

**On the occurrence of *Laurencia pyramidalis*
Bory ex Kützing
(Rhodophyta, Rhodomelaceae)
in the Mediterranean Sea**

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Abstract — The occurrence of *Laurencia pyramidalis* (Ceramiales, Rhodomelaceae) at Castelsardo (Sardinia, Italy) is reported, representing the first confirmed record of this species from the Mediterranean Sea. A study of tetrasporic specimens has shown that production of tetrasporangia is restricted to the 4th pericentral cell in *L. pyramidalis*, in contrast to *L. obtusa* (a species that *L. pyramidalis* has, in the past, been synonymized with) in which tetrasporangia are produced from both the 3rd and 4th pericentral cells.

Ceramiales / *Laurencia pyramidalis* / Mediterranean Sea / Rhodomelaceae / Rhodophyta

Résumé — Sur la présence de *Laurencia pyramidalis* Bory ex Kützing (Rhodophyta, Rhodomelaceae) en Mer Méditerranée. La présence de *Laurencia pyramidalis* (Ceramiales, Rhodomelaceae) à Castelsardo (Sardaigne, Italie) est signalée ; c'est la première confirmation de cette espèce en Mer Méditerranée. L'étude de tétrasporophytes a montré que la production des tétrasporocystes est limitée à la quatrième cellule péricentrale chez *L. pyramidalis*, alors que chez *L. obtusa* (espèce autrefois synonyme de *L. pyramidalis*) les tétrasporocystes sont produits à la fois par les troisième et quatrième cellules péricentrales.

Ceramiales / *Laurencia pyramidalis* / Mer Méditerranée / Rhodomelaceae / Rhodophyta

INTRODUCTION

Historically, species of *Laurencia* have been distinguished primarily on external morphology (Furnari & Serio, 1995). In the recent years, however, the taxonomy of the genus has undergone substantial revision, resulting in the separation of the genera *Osmundea* Stackhouse (Nam *et al.*, 1994) and *Chondrophyucus* (Tokida *et Saito*) Garbary *et J. Harper* (Garbary & Harper, 1998). Nam (1999) proposed the three genera be circumscribed as follows: *Osmundea* characterised by two pericentral cells in vegetative axial filaments, spermatangial development of

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the filament-type, and tetrasporangia produced from random epidermal cells; *Laurencia* by four pericentral cells in vegetative axial filaments, spermatangial development of the trichoblast-type, and tetrasporangia produced from particular pericentral cells; and *Chondrophyucus* by two pericentral cells in vegetative axial filaments, spermatangial development of the trichoblast-type, and tetrasporangia produced from particular pericentral cells. To date, nine species of *Laurencia* J.V. Lamouroux [*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) A.H.S. Lucas, *L. microcladia* Kützing, *L. minuta* Vandermeulen, Garbary et Guiry subsp. *scammaccae* G. Furnari et Cormaci, *L. obtusa* (Hudson) J.V. Lamouroux] are known to occur in the Mediterranean Sea (Furnari *et al.*, 2001).

