

THE RIBBONFISH GENUS *DESMODEMA*, WITH THE DESCRIPTION OF A NEW SPECIES (PISCES, TRACHIPTERIDAE)

RICHARD H. ROSENBLATT¹ AND JOHN L. BUTLER²

ABSTRACT

The genus *Desmodema* is unique within the Trachipteridae in that the upper caudal lobe, borne on the second ural centrum, is not upturned, and the lower caudal lobe, borne on the first ural centrum in other trachipterids, is absent, and in that there are seven dorsal pterygiophores before the first neural spine. *Desmodema lorum* n.sp. can be distinguished from *D. polystictum* (Ogilby) on the basis of having more vertebrae, fewer caudal rays, a longer tail, and the snout longer than the eye diameter. *Desmodema polystictum* is probably circumtropical; *D. lorum* is restricted to the North Pacific Ocean. The species of *Desmodema* have a distinctive prejuvenile phase characterized by polka dots on the sides, long pelvic fins, a relatively short tail, and elongation of the first six dorsal rays. Metamorphosis is abrupt and involves loss of the pelvic fins, elongated dorsal rays and polka dots, and a great lengthening of the tail. It is suggested that metamorphosis accompanies movement to a deeper habitat. The elongated tail is related to extension of the lateral-line sensory system. On the basis of joint possession of a dermal tubercle and pore system and an abruptly constricted body, *Desmodema* and *Zu* are regarded as related. *Desmodema*, but not *Zu*, agrees with *Regalecus* in the arrangement of the dorsal pterygiophores.

The genus *Desmodema* was erected for the reception of *Trachypterus jacksoniensis polystictus* Ogilby (Walters and Fitch 1960). Fitch (1964) subsequently redescribed *Desmodema polystictum*, mainly utilizing material from the northeast Pacific, and placed *Trachypterus misakiensis* Tanaka, 1908 and *T. deltoideus* Clark, 1938 in its synonymy. Our interest arose from the observation that two recently collected specimens had what appeared to be anomalously low vertebral counts. This initiated the present study, which has revealed the existence of two species, one of them undescribed. In addition to distinguishing and describing the species, our material has allowed us to amplify the generic description of *Desmodema* and to detail some of the remarkable ontogenetic changes undergone by its species.

MATERIALS AND METHODS

Specimens used in this study are housed in the following institutions: California Academy of Sciences (CAS), Department of Biology, University of California, Los Angeles (UCLA), Natural History Museum of Los Angeles County (LACM), and Scripps Institution of Oceanography (SIO). In the

material list the first length measurement is the snout-vent length (SV), the second the standard length (SL). A single value indicates snout-vent length of a broken specimen.

Because of the delicacy of the species, most of the specimens were damaged in some way, and not all counts and measurements were made on all specimens. In particular, fin lengths represent minimum measurements, since all fins seem to have been broken to some degree. No specimen appeared to have unbroken pelvic fins. Measurements are self-explanatory and were taken with flat-point dividers or dial calipers. Vertebral counts were taken from radiographs or cleared and stained material. Dorsal rays could be enumerated on only a few specimens.

RESULTS

Desmodema Walters and Fitch

Desmodema Walters and Fitch 1960. Type-species *Trachypterus jacksoniensis polystictus* Ogilby 1897, by original designation.

Diagnosis.—A trachipterid with 4-10 caudal rays, the caudal on the same axis as the caudal peduncle, all caudal rays borne on terminal centrum, no lower caudal lobe. Seven dorsal pterygiophores before first neural spine. Body con-

¹Scripps Institution of Oceanography, La Jolla, CA 92093.

²Southwest Fisheries Center, National Marine Fisheries Service, NOAA, P.O. Box 271, La Jolla, CA 92038.

stricted behind anus, tail exceedingly elongated in juveniles and adults. Young with numerous dark round spots. Skin of adults pierced by numerous pores.

Description—Body strongly compressed laterally, postanal portion of body narrowing into a whiplike tail in juveniles and adults (posterior vertebrae about four times as long as 14th vertebra). Posterior region of body of larvae and prejuveniles narrow, but not exceedingly elongate (posterior vertebrae shorter than 14th vertebra). Seven pterygiophores before first neural spine, one or two pterygiophores between first and second neural spines. First pterygiophore closely applies to back of skull, no predorsal bones. Anterior five or six dorsal rays elongated in larvae and prejuveniles to form a dorsal pennant; these rays completely lost in adults. Pelvics long and fanlike in young, absent in adults. Caudal well developed, of 4-10 unbranched rays, parallel to axis of tail. Caudal rays all borne on last ural centrum, no ventral caudal lobe (Figure 1).

Fin rays with a lateral row of small spines, these weak or absent on posterior pelvic rays, middle caudal rays, and pectoral rays. Each dorsal ray anterior to elongated tail portion of body with a single laterally directed stout spine on either side of the base.

Lateral line ending at caudal base, lateral-line scales with a pair of spines. Body otherwise scaleless at all sizes (*D. polystictum*), or young covered with scales, each with a pair of longitudinal spinous ridges (*D. lorum*). Skin of adults with cartilaginous tubercles, and pierced by numerous pores (Walters 1963). No enlarged tubercles on ventral midline.

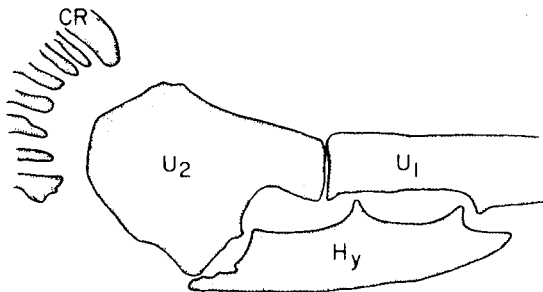


FIGURE 1.—Caudal skeleton of *Desmodema polystictum*, SIO 73-340. Camera lucida drawing at 25 \times magnification. Only bases of caudal rays shown. CR, caudal ray; Hy hypural; U₁, first ural centrum; U₂, second ural centrum and hypural.

Two nostrils in prejuveniles, the posterior just before anterior margin of eye; posterior opening obliterated in juveniles and adults. Nasal epithelium without ridges or folds at all sizes. Head bones cancellous and ridged. Mouth strongly oblique. Teeth restricted to one to four in each premaxilla and two enlarged, recurved fangs on mandible, one on either side of symphysis. Gill rakers (2-3) + (9-10) usually 3 + 9, fleshy, distally expanded and leaflike. Rakers of upper limb with a few teeth. Pseudobranch well developed. Gas bladder present in small juveniles (to about 30 mm SV), rudimentary or absent in large juveniles and adults.

Very young silvery, prejuveniles silvery with profuse dark spotting, adults without spots.

Growth changes.—Although we have no material smaller than 18.9 mm SV, it appears that development from a silvery or transparent form with a triangular outline with the head deepest, into the polka-dotted, deep bodied prejuvenile is gradual. The transition from prejuvenile to juvenile is probably rapid and can fairly be termed a metamorphosis. There is a large-size gap in our material of *D. polystictum* (91-260 mm SV), but our material of *D. lorum* includes the appropriate size classes. The difference between the prejuvenile and the final body form can be seen in Figure 5. The two specimens are almost identical in snout-vent length. However, the upper specimen is essentially a miniature adult. The major differences are in the change in the ventral profile, elongation of the tail, increase in eye size, eruption of lower jaw teeth, and loss of the spots, pelvic fins, and posterior nostril. Juveniles, including our largest (173 mm SV) have an elongate opening not yet covered over by the skin at the position of the pelvic fins, indicating that loss of the pelvics may be rapid, and from the base.

