

TAXONOMY AND DISTRIBUTION OF *ROULEINA ATTRITA* AND *ROULEINA MADERENSIS* (PISCES: ALEPOCEPHALIDAE)¹

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ABSTRACT

Three Atlantic species of *Xenodermichthys* and *Rouleina* are recognized: *X. copei*, *R. attrita*, and *R. maderensis*. *Bathytroctes mollis* and *B. aequatoris* are considered junior synonyms of *R. attrita*. *Anomalopterus megalops* is considered incerta sedis.

Diagnostic characters for *R. attrita* are: no photophores, convoluted testes, 43-48 lateral line scales, 43-46 preural vertebrae, papillae on body near lateral line, and maturation at a size around 250-300 mm standard length. Diagnostic characters for *R. maderensis* are: photophores present, lobate testes, 50-56 lateral line scales, 47-50 preural vertebrae, papillae usually peripheral to photophores on fins and fin bases, and maturation at a size around 200-250 mm standard length.

The two species are sharply segregated by depth: 91% of all *R. maderensis* were from bottom trawls made between 595 and 1,200 m while 88% of all *R. attrita* were from bottom trawls fished between 1,400 and 2,100 m.

The Alepocephalidae are moderate to large deep-sea salmoniform fishes, most commonly encountered below 1,000 m. In terms of biomass and species diversity, the family is one of the most important in the deep sea. Recent exploratory trawling has discovered commercial concentrations of alepocephalids west of the British Isles (Anonymous 1974) and in the northwestern Atlantic (Savvatimskii 1969). Off northwestern Africa, Golovan (1974) found about 20 species of alepocephalids and labeled the zone below about 1,000 m as "the kingdom of fishes of the family Alepocephalidae." As might be expected in a diverse group of deep-sea fishes, there are still many problems with identification and nomenclature.

One group of naked alepocephalids, those with approximately equal and opposite dorsal and anal fins, has been the subject of numerous descriptions and much confusion. Roule (1915) recognized two genera, *Rouleina* (= *Aleposomus* of Roule) and *Xenodermichthys*, the latter distinguished by a greater number (more than 25) of dorsal and anal fin rays.

The two known species of *Xenodermichthys*, *X. nodulosus* and *X. copei*, have caused few taxonomic problems and are easily diagnosed. Both have photophores arranged approximately

in quincunx on the body and fin bases, two pyloric caeca, and no lateral line scales in adults. *Xenodermichthys copei* has 27-31 dorsal and 26-30 anal fin rays, 46-50 vertebrae, and an unrestricted gill opening; *X. nodulosus* has 32-33 dorsal and anal fin rays, 50 vertebrae, and a dorsally restricted gill opening which begins at the upper base of the pectoral (Markle 1976). The nomenclature of the Atlantic species, *X. copei*, has been confused because the oldest of the three available names, *Aleposomus copei* Gill 1884, was originally described as: "an Alepocephalid, with the body as well as heads caeleless (sic), which I shall describe as *Aleposomus copei*." Grey (1959) and Krefft (1973) have considered *A. copei* Gill 1884 a nomen nudum, but Gill's (1884) sentence clearly refers to an alepocephalid with a naked head and body, and in 1884 that was a sufficient amount of information to clearly distinguish it from all known alepocephalids, with the possible exception of *X. nodulosus*. In any case the inadequate statement satisfies Articles 11 and 12 of the International Code of Zoological Nomenclature and the name has been used frequently since 1884. Gill's holotype (USNM 33551) was subsequently described and figured by Goode and Bean (1895).

The taxonomy of *Rouleina* is more confused, in part because there are 15 nominal species, many based upon damaged or poorly preserved specimens. All known species of *Rouleina* can be distinguished from *Xenodermichthys* by having less than 25 anal fin rays, more than two pyloric caeca,

¹Contribution No. 825 from the Virginia Institute of Marine Science.

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and modified ringlike lateral line scales in the adults. Photophores are present or absent: their loss appears secondary. For example, in *R. funebris* the size and arrangement of photophores are identical to *Xenodermichthys*: in *R. maderensis* the photophores are smaller; in *R. harperi* only dark spots remain; and in *R. attrita* there are no photophores. The purpose of this paper is to discuss the taxonomy and distribution of the two known Atlantic species, *R. attrita* and *R. maderensis*.