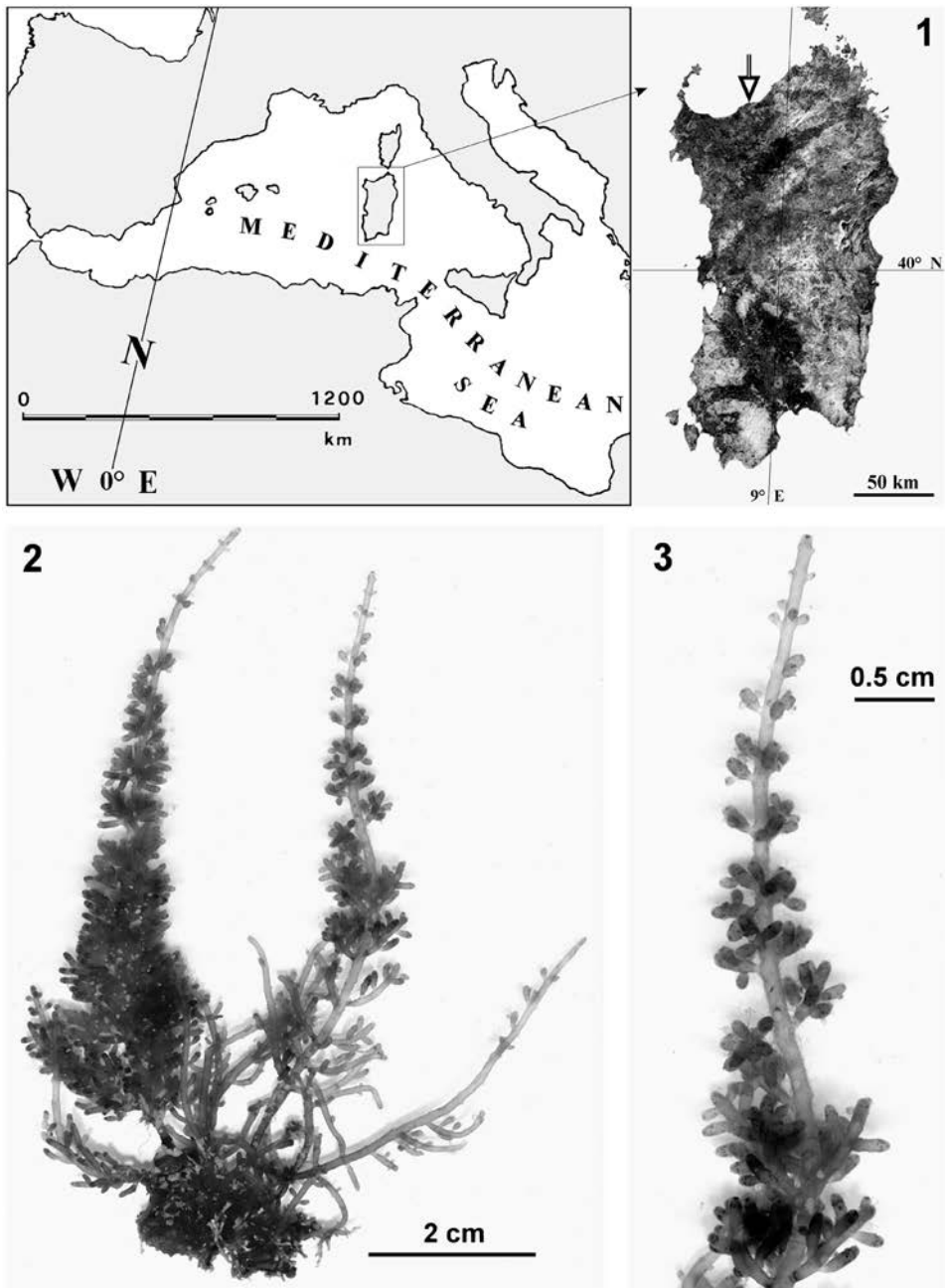
During studies on the marine benthic flora of the Italian coast (islands included), some specimens of *Laurencia pyramidalis* were found at Castelsardo (40°55'00" N, 08°43'00" E) near Sassari (Northern Sardinia, West Mediterranean Sea) (Fig. 1).

Laurencia pyramidalis was described by Kützing (1849: 854) based on a herbarium specimen from France, labelled as *L. pyramidalis* Bory, received from Lenormand. Some months later in the same year¹, Harvey (1849: 83), ignoring Kützing's species, described *L. obtusa* var. *pyramidalis* (Bory ex Harvey) Harvey, on specimens collected at Algoa Bay (South Africa, Indian Ocean). Harvey's variety was considered by J. Agardh (1852: 752) a misapplied name for *L. virgata* (C. Agardh) J. Agardh, a taxon later regarded as conspecific with *L. glomerata* (Kützing) Kützing by Papenfuss (1952: 182-183). *Laurencia obtusa* var. *pyramidalis* was previously published by Zanardini (1847: 200), but this name was invalid as he did not give a description. The name was subsequently validated in 1849 by Kützing and Harvey, at specific and varietal rank respectively. Both Furnari *et al.* (2001) and Gómez Garreta *et al.* (2001), in agreement with Maggs & Hommersand (1993), considered *L. obtusa* var. *pyramidata* (C. Agardh) J. Agardh [an illegitimate name since its protologue included *L. obtusa* var. *paniculata* J. Agardh (= *Chondrophyucus thuyoides* (Kützing) G. Furnari)] a synonym of *L. pyramidalis*. However, they believed that the occurrence of this species in the Mediterranean Sea, based on records of "*L. obtusa* var. *pyramidata*" by Pierpaoli (1923, 1947) (from Taranto, Ionian Sea and Ancona, Adriatic Sea, respectively) and Solazzi (1965, 1968) (from Ancona, Adriatic Sea and Lecce, Ionian Sea, respectively), needed confirmation. Taking into account the taxonomic complexity of the *Laurencia* complex, the above old records were not supported by a critical study and an adequate description of specimens. Unfortunately, attempts to get Zanardini's, Pierpaoli's and Solazzi's Herbarium specimens were unsuccessful.

