

CONTRIBUTION TO MARINE ALGAE OF PAKISTAN RHODOPHYCEAE-*POLYSIPHONIA* GREVILLE 1823

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Abstract

The present paper describes ten species of *Polysiphonia* from the coast of Karachi, Pakistan which includes four species viz., *P. abscissa*, *P. codicicola*, *P. carssicollis* and *P. lepadicola* as new records from the area.

Introduction

Karachi coast in Pakistan has a very luxuriant marine algal vegetation (Anand, 1940). A number of attempts have been made to explore the marine algal flora of this region but attention has been mostly paid on Chlorophyceae and Phaeophyceae algae (Anand, 1940; Boergesen, 1934b, 1935; Nizamuddin, 1963a, 1963b, 1964, 1967, 1968; Nizamuddin & Begum, 1973; Nizamuddin & Begum, 1978; Nizamuddin & Farooqi, 1968; Nizamuddin & Saifullah, 1967; Saifullah & Nizamuddin, 1977) with some fragmentary work dealing with members of Rhodophyceae (Anand, 1943; Boergesen, 1931, 1934a). The red algae which occur intensively on the coast have been neglected so far, therefore, there was a need to investigate the red algal flora of Pakistan.

The present and all past studies have been mainly confined to the algae collected from the rocky ledge of the littoral zone and the algae collected as a drift. Further, the vegetation at the rocky ledge has been recognized into four distinct belts (Anand, 1940) each having distinct colour determined by that of the dominant species - 1) *Phormidium-Pleurocapsa-Calothrix* belt; 2) *Ulva - Enteromorpha* belt; 3) *Colpomenia sinosa* belt; 4) The fourth and the most conspicuous community is represented by red algae *Gelidium* and *Polysiphonia*.

Studies were made on *Polysiphonia* as a first contribution to the Red algae from Pakistan. This investigation is based on extensive collections made during 1964-1975 from various localities around Karachi, viz., Cape Monze, Hawkes Bay, Korangi Creek, Manora Island and Paradise Point. A detailed morphological and anatomical study has been made to determine the species for the monographic work on *Polysiphonia* from the coast of Karachi, Pakistan. It is suggested that the following characters are important

from the taxonomic point of view; 1) The origin of branches, whether endogenous or exogenous; 2) the character of antheridia, the presence or absence of apical sterile cell and the number of stalk cell; 3) the shape of cystocarp; 4) the origin and the nature of rhizoids.

Four species, namely *P. elongata* (Hudson) Sprengel, *P. ferulacea* Suhr., *P. platycarpa* Boergesen and *P. variegata* (C. Agardh) Zanardini have been recorded (Boergesen, 1934b, Anand, 1943). Recently a new species *P. nizamuddinii* Farooqui and Begum (1978) has been reported from Karachi Coast.

The present study deals with ten species of *Polysiphonia* including four species: *P. abscissa* Hooker et Harvey, *P. codicola* Zanardini, *P. carssiculis* Boergesen and *P. lepadicola* (Lyngbye) Sprengel as a new record from Karachi coast, Pakistan.

Specimens were either fixed in 4% formalin - seawater for anatomical studies or mounted on herbarium sheets. The material was washed, bleached in 3% NaOH followed by washing with distilled water till the alkali was removed and then stained with 1% erythrosine for 10-20 minutes. The excess of stain was removed by treating with 5% HCl, washed with distilled water to remove the excess of HCl, and then the material was placed on slides in 10% Glycerine. Permanent mounts were made in 60% Karo. All specimens and permanent slides have been deposited in the Herbarium Botany Department, University of Karachi.

Systematic Enumerations

Fronds erect or decumbent producing filiform or terete or sub-compressed main axes. Main axes distinct or indistinct, erect, laterally and radially or dichotomously branched; axes filamentous, elongate, terete, coarse to firmly delicate, slender and flexible; polysiphonous with an axial cell surrounded by 4-24 pericentral cells, corticated or ecorticated. Axial cells and the pericentral cells of the same length so that the frond is segmented throughout. Branches or axes mostly exogenous or endogenous in origin. Growth monopodial and apical cell transversely or obliquely segmented. Main axes or axes covered by rhizoidal downwards growth; forming pseudoparenchymatous cortex; trichoblasts in regular order in many species, obsolete or persistent or deciduous leaving the scar cells on the branchlets. Tetrasporangia develop from the pericentral cells on the upper but slightly thicker branchlets in longitudinal series, either in spiral or straight rows, single in each segment, producing tetrahedral spores. Spermatangial stands shortly stalked, colourless, ovoid to cylindrical, developing from the trichoblasts, fertile portions polysiphonous producing numerous small spermatangia. Cystocarps ovate or urceolate or suburceolate, stalked or sessile borne on the branchlets. Pericarp thin, gonimoblast composed of branched filaments radiating from a basal placenta, bearing single carpospore in terminal segments. Male, female and asexual organs borne on separate plants.

Key to the species

- | | | |
|----|---|------------------------|
| 1. | Fronds corticated | 2 |
| | Fronds ecorticated | 3 |
| 2. | Pericentral cells 5-7 in number | <i>P. variegata</i> |
| | Pericentral cells 4 in number | <i>P. elongata</i> |
| 3. | Pericentral cells 9 in number | <i>P. nizamuddinii</i> |
| | Pericentral cells 4 in number | 4 |
| 4. | Main axes endogenous in origin | 5 |
| | Main axes exogenous in origin | 7 |
| 5. | Fronds robust with thick peripheral cell walls;
trichoblasts persistent | <i>P. kampsaxii</i> |
| | Fronds otherwise | 6 |
| 6. | Main axes alternately, distantly branched with
short lateral branch system | <i>P. codiicola</i> |
| | Main axes dichotomously branched with wide
angles | <i>P. lepadicola</i> |
| 7. | Sterile cell at the apex of the spermatangial
stands | 8 |
| | No sterile cell at the apex of the spermatangial
stands | 9 |
| 8. | Trichoblasts lacking, if present not connected
with the branches | <i>P. abscissa</i> |
| | Branches in the axil of the trichoblasts | <i>P. crassicollis</i> |
| 9. | Tetrasporangia in chains on ultimate ramuli | <i>P. platycarpa</i> |
| | Tetrasporangia near the end of spiral ramuli | <i>P. ferulacea</i> |

Polysiphonia variegata (C. Agardh) Zanardini.

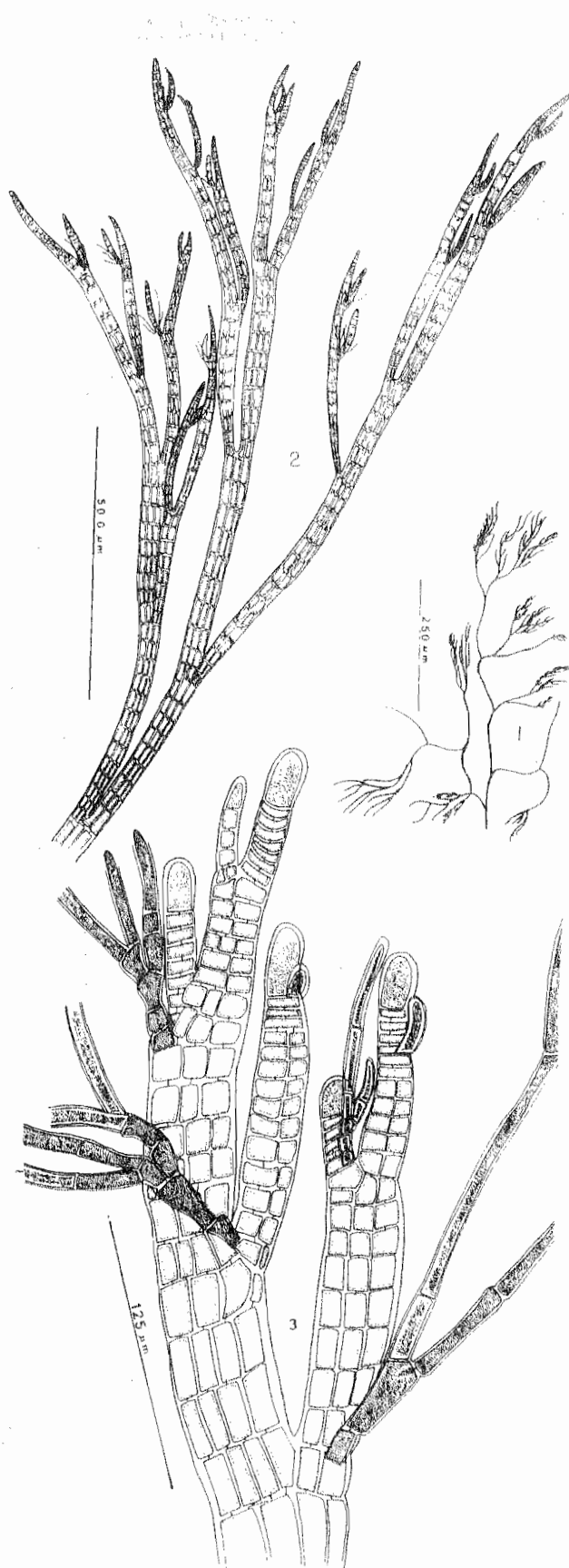
Basionym: *Hutchinsia variegata* C. Agardh 1824:153; 1828:81 J. Agardh 1842:129; 1863:1030. Anand 1943:39. Ardissonne 1883:81. Basson 1979:79. Boergesen 1934a:26; 1934b:48; 1935:62; 1945:35; 1954:41. Cribb 1956:137 de Toni 1903: 922. Falkenburg 1901:119, t. 21. Funk 1927:440; 1955:137. Kützting 1843:424; 1849:82; 1863:26, t. 81. Zanardini 1842:60.

