

Ganesan, E.K. (1994). Morphology and taxonomy of the little-known species *Gracilaria cuneata* J.E.Areschoug (Gracilariales: Rhodophyta) from Venezuela. ***Caribbean Journal of Science*. 30: 124-129**

ABSTRACT: The morphology, anatomy and reproduction (male, female and tetrasporophyte) of a poorly known species of Gracilaria, G. cuneata J. E. Areschoug (1855) are described and illustrated using material collected in eastern Venezuela. Spermatangia are produced in very shallow, ill-defined pit-like cavities ("x" type). Tubular nutritive cells are mostly restricted to the floor and basal lateral sides and rarely occur on the outer pericarp of the cystocarp. Cortical cells in the region of tetrasporangial formation show some evident modification (nemathecium). A specimen from the collection at Pernambuco, Brazil, which agrees in all respects with the Venezuelan specimens, is designated as the lectotype and is illustrated for the first time. Similarities and differences between G. cuneata and species of similar morphology, such as G. crispata, G. curtissiae and Petroglossum undulatum, are mentioned.

RESUMEN: Se describen e ilustran la morfología, anatomía y reproducción (masculina, femenina y tetraspórica) de una especie muy poco conocida de Gracilaria- G. cuneata J. E. Areschoug (1855), empleándose material recolectado en el oriente venezolano. Los espermatangios se producen en cavidades poco profundas e indefinidas (tipo "x"). Las células nutritivas tubulares están restringidas en su mayoría al piso y lados basales del cistocarpio, y muy raramente ocurren en el pericarpio externo. Las células corticales en el área de formación de los tetrasporangios muestran una evidente modificación (nematocio). Se designa como lectotipo un espécimen de la colección de Pernambuco, Brazil, que coincide perfectamente con las muestras venezolanas, siendo ilustrado por primera vez. Se señalan diferencias y semejanzas existentes entre G. cuneata y especies de morfología similar, tales como G. crispata, G. curtissiae y Petroglossum undulatum.

INTRODUCTION

The taxonomy and phylogenetic relationships of species of Gracilaria (Gracilariales, Rhodophyta) from different geographical latitudes have been evaluated in recent years by 18S rDNA sequences (Bird et al., 1992). However, critical information at the cellular level, especially reproductive morphology of sexual plants, is unknown for many species described in the last century; particularly those described by Agardhs, Harvey and Areschoug based on material collected from the tropical and subtropical western Atlantic (Ganesan, 1992). In this paper, details of morphology, anatomy and all phases of reproduction are described and illustrated for the poorly known species Gracilaria cuneata J. E. Areschoug (1855).

MATERIALS AND METHODS

Specimens were collected by the author in eastern Venezuela (see Ganesan, 1990). Liquid preserved (10 % seawater formalin) and herbarium specimens were studied. Sectioning, staining and mounting procedures are as in Ganesan (1992). Voucher specimens are filed in the herbarium of the Institute of Oceanography, Universidad de Oriente, Cumaná, Venezuela. For comparative purposes, reference specimens from the Herbarium and specimens borrowed from the Natural History Museum of Los Angeles County, Los Angeles (LAM), The University of Michigan, Ann Arbor, Michigan (MICH), University of Puerto Rico Herbarium, Mayagüez, Puerto Rico (UPR) and Swedish Musuem of Natural History, Stockholm, Sweden (S) were also studied.

RESULTS

Gracilaria cuneata was described by Areschoug (1855) from plants collected at Pernambuco, Brazil. Taylor (1960) also reported the species from "West Indies" and Venezuela. More than a century after its description, Dawson (1962: 388, fig. A) illustrated the species for the first time, using a specimen from Atlantic Costa Rica. Dawson noted that his specimen agreed "adequately with the original description of the type of this rare species" and that "cuneate, membranous blades (to a short stipe) and the more or less undulate margins appear to be distinctive, but reproductive material needs to be studied". Subsequently, a lectotype was designated and illustrated by Taylor (1969: 175, fig. 25). Apparently unaware of Dawson's paper, Taylor stated that "crisping of the margin, mentioned in the early (Areschoug's) description, is not obvious" in the specimen he examined. This has led to referring of specimens of Gracilaria with similar morphology (i. e., cuneate fronds with distal forkings and small marginal proliferations, but *without* crisping of the margins) to G. cuneata from other parts of the Caribbean as well (Richardson, 1975: pl.22, fig.1 for Trinidad; Ortiz and Almodovar, 1982: 56, fig. 5 for Puerto Rico).

