

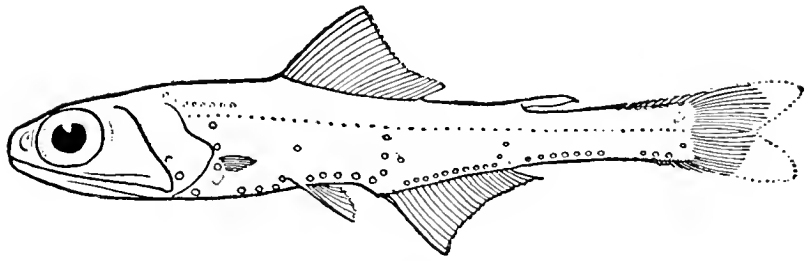


Fig. 200—*Gymnoscopelus (N.) fraseri*, holotype, 63.0 mm. From Fraser-Brunner (1931, p. 224, fig. 4).

Description

The following counts are taken from both Fraser-Brunner (1931) and Andriashev (1962).

D. 16-18; A. 20; P. 13; AO 10 + 7; gill rakers 7-9 + 1 + 17-19, total 26-28. No data available on numbers of vertebrae or scales in lateral line. (*Note:* Fraser-Brunner listed 20 rays in both the dorsal and anal fins.)

The following description is taken from Fraser-Brunner (1931). PLO much nearer lateral line than to pectoral origin; VLO midway between lateral line and pelvic origin. PLO and PVO_{1-2} form a nearly vertical line. Five PO, only the last elevated; 5 VO, none elevated. SAO series in a nearly vertical, straight line; SAO_1 only slightly above level of last VO; SAO_3 1.0 to 1.5 diameters below lateral line. AOp-Prc series well separated. Prc 3 + 1, the last widely separate and elevated.

Size: Only two sizes given, that of holotype and 6.95 mm for a questionable specimen reported by Andriashev.

Least depth of capture: A specimen from Antarctic waters, provisionally identified as *G. (N.) fraseri* by Andriashev, was taken at surface at night; others from 0 to 1000 m.

Distribution: Taken mostly in Antarctic waters, but the holotype was taken in Gulf of Guinea at 03°18′ S, 05°17′ E.

Gymnoscopelus (Nasolychnus) piabilis
(Whitley, 1931)

Description

D. 18-19; A. 18; P. 13-14; AO 7-8 + 8-9, total 15-17; gill rakers 9-10 + 1 + 18-19, total 28-30; vertebrae 42. (Note: In a key to identification of *G. fraseri* and *G. piabilis* (communicated to Andriashev by Bolin) the gill rakers for *G. piabilis* were given as 9-10 + 1 + 19-22, total 29-33.)

PLO less than its diameter below lateral line; PLO and PVO_{1-2} in a nearly straight line inclined somewhat forward. VLO midway between lateral line and pelvic origin. Five PO, the last slightly elevated; 5 VO, the last slightly below level of rest. SAO series almost equally spaced in a nearly vertical, slightly angulate line; SAO_1 a little above level of last VO; SAO_3 its diameter below lateral line. Prc 3 (4?) + 1, the last widely separate and elevated.

Size: To 122 mm.

Least depth of capture: No information. The holotype was found stranded on a beach at Macquarie Island (Whitley, 1931).

Distribution: Poorly known; mostly taken in Antarctic waters.

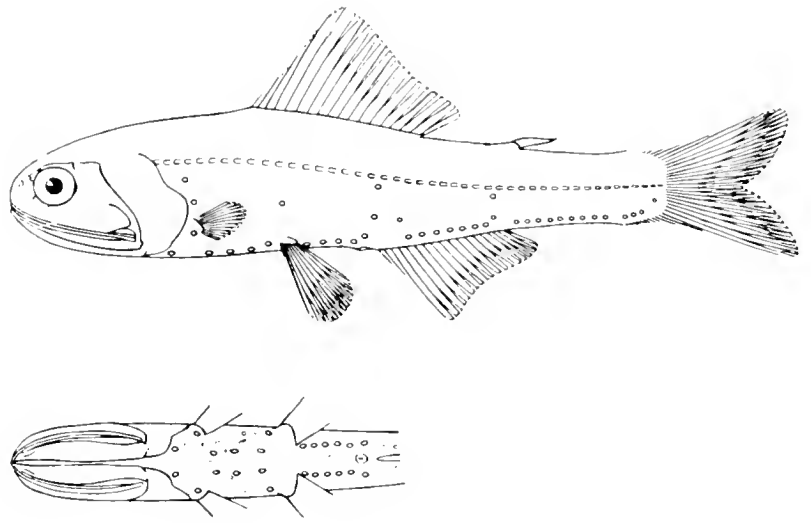


Fig. 201—*Gymnoscopelus (N). piabilis*, female, 122.0 mm. From Andriahsev (1962, p. 276, fig. 35).

