

Meristotheca spinella Núñez-Resendiz,
Dreckmann & Senties, sp. nov. (Solieriaceae,
Rhodophyta) a new cylindrical species
from the southwestern Gulf of Mexico

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***Meristotheca spinella* Núñez-Resendiz, Dreckmann & Senties, sp. nov. (Solieriaceae, Rhodophyta) a new cylindrical species from the southwestern Gulf of Mexico**

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ABSTRACT

The genus *Meristotheca* J. Agardh is the second largest in Solieriaceae with 13 species widely distributed whose thalli are mainly flattened. On the basis of molecular and morpho-anatomical evidence, *M. spinella* Núñez-Resendiz, Dreckmann & Senties, sp. nov. is the second species in the genus with cylindrical axes to be described from the southwestern Gulf of Mexico. rbcL sequences and genetic distance values indicate its separation from other species within *Meristotheca* and from other morphologically similar species occurring in its known distribution range as *M. cylindrica* Núñez-Resendiz, Dreckmann & Senties. The numerous short branchlets that cover the margins of main axes and branches, among other relevant anatomical and reproductive characters, is the main difference from *M. cylindrica*, its sister species.

KEYWORDS

Gigartinales,
Morphology,
rbcL,
red algae,
new species.

RÉSUMÉ

Meristotheca spinella (Solieriaceae, Rhodophyta) une nouvelle espèce cylindrique du sud-ouest du Golfe du Mexique.

Le genre *Meristotheca* J. Agardh est le deuxième plus important chez les Solieriaceae avec 13 espèces largement réparties dont les thalles sont principalement aplatis. Sur la base de preuves moléculaires et morpho-anatomiques, *M. spinella* Núñez-Resendiz, Dreckmann & Senties, sp. nov. est la deuxième espèce du genre présentant un axe cylindrique décrite dans le sud-ouest du golfe du Mexique. Les séquences de *rbcL* et les valeurs de distance génétique indiquent qu'il s'agit d'une espèce distincte des autres espèces de *Meristotheca* et des autres espèces morphologiquement similaires présentes dans son aire de répartition connue sous le nom de *M. cylindrica* Núñez-Resendiz, Dreckmann & Senties. Les nombreuses petites branches qui couvrent les marges des branches et des axes principaux constituent entre autres caractères anatomiques et reproducteurs pertinents la principale différence avec *M. cylindrica*, son espèce sœur.

MOTS CLÉS

Gigartinales,
Morphologie,
rbcL,
algues rouge,
espèce nouvelle.

INTRODUCTION

Meristotheca J. Agardh, type species *M. papulosa* (Montagne) J. Agardh, is the second largest genus in the Solieriaceae (Gigartinales) with 13 species currently accepted (Guiry & Guiry 2018). It is widely distributed in cold-temperate and tropical waters throughout the world (Fredericq *et al.* 1999; Faye *et al.* 2007, 2008; Nishihara *et al.* 2012). *Meristotheca* belongs to the group of genera in the family with gonimoblasts developed internally from a central pseudoparenchymatous mass of sterile cells that bear peripheral gonimoblast filaments (Gabrielson & Kraft 1984; Faye *et al.* 2004, 2005a). *Meristotheca* is distinguished from the other genera in the Solieriaceae by a flattened linear to blade-like, peltate or terete thallus attached by discoid holdfast; broad medullary filaments with numerous unbranched rhizoids and large or stellate inner cortical cells; gonimoblast development from an auxiliary cell; carposporophytes with a central placenta of mixed and partially fused gametophytic and gonimoblastic cells surrounded by carposporangial gonimoblast filaments, narrow sterile gonimoblasts and protuberant pericarp; and tetrasporangia cut off laterally (Gabrielson & Cheney 1987; Faye *et al.* 2005b; N'Yeurt & Payri 2009). Like many members of the family, some species of *Meristotheca* are important commercially resource for their cell wall carrageenans (Doty & Norris 1985; Watt *et al.* 2003).

In the southwestern Gulf of Mexico, *Meristotheca gelidium* (J. Agardh) E.J. Faye & M. Masuda has been traditionally recorded (Wynne 2017). Recently, under the spectrum of morphological variation attributed to *Euchematopsis isiformis* (C.Agardh) Núñez-Resendiz, Dreckmann & Senties (as *Eucheuma isimerme* (C.Agardh) J.Agardh) in the area, new diversity within Solieriaceae has been described (Núñez-Resendiz *et al.* 2019). As a result: 1) *M. cylindrica* Núñez-Resendiz, Dreckmann & Senties, was described as the first cylindrical species in the genus from Mexico (Núñez-Resendiz *et al.* 2017a); and 2) *Tepoztequiella rhizoidea* Núñez-Resendiz Dreckmann & Senties was described as a new genus and species from Mexico, similar to *Meristotheca* and sister to it (Núñez-Resendiz *et al.* 2017b). During sampling of marine

macroalgae along the coast of Campeche, cylindrical specimens previously recognized as *E. isiformis* were collected. DNA sequences indicating affinity with the genus *Meristotheca* and is described here as a new species.

