

NOAA Technical Report NMFS Circular 404

Revision of the Sea Basses
of the Genus *Diplectrum*
(Pisces: Serranidae)



Stephen A. Bortone

September 1977



U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
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ABSTRACT

Twelve species of *Diplectrum* are recognized: three western Atlantic (*D. formosum*, *D. bivittatum*, and *D. radiale*) and nine eastern Pacific species (*D. pacificum*, *D. conceptione*, *D. maximum*, *D. rostrum*, *D. labarum*, *D. eumelum*, *D. sciurus*, *D. macropoma*, and *D. euryplectrum*). All species are hermaphroditic and possess an ovarian sinus in the posteriormost gonadal area. *Diplectrum* osteological characters aid in defining the genus and in comparing its taxonomic status with *Serranus*. Definitions of the Serraninae and Serranidae are modified as a result of *Diplectrum* osteological characters. The genus is basically restricted to the warm tropical-subtropical coastal areas of the new world. *Diplectrum bivittatum*, however, often occurs at insular localities, and *D. conceptione* occurs in colder, temperate Peruvian waters. *Diplectrum formosum* is considered to have a northern subspecies, *D. f. formosum*, and a southern form, *D. f. radians*; *D. bivittatum* is also composed of two subspecies: *D. b. bivittatum* from South American and Caribbean areas and *D. b. arcuarium* from the Gulf of Mexico. An intermediate population occurs in the vicinity of southern Florida. *Diplectrum radiale* and *D. pacificum* are "geminate species" and similar morphologically. *Diplectrum mexicanum* is considered a junior synonym of *D. macropoma*.

INTRODUCTION

The genus *Diplectrum* is composed of nine Pacific (Rosenblatt and Johnson 1974) and three Atlantic species distributed in the tropical-subtropical areas of the Western Hemisphere. The species are colorful sea basses which bear an enlarged preopercle. All species thus far examined are considered to be synchronous hermaphrodites. Because of their small size (usually less than 300 mm) they are presently of little commercial importance, yet as they are abundant at some localities they may have potential as a food or industrial protein resource. Considerable confusion occurs in the literature because the genus has never been adequately defined. Species recognition has been difficult owing to inaccurate literature accounts and mislabeled museum material. Robins and Starck (1961) performed a preliminary investigation on the genus *Serranus*. This was the first major step in clarifying the subfamily Serraninae since the revision of the Serranidae by Jordan and Eigenmann (1890). Revisions of such genera will allow ichthyologists to begin assembling our knowledge and permit a system of order in the Serranidae (Smith 1971).

Herein is presented a systematic revision of the genus *Diplectrum*. The purposes of this paper are to define the genus, to make a preliminary evaluation of the status of the genus among the Serraninae, to describe the species recognized as associated with the genus, and to summarize our current knowledge of the life history and zoogeography of the species.

MATERIALS AND METHODS

Under the subsections entitled "Specimens examined" the following institutional abbreviations are used: BMNH, British Museum (Natural History); CAS, California Academy of Sciences; FMNH, Field Museum of Natural History; FSBC, Florida Department of Natural Resources; FSM, Florida State Museum; FSU, Florida State University; GCRL, Gulf Coast Research Laboratory; GMBL, Grice Marine Biological Laboratory; INP, Instituto Nacional de Pesca, Mexico; LACM, Los Angeles County Museum; MCZ, Museum of Comparative Zoology; MNHN, Museum National d'Historie Naturelle; MZUSP, Museu de Zoologia da Universidade de São Paulo; RMNH, Rijksmuseum van Natuurlijke Historie; SIO, Scripps Institution of Oceanography; SOSC, Smithsonian Oceanographic Sorting Center; TABL, Tropical Atlantic Biological Laboratory; UA, University of Arizona; UCLA, University of California at Los Angeles; UCR, Universidad de Costa Rica; UMML, Rosenstiel School of Marine and Atmospheric Sciences, University of Miami; UNC, University of North Carolina, Institute of Marine Sciences; UPR, University of Puerto Rico; USNM, National Museum of Natural History, Washington, D.C.; UTMSI, University of Texas, Marine Sciences Institute; UW, University of Washington.

When complete information is available for specimens examined, the abbreviation for the museum is followed by its museum catalog number, followed by a comma, the number of specimens in the lot, and the range of standard length in millimeters in parentheses. Type material is labeled holotype, paratype, lectotype, or paralectotype immediately after the catalog number.

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Uncataloged museum specimens are referred to by field numbers, cruise numbers, or other field data in place of catalog numbers.

All measurements were made with dial calipers and recorded to 0.1 mm, except standard, total, and fork lengths greater than 100 mm which were recorded to the nearest millimeter. Counts and measurements were made and recorded according to the methods of Hubbs and Lagler (1964) with the following additions and modifications: counts for cheek scale rows A, from the posteroventral angle of the eye downward and posteriorly toward the lower preopercular angle; counts for cheek scale rows B, from the posterior serrated upper arm of the preopercle downward and anteriorly to the distal corner of the maxillary (Ginsburg 1948); predorsal scale rows, immediately below the predorsal midline from the base of the first dorsal spine forward; gill rakers, counted on the left anteriormost arch and include all rudiments of gill rakers and tubercles; preopercular spur spines, counted between the upper and lower outside angles of the preopercular spur; only rays of the left pectoral fin were counted; all pseudobranch filaments were counted on the left side; interorbital width, as the least fleshy width of the interorbital area; cheek length, from the distal maxillary edge to the nearest border of the vertical preopercular arm; maxillary width, at the broadest part of the distal maxillary area; lacrimal width, from the anteroventral corner of the eye to the nearest anteroventral lacrimal edge; orbit width, the least distance between fleshy edges; lower jaw length, the length of mandible; pelvic origin to anus, distance from anterior pelvic fin base to base of anal spine; postanal length, from the anterior anal spine base posteriorly to the center of the hypural base.

Standard length (SL) is given in millimeters but all other measurements are presented in thousandths of SL. Data in the species accounts are presented in the following manner: character and mean value, followed in parentheses by standard deviation, range, and number of specimens. For meristic characters, the standard deviation and number of specimens are not included in the description but are found in the appropriate tables. Proportional measurements are presented only for specimens larger than 75 mm SL. Counts for meristic characters are presented for all fishes regardless of standard length.

Color descriptions were taken from live and/or preserved specimens and are indicated as such.

Osteological terminology generally follows that of Smith (1971), Monod (1968), and McAllister (1968), and the abbreviations used are as follows: AR, articular; B, branchiostegals; BB, 1-3, basibranchials; BO, basioccipital; BS, basisphenoid; CB, 1-5, ceratobranchials; CH, ceratohyal; CL, cleithrum; COR, coracoid; CP, 1-4, pre-ural centrum; E, 1-3, epurals; ECT, ectopterygoid; EH, epihyal; END, endopterygoid; EPO, epiotic; EXO, exoccipital; FR, frontal; H, hyoid; H', I-V, hypurals; HA, haemal arch; HB, 1-3, hypobranchials; HS, haemal spine; GH, glossohyal; IC, intercalar; LAC, lacrimal; LE, lateral ethmoid; LH, lower hypohyal; MET, metaptery-

goid; PA, parietal; PAL, palatine; PAS, parasphenoid; PH, parhypurals; PRO, prootic; PT, posttemporal; PTO, pterotic; PTS, pterosphenoïd; QU, quadrate; R, radial; RA, retroarticular; SC, scapula; SCL, supracleithrum; SE, supraethmoid; SO, supraoccipital; SS, subocular shelf; ST, stegural; SYM, symplectic; UH, upper hypohyal; V, vomer.

Osteological examination was conducted from radiographs on skeletons prepared by maceration, cleaning by dermestid beetles, soaking in ammonium hydroxide (Konnerth 1965), or staining with alizarin and clearing with trypsin. The method employed for clearing and staining was the procedure of Taylor (1967) but modified in that the staining was performed prior to clearing. Vertebral counts were separated into precaudal and caudal by a plus sign. Method for counting dorsal fin supports followed that of Smith and Bailey (1961).

Specimens examined osteologically

- Diplectrum formosum*. North Carolina: Uncat., 17 (42-210). Florida Gulf: LACM 33307-1, 1 (205); LACM 33306-1, 1 (228); LACM 33306-3, 1 (210); LACM 33306-2, 1 (210); LACM 33308-1, 1 (164); Uncat., 3 (ad.).
- D. bivittatum*. Cuba: USNM 110282, 1 (ad). Florida: Uncat., 1 (103). Texas: Uncat., 1 (ad). Honduras: TABL 105156, 1 (91); TABL 105160, 1 (85). Panama: Uncat., 1 (juv). Colombia: UMML 15397, 1 (75).
- D. pacificum*. Mexico: SIO 65-164, 1 (69). Panama: Uncat., 4 (117-207); Uncat., 1 (juv).
- D. macropoma*. Panama: Uncat., 2 (115-117); UMML 26246, 2 (74-84); UMML 25075, 1 (62); UMML 25094, 2 (50-61).
- D. rostrum*. Bahia de Banderas, Mexico: SIO 65-160, 6 (61-105).
- D. conceptione*. Peru: USNM 213578 and 211385, 3 (89-100).
- D. maximum*. Baja California: SIO 62-106, 1 (juv.).
- D. sciurus*. Gulf of California: SIO 70-70, 1 (109); USNM 46571, 1 (paralectotype).
- D. euryplectrum*. Costa Rica: Uncat., 5 (122-139). Panama: UMML 26244, 2 (60-73).
- D. labarum*. Golfo de Tehautepec, Mexico: SIO 63-524, 4 (juv.).
- D. eumelum*. Costa Rica: Uncat., 2 (209-228). Colombia: USNM 211393, 2 (74-88).
- Serranus phoebe*. North Carolina: Uncat., 1 (53). Cuba: USNM 110279, 1. No locality: UMML 638, 2 (ad.).
- S. tabacarius*. Cuba: USNM 26662, 1 (ad.).
- S. tigrinus*. Cuba: USNM 110283, 1 (ad.).
- S. notospilus*. Carolina: Uncat., 3 (juv.).

GENUS *DIPLECTRUM* HOLBROOK 1855

Diplectrum Holbrook 1855:32 (type-species: *Serranus fascicularis* Valenciennes = *Perca formosa* Linnaeus as subsequently designated by Goode and Bean 1886:203).

Diplectron Troschel 1858:24 (improper emendation).

Haliperca Gill 1863:236 (type-species: *Serranus bivittatus* Valenciennes, by monotypy).

Troschel (1858:80) invalidly emended *Diplectrum* as *Diplectron*. This error was later copied by Canestrini (1860:303, 306). Vieillot (1816:50, as cited by Neave 1939:106) had earlier applied *Diplectron* as a genus to the class Aves. Berg (1895:45) wrongly considered the generic names *Diplectrum* and *Diplectron* as homonyms and therefore thought *Diplectrum* (Pisces) to be preoccupied by *Diplectron* (Aves). Berg then applied the generic name *Centropristis* to *formosus* (= *formosum*) because of priority. The generic name *Diplectrum* is to be retained for Pisces under Article 56a of the International Code of Zoological Nomenclature (International Commission of Zoological Nomenclature 1964).

Description.—Small percid fishes, moderately compressed, moderate to slender depth with terminal jaws. Dorsal and ventral body profiles nearly equal. Caudal fin truncate or slightly forked. Upper caudal lobe usually somewhat longer than lower. Upper lobe sometimes extended as elongate filament. Dorsal fin continuous, only slightly indented between spinous and soft dorsal fins. Villiform teeth present in upper and lower jaws. Both jaws also with an outer row of 5-10 small caniniform teeth. Vomer with villiform teeth in wedge- or V-shaped pattern. Palatines with thin elongate band of villiform teeth. Preopercle forms almost right angle between horizontal and vertical limbs. Both limbs serrated entire length (except vertical limb in *D. euryplectrum*). Posterior preopercular angle expanded as spur of varied shape, composed of numerous enlarged spines. Operculum with three spines or projections posteriorly, the middle spine the longest. Posttemporal serrate. Top of cranium smooth. Midline suture of frontal bones flat. Epiotic-parietal-supraoccipital area next to supraoccipital crest nearly flat. Supraoccipital crest short and low, usually with supportive stay close to crest edge paralleling body line. Epiotic posttemporal facet elongate and narrow with a single posterior projection. Parietal "wings" elongate and broad. Epiotic posttemporal facet not delineated medially by a ridge. Parietal ridge present but low, not extending forward upon frontals. Lacrimal broader than distal maxillary tip except in *D. sciurus*. Supramaxillary absent. Pelvic fin origin under, or in advance of, pectoral fin. Branchiostegals 7, vertebrae 10 + 14. Predorsal fin supports weakly developed, with a formula of 0-0-0-2- or 0-0-2-. Dorsal fin formula X, 12. Anal fin formula III, 7 or 8. Pectoral rays 14-19. Snout naked and top of head naked posteriorly to vertical line with upper preopercular arm. Inter- and subopercles naked. Scales ctenoid. Small scales present in rows on some species along rays and spines at anal fin base. Scales absent from dorsal fin. Pored lateral-line scales with distal portion of pore projecting parallel to body midline.

All species are synchronous hermaphrodites. Ovarian

tissue comprises the anterior portion of the gonadal lobes; testicular tissue present posteriorly in a broad band in varied patterns. Posteriorly and ventrally an "ovarian sinus" of possible accessory-gland function occurs.

Color pattern in the genus is varied but basically the snout and cheeks bear spots or lines of yellow, orange, or blue. Dorsal and caudal fins have a combination of orange and blue patterns of spots and stripes; either spots or stripes may be absent. Body is brown dorsally, pale ventrally, lateral body surface is traversed vertically with dark bars and horizontally, with two dark stripes. Portions of this pattern are of varied intensity and distinctness.

The genus is endemic to the western hemisphere and is generally found in continental coastal areas in tropical-subtropical life zones.

OSTEOLOGY

General osteology of *Diplectrum* (Figs. 1-5)

Vomer with a narrow chevron-shaped patch of villiform teeth. Villiform medially and short caniniform teeth laterally present in narrow bands on dentary and premaxillary bones. Glossohyal teeth absent. Villiform teeth present on palatines in a thin elongate patch. Lateral ethmoid with three facets for articulation (see Gosline 1966). Interorbital area narrow. Frontals with deep grooves dorsally leading from anterior edge and terminating in a large elongate midfrontal foramen. Dorsal junction of frontals a broadened surface. Top of cranium smooth, without ridges, area rounded or somewhat flattened. Epiotics with a single elongate narrow posttemporal facet. The facet not sharply delineated from remaining portion of epiotic by a ridge. Epiotic-parietal-supraoccipital surfaces lateral to the supraoccipital crest nearly flat. Parietal ridge low and short, terminating at

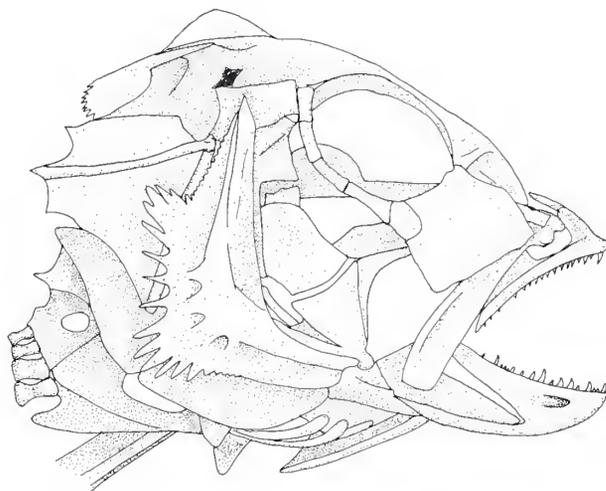


Figure 1.—*Diplectrum formosum*, Florida; right lateral view of skull.

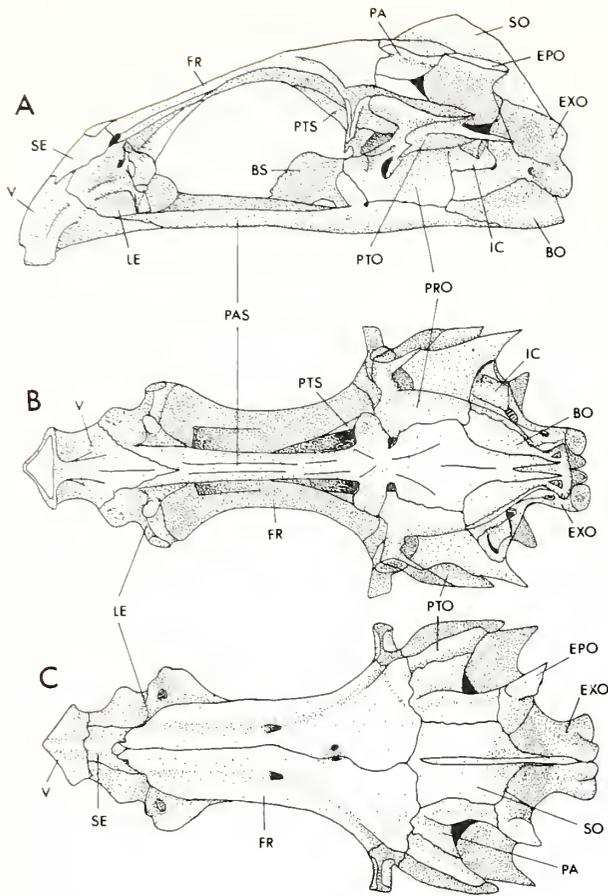


Figure 2.—*Diplectrum formosum*, 165 mm SL, North Carolina: 1) left lateral; B) ventral; and C) dorsal views of neurocranium. See text page 2 for abbreviations.

frontal border. Posterior frontal area with evidence of parietal-ridge extension forward and curving laterally, not a true ridge but as a corner on skull. Posttemporal fossae large. Pterotic "wings" elongate and broad. Supraoccipital crest short and low, extending posteriorly and ventrally to exoccipitals. Anteriorly, supraoccipital crest base only slightly expanded, terminating at posterior frontal edge. Intercalar with prominent posterior projection for articulation with posttemporal. Parasphenoid straight or nearly so. Prootic-basioccipital-parasphenoid area expanded as prominent otic capsule. Six subocular bones (Fig. 3). Subocular shelf composed of third and occasionally a portion of the fourth subocular bones. Predorsal fin supports thin and weakly developed, the formula (Smith and Bailey 1961) 0-0-0-2- or 0-0-2-. Vertebral column with 10 + 14 vertebrae. The eleventh vertebra bears the first haemal spine generally curving posteriorly, slightly flattened distally, but concave on proximal anteroventral surface (Fig. 4). Caudal fin type-Vb of Monod (1968). Ceratohyal with shallow, gently curved dorsal surface. Branchiostegals seven; $5\frac{1}{2}$ on the ceratohyal, $1\frac{1}{2}$ on the epihyal (Fig. 5). The first three attach ventrally to

ceratohyal, remaining branchiostegals having lateral attachment. Operculum with three prominent points or projections posteriorly. Posttemporal serrate.

Preopercle forming nearly right angle between horizontal and vertical arms. Horizontal arm always serrate. Preopercular spur with many elongate spines and expanded in various shapes.

Comparative osteology of *Diplectrum* spp.

Skeletons of various preparations for all species of *Diplectrum* except *D. radiale* were examined. Figures of *D. formosum* were prepared and are presented for comparative purposes. Although *D. formosum* may be one of the more specialized species, comparison will be made on its osteological morphology and differences with other species will be noted. The basic osteology for the genus has been presented above and the only special osteological aspects are considered here.

Vomerine-teeth patch forms a broad wedge-shaped pattern in *D. formosum*. *Diplectrum sciurus* has a narrower triangular vomerine-tooth patch. The anterior parasphenoid bends slightly downward in *D. formosum* but is nearly straight for the other species. The lateral

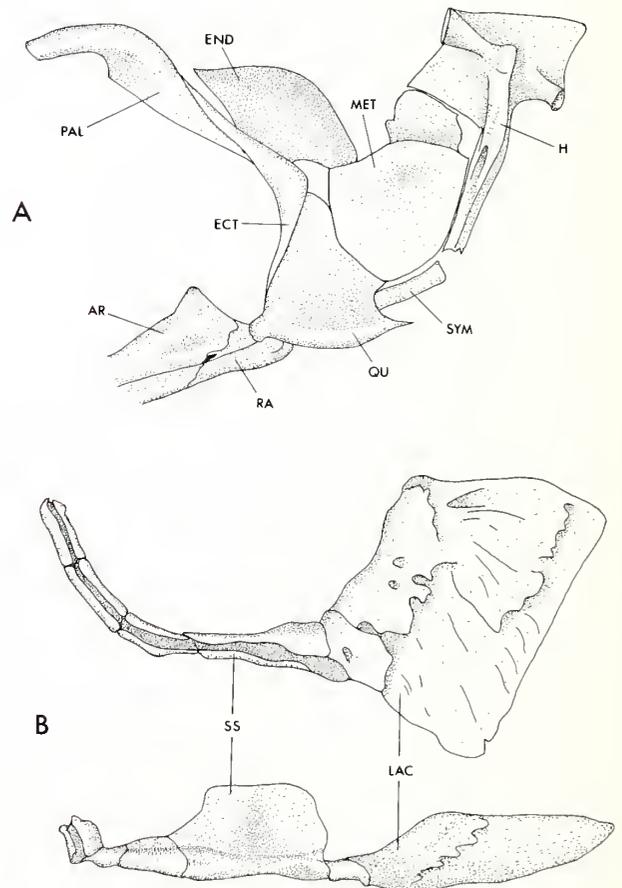


Figure 3.—*Diplectrum formosum*: A) jaw suspension, left lateral; B) suborbital bones above, right lateral; below, dorsal. See text page 2 for abbreviations.

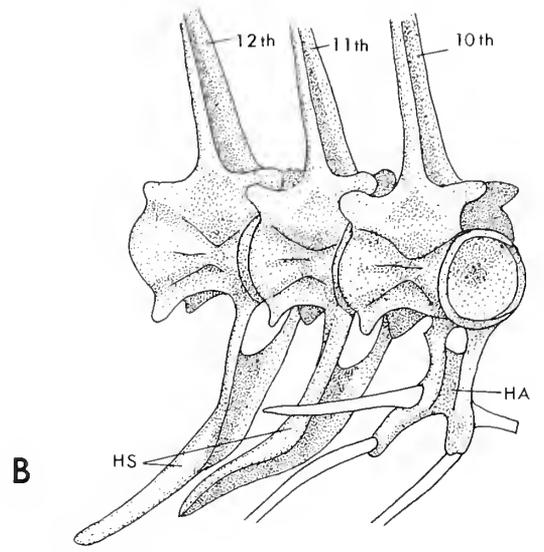
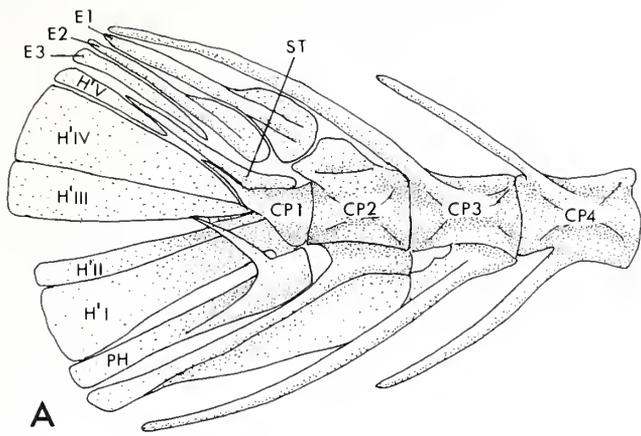


Figure 4.—*Diplectrum formosum*: A) caudal complex, left lateral; B) 10th, 11th, and 12th vertebrae, left lateral. See text pages 5-6 for abbreviations.

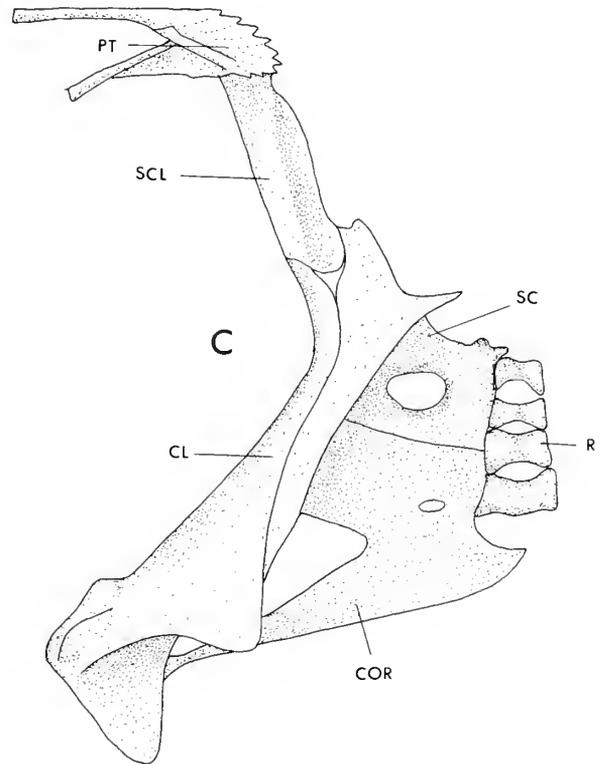
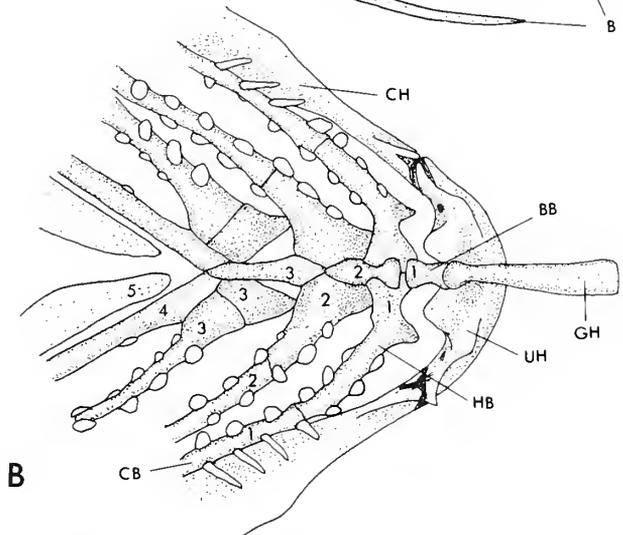
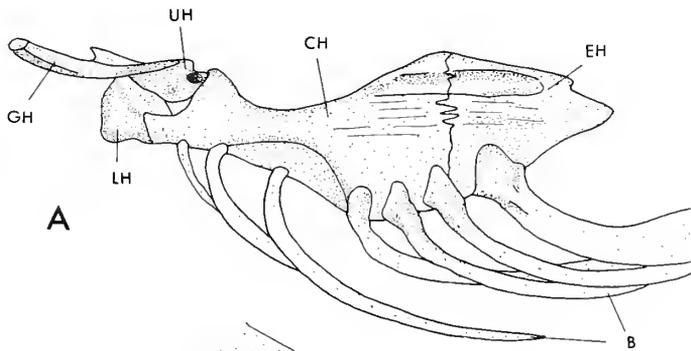


Figure 5.—*Diplectrum formosum*: A) hypobranchial apparatus, left lateral; B) hypobranchial apparatus, dorsal; C) pectoral girdle, left lateral. See text pages 5-6 for abbreviations.

parietal ridges are low in all species but slightly more developed in *D. maximum*, *D. eumelum*, and *D. pacificum*. *Diplectrum pacificum* and *D. maximum* show some evidence of a medial curl of the ridge near the frontal parietal borders. In *D. formosum* the supraoccipital crest originates at an abrupt angle, is higher, and its posterior edge approaches the exoccipitals at a low angle. In all other species of *Diplectrum* the crest originates at a low angle, its dorsal profile is nearly parallel to the central axis, and its posterior edge is at an abrupt angle. Also the supraoccipital stay (see Gosline 1966) is absent in *D. formosum*; its presence in other

Diplectrum is variable between species. The stay is greatly reduced in *D. bivittatum*. In *D. labarum* the stay runs closely along the dorsal crest edge. In other *Diplectrum* the ridge is present, strong, and parallels the central axis. Anterior supraoccipital-crest base is not noticeably thicker in *D. formosum* but appears slightly thickened for all other *Diplectrum*. Predorsal formula is 0-0-0-2- for all *Diplectrum* (the third predorsal support may be missing in a few individuals) except in *D. bivittatum*, *D. conceptione*, and *D. euryplectrum* which have a formula of 0-0-2-. First haemal spine with a low protuberance on the posterior surface for *D. formosum*,

