**Resumen**

A lo largo de aproximadamente 12 años se han estudiado de manera sistemática a las especies del complejo Laurencia en el Océano Atlántico tropical y subtropical, evidenciando una alta diversidad (48 especies), misma que se ha subestimado para la costa de Venezuela.

**Preguntas:** ¿Cuál es la diversidad de especies del complejo Laurencia en Venezuela?

**Especies de estudio:** Chondrophycus anabeliae, Laurencia digitata.

**Sitio y años de estudio:** Cayo Muerto, Parque Nacional Morrocoy, Estado Falcón, Venezuela, 2015.

**Métodos:** Para los estudios moleculares, se utilizaron el gen del plástido rbcL y el marcador mitocondrial del código de barras de ADN, COI-5P, combinado con el estudio de los caracteres morfo-anatómicos actuales utilizados para la identificación de las especies del complejo.

**Resultados:** La presencia del género Chondrophycus, como se circunscribe actualmente, se confirmó por primera vez para Venezuela. Chondrophycus anabeliae y Laurencia digitata se registran por primera vez fuera de sus localidades tipo. Los tetrasporófitos se describen por primera vez para L. digitata.

**Conclusiones:** Nuestros hallazgos amplían la distribución geográfica de Ch. anabeliae y L. digitata para el Caribe venezolano y el Océano Atlántico, respectivamente.

**Palabras clave:** COI-5P, filogenia, rbcL, Rhodmelaceae, taxonomía.

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**CHONDROPHYCUS ANABELIAE AND LAURENCIA DIGITATA (CERAMIALES, RHODOPHYTA) ARE RECORDED FOR THE FIRST TIME FOR VENEZUELA EXPANDING THEIR GEOGRAPHIC DISTRIBUTIONS BEYOND THE TYPE LOCALITIES**

**CHONDROPHYCUS ANABELIAE Y LAURENCIA DIGITATA (CERAMIALES, RHODOPHYTA) SE REGISTRAN POR PRIMERA VEZ PARA VENEZUELA EXPANDIENDO SUS DISTRIBUCIONES GEOGRÁFICAS MÁS ALLÁ DE LAS LOCALIDADES TIPO**

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**Abstract**

**Background:** Over the course of approximately 12 years, the species of the Laurencia complex have been systematically studied in the tropical and subtropical Atlantic Ocean, showing high diversity (48 species), which has been underestimated for the coast of Venezuela.

**Questions:** What is the species diversity of the Laurencia complex in Venezuela?

**Studied species:** Chondrophycus anabeliae, Laurencia digitata.

**Study site and dates:** Cayo Muerto, Parque Nacional Morrocoy, Estado Falcón, Venezuela, 2015.

**Methods:** For molecular studies, the plastid rbcL gene and the mitochondrial DNA barcode marker COI-5P were used, combined with the study of current morpho-anatomical characters used for the identification of the species of the complex.

**Results:** The occurrence of Chondrophycus, as currently circumscribed, was confirmed for the first time for Venezuela. Chondrophycus anabeliae and Laurencia digitata are reported for the first time beyond the type localities. Tetrasporophytes are described for the first time for L. digitata.

**Conclusions:** Our findings expand the geographic distribution of Ch. anabeliae and L. digitata for the Venezuelan Caribbean and the Atlantic Ocean, respectively.

**Keywords:** COI-5P, phylogeny, rbcL, Rhodmelaceae, taxonomy.

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The Laurencia complex encompasses an extremely diverse group of marine red macroalgae in which new species and genera have been defined in the last three decades (Nam et al., 1994, Garbary & Harper, 1998, Nam 2007, Martin-Lescanne et al., 2010, Cassano et al. 2012b, 2019, Metti et al., 2015, Machín-Sánchez et al., 2016, Sentíes et al., 2016, 2019, Francis et al., 2017, Rousseau et al., 2017, Collado-Vides et al., 2018, Bibi et al., 2019). The complex is comprised of 394 species, of these, 211 have been taxonomically accepted at this time (Guiry & Guiry, 2020), distributed in eight genera: Laurencia sensu stricto J.V.Lamouroux, Osmundea Stackhouse, Chondrophycus (Tokida & Y.Saito) Garbary & J.T.Harper, Palisada K.W.Nam, Yuzurua (K.W.Nam) Martin-Lescanne, Laurenciella Cassano, Gil-Rodriguez, Sentíes, Díaz-Larrea, M.C.Oliveira & M.T.Fujii, Corynecladia J.Agardh, and Ohelopapa F.Rousseau, Martin-Lescanne, Payri & L.Le Gall. Laurencia s.s. is the most speciose genus of the complex, with 138 species accepted taxonomically around the world (Guiry & Guiry, 2020), whereas Chondrophycus is much less representative, with 16 species accepted taxonomically, mostly cited for the Indo-Pacific Ocean. Chondrophycus anabeliae Sentíes, M.T.Fujii, Cassano & Dreckmann is the only species of the genus reported for the western Atlantic Ocean (Sentíes et al., 2016, Wynne, 2017).

Venezuela is an important area of occurrence of species of the Laurencia complex in the Atlantic. To date, 16 species and one variety have been reported: nine of Laurencia, four of Palisada, two of Osmundea and one of Yuzurua. However, the genera Chondrophycus (as currently circumscribed), Corynecladia, Laurenciella and Ohelopapa were not mentioned in the region (Rodríguez de Ríos, 1979, Ganesan, 1989, Gómez et al., 2020). Of the species cited for Venezuela, some are rare or endemic. Laurencia foldatsii N.Rodríguez Ríos is endemic to Venezuela (Rodríguez de Ríos, 1981, Hernández et al., 2017); Laurencia gracilis J.D. Hooker & Harvey [as Laurencia filiformis J.D. Hooker & Harvey nom. illeg.] is rare in the Atlantic; apart from Laurencia it is quoted only for the Indo-Pacific; and Osmundea pinnatifida (Hudson) Stackhouse and Osmundea oederi (Gunnerus) G.Furnari (= Laurencia bolivarii N.Rodríguez Ríos) are rare in the western Atlantic. The citations of the Laurencia complex species in Venezuela are mostly based on morpho-anatomical characters; only Laurencia natalsensis Kylin was studied based on molecular data (García-Soto & Lopéz-Bautista, 2019).

During our study of the Laurencia complex in the tropical and subtropical Atlantic, we identified two species not yet reported for the Venezuelan coast using molecular markers, rbcL and COI-5P, combined with morphological data. Our findings confirm the occurrence of the genus Chondrophycus for Venezuela, expanding the geographic distribution of Ch. anabeliae beyond the type locality, and of Laurencia digitata Francis, Bolton, Mattio & R.J. Anderson to the Atlantic Ocean.

