Taxonomy and Distribution of the Stomioid Fish Genus *Eustomias* (Melanostomiidae), I: Subgenus *Nominostomias*

ROBERT H. GIBBS, JR.,
THOMAS A. CLARKE,
and
JANET R. GOMON

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ABSTRACT

Gibbs, Robert H., Jr., Thomas A. Clarke, and Janet R. Gomon. Taxonomy and Distribution of the Stomioid Fish Genus *Eustomias* (Melanostomiidae), I: Subgenus *Nominostomias*. *Smithsonian Contributions to Zoology*, number 380, 139 pages, 44 figures, 13 tables, 1983.—Nine subgenera of *Eustomias* are recognized tentatively and diagnostic characters are given for each. *Nominostomias* is redefined and restricted to species having 3 pectoral rays, a slender barbel stem without branches and with little or no external pigment or row of dark spots, 1 or 2 terminal bulbs, no wide ventral body groove posterior to the pectoral-fin bases, high numbers of serial photophores and vertebrae (69–80 IC, 63–73 vertebrae), and no paired photophores in the lateral series.

Thirty-eight species of *Nominostomias* are recognized, primarily on the basis of barbel structure. A key and tables of diagnostic characters for all species supplement descriptions, synonymies, graphs of barbel and postorbital-organ dimensions, and illustrations of barbels. Eight currently accepted species are recognized: *E. longibarba, bibulbosus, melanostigma, patulus, bulbornatus, gibbsi, vitiazi,* and *multifilis.* Five species are resurrected from synonymy: *E. micraster, arborifer, bituberatus, bimargaritatus,* and *melanonema.* Twenty-five species are described as new: *E. austratlanticus, bibulboides, orientalis, australensis, bituberoides, inconstans, appositus, deofamiliaris, grandibulbus, crossotus, bimargaritoides, melanostigmoides, medusa, bertelseni, suluensis, posti, kreffti, teuthidopsis, cirritus, cancriensis, pacificus, spherulifer, curtatus, perplexus,* and *mesostenus.*

Thirteen species of *Nominostomias* occur only in the Atlantic, 3 only in the Indian Ocean, 1 only in the Sulu Sea, and 17 only in the Pacific. One species is found in the Atlantic and Indo-West Pacific and 3 in both the Indian and Pacific oceans. There are no bipolar subtropical species in the Atlantic, perhaps 3 in the Pacific. The paucity of species known from more than 1 ocean and the rarity of overlap in species ranges are noteworthy.

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Taxonomy and Distribution of the Stomioid Fish Genus *Eustomias* (Melanostomiidae), I: Subgenus *Nominostomias*

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Introduction

The mesopelagic predatory genus *Eustomias* is the most speciose of the numerous stomioid genera. The species occur in tropical and subtropical waters of all oceans, and all appear to undertake diel vertical migrations between depths greater than 300–400 m during the day and shallower than 200–250 m at night. Like other members of the family Melanostomiidae, they are black, elongate fishes with large fangs, serial photophores and other luminescent organs, chin barbels, and dorsal and anal fins placed very close to the caudal fin. *Eustomias* is distinguished from all other melanostomiids by a protrusible upper jaw, an anal-fin base that is about twice as long as the dorsal-fin base and has its origin well forward of that of the dorsal, a notochord that forms a pronounced U-shaped or reclining S-shaped bend behind the head, and the first 6 or 7 vertebrae represented by only incomplete parts.

Within the genus, there is little variation in body morphology and most meristic characters; most species have been distinguished primarily by barbel characters. Even as late as 1971 (Johnson and Rosenblatt), most species were known only from a few specimens, and there was little basis to assess the range of variation in barbel characters within or between species. Before the revision by Beebe and Crane (1939), nearly every variation in barbel structure was the basis for specific or subspecific recognition. Beebe and Crane and, subsequently, Morrow and Gibbs (1964) were conservative and relegated many nominal species to synonymy on the basis of supposed intraspecific variability or sexual dimorphism in barbel structure. Consequently, while Regan and Trewavas (1930) recognized 52 species, Morrow and Gibbs (1964) recognized only 38, despite description of 8 new nominal species between 1930 and 1964.

Prior to 1964, all except 2 original descriptions of *Eustomias* species were based on Atlantic specimens. Since then, several new forms, most of them obviously different from known species, have been described, and others of uncertain status have been reported—almost all from the Indian and Pacific oceans (Johnson and Rosen-

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blatt, 1971; Gibbs, 1971; Gibbs and Craddock, 1973; Parin and Pokhilskaya, 1974, 1978b; Parin, 1978). Still, only a half-dozen species have been represented by numbers of specimens sufficient to address adequately the problems of variability in barbel characters and, therefore, the validity of all but a few species.

We have examined several thousands of specimens of *Eustomias* from both older and recent collections. The most important of these collections, because they provided large enough samples of many species to demonstrate the consistent elements of barbel structure, are the extensive Atlantic collections made with a large trawl by the German Institut für Seefischerei under the leadership of G. Krefft and intensive collections from near Hawaii by Clarke and near Bermuda by Gibbs and associates made with smaller gear. Other surveys, notably the *Dana* circumglobal expedition of 1928–1930 (Jespersen and Tåning, 1934) and those of the Woods Hole Oceanographic Institution in the Atlantic (Backus and Craddock, 1977), the U.S. National Marine Fisheries Service in the central Pacific (e.g., King and Iversen, 1962), and the Institute of Oceanology of Akademia Nauk USSR in the Pacific, Indian, and Atlantic oceans, have provided significant materials and geographic coverage.

There are now sufficient specimens for many species to show clearly that there is little or no sexual dimorphism in the barbel of most and that, once the basic morphological features of the barbel are established at the end of metamorphosis, the species are recognizable at all sizes, even though allometric growth may change the size or length of some parts relative to others. Geographical variation remains to be assessed for many species, but such variation was either slight and questionable (e.g., *E. melanostigma*) or not apparent (e.g., *E. bulbornatus*) in most species treated in this study. We conclude that early investigators were indeed mostly correct in assigning to full specific status forms distinguished by minor differences in the barbel, and that, including many undescribed forms, the number of valid species in the genus is at least 100.

In order to present our results progressively but coherently, we have separated the species of *Eustomias* into groups that we recognize as subgenera and that we hope are monophyletic. The species in a subgenus have common general features of the barbel and also tend to share similar and often distinct ranges in meristic and some other characters. Some species, however, show no convincing association with any others, and a few have features of more than 1 group. Our tentative scheme of subgenera is modified from that of Regan and Trewavas (1930) and is given in a following section. Considerably more work will be necessary before this scheme can be examined in a phylogenetic context.

In this paper, we consider the species of the redefined subgenus *Nominostomias*. We continue to recognize 8 species that were considered valid by Morrow and Gibbs (1964) or described subsequently, restore to species status 5 forms previously relegated to the synonymies of these 8, and describe 25 new species.

ABBREVIATIONS.—The following abbreviations are used to designate institutions and collections cited:

AMNH	American Museum of Natural History, New York
AMS	Australian Museum, Sydney
BMNH	British Museum (Natural History), London
BOC	Bingham Oceanographic Collection, Peabody Museum, Yale University, New Haven
BPBM	Bernice P. Bishop Museum, Honolulu
FMNH	Field Museum of Natural History, Chicago
HIMB	Hawaii Institute of Marine Biology, Kaneohe
IOAN	Institut Okeanologii im. P.P. Shirshova, Akademia Nauk SSSR, Moscow
IOS	Institute of Oceanographic Sciences, Wormley
ISH	Institut für Seefischerei, Hamburg
MCZ	Museum of Comparative Zoology, Harvard University, Cambridge
NMFS	National Marine Fisheries Service, Honolulu
ORSTOM	Office de la Recherche Scientifique et Technique Outre Mer, Noumea
SIO	Scripps Institution of Oceanography, La Jolla
SUF	Shimonoseki University of Fisheries, Shimonoseki
UMML	Rosenstiel School of Marine and Atmospheric Sciences, University of Miami
USNM	collections of the former United States Na-

	tional Museum, deposited in the National Museum of Natural History, Smithsonian Institution, Washington, D.C.
VIMS	Virginia Institute of Marine Sciences, Gloucester Point
WHOI	Woods Hole Oceanographic Institution
ZMUC	Zoological Museum, University of Copenhagen

Abbreviations used in descriptive sections are as follows: D = dorsal-fin rays, A = anal-fin rays, P1 = pectoral-fin rays, P2 = pelvic-fin rays. See Figure 1 for subdivisions of photophore rows (OC, OA, OV, VAL, IC, IA, IP, PV, VAV, AC).

In "Material Examined" sections, ? = unsexed specimen; measurements in parentheses following specimen numbers = SL in mm; mw = meters of wire; and universal time spans, when given, indicate the starting and ending of sampling times.

ACKNOWLEDGMENTS.—We are greatly indebted to our colleagues at each of the institutions listed above for the loan and exchange of specimens, for information concerning specimens, and for courtesies provided us during visits to study their collections. Special thanks are due to G. Krefft and A. Post of ISH and to P. David, P. Herring, and J. Badcock of IOS for opportunities to participate in research cruises aboard *Walther Herwig*, *Anton Dohrn*, and *Discovery*.

Figures 1, 2, 5*a,b,e,f,h*, 10*a,b*, 11, 12*b,c,e*, 18, 20*a*, 27*b–f*, 28, 31, and 32 were drawn by Penelope Kay Hollingsworth. The remaining barbel illustrations were done by Gomon. Kenneth J. McCormick aided in preparation of computer-generated distribution maps and in modifying computer programs that we used. Michael R. Carpenter and Klaus Ruetzler aided us in preparing microphotographs.

Various drafts of the manuscript were prepared by Jean J. Smith, Carole Johnson, and Frigga K. Gibbs.

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Methods

The counts, measurements, and other observations used in this study have been made over a span of almost 20 years and have been made by all three of us on different specimens. This introduces the possibility of inter-observer bias.

There is little reason to suspect observer bias in the recording of meristic data, but some counts may be affected slightly by the condition of the specimen. In the dorsal and anal fins a very short anterior ray is sometimes present and might be missed in a damaged specimen. The last 2 rays of each fin were counted as one; the external bases of these were sometimes well separated, sometimes contiguous, and if the last element was both very thin and contiguous, it could have been overlooked. There is no ambiguity in pectoral or pelvic rays, except in metamorphosing juveniles, which often have, in addition to the primary rays that are retained in adults, 1–3 additional very short pectoral rays that are not visible externally in larger specimens. Only in the smallest specimens, in which the primary rays are short and the barbel characters undeveloped, do the additional rays cause confusion. Photophores were counted according to the scheme in Figure 1. The subdivisions of the ventral and lateral series are not distinct, so that the photophores at the end of one subdivision (IP, PV, OV) and the beginning of the next (VAV, VAL) may be misjudged if the loose skin is pulled in one direction or the other. The total count for the series (OA or IA) is not affected by this discrepancy. Vertebral counts were made from radiographs. In all species the notochord behind the cranium forms a bend that may be either U-shaped or reclining-S-shaped and that, except in *E. obscurus*, has only a single ossified centrum on its anterior limb as well as free neural-arch and haemal-arch elements (Re-

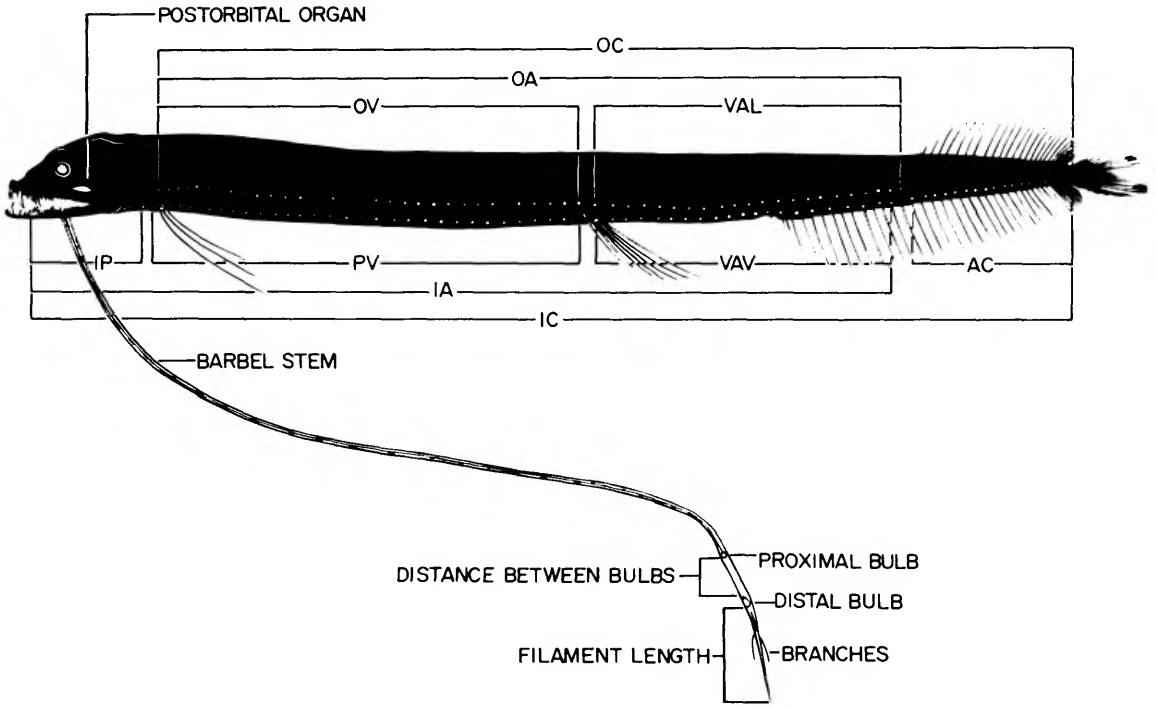


FIGURE 1.—Lateral view of *Eustomias austratlanticus* showing photophore rows and their subdivisions, barbel structures, and postorbital organ.

gan and Trewavas, 1930:45, fig. 17; 47, fig. 18; Morrow and Gibbs, 1964:379, fig. 100). Our vertebral counts were of the continuous series that begins after the notochordal bend, including a sometimes partially ossified anterior centrum and the terminal urostylar centrum.

In counting premaxillary and mandibular teeth, we have attempted to exclude replacement teeth and to include missing teeth. These are not always easy to determine, and some counts are doubtless off by 1 or 2 in either direction. We did not routinely count maxillary teeth, but our observations indicate that new serra-like teeth are added continuously at the posterior end. We have examined the numbers, sizes, and positions of fixed and depressible teeth in both jaws, but we were impressed with the variability of these and could not always be certain whether a given tooth was fixed, depressible, or a replacement. We have described these characteristics only for holotypes of new species. A thorough study of tooth placement patterns and tooth development might reveal species differences that we did not discern.

The dorsal series of paired spots, 1 of each pair on each side of the middorsal line, are associated with the muscles and remain when the skin is removed. Except in the darkest specimens, the spots can be discerned when the loose skin is moved back and forth, albeit sometimes with difficulty. The spots are variable in their development and may be large and very dark or may appear as weakly pigmented areas in the predictable location of a spot as judged by the usual spacing. Some species apparently lack these spots normally (Regan and Trewavas, 1930; Parin and Pokhilskaya, 1974). Spots on the caudal peduncle are highly variable in form and position and appear to be invariably present in some species, absent in some, and variably present or absent in others. These spots are much smaller than any of

the others and may be developed unilaterally or bilaterally. Usually, at least a few well-developed spots can be discerned on any specimen, but occasionally none are obvious.

A previously unnoticed character is exemplified by *E. pacificus*, which has, about midway along the anterior margin of the fleshy orbit, a well-developed, slender pedicel extending over the eyeball and bearing a small, white putative photophore on its tip (Figure 2*a*). Such a pedicel is found also in *E. obscurus*. In *E. gibbsi*, there is a noticeable, but much shorter, extension of the orbital margin (Figure 2*b*). All other species of *Nominostomias* have either no modification of the orbital margin or, at most, a slightly concave hump at the location of the putative photophore (Figure 2*c*). The photophore is present in all *Nominostomias* species, although not easily distinguished from other orbital photophores. Thus, among *Nominostomias*, *E. pacificus* is readily identified by this character, even without its barbel. Species of other subgenera have not yet been checked thoroughly for the presence of the particular photophore or of a pedicel.

Standard length (SL), 17 body dimensions, and 5 barbel dimensions were measured, where possible, on specimens chosen to represent the size range of all species, using needle-point dial calipers. Measurements used to define species (barbel, postorbital organ) were made on most available specimens. Almost all measurements are affected by the condition of the specimen and the degree of stretching or squeezing applied by the observer to straighten or otherwise orient the specimen. The resulting imprecision is probably greater than any error due to between-observer differences. The maximum difference in standard-length measurements in the few remeasured specimens was about 7%. In very small structures, such as barbel bulbs, the error may be even higher.

Scatter diagrams of size-on-size and ratio-on-size were computer-generated for each character and the species compared by overlaying the diagrams.

Body dimensions were measured as follows.

Predorsal, preanal, and prepelvic lengths: tip of snout to dorsal-fin origin, anal-fin origin, and pelvic insertion.

Head length: tip of upper jaw to posteriormost part of fleshy operculum.

Snout length: tip of upper jaw to anteriormost margin of fleshy orbit.

Fleshy-orbit length: anterior margin to posterior margin of the circular opening in the skin that forms the opening over the eyeball.

Postorbital-organ length: the longest dimension of the bulbous part of the organ; not restricted to the pale portion, and not including parts of the pocket that surround the bulb.

Lower-jaw length: anterior tip of mandible to its posteriormost angle.

Upper-jaw length: tip of upper jaw to posteriormost rounded edge of maxilla.

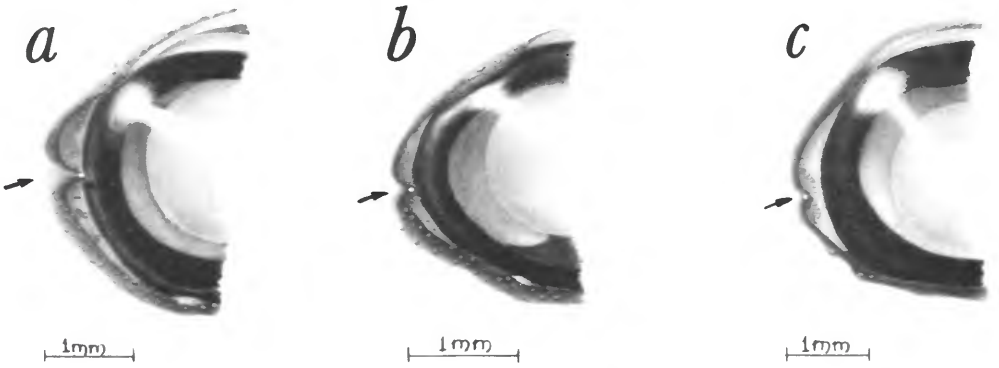


FIGURE 2.—Anterior part of left eye showing relative development of pedicel on mid-anterior border: *a*, *Eustomias pacificus*, long pedicel; *b*, *E. gibbsi*, short pedicel; *c*, *E. bibulbosus*, low hump.

Depth behind head: middorsal line to midventral line measured immediately behind head.

Greatest depth: normally is depth behind head (above); distended stomach will result in this measurement being near middle of SL.

Caudal-peduncle least depth: middorsal line to midventral line at the narrowest part of the peduncle.

Pectoral-fin and pelvic-fin lengths: insertion of fin to tip of longest ray. It can be difficult to be certain whether or not a ray is broken.

Dorsal-base and anal-base lengths: anteriormost junction of first ray with dorsal skin to posteriormost junction of last ray.

Longest premaxillary and mandibular teeth: apex of tooth to line of junction with jaw.

Definitions of barbel characters and their measurements are as follows.

Barbel length: measured from origin on chin to distal end of distal bulb—terminal filaments are excluded.

Bulbs or terminal bulbs: the relatively large, usually spheroidal or ovoid bodies at or near the distal end of the barbel. These are usually larger in diameter than the main stem, and the distalmost one commonly bears 1 or more relatively slender, often long or complex filaments. Where 2 bulbs are present, they are referred to as proximal and distal. (In some species not considered here, there may be 1 or 2 bulbs between the proximal and distal ones.) Bulb length is measured between the proximal and distal extremes of a bulb, including any projections. When only a projection, and not a filament, is present, the bulb may be measured both including and without including the projection (e.g., *E. longibarba*).

Bulblets: spheroidal, ovoid, or elongate bodies, with or without constrictions, occurring in filaments. These are usually much smaller than the bulbs, often perceivable only with considerable magnification, but in some species they are almost as large as the largest bulb (e.g., *E. kreffti*) or larger (some *E. bulbornatus*).

Distance between bulbs: measured between nearest edges of proximal and distal bulbs with this part of the stem in a straight line. Some species (e.g., *E. variabilis*), but none in *Nominostomias*, have bulbs between the proximal and distal ones, necessitating additional measurements with different designations.

Filaments and branches: as applied to the species of *Nominostomias*, filaments are the slender structures, often with complex branching, that arise from the main stem (rare) or from bulbs (called terminal filaments when arising from the distal or terminal bulb). Branches are any forks of the main filaments or any slender structures that arise along their length. In some other subgenera, forks of the main stem (e.g., *E. bifilis*) or relatively large appendages that arise from the main stem before the bulbs (e.g., subgenus *Dinematochirus*) are called branches, and slender structures arising from the branches are called filaments. In *Nominostomias*, filament length is measured from the distal end of the distal (terminal) bulb to the distal end of the filament, or to the distal end of the longest branch extending beyond the main filament when parallel to it.

Stem: the entire slender, cylindrical portion from the origin of the barbel to the distal bulb; also the proximal part of a terminal filament to the point of major branching.

Axis: the central, usually opaque core of the stem and filaments, occupied by nerves and blood vessels. The axis often is outlined by melanophores.

External striated areas (chevron-shaped, roundish): discrete, apparently flat structures with a striated appearance arranged sequentially in the main barbel stem outside the axis (Figure 3). Although they often appear to be on the outside of the stem, they actually seem to be associated with the outside of a concentric layer between the axis and an outer layer. They vary from readily visible to almost impossible to discern, apparently depending on preservation and barbel condition. They are best resolved with strong transmitted light. They commonly are chevron- or W-shaped in the proximal part of the barbel and become oblong or rounded distally. In some species, the distal ones are pigmented and conspicuous. Their function is unknown.

Colors of the barbel and postorbital organ have been recorded for a number of freshly caught specimens by us and others. Some colors change very rapidly in preservatives (e.g., the suborbital organ of *Aristostomias* changes from scarlet to green overnight in formalin), and all disappear eventually. In most specimens, however, the color observed in unpreserved ones persists for days or months after preservation, during which time most colors fade, but do not change hue. All color descriptions are subjective.

In species for which numerous observations are available, some are consistent in barbel color, others variable. All postorbital organs of *Eustomias* have been white or with pale tinges of yellow or pink. We do not know how much variation in colors of freshly caught, unpreserved specimens is due to changes with time after death, degree of stress, or physiological state before death.

Sex was determined by examination of intact gonads. Females were detected at fairly small sizes, but in individuals smaller than about 90 mm SL, we could not be certain whether a gonad without either obvious eggs or the cross-striated

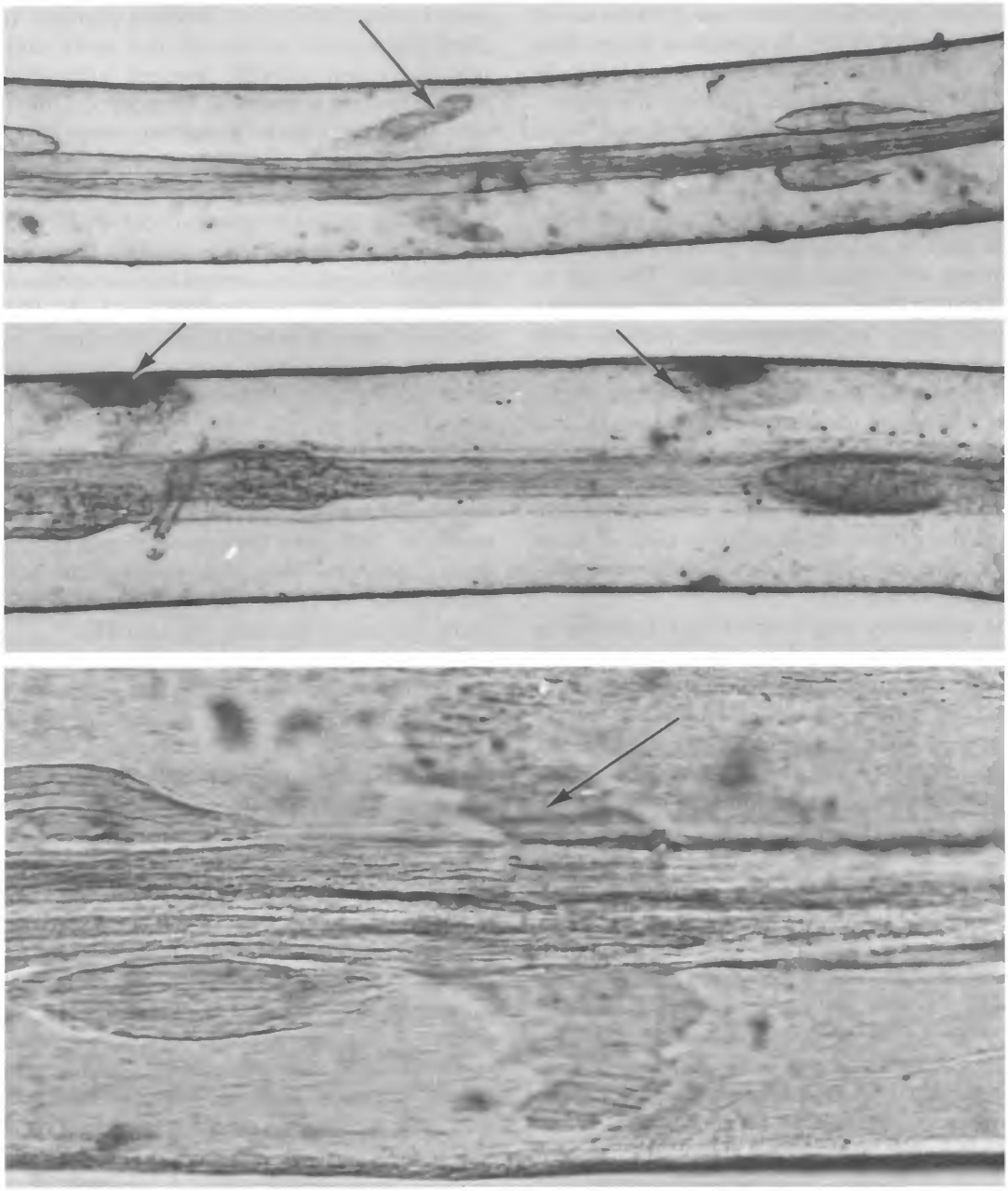


FIGURE 3.—Barbel stem of *Eustomias bibulbosus* photographed using transmitted light. *Top:* × ~40, external unpigmented chevron-shaped striated area indicated by arrow. *Middle:* × ~40, external pigmented roundish striated areas indicated by arrows. *Bottom:* × ~100, external unpigmented chevron-shaped striated area indicated by arrow. The central axis and mounds of undetermined structure applied to the axis are visible in all 3 photographs. In the middle photograph, a clear area is visible surrounding the darker axis, with discrete pigment spots on the outside margin, especially visible above the mound on the right.

appearance typical of testes was a testis or an undifferentiated ovary. In specimens larger than about 110 mm, males of most species can be identified by their enlarged postorbital organs.

Specimens not fully metamorphosed have short, opaque barbels with poorly developed bulbs and filaments; pectoral rays may not be differentiated, or small pectoral rays that later regress may be as long as the primary rays. Such specimens are seldom identifiable. The size at which barbel characters and pectoral rays attain definitive form (i.e., recognizable, perhaps with difficulty) apparently varies among species, from about 50 mm SL in some to 70–80 mm in others. There is a period of relatively rapid growth and morphogenesis after the species become recognizable, during which time relative sizes of barbel structures are similar in many or most species. Few of the differences in relative sizes of these structures among species are apparent much before about 80 mm SL.

The possibility that barbels may function as lures prompts the question of regeneration. We have seen a number of examples of bulbs that are represented only by a reticular network; we do not know whether such networks consist of blood vessels, nerves, or other structures. We also do not know whether these are examples of regenerating bulbs or of bulbs that have been crushed, so that their substance has been extruded, leaving only the associated vascular or nervous structures. Only a single specimen, mentioned as *E. cirritus*, has the reticular structure and also a shorter barbel than would be expected, suggesting that it might be regenerating. Many specimens lack the end of the barbel, but this is so easily broken by handling or by the rigors of capture that its loss can not be attributed to prey organisms. Evidence for regeneration, therefore, is exceedingly slim.

Subgenus *Nominostomias* Regan and Trewavas, 1930

TYPE-SPECIES.—*Eustomias bibulbosus* Parr, by original designation.

DEFINITION.—Three well-developed, free pectoral rays. Seven pelvic rays. Barbel with slender stem having little or no external pigment (axis often pigmented), no row of dark spots, and no branches proximal to the terminal bulbs (*E. multifilis* may have a few short filaments on the stem near the bulb). One or 2 relatively small terminal bulbs, the distalmost with a projection or filament of variable complexity (the projection almost indiscernible in a few species). No wide ventral body groove posterior to pectoral-fin base (a narrow, shallow groove observed in some specimens). Photophore and vertebral counts high. Photophores in ventral series (IC) 69–80 (seldom fewer than 72, species modes mostly 75–78), in lateral series (OC) 63–73 (seldom fewer than 66, species modes mostly 69–72), VAV and VAL 15–21 (seldom fewer than 16, species modes 17–18 and 18–19, respectively). Vertebrae in continuous series 64–71 (seldom fewer than 65, species modes mostly 67–69). No paired photophores in lateral series. Number of teeth high: premaxillary 11–20, mandibular 14–29 in large specimens (fewer in many specimens less than 100 mm SL).

RESTRICTION OF SUBGENUS.—Regan and Trewavas (1930) also included in their new subgenus species with only 2 long, free pectoral rays but which otherwise resemble the 3-rayed species in general barbel morphology and in lacking a ventral body groove. We have chosen to exclude these species from *Nominostomias*. The characters shared by these 2-pectoral-rayed species that distinguish them from *Nominostomias* include lower numbers of serial photophores and vertebrae, fewer VAV photophores above the anal-fin base, and fewer branchiostegal photophores. The two subgenera are compared in Table 1. The valid described species in the subgenus with 2 pectoral rays are *dubius*, *polyaster*, *variabilis* (including *trituberatus*), *brevibarbatus*, *xenobolus*, *pyrifer*, *macrophthalmus*, *leptobolus*, *schiffi*, and *ioani*. Of uncertain status, and possibly synonyms of other species, are *globulifer* and *micropterygius*. A revision of the subgenus is in progress by Gomon and Gibbs, who will name it.

Regan and Trewavas also included *E. simplex* in *Nominostomias*. We believe that this species is related to *E. enbarbatus* and the other nominal species for which Regan and Trewavas recog-

TABLE 1.—Meristic characters of subgenera most closely resembling *Nominostomias* (see Figure 1 for subdivisions of photophore rows, AC, IC, OC, OV, PV, VAL, VAV)

Character	Subgenera				Exceptions	
	Haploclonus		"2-pectoral-rays"	*Nominostomias*	"2-pectoral rays"	*Nominostomias*
	Species	*trewavasae*				
Ventral photophores (IC)						
Species means	66.00–67.14	69.50	72.30–74.45	75.22–78.00	*leptobolus* (n = 2) 76.0	*gibbsi* 74.35
Usual range	65–68	70–71	71–75	74–78	*ioani* (n = 1) 76.0	*micraster* 74.45
Species modes	66–67	70	72–74	75–78		*multifilis* (n = 1) 69.00
						mesostenus (n = 1) 73.00
Lateral photophores (OC)						
Species means	59.50–61.00	62.80	66.00–68.33	68.81–71.91	*ioani* (n = 3) 70.67	*gibbsi* 67.65
Usual range	59–62	?61–65	65–68	68–72		*micraster* 63.36
Species modes	59–61	?61–65	66–68	69–72		*multifilis* (n = 1) 63.00
						mesostenus (n = 1) 68.00
VAV photophores						
Species means	12.31–13.58	15.40	14.50–16.18	16.97–19.50	*leptobolus* (n = 2) 17.00	*mesostenus* (n = 1) 16.00
Usual range	11–14	?14–17	14–17	16–19		
Species modes	11–14	15	15–17	17–18		
VAL photophores						
Species means	13.04–14.24	16.08	15.67–17.20	17.50–20.50		*mesostenus* (n = 1) 16.00
Usual range	12–15	15–17	15–17	17–20		
Species modes	13–14	16	16–17	18–19		
VAV photophores over anal base						
Species mean	*simplex* 4.33	5.44	4.94–5.80	6.00–7.53	*leptobolus* (n = 2) 6.0	*mesostenus* (n = 1) 4.0
Usual range	*simplex* 4–5	5–6	4–6	6–8		
Species modes	*simplex* 4	5	4–6	6–7		
AC photophores						
Species means	17.33–19.25	15.81	16.83–18.00	18.12–20.00		*gibbsi* 17.74
Usual range	17–20	14–17	16–18	18–20		*bulbornatus* 17.71
Species modes	17–19	16	17–18 (few 18)	18–19		*spherulifer* 17.88
						multifilis (n = 1) 15.0
Vertebrae						
Species means	57.41–58.71	60.93	64.10–66.00	66.67–69.33	*ioani* (n = 3) 67.33	*gibbsi* 65.55
Usual range	56–59	?59–62 or 63	63–66	66–69	sp. nov. 1 (n = 2) 66.50	*micraster* 66.25
Species modes	57–59	?59 or 62	63–66	67–69	sp. nov. 2 (n = 1) 67.00	*bertelseni* 66.33
Anal rays						
Species means	33.42–34.52	34.50	34.46–36.64	37.00–39.45		*bulbornatus* 35.19
Usual range	32–36	32–36	33–38	36–40		*spherulifer* 35.57
Species modes	32–?36	?34–36	34–36 (38)	?37–38		*gibbsi* 36.16
						perplexus 36.50
						mesostenus (n = 1) 34.00
						multifilis (n = 1) 34.00
Branchiostegal photophores						
Species means	–	10.40	9.00–10.54	10.23–11.67		
Usual range	9–11	9–11	9–11	10–12		
Species modes	10	11	9–10 (11)	10–11 (12)		
Mandibular teeth (SL >100 mm)	6–10	10–17	9–18	11–24		*pacificus* to 9
						melanostigmoides to 29
Premaxillary teeth (SL >100 mm)	6–10	8–13	7–15	9–18	sp. nov. 3 to 20	*longibarba* to 20
PV photophores						
Species means	27.8–29.30	30.82	32.22–34.50	30.00–34.73	sp. nov. 2 (n = 1) 35.00	
Usual range	27–30	30–32	32–35	31–35	*ioani* (n = 1) 36.00	
Species modes	28–29	31	32–34	31–34		
OV photophores						
Species means	27.41–29.30	30.82	32.60–34.50	30.00–34.64	sp. nov. 2 (n = 1) 35.00	
Usual range	26–30	30–32	32–35	30–35	*ioani* (n = 3) 36.33	
Species modes	27–29	31	32–34 (36, 35)	31–35		

nized the subgenus *Haploclonus*. We also include in *Haploclonus*, *E. bifilis* (synonym *Diplostomias indicus* Kotthaus, 1967), and, with trepidation, *E. trewavasae*. The species of *Haploclonus* have 3 free pectoral rays as in *Nominostomias* and have a slender barbel stem with little or no external pigment and lack a deep ventral body groove as in both *Nominostomias* and the 2-pectoral-rayed group. Species of *Haploclonus* differ from the other 2 subgenera in having lower numbers of serial photophores and vertebrae. These are compared in Table 1. Were it not for *trewavasae*, the other species referred by us to *Haploclonus* would be unmistakably distinguished, not only by low photophore and vertebral counts, but by the presence of a row of black spots associated with photophores along part or all of the stem preceding the proximal bulb (absent in *Nominostomias* and the 2-pectoral-rayed subgenus), by the presence of only 5 or 6 pairs of dorsal spots anterior to the dorsal-fin origin (usually 8, sometimes 7, 9, or 10 in *Nominostomias* and the 2-pectoral-rayed subgenus), and by a small number of widely-spaced teeth—6–10 in both premaxilla and mandible of large specimens (11–20 premaxillary and 14–29 mandibular teeth in *Nominostomias* and the 2-pectoral-rayed subgenus). In *trewavasae* the total numbers of photophores in the serial rows are higher than in other *Haploclonus* species, but still lower than in either *Nominostomias* or the 2-pectoral-rayed subgenus. Within these photophore series, the PV and OV and the VAV and VAL counts are higher than in other *Haploclonus* species and overlap the low extreme of the other 2 subgenera, but the AC counts are lower than in any of these 3 subgenera. The number of teeth in either jaw is intermediate between other *Haploclonus* and the other 2 subgenera. The 9 pairs of dorsal spots anterior to the dorsal-fin origin is certainly more than in other *Haploclonus* and equal to high-count species of *Nominostomias* and the 2-pectoral-rayed subgenus. The presence of 2 pairs of dorsal spots under the dorsal-fin base is apparently unique to *trewavasae*, all other *Eustomias* species having only 1. Thus, *trewavasae* is currently an enigma. We are not certain that it is related to other *Haploclonus* species, but we include it with them for the present.

The subgenus *Eustomias* Vaillant, 1888 (synonym *Pareustomias* Bailly, 1930), including only *E. obscurus* (*Pareustomias chabanaudi* a synonym), shares with the 3 subgenera already discussed the slender barbel without branches and with little or no external pigment and the lack of a deep ventral body groove. Like *Nominostomias* and *Haploclonus*, it has 3 free pectoral rays. Like *Haploclonus*, it has a row of black spots associated with photophores along the barbel stem. The total numbers of serial photophores in both rows and the number of vertebrae are slightly higher than the highest (*Nominostomias*) of the other 3 groups, as are the PV, OV, and AC portions, but the VAV and VAL portions are lower than in *Nominostomias* and resemble the 2-pectoral-rayed subgenus. Its paired lateral photophores and the strongly S-shaped anterior notochord with 2 ossified centra, 1 on the anterior limb of the bend and 1 (lacking in the other 3 subgenera) on the ascending limb, unmistakably distinguish the monotypic subgenus *Eustomias* from all other subgenera or species in the genus.

Other Subgenera.—All other subgenera and species of *Eustomias* share the presence of a wide and deep ventral body groove that continues from the isthmus groove well posteriad of the pectoral-fin base. We briefly discuss those subgenera that appear to be valid, reserving definitive judgment until more comprehensive studies have been completed.

Spilostomias, erected by Regan and Trewavas (1930) to contain *E. braueri* and its synonym *E. stigmatopleura*, should include *Urostomias* Regan and Trewavas (1930) with its only described species *E. macrurus*. These species have relatively simple barbels with a single terminal bulb that bears no terminal filaments, but which has preceding it a pair of branches that may be barely visible to much longer than the bulb. The stem lacks external pigment in *macrurus* and 2 undescribed species, except for a series of spots associated with photophores; in *braueri* the stem is darkly pigmented for its entire length. The ven-

tral body groove extends to between PV 5 and 8. Both *braueri* and *macrurus* have a series of round luminous spots on the lower side of the body, for which *Spilostomias* presumably was named, but while these may resemble a row of large photophores in *braueri*, they are usually difficult to discern in *macrurus*. The species in *Spilostomias* have high numbers of pectoral rays, 8–16 in the described and undescribed species. There are 8 pelvic rays in *braueri*, normally 7 in the other species.

Rhynchostomias Regan and Trewavas (1930) includes only *E. parri*, a species also with a relatively simple barbel that usually has a short branch preceding a single terminal bulb, which bears a fairly short terminal appendage. The stem is darkly pigmented, except for a section proximal to the bulb. The branch arises at the junction of the pigmented and unpigmented sections. The barbel length is about 20%–23% SL, and the ventral body groove extends to about PV 15 or 16. There are 4–5 pectoral rays and 8 pelvic rays.

Triclonostomias, as originally constituted by Regan and Trewavas (1930), included *E. drechseli*, *E. furcifer*, and *E. tenisoni*. With these we tentatively include *radicifilis* Borodin and *decoratus* Gibbs. Three branches, 1 or all 3 long and variously complex, arise from the externally pigmented stem before the bulb. In *radicifilis* the branches arise near the base of a globular terminal bulb; in *tenisoni* and *decoratus* they arise at less than halfway to the terminal bulb; in *drechseli* and *furcifer* the region distal to the branches is swollen for a long distance, making a terminal bulb difficult or impossible to define. The barbel length to the end of the bulb or terminal swelling, exclusive of branches or terminal filaments, is about 20%–45% SL. The ventral body groove extends to PV 15–24. All the species have 8 pelvic rays. The number of pectoral rays is 14–15 in *decoratus*, 6–7 in the other 4 species.

Dinematochirus was established by Regan and Trewavas (1930) to include a dozen species with 7 pelvic rays, 2 pectoral rays that are closely bound together in black membrane, and a short barbel, in most species 20% SL or less, that usually has 3 branches arising together or from a short trunk from the darkly pigmented stem well before the single terminal bulb. Parin and Pokhilskaya (1974) described *E. achirus*, a species with a barbel typical of *Dinematochirus*, but lacking pectoral rays. Another Regan and Trewavas (1930) subgenus, *Achirostomias*, was recognized to include 3 nominal species (probably all synonymous with *lipochirus*) without pectoral rays, with short, relatively unpigmented barbels, and without apparent branches from the stem. We would include these in *Dinematochirus*. Very tiny branches have been found arising from the stem in virtually every specimen we have examined; these were illustrated by Parin and Pokhilskaya (1978a). Thus, except for the lack of external pigment, the barbel of *lipochirus* is of the *Dinematochirus* kind. There is 1 undescribed species of *Dinematochirus* that lacks branches from the stem.

The definition of *Dinematochirus* at present must be based on the short barbel (8%–24% SL) with a single terminal bulb, the presence of a relatively short ventral body groove that extends to PV 3–13, 7 pelvic rays, and pectoral rays either absent or 2 closely bound together. With few exceptions 1 or more branches arise from the stem well before the bulb; when more than a single branch is present, all arise together, either directly from the stem or from a common trunk. Also with few exceptions, the stem is darkly pigmented, at least to the origin of the branches. We currently recognize the following described species as belonging in *Dinematochirus: achirus*, *bigelowi* (including *parvibulbus* and probably *triramis*), *binghami* (including *frondosus*), *dendriticus* (questionably including *monoclonus*), *fissibarbis*, *lipochirus* (including *dactylobolus* and probably *melanobolus*), *macronema*, *paucifilis*, *satterleei*, *schmidti*, *silvescens*, and *similis*. A revision of *Dinematochirus* is being prepared by Clarke, Gibbs, and Gomon, who will describe a number of new species.

Eustomias crucis Gibbs and Craddock, 1973, is unique, combining the 2 closely bound pectoral rays and the short ventral body groove (reaching PV 8) typical of *Dinematochirus* with a barbel that, in length, more closely resembles the species of

Triclonostomias (either 48.6% or 62.5% SL, depending upon which fork is measured). The barbel structure, however, is not typical of either group. There is no terminal bulb, although the slightly swollen tip of the short fork possibly might be interpreted as such, and, if so, the long fork might be interpreted as a single branch from the stem.

Finally, the subgenus *Neostomias* Gilchrist, 1906 (synonym *Parastomias* Roule and Angel, 1931), is recognized as comprising *E. filifer* (including *ramulosus* and *monodactylus*) and *E. tetranema*. These species have 7 pelvic rays and a single long and a short, rudimentary pectoral ray present at all sizes. The barbel has 3 branches of variable complexity arising together from the stem. In *filifer* a single large bulb is present distad of the branches, and a long stem continues from that bulb to end in a smaller terminal bulb or swelling. In *tetranema* there are several bulbs between branches and distal tip. The ventral body groove extends to PV 9–17.

Composition of *Nominostomias*.—Parr (1927) described *E. longibarba*, *E. bibulbosus bibulbosus*, *E. b. micraster*, *E. b. arborifer*, and *E. microcephalus*. Regan and Trewavas (1930) raised all 3 subspecies of *bibulbosus* to species status, recognized *longibarba*, considered *microcephalus* a probable synonym of *longibarba*, and described *bituberatus*, *bimargaritatus*, *melanostigma*, *melanonema*, and *patulus*. Beebe and Crane (1939) placed *arborifer*, *micraster*, and *bimargaritatus* in the synonymy of *bibulbosus* on the assumption that specimens with branched terminal filaments were females. Gibbs (in Morrow and Gibbs, 1964) followed Beebe and Crane and, further, considered *bituberatus* a synonym of *bibulbosus* and *melanonema* a synonym of *melanostigma*. Thus, as of 1964, 10 species of *Nominostomias* described from the Atlantic had been reduced to 4 that were recognized as valid.

Four *Nominostomias* species—*bulbornatus* Gibbs, 1960; *gibbsi* Johnson and Rosenblatt, 1971; *vitiazi* Parin and Pokhilskaya, 1974; and *multifilis* Parin and Pokhilskaya, 1978a—have been described from Indo-Pacific specimens, and others identified as *longibarba*, *patulus*, and *bibulbosus* (all described herein as new) have been reported from there (Gibbs, 1960; King and Iversen, 1962; Johnson and Rosenblatt, 1971; Clarke, 1974; Parin and Pokhilskaya, 1974; Parin et al., 1977).

In our study, we continue to recognize the 8 currently accepted species, vindicate Parr, Regan, and Trewavas by resurrecting 5 out of 6 of their synonymized species, and describe 25 more as new. Only 1 of these species, *E. melanostigma*, is found in both the Atlantic and Indo-Pacific regions.

In spite of the fact that a few of the species treated in this paper are represented by only 1 or 2 specimens each, we are confident that they are valid, for their distinguishing features are of the kind that distinguish other species that are represented by many specimens.

The following list includes the nominal species that we recognize as belonging to *Nominostomias*. They are listed in order of the date of the original description, and their current names, if changed, are given in parentheses.

longibarbus Parr, 1927 (*longibarba*)
bibulbosus bibulbosus Parr, 1927 (*bibulbosus*)
bibulbosus micraster Parr, 1927(*micraster*)
bibulbosus arborifer Parr, 1927 (*arborifer*)
microcephalus Parr, 1927 (? *longibarba*)
bituberatus Regan and Trewavas, 1930
bimargaritatus Regan and Trewavas, 1930
melanostigma Regan and Trewavas, 1930
melanonema Regan and Trewavas, 1930
patulus Regan and Trewavas, 1930
bulbornatus Gibbs, 1960
gibbsi Johnson and Rosenblatt, 1971
vitiazi Parin and Pokhilskaya, 1974
multifilis Parin and Pokhilskaya, 1978a
crossotus, new species
grandibulbus, new species
bimargaritoides, new species
bituberoides, new species
austratlanticus, new species
bibulboides, new species
orientalis, new species
australensis, new species
appositus, new species
inconstans, new species
deofamiliaris, new species
melanostigmoides, new species
medusa, new species
suluensis, new species
bertelseni, new species

posti, new species
kreffti, new species
cirritus, new species
teuthidopsis, new species
cancriensis, new species
pacificus, new species
spherulifer, new species
curtatus, new species
perplexus, new species
mesostenus, new species

Three species—*gibbsi*, *multifilis*, and *mesostenus*—are low in many of the meristic characters used by us to define *Nominostomias* and to differentiate it from the 2-pectoral-rayed group; their inclusion in *Nominostomias* is tentative. Furthermore, because the projection from the terminal bulb of *longibarba*, *spherulifer*, *perplexus*, and *curtatus* (also *mesostenus*) is not filamentous, as in other *Nominostomias*, there is some question as to their inclusion in the subgenus.

Counts of fin-rays, photophores, vertebrae, and teeth are of little use in distinguishing most species of *Nominostomias*, for even those species that show modal differences overlap the ranges of most other species. These counts are given in Tables 7–12.

None of the body proportions showed convincing differences among species of *Nominostomias*. Differences in size or relative-growth patterns appeared to characterize a number of species for which few specimens were measured, but these are believed to be artifacts of sampling. The cloud of points of species with abundant measurements usually encompassed those of species with few measurements, and in those abundant species, isometric growth is indicated for almost every body part once metamorphosis is complete. The only body measurement to indicate allometric growth is the least caudal-peduncle depth, which decreases relative to SL. Ranges of variation of morphometric characters are given in Table 13.

The species accounts that follow, therefore, make almost no mention of most meristic characters or of morphometric characters other than barbel and postorbital-organ measurements.

Key to the Species of *Nominostomias*

(Some species are keyed out in more than one couplet)

1. Two terminal bulbs 2
   A single terminal bulb 29
2. Terminal filament single at base, with or without branches 3
   Three or more terminal filaments, sometimes arising from very short stem [Figures 18–21] Group III 20
3. Terminal filament with 1 or more branches long relative to main filament [Figures 10–13] Group II 4
   Terminal filament without branches or with branches very short relative to main filament [Figures 4, 5] Group I 9
4. First long branches of terminal filament arising close to distal bulb (less than 1.5 distal-bulb lengths distad) [Figures 10–12, 13*a*,*b*,*d*,*e*] 5
   First long branches of terminal filament arising distant from distal bulb (more than 1.5 distal-bulb lengths, up to 11 bulb lengths) [Figures 12*c*, 13] 8
5. Terminal filament short, 9% SL or less [Figure 16]. Bulblets in filament and its branches usually as wide as containing part, sometimes wider and causing swellings [Figures 10*a*–*d*, 11*a*] (tropical and subtropical Atlantic) ..... ***arborifer***
   Terminal filament long, 10%–23% SL [Figure 16]. Bulblets in filament

and its branches small, much smaller than width of containing part, not causing swellings 6

6. Long branches of terminal filament arising along most of its length [Figure 10*e*] (southeastern Atlantic) ..... ***grandibulbus***

All long branches of terminal filament arising close together, near bulb [Figures 11*a*, 12*a,b,d,e*] 7

7. Long branches of terminal filament with shorter branches [Figure 12*b*] (northern subtropical Atlantic) ..... ***bimargaritatus***

Long branches of terminal filament without shorter branches [Figures 11*b*, 12*a,d*] ..... A

A. Northern subtropical Atlantic ..... ***bimargaritatus***

Eastern Indian and western Pacific oceans ..... ***crossotus***

8. Long branches of terminal filament arising 1–5 distal-bulb lengths from bulb in specimens smaller than 120 mm SL [Figure 12*a,b*], up to 10 bulb lengths in larger specimens [Figure 13*b*]. Bulblets small, widely spaced in base of main filament and branches [Figure 12*b*]. Intact filament length 10%–17% SL in specimens smaller than 120 mm SL [Figure 16] (northern subtropical Atlantic) ..... ***bimargaritatus***

Long branches of filament arising 6–11 distal-bulb lengths from bulb at all sizes. Bulblets slightly larger, more closely spaced in filament and long branches, absent in filament proximal to branching [Figure 12*c*]. Intact filament length 21%–28% SL [Figure 16] (central Pacific) ..... ***bimargaritoides***

9. Four or more short branches present near base of filament, each with internal bulblets and, usually, a swollen tip [Figure 4*b*] (Antillean North Atlantic) ..... ***micraster***

No or, at most, 1–3 short, simple branches near base of filament (1 or 2 others may be present farther distad) 10

10. Proximal and distal bulbs contiguous [Figure 5*d,e*] 11

Proximal and distal bulbs separated 12

11. Length of distal bulb 0.75–1.29 times length of proximal bulb. No pigment in axis of stem or filament [Figure 5*e*] (northwestern Pacific) ..... ***appositus***

Length of distal bulb 2.6–3.6 times length of proximal bulb. Axis of stem and filament usually darkly pigmented [Figure 5*d*] (near Hawaiian Islands) ..... ***inconstans***

12. Proximal bulb not in center of stem, extending external to stem and bearing filaments [Figure 5*a*] (near Hawaiian Islands) .. ***deofamiliaris***

Proximal bulb in center of stem, without filaments 13

13. Distance between bulbs greater than 2% SL [Figure 8] 17

Distance between bulbs less than 2% SL 14

14. Barbel length longer than 75% SL, often longer than SL [Figure 6] .. 15

Barbel length shorter than 65% SL 16

15. One to 3 short branches near base of terminal filament. Proximal bulb 1.1% SL or longer in specimens smaller than 100 mm SL, 0.8% SL or longer in specimens larger than 100 mm SL [Figure 7]. Distal bulb

longer than 1.4% SL in specimens smaller than 100 mm SL, longer than 1.1% SL in specimens larger than 100 mm SL [Figures 7, 4*d*] (Antillean North Atlantic) ..... ***bituberatus***

No short branches on terminal filament. Proximal bulb 1.0% SL or shorter in specimens smaller than 100 mm SL, 0.8% SL or shorter in specimens longer than 100 mm SL. Distal bulb 1.3% SL or shorter in specimens smaller than 100 mm SL, 1.1% SL or shorter in specimens longer than 100 mm SL [Figure 4*e*] (northern central Pacific) ..... ***bituberoides***

16. Proximal bulb 1.3% SL in only specimen larger than 100 mm SL. Distal bulb 1.4% SL in 1 specimen smaller than 100 mm SL, 1.0% SL in 1 larger than 100 mm SL [Figures 7, 5*f*] (western North Pacific) ..... ***orientalis***

Proximal bulb 0.9% SL or shorter at all sizes. Distal bulb 1.0% SL or shorter in specimens smaller than 100 mm SL, 0.7% SL or shorter in specimens larger than 100 mm SL [Figure 5*g*] (northern central Pacific) ..... ***bibulboides***

17. Barbel very long, 83% SL to longer than SL [Figure 6]. Two or 3 short branches on terminal filament near bulb [Figure 4*d*] (Antillean North Atlantic) ..... ***bituberatus***

Barbel 85% SL or shorter. Terminal filament with or without short branches 18

18. Distance between proximal and distal bulbs less than twice proximal-bulb length, equal to distal-bulb length (only 1 known specimen) [Figure 5*h*] (off southeastern Australia) ..... ***australensis***

Distance between proximal and distal bulbs 2–8.5 times proximal-bulb length, 1.7–4.3 times distal-bulb length 19

19. Intact terminal filament 10% SL or shorter. Filament with 2 short branches near its base [Figure 4*c*] (southern South Atlantic) ..... ***austratlanticus***

Intact filament longer than 20% SL. Filament sometimes with a single short branch near its base, usually with none [Figure 4*a*] (subtropical North Atlantic) ..... ***bibulbosus***

20. Some filaments arising from sides as well as end of distal bulb and on stem just proximal to bulb [Figure 18*a*] (off southwestern Australia) ..... ***multifilis***

All filaments arising from distal end of distal bulb (sometimes from a very short stem) [Figures 18*b–f*, 19–21] 21

21. Terminal filaments short, 10% SL or shorter [Figure 24], from about as long as to 8 times distal-bulb length [Figures 18*b–f*, 19] 22

Terminal filaments long, 10%–35% SL, usually 11–35 times distal-bulb length (in some specimens smaller than 85 mm SL, 6–10 times bulb length) [Figures 19–21] 25

22. Terminal filaments containing prominent bulblets. Central filament usually forked well distad from base; some other filaments with branches from their distal halves [Figure 19] (central and western North Pacific) ..... ***medusa***

Terminal filaments without internal bulblets. All filaments usually simple,

occasionally forked near base [Figure 18*b–f*] 23

23. Distal bulb usually at least twice as long as wide, parallel-sided. In specimens longer than 75 mm SL, distal bulb 1.7–2.8 mm long and sum of lengths of proximal and distal bulbs 2.7–4.3 mm [Figure 18*b*] (eastern tropical Atlantic) ..... ***melanonema***

Distal bulb not more than 1.5 times as long as wide, convex-sided. In specimens longer than 75 mm SL, distal bulb 0.6–1.8 mm long and sum of lengths of proximal and distal bulbs 2.7 mm or less [Figure 18*c–f*] 24

24. Distance between bulbs 2.4%–4.1% SL in specimens longer than 85 mm SL and most specimens 75–85 mm [Figure 24] (tropical and subtropical North Atlantic) ..... ***melanostigma***

Distance between bulbs 2.4% SL or less at all sizes (near Hawaiian Islands) ..... ***melanostigmoides***

25. Seven to 10 terminal filaments of moderate length, not longer than 13% SL [Figure 24]. One filament usually forked; most with short branches in their distal halves. Both bulbs small, proximal 0.2%–0.5% SL, distal 0.5%–1.1% SL [Figures 23, 19] (central and western North Pacific) ..... ***medusa***

Two to 4 long terminal filaments, 14%–35% SL except in some specimens smaller than 85 mm SL; additional short filaments present in some species [Figures 20*a,b*, 21]. Long filaments not forked, without short branches. Bulbs larger, proximal 0.7%–1.4% SL, distal 1.2%–2.0% SL, except in some specimens smaller than 85 mm SL and in large *posti* (0.9%–1.3%) 26

26. Two long filaments, 1 with a large bulblet near its base; no other conspicuous bulblets in long filaments [Figure 20*c*]. Several short, bulblet-tipped filaments. Distance between bulbs 0.5%–2.0% SL [Figure 24]. Barbel length 44% SL or less [Figure 22] (tropical Atlantic) ..... ***kreffti***

Three or 4 long filaments, all with numerous bulblets or long inclusions. Few or no short filaments; when present, short filaments thin and not bulblet-tipped. Distance between bulbs 2.0%–3.0% SL. Barbel length 43%–60% SL 27

27. Three long filaments. All bulblets in filaments much smaller than proximal width of filaments. Proximal bulb 0.7%–0.8% SL [Figures 23, 20*b*] (Sulu Sea) ..... ***suluensis***

Four long filaments. Long inclusions or prominent bulblets present (some as wide as proximal part of filaments). Proximal bulb 0.8%–1.4% SL [Figures 23, 20*a*, 21] 28

28. Long inclusions, as well as bulblets, present in filaments. Distance between bulbs 2.7%–3.0% SL [Figures 24, 20*a*] (eastern equatorial Indian Ocean) ..... ***bertelseni***

Prominent bulblets, but no long inclusions in filaments. Distance between bulbs 2.0%–2.6% SL [Figure 21] (western South Atlantic) ..... ***posti***

29. Distal appendage of terminal bulb a simple finger-like projection or a

dome-like cap. Terminal bulb at least twice as long as wide [Figures 31, 32] Group V 30

Distal appendage or appendages of terminal bulb slender filaments of varying complexity. Terminal bulb not more than 1.5 times longer than wide [Figures 26–28] Group IV 34

30. Four VAV photophores over anal-fin base. Length of terminal bulb without distal projection 2.6% SL [Figure 33], its sides strongly concave at mid-length. Distal projection an extension of bulb sheath, covering entire end of bulb, including a short, thread-like projection from bulb [Figure 32*f*] (central South Indian Ocean) ..... ***mesostenus***

Six to 8 VAV photophores over anal-fin base. Length of terminal bulb without distal projection 0.4%–2.3% SL, its sides parallel, weakly concave, or widening distally (pear-shaped). Distal projection finger-like or low, dome-like, often difficult to discern; not covering entire end of bulb [Figures 31, 32*a–e*] 31

31. Terminal bulb with finger-like distal projection rarely shorter than 0.4% SL and usually 0.6%–1.8% SL [Figures 35, 31, 32*a*] 32

Terminal bulb with dome-like (often difficult to discern) or short conical projection not longer than 0.3% SL [Figure 32*b–e*] 33

32. Distal half of stem in specimens larger than 90–100 mm SL with spherical inclusions, widely spaced proximally, becoming larger and more crowded distally (these inclusions not well developed in smaller specimens) [Figure 31*e,f*] (subtropical South Atlantic) ..... ***spherulifer***

Distal half of stem in specimens larger than 90–100 mm SL with no spheres or with a few just proximal to bulb [Figures 31*a–d*, 32*a*] ....A

A. Tropical Atlantic, subtropical North Atlantic ..... ***longibarba***

Mainly equatorial Pacific and eastern Indian oceans ....***perplexus***

33. Barbel length 67%–83% SL [Figure 33], except in some specimens smaller than about 75 mm SL. Few or no spherical inclusions in stem before bulb [Figure 32*a–c*] (mainly equatorial Pacific and eastern Indian oceans) .....***perplexus***

Barbel length 56% SL or less. Specimens larger than about 100 mm SL with numerous spherical inclusions in stem before bulb [Figure 32*d,e*] (near Hawaiian Islands) ..... ***curtatus***

34. A single terminal filament [Figure 27*a,b,e,f*] 35

Three or more terminal filaments [Figures 26, 27*c,d*, 28] 37

35. Terminal bulb with an acentric nipple distally. A prominant round black area with unpigmented center at base of bulb. Terminal filament 11%–25% SL, with a pair of branches proximally, followed by 1 or more large bulblets and a second pair of branches [Figure 27*a*]. Filament and branches with prominent small bulblets along most of their length. Anterior edge of fleshly orbit with a long, slender pedicel, bearing a photophore at its tip, extending noticeably over cornea [Figure 2*a*] (central and western North Pacific) ..... ***pacificus***

Terminal bulb without nipple. Black area at base of bulb solid or absent. Terminal filament 10% SL or shorter, either simple, forked, or with

alternating branches. Filament and any branches without prominent bulblets. Anterior edge of fleshly orbit without a photophore-bearing pedicel, or with a very short pedicel 36

36. Solid black cap covering entire base of bulb, which is almost flat. Filament simple or forked [Figure 27*e,f*] (subtropical North and South Pacific) ..... ***gibbsi***

No pigment at base of bulb, which is rounded. Filament with several slender branches arising singly along its length (northeastern Atlantic) ..... ***patulus***

37. Distal bulb 0.3%–0.6% SL [Figure 29], with 1 side prominently pigmented, pigment forking distally and continuing along axis of 1 pair of terminal filaments. Six terminal filaments in 3 bilaterally symmetrical pairs, the longest usually 8 or more times bulb length, except in developing young. Two filaments with a large distal bulblet that may be larger than terminal bulb. Barbel short, 34% SL or less [Figures 29, 28] (equatorial Indian and Pacific oceans, southeastern Atlantic) ..... ***bulbornatus***

Distal bulb 0.7%–1.3% SL (1 questionable *cirritus* excepted), without pigment on its sides. Three to 13 or more terminal filaments, not obviously paired, the longest 1.1–6.8 times bulb length. No bulblets in filaments approaching size of terminal bulb. Barbel 31%–89% SL (less than 40% only in some specimens smaller than about 80 mm SL) .. 38

38. Longest filament 4.3% to about 10% SL, 4 or more times terminal-bulb length [Figure 30]. Filaments with long inclusions, as well as prominent bulblets [Figure 26*a*] (tropical South Pacific) ..... ***vitiazi***

Longest filament 0.5%–4.3% SL, 3.3 times terminal-bulb length or less. Filaments with or without bulblets, but without long inclusions ... 39

39. All terminal filaments simple or forked near their base, without bulblets, the longest 2.5–3.3 times terminal-bulb length [Figure 27*c,d*] (subtropical western North Pacific) ..... ***cancriensis***

At least some terminal filaments with branches and bulblets, longest filament 1.1–2.1 times terminal-bulb length 40

40. Three multi-branched filaments, each with numerous bulblets as wide as or wider than branch width. Barbel 53% SL or less [Figure 26*c*] (tropical South Pacific) ..... ***cirritus***

About 13 filaments, some with short branches and 2 noticeably thicker than others; bulblets few and mostly very small. Barbel 89% SL [Figure 26*b*] (tropical South Pacific) ..... ***teuthidopsis***

GROUP I

The species of this group have 2 terminal barbel bulbs and a single, simple terminal filament that, in most species, lacks side branches entirely (Figures 4, 5). In *E. inconstans* the proximal bulb may be absent. Three species apparently normally have very short filament branches: *E. austratlanticus* with 2 together at a short distance from the bulb and 1 farther distad (Figure 4*c*); *E. bituberatus* with 2 together very close to the bulb (Figure 4*d*); *E. micraster* with several bulblet-tipped ones close together very close to the bulb (Figure 4*b*). In *E. bibulbosus* the filament normally is simple, but a few specimens have 1–3 branches that have no constant positions. No branches

have been observed in any other species. Eleven species comprise this group. A synopsis of their salient characters is given in Table 2, and their barbel and postorbital-organ dimensions are plotted in Figures 6–9.

Eustomias bibulbosus Parr, 1927

FIGURE 4*a*

Eustomias bibulbosus Parr, 1927:70 [25°58'N, 77°26'W].—Regan and Trewavas, 1930:82 [2 additional specimens, N. Sargasso Sea].—Beebe, 1937:199 [lists 8 specimens from Bermuda].—Beebe and Crane, 1939:211, 219–221 [description of same 8 specimens; barbels, fig. 70; *E. arborifer* in synonymy; *E. bimargaritatus* tentatively in synonymy].—Grey, 1955:282 [1 specimen from Bermuda].—Morrow and Gibbs, 1964:391 [part; only additional specimen, from north of Puerto Rico, considered herein to be *bimargaritatus; E. micraster, bituberatus* in synonymy].—Blache et al., 1970:171 [part, fig. 459a only].—Gibbs, 1971:239 [8 additional specimens from Bermuda].

DIAGNOSIS.—Two terminal bulbs separated by a long interspace (2.2%–4.2% SL; usually 2–3 times length of distal bulb, but up to 7.5 times in some small specimens). Barbel 60%–85% SL in specimens over 100 mm. Terminal filament long, 22%–33% SL when intact, rarely with 1 or 2 short branches. Distal bulb usually 0.9%–1.6% SL, 1.0–1.6 times length of proximal bulb (0.5–2.0 times in small specimens). Axis of stem pigmented, usually darkly. External chevron-shaped or roundish striated areas on stem usually pigmented in specimens larger than 80 mm. Paired dorsal spots between occiput and dorsal-fin origin usually 8, occasionally 7.

DESCRIPTION.—Barbel length increases from 22% SL in the smallest specimen (48 mm) to 60%–85% in those longer than 100 mm. All specimens have black pigment in the axis of the stem and between the bulbs, and specimens larger than 80 mm have pigment in at least the proximal axis of the filament. The stem axis is usually quite dark, often becoming lighter distally. Between the bulbs, the pigment is often light or absent proximally, becoming darker distally, and there is often a very dark spot or cap at the base of the distal bulb. The external chevron-shaped or roundish striated areas on the stem are usually prominently pigmented, except in the smallest specimens.

Both proximal and distal bulbs vary in shape from spheroidal to long ovoid, sometimes having the ends flattened or, in one case, widened distally (pear-shaped). The bulbs are relatively small in some small specimens, but by about 70 mm both bulbs have attained dimensions that do not change relative to SL with growth. The proximal bulb in specimens larger than 60 mm is 0.6%–1.5% SL; the distal bulb in all over 70 mm is 0.9%–1.6%. In most specimens, the distal bulb is 1.0–1.6 times as long as the proximal bulb, but in small specimens the ratios are 0.5–2.0.

The distance between terminal bulbs is 2.2%–4.2% SL, apparently not changing with growth, and usually is 2–3 times the length of the distal bulb (in the smallest specimens the interspace is up to 7.8 times the distal bulb).

The terminal filament is long, 22%–33% SL when intact, without apparent change in relative length with growth. Short side branches are present occasionally, arising variously from close to the bulb to well distad on the filament. Four of our specimens had a single such branch, 1 had 2 together. Tiny bulblets are present along the filament axis but are difficult to discern in most specimens; they tend to be slightly larger and more prominent proximally.

The postorbital organs of 7 large males (112–132 mm) are relatively small, 1.2%–1.4% SL, 38%–50% of fleshy-orbit length. A male of 110 mm has an organ only 0.9% SL, indicating that enlargement begins at about this body size.

Beebe and Crane (1939:220) described the colors of the bulbs in a living male from Bermuda. The proximal bulb was translucent white, the distal bulb clear pink. In our observations of 4 males and 3 females from Bermuda and south, the proximal bulb varied from almost white to pink, while the distal bulb was pink to pinkish purple. The postorbital organs were white in both sexes. No sexual dimorphism in color is apparent.

