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The Red Algal Genera *Laurencia*, *Osmundea* and *Palisada* (Rhodomelaceae, Rhodophyta) in Turkey

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Abstract

In this paper, 12 taxa at specific and infraspecific level of the red algal genera *Laurencia* (7), *Osmundea* (2) and *Palisada* (3) are studied and evaluated from Turkey. *Laurencia minuta* Vandermeulen, Garbary & Guiry subsp. *scammaccae* G. Furnari and Cormaci is reported for the first time, and *Laurencia uvifera* (Forsskål) Børgesen is reported for the second time in Turkey. *L. minuta* subsp. *scammaccae* was collected at a depth of 10 m from the Iskenderun Gulf (the Mediterranean coast of Turkey).

Keywords: Red algae, *Rhodophyta*, tribe Laurencieae, Mediterranean Sea, Turkey.

Türkiye'de Kırmızı Alg Cinsleri *Laurencia*, *Osmundea* ve *Palisada* (Rhodophyta, Rhodomelaceae)

Özet

Bu çalışmada, Türkiye'den kırmızı alglerden *Laurencia* (7), *Osmundea* (2) ve *Palisada* (3) cinslerine ait 12 taksa (tür ve türaltı seviyede) çalışılmış ve değerlendirilmiştir. *Laurencia minuta* Vandermeulen, Garbary & Guiry subsp. *scammaccae* G. Furnari and Cormaci Türkiye'den ilk ve *Laurencia uvifera* (Forsskål) Børgesen ikinci kez bildirilmektedir. *L. minuta* subsp. *scammaccae* İskenderun Körfezi (Akdeniz, Türkiye) kıyılarından 10 m derinlikten toplanmıştır.

Anahtar Kelimeler: Kırmızı algler, *Rhodophyta*, tribe Laurencieae, Akdeniz, Türkiye.

Introduction

The red algal genus *Laurencia* was established by Lamouroux (1813), and *Laurencia obtusa* (Hudson) J.V.Lamouroux was designated as type species of the genus by Schmitz (1889). Starting from 1994, many species were transferred to segregate genera like *Osmundea*, *Chondrophycus*, *Palisada*, *Yuzurua*, and *Laurenciella* (Nam *et al.*, 1994; Garbary and Harper, 1998; Nam, 2007; Martin-Lescanne *et al.*, 2010; Cassano *et al.*, 2012).A total of 430 taxa at specific and infraspecific level (for convenience named species throughout the text) of the *Laurencia* complex are reported in AlgaeBase, 132 of which are currently accepted. They occur in temperate to tropical shores around the world (Guiry and Guiry, 2012).

The genus *Osmundea*, established by Stackhouse (1809) with three species, was for long regarded as congeneric with *Laurencia* until Nam *et al.* (1994) presented evidence for its reinstatement. Nam *et al.* (1994) transferred 10 species of *Laurencia* under *Osmundea*, designating *O. osmunda* (S.G. Gmelin) K.W. Nam *and* Maggs as type species based on *O. expansa* Stackhouse. Guiry and Guiry (2012) report 18 species of *Osmundea* as currently accepted. The other rhodomelacean genus *Palisada* was described by Nam (2007: 53), with *Palisada robusta* K.W.Nam, based on *Laurencia palisada* Yamada, designated as type species and comprehending a total of 19 species.

Recently, species of *Laurencia*, *Osmundea*, *Palisada* and *Chondrophycus* were studied by Furnari *et al.* (2001) and Wynne *et al.* (2005) from the Mediterranean Sea and the Sultanate of Oman, respectively. *Laurencia* differs from *Osmundea* in thalli cylindrical (compressed in *Osmundea*) and four pericentral cells per axial segment (two pericentral cells per axial segment in *Osmundea*). It also differs from *Palisada* by four pericentral cells per axial segment (two pericentral cells per axial segment in *Palisada*) and secondary pit connections between

epidermal cells present (absent in *Palisada*).