Materials and methods

Samples of Chondrophycus anabeliae and Laurencia digitata were collected in Cayo Muerto, Parque Nacional Morrocoy, Estado Falcón, Venezuela (10° 55' 48.08” N, 68° 15’ 31.73” W) in 2015. For each sample, small fragments of the thallus were dried in silica gel for molecular analyses, and the remaining material was preserved in 4 % formalin-seawater or pressed as herbarium vouchers for morphological studies. For morphological examination, transverse and longitudinal hand sections were stained with 0.5 % aqueous aniline blue and acidified with 1 N HCl. For each specimen studied, a minimum of 20 measurements of each morphometric character were made. Measurements are given as length × diameter. Images of whole specimens were taken with a Sony W5 digital camera (Sony, Tokyo, Japan), and details of branches and branchlets were captured with Sony W5 coupled to a Stemi SV 6-Zeiss stereomicroscope (Zeiss, Göttingen, Germany). Microscopic diagnostic features were taken with the Sony W5 coupled to a Nikon Eclipse E-200 optical microscope (Nikon, Tokyo, Japan). Voucher specimens were deposited in the herbaria of University of São Paulo (SPF) and Botanical Institute, São Paulo (SP), University of Carabobo, Venezuela (LUC), and Metropolitan Autonomous University (UAMIZ). Abbreviations follow Index Herbariorum (Thiers, 2020).

For molecular studies, DNA extraction followed manufacturer’s instructions of the DNeasy Plant Mini Kit (Qiagen, Valencia, USA). PCR protocols for both markers followed Cassano et al. (2019), using for rbcL the following pairs of primers: FrbCLstart-R492, F492-R1150 and F993-RrcbS (Freshwater & Rueness, 1994), and for COI-5P the primer pair GAZF1-GAZR1 (Saunders, 2005). For PCR amplification was used the PCR Master Mix (Promega, Madison, Wisconsin USA) in a final volume of 25 μl. The reactions were performed in a Techne TC-4000 thermocycler (Bibby Scientific, Staffordshire, UK). All PCR products were analyzed by electrophoresis in 1 % agarose to check product size and were purified with MicroSpinTMS-300 HR Columns (GE Healthcare Life Sciences, Piscataway, New Jersey, USA) as per manufacturer’s instructions.

Sequencing reactions were made using the same PCR primers mentioned above, and the BigDye Terminator Cycle Sequencing Ready Reaction kit (Applied Biosystems, Foster City, California, USA) on an ABI PRISM 3730 Genetic Analyzer (Applied Biosystems). Consensus sequences and multiple sequence alignments for both rbcL and COI-5P were generated using BioEdit 7.0.4.1 software (Hall, 1999). Multiple sequence alignment for rbcL consisted of 93 sequences, including three newly generated sequences from Cayo Muerto, Venezuela; the remaining
sequences were downloaded from GenBank (Appendix 1). Three Rhodomeleaceae species were used as outgroups, Chondria acrorhizophora Setchell & N.L.Gardner, Chondria collinsiana M. Howe, and Chondria dasypylla (Woodward) C.Agardh (Appendix 1). Neighbor-joining (NJ) analysis was conducted in PAUP v4.0 beta10 (Swoford 2002) with 2,000 bootstrap replicates. The most appropriate model of sequence evolution for maximum likelihood (ML) and Bayesian inference (BI) was selected using jModeltest v2.1.10 (Darriba et al. 2012) under the Akaikte information criterion (AIC) as implemented on the online server CIPRES Science Gateway v3.3 (Miller et al. 2010). The model selected was the general-time-reversible model of nucleotide substitution with invariant sites and gamma-distributed rates for the variable sites (GTR+I+G). Maximum likelihood (ML) analysis was performed using IQ-Tree v1.4.3 (Nguyen et al. 2015) with 1,000 bootstrap replicates on the IQ-Tree web portal. BI analysis was performed using MrBayes v3.2.2 (Ronquist et al. 2012). For BI analysis, two runs with four MCMC chains (one hot and three cold) were conducted with 4,000,000 generations and sampling every 1,000 generations, starting with a random tree. The first 100,000 generations in both runs were discarded as burn-in to build the consensus tree.

Multiple sequence alignment for COI-5P consisted of 69 sequences, including three newly generated sequences; the remaining were downloaded from GenBank (Appendix 1). One Rhodomeleaceae species was used as outgroup, Chondria baileyana (Montagne) Harvey (Appendix 1). The neighbor-joining (NJ) analysis was conducted in PAUP with 2,000 bootstrap replicates. Intra- and interspecific divergence values of rbcL and COI-5P were calculated using uncorrected “p” distances in PAUP.

Results

Molecular study. The rbcL final alignment included 93 sequences of 1,448 bp in length. The Chondrophyccus clade had full support (Figure 1). The two rbcL sequences of Chondrophyccus anabeliae from Venezuela were identical and formed a subclade with Ch. anabeliae from Mexico, its type locality, with high to moderate supports (Figure 1), diverging by 1.34 %. This subclade was sister to Chondrophyccus sp. 3 from New Caledonia plus Chondrophyccus sp. from Australia from which it diverged by 5.17-5.9 %. The subclade formed by Chondrophyccus cf. undulatus (Yamada) Garbary & J.T.Harper, Ch. sp.1, Ch. sp. 2 from New Caledonia, Chondrophyccus dotyi (Y.Saito) K.W.Nam from Hawaii, and Chondrophyccus tronoi (E.Ganzon-Fortes) K.W.Nam from Philippines diverged by 1.86 % (Ch. sp.1 vs Ch. cf. undulatus) to 6.4 % (Ch. dotyi vs Ch. tronoi). The interspecific divergence within Chondrophyccus genus ranging from 1.86 % to 7.8 % (Ch. anabeliae from Mexico vs Ch. sp.1 from New Caledonia).

Laurencia s.s. clade was highly supported (Figure 1). The rbcL sequence of L. digitata from Venezuela joined with L. digitata from South Africa, its type locality, with high to moderate support, diverging by 0.85 %. Laurencia digitata is sister to Laurencia cf. kuetzingii A.J.K.Millar from New Caledonia, diverging by 2.14-2.19 %. This subclade was resolved as sister to Laurencia pumila (Grunow) Papenfuss plus L. pumila var. dehoopiensis Francis, Bolton, Mattio & R.J.Anderson from South Africa plus Laurencia karachiana Bibi, Cassano & Rasheed from Pakistan with high to moderate supports. The interspecific divergence between sequences of L. digitata and L. pumila plus L. pumila var. dehoopiensis was 4.36-4.89 %, whereas L. digitata diverged from L. karachiana by 4.7-4.9 %.