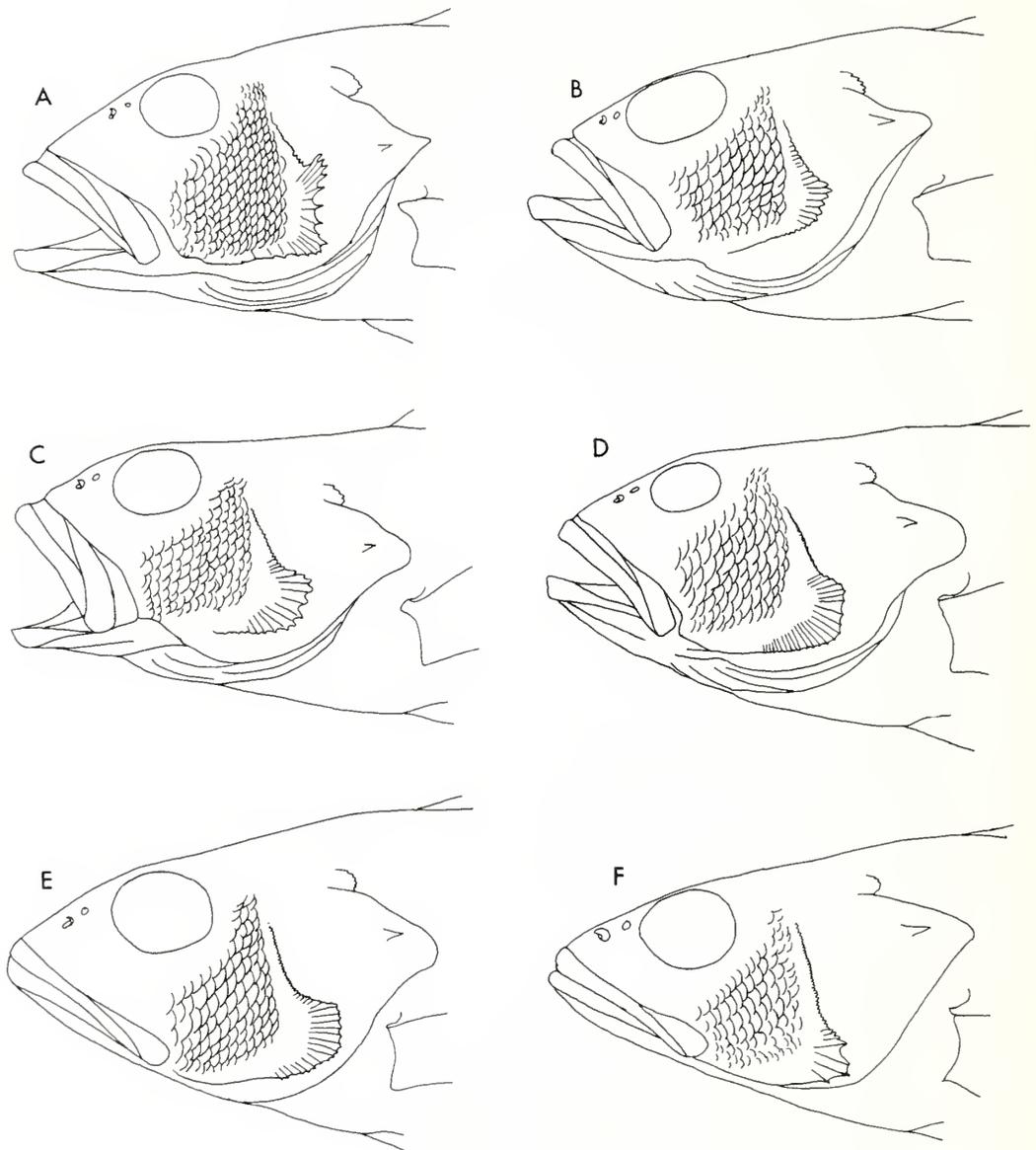


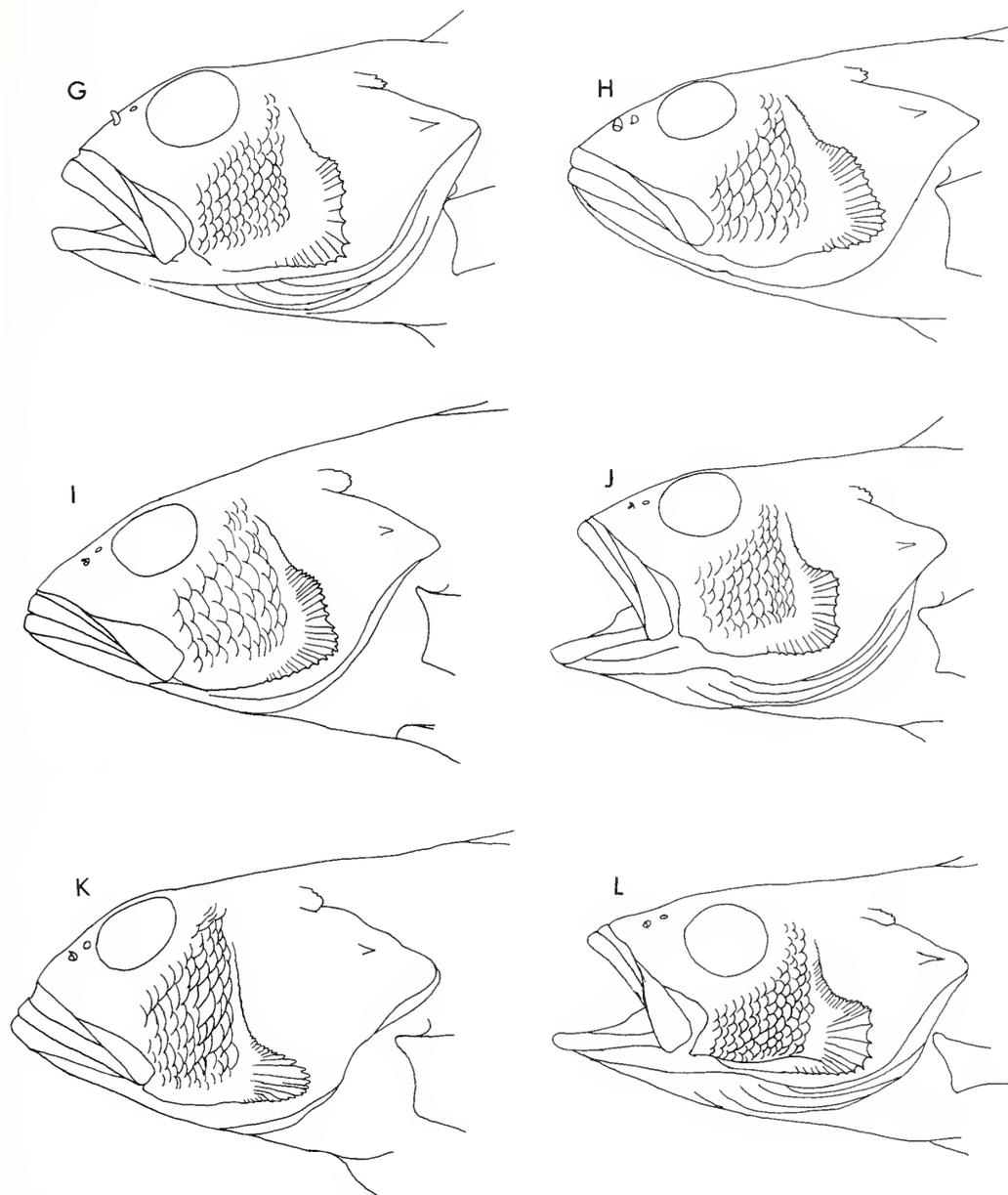
Figure 6.—Squamation of cheek and serration of preopercle in species of *Diplectrum*: A) *D. formosum*, 143 mm SL, UMML 3314, Jacksonville, Fla.; B) *D. bivittatum*, 104 mm SL, UMML 12324, St. Augustine, Fla.; C) *D. pacificum*, 133 mm SL, USNM 183980, Gulf of California; D) *D. radiale*, 197 mm SL, UMML 28749, Trinidad; E) *D. rostrum*, 117 mm SL, CAS 25295, Colombia; F) *D. conceptione*, 145 mm SL, USNM 213478, Ecuador; G) *D. euryplectrum*, 122 mm SL,

D. bivittatum, and *D. sciurus*. Posterior haemal spine smooth in *Diplectrum* except in *D. pacificum* where the posterior haemal spine curve is somewhat exaggerated. Lacrimal very broad, broadest in *D. formosum*, except for *D. sciurus* which may be considered to have a narrow lacrimal width. The maxillary is thin, broadest toward middle in *D. formosum*. In other species it is broadest distally but the shaft is thick and somewhat spatulate. *D. sciurus* has a broad maxillary tip and the shaft is thin.

The subocular shelf is rectangular, somewhat more square in *D. maximum*, *D. conceptione*, and *D. bivittatum*. The shelf is generally restricted to the third sub-

ocular bone, but in some individuals the fourth flattens out medially to form the posterior shelf edge. The post-temporal is variously serrate in all species. *Diplectrum bivittatum* and *D. maximum* have the least developed serrae; *D. conceptione* has enlarged serrae; and fewer serrae are found in *D. eumelum*, *D. euryplectrum*, and *D. labarum*.

Preopercles vary (Fig. 6), however, the species can be placed in several morphological groups with regard to this character. With its broad spur and double cluster of spines, *D. formosum* forms a category by itself. A second group with broad preopercular spurs is composed of *D.*



UMML 26251, Panama; H) *D. eumelum*, 189 mm SL, USNM 213813, Colombia; I) *D. macropoma*, 127 mm SL, USNM 213591, Colombia; J) *D. labarum*, 134 mm SL, SIO 65-257, outer Baja California; K) *D. maximum*, 302 mm SL, USNM 200373, Peru; L) *D. sciurus*, 126 mm SL, SIO 70-70, Gulf of California.

euryplectrum, *D. eumelum*, and *D. macropoma*. Decidedly truncate preopercles are seen in *D. labarum* and *D. sciurus*. *Diplectrum pacificum*, *D. radiale*, and *D. rostrum* may be grouped together with narrow, truncate spurs. *Diplectrum conceptione* and *D. maximum* form a final group having a narrow spur with fewer spines. *Diplectrum bivittatum* could justifiably be placed in either the *D. pacificum* or *D. conceptione* group.

In juveniles less than 75 mm SL the preopercular spur is not yet differentiated into the adult form. Figure 7 illustrates developmental changes in the preopercle for *D. formosum*. Preopercular spurs of smaller *Diplectrum* basically resemble the smallest *D. formosum* preopercular spur depicted.

Notes on *Serranus* Osteology

Owing to the obvious affinities of *Serranus* and *Diplectrum* some characters for the former genus are presented to clarify the latter. Inferences on relationships are made below. Only a few species and specimens of *Serranus* were examined, but a few obvious features are noted.

Vomer broad and U-shaped. Midlateral parietal ridges are prominent, extending upon the frontal area anteriorly and laterally. Epiotic bears two posterior projections and the posttemporal facet is broad. This facet is also sharply delineated from the remainder of the epiotic by

an irregular ridge. Epiotic-parietal-supraoccipital area not flat, but irregular and uneven. A groove or longitudinal depression along the junction of the frontals. Pterotic "wings" short and narrow. Horizontal and vertical preopercular arms join at an obtuse angle and the preopercular spur is never developed. Lacrimal narrow, equal to or narrower than maxillary width. Predorsal fin support formula 0-0-0-2-, the interneurals strong. Lateral supraoccipital crest stay not close to distal crest edge.

Differences have been emphasized in this partial osteological summary of *Serranus*. However, the notable character differences between the genera should serve as a means to define the genus *Diplectrum* more succinctly. I wish to stress the need for more complete osteological studies of *Serranus*.

Comments on the Systematic Status of *Diplectrum* and *Serranus*

The genera *Diplectrum* and *Serranus* are obviously similar in many morphological aspects. In the list of 16 characters used by Robins and Starck (1961:261) to define the genus *Serranus* only four do not apply to *Diplectrum*; those four characters are: "12) Lateral-line pores opening through tubes directed dorsally . . ." [directed parallel to body lines in *Diplectrum*]; "13) Dor-

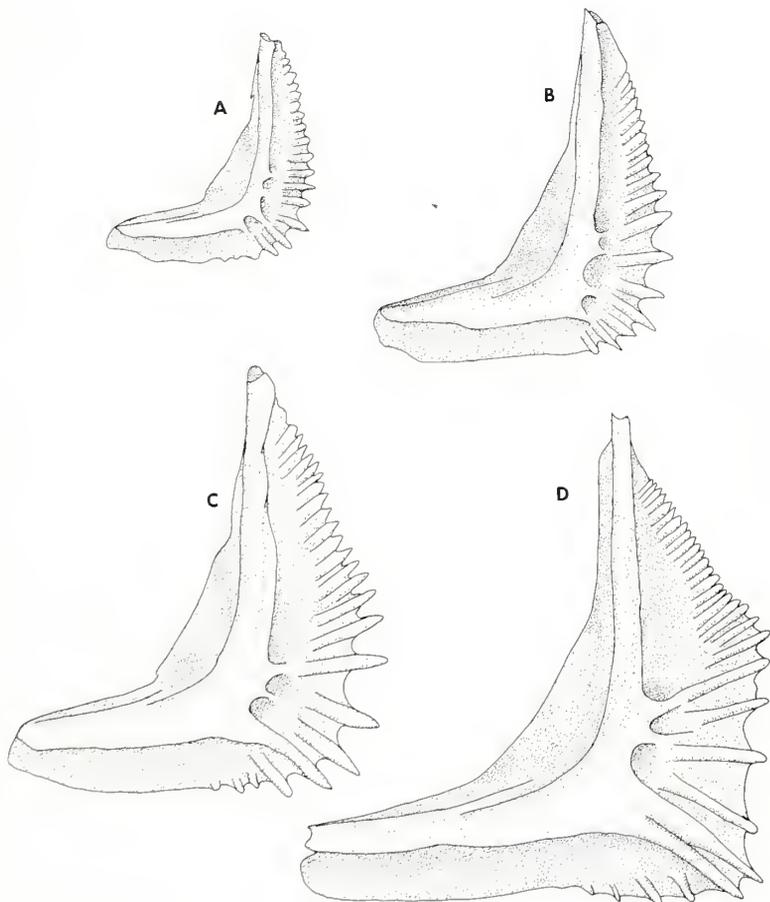


Figure 7.—Ontogenetic development of serrae on left preopercles of *Diplectrum formosum*: A) 41.7 mm SL, North Carolina; B) 59.5 mm SL, North Carolina; C) 70.7 mm SL, North Carolina; D) 79.8 mm SL, Florida Keys.

sal and anal fins with small wedges of scales" [present only on anal fins of *Diplectrum*]; "16) Size moderate . . . probably never more than 200 millimeters in standard length." [commonly reaching 200 mm SL or more in *Diplectrum*]; "17) No filamentous spines or rays" [*D. labarum* has filamentous spines]. Admittedly the above differences are minor, however, if osteological characters are considered, greater differences between these genera are apparent. In particular, these are the shape of the posttemporal facets of the epiotics, parietal ridge system, fusion line of frontals, preopercular spur shape and arm angle and width of lacrimal. The gonads are not similar in patterns of "territorial hermaphroditism." Smith (1965) has depicted *S. tigrinus* (and I have observed this condition in *S. fasciatus*, *S. phoebe*, and *S. notospilus*) with a thin band of testicular tissue. All *Diplectrum* have a wide band of testicular tissue. Also, but tentatively, the presence of an "ovarian sinus" with possible accessory-gland function is apparently restricted in the Serraninae to *Diplectrum* (Bortone in press a).

Serraninae is composed of a closely aligned morphological group of genera. Other workers attempted to separate these in keys with the character of pelvic fin origin in relation to pectoral fin (e.g., Norman 1966:227-228; P_2 below or behind P_1 for *Serranus*; P_2 in advance of P_1 for *Diplectrum*). Actually this character is variable and contributes little to the separation of these genera. Overall, the principal characters in distinguishing *Serranus* from *Diplectrum* are the obvious preopercular spur and the wide lacrimal bone of *Diplectrum*. Other previously mentioned characters may also be useful in separation.

On the basis of scale morphology, McCully (1961) suggested that *Diplectrum* spp. be placed in the genus *Dules* (= [in part] *Serranus* of Robbins and Starck 1961). The problem of the systematic position of *Diplectrum* and *Serranus* has not been resolved here. Further studies such as comparative osteology are needed on *Serranus* and other Serraninae to resolve this question. However, on the basis of present evidence, it is desirable to retain *Diplectrum* and *Serranus* as distinct genera.

Status of the Subgenus *Haliperca* Gill

Gill (1863:263) designated *S. bivittatus* (= *D. bivittatum*) as the type-species of his genus *Haliperca*. Later Jordan et al. (1930:318-319) considered *Haliperca* as a subgenus of *Diplectrum* to include *radiale* (= [in part] *D. bivittatum*), *D. pacificum*, *D. macropoma* (= [in part] *D. eumelum*), *D. sciurus*, and *D. euryplectrum*. Jordan et al. (1930:318-319) then limited the subgenus *Diplectrum* to *D. formosum*.

Diplectrum formosum is an apomorphic species with regard to its high scale meristics, the enlarged double preopercular spur, and other characters and may represent a long-separated phylogenetic line (Bortone 1973); relationships of the remaining *Diplectrum* are not easily interpreted. Rather than retain *Haliperca* as a subgenus

for a group of uncertain lineage and relationships, or establish more subgeneric names of equally tenuous status, the genus *Haliperca* is considered as a junior synonym of *Diplectrum*. Subgenera are not utilized for any species or species group at the present time. Further consideration of subgeneric status for major lineages may be necessary in the future when histological data on the gonads become available.

Comments on the Definition of Serraninae

Katayama (1960:119-120) summarized and defined the subfamily Serraninae based on the genus *Chelidoperca* Boulenger 1895. The osteological features of *Diplectrum* required modifications of Katayama's definition. Thus, gill rakers for Serraninae must be considered short or long, and in some species (e.g., *D. sciurus*) close together. Anal rays for Serraninae are III, 7 or 8 and not simply III, 7. The suborbital shelf for Serraninae is developed on the second, third, or fourth subocular bones and not always on all three of these as Katayama (1960) stated.

Comments on the Definition of Serranidae

In his admirable 1966 work Gosline considered and redefined the Serranidae, and although his definition is reasonably complete and in general agreement with specimens examined here, a comment is in order. Gosline (1966:120, table 1) listed characters which he believed would separate the well-defined Percichthyidae from the Serranidae. He thought the Serranidae could be defined by the presence of the supportive stay (longitudinal ridge of Gosline) of the supraoccipital crest, but in the present study *D. formosum*, *D. bivittatum*, and *Serranus phoebe* lack the supportive supraoccipital crest stay. This character, therefore, may not always lead to the distinction of the Serranidae from the Percichthyidae.

GONAD MORPHOLOGY

All *Diplectrum* examined in this study were "synchronous hermaphrodites" as defined by Smith (1959, 1965) in a condition referred to as "territorial hermaphroditism" by D'Ancona (1952). The gonads of *D. rostrum* (Bortone 1974), *D. formosum* (Bortone 1971), and *D. pacificum* (Bortone in press a) have been sectioned and determined to be ovotestes. In these three species, ovarian tissue appears yellow and granular, and testicular tissue appears as fine white tissue. The posteriormost region will be considered histologically in other works (Bortone in press a) and the area is considered to be a region of possible accessory gland function. As a general structure it is termed an "ovarian sinus." The structure is similar to the "oviducal pouch" described by Smith and Atz (1969) for *Pseudogramma bermudensis* but differs in many gross aspects. For instance in *Diplectrum* the pouch does not open into the body cavity. Smith (1965) used gross inspection to ex-

amine the pattern of hermaphroditism in serranid fishes. This method is considered reliable for general morphological purposes.

Schematic gonad diagrams (Fig. 8) suggest overall similarity for the genus but also suggest certain morphological affinities among species. In general the anterior lobes of the U-shaped ovotestis are ovarian tissues consisting of a central lumen which is surrounded by lamelli. The testicular tissue is generally a wide, diagonal band more posterior in orientation dorsally. The posteroventral portion of the ovotestis is composed of the "ovarian sinus."

Morphologically there are several groups. One group consisting of *D. formosum*, *D. pacificum*, *D. radiale*, *D. rostrum*, *D. euryplectrum*, and *D. eumelum* (Fig. 8A, C, D, E, G, H) shows a schematic pattern with regard to shape and position of testicular and "ovarian sinus" areas. Another group of species which are similar to ovotestis morphology is *D. sciurus* and *D. labarum* (Fig. 8J, L). In these species the "ovarian sinus" portion is evident as in the first group but the testicular tissue is somewhat extended into rounded anterior lobes which begin to invade the ovarian tissue. *Diplectrum macropoma* (Fig. 8I) is in a group by itself in that no "ovarian sinus" region is visible grossly, yet the anterior testicular lobes are present as in the second group. A fourth group is composed of the remaining species: *D. bivittatum*, *D.*

conceptione, and *D. maximum* (Fig. 8B, F, K). Testicular tissue in this group is present in very evident anterior projections. Also the "ovarian sinus" region is more ventral and slightly more anterior in position.

No apparent gross morphological differences were found at the subspecific level between *D. b. arcuarium* and *D. b. bivittatum* or *D. f. formosum* and *D. f. radians*.

KEY TO THE SPECIES OF *DIPLECTRUM*

(for specimens larger than 75 mm SL)

- 1a Atlantic Ocean specimens 2
- 1b Pacific Ocean specimens 4
- 2a Preopercle with two clusters of spines radiating from upper and lower posterior corners (Fig. 6A). Scales small; cheek scale rows A, 9-16 (modally 11); cheek scale rows B, 12-18 (modally 16); 8-12 scales above lateral line. Pectoral rays modally 16. Spinous-dorsal-fin profile nearly parallel to dorsum . . . *D. formosum*
- 2b Preopercle with a single cluster of spines (Fig. 6B, D). Scales larger; cheek scale rows A, 12 or less; cheek scale rows B, 14 or less. Scales above lateral line, 9 or less. Pectoral

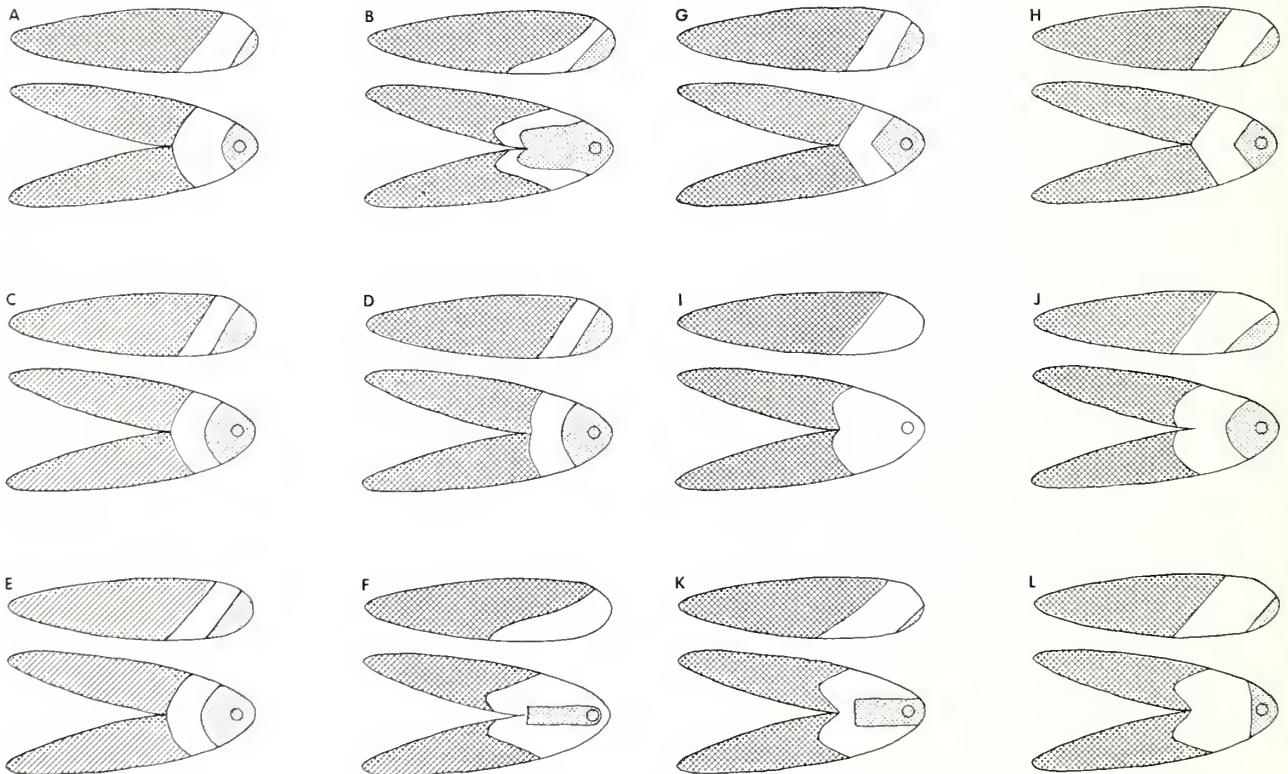


Figure 8.—Schematic gonad diagram of species of *Diplectrum*. Cross-hatched area, ovarian tissue; white area, testicular tissue; stippled area, posterior ovarian-sinus region. Top of each paired figure is a left lateral view of the gonad. The bottom figure is a ventral view (the gonopore is represented by a circle); the posterior portion of the gonad is to the right. A) *D. formosum*; B) *D. bivittatum*; C) *D. pacificum*; D) *D. radiale*; E) *D. rostrum*; F) *D. conceptione*; G) *D. euryplectrum*; H) *D. eumelum*; I) *D. macropoma*; J) *D. labarum*; K) *D. maximum*; L) *D. sciurus*.

- rays modally 15 or 17. Anterior dorsal fin elevated not parallel to dorsal profile 3
- 3a Second dorsal spine short, 1.7-2.1 into third. Preopercular spur square or rounded, its upper corner never pointed (Fig. 6D). Orbit length small, 71-95%. SL. Pectoral rays modally 17. Cheek scale rows A, 9-12 (modally 10). Upper caudal lobe without an extended filament *D. radiale*
- 3b Second dorsal spine long, 1.2-1.6 into third. Preopercular spur with a gentle curve to the lower angle, its upper angle most often pointed (Fig. 6B). Orbit length large, 83-103%. SL. Pectoral rays modally 15. Cheek scale rows A, 7-9 (modally 8). Upper caudal lobe often with an elongate filament . . . *D. bivittatum*
- 4a Total gill rakers 30 or more on first arch. Maxillary width equal to, or greater than, lacrimal width *D. sciurus*
- 4b Total gill rakers fewer than 30, maxillary width less than lacrimal width 5
- 5a Anal rays 8. A dark lateral band of pigment along soft-dorsal-fin base. Vertical preopercular arm above spur not serrate . . . *D. euryplectrum*
- 5b Anal rays 7 (except for *D. labarum* from outer Baja California in which 18% have 8 anal rays). No dark pigment present on soft-dorsal-fin base. Vertical preopercular arm serrate 6
- 6a Second, third, fourth, and occasionally fifth dorsal spines with tips extended as long black filaments (only on specimens larger than 75 mm SL) *D. labarum*
- 6b Second, third, fourth, and fifth dorsal spines with tips not extended 7
- 7a Second anal spine stronger than third and long, 0.9-1.2 into third. Preopercle as an elongate bony flap composed of thin spines (or consisting of 2-4 strong spines), not as a squared spur (Fig. 6F, K). Pelvic fins dusky 8
- 7b Second anal spine much shorter than third (1.2 or more). Second anal spine not appreciably stronger than third. Preopercle with a definite squared spur and not as a thin spiny flap nor as a cluster of 2-4 strong spines. Pelvic fins pale 9
- 8a Gill rakers 23-28. Preopercle with 2-4 very strong spines at its angle (Fig. 6F) . . *D. conceptione*
- 8b Gill rakers 17-21. Preopercle spur as a bony flap with 5-8 long thin spines at its angle (Fig. 6K) *D. maximum*
- 9a Cheek scale rows A, 8-12. Cheek scale rows B, 10-14 10
- 9b Cheek scale rows A, 5-8. Cheek scale rows B, 7-10 11
- 10a Snout with a distinct pale bar from the anteroventral corner of the eye, forward and downward to the anteroventral edge of the lacrimal. Soft dorsal fin with a distinct row of pale spots on upper half of membrane on a dark field. Gill rakers 22-25. Preopercular spur spines 7-11 (Fig. 6E) *D. rostrum*
- 10b Snout with a vague spot, not as a well-defined bar. Soft dorsal fin with 2-3 irregular rows of pale spots on a dark field. Gill rakers normally 15-22, occasionally 23 or 24. Preopercular spur spines 5-8 (Fig. 6C) . . *D. pacificum*
- 11a Caudal peduncle depth 2.9-3.5 in head length. Snout with 3-5 distinct pale spots. Snout blunt. Length of posterior dorsal and anal rays nearly equal to length of anterior rays *D. eumelum*
- 11b Caudal peduncle depth 2.5-2.8 in head length. Snout without distinct pale spots or wavy cheek bar. Snout pointed. Length of posterior dorsal and anal rays much shorter than anterior rays *D. macropoma*

Diplectrum formosum (Linnaeus 1766)

Figures 1-5, 6, 7-8, 9, 10

Perca formosa Linnaeus 1766:488-489 (original description, Carolina); Gmelin 1788:1322 (copy of original description); Linnaeus 1789:1322 (copy of original description); Cuvier and Valenciennes 1828:230 [in synonymy with *Haemulon formosum* = *Haemulon plumieri* (Lacépède)]; Goode and Bean 1886:203 (type examined).

Serranus radians Quoy and Gaimard 1824:313-314, pl. 58, fig. 2 (original description, Brazil); Boulenger 1895:295-296 (catalog); Devincenzi 1924:223 (description).

Serranus fascicularis Valenciennes in Cuvier and Valenciennes 1828:245-246 (original description, Brazil); Cuvier 1829:139 (generic description); DeKay 1842:23 (description); Storer 1846:28-29 (general account); Canestrini 1860:306 (systematics); Poey 1866:195 (Cuba); Jordan and Gilbert 1882:534 (not seen); Jordan and Gilbert 1883:273 (Pensacola, Fla.); Goode 1884:410, pl. 163 (South Carolina); Goode 1887:46 (South Carolina); Diaz 1893:52 (synonymy).

Serranus irradians Valenciennes in Cuvier and Valenciennes 1828:244-245, pl. 30 (in part, original description, Brazil); Castelnau 1855:3 (color notes, Rio de Janeiro).