In this study, the red algal genera *Laurencia*, *Osmundea* and *Palisada* are studied and evaluated from Turkey. A total of 12 species of *Laurencia* (7), *Osmundea* (2) and *Palisada* (3) are recorded. *L. minuta* Vandermeulen, Garbary and Guiry subsp. *scammaccae* G. Furnari and Cormaci is reported for the first time, and *L. uvifera* (Forsskål) Børgesen is reported for the second time from Turkey. Two species are cited as *taxa inquirenda* and four species are indicated as *taxa excludenda*.

Materials and Methods

Sampling was made from different localities (İstanbul, Dardanelles, Ayvalık, İzmir Gulf, and İskenderun Gulf) of Turkey in the years 2009 to 2012. Voucher specimens are deposited in the personal herbaria of Ergün Taşkın (ET) and Atakan Sukatar (AS). *Laurencia minuta* subsp. *scammaccae* was collected from the Iskenderun Gulf (Mediterranean coast of Turkey, 36°26'17"N; 35°54'07"E) at a depth of 10 m. The identification was made on the basis of the account by Furnari and Cormaci (1990). Photographs were taken using Nikon P5100.

Results

Laurencia J.V. Lamouroux 1813: 130

Thalli cylindrical, four pericentral cells per axial segment, tetrasporangia produced from pericentral cells, secondary pit connections between epidermal cells present, spermatangial branches produced from trichoblast.

Laurencia glandulifera (Kützing) Kützing 1849: 855

[*Chondria glandulifera* Kützing]

Thalli erect, terete (Figure 1), up to 8-10 cm high, epilithic, "*corps en cerise*" present, lenticular cell-wall thickenings are lacking in the medullary cells, in transverse section epidermal cells not palisade-like. This species was collected at the Dardanelles, in April, at 0-2 m depth. [ET]

Distributed in Malaysia, Aldabra Islands, Seychelles (Silva *et al.*, 1996), Philippines (Silva *et al.*, 1987), the Mediterranean Sea, Arabian Gulf, Japan, Korea (Furnari *et al.*, 2001), Eritrea (Lipkin and Silva, 2002), Canary Islands, Mauritania, Senegal (John *et al.*, 2004), and Turkey (Taskin *et al.*, 2008).

Laurencia microcladia Kützing 1865: 22

Thalli cylindrical, 5-10 cm high and 0.5-0.75 mm wide, epilithic, attached to the substratum by a stoloniferous holdfast (Figure 2), opposite branching generally and sometimes whorled, lenticular cell-wall thickenings in the medullary cells present, in transverse section epidermal cells not palisade-like. This species was collected at the Dardanelles, in April, at a 1 m depth. [ET]

Distributed in the Mediterranean Sea (Furnari *et al.*, 2001), including Turkey (Taşkın *et al.*, 2008).

Laurencia minuta* subsp. *scammaccae G.Furnari and Cormaci 1990: 532

Thalli light red, 3-3.5 mm high and 0.5 mm wide (Figure 3), one to five erect axes, mostly unbrached, epiphytic, attached to the substratum by a discoid holdfast, in transverse section epidermal cells not palisade-like, lenticular cell-wall thickenings in the medullary cells present, tetrasporangia occur in parallel lines and produced from pericentral cells. This species was collected at Iskenderun Gulf, in June, at a 10 m depth. [ET]

Distributed only in the Mediterranean Sea; Spain, Italy (Gómez Garreta *et al.*, 2001), Greece (Tsirika and Haritonidis, 2005), Malta (Cormaci *et al.*, 1997), and Turkey (this study).

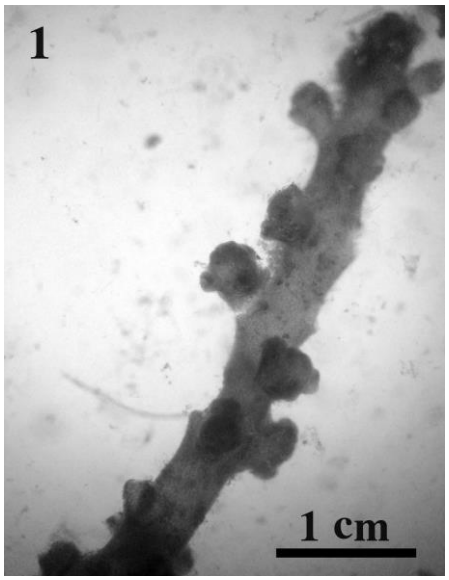

Figure 1. *Laurencia glandulifer*, apical portion of an axis.