MATERIAL AND METHODS

In a survey, eleven samples were collected at three localities along the Campeche coast in the southwestern Gulf of Mexico (Table 1), snorkeling at a depth of 1.0-1.5 m (see Núñez-Resendiz *et al.* (2017a) for a map showing the collecting localities). Each sample was divided into three portions: an apical section was preserved in silica gel for molecular analysis; a branch was preserved in 3% formaldehyde in seawater for morphological analysis; the rest of the sample was mounted on herbarium sheets and incorporated into the algal collections (Table 1) at Metropolitan Herbarium UAMIZ (Herbarium abbreviations follow the online Index Herbariorum <http://sciweb.nybg.org/science2/IndexHerbariorum.asp>). The only three cystocarpic plants found were part of the same voucher (UAMIZ-980).

DNA was extracted from 5-10 mg of dried tissue using a Qiagen DNeasy Plant Mini Kit (Qiagen, Valencia, California USA) according to the manufacturer's protocols. The plastid *rbcL* gene was amplified using the primer pairs F8-R753 (Freshwater & Rueness 1994; Shimada *et al.* 1999), and F765-R1381 (Freshwater & Rueness 1994; Wang *et al.* 2000). The PCR procedure followed Núñez-Resendiz *et al.* (2017a). PCR products were purified with QIAquick Gel Extraction Kit (Qiagen, Valencia, California, United States) and sequenced using the BigDye terminator cycle sequencing reaction kit on an ABI PRISM 3100 Genetic Analyzer (Applied Biosystems, Princeton, NJ, USA). Sequences were assembled and edited using the program Sequencher® 5.4.5. The final alignment included sequences of other species of Solieriaceae downloaded from GenBank and was performed using Bioedit (Hall 1999). *Gigartina pistillata* (S.G. Gmelin) Stackhouse and *Gymnogongrus griffithsiae* (Turner) C. Martius were used as outgroups. These species were selected as they

TABLE 1. — Collection data of specimens of *Meristotheca spinella* examined in the present study.

Site, GPS coordinates, date and collector	Voucher number	GenBank accession number	Reproductive state
Playa Bonita, Campeche, Mexico, 18.5939°N, 91.1106°W, 18.X.2001, M. Callejas	UAMIZ-980	MK135828	Cystocarpic
Bahia Tortuga, Campeche, Mexico, 19.2135°N, 90.4235°W, 06.VI.2015, M.L. Núñez & K.M. Dreckmann	UAMIZ-1331, isotype	MK135823	Tetrasporic
Bahia Tortuga, Campeche, Mexico, 06.VI.2015, M.L. Núñez & K.M. Dreckmann	UAMIZ-1332, holotype	MK135825	Tetrasporic
Bahia Tortuga, Campeche, Mexico, 05.IX.2017, A. Senties, M.L. Núñez & K.M. Dreckmann	UAMIZ-1333, paratype	—	Vegetative
	UAMIZ-1335, paratype	MK135824	Vegetative
	UAMIZ-1336, paratype	—	Vegetative
	UAMIZ-1337, paratype	—	Vegetative
Bahia Tortuga, Campeche, Mexico, 07.IX.2017, A. Senties	UAMIZ-1338	MK135826	Vegetative
Isla Aguada, Campeche, Mexico, 18.5013°N, 91.26051°W, 05.IX.2017, A. Senties, M.L. Núñez & K.M. Dreckmann	UAMIZ-1334	MK135827	Vegetative

belong to the same order. Phylogenetic analyses using maximum likelihood (ML) and Bayesian inference (BI) were performed separately partitioning the data into codons positions. The selected evolutionary model was GTR+I+G determined based on the Maximum Likelihood ratio test implemented by TOPALi version 2 software (Milne *et al.* 2009). ML analysis was performed using RAxML software (Stamatakis 2006). Support for each branch was obtained from 1000 bootstrap replications. BI analysis was performed using MrBayes 3.2.2 (Ronquist *et al.* 2012). Four chains of Markov chain Monte Carlo were used, starting with a random tree and sampling the data every 500 generations for 5×10⁶ generations. 25% of trees were discarded as burn-in. Pairwise distance values (*p* distances) were calculated using Mega version 5 (Tamura *et al.* 2011).

Microscopic cross-sections were made by hand using a razor blade and mounted in 80% Karo®. Photomicrographs were taken using an Olympus DP12 digital camera adapted to an Olympus BX51 microscope (DIC and bright-field). Photographs were taken with a Nikon D7000 digital camera. Morphological measurements were obtained from micrographs using SigmaScan©Pro automated image analysis software (Jandel Scientific, Sausalito, California).

RESULTS

PHYLOGENETIC ANALYSES

The *rbcL* alignment was 1346 base pair (bp) in length and included 41 sequences, six newly determined. The ML and BI analyses had identical topologies; only Bayesian tree, with BI and ML bootstrap values integrated, is shown (Fig. 1).

