

# The genus *Armina* (Gastropoda: Nudibranchia: Arminidae) in the southern Caribbean, with the description of a new species

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## ABSTRACT

The southern Caribbean species of the nudibranch genus *Armina* Rafinesque, 1814, are reviewed. *Armina juliana* Ardila and Díaz, 2002, and *Armina muelleri* (Ihering, 1886), two previously described species, are redescribed and their reproductive systems illustrated. The two North American species *Armina abbotti* Thompson, Cattaneo and Wong, 1990, and *Armina wattla* Marcus and Marcus, 1967, are regarded as synonyms of *A. muelleri*, which is reported from the Caribbean for the first time. A new species, *Armina elongata*, is described based on a single specimen collected from Colombia. The number of notal ridges, the size and the shape of the radular teeth, the features of the masticatory processes, and the morphology of reproductive system are the main distinguishing characteristics between the new species and other Atlantic species of *Armina*.

## INTRODUCTION

The Arminidae constitutes a poorly known group of living nudibranchs, with nearly 75 described species divided into six genera (Kolb and Wägele, 1998). Arminids are characterized by having an elongated, flattened body, narrower posteriorly, with longitudinal ridges or pustules on the dorsum. The notum bears marginal sacs along its edge. Arminids have a distinct oral veil and retractile rhinophores with a caruncle situated next to them; the radula typically has a broad, denticulated rachidian tooth, and the lateral teeth are falciform (Kolb, 1998). The majority of species in all other genera than *Armina* Rafinesque, 1814 (*Dermatobranchus* van Hasselt, 1824, *Histiomena* Mörch, 1860, *Linguella* de Férussac, 1822, *Pleurophyllidella* Eliot, 1903, and *Pleurophyllidiopsis* Tchang-Si, 1934) are geographically restricted to areas in the Indo-Pacific (Kolb and Wägele, 1998).

*Armina* is the most species-rich genus of the family, with more than 50 nominal species; it includes the most derived forms of the group (Kolb and Wägele, 1998). Features shared by members of this genus are a contin-

uous anterior mantle margin, the presence of branchial and hyponotal lamellae, and the close distance between the rhinophores. Although *Armina* has a world-wide distribution, only five species have been recorded in the western Atlantic (see Marcus and Marcus, 1960; 1967; Kolb and Wägele, 1998, Ardila and Díaz, 2002).

*Armina juliana* Ardila and Díaz, 2002, was the only species previously known from the southern Caribbean. The present paper describes two additional species of *Armina* collected from materials trawled off the northern Caribbean coast of Colombia.

## MATERIALS AND METHODS

Specimens were collected using a bottom trawl (9×1 m opening, 16 m length) during the cruises INVEMAR-MACROFAUNA I and II, 1999–2001, aboard the R/V ANCÓN, working off the Caribbean coast of Colombia at depths of 20–500 m. Specimens of Arminidae were sorted and preserved in 70% ethanol. Subsequently, jaws and radulae were dissected and examined using a scanning electron microscope (SEM). The specimens were dissected for study of the reproductive system.

The material examined is deposited at the Museo Nacional de Historia Natural Marina de Colombia, INVEMAR (MHNMC) and the Natural History Museum of Los Angeles County (LACM).

## SYSTEMATICS

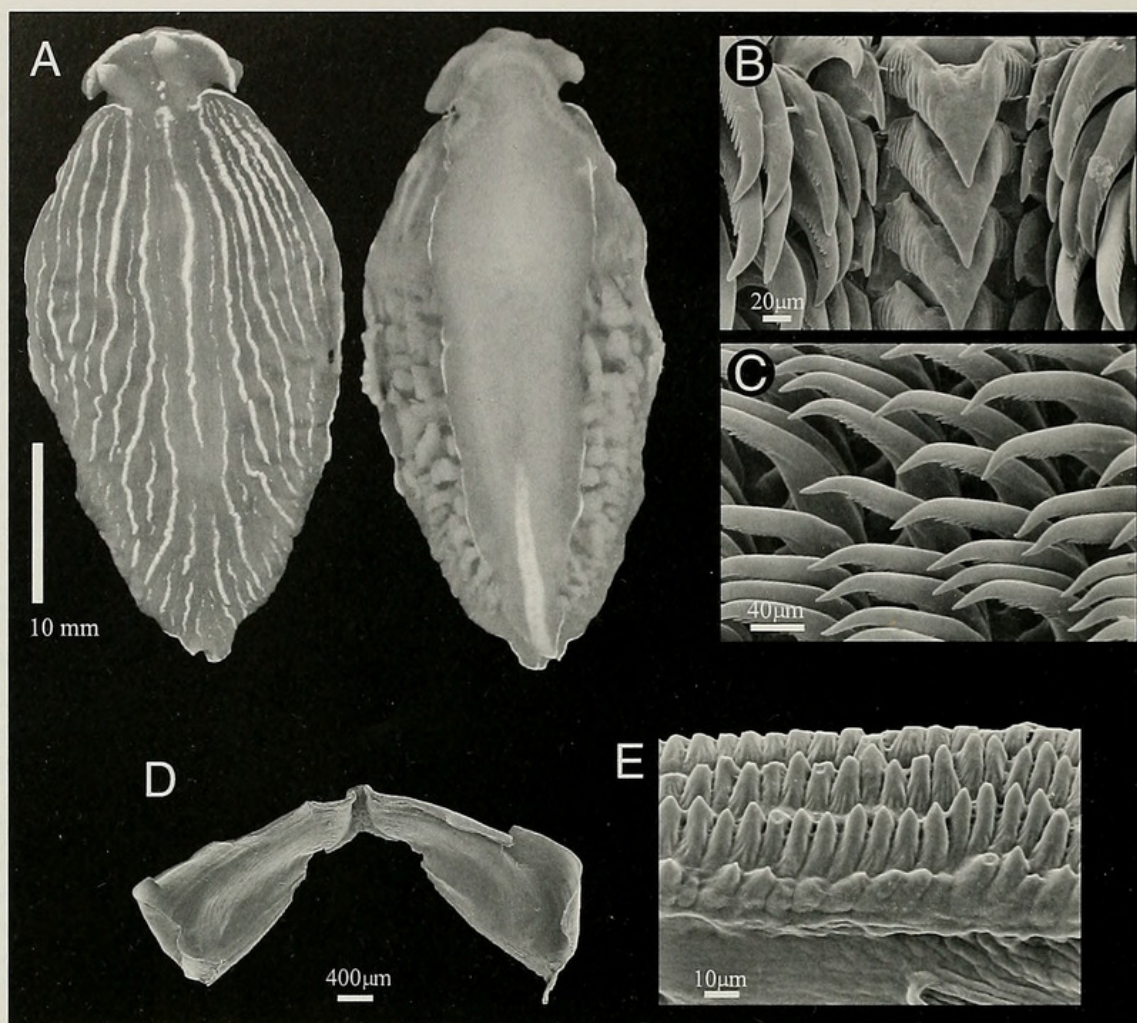
Family Arminidae Rafinesque, 1814  
Genus *Armina* Rafinesque, 1814