MATERIALS AND METHODS

Sterile and tetrasporic specimens of *L. pyramidalis* were hand-collected on 2.vi.2002 in some littoral rock pools where a population of *Cystoseira squarrosa* De Notaris also occurred. Herbarium specimens are held at CAT (the

1. Harvey's combination was published in November 1849, while Kützing's description was published in October 1849 (original edition 23-24 July 1849) (Staffeu & Cowan, 1979).



Figs 1-3. Collection site and morphology of *Laurencia pyramidalis*. Fig. 1. Location of the collection site (arrow). Figs 2-3. *Laurencia pyramidalis*. Fig. 2. Habit. Fig. 3. Main axis bearing branches grouped in whorls.

Herbarium of the Department of Botany of the University of Catania). Studies were carried out on material preserved in 4% formaldehyde-seawater. For microscopic observations, some specimens were stained with 1% aqueous aniline blue acidified with dilute HCl, which enhances pit connections. Photographs were made by a Nikon D1 digital camera and mounted using Adobe Photoshop 6.0.

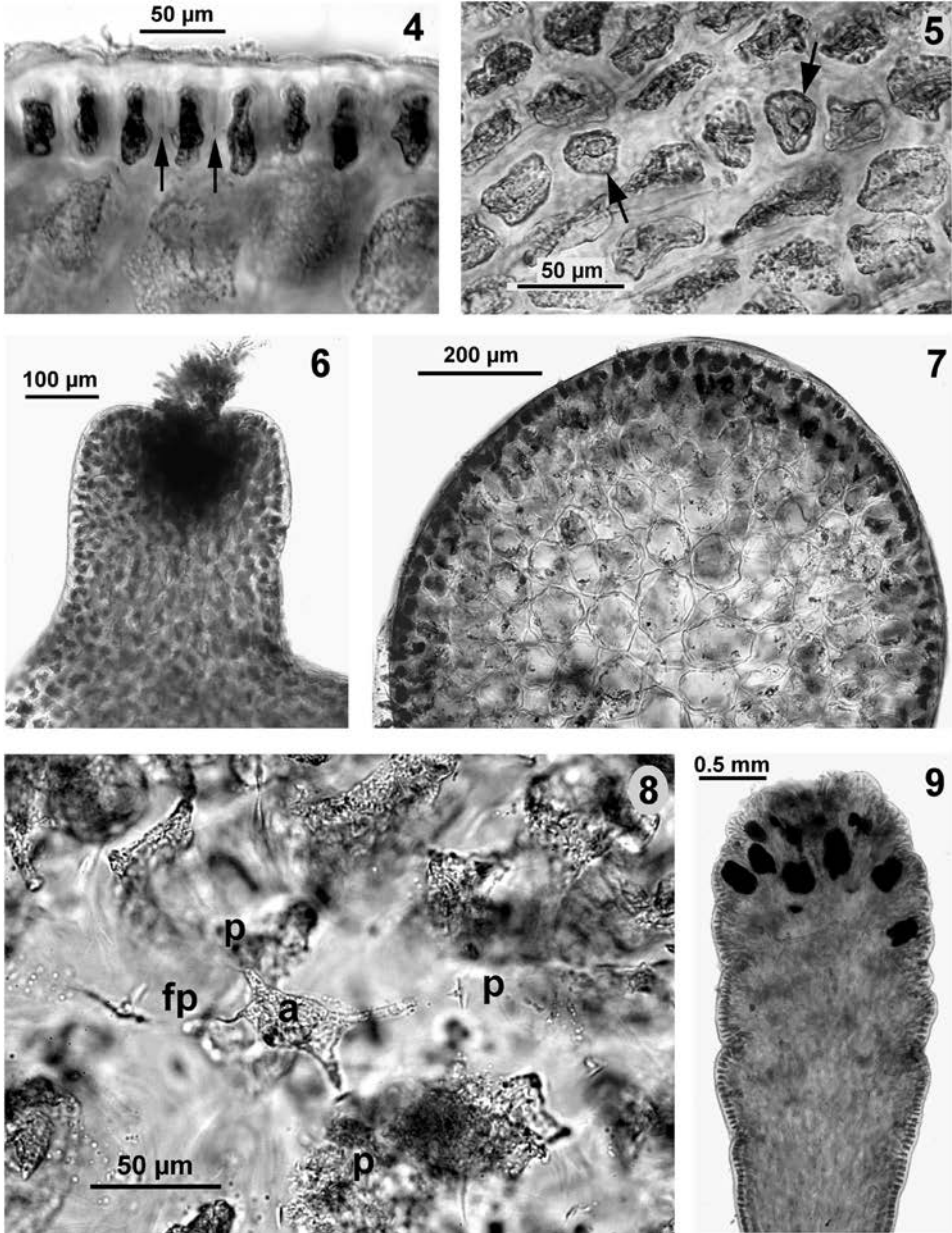
Observations were also made on tetrasporic specimens received from I. Bárbara, collected at Ría de Pontevedra (Galicia, Northwestern Iberian Peninsula) on 24.iv.1997 at 1 m depth.