METHODS

Standard taxonomic measurements and counts were made (Hubbs and Lagler 1958) with the following clarifications and additions. Caudal vertebrae were distinguished from precaudal vertebrae by the presence of a haemal arch and spine in the former. On radiographs there is a sharp demarcation, characterized by a reduction in the length of the pleural rib on the last precaudal vertebra and/or the apparent intersection of the last pleural rib with the first haemal spine. The last caudal vertebra counted is that which articulates with the parahypural, even if fused to a ural centrum. The one or more ural centra are variable in alepocephalids and were not counted.

The high water content and postpreservation shrinkage plus the damage inflicted on most alepocephalids during capture, causes a noticeable amount of variation in most measurements of a species or even in repeated measurements of an individual. The precision of alepocephalid morphometrics is therefore relatively low. In addition, most alepocephalid morphometrics exhibit definite allometry (Parr 1949, 1956, 1960). Before the allometry of morphometrics will be useful in identifying larvae and small juveniles, more smaller and less damaged specimens than are presently available will be needed.

MATERIAL

The following type-material of *Rouleina* was examined from the U.S. National Museum of Natural History, Washington, D.C. (USNM); Muséum National d'Histoire Naturelle, Paris (MNHN); Zoological Museum, University of Copenhagen (ZMUC); Zoological Museum, Berlin (ZMB); and Museu Municipal do Funchal, Madeira (MMF): *Bathytroctes attrita*, MNHN

85-166 and 85-169; *B. mollis*, MNHN B-2219; *B. aequatoris*, USNM 44085; *B. harperi*, USNM 92333; *B. welshi*, USNM 92332; *Xenodermichthys funebris*, USNM 99534, *Anomalopterus megalops*, USNM 170957; *Aleposomus nudus*, ZMB 17426; *A. lividus*, ZMB 22398; *R. danae*, ZMUC P1778; and *R. maderensis*, MMF 50, 2395, and 2396.

Additional material was examined from the British Museum (Natural History), London (BMNH); University Museum, Tokyo (UMT); Institute of Oceanographic Sciences, Wormley, England (IOS); Museum of Comparative Zoology, Harvard (MCZ); Field Museum of Natural History, Chicago (FMNH); Rosenstiel School of Marine and Atmospheric Sciences, Miami (UMML); Institut für Seefischerei, Hamburg (ISH); and Virginia Institute Marine Science, Gloucester Point (VIMS). These collections included four specimens of *R. guentheri* cataloged as BMNH 1898.7.13.19 and UMT 5785, 5785', and 20983; one specimen of *R. danae*, USNM 215490; 69 specimens of *R. attrita*, USNM 215479-215489 and 44085; ISH 123/73, 124/73, 950/73, 141/74, 163/74, 511/74, 512/74, 835/74, 844/74, 212/75, 234/75, and one uncatalogued; VIMS 3539, 3540, 3542, and 3543; FMNH 65711; UMML 22353; MCZ 40609; and IOS Discovery 8512#1; and 35 specimens of *R. maderensis*, USNM 215471-215478; ISH 130/75; VIMS 3541; MCZ 39349; BMNH 1945.7.20.5; IOS Discovery 7431, 7432, and 7436; and ZMUC Dana 1183¹.

RESULTS

The species of *Rouleina* separate conveniently into two groups. The first group, which lacks photophores or their remnants, contains *R. attrita* and *R. danae*. *Rouleina danae* differs from *R. attrita* by its reduced maxillary dentition and much larger orbit (43.5% of head length (HL) vs. 24-29% HL at about 100 mm standard length (SL)). The second group, which has photophores, contains *R. maderensis* and several Indo-Pacific species which differ from it in having fewer anal fin rays (16-19 vs. 20-22).

Although the two North Atlantic species, *R. attrita* and *R. maderensis*, are easily distinguished with undamaged material, most specimens are damaged and the two species are very similar in gross morphology. The following key summarizes characters which have been found useful to separate these species.

