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Characterization of *Chondrophycus tenerrimus* (Cremades) comb. nov. (Ceramiales, Rhodophyta), a species often misidentified as *C. papillosus* (C. Agardh) Garbary *et* J. Harper in the Mediterranean Sea[1]

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Abstract — Vegetative and reproductive features of the Mediterranean red alga *Chondrophycus tenerrimus* (Cremades) comb. nov. (Rhodomelaceae, Ceramiales) are described. The species is characterised by the following features: 1) a basal system composed of a spreading basal crust from which many terete axes arise; 2) the production of two pericentral cells from each vegetative axial segment; 3) the presence of a palisade-like superficial cortical layer; 4) the absence of projecting superficial cortical cells; 5) the absence of longitudinally oriented secondary pit connections between contiguous superficial cortical cells; 6) the absence of lenticular thickenings in the walls of medullary cells; 7) the absence of intercellular spaces between contiguous medullary cells; 8) a perpendicular arrangement of tetrasporangia, each of which is produced from the second pericentral cell in each fertile segment; and 9) flask-shaped cystocarps with a slightly to prominent ostiole. *Chondrophycus tenerrimus* belongs to the subgenus *Palisadi* section *Palisadi*. Features that distinguish *C. tenerrimus* from *C. papillosus* (C. Agardh) Garbary *et* J. Harper, with which it has often been misidentified in the Mediterranean Sea, are given.

Ceramiales / *Chondrophycus tenerrimus* / marine algae / Mediterranean Sea / Rhodomelaceae / Rhodophyta / taxonomy

Résumé — Caractérisation de *Chondrophycus tenerrimus* (Cremades) comb. nov. (Ceramiales, Rhodophyta), une espèce souvent identifiée à tord comme *C. papillosus* (C. Agardh) Garbary *et* J. Harper en Mer Méditerranée. Les caractéristiques végétatives et reproductrices de l'algue rouge méditerranéenne *Chondrophycus tenerrimus* (Cremades) comb. nov. (Rhodomelaceae, Ceramiales) sont décrites. Les caractères sont les suivants : 1) un système basal constitué d'une croûte étalée d'où s'élèvent beaucoup d'axes à section circulaire ; 2) la production de deux cellules péricentrales par chaque segment végétatif de

1. This paper is dedicated to Mrs Marie-Thérèse L'Hardy-Halos, on the occasion of her retirement.

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l'axe ; 3) la présence d'une couche corticale superficielle de type palissadique ; 4) l'absence de cellules corticales superficielles saillantes ; 5) l'absence de synapses secondaires orientées longitudinalement entre les cellules corticales superficielles contiguës ; 6) l'absence d'épaississements lenticulaires dans les parois des cellules médullaires ; 7) l'absence d'espaces intercellulaires entre les cellules médullaires contiguës ; 8) une disposition perpendiculaire des tétrasporocystes, chacun d'eux étant produit à partir de la seconde cellule péricentrale dans chaque segment fertile ; et 9) des cystocarpes en forme de gourde avec un ostiole légèrement proéminent. *Chondrophycus tenerrimus* appartient au sous-genre *Palisadi* section *Palisadi*. Les caractères qui permettent de distinguer *C. tenerrimus* de *C. papillosus* (C. Agardh) Garbary *et* J. Harper, avec lequel il a été souvent confondu en Mer Méditerranée, sont donnés. (Traduit par la Rédaction)

algues marines / Ceramiales / *Chondrophycus tenerrimus* / mer Méditerranée / Rhodomelaceae / Rhodophyta / taxinomie

INTRODUCTION

The taxonomy of the genus *Laurencia* J.V. Lamouroux (1813) has recently undergone a substantial improvement due to the use of new characters such as the number of pericentral cells per axial segment, the origin of tetrasporangia and the origin of spermatangial branches (Nam & Saito, 1990; 1991a; 1991b; 1994; 1995; Nam *et al.* 1991). On the basis of these characters, some species were transferred by Nam *et al.* (1994) to the resurrected genus *Osmundea* Stackhouse (1809 *emend.* Nam *et al.*, 1994). Garbary & Harper (1998) undertook a cladistic analysis of both vegetative and reproductive characters of the *Laurencia* complex and confirmed the generic rank of *Laurencia* and *Osmundea.* They also proposed raising the subgenus *Chondrophycus* Tokida *et* Y. Saito (*in* Saito, 1967) to generic rank. According to the system proposed by Nam (1999), this last genus includes the species of the *Laurencia* complex with the following characters: two pericentral cells in vegetative segments; spermatangial branches developing from trichoblasts ('trichoblast type'), and tetrasporangial production from particular pericentral cells. Nam (1999) also suggested the additional division of the genus *Chondrophycus* into four subgenera [*Chondrophycus*, *Kangjaewonia* K.W. Nam, *Palisadi "Palisada"* (Yamada) K.W. Nam and *Yuzurua* K. W. Nam].