*Armina juliana* Ardila and Díaz, 2002  
(Figures 1–2)

*Armina juliana* Ardila and Díaz, 2002: 27–30, text figs 1–7.

**Description:** The living animals are bright red with contrasting white longitudinal notal ridges; the anterior





**Figure 1.** *Armina juliana* Ardila and Díaz, 2002, holotype, MHNMC INV MOL1598. **A.** Dorsal and ventral views of the living animal. **B.** Rachidian teeth. **C.** Lateral teeth. **D.** Jaws. **E.** Detail of the jaw elements on the masticatory processes.

margin of the oral veil and the apical portion of the rhinophores are also white (Figure 1A). Preserved specimens are pale pink. The body is elongated, flattened, narrowing posteriorly. The notum bears 34 longitudinal dorsal ridges, whose margins do not exhibit any black spots of shimmer pigment. The oral veil is small but clearly distinct, with the lateral extension curved backwards and shorter than the widest part of the body (Figure 2A). There are two large club-shaped rhinophores, each one with about 10 vertical lamellae. The rhinophores are situated dorsally on the notum. The eyes are visible through the epidermis at the outer base of each rhinophore. The caruncle is also distinguishable anterior to the rhinophores. The genital opening is located on the right side, anterior to and below the branchial lamellae (Figure 2B). The anal papilla is located slightly behind the midpoint (3/5 of total length, from the anterior end of the body). There are twenty-one branchial lamellae on the right side of the body and nineteen on the left. Fifteen hyponotal lamellae are present on each side of the body. A deep groove is present along the center of the foot sole. The pedal gland is white and located at the posterior end of the foot sole (Figure 1A). Mantle glands (each about 0.7 mm in diameter) are

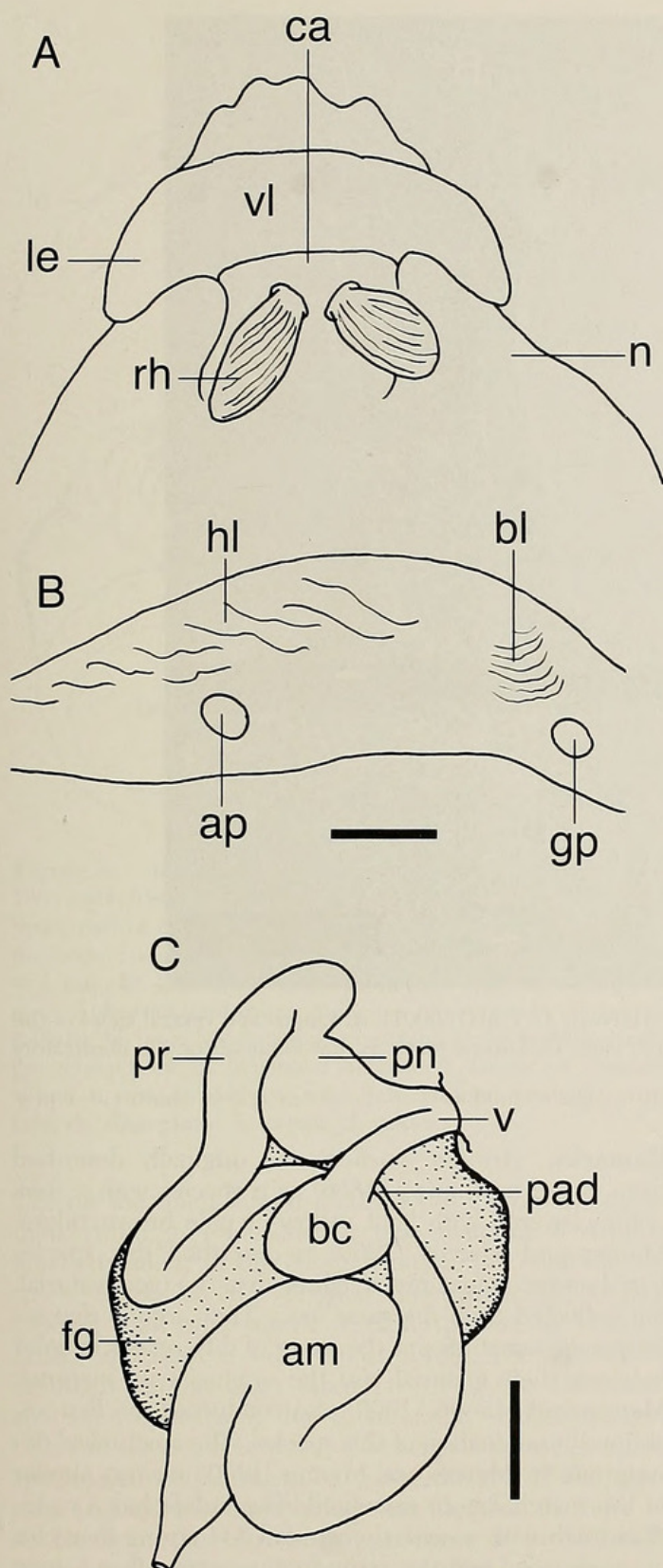
barely distinguishable macroscopically on both sides just behind the branchial lamellae (Ardila and Díaz, 2002).