Key to North Atlantic Species
of *Rouleina*

- 1a. No photophores: testes ribbonlike with many convolutions in mature specimens but folds always connected, never with separate lobes (Figure 1); lateral line with 43-48 modified ringlike scales, undetectable in specimens less than 155 mm SL; preural vertebrae 19-22 (precaudal) + 22-26 (caudal) = 43-46 (total); papillae on body especially near lateral line, along bases of vertical fins, and along all fin rays; mature around 250-300 mm SL *R. attrita* (Vaillant 1888)
- 1b. Flat superficial photophores present, commonly abraded; testes discrete, separate lobes even when immature (Figure 1); lateral line with 50-56 modified ringlike scales, undetectable at 131 mm SL; preural vertebrae 20-22 (precaudal) + 26-28 (caudal) = 47-50 (total); papillae restricted to fins and fin bases, usually peripheral to photophores which are more numerous below lateral line; mature around 200-250 mm SL *R. maderensis* Maul 1948

Rouleina attrita (Vaillant 1888)

Figure 2A

Bathytroctes attritus Vaillant 1888:158, fig. 2 (holotype, MNHN 85-166 only; lat. 37°35'N, long. 29°26'W, 1,442 m; paratype, MNHN 85-169, is *Bellocia koefoedi*).

Bathytroctes mollis Koehler 1896:517, pl. 26, fig. 2 (holotype, MNHN B-2219, Bay of Biscay, 1,700 m).

Bathytroctes aequatoris Goode and Bean 1896:44, fig. 50 (holotype, USNM 44085, lat. 01°03'N, long. 80°15'W, 1,355 m).

Nomenclature

Quéro (1974) suggested that *R. attrita* be treated as a nomen dubium since Vaillant (1888:158), using a 55-mm shred of skin from the caudal peduncle, had estimated 40-50 scale rows on the body and since Vaillant's dorsal and anal fin ray counts are wrong for *Rouleina*. The source of the problem is the nature of the skin of *Rouleina* and the fact that the remaining type-material represents two different genera (Vaillant originally listed four specimens, but two could not be located

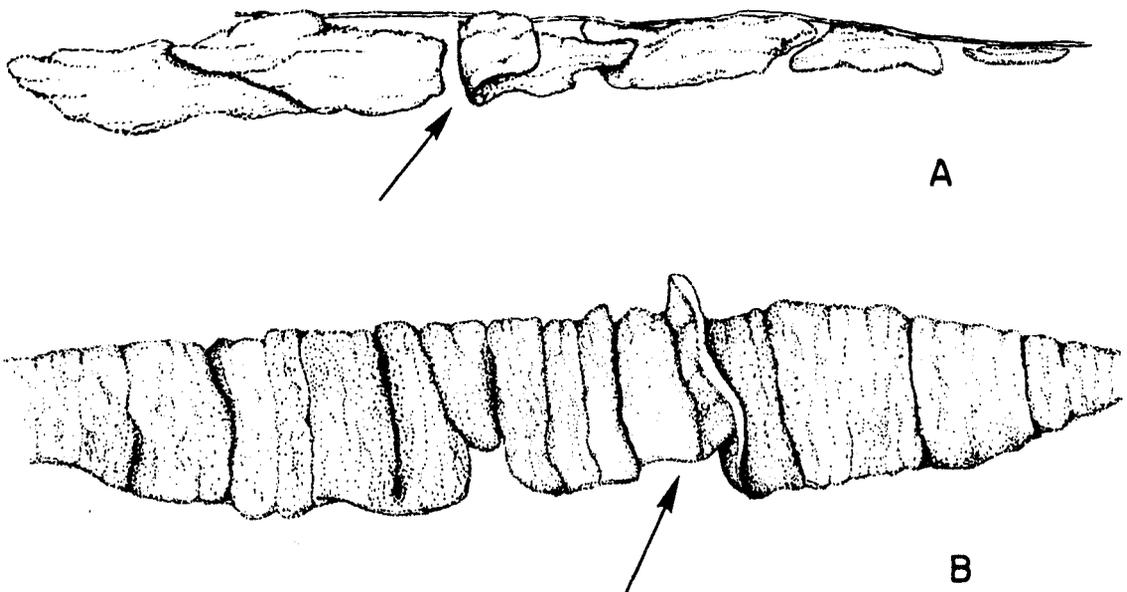


FIGURE 1.—A. *Rouleina maderensis*, USNM 215476, about 275 mm SL, testes, showing completely separated lobes (arrow). B. *Rouleina attrita*, USNM 215483, 369 mm SL, testes, showing convolutions without the formation of separate lobes (arrow).