Fronds dark-purple to red, tufted, 2-5 cm high, rather rigid at the base. Rhisoids numerous arising from each segment (rarely at some intervals) of the prostrate axes as well as from the lower portion of the erect axes, thin, elongate, slender to 1220 μm long, 2-30 μm thick, cut off by cross walls from the proximal end of the pericentral cells, provided with discoid haptera at the ends. Main axes erect arising from the prostrate axes, indistinct, rather rigid below 225-450 μm thick at the base, dichotomously branched, segments 2-2.5 times as long as broad, angle of dichotomy decreases upwards and uppermost branchlets becoming parallel forming acute angles. Branches elongated, slender, straight or bent on one side, exogenous, dichotomously or irregularly divided, forming acute angles, tapering upwards and downwards, axils patent, segments 2-4 times as long as broad. Branchlets also exogenous with obtuse or acute axils, unilateral, straight, parallel to one another, constricted at the base, 65-75 μm thick at the base. Ultimate branchlets short, straight or slightly curved towards the mother axes, tapering at both ends with patent axils and obtuse apices. Apical portions of branches and branchlets possess 5-10 rectangular or orbicular cells with a large prominent apical cell, 15-30 μm long. Pericentral cells 5-7 with one short axial cell. Axes or branches corticated near the lower parts otherwise ecorticated. Trichoblasts moderately developed, deciduous leaving persistent scars, 150-400 μm long, arising in right hand spiral with a $\frac{1}{4}$ divergence, one or twice forked, as long as broad at the base but middle and the upper segments vary in length.

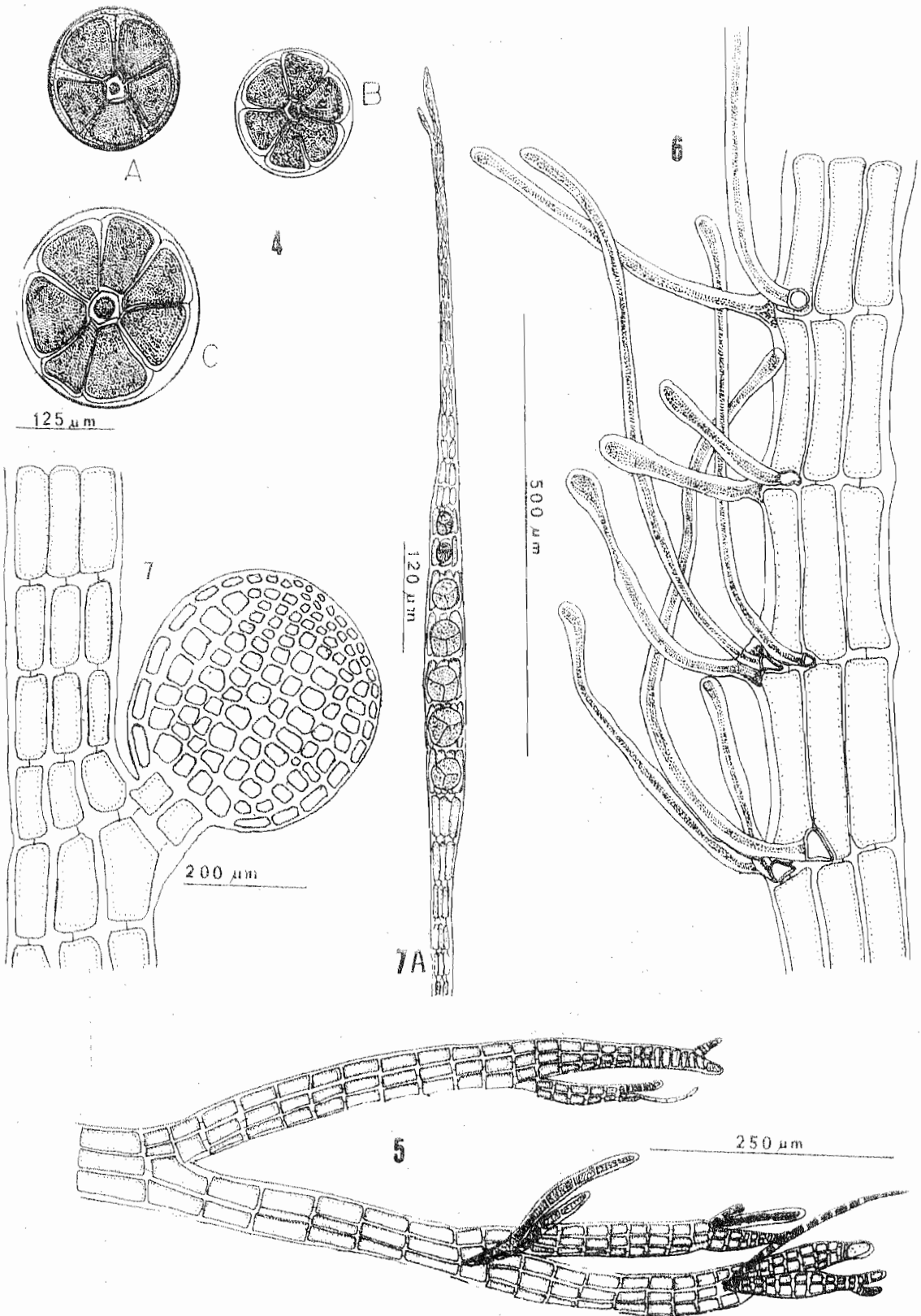
Tetrasporangia 40-60 μm diam. in a long straight series in the ultimate branchlets, tripartitely divided. Cystocarps broadly ovate with a short stalk, 400-5000 μm in diameter.

Local distribution: Cape Monze and Paradise Point. This species grows in sheltered places of mid-littoral zone as epiphyte on *Sargassum* sp. and also in association of *Ceramium* sp. and *Centroceras clavatum* (J. Ag.) Mont.

Our specimens resemble those described by Anand (1943), Boergesen (1934b) and Cribb (1956) but differ in length and thickness of the segments. There is a variation in the number of pericentral cells not only from different localities but also in the same plants as also reported by Anand, Boergesen, de Toni, Falkenberg and J. Agardh. The number of pericentral cells vary from 5 to 10 and axes are corticated near the lower parts only.



Figs. 1-3. *Polysiphonia variegata* (C. Ag.) Zan. 1. Habit of a filament. 2. Upper portion of the main axis. 3. Tip of a branch with trichoblasts.



Figs. 4-7a. *Polysiphonia variegata* 4. (A)-T.S. of an axis showing 5 pericentral cells (B) showing 6 pericentral cells (C)-showing 7 pericentral cells. 5. Apical portion of an axis 6. One to many rhizoids arising from the same segment of a prostrate axis. 7 A cystocarp. 7 a. Tetrasporangial branch.

Polysiphonia elongata (Hudson) Sprengel

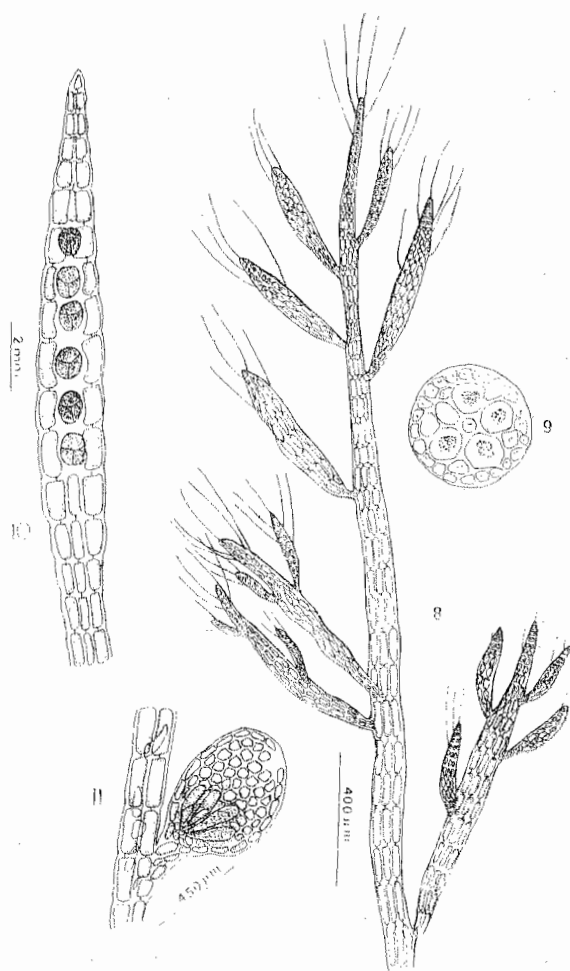
Basionym: *Conferva elongata* Hudson 1778:599; 1798:599.

Synonym: *Hutchinsia elongata* C. Agardh 1817:54; 1824:152; 1828:82 (excl. syn.).

Ceramium elongatum Lyngbye 1819:117. Greville, 1824b:310. *Polysiphonia rosea* Greville 1824b:310.

