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Diversity and Distribution of articulated Coralline algae (Rhodophyta, Corallinales) of the Atlantic coast of Mexico

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Abstract

This paper provides the first critical revision of the articulated coralline algae *Amphiroa* and *Jania* along the Atlantic coast of Mexico and Mexican Caribbean, based on morphological and anatomical characters of numerous specimens both genera. We found six species of *Amphiroa,* including one new record for this region: *Amphiroa valonioides.* In the other hand, *Amphiroa fragilissima* and *A. rigida* have the wider distribution along the Atlantic coast of Mexico. *Jania* to encompass six species, *J. capillacea* and *J. cubensis* are the best represented along the Atlantic coast of Mexico. Male and female reproductive structures of several species are recorded for first time in the study area. The distribution of *A. valonioides* and *A. vanbosseae* seems to be the warm temperate and tropical coast of the Atlantic and Pacific Ocean. Macro and microscopic characteristics and relevant photographs and descriptions are provided for each species. Data on the distribution of taxa along the Atlantic and Caribbean coast of Mexico are included.

Key words: *Amphiroa, Jania*, morphology, new records

Introduction

Articulated coralline algae, including species *Amphiroa* Lamouroux (1812), and *Jania* Lamouroux (1812), are common on the Atlantic coast of México and Mexican Caribbean. Both genera are classified into two subfamilies. Members of the subfamily Lithophylloideae are commonly formed by of cells of contiguous vegetative filaments linked by secondary pit-connections; genicula (when present) composed by one or more tiers of cells. This subfamily consists by seven genera, five of them are non-articulated genera, and only *Amphiroa* and *Lithothrix* are articulated. This subfamily is represented by 174 species. *Amphiroa* is a large genus widespread in tropical and subtropical regions with a variety of morphological types from a few millimeters high to as much as 30 cm. Intergenicula may be terete or flat, and sometimes have midribs and wings (Johansen 1970, 1981). In contrast, all members of the subfamily Corallinoideae (J.E. Areschough) Foslie are constructed of uncalcified genicula and calcified intergenicula and form branched fronds. This family is constituted by 14 genera and 101 species. The Tribe Corallineae J.E. Areschoug (1852) is characterized by genicula consisting of a single uncorticated and uncalcified of medullar cells and lateral cellular fusion. *Jania* is a genus widespread in tropical, subtropical and warm temperate areas (Guiry & Guiry 2014). Many records of articulated corallines belonging to *Amphiroa* and *Jania* have been reported in list or ecological publications (Aguilar-Rosas *et al*. 1989, Lehman & Tunnell 1992, Ortega *et al*. 2001. Mendoza-González *et al*. 2007, Cetz-Navarro *et al*. 2008). However, in spite of the abundance of *Amphiroa* and *Jania*, representatives of these genera in the Atlantic coast of Mexico have not been critically studied and have received little attention. This paper presents an analysis of *Amphiroa* and *Jania* along the Atlantic coast of Mexico based on studies of both external and internal vegetative and reproductive characters in order to find characters may be used in the delimitation of species of both genera.

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Material and Methods

Specimens of *Amphiroa* and *Jania* was borrowed from ENCB (Department of Botany, National School at Biological Sciences, Mexico, D.F.); CMMEX (Faculty of Marine Sciences, University of Baja California, Ensenada, Baja California), UNL (Macroalgae Laboratory, University of Nuevo León, Monterrey, Nuevo León); MEXU (National Herbarium, National Autonomous University of Mexico, Mexico, D.F.), UAMIZ (Macroalgae Laboratory, Metropolitan Autonomous University-Iztapalapa, México, D.F.), IZTA (Faculty of Graduate Studies, National Autonomous University of Mexico, Mexico, D.F.), US (United States National Herbarium Smithsonian Institution Washington, D.C.) and UC (University of California) University and Jepson Herbaria of the University of California at Berkeley; (Holmgren *et al.* 1990), these samples were collected for different people from 1940 to 2010. Also, specimens of *Amphiroa* and *Jania* was found in samples of general collections of common corallines collected by reef-walking or snorkeling at Playa Muñecos, Playa Hermosa, Monte Pio, (Veracruz), Puerto Real (Campeche), Progreso (Yucatán), Majahual, Río Hondo (Quintana Roo), during 2011, 2012 and 2013. Samples were preserved in 5% formalin/seawater. Preserved specimens were decalcified with 0.6M HNO_3. Small segments were stained with aniline blue and hematoxilin-eosine for anatomical observations and measurements.

The classification system of Wynne (2011) and Guiry & Guiry (2014) are used throughout this paper. In cell measurements length denotes the distance between primary pit connections whereas diameter denotes the maximum width of the cell lumen at right angles to this. Conceptacle measurements follow the system of Johansen (1970), Adey & Adey (1973). Descriptive terminology follows Johansen (1971), Johansen & Womersley (1994), Riosmena-Rodríguez & Siqueiros-Beltrones (1996) and Harvey *et al*. (2009). Pertinent remarks about the morphology, anatomy, detailed descriptive accounts, specimens examined and distributions are provided for each species. In this study we made observations on a total of 160 specimens (77 of *Amphiroa* and 83 of *Jania*) are housed at herbaria of the National School of Biological Sciences (ENCB), University Autonomous of Baja California (CMMEX) and UC (University of California) University and Jepson Herbaria of the University of California at Berkeley. Description of the vegetative, reproductive characters and information related to the habitat, the geographic distribution and examined specimens are included for each species.

Results

Genus *Amphiroa* Lamouroux 1812

The genus *Amphiroa* (Corallinaceae, subfamily Lithophylloideae) was described by Lamouroux (1812). It is characterized by a crustose or endophytic holdfast and geniculate fronds that may reach several centimeters in height. Fronds grow individually or form mats, branching are basically dichotomous. The decalcified portions (genicula) may or not may evident externally, and within have one or more tiers of cells with or without evident cortication. Intergenicula are calcified and formed by a medulla of regular parallel rows, the cortex is derivate from medullary cells. All types of reproductive structures are uniporate and originate by elongation from the cells of the intergenicular cortical wall. Gametangial conceptacles are dioecious (Riosmena-Rodríguez & Siqueiros-Beltrones 1996).

In this study we found six species of *Amphiroa.*

Description of species

Amphiroa beauvoisii J.V. Lamouroux 1816:299–300

Synonyms: *Amphiroa zonata* Yendo, 1902:10, pl. 1: figs. 11–14.
Type Locality: Portugal

Morphology: Thalli to 8.0 cm high more or less erect and open, but sometimes in compact pulvinate clumps. Branching dichotomous more or less in one plane, sometimes irregularly dichotomous, apex of terminal branches compressed to spatulate.

Anatomy: Intergenicula near base terete or subterete up to 600–800 µm in diameter, and 3–4 mm long. In longitudinal section, intergenicula showing a prominent medullar region with an alternation of 2–5 long cells (36–77mm long and 9–12 µm diameter) and one short cell (10–16 µm long and 8–10 µm diameter), the cortical cells

(made up 4–6 tiers of cells) are rounded 4–7 µm in breadth and 10–12 µm length; epithallial cells unistratose with oblongs cells 1–3 µm in length and 5–8 µm breadth. Genicula corticated usually visible between intergeniculas consisting of 3–5 tiers of medullary cells and 450–600 µm wide and irregularly disposed patches of cortical cells. *Reproductive structures:* Tetrasporangial conceptacles scattered over the erect branches, laterally, projected and rounded or apiculate, chambers without columella and 240–260 µm diameter and 120–200 µm high, tetrasporangia 25–40 µm breadth and 54–90 µm length, arranged in the floor of the chamber periphery. Bisporangial conceptacles, rare, chambers 196–300 µm in diameter and 120–200 µm high, bisporangia 20–24 µm breadth and 30–40 µm length. Gametangial plants not found.

Distribution and material examined (Figs. 1–4): MEXICO. *Veracruz*: Monte Pio, 4-October-2013, Mendoza González & Mateo Cid (ENCB 20059). *Yucatán*: Desertora Island, 15-November-1985, Huerta Múzquiz & Mateo Cid (ENCB 8940). *Quintana Roo*: Puerto Morelos (Huerta Múzquiz *et al*. 1987:45, Dreckmann *et al*. 1996:9) Akumal (Aguilar-Rosas *et al.* 1998:24); Xcalac (Huerta-Múzquiz *et al.* 1987:45); Banco Chinchorro (Huerta-Múzquiz *et al*. 1987:45); Banco Chinchorro (Huerta-Múzquiz *et al.* 1987:45). Habitat: On rocks, in exposed intertidal and tidepool; and in subtidal to 10 m. deep.

Amphiroa fragilissima (Linnaeus) J.V. Lamouroux 1816:298.

Basionym: *Corallina fragilisima* Linnaeus 1758:806
Type Locality: Jamaica

Morphology: Thalli pulvinate-caespitose, forming extensive mats, 4–5 cm high and 5–15 cm wide, regularly dichotomously branched, the angles rather acute, sometimes trichotomous or with adventitious branches, apex of terminal branches rounded.