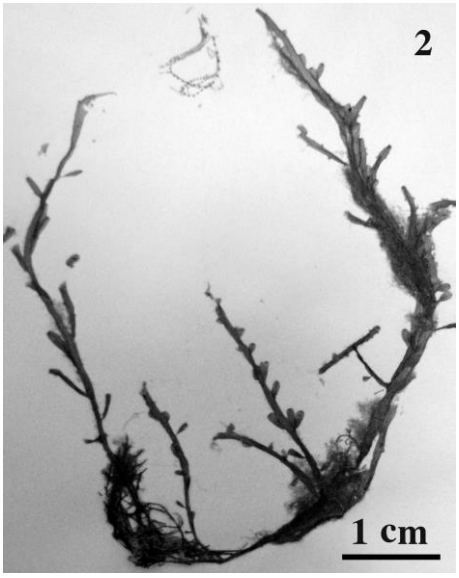

Figure 2. *Laurencia microcladia*, habit.

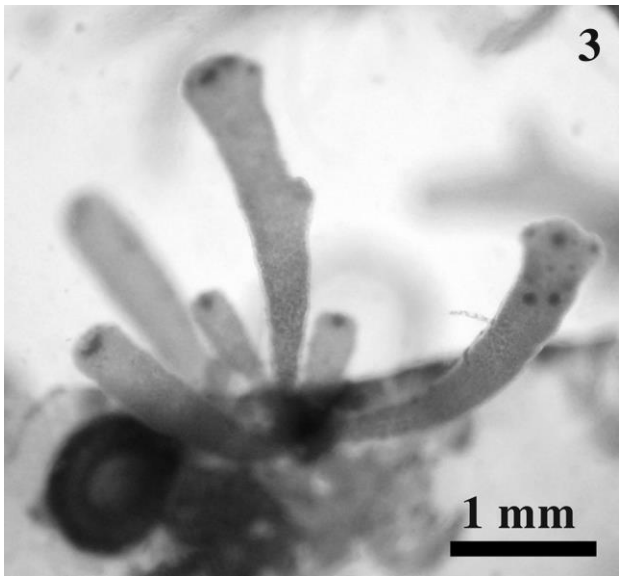

Figure 3. *Laurencia minuta* subsp. *scammaccae*, habit.

Note: *Laurencia minuta* was described by Vandermeulen *et al.* (1990) from the Gulf of Aqaba (Red Sea coast of Israel), growing on leaves of the seagrass host *Halophila stipulacea* (Forsskål) Ascherson. Furnari and Cormaci (1990) described *Laurencia minuta* subsp. *scammaccae* as a sister taxon of *L. minuta* from Italy. They reported that *L. minuta* subsp. *scammaccae* differs from *L. minuta* by cell-wall thickenings in the medullary cells. Turkish plants were found as epiphytes on leaves of the green alga *Caulerpa prolifera* (Forsskål) J.V.Lamouroux at a 10-m depth and with cell-wall thickenings in the medullary cells present.

Laurencia obtusa (Hudson) J.V.Lamouroux 1813: 130

[*Fucus obtusus* Hudson; *Chondria obtusa* (Hudson) C.Agardh]

Thalli cylindrical, 10-15 (-20) cm high and 1-1.5 mm wide (Figure 4), epilithic sometimes epiphytic, epidermal cells elongate polygonal, 26-40 µm long x 24-36 µm wide, "*corps en cerise*" present, in transverse section epidermal cells not palisade-like, t. This species was collected at Izmir Gulf (Sukatar, 1983) in all the seasons and Ayvalık (Aegean coast of Turkey), from March to June, 0-2 m depth. [ET]

Distribution: Widely distributed in the Mediterranean Sea and cosmopolitan in many seas (Furnari *et al.*, 2001).