J. Agardh 1842:136; 1863:1004. Ardissonne 1883:416. Boergesen 1930:93; 1934a: 25; 1934b:48. Falkenberg 1901:126, t. 21. Feldmann 1942:86. Funk 1927:440; 1955:136. Gayral 1966:589. Gray 1867:107. Harvey 1846:51 : Pl. 292; 1849:86; 1852:42. Kützting 1843:428; 1849:828; 1864:2, t. 4. Newton 1931:348. Sprengel 1827:349. Taylor 1957:336.

Frond solitary, robust, cartilaginous, reddish-brown, very dark in lower parts, upper parts



Figs. 8-11 *Polysiphonia elongata* (Huds.) Sprengel. 8. Upper portion of an axis. 9. T.S. of an axis showing 4 pericentral cells and cortifications. 10. A tetrasporic branch 11. A Cystocarp.

crimson in colour, 10-25 cm high. Main axes distinct, exogenous, irregularly branched. Branches erect, spreading, bare in winter but densely clothed with ramuli or ultimate branchlets in spring, attenuated at the base and apex and exogenous. Ultimate branchlets (ramuli) slender, tufted, multifid, 60-90 μm diam., 80-120 μm long, tapering at the apices and bases, distorted and flaccid. Axes possess generally 4 pericentral cells with strong cortication but in older parts 8 pericentral cells. Segments $\frac{1}{2}$ as long as broad but may be as long as broad. The segments in upper parts thin 130-160 μm long, being shorter than breadth. The cortical cells and the pericentral cells of the same length. In the main axes the axial and the pericentral cells thick-walled surrounded by 3-5 layers of cortical cells becoming gradually smaller towards the periphery. Trichoblasts well developed from each segment at the apical portion in the left hand spiral with a $\frac{1}{4}$ divergence forming a close tuft of bright red. Branches in the place of trichoblasts. Tetrasporangia seriate in ultimate branchlets, distorted, torulose, 100-130 μm long and 80-100 μm diam. Spermatangial stands conical with a rounded base, clustered near the tips of the branchlets. Cystocarps shortly pedicellate ovate, scattered or in clusters on the base of the branchlets, 450-510 μm diam.

Local distribution: Manora Island and Paradise Point. This species grows in mid-littoral to sub-littoral regions. Description of our specimens are in agreement with that of Harvey (1852) but differ in texture and colour.

— *Polysiphonia nizamuddinii* Farooqui and Begum.

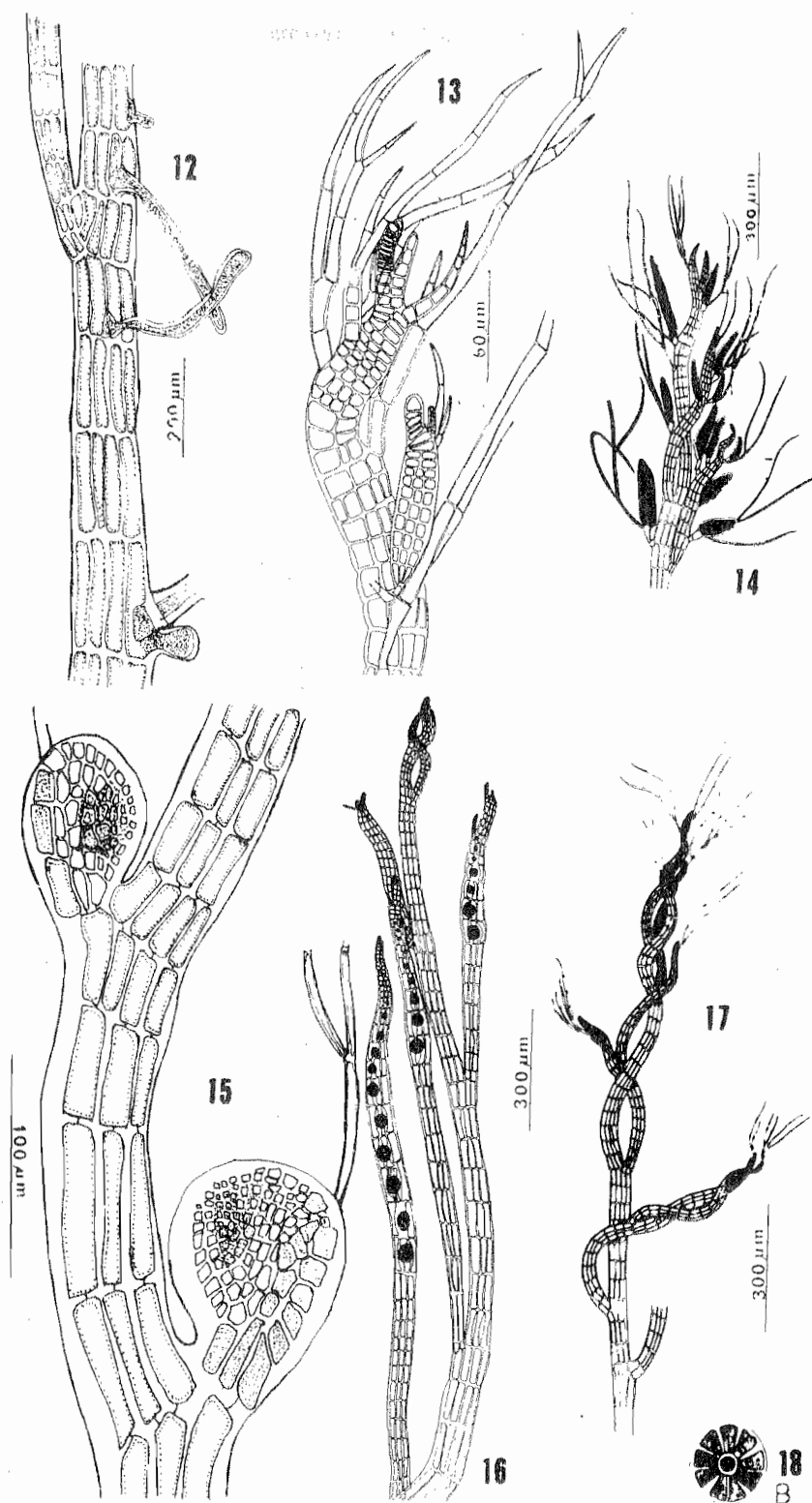
Farooqui & Begum, 1978:813

Polysiphonia nizamuddinii Characterized by alternate branches twisting around the main axis and 9 pericentral cells (For detail see Farooqui & Begum, 1978).

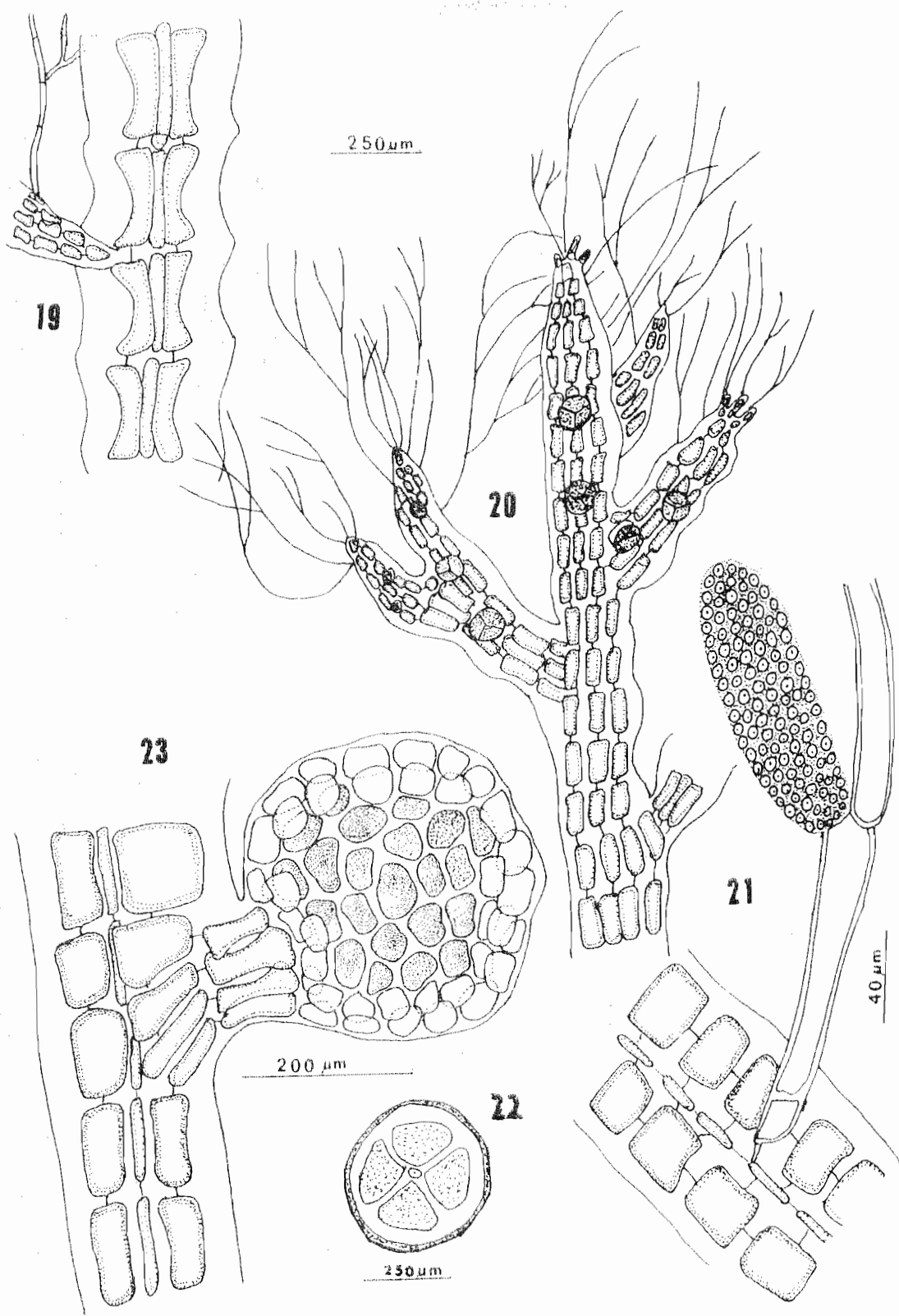
— *Polysiphonia kampsaxii* Begum, 1978).