Diplectrum fasciculare Holbrook 1855:32-35, pl. 5, fig. 2 (generic description, South Carolina); Holbrook 1860:35-38, pl. 5, fig. 1 (South Carolina); Gill 1862:30 (southeast United States); Gill 1864:93 (name only); Poey 1868:282 (generic designation); Poey 1871:54

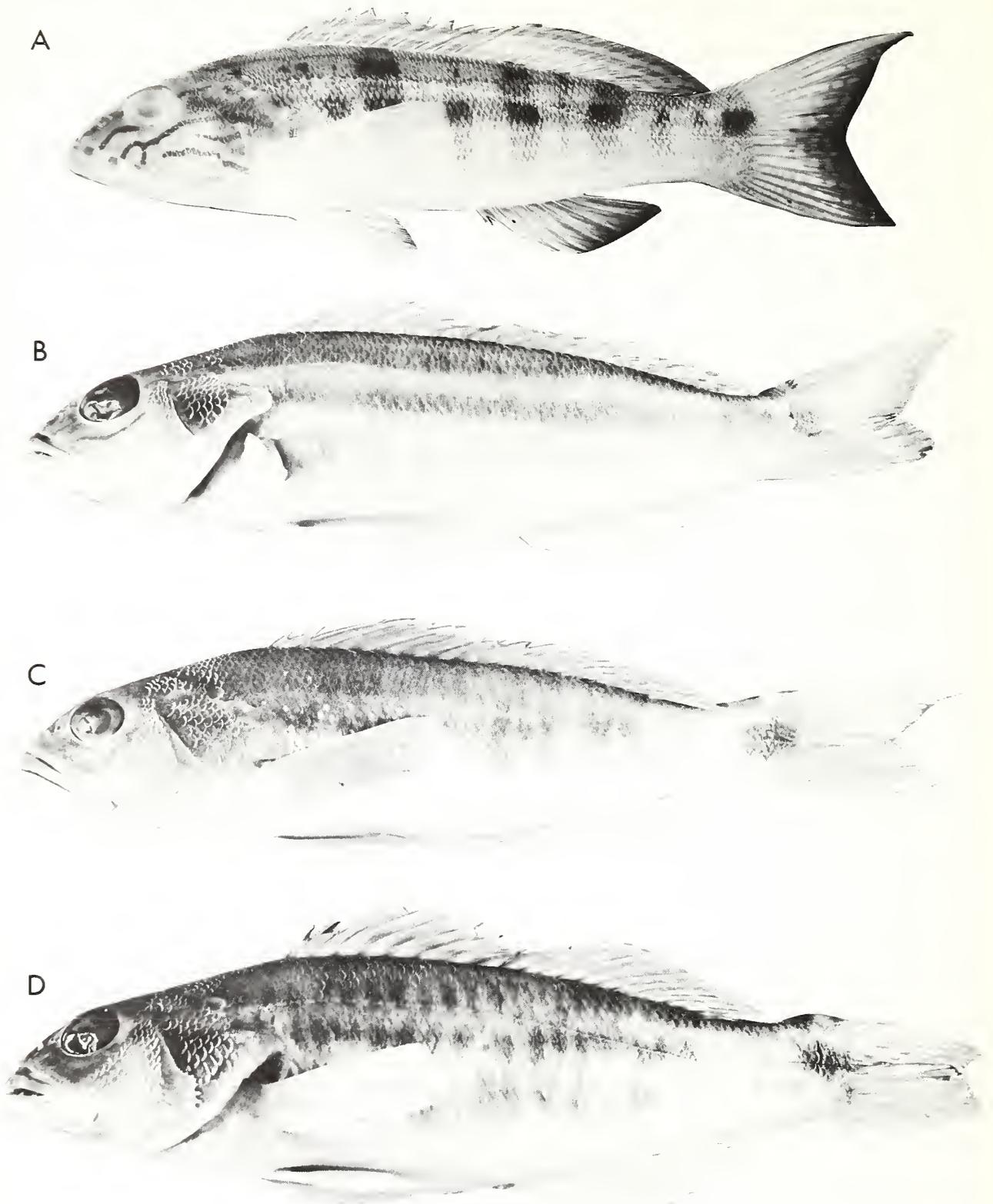


Figure 9.—A) *Diplectrum formosum*, 139 mm SL, (uncat.) northern Gulf of Mexico;
B) *D. bivittatum*, 117 mm SL, UMML 16302, Venezuela;
C) *D. pacificum*, 140 mm SL, USNM 183980, Gulf of California;
D) *D. radiale*, 107 mm SL, UMML 16302, Venezuela;

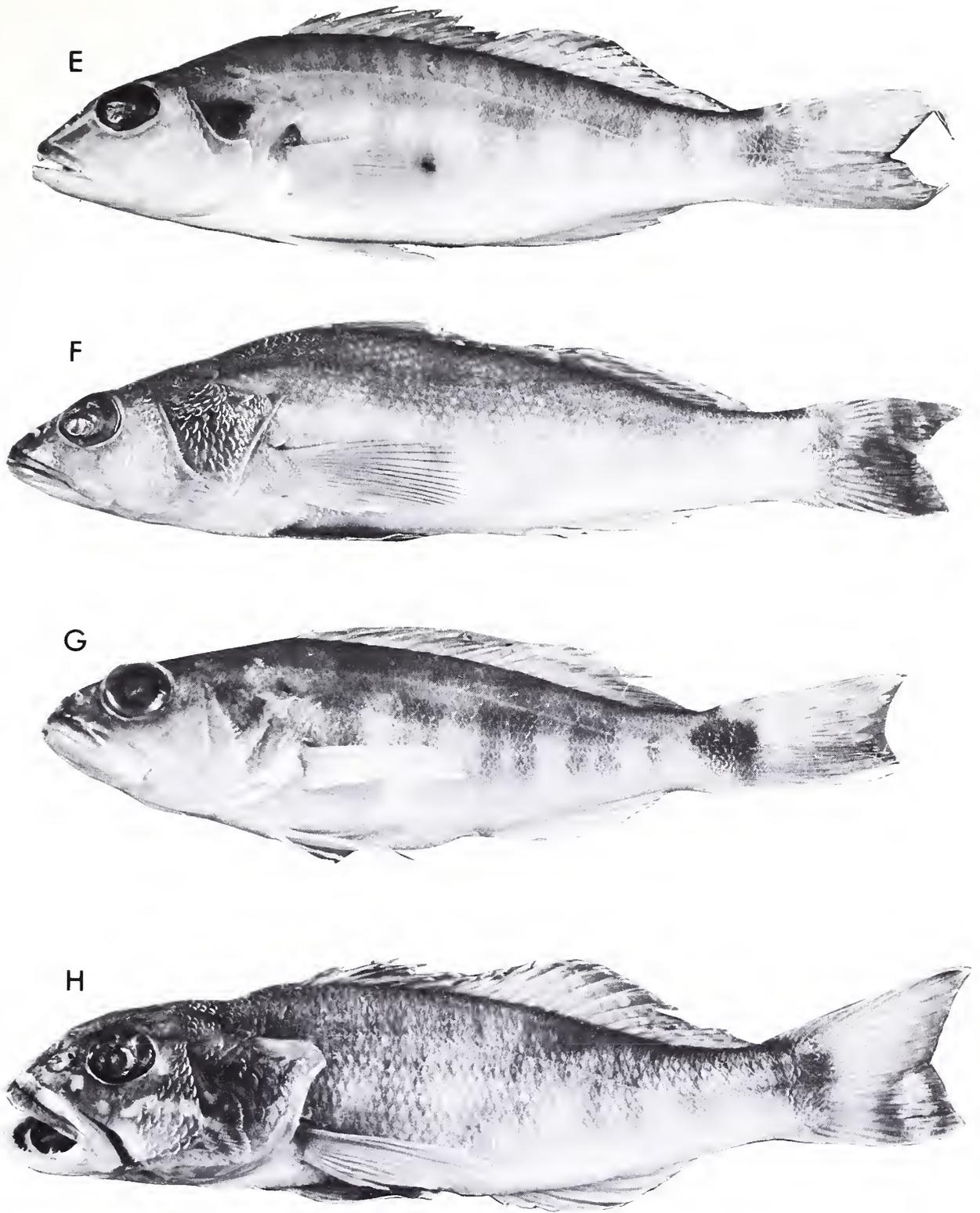


Figure 9.—Continued.

- E) *D. rostrum*, 131 mm SL, USNM 208197, Colombia;
F) *D. conceptione*, 145 mm SL, USNM 213578, Peru;
G) *D. euryplectrum*, 63 mm SL, UMML 26251, Panama;
H) *D. eumelum*, 180 mm SL, USNM 213813, Colombia;

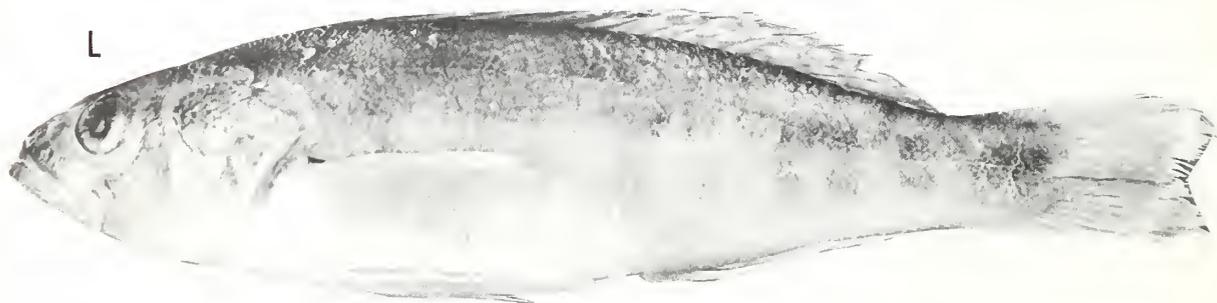


Figure 9.—Continued.

- I) *D. macropoma*, 127 mm SL, USNM 213591, Colombia;
J) *D. labarum*, 135 mm SL, LACM 32094-1, outer Baja California;
K) *D. maximum*, 93 mm SL, SIO 64-63, outer Baja California;
L) *D. sciurus*, 109 mm SL, SIO 70-70, Gulf of California.

- (generic designation); Gill 1873:28 (distribution); Goode 1880:115 (Florida).
- Centropristis fascicularis* Günther 1859:83 (catalog).
- Centropristis radicans* Günther 1859:83 (catalog).
- Diplectrum radicans* Poey 1876:23 (synonymy); Diaz 1893:52 (name only).
- Serranus formosus* Jordan 1885:125 (color description, Key West); Jordan 1887:82 (distribution, catalog); Adams and Kendall 1891:292, 309 (Florida); Henshall 1891:387 (Key West).
- Diplectrum formosum* Goode and Bean 1886:203 (examined type of *Perca formosa*); Jordan and Eigenmann 1890:397-398, pl. 65 (description and account); Henshall 1895:215 (Key West); Jordan and Evermann 1896:1204, 1207-1208 (systematics, synonymy); Smith 1896:175 (Florida); Evermann and Kendall 1900:75 (Florida); Fowler 1903:329 (color notes, Florida); Jordan and Thompson 1905:240-241 (color notes, Florida); Fowler 1907:263 (Florida); Smith 1907:282 (North Carolina); Jordan and Evermann 1923:398-399 (general account); Meek and Hildebrand 1925:472-474 (key, description, and synonymy); Fowler 1927:252 (Florida); Fowler 1929:453 (Florida); Borodin 1934:113 (Florida Keys); Gunter 1935:39, 40 (Louisiana); Bere 1936:608 (parasites); Fowler 1940a:14, fig. 20 (Florida); Fowler 1941a:770 (Rio de Janeiro); Fowler 1941b:86 (Florida); Galloway 1941:119 (lethal temperature); Longley and Hildebrand 1941:103-104 (life history, Florida); Fowler 1942:158 (Brazil); Baughman 1944:89, 90 (Texas); Fowler 1945a:200, 310 (synonymy, southeast United States); Breder 1948:166 (general account); La Monte 1952:104 (popular account); Outdoor Writers Association of America 1952 (check list); Pearse 1952a (parasites); Hildebrand 1954:304 (Campeche); Hildebrand 1955:208, 221-223, tables 2-4 (Campeche); Joseph and Yerger 1956 (Florida); Briggs 1958:272 (distribution); Hoese 1958:331 (Texas); Migdalski 1958:355 (popular account); Robins 1958 (check list, Florida); Bailey et al. 1960:25 (check list); Springer and Woodburn 1960:34 (ecological data, Florida); Clem et al. 1961:726-766 (tissue culture); Durand 1961:46, 50 (ecological data, Guyana); Smith and Bailey 1961:361 (osteology); Tabb and Manning 1961:618 (Florida); Lowe 1962:695 (Guyana); Freihofer 1963:131, table 2 (neuroanatomy); Gabrielson and La Monte 1963:51 (popular account); Brandão 1964:19 (Brazil); Tyler 1964:9 (Florida); Anderson and Gehringer 1965:table 12 (collection data, Florida); Bullis and Thompson 1965:44 (collection and distribution data); Christensen 1965 (Florida); Gunter and Hall 1965:31 (collection data, Florida); Moe and Martin 1965:138 (biological data, Florida); Roessler 1965:314, table 2 (ecological data, Florida); Roithmayr 1965:20, table A-1 (northern Gulf of Mexico); Cervigon 1966:321-323 (description, biology, Venezuela); Moe 1966:11, table 2 (Florida); Moe et al. 1966:32-33 (Florida); Starck and Davis 1966:320 (Florida); Anderson 1968:1-60 (trawl data from S. Atlantic coast of United States); Beaumariage 1968:8 (utilized for fish meal, Florida); Böhlke and Chaplin 1968:267 (Bahamas); Randall 1968:76, fig. 87 (general account, Caribbean); Starck 1968:19 (Florida); Wolf and Quimbe 1969:298, table 8 (tissue culture); Bailey et al. 1970:34 (check list); Bortone 1970:1-55 (life history, Florida); Godcharles 1970:11 (Florida); Mago Leccia 1970:94 (Venezuela); Anonymous 1971:61-62 (popular account); Bearden and McKenzie 1971:13 (collection data, South Carolina); Bortone 1971a:1-27 (life history, Florida); Bortone 1971b:28 (behavior and color notes, Florida); Dahl 1971:224, fig. 295 (Colombia); Ewald et al. 1971:54 (Venezuela); Godcharles 1971:34, table 8 (collection data, Florida); Grimes and Mountain 1971:40-41 (Florida); Nahhas and Powell 1971:4 (parasites); Smith 1971:108 (synonymy); Swingle 1971:33 (Alabama); Bortone 1972:55 (life history, North Carolina); Mountain 1972:60 (collection data, Florida); Galloway et al. 1972:89, 91 (key); Miller and Jorgenson 1973:310 (meristics); Cliburn 1973:18 (key); Dahlberg 1975:58, fig. 117 (Georgia); Walls 1975:169 (northern Gulf of Mexico).
- Centropristis formosus* Berg 1895:45-46 (synonymy, Uruguay).
- Haliperca formosa* Miranda-Ribeiro 1904:25 (Brazil); Miranda-Ribeiro 1915:29 (Brazil); Miranda-Ribeiro 1918:92-93 (Brazil).
- Diplectrum formosus* Jordan et al. 1930:318-319 (check list); Gunter 1941:195 (Louisiana); Baughman 1950:249 (Texas); Buller 1951:15 (southeast United States); Reid 1954:37-38 (life history, Florida).
- Diplectrum fascicularis* Poey 1955:186-187, pl. 46 (description, Cuba).
- Diplectrum radiale* Ringuet and Aramburu 1960:36, 62 (misidentification).
- I have not seen the type-specimen of *D. formosum*, but I accept the authority of Goode and Bean (1886:203) who examined the type at the Linnaean Society of London in Burlington House. They confirmed that the Linnaean type was what had been referred to on the eastern coast of the United States as *D. fasciulare* (= *S. fascicularis Valenciennes in Cuvier and Valenciennes 1828:245-246*).
- Valenciennes (*in Cuvier and Valenciennes 1828*) also described *Serranus irradians* and although the description is of *D. formosum* the syntypes are of two species (i.e., MNHN A464, A461, 7018 are *D. formosum*; the other syntype MNHN 462 is *D. radiale*). MNHN A464 is designated the lectotype for *Serranus irradians*.
- Diplectrum radicans* (Quoy and Gaimard 1824:313-314, pl. 58, fig. 2) represents the first description of *D. formosum* from Brazil.
- Diagnosis*.—As an adult, *D. formosum* is easily recognized because it is the only *Diplectrum* whose preopercle has two centers of diverging spines. These form a double pointed spur consisting of upper and lower projections. *Diplectrum formosum* modally has 16 pectoral rays while *D. bivittatum* and *D. radiale* have 15 to 17 each respectively (Table 1). Also *D. formosum* possesses small scales. This is reflected in the species having the highest

Table 1.—Number of pectoral rays in *Diplectrum* species.

Species	14	15	16	17	18	19	\bar{x}	s	n
<i>D. formosum</i>		22	236	8			15.95	0.32	266
<i>D. bivittatum</i>									
Gulf of Mexico	3	131	28				15.16	0.41	162
S. Florida	1	28	20				15.39	0.53	49
Caribbean and South America	3	145	129				15.45	0.52	277
Total	7	304	177				15.35	0.51	488
<i>D. radiale</i>			25	73	4		16.79	0.49	102
<i>D. pacificum</i>			11	104	14		17.02	0.44	129
<i>D. rostrum</i>			3	29	1		16.94	0.35	33
<i>D. conceptione</i>				4	38	13	18.16	0.54	55
<i>D. maximum</i>			1	14			16.93	0.26	15
<i>D. sciurus</i>			4	67	1		16.96	0.26	72
<i>D. euryplectrum</i>			2	47	85		17.62	0.52	134
<i>D. labarum</i>									
Outer Baja California				6			17.00		6
Gulf of California			28	9			16.24	0.43	37
Panama and Costa Rica			2	28	1		16.97	0.31	31
Total			30	43	1		16.61	0.52	74
<i>D. eumelum</i>			1	95	3		17.02	0.20	99
<i>D. macropoma</i>			3	130	21		17.12	0.38	154

mean scale numbers (Tables 2-7) of any *Diplectrum*. Juvenile *D. formosum* may be confused in general appearance with other Atlantic *Diplectrum* but eye size (small in *D. formosum*) and scale counts will separate the species. As an adult, *D. formosum* has the broadest lacrimal and narrowest maxillary bones.

Description.—Within *D. formosum* there are two morphological populations, a northern subspecies from coastal Gulf of Mexico and Atlantic North America and a southern subspecies from coastal Caribbean and Atlantic South America. The two forms are described separately for morphometric characters. Meristic character differences for both forms except gill raker counts are slight; therefore, these statistics are considered the same for both.

D, X, 12 (13); A, III, 7(6-8); P_1 , 15.95 (15-17); pored lateral-line scales, 49.76 (46-55); scale rows in lateral line, 76.78 (66-88); scales above lateral line, 9.38 (8-12); scale rows below lateral line, 21.36 (18-26); predorsal scale rows, 17.20 (14-22); cheek scale rows A, 11.77 (9-16); cheek scale rows B, 15.60 (12-18).

Northern form.—Gill rakers, 18.83 (17-22). Standard length, 140.4 (36.7, 77.6-220, 49). Total length, 1,340 (50.12, 1241-1451, 44); fork length, 1,191 (22.79, 1,136-1,308, 49); body depth, 275 (15.09, 250-318, 45); head length, 359 (12.58, 330-390, 49); postorbital length, 191 (8.34, 176-210, 49); snout length, 113 (8.77, 93-130, 48); lacrimal width, 59 (6.76, 45-70, 39); maxillary width, 26 (2.05, 22-29, 39); orbit length, 74 (6.42, 62-89, 49); orbit width, 59 (5.76, 48-72, 49); interorbital width, 74 (4.42, 64-82, 38); upper jaw length, 160 (7.10, 145-175, 49); lower jaw length, 179 (8.12, 154-198, 49); cheek height, 125 (9.85, 104-143, 49); cheek length, 128 (7.39, 115-145, 49); caudal peduncle depth, 134 (4.86, 122-146, 49); pectoral fin length, 235 (10.82, 207-257, 49); pelvic fin

length, 216 (10.53, 185-238, 39); predorsal length, 349 (10.62, 321-368, 39); pelvic origin to lower jaw, 341 (13.29, 313-379, 32); pelvic origin to anus, 306 (24.09, 254-357, 49); postanal length, 402 (13.90, 374-428, 48). Dorsal spine height: first, 51 (6.40, 35-68, 46); second, 78 (7.19, 58-90, 48); third, 95 (7.36, 79-108, 45); fourth, 105 (8.89, 84-125, 46); fifth, 110 (8.58, 91-131, 43). Anal spine height: first, 25 (4.41, 16-37, 46); second, 47 (6.80, 35-65, 48); third, 70 (8.37, 50-92, 46).

Southern form.—Mean gill rakers, 22.01 (19-24). Standard length, 119.1 (28.1, 76-167, 50). Total length, 1,269 (17.77, 1,232-1,312, 46); fork length, 1,183 (12.80, 1,149-1,207, 50); body depth, 270 (16.06, 238-299, 50); head length, 362 (15.31, 329-394, 48); postorbital length, 192 (9.66, 173-214, 50); snout length, 101 (7.89, 84-121, 50); lacrimal width, 52 (5.59, 41-62, 36); maxillary width, 27 (2.09, 21-31, 37); orbit length, 83 (6.14, 71-94, 50); orbit width, 63 (5.71, 54-78, 50); interorbital width, 73 (5.18, 63-83, 47); upper jaw length, 160 (7.22, 141-174, 50); lower jaw length, 181 (7.00, 165-195, 50); cheek height, 119 (8.97, 98-135, 50); cheek length, 129 (6.50, 116-144, 50); caudal peduncle depth, 125 (5.28, 111-137, 50); pectoral fin length, 238 (7.81, 220-263, 50); pelvic fin length, 210 (9.57, 182-232, 49); predorsal length, 350 (10.20, 335-370, 37); pelvic origin to lower jaw, 342 (16.66, 318-382, 50); pelvic origin to anus, 314 (20.07, 276-353, 50); postanal length, 401 (312, 371-422, 50). Dorsal spine height: first, 53 (5.08, 37-66, 50); second, 79 (6.34, 61-90, 49); third, 100 (7.93, 82-114, 49); fourth, 110 (8.09, 91-125, 46); fifth, 113 (8.29, 94-133, 49). Anal spine height: first, 29 (3.55, 20-35, 49); second, 53 (7.84, 40-78, 49); third, 74 (7.67, 60-93, 50).

Preopercular spur with two clusters of diverging spines. The number of spur spines variable, from 6 to 15, but more often from 9 to 12 between upper and lower clustered tips. The southern form with slightly more

Table 2.—Number of scale rows in lateral line of *Diplectrum* species and populations.

Species	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	
<i>D. formosum</i>																			1		1	2	3	
<i>D. bivittatum</i>							1		2	1	2	9	16	30	37	53	51	49	51	46	37	26	9	
<i>D. radiale</i>							1	1		1	2	7	7	5	10	16	14	10	12	6	6	1		
<i>D. pacificum</i>																1	1	2	4	6	5	8	10	3
Gulf of California																								
Mexican coast and Costa Rica											1	1			4	4	2	2	6	2	2	1		
Panama and Colombia										2		6	3	5	8	9	4	6	3	5				
Total										2	1	7	3	6	13	15	10	14	14	15	12	4		
<i>D. rostrum</i>													2	3	3	4	5	3				1		
Northern																								
Southern															1		2	1	1		3	3	2	
Total													2	3	4	4	7	4	1		3	4	2	
<i>D. conceptione</i>														2	1		3	2	4	7	5	8	6	
<i>D. maximum</i>														1		2	3	1		1	3	2	1	
<i>D. sciurus</i>																1	4	2	2	4	4	7	8	
<i>D. euryplectrum</i>									2	1	4	3	6	14	15	10	19	12	9	13	9	6	4	
<i>D. labarum</i>																								
Gulf of California								1	1	4	3	2	5	4	6	4	3	7	1					
Panama and Costa Rica				1	2	6	2	5	3	4	2	2	2			2								
Total				1	2	6	2	6	4	8	5	4	7	4	6	6	3	7	1					
<i>D. eumelum</i>	1		1		3	4	5	15	9	16	12	14	7	9	2	4	2							
<i>D. macropoma</i>	2	4	7	12	22	24	21	19	15	9	1	6	3	1		1								

Species	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	\bar{x}	s	n		
<i>D. formosum</i>	9	20	19	29	20	20	23	22	29	13	19	14	9	1	1		1	3	76.78	3.82	259		
<i>D. bivittatum</i>	5				1														64.69	2.95	426		
<i>D. radiale</i>	1																		63.36	3.07	100		
<i>D. pacificum</i>																							
Gulf of California	1		1	1															67.58	2.40	43		
Mexican coast and Costa Rica																			65.40	2.72	25		
Panama and Colombia	1																		63.79	2.82	52		
Total	2		1	1															65.48	3.13	120		
<i>D. rostrum</i>																							
Northern																			63.10	2.07	21		
Southern																			67.08	2.60	13		
Total																			64.62	2.98	34		
<i>D. conceptione</i>	4	5	4	2	2														68.82	3.34	55		
<i>D. maximum</i>			1																66.33	3.13	15		
<i>D. sciurus</i>	6	5	6	9	5	4			1										70.76	3.60	68		
<i>D. euryplectrum</i>	1	1	1																64.12	3.39	130		
<i>D. labarum</i>																							
Gulf of California																			61.27	2.95	41		
Panama and Costa Rica																			55.87	3.07	31		
Total																			58.94	4.02	72		
<i>D. eumelum</i>																			57.42	3.01	104		
<i>D. macropoma</i>																			53.86	2.70	147		

Table 3.—Scales above lateral line of *Diplectrum* species.

Species	5	6	7	8	9	10	11	12	\bar{x}	s	n
<i>D. formosum</i>				17	81	49	11	2	9.38	0.81	160
<i>D. bivittatum</i>		18	150	76	6				7.28	0.63	250
<i>D. radiale</i>		9	55	33	2				7.28	0.66	99
<i>D. pacificum</i>		1	52	51	12				7.64	0.68	116
<i>D. rostrum</i>			16	16	1				7.54	0.56	33
<i>D. conceptione</i>			10	32	6				7.92	0.58	48
<i>D. maximum</i>			1	8	4	2			8.47	0.83	15
<i>D. sciurus</i>			14	32	24	1			8.17	0.76	71
<i>D. euryplectrum</i>			50	61	12	1			7.71	0.67	124
<i>D. labarum</i>		11	30	8	1				6.98	0.68	50
<i>D. eumelum</i>	3	60	36	2	1				6.39	0.63	102
<i>D. macropoma</i>	9	73	51						6.32	0.60	133

Table 4.—Scales below lateral line of *Diplectrum* species.

Species	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	\bar{x}	s	n
<i>D. formosum</i>								2	18	31	32	32	33	6	1	2	21.36	1.60	157
<i>D. bivittatum</i>						6	34	74	66	46	15	3					18.69	1.25	244
<i>D. radiale</i>					1	3	13	29	35	13	6						18.57	1.20	100
<i>D. pacificum</i>						2	6	28	45	25	4						18.88	1.00	110
<i>D. rostrum</i>					5	8	10	10									16.76	1.06	33
<i>D. conceptione</i>							1	2	17	19	13	2	1				19.93	1.09	55
<i>D. maximum</i>								1	1	4	2	5	1		1		21.13	1.73	15
<i>D. sciurus</i>							1	18	25	21	6						19.18	0.96	71
<i>D. euryplectrum</i>					4	10	34	34	28	8							17.81	1.19	118
<i>D. labarum</i>				2	4	10	12	13	4								16.93	1.29	45
<i>D. eumelum</i>			1	9	38	42	12										15.54	0.85	102
<i>D. macropoma</i>	1	7	9	38	55	17	4	1									14.60	1.15	132

Table 5.—Number of predorsal scale rows of *Diplectrum* species and populations.

Species	10	11	12	13	14	15	16	17	18	19	20	21	22	\bar{x}	s	n
<i>D. formosum</i>					4	18	34	27	34	18	7	4	1	17.20	1.64	147
<i>D. bivittatum</i>																
Gulf of Mexico	1	13	31	48	14	9								12.76	1.08	116
S. Florida	2	4	5	3	4	3								12.57	1.60	21
Caribbean and South America				10	28	42	41	13	2					14.18	1.13	136
Total	3	17	46	79	60	53	13	2						13.45	1.36	273
<i>D. radiale</i>			2	6	19	32	27	8	5	1				15.25	1.33	100
<i>D. pacificum</i>		1	4	17	28	22	24	6	6	2				14.85	1.60	110
<i>D. rostrum</i>			2	9	10	4	7							14.16	1.25	32
<i>D. conceptione</i>			11	9	16	11	1	3	2					13.98	1.56	53
<i>D. maximum</i>					1	2	6	3		1	1			16.43	1.55	14
<i>D. sciurus</i>			2	2	12	11	11	2	9	1				15.48	1.70	50
<i>D. euryplectrum</i>																
Mexico		1	4	10	11	6	1	1						13.70	1.24	34
Panama		1	2	10	8	10	11	3	4					14.82	1.70	49
Colombia	2	8	11	11										11.97	0.93	32
Galapagos						1	1							15.50		2
Total	2	10	17	31	19	17	13	4	4					13.73	1.81	117
<i>D. labarum</i>		1	5	19	6	7	3	1						13.62	1.30	42
<i>D. eumelum</i>	18	36	30	8	3	2								11.46	1.11	97
<i>D. macropoma</i>																
Gulf of California		1	2	9	13	4	1		1					13.81	1.28	31
Panama		1	3	7	9	13	12	8	2					14.96	1.62	55
Colombia	1	5	11	14	14	3								12.92	1.18	48
Total	1	7	16	30	36	20	13	8	3					13.96	1.66	134

Table 6.—Number of cheek scale rows A of *Diplectrum* species.

Species	5	6	7	8	9	10	11	12	13	14	15	16	\bar{x}	s	n
<i>D. formosum</i>					1	19	86	40	40	10	4	2	11.77	1.24	202
<i>D. bivittatum</i>			68	305	97								8.06	0.59	470
<i>D. radiale</i>					24	62	13	3					9.95	0.69	102
<i>D. pacificum</i>				2	42	70	7	1					9.70	0.64	122
<i>D. rostrum</i>				17	15	1							8.52	0.56	33
<i>D. conceptione</i>			6	24	17	8							8.49	0.88	55
<i>D. maximum</i>					2	10	3						10.07	0.59	15
<i>D. sciurus</i>		2	24	41	4								7.66	0.63	71
<i>D. euryplectrum</i>	1		23	87	16	3							7.97	0.68	130
<i>D. labarum</i>		4	42	27	1								7.34	0.60	74
<i>D. eumelum</i>	10	84	8										5.98	0.42	102
<i>D. macropoma</i>	11	93	52	1									6.27	0.59	157

Table 7.—Number of cheek scale rows B of *Diplectrum* species.

Species	i	8	9	10	11	12	13	14	15	16	17	18	\bar{x}	s	n
<i>D. formosum</i>						1	6	36	67	104	43	6	15.60	1.08	263
<i>D. bivittatum</i>			1	4	140	225	81	4					11.86	0.75	455
<i>D. radiale</i>				5	28	54	9	1					11.73	0.78	97
<i>D. pacificum</i>				5	10	68	39	4					12.21	0.80	126
<i>D. rostrum</i>				1	25	7							11.18	0.46	33
<i>D. conceptione</i>			1	6	18	22	5	3					11.60	1.05	55
<i>D. maximum</i>				1	7	6	1						11.47	0.74	15
<i>D. sciurus</i>						12	29	20	10		1		13.44	1.02	72
<i>D. euryplectrum</i>		3	10	51	55	11	1						10.49	0.87	131
<i>D. labarum</i>				1	19	20	4						10.61	0.69	44
<i>D. cumelum</i>	7	51	39	5									8.41	0.69	102
<i>D. macropoma</i>	3	62	65	5									8.53	0.61	135

elongate spines tending to diverge earlier during ontogeny at about 75 mm SL as opposed to 90 mm SL for the northern form. Horizontal and vertical preopercular arms serrate. Gill rakers of moderate length, the first at the angle reaching to the third below in the northern form and to the fourth below in the southern form. Anterior nostril with short flap. Anterior chest scales embedded and slightly smaller than lateral body scales. Caudal fin slightly forked in the northern form, the upper lobe nearly always extended as an elongate filament. Southern form with caudal fin nearly truncate, upper lobe never extended as an elongate filament.

Color.—Color notes are here presented for live specimens of the northern form of *D. formosum* from North Carolina and Florida. Dorsum light brown, lateral surface tan, ventral surface white. Lateral body surface in juveniles with two dark brown stripes. In adults these stripes interrupted and appear as 5-7 vertical bars. Caudal spot distinct, equal to eye size, and present on upper half of caudal peduncle. Anal fin with pale yellow spots, pectoral and pelvic fins pale. Midlateral ventral area pink-orange in adults. Upper pharyngeal region yellow with blue flecks of pigment in adults. Posterior branchial cavity pale. Upper medial opercular surface with small patch of dark gray pigment, lower medial opercular surface pale white.