Walters (1963) indicated that juveniles of *D. polystictum* are scaled, but that adults are scaleless, and have cartilaginous tubercles and a subdermal canal system connected to the surface by numerous pores. In our material of *D. lorum* an 18.5-mm SV silvery individual lacks both scales and tubercles. An individual 36 mm SV is scaled, but lacks tubercles, and in another (36.5 mm SV), tubercles are present ventrally, and on the sides behind the head. Our largest polka-dotted prejuvenile is 95 mm SV. The upper sides are scaled; the remainder of the body is covered with tubercles and the subcutaneous canal system is well

developed, with surface pores present. A juvenile of 104 mm SV has scales along the dorsal base, and one of 131 mm SV lacks scales and has tubercles and pores over the entire body.

Desmodema polystictum does not agree with *D. lorum* in the course of development of the tubercles and pore system. None of our specimens has scales. Instead tubercles are developed in a specimen of 36 mm SV, and tubercles and pores are present in an individual of 42 mm SV. Walters (1963) was unaware of the existence of the two species of *Desmodema* and his figure 1 was undoubtedly based on a juvenile of *D. lorum*.

In juveniles the first six dorsal rays are elongated (broken in all our specimens). These rays, which are borne on the pterygiophores before the first neural spine, are lost, and in adults represented by a stiffening in the skin. The recurved, fanglike lower jaw teeth first appear at a snout-vent length of about 100 mm.

Life history and behavior.—We lack data from closing nets, and thus have no precise information on depth of capture of our material. Fitch and Lavenberg (1968) inferred that *Desmodema "polystictum"* lives "500 to 1,000 feet beneath the sea's surface" and Walters (1963) predicated his discussion of energetics on the assumption that *Desmodema* is mesopelagic. Harrison and Palmer (1968) speculated that *Desmodema*, which they described as "chocolate brown," might live deeper than its silvery relatives. Actually *Desmodema* is silvery and turns brown in preservative.

The number of polka-dotted juveniles of *D. polystictum* taken at or near the surface indicates that they probably mainly occupy the euphotic zone. The polka-dotted pattern would be maximally useful as protective coloration in the light-dappled environment near the surface. However, records (presumably juveniles) from stomachs of *Alepisaurus* (Fourmanoir 1969) suggest a considerable depth range. A number of juvenile *D. lorum* have been taken from albacore, *Thunnus alalunga*, stomachs, and others have been taken by gear fished near the surface. We see no reason to assume that the albacore had been feeding "far beneath the surface" (Fitch 1964); however, Fitch figured a metamorphosing juvenile of *D. lorum* from an *Alepisaurus* taken on a longline and listed four other such specimens, again indicating a wide depth range. Several of the metamorphosed specimens of *D. lorum* were taken by open nets fished to considerable depths. However, three of

the largest specimens were taken in purse seines, indicating depths of capture of no more than 100 m. We have three adult *D. polystictum*: two were taken in nets towed in the upper 500 m, and one was taken in a purse seine.

Fitch's (1964) report on stomach contents provides equivocal evidence; *Idiacanthus* is a mesopelagic vertical migrator, but *Phronima sedentaria* occurs in the upper 300 m (Eric Shulenberg, Scripps Institution of Oceanography, pers. commun.). There is thus no objective evidence that either species of *Desmodema* lives below 500 m (although the possibility is not excluded). The species of *Desmodema* would seem to be members of the deep epipelagic group as defined by Parin (1968).

Keeping in mind the sketchy nature of the available data on depth distribution, the following hypothetical scheme is suggested for both species. The silvery young have a gas bladder. The large fins and the deep head and rapidly tapering body suggest that they are feeble swimmers. They are probably epipelagic. The polka-dotted prejuveniles probably occupy the euphotic zone. The tail is short and anguilliform propulsive waves could involve almost the entire body. The very elongate, fanlike pelvic fins and dorsal pennant indicate that swimming is normally slow and probably involves undulations of the dorsal fin, rather than the body.

With metamorphosis the dorsal pennant and the pelvic fins are lost, the latter dropping off entirely. The tail rapidly elongates at this time (see Figure 5). The polka-dotted pattern is also lost, but more gradually. The greatly elongated tail with its associated dorsal rays would produce drag during active swimming, but probably less so than in *Trachipterus*, in which the posterior part of the body is deeper. We propose that adult *Desmodema* normally occupy the twilight zone of a few hundred meters, where they hover, probably in a head-up posture, maintaining position by undulations of the dorsal fin. Rapid bursts of anguilliform swimming would accompany prey capture or predator avoidance. The tubercle and pore system might act to maintain laminar flow during burst swimming, as hypothesized by Bone (1972) for the oilfish, *Ruvettus*.

The elongate tail of *Desmodema* can be related to the hypothesized mode of life. The lateral line runs the length of the tail, ending at the caudal. The tail then serves the function of greatly extending the lateral line, and in effect provides an an-

tenna for the reception of water displacement and low frequency sound. In this connection it may be pointed out that in the related *Stylephorus chordatus* the lateral line is continued onto the exceedingly elongated caudal filament (R.H. Rosenblatt pers. obs.). *Stylephorus* has tubular eyes directed forward, and it is assumed that it maintains a vertical posture in the water (Marshall 1971:44). That elongate bodies in deep-sea and pelagic fishes are related to a sensory function has been suggested by Wynne-Edwards (1962:80).

Our presumption is that adult *Desmodema* hover vertically, visually seeking prey silhouetted against downwelling light. The lateral-line system of the tail would be used to sense predators approaching beneath the field of view of the eyes. Undulations of dorsal fin would be used for position-holding and the lateral body musculature used for burst swimming for prey capture and predator avoidance.

This mode of life may predominate in the elongate trachipteroids. Nishimura (1963) has inferred a similar life-style for *Trachipterus ishikawai*. Adults of *Zu cristatus* have a long, thin tail, reminiscent of that of the species of *Desmodema*, and Clarke and Haedrich (in Gaul and Clark 1968) recorded the following observation: "A large oarfish, *Regalecus glesne*, was sighted at about 210 meters. It was hanging vertically in the water, head up, and appeared to be almost two meters in length. . . . The dorsal fin was moving continuously with wave-like motions progressing from the head end to the tail end, very much like the fin motions seen in file fish."

Distribution.—*Desmodema polystictum* is probably circumtropical, and *D. lorum* appears to be restricted to the northern Pacific (Figure 2). The most obvious feature of the distributions is the lack of sympatry. *Desmodema polystictum* is broadly distributed in the tropical Pacific; the northern and southernmost records for the species are in areas influenced by warm currents. *Desmodema lorum* on the other hand is mostly restricted to the cooler waters of the North Pacific. Twenty of the 21 eastern Pacific specimens were taken north of lat. 28°N, that is in areas north of the 20°C August surface isotherm and the 9°C 200-m isotherm. The single western Pacific capture (a metamorphosed juvenile) was in the area where the temperature at 200 m is about 16°C.