At present, three species of *Chondrophycus* [*C. thuyoides* (Kützing) G. Furnari, *C. papillosus* (C. Agardh) Garbary *et* J. Harper, *C. patentirameus* (Montagne) K. W. Nam], nine species of *Laurencia* [*L. caduciramulosa* Masuda *et* Kawaguchi, *L. chondrioides* Børgesen, *L. epiphylla* Boisset *et* Lino, *L. glandulifera* (Kützing) Kützing, *L. intricata* J.V. Lamouroux, *L. majuscula* (Harvey) Lucas, *L. microcladia* Kützing, *L. minuta* Vandermeulen, Garbary *et* Guiry subsp. *scammaccae* G. Furnari *et* Cormaci, *L. obtusa* (Hudson) J.V. Lamouroux], and six species of *Osmundea* [*O. maggsiana* Serio *et al.*, *O. pelagiensis* G. Furnari, *O. pelagosae* (Schiffner) K.W. Nam, *O. pinnatifida* (Hudson) Stackhouse, *O. truncata* (Kützing) K.W. Nam *et* Maggs, *O. verlaquei* G. Furnari] are known to occur in the Mediterranean Sea (Furnari *et al.*, 2001).

During our studies of the *Laurencia* complex from the Mediterranean Sea, numerous specimens superficially similar to *C. papillosus* were found. A detailed examination revealed that these specimens in fact belonged to *Laurencia tenerrimus* Cremades, a poorly known species that is herein transferred to

Chondrophycus. We have also identified this species in several Mediterranean herbarium collections dating since 1976, referred to *Laurencia papillosa* (C. Agardh) Greville (= *C. papillosus*).

MATERIALS AND METHODS

Observations were made using liquid-preserved specimens fixed in 4 % formalin in seawater, which were sectioned by hand using a razor blade and a pith stick. Sections of fixed materials were stained with aniline blue and mounted in a 80 % Karo® syrup solution. Throughout the text measurements are given as length × width.

Herbarium specimens are deposited in the Herbarium of the *Departamento de Biología Vegetal*, University of Valencia (VAB-Algae) and in the Herbarium of the *Dipartimento di Botanica*, University of Catania, Italy (CAT-Sectio Algae).

Examined material. *Fucus papillosus* (Holotype), Herb. Forsskål No. 886 (held in C, the Botanical Museum of Copenhagen, No. 638); *Fucus tenerrimus* (Lectotype), MA-Algae, Herbario Real Jardín Botánico, Madrid No. 1772, designated by Cremades *et* Pérez-Cirera 1990. *Laurencia papillosa*, Les Embiez, Var, France (10/07/1871, ex P. *et* H. Huvé Herbarium *in* Verlaque Herbarium, University of Aix-Marseille H 2903); *L. papillosa*, Adriatic Sea, Herb. Meneghini held *in* FI, Herbarium Universitatis Florentinae No. 4337/1 (specimen below at right), 4337/6 (specimen below); *Laurencia dinhii* (Holotype), SAP, Herbarium of the Graduate School of Science, Hokkaido University, Sapporo, No. 062606.

Spanish specimens (labelled as *Laurencia papillosa*): Les Rotes, Denia, Alicante, (*Boisset*, 21/7/88, VAB-Algae 1009); (*Boisset,* 15/6/90, VAB-Algae 908, 909); (*Boisset,* 2/12/93, tetrasporic, VAB-Algae 1234); Bahía de Jávea, Alicante, (*Boisset,* 9/10/93, male and cystocarpic, VAB-Algae 1232, 1291); (*Boisset*, 12/04/97, VAB-Algae 1966); (*Conde*, 25/09/83, MGC 1184); El Portitxol, Jávea, Alicante, (*Boisset*, 11/10/81, VAB-Algae 833); (*Boisset*, 13/07/88, VAB-Algae 474); (*Boisset*, 17/9/92, cystocarpic, VAB-Algae 1233); La Granadella, Jávea, Alicante, (*Boisset*, 16/07/96, male cystocarpic, VAB-Algae, 2002); (*Boisset*, 27/09/97, VAB-Algae, 1999); Cala Baladrar, Moraira, Alicante, (*Boisset,* 19/06/94, tetrasporic, VAB-Algae 1290); Serra Gelada, Altea, Alicante, (*Boisset,* 6/5/91, VAB-Algae 1012); Es Pujols, Formentera, the Balearic Islands, (*Boisset*, 25/08/95, male, cystocarpic and tetrasporic, VAB-Algae 1419, 1420); Cabo de Palos, Murcia, (*Boisset et Lino*, 28/06/97, VAB-Algae 2000); Binibeca, Menorca, the Balearic Islands, (*Lino*, 9/09/98, male, cystocarpic and tetrasporic, 2003); Los Escullos, Cabo de Gata, Almería, (*Boisset et Lino*, 25/06/97, male, cystocarpic and tetrasporic, VAB-Algae 2001); Porto Colom, Mallorca, the Balearic Islands, 2/08/78 (BCF-A 11612, 11621), 24/05/79 (BCF-A 11613), 17/02/80 (BCF-A 11615), 10/03/78 (BCF-A 11616), 25/11/78 (BCF-A 11618), 17/09/78 (VAB-Algae 11619); La Carolina, Aguilas, Murcia, 21/08/88 (BCF-A 11620, 11622).