It is difficult to assess the record of G. cuneata from Atlantic Colombia (Schnetter, 1980) or the Brazilian records (Ferreira and Pinheiro-Vieira, 1966; Pinheiro-Vieira and Ferreira, 1968), because no description or illustration of the specimen was given. I have found that certain large, fertile specimens

from Puerto Rico and Venezuela, identified as G. cuneata, lacked crisped margins. However, the Venezuelan alga recorded (with a query) by (Hammer and Gessner, 1967: 198, fig. 1) has crisped apical segments and lateral margins. Two small, crisped specimens from Venezuela (Fig. 3) were also doubtfully referred to G. cuneata by Taylor. Hanisak & Blair (1988) re-examined the earlier records of Petroglossum undulatum Schneider [in Schneider et Searles (1976)] from Cape Canaveral, Florida (Eiseman, 1979), another species with crisped or undulate margins, and concluded that these plants are referable, but doubtfully, to G. cuneata. It is evident that critical morphological, anatomical and reproductive details of samples currently placed in G. cuneata are unknown and that this binomial is applied to at least two species of Gracilaria.

Unfortunately, the lectotype designated by Taylor is missing at S. Thus, a syntype from the same herbarium (Fig. 1) was examined by me. It agreed well with the original description, my collections, Dawson's Costa Rican and Taylor's Venezuelan specimens. A revised description is given below:

Gracilaria cuneata J. E. Areschoug (1855: 351)

(Figs. 1-11)

Lectotype: A cystocarpic specimen (Fig. 1) from Pernambuco, Brazil (S).

Plants erect, 3 to 12 cm long, bright to light rose-red or with a greenish tinge; adhering well to paper on drying; a distinct terete stipe up to 1 cm long

and 1 mm broad at times evident, giving rise to many (up to 6) cuneate membranous blades (Figs. 1, 2), each blade markedly flattened throughout and mostly dichotomously (rarely trichotomously or irregularly) divided several times plane at narrow angles in the same; small plants (Figs. 3, 4) irregularly lobed a few times without showing evident dichotomy; segments 10 mm broad in most portions, up to 20 mm broad below the forkings, distal segments sometimes very narrow (up to 2 mm broad) and twisted; apices mostly obtuse, rounded or acute, but lateral margins of fronds distinctly crisped or undulating and folded inwards or outwards, a feature clearly observable in liquid-preserved specimens (Fig. 4); margins microscopically not erose or dentate; thallus structure typically gracilarioid (Fig. 5) with 1-2 layers of small, generally quadrate cells intermixed with larger distinctive hair-bearing cells, subcortex 2-3 layers and medulla of 4-5 layers of large colorless cells, thallus 600-1000 μm thick; sexual plants unisexual; mixed phase plants not observed; spermatangia in surface view in extensive irregular sori (Fig. 6) throughout the thallus surface; in transverse sections (Fig. 7) forming very shallow conceptacular-like cavities ("t" type); cystocarps isolated or in confluent groups of 2-7, distributed on both surfaces, prominently discoid or circular up to 1 mm broad, not basally constricted, with several long, irregularly lobed tubular nutritive cells mostly restricted to the floor and basal lateral sides of the cystocarp (Figs 8, 9), rarely to the outer pericarp; carposporangia 18-22 μm in maximum diameter; tetrasporangia extensively produced on both surfaces of the thallus, in surface view circular to oval (Fig. 10), in transverse sections mostly elongate, 15-20 μm broad and 30-40 μm long, and irregularly to regularly cruciately divided; some tetrasporangia with

lateral pit-connections; sterile cortical cells around tetrasporangia showing evident modification (pronounced anticlinal elongation) giving rise to a slightly elevated sorus or nemathecium (Fig.11) in comparison to the sterile areas (compare Figs. 5 and 11).

It appears that Gracilaria cuneata in Venezuela grows at subtidal sites with strong water movement (tidal currents), since all the collections were made in the drift. To my knowledge, no studies related to agar or other chemical aspects have been undertaken on this species.

REPRESENTATIVE SPECIMENS EXAMINED: Brazil: Pernambuco, unknown collector (lectotype: S). Atlantic Costa Rica: Portetele, 4.viii.1962, tetrasporic, Dawson 24341 (LAM). Venezuela: Isla Coche, 24. iii. 1963, tetrasporic, Gessner and Hammer s. n. (Herb. Inst. Oceanogr. Univ. Oriente, Cumaná); La Isleta, Isla de Margarita, 20.i.1966, cystocarpic, M. Velásquez 221 (Herb. W.R. Taylor); Puerto Fermin, Isla de Margarita, 17. xi. 1967, cystocarpic, Ganesan 67-27 (Herb. Inst. Oceanogr. Univ. Oriente, Cumaná); Punto Mosquito, Isla de Margarita, 24. i. 1980, tetrasporic, spermatangial and cystocarpic, Ganesan 80-90 (Herb. Inst. Oceanogr. Univ. Oriente, Cumaná).