SIMILAR SPECIES.—Only 2 similar species occur near or with *E. bibulbosus*. Of these *bituberatus* has a longer barbel at any given size (Figure 6) and apparently always has 2 small branches together

TABLE 2.—Synopsis of characters of Group I species (SL is given (in mm) when characters are from only part of the size range; see footnotes for "Other characters")

Species	Barbel length (% SL)	SL	Proximal bulb (% SL)	SL	Distal bulb (% SL)	SL	Distal/ proximal bulb	SL	Interbulb distance (% SL)	SL	Interbulb distance/ distal bulb	SL	Terminal filament (% SL)
appositus	49–57		1.0		0.8–1.3		0.8–1.3		0		–		2.2–5.0
australensis	55		1.1		1.8		1.6		1.8		1.0		≥9.4
austratlanticus	27–81		0.5–0.9		0.9–1.2		1.4–2.1		2.8–3.		2.8–3.0		3.9–9.4
bilbulboides	31–62		0.3–0.9		0.4–1.0		1.0–1.8	≤100	0.7–1.4		0.4–1.5		2.9–10.5
							0.5–1.0	≥100					
bilbulbosus	60–85	≥100	0.6–1.5	≥60	0.9–1.6	≥70	1.0–1.6		2.2–4.2		2.0–3.0	most	22–33
bituberatus	78–152		0.9–1.6		1.6–2.0	≤90	1.0–1.7		1.9–3.1		1.0–1.9		(11) 18–25
					1.1	133							
bituberoides	79–136		0.6–1.0		0.7–1.2		1.0–1.6		1.1–1.9	81–103	0.6–2.0		~20
									0.6–1.0	132–141			
deofamiliaris	66		1.0		1.5		1.5		3.6		2.4		11
inconstans	52–65		0.4–1.7	≥146	1.3–2.1		2.6–3.6		0		–		6.2–9.2
orientalis	50–53		0.8–1.3		0.9–1.4		0.7–1.8		0.6–0.8		0.5–0.6		4.2–5.3
micraster	44–68	≤75	1.0–1.8	≤75	1.0–1.4	≤75	0.5–1.3	≤75	2.9–4.5	≤75	2.6–7.8		16–21
	37–48	≥142	0.7–0.9	≥142	0.3–0.6	≥142	most ≤1.0	≥142	2.2–2.7	≥142			

[a] Stem axis pigmented. [b] Stem axis pigmented or not. [c] Filament axis pigmented. [d] Filament axis darkly pigmented. [e] Filament axis unpigmented. [f] Filament axis pigmented or not. [g] Terminal bulbs contiguous. [h] Proximal bulb external to stem, bearing filaments. [i] One or two terminal bulbs; when two, contiguous. [j] Basal filament branches with bulblets, swollen tips.

on the terminal filament near the distal bulb; only 1 specimen of *bibulbosus* had 2 branches, and these were well distad on the filament. The terminal bulbs of small *bituberatus* are larger than in *bibulbosus* (Figure 7), and the interspace is generally shorter in *bituberatus*, but there is some overlap (Figure 8). The interspace is 1.5–2.6 times the length of the proximal bulb and 1.0–1.9 times the length of the distal bulb in *bituberatus;* in *bibulbosus* these ratios are 2.3–8.5 and 2.0–7.5, respectively.

The terminal filament of *micraster* has 4 or more short branches close together near the distal bulb, and specimens larger than 100 mm have shorter barbels (less than 60% of SL) and distal bulbs smaller than the proximal (equal or greater in *bibulbosus*).

The South Atlantic species *austratlanticus* is very similar to *bibulbosus*, but apparently has a shorter filament with 2 short branches together a short distance from the distal bulb, and the only large male has a larger postorbital organ (1.7% SL, 57% of fleshy orbit vs. 1.2%–1.4% SL, 38%–50% of fleshy orbit in *bibulbosus*).

The similar Pacific species *bituberoides*, *bibulboides*, *orientalis*, and *australensis* have a shorter interspace between the terminal bulbs (Figure 8), and in *appositus* and *inconstans* the bulbs are contiguous. Each of these differs from *bibulbosus* in 1 or more other barbel characters.

DISTRIBUTION.—Known from the North Atlantic west of 50°W between 25° and 40°N. (Figure 40). Two specimens have been taken in the northern Bahamas. The 149.6 mm specimen from north of Puerto Rico recorded by Morrow and Gibbs (1964) is tentatively reidentified as *bimargaritatus* and discussed under that species.

A juvenile, ~56 mm SL (USNM 226471), taken at 34°15′N, 28°39′W, cannot be identified satisfactorily. The capture locality is far to the east of any others of *bibulbosus* and is out of the known range of any species of *Nominostomias* except *longibarba*, but the specimen appears to have 2 terminal bulbs and a terminal filament longer than the distal bulb. The range of *E. filifer* in-

Terminal filament branches	Male postorbital (% SL) [SL]	(% Fleshy orbit)	Predorsal pairs of spots	Other characters
0	–	–	7–8	b,e,g
0	–	–	8	a,e
2 simple, near base	1.7 [156]	57	8	a,f
0	2.2–2.6 [135–145]	69–92	8(7–9)	a,f
0 1–2 rare	1.2–1.4 [112–132]	38–50	(7) 8	a,f
2 simple, basal	0.7–0.8 [106–117]	23	8–9	a,c
0	1.6–1.9 [132–141]	56–66	8	a,f
0	0.9 [109]	29	?	a,d,h
0	1.4–2.0 [140–154]	45–82	8	a,d,i
0	–	–	8	b,e
4–11 basal	0.7–0.9 [112–128]	21–27	?	a,f,j

cludes the capture locality, but *filifer* has only 1 well-developed pectoral ray, while this specimen has 3. We are unable to resolve this problem.

MATERIAL EXAMINED (11 males, 14 females, 10 unsexed).—*Holotype:* BOC 2039 (♂, 118.4) 23°58′N, 77°26′W, 0–~2134 m (7000 ft wire), 2 Mar 1927.

Non-types: USNM 223655 (♀, 149.0), 36°43′N, 68°09′W, 0–3000 m, 1945, 28 Feb 1978. USNM 223741 (?, 53.4), 32°28′N, 64°02′W, 144–178 m, 2300–0000, 7 Sept 1971. USNM 223742 (♀, 89.2), 32°19N′, 63°38′W, 0–450 m, 0535–0840, 8 Sep 1969. USNM 223743 (♂, 115.5), 33°00′N, 64°45′W, 0–1425 m, 4 Jul 1968. USNM 223744 (♂, 97.0), 32°09′N, 63°59′W, 80–130 m, 0438–0455, 30 Oct 1967. USNM 223745 (♀, 120.7), 32°13′N, 64°23′W, 100 m, 2205–2305, 1 Jun 1970. USNM 223746 (?, 53.2), 32°22′N, 64°11′W, 210–222 m, 0112–0212, 8 Sep 1971. USNM 223747 (?, 62.0), 32°09′N, 63°59′W, 75–80 m, 0455–0555, 30 Oct 1967. USNM 223748 (?, 73.6), 32°00′N, 64°17′W, 500 m, 0340–0440, 6 Sep 1968. USNM 223749 (2♀, 134.9, 143.7), 32°25′N, 64°14′W, 0–760 m, 0115–0400, 23 Aug 1971. USNM 223750 (♀, 80.7), 31°56′N, 63°57′W, 0–1690 m, 2150–0515, 8 Sep 1968. USNM 223752 (?, 47.6), 32°12′N, 64°12′W, 722 m, 1603–1703, 3 Sep 1971. USNM 223753 (3♂, 115.0, 125.0, 137.0; 3♀, 132.0, 132.0, 142.5), 32°22′N, 64°04′W, 0–100 m, 2047–2207, 22 Aug 1971. USNM 226471 (?, 56), 34°15′N, 28°39′W, 0–460 m, 0001–0200, 5 Sep 1973. MCZ 56702 (♀, 123.5), 31°31′N, 67°31′W, 0–135 m, 1907–2137, 10 Dec 1968. MCZ 57018 (?, 81.6), 37°18′N, 63°22′W, 0–250 m, 0008–0343, 15 Dec 1976. MCZ 57020 (♀, 93.4), 39°49′N, 65°58′W, 500–750 m, 1232–1646, 6 Nov 1977. MCZ 57021 (?, 65.7), 35°31′N, 67°17′W, 0–165 m, 2245–0046, 26 Aug 1967. MCZ 57022 (♀, 77.8), 32°39′N, 68°41′W, 0–457 m, 1940–0055, 19 Sep 1962. MCZ 57023 (♀, 82.5), 30°10′N, 67°32′W, 0–217 m, 0440–0625, 28 Nov 1968. ZMUC P202702 (♀, 134.6), 35°42′N, 73°43′W, 0–~150 m (300 mw), 2000, 21 May 1922. BMNH 1929.7.6.98 (♂, 127.6), 27°02′N, 53°39′W, 0–~550 m (1100 mw), 2300, 30 Apr 1922. FMNH 49853 (?, 123.1), 32°16′N, 64°39′W, 0–275 m, 2050–2300, 14 Jul 1948. ISH 3192/79 (2♂, 110.2, 117.5; ♀, 120.8), 30°27′N, 66°08′W, 0–1800 m, 0405–0813, 15 Apr 1979. ISH 3193/79 (♂, 111.7), 26°35′N, 60°29′W, 0–600 m, 1932–2103, 24 Mar 1979. ISH 3194/79 (♀, 118.2), 26°45′N, 59°00′W, 0–1200 m, 1422–1650, 27 Mar 1979. ISH 3195/79 (♀, 127.4), 31°01′N, 63°15′W, 0–250 m, 2030–2130, 19 Mar 1979. VIMS 05772 (♂, 131.7), 29°52′N, 77°09′W, 0–1030 m, 2340–0010, 2 Nov 1979. UMML 16573 (?, 59), 25°36′N, 77°16′W, surface, 23 Jun 1962. UMML 33539 (♀, 150.0), 24°39′N, 76°30′W, 0–1637 m, 0426–0836, 7 Nov 1974.

Eustomias austratlanticus, new species

FIGURES 1, 4*c*

DIAGNOSIS.—Two terminal bulbs separated by a long interspace (2.8%–3.4% SL, 2.8–3.0 times distal-bulb length). Barbel long (81% SL) in the large specimen, short (27% SL) in the small specimen. Terminal filament short, 3.9%–9.4% SL, with 2 short branches together about 2 distal-

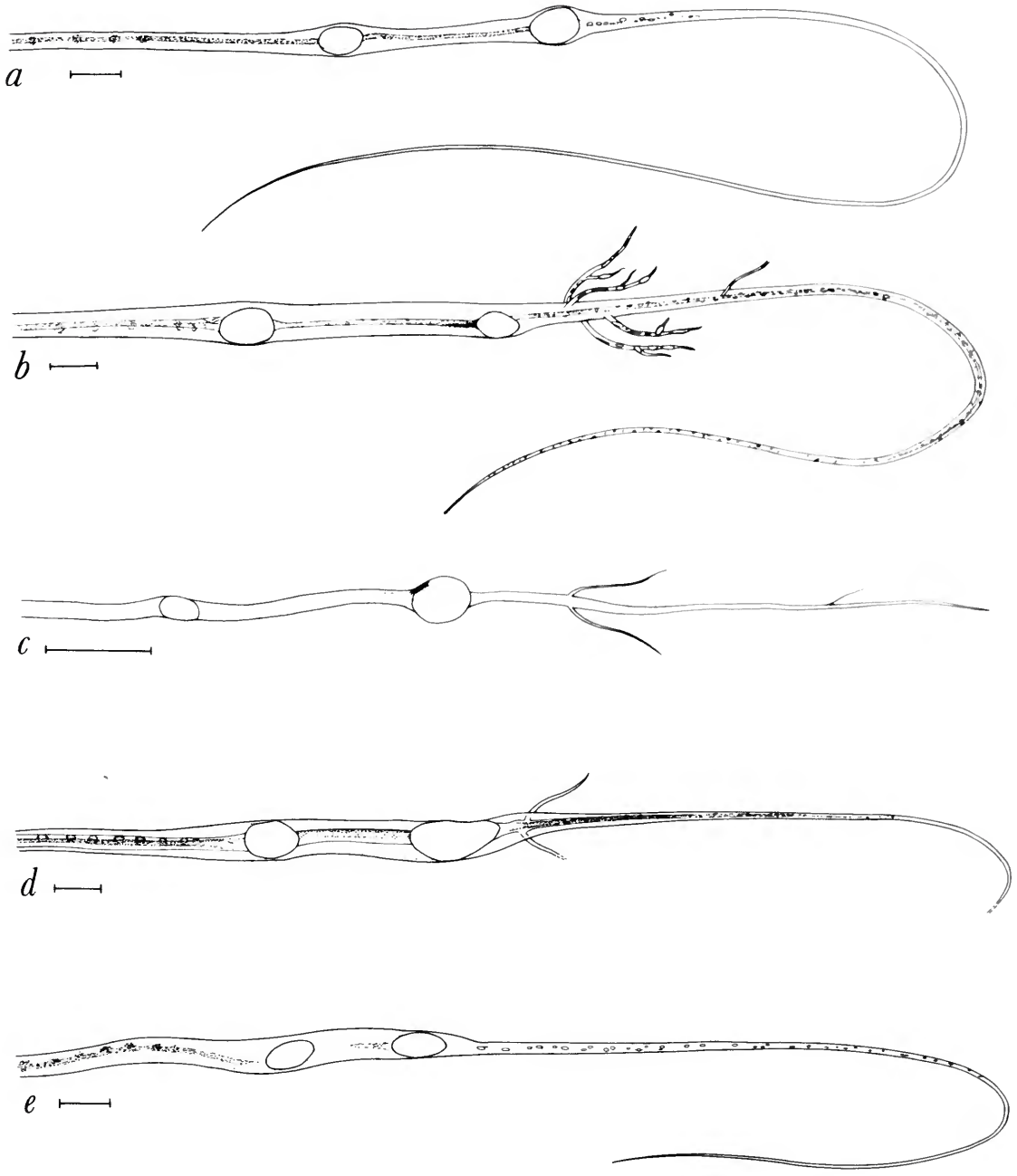


FIGURE 4.—Barbel ends of Group I species: *a*, *E. bibulbosus*, 81.6 mm SL, MCZ 57018; *b*, *E. micraster*, 128.0 mm SL, USNM 229981; *c*, *E. austratlanticus*, paratype, 74.2 mm SL, USNM 223777; *d*, *E. bituberatus*, 88.2 mm SL, UMML 33540; *e*, *E. bituberoides*, paratype, 101.0 mm SL, USNM 223728. (Bar = 1 mm.)

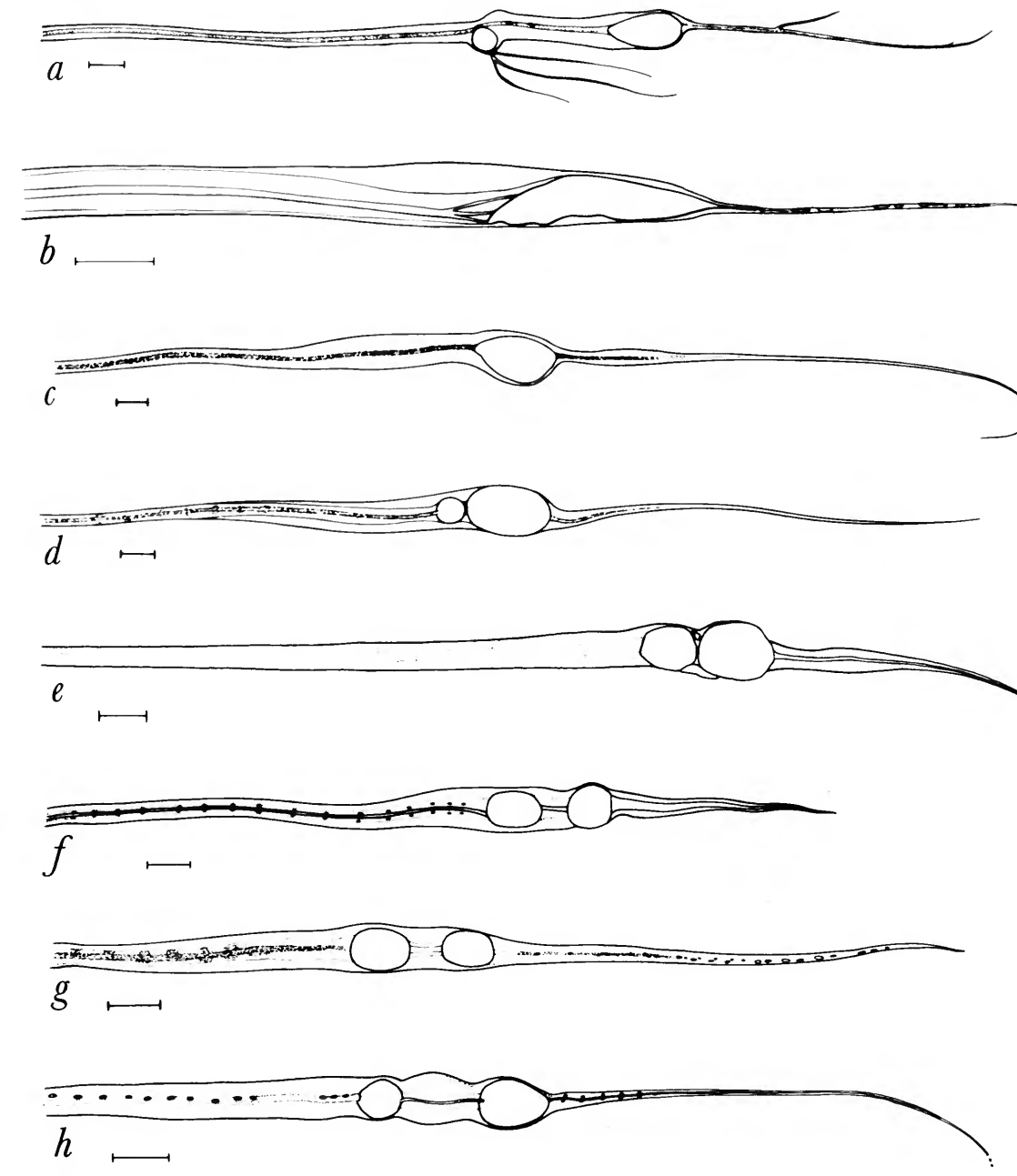


FIGURE 5.—Barbel ends of Group I species: *a*, *E. deofamiliaris*, holotype, 108.8 mm SL, USNM 223764; *b–d*, *E. inconstans* (*b*, 136.9 mm SL, USNM 225165 (aberrant bulb); *c*, paratype, 164.0 mm SL, USNM 223761; *d*, paratype, 151 mm SL, BPBM 26414); *e*, *E. appositus*, holotype, 136 mm SL, IOAN uncatalogued; *f*, *E. orientalis*, holotype, 118 mm SL, IOAN uncatalogued; *g*, *E. bibulboides*, holotype, 145 mm SL, USNM 223641; *h*, *E. australensis*, holotype, 87 mm SL, AMS I.20901-001. (Bar = 1 mm.)

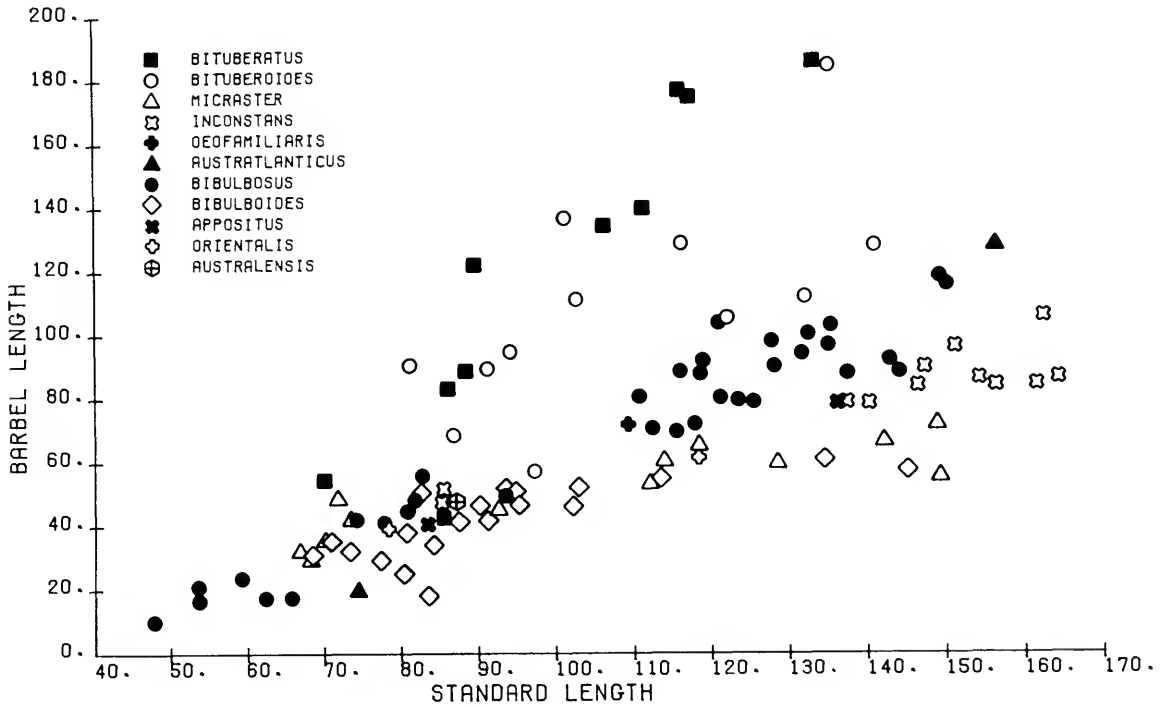


FIGURE 6.–Barbel length (mm) vs. SL (mm) in Group I species.

bulb lengths from the bulb. Distal bulb 1.4–2.1 times length of proximal bulb. Axis of stem pigmented, lightly in the small specimen, moderately darkly in the large specimen. External chevron-shaped or roundish striated areas on stem pigmented. Middorsal paired spots between occiput and dorsal-fin origin 8 (small specimen only).

DESCRIPTION.—Based on 2 specimens, 74 and 156 mm SL; proportions listed for small specimen followed by large specimen. In percent of SL: barbel length 27–81, filament length 3.9–9.4, proximal bulb 0.9–0.5, distal bulb 0.9–1.2, distance between bulbs 2.8–3.4. In percent of proximal bulb: distal bulb 140–211, distance between bulbs 420–589. In percent of distal bulb: distance between bulbs 300–279.

The postorbital organ of the 1 large male is 1.7% SL, 57% of fleshy orbit.

No color observations have been recorded.

DESCRIPTION OF HOLOTYPE.—Male, 156.3 mm SL. D 27. A 41. P1 3. P2 7. IP 7. PV 32. VAV 21. OV 32. VAL 22. AC 19. IA 60. IC 79. OA 54. OC 73. VAV photophores over anal-fin base 8. Branchiostegal photophores 12. Premaxillary teeth 17 left, 13 right: from anterior to posterior, a fixed long tooth followed by a long space, a fixed fang, a short-to-long series of 2 fixed and 2 depressible teeth (1 fixed, 2 depressible on right), a slightly graded series of 1 fixed tooth, 1 replacement tooth, and 3 depressible teeth—all intermediate in size (1 fixed, 3 depressible on right), and 6 small depressible teeth (2nd and 6th being replaced on right, 1st and 3rd on left). Maxilla with about 25 short, slanted, serra-like teeth. Mandibular teeth 22 left, 24 right: from anterior to posterior, a small fixed symphysial tooth followed by a moderate space, a fixed fang followed by a short space, a long depressible tooth (2 on right), a short-to-long series of 2 fixed and 2 depressible teeth, a short-to-long series of 2 fixed and 3 depressible teeth, a short-to-long series of 5 smaller depressible teeth, and a short-to-long se-

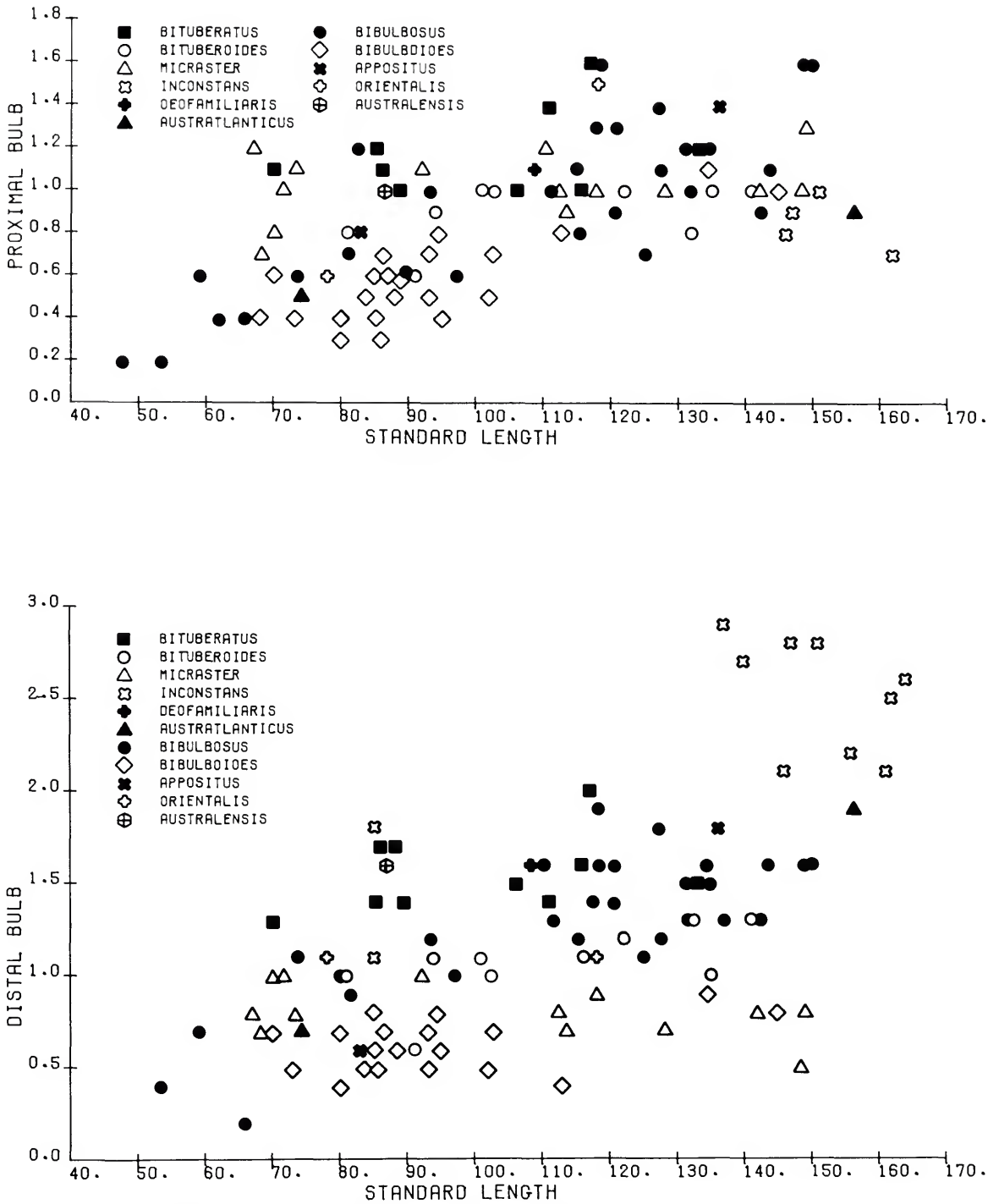


FIGURE 7.—Proximal-bulb and distal-bulb lengths (mm) vs. SL (mm) in Group I species.

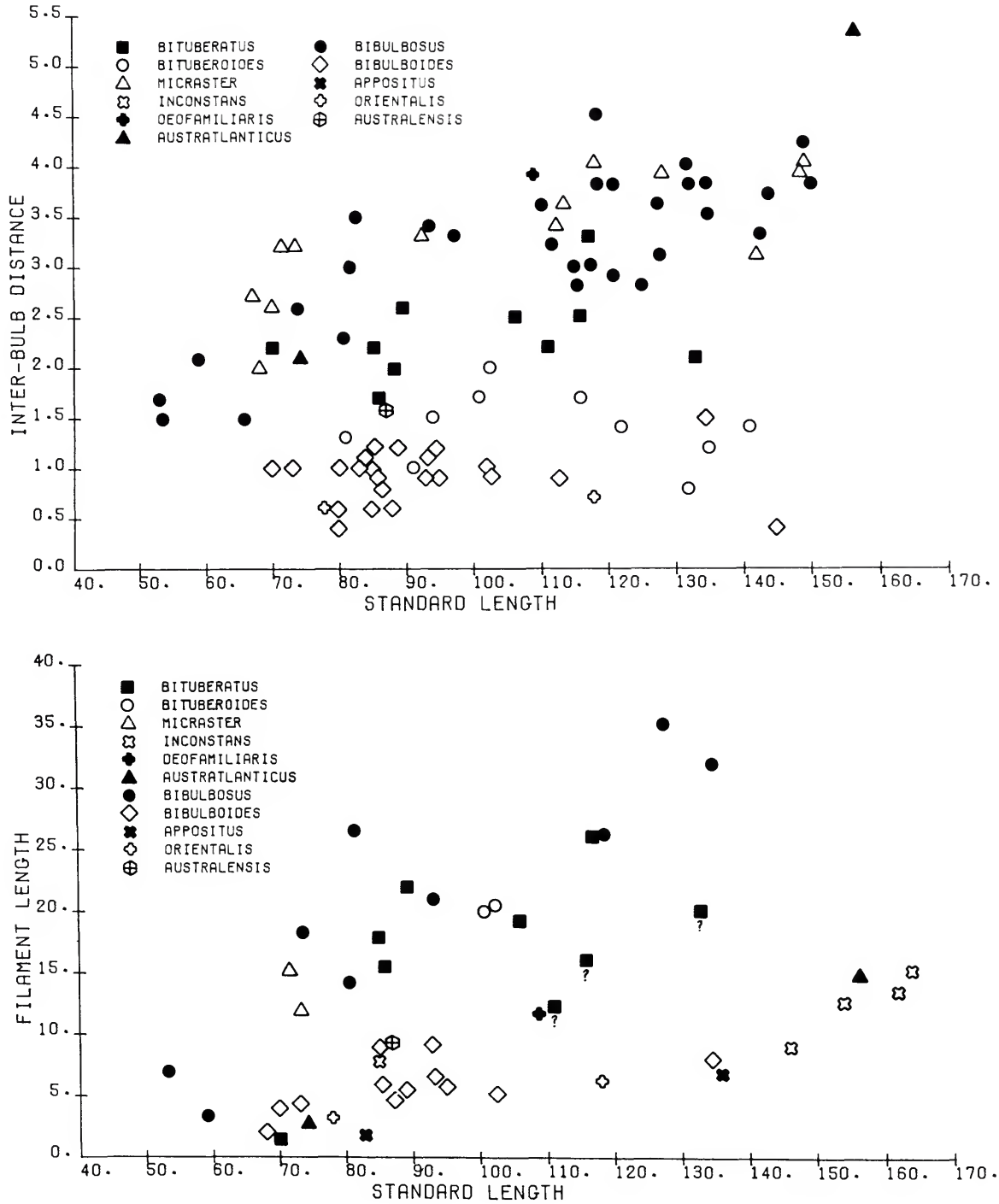


FIGURE 8.—Inter-bulb distance (mm) and filament length (mm) vs. SL (mm) in Group I species.

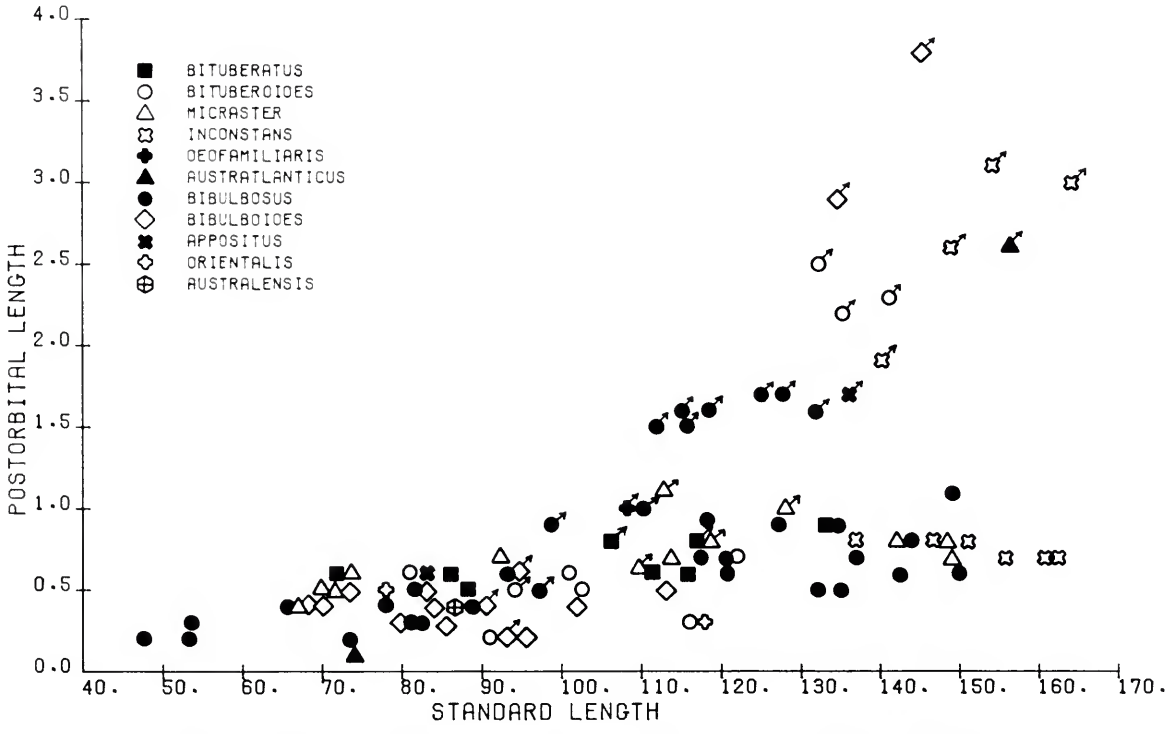


FIGURE 9.—Postorbital-organ length (mm) vs. SL (mm) in Group I species. Specimens not marked as males include both females and unknowns.

ries of 5 very small depressible teeth, the last being replaced (6 right, the 1st and last being replaced). Vertebrae 70.

Measurements (in mm): Predorsal length 131.1, preanal length 112.7, prepelvic length 84.1, head length 17.9, barbel length 126.5, proximal-bulb length 0.9, distal-bulb length 1.9, distance between bulbs 5.3, filament length 14.7, snout length 6.9, fleshy orbit length 4.6, postorbital-organ length 2.6, lower-jaw length 15.9, upper-jaw length 14.3, depth behind head (greatest depth) 10.5, caudal-peduncle depth 2.6, pectoral-fin length 20.4, pelvic-fin length 21.7, dorsal-base length 20.5, anal-base length 39.8, longest premaxillary tooth 2.9, longest mandibular tooth 1.9.

Barbel with proximal bulb spheroidal with flattened anterior and posterior ends, distal bulb ovoid.

SIMILAR SPECIES.—The most similar species is *bibulbosus*, which also has a long interspace between the terminal bulbs and rarely may have 2 short branches together on the terminal filament. In *bibulbosus* the terminal filament is longer (22%–33% of SL when intact, vs. less than 10%), and, in large specimens, the proximal bulb is larger (0.6%–1.5% of SL, vs. 0.5%; distal bulb 1.0–1.6 times length of proximal bulb vs. 2.1) (Figure 7), and the postorbital organ of males smaller (1.2%–1.4% of SL, 38%–50% of fleshy orbit at 112–132 mm, vs. 1.7% of SL, 57% of fleshy orbit at 156 mm SL).

Eustomias bituberatus also has 2 short branches near the base of the terminal filament, but the barbel is longer and the proximal bulb larger at all sizes (Figures 6 and 7), and the bulbs are separated by a shorter distance in large specimens (Figure 8).

Of the remaining species with relatively simple terminal filaments, only *micraster* has the bulbs

separated by a long interspace, but that species has a group of short branches, some with swollen tips, near the distal bulb, and, in large specimens, the barbel is shorter than in *austratlanticus*, and the distal bulb is smaller than the proximal.

DISTRIBUTION.—Known only from 2 stations in the subtropical south Atlantic, 1 in the southwest, the other in the southeast (Figure 40).

ETYMOLOGY.—An adjective combining the Latin *auster* (south) plus *atlanticus* (after the ocean of the same name), *austratlanticus* refers to the occurrence of this species in the South Atlantic Ocean.

MATERIAL EXAMINED (1 male, 1 unsexed).—*Holotype:* ISH 1554/71 (♂, 156.3), 27°14′S, 02°56′E, 0–2000 m, 1922–2345, 1 Apr 1971.

Paratype: USNM 223777 (?, 74.2), 33°15′S, 39°01′W, 0–195 m, 0215–0253, 9 Apr 1971.

Eustomias bibulboides, new species

FIGURE 5*g*

Eustomias bibulbosus.—Clarke, 1974:344 [part; 16 specimens off Hawaii].—Parin and Pokhilskaya, 1974:353–355 [part; 1 specimen, *Vityaz* sta 4320, examined by us].

DIAGNOSIS.—Two terminal bulbs separated by a short interspace (0.3%–1.4% SL, 0.5–1.8 times distal-bulb length in larger specimens; as much as 2.4 times in smaller ones). Barbel length 39%–62% SL, rarely slightly less. Terminal filament short, without branches, maximum length 11% SL. Distal bulb 0.5–1.0 times length of proximal bulb in larger specimens, up to 1.8 times in smaller specimens. Both bulbs relatively small, proximal bulb 0.3%–0.9% SL, distal bulb 0.4%–1.0%. Axis of stem pigmented, variably lightly to darkly. External chevron-shaped or roundish striated areas on stem seldom pigmented. Paired dorsal spots between occiput and dorsal-fin origin usually 8, occasionally 7 or 9.

DESCRIPTION.—The length of the barbel appears to increase fairly rapidly up to 90 mm SL and then slows. The range is 31%–62% SL, but in most specimens, regardless of size, the barbel is 39%–53% SL. Two badly damaged specimens lack pigment in the stem; all others have black pigment in the axis of the stem that is sometimes light but usually dense. Between the bulbs pigment is usually either absent or sparse; in the few specimens with well-developed pigment, it is darkest distally, becoming very dark at the base of the distal bulb. In the terminal filament, pigment is variably absent or present in the proximal axis. The external chevron-shaped or roundish areas on the stem are pigmented in a few specimens, but in most are unpigmented.

Both bulbs may be spheroidal to ovoid, sometimes having flattened ends, in one case widened distally (pear-shaped). The proximal bulb is relatively small, 0.3%–0.9% SL, at all sizes. The distal bulb is also relatively small, 0.4%–1.0% SL, and a slight decrease with growth is suggested by the few specimens larger than 100 mm SL. In specimens smaller than 100 mm, the distal bulb is 1.0–1.8 times the proximal-bulb length; in those larger than 100 mm, the proximal bulb is 1.0–2.0 times the distal bulb length.

The distance between the bulbs is short at all sizes and appears to remain constant with growth, mainly within 0.7%–1.4% SL. In most specimens, the interspace is longer than either the proximal (up to 3 times) or distal (up to 2.4 times) bulb. In 1 85 mm specimen, the proximal bulb is as long as the interspace; in 2, 80 and 88 mm, the distal bulb length equals the interspace, and in 2, 80 and 85 mm, the distal bulb is slightly longer than the interspace. The largest specimen (145 mm) is the extreme, having the absolutely shortest interspace, which is half the distal bulb length and 40% of the proximal bulb length.

The terminal filament is short at all sizes, the maximum observed being 11% SL. Most are 5%–7% SL, but broken filaments may not have been discerned. There are no branches. Tiny bulblets are present along the axis of the filament in most specimens. They may be prominent or difficult to discern, and they could not be seen in a few specimens. In some, the bulblets were most prominent proximally, in others distally.

The postorbital organs of the only 2 large males (135 and 145 mm) are 2.2% and 2.6% SL, 69% and 92% of fleshy orbit length. These organs are

very large relative to those of other *Nominostomias* species.

In a freshly collected, 89 mm female, the proximal bulb was pink, the distal bulb was red.

DESCRIPTION OF HOLOTYPE.—Male, 145 mm SL. D 24. A 40. P1 3. P2 7. IP 7. PV 31. VAV 20. OV 31. VAL 19. AC 18. IA 58. IC 76. OA 50. OC 68. VAV photophores over anal-fin base 8. Branchiostegal photophores 12. Premaxillary teeth 12 on both sides: from anterior to posterior, a fixed long anterior tooth followed by a long space, a fang followed by a moderate space, a short fixed tooth, a long depressible tooth, a moderate space, a short-to-long series of 1 fixed and 2 depressible teeth (1 fixed and 3 depressible on right), and a short-to-long series of 5 shorter depressible teeth (4 on right). Maxilla with a series of about 28 short, slanted, serra-like teeth. Mandibular teeth 22 on both sides: from anterior to posterior, a fixed short symphysial tooth followed by a moderate space, a fixed fang (with replacement tooth) followed by a long space, a long depressible tooth, 2 short fixed teeth, a long depressible tooth, 2 short fixed teeth, a short-to-long series of 4 depressible teeth, a short-to-long series of 5 short depressible teeth, 3 small depressible teeth. Vertebrae 68.

Measurements (in mm): Predorsal length 123.2, preanal length 101.7, prepelvic length 80.2, head length 18.1, barbel length 57.0, proximal-bulb length 1.0, distal bulb length 0.8, distance between bulbs 0.4, filament length 8.7 (end appears broken), snout length 4.6, fleshy orbit length 4.2, postorbital-organ length 3.8, lower-jaw length 16.4, upper-jaw length 15.4, depth behind head (greatest depth) 12.0, caudal-peduncle depth 2.4, pectoral fins broken, pelvic-fin length 18.1, dorsal-base length 16.5, anal-base length 39.9, longest premaxillary tooth 2.6, longest mandibular tooth 1.8.

Barbel with oblate-spheroidal proximal and distal bulbs, the distal smaller in all dimensions than the proximal.

SIMILAR SPECIES.—*Eustomias orientalis* is very similar to *E. bibulboides*. The distance between the bulbs of *orientalis* is at the short extreme for *bibulboides*, and the barbel and filament lengths are similar, but the terminal bulbs are larger in *orientalis*. The distal bulb is 1.1 mm long in both the large (118 mm) and small (78 mm) specimens of *orientalis* (0.4% and 1.0% SL); the longest in *bibulboides* is 0.9 mm (0.6% SL) in a 135 mm. The proximal bulb of the large specimen of *orientalis* is 1.5 mm long; the longest is 1.1 mm in *bibulboides*.

The only known specimen of *australensis* has a barbel length and terminal-filament length similar to *bibulboides*, but the distance between the bulbs is longer (1.6 mm, 1.8% SL vs. maximum 1.5 mm, 1.4% SL in *bibulboides*), the distal bulb is longer (1.6 mm, 1.8% SL vs. maximum 0.9 mm, 1.0% SL in *bibulboides*), and the proximal bulb is longer than in similar-sized *bibulboides* (1.0 mm, 1.1% SL vs. maximum 0.8 mm, 0.9% SL in *bibulboides* under 100 mm).

Of the other, less-similar Pacific species, *E. bituberoides* has a longer barbel, longer filament, and longer distal bulb than *bibulboides; appositus* and *inconstans*, when 2 terminal bulbs are present, have the bulbs contiguous, and specimens over 100 mm have much larger distal bulbs than *bibulboides*.

All Atlantic species that might be confused with *bibulboides* have a longer interspace between the bulbs.

DISTRIBUTION.—Almost all specimens have been taken close to Oahu off the Hawaiian Islands (Figure 40). One was taken just west of those islands, 1 about 500 miles southeast, and 1 (see below) at 11°25'S, 104°27'W.

REMARKS.—The specimen from the southeastern Pacific, 83.3 mm, (IOAN uncat.) may be another undescribed species. It has the shortest barbel of any specimen of *bibulboides* (18.2 mm, 21.8% SL); the next shortest barbel is 32% SL. The specimen's body is incompletely pigmented, and the barbel is unusually opaque. This suggests that it is metamorphosing at a size much larger than other *bibulboides*. Furthermore, the barbel stem appears to have pigment speckling not only on the axis but also scattered outside the axis internally, and there are external speckling and dashed markings not seen in other *bibulboides*.

ETYMOLOGY.—An adjective from the species name *bibulbosus* (2-bulbed) plus the Greek suffix *-oides* (resembling), *bibulboides* alludes to the similarly simple filament of the 2 species.

MATERIAL EXAMINED (7 males, 11 females, 18 unsexed).—*Holotype:* USNM 223641 (♂, 145), 21°20′N, 158°20′W, 0–300 m, 2335–0208, 8 Jul 1970.

Paratypes: USNM 223642 (?, 102.7), 21°30′N, 158°20′W, 0–325 m, 0255–0445, 2 May 1978. USNM 223643 (♂, 93.2), 21°20′N, 158°20′W, 0–900 m, 1252–1645, 2 Mar 1971. USNM 223644 (♂, 94.5), 21°10′N, 158°10′W, 0–300 m, 2145–2334, 25 Oct 1978. USNM 223645 (?, 80.1), 21°10′N, 158°10′W, 0–400 m, 2350–0155, 25 Oct 1978. USNM 223646 (?, 73), 21°20′N, 158°20′W, 0–350 m, 0102–0255, 25 May 1974. USNM 223647 (?, 70), 21°30′N, 158°20′W, 0–230 m, 2135–2320, 1 Nov 1977. USNM 223648 (♀, 89), 21°20′N, 158°30′W, 0–350 m, 0120–0320, 28 Aug 1973. USNM 223649 (?, 85), 21°20′N, 158°20′W, 0–125 m, 2310–0110, 27 Feb 1971. USNM 223650 (♀, 113), 21°10′N, 158°10′W, 0–800 m, 0722–1130, 12 Nov 1974. USNM 223651 (♀, 84), 21°20′N, 158°20′W, 0–85 m, 0303–0515, 17 Jun 1971. BPBM 26416 (?, 90; ♀, 95), 21°20′N, 158°20′W, 0–75 m, 2010–2210, 27 Feb 1971. BPBM 26417 (?, 84), 21°20′N, 158°20′W, 0–1000 m, 1 Mar 1971. IOAN uncat. (♂, 134.5), 20°02′N, 161°03′W, 0–300 m, 10 Feb 1959.

Non-types: USNM 223652 (?, 95), 21°20′N, 158°20′W, 0–800 m, 0810–1215, 7 Jul 1970. USNM 223653 (♂, 88; ♀, 86; ?, 85), 21°20′N, 158°20′W, 0–100 m, 2240–0040, 28 Feb 1971. USNM 223654 (♀, 68.0), 21°23′N, 158°18′W, 0–4000 m, 23 Apr 1971. USNM 223656 (?, 91), 21°10′N, 158°10′W, 0–350 m, 2220–0021, 2 Aug 1978. USNM 223657 (♂, 90), 21°00′N, 158°32′W, 0–60 m, 0343–0755, 26 Jul 1967. USNM 223658 (♀, 93.0; ?, 86.3), 21°24′N, 158°23′W, 0–139 m, 2005–2300, 9 Oct 1958. USNM 223659 (♀, 85.5), 21°32′N, 158°22′W, 0–170 m, 2008–2215, 11 Oct 1958. USNM 223660 (♀, 86), 21°20′N, 158°20′W, 0–650 m, 0655–1220, 10 Oct 1969. USNM 223661 (♂, 90), 21°01′N, 158°32′W, 0–21 m, 0342–0942, 14 Aug 1967. USNM 223662 (♀, 102), 21°20′N, 158°20′W, 0–100 m, 1957–2203, 15 Jun 1971. USNM 223663 (?, 80), 12°13′N, 149°56′W, 0–96 m, 2015–2148, 7 Nov 1958. USNM 223664 (♀, 91; ?, 77), 20°59′N, 158°34′W, 0–122 m, 1952–0152, 25 Jul 1967. USNM 223665 (?, 82), 21°20′N, 158°20′W, 0–1100 m, 1450–1800, 30 Aug 1973. USNM 223666 (3?, 80, 85, 87), 21°20′N, 158°20′W, 0–125 m, 2310–0110, 27 Feb 1971. IOAN uncat. (?, 83.3), 11°15′S, 104°27′W, 28 Mar 1978.

Eustomias orientalis, new species

FIGURE 5*f*

Eustomias bibulbosus.—Imai, 1957:559 [2 specimens from Suruga Bay, Japan; barbels fig. 9; not examined by us].—Parin et al., 1977:101, 102 [part; *Vityaz* sta 7171, examined by us].

DIAGNOSIS.—Two terminal bulbs separated by a very short interspace (0.6%–0.7% SL, 0.5–0.6 of distal-bulb length. Barbel 50%–53% SL. Terminal filament short, 4.1%–5.3% SL, without branches. Distal bulb 1.8 times length of proximal bulb in the small specimen, 0.7 in the larger specimen. Proximal bulb in larger specimen large for its size, 1.5 mm (1.3% SL) at 118 mm SL. Barbel without pigment in smaller specimen; larger specimen with fairly dense pigment in proximal part of axis, little or none in distal part. External chevron-shaped or roundish striated areas on stem not pigmented. Middorsal paired spots between occiput and dorsal-fin origin 8.

DESCRIPTION.—Based on 2 specimens, 78 and 118 mm; proportions listed for small specimen followed by large specimen. In percent of SL: barbel length 50–53; filament length 4.2–5.3; proximal bulb 0.8–1.3; distal bulb 1.4–0.9; distance between bulbs 0.8–0.6. In percent of proximal bulb: distal bulb 183–73; distance between bulbs 100–47. In percent of distal bulb: distance between bulbs 55–64.

The stem axis is well pigmented proximally, becoming lighter or unpigmented distally. The axis between the bulbs and in the filament is unpigmented. The external chevron-shaped or

roundish striated areas on the stem are unpigmented. The proximal bulb is ovoid, the distal spheroidal in both specimens. Tiny bulblets were present in the proximal part of the filament in the smaller specimen, but were not discerned in the larger.

No large males were available for measurement of the postorbital organ.

DESCRIPTION OF HOLOTYPE.—Female, 118.0 mm. D ~24. A 36. P1 3. P2 7. IP 7. PV 34. VAV 18. OV 35. VAL 17. AC 19. IA 59. IC 78. OA 52. OC 71. VAV photophores over anal-fin base 7. Branchiostegal photophores 11. Premaxillae missing. Maxilla with about 5 erect teeth and about 14 short, slanted, serra-like teeth. Mandibular teeth 15 left, 16 right: from anterior to posterior, a short fixed symphysial tooth followed by a moderate space, a fixed fang followed by a longer space, a long depressible tooth, a short fixed tooth (2 on right), a long depressible tooth, a short-to-long series of 1 fixed and 2 depressible teeth, a short-to-long series of 4 smaller depressible teeth, and a short-to-long series of 3 small depressible teeth. Vertebrae 68.

Measurements (in mm): Predorsal length ~91.4, preanal length 76.3, prepelvic length 64.4, head length ~11.9, barbel length 62.0, proximal bulb length 1.5, distal-bulb length 1.1, distance between bulbs 0.7, filament length 6.2, fleshy orbit length 2.5, postorbital length 0.3, lower-jaw length 11.4, depth behind head (greatest depth) 6.2, caudal-peduncle depth 1.4, pectoral fin broken, pelvic-fin length 14.6, dorsal-base length 14.0, anal-base length 28.6, longest mandibular tooth 1.4.

Barbel with ovoid proximal bulb narrowing distally, spheroidal distal bulb wider than proximal bulb.

SIMILAR SPECIES.—*Eustomias bibulboides* most closely resembles *orientalis*, but has a smaller proximal bulb in large specimens (maximum 0.9% SL, vs. 1.3% in the larger *orientalis*) and a smaller distal bulb (maximum 1.0% SL in specimens smaller than 100 mm, 0.7% in larger specimens vs. 1.4% in the smaller *orientalis*, 0.9% in the larger).

In *australensis* the distance between bulbs is longer (1.8% SL vs. 0.6%–0.8% in *orientalis*) and the distal bulb is longer (1.8% SL vs. 0.9%–1.4% in *orientalis*).

All other species with simple filaments have either longer barbels, a longer interspace between the bulbs, or contiguous bulbs.

DISTRIBUTION.—Known only from the westernmost Pacific from north of New Guinea to Suruga bay, Japan (Figure 40).

ETYMOLOGY.—From the Latin adjective *orientalis* (of the east), referring to the distribution of this species in the part of the world known as the Orient.

MATERIAL EXAMINED (1 female, 1 unsexed).—*Holotype:* IOAN uncat. (♀, 118), 25°13′N, 128°32′W, 0–100 m, 8 Feb 1975.

Paratype: ZMUC P202703 (?, 78.0), 02°10′N, 138°20′E, 0–~150 m (300 mw), 0320, 13 Jul 1929.

Eustomias australensis, new species

FIGURE 5*h*

DIAGNOSIS.—Two terminal bulbs separated by a distance equal to the distal-bulb length, 1.8% SL). Barbel 55% SL. Terminal filament longer than 9.4% SL, the tip broken. Distal bulb large, 1.8% SL, 1.6 times length of proximal bulb. Axis of stem pigmented, dark proximally, light distally. External chevron-shaped or roundish striated areas on stem well pigmented. Middorsal paired spots between occiput and dorsal-fin origin 8.

DESCRIPTION OF HOLOTYPE.—Sex not determined, 87.0 mm SL. D 23. A 36. P1 3. P2 7. IP 7. PV 34. VAV 18. OV 34. VAL 20. AC 18. IA 59. IC 77. OA 54. OC 72. VAV photophores over anal-fin base 7. Branchiostegal photophores damaged. Premaxillary teeth 10 left, 9 right: from anterior to posterior, a long fixed tooth followed by a long space, a fixed fang followed by a moderate space, a short-to-long series of 1 fixed and 2 depressible teeth (middle, depressible tooth not present right) followed by a moderate space, a short fixed tooth followed by a moderate space,

2 intermediate-sized depressible teeth followed by a moderate space, and 2 short depressible teeth. Maxilla with about 10 short, slanted serra-like teeth. Mandibular teeth 15 on both sides: from anterior to posterior, a short, fixed symphysial tooth followed by a moderate space, a fixed fang followed by a long space, a long depressible tooth, a short-to-long series of 1 fixed and 3 depressible teeth (1 and 4 on right), a short-to-long series of 5 depressible teeth (1 fixed, 3 depressible right), and a short-to-long series of 3 depressible teeth. Vertebrae approximately 67 (not X-ray dense).

Measurements (in mm): Predorsal length 73.8, preanal length 64.0, prepelvic length 52.1, head length ~10.9, barbel length 48.1, proximal-bulb length 1.0, distal-bulb length 1.6, distance between bulbs 1.6, fleshy orbit length ~1.8, postorbital-organ length 0.4, upper-jaw length 8.4, depth behind head 3.8, greatest depth 4.5, caudal-peduncle depth 1.5, pectoral fin damaged, pelvic-fin length ~11.5, dorsal-base length 10.6, anal-base length 21.6, longest premaxillary tooth 1.1, longest mandibular tooth 1.0.

Barbel stem with axis moderately darkly pigmented proximally, becoming light distally. External chevron-shaped or roundish striated areas darkly pigmented, large and closely spaced proximally, smaller and more widely spaced before bulb. Axis between bulbs unpigmented proximally, moderately dark distally. No visible pigment in filament. Proximal bulb spheroidal; distal bulb more or less ovoid, narrower distally, about 1.5 times as wide as proximal bulb.

SIMILAR SPECIES.—*Eustomias bituberatus* and *bituberoides* have a similarly intermediate interspace between the bulbs; in all other species with relatively simple terminal filaments the interspace is either longer (Atlantic species) or shorter (Pacific species). Both *bituberatus* and *bituberoides* have longer barbels than *australensis*, and *bituberoides* has a smaller distal bulb (Figures 6 and 7).

DISTRIBUTION.—Known only from the holotype, taken in the Tasman Sea off southeastern Australia (Figure 40).

ETYMOLOGY.—An adjective derived from the name of the continent of Australia plus the Latin suffix *-ensis* (denoting locality of occurrence), alluding to the place of capture of the only known specimen.

MATERIAL EXAMINED (1 unsexed).—*Holotype:* AMS i.20901-001 (?, 87), 36°37′S, 152°10′E, 0–500 m, 1959–2215, 20 Jan 1978.

Eustomias micraster Parr, 1927

FIGURE 4*b*

Eustomias bibulbosus micraster Parr, 1927:72 [24°51′N, 76°38′W].

Eustomias micraster.—Regan and Trewavas, 1930:84 [6 additional specimens, all from northern Lesser Antilles region].—Beebe and Crane, 1939:211 [*E. bituberatus* possibly in synonymy].

Eustomias bibulbosus.—Morrow and Gibbs, 1964:391 [part; no additional specimens; *E. micraster* in synonymy, wrongly attributed to Beebe and Crane, 1939].—Bekker et al., 1975:305 [part, sta 1177; examined by us].

DIAGNOSIS.—Two terminal bulbs separated by a long interspace (2.2%–4.5% SL, 2.6–7.8 times length of distal bulb, 2.3–4.0 times length of proximal bulb). Barbel length less than 60% SL (68% in one small specimen). Terminal filament long (16%–21% SL), with 4 or more short, bulblet-bearing branches near the bulb, the branches usually with expanded tips. Distal bulb shorter than proximal bulb in specimens over 90 mm SL, not more than 1.25 times the proximal bulb in smaller specimens, never longer than 1.0 mm. Stem axis and external chevron-shaped or roundish striated areas moderately to darkly pigmented. Number of middorsal paired spots between occiput and dorsal-fin origin not determined.

DESCRIPTION.—The barbel apparently grows little or not at all after about 100 mm SL, decreasing relative to SL from 44%–68% in specimens smaller than 75 mm to 37%–48% in the largest (142–149 mm). All specimens have black pigment in the axis of the stem, between the bulbs, and usually in the proximal part of the filament. The intensity of the pigment varies, and it may be uneven, uniform, or speckled. In all except 2 small specimens (68 and 70 mm) there is a dark spot or cap at the proximal end of the distal bulb.

The external chevron-shaped or roundish striated areas on the stem are usually pigmented, but may be unpigmented in the distal stem or throughout.

The proximal bulb is oblate-spheroidal to long-ovoid, the distal bulb spheroidal to ovoid. Neither terminal bulb appears to grow after 70 mm SL is attained. The proximal bulb decreases relative to SL from 1.0%–1.8% in specimens smaller than 75 mm to 0.7%–0.9% in the largest (142–149 mm). The distal bulb also decreases, from 1.0%–1.4% to 0.3%–0.6%. In some small specimens, the length of the proximal bulb equals or slightly exceeds that of the distal bulb. In most, including all over 100 mm SL, the distal bulb is smaller than the proximal.

The distance between the bulbs, relative to other species, is long in all specimens but decreases relative to SL from 2.9%–4.5% in specimens smaller than 75 mm to 2.2%–2.7% in the largest (142–149 mm). The relationship of the interspace to bulb length is quite variable, but no growth changes are apparent. The interspace is 2.3–4.0 times the proximal-bulb length, 2.6–7.8 times the distal-bulb length.

In 2 small specimens and 1 large one with unbroken terminal filaments, these filaments are long, 16%–21% of SL. The filament has 4–11 short branches, usually with internal bulblets and swollen tips, arising near the bulb. One or more single, short branches may be present distad from the basal group. Tiny bulblets are present along the filament axis; they may be few or difficult to discern in smaller specimens, but they are closely spaced and form 2–3 rows in larger ones.

The postorbital organ of the 3 largest males (112–128 mm) is 0.7%–0.9% SL, 21%–27% of fleshy orbit length, barely larger than those of female *micraster*.

A 110 mm male (ISH 1074/79) when fresh had a white proximal bulb and a pale blue distal bulb; the swollen branch tips were white, and the rest of the barbel lacked color; the postorbital organ was white.

Similar Species.—None of the other species with a single terminal filament has a group of 4 or more short branches near the distal bulb. In *arborifer*, small *bimargaritatus*, small *bimargaritoides*, *grandibulbus*, and *crossotus*, 2 branches arise near the bulb, but these branches are approximately as long as the main filament. In *E. kreffti* there are 2 long filaments, as well as several short filaments with swollen tips, but all of these arise from the bulb.

Distribution.—The vicinity of islands from the northern Bahamas to the Lesser Antilles and offshore in the southwestern Sargasso Sea (Figure 40).

Material Examined (4 males, 8 females, 2 unsexed).—*Holotype:* BOC 2040 (♀, 223.5), 24°51′N, 76°38′W, 0–~1200 m (8000 ft wire), 17 Mar 1930.

Non-types: ZMUC P202728 (?, 68.2, identity uncertain), 17°59′N, 64°41′W, 0–~150 m (300 mw), 2355, 12 Aug 1921. ZMUC P202729-30 (?, 67; ♀, 73.4), 19°01′N, 65°23′W, 0–~150 m (300 mw), 0050, 3 Jan 1922. ZMUC P202731 (♀, 92.2), 17°43′N, 64°56′W, 0–~500 m (1000 mw), 0010, 6 Mar 1922. BMNH 1929.7.6.101 (♀, 70.0), 15°08′N, 61°31′W, 0–~150 m (300 mw), 2215, 25 Nov 1921. BMNH 1929.7.6.102 (♀, 71.6), 17°59′N, 64°41′W, 0–~500 m (1000 mw), 1815, 30 Nov 1921. USNM 223964 (♀, 148.3), 20°10′N, 71°30′W, 0–250 m, 13 Oct 1963. USNM 229981 (♂, 128.0), 24°24′N, 77°20′W, 0–1526 m, 1758–2300, 20 Apr 1975. UMML 33542 (♀, 149.0), 24°39′N, 76°31′W, 0–1628 m, 1535–1920, 15 Apr 1975. UMML 33543 (♂, 118.0), 23°55′N, 77°18′W, 0–1390 m, 0710–1117, 2 Mar 1976. ISH 1074/79 (♂, 110.3), 25°14′N, 67°45′W, 0–1800 m, 1410–1820, 12 Apr 1979. IOAN uncat. (♂, 112.2), 20°14′N, 65°09′W, 0–500 m, 31 Jan 1973. VIMS 05738 (♀, 142), 23°47′N, 75°49′W, 0–1807 m, 1051–1153, 3 Sep 1980.

Eustomias bituberatus Regan and Trewavas, 1930

Figure 4*d*

Eustomias bituberatus Regan and Trewavas, 1930:83 [6 syntypes, the smallest with juvenile characters and considered herein to be *E. kreffti*].—Beebe and Crane, 1939:211 [no additional specimens].

Eustomias bibulbosus.—Morrow and Gibbs, 1964:391 [part, no additional specimens; *E. bituberatus* in synonymy].—Blache et al., 1970:171 [part, fig. 459b only].

DIAGNOSIS.—Two terminal bulbs separated by an interspace 1.6%–3.1% SL (1.0–1.9 times length of distal bulb). Barbel very long, 95%–152% SL in specimens over 80 mm SL, 78% at 70 mm. Terminal filament long, up to 25% SL, with 1–3 (usually 2) short branches near the base, these branches with tiny bulblets but without swollen tips. Distal bulb 1.1%–2.0% SL, 1.0–1.7 times length of proximal bulb. Stem axis and external chevron-shaped or roundish striated markings lightly to moderately pigmented. Middorsal paired spots between occiput and dorsal-fin origin 8 or 9.

DESCRIPTION.—The barbel is 78% SL in the smallest specimen (70 mm), increasing continuously to a maximum of 152% SL. All specimens have black pigment in the axis of the stem, between the bulbs, and in at least the proximal part of the filament. The external chevron-shaped or roundish striated areas on the stem are sometimes pigmented, sometimes unpigmented. The proximal and distal bulbs are both ovoid in shape. Both bulbs appear to increase in length only slightly with growth, and to decrease slightly relative to SL. The proximal bulb is 1.6% SL at 70 mm, 0.9%–1.4% in the largest specimens. The distal bulb is 1.6%–2.0% SL in specimens smaller than 90 mm SL, 1.1% in the largest specimen.

The 2 bulbs are equally long in 1 specimen. In all others, the distal bulb is 1.2–1.7 times the proximal-bulb length.

The distance between the bulbs also appears to increase slightly with growth, but to decrease relative to SL, from 3.1% at 70 mm to 1.9% in the largest specimen (133 mm). The distance is 1.0–1.9 times the distal-bulb length.

The terminal filament is 18%–25% SL in 4 specimens 85–117 mm SL. In 3 others, 111–133 mm, the filaments are 11%–15% SL; we did not record whether they appeared broken, but suspect that they were. The filament has 1–3 short branches, with small internal bulblets but without swollen tips, arising not far from the bulb. Tiny bulblets appear to form 2 rows along the filament axis; these bulblets were not observed in all specimens, but they are difficult to discern except under high power and good lighting.

The only 2 identified males, 106 and 117 mm, have very small postorbital organs (0.7% and 0.8% SL, 23% of fleshy orbit in the larger). It is possible that enlargement of their postorbital organs had not yet begun, although males of *E. bibulbosus* and other species at this size have distinctly enlarged postorbitals.

There are no reports of colors in fresh specimens.

LECTOTYPE DESIGNATION.—We select as lectotype ZMUC P201953, a female, 111.0 mm SL. D 24. A 38. P1 3. P2 7. IP 7. PV 33. VAV 18. OV 32. VAL 19. AC 19. IA 58. IC 77. OA 51. OC 70. VAV photophores over anal-fin base 7. Branchiostegal photophores 11. Premaxillary teeth 12. Mandibular teeth 19. Vertebrae 69.

Measurements (in mm): Predorsal length 95.8; preanal length 81.2, prepelvic length 65.4, head length 14.2, barbel length 139.0, proximal-bulb length 1.4, distal-bulb length 1.4, distance between bulbs 2.2, filament length 12.3 (probably broken), snout length 6.4, fleshy orbit length 4.3, postorbital-organ length 0.6, lower-jaw length 13.5, upper-jaw length 12.0, dorsal-base length 14.5, anal-base length 30.6, longest premaxillary tooth 2.3, longest mandibular tooth 1.2.

SIMILAR SPECIES.—The only other species in which the barbel exceeds SL is *bituberoides* from the Pacific. In that species the barbel apparently does not increase in length after 100 mm SL, and the range of relative barbel lengths (78%–135% SL) characterizes all sizes; in *bituberatus*, there appears to be a continuous increase in relative length, and all specimens over 100 mm have barbels exceeding SL. In *bituberoides* both terminal bulbs and their interspace are smaller than in *bituberatus* at any size (Figures 7 and 8). Both species apparently have a long terminal filament, but that of *bituberoides* lacks short proximal branches.

Three similar species occur in the Atlantic.

Large (over 100 mm) specimens of *bibulbosus* and *austratlanticus* may attain barbel lengths up to 85% SL and may have short branches on the terminal filament. The proximal bulb is smaller in *austratlanticus* than in *bituberatus* (0.6%–0.7% SL vs. 0.9%–1.6%), and in the smaller *austratlanticus* (74 mm) the distal bulb is about half as long as that of similar-sized *bituberatus* (Figure 7); the distance between the bulbs in the larger *austratlanticus* (156 mm) is much longer than in any *bituberatus* (3.4% SL vs. a maximum of 3.1%); and the terminal filament of *austratlanticus* is shorter in the larger specimen (9% SL) than in intact ones of *bituberatus* (18%–25%).

It is more difficult to differentiate *bibulbosus* except by barbel length and the fact that very few *bibulbosus* have branches on the terminal filament. Both terminal bulbs appear to be smaller in *bibulbosus* less than 100 mm SL, but there is considerable overlap at larger sizes (Figure 8). The distance between the bulbs tends to be greater in *bibulbosus*, but there is overlap. The relationship of bulb size to interspace provides a separation; in *bituberatus* the interspace is 1.5–2.6 times the length of the proximal bulb and 1.0–1.9 times the length of the distal bulb, while in *bibulbosus* these ratios are 2.3–8.5 and 2.0–7.5, respectively. The postorbital organ of large male *bibulbosus* and *austratlanticus* is larger than in the only large males of *bituberatus*.

The terminal filament of *E. micraster* has 4 or more short branches near the bulb, and some of these have swollen tips. Its barbel is shorter (maximum 68% SL) than in *bituberatus*, the distal bulb is smaller at any given size (Figure 7), and the proximal bulb is longer than the distal bulb in specimens over 90 mm SL.

DISTRIBUTION.—Known from the Straits of Florida, the Lesser Antilles, and the oceanic area just east of the southernmost Antilles (Figure 40). A paralectotype from the southern Sargasso Sea may not be this species; it is discussed below.

REMARKS.—One of the paralectotypes, BMNH 1929.7.6.99, 85.3 mm, cannot be identified with certainty. It was taken in the southern Sargasso Sea, 27°31′N, 59°52′W (*Dana* sta 941), which is outside of the otherwise Antillean distribution of *bituberatus*, but within the range of *bibulbosus* and just north of the range of *bimargaritatus*. It is definitely not the latter species; it could be *bibulbosus*.

The short barbel does not conform with other *bituberatus*, but fits *bibulbosus* at this size. The filament length fits either species; the presence of a single short branch near the bulb could be one of the unusual cases of *bibulbosus* or the only example of *bituberatus* with fewer than 2 branches. Both proximal and distal bulbs are larger than in similiar-sized *bibulbosus*, and the interspace is shorter, but only slightly so, than in *bibulbosus*. The ratios of proximal and distal bulbs to their interspace are typical of *bituberatus* and smaller than any for *bibulbosus*.

Resolution of this problem must await further observations on variability of both *bituberatus* and *bibulbosus* at small sizes.

The smallest paralectotype, described by Regan and Trewavas (1930) as having juvenile characters, is believed to be *E. kreffti* and is discussed with that species.

MATERIAL EXAMINED (2 males, 5 females, 4 unsexed).—*Lectotype:* ZMUC P201953 (♀, 111.0), 14°38′N, 61°16′W, 0–~150 m (300 mw), 0300, 6 Apr 1922.

Paralectotypes: ZMUC P201951 (♀, 86.0), 12°11′N, 57°12′W, 0–~150 m, 2130, 20 Nov 1921. ZMUC P201952 (♀, 133), 17°43′N, 64°56′W, 0–~350 m (700 mw), 1800, 16 Mar 1922. BMNH 1929.7.6.99 (?, 85.3), 27°31′N, 59°52′W, 0–~500 m (1000 mw), 0130–0530, 21 Apr 1921. BMNH 1929.7.6.100 (♀, 115.8), 14°38′N, 61°16′W, 0–~500 m, (1000 mw) 0300, 6 Apr 1922.