Lampichthys Fraser-Brunner, 1949

Upper PVO at least two of its diameters above pectoral origin. Five PO, only the last slightly elevated; 5 VO, the series curved. Dn and Vn present. Four to 6 photophores on cheek; small scales of luminous tissue on various parts of body, easily lost. A tiny secondary photophore present on hind margin of each scale pocket of body. Three Pol, forming a right-angled triangle. Caudal luminous glands small, inconspicuous, 1 or 2 scales in each. Body elongate, deepest at dorsal origin; caudal peduncle deep, slightly more than half the greatest depth of body. Nine dorsal, eleven ventral, procurrent caudal rays. Dorsal base much shorter than anal base.

A single species recognized.

Lampichthys procerus
(Brauer, 1904)

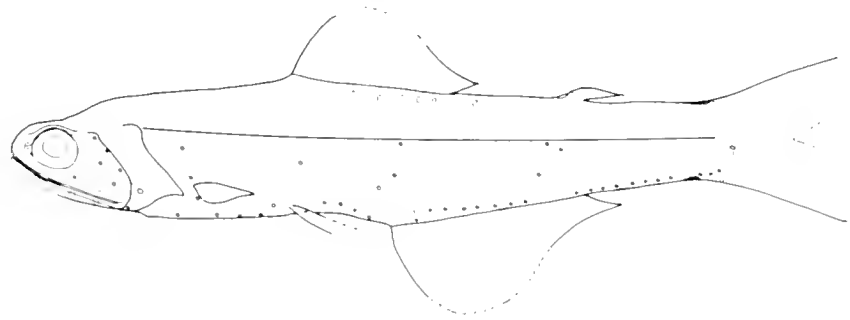


Fig. 202—*Lampichthys procerus*, 93.0 mm. The luminous scales on the body represent those found on several specimens.

Description

D. 17 (16-18); A. 22 (21-23); P. 11-13; AO 8-9 + 8-9, total 16-18; gill rakers 5 + 1 + 13-14, total 19-20; vertebrae 40-41.

Dn elongate, extending over entire upper margin of orbit; Vn small, rounded and hidden at about level of lower margin of nasal rosette. Three or 4 photophores in a row on cheek before preopercular ridge, 2 or 3 randomly placed between there and orbital rim. PLO well before vertical from pectoral origin and 2 or 3 of its diameters below lateral line. PLO and PVO_{1-2} form posteriorly slanting straight line, PO_2 often on this line. VLO 3 or 4 of its diameters below lateral line. SAO_3 and the 2 horizontal Pol at or very near lateral line. SAO series in a wide angle (ca 140°). SAO_1 high on body, slightly less than midway between ventral profile and lateral line. SAO_{1-2} interspace about one-third less than that of SAO_{2-3}. The 3 Pol form nearly right-angled triangle, first 2 in a nearly horizontal row near lateral line, a third Pol almost directly below, often its diameter before, the anteriormost of the upper two. Prc 3 + 1, the first 3 closely spaced and nearly on same level, the upper much elevated and distant by a space one and one-half times as great as that between first and third Prc.

Size: To about 100 mm.

Least depth of capture: To 200 m at night in the eastern Pacific Ocean.

Distribution: L. procerus is known from the southwestern Atlantic and southeastern Pacific Oceans. In the latter region, it has been taken primarily in the Peru Current from about 07° to 35° S, and to 85° W. Becker, 1967, did not report the species from among the large VITIAZ collections from the southwestern Pacific Ocean.

Discussion

Lampichthys rectangularis Fraser-Brunner, 1949 (p. 1103, fig. 14) is herein regarded as a synonym of *L. procerus*, as there appears to be insufficient evident to warrant retention of both species. Fraser-Brunner stated that the principal differences lay in the arrangement of the PVO, the lower position of VLO, the more posterior Pol, the fourth cheek photophore, and the much more elongate form of *L. rectangularis*. However, he recognized that these differences could be attributable to the large discrepancy in sizes of the specimens compared (22.3 mm vs 76 mm). Bussing (1965, p. 209, fig. 10) showed the number of cheek photophores to vary from 3 to 5 in specimens from off Chile.

