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REVISION OF THE CIRCUMTROPICAL SHOREFISH GENUS ENTOMACRODUS (BLENNIIDAE: SALARIINAE)

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Introduction

This revision is one of a series of studies on tropical blennioid fishes, a group which has engaged my attention since 1952. The purpose of these studies is to clarify the systematics, relationships, and nomenclature of the families, genera, and species included in the group.

The genus *Entomacrodus* is worldwide in distribution and occurs along the rocky and coral reef shores of primarily tropical and subtropical seas. The species are small, shallow-water, and bottom-dwelling forms. Of the 22 species included in the genus, 5 are here described as new, and 1 was recently described by me (1966) as a result of my study. If the state of our knowledge of other blenniid fishes is similar to that of *Entomacrodus*, then approximately 30 percent of the species remain to be described.

No comprehensive study of the genus *Entomacrodus* has been made, although Chapman (1951) and Schultz and Chapman (1960) revised certain of the Indo-Pacific species. My study, based on all the specimens available to Schultz and Chapman, and a large number of additional specimens resulting from increased collecting in recent years, is considerably different from previous studies. This difference is due not only to the increased amount of material, but also to a reinterpretation of the published data and my employment of additional taxonomic characters.

A large number of individuals and institutions aided me by providing specimens or laboratory space. To these I am greatly indebted, for without their consideration my study could never have progressed this far. To the following institutions and their personnel, responsible for the assistance I received, I extend my sincere appreciation (abbreviations as indicated are used throughout the text):

AMNH	American Museum of Natural History, D. E. Rosen
AMS	Australian Museum, F. H. Talbot
ANSP	Academy of Natural Sciences of Philadelphia, J. E. Böhlke
BMNH	British Museum (Natural History), P. H. Greenwood, A. C. Wheeler
BPBM	Bernice P. Bishop Museum, E. H. Bryan, Jr., J. E. Randall
CAS	California Academy of Sciences, W. I. Follett, L. P. Dempster
CNHM	Chicago Natural History Museum [now Field Museum], L. P. Woods, P. Sonoda
CU	Cornell University, E. C. Raney
IFAN	Institut Français D'Afrique Noire, J. Cadenat
IRSN	Institut Royal des Sciences Naturelle de Belgique, J. P. Gosse
LACM	Los Angeles County Museum, D. K. Caldwell
MCZ	Museum of Comparative Zoology, G. Mead, M. Dick
MNHN	Museum National D'Histoire Naturelle, M. L. Bauchot
RMNH	Rijksmuseum van Natuurlijke Historie, M. Boeseman
RU	Rhodes University, Department of Ichthyology, J. L. B. Smith
SIO	Scripps Institution of Oceanography, R. H. Rosenblatt
SU	Stanford University, Division of Systematic Biology, G. S. Myers, W. C. Freihofer
UBC	University of British Columbia, N. J. Wilimovsky, I. E. Efford
UCC	University of Corpus Christi, H. H. Hildebrand
UCLA	University of California, Los Angeles, B. W. Walker, W. J. Baldwin
UF	University of Florida, C. R. Gilbert
UH	University of Hawaii, W. A. Gosline, R. H. Snider
UMML	University of Miami, Institute of Marine Science, C. R. Robins
UMMZ	University of Michigan, Museum of Zoology, R. M. Bailey
UPR	University of Puerto Rico, J. E. Randall
USNM	United States National Museum
UW	University of Washington, R. Van Cleave
UZMK	Universitetets Zoologiske Museum (Kobenhavn), J. Nielsen
WAM	Western Australian Museum, R. McKay
ZSZM	Zoologisches Staatsinstitut und Zoologisches Museum (Hamburg), C. Kosswig

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I am especially indebted to Dr. W. A. Gosline for many valuable and stimulating discussions and suggestions concerning Pacific fish distributions. He also generously arranged with his students and colleagues in Hawaii for a collecting trip which provided significant material of the new Hawaiian species described below.

A trip to Dominica, B.W.I., sponsored by the Bredin-Archbold-Smithsonian Biological Survey of Dominica, afforded me the opportunity of collecting and observing *Entomacrodus nigricans* in the field. A large number of my central Pacific specimens of *Entomacrodus* were obtained through the efforts of the Smithsonian Pacific Biological Survey Program under the direction of Dr. P. S. Humphrey.

The drawings of the fishes were made by the following illustrators: Sharon L. Lesure (pls. 1, 2, 4–6, 8, 12–16, 18, 19, 21, 22, 25–30), Fanny L. Phillips (pls. 9, 11), Carolyn B. Gast (pls. 20, 24), and Peter McCrery (pl. 23).

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Methods

Measurements.—When possible, I made all measurements on the left side of each specimen, using a pair of needlepoint dividers that were marked off on a ruler graduated in half millimeters. I estimated to the nearest tenth millimeter. Later in the study, a set of needlepoint dial calipers measuring directly to the nearest tenth millimeter was employed. Over 100 comparisons of the two methods of measuring were made; differences ranged from 0 to ± 0.4 mm, the largest involving the longest measurements. These differences were not considered significant for the purpose of this study.

Tables of routine measurements are given for each taxon treated and are to be considered part of the description. In many instances there is no discussion of tabular material although the proportions frequently indicate significant changes correlated with standard length or indicate characters that show species differences. It will occasionally be necessary to compare all or many of these tables for a particular character (for example, caudal length) in order to note meaningful key characters for a species. For some characters (e.g., eye diameter, table 3, and supraorbital cirrus length, table 4), I have made many more measurements than are included in the tables of routine measurements.

Standard length (SL): Taken from the midtip of the upper lip to the midlateral posterior margin of the hypural vertebra as indicated externally on the specimen.

Head length (HL): Taken from the midtip of the upper lip to the posteriormost point reached by the fleshy margin of the opercle, exclusive of the branchiostegal membrane.

Orbital length (OL): The horizontal diameter between the fleshy rims of the orbit. This character decreases strikingly in relative size with increase in SL. The species vary noticeably from each other. I have attempted to illustrate this variation in table 3.

Supraorbital cirrus length (OCL): The distance from the lateral point where the base of the cirrus joins the conjunctiva of the eye to the most distal point reached by the cirrus (the cirrus thus measured is the main, or longest, supraorbital cirrus; other cirri on its margins are branches). This measurement and the next are taken while the cirri are wet (the cirri shrink considerably when dried even slightly).

Nuchal cirrus length (NCL): The longest measurement from the midbase of the cirrus to the distalmost tip of the cirrus. In those specimens where the nuchal cirri arise on each side from two separate bases, the measurement was made from that base supporting the longest cirrus.

Third dorsal spine length (DS3): From the proximalmost point of the posterior axil, formed by the spine with the body contour, to the distal tip of the spine, disregarding the normal curvature of the spine.

Thirteenth dorsal spine length (DS13): Similar to DS3.

First dorsal ray length (DR1): Similar to DS3.

Pectoral fin length (PECL): The length of the longest ray.

Pelvic fin length (PELL): Taken from the internal, proximalmost point of attachment of the fin to the body to the tip of the longest ray.

Caudal fin length (CL): The length of the longest ray.

Humeral blotch length (HBL): The longest horizontal distance between the anterior and posterior margins of this marking. Where this blotch is composed of two portions, the measurement is taken of the posterior marking.

Counts.—All counts of bilaterally paired structures were made on the left side of each specimen when possible. Where population or growth differences warrant it, I have given frequency distribution tables of the variation in particular counts. For the sake of convenience of species comparison I have also given summary tables of fin ray, vertebrae, gill-raker and pseudobranchial filament counts in which all the counts for a given character for a given species have been combined (tables 1 and 2).

Dorsal fin spines: A count of the bases of the unsegmented elements. The posteriormost spine (usually the 13th) is frequently visible only in skeletal preparations or on radiographs. This element when not obvious is assumed to be present when a space exists between the spinous and rayed portions of the fin greater than that separating the 11th and 12th dorsal spines.

Dorsal fin rays: A count of the bases of the segmented rays.

Anal fin rays: Two methods of counting the segmented anal rays are employed, method A and method B. In most specimens of most species the terminal "ray" consists of two elements, the posteriormost considerably reduced, closely applied to the next element anterior and difficult to see. Radiographs or skeletal preparations show that these two elements are supported by a single proximal pterygiophore; this condition is called "S" (split through base). In another condition (typical in some species), the terminal ray is removed from the next element anterior and the terminal proximal pterygiophore supports a single segmented ray; this condition is called "N" (not split). In method A counts, the split and unsplit conditions are not differentiated. Thus the two terminal elements, if supported by a single pterygiophore, or the terminal element, if supported separately, are counted as one. In method B counts, split elements are tallied as two. Method B counts, of course, will result in higher averages than method A counts. In those species which typically exhibit the S condition, individuals with counts one ray more than the modal value (using method A) usually prove to be of the N type. What has happened, then, is that a pterygiophore has been added at the end of the fin, and where the terminal pterygiophore normally supported two elements, the posteriormost element has become associated with the added pterygiophore (or conversely, a pterygiophore was lost and the posteriormost element has become associated with the next pterygiophore anterior). Determination of the N or S condition may be difficult with some specimens. I have checked several hundred of my determinations made externally on specimens with radiographs of the same specimens and found my error to be less than one percent.

The question arises as to which of the anal fin ray counts should be used for systematic purposes—method A or method B. In other words, should one count pterygiophores or fin rays? Unless otherwise noted, anal fin ray counts reported herein refer to method A counts. Method A counts are simplest to make, are those which have generally been employed in the literature of salarine blennies, and are the ones naturally made when uninstructed individuals count anal fin rays of salarines. Investigators who try to determine ecological effects on anal fin ray counts of salarine blenniids should test their data for both method A and method B type counts.

Vertebrae: Total count of centra including that of hypural vertebra, taken from radiographs. The caudal vertebrae are those which bear a haemal spine.

Superaorbital cirri: The number of free tips, all branches included, of the cirri above the eye. The cirri generally have a common transverse base. Counts of lateral or mesial cirri exclude the tip of the main or longest cirrus (see measurements above) and include only those cirri on the lateral or mesial margins of the main cirrus.

Nuchal cirri: The number of free tips, all branches included, of cirri on the side of the nape.

In some specimens (for example all *E. macrospilus*) the nuchal cirri are absent. The normal position for nuchal cirri can be recognized by the position of a pair of pores on each side of the nape. These pores lie on a slight transverse depression (constriction) which more or less separates the head from the body dorsally. In specimens with nuchal cirri the pores are just lateral to the cirri.

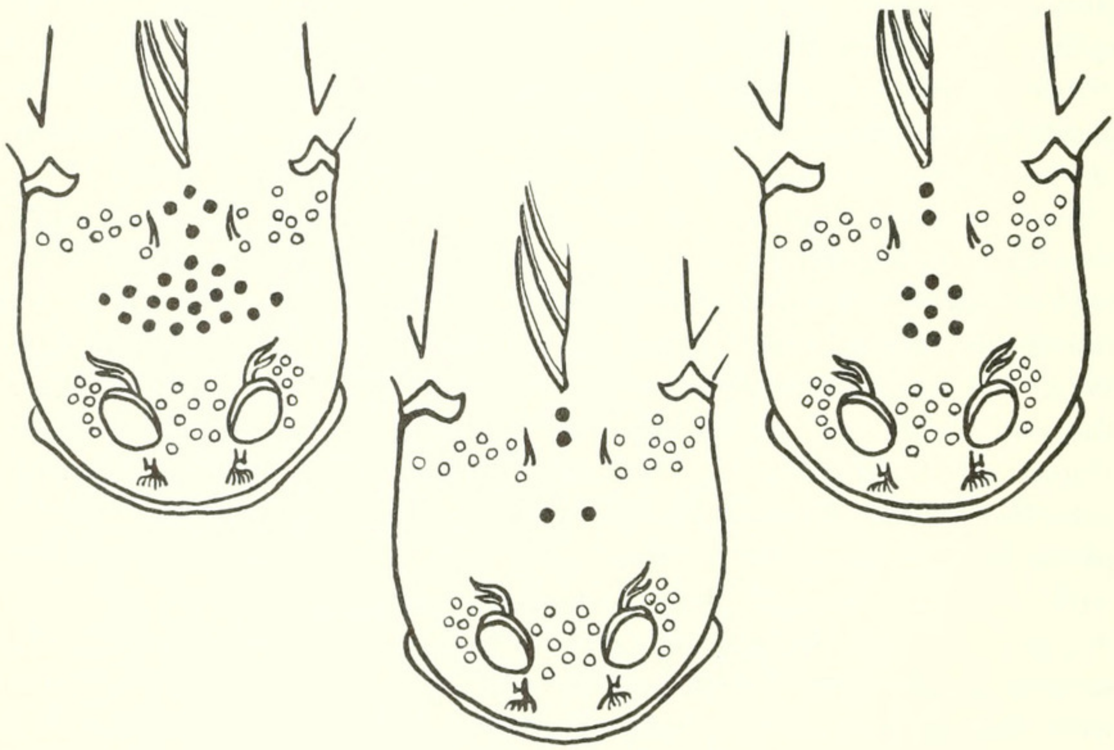

FIGURE 1.—Diagrammatic illustration of pores included in predorsal commissural group (solid dots) and other pores (open dots).

Predorsal commissural pores (fig. 1): A count of all pore openings in the region anterior to the first dorsal spine and between the bases of the nuchal cirri, extending anteriorly on top of the head a distance usually about one-half the head length or less. Anterior to the level of the nuchal cirri the area occupied by the pores frequently spreads laterally in both directions and covers an expanse broader than the internuchal cirri distance; all pores anterior to the nuchal cirri in this midregion are included in the count. In some specimens this is a difficult count to make. Overlying mucus must be removed and drying of the area is recommended. Inserting a tiny insect pin into each pore will greatly facilitate making counts.

Preopercular series of pores (fig. 2): For the purposes of this study, the first pore position is dorsalmost and occurs at about the level of the greatest horizontal distance between the posterior margins of the preopercle and opercle, excluding the branchiostegal membrane. The pore positions in most specimens number six, describing an arc between the first and last positions. The last pore position (ventral and anteriormost) is just ventral to the posterior corner where the membranous margins of the lips meet. Dorsal to the first pore position are a group of scattered pores. Some difficulty may be encountered in deciding which is the first pore position. Examination of the illustrations of the species should facilitate this decision. The pores at the various positions may be simple (one pore), paired (two pores connected more or less horizontally by a canal), or in multiples (more than two pores

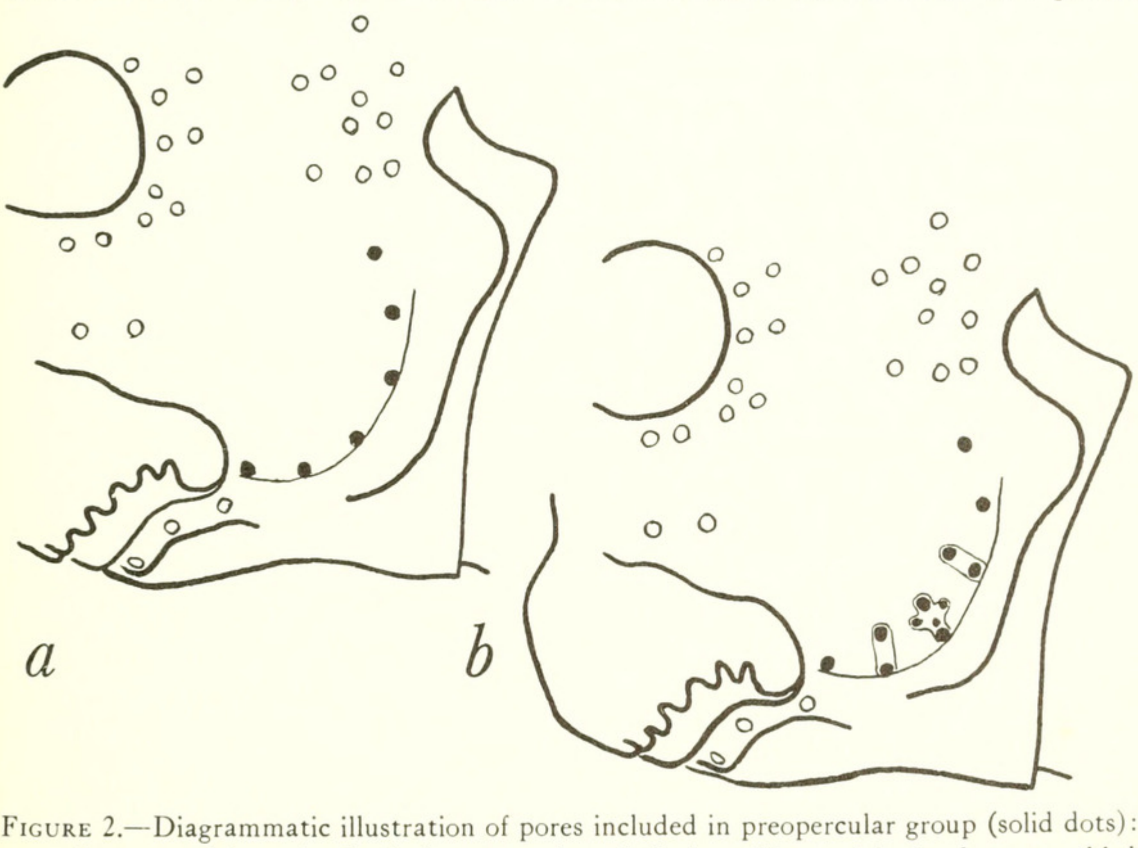

FIGURE 2.—Diagrammatic illustration of pores included in preopercular group (solid dots): *a*, all pore positions simple; *b*, first, second, and sixth positions with simple pores, third and fifth positions with paired pores, fourth position with multiple pores.

connected to a common canal). A count of the number of these three types of conditions at the pore positions is a useful taxonomic character.

Pores before anterior nostril: A count of the number of pore openings closely adjacent and more or less anterior to the anterior nostril.

Lateral line pores: Anteriorly the lateral line pores open into a continuous canal; posteriorly, on the midside, the pores occur in more or less regular, separated pairs, the members of a pair joined by a short canal. Large or small gaps in the occurrence of some pore pairs should be ignored in determining the level of occurrence (usually below a dorsal fin element) of the posteriormost pair of pores. Frequently, the posteriormost pair of pores is well removed from the others. Posterior to the last pair of pores there usually occurs what appears to be a series of simple pores. Close examination will show that these are merely shallow depressions or pits.

Lip crenulae (table 5): The number of small lobulations on the ventral margin of the upper lip. Some crenulae are broad, others very shallowly separated and scarcely distinct. If there is a doubt, the internal surface of the lip will sometimes exhibit the mucosal lining organized into pads corresponding to crenulations, and these may be counted instead of the crenulae. Counts of crenulae are unreliable where numerous irregularities occur on the lip.

Color pattern descriptions.—The word "dusky" denotes a dark area relative to the palest surrounding areas. Usually a dusky area consists of a concentration of nonimpinging black melanophores that may not be individually recognizable to the naked eye.

Plates.—The drawings of the complete lateral views of specimens are all made to a base total length of 6½ inches and are reproduced here 1:1. The head measurements were made as projections, rather than from point to point. For this reason, measurements of the head taken from the illustration will give different relative values from those which would be obtained if actual specimens were measured point to point. All efforts were made to obtain accuracy and completeness in representing the specimens drawn. All pore openings visible from the view drawn are included except those of the anterior continuous portion of the lateral line, which were impossible to determine accurately. The inserted drawing of the upper lip on each plate portrays the lip with its laterally, posteriorly projected portions expanded anteriorly. The snout region of the head in blenniids is fleshy and relatively soft, and the shape is variable in some degree. This apparent variation is increased because of the position in which the specimens were held when the artist drew the head contours. Some allowance should thus be made when comparing actual specimens with the drawings. Finally, because only one specimen has been illustrated from a particular population, some allowance must be made for natural variation, which is particularly great in color pattern.

Entomacrodus Gill

Entomacrodus Gill, 1859, Proc. Acad. Nat. Sci. Philadelphia, vol. 11, p. 168. [Type-species: *E. nigricans* Gill, monotypy.]

Salarichthys Guichenot, 1867, Mem. Soc. Sci. Nat. Cherbourg, vol. 13, pp. 96–100. [Type-species: *Salarias vomerinus* Valenciennes, original designation.]

Giffordella Fowler, 1932, Proc. U.S. Nat. Mus., vol. 80, no. 6, pp. 14–15. [Type-species: *G. corneliae*, original designation.]

Description.—Dorsal fin spines 13 (rarely 12 or 14); dorsal fin rays 13–18; anal fin spines 2; anal fin rays 14–19 (see methods); segmented caudal fin rays typically 13 (7 rays on upper half of hypural vertebra, 6 on lower half), typically 2 most dorsal and 2 most ventral rays simple, central 9 rays branched; pectoral fin rays 12–15 (14 in over 90 percent of specimens of all species); pelvic fin rays I,4; total gill-rakers on first arch 9–30 (number increasing with increase in SL in some species); pseudobranchial filaments 3–17 (number increasing with increase in SL in some species); vertebrae, including hypural, 33–36; 11th vertebra always bears first haemal spine; supraorbital cirri 1–38 (number increasing with increase in SL in some species); nuchal cirri 0–20 (rarely lacking cirri on both sides except in *E. thalassinus* and *E. macrospilus;* number increasing with increase in SL in some species); cirri present on posterior margin of tube rim of anterior nostril; predorsal commissural pores 2–69 (normally 3 or more, increasing in number with increase in SL in most species, constant in only one species); preopercular series of pores occupying 6 positions (rarely 5 or 7) and varying from all positions with simple pores to all positions with pairs or multiples of pores; pores before each anterior nostril 1–7; posterior nostrils present; paired, or multiples of, pores in circumorbital series at at least one position (usually along dorsoposterior margin of orbit); lateral line pores on body side continuous (sometimes with short side branches anteriorly) and arched in area above appressed pectoral fin, composed of short disconnected bipored tubes on midside, terminating posteriorly in area below and between posterior dorsal spines and caudal fin origin; over 100 freely movable teeth supported by each pair of premaxillaries and dentaries (more on premaxillaries than dentaries), implanted in connective tissue (rather than on bones of jaws); a relatively small to large recurved canine (rarely absent) inserted posteriorly on each articular bone; 1–11 short, truncate teeth on vomer (rarely absent, frequently easily removed); 6 branchiostegals; 4 pectoral fin radials (none fused together); 2 postcleithra; posttemporal forked; basisphenoid present; 5 circumorbital bones (dorsalmost is probably the dermosphenotic); interopercle reduced, internal to preopercle, well removed from subopercle, not extending posterior to connection with epihyal; premaxillary concave ventrally (to accept dental plate); dentary concave anteriorly (to accept dental plate); ascending wing of parasphenoid reaching descending wing of frontal; pterosphenoid and prootic excluded from orbit by ascending wing of parasphenoid; no pharyngobranchials; one upper pharyngeal bone on each side, bearing several strong, pointed teeth; 2nd, 3rd, and 4th epibranchials attached to upper pharyngeal bone.

Moderately small (to 153 mm SL) fishes with a deeply incised dorsal fin between spinous and rayed portions; first spine over opercle;

posteriormost dorsal segmented ray well anterior to caudal fin base, although bound by dorsal fin membrane to caudal peduncle or proximal portion of caudal fin. Longest dorsal ray usually longer than longest dorsal spine; posteriormost dorsal spine shortest dorsal element, greatly reduced and frequently visible only on skeletal preparations and radiographs; posteriormost dorsal ray shortest. Interradial membrane not incised between dorsal spines or between rays. First anal spine inserted below level of fourth to second posteriormost dorsal spine; posteriormost segmented anal ray inserted below level of third to second posteriormost dorsal segmented ray, not bound to body. Anal spines shorter than anal rays; interradial membrane incised up to one-half distance to base between spines and between rays, except for membrane between posteriormost 1–3 rays. Pectoral fin with longest ray on lower half (usually fifth or sixth ray from bottom); interradial membrane shallowly incised between lower 4–6 rays; lower rays thicker, stronger, than upper rays. Pelvic fin spine not visible externally, second from lateralmost ray longest, medialmost ray shortest, membrane incised only between lateralmost two rays. All fin rays, except central rays of caudal, normally simple, some ray tips of the dorsal, anal or pelvics shallowly bifurcate in some large specimens of some species.

Tip of snout ventral and anterior to anteriormost margin of orbit; gill opening complete, extending from one side to the other across the ventral body surface; no thin, fleshy, well-elevated crest on top of head; ventral margin of upper lip entire to completely crenulate (entire in only two species); free dorsal margin of upper lip incomplete, absent across snout.

SEXUAL DIMORPHISM.—Males: Anal papilla small, just posterior to anus and anterior to first anal spine; both anal spines distinct, the anterior slightly shorter than the posterior; skin of anal spines and as many as four anteriormost rays becoming swollen, fleshy, rugose, or plicate in presumably mature specimens. Flesh of dorsal portion of head becoming thickened, swollen in appearance, sometimes forming a low distinct fold medianly, never very prominent. Color pattern frequently darker, frequently more uniform than that of females in same collection. Supraorbital cirri frequently relatively longer than cirri of females from same collection. Females: Anal papilla present, included posteromedianly in a fleshy, posteriorly directed swelling behind anus; swelling incorporating much reduced first anal spine (frequently visible only in skeletal preparations or on radiographs); first anal spine frequently visible in young females. Flesh of head not thickened or swollen; head without median fold.

Several of the taxa considered here (see *E. s. lighti*, *E. epalzeocheilus*, *E. strasburgi*, *E. cadenati*, *E. t. longicirrus*, and some populations of *E. decussatus*) exhibit sexual dimorphism in average numbers of segmented dorsal rays. Other taxa either do not show such differences or the data are inconclusive. In all taxa where such sexual dimorphism occurs, males tend to average more rays than females. In all species, exceptionally high dorsal counts were usually from males and low counts from females. Dimorphism in other meristic characters was not noted.

The species dwell in shallow water, in tide pools, along reefs, or rocky shores and are essentially circum- and subtropical in distribution.

In all species of *Entomacrodus*, except *E. vermiculatus*, *E. niuafoouensis*, and *E. nigricans*, for which there were sufficient data, males attained a larger size than females, and the largest specimen in any given collection was usually a male. In the first two named exceptions, females attained a larger size than males, and in the latter exception the sexes attained equal size. In general, however, males averaged larger than females. Overall sex ratios in the different species were quite variable, and generalizations cannot be made.

Intrafamilial relationships.—The genus *Entomacrodus* is a member of the family Blenniidae and belongs in the subfamily Salariinae as defined by Norman (1943). (Norman's subfamily Ophioblenniinae is a synonym of the Salariinae; the former was based on specimens now known to be larval stages of salarines.) The genera of the Salariinae, with the exception of *Rhabdoblennius* Whitley and allied genera, are characterized primarily by the nature of the attachment of the teeth on the jaws. The very numerous teeth of the dentaries and premaxillaries are loosely held in each jaw in a thick band of connective tissue which is attached to the bone. The dentaries and premaxillaries have a concave surface where the connective tissue is attached. The arch of the bone encompassing the connective tissue and lying external to the bases of the teeth has been termed a "crest" by Norman. In the other subfamily of the Blenniidae (the Blenniinae), the teeth of both jaws are relatively few and firmly implanted on the bone. In *Rhabdoblennius* and allies, the premaxillary and dentary teeth are relatively few. The premaxillary teeth, while held to the jaw only by connective tissue, are tightly associated with the bone. The dentary teeth, in contrast, not only are held to the jaw by connective tissue, but some also are loosely inserted in openings in the dentary bone.

The genera and species of the Salariinae are poorly known and a meaningful discussion of relationships of the genera is not possible at present. *Entomacrodus* usually has been distinguished from all other salarine genera by the presence of teeth on the vomer; however, Smith (1959) described *Pereulixia*, which has vomerine teeth, and I have seen specimens of undescribed salarine genera with vomerine teeth. *Hirculops* Smith (1959), also with vomerine teeth, is related to *Rhabdoblennius*. The combination of characters given in the generic description above will serve to separate *Entomacrodus* from all other described blennioids.

Schultz and Chapman (1960) believed *Fallacirripectes* Schultz and Chapman to be intermediate between *Entomacrodus* and *Cirripectes* Swainson. I believe that *Fallacirripectes* is the genus most closely related to *Entomacrodus*. *Fallacirripectes* differs from *Entomacrodus* in having typically 15, rather than 14, pectoral rays, fewer dorsal spines, fewer segmented dorsal and anal rays, and no vomerine teeth. (Although I have seen no specimens of *Stanulus* Smith (1959), it appears probable that *Fallacirripectes* is a junior synonym of *Stanulus*).

Intrageneric relationships.—I recognize seven species groups within *Entomacrodus*. My recognition of these groups is influenced greatly by the nature (or absence) of the upper lip crenulae and secondarily by other characters. I am unable to delimit intergroup relationships as I do not know which characters are specialized or unspecialized, primitive or advanced. There is no fossil record of the Blenniidae to serve as a guide.

The species groups I recognize are characterized as follows:

1. *thalassinus* group (*E. thalassinus*, *E. macrospilus*). Smallest species, lacking crenulae on the upper lip. Indian, western and central Pacific Oceans.

2. *nigricans* group (*E. sealei*, *E. corneliae*, *E. chiostictus*, *E. caudofasciatus*, *E. nigricans*, *E. textilis*, *E. cadenati*, *E. vomerinus*). Relatively small species, the lateral thirds of the upper lip crenulate and the central portion entire. Circumtropical.

3. *stellifer* group (*E. stellifer*). Relatively large species, the middle third of the upper lip crenulate and the lateral thirds entire. Western Pacific Ocean.

4. *rofeni* group (*E. rofeni*). Relatively small species, the upper lip completely crenulate, high dorsal ray, anal ray and vertebral counts, constantly three pores in the predorsal commissural group, and the dorsal fin free from the caudal. Central Pacific Ocean.

5. *cymatobiotus* group (*E. cymatobiotus*, *E. strasburgi*, *E. chapmani*). Relatively small species, the upper lip completely crenulate, generally low meristic counts, and the dorsal fin free from the caudal. Western and central Pacific Ocean.

6. *striatus* group (*E. striatus*, *E. marmoratus*, *E. randalli*, *E. epalzeocheilus*, *E. niuafoouensis*). Relatively large species, the upper lip completely crenulate, generally high meristic counts, and the dorsal fin free from the caudal.

7. *decussatus* group (*E. decussatus*, *E. vermiculatus*). Largest species, having the upper lip completely crenulate in adults, generally high meristic counts, dorsal fin attached at, or posterior to, the caudal base. Indian, central and western Pacific Oceans.

Zoogeography.—Some aspects of this topic are discussed under the individual species accounts (see especially "Relationships" under *E. chiostictus*). There is a decreasing number of species of *Entomacrodus* in the various oceans as one progresses westward from the central Pacific Ocean around the world to the eastern Pacific Ocean (table 6). If one subscribes to the hypothesis that the center of origin of a particular taxonomic group is the area where the most species of that group occur, then the central Pacific Ocean is the area of origin of *Entomacrodus*. The central Pacific is also the only area where as many as six species (fig. 3) have been taken at a single locality. Ekman (1953, p. 18) has stated that the Indo-Malayan (Indonesian) region (here comprised of portions of the Indian Ocean and western Pacific areas of table 6) is the area from which adjacent regions derived their marine shore faunas; however, Ladd (1960), on the basis of geologic evidence, fossil molluscan faunas, and present meteorological conditions, postulated that the Indonesian area received its marine shore fauna by invasion from the central Pacific Ocean. Actually, the distribution of the species of *Entomacrodus* does not support an Indonesian origin as opposed to a central Pacific origin of the genus. If one eliminates from consideration the isolated island species of *Entomacrodus*, there are eight species found in the central Pacific and probably eight occurring in Indonesia (assuming that *E. niuafoouensis*, which has been recorded from the Indian and western Pacific Oceans but not Indonesia, probably does or did occur in Indonesia). There are six species common to both areas; this leaves two species in each area which do not occur in the other.

None of the areas of table 6 have representatives of all the species groups of *Entomacrodus*. The eastern Pacific and eastern and western Atlantic are all occupied by the same group, *nigricans*. The Indian ocean has four groups, and the central and western Pacific areas each have six groups. The central and western Pacific areas together have all seven groups. In spite of the lack of definitive data to support a contention that some portion of the Old World tropical Pacific is the area of origin of *Entomacrodus*, I find it difficult to believe otherwise.

Nine of the 15 central and western Pacific Ocean species of *Entomacrodus* have their entire distribution either along or near a line circumscribing the periphery of the tropical-subtropical portions of the area (fig. 4: the basis for the construction of the line is the distribution of the Pacific coral reefs as given by Wells, 1957, except that

TABLE 1.--Frequency distributions of number of segmented dorsal and anal fin ray elements and vertebrae (data combined for all specimens of each taxon) of species and subspecies of *Entomacrodus* (for meaning of methods A, B and N or S, see methods section)

Species and subspecies	Dorsal rays						Anal rays, method A						Anal rays, method B							Percent		Vertebrae			
	13	14	15	16	17	18	14	15	16	17	18	19	14	15	16	17	18	19	20	N	S	33	34	35	36
decussatus	-	-	-	40	115	3	-	-	1	9	126	17	-	-	-	1	14	124	14	4.5	95.5	-	4	82	2
vermiculatus	-	-	1	45	10	-	-	-	1	6	52	-	-	-	-	1	19	39	-	21.4	78.6	-	2	29	-
s. stellifer	-	-	2	19	4	-	-	-	-	4	19	2	-	-	-	3	15	7	-	80.0	20.0	-	-	14	6
s. lighti	-	-	57	31	-	-	-	-	2	49	36	-	-	-	1	33	49	4	-	74.8	25.2	-	10	41	3
marmoratus	-	1	57	33	-	-	-	1	51	41	-	-	-	1	4	81	7	-	-	38.6	61.4	-	38	10	-
epalzeocheilus	-	2	49	17	-	-	-	1	35	32	-	-	-	-	5	56	7	-	-	42.6	57.4	1	32	1	-
niuafoouensis	-	-	17	17	-	-	-	-	19	15	-	-	-	-	4	26	4	-	-	44.1	55.9	-	26	1	-
randalli	-	-	4	7	-	-	-	-	2	9	-	-	-	-	1	7	3	-	-	63.4	36.6	-	8	1	-
striatus	-	6	331	384	4	-	-	3	246	467	10	-	-	-	35	533	156	2	-	49.2	50.8	2	123	2	-
rofeni	-	-	-	12	1	-	-	-	-	1	12	-	-	-	-	-	7	5	-	46.2	53.8	-	-	12	-
strasburgi	1	15	22	-	-	-	-	-	35	3	-	-	-	-	7	29	3	-	-	18.0	82.0	-	24	3	-
cymatobiotus	11	116	11	-	-	-	-	4	117	16	-	-	-	-	8	120	9	-	-	8.0	92.0	1	19	-	-
chapmani	-	12	14	-	-	-	-	6	19	1	-	-	-	-	11	15	-	-	-	23.0	77.0	-	3	-	-
sealei	1	17	91	5	-	-	-	5	97	12	-	-	-	-	8	99	7	-	-	7.0	93.0	2	21	-	-
corneliae	1	6	6	-	-	-	-	-	9	2	-	-	-	-	2	9	-	-	-	36.8	63.2	-	8	-	-
chiostictus	-	105	423	3	-	-	-	26	471	27	-	-	-	-	40	465	19	-	-	4.0	96.0	8	89	2	-
vomerinus	-	-	16	101	9	-	-	1	4	96	25	-	-	1	-	11	96	18	-	11.9	88.1	-	5	57	5
textilis	-	11	60	-	-	-	-	8	63	-	-	-	-	1	12	58	-	-	-	8.4	91.6	-	10	-	-
cadenati	-	19	71	2	-	-	-	1	58	33	-	-	-	-	3	78	11	-	-	25.0	75.0	-	42	-	-
nigricans	1	245	265	1	-	-	3	23	428	27	-	-	1	3	49	413	15	-	-	9.7	90.3	3	77	1	-
caudofasciatus	-	12	122	12	-	-	-	2	106	34	-	-	-	-	7	107	28	-	-	7.4	92.6	2	79	4	-
t. thalassinus	35	245	20	-	-	-	-	45	234	13	-	-	-	1	83	198	10	-	-	14.5	85.5	2	54	6	-
t. longicirrus	20	62	4	-	-	-	-	24	57	5	-	-	-	6	47	33	8	-	-	46.5	53.5	6	20	2	-
macrospilus	-	-	5	1	-	-	-	-	-	3	3	-	-	-	-	-	4	2	-	16.2	83.8	-	-	3	2

TABLE 2.—Frequency distribution of number of pseudobranchial filaments and gill-rakers of species and subspecies of *Entomacrodus* (changes in numbers of elements associated with size of specimens has not been taken into consideration for this table)

	Pseudobranchial filaments															Gill-rakers																					
	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
decussatus	-	-	1	4	2	15	21	21	20	22	16	2	-	2	1	-	-	-	-	-	-	-	-	1	1	5	3	9	18	19	22	18	11	15	6	2	1
vermiculatus	-	-	-	-	-	9	11	15	12	1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	5	13	9	5	6	6	-	-	-	-
s. stellifer	-	-	-	1	6	13	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	4	10	4	1	-	-	-	-	-	-	-	-	-	-	-
s. lighti	-	-	-	4	24	45	9	1	-	-	-	-	-	-	-	-	-	-	-	-	1	6	29	23	15	6	2	-	-	-	-	-	-	-	-	-	-
marmoratus	-	-	-	3	1	18	30	6	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	3	8	20	19	8	5	4	1	1	1	-
epalzeocheilus	-	-	-	1	15	31	19	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2	6	12	16	18	7	1	1	1	-	-	-	-	-
niuafoouensis	-	-	-	-	7	19	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	4	6	8	7	5	1	1	-	-
randalli	-	-	-	-	2	1	4	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2	3	2	-	-	-	-	-	-
striatus	-	-	5	111	209	84	7	1	-	-	-	-	-	-	-	-	-	-	-	-	7	19	92	160	140	85	58	11	2	-	-	-	-	-	-	-	-
rofeni	-	-	1	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	8	1	2	-	-	-	-	-	-	-	-	-	-	-
strasburgi	-	-	32	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	7	9	7	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
cymatobiotus	-	5	71	23	-	-	-	-	-	-	-	-	-	-	-	5	3	24	26	23	10	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
chapmani	-	-	14	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	3	3	5	5	3	-	-	-	-	-	-	-	-	-	-	-	-
sealei	-	1	8	70	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	10	35	30	10	2	1	-	-	-	-	-	-	-	-	-
corneliae	-	-	3	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	1	-	-	-	-	-	-	-	-	-	-	-	-	-
chiostictus	-	-	20	229	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	70	150	152	62	19	2	-	-	-	-	-	-	-	-	-	-
vomerinus	-	-	1	58	10	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	6	23	27	30	18	6	3	1	-	-	-	-	-	-
textilis	-	3	8	41	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2	3	15	18	8	1	-	1	-	-	-	-	-	-	-
cadenati	-	-	6	44	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	12	28	16	7	1	-	-	-	-	-	-	-	-
nigricans	-	-	14	98	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	31	72	72	50	24	6	-	-	-	-	-	-	-	-	-	-
caudofasciatus	-	-	4	75	31	2	-	-	-	-	-	-	-	-	-	-	-	-	-	5	20	21	24	6	1	-	-	-	-	-	-	-	-	-	-	-	-
t. thalassinus	2	10	166	6	-	-	-	-	-	-	-	-	-	-	-	1	20	76	78	18	9	3	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
t. longicirrus	-	1	48	4	-	-	-	-	-	-	-	-	-	-	-	-	6	13	29	15	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
macrospilus	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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I have included Easter Island). All the remaining species of the genus that occur in the area are distributed along and well within the area circumscribed by the coral reef line, and a few extend into the Indian Ocean as well.

Seven of the nine species that have peripheral distributions are endemics. Of these seven, all but one, *E. rofeni* from the Tuamotus, are from isolated island groups—Hawaiian, Marquesas, Easter. Isolated islands are expected to harbor relatively more endemics than centrally located islands in close proximity to other islands. Island

TABLE 3.--Changes in orbital diameter (as percent SL) with increase in SL of species and subspecies of *Entomacrodus* (average for SL class followed in parentheses by number of specimens on which average is based and range of orbital diameter percentages for SL class)

SL(mm)	*decussatus*	*vermiculatus*	*s. stellifer*	*s. lighti*	*marmoratus*
15-19.9	-(1:94)	--	--	-(1:10.2)	--
20	--	-(1:8.3)	--	-(1:8.1)	--
25	8.5(4:8.1-9.2)	--	-(1:8.7)	-(1:8.4)	-(1:7.7)
30	8.4(5:7.9-9.0)	--	-(1:8.4)	7.4(2:7.3-7.4)	-(1:7.4)
35	8.2(5:8.0-8.3)	--	-(1:8.3)	-(1:7.4)	7.3(3:7.0-7.7)
40	8.0(5:7.4-8.6)	-(1:7.2)	7.5(3:7.4-7.5)	7.2(2:6.7-7.6)	-(1:7.1)
45	8.0(2:7.4-8.5)	-(1:6.8)	6.8(4:6.5-7.1)	--	6.4(4:6.2-6.7)
50	-(1:7.5)	6.7(3:6.2-7.0)	6.8(2:6.6-7.1)	6.4(2:6.4-6.5)	6.6(3:6.3-7.1)
55	7.1(7:6.6-7.6)	-(1:7.3)	6.2(4:5.9-6.9)	-(1:6.1)	6.4(7:6.0-6.9)
60	6.9(4:6.2-7.6)	6.4(2:6.2-6.5)	6.2(2:6.1-6.2)	6.4(2:6.3-6.4)	6.0(3:5.7-6.3)
65	6.4(5:6.1-6.7)	-(1:6.3)	-(1:5.9)	6.0(2:6.0-6.1)	6.0(4:5.6-6.2)
70	6.6(6:6.2-7.0)	6.6(2:6.1-7.0)	-(1:5.6)	5.8(4:5.6-6.0)	--
75	6.2(3:6.1-6.3)	-(1:6.5)	-(1:5.2)	-(1:5.4)	--
80	6.3(5:6.1-6.9)	--	-(1:5.6)	-(1:5.7)	5.8(4:5.6-6.0)
85	6.4(2:6.2-6.5)	5.9(2:5.6-6.2)		5.5(2:5.5)	5.5(3:5.4-5.5)
90	6.0(3:5.8-6.1)	--		--	5.3(2:5.3)
95	6.0(2:5.9-6.0)	-(1:6.0)		-(1:5.3)	-(1:5.2)
100	5.9(2:5.7-6.1)	--			-(1:5.1)
105	5.2(2:5.0-5.3)	--			-(1:5.0)
110	-(1:5.6)	5.1(4:4.7-5.2)			--
115	5.5(5:5.1-5.7)	5.1(4:4.9-5.3)			--
120	5.2(3:4.8-5.5)	5.2(2:5.0-5.4)			-(1:4.8)
125	5.4(3:5.1-5.6)	--			
130	5.4(2:4.9-5.9)	-(1:4.8)			
135	-(1:5.2)	-(1:5.2)			
140	-(1:4.7)	-(1:4.5)			
145	--	4.8(2:4.6-4.9)			
150	-(1:4.9)	-(1:4.8)			

TABLE 3.--Continued

SL (mm)	*epalzeocheilus*	*niuafoouensis*	*randalli*	*striatus*	*rofeni*
15-19.9	--	--	--	--	--
20	--	--	--	8.0(3:6.4-9.1)	--
25	7.0(5:6.7-7.2)	--	--	8.0(2:7.8-8.3)	7.5(3:7.1-7.7)
30	7.1(2:6.9-7.3)	7.6(2:7.6-7.7)	--	7.4(9:7.0-8.3)	6.6(2:6.3-6.9)
35	6.3(2:6.2-6.4)	--	--	7.3(14:6.4-8.2)	6.4(4:6.0-6.8)
40	6.3(8:6.0-6.8)	-(1:6.4)	--	7.0(21:6.3-7.7)	6.4(2:6.3-6.4)
45	6.3(5:6.0-6.4)	6.4(4:6.2-7.0)	-(1:6.9)	6.8(25:6.1-7.5)	
50	6.1(6:5.1-6.9)	6.3(3:6.2-6.4)	-(1:6.6)	6.5(21:5.7-7.4)	
55	6.4(2:6.4-6.5)	6.3(7:5.9-6.4)	--	6.2(18:5.6-6.9)	
60	6.0(3:5.7-6.3)	5.8(3:5.5-6.2)	--	5.8(16:5.5-6.8)	
65	5.4(3:5.2-5.7)	6.1(4:5.9-6.2)	--	5.6(8:5.2-5.9)	
70	-(1:5.4)	-(1:6.0)	--	5.4(5:5.1-5.8)	
75	5.1(2:5.0-5.2)	-(1:5.4)	--	5.0(2:5.0-5.1)	
80	5.4(2:5.0-5.7)	5.4(2:5.1-5.7)	--	4.9(3:4.8-5.0)	
85	-(1:4.5)	--	-(1:6.3)	-(1:5.1)	
90	--	--		-(1:4.5)	
95	4.8(2:4.8-4.9)	-(1:5.2)		-(1:4.7)	
100	-(1:4.5)				

SL (mm)	*strasburgi*	*cymatobiotus*	*chapmani*	*sealei*	*corneliae*
15-19.9	8.6(3:8.5-8.6)	--	--	--	--
20	7.9(5:7.4-8.6)	-(1:7.8)	--	-(1:8.5)	--
25	7.2(11:6.7-7.7)	6.9(12:6.3-8.2)	6.9(2:6.4-7.4)	7.5(4:7.1-8.2)	--
30	6.6(7:6.2-6.9)	6.3(8:6.1-6.6)	-(1:6.4)	6.9(13:6.6-7.4)	--
35	-(1:6.3)	6.0(7:5.4-6.3)	6.1(4:5.9-6.4)	6.7(10:6.1-8.1)	-(1:6.5)
40		5.8(8:5.4-6.1)	5.6(2:5.5-5.6)	6.2(4:5.8-7.2)	
45		5.4(6:5.0-5.8)	5.2(2:4.9-5.4)	6.5(5:6.0-6.8)	
50			5.4(5:5.0-5.8)	6.1(6:5.8-6.6)	
55			--	-(1:5.4)	
60			-(1:4.9)	-(1:5.7)	
65			--		
70			-(1:4.6)		
75					
80					
85					
90					
95					

TABLE 3.--Continued

SL(mm)	*chiostictus*	*vomerinus*	*textilis*	*cadenati*	*nigricans*
15-19.9	--	--	--	--	--
20	-(1:7.0)	--	-(1:7.6)	--	8.1(2:7.6-8.6)
25	6.8(4:6.1-7.4)	--	7.3(3:7.1-7.4)	-(1:7.0)	7.6(2:7.3-8.0)
30	7.1(8:6.7-7.5)	--	6.4(2:6.2-6.7)	6.9(3:6.4-7.3)	6.7(8:6.3-7.0)
35	6.7(13:6.1-7.3)	7.2(2:6.7-7.6)	6.3(3:6.4-6.8)	6.4(4:5.7-6.8)	6.6(14:6.1-7.4)
40	6.3(10:5.1-7.1)	6.4(3:5.8-7.0)	5.9(4:5.6-6.1)	5.8(2:5.5-6.0)	6.4(11:6.0-6.7)
45	6.0(12:5.5-6.6)	6.4(2:6.2-6.5)	6.2(5:5.9-6.7)	6.2(3:5.5-6.8)	5.9(12:5.7-6.5)
50	5.8(4:5.5-6.0)	-(1:6.1)	5.8(4:5.7-6.1)	5.8(4:5.5-6.0)	5.8(10:5.6-6.0)
55	-(1:5.2)	-(1:5.6)	5.5(2:5.3-5.7)	5.5(4:5.2-6.0)	5.4(3:5.3-5.5)
60	5.2(3:5.1-5.3)	-(1:5.2)	-(1:5.0)	5.5(8:5.1-5.9)	5.3(4:5.1-5.6)
65	4.9(3:4.7-5.2)	-(1:5.1)		5.4(3:5.1-5.7)	
70		5.3(4:5.0-5.7		--	
75		-(1:5.1)		-(1:4.7)	
80		4.9(6:4.6-5.3)			
85		5.0(2:4.6-5.4)			
90		-(1:4.4)			
95		--			
100		-(1:4.5)			

SL(mm)	*caudofasciatus*	*t. thalassinus*	*t. longicirrus*	*macrospilus*
15-19.9	--	--	8.2(2:7.8-8.7)	-(1:8.0)
20	--	7.4(7:6.8-8.0)	6.8(3:6.4-7.1)	
25	7.7(5:2.1-8.8)	6.6(29:5.7-7.5)	6.8(9:6.5-7.2)	
30	6.9(11:6.0-7.8)	5.8(12:5.0-7.0)	6.6(11:6.0-7.2)	
35	6.6(7:6.3-7.4)	5.4(6:5.0-5.9)	6.1(9:5.4-6.8)	
40	6.4(6:5.8-7.1)		5.6(8:5.2-6.0)	
45	6.1(7:6.0-6.5)		5.3(2:5.2-5.4)	
50	6.0(3:5.8-6.1)			

endemism can be explained in two ways: chance isolation (with possible subsequent divergence) of a species with a former, wider distribution (relicts); and arrival of a species with subsequent establishment of breeding populations and divergence before other possible competitors have had the chance to invade and become established.

The central Pacific of the past probably was much more densely spotted with islands than it is today (see Menard, 1964, especially his discussion of the Darwin Rise). Various factors (subsidence,

TABLE 4.--Frequency distributions of main supraorbital cirrus length, as percent SL, of species and subspecies of *Entomacrodus* (Note: table does not take into account differences between populations of a single taxon, or the regressions of cirrus length on size, which occur in most species; thus differences between and within many of the species, or the different sexes within a species, are even greater than is apparent from the table)

Males	Cirrus length as percent of SL (lower limits of class)																									
	1.9	2.3	2.7	3.1	3.5	3.9	4.3	4.7	5.1	5.5	5.9	6.3	6.7	7.1	7.5	7.9	8.3	8.7	9.1	9.5	9.9	10.3	10.7	11.1	11.5	11.9
decussatus	-	-	1	1	1	4	2	3	-	2	5	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-
vermiculatus	-	-	-	-	-	-	-	2	3	-	3	4	-	-	-	1	-	1	-	-	-	-	-	-	-	-
s. stellifer	-	-	-	-	-	-	-	-	-	-	-	-	-	2	1	1	-	-	1	1	1	2	2	1	1	-
s. lighti	-	-	-	-	-	-	-	-	-	-	-	2	1	2	2	3	4	2	2	2	2	1	1	-	-	1
marmoratus	-	-	-	-	-	1	1	4	3	5	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
epalzeocheilus	-	-	-	-	-	1	1	-	1	2	1	1	1	2	3	1	1	1	2	3	1	-	-	2	1	2
niuafoouensis	-	-	-	-	-	-	-	-	-	1	1	1	2	-	-	1	-	-	-	-	-	-	-	-	-	-
randalli	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
striatus	-	-	1	6	10	14	6	25	20	8	8	6	2	2	2	-	-	-	-	-	-	-	-	-	-	-
rofeni	-	-	-	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
strasburgi	-	1	5	6	1	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
cymatobiotus	-	-	-	6	8	14	11	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
chapmani	-	-	-	-	1	2	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
sealei	-	-	-	-	-	2	7	7	2	7	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
corneliae (none)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
chiostictus	-	-	2	3	9	14	16	35	25	35	26	7	5	2	2	-	-	-	-	-	-	-	-	-	-	-
vomerinus	-	-	3	5	5	8	3	3	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
textilis	-	-	2	-	5	5	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
cadenati	1	5	6	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
nigricans	1	13	16	13	4	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
caudofasciatus	-	-	-	-	3	1	3	2	9	6	7	6	3	1	2	-	-	-	-	-	-	-	-	-	-	-
t. thalassinus	1	9	17	18	10	8	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
t. longicirrus	-	-	-	-	-	-	-	-	-	-	5	7	4	8	6	1	8	-	1	1	-	-	-	-	-	-
macrospilus	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE 4.--Continued

Females	Cirrus length as percent of SL (lower limits of class) 1.9	2.3	2.7	3.1	3.5	3.9	4.3	4.7	5.1	5.5	5.9	6.3	6.7	7.1	7.5	7.9	8.3	8.7	9.1	9.5	9.9	10.3	10.7	11.1	11.5	11.9
decussatus	-	4	2	1	6	6	7	2	4	2	4	2	-	1	-	1	-	-	-	-	-	-	-	-	-	-
vermiculatus	-	-	-	-	1	2	4	2	-	2	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
s. stellifer	-	-	-	-	-	-	-	-	1	1	-	1	2	1	-	1	1	1	-	-	-	-	-	-	-	-
s. lighti	-	-	-	-	-	-	-	2	1	-	5	1	2	1	2	3	-	2	-	-	2	-	-	-	-	-
marmoratus	-	-	-	-	2	4	11	4	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
epalzeocheilus	-	-	-	-	-	-	1	-	5	3	4	2	1	1	2	1	-	1	1	-	-	-	-	-	-	-
niuafoouensis	-	-	-	-	-	-	3	-	2	4	5	4	2	2	-	-	-	-	-	-	-	-	-	-	-	-
randalli	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
striatus	-	-	2	12	21	14	9	4	3	3	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
rofeni	-	4	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
strasburgi	-	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
cymatobiotus	-	-	3	6	5	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
chapmani	-	-	3	1	1	6	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
sealei	-	-	2	5	6	8	4	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
corneliae	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
chiostictus	-	-	6	24	39	26	16	11	3	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
vomerinus	-	1	2	6	12	8	4	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
textilis	1	-	-	8	6	7	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
cadenati	1	11	14	5	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
nigricans	11	16	15	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
caudofasciatus	-	1	-	1	4	2	2	2	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
t. thalassinus	-	-	5	3	6	3	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
t. longicirrus	-	-	-	-	-	8	4	9	4	6	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
macrospilus (none)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

erosion) have removed many of the formerly existing islands from the ocean's surface. The Hawaiian Islands (on the periphery), for example, were probably once less isolated than presently. *Entomacrodus* species, of that island group, possibly arrived during times of decreased isolation. The species existing there now, well differentiated from their closest relatives, are either relatively unchanged relicts (of an earlier, more widely distributed species) or more recently evolved isolates. Gosline and Brock (1960) have noted the high percentage of fish species endemic to the Hawaiian Islands and have pointed out that some Hawaiian species are obvious relicts: e.g., *Chilorhinus platyrhynchus* (Norman), from the Hawaiian Islands and New Britain, both peripheral (the only other species of the genus is in the West Indies); *Acanthurus leucopareius* (Jenkins) from Hawaiian, Marcus, and Easter Islands, all peripheral; *Caranx cheilio* Snyder, from Hawaiian and Easter Islands.