Non-types: ZMUC P202701 (?, ~70), 17°43′N, 64°56′W, 0–~150 m (300 mw), 2000, 2 Mar 1922. USNM 223727 (♀, 89.4), 10°48′N, 52°17′W, 0–120 m, 2330–0130, 26 Mar 1977. USNM 229982 (♂, 117.0), 25°01′N, 79°35′W, 0–700 m, 1801–2051, 21 Feb 1974. UMML 33540 (2?, 71.8, 88.2), 24°37′N, 79°56′W, 0–260 m, 1827–2035, 22 Feb 1974. MCZ 56604 (♂, 106.1), 12°58′N, 73°34′W, 0–120 m, 0030–0505, 29 May 1966.

Eustomias bituberoides, new species

FIGURE 4*e*

Eustomias bibulbosus.—Clarke, 1974:344 [part; 3 specimens].

DIAGNOSIS.—Two terminal bulbs separated by an interspace 0.6%–1.9% SL (0.6–2.0 times length of distal bulb). Barbel 79%–136% SL. Terminal filament long, about 20% SL, without side branches. Distal bulb 0.7%–1.2% SL, 1.0–1.6 times length of proximal bulb. Stem axis and external chevron-shaped or roundish striated areas usually darkly pigmented. Middorsal paired spots between occiput and dorsal-fin origin 8.

DESCRIPTION.—The barbel length is 79%–136% SL, apparently not changing with growth. All specimens have black pigment in the axis of the stem, this pigment usually becoming less dense in the distal end before the proximal bulb. The axis between bulbs is pigmented, but less densely than in most of the stem, and the filament axis may be moderately pigmented proximally or lack pigment. The external chevron-shaped or roundish striated areas on the stem are usually pigmented.

The proximal and distal bulbs are usually ovoid in shape, occasionally spheroidal or oblate-spheroidal. The proximal bulb does not appear to grow after about 100 mm SL, and the distal bulb only slightly. The proximal bulb thus decreases relative to SL from 1.0% to 0.6%, while the distal bulb is 0.7%–1.2%. The distal bulb is equal to or up to 1.6 times longer than the proximal.

The distance between the bulbs apparently does not increase with growth and decreases relative to SL from 1.1%–1.9% SL in specimens 81–103 mm to 0.6%–1.0% in those 132–141 mm.

The terminal filament is about 20% SL in the only 2 specimens (101 and 103 mm) in which it was intact. In all other specimens, both larger and smaller, the filament is less than 8% of SL, and breakage was confirmed in most. The filament lacks side branches of any size. Tiny bulblets are present along the filament axis, but they are usually very difficult to discern.

The postorbital organ of large males (132–141 mm) is 1.6%–1.9% SL, 56%–66% of fleshy orbit length.

There are no reports of colors in fresh specimens.

DESCRIPTION OF HOLOTYPE.—Female, 102.6 mm SL. D 23. A 37. Pl 3. P2 7. IP 8. PV 31. VAV 19. OV 33. VAL 19. AC 19. IA 58. IC 77. OA 52. OC 71. VAV photophores over anal-fin base 7. Branchiostegal photophores 12. Premaxillary teeth 9 left, 12 right: from anterior to posterior, a fixed long anterior tooth, followed by a long space, a fixed fang followed by another long space, a short-to-long graded series of 1 fixed and 2 depressible teeth, another short-to-long series of 2 fixed and 2 depressible teeth (2 fixed and 3 depressible teeth on right side), and on right side only, 2 small depressible teeth. Maxilla with 1 small erect tooth (left side only) and a series of about 18 very short, slanted, serra-like teeth. Mandibular teeth 13: from anterior to posterior, a short fixed symphysial tooth followed by a moderate space, a fixed fang followed by a long space, 2 long depressible teeth, a short-to-long series of 2 fixed and 2 depressible teeth, another short-to-long series of 2 fixed and 2 depressible teeth, and 2 short depressible teeth. Vertebrae 67, the 1st ossified only ventrally.

Measurements (in mm): Predorsal length 87.3, preanal length 73.0, prepelvic length 56.8, head length 12.7, barbel 110.6, proximal-bulb length 1.0, distal-bulb length 1.0, distance between bulbs 2.0, filament length 20.5, snout length 5.6, fleshy orbit length 3.5, postorbital-organ length 0.5, lower-jaw length 11.4, upper-jaw length 10.4, depth behind head (greatest depth) 5.8, caudal-peducle depth 1.7, pectoral-fin length ~13, pelvic-fin length 14.4, dorsal-base length 12.2, anal-base length 25.0, longest premaxillary tooth 2.4, longest mandibular tooth 1.4.

Barbel with bluntly ovoid proximal bulb, slightly narrower, longish-ovoidal distal bulb with distinctly narrowed, tapering distal end.

SIMILAR SPECIES.—This species and the North Atlantic *E. bituberatus* both have a very long barbel and are the only 2 species in which the barbel may exceed the SL. In *bituberoides*, barbel length

apparently does not increase after about 100 mm SL, while that of *bituberatus* continues to grow, becoming relatively longer than in *bituberoides*. Short branches from the filament are present near the bulb in *bituberatus*; these are absent in *bituberoides*. Both terminal bulbs and the distance between them are longer in *bituberatus* at any given size than in *bituberoides* (Figures 7 and 8), and the postorbital organ is very small in the only maturing male *bituberatus*.

Three other Pacific species have 2 separated terminal bulbs and a simple terminal filament, but their barbels are shorter than in *bituberoides*, not more than 65% SL. In *bibulboides*, both terminal bulbs and their interspace are generally shorter than in *bituberoides*, but there is overlap (Figures 7 and 8). In *orientalis* the proximal bulb in the larger (118 mm) of 2 specimens is larger (1.3% SL) than in any *bituberoides* (maximum 1.0%), and the terminal bulbs are separated by a shorter space (Figure 8). The only specimen of *australensis* (87 mm) has a larger distal bulb (1.1% SL) than any bituberoides (maximum 1.0%).

The Atlantic species *bibulbosus*, *austratlanticus*, and *micraster*, in addition to having shorter barbels than *bituberoides*, have the terminal bulbs separated by a much greater distance (Figure 8).

DISTRIBUTION.—Known from off Oahu, Hawaiian Islands, and about 12°N, 150°W (Figure 40).

ETYMOLOGY.—A Latin adjective from the named species, *bituberatus* (2-bulbed), plus the suffix *-oides* (resembling), *bituberoides* alludes to the similarly very long barbel of both species.

MATERIAL EXAMINED (4 males, 6 females, 1 unsexed).—*Holotype:* USNM 223734 (♀, 102.6), 21°30′N, 158°20′W, 0–1000 m, 1215–1655, 22 Feb 1978.

Paratypes: USNM 223728 (♀, 101), 21°10′N, 158°10′W, 0–775 m, 1235–1712, 8 Nov 1974. USNM 223730 (♀, 94), 21°20′N, 158°20′W, 0–690 m, 0757–1202, 15 Dec 1970. USNM 223731 (♂, 135), 21°02′N, 158°30′W, 0–118 m, 1952–0152, 21 Jul 1967. USNM 223732 (♂, 132), 21°20′N, 158°20′W, 0–175 m, 0155–0355, 1 Mar 1961. USNM 223733 (♀, 116), 21°10′N, 158°10′W, 0–650 m, 0730–1132, 9 Nov 1974. SIO 80-173 (♀, 122), 12°16′N, 150°10′W, 0–290 m, 1945–2140, 14 Dec 1977. BPBM 26419 (♂, 91), 21°10′N, 158°10′W, 0–1050 m, 0710–1137, 31 Aug 1978.

Non-types: USNM 223729 (♀, 86.8), 12°13′N, 149°56′W, 7 Nov 1958. USNM 223735 (♂, 141), 21°20′N, 158°20′W, 0–125 m, 2310–0110, 27 Feb 1971. MCZ 54095 (?, ~81), 21°10′N, 158°20′W, 0–275 m, 0354–0454, 3 Feb 1973.

Eustomias inconstans, new species

FIGURE 5*b–d*

Eustomias patulus.—Johnson and Rosenblatt, 1971:310 [part; specimen from *Hugh M. Smith* cruise 32, sta 47, now BPBM 26411].

DIAGNOSIS.—Two continguous terminal bulbs or a single terminal bulb. Barbel 52%–65% SL. Terminal filament short, without branches, 3%–9% SL. Distal (or only) bulb 1.3%–2.1% SL, 2.6–3.6 times length of small proximal bulb, when the latter is present. Axis of stem and filament pigmented. External chevron-shaped or roundish striated areas on stem pigmented or unpigmented. Middorsal paired spots between occiput and dorsal-fin origin 8.

DESCRIPTION.—The barbel of *E. inconstans* is 52%–65% SL, apparently not changing with growth after 85 mm SL. The axis of the stem is variably darkly to lightly pigmented, often becoming lighter distally, and the pigment may be streaky or peppered. The axis of the filament is lightly to moderately pigmented proximally; in 1 large specimen, no pigment could be discerned. The external chevron-shaped or roundish striated areas on the stem are unpigmented in some specimens; in others they may be pigmented in the proximal half to three-fourths of the stem, in the middle portion only, or, rarely, distally.

There may be 1 or 2 terminal bulbs. The proximal bulb, in those specimens 146–157 mm SL where it is present, is spheroidal or oblate-spheroidal and is small, 0.4%–0.7% SL, and contiguous with the distal bulb. The distal bulb is

spheroidal to long-ovoid, widening distally in 1 specimen. It is 1.3%–2.1% SL, apparently not changing relative to SL with growth, and is 2.6–3.6 times the length of the proximal bulb, when the latter is present.

The terminal filament is 6.2%–9.2% SL at all sizes. It has very small bulblets that are difficult to discern.

The postorbital organ of large males (140–154 mm) varies from 1.4%–2.0% SL, 45%–82% of fleshy orbit length, and appears to increase relative to SL within this limited range.

No color observations have been recorded.

Description of Holotype.—Female, 157.0 mm SL. D 25. A 40. P1 3. P2 7. IP 7. PV 33. VAV 18. OV 32. VAL 18. AC 19. IA 58. IC 77. OA 50. OC 69. VAV photophores over anal-fin base 8. Branchiostegal photophores 11. Premaxillary teeth 13 left, 16 right: from anterior to posterior, a moderate fixed tooth followed by a long space, a fixed fang followed by a moderate space, a short-to-long series of 1 fixed and 2 depressible teeth (2 fixed, 1 depressible on right), 1 fixed and 3 depressible teeth of similar size, and 4 small depressible teeth; on right side only, 3 more smaller depressible teeth. Maxilla with about 25 small, slanting, serra-like teeth. Mandibular teeth 15 left, 16 right: from anterior to posterior, a short fixed symphysial tooth (replacement tooth also well developed) followed by a moderate space, a fixed fang followed by a moderate space, a long depressible tooth, a short-to-long series of 1 fixed and 2 depressible teeth, a short fixed tooth, 2 moderate depressible teeth (the rear appears to be a replacement tooth), a short-to-long series of 3 small depressible teeth (4 on right), and 3 smaller depressible teeth. Vertebrae 69.

Measurements (in mm): Predorsal length 138.2, preanal length 116.7, prepelvic length 94.0, head length 20.1, barbel length 105.0, proximal-bulb length 0.7, distal-bulb length 2.5, filament length 13.5, snout length 8.4, fleshy orbit length 5.0, postorbital-organ length 0.7, lower-jaw length 16.0, upper-jaw length 15.0, depth behind head 12.0, greatest depth 15.2, caudal-peduncle depth 3.4, pectoral fin broken, pelvic-fin length 24.0, dorsal-base length 19.4, anal-base length 41.3, longest premaxillary tooth 3.1, longest mandibular tooth 2.0.

Barbel with proximal bulb spheroidal; distal bulb ovoid and much larger in all dimensions.

Similar Species.—Only *E. appositus*, from the western Pacific, also has 2 contiguous bulbs, but in that species the proximal bulb is larger than in those large (146–162 mm) *inconstans* that have it (1.0% SL vs. 0.4%–0.7% in *inconstans*), and the distal bulb is smaller (0.7%–1.3% vs. 1.3%–2.1% SL; 0.7–1.3 times the proximal-bulb length vs. 2.6–3.6 times in *inconstans*). Neither specimen of *appositus* has pigment on the axis of the filament, whereas in all except 1 faded specimen of *inconstans* such pigment is prominent.

Of the other species of *Nominostomias* with a single terminal bulb, only *E. gibbsi* may have a single, unbranched terminal filament. In *gibbsi*, however, the bulb has a prominent black cap covering its proximal end.

Distribution.—Known only from off Oahu, Hawaiian Islands (Figure 40).

Remarks.—One specimen, USNM 225165, 136.9 mm female, differs in a number of ways from other *inconstans*. Its single bulb is long and slender and is 0.1 mm longer than in any other *inconstans*. Its filament is considerably shorter (4.6 mm) than any other, even that of the smallest specimens (85 mm). Its barbel length is consistent with that of other *inconstans*, but the axis of the stem is more lightly pigmented that most (the specimen is not faded) and is almost devoid of pigment at the distal end and in the filament. We do not consider this specimen as part of the type series, although its characters are used in the description.

Etymology.—From the Latin participle *inconstans* (changeable), used here in reference to the variable presence or absence of a second terminal bulb of the barbel.

Material Examined (5 males, 7 females, 1 unsexed).—*Holotype:* USNM 223756 (♀, 162), 21°20′N, 158°20′W, 0–150 m, 2345–0205, 26 Feb 1971.

Paratypes: USNM 223757 (♀, 85), 21°20′N, 158°20′W, 0–1100 m, 0226–0420, 1 Sep 1973. USNM 223760 (♀, 156), same data as holotype. USNM 223761 (♂, 164), 21°20′N, 158°20′W, 0–175 m, 0155–0355, 1 Mar 1971. USNM 223763 (♀, 147), 21°20′N, 158°20′W, 0–125 m, 2310–0110, 27 Feb 1971. BPBM 26411 (♀, 161.1), 21°15′N, 158°38′W, 0–191 m, 1935–2037, 8 Feb 1956. BPBM 26414 (♀, 151), 21°23′N, 158°15′W, 0–127 m, 1951–0152, 22 Aug 1967.

Non-types: USNM 223754 (♂, 140), 21°20′N, 158°20′W, 0–800 m, 0810–1215, 7 Jul 1970. USNM 223755 (♂, 148.7), same data as BPBM 26411. USNM 223758 (♂, 146), 21°10′N, 158°10′W, 0–300 m, 2145–2334, 25 Oct 1978. USNM 223759 (?, 85), 21°30′N, 158°30′W, 0–1100 m, 1425–1730, 29 Aug 1973. USNM 223762 (♂, 154), 21°20′N, 158°20′W, 0–770 m, 0128–1358, 27 Mar 1972. USNM 225165 (♀, 136.9), 21°10′N, 158°10′W, 0–320 m, 2325–0115, 26 Oct 1978.

Eustomias appositus, new species

FIGURE 5*e*

Eustomias bibulbosus.—Parin and Pokhilskaya, 1974:353–355 [part; 1 specimen from *Vityaz* sta 6429–54, examined by us, barbel fig. 19].—Parin et al., 1977:101, 102 [part; *Vityaz* sta 7394, examined by us].

DIAGNOSIS.—Two contiguous terminal bulbs. Barbel 49%–57% SL. Terminal filament short, without branches, 2%–5% SL. Distal bulb 0.6% SL in the small specimen, 1.8% in the large specimen, 0.8–1.3 times the length of the proximal bulb. Axis of stem unpigmented in the small specimen, pigmented in proximal two-thirds in the large specimen. Patchy external pigment in the distal one-third of the large specimen. Axis of filament unpigmented. External chevron-shaped or roundish striated areas on stem unpigmented. Middorsal paired spots between occiput and dorsal-fin origin 7 or 8.

DESCRIPTION.—The barbel is 49%–57% SL. The axis of the stem is unpigmented in the smaller specimen. In the larger, the proximal one-third of the axis is fairly densely pigmented, the middle third lighter and patchy, the distal third unpigmented; light, patchy external pigment is present on the distal third of the stem. Neither specimen has pigment in the filament. The external chevron-shaped or roundish striated markings on the stem are unpigmented.

The proximal bulb is ovoid in shape, the distal bulb spheroidal or oblate spheroidal, the bulbs contiguous. Both bulbs are represented by a reticular network in the smaller specimen (damaged? regenerating?). The proximal bulb is 1.0% SL in both specimens. The distal bulb is smaller than (0.8 of) the proximal in the small specimen, 1.3 times the proximal in the larger specimen.

The terminal filament is short in both specimens, 2% SL in the smaller, 5% in the larger. No bulblets were visible in it.

The postorbital organ in the only large male (136 mm SL) is small relative to other species (1.3% SL, 52% of fleshy orbit).

No color observations have been recorded.

DESCRIPTION OF HOLOTYPE.—Male, 136 mm SL. D 22. A 36. P1 3. P2 7. IP 7. PV 35. VAV 17. OV 35. VAL 18. AC 18. IA 59. IC 77. OA 53. OC 71. VAV photophores over anal-fin base 7. Branchiostegal photophores 10. Premaxillary teeth 13 (left side only; right damaged): from anterior to posterior, a small fixed tooth followed by a long space, a fixed fang followed by a short space, 2 small teeth—the first fixed, the 2nd a replacement tooth, 2 long depressible teeth, a short-to-long series of 1 fixed and 2 depressible teeth, and 4 short depressible teeth—the last not fully attached. Maxilla with 7 short, erect teeth and about 20 small, slanting, serra-like teeth. Mandibular teeth 18 (left only, right side broken): from anterior to posterior, a small fixed symphysial tooth followed by a long space, a fixed fang followed by a moderate space, 2 short teeth—the 1st fixed, the 2nd depressible, a moderately long depressible tooth, a short-to-long series of 5 depressible teeth, a short-to-long series of 3 depressible teeth, and 5 short depressible teeth. Vertebrae 67.

Measurements (in mm): Predorsal length 112.2, preanal length 99.5, prepelvic length 80.6, head

length 16.0, barbel length 78.0, proximal-bulb length 1.4, distal-bulb length 1.8, filament length 6.8, snout length 6.2, fleshy orbit length 3.3, postorbital-organ length 1.7, lower-jaw length 13.6, upper-jaw length 12.8, depth behind head (greatest depth) 7.4, caudal-peduncle depth 1.7, pectoral fin broken, pelvic-fin length 16.3, dorsal-base length 18.7, anal-base length 32.8, longest premaxillary tooth 1.9, longest mandibular tooth 1.5.

Barbel with proximal bulb ovoid; distal bulb an oblate spheroid, longer and wider than proximal bulb. A small, separate mass on 1 side in the groove between the bulbs.

SIMILAR SPECIES.—In *Eustomias inconstans*, when 2 bulbs are present they are also contiguous. In that species, the proximal bulb is smaller and the distal bulb larger than in *appositus*, and most specimens have prominent pigment in the axis of the filament. (See account of *inconstans*.)

All other species of *Nominostomias* with 2 terminal bulbs have the bulbs separated by at least a short distance. In large *bibulboides* and, especially, in *orientalis*, the bulbs may be only slightly separated, which suggests the possibility that some specimens might develop contiguous bulbs. At any given size, however, these 2 species differ from *appositus* in either barbel length or bulb sizes, though not in the same way at all sizes (see Figures 6 and 7).

DISTRIBUTION.—Known only from 2 stations in the northwestern Pacific (Figure 40).

ETYMOLOGY.—From the Latin *appositus* (a perfect participle meaning placed beside), referring to the contiguous terminal bulbs of the barbel.

MATERIAL EXAMINED (1 male, 1 unsexed).—*Holotype:* IOAN uncat. (♂, 136), 26°20′N, 143°22′W, 0–200 m, 7 May 1975.

Paratype: USNM 225164 (?, 83), 04°28′N, 142°26′W, 0–180 m, 3 May 1971 [a 2nd specimen in this collection has a broken barbel and cannot be identified].

Eustomias deofamiliaris, new species

FIGURE 5*a*

DIAGNOSIS.—Two terminal bulbs separated by a very long distance (3.6% SL, 2.4 times length of distal bulb). Barbel 66% SL. Proximal bulb not centered in stem, extending externally and bearing 3 slender filaments, the longest reaching end of distal bulb. Distal bulb 1.5% SL, 1.5 times proximal-bulb length, with an intermediate (~11% SL) terminal filament bearing a short side branch. Axis of stem between bulbs and in filament densely pigmented. External chevron-shaped or rounded striated areas unpigmented except near base of stem. Middorsal paired spots between occiput and dorsal-fin origin 8.

DESCRIPTION OF HOLOTYPE.—Maturing male, 108.8 mm SL. D 26. A 38. P1 3. P2 7. IP 8. PV 30. VAV 19. OV 31. VAL 19. AC 18. IA 57. IC 75. OA 50. OC 68. VAV photophores over anal-fin base 8. Branchiostegal photophores 12. Premaxillary teeth 14 on both sides: from anterior to posterior, a long fixed tooth followed by a long space, a fixed fang and replacement followed by a long space, a short fixed and a long depressible tooth, a short and a moderate depressible tooth (2 short fixed teeth right), a short and 2 moderate depressible teeth, and 5 short depressible teeth. Maxilla with about 25 short, slanting, serra-like teeth. Mandibular teeth 18 left, 20 right: from anterior to posterior, a short fixed symphysial tooth followed by a moderate space, a fixed fang and a short depressible tooth (replacement?) followed by a long space, a long and a short depressible tooth, a moderate fixed tooth, a short depressible tooth, a long depressible tooth, 2 short fixed and 1 moderate depressible tooth (a short-to-long series of 2 fixed and 2 depressible teeth right), 4 short depressible teeth (a short-to-moderate series right), and 3 very short depressible teeth (4 right). Vertebrae 68, the 1st only partially ossified.

Measurements (in mm): Predorsal length 92.0, preanal length 76.5 prepelvic length 62.1, head length 16.3, barbel length 71.8, proximal-bulb length 1.1, distal-bulb length 1.6, distance between bulbs 3.9, filament broken after being drawn and before being measured (estimated 12), snout length 6.0, fleshy orbit length 3.8, postorbital-organ length 1.0, lower-jaw length 12.7, upper-jaw length 11.7, depth behind head (greatest depth) 7.3, caudal-peduncle depth 1.7, pectoral

fin broken, pelvic-fin length 15.0, dorsal-base length 15.5, anal-base length 30.1, longest premaxillary tooth 2.0, longest mandibular tooth 1.5.

Axis of stem, between bulbs, and terminal filament densely pigmented. External chevron-shaped or roundish areas and internal mounds on axis unpigmented except close to base of stem. No bulblets seen in terminal filament. Tiny bulblets in proximal filaments, which are unpigmented. Diameter of stem between bulbs much wider than proximal to bulbs.

Proximal bulb oblate-spheroidal, located to side of stem axis and forming a bulge; 3 slender, unpigmented filaments at its lateral tip. Distal bulb ovoid, strongly narrowed proximally, with a slender filament that has a single short branch at about one-third of its length.

SIMILAR SPECIES.—No other species of *Nominostomias* with 2 terminal bulbs has an eccentric proximal bulb or filaments on that bulb. The density of stem and teminal-filament pigmentation is reminiscent of *inconstans*, and the barbel length and distal-bulb length are consistent with that species, but a proximal bulb, when present in *inconstans*, is contiguous with the distal bulb, is centered in the stem, and lacks filaments.

DISTRIBUTION.—The holotype and only known specimen is from off Oahu, Hawaiian Islands (Figure 40).

ETYMOLOGY.—From the Latin *deo* (dative of *deus*, god) plus the adjective *familiaris* (knowing intimately), in allusion to the fact that we mortals are uncertain whether this specimen represents a valid species or a wildly different anomalous condition of some other species.

MATERIAL EXAMINED (1 male).—*Holotype:* USNM 223764 (♂, 108.8), 21°20′-30′N, 158°20′-30′W, 0-70 m, 0038-0250, 25 Sep 1973. The specimen has its skin largely intact but free from the body, and most internal organs are missing, except for portions attached to the anterior and posterior ends.

GROUP II

The species of this group have 2 terminal bulbs and a single terminal filament that has 2 to many prominent side branches ranging in length from about half the central-filament length to longer than the central filament. The filament and its branches have bulblets along part or all of their length, the bulblets ranging in size from very small to wider than the diameter of the containing filament or branch and sometimes causing external swellings. Five species comprise this group. A synopsis of their salient characters is given in Table 3, and their barbel and postorbital-organ dimensions are plotted in Figures 14-17.

Eustomias arborifer Parr, 1927

FIGURES 10*a-d*, 11*a*

Eustomias bibulbosus arborifer Parr, 1927:72 [24°00′N, 77°-17′W].

Eustomias arborifer.—Regan and Trewavas, 1930:85 [no additional specimens].

Eustomias bibulbosus.—Beebe and Crane, 1939:211 [no additional specimens; *E. arborifer* in synonymy].—Morrow and Gibbs, 1964:391 [no additional specimens].

DIAGNOSIS.—Two terminal bulbs separated by a short interspace (0.3%-2.4% SL; less than half the length of distal bulb to 1.5 times its length, rarely longer). Barbel length increasing to 70%-91% SL in specimens 105-150 mm, apparently decreasing in large females (179-253 mm) to 46%-51%. Terminal filament short (9% SL or less, slightly longer to 5 times longer than distal bulb), with 2 well-developed side branches arising just distal to bulb and often other branches along its length. All branches with prominent internal bulblets, some nearly the same diameter as branch, resulting in a series of swellings in many specimens. No melanophores in stem, between bulbs, or in filaments in specimens up to 150 mm SL; none between bulbs at any size. Middorsal paired spots under skin between occiput and dorsal-fin origin usually 8, sometimes 7.

DESCRIPTION.—Barbel length increases from 3%-15% SL in specimens 75-77 mm SL, to 70%-91% in those 105-150 mm; all barbels longer than 80% SL are of males. The 3 largest specimens are females, 179-253 mm, with barbels only 46%-51% SL. Melanophores are absent in the barbels of specimens up to 150 mm. In the 3 largest

TABLE 3.—Synopsis of characters of Group II species (SL is given (in mm) when characters are from only part of the size range; see footnotes for "Other characters")

Species	Barbel length (% SL)	SL	Proximal bulb (% SL)	SL	Distal bulb (% SL)	SL	Distal/ proximal bulb	SL	Interbulb distance (% SL)	SL	Interbulb distance/ distal bulb	SL	Terminal filament (% SL)	SL
arborifer	70–91	105–150	0.1–0.3	≤98	0.1–0.5	75–77	1.5–6.0	≤115	0.3–0.5	≤78	0.5–1.5	most	0.8–3.1	≤78
	46–51	≥179	0.5–1.8	≥99	1.2–1.8	106–150	1.0–1.5	≥125	1.3–2.4	126–150			3.2–9.0	126–150
					0.6–0.9	≥179			0.4	≥179			2.5–5.0	≥179
bimargaritatus	58–70	≥89	0.7–1.3		1.0–1.8		1.0–1.8		0.6–1.6		0.4–1.3		10–16	85–117
													23	200
bimargaritoides	44–59	≥83	1.2–1.7	≤100	1.3–2.1		1.0–1.3		1.1–2.0		0.5–1.1		21–28	
			1.0–1.3	≥118										
crossotus	31–32	≤79	0.8–1.0	≤82	1.3–1.7	≥79	1.1–1.8		0.6–1.4	≤82	1.5	66	0.3	66
	52–63	≥82	1.0–1.3	≥123					0.4–0.8	≥123	0.3–0.7	≥79	11–22	≥82
grandibulbus	68		1.1		1.6		1.4		1.3		0.8		20	

[a] Stem axis pigmented. [b] Stem axis unpigmented to 150 mm SL. [c] Stem axis unpigmented. [d] Filament axis pigmented. [e] Filament axis pigmented or not. [f] Filament axis unpigmented to 150 mm SL. [g] Filament axis unpigmented. [h] Main branches 1–5 distal-bulb lengths from bulb (except 200 mm). [i] Main branches 6–11 distal-bulb lengths from bulb. [j] No filament branches far beyond base.

specimens (179–253 mm) there are melanophores peppered around the axis, from the base of the stem almost until the proximal bulb; this pigment is light in all 3, discontinuous in 2 and quite dense and streaky in the 3rd, except for a long area devoid of pigment near the base and a thinning of pigment before the proximal bulb. No specimen has melanophores between the bulbs. Only 1 has a light speckling on the filament axis. The external chevron-shaped or roundish striated areas are unpigmented in all specimens.

The proximal bulb is a small sphere in specimens up to 110 mm, after which it may be spherical, oblate-spheroidal, or have small, rounded projections at the end, resembling a short lemon. In specimens up to 99 mm, this bulb is very small, 0.1%–0.3% SL. Its relative size increases in specimens 99–150 mm from 0.5% SL to a maximum 1.8%. All proximal bulbs 1.0% SL or larger are of males. The 3 largest specimens, all females (179–253 mm), have proximal bulbs 0.5%–0.7% SL.

The distal bulb is an oblate spheroid, less than 1.5 times longer than wide in most specimens, but about twice as long as wide in 2 large specimens and wider distally than proximally (pear-shaped) in 2. This bulb increases in relative length from 0.1%–0.5% SL at 75–77 mm SL to 1.2%–1.8% at 106–150 mm; the only bulbs 1.4% SL or larger are of males. The 3 large females (179–253) have bulbs 0.6%–0.9% SL. In most specimens up to 115 mm SL, the distal bulb is 1.5–6 times longer than the proximal bulb, the ratio becoming 1.0–1.5 in specimens larger than 125 mm SL (with 1 exception at 2.0). The proximal bulb obviously grows faster than the distal bulb.

The distance between the bulbs increases from 0.3%–0.5% SL in specimens 75–78 mm SL to 1.3%–2.4% SL in those 126–150 mm. All distances 1.4% SL or more are of males. In all 3 large females (179–253 mm), the distance is 0.4%. The distance is 0.5–1.5 times the distal-bulb length in most specimens; 2 are less than 0.5, and 1 (75mm) is 3 times the bulb length.

The single terminal filament has 2 long branches arising together from near its base. These are almost as long as the main filament in small specimens. (The branches often were stuck to the main filament, giving the appearance of a single, unbranched filament.) The main filament

Terminal filament branches	Male postorbital (% SL) [SL]	(% eye)	Predorsal pairs of spots	Other characters
2 main, often branched, large bulblets	0.7–1.1 [126–150]	30–38	(7) 8	b,f,h
2 main, often branched, small bulblets	1.3 [143]	49	8?	c,e,h
2 main, often branched, small bulblets	0.8 [126]	37	8	c,g,i
2–4 main, not branched	1.6 [128]	49	(7) 8	a,d,j
5 main, many branches, small bulblets	–	–	?	a,d,h

becomes increasingly dominant with growth, acquiring numerous additional branches along its length in some specimens (Figure 10*b,d*), no more in others (Figure 10*c*). Once the filaments are formed definitively (~80 mm SL), prominent bulblets are easily visible along their length and in their branches. These bulblets commonly cause external swellings along the filaments, which are distinctive in this species when present.

The filament increases in relative length from 0.8%–3.1% SL in specimens 75–78 mm SL to 3.2%–9.0% at 126–150 mm SL. In the 2 large females (179–201 mm SL) with intact filaments, these were 2.5%–5.0% SL. The filament is 1.1–4.0 times the distal-bulb length, without obvious relation to standard length.

The postorbital organ in large males (126–150 mm SL) is relatively small, 0.7%–1.1% SL, 30%–38% of fleshy orbit length. In a 128 mm female, the only one in the size-range of large males, the organ is 0.6% SL, 28% fleshy orbit. The 3 largest females (179–253 mm) have organs 0.5%–0.9% SL, 26%–27% of fleshy orbit. Most specimens 75–110 mm have postorbitals 0.1%–0.6% SL, 6%–22% of fleshy orbit; 3 (75, 89, 106 mm) suspected of being males, have organs 0.7%–0.8% SL and 26%–28% of fleshy orbit. Although the postorbitals of large males are noticeably larger than those of females, the difference is less than in most other species.

Colors of the terminal bulbs have been recorded for 4 freshly caught specimens. The proximal bulb was yellowish-green, the distal bulb greenish blue or yellowish green in males 104 and 134 mm (USNM 223958) and a female 128 mm (ISH 2343/71). In a 126 mm male (ISH 1928/71) both bulbs were orangish white.

SIMILAR SPECIES.—*Eustomias grandibulbus* and *crossotus* resemble *arborifer* in the short distance separating the bulbs and in filament structure, but the filament is shorter in *arborifer* and has more-prominent bulblets and associated swellings than the other 2 species (see Figure 10*a–d*). Small *bimargaritatus* resemble *arborifer* in the 3-pronged appearance of the filament, which, however, is much longer in *bimargaritatus* at any size, the branching farther away from the bulb, and the internal bulblets not so prominent.

REMARKS.—The 3 large females (179–253 mm) pose problems in interpreting the variability and relative growth of barbel characters in this species. Their barbel length, bulb length, distance between bulbs, and terminal-filament length are relatively shorter than in the largest males (125–150 mm), and only these large females have pigment along the stem axis. The next largest female (128 mm), the only one in the size range of the large males, has barbel characters that are slightly small relative to the males.

These data suggest a sexual difference in relative growth after about 100 mm, with growth apparently stopping in females, while male barbels and their parts continue to increase in size. The resulting apparent sexual dimorphism would be the only obvious case in *Nominostomias*.

An alternative interpretation, which was strongly entertained, is that the large males, with long barbels and large bulbs, might represent a different species. All are from the subtropical South Atlantic, whereas most *arborifer* specimens are from the equatorial or northwestern subtropical Atlantic. The presence of at least 1 typical,

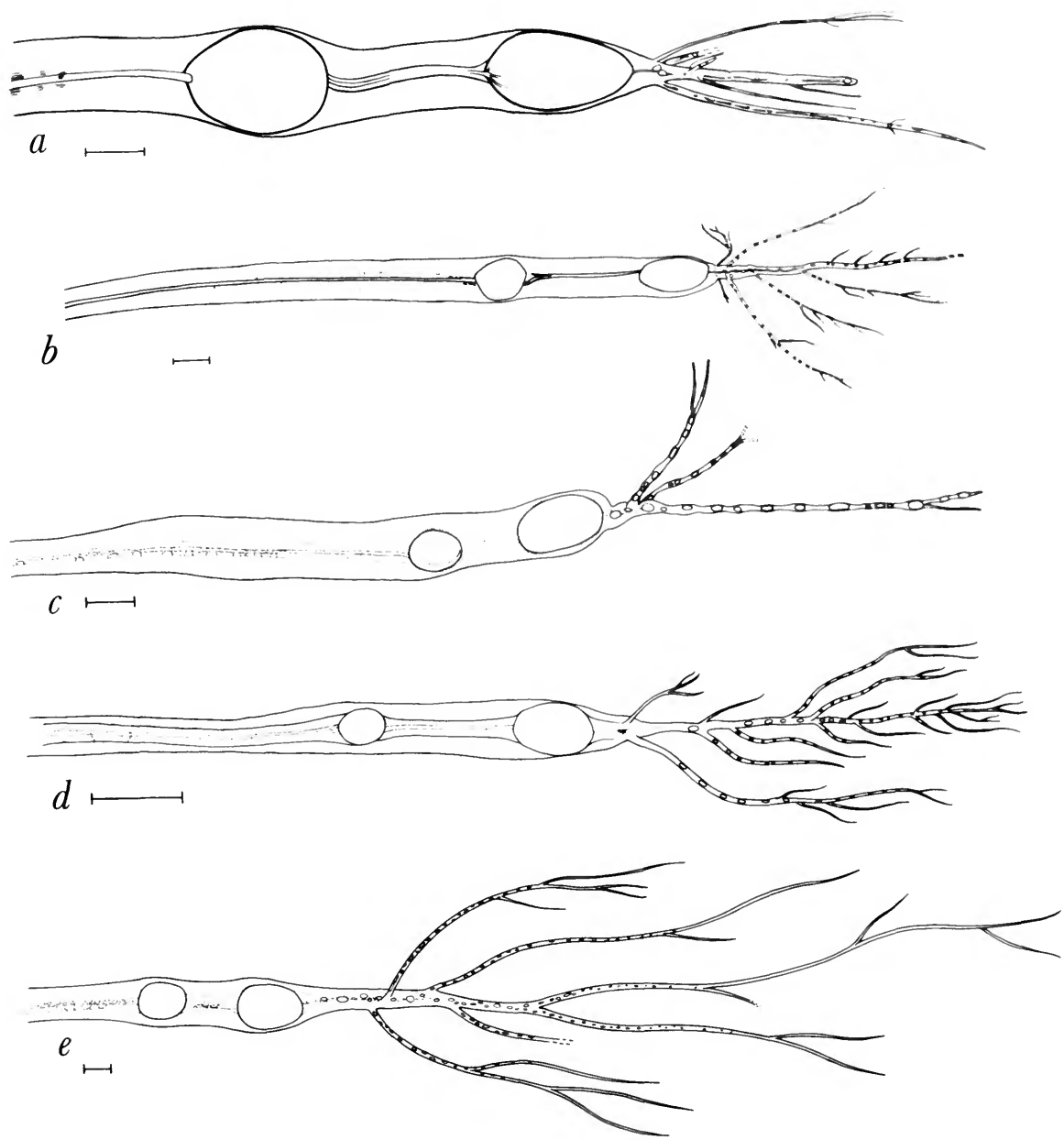


FIGURE 10.—Barbel ends of Group II species: *a–d*, *E. arborifer* (*a*, 125.9 mm SL, ISH 1928/71 (large-bulbed male, filaments broken, 11°S, 11°W); *b*, 150.0 mm SL, USNM 223959 (large-bulbed male, 16°S); *c*, 201.0 mm SL, ISH 1854/66 (small-bulbed female, 06°S); *d*, 100.8 mm SL, ISH 1856/66 (small-bulbed female, 21°S)); *e*, *E. grandibulbus*, holotype, 161.0 mm SL, ISH 1272/71. (Bar = 1 mm.)

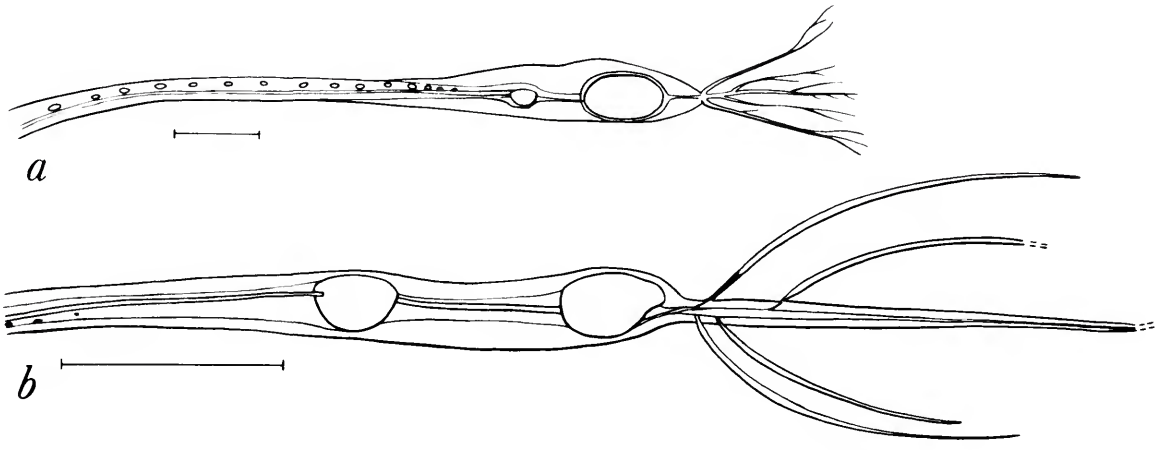


FIGURE 11.—Barbel ends of Group II species, young specimens: *a*, *E. arborifer*, 78.2 mm SL, UMML 33538; *b*, *E. crossotus*, paratype, 65.5 mm SL, ZMUC P202850. (Bar = 1 mm.)

small-bulbed female in the South Atlantic diminishes this hypothesis. On the other hand, there are no large males from more-northern areas to test the sexual-dimorphism hypothesis.

DISTRIBUTION.—Tropical and subtropical Atlantic (Figure 41). Most specimens have been taken west of 30°W between 12°N and 25°S. The holotype and 1 other specimen were taken far to the north of the main population, between Cuba and the Bahamas near the Straits of Florida.

MATERIAL EXAMINED (7 males, 15 females, 8 unsexed).—*Holotype:* BOC 2041 (♀, 104.8), 24°00′N, 77°17′W, 6000 ft wire, 28 Feb 1927.

Non-types: ISH 717/66 (♂, 128.5), 17°36′S, 28°53′W, 0–660 m, 2000–2315, 23 May 1966. ISH 1854/66 (♀, 201), 05°34′S, 26°58′W, 0–320 m, 2000–2315, 20 May 1966. ISH 1856/66 (♀, 100.8), 21°00′S, 30°00′W, 0–200 m, 2000–2220, 24 May 1966. ISH 1252/68 (♂, 134.4), 23°24′S, 33°28′W, 0–320 m, 2300–2315, 9 Feb 1968. ISH 1271/71 (?, 105.9), 23°26′S, 33°30′W, 0–560 m, 0010–0040, 10 Feb 1968. ISH 1928/71 (♂, 125.9), 10°57′S, 11°20′W, 0–1900 m, 1818–2218, 7 Apr 1971. ISH 2343/71 (♀, 127.7), 04°34′N, 19°39′W, 0–104 m, 1920–2008, 13 Apr 1971. ISH 562/74 (♀, 179), 05°25′N, 35°28′W, 0–550 m, 2230–2340, 22 Jul 1974. MCZ 56607 (♀, 111.5), 26°52′N, 89°23′W, 0–549 m, 1225–1640, 22 Jun 1966. MCZ 57024 (?, 82.3), 10°48′N, 52°17′W, 0–140 m, 0335–0530, 27 Mar 1977. MCZ 57025 (♀, 95.6) 09°02′N, 43°48′W, 0–505 m, 0205–0405, 20 Sep 1973. MCZ 57026 (♀, 87.5), 11°12′N, 53°49′W, 0–140 m, 0335–0530, 28 Mar 1977. MCZ 57027 (♀, 99.1), 10°58′N, 40°29′W, 0–460 m, 0145–0345, 16 Sep 1973. MCZ 57031 (?, 114.8), 18°21′S, 29°39′W, 0–75 m, 2129–2311, 5 Mar 1967. UMML 33538 (?, 78.2), 23°45′N, 76°59′W, 0–1360 m, 1309–1653, 1 Mar 1976. USNM 223955 (♀, 83.0), 00°13′N, 35°44′W, 0–195 m, 2335–0135, 15 Mar 1977. USNM 223956 (♀, 253), 07°41′N, 54°15′W, 0–482 fm, 17 Nov 1969. USNM 223957 (?, 75.2; ♂, 88.9), 10°03′N, 49°37′W, 0–120 m, 0250–0505, 26 Mar 1977. USNM 223958 (2♂, 103.6, 133.8), 08°00′S, 29°42′W, 0–1044 m, 0745–1018, 12 Feb 1969. USNM 223959 (♂, 150), 15°52′S, 31°08′W, 0–~500 m, 2006–2109, 30 Apr 1965. USNM 223960 (3?, 74.8, 76.7, 76.8), 0–85 m, 2340–0140, 19 Mar 1977. USNM 223961 (♀, 109.6) 08°00′N, 48°00′W, 0–183 m, 21 Jan 1969. USNM 223962 (♀, 94.5), 08°00′N, 48°00′W, 0–183 m, 2040–2200, 21 Jan 1969. USNM 223963 (2♀, 97.6, 98.6), 06°11′N, 37°01′W, 0–120 m, 0115–0315, 21 Mar 1977.

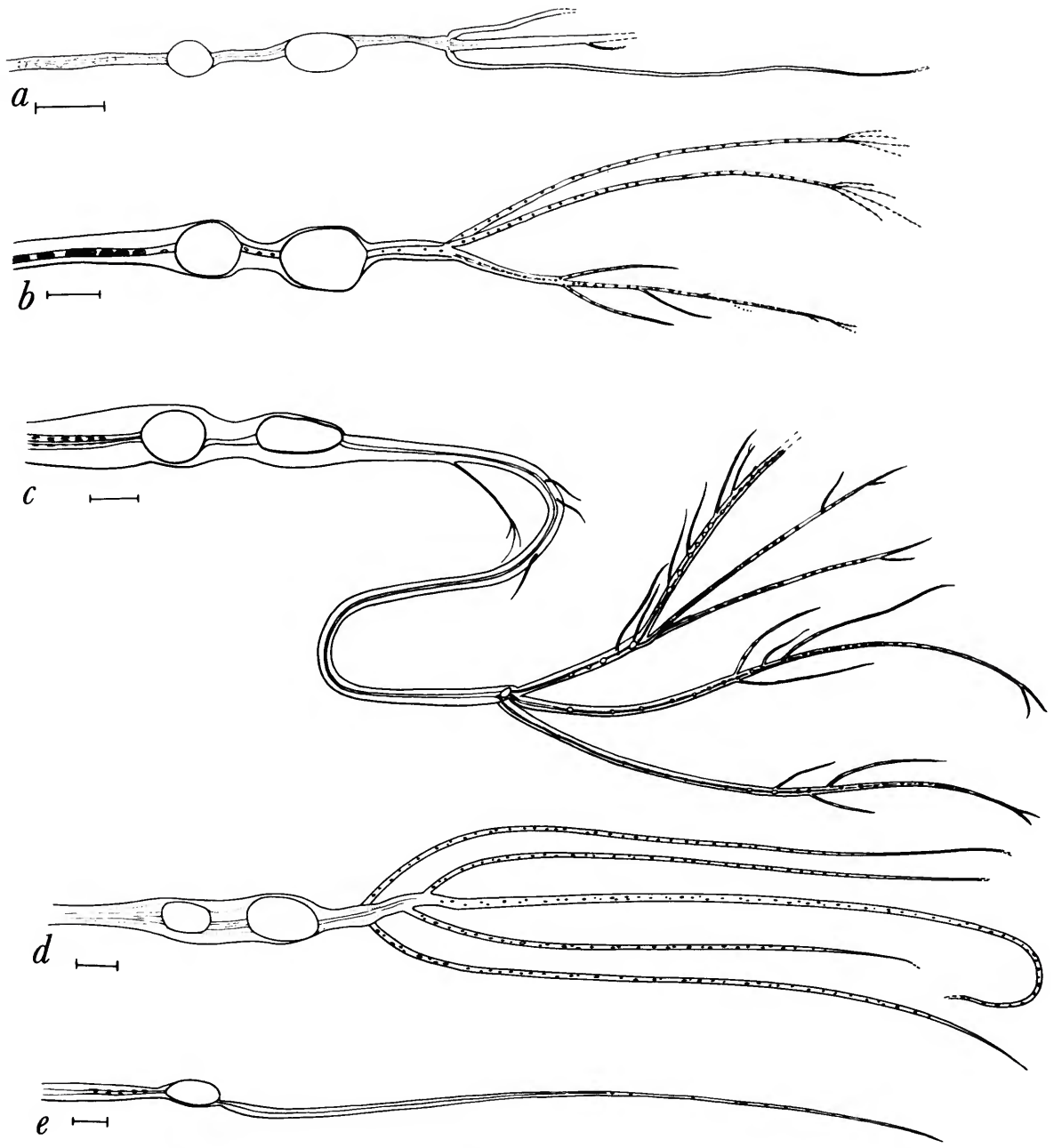


FIGURE 12.—Barbel ends of Group II species: *a,b*, *E. bimargaritatus* (*a*, 85.3 mm SL, USNM 224104; *b*, 100.3 mm SL, ISH 3189/79); *c*, *E. bimargaritoides*, holotype, 102.1 mm SL, SIO 71-296; *d*, *E. crossotus*, holotype, 128.1 mm SL, ZMUC P202846; *e*, *E. bimargaritoides*, 102.0 mm SL, USNM 224095 (unusual unbranched filament). (Bar = 1 mm.)

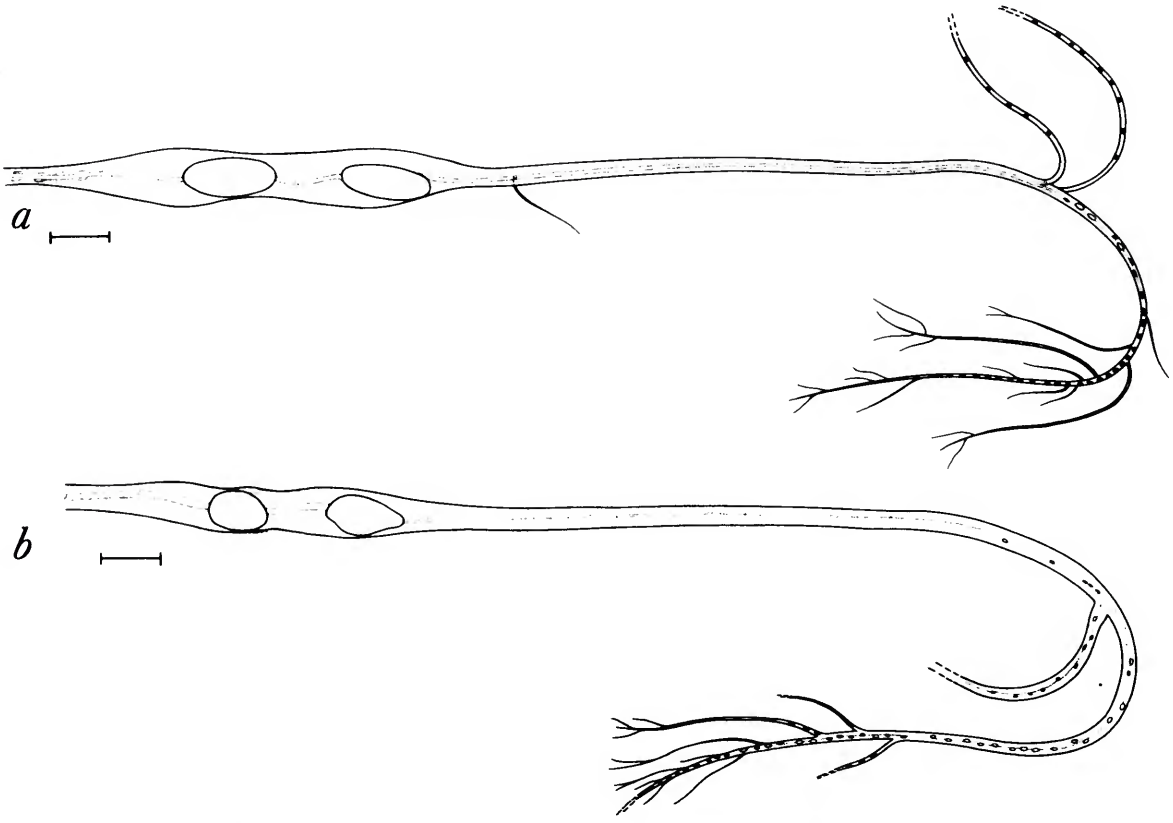


FIGURE 13.—Barbel ends of Group II species: *a*, *E. biamargaritoides*, paratype, 94 mm SL, USNM 224099; *b*, *E. bimargaritatus*, 200 mm SL, IOS uncatalogued. (Bar = 1 mm.)

Eustomias grandibulbus, new species

FIGURE 10*e*

DIAGNOSIS.—Two terminal bulbs separated by a short interspace (1.3% SL, shorter than length of distal bulb in only known specimen). Barbel 68% SL. Terminal filament long (20% SL), with a series of 5 long branches beginning a short distance (1 distal-bulb length) from bulb, all with small bulblets, none of which approaches the diameter of the filament. All long branches with 1 or more short branches. Stem axis uniformly peppered with melanophores; lightly pigmented on axis between bulbs and in proximal part of filament. Number of middorsal spots under skin uncertain (obscure and diffuse in holotype).

DESCRIPTION OF HOLOTYPE (only known specimen).—Female, 161.0 mm SL. D 26. A 40. P1 3. P2 7. IP 7. PV 31. VAV 18. OV 32. VAL 20. AC 18. IA 56. IC 74. OA 52. OC 70. VAV photophores over anal-fin base 7. Branchiostegal photophores 11. Premaxillary teeth 15 left and right: from anterior to posterior, a long fixed tooth followed by a wide space, a fixed fang followed by a wide space, a short-to-long series of 1 fixed and 2 depressible teeth (all depressible right), a short-to-long series of 1 fixed and 3 depressible teeth, a short-to-long series of 3 depressible teeth, 3 short depressible teeth. Maxilla with about 3 short erect teeth and 19 slanted, serra-like teeth. Left mandible damaged. Right mandibular teeth 19: from anterior to posterior, broken symphysial

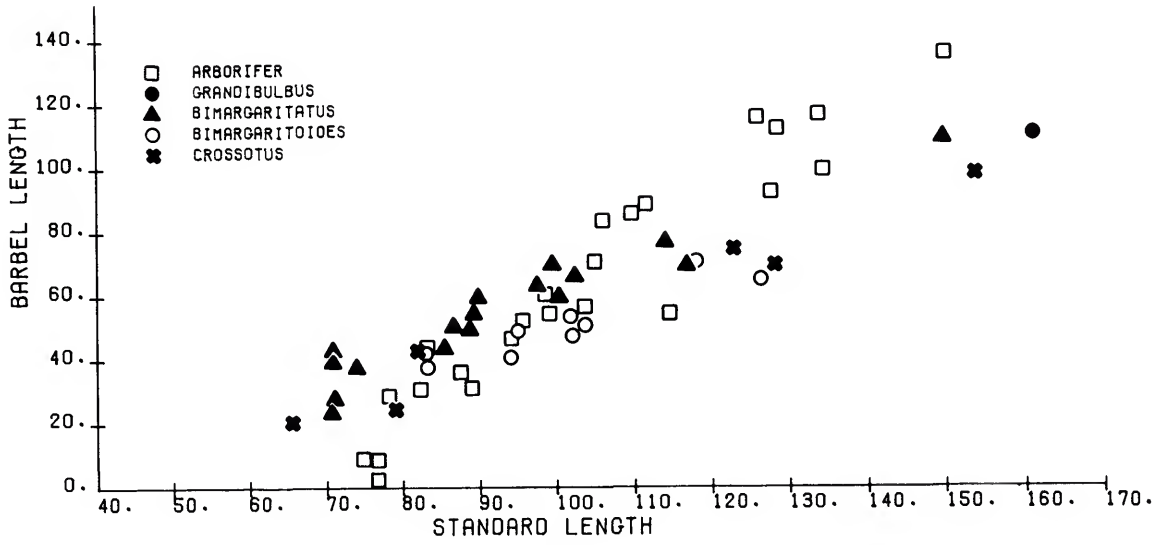


FIGURE 14.—Barbel length (mm) vs. SL (mm) in Group II species.

tooth followed by a moderate space, a fixed fang followed by a wide space, a long depressible tooth, 2 short depressible teeth, a long depressible tooth, a short-to-long series of 2 fixed and 2 depressible teeth, a short-to-long series of 5 depressible teeth, 2 short to long series of 4 depressible teeth, 2 short depressible teeth. Vertebrae 67.

Measurements (in mm): Predorsal length 136.5, preanal length 118.0, prepelvic length 88.7, head length 18.3, barbel length 109.3, proximal-bulb length 1.8, distal-bulb length 2.6, distance between bulbs 2.1, filament length 31.7, snout length 6.6, fleshy orbit length 4.7, postorbital-organ length 1.0, upper-jaw length 15.6, lower-jaw length 17.2, depth behind head (greatest depth) 11.7, caudal-peduncle least depth 2.2, pectoral-fin length 20.3, pelvic-fin length 22.2, dorsal-fin base 22.0, anal-fin base 42.8, longest premaxillary tooth 2.8, longest mandibular tooth 1.7.

Axis of barbel stem densely peppered with melanophores up to proximal bulb; a few melanophores on axis between bulbs; axis of terminal filament moderately darkly pigmented until about base of 3rd branch, becoming lighter distally. External chevron-shaped or roundish striated areas of stem unpigmented.

Proximal bulb spheroidal; distal bulb ovoid, somewhat smaller anteriorly. Distance between bulbs short, less than length of distal bulb. Terminal filament almost 20% SL, with 5 well-separated, long side branches, the 1st arising about 1 distal-bulb length from bulb, the 5th at about half filament length; each branch and main filament bearing 1 or more short side branches. Small bulblets present in all filament branches, most much smaller than filament diameter and none causing external swellings.

No color observations recorded.

SIMILAR SPECIES.—In *E. crossotus*, the long branches of the terminal filament all arise close together near the distal bulb, these branches lack any short side branches, and the distance between bulbs is shorter (0.4%–0.8% SL. in large specimens vs. 1.6% in *grandibulbus*). In the only other species with a similar filament, *E. arborifer*, the filament is shorter (9% SL or less) and has much larger bulblets, many of which approach the diameter of the filament and often cause external swellings. In the absence of small specimens of *grandibulbus*,

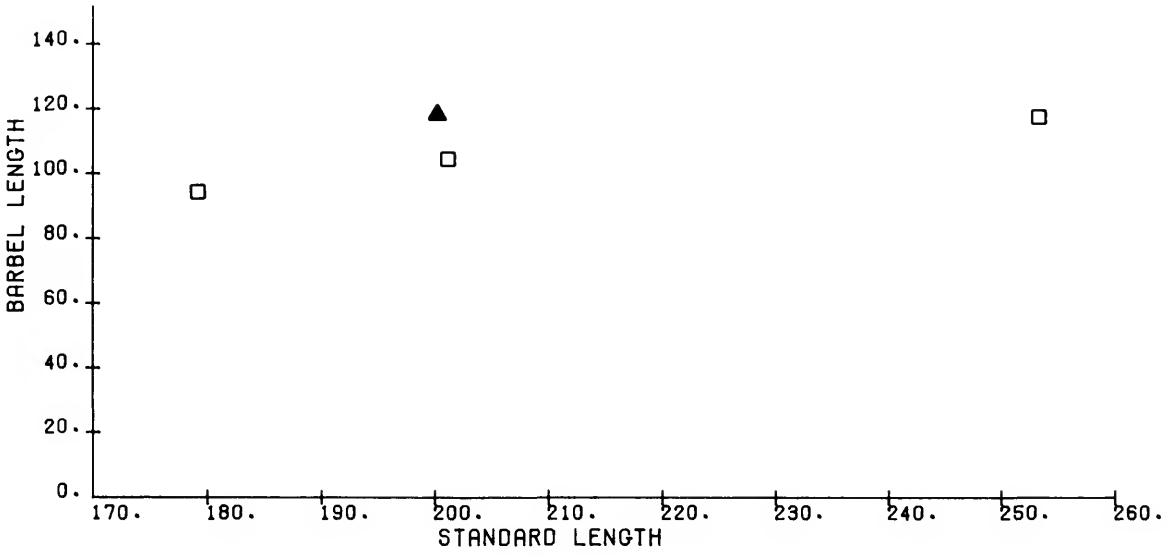


FIGURE 14.—Continued.

possible resemblance to small *bimargaritatus* cannot be ascertained.

DISTRIBUTION.—The only known specimen was taken in the southeastern Atlantic not far off South Africa (Figure 44).

ETYMOLOGY.—A Latin noun in apposition, *grandibulbus* is a combination of *grandis* (large) plus *bulbus* (a swelling), referring to the large distal bulb of this species.

MATERIAL EXAMINED (1 female).—*Holotype:* ISH 1272/71 (♀, 161.0), 34°25'S, 14°47'E, 0–112 m, 2108–2155, 28 Mar 1971.

Eustomias crossotus, new species

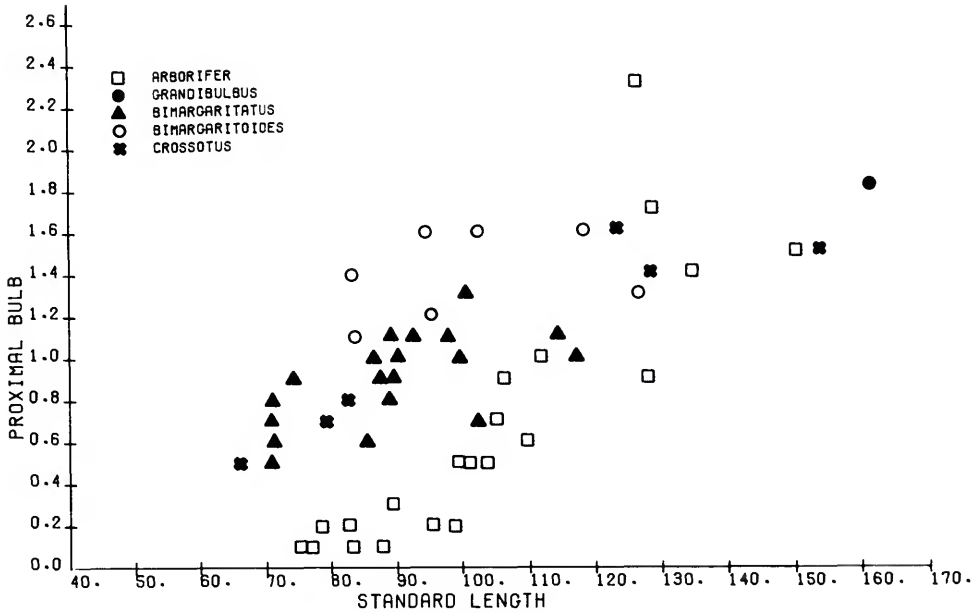
FIGURES 11*b*, 12*d*

Eustomias bibulbosus.—Parin and Pokhilskaya, 1974:353–355 [part; *Vityaz* stas 6064, 6493; fig. 19a; specimens examined by us].—Parin et al., 1977:101, 102 [part; *Vityaz* stas 7187, 7192; specimens examined by us].

DIAGNOSIS.—Two terminal bulbs separated by a short interspace (0.4%–1.5% SL, 0.3–1.5 times length of distal bulb). Barbel 52%–63% SL in specimens larger than 80 mm. Terminal filament long (11%–22% SL, except in smallest specimen), with 2–4 long branches arising closely together a short distance (less than 0.5 to about 1.3 distal-bulb lengths) from distal bulb. All branches with very small bulblets and without sub-branches. Stem axis well pigmented except in smallest specimen (66 mm); stem between bulbs and proximal part of filament usually lightly pigmented. Mid-dorsal paired spots under skin between occiput and dorsal-fin origin usually 8, sometimes 7.

DESCRIPTION.—Barbel length apparently increases from 31%–32% SL at 66–79 mm to 52%–63% in specimens 82 mm and larger. There is no barbel pigment in the smallest specimen; all others have the stem axis well pigmented, either peppered with melanophores or having streaky and diffuse pigment or both. On the axis between bulbs and in the filament, pigmentation is lighter or absent, without apparent relation to SL. The external chevron-shaped or roundish striated areas are unpigmented.

The proximal bulb varies from almost spherical to an elongate ovoid about twice as long as wide. In specimens 66–82 mm SL this bulb is 0.8%–1.0% SL, increasing relatively to 1.0%–1.3% at 123–154 mm.



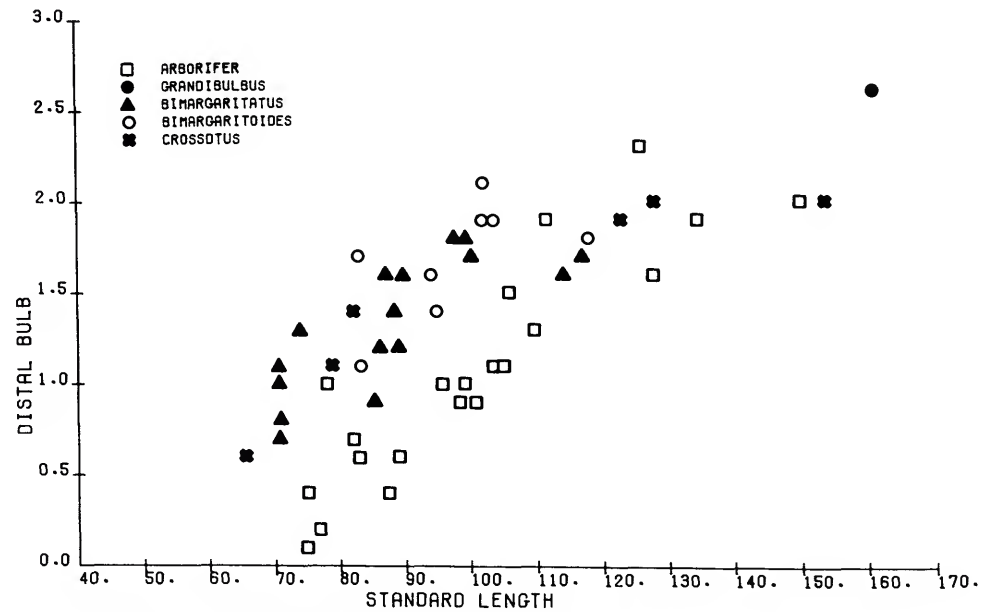
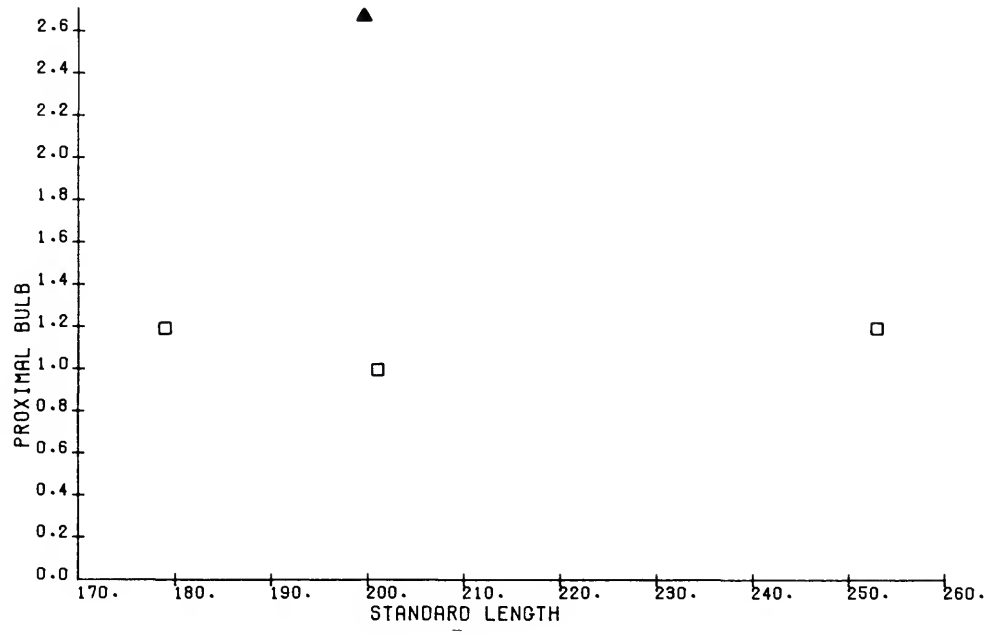


FIGURE 15.—Proximal-bulb and distal-bulb lengths (mm) vs. SL (mm) in Group II species.



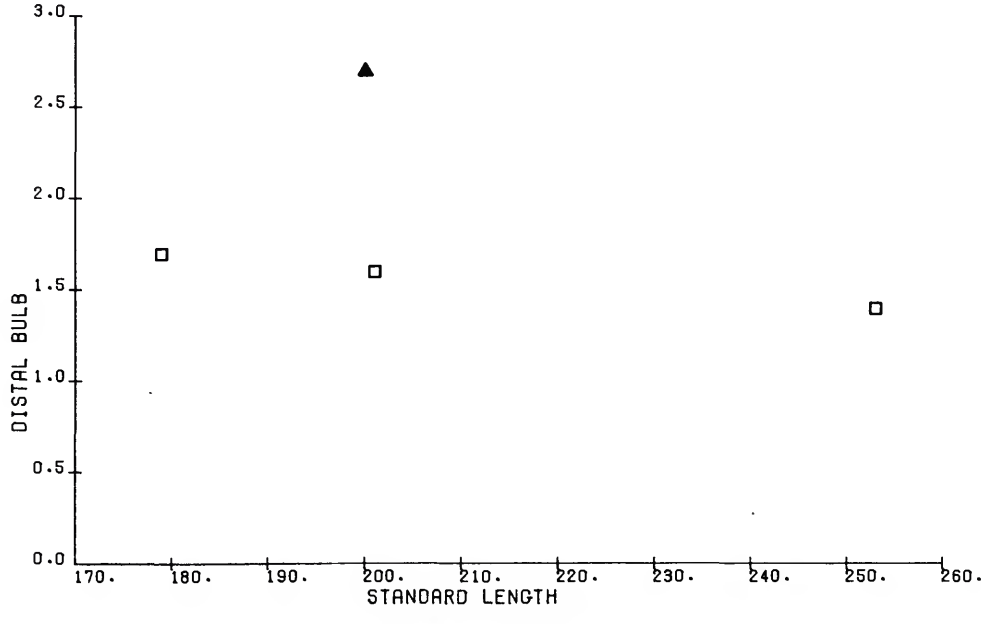
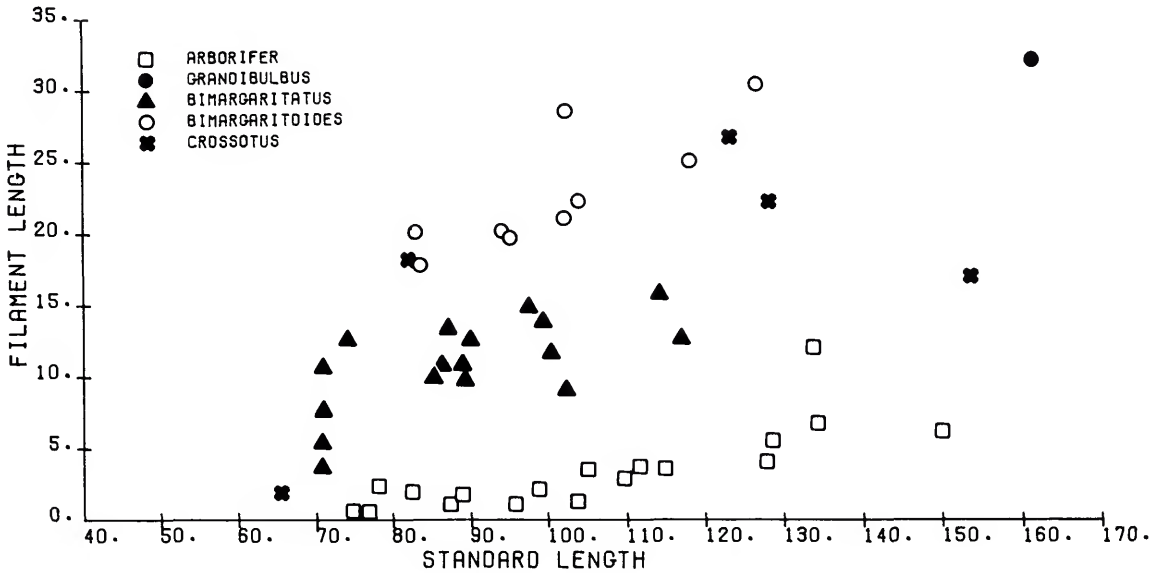


FIGURE 15.—Continued.