RESULTS AND DISCUSSION

Our specimens are in good agreement with the description of the species from the British Isles by Maggs & Hommersand (1993). Thalli were terete (Fig. 2), 10-18 cm high, brownish red to purple in colour, soft in texture. They were attached to the substratum by a stoloniferous holdfast (Fig. 2). Main axes were distinct, 1-1.5 mm in diameter, branched up to four orders. First-order branches, as well as branches of further orders, were spirally arranged, often grouped in whorls (Fig. 3). First-order branches decreased in length in the upper parts of the thallus giving it a conical outline. Epidermal cells showed secondary pit connections (Fig. 4) and one "corps en cerise" detectable in fresh material (Fig. 5). In surface view they were elongate-polygonal in basal to median parts of the thallus (30-60 μm long \times 15-25 μm wide), rather isodiametric (35-45 μm long \times 30-40 μm wide) near the apices, with outer walls not projecting in axes and sterile branchlets (Fig. 6), slightly projecting in fertile branchlets. In transverse section, epidermal cells did not show a palisade-like arrangement (Fig. 7). Lenticular thickenings were absent in the medullary cells (Fig. 7). Four periaxial cells were produced per axial segment. Tetrasporangia, produced from the fourth pericentral cell (Fig. 8), showed a parallel arrangement (Fig. 9). No additional tetrasporangial pericentral cells were produced. The two presporangial cover cells were aligned transversally to the stichidial axis in surface view. No reproductive gametophytes were found.

Laurencia pyramidalis was generally considered conspecific with *L. obtusa* until Maggs & Hommersand (1993) demonstrated its specific distinctiveness, mainly based on the texture of the thallus (soft and flexible in *L. pyramidalis*, rigid and brittle in *L. obtusa*) and on the branching pattern, which in *L. pyramidalis* is characterized by main axes bearing laterals spirally, often in groups resembling whorls, separated by portions of unbranched main axis with first order laterals decreasing in length upwards and bearing three further orders of branching in the same arrangement with a conical outline. Conversely, in *L. obtusa* the main axes bear laterals spirally (often in subopposite pairs or threes) with first order laterals occasionally equalling the main axis in length, shorter towards apices, producing a pyramidal outline, bearing three further orders of branching in the same spiral to subopposite arrangement.

The distinction between the two species is confirmed in this study on both the above morphological characters and on the basis of an additional character dealing with the origin of tetrasporangia, previously not observed. In both Italian and Galician specimens the origin of tetrasporangia from the fourth pericentral cell, vs. from the third and the fourth pericentral cells as in *L. obtusa* (Nam *et al.*, 1994), is clearly seen (Table 1). It should be noted that only three species of the



Figs 4-9. *Laurencia pyramidalis*. Fig. 4. Longitudinal section of a branch showing secondary pit connections (arrows) between epidermal cells. Fig. 5. Epidermal cells in surface view in subapical part of the axis. Arrows indicate the cells with a "corps en cerise". Fig. 6. Sterile branchlet showing epidermal cells with outer walls not projecting. Fig. 7. Transverse section of a branch showing the lack of lenticular thickenings in the medullary cells and the cuboid to ovoid epidermal cells. Fig. 8. Transverse section of a tetrasporic branch near the apex showing an axial cell (a) with three sterile pericentral cells (p) and one (the fourth) elongate fertile pericentral cell (fp). Fig. 9. Longitudinal section of a tetrasporic branch showing a parallel arrangement of tetrasporangia.