The only area of possible sympatry indicated is near Cape San Lucas, lower California, where

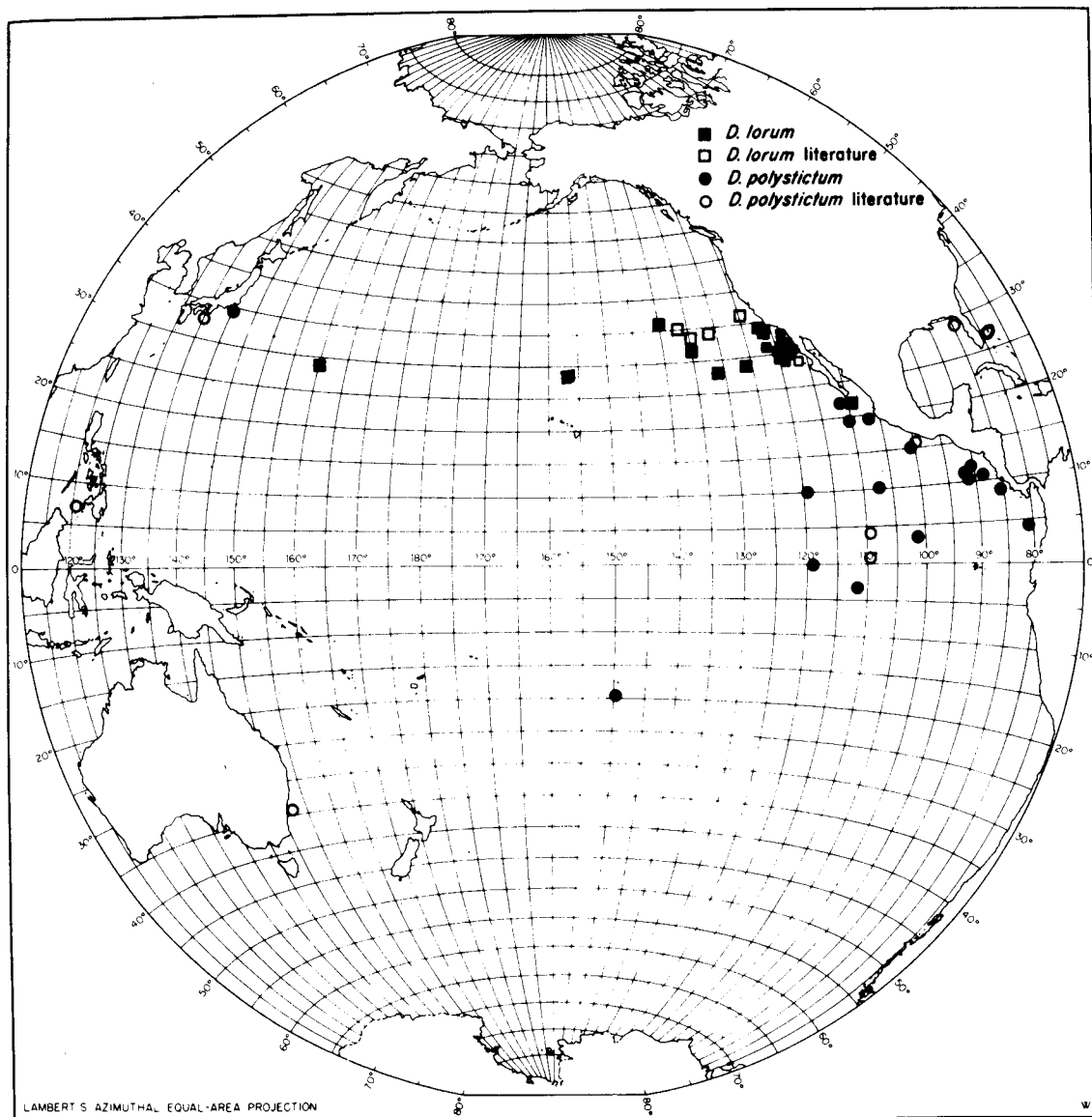
there are several records of *D. polystictum* and a single record of *D. lorum*. Occurrence of the latter that far south may be related to transport by the California Current.

From Figure 2 it appears that both species of *Desmodema* are especially common in the eastern Pacific. The pattern of captures more likely reflects effort. Many of the specimens of *D. polystictum* have been taken incidentally by the purse seine tuna fishery, which is concentrated in the eastern tropical Pacific. Similarly the predominantly eastern records for *D. lorum* probably reflect the intensive collection effort in the region of the California Current.

The presence of *D. polystictum* in the Atlantic rests on the records of Leapley (1953) and Walters (1963). G. Krefft, Institut für Seefischeri, Hamburg, has informed us that the RV *Walter Herwig* has taken several specimens of *Desmodema* in the central and southern Atlantic, but that the material is not available for study at the present time.

Comparison and relationships.—Walters and Fitch (1960) distinguished *Desmodema* from *Trachipterus* primarily on the basis of the nature of the caudal fin (parallel to the body axis), the length of the gastric caecum (long), the absence of sharp-tipped midventral tubercles, and the presence of scales in *Desmodema*. The last character is not diagnostic, since our study indicates that *D. polystictum* lacks scales at all sizes. The caudal structure of *Desmodema* is unique in the Trachipteridae in that all of the caudal rays are borne on the terminal centrum and the hypural of the first ural centrum is rayless (Figure 1). Additionally, in the species of *Desmodema* there are seven pterygiophores before the first neural spine and one or two between the first and second neural spines, and in *Zu* and *Trachipterus* there is a single pterygiophore before the first neural spine, and nine between the first and second neural spines.

Walters (1963) regarded *Zu* as the most generalized and *Desmodema* as the most specialized of the three trachipterid genera. Despite the specializations unique to *Desmodema* and *Zu* respectively, present evidence indicates that the two genera are more closely related to each other than either is to *Trachipterus*. The most important indicator of relationship is the presence in both of the dermal tubercles in large juveniles, and tubercles and a cutaneous pore system in juveniles and adults. Dermal tubercles,

FIGURE 2.—Distribution of the species of *Desmodema*.

pores, and subdermal canals have not previously been reported for *Zu cristatus*. Instead the species has been described as having deciduous cycloid scales (Tortonese 1958; Walters and Fitch 1960; Palmer 1961; Fitch 1964). However, none of our specimens (8, 27.5-811 mm SL) has scales. Two specimens of about 40 mm SL have the skin intact and smooth, except for small tubercles on the lower sides anteriorly, with no trace of scales. Two specimens of 135 and 141 mm SL respectively

have the body studded with soft tubercles, with a few interspersed pores; in a specimen of 210 mm SL both tubercles and pores are well developed. In the 811-mm SL adult the skin is superficially very similar to that of *Desmodema*. Our 135-mm SL specimen is from the Atlantic, so it does not appear that we are dealing with a difference between Atlantic and Pacific populations. We can only surmise that the tubercles and pores of *Zu* have been taken to represent scale pockets left behind by

deciduous scales. The "modified cycloid scales" mentioned by Harrison and Palmer (1968) may have been the dermal tubercles.

In addition to the tubercle and pore system, *Zu* and *Desmodema* agree in two other specialized characters: the body is constricted behind the vent to form an elongated, slender tail, and there is a distinctive prejuvenile which metamorphoses into the juvenile phase.