The topology resulting from the *rbcL* analysis showed that our sequences were placed in a strongly supported clade (BI = 0.92%, ML = 93%), including species of the genus *Meristotheca* and *M. papulosa*, the type of the genus (Fig. 1). Within this clade, the species were grouped, in turn, in two sister groups distinguishing with bars cylindrical species (Clade I) and flattened species (Clade II). Our specimens had identical sequences (see Table 1) and were resolved in a major clade, with full support, as sister to *M. cylindrica* (Clade I, Fig. 1).

Together, they formed a sister clade, with strong phylogenetic support (BI = 0.92%, ML = 93%), to Clade II composed of *M. papulosa* (Montagne) J. Agardh, *M. procumbens* P.W. Gabrielson & Kraft, *M. coacta* Okamura, *M. imbricata* E.J. Faye & M. Masuda, and a sequence designated as *Meristotheca* sp. from Taiwan (Fig. 1). *Meristotheca gelidium* and *M. dakarensis* Faye & Masuda were placed basally to the rest of the species in the genus.

The sequence divergence between our specimens and the other species of *Meristotheca* ranged from 1.5% (from *M. cylindrica* from Mexico) to 4.2% (from *M. papulosa* from Japan).

Order GIGARTINALES F. Schmitz *in* Engl., 1892

Family SOLIERIACEAE J. Agardh, 1876

Genus *Meristotheca* J. Agardh, 1872

Meristotheca spinella Núñez-Resendiz,

Dreckmann & Senties, sp. nov.

(Figs 2, 3)

HOLOTYPE. — UAMIZ-1332 (Fig. 2A), tetrasporophyte, collected at Bahia Tortuga (19.2135°N, 90.4235°W), Campeche (Mexico), on 06.VI.2015, collected by M.L. Núñez & K.M. Dreckmann. GenBank accession number MK135825.

ISOTYPE. — UAMIZ-1331, tetrasporophyte, collected at Bahia Tortuga, Campeche (Mexico), on 06.VI.2015, collected by M.L. Núñez & K.M. Dreckmann. GenBank accession number MK135823.

PARATYPES. — Listed in Table 1.

ETYMOLOGY. — The specific epithet *spinella* refers to the numerous short branches or spine-shaped proliferations that completely cover the margins of the main axes and branches.

DIAGNOSIS. — Thalli 20–35 cm high, terete, dark red in color, attached by a discoid holdfast, branching dichotomously, alternately, opposite or laterally, primary axes 1250–1500 µm in diameter; branches 550–750 µm in diameter, covered with small spine-shaped branchlets. Narrow medullary filaments with numerous single-celled rhizoids, 2.5–4 µm in diameter. Inner cortex with five to six layers of cells, 25–45 µm × 20–30 µm in diameter, with small connective filaments. Outer cortex with four to five layers of cells, 10–45 µm long and 4–14 µm in diameter. Tetrasporangia claviform, 20–30 µm