The COI-5P final alignment included 69 sequences of 644 bp in length (Figure 2). We were unable to obtain COI-5P sequence for L. digitata from Venezuela due to contamination, even after several amplification attempts. The two identical COI-5P sequences of Ch. anabeliae from Venezuela joined to the sequence of Ch. anabeliae from the type locality generated in this study (MN597440), diverging only by 0.3 % (Figure 2). This subgroup joined to Chondrophyccus succissus (A.B.Cribb) K.W.Nam (as Laurencia succisa A.B.Cribb) from Molokai (Hawaii, USA) with 5.4-5.7 % of divergence. The subgroup formed by one sequence of Ch. dotyi and four of Ch. cf. undulatus, all from the Hawaiian Islands, showed low genetic divergence (0.16-0.48 %) suggesting that these samples represent the same taxonomic entity. The divergence between these two subgroups (Ch. anabeliae-Ch. succissus and Ch. dotyi-Ch. cf. undulatus) ranging from 8.13 % to 8.76 %.

Morphological study. Chondrophyccus anabeliae Senties, M.T.Fujii, Cassano & Dreckmann in Senties et al. 2016: 261, figures 1-18. (Figures 3A, 4A-E, 5A-D, 6A-D)

Type locality. Mexico, Quintana Roo, Isla Mujeres, Garrafón de Castilla; holotype UAMIZ 1240!

Description. Plants forming erect tufts up to 5 cm high, reddish-brown to yellowish-brown, terete to partially compressed axes (Figures 3A, 4A), cartilaginous in texture, not adhering to herbarium paper when dried. Thalli attached to the substratum by a discoid holdfast. Erect branches irregularly alternate and spirally arranged, usually with 2-3 (4) orders of branches. The main axes are terete and slightly narrowing towards the terete apices. Ultimate branchlets cylindrical to clavate and truncate at the apices, 500-2,800 μm long and 525-1,000 μm in diameter.
Chondrophycus anabeliae and Laurencia digitata from Venezuela

Figure 1. Consensus tree derived from Maximum likelihood (ML) analyses of rbcL sequences. Bootstrap supports for NJ (2000 replicates)/ML (1000 replicates)/posterior probabilities, PP < 0.95 are given at the nodes. Sequence generated in this study in bold; - indicates lack of bootstrap support or values under 70; *indicates full support. Outgroups were removed from the figure only for better ingroups viewing.
Figure 2. NJ analysis for COI-5P sequences. Bootstrap values (2000 replicates) are shown at nodes; values under 70 were not considered. Sequence generated in this study in bold.
In surface view, the outermost cortical cells are translucent, isodiametric-polygonal in the middle portions, 17.5-32.5 × 17.2-37.5 μm without secondary pit connections (Figure 4B). Subcortical cells are pigmented, larger and connected to each other by secondary pit connections (Figure 4C). Outermost cortical cells translucent and subcortical cells present 1 (-2) crystals per cell (Figure 4C, D). In transverse section, thalli formed by two cortical cell layers, and four or five layers of medullary cells (Figure 4E). The cortical cells of translucent outer layer are quadratic, cuneiform to rectangular, smaller than the inner layer cells, measuring 17.5-30 × 22.5-30 μm in the ultimate branchlets (Figure 5A), and elongated, 47.5-55 × 27.5-35 μm in the middle portions of main axes. The inner layer of cortical cells is composed of pigmented and elongated cells, measuring 40-65 × 35-50 μm (Figure 5B) in the middle portions of main axes. Medullary cells are rounded or slightly radially elongated, measuring 65-145 × 47.5-107.5 μm in the middle portions of the main axes. Medullary cell walls uniformly thickened, but lenticular wall thickenings are absent. Each vegetative axial segment cuts off two pericentral cells (Figure 5C) that are slightly smaller than the medullary cells of the surrounding layer. In median longitudinal sections through a branchlet, the outer cortical cell walls near the apices are markedly projecting beyond the surface (Figure 5D).

Tetrasporangial branchlets are cylindrical or slightly compressed, simple or compound, 500-1,500 × 575-825 μm (Figure 6A). At the apex of fertile branches, each axial segment produces one fertile additional pericentral cell situated oppositely to the pre-existing two pericentral cells which remain vegetative (Figure 6B). The additional cell cuts off two pre-sporangial cover cells distally abaxially positioned in relation to the tetrasporangial initial (Figure 6C). Subsequently, one post-sporangial cover cell is produced and continues to divide, contributing to cortication around the tetrasporangia. Tetrasporangia are arranged in a right-angled pattern in relation to fertile branchlets (Figure 6D). Mature tetrasporangia are tetrahedrally divided, 50-100 μm in diameter. Gametangia were not observed.

Examined material. Venezuela. Estado Falcón: Parque Nacional Morrocoy, Cayo Muerto, 19 May 2015, tetrasporophyte, S. Ardito, M.T. Fujii, A. Sentíes, V. Cassano (SPF58487, SP470468, LUC7611, UAMIZ 1405). GenBank accession number for rbcL (MN597441, MN597442) and for COI-5P (MN597438, MN597439).

Distribution and habitat. This species is currently recorded only for Mexico (Sentíes et al. 2016), and Venezuela (this study). Epilithic specimens were collected growing in shallow waters on rocky coastline, northeast of Cayo Muerto. The environment is considered as an intertidal zone with medium-sized rocks and moderately strong waves.

Laurencia digitata Francis, Bolton, Mattio & R.J.Anderson in Francis et al. 2017: 812, Figure 5. (Figures 3B, 7A-F, 8A-D)

Type locality. South Africa, KwaZulu-Natal, Cape Vidal; holotype BOL150572.

Description. Plants forming small, very intricate cushion-like tufts, up to 5 cm high, yellowish-brown, terete, cartilaginous in texture, adhering to herbarium paper when dried (Figure 3B). Thallus attached to the substratum by a discoid holdfast, and basal descending branches. Erect branches irregularly alternate and spirally arranged, with up to 3 orders of branches (Figure 7A). Main axes 275-525 μm in diameter in middle portion of the thallus. Ultimate branchlets are cylindrical to clavate with truncated tips, 452-950 × 225-325 μm in diameter.
Figure 4. *Chondrophyccus anabeliae*. A) Part of branches of a sterile plant. B) Surface view of translucent cortical cells. C) Surface view of subcortical cells. Note secondary pit connections between subcortical cells (arrow) and crystals (arrowhead). D) Surface view of translucent cortical cells showing one crystal per cell. E) Transverse section of the thallus. Scale bar: A, 1 cm; B and D, 25 μm; C, 50 μm; E, 100 μm.
In surface view, cortical cells have 1-2 corps en cerise per cell (Figure 7B). Cortical cells are arranged regularly in longitudinal rows and connected to each other by longitudinally oriented secondary pit-connections (Figure 7C). Cortical cells are rounded to polygonal and slightly longitudinally elongated in middle portions of main axes, 37.5-57.5 × 27.5-50 μm. In transverse section, the thallus has 1-2 layers of pigmented cortical cells and 3-4 layers of hyaline medullary cells (Figure 7D). Cortical cells are quadrate, cuneiform to rectangular, not arranged as a palisade, and 25-35 × 22.5-37.5 μm in the middle portions of thalli. Medullary cells are rounded to slightly radially elongated, and 55-90 × 42.5-52.5 μm, gradually increasing in size toward the center of the thallus. Each vegetative axial segment cut off four pericentral cells slightly larger than the other surrounding cells (Figure 7E). In median longitudinal sections through a branchlet, the outer cortical cell walls near the apices projecting beyond the surface (Figure 7F). Lenticular thickening absent.

