

## RESEARCH ARTICLE

**TAXONOMIC ACCOUNT OF TWO RED SEA WEED GENERA *PORPHYRA* C. AGARDH AND *PYROPIA* J. AGARDH (BANGIALES: RHODOPHYTA) IN INDIA**
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**Abstract:** The red seaweed genus *Porphyra* is one of the economically important seaweeds, and belongs to the bladed order Bangiales of Rhodophyta. The recent global molecular assessment of the order Bangiales has led to many nomenclatural changes in the genus *Porphyra* and the resurrected genus *Pyropia*, under which 51 taxa of the genus *Porphyra* have been shifted. Therefore, presently *Porphyra* is represented by four taxa and *Pyropia* by five taxa in India. The study also revealed that of the nine taxa studied, seven taxa including all four taxa of *Porphyra* and three taxa of *Pyropia* are endemic to the Indian coast. The present paper deals with the comprehensive taxonomic account of these two important genera of red seaweeds in India.

**Keywords:** Endemic, Indian coast, *Porphyra*, *Pyropia*, Rhodophyta, Taxonomy.

## INTRODUCTION

The red seaweed order Bangiales (Nageli, 1874) is a morphologically simple and foliose algae with a distinctive character under Rhodophyceae which has been harvested and traded in Japan, China, Korea, and Southeast Asia for thousands of years (Mumford and Miura, 1988) and has usually found in the intertidal and shallow subtidal regions from tropical to cold temperate regions of the world (Brodie *et al.*, 2008). With molecular taxonomic evidences, the order now includes 14 genera, of which *Porphyra* is the dominant one. However, recent molecular phylogenetic study of Sutherland *et al.* (2011) and Sánchez *et al.* (2014) divided *Porphyra* sensu lato into nine genera namely *Boreophyllum*, *Clymene*, *Fuscifolium*, *Lysithea*, *Miuraea*, *Porphyra*, *Pyropia*, *Wildemania* and *Neothemis*. Further, 51 taxa of the genus *Porphyra* was shifted under *Pyropia* (Sutherland *et al.*, 2011; Kavale *et al.*, 2015). In the latest taxonomic revision, Yang *et al.* (2020) further divided the genus *Pyropia* into *Pyropia*, *Calidia*, *Neoporphyra*, *Neopyropia*, *Uedaea* and *Porphyrella*. Subsequently, Santiañez and Wynne (2020) reported *Calidia* as an illegitimate name, and hence proposed a new genus *Phycocalidia* (Kavale *et al.*, 2021). In the recent years, the taxonomic assessment of many of the Indian seaweed genera in India have been accessed (Kavale *et al.*, 2015; Yadav *et al.*, 2023). Therefore, the taxonomic status of the genus *Porphyra* has got many

nomenclatural changes, which has been described in details in reference to the Indian coast.

The genus *Porphyra* (family Bangiaceae) was originally described by C. Agardh (1824) and *Porphyra purpurea* (Roth) C. Agardh was designated as lectotype of this genus. Presently, this genus is represented by 83 taxa in the world (Guiry and Guiry, 2023). The occurrence of this genus from the Indian peninsular region was first reported by J.A. Murray (1881) from the Manora coast, Karachi, Pakistan. Anilkumar and Panikkar (1997) reported seven species of *Porphyra* from the Indian region, such as *P. chauhunii*, *P. crispata*, *P. suborbiculata*, *P. kanyakumuriensis*, *P. indica*, *P. viemumensis* and *P. okhaensis*. Among these, *P. viemumensis* was first reported from Madras harbor by Boergesen (1937), two species namely *P. kanyakumuriensis* from Kovalam coast, Chennai and *P. indica* from Boria Island, Gujarat by Krishnamurthy and Baluswami (1984), *P. okhaensis* from Okha coast, Gujarat by Joshi *et al.* (1992) and three species namely *P. chauhunii*, *P. crispata*, and *P. suborbiculata* were reported by Anilkumar and Panikkar (1995) from Quilon (Kollam) coast, Kerala. Similarly, Rao and Gupta (2015) documented nine taxa of the genus *Porphyra* from India. Palanisamy *et al.* (2020) and Palanisamy and Yadav (2022) also reported several species of *Porphyra* from various coastal localities of Kerala, Karnataka and Goa in the west coast of India. The genus *Porphyra* sensu lato is considered as one

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of the economically important seaweed genus, widely maricultured and used in food industries in many oriental countries because of its rich protein and vitamin contents (Sahoo *et al.* 2006). The genus is also known to have about 17 types of amino acids, including taurine, which controls blood cholesterol levels (Tsuji *et al.*, 1983) and has an annual value of over US\$ 1.8 billion (Yarish *et al.*, 1999). Because of its economic potential, the biology of this genus has been studied extensively (Guiry and Guiry, 2023).

The advancement in molecular science has led to many nomenclatural changes in taxonomy of the genus *Porphyra*. The molecular study of the genus revealed that it contains a polyphyletic assemblage of taxa that have all converged on simple blade morphology. Sutherland *et al.* (2011) redefined the genus *Porphyra* and resurrected the genus *Pyropia* by shifting many species of *Porphyra*. Therefore, in the present study, the current taxonomic status of these two seaweed genera in India has been attempted to describe in detail.

## MATERIALS AND METHODS

The present taxonomic study is mainly based on extensive botanical explorations to different coastal localities of India and a thorough study of fresh collections of seaweeds and relevant literature. For field survey and collection of fresh samples of seaweeds, the authors conducted several botanical explorations from 2011 to 2023 to different coastal localities of the Indian coast. During surveys, important field observations such as habit, habitats, nature of the coast, vegetation pattern, association with other plants, GPS position (Garmin 12 channel XL) etc. were recorded and photographed using a digital camera (Nikon Coolpix L120) and physico-chemical parameters of the water samples were analysed using Water Analysis Kit (Labtronics Model LT-59). All the samples were thoroughly preserved in the form of herbarium specimens (wet and dry forms) following the standard procedure (Srinivasan, 1969; Dhargalkar and Kavlekar, 2004) and studied microscopic characters under sophisticated compound microscopes (Nikon SMZ1500 and Nikon Eclipse 50i). The samples were identified following the standard literature (Srinivasan, 1973; Silva *et al.*, 1996; Desikachary *et al.*, 1990; Palanisamy *et al.*, 2020; Palanisamy and Yadav, 2022). The preserved specimens were deposited into different herbaria of the Botanical Survey of India such as Madras Herbarium (MH), Coimbatore, Tamil Nadu and Central National Herbarium (CAL), Howrah. Besides, the herbarium specimens at CAL, BSIS, BSI, PBL, NFMA and resources of virtual herbarium at BM, K, NY, CONN were also referred and examined. Further, all the relevant global algal databases such as Algaebase (<https://www.algaebase.org>), WoRMS

(<https://www.marinespecies.org>), Seaweeds (<https://www.seaweed.ie/>) and Macroalgal Herbarium Portal (<https://macroalgae.org>) etc. were referred for resolving nomenclatural ambiguities and provide the updated status of each taxon.

## RESULTS AND DISCUSSION

The present study revealed that the genus *Porphyrasensu lato* has undergone many nomenclatural changes. It was earlier represented by 10 taxa in India, and as of now it is delimited into two genera namely *Porphyra* and *Pyropia*. Besides, one more taxon *Porphyra crispata* Kjellm., which was reported from many parts of the Indian coast (Kollam, Kerala by Anilkumar and Panikkar, 1995; Kollam, Kozhikode and Thiruvananthapuram, Kerala by Palanisamy *et al.*, 2020 and Palolem, Goa by Pereira and Almeida, 2014), has been synonymized under *Monostroma nitidum* Witt. (Monostromataceae). Therefore, with the new nomenclatural changes, the genus *Porphyra* is presently represented by four taxa, while the resurrected genus *Pyropia* is represented by five taxa in India (Table 1).