The close relationship of the three endemic Marquesan species of *Entomacrodus* with nonendemic species and the probably younger age of the Marquesas (high islands), as compared with adjacent island groups (Tuamotus, low islands), tend to indicate relatively recent arrival and divergence of *Entomacrodus* species in the Marquesas.

The restriction of *E. rofeni*, *E. stellifer*, and *E. niuafoouensis* to the peripheral area is not so easily explained as are the endemics of the Hawaiian, Marquesas, and Easter Islands. I tentatively believe these three species to be relicts. The disjunct distribution of *E. niuafoouensis*, at least, would tend to support such a belief. The disjunct distribution (fig. 5) of the Pacific populations of *E. decussatus* (not peripherally limited) resulting in a group of northwestern and a group of southeastern populations, indicates that *E. decussatus*

TABLE 5.—Frequency distribution of number of crenulae on ventral margin of upper lip of certain species of *Entomacrodus*

Species	Number of crenulae																					
	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
cymatobiotus	-	-	-	-	-	-	-	-	3	9	14	23	23	19	9	6	4	2	-	-	-	-
strasburgi	-	1	-	3	4	3	6	4	5	-	-	1	-	-	-	-	-	-	-	-	-	-
chapmani	-	-	-	-	-	-	-	-	-	-	-	-	-	6	2	2	2	3	4	1	2	1
rofeni	-	-	-	-	-	2	2	2	2	1	1	-	-	-	-	-	-	-	-	-	-	-
striatus	1	1	3	2	12	11	31	37	40	36	35	19	7	4	1	2	1	-	-	-	-	-
niuafoouensis	-	-	-	-	-	-	-	-	-	1	4	1	4	7	6	3	2	2	1	-	-	1
epalzeocheilus	-	-	-	-	-	1	-	7	6	14	9	11	8	-	1	-	-	-	-	-	-	-
randalli	-	-	-	-	-	-	1	-	1	-	2	1	-	2	2	-	-	-	-	-	-	-
marmoratus	-	-	-	-	-	-	-	-	-	-	-	1	5	3	12	13	5	5	2	-	1	1

TABLE 6.--General distribution of the species of *Entomacrodus* (X indicates widespread occurrence; locality indicates only known distribution)

Species	Eastern Pacific Ocean	Western Atlantic Ocean	Eastern Atlantic Ocean	Indian Ocean	Western Pacific Ocean (105°E-180° longitude)	Central Pacific Ocean (180°-120°W longitude and Easter Island)
decussatus				Western Australia	X	X
vermiculatus				X		
stellifer					X	
marmoratus						Hawaii
epalzeocheilus				X		Tutuila[1]
niuafoouensis				Madagascar[1]	X	X
randalli						Marquesas
striatus				X	X	X
strasburgi						Hawaii
cymatobiotus					X	X
chapmani						Easter Island
rofeni						Raroia
sealei					X	X
corneliae						Marquesas
chiostictus	X					
caudofasciatus				Christmas, Cocos-Keeling	X	X
vomerinus		Brazil, Fernando Noronja				
nigricans		X				
cadenati			X			
textilis			Ascension, St. Helena			
thalassinus				Seychelles	X	X
macrospilus						Marquesas
Total species	1	2	2	6 or 7[1]		14 or 15[1]

[1] See geographic variation section under *E. niuafoouensis*, where the possibility is discussed that the Madagascar population of *E. niuafoouensis* may be a *niuafoouensis*-type development of *E. epalzeocheilus* and the Tutuila population of *E. epalzeocheilus* may be an *epalzeocheilus*-type development of *E. niuafoouensis*

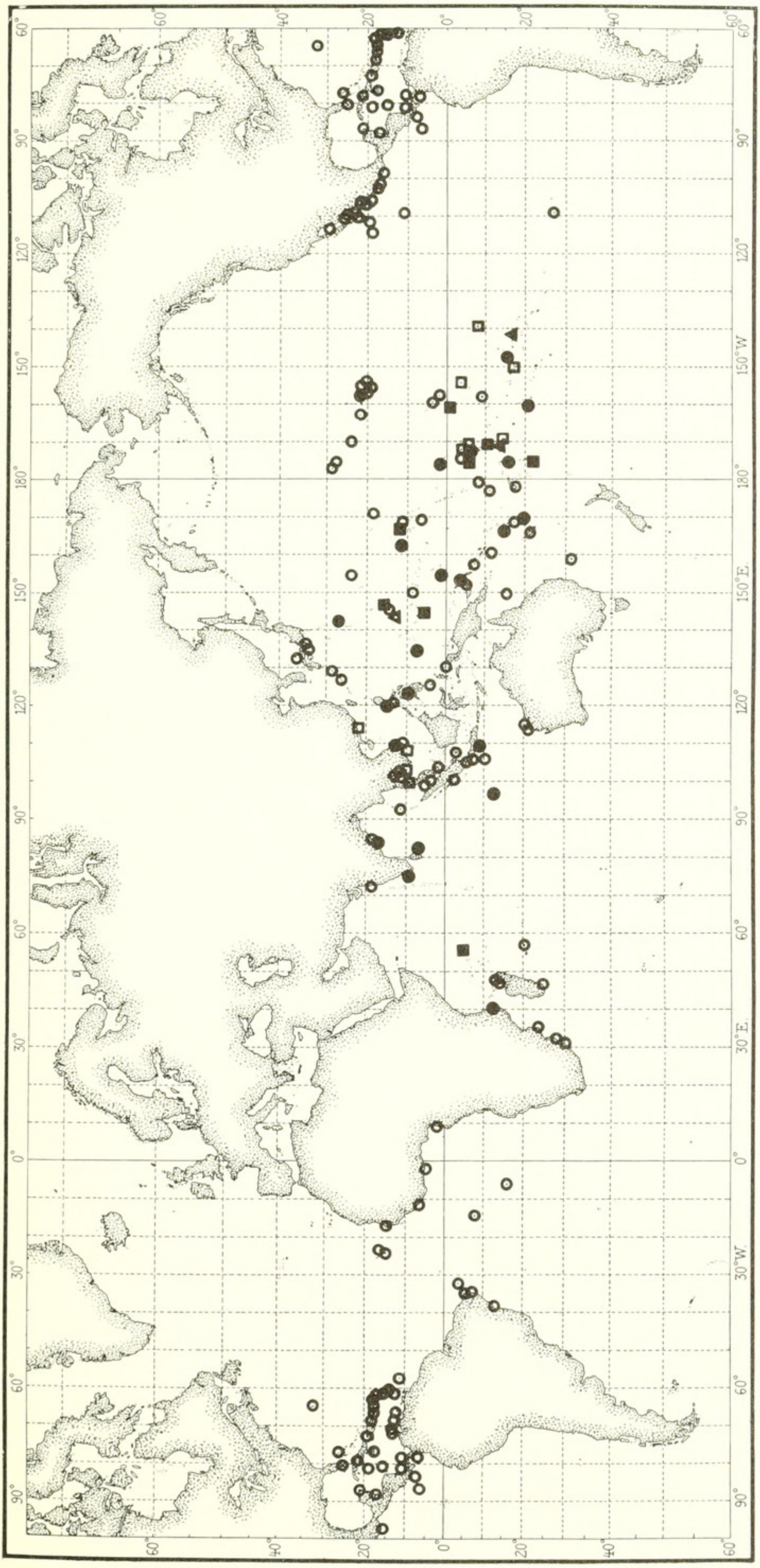

FIGURE 3.—Distribution of the genus *Entomacrodus* (symbols denote number of species at a particular locality).

○ 1 ● 2 □ 3 ■ 4 △ 5 ▲ 6

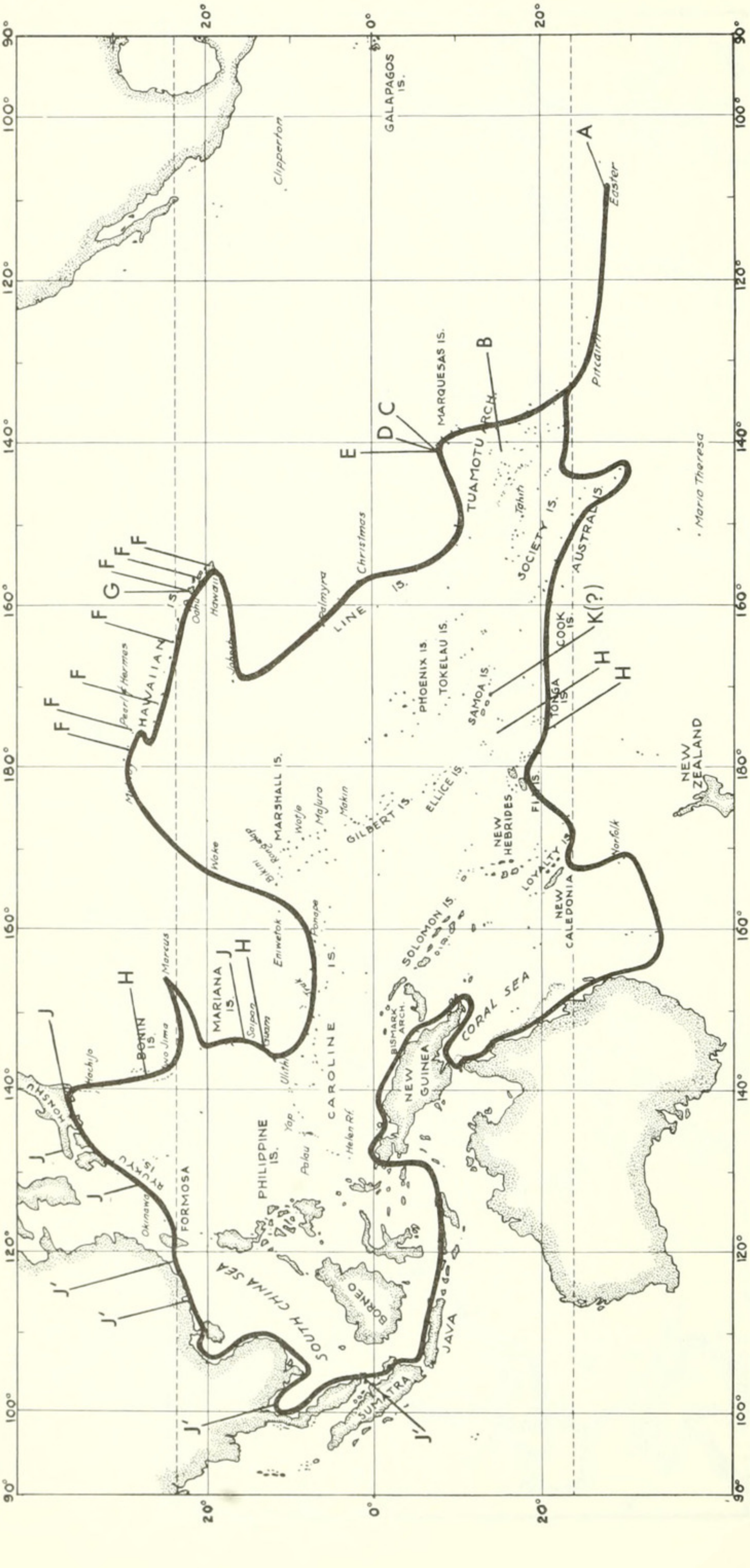

FIGURE 4.—Distribution of some species and subspecies of *Entomacrodus* in the central and western Pacific Ocean.

A	*E. chapmani*	D	*E. macrospilus*	G	*E. strasburgi*
B	*E. rofeni*	E	*E. corneliae*	H	*E. niuafoouensis*
C	*E. randalli*	F	*E. marmoratus*	J	*E. s. stellifer*
J'	*E. s. lighti*	K	*E. epalzeocheilus*		

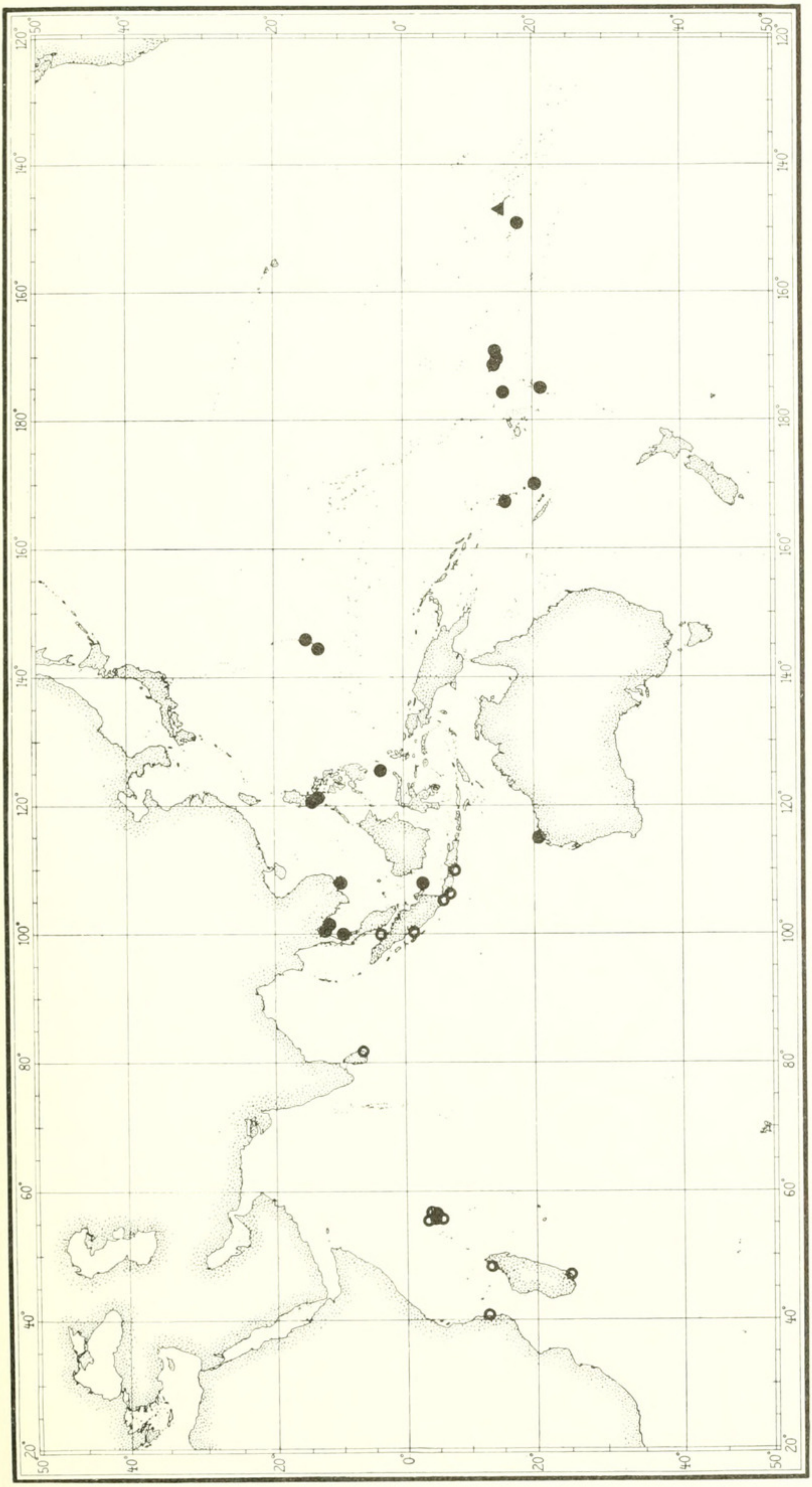

FIGURE 5.—Distribution of some species of *Entomacrodus*.
● *E. decussatus* ○ *E. vermiculatus* ▲ *E. rofeni*

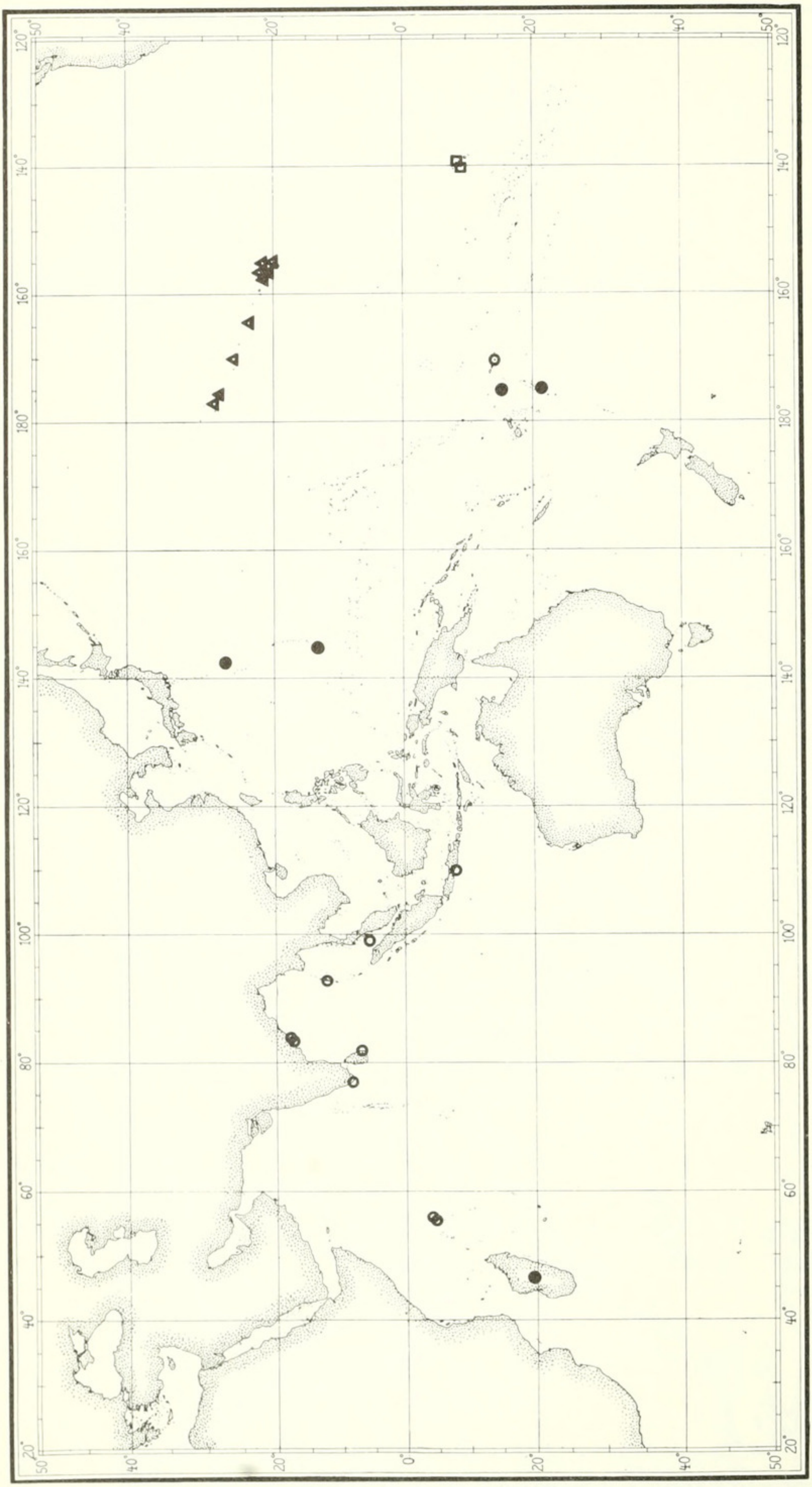

FIGURE 6.—Distribution of some species of *Entomacrodus*.

● *E. niuafoouensis* (Madagascar collection locality unavailable) □ *E. randalli*

○ *E. epalzeocheilus* (Java record based on Bleeker, 1859) △ *E. marmoratus*

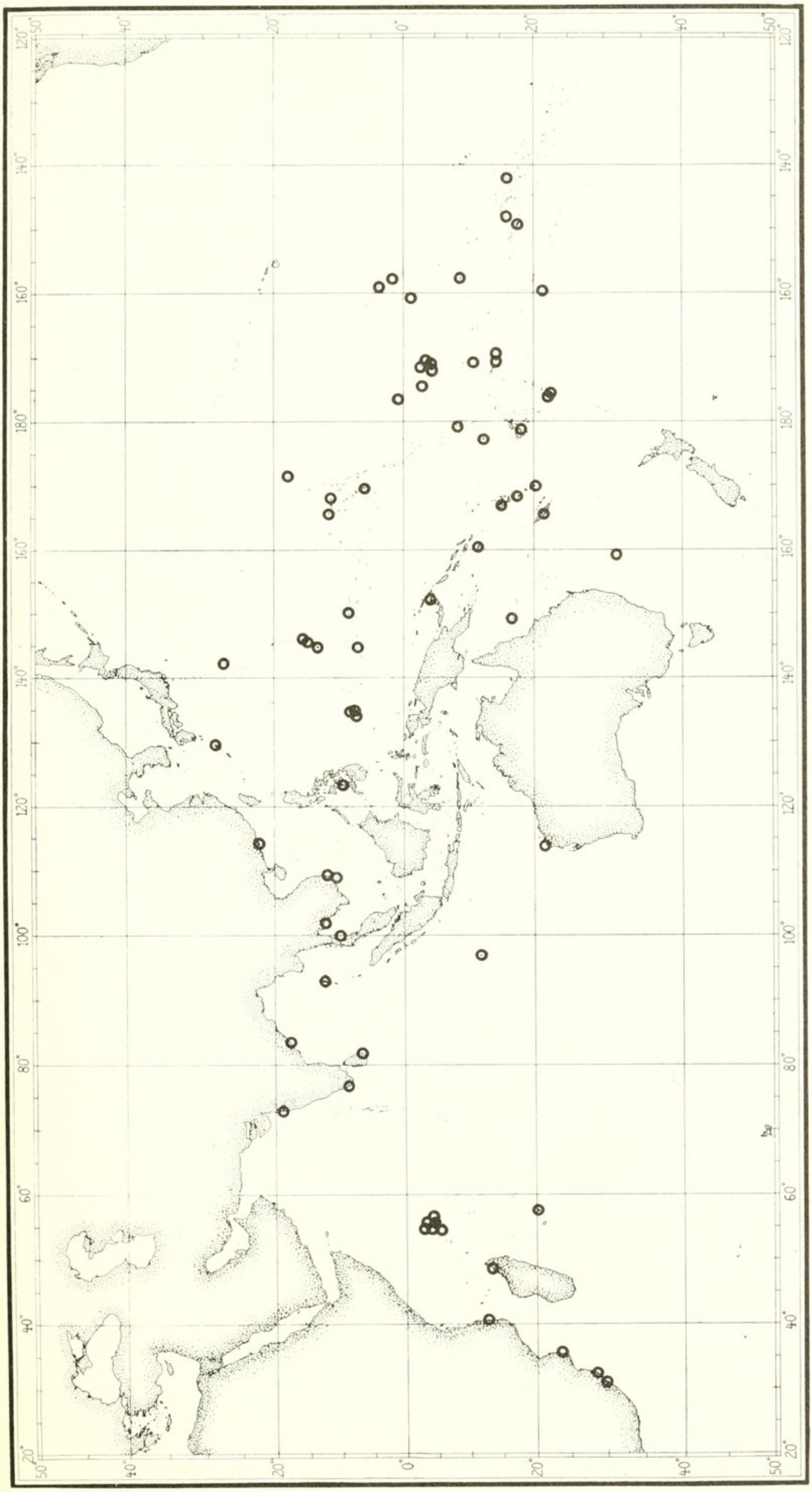

FIGURE 7.—Distribution of *Entomacrodus striatus*.

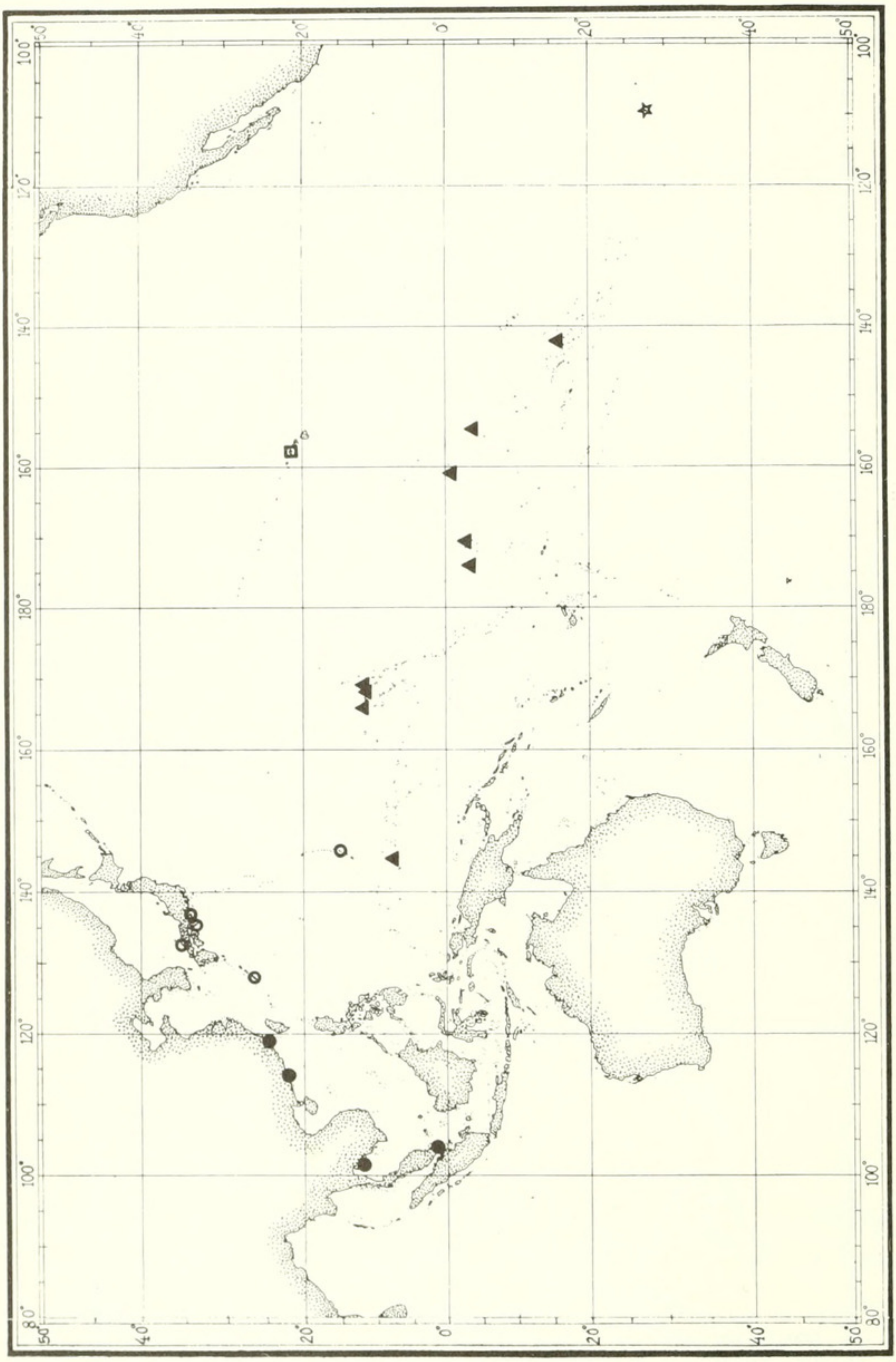

FIGURE 8.—Distribution of some species and subspecies of *Entomacrodus*.

▲ *E. cymatobiotus* □ *E. strasburgi* ★ *E. chapmani* ○ *E. s. stellifer* ● *E. s. lighti*

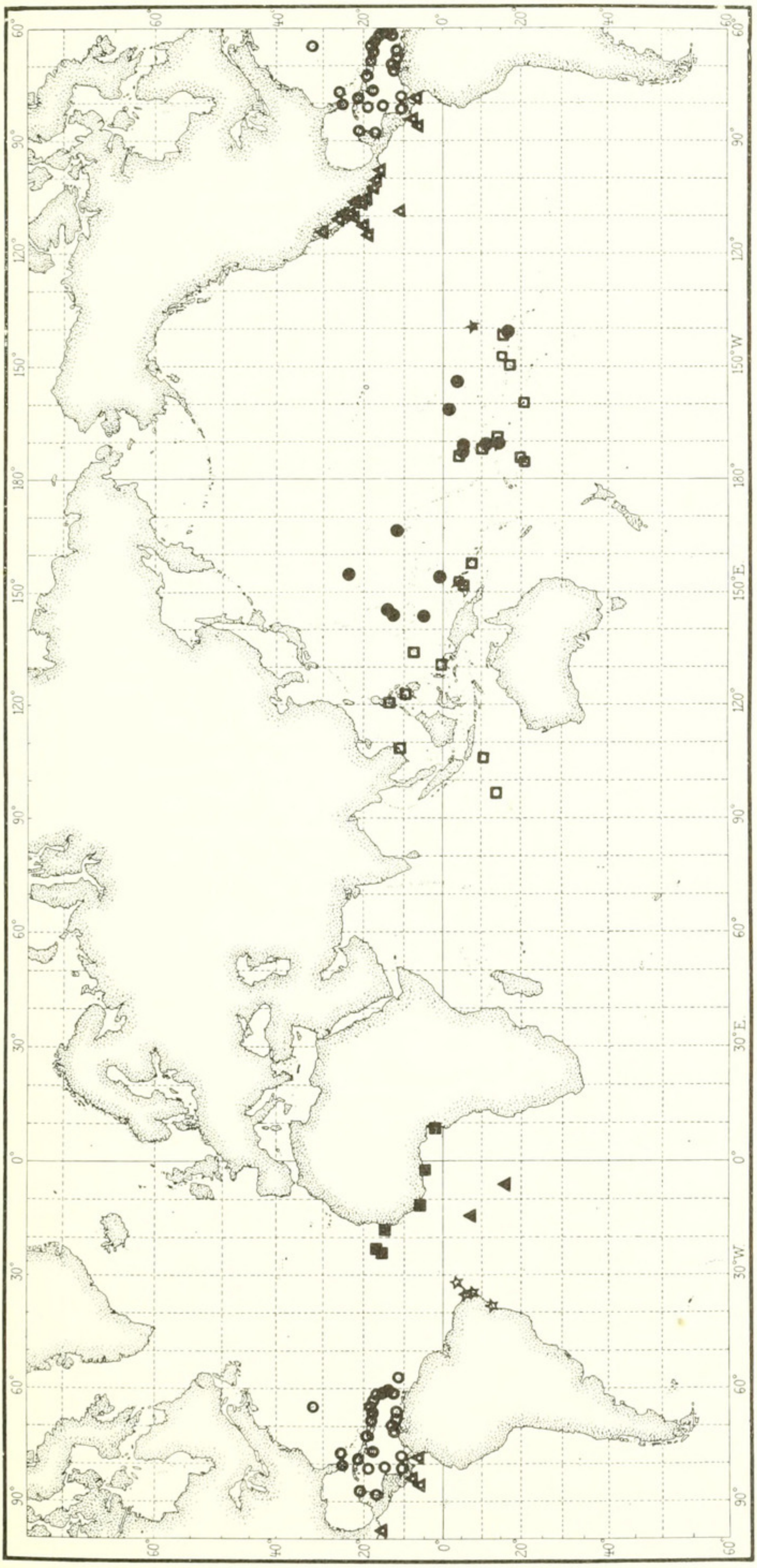

FIGURE 9.—Distribution of some species of *Entomacrodus.*

● *E. sealei* ○ *E. nigricans* ■ *E. cadenati* ☆ *E. vomerinus*
□ *E. caudofasciatus* ▲ *E. textilis* △ *E. chiostictus* ★ *E. corneliae*

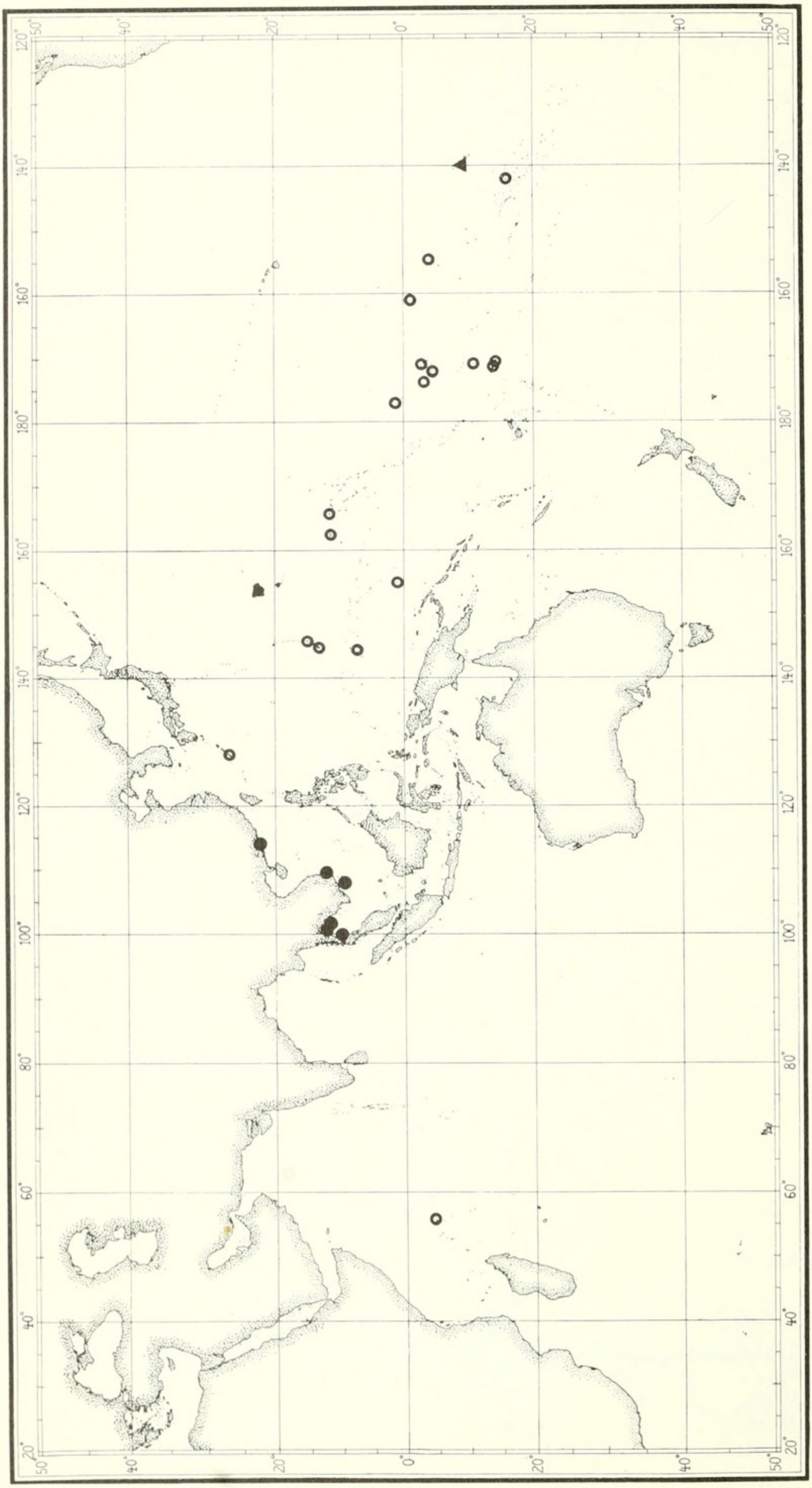

FIGURE 10.—Distribution of *Entomacrodus macrospilus* and the subspecies of *Entomacrodus thalassinus*.
○ *E. t. thalassinus* ● *E. t. longicirrus* ▲ *E. macrospilus*

also has a relict type distribution. It may be that the distribution of *E. decussatus* is contracting and will become peripherally limited.

To explain how a relict species might become limited to the periphery, one can draw on the example of the fairy-ring mushroom, which starts from a central area and spreads as an ever enlarging ring around the central area that no longer harbors the species. If the suitable habitat is limited, the mushroom (or fish) will have its last stand along the periphery of the habitat. Matthews (1915) postulated the displacement of primitive forms from a central area by the development of more progressive (successful) forms in the central area.

A perusal of several recent revisions of Indo-Pacific fishes indicates to me that many species will be found whose distributions in the central and western Pacific are restricted to the periphery of the area. The reason for basing a Pacific peripheral distribution hypothesis primarily on *Entomacrodus* species is that there have been available to me more collections from more diverse localities than have been available to authors of similar ichthyological revisions.

A peripheral hypothesis for shore fish distribution in the central and western Pacific makes less perplexing such distributions as that of *Acanthurus leucopareius*. The hypothesis indicates that a species such as *Zebrasoma flavescens* (Bennett) with a known distribution (completely peripheral) of Marcus, Guam, Saipan, Bikini, Wake, Johnston, the Hawaiian Islands, and Tuamotus (Randall, 1955), need not be expected to occur throughout the central and western tropical Pacific.

Key to Species and Subspecies of *Entomacrodus*

1a. Upper lip with crenulae on all or part of ventral margin; gill-rakers usually more than 14 (13 or less only in 8 percent of specimens of *E. caudo; fasciatus*, 61 percent of *E. cymatobiotus*, and 50 percent of *E. strasburgi*), several species commonly exceeding 100 mm SL 4

1b. Upper lip without crenulae on ventral margin; gill-rakers 9–15 (1 of 228 specimens with 18 gill-rakers; 13 or fewer gill-rakers in 93.0 percent of specimens); largest specimen known 49.7mm 2

2a. Some circumorbital pores included in dark spot on head posterior to eye; segmented dorsal rays 13–15 (uncommonly 15); segmented anal rays 15–17 (uncommonly 17) 3

2b. No circumorbital pores included in dark spot on head posterior to eye; segmented dorsal rays 15 or 16; segmented anal rays 17 or 18.
macrospilus (Marquesas Islands)

3a. Supraorbital cirrus of males 5.9–9.5 percent of SL, females 3.9–6.5 percent SL (fig. 11) . . . . **thalassinus longicirrus** (South China Sea)

3b. Supraorbital cirrus of males 2.3–4.9 percent of SL, females 2.7–4.7 percent SL (more than 4.1 percent in only one specimen, fig. 11).
thalassinus thalassinus (Indian and Pacific Oceans)

4a. Ventral margin of upper lip with middle one-third to three-fifths crenulate (sometimes weakly and very irregularly) and lateral portions entire . 5

4b. Ventral margin of upper lip completely crenulate (sometimes weakly and irregularly), or only middle one-third to one-half of ventral margin without crenulae (or, as a rarity, left or right side of ventral margin without crenulae) 7

5a. Supraorbital cirri usually 5 or more (less than 1 percent of specimens with less than 5); gill-rakers 19–30 (rarely less than 20); nasal cirri subequal in size and shape; without a distinct dark spot distally on membrane between 1st and 2nd dorsal spines; caudal fin frequently with distinct stripes, bars, or spots; posteriormost proximal anal pterygiophore supporting 2 rays in over 80 percent of specimens; posterior canines of lower jaw rarely absent 17

5b. Supraorbital cirri 1–3 (3 in only 1 of 111 specimens); gill-rakers 14–20 (91 percent of specimens with less than 19); nasal cirri irregular in size and shape, usually 1 cirrus on each anterior nostril a broad flap from which arise smaller cirri (pls. 4*c*, 5*d*); males (and frequently females) with a distinct dark spot distally on membrane between 1st and 2nd dorsal spines; caudal dusky without distinct stripes, bars, or spots; posteriormost proximal anal pterygiophore supporting a single ray in over 75 percent of specimens; 1 or both posterior canines in lower jaw frequently absent . 6

6a. Color pattern (when specimen immersed in liquid) on side of body consisting of dark bands either broken up by numerous pale or dark vermiculations or reticulations, or with inclusions of fine pale spots or dashes (pl. 4). **stellifer stellifer** (Pacific)

6b. Color pattern on side of body consisting of more or less uniformly, diffusely dark dusky bands or pairs of blotches (usually darker along midsides) neither broken by vermiculations or reticulations, nor with fine pale spots or dashes (pl. 5) . . . . **stellifer lighti** (South China Sea)

7a. Ventral margin of upper lip with middle one-third to one-half entire, lateral portions crenulate (species of Atlantic, Pacific, and Indian Oceans) . . 8

7b. Ventral margin of upper lip completely, sometimes very weakly and irregularly, crenulate (or, as a rarity, one side crenulate and the other entire) (species of Indian and Pacific Oceans) 16

8a. Upper lip with many fine dark spots (occasionally obscured by a dusky overlay); spots sometimes arranged in 7–10 more or less vertical rows; infrequently 1 or 2 rows with spots fused, forming stripes; sometimes ventral 2 spots of each row fused; a dark spot, or stripe, directed dorsoposteriorly from posterodorsal margin of eye, sometimes fused across top of head with stripe from other side; a disjunct continuation of this marking occasionally extends anteroventrally from below eye; an irregular J- or U-shaped dark marking posterior to, and separated from, eye by a pale interspace; shorter arm of marking anterior to longer arm, and open end of marking directed dorsoposteriorly; arms of marking occasionally outlined as dark spots and dashes . . . . **cadenati** (eastern Atlantic)

8b. Upper lip without dark spots; its markings variable, present as solid stripes or bands of variable intensity (sometimes restricted to ventral half of lip), occasionally obscured by a dusky overlay, or upper lip often pale with a few nebulous marks or none; a dark spot, or stripe, directed dorsoposteriorly from posterodorsal region immediately behind eye present only in Brazillian specimens; J- or U-shaped dark mark behind eye absent, but 1 arm of such a mark may be present in Brazillian specimens 9

9a. Darkest and usually largest marking on body a subovate to subquadrate blotch on side below lateral line and just posterior and dorsal to level of pectoral axil 10

9b. Darkest and largest markings on body posterior to region specified in 9a, usually in form of paired vertical bands or paired midlateral blotches, several of which are of similar intensity; occasional specimens with body almost uniformly pale or with diffuse dusky markings 11

10a. Gill-rakers 15–23 (modally 18 or 19); underside of head with alternating dark stripes and pale interspaces extending posteromedially from lower lip; pectoral base with 2 slender elongate dark markings, 1 on base of pectoral rays and 1 on anterior fleshy pectoral base, separated by a pale interspace; upper lip with 7–9 distinct dark stripes, sometimes restricted to ventral half of lip; stripes narrower than pale interspaces; terminal lateral line pores below segmented dorsal fin rays 4–7; supraorbital cirrus length 2.2–4.7 percent SL (usually less than 4.4 percent), about equal in similar size males and females; predorsal commissural pores usually fewer (table 55) than in 10b . . **textilis** (Ascension and St. Helena)

10b. Gill-rakers 13–18 (modally 14–16); underside of head unmarked, diffusely dusky, or with alternating pale stripes and dusky interspaces extending posteromedially from lower lip; some specimens from New Britain with slight indications of dark stripes; pectoral base uniformly or irregularly dusky, without slender elongate dark markings separated by a pale interspace (except 1 specimen from New Britain); upper lip usually diffusely dusky, infrequently with about 9 irregular faint dusky bands (never very distinct) mostly restricted to ventral half of lip; terminal lateral line pores in area below and between dorsal fin spine 8 and dorsal ray 5 (usually anterior to dorsal ray 3); supraorbital cirrus length 2.5–7.8 percent SL (usually less than 5 percent in females and more than 5 percent in males); predorsal commissural pores usually more (table 65) than in 10a . . . . **caudofasciatus** (Indian and Pacific Oceans)

11a. Preopercular series of pores with pairs or multiples of pores at 3 or more positions (rarely at only 3 positions). 12

11b. Preopercular series of pores with simple pores at all positions, or less than 3 positions with paired pores (except *E. chiostictus* with 0–22 percent, average 8 percent, of specimens, depending on population, with 3 or 4 positions with paired pores; only 2 specimens of over 500 with 5 positions paired), positions never with multiples of pores. 13

12a. Head with 2 conspicuous dark, more or less vertical, stripes behind each eye; upper lip variably pale and dusky. . **corneliae** (Marquesas Islands)

12b. Head without conspicuous dark markings; upper lip with 7 pale stripes alternating with broader dusky bands (occasionally median and one lateral stripe on each side Y- or ( )-shaped).
sealei (western Pacific, not Marquesas)

13a. Segmented dorsal fin rays usually 16 or 17; segmented anal fin rays usually 17 or 18; gill-rakers commonly 20–24; predorsal commissural pores usually fewer at any given size (compare data in table 52 with data in tables 49, 61, 65); vertebrae usually 35 or 36.
vomerinus (Brazil and Fernando Noronja)

13b. Segmented dorsal fin rays usually 13–15; segmented anal fin rays usually 15 or 16; gill-rakers usually 13–19 (rarely 20 or 21); predorsal commissural pores usually more numerous at any given size; vertebrae usually 33 or 34 14

14a. Supraorbital cirrus length 1.9–3.9 percent SL (usually less than 3.3 percent); upper lip usually with 7–9 dark stripes (frequently present only as faint indications and restricted to lower half of lip) alternating with pale bands; dark stripe on fleshy pectoral base separated by pale area from base of pectoral rays; preopercular series of pores simple, rarely with one or two positions with paired pores.
nigricans (Caribbean Sea, Florida, Bermuda)

14b. Supraorbital cirrus length 2.7–7.9 percent SL (usually more than 3.2 percent except in specimens from Cape San Lucas where cirri appear to be malformed); color pattern of upper lip variable, dark stripes present or absent, numbering up to 14; dark stripe present or absent on fleshy pectoral base; preopercular series of pores varying from all positions simple to all positions with paired pores 15

15a. A dark spot frequently present just posterior to eye; preopercular series of pores frequently including paired pores at 1 or more positions (60 percent of specimens); upper lip color pattern frequently of 10–14 dark stripes separated by pale interspaces, occasionally of about 7 pale stripes separated by dusky interspaces, or irregularly or uniformly dusky; a dark stripe frequently present on fleshy pectoral base separated by a pale area from pectoral rays . . . . . **chiostictus** (eastern Pacific)

15b. No dark spot just posterior to eye; preopercular series of pores usually all simple (never more than 1 pair included in series); no dark stripe present on fleshy pectoral base; lip stripes, when present, fewer than 8.
caudofasciatus (Tahiti, Raroia, Makatea, Rarotonga)

16a. Pseudobranchial filaments 5–16 (commonly 10 or more); segmented anal rays 16–19 (commonly 18–19, associated with more than 3 predorsal commissural pores); segmented dorsal rays 15–18 (commonly 17 or 18); main supraorbital cirrus with rarely less than 2 lateral branches; 13th dorsal spine frequently obvious (when obvious, usually more than 2.9 percent SL); membrane of last dorsal ray frequently attached over, or posterior to, caudal origin; color pattern of sides frequently much vermiculated, reticulated, or of several irregular light to dark longitudinal stripes; eye usually larger at any given size (table 3); commonly attaining sizes of over 100 mm SL (up to 153 mm) 17

16b. Pseudobranchial filaments 4–12 (rarely more than 9); segmented anal rays 14–18 (commonly 18 in only *E. rofeni*, which has only 3 predorsal commissural pores); segmented dorsal rays 13–17 (rarely 17); main supraorbital cirrus with or without lateral branches; 13th dorsal spine usually not obvious (when obvious, usually less than 2.9 percent SL); membrane of last dorsal ray attached anterior to caudal origin; color pattern of sides never vermiculated, reticulated, or of longitudinal stripes; eye usually smaller at any given size (table 3); only 2 species (*E. marmoratus* and *E. epalzeocheilus*) attaining a size of 100 mm SL (largest specimen known 121 mm) 18

17a. Color pattern of body of specimens over 80 mm SL with large number of tiny vermiculations; pectoral fin diffusely dusky, sometimes with a reticular pattern of fine dark lines; dorsal rays 15–17 (modally 16); anal rays 16–18; pores before anterior nostril 2 or more (55 of 56 specimens).
vermiculatus (Indian Ocean other than Australia)

17b. Color pattern of body of specimens over 80 mm SL quite variable, but never consisting of tiny vermiculations; pectoral fin usually striped, spotted, or

barred; dorsal rays 16–18 (modally 17); anal rays 16–19; pores before anterior nostril varying in number with population, but typically 1.
decussatus (Pacific Ocean and western Australia)

18a. Two to 20 cirri on each side of nape (sometimes in form of single main cirrus with several branches at its distal end, the free tip of each branch here counted as a cirrus) 19

18b. One cirrus on each side of nape (only rarely, in large specimens, 2 cirri on one side of nape) 20

19a. Nuchal cirri on each side almost always arising from 2 main bases (patches), the medial cirri patch the broadest based and usually with more cirri than the lateral patch; 1 pore before each anterior nostril; main supraorbital cirrus with at least 3 cirri arising from both its medial and lateral margins; 29–39 crenulae on ventral margin of upper lip (usually more than 30); preopercular series of pores with 0–7 positions with pairs or clusters of pores (less than 4 pairs or clusters in 73 of 80 specimens).
marmoratus (Hawaiian Islands from Midway to Hawaii)

19b. Nuchal cirri on each side arising from a single base (very rarely arising from 2 main bases on 1 side only); 2 or more pores before each anterior nostril (except in some specimens smaller than 60 mm SL, where a single pore may be present); main supraorbital cirrus with cirri arising only along its mesial margin (5 specimens with 1 cirrus and 1 with 2 cirri arising from lateral margin); 23–32 crenulae on ventral margin of upper lip (usually less than 30); preopercular series of pores with 4–7 (usually more than 4) positions with pairs or clusters of pores.
epalzeocheilus (Indian Ocean and Samoa)

20a. Pairs or clusters of pores at 2–5 positions in preopercular series of pores; up to 69 predorsal commissural pores (frequently more than 20) 21

20b. No pairs or clusters of pores included in preopercular series of pores (all pores simple); up to 33 predorsal commissural pores (rarely more than 20) 24

21a. One pore before each anterior nostril; gill-rakers 15–24 22

21b. Two to 4 pores before each anterior nostril (except in one specimen which had 2 on one side and 1 on the other); gill-rakers 23–26 23

22a. Gill-rakers 15–21 (rarely more than 19); pseudobranchial filaments 4–7; upper lip color pattern uniformly dusky or consisting of 7 or 8 dusky bands separated by pale stripes; no dark humeral blotch.
sealei (western Pacific)

[Note: Almost all specimens entering key couplet 22a will be *E. randalli* as only a few unusual specimens of *E. sealei* have the upper lip completely crenulate.]

22b. Gill-rakers 21–24; pseudobranchial filaments 8–10; upper lip pattern consisting of numerous diffuse spots; a slender dark humeral blotch present.
randalli (Marquesas Islands)

23a. Seven to 9 diffusely dusky bands on lip; dark blotch in humeral region conspicuous; nuchal cirrus 4.1–4.7 percent SL. **niuafoouensis** (Madagascar)

23b. Seventeen to 23 dusky stripes on upper lip; dark blotch in humeral region, if present, diffuse, not obvious; nuchal cirrus 2.4–3.9 percent SL.
niuafoouensis (Pacific Ocean)

24a. Predorsal commissural pores 3 in specimens 26–42 mm SL (apparently remaining constant); anal rays 18 (one specimen out of 13 with 17 rays); vertebrae 35; head smaller, 21.3–23.0 percent SL in specimens 26–42 mm SL, decreasing in relative size with increasing SL.
rofeni (Raroia, Tuamotus)

24b. Predorsal commissural pores more than 3 in specimens 26–42 mm SL (except 33–80 percent of specimens of *E. striatus*, depending on SL class, table 32); number of pores usually increases with increase in SL; anal rays 14–17 (less than 1 percent of specimens of *E. striatus* with 18 rays); vertebrae 33–35 (rarely 35); head larger, 21.3–26.3 percent of SL in specimens 26–42 mm SL, decreasing in relative size with increase in SL (head lengths rarely overlapping with *E. rofeni* in similar-sized specimens: see tables 35, 39, 42, 44, 66) 25

25a. A distinct subovate to subquadrate, more or less uniformly dark spot on body in humeral region dorsal to level of pectoral axil (this mark usually much larger and darker than other body markings); no dark spot just posterior to orbit . . . . . **caudofasciatus** (Indian and Pacific Oceans)

25b. No distinct, uniformly dark spot on body in humeral region dorsal to level of pectoral axil (markings in this region, when present, are diffuse, scarcely larger or darker than other body markings and correlated with an elongate dark spot just posterior to orbit) 26

26a. Color pattern on body usually consisting of clusters of dark spots, diameter of individual spots usually smaller than half orbital diameter; predorsal commissural pores usually fewer at any given size (compare table 52 with tables 41, 43); first dorsal ray 8.5–13.5 percent SL, usually less than 12.0 percent; main or longest supraorbital cirrus frequently with more than 2 lateral cirri branches; soft dorsal fin rays frequently 16 or 17, rarely 14 . . . . **striatus** (Indian and Pacific Oceans)

26b. Color pattern on body either absent or consisting of dark blotches, usually paired, some of which equal or exceed orbital diameter; predorsal commissural pores usually more at any given size (compare tables 41 and 43 with table 32); first dorsal ray 11.7–16.8 percent SL, usually more than 13.0 percent; main or longest supraorbital cirrus usually without lateral cirri branches, never more than 1; soft dorsal fin rays 13–15, never 16 or 17 27

27a. Distinct dark spot present on head posterior to orbit at or above mid-orbital level (pls. 15*c*, 17*a*); greatest width of spot usually more than half orbital diameter; paired blotches on body sides always present, well marked; dorsal lip crenulae 31–39; no dusky bands separated by pale stripes on upper lip . . . . **chapmani** (Easter Island)

27b. Distinct dark spot present or absent on head posterior to orbit at or above midorbital level; when present, greatest width of spot usually less than half orbital diameter (pls. 16*c*, 17*b*); paired blotches on body sides usually faint or absent; dorsal lip crenulae 19–35; dusky bands separated by pale stripes present or absent on upper lip (not Easter Island) 28

28a. Dorsal lip crenulations 26–35 (26 in only 3 of 107 specimens); dark spot, usually elongate, just posterior to eye at or above midorbital level, followed by an elongate pale area and then a diffuse dusky blotch lighter than the spot (pls. 15*c*, 17*a*); markings on upper lip a diffuse sprinkling of melanophores; predorsal commissural pores 6–22 (usually more than 10) in specimens 5–35 mm SL; first soft dorsal ray 14.0–16.8 percent SL in specimens 25–35 mm SL . . **cymatobiotus** (Pacific Ocean, not Hawaii)

28b. Dorsal lip crenulations 19–26; no dark spot on head posterior to eye at or above midorbital level; markings on upper lip consisting of 9 or 10 dusky bands alternating with pale interspaces; predorsal commissural pores 5–11 (rarely more than 9) in specimens 25–35 mm SL; first soft dorsal ray 10.7–14.6 percent SL in specimens 25–35 mm SL.
strasburgi (Hawaiian Islands)

Entomacrodus decussatus (Bleeker)

PLATE 1

Salarias decussatus Bleeker, 1858, Nat. Tijdschr. Nederl. Indië, vol. 15, pp. 230–231 [western Biliton and Sangi (Sangir) islands].
Salarias aneitensis Gunther, 1877, Journ. Mus. Godeffroy, vol. 4, no. 13, p. 205, pl. 118A [Aneiteum].
Salarias atkinsoni Jordan and Seale, 1906, U.S. Bur. Fish. Bull. 25 (1905), p. 428 [Apia, Samoa].