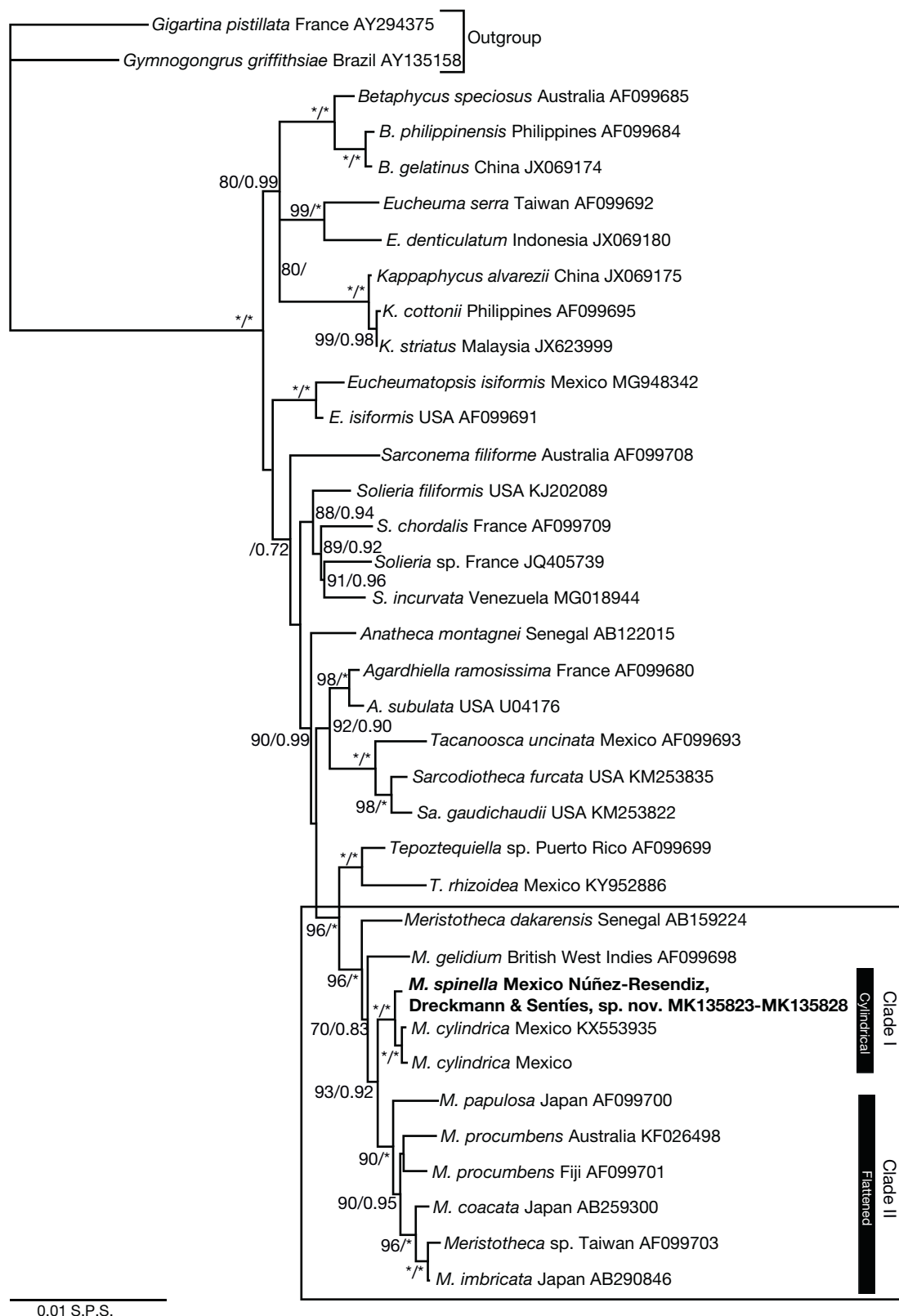


FIG. 1. — Bayesian inference topology based on *rbcL* sequence data. ML bootstrap (left) followed by BI values (right) on branches. Abbreviations and symbols: Asterisks indicate full support (ML = 100%, BI = 1.0%), values below 70% are not shown. Sequences generated in this study are in boldface (see Table 1). S.P.S. = substitutions per site.

