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THE GENUS *HERMAEA* LOVÉN, 1844 (MOLLUSCA: SACOGLOSSA) IN THE CARIBBEAN, WITH THE DESCRIPTION OF A NEW SPECIES FROM CUBA

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ABSTRACT

Three species of *Hermaea* Lovén, 1844 are known in the Western Atlantic: *Hermaea cruciata* Gould, 1870, *Hermaea coirala* Marcus, 1955 and *Hermaea nautica* Caballer & Ortea, 2007. In the Caribbean the most of the records are attributed to *H. cruciata*, which has shown a wide anatomy and habitat plasticity. A new species of *Hermaea* from Cuba, cryptic with *H. cruciata*, is described in this paper. It has several distinctive characters: dark red spots all over the body, absence of oral palps, cerata with the digestive gland branching cross-like, high number of radular teeth, which have serrate lateral expansions. In this species the dorsal branches of the digestive gland do not join ahead the cardiac area. A comparative synthesis of the characters of the species which inhabit in the Western Atlantic is tackled, with a discussion on their validity and distribution in the Caribbean.

Key words: Hermaeidae, sibling species, Western Atlantic, Cuba.

RESUMEN

En el Atlántico oeste se han descrito 3 especies del género *Hermaea* Lovén, 1844: *Hermaea cruciata* Gould, 1870, *Hermaea coirala* Marcus, 1955 y *Hermaea nautica* Caballer & Ortea, 2007. La mayoría de las citas del Caribe han sido atribuidas a *H. cruciata*, que tiene aparentemente una gran plasticidad anatómica y de hábitat. En éste trabajo se describe una especie nueva de *Hermaea* de Cuba, críptica con *H. cruciata*. Ésta especie tiene varios caracteres distintivos como son: manchas rojas por todo el cuerpo, ausencia de palpos orales, ceratas con las ramas del digestivo en su interior ramificadas en forma de cruz en el extremo distal y un alto número de dientes radulares con expansiones laterales serradas. Las ramas dorsales del digestivo no se unen por delante del área cardiaca. Se aporta una tabla comparativa de los caracteres de las especies que viven en el Atlántico oeste y se discute su validez y distribución en el Caribe.

Palabras clave: Hermaeidae, especies crípticas, Atlántico oeste, Cuba.

1. INTRODUCTION

Three species of the genus *Hermaea* Lovén, 1844 (Placobranchacea: Hermacidae) have been described in the Western Atlantic: *Hermaea cruciata* Gould, 1870 (type locality, Naushon Island, USA), *Hermaea coirala* Marcus, 1955 (type locality, Island of Sao Sebastiao, Brazil) and *Hermaea nautica* Caballer & Ortea, 2007 (type locality, Náutico de Playa, Havana, Cuba). These are easily distinguishable by the way the digestive gland branches inside the cerata; cross-like in the first, all-along the central axis in the second and undivided in the third.

In the Caribbean, the most of the records to the genus *Hermaea* have been attributed to *Hermaea cruciata* (Jensen [10], Jensen & Clark [14], Jensen [11], Jensen [12], Clark [4], Clark [5], Espinosa & Ortea [6], Redfern [17], Espinosa, Ortea, Caballer & Moro [7], Valdés, Hamann, Behrens & DuPont [20], Turner, Evans & Abgarian [19], Redfern [18]) but the original description of this species was not very precise, and the redescription by Vogel [21], contained some inaccuracies that made it impossible to find a true member of this species, which were supposed to bear three hooks in the penis. In addition, *H. cruciata* has been reported in sheltered areas, with reduced salinity (Jensen & Clark [14]) or exclusively in relatively eutrophic habitats (Clark [4]) or on high current or oligotrophic areas (Clark [5]); from cold to tropical waters, from north of the USA to Brazil (if we consider *H. coirala* synonymous as it has been suggested by Valdés *et al.* [20]); having blade-shaped radular teeth bearing denticles in the lateral expansions (Jensen [11] and [12]) or with smooth lateral expansions (Valdés *et al.* [20]); from 50 (Jensen [10]) to 95 μm (Jensen [12]).