DESCRIPTION.—Segmented dorsal fin rays 16–18 (rarely 18); segmented anal fin rays 16–19 (rarely 16); posteriormost anal pterygiophore supporting 1 or 2 external elements (supporting 2 in 95.5 percent of specimens); total gill-rakers on first arch 17–30, tending to increase in number with increase in SL (table 7); pseudobranchial filaments 5–17, tending to increase in number with increase in SL (table 8); vertebrae 34–36 (usually 35); supraorbital cirri 1–28, increasing in number with increase in SL (table 9); main, or longest, supraorbital cirrus with many short branches on both mesial and lateral margins; nape with 1 cirrus on each side (frequently with small side branches in specimens over 55 mm SL); predorsal commissural pores 3 to more than 50, increasing in number with increase in SL (table 10); preopercular series of pores varying from all positions with simple pores to all positions with pairs or multiples of pores (specimens less than 40 mm SL frequently with all positions with simple pores; specimens over 90 mm SL have at least 1 pair of pores included in the series); 1 or 2 (rarely 3) pores before each anterior nostril (see also geographic variation below); lateral line pores terminating on side in area below and between dorsal ray 2 and caudal base (posterior terminus somewhat determined by size; specimens less than 40 mm SL usually have last pore anterior to level of dorsal ray 11; specimens more than 70 mm SL usually have last pore posterior to level of dorsal ray 10); ventral margin of upper lip of specimens less than 80 mm SL usually partially (centrally) crenulate and partially entire (laterally); lip of specimens over 80 mm SL frequently weakly but completely crenulate (crenulae difficult to count).

Proportional measurements: See tables 3, 4, and 11.

Males develop slight modifications of the skin of the anal spines. These modifications appear in the form of fleshy distal extensions of the skin at the tip of the spine. Greatest development occurs on the second spine, which may become plicate at the tip. Only a few specimens, the smallest of which was 115 mm SL, were available with these modifications. It is presumed that these specimens represented mature males.

The largest male examined was 153 mm SL (mature), and the largest female 133 mm. Females outnumbered males in most size classes. The smallest specimen seen was approximately 15.5 mm SL and was not an ophioblennius stage. Specimens less than 20 mm SL had vomerine teeth but lacked posterior canines in the lower jaw.

COLOR PATTERN OF PRESERVED SPECIMENS.—There is considerable variation in color pattern of specimens, including individual, ontogenetic, and geographic variations. Specimens of 16–45 mm show indications of 5½ to 6½ pairs of irregular bands on the side of the body. The bands are usually broken into three portions: dorsal, middle, and ventral. The midportions of each pair of bands are usually fused (see Schultz and Chapman, 1960, plate 116 F and H) and sometimes appear ringlike. At about 50 mm SL specimens begin to exhibit indications of irregular undulating stripes that overlay, incorporate, and frequently obscure the bands. The striping is least obvious in specimens from the New Hebrides, which are marked with a sprinkling of fine dark spots and dashes covering the sides. Large specimens from all localities except the Gulf of Thailand, South China Sea, Montebello, and Tahiti (only one specimen from each of the last two localities) have less than five diffuse dark spots dorso-

TABLE 7.—Frequency distribution of number of gill-rakers of specimens of *Entomacrodus decussatus* arranged by SL classes (in mm)

Classes	Gill-rakers													
	17	18	19	20	21	22	23	24	25	26	27	28	29	30
15-19.9	-	-	1	-	-	-	-	-	-	-	-	-	-	-
20	1	1	-	-	-	-	-	-	-	-	-	-	-	-
25	-	-	3	1	3	3	2	-	-	-	-	-	-	-
30	-	-	-	-	1	1	-	1	2	-	-	-	-	-
35	-	-	1	-	2	1	1	2	2	-	-	-	-	-
40	-	-	-	-	-	3	4	-	-	-	1	-	-	-
45	-	-	-	1	1	-	2	1	-	1	1	-	1	-
50	-	-	-	-	-	1	1	-	-	-	-	-	-	-
55	-	-	-	-	-	1	2	3	2	4	2	-	-	-
60	-	-	-	-	-	1	1	1	1	1	2	2	-	-
65	-	-	-	1	-	-	-	-	4	1	2	-	-	-
70	-	-	-	-	1	2	2	4	-	1	1	1	-	-
75	-	-	-	-	-	2	-	-	-	-	2	-	-	-
80	-	-	-	-	1	-	1	3	-	-	1	-	-	1
85	-	-	-	-	-	-	-	1	-	-	-	-	-	-
90	-	-	-	-	-	-	-	-	-	-	1	1	1	-
95	-	-	-	-	-	2	-	-	-	-	-	-	-	-
100-109.9	-	-	-	-	-	-	2	1	1	1	-	-	-	-
110	-	-	-	-	-	1	-	2	2	1	1	-	-	-
120	-	1	-	-	-	-	2	1	3	-	-	1	-	-
130	-	-	-	-	-	-	-	-	1	1	-	1	-	-
140	-	-	-	-	-	-	-	-	-	-	1	-	-	-
150	-	-	-	-	-	-	-	1	-	-	-	-	-	-

anteriorly on the sides. Specimens from the other localities have numerous dark spots in that region.

The upper lip varies from uniformly dusky to having three broad, dark bands separated by pale interspaces.

At least the soft portion of the dorsal fin, and sometimes the caudal fin, bear a number of discrete dark pinstripes and dashes in specimens from the New Hebrides, Tau, Tutuila, Samoa, Tongatapu, and Niuafou Islands (the latter five islands are closely associated geographically). Specimens examined from the other localities have the dorsal and caudal fins marked with diffuse dark spots which may or may not appear as enlargements of portions of what might have been a basic pinstripe pattern. The spots are usually restricted to positions over the rays while the pinstripes and dashes are continuous

TABLE 8.--Frequency distribution of number of pseudobranchial filaments of specimens of *Entomacrodus decussatus* arranged by SL classes (in mm)

Classes	Pseudobranchial filaments												
	5	6	7	8	9	10	11	12	13	14	15	16	17
15-19.9	1	2	-	-	-	-	-	-	-	-	-	-	-
20	-	1	-	-	-	-	-	-	-	-	-	-	-
25	-	1	-	5	1	-	-	-	-	-	-	-	-
30	-	-	1	4	2	-	-	-	-	-	-	-	-
35	-	-	1	3	3	-	-	-	-	-	-	-	-
40	-	-	-	1	5	2	1	-	-	-	-	-	-
45	-	-	-	1	2	2	2	-	-	-	-	-	-
50	-	-	-	-	2	-	-	-	-	-	-	-	-
55	-	-	-	-	2	5	4	3	-	-	-	-	-
60	-	-	-	-	-	2	4	2	1	-	-	-	-
65	-	-	-	-	1	2	1	3	2	-	-	-	-
70	-	-	-	-	2	2	2	3	2	1	-	-	-
75	-	-	-	-	-	1	1	1	-	-	-	-	-
80	-	-	-	-	-	2	-	3	1	-	-	-	-
85	-	-	-	-	-	-	1	1	-	-	-	-	-
90	-	-	-	-	-	-	-	2	1	-	-	-	-
95	-	-	-	-	-	1	-	-	1	-	-	-	-
100-109.9	-	-	-	-	-	1	-	-	4	-	-	-	-
110	-	-	-	-	1	-	2	2	1	-	-	1	-
120	-	-	-	1	-	-	1	2	-	1	-	1	1
130	-	-	-	-	-	1	-	-	2	-	-	-	-
140	-	-	-	-	-	-	-	-	1	-	-	-	-
150	-	-	-	-	-	-	1	-	-	-	-	-	-

across the rays or are restricted to the membrane between the rays. Many specimens over 40 mm SL have two to three narrow, dark longitudinal stripes or bands on the anal fin. On close examination, all specimens are found to have these stripes but the area between the stripes is sometimes almost as dark as the stripes themselves and thus the pattern is obscured.

GEOGRAPHIC VARIATION.—(See also color pattern above.) Most specimens from Tau Island and many from Tongatapu Island have two or three pores before one or both anterior nostrils. Specimens from the other localities, with rare exceptions, have only one pore before each anterior nostril.

In at least two populations of *E. decussatus*, males appear to have higher segmented dorsal fin ray averages than females. In the Tongatapu population, of 23 males examined, 2 had 16 rays, 20 had 17 rays, and 1 had 18 rays. Of 23 females examined, 10 had 16 rays and 13 had 17 rays. In the South China Sea and Gulf of Thailand population, all 6 males examined had 17 rays; 5 females had 16 rays, and 5 had 17 rays. Sexual dimorphism of other meristic characters

TABLE 9.--Frequency distribution of number of supraorbital cirri of specimens of *Entomacrodus decussatus* arranged by SL classes (in mm)

Classes	Cirri number																											
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
15-19.9	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20	2	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
25	1	2	3	-	2	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
30	-	1	-	1	2	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
35	-	-	-	-	1	-	1	6	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
40	-	-	-	-	1	2	2	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
45	-	-	-	-	-	2	-	-	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
50	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
55	-	-	-	-	-	-	2	2	2	4	1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
60	-	-	-	-	-	-	-	1	1	2	3	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
65	-	-	-	-	-	-	-	-	-	3	2	1	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
70	-	-	-	-	-	-	-	1	3	2	4	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
75	-	-	-	-	-	-	-	1	-	1	-	-	1	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-
80	-	-	-	-	-	-	-	-	1	1	3	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
85	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-
90	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-
95	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
100-109.9	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	1	-	-	-	1	-	-	1	-	-	-
110	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	2	-	-	1	-	-	1	-	1	-	-	-
120	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	3	1	-	-	-	-	-	-	-	-	-	1
130	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
140	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
150	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-

was not noted, nor was sexual dimorphism of dorsal fin ray counts noted in specimens from other localities, but I do not consider my data conclusive.

Nomenclature.—Bleeker based his description of *Salarias decussatus* on four specimens, 51–128 mm (total length?), from Biliton and Sangir Islands. There are only four specimens, RMNH 4778, from Biliton and Sangir Islands in the Leiden museum. These specimens are approximately 40, 51, 105, and 127 mm SL, which indicates a possible discrepancy in the measurement of the largest specimen (a specimen 40 mm SL would be about 52 mm total length, 128 mm SL, about 155 mm total length). All four specimens are in poor condition. I here designate the 105 mm (approximately 128 mm total length) specimen from Sangir as lectotype. The lectotype, a male, in better condition than the other specimens, has 16 predorsal commissural pores; the paralectotypes have 10, 12, and more than 30 pores. The 127 mm paralectotype has two pores before each anterior nostril; the lectotype and other paralectotypes have one pore before each anterior nostril.

Salarias aneitensis was described by Günther from two dried specimens, seven inches long, in the British Museum. These specimens are no longer extant in the BMNH collections, apparently having been lost during World War II when the BMNH types were removed from

TABLE 10.--Frequency distribution of number of predorsal commissural pores of specimens of *Entomacrodus decussatus* arranged by SL classes (in mm)

Classes	Number of pores																						
	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	>25
15-19.9	11	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20	1	1	-	1	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
25	-	-	-	4	5	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
30	-	-	-	-	3	2	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-
35	-	-	1	-	1	1	-	1	1	1	-	-	-	1	-	1	1	-	1	-	-	-	-	-
40	-	-	-	-	-	-	-	1	1	-	-	-	-	-	1	1	1	-	-	1	-	1	3	-
45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	1	1	1	-	-	3
50	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-	1
55	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	2	-	-	1	10
60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	2	-	-	1	5
65	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	2	1	-	5
70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	1	-	-	1	6
75	-	-	-	-	-	-	-	-	1	-	-	-	-	1	1	1	-	-	-	-	-	-	-	1
80	-	-	-	-	-	-	-	-	1	-	-	-	-	1	1	-	1	-	-	-	-	-	-	3
85	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1
90	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	1
95	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1
100-109.9	-	-	-	-	-	-	-	-	1	-	-	-	-	1	-	-	1	-	-	-	-	-	1	2
110	-	-	-	-	-	-	-	-	-	-	1	1	-	1	-	-	-	-	-	1	1	1	-	1
120	-	-	-	-	1	-	-	-	-	-	1	1	-	-	1	-	-	-	1	-	1	-	-	2
130	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
140	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1
150	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1

the museum for safer storage. Chapman (1951, p. 279) supposedly reported on Günther's types, but the specimens he saw were too small (107 and 125 mm, much less than 7 inches) to be the types and were undoubtedly BMNH 1931.7.4.4–5, also from Aneiteum.

Chapman (1951) considered *E. aneitensis* a synonym of *E. decussatus*, but Schultz and Chapman (1960) recognized both species. The basis for this latter recognition seems concerned primarily with color pattern and the supposed fact that the nuchal tentacle of *E. decussatus* had one or two short cirri on its margin, while the nuchal tentacle of

TABLE 11.--Proportional dimensions as percent SL of specimens of *Entomacrodus decussatus* (for meaning of abbreviations see methods section)

Catalog no.	Locale	Sex	SL	HL	OL	OCL	NCL	DS3	DS13	DR1	PECL	PELL	CL
USNM 124118	Guam	-	32.1	25.5	9.0	6.2	4.1	11.8	4.7	14.0	26.0	19.6	25.5
USNM 124118	Guam	♂	35.4	26.6	8.2	6.2	3.4	12.2	3.7	13.8	22.6	19.2	-
USNM 115474	Tutuila	♀	37.8	26.0	8.3	5.2	2.6	11.7	3.4	13.5	25.7	20.0	24.9
USNM 115474	Tutuila	♂	38.5	25.1	8.2	4.5	2.6	11.9	2.6	14.6	25.4	18.5	24.1
USNM 124118	Guam	♀	42.2	24.6	8.1	7.1	2.8	12.6	4.3	15.4	23.9	19.0	26.1
USNM 115474	Tutuila	♂	44.7	25.0	8.5	4.5	3.1	12.1	3.4	11.2	24.8	19.0	24.6
USNM 115474	Tutuila	♀	55.1	24.3	7.4	4.5	2.7	12.7	3.4	14.1	24.0	17.0	25.4
USNM 115474	Tutuila	♀	55.8	24.0	7.6	3.5	2.8	12.2	3.5	14.2	24.0	17.0	23.2
USNM 115474	Tutuila	♀	62.1	24.5	7.6	3.7	2.4	12.2	3.4	13.5	23.2	16.4	22.8
USNM 124118	Guam	♀	68.2	24.2	6.7	6.0	2.2	11.9	3.8	13.3	23.6	17.7	24.0
USNM 115474	Tutuila	♀	71.4	24.2	7.0	4.3	2.1	12.0	3.5	12.6	22.8	14.7	22.4
USNM 139838	Guam	♂	72.9	23.3	6.6	6.2	2.7	-	4.1	12.9	23.0	15.1	24.7
SU 62003	S. China Sea	♂	75.5	22.5	6.1	6.4	2.0	11.9	4.0	13.8	23.3	15.2	25.2
USNM 139838	Guam	♀	79.6	23.4	6.2	6.2	3.1	11.3	3.9	12.6	23.5	15.7	24.5
USNM 139838	Guam	♀	81.8	23.2	6.4	4.4	2.3	12.2	5.4	13.2	23.6	16.1	23.8
USNM 115474	Tutuila	♂	83.2	23.6	6.9	3.0	1.9	11.0	3.6	12.5	22.5	15.2	22.1
USNM 139838	Guam	♂	84.8	23.0	6.1	5.7	2.6	12.4	4.7	13.0	22.0	15.7	23.6
SU 40641	Philippines	♀	88.7	23.1	6.5	8.1	2.4	10.9	2.6	13.0	22.9	-	23.4
SU 62003	S. China Sea	♀	90.0	23.3	5.8	5.6	2.0	11.7	3.6	13.2	24.3	16.3	24.7
USNM 139838	Guam	♀	96.0	22.4	5.9	5.4	2.4	11.7	5.3	12.5	21.8	15.3	22.9
SU 62003	S. China Sea	♀	101.6	22.5	5.7	6.6	1.9	9.5	3.7	12.0	21.6	16.2	23.8
SU 62003	S. China Sea	♂	115.2	23.4	5.6	6.2	1.6	11.7	3.6	14.1	21.4	15.4	23.8
SU 62005	Gulf of Siam	♀	125.0	23.2	5.1	5.0	1.7	11.9	3.2	13.5	23.6	15.8	23.8
SU 62003	S. China Sea	♀	125.0	23.2	5.6	5.3	1.9	12.2	4.2	12.6	20.0	16.2	22.4
USNM 139838	Guam	♀	130.6	24.5	5.9	2.4	.2.1	12.2	3.5	13.0	22.7	15.5	-
SU 62003	S. China Sea	♂	144.0	22.8	4.7	6.2	1.5	11.4	3.1	12.8	21.0	14.6	22.9
SU 62003	S. China Sea	♂	153.0	22.2	4.9	6.9	1.6	9.5	2.6	11.2	19.6	13.7	20.9

E. aneitensis had none. The large number of fine small spots on the sides of *E. aneitensis* may be of specific significance, but there is so much variation in color from population to population and specimen to specimen that I prefer not to accept color pattern variation as a basis for recognizing *E. aneitensis*. Some specimens from localities other than Aneiteum are heavily spotted though not in quite the same manner as specimens from Aneiteum. The spots are relatively larger and the perimeters of the spots less sharply delimited. The character of the fringing of the nuchal cirrus in *E. decussatus* is dependent on the size of the specimen concerned. The larger specimens tend to have the nuchal cirrus margins with small branches.

Salarias atkinsoni was described from a single specimen without comparison with other species. The holotype represents the normal juvenile of *E. decussatus*.

Relationships.—*Entomacrodus decussatus* is most closely related to *E. vermiculatus* and secondarily related to *E. stellifer* (for discussion, see relationships under the latter two species).

Remarks.—*Entomacrodus decussatus* has been collected with or from the same general locality as *E. stellifer*, *E. thalassinus*, *E. sealei*, *E. caudofasciatus*, *E. striatus*, *E. cymatobiotus*, *E. epalzeocheilus* and *E. niuafoouensis*. It differs from all these species in the nature of its color pattern and from all but *E. stellifer* in having a larger eye (table 3) and typically 35 vertebrae. In addition, it differs obviously: from *E. stellifer*, in having pinnately compound supraorbital cirri and typically more gill-rakers; from *E. thalassinus*, in having a crenulate upper lip and more gill-rakers, psuedobranchial filaments, and soft dorsal rays; from *E. sealei* and *E. caudofasciatus*, in having the central portion of the ventral margin of the upper lip with crenulae and in having more pseudobranchial filaments and soft dorsal and anal rays; from *E. striatus*, in having more predorsal commissural pores and pseudobranchial filaments at comparable sizes, and in frequently having some preopercular pores paired or in multiples; from *E. cymatobiotus*, in having more soft dorsal and anal rays, gill-rakers, pseudobranchial filaments, and in frequently having some paired pores in the preopercular series; from *E. epalzeocheilus*, in having the nuchal cirri basically simple (or when branched, the branches always much smaller than the main cirrus rather than subequal), and in having the lateral margins or the supraorbital cirrus with branches; and from *E. niuafoouensis*, in having the lateral margin of the supraorbital cirrus with branches.

Distribution (fig. 5).—*Entomacrodus decussatus* is known only from islands in the Pacific Ocean and that ocean's associated gulfs and seas.

MATERIAL.—Australia (western), Montebello Island: BMNH 1961.8.16.79; Gulf of Thailand, Goh Samet Island, 12°31'38"N, 101°26'46"E: SU 62005; Goh Sak Island, 12°56'37"N, 100°47'33"E: SU 62004; Goh Tao Island, Ao Mae Hat Bay: SU 62007; South China Sea, Ilot du Sud, 10°29'15"N, 108°57'30"E: SU 62003; Biliton Island: RMNH 4778 (includes lectotype of *Salarias decussatus*); Philippine Islands, Mindoro, Puerto Galero: SU 32329; Batangas, Nasugbu: SU 14731; Samar, Mercedes: SU 40640, 40641; Sangir Island: RMNH 4778; Marianas Islands, Saipan: SU 62082, USNM 123841, 124335; Guam: USNM 123936, 124118, 139838; New Hebrides, Venui Island, Espiritu Santo: ANSP 91364; Aneiteum: BMNH 1931.7.4.4–5; Niuafou Island: USNM 91940, 91941, 91954, 91966; Tutuila Island: USNM 115474; Tau Island: USNM 115475, 143788; Samoa: BPBM 5236, USNM 51791 (holotype of *Salarias atkinsoni*); Tonga Islands, Tongatapu: UH 03082; Tahiti: BMNH 1881.10.18.12.

Entomacrodus vermiculatus (Valenciennes)

PLATES 2, 3

Salarias vermiculatus Valenciennes *in* Cuvier and Valenciennes, 1836, Hist. Nat. Poissons, vol. 11, p. 301 [Seychelles].

Salarias vermiculatoides Bleeker, 1857, Nat Tijdschr. Nederl. Indië, vol. 13, p. 478 [Karangbollong, south coast Java; name only]; 1858, Act. Soc. Sci. Indo-Neerl., vol. 3, p. 40 [Trussan, western Sumatra].

?*Salarias reuteri* Lenz, 1881, Zool. Anzeig., vol. 93, p. 506 [Nossi-Bé, Madagascar].

DESCRIPTION.—Segmented dorsal fin rays 15–17 (rarely 15); segmented anal fin rays 16–18 (rarely 16); posteriormost anal pterygiophore supporting 1 or 2 external elements (supporting 2 in 78.6 percent of specimens); total gill-rakers on first arch 20–26 (rarely 20); pseudobranchial filaments 8–13 (usually 8–11, probably not increasing in number with increase in size beyond 65 mm SL, table 12); vertebrae 34 or 35 (usually 35); supraorbital cirri 2–38, increasing in number with increase in SL (table 13); main or longest cirrus with many short branches on both mesial and lateral margins; nape with 1 cirrus on each side (occasionally with small side branches in large specimens); predorsal commissural pores 7 to more than 50, increasing in number with increase in SL (table 14); at least first 5 preopercular pore positions with pairs or multiples of pores; 1–7 pores before each anterior nostril, (only 1 specimen with 1 pore before each anterior nostril), tending to increase in number with increase in SL; lateral line pores terminating on caudal peduncle posterior to level of last dorsal ray (in specimens over 50 mm SL; termination below segmented dorsal ray 14 in one specimen); ventral margin of upper lip completely, but weakly and irregularly, crenulate (crenulae difficult to count).

Proportional measurements: See tables 3, 4, and 15.

Males may develop slight modifications of the skin of the anal spines and rays. These modifications appear as fleshy envelopments of the fin elements. In a few specimens, larger than 114 mm SL, the skin of the anal spines and the first two anal rays was slightly rugose.

If males with rugose anal elements are considered to be mature, then both mature and immature males may occur in the same collection, and in these collections immature males may be as much as 15 mm longer than mature males.

The largest male examined was 149 mm SL, and the largest female, 153 mm. Males and females occurred with relatively equal frequency in the various size classes. The smallest specimen examined was a nonophioblennius stage juvenile, 22.9 mm, with the upper lip crenulae restricted to the middle third of the ventral lip margin.

COLOR PATTERN OF PRESERVED SPECIMENS.—This species has the most complex color pattern of all the members of its genus (see pls. 2, 3). Underlying the vermiculated pattern there seem to be 5½ to 6½ pairs of bands on the body (the members of a pair coalesce at their midportions). The bands are positioned on the sides somewhat similarly to the bands of other species of *Entomacrodus*.

The color pattern undergoes extreme ontogenetic change (pl. 3). At 22.9 mm, a size at which specimens of most of the other species show indications of their adult color pattern, *E. vermiculatus* is uniformly pale. One specimen, USNM 72735, about 24 mm, in poor condition, did show indications of a faded pattern. Up to about 50–70 mm, specimens exhibit a loose network of dark lines on the body that

TABLE 12.--Frequency distributions of pseudobranchial filaments and gill-rakers of specimens of *Entomacrodus vermiculatus* arranged by SL classes (in mm)

Classes	Gill-rakers							Filaments					
	20	21	22	23	24	25	26	8	9	10	11	12	13
20-24.9	-	-	-	-	-	-	-	1	-	-	-	-	-
40-44.9	1	-	-	-	-	-	-	1	-	-	-	-	-
45	-	-	1	-	-	-	-	1	-	-	-	-	-
50	1	-	1	-	1	-	-	2	1	1	-	-	-
55	-	-	1	-	-	-	-	1	1	1	-	-	-
60	-	1	-	-	1	-	-	2	-	-	-	-	-
65	-	-	1	3	-	-	-	-	1	2	1	-	-
70	1	-	-	-	-	1	-	-	-	1	1	-	-
75	-	1	-	-	-	-	-	-	1	-	-	-	1
80	-	-	-	-	-	-	-	-	-	1	-	-	-
85	-	-	1	-	-	-	-	-	-	-	1	-	-
90	-	-	1	-	1	1	-	2	2	-	-	-	-
95	-	1	1	-	-	1	1	-	-	1	2	-	-
100-109.9	-	-	2	-	-	-	-	-	-	-	-	-	2
110	1	-	1	3	-	1	2	1	3	3	-	-	-
120	-	-	-	2	1	-	-	-	-	-	3	-	-
130	-	-	3	1	-	1	-	-	1	2	-	2	-
140	-	2	-	-	1	-	2	-	1	2	2	-	-
150	-	-	-	-	-	-	1	-	-	-	1	-	-
160	-	-	-	-	-	1	-	-	-	1	-	-	-

are more or less grouped at the positions of the bands mentioned above. At larger sizes the network becomes increasingly complex until it forms tiny vermiculations, spots, and reticulations over the entire body, except for the venter of females. The upper lip may show indications of two or three dusky bands alternating with pale interspaces, or the lip may be irregularly dusky. There may be indications of a diffuse dusky band behind the eye, but there is never a distinct dark spot at that position. The vertical and pectoral fins are variously pale, dark spotted, and reticulated, depending on size.

NOMENCLATURE.—Valenciennes based his description of *Salarias vermiculatus* on a single specimen, but included comments on specimens collected by both Dussumier and Reynaud. Inferences from the description lead me to the conclusion that the description is based on Dussumier's specimen. There are two specimens from the Seychelles in the Paris museum collection, one collected by Dussumier from the "Seychelles" (MNHN A 1809) and the other from "Detroit de la Sonde" (MNHN A 2029), the locality from which Reynaud made collections (data included with this latter specimen do not mention the collector). The Dussumier specimen has 15 soft dorsal rays, the number mentioned in the description; the other specimen has 16 soft dorsal rays. I here designate Dussumier's specimen lectotype of the species. The other specimen becomes, then, a paralectotype.

TABLE 13.--Frequency distribution of number of supraorbital cirri of left eye of specimens of *Entomacrodus vermiculatus* arranged by SL classes (in mm)

Classes	Number of cirri																			
	2	5	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	>25
20-24.9	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
40-44.9	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
45	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
50	-	-	-	1	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
55	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-
60	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
65	-	-	-	-	1	1	-	1	-	1	-	-	-	-	-	-	-	-	-	-
70	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-
75	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-
80	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
85	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
90	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
95	-	-	-	-	-	-	-	1	1	1	-	-	1	-	-	-	1	-	-	-
100-109.9	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	-	-	-	-	-
110	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	1	2	1	-	3
120	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
130	-	-	-	-	-	1.	-	-	-	-	-	1	1	-	-	-	-	1	-	2
140	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	1	2
150	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1

The syntypes of *Salarias vermiculatoides* Bleeker, from Trussan, Sumatra, are included among a number of Bleeker specimens (RMNH 4777), all conspecific with *S. vermiculatus*, and with mixed locality data, including Trussan. Since *S. vermiculatoides* is a synonym of *S. vermiculatus*, I see no reason for designating a lectotype. Bleeker (1857, see synonymy) gave no description with his first mention of *S. vermiculatoides*; the name therefore dates from 1858.

Salarias reuteri Lenz is poorly described, but mention is made that it is similar to *S. vermiculatus*. From the description it could be synonymous with *S. vermiculatus*. The holotype of *S. reuteri*, the only known specimen, was destroyed during World War II (G. von Studnitz, Director, Naturhistorisches Museum, Lübec, pers. comm.); I have, therefore, only tentatively synonymized *S. reuteri* with *S. vermiculatus*.

RELATIONSHIPS.—*Entomacrodus vermiculatus* is most closely related to *E. decussatus*. It shares many characteristics with *E. decussatus* and could be considered an Indian Ocean cognate of *E. decussatus*. The shared characters include a relatively deeper body, frequent presence of a well-developed 13th dorsal spine, a more posterior point of attachment of the dorsal fin membrane (to the caudal base or beyond in large specimens), generally larger number of gill-rakers and pseudobranchial filaments, typically 35 vertebrae, supraorbital cirrus with numerous lateral and mesial branches, numerous predorsal commissural pores, a relatively small posterior canine on each side

TABLE 14.--Frequency distribution of number of predorsal commissural pores of specimens of *Entomacrodus vermiculatus* arranged by SL classes (in mm)

Classes	Number of pores																
	7	10	13	14	15	16	17	18	19	20	21-25	26-30	31-35	36-40	41-45	46-50	>50
20-24.9	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
40-44.9	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
45	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
50	-	-	-	-	-	1	1	1	1	-	-	-	-	-	-	-	-
55	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-	-	-
60	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-
65	-	-	-	-	-	1	-	-	-	-	2	-	1	-	-	-	-
70	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-
75	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
80	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
85	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-
90-99.9	-	1	-	-	-	-	-	1	-	-	1	1	-	-	-	-	-
100	-	-	-	-	-	-	1	-	-	-	-	-	-	1	-	-	-
110	-	-	-	-	-	-	-	-	-	-	2	1	-	1	-	1	3
120	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	1
130	-	-	-	1	-	-	-	-	-	-	-	1	-	1	-	-	2
140	-	-	-	-	-	1	-	-	1	-	1	1	1	-	-	-	-
150	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
160	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1

of the lower jaw, and a weakly crenulate upper lip. *Entomacrodus vermiculatus* differs from *E. decussatus* primarily in the nature of its complex color pattern which appears to be an elaboration of that of *E. decussatus*. It also differs from most specimens of *E. decussatus* in having more than one pore before each anterior nostril, and modally fewer soft dorsal rays. The posterior extension of the lateral line pores beyond the level of the last dorsal ray onto the caudal peduncle occurs with greater frequency in *E. vermiculatus* than in *E. decussatus*. It is, with *E. decussatus*, the closest relative of *E. stellifer*, but both *E. vermiculatus* and *E. decussatus* can be easily distinguished from *E. stellifer* by color pattern and the number of supraorbital cirri.

REMARKS.—*Entomacrodus vermiculatus* has been collected with or from the same general locality as *E. thalassinus*, *E. striatus*, and *E. epalzeocheilus*. It differs most obviously from all these species in the nature of its color pattern. In addition it differs: from *E. thalassinus*, in having crenulae on the upper lip, multiple pores in the preopercular series, more than one pore before each anterior nostril, and in having more gill-rakers (it also attains a maximum size of more than three times that of *E. thalassinus*); from *E. striatus*, in having multiple pores in the preopercular series, more than one pore before each anterior nostril, and more predorsal commissural pores at any particular size; and from *E. epalzeocheilus*, in the nature of its nuchal cirri, in having more supraorbital cirri, and in having lateral branches on the main supraorbital cirrus.

TABLE 15.--Proportional dimensions as percent SL of specimens of *Entomacrodus vermiculatus* (for meaning of abbreviations see methods section)

Catalog no.	Locale	Sex	SL	HL	OL	OCL	NCL	DS3	DS13	DRI	PECL	PELL	CL
USNM 199425	Malacca Str.	♀	44.6	22.8	7.2	4.5	2.7	10.3	3.6	13.2	22.8	16.1	24.2
RMNH 4777	Java	♀	57.2	25.4	7.3	6.5	2.3	11.2	3.5	12.9	23.4	16.1	23.4
USNM 197685	Mozambique	♂	61.7	22.7	6.5	6.2	3.2	11.3	-	-	21.1	16.2	25.3
RU(no number)	Seychelles	♂	64.2	22.4	6.2	5.0	2.6	-	3.9	11.8	24.6	-	23.7
USNM 178989	India?	♀	74.0	23.8	7.0	7.4	2.4	11.5	5.1	13.0	24.3	17.0	23.5
RMNH 4777	Java	♀	79.7	23.3	6.5	6.5	1.8	11.9	3.8	12.6	23.0	16.6	23.8
USNM 178989	India?	♀	89.0	23.0	6.2	6.7	2.4	11.8	4.5	13.9	23.6	16.4	23.8
USNM 197636	Seychelles	♀	89.0	22.7	5.6	4.0	2.7	9.9	3.4	11.8	23.8	14.8	21.4
RMNH 1812	Java	♀	96.6	24.3	6.0	6.2	2.2	11.8	3.1	13.2	22.8	15.5	23.3
RU(no number)	Mozambique	♂	115.0	22.0	5.2	>5.2	2.1	11.3	-	-	19.6	-	21.2
RMNH 4777	Java?	♀	116.5	22.5	5.3	5.0	1.5	10.6	2.2	12.2	20.6	15.4	21.7
RMNH 4777	Java?	♀	120.0	22.2	5.4	4.8	1.8	10.8	3.0	13.2	20.8	14.5	21.6
ANSP 102198	Seychelles	♀	134.5	22.5	4.8	4.3	1.9	12.4	-	12.8	22.7	15.5	22.2
USNM 178989	India?	♀	135.7	22.0	5.2	4.3	1.5	10.2	3.2	12.3	22.9	14.3	22.8
ANSP 102195	Seychelles	♂	148.6	23.8	4.6	8.0	2.2	10.7	-	11.3	21.3	14.3	21.4

DISTRIBUTION (fig. 5).—*Entomacrodus vermiculatus* is known only from the Indian Ocean, and is the only species of *Entomacrodus* endemic to that ocean.

MATERIAL.—Mozambique, Ibo: USNM 197685, RU uncataloged; Seychelles: BMNH 1860.3.1.18, MNHN A 1809 (lectotype of *Salarias vermiculatus*); Beacon Island: ANSP 102195; Curieuse Island: ANSP 102198; Mahé: USNM 197636; La Digue: RU uncataloged; Madagascar, Fort Dauphin: MNHN 1914–15; Nossi Be: USNM 199246; Ceylon: BMNH 1866.1.24.10–17, 1903.5.12.2–4; Java (Karangbollong) and/or Sumatra (Trussan): RNHM 4777 (includes syntypes of *Salarias vermiculatoides*); Java, locality unknown: RMNH 1812; Pelabuhan Ratu, 6°59′ S, 106°33′ E: USNM 72735; locality unknown (collected by Indian Zoological Survey): USNM 178989; Malacca Straits, Pulo Jarak (03°59′N, 100°16′E): USNM 199425; Detroit de la Sonde (Sunda Strait): MNHN A2029.

Entomacrodus stellifer (Jordan and Snyder)

(For synonymy, see subspecies)

DESCRIPTION.—Segmented dorsal fin rays 15–17 (table 16); segmented anal fin rays 16–19 (table 16); posteriormost anal pterygiophore supporting 1 or 2 external elements (supporting 2 elements in 25.2 percent of specimens of *E. s. lighti* and 20.2 percent of *E. s. stellifer*); total gill-rakers on first arch 14–20 (rarely 14 or 20); pseudobranchial filaments 6–10, increasing in number with increase in SL (table 17); vertebrae 34–36 (table 16); supraorbital cirri 1–3 (1 in over 90 percent of specimens), number not increasing with increase in SL; predorsal commissural pores 3–9, not obviously increasing in number with increase in SL (table 18); nape with 1 cirrus on each side (a flap occasionally with frayed edges); all preopercular pore positions with simple pores (rarely with 1 pair of pores at one position); 1 pore before each anterior nostril; lateral line pores terminating on side in area below and between dorsal fin ray 10 and posterior end of caudal peduncle; ventral margin of upper lip with middle one-third to three-fifths unevenly crenulate, lateral thirds or fifths entire.

Proportional measurements: See tables 3, 4, and 19.

Males do not develop noticeable modifications of the skin of the anal spines and rays and it is therefore not possible to differentiate mature from immature males externally. Males (and rarely females), presumably mature or maturing, tend to develop a low fleshy predorsal crest. Males as small as 43 mm SL may show indications of such a crest, while males as large as 60 mm may not.

The largest specimen of *E. s. stellifer* examined was a male, 82.8 mm SL, and the largest female, 67.8 mm. Too few specimens were available to determine if there was a significant difference in relative numbers of either sex at any particular size. The smallest specimen examined, 28.7 mm SL, was a juvenile male.

The largest specimen of *E. s. lighti* examined was a male, 96.6 mm SL, and the largest female was 92.0 mm. Males and females occurred with about relatively equal frequencies in any particular size class. The smallest specimen seen, 15.5 mm, was not an ophioblennily larva. At this size the ventral margin of the upper lip is almous completely entire and superficially the specimen might be mistakenlst identified as *E. thalassinus;* however, there would be more predorsa, commissural pores (table 69) in specimens of this size of *E. thalassinus*, and the number of soft dorsal and anal rays would usually be less.

Color pattern of preserved specimens.—(Specimens should be examined for color pattern while immersed in alcohol.) *E. s. stellifer:* There are most frequently 4½ pairs of dark bands on the sides. The half pair is on the caudal peduncle at the caudal base. The anteriormost pair of bands is below dorsal spines 9–11. Occasional specimens show faint indications of a half pair or pair of bands anterior to the anteriormost pair of bands just mentioned. The members of a pair of bands are separated by a narrow pale interspace. Each dark band is marked by inclusions of pale spots or dashes that increase in number in the anterior bands to the point where the pattern may appear composed of numerous small pale and dark spots and vermiculations. Dorsally the bands encroach on the bases of the dorsal fin elements. Ventrally the bands disappear just before reaching the anal fin base. The areas between the pairs of bands (or between a half pair and a pair) are variably marked with spots, which are much darker above the midline of the body than below. The sides of the head vary from almost uniformly dusky to densely marked with small dark spots, a continuation of the pattern from the anterior portion of the sides. There is frequently an indistinct dusky spot behind the midlevel of the eye, another below the eye at about its midpoint, and a third just anterior to this latter spot. These three spots are ventroposteriorly directed. The upper lip and snout vary from uniformly dusky to variegated with numerous diffuse dark and pale spots. The ventral portion of the head is variably dusky, showing adumbrations of dusky chevrons or vermiculations.

The dorsal fin bears a dark spot distally on the membrane between the anterior two spines. This spot is usually much darker in males than in females from the same collection. The remainder of the dorsal fin, except for the encroachments of the body bands, is usually light to dark dusky with indications of dark and pale dorsoposteriorly directed stripes. The anal fin is light to dark dusky in males, the pigment increasing in intensity distally. Females (and some young males) have the distal portions of the anal rays pale (without melanophores); the remainder of the fin is similar to that of males. The pectoral fin is light dusky, frequently with a broad half-moon concentration of pigment basally, which may include a number of small dark spots. The fleshy pectoral base is diffusely dusky spotted or vermiculated. The pelvic fins are pale to dark dusky. The caudal fin is dusky (without stripes or bands) with two irregular pale spots at the base which sometimes extend onto the caudal peduncle. (See also: Jordan and Snyder, 1902, fig. 10; Schultz and Chapman, 1960, pl. 115c.)

E. s. lighti: There are usually indications of about 4½ pairs of dark bands, often very irregular in shape, on the body. These are in similar position to those mentioned for *E. s. stellifer*. There may be additional bands or portions of bands anterior to these. The bands are frequently darkest and broadest in their midportions, palest and most slender ventrally. The pigment of the bands is more or less evenly distributed and no more than a few relatively large pale areas are included in them. Dorsally the bands encroach on the dorsal fin, ventrally they fail to reach the anal base. The sides of the head are variable, but at least three well-marked, posteroventrally directed bands extend from the orbit at similar positions to the marks described in this area for *E. s. stellifer* (these bands are much better defined than those found in *E. s. stellifer*). The anteriormost of these three bands may extend onto the sides of the upper lip. Occasionally a third band extends from the snout onto the upper lip between these two lateral bands. The upper lip is sometimes dusky with numerous pale spots (spots larger than those in comparably sized specimens of *E. s. stellifer*). The underside of the head bears adumbrations of dusky chevrons. The fins are similarly marked to those of *E. s. stellifer* except that the fleshy pectoral base may exhibit a distinct dark area separated by a pale area from the base of the pectoral rays.

For geographic distribution, discussion, and material, see subspecies accounts.

RELATIONSHIPS.—*Entomacrodus stellifer* is quite distinct from all other species of its genus. It is the only species in which the crenulations of the upper lip are always restricted to the middle third of the ventral margin, the nasal cirri arise from a broad flap, and there is a dark spot between the anterior two dorsal spines. Except for *E. macrospilus*, *E. stellifer* is the only species of *Entomacrodus* in which the supraorbital cirrus is typically simple. *E. stellifer* is unusual in that a large number of specimens lack one or both posterior canines in the lower jaw. This species exhibits the greatest development of any species of *Entomacrodus* of the "crest" on top of the head of males.

The restriction of the dorsal lip crenulae to the middle third of the ventral margin (present in some juveniles of *E. decussatus* and *E. vermiculatus*), the lack of rugose modifications of the skin of the anal spines and rays of males, the relatively small posterior canine in the lower jaw, the large number of vertebrae and dorsal and anal segmented rays, and the frequent occurrence of a well-developed thirteenth dorsal spine are characters that *E. stellifer* shares with *E. decussatus* and *E. vermiculatus* and which I believe relate *E. stellifer* with those species.

REMARKS.—*Entomacrodus stellifer* has been collected with or from the same restricted geographic area as *E. thalassinus* (both subspecies), *E. decussatus*, *E. striatus*, *E. niuafooensis*, and *E. sealei*.

TABLE 16.--Frequency distribution of number of segmented dorsal and anal rays and vertebrae of subspecies of *Entomacrodus stellifer* arranged geographically

Subspecies	Dorsal rays			Anal rays				Vertebrae		
	15	16	17	16	17	18	19	34	35	36
stellifer										
Japan	2	9	-	-	4	7	-	-	8	1
Okinawa	-	9	4	-	-	11	2	-	5	5
Saipan	-	1	-	-	-	1	-	-	1	-
lighti										
Amoy, China	1	-	-	-	-	-	-	-	-	-
Hong Kong	54	30	-	2	47	35	-	10	40	3
Thailand	-	1	-	-	-	1	-	-	-	-
Singapore	2	-	-	-	2	-	-	-	1	-

TABLE 17.--Frequency distribution of number of pseudobranchial filaments of subspecies of *Entomacrodus stellifer* arranged by SL classes (in mm)

Classes	Pseudobranchial filaments								
	lighti					*stellifer*			
	6	7	8	9	10	6	7	8	9
15-15.9	1	-	-	-	-	-	-	-	-
20	-	1	-	-	-	-	-	-	-
25	-	2	-	-	-	1	-	-	-
30	-	3	-	-	-	-	2	-	-
35	1	4	3	-	-	-	1	-	-
40	1	2	6	-	-	-	-	3	-
45	-	6	6	-	-	-	2	2	-
50	-	1	7	-	-	-	-	3	-
55	-	1	4	-	-	-	-	3	1
60	-	-	5	2	-	-	-	1	1
65	-	2	4	1	-	-	-	1	-
70	1	-	6	2	-	-	-	-	-
75	-	-	1	3	-	-	1	-	-
80	-	-	1	1	-	-	-	1	-
85	-	2	1	-	-	-	-	-	-
90	-	-	1	-	-	-	-	-	-
95	-	-	-	-	1	-	-	-	-

Entomacrodus stellifer stellifer (Jordan and Snyder)

PLATE 4

Scartichthys stellifer Jordan and Snyder, 1902, Proc. U.S. Nat. Mus., vol. 25, p. 461, fig. 10 [Wakanoura, Japan].

GEOGRAPHIC VARIATION.—Though few specimens are available, it appears that Japanese specimens have lower average counts than do specimens from the other localities. The low fin ray counts of the Japanese specimens are most similar to those of specimens of *E. s. lighti* from Hong Kong (table 16). Specimens of *E. s. stellifer* from Okinawa, the locality at which *E. s. stellifer* occurs most closely to *E. s. lighti* (at Hong Kong), have higher average counts than do specimens of *E. s. lighti.*

DISCUSSION.—*E. s. stellifer* is differentiated from *E. s. lighti* by its color pattern, in which the bands on the body are punctuated with small pale dots and dashes, and the anterior portion of the sides and head frequently bear numerous dark spots and vermiculations. In *E. s. lighti* the bands are unbroken by pale spots and dashes; and dark spots and vermiculations, when present on the head and anterior portions of the sides, are not numerous.

Males and females of *E. s. stellifer,* unlike *E. s. lighti,* do not exhibit sexual dimorphism in numbers of dorsal fin rays.

TABLE 18.--Frequency distribution of number of predorsal commissural pores of subspecies of *Entomacrodus stellifer* arranged by SL classes (in mm)

Classes	Number of pores												
	lighti						*stellifer*						
	3	4	5	6	7	8	3	4	5	6	7	8	9
15-19.9	2	-	-	-	-	-	-	-	-	-	-	-	-
20	1	-	-	-	-	-	-	-	-	-	-	-	-
25	1	-	1	-	-	-	-	1	-	-	-	-	-
30	2	-	1	-	-	-	-	2	-	-	-	-	-
35	5	3	-	-	-	-	-	1	-	-	-	-	-
40	5	3	-	-	1	-	-	1	-	-	-	-	1
45	9	3	1	-	-	-	1	1	-	1	1	1	-
50	4	1	2	1	-	-	1	1	-	-	-	-	1
55	5	2	-	-	-	-	-	3	-	1	-	-	-
60	2	4	1	-	-	-	1	-	1	-	-	-	-
65	3	2	3	-	-	-	-	1	-	-	-	-	-
70	4	2	1	1	1	-	1	-	-	-	-	-	-
75	1	2	-	1	-	-	-	1	-	-	-	-	-
80	1	-	-	1	-	-	-	-	1	-	-	-	-
85	-	2	1	-	-	-	-	-	-	-	-	-	-
90	-	-	-	-	-	1	-	-	-	-	-	-	-
95	-	-	1	-	-	-	-	-	-	-	-	-	-

DISTRIBUTION (fig. 8).—*E. s. stellifer* is known only from Japan, Okinawa and Saipan.

MATERIAL.—Japan, Wakanoura: SU 7069 (holotype of *S. stellifer*), 7156, USNM 50298; Kamishima: UCLA W57-24; tide pools near Egumi, Shumane-Ken: UMMZ 144750; Okinawa, tide pool at Kimmu Wan: USNM 111605, 132795; Marianas, Saipan: USNM 132845.

TABLE 19.--Proportional dimensions as percent of SL of subspecies of *Entomacrodus stellifer* (for meaning of abbreviations see methods section)

Catalog no.	Locale	Sex	SL	HL	OL	OCL	NCL	DS3	DS13	DR1	PECL	PELL	CL
stellifer													
USNM 111605	Okinawa	♀	28.7	24.7	8.7	6.6	-	10.1	-	12.5	-	18.8	23.0
USNM 111605	Okinawa	♀	32.0	23.4	8.4	6.9	-	10.0	1.6	13.1	25.9	19.1	22.5
USNM 132795	Okinawa	♀	36.0	23.6	8.3	5.8	1.4	9.7	1.7	11.7	24.2	18.0	22.4
USNM 132845	Saipan	♂	40.0	23.5	7.5	10.0	1.8	9.3	-	11.2	22.5	16.5	21.5
USNM 132795	Okinawa	♀	41.5	22.7	7.5	8.4	1.7	10.4	1.2	12.0	24.3	17.8	21.7
USNM 132795	Okinawa	♂	43.4	23.7	7.4	7.4	1.4	10.4	2.3	11.5	23.3	15.0	21.0
UMMZ 144750	Japan	♀	47.8	22.8	6.7	8.2	2.1	10.5	2.5	13.8	23.8	17.2	22.2
USNM 132795	Okinawa	♂	48.2	22.8	7.1	9.5	-	10.4	2.1	12.0	23.9	16.8	21.8
SU 71536	Japan	♀	48.8	22.8	7.0	5.3	2.0	10.4	1.6	12.5	24.2	-	21.5
USNM 132795	Okinawa	♂	49.2	22.8	6.5	7.3	1.8	10.6	2.4	11.4	23.2	16.3	21.3
USNM 132795	Okinawa	♀	50.5	22.8	7.1	7.1	1.0	9.5	2.4	12.5	23.4	16.4	20.8
UMMZ 144750	Japan	♂	51.7	23.2	6.6	11.6	1.7	11.0	2.9	13.0	23.2	15.5	21.6
USNM 50298	Japan	♂	55.6	21.4	5.9	10.4	1.8	10.8	-	12.6	21.8	15.3	22.5
USNM 132795	Okinawa	♀	56.2	23.0	6.9	8.9	1.4	9.6	1.8	11.7	23.5	16.0	21.7
UMMZ 144750	Japan	♂	56.6	22.6	6.2	11.0	1.9	10.6	2.5	13.4	23.8	14.8	23.0
USNM 132795	Okinawa	♂	60.8	21.5	6.2	8.2	1.6	9.2	2.3	12.3	21.9	14.0	19.9
UMMZ 144750	Japan	♂	61.0	22.0	6.1	10.8	1.6	10.3	2.0	11.3	21.3	15.7	21.3
UMMZ 144750	Japan	♀	67.6	20.8	5.9	6.8	1.9	10.0	2.1	12.6	22.5	15.5	21.3
SU 7069[1]	Japan	♂	74.9	21.8	5.6	11.3	1.5	10.0	2.3	12.9	20.8	-	20.6
UMMZ 144750	Japan	♂	82.8	21.2	5.6	7.5	1.2	10.5	2.4	14.7	23.3	15.9	23.0
lighti													
SU 62071	Hong Kong	♂	24.8	24.6	8.1	6.8	2.4	10.5	-	11.7	26.2	18.1	21.8
SU 30664	Singapore	♂	28.4	25.3	8.4	5.6	2.8	12.0	-	12.3	25.7	19.4	22.5
SU 62071	Hong Kong	♂	30.0	25.0	7.3	7.3	2.0	10.7	2.0	12.3	26.6	18.7	21.7
SU 62071	Hong Kong	♂	33.6	24.4	7.4	10.1	2.1	10.7	1.8	12.2	26.8	19.3	22.6
SU 62071	Hong Kong	♀	38.0	24.0	7.4	8.2	1.8	10.5	1.6	13.2	25.6	18.7	21.3
SU 62071	Hong Kong	♀	40.5	23.7	7.6	7.7	2.5	11.1	2.5	13.6	24.7	16.6	22.0
SU 62072	Hong Kong	♂	44.9	22.7	6.7	8.9	1.3	11.6	-	13.6	22.5	-	22.3
SU 62071	Hong Kong	♀	51.5	21.8	6.4	8.7	1.9	9.7	1.7	13.2	24.5	16.7	20.4
SU 62072	Hong Kong	♀	53.7	22.2	6.5	6.0	1.7	8.2	-	11.9	21.4	-	20.1
SU 62071	Hong Kong	♀	59.0	22.2	6.1	6.9	1.7	10.0	-	11.4	22.5	15.1	19.8
SU 30664	Singapore	♂	62.8	22.3	6.4	7.3	0.8	10.3	-	12.3	21.5	14.6	20.9
SU 62072	Hong Kong	♀	63.7	22.3	6.3	5.5	1.6	10.0	-	12.2	22.9	-	20.4
SU 62071	Hong Kong	♂	65.5	22.0	6.1	9.5	1.1	11.0	-	12.4	22.8	14.5	20.6
SU 62072	Hong Kong	♀	67.0	21.5	6.0	6.0	1.5	9.0	-	11.8	20.9	-	20.2
SU 62071	Hong Kong	♂	72.0	22.1	5.6	8.5	1.4	10.8	2.5	13.3	21.8	14.7	20.3
SU 62071	Hong Kong	♀	73.0	22.7	6.0	6.8	0.7	9.2	-	12.7	23.6	17.0	20.0
SU 62072	Hong Kong	♀	73.0	20.8	5.8	5.2	1.5	9.6	-	12.0	21.6	-	20.0
SU 62071	Hong Kong	♂	73.8	22.6	5.7	9.1	1.2	11.2	-	13.3	22.4	14.9	21.1
SU 62072	Hong Kong	♂	78.0	21.2	5.4	8.3	1.4	10.2	-	13.1	20.8	-	20.5
SU 62072	Hong Kong	♂	84.8	21.8	5.7	8.0	1.4	10.6	-	13.2	20.6	-	20.6
SU 62071	Hong Kong	♂	87.4	22.1	5.5	8.7	1.1	10.5	-	12.2	20.1	13.8	19.4
SU 62071	Hong Kong	♂	87.9	21.8	5.5	8.0	1.5	11.5	2.3	14.2	22.8	15.0	21.0
SU 62071	Hong Kong	♂	96.6	21.5	5.3	6.6	1.0	10.3	-	12.9	20.2	13.4	20.2

[1] Holotype of *Scartichthys stellifer*

Entomacrodus stellifer lighti (Herre)

PLATE 5

Salarias lighti Herre, 1938, Proc. Biol. Soc. Washington, vol. 51, p. 65 [Dodd Island, Amoy, China].