Anatomy: Intergenicula terete through to 300–350 µm in diameter, and 1–3 mm long. In longitudinal section, intergenicula showing a prominent medullar region with an alternation of 1–2 long cells (30–40 µm long and 6–10 µm diameter) and one short cell (14–16 µm long and 6–8 µm diameter), the cortical cells (made up 3–5 tiers of cells) are rounded 5–8 µm in breadth and 6–10 µm length; epithallial cells unistratose with oblongs cells 1–3 µm in length and 5–6 µm breadth. Genicula corticated usually barely visible between intergeniculas consisting of 5–7 tiers of medullary cells and 350–400 µm wide.

Reproductive structures: Tetrasporangial conceptacles scattered over the erect branches, laterally projected and rounded chambers without columella and 240–250 µm diameter and 75–90 µm high, tetrasporangia 20–30 µm breadth and 50–60 µm length, arranged in the floor of the chamber periphery. Gametangial plants not found.

Distribution and material examined (Figs. 5–8): MEXICO. *Veracruz*. Lobos Island, 2-May-1963, Garza (UNL 3506), 17-May-1980, E. Hidalgo (ENCB 11752) (Huerta-Múzquiz 1964:14); Tuxpan (Huerta-Múzquiz 1964:14) Monte Pío, (Sánchez-Rodríguez 1980:349); Blanquilla Reef (Huerta-Múzquiz 1964:14, De la Campa 1965:19; Quintana y Molina 1991:82); Enmedio Island, May-1957, Chávez Barrera (ENCB 1410), 20-May-1963, Ramírez (ENCB 12479); 25-April-1966, De la Campa & Chávez (ENCB 2370), 16-May-1971, Polaco (ENCB 2816), 2-December-1984, Flores (ENCB 11750) (Huerta-Múzquiz 1964:19, De la Campa 1965:19, Lehman & Tunnell 1992:450); Santiaguillo Island (Mendoza-González & Mateo-Cid 1985:15); Verde Island, May-1960, Huerta Múzquiz (ENCB 3053), 25-November-1985, Mendoza González & Mateo Cid (ENCB 7923), 11-February-1992, Zizumbo (IZTA 644) (Mateo-Cid *et al*. 1996:67); Catemaco (De la Campa 1965:19). *Campeche*: Alacranes Reef [Pérez Island] (Huerta-Múzquiz 1961:20), Lerma, 02-April-1966, Vargas (ENCB 2417), 28-December-1973, Aguirre (ENCB 11748), Puerto Real, 10-April-1966, Vargas (ENCB 2753). *Yucatán*: Alacranes Reef [Pérez Island], May-1955, Huerta Múzquiz (ENCB 1411), 10-July-1960, Huerta Múzquiz (ENCB 12244); [Pájaros Island], October-1985, Huerta Múzquiz & Mateo Cid (ENCB 11747), [Desertora Island], 17-July-1960, Huerta Múzquiz (ENCB 804), 24-May-1983, Huerta Múzquiz & Calva (ENCB 11746) (Huerta-Múzquiz 1961:20, Huerta-Múzquiz *et al*. 1987:44); Progreso (Huerta-Múzquiz *et al*. 1987:44). *Quintana Roo*: Cancún (Huerta-Múzquiz *et al*. 1987:45); Mujeres Island, 31-March-1960, Schmitt (US 00050071); 17-March-1972, Garza (UNL 3504), 1-March-1985, Mendoza González & Mateo Cid (ENCB 11731), June-1986, Cevallos (ENCB 11741); 1-September-1984, Mateo Cid & Mendoza González (ENCB 11727) (Mendoza-González & Mateo-Cid 1992:47); Xcalac, 22-December-1972, Huerta Múzquiz (ENCB 12478), 5-May-1972, Huerta Múzquiz (ENCB 12477), Cozumel Island [Colombia Reef] 14-September-1993, Searles & Robles (ENCB 11724), [Palancar Reef], 10-August-1966, Hernández (US 00045356); 16-May-1993, Searles & Volovseck (ENCB 11745), 12-September-1993, Searles &

Robles (ENCB 11740), [Caracol Beach] 02-September-1985, Mendoza González & Mateo Cid (ENCB 11735), (Mateo-Cid & Mendoza-González 1991:70); Puerto Morelos 26-October-1995, Dreckmann (UAMIZ 862) (Huerta-Múzquiz *et al.* 1987:45, Dreckmann *et al*. 1996: 9), Xel-ha, 12-April-1983, Ballantine (US 00014397), Punta Hualapich (Aguilar-Rosas *et al*. 1998:24); Punta Xoquem (Aguilar-Rosas *et al*. 1998:24); Ascensión Bay, 14-April-1960, Bousfield (US 00049991) (Aguilar-Rosas, 1990:25); Cocalito, Ascensión Bay, 13-March-2010, Acosta Calderón (ENCB 20098); Cayo Valencia, 21-June-2010, Mendoza González, Mateo Cid & Acosta (ENCB 20062); Banco Chinchorro [Cayo Norte], 7-May-1972, Huerta Múzquiz (ENCB 12476), (Huerta-Múzquiz & Garza-Barrientos 1980:40); [Cayo Centro], 8-July-1982, Huerta Múzquiz & Flores (ENCB 11732) (Huerta-Múzquiz & Garza-Barrientos 1980:40; Huerta-Múzquiz *et al*. 1987:45); Río Indio, 06-November-2013, Mendoza González, Mateo Cid & García López (ENCB 20065); Xcalac (Huerta-Múzquiz & Garza-Barrientos 1980:40); Chetumal (Huerta-Múzquiz & Garza-Barrientos 1980:40). Habitat: On rocks, in exposed intertidal and tidepool; and in subtidal to 10 m deep.

Amphiroa rigida J.V. Lamouroux 1816:297

Heterotypic Synonimous: *Amphiroa rigida* var. *antillana* Børgesen; 1917: 182
Type Locality: Mediterranean Sea.

Morphology: Thallus irregular and dichotomously branched. The dichotomous branching often occurs in the middle of a joint or at its edge, apex of terminal branches compressed. The joints are solid and maintain their shape. The alga sometimes reaches several centimeters in length, usually 1–3.5 cm. The joints are 0.5 mm to 1 mm wide and double to five times that in length.

Anatomy: Intergenicula terete throughout 0.5–1.2 mm in diameter; variable in length. In longitudinal section, intergenicula showing a prominent medullar region with an alternation of 2–3 long cells (35–80 µm long and 6–15 µm diameter) and one short cell (18–20 µm long and 7–9 µm diameter), the cortical cells (made up 6–8 tiers of cells) are rounded 10–15 µm in breadth and 10–12 µm length; epithallial cells unistratose with oblongs cells 1–3 µm in length and 5–8 µm breadth. Genicula conspicuous, more or less concealed by calcification, of 2 tiers of cells, genicula 150–160 µm long and 375–400 µm in diameter, nearly invisible in the young parts of fronds.

Reproductive structures: Tetrasporangial conceptacles scattered over the erect branches, laterally, projected and rounded, chambers without columella and 150–185 µm diameter and 100–120 µm high, tetrasporangia 20–30 µm breadth and 50–70 µm length, arranged in the floor of the chamber periphery.

Distribution and material examined (Figs. 9–12): MÉXICO: *Veracruz*: Lobos Reef (Huerta-Múzquiz 1964:14 as *A. rigida* var. *antillana*); Tuxpan, 28-March-1966, Garza (UNL 3493); Monte Pío, 19-May-1962, Sánchez (ENCB 12222); Blanquilla Reef (Huerta-Múzquiz 1964:14, as *A. rigida* var. *antillana*) Enmedio Island (De la Campa 1965:19); Verde Island, 26-November-1985, Mendoza González & Martínez (ENCB 7924) (Mateo-Cid *et al*. 1996:67 as *A. rigida* var. *antillana*); Santiaguillo Island, 9-November-1983, Mateo Cid (ENCB 11866) (Mendoza-González & Mateo-Cid 1985 as *A. rigida* var. *antillana*); Sacrificios Island (De la Campa 1965:19, Mendoza-González & Mateo-Cid 1985:15, both as *A. rigida* var. *antillana*). *Yucatán:* Arrecife Alacranes [Pérez Island, 18-July-1960, Huerta Múzquiz (ENCB 3144), 14-October-1985, Huerta Múzquiz & Mateo Cid (ENCB 11865) (Huerta-Múzquiz *et al*. 1987:33 as *A. rigida* var. *antillana*); [Desertora Island], 24-May-1983, Huerta Múzquiz (ENCB 11864). *Quintana Roo*: Contoy Island (Huerta-Múzquiz *et al*. 1987:33 as *A. rigida* var. *antillana*); Cancún (Huerta-Múzquiz *et al*. 1987:33 as *A. rigida* var. *antillana*); Mujeres Island, 27-December-1963, Garza (UNL 3494), 02-June-1985, Mendoza González & Mateo Cid (ENCB 11845); 14-September-1985, Mendoza González & Mateo Cid (ENCB 11844) (Huerta Múzquiz *et al*. 1987:33; Mendoza González & Mateo Cid, 1992:48, both as *A. rigida* var. *antillana*); Puerto Morelos, 13-May-1987, Mendoza González & Mateo Cid (ENCB 11849) (Huerta-Múzquiz *et al*. 1987:33, Dreckmann *et al*. 1996: 9, Collado-Vides *et al*. 1998:138, all as *A. rigida* var. *antillana*); Cozumel Island [Maya Beach], 27-February-1985, Mendoza González & Mateo Cid (ENCB 11860), 7-June-1985, Mateo Cid & Mendoza González (ENCB 11843), [Chen Río], 8-November-1984, Mendoza González & Mateo Cid (ENCB 11859), [Colombia Reef], 19-March-1994, Searles & Robles (ENCB 11853), [Palancar Reef], 12-September-1993, Searles &. Robles (ENCB 11852); [Paraíso Reef], (Huerta-Múzquiz *et al*. 1987:33; Mateo-Cid & Mendoza-González 1991:70 both as *A. rigida* var. *antillana*); Ascensión Bay [Punta Hualapich] (Aguilar-Rosas 1990:25; Aguilar-Rosas *et al*. 1998:24, both as *A. rigida* var. *antillana*); Punta Xoquem, 17-January-2011, Mateo Cid, Mendoza González & Trinidad Calderón (ENCB 20060); Banco Chinchorro [Cayo