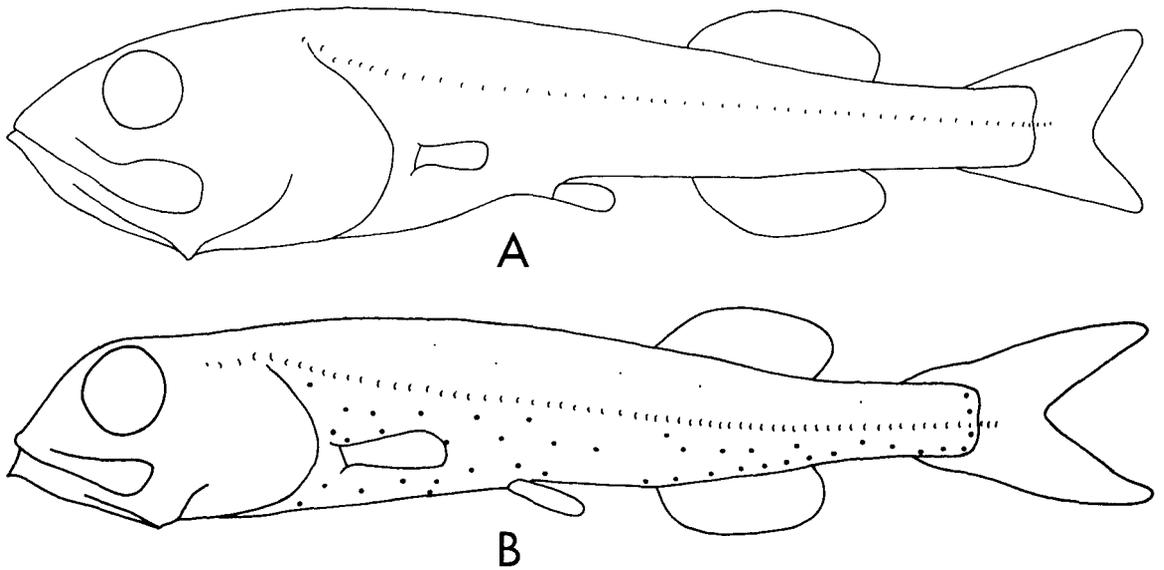


FIGURE 2.—A. *Rouleina attrita*, redrawn from Koefoed (1927, plate 3, fig. 5). B. *Rouleina maderensis*, redrawn from Maul (1948, fig. 1), with photophore distribution based upon USNM 215478, 131 mm SL.

in MNHN). Fortunately, Vaillant clearly indicated that the description of each species is based on a unique individual chosen from the collection (Bauchot et al. 1971). On the bottom of page 159, following a list of measurements of a 250-mm specimen, Vaillant (1888) made the notation "No.

85-166, Coll. Mus.," a clear designation of a holotype. This specimen is now in very poor condition but a piece of skin clearly shows the typical ring-like lateral line scales (Figure 3) and indications of fluid-filled dermal compartments typical of *Rouleina*. The latter could be mistaken for scale poc-

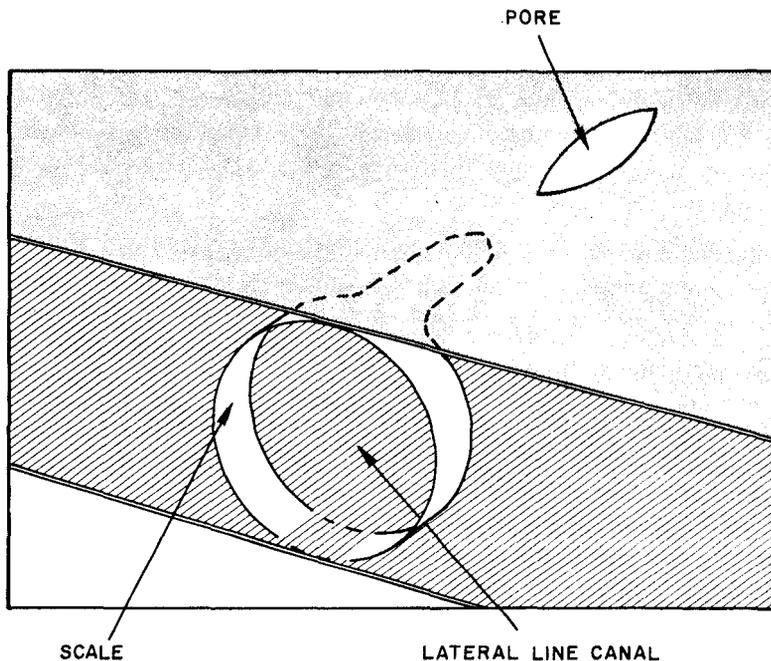


FIGURE 3.—*Rouleina attrita*, schematic of lateral line scale and subsequent pore from the midbody region.