Boergesen 1939:122 figs. 35-38. Segi 1951:183. Newton 1955b:143. Nizamuddin and Gessner 1970:12.

Frond caespitose, dark brown, erect, elongate, robust, thick, to 10 cm high, arising from decumbent axes (370-450 μm thick) attached by unicellular long rhizoids developing irregularly as outgrowths of the pericentral cells not cut off by cross walls, 370-1170 μm long, 45-60 μm thick, sometimes discoid haptera at the end. Main axes erect, indistinct, arising endogenously from the decumbent axes, 800 μm thick or more segment 2-3 times as long as broad, sparsely and distantly branched with acute axils, attenuated towards the summit alternately branched. Branches exogenous in origin forming acute axils with the main axes. Adventitious branches common and well developed on the main axis. Ultimate branchlets virgate, slightly narrow at the base, 150 μm thick at the middle rather



Figs. 12-18. *Polysiphonia nizamuddinii* Farooqui & M. Begum. (After Farooqui and M. Begum 1978). 12. Rhizoids developing from erect main axis. 13. Apical portion curved with short branchlets arising from concave side of a parent branch. 14. Antheridial stand with 2-celled stalk. 15. A cystocarpic plant. 16. Tetrasporangia in upper middle portion of the lateral branches. 17. Twisted lateral branches. 18. Transverse section of an axis showing 9 pericentral cells.



Figs. 19-23. *Polysiphonia kampsaxii* Borg. 19. Lower portion of an axis. 20. Upper part of an axis with tetrasporangia and trichoblasts. 21. Antheridial stand. 22. T.S. of an axes showing 4 pericentral cells. 23. A cystocarp.

acute at the tip. Peripheral cell walls strongly thickened. Trichoblasts numerous, strongly developed persistent, densely covering the plant except the lower parts, arising in left hand spiral with a $\frac{1}{4}$ divergence such that fifth trichoblast is just above the first one, robust, elongated, 1-2 forked, to 300 μm long. Branches in the place of trichoblasts. In upper parts segments 75 μm long and 210 μm broad and in lower parts segments 250-320 μm long and to 500 μm broad, as well as thick-walled. Axes ecorticated with 4 pericentral cells. Tetrasporangia formed on the upper parts of the branchlets in short or long rows in screw-form, globose rather small 50-75 μm diam., tripartitely divided. The sporangia about 275 μm broad. Spermatangial stands formed on the first side branch of the trichoblasts, the second basal cell of the trichoblast to 130 μm long whereas the basal one remains short and embedded in the wall of the mother-axis. The spermatangial stands directed upwards, subcylindrical, 120 x 35 μm . No sterile cell at the tip. Cystocarps few, scattered on the ultimate branchlets, ovate or broadly urceolate with a small ostiole not surrounded by large cells, 330-370 x 300-400 μm .

Type: Bushire, Persian Gulf (Koie nos. 22,23 in C).

Local distribution: Karachi (G. 17.3.1965). Bushire, Persian Gulf.

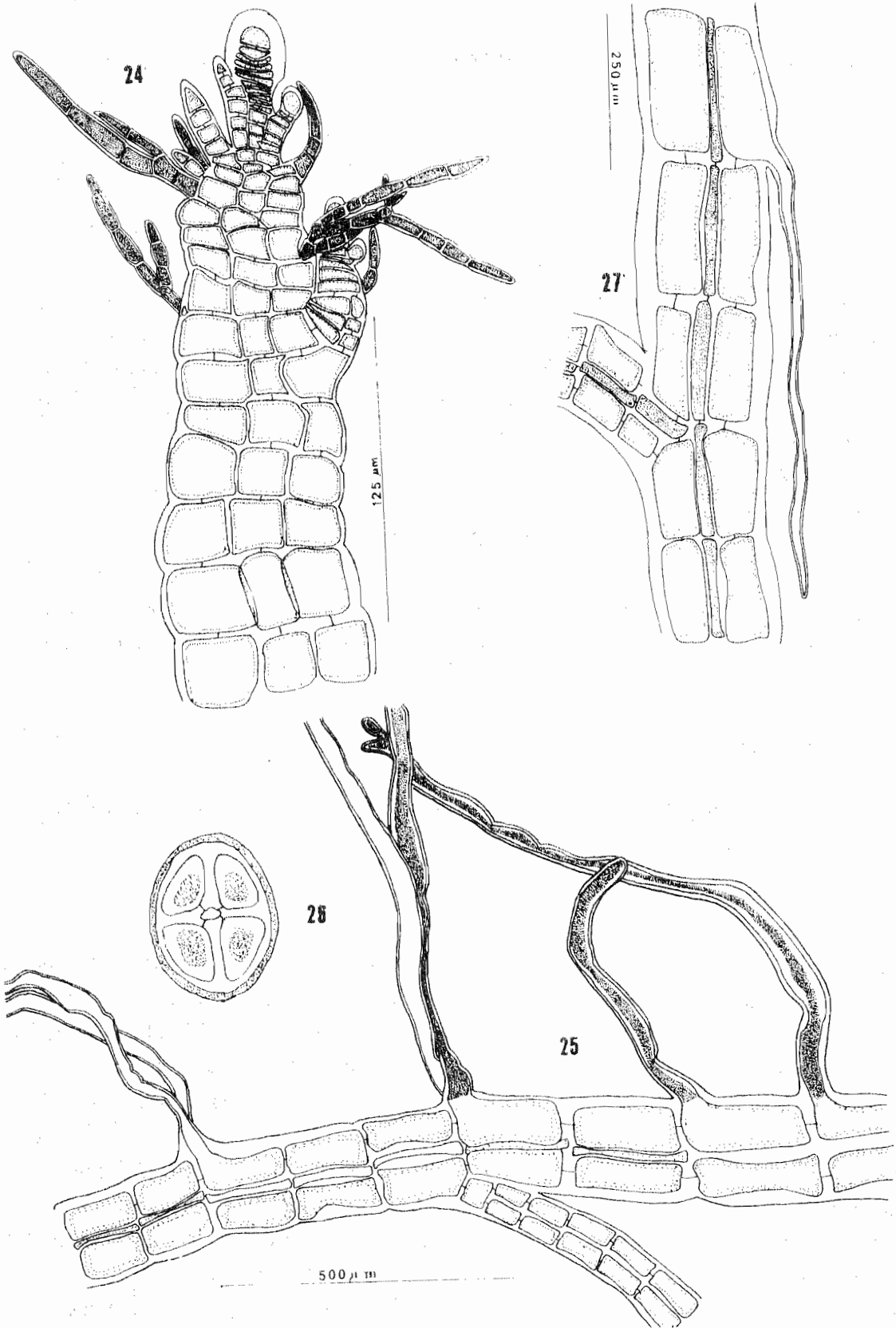
This species grows in low water mark and is easily distinguishable from *P. ferulacea* Shur by means of its robust thallus, very thick peripheral cell walls and numerous persistent trichoblasts.