Laurencia obtusa* var. *gracilis (C.Agardh) Zanardini 1847: 200

[*Chondria obtusa* var. *gracilis* C.Agardh; *Laurencia gelatinosa* J.V.Lamouroux; *Laurencia*

obtusa var. *crucifera* Kützing]

Thalli cylindrical, 5-10 cm high and 0.5-0.8 mm wide (Figure 5), epilithic, epidermal cells elongate, 60-100 µm long x 12-14 µm wide, in transverse section epidermal cells not palisade-like, 40-55 µm long × 30-50 µm wide. This species was collected at İzmir Gulf, in October, at a 0-1 m depth. [AS]

Distributed in Italy (Giaccone, 1969), Greece (Athanasiadis, 1987), Turkey (Sukatar, 1983), South Africa, India, Tanzania (Silva *et al.*, 1996), and Western Atlantic (Wynne, 2011).

Note: This taxon was considered as a taxon inquirendum by Furnari *et al.* (2001), however, it was given as a current name by Wynne (2011) and Guiry and Guiry (2012).

Laurencia pyramidalis Bory *ex* Kützing 1849: 854

Thalli cylindrical, branchlets giving a pyramidal outline, 5-10 cm high and 0.7-0.9 mm wide (Figure 6), epilithic, epidermal cells elongate, polygonal, 40-65 µm long x 20-40 µm wide, in transverse section epidermal cells not palisade-like. This species was collected at İzmir Gulf, found from June to August, at a 0-1 m depth. [AS]

Distributed in the northeastern Atlantic Ocean (Maggs and Hommersand, 1993), Italy (Furnari *et al.*, 1999), Turkey (Sukatar, 1983).

Laurencia uvifera (Forsskål) Børgesen 1932: 12

[*Fucus uvifer* Forsskål]

Thalli cylindrical, 4-6 cm high and 1 mm wide (Figure 7), epilithic, epidermal cells oblong, 70-110 µm long x 15-40 µm wide, in transverse section epidermal cells not palisade-like, lenticular cell-wall

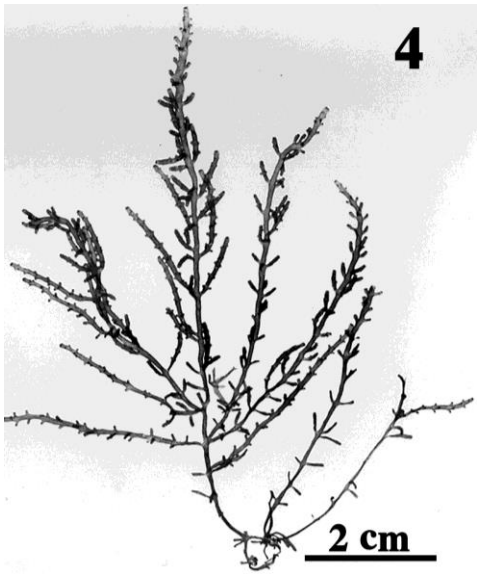

Figure 4. *Laurencia obtusa*, habit.

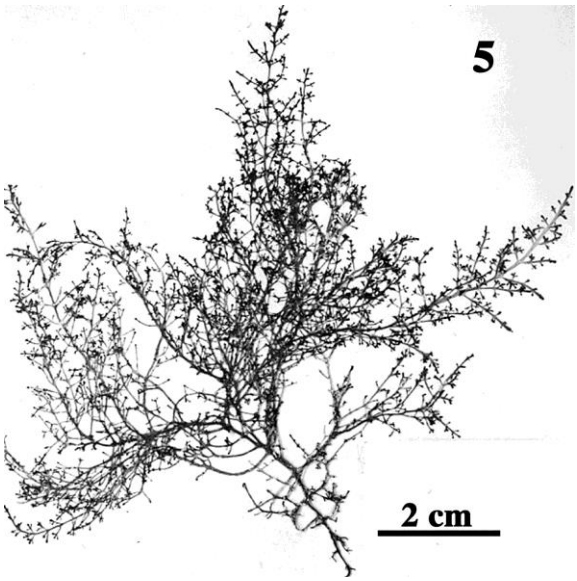

Figure 5. *Laurencia obtusa* var. *gracilis*, habit.