In our interpretation, *Trachipterus* is the most generalized trachipterid genus, with *Desmodema* and *Zu* specialized in respect to the characters given above. *Desmodema* is advanced with respect to *Zu* in the loss of the lower caudal rays and great elongation of the tail, and probably in the crowding of the pterygiophores before the first neural spine. The significance of the difference in the relationship of the anterior dorsal fin pterygiophores between *Trachipterus* and *Zu* on the one hand and *Desmodema* on the other is difficult to interpret. In *Lophotus* there is a single rayless pterygiophore before the strongly forward-curved first neural spine, then about 15 uncrowded pterygiophores in the wide interspace between the first and second neural spines. The

figure of *Regalecus* given by Parker (1886) clearly shows a condition much like that of *Desmodema*. Although the caudal of *Regalecus* has been described as lacking a ventral lobe, we find that two caudal rays are associated with the terminal centrum and four with the (ventral) hypural of the first ural centrum.

Desmodema polystictum (Ogilby)

Figures 3, 4

Trachipterus jacksoniensis polystictus Ogilby 1897:649; Newcastle, New South Wales, Australia; holotype, Australian Museum.

Trachipterus misakiensis Tanaka 1908:52, pl. IV, fig. 2, "shores of Misaki" Japan; holotype, Zool. Inst. University of Tokyo, No. 960. Herre and Herald 1951:318, fig. 3; 6°26'N, 121°35'E.

Trachipterus deltoideus Clark 1938:180; Rurutu Island, "Australs" (Tubuai Islands); holotype, CAS 5532.

Desmodema polysticta. Walters 1963:260; 28°58'N, 88°18'W; Integumentary system. Fitch 1964:230; in part, see synonymy of *D.*

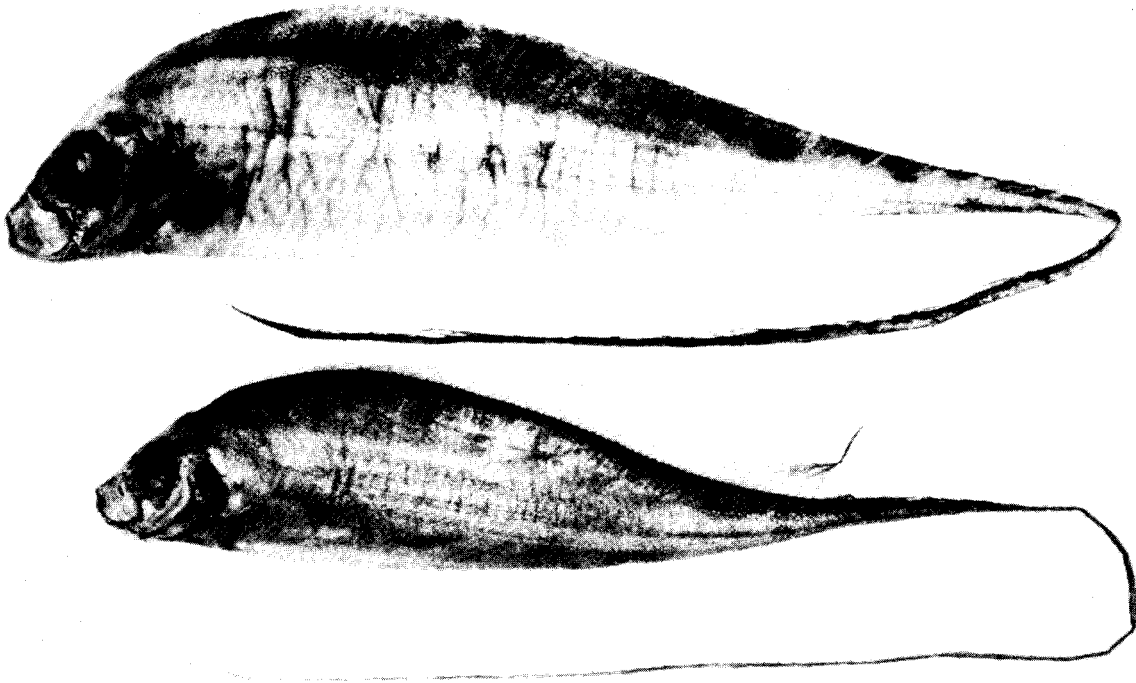


FIGURE 3.—Adults of the species of *Desmodema*. Upper figure *D. polystictum*, SIO 68-333, 1,040 mm SL. Lower figure holotype of *D. lorum*, USNM 216726, 1,098 mm SL.



FIGURE 4.—Prejuveniles of *Desmodema*. Upper figure *D. lorum*, LACM 30597-1, 87 mm SV, 188 mm SL. Lower figure *D. polystictum*, SIO 75-55, 88 mm SV, 125 mm SL.

lorum. Fourmanoir 1969:36. Legand et al. 1972:383.

Trachipterus trachyurus, not of Poey. Leapley 1953:236; Fort Lauderdale, Fla.

Diagnosis.—A *Desmodema* with 71-74 total vertebrae (18-20 precaudal and 37-42 before the anus), 7-10 (usually 8) caudal rays, snout length less than eye diameter, attenuate tail in juveniles and adults (Figures 3, 7), and scales absent at all sizes.

Description of adult (see also Tables 1-3).—Ventral profile of body almost straight to anus, then tapering to elongate tail. Dorsal profile rising in a gentle curve to a point a little less than 1 head length behind head, then tapering rapidly to a

point about $1\frac{1}{2}$ head lengths behind anus, then tapering more gradually along elongate tail section. Tail long and straplike, postanal length almost two-thirds of standard length. Anus on ventral midline.

Head 2.2-2.5 in snout-vent length, and about 1.3 in greatest body depth. Eye large, diameter slightly greater than snout length. Ascending processes of premaxillae extending back to a point over posterior third of eye.

Dorsal origin over preopercle, preceded by a thickening representing pterygiophores of first six dorsal rays of juveniles. First fin rays short, succeeding rays becoming rapidly longer to about point of maximum body depth, height of fin then increasing more slowly, with longest rays slightly before anus. Behind level of anus fin rays become

TABLE 1.—Regression parameters for selected morphometric characters in *Desmodema*; p = *polystictum*, l = *lorum*.

| Characters | Species | Intercept | Slope | Correlation coefficient | N |
|-------------------------------|---------|-----------|-------|-------------------------|----|
| SV vs. SL ¹ | p | 40.7 | 0.30 | 0.97 | 11 |
| | l | 54.8 | 0.19 | 0.97 | 8 |
| HL ² vs. SV | p | -1.95 | 0.29 | 0.95 | 15 |
| | l | -1.02 | 0.28 | 0.98 | 15 |
| Depth at pelvics vs. SV | p | 8.72 | 0.30 | 0.97 | 15 |
| | l | 14.57 | 0.28 | 0.96 | 15 |
| Greatest depth vs. SV | p | 6.93 | 0.35 | 0.97 | 15 |
| | l | 10.66 | 0.35 | 0.97 | 14 |
| Depth at anus vs. SV | p | -0.39 | 0.20 | 0.92 | 15 |
| | l | 5.16 | 0.20 | 0.97 | 15 |
| Depth at caudal base vs. HL | p | -0.13 | 0.02 | 0.95 | 11 |
| | l | 0.65 | 0.03 | 0.78 | 8 |
| Orbit diameter vs. HL | p | 0.05 | 0.40 | 0.97 | 14 |
| | l | 0.09 | 0.36 | 0.98 | 15 |
| Eye length vs. HL | p | -0.52 | 0.38 | 0.96 | 14 |
| | l | -0.46 | 0.33 | 0.99 | 14 |
| Snout vs. HL | p | -1.19 | 0.38 | 0.99 | 15 |
| | l | -1.50 | 0.42 | 0.93 | 15 |
| Maxillary length vs. HL | p | 0.65 | 0.37 | 0.99 | 15 |
| | l | 0.44 | 0.38 | 0.99 | 15 |
| Maxillary width vs. HL | p | -2.27 | 0.34 | 0.96 | 15 |
| | l | -2.81 | 0.34 | 0.96 | 15 |
| Interorbit vs. HL | p | 0.31 | 0.23 | 0.96 | 13 |
| | l | -0.56 | 0.26 | 0.71 | 15 |
| Pectoral-pelvic origin vs. HL | p | 4.10 | 0.25 | 0.97 | 15 |
| | l | 8.07 | 0.23 | 0.75 | 14 |
| Pectoral length vs. HL | p | 4.26 | 0.32 | 0.95 | 12 |
| | l | 6.69 | 0.21 | 0.97 | 8 |
| Longest dorsal ray vs. HL | p | 19.66 | 0.31 | 0.81 | 11 |
| | l | 2.90 | 0.88 | 0.94 | 12 |

¹SV = Snout vent length, SL = Standard length.
²HL = Head length.