kets and are very similar to the dermal compartments in *Xenodermichthys* as illustrated and described by Best and Bone (1976).

Vaillant (1888, pl. 12, fig. 2) illustrated otoliths and gave a vertebral count (Vaillant 1888, 159) "Il y a 20 vertebres dorsales et 25 caudales." A radiograph of the contents of the jar containing MNHN 85-166 showed that the otoliths were intact and there were 20 + 24 vertebrae. It is likely therefore that both observations came from the missing paratypes. A comparison of the illustrated otoliths with recently collected material of *Alepocephalus agassizii*, *Xenodermichthys copei*, *Bathytroctes microlepis*, *Narctes stomias*, and *Rouleina attrita* shows they were undoubtedly taken from a *Rouleina*. Haedrich and Polloni (1974) found un-stated "significant differences" between their *Rouleina* otoliths and Vaillant's, but their description and my examination of their specimens (ISH 950/73) shows them to be *R. attrita*. Therefore, the vertebral counts, lateral line scales, Vaillant's estimate of number of (lateral line) scales, and otoliths indicate that the holotype and probably the missing paratypes agree with recently collected material of *R. attrita*.

The remaining paratype, MNHN 85-169 (lat. 15°48'N, long. 20°23' W, 3,655 m), is a specimen of *Bellocia koefoedi* Parr 1951. This identification is based on examination of the type series of *B. koefoedi* in the Zoological Museum, Bergen, and the presence of the following diagnostic characters in MNHN 85-169: palatine teeth present, gill rakers 4-1-14 on first arch, body scaled, dorsal inserted in advance of anal, and a radiograph shows 22 + 18 = 40 vertebrae, 11 anal fin rays, and about 16 dorsal fin rays. The radiograph also shows otoliths in the skull and a standard length of no more than 220 mm (Quéro 1974 stated about 230 mm). The length, intact otoliths, and vertebral count indicate that Vaillant (1888) was not basing his

description of *R. attrita* on MNHN 85-169. However, since its condition is somewhat better than the holotype, Vaillant's reference to scale rows and a minimum of 11 anal fin rays may have been based on comparison with this specimen.

Description

Accurate descriptions and illustrations can be found in Goode and Bean (1895, as *B. aequatoris*), Koehler (1896, as *B. mollis*), Koefoed (1927, as *Talismania mollis*), Grey (1959), Haedrich and Polloni (1974), and Pakhorukov (1976). Important diagnostic meristic characters are in Table 1. In addition, the present material showed the following meristic variation (number of specimens in parentheses): P₁ 6-7 (26), P₂ 6-7 without a splint bone (27), gill rakers on first arch [7-8] + 1 + [15-20] = [23-28] (23), branchiostegal rays 6 (5), and pyloric caeca 7-11 (16). Teeth are present only on the dentary, premaxillary, maxillary, third and fourth infrapharyngobranchials, fourth epi-branchial, and fifth ceratobranchial.

Twenty-six specimens of *R. attrita*, 57.1-378 mm SL, showed much morphometric variation and no noticeable differences with 19 *R. maderensis*, 86.7-323 mm SL. In both species smaller specimens have relatively shorter caudal peduncles. In addition, smaller specimens of *R. attrita* (<155 mm SL) lacked lateral line scales and the papillae on the body were relatively longer and more noticeable than in larger specimens.

In one well-preserved large specimen, 347 mm SL (USNM 215481), the branchiostegal membranes, gill cavity, orbit, and bases of fins are bluish. The rest of the body is covered by thin black skin, under which is a network of longitudinally aligned, fluid-filled, oblong dermal compartments (Best and Bone 1976). The lateral line, which extends onto the caudal fin, is a tube supported by

TABLE 1.—Selected counts of *Rouleina attrita* and *R. maderensis* (superscript prefix indicates type material of: A—*Bathytroctes attritus*, B—*R. maderensis*, C—*B. aequatoris*, and D—*B. mollis*).