Tetrasporangial branchlets are cylindrical, simple or compound, 575-2,125 × 225-400 μm (Figure 8A). At the apex of fertile branches, each axial segment produces one fertile pericentral cell, the fourth ones (Figure 8B), the other pericentral cells remain sterile. Fertile pericentral cell cuts off two pre-sporangial cover cells distally abaxially positioned in relation to the tetrasporangial initial (Figure 8D). Subsequently, one post-sporangial cover cell is produced and continues to divide, contributing to cortication around the tetrasporangia. Tetrasporangia are arranged in a parallel pattern in relation to fertile branchlets (Figure 8A, C). Mature tetrasporangia are tetrahedrally divided, 47.5-75 μm in diameter. Gametangia were not observed.

**Material examined.** Venezuela. Estado Falcón: Parque Nacional Morrocoy, Cayo Muerto, 19 May 2015, tetrasporophyte, S. Ardito, M.T. Fujii, A. Sentíes, V. Cassano (SPF58488, SP470469, UAMIZ 1406). GenBank accession number for rbcL (MN597443).

**Distribution and habitat.** This species is currently recorded only for South Africa (Francis et al. 2017) and Venezuela (this study). Laurencia digitata was collected as drift specimens in shallow waters on rocky coastline, northeast of Cayo Muerto. The environment is considered as an intertidal zone with medium-sized rocks and moderately strong waves.
Discussion

Comparison of *rbcL* and COI-5P sequences of *Ch. anabeliae* from the type locality (Mexico) with our material confirmed the occurrence of this species on the Venezuelan coast, whereas *L. digitata* was confirmed only by comparison with *rbcL* sequence from the type locality (South Africa), since we were unable to generate COI-5P sequences and there are also no sequences available of this marker in databases.

Considering our results for *rbcL*, intraspecific value between the Venezuelan and South African *L. digitata* (0.85 %) is within the range observed in previous works for *Laurencia s.s.* (0-1.35 %) reported by Cassano *et al.* (2012a, b), Metti *et al.* (2013), and Collado-Vides *et al.* (2018). Interspecific divergences for the *rbcL* gene between *L. digitata* and *Laurencia* species closest molecularly (i.e., *L. cf. kuetezingii*, *L. pumila*, *L. pumila* var. *dehoopiensis*, and *L. karachiana*, 2.14-4.9 %) were within the variation observed for *Laurencia s.s.* by Cassano *et al.* (2012b, 1.0-6.8 %) and Cassano *et al.* (2019, 2.4-3.7 %).

There are no data available in the literature for the *rbcL* gene to compare the intraspecific divergence for *Chondrophycus*. However, the intraspecific value obtained for *Ch. anabeliae* (1.34 %) is below the interspecific variation range described for the genus by Cassano *et al.* (2012b, 1.8-6.9 %), by Sentíes *et al.* (2016, 3.4-7.8 %), and that found in this study (1.86-7.8 %).

For COI-5P gene, the intraspecific divergence values reported for the *Laurencia* complex are low, not exceeding 1 %. The lowest range of intraspecific divergence was observed in this study (0-0.3 %) for samples of *Ch. anabeliae* from the Caribbean Sea (Venezuela and Mexico), whereas divergences up to 0.52 % were reported by Machín-Sánchez *et al.* (2014) for *Laurencia*, up to 0.67 % by Machín-Sánchez *et al.* (2016) for *Osmundea*, and up to 0.7 % by Cassano *et al.* (2012b), Machín-Sánchez *et al.* (2014), and Collado-Vides *et al.* (2018) for *Laurenciella*. The interspecific divergence obtained in this study for COI-5P (5.4-8.76 %) is within the range found for other genera of the complex, i.e. for *Laurenciella* species (7.4-9.2 %, Collado-Vides *et al.* 2018), and for *Laurencia* species (2.6-10.2 %, Cassano *et al.* 2019).

Figure 6. *Chondrophycus anabeliae*. A) Detail of tetrasporangial branches. B) Transverse section of tetrasporangial axial segment showing an axial cell (arrow) and two vegetative pericentral cells (p); an additional third fertile pericentral cell is formed in the opposite position (arrowhead). C) Detail of fertile pericentral cell (fp) with two pre-sporangial cover cells (pr), tetrasporangium (te, out of focus); post-sporangial cover cell not shown. D) Longitudinal section through tetrasporangial branchlet showing right-angle arrangement of the tetrasporangia. Scale bar: A, 3 mm; B and C, 25 µm; D, 100 µm.
Figure 7. Laurencia digitata. A) Part of branches of a sterile plant. B) Surface view of cortical cells showing corps en cerise in living material. C) Surface view of cortical cells showing secondary pit-connections (arrow). D) Transverse section of the thallus. E) Transverse section of upper portion of branch showing an axial cell (a) with four pericentral cells (p). F) Longitudinal section through to a branchlet showing projecting cortical cells. Scale bar: A, 3 mm; B and C, 25 µm; D, 100 µm; E and F, 50 µm.
Morphologically, Venezuelan *Ch. anabeliae* shares all diagnostic characters described for the species by Sentíes et al. (2016), such as: (i) thallus slightly compressed; (ii) two cortical cell layers, the outmost layer formed by translucent cells with conspicuous cell wall projections near the apices and absence of secondary pit connections, and the inner layer formed by pigmented and pit connected cells; and (iii) tetrasporangia produced from one additional fertile pericentral cell. The presence of 1 (-2) crystals per cortical and subcortical cells is a characteristic unique for *Ch. anabeliae* from Venezuela; they were not found in Mexican *Ch. anabeliae* and were not described for other *Chondrophycus* species.

Venezuelan and South African *Laurencia digitata* share the cushion-like tufted habit and absence of lenticular thickenings. However, the South African material differed from ours by color (reddish-brown), branching pattern (alternate but subopposite and/or subverticillate at the tips of some branches), and absence of cortical cell walls projections near the apices (Francis et al. 2017). The tetrasporophyte has typical features of the genus *Laurencia* and is described for the first time for this species.