– *Polysiphonia codiicola* Zanardini

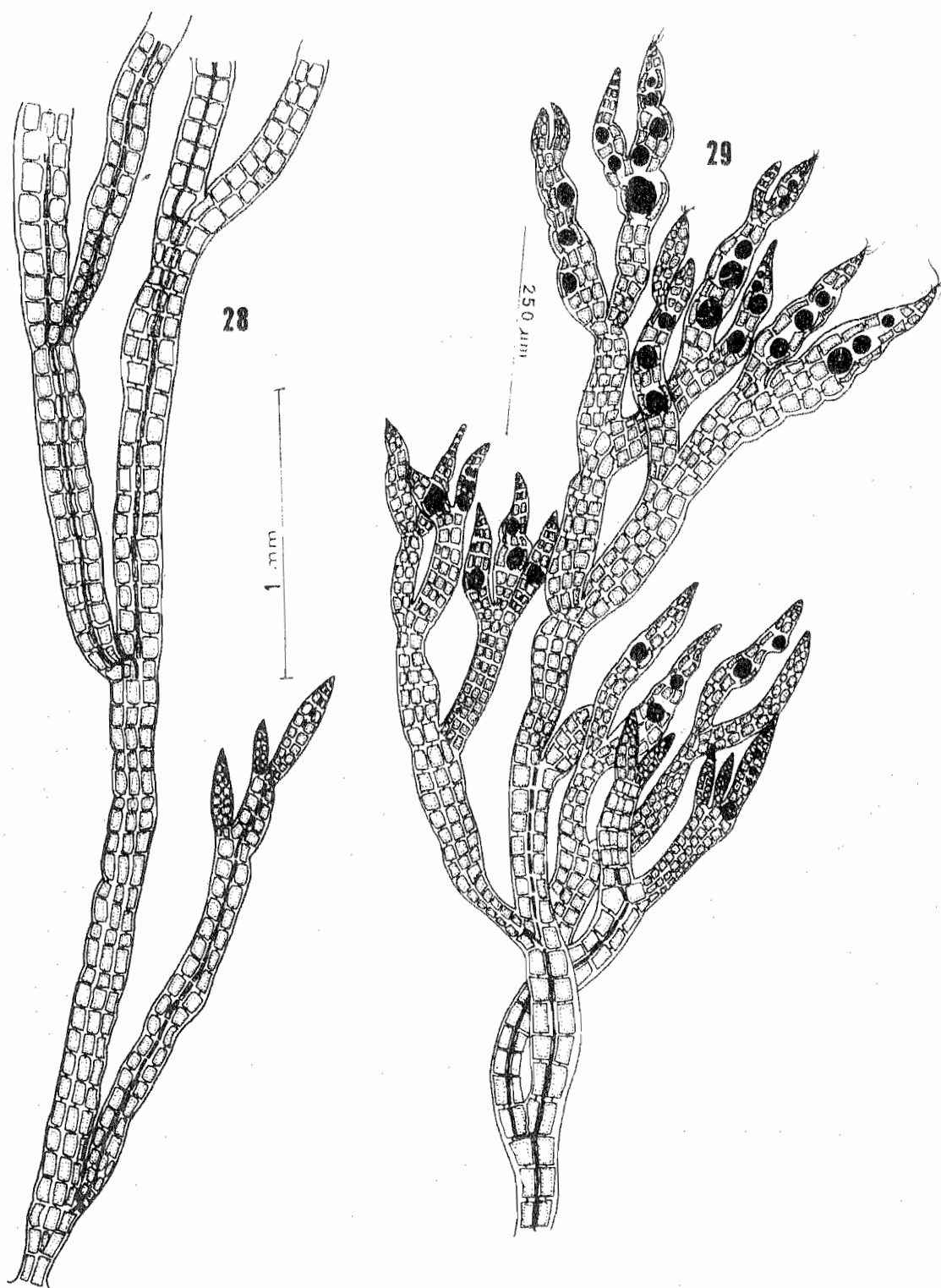
Synonym: *Polysiphonia kotschyana* Grunow 1867:89. De Toni 1903:388 Segi 1951:186.

De Toni 1903:888, 959. Kutzing 1864:19, t. 52. Segi 1951:186.

Fronds rigid, forming dense tufts, erect 2-3 cm high. Erect axes and rhizoids arise from prostrate axes. Rhizoids usually one, rarely many from the proximal end of the pericentral cells not cut off by cross walls, usually long, slender, relatively thin, 300-600 μm long, 30-45 μm thick, sometimes with discoid haptera, dilated or slightly swollen at the end. Prostrate axes 225-240 μm thick, segments 1.5-3 times as long as broad. Main axes erect, distinct, straight, endogenous at 40-60° but not at 90°, alternately branched producing short lateral branch system. Axes 150-250 μm thick at the base, segments 1-2.5 times as long as broad, the thickness of the axes and the length of the segments decreasing upwards. Lateral branches divide di-or trichotomously generally after 8-11 segments but the branching much more profuse at the apical portion, apices simple or bifid, 150-175 μm thick, segments 1-2 times as long as broad. Ultimate branchlets mostly unilateral, straight, virgate, paniculate, constricted at the base, 75-110 μm thick at the middle, segments 1-1.5 times as long as broad, apices obsolete. Trichoblast moderately developed at the



Figs. 24-27. *Polysiphonia codicicola* Zan. in Kg. 24. Tip of the branches with obsolete apices. 25. Rhizoids arising as outgrowths of pericentral cells. 26. T.S. of an axes showing 4 pericentral cells. 27. Lateral branches arising endogenously.



Figs. 28,29. *Polysiphonia codicola* 28. Lower portion of the main axes with distantly and alternately placed branches. 29. Apical portion of the main axes with tetrasporangia.

apical portion of branches and branchlets, 150-200 μm long, arising in left hand spiral with a $\frac{1}{4}$ divergence. Branches not associated with the trichoblasts. Axes ecorticated with 4 pericentral cells. Tetrasporangia numerous, continuous, spirally seriate on the upper part of the branchlets, prominent, globose, 40-75 μm diam. and tripartite. Cystocarps numerous, scattered on the upper part of the branchlets, globose, 250-300 x 240-290 μm , 1-2 celled stalked, with a wide ostiole.

Type locality: Dalmatia (Leg. Sandri).

Local distribution: Manora Island.

This species has been found growing in mid-littoral rocky pools. Our specimens resemble in morphology with those of Segi (1951) described from Japan but differ in endogenous origin of the main axis, lateral branches and unilateral branchlets.

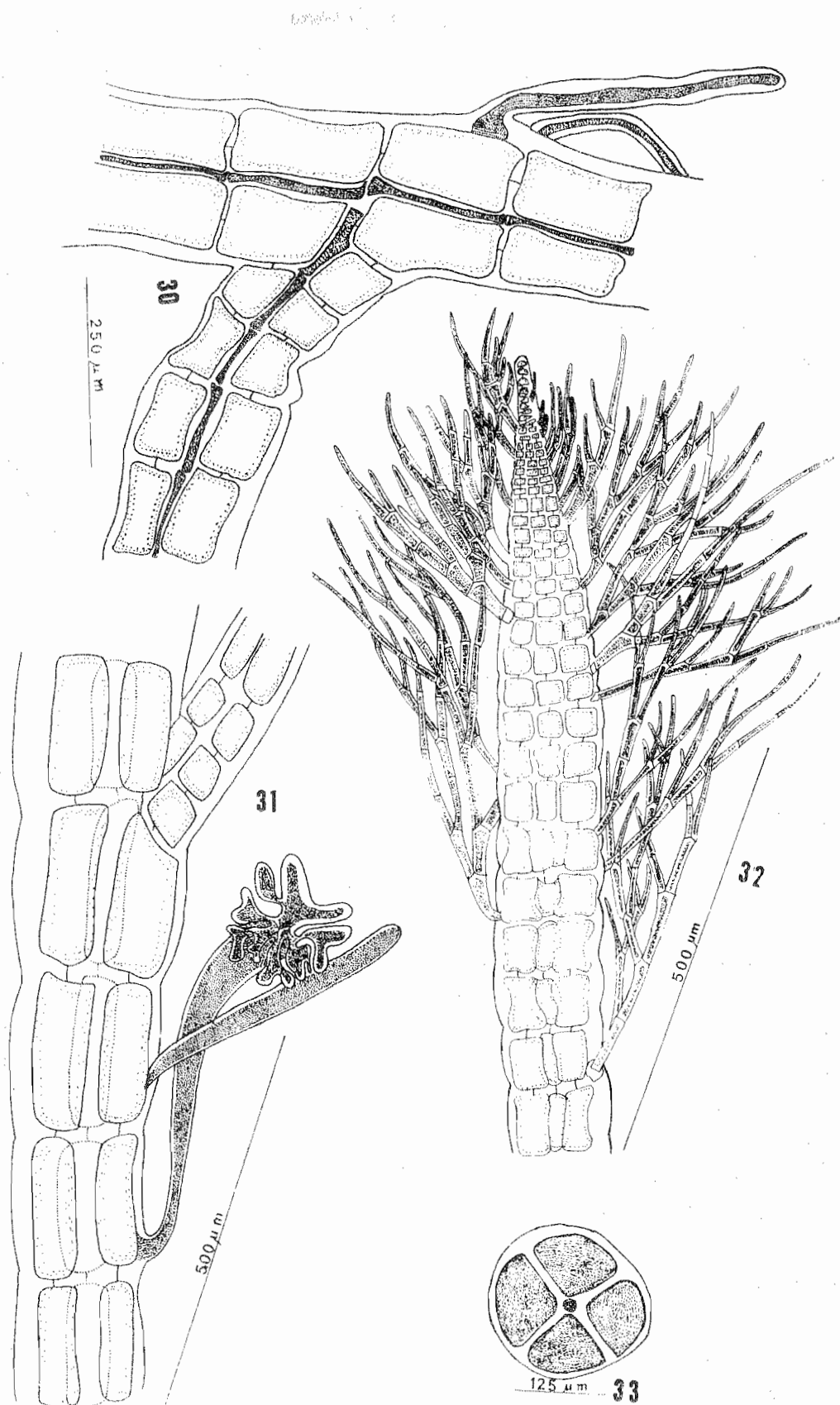
– *Polysiphonia lepadicola* (Lyngbye) Sprengel

Basionym: *Hutchinsia lepadicola* Lyngbye 1819:113, Pl. 35.

Synonym: *Polysiphonia ureceolata* (Dilwyn) f. *lepadicola* (Lyngb) Segi 1951:242.