Notoscopelus Günther, 1864

Doral base notably longer than anal base; anal base beginning under last third of dorsal. Upper PVO well above, lower PVO at lower end of, pectoral base. Two Pol (rarely 1 or 3) in horizontal line. Prc 2 + 2 or 2 + 1. Ventral procurrent caudal rays 12 or 13. Small patches of luminous tissue, easily lost, are variously located on body and below some photophores.

A single species in eastern Pacific Ocean.

Notoscopelus resplendens
(Richardson, 1844)

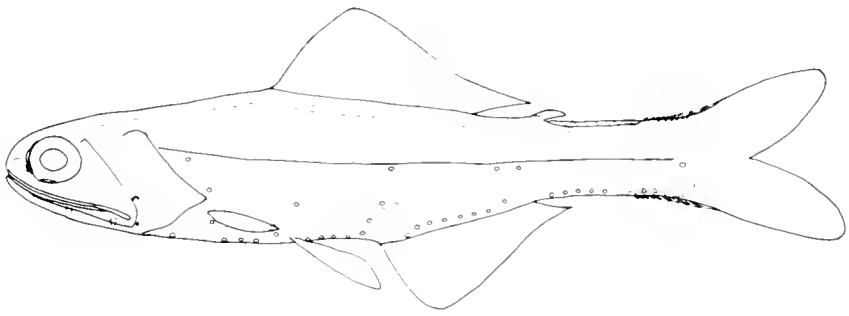


Fig. 203—*Notoscopelus resplendens*, 78.1 mm. The luminous scales of the body represent those of several specimens.

Description

D. 22 (21-23); A. 19 (18-20); P. 12 (11-13); AO 8-9 + 5 (4), total 13-14; gill rakers 6 (7) + 1 + 13 (12-14), total 20 (19-22); vertebrae 37 (35-38).

Dn somewhat elongate along anterodorsal margin of orbit; Vn tiny, often hidden in pigmented tissue, slightly below level of nasal apparatus. A thin streak of whitish tissue is present on iris above ventral margin of orbit. Only the last PO and VO are slightly elevated. AOa series curved anteriorly; last AOa slightly elevated. AOa-AOp interspace usually somewhat greater than half the least depth of caudal peduncle. Prc 2 + 1 in all eastern Pacific specimens.

Supracaudal luminous gland long, of 8-10 scales, filling space between base of adipose fin and first procurrent caudal ray. No infracaudal gland. Small paired luminous scales over bases of procurrent caudal rays. The patches of luminous tissue (Fig. 203, dotted lines) are a composite of several specimens in good condition. There was no indication that in life each scale bore a luminous patch.

Size: To about 80 mm.

Least depth of capture: To 200 m at night in eastern Pacific. In the North Atlantic, it has been taken at night between 0 and 30 m.

Distribution: Known primarily from near-shore waters, possibly due to greater collecting effort, in eastern Pacific between Southern California and Chile (35° N to 33° S). Scattered collections from near Hawaii and from 37° N, 140° W indicate that it may also range into midocean. Aron (1960) reported "*Notoscopelus elongatus*" from the north-central Pacific, but I have not seen these specimens.

Discussion

Bolin (1959) revised the genus and restricted *N. elongatus* to the inner Mediterranean Sea. According to Bolin's data, all specimens from the eastern Pacific examined by me, were *N. resplendens*. A far western form, *N. japonicus*, has strongly dentate scales. Matsubara (1938) recorded "*N. resplendens*" from off Japan, but did not mention body scales; he listed 8-9 + 16-17 gill rakers—well above the number for *N. resplendens*. Also, Matsubara gave the size as up to 153 mm "body length." None of the material before me exceeded 75 mm.

Body proportions for *N. resplendens* from the eastern Pacific Ocean (Table 42) are compared with similar data given by Bolin (1939, p. 152, as *N. elongatus*). Bolin's data were based on two large specimens (110 and 113.5 mm) from Misaki Sea, Japan. These data differ significantly from those of *N. notoscopelus* from the eastern Pacific.

TABLE 42. BODY PROPORTIONS FOR *NOTOSCOPELUS RESPLENDENS* FROM THE EASTERN PACIFIC OCEAN, AND FOR TWO SPECIMENS IDENTIFIED BY BOLIN (1939) AS *N. ELONGATUS* FROM OFF JAPAN.