Norte], 7-May-1972, Garza (UNL 3496), 02-July-1982, Huerta Múzquiz & Flores (ENCB 11848); [Cayo Lobos], June-1984, Huerta Múzquiz & Mateo Cid, (ENCB 11861) (Huerta-Múzquiz & Garza-Barrientos 1980:40, Huerta-Múzquiz *et al*. 1987:33, both as *A. rigida* var. *antillana*); Xcalac, 5-May-1972, Garza (UNL 3495) (Huerta-Múzquiz & Garza-Barrientos 1980:40, Huerta-Múzquiz *et. al*. 1987:33, all of them as *A. rigida* var. *antillana*); La Herradura, 07-November-2013, Mateo Cid, Mendoza González & García López (ENCB 20064); Chetumal (Huerta-Múzquiz & Garza-Barrientos 1980:40; Huerta-Múzquiz *et al*. 1997:33, all of them as *A. rigida* var. *antillana*).

NOTES: The distribution of *Amphiroa rigida* is widespread, occurring in such diverse areas as the Mediterranean Sea (type locality), in Japan (Segawa 1940), the Gulf of California, Pacific Mexico, Pacific Costa Rica and the Caribbean Sea (Guiry & Guiry 2013). *Amphiroa rigida* shades of pink ranging from gentle to vivid. The alga is characterized by its pink colour and its coral-like shape. They are also elongated and straight, as opposed to the triangular joints.

Amphiroa tribulus (J. Ellis & Solander) J.V. Lamouroux 1816:302.

Basionym: *Corallina tribulus* Ellis & Solander 1786:124
Type locality: West Indies

Morphology: Thalli loosely bushy, 5–6.5 cm high, widely ditrichotomous or irregularly branching or verticillate and 7–12 cm wide; more or less terete throughout, or only short and subterete near of the base, but intermediate and terminal segments flattened, oblong to narrowly cuneate, 2–5 mm broad, apex of terminal branches tapered or rounded, with a more or less distinct midrib at least on one face.

Anatomy: Basal intergenicula terete 500–600 µm in diameter, the segments flattened 2–3.5 mm wide and 480–500 µm thick. In longitudinal section, intergenicula showing a prominent medullar region with an alternation of 3–4 long cells (70–80 µm long and 12–15 µm diameter) and one short cell (17–20 µm long and 8–12 µm diameter), the cortical cells (made up 10–30 tiers of cells) are rounded 6–12 µm in breadth; epithallial cells unistratose with oblongs cells 2–3 µm in length and 6–8 µm breadth. Genicula conspicuous, more or less concealed by calcification, of 7–9 tiers of cells, genicula 800–900 µm long and 800–1500 µm in diameter.

Reproductive structures: Spermatangial conceptacles immersed into the branches, chambers without columella and 350–370 µm diameter and 90–100 µm high, spermatia arranged on the floor of the chamber periphery.

Distribution and material examined (Figs. 13–16): MEXICO: *Yucatán:* Alacranes Reef [Pájaros Island], 25-July-1961, Conover & Perkins (ENCB 10841); [Pérez Island], 27-January-1985, Huerta Múzquiz (ENCB 11830); 28-June-1960, Conover & Perkins (ENCB 10840); (Huerta-Múzquiz 1961:20, Huerta-Múzquiz *et al*. 1987:44); [Desertora Island], 17-July-1960, Huerta-Múzquiz (ENCB 805), 24-May-1983, Huerta-Múzquiz & Calva (ENCB 11823). *Quintana Roo*: Cancún (Huerta-Múzquiz *et al*. 1987:44, Aguilar-Rosas 1990:26); Mujeres Island (Mendoza-González & Mateo-Cid 1992:48); Puerto Morelos, 26-October-1995, Dreckmann (UAMIZ 868) (Dreckmann *et al*. 1996: 9, Collado-Vides *et al*. 1998:138); Cozumel Island [Colombia Reef], 21-March-1994, Searles & Robles (ENCB 12259), 19-May-1993, Searles &Volovseck (ENCB 11827), [Palancar Reef], 22-May-1992, Searles & Robles (ENCB 11819); [Caracol Beach] 7-June-1985, Mendoza González & Mateo Cid (ENCB 11825) (Huerta-Múzquiz *et al.* 1987:44, Mateo-Cid & Mendoza-González 1991:70); Ascensión Bay (Aguilar-Rosas 1990:26); La Herradura, 07-November-2013, Mateo Cid, Mendoza González & García López (ENCB 20061); Banco Chinchorro [Cayo Lobos] 7-June-1987, Jordán (ENCB 11817) (Huerta-Múzquiz *et al*. 1987:44). Habitat: On rocks, in exposed intertidal and tidepool; and in subtidal to 30 m. deep. NOTES: The distribution of *A. tribulus* is restricted to the Caribbean waters of the Yucatan Peninsula and is one of the most easily distinguished by its prominent midline and the whorled branching. In some specimens that grow in the intertidal exposed, the "midline" is restricted to the basal intergeniculas, and the verticilar branching succeeds in these specimens. Male reproductive structures are recorded for first time in the study area.

Amphiroa valonioides Yendo 1902:5

Type Locality: Japan

Morphology: Thalli erect, terete, 5–8 µm high, forming a low spreading tuft, growing on crustose corallines, consisting of many

erects, sparsely branched axes from a spreading , crustose substratum, erect axes 300-350 µm diameter and 4–12 mm length strictly cylindrical, unbranched above or occasionally dichotomously branched, apex of terminal branches rounded to compressed.

Anatomy: Basal intergenicula 250–300 µm in diameter and 2–4 mm long. In longitudinal section, intergenicula showing a prominent medullar region with an alternation of 2 long cells (40–60 µm long and 8–10 µm diameter) and one short cell (15–18 µm long and 6–8 µm diameter), the cortical cells (made up 2–3 tiers of cells) are rounded 4–6 µm in breadth; epithallial cells unistratose with oblongs cells 2 µm in length and 3–5 µm breadth. Genicula inconspicuous, more or less concealed by calcification, of one or two tiers of cells, genicula 110–130 µm long. and 150–160 µm in diameter.

Reproductive structures: Conceptacles scattered over intergenicular surfaces, protruding only slightly, becoming buried are being generated by cortical growth, spermatangial conceptacles 120–150 µm inside diameter, and 70–80 µm high. Carposporangial conceptacles 110–120 µm inside diameter and 40–50 µm high.

Distribution and material examined (Figs. 17-21): MEXICO. *Yucatán*: Alacranes Reef, Pérez Island, 08-03-1989, Huerta Múzquiz & Mateo-Cid (ENCB 20091); *Quintana Roo*: Punta Pelicanos, 17- January-2011, Mendoza González & Mateo Cid (ENCB 20063). Habitat: On rocks, in exposed intertidal.