J. Agardh 1863:945. De Toni 1903:873. Kützinger 1849:807; 1863:13, t. 37. Sprengel 1827:348.

Fronds tufted, rather rigid below, dark-brown in colour, to 5 cm high, attached by unicellular rhizoids arising from the prostrate axis and also from the lower portion of the main axes. Prostrate axes 250-280 μm thick, segments 1-2 (-3) times as long as broad. Rhizoids develop from the proximal end or the middle portion of the pericentral cells one or more per segment, mostly elongated, slender, thin to 2.2 mm long and 22-30 μm broad, sometimes short and thick with terminal discoid haptera, 360 μm long, 45-90 μm broad and disc to 150 μm diam. Main axes indistinct, erect, straight, arising endogenously from the prostrate axes, dichotomously divided with wide angles, rarely irregularly divided, decreasing in thickness upwards, 150-250 mm thick at the base, segments 2-2.5 times as long as broad but the length of the segments decreasing upwards reaching 1-0.5 times as long as broad. Branches or axes exogenous in origin from the main axes, sublternate or unilateral with acute axils, long, slender, straight 75-200 μm diam. at the base and the middle portion, sharply attenuated, apices sub-acute, segments 1.5-2.5 times as long as broad. Branchlets also exogenous in origin, mostly alternate rarely irregular in arrangement, straight, constricted at the bases with or without branchlets arising from the apical portion, tapering at both ends, 150-175 μm diam., axils acute. Axes ecorticated with 4 pericentral cells. Trichoblasts pellucid, short, abundantly arising near the apices, sometimes completely lacking, 550 μm long, constricted, di- or trichotomously divided, arising in left hand spiral, one per segment, deciduous, leaving persistent scar cells, segments 1-4 times as long as broad at the lower portion, 4-5 times as long as broad at the middle and the



Figs. 30-33. *Polysiphonia lepadicola* (Lyngb.) Sprengel. 30. Rhizoids arising from cross septa. 31. Rhizoids arising from cross septa, note with discoid hapteron. 32. Apical portion with trichoblasts in abundance. 33. T.S. of an axis showing 4 pericentral cells.

upper portions. Branches not associated with the trichoblast. Reproductive organs not observed.

Type : ad insulas Faeroeneses, testam **Lepadis balanoides** perreptans

Local distribution: Paradise Point, Hawkes Bay, Manora Island. This species was found growing in association of *Hypnea musciformis* (Wulf.) Lamx., *Pandina pavonia* (L.) Lamx. and *Centroceras clavatum*. (C. Ag.) Mont. in sandy bottom mid-littoral rocky pools and has also been found growing on shells attached by haptera. This is the first record from Karachi.

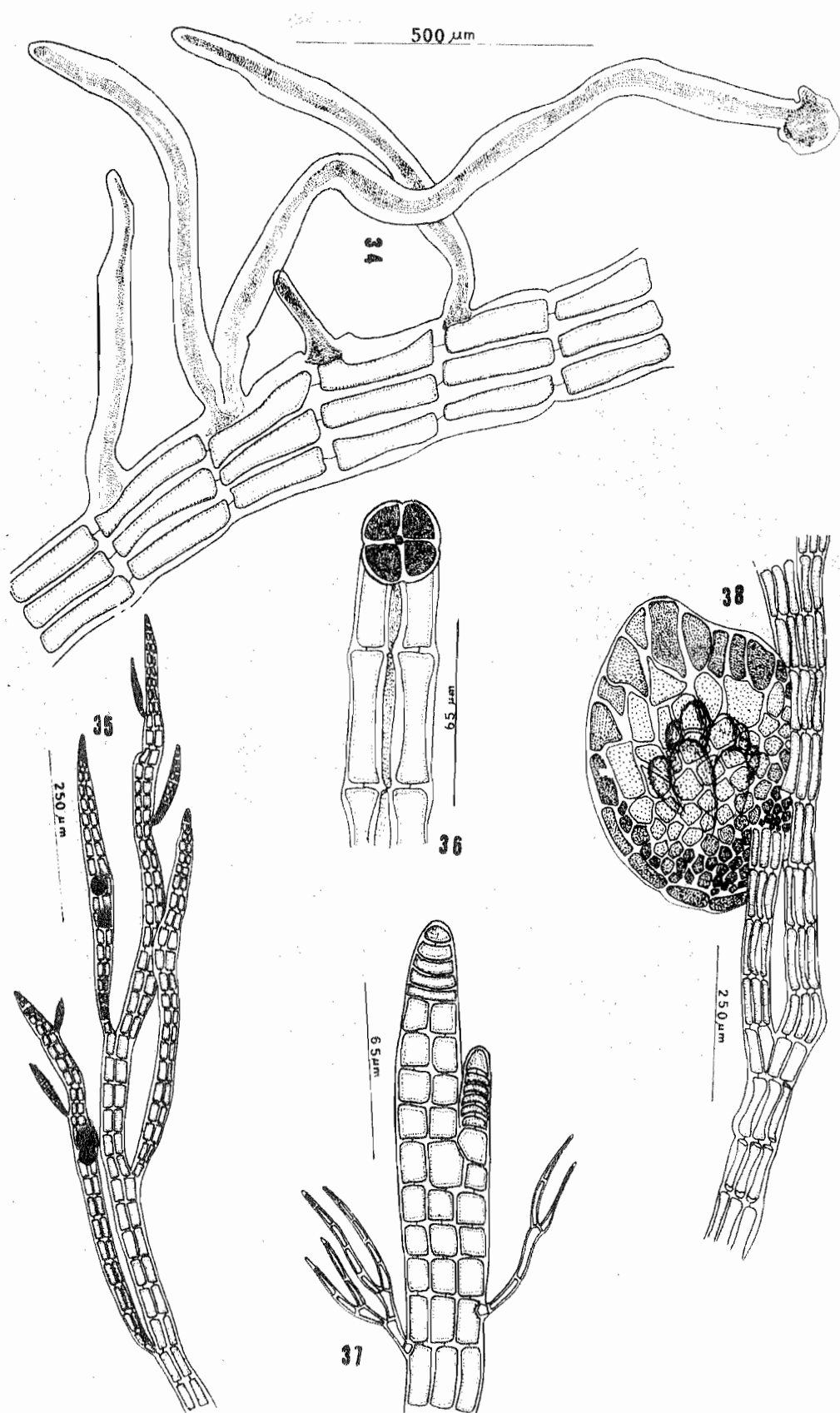
P. lepadicola is characterized by less branching having distantly placed branches or axes. These branches are alternately or irregularly arranged without branchlets but with one short curved ramulus at the upper portion forming sub-acute apices. Our specimens agree with Kutzing (1863) and Segi (1951).

Polysiphonia abscissa Hooker et Harvey

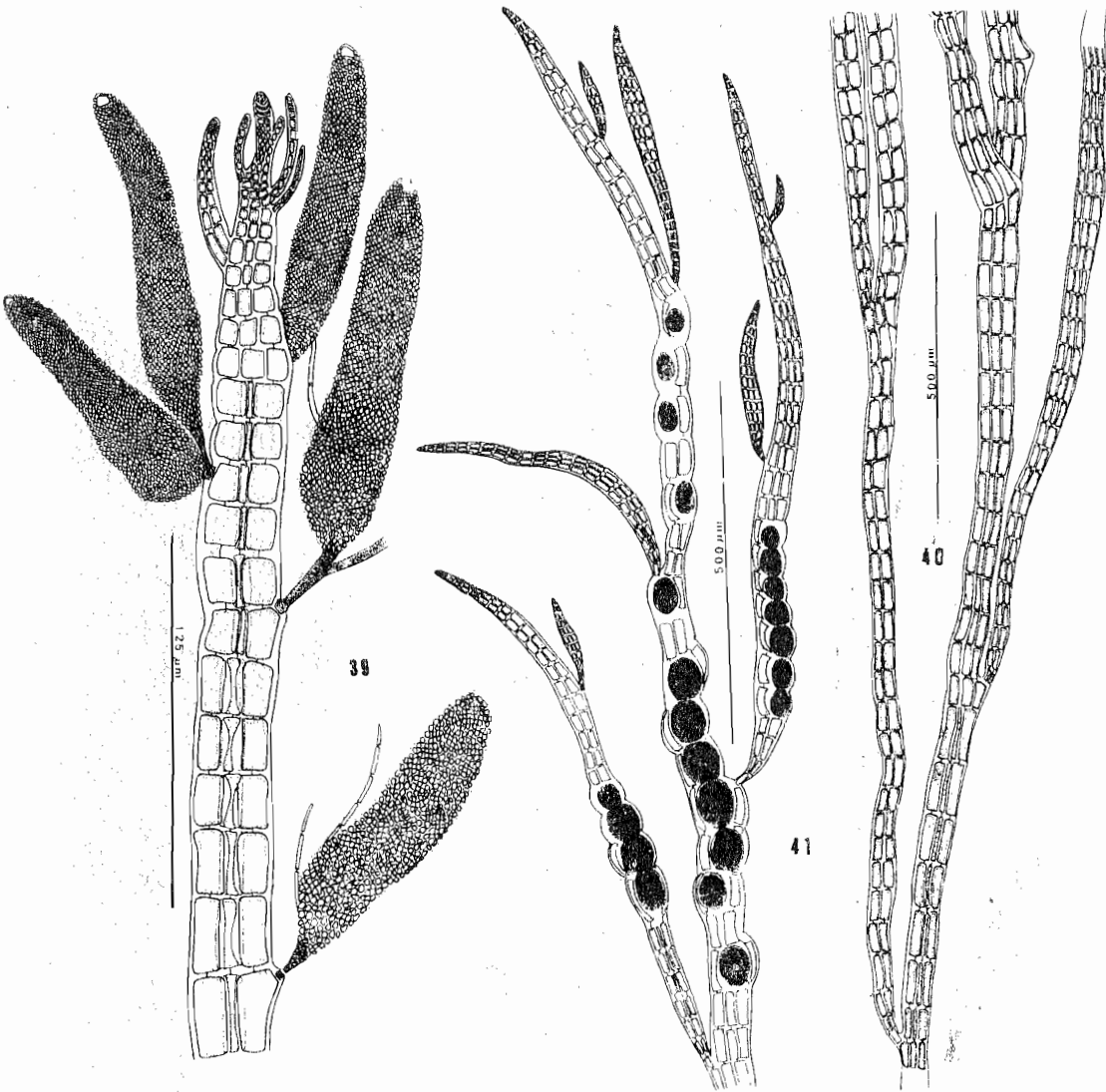
Synonyms: **Polysiphonia microcarpa** Hooker et Harvey 1845: 265. De Toni 1903: 879.