DISCUSSION

By its distinctive external morphology (i.e., cuneate membranous fronds with crisping of the margins in typical individuals), G. cuneata is unlikely to be confused with other species of Gracilaria from this area. In its habit, crisped margins and spermatangial formation, G. cuneata appears closely related to G. crispata Setchell and Gardner (1924; see also Dawson, 1949; 1961; Norris, 1985 a, b), a species known only from Baja California, Mexico. In certain morphological (lack of minute, sharp dentations in the lower part of the blades), anatomical (outer cortex of sterile areas with only 1-2 layers, with the outermost layer *not* anticlinally elongated) and reproductive details (tetrasporangia in modified nemethecia and cystocarps with absorbing nutritive cells restricted mostly to the floor and lower part), the Caribbean species seems distinct from the Pacific G. crispata. However, ecological and biochemical studies are needed to show as to what degree these differences are environmentally stable and genetically controlled in this vicarious pair.

Although Petroglossum undulatum (Phyllophoraceae, Gigartinales) is strikingly similar to G. cuneata in external morphology and anatomy, it is very different in reproductive details of sexual plants (see Schneider and Searles, 1976; 1991).

As stated earlier, the binomial G. cuneata, as judged from a study of specimens from Puerto Rico and Venezuela, has been applied to species with large ribbon-like or cuneate, terminally forked blades, and with or without marginal proliferations, but *without* crisping of the margins. Such specimens have also been assigned to G. curtissiae J. Agardh (1885), another poorly known species described from Florida, U.S.A. Examination of the lectotype collection of G. curtissiae from the Agardh herbarium, LD (designated by Mrs. Steentoft in 1975), revealed that this species is different morphologically and reproductively from G. cuneata. Details of these observations will be published elsewhere.

On the basis of the tubular nutritive cells being restricted mostly to the lateral and basal sides of the cystocarp, G. cuneata could be assigned to Hydropuntia (Fredericq and Hommersand, 1990). However, it does not produce spermatangia in confluent multi-cavities conceptacles (" *m* " type), as characteristic of that genus. In agreement with recent studies (Abbott et al., 1991; Gargiulo et al., 1992; Bird et al., 1992; Ganesan, 1992), the present observations do not support Hydropuntia as an independent genus within the Gracilaria-Gracilariopsis complex.

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FIGURE LEGENDS

(FIGS. 1-4)

Figs. 1-4. Gracilaria cuneata. Lectotype (S) from Pernambuco, Brazil. Fig. 2. A large cystocarpic specimen from Venezuela. Fig. 3. Two small specimens from Venezuela, one on the left with pronounced crisping of the margins (Herb. W.R. Taylor); Fig. 4. A liquid-preserved female from Venezuela showing pronounced crisping of the margins.

FIGURE LEGENDS

(Figs. 5-11)

Figs. 5-11. Gracilaria cuneata. Fig. 5. Transverse section of a sterile thallus. Fig. 6. Surface view of a male plant to show scattered spermatangia. Fig. 7. Transverse section of a male plant to show the shallow and ill-defined conceptacular-like spermatangial cavities [textorii ("t") type]. Fig. 8. Transverse section of a cystocarp to show the tubular nutritive cells (arrows), mostly at the basal part. Fig. 9. Magnified view of part of a basal section of the cystocarp, showing the prominent and darkly stained tubular nutritive cells (arrows). Fig. 10. Surface view of a tetrasporic plant to show irregular disposition of tetrasporangia and initials. Fig. 11. Transverse section of part of a tetrasporic thallus to show anticleinally elongated cortical cells surrounding the tetrasporangia. Scale in Figs. 5-7, 9-11 - 35 μm ; Scale in Fig. 8 - 300 μm .



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HERBARIUM

OF
WILLIAM RANDOLPH TAYLOR

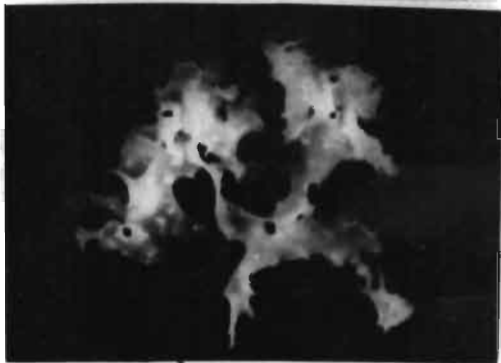
Oposifera cuneata (L.) W. G. S. M.

Opuscula Mayanitas, La Salata

7th July 1921 20126



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