Italian specimens (labelled as *Laurencia papillosa*): Cape Zafferano, Palermo, Sicily, (6/09/83, BCF-A. 11161); Brucoli, Syracuse, Sicily (*Serio*, 29/05/93, tetrasporic, CAT-Sectio Algae 1698); Lachea Island, Catania, Sicily, (*Serio*, 03/07/91, CAT-Sectio Algae 1664); Lachea Island, Catania, Sicily, (*G. Furnari*, 13/01/76, tetrasporic, CAT-Sectio Algae 103); Cape Murro di Porco, Syracuse,

Sicily (*Cormaci*, 28/10/89, male and tetrasporic, CAT-Sectio Algae 1480); Cape San Vito, Trapani, Sicily, (*Serio*, 19/09/93, cystocarpic and tetrasporic, CAT-Sectio Algae 1474), (*Serio*, 20/09/93, tetrasporic, CAT-Sectio Algae 1662); Cape Molini, Catania, Sicily, (*Serio*, 22/12/92, CAT-Sectio Algae 1663); Cape Gallo, Palermo, Sicily, (*Giaccone*, 20/07/89, CAT-Sectio Algae 1712); Sampieri, Ragusa, Sicily, (*Serio*, 17/06/91, male gametophyte, CAT-Sectio Algae 1816); Pantelleria Island, (*Catra*, 29/05/96, male gametophyte, CAT-Sectio Algae 1483).

Italian specimens (labelled as *Chondrophycus papillosus*): Brindisi, Adriatic Sea (*Catra*, 29/05/00, CAT-Sectio Algae 1975); Cava d'Aliga, Ragusa, Sicily, (*Serio*, 5/07/99, male and tetrasporic, CAT-Sectio Algae 1880); Cape Otranto, Lecce, (*Catra*, 25/05/00, CAT-Sectio Algae 1984), (*Catra*, 29/09/00, CAT-Sectio Algae 1494).

Specimens from other localities: Side Antalya, Turkey, (*Turna*, as *Chondrophycus papillosus*, 10/08/00, tetrasporic, CAT-Sectio Algae 1981); Sounio, Saronikos Gulf, Greece, (*Belegratis*, as *Laurencia* sp., 16/06/01, tetrasporic, CAT-Sectio Algae 1988.); El-Batrūm, Lebanon (*Lakkis*, as *Laurencia* sp., 02/04/01, male and tetrasporic, CAT-Sectio Algae 1499).