*Chondrophycus anabeliae* seems to be restricted to the Caribbean Sea so far. The range of distribution of *Ch. anabeliae* represents the limits from the western to the southeast Caribbean, whereas *L. digitata*, previously considered endemic to South Africa by Francis et al. (2017), presents a disjunct distribution in the Indian and Atlantic Oceans. The disjunct distribution of *L. digitata* is similar to that of *L. natalensis* whose occurrence was recorded only for the Indian Ocean, nevertheless with wider distribution [South Africa, Mozambique, Kenya, Mauritius, Sri Lanka and Vietnam (Guiry & Guiry 2020)], and it was cited for Venezuela by Garcia-Soto & Lopéz-Bautista

**Figure 8. Laurencia digitata** A) Detail of tetrasporangial branches. B) Transverse section of two superimposed tetrasporangial segments showing an axial cell (a) and one fertile pericentral cell, the fourth (arrow); the other pericentral cells (p) remain sterile (pit connections between axial and pericentral cells, out of focus). C) Longitudinal section through a tetrasporangial branchlet showing parallel arrangement of tetrasporangia. D) Detail of fertile pericentral cell (fp) with two pre-sporangial cover cells (pr, only one visualized), tetrasporangium (te); post-sporangial cover cell not shown. Scale bar: A, 500 µm; B and D, 25 µm; C, 40 µm.
Chondrophycus anabeliae and Laurencia digitata from Venezuela

(2019). However, more studies of biogeography and phylogeography are needed in the area, which will allow us to explain this further.

Although macroalgal floristic studies have been carried out for the Venezuelan coast (e.g., Gomez et al. 2017), the diversity for this region is still underestimated. Similar underestimations have already been reported for other groups of red algae (e.g., Adey et al. 2015, Basso et al. 2015, Hind et al. 2015, Ardito et al. 2017, Núñez-Resendiz et al. 2018). For this reason, it is necessary to continue performing floristic surveys that incorporate molecular-assisted alpha taxonomy to accurately identify all and potential new species from this region, especially for ecologically and economically important taxonomic groups such as those included in the Laurencia complex.

The use of rbcL gene for phylogenetic inference, and the COI-5P barcode marker for species delimitation allied to morphological study revealed the presence of two species of the Laurencia complex for Venezuela, Chondrophycus anabeliae and Laurencia digitata. Both constitute new records for the region and their first occurrence outside the type localities. Our findings expand the geographic distribution of Ch. anabeliae to the southeast of the Caribbean Sea, where the species seems to be restricted so far, whereas the first report of L. digitata for the Atlantic Ocean established a disjunct distribution of this species in the Atlantic and Indian Oceans.

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### Appendix 1. Taxa used in this study for molecular analysis.