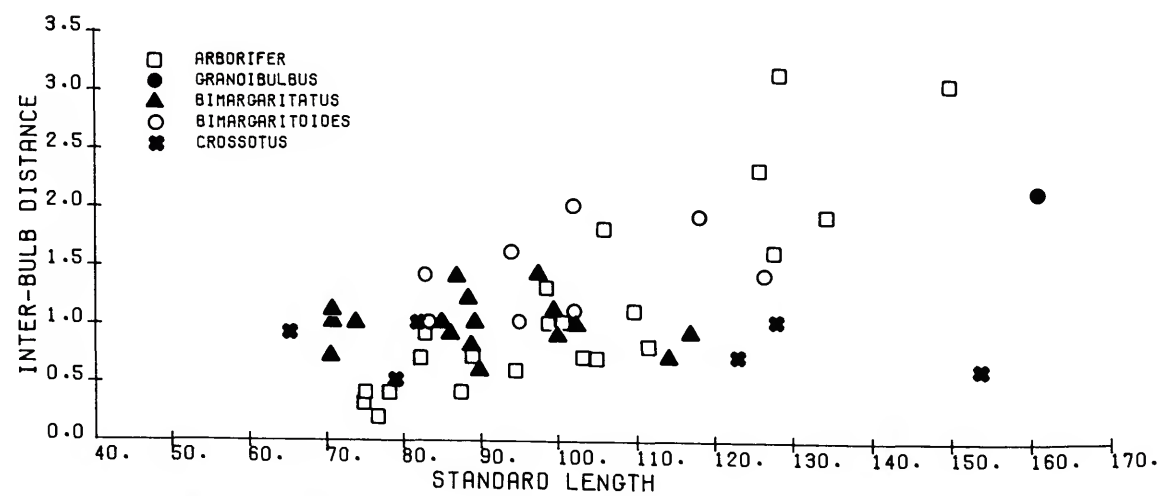
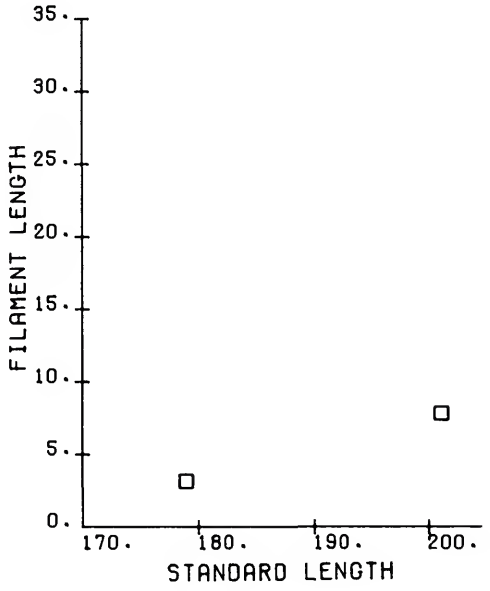


FIGURE 16.—Filament length (mm) and inter-bulb distance (mm) vs. SL (mm) in Group II species.



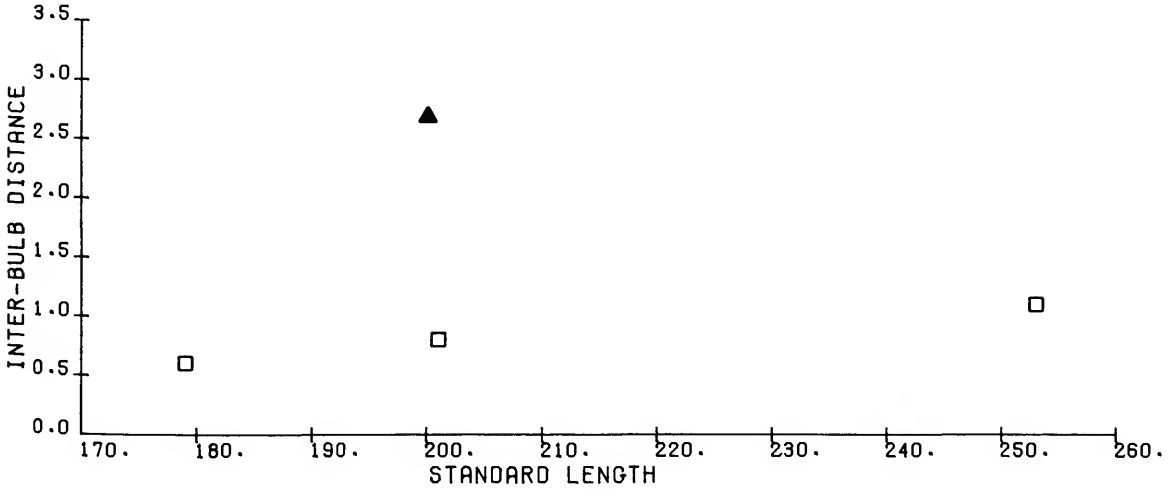


FIGURE 16.—Continued.

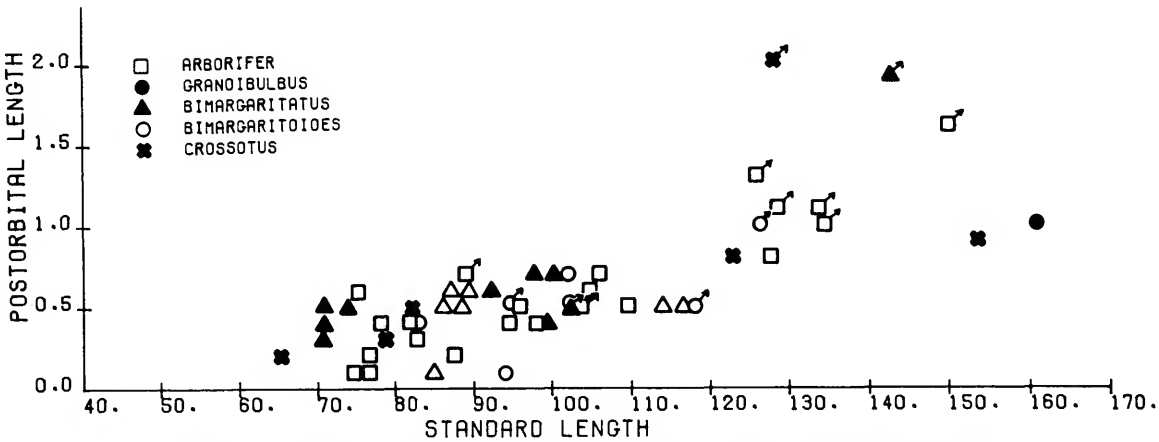


FIGURE 17.—Postorbital-organ length (mm) vs. SL (mm) in Group II species. Specimens not marked as males include both females and unknowns.

The distal bulb is variously an oblate spheroid, pear-shaped with a narrow distal end, ovoid, or an elongate ovoid about twice as long as wide. In the smallest specimen (66 mm) it is 0.9% SL; in the others, 79–154 mm, it is 1.3%–1.7% SL. The distal bulb is longer than the proximal in all specimens and increases from 1.1 times proximal-bulb length in the smallest specimen to 1.8 times its length in the largest.

The distance between bulbs apparently does not change with growth, decreasing relative to SL from 0.6%–1.4% at 66–82 mm to 0.4%–0.8% at 123–154 mm. Only in the smallest specimen is the distance longer (1.5:1) than the distal bulb; in the largest it is less than one-third the length of the distal bulb.

The single terminal filament has 2–4 long side branches arising a short distance (slightly less to slightly more than 1 distal-bulb length) from the bulb. Neither the main filament nor its long branches have any more side branches. Many very small bulblets, mostly along the axis, are present in the specimens 82–154 mm; bulblets were not discerned in the 66 and 79 mm ones. The bulblets are much smaller than the filament diameter.

The filament is only 3% SL in the smallest (66 mm) specimen. Rapid growth occurs after this, and the filament is 11%–22% after 82 mm; the relatively shortest filament is that of the largest specimen, suggesting a decrease in relative length with growth in SL. In the smallest specimen, the filament is 3.3 times as long as the distal bulb; in the others it is 8.5–14.0 times the bulb length.

The postorbital organ of the only large male (128 mm) is 1.6% SL, 49% of fleshy orbit length.

No observations of barbel colors have been recorded.

DESCRIPTION OF HOLOTYPE.—Male, 128.1 mm SL. D 25. A 38. P1 3. P2 7. IP 8. PV 30. VAV 20. OV 31. VAL 21. AC 18. IA 58. IC 78. OA 52. OC 72. VAV photophores over anal-fin base 8. Branchiostegal photophores 11. Premaxillae missing. Maxilla with a short erect tooth and about 20 very short, slanted, closely-spaced serra-like teeth. Mandibular teeth 16 left, 15 right: from anterior to posterior, a short fixed symphysial tooth followed by a long space, a fixed fang (a replacement fang inside and posterior) followed by a long space, 2 short fixed teeth (the 1st shorter than the 2nd, missing on right), a long and a short depressible tooth, 3 increasingly longer depressible teeth, another short-to-long series of 4 depressible teeth (smaller than those of the preceding series), and 3 short depressible teeth. Vertebrae 68 (the first only partially ossified).

Measurements (in mm): Predorsal length 105.0, preanal length 88.0, prepelvic length 68.0, head length 15.0, barbel length 68.6, proximal-bulb length 1.4, distal-bulb length 2.0, distance be-

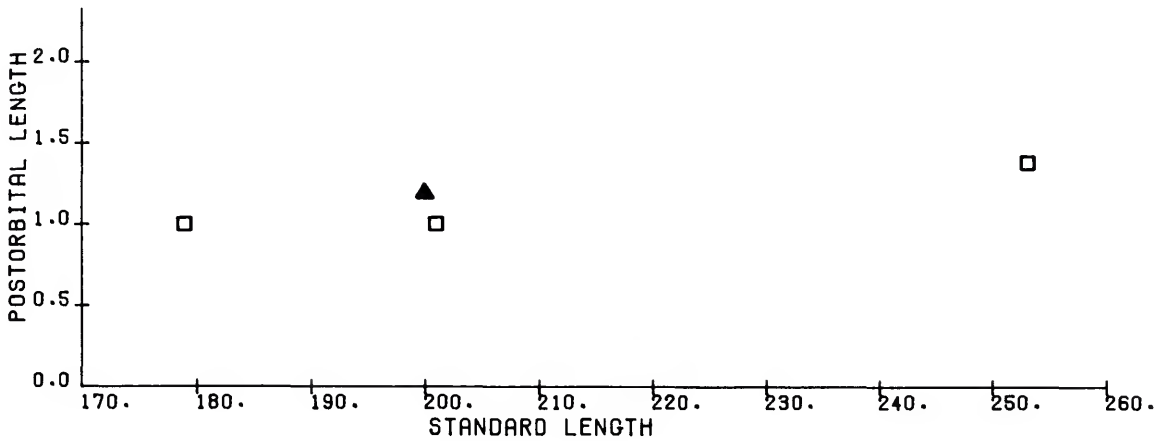


FIGURE 17.—Continued.

tween bulbs 1.0, filament length 22.1, fleshy orbit length 4.1, postorbital-organ length 2.0, upper jaw lacking premaxillae, lower-jaw length 14.0, depth behind head (greatest depth) 8.5, caudal-peduncle least depth 1.9, pectoral-fin length 14.5, pelvic-fin length 17.0, dorsal-base length 15.8, anal-base length 31.7, premaxillary teeth missing, longest mandibular tooth 1.5.

Barbel with longish oblate-spheroidal proximal bulb with almost flat ends, oblate-spheroidal distal bulb with asymmetrically narrowed anterior end. Terminal filament with 4 long branches, the 1st arising about length of distal bulb beyond bulb.

SIMILAR SPECIES.—In the only specimen of *grandibulbus* (161 mm), which is larger than the largest *crossotus* (154 mm), the long branches of the filament arise farther apart from one another than in *crossotus*, some up to halfway along the filament, and have short side branches, which *crossotus* lacks; the distance between the bulbs is 1.6% SL (0.4%–0.8% in the largest *crossotus*). *Eustomias arborifer* has a shorter terminal filament with much larger bulblets (often forming swellings) and lacks dark pigment in the barbel of specimens up to 150 mm SL; its males have a smaller postorbital organ (maximum 1.1% SL, 38.1% of fleshy orbit vs. 1.6% and 48.8% in *crossotus*). Small *bimargaritatus* with only 2 filament branches and these branches very close to the distal bulb have no obvious barbel characters that differentiate them from small *crossotus*, but the 2 species are widely separated geographically.

DISTRIBUTION.—Eastern Indian Ocean off Sumatra; South China Sea and northwestern Pacific between 10° and 20°N and 120° and 140°E; southwestern Pacific off the Solomon Islands (Figure 41).

ETYMOLOGY.—An adjective derived from the Greek *krossotos* (fringed), referring to the branched filament of this species.

MATERIAL EXAMINED (1 male, 3 females, 2 unsexed).—*Holotype:* ZMUC P202846 (♂, 128.1), 16°55′N, 120°03′E, 0–~300 m (600 mw), 2245, 15 Jun 1929.

Paratypes: ZMUC P202850 (?, 65.5), 03°36′S, 97°37′E, 0–~150 m (300 mw), 2210, 10 Sep 1929. IOAN uncat. (?, 79 mm), 13°31′N, 139°58′E, 0–330 m, 5 Jul 1971. IOAN uncat. (♀, 82.3), 09°45′S, 164°09′E, 0–70 m, 7 Feb 1969. IOAN uncat. (♀, 153.7), 17°53′N, 127°56′E, 0–200 m, 11 Feb 1975. USNM 223965 (♀, 122.9), 15°21′N, 126°54′E, 0–200 m, 13 Feb 1975.

Eustomias bimargaritatus Regan and Trewavas, 1930

FIGURES 12*a–b*, 13*b*

Eustomias bimargaritatus Regan and Trewavas, 1930:84, 85 [7 syntypes; barbels fig. 63].

Eustomias bibulbosus.—Beebe and Crane, 1939:211 [no additional specimens; *bimargaritatus* in synonymy].—Morrow

and Gibbs, 1964:396 [Beebe and Crane's decision accepted; 149.6 mm specimen may be *bimargaritatus*, see "Remarks" below].—Blache et al., 1970:171 [part; fig. 459c,d only].—Bekker et al., 1975 [part; stas 1253, 1255; examined by us].

DIAGNOSIS.—Two terminal bulbs separated by a short interspace (0.6%–1.6% SL, 0.6–1.7 times length of distal bulb). Barbel length 58%–70% SL in specimens larger than 90 mm. Terminal filament 10%–23% SL, except in some small specimens, with 2–3 (usually 2) prominent branches arising closely together at 1–5 distal-bulb lengths from the distal bulb in specimens to 114 mm SL (at 10 bulb lengths in a 200 mm specimen). Stem of filament proximal to major branches with widely-spaced tiny bulblets and without short basal branches; all long branches with very small, well-spaced bulblets (bulblets larger and more conspicuous in a 200 mm specimen). Barbel without melanophores (rarely very sparse pigment on axis of stem or filament). Paired middorsal spots between occiput and dorsal-fin origin probably 8, often diffuse or obscure.

DESCRIPTION.—Rapid increase in barbel length is indicated by specimens 71–74 mm SL with barbels 34%–60% SL. All specimens 89 mm or larger have barbels 58%–70% SL. The barbel is entirely without black pigment in all except 2 specimens, and in those the pigment is difficult to discern. In 1, there are 2 short areas of stem where melanophores form a row along the axis, and there is a row of very tiny flecks along the axis of the filament stem. The other has only a short pigment streak at the base of the filament. External chevron-shaped or roundish striated areas are unpigmented.

The proximal bulb may be spherical or an oblate spheroid. It is 0.7%–1.3% SL at all sizes.

The distal bulb is variously an oblate spheroid or short oval to an elongate, straight-sided oval; 2 specimens have a small, distinct proximal projection directed proximad. The bulb is 1.0%–1.8% SL and 1.0–1.8 times the length of the proximal bulb at all sizes.

The distance between bulbs is 0.6%–1.6% SL, not changing obviously with growth in SL, and is 0.4–1.3 times the length of the distal bulb.

The terminal filament has 2 branches arising together a moderate distance (1–5 distal-bulb lengths) from the distal bulb (10 bulb lengths in the 200 mm specimen). Regan and Trewavas (1930) record 2–4 branches (including the main filament); we observed no variants from 3 (2 branches). Small side branches on the filament proximal to the main branches are absent, except in a 117 mm specimen, which has 1. The main filament is thicker than the 2 long branches and has more secondary branches and more and larger bulblets. Except in the 200 mm specimen, bulblets are tiny and quite widely spaced in the branches, and proximal to the branches they are so tiny and widely spaced that they are difficult to discern. In the 200 mm specimen bulblets in the branches are prominent and closely spaced, causing swellings in the smallest secondary branches.

Rapid filament growth is indicated by specimens 71–74 mm SL with filaments 5%–17% SL. Between 85 and 117 mm, filaments are 10%–16% SL, with no apparent change relative to SL, but the 200 mm specimen has a filament 23% SL. The filament is 5.4–11.2 times the distal-bulb length in specimens up to 117 mm SL, 16.9 times the bulb length in the 200 mm specimen.

The only large male (143 mm) has a postorbital organ 1.3% SL, 49% of fleshy orbit length (barbel observed at sea, but lost prior to measurement). The next largest male, 114 mm, has a small organ, 0.6% SL.

Bulbs of 10 freshly caught specimens 68.0–142.8 mm all were pale green, with variation subjectively noted as yellow-green, lime-green, or grass-green. No other barbel pigments were noted. Postorbital organs were white in most, but red in 1 female and reddish on 1 side, white on the other of 1 male.

SIMILAR SPECIES.—In *bimargaritoides*, the most similar species, the 3 branches of the filament arise much farther distad, 6–11 distal-bulb lengths from the distal bulb (branching occurs at 10 bulb lengths in the 200 mm specimen of *bimargaritatus*, the only one in which it occurs at

more than 5 bulb lengths), bulblets in the branches are closer together and somewhat larger, there are no bulblets in the filament proximal to the branches, and there are 1–6 small side branches in the proximal half of the filament (1 *bimargaritatus* has a single such branch). Also in *bimargaritoides*, the filament is longer (21%–28% SL vs. 17% or less except in the 200 mm specimen), the barbel length tends to be shorter in specimens larger than 80 mm (44%–59% vs. 51%–67%). *Eustomias arborifer* has a shorter terminal filament (9% SL or less) with its first branching always close to the distal bulb and with much larger bulblets; large males (126–150 mm) have a smaller postorbital organ (0.7%–1.0% SL) than does the only large male (143 mm) *bimargaritatus* (1.3% SL). Small *crossotus*, perhaps also *grandibulbus*, before stem pigment has developed, would be virtually impossible to differentiate from small *bimargaritatus* in which the branches of the filament arise close to the distal bulb; fortunately, these species are well separated geographically.

Distribution.—Across the North Atlantic between 18° and 28°N from the Florida Current to north of the Cape Verde Islands (Figure 41).

Remarks.—The 149.6 mm specimen listed by Morrow and Gibbs (1964) probably is *bimargaritatus*. It could not be located for this study, and so most barbel measurements could not be made, but the barbel length originally recorded (108.2 mm) fits both *bibulbosus* and *bimargaritatus*. A sketch of the end of the barbel shows the distance between bulbs to be about equal to the distal-bulb length, and a suggestion of a branch is indicated on the terminal filament about 4.5 bulb lengths out; both are characteristic of *bimargaritatus*, but the accuracy of the sketch is questionable. The specimen was taken at 20°31′N, 64°55′W, well within the known range of *bimargaritatus*, but several degrees south of the known range of *bibulbosus*. It is indicated by a question mark on the map (Figure 41).

Lectotype Designation.—We select as lectotype ZMUC P201950, unsexed, 89.3 mm SL. D 26. A 39. P1 3. P2 7. IP 7. PV 34. VAV 18. OV 33. VAL 18. AC 19. IA 59. IC 78. OA 51. OC 70. VAV photophores over anal-fin base 7. Branchiostegal photophores 10. Premaxillary teeth 9. Maxillary serra-like teeth 12. Mandibular teeth 10. Vertebrae 67.

Measurements (in mm): Predorsal length 73.7, preanal length 65.2, prepelvic length 53.6, head length 11.5, barbel length 55.1, proximal-bulb length 0.9, distal-bulb length 1.2, distance between bulbs 1.0, filament length 9.9, snout length 4.3, fleshy orbit length 2.8, postorbital-organ length 0.6, upper-jaw length 10.3, pectoral fin broken, pelvic-fin length 11.0 (end possibly broken), dorsal-base length 13.5, anal-base length 23.4, longest premaxillary tooth 1.6, longest mandibular tooth 1.7.

Material Examined (2 males, 7 females, 21 unsexed).—*Lectotype:* ZMUC P201950 (?, 89.3), 28°02′N, 62°26′W, 0–~150 m (300 mw), 8 May 1922.

Paralectotypes: ZMUC P201946–201947 (2?, 70.8, 70.9), 22°12′N, 48°00′W, 0–~150 m (300 mw), 1930, 28 Mar 1921. ZMUC P201948 (?, 86.2), 20°50′N, 66°30′W, 0–~100 m (200 mw), 2230, 9 Apr 1921. ZMUC P201949 (?, 70.6), 19°01′N, 65°23′W, 0–~150 m, 0050, 3 Jan 1922. BMNH 1929.7.6.103 (?, 88.7), 22°14′N, 67°22′W, 0–~50 m (100 mw), 2230, 27 Apr 1921. BMNH 1929.7.6.104 (?, 70.8), 22°31′N, 62°07′W, 0–~75 m (150 mw), 2000, 27 Feb 1921.

Non-types: MCZ 56660 (?, 105), 23°04′N, 45°10′W, 0–1100 m, 2332–0505, 17 Oct 1973. ISH 496/79 (?, 88.5), 24°23′N, 57°20′W, 0–100 m, 1725–2015, 31 Mar 1979. ISH 1068/79 (?, 74.0; ♀, 97.6), 25°14′N, 67°45′W, 0–1800 m, 1410–1820, 12 Apr 1979. ISH 3185/79 (?, 68.0), 26°42′N, 60°30′W, 0–150 m, 2117–2232, 24 Mar 1979. ISH 3186/79 (?, 76.7), 27°38′N, 52°22′W, 0–2000 m, 23 Apr 1979. ISH 3187/79 (?, 76.3), 25°19′N, 55°31′W, 0–800 m, 1710–1911, 3 Apr 1979. ISH 3188/79 (?, 79.6), 25°02′N, 67°38′W, 0–1800 m, 1707–1955, 10 Apr 1979. ISH 3189/79 (♀, 87.1; ?, 100.3), 24°41′N, 66°20′W, 0–1800m, 0400–0808, 10 Apr 1979. ISH 3190/79 (?, 89.8), 23°46′N, 58°59′W, 0–1200 m, 1542–1742, 28 Mar 1979. ISH 3191/79 (?, 92.3; ♀, 105.0), 25°08′N, 67°39′W, 0–1800 m, 0416–0820,

12 Apr 1979. IOAN uncat. (?, 99.4), 19°21′N, 80°38′W, 0–1000 m, 19 Mar 1973. IOAN uncat. (♀, 116.9), 19°10′N, 80°43′W, 0–1000 m, 19 Mar 1973. IOS uncat. (♀, 200.0), 17°31′N, 25°15′W, 0–1000 m, 0257–0952, 22 Nov 1969. USNM 224101 (♀, 97.7), 27°49′N, 52°13′W, 0–300 m, 1900–1948, 23 Apr 1979. USNM 224102 (?, 74.5), 25°49′N, 54°58′W, 0–2000 m, 22 Apr 1979. USNM 224103 (?, 90.6), 25°09′N, 58°07′W, 0–1200 m, 1630–1850, 4 Apr 1979. USNM 224104 (?, 85.3), 26°12′N, 37°41′W, 0–310 m, 1931–2110, 1 Dec 1970. USNM 224105 (♂, 142.8), 24°42′N, 60°30′W, 0–150 m, 1944–2058, 23 Mar 1979. USNM 224106 (♀, 114.1), 26°42′N, 79°31′W, 400–750 m, 1320–1657, 7 Aug 1978. USNM 224107 (♂, 102.2), 26°34′N, 40°56′W, 0–110 m, 2112–2305, 2 Dec 1970.

Eustomias bimargaritoides, new species

FIGURES 12*c*,*e*, 13*a*

Eustomias bibulbosus.—Clarke, 1974:344 [part; Hawaii area; *bibulboides*, *bituberoides* also included].

DIAGNOSIS.—Two terminal bulbs separated by a short interspace (1.1%–2.0% SL, 0.5–1.1 times length of distal bulb). Barbel length 44%–59% SL. Terminal filament long (21%–28% SL), with 2 long branches arising closely together at 6–11 distal-bulb lengths from the distal bulb (at all available sizes, 83–126 mm SL); all long branches with conspicuous closely spaced bulblets. Stem of filament with no bulblets and with 1–6 short, slender branches in its basal half. Barbel without melanophores (rarely very sparse on axis of stem). Paired middorsal spots under skin between occiput and dorsal-fin base, 8.

DESCRIPTION.—The barbel of *bimargaritoides* is 44%–59% SL, its growth apparently isometric in the observed size range (83–126 mm). In most specimens the barbel is entirely without melanophores. Three specimens have sparse, widely spaced melanophores along the stem axis, and 1 has some light, patchy external pigment near the bulb. None of these has pigment between the bulbs or in the filament. The external chevron-shaped or roundish striated aras are not pigmented.

The proximal bulb is variously spheroidal, ovoid, squarish, oblate, or lemon-shaped. The bulb appears to decrease relative to SL, from 1.2%–1.7% in specimens smaller than 100 mm to 1.0%–1.3% in the 2 largest (118 and 126 mm).

The distal bulb is ovoid and elongate, its width equal to or narrower than that of the proximal bulb. Distal-bulb length is 1.3%–2.1% SL, 1.0–1.3 times the proximal-bulb length, and does not appear to change relative to SL.

The distance between the bulbs is 1.1%–2.0% SL, 0.5–1.1 times the distal-bulb length, and also appears not to change relative to SL.

In all except 1 specimen, the terminal filament has 1–5 small, fairly widely spaced side branches proximally and 2 large branches arising together 6–11 distal-bulb lengths beyond the bulb. The long branches and main filament distal to the branching have prominent, closely spaced internal bulblets. The main filament is better developed than the branches and has more and larger bulblets and more secondary branches. There are no bulblets in the stem of the filament until just before the main branches arise.

Filament length is 21%–28% SL, 11–16 times the distal-bulb length, with no apparent change relative to SL.

The largest male (126 mm), which has well-developed testes, has a postorbital organ only 1.0 mm long (0.8% SL, 37% of fleshy orbit length). A 115 mm male with testes just beginning to enlarge has a 0.5 mm postorbital. Development of the organ in males apparently begins at a relatively large size, and it probably remains relatively small at larger SL.

No observations of barbel colors have been recorded.

DESCRIPTION OF HOLOTYPE.—Sex undetermined, 102.1 mm SL. D 25. A 38. P1 3. P2 7. IP 7. PV 34. VAV 17. OV 34. VAL 18. AC 19. IA 58. IC 77. OA 52. OC 71. VAV photophores over anal-fin base 6. Branchiostegal photophores 12. Premaxillary teeth 11 left, 14 right: from anterior

to posterior, a long fixed tooth followed by a long space, a fixed fang followed by a moderate space, a short fixed tooth, 2 long depressible teeth (2nd longer than 1st), 2 short fixed teeth (2nd longer), a missing tooth, a short-to-long series of 3 moderate depressible teeth, and a short-to-long series of 3 small depressible teeth (on the left side 2 represented by spaces, but there is no place for a 3rd). Maxilla with 3 small erect teeth and about 17 short, slanted, closely spaced serra-like teeth. Mandibular teeth 17 left, 18 right: from anterior to posterior, a short fixed symphysial tooth followed by a wide space, a fixed fang followed by a wide space, a long depressible tooth, 2 short fixed teeth, a long depressible tooth, 2 short-to-long series of 3 depressible teeth, a short-to-moderate series of 4 depressible teeth, and 2 short depressible teeth. The missing teeth on the left side of both jaws are represented by spaces, some with attachment marks. Vertebrae 68 (the first only partially ossified).

Measurements (in mm): Predorsal length 85.4, preanal length 73.0, prepelvic length 55.3, head length 11.8, barbel length 53.1, proximal-bulb length 1.6, distal-bulb length 2.1, distance between bulbs 1.1, filament length 28.5, snout length 3.9, fleshy orbit length 2.8, postorbital-organ length 0.7, lower-jaw length 11.8, upper-jaw length 10.7, depth behind head (greatest depth) 7.0, caudal-peduncle least depth 1.9, pectoral-fin length 15.4, pelvic-fin length 16.0, dorsal-base length 14.1, anal-base length 26.2, longest premaxillary tooth 2.1, longest mandibular tooth 1.7.

Barbel with slightly oblate-spheroidal proximal bulb, long-ovoid distal bulb narrower than proximal bulb. Terminal filament with a short side branch 2.6 mm from distal bulb, 2 together at 4.4 mm; 2 long branches arise 16.8 mm from bulb, these and main filament with distal secondary branches.

SIMILAR SPECIES.—The North Atlantic *E. bimargaritatus* closely resembles *bimargaritoides* in having large branches arising well distad on the filament, but in *bimargaritatus* these branches arise closer to the bulb (1–5 distal-bulb lengths out except in a 200 mm specimen, in which they are 10 bulb lengths out) and have smaller, more widely spaced bulblets. The filament is shorter in *bimargaritatus* (16% SL or less, except in a 200 mm specimen, vs. 21%–28%); proximal to the long branches, tiny bulblets are present and short side branches are absent (1 exception); and the barbel tends to be longer (in specimens larger than 90 mm 58%–70% SL vs. 44%–59%). *Eustomias arborifer*, *E. crossotus*, and *E. grandibulbus* have branches arising closer to the bulb than in any *bimargaritoides*, and *crossotus* and *grandibulbus* have the stem axis well pigmented in all except the smallest specimens.

REMARKS.—One specimen, 102 mm SL, lacks branches, and there is no sign that these have been broken off. The end of the simple filament has very few bulblets, but has longish bodies that were not seen in other specimens of *bimargaritoides*. This specimen (not designated as a paratype) is considered to be *bimargaritoides*, because its filament (21% of SL) is longer than in any other Pacific species with a simple filament except *bituberoides*, which has a much longer barbel.

DISTRIBUTION.—Known from the North Pacific near the Hawaiian Islands and from the South Pacific near the Marquesas Islands (Figure 41).

ETYMOLOGY.—A Latin adjective from the species name, *bimargaritatus* (adorned with two pearls), plus the suffix *-oides* (resembling), *bimargaritoides* alludes to the similarity of the terminal barbel filaments of the 2 species.

MATERIAL EXAMINED (2 males, 4 females, 3 unsexed).—*Holotype:* SIO 71-296 (?, 102.1), 27°28′N, 155°26′W, 29 Sep 1971.

Paratypes: USNM 224094 (♀, 118), 21°20′N, 158°02′W, 0–810 m, 1045–1355, 14 Dec 1970. USNM 224096 (♀, 83), 21°20′N, 158°20′W, 0–350 m, 2245–0044, 26 May 1974. USNM 224097 (♂, 126.3), 07°52′S, 135°04′W, 0–176 m, 2006–2107, 21 Aug 1956. USNM 224098 (?, 103.7), 21°20′N, 158°20′W, 0–1200 m, 1122–1543, 4 Jul 1978. USNM 224099 (♀, 94), 06°33′S, 139°30′W, 0–337 m, 2010–2111, 22 Nov 1955. USNM 224100 (?, 83.5), 15°50′N, 158°00′W, 0–300 m, 0021–0215, 13 Jul 1979. BPBM 26413 (♂, 95),

TABLE 4.—Synopsis of characters of Group III species (SL is given (in mm) when characters are from only part of the size range; see footnotes for "Other characters")

Species	Barbel length (% SL)	SL	Proximal bulb (% SL)	SL	Distal bulb (% SL)	SL	Distal/ proximal bulb	SL	Interbulb distance (% SL)	SL	Interbulb distance/ distal bulb
bertelseni	43–60		0.9–1.4		0.9–1.5		1.0		2.7–3.0		2.0–3.0
kreffti	17–19	≤78	0.3–0.4	≤76	0.7–0.8	≤76	2.5	67	0.5–2.0		0.4–1.6
	37–44	≥84	0.7–0.8	78–114	1.1–1.5	≥78	1.4–1.9	76–114			
			1.0–1.2	112–125			1.2–1.3	≥121			
medusa	36–65		0.2–0.5		0.7–1.1	≤85	2.0–3.0	≤110	0.8–2.4		1.5–3.6
					0.5–0.7	≥130	1.5–2.0	≥110			
melanonema	76–92		1.2–1.5	86–102	2.0–2.8	86–102	1.5–2.0	86–102	2.4–3.5	86–94	0.6–1.8
			0.7	148	1.7	148	2.5	148	1.8–2.5	101–102	
									1.4	148	
melanostigma	48–82	most	0.3–0.5	≤72	0.6–0.7	≤72	1.2–2.5		2.1–2.2	72–85	1.7–3.8
		≥70	1.2–1.6	71–76	1.7–2.2	71–81			3.4–4.1	71–96	
			0.5–0.9	≥120	1.0–1.5	≥120			2.5–2.8	≥120	
melanostigmoides	67–86	≥90	0.3–0.7		0.7–1.5		1.5–4.3		1.0–2.4		1.6–2.4
multifilis	45		0.7		0.8		1.2		1.6		1.9
posti	43–50		0.8–1.2		2.0	≤100	0.9–1.6		1.9–2.6		1.3–2.5
					0.8–1.2	≥100					
suluensis	50–59		0.7–0.8		1.2–1.3		1.5–1.8		2.4–2.8		1.9–2.4

[a] Stem axis pigmented. [b] Stem axis pigmented or not. [c] Filament axis pigmented after 80 mm SL. [d] Some filaments pigmented externally. [e] Filaments pigmented externally or not. [f] Distal bulb narrowed, with distal rostrum. [g] Central branch usually forked. [h] Proximal + distal bulb 2.7 mm or more. [i] Proximal + distal bulb 2.7 mm or less. [j] Filaments on stem, sides of bulb. [k] AC 15, IC 69.

20°59′N, 158°34′W, 0–122 m, 1952–0152, 25 Jul 1967.

Non-type: USNM 224095 (♀, 102), 21°20′N, 158°20′W, 0–1100 m, 0245–0600, 31 Aug 1973.

GROUP III

The species of this group have 2 terminal bulbs and 3 to many terminal filaments arising together from the distalmost bulb. In some species the filaments are simple and only about twice as long as the bulb; in others the filaments are very long and may have prominent bulblets or elongate inclusions. Nine species comprise this group. A synopsis of their salient characters is given in Table 4, and their barbel and postorbital-organ dimensions are plotted in Figures 22–25.

Eustomias melanostigma Regan and Trewavas, 1930

FIGURE 18*c,d*

Eustomias melanostigma Regan and Trewavas, 1930:85 [2 syntypes, 17°43′ and 45′N, 64°56′W].—Morrow and Gibbs, 1964:417, 418 [part; *melanonema* in synonymy; no additional specimens].—Blache, Cadenat, and Stauch, 1970 [part; in key; no additional specimens].

Eustomias bibulbosus.—Parin and Pokhilskaya, 1974:353–355 [part, *Vityaz* sta 4921; examined by us].—Bekker et al., 1975:305 [part, sta 1256; examined by us].—Parin et al., 1977:101, 102 [part, *Vityaz* sta 7285; examined by us].

DIAGNOSIS.—Two terminal bulbs separated by

Terminal filaments (% SL)	Filament number	Filament inclusions	Male postorbital (% SL) [SL]	Male postorbital (% eye)	Predorsal pairs of spots	Other characters
17–19 (21)	4 long, no short, no branches	long inclusions + bulblets	-	-	8–9	a,d
7–35 increase w/SL	2 long, 3–9 short, some branches	large bulblet in 1 long, swollen tips in short	1.3–1.7 [114–124]	43–60	8	a,c
5–13	7–10 short, complex	prominent bulblets, largest near mid-length	1.5 [150]	64	(7) 8	b,f,g
≤6	5–9 short, simple	none	1.3 [101]	46	8	b,d,h
≤10	3–7 short, simple	none	1.0–1.9 [123–136]	39–71	7–8 (9)	a,d,i
≤9	4–6 short, simple	none	0.8 [115]	29	8 (9)	a,e
1.3	16 short, some branched	bulblets in all	1.7	57	7	a,j,k
13–29	4 long, no short, some branched	bulblets conspicuous in all	1.2–1.9 [124–156]	56–71	(7) 8	a,e
15–20	3 long, no short, no branches	bulblets very small	-	-	9 in 1	b,e

a long distance (2.1%–4.1% SL, 1.7–3.8 times length of distal bulb in specimens larger than 70 mm SL). Barbel length 31%–82% SL except when developing. Three to 7 short terminal filaments (less than 10% SL), without prominent bulblets, arising together from distal bulb or from a short distal stem; 1 filament thicker and longer than the rest. Some or all filaments with pigmented axes. Distal bulb ovoid in shape, only slightly longer than wide, 1.0%–2.2% SL (smaller in some specimens less than 75 mm), 1.2–2.5 times proximal-bulb length. Sum of proximal- and distal-bulb lengths 2.7 mm or less. Axis of stem and between bulbs variably pigmented; a black spot or cap almost always formed at proximal end of distal bulb. External chevron-shaped or roundish striated areas on stem unpigmented. Middorsal paired spots between occiput and dorsal-fin origin 7 or 8, occasionally 9.

DESCRIPTION.—The barbel apparently grows very rapidly in small specimens, those 70–75 mm SL having barbels 31%–82% SL. The range at most larger sizes is 48%–80% and appears not to change relative to SL with growth. Almost all specimens have the axis of the stem peppered with melanophores, some lightly, others fairly darkly; there is a tendency for the portion just preceding the proximal bulb to become noticeably lighter. The external chevron-shaped or roundish areas are unpigmented. The axis between the bulbs is unpigmented or very sparsely pigmented proximally, becoming darkly pigmented

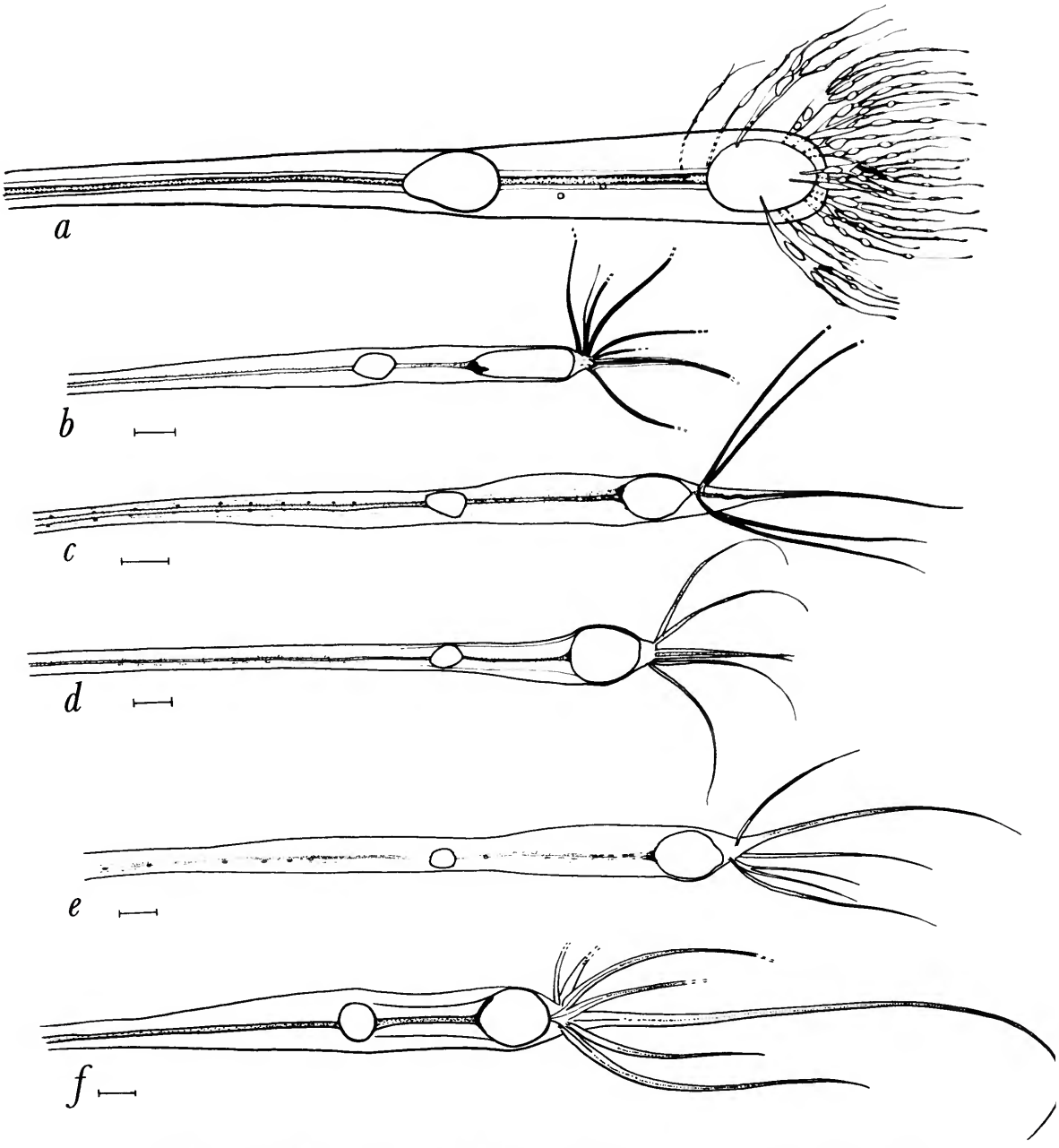


FIGURE 18.—Barbel ends of Group III species: *a*, *E. multifilis*, 144.5 mm SL, ZIAN 42661 (after Parin and Pokhilskaya, 1978a); *b*, *E. melanonema*, 147.8 mm SL, IOAN uncatalogued; *c*, *d*, *E. melanostigma* (*c*, 134.6 mm SL, USNM 223737 (Atlantic); *d*, 120.1 mm SL, IOAN uncatalogued (Indian Ocean)); *e*, *f*, *E. melanostigmoides* (*e*, holotype, 165 mm SL, USNM 223765; *f*, paratype, 155 mm SL, USNM 223766). (Bar = 1 mm.)

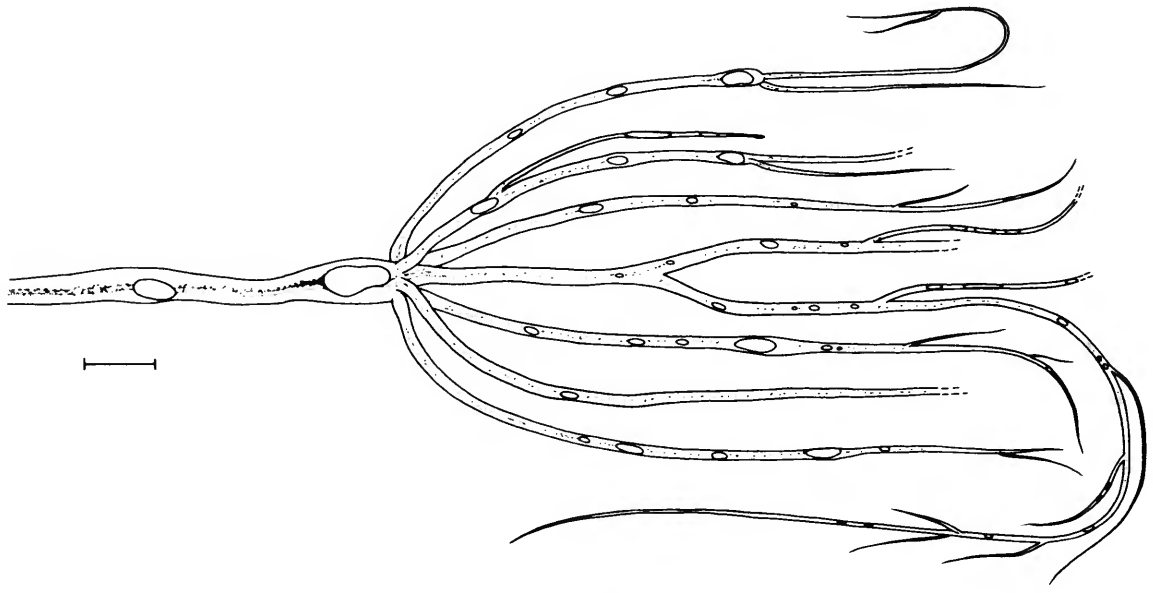


FIGURE 19.—Barbel end of *E. medusa*, paratype, 150 mm SL, USNM 223844, a Group III species. (Bar = 1 mm.)

distally in specimens smaller than about 100 mm: pigmentation in this area is relatively uniform in larger specimens. At the base of the distal bulb, pigmentation becomes very dark on 1 side of the axis to form a spot, or, usually, a partial cap that extends distad a short distance on the bulb. Two small Indo-Pacific specimens (58 and 81 mm) lack pigment in the stem, between bulbs, and in the filaments. The larger of these has a barely visible spot at the base of the distal bulb; the specimen is somewhat faded generally, but no more so than some other specimens. The smaller specimen is quite bleached and also has the least-developed barbel of any *melanostigma*.

The proximal bulb is spheroidal to ovoid in shape, occasionally with 1 or both ends flattened; in 1 small specimen this bulb is long and very thin, perhaps having been damaged. The distal bulb is short-ovoid to long-ovoid and larger in every dimension than the proximal; it is almost rectangular in 1 specimen and notably smaller distally in another.

Both the proximal and distal bulbs apparently attain their largest relative length at less than 80 mm SL, after which they grow little or not at all and decrease relative to SL. The proximal bulb is 0.3%–0.5% SL in 2 specimens 58 and 72 mm, 1.2%–1.6% in 3 specimens 71–76 mm, and decreases to 0.5%–0.9% in 5 specimens 120–136 mm. The distal bulb is 0.6%–0.7% SL at 58–72 mm, 1.7%–2.2% at 71–81 mm, and decreases to 1.0%–1.5% at 120–136 mm. The distal bulb is 1.2–2.5 times as long as the proximal bulb.

The distance between bulbs is 1.4% SL at 58 mm, 2.1%–2.2% in 2 specimens 72 and 85 mm, and 3.4%–4.1% in others 71–96 mm. Thereafter the distance decreases relative to SL to 2.5%–2.8% at 120–136 mm. The interspace is 1.7–3.8 times the length of the distal bulb.

Three to 7 short, simple terminal filaments arise close together either directly from the distal end of the distal bulb or from a short stem; 1 of these filaments is thicker and longer than the others, and this filament is less than 10% SL. There is no apparent change in length relative to SL with growth. The dominant filament has its axis well-pigmented about 3 melanophores wide; the remaining filaments usually have a single row

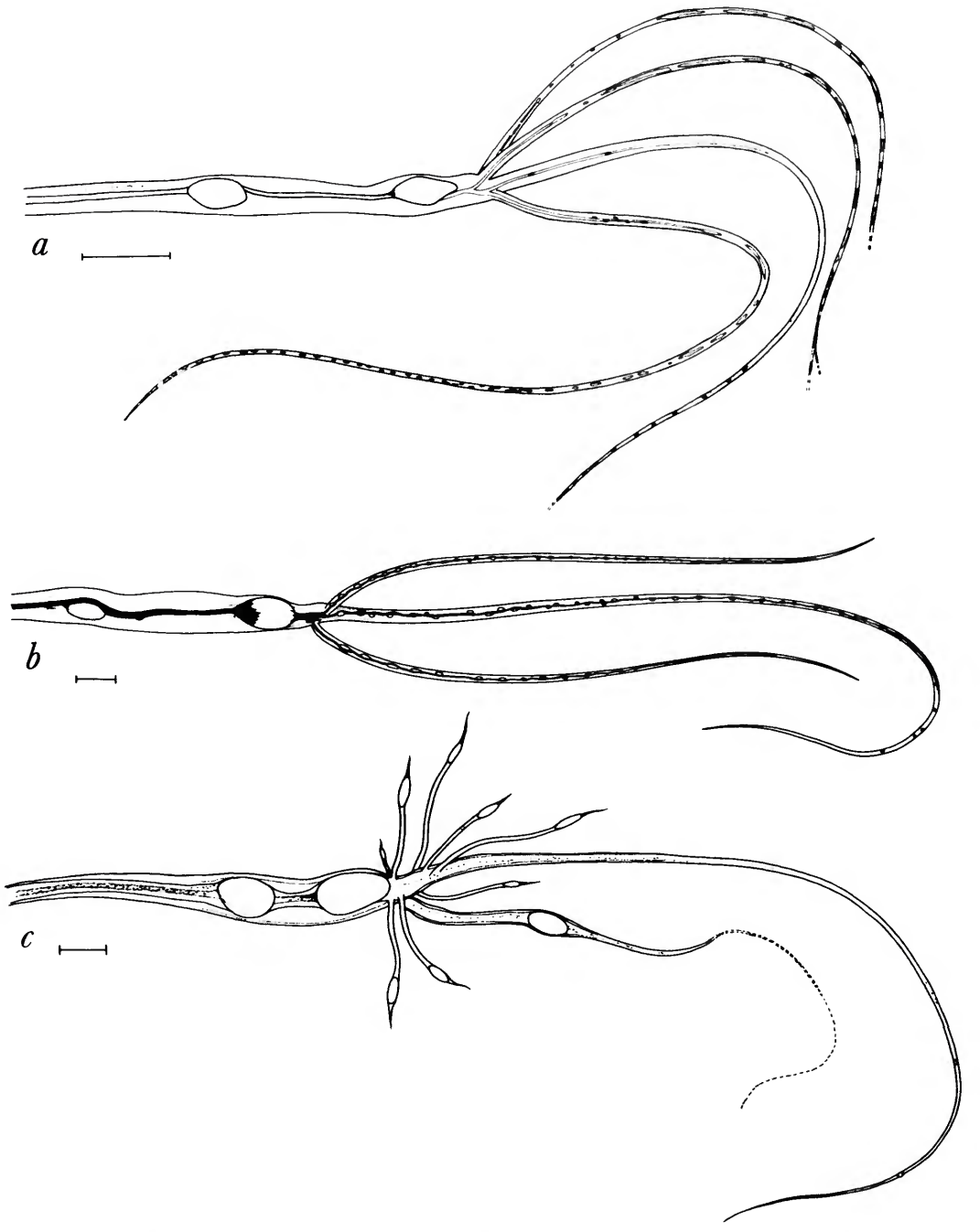


FIGURE 20.—Barbel ends of Group III species: *a*, *E. bertelseni*, holotype, 66.5 mm SL, ZMUC P202851; *b*, *E. suluensis*, holotype, 138.3 mm SL, USNM 223714; *c*, *E. kreffti*, paratype, 107 mm SL, ISH 562/74 (1 long filament broken). (Bar = 1 mm.)

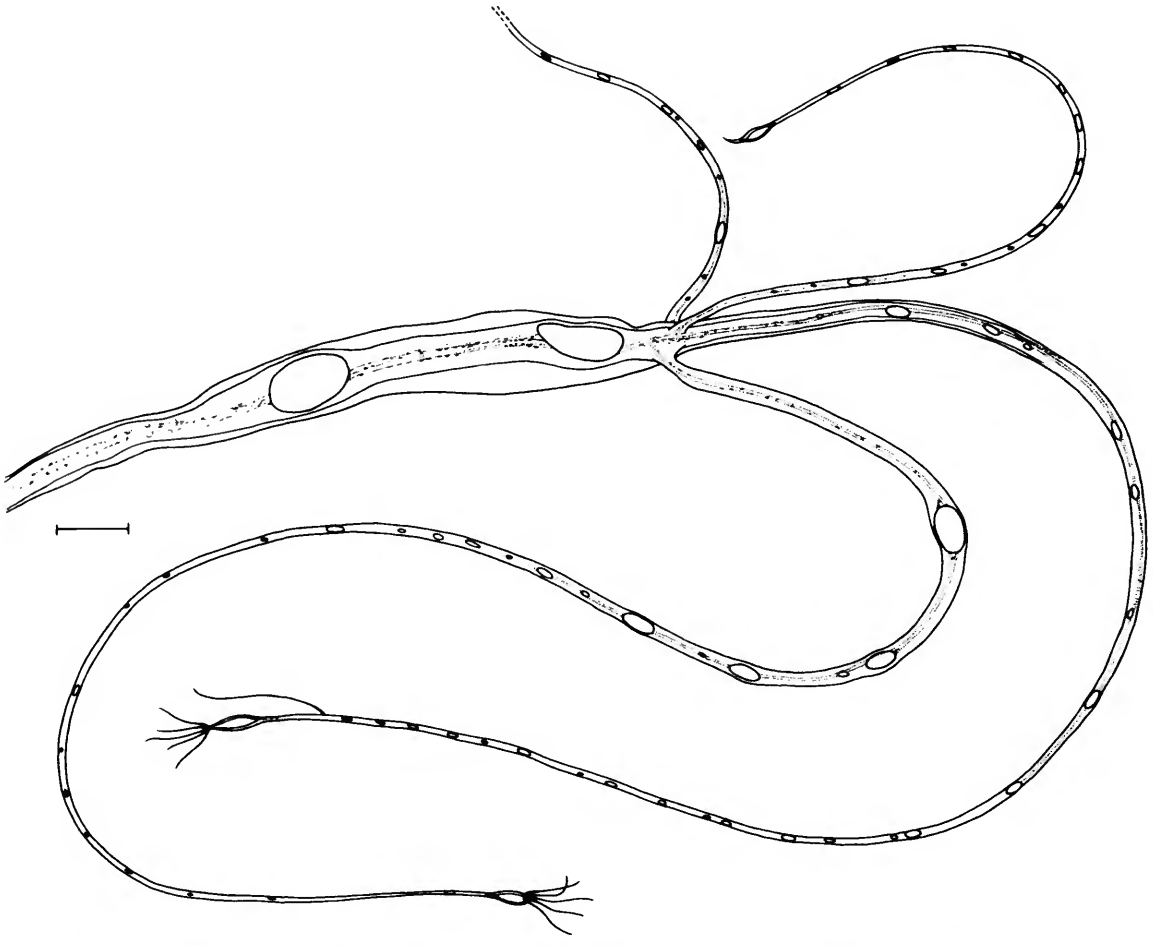


FIGURE 21.—Barbel end of *E. posti*, paratype, 156.4 mm SL, ISH 1857/66, a Group III species. (Bar = 1 mm.)

of melanophores and are lighter than the strongest filament, but some may lack pigment entirely. Tiny bulblets are seen occasionally, but are absent in almost all.

The postorbital organ in the 2 largest males (135 and 136 mm) is 1.3%–1.9% SL, 39%–71% of fleshy orbit length. The next smaller male, 123 mm, has an organ which may be in the process of enlarging, 1.0% SL, 41% of fleshy orbit.

There was no color other than from blood vessels in the bulbs or other parts of the barbel of a 76 mm specimen from southwest of the Canary Islands. In a fresh 123 mm male from the same vicinity, both bulbs were light grayish blue. Parin et al. (1977) observed that both bulbs of their 85 mm specimen from *Vityaz* station 7285 were green (salatnyi tsvet).

LECTOTYPE DESIGNATION.—We select as lectotype ZMUC P201971, an immature male, 102.4 mm SL. D 25. A 37. P1 3. P2 7. IP 7. PV 32. VAV 18. OV 33. VAL 20. AC 18. IA 57. IC 75. OA 53. OC 71. VAV photophores over anal-fin base 7. Branchiostegal photophores 11. Premaxillary teeth 13. Mandibular teeth 16. Terminal

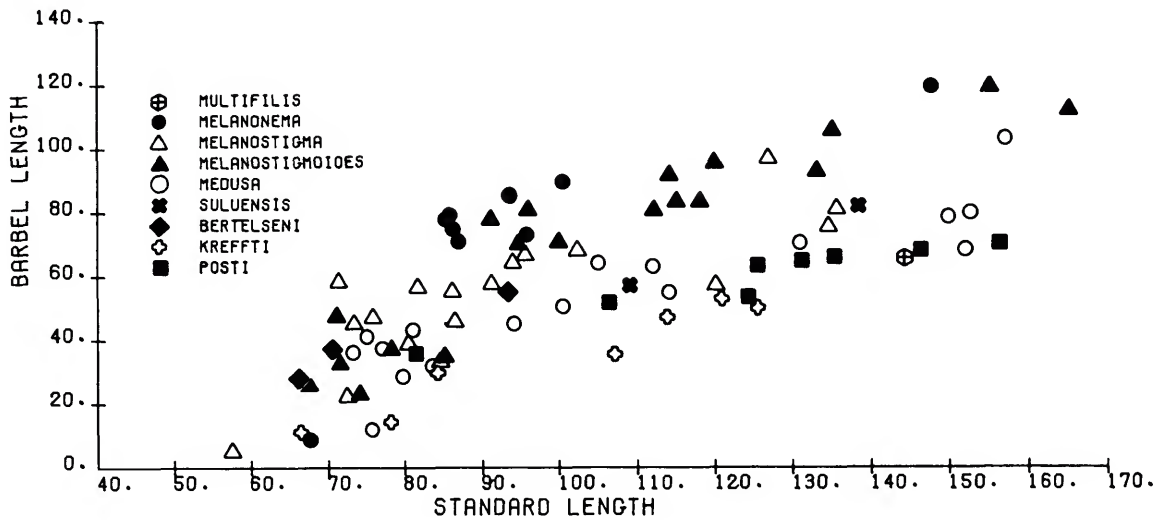


FIGURE 22.—Barbel length (mm) vs. SL (mm) in Group III species.

filaments 6, 1 without pigment, the others with well-pigmented axes. Vertebrae 68, the 1st only partially ossified.

Measurements (in mm): Predorsal length 86.6, preanal length 75.1, prepelvic length 58.5, head length 13.5, barbel length 67.8, proximal-bulb length 1.0, distal-bulb length 1.5, distance between bulbs 3.0, longest filament length 3.5, snout length 6.3, fleshy orbit length 3.0, postorbital-organ length 0.7, lower-jaw length 11.5, upper-jaw length 10.5, depth behind head (greatest depth) 7.3, caudal-peduncle least depth 2.3, pectoral and pelvic fins broken, dorsal-base length 13.4, anal-base length 24.6, longest premaxillary tooth 2.0, longest mandibular tooth 1.5.

SIMILAR SPECIES.—Two other species have 2 terminal bulbs and several short, simple terminal filaments that have no well-developed bulblets or other inclusions: *melanonema* from the eastern Atlantic and *melanostigmoides* from the Pacific. In other species with 2 terminal bulbs and multiple terminal filaments, the filaments are longer than 10% SL or have prominent bulblets or inclusions, or both.

In *melanonema*, the distal bulb is parallel-sided and more than twice as long as wide, whereas it is ovoid and only slightly longer than wide in *melanostigma*. The smallest *melanonema* (68 mm), however, has a short, ovoid bulb and is considered to be that species only on the basis of its capture locality. It is not considered in the following discussion, but it suggests that bulb shape may not always be diagnostic. Bulb lengths and barbel length are helpful characters, but statements concerning them are tentative, because only 1 range of sizes is represented in both species: 85–102 mm in *melanonema*, 81–102 mm in *melanostigma*. The only other *melanonema* specimen is 148 mm; *melanostigma* has groups of 71–81 mm and 120–136 mm. With these limitations in mind, the barbel in *melanonema* is 76%–92% SL; in most *melanostigma* it is less than 70%, but in a 71 mm specimen it is 82% and in a 127 mm specimen, 76%. In specimens larger than 81 mm the distal bulb in *melanonema* is 1.7%–2.8% SL, in *melanostigma* 1.0%–1.6%, but in 71–81 mm *melanostigma* the bulb is 1.7%–2.2%. We can anticipate considerable overlap in specimens smaller than about 90 mm. When the lengths of the proximal and distal bulbs are added together for specimens larger than 72 mm, the sum in *melanonema* is 2.7–4.3 mm, in *melanostigma* 1.5–2.7 mm. The distance between bulbs is 0.6–

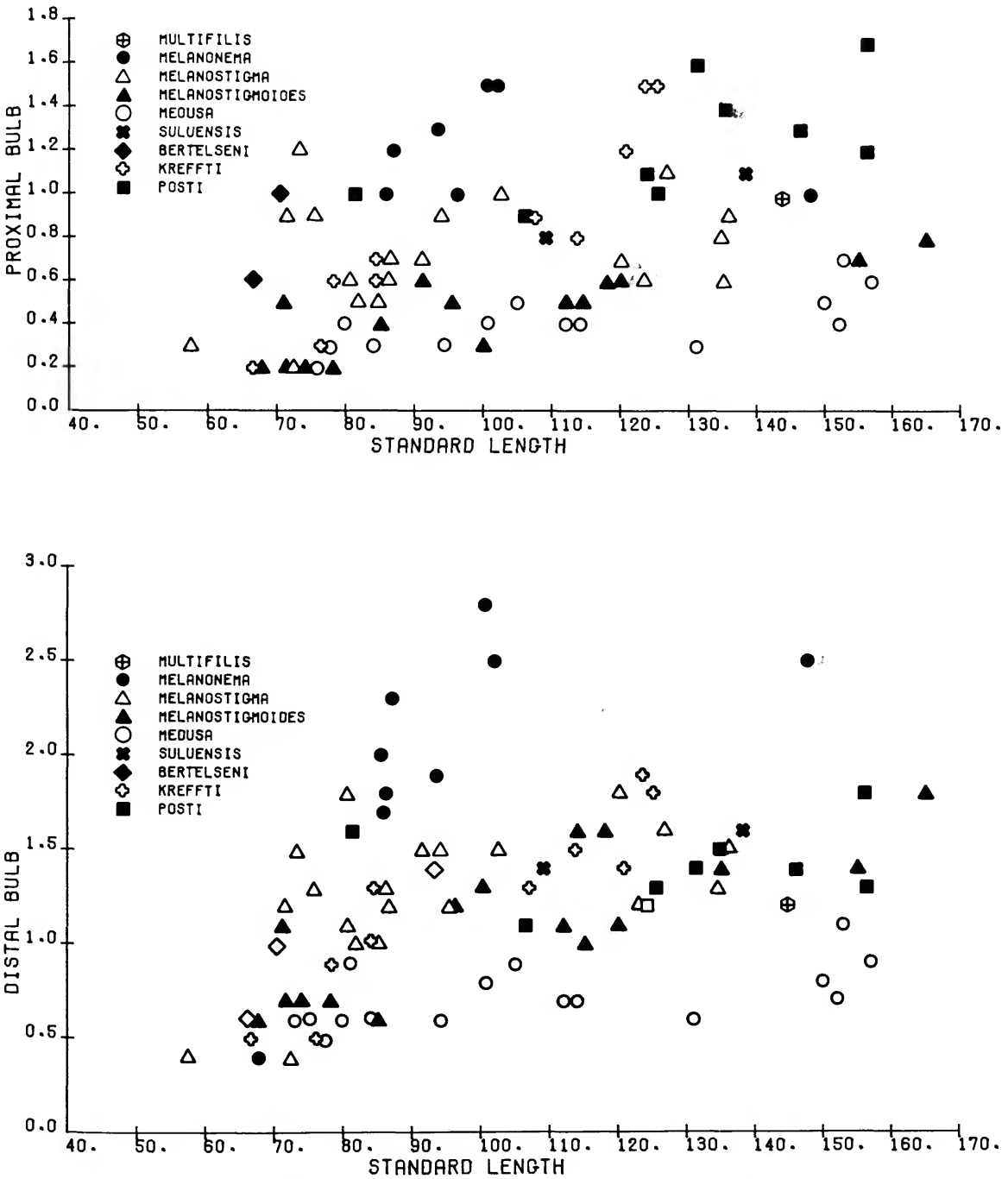


FIGURE 23.—Proximal-bulb and distal-bulb lengths (mm) vs. SL (mm) in Group III species. Calculated for *E. multifilis* (see text).

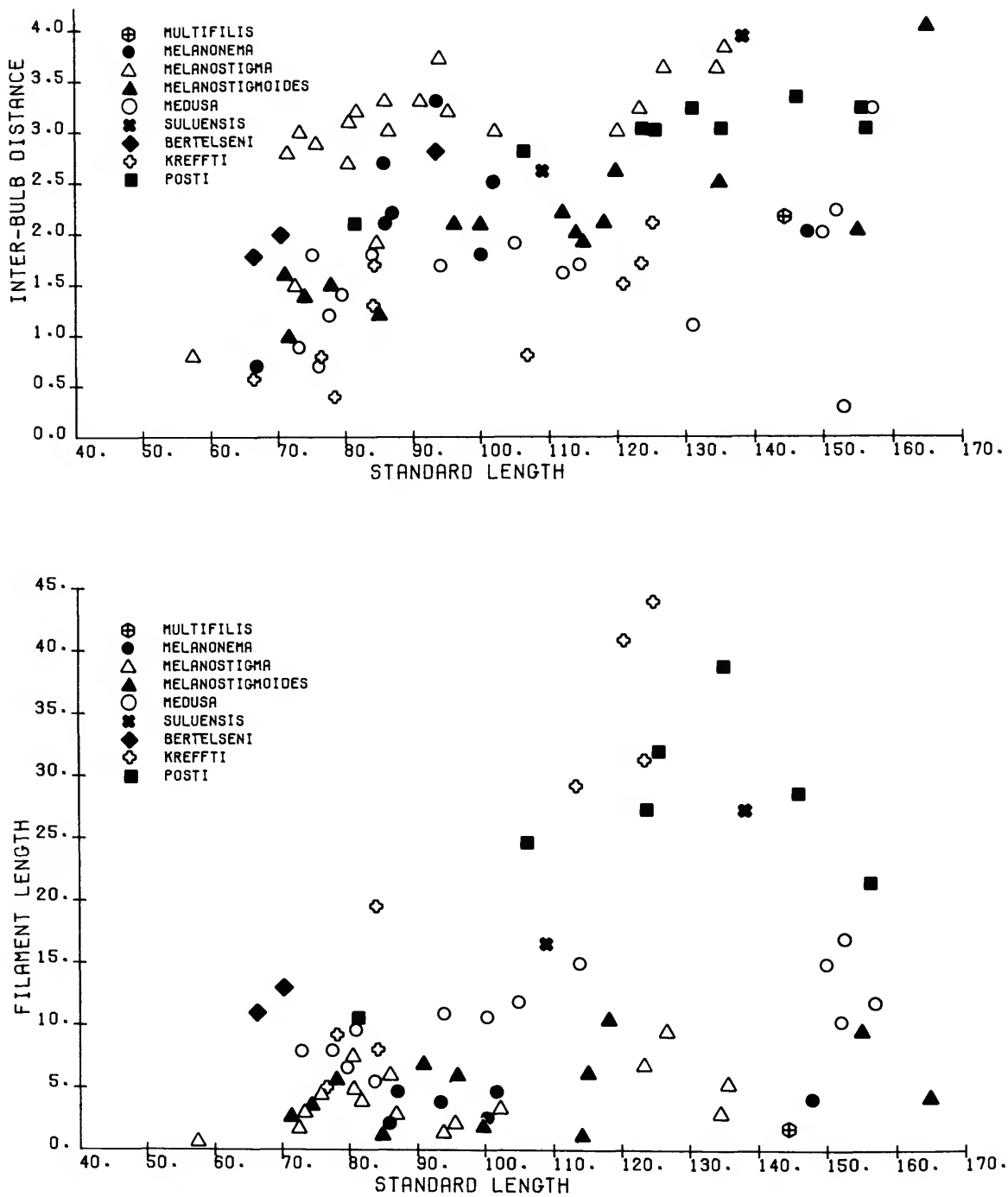


FIGURE 24.—Inter-bulb distance (mm) and filament length (mm) vs. SL (mm) in Group III species. Inter-bulb distance calculated for *E. multifilis* (see text).

