

DESCRIPTION AND DISTRIBUTION OF *NEMACYSTUS HOWEI* (W.R. TAYLOR) KYLIN
(CHORDARIACEAE) FROM THE NORTHERN COAST OF THE YUCATÁN PENINSULA
DESCRIPCIÓN Y DISTRIBUCIÓN DE *NEMACYSTUS HOWEI* (W.R. TAYLOR) KYLIN
(CHORDARIACEAE) EN LA COSTA NORTE DE LA PENÍNSULA DE YUCATÁN

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Abstract

Background: There are few studies about *Nemacystus* on the Atlantic coast, and *N. howei* has been reported only once for Mexico; that record, however, did not provide a description of this species.

Question: What are the morphological characteristics of *Nemacystus howei* and its distribution on the Yucatan coast?

Species study: Macroalgae, Phaeophyceae, *Nemacystus howei*.

Study site and year of study: North coast of Yucatán Peninsula of Mexico. Dry and rainy seasons from 2017 to 2019.

Methods: Sampling was carried out at five localities, at 5 and 10 m depths, with scuba equipment. Specimens were preserved in diluted formalin in sea water; silica gel and dried-pressed vouchers are housed at the UADY

Results: Six samples were collected at the five localities. Each one contains a small mass of filamentous of specimens of *Nemacystus howei*, that were found only during dry season, at both depths sampled. This alga has a thallus of an entangled filamentous mass of cylindrical, mucilaginous axes, of a light brown color. Younger branches have a solid central axis. Branching is abundant. The main, older axes are hollow. The assimilatory filaments are branched a few times, producing uniseriate colorless hairs and with plurilocular sporangia arising from the base. *Nemacystus howei* is easily confused with *Cladosiphon occidentalis* Kylin due to their similar morphology, branching pattern, and size.

Conclusion: The significant morphological similarities between these species as well as the paucity of specific works on the Phaeophyceae of the Yucatan Peninsula may explain why *Nemacystus howei* had not been previously reported.

Keywords: *Cladosiphon*, Gulf of Mexico, morphology, Phaeophyceae.

Resumen

Antecedentes: *Nemacystus* es un género poco estudiado y *N. howei* solo se ha reportado una vez para México, sin una descripción de esta especie.

Pregunta: ¿Cuáles son las características morfológicas de *Nemacystus howei* y su distribución en la costa de Yucatán?

Especie de estudio: Macroalgas, Phaeophyceae, *Nemacystus howei*.

Sitio y años de estudio: Costa norte de la península de Yucatán. Temporadas de secas y lluvias, de 2017 a 2019.

Métodos: Se muestrearon 5 sitios a lo largo de la costa a 5 y 10 metros de profundidad, con equipo de buceo autónomo. Los especímenes se conservaron en formalina al 4 %, sílica gel y en cartulina y se depositaron en el herbario de la UADY Mérida.

Resultados: Se colectaron 6 muestras en cinco localidades cada una contenía unos filamentos de especímenes de *Nemacystus howei*. Solo se encontró durante la época de seca, a ambas profundidades. Se presenta como una masa de filamentos cilíndricos, y mucilaginosos, de color café claro. Los ejes principales son huecos y las ramas juveniles tienen eje central sólido. La ramificación es abundante. Los filamentos asimiladores son poco ramificados, producen pelos incoloros uniseriados y la esporangia plurilocular surge de su base. *Nemacystus howei*, se confunde fácilmente con *Cladosiphon occidentalis* Kylin, debido a su morfología, patrón de ramificación y tamaño similares.

Conclusión: Se considera que, por la gran similitud morfológica con *C. occidentalis* y la falta de trabajos especializados sobre el grupo Phaeophyceae, es posible que por ello no se había reportado anteriormente para la Península de Yucatán.

Palabras claves: *Cladosiphon*, Golfo de México, morfología, Phaeophyceae.

Nemacystus is a genus in the family Chordariaceae (Order Ectocarpales, Class Phaeophyceae) and contains 8 species (Guiry & Guiry 2020). The type species of the genus is *N. ramulosus* Derbès & Solier. There are relatively few studies on *Nemacystus*, the most complete one being that of de Jong & Prud'homme (1997), who did a review of the genus based on morphological characters and presumed phylogenetic relationships. A molecular phylogeny, however, has not yet been carried out for this genus. Species differ from each other on such subtle morphological traits as the dimensions and shape of the assimilatory filaments, plurilocular sporangia, color, ramification, and general habit (Jong & Prud'homme 1997).