Measurement	*N. resplendens* N = 12 (35.2-78.1 mm)		*N. elongatus*	
	Ave.	Range	110.0 mm	113.5 mm
Head length	303	290-320	264	266
Head depth	187	177-195	—	—
Orbit length	75	67-83	58	61
Upper jaw length	219	206-231	189	195
Prepectoral length	311	296-329	273	278
Prepelvic length	426	410-436	413	414
Preanal length	578	571-592	574	587
Predorsal length	425	414-440	393	423
Preadipose length	806	792-813	786	837
Dorsal origin to pelvic origin	202	190-212	141	156
Dorsal origin to anal origin	270	254-284	236	251
Dorsal base length	309	296-323	266	268

TABLE 42 (Continued)

Anal base length	224	214-233	210	211
Caudal peduncle length	214	200-236	—	—
Caudal peduncle depth	99	88-106	76	90
Pectoral fin length	118	84-135	—	—
Pelvic fin length	148	138-160	—	—
Supracaudal gland length	138	122-161	—	—

Hintonia Fraser-Brunner, 1949

Body robust and heavy; head deep, about 1.4 in its length; caudal peduncle short and deep, its depth about half its length. Dorsal base longer than anal base, anal about 1.4 in dorsal. Six PO, only the last slightly elevated; 5 VO, the series curved; VO_2 much elevated, the last three in descending series. Photophores weakly developed and inconspicuous but not notably small, often not formed on specimens less than 25 mm. A small patch of luminous tissue present on most scale pockets and at many photophores. Two Pol. Prc 6 (5-7), last 2 widely separate from rest. Secondary (procurrent) caudal rays numerous, stiff and spine-like, 10 (9-11) dorsally and 12-13 (11-14) ventrally.

A single species recognized.

Hintonia candens
Fraser-Brunner, 1949

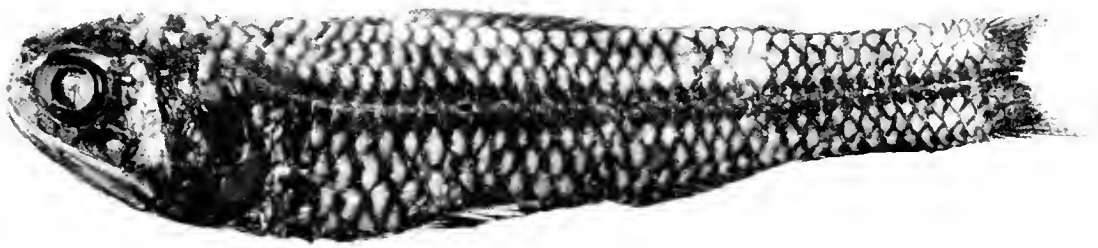


Fig. 204—*Hintonia candens*, female, 110.0 mm.

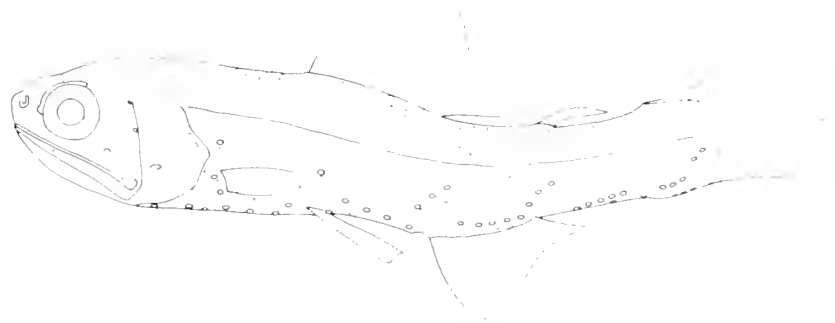


Fig. 205—*Hintonia candens*, holotype, 78.3 mm. From an unpublished drawing by Rolf L. Bolin.

Description

D. 15 (14-16); A. 13-14 (12); P. 13-14; AO 6-7 + 5-6 (7), total (11-13, rarely 14); gill rakers 6-7 + 1 + 12 (10-13), total 18-19 (17-21); vertebrae 38 (37-39). Correlated counts of AO photophores and of gill rakers are given in Table 43.

TABLE 43. CORRELATED COUNTS OF AO PHOTOPHORES AND GILL RAKERS FOR *HINTONIA CANDENS*.