The study also revealed interestingly that, out of the nine taxa recorded from India, seven taxa, comprising all four taxa of *Porphyra* and three taxa of *Pyropia*, viz. *Porphyra chauhanii* C. Anil Kumar & M.V.N. Panikkar, *Porphyra indica* V. Krishnam. & M. Baluswami, *Porphyra malvanensis* Anil Kumar and P.S.N. Rao, *Porphyra okhaensis* H.V. Joshi & al. H.V. Joshi, R.M. Oza & A. Tewari, *Pyropia kanyakumariensis* (V. Krishnam. & Baluswami) Santiañez & M.J. Wynne, *Pyropia acanthophora* var. *robusta* M.G. Kavale, M.A. Kazi & N. Sreenadhan and *Pyropia sukshma* (M.G. Kavale & M.A. Kazi) Santiañez & M.J. Wynne are endemic to the Indian coast. Whereas two taxa viz. *Pyropia suborbiculata* (Kjellman) J.E. Sutherland, H.G. Choi, M.S. Hwang & W.A. Nelson and *Pyropia suborbiculata* (Kjellman) J.E. Sutherland, H.G. Choi, M.S. Hwang & W.A. Nelson are cosmopolitan and distributed in many parts of the world. The presence of these endemic seaweeds in the Indian coast reflects the importance of taxonomic study and its conservation. Therefore, the present study deals with the updated taxonomical circumscription with distinguishing characters of these two genera in India, as given below:

### Key to the genera

- 1a. Thallus linear to lanceolate, orbicular to broadly expanded; light-dark pinkish red in colour; mono-di-stromatic; anatomically cells in the distal part of the blade without small appendages; marginal spines mostly absent  
**1. *Porphyra***
- 1b. Thallus lanceolate, linear-lanceolate, linear, lacinate, orbiculate or ovate; pink, brown, purple, grey, red to olive green in colour;

monostromatic; anatomically cells in the distal part of the blade with small appendages; marginal spines mostly present

**2. *Pyropia PORPHYRA*** C. Agardh

The thallus is usually elongate or linear to lanceolate, orbicular to broadly expanded; light-dark pinkish red, up to 35 cm (- 3 m) long, membranous, mucilaginous and fragile in nature (**Fig. 1, A**). Thallus mono or distromatic, usually epilithic or epiphytic, firmly attached with discoid holdfast. Fronds foliaceous, with smooth surface, margins with or without microscopic spinous outgrowths. Cells with 1-2 stellate chloroplasts, each with a central pyrenoid. Asexual reproduction by means of spores; sexual plants monoecious, dioecious or androdioecious.

Currently, 83 taxa in the world (Guiry and Guiry, 2023) and 4 in India.

**Key to the species**

1a. Thallus 3-6 lobed; margins entire, wavy to folded or laciniate; with microscopic spines at the margins; spermatia 256, in 8 tiers

**1. *P. chauhanii***

1b. Thallus entire or lobed; without microscopic spines at the margins; spermatia variable in number **2**

2a. Thallus usually linear-lanceolate or elongate, up to 22 cm long; spermatia 64, arranged in 4 tiers

**2. *P. indica***

2b. Thallus usually orbicular to broadly expanded, upto 35 cm long; spermatia 64 or indefinite **3**

3a. Thallus reddish brown in colour, small, upto 0.8 cm long and 0.9 cm broad, lobes orbicular to broadly expanded, spermatia 64, arranged in 4 tiers

**3. *P. malvanensis***

3b. Thallus reddish pink in colour, large, upto 35 cm long and 20 cm broad, lobes orbicular; spermatia indefinite in number, arranged along margins

**4. *P. okhaensis***

**1. *Porphyra chauhanii*** C. Anil Kumar & M.V.N. Panikkar, Seaweed Res. Utiln. 17(1&2): 153, figs. 1a, 2. 1995; C. Anil Kumar & M.V.N. Panikkar in Feddes Repert. 108 (5-6): 420. 1997. Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 3. 2001; M.U. Rao in Tewari (ed.), Rec. Adv. Appl. Asp. Ind. Mar. Alg. Ref. Glob. Scen. 1: 49. 2006; P.S.N. Rao & R.K. Gupta, Algae India 3: 33. 2015; Palanisamy & al., Seaweeds Kerala, India 103. 2020.

*Type locality:* Thirumullavaram, Kollam district, Kerala, India.

Thallus dark-pinkish red, foliose, usually lobed, 3-15.5 × 0.8-1.6 cm, membranous, mucilaginous, monostromatic, fragile in nature, epilithic. Holdfast discoid, up to 3 mm wide, loosely attached on rocky substrata in surf-exposed areas. Stipe small, sometimes indistinct, up to 5 mm long. Fronds usually incised into 3-6 lobes; lobes elongate or linear to lanceolate, usually widened in middle and gradually tapering towards apex; surface smooth, slippery; margins entire to wavy to folded or laciniate,

with a number of microscopic spinulose processes; apex acute - obtuse. *Microscopic characters:* Cells in surface view rounded - spherical, compactly arranged. In cross-section, thallus 4-11 μm thick. Reproductive structures develop on thallus surface, monoecious; fertile zones lightly coloured; spermatia 256, arranged in 8 tiers of 16 each.

*Occurrence:* Usually Monsoon season. Scanty.

*Distribution:* **INDIA:** Andhra Pradesh (Srikakulam) and Kerala (Thirumullavaram).

*Global distribution status:* Not reported from any other parts of the world.

*Specimens examined:* **INDIA: Andhra Pradesh:** Srikakulam Distr.: Yerramukkam, 20.03.2017, M. Palanisamy & Aron Santhosh Kumar 137103 (MH); 06.09.2018, Palanisamy & Aron Santhosh Kumar 137527 (MH). **Kerala:** Kollam Distr.: Thangassery coast, 16.06.2013, M. Palanisamy & S.K. Yadav 128825 (MH); Kollam, 28.08.1999, D.B. Sahoo *s.n.* (CONN, CONN01009464 image!).

*Notes:* This species was originally reported by Anilkumar and Panikkar (1995) from the Thirumullavaram coast (Kollam district) of Kerala and its type specimens are deposited at the Department of Botany, Sree Narayana College, Quilon, Kerala. A digital image of a herbarium specimen, showing a collection of Sahoo (*op. cit.*) from the rocky habitats of Kollam coast, Kerala is also available at CONN - University of Connecticut, USA (<https://macroalgae.org>).

*Distribution Status:* Endemic to the Indian coast (Palanisamy *et al.*, 2020).

**2. *Porphyra indica*** V. Krishnam. & M. Baluswami, Seaweed Res. Utiln. 7(1): 35, figs. 1-13. 1984; Desikachary & al., Rhodophyta, 2 (2A) 35. 1990; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 92. 1996; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 3. 2001; P.S.N. Rao & R.K. Gupta, Algae India 3: 34. 2015; Palanisamy & al., Seaweeds Kerala, India 105, fig. plate 51 C-E, 2020. (**Fig. 1, B-D**).

*Type locality:* Boria Reef, Gulf of Kutch, Gujarat, India.