Amphiroa vanbosseae Me. Lemoine 1929:71

Type Locality: Galapagos Islands

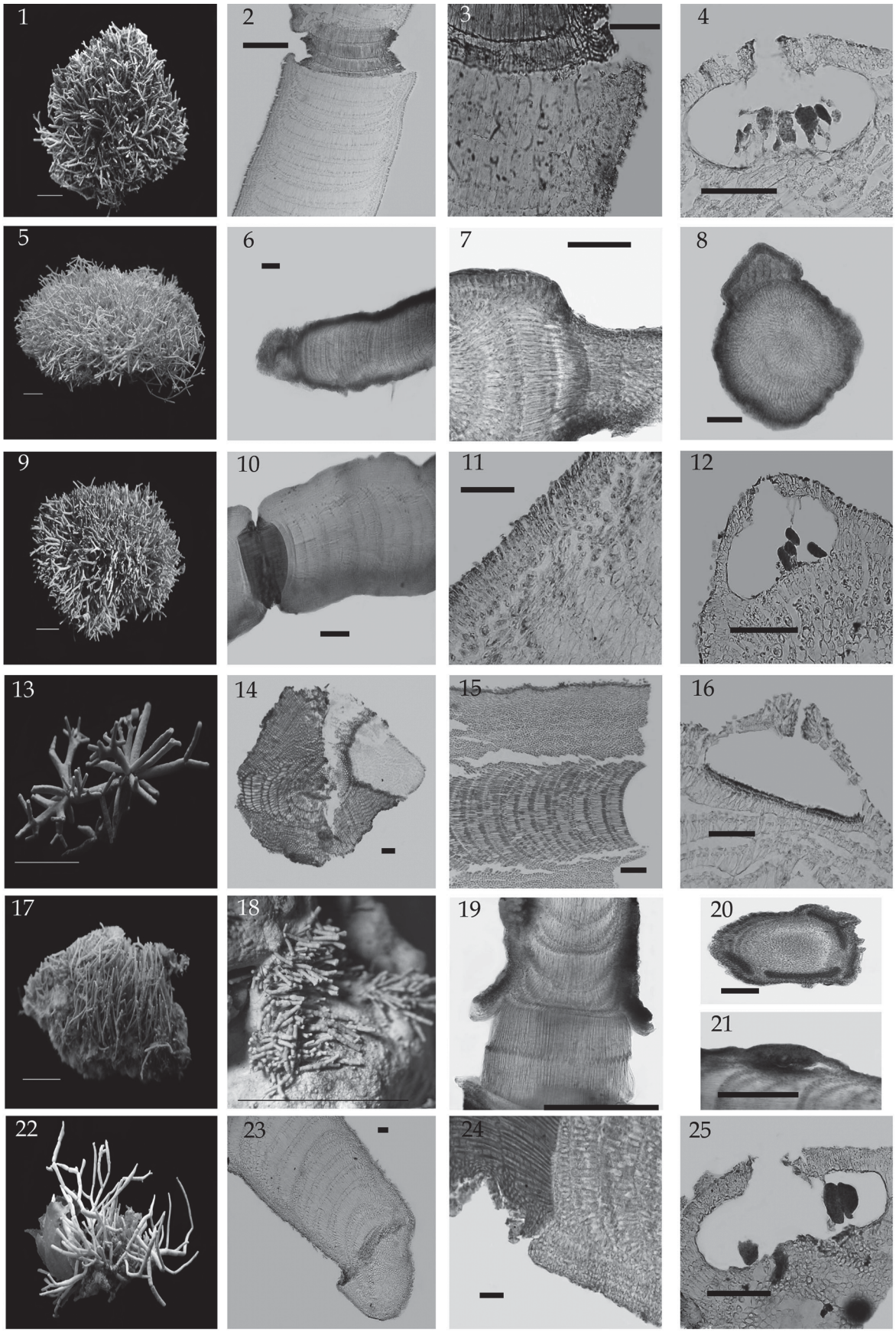
Morphology: Fronds up to 10 cm high, more or less erect, often in clumps. Branching basically dichotomous, often obscure and irregular, apex of terminal branches tapered. Intergenicula terete to subterete, 1–2 mm diameter and variable in length but up to or more than 1 cm long, length difficult to discern because of genicula that are barely visible, thickening with age.

Anatomy: Basal intergenicula 1–2 mm in diameter and 4–12 mm long. In longitudinal section, intergenicula showing a prominent medullar region with an alternation of 2–3 long cells (70–120 µm length and 17–20 µm diameter) and one short cell (15–18 µm long and 6–8 µm diameter), the cortical cells (made by 8–10 tiers of cells) are rounded 17–20 µm in breadth; epithallial cells unistratose with oblongs cells 2–4 µm in length and 7–8 µm breadth. Genicula developing by cracking and sloughing of calcified cortical tissue overlying thin calcified genicula, fully formed genicula usually barely visible between intergenicula near branch apices consisting of 8–10 tiers of medullary cells.

Reproductive structures: Conceptacles scattered over intergenicular surfaces, protruding only slightly, becoming buried are being generated by cortical growth, tetrasporangial conceptacles 250–350 µm inside diameter, and 130–150 µm high; tetrasporangia 80–88 µm length and 60–65 µm breadth. Sexual thalli not encountered.

Distribution and material examined (Figs. 22–25): MEXICO. *Quintana Roo*: Cancún, Huerta Múzquiz, Mendoza González & Mateo Cid (ENCB 20057); Mujeres Island, 1-March-1985, Mateo Cid & Mendoza González (ENCB 8987), Cozumel Island, 8-February-1984, Mendoza González & Mateo Cid (ENCB 8986); Pulticub, 14-04-2012, Mendoza González, Mateo Cid & Acosta Calderón (ENCB 20058). Habitat: On rocks, in exposed intertidal and tidepool; and in subtidal to 4 m. deep.

FIGURES 1–4, *Amphiroa beauvoisii*
1) External morphology; Scale bar 1 cm. 2) Detail of geniculum. 3) Cortical cell shape. 4) Aspect of tetrasporangial conceptacle. Scale bar 100 µm
FIGURES 5–8, *A. fragilissima*
5) External morphology; Scale bar 1 cm. 6) Aspect of corticated geniculum. 7) Feature of cortical cell. 8) Detail of prominent tetrasporangial conceptacle. Scale bar 100 µm.
FIGURES 9–12, *A. rigida*
9) External morphology. Scale bar 1 cm. 10) Old branch showing a geniculum. 11) Arrangement of epithallial and cortical cell. 12) Aspect of tetrasporangial conceptacle. Scale bar 100 µm.
FIGURES 13–16, *A. tribulus*
13) External morphology. Scale bar 1 cm. 14) Section of old branch showing part of geniculum. 15) Detail of epithallial and cortical cell. 16) Male conceptacle showing spermatia at base of chamber. Scale bar 100 µm.
FIGURES 17–21, *A. valonioides*
17) External morphology of female thalli: 18) Morphology of male thalli. Scale bar 1 cm: 19) Old branch showing a geniculum. 20) Male conceptacle. 21) Female conceptacle. Scale bar 100 µm.
FIGURES 22–25, *A. vanbossea*
22) External morphology. Scale bar 1 cm. 23) Section of old branch showing part of geniculum. 24) Arrangement of epithallial and cortical cell.. 25) Tetrasporangial conceptacle. Scale bar 100 µm.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Genus ***Jania*** Lamouroux 1812

The genus *Jania* (Corallinaceae, subfamily Corallinoideae) was described by Lamouroux (1812). It is characterized by possess erect fronds that are primarily dichotomously branched, attached by minute to small crustose holdfast and stolon-like holdfasts. Intergenicula are cylindrical, subcylindrical or compressed, and smooth, winged or lobed. The intergenicula is usually considerably longer than broad, and composed of arching tiers of medullary cell, an outer cortex of pigmented cells, and external single-layer of epithallial cells. Medullary cells in tiers that are all the same height. Cells are without pit-connections. Trichocytes are present, but not always evident. Genicula (joints) uncalcified, and consist of a single tier of long, straight cells (sometimes partially covered by overlapping calcification of intergenicula). Sporangial conceptacles contain up to 12 (–15) tetrasporangia or bisporangia. Conceptacles are solitary and terminals with an apical pore, sometimes the conceptacles give rise to new branches, so they are called antenniferous. Carposporangial conceptacles with narrow fusion cells. Spermatangial conceptacles long and narrow, lanceolate; spermatangia along inner walls of chamber.

In this research six species of *Jania* were found.

Jania adhaerens J.V. Lamouroux, 1816:270

Type locality: "Méditerranée?"

Morphology: Thalli small epiphytic, or on hard surfaces, forming dichotomously branched brittle turfs, usually less than 2 cm tall; attached by a crustose base, and secondarily by creeping, rhizomatous basal segments with lateral discoid holdfasts. Branch apices generally finely modified angles, more often than not less than 30°. Axes are dichotomously branched, mostly in one plane, cylindrical, and sometimes slightly flattened at branch dichotomies; mostly 120–200 µm in diameter and 300–900 in length.

Anatomy: In longitudinal section cells of the medulla 7–11 µm breadth and 50–90 µm length, cortical region typically comprise by 2–3 layers of cells, these of 6–8 µm breadth and 9–10 µm length. Genicula 105–125 (140) µm breadth by (220) 240–312 (330) µm length.

Reproductive structures: Tetrasporangial conceptacles vasiform, in swollen branches, with subapical and lateral antenniferous branches, chambers that are 150–180 µm in diameter and 250–280 µm high. Tetrasporangia are zonately divided, 140–150 µm length and 40–50 µm breadth. Male chambers 170–180 µm in diameter and 280–300 µm length.