Table 1. Comparison of species of *Laurencia* from the Mediterranean Sea. All species show the following characters: four pericentral cells per axial segment, epidermal cells with secondary pit connections and without a palisade-like arrangement.

Species	Vegetative structure			Tetrasporangial stichidium			Female structure		Male structure	References	
	Type of attachment	Corps en cerise per cell	Epidermal cells (projection)	Lenticular thickenings	Additional	Tetrasporangia (position)	Tetrasporangia (arrangement)	Procarp-bearing segment			Cystocarp shape
<i>L. caduciramulosa</i> Masuda & Kawaguchi	Stoloniferous	ND	Present (slightly)	Present	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	I
<i>L. chondrioides</i> Børgesen	Discoïd holdfast and stolons	ND	Present (slightly)	Absent	Unknown	Unknown	Parallel	Unknown	Urceolate	T	I
<i>L. epiphylla</i> Boisset & Lino	Discoïd holdfast	ND	Absent	Present	Unknown	Unknown	Parallel	Unknown	Unknown	Unknown	I
<i>L. glandulifera</i> (Kützing) Kützing	Discoïd holdfast and stolons	1	Present	Absent	Absent	3rd, 4th	Parallel	Unknown	Urceolate	T	I
<i>L. intricata</i> J.V. Lamouroux	Stoloniferous	2-4	Present	Absent	Absent	3rd, 4th	Parallel	With 5P	Ovoid	T	"I, II"
<i>L. majuscula</i> (Harvey) Lucas	Stoloniferous	1-2	Present	Absent	Absent	3rd, 4th	Parallel	Unknown	Urceolate	T	I
<i>L. microcladia</i> Kützing	Stoloniferous	1	Present	Present	Absent	3rd, 4th	Parallel	Unknown	Urceolate	T	I
<i>L. minuta</i> Vandermeulen & al. subsp. <i>scammiae</i>	Discoïd holdfast	ND	Present	Present	Absent	3rd, 4th	Parallel	Unknown	Ovoid	T	I
G. Furnari & Cormaci <i>L. obtusa</i> (Hudson)	Stoloniferous	1	Absent	Absent	Absent	3rd, 4th	Parallel	With 5P	Ovoid	T	"I, III"
J.V. Lamouroux <i>L. pyramidalis</i> Bory ex Kützing	Stoloniferous	1	Absent or present (slightly)	Absent	Absent	4th	Parallel	Unknown	Urceolate	T	"IV, V"

I = Furnari & al., 2001; II = Nam & Saito, 1995; III = Nam & al., 1994; IV = Maggs & Hommersand, 1993; V = This study.
ND = Not detected; P = Pericentral cell; T = Trichoblast-type.

genus *Laurencia*, *L. similis* K.W. Nam *et* Saito (Nam & Saito, 1991), *L. brongniartii* J. Agardh (Abe *et al.*, 1998) and *L. pygmaea* Weber-van Bosse (commonly considered as synonym of *L. decumbens* Kützing) (Yamagishi *et al.*, 2003), have only one cell (the fourth) producing a tetrasporangium per axial segment.

Finally, although our finding represents the first documented record of this species in the Mediterranean Sea (see Gómez Garreta *et al.*, 2001), in our opinion such a record does not support any hypotheses of a recent introduction of *L. pyramidalis* in the region. Conversely, it suggests that the species found in the Gulf of Venice (Adriatic Sea) and invalidly published by Zanardini (1847) as *L. obtusa* var. *pyramidalis*, as well as the above mentioned records of *L. obtusa* var. *pyramidata* from Ancona (Adriatic Sea), Taranto and Lecce (Ionian Sea), should most probably be attributed to *L. pyramidalis*. It is also very likely that, due to the possible misidentification of *L. pyramidalis* with *L. obtusa*, a re-examination of old records of *L. obtusa* from the Mediterranean Sea could result in a wider distribution of *L. pyramidalis* in the region.