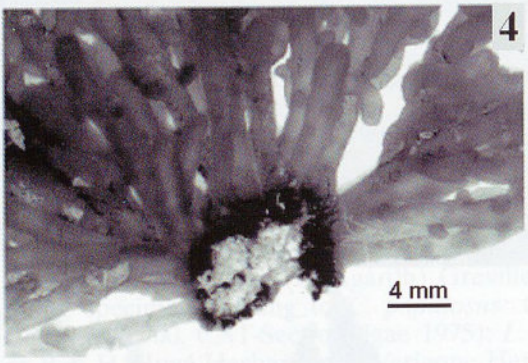
RESULTS

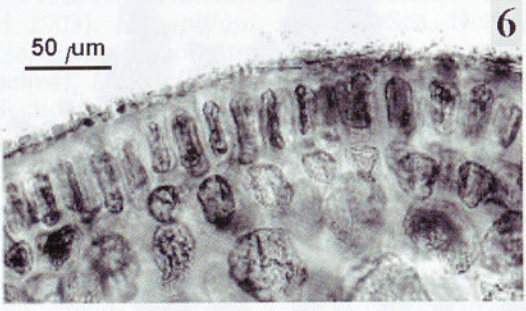
From the study of the above mentioned Mediterranean specimens labelled as *L. papillosa* (C. Agardh) Greville and/or *C. papillosus*, only the following specimens belong to *C. papillosus: C. papillosus* Brindisi, Adriatic Sea (*Catra*, 29/05/00, CAT-Sectio Algae 1975); *L. papillosa*, Les Embiez, Var, France (ex P. & H. Huvé Herbarium *in* Verlaque Herbarium, University of Aix-Marseille H 2903); *L. papillosa*, Adriatic Sea, Herb. Meneghini held *in* FI, Herbarium Universitatis Florentinae No. 4337/1 (specimen below at right), 4337/6 (specimen below); *L. papillosa*, Brucoli, Syracuse, Sicily (*Serio*, 29/05/93, tetrasporic, CAT-Sectio Algae 1698); *L. papillosa*, Lachea Island, Catania, Sicily, (*Serio*, 03/07/91, CAT-Sectio Algae 1664). Conversely, all other specimens show both vegetative and reproductive structures as below described.

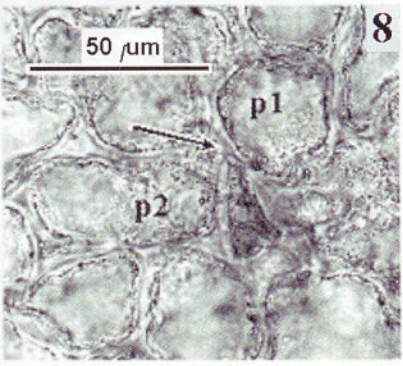
Vegetative structures. Plants are to 10 cm high, with terete axes, (Fig. 2), yellowish-green or red purple, robust, rigid, cartilaginous, irregularly pyramidal in outline, adhering imperfectly to herbarium paper when dried. The basal attachment system, which lacks stolon-like branches, is initially a discoid holdfast (Fig. 4) but spreads to become a crust to 2-3 cm in diameter, often bearing numerous erect terete axes (to more than 20) of different ages, giving a tuft-like aspect to the whole thallus. Young axes are slightly or not branched. Main axes, to 2 mm in diameter in the median parts, are often denuded in the proximal region and radially branched to four orders in median and distal parts. The pattern of branching is highly variable, either irregularly alternate, subopposite or subverticillate, often with arched branches (Fig. 3). First-order branches grow to 1.5 mm in diameter and are often arranged in a subsecund pattern, densely clothed in median and distal parts with terete branchlets (Fig. 5). Ultimate branchlets are slightly clavate, 1-4 mm in length and 1 mm in diameter, and form conspicuous trichoblasts.

Superficial cortical cells do not protrude at the end of branchlets and lack secondary pit connections; in surface view of the median parts, superficial cortical cells are 25-50 × 15-40 μm, isodiametric on branchlets, irregularly polygonal and

Figs 1-2. *Chondrophycus tenerrimus*. Fig. 1. Habit of the species in its natural habitat (Les Rotes, Denia, Alicante, Spain, 6/06/2001). Fig. 2. Habit of the Herbarium specimen CAT- Sectio Algae 1480.







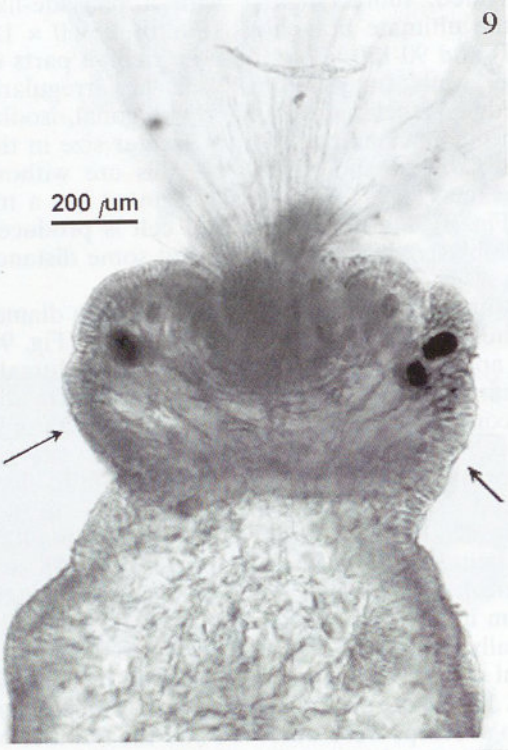
not arranged in longitudinal rows. In fresh material, no *"corps en cerise"* were detected either in epidermal cells or in trichoblasts. In transverse section, superficial cortical cells are radially elongated, subrectangular with a palisade-like arrangement, 30-50 × 12-22 μm in the ultimate branchlets (Fig. 6), 35-60 × 15-30 μm on first-order branches (Fig. 7) and 90-130 × 35-60 μm in median parts of main axes, with progressively thicker walls. Inner cortical cells are irregularly rounded and 20-25 × 25-50 μm. Medullary cells are rounded-polygonal, isodiametric, variable in size, 75-150 μm in diameter and of slightly greater size in the intermediate region of the medulla. Cortical and medullary cells are without lenticular thickenings and closely packed (Fig. 7). Each axial segment has a trichoblast and two pericentral cells (Fig. 8), the first pericentral cell is produced underneath the basal cell of the trichoblast, while the second is at some distance from the basal cell of the trichoblast.