Species	Lateral line pores																		
	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57				
<i>R. attrita</i>	1	1	4	2	1														
<i>R. maderensis</i>								2		1	1	1	B ₁	2	B ₁				
	Precaudal vertebrae					Caudal vertebrae					Total vertebrae								
	19	20	21	22	22	23	24	25	26	27	28	43	44	45	46	47	48	49	50
<i>R. attrita</i>	4	A,C,D ²²	7	2	1	D ₁	A,C ¹³	15	4			D ₁	A,C ¹³	15	7				
<i>R. maderensis</i>			2	B ₁₇	17				B ₁₉	B ₁₅	3					B ₈	B ₂₂	8	1
	Dorsal fin rays					Anal fin rays													
	18	19	20	21	22	18	19	20	21	22									
<i>R. attrita</i>	5	D ₁₀	C ₁₀	1		D ₇	10	C ₉	1										
<i>R. maderensis</i>			3	B ₈	B ₅			5	B ₆	4									

modified ringlike scales with pores usually situated midway between and not touching the scales (Figure 3). The skin along the dorsal midline, above the supracarinalis muscle, is typically split open, exposing dense fat deposits and mucus. Ventrally, the skin overlying the lower hypaxial muscles is also split open. In addition, the area ventral to the heart, between the cleithra, contains a mucus-filled network of connective tissue.

Testes are thin ribbonlike structures in immature males and become thick and convoluted in mature specimens. The convolutions, however, never become separate lobes (Figure 1). The ovaries, back to about the level of the pelvis, are completely enclosed by ovarian tunic medially and the body wall laterally. Posteriad the lateral ovarian surface is exposed. The ovary contains few eggs up to 3.2 mm in diameter.

Rouleina maderensis Maul 1948

Figure 2B

Rouleina maderensis Maul 1948:7, fig. 1 (holotype, MMF 2398, Madeira, 600-1,600 m depth range for type series).

As a supplement to Maul's (1948) description, Table 1 summarizes important diagnostic meristic characters. In addition, the present material showed the following meristic variation (number of specimens in parentheses): P_1 5-7 (13), P_2 5-6 without a splint bone (13), gill rakers on first arch [6-8] + 1 + [15-21] = [22-30] (8), branchiostegal rays 6 (12), and pyloric caeca 10-11 (7). Dentition similar to *R. attrita*.

Lateral line scales were absent in the two specimens <131 mm SL but were present in a 177-mm SL specimen. Photophores were present on the smallest specimen, 86.7 mm SL. Generally, photophores are more difficult to find in larger specimens.

Black papillae are distributed along the base of the caudal, on primary caudal rays, dorsal and anal rays, on the supratemporal, and from the interorbital area to the snout. An irregularly arranged row of papillae lies between the lateral line and dorsal profile. Small flat photophores are mostly located below the lateral line; a paratype (MMF 50) has nine photophores along the anal fin, two on the base of the lower caudal and one or two on the upper caudal base; body photophores are arranged approximately in quincunx. The super-

ficial layer of black skin covers longitudinally aligned, fluid-filled, oblong, dermal compartments and is frequently split along the midline as in *R. attrita*. The modified ringlike lateral line scales have a relatively broad and long posterior tab. Lateral line pores are usually at the end of the scale tab of the preceding lateral line scale, approximately midway between scales but touching the anterior scale.

Testes, even when immature, are always lobed (Figure 1). The ovary is similar to that in *R. attrita*. Eggs are large, up to 3.7 mm.

Incerta sedis

Anomalopterus megalops Beebe 1933

An examination of Beebe's damaged and contorted holotype (USNM 170957), now about 25 mm SL, indicates that it might be a *Rouleina*. The dorsal and anal origins appear approximately opposite in contrast to Beebe's (1933) statement that the anal origin was under the middle of the dorsal. The "numerous small tubercles" which Beebe found abundant on the head and less so on the body are no longer visible. Beebe's (1933) description, the best source for deciphering the identity of the specimen, agrees with *Rouleina*, especially *R. maderensis*. However, the seven branchiostegal rays and anal fin extending well posteriad of the end of the dorsal fin are characters which are unknown in the available North Atlantic *Rouleina*. Identification of this specimen should be postponed until more larval and juvenile material are available.