J. Agardh 1863:974. De Toni 1903:879. Harvey 1847:43. Hooker 1847:480. Hooker et Harvey 1845:266. Kutzing 1849:817; 1863:22, t. 70. Segi 1951:236.

Fronds small, tufted elongate, slender, thin, 1-3 cm high arising from a decumbent base, rhizoids at the basal portion of the main axes, arising from the proximal or middle portion of the pericentral cells, cut off by cross walls, one or many per segment, very thick and robust, 400 μ m long, 20-45 μ m thick. Main axes indistinct, erect, lower portion dichotomously divided, upper parts much branched, 100-150 μ m dian.. at the base, segments 3-6 times as long as broad. Branchlets straight, elongate, exogenous, with acute axils, constricted at the base, slightly tapering at both ends, 45-75 μ m thick at the middle, segments 2-3 times as long as broad at the lower portion but length of the segments decreases upwards; subultimate branchlets alternate, straight, constricted at the base, 30-45 μ m diam. at the middle, segments 2-2.5 times as long as broad. Ultimate branchlets alternate, terminating in plumose manner, lowest longest, gradually becoming shorter upwards, straight or slightly curved with or without ramuli, apices obtuse. Axes ecorticated with 4 pericentral cells. Trichoblasts completely absent if present few, not connected with the branches in origin. Tetrasporangia numerous, scattered, or rarely interrupted, prominent, spirally arranged on lower or in the middle part of the branchlets, 45-70 μ m diam., tripartitely divided. Spermatangial stands numerous, developed on the apical portion of the branchlets, 1-celled stalk, arising as primary branch of the trichoblasts, one or two on the same trichoblast, elliptical with rounded apices, 20-30 x 80-150 μ m



Figs. 34-38. *Polysiphonia abscissa* Hooker et Harvey 34. Rhizoids arising from cross septa. 35. Apical portion of the main axes with alternate and subulate branchlets. 36. T.S. of an axes showing 4 pericentral cells. 37. Few trichoblasts. 38. A cystocarpic plant.



Figs. 39-41. *Polysiphonia abscissa* 39. Antheridial stand with one sterile cell at the tip and 1-celled stalk. 40. Lower portion of the main axes. 41. Tetrasporangia spirally arranged and branchlets apart from the main axes.

one prominent sterile cell at the tip. Cystocarps on lateral branchlets, broadly ovate, 200 μm diam. and shortly stalked.

Type locality: Cape Horn.

Local distribution: Paradise Point, Manora Island, Korangi Creek.

This species was found along the coast of Pakistan, growing as epiphyte on *Ulva grande* Saif-ullah and Nizamuddin (1977) and also growing in association of *Hypnea musciformis* (Wulf.) Lamx. In drift this algae was found intermingled with *Ceramium* sp. and *Enteromorpha* sp. Our specimens belonging to *P. abscissa* agree with those of Segi (1951:236) from Japan in morphological attributes i.e. alternate and plumose arrangement of branchlets, strongly branched main axes in the upper portion but differs in size, small subulate axes, sharply tapering at both ends and diverging from the main branches. These differences appear to be of ecological nature. The occurrence of this species is the first record from Pakistan.

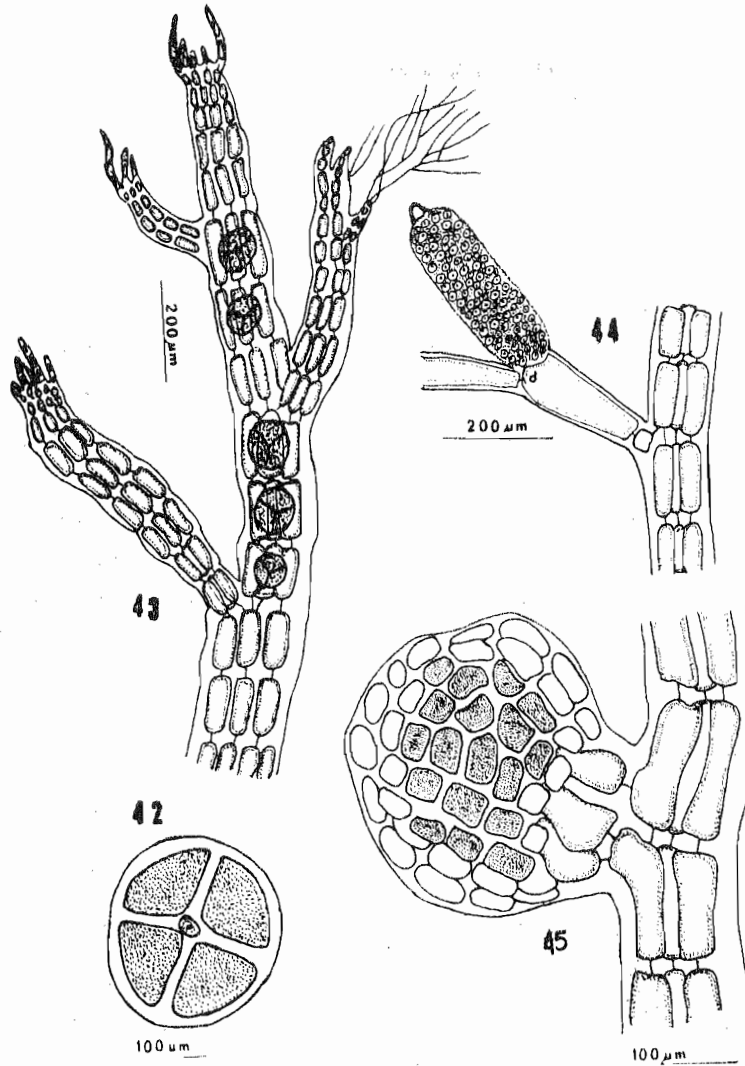
Polysiphonia crassicollis Boergesen

Bason 1979:79; Boergesen 1939:126, figs. 39-40. Newton 1955a:101. Nizamuddin and Gessner 1970:13.

Fronds caespitose, giving rise to several main axes, 4-8 cm high, attached to the substrata by means of rhizoids developing from the lowermost cells and fixed by means of irregularly lobed disc (200 μm diam). Main axes giving rise to branches in all directions either long or short, ecorticated having 4 pericentral cells. Main axes having thick walls near the base, segments 350 μm thick and variable in length. Upwards segments becoming longer, thinner, 200 μm broad and 2-3 times as long as broad. In the lower parts segments spindle-shaped being narrowed in the middle with thick walls. Higher up the walls thinner and segments cylindrical. Upper ends of the axes 55 μm broad and segments 120 μm long. Trichoblasts and branches exogenous in origin. Trichoblasts one in each segment in left hand spiral with a $\frac{1}{4}$ divergence. Branches in the axil of the trichoblasts. Tetrasporangia develop on the upper end of the branches in short rows generally 2-4 in each row. The fertile segments about 80 μm thick. Sporangia oblong and rounded about 50-60 μm broad. Spermatangial stands subcylindrical 75-105 μm broad, 180-240 μm long, with one sterile cell at the tip, develop on the second long cell of the trichoblasts. The cystocarps urceolate, 160-190 x 180-220 μm , very thick, short stalked, with a small ostiole not protruding.

Type locality: 6 km south of Bushire, Persian Gulf (Leg. KOIE, no. 51). Type-in C.

Local distribution: Karachi (Gessner, 17.3.1965). Sta. 288, Persian Gulf (Gessner, 2.4.1965).



Figs. 42-45. *Polysiphonia crassicollis* Borg. 42. T.S. of an axes showing 4 pericentral cells. 43. Tetrasporic plant (trichoblasts shown diagrammatic). 44. An antheridial stand. 45. A cystocarpic plant.