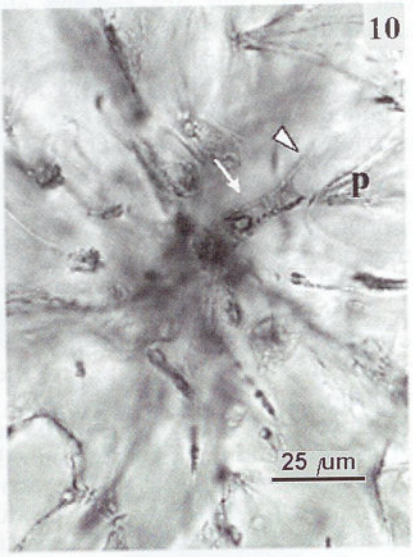
Reproductive structures. Mature tetrasporangia are 80-125 μm in diameter and arranged perpendicular to the axis of branchlets ('right-angle') (Fig. 9), cut-off abaxially and located on the apical portions of ultimate and penultimate tetrasporangial branchlets of 1-2.5 mm in length and 0.8-1.5 mm width. In the tetrasporangial axial segment, the second pericentral cell is fertile and additional tetrasporangium-bearing pericentral cells are absent (Fig. 10). As in most species of the *Laurencia* complex, the two presporangial cover cells remain undivided. Spermatangial branches are produced from one of the two laterals on the suprabasal cell of the trichoblasts (Fig. 11), which are formed in apical pits (400-500 × 700-1200 μm) of ultimate and penultimate branches, and terminate in single, initially pyriform later subspherical, sterile cells of 25-30 μm in diameter. Spermatangia are ellipsoidal, 12-17 μm in length with their distal portions deeply stained. Cystocarps are formed laterally on ultimate branchlets, 700-1100 × 700-1000 μm, flask-shaped without a basal constriction, and sometimes with a prominent carpostome to 180 μm long (Fig. 12). Mature carposporangia are clavate and 100-190 × 30-50 μm. Unfortunately no procarps were observed and the number of pericentral cells in procarp-bearing segments of trichoblasts is unknown.

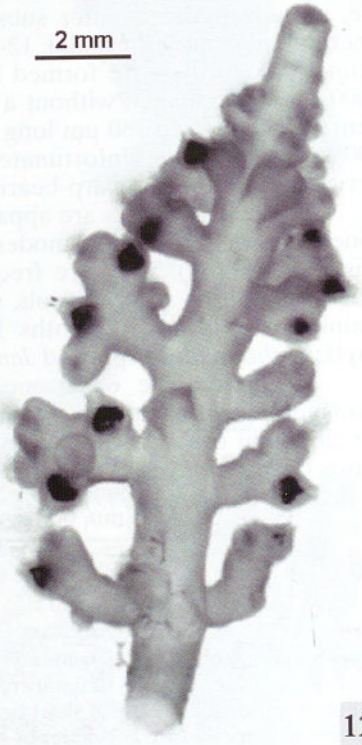
Ecology. Plants are apparently perennial and occur in the lower intertidal zone, on rocks or in pools moderately exposed to waves, often forming a band at this level (Fig. 1). They are frequent in biotopes moderately exposed to waves (rocks, platforms, littoral pools, vermetids platforms) and the growing season is mainly in the summer months. Mature thalli are often heavily covered by epiphytic *Lithophyllum* spp. and *Jania* spp.

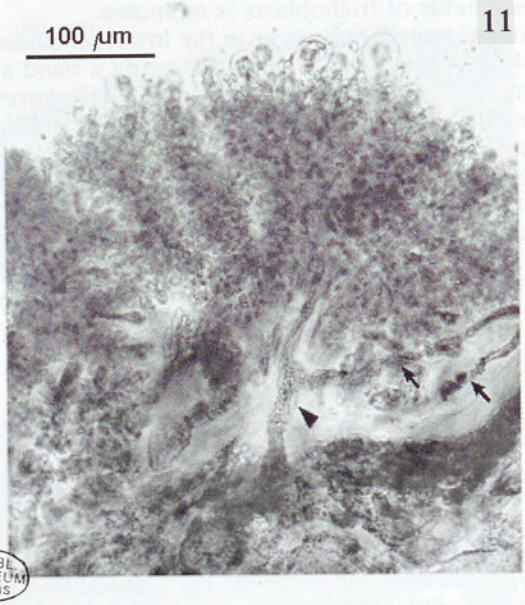
Due to the occurrence of two pericentral cells per axial segment, tetrasporangial production from particular pericentral cells and spermatangial development of the trichoblast type, the above described specimens belong to the genus *Chondrophycus* (Tokida *et* Y. Saito) Garbary *et* J. Harper (1998) as recently re-defined by Nam (1999).