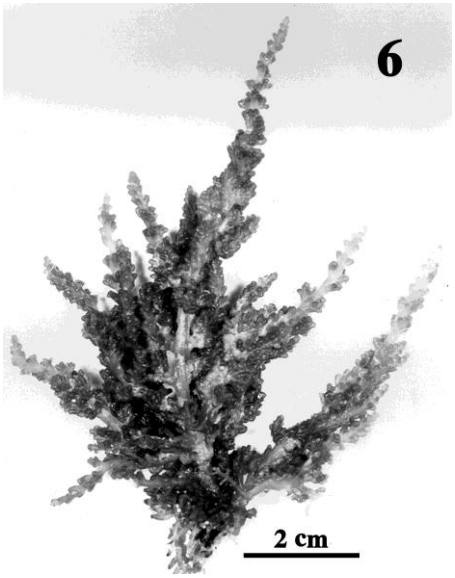

Figure 6. *Laurencia pyramidalis*, habit.

Figure 7. *Laurencia uvifera*, apical portion of an axis.

thickenings in the medullary cells sometimes present. This species was collected at İstanbul, July, at 1 m depth. [ET]

Distributed only in Turkey (Børgesen, 1932; this study) and Eritrea (Lipkin and Silva, 2002).

Note: This species was described for the first time by Forsskål (1775) as *Fucus uvifer* Forsskål from Istanbul and later reduced to a variety by Turner (1808) as *Fucus obtusus* gamma *uvifer* Turner. It was collected in August 1761 (Figure 8). This species is reported for the second time from Turkey in the present study. *Fucus uvifer* Forsskål was listed as a synonym of *Chondria botryoides* C.Agardh [=*Laurencia botryoides* (C.Agardh) Gaillon] by Agardh (1823: 346). Later, this species was indicated as a synonym of *Laurencia seticulosa* (Forsskål) Greville [=*Chondria seticulosa* (Forsskål) C.Agardh] by J. Agardh (1852: 758). After examining the type material in Copenhagen, Børgesen (1932) transferred *Fucus uvifer* to the genus *Laurencia*.

Osmundea Stackhouse 1809: 56,79,80

Thalli compressed, two pericentral cells per axial segment, tetrasporangia produced from epidermal cells, secondary pit connections between epidermal cells generally present.

Osmundea pelagosae (Schiffner) K.W.Nam in Nam *et al.* 1994: 393

[*Rodriguezella pelagosae* Schiffner; *Laurencia pelagosae* (Schiffner) Ercegovic]

Thalli compressed, 10-15 cm high and 1-3 mm wide, epilithic, epidermal cells in surface view

elongate, with secondary pit connections between epidermal cells, lenticular cell-wall thickenings in the medullary cells present. This species was collected at the Dardanelles, in April, at a 0-2 m depth. [ET]

Distributed only in the Mediterranean Sea (Gómez Garreta *et al.*, 2001), including Turkey (Taşkın *et al.*, 2008).

Osmundea pinnatifida (Hudson) Stackhouse 1809: 79

[*Fucus pinnatifidus* Hudson; *Laurencia pinnatifida* (Hudson) J.V.Lamouroux; *Chondria pinnatifida* (Hudson) C.Agardh]

Thalli compressed, 5-15 cm high and 1-3 mm wide (Figure 9), epilithic, holdfast stolon-like, epidermal cells in surface view elongate, secondary pit connections between epidermal cells absent, in transverse section epidermal cells not palisade-like, lenticular cell-wall thickenings in the medullary cells sometimes present. This species was collected at the Dardanelles, from March to May, at a 0-2 m depth. [ET]

Distributed in the northeastern Atlantic Ocean and the Mediterranean Sea (Maggs and Hommersand, 1993; Furnari *et al.*, 2001), including Turkey (Sukatar, 1983 as *Laurencia pinnatifida* (Gmelin) J.V.Lamouroux; Taşkın *et al.*, 2008).

Palisada K.W.Nam 2007: 53

Thalli cylindrical, two pericentral cells per axial segment, tetrasporangia produced from particular pericentral cells, secondary pit connections between epidermal cells absent, spermatangial branches produced from trichoblasts.

Figure 8. *Laurencia uvifera*, habit, holotype in the Herbarium Forsskålii (Copenhagen) (Photo E. Taşkın).