REMARKS.—Males tend to have a higher average number of segmented dorsal fin rays than do females. Of 50 males examined, 25 had 15 dorsal rays and 25 had 16 dorsal rays. Of 35 females examined, 29 had 15 dorsal rays and 6 had 16 dorsal rays. Other meristic characters did not exhibit sexual dimorphism.

DISTRIBUTION (fig. 8).—This subspecies is restricted to the South China Sea and its extension, the Gulf of Thailand. The area is more or less enclosed by a chain of closely approximated islands extending from Taiwan to Sumatra. These islands probably have acted as an effective barrier, isolating populations of this taxon from populations of the nominal subspecies. The same area also defines the distribution of *E. t. longicirrus*.

MATERIAL.—China, Amoy, Dodd Island: SU 33001 (holotype of *S. lighti*); Hong Kong, Sharp Island: SU 62072; Cape D'Aguilar: SU 62071; Shelter Island: USNM 197976; Kiu Tsui Chau: USNM 197985; Thailand, Hinson Chalam, 12°30′15″N, 101°26′45″E: SU 62093; Malaya, Singapore: SU 30664.

Entomacrodus marmoratus (Bennett)

PLATES 6, 7*a–b*

Blennius marmoratus Bennett, 1828, Zool. Journ., vol. 4, pp. 35–36 [Sandwich Islands = Hawaiian Islands].

DESCRIPTION.—Segmented dorsal fin rays 14–16 (rarely 14), varying with population (table 20); segmented anal fin rays 15–17 (rarely 15), varying with population (table 20); posteriormost anal pterygiophore supporting 1 or 2 external elements (60.2 percent supporting 2); total gill-rakers on first arch 19–29 (usually 21–26); pseudobranchial filaments 8–12 (rarely 11 or 12; 6 or 7 in specimens 19–22 mm SL); vertebrae 34 or 35 (34 in 38 of 48 specimens); supraorbital cirri 1–34, number increasing with increase in SL (table 21); main or longest supraorbital cirrus with lateral and mesial branches in specimens over 25 mm SL; nape with 2–20 cirri on each side (specimens over 19 mm SL); number increasing with increase in SL (table 22); arising from 2 main bases on each side (85 of 93 specimens; on at least 1 side in 90 of 93 specimens; from 1 base on each side in 3 of 93 specimens); the medialmost nuchal cirrus on each side with the broadest base and usually the most branches; predorsal commissural pores 3–23, number increasing with increase in SL (table 23); preopercular series of pores ranging from all positions with simple pores to all positions with pairs or multiples of pores (usually including 2 or 3 positions with simple pores); 1 pore before each anterior nostril (2 before each nostril in only 1 specimen); lateral line terminating on side in area below and between segmented dorsal fin rays 4 and 16 (posterior to ray 8 in specimens over 40 mm SL); ventral margin of upper lip completely crenulate; lip crenulae number 29–39 (usually 30–36).

Proportional measurements: See tables 3, 4, and 24.

Only three males, 86, 94, and 121 mm SL, were seen with rugose fleshy modifications of the skin of the anal spines and first to third anal rays. Presumably these males, each the largest in its respective collection, were mature. The largest male examined was 121 mm SL, the largest female 114 mm. Females were about twice as numerous as males in all size classes up to that of the largest female.

The smallest metamorphosed specimen examined, 19.2 mm SL, was well marked with vertical bands on the body. This specimen had two cirri on each side of the nape and vomerine teeth, but I could not see posterior canines in the lower jaw (canines also not present in a specimen 20.5 mm, but present in a specimen 22.5 mm). The largest ophioblennius stage examined, 20 mm SL (the smallest 19.5 mm), lacked vomerine teeth and had dark pigment only on top of the head and at the tips of the pectoral rays. Three or four larval canine teeth were present laterally on each side of the lower jaw, the most anterior were the largest on each side.

A group of smaller ophioblennius larvae that might contain specimens of *E. marmoratus* was collected with the three larvae mentioned (for discussion, see *E. strasburgi*).

COLOR PATTERN OF PRESERVED SPECIMENS.—Strasburg (1956, fig. 2) has figured a specimen of *E. marmoratus* and I present three (pls. 6, 7*a*, *b*). None of these four illustrations adequately portrays color pattern, which is quite variable. There are usually 4½ pairs of dusky, irregular, vertical bands, or spots, on the body, the half pair at the caudal base. The bands, or spots, may be so poorly

TABLE 20.--Frequency distribution of number of segmented dorsal and anal rays in specimens of *Entomacrodus marmoratus* arranged geographically southeast to northwest (for meaning of N and S see methods section)

Locale	Dorsal rays			Anal rays				
	14	15	16	15	16	17	N	S
Hawaii	-	11	13	-	10	4	1	13
Maui	-	2	2	-	1	3	3	1
Molokai	-	1	-	-	-	1	1	-
Lanai	-	2	-	-	-	2	2	-
Oahu	-	24	6	-	21	10	11	20
Necker	-	-	1	-	-	1	1	-
Laysan	-	10	9	-	10	10	10	10
Pearl and Hermes	-	1	-	-	1	-	-	1
Midway	1	6	12	1	8	10	8	11

TABLE 21.--Frequency distribution of supraorbital cirri of left side of specimens of *Entomacrodus marmoratus* arranged by SL classes (in mm)

Classes	Number of cirri																																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
15-19.9	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20	2	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
25	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
30	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
35	-	-	-	-	-	-	-	-	-	2	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
40	-	-	-	-	-	-	-	-	-	2	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
45	-	-	-	-	-	-	-	-	-	-	1	-	-	1	1	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
50	-	-	-	-	-	-	-	-	-	1	-	-	1	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
55	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	2	1	1	-	1	-	1	-	-	1	-	-	-	-	-	-	-
60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-
65	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	2	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-
70	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
75	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
80	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
85	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	1	-	-	3	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	1	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-
95	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	2	-	-	-	-	-	-	-
100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1
105	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
110	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
115	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
120	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-

represented as to be almost unrecognizable as such. Usually the midportions of the bands are darkest; sometimes the members of a pair are fused at the midportions. Dorsally the bands usually extend onto the spinous and soft dorsal fins. Ventrally the bands are palest failing to reach the ventral body contour. Various pale spots and irregular dusky markings are scattered on the sides (usually ventrally or between the band pairs). A small faint to dark spot is frequently found in the humeral region. This spot may vary from absent to most obvious mark on the body in a single collection of specimens. In life the humeral spot is irridescent dark olive green. The most noticeable mark on the head is a dark, irregularly crescentic area just posterior to the orbit. This area may fuse ventrally with a large darkly dusky area in the preopercular region. The opercular area is usually paler than the preopercular area. The upper lip may be almost uniformly dusky, include adumbrations of up to 20 dusky stripes (rarely), or consist of about 7 dusky bands separated by pale stripes. The underside of the head varies from uniformly pale to marked with some irregularly dusky, almost indistinct, chevrons separated by fine pale stripes.

The spinous dorsal fin is irregularly dusky with darker dusky areas

TABLE 22.--Frequency distribution of total number of cirri on left side of nape of specimens of *Entomacrodus marmoratus* arranged by SL classes (in mm)

Classes	Number of cirri																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
15-19.9	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20	1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
25	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
30	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
35	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
40	-	2	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
45	-	1	1	1	-	-	-	1	-	1	1	-	-	-	-	-	-	-	-	-
50	-	-	-	-	1	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-
55	-	1	-	2	1	1	1	-	-	1	1	-	-	-	-	-	-	-	-	-
60	-	-	-	-	1	-	2	-	2	-	-	1	-	-	-	-	-	-	-	1
65	-	-	-	1	-	1	-	-	1	1	2	-	-	-	-	1	-	-	-	-
70	-	-	-	-	-	2	-	-	-	1	-	-	-	-	-	-	-	-	-	-
75	-	-	-	-	-	-	-	1	-	-	1	-	-	1	-	-	-	-	-	-
80	-	-	-	-	1	-	1	1	2	-	-	1	-	-	-	-	-	-	-	-
85	-	-	-	-	3	1	1	1	-	-	-	2	-	-	-	-	-	-	-	-
90	-	-	-	-	-	1	2	-	1	2	-	-	1	1	-	-	-	-	-	-
95	-	-	-	-	1	1	-	-	-	1	-	1	-	1	-	-	-	-	-	-
100	-	-	-	-	-	1	1	-	-	-	-	1	-	-	-	-	1	-	-	-
105	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-
110	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
115	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
120	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-

overlying the bases of some spines (extensions of the body bands onto the fin). Each soft dorsal fin ray bears two or three dusky spots, so arranged that they form diagonal bands, separated by pale interspaces, across the fin. The anal fin is evenly dusky, grading darker distally and paler proximally, with the anterior surface or the tips of the rays distinctly palest. One large mature male had evenly dusky dorsal fins and the anal fin dusky, grading darker distally with the darkest areas the anterior surface of the tips of the rays. Few males were available but it seems the darker anal fin may be a male character. The caudal fin is more or less evenly dusky, frequently with one or two vertical rows of slightly darker dusky spots. The pectoral fin is evenly dusky, grading to much darker ventrally. The fleshy pectoral base is irregularly to uniformly dusky. The pelvic fins are pale dusky.

Geographic variation.—There are indications of a cline in average number of soft dorsal and anal rays (table 20). The averages are lowest from the island of Hawaii and gradually increase as one progresses northwesterly through the island chain to Midway.

Nomenclature.—Bennett (1828) described *Blennius marmoratus* from a single specimen which now appears to be lost. If *B. marmoratus* actually came from the Hawaiian Islands, the type description

TABLE 23.--Frequency distribution of number of predorsal commissural pores of specimens of *Entomacrodus marmoratus* arranged by SL classes (in mm)

Classes	Number of pores 3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
15-19.9	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
25	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
30	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
35	-	-	-	-	-	2	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
40	-	-	-	-	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
45	-	-	-	-	-	1	3	1	1	-	-	-	-	-	-	-	-	-	-	-	-
50	-	-	-	-	1	-	1	-	-	1	1	-	1	-	-	-	-	-	-	-	-
55	-	1	-	-	-	1	2	3	-	-	-	1	-	-	-	-	-	-	-	-	-
60	-	-	-	-	2	1	-	-	1	-	1	1	-	-	-	-	-	-	-	-	-
65	-	-	-	-	-	1	3	-	-	-	1	-	-	-	1	-	1	-	-	-	-
70	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
75	-	-	-	-	-	-	1	-	-	-	-	-	-	1	-	-	-	-	-	-	1
80	-	-	-	-	-	-	-	-	2	1	-	1	1	1	-	-	-	-	-	-	-
85	-	-	-	-	-	-	3	1	-	-	1	1	-	1	-	1	1	-	-	-	-
90	-	-	-	-	-	-	-	2	1	-	2	1	-	-	-	-	1	-	-	-	-
95	-	-	-	-	-	-	1	-	-	2	-	1	1	-	-	-	-	-	-	-	-
100	-	-	-	-	-	-	-	-	-	1	-	1	-	-	1	1	-	-	-	-	-
105	-	-	-	-	-	-	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-
110	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
115	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
120	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-

undoubtedly refers to the species treated here. If it did not come from the Hawaiian Islands—and there is some reason to doubt that it did—it must refer to another species, probably *E. striatus*. Under these circumstances it would be a senior synonym of *E. striatus*, and the species treated here as *E. marmoratus* would be without a name. My reason for questioning the origin of Bennett's specimen is based on the fact that *Blennius sordidus* and *Scorpaena asperella*, described in the same paper and also supposedly from Hawaii, appear not to occur in the Hawaiian Islands (Strasburg, 1956, p. 243; Gosline, 1955, p. 461). For reasons I intend to publish elsewhere, I believe *Blennius sordidus* to be an eastern Pacific species. Furthermore, in Bennett's description of *B. marmoratus*, he stated, in reference to the nuchal cirri: " . . . there is also a very short filament on each side . . . ." Since in the 4-inch long specimen of the species treated here one would expect to find several cirri on each side of the nape, the description does not seem to apply to the species I am treating. Bennett did note the branching on both margins of the supraorbital cirrus and one would have expected him to report multiple cirri on each side of the nape had they been present.

In spite of the indications to the contrary, I favor allocating Bennett's name to the Hawaiian species of *Entomacrodus*, with which it most closely agrees in description and in which sense I employ it here. The name *marmoratus* is now fairly widely employed for this

TABLE 24.--Proportional dimensions as percent SL of specimens of *Entomacrodus marmoratus* (for meaning of abbreviations see methods section)

Catalog no.	Locale	Sex	SL	HL	OL	OCL	NCL	DS3	DR1	PECL	PELL	CL
USNM 142060	Oahu	♂	32.2	24.8	7.4	4.3	3.1	10.9	12.1	24.2	14.3	23.3
USNM 142060	Oahu	♂	36.1	23.8	7.2	3.0	3.0	11.1	13.8	23.8	17.4	26.0
UH 933	Midway	♀	48.0	23.3	6.7	4.8	3.1	10.4	12.5	22.9	15.6	22.9
USNM 78053	Hawaii	♂	48.0	24.0	6.2	5.8	2.1	11.0	12.5	24.6	18.1	26.0
USNM 78053	Hawaii	♀	53.6	23.1	6.3	3.7	3.0	10.1	14.0	23.0	16.6	23.0
USNM 78053	Hawaii	♂	55.2	22.6	6.0	4.0	3.1	9.2	10.8	20.7	14.6	22.6
USNM 142060	Oahu	♂	58.8	24.0	6.1	4.8	3.4	8.8	12.7	23.6	16.1	24.0
USNM 142060	Oahu	♀	62.0	23.7	6.3	4.8	2.3	10.2	12.1	22.9	15.5	22.9
UH 933	Midway	♀	80.8	23.3	5.6	5.2	2.5	9.4	12.4	22.3	14.9	22.9
USNM 142060	Oahu	♀	85.8	23.1	5.4	4.0	2.3	8.7	10.5	23.3	15.5	23.6
UH 933	Midway	♀	93.6	22.9	5.3	5.0	3.1	9.6	13.5	21.9	14.4	23.2
USNM 142060	Oahu	♂	94.6	22.6	5.3	5.5	2.2	7.1	11.8	21.6	13.6	21.9
UH 933	Midway	♂	104.5	23.7	5.1	4.8	2.8	8.7	9.8	20.0	12.9	20.8
UH 933	Midway	♀	105.0	23.0	5.0	4.4	2.4	9.3	13.0	21.9	16.2	22.8

species of *Entomacrodus* and there is no benefit to be derived from using it otherwise. In any event, *Blennius marmoratus* is the oldest name available for any species of *Entomacrodus* and it matters not to Bennett's honor to which species it is applied. Let it therefore accrue to a Hawaiian species.

Relationships.—(See also "Relationships" under *E. niuafoouensis*.) *Entomacrodus marmoratus* is a member of the *E. striatus* species group. *E. marmoratus* differs: from all other members of the group most obviously, in having the nuchal cirri on each side arising from two bases; from all but *E. striatus*, in having both lateral and mesial branches on the main supraorbital cirrus (more cirri at a given size); and from *E. epalzeocheilus* and *E. niuafoouensis*, in having only one pore before each anterior nostril.

Distribution (fig. 6).—*E. marmoratus* has been taken only from the Hawaiian Islands, where it has been collected with the only other species of *Entomacrodus* occurring there, also an endemic, *E. strasburgi*. It differs from *E. strasburgi* in having more supraorbital cirri, nuchal cirri, gill-rakers, pseudobranchial filaments, and crenulations on the upper lip. Strasburg (1956) reported that *E. marmoratus* abounds in areas of heavy surf occurring along rocky shores. It has also been taken from tide pools, and the larvae have been taken from under a light offshore.

Material.—Hawaiian Islands: Hawaii: USNM 78051, 78053, 126689; Maui: UH 2022; Molokai: USNM 164992 (in part); Lanai: USNM 164993 (in part); Oahu: USNM 7785, 78052, 142060, 149990, 197201; Necker: BPBM 4932; Laysan: BPBM 4929, 4930, CNHM 7718, 55942, USNM 55121; Pearl and Hermes Reef: USNM 92272; Midway: UH 933.

Entomacrodus epalzeocheilus (Bleeker)

Plates 8, 10*a*–*b*

Salarias epalzeocheilus Bleeker, 1859, Nat. Tijdschr. Nederl. Ind., vol. 19, pp. 343–344 (16–17 on the separate) [Karangbollong, Java, in the sea].

Salarias epalzeorhynchus Gunther, 1861, Cat. Fish. British Mus., vol. 3, p. 240 [misspelling of *epalzeocheilus*].

Description.—Segmented dorsal fin rays 14–16 (usually 15 or 16); segmented anal fin rays 15–17 (usually 16 or 17); posteriormost anal pterygiophore supporting 1 or 2 external elements (57.4 percent supporting 2); total gill-rakers on first arch 16–25 (usually 16–19 in specimens less than 40 mm SL; usually 20–22 in specimens over 40 mm SL); pseudobranchial filaments 6–10 (6 or 7 in specimens less than 30 mm SL; usually 8 or 9 in specimens over 35 mm SL); vertebrae 33–35 (34 in 32 of 34 specimens); supraorbital cirri 3–9 (usually 4–7), number not increasing much, if any, with increase in SL; main, or longest supraorbital cirrus with all branches mesially (60 of 65 specimens, 4 specimens also with 1 lateral branch, and 1 with 2); nape with 1–10 cirri on each side (2 or more in specimens over 30 mm SL, rarely more than 7), usually arising on each side from common base (from 2 bases on only 1 side in 2 specimens); nuchal cirri number increasing very slightly with increase in SL; predorsal commissural pores 3–66, number increasing with increase in SL (table 25); preopercular series of pores with pairs or multiples of pores at all positions (rarely a simple pore included in series); 1–3 pores before each anterior nostril (2 or 3 in 56 of 65 specimens); lateral line terminating on side in area below and between segmented dorsal fin rays 2 and 11 (usually between rays 3 and 9); ventral margin of upper lip completely crenulate; lip crenulae number 23–32 (usually 25–30).

Proportional measurements: See tables 3, 4, and 26.

Males develop fleshy rugose modifications of the skin of the anal spines and the anterior two anal rays. If one considers males with these modifications to be mature, the smallest mature male examined was 52.8 mm SL. Mature and immature males may occur in the same collection and in these collections immature males may be as much as 37 mm longer than mature males.

The largest specimen examined was a male, 104.5 mm SL; the largest female was about 78 mm SL. Below 79 mm SL females were about as common as males in the various SL classes. The smallest specimen examined, 20.1 mm SL, was not an ophioblennius stage; however, posterior canines in the lower jaw were absent. These teeth were present in specimens 25 mm SL. Adult type color pattern was developed in the smallest specimen.

Color pattern of preserved material.—Description of a male, USNM 199423, approximately 80 mm SL, from Malacca Strait, followed by variations encountered in other specimens: The ground color of the side of the body varies from dusky anteriorly to pale dusky posteriorly. There are 4½ pairs of vertical series of diffuse dusky spots, the half pair at the caudal peduncle. There are three spots in each member of a paired series, the ventralmost is faintest, fading completely before reaching the ventral body contour. Dorsally the spots are darkest and continuous onto the base of the spinous and soft dorsal fins. Anteriorly, in the region above the pectoral fin, the side bears a fine network of dusky lines encompassing tiny paler spots. The venter is uniformly pale. The side of the head is mostly dark dusky with a black spot posterior to the eye a distance about equal to the eye diameter. Three short dusky lines, separated by paler interspaces, extend from the ventroposterior (4 o'clock position) margin of the eye to the preopercular area, where they fuse with a deep dusky blotch (the black spot behind the eye extends ventrally and similarly fuses with the same blotch). Ventral to the dusky lines (5 o'clock position) are some irregular dusky lines, spots,

TABLE 25.--Frequency distribution of number of predorsal commissural pores of specimens of *Entomacrodus epalzeocheilus* arranged by SL classes (in mm)

Classes	Number of pores																														
	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	35	37	65
20-24.9	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
25	-	1	1	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
30	-	1	-	-	-	1	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
35	-	1	-	1	-	1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
40	-	-	-	-	1	1	1	1	4	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
45	-	-	-	-	-	-	1	1	1	1	1	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
50	-	-	-	-	-	-	1	-	-	-	1	1	-	1	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
55	-	-	-	-	-	-	-	1	-	1	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	1	-	-
65	-	-	-	-	-	-	1	-	-	-	-	1	1	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
70	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
75	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	1	-	1	-	-	-	-	-	-	-	1	-
80	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
85	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
95	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
100	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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and dashes separated by paler interspaces that extend onto the ventral preopercular area. (The posterior margin of the preopercular area is diffusely pale and dusky, lighter than the almost uniformly dusky opercular area.) Below the eye (6 o'clock position) is a dusky band extending to the dorsal margin of the upper lip. Within the band are the pale openings of pores. The upper lip bears 20 vertical dark stripes of varying width and intensity, separated by paler interspaces. These stripes extend onto the snout, where they may take the form of spots. The underside of the head is dusky with the area just behind the lower lip darkest.

Except for the darkened area where the spots on the body enter the spinous dorsal fin, that fin is more or less uniformly dark dusky. The membrane of the soft dorsal fin is also dusky but the spines are mostly pale and there are several fine pale diagonal stripes coursing over the fin. The anal fin is uniformly dark dusky. The caudal fin is pale dusky with three darker vertical stripes on the proximal portion, the two posterior stripes not entering the dorsal third of the fin. There are two dark spots on the central caudal base. The pectoral fin is uniformly dusky. The fleshy pectoral base bears several small dusky spots. The pelvic fin is dusky, with the rays paler than the webbing.

The color patterns of specimens (Indian Ocean) in a single collection are quite variable. The body spots may be fused into solid bands (pl. 10*a*), limited only to the middle spots of each vertical series, or absent. The body may bear numerous scattered, small, dusky spots (pl. 10*b*) or may bear vertical paired series of spots and scattered small dusky spots, somewhat paler than the vertical series. No specimens were seen which had a humeral blotch, as found in some specimens of *E. niuafoouensis* and all *E. randalli*. The underside of the head may bear diffuse dark chevrons, the middle two joined to form a Y, or may be entirely pale. The side of the head may be pale with the only dark mark a black elongate spot behind the eye. The lip stripes may be pale to absent, or fused, and represented as a few diffuse, dusky and pale bands. The fins may be variably dusky spotted; the fleshy pectoral base may bear two dark stripes separated by a broader, paler interspace. Females do not appear to differ much, if any, in coloration from males, although in specimens from the same collection the females are less intensely marked than the males.

Two specimens from Tutuila, the only specimens of the species known from the Pacific Ocean, differed from the other specimens primarily in having the soft dorsal fin darkly spotted, with about three spots over each ray, and in having numerous pale spots on the ventral portion of the body sides.

Remarks.—There is a tendency for males from the Indian Ocean to have higher numbers of segmented dorsal fin rays than females. Of 41 males examined, 1 had 14 rays, 25 had 15 rays, and 15 had 16 rays. Of 25 females examined, 1 had 14 rays and 24 had 15 rays. There was no evidence of sexual dimorphism in other meristic characters. The male and female specimens from Samoa each had 16 dorsal rays.

NOMENCLATURE.—*E. epalzeocheilus* was described by Bleeker (1859) from a single specimen, 85 mm, from Karangbollong, south coast (Indian Ocean) of Java. I have been unable to locate the holotype, but it is clear from the Latin description (especially "vertice cristis nullis sed poris valde conspicuis longitudinaliter seriatis; nucha utroque latere cirro membranaceo plurifimbriato occulo breviore"), that the specimens considered here are the same species as that described by Bleeker.

RELATIONSHIPS.—(See also relationships under *E. niuafoouensis*.) *Entomacrodus epalzeocheilus* is a member of the *E. striatus* species group. *E. epalzeocheilus* differs: from *E. niuafoouensis*, in having multiple nuchal cirri and in usually having fewer crenulae on the ventral margin of the upper lip; from *E. randalli*, in having more than one pore before each anterior nostril, in having stripes or bands on the upper lip, and in lacking a dark spot in the humeral region; from *E. marmoratus*, in usually lacking lateral branches on the main, or longest supraorbital cirrus, in having the nuchal cirri on each side arising from

TABLE 26.--Proportional dimensions as percent SL of specimens of *Entomacrodus epalzeocheilus* (for meaning of abbreviations see methods section)

Catalog no.	Locale	Sex	SL	HL	OL	OCL	NCL	DS3	DS13	DR1	PECL	PELL	CL
SU 14732	India	♂	32.0	24.4	7.3	4.2	3.0	10.6	-	12.5	25.6	17.2	25.0
ANSP 102201	Seychelles	♀	35.3	23.2	6.2	6.2	2.8	9.3	-	10.8	24.6	16.4	24.4
ANSP 102201	Seychelles	♀	41.8	23.0	6.7	6.0	2.9	9.1	-	11.5	26.3	16.5	23.4
ANSP 102201	Seychelles	♂	48.7	24.4	6.6	11.5	2.7	10.3	-	11.9	23.2	15.0	23.0
BMNH 1903.5.12.4	Ceylon	♀	52.4	23.3	6.1	6.7	3.1	10.5	1.9	12.2	25.8	17.2	24.0
USNM 195780	East of India	♀	54.8	22.6	6.7	5.1	3.1	10.0	1.8	12.0	25.5	15.5	-
USNM 112035	Andaman Is.	♀	54.8	24.6	6.9	5.1	2.2	9.8	-	10.8	25.4	16.4	23.8
SU 14734	India	♂	55.0	24.9	6.5	8.0	2.7	-	-	10.7	24.6	17.3	21.8
ANSP 102201	Seychelles	♂	55.1	24.3	6.4	9.8	2.5	10.5	-	12.3	23.6	14.9	24.0
SU 37131	Andaman Is.	♀	63.8	23.5	6.3	6.0	3.1	9.6	-	11.8	23.8	15.0	23.5
SU 37131	Andaman Is.	♂	64.4	24.1	5.9	5.6	3.0	10.1	-	11.5	24.8	15.0	22.8
ANSP 102201	Seychelles	♀	66.1	23.3	5.3	6.0	2.6	8.9	-	11.5	22.4	15.0	22.5
SU 14733	India	♀	69.8	24.4	5.7	7.7	2.1	10.6	-	11.2	24.2	16.5	23.2
ANSP 102201	Seychelles	♀	72.1	24.4	5.4	8.9	2.5	8.2	-	11.0	21.8	14.3	20.8
SU 14732	India	♀	76.2	24.3	5.2	8.0	2.4	10.0	-	11.4	25.6	17.2	25.0
USNM 195780	East of India	♂	80.5	23.6	5.7	7.0	2.4	11.0	2.5	13.9	23.2	14.4	22.8
ANSP 102201	Seychelles	♂	81.7	23.5	5.0	12.5	2.0	9.6	-	11.0	20.6	14.1	20.7
ANSP 102201	Seychelles	♂	104.5	21.5	4.5	11.1	2.3	9.1	-	11.7	19.6	14.2	19.3

a common base, in having more than one pore before each anterior nostril, in usually having numerous dark stripes on the upper lip, and in never having a dark humeral spot; from *E. striatus*, in having more than one pore before each anterior nostril, branched nuchal cirri, paired pores in the preopercular series, a different color pattern, and in lacking lateral branches on the main supraorbital cirrus.

REMARKS.—*E. epalzeocheilus* has been collected with or from the same generally restricted geographic locality as *E. striatus*, *E. vermiculatus*, *E. decussatus*, *E. t. thalassinus*, *E. sealei*, and *E. caudofasciatus*. It may be most obviously differentiated from: *E. decussatus* and *E. vermiculatus*, in having fewer vertebrae, usually fewer predorsal commissural pores, supraorbital cirri (lacking lateral branches on the main supraorbital cirrus), and in its strikingly different color pattern; from *E. t. thalassinus*, *E. sealei*, and *E. caudofasciatus*, in having the ventral margin of the upper lip completely crenulate, and in having more pseudobranchial filaments, more than one pore before each anterior nostril, and more than one cirrus on each side of the nape.

DISTRIBUTION (fig. 6).—*E. epalzeocheilus* is known from the Indian Ocean, northern Malacca Strait, and Tutuila, Pacific Ocean. The Tutuila population possibly represents a relict population of the species, which previously was more broadly distributed.

MATERIAL.—Indian Ocean: Seychelles Islands, Beacon Island: ANSP 102201, USNM 258171 F-2 (cleared and stained); Curieuse Island: ANSP 102183; East of India (only data): USNM 195780; India: Travancore, Konival, 10 miles south of Trivandrum: SU 14734; Madras, Vizagapatam, foot of Dolphin's Nose: SU 14733; Waltair: SU 14732; Andaman Islands: SU 37131, USNM 112035; Ceylon: BMNH 1903.5.12.4, MNHN A 2042; Malacca Strait: Pulo Perak, 05°41'N, 98°56'E: USNM 199423; Pacific Ocean: Samoa Islands, Tutuila: USNM 147653.

Entomacrodus niuafoouensis (Fowler)

PLATES 9, 10*c–d*

Salarias niuafoouensis Fowler, 1932b, Proc. U.S. Nat. Mus., vol. 81, no. 8, pp. 7–8 [Niuafoou Island].

DESCRIPTION.—Segmented dorsal fin rays 15 or 16; segmented anal fin rays 16 or 17; posteriormost anal pterygiophore supporting 1 or 2 external elements (55.9 percent supporting 2); total gill-rakers on first arch 21–28 (usually 22–26); pseudobranchial filaments 7–9, number not increasing with increase in SL (above 32 mm SL); vertebrae 34 or 35 (rarely 35); supraorbital cirri 4–7, number not increasing with increase in SL (above 32 mm SL); main, or longest, supraorbital cirrus with all branches mesially (32 of 34 specimens; 1 specimen each also having 1 and 2 lateral branches); nape with 1 cirrus on each side (cirrus rarely with 1 branch in large specimens); predorsal commissural pores 6–69, number increasing with increase in SL (table 27); preopercular series of pores with all positions with multiples of pores;

positions occasionally including some pore pairs (usually at position number 6); 1–6 pores before each anterior nostril (2 or more in 32 of 34 specimens; total number of pores before anterior nostrils 3–9 in all specimens); lateral line terminating on side in area below and between segmented dorsal ray 4 and midcaudal peduncle (usually posterior to dorsal ray 10 in specimens over 40 mm SL); ventral margin of upper lip completely crenulate; lip crenulae number 27–39 (usually 30 to 36).

Proportional measurements: See tables 3, 4, and 28.

No males were seen with fleshy rugose modifications of the skin of the anal spines and rays. The largest male examined was approximately 81 mm SL; the largest female examined was 95.6 mm SL. The smallest specimen examined, 32.6 mm, was not an ophioblennius stage. Only 8 of the 34 specimens available were males.

Color pattern of preserved specimens.—Pacific Ocean specimens: The sides of the body vary from almost uniformly pale to bearing 4½ or four and two half pairs of somewhat vertical series of light to dark dusky spots. The half pair series of spots are on the caudal peduncle and in the humeral region. A small, diffusely dusky spot is noticeable in the humeral region of some specimens. The ventralmost spots of each paired vertical series are least intense and widely separated from each other. The most noticeable marking on the side of the head is a slender, more or less vertical, irregular stripe posterior to, and well separated from, the eye. Occasionally this stripe expands into, and joins ventrally, an irregular dark blotch (see: Schultz and Chapman, 1960, plate 114 D; Fowler, 1932b, fig. 3). There may be other dusky markings with included pale vermiculations, usually, but not always, between the eye and the upper lip. The posterodorsal portion of the opercle is occasionally dark margined or completely dusky. The top of the head is irregularly dusky. The ventral portion of the head always bears indications of dark or dusky chevrons, each sometimes with a distinct pale margin (see Schultz and Chapman, 1960, plate 114 D). The upper lip is marked by up to 22 dusky, sometimes irregular, stripes of varying intensity, separated by narrower pale stripes, and arranged in groups of equal intensity. Frequently the darkest stripes on each side of the lip are in the area below the eye.

The spinous dorsal fin usually bears a narrow dusky distal band followed proximally by irregular, diffuse, dusky, and pale stripings. There are up to five darkly dusky areas at the base of the fin which are extensions onto the fin of the spots on the body. The soft dorsal rays each bear two or three light to dark dusky spots arranged in diagonal series across the fin. The tips of the anal fin rays are pale, especially anteriorly on the rays. The remainder of the rays are dusky. The interradial membrane is pale to dusky, darker distally. The caudal fin bears up to five irregular vertical dusky bands or stripes separated by paler interspaces. The pectoral fins are more or less uniformly pale or light dusky except for an occasional cresentic darker area at the base of the rays. The fleshy pectoral base is pale distally and usually has a dusky cresentic area proximally. The pelvic rays are usually pale; the interradial membrane dusky.

Indian Ocean specimens: Two female specimens are available from Madagascar. These two specimens differ in color pattern from Pacific specimens primarily in two features. They have well-developed subquadrate dark blotches in the humeral region above the pectoral axil as the darkest markings on the body, and the markings on the upper lip consist of about six broad dusky bands separated by fine pale stripes.

GEOGRAPHIC VARIATION.—Pacific Ocean populations appear to be very similar, but the two specimens from Madagascar are somewhat different from Pacific specimens. Aside from color pattern (see above) these two specimens have longer nuchal cirri (table 28) and possibly more predorsal commissural pores (table 27) than Pacific specimens of equal size. Their segmented anal fin ray counts of 16, with the last anal pterygiophore supporting only a single element, occurred in only 2 of the 32 Pacific specimens available. Possibly, this indicates lower average counts for the Madagascar population.

RELATIONSHIPS.—*Entomacrodus niuafoouensis* is a member of the *E. striatus* species group. Of this group, *E. niuafoouensis* differs: from *E. epalzeocheilus*, in having the nuchal cirri simple (with one branch in a few of the larger specimens) and in usually having more crenulae on the ventral margin of the upper lip; from *E. randalli*, in having more than one pore before each anterior nostril and in having stripes or bands on the upper lip; from *E. marmoratus*, in usually having no lateral branches on the main supraorbital cirrus (almost always fewer supraorbital cirri at any given SL), simple nuchal cirri, more than one pore before each anterior nostril, and in having more stripes, when present, on the upper lip; from *E. striatus*, in having more than one pore before each anterior nostril, paired pores in the preopercular series, lacking lateral branches on the main supraorbital cirrus, and in having a distinctly different color pattern.

Members of the *E. striatus* group are quite closely related. With the exception of *E. striatus* (collected with *E. epalzeocheilus* and *E. niuafoouensis*), no two of them have been collected from the same locality. Because of the existence of a Madagascar population of *E. niuafoouensis* (otherwise known only from the Pacific Ocean) and a Samoa Islands population of *E. epalzeocheilus* (otherwise known only from the Indian Ocean), there is general overlap in the range of these

TABLE 27.--Frequency distribution of number of predorsal commissural pores of specimens of *Entomacrodus niuafoouensis* arranged by SL classes (in mm)

Classes	Number of pores																													
	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	33	38	41	48	51	63	69
30-34.9	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
40	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
45	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
50	-	-	-	-	-	-	-	1	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
55	-	-	-	-	-	-	-	-	-	2	-	-	2	-	2	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	1[1]	-	-	-
65	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	1[1]	-	-
70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-
75	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	-	1	-	-	-	-
85	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
95	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-

[1] Madagascar specimens

two species, and they might be expected to occur in the same locality. It is conceivable, however, that the Samoan Island population is only a parallel *epalzeocheilus*-type offshoot of *E. niuafoouensis*, and the Madagascar population is a comparable *niuafoouensis*-type offshoot of *E. epalzeocheilus*, and no true overlap in the ranges of these two species really occurs. The two species are quite closely related and only slight convergent modifications would be needed to make proper identification difficult. Another possibility is that the distantly removed population of each species is a relict, indicating an early wide distribution of the species. The other two species of the related complex, *E. randalli* and *E. marmoratus*, are endemics in the Marquesas and Hawaiian Islands, respectively, and their distributions lend some support to the idea that *E. epalzeocheilus* and *E. niuafoouensis* are restricted in distribution also.

REMARKS.—*Entomacrodus niuafoouensis* has been collected with or from the same restricted geographic locality as *E. striatus*, *E. decussatus*, *E. vermiculatus*, *E. t. thalassinus*, *E. sealei*, and *E. caudofasciatus*. It may be most obviously differentiated: from *E. decussatus* and *E. vermiculatus*, in usually having fewer vertebrae, pseudobranchial filaments, supraorbital cirri (lacking lateral branches), and in having

TABLE 28.--Proportional dimensions as percent SL of specimens of *Entomacrodus niuafoouensis* (for meaning of abbreviations see methods section)

Catalog no.	Locale	Sex	SL	HL	OL	OCL	NCL	DS3	DR1	PECL	PELL	CL
UH 03084	Tongatapu	♂	34.4	23.0	7.6	4.4	2.6	10.2	13.1	25.0	16.6	25.9
UH 03083	Tongatapu	♂	45.2	24.6	6.2	6.2	3.1	10.6	13.3	24.3	17.7	24.3
UMMZ 144749	Bonin Is.	♂	45.8	23.1	7.0	5.7	3.1	11.1	12.0	26.2	17.9	24.5
UMMZ 144749	Bonin Is.	♂	49.6	23.8	6.2	8.1	2.4	9.5	12.1	26.0	17.5	25.4
UH 03083	Tongatapu	♀	51.4	24.9	6.4	5.8	3.9	10.1	14.8	24.7	18.5	23.5
USNM 124117	Guam	♀	58.5	24.1	6.3	6.5	3.4	9.7	12.3	22.9	16.6	23.6
UH 03084	Tongatapu	♀	61.5	24.4	5.8	5.4	2.6	9.8	11.0	23.9	17.4	23.9
MNHN A2042	Madagascar	♀	64.1	24.2	6.2	7.2	4.7	10.9	13.7	27.8	18.7	22.2
MNHN A2042	Madagascar	♀	65.5	25.0	6.1	6.7	4.1	11.1	11.4	27.6	18.3	22.4
UMMZ 144749	Bonin Is.	♀	66.3	24.1	6.2	6.2	3.3	10.0	13.0	25.6	16.6	24.9
UMMZ 144749	Bonin Is.	♀	68.3	24.3	6.1	6.4	3.1	10.2	12.4	25.3	17.6	23.4
UMMZ 144749	Bonin Is.	♀	73.2	23.0	6.0	5.9	2.7	9.7	12.8	24.6	16.5	24.2
UH 03084	Tongatapu	♀	75.4	23.7	5.4	6.2	3.2	9.7	11.9	22.9	15.2	21.5
UH 03084	Tongatapu	♀	80.9	24.6	5.1	6.2	2.5	11.9	13.6	26.0	16.3	23.9
UMMZ 144749	Bonin Is.	♀	83.5	23.7	5.7	6.3	2.4	10.7	12.5	25.1	16.5	23.5
UH 03083	Tongatapu	♀	95.6	24.3	5.2	5.6	2.5	11.5	12.6	23.2	15.7	23.1

a strikingly different color pattern; from *E. t. thalassinus*, *E. sealei*, and *E. caudofasciatus*, in having the entire ventral margin of the upper lip crenulate, and in having more gill-rakers, usually more pseudobranchial filaments, and more than one pore before each anterior nostril.

DISTRIBUTION (fig. 6).—*E. niuafoouensis* is known from Madagascar, Bonin, Marianas, Tonga and Niuafou Islands.

MATERIAL.—Madagascar: MNHN A 6924; Bonin Islands (Ogasawara), Ototoshima: UMMZ 144749; Mariana Islands, Guam: USNM 124117; Tonga Islands, Tongatapu: UH 03083, 03084; Niuafou: USNM 91932 (holotype of *Salarias niuafoouensis*), 137821, 138298.

Entomacrodus randalli, new species

PLATE 11

DESCRIPTION.—(Characters for holotype given in parentheses.) Segmented dorsal fin rays 15 or 16 (16); segmented anal fin rays 16 or 17 (17); posteriormost anal pterygiophore supporting 1 or 2 external elements (supporting 1 element in 7 of 11 specimens; supporting 1 in holotype); total gill-rakers on first arch 21–24 (23); pseudobranchial filaments 7–10 (7); vertebrae 34 or 35 (34 in 8 of 9 specimens; holotype with 34); supraorbital cirri 4–8 (5, too few specimens available to determine if cirri or predorsal commissural pores increase in number with increase in size); main, or longest, supraorbital cirrus with all branches mesially; nape with 1 cirrus on each side; predorsal commissural pores 9–42 (21 in holotype; 9–21 in 9 specimens 39–72 mm SL; 42 in specimen 87.5 mm SL); preopercular series of pores with at least 4 positions with pairs or multiples of pores (6); 1 pore before each anterior nostril; lateral line terminating on side of body in area below and between dorsal fin ray 10 and point just posterior to level of posteriormost dorsal fin ray (below dorsal ray 10); ventral margin of upper lip completely crenulate; lip crenulae number 24–32 (28).

Proportional measurements: See tables 3, 4, and 29.

Of the 11 specimens available, the largest, 87.5 mm SL, was a male with the anal spines and first two anal rays covered with fleshy rugose modifications of the skin, indicating probable sexual maturity.

COLOR PATTERN OF HOLOTYPE.—(None of the specimens available were in good condition and for the most part color pattern was indiscernible. As far as could be recognized, the color pattern of all the paratypes appeared to agree in all essentials with that of the holotype.) There are six areas on the side of the body bearing irregular bandlike dusky marks. The area on the caudal peduncle consists of a pair of spots arranged one over the other. The next four areas anterior are each dusky X-like markings, darkest midlaterally, palest ventrally. These marks do not reach the ventral body contour.

Dorsally, these marks extend onto the dorsal fin taking a dorso-posterior direction. The anteriormost bandlike area is restricted to the side below the anterior dorsal fin spines. In the region of the pectoral axil this marking forms a dark (humeral) blotch.

As its darkest mark, the head bears an elongate stripe posterior to the eye. This stripe extends ventrally into a larger, paler, irregular area on the cheek. The snout and upper lip bear numerous small dusky spots arranged in somewhat vertical series. There are faint indications of a dusky Y-shaped chevron midventrally on the head.

The anal fin membranes are evenly dusky, grading darker distally, darker than the anal elements. The pectoral fin is pale dusky with a darker, diffuse, elongate spot at the bases of the central rays. Another such spot, separated by a pale area, is on the fleshy pectoral base. The pelvic fins are pale dusky. The caudal fin is pale dusky, darker along the rays, with indications of some irregular marks on its proximal half.

Relationships and comparisons.—*Entomacrodus randalli* is a member of the *E. striatus* species group. It differs from other members of the group in the following: from *E. niuafooensis* and *E. epalzeocheilus*, in having a single pore before each anterior nostril, and spots, instead of stripes, on the upper lip; from *E. epalzeocheilus* and *E. marmoratus*, in having a single cirrus on each side of the nape; from *E. marmoratus* and *E. striatus*, in having branches of the supraorbital cirrus only on the mesial margin of the cirrus; from *E. striatus*, in having paired pores in the preopercular series and a strikingly different color pattern. *E. randalli* is quite similar to *E. niuafooensis* and is probably a relatively recent derivative of the same species which gave rise to *E. niuafooensis*.

Remarks.—*Entomacrodus randalli* is endemic to the Marquesas Islands and has been taken in the same collection with the other two species (fig. 6) of Marquesan *Entomacrodus*, *E. corneliae* and *E. macrospilus*, also endemics. *E. randalli* differs from these two species most prominently in having the ventral margin of the upper lip completely crenulate, more gill-rakers, and more pseudobranchial filaments.

TABLE 29.--Proportional dimensions as percent SL of specimens of *Entomacrodus randalli* (specimens in poor condition; proportions approximate; for meaning of abbreviations see methods section)

Catalog No.	Locale	Sex	SL	HL	OL	OCL	NCL	DS3	DR1	PECL	PELL	CL
BPBM 2333-2334	Marquesas	♀	49.0	24.5	6.9	6.5	3.7	10.8	12.8	26.1	17.3	25.5
USNM 199985 Holotype	Marquesas	♀	51.2	24.0	6.6	4.9	3.5	10.9	12.3	25.8	18.2	25.4
BPBM 2333-2334	Marquesas	♂	87.5	24.2	6.3	11.4	2.3	10.3	11.0	22.9	15.2	21.8

Holotype.—USNM 199985, female, 51.2 mm SL, east side of Anaho Bay near cliffs at shore, Nuku Hiva, Marquesas, July 17, 1957, collected by J. E. Randall.

Paratypes.—USNM 199986, two females, same data as holotype; ANSP 82148 (3 specimens), BPBM 2333 and 2334 (2 specimens), CHNM 25140 and 25141 (2 specimens), and SU 24522 (1 specimen), all from Nuku Hiva.

Etymology.—Named for John E. Randall, whose collections of Marquesan fishes were of great importance for my study.

Entomacrodus striatus (Quoy and Gaimard)

Plates 5, 7*b–c*, 12

Salarias striatus Quoy and Gaimard, 1836, *in* Cuvier and Valenciennes, Hist. Nat. Poissons, vol. 11, pp. 309–310 [le rivage près du Masson, Isle de France].

Salarias fraenatus Valenciennes, 1836, *in* Cuvier and Valenciennes, Hist. Nat. Poissons, vol. 11, pp. 342–344 [Côte Malabre].

?*Salarias arenatus* Bleeker, 1855, Nat. Tijdschr. Nederl. Indië, vol. 8, pp. 173–174 [Cocos Islands].

Salarias penotus Sauvage, 1891, Hist. Phys. Nat. Polit. Madagascar, vol. 14, p. 389 [misspelling of *fraenatus;* Madagascar].

Entomacrodus wolffi Rofen, 1958, Mar. Fish. Rennell Is., *in* Nat. Hist. Rennell Is., pp. 202–204 [Rennell Island].

Entomacrodus plurifilis plurifilis Schultz and Chapman, 1960, U.S. Nat. Mus. Bull. 202, pt. 2, pp. 338–340 [Tau Island, reef at Siulagi Point].

Entomacrodus plurifilis marshallensis Schultz and Chapman, 1960, U.S. Nat. Mus. Bull. 202, pt. 2, pp. 341–343 [Bikini Atoll, Enyu Island].

Description.—Segmented dorsal fin rays 14–17 (rarely 14 or 17, table 1); segmented anal fin rays 15–18 (rarely 15 or 18, table 1); posteriormost anal pterygiophore supporting 1 or 2 external elements (50.8 percent supporting 2); total gill-rakers on first arch 14–22 (16–20 in 93 percent of specimens); pseudobranchial filaments 5–10 (usually 6–8), increasing in number only slightly with increase in SL (table 30); vertebrae 33–35 (34 in 97 percent of specimens); supraorbital cirri 1–20, number increasing with increase in SL (table 31); main, or longest supraorbital cirrus with branches mesially and usually laterally (depending on population, see variation below); nape with 1 cirrus on each side (occasionally absent); predorsal commissural pores 2–10, increasing in number slightly with increase in SL up to 49 mm SL (table 32); preopercular series of pores with all positions with simple pores; 1 pore before each anterior nostril; lateral line pores terminating on side in area below and between dorsal fin spine 11 and dorsal ray 10 (usually between dorsal spine 13 and dorsal ray 6); ventral margin of upper lip usually completely crenulate, sometimes weakly; lip crenulae numbering 18–34 (22–29 in 91 percent of specimens).

Proportional measurements: See tables 2, 3, and 35.

Males develop fleshy rugose modifications of the skin of the anal spines and the anterior first to fourth anal rays. If one considers males with these modifications to be mature, the smallest mature male examined was 44.7 mm SL. Mature and immature males may occur in the same collection and in these collections immature males may be as much as 27 mm longer than mature males.

The largest specimen examined was a male 95.5 mm SL; the largest female was 72.3 mm SL. Only 4 (1.5 percent) of 259 females (30–72 mm SL) measured were over 69 mm SL, whereas 38 (9.9 percent) of 384 males (30 mm SL and larger) were over 69 mm. In general, males outnumbered females in all size classes over 49 mm SL, but the sexes were about equal in number in the 30–49 mm size classes; thus, the proportionate number of females at these smaller sizes was greater than the proportionate number of males. The smallest specimen examined, 15.8 mm SL, was not an ophioblennius stage and no such stages were seen. Vomerine teeth and one posterior canine were visible.

COLOR PATTERN OF PRESERVED MATERIAL.—There is considerable variation in color pattern even among specimens within a single collection. The following description is based on specimens from Jarvis Island. Some variations are discussed following this description.

In specimens with the most developed pattern the sides of the body are conspicuously marked with numerous dark spots, none of which

TABLE 30.--Frequency distribution of number of pseudobranchial filaments of specimens of *Entomacrodus striatus* arranged by SL classes (in mm)

Classes	Pseudobranchial filaments						
	5	6	7	8	9	10	Average
20-24.9	1	3	2	-	-	-	6.2
25	1	7	11	-	-	-	6.5
30	-	12	13	-	-	-	6.5
35	1	19	21	6	-	-	6.7
40	1	15	40	8	1	-	6.9
45	-	19	24	17	-	-	7.0
50	1	8	39	13	-	-	7.0
55	-	14	20	14	-	-	7.0
60	-	8	20	9	2	-	7.1
65	-	2	6	7	1	-	7.4
70	-	3	5	4	3	-	7.5
75	-	-	2	3	-	-	7.6
80	-	1	4	2	-	1	7.5
85	-	1	-	-	-	-	-
90	-	-	1	-	-	-	-
95	-	-	1	-	-	-	-

are larger than about half the area of the orbit; most are smaller. The spots are darkest along the midline of the side and largest in the area between and under the posterior half of the spinous and anterior half of the soft dorsal fin. From this area the spots decrease in size and increase in number anteriorly to the pectoral axil, where they are smallest. The spots decrease in size and number posteriorly to the caudal peduncle. The spots also decrease in size and intensity both dorsally and ventrally to the dorsal and ventral body contours. The darkest spots cluster in about five areas on the body, which may indicate that the spots are derived from a bandlike pattern (evident in specimens from other collections). The venter is pale.

The side of the head is variably dusky with an irregular, slender, somewhat vertical dark stripe posterior to the orbit, and separated from the orbit by a distance half the orbital diameter. A faint second stripe extends from the ventral midmargin of the orbit to the upper lip. The top of the head is not noticeably marked. The underside of the head in males varies from almost uniformly dusky to having a pattern of dusky chevrons separated by pale stripes; the underside of the head infrequently has a pattern of numerous dusky spots. In females the underside of the head is marked as in males but the pale stripes are more obvious and the dusky chevrons are intruded by small pale spots. The upper lip is faintly dusky.

The spinous dorsal fin of males is dusky with two or three rows of pale spots coursing through it; that of females marked with diffuse dusky and pale spots, a pattern which can be derived from that of the males. The soft dorsal fin of both sexes bears dusky stripes coursing

TABLE 31.--Frequency distribution of number of supraorbital cirri of left eye of specimens of *Entomacrodus striatus* arranged by SL classes (in mm)

Classes	Number of cirri																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Average
15-19.9	8	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.2
20	1	3	3	6	2	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	3.8
25	-	-	3	4	9	2	4	1	-	1	-	-	-	-	-	-	-	-	-	-	5.3
30	-	1	3	3	10	11	10	6	2	2	1	-	1	-	-	-	-	-	-	-	6.4
35	-	-	-	8	12	14	11	13	17	10	3	-	-	-	1	-	-	-	-	-	7.4
40	-	-	-	1	8	18	12	21	20	9	4	1	1	1	1	-	-	-	-	-	8.0
45	-	-	-	5	6	11	12	18	21	15	9	7	2	1	-	-	-	-	-	-	8.5
50	-	-	-	1	7	8	14	18	11	6	15	10	3	4	-	-	-	1	-	-	9.0
55	-	-	-	2	2	6	7	9	13	9	12	4	5	4	2	-	1	-	1	-	9.7
60	-	-	1	-	1	1	6	8	6	6	11	11	5	2	2	1	-	-	-	-	10.3
65	-	-	-	-	-	1	2	2	3	3	1	4	1	2	1	3	1	1	-	-	11.6
70	-	-	-	-	-	1	-	2	1	1	1	3	3	-	3	3	1	-	1	-	12.8
75	-	-	-	-	-	-	-	-	-	2	-	1	1	-	-	1	-	2	-	1	14.6
80	-	-	-	-	-	-	-	1	-	-	1	1	2	-	-	2	-	-	-	-	12.7
85	-	-	-	-	-	-	-	-	-	-	1	1	-	1	-	-	-	-	-	-	12.3
90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	17.0
95	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-

diagonally (ventroanteriorly to dorsoposteriorly) across the fin, and separated by pale areas. The stripes are so arranged that about three or four pass over each ray, but the same stripes do not pass over all the rays. The anal fin membrane (between each ray) is variably dusky, becoming more intense distally, generally much darker in males than females. The anal rays are paler than the interradial membrane. The caudal fin is marked by a variable number of alternating, irregularly vertical dark and pale stripes (increasing in number with increase in SL, up to about 10 or 11 dark stripes). Most of the dark pigment of the stripes is restricted to the caudal fin membrane. The pectoral fins are very faintly dusky with a concentration of pigment sometimes at the base of the rays. The fleshy pectoral base is diffusely dusky but may show evidence of a diffusely dusky band anteriorly. The pelvic fins are pale to dusky, darker in males than females.