**Jaws and Radula:** The radular formula is  $27 \times 33.1.33$  (holotype). The rachidian tooth is broad and bears 12 elongated denticles on each side of the median cusp (Figure 1B). The first lateral tooth is short, bulky and denticulated on the outer side of the cusp. The remaining lateral teeth are elongated and also bear denticles, which become progressively smaller towards the marginal tooth rows. The jaws have a denticulated masticatory border with four rows of denticles (Figures 1D–E).

**Reproductive System (Figure 2C):** The reproductive system is diaulic. The ampulla is very long, wide and convoluted. The prostate is short and convoluted, composed of two regions: a glandular, proximal region that narrows into the distal, muscular ejaculatory region, which connects directly to the penis. The vagina is short and connected directly to the rounded bursa copulatrix.

**Type Material:** Holotype (MHNMC INV MOL1598), 41 mm length alive, from type locality; Paratype (LACM 2908), off Palomino, Colombia ( $11^{\circ}26' \text{ N}$ ,  $73^{\circ}32' \text{ W}$ ), 306–312 m depth, muddy bottom, 14 mm length alive.





**Figure 2.** *Armina juliana* Ardila and Díaz, 2002, paratype, LACM 2908. **A.** Dorsal view of the anterior end of the body. Scale bar as in B. **B.** Lateral view of the body. Scale bar = 1 mm. **C.** Reproductive system. Scale bar = 1 mm. Abbreviations: am, ampulla; ap, anal pore; bc, bursa copulatrix; bl, branchial lamellae; ca, caruncule; fg, female glands; gp, genital pore; hl, hyponotal lamellae; le, lateral extension of velum; n, notum; pad, post-ampullary duct; pn, penis; pr, prostate; rh, rhinophore; v, vagina; vl, velum.

**Type Locality:** Off Cabo de La Vela, Colombia (12°19' N, 72°42' W), 460 m depth, muddy bottom.

**Distribution:** Off Cabo de La Vela and Palomino, Colombia (Ardila and Díaz, 2002).

**Remarks:** This species was recently described in detail by Ardila and Díaz (2002); a description is repeated here to allow for quick comparisons with the other species treated in this paper. *Armina juliana* can be easily distinguished from other species here described by the position of the genital papilla, which is located anterior to the branchial lamellae, whereas in the other species it is located just posterior to the lamellae. For a comprehensive discussion of *A. juliana* versus other Atlantic species see Ardila and Díaz (2002).

*Armina muelleri* (Ihering, 1886)  
(Figures 3–4)

*Pleurophyllidia mülleri* Ihering, 1886: 223–228, pl. 9, fig. 1.