| Samples | Collection data | GenBank accession numbers |
|---------|-----------------|--------------------------|
| **Chondria baileyana** (Montagne) Harvey | Canada, Nova Scotia, Pomquet (far on Monks Head Road), 16 Aug. 2012, G.W. Saunders, A. Savoie, C. Longtin, K. Dixon, M. Bruce | KU564345 - |
| **C. californica** (Collins) Kylin | USA, California, San Diego Co., Beach Club Reef (La Jolla Shores), 1 Jul. 1996, M. Volovsek | - AY172578 |
| **C. collinsiana** M.A. Howe | Brazil, Rio de Janeiro, Armação dos Búzios, Praia Rasa, 13 Jan. 2005, V. Cassano, J.C. De-Paula | - GU330225 |
| **C. dasyphylla** (Woodward) C. Agardh | USA, North Carolina, Carteret Co., Bogue Sound | - U04021 |
| **Chondrophycus anabeliae** Sentes, M.T.Fujii, Cassano & Dreckmann | Mexico, Quintana Roo, Isla Mujeres, Garrafón de Castilla, 12 Feb. 2007, A. Sentes, M.C. Gil-Rodriguez | MN597440 - MN597441 |
| **Ch. anabeliae** | Venezuela, Estado Falcón, Parque Nacional Morrocoy, Cayo Muerto, 19 May 2015, S. Ardito. M.T. Fujii, A. Sentíes, V. Cassano | MN597438 - MN597442 |
| **Ch. dotyi** (Y. Saito) K.W. Nam | USA, Hawaii | HQ423050 - |
| **Ch. dotyi** | USA, Hawaii, Oahu, Sandy Beach, 31 May 2015, E.M. Stein | - KX815263 |
| **Ch. cf. undulatus** (Yamada) Garbary & J.T. Harper | New Caledonia, Loyalty Is., Marè, 22 Mar. 2005, C. Payri | - FJ785307 |
| **Ch. cf. undulatus** | USA, Maui, 12 Dec. 2007 | GU223886 - |
| **Ch. cf. undulatus** | USA, Hawaii | HQ422752 - HQ422996 |
| **Ch. succissus** (A.B. Cribb) K.W. Nam | USA, Molokai, 11 Feb. 2007 | GU223884 - |
| **Ch. tronoi** (E. Ganzon-Fortes) K.W. Nam | Philippines, A.O. Lluisma | - AF489864 |
| **Ch. sp.** | Australia, Norfolk Island, Collins Head, 21 Mar. 2005, Y. Metti, A. Millar | KY120337 |
| **Ch. sp. 1** | New Caledonia, Loyalty Is., Lifou, 26 Mar. 2005, C. Payri | - FJ785309 |
| **Ch. sp. 2** | New Caledonia, Loyalty Is., Marè, 21 Mar. 2005, C. Payri | - FJ785310 |
| **Ch. sp. 3** | New Caledonia, Loyalty Is., Beaufort/Beaupré, 06 Apr. 2005, C. Payri | - FJ785311 |
| **Corynecladia clavata** J. Agardh | Australia, Victoria, Walkerville, 20 Jan. 2015, P. Diaz-Tapia, M. Brookes | - MF094079 |
| **C. clavata** | Australia, Victoria, The Caves, 21 Jan. 2015, P. Diaz-Tapia, M. Brookes | MH704456 - |
| **C. clavata** (as Ceramiales sp.) | Australia, Tasmania, 24 Jan. 2004, G.W. Saunders, R. Withall | HM915955 - |
| **C. elata** (C. Agardh) Cassano, M.C. Oliveira & M.T. Fujii | Australia, Western Australia, Rottnest Island, 15 Nov. 2008, J. Eu | - KY120339 |
| **C. nova** (Metti) Cassano, M.C. Oliveira & M.T. Fujii | Australia, NSW, Jervis Bay, Plantation Point, 15 Feb. 2005, Y. Metti, A. Millar | - KY120340 |
| **Laurencia aldingensis** | Brazil, Rio de Janeiro, Armação dos Búzios, Praia Rasa, 13 Jan. 2005, V. Cassano, J.C. De-Paula | - JF810351 |
| **L. alfredensis** Francis, Bolton, Mattio & Anderson | South Africa, 04 Jul. 2008, R.J. Anderson, J.J. Bolton | - KY927749 |
| **L. brachyclados** Pilger | USA, Hawaii | HQ423046 - |
| Samples | Collection data | GenBank accession numbers |
|---------|----------------|-------------------------|
|         |                | COI-5P | rbcl |
| L. cf. brongiartii J. Agardh | Australia, Tarcoola Beach, 1996, S. Fredericq | - | EF061654 |
| L. caduciramulosa Masuda & Kawaguchi | Brazil, Rio de Janeiro, Angra dos Reis, Praia do Velho, 19 Apr. 2006, V. Cassano, J.C. De-Paula | - | KJ700865 |
| L. caraibica P.C. Silva | Mexico, Quitana Roo, Cancún, Isla Mujeres, 2006, A. Senties | - | EF658642 |
| L. caraibica | Venezuela, Falcon, Cabo San Roman, 06 Oct. 2012, G. Garcia-Soto | - | MHJ38533 |
| L. catarinensis Cordeiro-Marino & M.T. Fujii | Spain, Canary Islands, Tenerife, Punta del Hidalgo, 02 Jun. 2012, M.C. Gil-Rodriguez, M. Machín-Sánchez | - | KF492781 |
| L. catarinensis | Spain, Canary Islands, Lanzarote, Pechiguera, 15 Jan. 2013, M.C. Gil-Rodriguez, M. Machín-Sánchez | KF492718 | - |
| L. complanata (Suhr) Kützing | South Africa, 09 Dec. 2010, R.J. Anderson, J.J. Bolton | - | KY927738 |
| L. corymbosa J. Agardh | South Africa, 19 Aug. 2008, R.J. Anderson, J.J. Bolton | - | KY927760 |
| L. dendroidea J. Agardh | Brazil, Bahia, Lauro de Freitas, Praia Vilas do Atlântico, 08 Jan. 2008, A. Oliveira | - | GU330228 |
| L. dendroidea | Venezuela, Falcon, Playa Buchuacos, 06 Oct. 2012, G. Garcia-Soto | - | MHJ38528 |
| L. dendroidea (as L. majuscula) | Australia, NSW, Kiama Harbour, North side, 03 Apr. 2004, Y. Metti, D. Williams | - | - |
| L. dendroidea | Spain, Canary Islands, La Gomera, Punta de La Dama, 21 Sept. 2009, E. Ayagas, M.C. Gil-Rodriguez, M. Machín-Sánchez | KF492725 | - |
| L. dendroidea | Spain, Canary Islands, Lanzarote, Pechiguera, 15 Jan. 2013, M.C. Gil-Rodriguez, M. Machín-Sánchez | KF492728 | - |
| L. dendroidea (as L. majuscula) | USA, Molokai, 10 Feb. 2007 | GU223887 | - |
| L. dichotoma Francis, Bolton, Mattio & Anderson | South Africa, 22 Mar. 2011, J.J. Bolton | - | KY927786 |
| L. digitata Francis, Bolton, Mattio & Anderson | South Africa, 04 Jul. 2008, R.J. Anderson, J.J. Bolton | - | KY927748 |
| L. digitata | Venezuela, Estado Falcón, Parque Nacional Morrocoy, Cayo Muerto, 19 May 2015, S. Ardito, M.T. Fujii, A. Senties, V. Cassano | - | MN597443 |
| L. flexuosa Kützing | South Africa, S. KwaZulu-Natal, Palm Beach, 07 Feb. 2001, S. Fredericq | - | AF465815 |
| L. cf. flexuosa | South Africa, Eastern Cape Province, 15 Jun. 2003, O. De Clerck | KX258821 | - |
| L. filiformis (C. Agardh) Montagne | Western Australia, Geraldton, Tarcoola Beach, 21 Sept. 1995, M.H. Hommersand, F.H. Hommersand | - | MHJ04449 |
| L. galtsoffi M.A. Howe | USA, Hawaii | HQ422984 | - |
| L. glomerata (Kützing) Kützing | South Africa, 03 Mar. 2009, R.J. Anderson, J.J. Bolton | - | KY927763 |
| L. heteroclada Harvey f. decussata Cribb | Australia, NSW, Arrawarra headland, 28 Jul. 2004, Y. Metti | - | KY120344 |
| L. intricata J.V. Lamouroux | Cuba, Ciego de Ávila, Cayo Coco, 25 Sept. 2005, M.T. Fujii | - | GU330238 |
| L. intricata | USA, Florida, Long Key, Channel 5 (ocean side), 10 Dec. 1998, B. Wyssor, T. Frankovich | - | AY588410 |
| L. karachiana Bibi, Cassano & Rasheed | Pakistan, Karachi, French Beach (Buleji), 13 Aug. 2018, R. Bibi | MK796229 | MK796228 |
| L. cf. kuertzingii A. Millar | New Caledonia, Loyalty Is., Ouvéa, 31 Mar. 2005, C. Payri | - | FJ785322 |
**Samples** | **Collection data** | **GenBank accession numbers**
---|---|---
*L. laurahuertana* Mateo-Cid, Mendoza-González, Senties & Díaz-Larrea | Mexico, Quintana Roo, Punta Herrero, 12 Apr. 2012, A.C. Mendoza González, L.E. Mateo-Cid | - KF279401
*L. longiramea* Cassano, G.N. Santos, J.M.C. Nunes, M.C. Oliveira & M.T. Fuji | Brazil, Espírito Santo, Anchieta, Ilhote de Ubu, 30 Jun. 2007, E.M. Stein | MH704454 -
*L. longiramea* | Brazil, Rio de Janeiro, Armação dos Búzios, Praia Rasa, 13 Jan. 2005, V. Cassano, J.C. De-Paula | MH704455 MH704451
*L. cf. majuscula* (Harvey) A.H.S Lucas | Oman, Dhofar, Sept. 2001, M. Wynne | - KX146184
*L. cf. mariannensis* Yamada | New Caledonia, Lagon Sud-Ouest, Ilot Larégnère, 11 Jul. 2003, C. Payri | - FJ785313
*L. mcdormidiae* I.A. Abbott | USA, Oahu, 08 Apr. 2007 | GU223877 -
*L. mcdormidiae* | New Caledonia, Ile des Pins, 09 Nov. 2005, C. Payri | - FJ785314
*L. multiavata* Francis, Bolton, Mattio & Anderson | South Africa, 29 Mar. 2010, R.J. Anderson | - KY927766
*L. mutuæae* Senties, Cassano & Dreckmann | Mexico, Guerrero, Acapulco, Isla la Roqueta, 07 Jun. 2017, A. Senties, K.M. Dreckmann | MK182532 MK159179
*L. natalensis* Kylin | South Africa, S. KwaZulu-Natal, Palm Beach, 07 Feb. 2001, S. Fredericq | - AF465816
*L. natalensis* | Venezuela, Falcon, Cabo San Roman, 06 Oct. 2012, G. Garcia-Soto | MH388523
*L. nidifica* J. Agardh | USA, Hawaii | HQ422750 -
*L. nidifica* | USA, Hawaii | HQ422751 -
*L. cf. nidifica* | New Caledonia, Ile des Pins, 30 Nov. 2005, C. Payri | - FJ785315
*L. nipponica* | Russia, Sakhalin, 23 Jun. 2003 | GU223874 -
*L. obtusa* (Hudson) J.V. Lamouroux | Ireland, County Donegal, Fanad Head, C.A. Maggs | - AF281881
*L. obtusa* | France, Languedoc-Roussillon, Pyrenees-Orientales, Cap Beart, Banyuls-sur-Mer, 11 Jul. 2007, L. Bittner | KX258828 -
*L. oliveirana* Yoneshigue | Brazil, Rio de Janeiro, Arraial do Cabo, Ponta da Cabeça, Praia Grande, 07 Jul. 2008, V. Cassano, J.C. De-Paula | JF810352
*L. pacifica* Kylin | USA, California, Stillwater Cove, Pebble Beach, 20 May 2010, B. Clarkston, K. Hind, S. Toews | KM254466 -
*L. pacifica* | USA, California, Moss Beach, Central Beach, 17 Feb. 1992, S. Fredericq | - AY588411
*L. pumila* (Grunow) Papenfuss | South Africa, 10 Jun. 2009, R.J. Anderson, J.J. Bolton | JF810352
*L. pumila var. dehoopiensis* Francis, Bolton, Mattio & Anderson | South Africa, 19 Aug. 2008, R.J. Anderson | - KY927765
*L. pyramidalis* Bory ex Kützing | France, Brittany, Roscoff, 05 Dec. 2002, F. Rousseau | - FJ785316
*L. pyramidalis* | Portugal, Madeira, Seixal, Praia da Laje, 07 Jul. 2011, E. Nogueira, V. Cassano, A. Senties | KF492733 -
*L. pyramidalis* | Portugal, Madeira, Porto Muniz, 07 Jul. 2011, M.T. Fujii, A. Neto, M. Machín-Sánchez | KF492739 -
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| Samples | Collection data | GenBank accession numbers |
|---------|-----------------|--------------------------|
| L. pyramidalis | Portugal, Azores, São Miguel, Mosteiros, 27 Jun. 2011, M.T. Fujii, A. Prestes, A. Pacheco, M. Machín-Sánchez | KF492751 |
| L. pyramidalis | Spain, Canary Islands, Fuerteventura, Garcey, 10 Sept. 2012, M. Machín-Sánchez | KF492756 |
| L. pyramidalis | Spain, Canary Islands, Tenerife, Puerto de La Cruz, 20 May 2011, M.C. Gil-Rodríguez, M. Machín-Sánchez | KF492746 |
| L. rigida J. Agardh | Australia, NSW, Botany Bay, 11 May 2000, G.C. Zuccarello, J.A. West | - |
| L. saitoi Perestenko | USA, California, Monterey, McAbee Beach, 21 May 2010, B. Clarkston, K. Hind, S. Toews | KM254876 |
| L. snackeyi (Weber van Bosse) M. Masuda | Unspecified | MF093985 |
| L. sodwaniensis Francis, Bolton, Mattio & Anderson | South Africa, 22 Mar. 2011, C.M. Francis | - |
| L. stegengae (Stegenga, Bolton & Anderson) Francis, Bolton, Mattio & Anderson | South Africa, 18 Mar. 2010, R.J. Anderson | - |
| L. tasmanica J.D. Hooker & Harvey | Australia, Victoria, Tween Reef, between Cape Paterson and Inverloch, P. Díaz-Tapia | - |
| L. venusta Yamada | Mexico, Quintana Roo, Puerto Morelos, Punta Brava, 2004, J. Diaz-Larrea, A. Sentíes | - |
| L. viridis Gil-Rodríguez & Haroun | Spain, Canary Islands, Tenerife, Punta del Hidalgo, Roca Negra, 06 Oct. 2005, M.C. Gil-Rodríguez | - |
| L. viridis | Spain, Canary Islands, Fuerteventura, El Cotillo, 07 Mar. 2011, M.C. Gil-Rodríguez | KF492757 |
| L. viridis | Portugal, Azores, Santa Maria, Boca de Ribeira Seca, 02 Jul. 2011, M.T. Fujii, A. Neto, J. Pombo, M. Machín-Sánchez | KF492760 |
| “L. yamadana” M.A. Howe | USA, HI, Maui, Kihei, 05 Apr. 2006, A.L. Carlile, J.R. Waaland | - |
| Laurencia sp. | New Caledonia, Loyalty Islands, Maré, 21 Mar. 2005, C. Payri | KX258820 KX146182 |
| Laurencia sp. | New Caledonia, Loyalty Islands, Maré, 19 Mar. 2005, C. Payri | KX258819 |
| Laurencia sp. | USA, Oahu | GU223889 GU223891 GU223893 GU223894 |
| Laurencia sp. | USA, Lanai | GU223892 |
| Laurencia sp. | Sri Lanka, Odayapiti lagoon, 08 Nov. 2006, E. Coppejans | KX258826 |
| Laurencia sp.1 | Australia, Victoria, Mallacoota, H. Verbruggen, K. Dixon | - |
| Laurencia sp.2 | Australia, Victoria, Mallacoota, H. Verbruggen, K. Dixon | - |
| Laurencia marilzae (Gil-Rodriguez et al.) Gil-Rodriguez et al. | Spain, Canary Islands, Tenerife, Punta del Hidalgo, 12 Jul. 2006, M.C. Gil-Rodriguez, M.T. Fujii, A. Sentíes | - |
| La. marilzae | Spain, Canary Islands, Lanzarote, Pechiguerras, 15 Jan. 2013, M.C. Gil-Rodriguez, M. Machín-Sánchez | KF492762 |
### Samples