Distribution and material examined (Figs. 26–29): MÉXICO. *Veracruz*: Tuxpan, 22-September-1965, Chávez (ENCB 2007), 28-March-1966, Garza (UNL 3563); Playa Paraíso (Sánchez-Rodríguez 1980:349); Verde Island, 25-November-1985, Mateo Cid (ENCB 7927) (Mateo-Cid *et al*. 1996:67). *Campeche*: Lerma, 4-September-1965, Vargas (ENCB 2673); Puerto Real, 10-April-1966, Vargas (ENCB 3011) (Huerta-Múzquiz *et al*. 1987:44); Laguna de Términos, April-1965, Cruz (MEXU 1226) (Ortega 1995:11). *Yucatán*: Chelem, 1-May-1972, Garza. (UNL 3564) (Huerta-Múzquiz *et al*. 1987:44); Progreso, May-1975, Huerta Múzquiz (ENCB 4351) (Huerta-Múzquiz *et al*. 1987:44); Alacranes Reef (Huerta-Múzquiz *et al*. 1987:44). *Quintana Roo*: Contoy Island (Huerta-Múzquiz *et al*. 1987:44), Puerto Morelos, 20-March-1970, Huerta Múzquiz (ENCB 3954) (Huerta-Múzquiz *et al*. 1987:44, Aguilar-Rosas M., 1990:26, Dreckmann *et al*. 1996: 9, Collado-Vides *et al*. 1998:13); Cancún (Huerta-Múzquiz *et al*. 1987:44); Laguna Nichupté, 8-October-1983, Mendoza-González & Mateo Cid (ENCB 12038); Mujeres Island, 28-May-1975, Garza (UNL 3559) (Huerta-Múzquiz *et al*. 1985:44, Aguilar-Rosas M. 1990:26), 13-September-1985, Mendoza González & Mateo Cid (ENCB 12036) (Mendoza-González & Mateo-Cid 1992:48); (Playa Los Cocos) 11-June-1985, Mateo Cid & Mendoza González (ENCB 6882) (Mendoza-González & Mateo-Cid 1992:48); (Manchones Reef), 14-August-1997, Searles (ENCB 15762); Xcalac (Aguilar-Rosas, M., 1990:26); Cozumel Island, 9-June-1984, Mendoza González & Mateo Cid (ENCB 12039) (Aguilar-Rosas, M. 1990:26; Huerta-Múzquiz *et al*. 1985:44); 25-February-1985, Mateo Cid & Mendoza González (ENCB 6885) (Mateo-Cid & Mendoza-González 1992:70 (Punta Morena), 7-June-1985, Mendoza González & Mateo Cid (ENCB 12033) (Mateo-Cid y Mendoza-González 1992:70); (Paraíso Reef), 18-March-1994, Searles & Robles (ENCB 12029); Punta Hualapich, Xoquem and Yamach (Ascensión Bay) (Aguilar-Rosas M. 1990:26, Aguilar-Rosas M. *et al*. 1998:24); Banco Chinchorro (Huerta-Múzquiz & Garza-Barrientos 1980:40); Chetumal (Huerta-Múzquiz *et al*. 1985:44). Habitat: Epilithic and in tide pools; intertidal to shallow subtidal.

Jania capillacea Harvey 1853:84

Type locality: Bahia Honda Key (Bahia Honda State Park), Florida Keys, Florida.

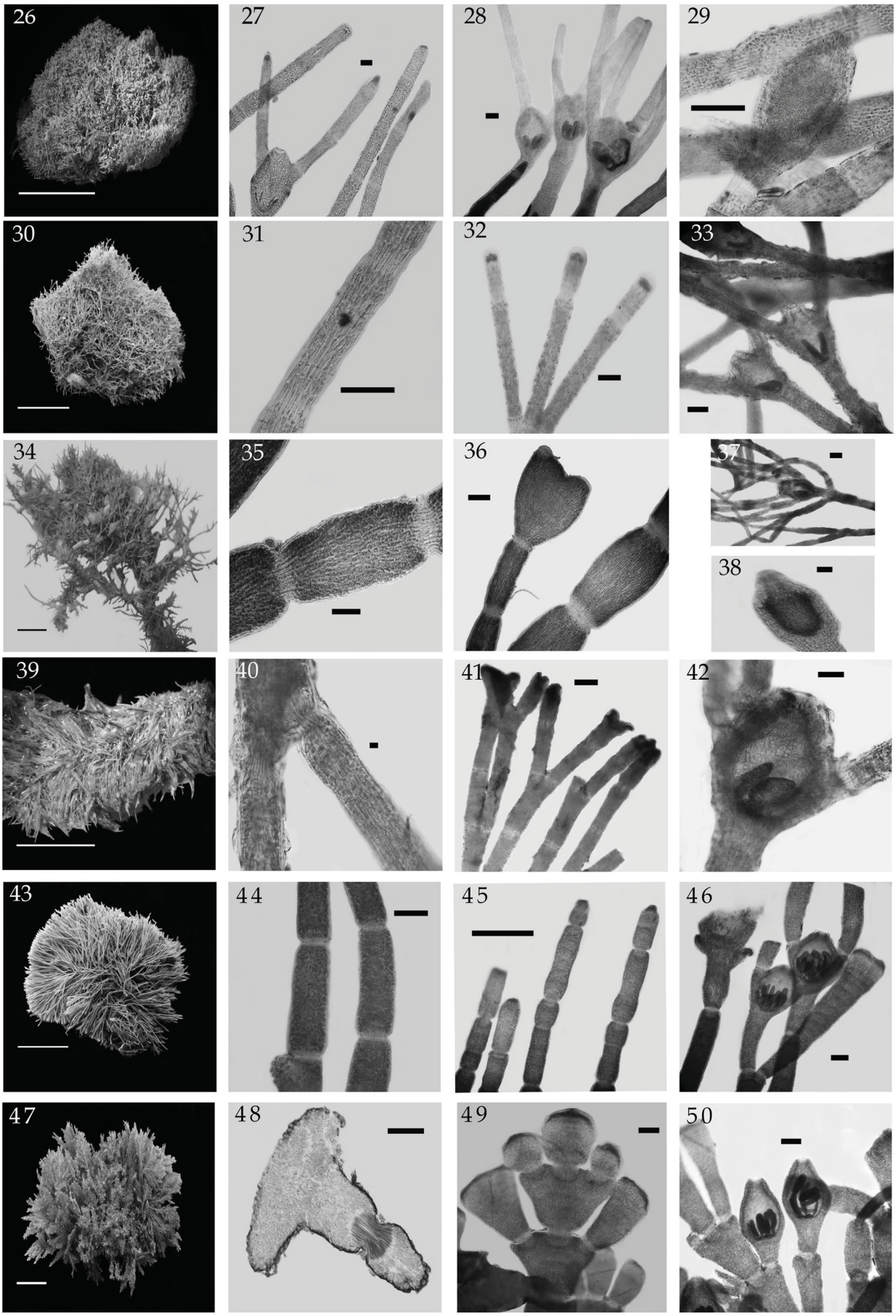
Morphology: Thalli minute tufts, 1.0–1.3 cm tall; branching dichotomously or sometimes more or less decussate; branch angles very wide, 60°–90°; attached by a disc. Intergenicula (segments) cylindrical, 80-90 µm in diameter, ultimate branches usually 50–60 µm in diameter and 400–800 µm in length.

Anatomy: In longitudinal section cells of the medulla 7–9 µm breadth and 25–50 µm length, cortical region composed by 1–2 layers of cells, these of 6–9 µm breadth and 7–9 µm length. Genicula 50–70 µm breadth and 50–85 µm length.

Reproductive structures: Tetrasporangial conceptacles, ovoid-shaped, on swollen tips of branches and occur terminally between 2 long antenna-like branches, about 300 µm wide, chambers measure 200–250 µm in diameter by 350–380 µm length. Tetrasporangia are zonately divided, 140–150 µm length and 40–45 µm breadth. Gametangial thallus not found.

Distribution and material examined (Figs. 30–33): MEXICO. *Tamaulipas:* Soto La Marina (Martínez-Lozano & López-Bautista 1991:18). *Veracruz*: Tuxpan, 1-January-1967, Garza (UNL 3555); Punta Limón, 5-May-1976, Chávez (ENCB 4295); Verde Island, May-1960, Huerta Múzquiz (ENCB 1714). *Campeche*: Lerma, 1-September-1965, Vargas (ENCB 3009); Puerto Real, 4-September-1965, Vargas (ENC 2668). *Yucatán*: Alacranes Reef (Cayo Arcas, Cayo Arenas & Triángulo Oeste) (Huerta-Múzquiz *et al*. 1985:44); Progreso, 26-May-1975; Sánchez (ENCB 7966) (Huerta-Múzquiz *et al*. 1985:44); Yucaltepen, 2-June-1987, Huerta Múzquiz & Mendoza González (ENCB 12094). *Quintana Roo*: Contoy Island, 14-December-1972, Garza (UNL 3587) (Garza-Barrientos 1975:23); Puerto Morelos (Garza-Barrientos 1975:23); Laguna Nichupté, 8-October-1983, Huerta Múzquiz & Mendoza González (ENCB 10253); Mujeres Island, 30-March-1960, Schmitt & Rehder (US 00050015); 26-December-1964, Garza (UNL 2660); 26-October-1965, De La Chica (ENCB 2660) (Huerta-Múzquiz *et al*. 1985:44); (Extremo Norte), 1-November-1984, Mendoza González & Mateo Cid (ENCB 12090); Cozumel Island, 22-April-1960, Bousfield (US 00050017), 20-December-1968, Castillo (UNL 3552) (Huerta-Múzquiz *et al*. 1985:44); (Caletilla), 20-December-1968, Garza (UNL 3596); (Santa Rosa Reef), 20-March-1994, R.B. Searles y M. Volovseck (ENCB 12027); (Chen Río), 11-November-1985, Mendoza González & Mateo Cid (ENCB 12088); Xcalac, 5-May-1972, Garza (UNL 3576) (Garza-Barrientos 1975:23; Huerta-Múzquiz & Garza-Barrientos 1980:40); Ascensión Bay, 14-April-1960, Bousfield (US 00050009); Cocalito, 13-February-2009, Acosta Calderón (ENCB 20066); Punta Xoquem, 17-04-2012, Mendoza González, García López & Mateo Cid (ENCB 20069); Chinchorro Reef (Cayo Lobos), 6-June-1972, Garza (UNL 3587), (Cayo Centro), 9-July-1982, Huerta Múzquiz & Flores (ENCB 4661) (Huerta-Múzquiz & Garza-Barrientos 1980:40, Huerta-Múzquiz *et al*. 1985:44); Chetumal (Huerta-Múzquiz & Garza-Barrientos 1980:40, Huerta-Múzquiz *et al*. 1985:44). Habitat: usually growing among other turf-algae, sometimes on rocks or epizoic on sponges; intertidal.