Snout with two bright blue lines from anterior lacrimal edge to orbit with bright blue irregular lines below joining to form a single line running irregularly across upper cheek. Three or four more blue lines on cheek, preopercle, and opercle. Maxillary with blue spots. Lower jaw bluish purple. Throat white, a bluish-purple blotch ventral and posterior to lower jaw symphysis. Top of head brown with four to five bluish-green lines. Seven to nine longitudinal blue lines trimmed with yellow along sides of body. These bright blue above and paler ventrally. Anterior dorsal fin with two longitudinal blue lines on an orange field. These blue lines irregular anteriorly, developing into three posteriorly, and into four lines on the soft dorsal. Tips of spines bright red-orange. Caudal fin with numerous orange spots or rows of fused spots or vertical lines on a pale blue field. Extended caudal filament orange. All colors fading with preservation. Orange and yellow becoming pale and blue becoming dusky.

In preservative the following differences between the northern and southern forms are noted: in the southern form lines on cheek and snout more wavy; dark brown vertical body bars broader, more intense, extending further ventrally; caudal spot larger than eye, extending below midcaudal peduncle line and vertical in orientation; blue lines on top of head and seven to nine body stripes not discernible; base of pectoral fin brown, not pale as in the northern form; blue dorsal fin lines tending to be more irregular, terminating in three, rather than four, stripes; caudal fin spots more irregular; definite dark brown spot dorsally on caudal peduncle.

Size.—The species attains a moderate size and 224 mm SL is the maximum size known.

Habits.—*Diplectrum formosum* is found in coastal areas over sand bottom at the base of reefs and upper edges of depressions in the substrate (Bortone 1971a). The species is recorded from depths of 1-80 m but is most often found at depths of 7-50 m. Larger adults tend to be found in deeper water while juveniles are more commonly taken from shallow water (Bortone 1971a).

Distribution.—*Diplectrum formosum* is a continental species found throughout the Gulf of Mexico, around peninsular Florida, and northward along the east coast of the United States to Chincoteague, Va. A record from a New York market (USNM 15844) is not confirmed to be from New York and most probably came from the North Carolina area as part of an exported fish catch. The species has been recorded from the Bahamas (Böhlke and Chaplin 1968:267). This is the only plotted literature record (Fig. 10) not verified in the present study. One specimen is from the Virgin Islands (FSBC 5393). The species is also found along the northern coast of South America, and southward to about São Paulo, Brazil. Literature accounts (e.g., Berg 1895:45-46; Cuvier and Valenciennes 1828:244-245) of the species occurring south to Uruguay cannot be confirmed at this time.

The northern form would include North American specimens examined. The southern form includes specimens from South America and the Virgin Islands. The type-locality is the Carolinas.

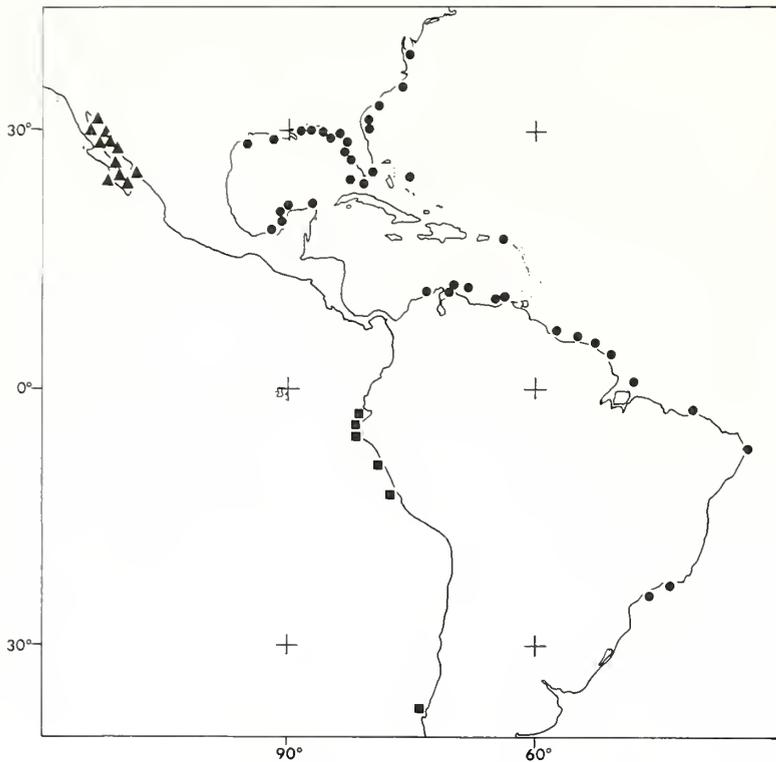


Figure 10.—Distribution map for *Diplectrum formosum* (circles); *D. sciurus* (triangles); and *D. conceptione* (squares). [Localities are based on the materials examined in this study.]

Variation.—Among meristic characters the number of gill rakers shows the most noticeable variation (Table 8). The northern form shows a mean of 18.83. There is slight variation at different localities with North Carolina specimens having a mean of 18.18, those in the Florida Keys with 19.31, and those off Yucatan with 19.80. This slight variation may be temperature induced. In the distribution of the species a sharp separation between southern and northern forms is also shown in mean gill raker count; from Venezuela southward higher mean counts increase from 21.67 to 22.48 in Brazil.

The northern subspecies has a considerably greater total length than the southern form, because of the elongate filamentous upper caudal lobe of the former. Snout length tends to be greater for the northern form, and eye size is generally larger in the southern form. All dorsal and anal spines measured tend to be slightly longer for the southern form. Color descriptions presented herein reflect discernible differences between the two forms. It cannot be established what significance the differences may have, however, until live southern form *D. formosum* are examined. The more exaggerated and earlier formed double-spur preopercle of the southern form *D. formosum* is also an important character for separating the subspecies.

Systematic comments.—The differences as well as similarities of the two forms are readily apparent. The question of separation of the two forms into different species seems at this point somewhat arbitrary in view of the obvious overlap in characters and lack of live specimens for color comparisons. It does seem, however,

that the significance of these differences should be emphasized and recognized. Therefore it is recommended that the two forms be considered as subspecies: *D. formosum formosum* (Linnaeus 1766), the northern form, and *D. formosum radians* (Quoy and Gaimard 1824), the southern form.

Specimens examined.—A total of 352 specimens from 29 to 224 mm SL. NEW YORK: USNM 15844, 1 (145). VIRGINIA: USNM 143388, 1 (120). CAROLINAS: UNC 2687, 2 (192-200); UNC 194, 1 (82); UNC 6058, 27 (150-210); BMNH 207, 2 (167-224); GMBL 70-113, 2 (187-109); GMBL 67-1, 1 (125); MCZ 10255, 1 (196); MCZ 2860, 1 (178); MCZ 10254, 1 (202). JACKSONVILLE, FLA.: UNC 5225, 27 (68-175); SIO 65-522, 1 (167). S. FLORIDA, KEYS AND CUBA: USNM 4676, 2 (100-151); USNM 13057, 1 (153); UMML 2081, 4 (55-104); UMML 7778, 1 (83); UMML 17409, 1 (136); UMML 5195, 1 (57); FMNH 46165, 2 (165-168); UMML 3223, 15 (49-147); MCZ 45033, 1 (184); TABL (Key Biscayne, 13 Dec. 1967), 4 (55-72); CAS SU1422, 6 (65-169); FSBC 336, 5 (57-115); MCZ 2932, 1 (113); MCZ 2929, 1 (105); MCZ 21768, 1 (164); MCZ 21766, 1 (155); MCZ 21767, 1 (145); MCZ 21765, 1 (155); MCZ 38654, 1 (183); MCZ 2863, 2 (143-178); MCZ 46663, 1 (155); UMML 16240, 1 (80). EASTERN GULF OF MEXICO: UMML 1814, 1 (92); FMNH 33952, 1 (94); FMNH 33953, 1 (88); FSBC 2955, 7 (75-155); FSBC 4667, 7 (94-150); FSBC 6376, 17 (42-88); MCZ 45116, 1 (147); TABL (Sanibel Is., 14 Aug. 1959), 1 (68); MCZ 38656, 1 (197). NORTHERN GULF OF MEXICO: USNM 142852, 8 (29-45); FSU 17893, 4 (41-65); FSU 17890, 3 (81-95); FSU 14724, 1 (100); FSU 269, 2 (71-78); FSU 18508, 35 (33-93); MCZ 35111, 3 (184-198); UW 16762, 1 (124); UW 16648, 4 (95-116); USNM 155208, 2 (135-138); GCRL 812, 3 (94-107); GCRL 1213, 1 (137); GCRL 1444, 1 (72). TEXAS: USNM 143389, 1 (124). MEXICO: USNM 134192, 1 (167); FMNH 45476, 2 (155-162); MCZ 38, 1 (177); INP LB776, 1 (140); GCRL 2981, 2 (102-107); UTIMS 923, 1 (155); UTIMS 924, 4 (66-130); UTIMS 919, 1 (124); UTIMS 916, 2 (51-84). VIRGIN ISLANDS: FSBC 5393, 1 (62). COLOMBIA: USNM 211406, 3 (150-157); USNM 211403, 3 (145-148). VENEZUELA: UNC (Cubagua, 11 Oct. 1971), 9 (109-167); MCZ 40942, 7 (52-92); MCZ 41088, 1 (160); UPR 2665, 3 (108-144); USNM (lat. 10°30'N, long. 70°30'W, 15 Nov. 1958), 5 (72-104);

Table 8.—Total number of gill rakers of *Diplectrum* species and populations.

Species	15	16	17	18	19	20	21	22	23	24	25	26	27	28
<i>D. formosum</i>														
North Carolina			2	29	5	2								
Jacksonville				19	9	2								
S. Florida			1	10	22	12	5	2						
W. Florida				11	18	6								
N. Florida				21	25	7								
Mississippi, Louisiana, Texas				2	5		1							
Yucatan				1	5	7		2						
Northern total			3	93	89	36	6	4						
Southern total					1	6	32	31	28	10				
Venezuela						5	11	11	9					
Guyana					1	1	11	9	7	1				
Brazil							10	11	12	9				
Total			3	93	90	42	38	35	28	10				
<i>D. bivittatum</i>														
Gulf of Mexico						7	54	70	40	15	1			
S. Florida				1	6	19	24	12	1					
Caribbean and South America		1	2	28	102	118	38	8	5					
Total		1	2	29	108	144	116	90	46	15	1			
<i>D. radiale</i>	1	2	23	46	18	12	5							
<i>D. pacificum</i>			1	5	28	75	56	8	2	2				
<i>D. rostrum</i>								1	21	5	5			
<i>D. conceptiane</i>									5	6	23	13	8	1
<i>D. maximum</i>			1	3	2	7	1							
<i>D. sciurus</i>														
<i>D. euryplectrum</i>							3	20	58	70	33	4	2	
<i>D. labarum</i>					6	17	42	58	20	2				
<i>D. eumelum</i>				6	47	38	11	1						
<i>D. macropoma</i>			1	13	53	71	30	11	3	2				
Species	32	33	34	35	36	37	38	39	40	41	\bar{x}	s	n	
<i>D. formosum</i>														
North Carolina											18.18	0.61	38	
Jacksonville											18.43	0.63	30	
S. Florida											19.31	1.08	52	
W. Florida											18.86	0.69	35	
N. Florida											18.74	0.68	53	
Mississippi, Louisiana, Texas											19.00	0.92	8	
Yucatan											19.80	1.08	15	
Northern total											18.83	0.92	231	
Southern total											22.01	0.74	108	
Venezuela											21.67	1.01	36	
Guyana											21.77	1.07	30	
Brazil											22.48	1.09	42	
Total											19.74	1.68	339	
<i>D. bivittatum</i>														
Gulf of Mexico											22.03	1.01	187	
S. Florida											20.68	1.00	63	
Caribbean and South America											19.67	1.05	302	
Total											20.58	1.49	552	
<i>D. radiale</i>											18.25	1.17	107	
<i>D. pacificum</i>											20.25	1.02	177	
<i>D. rostrum</i>											23.44	0.80	32	
<i>D. conceptiane</i>											25.28	1.17	56	
<i>D. maximum</i>											19.28	1.14	14	
<i>D. sciurus</i>	1	3	3	28	33	42	26	12	1	2	36.64	1.51	151	
<i>D. euryplectrum</i>											23.68	1.06	190	
<i>D. labarum</i>											21.52	1.05	145	
<i>D. eumelum</i>											19.55	0.80	103	
<i>D. macrapama</i>											19.93	1.16	184	

BMNH 1904-3.15:26-7. 1 (163); RMNH 23349, 2 (162-170). CURAÇAO: RMNH 22193, 1 (188); RMNH 22194, 1 (177). GUYANA: BMNH 1961-8.31:122-127, 3 (129-150); FMNH 64975, 5 (80-143); USNM 15681, 3 (128-154). SURINAM: USNM 185497, 2 (142-151); USNM 185306, 7 (115-135). FRENCH GUIANA: FMNH 64966, 2 (130-146); UMML 11593, 1 (131). BRAZIL: MCZ 2864, 5 (142-153); USNM 185028, 2 (44-66); MZUSP 9059, 1 (117); MZUSP 9055, 1 (125); MZUSP 8989, 1 (114); MZUSP 9060, 1 (144); MZUSP 9058, 1 (127); MZUSP 9057, 1 (99); MZUSP 9056, 1 (119); MNHN 7022, 1 (133); MNHN A464, lectotype, 1 (148); MNHN A461, 1 (123); MNHN 7018, 1 (104); MCZ 44166, 2 (105-106); USNM 156780, 5 (101-140); USNM (*Oregon* 4241), 2 (121-141); USNM 100853, 1 (123); MZUSP 9066, 1 (80); MZUSP 9067, 1 (80); MZUSP 9068, 1 (69); MZUSP 9069, 1 (67); MZUSP 9070, 1 (76); MCZ 10245, 9 (83-131); MZUSP 9061, 1 (97); MZUSP 9062, 1 (94); MZUSP 9063, 1 (92); MZUSP 9064, 1 (77); MZUSP 9065, 1 (87); UMML 115411, 2 (120-123); BMNH 1923-7.30:80-82, 1 (129).

Diplectrum bivittatum (Valenciennes 1828)

Figures 6, 8, 9, 11

Serranus bivittatus Valenciennes in Cuvier and Valenciennes 1828:241-242 (original description, Martinique and Havana); Storer 1846:27 (general account); Gill 1863:236 (generic affinity with *Haliperca*); Poey 1866:185 (Cuba); Poey 1868:282 (description, Cuba); Boulenger 1895:297 (catalog).

Centropristis bivittatus Günther 1859:82 (catalog).

Haliperca bivittatus Poey 1871:52-54 (systematics).

Serranus radialis Jordan 1886:376 (in part, distribution); Jordan 1887:82 (catalog, West Indies); Metzelaar 1919:54-55 (synonymy, West Indies).

Diplectrum radiale Jordan and Eigenmann 1890:398-399 (in part, systematics); Jordan and Evermann 1896:1203-1205 (in part, systematics); Evermann and Marsh 1902:159 (Puerto Rico); Fowler 1907:263 (in part, distribution); Meek and Hildebrand 1925:472, 475-477, pl. 46, fig. 1 (systematics, Panama); Nichols 1929:255 (Puerto Rico and Virgin Islands); Jordan et al. 1930:318 (in part, check list); Longley 1932:286 (biology, Florida); Beebe and Tee-Van 1933:135-136 (description, Bermuda); Baughman 1950:249 (Texas); Briggs 1958:272 (in part, distribution); Caldwell and Caldwell 1964:16 (Colombia and Aruba); Randall 1968:73, 76, fig. 86 (description, Caribbean); Anonymous 1971:63-65 (popular account); Dahl 1971:225 (Colombia); Dahlberg 1975:58 (Georgia).

Haliperca bivitata Diaz 1893:52 (name only, misspelled).

Diplectrum bivittatum Longley and Hildebrand 1941:104-105 (field data, Florida); Ginsburg 1948:266-270 (systematics); Hildebrand 1955:208, 222-223, table 7 (systematics, Campeche); Bailey et al. 1960:25 (check list); Bullis and Thompson 1965:44 (field data); Roessler 1965:314, table 2 (field data, Florida); Caldwell 1966:40 (Jamaica); Moe et al. 1966:32 (Florida); Starck and Davis 1966:320 (Florida); Starck 1968:19 (Florida); Bailey et al. 1970:34 (check list); Gallaway et al. 1972:89 (key); Miller and Jorgenson 1973:310 (meristics); Dahlberg 1975:55 (Georgia); Walls 1975:168-169 (northern Gulf of Mexico).

Diplectrum arcuarium Ginsburg 1948:266-270 (original

description, Gulf of Mexico); Baughman 1950:249 (Texas); Pearse 1952b (parasites); Hildebrand 1954:304 (Texas); Hildebrand 1955:224, table 7 (systematics, Gulf of Mexico); Briggs 1958:272 (distribution); Hoese 1958:331 (Texas); Bullis and Thompson 1965:44 (field data); Gunter and Hall 1965:31 (field data, Florida); Cervigon 1966:324 (name only); Swingle 1971:33 (Alabama); Franks et al. 1972:84 (Mississippi).

Diplectrum spp. Lowe 1962:695 (in part, Guyana).

Diplectrum bivittatum Cervigon 1966:324 (name only, misspelled).

The species was described originally as *Serranus bivittatus* by Valenciennes in Cuvier and Valenciennes (1828:241-242) from two specimens (syntypes). In the absence of any designated holotype, MNHN 6988 (Martinique) is designated the lectotype. MNHN 5889 (Havana, Cuba) was not chosen as the lectotype as it is from the area of the intermediate population (see below) and is here considered the only paralectotype.

Early confusion in the literature regarding *D. bivittatum* probably was due to inclusion of its specific name under the synonymy of *D. radiale* by Jordan and Eigenmann (1890:399) because they considered *Serranus bivittatus* to be the young of *D. radiale*. It was not until Longley and Hildebrand (1941:104-105) that *D. bivittatum* was restored to specific status.

Ginsburg (1948:266-270) considered the Gulf of Mexico population to be a distinct subspecies. However, designation by Ginsburg (1948:268) as *D. arcuarium* and not as *D. b. arcuarium* led later authors incorrectly to accord specific status to Ginsburg's subspecies.

Figures by Meek and Hildebrand (1925:pl. 46, fig. 1) and Randall (1968:fig. 86) are labeled as *D. radiale* but actually depict *D. bivittatum*.

Diagnosis.—*Diplectrum bivittatum* in the Atlantic can be confused only with *D. radiale*. The problem becomes especially important in the area of sympatry along the northern and northeastern coasts of South America. *Diplectrum bivittatum* has a larger eye, lower number of pectoral rays, a longer second and shorter third dorsal spine (1.2-1.6 vs. 1.7-2.1, the second into the third) than *D. radiale*. Also, the preopercular structure is more pointed in *D. bivittatum* but definitely squared in *D. radiale*. The upper caudal lobe is often extended as a filament in *D. bivittatum* but never in *D. radiale*. Coloration and cheek scale rows A (mean 8.06 for *D. bivittatum* vs. 9.95) also separate the species.

Description.—Because of the systematic problems present in *D. bivittatum*, the two geographic forms from the Gulf of Mexico and Caribbean and an intermediate group from south Florida will each be described separately for morphometric characters. Meristic characters except numbers of pectoral rays, predorsal scale rows, and gill rakers are virtually identical for all three groups and are presented under the description for the Gulf of Mexico specimens.

Gulf of Mexico.—D, X, 12; A, III, 7 (6-8); P₁, 15.16 (14-16); pored lateral-line scales 48.54 (44-51); scale rows in lateral line, 64.69 (54-75); scales above lateral line, 7.28 (6-9); scales below lateral line, 18.69 (16-22); predorsal scale rows, 12.76 (10-15); cheek scale rows A, 8.06 (7-9); cheek scale rows B, 11.86 (9-14); gill rakers, 22.03 (20-25).

Standard length, 91.38 (11.28, 75-125, 53). Total length, 1,304 (47.77, 1,231-1,440, 45); fork length, 1,169 (13.07, 1,143-1,203, 51); body depth, 267 (12.34, 237-296, 53); head length, 347 (8.13, 324-369, 53); postorbital length, 179 (5.76, 169-191, 53); snout length, 89 (6.01, 76-106, 53); lacrimal width, 40 (4.53, 29-51, 53); maxillary width, 28 (1.82, 25-34, 53); orbit length, 92 (4.74, 83-103, 53); orbit width, 72 (4.98, 60-83, 53); interorbital width, 71 (3.50, 64-80, 53); upper jaw length, 156 (3.80, 148-165, 53); lower jaw length, 176 (5.78, 158-188, 52); cheek height, 110 (5.70, 96-123, 53); cheek length, 117 (4.35, 109-128, 53); caudal peduncle depth, 123 (4.32, 111-131, 52); pectoral fin length, 267 (10.38, 250-283, 51); pelvic fin length, 222 (10.29, 203-249, 53); predorsal length, 344 (11.62, 316-372, 53); pelvic origin to lower jaw, 339 (17.59, 313-398, 52); pelvic origin to anus, 311 (11.93, 259-349, 53); postanal length, 398 (12.84, 364-425, 52). Dorsal spine height: first, 52 (6.21, 38-64, 52); second, 78 (8.27, 59-95, 50); third, 105 (11.60, 79-134, 50); fourth, 124 (10.46, 101-147, 49); fifth, 132 (8.91, 103-152, 51). Anal spine height: first, 36 (5.32, 20-49, 53); second, 63 (6.93, 33-73, 52); third, 86 (7.90, 69-105, 52).

Caribbean and South America.—P₁, 15.45 (14-16); predorsal scale rows, 14.18 (12-17); gill rakers, 19.67 (16-23). Standard length, 94.00 (11.43, 76-122, 51). Total length, 1,309 (60.74, 1,226-1,477, 48); fork length, 1,145 (24.56, 1,040-1,251, 51); body depth, 265 (14.63, 234-296, 51); head length, 353 (10.75, 328-376, 51); postorbital length, 173 (5.05, 164-185, 51); snout length, 96 (7.15, 82-110, 51); lacrimal width, 39 (3.99, 30-47, 39); maxillary width, 28 (2.07, 24-33, 39); orbit length, 98 (5.44, 87-114, 51); orbit width, 78 (5.29, 69-90, 51); interorbital width, 74 (3.93, 63-82, 38); upper jaw length, 167 (5.48, 158-177, 51); lower jaw length, 187 (5.10, 175-197, 51); cheek height, 108 (5.45, 100-119, 51); cheek length, 119 (5.73, 108-135, 51); caudal peduncle depth, 115 (4.29, 105-122, 51); pectoral fin length, 240 (11.25, 219-273, 48); pelvic fin length, 204 (9.94, 186-226, 49); predorsal length, 352 (10.74, 329-377, 33); pelvic origin to lower jaw, 351 (24.85, 322-402, 46); pelvic origin to anus, 312 (18.27, 273-346, 51); postanal length, 389 (13.81, 360-416, 51). Dorsal spine height: first, 49 (4.99, 39-62, 48); second, 73 (6.92, 58-87, 48); third, 99 (9.59, 84-120, 47); fourth, 116 (8.22, 102-131, 48); fifth, 124 (7.20, 113-137, 45). Anal spine height: first, 32 (3.97, 24-41, 50); second, 61 (5.85, 47-76, 50); third, 81, (5.26, 69-93, 51).

Intermediate population from South Florida, Florida Keys, Tortugas, and Cuba.—P₁, 15.39 (14-16); predorsal scale rows, 12.57 (10-15); gill rakers, 20.68 (18-23). Standard length, 97.00 (13.54, 77-118, 36). Body depth, 257 (8.99, 242-269, 13); head length, 342 (9.84, 324-355, 18); postorbital length, 174 (7.48, 158-184, 17); snout

length, 90 (7.02, 74-108, 33); lacrimal width, 39 (4.15, 30-50, 32); maxillary width, 27 (1.89, 24-30, 13); orbit length, 91 (3.94, 84-102, 34); orbit width, 71 (3.60, 65-82, 34); upper jaw length, 161 (4.80, 147-171, 22); lower jaw length, 179 (4.27, 173-185, 22); caudal peduncle depth, 120 (4.04, 113-130, 22); pectoral fin length, 258 (13.89, 229-294, 22); pelvic fin length, 222 (10.85, 198-244, 22). Dorsal spine height: first, 51 (4.11, 45-61, 18); second, 74 (6.55, 64-86, 18); third, 100 (9.52, 85-119, 18).

Diplectrum bivittatum with narrow preopercular spur slightly pointed at dorsal angle, rounded at ventral angle, four to nine spines. Vertical and horizontal preopercular limbs serrate. Anterior nostril with short flap. Chest scales slightly smaller than lateral body scales, not embedded. Gill rakers moderate in length; for Gulf of Mexico and south Florida specimens first gill raker at angle reaching to base of the fourth below; for Caribbean and South American specimens first gill raker only reaching to base of the third. Upper caudal lobe on most specimens with elongate filament. Row of small scales occasionally along base portion of third anal spine.

Color.—The following color description is based on five live adult *D. bivittatum* collected at Pensacola, Fla. in the northern Gulf of Mexico in May 1973. Dorsum brown with copper tinge. Sides tan with evidence of two broad brown lateral stripes, the upper appearing to pass through eye and continuing as a brown bar on snout. A tendency for five or six blotches of more intensified pigment along lateral stripes. Lateral surface tan, ventral and lower lateral surface white, but each scale bearing a small yellow dot at base. Chest and throat white. A distinct caudal spot (equal to eye in size) appearing as an extension of midlateral stripe but separated from it. Pectoral fin pale orange, tips black. Pelvic fins pale yellow-orange with white anterior and posterior edges. Anal fin white at base and distal edge, pale yellow through medial fin portion. Snout with narrow brown bar, and a narrow blue one beneath, below this a blue cheek stripe running upward from middle anterior lacrimal edge posteriorly to eye, passing under the orbit and across upper cheek. Another blue stripe below this on central cheek area. Opercle with pale greenish-yellow blotch. A thin blue line present on lower jaw and along upper maxillary. Pale blue spots on head with two pale blue chevrons above. Spinous dorsal fin with wavy blue bar at base, above this an orange bar, above this a blue bar, and distally an orange bar. Soft dorsal fin with irregular yellow spots along base. Above are two parallel longitudinal rows of pale blue spots on an orange field. Distal portion of fin with orange bar. Caudal fin with five or six orange spots in vertical rows on a pale blue field, upper lobe and edge orange, lower caudal blue. Upper pharyngeal region bright yellow. Posterior branchial surface with yellow and black blotches, medial opercular surface black.

An 80-mm-SL specimen from Galeta Point, Panama, agreed with the above color description with the following emendations: yellow spots and blotches on dorsal fin paler and the distal area of dorsal membranes with

wedge-shaped white spots behind anterior spines. Anterior dorsal spine orange. Dorsal caudal peduncle with two dark brown spots bordered by white spots forming a longitudinal line. Dorsum brown-copper with a trace of olive-green pigment.

Orange and yellow pigments are pale to clear in preserved specimens, blue appears dusky. Upper medial opercular surface dusky, paler below; posterior branchial surface dusky.

Size.—*Diplectrum bivittatum* is a small species, the largest specimen recorded in the present study is 126 mm SL.

Habits.—*Diplectrum bivittatum* has been captured at a wide range of depths from 2 to 110 m but most frequently at 15-80 m. In January-February 1973 I observed the species off Galeta Point, Panama, in 2-3 m of water. It appeared to be solitary and occurred over a clean coral-shell bottom at the base of reefs. This species is the most insular of all *Diplectrum*, frequently taken in the Antilles. Starck (1968:19) listed *D. bivittatum* as being common at Alligator Reef, Fla. Gulf of Mexico specimens are found more often over a more mud-silt bottom than Caribbean and intermediate populations.

Distribution.—*Diplectrum bivittatum* is found in the western Gulf of Mexico but terminates its northern Gulf of Mexico distribution near Pensacola, Fla. (Fig. 11). It occurs in the area of the Dry Tortugas, northern Cuba, southern Florida, and northward along the Florida east coast to lat. 29°43'N, long. 80°49'W near St. Augustine,

Fla. Beebe and Tee-Van (1933:135-136) reported *D. bivittatum* (as *D. radiale*) from Bermuda. This record is not plotted as it could not be verified (W. Smith-Vaniz, Acad. Nat. Sci. Philadelphia, pers. commun.). The species is found at Jamaica, Puerto Rico, and throughout the Lesser Antilles. *Diplectrum bivittatum* is also found off Central America, along the northern and southern coasts of South America, and terminates its southern distribution off Brazil at lat. 2°23'S, long. 40°31'W. The type-specimens are from Martinique and Havana, Cuba.

Variation.—Meristic and morphometric data confirm the existence of two reasonably distinct geographical subspecies. One subspecies is in the Gulf of Mexico and the other is found in the Caribbean and along the northern South American coast; an intermediate population occurs in the vicinity of Florida Keys, southern Florida, Tortugas, and northern Cuba (this general area referred to hereafter as S. Florida).

The Gulf of Mexico subspecies has a lower mean number of pectoral rays and predorsal scale rows, but a much higher mean gill raker count than the Caribbean and South American subspecies. The S. Florida population is intermediate for mean number of pectoral rays and gill raker count. The Gulf of Mexico subspecies has several morphometric characters differing from the Caribbean and South American subspecies (Table 9). The S. Florida population is intermediate in several characters, notably snout length, postorbital length, upper- and lower-jaw lengths, caudal peduncle depth, pectoral fin length, and dorsal spine height.

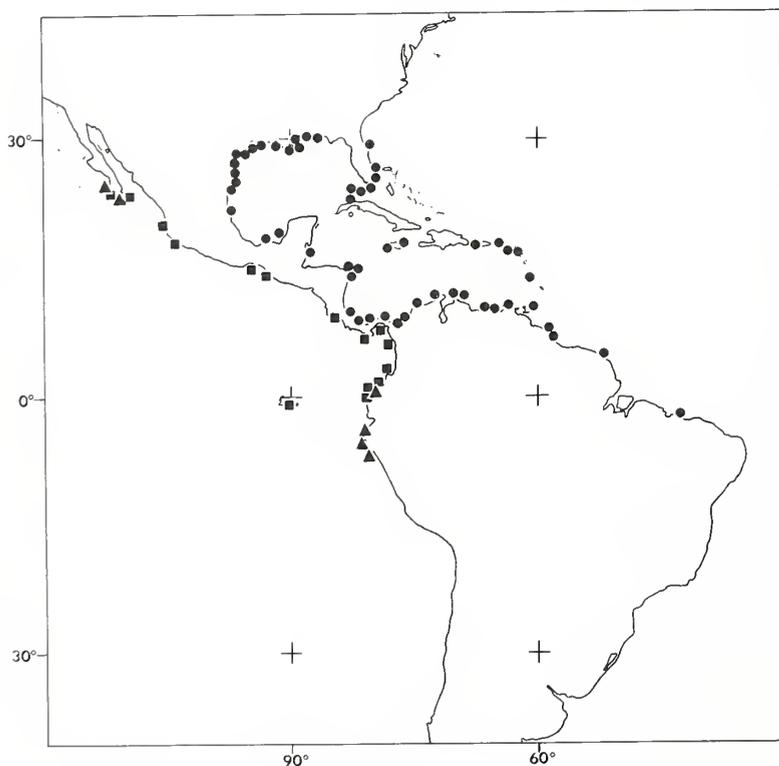


Figure 11.—Distribution map for *Diplectrum bivittatum* (circles); *D. maximum* (triangles); and *D. euryplectrum* (squares). [Localities are based on the materials examined in this study.]