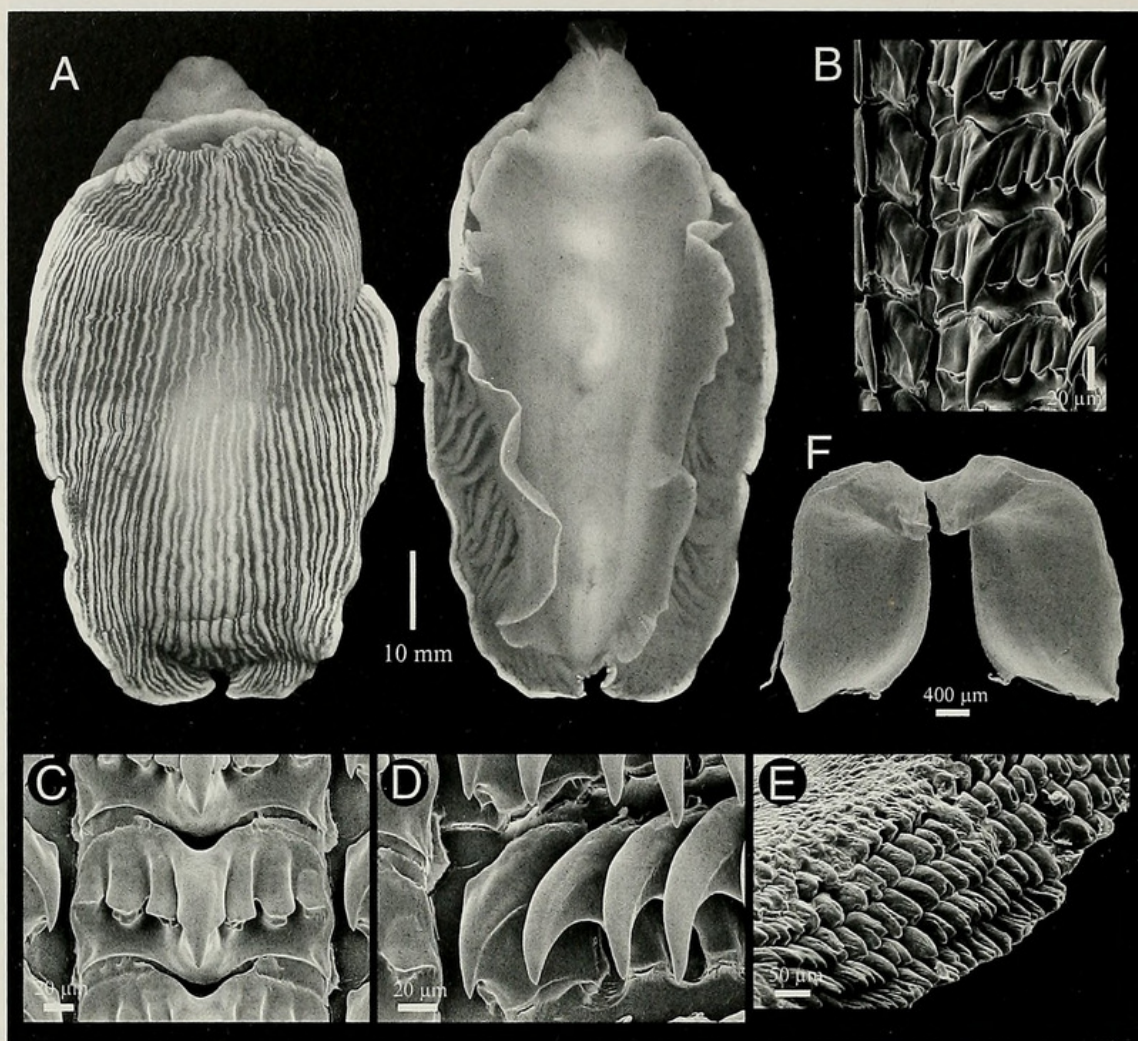
*Armina abbotti* Thompson, Cattaneo and Wong, 1990: 403.

*Armina wattla* Marcus and Marcus, 1967: 213–216, figs. 16–20.

**Description:** The animal is red with contrasting yellow longitudinal notal ridges. The anterior margin of the oral veil and the edge of the notum is also yellow (Figure 3A). There are two thin yellow lines surrounding the foot sole and the external edge of the oral tentacles. Preserved specimens are pale grayish. The body is wide, elongated, flattened, with a small notch on the posterior tip. The notum bears 54 longitudinal dorsal ridges, with wider, entire ridges, and thinner, broken ridges intercalated. The oral veil is distinct and has two large, tentacular lateral extensions lacking any projections (Figure 4A). The extensions are as wide as the notum. There are two club-shaped rhinophores, each one with about 30 vertical lamellae. The rhinophores are situated in a notch covered by the anterior end of the notum in the preserved specimens. The eyes are visible through the epidermis at the outer base of each rhinophore. The caruncle is also distinguishable anterior to the rhinophores. The genital opening is located on the right side of the body, slightly posterior to and below the branchial lamellae (Figure 4B). The anal papilla is located behind the midpoint (2/3 of total animal length, from the anterior end of the body). There are 23 branchial lamellae and the same number of hyponotal lamellae on each side of the body. The pedal gland is white and located at the posterior end of the foot sole (Figure 3A). The mantle edge is surrounded by a number of small mantle glands distinguishable macroscopically on both sides.

**Jaws and Radula:** The radula formula is  $36 \times 35.135$  in the single specimen examined. The rachidian tooth is very broad and bears 3–4 large denticles on each side of the median cusp (Figure 3B); the innermost denticle lies very close to median cuspid (Figure 3C). The lateral teeth are elongated and lack denticles (Figure 3D). The jaws have a denticulated masticatory border with four to five rows of denticles (Figures 3E–F).





**Figure 3.** *Armina muelleri* Thompson, Cattaneo and Wong, 1990 (MHNMC INV MOL3901). **A.** Dorsal and ventral views of the living animal. **B.** Rachidian teeth, lateral view. **C.** Rachidian teeth, upper view. **D.** Lateral teeth. **E.** Jaw elements on the masticatory processes. **F.** Jaws.

**Reproductive System (Figure 4C–D):** The reproductive system is diaulic. The ampulla is very long, wide and convoluted. There is no post-ampullary duct and the ampulla connects directly to the prostate and the female glands. The prostate is very long and convoluted, composed of two regions: a glandular, proximal region that narrows into the distal, muscular ejaculatory region, which connects directly to the penis. The vagina is short, irregular, and connected directly to the rounded bursa copulatrix.