Thallus dark-reddish pink, foliose, fragile in nature, flat, 7-22 × 2-12 cm, membranous, mucilaginous, monostromatic, epilithic. Holdfast minute, discoid, up to 2.2 mm in diameter, further divided into several minute hairlike branches called rhizines, firmly attached on rocky substrata in surf-exposed areas in upper intertidal regions. Stipe small, stalked to sessile, sometimes indistinct. Fronds membranous, linear-lanceolate; surface smooth, mucilaginous; margins entire without any microscopic spinulose processes; apex acute or obtuse. *Microscopic characters:* Cells in surface view elongate - spherical or polygonal, 11-14 × 20.2-27 μm, thick walled, irregularly and sparsely arranged. In cross-section, thallus monostromatic, up to 39 μm thick, heavily mucilaginous; mucilage up to 3 μm thick; cells usually elongate, 16-32 × 4.5-15 μm, loosely arranged. Cells with single chromatophore;

chromatophores with slender arms, extended towards periphery. Reproductive structures develop on thallus surface, monoecious, fertile zones lightly coloured, forming a distinct patch on thallus surface; spermatangia develop in narrow patches, spermatia 64, arranged in 4 tiers, each tier with 16 cells; carposporangia usually develop towards margins, carpospores 16, 4-6  $\mu\text{m}$  across.

*Occurrence:* Summer season. Scanty.

*Distribution:* **INDIA:** Gujarat, Kerala (Kollam and Thiruvananthapuram).

*Global distribution status:* Not reported from any other parts of the world.

*Specimens examined:* **INDIA: Kerala:** Kollam Distr.: Paravur coast, 15.06.2013, *M. Palanisamy & S.K. Yadav* 128813 (MH); Thirumullavaram coast, 05.07.2012, *M. Palanisamy & S.K. Yadav* 127709 (MH); Thiruvananthapuram Distr.: Varkala coast, 04.07.2012, *M. Palanisamy & S.K. Yadav* 127668 (MH); 15.06.2013, *M. Palanisamy & S.K. Yadav* 128591 (MH); Edava coast, 15.06.2013, *M. Palanisamy & S.K. Yadav* 128805 (MH).

*Notes:* This species was first described by Krishnamurthy and Baluswami (1984) from the Boria Reef, Gulf of Kutch, Gujarat, India. Its type specimen is deposited at CAS in Botany, Madras University, Chennai, India. This species is reported hitherto only from the Gujarat coast (Rao and Gupta, 2015) and Kollam and Thiruvananthapuram coasts of Kerala in the West coast of India (Palanisamy *et al.*, 2020).

*Distribution status:* Endemic to the Indian coast (Oza and Zaidi, 2001).

**3. *Porphyra malvanensis*** Anil Kumar and P.S.N. Rao in Feddes Repert. 116: 223-224, fig. 1A. 2005; P.S.N. Rao & R.K. Gupta, *Algae India* 3: 34. 2015.

*Type locality:* Malvan coast, Maharashtra, India.

Thallus reddish brown, small, 0.5-0.8  $\times$  0.6-0.9 cm, membranous, fragile, in nature, mucilaginous, monostromatic. Holdfast minute, firmly attached on rocky substrata in mid to upper intertidal regions. Fronds membranous, orbicular, broadly expanded; margins entire, smooth, without any microscopic spinuloses. *Microscopic characters:* Cells in surface view polygonal, 14-16  $\times$  9-14  $\mu\text{m}$  in size, usually sparsely arranged, mucilage 23 - 36  $\mu\text{m}$  thick. In cross-section, thallus monostromatic; cells usually elongate, 14-16  $\times$  9-14  $\mu\text{m}$ . Cells with single chromatophore; chromatophore with stellate arms, extended towards periphery. Reproductive structures develop on mature thallus surface, monoecious, carposporangia and spermatangia sometimes mixed or in narrow patches; spermatia 64, arranged in 4 tiers, each tier with 16 cells; carpospores 8, arranged in 2 tiers of 4 cells, 7-9  $\mu\text{m}$  across.

*Occurrence:* Post monsoon season. Scanty.

*Distribution:* **INDIA:** Maharashtra (Malvan).

*Global distribution status:* Not reported from any other parts of the world.

*Specimen examined:* **INDIA: Maharashtra:** Sindhudurg Distr.: Malvan coast, 03.08.2004, *Anil Kumar & P.S.N. Rao* 177441(BSI).

*Notes:* This species was reported from the Malvan coast of Maharashtra by Anil Kumar and Rao (2005) and the *Holotype* specimen is deposited at 'BSI' - the herbarium of Botanical Survey of India, Western Regional Centre, Pune. The species is named after the type locality *i.e.* Malvan coast. In nature, the species is usually found growing in association with the species of *Ulva* and other green algae in the upper intertidal zone.

*Distribution status:* Endemic to the Indian coast.

**4. *Porphyra okhaensis*** H.V. Joshi, R.M. Oza & A. Tewari in *Indian J. Mar. Sci.* 21: 263, figs. 1, 2. 1992; Anil Kumar & P.S.N. Rao in Feddes Repert. 116: 222. 2005; C. Anil Kumar & M.V.N. Panikkar in Feddes Repert. 108 (5-6): 422, figs 2/1, 4, 5, 6. 1997. Oza & Zaidi, *Rev. Checkl. Ind. Mar. Alg.*: 3. 2001; P.S.N. Rao & R.K. Gupta, *Algae India* 3: 34. 2015.

*Type locality:* Okha coast, Gujarat, India.

Thallus reddish pink, leafy, upto 35 cm long and 10-20 cm broad, membranous, fragile, mucilaginous, monostromatic, lithophilic. Holdfast firmly attached on rocky substrata in sub-littoral regions. Fronds membranous, lobes orbicular, mucilaginous; margins entire without any microscopic spines. *Microscopic characters:* Cells in surface view polygonal, 10-20  $\mu\text{m}$ , across. In cross-section, thallus monostromatic, 10-20  $\mu\text{m}$  thick in vegetative parts and 35-37.5  $\mu\text{m}$  in reproductive parts. Cells with single chromatophore. Reproductive structures develop on thallus surface first from the apex and margins, and later extends inwards, Carposporangia and spermatangia develop in irregular patches on thallus surface; spermatia indefinite, arranged along the margins; carpospores 4-8, 10-20  $\mu\text{m}$  across.

*Occurrence:* Usually post monsoon and winter season. Scanty.

*Distribution:* **INDIA:** Gujarat (Okha coast).

*Global distribution status:* Not reported from any other parts of the world.

*Notes:* This species was first reported from the Okha coast, Gujarat in the west coast of India by Joshi *et al.* (1992) and studied the life history of this species in culture condition. The type specimen (Joshi, Oza & Tewari 5; December 26, 1986) of this species is deposited at the National Facility for Marine Algae Herbarium (NFMAH), CSIR- Central Salt & Marine Chemicals Research Institute Mandapam, Ramanathapuram, Tamil Nadu. The species is named after the type locality *i.e.* Okha coast. Dipakkore *et al.* (2005) studied the production and seeding of protoplasts of this species in culture medium and reported high yield of viable protoplasts following enzymatic digestion technique. This species has been included here based on the report by Joshi *et al.*

(1992). In our present study, it could not be collected.

*Distribution status*: Endemic to the Indian coast (Oza and Zaidy, 2001).

**PYROPIA** J. Agardh

The thallus is usually lanceolate, linear-lanceolate, linear, lacinate, orbiculate, ovate; variable in colour ranging from pink, brown, purple, grey, red to olive green in colour, up to 25 (-100) cm long, membranous, mucilaginous, fragile in nature. The thallus is monostromatic, usually epilithic, firmly attached with discoid holdfast. Fronds foliaceous, with smooth surface, margins with or without microscopic spinous outgrowths. Cells with 1-2 stellate chloroplasts, each with a pyrenoid. Sexual plants usually monoecious or dioecious. Distinguished from other bladed Bangiales by *rbcL* and 18S gene sequence differences. Originally, *Pyropia* was distinguished from *Porphyra* by cells in the distal part of the blade having small appendages as illustrated by Agardh (1899, fig. 5c) (Sutherland *et al.* (2011).