FIGURES 26–29, *Jania adhaerens*
26) External morphology. Scale bar 1 cm: 27) Detail of intergenicula: 28) Apical branches: 29) Detail of tetrasporangial conceptacle. Scale bar 100 µm.
FIGURES 30–33, *J. capillacea*
30) External morphology. Scale bar 1 cm. 31) Surface view of intergeniculum. 32) Branched apexes. 33) Detail of tetrasporangial conceptacle. Scale bar 100 µm.
FIGURES 34–38, *J. cubensis*
34) External morphology. Scale bar 1 cm: 35) Surface view of intergenicula: 36) Branched apexes. 37) Detail of tetrasporangial conceptacle: 38) Detail of male conceptacle. Scale bar 100 µm.
FIGURES 39–42, *J. pumila*
39) External morphology. Scale bar 1 cm. 40) Surface view of intergenicula. 41) Branched apexes. 42) Detail of tetrasporangial conceptacle. 38) Detail of male structure. Scale bar 100 µm.
FIGURES 43–46, *J. rubens*
43) External morphology. Scale bar 1 cm. 44) Detail of the surface of intergenicula. 45) Branched apexes. 46) Detail of tetrasporangial conceptacle. Scale bar 100 µm.
FIGURES 47–50, *J. subulata*
47) External morphology. Scale bar 1 cm. 48) Surface view of intergenicula. 49) Branched apexes. 50) Detail of tetrasporangial conceptacle. Scale bar 100 µm.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Jania cubensis Montagne ex Kützing 1849:709

Homotypic Synonimous: *Corallina cubensis* (Montagne ex Kützing) Kützing 1858:37.
Haliptilon cubense (Montagne ex Kützing) Garbary & Johansen 1982:218.
Type Locality: Cuba

Morphology: Thalli tufted; densely crowded (0.5) 1.0–2.5 (3.0) cm high, the slender main axes irregularly and often oppositely branched, at the upper ends of the segments irregularly pinnate, usually opposite, sometimes verticillate branchlets.

Anatomy: Basal intergenicula terete (135) 150–260 (300) µm in diameter and (150) 200–575 (650) µm long. In longitudinal section cells of the medulla 5–7 µm breadth and 25–40 µm length, cortical region composed by 1–2 layers of cells, these of 7.0–10.5 (11.5) µm breadth and (20) 21–30 (32) µm length. Genicula 60–65 µm breadth and 55–60 µm length.

Reproductive structures: Tetrasporangial conceptacles, ovoid-shaped, on swollen tips of branches and occur terminally between 3–4 long antenniferous branches, about 240–310 (350) µm wide, chambers measure 200–250 µm in diameter by 300–420 (450) µm length. Tetrasporangia are zonately divided, (90) 95–122 (130) µm length and (26) 30–50 (55) µm breadth. Spermatangial (male) conceptacles not antenniferous, chambers 210–270 (300) µm in diameter, spermatia developed on the walls and floor of conceptacle.

Distribution and material examined (Figs. 34–38): MÉXICO: *Tamaulipas*: La Pesca, Soto La Marina, 9-May-1996, Galicia & Tejeda-Hernández (ENCB 12457) (Martínez-Lozano & López-Bautista 1991:18, as *Corallina cubensis*); San Fernando (Martínez-Lozano & Villarreal-Rivera 1991:10); El Mezquital (Matamoros) (Martínez-Lozano & Guajardo-Ríos 1991:22). *Veracruz:* Tuxpan, 7-June-1964, Tovar (ENCB 12458); 11-June-1985, Huerta Múzquiz & Mateo Cid (ENCB 12014); 27-May-1986, Rojas Rosas (ENCB 15737) (De la Campa 1965:18, as *Corallina cubensis,* De Lara-Isassi & Álvarez-Hernández 1998:70); Villa Rica, 21-February-1986, Labia (IZTA 35), Monte Pío, May-1956, Aguilar (ENCB 12456), 19-March-1965, Sánchez (ENCB 622) (Sánchez-Rodríguez 1980:349, as *Corallina cubensis*); Mocambo Beach, May-1958, Huerta Múzquiz & Chávez Barrera (ENCB 1850); Sacrificios Island (Huerta-Múzquiz 1962:43, as *Corallina cubensis*); Enmedio Island (Huerta-Múzquiz 1962:43, as *Corallina cubensis*); Verde Island (Huerta-Múzquiz 1962:43, as *Corallina cubensis*). *Yucatán:* Cayo Arcas (Huerta Múzquiz *et al*. 1987:44, as *Corallina cubensis*); Desertora Island, 15-October-1985, Huerta Múzquiz & Mateo Cid (ENCB 12011); Pérez Island, 27-January-1985, Huerta Múzquiz & Mateo Cid (ENCB 12012); Progreso, 11-January-1982, Huerta Múzquiz & Mendoza González (ENCB 12008); Yucaltepen, 2-June-1987, Huerta Múzquiz & Mendoza González (ENCB 12009); Río Lagartos, 2-June-1987, Huerta Múzquiz & Mendoza González (ENCB 12010). *Quintana Roo*: Puerto Morelos (Dreckmann *et al*. 1996:9, Collado-Vides *et al*. 1998: 139, as *Haliptilon cubense*); Isla Cancún (Huerta Múzquiz *et al*. 1987:45); Mujeres Island, 28-May-1975, Garza (UNL 3484); (Punta Este), 12-June-1985, Mateo Cid & Mendoza González (ENCB 6891); (Extremo Norte) 13-August-1998, Mendoza González (ENCB 15735) (Huerta Múzquiz *et al*. 1987:45, Mendoza González & Mateo-Cid, 1992:48); Cozumel Island, (Playa Santa Pilar), 10-August-1966, Huerta-Múzquiz & Garza (ENCB 15734), (Caracol Beach), 7-June-1985, Mendoza González & Mateo Cid (ENCB 12003); (Chen Río), 27-February-1985, Mendoza González & Mateo Cid (ENCB 12002); (Huerta-Múzquiz *et al*. 1987:45, Aguilar-Rosas M. 1990:26, Mateo-Cid & Mendoza-González 1991:70); Ascensión Bay (Aguilar-Rosas M. 1990:26, Aguilar-Rosas M. *et al*. 1998:24); Akumal, Xcacel, Chac-Mool (Aguilar-Rosas M. 1990:26, Xcalac (Huerta-Múzquiz *et al.* 1987:45); Banco Chinchorro (Huerta-Múzquiz *et al.* 1987:45, Aguilar-Rosas M. 1990:26). Habitat: Usually growing among other turf-algae, on rocks or epizoic on mollusks; intertidal.

Jania pumila J.V. Lamouroux 1816: 269

Homotypic Synonimous: *Corallina pumila* (J.V. Lamouroux) Kützing 1858: 39
Type Locality: Mer Rouge; West Indies
Morphology: Thalli very small, 3–7 µm tall, decumbent and forming extended cushions; are branching usually dichotomously dividing 2–3 times.

Anatomy: Intergenicula subterete, segments 70–80 µm in diameter and 200–230 µm long. In longitudinal section cells of the medulla 5–7 µm breadth and 25–40 µm length, cortical region composed by 1 layer of cells, these of 6.0–10 µm breadth and 11–15 µm length. In superficial view epithallial cells 7–9 µm breadth and 20–25 µm length.

Genicula 45–50 µm breadth and 55–60 µm length.

Reproductive structures: Tetrasporangial conceptacles in cuneate segments, ovoid-shaped, on tips of branches and occur terminally between 2 long antenna-like branches, about 170–190 µm wide, chambers measure 140–150 µm in diameter by 250–270 µm length. Tetrasporangia are zonately divided, 90–100 µm length and 30–40 µm breadth. Spermatangial (male) conceptacles not antenniferous, chambers 75–80 µm in diameter and 180–200 µm length, spermatia developed on the walls and floor of conceptacle.

Distribution and material examined (Figs. 39-42): MEXICO. *Quintana Roo*: Puerto Morelos (Dreckmann *et al.* 1996: 9); Cancún, 02-October-1983, Huerta Múzquiz, Mendoza González & Mateo Cid (ENCB 20070); Mujeres Island (Huerta-Múzquiz *et al*. 1987: 44-45); Cozumel Island, Santa Pilar Beach, 23-March-1970, Huerta Múzquiz (ENCB 20071); (Isla de La Pasión) 15-December-1972, Huerta Múzquiz (ENCB 3151); Chinchorro Bank (Huerta-Múzquiz & Garza 1980:40, Huerta-Múzquiz *et al*. 1987: 44-45). Habitat: usually growing among other turf-algae, intertidal.