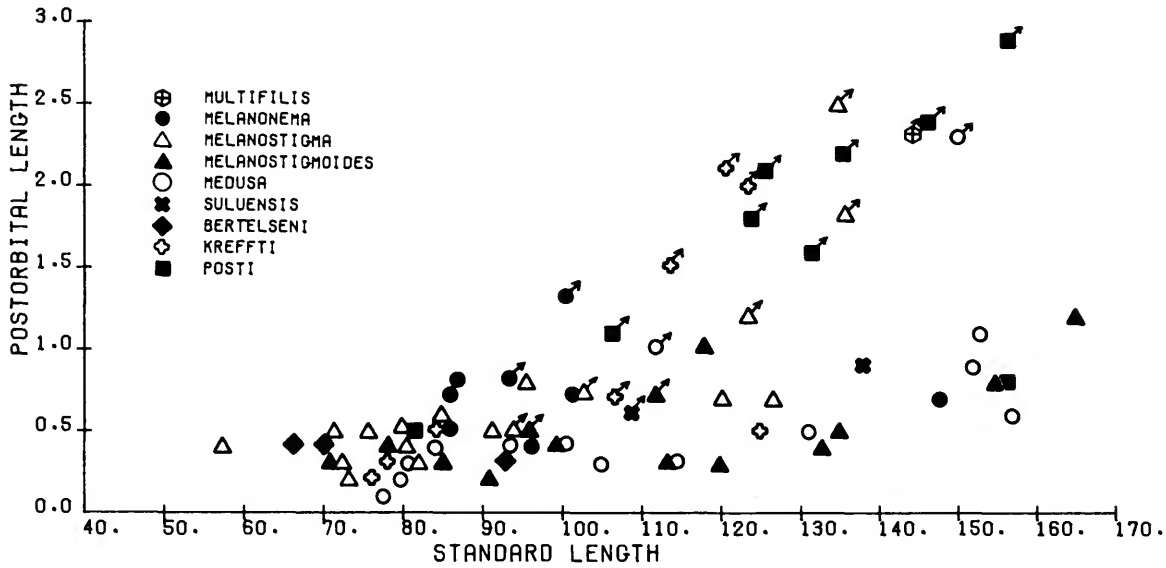


FIGURE 25.—Postorbital-organ length (mm) vs. SL (mm) in Group III species. Specimens not marked as males include both females and unknowns. Calculated for *E. multifilis* (see text).

1.8 times the distal-bulb length in *melanonema*, 1.7–3.8 times in *melanostigma*; in most *melanostigma* the ratio is greater than 2.0.

In *melanostigmoides* the barbel is also longer than in *melanostigma* in most specimens at sizes greater than 85 mm (maximum 86% of SL), the proximal bulb is generally smaller (Figure 23), and the distance between the bulbs is generally smaller (at sizes over 85 mm 1.3%–2.4% of SL vs. 2.4%–4.1%, Figure 24).

DISTRIBUTION.—Atlantic Ocean north of the equator in a broad semicircle extending from near Madeira in the east southwestward to about 6°N, 35°W and northwestward to the Straits of Florida in the west. Three localities in the Indian Ocean: 1 between northern Madagascar and Africa, 2 in the central part at 4°N and 11°S. Three localities in the western Pacific Ocean: 1 just north of New Guinea and 2 near Halmahera. This is the only species of *Nominostomias* known to occur in both the Atlantic and the Indo-Pacific (Figure 42).

GEOGRAPHIC VARIATION.—There are few apparent differences between Atlantic and Indo-Pacific specimens of *melanostigma*. The distal bulb appears to be larger in Indo-Pacific specimens (Figure 23); 2 have larger bulbs than any Atlantic specimen, and 2 others equal the largest observed from the Atlantic. Similarly, the longest terminal filament is longer in Indian Ocean forms (Figure 24), where the maximum relative length is 9.3% of SL, the mean 6.2%; in the Atlantic the maximum is 5.9%, the mean 3.6%. Some of the filament difference could be due to breakage.

MATERIAL EXAMINED (5 males, 5 females, 10 unsexed).—*Lectotype:* ZMUC P201971 (♂, 102.4), 17°43′N, 64°56′W, 0–~150 m (300 mw), 1920, 4 Mar 1922.

Paralectotype: BMNH 1929.7.6.105 (?, 95.5), 17°45′N, 64°56′W, 0–~150 m (300 mw), 1900, 13 Mar 1922.

Non-types (Atlantic): ZMUC P202727 (?, 84.8), 13°35′N, 30°11′W, 0–~150 m (300 mw), 2200, 6 Nov 1921. USNM 206680 (♂, 123.4), 23°47′N, 20°59′W, 0–2100 m, 1745–2147, 19 Apr 1971. USNM 223736 (♂, 94.0), 07°43′N, 42°04′W, 0–100 m, 0045–0245, 23 Mar 1977. USNM 223737 (♂, 134.6), 18°29′N, 29°13′W, 0–155 m, 2155–0010, 26 Nov 1970. USNM 223739 (♀, 81.8), 05°32′N, 34°40′W, 0–100 m, 0145–

0345, 20 Mar 1977. USNM 223740 (?, 72.4), 11°12′N, 53°49′W, 0–140 m, 0335–0530, 28 Mar 1977. MCZ 56656 (?, 86.5), 09°03′N, 40°41′W, 0–455 m, 2110–2310, 19 Sep 1973. ISH 1731/66 (♂, 135.8), 31°41′N, 17°19′W, 0–230 m, 2140–2300, 11 May 1966. ISH 323/68 (?, 75.7), 26°10′N, 19°26′W, 0–580 m, 2233–2303, 22 Jan 1968. UMML 33541 (?, 73.3), 24°25′N, 79°47′W, 0–700 m, 1515–1808, 22 Feb 1974. IOAN uncat. (?, 71.4), 19°24′N, 80°32′W, 0–1500 m, 1326–1615, 19 Mar 1973.

Non-types (Indo-Pacific): ZMUC P202848 (?, 57.5), 03°18′N, 129°02′E, 0–~300 m (600 mw), 2145, 8 Jul 1929. ZMUC P202849 (♀, 126.7), 01°13′S, 138°42′E, 0–~1450 m (2900 mw), 0730, 23 Jul 1929. ZMUC P202852 (?, 86.1), 03°14′N, 75°21′E, 0–~150 m (300 mw), 2010, 3 Dec 1929. USNM 223738 (?, 80.5), 12°06′S, 44°21′E, 0–600 m, 19 Aug 1964. IOAN uncat. (♀, 120.1), 11°14′S, 88°48′E, 13 Jun 1977. IOAN uncat. (♀, 91.2), 04°22′N, 83°06′E, 0–1000 m, 24 Jan 1961. IOAN uncat. (♀, 80.6), 03°08′N, 130°57′E, 25 Mar 1975.

Eustomias melanonema Regan and Trewavas, 1930

FIGURE 18*b*

Eustomias melanonema Regan and Trewavas, 1930:85, 86 [holotype and 1 non-type, the latter considered herein to be *E. melanostigma*].—Fowler, 1936:1179 [compilation; no new specimens].

Eustomias melanostigma.—Morrow and Gibbs, 1964:417, 418 [part; *melanonema* in synonymy; no additional specimens].—Backus et al., 1965:143 [1 specimen, examined by us].—Blache et al., 1970 [part, fig. 460].

Eustomias bibulbosus.—Parin, Sazonov, and Mikhailin, 1978:172 [2 specimens from Gulf of Guinea, 1 examined by us].

DIAGNOSIS.—Two terminal bulbs separated by a long distance (1.4%–3.5% SL, 0.6–1.8 times length of distal bulb). Barbel length 76%–92% SL. Five to 9 short (less than 6% SL) filaments, without prominent bulblets, arising together from distal bulb or from a short distal stem; 1 filament thicker and longer than the rest. Some or all filaments with pigmented axes (unpigmented or completely faded in 1 specimen). Distal bulb long (1.7%–2.8% SL), about twice as long as wide, with almost straight, parallel margins, 1.5–2.5 times proximal-bulb length. Axis of stem and between bulbs with or without pigment, a black spot at proximal end of distal bulb in those with pigment. External chevron-shaped or roundish striated areas on stem unpigmented. Middorsal paired spots between occiput and dorsal-fin origin 8.

DESCRIPTION.—A developing 68 mm specimen is considered to be *melanonema* on the basis of its capture locality. It could as easily be *melanostigma* and is omitted from the diagnosis and description. All except 1 of the remaining specimens are 86–102 mm, the largest is 148 mm. Growth changes, therefore, are noted tentatively.

Barbel length is 76%–92% SL and apparently does not change with growth. Barbel pigmentation is exceedingly variable. The axis of the stem and between the bulbs is unpigmented to moderately peppered with melanophores. A dark spot or cap at the proximal end of the distal bulb is sometimes present, sometimes absent. The filament axes are usually well pigmented, but are all unpigmented in 1 specimen. The external chevron-shaped or roundish striated areas on the stem are unpigmented.

The proximal bulb is ovoid to long-ovoid, truncate anteriorly in 1 specimen, straight-sided in another. The distal bulb is long with parallel sides (cylindrical) with the ends rounded or truncate, its length about twice its width.

The proximal bulb is 1.2%–1.5% SL at 86–102 mm, decreasing to 0.7% at 148 mm. The distal bulb decreases from 2.0%–2.8% SL to 1.7%. Apparently, neither bulb increases much or at all in size after 85 mm SL. The distal bulb is 1.5–2.0 times the length of the proximal in the smaller specimens, 2.5 times in the largest.

The distance between the bulbs also decreases relative to SL, from 2.4%–3.5% at 86–94 mm to 1.8%–2.5% at 101–102 mm and 1.4% at 148 mm. Again, there appears to be no increase in actual size with growth. The distance is 0.6–1.8 times the distal bulb length, with no apparent relationship to SL.

Five to 9 short, simple terminal filaments arise close together either from the distal end of the distal bulb or from a short stem. One filament is thicker and longer than others, and this filament is less than 6% of SL and does not change relative to SL. No bulblets were seen in the filaments.

There are no large males to indicate the definitive size of the postorbital organ. The largest, 101 mm, has an organ 1.3 mm long (1.3% SL, 46% of fleshy orbit), which is larger than in most males of other species at that size. This indicates early development and suggests the possibility of a large organ in large males.

In 2 fresh specimens, 1 (87.0 mm, sex undetermined) had a dark purple proximal bulb and a distal bulb that was dark purple basally, becoming light purple for most of its length; the other (102.0 mm female) had both bulbs light purple.

SIMILAR SPECIES.—The geographically adjacent *melanostigma* is the most similar species, but has an ovoid distal bulb that is only slightly longer than wide, a generally shorter barbel and distal bulb, a smaller sum of proximal- plus distal-bulb lengths, and a larger ratio of distal bulb to interspace. Details are given under *melanostigma.*

In Pacific *melanostigmoides*, the only other 2-bulbed species with multiple short filaments that lack bulblets or inclusions, the barbel is 65% SL or less (76% or more in *melanonema*) and both proximal and distal bulb are smaller (Figures 22 and 23).

REMARKS.—The 85 mm specimen taken with the holotype, noted by Regan and Trewavas (1930) as having the small head and short paired fins of a juvenile, has been reidentified as *melanostigma.* Its barbel length and bulb lengths are consistent with other *melanostigma*, but the distance between the bulbs is suggestive of *melanonema.* The distal bulb is ovoid, however, and does not resemble the long, parallel-sided bulbs of other *melanonema.* The capture locality, 13°35′N, 30°11′W, appears to be in a narrow zone of overlap in the ranges of the 2 species.

DISTRIBUTION.—Apparently restricted to a portion of the eastern tropical Atlantic extending from the Gulf of Guinea to west of the Cape Verde Islands (the Guinean Province of Backus et al., 1977; Figure 42).

MATERIAL EXAMINED (2 males, 4 females, 4 unsexed).—*Holotype:* ZMUC P201904 (♀, 86.1), 13°35′N, 30°11′W, 0–~150 m (300 mw), 2200, 6 Nov 1921.

Non-types: USNM 223726 (?, 95.8), 15°43′N, 26°28′W, 0–145 m, 0130–0245, 25 Nov 1970. IOS uncat. (♀, 85.8), 10°57′N, 19°56′W, 320–410 m, 1100–1344, 15 Feb 1968. IOS uncat. (♂, 93.5), 10°51′N, 19°55′W, 610–680 m, 2249–0211, 17 Feb 1968. ISH 2383/71 (?, 87.0), 04°36′N, 19°40′W, 0–256 m, 2012–2109, 13 Apr 1971. ISH 2570/71 (♀, 102.0), 10°50′N, 22°08′W, 0–111 m, 1941–2023, 15 Apr 1971. ISH 576/74 (♂, 100.5), 11°02′N, 26°04′W, 0–352 m, 2100–2150, 19 Jul 1974. IOAN uncat. (♀, 147.8), 01°07′S, 06°42′E, 0–75 m, 31 Jan 1976. WHOI uncat., specimen apparently lost (?, 85.4), 07°17′N, 14°12′W, 0–~200 m (400 mw), 2140–2335, 20 Apr 1961.

Uncertain Identity: MCZ 56699 (?, 67.6), 00°01′N, 05°12′E, 0–75 m, 2035–2235, 17 Jun 1971.

Eustomias melanostigmoides, new species

FIGURE 18*e,f*

DIAGNOSIS.—Two terminal bulbs separated by a distance 1.0%–2.4% SL, 1.2–2.4 times length of distal bulb. Barbel length 31%–71% SL in specimens less than 80 mm, 67%–91% SL in larger ones. Four to 6 short (less than 9% SL) filaments, without prominent bulblets, arising together from distal bulb or from a short distal stem; 1 filament thicker and longer than the rest. Pigment in filament axes variably present or absent. Distal bulb 0.7%–1.5% SL, spheroidal to ovoid in shape, not much longer than wide, 1.5–4.3 times proximal-bulb length. Axis of stem usually lightly pigmented, between bulbs unpigmented or lightly pigmented; dark spot present or absent at proximal end of distal bulb. External chevron-shaped or roundish striated areas on stem unpigmented. Middorsal paired spots between occiput and dorsal-fin origin 8, occasionally 9.

DESCRIPTION.—The barbel apparently increases in length rapidly until about 90 mm SL, at which size it is 67%–86% SL and does not change relative to SL with further growth. Pigmentation in the stem axis varies greatly in intensity and distribution. One small specimen lacks pigment; in others pigment may be relatively uniform or lighter at either end than at the other. The external chevron-shaped or roundish striated areas are unpigmented. Pigment between the bulbs is lacking in some and is light proximally becoming darker distally in others. Most specimens have a spot at the proximal end of the distal bulb, even when pigment is otherwise lacking, although the spot may be very faint.

The proximal bulb is spheroidal to ovoid; in 1 specimen it is very thin. The distal bulb is spheroidal to ovoid and much larger in every dimension than the proximal. The proximal bulb is 0.3%–0.7% SL and the distal bulb 0.7%–1.5%; neither appears to change relative to SL with growth. The distal bulb is 1.5–4.3 times the proximal-bulb length.

The distance between bulbs is 1.0%–2.4% SL, and there is no change relative to SL with growth. This interspace is 1.6–2.4 times the distal-bulb length at all sizes.

Four to 6 short, simple terminal filaments arise close together from the distal end of the distal bulb or from a short stem. One of these filaments is thicker and longer than the others, less than 9% SL, and does not change relative to SL with growth. The large filament has its axis pigmented in all except 1 specimen; all to none of the remaining filaments may be pigmented. Tiny bulblets were seen only in 1 small filament of 1 specimen.

The largest male, 115 mm SL, had a badly damaged head, so the postorbital-organ length of 1.0 mm (0.8% SL, 29% of fleshy orbit) is suspect. This would be a small organ, perhaps at an early stage of development.

DESCRIPTION OF HOLOTYPE.—Female, 165 mm SL. D 24. A 39. P1 3. P2 7. IP 7. PV 34. VAV 17. OV 34. VAL 18. AC 18. IA 59. IC 77. OA 52. OC 70. VAV photophores over anal-fin base 7. Branchiostegal photophores 10. Premaxillary teeth 14 left, 12 right: from anterior to posterior, a long fixed tooth followed by a long space, a fixed fang followed by a moderate space, a moderate fixed tooth, a long depressible tooth, 1 fixed and 3 depressible moderate teeth, 3 smaller depressible teeth, and 3 short depressible teeth (the last 6 teeth represented on right by 4 short depressible teeth). Maxilla with about 20 short, slanted, serra-like teeth. Mandibular teeth 22 left, 27 right: from anterior to posterior, a short fixed symphysial tooth followed by a long space, a fixed fang followed by a moderate space, a long depressible tooth (2 right) followed by a short space, a short fixed tooth, 2 long depressible teeth, 2 short fixed teeth (1 right), 2 moderate depressible teeth (a short-to-long series of 3 on right), a short-to-long series of 4 depressible teeth, 6 short depressible teeth (3 fixed, 4 depressible right), and 2 very short fixed teeth (5 more short, depressible teeth on right). Vertebrae 68, the 1st only partially ossified.

Measurements (in mm): Predorsal length 138.5, preanal length 119.5, prepelvic length 95.9, head length 22.2, barbel length 111.2, proximal-bulb length 0.8, distal-bulb length 1.8, distance between bulbs 4.0, filament length greater than 4.4 (ends tangled), snout length 9.9, fleshy orbit length 4.1, postorbital-organ length 1.2, lower-jaw length 18.7, upper-jaw length 17.0, depth behind head (greatest depth) 10.8, caudal-peduncle least depth 2.5, pectoral fin broken, pelvic-fin length 22.8, dorsal-base length 21.0, anal-base length 41.3, longest premaxillary tooth 3.0, longest mandibular tooth 2.5.

Proximal bulb oblate-spheroidal, distal bulb ovoid. Axis of stem lightly pigmented proximally, becoming moderately darker distally. Axis between bulbs light proximally, becoming moderately darker distally; a black spot formed at base of distal bulb. Five terminal filaments, 1 longer and thicker than others, 1 smaller filament branched near its base. Central filament with axis pigmented except at its proximal end; 1 other filament with little pigment, the remainder unpigmented.

SIMILAR SPECIES.—The North Atlantic–Indian Ocean species *melanostigma* may not be distinguishable from *melanostigmoides* at sizes smaller than about 90 mm SL. At larger sizes the barbel length of *melanostigmoides* is 67%–86% SL, of *melanostigma* 48%–76%; very little overlap is indicated by the available data (Figure 22). There is also overlap in proximal-bulb length, but *melanostigma* has the generally larger bulb (Figure 23). The distance between the bulbs appears to distinguish all except some small specimens (Figure 24); in all except 3 small *melanostigma* (58–86 mm) this distance is 2.7 mm or greater, while only in the largest *melanostigmoides* (165 mm) is the distance greater than 2.6 mm. In terms of relative length, the interspace is 2.5%–4.1% SL or greater in *melanostigma* (except the 3 small specimens, the 2 larger being 2.1%–2.2%), 1.3%–2.4% in *melanostigmoides*.

Another Atlantic species, *melanonema*, has short, simple filaments, but has longer proximal and distal bulbs that are farther apart than in *melanostigmoides* (Figures 23 and 24).

The most similar Pacific species, *medusa*, has 7–10 filaments (vs. 4–6) that are longer and have prominent bulblets, a shorter barbel, and smaller terminal bulbs (Figures 22–24).

DISTRIBUTION.—Known only from off Oahu, Hawaiian Islands, and from 1 station about 350 miles north of Hawaii (Figure 42).

ETYMOLOGY.—From the species name, *melanostigma* (black spot), plus the suffix *-oides* (resembling), *melanostigmoides* refers to the basic similarity of the barbels of the 2 species.

MATERIAL EXAMINED (3 males, 8 females, 6 unsexed).—*Holotype:* USNM 223765 (♀, 165), 21°30′N, 158°20′W, 0–900 m, 0657–1132, 1 Nov 1977.

Paratypes: USNM 223766 (♂, 112; 2♀, 91, 155), 21°20′N, 158°20′W, 0–200 m, 0245–0445, 28 Feb 1971. USNM 223767 (♀, 100), 21°20′N, 158°20′W, 0–100 m, 2240–0040, 28 Feb 1971. USNM 223768 (?, 78), 21°20′N, 158°20′W, 0–400 m, 1815–1955, 30 Aug 1973. US 223769 (♀, 135), 21°00′N, 158°32′W, 0–60 m, 0343–0755, 26 Jul 1967. USNM 223770 (?, 71.5), 21°20′N, 158°20′W, 0–350 m, 2001–2155, 28 Aug 1973. BPBM 26415 (?, 74; ♀, 118), 21°33′N, 158°22′W, 0–133 m, 0355–1100, 12 Feb 1971. SIO 80-175 (♀, 114), 21°24′N, 158°18′W, 0–124 m, 2310–0110, 27 Feb 1971.

Non-types: USNM 223771 (?, 95), 21°00′N, 158°32′W, 0–60 m, 0343–0755, 26 Jul 1967. USNM 223772 (♀, 120), 21°25′N, 158°20′W, 0–~250 m, 0005–0205, 27 Feb 1971. USNM 223773 (?, 71), 21°23′N, 158°18′W, 0–4000 m, 17 Mar 1971. USNM 223774 (♂, 115), 21°28′N, 158°20′W, 0–200 m, 0825–1358, 11 Feb 1971. USNM 223775 (♂, 96), 21°20′N, 158°20′W, 0–399 m, 0835–1035, 28 Feb 1971. USNM 223776 (♀, 133), 21°24′N, 158°18′W, 0–124 m, 2310–0110, 27 Feb 1971. SIO 71-298 (?, 67.5), 27°25′N, 155°11′W, 30 Sep 1971.

Eustomias medusa, new species

FIGURE 19

Eustomias vitiazi.—Parin et al., 1977:101 [1 specimen from the western Pacific].

DIAGNOSIS.—Two terminal bulbs separated by an interspace 0.8%–2.4% SL (1.4–3.6 times length of distal bulb). Barbel length mostly 36%–65% SL (16% in 1 small specimen). Seven to 10 terminal filaments arising together from distal bulb or from a short stem, the longest 5.3%–13.2% SL, all with prominent bulblets of various sizes and with side branches distally; 1 filament a little thicker than others and usually forked. Pigment in filament axes variably present or absent. Distal bulb small (0.5%–1.1% SL), ovoid, usually with an abruptly narrowed distal end, 1.5–3.0 times length of proximal bulb, which is very small (0.2%–0.5% SL). Axis of stem and between bulbs usually pigmented, variably lightly to darkly, occasionally unpigmented. A black spot almost always present at proximal end of distal bulb, usually partially capping base of bulb. External chevron-shaped or roundish striated areas on stem pigmented or unpigmented. Paired middorsal spots between occiput and dorsal-fin origin usually 8, occasionally 7.

DESCRIPTION.—In the known size range (73–153 mm) barbel growth is apparently isometric, its length 36%–65% SL at any size. The axis of the stem usually is moderately to darkly peppered with melanophores; occasionally the pigment is streaky or solid, and in a few specimens pigment is lacking. Between the bulbs pigment is absent or light proximally, becoming dark distally; a black spot is formed at the proximal end of the distal bulb, usually partially capping the base of the bulb. One specimen lacks all pigment between bulbs, and 1 other lacks a spot at the distal bulb. The external chevron-shaped or roundish striated areas are unpigmented in specimens smaller than 100 mm SL, pigmented in most larger ones.

The proximal bulb is spheroidal to ovoid in shape; it is not always symmetrical, and, in 2 specimens, it is formed of 2 separate halves, which are offset and appear as 2 bulbs in 1 specimen. The bulb is very small, 0.2%–0.5% SL, and does not change relative to SL with growth.

The distal bulb is abruptly narrowed distally, having a distinct rostrum (Figure 19); in 1 specimen, however, the bulb widens distally. There is a tiny bulb just before the distal bulb in 1 specimen. The distal bulb decreases slightly relative to SL with growth, from 0.7%–1.1% SL in specimens smaller than 85 mm to 0.5%–0.7% in those 130–157 mm. As a result of the differential growth patterns, the distal bulb is 2 to 3 times longer than the proximal bulb in most specimens smaller than 110 mm, 1.5 to 2 times in larger specimens.

The distance between the bulbs is 0.8%–2.4% SL, not changing relative to SL with growth. Relative to the bulbs, this distance increases with increasing SL from 3.5 to 9.0 times the length of the proximal bulb, and from 1.5 to 3.6 times the length of the distal bulb.

The longest of the 7–10 terminal filaments are 5%–13% SL, apparently not increasing in length relative to SL. A central filament is usually longer and thicker than the others and is usually forked. Pigment in the filament axes is lacking in some small specimens, but is present in the central, forked filament of most specimens, in which the remaining filaments may be lighter or lack pigment. Prominent bulblets of various sizes are present in all filaments; the largest bulblets are near the middle of the length of each filament. Some or all filaments have rather long side branches distally; the central filament has more branches than the rest.

The 150 mm male has a postorbital organ 1.5% SL, 64% of fleshy orbit. In the only other male, 112 mm, this organ is 0.9% SL, apparently being in an early stage of enlargement.

No observations of barbel colors have been recorded.

DESCRIPTION OF HOLOTYPE.—Female, 94 mm. D 24. A 38. P1 3. P2 7. IP 7. PV 33. VAV 19. OV 33. VAL 19. AC 18. IA 59. IC 77. OA 52. OC 70. VAV photophores over anal-fin base 8. Branchiostegal photophores 10. Premaxillary teeth 13 on both sides: from anterior to posterior, a long fixed tooth followed by a long space, a fixed fang followed by a moderately long space, a short-to-long series of 1 fixed and 2 depressible teeth, a short-to-long series of 1 fixed and 5 depressible teeth, and 2 short fixed teeth. Maxilla with about 16 short, slanting, serra-like teeth. Mandibular teeth 16 left (right missing a number of teeth, not described): from anterior to posterior, a short fixed symphysial tooth followed by a long space, a fixed fang followed by a long space, a long depressible tooth followed by a moderately long space, 2 short fixed teeth followed by a long space, a long depressible tooth, a short-to-long series of 1 fixed and 5 depressible teeth (the last missing) followed by a moderate space, 3 short depressible teeth, and 1 short replacement tooth. Vertebrae 68, the 1st only partly ossified.

Measurements (in mm): Predosal length 77.5, preanal length 67.0, prepelvic length 52.0, head length 10.4, barbel length 45.0, proximal-bulb length 0.3, distal-bulb length 0.6, distance between bulbs 1.7, filament length 11.0, snout length 3.3, fleshy orbit length 2.5, postorbital-organ length 0.4, lower-jaw length 9.0, upper-jaw length 8.9, depth behind head (greatest depth) 5.7, caudal-peduncle least depth 1.4, pectoral fins broken, pelvic-fin length 12.7, dorsal-base length

11.0, anal-base length 22.1, longest premaxillary tooth 1.2, longest mandibular tooth 1.0.

Proximal bulb long-ovoid; distal bulb ovoid, its distal one-third narrowed rather abruptly and forming a blunt-ended rostrum, the 2 parts demarcated by an indistinct constriction. Stem axis moderately darkly peppered with melanophores, becoming lighter just before proximal bulb; external chevron-shaped or roundish striated areas unpigmented. Axis between bulbs lightly pigmented proximally, becoming slightly darker distally until shortly before distal bulb, where pigment becomes very dark on 1 side of axis and spreads laterally, forming a streak ending in a black spot at base of distal bulb. Nine filaments arising from distal bulb, 1 thicker than others, forked at about one-fourth its length, each fork with many side branches. All filaments with moderately-darkly pigmented axes.

SIMILAR SPECIES.—The South Pacific species *vitiazi* has terminal filaments resembling those of *medusa* in length and the presence of prominent bulblets, but *vitiazi* has some very short filaments, none of which is forked, has long inclusions in at least some of the filaments, and has only a single terminal bulb, which is longer at any given size over 85 mm than that of *medusa*.

In the 2-bulbed species *melanostigmoides*, *melanostigma*, and *melanonema*, the terminal filaments are shorter than in *medusa* at sizes over 85 mm, have no prominent bulblets or inclusions, and lack distal branches. In *bertelseni*, *suluensis*, *kreffti*, and *posti*, the filaments have bulblets, but except in a few small specimens of *kreffti* and *bertelseni*, the filaments are longer than those of *medusa* and both bulbs larger (Figures 24 and 23).

DISTRIBUTION.—One specimen is known from the northwestern Pacific (Parin et al., 1977, as *vitiazi*). All others have been taken off Oahu, Hawaiian Islands (Figure 42).

ETYMOLOGY.—A Latin noun in apposition, *medusa* (the name of a gorgon with snaky locks), alludes to the numerous filaments arising from the distal bulb of this species.

MATERIAL EXAMINED (3 males, 7 females, 7 unsexed).—*Holotype:* USNM 223855 (♂, 94), 21°20′N, 158°20′W, 0–100 m, 1942–2148, 15 Dec 1970.

Paratypes: (USNM and BPBM all from 20°59′–21°32′N, 158°10′–34′W.) USNM 223843 (?, 77.5), same data as holotype. USNM 223844 (♂, 150), 0–710 m, 0750–1205, 1 Mar 1971. USNM 223845 (♂, 112), Feb 1975. USNM 223846 (♀, 131), 0–~200 m, 0825–1358, 11 Feb 1971. USNM 223847 (?, 79.7), 0–350 m, 2220–0021, 2 Aug 1978. USNM 223848 (?, 84), 0–122 m, 1952–0152, 25 Jul 1967. USNM 223850 (♀, 152), 0–320 m, 0215–0403, 7 Apr 1978. USNM 223851 (♀, 152), 0–200 m, 0245–0445, 28 Feb 1971. USNM 223853 (♀, 105), 0–225 m, 0119–0340, 21 Sep 1970. BPBM 26412 (♀, 100.5), 0–170 m, 2008–2215, 11 Oct 1958. SIO 76-110 (♀, 114), 24°00′N, 142°43′W, 0–484 m, 0206–0331, 30 Oct 1972. IOAN uncat. (♀, 152.8), 17°48′N, 143°46′W, 0–200 m, 30 Apr 1975.

Non-types: USNM 223849 (?, 81.0), 0–170 m, 2008–2215, 11 Oct 1958. USNM 223852 (?, 73), 0–300 m, 2335–0208, 8 Jul 1970. USNM 223854 (?, 76), 0–~450 m, 0410–0650, 27 Sep 1973. USNM 223856 (?, 75), 0–21 m, 1148–1748, 13 Aug 1967.

Eustomias bertelseni, new species

FIGURE 20*a*

DIAGNOSIS.—Two terminal bulbs separated by a long distance (2.7%–3.0% SL, 2.0–3.0 times length of distal bulb). Barbel length increasing with size from 43% to 60% SL. Four relatively long filaments (17%–19% SL in 2 small specimens, estimated 21% at 93 mm) arising together from distal end of distal bulb or from a short stem, with long inclusions as well as rounded bulblets. Distal bulb 0.9%–1.5% SL, equal in length to proximal bulb. Axis of stem with some pigment, but light or unpigmented before proximal bulb; between bulbs pigment noticeably darker at base of distal bulb, forming a spot or small cap. External chevron-shaped or rounded striated areas pigmented or unpigmented. Middorsal paired spots between occiput and dorsal-fin origin 8 or 9.

DESCRIPTION.—The 3 specimens (67–93 mm SL) show an increase in barbel length with fish size from 43% to 60% SL. In the largest specimen pigment has faded very much everywhere, and barbel pigment, if ever present, is no longer apparent except for a dark area at the base of the distal bulb. In the other 2 specimens the axis of the stem is moderately pigmented proximally, becoming light or unpigmented distally; the interspace is lightly to moderately pigmented, with a dark area at the distal bulb forming or suggesting a spot or small cap; and the external chevron-shaped or roundish striated areas on the stem are pigmented in the mid-stem in one small specimen, unpigmented in the other.

The proximal bulb is a slender ovoid in shape. The distal bulb is ovoid, about the same length as the proximal, but thicker, and it may be narrowed either proximally or distally. Both proximal and distal bulbs increase relative to SL, the proximal (only in the 2 smallest specimens) from 0.9% to 1.4%, the distal from 0.9% to 1.5%. The 2 bulbs are equal in length in the 2 small specimens, and appear to be so in the sketch of the largest, made before the barbel had dried out.

The distance between bulbs increases very slightly relative to SL, from 2.7% to 3.0%, in the 3 specimens. In the smallest, the distance is 3 times the distal-bulb length, in the others twice the bulb length.

The filaments are 17%–19% SL in the 2 smallest specimens, (67 and 70 mm), in both of which they are well formed. In the largest specimen (93 mm) the filaments were not measured before the barbel was apparently clamped outside its container, allowing the end of the barbel to dry and the filaments to break off; from an earlier rough sketch, the filaments are estimated to have been about 21% SL. The axes of the 2 thicker filaments are lightly pigmented; the 2 slender filaments are unpigmented. One of the thick filaments has only a few bulblets, all very small. The other 3 filaments have small bulblets proximally, beyond which there are very long bodies or elongate bulblets, and distally the long bodies and bulblets become smaller and again ovoid or spheroid.

There are no large males to indicate the ultimate size of the postorbital organ.

DESCRIPTION OF HOLOTYPE.—Sex undetermined, 66.5 mm. D 24. A 38. P1 3. P2 7. IP 7. PV 33. VAV 17. OV 33. VAL 18. AC 19. IA 57. IC 76. OA 51. OC 70. VAV photophores over anal-fin base 6. Branchiostegal photophores 11. Premaxillary teeth 10 right (left missing): from anterior to posterior, a long fixed tooth followed by a long space, a depressible fang followed by a long space, a short fixed tooth, 2 moderate depressible teeth, a short-to-moderate series of 1 fixed and 2 depressible teeth, 2 very short depressible teeth (developing). Maxilla with about 10 short, slanting serra-like teeth (mostly broken). Mandibular teeth 10 right (left damaged): from anterior to posterior, a short depressible symphysial tooth followed by a long space, a fixed fang followed by a long space, a short fixed and a long depressible tooth close together followed by a moderate space, a short and a moderate depressible tooth close together followed by a short space, a long depressible tooth followed by a moderate space, 2 short and 1 moderate depressible teeth. Vertebrae 66.

Measurements (in mm): Predorsal length 55.7, preanal length 47.4, prepelvic length 37.2, head length 8.1, barbel length 28.4, proximal-bulb length 0.6, distal-bulb length 0.6, distance between bulbs 1.8, filament length 11.1, snout length 3.6, fleshy orbit length 1.5, postorbital-organ length 0.4, lower-jaw length 7.4, upper-jaw length 7.0, depth behind head (greatest depth) 4.0, caudal-peduncle least depth 1.5, pectoral-fin length 7.5, pelvic-fin length 8.3, dorsal-base length 8.8, anal-base length 16.3, longest premaxillary tooth 1.2, longest mandibular tooth 0.8.

Proximal bulb long-ovoid. Distal bulb ovoid with distal end demarcated by a constriction, tapering, becoming narrow. Stem axis moderately peppered with melanophores in its proximal two-fifths, the pigment then becoming first streaky and irregular and, before the proximal bulb, light or absent. Axis between bulbs lightly pigmented proximally, dark distally, forming a sort of cap at the base of the distal bulb. Four long terminal filaments, 2 thicker and with lightly pigmented axes, 2 more slender and unpigmented. One thick

filament with only a few small bulblets, the other 3 with prominent long bodies, as well as prominent bulblets of various sizes and shapes.

SIMILAR SPECIES.—The most similar species is the South Atlantic *posti*, which also has 4 long terminal filaments that have numerous bulblets, but these filaments have no long inclusions. The distance between the bulbs is shorter in *posti* (2.0%–2.6% SL vs. 2.7%–3.0% in *bertelseni*), but this interspace decreases relative to SL in *posti*, and the only specimen of *posti* as small as known *bertelseni* has an interspace 2.6% SL. The presence of long bodies in the filaments of *bertelseni* is the only convincing difference given present information.

Two other species have multiple long terminal filaments: *kreffti* has only 2, which have few bulblets except for 1 large one in 1 filament, and it has several short filaments with swollen tips; *suluensis* has only 3 filaments, and these have numerous very small bulblets, but no large ones and no long inclusions.

DISTRIBUTION.—Known only from 2 collections in the eastern equatorial Indian Ocean off the west coast of Sumatra (Figure 42).

ETYMOLOGY.—Named for our good colleague, Erik Bertelsen, in honor of his contributions to deep-sea biology and his long service to ichthyologists, especially those who have worked with the *Dana* collections under his care.

MATERIAL EXAMINED (3 unsexed).—*Holotype:* ZMUC P202851 (?, 66.5), 01°22′N, 96°07′E, 0–~1500 m (3000 mw), 1600, 18 Sep 1929.

Paratype: USNM 223786 (?, 70.4), same data as holotype.

Non-type (barbel dried and damaged): ZMUC P202850 (?, 93.2), 03°36′S, 97°37′E, 0–~150 m (300 mw), 2210, 10 Sep 1929.

Eustomias suluensis, new species

FIGURE 20*b*

DIAGNOSIS.—Two terminal bulbs separated by a long distance (2.4%–2.8% SL, 1.9–2.4 times length of distal bulb). Barbel length 52%–59% SL. Three long filaments (15%–20% SL) arising together from distal end of distal bulb or from a short stem, with numerous very small bulblets along most of their length. Distal bulb 1.2%–1.3% SL, 1.5–1.8 times length of proximal bulb. Barbel pigment variable, but a prominent dark spot or cap formed at base of distal bulb. Middorsal paired spots between occiput and dorsal-fin origin 9 (smaller specimen).

DESCRIPTION.—Based on only 2 specimens (109 and 138 mm SL), so suggestions of growth patterns uncertain.

Barbel length is 50% SL in the smaller specimen, 59% in the larger. The smaller specimen has faded very much everywhere, and the only discernible barbel pigment is a suggestion of a spot at the base of the distal bulb. In the larger specimen, the axis of the stem, between the bulbs and in all filaments, is darkly pigmented; the pigmented stem axis is continuous around the outside of the proximal bulb, forming a stripe on that bulb; at the distal end of the axis between the bulbs, the pigment is very dark, forming a wide black cap over the base of the distal bulb; the external chevron-shaped or roundish striated areas on the stem are unpigmented in the proximal one-fifth of the stem, pigmented in the next two-fifths, and unpigmented in the distal two-fifths until pigmented just before the proximal bulb.

The proximal and distal bulbs are both ovoid in shape, the distal larger in all dimensions. The proximal bulb is 0.7% SL in the smaller specimen, 0.8% in the larger. The distal bulb is 1.3% SL in the smaller specimen, 1.2% in the larger. The distal bulb is 1.5–1.8 times the length of the proximal bulb.

The distance between bulbs is 2.4% SL in the smaller specimen, 2.8% in the larger. This distance is 1.9–2.4 times the length of the distal bulb and 3.3–3.5 times the proximal bulb.

The filaments are 15% SL in the smaller specimen, 20% in the larger. The filaments have bulblets rather closely spaced for almost their entire length; these bulblets are very small proximally, becoming tiny distally, and in the large specimen they are conspicuous against the pigmented axis.

The only male (109 mm) has a very small postorbital organ, 0.5% SL, 24% of fleshy orbit. Apparently, enlargement of this organ begins at a relatively large size.

No barbel colors have been recorded.

DESCRIPTION OF HOLOTYPE.—Female, 138.3 mm. D 24. A 39. P1 3. P2 7. IP 7. PV 33. VAV 16. OV 32. VAL 18. AC 19. IA 56. IC 75. OA 50. OC 69. VAV photophores over anal-fin base 6. Branchiostegal photophores 12. Premaxillary teeth 13 on both sides: from anterior to posterior, a long fixed tooth followed by a long space, a fixed fang, 2 short fixed teeth, a long depressible tooth, a short-to-moderate series of 2 fixed and 2 depressible teeth, and 4 short depressible teeth. Maxilla with about 20 short, slanting, serra-like teeth. Mandibular teeth 21 left, 20 right: from anterior to posterior, a short fixed symphysial tooth followed by a moderate space, a fixed fang (with replacement), 2 long depressible teeth, 2 short fixed teeth, 2 long depressible teeth, a short fixed tooth, 2 long depressible teeth, (a 3rd forming right), a short-to-moderate series of 5 depressible teeth (the 5th forming on right), and 5 short depressible teeth, the last one forming (4, the last one forming right). Vertebrae 67.

Measurements (in mm): Predorsal length 115.1, preanal length 96.3, prepelvic length 77.6, head length 18.9, barbel length 81.5, proximal-bulb length 1.1, distal-bulb length 1.6, distance between bulbs 3.9, filament length 27.2, snout damaged, fleshy orbit length 3.6, postorbital-organ length 0.9, lower-jaw length 15.8, upper-jaw length 14.6, depth behind head (greatest depth) 9.6, caudal-peduncle least depth 1.9, pectoral fins damaged, pelvic-fin length 18.2, dorsal-base length 17.9, anal-base length 35.5, longest premaxillary tooth 2.2, longest mandibular tooth 1.6.

Proximal and distal bulbs both ovoid, the proximal somewhat flattened on side away from pigmented axis. Barbel pigmentation and filament bulblets described above.

SIMILAR SPECIES.—The other 3 species with multiple long filaments have either 2 (*kreffti*) or 4 (*posti, bertelseni*), and all of these have prominent large bulblets and/or inclusions in 1 or more of the filaments, whereas *suluensis* has 3 filaments containing only very small bulblets.

Eustomias crossotus bears some resemblance to *suluensis*, but in *crossotus* all branches arise from a single terminal filament, albeit fairly close to the distal bulb, and the bulbs are much closer together (the interspace usually shorter than the distal bulb).

DISTRIBUTION.—Both known specimens were taken in the eastern part of the Sulu Sea, off the Philippine Islands (Figure 42).

ETYMOLOGY.—An adjective combining Sulu (the Southeast Asian Sea) plus the Latin suffix *-ensis* (denoting locality of occurrence), alluding to the habitat of the only known specimens in the Sulu Sea.

MATERIAL EXAMINED (1 male, 1 female).—*Holotype:* USNM 223714 (♀, 138.3), 09°22′N, 122°06′E, 0–110 m, 2307–2358, 5 Jun 1975.

Paratype: ZMUC P202847 .(♂, 109.1), 07°23′N, 121°29′E, 0–300 m (600 mw) 0245, 30 Jun 1929.

Eustomias posti, new species

FIGURE 21

DIAGNOSIS.—Two terminal bulbs separated by a long distance (2.0%–2.6% SL, 1.3–2.5 times length of distal bulb). Barbel length 43%–50% SL. Four long filaments (13%–29% SL) arising together from distal end of distal bulb or from a short stem, all with numerous conspicuous bulblets of variable size. Distal bulb 0.8%–1.2% SL in specimens larger than 100 mm, 2.0% in 1 smaller specimen, 0.9–1.6 times the proximal-bulb length. Axis of stem lightly, often sporadically pigmented; axis between bulbs and in filament unpigmented or lightly pigmented. Suggestion of spot at base of distal bulb in one specimen. External chevron-shaped or roundish striated areas unpigmented. Middorsal paired spots between occiput and dorsal-fin origin 8, occasionally 7.

DESCRIPTION.—Barbel length apparently does

not change relative to SL, being 43%–50% SL at any size. Pigment in the stem axis is present, but light, in all specimens, often intermittent or sporadic. The axis between bulbs and in the filaments may be unpigmented or lightly pigmented. In 1 specimen there was a semblance of a spot at the base of the distal bulb. The external chevron-shaped or roundish striated areas on the stem are unpigmented.

The proximal bulb is ovoid, sometimes long with straight margins. The distal bulb, which may be a little shorter or longer than the proximal, is ovoid to long-ovoid and may be tapered proximally or distally to become narrow in that direction. The proximal bulb is 0.8%–1.2% SL, and there is no apparent change relative to SL with growth. The distal bulb is 2.0% SL in the only specimen (81 mm) smaller than 100 mm; in all others it is 0.8%–1.2% SL, suggesting a sharp decrease in relative size between 80 and 100 mm. The distal bulb is 0.9–1.6 times the length of the proximal bulb. The smallest specimen is the only one with a ratio over 1.3, and most are 1.1.

The distance between the bulbs decreases relative to SL from 2.6% to 1.9%–2.0%. It is 1.3–2.5 times the length of the distal bulb, mostly 2.0–2.5 times, and there is no indication that the ratio changes with growth.

There are 4 long filaments, 1 of which is thicker than the others. Each filament has a variable number of conspicuous bulblets, and some or all filaments may have a bulblet at their tips, with 1 or several short distal branches. The filaments vary considerably in length—the longest filament in the small specimen is 13% SL, in the large ones 14%–29%. There is no indication of change relative to SL with growth. Breakage may contribute to the wide variation, but this could not be ascertained. A few short filaments may or may not be present; these do not have swollen tips.

The postorbital organ of the 7 males increases relative to SL from 1.0% at 106 mm to 1.9% at 156 mm. It is 56%–71% of fleshy orbit in those 124–156 mm, with no apparent trend, although the largest specimen has the relatively largest postorbital organ.

The bulbs were yellow in the 131 mm male. The 81 mm specimen and the 135 mm male had pink bulbs.

Description of Holotype.—Male, 143.6 mm. D 25. A 38. P1 3. P2 7. IP 7. PV 32. VAV 17. OV 32. VAL 19. AC 19. IA 56. IC 75. OA 51. OC 70. VAV photophores over anal-fin base 6. Branchiostegal photophores 10. Premaxillary teeth 15 left, 13 right: from anterior to posterior, a long fixed tooth followed by a long space, a fixed fang, a fixed and a depressible short tooth, a long depressible tooth, a moderate fixed tooth, a short-to-moderate series of 3 depressible teeth, 6 short depressible teeth (4 right). Maxilla with about 30 short, slanting, serra-like teeth. Mandibular teeth 19 left, 22 right: from anterior to posterior, a short fixed symphysial tooth followed by a moderate space, a long fang followed by a long space, a long depressible tooth, a short fixed tooth (a 2nd depressible tooth right), a long depressible tooth, a short-to-long series of 1 fixed and 4 depressible teeth, a short-to-moderate series of 4 depressible teeth, and 5 short depressible teeth (7 right). Vertebrae 67.

Measurements (in mm): Predorsal length 122.9, preanal length 105.7, prepelvic length 83.9, head length 19.6, barbel length 67.5, proximal-bulb length 1.3, distal-bulb length 1.4, distance between bulbs 3.3, filament length 28.6, snout length 7.5, fleshy orbit length 4.1, postorbital-organ length 2.4, lower-jaw length 16.4, upper-jaw length 15.4, depth behind head 11.9, greatest depth 14.4, caudal-peduncle least depth 2.5, pectoral and pelvic fins damaged, dorsal-base length 20.1, anal-base length 38.8, longest premaxillary tooth 2.1, longest mandibular tooth 1.6.

Proximal bulb ovoid, somewhat flattened on one side. Distal bulb an irregular ovoid, tapering to become narrower distally. Stem axis lightly pigmented, the pigment uneven and intermittent; only a little pigment distally between bulbs, not forming a spot, and none in filaments. Four long filaments, 2 slender with several elongate bulblets and a few tiny ones, 2 thicker with several large bulblets; 1 filament with a prominent bulblet at its tip and no distal branches, the others with

several short distal branches but lacking a prominent bulblet.

SIMILAR SPECIES.—*Eustomias kreffti* is the only other Atlantic species with multiple long terminal filaments, and it has only 2; 1 of these filaments has a prominent large bulblet a short distance from its origin, but few or no other conspicuous ones, while the filaments of *posti* have numerous conspicuous bulblets. In *kreffti* there are always several short terminal filaments, most of them with swollen tips; when short filaments are present in *posti*, they lack swollen tips. The distance between the bulbs is shorter in *kreffti* (0.5%–1.7% SL vs. 2.0%–2.6% in *posti*).

The most similar species is the Indian Ocean *bertelseni*, which also has 4 long terminal filaments, but these have long inclusions as well as bulblets. In *suluensis*, there are only 3 filaments, which have only very small bulblets of uniform size.

DISTRIBUTION.—Known only from the western part of the subtropical South Atlantic between 13° and 24°S (Figure 42).

ETYMOLOGY.—Named in honor of our colleague Alfred Post for his contributions to the knowledge of deep-sea fishes and his continuing services to the ichthyological community.

MATERIAL EXAMINED (7 males, 1 female, 1 unsexed).—*Holotype:* ISH 754/66 (♂, 146.2), 21°00′S, 30°00′W, 0–200 m, 2000–2200, 24 May 1966.

Paratypes: ISH 1857/66 (♂, 156.4; ♀, 156.3), same data as holotype. ISH 718/66 (♂, 135.3), 17°36′S, 28°53′W, 0–660 m, 2000–2315, 23 May 1966. ISH 2200/68 (?, 81.3), 23°24′S, 33°28′W, 0–320 m, 2300–2315, 9 Feb 1968. USNM 223966 (♂, 131.2), 13°31′S, 28°09′W, 0–160 m, 2000–2200, 22 May 1966. USNM 223967 (2♂, 123.8, 125.5), same data as holotype. MCZ 56669 (♂, 106.4), 18°21′S, 29°39′W, 0–75 m, 2129–2311, 5 Mar 1967.

Eustomias kreffti, new species

FIGURE 20*c*

Eustomias bituberatus.—Regan and Trewavas, 1930:83 [part; smallest specimen only, discussed here in "Remarks"].

DIAGNOSIS.—Two terminal bulbs separated by a short distance (0.5%–2.0% SL; 0.4–1.6 times length of distal bulb). Barbel length short (37%–44% SL in specimens over 80 mm). Three to 9 short, usually bulblet-tipped filaments and 2 long filaments, all arising together from distal end of distal bulb or from a short stem. Longest filament becoming 23%–35% SL in specimens larger than 80 mm SL; 1 long filament with a prominent large bulblet. Distal bulb 0.7%–1.5% SL, 1.2–2.5 times length of proximal bulb. Axis of stem well pigmented; between bulbs variably pigmented, sometimes forming a dark spot or small cap at proximal end of distal bulb. External chevron-shaped or roundish striated areas usually unpigmented. Middorsal paired spots between occiput and dorsal-fin origin 8.

DESCRIPTION.—Barbel length appears to increase rapidly at about 80 mm SL; in 3 specimens 67–78 mm, the barbel is 17%–19% SL, while in those 84–125 mm, it is 37%–44%. No change relative to SL is apparent after 84 mm. No pigment was apparent in the barbel of the 67 mm specimen. In all others, the axis of the stem is moderately darkly peppered with melanophores, the axis between bulbs lighter, but commonly forming a dark spot or cap at the base of the distal bulb. The external chevron-shaped or roundish striated areas on the stem may be pigmented, but usually are unpigmented.

The proximal bulb varies in shape from spheroidal to ovoid, being eccentric in some, and having lemon-like proximal and distal protrusions in one. The distal bulb is ovoid to long-ovoid, often narrowing distally, but narrowing proximally in 2 specimens. The proximal bulb increases relative to SL in 2 steps from 0.3%–0.4% at 67–76 mm to 0.7%–0.8% at 78–114 mm and 1.0%–1.2% at 112–125 mm. The distal bulb increases from 0.7%–0.8% at 67–76 mm to 1.1%–1.5%, apparently not changing with further growth after 78 mm. The distal bulb is 2.5 times the proximal at 67 mm, 1.4–1.9 times at 76–114 mm, and 1.2–1.3 times at 121–125 mm.

The distance between the bulbs is 0.5%–2.0% SL and changes little or not at all relative to SL

with growth. This distance is 0.6–3.0 times the length of the proximal bulb, 0.4–1.6 times the length of the distal bulb with no apparent relation to SL.

The 2 long terminal filaments grow very rapidly. At 67 mm SL, they are very short and stubby. From 76 to 125 mm SL, they increase from 7% at 76 mm to 25%–35% SL in the largest specimens (the latter the longest relative filament length among all *Nominostomias*). Pigment in the axes of the 2 long filaments apparently increases in density and intensity with size, there being none in specimens smaller than 80 mm SL. The short filaments have little or no pigment in their axes. One of the long filaments invariably has a prominent large bulblet not far distad from the distal bulb; other bulblets in these filaments, when present, are small or tiny and widely spaced. All or most of the short filaments have bulblets, 1 of which forms a prominent swelling at the tip (in a few there is a slender extension beyond the tip, which may have 1 or more smaller bulblets).

The postorbital organ is 0.7% SL, 26% of fleshy orbit in the smallest male (107 mm); 1.3% SL, 43% of fleshy orbit in the 114 mm one; and 1.6%–1.7% SL, 51%–60% of fleshy orbit in the 2 largest (121–124 mm).

In the 125 mm female (holotype) the proximal bulb was light grayish blue, the distal bulb and all filament bulblets light turquoise blue.

Description of Holotype.—Female, 125.2 mm. D 25. A 38. P1 3. P2 7. IP 7. PV 34. VAV 17. OV 34. VAL 18. AC 18. IA 58. IC 76. OA 52. OC 70. VAV photophores over anal-fin base 6. Branchiostegal photophores 11. Premaxillary teeth 12 left, 13 right: from anterior to posterior, a moderate fixed tooth followed by a long space, a fixed fang followed by a long space (partially filled by a replacement fang left), a short fixed tooth, a long depressible tooth, a short-to-long series of 2 fixed and 2 depressible teeth (depressible, fixed, 3 depressible right), and a short-to-moderate series of 4 depressible teeth. Maxilla with about 30 short, slanting, serra-like teeth. Mandibular teeth 17 left, 18 right: from anterior to posterior, a short fixed symphysial tooth followed by a moderate space, a fixed fang followed by a long space, a long depressible tooth followed by a moderate space, a short fixed tooth (2 right), a long depressible tooth, 2 short depressible teeth and 2 long depressible teeth (a short-to-long series of 2 fixed and 2 depressible right), a short-to-moderate series of 4 depressible teeth, and 4 short depressible teeth. Vertebrae 68.

Measurements (in mm): Predorsal length 104.9, preanal length 90.3, prepelvic length 71.3, head length 15.3, barbel length 50.8, proximal-bulb length 1.5, distal-bulb length 1.8, distance between bulbs 2.1, filament length 44.0, snout length 4.6, fleshy orbit length 3.4, postorbital-organ length 0.5, lower-jaw length 13.5, upper-jaw length 12.5, depth behind head (greatest depth) 9.5, caudal-peduncle least depth 1.7, pectoral and pelvic fins broken, dorsal-base length 15.8, anal-base length 30.8, longest premaxillary tooth 2.0, longest mandibular tooth 1.1.

Proximal bulb an eccentric, short ovoid with lemon-like protrusions at each end. Distal bulb longish ovoidal, obliquely narrowed posteriorly. Stem axis moderately darkly peppered with melanophores, becoming lighter just before proximal bulb; external chevron-shaped or roundish striated areas unpigmented. Axis between bulbs lightly pigmented; no spot formed at base of distal bulb. Two long terminal filaments, both with axes lightly pigmented proximally, 1 with a prominent large bulblet about 1 distal-bulb length from the bulb. Three short filaments of unequal length, 1 with only a terminal bulblet, 1 with a terminal and 1 smaller subterminal bulblets, and 1 with 3 small bulblets.

Remarks.—The smallest specimen (67 mm) is the one referred by Regan and Trewavas (1930) to *bituberatus*, noting its juvenile characters and its short terminal appendage with 2 branches. By its combination of barbel measurements, especially the short barbel length, its development of 2 stubby filaments that foreshadow those of *kreffti*, and its geographic distribution, this specimen best fits *kreffti*. It is almost certainly not *bituberatus*.

Similar Species.—The 3 other species with 2 terminal bulbs and 2 or more long to very long

terminal filaments—*posti*, *bertelseni*, and *suluensis*—have 3 or 4 such filaments and lack the group of short, bulblet-tipped filaments (*posti* sometimes has short filaments, but these lack the swollen tips). None of these species has the single, large bulblet in 1 long filament; either there are numerous conspicuous, but smaller, bulblets or inclusions in most of the long filaments, or all bulblets are very small and inconspicuous. Furthermore, all 3 species have longer barbels (43%–60% SL vs. maximum 44% in *kreffti*) and have the bulbs separated by a greater distance (2.0%–3.0% SL vs. 0.5%–2.0% in *kreffti*).

DISTRIBUTION.—All specimens except one have been taken in the tropical Atlantic between 10°N and 6°S, 20° to 51°W (Fig. 42). One was taken in the southern Sargasso Sea at 20°N, 46°W.

ETYMOLOGY.—Named in honor of Gerhard Krefft, whose scientific contributions have enriched our knowledge, and whose inspiration and leadership of the "Walther Herwig" expeditions and sharing of the resulting materials have revolutionized studies of the systematics and zoogeography of deep-sea fishes.

MATERIAL EXAMINED (4 males, 1 female, 5 unsexed).—*Holotype:* ISH 2343/71 (♀, 125.2), 04°34′N, 19°39′W, 0–104 m, 1920–2008, 13 Apr 1971.

Paratypes: ISH 1855/66 (♂, 120.8), 05°34′S, 26°58′W, 0–320 m, 2000–2315, 20 May 1966. ISH 562/74 (♂, 107), 05°25′N, 35°28′W, 0–550 m, 2230–2340, 22 Jul 1974. ISH 656/74 (♂, 123.6), 02°26′N, 34°50′W, 0–550 m, 2219–2331, 24 Jul 1974. USNM 223715 (?, 76.4), 10°03′N, 49°37′W, 0–120 m, 0250–0505, 26 Mar 1977. USNM 223718 (?, 84.3), 00°01′N, 37°40′W, 0–130 m, 0045–0345, 15 Mar 1977. USNM 223723 (♂, 113.7), 05°34′S, 26°58′W, 0–320 m, 2000–2315, 20 May 1966. USNM 225163 (?, 78.3), 00°10′S, 34°43′W, 0–100 m, 0110–0245, 3 Jul 1971. IOAN uncat. (?, 84.4), 20°24′N, 45°49′W, 0–150 m, 3 Jun 1980.

Non-type: ZMUC P202707 (?, 66.5, Regan and Trewavas' specimen with juvenile characters), 05°35′N, 51°08′W, 0–∞150 m (300 mw), 1900, 16 Nov 1921.

Eustomias multifilis Parin and Pokhilskaya, 1978

FIGURE 18*a*

Eustomias multifilis Parin and Pokhilskaya, 1978a:72, 73 [holotype only, ZIAN 42661, *Dmitry Mendeleev* sta 1387, 33°34′S, 112°53′E, 8 Mar 1976, 0–1000 m].

We have not examined the holotype, which is the only known specimen. In the original description, no measurements were given of the terminal bulbs, the distance between them, or of the postorbital organ. The distance that the filaments extend beyond the bulb is presumably the difference between the length of the barbel to the distal bulb (45.0% SL) and the total length of the barbel (46.3%), which is 1.3% SL of 144.5 mm or 1.9 mm. Using this measurement, we calculated that actual measurements were 0.097 of those of Parin and Pokhilskaya (1978, fig. 2A), and the bulb and interspace length in the illustration were multiplied by this factor to obtain the estimates used here. The length of the postorbital organ was obtained by a similar calculation, which showed the actual head length (14.0% SL, or 20.2 mm) to be 0.59 that of Parin and Pokhilskaya (1978, fig. 2B).

DIAGNOSIS.—Two terminal bulbs separated by an interspace 1.6% SL (1.9 times length of distal bulb). Barbel length short, 45% SL. Sixteen short filaments arising not only from the distal end of the distal bulb but also from its sides and from the stem proximal to it. Many filaments branched, all apparently with prominent bulblets. Distal bulb 0.8% SL, ovoid in shape, less than 1.5 times as long as wide, 1.2 times length of proximal bulb. Photophore counts low, especially the 15 AC and 69 IC.

DESCRIPTION OF HOLOTYPE (from Parin and Pokhilskaya, 1978a, except as noted above).—Male (as indicated by the large postorbital organ), 144.5 mm SL. D 23. A 34. P1 3. P2 7. IP 7. PV 30. VAV 17. OV 30. VAL 18. AC 15. IA 54. IC 69. OA 48. OC 63. VAV photophores over anal-fin base 6. Premaxillary teeth 11. Mandibular teeth 16.

Measurements (in mm, converted from % SL given by Parin and Pokhilskaya, 1978, except as noted above): Predorsal length 124.6, preanal length 109.8, prepelvic length 85.5, head length 20.2, barbel length 65.0, proximal-bulb length 1.0, distal-bulb length 1.2, distance between bulbs 2.3, filament length beyond distal bulb 1.9, snout length 6.8, fleshy orbit length 4.2, postorbital-organ length 2.4, upper-jaw length 16.2, greatest depth 12.4, pectoral-fin length 14.5, pelvic-fin length 17.7.

Barbel with axis of stem and between bulbs pigmented (Parin and Pokhilskaya, 1978, fig. 2A shows the proximal part of the axis between bulbs lighter than the distal part).

Dorsum with 8 pairs of pigment spots, the last pair beside the dorsal-fin base.

SIMILAR SPECIES.—All other *Nominostomias* species have terminal filaments arising only from the distal end of the distal (or single) bulb. The filaments of *medusa* (among species with 2 terminal bulbs) are reminiscent of those illustrated for *multifilis*, but are longer (5%–13% of SL vs. 1.3% in *multifilis*); *medusa* also has smaller proximal and distal bulbs (Figures 23 and 24) and usually has a prominent dark spot at the proximal end of the distal bulb. Among species with a single bulb, the filaments of *cirritus* are roughly similar in structure and length to those of *multifilis*, but there are only 3 (16 in *multifilis*); the terminal bulb of *cirritus* also is larger than the distal bulb of *multifilis* (Figure 23 vs. Figure 29).

DISTRIBUTION.—The holotype was taken in the southeastern Indian Ocean not far off the coast of Australia (Figure 42).

GROUP IV

The species of this group have a single terminal bulb with 1 to many terminal filaments (as opposed to the dome-like cap or finger-like projections of group V species). Only *E. gibbsi*, *E. pacificus*, and *E. patulus* have a single terminal filament; all other species have 3 or more. Eight species comprise this group. A synopsis of their salient characters is given in Table 5, and their barbel and postorbital-organ dimensions are plotted in Figures 29, 30.

Eustomias vitiazi Parin and Pokhilskaya, 1974

FIGURE 26*a*

Eustomias vitiazi Parin and Pokhilskaya, 1974:350–352 [holotype, 07°58'S, 175°57'W; 2nd specimen without end of barbel doubtfully assigned; neither specimen seen by us].

DIAGNOSIS.—A single terminal bulb 1.0%–1.2% SL. Barbel length short to intermediate (32%–60% SL). Nine or more short terminal filaments of various sizes, the longest 4% to 15% SL; shortest filaments often bulblet-tipped, longer filaments with bulblets and inclusions of various sizes and shapes; 1 filament thicker and longer than others, not forked, with 1 or more long inclusions filling most of its distal end. Axis of stem lightly or not pigmented. A dark spot usually present at base of bulb. External chevron-shaped or roundish striated areas unpigmented. Middorsal paired spots between occiput and dorsal-fin origin 7 (Parin and Pokhilskaya, 1974).

DESCRIPTION.—We have not examined the holotype, but its counts and measurements from Parin and Pokhilskaya (1974) are included here. The 2nd questionable specimen that lacks the end of the barbel is not included. With the holotype, we have data for only 6 specimens, 4 of them 77–97 mm, 2 140–158 mm. Growth changes are, therefore, not easily interpreted.

Barbel length appears to increase slightly relative to SL, from 32%–55% in the small specimens to 57%–60% in the large ones. The axis of the stem is lightly pigmented with scattered melanophores in most specimens, becoming darker just before the terminal bulb and forming a dark spot at the base of that bulb. One specimen (97 mm) lacks stem pigment and the bulb spot.

The terminal bulb is ovoid to long-ovoid in shape. It is 1.0%–1.2% SL, and does not change relative to SL with growth.

Filament length appears to decrease relative to SL, the longest being 5.7%–15.2% SL in the 3 small specimens, 4.3%–4.4% in the 2 large ones.

TABLE 5.—Synopsis of characters of Group IV species (SL is given (in mm) when characters are from only part of the size range; see footnotes for "Other characters")

Species	Barbel length (% SL)	SL	Bulb (% SL)	SL	Filament length (% SL)	SL	Filament number	Filament structure
bulbornatus	21–35	≥84	0.4–0.6	≤100	2.8–6.8		6 (3 pairs)	bilaterally symmetrical, complex;
			0.3–0.5	≥100				1 pr, w/large distal bulblet
cancriensis	47–53		~0.7–1.3		1.9–4.3		3–6 simple or forked	no bulblets, mostly unpigmented
cirritus	48–49		1.1–1.2		2.0–2.3		3 complex	complex branching, many bulblets
gibbsi	30–52	≥80	1.0–1.5	70–80	3.6–5.1	≤82	1 simple	simple or forked,
			0.9–1.2	≥100	1.6–2.0	≥130	or forked	no bulblets
pacificus	41–58		1.5–1.8	≤110	12–25		1 complex	complex branches and large
			0.8–1.5	≥113				bulblets
patulus	56		1.4		2.7		1 branched	no bulblets
teuthidopsis	89		0.8		1.5		~13	2 larger, thicker, w/o bulblets
vitiazi	32–55	≤97	1.0–1.2		5.7–15.2	≤97	9–16	variable size, structure;
	57–60	≥140			4.4	≥140		largest with long inclusion

[a] Stem axis pigmented. [b] Stem axis pigmented or not. [c] Filament(s) pigmented. [d] 1 filament pair pigmented, 2 unpigmented. [e] Few or no filaments pigmented. [f] Filament(s) unpigmented. [g] Bulb flat proximally with large black cap. [h] Bulb with nipple. [i] Short eye pedicel. [j] Long eye pedicel.

The filaments number 9 to 16 (they are very difficult to count); their axes are unpigmented. Several sizes and configurations are present in any specimen, ranging from short and simple to short and bulblet-tipped, slightly longer and with a filament from the bulblet, still longer with bulblets and long inclusions and 1 that is longer than all others and has a very long inclusion occupying its distal half. Short branches may arise from the sides or distal ends of the filaments. In one specimen in poor condition (140 mm) no bulblets could be discerned in any of the filaments.

The only large male (158 mm) has a postorbital organ 1.6% SL, 89% of fleshy orbit.

Parin and Pokhilskaya (1974) counted 8 pairs of spots along the dorsum, 7 between the head and the dorsal-fin origin, 1 under the dorsal-fin base. In our specimens, either the spots have faded or they are missing in some areas, or the midline of the dorsum is extensively pigmented but no paired spots formed.

REMARKS.—Parin and Pokhilskaya (1974) believed that a 2nd specimen, 152.5 mm, but lacking the end of the barbel, belonged to this species. Their judgment was based on the presence of 8 pairs of spots along the dorsum, a number shared only by *E. macrurus* among their material. We confirm their observation that most *Nominostomias* species have 9 or more pairs of dorsal spots (rarely, we have seen 8 or 10 in a species for which 9 was typical), but we have been unable to count these spots in *vitiazi* and can neither confirm nor refute their assignment of the questionable specimen. On the basis of known distribution, few species other than *vitiazi* would be expected to occur at the capture location (16°24′S, 149°11′E). Other possibilities are *crossotus*, *teuthidopsis*, and *cirritus*.

Male postorbital (% SL) [SL]	Male postorbital (% eye)	Predorsal pairs of spots	Other characters
1.5–1.7 [124–139]	56–70	(7–8) 9–10	a,d
1.3 [142]	45	7 (–9)	a,e
–	–	7 (in 1)	a,f
0.6–1.1 [104–136]	24–46	8 (9)	a,f,g,i
0.5–0.7 [110–125]	19–29	7 (8)	b,f,h,j
1.7–1.8 [142–151]	59–68		
2.3 [133]	77	?	a,c
–	–	?	a,c
1.6 [158]	89	7 (in 1)	b,f

SIMILAR SPECIES.—*Eustomias medusa* is very similar to *E. vitiazi*, but has 2 terminal bulbs and fewer terminal filaments (7–10 vs. 9–16 in *vitiazi*). The longest filament is forked in *medusa* and apparently is longer (large specimens 7%–11% SL, less than 5% in large *vitiazi*). All the filaments are fairly long in *medusa* (there are no short, bulblet-tipped filaments as in *vitiazi*) and lack long inclusions (present at least in the longest filament of *vitiazi*).

Of the other *Nominostomias* species with single bulbs and multiple or complex filaments, none has filaments resembling those of *vitiazi*. In *pacificus* the single complex filament is longer (12%–25% SL vs. less than 15% in *vitiazi*, and the bulb has a nipple-like distal projection. In *cirritus*, *teuthidopsis*, and *cancriensis*, the filaments are shorter at any size than in *vitiazi* (4% SL or less vs. 4%–15% in *vitiazi;* see Figure 30) and have only small bulblets as inclusions, lacking the long inclusions of *vitiazi*). In *bulbornatus* the bulb is smaller (0.3%–0.6% SL vs. 1.0%–1.2%), and its 3 pairs of filaments are unique. The barbel is longer in *teuthidopsis* (89% SL vs. 32%–60% in *vitiazi*) and shorter in *bulbornatus* (maximum 35%).

DISTRIBUTION.—Taken in the South Pacific between 8° and 20°S from 168°E to 143°W (Figure 43), possibly extending to 149°E, if Parin and Pokhilskaya's (1974) questionable specimen is really *vitiazi*.

MATERIAL EXAMINED (1 female, 4 unsexed).—USNM 223720 (♀, 97.4), 12°21′S, 143°04′W, 0–166 m, 1900–2000, 29 Aug 1956. USNM 223721 (2?, 77, 82), 12°48′S, 150°09′W, 0–300 m, 0040–0230, 5 Dec 1977. ORSTOM (Noumea) uncat. (?, 140), 22°06′S, 165°43′E, 160–280 m, 0045, 22 Feb 1974. ORSTOM (Noumea) uncat. (?, 158), 20°17′S, 167°40′E, 0–415 m, 1846, 3 Jul 1972.