TABLE 2.—Caudal and pectoral rays in *Desmodema*.

| Species | Caudal rays | | | | | | | \bar{x} |
|-----------------------|---------------------|----|----|----|----|------|-----------|-----------|
| | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
| <i>D. polystictum</i> | | | | 5 | 8 | 1 | 1 | 7.9 |
| <i>D. lorum</i> | 1 | 1 | 9 | 1 | | | | 5.8 |
| Species | Total pectoral rays | | | | | | \bar{x} | |
| | 23 | 24 | 25 | 26 | 27 | | | |
| <i>D. polystictum</i> | | 5 | 3 | 6 | 2 | 25.3 | | |
| <i>D. lorum</i> | 2 | 7 | 2 | 3 | | 24.4 | | |

rapidly shorter, then fin margin even to caudal base. Pelvics absent but with buried bases still evident. Pectorals low, their bases almost horizontal, outline pointed, tip probably extending almost to lateral line when fin is intact.

Color in alcohol dark brown. Dorsal fin clear, becoming dusky, then black along tail. Caudal black. Pectoral clear. Iris dark, with a golden ring around pupil. In life the fish is silvery with dark red tones dorsally and on the head, and the fins red, except that the dorsal rays along the tail extension are black.

Description of prejuvenile.—Ventral profile of body sloping gradually down from tip of lower jaw to pelvic, then tapering in a gentle curve back to beginning of narrow tail section. Vent asymmetrical, opening on left side. Dorsal profile of head steep, but less so than in *D. lorum* of the same size. In the 44-mm SV individual, the profile is almost vertical to the dorsal origin, but in larger juveniles the slope is gentler, and slightly rounded above the eyes.

Dorsal profile of body curved from dorsal origin to over opercle then tapering back to tail. Point of maximum body depth just behind pelvic bases. Tail extension thin, but relatively short; postanal length about one-quarter of standard length. The narrow part of the tail is characteristically curved upward, so that caudal fin points up and forward.

Head length about 4 in snout-vent length, about 1.6 in greatest body depth. Eye diameter slightly greater than snout length. Ascending processes of premaxillae end over anterior third of eye. Dorsal origin over middle of eye, first five or six dorsal rays elongate, remainder of fin much as in adults.

Pelvic fins present, close together, origin level

TABLE 3.—Vertebral counts in *Desmodema*.

| Species | Precaudal | | | | | | | | | | \bar{x} | | |
|-----------------------|-----------|----|----|----|----|----|-----|-----|-----|-----|-----------|-----|-------|
| | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | | | | | |
| <i>D. polystictum</i> | | 1 | 3 | 3 | | | | | | | 19.3 | | |
| <i>D. lorum</i> | | | | | 2 | 6 | 9 | 2 | 2 | | 22.8 | | |
| Species | Preanal | | | | | | | | | | \bar{x} | | |
| | 37 | 38 | 39 | 40 | 41 | 42 | 46 | 47 | 48 | 49 | | 50 | 51 |
| <i>D. polystictum</i> | 1 | 3 | 1 | 1 | — | 1 | | | | | | | 38.5 |
| <i>D. lorum</i> | | | | | | | 3 | 5 | — | 5 | 3 | 1 | 48.2 |
| Species | Total | | | | | | | | | | \bar{x} | | |
| | 71 | 72 | 73 | 74 | | | 106 | 107 | 108 | 109 | | 110 | |
| <i>D. polystictum</i> | | 4 | 2 | — | 1 | | | | | | | | 71.7 |
| <i>D. lorum</i> | | | | | | | 2 | — | 2 | 2 | 2 | | 108.5 |

with rear end of pectoral base. Orientation of fin bases and shape of rays as described for *D. lorum*. Pelvics frayed in all specimens, but reaching beyond end of caudal in one and to caudal base in another.

Color in alcohol pale, with a dusky area above and behind head, extending over forehead and anterior to snout tip. Ventral parts of head dusky, a dark streak below eye, running down behind maxilla, a dusky streak along throat to pelvic base. Body with conspicuous black spots which are somewhat larger and more widely spaced posteriorly and above midline. No spots conspicuously larger than others. A narrow dark streak on back along dorsal base, running out to caudal base. Probable life colors, based on two frozen specimens, silver with black spots; iris silver and the dorsal and caudal red; pectorals with pink tinge. This coloration corresponds well with that of the figure given by Tanaka (1908) except that the iris is shown by him as green. Smaller individuals differ (our smallest 32 mm SV) mainly in that the body is less deep and the ventral profile nearly straight, and there are no polka dots. The 37.5-mm SV holotype of *T. deltoideus* was described as "uniform bright silvery." A 55-mm SL individual in poor condition has traces of spots.

Remarks.—Leapley (1953) figured and described a Florida specimen of *D. polystictum* under the name *Trachipterus trachyurus* Poey 1861. The identification was based on the presence of 76 dorsal rays in Leapley's specimen, Poey's specimen having been reported to have 82 dorsal rays.

Leapley's photograph is of a *Desmodema* with a large eye and a relatively deep tail, in agreement with *D. polystictum*. No vertebral counts were given, but Frank Schwartz (pers. commun.) has supplied vertebral counts for Leapley's specimens, as well as an additional individual from the western North Atlantic. Both have 18 precaudal vertebrae, also in agreement with *D. polystictum*.

If Leapley's identification were correct, Poey's name would be a senior synonym of *Desmodema polystictum* (Ogilby 1897). However, three characters indicate that *D. polystictum* cannot be identified with *T. trachyurus*. These are number of ventral rays (6 in *trachyurus*, 8 or 9 in *polystictum*), pectoral rays (15, vs. 12-14), and coloration (silvery with a midlateral yellow band vs. polka-dotted). In addition, *T. trachyurus* was described as having vertebral processes piercing the skin (probably an artifact caused by postmortem dry-

ing) and lacking elongated anterior dorsal rays (present in all juvenile trachipterids).

The supposed agreement in low number of dorsal rays is invalid, since Leapley's specimen was broken far in advance of the caudal. Using his value for body depth of his specimen (141 mm) we estimate the actual length to have been between 1,400 and 1,500 mm. Poey's description does not allow the identification of *T. trachyurus* with any known trachipterid. *Zu cristatus* is excluded because juveniles of that form are strongly barred and have peculiar fleshy abdominal lobes that are unlikely to go unmentioned in a description.