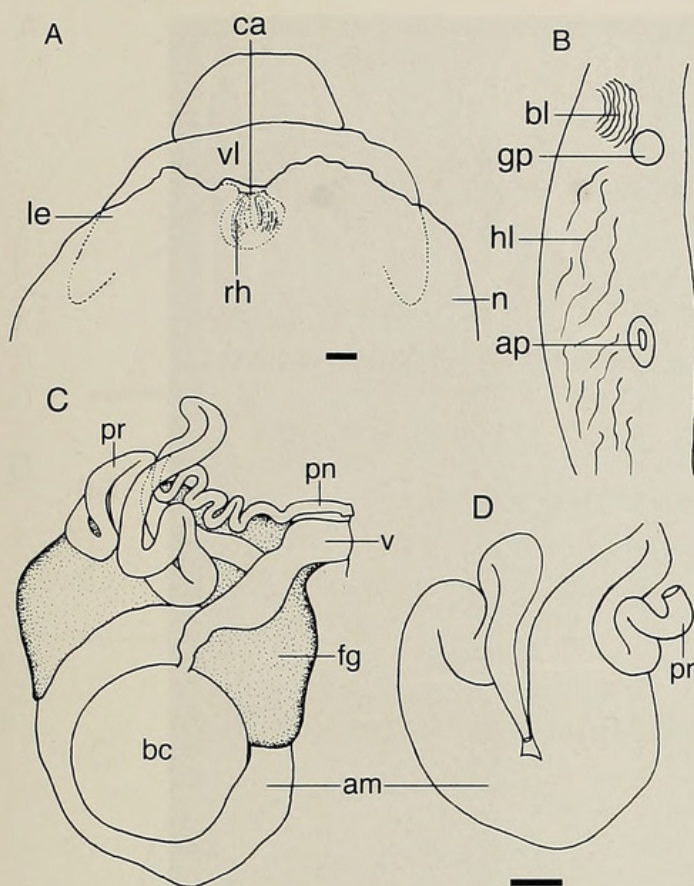
**Type Material:** Holotype (MHNMC INV MOL3901), 32 mm length alive, from type locality.

**Type Locality:** Off Salamanca Island, Colombia (11°5'46" N, 74°40'35" W), 20 m depth, hard bottom with pennatulaceans (*Renilla reniformis* and *Renilla muelleri*).

**Distribution:** This species is widespread in the North America and the Caribbean, including records from North Carolina, South Carolina, East Florida, West Florida, Texas, Mexico (Abbott, 1954; Eyster, 1981), and Colombia (present study).

**Remarks:** *Armina muelleri* was originally described from Brazil by Ihering (1886) as a species with a dark notum covered with light yellow or pale brown ridges. Marcus and Marcus (1960) re-described this species based on specimens much lighter than the type material, but collected from the same area. They argued that intraspecific variation was the cause of differences in color between their material and the original type material. Marcus and Marcus (1960) also conducted the first anatomical examination of this species. The anatomical descriptions by Marcus and Marcus (1960) are very similar to the material here examined. The radula has a rachidian tooth with a central cusp and 3–4 strong denticles on each side, and the reproductive system has a long and convoluted ampulla that connects to an elongate and curved prostate; the vagina is long and straight, connect to an oval bursa copulatrix. Externally, both specimens are also very similar, having a wide and flattened body, with small rhinophores emerging from below the anterior end of the notum, and the genital opening situated slightly posterior to and below the branchial lamellae. The only consistent difference is the absence of denti-





**Figure 4.** *Armina muelleri* Thompson, Cattaneo and Wong, 1990 (MHNMC INV MOL3901). **A.** Dorsal view of the anterior end of the body. Scale bar = 1 mm. **B.** Lateral view of the body. Scale bar as in A. **C.** Reproductive system. Scale bar = 1 mm. **D.** Detail of some reproductive organs. Scale bar as in C. Abbreviations: am, ampulla; ap, anal pore; bc, bursa copulatrix; bl, branchial lamellae; ca, caruncule; fg, female glands; gp, genital pore; hl, hyponotal lamellae; le, lateral extension of velum; n, notum; pad, post-ampullary duct; pn, penis; pr, prostate; rh, rhinophore; v, vagina; vl, velum.

cles on the inner lateral teeth of the Caribbean specimen. Attempts to locate the type material of *Armina muelleri* failed, so the comparisons to our material are solely based on the original description by Ihering (1886), and subsequent re-descriptions by Ihering (1915) and Marcus and Marcus (1960). The absence of denticles on the inner lateral teeth of the Caribbean specimen is probably due to variability within the species, but the possibility that it belongs to an undescribed species cannot be discarded. Since the rest of the anatomy and external morphology are identical to those of *A. muelleri*, the Caribbean specimen is provisionally placed in this species until more material becomes available.

The species name *Armina abbotti* was introduced by Thompson, Cattaneo and Wong (1990) for the North American specimens identified by Abbott (1954) and Eyster (1981) as *Armina tigrina* Rafinesque, 1814. The publication of the name is accompanied by bibliographic references to descriptions and therefore it meets the requirements of the International Code of Zoological No-