Eustomias teuthidopsis, new species

FIGURE 26*b*

DIAGNOSIS.—A single terminal bulb 0.8% SL. Barbel length long, 89% SL. About 13 short terminal filaments (1.5% SL, 1.8 times bulb length); 2 filaments notably thicker than others, with blunt distal ends and with few or no bulblets. Axis of stem lightly peppered with melanophores; a small dark spot at base of terminal bulb; groups of small melanophores forming external spots just proximal to bulb. External chevron-shaped or roundish striated areas unpigmented. Number of paired spots along dorsum unknown.

DESCRIPTION OF HOLOTYPE.—Female, 190.7 mm SL, with moderately large eggs (to 0.3 mm). D 25. A 36. P1 3. P2 7. Body almost completely skinned; photophores cannot be counted. Branchiostegal photophores 10. Premaxillary teeth 14 right, probably also left: from anterior to posterior, a long fixed tooth followed by a long space, a fixed fang followed by a moderate space, a short-to-long series of 2 fixed and 2 depressible teeth, a short-to-moderate series of 1 fixed and 3 depressible teeth, and 4 short depressible teeth. Maxilla with about 24 short, slanting, serra-like

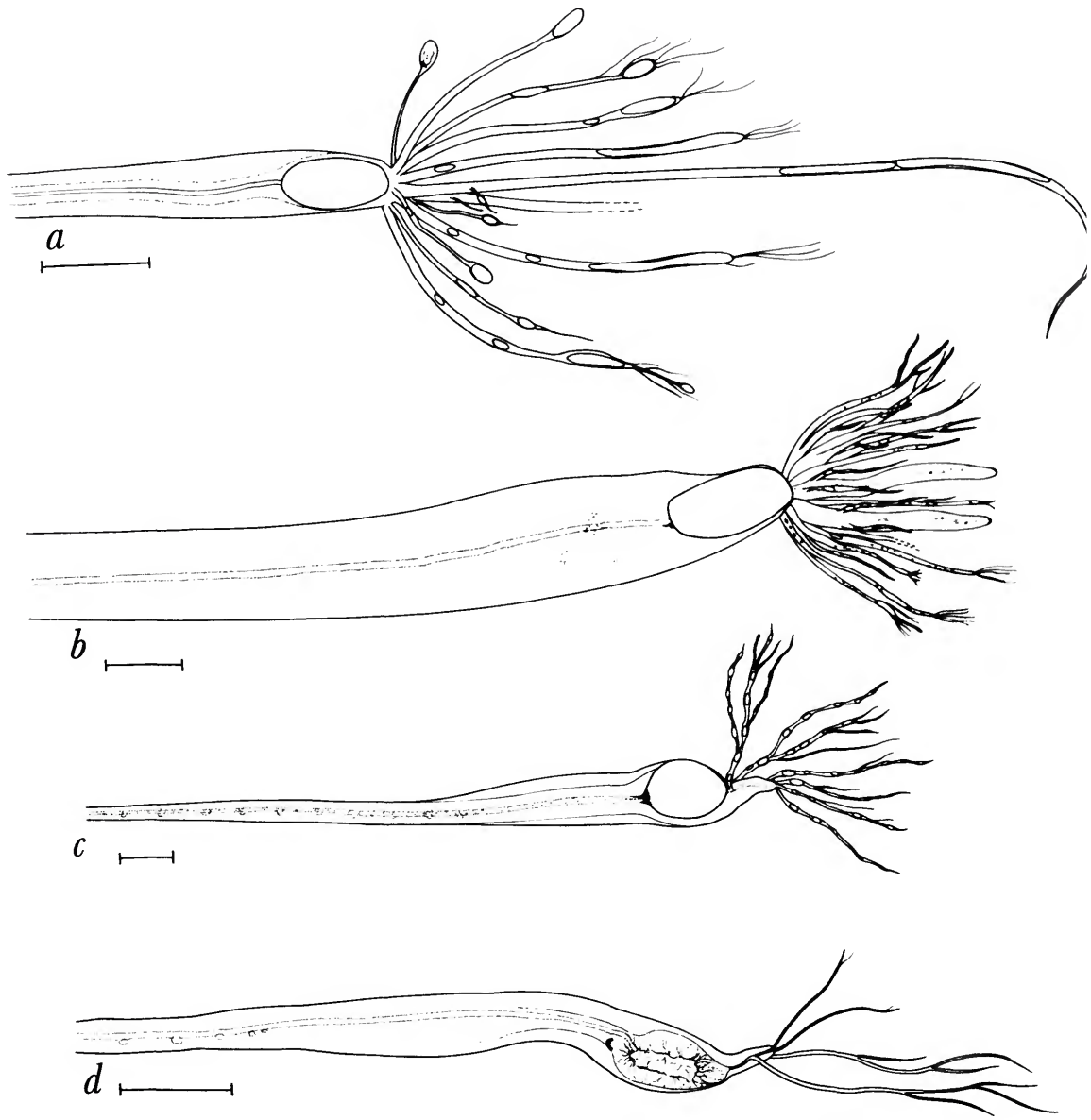


FIGURE 26.—Barbel ends of Group IV species: *a*, *E. vitiazi*, 97.4 mm SL, USNM 223720; *b*, *E. teuthidopsis*, holotype, 190.7 mm SL, USNM 223719; *c*, *E. cirritus*, holotype, 147.5 mm SL, ZMUC P201873; *d*, *E. cirritus*, 192.4 mm SL, USNM 223722 (aberrant barbel, possible regenerating). (Bar = 1 mm.)

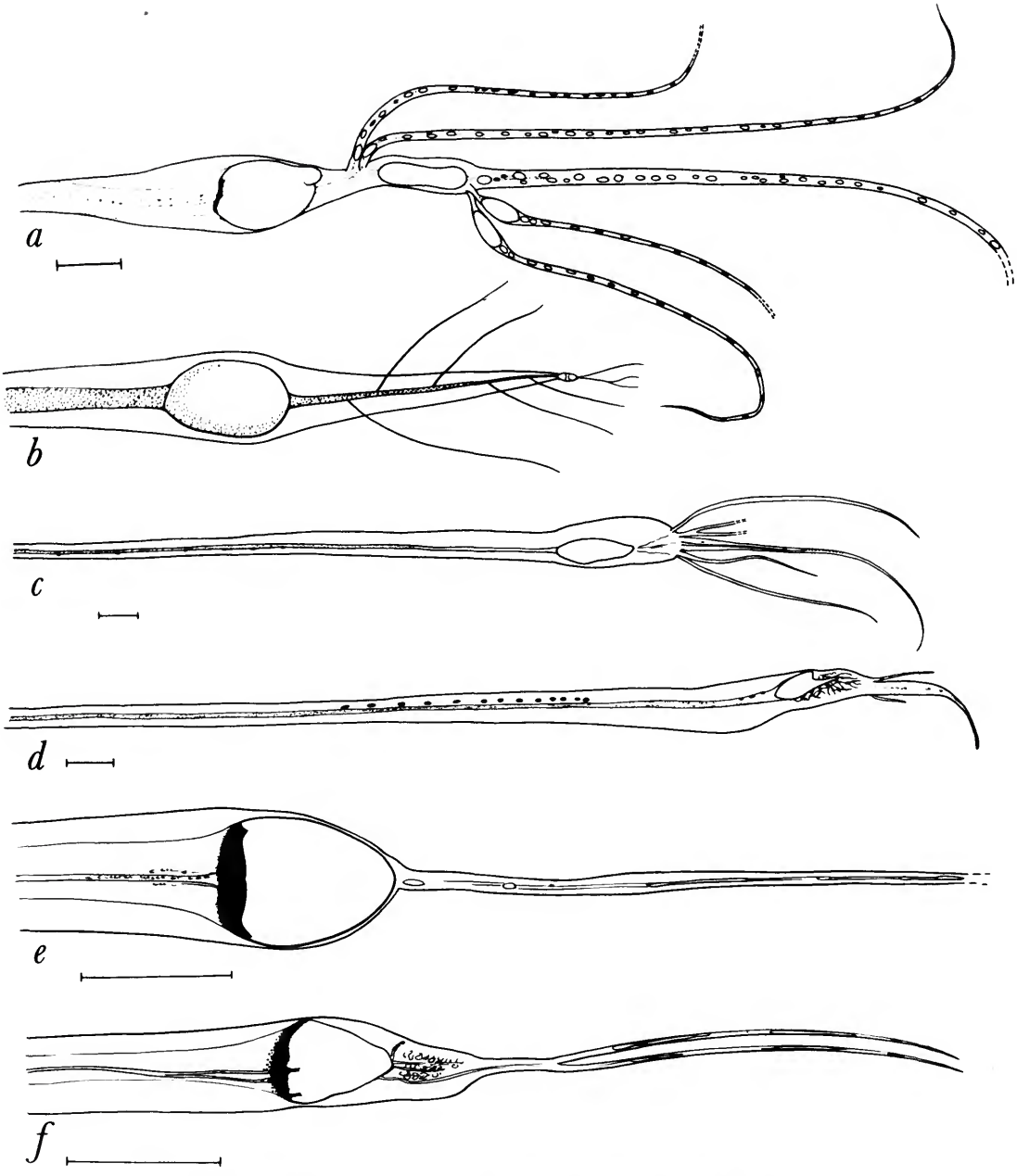


FIGURE 27.—Barbel ends of Group IV species: *a*, *E. pacificus*, holotype, 148 mm SL, USNM 223788; *b*, *E. patulus*, holotype, 132.5 mm SL, ZMUC P201907 (after Regan and Trewavas, 1930); *c*, *d*, *E. cancriensis* (*c*, paratype, 70.3 mm SL, SI0 68-483; *d*, holotype, 142 mm SL, IOAN uncatalogued); *e*, *f*, *E. gibbsi* (*e*, 109 mm SL, USNM 224250; *f*, 77 mm SL, USNM 224245). (Bar = 1 mm.)

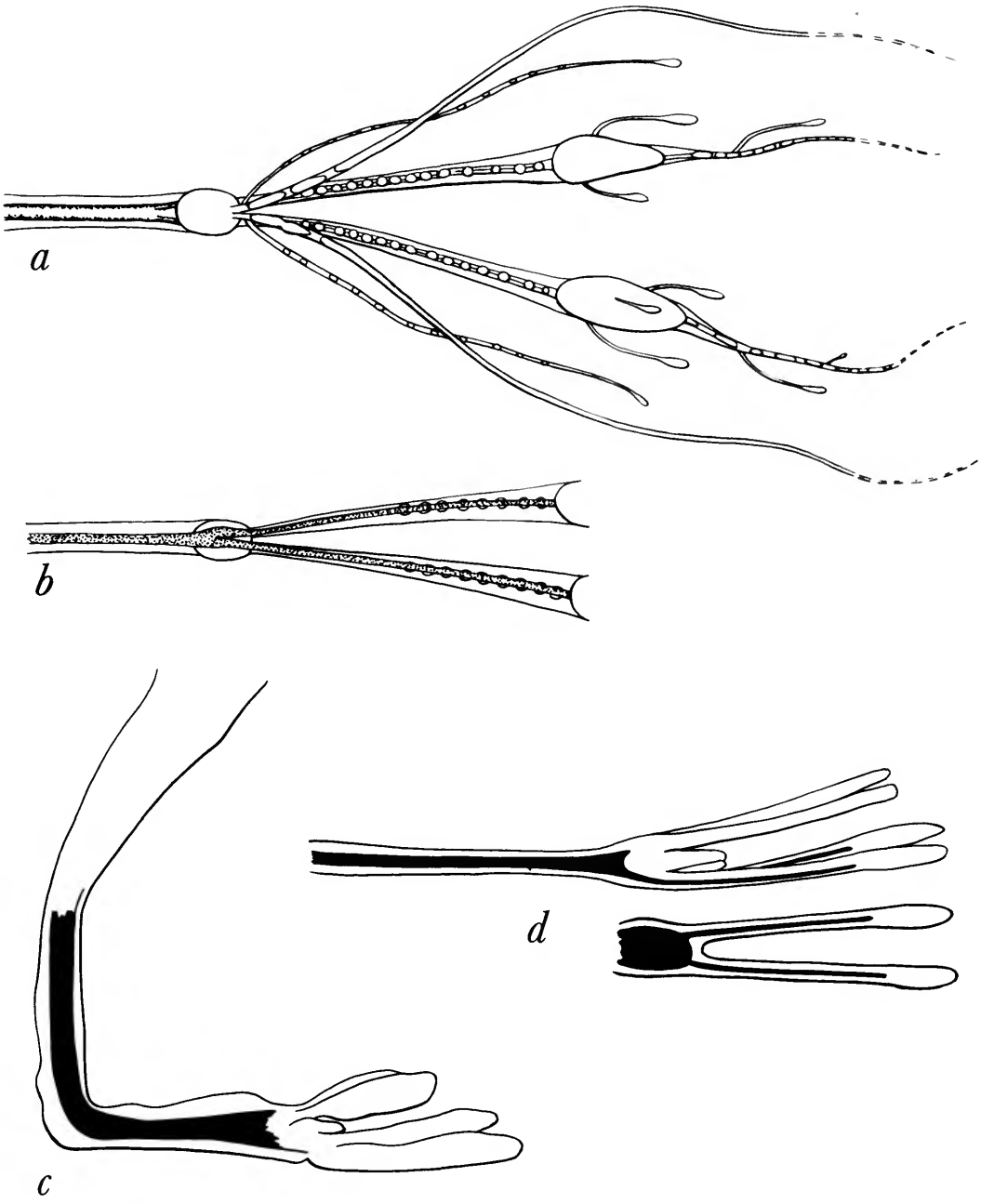


FIGURE 28.—Barbels of *E. bulbornatus*, a Group IV species: *a*, *b*, 125.2 mm SL, after Parin and Pokhilskaya, 1974 (*a*, dorsal view; *b*, ventral view); *c*, *d*, developing barbels (*c*, 95.5 mm SL, lateral view; *d*, 71.2 mm SL, lateral and ventral views).

teeth. Mandibular teeth 18 left, damaged right: from anterior to posterior, a short depressible symphysial tooth followed by a moderate space, a fixed fang followed by a moderate space, a long depressible tooth, a short-to-long series of 1 fixed and 2 depressible teeth, 2 short depressible teeth, a short-to-moderate series of 3 depressible teeth, 3 missing teeth and 1 short depressible tooth. Vertebrae 67.

Measurements (in mm): Predorsal length 161.4, preanal length 139.7, prepelvic length 111.5, head length 23.5, barbel length 169.6, terminal-bulb length 1.5, filament length 2.8, snout length 11.5, fleshy orbit damaged, postorbital-organ length 1.0, lower-jaw length 20.6, upper-jaw length 19.0, depth behind head (greatest depth) 10.7, caudal-peduncle least depth 2.2, pectoral and pelvic fins damaged, dorsal-base length 22.7, anal-base length 45.2, longest premaxillary tooth 2.5, longest mandibular tooth 2.1.

Barbel described mostly in diagnosis. Bulb an irregular long ovoid. Axes of all filaments moderately speckled. Two large filaments without bulblets; most others with 1 or a few; thinner filaments with swellings caused by bulblets and bulblet-tipped or with a filament distal to the bulblet.

SIMILAR SPECIES.—Of the *Nominostomias* species with single terminal bulbs and multiple terminal filaments, *bulbornatus*, *pacificus*, and *vitiazi* have longer filaments with different structure and arrangement; *cancriensis* has fewer filaments that are simpler and without bulblets. Perhaps the most similar species is *cirritus*, which has only 3 short, much-branched filaments that have numerous small bulblets causing swellings. The barbel length in *teuthidopsis* is longer than any of these other species (89% SL vs. 60% maximum), and the 2 thick, blunt filaments and the external spots preceding the bulb are unique.

In comparable species with 2 terminal bulbs and multiple filaments the filaments are either longer and differently structured (e.g., *medusa*) or fewer and simple, without bulblets.

DISTRIBUTION.—The only known specimen was taken at 11°37′S, 160°00′W, in the South Pacific near the Cook islands (Figure 43).

ETYMOLOGY.—From the Greek *teuthis*, *-idos* (squid) plus the adjectival suffix *-opsis* (having the appearance of), *teuthidopsis* alludes to the terminal filaments, which resemble the arms and enlarged pair of tentacles of squid.

MATERIAL EXAMINED.—*Holotype:* USNM 223719 (♀, 190.7), 11°37′S, 160°00′W, 0–171 m, 2001–2101, 9 Sep 1956.

Eustomias cirritus, new species

FIGURE 26*c,d*

Eustomias patulus.—King and Iversen, 1962: 319 [listed from South Equatorial Current].—Johnson and Rosenblatt, 1971: 310 [part; *Hugh M. Smith* cruise 31, sta 164; this and the King and Iversen record refer to the specimen tentatively called *cirritus* below].

Eustomias sp.—Parin et al., 1981: 9 [E. Pacific; examined by us].

DIAGNOSIS.—A single terminal bulb 1.1%–1.2% SL. Barbel length 48%–49% SL at 112–148 mm, 32%–37% at 192–214 mm. Three short, slender terminal filaments (2.0%–2.3% SL, 1.7–2.1 times bulb length), each filament branching complexly and with numerous small bulblets forming swellings. Axis of stem well pigmented proximally, becoming sparsely pigmented distally; a dark spot at base of distal bulb. No external pigment spots proximal to bulb. External chevron-shaped or roundish striated areas unpigmented. Middorsal paired spots between occiput and dorsal-fin origin 7 and 1 specimen.

DESCRIPTION OF HOLOTYPE.—Female, 147.5 mm SL, with a developing ovary. D 25. A 38. P1 3. P2 7. IP 7. PV 34. VAV 17. OV 34. VAL 19. AC 19. IA 58. IC 77. OA 53. OC 72. VAV photophores over anal-fin base 6. Branchiostegal photophores 10. Premaxillary teeth 15 left, 13 right: from anterior to posterior, a long fixed tooth followed by a moderate space, a fixed fang, a short-to-long series of 2 fixed and 3 depressible teeth (1 fixed, 3 depressible right), short-to-long series of 4 depressible teeth, and 4 moderate depressible teeth (3 right). Maxilla with about 20 short, slanting, serra-like teeth. Mandibular teeth

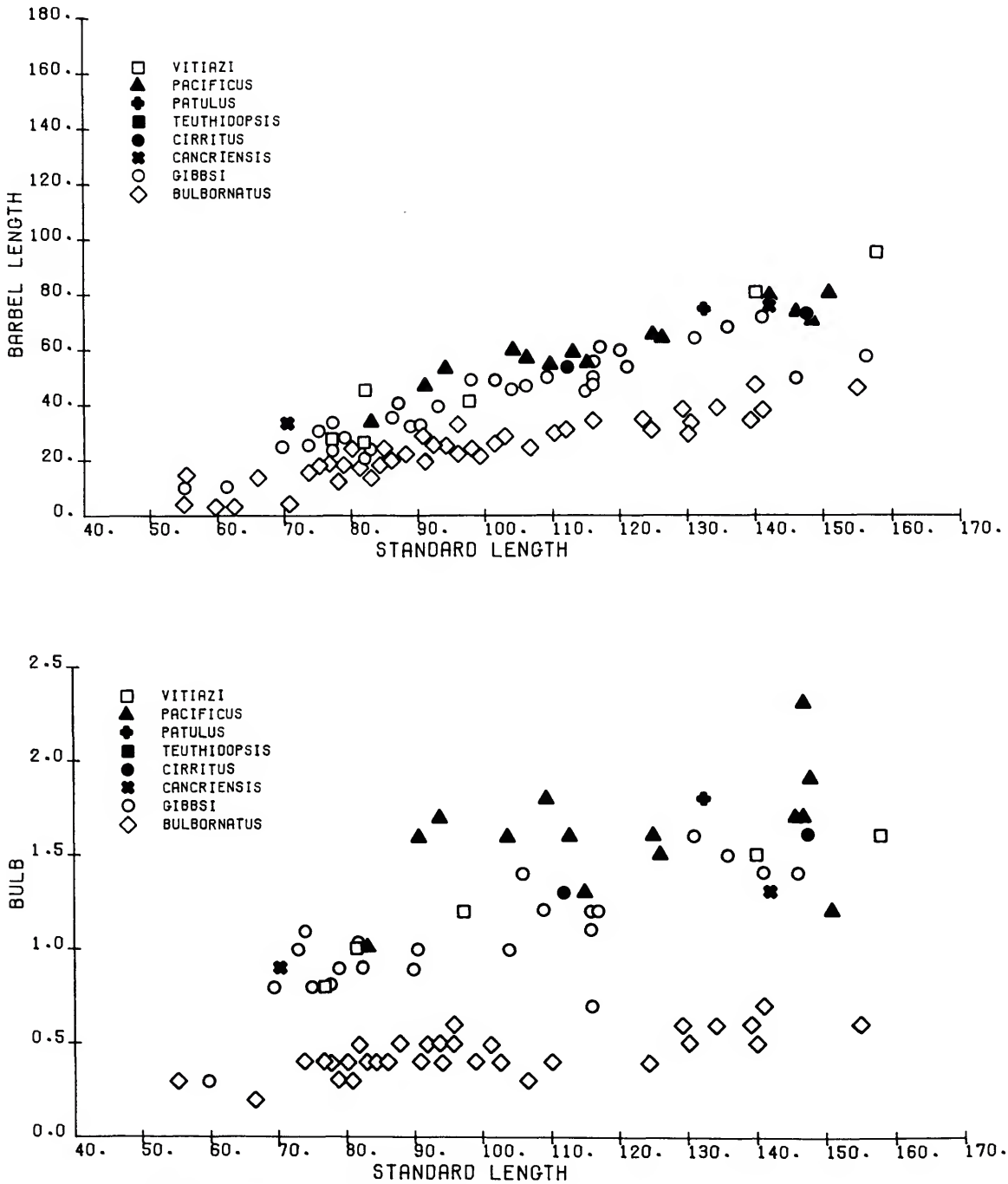
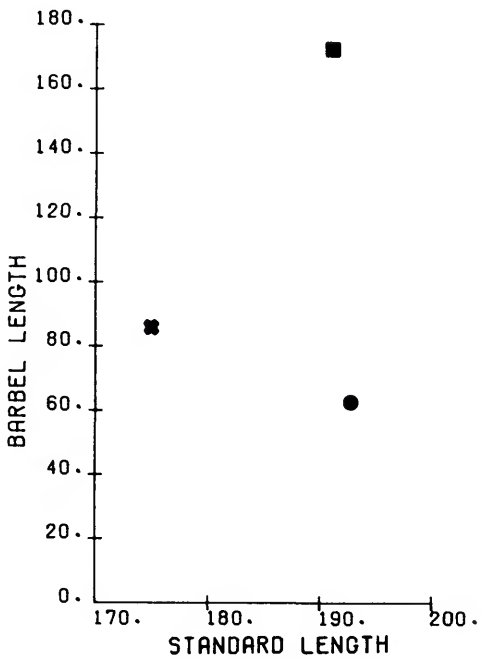


FIGURE 29.—Barbel length (mm) and terminal-bulb length (mm) vs. SL (mm) in Group IV species.



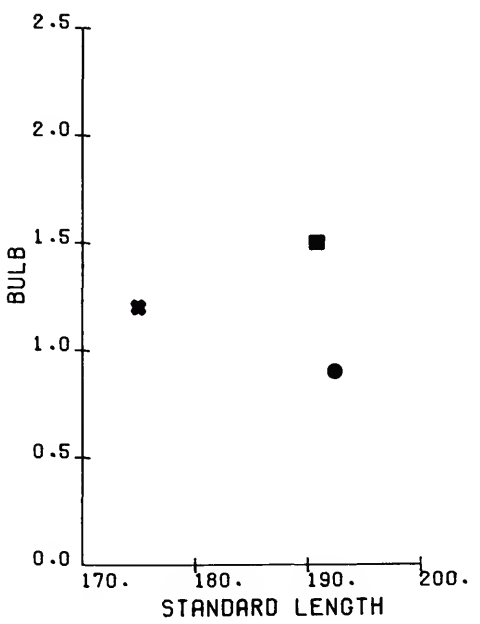


FIGURE 29.—Continued.

19 left, 20 right: from anterior to posterior, a short fixed symphysial tooth followed by a moderate space, a fixed fang followed by a moderate space, 2 long depressible teeth, a short fixed tooth (2 right), 2 long depressible teeth, a short-to-long series of 5 depressible teeth, a short-to-moderate series of 4 depressible teeth, and another short-to-moderate series of 4 depressible teeth. Vertebrae 68, the 1st only partly ossified.

Measurements (in mm): Predorsal length 124.0, preanal length 109.5, prepelvic length 84.0, head length 17.3, barbel length 72.4, terminal-bulb length 1.6, filament length 3.4, snout length 5.8, fleshy orbit length 4.0, postorbital-organ length 1.1, lower-jaw length 16.0, upper-jaw length 14.8, depth behind head (greatest depth) 10.4, caudal-peduncle least depth 2.0, pectoral and pelvic fins damaged, dorsal-base length 19.3, anal-base length 37.3, longest premaxillary tooth 2.3, longest mandibular tooth 1.5.

Barbel described in diagnosis. Bulb shape could be called short-ovoid or oblate spheroid. Filaments unpigmented. Three multi-branched filaments, 1 of which is continuous with a thick distal projection of the material surrounding the bulb.

SIMILAR SPECIES.—Only *teuthidopsis* has a single terminal bulb and short filaments with bulblets and fairly complicated structure; that species has a longer barbel (89% SL vs. 48%–49% in *cirritus*), the bulblets in the filaments are not as prominent as in *cirritus*, there are more filaments, and 2 of the filaments are notably thick and blunt-tipped. The short filaments of *cancriensis*, another species with a single terminal bulb, are simple and without bulblets. The other single-bulbed species with multiple terminal filaments (*vitiazi*, *bulbornatus*, and *pacificus*) have longer filaments with different structure.

The Atlantic species *arborifer* somewhat resembles *cirritus*, but has 2 terminal bulbs and a single main terminal filament that bears all branches.

REMARKS.—A 192.4 mm specimen is tentatively assigned to *cirritus*. It has a much shorter barbel than the other 2 specimens (32% SL) and a bulb that is either damaged or regenerating, represented by a reticular network. The filaments

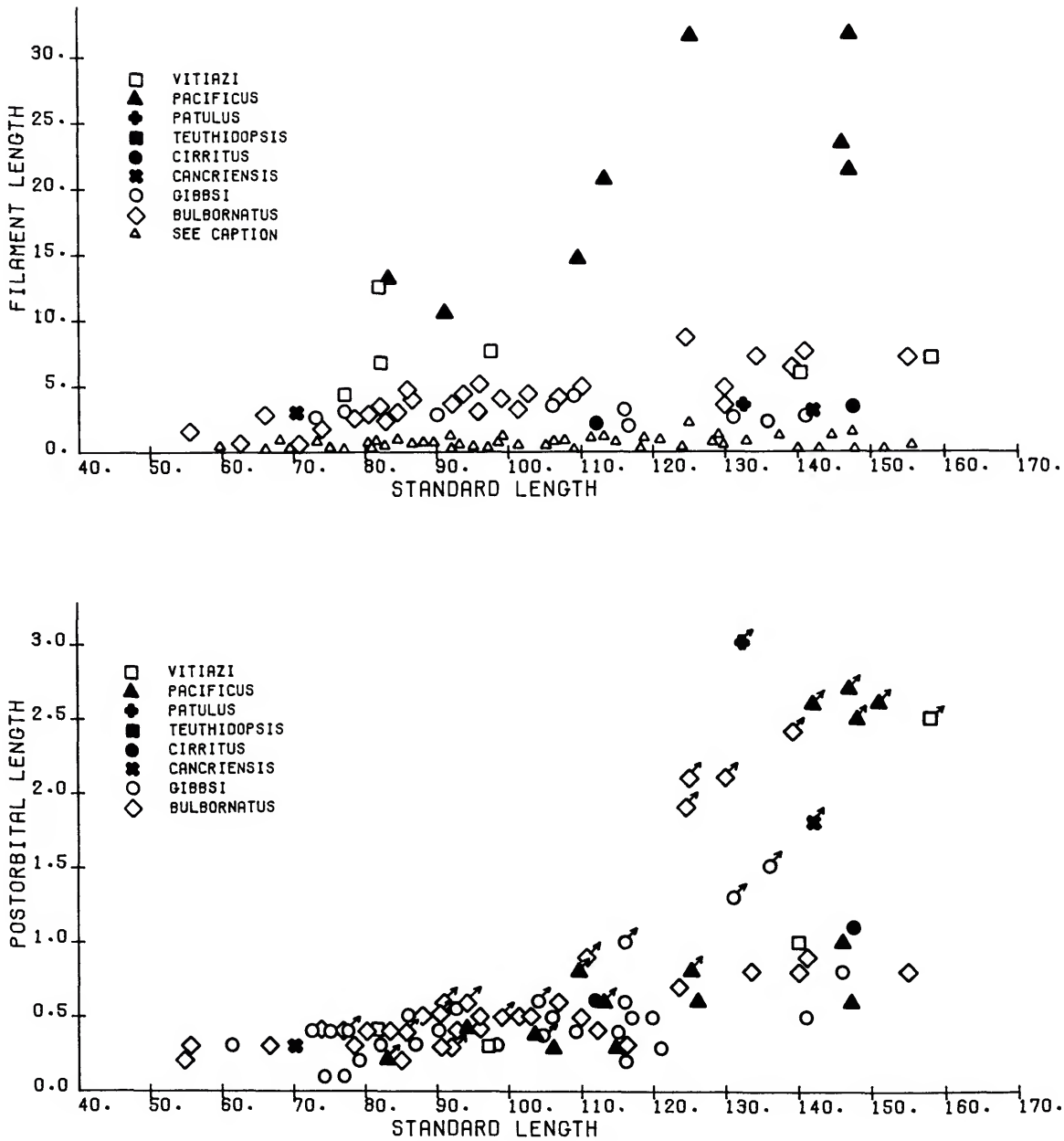
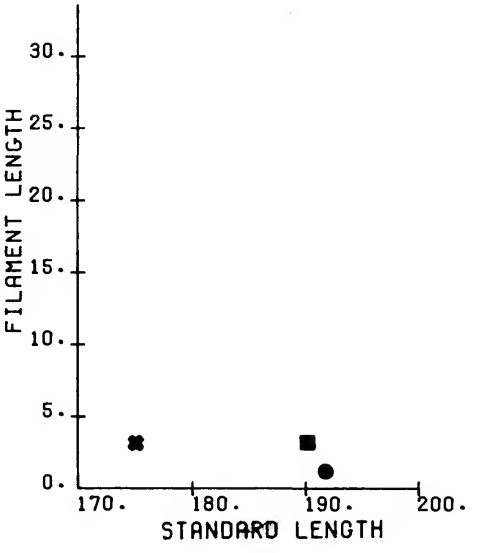


FIGURE 30.—Filament length (mm) and postorbital-organ length (mm) vs. SL (mm) in Group IV species. On the graph of filament length, the open triangles represent the length of the terminal projection of all Group V species for comparison. For postorbital organ, specimens not marked as males include both females and unknowns; the 3 specimens larger than 170 mm SL are not plotted (the organ of the *cancriensis* was not measured, that of the 191 mm female *cirritus* = 1.0 mm, and that of the 192 mm female *teuthidopsis* = 1.0 mm).



resemble those of the holotype in arrangement, but are shorter (0.5% SL) and lack bulblets, and the projection beyond the bulb is similar. Pigment is entirely lacking in the stem and filaments, except for a spot at the base of the bulb. We suspect that the barbel may have lost its distal end at one time and was in the process of regenerating.

After this paper had gone to press, N.V. Parin reported (pers. comm.) a female *E. cirritus*, 214 mm SL, from 19°34'S, 81°36'W, with a barbel of 78.8 mm (only 37% SL). The shortness of this barbel suggests that the supposedly regenerating barbel of the 192.4 mm specimen is of normal length.

DISTRIBUTION.—The holotype was taken just southeast of New Caledonia, the paratype on the opposite side of the Pacific over the Nazca Ridge. The tentatively identified specimen was taken just north of the Marquesas Islands (Figure 43).

ETYMOLOGY.—From the Latin adjective *cirritus* (filamentous, having fine filaments), alluding to the delicate terminal filaments of this species.

MATERIAL EXAMINED (3 females).—*Holotype:* ZMUC P201873 (147.5), 24°47'S, 170°19'E, 0–~300 m (600 mw), 2110, 7 Dec 1928.

Paratype: IOAN uncat. (112), 21°29'S, 81°42'W, 0–335 m, 15 Oct 1979.

Non-type: USNM 223722 (192.4), 06°37'S, 141°53'W, 0–337 m, 2010–2111, 1 Nov 1955.

Eustomias cancriensis, new species

FIGURE 27*c,d*

Eustomias patulus.—Johnson and Rosenblatt, 1971:309 [part; SIO 68-483 only; barbel fig. 2*f*].

Eustomias patulus?—Parin et al., 1977:100, 101 [*Vityaz* sta 7171 and 7381].

DIAGNOSIS.—A single terminal bulb 0.7%–1.3% SL. Barbel 47%–53% SL. Three to 6 short (1.9%–4.3% SL) terminal filaments, 1 filament thicker and longer than the others, all filaments simple or forked and lacking bulblets. Axis of stem pigmented; no spot formed at base of bulb. No external pigment spots proximal to bulb. External chevron-shaped or roundish striated areas unpigmented. Middorsal paired spots between occiput and dorsal-fin origin 7 to (questionably) 9.

DESCRIPTION.—The barbel is 47%–53% SL, apparently not changing relative to SL with growth. Pigment in the stem axis appears to increase in density and intensity with growth. The axis is lightly peppered in the 70 mm specimen, very dark and nearly solid in the 175 mm one. There is no spot at the base of the bulb. The external chevron-shaped or roundish striated areas are unpigmented.

All 3 specimens have bulbs that appear to be damaged, and their normal shapes cannot be ascertained. The approximate measurements indicate probable decrease relative to SL from 1.3% to 0.7% (70–175 mm SL).

The filaments also apparently decrease relative to SL with growth from 4.3% to 1.9%. The filament axes are unpigmented in the smallest specimen; in the 2 large specimens the axis of the dominant filament is moderately or darkly pigmented, and in the largest (175 mm) specimen 1 of the shorter filaments has some pigment.

The only large male (142 mm holotype) has a

postorbital organ 1.3% SL, 45% of fleshy orbit.

In the smallest specimen there are 7 pairs of dark spots along the dorsum between the occiput and the dorsal-fin origin. In the 142 mm holotype, there appear to be 9 pairs, but the anteriormost 2 pairs are not discrete spots, being represented by long areas of diffuse pigment.

DESCRIPTION OF HOLOTYPE.—Male, 142.0 mm SL, with moderately large testes. D 25. A 39. P1 3. P2 7. IP 7. PV 31. VAV 19. OV 33. VAL 19. AC 18. IA 57. IC 75. OA 52. OC 70. VAV photophores over anal-fin base 8. Branchiostegal photophores approximately 11. Premaxillary teeth 14 left, 11 right: from anterior to posterior, a long fixed tooth followed by a long space, a fixed fang followed by a long space, a moderate fixed tooth, a long depressible tooth, a moderate fixed tooth, 3 short depressible teeth, and 3 very short depressible teeth (absent on right). Maxilla with about 25 short, slanting, serra-like teeth. Mandible missing. Vertebrae 68.

Measurements (in mm): Predorsal length 120.5, preanal length 100.5, prepelvic length 79.5, head damaged, barbel length 75.0, terminal-bulb length 1.3, filament length 3.2, snout length ~8.0, fleshy orbit length ~4.0, postorbital-organ length 1.8, lower jaw missing, upper-jaw length 13.6, depth behind head 7.3, greatest depth 7.9, caudal-peduncle least depth 2.4, pectoral and pelvic fins damaged, dorsal-base length 18.6, anal-base length 39.0, longest premaxillary tooth 2.5, mandibular teeth missing.

Barbel with stem axis darkly pigmented, the pigment streaky or almost solid, a little lighter distally; no spot at base of bulb. Axis of longest filament moderately pigmented; no pigment in the 2 other, shorter filaments. External chevron-shaped or roundish striated areas unpigmented.

Terminal bulb apparently crushed, its distal portion represented by a reticulate network of fibers (blood vessels? nerves?).

Nine pairs of spots near dorsal midline between occiput and dorsal-fin origin, 1 pair beside dorsal base; anteriormost 2 pairs not well defined.

SIMILAR SPECIES.—All other *Nominostomias* species with single terminal bulbs and multiple terminal filaments have complicated, branching filaments or numerous bulblets or other inclusions in the filaments or both. In *teuthidopsis* the barbel is also longer (89% SL vs. 47%–53% in *cancriensis*), and in *bulbornatus* it is shorter (maximum 35%). In *pacificus* and *vitiazi* the filaments are also longer (4% SL or longer vs. maximum 4% in *cancriensis*).

The filament structure of *cancriensis* suggested the possibility that it might be *melanostigma* or *melanostigmoides* without a 2nd terminal bulb. The former has been taken in the westernmost Pacific near the equator, the latter so far only from the Hawaiian region. Both, however, have longer barbels than *cancriensis*, at least at larger sizes (in specimens larger than 90 mm SL, one 48%, all others 55%–86% SL vs. 47%–53% in *cancriensis*). A black spot at the base of the distal bulb is common in *melanostigma* and *melanostigmoides*, but is not present in the 3 specimens of *cancriensis*.

DISTRIBUTION.—All 3 known specimens have been taken in a narrow latitudinal zone between 21° and 25°N in the western Pacific, from 128° to 178°E (Figure 43).

ETYMOLOGY.—From the Latin *cancer* (crab) plus the suffix *-ensis* (denoting a locality), in reference to the distribution of this species along the Tropic of Cancer.

MATERIAL EXAMINED (1 male, 2 unsexed).—*Holotype:* IOAN uncat. (♂, 142), 25°13′N, 128°32′E, 0–100 m, 0252–0322, 8 Feb 1975.

Paratype: SIO 68-483 (?, 70.3), 25°38′N, 178°07′E, 0–~1500 m (3000 mw), 9045–1445, 19 Sep 1968.

Non-type: IOAN uncat. (?, 175), 21°36′N, 143°51′E, 0–500 m, 0244–0344, 2 May 1975.

Eustomias pacificus, new species

FIGURE 27*a*

Eustomias sp. 6.—Parin et al., 1977:102 [*Vityaz* sta 7380, examined by us].

DIAGNOSIS.—A single terminal bulb, 0.8%–1.8% SL, with a nipple-like distal protuberance. Barbel 41%–58% SL. A single, but complex, terminal filament with 2 long branches arising together

near its base, followed by 1 to 5 large bulblets, followed by 2 short branches arising together, each usually with a prominent large bulblet; all branches and the main filament with numerous, prominent small bulblets. Filament length 12%–25% SL. Axis of stem unpigmented or lightly to moderately pigmented; a prominent, wide black circle forming a cap at base of terminal bulb. External chevron-shaped or roundish striated areas unpigmented. Middorsal paired spots between occiput and dorsal-fin origin usually 7, sometimes 8. Anterior margin of fleshy orbit with a distinct slender pedicel extending posteriad over the eye (Figure 2*a*).

DESCRIPTION.—The smallest specimen (83 mm) has the relatively shortest barbel (41% of SL). In all others (91–157 mm) barbel is 44%–58% of SL, apparently not changing relative to SL with growth. The stem axis is usually pigmented, variably darkly to very lightly in its proximal portion, becoming lighter or unpigmented distally. A prominent, very dark circular cap is formed at the base of the terminal bulb. The external chevron-shaped or roundish striated areas are unpigmented.

The shape of the terminal bulb is ovoid, usually appearing somewhat block-like. A rounded protuberance projects from 1 side of the distal end, usually with its proximal end constricted. One specimen has an apparently distorted bulb that tapers distally and does not have a well-defined protuberance. The terminal bulb appears to decrease relative to SL. In the smallest specimen, the bulb is 1.2% SL and may represent a stanza of increase. In specimens 91–110 mm SL the bulbs are 1.5%–1.8% SL, in those 113–157 mm they are 0.8%–1.5%.

The terminal filament is 12%–25% SL. An increase relative to SL is suggested, with filaments 12%–16% in 2 specimens 83–91 mm, 13%–18% in 2 110–113 mm, and 14%–25% in 4 125–157 mm. The filament axes are unpigmented in all except 1 specimen, which has a few specks just distad from the bulb. Two long branches arise together just distad of the terminal bulb. Beyond these, there are 1 to 5 prominent, large bulblets, varying in shape from spheroidal to long and either straight-sided or constricted; these bulblets often are large enough to be considered as distal bulbs. Two short branches then arise together, each usually with a single prominent bulblet from which a slender filament arises; in 1 specimen these 2 branches lacked the large bulblets. The main filament and all branches have numerous prominent small bulblets.

The postorbital organ in males 110–125 mm is 0.5%–0.7% SL, 19%–29% of fleshy orbit, and is apparently just beginning to enlarge. In the 4 larger males, 142–151 mm, the organ is 1.7%–1.8% SL, 59%–68% of fleshy orbit.

The mid-anterior edge of the fleshy orbital margin has a slender pedicel extending posteriad over the eye and bearing a white photophore at its tip. Other species of *Nominostomias* have at most a short pedicel-like extension (*gibbsi*, Figure 2*b*); most have only a slight bulge from the orbital rim.

DESCRIPTION OF HOLOTYPE.—Male, 148.0 mm SL. D 24. A 39. P1 3. P2 7. IP 7. PV 34. VAV 18. OV 34. VAL 19. AC 19. IA 59. IC 78. OA 53. OC 72. VAV photophores over anal-fin base 7. Branchiostegal photophores 10. Premaxillary teeth 12 left, 13 right: from anterior to posterior, a moderate fixed tooth followed by a long space, a fixed fang followed by a moderate space, a short-to-long series of 1 fixed and 3 depressible teeth, a short-to-moderate series of 3 depressible teeth, and 4 short depressible teeth (5 right). Maxilla with 5 short erect teeth and 4 short posteriad-slanting teeth, a toothless space about as long as occupied by the 1st 5 teeth, and about 17 more short, slanting, serra-like teeth. Mandibular teeth 19 on both sides: from anterior to posterior, a very short fixed tooth followed by a moderate space, a fixed fang followed by a moderate space, a long depressible tooth, a very short fixed tooth, 2 long depressible teeth, a short-to-long series of 5 depressible teeth, a short-to-moderate series of 4 depressible teeth, and 4 short depressible teeth. Vertebrae 69.

Measurements (in mm): Predorsal length 122.4; preanal length 100.2, prepelvic length 79.6, head

length 16.5, barbel length 70.0, terminal-bulb length 1.9, filament broken, 1st pair of branches at end of terminal-bulb protuberance, distance from 1st pair to 2nd pair of branches 2.3, 1st branches broken, 2nd-branch length 5.8, snout length 5.1, fleshy orbit length 3.8, postorbital-organ length 2.5, lower-jaw length 14.5, upper-jaw length 13.5, depth behind head (greatest depth) 8.8, caudal-peduncle least depth 2.0, pectoral-fin length 26.3, pelvic-fin length 22.3, dorsal-base length 17.5, anal-base length 37.2, longest premaxillary tooth 2.0, longest mandibular tooth 1.8.

Barbel with stem axis moderately peppered proximally, becoming somewhat lighter distally. Two separated black areas of pigment at base of terminal bulb, forming an incomplete circle. External chevron-shaped or roundish striated areas on stem unpigmented. Filament with a few pigment specks proximally, otherwise unpigmented.

Terminal bulb ovoid with a prominent rounded protuberance, constricted at its base, arising from distal end. A pair of branches arising just at end of protuberance, broken, but intact part with closely spaced small bulblets. Beyond these branches a short portion without bulblets, followed by 2 prominent small bulblets and a large, irregularly spheroidal bulblet about half the length of the terminal bulb. Immediately after the large bulblet, a 2nd pair of branches, each with a prominent basal bulblet about two-thirds the length of the preceding large bulblet and a long, filamentous extension. Beyond 2nd pair of branches, filament with several small bulblets before broken tip.

Paired spots along dorsum not counted, because skin was very darkly pigmented.

SIMILAR SPECIES.—Two other single-bulbed species, *patulus* and *gibbsi*, and some *inconstans*, have a single terminal filament, but in all, the filament is shorter and simpler. All other *Nominostomias* species with single terminal bulbs have 3 or more filaments arising from the bulb or close to it, and these filaments are shorter (15% SL or less, vs. 12% or more in *pacificus*). No single-bulbed or two-bulbed species of *Nominostomias* has a protuberance from the terminal bulb or has terminal filaments that approach the unique structure of those of *pacificus*, in which a pair of basal branches is followed by one or more prominent large bulblets and a 2nd pair of branches that usually have quite large basal bulblets.

The only species with a barbel suggestive of *pacificus* is *E. polyaster*, which has 2 terminal bulbs and only 2 pectoral rays and is not treated in this paper. The barbel of *polyaster* has a notched distal bulb that suggests but is not similar to the bulb with protuberance of *pacificus*, and the terminal filament is complex, with several large bulblets and a variable number of side branches along its length, but the bulblets and branches are not constant in their number and arrangement as are those of *pacificus*.

REMARKS.—A specimen 71 mm SL is tentatively regarded as *pacificus*. This would be the smallest known specimen of the species. Its barbel is opaque, poorly developed, only 7.3% SL, and bears 1 thick and 3 thinner, short, blunt projections, 3 arising from the distal end of the single bulb, 1 apparently from the side of the bulb itself. By this size, other species with relatively complicated filaments are quite recognizable, and none of the smaller specimens of other species with poorly developed bulbs have the same arrangement of developing filaments. The relatively large size at which postorbital organs of males enlarge suggests that attainment of fully formed barbel structure may also occur at relatively large sizes in *pacificus*. The evidence is slim, however, that this specimen really is *pacificus*.

DISTRIBUTION.—One specimen was taken from the northwestern Pacific at 21°N, 144°W. All others are from off Oahu, Hawaiian Islands (Figure 43).

ETYMOLOGY.—From the Latin adjective *pacificus* (peaceful), alluding to the obvious characteristic of the ocean of the same name, to which this species is endemic.

MATERIAL EXAMINED (9 males, 4 females, 4 unsexed).—*Holotype:* USNM 223788 (♂, 148), 21°20′N, 158°20′W, 0–170 m, 2346–0135, 5 Oct 1971.

Paratypes (all except AMNH and IOAN specimens from 21°00′–21°20′N, 158°00′–20′W): USNM 223787 (♂, 151), 0–200 m, 0120–0500, 22 Jun 1971. USNM 223789 (♀, 145.9), 0–550 m, 0430–0530, 4 July 1978. USNM 223790 (♂, 125), 0–75 m, 0048–0400, 27 Feb 1972. USNM 223791 (♀, 115), 0–250 m, 0143–0403, 6 Oct 1971. USNM 223792 (♀, 126), 0–140 m, 0035–0252, 16 Jun 1971. USNM 223793 (♂, 113), 0–120 m, 1953–2310, 12 Nov 1969. USNM 223794 (?, 94), only locality known. USNM 223795 (♂, 83), 0–450 m, 1535–1802, 9 Nov 1974. BPBM 26418 (♂, 104), 0–190 m, 1953–2142, 5 Oct 1971. SIO 80-174 (♂, 109.5), 0–1000 m, 1215–1655, 22 Feb 1978. AMNH 43494 (♂, 147), ~19°30′N, 156°00′W, taken in 1975. IOAN uncat. (?, 157), 21°17′N, 143°37′E, 0–100 m, 2313–0013, 1 May 1975.

Non-types: USNM 223796 (♂, 142), 0–425 m, 0730–1010, 9 Jun 1971. USNM 223797 (♀, 106), 0–~500 m, 0721–1028, 25 Sep 1973. USNM 223798 (?, 91), 0–650 m, 0730–1132, 9 Nov 1974. USNM 223799 (?, 71), 0–500 m, 1820–2023, 29 Aug 1973.

Eustomias bulbornatus Gibbs, 1960

FIGURE 28*a–d*

Eustomias bulbornatus Gibbs, 1960:200–202 [1 specimen, off southern Japan; fig. 1, head, barbel].—Morrow and Gibbs, 1964:385 [in key].—Fourmanoir, 1970:21 [2 specimens, equatorial West Pacific].—Krefft, 1974:232 [Agulhas pattern of distribution in Atlantic].—Parin and Pokhilskaya, 1974:345–350 [41 specimens, equatorial Indian and Pacific oceans; detailed description; fig. 14, barbels].—Parin, 1976:198 [occurrence in western Pacific].—Parin et al., 1977:101 [15 specimens, western Pacific; barbel variations and color noted].—Parin and Pokhilskaya, 1978a:75 [specimen from 36°19′S, 19°56′E].

DIAGNOSIS.—A single, very small terminal bulb (0.3%–0.6% SL). Barbel short, 20%–35% SL in specimens over 80 mm SL and some smaller ones, shorter in some developing specimens up to about 80 mm SL. Three pairs of short filaments (2.2%–6.8% SL, but 4 times (young) to 21 times longer than bulb). Each filament of 1 pair with a prominent, elongate distal bulblet that may be larger than the terminal bulb; 1 pair slender, with closely spaced very small bulblets; 1 pair simple, with few or no inclusions, and usually the longest. Axis of stem moderately pigmented, becoming darker before bulb and very dark over 1 side of bulb, where pigment forks and extends along axis of the pair of filaments with large bulblets. External chevron-shaped or roundish striated areas unpigmented. Nine or 10 (rarely 7 or 8) pairs of dorsal spots under skin between occiput and dorsal-fin origin.

DESCRIPTION.—Three specimens, 55–71 mm, have very short barbels, 5%–8% SL. Relative length increases rapidly in this size range, for the next shortest barbels are 16%–20% SL in a few specimens 67–83 mm SL. All others, including 1 of 55 mm and most in the 74–83 mm range, have barbels 21%–35% SL, with no change in relative length with further growth. The stem axis is usually moderately, sometimes only lightly peppered with melanophores. Sometimes this pigment becomes gradually darker distally, but usually the distal one-tenth is abruptly darker. One side of the spheroidal-to-ovoid bulb has very dark pigment, continuous with that of the stem axis but broader, and, distinctively, forking at the distal end of the bulb to continue along the axis of the pair of filaments that bears large bulblets.

The spheroidal terminal bulb is relatively the smallest of any *Nominostomias* species, being 0.4%–0.6% SL in specimens smaller than 100 mm and decreasing to 0.3%–0.5% at larger sizes.

The filaments of 5 small specimens, 55–71 mm, were not completely formed (Figure 28*c,d*). In these, a dorsal and a ventral pair were elongating, while a central pair was represented by low, round protuberances; the longest of the filaments in these 3 specimens were 0.2–1.5 mm (2 were not measured). In 1 other specimen the filaments were short, 1.6 mm, but fully formed. All others measured had filaments 2.4 mm long or longer; 1 fairly large specimen had filaments 6.8% SL; all others were 2.8%–5.6% SL with no indication of change relative to SL with growth. In the filaments with the large bulblets, a series of small colorless bulblets on 1 side of each pigmented axis contrast strongly aginst the black axis pigment

between the filament origin and the bulblet; the filament and its branches beyond the large bulblet are unpigmented. The 2 other pairs of filaments are unpigmented. One pair, usually the longest of the 3, has no bulblets. The other pair, the shortest, has numerous small bulblets.

The postorbital organ of large males (124–139 mm) is 1.5%–1.7% SL, 56%–70% of fleshy orbit. The next smaller male (111 mm) has an organ 0.8% SL, 32% of fleshy orbit, just beginning to enlarge.

There are usually 9 or 10 pairs of dorsal spots under the skin between the occiput and the dorsal-fin origin. Two specimens had 7 and 8 pairs, respectively.

The terminal bulb, the small bulblets in the proximal part of the filaments with large distal bulblets, and the entire long filament without bulblets (except for some short gaps) were reddish purple in a fresh South Atlantic specimen. No colors were present in the stem, the distal part (including the large bulblet) of the clubbed filament, or the slender filaments with closely spaced bulblets. Parin et al. (1977) described the filaments of freshly caught specimens as raspberry-colored, the pair of distal bulblets as yellow.

Similar Species.—The 3 bilaterally similar pairs of terminal filaments, 1 pair with a pigmented axis and with a large bulblet distally, 1 pair unpigmented with numerous small bulblets only, and 1 pair unpigmented and without inclusions, are unique to *bulbornatus*, as is the very dark pigment on 1 side of the bulb, which pigment forks at the distal end of the bulb and continues along the axis of the 2 filaments that bear large bulblets. Furthermore, the barbel of *bulbornatus* is the shortest and the terminal bulb the smallest of any *Nominostomias* species.

There are 32–37 anal rays in *bulbornatus*, with a mean of 35.19 and a mode at 35. Although counts of 32 have been recorded for a few other species of *Nominostomias*, the majority of specimens of all other species have 36–41 rays: *multifilis* has 34 rays, 5 species have means from 35.6 to 36.5, and in all others the means are 37 or greater.

The AC photophores are mostly 17 or 18, with a mean of 17.71. This low distribution is shared only with *gibbsi* among *Nominostomias* species. The count is 15 in *multifilis*. In all others, the counts are mostly 18 to 19 and the means of only 6 are less than 18.5.

Distribution.—An essentially equatorial species, *bulbornatus* is 1 of the most commonly caught species of *Eustomias* (Figure 43). It has been taken between 10°N and 15°S in the central and western Pacific and the Indian Ocean. Outside of these latitudes, it has been taken in the South China Sea, off southern Japan (the holotype), off the North West Cape of Australia (Parin and Pokhilskaya, 1974), and in the southeastern Atlantic just west and south of the Cape of Good Hope (Krefft, 1974; Parin and Pokhilskaya, 1978a).

Remarks.—Our observations are almost in complete agreement with those of Parin and Pokhilskaya (1974). Our counts of VAL photophores, modally 18, include more at 19 than at 17; Parin and Pokhilskaya had about equal numbers at 17 and 18, but only a single 19. Their mean head length as %SL of 25 specimens is about 12.9% compared to our 11.8%, and the mean of their upper jaw relative to SL is about 10.7% compared to our 10.0%. We regard these apparent differences as due to sampling error. Some of their morphometric data, divided into 3 size-classes, suggest allometry, whereas ours do not. We agree, however, in the pattern of barbel growth—early increase in relative growth, but no change relative to SL throughout the remaining size range.

Material Examined (11 males, 18 females, 83 unsexed).—*Holotype:* USNM 150566 (♀, 95.8), 30°22′N, 129°09′E, 13 Aug 1906.

Non-types (Pacific): USNM 225144 (2♀, 75, 116), 03°04′N, 145°00′W, 0–200 m, 0445, 10 Feb 1970. USNM 225145 (5?, 55.4, 80.2, 88.0, 91.0, 95.9; ♂, 99.0; ♀, 93.7), 06°06′N, 150°28′W, 0–96 m, 2017–2200, 5 Nov 1958. USNM 225146 (♂, 124.4), 02°53′S, 159°53′W, 0–166 m, 1906–2004, 25 Sep 1956. USNM 225147 (♀, 101.3), 00°44′N, 168°00′W, 0–1050 m, 12 Aug 1963. USNM 225148 (2?, 94.2, 99.7; 2♀, 83.0, 102.7), 03°38′S,

149°56′W, 0–91 m, 2012–2205, 1 Nov 1958. USNM 225149 (♀, 112), 03°04′N, 145°00′W, 0–500 m, 2210, 7 Feb 1970. USNM 225151 (3♂, 81, 92, 130; ♀, 140), 03°28′N, 144°59′W, 0–~25 m (50 mw), 3 Feb 1970. USNM 225153 (♂, 85; ♀, 85), 03°16′S, 145°02′W, 0–~25 m (50 mw), 6 Nov 1969. USNM 225154 (3?, 78, 78.8, 81.9; 2♂, 86.5, 110.7; 4♀, 84.5, 92.4, 106.7, 109.8), 02°56′N, 150°03′W, 0–93 m, 2013–2153, 4 Nov 1958. USNM 225155 (♂, 91; ♀, 141), 03°25′S, 144°47′W, 0–~25 m (50 mw), 3 Nov 1969. USNM 225156 (?, 65.7; ♀, 155), 04°19′N, 160°08′W, 0–176 m, 1905–2005, 29 Sep 1956. SIO 68-533 (?, 76.5), 04°57′S, 167°07′W, 10 Aug 1968. SIO 73-169 (?, 75.5), 00°08′S, 155°01′W. BPBM 26290 (?, ~70), 00°01.9′N, 143°02.3′W, 0–176 m, 2015–2115, 2 Sep 1956. BPBM 26300 (2?, 89.0, 89.4), 08°45′S, 150°59′W, 0–171 m, 2000–2100, 8 Sep 1956. BPBM 26310 (4?, 64.3, 68.9, 92.5, 92.6), 00°02′N, 159°50′W, 0–176 m, 1905–2005, 26 Sep 1956. BPBM 26892 (?, 75), 04°57′S, 149°56′W, 0–96 m, 2013–2153, 30 Oct 1958. BPBM 26918 (?, 80), 00°37′N, 149°58′W, 0–86 m, 0838–1018, 3 Nov 1958. BPBM 26992 (4?, 70.3, 101.8, 104.7, 125.3), 04°49′N, 161°04′W, 0–90 m, 1848, 21 May 1954. BPBM 26995 (?, 128.2), 05°18.5′N, 161°29′W, 0–100 m, 1855, 22 May 1954. NMFS lost (4?, 87.1, 87.5, 91.6, 96.4), 00°44′S, 149°46′W, 0–85 m, 2013–2158, 2 Nov 1958. NMFS lost (2?, 73, 86), 02°09′S, 149°47′W, 0–99 m, 0843–1027, 2 Nov 1958. NMFS lost (2?, 80, 89), 00°28′N, 151°14′W, 0–176 m, 1958–2058, 5 Sep 1956. NMFS lost (?, 75.0), 14°14′S, 135°02′W, 0–180 m, 2000–2100, 23 Aug 1956.

Non-types (Southeast Asian Seas): USNM 225143 (♂, 139.3), 04°50′S, 129°46′E, 800–1050 m, 1605–1810, 13 Apr 1975. USNM 225150 (?, 73.7), 04°58′S, 130°12′E, 0–750 m, 2115–0025, 28 Apr 1975. USNM 225152 (?, 76.7), 01°28′N, 125°37′E, 0–90 m, 2114–2207, 31 May 1975. USNM 225157 (?, 82.2), 02°39′N, 124°36′E, 0–1250 m, 1220–1540, 1 Jun 1975. ZMUC P201834 (♀, 133.5), 00°02′S, 131°18′E, 0–~150 m (300 mw), 1910, 29 Jul 1929. ZMUC P201835-36 (♂, 124.9; ♀, 123.4), 00°02′S, 131°18′E, 0–~100 m (200 mw), 1910, 29 Jul 1929. ZMUC P202823 (2?, 76.4, 76.4), 13°57′N, 112°45′E, 0–~150 m (300 mw), 0340, 19 May 1929. ZMUC P202824 (?, 109.7), 14°37′N, 119°52′E, 0–~150 m (300 mw), 2230, 16 Jun 1929. ZMUC P202825 (4?, 62.5, 67.0, 67.7, 70.7), 03°18′N, 129°02′E, 0–~300 m (600 mw), 2145, 8 Jul 1929. ZMUC P202826 (?, 73.6), 01°13′S, 138°42′E, 0–~1450 m (2900 mw), 0730, 23 Jul 1929. ZMUC P202827 (?, 97.9), 04°10′N, 127°03′E, 0–~100 m (200 mw), 2310, 7 Aug 1929. ZMUC P208149 (?, 70.0), 04°10′N, 127°03′E, 0–~300 m (600 mw), 0140, 8 Aug 1929.

Non-types (Indian Ocean): USNM 201026 (?, 66.7), 06°54′N, 59°55′E, 0–750 m, 1845–2213, 16 Aug 1963. USNM 201027 (?, 55), 07°14′N, 59°53′E, 0–2250 m, 1255–1815, 16 Aug 1963. USNM 201028 (?, 90.0), 10°01′S, 64°19′E, 0–2250 m, 2310–0600, 2 Jun 1964. USNM 201029 (?, 66.5), 09°57′S, 64°55′E, 0–580 m, 1755–2250. ZMUC P202828 (2?, 75.4, 77.4), 04°38′S, 99°24′E, 0–~300 m (600 mw), 1920, 9 Sep 1929. ZMUC P202829 (?, 102.8), 02°15′S, 98°56′E, 0–~500 m (1000 mw), 2045, 11 Sep 1929. ZMUC P202830 (2?, 114, 130.4), 01°22′N, 96°07′E, 0–~1500 m (3000 mw), 1600, 18 Sep 1929. ZMUC P202831 (?, 72.6), 03°40′S, 99°48′E, surface, 1920, 23 Sep 1929. ZMUC P202832 (?, 72.1), 03°28′S, 100°00′E, surface, 2025, 24 Sep 1929. ZMUC P202833 (?, 82.3), 03°40′S, 100°02′E, 0–~175 m (350 mw), 1910, 6 Oct 1929. ZMUC P202834 (?, 83.6), 01°04′N, 96°27′E, 0–~175 m (350 mw), 0435, 4 Nov 1929. ZMUC P202835 (?, 134.3), 05°50′N, 93°28′E, 0–~500 m (1000 mw), 1915, 17 Nov 1929. ZMUC P202836 (?, 84.6), 05°18′N, 90°55′E, 0–~1250 m (2500 mw), 1745, 18 Nov 1929. ZMUC P202837 (?, 84.7), 01°45′N, 71°05′E, 0–~50 m (100 mw), 2210, 5 Dec 1929. ZMUC P202838 (?, 129.2), 11°24′S, 50°05′E, 0–~200 m, 1900–0005, 20 Dec 1929. ZMUC P202839 (?, 130.2), 09°26′S, 46°05′E, 0–~200 m (400 mw), 1910, 22 Dec 1929. ZMUC P202840 (2?, 112.4, 120.3), 09°26′S, 46°05′E, 0–~150 m (300 mw), 1910, 22 Dec 1929. ZMUC P202841 (2?, 82, 104.2), 08°44′S, 43°54′E, 0–~250 m (500 mw), 23 Dec 1929. ZMUC P202842

(?, 87.5), 07°24′S, 41°51′E, 0–~100 m, 2015, 24 Dec 1929. ZMUC P202843 (?, 105.4), 11°33′S, 41°44′E, 0–~300 m (600 mw), 1915, 6 Jan 1930. ZMUC P202844 (?, 85.5), 12°23′S, 41°44′E, 0–~100 m (200 mw), 0400, 7 Jan 1930. ZMUC P208150 (?, 75.6), 07°06′S, 103°30′E, 0–~150 m (300 mw), 2025, 7 Sep 1929. ZMUC P208151 (?, 86.0), 07°24′S, 41°51′E, 0–~150 m (300 mw), 2015, 24 Dec 1929. MCZ 57388 (?, 67.8), 07°14′N, 59°53′E, 0–2250 m, 1255–1815, 16 Aug 1963. MCZ 57389 (?, 60), 09°57′S, 64°55′E, 0–580 m, 1755–2250, 2 Jun 1964. MCZ 57390 (?, 95), 14°03′S, 65°11′E, 0–3080 m, 0540–1255, 5 Jun 1964. SUF uncat. (?, 71.4), 02°23′N, 94°20′E, 26 Nov 1962. SUF uncat. (2?, 128.8, 131.9), 02°30′S, 94°00′E, ~150 m (300 mw), 0920–1033, 30 Nov 1962. SUF uncat. (?, 80.1), 02°43′S, 94°13′E, 3 Dec 1962.

Eustomias patulus Regan and Trewavas, 1930

FIGURE 27*b*

Eustomias patulus Regan and Trewavas, 1930:86 [holotype only; barbel fig. 65].

DIAGNOSIS.—A single terminal bulb 1.4% SL. Barbel length 56% SL. A single short terminal filament (2.7% SL) with several side branches along its length, none of which has prominent bulblets. Axis of stem, main filament, and most-proximal filament branch lightly pigmented. No spot at base of bulb. External chevron-shaped or roundish striated areas unpigmented. Paired spots along dorsum not counted.

DESCRIPTION OF HOLOTYPE (and only known specimen).—Male, 132.5 mm SL. D 24. A 36. P1 3. P2 7. IP 7. PV 33. VAV 18. OV 33. VAL 19. AC 19. IA 58. IC 77. OA 52. OC 71. VAV photophores over anal-fin base 7. Branchiostegal photophores 10. Premaxillary teeth 13. Mandibular teeth 18. Vertebrae 68.

Measurements (in mm): Predorsal length 112.7, preanal length 94.8, prepelvic length 73.4, head length 18.1, barbel length 74.3, terminal-bulb length 1.8, filament length 3.6, snout length 7.5, fleshy orbit length 3.9, postorbital-organ length 3.0, lower-jaw length 13.6, upper-jaw length 13.5, depth behind head (greatest depth) 8.4, caudal-peduncle least depth 2.5, pectoral-fin length ~12, pelvic-fin length ~17, dorsal-base length 17.0, anal-base length 33.5, longest premaxillary tooth 2.1, longest mandibular tooth 1.6.

SIMILAR SPECIES.—All other known species of *Nominostomias* with a single terminal bulb and terminal filaments (as opposed to the projection of *longibarba*, etc.) occur in the Pacific Ocean; all of these except *pacificus*, *gibbsi*, and single-bulbed *inconstans* have 3 or more terminal filaments and smaller terminal bulbs (Figures 26–28), and all have very different filament structures.

Of the species with 2 terminal bulbs, *arborifer* most closely resembles *patulus* in having a single, short terminal filament with several side branches, but *arborifer* has prominent small bulblets in the filament and its branches and has a longer barbel (greater than 70% SL in males over 120 mm SL vs. 56% in the holotype of *patulus*).

REMARKS.—One specimen illustrated as *patulus* by Johnson and Rosenblatt (1971, fig. 2f) has been re-drawn here (as Figure 27*c*); its apparently damaged barbel end actually has all filaments arising together, and it is 1 of our new species, *cancriensis*. Their other 2 presumptive *patulus* specimens are *cirritus* and *inconstans*.

DISTRIBUTION.—Known only from the type-locality in the eastern Atlantic between the Canary and Cape Verde islands (Figure 40).

MATERIAL EXAMINED (1 male).—*Holotype:* ZMUC P201907 (♂, 132.5), 26°15′N, 20°52′W, 0–~200 m (400 mw), 1915, 24 Oct 1921.

Eustomias gibbsi Johnson and Rosenblatt, 1971

FIGURE 27*e*, *f*

Eustomias gibbsi Johnson and Rosenblatt, 1971:307–309 [8 specimens; northwestern, north-central, and south-central Pacific; holotype SIO 69-354, 17°47.7′–50.7′N, 143°41.2–50.0′W, not examined by us].—Clarke, 1974:345 [28 Hawaii specimens, most included in this study; vertical distribution].—Parin and Pokhilskaya, 1974:343–345 [6 specimens, northwestern Pacific. Full description; fig. 13, whole fish, teeth, barbel].—Parin, 1976:198 [listed, north-

western Pacific].—Parin et al., 1977:101 [2 specimens, northwestern Pacific].

DIAGNOSIS.—A single cone-shaped terminal bulb, 0.9%–1.5% SL except in the smallest specimen. Barbel relatively short, 25%–52% SL except in specimens smaller than 70 mm. A single, simple or bifurcate, short terminal filament 5.1%–1.6% SL, decreasing relatively with growth. Proximal end of bulb almost flat, with a solid black cap. Axis of stem moderately to lightly pigmented. External chevron-shaped or roundish striated areas unpigmented. Middorsal paired spots between occiput and dorsal-fin origin 8 (rarely 9).

DESCRIPTION.—The barbel increases in relative length until about 70–80 mm SL, after which it is 30%–52% SL and does not change with growth. Pigment in the stem axis is light to moderate proximally, decreasing in density distally until only a few scattered melanophores are present. As much as one-third of the distal stem may be unpigmented. The external chevron-shaped or rounded striated areas on the stem are unpigmented.

The terminal bulb also apparently increases relative to SL until about 70 mm SL, after which it appears to decrease slightly from 1.0%–1.5% at less than 80 mm to 0.9%–1.2% in those larger than 100 mm. The bulb is almost flat proximally and has a solid black cap covering its base. This black cap is a persistent structure, remaining intact even when the rest of the bulb has been mutilated. The bulb itself, when intact, is shaped like a blunt-tipped cone.

The terminal filament decreases relative to SL from 3.6%–5.1% in specimens smaller than 85 mm to 1.6%–2.0% in those larger than 130 mm. The filament is unpigmented. There were tiny bulblets in the filament of only 1 specimen. Most filaments are simple, but some are bifurcated at about one-third or more of their length.

The postorbital organ of males increases from 0.6% SL, 24% of fleshy orbit at 104 mm SL to 1.1% SL, 46% of fleshy orbit at 136 mm.

On the anterior margin of the eye is a short projection extending very slightly over the eye and bearing a photophore at its tip.

SIMILAR SPECIES.—Only *inconstans* may share with *gibbsi* a single terminal bulb and a single simple terminal filament, but *inconstans* lacks the black cap at the base of the bulb, its barbel is longer (52%–67% SL vs. maximum 52% in *gibbsi*), and its terminal filament is longer (6.2%–9.2% SL vs. maximum 5.1%) and has a pigmented axis (unpigmented in *gibbsi*).

One other species, *pacificus*, has a large black cap developed over the proximal end of the bulb, but the cap is not solid, having a central unpigmented area. Furthermore, its bulb with its distal, nipple-like projection and the complex terminal filament are very different from those of *gibbsi*.