Table 9.—Mean proportional data in thousandths of standard length (SL) for *Dipteris* species and populations.

	<i>D. formosum</i> northern	<i>D. formosum</i> southern	<i>D. bivittatum</i> Gulf	<i>D. bivittatum</i> S. Florida	<i>D. bivittatum</i> Carib. & S.A.	<i>D. radiata</i>	<i>D. pacificum</i>	<i>D. rostrum</i>	<i>D. conceptione</i>	<i>D. maximum</i> small	<i>D. maximum</i> large	<i>D. scirtus</i>	<i>D. euryplectrum</i>	<i>D. labarum</i>	<i>D. eumelum</i>	<i>D. macropoma</i>
SL in mm	140	119	91	97	94	137	150	120	108	65	245	95	112	117	152	107
Total length	1,340	1,269	1,304		1,309	1,249	1,289	1,320	1,275	1,224	1,245	1,263	1,260	1,271	1,279	1,308
Fork length	1,191	1,183	1,169		1,145	1,179	1,178	1,165	1,187	1,189	1,178	1,172	1,193	1,179	1,187	1,190
Body depth	275	270	267	257	265	264	278	288	277	257	285	269	291	291	286	306
Head length	359	362	347	342	353	367	369	369	379	361	363	356	423	381	387	367
Postorbital length	191	192	179	174	173	211	211	193	213	189	211	186	241	204	221	202
Snout length	113	101	89	90	96	93	97	103	94	91	102	89	103	99	99	96
Lacrimal width	59	52	40	39	39	48	49	51	37	33	54	27	46	42	48	41
Maxillary width	26	27	28	27	28	27	27	27	34	35	30	36	36	33	33	35
Orbit length	74	83	92	91	98	81	79	90	90	99	67	92	102	95	86	87
Orbit width	59	63	72	71	78	65	63	72	75	76	50	78	84	76	72	73
Interorbital width	74	73	71		74	70	70	74	69	73	72	79	88	77	70	67
Upper jaw length	160	160	156	161	167	164	163	164	159	158	159	142	189	176	171	163
Lower jaw length	179	181	176	179	187	180	176	175	182	181	173	172	206	194	184	182
Cheek height	125	119	110		108	129	128	119	111	98	130	95	141	128	129	119
Caudal peduncle depth	128	129	117		119	118	118	122	108	111	97	122	130	121	121	118
P ₁ length	134	125	123	120	115	125	129	121	116	118	124	105	106	117	122	139
P ₂ length	235	238	267	258	240	236	244	257	256	230	234	254	256	250	267	265
Predorsal length	216	210	222	222	203	187	195	214	215	196	202	211	212	203	201	196
P ₂ to lower jaw	349	350	344		352	367	359	360	365	366	352	343	375	363	369	382
P ₂ to anus	341	342	339		351	342	334	336	336	337	340	351	361	349	339	348
Postanal length	306	314	311		312	314	313	321	317	286	322	336	309	346	314	296
Dorsal spine height	402	401	398		389	399	406	397	401	406	403	372	374	378	402	411
1	51	53	52	51	49	43	49	57	46	77	66	62	60	61	50	46
2	78	79	78	74	73	64	70	83	72	95	83	88	87	140	74	67
3	95	100	105	100	99	118	122	129	147	132	128	125	118	170	121	130
4	105	110	124		116	128	135	143	158	146	137	142	132	165	132	142
5	110	113	132		124	126	136	145	150	140	135	146	137	151	133	144
Anal spine height																
1	25	29	36		32	30	33	32	45	56	41	31	32	39	29	32
2	47	53	63		61	58	60	59	84	91	68	59	62	69	60	59
3	70	74	86		81	79	80	80	95	88	74	86	82	91	83	90

Systematic comments.—Ginsburg (1948:266-270) described the Gulf of Mexico form as the subspecies *D. b. arcuarium*. Ginsburg (1948:268) and later Hildebrand (1955:208) suggested that further studies should be conducted on the correct status of *D. b. arcuarium* especially with regard to proper identification of *D. bivittatum* from South America (for comparative purposes). Confusion of *D. bivittatum* with *D. radiale* had occurred for many years. In the present study only "good" *D. bivittatum* from the Caribbean and South America were compared with *D. b. arcuarium*. Although the question of the "true" status of *D. b. arcuarium* may never be completely answered, on the basis of meristic counts, morphological data, and geographical distribution, it is suggested that *D. b. arcuarium* Ginsburg 1948 be recognized as a subspecies. The Caribbean and South American form of *D. bivittatum* should hereafter be considered subspecifically as *D. b. bivittatum* (Valenciennes 1828). The S. Florida population of *D. bivittatum* represents an intermediate of the two subspecies both morphologically and geographically. Future studies should be conducted to examine further the nature of the S. Florida population.

Specimens examined.—A total of 568 specimens from 22 to 126 mm SL. S. FLORIDA AND KEYS: UMML 3804, 1 (63); UMML 10170, 1 (68); UMML 2959, 1 (98); UMML 3957, 6 (86-109); UMML 2081, 1 (109); UMML 10150, 5 (22-84); USNM 117201, 20 (73-119); TABL (*Silver Bay* Stn. 4329), 2 (33-53); TABL (*Silver Bay* Stn. 2354), 1 (47); UMML 12324, 2 (90-104); FMNH 61315, 5 (105-118); USNM 4869, 3 (90-110); FSBC 799, 1 (103); FSBC 1583, 3 (57-90); FSBC 336, 11 (55-90); MNHN 5889, paralectotype, 1 (80); MCZ 10242, 1; UPR 2086, 1 (96). NORTHERN GULF OF MEXICO: FMNH 50726, 6 (62-90); GCRL 4208, 1 (81); GCRL 533, 2 (98-115); GCRL 35, 2 (81-99); GCRL 671, 1 (33); GCRL 2318, 1 (91, deformed snout); UW 16899, 3 (62-83); UW 16569, 3 (95-110); USNM 155177, 2 (81-100); USNM 129817, 1 (74); TABL 101472, 4 (69-97); TABL (*Silver Bay* Stn. 5004), 1 (105); FSM 5207, 7 (73-102); FMNH 59807, 5 (66-112); FMNH 16187, 1 (78); FMNH 16188, 1 (78); GCRL 276, 2 (87-91); USNM 144214, 1 (83); USNM 144213, 1 (117); USNM 155175, 2 (72-107). TEXAS: FSM 5177, 4 (96-103); FMNH 40263, 3 (76-105); FMNH 45144, 2 (90-91); INP LB3241, 1 (113); UMML 28700, 3 (93-108); UTIMS 926, 2 (30-37); UTIMS 1629, 2 (88-100); UTIMS 920, 1 (97); UTIMS 918, 1 (111); UTIMS 925, 4 (63-76); UTIMS 1484, 3 (30-81); UTIMS 1627, 2 (88-88); UTIMS 922, 37 (56-112); UTIMS 1024, 2 (101-105); CAS SU 50185, 1 (93); USNM 155176, 2 (80-85); USNM 144215, 9 (91-112); USNM 144216, 1 (80); USNM 155173, 1 (52); USNM 155174, 1 (96); USNM 118536, 1 (88); USNM 118535, 11 (90-97); UMML 15398, 2 (82-90); UMML 7749, 4 (33-51). YUCATAN: FSM 5209, 1 (97); UTIMS 917, 2 (90-96); UTIMS 921, 6 (54-125); USNM 188298, 30 (88-107). JAMAICA: LACM 5433, 1 (70); LACM 5434, 3 (99-108); LACM 6203, 8 (87-110); LACM 6204, 1 (72); LACM 6201, 16 (62-100); LACM 6200, 10 (62-113); LACM 6199, 23 (62-113); UMML 28699, 1 (90). PUERTO RICO AND ANTILLES: UMML 7324, 1 (49); USNM 128262, 1 (109); UMML 7110, 1 (88); FMNH 64989, 2 (86-97); FMNH 64982, 4 (110-114); MNHN 6988, lectotype, 1 (108); BMNH 1904-7.26:67, 1 (97); LACM 6741-14, 7 (46-88); LACM 6768-1, 22 (37-98); TABL (*Oregon* Stn. 2631), 1 (105); UPR 2713, 5 (67-81); UPR 2158, 1 (93); UPR 239, 1 (94); UPR 1329, 2 (76-84); UPR 1328, 1 (42); UPR 2692, 1 (92); UPR 2055, 1 (65); UPR 238, 1 (90); UPR 1330, 1 (44). BELIZE: TABL 105165, 2 (94-99); TABL 105164, 10 (86-112). HONDURAS: FMNH 64956, 4 (95-106); USNM 185143, 2 (96-99); TABL 105155, 11 (94-107); TABL 105156, 8 (86-103); TABL 105157, 7 (82-102); TABL 105158, 1 (96); TABL 105160, 30 (74-109). COSTA RICA: UCR 253-31, 2 (88-92); LACM 30729-5, 1 (103). PANAMA: UCR 226-4, 3 (103-114); FMNH 8392, 9 (44-62); FMNH 8393, 3 (31-40); MCZ 45530, 2 (31-64); UMML 23897, 5 (69-90); UMML 22007, 6 (90-103). VENEZUELA: RMNH 8448, 1; RMNH 8422, 1 (120); RMNH 9377, 1 (109); USNM (*Oregon* Stn. 4865), 6 (37-117);

TABL (*Geronimo* Stn. 7), 1 (122); UMML 28736, 1 (119); UMML 28759, 1 (110); UMML 28769, 4 (93-103); UMML 28767, 6 (94-107); UMML 28694, 7 (92-112); UMML 27242, 7 (31-61); UMML 27220, 12 (76-99); UMML 26613, 3 (49-54); UMML 17071, 1 (102); UMML 16302, 1 (117); UMML 16283, 1 (85); UMML 15397, 10 (64-78); UMML 15390, 2 (98-104); UMML 15368, 1 (108); UMML 15301, 5 (108-115); UMML 15081, 1 (96). TRINIDAD-TOBAGO: BMNH 1920-12.22:38, 1 (110); UMML 28757, 1 (116); UMML 28670, 1 (100); UMML 16802, 2 (112-122). GUYANA: UMML 5375, 1 (115); FMNH 67904, 5 (90-118); USNM 156792, 2 (95-99); UMML 12247, 2 (117-126). FRENCH GUIANA: UMML 6706, 3 (105-107). BRAZIL: USNM (Acc. No. 247715), 1 (103).

Diplectrum radiale (Quoy and Gaimard 1824)

Figures 6, 8, 9, 12

Serranus radialis Quoy and Gaimard 1824:316-317 (original description, Rio de Janeiro); Cuvier and Valenciennes 1828:243-244 (description, Brazil); Cuvier 1829:139 (generic position); Boulenger 1895:297-298 (in part, catalog).

Serranus irradians Valenciennes in Cuvier and Valenciennes 1828:244-245 (in part, original description, Brazil); Canestrini 1860:306 (systematics).

Centropristis radialis Günther 1859:83 (catalog); Steindachner 1876:6 (systematics).

Centropristis ayresi Steindachner 1868:1-3, pl. 1, fig. 1 (original description, Brazil).

Diplectrum radiale Jordan 1895:451 (Mexico); Jordan and Eigenmann 1890:397-398 (in part, systematics); Jordan and Evermann 1896:1203-1205 (systematics); Fowler 1907:263 (in part, distribution); Fowler 1916a:534 (West Indies); Jordan et al. 1930:318 (in part, check list); Longley and Hildebrand 1941:104 (systematics); Fowler 1942:158 (Brazil); Ginsburg 1948:268-270 (systematics); Schultz 1949:119-120 (Venezuela); Briggs 1958:272 (in part, distribution); Durand 1961:46, 50 (field data, Guyana); Brandão 1964:19 (Brazil); Bullis and Thompson 1965:44 (southeast coast of United States); Cervigon 1966:323-324 (systematics, distribution, and biology, Venezuela); Mago Leccia 1970:94 (Venezuela); Ewald et al. 1971:54 (Venezuela); Miller and Jorgenson 1973:310 (meristics).

Haliperca radialis Miranda-Ribeiro 1915:29-30 (Brazil); Miranda-Ribeiro 1918:93 (synonymy, Brazil). *Diplectrum* spp. Lowe 1962:695 (in part, Guyana).

Valenciennes in Cuvier and Valenciennes (1828:244-245) described *Serranus irradians* and that description is clearly of *D. formosum*. However, examination of the four syntypes for *S. irradians* shows that MNHN A461, A464, and 7018 are *D. formosum* but the other syntype, MNHN A462, is actually *D. radiale*.

Many references in the synonymy are listed "in part" owing to confusion when Gulf of Mexico *Diplectrum*, other than *D. formosum*, were called *D. radiale* while in the Pacific Ocean *D. pacificum* was referred to as *D. radiale* until the description of *D. pacificum* by Meek and Hildebrand (1925).

Centropristis ayresi was described by Steindachner

(1868:1-3) but later it was placed in the synonymy of *D. radiale* [*Centropristis* (= *Diplectrum*) *radiale*, Steindachner 1876:6].

The species was included under the genus *Haliperca* by Miranda-Ribeiro (1915:29-30) at the inference of Gill's (1863) generic interpretation.

Diagnosis.—*Diplectrum radiale* is a species with a narrow preopercular spur and in the Atlantic can only be confused with *D. bivittatum*. Separation of these species is possible when one considers the relative height of the dorsal spines, especially the number of times the second spine fits into the third (1.7-2.1 for *D. radiale*, 1.2-1.6 for *D. bivittatum*). The eye is smaller for *D. radiale*. Also the mean number of pectoral rays and of cheek scale rows A is higher; the preopercle generally is more squared off in *D. radiale* and definitely more pointed in *D. bivittatum* at its upper angle.

Diplectrum radiale in the Atlantic is a "geminate species" with *D. pacificum* in the Pacific as defined by Jordan (1908). The species can be discriminated by several characters: notably the gill raker length, color pattern, and other characters considered under the diagnosis for *D. pacificum*.

Description.—D, X, 12 (13); A, III, 7; P₁, 16.79 (16-18); pored lateral-line scales, 48.82 (47-52); scale rows in lateral line, 63.36 (54-71); scales above lateral line, 7.28 (6-9); scales below lateral line, 18.57 (15-21); predorsal scale rows, 15.25 (12-19); cheek scale rows A, 9.95 (9-12); cheek scale rows B, 11.73 (10-14); gill rakers, 18.25 (15-21).

Standard length, 136.97 (23.12, 84.4-168, 42). Total length, 1,248 (10.70, 1,222-1,276, 42); fork length, 1,179 (9.75, 1,160-1,207, 42); body depth, 264 (20.10, 218-302, 40); head length, 367 (19.54, 335-406, 42); postorbital length, 211 (16.61, 188-254, 42); snout length, 93 (8.33, 74-114, 42); lacrimal width, 48 (5.15, 40-57, 32); maxillary width, 27 (2.72, 22-30, 32); orbit length, 81 (5.55, 71-95, 40); orbit width, 65 (5.95, 54-79, 42); interorbital width, 70 (8.56, 54-83, 32); upper jaw length, 164 (12.41, 144-193, 42); lower jaw length, 180 (9.44, 160-208, 42); cheek height, 129 (11.98, 105-149, 42); cheek length, 118 (6.50, 107-132, 42); caudal peduncle depth, 125 (6.29, 110-137, 39); pectoral fin length, 236 (6.64, 213-250, 42); pelvic fin length, 187 (10.63, 152-204, 42); predorsal length, 367 (11.98, 348-397, 32); pelvic origin to lower jaw, 342 (12.82, 318-372, 39); pelvic origin to anus, 314 (19.29, 264-355, 41); postanal length, 399 (11.45, 377-420, 42). Dorsal spine height: first, 43 (5.14, 33-54, 42); second, 64 (5.12, 55-72, 40); third, 118 (8.25, 104-136, 41); fourth, 128 (7.32, 114-144, 40); fifth, 126 (7.03, 110-140, 38). Anal spine height: first, 30 (4.06, 21-38, 42); second, 58 (5.87, 47-76, 42); third, 79 (7.35, 64-97, 42).

Preopercular spur square but narrow, bearing 5-10 elongate spines. Vertical and horizontal preopercular arms serrate. Anterior nostril with elongate nostril flap. Gill rakers short, the first at angle not reaching to base of third below. Scales present in a row along second anal spine. Chest scales not noticeably smaller and not em-

bedded. Caudal lobes nearly equal in length, upper only slightly longer and never extended as a filament. Caudal fin margin nearly straight.

Color.—Color notes are from preserved specimens. Dorsum and lateral body surface light to medium brown, five to seven irregular dark vertical bars on lateral surface terminating before ventral region. Caudal spot distinct, equal to eye size. Ventral area white. Snout, head, and cheek gray-brown. Lower preopercle pale below. Maxillary gray-brown and paler distally. Lower jaw dusky at midline. Pectoral, anal, and pelvic fins pale. Caudal fin with three to four pale broad vertical bars bordered by darker bars of equal breadth. Two indistinct dark spots on dorsum of caudal peduncle, separated by a smaller pale spot. First and second dorsal spines dark. Spinous dorsal fin dusky, black at spine tips. Soft dorsal with two regular rows of pale spots on a dusky field. Soft dorsal ray tips and caudal ray tips black. Medial opercular surface black or dusky above, white below. Posterior branchial surface dusky.

Size.—The species attains a reasonably large size; 197 mm SL is the maximum size examined in the present study.

Habits.—Depth data indicate that *D. radiale* occurs in depths ranging from 20 to 80 m. Durand (1961) confirmed this depth distribution off the coast of Guyana. He took the species from sand-mud, and shell and sand-bottom types. Cervigon (1966) stated the species principally consumes crustaceans and small fish.

Distribution.—*Diplectrum radiale* is found in coastal areas of eastern and northeastern coasts of South America (Fig. 12). Its westernmost distribution along the Venezuelan coast is the Gulf of Venezuela. The species extends southward to São Paulo, Brazil. Literature records indicate the species occurring southward to Uruguay but this has not been confirmed. One specimen (BMNH 1904-3.15:24-5) was accompanied by a label which stated "St. Thomas." It was presumed that this meant St. Thomas Island in the Virgin Islands. Other than this record the species has not been taken from the Caribbean Antilles. It is possible that the locality is in error or that "St. Thomas" refers to a city on continental South America. The type-locality is Rio de Janeiro.

Variation.—No discernible geographic variation in meristic characters was observed for this species. There appears to be a slight (but statistically untested) trend of morphological variation in *D. radiale*. Northern specimens appear to have slightly larger heads and jaws than specimens from the southern parts of South America.

Specimens examined.—A total of 103 specimens from 64 to 197 mm SL. ST. THOMAS: BMNH 1904-3.15:24-5, 1 (174). VENEZUELA - TRINIDAD: UPR 1830, 1 (89); BMNH 1922-2.3:29, 1 (128); UMML 28757, 1 (166-166); UMML 28749, 2 (195-197); UMML

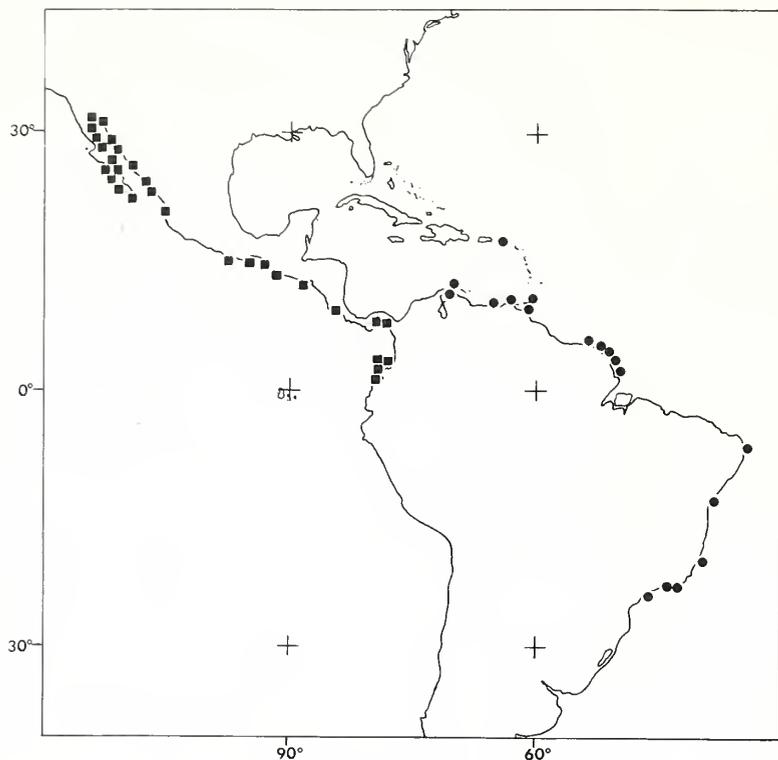


Figure 12.—Distribution map for *Diplectrum radiale* (circles); and *D. pacificum* (squares). [Localities are based on the materials examined in this study.]

21851, 3 (170-173); UMML 16302, 1 (107); USNM 123132, 1 (100); TABL (Gulf of Cariaco, 14 Apr. 1966). GUYANA - NE BRAZIL: FMNH 64967, 2 (166-167); FMNH 64980, 4 (151-158); UMML 12237, 1 (136); USNM 185497, 4 (151-164); USNM 156806, 1 (184); USNM 185484, 5 (155-168); UMML 11536, 1 (159); UMML 11581, 1 (186); UMML 11588, 1 (178); UMML 11553, 1 (153). SE BRAZIL: BMNH (Bahia), 1 (142); MZUSP 9007, 1 (102); MZUSP 9008, 1 (96); MZUSP 9009, 1 (90); MZUSP 9010, 1 (84); MZUSP 9011, 1 (86); MZUSP 9002, 1 (141); MZUSP 9003, 1 (125); MZUSP 9004, 1 (113); MZUSP 9005, 1 (119); MZUSP 9006, 1 (119); MZUSP 8997, 1 (136); MZUSP 8998, 1 (131); MZUSP 8999, 1 (131); MZUSP 9000, 1 (107); MZUSP 9001, 1 (151); USNM 100858, 5 (119-127); MNHN 7015, holotype, 1 (125); MNHN 7015, paratype, 1 (140); MCZ 44166, 23 (90-170); MCZ 4504, 4 (153-160); BMNH 1906-6.9:14-15, 2 (174-177); BMNH 1923-7.30:77-9, 1 (142); CAS SU 54082, 1 (64); MCZ 10245, 1 (124); BMNH 1892-6.29:4, 1 (127); RMNH 166, 1 (140); MZUSP 8990, 1 (113); MZUSP 8987, 1 (178); MZUSP 5222, 1 (165); MZUSP 8991, 1 (115); MZUSP 8988, 1 (124); USNM 100858, 1 (131); MZUSP 8995, 1 (135); MZUSP 8993, 1 (122); MZUSP 8994, 1 (131); MZUSP 8992, 1 (157); MZUSP 8996, 1 (112); MZUSP 10244, 2 (82-109); MNHN A462, 1 (166).

Diplectrum pacificum
Meek and Hildebrand 1925

Figures 6, 8, 9, 15

Centropristis radiale Steindachner 1876:6 (in part, Panama).

Serranus radialis Jordan and Gilbert 1881:274 (Baja California); Jordan 1886:376 (Panama and Mazatlan); Jordan 1887:82 (in part, catalog); Boulenger 1895:297-298 (in part, catalog).

Diplectrum radiale Jordan and Bollman 1890:157-158, 181 (Panama); Jordan and Eigenmann 1890:398-399 (in part, systematics account); Evermann and Jen-

kins 1892:127-128, 142 (Gulf of California); Jordan 1895:451 (Sinaloa, Mexico); Jordan and Evermann 1896:1203-1205 (systematics); Gilbert and Starks 1904:97 (Panama); Fowler 1916b:409 (Panama); Osburn and Nichols 1916:163 (Baja California); Kumada 1937:39, pl. 6, fig. C (Mexico).

Diplectrum pacificum Meek and Hildebrand 1925:472, 477-478, pl. 46, fig. 2 (original description, Panama); Jordan et al. 1930:318 (check list); Breder 1936:24 (Pacific coast); Walford 1937:123 (general account); Seale 1940:20, 23 (Panama); Fowler 1944:262-263 (color notes); Hildebrand 1946:185 (key); Grey, 1947:140 (type catalog); Berdegue Anzar 1956:53, 264-265, fig. 183 (key and fishery data, Mexico); Orces 1959:81 (systematics, Ecuador); Gosline 1966:91-112 (osteology); Rosenblatt and Johnson 1974:178-191 (key, systematics); Chirichigno F. 1974:294-298 (key, Peru); Bortone in press a (gonad morphology); Bortone in press b (life history, Panama).

Diplectrum radialis Streets 1877:52-53 (systematics, Baja California).

Earlier authors considered *D. pacificum* as a Pacific Ocean representative of *D. radiale*. Meek and Hildebrand (1925) described the Pacific form as a new species and considered it distinct from *D. radiale* as they knew it. However, the specimen of *D. radiale* figured by them (Meek and Hildebrand 1925:pl. 46, fig. 2) is actually *D. bivittatum*. Nevertheless, *D. pacificum* and *D. radiale* are distinct species, qualifying as "geminate species" as defined by Jordan (1908).

Diagnosis.—*Diplectrum pacificum* is distinguished from other Pacific *Diplectrum* by a combination of characters which include: less than 30 total gill rakers; 7 anal rays; lack of extended tips on second, third, or fourth spines; lack of an enlarged second anal spine; a relatively high number of cheek scale rows A (8-12) and B (10-14); and a narrow preopercular spur.

Diplectrum pacificum could readily be confused with *D. rostrum*, another Pacific species. It can be differentiated from *D. rostrum* by the following characters: snout spot present in *D. pacificum* but not a distinct bar as in *D. rostrum*; the soft-dorsal-fin color patterns, total gill raker counts; orbit length and width, preopercle shape and other characters listed under diagnosis for *D. rostrum*.

It might readily be confused with its geminate Atlantic form, *D. radiale*. Separation of these species admittedly is difficult but several discernible differences are evident. Meristically the number of gill rakers is higher for *D. pacificum* (20.25 vs 18.25), but other characters show a high degree of overlap and do not allow discrimination. Morphometrically there are no character differences reliably separating these species but in general the eye is smaller for *D. pacificum*, the caudal peduncle deeper, the upper caudal lobe more elongate, and fins and spines tend to be longer in *D. pacificum*. Gill rakers are moderate in length in *D. pacificum* (the first at the angle reaching to the origin of the fourth below) and are short in *D. radiale* (the first not reaching to the base of the third, usually reaching only to the base of the second below).

In preservative there are color differences between the species which surely are more distinctive in fresh specimens but no satisfactory color data for living *D. radiale* exist. Caudal fin of *D. pacificum* with five or six thin, light caudal bands bordered by wider dusky bands; *D. radiale* bears four light bands equal in width to the dusky bands which border them. The soft dorsal fin bears several irregular rows of spots in *D. pacificum* but *D. radiale* has one or two rows of regularly spaced, larger spots.

Description.—D, X, 12 (13); A, III, 7 (8); P₁, 17.02 (16-18); pored lateral-line scales, 49.05 (47-51); scale rows in lateral line, 65.48 (58-74); scales above lateral line, 7.64 (6-9); scales below lateral line, 18.88 (16-21); predorsal scale rows, 14.85 (11-19); cheek scale rows A, 9.70 (8-12); cheek scale rows B, 12.21 (10-14); gill rakers, 20.25 (17-24).

Standard length, 150 (29.12, 101-211, 40). Total length, 1,289 (24.57, 1,242-1,354, 40); fork length, 1,178 (17.23, 1,128-1,229, 40); body depth, 278 (16.66, 240-327, 37); head length, 369 (12.13, 339-392, 39); postorbital length, 211 (9.54, 188-231, 40); snout length, 97 (6.82, 84-108, 40); lacrimal width, 49 (3.98, 39-56, 39); maxillary width, 27 (1.72, 24-31, 39); orbit length, 79 (6.66, 66-90, 40); orbit width, 63 (5.07, 53-71, 40); interorbital width, 70 (4.27, 63-77, 39); upper jaw length, 163 (6.15, 149-176, 38); lower jaw length, 176 (5.54, 163-189, 39); cheek height, 128 (6.77, 114-146, 40); cheek length, 118 (5.90,

108-133, 40); caudal peduncle depth, 129 (6.18, 115-142, 40); pectoral fin length, 244 (10.04, 218-268, 40); pelvic fin length, 195 (8.05, 176-212, 39); predorsal length, 359 (9.22, 341-378, 39); pelvic origin to lower jaw, 334 (10.93, 307-358, 28); pelvic origin to anus, 313 (20.23, 273-363, 40); postanal length, 406 (13.95, 364-428, 40). Dorsal spine height: first, 49 (5.83, 36-60, 39); second, 70 (5.80, 60-84, 37); third, 122 (6.42, 106-134, 38); fourth, 135 (7.33, 120-150, 40); fifth, 136 (6.98, 122-152, 39). Anal spine height: first, 33 (4.58, 21-44, 40); second, 60 (6.33, 47-72, 40); third, 80 (5.62, 68-92, 39).

Preopercle with narrow spur bearing five to eight elongate spines (an occasional spine missing). Vertical and horizontal preopercular arms serrate. Anterior nostril with short flap. Upper caudal lobe noticeably longer than the lower. Caudal fin only slightly forked. Second anal spine as stout or more stout than third. Gill rakers moderate in length, first at angle reaching to base of fourth below. Chest scales smaller than lateral scales and slightly embedded.

Color.—Color notes were taken from live specimens from the Bay of Panama in January-February 1973. Dorsum green-brown with a copper cast. Ventral surface white. Sides of juveniles with two distinct lateral stripes, the lower passing through eye into snout. In adults lateral bars becoming disrupted by five or six vertical brown bars. Caudal spots distinct and equal to eye size. Lower lateral surface (area just above anus to midanal fin) with pink-orange blotch, about one-fourth body depth in height. Anal fin with white bars distally and proximally, the central portion of the fin yellow. Anterior and posterior edges of pelvic fin white, the central portion yellow. Pectoral fin pink-orange, occasionally a blue bar at its base. First and second dorsal spines dark blue-black, remainder of spines with orange tips. Spinous dorsal fin membrane clear at base, dusky brown through its central portion and pale blue above. Distal edge of soft dorsal fin orange. Remainder of membrane a pale blue field with irregular series of orange spots and blotches. These spots variable in shape and pattern between individuals; usually the anterior spots more rounded, posteriorly the spots elongate or fuse with other spots presenting a wavy-bar appearance. Upper caudal lobe bright orange, lower white. Two parallel orange stripes just below upper caudal lobe. Distal caudal ray tips black. Body of caudal fin with five to six pale orange bars separated by equally wide pale blue bars. Caudal fin base with small orange spots on pale blue background. Snout region with irregular elongate pale orange-yellow bar running from anterior snout to anterior orbit rim. Two or three pale orange-yellow spots below this, a thin similarly colored bar just below orbit rim, and a pale orange-yellow wavy cheek bar. The first snout bar irregular and not well delineated. Occasional spots of orange about preopercle and on the opercular-interopercular area bordering preopercular spur. Upper pharyngeal region bright yellow in adults. The medial opercular surface black above and white below. Posterior branchial region variable, black to clear. Dentary and

maxillary pale blue, small spots of orange present on these bones.