This wideness on habitat, distribution and radular morphology, together with the imprecise diagnosis of the species and its rareness and ability for camouflage, led to the suspicion that a complex of species could be hidden under the name *H. cruciata*. Thus, the specimen in which Vogel [21] based the redescription of the species (USNM 577625) and some others from Woods Hole from the USNM Collections, was reexamined and compared with samples from Cuba which, in fact, belong to a different species of the genus, close related to *H. cruciata*, whose description is tackled in this work.

2. MATERIALS AND METHODS

The specimens were collected in the intertidal zone or in shallow waters by snorkeling, in Guanahacabibes Peninsule, Cuba, October 15, 2003, November 4, 2004 and October, 5, 2005. External anatomy and coloration pattern of each specimen were studied using a stereoscopic microscope Olympus SZX16. Then, photographed using a Nikon D80 camera and preserved in ethanol 96%. Data on the internal anatomy were taken using a stereoscopic microscope Olympus SZX16. Radula and genital apparatus were mounted in microscopy slides and observed in a Nikon Eclipse optical microscope.

Abbreviations: MCIES, Malacological Collection of the "Instituto de Ecología y Sistemática", Ministerio de Ciencia, Tecnología y Medio Ambiente, Havana, Cuba; MCNT, Museo de Ciencias Naturales de Tenerife, Organismo Autónomo de Museos, Santa Cruz de Tenerife, Canary Islands, Spain; USNM, Smithsonian National Museum of Natural History Collections, Washington D.C, USA.

3. SYSTEMATICS

Family Hermaeidae H. Adams & A. Adams, 1854

Genus ***Hermaea*** Lovén, 1844

Type species: *Doris bifida* Montagu, 1815 by subsequent designation of Gray (1847).

Hermaea cruciata Gould, 1870

(Figures 1 B and 3 A-B. Table 1)

Hermaea cruciata Gould, 1870: *Report on the Invertebrata of Massachusetts.* Binney, W.G. (Ed.): 253, Fig. 256. Type locality: Naushon Island, Massachusetts, USA.

References:

Doto pita: Turner *et al.* [19]: 44.

Hermaea bifida: Turner *et al.* [19]: 66.

Hermaea cruciata: Vogel [21]: 155-157, Figs. 1-3; Marcus [16]: 307-308, Fig. 4; Jensen ([10]: 138); Jensen & Clark [14]; Clark [4]; Espinosa and Ortea [6]; Valdés *et al.* [20]: 86-87; Turner *et al.* [19]: 67. Undetermined sp 3: Turner *et al.* [19]: 98.

Material examined: Woods Hole, Massachusetts, USA, 1 specimen 3.6 mm long fixed, (1882), deposited in USNM (USNM 382300). Woods Hole, on wharf Piles, Massachusetts, USA, 8 specimens from 1 mm to 3.5 mm long fixed, (may 8, 1883), deposited in USNM (USNM 382332). Woods Hole, on wharf piles, Massachusetts, USA, 17 specimens from 1.6 to 4.5 mm long fixed, (august 14, 1888), deposited in USNM (USNM 382320). Neotype: Chesapeake Bay, Deal Island, Maryland, North Atlantic, USA, 1 specimen 4.9 mm long fixed, collected by D.G. Cargo and M.J. Beber (October 16, 1968), determined by R. M. Vogel, deposited in USNM (USNM 577625, Acc 291968).

Diagnosis: Body crystalline to cream, with a greenish cast and numerous white dots, lacking red pigment. Oral appendages present. Dorsal branches of the digestive gland join in the tail and ahead the cardiac area, where a central cerata is present. Cerata club-shaped, with the digestive gland branching cross-like near the tip, but not exclusively. Teeth with smooth lateral expansions. Radular formula: 17-19 x 0.1.0 in specimens 8-10 mm long alive. Penis unarmed.

Description: Crystalline body, with snow-white granules concentrated on head, rhinophores, cardiac area and the distal part of the cerata. Oral appendages present and well developed. Rhinophores almost as long as longest cerata, dorsal fold of each rhinophore longer than the ventral fold and oriented forward characteristically. Eyes big, in clear areas behind rhinophores base, with golden tinge in fixed animals. Anterior border of the foot bilobated and laterally angulated. Tail long and thin. Cardiac area globose and prominent. Both branches of the digestive gland in the dorsum join in the tail and ahead the cardiac area, where a central cerata is present in all the specimens studied (28). Digestive gland inside cerata, branching cross-like distally and, in some cases, in the middle of it. Each side of the body bears a simple row of 10-30 cerata. Cerata club-shaped, wider distally, sometimes with tubercles, one for each branch of digestive gland.