| La. marilzae | Portugal, Azores, São Miguel, Cerco da Caloura-Baia, E. Nogueira, V. Cassano, A. Senties | KF492765 - |
| La. marilzae | Spain, Canary Islands, Tenerife, Punta del Hidalgo, 13 Jan. 2012, M.C. Gil-Rodríguez, M. Machín-Sánchez | KF492769 - |
| La. marilzae | Brazil, São Paulo, Laje de Santos Marine State Park, Parcel do Sul, 25 Mar. 2007, R. Rocha-Jorge | KF270693 | GU938189 |
| La. marilzae | Croatia, Scerdo, 11 Jun. 2007, J. Utge, L. Le Gall | KX258829 - KX146186 |
| La. mayaimii, L. Collado-Vides, Cassano & M.T. Fujii | USA, Florida, Biscayne Bay at Deering Estate, 12 Aug. 2013, L. Collado-Vides, V. Cassano, M.T. Fujii | MG004176 - |
| La. mayaimii | USA, Florida, Key Largo, John Pennekamp Park, 14 Aug. 2013, L. Collado-Vides, V. Cassano, M.T. Fujii | MG004178 MG004183 |
| Laurenciella sp. | USA, Florida, Key Biscayne, Crandon Park, 12 Aug. 2013, L. Collado-Vides, V. Cassano, M.T. Fujii | MG004179 MG004184 |