Color is faded in preserved specimens but above pattern may be discernible with orange appearing pale and blue appearing dusky.

Size.—The largest specimen observed in the present study is 224 mm SL, however, Rosenblatt and Johnson (1974) recorded a specimen 226 mm SL.

Habits.—*Diplectrum pacificum* was collected from the Bay of Panama at many different localities. Juveniles (30-70 mm SL) were common in shallow water (2 m) over mud bottom. Adults were collected in deeper water (20-30 m) over mud-sand bottom. The species was abundant at certain localities and was usually taken with *D. macropoma* (Bortone in press b). Field-collection data from museum specimens indicate the species has been taken from water 0.1-90 m deep but appearing more frequently at 15-30 m. The shallowest depth record is about 0.1 m (UA66-69) from a tide pool near Puerto Peñasco, Gulf of California.

Distribution.—*Diplectrum pacificum* is found in the coastal areas of the Gulf of California (Fig. 12), northward along the outer Baja California coast of Bahía San Juanico (lat. 26°15'N, long. 112°28'W), along the Central American coast, and southward to Ecuador-Peru (lat. 3°15'S, long. 80°25'W). The type-locality is Naos Island in the Bay of Panama.

Variation.—There is noticeable variation in the posterior branchial surface pigmentation. Southern populations tend to be very heavily pigmented in this body region. Northward along the extensive Mexican coast the degree of pigmentation decreases. Finally, populations of *D. pacificum* in the Gulf of California and outer Baja California are generally devoid of pigment. Geographical variation occurs with the number of scales in lateral line (Table 2); a trend from higher numbers to lower numbers occurs from north to south. It would appear that more concentrated studies on variation in *D. pacificum* are in order.

Specimens examined.—A total of 156 specimens examined from 25 to 224 mm SL. OUTER BAJA CALIFORNIA: LACM W55-92, 1 (131); USNM 125347, 2 (101-119); CAS SU 19107, 1 (160); SIO 60-296, 1 (142); LACM W52-195, 1 (223); USNM 167563, 2 (154-177); LACM 3667, 1 (115); SIO 65-175, 7 (97-108); SIO 64-78, 1 (182). GULF OF CALIFORNIA: USNM 165509, 2 (130-133); FMNH 62751, 4 (119-139); GCRL 2593, 5 (155-202); FMNH 63062, 2 (131-154); FMNH 63063, 2 (109-150); FMNH 57546, 1 (140); USNM 167562, 9 (122-190); LACM 9602-1, 1 (110); SIO 62-236, 10 (94-224); SIO 72-60, 8 (122-145); SIO 70-90, 4 (169-217); SIO 70-70, 1 (141); SIO 65-304, 2 (171-173); USNM 216384, 1 (134); USNM 211361, 1 (150); USNM 211411, 1 (185); USNM 183980, 13 (118-140); UA 66-69, 1 (81). CENTRAL MEXICAN COAST: LACM 30121-10, 1 (118); FMNH 70807, 6 (166-183); CAS (Acc. No. 1951-III:7), 1 (184); CAS 2327, 1 (68); INP LB-1341, 1 (164); SIO 65-164, 1 (69). GUATEMALA: UCR 463-48, 6 (125-173). COSTA RICA: LACM 9754-24, 5 (105-156); LACM 6917-12, 1 (133); LACM 30710-22, 1 (127); LACM 30713-6, 1 (144); LACM 30728-7, 1 (164); LACM 30717-3, 1 (156). PANAMA: SIO 64-365, 2 (103-109); SIO 63-295, 7 (76-189); SIO 69-386, 2 (113-120); LACM 31310-20, 2 (134-137); MCZ 46148, 6 (157-

211); UMML 26229, 1 (197); UMML 25069, 4 (160-168); UMML 25068, 1 (160); UMML 26248, 1 (174); USNM 81756, holotype, 1 (72); USNM 80228, paratypes, 3 (33-46); LACM 6509-23, 17 (25-148); UP (6 Dec. 1971), 1 (165); USNM (Acc. No. 247715), 7 (130-149). COLOMBIA: USNM 211392, 1 (149); USNM 211370, 1 (125); USNM 211353, 1 (150); USNM 211382, 1 (148); USNM 211395, 1 (202); USNM 211400, 4 (124-162); USNM 211356, 1 (142); USNM 211380, 3 (180-189).

Diplectrum rostrum Bortone 1974

Figures 6, 8, 9, 13

Diplectrum rostrum Bortone 1974:61-65, fig. 1-2 (original description, eastern Pacific); Rosenblatt and Johnson 1974:191 (systematics).

The species is not common within its range and perhaps some references pertaining to *D. pacificum* may in fact refer to *D. rostrum*.

Diagnosis.—*Diplectrum rostrum* is distinct from other species of *Diplectrum* in that it has two light bars on each side of the snout and by the unique marking on the soft dorsal fin which consists of a transverse row of seven to nine light spots on a dark field. Confusion with *D. pacificum* might arise because of the similar preopercle shape. However, these two species can easily be separated by the already mentioned color patterns; gill raker count, 20.25 (17-24) in *D. pacificum*, 23.44 (22-25) in *D. rostrum*; orbit length, 78.52 (66-90) in *D. pacificum* and 90.68 (81-100) in *D. rostrum*; cheek scale rows A, 9.70 (8-12) in *D. pacificum* and 8.52 (8-10) in *D. rostrum*. Also the caudal pigmentation is a series of dark and light bands in *D. pacificum* and a spotted (light on dark) pattern in *D. rostrum*. The preopercular spur tends to have a more rounded lower edge in *D. rostrum*. Other notable differences between *D. rostrum* and *D. pacificum* are: the caudal lobe tends to be more elongate in *D. rostrum* as evidenced by its greater total length (1,320 for *D. rostrum*, 1,289 for *D. pacificum*); *D. rostrum* has a shorter postorbital length (193.35 vs. 211.05); a larger orbital width (71.50 vs. 62.58) and a shorter caudal peduncle depth (120.92 vs. 129.32) than *D. pacificum*.

Description.—D, X, 12 (13); A, III, 7 (8); P₁, 16.94 (16-18); pored lateral-line scales, 49.00 (48-51); scale rows in lateral line, 64.62 (60-70); scales above lateral line, 7.54 (7-9); scales below lateral line, 16.76 (15-18); predorsal scales, 14.16 (12-16); cheek scale rows A, 8.52 (8-10); cheek scale rows B, 11.18 (10-12); gill rakers, 23.44 (22-25).

Standard length, 120.50 (21.78, 78.8-166, 26). Total length, 1,320 (23.08, 1,277-1,360, 25); fork length, 1,165 (13.13, 1,133-1,186, 26); body depth, 288 (16.15, 251-310, 26); head length, 369 (9.49, 354-388, 26); postorbital length, 193 (7.22, 183-206, 26); snout length, 103 (6.98, 88-117, 26); lacrimal width, 51 (4.14, 43-58, 26); maxillary width, 27 (2.21, 24-33, 26); orbit length, 91 (5.41, 81-100, 25); orbit width, 72 (3.92, 66-78, 25); interorbital width, 74 (6.89, 66-102, 26); upper jaw length, 164 (5.66, 150-173, 26); lower jaw length, 175 (5.75, 162-187, 26);

cheek height, 119 (6.24, 110-129, 26); cheek length, 122 (4.96, 112-129, 26); caudal peduncle depth, 121 (5.19, 109-130, 26); pectoral fin length, 257 (14.30, 233-292, 26); pelvic fin length, 214 (11.56, 186-237, 26); predorsal length, 360 (10.17, 342-385, 21); pelvic origin to lower jaw, 336 (14.46, 314-367, 19); pelvic origin to anus, 321 (20.32, 291-382, 24); postanal length, 397 (14.83, 369-421, 26). Dorsal spine height: first, 57 (6.81, 37-68, 26); second, 83 (7.80, 70-94, 24); third, 129 (9.12, 113-150, 25); fourth, 143 (8.05, 130-159, 23); fifth, 145 (8.92, 130-162, 25). Anal spine height: first, 32 (4.02, 19-37, 26); second, 59 (5.57, 46-66, 26); third, 80 (5.85, 66-89, 26).

Preopercle with narrow spur bearing 7-11 spines at angle. Upper spur edge somewhat squared off, lower edge more rounded. Vertical and horizontal preopercular limbs serrate. Caudal fin slightly forked, the upper lobe extending further posteriorly than lower lobe, almost as a filament. Chest scales not embedded but reduced in size anteriorly. Anterior nostril with elongate flap. Gill rakers moderately long, the first at the angle reaching to fifth below.

Color.—Characteristic color patterns remain discernible in preserved specimens. Snout gray-brown with two lighter bands, perhaps pinkish in fresh specimens (J. E. McCosker, pers. commun.), passing from anterior orbital edge forward to anterior lacrimal edge. Cheeks with somewhat less distinct wavy bar of lighter pigment. Soft-dorsal-fin membrane bearing color pattern consisting of seven to nine light spots on dark field which traverses fin laterally. Distal edge of fin not pigmented but a lightly pigmented band near base of fin. Dorsal spines tipped

with black. Caudal peduncle blotch equal to eye size, but irregular in outline. Dorsal surface of caudal peduncle with two dark spots separated by a lighter spot. Caudal fin bearing series of small light spots on dark background. Lateral body surface with five to seven indistinct darkened vertical bars appearing darker dorsally. The lateral body surface also traversed by an indistinct midlateral stripe.

Size.—The species is of medium size; a maximum of 166 mm SL recorded in the present study.

Habits.—Virtually nothing is known of the habits of *D. rostrum* except what could be ascertained from collection data. It has been collected at depths ranging from 13 to 80 m and does not appear to be abundant anywhere.

Distribution.—Collection data indicate that *D. rostrum* occurs on the western side of the Gulf of California; at Bahia de Banderas, Mexico; Puntarenas, Costa Rica; Gulf of Panama; the Galapagos Islands; and along the northwest coast of South America (Fig. 13). The species ranges from lat. 23°34.3'N, long. 110°23.9'W along the outer Baja California Sur to lat. 3°39'S, long. 80°41'W in the south.

Variation.—No significant morphological or meristic variation was noted for this species except for number of scale rows above the lateral line. A group of northern specimens (from Bahia de Banderas northward) had a mean value of 63.10 for scale rows above the lateral line while the southern group had a mean value of 67.08 for

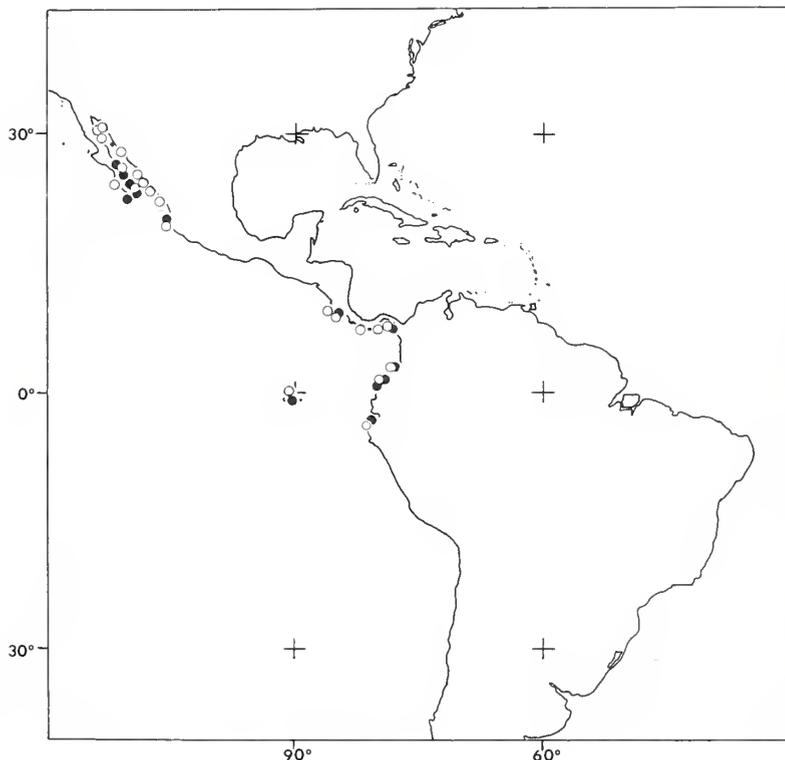


Figure 13.—Distribution map for *Diplectrum rostrum* (closed circles); and *D. macropoma* (open circles). [Localities are based on the materials examined in this study.]

this same character. Insufficient material was available throughout the range of the species to permit speculation about the nature of this variation.

Specimens examined.—A total of 36 specimens from 60 to 166 mm SL. OUTER BAJA CALIFORNIA: SIO 64-867, paratype, 1 (132). GULF OF CALIFORNIA: LACM 64-64, paratypes, 4 (62-128); SIO 65-349, paratypes, 2 (98-137); SIO 65-257, paratype, 1 (126); SIO 65-285, paratype, 1 (103); SIO 65-304, paratype, 1 (113); UA 67-65-3, 1 (142); INP LB1816, 1 (148); USNM 125347, 1 (71); UA 67-121-1, 2 (63-72); SIO 70-62, paratype, 1 (71). BAHIA DE BANDERAS, MEXICO: SIO 65-160, 6 (60-104). COSTA RICA: LACM 30714-12, 2 (134-142). PANAMA: USNM (lat. 7°33'N, long. 78°11'W), 1. COLOMBIA: USNM 208199, paratype, 1 (87); USNM 208198, paratype, 1 (144); CAS 15296, paratype, 1 (145). ECUADOR: USNM 208196, holotype, 1 (131); USNM 208197, paratypes, 5 (100-130); CAS 15295, paratype, 1 (117). GALAPAGOS: FMNH 41433, 1 (166).

Diplectrum conceptione (Valenciennes 1828)

Figures 6, 8, 9, 12

Serranus conceptionis Valenciennes in Cuvier and Valenciennes 1828:246 (original description, Concepcion, Chile); Guichenot 1848:148-149 (description and color notes, Chile); Boulenger 1895:296-297 (catalog); Porter 1909:8 (Chile).

?*Plectropoma paytensis* Lesson 1830:233-244 (original description, Peru); Günther 1859:165 (catalog).

Serranus conceptionis Lesson 1830:236 (Chile).

Centropristis conceptionis Günther 1859:84 (catalog).

Diplectrum conceptione Jordan and Eigenmann 1890:397-399 (systematics); Abbott 1900:349 (Callao, Peru); Delfin 1901:62-63 (Chile and Peru); Evermann and Radcliffe 1917:75-76 (in part, Peru); Fowler 1945b:217 (Peru); Fowler 1945c:78 (Chile); Hildebrand 1946:185, 186-187 (description, Peru); Orces 1951:304 (Ecuador, as cited by Koepke 1963); Mann F. 1954:65, 81, 223 (description, economics, Chile); Koepke 1963:241 (synonymy, Peru); Chirichigno F 1974:294-298, fig. 576 (key, Peru); Rosenblatt and Johnson 1974:178-191 (key, systematics).

Hemilutjanus paytensis Jordan and Eigenmann 1890:345 (systematics).

Diplectrum conceptione was described from a single specimen by Valenciennes in 1828. Since that time only slight confusion has resulted regarding the correct identity of the species. Lesson (1830:233-244) described a new species, *Plectropoma paytensis*, from a drawing. He did not believe that Valenciennes (Cuvier in Lesson's interpretation) had described the species. It would appear from the species description of Lesson that he may have been referring to *D. conceptione* but several doubts exist concerning the inclusion of Lesson's species in the synonymy. First, Lesson was aware of the *Serranus conceptionis* description by Valenciennes (Lesson 1830:236). The collection label indicates Lesson collected the specimen so therefore why did he state that *P. paytensis* had been overlooked by Cuvier? Second, Lesson stated that the species is common near Paita, Peru, but others (Mann F. 1954:223; Hildebrand 1946:187) imply *D. con-*

ceptione is infrequently seen. The color description of *P. paytensis* does not closely fit other color descriptions for *D. conceptione* (e.g., Evermann and Radcliffe 1917:75-76). The inclusion of *Plectropoma paytensis*, Günther (1859:165) and *Hemilutjanus paytensis* Jordan and Eigenmann (1890:345) in the synonymy for *D. conceptione* may in fact not be justified because *Plectropoma paytensis* may be a nomen nudum.

Fowler (1945c:78-79) listed *Pristipoma conceptione* as a synonym of *D. conceptione*. This action was not justified in that characters given by Steindachner (1875:6-8) and Guichenot (1848:195-196) as referred to in Fowler's citation of Schmeltz (1869:13) and Cuvier and Valenciennes (1828:268) exclude this species from the genus *Diplectrum* on the basis of dorsal- and anal-fin elements.

Diagnosis.—*Diplectrum conceptione* is readily distinguishable from other *Diplectrum* in having two to four strong spines at the angle of the preopercle and a high number of pectoral rays (modally 18). The rather long second anal spine can confuse this species only with *D. maximum* from which it can be distinguished by the above characters, color patterns, number of gill rakers, and number of cheek scale rows A.

Description.—D, X, 12 (11-13); A, III, 7; P₁, 18.16 (17-19); pored lateral-line scales, 49.84 (48-51); scale rows in lateral line, 68.82 (61-75); scales above lateral line, 7.92 (7-9); scales below lateral line, 19.93 (17-23); predorsal scales, 13.98 (12-18); cheek scale rows A, 8.49 (7-10); cheek scale rows B, 11.60 (9-14); gill rakers, 25.28 (23-28).

Standard length, 107.77 (23.00, 80-161, 39). Total length, 1,275 (17.45, 1,236-1,318, 37); fork length, 1,187 (13.78, 1,160-1,214, 39); body depth, 277 (12.72, 254-305, 34); head length, 379 (10.74, 361-408, 39); postorbital length, 213 (7.48, 202-237, 39); snout length, 94 (7.07, 79-106, 39); lacrimal width, 37 (3.48, 32-46, 39); maxillary width, 34 (1.89, 30-37, 39); orbit length, 90 (6.05, 82-101, 39); orbit width, 75 (5.81, 62-87, 39); interorbital width, 69 (3.18, 63-76, 38); upper jaw length, 159 (6.12, 145-173, 39); lower jaw length, 182 (5.15, 169-196, 39); cheek height, 111 (6.01, 98-127, 39); cheek length, 108 (5.17, 96-119, 39); caudal peduncle depth, 116 (4.32, 108-128, 39); pectoral fin length, 256 (9.98, 235-279, 39); pelvic fin length, 215 (8.18, 196-230, 39); predorsal length, 365 (10.34, 342-399, 38); pelvic origin to lower jaw, 336 (11.96, 317-363, 31); pelvic origin to anus, 317 (19.88, 282-369, 37); postanal length, 401 (12.10, 381-438, 37). Dorsal spine height: first, 46 (5.23, 38-57, 37); second, 72 (7.20, 57-87, 39); third, 147 (10.17, 127-165, 35); fourth, 158 (10.56, 132-183, 32); fifth, 150 (9.23, 126-168, 37). Anal spine height: first, 45 (4.70, 37-54, 39); second, 84 (8.69, 66-100, 39); third, 95 (8.19, 76-113, 39).

Preopercle with a group of two to four strong spines at angle. Few serrae present on ventral edge, many on vertical edge of preopercle. Gill rakers long and slender, the first reaching the base of fifth below. Anterior nostril without distinct flap. Scales on operculum in definite rows. Small scales running down membrane between

third spine and first soft anal ray. Also, small scales along base of anterior soft dorsal rays. Second anal spine more stout than third. Caudal fin nearly straight.

Color.—Color description is from preserved specimens. Pelvic fin, ventral edge light, pale along medial base and edge, body of fin appearing dusky, with dark pigment mainly on interradiial portions. Pectorals with line of dark pigment along the dorsal edge of each ray, no pigment interradially. Anal fin pale. Caudal fin dusky to dark. Spinous dorsal membrane dusky, distal edge of membrane white with black at extreme distal edge. Base of spinous dorsal less dusky than body of membrane. Soft dorsal fin with a broad pale distal margin, a darker band below, and below this a dusky field bearing a group of irregular light spots fusing into diagonal bars. This pattern of light spots and bars quite variable and occasionally appearing only as spots or only as horizontal light bars on the soft dorsal. Caudal spot present but indistinct and smaller than orbit. Ventral portion of body light brown. Dorsum medium brown, bases of soft dorsal rays black. Lateral body surface with nine indistinct dusky vertical bars terminating above midventral line. Evidence of interconnecting midlateral stripes on body. Lateral and medial opercular surfaces black. Posterior branchial cavity black. Slight evidence of small indistinct spots of light pigment on lacrimal area, about five in number, and may interconnect. Lower premaxillary border with dark edge, remainder of premaxillary dusky. Center tip of lower jaw dusky. No evidence of pigment in upper pharyngeal area.

The following color description of live *D. conceptione* is quoted from Evermann and Radcliffe (1917:75-76): "Color in life: Back and upper part of sides dark olive green, but with three pale horizontal stripes; one, from just above pectoral to just beneath lateral line on peduncle; a second, from level of eye, and beginning a short distance posterior to eye, to upper part of peduncle; a third, at a corresponding distance above the second; a darker mottling on the sides gives an indistinct effect of cross-barring, especially on upper part of sides; sides, below lowest stripe, dusky, greenish with much gold; below white with a tinge of orange along median line of belly; head above olive with reddish spots, orange on lower part of sides; under side of opercle with jet black and gold; skin posterior to fourth gill blue-black; caudal mostly reddish orange, ventral margin pale; dorsal light olive with large spots of bright orange; a little black on tips of membrane between dorsal spines; pectorals olivaceous; ventrals mixed dusky olive and orange; anal mostly white, but with some orange on membrane between consecutive rays."

Size.—Maximum size of specimens examined is 169 mm SL.

Habits.—The species seems to prefer fairly deep water with only one collection of specimens from 13 m and the remainder from 33 to 80 m deep. Little is known of the habits of this species.

Distribution.—*Diplectrum conceptione* is limited in its distribution to the coasts of Ecuador, Peru, and Chile in the eastern Pacific (Fig. 12). The northernmost locality is at lat. 3°15'S and its southern limit is also the type-locality at Conception, Chile (lat. 37°S).

Variation.—Most material examined of this species is from the same general area off the coast of Peru; therefore, no variation was discernible over the species range.

Specimens examined.—A total of 230 specimens from 69 to 169 mm SL. ECUADOR: USNM 213574, 72 (96-136); USNM 211418, 1 (135); USNM 211414, 1 (96). PERU: USNM 213583, 60 (69-161); USNM 213582, 15 (92-138); USNM 211371, 1 (144); USNM 211390, 2 (119-129); USNM 213578 + 211385, 69 (89-169); USNM 77549, 1 (94); USNM 77541, 1 (111); USNM 127969, 1 (137); CAS SU 6293, 5 (130-159). CHILE: MNHN 7025, holotype, 1 (102).

Diplectrum maximum Hildebrand 1946

Figures 6, 8, 9, 11

Diplectrum conceptione Evermann and Radcliffe 1917:75-76, pl. 7, fig. 2 (in part, figure and one text description is of *D. maximum*, Peru).

Diplectrum maximum Hildebrand 1946:185-187, fig. 42 (original description, Paita, Peru); Orces 1951:304 (not seen, Ecuador); Orces 1959:81 (*D. maximum* possibly a subspecies of *D. pacificum*); Rosenblatt and Johnson 1974:178-191 (description of juveniles, Baja California); Chirichigno F. 1974:294-298, fig. 577 (key, Peru).

Diplectrum pacificum maximum Koepke 1963:241 (Peru).

The larger specimen described and figured by Evermann and Radcliffe (1917:75-76, pl. 7, fig. 2) is USNM 77698. This specimen was examined and is most certainly *D. maximum*. One of the other specimens to which they referred (Evermann and Radcliffe field no. 09529) was designated as the holotype as figured by Hildebrand (1946:185-187, fig. 42). The other specimens they referred to (Evermann and Radcliffe field nos. 09543 and 09547) were examined and are *D. conceptione* bearing USNM numbers 77549 and 77541, respectively. Koepke (1963:241) appears to have accepted the suggestion of Orces (1959:81) that *D. maximum* may be a subspecies of *D. pacificum*. Orces (1959:81) indicated they were closely aligned because of similar number of scales on the "preopercle" (i.e., cheek) and the caudal fin shape. The indiscriminate acceptance of the suggestion by Orces seems to have led to the recognition of an invalid subspecies of *D. pacificum*.

Diagnosis.—*Diplectrum maximum* is the largest of all known *Diplectrum*, reaching 302 mm SL. It can be distinguished from *D. conceptione* by its lower mean total gill raker count, 19.28 (17-21), as opposed to 25.28 (23-28) for *D. conceptione*; cheek scale rows A tend to be higher, 10.07 (9-11) than those of *D. conceptione*, 8.49 (7-10); and the preopercle of *D. conceptione* bears two to four

strong spines while that of *D. maximum* is in the shape of an elongate bony flap bearing four to eight longer and thinner spines. The species also can be separated on the basis of color patterns described below. Confusion with *D. pacificum* should not occur due to the distinctive preopercular shape of *D. maximum*. Also the second anal spine is notably stout and nearly equal (longer in juveniles) in length to the third in *D. maximum*, but the second anal spine is much shorter than the third in *D. pacificum*.

Description.—D, X, 12; A, III, 7; P₁, 16.93 (16-17); pored lateral-line scales, 49.36 (48-50); scale rows in lateral line, 66.33 (61-72); scales above lateral line, 8.47 (7-10); scales below lateral line, 21.13 (18-25); predorsal scale rows, 16.43 (14-20); cheek scale rows A, 10.07 (9-11); cheek scale rows B, 11.47 (10-13); gill rakers, 19.28 (17-21).

Owing to the unusual nature of the size disparity involved with this species and because so few specimens were available for examination it was decided to present the data for each character in the following manner: character data for the eight larger specimens of *D. maximum*, 245.38 mm SL (32.56, 205-302, 8) followed immediately by character data for the seven smaller specimens, 64.43 mm SL (17.31, 45.9-93.2, 7); data for larger specimens are separated from data for smaller specimens by a hyphen. Total length, 1,245 (16.77, 1,221-1,270, 8) - 1,224 (20-21, 1, 191-1,248, 6); fork length, 1,178 (13.09, 1,162-1,200, 8) - 1,189 (14.15, 1,168-1,207, 7); body depth, 285 (19.38, 257-319, 7) - 257 (13.99, 241-276, 7); head length, 363 (4.74, 354-369, 8) - 361 (7.20, 350-373, 7); postorbital length, 211 (3.73, 203-214, 8) - 189 (2.16, 187-192, 7); snout length, 102 (2.82, 98-106, 8) - 91 (6.34, 80-98, 7); lacrimal width, 54 (3.01, 50-59, 8) - 33 (3.56, 28-39, 7); maxillary width, 30 (2.25, 26-32, 8) - 35 (2.45, 31-38, 7); orbit length, 67 (3.36, 62-72, 8) - 99 (7.03, 87-108, 7); orbit width, 50 (4.10, 46-57, 8) - 76 (6.85, 66-87, 7); interorbital width, 72 (3.31, 67-76, 8) - 73 (3.30, 70-78, 7); upper jaw length, 159 (6.27, 149-167, 8) - 158 (5.19, 152-168, 7); lower jaw length, 173 (6.75, 164-180, 8) - 181 (1.91, 179-184, 7); cheek height, 130 (4.78, 121-134, 8) - 98 (5.71, 87-105, 7); cheek length, 97 (5.18, 87-103, 8) - 111 (5.59, 106-122, 7); caudal peduncle depth, 124 (4.10, 120-130, 8) - 118 (1.80, 116-121, 7); pectoral fin length, 234 (6.58, 225-242, 8) - 230 (7.21, 222-239, 7); pelvic fin length, 202 (7.77, 198-212, 8) - 196 (13.86, 175-209, 7); predorsal length, 352 (10.50, 336-370, 8) - 366 (10.05, 349-374, 6); pelvic origin to lower jaw, 340 (14.21, 326-371, 8) - 337 (9.88, 320-344, 5); pelvic origin to anus, 322 (22.94, 295-352, 8) - 286 (15.14, 255-301, 7); postanal length, 403 (13.54, 380-419, 8) - 406 (11.07, 389-420, 7). Dorsal spine height: first, 66 (7.49, 54-76, 8) - 77 (4.80, 73-82, 5); second, 83 (9.85, 67-96, 8) - 95 (7.98, 84-105, 5); third, 128 (9.01, 117-144, 7) - 132 (6.56, 125-143, 6); fourth, 137 (11.63, 115-154, 8) - 146 (6.68, 133-153, 6); fifth, 135 (10.08, 118-150, 8) - 140 (2.88, 137-144, 6). Anal spine height: first, 41 (3.74, 36-46, 8) - 56 (8.10, 45-70, 7); second, 68 (2.83, 64-72, 8) - 91 (4.30, 85-98, 7); third, 74 (4.07, 68-80, 8) - 88 (5.21, 81-94, 7).

Preopercle with a notable elongate shape bearing four to eight elongate spines at its angle. Vertical and horizontal preopercular arms serrate. Second anal spine very strong, much stronger than third. First gill raker at the angle reaching to the base of the fourth below. Anterior nostril with elongate flap. Rows of small scales along third anal spine, first anal ray, and first and second membranous portions of soft-dorsal-fin base. Thoracic scales smaller, slightly embedded. Caudal fin nearly truncate.

Color.—Color description for larger preserved specimens: anterior lateral edges of pelvic fins light, fin dusky but paler at base and on medial rays. Pectoral fin rays dusky, membrane pale. Anal fin pale. Distal edges of caudal fin black, fin brown with a dusky dorsal edge. Spinous dorsal dusky between first and second spines, tips of all spines black, membrane dusky, paler distally. Soft dorsal with black edge distally, small black spots at interradial bases. Remainder of membrane pale except between last two dusky interradials. Body brown, paler ventrally, slight evidence of indefinite blotches on dorsolateral surface. Posterior branchial area dusky to black, medial opercular surface black. Dorsum brown, slightly darker at anterior base of spinous dorsal. Snout with a pale wedge-shaped spot anteriorly. Anterior tip of lower jaw dusky. An indistinct bar of light pigment at lateral pectoral base.