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REFERENCES

- ABE T., MASUDA M., KAWAGUCHI S. & KAMURA S., 1998 — Taxonomic notes on *Laurencia brongniartii* (Rhodomelaceae, Rhodophyta). *Phycological Research* 46: 231-237.
- AGARDH J., 1852 — *Species genera et ordines algarum. Volumen secundum: algas florideas complectens*. Lund, Part 3, fasc. 1: 701-786.
- FURNARI G., CORMACI M. & SERIO D., 2001 — The *Laurencia* complex (Rhodophyta, Rhodomelaceae) in the Mediterranean Sea: an overview. *Cryptogamie, Algologie* 22: 331-373.
- FURNARI G. & SERIO D., 1995 — Progress in the taxonomy of the genus *Laurencia* (Ceramiales, Rhodophyta) up to the resurrection of the genus *Osmundea*. *Giornale Botanico Italiano* 129 (1): 185-188.
- GARBARY D.J. & HARPER J.T., 1998 — A phylogenetic analysis of the *Laurencia* complex (Rhodomelaceae) of the red algae. *Cryptogamie, Algologie* 19: 185-200.
- GÓMEZ GARRETA A., GALLARDO T., RIBERA M.A., CORMACI M., FURNARI G., GIACCONE G. & BOUDOURESQUE Ch.F., 2001 — Check-list of Mediterranean Seaweeds III. Rhodophyceae Rabenhorst. 1. Ceramiales Oltmanns. *Botanica Marina* 44: 425-460.
- HARVEY W.H., 1849 — *Nereis australis*..... London, pp. 65-124, pls: XXVI-L.
- KÜTZING F.T., 1849 — *Species algarum*. Lipsiae, VI + 922 p.
- MAGGS C.A. & HOMMERSAND M.H., 1993 — *Seaweeds of the British Isles. I Rhodophyta. Part 3A Ceramiales*. London, HMSO Books, The Natural History Museum, 464 p.
- NAM K.W., 1999 — Morphology of *Chondrophycus undulata* and *C. parvipapillata* and its implications for the taxonomy of the *Laurencia* (Ceramiales, Rhodophyta) complex. *European Journal of Phycology* 34: 455-468.
- NAM K.W., MAGGS C.A. & GARBARY D.J., 1994 — Resurrection of the genus *Osmundea* with an emendation of the delineation of *Laurencia* (Ceramiales, Rhodophyta). *Phycologia* 33: 384-395.
- NAM K.W. & SAITO Y., 1991 — *Laurencia similis* (Ceramiales, Rhodophyta), a new species from Queensland, Australia. *British Phycological Journal* 26: 375-382.

- NAM K.W. & SAITO Y., 1995 — Vegetative and reproductive anatomy of some *Laurencia* (Ceramiales, Rhodophyta) species with a description of *L. maris-rubri* sp. nov. from Red Sea. *Phycologia* 34: 157-165.
- PAPENFUSS G.F., 1952 — Notes on South African marine algae. III. *Journal of South African Botany* 17: 167-188.
- PIERPAOLI I., 1923 — Prima contribuzione allo studio delle alghe nel golfo di Taranto. *Rivista di Biologia* 5: 693-710.
- PIERPAOLI I., 1947 (1945) — Rilievi sulla flora algologica anconetana. *Nuovo Giornale Botanico Italiano* 52: 14-20.
- SOLAZZI A., 1965 (1964) — Primi dati sulle alghe della scogliera "I travi" di Portonovo (Ancona). *Giornale Botanico Italiano* 71: 253-257.
- SOLAZZI A., 1968 — Flora e vegetazione macroscopica bentonica della costa Neretina (Lecce). *Atti e Relazioni dell'Accademia Pugliese delle Scienze*. 26: 3-33.
- STAFLEU F.A. & COWAN R.S., 1979 — *Taxonomic literature. A selective guide to botanical publications and collections with dates, commentaries and types*. Vol. II: H-Le. Second edition. The Hague. XVIII+267 p.
- YAMAGISHI Y., MASUDA M., ABE T., UWAI S., KOGAME K., KAWAGUCHI S. & PHANG S.M., 2003 — Taxonomic notes on marine algae from Malaysia. XI. Four species of Rhodophyceae. *Botanica Marina* 46: 534-547.
- ZANARDINI G., 1847 — Notizie intorno alle cellulari marine delle lagune e de litorali di Venezia. *Atti del Reale Istituto Veneto di Scienze, Lettere ed Arti* 6: 185-262.