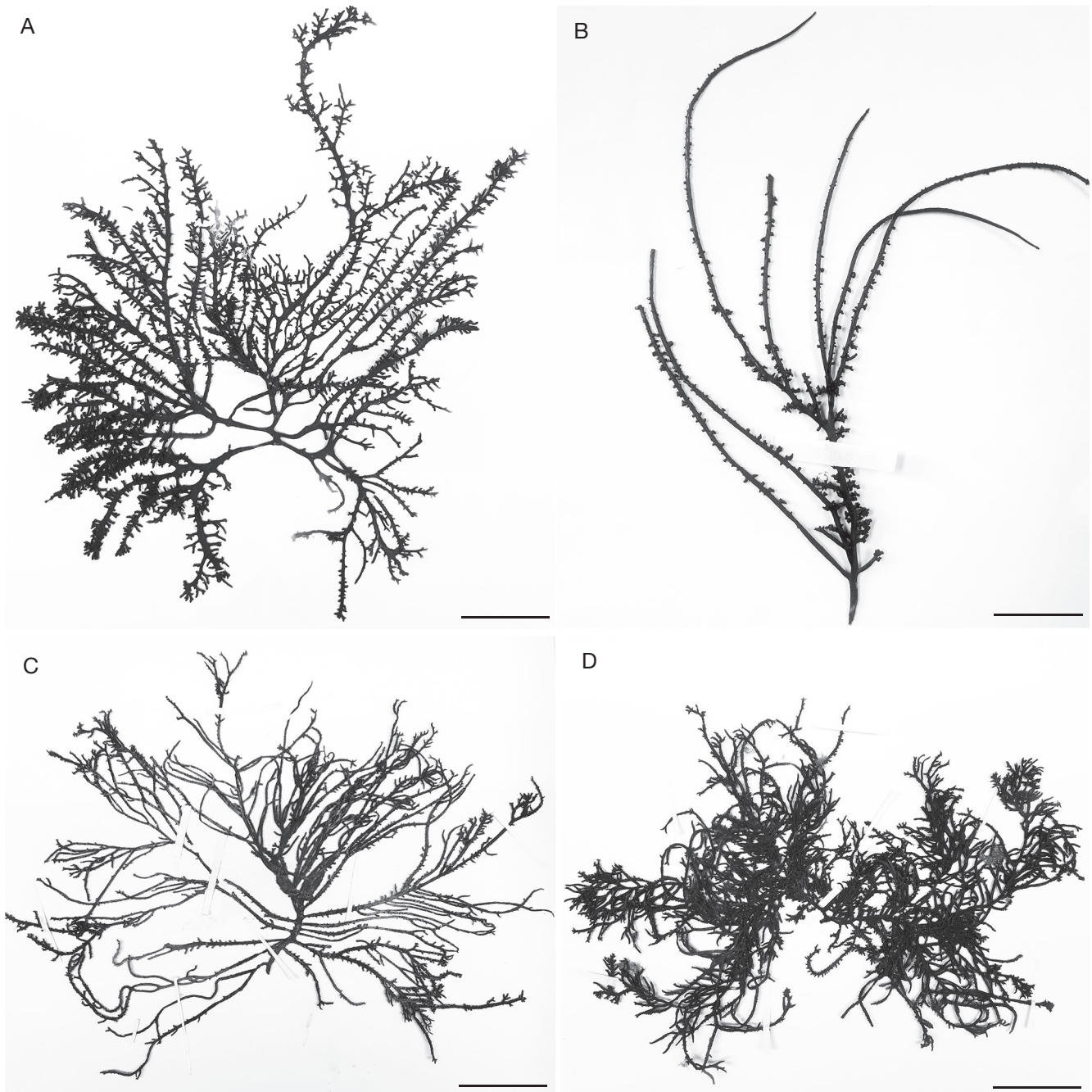


FIG. 2. — *Meristotheca spinella* Núñez-Resendiz, Dreckmann & Senties, sp. nov.: **A**, Holotype specimen; tetrasporic plant; **B**, Cystocarpic plant with numerous spines and short laterals; **C**, Habit of a vegetative plant; **D**, Vegetative plant with abundant branches and spines. Scale bars : A, 3 cm; B, 2 cm; C, D, 4 cm.

long and 4–7 μm in diameter, basally anchored by an elongated supporting cell that can form 3-celled cortical filaments, 7–10 μm long and 4–6 μm in diameter. Cystocarps ellipsoidal, 600–650 μm long and 320–430 μm in width.

ECOLOGY. — Populations of *Meristotheca spinella* Núñez-Resendiz, Dreckmann & Senties, sp. nov. were found throughout the year, with greater abundance during the spring (tetrasporophytic state) and summer (vegetative state). They were growing in sandy environments of turbid waters, with little exposure to light, attached to rocky substrata (1–1.5 m deep). They were part of the algal canopy of the submerged algal community together with different species of large red algae, such as *Asidium seaforthii* (Turner) J. Agardh, *Crasiphycus corneus* (J. Agardh) Gurgel, J.N. Norris & Fredericq, *C. us-*

neoides (C. Agardh) Gurgel, J.N. Norris & Fredericq, *Eucheumatopsis isiformis*, *Meristotheca cylindrica*, and *Tepoztequiella rhizoidea*, which were as abundant as *M. spinella* Núñez-Resendiz, Dreckmann & Senties, sp. nov. It was also a conspicuous component of the algal drift at the end of summer.

VEGETATIVE MORPHOLOGY

Thalli 20–35 cm high, terete, erect, dark red in color, cartilaginous in consistency, solitary, and attached to the substratum by a discoid holdfast (Fig. 2). Main axes ramifying dichotomously, alternately opposite or laterally (Fig. 2A), 1250–1500 μm in diameter. Branches strictly cylindrical (Fig. 3A), stout, 550–

750 µm in diameter, with margins completely covered with small spine-shaped branchlets (Fig. 2). Spines arranged alternately opposite or laterally, 0.5–4 mm long in vegetative plants and 2–8 mm long in reproductive plants, with acute apices. Thalli multiaxial, with a filamentous medulla and a pseudoparenchymatous cortex (Fig. 3A, B). Medulla comprised of narrow axial filaments arising from inner cortex cells, running parallel to the longitudinal plane of axes (Fig. 3B), 2.5–4 µm in diameter, with numerous single-celled rhizoids (Fig. 3C). Cross-wise filaments produced from inner cortical cells that traversed the axes forming secondary pit connections with inner cortical cells at the opposite side. Inner cortex composed of five to six layers of large cells, slightly pigmented, rounded, 25–45 × 20–30 µm in diameter, laterally connected by secondary pit connections or by small connective filaments that are arranged between the cells and connect them to each other (Fig. 3D). Outer cortex consisted of four to five layers of small cells arranged in filaments or rows, 10–45 µm long and 4–14 µm in diameter, elongate, oviform, pigmented and connected to each other by primary pit connections (Fig. 3E).

REPRODUCTIVE MORPHOLOGY

Tetrasporophytic plants morphologically similar to vegetative plants but with conspicuously more spines on the surface (Fig. 2A); spines associated with tetrasporangia. Tetrasporangia elongate, claviform, zonately divided, 20–30 µm long and 4–7 µm in diameter (Fig. 3F, G), isolated or in sori. Tetrasporangia scattered among cortical cells (Fig. 3F), arising basally from a support cell which in some cases formed a long cortical filament (20–30 µm long) composed of three cells morphologically differentiated from the rest of the outer cortical cells, elongated or quadrangular, 7–10 µm long and 4–6 µm in diameter (Fig. 3G). Cystocarpic plants shorter and less branched than tetrasporic or vegetative plants (Fig. 2B), with small lateral perforations associated with cystocarps instead of spines (Fig. 3H). Immature cystocarps (380–460 µm in diameter) consisted of a centrally placental carposporophyte with peripherally arranged carposporangia, inner enveloping tissue and a surrounding ostiolate pericarp (Fig. 3I, J). Vegetative cells surrounding the diploidized auxiliary cell elongate and divide to form nutritive-cell clusters (Fig. 3I). Cortical cells, that lie directly above a diploidized auxiliary cell, become meristematic and locally form an expanded cortex or pericarp over the developing cystocarp (Fig. 3J). An ostiole begins to be formed at an early developmental stage of each pericarp (Fig. 3K). Gonimoblast composed of small tubular and elongated cells that fuse or connect with cells of the sterile enveloping tissue (Fig. 3J, K). Mature cystocarps with a central pseudoparenchymatous tissue (placenta) and peripheral carposporangial chains, ellipsoidal, 600–650 µm long and 320–430 µm in diameter (Fig. 3K). Male plants unknown.