Color description for smaller preserved specimens: lateral body surface with two wide brown horizontal stripes, a narrower stripe of light pigment between these brown stripes. Below the midlateral brown stripe, a row of 8-10 pale or white blotches. White spots above and below the lateral band on caudal peduncle. White predorsal stripe extending to interorbital area. Ventral body surface white. Dark pigment on first through fifth spinous dorsal membranes. Anterior base of pectoral dusky. Dorsal spines with black tips. Upper pharyngeal area slightly pigmented.

Habits.—Nothing is known of the habits of *D. maximum*. The larger specimens came from deeper water (70-128 m) but the smaller specimens were from shallow water (1-7 m). The species attains considerable size (302 mm SL) and may prefer cooler waters of the subtropics.

Distribution.—Two areas of distribution are noted (Fig. 11): the northern group of smaller specimens with northernmost distribution lat. 24°44.35'N, long. 111°58.4'W in Bahia de Magdalena; the southern group of larger specimens found along the Peruvian-Ecuador coast having as its southernmost point of distribution Lobos de Tierra, Peru. The type-specimens are from Paita and Lobos de Tierra, Peru.

Variation.—The small sample sizes and the disjunct distribution of specimen size did not allow for satisfactory studies on variation for this species. However, the few meristic data available do not indicate any obvious variations between the two known distribution centers.

Rosenblatt and Johnson (1974) noted that juveniles are found only off the outer Baja California coast and possess a jet black blotch on the anterior portion of the spinous dorsal fin membrane. While this character is lacking in adults of *D. maximum*, there is evidence of some, but less intensified, pigmentation on this fin. Rosenblatt and Johnson (1974) suggested there can be no further speculation as to an ontogenetic or genetic explanation for this noted variability until additional material is available.

There is some question concerning the species integrity of *D. maximum* because of the extreme geographical and size differences in the two populations considered. Examination of additional material (presently unavailable) of intermediate size and parts of its range may warrant reevaluation of the present scope of *D. maximum*.

Specimens examined.—A total of 15 specimens from 46 to 302 mm SL. OUTER BAJA CALIFORNIA: SIO 62-726, 2 (46-50); SIO 62-106, 1 (69); SIO 62-706, 2 (74-75); SIO 64-63, 1 (93); SIO 64-869, 1 (50). ECUADOR: USNM 213581, 2 (260-275). PERU: USNM 77624, holotype, 1 (241); USNM 77698, paratype, 1 (222); USNM 200373, 1 (302); USNM 213809, 2 (205-243); USNM 211407, 1 (215).

Diplectrum sciurus Gilbert 1892

Figures 6, 8, 9, 10

Diplectrum sciurus Gilbert 1892:550-551 (original description, Gulf of California; Jordan and Evermann 1896:1203-1204 (systematics); Osburn and Nichols 1916:162 (Baja California); Jordan et al. 1930:318 (check list); Walford 1937:123 (general account); Rosenblatt and Johnson 1974:178-191 (key, systematics).

Serranus sciurus Boulenger 1895:298 (catalog).

The USNM has three syntypes listed as designated by Gilbert: USNM 46630 (an 87-mm-SL specimen in good condition) is here designated the lectotype in the absence of any known designated holotype; USNM 46571 (an incomplete skeleton) and USNM 125348 now become paralectotypes.

Diagnosis.—*Diplectrum sciurus* is immediately recognized by its numerous and elongate gill rakers (the first reaching almost to the base of the 12th below). The species also has the least caudal peduncle depth, least lacrimal width, and greatest maxillary width of any *Diplectrum*. It is the only *Diplectrum* whose maxillary width is consistently greater than its lacrimal width as an adult. The upper- and lower-jaw lengths are also the least of any *Diplectrum*. The species has the least cheek height and least postanal length. The species has eight anal rays which separates it from all other *Diplectrum* except *D. euryplectrum* and outer Baja populations of *D. labarum*. Again the high number of gill rakers for *D. sciurus* facilitates identification.

Description.—D, X, 12 (11-13); A, III, 8 (7); P₁, 16.96

(16-18); pored lateral-line scales, 49.18 (47-52); scale rows in lateral line, 70.76 (63-79); scales above lateral line, 8.17 (7-10); scales below lateral line, 19.18 (17-21); predorsal scale rows, 15.48 (12-19); cheek scale rows A, 7.66 (6-9); cheek scale rows B, 13.44 (12-17); gill rakers, 36.64 (32-41).

Standard length, 95.04 (10.40, 76.8-116, 33). Total length, 1,263 (16.78, 1,228-1,298, 33); fork length, 1,172 (11.94, 1,149-1,201, 32); body depth, 269 (13.15, 245-296, 33); head length, 356 (9.87, 333-376, 33); postorbital length, 186 (5.99, 171-198, 33); snout length, 89 (5.08, 79-97, 33); lacrimal width, 27 (2.43, 23-33, 33); maxillary width, 36 (2.58, 30-41, 33); orbit length, 92 (4.31, 84-100, 33); orbit width, 78 (4.28, 71-90, 33); interorbital width, 79 (3.70, 70-84, 33); upper jaw length, 142 (5.69, 130-159, 33); lower jaw length, 172 (6.68, 159-191, 33); cheek height, 95 (3.40, 86-103, 33); cheek length, 122 (3.47, 116-129, 33); caudal peduncle depth, 105 (3.39, 98-112, 33); pectoral length, 254 (10.90, 234-275, 33); pelvic length, 211 (6.31, 194-224, 33); predorsal length, 343 (7.73, 330-361, 32); pelvic origin to lower jaw, 351 (9.20, 331-366, 30); pelvic origin to anus, 336 (16.79, 302-363, 32); postanal length, 372 (8.82, 355-388, 33). Dorsal spine height: first, 62 (5.61, 53-74, 32); second, 88 (5.95, 80-101, 31); third, 125 (9.93, 110-157, 32); fourth, 142 (9.54, 125-167, 32); fifth, 146 (9.42, 129-166, 33). Anal spine height: first, 31 (3.75, 24-40, 32); second, 59 (6.06, 47-73, 33); third, 86 (6.44, 76-99, 32).

Diplectrum sciurus is a highly specialized member of the genus with a high number of elongate gill rakers, broad maxillary, narrow lacrimal, and short upper and lower jaws. Distal tip of maxillary arm not exceeding midpoint of eye on a vertical plane. Preopercle somewhat square in outline bearing a single cluster of 5-10 enlarged spines on spur. Vertical and horizontal preopercular arms serrate. Second anal spine as strong as third. Distally the maxillary very broad and spatulate. Lacrimal wedge-shaped, broadest anteriorly. Anterior nostril with low flap perhaps absent in some specimens. Opercular scales small. Chest scales present and well developed. Caudal fin slightly forked, upper lobe extending further posteriorly than lower.

Color.—Color notes are based on preserved specimens. Dorsum and lateral body surfaces light brown. Lateral body surface with two wide brown longitudinal stripes irregularly interrupted by light brown flecks. Eight to ten brown indistinct vertical bars along sides, extending about four-fifths the body depth down the sides. Ventral surface pale. Premaxillary dusky, like lower jaw at midline. Top of head dark brown. Caudal fin with irregular pattern of small, pale blotches on dusky background. Upper caudal edge pale, the lower tending to be dusky. Anal, pectoral, and ventral fins pale. Spinous dorsal fin with three rows of large, irregular, pale blotches on darker field. Blotches present along the distal edge, mid-laterally, and along base of spinous dorsal fin membrane. Soft dorsal with two midlateral rows of pale blotches on darker field. Often blotches fusing together

to form a wavy, pale bar. Distal, soft dorsal edge clear. No apparent cheek or snout bars on preserved specimens. Caudal peduncle spot present but small, irregular in outline, appearing as intensified portion of midlateral body bar. Upper pharyngeal, medial opercular, and posterior branchial surfaces lacking pigment.

Gilbert (1892:550-551) stated that a light blue line ran just below the orbit and that the soft dorsal and caudal fins bore yellow spots surrounded by pale blue.

Size.—The species is small in size, reaching no longer than 137 mm SL in the present study.

Habits.—The extreme modifications of the jaws, gill rakers, and lacrimal area suggest that *D. sciurus* may have different feeding habits than other *Diplectrum*. Although no data are yet available, the species probably feeds on small crustaceans and generally may live just off the bottom as opposed to the benthic habits known for the other species. The species has been taken at depths ranging from 25 to 100 m. The few data available do not indicate any depth preference.

Distribution.—*Diplectrum sciurus* is found almost exclusively along the coastal areas of the Gulf of California (Fig. 10). It does occur along the outer Baja California to lat. 24°35'50"N, long. 112°05'00"W near Bahía de Magdalena. The type-locality is lat. 31°22'00"N, long. 114°07'00"W from the upper Gulf of California.

Variation.—The species does not show any obvious geographical variation due to its limited distribution.

Specimens examined.—A total of 201 specimens from 67 to 137 mm SL. GULF OF CALIFORNIA: USNM 46630, lectotype, 1 (87); USNM 125348, paralectotype, 1 (92); USNM 46571, paralectotype, 1 (incomplete, disarticulated skeleton); LACM 8825-7, 79 (68-98); LACM 8824-7, 22 (84-116); LACM 8339-4, 5 (94-99); LACM 8834-1, 1 (98); CAS W 53-93, 1 (104); CAS SU 53100, 1 (105); FMNH 62747, 1 (90); CAS W 59-17, 4 (77-103); SIO 60-120, 17 (120-137); SIO 70-225, 28 (100-123); SIO 68-71, 36 (67-110). OUTER BAJA CALIFORNIA: CAS SU 243, 3 (92-97).

Diplectrum euryplectrum Jordan and Bollman 1890

Figures 6, 8, 9, 11

Diplectrum euryplectrum Jordan and Bollman 1890:157-158 (original description, Galapagos); Jordan and Eigenmann 1890:397-398 (review); Jordan and Evermann 1896:1203, 1206 (systematic account); Gilbert and Starks 1904:98 (Panama); Meek and Hildebrand 1925:472, 474 (Panama); Jordan et al. 1930:318 (check list); Walford 1937:124 (general account); Hildebrand 1946:184 (key); Chirichigno F. 1974:294-298 (key, Peru); Rosenblatt and Johnson 1974:178-191 (key, systematics).

Diplectrum macropoma Gilbert and Starks 1904:97-98 (in part, misidentified, Gulf of California).

Diagnosis.—This species is easily recognized by the broad spur at the preopercular angle, eight anal rays (rarely seven or nine) and a dark band of pigment on the soft-dorsal-fin base. It has the greatest fork length, head length, postorbital length, eye diameter, interorbital width, upper- and lower-jaw length, cheek height and length, and pelvic-origin-to-lower-jaw dimensions of any *Diplectrum*. It is a distinct species but juveniles of *D. euryplectrum* might possibly be confused with juveniles of *D. labarum*. Except for a population of *D. labarum* from outer Baja California which has a high proportion of individuals with eight anal rays they could normally be separated on this character alone. Scales tend to be smaller in *D. euryplectrum* than in *D. labarum* (Tables 2-7). Also, total number of gill rakers is higher in *D. euryplectrum* (23.68, 21-27) and lower in *D. labarum* (21.52, 19-24). The only other species having eight anal rays is *D. sciurus* but this species is easily distinguished by the high total gill raker count.

Description.—D, X, 12 (13); A, III, 8 (7-9); P₁, 17.62 (16-18); pored lateral-line scales, 48.77 (46-52); scale rows in lateral line, 64.12 (56-73); scales above lateral line, 7.71 (7-10); scales below lateral line, 17.81 (15-20); predorsal scales, 13.73 (10-18); cheek scale rows A, 7.97 (5-10); cheek scale row B, 10.49 (8-13); gill rakers, 23.68 (21-27).

Standard length, 111.62 (13.75, 76.8-143, 39). Total length, 1,260 (15.56, 1,217-1,293, 36); fork length, 1,193 (12.92, 1,155-1,222, 38); body depth, 291 (1,278, 261-313, 38); head length, 423 (12.99, 384-449, 39); postorbital length, 241 (10.47, 215-264, 39); snout length, 103 (7.96, 91-117, 39); lacrimal width, 46 (3.89, 39-53, 20); maxillary width, 36 (1.96, 32-39, 20); orbit length, 102 (4.74, 90-111, 39); orbit width, 84 (4.78, 72-93, 39); interorbital width, 88 (5.89, 78-98, 20); upper jaw length, 189 (6.00, 174-198, 39); lower jaw length, 206 (5.95, 198-222, 39); cheek height, 141 (6.15, 127-158, 39); cheek length, 130 (5.69, 117-143, 30); caudal peduncle depth, 106 (4.65, 98-116, 37); pectoral fin length, 256 (9.98, 235-276, 39); pelvic fin length, 212 (9.41, 188-224, 22); predorsal length, 375 (9.10, 363-392, 20); pelvic origin to lower jaw, 361 (11.21, 345-397, 35); pelvic origin to anus, 309 (23.32, 268-368, 38); postanal length, 374 (10.22, 356-397, 38). Dorsal spine height: first, 60 (8.90, 42-80, 37); second, 87 (7.34, 71-104, 34); third, 118 (9.36, 102-138, 34); fourth, 132 (9.29, 117-162, 32); fifth, 137 (7.63, 124-154, 31). Anal spine height: first, 32 (4.77, 25-44, 37); second, 62 (6.94, 49-77, 37); third, 82 (7.24, 70-100, 36).

Preopercle with wide broad spur, bearing 6-12 spines. Vertical preopercular arm generally lacking serrae with only a few near base at dorsal point of spur. Head large, caudal peduncle shallow. Gill rakers moderately long and slender, the first at the angle reaching to the fifth below. Gill filaments long. Anterior nostril bears elongated flap. Scales absent on anal fin base. Chest scales not noticeably reduced in size. Caudal fin straight without elongated filament. Second anal spine as strong as third. Scales somewhat deciduous.

Color.—The following color description is based on

three adults and two juveniles obtained live from the Gulf of Nicoya, Costa Rica, 29 June 1973. Membrane between first and third dorsal spines pale blue, slightly darker on spines and distal margin. Remainder of spinous dorsal fin dusky blue on distal half. Spine tips orange. Pale brown blotch on middle portion of spinous dorsal. Soft dorsal fin pale gray, a dark lateral band on base about one-sixth to one-fifth fin height. Distal, soft dorsal membrane pale blue. Soft dorsal ray tips pale orange. Caudal fin dusky with traces of pale yellow on membranes. Lower caudal edge pale orange. Ventrals dark gray with same pale yellow on membrane. Pectoral fin dusky. A dusky midventral stripe present from the posterior ventral fin base to the anus. Remainder of ventral area pale gray. Dorsum gray-brown interspersed with small gold flecks in two lateral rows, one on upper dorsum, the other more lateral. Snout with indistinct yellow bar between anterior edge of orbit to anterior lacrimal edge. Another indistinct yellow bar passes from lacrimal area to just below and along lower orbital edge diverging into two to four indistinct bars on cheek. Distal edge of premaxillary yellow. Distal maxillary tip pale yellow. Lower jaw dusky at midline. Upper pharyngeal region white. Branchiostegal membrane white. Caudal peduncle spot and vertical body bars present but not distinct in specimens examined.

The following color description is from preserved specimens. Pelvic fin dusky, but paler medially. Pectoral fin pale with some dark pigment on dorsal side of rays. Anal fin pale. Caudal fin dusky, pale dorsal edge, broad pale ventral edge, posterior border black. Spinous dorsal with pale base, becoming darker distally. Tips of first and second spines black. Base of soft dorsal fin with distinct dusky band about one-fifth fin height. Above the band soft dorsal dusky with pale distal edge. Dorsum brown, sides becoming pale to white ventrally. Lateral body surface with five wide, indistinct, vertical bars with pale narrow bars between. Caudal spot distinct, equal to eye size. Lateral and medial opercular surfaces black with white area below blotch on medial opercular surface. Posterior branchial area pale or slightly pigmented. Chest white. Pectoral fin base white with pale orange bar distal to base. Head brown above, pale below. An indistinct pattern of pale orange bars on head; some pale orange on distal maxillary, cheeks, preopercle spur, and operculum. Indistinct pale orange markings on snout. Upper pharyngeal area pale. Upper jaw dusky, lower jaw somewhat paler.

Size.—The largest specimen examined was 163 mm SL.

Habits.—*Diplectrum euryplectrum* is found in waters of the eastern Pacific from 15 to 150 m deep. However, the species appears to be more commonly taken from 60 to 90 m depth and is abundant at some localities. The species does not seem to prefer shallow coastal areas.

Distribution.—The species is found along the tropical-subtropical eastern Pacific coast, in the Gulf of Califor-

nia, and at the Galapagos Islands (Fig. 11). The northern range of the species ends along the outer Baja California coast at lat. 24°27'N, long. 111°59'W and extends south to Ecuador at lat. 01°03'S, long. 80°59'W. The type-locality is the Galapagos Islands.

Variation.—There is little evidence of geographical variation in this species except for the number of predorsal scales. The differences in this character among three areas (i.e., Mexico, Panama, and Colombia; Table 5) appear distinct and may reflect real population differences.

Specimens examined.—A total of 152 specimens from 32 to 163 mm SL. BAJA CALIFORNIA: CAS SU 47, 1 (43); SIO 70-257, 3 (116-122). MEXICO: CAS 4780, 1 (68); CAS 4781, 1 (71); CAS 4782, 1 (69); CAS 4783, 1 (71); USNM 131405, 36 (35-77); GCRL 2495, 1 (94); SIO 63-513, 25 (62-137); SIO 63-518, 13 (43-86); SIO 63-515, 2 (82-123); LACM 30123-12, 1 (anterior half only, head length 20 mm). COSTA RICA: UCR 323-15, 1 (93); UCR 139-14, 1 (120); UCR 323-27, 5 (74-112); LACM 30718-2, 2 (93-122). PANAMA: USNM uncat. (*Pelican* 685), 1 (98); USNM 41148, paratype, 1 (108); UMML 26084, 4 (100-137); UMML 26041, 13 (98-126); CAS SU 1458, paratypes, 4 (108-143); CAS SU 1172, paratypes, 4 (70-137); UMML 26268, 13 (59-117); USNM uncat. (*Pelican* 760), 5 (115-135); CAS SU 1409, 1 (104); UMML 26255, 16 (57-111); UMML 26267, 11 (74-112); UMML 26267, 18 (49-66); UMML 28621, 9 (53-115); UMML 26269, 10 (32-55); SIO 71-57, 10 (65-93). GALAPAGOS ISLANDS: USNM 41141 Holotype, 1 (130); USNM 41141, paratype, 1 (128). ECUADOR: USNM 211389, 1 (113); USNM 213598, 1 (110); USNM 213572, 30 (123-163); USNM 211372, 1 (126); USNM 211415, 2 (92-95).

Diplectrum labarum Rosenblatt and Johnson 1974

Figures 6, 8, 9, 14

Diplectrum macropoma Gilbert and Starks 1904:97-98
(in part, misidentification).

Diplectrum labarum Rosenblatt and Johnson 1974:178-191, fig. 1A. (original description, coastal eastern Pacific).

Gilbert and Starks (1904:97-98) stated they obtained *D. macropoma* from outer Baja California in 1889 at *Albatross* Stn. 3039 and this collection was cataloged as CAS SU 47 under the identification of *D. macropoma*. This collection, in fact, contained *D. euryplectrum*, *D. eumelum*, *D. labarum*, and *D. macropoma*.

Diagnosis.—*Diplectrum labarum* is distinguishable as an adult from other species of *Diplectrum* by the elongate, filamentous tips on the second, third, and fourth (occasionally the fifth) dorsal spines. Juveniles of this species might be confused with juvenile *D. euryplectrum* but may be separated by the number of anal rays (eight in *D. euryplectrum*, seven in most populations of *D. labarum*). Juvenile *D. labarum* might also be confused with juvenile *D. eumelum*. *Diplectrum labarum* tends to have higher scale meristics (Tables 3-7), especially in number of cheek scale rows B (10.61, 9-12 in species C; 8.41, 7-10 in *D. eumelum*).

Description.—D, X, 12 (11-13); A, III, 7(8); P₁, 16.61 (16-18); pored lateral-line scales, 48.14 (47-49); scale rows in lateral line, 58.94 (51-66); scales above lateral line, 6.98 (6-9); scales below lateral line, 16.93 (14-19); predorsal scale rows, 13.62 (11-17); cheek scale rows A, 7.34 (6-9); cheek scale rows B, 10.61 (9-12); gill rakers, 21.52 (19-24).

Standard length, 116.64 (33.50, 78.4-188, 37). Total length, 1.271 (21.25, 1.232-1.311, 35); fork length, 1.179 (15.76, 1.142-1.211, 37); body depth, 291 (23.43, 257-341, 35); head length, 381 (11.36, 364-410, 37); postorbital length, 204 (10.24, 184-227, 37); snout length, 99 (6.95, 85-115, 37); lacrimal width, 42 (5.47, 33-54, 37); maxillary width, 33 (1.82, 28-37, 36); orbital length, 95 (7.34, 78-110, 37); orbit width, 76 (5.58, 67-90, 37); interorbital width, 77 (4.38, 69-86, 36); upper jaw length, 176 (8.03, 157-197, 37); lower jaw length, 194 (7.47, 176-209, 36); cheek height, 128 (10.09, 108-147, 37); cheek length, 121 (5.13, 111-132, 37); caudal peduncle depth, 117 (4.50, 110-131, 37); pectoral fin length, 250 (13.42, 221-270, 36); pelvic fin length, 203 (9.70, 175-221, 37); predorsal length, 363 (9.43, 347-390, 36); pelvic origin to lower jaw, 349 (8.87, 326-365, 32); pelvic origin to anus, 346 (18.53, 318-376, 34); postanal length, 378 (12.72, 351-401, 34). Dorsal spine height: first, 61 (10.87, 36-84, 35); second, 140 (22.52, 99-186, 29); third, 170 (20.34, 129-204, 30); fourth, 165 (11.60, 147-187, 30); fifth, 151 (11.18, 127-175, 32). Anal spine height: first, 39 (4.92, 28-51, 37); second, 69 (7.70, 56-82, 37); third, 91 (7.96, 75-106, 37).

Second, third, and fourth (occasionally the fifth) dorsal spines with elongate filamentous tips. Tips developing gradually during ontogeny beginning about 60 mm SL and increasing in proportion to standard length thereafter. Elongate filaments occasionally broken but spines bearing dark pigment their entire length. Preopercle squared, broader than in *D. sciurus* but not quite as broad as in *D. euryplectrum*. Enlarged spines, usually about 8-13 in number, occurring on spur. Vertical and horizontal preopercle arms serrate. Anterior nostril with distinct flap. Caudal fin slightly forked, upper lobe a little longer than lower but never extending as elongated filament.

Color.—Color description is based on preserved specimens. Dorsum, light brown, becoming darker on head. Lateral body surface with two indistinct wide horizontal stripes interrupted by five to seven wide, indistinct vertical bars. Bars not extending to paler ventral area. Caudal spot distinct and equal to orbit. Dorsum of caudal peduncle with two dark spots with a white spot of equal size bordering these anteriorly and posteriorly. Caudal fin dusky, becoming darker distally. Evidence of pale caudal fin spots present on some specimens. Anal, pelvic, and pectoral fins pale. Spinous-dorsal-fin membrane pale, becoming dusky distally. Tips of spines, extended filaments, and first three spines dark. Soft dorsal fin dusky with three to four pale elongate blotches on basal portion. Cheek and branchiostegal membranes white. Premaxillary and midline of lower jaw dusky. No apparent snout or cheek markings. A dark

blotch present on lateral and medial opercular surfaces. Posterior branchial surface devoid of pigment. Upper pharyngeal area lacking pigment.

The following live color description is taken from Rosenblatt and Johnson (1974): “. . . a dull orange line running longitudinally along the membrane of the spinous dorsal, slightly above its base; on the soft dorsal 5 dull orange diagonal bars (sloping backwards), and a very narrow line of brighter orange running just at the tips of the rays; 2 yellow stripes on the soft anal joining between the 2nd and 3rd rays; 3 dark orange vertical wavy lines on the caudal fin; the upper and lower caudal margin tipped posteriorly with reddish orange; pectorals transparent; ventrals pale to dusky.”

Size.—The species attains a maximum size of 212 mm SL.

Habits.—Depth records from collection data indicate that *D. labarum* has been captured at depths ranging from 25 to 160 m. However, the species seems to be taken more often at depths of 40-120 m. Nothing is known of the life history aspects of *D. labarum*.

Distribution.—*Diplectrum labarum* occurs in the Gulf of California and northward along outer Baja California to a limit at lat. 27°07.3'N, long. 114°08.3'W and southward along the Central American coast to the Perlas Islands in the Gulf of Panama (Fig. 14). The type-locality is Bahía de Banderas, Jalisco, Mexico.

Variation.—Rosenblatt and Johnson (1974) noted a discernible variation in the number of anal rays. They observed that populations of *D. labarum* along the outer Baja California (from Almejas Bay northward) had a significantly greater number of individuals with eight anal rays (mean 7.12) than those populations southward of Almejas Bay along the Baja (7.04) or through the remainder of its range (7.02). In this study 18% of the specimens examined (94) from the outer Baja California coast had eight anal rays. Only 6% of all other *D. labarum* examined from other localities (50) had eight anal rays. Rosenblatt and Johnson (1974) were unable to substantiate their hypothesis that this variation was induced by environmental variables.

Other recognizable differences are seen in the mean number of scale rows in lateral line for *D. labarum* (61.27 for Gulf of California and 55.87 for Panama and Costa Rica specimens). Slight but recognizable differences are observed in the mean number of pectoral rays in the population from outer Baja (17.00), Gulf of California (16.24), and Panama and Costa Rica (16.97).

Specimens examined.—In addition to those listed by Rosenblatt and Johnson (1974); a total of 630 specimens from 34 to 212 mm SL. OUTER BAJA CALIFORNIA: LACM 33329-1, 1 (82); LACM 32094-1, 1 (135); CAS SU 47, 4 (70-88). GULF OF CALIFORNIA: LACM 8841-4, 1 (107); LACM 8834-4, 9 (84-139); LACM 8839-5, 15 (88-188); LACM 8834-3, 3 (106-173); LACM 8824-6, 9 (79-172); UA 67-59-6, 2 (66-76); UA 70-29-7, 1 (126); UA 67-58-3, 3 (65-88). MEXICO: CAS 4853, 1 (57).

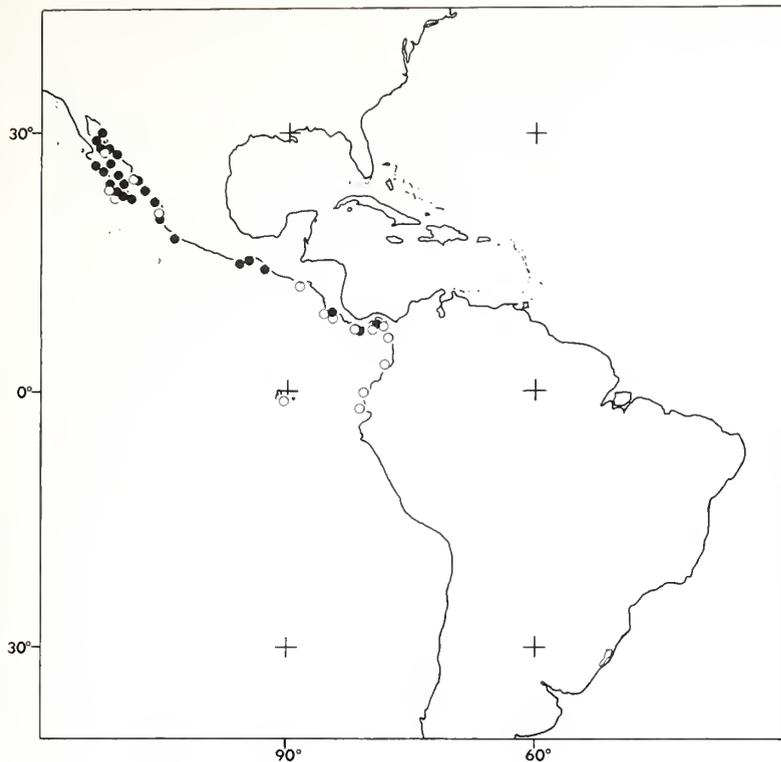


Figure 14.—Distribution map for *Diplectrum eumelum* (open circles); and *D. labarum* (closed circles). [Localities are based on the materials examined in this study.]

Diplectrum eumelum
Rosenblatt and Johnson 1974

Figures 6, 8, 9, 14, 15

Diplectrum macropoma Jordan and Eigenmann 1890: 397-398 (key, description); Jordan and Evermann 1896:1203, 1205-1206 (systematics); Gilbert and Starks 1904:97-98 (in part, Panama and Gulf of California); Walford 1937:123-124 (key, systematics); Meek and Hildebrand 1925:472, 475 (key, systematics, Panama); Orces 1959:81 (description, Ecuador).

Diplectrum eumelum Rosenblatt and Johnson 1974:178-191, fig. 1B (original description, coastal eastern Pacific).

The description given by Jordan and Eigenmann (1890:397-398), although vague in many respects, can nevertheless be attributed to *D. eumelum* and not to *D. macropoma*. Meristic and proportional data presented could be assigned to either species, however, the color description depicting the snout with "... four or five pale blotches ..." (Jordan and Eigenmann 1890:397) clearly indicates *D. eumelum*. Later publications, it appears, merely followed the error of Jordan and Eigenmann (1890).

Gilbert and Starks (1904:97-98) recorded this species from Magdalena Bay, outer Baja California, from *Albatross* Stn. 3039. These specimens are now cataloged as *D. macropoma*, CAS SU 47, but examination of this lot revealed that *D. macropoma*, *D. labarum*, *D. euryplectrum*, and *D. eumelum* were taken at that station.

ford (1937:123-124) and Orces (1959:81) presented data for size and color of *D. macropoma* which can only be attributed to *D. eumelum*.

Diagnosis.—*Diplectrum eumelum* is immediately recognized by the distinct series of three to five pale (orange in live specimens) spots on the snout and lacrimal area. It has large scales which separate it meristically (Tables 2-7) from other *Diplectrum* except *D. macropoma*. *Diplectrum eumelum* differs from *D. macropoma* on the basis of its color pattern, and size (*D. macropoma* is usually no greater than 140 mm SL). Caudal-peduncle-depth-to-head ratio is 1:3.2 for *D. eumelum* and 1:2.7 for *D. macropoma*. The posteriormost dorsal and anal rays are as long as each fin's respective anterior rays in *D. eumelum* and shorter than each fin's respective rays for *D. macropoma*. The snout is blunt for *D. eumelum* and more pointed for *D. macropoma*. The number of pseudobranch filaments is tentatively a character which may separate these species (Fig. 15) but consideration must be given to the standard length of specimens.