Figure 9. *Osmundea pinnatifida*, apical portion of thallus.

Palisada patentiramea (Montagne) Cassano, Sentíes, Gil-Rodríguez and M.T.Fujii in Cassano *et al.* 2009: 95

[*Chondria obtusa* (Hudson) C.Agardh var. *patentiramea* Montagne; *Laurencia obtusa* var. *patentiramea* (Montagne) Rabenhorst; *Laurencia patentiramea* (Montagne) Kützing; *Chondrophycus patentirameus* (Montagne) K.W.Nam]

Thalli cylindrical, 5-10 cm high and 1-2 mm wide (Figure 10), epilithic, attached to the substratum by a discoid holdfast, cartilaginous, epidermal cells in surface view elongate, lenticular cell-wall thickenings in the medullary cells present. This species was collected at the Dardanelles, in May, at a 1 m depth. [ET]

Distributed in the Mediterranean Sea (Gómez Garreta *et al.*, 2001; Furnari *et al.*, 2001), Turkey (Taşkın *et al.*, 2008), Cape Verde Islands (Prud'homme van Reine *et al.*, 2005), Salvage Islands (Parente *et al.*, 2000), Indonesia (Atmadja and Prud'homme van Reine, 2012), Philippines (Silva *et al.*, 1987) and Fiji (South and Skelton, 2003).

Palisada perforata (Bory) K.W.Nam 2007: 54

[*Fucus perforatus* Bory; *Fucus papillosus* Forsskål nom. illeg.; *Chondria papillosa* C.Agardh; *Laurencia papillosa* (C.Agardh) Greville; *Laurencia vaga* Kützing; *Chondrophycus papillosus* (C.Agardh) D.J.Garbary and J.T.Harper; *Chondrophycus perforatus* (Bory) K.W.Nam; *Palisada papillosa* (C.Agardh) K.W.Nam]

Thalli cylindrical (Figure 11), 5-15 (-20) cm high and 1,5-2 mm wide, epilithic, attached to the substratum by a discoid holdfast, cartilaginous,

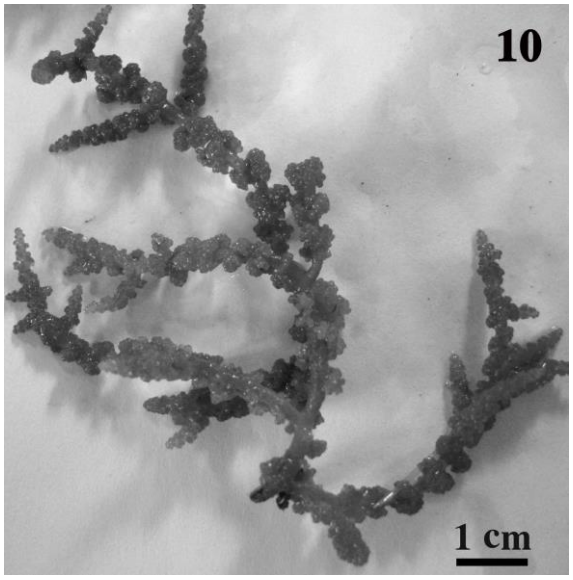

Figure 10. *Palisada patentiramea*, habit.

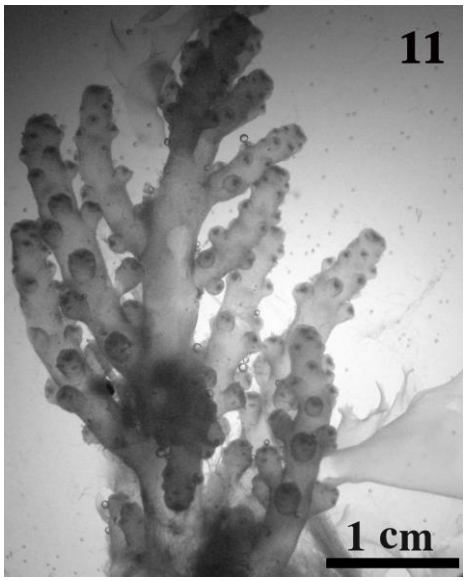

Figure 11. *Palisada perforata*, apical portion of thallus.

epidermal cells in surface view elongate, in transverse section epidermal cells palisade-like (Figure 12), cell-wall thickenings in the medullary cells sometimes present. This species was collected at İzmir Gulf and İskenderun Gulf, found from March to August, at 0-2 m depth. [ET]

Distributed widely in the Mediterranean Sea and cosmopolitan in the tropical and subtropical seas around the world (Furnari *et al.*, 2001).