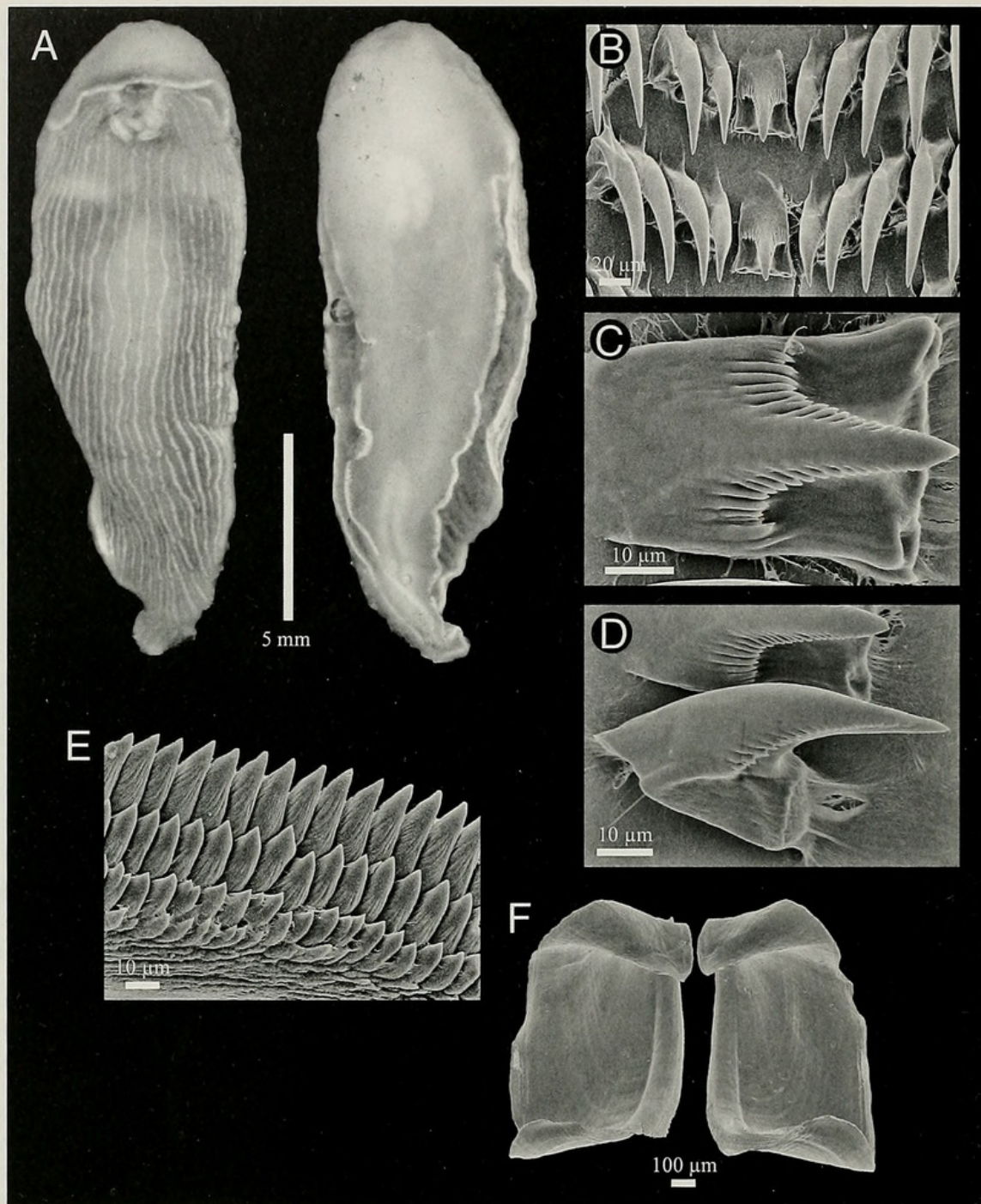
menclature, ICZN (1999: Article 13.1.2). Examination of the descriptions of specimens of *A. tigrina* in the papers of Abbott (1954) and Eyster (1981), and the original description of *Armina muelleri* and subsequent re-descriptions by Ihering (1915) and Marcus and Marcus (1960) revealed that the external morphology and anatomy of all these specimens are virtually identical, and there is no doubt they belong to the same species. Again, the type material of *Armina abbotti* is untraceable, so comparisons are based on the literature available. The radula of the material studied by Eyster (1981) from South Carolina has a rachidian tooth with a central cusp and 4 strong denticles on each side, and the inner lateral teeth bear some denticles, very similar to those of the specimens from Brazil. The illustrations of the living animals by Eyster (1981) show a species with a broad velum and the rhinophores emerging ventrally to the anterior end of the notum.

Nijssen-Meyer (1965) described one specimen of *Armina* from Surinam that he identified as belonging to the tropical Indo-Pacific species *Armina semperi* (Bergh, 1861). This identification was based on the fact that the specimen from Surinam had more rows of denticles in the masticatory process than specimens of *Armina muelleri* and the innermost lateral teeth had numerous denticles instead of a few or none. These differences in the number of rows seem to be due to intraspecific variation. The external morphology and the shape of the rachidian tooth and the lateral teeth of the Surinam material are identical to those of other references to *A. muelleri* (Ihering, 1915; Marcus and Marcus, 1960). Thus the specimen described by Nijssen-Meyer (1965) is here regarded as *A. muelleri*, concurring with the earlier suggestion by Marcus and Marcus (1967).

A third species name introduced for the Western Atlantic is *Armina wattla* Marcus and Marcus (1967), originally described from Georgia, USA. This species is also similar to *Armina muelleri* in radular and reproductive morphology. Both species have wide rachidian teeth with a few strong denticles on each side of the cusp and innermost denticulate lateral teeth. The reproductive only differs in the more elongate vagina of *A. wattla*; we assume that the elongate duct interpreted by Marcus and Marcus (1967) as the albumen gland is actually the ampulla. Externally, *A. wattla* is similar to *A. muelleri* by having a wide and flattened body, lamellated rhinophores emerging from below the anterior border of the notum, and the genital opening situated posterior to and below the branchial lamellae. Marcus and Marcus (1967) argued that *A. wattla* differs from *A. muelleri* by the shape of the caruncule (with two lobes in the former) and the size of the radular teeth. However, examination of the re-description of *A. muelleri* by Marcus and Marcus (1967) shows no significant differences in the shape of the caruncle.