In North America only two species have been reported, *Nemacystus brandegeei* (Setchell & Gardner) Kylin on the Pacific coast (Pedroche *et al.* 2008, Norris 2010) and *Nemacystus howei* (W.R. Taylor) Kylin on the Atlantic coast. On the Atlantic coast *N. howei* has been reported and described from Florida, North Carolina, and Bermuda (Taylor 1928, 1960, Schneider & Searles 1975, 1991, Schneider 2003). In Brazil, this species was reported by Cassano & Pedrini (1992), which was the first report for the Atlantic coast of South America. Menezes & Campos de Paula (2010) later reported it from the southeastern coast of Brazil. It was reported and described from Florida by Taylor (1928, 1960) and Dawes & Mathieson (2008); for North Carolina it was reported and described by Schneider & Searles (1991), and for the Caribbean islands of Aruba and Bonaire by Vroman & Stegenga (1988). For the Gulf of Mexico, Fredericq *et al.* (2009) reported *N. howei* as a synonym of “*Eudesme howei*” Taylor nom. inval., citing the

report of Phillips & Springer (1960) for the Gulf coast of Florida. Finally, for the Atlantic coast of Mexico, Mateo-Cid *et al.* (2013) reported *N. howei* as a new record from the subtidal benthic macroalgae from the Campeche Banks.

Almost all the previous works with descriptions showed only illustrations of the species, especially of the assimilatory filaments and the plurilocular sporangia, except that of Cassano & Pedrini (1992), which also included photos of transverse sections of the thallus, depicting the central axis to be solid in younger parts and hollow in older parts. For the Atlantic coast of Mexico, however, despite being the first report, a description of the morphological characteristics or figures of this species has not yet been given for Mexico. So, this report is the first morphological descriptive account of this species in Mexico, and we provide the distribution of *Nemacystus howei* for the northern coast of the Yucatan Peninsula.

Materials and methods

Sampling was carried out on the northern coast of Yucatan during the dry season (with a 26.6 °C temperature average, 38 UPS and 8.8 pH) and the rainy season (with a 29.4 °C temperature average, 36 UPS and 7.9 pH) at five localities: Ria Lagartos, 21° 38' 31.5" N; 88° 10' 19.8" W, San Felipe 5m (21° 37.080' N; 88° 13.818' W), San Felipe 10 m (21° 39.344' N; 88° 16.344' W), Coloradas 10 m (21° 43' 17.2" N; 87° 58' 187" W), Chicxulub 10 m (21° 32.284' N; 89° 30.973' W), “Bajos 10” 10m (21° 21.210 N; 90° 09.125 W) and “Bajos 10” 5m (21° 20.870 N; 90° 08.940 W.) at Sisal reefs (Figure 1) from 2017 to 2019 at two depths (5 and 10 m) in the sublittoral, using SCUBA