DISCUSSION

Our molecular and morphological data clearly show that the new species is placed in the genus *Meristotheca* and that

it is distinct from the other species of the genus. *M. spinella* Núñez-Resendiz, Dreckmann & Senties, sp. nov. shares the morphological characters of the genus with the other 13 known species, such as broad medullary filaments with numerous unbranched rhizoids, gonimoblast development from an auxiliary cell, carposporophytes with a central placenta of mixed and partially fused gametophytic and gonimoblastic cells surrounded by carposporangial gonimoblast filaments (Faye *et al.* 2004). Although only eight of the 14 currently recognized species for *Meristotheca* have been sequenced, our phylogenetic analyses show two major sister clades (Clade I and Clade II) in which these species are grouped, which in turn are consistent with the distribution pattern of the species that they contain. Clade I, composed of *M. cylindrica* and *M. spinella* Núñez-Resendiz, Dreckmann & Senties, sp. nov., groups species that are endemic to the Western Atlantic and have cylindrical habits (Núñez-Resendiz *et al.* 2017a), so they are most closely related. Clade II, composed of *M. papulosa*, *M. procumbens*, *M. coacta* and *M. imbricata*, groups Indo-Pacific species that have flat or laminar thalli (Faye *et al.* 2005b, 2007, 2008). Other two species, *M. dakarensis* from Senegal and *M. gelidium* from the British West Indies, were resolved as the earliest diverged lineages in the *Meristotheca* clade. Both have a flat habit and are distributed in the Atlantic Ocean (Faye *et al.* 2004).

Sequence divergence between *Meristotheca spinella* Núñez-Resendiz, Dreckmann & Senties, sp. nov. and other species of the genus (1.5%–4.2%) are also consistent with previously reported interspecific distance values within the family (e.g. 2.8%–4.4%, Núñez-Resendiz *et al.* 2017a), supporting the recognition of *M. spinella* Núñez-Resendiz, Dreckmann & Senties, sp. nov. as a new species. The minimum distance value between *M. spinella* Núñez-Resendiz, Dreckmann & Senties, sp. nov. and *M. cylindrica* is also consistent with those values found among other closely related species of *Meristotheca*, such as *M. coacta* and *M. imbricata* from Japan (divergence 1.5%).

Morphologically, *Meristotheca spinella* Núñez-Resendiz, Dreckmann & Senties, sp. nov. also differs from other species of the genus, with the exception of *M. cylindrica*, in its cylindrical thallus. Regarding *M. cylindrica*, which also has cylindrical thallus, the main character to discriminate them in the field is that in *M. spinella* Núñez-Resendiz, Dreckmann & Senties, sp. nov. both vegetative and reproductive thalli have numerous spine-like branchlets, not necessarily associated with reproduction, consistently arranged alternately opposite or laterally in branches and main axes. Although reproductive specimens of *M. cylindrica* can also have spine-like laterals, they are irregularly arranged and are always associated with reproductive structures (Núñez-Resendiz *et al.* 2017a). Anatomically, there are also notable differences among them. For example, *M. spinella* Núñez-Resendiz, Dreckmann & Senties, sp. nov. has a more developed inner and outer cortex (5–6 and 4–5 cells, respectively) in contrast to *M. cylindrica* (4–5 and 1–2 cells, respectively). In contrast, *M. cylindrica* has a greater development of the medulla than *M. spinella* Núñez-Resendiz, Dreckmann & Senties, sp. nov., where the coverage of the medullary filaments is significantly lower than in *M. cylindrica*.