Juvenile *D. eumelum* might be confused with juveniles of *D. labarum* but color patterns and meristics (especially cheek scale rows B) will separate these forms.

Description.—D, X, 12 (13); A, III, 7 (8); P₁, 17.02 (16-18); pored lateral-line scales, 48.63 (45-52); scale rows in lateral line, 57.42 (48-64); scales above lateral line, 6.39 (5-9); scales below lateral line, 15.54 (13-17); predorsal scale rows, 11.46 (10-15); cheek scale rows A, 5.98 (5-7); cheek scale rows B, 8.41 (7-10); gill rakers, 19.55 (18.22).

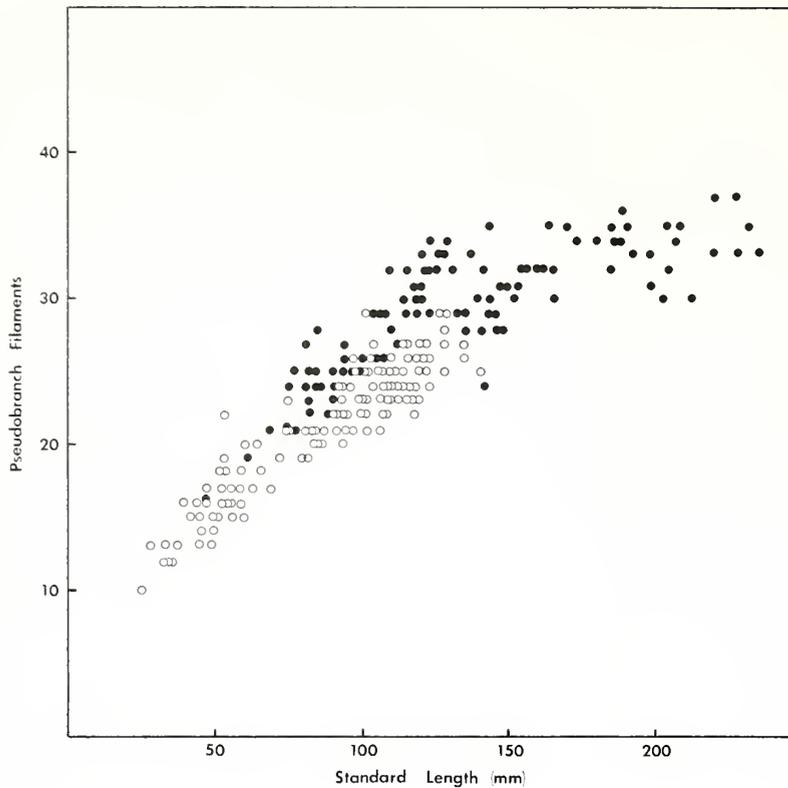


Figure 15.—Scatter diagram of number of pseudobranch filaments versus standard length for *Diplectrum macropoma* (open circles) and *D. eumelum* (closed circles). [Localities are based on the materials examined in this study.]

Standard length, 151.63 (47.92, 81.0-233, 41); total length, 1,279 (15.74, 1,241-1,310, 39); fork length, 1,187 (14.00, 1,156-1,212, 40); body depth, 286 (18.54, 232-321, 35); head length, 387 (11.96, 369-412, 41); postorbital length, 221 (12.21, 200-266, 41); snout length, 99 (7.29, 87-118, 39); lacrimal width, 48 (4.05, 40-56, 40); maxillary width, 33 (1.85, 28-36, 41); orbit length, 86 (7.73, 72-102, 40); orbit width, 72 (7.93, 56-93, 40); interorbital width, 70 (3.80, 64-79, 36); upper jaw length, 171 (5.52, 160-180, 41); lower jaw length, 184 (6.15, 166-196, 40); cheek height, 129 (7.87, 110-143, 41); cheek length, 121 (5.31, 110-134, 41); caudal peduncle depth, 122 (5.10, 110-133, 40); pectoral fin length, 267 (7.89, 244-285, 40); pelvic fin length, 201 (10.09, 175-223, 41); predorsal length, 369 (8.44, 353-382, 36); pelvic origin to lower jaw, 339 (9.47, 316-361, 33); pelvic origin to anus, 314 (13.11, 286-343, 36); postanal length, 402 (10.38, 380-421, 36). Dorsal spine height: first, 50 (5.69, 39-66, 36); second, 74 (5.80, 61-86, 36); third, 121 (8.45, 107-142, 36); fourth, 132 (20.37, 118-147, 38); fifth, 133 (7.54, 119-146, 36). Anal spine height: first, 29 (4.88, 21-36, 41); second, 60 (9.38, 48-83, 41); third, 83 (9.21, 69-107, 41).

Diplectrum eumelum has broad spur at preopercular angle bearing 8-14 elongate spines. Vertical and horizontal preopercular arms serrate. Anterior nostril with elongate flap. Single row of scales along posterior edge of second anal spine. Caudal fin without elongate filament but upper lobe noticeably longer than lower. Chest scales not reduced or embedded. Gill rakers short, the first at the angle not reaching past base of the third below. Pseudobranch filaments numerous, 28-35 in adults.

Color.—Color notes are from two adult specimens taken from the Gulf of Nicoya, Costa Rica, 28 June 1973. The specimens had been on ice for 24 h before examination. Dorsum gray-brown, paler ventrally. Ventral surface white with copper tinge more laterally. Lateral body surface with gold flecks. Some evidence of five to six indistinct, thin, dusky ventral bars becoming paler ventrally. Somewhat intensified cluster of black pigment in series of large midlateral blotches. Spinous dorsal fin pale blue along base, body of fin pale orange. Distally each interspinous membrane bears a scalloped-shaped pale orange wedge. Distal portion of spines tipped with black and orange. Soft dorsal with blue field bearing series of wavy, orange diagonal lines. Posteriorly, the wavy bars interrupted to present spotted pattern, pale orange on pale blue. Anal white at base becoming blotched with pale orange-yellow distally. Snout with three to five orange spots in row. These becoming more irregular posteriorly, the last in series as elongate bar traversing cheek in a wavy pattern terminating at lower distal portion of preopercular spur. Irregular arrangement of orange spots also present on preopercles and opercles. Distal premaxillary edge with orange pigment line. Distal maxillary with small orange blotch.

Color notes from preserved specimens: preserved specimens show similar pattern but pale blue appearing as gray and orange as pale or clear. Caudal peduncle spot distinct, dark, and as large as eye but oriented vertically. Caudal fin with numerous pale spots in vertical row on dusky field. Distal caudal ray tips black. Medial opercular surface black like the posterior branchial cavi-

ty. Chest and branchiostegal region pale. Anterior nasal flap pale. Each lateral body scale with dark pigment at base giving lateral surface appearance of being marked by X's. Upper pharyngeal area with dark pigment. Pelvic and pectoral fins dusky, pigment running along ray edge.

Size.—The species is large, reaching at least 234 mm SL as observed in the present study.

Habits.—The two adults (209-228 mm SL) from the Gulf of Nicoya on 28 July 1973 had enlarged gonads but the ovaries did not contain ripe eggs. Stomachs were empty. Available collection depth data show that the species is taken from 15 to 100 m but most often from depths of 50 to 90 m.

Distribution.—*Diplectrum eumelum* is infrequently taken within its range which extends northward off the outer Baja California to Bahia Magdalena (Fig. 14), into the Gulf of California, and southward along the eastern Pacific coast to Ecuador (lat. 2°29'S, long. 80°59'W). It is also found at the Galapagos Islands.

Variation.—No obvious variation in characters was discernible for *D. eumelum* throughout its distribution.

Specimens examined.—In addition to those listed by Rosenblatt and Johnson (1974), a total of 130 specimens from 40 to 234 mm SL. OUTER BAJA CALIFORNIA: UCLA W55-78, 1 (87); CAS SU 47, 6 (47-121); LACM W52-195, 1 (216). GULF OF CALIFORNIA: UCLA W62-61, 8 (72-107). SAN SALVADOR: CAS 4761, 1 (54). COSTA RICA: LACM 30719-3, 2 (160-188); UCR 323-15, 1 (165). PANAMA: USNM (lat. 6°44'N, long. 77°33'W, 8 Dec. 1967), 2 (146-149); USNM (Gulf of Chiriqui, 29 Mar. 1963), 4 (136-188); CAS SU 1409, 2 (98-145); UMML 25094, 2 (96-156); UMML 26255, 2 (150-163); USNM 41481, 5 (40-93); UMML 26150, 1 (142); UMML 26252, 1 (130). COLOMBIA: USNM 211393, 12 (75-123); USNM 211391, 1 (150); USNM 211381, 1 (205); USNM 213813, 7 (173-213); USNM 213588, 19 (100-170). ECUADOR: USNM 213808, 10 (191-234); USNM 211396, 1 (186). GALAPAGOS ISLANDS: UCLA W53-12, 2 (42-78).

Diplectrum macropoma (Günther 1864)

Figures 6, 8, 7, 13, 15

Centropristis macropoma Günther 1864:145 (original description, Panama); Günther 1869:409, pl. 65, fig. 1 (redescription and figure, Panama).

Diplectrum macropoma. Jordan and Bollman 1890:157-158, 181 (Panama); Gilbert and Starks 1904:97 (in part, Panama and Gulf of California); Jordan et al. 1930:318 (check list); Hildebrand 1946:185 (key); Berdegue A. 1956:53, 264-265 (key, fishery data, Mexico); Chirichigno F. 1974:294-298, fig. 574 (key, Peru); Rosenblatt and Johnson 1974:178-191, fig. 1C (key, systematics).

Diplectrum mexicanum Hildebrand 1948:13-15, fig. 6 (original description, Gulf of California); Bortone in press b (life history, Panama).

The taxonomic confusion of *D. macropoma* with *D.*

eumelum has already been discussed under the heading of the latter. References by Jordan and Bollman (1890), Jordan et al. (1930), and Hildebrand (1946) may have actually referred to *D. eumelum*, but there is no way to determine this positively from data presented by those authors.

Günther (1864:145) described *Centropristis macropoma* from three specimens collected by Dow and Salvin from the Pacific coast of Panama. The same description reappeared accompanied by a figure (Günther 1869:409, pl. 65, fig. 1). Hildebrand (1948:13-15, fig. 6) described *Diplectrum mexicanum* based on one specimen from the Gulf of California. Examination of the syntype (designated as the lectotype in the absence of a holotype) of *Centropristis macropoma* (BMNH 1864-1.26:426, labeled as *Serranus macropoma* and hereafter referred to as a *Diplectrum*) and a comparison with the holotype of *Diplectrum mexicanum* (USNM 46518) assures me that the two species are synonymous.

The most notable characters used by Günther to designate *D. macropoma* were: the long spines at the preopercular angle graduating to a serrated preopercular arm; six rows of cheek scales; and a distinct notch between the spinous and soft portions of the dorsal fin. Other characters more clearly noted from his figure and from the syntype include: dark pigment (not discernible in a pattern) on the distal half of the dorsal fin; deep body (3.7 in SL); and an angular snout. The characteristics of *D. mexicanum* presented by Hildebrand (1948) include: deep body (3.2 in SL); angular snout; and six cheek scale rows. The figure also depicts a preopercular structure similar to that described and figured by Günther (1864, 1869).

Hildebrand's specimen was collected in 1889 and the fact that he did not describe any dorsal fin pigmentation could be owing to its loss during prolonged preservation. Current examination also shows a lack of dorsal fin pigmentation. A comparison of other meristic and morphometric data indicate no apparent specific differences.

Jordan and Eigenmann (1890:397-398) and Meek and Hildebrand (1925:475) gave accounts of *D. macropoma* which are apparently not of this species but of *D. eumelum*. Later, Hildebrand considered *D. mexicanum* as distinct from *D. macropoma* as understood by Meek and Hildebrand.

Diagnosis.—*Diplectrum macropoma* has large scales and, therefore, scale counts tend to be low for this species (Tables 2-7). These characters should separate it from other species of *Diplectrum* except *D. eumelum* which it closely resembles. *Diplectrum macropoma* has pale yellow markings on its snout but these are inconspicuous in live material and nonexistent in preserved specimens. *Diplectrum macropoma* has a more pointed snout, a proportionally lower number of pseudobranch filaments (Fig. 15), and the posterior dorsal and anal rays are considerably shorter than the anterior rays. These characters all differ for *D. eumelum*. Other differences are noted under the diagnosis for *D. eumelum*.

Confusion with *D. labarum* might occur but *D. macropoma* has none of its anterior spines elongated and the mean caudal peduncle depth is considerably greater than that of *D. labarum* (138.51 as opposed to 117.11 for *D. labarum*). *Diplectrum macropoma* has the greatest body depth, caudal peduncle depth, predorsal length, and postanal length of any *Diplectrum*.

Description.—D, X, 12 (11-13); A, III, 7; P, 17.12 (16-18); pored lateral-line scales, 48.09 (44-51); scale rows in lateral line, 53.86 (48-63); scales above lateral line, 6.32 (5-7); scales below lateral line, 14.60 (11-18); predorsal scale rows, 13.96 (10-18); cheek scale rows A, 6.27 (5-8); cheek scale rows B, 8.53 (7-10); gill rakers, 19.93 (17-24).

Standard length, 107.39 (13.74, 90.6-140, 41). Total length, 1,308 (28.13, 1,260-1,350, 26); fork length, 1,190 (9.30, 1,175-1,207, 25); body depth, 306 (14.64, 273-338, 39); head length, 367 (8.30, 353-391, 41); postorbital length, 202 (6.12, 194-216, 41); snout length, 96 (6.39, 82-106, 41); lacrimal width, 41 (2.28, 36-47, 36); maxillary width, 35 (3.05, 30-43, 36); orbit length, 87 (4.43, 79-97, 41); orbit width, 73 (4.94, 64-85, 41); interorbital width, 67 (4.03, 59-77, 36); upper jaw length, 163 (6.10, 148-177, 41); lower jaw length, 182 (5.85, 165-191, 41); cheek height, 119 (4.56, 112-135, 41); cheek length, 118 (4.25, 107-140, 41); caudal peduncle depth, 139 (4.31, 128-147, 41); pectoral fin length, 265 (8.93, 246-281, 41); pelvic fin length, 196 (9.06, 175-210, 36); predorsal length, 382 (9.90, 366-410, 33); pelvic origin to lower jaw, 348 (11.77, 333-373, 27); pelvic origin to anus, 296 (13.04, 269-318, 37); postanal length, 411 (15.51, 387-456, 40). Dorsal spine height: first, 46 (5.33, 35-63, 40); second, 67 (5.62, 54-79, 39); third, 130 (9.87, 109-154, 40); fourth, 142 (10.47, 122-158, 21); fifth, 144 (10.31, 126-155, 20). Anal spine height: first, 32 (3.78, 23-38, 41); second, 59 (5.70, 47-69, 41); third, 90 (6.29, 73-101, 40).

Preopercular spur broad, with 8-13 elongate spines. Vertical and horizontal arms serrate. Distinct flap present on anterior nostril. Gill rakers moderate in length, the first at angle not reaching past the fourth below. Scales large but notably smaller in predorsal area. Scales present along third anal spine and first anal ray. Caudal lobes unequal, upper being longer but tip not produced as a filament. Caudal fin only slightly forked. Chest scales not embedded. Posteriormost soft dorsal and anal rays short, nearly 1.5 into longest respective soft dorsal and anal rays. Second anal spine slightly more stout than third. Pseudobranch filaments few, 20-30 in adults (Fig. 15).

Color.—Color notes were taken from numerous *D. macropoma* from the Bay of Panama, January-February 1973. Dorsum pale copper to pale brown. Venter white, almost silvery. Sides in smaller specimens (60 mm SL) with two dark brown stripes, uppermost running through eye onto snout. Larger specimens with two lateral bands interrupted by pale pigment and appearing indistinct in outline. Dark snout bar yellow in larger specimens. Pectoral fin pale reddish-orange, pelvic fin pale orange. Anal fin white at base and distally; a wide pale yellow lateral

band through the center of fin. Caudal fin bright reddish orange on upper lobe, pale gray or white on lower. Body of caudal fin with five to six vertical rows of small orange spots on pale blue field. Caudal spot distinct; as large as eye, oval shaped, oriented laterally (an extension of lateral stripe) in small specimens; vertical in orientation in larger specimens. Spinous dorsal fin white, becoming pale gray distally. Spine tips orange. Soft dorsal rays tipped with orange. Body of fin with two rows of distinct round orange spots on pale blue field. Below this, fin clear to base. Chest and branchiostegal membranes white. Upper medial opercular surface black, area below yellow. Posterior branchial area black with yellow lining. Upper pharyngeal region yellow with sparse gray-blue flecks. Dorsal surface of eye blue-black, yellow laterally, and white below. Smaller specimens with dark spot on caudal peduncle dorsum disappearing in larger specimens. Maxillary gray-brown, dentary white. Lateral opercular surface metallic blue-green. Three to four pale, indistinct yellow spots on snout, the uppermost elongate. Snout spots fade quickly, barely discernible.

Color in preserved specimens shows a similar pattern as above but all colors have faded. The venter appears silvery, dorsum tan with evidence of brown lateral indistinct bars. Caudal spot larger than eye and vertical in orientation. Soft dorsal fin with appearance of wide dark band above and pale or clear bar below.

Size.—*Diplectrum macropoma* is a small species not exceeding 144 mm SL (Rosenblatt and Johnson 1974).

Habits.—In the Bay of Panama (10-15 km east of Naos Island) I collected the species from about 20 to 30 m over an open mud and sand bottom along with *D. pacificum* (Bortone in press b). *Diplectrum macropoma* was abundant at this locality with about 50 being obtained in each 20-min tow with a 10-m otter trawl at night. The species has been recorded to occur at depths ranging from 9 to 80 m but is more frequently taken at depths of 20-40 m.

Distribution.—*Diplectrum macropoma* is found in the Gulf of California; northward on the outer Baja California to at least lat. 24°27'N, long. 111°59'W; and southward along the eastern Pacific coast to the Ecuador-Peruvian border at lat. 3°39'S, long. 80°41'W (Fig. 13). The species was also taken at the Galapagos Islands. The type-locality is the Pacific coast of Panama (Günther 1864).

Variation.—Examination of meristic data indicates some variation in *D. macropoma* with regard to the mean number of predorsal scale rows (Table 5). Gulf of California (13.81), Panama (14.96), and Colombia (12.92) populations all show different means for this character.

Specimens examined.—OUTER BAJA CALIFORNIA: CAS SU 47, 2 (113-113); SIO 64-807, 1 (29). GULF OF CALIFORNIA: USNM 46518, 1 (95); USNM 183977, 2 (128-140); SOSO (Choya Bay, Mexico, 14 Feb. 1969), 1 (141); SIO 68-72, 24 (54-114); CAS W 59-14, 26 (36-102); INP 6601, 7 (97-129); FMNH 62743, 8 (38-135); UA 67-74-3, 3 (45-50); UA 67-72-2, 1 (120); SIO 62-75, 1 (128); USLA W52-45, 12 (110-138); SIO 70-141,

4; SIO W62-60, 8 (72-139). MEXICO: SIO 62-37, 3 (95-108); SIO 62-46, 1; SIO 62-36, 2 (97-100). COSTA RICA: SIO W63-148, 2. PANAMA: BMNH 1864-1.26:426, lectotype, 1 (91); SOSC (lat. 8°08'N, long. 80°20'W, 23 July 1967), 22 (86-118); UMML 25094, 21 (25-85); UMML 25075, 5 (33-74); UMML 26094, 2 (111-118); UMML 26253, 4 (30-115); UMML 25041, 1 (106); UMML 25067, 8 (63-120); UMML 2646, 13 (52-109); CAS SU 1641, 1 (126); UCR 223-8, 1 (109); UMML 26247, 1 (122). COLOMBIA: USNM 211369, 2 (96-97); USNM 216385, 2 (83-90); USNM 211421, 1 (104); USNM 211416, 2 (117-122); USNM 211410, 5 (90-129); USNM 211394, 13 (81-136); USNM 211398, 18 (97-121); USNM 213590, 8 (91-122); USNM 211402, 15 (91-119); USNM 213591, 152 (62-128); USNM 21E397, 12 (100-131). GALAPAGOS ISLANDS: CAS SU 1569, 1 (116).

ZOOGEOGRAPHY

The genus *Diplectrum* is restricted to the western hemisphere (Rosenblatt 1967) and, in general, is found in coastal areas of tropical-subtropical regions. Ekman (1953) has termed groups with this distribution pattern as "endemic amphi-American thermophiles." The generic distribution closely parallels other groups such as the decapod crustacean genus *Mithrax*, the penaeularian genus *Renilla* (Ekman 1953) and numerous fish genera such as *Centropomus* (Fraser 1968), *Calamus* (Randall and Caldwell 1966), *Haemulon* (Courtenay 1961), and *Mycteroperca* (Smith 1959). *Diplectrum* has affinities for continental coastal areas but *D. bivittatum* is commonly present in the Antillean Archipelago.

Six of the nine Pacific species have a fairly continuous coastal distribution which encompasses nearly the entire Panamanian province (i.e., the Eastern Pacific Zoogeographic Region of Briggs (1974)). Of these six, only *D. euryplectrum* and *D. maximum* are not found in the Gulf of California. *Diplectrum maximum* is unique (Fig. 11) in that its northern population is separated by a long geographical range from its southern population. As stated previously, only juveniles were taken at the northern locality. Although the larval life history of some serranids may be relatively long (Smith 1959), the vast distance involved does not allow for transport of larvae or juveniles from the southern population (Rosenblatt and Johnson 1974). Most assuredly this deepwater species will be found as adults much further north of its southern population.

Diplectrum sciurus is almost restricted to the Gulf of California. Although its movement out of the Gulf may be hindered by geographical and hydrological barriers (Walker 1960), its extreme morphological adaptations related to feeding (i.e., long and numerous gill rakers) give credence to the hypothesis of a restricted distribution owing to competitive interaction.

Diplectrum conceptione is outside the Panamanian province in the Peru-Chilean province of Briggs (1974). It is the only nonthermophilic species in the genus. This species' southernmost limit at Concepcion, Chile (the type-locality) could be explained by possible mislabeling by early collectors. Its northern limit is governed by rapid temperature changes caused by a westward turn of the Peru Current near Punta Aguja, Paita, Peru. This temperature block is formidable during "El Nino" years (Rosenblatt and Walker 1963).

Four species of *Diplectrum* have been recorded from the Galapagos Islands (i.e., *D. euryplectrum*, *D. rosstrum*, *D. macropoma*, and *D. eumelum*). The fauna of the Galapagos Archipelago represents a unique zoogeographical situation (Rosenblatt and Walker 1963). Although comparative material is scarce, there seem to be no significant taxonomic differences between Galapagos and mainland conspecific representatives. This suggests a nonisolated gene pool for Galapagos *Diplectrum*. Larvae may periodically invade the islands from the Panamanian province during "El Nino" years when current patterns seem to favor this transport mechanism (Rosenblatt and Walker 1963). Briggs (1974) has also indicated the currents which flow toward the Galapagos Islands from the Panama area during February through April may be important in explaining the similarities in marine inshore fauna between the Galapagos and Panamanian province. It may be significant to note the absence of *D. conceptione*, a Peru-Chilean province species. Currents would seem to favor its movement to the Galapagos (Rosenblatt and Walker 1963), yet its absence may be due to competitive exclusion or simply inadequate sampling.

Hubbs (1960) has stated that the northern boundary for the Panamanian province is not abrupt. Northern limits for Pacific *Diplectrum* support this statement. Magdalena Bay (lat. 24.5°N) is the northern limit for five of eight Pacific species recorded from the outer Baja California. Magdalena Bay is considered a northern boundary for the eastern Pacific tropical fish fauna (Rosenblatt 1967). Hubbs (1960) indicated that rapid temperature changes in this area are due to insolation and upwelling. This is a plausible reason for *Diplectrum* northern distribution limits in this area. Two species go beyond the above faunal boundary and one of these (*D. labarum*) extends to Bahia Asuncion (lat. 27°N). It would be reasonable to expect *Diplectrum* to extend further north of the Panama-San Diegan province boundary, especially when local weather conditions favor northern movement of warm-water species.

In the western Atlantic, the northern limit for the Carolina Province water is Cape Hatteras, N.C. (Briggs 1974). From collection data it appears Cape Lookout (110 km southwest of Cape Hatteras) is the northernmost area of abundance for *D. formosum*. The one locality record from Chincoteague, Va. (lat. 38°N) apparently occurred at a time during favorable weather conditions. *Diplectrum bivittatum* (from the intermediate population) is probably limited more by favorable reef habitat than temperature along the southeast U.S. coast. Presumably the species occurs at deep patch reefs at higher latitudes than it is currently known.

Southern limits for Atlantic *Diplectrum* have been reported in the literature to be Montevideo, Uruguay. This southern distribution limit cannot be confirmed as yet. Montevideo (i.e., Rio del Plata) is certainly considered a zoogeographic boundary (Ekman 1953) and Briggs (1974) considered this area as the southernmost boundary of the Eastern South American Region. However, the present study indicates a slightly more

northern boundary for S. Atlantic *Diplectrum* near São Paulo and Rio de Janeiro. This area is also considered a boundary by Ekman (1953), and Briggs (1974) attributed the presence of this boundary to a cooling of the Brazil current.

Diplectrum formosum, with its two subspecies, presents an interesting distribution pattern. The northern form (*D. f. formosum*) is almost restricted to continental North America. Except for a single record from the Virgin Islands, the southern form is essentially restricted to continental South America. The vast expanse of Caribbean Sea with its Antillean Island chain (i.e., West Indian Province of Briggs (1974)), appears to have been a formidable barrier to the species distribution which led to considerable genetic isolation. Conceivably the species may have lacked the competitive ability of other reef-dwelling serranids and was therefore not able to occupy or use the Antilles coast for its habitat.

Diplectrum bivittatum presents us with two geographical populations herein considered subspecies. The Gulf of Mexico form (*D. b. arcuarium*) seems restricted to areas of the Gulf with characteristically "soft" bottom (i.e., mud or sand; Lynch 1954:fig. 19). The absence of *D. b. arcuarium* from the west peninsular Florida coast and the coast of the Yucatan Peninsula, both characterized by limestone and coral substrates, attests to this premise. *Diplectrum bivittatum* with its distribution in the Antilles is apparently capable of surviving at reef as well as coastal localities. The intermediate form of the two recognized subspecies must be considered by itself zoogeographically. Because the apparent ranges for the two subspecies do not actually overlap, an explanation must be offered for the existence of the S. Florida population. Gulf currents may favor a larval drift of the northern Gulf of Mexico form to the south Florida area, especially during summer months (Leipper 1954; Nowlin 1971). Larval transport across the mouth of the Gulf from Yucatan is not probable in view of these currents (Leipper 1954; Nowlin 1971). General circulation in the Caribbean and Antilles areas favors a northwest drift of larvae from these areas to south Florida. Another possible explanation for the existence of an intermediate form of the two subspecies is that the intermediate form represents a third subspecies, almost completely isolated from the Gulf and excluded by an unknown factor from the southern form. The first view is the most favored. Further studies on these forms will help resolve this question.

Both *D. formosum* and *D. radiale* terminate their distribution along the northern coast of South America at or near the Gulf of Venezuela. The significance of this distribution pattern is important when considering the ampho-American distribution of *Diplectrum* and particularly the very close "geminata" relation *D. radiale* has with *D. pacificum*.

It is reasonable to postulate that in view of the obvious affinity of the two species, *D. radiale* may at one time have had a distribution which included the Atlantic side of Panama and Colombia. There is general agreement that the latest transoceanic passage available to

marine species occurred during the late Pliocene (Simpson 1950). Considering the present distribution of the geminate pair, the Colombian "gap," open from middle Eocene to late Eocene or late Oligocene (Smith 1971), may have served as the last area and time for passage.

If this is true, then relative selective differences between *D. radiale* and *D. pacificum* have been small. A test for this hypothesis, assuming the species are indeed distinct, would be to perform comparative in situ life history studies of the two species. Rosenblatt (1967) has suggested that morphological diversity and genetic changes may not be clearly related.

Diplectrum thus portrays an almost classic case of a distribution limit, approaching lat. 25°N and 5°S (except for *D. conceptione*) along the coastal east Pacific, due to cold-water current "squeeze" (Rosenblatt 1967). The Atlantic warm-water gyres have allowed the genus to assume the classic warm-water distribution which is essentially from lat. 35°N to 35°S.

ACKNOWLEDGMENTS

Many persons aided me in the course of this study. I thank the following: Allwyn C. Wheeler (BMNH), William N. Eschmeyer (CAS), Loren P. Woods (FMNH), Robert W. Topp (FSBC), Carter R. Gilbert (FSM), Ralph W. Yerger (FSU), Charles E. Dawson (GCRL), William D. Anderson, Jr. (GMBL), Aurelio Solorzano P. (INP), Camm C. Swift (LACM), Myvanwy Dick (CMZ), M. L. Bauchot (MNHN), Naercio A. Menezes (MZUSP), Maurice Boesemen (RMNH), Richard H. Rosenblatt (SIO), Leslie W. Knapp (SOSC), George C. Miller (TABL), Lloyd T. Findley (UA), Boyd W. Walker (UCLA), William C. Bussing (UCR), C. Richard Robins (UMML), Frank J. Schwartz (UNC), William H. Eger (UPR), Victor G. Springer (USNM), Donald E. Wohlschlag (UTMSI), and Arthur D. Welander (UW) for making available museum specimens from their respective institutions; Fernando Cervigon, Nucleo de Nueva Esparta, Porlamar, Venezuela, and Richard Moore, University of Texas, Marine Sciences Institute, for personally collecting specimens used in this study; Ben Cooper, Costa Rica, and David Drennan, Panama, for collecting specimens in their respective countries; Ira Rubinoff, Smithsonian Tropical Research Institute, Panama, for making available facilities at that institution; James K. Dooley, Richard H. Rosenblatt, David Johnson, John E. McCosker, C. Lavett Smith, Robert Lavenberg, C. Richard Robins, and Victor G. Springer for contributing through helpful discussion, advice, and correspondence; Charles M. Johnson for aid in obtaining specimens and histological advice; A. F. Chestnut, Institute of Marine Sciences, University of North Carolina, for making available facilities necessary for conducting my research at that institution; Camm C. Swift for aid in collecting specimens, loan of material, and very able advice; the members of my graduate committee, Elizabeth A. McMahan, H. Eugene Lehman, Jan J. Kohlmeier, William J. Woods, University of North

Carolina, and Joseph R. Bailey, Duke University, for serving on that committee and editing this manuscript. Jan J. Kohlmeyer also translated several references.

Special thanks are due to William E. Fahy, my graduate advisor, for his editing of the manuscript and for his direction and guidance; and to my wife Midge for collecting specimens, typing the manuscript, and maintaining stability in the laboratory and at home.

This work was supported by a traineeship through the National Science Foundation, an Advanced Service Fellowship from the University of North Carolina, a grant (GB34290) from the National Science Foundation, and my wife's salary.

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