Hermaphroditic gland white, visible through the body, with 16-26 yellowish white ovotestis grouped from cardiac area to mid-body. Anus stalked, ahead the cardiac area. Penis unarmed.

Radular formula: 19 x 0.1.0. in 1 specimen 4.5 mm long fixed (USNM382320), with 4 teeth in ascending series, 11 in descending, 3 in ascus and 1 developing teeth. Last tooth of ascending series 83 µm long. Functional tooth 75 µm long. Radular teeth shows a rectangular base and a blade-shaped functional part with smooth (Valdés *et al.* [20] and present work) lateral expansions.

Distribution and habitat: East coast of USA: Woods Hole, Massachusetts, to Florida (Valdés *et al.* [20]). Costa Rica (Espinosa & Ortea [6]). Cayman Islands (Turner *et al.* [19]: under several names).

It is found in low salinity waters (Vogel [21]), eutrophic (Clark [4]), feeding on filamentous red algae on detritus, rocks or epimangle (Clark [4], Valdés *et al.* [20]). It can also be found on substratums, torn and swept away by the sea (Espinosa & Ortea [6], Turner *et al.* [19]).

Remarks: Vogel [21] stated that *Hermaea cruciata* bears 3 hooks in the penis. In more than 40 years, any specimen with that character has been found, but several have been recorded as *H. cruciata* (Jensen & Clark [14], Clark [4], Espinosa & Ortea [6], Redfern [17], Espinosa *et al.* [7], Valdés *et al.* [20], Turner *et al.* [19]; Redfern [18]). Reexamination of the specimen studied by Vogel [21] (USNM 577625) and several others from Woods Hole, a bay 1 km north from the type locality of *H. cruciata*, lead to the conclusion that her assessment about the hooks in the penis was a misinterpretation.

Valdés *et al.* [20] illustrated a typical specimen of *H. cruciata* accompanied by a SEM-photo of the teeth of the species; 60 µm long (for specimens up to 5 mm), blade shaped with smooth lateral expansions. In other hand, Jensen [11] considered this species to bear teeth with denticles in the lateral expansions, and Jensen [12] published a SEM-photo of some radular teeth, about 95 µm long, with fine denticles in the lateral expansions. These specimens captured in Florida and determined as *H. cruciata* were never illustrated or described, so, they could belong to *H. cubana* sp. nov.

Considered a temperate water species, with southern limit in Florida (Jensen [13]), *H. cruciata* is apparently more frequent in the north and its distribution in the Caribbean could be accidental (i.e. on seaweed torn by the sea).

Hermaea cubana sp. nov.

(Figures 1 A, 2 and 3 D-G, Table 1)

References:

Hermaea cruciata: Figure species 809; Espinosa *et al.* [7]: 56.

?Hermaea cruciata: Redfern [17]: 164-165, Figs. 682 A-B; Redfern [18]: 294, Figure species 809.

Type material: Holotype: Bolondrón (type locality), Guanahacabibes Peninsule, Pinar del Río, Cuba, 21°54'34"N, 84°51'32"W, 1 m deep, 1 specimen 2 mm long (october 5, 2005), deposited in MCIES051005. Paratype: 1: Playa Baracoa, Havana, Cuba, 23°03'10"N, 82°33'27"W, 1 specimen 1.5 mm long (october 15, 2003), 1 m deep, deposited in MCNT (TFMCBM/11311; MO/05141). Paratype 2: María La Gorda, Guanahacabibes Peninsule, Pinar del Rio, Cuba, 21°49'15"N, 84°29'47"W, 1.5 m deep, 1 specimen 2 mm long (november 10, 2003), deposited in MCIES051006.

Diagnosis: Translucent body with reddish blotches of pigment on surface. Oral appendages absent. Dorsal branches of the digestive gland join only in the tail. Cerata club-shaped with

the digestive gland branching cross-like near the tip. High number of teeth with serrated lateral expansions. Radular formula: 22-25 x 0.1.0. in 1.5-2 mm specimens. Penis unarmed.