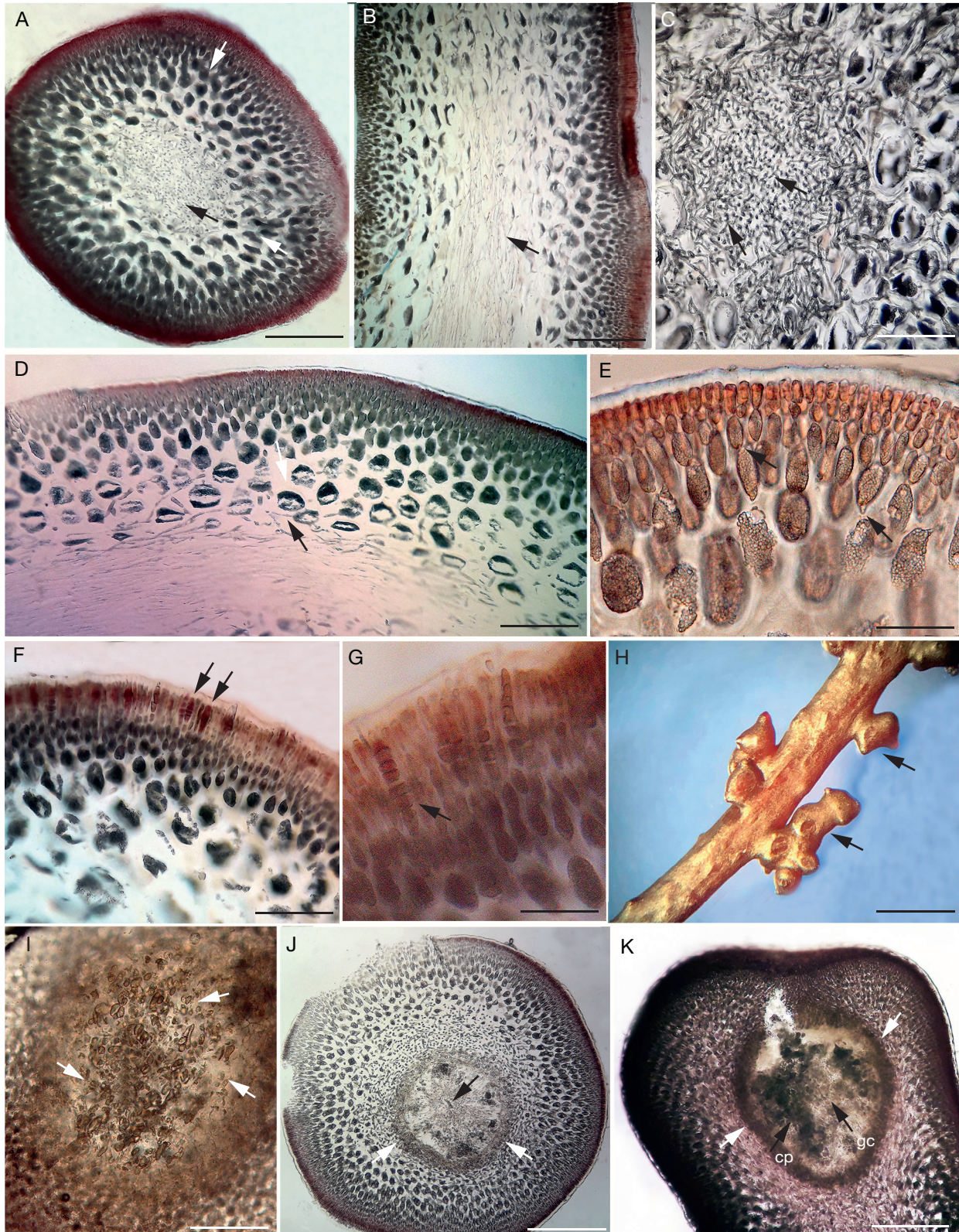


FIG. 3. *Meristotheca spinella* Núñez-Resendiz, Dreckmann & Senties, sp. nov.: **A**, cross section showing a filamentous medulla (arrow) surrounded by cortical cells (white arrow); **B**, Longitudinal section showing medullary filaments (arrow) running parallel to the main axes and cortical cells; **C**, Medullary filaments with numerous rhizoids (arrows); **D**, Inner cortical cells interconnected by small cortical connective filaments (arrow) and secondary pit connections (white arrow); **E**, Outer cortical cells interconnected by primary pit connections (arrows); **F**, Tetrasporangia arising from outer cortical cells; **G**, Tetrasporangia arising from a four-celled cortical filament (arrow); **H**, Branch with short laterals bearing cystocarps (arrows); **I**, Nutritive cell clusters formed from vegetative cells around the diploidized auxiliary cell (white arrows); **J**, Mature cystocarp arising from medullary filaments cells: auxiliary cell (arrow) and enveloping tissue (white arrows); **K**, Mature cystocarp showing the pericarp (white arrows), sterile gonimoblast cells (gc), and chains of carpospores (cp). Scale bars: A, B, 150 µm; C, 70 µm; D, 100 µm; E, I, 60 µm; F, 80 µm; G, 40 µm; H, 3 mm; J, K, 250 µm.

TABLE 2. — Comparison of the morphological features of *Meristotheca spinella* Núñez-Resendiz, Dreckmann & Senties, sp. nov., *M. cylindrica* Núñez-Resendiz, Dreckmann & Senties and other common morphologically similar cylindrical species in the Yucatan Peninsula.