The short projection extending over the eyeball from the anterior fleshy orbit in *gibbsi* is unique among *Nominostomias*. In *pacificus* there is a long, slender projection; all other species have only a low hump.

DISTRIBUTION.—Northwestern and north-central Pacific between about 10° and 25°N, and south-central and southeastern Pacific between about 20° and 30°S. As suggested by Parin and Pokhilskaya (1974), this appears to be a bicentral species, inhabiting the central water masses of the Pacific, but not occurring in the Equatorial ones (Figure 43).

MATERIAL EXAMINED (6 males, 9 females, 22 unsexed).—*Paratype:* USNM 205222 (?, 82.5), 20°45′N, 157°15′W, 0–209 m, 2011, 28 Jul 1954.

Non-types: (USNM, BPBM, ZMUC, and HIMB all from 21°20′–23′N, 158°18′–20′W): USNM 224239 (?, 59.7), 0–185 m, 0038–0253, 28 Feb 1971. USNM 224240 (?, 90), 0–1100 m, 0245–0600, 31 Aug 1973. USNM 224241 (♂, 104), 0–800 m, 2000–0012, 2 Mar 1971. USNM 224242 (♀, 120), 0–70 m, 2242–0047, 23 Sep 1970. USNM 224243 (♀, 141), 0–350 m, 0015–0210, 29 Aug 1973. USNM 224244 (♀, 121), 0–400 m, 2225–0107, 20 Sep 1970. USNM 224245 (♂, 116; ?, 77), 0–710 m, 0750–1205, 1 Mar 1971. USNM 224246 (2?, 82, 106), 0–75 m, 2010–2210, 27 Feb 1971. USNM 224247 (?, 77), 0–95 m, 0105–0311, 1 Mar 1971. USNM 224248 (?, 61.3), 29 Jan 1972. USNM 224249 (?, 70), 0–150 m, 2345–0205, 26 Feb 1971. USNM 224250 (♀, 109), 0–500 m,

0535-0742, 28 Aug 1973. USNM 224251 (2?, 55, 86.1), 31 Jan 1972. USNM 224252 (♂, 74; ♀, 116), 0-65 m, 0200-0403, 7 Jul 1970. USNM 224253 (♂, 135.9), 0-250 m, 0145-0515, 11 Nov 1974. USNM 224254 (♂, 131; ♀, 117), 0-200 m, 0245-0445, 28 Feb 1971. USNM 224255 (?, 73), 19 Mar 1971. USNM 224256 (3?, 55, 87, 89), 0-250 m, 0421-0600, 27 Feb 1971. USNM 224257 (♀, 104), 0-140 m, 0035-0252, 16 Jun 1971. USNM 224258 (?, 79), 0-125 m, 2310-0110, 27 Feb 1971. BPBM 26541 (3?, 75, 115, 116), 0-175 m, 0155-0355, 1 Mar 1971. ZMUC P208153 (?, 77), 0-100 m, 2240-0040, 28 Feb 1971. HIMB uncat. (?, 97), 0-800 m, 0810-1215, 7 Jul 1970. HIMB uncat. (♀, 98), 0-65 m, 2124-2326, 6 Jul 1970. SIO 60-252 (?, 101.4), 19°56'N, 156°11'W, 14 Jul 1960. IOAN uncat. (♀, 146.0), 26°35'S, 92°46'W, 5 Dec 1975. IOAN uncat. (?, 90.6), 26°26'S, 101°56'W, 7 Dec 1975. Data from Parin and Pokhilskaya (1974) were used for a 156.2 mm male.

Group V

The species of this group have a single terminal bulb with either a dome-like or finger-like projection at its distal end. The projection may be so low as to be indiscernible or may be longer than the bulb in extreme examples. Five species comprise this group. A synopsis of their salient characters is given in Table 6, and their barbel and postorbital-organ dimensions are plotted in Figures 33-36.

Eustomias longibarba Parr, 1927

Figure 31*a-d*

Eustomias longibarbus Parr, 1927:64, 65 [2 specimens, no holotype designated; fig. 34, heads of both specimens; fig. 35, lateral view; fig. 36B, barbel].—Fowler, 1936:1179 [compiled].

Eustomias longibarba.—Regan and Trewavas, 1930:86, 87 [4 additional specimens; *E. microcephalus* Parr a probable synonym].—Beebe and Crane, 1939:212 [no additional specimens; types of *longibarba* and *microcephalus* examined; agree with Regan and Trewavas, 1930].—Morrow and Gibbs, 1964:413-415 [part, syntype of *longibarba* and holotype of *microcephalus* only; 2 additional eastern-Pacific specimens, 1 identified here as *E. perplexus*, the other not identifiable].—Badcock, 1970:1036 [1 specimen, off Fuertaventura, Canary Islands].—Gibbs, 1971:240 [2 specimens, off Bermuda].—Rass, 1971:511 [listed for Caribbean Sea].—Bekker et al., 1975:304 [1 specimen, 19°51'N, 76°43'W].

?Eustomias microcephalus Parr, 1927:75, 76 [holotype only, a juvenile not fully developed].

Diagnosis.—A single terminal bulb 1.1%-2.3%

Table 6.—Synopsis of characters of Group V species (SL is given (in mm) when characters are from only part of the size range; see footnotes for "Other characters")

Species	Barbel length (% SL)	SL	Bulb length (% SL)	SL	Projection length (% SL)	Projection length (% bulb)	SL	Bulb & projection (% SL)	SL	Male postorbital (% SL) [SL]	Male postorbital (% eye)	Predorsal pairs of spots	Other characters
curtatus	24-35	≤70	0.8-1.3	≤100	0.1-0.3	0-25		0.9-1.6	≤100	1.1-2.0	50-83	8 (7-9)	a,c
	52-57	118-130	0.4-1.0	≥100				0.4-1.1	≥100	[110-152]			
	35-49	≥134											
longibarba	52-78	≥70	1.2-2.3		0.6-1.1	13-90		2.6-3.0	≤90	1.2-2.6	50-91	8 (9)	a,e
								1.9-2.6	≥121	[99-156]			
mesostenus	43		2.6		0.5	20		3.2				9	b,g
perplexus	67-83	≥75	1.0-1.6	≥75	0.1-0.7	0-55		0.8-2.2		1.6-1.8	60-62	8 (9)	a,d,f
										[118-129]			
spherulifer	60-76	≥85	1.1-1.4	≤85	0.9-1.3	40-100	≤108	2.0-3.4		1.4-2.0	47-68	8	a,c
			1.7-1.9	88-108	0.6-1.0		≥130						
			1.1-1.5	≥145	1.8		125 (1)						

[a] Stem axis pigmented. [b] Stem axis unpigmented. [c] Inclusions in distal half of stem, becoming crowded distally. [d] Inclusions in distal half of stem, widely spaced, not crowded. [e] Few or no inclusions in stem, near bulb only. [f] Bulb narrower proximally than distally. [g] VAV, VAL 16; 4 VAV over anal-fin base.

SL, its length more than twice its width, with a single, digitate terminal projection 12%–90% of bulb length. Bulb and projection combined 1.9%–3.0% SL. Barbel 40%–78% SL, mostly more than 50%. Axis of stem moderately to darkly pigmented. External chevron-shaped or roundish striated areas unpigmented, closely spaced or contiguous distally. A few tiny spheres outside axis proximal to bulb in some specimens; otherwise no spherical or granular inclusions in stem. Mid-

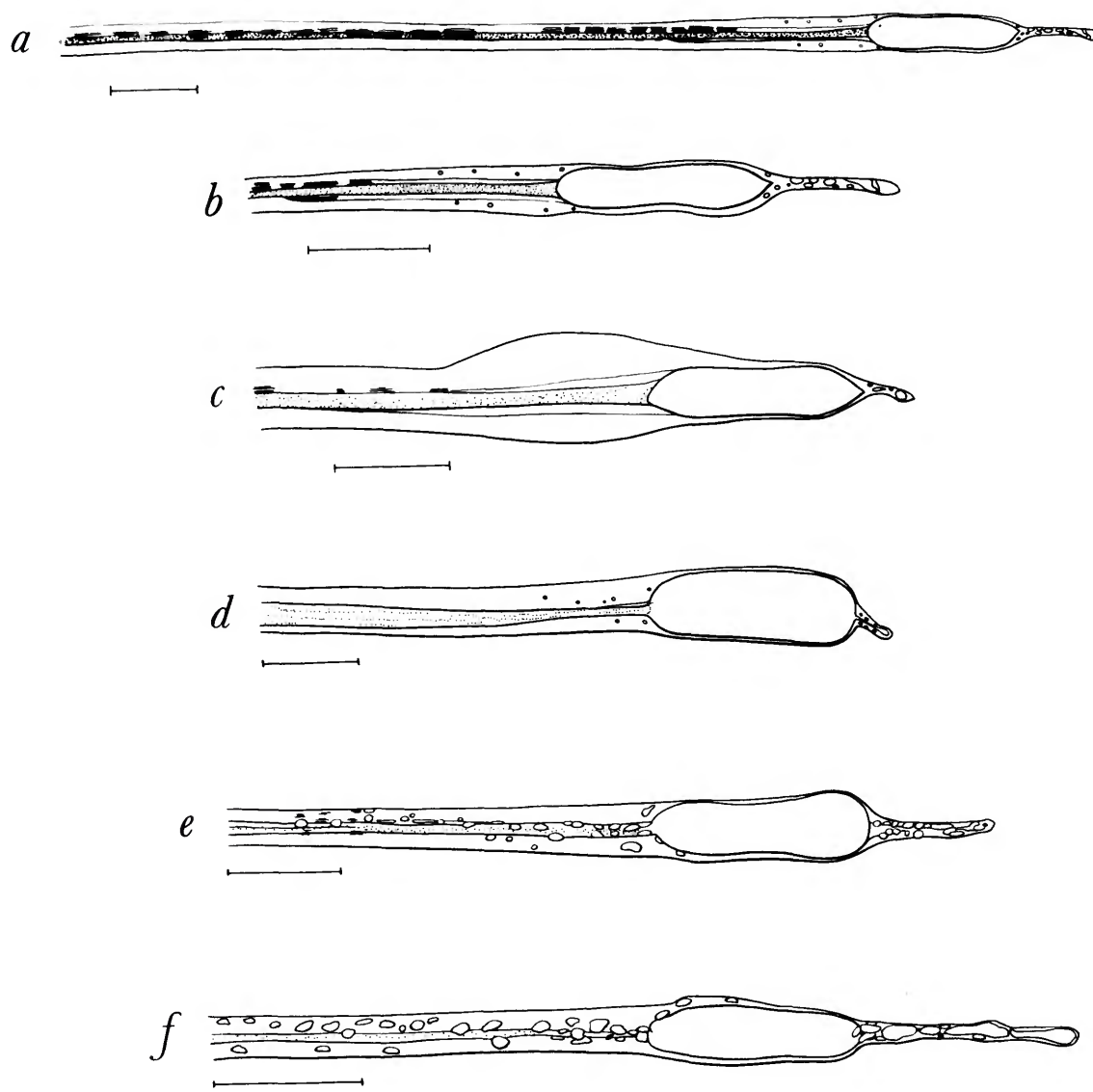


FIGURE 31.—Barbel ends of Group V species: *a–d*, *E. longibarba* (*a*, 111.5 mm SL, ISH 3197/79, showing closely spaced striated areas distally; *b*, same specimen enlarged; *c*, 93.4 mm SL, USNM 225162; *d*, 155.8 mm SL, ISH 627/66); *e*, *f*, *E. spherulifer* (*e*, paratype, 108 mm SL, USNM 226786; *f*, holotype, 148 mm SL, ISH 1428/68). (Bar = 1 mm.)

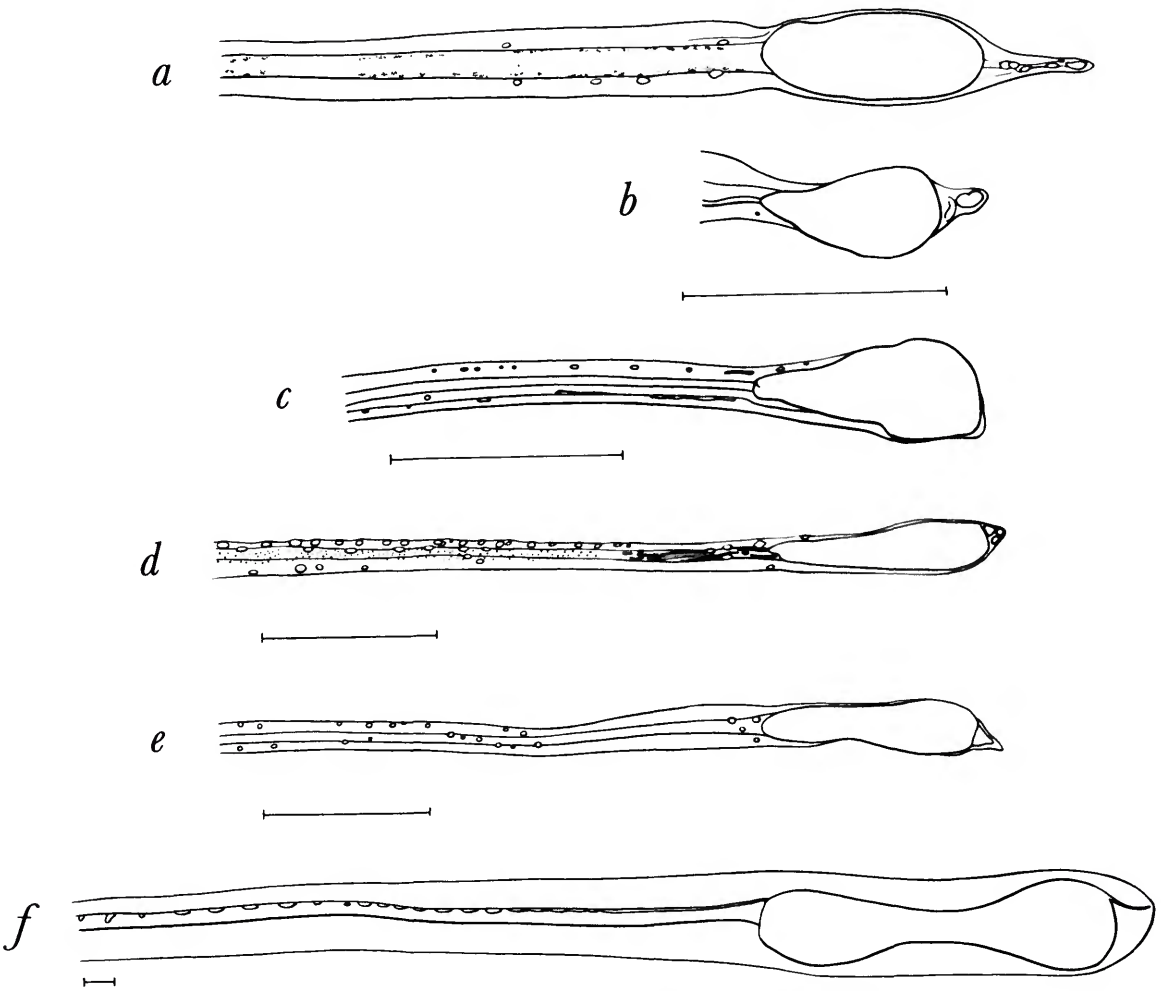


FIGURE 32.—Barbel ends of Group V species: *a–c*, *E. perplexus* (*a*, paratype, 118.3 mm SL, IOAN uncatalogued; *b*, paratype, 82.8 mm SL, USNM 226785; *c*, paratype, 90.0 mm SL, ZMUC P202725); *d*, *e*, *E. curtatus* (*d*, holotype, 124 mm SL, USNM 224203; *e*, paratype, 109 mm SL, USNM 224190); *f*, *E. mesostenus*, holotype, ~95 mm SL, SIO 61-34. (Bar = 1 mm.)

dorsal paired spots between occiput and dorsal-fin origin usually 8, occasionally 9.

DESCRIPTION.—In a 68 mm specimen, the barbel is only 46% SL and is presumably still in the stage of rapid growth during transformation. In the others, barbel length is 52%–78% SL and does not change relative to SL with growth. The stem axis is moderately to darkly pigmented, usually becoming lighter distally, and pigment may be lacking immediately proximal to the bulb. The terminal projection from the bulb is unpigmented. The external chevron-shaped or roundish striated areas on the stem are unpigmented in all specimens except 1, in which they are pigmented in the proximal two-thirds of the stem. These areas become crowded distally, being contiguous just before the bulb. Very small spheres are often, but not always, present outside the

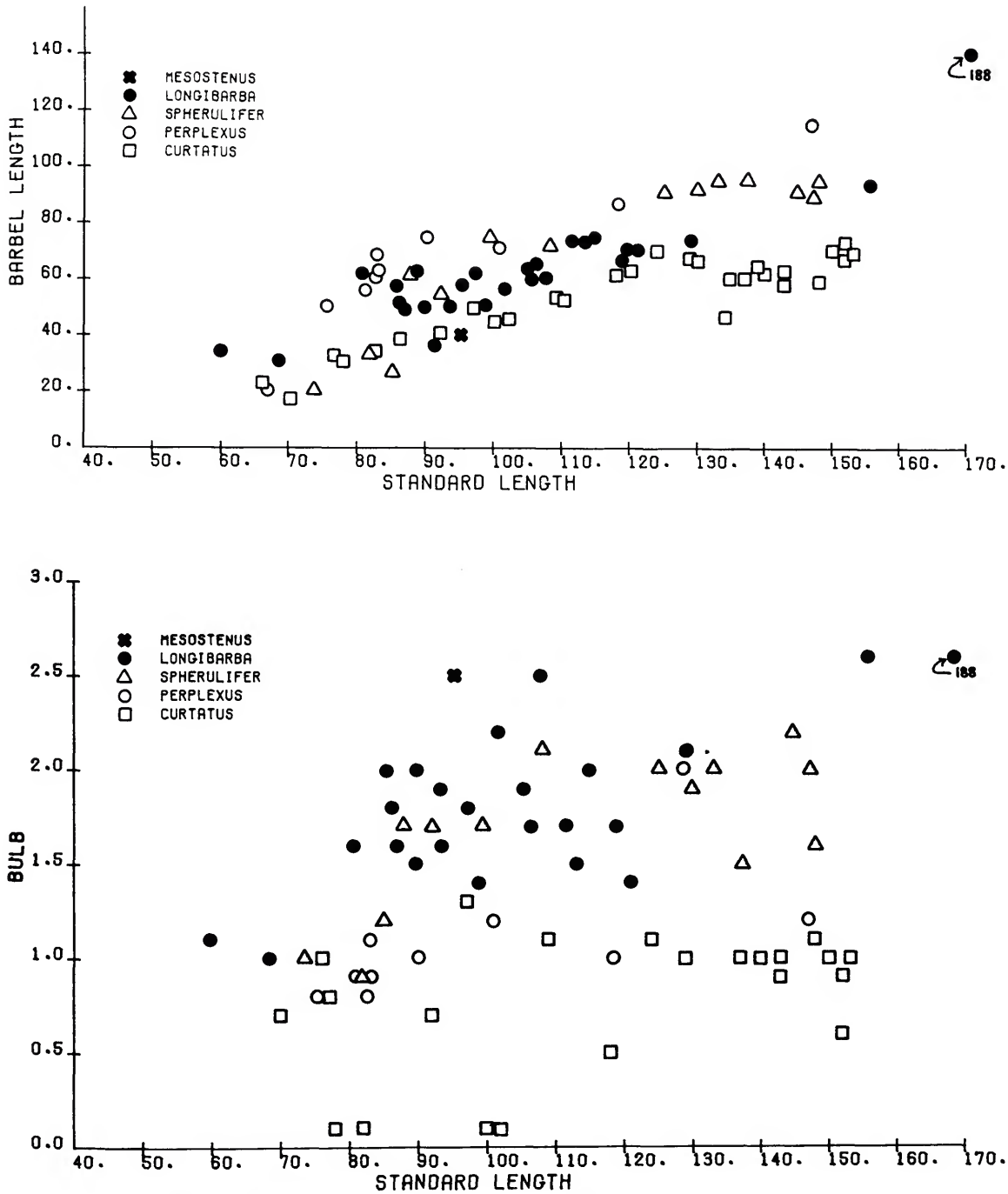


FIGURE 33.—Barbel length (mm) and terminal-bulb length (mm) vs. SL (mm) for Group V species.

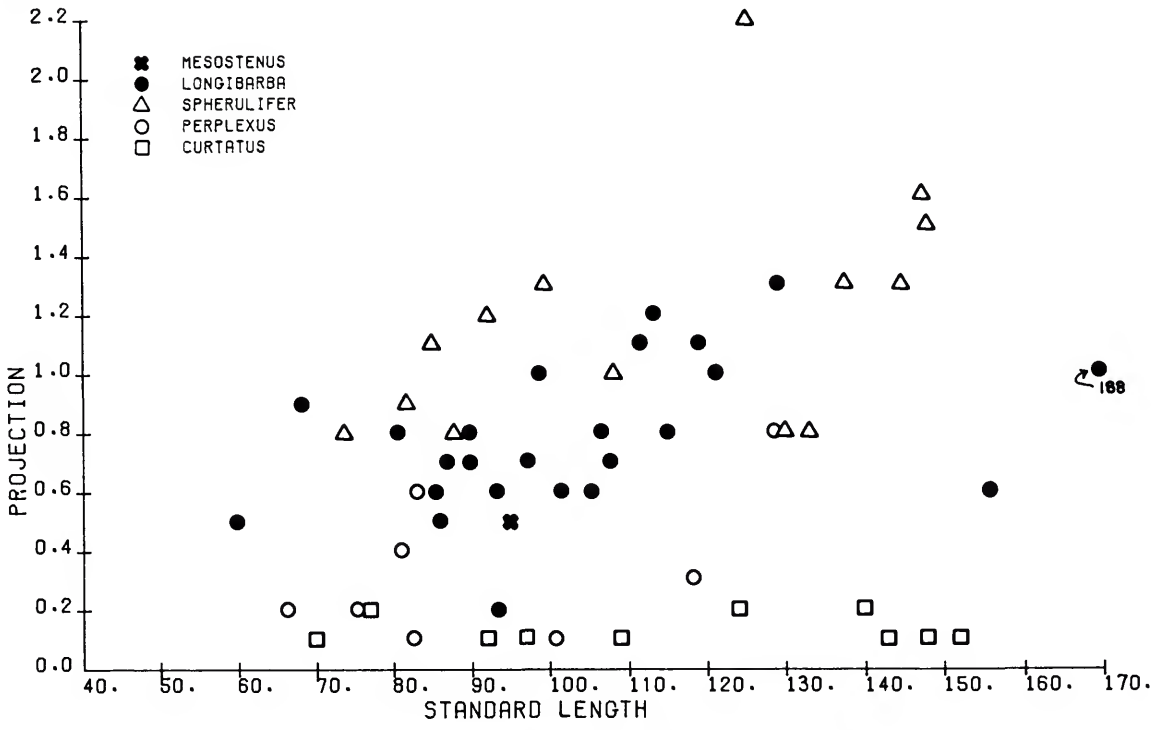


FIGURE 34.—Terminal-projection length (mm) vs. SL (mm) for Group V species.

stem axis in the region just proximal to the bulb. When present they are few and rather widely spaced. The bulb may be rather bulky or quite slender. It is 3–6 times as long as its greatest width (rarely less) and may be parallel-sided or slightly to considerably wider distally than proximally. The terminal projection has prominent spheres, at least in its basal portion. Its distal end, however, is often occupied by an apparently solid mass of opaque tissue. The lengths of the bulb and its terminal projection and the sexual dimorphism in these characters differ in specimens from the subtropical North Atlantic (Bermuda to Madeira and the Canary Islands) from those in the tropical Atlantic (Bahamas, Gulf of Mexico, Caribbean Sea, western tropical North and South Atlantic). We have examined 9 subtropical specimens: 1 female (106 mm), 6 males (99–129 mm), and 2 small ones (60–68 mm) of undetermined sex and 16 tropical specimens: 9 females (86–188 mm), 6 males (87–156 mm), and 1 of undetermined sex (81 mm). The subtropical population appears to be sexually dimorphic in bulb size and length of terminal projection, while there is little or no sexual dimorphism in these structures in the tropical population. The tropical population and females and some young of the subtropical population have larger bulbs but shorter terminal projections than males and some young of the subtropical population.

The bulb is larger relative to SL in tropical specimens than in subtropical males and some subtropical young (Figure 37). In the tropical specimens, the bulb is 1.4% SL in the largest specimen, 1.6%–2.3% in the others. In subtropical specimens, the bulbs of the smallest (60 mm) specimen and the only female are 1.8% SL, resembling the tropical specimens; in males the bulbs

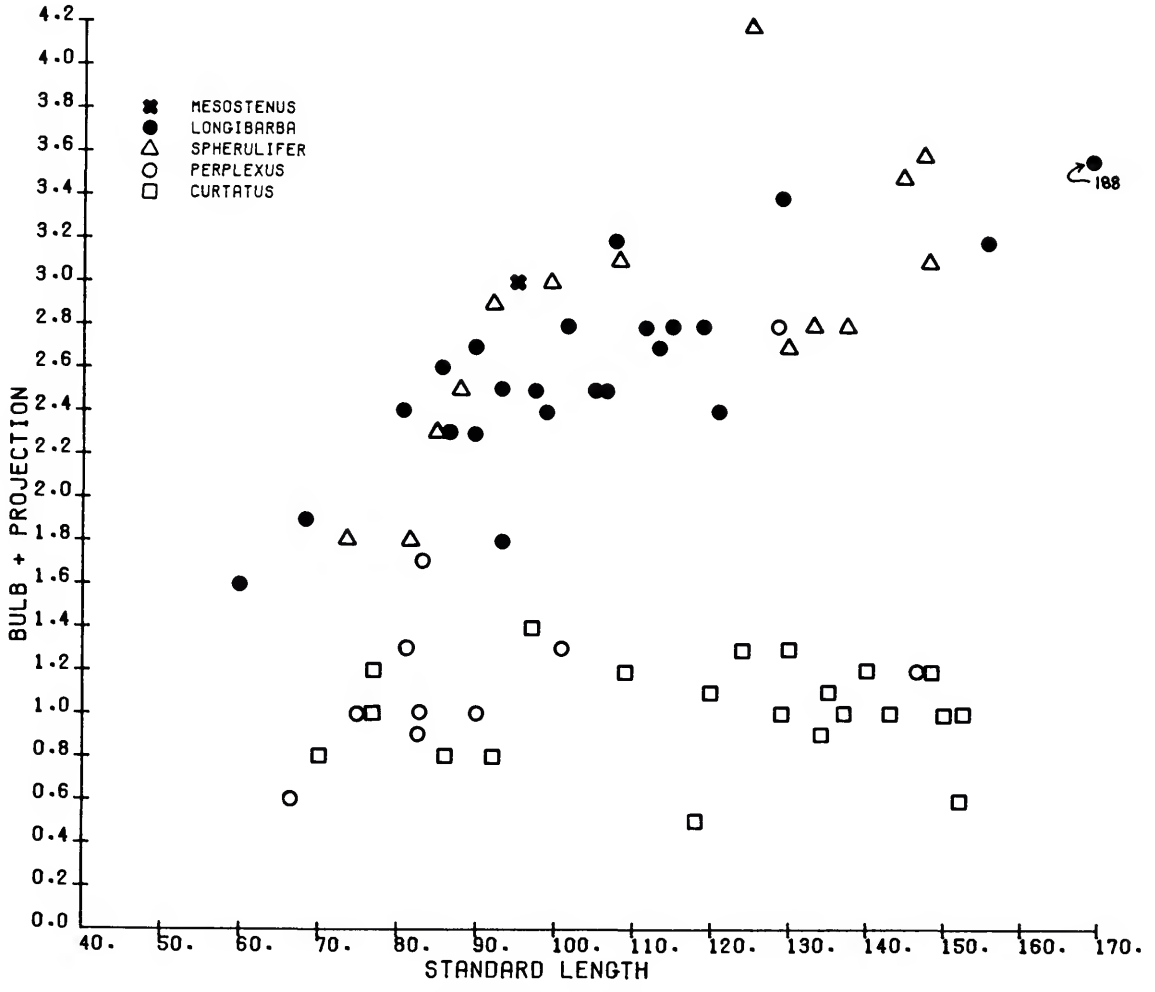


FIGURE 35.—Combined length of terminal bulb and projection (mm) vs. SL (mm) for Group V species.

are smaller, 1.2%–1.6% SL. Change relative to SL with growth is little or none in either area at sizes up to 129 mm, but the 2 large tropical specimens (1.4%–1.7% SL) suggest a decrease relative to SL at larger sizes, at least in that area.

The terminal projection is smaller relative to SL in tropical specimens than in subtropical males and some subtropical young. It appears to decrease relative to SL in both groups. In tropical specimens the projection is 0.2%–1.0% SL. In subtropical specimens, the projection is 0.8% SL in the smallest (60 mm) specimen and 0.6% in the only female, resembling the tropical specimens; in a 69 mm subtropical specimen, it is 1.3%, and in the 6 males (99–129 mm) 0.8%–1.1%, all relatively longer at any size than in the tropical specimens (Figure 38). All subtropical specimens except the smallest (60 mm) and the female have projections 62%–90% of bulb length; in all tropical specimens the projection is 13%–50% of bulb length (Figure 39).

The combined length of bulb and projection

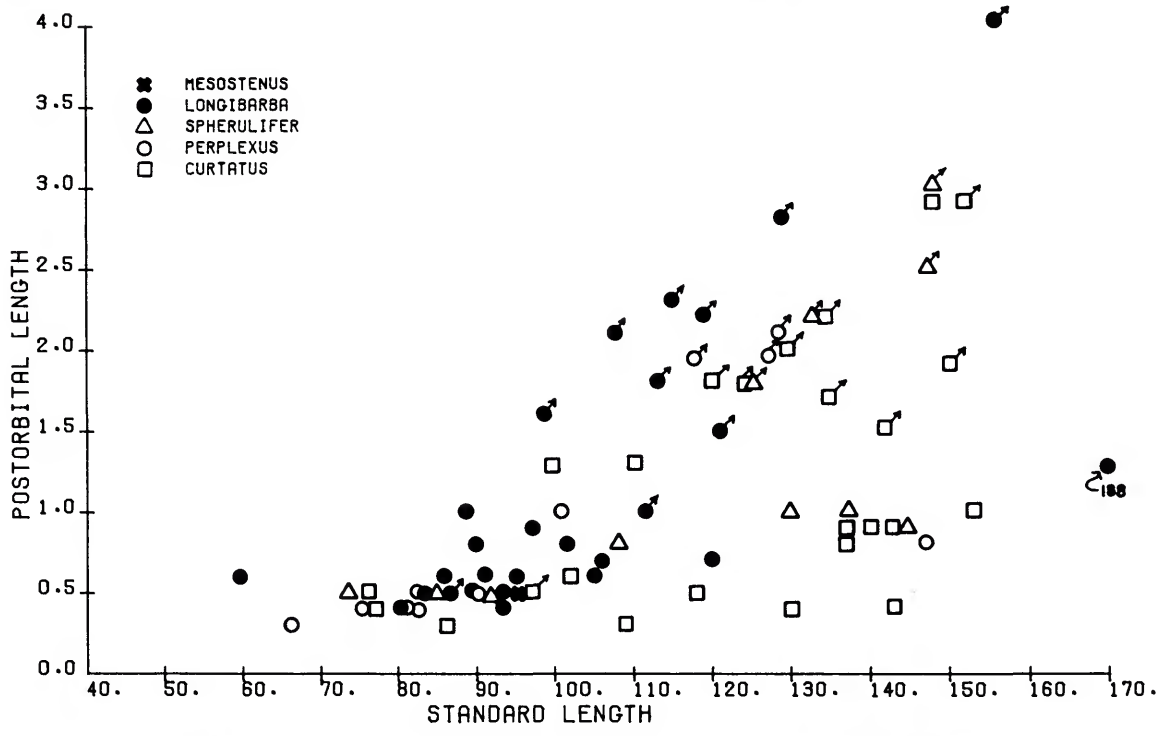


FIGURE 36.—Postorbital-organ length (mm) vs. SL (mm) for Group V species. Specimens not marked as males include both females and unknowns.

decreases relative to SL in tropical specimens from 2.6%–3.0% at 81–90 mm to 1.9%–2.1% in the 2 largest specimens (156–188 mm). Subtropical specimens follow this regression, from 2.7%–2.8% at 60–68 mm, to 2.0%–2.6% at 121–129 mm.

The few recorded bulb colors may also be indicative of population differences. Parr (1927) described the bulb of 1 or both type specimens (tropical) as roseous (he did not indicate whether the specimens were fresh or preserved). In 2 mid-North Atlantic specimens (subtropical), a 111.5 mm male had the bulb and the inclusions in the projection mostly yellowish green, with orange-red areas in the middle of the bulb and at the distal end of the projection, while a 105.6 mm female had a yellowish green bulb with a much paler tip. In an 83.2 mm female from south of the Canary Islands (also subtropical), the bulb was yellowish green and the projection was not colored.

Enlargement of the postorbital organ appears to have begun in an 89 mm male (1.1% SL, 38% of fleshy orbit), but in 3 others 90–112 mm, the organ is 0.7%–0.9% SL. Other males are 99–156 mm, with organs 1.2%–2.6% SL, 50%–91% of fleshy orbit.

SIMILAR SPECIES.—The South Atlantic species *spherulifer* very closely resembles *longibarba*, especially the subtropical population of the latter, in barbel dimensions. The only truly distinguishing character is the presence in *spherulifer* of prominent spheres and granules in the stem outside of the axis; these inclusions may be present in as much as half of the distal stem, being few, small, and widely spaced proximally, but becoming large and crowded distally. In *longibarba* some specimens have very small spheres just before the bulb, but these are much smaller than those of *spherulifer* and are never more than a few. One consequence of the difference in development of

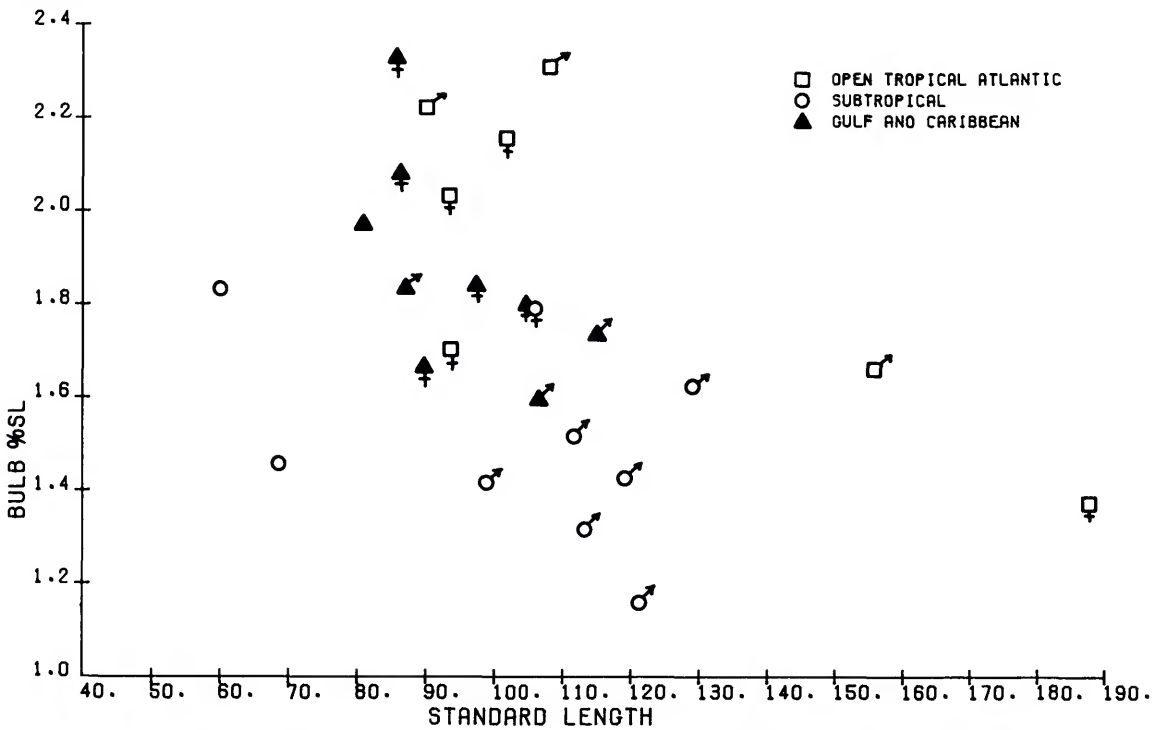


FIGURE 37.—Terminal-bulb length as a percent of SL vs. SL (mm) in the 3 geographic groups of *E. longibarba*. Specimens not marked as males or females were of undetermined sex.

stem inclusions is that the closely spaced external striated areas proximal to the bulb are readily discernible in *longibarba*, but masked in *spherulifer*.

Unfortunately spheres or granules become obvious only at sizes larger than about 100 mm SL. Smaller specimens of these 2 species may be virtually impossible to distinguish except by geographic area of occurrence.

Three other species—*mesostenus*, *perplexus*, and *curtatus*—have single, slender bulbs (their length more than twice the width) that may have a terminal projection. With the exception of 2 specimens of *perplexus* (see the account of that species), both *curtatus* and *perplexus* have extremely short terminal projections—not more than 0.2 mm long and often barely developed—and specimens larger than 100 mm SL have shorter bulbs (maximum 1.3 mm; only in about one-third of the small specimens of *longibarba* and in none larger than 100 mm is it shorter than 1.4 mm). Furthermore, *curtatus* usually has a shorter barbel (maximum 53% SL; only in a few developing *longibarba* is it less than 52%). In *mesostenus*, the bulb is very long, but the terminal projection appears to be a wide extension of the transparent outer sheath of the bulb, with only a thin projection of the bulb within it; *mesostenus* has only 4 VAV photophores over the anal-fin base, compared to 6–8 in *longibarba*.

All other species with single terminal bulbs have terminal filaments that are longer than the projection of *longibarba*, and their terminal bulbs are less than twice as long as wide.

REMARKS.—Regan and Trewavas (1930) and Beebe and Crane (1939) commented on the nominal species *microcephalus* Parr, 1927. All agreed that the single specimen (66 mm according to Parr, 65.2 mm our measurement) probably is a young *longibarba*, but that it was too undeveloped to be certain. Parr described the barbel as

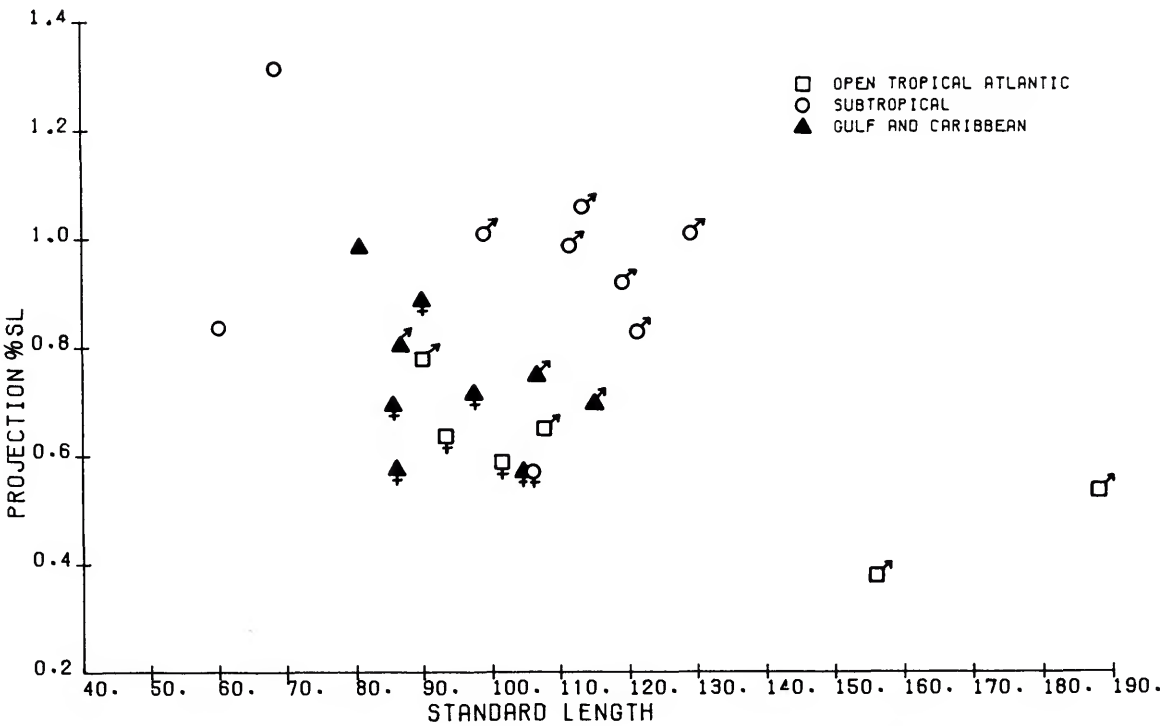


FIGURE 38.—Terminal-projection length as a percent of SL vs. SL (mm) in the 3 geographic groups of *E. longibarba*. Specimens not marked as males or females were of undetermined sex.

"narrow, elongate . . . very possible that the barbel may be torn." The bulb is, indeed, torn, but it appears to be so long that it could resemble only *longibarba* among species of *Nominostomias* in the Bahamas and adjacent areas, where *microcephalus* was taken. Beebe and Crane (1939) noted "at least 10 or 11 larval spots." Our count is 8 predorsal, 1 beside the dorsal base, 1 on the caudal penduncle, 1 at the caudal base.

LECTOTYPE DESIGNATION.—Parr (1927) did not designate a holotype from his type specimens of *E. longibarbus*. We select as lectotype the larger of the 2, BOC 2037, an immature female 85.5 mm SL. D 23. A 35. P1 3. P2 7. IP 7. PV 34. VAV 17. OV 34. VAL 17. AC 20. IA 58. IC 78. OA 51. OC 71. VAV photophores over anal-fin base 6. Branchiostegal photophores 11. Premaxillary teeth 10. Mandibular teeth 12. Vertebrae unknown. Middorsal paired spots between occiput and dorsal-fin origin 8.

Measurements (in mm): Predorsal length 71.4, preanal length 63.1, prepelvic length 51.3, head length 10.7, barbel length 58.1, terminal-bulb length without projection 2.0, terminal-projection length 0.6, snout length 4.7, fleshy orbit length 2.2, postorbital-organ length 0.5, lower-jaw length 9.3, upper-jaw length 8.8, depth behind head (greatest depth) 5.8, caudal-peduncle least depth 1.3, pectoral-fin length 15.0, pelvic-fin length 13.3, dorsal-base length 11.9, anal-base length 20.3, longest premaxillary tooth 1.5, longest mandibular tooth 1.2.

Axis of stem well peppered with melanophores, these becoming slightly less dense distally, but reaching the bulb. External chevron-shaped to roundish striated areas unpigmented, becoming

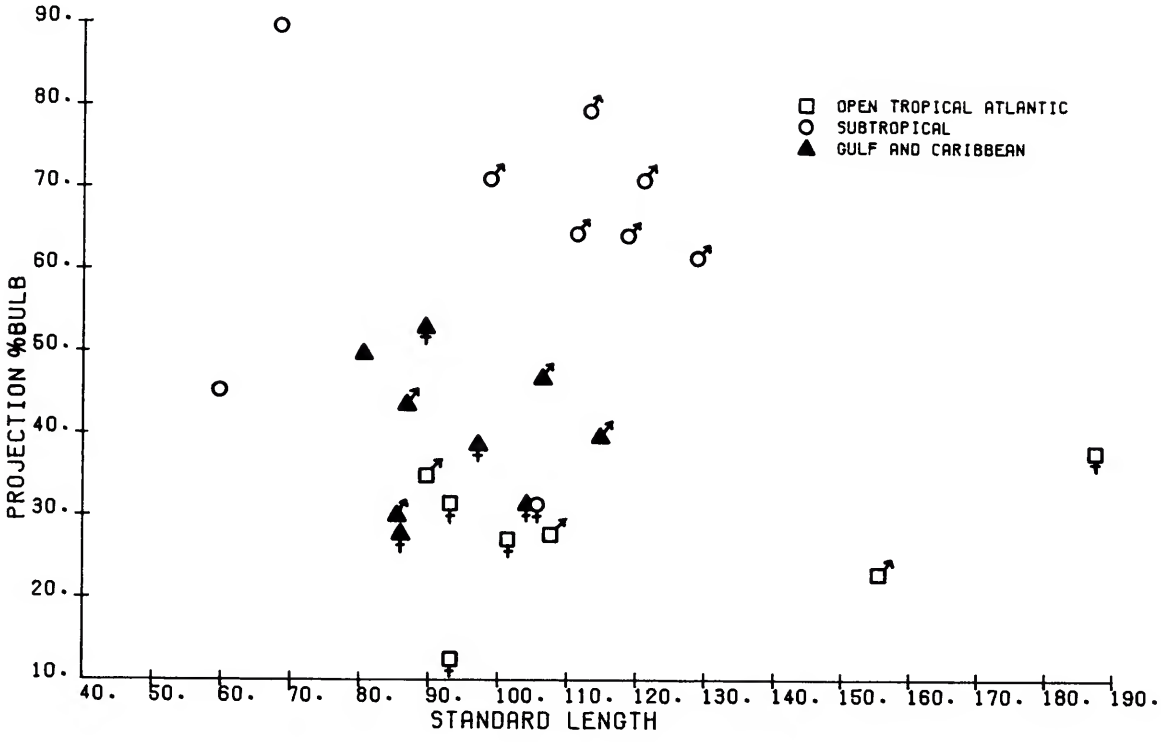


FIGURE 39.—Terminal-projection length as a percent of bulb length vs. SL (mm) in the 3 geographic groups of *E. longibarba*. Specimens not marked as males or females were of undetermined sex.

contiguous distally. No spherical inclusions in stem just before bulb.

As suggested by Regan and Trewavas (1930), Parr's illustration of the terminal bulb (1927:65, fig. 36b) is inaccurate, showing the terminal bulb as too round. Beebe and Crane (1939) noted that the terminal projection has basal spheres and that the postorbital organs in Parr's figure (1927, fig. 35) are much longer than in the specimens.

DISTRIBUTION.—Across the North Atlantic between 30° and 35°N from Bermuda to Madeira, and extending to south of the Canary Islands, Straits of Florida, northern Bahamas, Gulf of Mexico, Caribbean Sea; tropical western and central Atlantic from 13°N to 10°S (Figure 44). This species apparently does not occur in the southern portion of the North Atlantic Subtropical Region of Backus et al. (1977), except in its easternmost extent, and it has not been recorded from the eastern tropical Atlantic. In view of its occurrence in the tropical west Atlantic and the Caribbean Sea, its absence from the Lesser Antilles is inexplicable but apparently real, for the 1920–1922 *Dana* expeditions collected extensively there.

GEOGRAPHIC VARIATION.—The differences in bulb length, terminal-projection length, and bulb color between the population that occurs from Bermuda to Madeira and the Canaries and the remaining, tropical population have been described. There is evidence that suggests that the "tropical population" may consist of 2 populations, 1 in the Bahamas, Gulf of Mexico, and Caribbean Sea, another in the tropical western

and central Atlantic to 10°S. The latter population attains the longest bulbs, and 4 of the 7 specimens have the shortest terminal projections relative to bulb length (13%–28% of bulb) (Figures 37–39).

MATERIAL EXAMINED (13 males, 10 females, 3 unsexed).—*Lectotype:* BOC 2037 (♀, 85.5), 24°00′N, 77°17′W, 0–~1820 m (6000 ft wire), 28 Feb 1927.

Paralectotype: BOC 2038 (?, 80.6), 23°49′N, 76°59′W, 0–~2120 m (7000 ft wire), 9 Mar 1927.

Non-types (Tropical): USNM 225161 (♀, 105), 28°58′N, 88°18′W, 0–~991 m (545 fm), 27 Oct 1960. USNM 225162 (♀, 93.4), 07°43′N, 42°04′W, 0–100 m, 0045–0245, 23 Mar 1977. USNM 226790 (♂, 107.7), 04°08′N, 24°41′W, 0–600 m, 2225–2255, 1 Feb 1968. USNM 226791 (♂, 89.8), 09°43′S, 27°07′W, 0–100 m, 2045–2100, 5 Feb 1968. ISH 627/66 (♂, 155.8), 05°34′S, 26°58′W, 0–320 m, 2000–2315, 20 May 1966. ISH 742/68 (♀, 187.7), 04°11′N, 24°39′W, 0–200 m, 2121–2136, 1 Feb 1968. ISH 941/68 (♀, 93.2) 04°43′S, 26°39′W, 0–~2000 m, 1155–1215, 4 Feb 1968. ZMUC P202723 (♂, 114.9), 18°50′N, 79°07′W, 0–~1000 m (2000 mw), 0630, 29 Jan 1922. BMNH 1929.7.6.107 (♀, 97.2), 24°05′N, 74°36′W, 0–~150 m (300 mw), 2000, 14 Feb 1922. MCZ 56605 (♂, 106.4), 12°58′N, 73°34′W, 0–120 m, 0030–0505, 29 May 1966. UMML uncat. (♂, 101.5), 12°32′N, 50°03′W, 0–5020 m, 0846–1010, 5 Aug 1973. UMML uncat. (♀, 86.0), 17°43′N, 76°35′W, 0–80 m, 2105–2206, 4 Jul 1970. IOAN uncat. (♀, 89.7), 0–150 m, 29 Apr 1962. IOAN uncat. (♂, 86.8), 19°54′N, 76°38′W, 0–1500 m, 24 Mar 1973.

Non-types (Subtropical): USNM 225158 (2♂, 118.9, 129), 32°13′N, 64°16′W, 0–950 m, 0810–1053, 24 Aug 1971. USNM 225159 (♂, 113.2), 32°00′N, 64°23′W, 175 m, 0105–0205, 4 Sep 1968. USNM 225160 (♂, 98.7), 31°49′N, 64°18′W, 0–360 m, 1900–2005, 3 Sep 1968. ISH 78/66 (♂, 121.1), 33°45′N, 16°00′W, 0–600 m, 2110–2225, 10 May 1966. ISH 324/68 (♀, 83.2), 26°10′N, 19°26′W, 0–500 m, 22 Jan 1968. ISH 3196/79 (♀, 105.6), 34°21′N, 35°29′W, 0–1300 m, 1600–1852, 28 Apr 1979. ISH 3197/79 (♂, 111.5), 30°43′N, 46°16′W, 0–2000 m, 1600–1820, 25 Apr 1979. ZMUC P202722 (?, 68.3), 32°55′N, 21°51′W, 0–~250 m (500 mw), 1815, 20 Oct 1921. BMNH 1929.7.6.106 (?, 59.8), 31°59′N, 59°52′W, 0–~55 m (110 mw).

Eustomias spherulifer, new species

FIGURE 31*e*, *f*

Eustomias longibarba.—Parin and Andriashev, 1972:962 [listed as first record for South Atlantic].—Parin et al., 1974:90 [25°19′S, 26°33′W].

DIAGNOSIS.—A single, terminal bulb (1.1%–1.9% SL), its length more than twice its width, with a single, digitate terminal projection 40%–110% of bulb length. Bulb and projection combined 2.0%–3.4% SL. Barbel 28%–41% SL in small specimens, 60%–76% SL in those over 85 mm SL. Axis of stem well pigmented. External chevron-shaped or roundish striated areas unpigmented, closely spaced or contiguous distally, but often obscured distally by inclusions. Spherical or granular inclusions present in distal half of stem, small and widely spaced proximally, becoming large and crowded distally; inclusions not well developed in specimens smaller than about 100 mm SL. Middorsal paired spots between occiput and dorsal-fin origin 8.

DESCRIPTION.—There is no apparent sexual dimorphism in barbel characters. The barbel grows rapidly relative to SL until about 85 mm SL, after which it is 60%–76% SL at all sizes. Pigmentation of the stem was not recorded for most specimens. The stem axis was rather darkly pigmented and the terminal projection without pigment in the ones that were noted. External chevron-shaped or roundish striated areas of the stem are unpigmented and become closely spaced or contiguous distally, where they are obscured by the granular inclusions. Spherical or granular inclusions are present in most of the distal half of the stem in specimens larger than about 100 mm SL. These inclusions are small and widely spaced in their proximal extent but become large and crowded distally. Their size and number appear to increase in larger specimens. In specimens less

than 100 mm SL, the inclusions are relatively few and small or not apparent. The terminal bulb is variable in shape, but is usually straight-sided or slightly concave and 3 or more times as long as wide. The distal projection is less than half as wide as the distal end of the bulb, and its inclusions vary from small spheres to long masses.

The terminal bulb increases in length relative to SL from 1.1%–1.4% at 74–85 mm to 1.7%–1.9% at 88–108 mm, after which it decreases to 1.1%–1.5% at 145–148 mm.

The terminal projection in a 125 mm specimen is very long, 1.8% SL, 110% of bulb length. In the others the projection decreases relative to SL from 0.9%–1.3% in specimens 74–108 mm SL to 0.6%–1.0% in those 130–148 mm, and decreases relative to bulb length, from 100% to 40% of bulb length.

The postorbital organ in large males (125–148 mm) is 1.4%–2.0% SL, 47%–68% of fleshy orbit.

In 3 females 125–146 mm SL from a single collection, the bulb was light proximally, dark red distally, and the terminal projection had red bulblets (inclusions). A 137 mm female from a different collection had a pale, almost colorless bulb, and the terminal projection had pale golden-yellow bulblets. These specimens were all from the southeastern Atlantic.

Description of Holotype.—Mature male, 148.0 mm SL. D 25. A 36. P1 3. P2 7. IP 7. PV 33. VAV 19. OV 33. VAL 19. AC 19. IA 59. IC 78. OA 52. OC 71. VAV photophores over anal-fin base 7. Branchiostegal photophores 11. Premaxillary teeth 12 on both sides: from anterior to posterior, a moderate fixed tooth followed by a long space, a fixed fang followed by a long space (moderate space on right), 2 long depressible teeth (a moderate-to-long series of 1 fixed and 2 depressible on right) a short-to-moderate series of 1 fixed and 3 depressible teeth (1 fixed, a short space, 2 depressible on right), and a short-to-moderate series of 4 depressible teeth. Maxilla with about 7 erect teeth and 17 short, slanting, serra-like teeth. Mandibular teeth 16 left, 17 right: from anterior to posterior, a short fixed symphysial tooth followed by a moderate space, a semi-depressible fang and replacement followed by a moderate space, a long depressible and a short fixed tooth followed by a moderate space, a short-to-long series of 5 depressible teeth, the middle one missing (present on right), a short-to-moderate series of 3 depressible teeth (4 on right), and a very short-to-short series of 4 depressible teeth. Vertebrae 69.

Measurements (in mm): Predorsal length 123.0, preanal length 104.3, prepelvic length 82.9, head length 15.6, barbel length 95.2, terminal-bulb length without projection 1.6, terminal-projection length 1.5, snout length 4.1, fleshy orbit length 4.4, postorbital-organ length 3.0, lower-jaw length 14.7, upper-jaw length 13.6, depth behind head 9.7, greatest depth 11.3, caudal-peduncle least depth 2.4, pectoral-fin length 23.4, pelvic-fin length 21.4, dorsal-base length 19.6, anal-base length 37.6, longest premaxillary tooth 2.3, longest mandibular tooth 1.7.

Axis of stem moderately darkly peppered with melanophores. External chevron-shaped and roundish striated areas of stem unpigmented, widely spaced proximally, becoming almost contiguous distally. Spherical inclusions present in distal 40% of stem, small and widely separated proximally, larger and more crowded distally, very prominent just before bulb. Terminal bulb about 4 times longer than wide, slightly constricted at its mid-length. Terminal projection almost as long as bulb, filled with crowded inclusions of various sizes and tipped with a solid, rounded body.

Similar Species.—*Eustomias longibarba* is the most similar species. The only characters that distinguish *spherulifer* from *longibarba* are the presence in most of the distal half of the stem of *spherulifer* of spherical or granular inclusions, which become large and crowded near the bulb, and the irregular and crowded inclusions in the distal projection. In *longibarba* there are few or no inclusions in the stem, and, when present, they are small, inconspicuous, and present only near the bulb; the terminal projection of *longibarba* has only small spheres that appear to form rows along the proximal axis. Unfortunately, these characters are not clearly developed in *spherulifer* smaller

than about 100 mm SL, and the 2 species may be impossible to distinguish at small sizes.

Eustomias curtatus, like *spherulifer*, has inclusions in the distal half of the stem, but these do not become as large or as crowded as in *spherulifer*. In *curtatus* the barbel and bulb are both shorter than in *spherulifer* at any given size, and the terminal projection is either absent or very short (not more than 0.2 mm long).

The only other confusing species is *perplexus*, in which the bulb usually is shorter than in *spherulifer* and there is little development of spherical inclusions in the stem just proximal to the bulb. In most specimens of *perplexus*, the terminal projection is absent or very short, but a few have long ones.

DISTRIBUTION.—Known only from the South Atlantic south of 10°S (Figure 44) in the South Atlantic Subtropical Region and the southeastern extreme of the Atlantic Tropical Region of Backus et al. (1977).

ETYMOLOGY.—An adjective from the Latin *spherula* (little sphere or ball) plus the adjectival suffix *-fer* (indicating a bearer), in reference to the inclusions in the stem of this species.

MATERIAL EXAMINED (5 males, 7 females, 6 unsexed).—*Holotype:* ISH 1428/68 (♂, 148.0), 30°01′S, 42°30′W, 0–590 m, 0040–0110, 13 Feb 1968.

Paratypes: ISH 408/66 (2?, 87.7, 99.3), 23°02′S, 33°19′W, 0–180 m, 2000–2215, 25 May 1966. ISH 1212/68 (♀, 92), 21°04′S, 30°08′W, 0–560 m, 2335–0005, 8 Feb 1968. ISH 1270/68 (3?, 73.5, 81.6, 84.9; ♂, 147.3), 23°26′S, 33°30′W, 0–560 m, 0010–0040, 10 Feb 1968. ISH 1362/68 (♂, ~125), 27°50′S, 39°46′W, 0–560 m, 2350–0020, 11 Feb 1968. ISH 1734/71 (3♀, 125, 129.8, 144.7), 18°36′S, 04°18′W, 0–760 m, 2052–2241, 4 Apr 1971. USNM 226786 (?, 108.0), same data as holotype. USNM 226787 (♀, 137.4), 15°45′S, 06°06′W, 0–1900 m, 1849–2305, 5 Apr 1971. USNM 226789 (♂, 133.0), 25°27′S, 36°56′W, 0–160 m, 2100–2315, 26 May 1966.

Non-types: ISH 1840/71 (♂, 150; ♀, 165), 13°10′S, 09°00′W, 0–300 m, 2024–2126, 6 Apr 1971. ISH 1873/71 (♀, 150), 13°07′S, 09°02′W, 0–1010 m, 2131–2344, 6 Apr 1971.

Eustomias curtatus, new species

FIGURE 32*d,e*

DIAGNOSIS.—A single terminal bulb 0.4%–1.3% SL, its length more than twice its width, with a very short or no terminal projection (up to 25% of bulb length, not over 0.2 mm long). Bulb and projection combined 0.4%–1.6% SL. Barbel length 35%–57% SL, except in 1 young specimen. Axis of stem moderately pigmented proximally, usually becoming much lighter distally. External chevron-shaped or roundish striated areas unpigmented, becoming closely spaced distally. Spherical to ovoid inclusions present in distal half of stem, small and widely spaced proximally, becoming fairly crowded distally, difficult to discern in specimens smaller than about 90 mm SL. Middorsal paired spots between occiput and dorsal-fin origin 8, occasionally 7 or 9.

DESCRIPTION.—There is no apparent sexual dimorphism in barbel characters. Barbel length appears first to increase relative to SL, from 24%–35% at 66–70 mm to 52%–57% at 118–130 mm, and then to decrease to 35%–49% at 134–153 mm. The axis of the stem is moderately darkly pigmented in most specimens, lightly or very darkly in a few. The pigment becomes much lighter toward the distal end and is usually absent well proximal to the bulb; in a few specimens pigment reaches all the way to the bulb. The distal projection is unpigmented. External chevron-shaped or roundish striated areas of the stem are unpigmented and become closely spaced distally, though not contiguous. Spherical to ovoid inclusions are present in most of the distal half of the stem in specimens larger than about 90 mm SL. These inclusions are small and widely spaced proximally, becoming somewhat larger and more crowded distally. Their size and number appear to increase with specimen size. In specimens smaller than 90 mm SL, the inclusions may or may not be apparent; if present they are few and small.

The terminal bulb tends to be quite slender proximally and to widen distally. The distal projection, when developed, is a small, more or less conical hump and may or may not contain a few

inclusions. The bulb without its terminal projection decreases relative to SL from 0.8%–1.3% at less than 100 mm to 0.4%–1.0% at greater than 100 mm. Combining bulb and projection, the decrease is from 0.9%–1.6% to 0.4%–1.1%.

The postorbital organ is small in a 109 mm male, but enlarged (1.2% SL) in one of 110 mm and in all larger ones (120–152 mm). The enlarged postorbital is 1.1%–2.0% SL and 50%–83% of fleshy orbit.

Description of Holotype.—Maturing male, 128.0 mm SL. D 25. A 40. P1 3. P2 7. IP 7. PV 33. VAV 18. OV 33. VAL 18. AC 19. IA 58. IC 77. OA 51. OC 70. VAV photophores over anal-fin base 8. Branchiostegal photophores 12 left, 10 right. Premaxillary teeth 13 left, 12 right: from anterior to posterior, a short fixed tooth followed by a long space, a fixed fang followed by a short space, a short fixed and a long depressible tooth, a short depressible tooth (absent right), a short-to-moderate series of 1 fixed and 3 depressible teeth (1 fixed and 2 depressible right), and 4 short depressible teeth (5 right). Maxilla with 7 short erect teeth and about 15 short, slanting, serra-like teeth. Mandibular teeth 16 left, 14 right: from anterior to posterior, a short fixed symphsial tooth followed by a moderate space, a fixed fang (and replacement) followed by a moderate space, a long and a short depressible tooth (the latter absent right), a short fixed tooth, a long depressible and a short fixed tooth, 2 long depressible teeth, a short-to-moderate series of 4 depressible teeth (2nd tooth absent right), and 3 short depressible teeth. Vertebrae 68, the 1st only partially formed.

Measurements (in mm): Predorsal length 102.4, preanal length 86.2, prepelvic length 70.2, head length 14.3, barbel length 70.4, terminal-bulb length without distal projection 1.1, distal-projection length 0.2, snout length 4.4, fleshy orbit length 3.4, postorbital-organ length 1.8, lower-jaw length 13.3, upper-jaw length 12.6, depth behind head (greatest depth) 9.4, caudal-peduncle least depth 2.1, pectoral-fin length 16.0, pelvic-fin length 19.4, dorsal-base length 17.8, anal-base length 32.2, longest premaxillary tooth 2.2, longest mandibular tooth 1.1.

Axis of stem moderately peppered with melanophores until just before terminal bulb. External chevron-shaped and roundish striated areas becoming smaller and close together distally, ending just before bulb. Prominent spherical and ovoid bodies present in distal 60% of stem, small and widely spaced proximally, larger and more crowded distally.

Terminal bulb narrowest proximally (~0.2 mm), wider distally (~0.4 mm), about 3 times as long as wide, ending in a short, subconical projection with about 3 small inclusions.

Dorsal spots not counted, because skin was very dark.

Similar Species.—Four other species, *perplexus*, *spherulifer*, *longibarba*, and *mesostenus*, have single terminal bulbs that are more than twice as long as wide and have a terminal projection, rather than a filament. In some *perplexus*, 1 specimen of *longibarba*, and all *curtatus*, the distal projection from the bulb is 0.2 mm or shorter; in all others of those species the projection is at least 0.5 mm long. The projections of *longibarba*, *spherulifer*, and those *perplexus* with long projections are finger-like; that of *mesostenus* is as broad as the end of the bulb and short. The terminal bulb of some *perplexus*, the most similar species, is small, as in *curtatus*, and the combined measurement of bulb and projection (1.6% SL or less) distinguish all *curtatus* and most specimens of *perplexus* from the other 3 species. The barbel is longer in *perplexus* than in *curtatus* (67%–83% SL, except in a 66 mm specimen, vs. maximum 57%), and *perplexus* larger than 90 mm SL have, at most, only a few small spherical inclusions in the stem compared to *curtatus*. In development of stem inclusions, the Atlantic species *spherulifer* resembles *curtatus*, but has a long, finger-like distal projection from the bulb and a longer bulb and barbel in most specimens up to 100 mm SL and in all larger specimens.

Distribution.—Known only from the vicinity of the Hawaiian Islands (Figure 44).

Etymology.—From the perfect participle of the Latin verb *curto* (shorten), *curtatus* alludes to the diminutive projection of the bulb of this species and to the short barbel.

Material Examined (15 males, 10 females, 11

unsexed).—*Holotype:* USNM 224203 (♂, 124), 21°20′N, 158°20′W, 0–350 m, 0102–0255, 25 May 1974.

Paratypes (all except AMNH from 20°59′–21°32′N, 158°20′–34′W): USNM 224183 (♀, 143), 0–710 m, 0750–1205, 1 Mar 1971. USNM 224184 (♀, 130), 0–200 m, 1900–2320, 25 Apr 1971. USNM 224185 (2♀, 140, 143), 100–150 m, 2100–0000, 21 Jun 1971. USNM 224186 (2♂, 120, 135), 0–250 m, 0421–0600, 27 Feb 1971. USNM 224187 (♂, 152), 0–185 m, 0038–0253, 28 Feb 1971. USNM 224188 (?, 100; ♀, 102), 0–70 m, 0038–0250, 25 Sep 1973. USNM 224189 (2?, 76, 77), 0–121 m, 0354–0954, 13 Aug 1967. USNM 224190 (♂, 109), 0–1100 m, 0230–0545, 14 Sep 1973. USNM 224191 (?, 76), 0–900 m, 1141–1553, 22 Sep 1970. USNM 224192 (?, 77), 0–750 m, 0710–1127, 17 Sep 1970. USNM 224193 (♀, 86; ♂, 97), 0–225 m, 0119–0340, 21 Sep 1970. ZMUC P208154 (♂, 150), 0–125 m, 1955–2138, 18 Sep 1971. BPBM 26542 (♂, 148), 0–350 m, 2207–0005, 28 Aug 1973. BPBM 26543 (?, 92), 0–110 m, 0230–0437, 26 Sep 1973. SIO 81-12 (♀, 137), 0–930 m, 1200–1625, 17 Jun 1971. IOAN uncat. (♀, 118), 0–160 m, 0900–1225, 17 Feb 1971. AMNH 43494 (♂, 129), ~19°30′N, 156°00′W, 1975.

Non-types (all from 20°59′–21°32′N, 158°20′–34′W): USNM 224194 (♀, 153.1), 0–170 m, 2008–2215, 11 Oct 1958. USNM 224195 (?, 66; ♂, 141.7), 0–60 m, 0343–0755, 26 Jul 1967. USNM 224196 (2♂, 135, 139), 0–125 m, 2310–0110, 27 Feb 1971. USNM 224197 (?, 86), 0–1000 m, 1204–1637, 15 Sep 1970. USNM 224198 (♂, 110), 0–200 m, 0245–0445, 28 Feb 1971. USNM 224199 (2♂, 134, 152), 675–850 m, 1315–1630, 18 Mar 1971. USNM 224200 (♀, 137), 0–775 m, 1338–1705, 9 Jun 1971. USNM 224201 (?, 78), 0–350 m, 0120–0320, 28 Aug 1973. USNM 224202 (?, 82), 0–122 m, 1952–0152, 25 Jul 1967. USNM uncat. (?, 70), same data as BPBM 26542; lost?.

Eustomias perplexus, new species

FIGURE 32*a–c*

Eustomias longibarba.—Gibbs, 1960:202, 203 [2 specimens from northeastern Pacific; 1 considered herein as not identifiable].—Morrow and Gibbs, 1964:413–415 [part, 2 eastern Pacific specimens].—Johnson and Rosenblatt, 1971:309 [re-examined Gibbs' 2 specimens, 1 additional from south China Sea].—Parin and Pokhilskaya, 1974:342, 343 [2 specimens, 13°33′N, 90°54′E and 9°45′S, 164°09′E, and a 3rd, questionable specimen from the former locality].—Parin et al., 1977:101 [1 specimen, 00°46′S, 144°49′E].

DIAGNOSIS.—A single, terminal bulb 0.8%–1.6% SL, its length more than twice its width, with a terminal projection that may be undeveloped or up to 55% of bulb length. Bulb and projection combined 0.8%–2.2% SL. Barbel length 67%–83% SL, except in the smallest specimen. Axis of stem moderately to fairly darkly pigmented proximally becoming lighter or unpigmented distally. External chevron-shaped or roundish striated areas unpigmented, becoming closely spaced distally. Widely spaced spherical inclusions present in distal one-third to one-half of stem, sparse or absent before bulb. Middorsal paired spots between occiput and dorsal-fin origin 8, occasionally 9.

DESCRIPTION.—There is no apparent sexual dimorphism in barbel characters.

In the smallest (66 mm) specimen, the barbel is 32% SL. From 75 to 147 mm SL, barbel length is 67%–83% SL, apparently not changing in relative length with growth. The 66 mm specimen has no pigment in the stem. In the others, the axis is moderately to fairly darkly peppered with melanophores proximally, becoming lightly pigmented or unpigmented distally. The external chevron-shaped or roundish striated areas are unpigmented; although they become smaller distally, they do not become contiguous. Very small, widely spaced spherical inclusions are present in the distal one-third to one-half of the stem. In some specimens there are a few spherical inclusions just proximal to the bulb, but in others these are absent. In 1 specimen, there are long inclusions before the bulb which resemble the striated external areas that usually end more proximad.