ECOLOGY

Direct sighting of two *R. attrita* <1 m from the bottom at 1,800 m off Virginia was made during DSRV *Alvin* dive 575, 4 June 1975. The moderate-sized individuals had a more rounded head than the more commonly sighted alepocephalid, *Alepocephalus agassizii*. The dorsal and ventral profiles of the snout and lower jaw regions are approximately equal arcs in *R. attrita* (Figure 2A), while in *A. agassizii* the ventral profile of the lower jaw is straighter. The skin of *R. attrita* also appears smoother since it is mostly scaleless, but both are about equally black in situ.

An unexpected observation was that the two *R. attrita* had shredded sheets of mucus hanging from their jaws and body. The two individuals drifted

motionless by the observation port, one head down, the other more or less on its side. *Alepocephalus agassizii* was observed in similar motionless positions and were seen to move when disturbed, so that the motionless positions are probably not a sign of death. The observation of mucus is, as yet, uncorroborated by others. However, Koehler (1896:518) described the fresh condition of the holotype of *B. mollis* as being flaccid as a holothurian and retrieved from the trawl in a thick mucus. The split skin along the dorsal and ventral midline commonly observed in preserved specimens of *Rouleina* may be related to fat and mucus concentrations in these regions of the body. The function of these concentrations and the mucus sheets is unknown.

All of the *R. attrita* and most of the *R. maderensis* were from bottom trawls, but two of the smaller *R. maderensis*, 86.7 and 177 mm SL, were from nonclosing midwater trawls. It is possible that the rather amorphous and almost degenerate photophores (based on microsections from a 236-mm SL specimen) of demersal adult *R. maderensis* represent organs which are functional only in mesopelagic juveniles.

DISTRIBUTION

Both species are known from the southeastern Pacific and North Atlantic, while *R. attrita* is also known from the South Atlantic and southwestern Indian Ocean (Figure 4). The two species have been caught in the same net once in the western Atlantic and once in the southeast Pacific. Although the geographic distributions are similar, *R. attrita* and *R. maderensis* segregate sharply by depth. Thirty of 33 specimens (91%) of *R. maderensis* were from bottom trawls fished between 595 and 1,200 m. In contrast, 66 of 75 specimens (88%) of *R. attrita* were from bottom trawls fished between 1,400 and 2,100 m.

Off the east coast of the United States, the most consistent physical characteristic between 1,200 and 1,400 m is the 4°C isotherm (VIMS unpubl. data, Churgin and Halminski 1974a). However, in the Gulf of Mexico (Churgin and Halminski 1974b) and eastern North Atlantic (Lenz 1975), the 4°C isotherm is considerably deeper. A characteristic feature of the demersal ichthyofauna on the continental slope off Virginia is a sharp increase in mean weight of individual fish around 1,500 m (Markle 1976; C. A. Wenner and J. A. Musick pers. commun.). Consistent with this

phenomenon is the observation of generally larger body size in the deeper dwelling *R. attrita* compared with its shoaler dwelling congener, *R. maderensis*. Although this suggests a possible biological factor in their distribution, a lack of appropriate ecological data for most of the available collections precludes such a statement. Without comprehensive ecological information for all collections, the mechanism of bathymetric segregation in the two Atlantic species of *Rouleina* remains unknown.

ACKNOWLEDGMENTS

I am grateful to the following individuals and institutions for loan of material: D. M. Cohen, National Marine Fisheries Service, Systematics Laboratory; R. H. Gibbs, Jr., S. H. Weitzman, and S. Karnella, USNM; M. L. Bauchot, MNHN; A. Wheeler, BMNH; G. Krefft, ISH; R. K. Johnson, FMNH; C. R. Robins, UMML; K. Liem and R. Schoknecht, MCZ; N. R. Merrett, IOS; T. Abe, UMT; J. Nielsen and E. Bertelsen, ZMUC; G. E. Maul, MMF; J. A. Musick, VIMS; and C. Karrer, ZMB. Travel expenses were partly defrayed by the 1976 Raney Award from the American Society of Ichthyologists and Herpetologists and a Grant-in-Aid of Research from Sigma Xi. This work was supported in part by NSF grant No. GA-37561 and OCE 73-06539, J. A. Musick principal investigator.