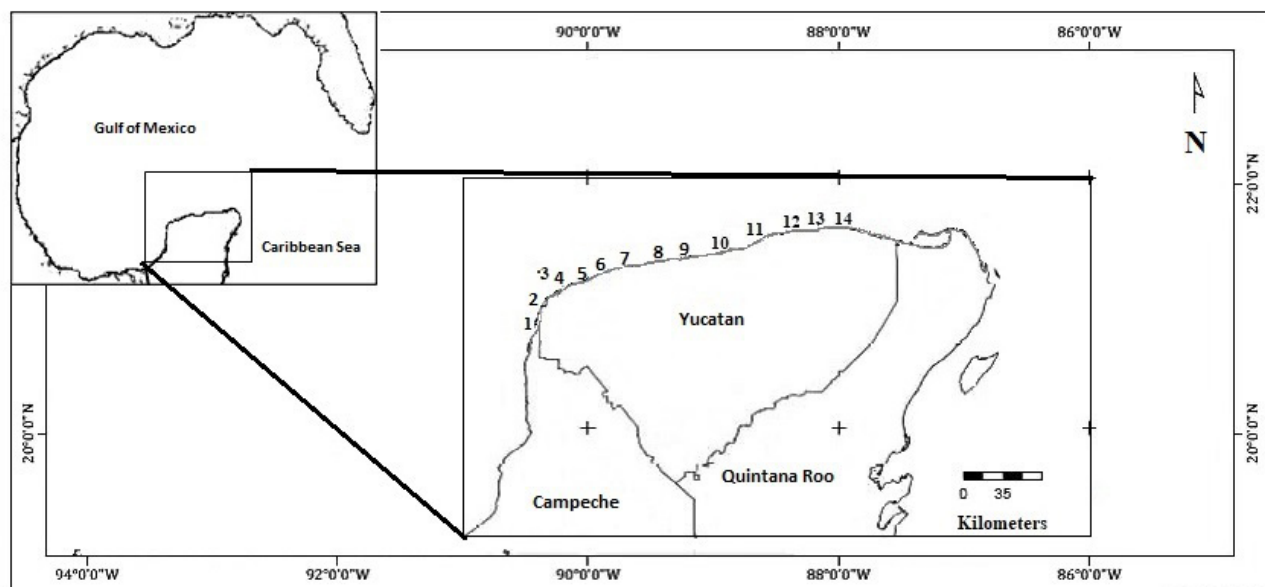


Figure 1. Sampling sites of *Nemacystus howei*: 1.- “Bajos de 10” (Sisal reefs), 2.- Chicxulub, 3.- San Felipe, 4.- Rio Lagartos, 5.- Las Coloradas. Telchac was the locality where *N. howei* (reported as *brandegei*) was found at the UADY herbarium.

equipment. Specimens were separated, labeled, and preserved in a 4 % formaldehyde solution in seawater, silica gel and two dry vouchers were made from each sample, which are housed at the Herbarium Alfredo Barrera Marin of the University Autonomous of Yucatan (UADY). The determination was made using the keys and descriptions of [Taylor \(1960\)](#), [Schneider & Searles \(1991\)](#), [Cassano & Pedrini \(1992\)](#), and [Dawes & Mathieson \(2008\)](#).

Results

Six samples were collected at the five localities and each one contains a small mass of filamentous specimens of the species *Nemacystus howei* (W.R. Taylor) [Kylin 1940](#), that belongs to: Kingdom Chromista, Phylum Ochrophyta, Class Phaeophyceae, Order Ectocarpales, Family Chordariaceae, Genus *Nemacystus* Derbès & Solier, 1850.

Basionym. *Castagnea howei* W.R. [Taylor 1928: p. 111](#), Reported by [Taylor 1960: p. 249](#), [Earle 1969: p. 184](#), [Dawes 1974: p. 107](#), [Schneider & Searles 1991: p.138](#), [Dawes & Mathieson 2008: p.145](#). Type locality: Dry Tortugas, Florida. Distribution in the Western Atlantic: The Carolinas, Florida, northern Gulf of Mexico, Gulf of Mexico, Brazil, Bermuda. Distribution on the northern coast of Yucatán Ria Lagartos, San Felipe, Coloradas, Chicxulub, and “Bajos 10” at Sisal reefs and Telchac ([Figure 1](#)). We observed *N. howei* to occur only in the dry season between March-June. It can be epiphytic or saxicolous, from 5 to 10 m depths ([Table 1](#)).

Examined Material. We collected six samples of specimens of *Nemacystus howei* ([Table 1](#)): UADY 1594 at Coloradas, UADY 1595 at Ria Lagartos, UADY 1596 at San Felipe, UADY 1597 at San Felipe, UADY 1598 at Chicxulub, UADY 1599 at “Bajos de 10” (Sisal Reefs).

Description. Thallus with a filamentous form, soft and mucilaginous entangled masses, up to 45 cm long, color light brown and somewhat greenish ([Figure 2A-B](#)). The axis is cylindrical, and the uniaxial structure is visible proximal to the apical cells. Branching is abundant, up to three orders, alternate to irregular. The internal structure is differentiated between a medulla (with 2-4 rows of colorless cells) and cortical cells. The main and older axes become hollow with a diameter between 0.3 - 0.6 mm ([Figures 2C, 3A](#)); the younger branches have a solid central axis, thin, cylindrical and often entangled, 0.1 - 0.3 mm in diameter ([Figure 3C](#)). The medullary cells are from 55-120 by 30-60 μm in diameter. The cortical cells are 12-25 by 12-45 μm in diameter.