Palisada thuyoides (Kützing) Cassano, Sentíes, Gil-Rodríguez and M.T.Fujii in Cassano *et al.* 2009: 95

[*Laurencia thuyoides* Kützing; *Chondrophycus thuyoides* (Kützing) G.Furnari; *Chondria obtusa* var. *paniculata* C.Agardh; *Laurencia obtusa* var. *paniculata* (C.Agardh) Zanardini; *Laurencia paniculata* (C.Agardh) J.Agardh; *Chondrophycus paniculatus* (C.Agardh) G.Furnari]

Thalli cylindrical, 5-10 cm high and 1-1.5 mm wide, epilithic, epidermal cells in surface view elongate, rounded, jk, in transverse section epidermal cells palisade-like, 34-44 µm long x 22-32 µm wide (Figure 13). This species was collected at İzmir Gulf, found from June to August, at 0-1 m depth. [AS]

Distributed in the Mediterranean Sea (Gómez Garreta *et al.*, 2001; Furnari *et al.*, 2001), Turkey (Sukatar, 1983; Taşkın *et al.*, 2008), Atlantic, Pacific and Indian Oceans (Furnari *et al.*, 2001).

Note: The name *Laurencia paniculata* (C.Agardh) J.Agardh is based on *Chondria obtusa* var. *paniculata* C.Agardh (J. Agardh 1852: 755);

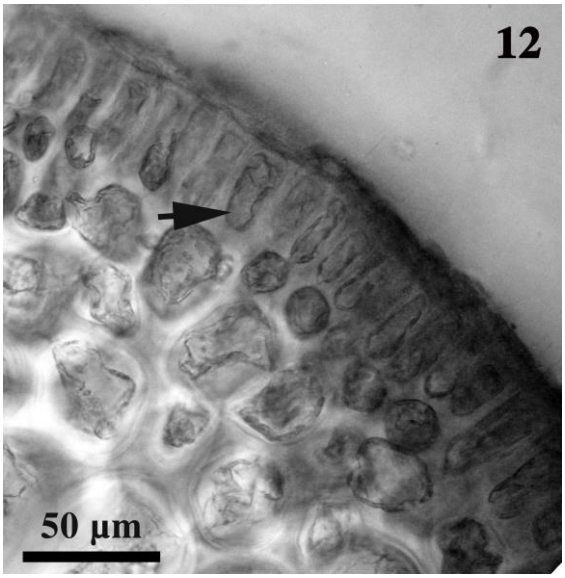

Figure 12. *Palisada perforata*, transverse section of thallus showing palisade-like epidermal cells (arrow).

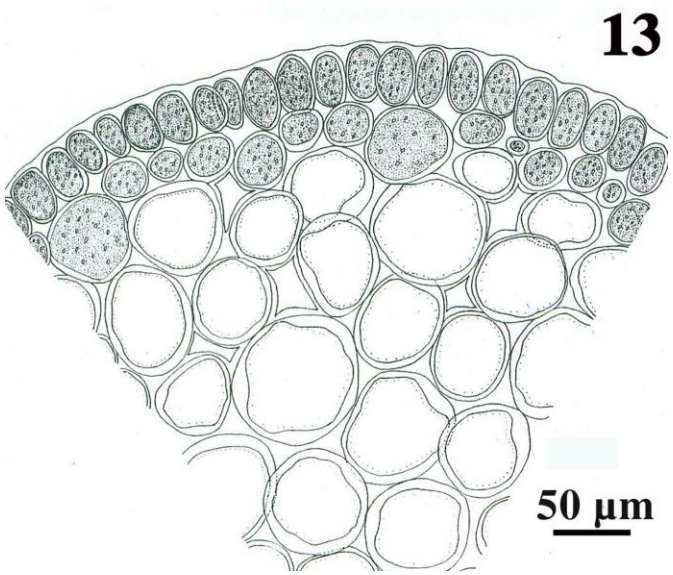

Figure 13. *Palisada thuyoides*, in transverse section of thallus showing palisade-like epidermal cells.

however, it is a later homonym of *Laurencia paniculata* Kützing (1849: 855). Although Silva *et al.* (1996) treated *L. paniculata* (C. Agardh) J.Agardh as conspecific with *L. glandulifera* (Kützing) Kützing, subsequent workers have not accepted that taxonomic proposal.