In Marshall Islands specimens, the pale striping on the underside of the head may be very conspicuous. Pale spots and dashes may extend onto the upper lip, snout, and sides of the head. In specimens from many diverse localities, the only distinct markings are the large

TABLE 32.--Frequency distribution of number of predorsal commissural pores of specimens of *Entomacrodus striatus* arranged by SL classes (in mm)

Classes	Number of pores 2	3	4	5	6	7	8	9	10	Average
15-19.9	-	9	-	-	-	-	-	-	-	3.0
20	1	15	1	-	-	-	-	-	-	3.0
25	-	22	3	3	-	-	-	-	-	3.3
30	2	28	22	3	1	-	-	-	-	3.5
35	1	27	32	17	1	2	-	-	-	4.0
40	1	36	36	25	4	2	-	-	-	4.0
45	-	26	41	24	12	1	5	1	-	4.4
50	2	22	41	24	8	-	1	-	1	4.2
55	1	22	25	15	5	4	2	-	-	4.3
60	-	15	21	10	5	6	2	-	2	4.7
65	1	7	10	3	1	2	1	-	-	4.2
70	1	5	6	-	4	1	-	-	1	4.6
75	-	4	3	2	-	-	-	-	-	3.8
80	-	1	5	1	1	-	-	-	-	4.2
85	-	-	1	2	-	-	-	-	-	4.7
90	-	-	2	-	-	-	-	-	-	4.0
95	-	1	-	-	-	-	-	-	-	3.0

dark spots along the midlateral length of the body. Some specimens from the South China Sea have strong indications of diffuse, dark, bandlike extensions dorsally from the concentrated areas of body spots, and some specimens exhibit three diffuse vertical bands on the upper lip.

TABLE 33.--Frequency distributions of number of segmented dorsal and anal fin rays of specimens of *Entomacrodus striatus* from the Pacific Ocean arranged north to south by latitude (for definition of method A, method B, S and N, see methods section)

Locale	Approximate latitude	Segmented dorsal rays					Segmented anal rays method A					Segmented anal rays method B					
		14	15	16	17	Average	15	16	17	18	Average	16	17	18	Average	S	N
Amami Oshima	28° 30' N	-	-	2	-	16.00	-	-	2	-	17.00	-	1	1	17.50	1	1
Ototoshima	27° 10' N	-	1	2	-	15.67	-	2	1	-	16.33	1	2	-	16.67	1	2
Wake	19° 20' N	-	1	1	-	15.50	-	2	-	-	16.00	-	2	-	17.00	2	-
Saipan	15° 15' N	1	21	25	-	15.51	-	22	26	-	16.54	-	34	14	17.29	36	12
Tinian	15° 00' N	-	1	3	-	15.75	-	2	2	-	16.50	-	3	1	17.25	3	1
Guam	13° 20' N	-	9	11	-	15.55	-	8	14	-	16.64	3	15	4	17.04	9	13
Bikini	11° 40' N	-	22	24	-	15.52	-	19	27	-	16.59	3	37	6	17.06	22	24
Rongerik	11° 20' N	-	11	7	-	15.39	-	9	9	-	16.50	3	12	3	17.00	9	9
Duamaguete, P.I.	09° 30' N	-	-	1	-	-	-	-	1	-	-	-	-	1	-	1	-
Ngarungl, Palaus	08° 10' N	-	15	10	-	15.40	-	10	14	-	16.58	-	20	4	17.17	14	10
Koror, Palaus	07° 25' N	-	1	1	-	15.50	-	1	1	-	16.50	-	2	-	17.00	1	1
Ifaluk	07° 15' N	-	4	4	-	15.50	-	2	6	-	16.75	-	8	-	17.00	2	6
Peleliu, Palaus	07° 00' N	-	-	1	-	-	-	-	1	-	-	-	1	-	-	-	1
Jaluit	05° 50' N	-	4	11	-	15.73	-	3	12	-	16.80	1	12	2	17.07	4	11
Fanning	04° 00' N	-	1	3	-	15.75	-	1	3	-	16.75	-	4	-	17.00	1	3
Christmas	02° 00' N	-	-	2	-	16.00	-	-	2	-	17.00	-	2	-	17.00	-	2
Howland	00° 50' N	-	6	7	-	15.54	-	4	9	-	16.69	1	9	3	17.15	6	7
Jarvis	00° 25' N	-	21	29	-	15.58	-	8	42	-	16.84	2	44	4	17.04	10	40
Enderbury	02° 50' S	-	14	6	-	15.30	-	11	9	-	16.45	1	16	3	17.10	13	7
Canton	02° 50' S	-	13	14	-	15.52	-	8	19	-	16.70	1	18	8	17.26	15	12
Phoenix	03° 00' S	-	6	4	-	15.40	-	1	9	-	16.90	-	9	1	17.10	2	8
McKean	03° 00' S	-	1	-	-	-	-	1	-	-	-	-	1	-	-	1	-
Hull	04° 00' S	1	2	2	-	15.20	-	1	4	-	16.80	-	2	3	17.60	4	1
New Britain	04° 15' S	-	-	2	-	16.00	-	-	2	-	17.00	-	1	1	17.50	1	1
Funafuti	08° 30' S	-	1	4	-	15.80	-	1	4	-	16.80	-	4	1	17.20	2	3
Penrhyn	09° 00' S	-	1	2	-	15.67	-	-	3	-	17.00	-	-	3	18.00	3	-
Swains	11° 05' S	-	7	6	-	15.46	-	3	10	-	16.77	-	10	3	17.23	6	7
Rennell	11° 40' S	-	-	1	-	-	-	-	1	-	-	-	1	-	-	-	1
Rotuma	12° 30' S	-	1	1	-	15.50	-	1	1	-	16.50	-	1	1	17.50	2	-
Tau	14° 15' S	1	13	36	1	15.72	-	15	36	-	16.70	3	36	12	17.18	24	27
Tutuila	14° 15' S	-	1	12	-	15.92	1	1	11	-	16.77	1	10	2	17.08	4	9
Santo, New Hebrides	15° 20' S	-	-	2	-	16.00	-	-	2	-	17.00	-	1	1	17.50	1	1
Makatea	15° 40' S	-	-	1	-	-	-	-	1	-	-	-	1	-	-	-	1
Raroia	16° 00' S	-	2	5	-	15.71	-	1	5	1	17.00	-	3	3	17.71	5	2
Herald Cay	17° 00' S	-	-	2	-	16.00	-	-	1	1	17.50	-	-	1	18.50	2	-
Tahiti	17° 40' S	-	7	13	1	15.71	-	3	16	2	16.95	-	10	11	17.52	12	9
Efate, New Hebrides	18° 10' S	-	3	6	-	15.67	-	1	7	1	17.00	1	4	4	17.33	3	6
Fiji	18° 10' S	-	2	9	-	15.81	-	3	8	-	16.73	-	9	2	17.18	6	5
Aneityum, New Hebrides	20° 10' S	-	-	1	-	-	-	-	1	-	-	-	1	-	-	-	1
Tongatapu	21° 10' S	-	-	10	1	16.09	-	-	10	1	17.09	-	8	3	17.27	2	9
Rarotonga	21° 30' S	-	1	8	1	16.00	-	-	8	2	17.20	-	3	7	17.70	5	5
New Caledonia	22° 30' S	-	2	1	-	15.33	-	1	2	-	16.67	-	3	-	17.00	1	2
Lord Howe	31° 30' S	-	-	5	-	16.00	-	-	5	-	17.00	-	3	2	17.40	2	3

In general, specimens from the western and northern Indian Ocean appear to have fewer spots on the sides than do Pacific Ocean specimens, but this character is difficult to evaluate. One collection of Seychelles Island specimens (ANSP 102188) as opposed to others, contained specimens with very large spots, over half the orbital diameter in size. Other specimens in the same collection exhibited paired broken bands on the sides, and alternating pale and diffusely dusky stripes on the lips. Specimens from the Seychelles, Mauritius, Madagascar, and East Africa tend to have a fusion of the spots in the humeral area which gives the appearance of a noticeable blotch, but this fusion is by no means a consistent feature. Among other Indian Ocean populations, specimens from India may or may not have a humeral blotch, and specimens from the Cocos Islands (with the possible exception of the holotype of *Salarias arenatus*) do not. Dark humeral blotches or slender spots appeared variably on specimens from Pacific Ocean and South China Sea localities but were common only in collections from Rarotonga and Fiji.

Meristic and proportional variation.—Variation in the number of lateral (as opposed to mesial) cirri branches on the main supraorbital cirrus appears to occur in certain populations. Since the number of cirri is also dependent on size (table 31), one must select specimens of about 40 mm SL or longer to insure that some lateral cirri, if they are to be developed, will be present. Under these circumstances it was found that specimens from the coast of India usually lack lateral branches (24 of 42 specimens) whereas specimens from the various Pacific populations almost always have at least one laterally placed cirrus (exception: 2 of 24 specimens from the Palaus) and frequently as many as three or four (up to seven). Seychelles Islands specimens all had lateral cirri; however, specimens from the South China Sea commonly lacked lateral cirri (the 2 specimens from Hong Kong; 10 of 44 specimens from the Viet Nam coast; 2 of 12 specimens from the Thailand coast). Specimens from Western Australia may lack lateral cirri but the supraorbital cirri of specimens from this area appeared to have been abnormally reduced or aborted, and the lack of lateral cirri may be teratological. There does not appear to be a relationship between the mesial cirri branches and the presence or absence of lateral cirri branches; thus, populations with lateral branches have more cirri at a given SL interval than do those without such branches. Presence or absence of lateral cirri branches was not considered in the construction of table 31, where data for all populations were combined (exclusive of the Western Australia specimens).

There is considerable variation also in the relative length of the main supraorbital cirrus. A selected sample of the populations indi-

TABLE 34.--Frequency distributions of number of segmented dorsal and anal fin rays of specimens of *Entomacrodus striatus* from the South China Sea (including the Gulf of Thailand) and the Indian Ocean arranged north to south by latitude (for definition of method A, method B, and S and N, see methods section)

Locale	Approximate latitude	Segmented dorsal rays 14	15	16	Average	Segmented anal rays, method A 15	16	17	18	Average	Segmented anal rays, method B 16	17	18	Average	S	N
SOUTH CHINA SEA																
Hong Kong	22° 13' N	-	3	-	15.00	-	2	1	-	16.33	-	3	-	17.00	2	1
Goh Samet	12° 32' N	-	5	6	15.54	-	1	10	-	16.91	-	9	2	17.18	3	8
Nhatrang	12° 22' N	-	5	11	15.69	-	5	11	-	16.69	1	11	4	17.19	8	8
Ilot du Sud	10° 29' N	-	13	29	15.69	-	8	32	1	16.83	1	28	12	17.27	18	23
Goh Tao	06° 00' N	-	1	-	-	-	1	-	-	-	1	-	-	-	-	1
INDIAN OCEAN																
Bombay, India	18° 15' N	-	8	-	15.00	-	7	1	-	16.12	1	6	1	17.00	7	1
Vizagapatam, India	17° 30' N	1	16	8	15.28	2	9	14	-	16.48	4	16	5	17.04	13	12
Andaman Is.	12° 15' N	-	3	3	15.50	-	2	4	-	16.67	-	4	2	17.33	4	2
Konival, India	07° 50' N	-	9	4	15.31	-	4	9	-	16.69	1	11	1	17.00	4	9
Ceylon	07° 00' N	-	2	-	15.00	-	2	-	-	16.00	-	2	-	17.00	2	-
Praslin, Seychelles	04° 20' S	-	-	1	-	-	-	1	-	-	-	1	-	-	-	1
Curieuse, Seychelles	04° 20' S	-	16	2	15.11	-	15	3	-	16.17	1	16	1	17.00	15	3
La Digue, Seychelles	04° 20' S	-	1	-	-	-	1	-	-	-	-	1	-	-	1	-
Anonyme, Seychelles	04° 50' S	-	4	-	15.00	-	3	1	-	16.25	-	4	-	17.00	3	1
Mahé, Seychelles	05° 00' S	-	22	7	15.24	-	18	11	-	16.38	1	22	6	17.17	23	6
St. Pierre	09° 00' S	-	-	1	-	-	1	-	-	-	-	1	-	-	1	-
Cocos-Keeling	12° 20' S	-	9	7	15.44	-	7	9	-	16.56	1	13	2	17.06	9	7
Ibo, Mozambique	12° 30' S	-	1	-	-	-	1	-	-	-	-	1	-	-	1	-
Tanikely, Madagascar	13° 30' S	-	1	-	-	-	1	-	-	-	-	1	-	-	1	-
Mauritius	20° 30' S	-	2	2	15.50	-	1	2	1	17.00	-	2	2	17.50	2	2
NW Cape, Australia	22° 00' S	1	11	8	15.35	-	9	11	-	16.55	1	15	4	17.15	12	8
Inhambane, Mozambique	23° 30' S	-	1	-	-	-	1	-	-	-	-	1	-	-	1	-
St. Lucia, So. Africa	28° 00' S	1	3	-	15.00	-	1	2	-	16.67	1	2	-	16.67	-	3
Durban, So. Africa	30° 00' S	1	-	-	-	-	1	-	-	-	-	1	-	-	1	-

cated that this variation was geographically, sexually, and ontogenetically correlated. Different samples from a relatively limited geographical area (i.e., Phoenix Islands) may have quite different relative cirrus lengths. Within most populations males tend to have relatively longer cirri than females. Relative cirrus lengths of specimens from India do not overlap with cirrus lengths of specimens from Samoa; however, plotting lengths for other populations of the species show that the cirri lengths of some populations overlap both the Indian and Samoan populations. No clinal change (east to west, north to south) in relative cirrus lengths was noted. In conclusion, it appears that the character of main supraorbital cirrus length is affected by a complex of factors and can be expected to vary considerably from one locality to the next.

Variation in average number of segmented dorsal or anal fin rays occurs among the various populations of *E. striatus*. Such variation prompted Schultz and Chapman (1960) to recognize subspecies within this species. In an attempt to determine if the variation followed any geographic pattern, I arranged frequency distributions of the counts on a latitudinal north to south basis (regardless of longitude) within the three major areas where the species occurs (tables 33, 34): Pacific Ocean, South China Sea, Indian Ocean. Inasmuch as the method of counting anal rays generally employed in the present study (method A) might obscure significant counts of the anal fin, I have also given frequency distributions of the total segmented anal elements (method B).

In the Pacific Ocean the highest average fin ray counts were obtained for populations south of the equator. A trend of increasing averages for anal rays, both methods, from north to south is particularly noticeable if averages are taken of the counts grouped by 10 degree latitude intervals; dorsal rays appear to increase in both directions from the equator:

latitude class	*dorsal ray average*	*no.*	*anal rays*		*no.*
			method A average	*method B average*	
29°–20° N	15.80	5	16.60	17.00	5
19°–10° N	15.51	137	16.56	17.14	140
09°–00° N	15.57	121	16.76	17.08	120
00°–09° S	15.43	73	16.68	17.24	73
10°–19° S	15.73	132	16.81	17.30	132
20°–29° S	15.96	25	17.08	17.40	25
30°–39° S	16.00	5	17.00	17.40	5

The validity of grouping the data in the above manner is not known, but perhaps it is suspect because the fin ray counts grouped north to south by 10 degree longitude intervals present no clear-cut trend within a particular interval. The difficulty is perhaps due to the fact that there is insufficient material from within the intervals

TABLE 35.--Proportional dimensions as percent SL of specimens of *Entomacrodus striatus* (for meaning of abbreviations see methods section)

Catalog no.	Locale	Sex	SL	HL	OL	OCL	NCL	DS3	DS13	DR1	PECL	PELL	CL
USNM 197907	Phoenix Is.	♀	30.0	23.6	7.0	5.0	2.7	10.7	1.7	11.7	24.0	16.0	25.6
USNM 115452	Samoa	♂	32.5	24.6	8.3	3.1	2.8	9.5	-	9.2	24.6	16.3	26.1
SU 14735	India	♂	37.7	23.9	6.6	6.1	2.1	9.3	-	10.9	23.8	15.1	24.1
USNM 115449	Phoenix Is.	♀	37.7	23.9	7.4	3.2	2.1	9.5	-	12.5	25.2	17.0	26.0
USNM 142165	Bikini	♀	40.0	24.5	7.5	4.5	2.2	9.0	2.0	13.5	23.0	14.5	25.0
SU 14735	India	♂	42.0	23.3	6.9	7.6	-	8.3	-	11.7	23.3	17.3	25.2
USNM 115452	Samoa	♂	42.1	25.2	7.1	2.8	2.4	9.5	1.2	10.9	22.3	15.4	25.2
USNM 142159	Bikini	♂	42.2	23.2	7.1	4.7	2.8	9.5	-	11.8	22.7	15.9	24.9
USNM 115449	Phoenix Is.	♀	42.4	23.8	6.8	4.5	2.1	9.9	-	11.8	23.6	15.1	23.6
USNM 142162	Bikini	♀	43.0	23.7	7.4	3.7	2.3	9.8	-	12.8	23.7	15.6	24.7
SU 14735	India	♀	44.0	22.7	6.6	5.0	1.8	8.9	-	11.3	22.5	15.0	25.0
USNM 115452	Samoa	♂	45.2	24.6	7.5	4.2	2.2	9.1	-	13.3	23.2	15.2	23.9
USNM 115452	Samoa	♂	45.5	24.4	6.6	4.0	2.4	9.0	1.8	12.7	22.6	15.8	24.4
USNM 142165	Bikini	♂	46.0	22.2	6.7	4.3	1.7	9.8	2.2	11.7	22.8	15.2	23.9
USNM 142158	Bikini	♂	47.4	23.2	6.3	3.6	2.5	9.3	-		22.8	16.2	25.3
SU 14735	India	♀	49.2	22.8	6.1	6.1	2.4	8.9	2.0	8.5	23.1	15.6	23.6
USNM 123855	Saipan	♀	49.2	24.0	6.9	4.5	2.2	8.7	-	12.1	22.8	13.6	23.6
USNM 115449	Phoenix Is.	♂	49.5	22.2	6.5	4.4	2.4	10.9	2.0	11.7	23.6	14.7	22.4
USNM 115449	Phoenix Is.	♀	50.0	22.4	6.0	3.8	2.4	9.2	-	11.0	22.2	14.4	23.4
USNM 142162	Bikini	♂	50.4	24.2	6.5	4.4	2.6	8.9	-	12.3	23.0	14.3	23.8
USNM 115452	Samoa	♀	51.0	23.5	6.7	3.9	1.8	8.8	0.8	11.0	22.7	14.7	24.5
USNM 123855	Saipan	♂	52.2	24.1	6.7	5.0	-	8.6	-	11.5	21.1	13.4	22.2
SU 14735	India	♂	52.8	22.9	5.7	7.2	2.6	8.5	-	10.4	22.9	15.1	23.5
USNM 115452	Samoa	♀	53.0	23.8	7.0	3.0	2.1	9.8	-	11.3	24.0	15.8	24.9
USNM 115449	Phoenix Is.	♂	53.5	22.4	6.0	5.2	2.2	11.0	-	10.8	20.7	14.0	22.4
USNM 123855	Saipan	♂	55.4	23.8	6.3	5.6	2.0	9.0	-	10.8	20.7	13.3	22.0
USNM 142165	Bikini	♂	55.5	24.5	6.5	4.5	2.0	9.9	1.8	11.0	-	13.5	23.8
USNM 142163	Bikini	♂	55.6	23.4	6.3	7.0	2.2	9.9	1.4	11.9	21.8	13.7	24.8
USNM 115452	Samoa	♂	56.2	23.1	6.6	3.6	2.7	9.2	-	12.4	21.4	13.9	23.8
USNM 123855	Saipan	♂	56.8	23.2	6.3	4.6	2.3	8.6	-	12.1	20.8	13.0	22.4
USNM 115449	Phoenix Is.	♂	59.2	22.1	5.9	4.2	-	9.3	-	10.1	20.8	12.5	22.8
SU 14735	India	♀	60.0	21.8	5.7	5.7	1.8	9.0	-	10.0	21.7	14.0	23.0
USNM 144720	Samoa[1]	♂	61.3	22.8	6.2	3.6	2.1	9.0	2.0	12.1	20.3	13.8	22.8
USNM 123855	Saipan	♂	62.2	23.5	6.4	6.4	2.4	9.5	-	12.2	21.0	12.5	22.5
USNM 115452	Samoa	♀	62.6	23.8	6.2	3.2	2.1	8.8	1.6	11.2	22.4	13.6	22.4
USNM 115449	Phoenix Is.	♂	63.6	22.3	5.5	4.7	1.7	9.9	1.6	11.0	20.4	13.4	22.2
UZMK P75354	Solomon Is.[2]	♀	64.6	23.2	6.2	3.6	-	8.8	1.7	11.6	22.2	-	23.2
USNM 142155	Bikini[3]	♂	65.7	22.7	5.8	4.6	1.8	10.0	-	-	20.6	13.7	23.2
USNM 115449	Phoenix Is.	♂	65.7	21.6	5.5	4.3	2.4	10.5	2.4	11.4	21.3	13.1	22.8
SU 14735	India	♂	66.2	21.9	5.7	6.8	1.0	10.4	-	12.2	21.1	13.3	23.4
RU(no number)	Seychelles	♂	67.0	23.0	5.2	4.8	1.8	-	-	12.2	21.5	-	22.4
SU 14735	India	♂	67.3	22.3	5.5	7.7	0.9	9.9	1.9	10.4	20.8	13.5	22.7
SU 14735	India	♂	67.9	22.8	5.9	5.3	1.3	9.7	-	11.5	22.1	11.3	22.7
SU 14735	India	♂	69.0	23.6	5.6	6.2	1.4	9.1	-	10.4	21.4	-	23.5
USNM 115449	Phoenix Is.	♂	72.6	21.9	5.2	4.7	1.6	10.6	-	11.7	20.6	13.1	22.8
USNM 115452	Samoa	♂	74.5	22.5	5.4	5.1	1.9	8.7	1.6	11.7	20.5	12.3	24.2
USNM 198141	Phoenix Is.	♂	79.4	21.5	5.0	5.0	1.8	8.8	-	10.1	21.0	12.5	22.7
USNM 198141	Phoenix Is.	♂	85.9	22.1	5.1	5.2	2.3	9.9	-	-	21.0	12.7	21.9
USNM 198141	Phoenix Is.	♂	95.5	22.4	4.7	4.7	1.6	9.5	-	10.7	21.5	12.5	22.8

[1] Holotype *Entomacrodus plurifilis plurifilis*
[2] Holotype *Entomacrodus wolffi*
[3] Holotype *Entomacrodus plurifilis marshallensis*

on which to base a meaningful study of north-south trends.

I have entered the fin ray averages of Pacific Ocean populations at their geographic locations on a map in a search for more complex trends. I could observe only that similar averages tended to group in certain locations, but there was no obvious relationship of widely separated areas with similar averages (e.g., the Line Islands and the Marshall Islands) or with averages of populations along island groups radiating out from them.

Fin ray counts and averages of populations (table 34) from the South China Sea (SCS) and Indian Ocean (IO) indicate no trends, nor are these averages similar to those of Pacific Ocean specimens from similar latitudes:

latitude class	*dorsal ray average*				*anal ray average method A*				*anal ray average method B*			
	SCS	*no.*	*IO*	*no.*	*SCS*	*no.*	*IO*	*no.*	*SCS*	*no.*	*IO*	*no.*
29°–20° N	15.00	3			16.33	3			17.00	3		
19°–10° N	15.67	69	15.26	39	16.81	68	16.44	9	17.24	68	17.08	39
09°–00° N	15.00	1	15.27	15	16.00	1	16.60	15	16.00	1	17.00	15
00°–09° S			15.20	54			16.30	54			17.09	54
10°–19° S			15.39	18			16.50	18			17.06	18
20°–29° S			15.32	28			16.61	28			17.14	28
30°–39° S			14.00	1			16.00	1			17.00	1

Strasburg (1955) reported that north-south differentiation in number of soft dorsal and anal rays occurred in the western Pacific salarine blenniid, *Istiblennius edentulus* (which has much the same distribution in the Pacific Ocean as does *E. striatus*). The average number of rays, he reported, tended to decrease from the northern latitudes to the equator and then to increase from the equator south as one progressed southeasterly along what Strasburg called the "main band" of islands (Wake, Marianas, Marshalls, Gilberts, Samoa, Tuamotus, Fijis, Societies, Gambiers). Strasburg gave no reasons to support his choice of the main band of islands upon which he based his evaluation.

Strasburg calculated regression lines for fin ray counts for the main band of islands based on average annual temperatures (which are generally correlated with latitude, decreasing north and south from the equator). He then set confidence limits at p .01 level and calculated the expected range of fin ray averages based on average annual temperatures for populations of *I. edentulus* from island groups outside the main band and demonstrated that almost all the averages fell within the range of those expected, inferring, thus, that there is some relationship between temperature and average fin ray count. Here it should be noted that if one were to eliminate the single high dorsal ray average for the Gambier specimens from Strasburg's calculations, his regression for dorsal fin rays would be hardly different from a straight line.

The temperatures Strasburg used were obtained by averaging the surface temperatures for the months of February and August as obtained from Charts II and III of Sverdrup, et al (1946). These charts were obviously redrawn from Schott (1935, pls. XX and XXII). Schott also gave temperatures for May and November (pls. XXI and XXIII). The temperatures that Strasburg has recorded to the nearest 0.1 degree centigrade were taken from the charts, which are only general plots of whole-degree centigrade isothermal lines on a map of the Pacific. The total temperature range forming the basis of Strasburg's regression, 25.5–28.0° C, covers only 2.5°. It is not unlikely that actual average temperatures for any of Strasburg's localities might differ as much as a degree from those he selected. Such differences might well alter Strasburg's conclusions. For this reason I am hesitant to test my counts against similarly derived temperature data.

Another point bearing on Strasburg's findings is the fact that he has used method A anal fin counts. Method B counts (indeterminable from his data) might have produced different results.

Nomenclature.—The description of *Salarias striatus* Quoy and Gaimard was based on more than one specimen (exact number not mentioned) from Mauritius. There are three specimens (approximately 41, 44, and 58 mm SL) in the type series (MNHN A1796) in the Paris Museum. All are in poor condition. I here designate the largest of these three specimens lectotype. Aside from its greater length, the lectotype, a female, can be distinguished from the other two specimens (male and female) in having the dorsal fin rays XIV, 16 (the 14th spine is not clearly visible) as opposed to XIII, 15 or 16 (13th spine not visible) for the paralectotypes, and the soft anal rays 18 (the last not split to the base) as opposed to 17 (the last not split to the base) or 17 (the last split to the base) in the paralectotypes. The lectotype and female paralectotype have well-developed, dark humeral blotches. The male paralectotype has no humeral blotch.

Salarias fraenatus Valenciennes was based on several specimens from Bombay and although the description appears in the same work as that including the original description of *Salarias striatus*, *S. fraenatus* was compared only with the distantly related *S. textilis*. The Bombay specimens differ from the types of *S. striatus* primarily in having only a faint blotch in the humeral region, much smaller than the blotch found in the types of *S. striatus*. *S. striatus* has page priority over *S. fraenatus*.

Salarias arenatus Bleeker was described from a single specimen, 62 mm, from the Cocos Islands (Indian Ocean). Chapman (1951, p. 285) stated that Bleeker (1879, p. 20) synonymized *S. arenatus* Bleeker with *S. striatus*. Actually, Bleeker (1875, p. 74) first gave his synonymy in a paper on Madagascar fishes in which he noted the synonymy as "*Salarias arenatus* Blkr?=Salarias striatus Q&G CV," which denotes Bleeker questioned his action. In the 1878 paper Bleeker repeated this same questioned synonymy. I have been unable to locate the holotype of *S. arenatus* and it seems quite possible that it was lost even in Bleeker's day. From the description it is not possible to positively place *S. arenatus* in the synonymy of *E. striatus*. The main discrepancy I find is that Bleeker stated that his specimen had a black humeral spot "regione suprascapulari macula nigricante," whereas none of the 16 specimens I have examined from the Cocos Islands had such a mark. This may be a minor matter as occasional specimens with humeral blotches have been found in collections of specimens of *E. striatus*, where specimens with such blotches were uncommon. The only other species from the Indian Ocean with which *S. arenatus* might be identified is *Entomacrodus epalzeocheilus* (Bleeker, 1859). The described presence of a humeral spot on the body of *S. fraenatus* probably excludes it from synonymy with *E. epalzeocheilus*, which lacks such a mark.

Entomacrodus wolffi was described from a single specimen and differentiated from *E. striatus* by lacking nuchal cirri, by lacking canines in the lower jaw, in having filaments on both sides of the main supraorbital cirrus, and in having a black pectoral fin axilla. I have examined the holotype and have no reservations about including *E. wolffi* in the synonymy of *E. striatus*. Nuchal cirri are occasionally lacking in specimens of *Entomacrodus striatus* as are also canines in the lower jaw. The disposition of the lateral and mesial cirri on the main supraorbital cirrus is quite variable within a population (see discussion of variation above). The pectoral axilla of the holotype is not actually black. The blackness is due to the transparency of the skin of the axilla. Below the skin is a hollow which appears dark through the skin. This condition prevails in many specimens of *E. striatus* and depends to some extent on preservation.

Entomacrodus plurifilis was differentiated from *E. striatus* and *E. arenatus* by lacking cirri on the lateral margin of the main supraorbital cirrus and by lacking a humeral blotch. The invalidity of these two characters for species recognition within *E. striatus*, as considered here, has been discussed above. *Entomacrodus p. plurifilis* was separated from *E. p. marshallensis* because "about 71 percent of the specimens of *E. p. marshallensis* have 15 soft dorsal rays and about 51 percent have 16 soft anal rays, whereas *E. p. plurifilis*, respectively, have 70 percent with 16 soft dorsal and 83⅓ percent with 17 soft anal rays" (Schultz and Chapman, 1960). The variability of dorsal and anal fin ray counts that I have found in populations of *E. striatus* convinces me that the differences noted are insufficient for subspecies recognition.

RELATIONSHIPS.—*Entomacrodus striatus* is most closely related to a group of Indo-Pacific species (*E. striatus* species group): *E.*

epalzeocheilus, *E. niuafoouensis*, *E. randalli*, and *E. marmoratus*. The latter species are trenchantly different from *E. striatus* but are similar in having the ventral margin of the upper lip completely crenulate. In body form all these species attain a rather large size (over 85 mm SL) and have a rather robust body form, possibly a function of size. In addition, all have a well-developed, slender, elongate, dark mark just posterior to the orbit. *E. striatus* differs from all of the related forms except possibly *E. randalli* in having fewer predorsal commissural pores at any given size. It also differs from the other members of its group in always having the preopercular pore positions with simple pores. In addition, if differs: from *E. epalzeocheilus* and *E. niuafoouensis*, in usually having cirri on the lateral margin of the main supraorbital cirrus and in having a single pore before each anterior nostril; from *E. epalzeocheilus* and *E. marmoratus*, in having simple nuchal cirri; from *E. niuafoouensis* and *E. randalli*, in having fewer gill-rakers; and from *E. randalli*, in having cirri on the lateral margin of the main supraorbital cirrus.

REMARKS.—*Entomacrodus striatus* has been collected with or from the same restricted geographical area as all the other species and subspecies of Indo-Pacific *Entomacrodus*, except *E. strasburgi*, *E. marmoratus*, *E. randalli*, *E. macrospilus*, and *E. chapmani*, all of which have very limited distributions. Differentiations of *E. striatus* from the species not mentioned above can be made from the key and by referring to the various tables.

DISTRIBUTION (fig. 7).—*E. striatus* is the most widely distributed species of *Entomacrodus*, occurring from the eastern Indian Ocean to Raroia, Tuamotus, in the Pacific Ocean. It ranges from 28°30′N to 31°30′S latitude. It is primarily found in shallow tide pools and near shallow reefs.

MATERIAL.—INDIAN OCEAN: India, Konival: SU 14737; Bombay: MNHN 996 (syntypes of *Salarias fraenatus*); Vizagapatam: SU 14735, 14736; Ceylon: BMNH 1903.5.12.3, SU 22855; Andaman Islands: SU 16449, USNM 195781; Seychelles Islands: BMNH 1912.5.3.23–4; Praslin: BMNH 1908.5.14.27; Curieuse: ANSP 102186; La Digue: RU (no number); Anonyme: ANSP 102182; Mahé: ANSP 102188, 102192, RU (no number); St. Pierre: RU (no number); Mauritius: MNHN A1796 (lectotype of *Salarias striatus*), B2525, 997; Madagascar, Tanikely: USNM 199424; Cocos-Keeling Islands: BMNH 1949.11.29.604–618; Western Australia, Northwest Cape: WAM P.4654; Mozambique, Ibo: RU (no number); Inhambane: RU (no number); South Africa, St. Lucia coast, North Zululand: ANSP 54995–97; Durban, Natal: ANSP 55161.

SOUTH CHINA SEA: Hong Kong: SU 62069; Viet Nam, Nhatrang: SU 62047; Ilot du Sud (near Poulo Cécir de Mer): SU 62002; Gulf of Thailand, Goh Tao Island: SU 62008; Goh Samet Island: SU 62006.

PACIFIC OCEAN: Japan, Amami-Oshima: USNM 199816; Bonin Islands, Ototo-shima: UMMZ 144748; Wake Island: SU 50164; Marianas Islands, Guam: USNM 123953, 137770, 139839; Saipan: SU 62078, 62079, 62080, USNM 123855; Tinian: USNM 124275; Marshall Islands, Rongerik Atoll, Bock Island: USNM 142176, 142177; Bikini Atoll, Enyu Island: USNM 142155 (holotype of *Entomacrodus plurifilis marshallensis*), 142164; Cherry Island: USNM 142162, 142163; Namm Island: USNM 142159; Erik Island: USNM 142157; Druk Island: USNM 142165; Boby Island: USNM 142158; Romuk Island: USNM 142161; Philippine Islands, Duamaguete: SU 28428; Palau Islands, 8 mi. northwest of Koror Island: SU 62049; Peleliu Island: USNM 123811; Ngarungl Island: SU 62056; Caroline Islands, Ifaluk Atoll: SU 62027, 62037, 62041, 62042, 62053, 62054; Jaluit (Bonham Island): BMNH 1873.4.3.190, ZSZM 20229; Christmas Island: BMNH 1964.2.14.1-2; Fanning Island: ANSP 64288-89, BPBM 4934; Howland Island: USNM 197905, 197907; Jarvis Island: USNM 198655; Phoenix Islands, Canton Island: USNM 115453; Hull Island: USNM 115454; Enderbury Island: USNM 115449; McKean Island: USNM 197906; Phoenix Island: USNM 198141; Ellice Islands Funafuti: AMS I3566, I3567, I3568, I3571, I3573; Penrhyn Island: ANSP 64352, BPBM 4935, 4936; Swains Island: USNM 115450; New Britain, Rabaul: USNM 200099; Solomon Islands, Rennell Island: UZMK P.75354 (holotype of *Entomacrodus wolffi*); Rotuma Island: BMNH 1897.8.23.108-109; Fiji Islands, Rat-tail Passage Reef, Suva, Viti Levu: UH 03079; Tonga Islands, Monotapu Beach, Tongatapu: UH 03073; near Houma Beach, Tongatapu: UH 03074, 03075; Samoan Islands, Tau Island: USNM 115452, 144720 (holotype of *Entomacrodus plurifilis plurifilis*); Tutuila Island: USNM 52264, 115456, 115457, 115459; New Hebrides: AMS I14264; Santo Island: AMS I6497, BMNH 1926.3.6.22; Efate: UH 03076, 03077; Aneiteum: BMNH 1871.4.16.6; New Caledonia, La Roche Perce, Borial: UH 03078; Australia, Coral Sea, Herald Cay: AMS IB5031, IB5032; Lord Howe Island: AMS I1864, I1865, I1866, I1867, I5903; Cook Islands, near Nikau Village, Rarotonga: UH 03072; Society Islands, Tahiti: BMNH 1873.4.2.88, UH 03080, 03081, USNM 87621, ZSZM 8205; Tuamotu Archipelago, Raroia: SU 62030, 62043; Makatea: USNM 200282.

Entomacrodus rofeni, new species

Plate 13

Description.—(Figures in parentheses for holotype.) Segmented dorsal fin rays 16 or 17 (17), usually 16; segmented anal fin rays 17 or 18 (18), usually 18; posteriormost anal pterygiophore supporting 1 or 2 (2) external elements (2 in 53.8 percent of specimens); total gill-rakers on first arch 16-19 (17); pseudobranchial filaments 5 or 6 (6); vertebrae 35; supraorbital cirri 5-8 (8); supraorbital cirri variable, sometimes arising from a common base, sometimes from both mesial and lateral edges of main, or longest cirrus; nape with 1 cirrus on each side; predorsal commissural pores 3, apparently unvarying; preopercular series of pores with all positions with simple pores; 1 pore before each anterior nostril; lateral line terminating on side in area below and between dorsal spines 10 and 11 (11); ventral margin of upper lip completely crenulate; lip crenulae numbering 23-28 (28).

Proportional measurements: See tables 3, 4, and 36.

Males ranged from 26.0 to 39.7 mm SL. No males were seen with rugose fleshy modifications of the skin of the anal spines and rays. Females ranged from 28.2 to 42.2 mm SL. The smallest specimen was not an ophioblennius stage.

Color pattern of holotype.—Male. The sides of the body are delicately marked with scattered melanophores. There are a few loose concentrations of melanophores on the sides which give the appearance of spots. The head is more or less uniformly covered with scattered melanophores. The upper lip has indications of five dark stripes separated by dusky interspaces. The spinous dorsal fin is irregularly dusky. The soft dorsal fin bears about three dusky spots are over each ray arranged in diagonal series from ray to ray. The anal fin is irregularly dusky distally, unmarked basally, on its anterior half, and completely unmarked on its posterior half. The caudal fin bears four or five rows of irregularly vertically arranged spots concentrated at the rays. The pectoral fin, its fleshy base and the pelvic fin are lightly covered with scattered melanophores.

The paratypic males are similarly marked to the holotype. The females are also similar but the dorsal fin bears fewer marks, the anal fin is immaculate, and the lateral stripe on either side of the upper lip is broader and more bandlike than the stripes in the same position on the lips of the males.

All in all, this is an inconspicuously marked species.

Relationships.—In spite of the fact that it shares certain characters with various other species of *Entomacrodus*, I find it difficult to relate *E. rofeni* closely to any of the other species. Its rather high vertebral number (35) is found commonly only in: *E. vomerinus*, *E. stellifer* (from both of which it obviously differs in disposition of dorsal lip crenulae and nature of supraorbital cirri), *E. marmoratus* (from which

TABLE 36.--Proportional dimensions as percent SL of specimens of *Entomacrodus rofeni* (for meaning of abbreviations see methods section)

Catalog no.	Locale	Sex	SL	HL	OL	OCL	NCL	DS3	DR1	PECL	PELL	CL
SU 62031	Raroia	♂	26.0	23.0	7.7	3.5	3.5	7.7	-	23.1	15.4	26.9
SU 62031	Raroia	♂	26.1	22.2	7.7	3.4	3.1	9.6	9.2	23.1	15.3	26.0
SU 62031	Raroia	♀	28.2	22.0	7.1	2.8	3.5	9.9	10.3	23.8	16.0	26.6
SU 62031	Raroia	♂	32.0	22.5	6.9	3.1	2.4	9.4	10.0	20.6	14.8	24.2
SU 62035[1]	Raroia	♂	34.7	22.4	6.3	3.7	2.9	9.2	9.5	21.0	13.5	25.1
SU 62038	Raroia	♀	36.4	22.0	6.0	2.7	2.7	9.6	11.3	23.0	14.3	26.2
USNM 199402	Raroia	♀	37.0	21.6	6.8	2.7	3.2	9.7	10.3	21.0	13.5	25.1
USNM 199402	Raroia	♀	37.4	21.4	6.4	2.4	2.7	9.6	10.7	21.4	15.5	25.4
SU 62031	Raroia	♂	39.7	21.4	6.3	3.8	2.5	9.3	10.1	20.7	13.6	23.9
SU 62031	Raroia	♀	41.5	21.5	6.3	2.4	2.4	9.4	9.2	20.5	14.9	24.6
SU 62031	Raroia	♀	42.5	21.3	6.4	2.6	2.4	9.2	9.5	22.7	14.2	-

[1] Holotype of *Entomacrodus rofeni*

it obviously differs in number of predorsal commissural pores, anal rays and nuchal cirri), and *E. decussatus* and *E. vermiculatus* (from both of which it obviously differs in number of gill-rakers and predorsal commissural pores, eye size, and robustness of body). *E. rofeni* has a consistently lower number of predorsal commissural pores than any other species of *Entomacrodus*. *E. striatus* has relatively few such pores, but here there is a range of variation (up to 10 pores). *E. rofeni* commonly lacks vomerine teeth (4 of 13 known specimens), a lacking found in only very large specimens of *E. vermiculatus*.

REMARKS.—*E. rofeni* has been collected with or from the same restricted geographic locality as *E. striatus*, *E. thalassinus*, *E. sealei*, and *E. caudofasciatus*. It can be differentiated from *E. striatus* by the characters given in key couplet 22; it differs most obviously from the other three species in having the upper lip completely crenulate and in having more vertebrae and dorsal and anal fin rays.

DISTRIBUTION (fig. 5).—*E. rofeni* is known only from Raroia, Tuamotu Archipelago.

HOLOTYPE.—SU 62035, an immature male, 34.7 mm SL, from outer reef flat near Garumaoa village, west side of atoll, Raroia, Tuamotu Archipelago, July 11, 1952.

PARATYPES (Collected with holotype).—USNM 199402 (4 specimens); channel between Geogeo and Kukina Islets, near Garumaoa village, west side of atoll: SU 62038 (1 specimen); outer reef near Garumaoa village on west side of atoll on shallow tidal flat next to shore: SU 62031 (7 specimens).

ETYMOLOGY.—Named for Robert R. Rofen, who collected all the known specimens.

Entomacrodus strasburgi, new species

PLATE 14

DESCRIPTION.—(Character for holotype in parentheses.) Segmented dorsal fin rays 13–15 (14); segmented anal fin rays 16 or 17 (16); posteriormost anal pterygiophore supporting 1 or 2 (2) external elements (supporting 2 in 82 percent of specimens); total gill-rakers on first arch 11–15 (14); pseudobranchial filaments 5, unvarying with increase in size; vertebrae 34 or 35 (34); supraorbital cirri 1–4 (3), number increasing with increase in SL (table 37); main, or longest supraorbital cirrus with all branches mesially; nape with 1 cirrus on each side; predorsal commissural pores 3–12 (9), increasing slightly with increase in SL (table 38); preopercular series of pores with all positions with simple pores; 1 pore before each anterior nostril; lateral line pores terminating on side in area below and between dorsal fin spine 11 and dorsal ray 4 (dorsal ray 4), usually posterior to dorsal ray 1; ventral margin of upper lip completely crenulate; lip crenulae number 19–26 (25) (see table 5). (The left pectoral fin of the holotype has 13 rays, the right 14; the pectorals of 13 paratypes counted had 14 on each side.)

Proportional measurements: See tables 3, 4, and 39.

No males with fleshy rugose modifications of the anal spines were seen, although in the largest males the anal spines and anterior rays were noticeably more fleshy than the remaining rays.

The largest specimen examined was a male, 35.0 mm SL, the holotype. The largest female examined was 27.1 mm SL. Males and females were about equally common in the single large collection made. The smallest specimen examined (see also material list) was about 14.5 mm SL, not an ophioblennius stage, although posterior canines in the lower jaw and vomerine teeth were absent. These teeth were present in specimens 16.2 mm and larger.

Twenty-six ophioblennius larvae, 15.0–19.5 mm SL (see material below) from Oahu, Lanai, and Molokai, include 23 specimens which could be *E. strasburgi* (the remaining 3 are *E. marmoratus*, as evidenced by paired nuchal cirri on each side). These 23 specimens have the following counts: segmented dorsal rays 14 in 12 specimens, 15 in 11 specimens; segmented anal fin rays 16 in 20 specimens, 17 in 3 specimens; last anal pterygiophore supporting a single element in 5 specimens, 2 elements in 18 specimens. My reason for believing that these larvae are not all *E. marmoratus* is based on the fact that only 1 of 92 recognizable specimens of *E. marmoratus* had a segmented dorsal ray count of 14.

COLOR PATTERN OF HOLOTYPE (preserved).—The ground color of the sides of the body is pale. On the side below the soft dorsal fin there are several groups of diffuse, dusky spots formed by loose aggregations of melanophores. The side of the head is light dusky, darker below the level of the orbit. There are faint indications of two diffuse, dark, posteroventrally directed spokes from the ventral

TABLE 37.--Frequency distribution of number of supraorbital cirri of left eye of specimens of *Entomacrodus strasburgi* arranged by SL classes (in mm)

Classes	Number of cirri 1	2	3	4	Average
15-19.9	9	1	-	-	1.1
20	-	7	2	-	2.2
25	-	5	7	-	2.6
30	-	3	3	1	2.7
35	-	-	1	-	-

margin of the orbit. The top of the head is light dusky; the bottom of the head is dusky, darker than the top (the prepelvic area of the body is even darker). There is faint indication of a dusky chevron pattern on the bottom of the head, and pale stripes between the chevrons. The upper lip bears indications of 9 or 10 dusky bands separated by pale stripes.

The spinous dorsal fin bears a broad, immaculate band distally; basally there is a narrow, dusky band; the soft dorsal is irregularly dusky except for a narrow, immaculate distal margin. The anal fin is dark dusky, grading darker distally. The caudal fin bears about four irregular dusky bands punctuated by pale spots. The pectoral fin is almost entirely dusky, darker ventrally. The fleshy pectoral base is irregularly light dusky. The pelvic fin is pale with sparsely scattered melanophores over the fin membrane.

The paratypes are generally similar in color pattern to the holotype; however, the lower half of the preopercular area may bear a dark blotch or irregular vertical stripes. Females are paler than males and have the anal fin immaculate, the lip markings more diffuse.

TABLE 38.--Frequency distribution of number of predorsal commissural pores of specimens of *Entomacrodus strasburgi* arranged by SL classes (in mm)

Classes	Number of pores 3	4	5	6	7	8	9	10	11	12	Average
15-19.9	3	-	1	-	4	3	-	-	-	-	6.0
20	1	-	1	2	1	1	2	-	-	1	7.2
25	-	-	1	2	2	4	2	-	-	-	7.4
30	-	-	-	2	4	-	-	-	1	-	7.3
35	-	-	-	-	-	-	1	-	-	-	-

TABLE 39.--Proportional dimensions in percent SL of specimens of *Entomacrodus strasburgi* (for meaning of abbreviations see methods section)

Catalog no.	Locale	Sex	SL	HL	OL	OCL	NCL	DS3	DR1	PECL	PECT	CL
USNM 200283	Hawaii	♀	27.1	23.6	7.4	3.0	2.6	11.4	10.7	22.1	15.1	18.1
USNM 199272	Hawaii	♂	28.0	23.9	7.1	3.2	1.8	-	14.6	24.3	15.7	21.4
USNM 199272	Hawaii	♂	29.0	23.4	7.5	3.6	2.4	11.4	12.4	21.4	15.9	20.0
USNM 200283	Hawaii	♂	29.5	22.7	6.8	3.4	0.7	13.9	13.9	23.7	15.3	19.0
USNM 199272	Hawaii	♂	29.8	23.1	6.7	3.4	2.7	13.1	12.8	-	15.8	19.5
USNM 200283	Hawaii	♂	30.8	24.4	6.8	2.9	1.6	11.4	13.6	19.8	14.6	18.8
USNM 200283	Hawaii	♂	31.5	23.8	6.7	4.4	2.2	11.7	12.1	21.6	16.5	19.4
USNM 200283	Hawaii	♂	32.0	24.0	6.2	2.8	1.9	12.2	13.4	19.4	14.7	18.8
USNM 200283	Hawaii	♂	32.1	23.7	6.2	2.8	2.2	13.1	12.5	20.6	14.0	18.7
USNM 179202 (holotype)	Hawaii	♂	35.0	23.4	6.3	3.4	1.7	13.2	11.2	21.1	14.0	18.3

Freshly caught specimens bear about 5½ pairs of vertical reddish-brown bands on the body, the half pair at the caudal peduncle. The preopercular area exhibits several reddish-brown vertical stripes. These markings are lost in preservation.

Relationships.—*Entomacrodus strasburgi* is a member of the *E. cymatobiotus* species group. For differentiation, see key couplets 27 and 28. In addition, *E. strasburgi* appears to differ from the other two members of the group in having a shorter caudal fin.

Entomacrodus strasburgi (fig. 8) has been collected with only one other species of *Entomacrodus*, *E. marmoratus*. Both species are endemic to the Hawaiian Islands and are the only species of *Entomacrodus* known from these islands. Both occur in the surge zone on rocky shores at depths not exceeding two meters.

Remarks.—There is indication of sexual dimorphism in segmented dorsal ray numbers. Of those specimens sexed (20.0 mm SL and larger) 4 males had 14 rays and 13 males had 15 rays; 1 female had 13, 9 had 14, and 1 had 15 rays. There was no other apparent sexual dimorphism of meristic characters, except that of all the specimens, only 3 males had a B condition anal ray count as high as 18.

Holotype.—USNM 179202, an immature male, 35.0 mm SL, Makapuu Point, Oahu, Hawaii, Feb. 21, 1963, W. A. Gosline and class.

Paratypes.—USNM 199272, three immature males, 28.0–29.8 mm SL, collected with the holotype; USNM 200283, 36 specimens, 14.5–32.1 mm SL, including 13 males, 11 females, and 12 sex indeterminates, same locality as holotype, Feb. 19, 1966.

Other possible material (23 ophioblennius larvae, 15.0–19.5 mm SL), not included in tables: Oahu: USNM 149991; Lanai: USNM 164993; Molokai: USNM 118063, 133913, 133918, 164992 (note: an additional three larvae, the largest two included in USNM 164993 and the largest in USNM 164992, are *E. marmoratus*).

Etymology.—Named for Donald W. Strasburg in recognition of his studies on Hawaiian Blenniidae.

Entomacrodus cymatobiotus Schultz and Chapman

Plates 15, 17*a*

Entomacrodus cymatobiotus Schultz and Chapman, 1960, U.S. Nat. Mus. Bull. 202, pt. 2, pp. 335–337 [Eman Island, Bikini Atoll, Marshall Islands].

Description.—Segmented dorsal fin rays 13–15 (14 in 84 percent of specimens); segmented anal fin rays 14–16 (15 in 85 percent of specimens); posteriormost anal pterygiophore supporting 1 or 2 external elements (supporting 2 in 92 percent of specimens); total gill-rakers on first arch 10–16 (12–14 in 75 percent of specimens); pseudobranchial filaments 4–7 (5 in 71 percent of specimens), number not increasing much, if any, with increase in SL; vertebrae 33–34 (34 in 19 of 20 specimens); supraorbital cirri 2–6, number increasing with increase in SL (table 40); main or longest supraorbital cirrus with all branches mesially, or all cirri arising from a common base; nape with 1 cirrus on each side; predorsal commissural pores 4–32 (rarely more than 20), number increasing with increase in SL (table 41); preopercular series of pores with all positions with simple pores; single pore before each anterior nostril; lateral line pores terminating on side in area below and between dorsal fin spine 11 and dorsal ray 6 (usually anterior to dorsal ray 3); ventral margin of upper lip completely crenulate; lip crenulae number 26–35 (27–33 in 92 percent of specimens).

Proportional measurements: See tables 3, 4, and 42.

Males develop fleshy rugose modifications of the skin of the anal spines and the anterior first to fourth anal rays. If one considers males with these modifications to be mature, the smallest mature male examined was 26.6 mm SL. Mature and immature males may occur in the same collection and in these collections immature males may be as much as 6 mm longer than mature males.

The largest specimen examined was a mature male 48.2 mm SL; the largest female was 41.1 mm SL. Males were more than twice as common as females in collections, but in relative numbers the sexes were about equal at sizes up to 35 mm SL. Above 35 mm SL males were relatively more common. About 22 percent of the males achieved a size of more than 40 mm SL, whereas only 1 (2.8 percent) female attained such a size. The smallest specimen examined, 16.4 mm SL, was not an ophioblennius stage. Vomerine teeth were present in this specimen, but the posterior canines of the lower jaw

TABLE 40.--Frequency distribution of number of supraorbital cirri of left eye of specimens of *Entomacrodus cymatobiotus* arranged by SL classes (in mm)

Classes	Number of cirri					Average
	2	3	4	5	6	
15-19.9	5	14	2	-	-	2.8
20	·	13	22	-	1	3.7
25	-	7	19	4	1	4.0
30	-	-	14	4	-	4.2
35	-	1	6	-	2	4.3
40	-	-	8	2	2	4.5
45	-	-	-	5	1	5.2

were undeveloped, as were the crenulations on the lateral portions of the ventral margin of the upper lip.

COLOR PATTERN OF PRESERVED MATERIAL.—In male specimens over about 30 mm SL the sides of the body are usually uniformly pale. Some specimens have diffusely dusky markings on the sides in the form of 3–5 pairs of midlateral spots. The remainder of the body in these specimens may be uniformly pale or marked with scattered fine, light dusky spots and dashes. One mature male from Jarvis Island (pl. 15) was unique in having a better developed color pattern than was found in the other specimens. In this specimen there were six pairs of midlateral bars (in the drawing, the anterior pair hidden by the pectoral fin). The bands were variously interrupted, but the posterior four pairs tended to diminish in intensity dorsally and ventrally as they extended to the body contours. Diffusely dusky marks were scattered over the sides of this specimen. In males below 30 mm SL the paired markings on the sides of the body appeared much more frequently than among larger males.