Taxa	<i>Meristotheca spinella</i> Núñez-Resendiz, Dreckmann & Senties, sp. nov.	<i>Meristotheca cylindrica</i> Núñez-Resendiz, Dreckmann & Senties	<i>Eucheumatopsis</i> <i>isiformis</i> (C. Agardh) Núñez-Resendiz, Dreckmann & Senties	<i>Tepoztequiella</i> <i>rhizoidea</i> Núñez- Resendiz Dreckmann & Senties
Thallus: position with respect to the substrate; attachment	Erect; attached by a discoid hold-fast	Erect; attached by a discoid holdfast	Erect; attached by a discoid holdfast	Erect; attached by a discoid holdfast
Thallus: length	20–35 cm	5–30 cm	15–40 cm	20–30 cm
Shape of the main axes in cross section	Terete	Terete to complanate	Terete	Terete
Branching	Dichotomous, alternate opposite or lateral	Alternate opposite, and branches, in turn, ramified in the same way	Radial alternate, subopposite or irregular	Irregular to pseudodichotomous
Branches: diameter	550–750 µm	380–780 µm	350–850 µm	360–450 µm
Medulla composition	Narrow axial filaments with numerous single-celled rhizoids	Axial filaments and adventitious filaments	A dense mass of thick filaments and numerous single-celled and un-branched rhizoids	Axial filaments and adventitious filaments with many rhizoids
Medullary filaments: diameter	2.5–4 µm	4.5–7 µm	1.8–6 µm	1.3–2.5 µm
Inner cortex cells: layers of cells; diameter	5–6; 25–45 × 20–30 µm	4–5; 40–80 µm	2–6; 34–106 µm × 40–140 µm	4–6; 40–70 × 60–100 µm
Inner cortical cells: connection	Secondary pit connections and small connective filaments	Secondary pit connections and cross wise filaments	Secondary pit connections	Secondary pit connections
Outer cortex cells: layers of cells; size	4–5; 10–45 × 4–14 µm	1–2; 9–15 µm	2–3; 6–13 × 3.5–4.4 µm	2; 5–7 × 2.5–4.0 µm
Rhizoids	Medullary filaments	Absent	Medullary filaments	Medullary filaments and outer cortex cells
Tetrasporangia: anchored	Basally from a support cell which in some cases formed a long cortical filament composed of three cells	Laterally by an irregular support cell	Laterally by a stellate support cell	Basally by an elongated support cell
Tetrasporangia: size	20–30 µm long and 4–7 µm in diameter	50–60 µm long and 18–25 µm in diameter	30–40 µm long and 10–15 µm in diameter	16–25 µm long and 5–11.5 µm in diameter
Tetrasporangia: support cell size	7–10 µm long and 4–6 µm in diameter	30–45 µm in diameter	7–9 µm long and 4–6 µm in diameter	6.5–10 µm long and 3.5–7 µm in diameter
Cystocarps: position in the thallus	Small lateral perforations	In the margins of the branches or in lateral proliferations	Short laterals	Unknown
Cystocarps: goni-moblast development	From a central pseudoparenchymatous mass of sterile cells	From a central pseudoparenchymatous mass of sterile cells	From a single large central fusion cell	From a central pseudoparenchymatous mass of sterile cells
Cystocarps: size	600–650 µm long and 320–430 µm in diameter	625–864 µm long and 480–672 µm in diameter	360–498 µm long and 400–640 µm in diameter	Unknown
References	This study	Núñez-Resendiz <i>et al.</i> 2017a	Núñez-Resendiz <i>et al.</i> 2018	Núñez-Resendiz <i>et al.</i> 2017b

(Table 2). Another important difference between them, at the reproductive level, is the development of tetrasporangia. In *M. cylindrica* tetrasporangia arise laterally from a kidney-shaped auxiliary cell (Núñez-Resendiz *et al.* 2017a), whereas in *M. spinella* Núñez-Resendiz, Dreckmann & Senties, sp. nov. they arise basally from an elongated supporting cell, which in turn can form a 3-celled filament morphologically differentiated in size and shape from the rest of the outer cortex cells. Other morphological differences among them such as cell measurements and branching patterns are summarized in Table 2.

Meristotheca cylindrica, *Tepoztequiella rhizoidea* and *M. spinella* Núñez-Resendiz, Dreckmann & Senties, sp. nov. were previously missidentified as *Eucheumatopsis isiformis* (Callejas-Jiménez *et al.* 2005). This is due to these four species share the same distribution area and *E. isiformis* has a high morphological plasticity (Gabrielson 1983; Cheney 1988; Núñez-Resendiz *et al.* 2018). Phylogenetic affinities and morphological characters between these species and *M. spinella* Núñez-Resendiz, Dreckmann & Senties, sp. nov. are clearly distinct (Fig. 1, Table 2). However, they are similar in outer morphology and they could be confused in the field, since

they share their distribution (Núñez-Resendiz *et al.* 2017b). Table 2 summarizes the characters to distinguish these morphologically similar taxa.

The knowledge of the diversity of cylindrical species in the Solieriaceae from the Yucatan Peninsula is increasingly robust. By contrast, flat species remain understudied. Consequently, it is necessary to continue with a detailed study on the family in the area.

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