Currently 81 taxa in the world (Guiry and Guiry, 2023) and 5 in India.

**Key to the species**

- 1a. Thallus usually pinkish red in colour; large, upto 25 cm long; spermatia more **2**
- 1b. Thallus usually purple red in colour; small, upto 10 cm long; spermatia less **3**
- 2a. Thallus pinkish red in colour, upto 25 cm long and 8 cm broad; lobes linear-lanceolate; margins entire-deeply lacinate; spines unicellular; spermatia 128 **1. P. kanyakumariensis**
- 2b. Thallus greenish-reddish brown in colour, upto 4cm long and 14 cm broad; lobes broadlyorbicular-ovate; margins undulate; spines 1-5 celled; spermatia 256 **4. P. acanthophora** var. **robusta**
- 3a. Thallus dark purple red in colour, up to 7 cm long; spermatia 64 **4**
- 3b. Thallus reddish purple in colour, upto 10 cm long long; spermatia 64 **5. P. sukshma**
- 4a. Thallus deep purple red, upto 4 cm long; lobes orbicular, margins undulate-lacinate **2. P. suborbiculata**
- 4b. Thallus light-dark purple red, upto 7 cm long; lobes linear-lanceolate, margins undulate-dentate **3. P. vietnamensis**

**1. Pyropia kanyakumariensis** (V. Krishnam. & Baluswami) Santiañez & M.J.Wynne, *Notulae Algarum* 258: 1-2. 2022. *Phycocalidia kanyakumariensis* (V.Krishnam. & M. Baluswami) M.G.Kavale & M.A.Kazi, in Kavale *et al.*, *European J. Phycology* 56(3): 341, figs 11– 18, 2021. *Porphyra kanyakumariensis* V. Krishnam. & Baluswami, *Seaweed Res. Utiln.* 7(1): 35. 1984; Desikachary & al., *Rhodophyta*, 2 (2A): 37. 1990; Anilkumar & Panikkar, *Seaweed Res. Utiln.* 17(1&2): 151. 1995; Oza & Zaidi, *Rev. Checkl. Ind. Mar. Alg.*: 3. 2001; P.S.N. Rao & R.K. Gupta, *Algae India* 3: 34. 2015:

Palanisamy & al., 106. fig. plate 51 F-G, 2020; Palanisamy & Yadav, 80. fig. plate 26 a. 2022. (**Fig. 2, A-B**).

*Type locality*: Kovalam coast, near Kanniyakumari, Tamil Nadu, India.

Thallus dark-pinkish red, leafy, flat, 8-25 × 2.5-8 cm, membranous, fragile, mucilaginous, monostromatic, epilithic. Holdfast minute, discoid, 1.3 mm wide, loosely attached on rocky substrata in surf-exposed areas in upper intertidal regions, usually forming a slippery surface. Stipe small, stalked or sessile. Fronds membranous, linear or lanceolate; surface smooth, slippery with reticulate orientations; margins entire to deeply lacinate with a number of unicellular microscopic spinulose processes; apex acute or obtuse. *Microscopic characters*: Cells in surface view spherical to polygonal, 9.4-17.5 µm across, thick walled, irregularly arranged, forming a reticulate structure. In cross-section, thallus monostromatic, up to 40-50 µm thick in vegetative portion and up to 80 µm thick in fertile portion, heavily mucilaginous; mucilage up to 2.8 µm, thick; cells usually elongate to slightly spherical, 25-32 × 8.5-18 µm, thick walled, compactly or sparsely arranged. Cells with single chromatophore; chromatophores stellate, extended towards periphery. Reproductive structures develop on thallus surface, monoecious; fertile areas lightly coloured, extending from margins towards inside; spermatangia and carposporangia mixed distributed; spermatia 128, 3.5 µm across; carposporangia 16, 6-10 µm across.

*Occurrence*: Post-monsoon and summer seasons. Moderate.

*Distribution*: INDIA: Kerala, Karnataka and Tamil Nadu.

*Global distribution status*: Not reported from any other parts of the world.

*Specimens examined*: INDIA: **Kerala**: Kasaragod Distr.: Bekal fort, 22.06.2013, *M. Palanisamy & S.K. Yadav* 128968 (MH); Chamberica, 22.06.2013, *M. Palanisamy & S.K. Yadav* 128986 (MH); Hosabettu coast, 22.06.2013, *M. Palanisamy & S.K. Yadav* 128994 (MH); Kollam Distr.: Thangassery coast, 16.06.2013, *M. Palanisamy & S.K. Yadav* 128824 (MH); Azheekkal coast, 16.06.2013, *M. Palanisamy & S.K. Yadav* 127741 (MH); Thiruvananthapuram Distr.: Kovalam beach, 14.06.2013, *M. Palanisamy & S.K. Yadav* 128574 (MH); Vizhinjam coast, 13.06.2013 *M. Palanisamy & S.K. Yadav* 128565 (MH); Varkala coast, 15.06.2013, *M. Palanisamy & S.K. Yadav* 128592 (MH); Thrissur Vemballur coast, 18.06.2013, *M. Palanisamy & S.K. Yadav* 128895 (MH). **Karnataka**: Uttara Kannda Distr.: Karwar coast, 31.08.2016, *M. Palanisamy & S.K. Yadav* 135778 (MH).

*Notes*: This species was first described by Krishnamurthy and Baluswami (1984) from the Kovalam coast near Kanyakumari, Tamil Nadu, India. Its type specimen is deposited at the Centre for

Advanced Studies (CAS) in Botany, University of Madras, Madras (S. Sasidharan & M. Baluswami 4830, Sept. 5. 1982). Chennubhotla *et al.* (1990) and more recently Palanisamy *et al.* (2020) reported the occurrence of this species from Varkala coast, Kerala. Recently, *Porphyra kanyakumariensis* was transferred to the genus *Phycocalidia* by Kavale and Kazi (2021) based on molecular phylogenetic. Like other species of *Porphyra*, it is recognized as an edible seaweed with high nutritional benefits (Sahoo *et al.*, 2002).

*Distribution status:* Endemic to the Indian coast (Oza and Zaidi, 2001).

**2. *Pyropia suborbiculata*** (Kjellman) J.E. Sutherland, H.G. Choi, M.S. Hwang & W.A. Nelson in Sutherland & al., *J. Phycol.* 47(5): 1145. 2011. *Porphyra suborbiculata* Kjellm., *Bih. Kongl. Svenska Vetensk.-Akad. Handl.* 23 (Afd. 3, 4): 10, pl. 1: figs. 1-3; pl. 2: figs. 5-9; pl. 5: figs. 4-7. 1897; Desikachary & al., *Rhodophyta*, 2 (2A): 37. 1990; Anilkumar & Panikkar, *Seaweed Res. Utiln.* 17(1&2): 151. 1995; P.C. Silva & al., *Cat. Benth. Mar. Alg. Ind. Ocean*: 93. 1996; Oza & Zaidi, *Rev. Checkl. Ind. Mar. Alg.*: 4. 2001; P.S.N. Rao & R.K. Gupta, *Algae India* 3: 34. 2015; Palanisamy & al., 107. 2020.

*Type locality:* Goto-retto, Nagasaki Prefecture, Japan.