Taxa Inquirenda

Laurencia radicans Rabenhorst 1847: 155

Fritsch (1899) reported this species from Istanbul (Turkey), noting that J.Agardh indicated *Laurencia radicans* as well *Laurencia perforata* (Bory) Montagne [current name *Palisada perforata* (Bory) K.W.Nam] from warmer seas.

The name *Laurencia radicans* was described by Rabenhorst (1847: 155) who referred to Kützing, but not giving any basionym. Later Kützing (1849: 853), combined his *Chondria radicans* Kützing under the genus *Laurencia* as *Laurencia radicans* (Kützing) Kützing, but this binominal is illegitimate being a later homonym *Laurencia radicans* Rabenhorst. This species, as *Laurencia radicans* (Kützing) Rabenhorst was considered as a *taxon inquirendum* by Furnari *et al.* (2001).

Palisada intermedia (Yamada) K.W.Nam 2007: 54

[*Laurencia intermedia* Yamada; *Chondrophycus intermedius* (Yamada) Garbary and J.T.Harper]

This species was reported from the Black Sea coast of Turkey by Aysel *et al.* (1986) with a brief description too. However, in our opinion, the record should be confirmed from Turkey and the Mediterranean Sea.

Taxa Excludenda

Osmundea spectabilis (Postels and Ruprecht) K.W.Nam in Nam *et al.* 1994: 393

[*Laurencia spectabilis* Postels and Ruprecht; *Laurencia pinnatifida* var. *spectabilis* (Postels and Ruprecht) Farlow, Anderson and Eaton]

This species is known from the Pacific coast of North America (Nam *et al.*, 1994). *Osmundea pinnatifida* (Hudson) Stackhouse is similar to *Osmundea spectabilis* in having a strongly compressed thallus, but it differs in having many lenticular thickenings in its medullary cell walls (Nam *et al.*, 1994). *O. spectabilis* was reported from the Aegean coast of Turkey (Taskin *et al.*, 2008), but the record was a mistake because of confusing it with the somewhat similar *O. pinnatifida*, and thus the occurence of this species in the Mediterranean Sea should be excluded.

Osmundea splendens (Hollenberg) K.W.Nam in Nam *et al.* 1994: 393 [*Laurencia splendens* Hollenberg]

This species is known from the Pacific coast of North America (Nam *et al.*, 1994). It was reported from the Sea of Marmara (Turkey) by Aysel *et al.* (1993). Taşkın *et al.*, (2008) reported that this species should be confirmed in the Mediterranean Sea and Turkey. In our opinion, the record was a mistake because of confusing it with other somewhat similar species, and thus the occurence of this species in the Mediterranean Sea should be excluded.

Palisada capituliformis (Yamada) K.W.Nam 2007: 54

[*Laurencia capituliformis* Yamada; *Chondrophycus capituliformis* (Yamada) Garbary and J.T.Harper]

This species is known only from Korea, Japan, China and Philippines. It was recorded as *Laurencia capituliformis* Yamada from the Sea of Marmara (Turkey) by Aysel *et al.* (1993), but it was treated as a misidentificationa by Taşkın *et al.* (2008). Thus, the occurence of this species in Turkey should be excluded.

Palisada cruciata (Harvey) K.W.Nam 2007: 54

[*Laurencia cruciata* Harvey; *Chondrophycus cruciatus* (Harvey) K.W.Nam]

This species was recorded as *Laurencia cruciata* Harvey from the Sea of Marmara in Turkey by Aysel *et al.* (1993). However, the occurence of this species in Turkey should be excluded.

Acknowledgments

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