Description: Translucent body with scattered reddish or brownish red blotches (Figure 1 A an 2 A). Snow-white granules all over integument, including head, rhinophores, cerata and cardiac area. Oral appendages absent (Figure 2 B). Rhinophores sharpen and directed downwards (Figure 2 C), not as long as longest cerata. Eyes behind rhinophores base. Anterior border of foot orange tinged, bilobated and laterally angulated. Tail long and sharp, projected behind last pair of cerata. Cardiac area oval. Digestive gland reddish or brownish red; translucent during starvation; the branches in the dorsum join in the tail but not ahead of the cardiac area. Digestive gland inside cerata branching cross-like near the tip (Figures 2 D-E).

Each side of the body with 9-10 cerata in a simple row. Cerata translucent, with snow-white granules and red spots, club-shaped, wider in distal third, with 4 tubercles, one for each branch of digestive gland.

Hermaphroditic gland white, visible through sole, with 8-10 ovotestis grouped from neck to mid-body. Anus in cardiac area. Gonopore on right side, laterally below eye. Penis unarmed.

Radular formula: 22-25 x 0.1.0. in 2 specimens 1.5-2 mm long, with 4-5 teeth in ascending series, 12-17 in descending, 4-5 in ascus and 1-2 developing teeth. Last tooth of ascending series, 45-48 μm long. Functional tooth, 42-44 μm long.

Radular teeth (Figures 3 D-G) with a rectangular basal part with two anchorage growths and blade-shaped functional part, with lateral expansions strongly cuspidate, like wings to fit into base of anterior tooth.

Distribution and habitat: Cuba, from Havana to Guanahacabibes Peninsule. Open shore. Intertidal zone on filamentous red algae on rocks, 0-8 m depth.

Remarks: The way in which the digestive gland branches inside the cerata is, usually, a very useful characteristic to distinguish species of the genus *Hermaea*. In both, *Hermaea cubana* sp. nov. and *H. cruciata*, the gland divides at the distal end of each cerata cross-like, thus, to clearly establish the differences between them, we must use other characters.

Compared to *Hermaea cruciata*, *Hermaea cubana* sp. nov. is smaller sized (the fifth) and has different body color (translucent with red spots *versus* crystalline without red pigment); shorter rhinophores; higher number of teeth in specimens five times smaller; teeth with serrated lateral expansions; lack oral appendages; lack stalked anus, which is actually in the cardiac area.

Compared to *Hermaea cubana* sp. nov., *Hermaea cruciata* has the eyes surrounded by clear areas; both branches of the digestive gland in the dorsum join ahead the cardiac area and there is 1 central cerata in the connection area. In addition, *H. cruciata* lives in low salinity (Vogel [21]) or eutrophic (Clark [4]) localities, while *H. cubana* sp. nov. lives on the intertidal, in the open shore.

The record of *Hermaea cruciata* in Cuba (Espinosa *et al.* [7]) was based on the specimens here described as *Hermaea cubana* sp. nov., thus, it must be rejected.

The specimens cited in Bahamas by Redfern ([17] & [18]) and found on *Sargassum*, could belong to *H. cubana*, given their morphological similarities and special biogeographic relationships between the archipelagos of Cuba and Bahamas. Despite this, Redfern ([17] &

[18]), in the description of the specimens, fails in mentioning the red dots in the body of the animals that can be seen in the illustrations. Additionally, The photos do not allow to see if the digestive gland in the dorsum joins ahead the cardiac area.

A comparison of both species can be seen in Table 1.

Etymology: *H. cubana*, in honor to the people inhabiting Cuba and also referring to the name of the country, in which its type locality is found.

4. DISCUSSION

The first western Atlantic species of *Hermaea* was *Hermaea cruciata*. It was described from Massachusetts by Gould [8], based on one specimen and some field drawings in ventral view left by Alexander Agassiz. He provided no data about coloration nor size, but suggested that the characteristics of the species, such as the digestive gland inside cerata branching cross-like, probed that it was undescribed at the moment. The second western species was *Hermaea coirala*, and the author argued that: "...description of *H. cruciata* its not enough to apply its name to one slug found 7000 km south..." (Marcus [15]). Due to the practical absence of data on *H. cruciata*, Vogel [21] redescribed the species based on one specimen, 10 mm long, collected in Deal Island, Maryland (USA), in 1968. Marcus [16] used the same specimen to compare *H. cruciata* with *H. coirala*, and concluded that both taxa were different and distinguishable because: "the diverticula of the digestive gland are united in front, and on this transverse canal there arises an unpaired ceras".