Thallus light-deep purple red, foliaceous, flat, small, 2-4 (-8) × 1.5-5 cm, membranous, transparent, fragile, mucilaginous, monostromatic, epilithic. Holdfast minute, discoid, up to 1.5 mm wide, loosely attached on rocky substrata in surf-exposed areas, usually forming a slippery surface. Stipe minute, stalked to slightly flattened, sometimes indistinct. Fronds membranous, simple or lobed, usually orbiculate, occasionally slightly lanceolate-ovate; surface smooth, slippery; base cordate to cuneate; margins usually undulate to lacerate, sometimes inrolled, slightly dentate with several microscopic spinulose processes; apex round to obtuse. *Microscopic characters:* Cells in surface view usually spherical to polygonal, thick walled, irregularly arranged. In cross-section, thallus monostromatic, 18-50 µm thick in vegetative portions and up to 70 µm thick in fertile portions; heavily mucilaginous; mucilage up to 3 µm, thick; cells usually elongate to quadrangular, 25-34 × 12-25 µm, thick walled, compactly or sparsely arranged. Cells with single chromatophore; chromatophores stellate. Reproductive structures develop on thallus surface mostly along the margins, monoecious; fertile areas lightly coloured; spermatangia usually develop in sori or patches; spermatia 64; carposporangia usually develop in the interior area, occasionally towards margins; carpospores 32; Cystocarps usually spherical to ellipsoidal.

*Occurrence:* Post-monsoon season. Moderate.

*Distribution:* INDIA: Goa (Palolem) and Kerala (Kannur, Kasaragod, Kollam, Kozhikode and Thiruvananthapuram).

*Global distribution status:* **Asia:** India, Sri Lanka, Myanmar, Philippines, Viet Nam, China, Japan, Korea, Taiwan, Korea; **Africa:** South Africa; **Europe:** Portugal, Spain; **North America:** U.S.A. (Connecticut, Massachusetts, North Carolina, California), Mexico (Pacific); **South America:** Brazil, Peru; **Australia:** New Zealand; **Atlantic Ocean:** Western Atlantic, Canary Islands (Silva *et al.*, 1996; Guiry and Guiry, 2023; <https://www.algaebase.org>).

*Specimens examined:* INDIA: **Andhra Pradesh:** Srikakulam Distr.: Dokulupadu, 22.09.2017, Palanisamy & Aron Santhosh Kumar 137306 (MH); Visakhapatnam Distr.: Sagar Coast, 22.03.2019, Palanisamy & Aron Santhosh Kumar 140332 (MH). **Kerala:** Kannur Distr.: Azhikode, 23.09.2011, M. Palanisamy & S.K. Yadav 127253 (MH); Ezhimala coast (near INA), 23.09.2011, M. Palanisamy & S.K. Yadav 127259 (MH); Kasaragod Distr.: Chamberica coast, 24.09.2011, M. Palanisamy & S.K. Yadav 127283 (MH); Kollam Distr.: Thangeswari (Thangassery), 28.08.1999 (MH), D.B. Sahoo *s.n.* (CONN, CONN01009463 image!); Kozhikode Distr.: Beypore coast, 20.09.2011, M. Palanisamy & S.K. Yadav 127199 (MH); Thiruvananthapuram Distr.: Edava coast, 02.10.2013, M. Palanisamy & S.K. Yadav 129426 (MH).

*Notes:* This species was first recorded from Goto-retto, Nagasaki, Japan (Silva *et al.*, 1996). Broom *et al.* (2002) published a reassessment study based on molecular and morphological data on three species of *Porphyra* from the Pacific and Atlantic oceans and suggested that all three taxa *P. suborbiculata*, *P. liliputiana* and *P. coralinensis* represented a single species namely *Porphyra suborbiculata*.

**3. *Pyropia vietnamensis*** (Tak. Tanaka & P.H. Ho) J.E. Sutherland & Monotilla in Sutherland & al., *J. Phycol.* 47(5): 1145, 2011. *Phycocalidia vietnamensis* (Tak. Tanaka & P.H. Ho) Santiañez & M.J. Wynne in Santiañez, W.J.E. & Wynne, M.J., *Notulae Algarum* 140: 2, 2020. *Porphyra vietnamensis* Tuy. Tanaka & P.H. Ho in Mem. Fac. Fish. Kagoshima Univ. 11: 34, figs 10, 11. 1961; V. Krishnam. & H.V. Joshi, *Checkl. Ind. Mar. Alg.*: 4. 1970; Desikachary & al., *Rhodophyta*, 2 (2A): 36. 1990; Oza & Zaidi, *Rev. Checkl. Ind. Mar. Alg.*: 4. 2001; P.S.N. Rao & R.K. Gupta, *Algae India* 3: 34. 2015.; Palanisamy & al., 108. fig. plate 51 H-I, 2020; Palanisamy & Yadav, 81. 2022. (**Fig. 2, C-D**).

*Type locality:* Vung-Tau (Cap St. Jacques), Vietnam. Thallus light-dark purple red, foliaceous, 3-7 × 0.5-3 cm, membranous, transparent, fragile, mucilaginous, epilithic. Holdfast minute, discoid, up to 1.8 mm wide, loosely attached on rocky substrata in surf-exposed areas. Stipe minute, usually stalked or

slightly flattened, occasionally (sub)sessile. Fronds membranous, usually lobed into 2-6 parts, sometimes simple; lobes usually lobed, linear-lanceolate; surface smooth, slippery; base cordate to ovate; margins usually undulate, dentate with frequent microscopic spinulose processes; apex round to obtuse. *Microscopic characters*: Cells in surface view usually spherical to elongate or polygonal, 14-21  $\mu\text{m}$  across, thick walled, compactly arranged; spinulose processes 10-18  $\times$  8-11  $\mu\text{m}$ , usually at intervals of 35-50  $\mu\text{m}$ . In cross-section, thallus monostromatic, 18-24  $\mu\text{m}$  thick in vegetative portions and up to 36  $\mu\text{m}$  thick in fertile portions; heavily mucilaginous; mucilage up to 8  $\mu\text{m}$ , thick; cells usually elongate to spherical, 12-18  $\times$  6-12  $\mu\text{m}$ , thick walled, usually sparsely arranged. Cells with single chromatophore; chromatophores substallate with a central pyrenoid. Reproductive structures develop on thallus surface, mostly found from the margins to inward, monoecious; fertile areas lightly coloured, distinctly arranged; spermatangia develop in patches near the margins; spermatia 64, arranged in 4 tiers; carposporangia usually develop in interior area, occasionally mixed with spermatangia; carpospores 8, spherical to ellipsoidal, 10-14  $\mu\text{m}$  across.

*Occurrence*: Throughout the year. Common.

*Distribution*: INDIA: Andhra Pradesh, Goa, Karnataka, Kerala, Maharashtra and Tamil Nadu. *Global distribution status*: **Asia**: India, Indonesia, Viet Nam, China (South China Sea), Taiwan, Philippines, Thailand, Yemen; **North America**: Hawaiian Islands; **South America**: Brazil; **Atlantic Ocean**: Western Atlantic (Silva *et al.*, 1996; Guiry and Guiry, 2023; <https://www.algaebase.org>).

*Specimens examined*: INDIA: **Pradesh**: Srikakulam Distr.: Yerramukkam, 18.03.2019, *Palanisamy & Aron Santhosh Kumar* 137983 (MH); Dokulupadu, *Palanisamy & Aron Santhosh Kumar* 140390 (MH). **Goa**: Goa coast: South Goa Distr.: Cola Coast, 30.10.2018, *M. Palanisamy & S.K. Yadav* 143896 (MH); North Goa Distr.: Vagathor coast, 19.08.2012, *M.G. Kavale and M.A. Kazi* ARC-P-196 (CAL) [CAL/ALG/048, Barcode: CAL0000062791!]; Dona Paula coast, 18.08.2012, *M.G. Kavale and M.A. Kazi* ARC-P-183 (CAL) [CAL/ALG/046, Barcode: CAL0000062797!]; Anjuna coast, 19.08.2012, *M.G. Kavale and M.A. Kazi* ARC-P-192 (CAL) [CAL/ALG/047, Barcode: CAL0000062798!].