Because of the absence of consistent and distinctive differences, we regard *A. wattla* and *A. abbotti* as junior synonyms of *A. muelleri*.





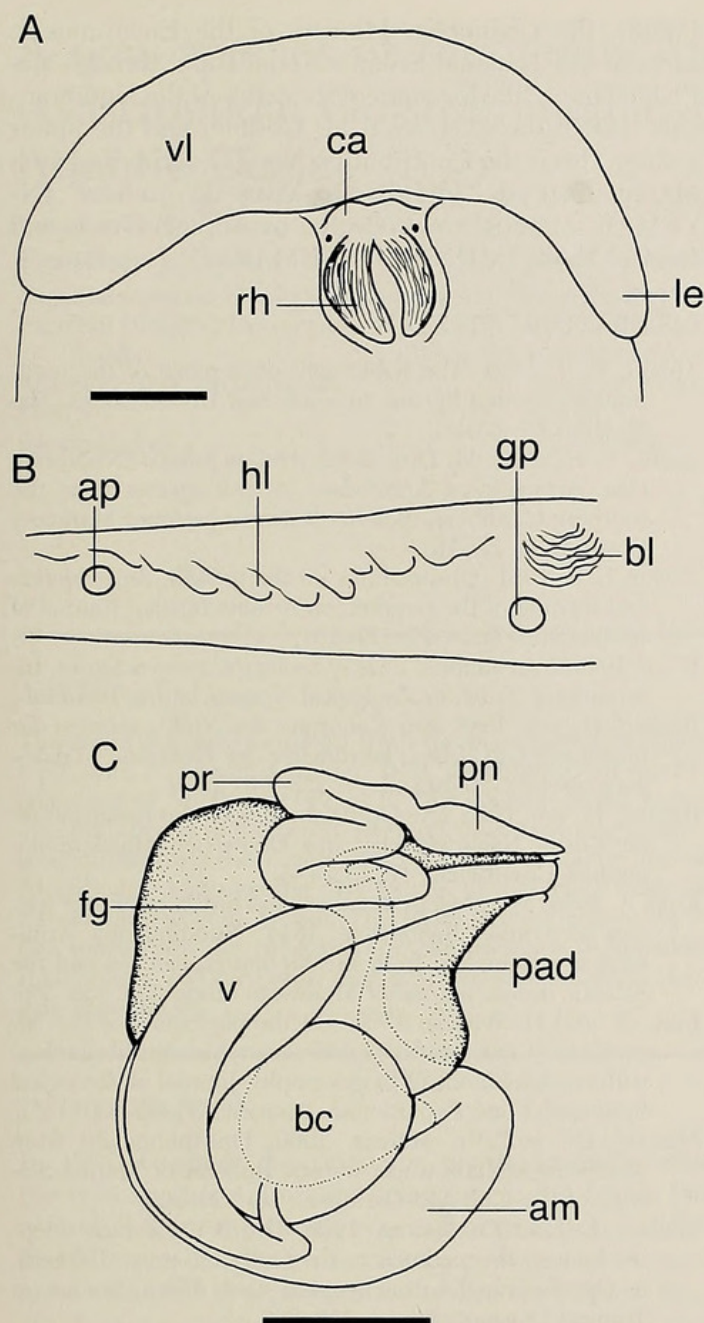
**Figure 5.** *Armina elongata* new species, holotype, MHNMC INV MOL3902. **A.** Dorsal and ventral views of the living animal. **B.** Rachidian teeth and inner lateral teeth. **C.** Detail of the rachidian tooth. **D.** Detail of the innermost lateral tooth. **E.** Jaw elements on the masticatory processes. **F.** Jaws.

*Armina elongata* new species  
(Figures 5–6)

**Description:** The living animal is red with white longitudinal notal ridges. The anterior margin of the oral veil and the apical portion of the rhinophores are also white (Figure 5A). The preserved specimen is pale grayish, almost white, with the spaces between the longitudinal notal ridges pigmented with dark gray. The body is elongated, flattened, and narrower posteriorly. The notum bears 24 longitudinal dorsal ridges. The oral veil is distinct and has two large, tentacular lateral extensions

without any projections. The extensions are as wide as the notum. There are two club-shaped rhinophores, each one with about 20 vertical lamellae situated on a dorsal notch. The eyes are visible through the epidermis at the outer base of each rhinophore. The caruncle is also distinguishable anterior to the rhinophores. The genital opening is located on the right side, slightly posterior to and below the branchial lamellae. The anal papilla is located behind the midpoint (2/3 of total animal length, from the anterior end of the body). There are 22 branchial lamellae and 23 large hyponotal lamellae on each side of the body. The branchial and hyponotal





**Figure 6.** *Armina elongata* new species, holotype, MHNMC INV MOL3902. **A.** Dorsal view of the anterior end of the body. Scale bar = 1 mm. **B.** Lateral view of the body. Scale bar as in A. **C.** Reproductive system. Scale bar = 1 mm. Abbreviations: am, ampulla; ap, anal pore; bc, bursa copulatrix; bl, branchial lamellae; ca, caruncle; fg, female glands; gp, genital pore; hl, hyponotal lamellae; le, lateral extension of velum; n, notum; pad, post-ampullary duct; pn, penis; pr, prostate; rh, rhinophore; v, vagina; vl, velum.

lamellae show alternation of larger and smaller lamellae. The pedal gland is white and located at the posterior end of the foot sole (Figure 5A).