Later, *Hermaea nautica* was described based on 1 specimen (2 mm long) from Cuba, because of the pattern of red lines on its surface, the undivided digestive gland inside the cerata and a really different kind of teeth (Figure 3 C).

Hermaea coirala, as many other species, has not been captured again since it was described, and may be this is the reason why, Valdés *et al.* [20] regard it as a junior synonym of *Hermaea cruciata*, unfortunately they don't give any argument for the change, nor give an explanation.

The european species *Hermaea bifida* has been recorded in the Caribbean by Espinosa & Ortea [6] and Valdés *et al.* [20]. Espinosa & Ortea [6] mention the strong musky odor left by their specimens from Costa Rica in the tools they touched, but didn't illustrate them. There were some field drawings and data that have been reexamined: *H. coirala* is a much more appropriate name to be applied, but, in order to avoid new misinterpretations, this species should be redescribed based on specimens from Brazil, when they are found.

Hermaea bifida was carefully redescribed by Alder and Hancock ([1]: Fam. 3, Pl. 39). The specimen from Tobago illustrated by Valdés *et al.* [20] is different from the european animals and actually is quite similar to *Hermaea ghanensis* Caballer, Ortea & Moro, 2006 from Ghana (Caballer, Ortea & Moro [3]), therefore, to assign the correct name, internal anatomy studies must be tackled. Thus, the records of *H. bifida* in the Western Atlantic must be rejected and this species regards as exclusive from the Eastern Atlantic.

In synthesis, at least four species of *Hermaea* can be found in the Western Atlantic: *Hermaea cruciata*, *Hermaea coirala*, *Hermaea nautica* and *Hermaea cubana* sp. nov. The number is likely to increase with future targeted searches, but some more may be discovered hidden in sibling species complexes. Thus, it is suggested that, in the future, data on some particular characters should be supplied (if available) when describing and characterizing species

of the genus, at least: 1) coloration pattern of the body, 2) presence/absence of oral palps, 3) shape of the cerata and the way in which the digestive gland branches inside, 4) detailed description of the digestive gland in the dorsum, 5) position of the anus relative to the cardiac area, 6) the shape and number of the radular teeth. 7) the spawn and the size and color of the eggs. A color photo of the living animal in dorsal view is also advisable.

A comparison of the characteristics of the valid western Atlantic species can be seen in Table I.