The terminal bulb is narrow proximally, wider distally, and unpigmented. The proximal and distal parts appear to have different textures. The bulb is 0.6% SL at 66 mm, apparently increasing relative to SL to 1.0%–1.3% at 75–101 mm. The remaining 3 specimens show no clear pattern. In

an Indian Ocean male, 118 mm, the bulb is 0.6% SL; in an eastern Pacific male, 129 mm, 1.6%; in an eastern Pacific female, 147 mm, 0.8%.

The terminal projection may be barely visible or up to 55% of bulb length. There is no apparent geographic or growth pattern in its development. In 6 specimens, the projection is 0–25% of bulb length, and in 5, 40%–55%. Both short and long projections are found in specimens 66–90 mm, as well as in those 101–147 mm.

The postorbital organ in a 101 mm male is 1.0% SL, perhaps just beginning to enlarge. In the other 2 males, 118–129 mm, the organ is 1.6%–1.8% SL, 60%–62% of fleshy orbit.

Description of Holotype.—Sex undetermined, 75.3 mm SL. D 24. A 35. P1 3. P2 7. IP 7. PV 33. VAV 18. OV 33. VAL 19. AC 19. IA 58. IC 77. OA 52. OC 71. VAV photophores over anal-fin base 7. Branchiostegal photophores 11. Premaxillary teeth 11 left, 10 right: from anterior to posterior, a long fixed tooth followed by a long space, a fixed fang followed by a moderate space, a short fixed and a long depressible tooth, a short fixed and a short depressible tooth (both depressible right), 2 moderate depressible teeth, and 3 short, depressible teeth (2 right). Maxillary teeth mostly broken. Mandibular teeth 16 left, 14 right: from anterior to posterior, a short fixed symphysial tooth followed by a moderate space, a fixed fang followed by a long space, a long depressible tooth followed by a moderate space, 2 short fixed and 1 short depressible teeth (1 fixed, 1 depressible right), 2 long depressible teeth, 3 short fixed teeth and 2 moderate depressible teeth (a short-to-moderate series of 4 depressible right), and 3 short depressible teeth. Vertebrae 67.

Measurements (in mm): Predorsal length 61.9, preanal length 54.0, prepelvic length 42.0, head length 9.1, barbel length 50.5, terminal-bulb length without distal projection 0.8, distal-projection length 0.2, snout length 3.7, fleshy orbit length 2.1, postorbital-organ length 0.4, lower-jaw length 8.0, upper-jaw length 7.5, depth behind head (greatest depth) 5.4, caudal-peduncle least depth 1.2, pectoral fin broken, pelvic-fin length 11.1, dorsal-base length 10.5, anal-base length 19.8, longest premaxillary tooth 1.5, longest mandibular tooth 1.0.

Axis of stem moderately darkly peppered with melanophores proximally, pigment becoming sparse distally and finally absent. A few external pigment spots on proximal one-fifth of stem. External chevron-shaped to roundish striated areas unpigmented. Tiny, widely spaced spherical inclusions in distal one-third of stem; the 5 or 6 just proximal to the bulb slightly larger than others.

Terminal bulb elongate-pear-shaped, the narrow proximal part white, the globular distal part orangish (after long preservation). Mid-distal projection with a few inclusions of various sizes.

Nine pairs of middorsal spots between occiput and dorsal origin, the last just anterior to the dorsal; none beside dorsal-fin base; 1 on caudal peduncle.

Similar Species.—Specimens of *perplexus* with long distal projections can not be distinguished from *longibarba* and *spherulifer* except by the development of spherical inclusions in the distal stem, which are more numerous than in *longibarba* (which has none or very few), less numerous and smaller than in *spherulifer* (in which they are large and crowded). Other *perplexus* specimens differ in having almost no projection or one that is conical and less than 0.2 mm long (finger-like and longer than 0.5 mm in all except 1 *longibarba* and *spherulifer*; 0.2 mm, but finger-like in 1 *longibarba*).

In *curtatus* the distal projection is short, as in some *perplexus*. The barbel, however, is relatively shorter in *curtatus* than in all except the smallest *perplexus* (maximum 57% SL vs. 67%–83% in *perplexus*).

The only remaining species with a single terminal bulb that is twice or more as long as wide is *mesostenus*, which has a longer bulb (without projection 2.6% SL vs. maximum 1.6% in *perplexus*) and only 4 VAV photophores over the anal-fin base (vs. 6 or more in *perplexus*).

Distribution.—Bay of Bengal, North China Sea to Solomon Islands, central equatorial Pacific, and northeastern Pacific between 10° and 20°N (Figure 44).

Remarks.—One of the 2 northeastern-Pacific specimens identified as *longibarba* by Gibbs (1960) has the end of the barbel missing (noted by

Johnson and Rosenblatt, 1971). This specimen can not be identified with certainty, but *perplexus* is the only species of *Nominostomias* yet known from that area.

ETYMOLOGY.—From the Latin adjective *perplexus* (puzzling), alluding to the perplexing combination in this species of characteristics of *longibarba* and *curtatus*.

MATERIAL EXAMINED (4 males, 2 females, 6 unsexed).—*Holotype:* ZMUC P207437 (?, 75.3), 10°34′N, 112°51′E, 0–2600 M, 1610–1810, 2 Jul 1951.

Paratypes: ZMUC P202724 (?, 66.3), 03°18′N, 129°02′E, 0–~300 m (600 mw), 2145, 8 Jul 1929. ZMUC P202725 (♂, 90.0), 04°10′N, 127°03′E, 0–~150 m (300 mw), 2310, 7 Aug 1929. ZMUC P208152 (♀, 82.6), 07°06′S, 103°30′E, 0–~150 m (300 mw), 7 Sep 1929. USNM 226785 (?, 82.8), same data as ZMUC P202725. USNM 226217 (♀, 147 mm), 11°36′N, 97°53′W, 0–200 m, 0800–0845, 31 Aug 1971. SIO 52-309 (♂, 128.5), 17°48′N, 127°07′W, 23 May 1952. SIO 73-164 (?, 83), 00°20′N, 155°00′W, 2340–0452, 14 Jul 1972. IOAN uncat. (?, 81.0), 09°45′S, 164°09′E, 0–110 m, 7 Feb 1979. IOAN uncat. (♂, 100.8), 02°34′S, 147°36′E. IOAN uncat. (♂, 118.3), 13°33′N, 90°54′E, 0–100 m, 15 Feb 1961.

Non-type (uncertain identity): SIO 54-95 (?, 133.5), 23°05′N, 119°08′W, 0–~2426 m (1333 fm), 2215–0855, 23 Jun 1954.

Eustomias mesostenus, new species

FIGURE 32*f*

DIAGNOSIS.—A single, very long terminal bulb (2.6% SL) its length more than twice its greatest width, constricted at its mid-length, with a short, very slender terminal projection included in a broad distal extension of the outer covering membrane of the bulb. Bulb and projection 3.2% SL. Barbel short, 42.5% SL. Axis of stem without pigment. External chevron-shaped or roundish striated areas unpigmented, becoming almost contiguous distally. No inclusions in stem. Mid-dorsal paired spots between occiput and dorsal-fin origin 9. VAV and VAL photophores 16, only 4 VAV over anal-fin base.

DESCRIPTION OF HOLOTYPE.—Immature male, 95.0 mm SL. D 24. A 34. P1 3. P2 7. IP 7. PV 32. VAV 16. OV 34. VAL 16. AC 18. IA 55. IC 73. OA 50. OC 68. VAV photophores over anal-fin base 4. Branchiostegal photophores 11. Premaxillae missing. Maxillary teeth mostly missing; a few erect teeth anteriorly. Mandibular teeth 15 left, 16 right: from anterior to posterior, a short fixed symphysial tooth followed by a moderate space, a fixed fang followed by a long space, a long depressible tooth, 2 short fixed teeth, a long depressible tooth (2 right), a short-to-moderate series of 1 fixed and 3 depressible teeth, and 5 short depressible teeth. Vertebrae 67.

Measurements (in mm): Predorsal length 77.8, preanal length 68.5, prepelvic length 57.0, head damaged, barbel length 40.4, snout not intact, fleshy orbit length 3.0, postorbital-organ length 0.5, lower-jaw damaged, upper-jaw missing, depth behind head (greatest depth) 6.6, caudal-peduncle least depth 1.6, pectoral fin damaged, pelvic-fin length 13.6, dorsal-base length 12.9, anal-base length 20.2, longest mandibular tooth missing.

No pigment in any barbel structure. External chevron-shaped areas very narrow and perpendicular to stem axis for most of stem length, becoming wider and close together, almost contiguous, distally. No inclusions apparent. Bulb about 5 times as long as its greatest width, strongly constricted at midlength. A slender, thread-like distal projection from bulb, included in a broad extension of the transparent outer membrane of bulb.

Ten pairs of spots along dorsal midline, 9 between occiput and dorsal-fin origin, 1 beside anterior dorsal-fin base, none on caudal peduncle.

SIMILAR SPECIES.—Among species with single terminal bulbs that are more than twice as long as wide, only *longibarba* approaches *mesostenus* in bulb length without distal projection (maximum 2.3% SL vs. 2.6% in *mesostenus*); *longibarba*, however, has a very different distal projection, finger-like and with the outer transparent membrane

closely enveloping the projection.

Eustomias curtatus and some *perplexus* resemble *mesostenus* in having a very short or no distal projection from the bulb, but in those 2 species the bulb is much shorter (without terminal projection, maximum 2.0 mm and 1.6% SL vs. 2.5 mm and 2.6% in *mesostenus;* with projection, maximum 2.8 mm and 2.2% vs. 3.0 mm and 3.2%). Further, *curtatus* has prominent spherical or ovoid inclusions in the distal stem (lacking in the single *mesostenus*), and usually has only 8 pairs of mid-dorsal spots before the dorsal-fin origin (9 in *mesostenus*).

No other species of *Nominostomias* has as few as 4 VAV photophores over the anal-fin base; *gibbsi* occasionally has 5, and all others have 6 or more. This is congruent with the low VAV and VAL photophores counts of *mesostenus;* its VAV count of 16 is the lowest recorded for any other *Nominostomias* species except *gibbsi* (mode 17, minimum 15); its VAL is the lowest for *Nominostomias*, recorded otherwise only in *curtatus* and *gibbsi.* The anal-ray count of 34 in *mesostenus* is lower than in all except 6 other *Nominostomias* species. The usefulness of these meristic characters in distinguishing *mesostenus*, however, will be determined only after their variation is known.

DISTRIBUTION.—The holotype and only known specimen was taken in the south-central Indian Ocean.

ETYMOLOGY.—An adjective derived from the Greek *meso-* (middle) plus *stenos* (narrow), *mesostenus* refers to the constricted terminal bulb of this species.

MATERIAL EXAMINED.—*Holotype:* SIO 61-34 (♂, 95), 18°49′S, 88°05′E, 0–1643 m, 1817–2300, 27 Nov 1960.

Geographic Distribution

The geographic distributions of the species of *Nominostomias*, all in tropical and/or subtropical regions, are notable for their restriction to relatively small oceanic areas and for their limited overlap with one another. Especially noteworthy is the lack of species that occur in all 3 oceans, a fact at variance with other studies of mesopelagic fishes (e.g., Ebeling, 1962—Melamphaidae; Johnson, 1974; 1982—Scopelarchidae, Evermannellidae; Parin and Novikova, 1974—Chauliodontidae; Nafpaktitis et al., 1977—Myctophidae; Shcherbachev and Novikova, 1976—Stomiatidae; Parin and Pokhilskaya, 1978b—*Melanostomias*; Borodulina, 1978—Sternoptychidae; Mukhacheva, 1972, 1974—*Gonostoma*, *Cyclothone*; Gibbs and Clarke, unpublished data on other subgenera of *Eustomias*). Ebeling (1962) and subsequent authors have recognized a primary "circum-central-tropical" zoogeographic region or distribution pattern, because so many species traverse equatorial and subtropical (central) waters and occur in all 3 oceans. Our studies of *Nominostomias* suggest that closer taxonomic study of widespread "species" may reveal several species (or different entities) being confounded under a single name and that the concept of a circumglobal tropical-subtropical region may not be justified.

Fourteen species of *Nominostomias* occur in the Atlantic and 25 occur in the Indo-Pacific. Only 1 species, *E. melanostigma*, is common to both regions.

Only 6 species have been taken in the Indian Ocean. Three of these, *E. melanostigma*, *E. bulbornatus*, and *E. perplexus*, are widespread and extend into the Pacific. The other 3 are known only from the Indian Ocean, *E. mesostenus* and *E. multifilis* from a single specimen each, and *E. bertelseni* from 3.

One species, *suluensis*, is known only from the Sulu Sea, one of the enclosed Southeast Asian seas. Otherwise, only the widespread *E. bulbornatus* is known from these seas, but from their adjacent distributions in both the Indian and Pacific oceans, 3 other species, *E. melanostigma*, *E. crossotus*, and *E. perplexus*, might be expected there. Twenty-one species are known from the Pacific, 17 only from there.

ATLANTIC.—Most of the 14 Atlantic species have virtually non-overlapping distributions. Three species—*E. longibarba*, *E. melanostigma*, and *E. arborifer*—have rather extensive geographic

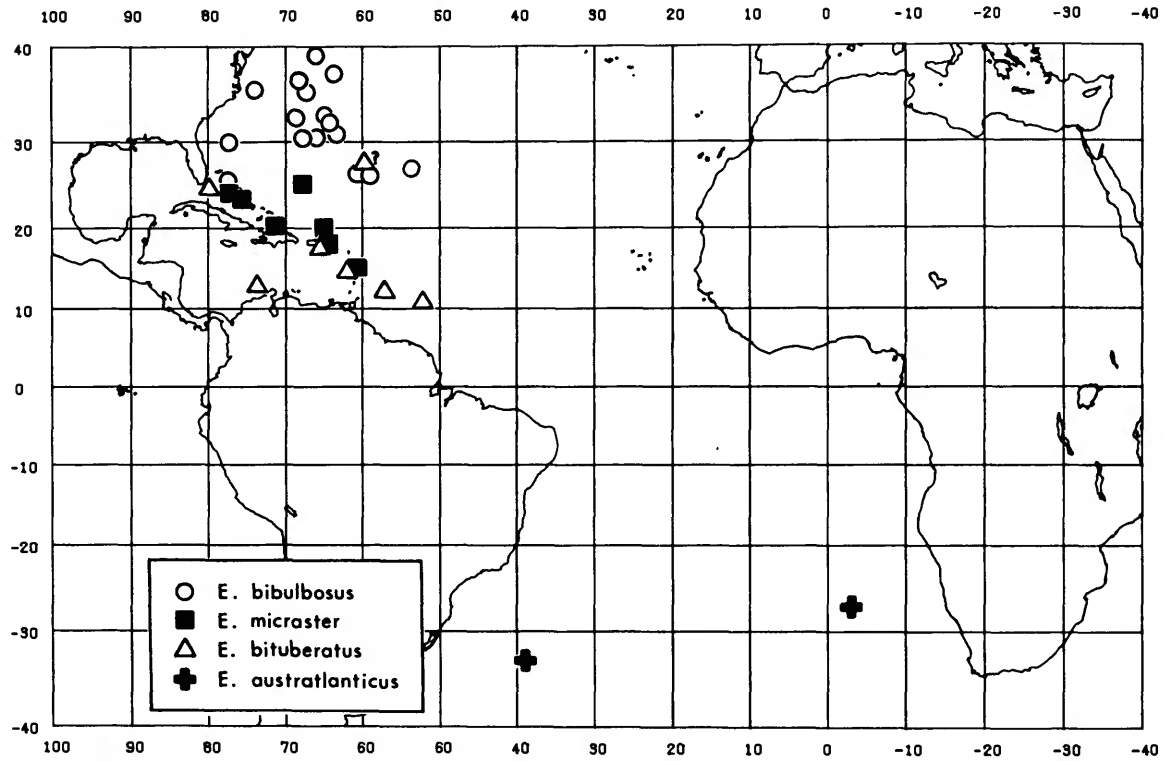


FIGURE 40.—Geographic distribution of Group I species. The questioned record of *E. bituberatus* is discussed in the text.

ranges and will be considered after the other 11 species. References to Atlantic regions and provinces are those of Backus et al. (1977).

Beginning in the north, *E. bibulbosus* is a subtopical species found only in the west, mainly west of 60°W between 30° and 40°N. This is in the Northern Sargasso Sea Province and corresponds to the western half of the Gulf Stream circulation at the lower-thermocline and deep levels (Worthington, 1976, figs. 11, 24). The occurrences of *E. bibulbosus* in the northern Bahamas is within Worthington's (1976, fig. 26) stream lines of the circulation of the mid-thermocline layer. The southeastward extension of the species' range to about 25°N may be related to the shifting front (Northern Subtropical Convergence) that is considered the boundary between the Northern and the Southern Sargasso Sea provinces. Only in this area, does the range of *E. bibulbosus* overlap that of *E. bimargaritatus*.

Next to the south, *E. bimargaritatus*, also a subtropical species, occurs mainly between 20° and 28°N, extending across the Atlantic in the Southern Sargasso Sea and the Southern North African Subtropical Sea provinces. All records except one near the Cape Verde Islands are within Worthington's (1976, fig. 29) slowest, southernmost westward stream lines of the Gulf Stream circulation in the upper-thermocline area.

In the eastern subtropical Atlantic, *E. patulus*, known only from the holotype, has been taken southwest of the Canary Islands. Both the status of this species and its geographic range are open to question.

Two species are closely associated with the Bahamas and Antilles island chain. *Eustomias mi-*

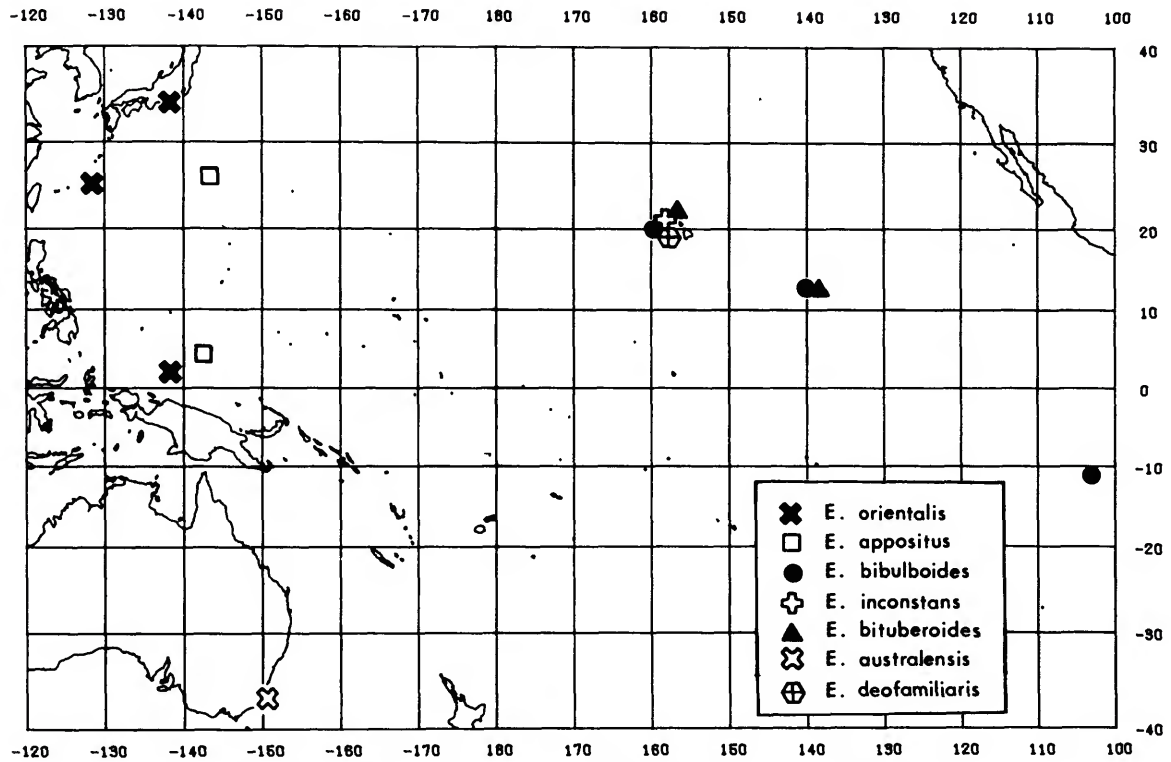


FIGURE 40.—Continued.

craster occurs from the northern Bahamas to the southern Leeward Islands; *E. bituberatus* has been taken in the Straits of Florida, but most are from south of Puerto Rico, extending to southern Caribbean Sea and into the open ocean along about 10°N. The distribution of *E. micraster* is at the western edge of the Southern Sargasso Sea Province, where *E. bimargaritatus* has its westernmost limits, and it may be considered a subtropical species; *E. bituberatus* occurs mainly in the Antillean Province, of the Atlantic Tropical Region, and it can be considered a tropical species.

Extending southward from 10°N to 06°S in the western Atlantic, *E. kreffti*, a tropical species, occurs mainly in the Amazonian Province, which is approximately equivalent to the Guiana Basin of Wright and Worthington (1970). The area is outside the primary Gulf Stream gyre circulation and is comprised largely of South Atlantic water in its upper layer.

In the eastern tropical Atlantic, *E. melanonema* occurs from the vicinity of the Cape Verde Islands to the eastern Gulf of Guinea at the equator. This is the northern part of the Guinean Province, which Backus et al. (1977) suggested might be a separate province, but declined to name. It is also equivalent to the Guinea Basin of Wright and Worthington (1970).

In the western South Atlantic Subtropical Region, *E. posti* has been taken between 13° and 23°S, *E. spherulifer* from 20° to 30°S, and *E. austratlanticus* at 33°S. The latter 2 species also occur in the eastern Atlantic but at higher latitudes than in the west, *sperulifer* at 13° to 18°S, *austratlanticus* at 27°S. This places the eastern occurrences of *spherulifer* in Backus et al.'s Atlantic

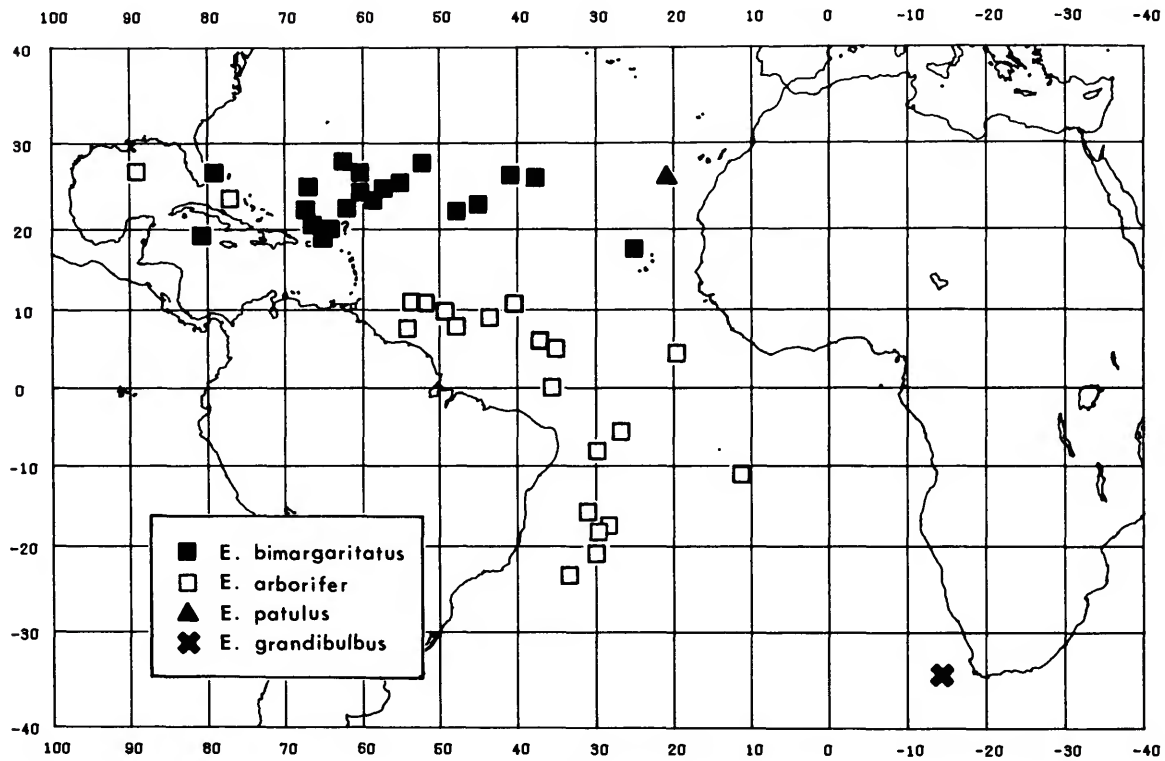


FIGURE 41.—Geographic distribution of Group II species and *E. patulus*, a Group IV species. The questioned record of *E. bimargaritatus* is the specimen identified as *E. bibulbosus* in Morrow and Gibbs (1964) but which could not be found for this study (see text).

Tropical Region and causes us to question their southward-depressed eastern boundaries for that region. Hulley (1981) has discussed the problems associated with defining a Tropical-Subtropical boundary, noting in particular the influence of the Benguela Current in the east and suggesting that the boundary on that side of the Atlantic is at 05°–11°S.

The only known specimen of *E. grandibulbus* is from west of the southern tip of Africa. We suspect that this may be an Indian Ocean tropical or subtropical species that has the Agulhas pattern of distribution (Krefft, 1974; Hulley, 1981).

We come now to the three widespread species, *E. longibarba*, *E. arborifer*, and *E. melanostigma*, all of which have distributions that include both Tropical and Subtropical regions. We have suggested that *E. longibarba* may be comprised of 3 differentiated geographic groups—north subtropical; Bahamas, Gulf, and Caribbean; and open-ocean tropical—and that the southern subtropical population of *E. arborifer* may differ from the tropical population. In *E. melanostigma*, no suggestive differences have been detected.

The north subtropical unit of *E. longibarba* ranges from Bermuda to Madeira between 30° and 35°N and extends southward in the east to south of the Canary Islands. In most of this extent, *longibarba* is the only species of *Nominostomias*. At the extremes of the range, it and *E. bibulbosus* both occur at Bermuda, and it, *E. melanostigma*, and *E. patulus* all occur between Madeira and south of the Canaries.

The distribution of *E. melanostigma* extends in

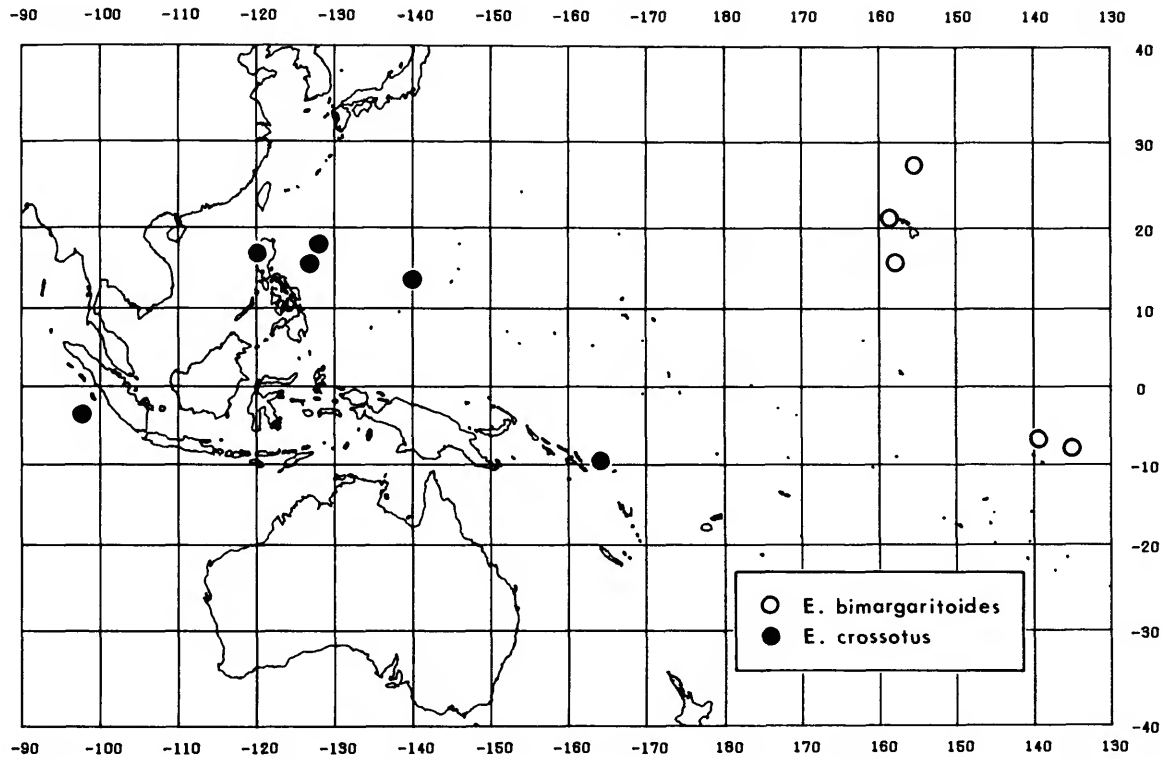


FIGURE 41.—Continued.

a narrow V from Madeira southwestward west of the Cape Verde Islands to about 04°N and northward again to Puerto Rico and the Straits of Florida. In following this path, the range cuts across those of *E. longibarba*, *patulus*, and *bimargaritatus* in the northeastern Subtropical Region, touches the westernmost extent of *E. melanonema* in the tropical Guinean Province, extends along the northern limits of *E. kreffti*, *E. arborifer*, and the open-ocean tropical group of *E. longibarba*, overlaps the range of *E. bituberatus* and *micraster* almost completely, and occurs with 6 other species, including the other 2 widespread ones, in the Straits of Florida–Bahamas area. This distribution could be interpreted as mostly tropical, but its eastern extension into the North Atlantic Subtropical Region and its limitation to the northern edge of the Tropical Region suggest that it is a peripheral distribution, at the boundary of the southern half of the main North Atlantic (Gulf Stream) circulation. This includes areas on the east and west, where the flow is influenced by land or islands, and the southern area, where South Atlantic water intrudes. Both situations could result in ecotones of increased mixing and productivity.

The ranges of *E. arborifer* and the open-ocean tropical group of *E. longibarba* coincide almost exactly between 10°S and 11°–12°N, where they both occur with *E. kreffti*, which is restricted to this area of the Tropical Region. After a wide gap in the open Atlantic, both species occur in the Bahamas and northern Gulf of Mexico, where so many other *Nominostomias* species also are found. In this area and in the Caribbean Sea, however, *longibarba* is common, probably resident, and may be distinct from the 2 other populations in the northern subtropical area and the open

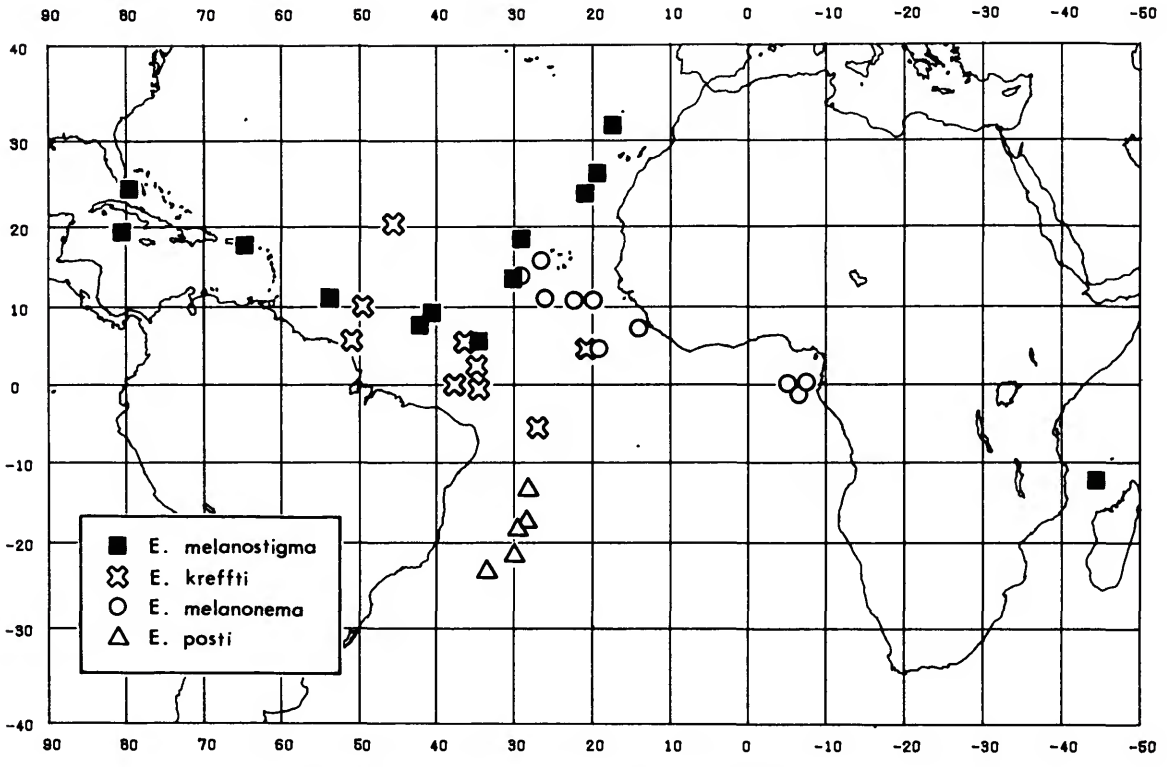


FIGURE 42.—Geographic distribution of Group III species.

tropical Atlantic, while *E. arborifer* is uncommon and may be expatriated.

The *E. arborifer* south of 10°S in the South Atlantic Subtropical Region may eventually be recognized as a species distinct from the tropical form.

If we ignore the Bahamian area, which appears to be the common meeting ground of a number of species, there are only 2 areas where species of *Nominostomias* co-occur broadly. In the western tropical Atlantic, *E. arborifer*, *kreffti*, and *longibarba* have the same range, and in the western subtropical Atlantic, *E. arborifer* and *E. posti* have similar ranges. All other species have little or no overlap in distribution. It is worthy of note that, again with the exception of the Bahamian area, there is virtually no overlap in the ranges of species within a single group, I–V. All overlap involves species belonging to different groups, and never more than a single species from any group in any given area.

It is noteworthy that *E. patulus* is the only group IV species in the Atlantic.

INDO-PACIFIC.—Distributions of most of the 25 Indo-Pacific species of *Nominostomias* can not be characterized confidently, because records and collections are few and widespread. Only the Hawaiian area and the equatorial areas of both oceans have been sampled sufficiently.

The equatorial waters between 10°N and 10°S are dominated by *E. bulbornatus*, which is by far more abundant where it occurs than are any other species of *Nominostomias* within their ranges. *Eustomias melanostigma* co-occurs with it across the Indian Ocean and the westernmost Pacific, but has not been taken in the Southeast Asian seas. *Eustomias perplexus* and *E. crossotus* have been taken from the easternmost Indian Ocean and the Pa-

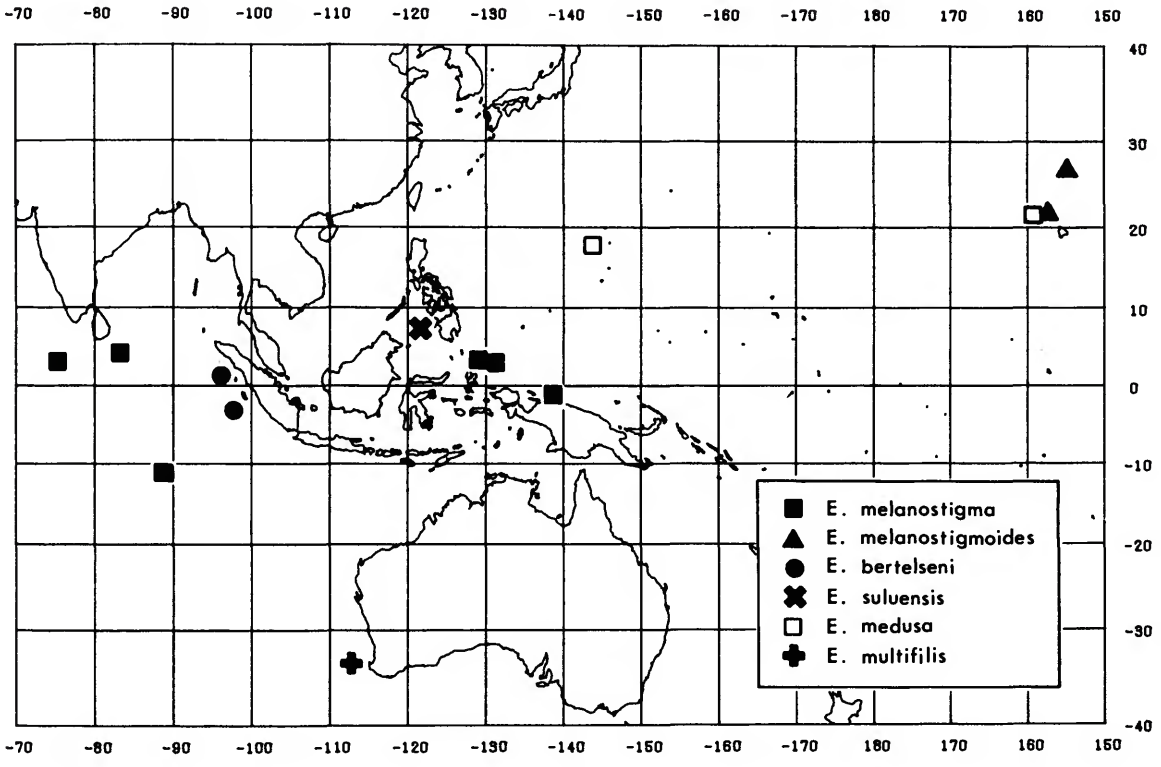


FIGURE 42.—Continued.

cific, the former apparently extending into the eastern Pacific west of Mexico, the latter only into the westernmost Pacific, neither having been taken in Southeast Asian seas. *Eustomias bertelseni* is known only from the Indian Ocean west of Sumatra and *E. suluensis* only from the Sulu Sea, the latter being the only species of *Nominostomias* other than *bulbornatus* taken in Southeast Asian seas. At the eastern end of the range of *bulbornatus* near 140°W, both *E. bimargaritoides* and *E. cirritus* have been taken in equatorial waters, but both species have their main distribution north or south of the equatorial waters. A specimen of *E. vitiazi* taken at 180° is somewhat north of the apparent range of that species. Two species, *E. orientalis* and *E. appositus*, have been taken both in equatorial waters north of New Guinea and again north of 25°N. The northern occurrences may be the result of transport by the Kuroshio Current, as may be the presence of *E. bulbornatus* in Japanese waters.

Two subtropical species are known from the Indian Ocean, each from a single specimen: *E. mesostenus* from about 18°S in the central part and *E. multifilis* from off southwestern Australia. The 2 north-south midwater-trawling transects of the International Indian Ocean Expedition along 60° and 65°W took no *Nominostomias* except *bulbornatus*.

Eleven subtropical species are known from the subtropical North Pacific. All except 1, *E. cancriensis*, have been taken near the main Hawaiian islands. Four have been taken only there: *E. melanostigmoides*, *E. inconstans*, *E. deofamiliaris* (1 specimen), and *E. curtatus*. Two have been taken otherwise only in the western Pacific near 140°E: *E. medusa* at 18°N, *E. pacificus* at 21°N. A distribution slightly to the north of either of the last 2

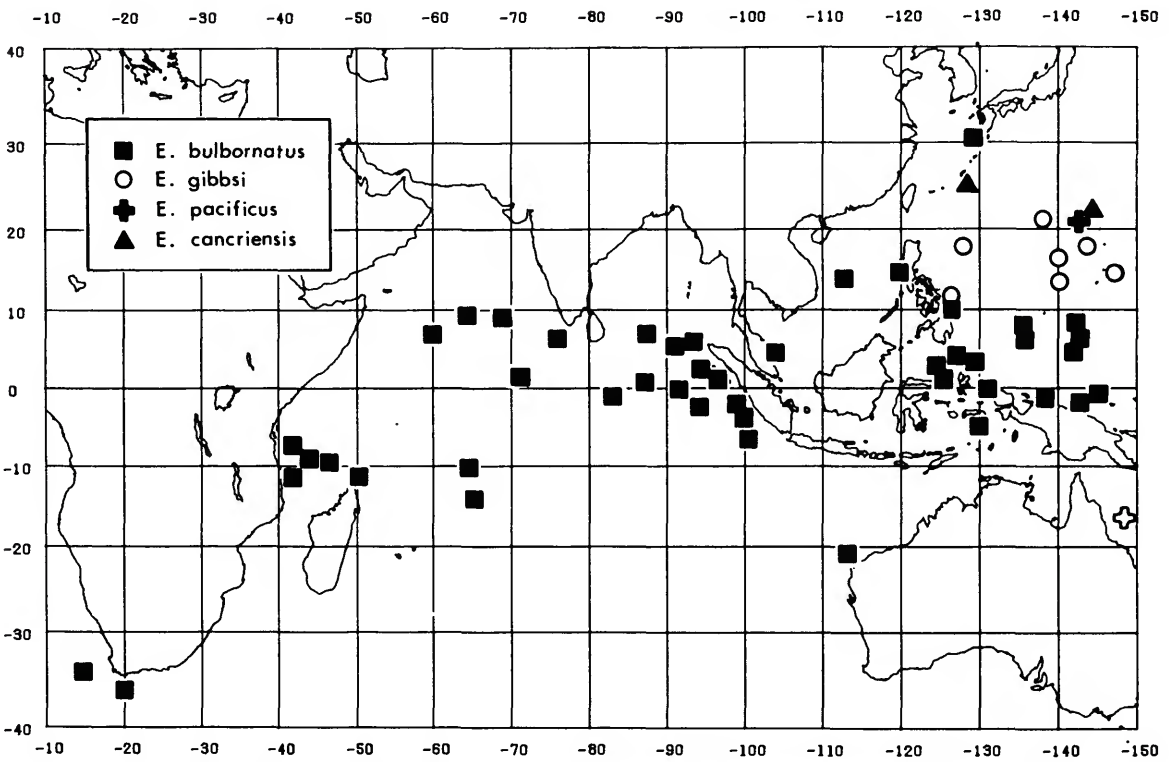


FIGURE 43.—Geographic distribution of Group IV species. *E. patulus* is plotted with Group II species (Figure 40).

species is indicated for *E. cancriensis*, which has been taken between 22° and 26°N in the western Pacific, reaching eastward almost to 180°. There is a gap between 150°E and 160°W where only 1 specimen of *Nominostomias* has been taken. This is probably due to a paucity of sampling.

The only other species apparently confined to North Pacific subtropical waters is *E. bituberoides*, which has been taken in the Hawaiian area and at 12°N, 140°W.

Three species appear to have bipolar subtropical distributions, occurring in both the North and South Pacific, but with a wide gap in equatorial waters. This is certainly the case for *E. gibbsi*, after *E. bulbornatus* the species that has been taken most often and at widely distributed locations. In the North Pacific, *E. gibbsi* occurs between about 10° and 22°N, and the western Pacific gap is evident. In the South Pacific, it has been taken between 25° and 27°S. Most *E. bibulboides* have been taken near Hawaii; the only other records are from 12°N, 140°W and 11°S, 104°W; the latter specimen has been noted in the text as possibly a different species. Records of *E. bimargaritoides*, other than within about 500 miles of Hawaii, are from 07°–08°S, 135°–140°W. The southern records may be marginal between equatorial and subtropical waters. They are east of the eastern limit of *E. bulbornatus*, and it is possible that lack of competition allows other species than *bulbornatus* to exist in equatorial waters of the eastern Pacific.

Four species appear to occur only in the subtropical South Pacific. Most *E. vitiazi* are from 12° to 22°S, but 1 specimen is from within the equatorial range of *E. bulbornatus* at 07°S, 178°W.

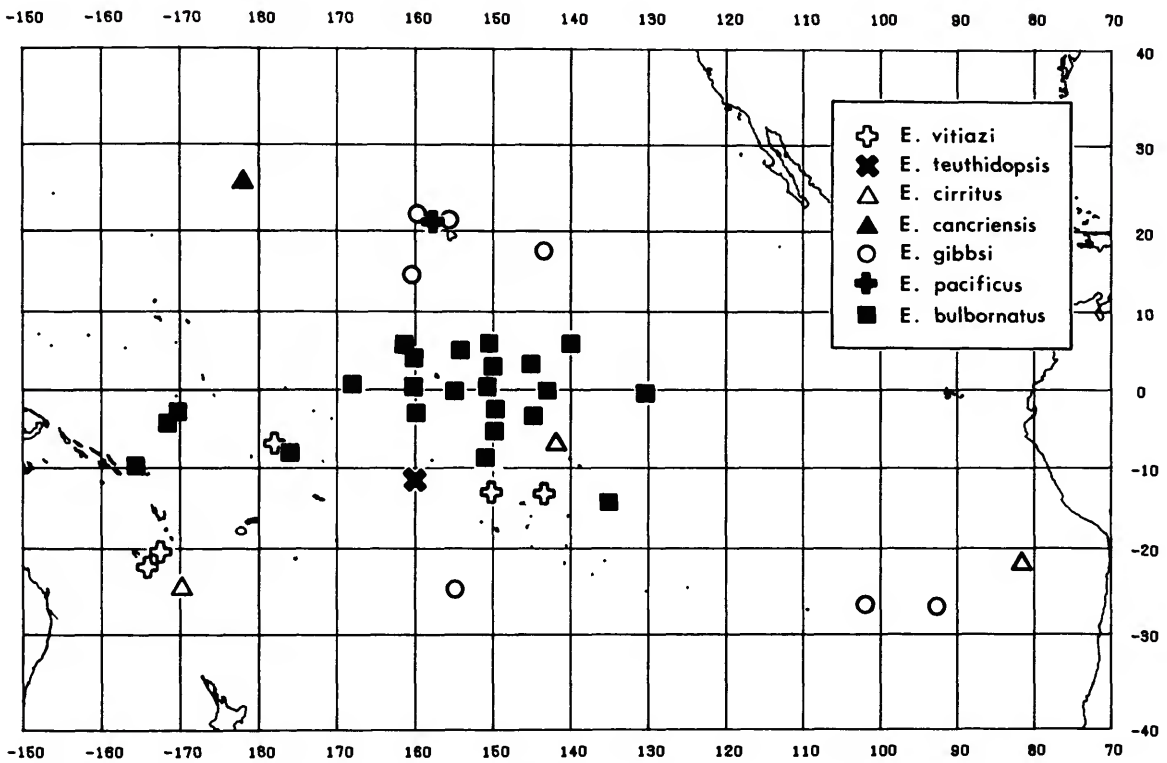


FIGURE 43.—Continued.

The only known specimen of *E. teuthidopsis* is from 11°S, 160°W. Two of the 3 known specimens of *E. cirritus* are from opposite sides of the Pacific from 21° to 24°S; the 3rd, an aberrant specimen (see species account), is from *bulbornatus* range at 07°S, 142°W. The last species, *E. australensis*, is known from a single specimen off southeastern Australia at 37°S. It could conceivably be an equatorial species, transported by southward flow of the East Australian Current; a less likely possibility, because the *Eltanin* and other recent expeditions did not take it, is that *E. australensis* is a Subtropical Convergence species.

As in the Atlantic, most of the overlap in Indo-Pacific species ranges is in equatorial waters, in this case mostly in the easternmost Indian Ocean and the westernmost Pacific, where *bulbornatus*, *crossotus*, and *melanostigma* occur, along with other species that are found in one or the other area, but not both. Subtropical species in the North Pacific have a common meeting ground in Hawaii, where 11 species are known to occur, but otherwise they appear to have ranges that are largely separate. In the western North Pacific, *E. cancriensis* has the most northerly distribution, followed in order to the south by *E. pacificus*, *E. medusa*, and *E. gibbsi*. East of Hawaii, *E. gibbsi*, *bibuloboides*, and *bituberoides* may co-occur. In the South Pacific, *E. vitiazi* and *E. teuthidopsis* are found closest to the equator, followed in order to the south by *E. cirritus*, *E. gibbsi*, and *E. australensis*.

Unlike the Atlantic, there are bipolar subtropical species in the Pacific: *E. gibbsi*, *E. bibulboides*, and *E. bimargaritoides*. The latter 2 are known mainly from Hawaii, with only 1 or 2 specimens from the South Pacific.

To establish the kind of picture of species dis-

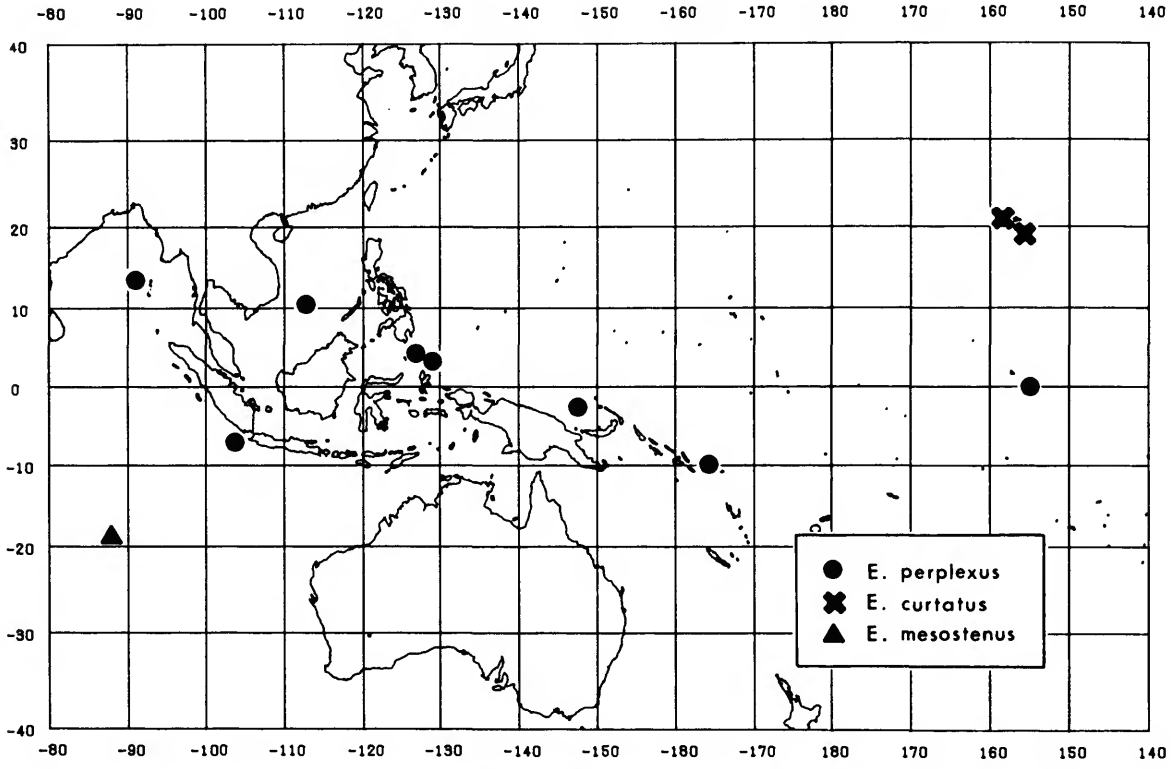


FIGURE 44.—Geographic distribution of Group V species.

tributions that is emerging for the Atlantic, a great deal more collecting must be done in the subtropical Indian and Pacific oceans, from most of which information is almost entirely lacking. Surveys using very large nets, such as the Engel trawl or Cobb trawl, would provide maximum catch in available time. A 2-month cruise across both the North and South Pacific using large nets would provide much of the basis for establishing reasonable zoogeographic conclusions. The same could be accomplished in a month's cruise across the subtropical Indian Ocean.

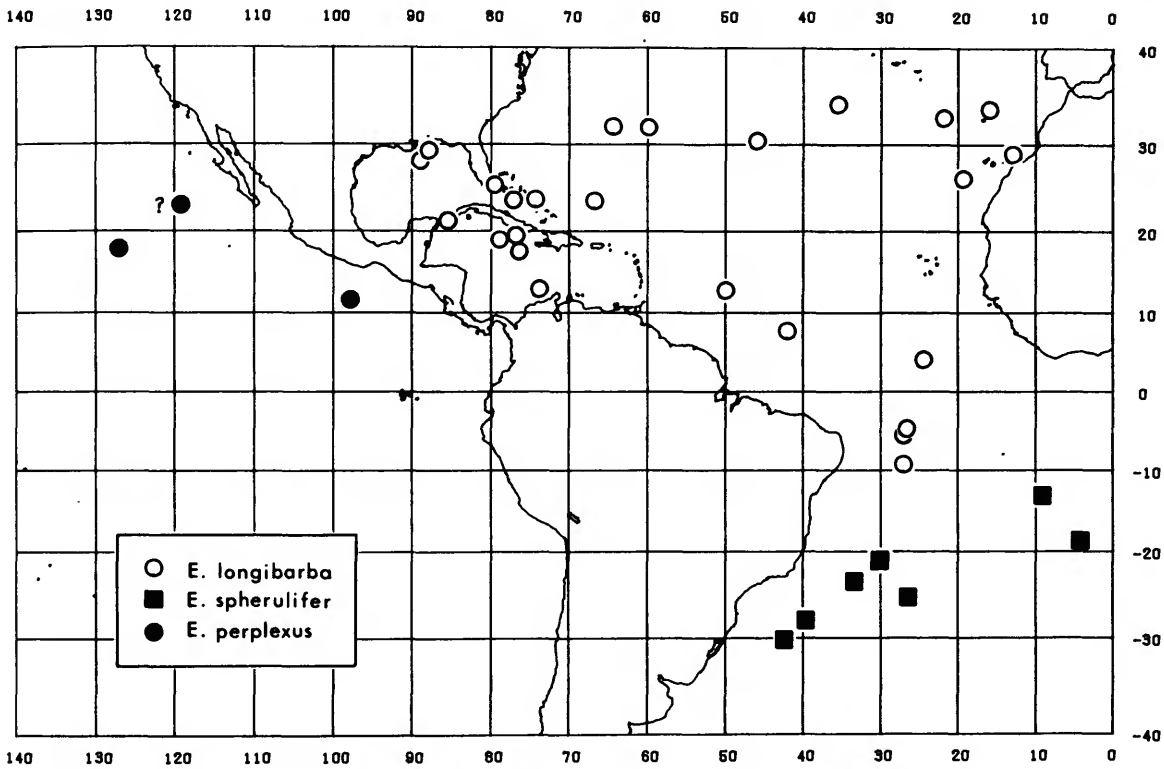


FIGURE 44.—Continued.

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TABLE 7.—Frequency distributions of fin-ray counts in the species of *Nominostomias*

Species	Dorsal								Anal										
	21	22	23	24	25	26	27	28	32	33	34	35	36	37	38	39	40	41	42	43
arborifer			2	6	8	6	4					1	7	7	5	1	2	1	1	
grandibulbus						1											1			
bimargaritatus				4	11	7					1	–	2	5	6	5	3			
bimargaritoides				4	2	1							1	2	2	1	1			
crossotus					4									1	4	–	–	–	–	1
bituberatus		1	1	2	1	1	1						1	1	4	–	–	1		
bituberoides			1	1	2	4	3							2	2	1	2	3	1	
micraster		1	2	2	8				1	–	–	1	2	3	2	1	2			
bibulbosus	2	6	10	10	3	3							6	12	11	5	1			
austratlanticus					1	–	1						1	–	–	–	–	1		
bibulboides				13	4	5	1						1	3	9	3	4	2	–	1
australensis			1										1							
orientalis				2									1	–	1					
appositus		1											1							
inconstans			1	6	3	1								4	4	1	1	1		
deofamiliaris						1									1					
multifilis			1								1									
melanonema			4	2	2	1						2	2	1	1	1	1			
melanostigma			3	3	3	3							1	5	3	2	1			
Ind-WPac *melanostigma*			2	2	3								1	2	1	1	2			
melanostigmoides			3	3	5	4								5	3	3	4			
medusa				5	2	4	3						3	2	3	2	3			
suluensis				1	1									1	–	1				
bertelseni				2	–	1							1	1	1					
kreffti			2	1	5	1				1	–	–	1	3	3	1				
posti				2	6	1							3	3	2	1				
vitiazi			1	1	–	1	–	1					1	1	–	–	–	1		
pacificus		1	3	3	3	1	1						1	3	3	2	2	1		
patulus				1									1							
teuthidopsis					1								1							
cirritus		1	–	–	2					1	–	–	–	–	1	–	1			
cancriensis			1	–	1								1	–	–	1				
longibarba			4	2	6	3						3	4	3	5	1				
spherulifer		1	1	3	1	1				1	1	1	1	3						
perplexus			1	5	1	1	1					3	1	2	2	1				
curtatus				5	11	5							1	3	8	4	3	1		
mesostenus				1							1									
gibbsi		1	1	6	11	2	1			1	–	3	8	5	2					
bulbornatus		3	7	21	15	6			1	1	10	24	9	8						

TABLE 8.—Frequency distributions of photophores in three sections of the ventral series in the species of Nominostomias (see Figure 1)

Species	PV								VAV							AC					
	29	30	31	32	33	34	35	36	15	16	17	18	19	20	21	15	16	17	18	19	20
arborifer				1	12	9	3	1		3	6	15	2					2	12	12	1
grandibulbus			1									1							1		
bimargaritatus				4	8	7	2			2	8	8	4					1	14	6	
bimargaritoides				1	1	5	1			1	4	2								3	2
crossotus		1	3	1									4	1				1	1	–	4
bituberatus				2	5	1						7	1						4	1	3
bituberoides			4	3	1							2	7	–	1				3	3	4
micraster	1	3	7	2							5	9							4	10	
bibulbosus		2	15	13						1	4	17	12					2	14	15	2
australanticus				1	1							1	–	–	1				1	1	
bibulboides			8	8	6						1	14	5	4					10	12	2
australensis						1						1							1		
orientalis				1	–	1						2								2	
appositus						1	1				2								1	1	
inconstans				1	8	1					1	6	3						3	5	2
deofamiliaris		1											1						1		
multifilis		1									1					1					
melanonema			2	1	5						2	4	2					1	2	3	2
melanostigma			1	4	4	3					3	6	2	1				1	5	5	1
Ind-WPac *melanostigma*				3	3						3	3	1						2	3	1
melanostigmoides				2	6	5				1	2	8	4						7	6	3
medusa				5	4	4					1	6	4	3				1	6	3	4
suluensis					2					1	–	1								1	1
bertelseni			1	–	2						2	1								2	1
kreffti		1	1	2	3	3				1	4	2	1	1				1	4	3	2
posti				4	1	4				1	4	4						1	2	3	2
vitiazi					1	2					2	1									2
pacificus					2	3	5	2			8	3	1						4	7	1
patulus					1							1								1	
teuthidopsis																					
cirritus					1	2					1	1							1	1	
cancriensis			1	1							1	–	1						1	1	
longibarba				2	9	4	1			4	7	6					1	3	6	6	1
spherulifer				2	3	2				1	2	3	1			1	–	–	5	2	
perplexus		1	2	2	5					1	3	4	2					1	6	3	
curtatus			1	–	9	11	6			2	10	9	5	1				1	10	12	2
mesostenus				1						1									1		
gibbsi			1	11	10	4			1	6	16	5	1				2	8	17	4	
bulbornatus				12	18	17	5			8	16	23	5	2			2	21	23	9	

TABLE 9.—Frequency distributions of photophores of the ventral series without AC (IA) and with AC (IC) in the species of *Nominostomias* (see Figure 1)

Species	IA									IC										
	53	54	55	56	57	58	59	60	61	69	70	71	72	73	74	75	76	77	78	79	80
arborifer				2	3	9	7	3	1						2	2	7	7	3	3	1
grandibulbus				1											1						
bimargaritatus					6	6	7	1								5	3	8	2		
bimargaritoides				1	1	3	2									1	–	2	2		
crossotus					3	2											1	3	1		
bituberatus					1	4	2										2	3	1	1	
bituberoides					1	6	1									1	1	2	3		
micraster	1	1	4	5	2								1	3	3	5	1				
bibulbosus		2	2	8	11	7						1	–	2	4	9	8	3	1		
australanticus						1	–	1									1	–	–	1	
bibulboides				2	5	6	2								1	3	4	4	1		
australensis							1											1			
orientalis					1	–	1										1	–	1		
appositus						1	1											2			
inconstans					1	6	3										3	3	4		
deofamiliaris					1											1					
multifilis		1								1											
melanonema				3	1	2	2							1	–	1	2	3	1		
melanostigma				1	3	4	2	1								3	4	1	3		
Ind-WPac *melanostigma*				1	3	2										1	4	1			
melanostigmoides					2	5	5									1	1	8	1	1	
medusa					1	4	7	1								1	3	4	2	2	
suluensis				1	–	1										1	–	–	1		
bertelseni				1	1	1										1	1	–	1		
kreffti			1	1	2	3	1							1	–	3	2	1	1		
posti				2	3	3	1								1	2	2	3			
vitiazi						3													2		
pacificus					2	1	5	3	1							1	1	3	4	1	2
patulus						1												1			
teuthidopsis																					
cirritus						2											1	1			
cancriensis				1												1					
longibarba				4	4	7	1								3	2	6	3	1		
spherulifer					4	2	1							1	–	3	2	–	1		
perplexus		1	–	1	6	2							1	–	2	2	4	1			
curtatus				1	4	8	8	3	1							1	5	7	8	1	
mesostenus			1											1							
gibbsi			1	10	9	3							1	4	8	6	4				
bulbornatus			1	4	8	15	16	3	2				2	–	4	13	12	12	2	3	

TABLE 10.—Frequency distributions of photophores in two sections of the lateral series in the species of *Nominostomias* (see Figure 1)

Species	OV								VAL							
	29	30	31	32	33	34	35	36	15	16	17	18	19	20	21	22
arborifer				2	9	9	4				4	8	13	2		
grandibulbus				1										1		
bimargaritatus			1	9	7	5					5	9	6	2		
bimargaritoides					2	4						6	–	1		
crossotus			3	1									3	1	1	
bituberatus	1	–	1	2	3	1						2	4	–	2	
bituberoides		1	2	4	2							1	6	4		
micraster	1	5	6	1							2	–	9	3		
bibulbosus		3	13	14	2						3	5	22	4		
austratlanticus				1	1								1	–	–	1
bibulboides		3	11	7	5							8	12	7	4	
australensis						1								1		
orientalis				1	–	–	1				1	–	1			
appositus						1	1				1	1				
inconstans			1	3	5	1						3	5	2		
deofamiliaris			1										1			
multifilis		1										1				
melanonema		1	1	3	1						1	2	4	1		
melanostigma			2	2	5	2	1					6	2	3	1	
Ind-WPac *melanostigma*			1	3	1						1	2	3	1		
melanostigmoides				2	5	7					1	6	7	2		
medusa				3	5	5	1				2	2	10	1		
suluensis				1	1							2				
bertelseni				1	2						1	2				
kreffti		1	–	1	4	3						6	3			
posti				3	3	3					1	5	3			
vitiazi				1	2							1	2			
pacificus					2	3	6	1				6	6			
patulus					1								1			
teuthidopsis																
cirritus					1	1							1			
cancriensis				1								1	1			
longibarba				2	7	7	1				7	4	6			
spherulifer				1	3	2					1	4	2			
perplexus				5	4	1					1	5	4			
curtatus				1	11	13	5	1		2	5	12	9	2		
mesostenus						1				1						
gibbsi			2	14	9	1				1	11	14	3	1		
bulbornatus				5	20	18	8	1	2	3	9	25	13	2		

TABLE 11.—Frequency distributions of photophores of the lateral series without AC (OA) and with AC (OC) in the species of *Nominostomias* (see Figure 1)

Species	OA									OC									
	47	48	49	50	51	52	53	54	55	63	64	65	66	67	68	69	70	71	72	73
arborifer					5	11	6	2								3	11	3	6	1
grandibulbus						1											1			
bimargaritatus			3	3	5	8	1							2	4	3	7	2		
bimargaritoides					1	4	1										1	1	2	
crossotus				1	2	1											2	2		
bituberatus			1	1	2	2	1								1	2	2	–	1	1
bituberoides			1	1	4	3								1	–	2	1	2	2	
micraster	1	2	2	6	2								1	2	5	4	1			
bibulbosus		1	7	8	11	3							1	4	6	8	5	4		
austratlanticus						1	–	1									1	–	–	1
bibulboides			1	8	3	4								1	4	5	1	3		
australensis								1											1	
orientalis					1	1											1	1		
appositus					1	–	1										1	1		
inconstans				1	3	6										1	4	5		
deofamiliaris				1											1					
multifilis		1								1										
melanonema		1	1	–	4							1	–	–	–	2	2	1		
melanostigma			1	1	2	4	2	1							1	3	2	3	2	
Ind-WPac *melanostigma*			1	2	2										1	2	2			
melanostigmoides					4	6	2										6	5	1	
medusa				1	3	5	4	1							1	1	3	5	2	1
suluensis				1	1											1	–	1		
bertelseni			1	–	2										1	–	1	1		
krefflti			1	1	2	4								1	–	2	3	2		
posti					7	2									1	1	3	3		
vitiazi				1	–	2											1	–	1	
pacificus						3	6	3									1	4	4	3
patulus						1												1		
teuthidopsis																				
cirritus							1												1	
cancriensis				1												1				
longibarba			1	1	5	8	1							2	–	3	8	3		
spherulifer				1	2	3									1	1	3	1		
perplexus			1	2	4	3								1	2	4	1	2		
curtatus		1	1	2	5	10	7	2	1					1	1	1	5	8	5	2
mesostenus				1											1					
gibbsi			10	4	8	1							4	7	6	5	1			
bulbornatus		2	1	3	13	20	7	2					2	2	6	19	8	8	2	

TABLE 12.—Frequency distributions of numbers of VAV photophores above the anal-fin base, branchiostegal photophores, and vertebrae in the species of *Nominostomias*

Species	VAV above anal fin					Branchiostegal					Vertebrae							
	4	5	6	7	8	9	10	11	12	13	64	65	66	67	68	69	70	71
arborifer			8	16	1	1	11	13	1				2	5	8	6	2	
grandibulbus				1				1						1				
bimargaritatus			9	11			10	6	2				1	4	2	2	1	
bimargaritoides			2	3			1	2	5					1	3	3	1	
crossotus				4	2		2	1	1					3	1	2		
bituberatus				5	2		1	4	1						2	1	1	
bituberoides				6			2	6	3					4	3	4		
micraster			5	9			5	6			1	2	3	2	2			
bibulbosus			8	19	2	4	17	12				3	9	9	5	2		
australanticus					1		1	–	1						1	–	1	
bibulboides			1	5	9		2	11	2				2	9	13	7		
australensis				1														
orientalis				2				2							1			
appositus				1			1	1						1	–	1		
inconstans			1	2	2		1	7						1	8	2	1	
deofamiliaris					1				1						1			
multifilis			1															
melanonema			2	5			1	3	4				2	2	–	1		
melanostigma			4	8			1	6	4					3	3	3		
Ind-WPac *melanostigma*			3	3	1		3	1	3				2	1	4			
melanostigmoides			2	9	1		4	6	2						11	1		
medusa			3	5	5		8	5						3	5	3	1	
suluensis			1	1				1	1					1	1			
bertelseni			3					2	–	1			2	1				
kreffti			4	3		1	1	4	1	2			1	3	5			
posti			3	5			4	3	2					3	3	1		
vitiazi				2		1	1	1	1						2			
pacificus			2	9			7	4	1						1	6	2	1
patulus							1								1			
teuthidopsis							1							1				
cirritus			1				2	1					2	–	1			
cancriensis				1	1					1		1						
longibarba			10	5	4	2	4	5	2				1	3	8	4		
spherulifer			7	5			2	1						3	1	5		
perplexus			2	5	1		3	4	1					4	3	1		
curtatus			1	3	1			3	2						8	2	4	
mesostenus	1							1						1				
gibbsi		2	11	1			1	6	7		1	5	3	2				
bulbornatus		1	14	8			1	14	13			1	3	5	2	1		

TABLE 13.—Range of variation of morphometric characters of all species of *Nominostomias* combined (based on all individual specimens and on species means where 4 or more specimens of a species were measured)

Character	Range (% SL)	
	Individuals	Species means
Predorsal length	77.5–86.6	82.2–84.5
Preanal length	64.1–77.3	69.7–72.9
Prepelvic length	50.2–64.9	53.3–59.1
Head length	8.3–15.0	11.4–13.3
Snout length	2.8–7.0	4.1–5.4
Fleshy-orbit length	1.4–4.0	2.3–3.3
Lower-jaw length	7.0–12.3	9.9–11.8
Upper-jaw length	7.0–12.4	9.1–11.0
Depth behind head	4.0–8.3	5.5–7.2
Greatest depth	4.1–12.3	5.0–8.6
Caudal-peduncle depth	1.0–2.4	1.5–1.8
Pectoral-fin length	4.0–20.5	11.9–16.2
Pelvic-fin length	5.8–17.2	12.1–14.8
Dorsal-base length	10.5–15.5	11.9–13.6
Anal-base length	20.3–30.0	22.5–27.3
Longest premaxillary tooth	0.9–2.5	1.5–2.1
Longest mandibular tooth	0.7–1.9	1.1–1.6

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