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SPECIES OF THE GENUS *BRYOPSIS* LAMOUROUX (BRYOPSIDALES-CHLOROPHYCEAE-CHLOROPHYTA) FROM THE COAST OF PAKISTAN

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Abstract

A critical study of the genus *Bryopsis* Lamour., from the coast of Pakistan showed the occurrence of 16 species comprising 4 new ones viz., *B. aishae* Nizam. *sp.nov.*, *B. pakistanica* Nizam. *sp.nov.*, *B. manorensis* Nizam. *sp.nov.* and *B. qasimensis* Nizam. *sp.nov.*, 8 new records viz., *B. caespitosa* Suhr, *B. corticulans* (?) Setchell, *B. duplex* De Not., *B. fastigiata* Kütz., *B. harveyana* J. Ag., *B. indica* A. & E.S. Gepps, *B. penicillata* Suhr and *B. pennata* Lamour., whereas the remaining 4 ones viz., *B. corymbosa* J. Ag., *B. hypnoides* Lamour., *B. pennatula* J. Ag. and *B. plumosa* (Huds.) C.Ag. have been reported earlier.

Introduction

Pakistan lies in the northern part of the Arabian Sea extending from the Iranian coast in the west to the Gulf of Kutch-India, in the east. Contributions in the field of marine algae have been made by Anand (1940), who described *Bryopsis pennata* var. *minor* J. Ag. (= *B. pennatula* J. Ag.) and *B. corymbosa* J. Ag., from Karachi coast followed by Shameel (1987), Shameel & Afaq-Husain (1987) and Shameel & Tanaka (1992) who listed only the above species with the addition of *B. hypnoides* Lamour. These specimens are, however, not traceable to authenticate them. From the Arabian Sea (western coast of India) Biswas (1945), Krishnamurthy & Joshi (1970), Bǿrgesen (1934, 1936, 1939) and Durairatnam (1961) from Sri Lanka reported the occurrence of the above species including *B. implexa* De Not. (=*B. corymbosa* J. Ag.), *B. indica* A. & E. Gepps and *B. plumosa* (Hudson) C. Ag. All the above informations are sketchy and a detailed study on the genus *Bryopsis* was therefore carried out using fresh and preserved collection of specimens. Earlier study was based on collections made once and from limited localities like Manora and Sandspit.

Material and Methods

Specimens were collected from different localities lying on the coast of Pakistan. These were either preserved in 4% formalin-seawater solution for anatomy or mounted on herbarium sheets, which are kept in the Seaweed Herbarium (KU-SW), M.A.H. Qadri Biological Research Centre, University of Karachi. Camera lucida was used for the drawings. The terminology used in the text is shown in Fig.1.

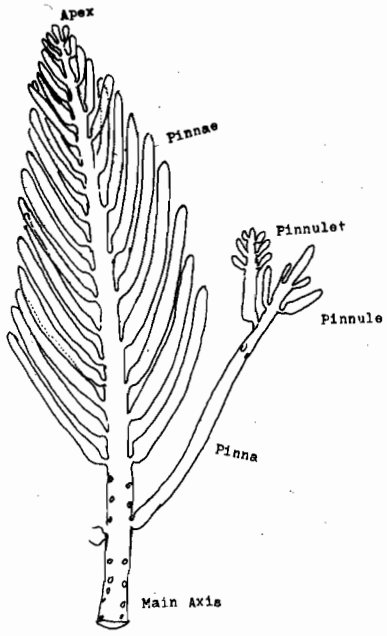

Fig. 1. Terminology used in the text in the description of the species of *Bryopsis* Lamour.

DESCRIPTION OF THE TAXA

Order Bryopsidales Feldmann 1946: Thallus heterotrichous, siphonous, coenocytic; basal parts prostrate giving rise to erect main axes. Axes pinnately or radially or irregularly much branched; structurally simple, lacking trabeculae, homoplastic; chloroplasts with distinct pyrenoids; siphonein and siphonoxanthin as accessory pigments; lutein present but luteinepoxide lacking. Main constituents of cell wall are ß-1, 3-xylan; ß-1, 4-mannan and ß-1, 4-glucan and also contain proteins, hydroxyproteins and proline (Maeda & Nisizawa, 1972). Specialized reproductive organs lacking. Asexual reproduction by stephanokont meiozoospores. Sexual reproduction anisogamous; sporic meiosis but in some gametic meiosis also occur. Thallus diploid, diplohaplobiontic, monoecious or dioecious and heteromorphic.

It is a small order comprising the only family Bryopsidaceae and a single genus *Bryopsis*.

Family Bryopsidaceae (Bory 1828:203) em. Thuret 1850: 317: Character of the family is the same as that of the order.

Womersley (1984) and Ardré (1970) retain the family within the order Derbesiales Feldm. and Codiales Feldm, respectively whereas Bold & Wyne (1985) include the genus *Bryopsis* within the family Derbesiaceae under the order Caulerpales. Nizamuddin (1991) agrees with Feldmann (1946) in retaining the order Bryopsidales on

the basis of unspecialized reproductive organs, lacking trabecular system, mode of gametic extrusion, absence of luteinepoxide, presence of proteinaceous-plug of carbohydrate (Burr & West, 1971).