Jania rubens (Linnaeus) J.V. Lamouroux 1816:272.

Basionym: *Corallina rubens* Linnaeus 1758:806
Type Locality: Europe

Morphology: Thalli tufted, erect, rose red, attached by small discoid holdfast, the height (2.0) 2.5–4.0 (5.0) cm, branching dichotomous and habit corymbose, the branching tips acute.

Anatomy: Basal intergenicula terete of (125) 156–200 (210) µm in diameter and (0.72) 0.8–1.8 (2.4) mm long; apical branches (120) 122–142 (150) µm in diameter. In longitudinal section cells of the medulla (9) 10–12 (14) µm breadth and (80) 90–146 (156) µm length, cortical region composed by 1–3 layers of cells, these of (6.0) 7.5–12 (13) µm breadth. Genicula 150-180 µm breadth and (80) 90–168 (175) µm length.

Reproductive structures: Tetrasporangial conceptacles, vessel-shaped, on swollen tips of branches and occur terminally between 2 long antenna-like branches, about 310–350 µm wide, chambers measure (240) 280–300 µm in diameter by (180) 190–210 (350) µm length. Tetrasporangia are zonately divided 130–150 µm length and (45) 50–70 µm breadth.

Distribution and material examined (Figs. 43–46): MÉXICO. *Tamaulipas*: Altamira (Martínez-Lozano *et al*. 1992:32). *Veracruz*: Lechuguillas Beach, 17-August-2013, Mendoza González, Mateo Cid & García López (ENCB 20099); Playa El Morro, Punta Delgada and Laguna Verde (Sánchez-Rodríguez 1980:349); Villa Rica, 25-July-1974, Ramírez (ENCB 4486), 10-September-1998, Mendoza González (ENCB 15755) (Sánchez-Rodríguez 1980:349); Playa Paraíso (Sánchez-Rodríguez 1980:349); Monte Pío, 19-May-1962, Sánchez (ENCB 609) (Sánchez-Rodríguez 1980:349); Playa Hermosa, 3-September-1984, Blanco & De Gante (ENCB 12084); Verde Island, May-1960, Huerta Múzquiz (ENCB 1715); Enmedio Island, (De La Campa 1965:19). *Campeche*. Puerto Real, 24-May-1965, Villamar & Guzmán del Proo (ENCB 2369); 10-April-1966, Vargas (ENCB 2752). *Yucatán*: Alacranes Reef (Isla Pérez) (Huerta-Múzquiz 1961:20). *Quintana Roo*: Puerto Morelos, 16-November-1984, Mendoza González & Mateo Cid (ENCB 12081); Cancún (Huerta-Múzquiz *et al*. 1987:45; Mujeres Island (Playa Los Cocos), 5-June-1985, Mendoza González & Mateo Cid (ENCB 120789 (Huerta-Múzquiz *et al*. 1987:45); Cozumel Island, (Playa San Juan, 7-September-1985, Mateo Cid & Mendoza González (ENCB 12079); (Chen Río), 8-November-1984, Mendoza González & Mateo Cid (ENCB 12082) (Mateo-Cid & Mendoza-González 1991:70); Punta Hualapich and Punta Xoquem (Aguilar-Rosas M. *et al*. 1998:24); Banco Chinchorro (Huerta-Múzquiz *et al*. 1985:45). Habitat: usually growing on rocks or epizoic; intertidal.

Jania subulata (J. Ellis *et* Solander) Sonder 1848: 186

Basionym: *Corallina subulata* Ellis & Solander 1786:119–120
Homotypic Synonimous: *Haliptilon subulatum* (Ellis & Solander) Johansen 1970:79 (*subulata*).
Type Locality: West Indies

Morphology: Thalli terete bushy, (1.0) 1.5–4.0 (5.0) cm high, the main axes dichotomously branched, the divisions conspicuosly flat, plumose, branching pinnate, the width of the each blade 1–3 µm. Terminal branchlets cylindrical, sometimes flagelliform of (48) 72–96 (105) µm diameter and (180) 190–280 (300) µm in length

Anatomy: Basal intergenicula (360) 420–450 (470) µm wide and (280) 300–380 (420) µm long, apical intergenicula 300–380 (400) µm long and 360–480 (510) µm wide. In longitudinal section cells of the medulla 9–12

(14) µm breadth and (35) 40–55 (60) µm length, cortical region composed by 1 layers of cells, these of (10) 12–15 (17) µm breadth and (12) 14–18 (21) µm length. Genicula (80) 105–125 (140) µm breadth and (70) 80–100 (150) µm length.

Reproductive structures: Tetrasporangial conceptacles, ovate-shaped, on swollen tips of branches and occur terminally between 2 long antenniferous branches, about 300–350 µm wide, chambers measure (220) 240–270 µm in diameter by (300) 330–360 (380) µm length. Tetrasporangia are zonately divided (130) 135–145 (160) µm length and (30) 33–36 (40) µm breadth. Spermatangial (male) conceptacles not antenniferous, chambers 50–60 µm in diameter and 280–300 µm length, spermatia developed on the walls and floor of conceptacle.

Distribution and material examined (Figs. 47-50): MÉXICO. *Tamaulipas*: Ciudad Madero, 1-October-1977, Garza (UNL 3535). *Veracruz*: Tuxpan, 16-December-1964, Chávez (ENCB 2434); 6-June-1986, Pierdant (ENCB 12023); Playa Los Muñecos, 26-October-2013, Mendoza González & Mateo Cid (ENCB 20088); Villa Rica 1-October-1973, Ramírez (ENCB 4905), 9-February-1974, Ramírez (ENCB 4908); 19-August-1974, Sánchez (ENCB 3837) (Sánchez-Rodríguez 1980:349); Playa Boca Andrea (Sánchez-Rodríguez 1980:349); Playa Hermosa, 05-May-2013, Mendoza González, Mateo Cid & Cano Hernández (ENCB 20100); Playa Escondida, 5-September-1984, Sánchez & Valenzuela (ENCB 12460); 26-April-1985, Sánchez & Chávez (ENCB 7950); Playa Hermosa 3-September-1984, Blanco & De Gante (ENCB 5654); Punta Órgano, 3-September-1984, Valenzuela & Carmona (ENCB 5635). *Quintana Roo*: Puerto Morelos (Aguilar-Rosas M. 1990:26, Dreckmann *et al*. 1996: 9, Collado-Vides *et al.* 1998:139 all as *Haliptilon subulatum*); Punta Estrella and Xcacel (Aguilar-Rosas M. 1990:26, Aguilar-Rosas M. *et al*. 1998:24). Habitat: usually growing among other turf-algae, sometimes on rocks or epizoic on sponges; intertidal to 3 m deep.

Discussion

Amphiroa

This is a large genus widespread in tropical and subtropical regions, the total numbers of described species of this genus are considered from 40–50 (Guiry & Guiry 2014). *Amphiroa* includes species are common in the Coral Reef of Mexican Caribbean, especially in the intertidal and subtidal. In the present study, a combination of vegetative morphological and anatomical characters was found as stable and reliable in species segregation within the genus *Amphiroa* in the Atlantic coast of México. In *Amphiroa* we may be namely: (1) shape of the intergenicula; (2) branching type; (3) shape of apical intergenicula; (4) number of genicular tiers in mature genicula; and (5) pattern of long vs. short intergenicular tiers of cells (Table 1). The consistency of the shape of the thallus and the pattern of long vs. short intergenicular tiers of cells were previously considered important characters to segregate species within this genus (Norris & Johansen 1981, Riosmena-Rodríguez & Siqueiros-Beltrones 1996). The pattern of long vs. short intergenicular tiers of cells had been already cited by Riosmena-Rodríguez & Siqueiros-Beltrones (1996) as a possible discriminating aspect, in the present study this character was reliable for species segregation and constant for all species found in our study. In the other hand, the taxonomic potential of the number of cell tiers per mature geniculum was previously noted by Riosmena-Rodríguez & Siqueiros-Beltrones (1996) for thallus from the Gulf of California, and our results are consistent those presented by this authors. Based on the combination of the five specific characters, *A. beauvoisii, A. fragilissima, A. rigida, A. tribulus, A. valonioides and A. vanbosseae were confirmed* to occur in the Atlantic coast of Mexico. In general, the range of values for vegetative characters of Mexican specimens overlap those recorded for plants from other locations as Australia, Gulf of California and Azores (Rosas-Alquicira *et al*. 2011). Furthermore, the morphology of *A. valonioides and A. vanbossea* from Mexican Caribbean agreed with the description in Riosmena-Rodríguez & Siqueiros-Beltrones (1996) for the Gulf of California.

The present study confirmed the diagnostic importance of the position of the tetrasporangial conceptacle as well the diameter of the chamber in order to distinguish species. Rosas-Alquicira *et al*. (2013) described the development of sporangial and gametangial conceptacles for *Amphiroa,* and they found four development patterns: two for sporangial conceptacles; one for spermatangial conceptacles; and one for carposporangial conceptacles. These authors concluded that the sporangial pore canal anatomy has diagnostic importance in distinguishing between species within the subfamily Lithophylloideae, namely in *Lithophyllum* and *Amphiroa*. The type of sporangial pore canal anatomy reported in this study for *Amphiroa beauvoisii and A. rigida* was also previously reported by Choi (1997: 163, fig. 3C) and Rosas-Alquicira *et al*. (2013: 702, fig. 14).