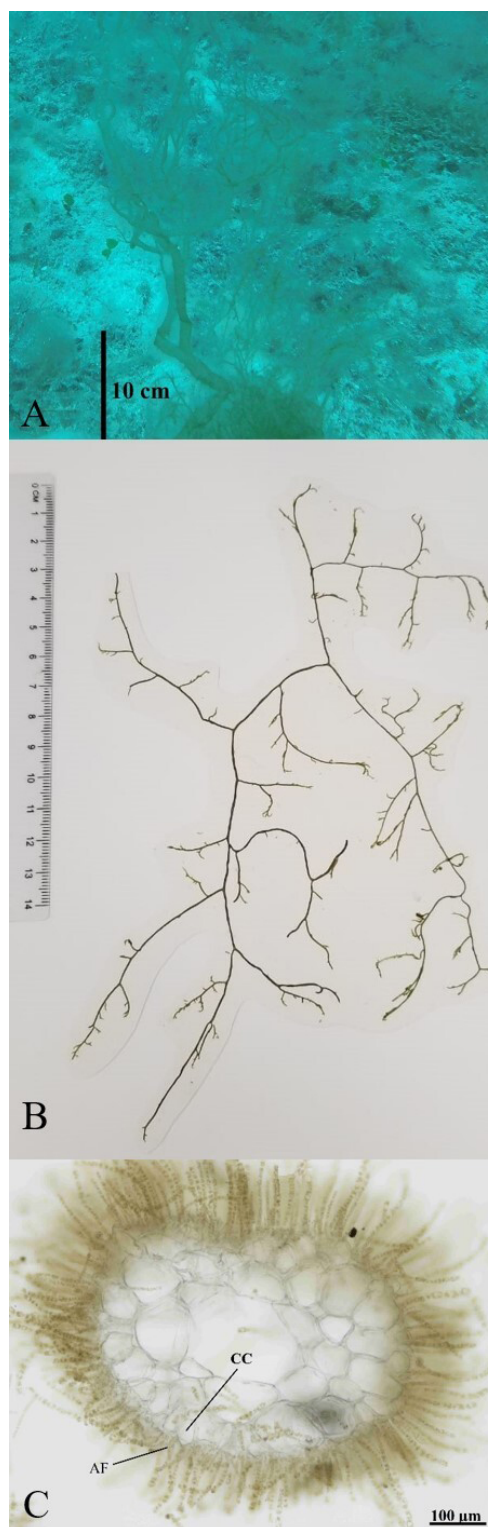


Figure 2. *Nemacystus howei*. A) Habit, B) A pressed specimen, C) Transverse section with cortical cells (CC) ramified assimilatory filaments (AF) and showing sporangia and a hollow interior.

Nemacystus howei (W.R. Taylor) Kylin from the Yucatan Peninsula

Table 1. Material examined.

Date	Localities	Genus	species	I.D Number	Depth (m)
06/05/2017	Coloradas	<i>Nemacystus</i>	<i>howei</i>	UADY 1594	10
06/05/2017	Ría Lagartos	<i>Nemacystus</i>	<i>howei</i>	UADY 1595	5
06/05/2017	San Felipe	<i>Nemacystus</i>	<i>howei</i>	UADY 1596	5
06/05/2017	San Felipe	<i>Nemacystus</i>	<i>howei</i>	UADY 1597	10
07/06/2019	Chicxulub	<i>Nemacystus</i>	<i>howei</i>	UADY 1598	10
15/06/2019	Bajos de 10	<i>Nemacystus</i>	<i>howei</i>	UADY 1599	5
28/04/2017	Bajos de 10	<i>Cladosiphon</i>	<i>occidentalis</i>	UADY 1593	10
17/10/2010	Telchac	<i>Nemacystus howei</i> (reported as <i>brandegeei</i>)		UADY 1136 - (Epiphyte of <i>Sargassum</i>)	

The assimilatory filaments are not branched, 6-8(-13) cells long, with rounded moniliform or reniform cells, 10-15 μm near the apices and to 4-6 μm below. There are several discoid plastids per cell. These cells produce colorless hairs, 8-10 μm in diameter (Figure 3C). Unilocular sporangia were not observed. Plurilocular sporangia are uniseriate, arising from the base of the assimilatory filaments or directly from the cortical cells; 40-80 μm long with 8-23 loculi, which are 4-6 μm in diameter (Figure 3D).