On most males, the most intense mark on the side of the head is a dark elongate spot about half an eye diameter posterior to the eye. This spot is followed by an irregular pale stripe, then a broad irregularly dusky area, another pale stripe, and sometimes another broad dusky area. In some males there were several additional pale dusky stripes directed ventrally and ventroposteriorly from the orbit.

The top of the head is irregularly dusky and the ventral portion pale and unmarked. The upper lip bears scattered dusky spots.

The spinous dorsal of males is either uniformly light dusky with a narrow pale distal margin or irregularly dark dusky with indications of light or dark spots and a pale distal margin. The soft dorsal bears up to four rows of dusky spots over each ray, with the distal portion of the fin uniformly pale dusky. The anal fin is pale proximally, grading into dark dusky distally. The caudal fin bears up to about nine irregular vertical rows of dusky spots, usually overlying the rays; the number of rows is greater in large than in small specimens. The pectoral fin is light dusky, increasing slightly in intensity

TABLE 41.--Frequency distribution of number of predorsal commissural pores of specimens of *Entomacrodus cymatobiotus* arranged by SL classes (in mm)

Classes	Number of pores																			
	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	33(sic)
15-19.9	1	2	-	4	1	1	4	2	-	-	-	-	-	-	-	-	-	-	-	-
20	-	-	2	4	6	5	9	7	5	-	1	1	-	-	-	-	-	-	-	-
25	-	-	1	1	1	5	3	6	1	5	2	2	1	3	-	2	-	-	-	-
30	-	-	-	-	-	-	3	3	2	3	2	1	1	1	1	-	-	-	-	-
35	-	-	-	-	-	-	-	1	1	1	-	3	2	-	-	-	-	-	1	-
40	-	-	-	-	-	-	2	-	2	-	1	2	2	1	1	-	1	-	-	1
45.	-	-	-	-	-	-	-	-	1	-	-	1	1	-	-	1	2	-	-	-

ventrally. The fleshy pectoral base is irregularly marked with dusky. The pelvic fins are dusky.

Females differ from males in bearing almost no marks on the head and body except for very faint adumbrations of the marks behind the eye. The dorsal, anal, and caudal fins are delicately spotted with dusky. The pectorals and pelvics are paler than in males from the same collection.

RELATIONSHIPS.—*Entomacrodus cymatobiotus* is very closely related to *E. strasburgi* and *E. chapmani* (for differentiation, see key couplets 25 and 26). It appears to be closer to *E. chapmani* than to *E. strasburgi* as evidenced by general color pattern. Some males of *E. chapmani* (pl. 17*b*) exhibit adumbrations of the head color pattern of *E. cymatobiotus* (pl. 17*a*), though lacking the spot behind the eye of the latter species. The spot on the head of each of the latter two species results from intensification of the color pattern in the areas where the spots occur. In *E. strasburgi* it appears that both the areas where the spots occur in the other two species have been de-

TABLE 42.--Proportional dimensions as percent SL of specimens of *Entomacrodus cymatobiotus* (for meaning of abbreviations see methods section)

Catalog no.	Locale	Sex	SL	HL	OL	OCL	NCL	DS3	DR1	PECL	PELL	CL
USNM 142182	Marshall Is.	♂	24.4	25.4	7.8	3.3	3.3	12.3	14.8	22.5	15.6	22.5
USNM 178999	Phoenix Is.	♀	25.2	26.2	8.2	3.6	4.5	11.9	16.7	25.4	17.9	23.4
USNM 142183[1]	Marshall Is.	♂	26.0	24.6	6.9	3.8	2.7	11.5	15.4	21.5	15.5	22.7
SU 62011	Raroia	♀	26.2	26.3	7.6	3.8	3.0	11.4	16.0	22.9	-	22.9
SU 62011	Raroia	♂	26.6	24.4	6.4	4.5	3.8	11.6	16.5	24.4	-	21.8
USNM 142182	Marshall Is.	♀	28.1	24.9	7.1	3.9	2.5	12.5	16.7	23.1	14.6	21.7
USNM 142160	Marshall Is.	♂	28.4	25.4	6.3	4.2	3.5	12.0	16.2	22.5	15.8	23.2
SU 62011	Raroia	♂	28.5	24.9	6.7	4.6	3.5	11.2	14.0	21.4	-	21.0
SU 62023	Raroia	♂	32.5	24.6	6.5	4.0	3.7	12.0	16.9	23.4	15.7	22.8
SU 62011	Raroia	♂	33.0	24.8	6.1	3.6	3.6	12.1	14.8	22.1	-	21.2
SU 62023	Raroia	♂	35.8	24.3	6.1	3.1	2.0	-	16.8	23.7	15.4	22.3
USNM 198654	Jarvis Is.	♀	35.8	23.2	6.1	3.4	3.1	10.0	13.4	22.9	15.1	21.5
USNM 198594	McKean Is.	♂	37.3	23.0	5.4	4.0	2.1	9.7	14.5	19.8	13.9	20.1
USNM 198654	Jarvis Is.	♂	40.4	23.7	5.9	4.2	2.5	10.4	16.1	19.5	13.1	21.8
SU 62023	Raroia	♂	40.5	23.5	5.9	4.2	3.5	10.6	15.0	21.0	13.3	21.0
USNM 198654	Jarvis Is.	♀	41.1	23.3	6.1	3.4	1.7	10.0	13.4	21.4	12.6	20.7
USNM 198654	Jarvis Is.	♂	45.8	23.1	5.5	4.6	2.4	9.6	16.4	21.0	12.7	23.1
USNM 198654	Jarvis Is.	♂	48.2	23.6	5.0	3.3	1.0	-	16.0	19.9	12.0	22.2

[1] Holotype of *Entomacrodus cymatobiotus*

intensified (or lack intensification). In terms of habitat occupied, *E. cymatobiotus* is most similar to *E. strasburgi*. Both these species occur in surge areas and on the ocean sides of reefs, whereas *E. chapmani* appears to be a tide pool form.

Remarks.—*Entomacrodus cymatobiotus* has been collected with or from the same restricted locality as *E. striatus, E. rofeni, E. sealei, E. caudofasciatus,* and *E. t. thalassinus*. It differs: from *E. striatus*, in having usually fewer gill-rakers and dorsal rays, more predorsal commissural pores, and in lacking lateral branches on the main supraorbital cirrus; from *E. rofeni*, in having fewer vertebrae, soft dorsal and anal rays, and gill-rakers, and in having more predorsal commissural pores at any given size; from *E. sealei, E. caudofasciatus,* and *E. t. thalassinus*, in the disposition of its lip crenulae; from *E. sealei*, in having simple preopercular pores and fewer gill-rakers; and from *E. caudofasciatus*, in lacking a humeral blotch.

Distribution (fig. 8).—*E. cymatobiotus* is restricted to the western and central Pacific islands.

Material.—Marshall Islands: Bikini Atoll, Eman Island: USNM 142183 (holotype of *Entomacrodus cymatobiotus*); Bikini Atoll, Namu Island: USNM 142160; Eniwetok Atoll, Mui Island: USNM 142181, 142182; Caroline Islands, Ifaluk Atoll: SU 62033; McKean Island: USNM 198594; Jarvis Island: USNM 198654; Phoenix Islands, Enderbury Island: USNM 178999; Malden Island: USNM 199456; Tuamotu Archipelago, Raroia: SU 62011, 62017, 62021, 62023.

Entomacrodus chapmani, new species

Plates 16, 17*b*

Description.—(Figures in parentheses for holotype.) Segmented dorsal fin rays 14 or 15 (15); segmented anal fin rays 15–17 (16), usually 16; posteriormost anal pterygiophore supporting 1 or 2 (1) external elements (2 in 77 percent of specimens); total gill-rakers on first arch 13–18 (18); pseudobranchial filaments 5 or 6 (6); vertebrae 34; supraorbital cirri 4–8 (7), number not increasing much, if any, with increase in SL (table 43); main or longest supraorbital cirrus with all branches mesially (except holotype, which has one lateral branch); nape with 1 cirrus on each side; predorsal commissural pores 6–16 (7), number not increasing much, if any, with increase in SL (table 43); preopercular series of pores with all positions with simple pores (except one specimen with 1 pair of pores included in series); 1 pore before each anterior nostril; lateral line terminating on side in area below and between dorsal fin spine 11 and dorsal ray 4 (dorsal ray 1); ventral margin of upper lip completely crenulate; lip crenulae number 31–39 (37).

Proportional measurements: See tables 3, 4, and 44.

No males with fleshy rugose modifications of the skin of the anal spines and rays were seen, but two males, 53.5 and 63.8 mm SL,

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appeared to be developing such modifications on the anal spines, which probably indicates approaching maturity. The largest specimen examined was a male, 73.7 mm SL, the largest female 52.5 mm. The smallest specimen examined, 25.6 mm SL, was not an ophioblennius stage.

COLOR PATTERN OF HOLOTYPE (preserved).—The sides of the body exhibit five pairs of irregular dark bands: the first pair, almost fused, is under dorsal spines 8–10; the last pair is on the caudal peduncle. Anterior to these pairs are two much paler, irregular bands, the posteriormost split ventrally. Each member of each of the paired bands consists of about three vertically arranged blotches, the ventralmost blotch, the palest. The head is dusky with an irregular dark spot, deeper than wide, placed posterodorsally and bounded ventroposteriorly by a narrow pale margin, below which is a large dusky area, paler than the dark spot. The dorsal and ventral portions of the head are uniformly dusky. The upper lip is uniformly dusky except for a faint band at each corner.

The spinous dorsal fin bears irregular light dusky spots, most conspicuous over the spines. The interradial membrane is unmarked distally between the spines. The soft dorsal fin bears three, sometimes two, dusky spots over each ray; the spots arranged in diagonal series from one ray to the next. The anal fin is more or less uniformly dusky over its anterior two-thirds, grading into spots, mostly over the rays, posteriorly. The caudal fin bears about seven irregular vertical rows of spots which are mostly centered over the rays. The pectoral fin is light dusky over the rays; the interradial membrane is immaculate. The fleshy pectoral base is uniformly dusky. The pelvic fins are light dusky.

Other females are similar to the holotype but may be more intensely marked. The number of rows of caudal spots is variable.

Males differ from females in generally having the bands on the body much paler, the spot on the head (pls. 16*c*, 17*b*) much larger, the nar-

TABLE 43.--Frequency distribution of number of predorsal commissural pores and supraorbital cirri of specimens of *Entomacrodus chapmani* arranged by SL classes (in mm)

Classes	Predorsal pores											Supraorbital cirri							
	6	7	8	9	10	11	12	13	14	15	16	1	2	3	4	5	6	7	8
25-29.9	1	-	-	-	1	1	-	-	-	-	-	-	-	-	2	-	1	-	-
30	-	-	-	-	1	1	-	1	-	-	-	1	-	-	-	3	-	-	-
35	-	-	-	1	1	-	1	1	-	-	-	-	-	-	3	-	1	-	-
40	-	-	1	-	1	1	1	-	-	-	1	-	-	-	-	4	-	-	1
45	1	-	1	-	1	-	-	-	-	-	-	-	-	-	-	1	2	-	-
50-54.9	-	1	-	1	1	-	1	1	-	-	-	-	-	-	-	2	2	1	-
70-74.5	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-

row pale margin bounding the ventroposterior margin of the spot better delineated, the blotch following the pale margin much darker (sometines approaching the spot in intensity). Occasionally, there are faint indications of pale and light dusky stripes extending posteroventrally from the eye (adumbrating the condition in males of *E. cymatobiotus*) (pl. 17). The spinous and soft dorsal fins are more uniformly dusky, the spinous darker. The anal fin is also much darker then that of females and lacks the spotting posteriorly.

Relationships.—*Entomacrodus chapmani* is most closely related to *E. cymatobiotus* and *E. strasburgi* (for differentiation, see key couplets 24 and 25). Of the latter two species, *E. chapmani* appears to be closer to *E. cymatobiotus* (for discussion, see "Relationships" under *E. cymatobiotus*).

Distribution (fig. 8).—*Entomacrodus chapmani* is known only from Easter Island, where it is also the only member of its genus known. *E. chapmani* is the same species as the misidentified *Entomacrodus striatus* reported by de Buen (1963, p. 59).

Holotype.—MCZ 29446, an adult female, 52.5 mm SL, with a label reading: "E. Pacific Ex. 1904–05. 'Albatross'. Easter Island, Dec. 20. Shore." This is presumably one of the two specimens mentioned by Kendall and Radcliffe (1912, p. 154) as MCZ 29436. I have been unable to locate the other specimen.

Paratypes.—Easter Island, Hanga Roa: UBC BC65–410 (2 specimens), BC65–455 (3), BC65–458 (1); Hanga Pico: UBC BC65–428 (2), BC65–438 (1); Vinapu: UBC 65–449 (1); Anekena: UBC BC65–440 (1); Rano Raraku: UBC 65–430 (9), BC 65–429 (2); Cave Bay: MNHN 1942–76 (2); Easter Island (only): BMNH 1913.12.7.10 (1).

TABLE 44.--Proportional dimensions as percent SL of specimens of *Entomacrodus chapmani* (for meaning of abbreviations see methods section)

Catalog no.	Locale	Sex	SL	HL	OL	OCL	NCL	DS3	DR1	PECL	PELL	CL
UBC BC 65-455	Easter Is.	♀	29.5	26.4	6.4	3.4	2.7	10.2	14.9	25.1	17.6	21.7
UBC BC 65-455	Easter Is.	♂	37.5	24.0	6.4	4.0	1.6	8.5	11.7	21.9	16.3	20.5
UBC BC 65-428	Easter Is.	♀	39.5	21.3	6.1	3.0	1.3	8.9	13.7	22.5	14.7	21.3
UBC BC 65-430	Easter Is.	♀	43.6	23.0	5.5	4.1	1.6	8.9	13.3	23.9	14.4	19.5
UBC BC 65-458	Easter Is.	♀	44.3	23.2	5.6	3.8	1.8	9.5	13.8	22.6	14.9	19.2
UBC BC 65-410	Easter Is.	♀	48.2	22.8	5.4	4.6	2.1	10.4	15.6	25.7	16.2	21.2
UBC BC 65-430	Easter Is.	♂	52.4	22.5	5.0	3.8	1.1	9.0	13.4	22.1	13.9	20.0
MCZ 29446[1]	Easter Is.	♀	52.5	22.9	5.5	3.0	1.9	9.1	13.9	24.8	15.4	21.3
UBC BC 65-449	Easter Is.	♂	53.5	23.4	5.2	5.0	2.4	9.5	15.1	23.6	14.6	21.5
UBC BC 65-410	Easter Is.	♂	63.8	22.7	4.9	5.0	1.3	9.4	15.0	23.7	14.4	21.5
BMNH 1913.12.7.10	Easter Is.	♂	73.7	22.8	4.6	4.7	2.1	8.7	12.2	19.0	12.9	21.0

[1] Holotype of *Entomacrodus chapmani*

ETYMOLOGY.—This species is named for Wilbert M. Chapman in recognition of his studies on blenniid fishes. Since the foregoing description, I have learned that Chapman, many years ago, independently concluded that this form represented a new taxon—making it doubly appropriate that the species be named for him.

Entomacrodus sealei Bryan and Herre

PLATE 18

Entomacrodus sealei Bryan and Herre, 1903, Occ. Pap. Bernice P. Bishop Mus., vol. 2, no. 1, pp. 138–139 [Marcus Island].

Entomacrodus incisolabiatus Schultz and Chapman, 1960, Bull. U.S. Nat. Mus., vol. 202, pt. 2, pp. 332–334 [ocean reef and surf, southeast end Enyu Island, Bikini Atoll].

DESCRIPTION.—Segmented dorsal fin rays 13–16 (15 in 80 percent of specimens); segmented anal fin rays 15–17 (16 in 85 percent of specimens); posteriormost anal pterygiophore supporting 1 or 2 external elements (2 in 93 percent of specimens); total gill-rakers on first arch 15–21 (16–19 in 92 percent of specimens); pseudobranchial filaments 4–7 (6 or 7 in 90 percent of specimens), number not increasing with increase in SL; vertebrae 33 or 34 (33 in 2 of 23 specimens); supraorbital cirri 1–7, number increasing with increase in SL (table 45); main or longest supraorbital cirrus with all branches mesially; nape with 1 cirrus on each side; predorsal commissural pores 3–34, number increasing with increase in SL (table 46); preopercular series of pores including 3–5 positions with pairs or multiples of pores (pore positions never all simple in specimens over 22 mm SL); 1 pore before each anterior nostril; lateral line pores terminating on side in area below and between dorsal fin spine 11 and dorsal ray 5; ventral margin of upper lip crenulate on lateral thirds, entire on middle third (one specimen, 22 mm SL, from Raroia had upper lip completely crenulate); lip crenulae usually numbering 7–10 on each side.

Proportional measurements: See tables 3, 4, and 47.

Males develop fleshy rugose modifications of the skin of the anal spines and the anterior first to third rays. If one considers males with these modifications to be mature, the smallest mature male examined was 39.0 mm SL. Mature and immature males may occur in the same collection and in these collections immature males may be as much as 7 mm longer than mature males.

The largest specimen examined was a male, 64.2 mm SL; the largest female was 54.1 mm SL; below the latter size males and females occur with relative equal frequency. Only two specimens, males, were larger than 59.9 mm SL. Males and females occurred in collections in about equal numbers. The smallest specimen examined was 18.0 mm, not an ophioblennius stage. It had two pairs of pores included in the preopercular series. Several nonophioblennius stage specimens as small as 15.7 mm SL were examined from lots containing specimens identifiable as *E. sealei*, but these specimens had all preopercular pores simple and no lip crenulae. It is possible that these specimens belong to another species (i.e., *E. thalassinus*) and the data from these specimens were not included in the description and tables in this paper. Positive identification awaits more information on developmental stages (small specimens of *E. thalassinus*, to less than 15.0 mm, could be identified when present in large series by following gradual morphological changes throughout the series, but isolated small specimens, such as mentioned above, could not be so identified with the material available).

COLOR PATTERN OF PRESERVED MATERIAL.—Specimens from the same collection may have almost no distinct markings on the body sides, or they may have several dusky blotches, or pairs of blotches of variable intensity on the midline of the side. These blotches, grouped in six or seven areas on the sides, appear to correspond to the bands of other species of the *E. nigricans* group to which *E. sealei* belongs. The posterior two pairs of blotches, at the caudal peduncle and under the posterior soft dorsal rays, are often pale or absent. A conspicuous blotch may be present in the humeral region but usually is lacking. Infrequently there are faint marks at the base of the dorsal fin that are probably disconnected dorsal extensions from the body blotches. Extensions from these faint marks may enter the dorsal fin, where, on the soft dorsal, they may intensify as stripes and become dorsoposteriorly directed. The dorsal fin may be almost uniformly light dusky or have a pale or dark distal margin.

On the side of the head a number of irregular dusky marks are

TABLE 45.--Frequency distribution of number of supraorbital cirri of left eye of specimens of *Entomacrodus sealei* arranged by SL classes (in mm)

Classes	Number of cirri							
	1	2	3	4	5	6	7	Average
15-19.9	1	-	2	1	-	-	-	2.8
20	-	-	5	10	2	-	-	3.8
25	-	-	2	13	12	2	-	4.5
30	-	-	2	7	8	4	1	4.8
35	-	-	-	2	10	4	-	5.1
40	-	-	-	1	2	1	-	5.0
45	-	-	-	2	3	2	-	5.0
50	-	-	-	1	3	5	1	5.6
55	-	-	-	-	1	1	-	5.5
60	-	-	-	-	-	1	1	6.5

separated by pale areas; infrequently there is a darkly dusky area (spot) just behind the eye, which, when present, is the most conspicuous mark on the side of the head. The upper lip usually bears seven pale, slender stripes alternating with eight light to dark dusky bands, more than twice the width of the stripes. The dark band at each corner of the lip is the narrowest and may be only slightly wider than the adjacent stripe. The lip bands may be almost absent in females. Extensions of the lip bands and stripes may appear on the underside of the head as chevrons.

The anal fin is light to dark dusky with scattered pale spots. The spots may be absent in males. The anal spines of males are dark dusky, those of females, pale. The caudal fin bears about three to six irregular dusky bands alternating with pale areas, the number depending on the length of the specimen (larger specimens tend to have more bands).

Nomenclature.—*Entomacrodus sealei* was described from a single specimen. This specimen is now in very poor condition, the head almost detached, but it was possible to determine that the upper lip was crenulate on at least one side and entire in the middle; the opposite side was damaged. There were at least three pore pairs included in the preopercular series and there were indications of pale stripes and dusky bands on the upper lip. With this information it is possible to place *E. incisolabiatus* in the synonymy of *E. sealei*. The holotype of *E. incisolabiatus* has four pairs or multiples of pores included in the preopercular series and pale stripes and dusky bands on the upper lip. Schultz and Chapman (1960) apparently overlooked the description of *E. sealei* at the time of their description of *E. incisolabiatus*.

Relationships.—*Entomacrodus sealei* is a member of the *E. nigricans* species group. Of this group it is most closely related to *E. corneliae* from which it differs usually in having pale stripes and dark bands on the upper lip and in lacking dark vertical stripes on the head behind the eye (see "Relationships" under *E. corneliae*).

Entomacrodus sealei (and *E. corneliae*) is next most closely related to *E. chiostictus* (see "Relationships" under *E. chiostictus*). It differs from *E. chiostictus* in having three to five pairs or multiples of pores included in the preopercular series (only 2.8 percent of *E. chiostictus* specimens overlap *E. sealei* in this character) and in the nature of the lip stripes and bands (adumbrated by a few Clipperton Island specimens of *E. chiostictus*). Usually *E. chiostictus* specimens have more complete banding of the body than do specimens of *E. sealei*.

Remarks.—*E. sealei* is occasionally collected with *E. caudofasciatus*, from which it can be distinguished (and from all Atlantic Ocean species of the genus also) by having three or more pairs of pores

TABLE 46.--Frequency distribution of number of predorsal commissural pores of specimens of *Entomacrodus sealei* arranged by SL classes (in mm)

Classes	Number of pores																
	3-4	5-6	7-8	9-10	11-12	13-14	15-16	17-18	19-20	21-22	23-24	25-26	27-28	29-30	31-32	33-34	Average
15-19.9	1	1	2	1	-	-	-	-	-	-	-	-	-	-	-	-	6.4
20	-	3	4	6	1	2	1	-	1	-	-	-	-	-	-	-	9.8
25	-	1	2	9	8	5	3	-	-	-	-	-	-	-	-	-	11.1
30	-	1	-	2	6	6	4	-	-	-	1	-	-	-	-	-	13.0
35	-	-	-	4	2	3	4	-	-	1	1	-	-	-	-	-	13.9
40	-	-	-	-	-	1	1	1	1	-	-	-	-	-	-	-	16.5
45	-	-	-	-	-	-	-	1	-	1	2	1	1	1	-	-	23.6
50	-	-	-	-	1	-	1	2	3	1	1	-	-	-	-	1	19.6
55	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	23.5
60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	32.5

included in the preopercular series and by the pale stripes and dark bands on the upper lip. It further differs from *E. caudofasciatus* in usually lacking a humeral blotch and by commonly having more than 13 predorsal commissural pores. (For further distinguishing characters, see "Relationships" under the Atlantic species of *Entomacrodus*.)

Entomacrodus sealei has also been collected with or from the same restricted geographic locality, as: *E. t. thalassinus*, from which it differs obviously in having crenulae on the upper lip and more gill-rakers, and paired pores included in the preopercular series;

TABLE 47.--Proportional dimensions as percent SL of specimens of *Entomacrodus sealei* (for meaning of abbreviations see methods section)

Catalog no.	Locale	Sex	SL	HL	OL	OCL	NCL	DS3	DR1	PECL	PELL	CL
USNM 123934	Guam	♀	27.7	26.0	7.6	3.2	3.6	10.8	13.7	25.3	18.0	23.5
USNM 111883	Samoa	♂	31.2	26.3	7.4	5.1	3.8	11.5	14.1	26.6	17.6	24.3
SU 62077	Saipan	♀	32.4	24.7	7.1	3.7	3.1	9.3	15.1	24.7	-	22.2
SU 62052	Ifaluk	♂	32.8	24.4	6.7	5.8	3.7	10.4	11.6	23.2	-	23.8
SU 62052	Ifaluk	♂	32.8	24.4	7.3	4.6	3.4	10.4	12.8	23.2	-	22.0
SU 62012	Raroia	♀	36.0	25.0	8.1	3.1	3.9	11.1	14.4	24.4	-	22.5
USNM 198140	Phoenix	♂	36.1	23.8	6.4	4.2	4.2	-	14.7	24.9	16.6	23.5
USNM 198140	Phoenix	♀	36.1	24.4	6.9	3.9	3.0	9.1	13.8	25.2	16.3	23.6
USNM 142189	Bikini	♂	36.7	24.5	6.8	4.4	3.0	10.6	14.2	22.6	16.3	22.6
USNM 111882	Saipan	♀	37.0	24.3	7.0	4.3	3.0	8.9	10.8	22.7	14.9	21.1
SU 62077	Saipan	♂	37.1	24.2	6.7	5.7	3.2	10.5	13.7	22.1	-	22.1
SU 62012	Raroia	♀	41.5	24.3	7.2	3.9	3.6	10.8	14.5	23.9	-	21.9
BMHN 1943.8.23.3	Swains	♀	43.0	24.4	5.8	3.0	3.5	10.5	12.8	23.0	16.5	23.5
USNM 198140	Phoenix	♂	44.8	24.3	6.0	6.0	3.3	10.0	14.5	21.9	16.3	23.4
USNM 142188[1]	Bikini	♂	45.2	23.2	6.6	5.5	2.4	10.4	12.2	20.8	14.2	23.0
SU 62022	Raroia	♂	45.8	24.0	6.8	4.6	3.9	10.7	14.4	22.3	-	23.2
USNM 62012	Raroia	♀	46.4	24.8	6.7	4.1	3.7	10.8	16.8	24.1	-	23.1
USNM 147654	Swains	♂	46.7	23.1	6.0	4.9	3.2	10.7	-	-	14.3	23.6
USNM 111881	Guam	♂	50.0	24.2	6.0	5.2	3.0	10.8	14.2	20.0	14.0	21.2
SU 62012	Raroia	♂	51.0	23.5	6.5	4.7	3.1	10.0	14.1	22.5	-	21.8
USNM 198653	Jarvis	♀	51.7	23.9	5.9	4.1	3.1	10.2	13.5	22.3	14.3	23.5
SU 62019	Raroia	♀	53.4	23.4	6.6	3.6	3.6	10.9	14.2	22.8	15.4	22.3
SU 62012	Raroia	♀	54.1	23.7	5.9	4.1	3.7	11.1	15.2	23.7	-	22.6
USNM 198653	Jarvis	♂	59.2	22.8	5.4	4.7	2.4	10.5	14.0	18.7	13.7	20.8
SU 62019	Raroia	♂	63.4	23.8	5.7	4.6	3.2	11.4	15.0	19.7	14.2	21.9

[1] Holotype of *Entomacrodus incisolabiatus*

E. s. stellifer, from which it differs obviously in the disposition of its lip crenulae and in having more and shorter supraorbital cirri, fewer vertebrae, and paired pores included in the preopercular series; *E. decussatus*, from which it differs obviously in the disposition of its lip crenulae and in having a smaller eye at comparable SL's, usually fewer vertebrae, gill-rakers, and dorsal and anal segmented rays; *E. striatus*, from which it differs obviously in the disposition of its lip crenulae and in having paired pores included in the preopercular series and more predorsal commissural pores at comparable SL's; *E. cymatobiotus*, from which it differs obviously in the disposition of its lip crenulae and in having paired pores included in the preopercular series, usually more gill-rakers and pale stripes and dusky bands on the upper lip; *E. niuafoouensis*, from which it differs obviously in the disposition of its lip crenulae and in having only one pore before each anterior nostril, shorter supraorbital cirri, and fewer gill-rakers; *E. epalzeocheilus*, from which it differs obviously in the disposition of its lip crenulae and in having only one cirrus on each side of the nape and one pore before each anterior nostril; and *E. rofeni*, from which it differs in the disposition of its lip crenulae and in having paired pores included in the preopercular series, fewer segmented anal rays, vertebrae, and more predorsal commissural pores.

Distribution (fig. 9).—*Entomacrodus sealei* is known only from the islands of the western and central Pacific Ocean. Collection data indicate that this species occurs on the outer (ocean) sides of reefs along open or surge channels.

Material.—Marcus Island: BPBM 2458 (holotype of *E. sealei*); Marianas, Guam: USNM 111881, 123934; Saipan: SU 62055, 62077, USNM 111882; Carolines, Ifaluk: SU 62039, 62052; Kapingamarangi: SU 62029; Marshalls, Bikini: USNM 142188 (holotype of *E. incisolabiatus*), 142189; Phoenix Group, Phoenix Island: USNM 198140; McKean: USNM 198593; Jarvis: USNM 198653; Swains: BMNH 1943.8.23.3, USNM 147654; Samoa, Tutuila: USNM 111883; Malden: USNM 199457; Tuamotus, Raroia: SU 62012, 62016, 62019, 62022.

Entomacrodus corneliae (Fowler)

Plate 19

Giffordella corneliae Fowler, 1932a, Proc. U. S. Nat. Mus., vol. 80, no. 6, pp. 14–15 [near light, Nuku Hiva, Marquesas Islands].

Description.—Segmented dorsal fin rays 13–15 (13 only in holotype); segmented anal fin rays 16–17; posteriormost anal pterygiophore supporting 1 or 2 external elements (supporting 1 in 4 of 11 specimens); total gill-rakers on first arch 16 or 17; pseudobranchial filaments 5 or 6; vertebrae 34; supraorbital cirri 3–6 (too few specimens available to determine if cirri or predorsal commissural pores increase in number with increase in size); main or longest supraorbital cirrus with all branches mesially; nape with 1 cirrus on each side; predorsal commissural pores 8–19 in specimens 23–40 mm SL; preopercular series of pores with at least 5 pairs or multiples of pores included in the series; 1 pore before each anterior nostril; lateral line terminating on side of body in area below and between dorsal rays 2 and 4; ventral margin of upper lip crenulate on lateral thirds, entire on middle third; lip crenulae number 6–10 on each side.

Proportional measurements: Only one specimen, female, 35.3 mm SL, was in sufficiently good condition to allow measurement. Measurements as percent SL on this specimen: HL 23.8; OL 6.5; OCL 4.0; NCL 4.5; DS3 10.2; DR1 12.5; PECL 23.5; PELL 17.3; CL 21.5.

Of the nine subadult-adult specimens available, only one was a male, approximately 40 mm SL and immature.

Color pattern of preserved specimens.—In specimens with the most developed color pattern there are 6½ pairs of pale dusky, vertical bands on the body (half pair on side beneath anterior dorsal spines). The bands are darkest in their midportions. Ventrally the bands fail to reach the ventral body contour. Dorsally the bands extend onto the dorsal fin where they intensify considerably and take a dorsoposterior direction. On the midside between the band pairs, some specimens show indications of pearly white spots. The head, posterior to the eye, bears as its darkest markings two short, more or less vertical stripes separated by a broader pale area. Ventral to the stripes, some specimens bear a short pearly white horizontal stripe or band. The upper lip is variably dusky, sometimes bearing several irregular bands extending onto the snout. The underside of the head is uniformly dusky.

The anal fin (for dorsal fin, see above) is evenly dusky anteriorly, grading darker distally. Posteriorly, the fin is dusky with included pale spots. The pectoral fin is dusky, darkest on the ventralmost rays. The pelvic fins are dusky. The caudal fin bears three or four dark vertical stripes composed of series of dark spots overlying the rays.

Nomenclature.—Fowler (1932a) described *Giffordella corneliae* (new genus, new species, monotypic) from a larval (ophioblennius) specimen (and 10 larval paratypes) from the Marquesas Islands. The holotype (USNM 91821), approximately 17 mm SL, has 13 dorsal spines, 13 segmented dorsal rays (in four countable paratypes, 14, 15, 15, and 15 rays), 16 segmented anal rays (the last split to the base), 14 pectoral rays, I,4 pelvic rays, a notch between the spinous and soft dorsal fins, nasal, nuchal, and supraorbital cirri (one each on each side), a pair of pores included in the circumorbital series (left side only), and three predorsal commissural pores. This combination of characters leaves no doubt in my mind that the holotype is a species of *Entomacrodus* (*Giffordella* is therefore a junior generic synonym of

Entomacrodus). Lip crenulae, vomerine teeth, and posterior canines in the lower jaw are absent in the type material but are usually not developed in larval stages of *Entomacrodus*.

It is not possible to positively identify the types of *Giffordella corneliae* with the adults of any of the three species of *Entomacrodus* known from the Marquesas. Inasmuch as the three adult forms of *Entomacrodus* known from the Marquesas are all endemics (*E. macrospilus*, *E. randalli*, and the adults included here as *E. corneliae*), it seems that the types probably represent an endemic species also—one of the three forms known from the Marquesas.

E. macrospilus can be eliminated from consideration as the adult of *E. corneliae* because of the higher anal ray count and lack of nuchal cirri of *E. macrospilus*. It is more difficult to eliminate *E. randalli* as the possible adult, but since the dorsal ray count of *E. randalli* is slightly higher (15 or 16) than that of the *E. corneliae* types (13–15), I have elected to apply the latter name to the adults of the third species, which has similar dorsal ray counts (14 or 15) to those of the larvae.

Relationships.—*Entomacrodus corneliae* is a member of the *E. nigricans* species group. Of this group it is most closely related to *E. sealei*, from which it differs only in having two dark vertical stripes on the head behind the eye and in lacking pale stripes and dark bands on the upper lip. The fact that the other two species of *Entomacrodus* in the Marquesas are well differentiated from their nearest relatives and that *E. sealei* is widely distributed and relatively consistent in appearance enforces my decision not to consider *E. corneliae* and *E. sealei* as conspecific. The Marquesas are high islands and of probably more recent origin than the low Tuamotu islands, the nearest island group to the Marquesas (*E. sealei* occurs in the Tuamotus). It seems, therefore, that *E. corneliae* is a more recently evolved species than *E. sealei* and quite possibly a derivative of the widely occurring *E. sealei*.

Entomacrodus corneliae (and *E. sealei*) is next most closely related to *E. chiostictus* (see "Relationships" under *E. chiostictus*) and differs from that species in color pattern and in having all specimens with more pore pairs or groups of pores included in the preopercular series (only 2.8 percent of *E. chiostictus* specimens overlap *E. corneliae* and *E. sealei* in this character).

Remarks.—*Entomacrodus corneliae* (fig. 9) has been taken in the same collection as *E. randalli* and *E. macrospilus*. Adults of *E. corneliae* differ most obviously from the other two species in having two dark vertical stripes on the head posterior to the eye and in the disposition of the upper lip crenulae.

Material.—USNM 91821 (holotype of *Giffordella corneliae*), 91822, 199991.

Entomacrodus chiostictus (Jordan and Gilbert)

PLATE 20

Salarias chiostictus Jordan and Gilbert, 1882, Proc. U.S. Nat. Mus., vol. 4, p. 363 [deep rock pool at Mazatlán, Mexico].

Entomacrodus cruentatus Garman, 1899, Mem. Mus. Comp. Zool., vol. 24, pp. 123–124 [off Cocos Islands].

Salarichthys vanderbilti Fowler, 1944, Acad. Nat. Sci. Philadelphia, monogr. 6, pp. 234–235 [Death River tide pools at foot of Mt. Sapo, Panama].

DESCRIPTION.—Segmented dorsal fin rays 14–16 (16 in less than 1 percent of specimens); segmented anal fin rays 15–17 (90 percent with 16), posteriormost anal pterygiophore supporting 1 or 2 external elements (96 percent supporting 2); total gill-rakers on first arch 14–20 (15–18 in 94 percent); pseudobranchial filaments 5–7 (84 percent with 6), number not increasing with increase in SL; vertebrae 33–35 (34 in 90 percent); supraorbital cirri 1–10, number increasing with increase in SL (table 48); main or longest supraorbital cirrus with all branches mesially (rarely with 1 lateral branch also); nape with 1 cirrus on each side (occasionally with 1, rarely 2, branches at tip of cirrus on one side); predorsal commissural pores 3–24 (rarely more than 17), number increasing with increase in SL (table 49); preopercular series of pores with all positions with simple pores in 40 percent of specimens, including 1–5 pairs of pores in series in 60 percent of specimens (usually only 1 or 2 pairs; 92 percent of specimens with 0–3 pairs of pores; fourth and fifth positions of series most frequently with paired pores):

number of pore pairs included in series	0	1	2	3	4	5
frequency of occurrence	204	165	97	29	12	2

1 pore before each anterior nostril; lateral line pores terminating on side in area below and between dorsal fin spine 12 and dorsal segmented ray 6 (usually anterior to dorsal ray 4); ventral margin of upper lip crenulate on lateral thirds, entire on middle third; lip crenulae usually numbering 7 to 10 on each side.

Proportional measurements: See tables 3, 4, and 50.

REMARKS.—Males may develop fleshy rugose modifications of the skin of the anal spines and the anterior first to third anal rays, similar to those of *E. nigricans* (pl. 24*f*). If one considers males with these modifications to be mature, the smallest mature male examined was 30.6 mm SL. Mature and immature males may occur in the same collection and in these collections immature males may be as much as 15 mm longer than mature males.

The smallest nonophioblennius stage examined was 17.4 mm SL. Ophioblennius stages examined ranged from about 16 mm (holotype of *E. cruentatus*) to 22.5 mm. In the larvae there were one or two posterolaterally directed canines on each side of the lower jaw. Where two such canines on each side were present the posterior was about twice the size of the anterior. All the ophioblennius stages had small posterior canines in the lower jaw in relatively the same position as the adult canines.

The largest specimen examined was 68.3 mm SL, a male, the largest female was 55.4 mm, both specimens from Panama. If one excludes Panamanian specimens from consideration, the largest male examined was 60 mm SL and the largest female was 47 mm. Females slightly outnumbered males in collections at sizes below 41 mm SL; males greatly outnumbered females at sizes over 40 mm. In the Panamanian collection, females outnumbered males up to 49 mm SL; above 49 mm, males greatly outnumbered females. In most large collections the largest male usually was about 10 mm larger than the largest female.

COLOR PATTERN OF PRESERVED MATERIAL.—In specimens with the most developed pattern there are 6½ pairs of dark bands, or where the members of these pairs are each fused, seven bands, on the sides. The bands are most intense in their midportions (frequently only the midportions are visible) abruptly decreasing in intensity dorsally and ventrally. The dorsal and ventral extensions of the bands may be displaced slightly in relation to the midportions. The posteriormost pair of bands, just anterior to the caudal base, and the anteriormost band (half pair), in the region below dorsal spines 2–4, are less intense than the others and may be absent. Upon entering the dorsal fin, the bands may increase in intensity but they never extend more than about midway onto the fin. Portions of the dorsal fin above and between the bands are diffusely dusky and paler than the banded portions. The area on the body above the lateral line, anterior to the anterior dorsal rays, frequently contains numerous small dark

TABLE 48.--Frequency distribution of number of supraorbital cirri of left eye of specimens of *Entomacrodus chiostictus* arranged by SL classes (in mm)

Classes	Number of cirri 1	2	3	4	5	6	7	8	9	10	Average
15-19.9	5	2	-	-	-	-	-	-	-	-	1.3
20	2	1	7	7	2	-	-	-	-	-	3.3
25	-	-	10	37	21	1	-	-	-	-	4.2
30	-	-	7	31	41	18	-	-	-	-	4.7
35	-	1	-	31	24	10	11	3	-	-	5.1
40	-	-	3	24	18	14	10	1	-	-	5.2
45	-	1	1	7	22	9	1	1	3	-	5.3
50	-	-	-	2	11	11	8	1	-	-	5.8
55	-	-	1	-	2	3	1	-	-	-	5.4
60	-	-	-	-	2	3	5	1	2	-	6.8
65	-	-	-	-	-	2	1	1	1	1	7.7

spots. The anal fin is variably dusky, always darker and more extensively pigmented in males than females from the same collection. There are indications of diffuse pale spots posteriorly on the anal fin in males, whereas in females the pale areas in this region may give the impression of banding. There is evidence of 3–5 irregular dusky bands on the caudal fin, darkest ventrally and sometimes restricted to the ventral portion of the fin. The pectoral fin is pale with a variable dusting of fine melanophores, concentrated ventrally and basally. There is frequently a dark vertical stripe on the pectoral base. The pelvic fins are pale.

The head is pale to dusky usually with a dark spot just posterior to the eye. The upper lip in most specimens from Panama and the Mexican mainland and adjacent islands, except Clarion Island, usually has or shows traces of 11–14 dark stripes alternating with paler interspaces. The stripes may be absent above the crenulated portions of the lip. There are about six stripes above the noncrenulated portion of the lip. The stripes are darkest ventrally on the lip and may grade into a pale stripe dorsally. Specimens from Clipperton and Socorro Islands may have the lip stripes, a complementary pattern (pale stripes and dusky interspaces or bands), or lack the stripes entirely. Specimens from Clarion Island either had only faint indications of the complementary stripe pattern or completely lacked stripes. The underside of the head frequently exhibits an extension of the upper lip pattern in the form of chevrons. Fowler (1944, as *Salarichthys vanderbilti*) described the color pattern of fresh alcoholic specimens. In contrast to the old preserved material I examined, he noted that numerous pearly white spots were scattered over the body.

GEOGRAPHIC VARIATION.—Aside from variation in color pattern (see above), there was little variation noted between collections of specimens from different localities. Series from Clipperton Island, Socorro Island, Acapulco, the Cape San Lucas area, and the Tres Marias

TABLE 49.--Frequency distribution of number of predorsal commissural pores of specimens of *Entomacrodus chiostictus* arranged by SL classes (in mm)

Classes	Number of pores 3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	17	19	20	21	22	23	24	Average
15-19.9	5	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.2
20	3	3	4	2	2	3	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.8
25	-	-	4	6	10	22	15	8	-	2	3	-	-	-	-	-	-	-	-	-	-	-	8.3
30	-	2	3	3	8	13	20	24	13	8	2	2	-	-	-	-	-	-	-	-	-	-	9.3
35	-	-	1	3	5	11	19	12	8	15	6	4	1	-	-	-	-	-	-	-	-	-	9.9
40	-	-	-	-	-	2	4	14	9	15	8	3	1	6	2	2	-	-	-	-	-	-	12.0
45	-	-	-	-	-	-	7	6	9	2	8	5	3	1	2	-	-	-	-	-	-	1	12.2
50	-	-	-	-	-	2	1	4	3	4	1	6	5	3	3	-	1	-	-	-	-	-	13.2
55	-	-	-	1	-	-	1	1	1	1	-	1	-	1	-	-	-	-	-	-	-	-	11.1
60	-	-	-	-	-	-	1	1	3	1	2	2	1	-	1	-	-	-	-	-	-	-	12.5
65	-	-	-	1	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	11.2

Islands had somewhat higher percentages of specimens with 14 dorsal soft rays than collections from other localities. Series from Acapulco and Clipperton Island had somewhat higher percentages of specimens with 15 anal soft rays than specimens from other localities. Since this variation is not great nor does it conform to a pattern, I have not reported these data uncombined. Specimens from the Gulf of California frequently had what appeared to be teratological development of the supraorbital cirri (short and club shaped, rather than long,

TABLE 50.--Proportional dimensions as percent SL of specimens of *Entomacrodus chiostictus* (for meaning of abbreviations see methods section)

Catalog no.	Locale	Sex	SL	HL	OL	OCL	NCL	DS3	DR1	PECL	PELL	CL
CNHM 63903	Acapulco	♀	24.4	25.8	7.0	4.1	3.3	11.1	15.2	25.8	18.5	25.4
CNHM 63903	Acapulco	♂	27.0	23.7	7.4	5.9	2.6	10.7	12.2	24.4	17.8	25.5
CNHM 63903	Acapulco	♀	27.5	24.4	6.9	3.6	3.3	10.6	12.7	24.0	17.4	23.3
SU 18973	Baja Calif.	♂	29.7	23.2	6.1	5.0	<1.7	10.1	-	22.6	15.2	24.2
USNM 181273	Clipperton	♀	29.8	25.2	6.7	4.0	2.7	10.7	12.1	24.8	15.4	22.8
USNM 181273	Clipperton	♂	30.5	24.9	7.2	5.6	2.6	11.1	13.4	23.9	15.7	22.9
ANSP 90026	Clipperton	♀	30.6	24.5	7.2	4.2	3.3	10.1	13.4	24.2	16.0	22.9
ANSP 90806	Baja Calif.	♀	31.8	22.6	7.5	4.1	2.8	10.4	11.3	22.6	14.5	23.9
SU 18973	Baja Calif.	♀	32.1	24.9	7.2	5.0	3.1	9.3	11.2	23.7	17.1	24.3
USNM 181273	Clipperton	♂	33.0	24.8	7.3	4.2	2.7	10.3	13.6	22.4	16.4	23.0
CNHM 63903	Acapulco	♀	35.4	25.4	7.3	4.5	2.3	9.9	14.1	25.4	16.7	25.4
CNHM 63903	Acapulco	♀	37.5	24.3	6.9	4.0	2.7	8.8	12.0	24.3	17.1	23.2
USNM 181273	Clipperton	♂	37.5	25.2	6.9	6.9	2.7	10.4	-	23.2	15.2	23.2
ANSP 90806	Baja Calif.	♂	38.2	24.9	6.8	5.2	2.6	10.5	12.3	23.6	16.5	23.6
ANSP 90026	Clipperton	♂	39.4	23.6	6.3	5.1	3.0	9.4	14.2	21.6	15.2	21.6
UCLA W59-248	Baja Calif.	♀	39.5	23.0	6.1	3.8	3.0	8.9	12.7	22.8	14.4	20.8
SU 18973	Baja Calif.	♀	40.2	23.1	6.2	4.0	2.5	9.2	11.9	19.9	15.4	22.4
ANSP 90026	Clipperton	♂	40.5	22.7	6.4	5.4	3.0	9.9	13.3	21.0	14.6	21.5
ANSP 90026	Clipperton	♂	41.0	23.4	5.1	5.6	2.9	10.0	13.7	21.5	14.6	22.9
ANSP 90026	Clipperton	♀	41.5	23.6	6.5	5.3	2.4	8.9	13.5	23.8	16.1	19.8
USNM 177784	Clipperton	♂	42.2	23.7	7.1	5.9	3.6	9.5	13.7	21.3	15.2	23.7
USNM 28117[1]	Mazatlan	♀	43.2	24.1	6.7	4.4	2.8	10.2	12.5	22.9	15.5	22.7
USNM 177784	Clipperton	♂	43.8	25.1	6.4	5.7	2.7	10.5	14.4	21.9	13.7	23.8
CNHM 63903	Acapulco	♂	44.0	23.0	5.9	5.0	2.3	10.2	13.2	22.0	14.8	22.7
ANSP 90026	Clipperton	♂	45.4	23.1	6.6	5.5	3.2	9.0	11.9	21.6	13.6	21.6
USNM 181273	Clipperton	♂	46.8	23.5	5.8	5.6	3.2	9.6	13.0	23.7	14.3	22.9
ANSP 90026	Clipperton	♂	47.6	22.7	5.5	5.9	2.5	9.4	14.7	21.4	14.5	22.7
CNHM 63903	Acapulco	♂	48.0	24.0	5.6	5.0	2.3	9.4	14.2	22.7	14.6	24.0
SU 18973	Baja Calif.	♂	49.9	24.0	5.8	6.0	2.6	8.0	13.0	21.6	14.8	22.4
CNHM 63903	Acapulco	♂	50.0	24.0	5.8	5.6	2.4	9.6	13.4	21.8	15.4	23.2
CNHM 63903	Acapulco	♂	52.7	23.0	5.5	4.2	1.9	9.5	14.8	22.4	14.2	23.0
USNM 177784	Clipperton	♂	54.6	23.1	6.0	5.5	3.1	9.7	14.6	20.9	13.0	23.3
UCLA W59-248	Baja Calif.	♂	59.2	23.0	5.2	6.8	2.7	8.6	13.5	21.1	13.5	22.5
UCLA W59-248	Baja Calif.	♂	60.1	22.8	5.2	5.0	2.7	9.8	13.3	21.3	13.0	22.0
ANSP (Argosy 13)	Panama	♂	64.3	23.2	5.1	5.9	3.1	10.3	15.4	21.2	13.8	21.3
ANSP (Argosy 13)	Panama	♂	65.6	23.0	4.9	5.6	3.4	9.4	13.6	20.3	13.7	20.6
ANSP (Argosy 13)	Panama	♂	66.8	21.9	5.2	4.6	3.0	9.6	12.9	19.8	12.7	20.8
ANSP (Argosy 13)	Panama	♂	68.3	22.0	4.7	4.5	2.6	9.2	12.6	19.3	13.0	20.0

[1] Lectotype of *Salarias chiostictus*

slender, and tapering). Much of the overlap in relative cirri lengths of *E. chiostictus* with *E. nigricans*, for example, as indicated in table 4, is the result of measurements based on Gulf of California specimens.

NOMENCLATURE.—*Entomacrodus cruentatus* Garman is an ophioblennius larval stage approximately 16 mm SL. The specimen is now in poor condition but still exhibits some of the posterolaterally directed canines in the lower jaw. The dorsal fin formula is XIII,15, the pectoral rays number 14. The only salarine blenniid in the eastern Pacific with this combination of counts is *E. chiostictus*. Garman did not compare his species with any other. *Salarichthys vanderbilti* Fowler is the normal adult of *E. chiostictus*. Fowler compared his species only with the Altantic *E. textilis*. The published description gives the type-locality of *S. vanderbilti* as Death River tide pools at the foot of Mt. Sapo, Panama. The label in the bottle with the holotype states only "Tidepools off Playa Muerto, Panama." Both the published description and the label give the date of collection as Apr. 16, 1941.

The syntypic material of *Salarias chiostictus* consists of two specimens, both females, USNM 28117. I here designate one of these specimens lectotype. The lectotype retains the orginial catalog number. The paralectotype is recataloged USNM 200284. The lectotype, 43.2 mm SL, has D. XIII,15, A. II,16S, and two pairs of pores included in the preopercular series. The paralectotype, 46.2 mm SL, has D. XIII,14, A. II,16N, and all preopercular pores simple.

RELATIONSHIPS.—*E. chiostictus* is a member of the *E. nigricans* species group. *E. chiostictus* differs from all the Atlantic species of the genus (and species group) in having a longer supraorbital cirrus and more lip stripes, as well as by having a much higher percentage of specimens with pore pairs included in the preopercular series. It differs from most populations of *E. caudofasciatus* in lacking a humeral blotch, usually having more lip stripes, and a much higher percentage of specimens with paired pores in the preopercular series. It differs from most specimens of *E. sealei* in having a different type color pattern on the upper lip and in usually not having as many as three pore pairs included in the preopercular series. It differs from *E. corneliae* in lacking a pair of dark vertical stripes on the head behind the eye and in rarely having as many as four or five pore pairs included in the preopercular series.

The members of the *E. nigricans* group are closely interrelated and some investigators might consider them merely populations of one species; however, this interpretation is in part excluded by the fact that two western Pacific forms (*E. sealei* and *E. caudofasciatus*) occur together and are always readily distinguishable (the third western Pacific form, *E. corneliae*, is endemic to the Marquesas, where no other member of the *nigricans* group occurs).

Some of the specimens of *E. chiostictus* from Clipperton and Clarion Islands appear to be intermediate between *E. sealei* and *E. caudofasciatus* and can be expected to key to either of these two western Pacific species, especially to the Rarotonga, Tahiti, Makatea, and Raroia populations of *E. caudofasciatus* (these populations represent the easternmost occurrences of *E. caudofasciatus;* the easternmost occurrence of *E. sealei* is Raroia). *E. chiostictus,* in common with *E. sealei* and *E. caudofasciatus,* has a proportionately longer supraorbital cirrus than is found in the Atlantic members of the *nigricans* species group. This fact and the increased occurrence of paired pores in the preopercular series of pores of *E. chiostictus* over their occurrence in the Atlantic species (and *E. caudofasciatus*) appears to relate *E. chiostictus* most closely with *E. sealei.* It would seem, therefore, that at some time individuals of the form ancestral to *E. sealei* and *E. chiostictus* reached eastern Pacific shores and diverged. Differentiation appears to be more advanced in the mainland populations than in the Clarion Island and Clipperton Island populations.

Support for an Indo-West Pacific origin of the species ancestral to *E. chiostictus* is the appearance in the eastern Pacific (but not the western or eastern Atlantic) of a blenniid genus, *Runula,* which has the Indo-West Pacific as its center of abundance. Other blennioids, certain Tripterygiidae (R. H. Rosenblatt, pers. comm.), subfamily Clininae, of the Clinidae (M. L. Penrith, in litt.), found in the eastern Pacific also have their closest relatives in the western Pacific and no closely related representatives in the Atlantic. Briggs (1961) has postulated a western Pacific origin of all the shore fishes not worldwide in distribution and found common to both the eastern and western Pacific ocean. He bases this on the direction of flow of ocean currents, the fact that most of the genera in common have far more species in the western Pacific than in the eastern Pacific, the fact that most of the forms occur primarily or only on the offshore islands in the eastern Pacific, and the fact that no species of a typically tropical New World genus has colonized the western Pacific. The evidence, though circumstantial, thus also favors an Indo-West Pacific origin of the form ancestral to *Entomacrodus chiostictus.*

I believe that *Entomacrodus* reached the eastern Pacific by island hopping and by movement of populations along rocky coasts. The most probable route would be along the chain of islands extending out to Easter Island and Sala-y-Gomez, thence along formerly existing islands of the Sala-y-Gomez and Nasca Ridges to Peru, and up the coast to Central America and Mexico. The movement would have taken place during a period of warmer climatic conditions than exist today. Subsequent climatic cooling would have eliminated the

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genus from South America. Menard (1964) reported that reef debris of from late Tertiary to Recent age has been dredged from the Nasca Ridge and that there were some Tertiary islands on the Nasca Ridge which no longer exist today. While there is no data available on the adjacent Sala-y-Gomez Ridge for the same period, the bathymetric similarity of the two ridges would tend to confirm similar geologic histories.