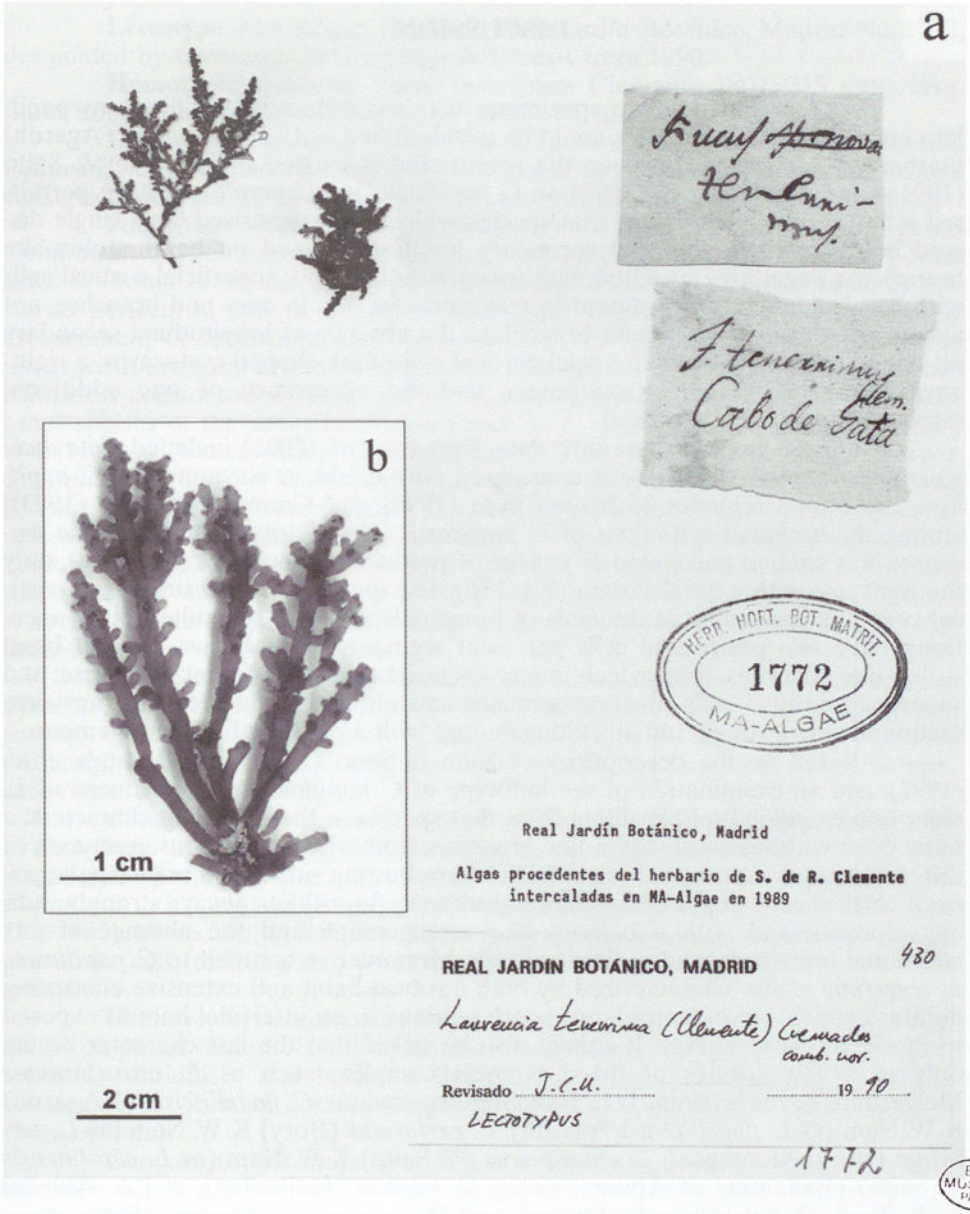
◀ Figs 3-8. *Chondrophycus tenerrimus*. Fig. 3. Habit of a specimen showing axes and branches evidently arched. Fig. 4. Detail of basal crust. Fig. 5. Detail of a portion of thallus showing first-order branches densely clothed with short branchlets. Fig. 6. Detail of a transverse section of a branch showing palisade-like arrangement of epidermal cells. Fig. 7. Detail of a transverse section of an ultimate branchlet showing palisade-like arrangement of epidermal cells. Fig. 8. Transverse section of a branch near the apex showing an axial cell (a) with two pericentral cells (p1 and p2) and the basal cell of trichoblast (arrow).