Discussion

The review of the morphological descriptions of the specimens of *Nemacystus howei* by previous authors (Taylor 1960, Schneider & Searles 1991, Cassano & Pedrini 1992, de Jong & Prud'homme 1997, Dawes & Mathieson 2008), with respect to what was found in Yucatan, are very similar in size.

The reports of *N. howei* from the northern Gulf of Mexico, Florida, and Bermuda, showed a thallus length of

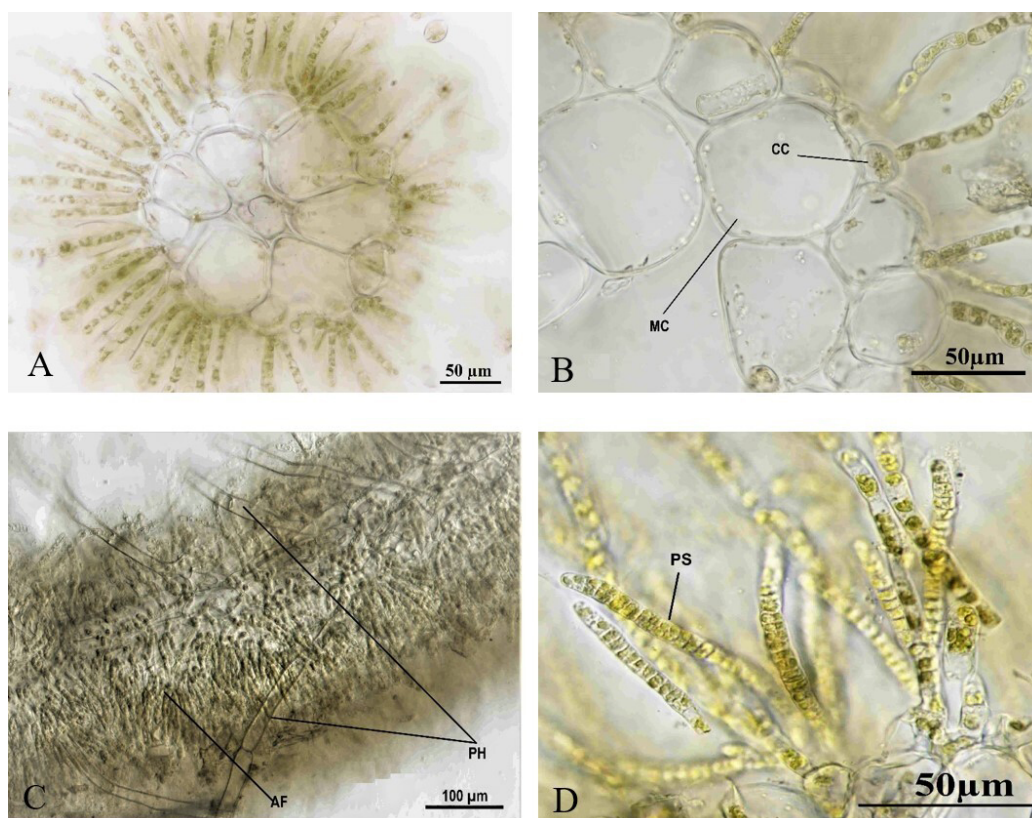


Figure 3. *Nemacystus howei*. A) Rows of medullary cells (MC) and cortical cells (CC), B) Transverse section showing a solid axis, C) Phaeophycean hairs (PH) and assimilatory filaments (AF), D) Plurilocular sporangia (PS).