5. ACKNOWLEDGMENTS

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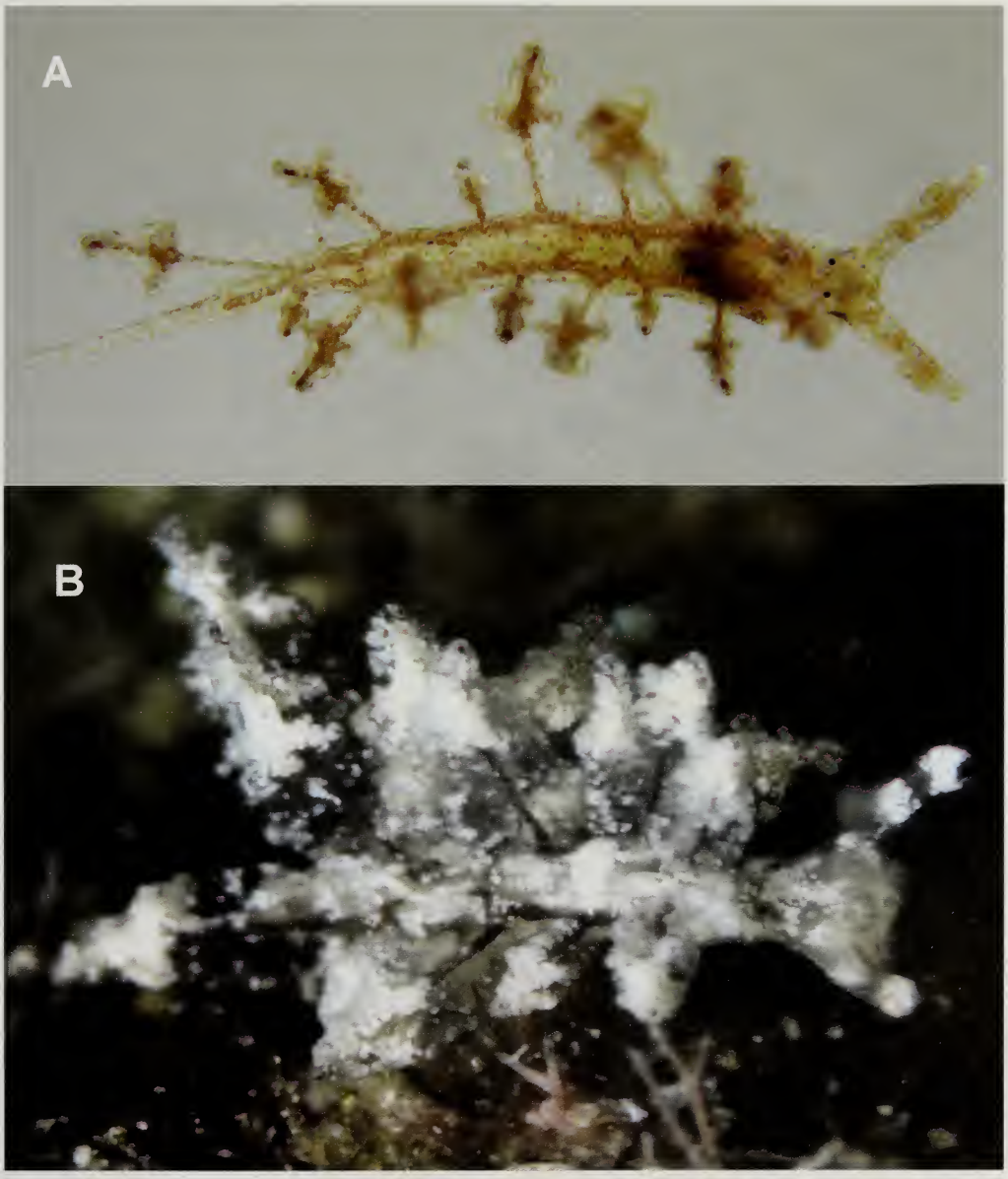

Figure 1.- A, *Hermaea cubana* sp. nov., dorsal view, holotype, (courtesy of Leopoldo Moro); **B**, *Hermaea cruciata* Gould, 1870, 7 mm long specimen from Grand Cayman (courtesy of Everett Turner).