Figs 13a, b. *Laurencia tenerrima*. Fig. 13a. Herbarium sheet of the Lectotype. Fig. 13b. Rehydrated lectotype (specimen at right in the Herbarium sheet).

◀ Figs 9-12. *Chondrophycus tenerrimus*. Fig. 9. Longitudinal section of a tetrasporangial branch (arrows) showing the right-angle arrangement of tetrasporangia. Fig. 10. Transverse section of a tetrasporangial branch near the apex showing an axial cell (arrow) with one elongate fertile pericentral cell (arrowhead) and one sterile pericentral cell (p). Fig. 11. Longitudinal section of a branchlet showing a mature male trichoblast with spermatangial and sterile branches (arrows) on its suprabasal cell (arrowhead). Fig. 12. Portion of a branch with flask-shaped cystocarps with a prominent carpostome.

DISCUSSION

As mentioned above, specimens of *C. tenerrimus*, with their many papillate and aggregate branchlets, could be misidentified as *C. papillosus* (C. Agardh) Garbary *et* J. Harper. However, the recent studies carried out by Nam & Saito (1991a) and Masuda *et al.* (1997) on *C. papillosus* (as *L. papillosa*), have permitted a better understanding of that species, which is characterised by: a single discoid holdfast with occasional secondary holdfasts formed on basal, stolon-like branches; a vegetative structure with two pericentral cells; superficial cortical cells with a palisade-like arrangement in transverse section in axes and branches, not always present in the ultimate branchlets; the absence of longitudinal secondary pit connections between superficial cortical cells; flask-shaped cystocarps; a right-angle arrangement of tetrasporangia; and the occurrence of one additional tetrasporangial pericentral cell.

On the basis of literature data, Furnari *et al.* (2001) included *Laurencia tenerrima* Cremades [which was considered, with doubt, as a synonym of *C. papillosus* by both Cremades & Pérez-Cirera (1990) and Cremades Ugarte (1993)] among the accepted synonyms of *C. papillosus*. The lectotype of *Laurencia tenerrima* was studied and found to consist of two sterile specimens (Fig. 13 a), only the right one with a basal system (Fig. 13b). The specimens show superficial cortical cells not protruding at the ends of branchlets and lack secondary pit connections; have two pericentral cells per axial segment, a basal crust without basal stolon-like branches, from which numerous erect axes of different ages arise; and superficial cortical cells of axes, branches and ultimate branchlets in transverse section always strongly radially elongate and with a palisade-like arrangement.

Based on the descriptions of Nam & Saito (1991a) and Masuda *et al.* (1997), and an examination of the holotype of *C. papillosus*, the specimens of *L. tenerrima* examined herein differ from that species in the following characters: a basal crust without basal stolon-like branches, from which numerous erect axes of different ages arise; a branching pattern often showing subsecund branches; superficial cortical cells of axes, branches and ultimate branchlets always strongly radially elongate and with a palisade-like arrangement; and the absence of any additional tetrasporangial pericentral cells. Moreover, in contrast to *C. papillosus*, *L. tenerrima* is also characterized by both a robust habit and extensive encrusting holdfast, which can be considered as adaptations to an intertidal habitat exposed to moderate wave energy. It should also be noted that the last character occurs only in a few species of the *Laurencia* complex, such as *L. crustiformans* McDermid, *L. coelenterata* D.L. Ballantine *et* Aponte, *C. flagelliferus* (J. Agardh) K.W. Nam (as *L. flagellifera* J. Agardh), *C. perforatus* (Bory) K.W. Nam [as *L. perforata* (Bory) Montagne], *C. carolinensis* (Y. Saito) K.W. Nam (as *L. carolinensis* Y. Saito) (Ballantine & Aponte, 1995), *O. blinksii* (Hollenberg *et* I.A. Abbott) K.W. Nam, *O. pelagiensis* G. Furnari and *O. verlaquei* G. Furnari (Serio *et al.*, 1999).

The studies described herein have demonstrated that *L. tenerrima* is an independent species and displays all characteristics consistent with placement in *Chondrophycus;* as such the following new combination is proposed:

***Chondrophycus tenerrimus* (Cremades) G. Furnari, Boisset, Cormaci *et* Serio comb. nov.**

Basionym. *Laurencia tenerrima* Cremades *in* Cremades & Pérez-Cirera, 1990: 490.