		AOp		
		5	6	7
AOa	6	21	23	2
	7	8	20	2

		Lower rakers (including central raker)			
		11	12	13	14
Upper rakers	6	3	30	23	1
	7	—	4	11	2

Characters given for the genus will also serve for the species. Fraser-Brunner (1949) provided a moderately detailed description of the holotype of *H. candens*. Rolf L. Bolin prepared a considerably more detailed description of the holotype (unpublished) and kindly made it available to me. As *H. candens* is poorly known, and as the two descriptions differ somewhat (see *Discussion*), it seems advisable to present Bolin's description verbatim.

Description of the holotype of *Hintonia candens*, 78.3 mm (Fig. 205) in the British Museum, Natural History, taken at Discovery Station 1774 in the southeastern Atlantic Ocean between 41°50.0′ S, 00°01.7′ E and 45°54.3′ S, 00°03.3′ E, between 400 and 650 m:

Body heavy, robust throughout. Snout rather pointed, markedly protruding, mouth definitely inferior, lower jaw somewhat shorter than upper, slightly included. Maxillary not expanded posteriorly, ending in a rounded point, bent slightly downward, extending about 1.1 orbital diameters behind orbit, about 0.4 of its length lying behind a perpendicular to mouth drawn through posterior margin of orbit. Premaxillary and dentary with narrow bands of cardiform teeth, the inner ones somewhat enlarged in the premaxillary and developed into quite heavy canine-like structures on the dentaries. Palatine teeth in a single series, about equal in size to the outer teeth of the jaw. No teeth on vomer. Pterygoid teeth rather widely scattered, the dorsal ones much enlarged as in *Lampadena*. Opercular margin ending in a somewhat pointed flap, its upper portion bearing a feebly ctenoid lobe. Gill rakers moderately long but rather heavy, this posterior surfaces conspicuously toothed.

Origin of dorsal about midway between snout and AOp_1. Anal origin slightly behind end of dorsal base. Adipose fin slightly behind end of anal base. Pectoral base on a vertical midway between snout and anus. Fin broken, probably extending to, or slightly beyond, ventral base. Ventral base slightly posterior to dorsal origin, fin extending about to VO_5. Body scales in general cycloid, those of the lateral line somewhat cremate and displaying a deep posterior notch.

A moderately prominent Dn under anterior portion of frontal margin. A very deeply embedded Vn appears to be present. OP_1 deeply embedded opposite lower end of premaxillary. Op_2 slightly larger than adjacent body organs, somewhat above end of premaxillary. A rather well developed Bu about on level of lower orbital margin and somewhat behind the eye. PLO almost directly over the base of upper pectoral ray and about midway between it and lateral line. PVO_1 somewhat in advance of upper part of lower end of pectoral base. PVO_2 immediately below and in front of lower end of pectoral base. Six PO.

The first pair about under posterior end of PVO_2, rather close together. Second to fifth pairs somewhat more widely divergent, forming equally spaced and roughly parallel straight lines from ventral view. PO_6 widely divergent, located somewhat more than an organ diameter in front of base of outer pectoral ray. Five VO. VO_1 rather close together, posteromesad to inner ventral ray. VO_2 markedly elevated forming, with the next two organs, evenly spaced descending or convergent lines. VO_4 and VO_5 about as widely spaced from midline as VO_1. VO_5 just anterolaterad to anus. Three SAO forming an evenly spaced, almost straight and strongly oblique, isolated series. SAO_1 very slightly behind, or even over, VO_5, about twice as close to lateral line as to anal base. Seven AOa forming a continuous sigmoid curve with the Pol. AOa_1 slightly elevated, separated from second by a somewhat enlarged interspace. Second to fifth organs forming a slightly curved line, the concavity directed upward, penultimate and ultimate organs progressively elevated toward the Pol, which lies about on the vertical of the end of the adipose base and is markedly closer to lateral line than to ventral body margin. Five AOp, evenly spaced in a straight series. Prc 3 + 2 or 4 + 2, separated from last AOp by an interspace equal to about 0.4 depth of caudal peduncle. The first three or four Prc very closely spaced, the last interspace markedly larger and the penultimate one larger still, the final organ lying somewhat behind end of hypural and somewhat more than its own diameter below lateral line. Well developed luminous organs displaying a somewhat spongy character are widely scattered over the head and the body. Particularly well defined or prominent ones occur below the lower PVO, Bu, VLO, each of the SAO and in the interorbital space. No indication of any well defined glands among the procurrent rays of the caudal fin. The body of this fish has very much the same general character as that of many large lampadenas. That is, where the scales are lost a pale pinky grey area is surrounded by a broad brownish band marking the scale pockets and giving the entire fish a lattice work appearance.