Table 1. Morphological and reproductive characters used to determine *Amphiroa* species in the Mexican Atlantic

Character			Species					
			A. beauvoisii	***A. fragilissima***	***A. rigida***	***A. tribulus***	***A. valonioides***	***A. vanbosseae***
Vegetative								
		Diameter (µm)	600-800	300-350	500-1200	480-500	250-300	1000-2000
		Shape in cross section	terete-subterete	terete	terete	flattened	terete to compressed	terete to subterete
		Apex	tapered compressed - spatulate	rounded	compressed	tapered rounded	compressed	tapered rounded
Intergenicula		**Branching**	dichotomous to irregular	dichotomous-trichotomous	irregular and dichotomous	ditrichotomous, irregular, verticillate	Unbranched or dichotomous	dichotomous, Irregular
		No. of tiers of medullar cells	3-5	5-7	2	20-40	1-2	5-10
		Long /diameter of long cells (µm)	36-77/9-12	30-40/6-10	35-80/6-15	70-80/12-15	40-60/8-10	70-120/17-20
		Alternation of long/short rows	2-5/1	1-2/1	2-3/1	3-4/1	2/1	2-3/1
		No. cortical cells	4-6	3-5	6-8	10-30	2-3	8-10
		Breadth of cortical cells (µm)	4-7	5-8	10-15	6-12	4-6	17-20
Genicula		**Number of tiers**	3-5	2	2	7-8	1-2	8-10
		Cortication	present	present	present or ausent	present	ausent	ausent
Reproductive								
Conceptacles	**Tetrasporic**	**Form**	projected, rounded or apiculate	projected, rounded chambers	projected, rounded chambers	NA	NA	NA
		Diameter	240-260	240-250	150-185		NA	250-350
	Male	**Form**	NA	NA	NA	Inmersed	NA	NA
		Diameter				350-370	120-150	NA
	Female	**Form**	NA	NA	NA	NA	NA	NA
		Diameter					110-120	NA

Table 2 Morphological and reproductive characters used to determine *Jania* species in the Mexican Atlantic

Character		Species					
Vegetative		***J. adhaerens***	***J. capillacea***	***J. cubensis***	***J. pumila***	***J. rubens***	***J. subulata***
Intergenicula	**Shape**	cylindrical, sligthly compressed	terete	terete	subterete	terete	terete to flattened
	Diameter/length(µm)	120-200/300-900	80-90/400-800	150-260/200-575	70-80/200-300	156-200/800-1800	360-480/300-380
	Branching	dichotomous	dichotomous, decussate	oposite, pinnate, verticillate	dichotomous	dichotomous	Dichotomous and pinnate
	Large/wide ratio	2.5-4.5	5-8	1-2	2-4	5-9	0.5-0.8
Reproductive							
Tetrasporangial Conceptacle	**Form**	vasiform	ovoid	ovoid	ovoid	vessel	ovate
	Diameter(µm)	150-180	200-250	200-250	140-150	280-230	240-270

Jania

The genus *Jania* is widely distributed in tropical and sub- tropical waters of the planet. The total number of described species of this genus is controversial, are considered from 20 – 70 (Johansen 1981). According to Johansen & Womersley (1994), many species need to be reexamined due to inappropriate diagnosis or nomenclatural problems. During the analysis of articulate coralline *Jania* from the shores of the Atlantic coast of Mexico was verified the presence of six taxa. In our study we found species of *Jania* may be distinguished for vegetative morphological, anatomical and reproductive characters, four of them are: 1) Shape of intergenicula; 2) Large/wide radio of intergenicula 3) Type of branching; and 4) Shape and diameter of sporangial conceptacles. Morphological characters as shape of intergenicula, type of branching and large/wide ratio of intergenicula can be used to distinguish among *J. adhaerens, J. capillacea, J. cubensis, J. pumila, J. rubens* and *J. subulata* (Table 2). In the case of *Jania subulata*, there is a notorious pinnate branching and compressed intergenicula; while J. *rubens* has a dichotomous branching and terete intergenicula. Broadly, the range of values for vegetative characters of Mexican specimens of *Jania* overlap those recorded for plants from other locations as Australia, Gulf of California and Pacific coast of Mexico (Dawson 1953, Johansen & Womersley 1994, Mateo-Cid *et al*. 2013). Furthermore, the morphology of *J. pumila* from Mexican Caribbean agreed with the description in Taylor (1960) and Littler & Littler (2000) for Caribbean islands and Brazil.

The present study confirmed the diagnostic importance of the shape of the tetrasporangial conceptacle as well the diameter of the chamber in order to distinguish species. Most fertile specimens of *Jania* from Atlantic coast of Mexico are tetrasporangial; all asexual conceptacles examined contained tetrasporangium, all species may be distinctive in shape and size of tetrasporangial conceptacle (Table 2). Johansen & Womersley (1994) characterized the Australian species of *Jania* by type of branching, shape and large/wide radio of intergenicula and the size and shape of the tetrasporangial conceptacle. Considered this precedent we can point out the morphological and reproductive characters used in our study are reliable for segregating species within genus *Jania*.

Diversity and distribution

Based on the presented of perennial populations of *Amphiroa,* its distribution along the Atlantic coast of Mexico, was determined to extend from Lobos Island, Veracruz to La Herradura, Quintana Roo; while, *Jania* has a wide distribution since Soto La Marina, Tamaulipas to Chetumal, Quintana Roo. Genera from tropical environments, such as *Amphiroa* and *Jania*, present a wide distribution and successful growth in subtropical or transitional zones using morphological and seasonal strategies. This supports the strict ratio proposed between the biogeographic patterns tendencies within the order Corallinales (Steneck 1986, Woelkerling 1991). The same has been observed in the northeast coast of Mexico where the distribution of the species of the genus *Amphiroa* is restricted to the west coast of the Baja California Peninsula. Three species of *Amphiroa*: *A. beauvoisii, A. fragilissima* and *A. rigida* have a wide distribution. *A. tribulus* is distributed in Atlantic coast of America, Africa, Asia and Fiji. *Amphiroa valonioides* was described originally for Japan by Yendo (1902), and is recorded in Galapagos Islands, North America, Hawaii and Asia. In the case of *A. vanbossea* it was described for Galapagos Islands and it has been recorded for Portugal, Spain, Brazil and Mauritania. *Jania adhaerens, J. capillacea, J. pumila* and *J. rubens* not only occur in the Atlantic coast of Mexico; also, have been recorded in the Mediterranean, Indian Ocean, eastward to the Pacific coast of Australia, Gulf of California, South America, Africa, Europe and Asia. Suggesting that species are widely distributed; in contrast, *J. cubensis* and *J. subulata* have a restricted distribution.

The number of species of articulated coralline found in this study is less than found in the Pacific coast of Mexico where Dawson (1953), Riosmena-Rodriguez & Siqueiros-Beltrones (1996) and Mateo-Cid *et al*. (2013) recorded 33 taxa. In the Macaronesian region Rosas-Alquicira *et al*. (2011) reported 31 species of articulated coralline. In contrast, there are only eight species in the Mediterranean Sea and nine in New Zealand (Guiry & Guiry 2014).

The common distribution of articulated coralline algae in the study area might suggest that these genera play an important role in Coral reefs and intertidal coast. Williams *et al*. (2008) mentioned that Coralline algae are commonly reported inductive cues for marine invertebrate settlement and metamorphosis. Corallines or their associated biofilm have been demonstrated to induce settlement in the larvae of echinoderms and scleractinian corals. Because of their ability to induce settlement, metamorphosis, or both, of larvae, coralline algae play a crucial role in the life cycle of diverse pelagobenthic marine invertebrates. The specificity and location of this cue

in the benthic environment determines where larvae can settle and thus can significantly influence population structure. In the tropical abalone *Haliotis asinina*, competent larvae settle and metamorphose in response to articulated *Amphiroa* spp. significantly more than to crustose species, articulated *Amphiroa* spp. were the best inducers of *H. asinina* larvae, with in some cases an astonishing 100% of larvae metamorphosing by 48 h postinduction (Williams *et al.* 2008). In this sense, these data suggest the importance of these organisms in the marine environment, which indicates that it is necessary to conduct studies to understand the ecological role of *Amphiroa* and *Jania* on the Mexican Coral Reefs.

Conclusions

Six species of *Amphiroa* and six of *Jania* were located in the study area; our morphological and reproductive data indicate that the species of *Amphiroa* and *Jania* could be delineated by the branching pattern of the main axes, intergenicular shape, large/wide radio of intergenicula, number of genicular tiers in mature genicula; pattern of long vs. short intergenicular tiers of cells and tetrasporangial conceptacle shape. *A. valonioides* is a new record in this region. However, the morphological variability of *Amphiroa* species requires molecular studies to achieve a more consistent classification of this genus. Finally, ecological studies are required to explore the importance of these organisms in the Atlantic coast of Mexico.

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