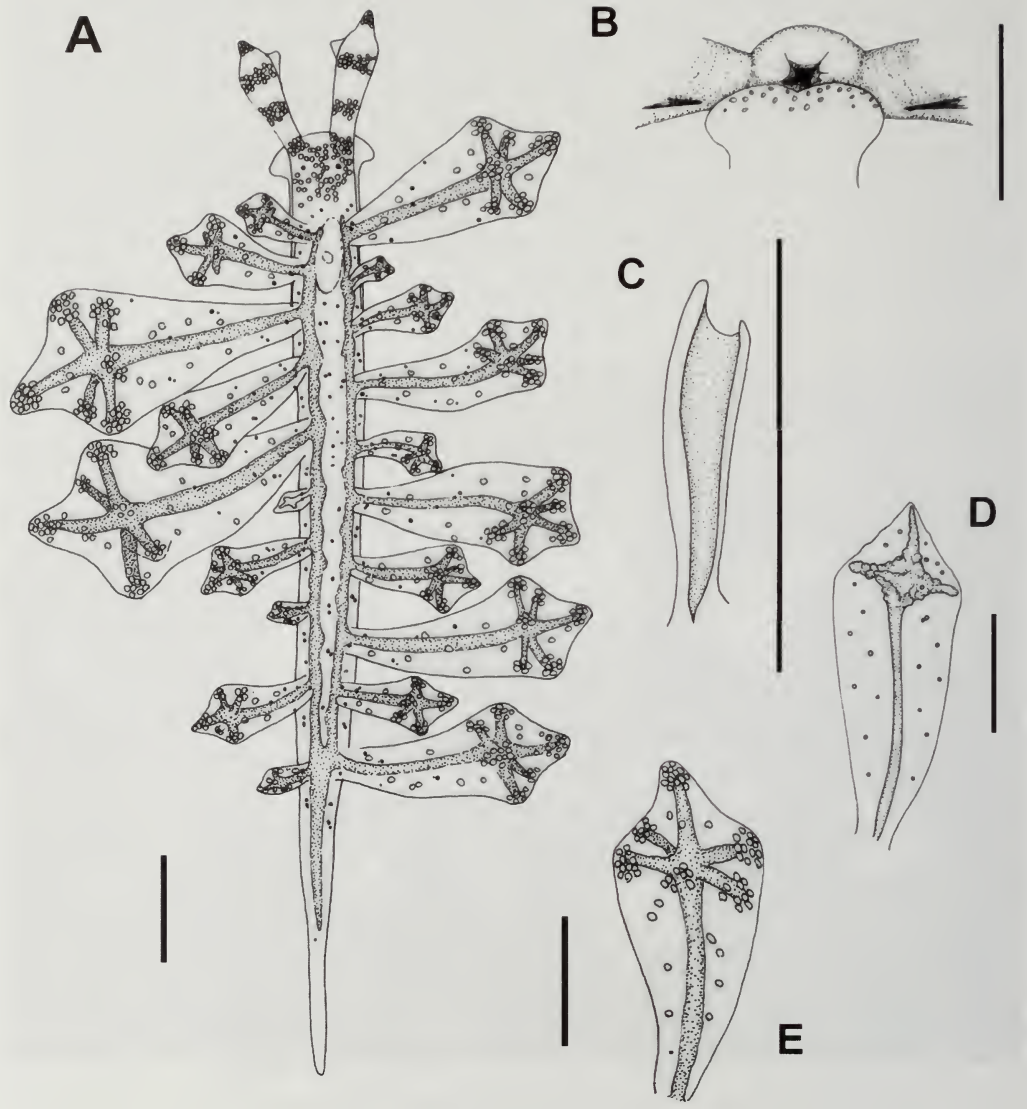

Figure 2.- *Hermaea cubana* sp. nov., line drawings, holotype, MCIES051005; **A**, animal in dorsal view; **B**, detail of the mouth in ventral view (Paratype 2); **C**, Lateral view of a rhinophore; **D-E**, lateral view of the cerata (Paratype 2); **D-E**, lateral view of the cerata. Scale bar = 0.2 mm.