**Karnataka**: Uttara Kannada Distr.: Gorte coast, 20.09.2015, *M. Palanisamy*133228 (MH); Talgode

coast, 21.09.2015, *M. Palanisamy*133244 (MH). **Kerala**: Kannur Distr.: Muzhappilangad coast, 22.09.2011, *M. Palanisamy & S.K. Yadav* 127240 (MH); Peyambalam beach, 23.09.2011, *M. Palanisamy & S.K. Yadav* 127249 (MH); Ezhimala (near INA), 11.07.2012, *M. Palanisamy & S.K. Yadav* 127761 (MH); Kollam Distr.: Puthenthura coast, 16.06.2013, *M. Palanisamy & S.K. Yadav* 128860 (MH); Thiruvananthapuram Distr.: Varkala coast, 02.10.2013, *M. Palanisamy & S.K. Yadav* 129412 (MH); Edava coast, 15.06.2013, *M. Palanisamy & S.K. Yadav* 128806 (MH); Thiruvananthapuram Distr.: Mullur coast, 13.08.2014, *M.G. Kavale and M.A. Kazi* ARC-P-217 (CAL) [CAL/ALG/033, Barcode: CAL0000062796!]. **Maharashtra**: Ratnagiri Distr.: Hedavi coast, 12.09.2013, *M.G. Kavale and M.A. Kazi* ARC-P-20 (CAL) [CAL/ALG/037, Barcode: CAL0000062780!]; Hedavi coast, 12.09.2013, *M.G. Kavale and M.A. Kazi* ARC-P-12 (CAL) [CAL/ALG/036, Barcode: CAL0000062786!]; Velaneshwar coast, 12.09.2013, *M.G. Kavale and M.A. Kazi* ARC-P-08 (CAL) [CAL/ALG/035, Barcode: CAL0000062787!]; Purnagad coast, 15.08.2012, *M.G. Kavale and M.A. Kazi* ARC-P-21 (CAL) [CAL/ALG/038, Barcode: CAL0000062788!]; Purnagad coast, 15.08.2012, *M.G. Kavale and M.A. Kazi* ARC-P-22 (CAL) [CAL/ALG/039, Barcode: CAL0000062789!]; Raigad Distr.: Harihareshwar coast, 28.09.2013, *M.G. Kavale and M.A. Kazi* ARC-P-31 (CAL) [CAL/ALG/041, Barcode: CAL0000062782!]; Raigad Distr.: Shekhadi coast, 20.08.2012, *M.G. Kavale and M.A. Kazi* ARC-P-80 (CAL) [CAL/ALG/045, Barcode: CAL0000062783!]; Palshet coast, 12.09.2013, *M.G. Kavale and M.A. Kazi* ARC-P-3 (CAL) [CAL/ALG/034, Barcode: CAL0000062795!]; Sindhudurg Distr.: Malvan coast, 20.08.2012, *M.G. Kavale and M.A. Kazi* ARC-P-48 (CAL) [CAL/ALG/042, Barcode: CAL0000062792!]; Redi coast, 20.08.2012, *M.G. Kavale and M.A. Kazi* ARC-P-73 (CAL) [CAL/ALG/044, Barcode: CAL0000062794!].

*Notes*: This species was first recorded from Vung-Tau, Vietnam by Tanaka & Ho (1962). In India, this species was first described by Boergesen (1937) as *P. tenera* Kjellm. from the barbour area of Madras and later it was described from the Visakhapatnam coast (Waltair) as *P. naidum* Anderson by Sreeramulu (1952). Later, Rao and Sreeramulu (1964, 1970) confirmed this species as *P. vietnamensis*. Since then, it has been reported from various coast of India by various workers (Dhargalkar *et al.*, 1981;

Chennubhotla *et al.*, 1990; Sahoo *et al.*, 2001, 2006; Ghosh and Keshri, 2009; Palanisamy *et al.*, 2020). This is one of the most common species of *Porphyra* in Indian coast and found growing mainly in association with the species of *Chnoospora*, *Ulva*, *Gracilaria* and *Hypnea*. It is an edible seaweed and reported to contain high mineral composition (Na, K, Ca, Mg, B, Pb, Cr, Co, Fe, Zn, Mn, Hg, Cu, As, Ni, Cd and Mo) than several other edible seaweeds and land vegetables and also recommended to be used as food supplement as a spice to improve the nutritive value in our diet, as practiced in many western countries (Subba Rao *et al.*, 2007).

**4. *Pyropia acanthophora* var. *robusta*** M.G.Kavale, M.A.Kazi & N.Sreenadhan in Indian J. Geo-Mar. Sciences 44(6): 3.fig. 1 a-j. 2015; Kavale & al., J. Appl. Phycol. 29: 2013. 2017. *Phycocalidia acanthophora* var. *robusta* (M.G.Kavale, M.A.Kazi & N.Sreenadhan) Santiañez, *Notulae Algarum* 216: 2.2021. (Fig. 3, A).

*Type locality*: Cola coast, Goa, India.

Thallus greenish-reddish brown in colour, foliaceous, 5-24 × 3-14 cm, membranous, fragile, mucilaginous. Holdfast sessile with umbilical base, attached on substrata. Fronds membranous, broadly ovate-orbicular, lanceolate -orbilanceolate; surface perforated, slippery; margins undulate, with frequent microscopic spinuloses. *Microscopic characters*: Cells in surface view usually oblong-polygonal, 19.8-26.4 × 6.6-26.4 µm; spinulose processes one-five celled, 9.9-16.5 µm long. In cross-section, thallus monostromatic, 49.5-52.8 µm thick in vegetative portions, cells usually 13.2-23.1 µm across, barrel shaped with blunt corners. Cells with single stellate chromatophore, having a pyrenoid. Reproductive structures develop on thallus surface, mostly found along the margins to inward, monoecious; fertile areas coloured, irregularly patched; spermatangia usually pale yellow coloured; spermatia 256, arranged in a/8, b/4, c/8 tiers, upto 3.3 µm in diameter; zygotosporangium with 16 zygotospores, arranged in a/4, b/2, c/3 tiers, 6.6-13.2 µm in diameter.

*Occurrence*: Monsoon season. Scanty.

*Distribution*: INDIA: Goa.

*Global distribution status*: Not reported from any other parts of the world.

*Specimen examined*: INDIA: **Goa**: Cola, 03.08.2004, Anil Kumar & P.S.N. Rao 177441 (BSD); Goa: Cola, 18.08.2012, M.G. Kavale and M.A. Kazi et N.Sreenadhan ARC-P-226 (CAL) [Holotype - CAL/ALG/049, Barcode: CAL0000062761!].

*Notes*: The species *Pyropia acanthophora* was first described by Oliveira and Coll (1975) from São Paulo State, Brazil. The present variety *i.e.* *Pyropia acanthophora* var. *robusta* was reported by Kavale *et al.* (2015) from the Cola coast, Goa, India and its type specimen (*op. cit.*) is deposited at 'CAL' - the herbarium of Botanical Survey of India, Central National Herbarium, Howrah. This variety is distinguished from its proper species and other varieties in having comparatively larger size, rosette tuft form and robust texture of the thallus, in addition to variation in number of spermatia and zygotospores.

*Distribution status*: Endemic to the Indian coast.

**5. *Pyropia sukshma*** (M.G. Kavale & M.A. Kazi) Santiañez & M.J.Wynne in *Notulae Algarum* 258: 1. 2022. *Phycocalidiasukshma* M.G.Kavale & M.A.Kazi, *European J. Phycol.* 56(3): 339, 341, figs 3-10. 2021. (Fig. 3, B).

*Type locality*: Karwar, Karnataka, India.