Probably in life a luminous gland was borne on the posterior part of every scale pocket.

Bolin did not mention a Ce photophore, but Fraser-Brunner did. On the several specimens in excellent condition before me, what may be interpreted as a Ce lies just above the anterodrosal insertion of the operculum and about over PO_1; this organ, however, is very similar to the small, weakly formed and easily lost patches of luminous tissue present on most scale pockets; it is differentiated primarily in having a very narrow black margin not visible on other patches. Also, Bolin did not mention the VLO, where Fraser-Brunner did, correctly located it about midway between lateral line and pelvic base. A character not mentioned by either author is that the photophore are mostly kidney-shaped, the concavity directed downward; the ventral margins are usually more heavily bordered by dark pigment than the upper margins.

Although Bolin considered only 1 Pol to be present, Fraser-Brunner interpreted two; the latter opinion is herein accepted. The arrangement of the 2 Pol is variable; usually they are in a straight, oblique line with the elevated last, or last 2, AOa; occasionally Pol_2 is either slightly behind that line but above the level of Pol_1 or is on the line and slightly below the level of Pol_1.

The pectoral fin of a few specimens (43-49 mm) reached to SAO_1, but on one larger specimen (86 mm) it reached only to VO_2. Unbroken pectoral fins of larger fishes did not extend beyond VO_1, usually to about over pelvic base.

Size: To about 120 mm.

Least depth of capture: To 200 m at night.

Distribution: Probably occurs circumglobally in a restricted area between about 40° and 50° S (Fig. 206). The hiatus in distribution in the southern Atlantic and Indian Oceans is no doubt due to lack of collecting effort in those areas. All but two collections shown in Fig. 206 were taken by the USNS ELTANIN during the United States Antarctic Research Program of

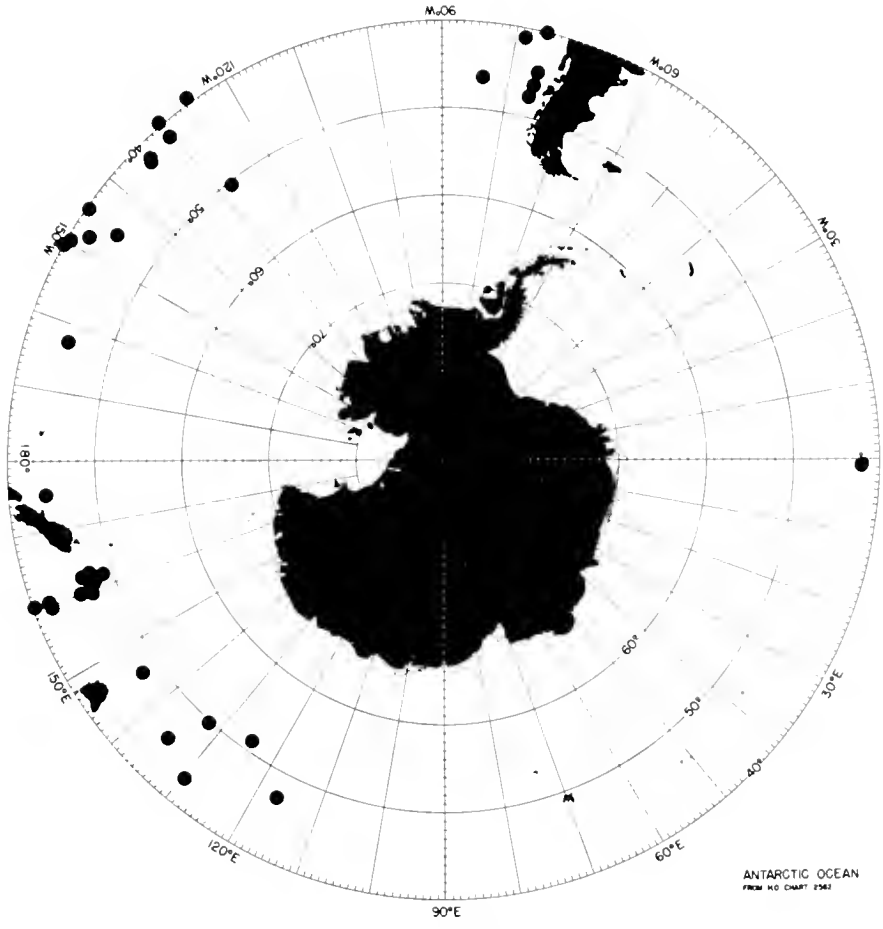


Fig. 206—Capture localities for *Hintonia candens*.

the National Science Foundation; exceptions are the holotype and a specimen taken by Scripps Expedition Lusiad at about 49°26′ S, 132°18′ E.