Lectotype. MA-Algae, Herbario Real Jardín Botánico, Madrid No. 1772, designated by Cremades *in* Cremades & Pérez-Cirera 1990.

Homotypic synonym. *Fucus tenerrimus* Clemente 1807: 315 *nom. illeg.* (later homonym of *F. tenerrimus* Esper 1800: 198, pl. CX).

Distribution. Known from the Mediterranean coast of the Iberian Peninsula, the Balearic Islands, Sicily, Adriatic Sea, the Mediterranean Turkish coast, Lebanon and Greece. Probably broadly distributed in the Mediterranean.

Following Nam's (1999) infrageneric circumscription of the genus *Chondrophycus*, *C. tenerrimus*, belongs to the subgenus *Palisadi* (Yamada) Nam since it shows: 1) no secondary pit connections between epidermal cells; 2) one sterile pericentral cell in tetrasporangial axial segments; and 3) a right-angle arrangement of tetrasporangia. Moreover, the first pericentral cell is produced underneath the basal cell of the trichoblast (Fig. 8). It should be noted that the last character, considered by Nam (1999) of phylogenetic significance, is shared by other species of the subgenus *Palisadi* such as *C. intermedius* (Yamada) Garbary *et* J. Harper ('*intermedia*'), *C. capituliformis* (Yamada) Garbary *et* J. Harper, *C. tumidus* (Y. Saito *et* Womersley) Garbary *et* J. Harper ('*tumida*'), *C. papillosus, C. maris-rubri* (K.W. Nam *et* Saito) Garbary et J. Harper (Nam, 1999), *C. patentirameus* and *C. thuyoides* [as *C. paniculatus* (C. Agardh) G. Furnari] (Boisset *et al.*, 2000, fig. 13 and fig. 23 respectively). In *C. dinhii* (Masuda *et* Kogame) K.W. Nam, this character was not taken into consideration by Masuda & Kogame (1998) and is not detectable by the original iconography, nor is it possible to detect it in rehydrated portions of the holotype.

The section *Palisadi* also includes *C. palisadus* (Yamada) K.W. Nam ('*palisada*'), *C. intermedius*, *C. perforatus* (Bory) K.W. Nam ('*perforata*'), *C. capituliformis*, *C. dinhii*, *C. concretus* (Cribb) K.W. Nam ('*concreta*'), *C. thuyoides* (Kützing) G. Furnari and *C. tumidus*. These species can be distinguished from *C. tenerrimus* by the following:

Chondrophycus capituliformis, *C. palisadus* and *C. perforatus* differ from *C. tenerrimus* in having one additional tetrasporangial pericentral cell (no additional tetrasporangial pericentral cells in *C. tenerrimus*); *C. intermedius* and *C. tumidus* in having two (three) additional tetrasporangial pericentral cells (Nam 1999: 465). Moreover, *C. tumidus* differs from *C. tenerrimus* in the two presporangial cover cells dividing into several small cells (remaining undivided in *C. tenerrimus*).

Chondrophycus concretus differs from *C. tenerrimus* in its cushion-shaped habit composed of densely entangled axes fixed to the substratum by primary and secondary holdfasts, and branches usually linked by anastomoses (Masuda & Kogame, 1998) (neither cushion-shaped habit nor anastomosing branches occur in *C. tenerrimus*).

Chondrophycus thuyoides, differs from *C. tenerrimus* in having a single discoid holdfast, a loose pattern of branching and in its sublittoral habitat (Boisset *et al.*, 2000) (a discoid holdfast rapidly becoming a spreading basal crust to 2-3 cm in diameter, thalli densely branched in median and distal parts, intertidal habitat in *C. tenerrimus*).

Chondrophycus dinhii differs in having a single primary discoid holdfast from which only one to seven upright axes arise, a palisade-like arrangement of cortical cells in transverse section in axes and branches, not always present in the ultimate branchlets (Masuda personal communication and our observations on the holotype), the presence of intercellular spaces between medullary cells in transverse section (Masuda & Kogame, 1998) (a discoid holdfast rapidly becoming a spreading basal crust to 2-3 cm in diameter with numerous upright axes;

palisade-like arrangement of cortical cells in axes, branches and branchlets; no intercellular spaces between medullary cells in transverse section in *C. tenerrimus*).

In conclusion, due to the superficial resemblance between *C. tenerrimus* and *C. papillosus* [the last reported from all regions of the Mediterranean Sea (Gómez Garreta *et al.*, 2001)] a thorough re-examination of Mediterranean specimens ascribed to as *C. papillosus* should be undertaken in order to ascertain the true distribution of both species in the Mediterranean Sea.

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