### GenBank accession numbers

| Collection data | GenBank accession numbers |
|-----------------|---------------------------|
| O. apertum (A.P. de Candolle) K.W. Nam | France, Brittany, St. Lunaire, 20 Mar. 1999, F. Rousseau | KJ960875 - |
| O. apertum | France, Brittany, Le Loup, 19 May 2011, L. Couceiro, M. Robuchon | KJ960867 - |
| O. pinnatifida (Hudson) Stockhouse | France, Brittany, Penmarch | AF259495 |
| O. pinnatifida | France, Brittany, Le Loup, 08 Mar. 2012, L. Couceiro, M. Robuchon | KJ960886 - |
| O. sanctum | Brazil, São Paulo, Laje de Santos Marine State Park, Parcel do Sul, 19 Aug. 2012, R. Rocha-Jorge, M.B. Barros-Barreto | KC012601 |
| O. sinicola (Setchell & N.L. Gardner) K.W. Nam | USA, California, Orange Co., Crescent Beach, 28 May 2002, S. Murray | AY588407 |
| O. spectabilis (Postels & Ruprecht) K.W. Nam var. spectabilis | Mexico, Baja California, Punta Santo Thomas, 02 Jul. 1996, M.H. Hommersand | AY172574 |
| O. spectabilis | USA, California, Aquarium Reef, Monterey Bay, 23 May 2010, B. Clarkston, S. Toews | KM254974 - |
| O. spectabilis | USA, California, Monterey, Mcabee Beach, 21 May 2010, B. Clarkston, K. Hind, S. Toews | KM254320 - |
| O. splendidens (Hollenberg) K.W. Nam | Mexico, Baja California, Drift, Bahia Colnett, 02 Jul. 1996, M.H. Hommersand, J. Hughey | AY172576 |
| O. splendidens | USA, California, Santa Cruz (Four Mile), 19 May 2010, B. Clarkston, K. Hind, S. Toews | KM254377 - |
### Samples Collection data GenBank accession numbers

| Samples | Collection data | GenBank accession numbers |
|---------|-----------------|--------------------------|
| **Palisada cervicornis** (Harvey) Collado-Vides, Cassano & M.T. Fujii | USA, Florida, Key Largo, Pickles Reef, 14. Aug. 2013, A. Duran | - MG030375 |
| | | MG020476 |
| **P. corallopis** (Montagne) Sentíes, M.T. Fujii & Diaz-Larrea | Mexico, Yucatán, Cancún, Chaac Mool Beach, 2005, J. Diaz-Larrea, A. Sentíes | - EF061646 |
| **P. crustiformans** (McDermid) A.R. Sherwood, A. Kurihara & K.W. Nam | USA, Hawaii | HQ422768 - |
| **P. crustiformans** | USA, Hawaii, Oahu, Makapuu, 26 May 2007, A. Kurihara | - KX146196 |
| **P. flagellifera** (J. Agardh) K.W. Nam | Brazil, Rio de Janeiro, Rio das Ostras, Praia do Cemitério, 03 Aug. 2005, V. Cassano, M.B.B. Barreto | - GU330227 |
| **P. flagellifera** | Spain, Canary Islands, Tenerife, Punta del Hidalgo, 13 Jan. 2012, M.C. Gil-Rodríguez, M. Machín-Sánchez | KF492772 |
| **P. furcata** (Cordeiro-Marino & M.T. Fujii) Cassano & M.T. Fujii | Brazil, Paraiba, Praia de Tambaú, 24 Feb. 2004, M.T. Fujii | - GU330226 |
| **P. parvipapillata** (C.K. Tseng) K.W. Nam | USA, Oahu,18 Sept. 2007 | GU223895 - |
| **P. perforata** (Bory) K.W. Nam | Spain, Canary Islands, Tenerife, Punta del Hidalgo, Faro, Bahia Izquierda, 06 Oct. 2005, M. Gil-Rodríguez | - EU256327 |
| **P. perforata** | Mexico, Quintana Roo, Isla Mujeres, 2007, A. Sentíes, M.C. Gil-Rodríguez | - EF658641 |
| **P. perforata** | Spain, Canary Islands, Tenerife, Punta del Hidalgo, 13 Jan. 2012, M.C. Gil-Rodríguez, M. Machín-Sánchez | KF492773 |
| **P. cf. robusta** (Yamada) K.W. Nam | New Caledonia, Lifou, 23 Mar. 2005, C. Payri | - FJ785321 |
| **P. yamadana** (M.A. Howe) K.W. Nam | USA, Hawaii | HQ422794 |
| **Palisada sp.** | New Caledonia, Ilot Bayes, 01 Jan. 2001, C. Payri | - KX146194 |
| **Y. poiteaui var. gemmifera** (Harvey) M.J. Wynne | Mexico, Quintana Roo, Puerto Morelos, Ojo de Agua, 2004, J. Diaz-Larrea, A. Sentíes | - EF061648 |
| **Y. poiteaui var. gemmifera** | Cuba, La Havana, Rincon de Guanabo, 2005, J. Diaz-Larrea, A. Areces | - EF061650 |
| **Y. poiteaui var. poiteaui** | USA, Florida, Long Key, Ovan Side, 1998, S. Fredericq | - EF061652 |
| **Y. poiteaui var. poiteaui** | Mexico, Quitana Roo, Cancún, Playa del Carmen, 2005, J. Diaz-Larrea, A. Sentíes | - EF061653 |
| **Yuzurua sp.** | West Indies, Guadeloupe, Grand Cul-de-Sac Marin, Chenal illet Colas, 03 May 2012, F. Rousseau, Y. Buske, J. Espinosa, M. Snyder, G. Dirberg | KX258843 |