**Jaws and Radula:** The radula formula is  $26 \times 33.133$  in the holotype. The rachidian tooth is narrow, with a long and pointed median cusp, and bears approximately 20 thin and elongated denticles on either side of the median cusp (Figure 5C). The lateral teeth are elongat-

ed, curved and also bear denticles that become progressively smaller towards the outermost teeth. The jaws have a denticulated masticatory border with three to four rows of denticles (Figures 5E–F).

**Reproductive System** (Figure 6): The reproductive system is dialic. The ampulla is large and convoluted; it narrows into a long post-ampullary duct that connects to the prostate and the female glands. The prostate is short and convoluted, and connects directly to the penis. The vagina is very long, curved and connected directly to the rounded bursa copulatrix.

**Type Material:** Holotype (MHNMC INV MOL3902), length 16 mm alive, from type locality.

**Type Locality:** Off Manaure, Colombia ( $11^{\circ}53'5''$  N,  $72^{\circ}36'39''$  W), 22 m depth, substratum with coralline algae and gravel.

**Distribution:** This species is only known from the type locality, off Manaure, Colombia.

**Etymology:** The specific name refers to the elongate shape of the body and the masticatory processes of this species.

**Remarks:** *Armina elongata* is clearly distinguishable from other species of the genus in several regards. Externally, the body shape of *A. elongata* is proportionally longer and narrower than that of *A. juliana* or *A. muelleri*. The velum is much wider than that of *A. juliana* and as wide as the notum. The genital opening is situated posterior to the branchial lamellae, whereas in *A. juliana* is anterior to the branchial lamellae.

Other differences include the reproductive system and the radular morphology. *Armina elongata* has a much more elongated vagina than those of *A. juliana* and *A. muelleri*. The rachidian tooth of *A. elongata* is most similar to that of *A. juliana*, but the central cusp is sharper and more elongated and has more denticles, almost reaching the apex of the cusp.

The description of *A. elongata* constitutes the second record of the genus *Armina* and the family Arminidae in the Caribbean Sea after the original description of *A. juliana* (see Ardila and Díaz, 2002). Additionally, this is the third arminid known to occur in the western Atlantic with *A. juliana* and *A. muelleri* (see Kolb and Wägele, 1998 and Ardila and Díaz, 2002).

## DISCUSSION

Comparisons of the external morphology and anatomy of *Armina elongata*, *A. muelleri*, and *A. juliana*, examined in this study, reveal that they are easily distinguishable from each other and from other Atlantic species of the genus by at least one or more external characters. The numbers of branchial and hyponotal lamellae, which vary little within the southern Caribbean species, show a great variation among other Atlantic species, and in some cases the number of lamellae differs from side to side. *Armina tigrina* has the largest number of branchial



lamellae (more than 100 per side), whereas *A. maculata* has the largest number of hyponotal lamellae (more than 100 per side). For other Atlantic species, *Armina neapolitana* has 18–32 branchial lamellae and 9–19 hyponotal lamellae, and *Armina loveni* has 9–26 branchial lamellae and 15–25 hyponotal lamellae (see Kolb, 1998). *Armina wattla* has 28 branchial leaves and more than 29 lateral lamellae when all primordial are counted (Marcus and Marcus, 1967).

The shape of the radular teeth, which appears to show little intraspecific variability in arminids (Marcus and Marcus, 1966), is another useful set of characters to distinguish species (see Kolb, 1998 and Ardila and Díaz, 2002). Several species have a distinct innermost lateral tooth, frequently bearing small denticles on the sides of the cusp, whereas the other lateral teeth have elongate cusps that can be denticulated or smooth. However, the material of *Armina muelleri* here examined lacks denticles on the innermost lateral teeth, which are present in other specimens described in the literature. However, other anatomical similarities suggest that this variation in the presence of denticles is likely due to intraspecific variability. Distinctive radular formulae and rachidian teeth morphology are found in other Atlantic species of the genus. In *A. tigrina* the radular formula is  $35 \times 56.1.56$  and the central cusp of the rachidian tooth is not as broad as in *A. juliana* and *A. muelleri* and bears 15–18 fine denticles. In *A. loveni* the radular formula is  $35 \times 29.1.29$  and the rachidian tooth has five coarse denticles on each side.

Finally, the morphology of the reproductive system has provided useful information to distinguish the three species here examined. In *A. elongata* the vagina is very long, curved and the ampulla is large and narrows into a long post-ampullary duct that connects to the prostate, whereas in *A. muelleri* the vagina is short and there is no post-ampullary duct connecting the ampulla directly to the prostate, which is very long and convoluted. *Armina juliana* also has a post-ampullary duct, but the vagina is much shorter than in the other two species.

## ACKNOWLEDGMENTS

Scott Whitaker and Susan Braden assisted with the production of the SEM images, which were improved and composed with the help of the staff and facilities of INVEMAR, Santa Marta. This paper has been supported by INVEMAR, COLCIENCIAS (Grant No. 210509-

11248), the Colombian Ministry of the Environment, and the US National Science Foundation, through the PEET Grant "Phylogenetic systematics of the Nudibranchia" (DEB-0329054) to T. M. Gosliner and the junior author. This is the Contribution No. 777 of the Research Marine Institute "José Benito Vives de Andreis" INVEMAR. Material was collected by Adriana Gracia and Gabriel Navas (MHNMC-INVEMAR).

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2004. "The genus *Armina* (Gastropoda: Nudibranchia: Arminidae) in the southern Caribbean, with the description of a new species." *The Nautilus* 118, 131–138.

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