Thallus reddish-purple brown in colour, foliaceous, upto 10 cm long and 4 cm wide, membranous, fragile, mucilaginous. Holdfast discoid, sessile. Fronds several, arising directly from the holdfast, membranous, lanceolate, with cordate base; margins usually undulate, rarely flat; marginal spines present, 1-2 celled, 3.3-9.6 µm in length. *Microscopic characters*: Cells in surface view triangular to polygonal with blunt corners, 9.7-16.5 µm across, In cross-section, thallus monostromatic, 17.6-22 µm thick in vegetative parts and 19.7-23 µm in reproductive parts; cells rectangular or squarish with rounded corners, 9.3-12.3 × 6.9-15.1 µm. Cells with a stellate plastid with central pyrenoid. Reproductive structures develop on thallus surface, monoecious; spermatangia pale yellow in colour, develop in stripes or irregular patches or mixed;

**Table 1.** List of taxa under *Porphyra* and *Pyropia* in India and its distributional status.

Sl. No.	Name of the taxa	Type locality	Distribution in India	Distribution in World	Endemic status
1.	<b><i>Porphyra chauhanii</i></b> C. Anil Kumar & M.V.N. Panikkar	Thirumullavaram, Kollam district, Kerala, <b>India.</b>	Andhra Pradesh, Kerala	Not reported from any other parts of the world.	Endemic to the Indian coast.
2.	<b><i>Porphyra indica</i></b> V.	Boria Reef, Gulf of	Gujarat, Kerala	Not reported from any	Endemic to



	Krishnam. & M. Baluswami	Kutch, Gujarat, <b>India.</b>		other parts of the world.	the Indian coast.
3.	<b>Porphyra malvanensis</b> Anil Kumar and P.S.N. Rao	Malvan coast, Maharashtra, <b>India.</b>	Maharashtra	Not reported from any other parts of the world.	Endemic to the Indian coast.
4.	<b>Porphyra okhaensis</b> H.V.Joshi, R.M.Oza & A.Tewari	Okha coast, Gujarat, <b>India.</b>	Gujarat	Not reported from any other parts of the world.	Endemic to the Indian coast.
5.	<b>Pyropia kanyakumariensis</b> (V. Krishnam. & Baluswami) Santiañez & M.J.Wynne	Kovalam coast, near Kanniyakumari, Tamil Nadu, <b>India.</b>	Kerala, Karnataka and Tamil Nadu	Not reported from any other parts of the world.	Endemic to the Indian coast.
6.	<b>Pyropia suborbiculata</b> (Kjellman) J.E.Sutherland, H.G.Choi, M.S.Hwang & W.A.Nelson	Goto-retto, Nagasaki Prefecture, <b>Japan.</b>	Andhra Pradesh, Goa and Kerala	<b>Asia:</b> India, Sri Lanka, Myanmar, Philippines, Vietnam, China, Japan, Korea, Taiwan, Korea; <b>Africa:</b> South Africa; <b>Europe:</b> Portugal, Spain; <b>North America:</b> U.S.A., Mexico (Pacific); <b>South America:</b> Brazil, Peru; <b>Australia:</b> New Zealand; <b>Atlantic Ocean:</b> Western Atlantic, Canary Islands.	Common
7.	<b>Pyropia vietnamensis</b> (Tak. Tanaka & P.H. Ho) J.E. Sutherland & Monotilla	Vung-Tau (Cap St. Jacques), <b>Vietnam.</b>	Andhra Pradesh, Goa, Karnataka, Kerala, Maharashtra and Tamil Nadu.	<b>Asia:</b> India, Indonesia, Vietnam, China (South China Sea), Taiwan, Philippines, Thailand, Yemen; <b>North America:</b> Hawaiian Islands; <b>South America:</b> Brazil; <b>Atlantic Ocean:</b> Western Atlantic.	Common.
8.	<b>Pyropia acanthophora</b> var. <b>robusta</b> M.G.Kavale, M.A.Kazi & N.Sreenadhan	Cola coast, Goa, <b>India.</b>	Goa	Not reported from any other parts of the world.	Endemic to the Indian coast.
9.	<b>Pyropia sukshma</b> (M.G.Kavale & M.A.Kazi) Santiañez & M.J.Wynne	Karwar, Karnataka, <b>India.</b>	Karnataka	Not reported from any other parts of the world.	Endemic to the Indian coast.

spermatia 16, up to 3.9 µm in diameter; carposporangia usually reddish brown colour, occasionally mixed with spermatangia; carpospores 8, 4.9–5.9 µm in diameter.

*Occurrence:* Monsoon season. Scanty.

*Distribution:* INDIA: Karwar, Karnataka coast.

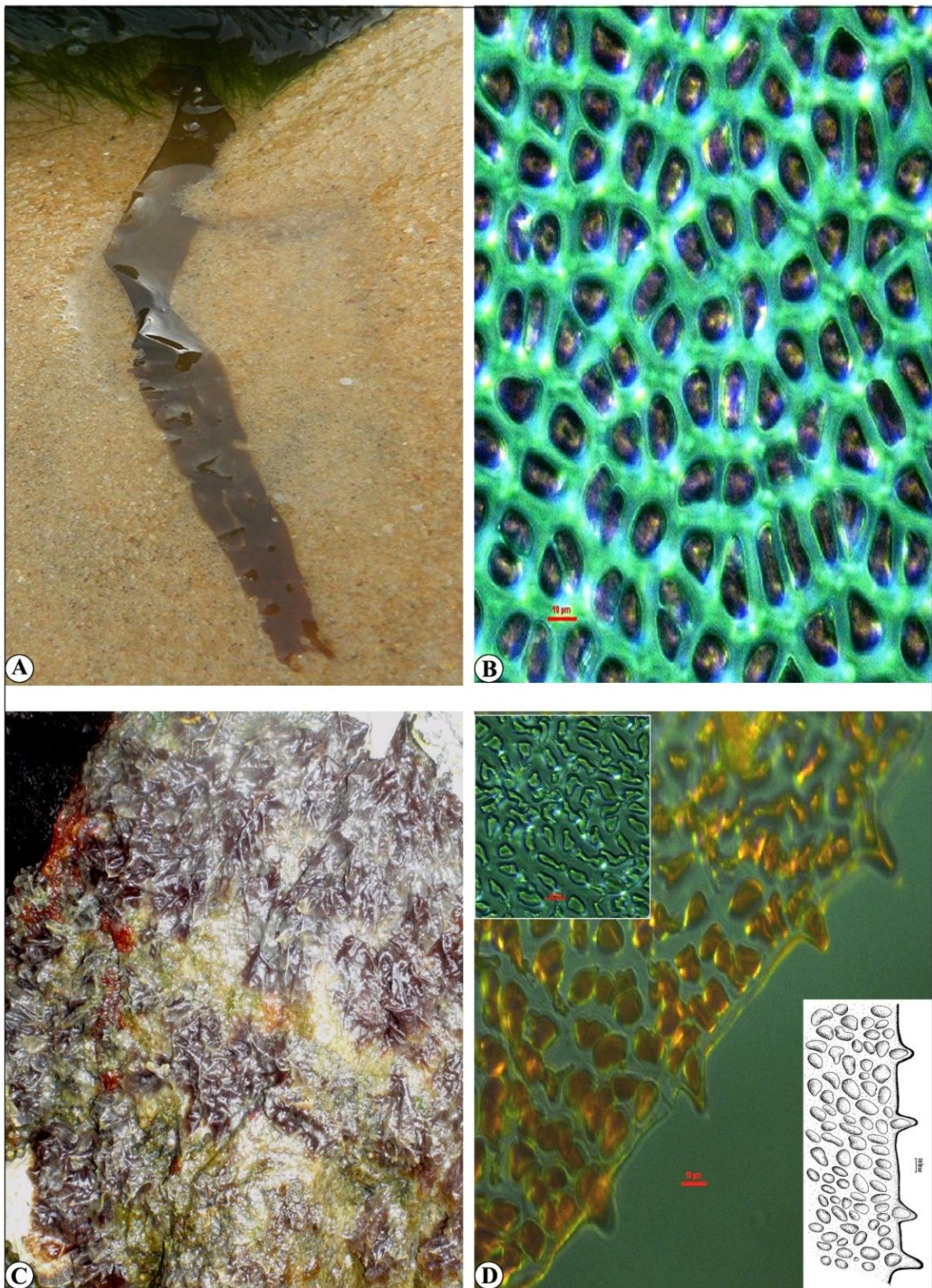
*Global distribution status:* Not reported from any other parts of the world.