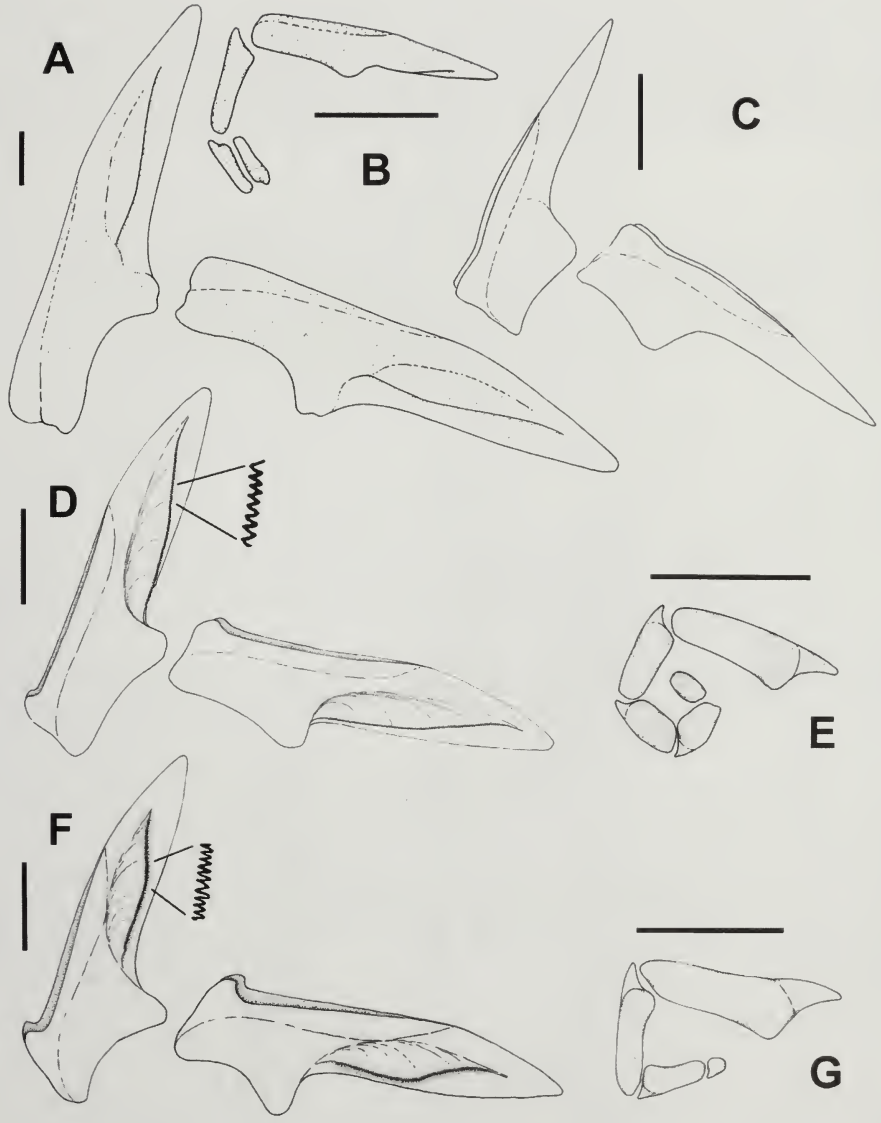

Figure 3.- A-B, *Hermaea cruciata*, 4.5 mm specimen (USNM382320); **A**, last tooth of the ascending series and first tooth of the descendent series; **B**, ascus; **C**, *Hermaea nautica* Caballer & Ortea, 2007, holotype (2 mm), last tooth of the ascending series and first tooth of the descendent series; **D-G**, *Hermaea cubana* sp. nov.; **D-E**, Paratype 2; **D**, Last tooth of the ascending series and first tooth of the descendent series; **E**, ascus; **F-G**, Paratype 1; **F**, Last tooth of the ascending series and first tooth of the descendent series; **G**, ascus. Scale bar = 10 μm.

	Length	Body color	Cerata	Cerata pigmentation	Oral palps	Anus	Branching of digestive gland inside cerata	Junction of the digestive gland on the dorsum	Radular teeth	Penis	Habitat	References
H. cruciata	Up to 10 mm	Crystalline to cream with white dots, sometimes with a greenish cast. Lacks red pigment	Slender, elongate, wider near the tip	Cristalline with - opaque white dots densely grouped	Present	Anterior to the cardiac area. Stalked	Cross-like near the tip and occasionally branched in the middle area	In the tail and ahead the cardiac area. At least 1 central cerata present	19 x 0.1.0 (4.5 mm fixed specimen = 9 mm alive aprox.) blade shaped with smooth lateral expansions 83-108 μm long	Unarmed	Low salinity waters or eutrophic, on detritus, rocks or epimangle. Also on substratums torn and swept away by the sea	This paper, Vogel [21], Marcus [16], Valdés *et al.* [20]
H. coirala	6-9 mm	Crystalline. Any pigmentation	Wider over the middle	Crystalline	Absent	Anterior and separated to cardiac area. Stalked	All along the central axis. At right angles	Only in the tail	25 x 0.1.0. blade shaped with smooth lateral expansions. 67 μm long	Unarmed	Algae on rocks in the upper littoral	Marcus [15]
H. nautica	2 mm	Crystalline with a pattern of red lines	Globose, ovoid	Crystalline with red dots	Present	In cardiac area	Undivided	Only in the tail	13 x 0.1.0 (holotype) Awl shaped. No expansions 33 μm long	Unarmed	Open shore, on rocks	Caballer & Ortea [2]
H. cubana sp. nov.	1.5-2 mm	Translucent with conspicuous reddish blotches. Some white dots	Slender, short, wider near the tip	Translucent with red blotches and white dots	Absent	In cardiac area. Not stalked	Cross-like near the tip	Only in the tail	25-27 x 0.1.0. (1.5-2 mm long) Blade shaped with lateral expansions strongly cuspidate 42-48 μm long	Unarmed	Open shore, intertidal, on rocks	This work

Table 1.- Comparison of western Atlantic species of *Hermaea*.