In this scheme the populations of *Entomacrodus* at Clipperton and Clarion Islands would be derivative of the mainland populations. The resemblance of the Clipperton Island and Clarion Island individuals to specimens of *E. sealei* or *E. caudofasciatus* would then be a secondary, parallel development. Some support for the derivation of the Clipperton Island (farthest offshore tropical eastern Pacific island) population of *Entomacrodus* from the eastern Pacific mainland form is to be found in the primarily New World salarine genus *Ophioblennius* Gill (eastern Pacific, western and eastern Atlantic in distribution—Springer, 1962). In the eastern Pacific, *O. s. steindachneri* Jordan and Evermann is distributed widely from Mexico to Peru, while the population at Clipperton, *O. s. clippertonensis* Springer, is endemic. In view of the predominant offshore flow of the currents from the mainland and the very large size attained by the larvae of *Ophioblennius* (up to 66 mm SL), specimens of which have been taken offshore over deep water (Springer, 1962), I believe it quite possible for *Ophioblennius* (and *Entomacrodus*) to have made the 600-mile journey from the Mexican mainland to Clipperton. The North Equatorial Current, which flows at the constant rate of 0.3 knot per hour (Wyrtki, 1965) would be the vehicle of transport and the time involved only 83 days. The main objection to this hypothetical origin of the Clipperton population is the question of how the population is able to maintain its distinctiveness in the face of a probable continuing inflow of larvae from the mainland. A conjecture proposed by Gosline (1957) to explain endemism of Hawaiian fishes may answer this objection. Gosline believes that once a population of a species colonizes a new area and becomes adapted to that area (evolved), it either competitively excludes subsequent colonization by the less adapted parental form or genetically swamps the subsequent arrivals. This conjecture requires a low intensity of continuing immigration of the parental form.

The alternative to the previous method of introducing *Entomacrodus* to the eastern Pacific is to bring the colonizers across open ocean. If the introduction was effected over the shortest route from the central Pacific, it is still necessary to explain the mechanism of transport. Such transport could be effected by the Equatorial Countercurrent, which occasionally skirts Clipperton Island (for discussion, see Sachet, 1962, p. 25; for diagrams of the current, see Wyrtki, 1965). Clipperton Island, closest tropical eastern Pacific island to the tropical central Pacific atolls, is 2300 miles from the nearest such atoll, the Tuamotus; however, the Tuamotus lie in the path of the South Equatorial Current and would not be expected to contribute faunal elements to the eastern Pacific. The Line Islands, over 4000 nautical miles from Clipperton, are the nearest central Pacific atolls to Clipperton lying in the path of the Equatorial Countercurrent. Movement of this current is about 0.75 knot per hour (Wyrtki, 1965). At this speed it would require well over 200 days for an individual larva to travel from the Line Islands to Clipperton. It seems unlikely that *Entomacrodus* larvae would be the forms transported, as it appears from the small size at transformation (less than 25 mm SL) that *Entomacrodus* species have only a brief larval life.

It is also difficult to postulate adult transport (for instance by flotsam). The problem here is that adults are bottom dwellers found only in rocky or coral reef areas; no adults have been recorded from the open ocean out of sight of land or from near floating objects.

Assuming that *Entomacrodus* did reach the eastern Pacific from the western Pacific, it seems probable that the genus moved from the eastern Pacific to the western Atlantic during times when there was a Central American passage between the eastern Pacific and the western Atlantic. When the isolating Central American land bridge appeared, the populations on either side diverged. (It seems probable, however, that the eastern Pacific population did not diverge from the central Pacific population until well after the isolation of the Pacific from the Atlantic, and therefore the Atlantic populations are more divergent from the ancestral form than are the eastern Pacific populations.) Subsequently, the western Atlantic form populated other areas of the Atlantic, and these populations in turn diverged. The progressively lower percentage of specimens with paired pores occurring in the preopercular series of pores as one examines populations from the central Pacific (*E. sealei* and *E. corneliae*), eastern Pacific (*E. chiostictus*), western Atlantic (*E. nigricans*, *E. vomerinus*), and eastern Atlantic (*E. cadenati*, *E. textilis*), would support this reasoning. In this scheme *E. caudofasciatus*, with predominantly simple pores, presents the only problem. Its distribution, eastern Indian Ocean to the Tuamotus, and the fact that there are several differentiated populations as opposed to the undifferentiated populations of *E. sealei*, seems to indicate a species of limited mobility which originated in the Indo-West Pacific area and has remained there. Confusing specimens of *E. chiostictus* would then represent convergent rather than direct relationship with *E. caudofasciatus* (and *E. sealei*).

Distribution (fig. 9).—*Entomacrodus chiostictus* is restricted to the eastern Pacific ocean. It has been collected as far north as the northern end of Isla Angel de la Guarda in the Gulf of California but is apparently uncommon north of Isla Cerralvo. It is not reported from the west coast of Baja California or the mainland coast of Mexico north of Mazatlán. It is known to reach as far south as Punta Galero, Oaxaca, on the Mexican coast but is not reported from the rockless area between this locality and Playa Muerto, Panama (see Springer, 1959, for this "Pacific Central American Faunal Gap"). The southernmost specimens come from Piñas Bay, Panama. *E. chiostictus* is recorded from the following major offshore islands: Trés Marias, Revillagigedos, Clipperton, Cocos.

Material studied.—Mexico: Gulf of California, Isla Angel de la Guarda: UCLA W59-183; Baja California, Cape San Lucas and vicinity: ANSP 90806, SU 18973, 18974, UCLA W52-263, W59-248, W61-35; Sinaloa, Mazatlán: USNM 28117 (lectotype of *S. chiostictus*), 120934, 200284; Islas Trés Marias: SIO 62-16, UBC 59-202, 61-142; Islas Revillagigedos, Socorro: SIO 57-134, SU 5885, UCLA W53-350 (now CAS), USNM 67572, 126986; Roca Partida: SIO 60-385; Clarion: BMNH 1898.19.29.64-65, CNHM 1786, LACM 1132, SU 2673, UBC 58-383, 59-254, USNM 54501; Colima, Ensenada Carrizal: UCLA W56-231; Nayarit, Chacala: UCLA W58-2, W58-5; San Blas: UCLA W58-30; Sayula: UMMZ 172089; Guerrero, Isla Grande: UBC 54-50, 61-130; Acapulco: CNHM 63903; Oaxaca, Punta Galero: SU 37572; Clipperton Island: ANSP 90026, SU 51230, USNM 177784, 181273; Islas Cocos: MCZ 28695 (holotype of *E. cruentatus*), UCLA W58-378; Panama, Playa Muerto: ANSP 70070 (holotype of *S. vanderbilti*), 70071, 70072, 70073; Piñas Bay: ANSP (Argosy station 13).

Entomacrodus vomerinus (Valenciennes)

Plate 21

Salarias vomerinus Valenciennes, 1836, *in* Cuvier and Valenciennes, Hist. Nat. Poissons, vol. 11, p. 349 [near Bahia, Brazil].

Description.—Segmented dorsal fin rays 15–17 (16 in 80 percent of specimens); segmented anal fin rays 15–18 (17 in 76 percent of specimens 15 in only 1 of 126 specimens); posteriormost anal pterygiophore supporting 1 or 2 external elements (2 in 88 percent of specimens); total gill-rakers on first arch 16–24 (19–24 in 74 percent of specimens); pseudobranchial filaments 5–8 (6 in 75 percent of specimens), number not increasing with increase in SL; vertebrae 34–36 (35 or 36 in 85 percent of specimens); supraorbital cirri 4–15, number increasing with increase in SL (table 51), main, or longest supraorbital cirrus with most branches mesially, frequently with 1 or 2 branches laterally; nape with 1 cirrus on each side; predorsal commissural pores 3–16 (usually less than 11), number tending to increase with increase in SL (table 52); preopercular series of pores with all positions simple in 97 percent of specimens (only 3 specimens with 1 pair, and 1 with 2 pairs of pores included in series); 1 pore before each anterior nostril; lateral line pores terminating on side in area below and between dorsal fin spine 11 and ray 3 (usually between spine 12 and ray 1); ventral margin of upper lip crenulate on lateral thirds, entire on middle third; lip crenulae numbering 6–13 on each side (usually 7–10).

Proportional measurements: See tables 3, 4, and 53.

Only two males, 72.7 and 85.3 mm SL, were seen with fleshy rugose modifications of the skin of the anal spines and rays (first four rays). If one considers males with these modifications mature, then mature males occurred in the same collection with immature males as large as 100.5 mm SL.

Below 85 mm SL, males and females occur in collections with relatively equal frequency at various sizes; however, the largest female examined, 83.7 mm, was somewhat smaller than the largest male, 100.5 mm. Males larger than 84 mm are relatively common, indicating that males generally attain a larger size than females.

Color pattern of preserved material.—None of the material available to me was less than 50 years old and much of the color pattern in this material has been lost. The specimen illustrated in plate 21 shows a color pattern more clearly than any of the other available specimens but seems to be somewhat atypical in the evenness of shade of the body bands. In other specimens with preserved patterns, there appear to be indications of $6\frac{1}{2}$ to 7 pairs of bands on the body. There are no indications of fusions between the midportions of the members of a pair, except possibly the anteriormost, shortest pair in the region above the pectoral axil. In many specimens the bands appear to have

TABLE 51.--Frequency distribution of number of supraorbital cirri of left eye of specimens of *Entomacrodus vomerinus* arranged by SL classes (in mm)

Classes	Number of cirri 4	5	6	7	8	9	10	11	12	13	14	15	Average
35-39.9	1	-	1	1	-	-	-	-	-	-	-	-	5.4
40	1	2	3	2	-	-	-	-	-	-	-	-	5.8
45	-	2	2	1	-	-	-	-	-	-	-	-	5.8
50	-	1	3	1	2	-	-	-	-	-	-	-	6.6
55	-	1	2	1	-	-	-	-	-	-	-	-	6.0
60	-	-	2	-	2	2	-	-	-	-	-	-	7.7
65	-	1	1	1	1	-	-	-	-	-	-	-	6.5
70	-	2	2	1	-	5	1	2	1	-	-	-	7.6
75	-	-	1	-	1	-	1	-	1	-	-	-	9.0
80-89.9	-	1	2	-	4	-	2	2	1	-	-	2	8.9
90	-	1	-	-	-	-	-	-	-	-	-	-	-
100	-	-	-	-	1	-	-	-	-	-	-	-	-

been composed of darker midportions and paler dorsal and ventral portions. Dorsally the bands enter the dorsal fin for a variable distance, taking on a posterodorsal direction, but failing to extend to the distal fin margin. There is no evidence of a humeral blotch, but the bands are most intense in the area where such a blotch might occur. Posteriorly on the side, the bands may be very faint to absent. Ventrally the bands become faint and may have reached the anal fin base but do not appear to have entered that fin. I find no evidence of the tiny dark spots that occur on the sides below the spinous dorsal fin in all the other Atlantic species.

The head is variably dark with two or one (when presumably the two are fused) daık stripes passing from the upper lip to the eye and then continuing dorsoposteriorly for a very short distance from the dorsal margin of the eye. Just posterior to the eye there is a pale area extending from the corner of the lip to the top of the head. The pale area may have a dark margin posteriorly, darkest at mideye level, giving the appearance of a spot. In small specimens, 7–9 dark, uninterrupted stripes may be seen on the upper lip. In large specimens the lip has become almost uniformly dark, but in some of these specimens indications of the stripes persist. Dark chevrons appear on the underside of the head in many specimens, but these are frequently diffuse or obscured.

Aside from the extensions of the body bands entering the dorsal fin, the soft dorsal fin shows some pale diffuse striping. Other than these marks the dorsal fin is more or less uniformly dusky. The anal fin membranes are uniformly dusky, except possibly for a basal pale area or some diffuse pale spots in the posterior distal region on the fin of some specimens. The caudal fin bears about 5–8 dark bands, depending on size; small specimens with fewer stripes than large specimens. The pectoral fin is variably dusky with possible indications basally of intensification of the melanophores. The pectoral base may have a pale area just proximal to the pectoral rays, followed by a diffuse dark cresentic mark. The pelvic fins are dusky.

I noted no evidence of sexual dichromatism, but better preserved material may alter this impression.

Remarks.—There is a tendency for males to have more segmented dorsal fin rays than females. Of 51 males examined, 3 had 15 rays, 41 had 16 rays, and 8 had 17 rays. Of 74 females examined, 13 had 15 rays, 60 had 16 rays, and 1 had 17 rays. No sexual dimorphism was noted for other meristic characters.

Relationships.—*Entomacrodus vomerinus* is a member of the *E. nigricans* species group. Of this group, the Atlantic species appear to be most closely interrelated (see "Relationships" under *E. nigricans*).

Entomacrodus vomerinus differs from all the other members of its group in usually having a higher number of soft dorsal and anal rays and more vertebrae. It differs: from *E. textilis* and *E. caudofasciatus*, in lacking a humeral blotch, and from the latter of these two in usually having a higher number of gill-rakers; from *E. cadenati*, in not having the lip stripes broken into spots and in lacking the peculiar well-developed markings on the head of that species; from *E. chiostictus*, *E. sealei*, and *E. corneliae*, in rarely having any of the pores of the preopercular series paired; from *E. chiostictus* and *E. sealei*, in having proportionately shorter supraorbital and nuchal cirri; from *E. chiostictus* also, in having fewer lip stripes, and from *E. sealei*, in having the pale areas between the lip stripes broader than the stripes.

The syntypic material of *S. vomerinus* in the Paris museum comprises eight specimens, all previously catalogued as MNHN 3082. I here designate one of these eight specimens lectotype. The lectotype retains the original catalog number. The paralectotypes are now MNHN B2526. The lectotype is a male, approximately 69 mm SL, with the following characters: dorsal, XIII,17; anal, II,18S; predorsal commissural pores 4; vomerine teeth 6; pseudobranchial filaments 6.

Distribution (fig. 9).—*Entomacrodus vomerinus* is known from the coast of Brazil from Natal to Bahia, and from the island of Fernando de Noronja. One specimen, MCZ 4637, collected by Agassiz and Bourget on the Thayer Expedition, is labeled as having come from Para. The best known "Para," of which there are many, is another name for Belem in the north of Brazil on the Para River. Although the Thayer Expedition visited Belem, it is doubtful that they obtained an *Entomacrodus* there as none of the species of this genus have been

TABLE 52.--Frequency distribution of number of predorsal commissural pores of specimens of *Entomacrodus vomerinus* arranged by SL classes (in mm)

Classes	Number of pores 3	4	5	6	7	8	9	10	11	12	13	14	15	16	Average
35-39.9	1	-	2	2	-	-	-	-	-	-	-	-	-	-	5.0
40	2	1	2	2	-	-	-	-	-	-	-	-	-	-	4.6
45	-	2	3	1	2	-	-	-	-	-	-	-	-	-	5.4
50	2	1	1	3	-	-	1	-	-	-	-	-	-	-	5.2
55	-	1	1	3	-	1	-	1	-	-	-	-	-	-	6.4
60	1	2	1	3	1	1	-	1	-	-	-	-	-	1	6.8
65	-	2	2	8	3	-	3	-	-	-	-	-	-	-	6.3
70	-	2	3	8	3	6	1	3	-	-	-	-	-	-	6.9
75	-	2	1	2	4	2	1	1	-	1	-	-	-	-	7.1
80-89.9	1	1	-	4	6	3	-	2	1	-	-	-	-	-	7.1
90	-	1	-	-	-	-	1	-	-	-	-	-	-	-	6.5
100	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-

recorded from freshwater. The Thayer Expedition visited other points on the Brazilian coast within the verifiable range of *E. vomerinus*, points which various atlases and gazetteers show have also been known as "Para." It seems more likely that the MCZ specimen came from one of these localities.

MATERIAL.—Brazil, Natal: (all originally SU 22443), AMNH 3842, CNHM 59056, IFAN (no number), SU 22443, USNM 112264; Pernambuco: BMNH 1887.12.3.11, MCZ 12535, CNHM 7225; Bahia: MNHN 3082 (lectotype of *Salarias vomerinus*), B2526 (paralectotypes), USNM 43283; Fernando de Noronja: BMNH 1888.19.72–81; "Para": MCZ 4637 (see "Distribution").

TABLE 53.--Proportional dimensions as percent SL of specimens of *Entomacrodus vomerinus* (for meaning of abbreviations see methods section)

Catalog no.	Locale	Sex	SL	HL	OL	OCL	NCL	DS3	DR1	PECL	PELL	CL
SU 22443	Brazil	♂	37.0	23.8	7.6	4.1	<1.3	10.0	12.2	23.0	16.5	23.8
SU 22443	Brazil	♂	37.4	25.4	6.7	5.4	2.1	10.7	13.4	24.1	15.8	23.5
SU 22443	Brazil	♀	40.0	24.5	7.0	4.2	1.8	9.2	13.0	25.0	16.8	24.2
SU 22443	Brazil	♀	42.8	24.1	6.3	3.7	1.2	9.3	12.6	25.5	15.6	22.9
SU 22443	Brazil	♂	44.5	23.6	5.8	3.4	1.1	9.0	13.5	22.5	15.7	23.6
SU 22443	Brazil	♀	46.2	24.2	6.5	4.3	1.7	10.0	13.4	24.9	16.9	23.2
SU 22443	Brazil	♀	48.4	23.4	6.2	3.3	2.1	10.3	13.0	23.8	14.3	23.8
SU 22443	Brazil	♂	52.5	24.2	6.1	3.8	1.3	9.5	12.4	24.6	14.3	22.9
SU 22443	Brazil	♀	59.0	23.7	5.6	3.7	1.7	11.0	13.9	24.9	16.4	24.9
SU 22443	Brazil	♀	61.5	22.6	5.2	3.9	2.0	9.8	12.3	23.7	15.2	22.0
USNM 112264	Brazil	♀	68.9	22.6	5.1	4.2	2.2	8.9	12.9	24.5	14.1	23.2
SU 22443	Brazil	♀	70.4	22.2	5.7	5.7	2.1	10.1	13.6	25.3	13.9	23.4
USNM 112264	Brazil	♀	72.2	22.2	5.3	4.3	1.8	10.8	14.8	24.9	14.4	22.4
SU 22443	Brazil	♀	73.7	22.7	5.0	3.4	1.4	9.5	14.0	23.5	14.9	22.7
USNM 112264	Brazil	♀	74.5	22.8	5.2	4.0	1.7	9.9	12.3	21.1	13.5	21.1
SU 22443	Brazil	♀	76.4	24.2	5.1	3.9	1.2	10.2	14.1	22.4	13.3	23.5
SU 22443	Brazil	♂	80.4	22.1	4.7	4.2	1.5	9.6	14.2	23.6	12.7	22.0
USNM 112264	Brazil	♂	80.7	21.8	5.0	4.0	1.2	9.9	11.3	21.7	14.1	23.2
SU 22443	Brazil	♂	81.0	23.1	4.6	3.7	1.2	-	14.1	22.2	13.0	22.3
SU 22443	Brazil	♂	82.8	23.0	4.8	4.6	1.3	12.6	13.5	23.2	13.3	23.1
USNM 112264	Brazil	♀	83.7	22.9	4.8	3.7	1.7	9.8	14.7	23.2	13.6	23.3
SU 22443	Brazil	♂	84.4	23.0	5.3	3.9	1.5	9.5	13.6	23.5	13.0	21.9
SU 22443	Brazil	♂	85.5	24.3	5.4	4.8	2.2	11.6	11.8	21.9	12.2	22.8
USNM 112264	Brazil	♂	87.5	22.9	4.6	4.3	1.4	11.4	15.4	22.5	12.3	23.2
USNM 112264	Brazil	♂	90.5	22.4	4.4	4.4	1.1	10.7	13.8	21.3	11.7	-
USNM 112264	Brazil	♂	100.5	23.0	4.5	2.9	2.0	9.1	13.6	21.4	12.7	21.6

Entomacrodus textilis (Quoy and Gaimard)

PLATE 22

Salarias textilis Quoy and Gaimard, 1836, *in* Cuvier and Valenciennes, Hist. Nat. des Poissons, vol. 11, p. 307 [Ascension].

DESCRIPTION.—Segmented dorsal fin rays 14 or 15 (15 in 84 percent of specimens); segmented anal fin rays 15 or 16 (16 in 89 percent of specimens); posteriormost anal pterygiophore supporting 1 or 2 external elements (supporting 2 in 92 percent of specimens); total gill-rakers on first arch 15–23 (16–20 in 94 percent of specimens); pseudobranchial filaments 4–7 (6 in 76 percent of specimens) number not increasing with increase in SL; vertebrae 34 (10 specimens); supraorbital cirri 1–8, number increasing with increase in SL (table 54), main, or longest, supraorbital cirrus with most branches mesially, sometimes with 1 or 2 branches laterally; nape with 1 cirrus on each side; predorsal commissural pores 3–12 (usually less than 9), number increasing with increase in SL (table 55); preopercular series of pores with all positions with simple pores (only 1 specimen with 1 pair of pores included in preopercular series); 1 pore before each anterior nostril; lateral line pores terminating on side in area below and between dorsal fin rays 4 and 7; ventral margin of upper lip crenulate on lateral thirds, entire on middle third; lip crenulae usually numbering 7–11 on each side.

Proportional measurements: See tables 3, 4, and 56.

No males with the skin of the anal spines and rays modified into fleshy rugose pads were seen. It is presumed that all males available were immature. The largest of these was 60.5 mm SL. The largest female examined was 54.8 mm SL. The smallest specimen examined was 18.5 mm. No ophioblennius stages were seen.

COLOR PATTERN OF PRESERVED MATERIAL.—The most striking and characteristic marking of this species is a dark subquadrate blotch in the humeral region between the pectoral axil and the lateral line. This mark was present in all specimens examined.

In specimens with the most developed color pattern there are seven pairs of bands on the sides of the body (fusions between the mid-portion of the members of a pair as in *E. chiostictus* were not noted). Each member of the posterior six pairs of bands may be broken vertically into three subquadrate sections, the middle section of which is usually most intense (whether or not the band is broken into sections), and the ventral section usually least intense. The posteriormost two pairs of bands are usually paler than the others and may be only diffusely represented or absent. The anterior pair of bands consists of an anterior, slender, dark to faint member and the posterior much darker and larger subquadrate humeral blotch previously mentioned. The dorsal portions of the body bands extend onto the dorsal fin for a variable distance taking a dorsoposterior direction on the fin.

The ventral portions of the body bands do not extend onto the anal fin. The areas between the pairs of bands and between the members of each pair are usually narrower than the width of a single member of each band pair. The anterodorsal portion of the sides in the region below the spinous dorsal (usually anterior to dorsal spine seven) frequently bears a variable number of small dark spots. The head is variably marked with distinct spots and diffuse splotches, but a simple accentuated spot just posterior to the posterior margin of the orbit is usually not present. The upper lip is usually marked with seven to nine dark stripes, narrower than the paler interspaces. Some of the lip stripes extend onto the ventral side of the head as chevrons.

TABLE 54.--Frequency distribution of number of supraorbital cirri of left eye of specimens of *Entomacrodus textilis* arranged by SL classes (in mm)

Classes	Number of cirri								
	1	2	3	4	5	6	7	8	Average
15-19.9	1	-	2	-	-	-	-	-	2.3
20	-	-	3	-	-	-	-	-	3.0
25	-	-	4	4	-	-	-	-	3.5
30	-	-	3	1	2	1	-	-	4.1
35	-	-	-	4	3	1	2	-	5.1
40	-	-	1	2	5	6	-	-	5.1
45	-	-	-	2	3	2	2	2	5.9
50	-	-	-	1	3	1	-	-	5.0
55	-	-	-	1	-	-	1	-	5.5
60	-	-	-	-	-	-	1	-	-

TABLE 55.--Frequency distribution of number of predorsal commissural pores of specimens of *Entomacrodus textilis* arranged by SL classes (in mm)

Classes	Number of pores										
	3	4	5	6	7	8	9	10	11	12	Average
15-19.9	3	-	-	-	-	-	-	-	-	-	3.0
20	4	-	1	-	-	-	-	-	-	-	3.4
25	2	4	1	-	1	-	-	-	-	-	4.2
30	1	2	1	2	-	-	-	-	-	-	4.7
35	3	-	3	3	-	2	-	-	-	-	5.3
40	1	3	-	7	3	-	-	-	-	-	5.6
45	-	1	-	5	2	2	-	-	-	1	6.9
50	-	1	1	2	-	-	-	-	-	-	5.2
55	-	-	-	-	-	1	-	-	-	-	8.0
60	-	-	-	-	-	-	-	-	1	-	-

The spinous dorsal fin is variably dusky, frequently with a narrow pale distal margin. The soft dorsal is usually dusky between and also distal to the body band extensions on the fin. In males the anal fin is uniformly dusky with a narrow proximal pale stripe. In females the anal fin is variably dusky anteriorly but posteriorly with pale areas forming diffuse spots distally on the fin. The caudal fin bears three to five (usually four) dusky, sometimes irregular, bands, palest posteriorly and dorsally. The pectoral fin is dusky with a darker, sometimes well-defined area basally on the ventral rays. There is a pale band anterior to this last area on the fleshy pectoral base, followed by a dark crescentic mark and sometimes additional dark marks, also on the base. The pelvic fin is variably pale to dusky.

LECTOTYPE DESIGNATION.—The syntypic material upon which Valenciennes based his description of *Salarias textilis* is contained in three lots, MNHN A2025 (1 specimen), A2026 (3 specimens), and B2524. I here designate A2025, a 60.5 mm SL male, as lectotype.

TABLE 56.--Proportional dimensions as percent SL of specimens of *Entomacrodus textilis* (for meaning of abbreviations see methods section)

Catalog no.	Locale	Sex	SL	HL	OL	OCL	NCL	DS3	DR1	PECL	PELL	CL	HBL
BMNH 1935.5.2.25-30	Ascencion	♂	27.0	25.2	7.4	3.7	3.3	11.1	14.8	25.8	16.7	24.8	4.8
BMNH 1946.5.23.10-12	St. Helena	♂	27.1	24.7	7.4	3.7	1.8	10.7	13.6	24.0	17.0	23.6	3.3
BMNH 1960.3.1.45-60	St. Helena	♀	28.1	25.3	7.1	3.6	2.8	10.0	13.5	24.9	18.9	23.1	2.1
BMNH 1960.3.1.45-60	St. Helena	♀	32.2	24.8	6.2	2.2	1.9	9.3	12.4	24.2	16.8	23.3	4.7
BMNH 1960.3.1.45-60	St. Helena	♀	33.0	26.0	6.7	3.3	2.4	10.0	13.6	24.5	16.7	23.0	3.3
BMNH 1960.3.1.45-60	St. Helena	♀	36.9	24.4	6.8	3.3	2.4	10.0	14.1	24.9	16.8	23.0	4.1
MNHN A2025	Ascencion	♀	37.4	24.6	6.7	4.5	2.4	10.2	13.6	24.6	16.0	24.1	5.3
BMNH 1960.3.1.45-60	St. Helena	♂	39.2	24.0	6.4	4.1	2.6	10.2	12.5	23.0	16.8	24.2	4.1
BMNH 1960.3.1.45-60	St. Helena	♂	40.8	24.8	6.1	4.7	2.5	9.8	12.5	23.5	17.2	22.8	3.9
BMNH 1960.3.1.45-60	St. Helena	♂	43.0	23.2	6.0	4.2	2.1	8.6	13.5	23.5	17.2	22.1	4.2
BMNH 1960.3.1.45-60	St. Helena	♀	43.0	24.2	6.0	4.0	1.2	8.8	12.1	24.9	16.7	24.0	4.7
BMNH 1960.3.1.45-60	St. Helena	♂	43.1	24.4	5.6	4.2	2.6	9.3	12.5	24.4	16.2	23.2	2.8
MNHN A2025	Ascencion	♀	45.1	24.4	6.0	3.3	2.4	8.6	15.1	23.0	15.5	22.2	4.9
BMNH 1960.3.1.45-60	St. Helena	♂	46.4	24.2	6.7	3.9	2.6	9.5	13.6	21.8	15.7	21.9	4.5
MNHN A2025	Ascencion	♂	47.5	24.2	5.9	3.8	2.1	8.8	14.3	23.0	13.7	21.5	3.4
BMNH 1935.5.2.25-30	Ascencion	♀	49.9	24.1	6.0	3.2	2.6	8.4	16.0	23.6	15.4	25.1	5.4
BMNH 1960.3.1.45-60	St. Helena	♀	50.7	23.7	6.1	3.5	2.0	9.5	13.8	25.0	16.4	24.5	3.4
BMNH 1960.3.1.45-60	St. Helena	♀	52.0	24.0	5.8	2.9	1.9	9.6	13.4	21.5	16.1	22.1	4.8
BMNH 1960.3.1.45-60	St. Helena	♀	54.8	23.0	5.8	3.3	3.3	9.5	13.0	23.5	15.7	21.9	5.5
MNHN A2026	Ascencion	♂	57.1	24.4	5.3	3.0	2.3	8.8	13.0	23.5	14.5	23.6	5.1
MNHN A2025[1]	Ascencion	♂	60.5	23.8	5.0	3.0	2.5	8.4	13.9	21.6	13.9	21.5	4.5

[1] Lectotype of *Salarias textilis*

Relationships.—*Entomacrodus textilis* is a member of the *E. nigricans* species group. Of this group the Atlantic species appear to be most closely interrelated (see "Relationships" under *E. nigricans*). *Entomacrodus textilis* differs from its geographically closest relative, *E. cadenati*, in having the stripes on the upper lip solid and in having a well-developed subquadrate humeral blotch. *Entomacrodus cadenati* frequently has as the most prominent markings on each side of the body two rectangular humeral blotches (comprising the anterior pair of body bands). The anterior of these blotches is much more prominent than marks in a comparable position on *E. textilis*. The posterior of these two blotches in *E. cadenati* is never as prominent (or large) or uniformly dark as that in *E. textilis*. The peculiar dark markings behind the eye in *E. cadenati* are not found in *E. textilis*. *E. textilis* differs: from *E. vomerinus*, in having typically lower dorsal, anal, vertebral, and gill-raker counts, and in having a humeral blotch; from *E. nigricans*, in having a humeral blotch, in not having a prominent spot just posterior to the eye, and in having the pores of the lateral line terminating farther posteriorly; from *E. chiostictus* and *E. sealei*, in having a humeral blotch, a proportionately shorter supraorbital cirrus, and in almost never having any paired pores included in the preopercular series; from *E. chiostictus*, in having fewer lip stripes; and from *E. sealei*, in having a shorter nuchal cirrus and third dorsal spine (in specimens over 39 mm SL), fewer predorsal commissural pores at any particular size, and in having the dark upper lip stripes narrower than the pale interspaces; and from *E. corneliae*, in having a humeral blotch and lip stripes and in lacking two dark stripes on the head behind the eye and pairs or multiples of pores in the preopercular series. It can be differentiated from *E. caudofasciatus* by the characters given in key couplet 10.

Distribution (fig. 9).—*E. textilis* is endemic to Ascension and St. Helena Islands. These two islands have a high proportion of endemics among their fish fauna (24.3 percent—Cadenat and Marchal, 1963).

Material.—Ascension Island: BMNH 1881.11.10.3, 1908.7.24.23–4, 1935.5.2.25–30, MNHN A2025 (lectotype of *S. textilis*), A2026, B2524; St. Helena Island: BMNH 1946.5.23.10–12, 1960.3.1.45–60, 1964.2.3.1–7, 1964.2.3.8–28, USNM 42318.

Entomacrodus cadenati Springer

Plate 23

Entomacrodus cadenati Springer, 1966, Atlantide Rep., no. 9, pp. 59–61, pl. 6 [Goreé-Senegal].

Description.—Segmented dorsal fin rays 14–16 (15 in 77 percent of specimens); segmented anal fin rays 15–17 (16 in 63 percent of specimens); posteriormost anal pterygiophore supporting 1 or 2 external elements (supporting 2 in 75 percent of specimens); total gill-rakers on first arch 17–22 (17–20 in 90 percent of specimens); pseudobranchial filaments 5–7 (6 in 78 percent of specimens), not increasing in number with increase in SL; vertebrae 34; supraorbital cirri 1–15, number increasing with increase in SL (table 57), main or longest supraorbital cirrus with most branches mesially, commonly with several lateral branches; nape with 1 cirrus on each side; predorsal commissural pores 3–16 (rarely more than 11), number increasing with increase in SL (table 58); preopercular series of pores with all positions with simple pores; 1 pore before each anterior nostril; lateral line pores terminating on side in area below and between dorsal fin spines 13 and dorsal fin ray 10 (usually between dorsal rays 3–6); ventral margin of upper lip crenulate on lateral one-third, entire on middle third; lip crenulae usually numbering 7–11 on a side.

Proportional measurements: See tables 3, 4, and 59.

No males with the skin of the anal spines and rays modified into fleshy rugose pads were seen. A few males showed incipient development of these modifications. It is presumed that all males available were immature. The largest male examined was 68.8 mm SL and the largest female 66.9 mm SL. Males and females occurred with about relative equal frequency in all size classes. The smallest specimen seen was 17.5 mm SL. No ophioblennius stages were seen.

Color pattern of preserved specimens.—In specimens with what appears to be the most developed pattern there are 6½ to 7 pairs of irregular dark bands on the sides of the body (except for the anterior and posteriormost pairs, there were no fusions between the midportions of the members of a pair). The anteriormost pair of bands, over the pectoral base and axil, is the shortest and frequently the darkest of the bands. Occasionally the anteriormost band pair

TABLE 57.--Frequency distribution of number of supraorbital cirri of left eye of specimens of *Entomacrodus cadenati* arranged by SL classes (in mm)

Classes	Number of cirri															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Average
15-19.9	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.0
20	-	1	2	1	1	-	-	-	-	-	-	-	-	-	-	3.4
25	-	-	-	2	1	2	-	-	-	-	-	-	-	-	-	5.0
30	-	-	1	5	3	-	1	1	-	-	-	1	-	-	-	5.4
35	-	-	-	1	-	1	5	1	1	-	-	-	-	-	-	6.9
40	-	-	-	-	1	2	2	-	-	-	-	-	-	-	-	6.2
45	-	-	-	-	1	2	1	2	1	2	-	-	-	-	-	7.7
50	-	-	-	-	1	1	4	3	2	1	-	-	-	-	-	7.6
55	-	-	-	-	-	-	2	4	4	1	1	-	1	-	2	9.7
60	-	-	-	-	-	-	3	-	1	2	2	1	-	-	1	9.9
65-69.9	-	-	-	-	-	-	-	2	-	-	1	-	1	1	1	11.5
75-79.9	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-

forms a small double blotch or, when fused, a single blotch, which is the most obvious mark on the body. The composition of the body bands is variable; sometimes each member of a pair is in three vertically arranged portions, either connected with or detached from each other. The middle of these three portions is usually the darkest, and the ventral portion the palest (the ventral portion fails to reach the anal fin base). The dorsal portions of the bands reach to and enter the dorsal fin taking a posterodorsal direction, sometimes reaching the distal dusky margin of the fin. The area between the bands on the body may be pale or dusky, usually with some short, slender, dark markings, which may extend dorsally to the dorsal fin base but usually do not extend ventrally much lower than the middle of the side. The dorsal portions of the body below the dorsal fin, as far posteriorly as the anterior four soft rays, usually is marked with a number of tiny dark spots. These spots usually appear along the margins of the bands. The head is strikingly marked with a J- or U-shaped dark area behind the eye (see pl. 23*a*, *d*) which is separated by a pale area from the eye. The area between the arms of the J or U may be pale or dusky, and the entire mark extends dorsoposteriorly from behind the eye across the top of the head, where it may join with the same mark from the other side. A dark, sometimes interrupted stripe begins at the margin of the upper lip, extends to the ventroposterior margin of the orbit, where the stripe is interrupted by the eye, and begins again at the dorsoposterior margin of the eye, where it may join across the top of the head with a similar stripe from the other side. There are irregular dusky areas and numerous tiny dark spots on the sides of the head. The upper lip has numerous tiny dark spots (comprised of groups of melanophores) that are frequently

TABLE 58.--Frequency distribution of number of predorsal commissural pores of specimens of *Entomacrodus cadenati* arranged by SL classes (in mm)

Classes	Number of pores														Average
	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
15-19.9	2	-	-	-	-	-	-	-	-	-	-	-	-	-	3.0
20	4	1	-	-	-	-	-	-	-	-	-	-	-	-	3.2
25	1	-	1	1	2	-	-	-	-	-	-	-	-	-	5.6
30	3	-	2	3	1	3	-	-	-	-	-	-	-	-	5.7
35	1	-	-	2	4	1	-	-	-	-	-	-	-	-	6.4
40	-	-	-	2	2	1	-	1	-	-	-	-	-	-	7.3
45	-	-	3	-	1	1	2	-	-	-	-	-	-	-	6.8
50	-	-	1	4	2	2	1	2	-	-	-	-	-	-	7.3
55	-	1	-	1	4	2	1	2	3	1	-	-	-	-	8.5
60	-	-	-	1	2	2	1	2	-	-	-	-	-	2	9.7
65-69.9	-	-	1	1	1	1	1	-	-	1	-	-	-	-	7.8
75-79.9	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-

aligned in 7–10 more or less vertical rows corresponding to the lip stripes of *E. nigricans* and *E. textilis*. The underside of the head may bear several dark or dusky chevrons.

The anal fin membrane is uniformly dusky anteriorly, but the duskiness becomes separated posteriorly into two portions by a pale diffuse stripe. The anal rays are dark distally but become paler proximally, except for a slight, diffusely pale-dusky sub-basal stripe. The caudal fin bears three to six irregular dark bands, depending on the length of the specimen (the longer the specimen, the more the bands). The pectoral is dusky, though much paler dorsally; there may be on the fleshy pectoral base one or a few dark blotches separated by a pale cresentic mark. A dusky area, also on the fleshy pectoral base, is proximal to the pale area. The pelvic fins vary from pale to dusky.

In general, males are more uniformly colored than females, but there are exceptions.

Relationships.—*Entomacrodus cadenati* is a member of the *E. nigricans* species group. Of this group the Atlantic species appear

TABLE 59.--Proportional dimensions as percent SL of specimens of *Entomacrodus cadenati* (for meaning of abbreviations see methods section)

Catalog no.	Locale	Sex	SL	HL	OL	OCL	NCL	DS3	DR1	PECL	PELL	CL
MNHN 1965-706	Senegal	♂	28.4	25.0	7.0	2.5	2.8	9.9	12.7	26.8	15.8	23.2
MNHN 1965-706	Senegal	♂	30.4	23.7	7.3	3.0	2.0	9.6	13.5	25.6	17.1	24.7
USNM 199481	Senegal	♂	34.2	24.0	6.4	2.9	2.0	9.4	13.2	22.5	17.0	24.6
MNHN 1965-706	Senegal	♂	34.7	25.1	6.9	3.5	1.4	10.1	12.1	23.6	16.1	23.0
MNHN 1965-706	Senegal	♀	37.2	23.4	6.7	3.0	2.2	9.1	12.6	24.2	15.3	24.2
MNHN 1965-706	Senegal	♀	38.2	24.1	5.7	2.6	1.6	9.7	11.0	24.6	15.7	22.8
MNHN 1965-706	Senegal	♂	39.0	23.8	6.2	2.6	1.8	10.2	12.8	24.4	15.1	24.1
USNM 199481	Senegal	♂	41.5	23.4	5.5	2.6	1.4	9.6	12.0	23.8	16.1	21.7
MNHN 1965-706	Senegal	♀	45.1	24.4	6.8	3.1	2.2	10.0	14.0	26.2	14.9	26.0
MNHN 1965-706	Senegal	♀	49.5	24.4	5.5	3.0	2.6	10.1	13.3	23.8	15.8	22.8
USNM 199481	Senegal	♀	50.0	23.8	6.0	3.0	1.4	9.8	12.0	25.2	15.0	23.0
USNM 199481	Senegal	♀	52.8	22.9	5.5	3.0	1.5	9.5	12.7	23.7	14.2	21.4
MNHN 1965-706	Senegal	♀	56.7	25.0	6.0	3.4	1.6	10.0	12.9	24.8	14.3	22.8
USNM 199481	Senegal	♀	58.0	23.4	5.2	2.2	1.9	9.3	12.8	24.4	14.5	22.1
USNM 199481	Senegal	♂	61.8	21.7	5.3	2.6	1.6	9.4	12.6	24.7	14.9	22.7
MNHN 1965-705	Senegal[1]	♂	64.0	23.8	5.5	3.1	1.9	9.5	13.4	23.2	14.4	23.0
MNHN 1965-706	Senegal	♀	64.4	23.9	5.9	2.3	1.6	10.4	14.1	25.6	14.4	22.6
USNM 199481	Senegal	♂	68.8	23.0	5.1	2.9	1.7	9.9	14.5	24.2	12.8	23.4

[1] Holotype of *Entomacrodus cadenati*

to be most closely interrelated (see "Relationships" under *E. nigricans* and *E. chiostictus*).

Entomacrodus cadenati differs: from all its closest relatives, in having numerous dark spots on the upper lip (arranged in more or less vertical rows) and in the peculiar well-developed dark marks behind its eye; from its geographically closest relative, *E. textilis*, in not having a relatively large, well-developed subquadrate blotch in the humeral region; from *E. vomerinus*, in having fewer segmented dorsal and anal fin rays and vertebrae; from *E. chiostictus*, *E. caudofasciatus*, and *E. seali*, in its usually shorter supraorbital and nuchal cirri; and from the latter species and *E. corneliae* (and frequently *E. chiostictus*), in having no paired pores in the preopercular series. *E. cadenati* has fewer predorsal commissural pores at any particular size than does *E. sealei*, and more gill-rakers than *E. caudofasciatus*.

Remarks.—There is a tendency for males to have a higher average number of segmented dorsal fin rays than females. Of 30 males examined, 2 had 14 rays, 26 had 15 rays, and 2 had 16 rays. Of 47 females examined, 14 had 14 rays and 33 had 15 rays. There was no evidence of sexual dimorphism in other meristic characters.

Distribution (fig. 9).—*Entomacrodus cadenati* is known only from the eastern Atlantic Ocean from the Cape Verde Islands to the Ile de Roumé, French Guinea. According to J. Cadenat (in litt.), the species is characteristic of the wave-battered rocky shores of Goreé, Senegal.

Material.—Cape Verde Islands, Ile de Sao Thiago: USNM 199623; Ile de Sal: IFAN (no number); Senegal, Goreé: MNHN 1965–705 (holotype of *E. cadenati*), 1965–706, USNM 199481; French Guinea, Ile de Roumé: IRSN 401; Liberia, Robertsport: RMNH 5323; Ghana, Takoradi: CU 44175 44176; French Congo, Bata: MNHN 92–24.

Entomacrodus nigricans Gill

Plate 24

Entomacrodus nigricans Gill, 1859, Proc. Acad. Nat. Sci. Philadelphia, vol. 11, p. 168 [near Bridgetown, Barbados].

Salarias margaritaceus Poey, 1860, Memorias sobre la historia natural de la Isla de Cuba, vol. 2, pp. 289–290 [Cuba].

Entomacrodus decoratus Poey, 1868, Reperterio fisico-natural de la Isla de Cuba, vol. 2, p. 398 [Cuba].

Description.—Segmented dorsal fin rays 13–16 (14 or 15 in all but 2 specimens); segmented anal fin rays 14–17 (89 percent with 16); posteriormost anal pterygiophore supporting 1 or 2 external elements (supporting 2 in 90 percent of specimens); total gill-rakers on first arch 14–20 (15–18 in 86 percent of specimens); pseudobranchial filaments 5–7 (6 in 80 percent of specimens, number not increasing with increase in SL); vertebrae 33–35 (34 in 95 percent of specimens); supraorbital cirri 1–11, number increasing with increase in SL (table

60); main or longest supraorbital cirrus with most branches mesially, not uncommonly with a short lateral branch; nape with 1 cirrus on each side; predorsal commissural pores 2–23 (rarely more than 17), number increasing with increase in SL (table 61); preopercular series of pores with all positions with simple pores (93 percent of specimens, including 1 or 2 pairs of pores in series in 6 and 1 percent of specimens respectively; fourth pore of series most frequent paired pore); 1 pore before each anterior nostril; lateral line pores terminating on side in area below and between dorsal fin spine 10 and dorsal soft ray 2 (usually between spine 11 and ray 1); ventral margin of upper lip crenulate on lateral thirds, entire on middle third; lip crenulae usually numbering 6–11 on each side.

Proportional measurements: See tables 3, 4, and 62.

Males develop fleshy, rugose modifications of the skin of the anal spines and the anterior first to fourth anal rays (pl. 24*f*). If one considers males with these modifications to be mature, the smallest mature male examined was 34 mm SL. Mature and immature males may occur in the same collection and in these collections immature males may be as much as 22 mm SL longer than mature males.

Largest specimen examined, 62.6 mm SL, a size achieved by both males and females. There does not appear to be any difference in proportional numbers of males and females in any given size class, although in total numbers males outnumber females. The smallest nonophioblennius stage and the largest ophioblennius stage examined were both 15.5 mm SL and occurred in the same collection, indicating that transformation occurs at about this size.

The ophioblennius larval stage of *E. nigricans* is characterized by the presence of a pair of posterolaterally directed canines anteriorly on each side of the lower jaw. The more median and anterior canine on each side is about one-third the size of the more posterior canine.

TABLE 60.—Frequency distribution of number of supraorbital cirri of left eye of specimens of *Entomacrodus nigricans* arranged by SL classes (in mm)

Classes	Number of cirri 1	2	3	4	5	6	7	8	9	10	11	Average
15-19.9	20	4	4	1	-	-	-	-	-	-	-	1.5
20	1	6	16	7	-	1	-	-	-	-	-	3.1
25	-	-	5	29	13	1	-	-	-	-	-	4.2
30	-	-	11	21	22	7	2	-	-	-	-	4.5
35	-	-	7	18	30	14	3	1	-	-	-	4.9
40	-	1	1	14	23	18	5	3	2	-	-	5.4
45	-	-	-	6	15	17	1	1	-	1	-	5.5
50	-	-	1	3	7	7	6	2	-	1	1	6.1
55	-	-	-	1	3	2	-	1	-	-	-	5.6
60	-	-	-	-	-	-	1	-	2	-	1	9.0

The smaller canines are either lost first during transformation or fail to develop in some specimens, as several specimens had only the larger canines. The posterolaterally directed canines occur internal to the salarine type dentition. In some specimens the posterior recurved canine of the adult (not included in the canines just discussed) is just noticeable; vomerine teeth have not been noted in the ophioblennius stage. The ophioblennius stage specimens are either uniformly pale or have some indications of paired vertical stripes on the sides of the body.

COLOR PATTERN OF PRESERVED SPECIMENS.—In specimens with the most developed color pattern there are 6 to 6½ pairs of dark bands on the sides of the body (fusion between the midportion of the members of a pair, as in *E. chiostictus*, were not noted). The posteriormost two pairs of body bands are usually less intense than the others and may be absent. The anteriormost half-pair band is frequently broken into irregular markings or may be absent altogether. The interspaces between the bands may be marked with pale or pearly white spots. The anterodorsal portion of the sides, in the region below the spinous dorsal, frequently bears a variable number of small dark spots.

The head is pale to deep dusky with a dark spot just posterior to the eye. The upper lip of most specimens bears 7–10 dark, narrow stripes alternating with broader, paler bands. The basic number of stripes is seven, but three of these stripes may divide, usually dorsally only, and be interpreted as two stripes each. The stripes may be fewer in number in small or occasional specimens. The underside of the head usually exhibits a pattern of dark chevrons, which are extensions from some of the lip stripes.

Portions of the dorsal fin above and between the body bands are marked with a variable number of diffuse dusky spots. These spots sometimes coalesce, especially on the posterior soft dorsal fin, and the markings thus formed alternate with pale spots. The anal fin is variably dusky, always darker and more extensively pigmented in

TABLE 61.--Frequency distribution of number of predorsal commissural pores of specimens of *Entomacrodus nigricans* arranged by SL classes (in mm)

Classes	Number of pores																						
	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Average
15-19.9	1	16	2	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.4
20	-	4	3	5	2	7	3	3	-	1	-	-	-	-	-	-	-	-	-	-	-	-	6.1
25	-	1	-	7	9	5	7	6	11	4	2	1	1	-	1	-	-	-	-	-	-	-	8.3
30	-	-	-	2	4	7	9	13	10	5	3	4	1	-	-	1	-	-	-	-	-	-	9.2
35	-	-	-	1	4	6	10	14	12	5	13	5	3	3	1	-	-	-	-	-	-	-	10.1
40	-	-	-	-	-	1	4	12	18	10	11	6	4	2	2	-	1	-	1	-	-	-	11.2
45	-	-	-	-	2	4	3	7	5	5	7	4	1	2	1	1	1	1	-	-	-	-	11.0
50	-	-	-	-	-	-	3	2	4	3	1	5	5	1	-	-	-	-	1	-	1	1	12.7
55	-	-	-	-	-	-	-	-	1	3	1	1	-	-	1	-	-	-	-	-	-	-	12.0
60	-	-	-	-	-	-	-	-	1	1	-	-	-	1	-	1	-	-	-	-	-	-	13.2

TABLE 62.--Proportional dimensions as percent SL of specimens of *Entomacrodus nigricans* (for meaning of abbreviations see methods section)

Catalog no.	Locale	Sex	SL	HL	OL	OCL	NCL	DS3	DR1	PECL	PELL	CL
USNM 197324	Serrana Bank	♀	25.1	24.3	8.0	2.4	1.6	10.0	13.5	23.9	15.5	22.7
USNM 195755	Venezuela	♀	27.5	24.7	7.3	2.5	2.2	10.9	12.4	25.1	14.2	23.3
UF 8866	Bahamas	♂	31.1	25.4	6.8	2.9	2.6	10.6	13.5	24.1	17.7	24.1
LACM 5017	Pedro Cay	♀	31.5	24.4	7.0	2.2	2.2	9.8	13.0	23.8	17.5	21.6
UF 9606	Bahamas	♂	32.1	24.0	6.9	2.5	2.2	10.0	14.6	23.4	16.8	23.4
USNM 192201	Cuba	♂	33.2	23.5	6.3	3.0	1.5	9.9	13.3	23.2	15.0	22.6
USNM 197324	Serrana Bank	♂	34.0	24.4	6.5	2.6	1.8	10.3	13.2	21.5	15.3	22.3
USNM 192201	Cuba	♀	35.0	22.3	6.3	2.9	1.7	10.0	13.1	22.8	16.3	22.9
USNM 195754	Venezuela	♂	35.6	22.8	7.0	2.8	2.8	11.2	14.0	23.0	16.9	24.4
USNM 195755	Venezuela	♀	37.1	23.2	6.7	2.7	1.6	10.8	13.5	24.2	17.5	22.9
USNM 197668	Bermuda	♂	37.8	24.1	6.6	2.6	1.8	10.6	13.0	24.3	-	23.3
UF 9606	Bahamas	♂	39.6	23.5	6.3	3.3	2.5	9.1	13.9	22.5	14.9	23.7
LACM 5017	Pedro Cay	♀	39.8	23.6	6.5	2.8	2.0	11.0	13.6	23.6	16.3	22.1
UF 8866	Bahamas	♂	41.8	22.7	6.5	3.3	1.4	9.3	14.8	23.2	15.8	23.4
USNM 192201	Cuba	♀	42.0	22.1	6.2	2.4	1.2	10.2	13.1	23.8	15.2	23.3
USNM 197324	Serrana Bank	♂	43.3	23.3	6.5	3.7	1.8	11.1	15.0	21.7	15.0	25.0
UF 9606	Bahamas	♀	43.8	24.2	6.4	2.3	2.0	10.7	14.4	22.8	15.3	23.3
USNM 192201	Cuba	♀	44.0	25.0	6.6	2.7	1.8	10.2	13.4	23.9	15.9	22.3
USNM 178738	Bermuda	♀	44.8	22.8	6.0	2.5	1.6	10.0	13.6	25.7	16.5	24.3
USNM 195752	Venezuela	♂	45.0	22.2	5.8	3.1	1.3	9.5	13.8	21.1	14.0	22.2
USNM 192201	Cuba	♀	45.4	23.1	5.9	2.2	1.5	10.4	13.2	22.9	16.5	23.1
USNM 195755	Venezuela	♂	46.2	23.2	6.1	2.8	1.9	9.5	13.8	23.8	15.1	21.9
LACM 5013	Jamaica	♀	46.7	23.4	5.8	2.6	2.4	9.8	14.1	22.7	14.4	22.3
USNM 197324	Serrana Bank	♂	48.5	22.9	5.8	3.3	1.4	9.7	13.8	21.6	15.0	22.7
USNM 192201	Cuba	♀	48.6	23.9	5.8	2.1	1.6	10.9	13.4	21.8	14.4	23.0
USNM 178738	Bermuda	♀	49.2	23.0	5.7	2.8	2.1	9.1	14.2	24.4	16.2	23.2
ANSP 81749	Bahamas	♂	50.0	22.6	5.8	2.4	2.0	9.8	14.0	21.2	13.0	22.0
USNM 178738	Bermuda	♂	50.2	23.1	6.0	2.8	1.6	10.0	14.9	25.1	15.9	23.3
USNM 178738	Bermuda	♂	51.8	22.2	5.8	2.2	1.5	7.7	13.9	21.6	14.5	22.8
LACM 5021	Morant Cay	♀	53.0	23.0	5.7	2.6	1.9	10.6	12.8	23.2	14.3	23.2
USNM 197324	Serrana Bank	♂	56.1	22.8	5.3	3.2	1.4	9.6	14.3	20.9	14.3	22.6
USNM 195753	Venezuela	♀	58.3	22.6	5.5	2.1	1.4	9.8	13.7	23.3	13.7	22.6
USNM 178738	Bermuda	♂	59.8	22.1	5.3	3.2	2.2	9.4	13.0	23.4	14.7	21.7
USNM 197324	Serrana Bank	♀	61.9	24.2	5.5	2.4	1.9	8.7	13.1	22.6	15.5	21.8
USNM 178738	Bermuda	♂	62.6	22.0	5.1	3.2	1.6	9.6	13.3	24.0	14.4	22.7

males than females from the same collection. A few diffuse pale spots occur posteriorly on the anal fin. There are three to six, usually five, irregular dusky bands on the caudal, darkest ventrally and palest dorsoposteriorly. The pectoral fin is pale to dusky, darker basally where a dark crescentic stripe or some diffuse spots may occur. A dusky stripe is usually present on the pectoral base. The pelvic fins are pale.