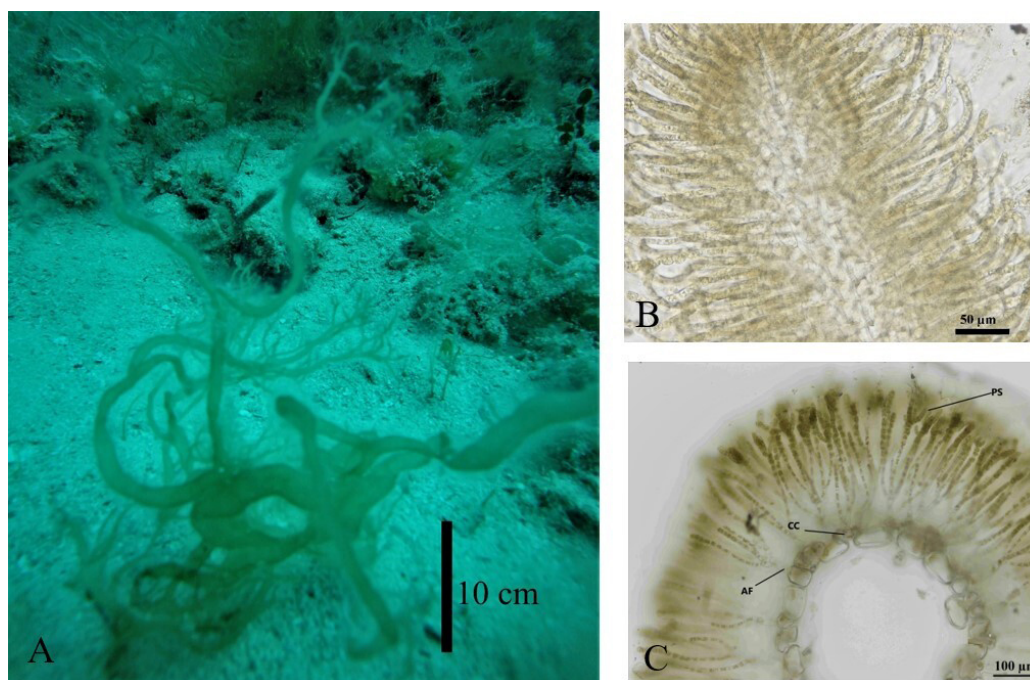


Figure 4. *Cladosiphon occidentalis*. A) Habit, B) Branch, C) Transverse section of *C. occidentalis* with cortical cells (CC) ramified assimilatory filaments (AF) and plurilocular sporangia (PS).

approximately 45 cm, which is like our specimens, and with a diameter similar to those values for North Carolina specimens, as reported by [Schneider & Searles \(1991\)](#), who found specimens to be slender with main axes not exceeding a diameter of 0.5 mm. Also, our specimens were found at lower depths than other reports ([Table 2](#) in [Appendix 1](#)).

Nemacystus howei ([Figure 2A, 3C](#)) has often been misidentified and easily confused with *Cladosiphon occidentalis* Kylin ([Kylin 1940](#), [Schneider & Searles 1975](#), de [Jong & Prud'homme 1997](#)) because of their very similar external morphology, ramification, and size ([Figure 4A-B](#)).

We found *C. occidentalis* (UADY 1593) at one locality (“Bajos de 10” at Sisal Reef) ([Table 1](#)), and it was necessary to make transverse sections to verify the identity. The main differences are the solid medulla of the younger branches and more medullary cells in the older branches of *N. howei*, whereas the cortex in *C. occidentalis* is formed of only one row of cells. The assimilatory filaments in *C. occidentalis* have a pedicel and then bifurcate two or three times; also, the sporangia are formed at the end of the filaments ([Figure 4C](#)), whereas in *N. howei* the filaments are uniseriate and the sporangia arise at the base of the filaments or directly on the cortical cells ([Figure 3A](#)).

At the UADY herbarium we found a single collection that had been identified as *N. brandegeei* (Setchell &

Gardner) Kylinin Telchac, Yucatan ([Figure 1](#)), but it was misidentified and turned out to be *N. howei* ([Table 1](#)). There were no vouchers of *Cladosiphon* besides the ones that we collected.