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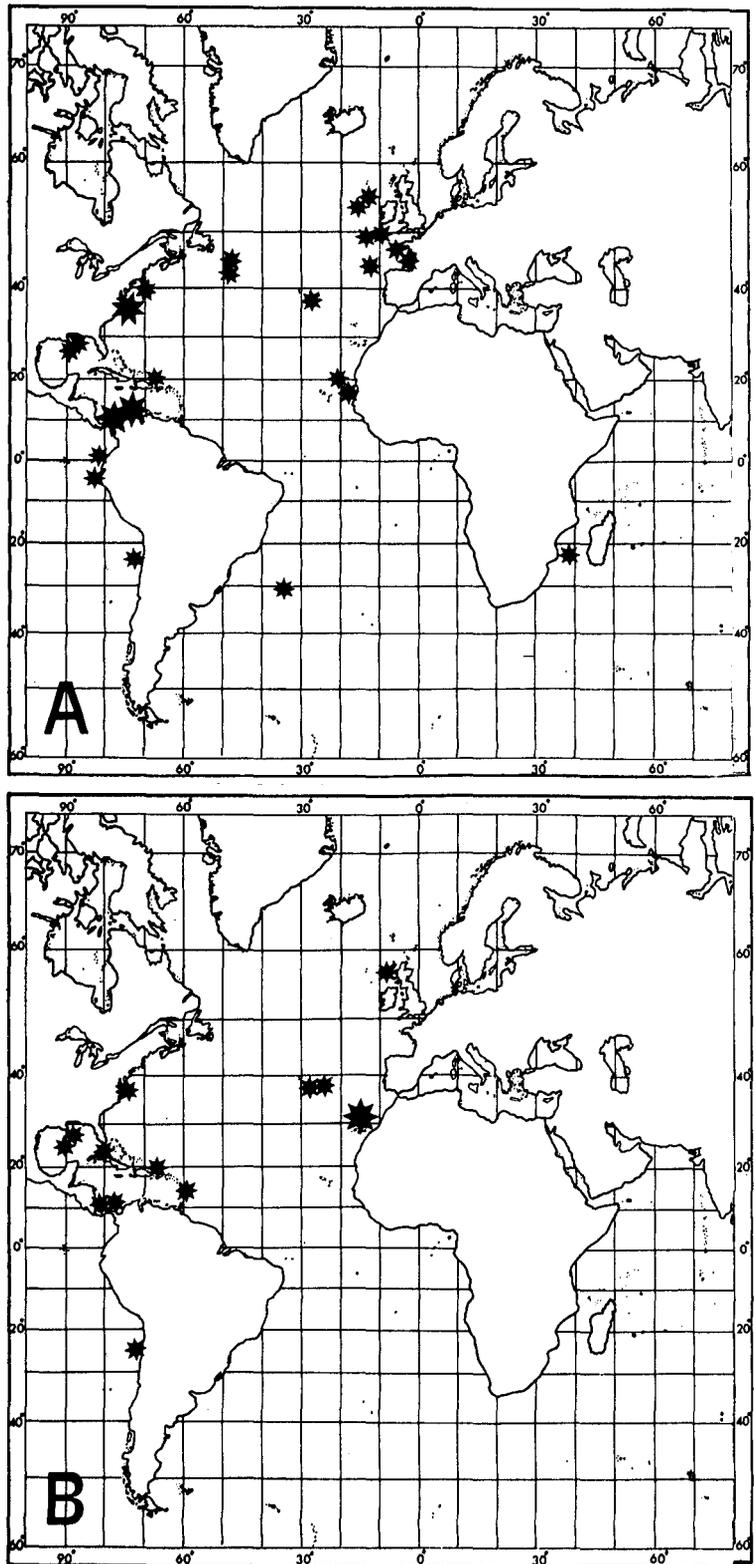


FIGURE 4.—A. *Rouleina attrita*, geographic distribution of collections examined plus recent capture in South Atlantic of Pakhorukov (1976). B. *Rouleina maderensis*, geographic distribution of collections examined. Larger symbols indicate multiple captures.

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