Discussion

There appear to be distinct differences in the rate of growth with size (or age) in certain parts of the body in *Hintonia candens*. Although isometry is indicated for most of the characters given in Table 44, allometry is also indicated in that the smaller sizes tend to have higher values for thousandths of standard lengths (with no overlap), the values decreasing with increasing size of fish; this is true for the lengths of the head and upper jaw, and the prepectoral, prepelvic, and predorsal lengths. Conversely, the depth of the caudal peduncle appears to be relatively greater in smaller than in larger specimens.

An unusual, and not readily explained, curvature of the vertebral column, determined by X-ray, occurred in about 29% of the specimens. This curvature (Fig. 207) appears not to be a result of distortion during preservation, for several specimens having a distinct bend in the body in the area of the curvature shown in Fig. 207 were manually straightened and pinned to a paraffin block and X-rayed; the curvature of the vertebral column persisted. Similar variously pronounced curvatures of the vertebral column were found in the remaining specimens, although some of the bodies were somewhat bent. As the figure of the holotype, drawn by Bolin (Fig. 205), shows a distinct bend in the body, the vertebrae column is probably also curved.

TABLE 44. BODY PROPORTIONS FOR 15 SPECIMENS IN EACH OF FOUR SIZE-CLASSES OF *HINTONIA CANDENS*.

Measurement	SL—20-30 mm		SL—40-50 mm		SL—51-60 mm		SL—70-118 mm	
	Ave.	Range	Ave.	Range	Ave.	Range	Ave.	Range
Head length	327	320-342	326	314-339	309	288-319	290	280-308
Head depth	225	219-230	222	210-230	216	208-226	216	206-238
Upper jaw length	232	222-247	226	211-239	215	198-225	202	192-217
Snout length	80	70-89	69	62-78	64	52-74	59	51-75
Orbit length	87	76-94	88	79-97	83	75-90	82	73-89
Interorbital width	112	101-128	123	118-129	120	107-127	116	110-124
Prepectoral length	344	333-361	336	323-346	324	309-341	312	300-328
Prepelvic length	475	462-486	464	452-474	466	435-483	447	433-461
Preanal length	642	630-656	635	622-657	639	621-656	630	608-657
Predorsal length	473	467-483	450	433-469	444	436-456	435	421-455
Preadipose length	805	792-828	793	785-802	789	777-805	785	772-807
Dorsal to pelvic origins	213	203-221	197	178-210	196	182-218	217	201-245
Dorsal to anal origins	292	282-302	291	278-307	296	281-311	313	301-339
Caudal peduncle length	245	238-259	243	236-261	242	227-254	264	251-289
Caudal peduncle depth	102	92-110	107	92-121	113	104-121	126	112-143
Dorsal base length	201	189-217	193	179-202	197	191-205	211	186-219
Anal base length	145	136-154	138	123-153	133	129-151	144	135-160

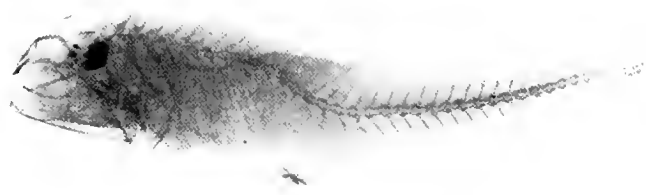


Fig. 207—Radiograph of *Hintonia candens* showing curvature of vertebral column.

Scopelopsis Brauer, 1906

Dorsal and anal bases long, nearly one-third of standard length, about equal in length. Pectoral short, reaching but little beyond pelvic origin, rather heavy and broad-based. Dn and Vn present. Dn small, round, prominent; immediately below and in contact with Dn is a larger patch of luminous tissue; Vn large, deeply buried.

Small secondary photophores, heavyily margined in black, on head and body at bases of dorsal and anal fins and extending along rays of all fins, probably to the tips, where they appear on a very thin, easily lost integument covering the rays. These small photophores (luminous dots) on head and body are often expanded and may be confused with the primary ones. The only valid criteria for separating the two is that scales overlying the primary series have the characteristic lens-like modification (Tåning, 1932), but scales over the secondary dots do not.