The species of *Trachipterus* are not completely understood, but juveniles of that genus have dark markings, a dorsal pennant, and tubercles along the venter.

Material examined.—Western and Central Pacific: CASSU 23783, Sagami Bay 1(72.8, 102.5); CAS 5532, Rurutu, Tubuai Islands 1(37.5, 49.9), holotype of *Trachipterus deltoideus*. Eastern Pacific: UCLA W58-103, 96 km southwest of Cabo San Lucas, Baja California, tuna purse seine, 2(66, 91 and 88, 125); SIO 70-142, 19°50'N, 106°15'W, tuna purse seine, 1(260); SIO 68-33, 19°53'N, 110°46'W, "5 × 5" nekton net towed at 5 knots, 800 m wire out, 1(333, 1,040); SIO 63-915, 16°01.5'N, 100°54'W, "5 × 5" nekton net, 0-200 m, 1(277, 785); SIO 76-167, 12°55'N, 90°54'W, tuna purse seine, 1(111.5); SIO 76-294, 12°35'N, 92°15'W, tuna purse seine, 1(84.9, 126.5); SIO 76-67, 12°15'N, 92°25'W, tuna purse seine, 1(42); UCLA W67-135, 11°48'N, 88°25'W, 1(60 SL); SIO 73-392, 11°18'N, 91°31'W, tuna purse seine, 1(91.5); SIO 75-139, 10°00'N, 119°00'W, midwater trawl, 0-50 m, 2(74.3, 100.5 and 90 SL); SIO 76-325, 10°24'N, 107°46'W, midwater trawl, 225 m wire out, 1(25.5); SIO 73-400, 08°41'N, 85°03'W, dipnetted at surface, 1(82); SIO 64-397, 03°18.4'N, 101°54.3'W, stomach of *Alepisaurus ferox* 1(55.5); SIO 63-299, 04°03'N, 80°46'W, meter net, 400 m wire out, 1(23); SIO 75-590, 00°00.2'S, 119°17.0'W, meter net, 0-200 m, 1(28.0, 36.0); SIO 52-334, 02°47'S, 112°13'W, meter net, 0-250 m, 1(29, 40.5); SIO 73-340 "Eastern N. Pacific," tuna purse seine, 1(296, 835).

Desmodema lorum n.sp.

Figures 3, 4, 5, 6

Desmodema polysticta, not of Ogilby. Fitch

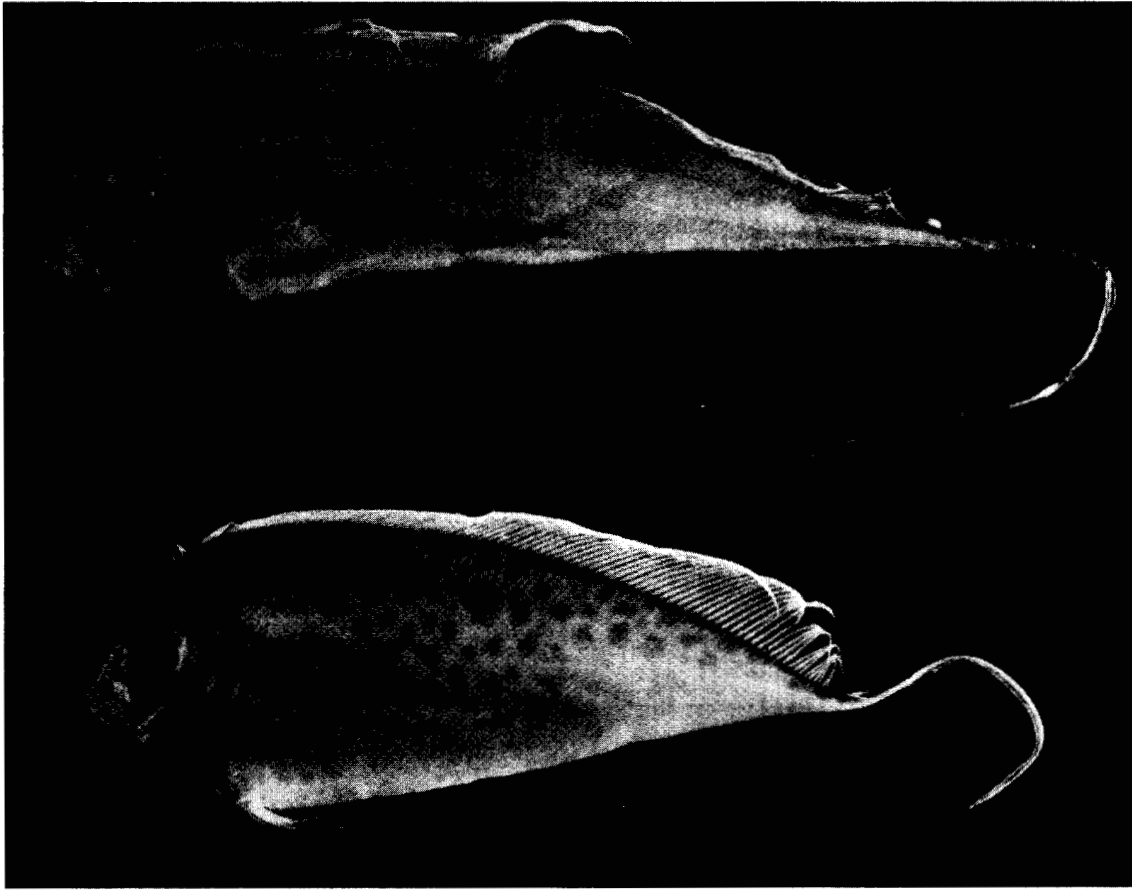


FIGURE 5.—Juvenile and prejuvenile of *Desmodema lorum*. Upper figure juvenile, LACM 35237-1, 103.7 SV, 412 mm SL. Lower figure prejuvenile, LACM 30230-1, 95 mm SV, 198 mm SL.

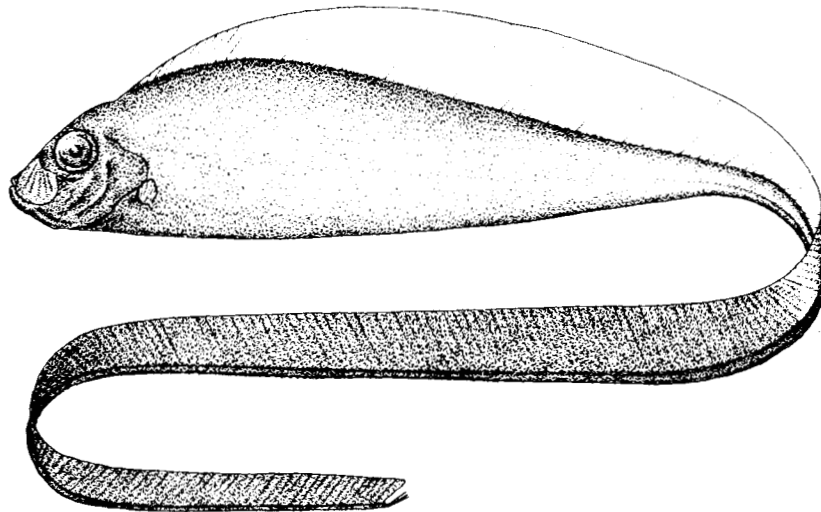


FIGURE 6.—Holotype of *Desmodema lorum*. USNM 216726. Fins reconstructed.