*Specimen examined:* INDIA: **Karnataka:** Uttara Kannada Distr.: Karwar coast, 14.08.2004, *M.G.*

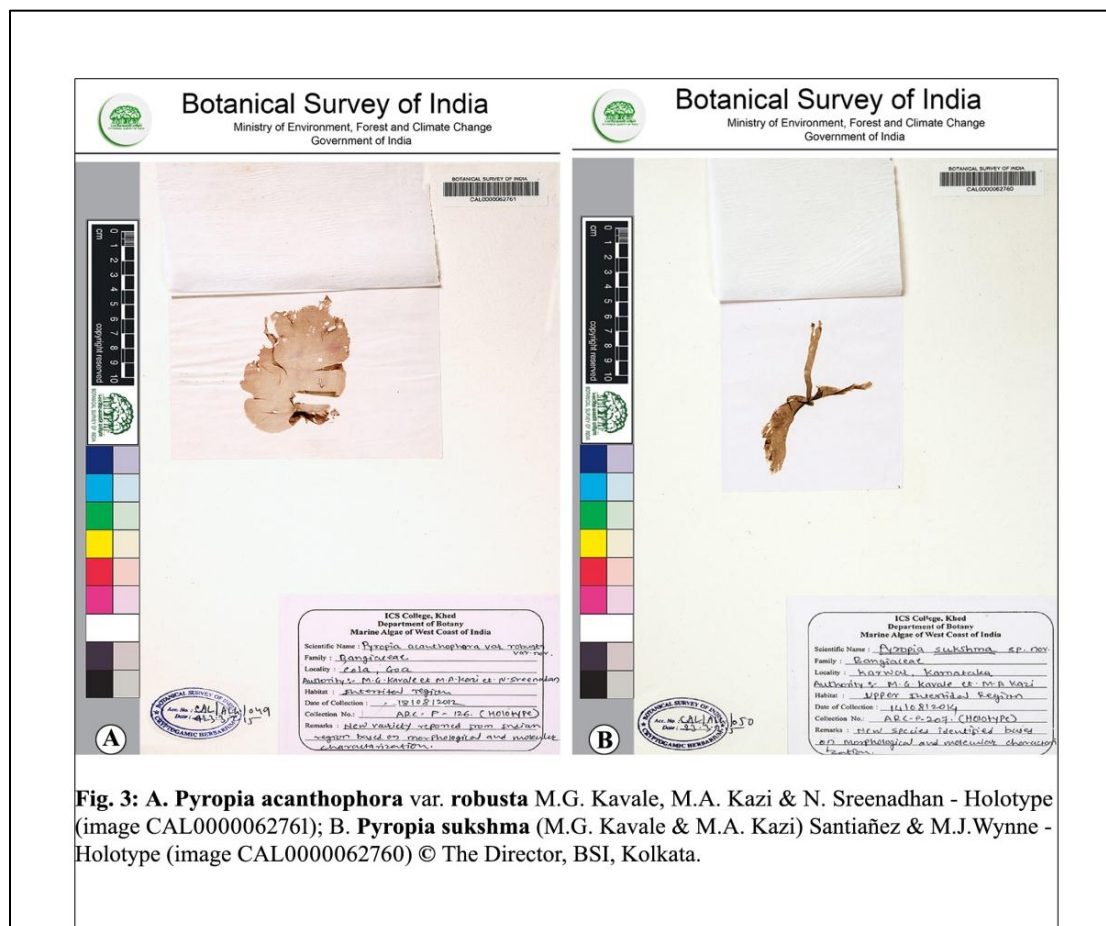
*Kavale and M.A. Kazi* ARC-P-207 (CAL) [Holotype - CAL/ALG/050, Barcode: CAL0000062760!]; Karwar coast, 14.08.2004, *M.G. Kavale and M.A. Kazi* ARC-P-208 (CAL) [Isotype - CAL/ALG/051, Barcode: CAL0000062769!].

*Notes:* This species has been included here based on the report by Kavale *et al.* (2021) from the Karwar coast, Karnataka. The type specimens (Holotype and Isotype) of this species are deposited at 'CAL' - the Herbarium of Botanical Survey of India, Central National Herbarium, Howrah. The specific epithet





**Fig. 2: A-B. *Pyropia kanyakumariensis*** (V.Krishnam. & M.Baluswami) Santiañez & M.J.Wynne; **A.** Habit; **B.** Microscopic image of thallus surface cells; **C-D. *Pyropia vietnamensis*** (Tak. Tanaka & P.H. Ho) J.E. Sutherland & Monotilla; **C.** Habit; **D.** Microscopic image and illustration showing surface cells and spinulose processes along the margins.



'*sukshma*' refers to the delicate nature and small size of the thallus. Kavale *et al.* (2021) reported this species as *Phycocalidia sukshma*. However, Santiañez and Wynne (2022) recently transferred this species under the genus *Pyropia* as proposed a new combination as *P. sukshma*. The species is usually found growing in the monsoon season in heavy surf exposed areas.

*Distribution status:* Endemic to the Indian coast.

## CONCLUSION

The marine habitat is one of the important components of the biodiversity. The Indian coastline, which is about 7500 Km in length, supports a rich diversity of seaweeds, including many economically important and endemic species. The taxonomic study of plants provides an updated comprehensive account of such plants that may lead to undertaking more intensive research on their conservation, sustainable utilization and other aspects of the plants. The red seaweed genera *Porphyra* and *Pyropia*, belonging to the order Bangiales, have undergone many nomenclatural changes, owing to the advancement in

molecular phylogenetic study and its recent reassessment by several researchers in the recent years (Sutherland *et al.*, 2011; Sánchez *et al.*, 2014; Yang *et al.* 2020; Kavale *et al.*, 2021). In India, now the genus *Porphyra* is represented by four taxa namely *P. chauhanii* C. Anil Kumar & M.V.N. Panikkar, *P. indica* V. Krishnam. & M. Baluswami, *P. malvanensis* Anil Kumar & P.S.N. Rao and *P. okhaensis* H.V. Joshi *et al.* H.V. Joshi, R.M. Oza & A. Tewari. Similarly, the resurrected genus *Pyropia* is represented by five taxa namely *P. kanyakumariensis* (V. Krishnam. & Baluswami) Santiañez & M.J. Wynne, *P. suborbiculata* (Kjellman) J.E. Sutherland, H.G. Choi, M.S. Hwang & W.A. Nelson, *P. vietnamensis* (Tak. Tanaka & P.H. Ho) J.E. Sutherland & Monotilla, *P. acanthophoravar. robusta* M.G. Kavale, M.A. Kazi & N. Sreenadhan, *P. sukshma* (M.G. Kavale & M.A. Kazi) Santiañez & M.J. Wynne. It is also interesting to reveal that among these nine taxa, seven taxa (all four taxa of *Porphyra* and three taxa of *Pyropia*) are endemic to the Indian coast, which reflects the importance of taxonomic study and also inspires for intensive research on its conservation and sustainable utilization.

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