Even though the external morphologies of these two species are very similar, it is relatively easy to distinguish them when their internal characteristics are checked. Their external resemblances have likely resulted in past confusion in their accurate determinations. Also, the paucity of specific works on the Phaeophyceae for the Yucatan Peninsula is another probable explanation why this is the first report of *N. howei* for the Yucatan Peninsula.

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Authors contribution: IOA Writing paper, analyzing data, field work, specimen's examination, taxonomic review, taxonomic determination. AMS specimens examination, taxonomic review, taxonomic determination, writing analysis, reviewing paper. MCGS field work, writing analysis and compilation of the database, reviewing paper. MJW Taxonomic review and nomenclature, herbarium review of the type specimen, reviewing paper.

Appendix 1. Morphological characters of *Nemacystus howei* by different authors.

	Taylor 1960	Schneider & Searles 1991	Cassano & Pedrini 1992	Jong & Prud'homme 1997	Dawes & Mathieson 2008	Ortegon-Aznar <i>et al.</i> this work
Habit	Entangled with other algae	In tangled masses	Filamentous, twisted and matted with other algae.	Much entangled. dark brown	Attached by a rhizoidal holdfast, epiphytic, entangled or on limestone	Filamentous, twisted and matted with other algae.
Depth (m)	7-55	15-25	-	Bermuda: 54-64, Florida: 7.2-34.2, North Carolina: 15-25.	13- 55	5-10
Distribution months	-	May-August, November.	October- December	-	-	March-June
Size (cm)	20-40	40	35	20-50	40	20-45
Branches ramification	Alternate abundant	Alternate abundant, to 3 orders	Irregular abundant rarely alternate	Abundant irregular, occasionally dichotomous, Alternate to 3 orders	Alternate to irregular abundant, to 3 orders	Alternate to irregular abundant, to 3 orders
Cortex	-	-	Solid at apical zones and hollow in intermediate part	Central axis solid, hollow in older portions	-	Solid at apical zones and hollow in older parts
Cortex diameter (mm)	0.3-1	to 1	-	0.3- 1	to 1	0.3-06
Medullar cells (µm) wide by long	58-166 x 132-1410	30-166 by 132-1410	48-91 by 26.5-60	30-166 by 132-1410	60-170 by 130-1400	55-120 by 30-60
Cortical cells (µm) wide by long	-	-	19-39 by 12-27	22 x 14	-	12-25 by 12-45
Assimilatory filaments Shape	Cylindrical below moniliform or reniform above unbranched	Cylindrical below moniliform or reniform above -	Cylindrical, moniliform to reniform Simple to branched	Cylindrical below moniliform or reniform above. Simple, in small bundles at the base (Branched at the base)	rounded cells unbranched	Rounded moniliform or reniform Unbranched or rarely branched
Assimilatory filaments Number of cells long	8	8-13	(6-) 8-12 (-16)	(6-)7-9 (-12)	8-13	6-8 (-13)
Assimilatory filaments Size diam (µm)	10-16.5 toward their summits 3.2-8 toward the bases	10-17 near apices	12-26 apical cell	16-19 apical cell	10-15 apical cells	10-15 apical cells

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	Taylor 1960	Schneider & Searles 1991	Cassano & Pedrini 1992	Jong & Prud'homme 1997	Dawes & Mathieson 2008	Ortegon-Aznar <i>et al.</i> this work
Sporangia Plurilocular Shape	-	Uniseriate-bi seriate	Single, rarely branched, straight or curved, with pedicel	Single or branching pedicel or without pedicel	Uniseriate-bi seriate, Single or branching pedicel	Single, rarely branched, straight or curved,
Sporangia size long (µm)		37-68	29-77	30-80	40-80	40-80
No of sporangia per fascicle	to 10	to 10	to 15	to 10	to 6	To 6
Sporangia Size diam (µm)	6.6-7.5	6-8	5-7	4.6-8.3	6-8	4-6
Loculi	-	-	-	8-20	-	8-23
Unilocular sporangia Shape	Spherical to ovoid	Spherical to ovoid	Spherical to ovoid	Spherical to oval regular or asymmetrical	ovoid	-
Unilocular sporangia size (µm)	18-37	18-37	49-62 x 17-40	20-50 x 18-39	20-40	-
Phaeophycean or colorless hairs, diam (µm)	8-10	8-10	8-10	-	8-10	8-10