1964:321; in part, all but 10th, 12th, 13th of listed specimens (fig. 2 is *D. lorum*, fig. 3 is *D. polystictum*).

Desmodema polystictum, not of Ogilby. Berry and Perkins 1966:668. Fitch and Lavenberg 1968:88. Miller and Lea 1972:87.

Desmodema polystictus, not of Ogilby. Radovich 1961:18.

Diagnosis.—A *Desmodema* with 106-111 total vertebrae (21-25 precaudal and 46-50 before the anus), 4-7 (usually 6) caudal rays, snout length greater than eye diameter, an exceedingly long attenuate tail in juveniles and adults (Figures 3, 7) and scales present in prejuveniles and small juveniles.

Description of adult (see also Tables 1-3).—Ventral profile of body almost straight, but with a slight convexity back to anus, then tapering back to elongate tail section. Dorsal profile rising rapidly from snout tip to dorsal origin, then ascending more gently to maximum depth of body about one-half to three-quarters of head length behind head, then tapering back to tail. Tail exceedingly long and narrow, postanal length three-quarters of standard length. Anus on ventral midline.

Head length 3.2-3.8 in snout-vent length, 1.2-1.3 in greatest body depth. Eye moderate, equal to or (usually) shorter than snout. Ascending processes of premaxillae ending over or behind rear margin of eye. Dorsal origin just behind preopercle to over middle of opercle, preceded by a horny process representing pterygiophores of first six dorsal rays. First few dorsal rays short, succeeding rays becoming longer, with maximum height of fin over and posterior to anus. Fin height decreases gradually along tail, probably as reconstructed in Figure 6. Pelvics absent, but with buried bases still evident. Pectorals low, their bases horizontal. Pectoral pointed, but tip frayed and broken in all specimens.

Color in alcohol tan. Dorsal fin clear, becoming dusky, then black along tail. Caudal black. Pectorals clear. Iris dark with a golden ring around pupil. In life, probably silvery with red tones dorsally and on the head, and with the fins red.

Description of prejuvenile.—Ventral profile sloping down from tip of lower jaw to pelvics, then tapering convexly back to vent, then tapering more sharply to beginning of tail, then straight.

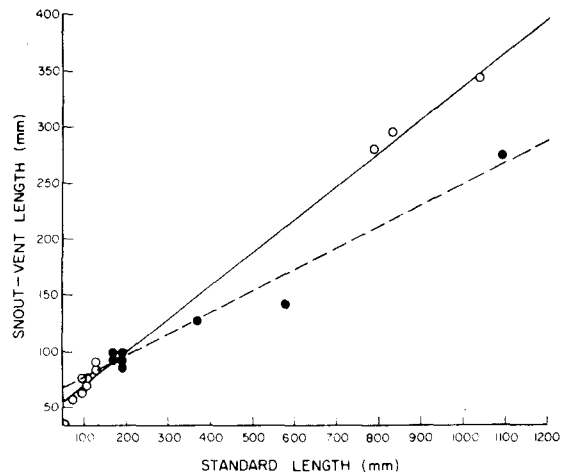


FIGURE 7.—The regression of snout-vent length on standard length in *Desmodema*. Open circles *D. polystictum*, closed circles *D. lorum*.

Usually a notch in outline at position of vent, which is asymmetrical, opening on the left side. Dorsal profile of head steep, almost vertical in smaller specimens. Back curved, point of maximum body depth just behind pelvic base. Dorsal profile becomes straight along tail elongation. Tail long and thin, postanal length about one-half of standard length.

Head length 3.8-4.2 in snout-vent length, 1.8-2.2 in greatest body depth. Eye about equal to snout length. Because of the steepness of the forehead, the ascending processes of the premaxillae end over the anterior third of the eye.

Dorsal origin over middle to posterior third of eye. First five or six dorsal rays elongate, remainder of fin shaped much as in adult except that the rays along the elongate tail are not as long. Pelvic fins present, close together, origin under pectoral base. Anteroposterior axes of pelvics parallel with sides. Pelvics broken in all our material, but reaching beyond anus in one specimen. Pelvic rays flattened and bladelike basally, the first the broadest, becoming filamentous distally. Minute prickles along rays. Pectorals as in adults.

Color in alcohol tan, a darker area on back over and behind head, extending down over forehead onto snout. A variably developed dusky streak from lower margin of orbit down behind maxilla. A dusky streak along throat to pelvic bases. Spotting somewhat variable but spots becoming larger and more widely spaced posteriorly and above midline. Three of five specimens with two noticeably larger

spots on upper back on middle-third of body (see Figure 4). A narrow dark streak on back at base of dorsal, broadening on narrow part of tail. Individuals of about 35 mm SV differ in that the body is not so deep, and there is little or no pigment. Also the dorsal is relatively higher. Our smallest specimen, 18.5 mm SV, has the back with a straight taper behind the head, the ventral profile more evenly tapering, and has scattered melanophores on the head and over the viscera. These probably represent the larval pigmentation.

Identification and remarks.—The characters given in the generic and specific diagnoses serve to distinguish *D. lorum* adequately from all known trachipterids. In addition to the characters given in the diagnoses, the two species of *Desmodema* differ in number of dorsal rays. The single *D. lorum* counted had 197 dorsal rays and three *D. polystictum* had 120, 124, and 121, respectively. Another feature is the height of the dorsal. Large *D. lorum* have proportionately longer dorsal rays than do *D. polystictum* of equivalent size (Figure 8, Table 1). Prejuveniles of *D. lorum* can most easily be distinguished from those of *D. polystictum* by their deeper body, and more rounded anteroventral contour (Figure 4).

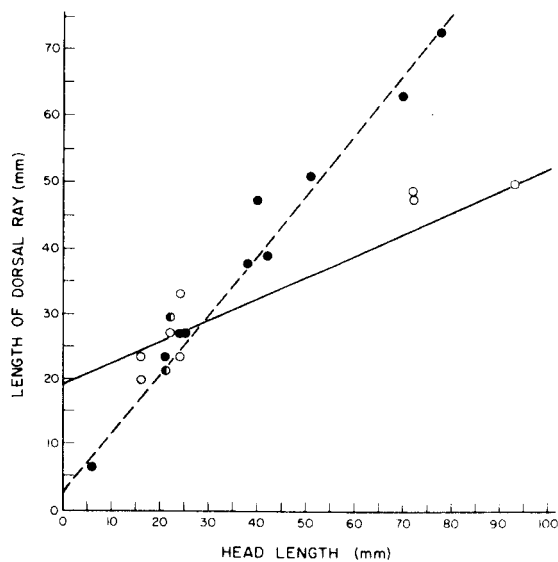


FIGURE 8.—The regression of length of longest dorsal ray on head length in *Desmodema*. Open circles *D. polystictum*, closed circles *D. lorum*.

Although Ogilby did not illustrate the holotype of *Trachipterus jacksoniensis polystictus*, his description is sufficiently detailed to allow identification with considerable certainty. The polka-dotted coloration and lack of lower caudal lobe are diagnostic of *Desmodema*, and the dorsal ray count of 126 indicates that our material has been correctly assigned. The caudal count of seven or eight rays also accords with our concept of *D. polystictum*. Tanaka's (1908) excellent figure indicates that *Trachipterus misakiensis* has properly been synonymized with *D. polystictum*, and the presence of eight caudal rays in the small holotype of *Trachipterus deltoideus* dictates a similar placement.