Life coloration.—(Described from an immature male of adult size from Dominica, B.W.I.) The nasal and orbital cirri were light coral pink; the lip stripes light olive brown; a dark brown spot with a bright white posterior margin was present below the eye; the white margin was followed posteriorly by a pale area. There were dark brown spots posterior to the eye and on the anterodorsal area of the body of the same color as the spot behind the eye. The paired body bands were chocolate brown, much paler on the ventral portion of the body. Bright white spots were present in pale interspaces between the bands on the body. The interspaces were pale olive yellow dorsally and extended onto the ventral portion of the dorsal fin. This same olive-yellow color occurred distally on the soft dorsal. Chocolate-brown marks were present on the caudal fin, pectoral base, and dorsal fin. The anal rays graded distally from olive yellow to dusky; the pectorals were dusky and the pelvics, pale.

Geographic variation.—There appears to be little variation between collections from diverse localities, except possibly those from Bermuda as compared with collections from other localities. Specimens from the Caribbean, Florida, and the Bahamas show essentially a one-to-one ratio of specimens with 14 and 15 dorsal rays. Of the 53 Bermuda specimens counted, 12 had 14 rays, 40 had 15 rays, and 1 had 16 rays (the only specimen with this count, of over 500 examined of the species).

Nomenclature.—*Salarias margaritaceus* Poey was described without comparison. The holotype is a normal adult of *E. nigricans*. In the jar containing the holotype (MCZ 12513) are three specimens. The largest of these, 57 mm total length, is more than 10 mm larger than the next size (the largest is a female, the two smaller, males). Poey gave the total length of the holotype as 60 mm; the largest specimen in the bottle must therefore be considered the holotype with the difference in size noted accounted for by shrinkage.

I have been unable to locate type material of *Entomacrodus decoratus* Poey (nor did Longley, *in* Longley and Hildebrand, 1941). The description clearly indicates a salarine blenniid. The only other salarine in the Caribbean area, besides *E. nigricans*, is *Ophioblennius atlanticus macclurei* (Silvester). The dorsal fin formula given by Poey, XII,19, could apply only to *O. a. macclurei;* the anal and pectoral fin formulae, 15 and 14 respectively, could apply only to *E. nigricans*. The color description is applicable to *E. nigricans* and positively excludes *O. a. macclurei*. I therefore place *E. decoratus* in synonymy with *E. nigricans* and ascribe Poey's dorsal fin formula to an error.

Relationships.—*Entomacrodus nigricans* is most closely related to the Atlantic Ocean species *E. cadenati*, *E. textilis*, and *E. vomerinus* and the Pacific Ocean species *E. caudofasciatus* (also Indian Ocean), *E. sealei*, *E. corneliae*, and *E. chiostictus* (the *E. nigricans* species group) (see "Relat'onships" under *E. chiostictus*). All these species have the crenulations of the upper lip predominantly restricted to the lips' lateral thirds. Of this group the Atlantic species appear to be most closely interrelated. I base this conclusion on certain similarities of color pattern (the basic lip pattern of 7–10 dark stripes), relative lengths of the supraorbital cirri, and the usual presence of only simple pores in the preopercular series. *Entomacrodus nigricans* differs from *E. cadenati* in having the lip stripes as solid lines, whereas *E. cadenati* has the stripes as a series of more or less vertically arranged spots. The peculiar U-shaped black marking behind the eye in *E. cadenati* also distinguishes that species from *E. nigricans*, where the marking is not present. The lateral line pores of *E. cadenati* and *E. textilis* usually terminate farther posteriorly than those of *E. nigricans*. *E. nigricans* is further distinguished from *E. textilis* in that *E. nigricans* lacks the black humeral blotch of the latter. It differs from *E. vomerinus* in having typically fewer dorsal and anal fin rays, fewer gill-rakers, and vertebrae, and, at any given size, usually more predorsal commissural pores. None of the specimens of *E. vomerinus* examined had any dark spots on the sides in the region below the spinous dorsal as found in *E. nigricans*. The lip stripes in *E. vomerinus* are usually not so obvious as those in *nigricans*.

Many recent writers have considered all four Atlantic species of *Entomacrodus* that I recognize as conspecific, under the specific name *textilis* (combined with *Alticus*, *Rupiscartes*, *Salarichthys*, or *Entomacrodus*). Although the differences between the species as conceived here are not great, my reasons for recognizing them as distinct are as follows: On the basis of color pattern and/or meristic characters, four distinct, homogeneous groupings (populations) of specimens are discernible; each of these four groupings is restricted to a particular geographic range well separated from that of any of the others; the ranges, except for the Ascension-St. Helena area, are extensive, covering several thousand miles of latitude and/or longitude, which indicates long term stability of the populations. The sum of these reasons implies isolation and fixation of subsequent divergences of each population. It is assumed that the immense distances separating the populations combined with a probable short pelagic larval stage are the bases for continued separation. The present distribution of the four species would favor a continental drift theory, wherein an initially homogeneous single population was gradually broken up as shorelines separated.

Distribution (fig. 9).—*Entomacrodus nigricans* is restricted to the rocky shores of the tropical-subtropical western Atlantic north of the equator. It is found only at depths of a few centimeters to a meter and, as noted by Breder (1948, as *Salarichthys textilis*), is a common tide pool form. Specimens that I collected on the bottom in deeper water (to 5 meters) were actually residents on rocks near the surface of the water. The specimens had become incapacitated by rotenone and had fallen to the bottom. I mention this because I have seen collection data for *Entomacrodus* reporting occurrences as deep as 7 meters; I doubt that any species of the genus occurs naturally at depths of much more than 1 or 2 meters.

Material.—Bermuda: USNM 21936, 21944, 23802, 178367, 178738, 178834, 178967, 178968, 178969, 178970, 197668; south Florida: UMML 3011, 5704, 6647, 9872, 9939, USNM 116832; Bahamas: ANSP 81739, 81742, 81749, 81752, UF 8866, 8867, 8868, 8869, 8870, 8871, 9606; Cuba: MCZ 12513 (holotype of *Salarias margaritaceus*), USNM 37534, 192201; Haiti: CNHM 72334, 72335; Dominican Republic: BMNH 1938.6.20.9; Puerto Rico: UMML 1776, UPR 130, 381, 724, 842, USNM 117410; Virgin Islands: UMML 2471, 3735, 5457, 6223; St. Martins: UMML 6480; St. Eustatius: RMNH 18748; Antigua: USNM 178978; Dominica: USNM 198279, 198280; Union Island: USNM 178424; Barbados: BMNH 1922.3.26.14, SU 32036, 32037, 37304, USNM 34625 (holotype of *E. nigricans*), 86745, 86746, 86749; Los Roques (Venezuela): USNM 195752, 195753, 195754, 195755; Venezuela: USNM 259156 F-1; Bonaire: RMNH 23579; Aruba: RMNH 23540, 23586; Curacao: RMNH 9820; Panama (Atlantic): MCZ 41492; Costa Rica: CNHM 72359, LACM 2557; British Honduras: UMML 9981; Yucatan: UCC (no number), UMML 9213, 9363; Cayman Islands: BMNH 1939.5.12.175; Jamaica: CNHM 72326, 72327, LACM 5013, 5017, 5021; Serrana Bank: USNM 197324.

Entomacrodus caudofasciatus (Regan)

Plates 25, 26, 27

Salarias caudofasciatus Regan, 1909, Proc. Zool. Soc. London, p. 405 [Christmas Island, Indian Ocean].

Salarias rarotongensis Whitley, 1965, Australian Zool., vol. 13, no. 2, p. 118 [Rarotonga, Cook Islands].

Description.—Segmented dorsal fin rays 14–16 (table 63); segmented anal fin rays 15–17 (table 63); posteriormost anal pterygiophore supporting 1 or 2 external elements (supporting 2 in 67–100 percent of specimens depending on population); total gill-rakers on first arch 13–18 (table 63); pseudobranchial filaments 5–8 (usually 6 or 7, number not increasing with increase in SL); vertebrae 33–35 (34 in 93 percent of specimens); supraorbital cirri 1–8, increasing in number with increase in SL (table 64); main or longest supraorbital cirrus with all branches mesially (2 specimens only had 1 branch laterally); nape with 1 cirrus on each side (2 on one side in 1 specimen); predorsal commissural pores 4–25 (number increasing with increase in SL, table 65); preopercular series of pores with all positions with simple pores (4 specimens, of 145 examined, each with 1 pair of pores included in series); lateral line pores terminating on side in area below and between dorsal fin spine 8 and dorsal soft ray 5; ventral margin of upper lip mainly crenulate on lateral thirds, entire to very weakly crenulate on middle third; main (lateral) crenulae usually numbering 7–11 on each side.

Proportional measurements: See tables 3, 4, and 66, and "Discussion."

Males develop fleshy rugose modifications of the skin of the anal spines and anterior first to third anal rays. If one considers males with these modifications to be mature, the smallest mature male examined was 29.6 mm SL (Swains Island). Mature and immature males may occur in the same collection and in these collections immature males may be as much as 14 mm longer than mature males.

Largest specimen examined, a male, 54.8 mm SL (Tongatapu); largest female was approximately 47.8 mm SL (Tongatapu). Males and females occurred with about equal frequency in collections except for the Swains Island collection, in which males greatly outnumbered females. The smallest specimen examined, 17.7 mm, was not an ophioblennius larva. It had a humeral blotch and vomerine teeth but no canine teeth.

TABLE 63.--Frequency distribution of number of segmented dorsal and anal rays and gill-rakers of specimens of *Entomacrodus caudofasciatus* arranged geographically

Locales	Dorsal rays			Anal rays			Gill-rakers					
	14	15	16	15	16	17	13	14	15	16	17	18
Indian Ocean	-	3	-	-	3	-	-	-	-	1	1	-
Poulo Cécir de Mer (S. China Sea)	-	4	-	-	4	-	-	-	-	2	2	-
Philippines	6	7	-	-	8	4	3	4	1	1	-	-
Palaus	-	1	-	1	-	-	-	-	-	1	-	-
Waigeo	-	1	-	-	-	1	-	-	1	-	-	-
New Britain	-	6	-	-	1	5	1	2	2	1	-	-
New Georgia	-	2	-	-	-	2	-	1	-	1	-	-
McKean	-	6	-	-	5	1	1	1	2	1	-	1
Swains	3	28	-	1	30	-	-	4	7	9	3	-
Tutuila	-	1	-	-	-	1	-	-	-	-	-	-
Tau	-	2	1	-	2	1	-	-	3	-	-	-
Tongatapu	-	39	10	-	31	15	2	3	13	14	8	2
Rarotonga	2	6	-	-	7	1	-	1	1	1	-	-
Tahiti	-	1	-	-	-	1	-	1	-	-	-	-
Makatea	-	15	1	-	14	2	-	5	4	6	-	-
Raroia	1	-	-	-	1	-	-	-	1	-	-	-

Color pattern of preserved material.—There are several different types of color pattern found in this species. By and large, these types are associated with geographic destribution, with no two types occurring in the same area. All specimens except those from Rarotonga, Tahiti, Makatea, and Raroia, are characterized by having a dark humeral blotch on the body. The nature of this blotch is more or less characteristic within a given geographic area.

A tentative grouping of specimens on the the basis of similarity of color pattern is as follows:

1. Indian Ocean: A relatively large, dark humeral blotch is present. The bands on the body are relatively well developed. In the holotype of *E. caudofasciatus*, there appear to be pearly white spots in irregular longitudinal rows. There is no dark spotting on the body. There may be present indistinct or irregular dark or dusky stripes or bands on the upper lip.

2. Philippine Islands and the Palaus (pl. 26): A relatively small humeral blotch is present and there is usually present a much smaller and paler secondary humeral mark separated by an immaculate area immediately anterior to the main (largest) humeral blotch. The bands on the body are relatively well developed. There are no white spots on the body (although these might have been present in fresh material), and dark spots, if present, are paler than the humeral blotch and not easily distinguished. Such spots are restricted to the anterior area of the sides. There are no stripes or bands on the upper lip.

3. Waigeo, New Britain, New Georgia (pl. 27): A relatively small dark humeral blotch is present and there may be a secondary mark similar to that described for the Philippine Islands and Palaus specimens. Indications of banding may be present on the body appearing usually as paired blotches along the midlength of the sides. There are no white spots on the body, but there are numerous small dark spots, several of which are equally as dark as the main humeral blotch. There are no stripes or bands on the upper lip.

TABLE 64.--Frequency distribution of number of supraorbital cirri of left eye of specimens of *Entomacrodus caudofasciatus* (all populations combined) arranged by SL classes (in mm)

Classes	Number of cirri								
	1	2	3	4	5	6	7	8	Average
15-19.9	2	3	3	2	-	-	-	-	2.5
20	-	-	2	5	1	-	-	-	3.9
25	-	-	3	8	13	2	-	-	4.5
30	-	-	2	14	11	9	-	-	4.8
35	-	-	-	5	9	8	-	-	5.1
40	-	-	-	3	7	10	1	-	5.4
45	-	-	-	-	2	5	2	1	6.2
50	-	-	-	-	-	2	1	-	6.3

4. Poulo Cécir de Mer, McKean, Swains, Tutuila, Tau, and Tongotapu Islands (pl. 25): A relatively large dark humeral blotch is present; there is no secondary humeral mark. There may be little or no color pattern on the body other than the humeral blotch or there may be faint indications of the body bands, or indications of the body bands and irregular longitudinal rows of pale dusky spots, or only dusky spots. There are occasionally present indistinct or irregular dark or dusky stripes and bands on the upper lip.

5. Tahiti, Makatea, Raroia, and Rarotonga: No humeral dark blotch is present; the only markings in the humeral region are small scattered dusky spots. There are weak to strong indications of the paired body bands but no distinct pale or dark spots. There may be seven dark stripes on the upper lip.

The body bands in the various populations are usually represented only by diffuse pairs of blotches along the midline of the body and the dark humeral blotch (and the secondary humeral mark), which represents the anteriormost pair of bands. The pair of bands frequently found on the caudal peduncle of other members of the *Entomacrodus nigricans* species group is frequently absent.

The head is variably and irregularly marked, usually pale in females, darker in males. Only a few specimens exhibited any indication of a dark spot just posterior to the eye. The underside of the head may be uniformly dusky (usually so in females), may bear broad dusky chevrons separated by pale stripes (some males) or, in some New Britain specimens, may bear faint indications of dark chevrons.

The color pattern types of the fins can be best determined from the plates (25, 26, 27), although the dorsal fins of specimens from Poulo Cécir de Mer appear to be almost uniformly dusky rather than variably dusky as appears in the illustrated specimens. The stripes on the caudal fin increase in number with increase in SL. The anal fin of females is always paler (spines frequently without melanophores) than in males from the same collection. In only one specimen (USNM 200100) was there a dark crescentic mark on the fleshy

TABLE 65.--Frequency distribution of number of predorsal commissural pores of specimens of *Entomacrodus caudofasciatus* (all populations combined) arranged by SL classes (in mm)

Classes	Number of pores																				
	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	25	Average
15-19.9	3	-	4	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.7
20	-	1	1	2	3	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	6.8
25	-	1	1	3	2	3	3	4	4	1	3	1	-	-	-	-	-	-	-	-	9.3
30	-	-	3	1	2	3	5	6	4	3	3	2	2	-	-	-	-	-	-	-	10.0
35	-	-	-	1	2	3	2	4	1	2	2	1	1	-	1	1	2	-	-	-	11.1
40	-	-	-	-	-	1	1	3	2	1	1	4	2	1	1	1	1	2	-	-	13.8
45	-	-	-	-	1	1	-	-	-	1	1	1	-	-	2	-	-	-	2	1	15.5
50	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-	1	-	-	-	14.3

pectoral base although faint indications of such a mark may occur on the pectoral rays of some specimens.

Geographic variation.—Aside from the differences in color pattern discussed above, there appears to be some slight meristic (number of dorsal and anal rays, table 63) and proportional (dorsal spine three, dorsal ray one, and horizontal humeral blotch lengths, table 66) differences which are associated with some of the various color pattern types. Also, specimens from the Philippines, Palaus,

TABLE 66.--Proportional dimensions as percent SL of specimens of *Entomacrodus caudofasciatus* (for meaning of abbreviations see methods section)

Catalog no.	Locale	Sex	SL	HL	OL	OCL	NCL	DS3	DR1	PECL	PELL	CL	HBL
BMNH 1949.11.29.633	Cocos-Keeling Is.	♂	33.0	25.4	7.0	4.5	1.8	11.5	14.8	23.3	16.7	21.7	4.8
BMNH 1949.11.29.634	Cocos-Keeling Is.	♂	38.5	24.2	6.5	4.2	2.3	10.4	14.3	21.3	14.3	22.3	3.9
BMNH 1909.3.4.68[1]	Christmas Is.	♂	43.3	23.3	5.8	5.5	1.6	10.2	13.9	18.9	13.9	22.6	4.6
SU 62000	Viet Nam	♀	33.8	24.2	6.8	3.6	3.0	10.9	13.9	23.4	16.3	23.4	4.1
SU 62000	Viet Nam	♂	40.0	24.0	6.5	6.0	2.2	11.2	15.0	23.8	15.0	22.5	5.0
SU 62000	Viet Nam	♂	45.4	23.6	6.2	6.6	2.9	10.4	14.1	22.2	16.5	22.2	3.3
SU 62000	Viet Nam	♂	51.0	23.9	6.1	7.4	2.0	10.8	15.1	22.0	14.5	23.1	3.7
UW 11373	Philippines	♂	33.1	24.2	6.0	4.5	2.7	9.7	11.2	21.2	14.5	21.7	3.3
SU 32303	Philippines	♀	33.2	23.5	6.6	3.6	1.8	9.0	12.0	23.2	-	24.1	2.4
SU 32303	Philippines	♂	35.0	24.3	6.3	5.1	2.3	10.9	13.7	20.3	-	22.0	2.9
UW 10320	Philippines	♀	36.8	22.8	6.7	3.3	2.7	9.5	10.9	21.7	14.9	23.4	3.5
UW 10320	Philippines	♂	39.9	23.1	6.5	5.0	2.3	10.8	12.5	22.0	14.8	22.6	4.0
USNM 144704	Solomon Is.	♂	27.0	22.6	8.8	3.7	1.9	9.3	13.0	23.3	16.3	24.1	3.0
USNM 195779	Solomon Is.	♂	28.4	24.6	7.7	5.3	2.8	8.8	11.6	21.5	13.7	22.9	3.5
SU 62070	New Britain	♂	33.5	23.6	6.2	5.6	2.1	8.4	11.9	20.6	13.1	21.5	2.7
SU 62070	New Britain	♀	34.4	23.2	7.0	3.5	2.9	8.7	12.5	22.1	14.2	22.7	3.5
SU 62070	New Britain	♂	43.0	21.4	6.3	4.6	-	9.3	13.0	20.5	12.8	20.9	2.8
USNM 198592	McKean Is.	♀	29.8	24.2	7.4	4.0	2.7	10.1	11.7	-	15.4	21.1	3.3
USNM 198592	McKean Is.	♂	41.7	22.8	6.0	6.0	2.2	10.6	13.2	21.1	12.7	22.1	4.6
USNM 198592	McKean Is.	♂	48.1	23.1	6.0	5.2	1.2	7.8	12.7	20.6	11.2	22.2	5.0
USNM 150586	Swains Is.	♂	31.5	24.8	6.8	6.2	2.5	11.1	14.6	21.3	15.9	22.8	4.6
USNM 150586	Swains Is.	♂	32.2	24.8	7.8	6.5	3.1	11.2	14.0	21.7	16.5	23.7	5.6
USNM 150586	Swains Is.	♀	33.5	25.1	7.5	3.6	4.2	10.4	14.3	-	17.0	23.0	6.0
USNM 150586	Swains Is.	♂	34.2	24.0	7.6	6.1	2.6	9.6	13.4	-	14.9	21.3	5.0
USNM 150586	Swains Is.	♂	35.2	24.4	7.4	6.5	3.4	11.1	14.5	22.2	15.3	22.2	5.1
USNM 150586	Swains Is.	♂	38.8	23.2	6.3	8.0	2.6	11.3	13.7	21.9	16.0	22.4	5.0
USNM 150586	Swains Is.	♂	38.9	24.7	6.3	8.0	3.0	11.8	14.1	21.8	15.4	21.8	5.5
USNM 150586	Swains Is.	♂	40.3	25.3	6.7	5.2	3.5	9.9	13.1	-	13.6	19.8	5.0
USNM 150586	Swains Is.	♂	41.6	22.8	6.2	6.7	2.4	10.8	13.9	19.5	13.7	20.9	5.3
UH 03085	Tongatapu	♂	53.7	22.9	6.0	6.3	2.6	10.2	14.4	20.3	11.6	22.0	3.4
USNM 199496	Rarotonga	♂	30.4	23.4	7.2	4.9	2.6	9.5	13.8	23.0	16.1	21.7	-
SU 62013	Raroia	♂	37.9	24.3	7.1	5.5	2.9	10.5	13.5	21.4	14.2	20.6	-

[1] Holotype of *Salarias caudofasciatus*

New Georgia, New Britain, and Waigeo may have the midportion of the ventral margin of the upper lip very weakly crenulate. A great deal more material from many localities will be necessary to determine if any of the populations merit naming. The two most obviously distinct groups are the Tahiti-Makatea-Raroia-Rarotonga group, which lacks a humeral blotch, and the New Georgia-New Britain-Waigeo group, which shows the dark-spotted color pattern associated with a high anal ray count, shorter dorsal spine three, shorter dorsal ray one, shorter horizontal humeral blotch length, and, in some specimens, a weakly crenulated midportion of the upper lip ventral margin.

It can be assumed from the population variations noted that there is relatively little dispersal and interbreeding among the various island populations. There is no information available to explain the initial and subsequent factors that distributed this species and then isolated the various populations. Why the South China Sea specimens are similar to the populations much farther to the east in the Pacific, in spite of the presence of the intervening and different Philippine-Palaus populations, requires attention. One would expect the South China Sea populations to have diverged—perhaps most of all—in view of the fact that two (*E. thalassinus* and *E. stellifer*) of the other four species of *Entomcarodus* present in that area are represented by endemic subspecies. Perhaps the South China Sea population of *E. caudofasciatus* has in fact diverged, but along parallel rather than derivative lines, from that population which gave rise to the Pacific populations to which it bears resemblance. One cannot exclude the possibility, however, that the South China Sea and Pacific populations represent a relict distribution or a once more widely distributed form.

Discussion.—The spotted appearance of the body and nature of the upper lip crenulations of the specimens from Waigeo and New Georgia caused Chapman (1951, p. 285) to mistakenly identify these specimens as *E. striatus*. The pattern of spots on the body of *E. striatus* is of an entirely different nature (pls. 7*c*, *d*, 12) than that of these specimens (plate 27, of a New Britain specimen, exhibits the same type spotting as does the New Georgia and Waigeo specimens). When a humeral blotch does occur in specimens of *E. striatus*, it is never so distinct or relatively so large as that of specimens of *E. caudofasciatus*. Specimens of *E. striatus* have a distinct dark spot behind the eye, a mark not found in *E. caudofasciatus* specimens. The gill-raker count of 14–16 in the Waigeo-New Georgia specimens is at the extreme low end of the range for *E. striatus*. In 84 specimens of *E. striatus*, 25.0 to 34.9 mm SL, the predorsal commissural pores ranged from 2 to 6 (only 6 specimens with 5 pores and 1 with 6) while the 3 Waigeo-New Georgia specimens, 27.0 to 29.0 mm SL, had 4, 7, and 9 predorsal commissural pores, generally higher than would be expected for *E. striatus*. All these characters exclude the possibility that the Waigeo-New Georgia specimens belong in *E. striatus*.

Further discussion of the specimens from Tahiti, Raroia, Makatea, and Rarotonga is given in "Relationships" under *E. chiostictus*.

NOMENCLATURE.—*Salarias rarotongensis* was described without comparison. I have examined the holotype and find it a typical specimen of the Tahiti-Makatea-Raroia-Rarotonga populations of *E. caudofasciatus*. Should that group warrant a name, *S. rarotongensis* is the only name available.

RELATIONSHIPS.—*Entomacrodus caudofasciatus* is a member of the *E. nigricans* species group. Of this group *E. caudofasciatus* appears to be most closely related to the Pacific species in generally having a relatively long supraorbital cirrus (distinguishes *E. caudofasciatus* from most Atlantic specimens of *Entomacrodus*) (see also "Relationships" under *E. chiostictus*). *E. caudofasciatus* is distinguished from *E. orneliae* and *E. sealei* and from most specimens of *E. chiostictus* in having only simple pores in the preopercular series (only four specimens of *E. caudofasciatus*, each with one pair of pores in the series, were encountered). The presence of a dark humeral blotch in most populations of *E. caudofasciatus* distinguishes that species from *E. chiostictus* and the Atlantic species, except *E. textilis* (differentiated from the latter species in key couplet 10).

REMARKS.—*E. caudofasciatus* has been collected with or from the same restricted geographic areas as *E. thalassinus*, both subspecies, from which it differs obviously in having crenulae on the ventral margin of the upper lip and, usually, a humeral blotch; *E. decussatus*, from which it differs obviously in the disposition of the upper lip crenulae and in having usually fewer dorsal and anal rays, gill-rakers, pseudobranchial filaments, and in having a humeral blotch; *E. striatus* (for differences, see "Discussion" above); *E. cymatobiotus*, from which it usually differs obviously in the disposition of the upper lip crenulae, in modal number of dorsal and anal rays, and in having a humeral blotch; *E. rofeni*, from which it differs obviously in the disposition of the upper lip crenulae and in having a humeral blotch and usually fewer vertebrae and dorsal and anal rays, and more predorsal commissural pores; and *E. epalzeocheilus*, from which it differs obviously in the disposition of the upper lip crenulae and in having fewer nuchal cirri, pores before the anterior nostril, gill-rakers, pseudobranchial filaments, and in having simple preopercular pores.

DISTRIBUTION (fig. 9).—*Entomacrodus caudofasciatus* is known from the islands of the mideastern Indian Ocean, the South China Sea, Zulu Sea, and the tropical western Pacific from the Palaus to Raroia.

MATERIAL.—INDIAN OCEAN: Christmas Island: BMNH 1909.3.4.68 (holotype of *Salarias caudofasciatus*); Cocos-Keeling Island: BMNH 1949.11.29.633–634.

SOUTH CHINA SEA: Poulo Cécir de Mer: SU 62000; Zulu Sea, Philippines, Nusugbu: SU 32303; Duamaguete: SU 14730, UW 10320, 11373.

PACIFIC OCEAN: Palau Islands, 8 miles north of Koror: SU 62050; Waigeo: SU 28082; New Britain: SU 62070, USNM 200100, 200101; New Georgia: USNM 144704, 195779; McKean Island: USNM 198592; Swains Island: USNM 150586; Tutuila: USNM 179899; Tau Island: USNM 115476; Tongatapu: UH 03085; Rarotonga: AM IA5358 (holotype of *Salarias rarotongensis*), USNM 199496; Tahiti: ANSP 89164; Raroia: SU 62013; Makatea: USNM 200281.

Entomacrodus thalassinus (Jordan and Seale)

(For synonymy, see subspecies)

DESCRIPTION.—Segmented dorsal fin rays 13–15 (table 67); segmented anal fin rays (15–17); posteriormost anal pterygiophore supporting 1 or 2 external elements (2 in 86 percent of specimens of *E. t. thalassinus* and 54 percent of *E. t. longicirrus*); total gill-rakers on first arch 9–18 (11–13 in 84 percent of specimens; only one specimen with 18)[1] pseudobranchial filaments 3–6 (5 in 89 percent of specimens), not increasing in number with increase in SL; vertebrae 33–35 (34 in 90.5 percent of specimens); supraorbital cirri 1–8, number increasing with increase in SL (table 68); supraorbital cirri subequal and arising from a common base, or main or longest cirrus with short branches mesially, rarely 1 or 2 branches laterally; nape with 1 cirrus on each side (frequently missing from one or both sides). Occasionally the cirri appear to be aborted in development; in the figure of the holotype of *E. t. longicirrus* (pl. 29), the left nuchal cirrus is actually missing; the right has been illustrated in its place; predorsal commissural pores 3–17, number increasing with increase in SL (table 69); preopercular series of pores with all positions with simple pores; 1 pore before each anterior nostril; lateral line pores terminating on side in area below and between dorsal fin spines 8 and 13; ventral margin of upper lip entire (no crenulations).

Proportional measurements: See tables 3, 4, and 70, and fig. 11.

Males develop fleshy rugose modifications of the skin of the anal spines and the first to third anal rays (see Schultz and Chapman, 1960, pl. 115E). If one considers males with these modifications to be mature, the smallest mature male examined was 24.3 mm SL. Mature and immature males may occur in the same collection and in these collections immature males may be as much as 7.9 mm longer than mature males.

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[1] Gill-rakers in this species are sometimes difficult to count because they may merge dorsally in a continuous line (arch) with rakers associated with the pseudobranchial filaments. Under these circumstances the dorsalmost gill-raker of the first arch is usually abruptly larger than the adjacent raker of the pseudobranchiae.

The largest specimen of *E. t. thalassinus* examined was a male, 39.7 mm SL; the largest female was 34.4 mm. Males were relatively common over 35.0 mm, but females occurred rarely at sizes larger than 28.0 mm. In general, males were more numerous than females in collections. The smallest nonophioblennius stage was 13.4 mm SL and the largest ophioblennius larva was 13.7 mm. The larvae had five anterior canines, two directed posterolaterally on each side of the lower jaw and one directed posteriorly at the symphysis of that jaw. There were no posterior canines in specimens below 14.1 mm, but vomerine teeth were visible in nonlarvae 13.4 mm. Head cirri were well developed in a larva 13.7 mm.

There was no apparent sexual dimorphism of meristic characters among specimens of *E. t. thalassinus*.

The largest specimen of *E. t. longicirrus* examined was a male, 49.7 mm; the largest female was 39.0 mm. Males are common at lengths over 40.0 mm; below this size the sexes occur with relatively equal frequency. In general, males were much more numerous than females in collections. The smallest specimen examined, 18.5 mm, was not an ophioblennius larva.

Males tend to have a higher average number of segmented dorsal rays than females. Of 44 males examined, 4 had 13 rays, 38 had 14 rays, and 2 had 15 rays. Of 40 females examined, 15 had 13 rays, 23

TABLE 67.--Frequency distribution of number of segmented dorsal and anal fin rays and vertebrae of specimens of subspecies of *Entomacrodus thalassinus* arranged geographically

Subspecies	Dorsal rays			Anal rays			Vertebrae		
	13	14	15	15	16	17	33	34	35
longicirrus	-	-	-	-	-	-	6	20	2
Thailand	19	48	4	21	45	5	-	-	-
Viet Nam	1	11	-	3	9	-	-	-	-
Hong Kong	-	3	-	-	3	-	-	-	-
thalassinus	-	-	-	-	-	-	-	41	4
Seychelles Is.	9	61	5	19	49	1	-	-	-
Riu Kiu Is.	-	1	-	-	1	-	-	-	-
Marianas Is.	1	5	5	-	6	5	-	-	-
Ifaluk	1	15	2	2	14	1	-	-	-
Kapingamarangi	1	1	-	-	2	-	-	-	-
Marshall Is.	4	14	1	4	15	-	-	-	-
Phoenix Is.	7	49	1	5	51	1	-	-	-
Jarvis	-	9	-	-	9	-	-	-	-
Malden	5	40	4	7	39	3	-	-	-
Samoa	1	13	2	1	13	1	-	-	-
Raroia	6	37	-	7	35	1	-	-	-

had 14 rays, and 2 had 15 rays. I noted no other sexual dimorphism of meristic characters.

Color pattern of preserved specimens.—*E. t. thalassinus:* The body is uniformly pale, or pale with a single concentrated spot of melanophores midlaterally, or pale with scattered sprinklings of melanophores, some of which may be concentrated into a few midlateral blotches (see: Jordan and Seale, 1906, fig. 106; Schultz and Chapman, 1960, pl. 115D). In freshly preserved specimens there is evidence of a number of vertical orange bands on the body (pl. 28: pattern indicated on body). These bands fade completely in alcohol. Specimens of less than 16 mm SL from Raroia exhibited four types of body coloration: (1) completely pale; (2) a loose concentration of melanophores at the caudal base; (3) a loose concentration of melanophores midlaterally; and (4) a loose concentration of melanophores midlaterally and at the caudal base. The head is pale with a dark spot behind the eye, sprinklings of melanophores on the upper lip and snout, and a concentration of melanophores on the ventral surface, which in mature males forms a noticeable blotch (see Schultz and Chapman, 1960, pl. 115E). The fins are essentially as described for *E. t. longicirrus* (see below), but the dark spots and stripes are smaller (on the caudal fin they may be completely absent).

E. t. longicirrus: Specimens exhibit more markings on the body, in general, than do specimens of the other subspecies. The body

TABLE 68.--Frequency distribution of number of supraorbital cirri of left eye of specimens of subspecies of *Entomacrodus thalassinus* arranged by SL classes (in mm)

Subspecies	Classes	Number of cirri 1	2	3	4	5	6	7	8	Average
thalassinus	10-14.9	1	-	-	-	-	-	-	-	1.0
thalassinus	15	3	24	13	2	-	-	-	-	2.3
longicirrus		-	1	-	1	-	-	-	-	3.0
thalassinus	20	-	12	31	23	3	-	-	-	3.2
longicirrus		-	-	1	1	1	-	-	-	4.0
thalassinus	25	1	8	50	31	5	3	-	-	3.2
longicirrus		-	-	9	6	10	1	-	-	4.1
thalassinus	30	1	2	17	16	6	2	-	-	3.7
longicirrus		-	-	-	11	9	1	1	-	4.6
thalassinus	35	-	-	3	7	-	2	-	-	4.1
longicirrus		1	-	3	5	3	3	2	1	4.7
longicirrus	40	-	1	2	2	3	1	1	-	4.4
longicirrus	45	-	-	1	-	2	-	-	-	4.3

markings are irregular and highly variable but there are usually present indications of three or four pairs of dark vertical bands in the region below the dorsal fin and between the posterior dorsal spines and the last dorsal ray. The bands may be absent or represented only as pairs of midlateral dark spots; the members of one or more pairs may be fused. Females frequently have more distinct banding than males. In females the bands may be complete and almost uniformly dark, or darker in their midportions, and extend from the dorsal to the ventral body contour. The sides and venter are everywhere marked with splashes of melanophores giving the specimens a smudged appearance. Specimens of less than 25 mm SL exhibit few or no markings on the body. The head always bears a dark spot just behind the eye; in females a secondary, usually paler, spot follows the first and is sometimes linked ventrally to it, giving the appearance of a U. The head is variably splashed with melanophores; the upper lip is irregularly marked but may show adumbrations of about eight dusky bands and eight pale stripes. The underside of the head is splotched and dusky, frequently with a large noticeable concentrated area of melanophores.

The spinous dorsal bears various dark and pale spots, which may be regularly or irregularly distributed. There is a pale distal band along the length of the spinous dorsal. The fin is darker in males than in females from the same collection. The soft dorsal bears one to four dusky spots over each ray with scattered, paler, dusky markings on the fin membrane basally. Distally the soft dorsal has a broad, pale to

TABLE 69.--Frequency distribution of number of predorsal commissural pores of specimens of subspecies of *Entomacrodus thalassinus* arranged by SL classes (in mm)

Subspecies	Classes	Number of pores 3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Avg.
thalassinus	10-14.9	2	1	1	2	1	-	1	-	-	-	-	-	-	-	-	5.3
thalassinus	15	-	-	4	5	6	12	11	6	3	1	-	1	-	-	-	8.3
longicirrus		-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	8.0
thalassinus	20	-	-	-	2	5	12	16	12	10	5	2	-	1	1	-	9.6
longicirrus		-	-	-	-	-	1	1	1	-	-	-	-	-	-	-	9.0
thalassinus	25	-	-	3	5	10	17	18	16	11	7	6	-	-	-	2	9.4
longicirrus		-	-	1	-	1	2	9	6	2	4	-	1	1	-	-	9.9
thalassinus	30	1	-	-	4	7	8	6	6	6	2	3	1	-	-	-	9.0
longicirrus		-	-	-	1	1	2	7	3	2	1	2	-	1	1	-	10.1
thalassinus	35	-	-	-	1	1	3	2	2	2	1	-	-	1	-	-	9.5
longicirrus		-	-	-	-	-	2	4	2	3	1	1	2	1	1	1	11.4
longicirrus	40	-	-	-	-	-	4	2	-	1	1	-	1	-	1	-	10.3
longicirrus	45	-	-	-	-	-	-	-	1	1	-	1	-	-	-	-	11.3

dusky margin. The anal fin is variably dusky, frequently with dusky spots posteriorly (especially obvious in females). The tips of the anal rays are frequently much paler than the distal portions of the inter-radial membrane. The pectoral fin and its fleshy base are splashed with melanophores; there are no dark crescentic marks on either.

TABLE 70.--Proportional dimensions as percent SL of specimens of subspecies of *Entomacrodus thalassinus* (for meaning of abbreviations see methods section)

Catalog no.	Locale	Sex	SL	HL	OL	OCL	NCL	DS3	DR1	PECL	PELL	CL
longicirrus												
SU 63345	Thailand	♂	29.8	22.4	6.7	6.7	<1.7	11.4	13.4	22.1	15.1	21.8
SU 63345	Thailand	♀	31.6	24.0	6.6	6.0	1.6	10.1	12.3	23.4	16.4	20.6
SU 63345	Thailand	♀	34.5	23.7	6.4	4.9	1.4	9.6	13.0	21.2	13.9	20.6
SU 63345	Thailand	♂	35.4	22.9	6.8	8.5	<1.1	11.0	14.4	22.0	15.0	21.8
SU 63345	Thailand	♂	35.7	23.2	6.4	7.3	-	9.5	12.6	19.6	13.2	20.7
SU 63345	Thailand	♀	37.5	22.4	6.7	4.5	1.3	9.6	12.2	21.3	14.1	19.7
USNM 199480	Thailand	♀	38.0	23.7	6.1	4.2	1.8	9.7	13.2	21.6	-	19.5
SU 62089[1]	Thailand	♂	40.7	23.3	5.4	7.6	<1.2	10.3	12.8	20.9	13.3	21.1
SU 63345	Thailand	♂	43.6	21.8	5.7	6.6	1.1	9.2	12.6	19.5	13.1	20.2
SU 63345	Thailand	♂	49.7	22.2	5.4	6.2	<1.0	9.5	10.0	20.1	13.7	21.6
thalassinus												
USNM 115478	Tutuila	♂	20.0	26.0	8.0	3.0	2.0	12.0	13.0	-	-	23.0
USNM 115478	Tutuila	♀	21.2	26.4	7.5	4.7	1.9	11.3	13.2	23.6	17.0	20.8
SU 8693	Samoa	♀	22.5	24.9	8.0	3.1	-	11.1	13.3	22.2	-	21.3
SU 62032	Ifaluk	♂	24.4	23.8	7.4	3.3	<2.0	11.5	12.3	21.7	-	21.3
USNM 51790[2]	Samoa	♀	25.7	24.1	7.4	2.7	<1.9	10.5	12.1	19.4	-	19.4
USNM 115478[3]	Tutuila	♀♂	26.3	25.1	7.2	3.8	2.3	11.4	12.9	21.3	17.1	19.8
USNM 115478	Tutuila	♂	26.8	26.1	7.5	4.1	1.1	10.8	14.2	-	16.0	22.0
USNM 115478	Tutuila	♂	27.7	25.2	7.2	4.0	2.9	10.5	15.2	21.6	15.5	19.9
SU 62081	Saipan	♂	27.8	21.9	6.8	3.6	<1.8	10.1	12.6	18.0	-	20.1
SU 62076	Saipan	♂	32.2	22.0	5.6	3.7	<1.6	9.3	9.9	18.6	-	19.2
USNM 124193	Guam	♂	32.9	22.2	6.2	3.0	<1.5	10.0	11.2	16.7	12.2	18.5
SU 62076	Saipan	♂	33.1	24.2	6.3	3.0	-	11.5	12.7	18.4	-	20.8
SU 51795[4]	Samoa	♂	33.4	22.8	6.0	3.0	1.5	9.9	12.0	17.4	12.0	18.3
USNM 198591	McKean	♂	36.2	21.6	5.0	2.5	<1.0	9.4	13.0	20.2	12.4	20.2
USNM 124193	Guam	♂	37.5	21.8	5.3	-	-	-	12.2	-	-	18.9
USNM 198652	Jarvis	♂	39.7	21.4	5.3	2.5	-	8.6	12.1	19.6	12.1	21.4

[1] Holotype of *Entomacrodus thalassinus longicirrus*
[2] Holotype of *Alticus musilae*
[3] Hermaphrodite
[4] Holotype of *Alticus thalassinus*

228-965 O - 67 - 10

The pelvic fin is uniformly pale dusky. The caudal fin bears up to nine dark stripes composed of regularly arranged spots appearing over the caudal rays; the number of stripes increases with size.

RELATIONSHIPS.—*Entomacrodus thalassinus* is most closely related to *E. macrospilus*. (For differentiation, see "Relationships" under *E. macrospilus*.)

REMARKS.—*Entomacrodus thalassinus* has been collected with or from the same restricted geographic locality as *E. stellifer* (both subspecies), *E. decussatus*, *E. vermiculatus*, *E. niuafoouensis*, *E. epalzeocheilus*, *E. cymatobiotus*, *E. striatus*, *E. rofeni*, *E. sealei*, and *E. caudofasciatus*.

For geographic distribution, discussion, and material, see subspecies accounts.

Entomacrodus thalassinus thalassinus (Jordan and Seale)

PLATE 28

(For differentiation, see *E. t. longicirrus*)

Alticus thalassinus Jordan and Seale, 1906, U. S. Bur. Fish. Bull. 25 (1905), p. 425 [Apia, Samoa].

Alticus musilae Jordan and Seale, 1906, U. S. Bur. Fish. Bull. 25 (1905), pp. 425–426 [Apia, Samoa].

Salarias lacunicola Fowler, 1948, Proc. Acad. Nat. Sci. Philadelphia, vol. 98, p. 178 [Agu-Shima, Ryukyu Islands].

NOMENCLATURE.—*Alticus thalassinus* and *Alticus musilae* were described in the same paper and were not differentiated from each other. The former is based on a male and the latter, a female of the same species. *Salarias lacunicola* was described without comparison with other species. The noncrenulated ventral margin of the upper lip, presence of vomerine teeth, color pattern, short supraorbital cirrus and low gill-raker and fin ray counts are sufficient to synonymize these three nominal forms. Of the two described together, *A. thalassinus* appeared first in the paper and is the name in most common usage. Since the original description, *A. musilae* has been considered a synonym of one species or another of *Entomacrodus*. Schultz (1943) first placed *A. musilae* in synonymy with *A. thalassinus*. Schultz and Chapman (1960, p. 343) synonymized *S. lacunicola* with *E. niuafoouensis* but gave no reasons for their action. *Entomacrodus niuafoouensis* differs in many ways from *E. t. thalassinus*, but it is sufficient to mention here that *E. niuafoouensis* has a crenulated ventral margin of the upper lip, pairs or multiples of pores included in the preopercular series of pores, and more than one pore before each anterior nostril.

Distribution (fig. 10).—*Entomacrodus t. thalassinus* is an island form known from the Seychelles, Indian Ocean, and in the Pacific Ocean from the Ryukyus to Raroia. Collection data indicate that this subspecies occurs on the outer (ocean) sides of reefs along surge or open channels.

Material.—indian ocean: Seychelle Islands: ANSP 102184, 102185.

pacific ocean: Ryukyu Islands: ANSP 72049 (holotype of *S. lacunicola*); Marianas Islands, Guam: USNM 124193; Saipan: USNM 149914, SU 62076, 62081; Caroline Islands, Ifaluk: SU 62026, 62032, 62034, 62036, 62045, 62046; Marshall Islands, Bikini: USNM 142184, 142185, 142190; Eniwetok: USNM 142186, 142187; Kapingamarangi: SU 62028, 62040; Phoenix Islands, Howland: USNM 179904; Enderbury: USNM 115480, 197908; Hull: USNM 115477, 116173; McKean: USNM 198591; Jarvis Island: USNM 198652; Malden Island: USNM 199458; Samoan Islands, Tutuila: USNM 115478; Samoa: SU 8693, USNM 51795 (holotype of *A. thalassinus*), USNM 51790 (includes holotype of *A. musilae*); Swains Island: USNM 115479; Tuamotus, Raroia: SU 62010, 62015, 62018, 62020, 62024, 62025.

Entomacrodus thalassinus longicirrus, new subspecies

Plate 29

Discussion.—*E. t. longicirrus* differs from *E. t. thalassinus* primarily in having a much longer supraorbital cirrus (fig. 11). There are minor differences in color pattern, which are manifested in *E. t. longicirrus* having more melanic pigment. The new subspecies appears to attain a larger size than the nominal subspecies.

Distribution (fig. 10).—*E. t. longicirrus* is an island form restricted to the South China Sea and its extension, the Gulf of Thailand. This area is more or less enclosed by a chain of closely approximated islands extending from Taiwan to Sumatra (see "Distribution" under the nominal subspecies). A South China Sea endemic subspecies is also indicated for *E. stellifer*.

Holotype.—SU 62089, a mature male, 40.7 mm SL, shore reef region on east side at Goh Kram Island, east side Gulf of Thailand, 12°41′33″N, 100°48′28″E, Oct. 25, 1957, collected by R. R. Rofen.

Paratypes.—SU 63345, 45 specimens, and USNM 199480, 10 specimens, all with same data as holotype. SU 62001, 10 specimens, South China Sea, Ilot du Sud, 10°29′15″N, 108°57′30″E; SU 62092, 4 specimens, Gulf of Thailand, Go Samet Island, 12°31′15″N, 101°26′45″E; SU 62009, 1 specimen, Gulf of Thailand, rocky shore reef in Ao Mae Hat Bay, Goh Tao Island; SU 62048, 12 specimens, Viet Nam, neighborhood of Nahtrang, Binchang Bay, 12°21′40″N, 109°15′38″E; USNM 197978, 3 specimens, Hong Kong, Shelter Island.

Etymology.—From Latin, "longi" (long) + "cirrus" (a curl) refers to the distinguishing characteristic of a long supraorbital cirrus.

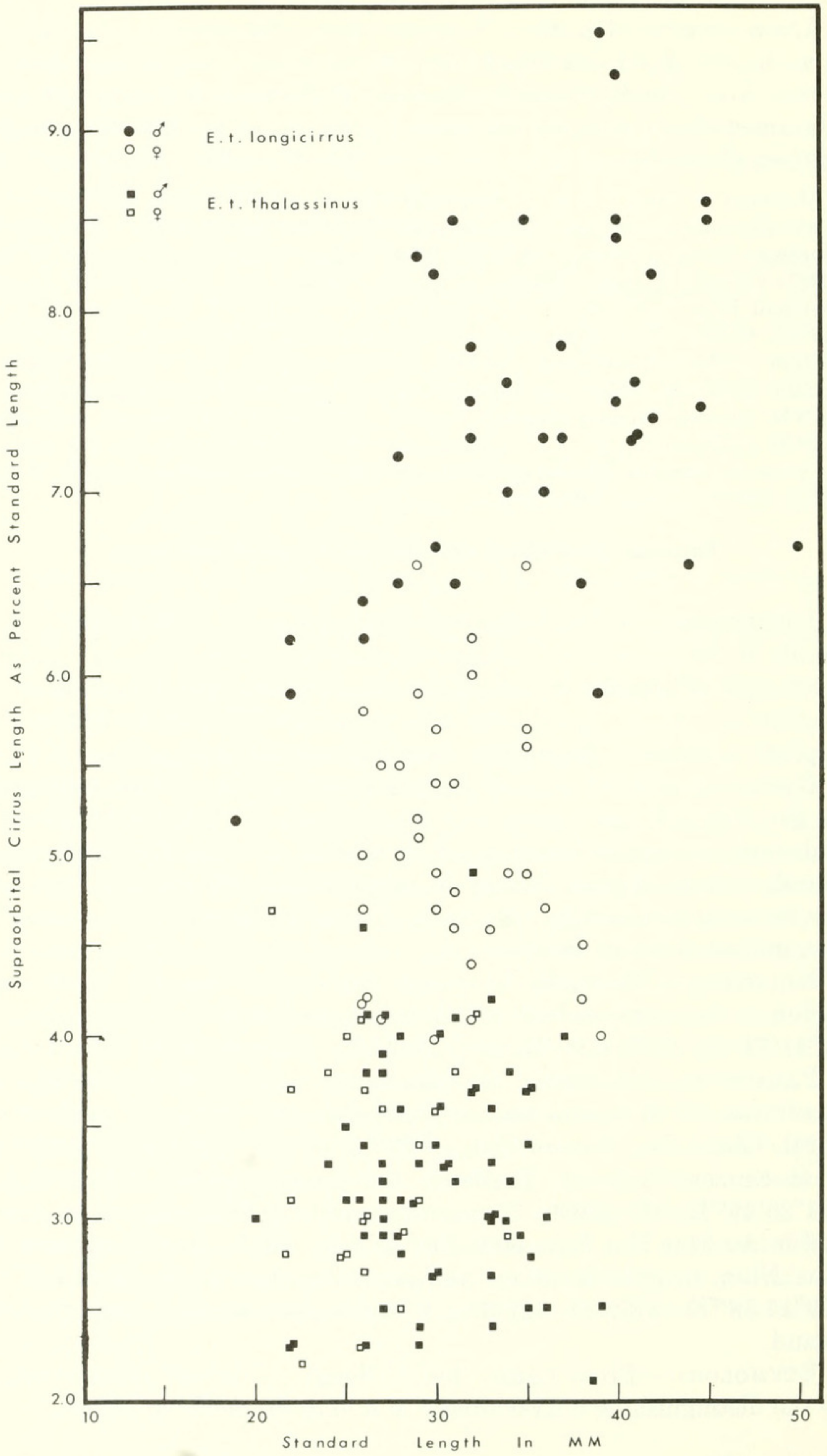

FIGURE 11.—Graphical comparison of supraorbital cirri lengths in subspecies of *Entomacrodus thalassinus*.

Entomacrodus macrospilus, new species

PLATE 30

DESCRIPTION.—(Character for holotype in parentheses.) Segmented dorsal fin rays 15 or 16 (16); segmented anal rays 17 or 18 (18); posteriormost anal pterygiophore supporting 1 or 2 external elements (2); total gill-rakers on first arch 13 or 14; pseudobranchial filaments 5; vertebrae 35 or 36 (35); 1 supraorbital cirrus on each eye; nape without cirri; predorsal commissural pores 9–18 (13) (too few specimens available to determine if pore number increases with increase in size); preopercular series of pores with all positions with simple pores; 1 pore before each anterior nostril; lateral line pores terminating on side in area below and between dorsal spines 10 and 11 (10); ventral margin of upper lip entire (without crenulations).

Proportional measurements (as percent SL, except as noted; only the holotype was in sufficiently good condition to afford measurement; for abbreviations, see "Methods"): SL 18.7, HL 24.6, OL 8.0, OCL 5.3, DS3 10.2, DR1 10.7, PECL 21.4, PELL 14.4, CL 18.2.

No mature males were recognizable. The largest specimen was a male, approximately 21.9 mm SL; the smallest, a male, approximately 14.0 mm SL, was not an ophioblennius stage.

COLOR PATTERN.—The color pattern is best discerned from plate 30, the holotype. The paratypes are essentially similar except that the smallest specimen lacked the large dark spot on the head.

RELATIONSHIPS.—*Entomacrodus macrospilus* is a member of the *E. thalassinus* species group. It differs from *E. thalassinus*, the only other member, in having higher average dorsal ray, anal ray, and vertebral counts; in having a single cirrus above each eye (apparently constant with size), and in having on the head a large dark spot that does not encroach on the circumorbital pores.

The Marquesas Islands, only locality from where *E. macrospilus* is known (fig. 10), are probably of more recent origin than the low Tuamotus, nearest island group to the Marquesas. As *E. thalassinus* is widely distributed in the central Pacific and occurs in the Tuamotus, it seems possible that *E. macrospilus* is a derivative of *E. thalassinus*.

REMARKS.—*Entomacrodus macrospilus* has been collected with *E. corneliae* and *E. randalli*, both endemic to the Marquesas. *E. macrospilus* differs most prominently from both these species in having only simple pores in the preopercular series, no crenulae on the upper lip, no nuchal cirri, and probably more predorsal commissural pores at comparable sizes.

HOLOTYPE.—USNM 200279, an immature male, 18.7 mm SL, from east side of Anaho Bay, near cliffs at shore, coll. J. E. Randall, July 17, 1957.

PARATYPES.—USNM 200280, five specimens about 14.0 to about 21.9 mm SL, collected with holotype.

ETYMOLOGY.—The specific name, *macrospilus*, means "large spot," and refers to the head spot characteristic of this species.

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