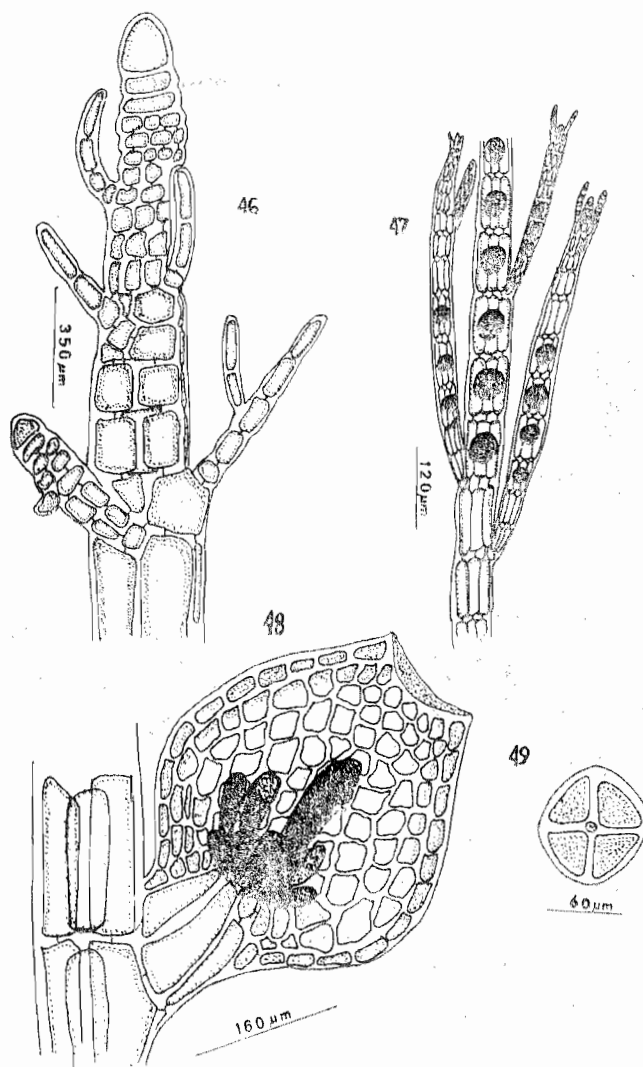
P. crassicollis generally grows as epiphyte on *Laurencia obtusa* (Huds) Lamx. in mid-littoral pools.

This species is easily distinguishable from *P. kamapsaxii* by the absence of decumbent axes and from *P. platycarpa* by its smaller and globular cystocarps. Our specimens agree with the type description and figures but differ in the presence of sterile cell at the tip of the spermatangial stands.

Polysiphonia platycarpa Boergesen

Anand 1943:38. Boergesen 1934a:23, figs. 15-17; 1935:60; 1937:349; 1945:34.

Fronds caespitose, brownish-red in colour, erect, 4-6 cm high, attached to the substrata by means of unicellular rhizoids developing from the base of the erect axes and decumbent



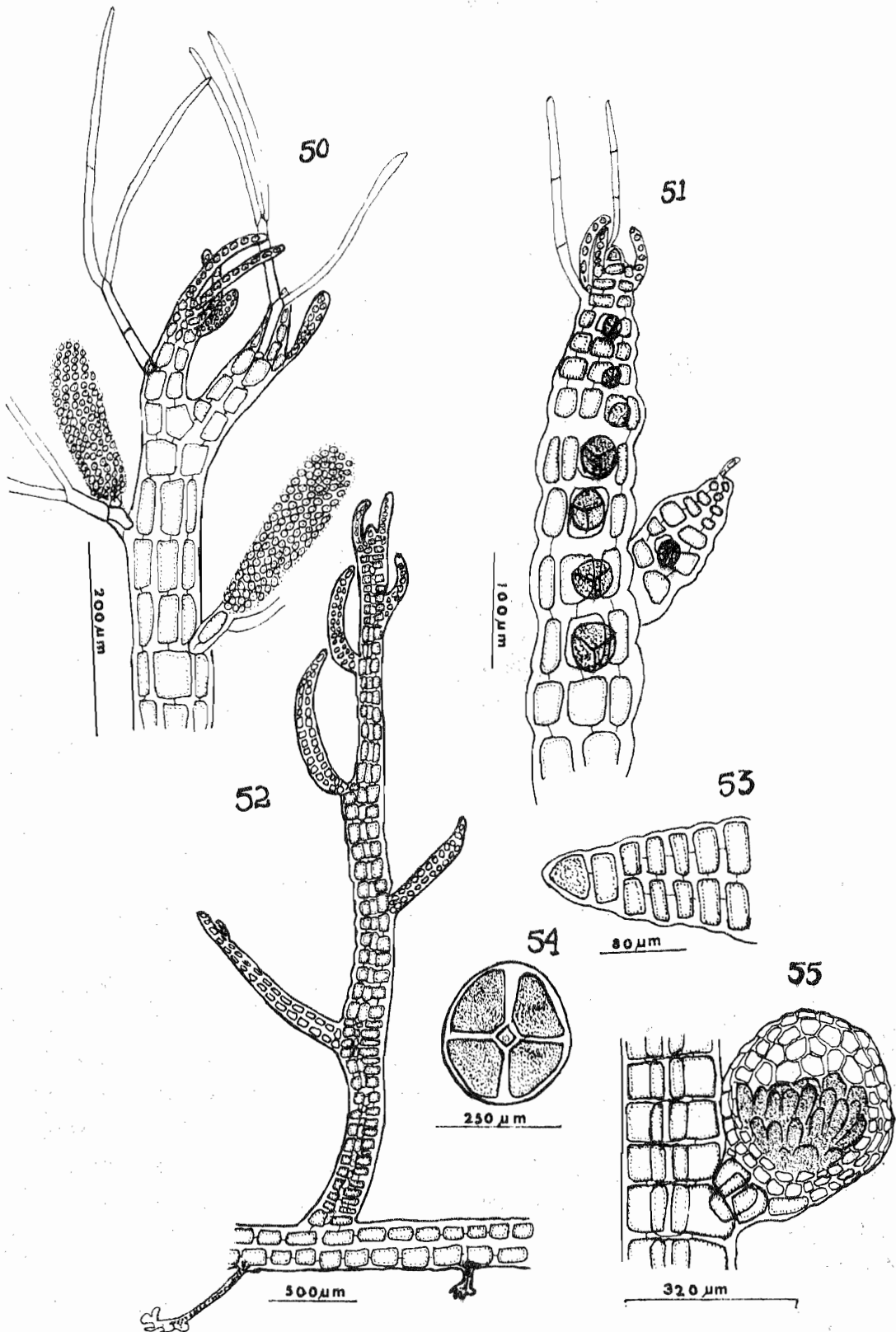
Figs. 46-49. *Polysiphonia platycarpa* Borg. 46. Apex of an axes. 47. Axes showing tetrasporangia. 48. A cystocarpic branch. 49. T.S. of an axes showing 4 pericentral cells.

axes to 250 μm thick. Axes irregularly branched, ecorticated having 4 pericentral cells, exogenous in origin, segments as long as broad near the base, 150-170 μm long and 80-100 μm broad in the middle portion. Trichoblasts well developed near the tips in left hand spiral with a $\frac{1}{4}$ divergence. Branches associated with the trichoblasts or in the place of trichoblasts. Tetrasporangia in chains in ultimate branchlets, 90-100 μm diam. Spermatangial stands subcylindrical. 200-250 μm long, 35-45 μm broad, no sterile cell at its tip. Cystocarps more or less spherical 250-320 x 280-340 μm or about 400 μm diam. With short stalk.

Type locality : Bombay (Leg. Boergesen, no. 5024).

Type-in C.

This species was generally found growing on buoys, wooden wharves in Keamari Harbour



Figs. 50-55. *Polysiphonia ferulacea* Suhr in J. Ag. 50. Apical portion of an axes with antheridial stands. 51. Apical portion of an axes with tetrasporangia. 52. Prostrate and erect axes. 53. Apex of an erect axes. 54. T.S. of an axes showing 4 pericentral cells. 55. A cystocarp.

and on Mangroves in Sands Pit.

P. platycarpa resembles *P. macrocarpa* Harvey in exogenous origin but differs in possessing branches and branchlets directed upwards whereas these are recurved in *P. macrocarpa*.

Polysiphonia ferulacea Suhr in J. Agardh

Synonym: *Polysiphonia breviarticulata* Harvey 1852:36, Pl. 168 non C. Agardh, non Zanardini. *Polysiphonia dichotoma* Kuttzing 1843:423; 1849:819.

J. Agardh 1863:980. Anand 1943:39. Boergesen 1931:16; 1934b:47; 1936:94; 1945:34. De Toni 1903:892. Joly 1965:221. Nizamuddin and Gessner 1970:13. Richardson 1975:130. Segi 1951:209. Taylor 1960:578.

Fronds erect, large, dark-brown to red, 7-17 cm high. Prostrate axes to 300 μ m thick attached by rhizoids ending in discoid haptera, arising at the corner of the pericentral cells cut off by cross walls 300-600 μ m long, 50-70 μ m thick. Main axes erect, 450-500 μ m broad, gradually attenuated upwards, sparingly alternately branched below, upper parts sub-dichotomously branched in fastigiate manner. Axes exogenous in origin at intervals of 5-7 segments apart, denuded near the base. Branchlets simple or irregularly branched upwards, virgate, furcate or forcipate at the apices. Trichoblasts well developed with a $\frac{1}{4}$ divergence, one in each segment. The branches arise in the same position as the trichoblasts. The axes ecorticated with 4 pericentral cells. Tetrasporangia near the end of the ultimate spiral branchlets one in each segment. The spermatangial stands cylindrical without sterile cell at the tip. Cystocarps nearly spherical to 400 μ m long, 365 μ m broad, shortly stalked, with a non-protruding ostiole.

Type locality: Adriatic Sea.

Local distribution: Cape Monze, Paradise Point, Hawkes Bay, Manora Island. Sta. 273 (Gessner, 31.3.1965).

This species was found growing as epiphyte on *Codium flabellatum* Silva and Nizamuddin *in ed.*, *Tolypocladia glomerulata* (J. Ag.) Schmitz [*Roschera glomerulata* (J. Ag.) Web. von Bosse] and on *Gelidium Pusillum* (Stackh.) Le Jollis.

P. ferulacea from Pakistan coast agrees with those described by Boergesen (1931) and De Toni (1903) but differs from the West Indies specimens in size and in absence of sterile cell at the tip of the spermatangial stands but resembles with the type description.

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