Etymology.—From the Latin *lorum*, a whip, in reference to the elongate tail. Suggested common name, whiptail ribbonfish.

Material examined.—Holotype: USNM 216726, formerly SIO 62-434, a 1,098 mm SL (276 mm SV) male, taken between 29°05'N, 126°37'W and 29°03'N, 126°42'W by RV *John N. Cobb* with a Cobb Mk II trawl with 1,200 m wire out (estimated fishing depth 400 m) between 1930 and 2110 h on 25 August 1962. (Original station number 90.160, C6208, see Berry and Perkins 1966.) Paratypes: LACM 30217-1, 34°42'N, 121°20'W, spit up by *Thunnus alalunga*, 1(91.5, 167); LACM 9890-2, 34°25'N, 120°28'W, 15.2-m midwater trawl, 8 fm, 1(97, 173); LACM 9982, 33°00'N, 118°03'W, IKMT, 2,743 m wire out, 1(131); SIO 76-335, 13 km west of Oceanside, Calif., bait net, 1(95, 198); LACM 30597-1, 32°48'N, 118°16'W to 32°30'N, 118°30'W, IKMT, 1(87, 188); LACM 35237-1, 32°43'N, 118°57.5'W, 10-m midwater trawl, 1(103.7, 412); LACM 31678-1, San Clemente Island, Calif., off Pyramid Head, 1(83); LACM 30998-1, 31°45'N, 118°48'W to 31°44'N, 118°00'W, IKMT, 1,300 m, 1(93); SIO 63-375, 31°40.5'N, 122°03.5'W to 31°37.0'N, 122°04.3'W, Cobb Mk II trawl, 1,144 m wire out, 1(139.8, 580); SIO 63-429, 29°58.5'N, 120°07'W, IKMT, 4,500 m wire out, 1(173); LACM 9726-8, 29°29'N, 118°35'W, IKMT, 2,134 m wire out, 1(92.5, 189); SIO 74-47, 28°10.2'N, 160°00.9'E, IKMT, 0-1,000 m, 1(125, 364); UCLA W61-125, 64 km off Cabo Colnett, Baja California, 1(286), LACM 31800-2, 129 km south of Cabo San Lucas, Baja California, 1(283).

Additional material.—UCLA W55-320,

33°39'N, 135°00'W, 1; SIO 75-588, 29°17'N, 116°59'W, 1(55); UCLA A343, 28°N, 132°W, 1; UCLA W62-73, 32°10'N, 118°24'W, 1(53); SIO 75-589, 28°37.5'N, 118°18'W, 1(18.5); SIO 75-591, 33°34'N, 118°34'W, 1(89+ SL); LACM 31804, no data, 1(132); SIO 64-96, 31°39'N, 117°51'W, 1(289); SIO 72-16, 27°22'N, 155°23'W, 1(19.8, 26.4).

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LITERATURE CITED

- BERRY, F. H., AND H. C. PERKINS.
1966. Survey of pelagic fishes of the California Current area. U.S. Fish Wildl. Serv., Fish. Bull. 65:625-682.
- BONE, Q.
1972. Buoyancy and hydrodynamic functions of integument in the castor oil fish, *Ruvettus pretiosus* (Pisces: Gempylidae). Copeia 1972:78-87.
- CLARK, H. W.
1938. The Templeton Crocker Expedition of 1934-35. Additional new fishes. Proc. Calif. Acad. Sci., Ser. 4, 22:179-185.
- FITCH, J. E.
1964. The ribbonfishes (Family Trachipteridae) of the eastern Pacific Ocean, with a description of a new species. Calif. Fish Game 50:228-240.
- FITCH, J. E., AND R. J. LAVENBERG.
1968. Deep-water teleostean fishes of California. Univ. Calif. Press, Berkeley, 155 p.
- FOURMANOIR, P.
1969. Contenus stomacaux d'*Alepisaurus* (poissons) dans le Sud-Ouest Pacifique. Cah. ORSTOM, Sér. Océanogr. 7(4):51-60.
- GAUL, R. D., AND W. D. CLARKE.
1968. Gulfview diving log. Gulf Res. Corp. Publ. 106, 37 p.
- HARRISSON, C. M. H., AND G. PALMER.
1968. On the neotype of *Radicephalus elongatus* Osorio with remarks on its biology. Bull. Br. Mus. (Nat. Hist.) Zool. 16:185-208.
- HERRE, A. W., AND E. S. HERALD.
1951. Noteworthy additions to the Philippine fish fauna with descriptions of a new genus and species. Philipp. J. Sci. 79:309-340.
- LEAPLEY, W. T.
1953. First record of the ribbonfish, *Trachipterus trachyurus*, from the mainland of North America. Copeia 1953:236.
- LEGAND, M., P. BOURRET, P. FOURMANOIR, R. GRANDPERRIN, J. A. GUÉRÉDRAT, A. MICHEL, P. RANCUREL, R. REPELIN, AND C. ROGER.
1972. Relations trophiques et distributions verticales en milieu pélagique dans l'Océan Pacifique intertropical. Cah. ORSTOM, Sér. Océanogr. 10:301-393.
- MARSHALL, N. B.
1971. Explorations in the life of fishes. Harvard Univ. Press, Camb., 203 p.
- MILLER, D. J., AND R. N. LEA.
1972. Guide to the coastal marine fishes of California. Calif. Dep. Fish Game, Fish Bull. 157, 235 p.
- NISHIMURA, S.
1963. Observations on the dealfish, *Trachipterus ishikawai* Jordan & Snyder, with descriptions of its parasites. Publ. Seto Mar. Biol. Lab. 11:75-99.
- OGLBY, J. D.
1897. On a *Trachipterus* from New South Wales. Proc. Linn. Soc. N.S.W. 3:646-659.
- PALMER, G.
1961. The dealfishes (Trachipteridae) of the Mediterranean and north-east Atlantic. Bull. Br. Mus. (Nat. Hist.) Zool. 7:335-352.
- PARIN, N. V.
1968. Ichthyofauna of the epipelagic zone. Akad. Nauk SSSR Inst. Okeanol. Moskva. (Engl. transl., Israel Program Sci. Transl., TT69-59020, 206 p.)
- PARKER, T. J.
1886. Studies in New-Zealand ichthyology. I. On the skeleton of *Regalecus argenteus*. Zool. Soc. Long., Trans. 12:5-33.
- POEY, F.
1861. Memorias sobre la historia natural de la Isla de Cuba, Apéndice:415-427.
- RADOVICH, J.
1961. Relationships of some marine organisms of the northeast Pacific to water temperatures. Calif. Dep. Fish Game, Fish Bull. 112, 62 p.
- TANAKA, S.
1908. Notes on some Japanese fishes, with descriptions of fourteen new species. J. Coll. Sci., Imp. Univ. Tokyo 23(7):1-54.
- TORTONESE, E.
1958. Cattura di *Trachipterus cristatus* Bon. e note sui Trachipteridae del Mare Ligure. Doriania 11:1-5.
- WALTERS, V.
1963. The trachipterid integument and an hypothesis on its hydrodynamic function. Copeia 1963:260-270.
- WALTERS, V., AND J. E. FITCH.
1960. The families and genera of the lampridiform (Allotriognath) suborder Trachipteroidei. Calif. Fish Game 46:411-451.
- WYNNE-EDWARDS, V. C.
1962. Animal dispersion in relation to social behaviour. Oliver and Boyd Ltd., Edinb., 653 p.