Scales of lateral line with dentate margins, those of rest of body smooth-edged. Body color very dark brown in preservative.

A single species is recognized.

Scopelopsis multipunctatus
Brauer, 1906

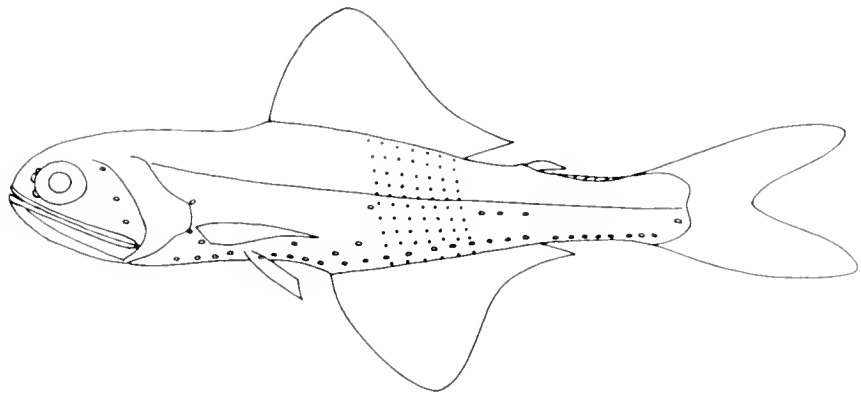


Fig. 208—*Scopelopsis multipunctatus*, 51.8 mm. The principal photophores represent those found on several specimens. The tiny secondary photophores, present on each scale pocket of head and body, are shown only on the midbody.

Description

D. 22 (21-23); A. 24 (23-25); P. 10-11; 5 PO and 5 VO, none elevated; 2 or 3 Pol, horizontally arranged; 4 to 6 Prc, the last elevated and widely separate from the rest. AO difficult to perceive but appear to range from 7 to 10 + 5 to 6; gill rakers 8 (7-9) + 1 + 16 (15-17), total 24-25 (23-26); vertebrae 38 (37-40).

The drawing in Fig. 208 is a composite of observations from several specimens and is intended only to show the general pattern of the primary photophores (small open circles); the secondary dots are shown only for the midregion (tiny solid dots). Unfortunately, the body scales are very deciduous, and fully, or even mostly, scaled specimens are rare. When most or all scales are lost it is not always possible to distinguish between primary and secondary photophores. Nafpaktitis and Nafpaktitis (1969) stated that they were unable to substantiate Fraser-Brunner's (1949, p. 1098) distinction of "primary" and "secondary" photophores; however, that distinction is supported herein (see diagnosis of the genus).

Supracaudal luminous gland long and broad, with 6 or 7 overlapping, roughly triangular plates. An infracaudal luminous gland may not be present, or not in the usual position, but on an occasional specimen two small patches of luminous tissue may be found along bases of anteriormost ventral procurrent caudal rays. Supracaudal glands begin to develop on specimens of about 55 mm.

Size: To about 76 mm.

Least depth of capture: It has been taken off Peru at night with as little as 350 m of wire out.

Distribution: Circumglobal in southern seas. It is plentiful off South Africa, New Zealand, and in the southern Indian Ocean. In the eastern Pacific, occasional specimens have been taken as far north as 15° S in the Peru Current and may be migrants, or expatriates, moving north with this cold current. It has been taken at about 25° S, 155° W in mid-Pacific.

Discussion

Despite the not insignificant literature on this species, only Brauer's original account offers body proportions, and for only one specimen. Therefore, I present the following morphometric data based on 15 specimens, 25.5 to 76.7 mm, taken off South Africa and Chile. The average value is given first, followed by the range in values in parentheses:

Head length 293 (262-325); head depth 187 (160-208); orbit length 67 (55-75); upper jaw length 218 (202-238); prepectoral length 299 (276-321); prepelvic length 368 (345-384); predorsal length 416 (395-451); preanal length 508 (491-524); preadipose length 802 (781-823); dorsal

origin to pelvic origin 224 (195-230); dorsal origin to anal origin 237 (223-256); dorsal base length 300 (286-327); anal base length 309 (290-328); caudal peduncle length 203 (187-217); caudal peduncle depth 84 (77-93). The tips of all pectoral and pelvic fins were broken but reached nearly to origin of anal fin in a few specimens.

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