Genus Bryopsis Lamouroux 1809b: 133: Thallus heterotrichous, diplohaplobiontic, monoecious or dioecious; gametophyte erect arising from prostrate, cylindrical axis, bilaterally, pinnately, radially or irregularly branched; last order of the branches (termed either pinnae or pinnules or pinnulets) transformed into gametangia (either unisexual or bisexual) forming septa at their bases. Gametes liberate through many pores on the gametangial walls. Sexual reproduction anisogamous. Zygotes on germination develop either new thalli or horizontal creeping filaments producing stephanokont meiozoospores within the filaments which on germination produce haploid macroscopic thalli. Sporophyte minute, slightly irregularly branched. Alternation of generations heteromorphic but lacking in some species; sporic meiosis but gametic in some. Chloroplasts numerous, discoid or ovoid with distinct pyrenoids.

Type: Bryopsis pennata Lamouroux 1809b: 133: A large number of species of *Bryopsis* have been described especially from the Mediterranean Sea (Nizamuddin, 1991) but their specific limits are often uncertain (Womersley, 1984). Culture and life-history studies helped in understanding the species, but did not solve the problems of identification. Presently, differentiation of species is mostly based on morphology. Chloroplasts and pyrenoids features are of little importance in identification as these are variable even within the same species (Table 1).

Key to the species of *Bryopsis*

1	Thallus radially branched	2
	Thallus branched otherwise	3
2	Ramification regular.	*B. hypnoides*
	Ramification irregular.	*B. corymbosa*
3	Thallus distichously branched	4
	Thallus alternately branched	5
4	Main axis 1 mm diam	*B. plumosa*
	Main axis less than 1 mm diam	6
5	Pinnae distantly arranged; L/B (8-) 11-26	*B. fastigiata*
	Pinnae closely arranged; L/B 6-16	*B. penicillata*
6	Pinnae distichous, irregular in shape and form or in groups of two or three	*B. pakistanica*
	Pinnae otherwise	7
7	Pinnae in double row on either side of the axis	*B. indica*
	Pinnae otherwise.	8
8	Pinnae bilateral or unilateral, densely arranged	*B. harveyana*
	Pinnae otherwise	9
9	Attaching organ hapteroid	*B. caespitosa*
	Attaching organ prostrate	10

Table 1. Measurement of chloroplasts in *Bryopsis* species.

Name of the species	Chloroplasts Discoid (in μm)	Chloroplasts Ovoid (in μm)	Pyrenoid	Reference
1. *B. aishae*	3-6	9x3	1-2	Nizamuddin
2. *B. caespitosa*	2	9-15x6-9	-	Nizamuddin
3. *B. corticulans*	6	-	-	Nizamuddin
4. *B. corymbosa*		7-10x5-8	-	Feldmann (1936-37)
	7-10	-	-	Gayral (1958, 1966)
	7-10	30-40x7-10*	-	Nizamuddin (1991)
	6-12	6x9	1	Nizamuddin
5. *B. duplex*	-	12-28x8-9	-	Koster (1941)
	7.5	17.5x7.5-10	-	Nizamuddin (1991)
	6-9	-	1	Nizamuddin
	-	6-8x4-6	-	Pignatti (1962)
6. *B. fastigiata*	6	-	1	Nizamuddin
	2.8-7.5	-	-	Nizamuddin (1991)
	-	10x7-8	-	Feldmann (1936-37)
7. *B. harveyana*	6	-	1	Nizamuddin
8. *B. hypnoides*	6	-	1	Nizamuddin
	-	7-10x6-8	-	Nizamuddin (1991)
	-	4-5x3-4	-	Pignatti (1962)
9. *B. indica*	6	-	1	Nizamuddin
10. *B. manorensis*	6-7.5	9x6	1-2(-4)	Nizamuddin
11. *B. pakistanica*	6-9	-	1	Nizamuddin
12. *B. penicillata*	2-9	-	1	Nizamuddin
	-	8-15x5-8	-	Funk (1955)
13. *B. pennata*	30-33	-	-	Ardré (1970)
	-	15-20x8-10	-	Feldmann (1936-37)
	10-20	-	-	Gayral (1958, 1966)
	-	12x9	1	Nizamuddin
14. *B. pennatula*	3	-	1	Nizamuddin
15. *B. plumosa*	-	5-32x5-8	-	Koster (1941)
	-	8-10x6-8	-	Pignatti (1962)
	5-7.5	7.5-15x5-7.5	-	Nizamuddin (1991)
	6-9	-	1	Nizamuddin
16. *B. qasimensis*	15-25	-	1-2	Nizamuddin

*Fusiform.

10 Pinnae, pinnules abaxial..... *B. aishae*
Pinnae, pinnules adaxial..... 11
11 Pinnae generally simple and in 3-rows in lower part of the main axis .....
..... *B. manorensis*
Pinnae otherwise..... 12
12 Main axis 500 μm or more in diam..... 13
Main axis less than 500 μm in diam..... 14
13 Main axis furcate..... *B. duplex*
Main axis not furcate..... *B. pennata*
14 Main axis up to 260 μm in diam..... *B. qasimensis*
Main axis more than 260 μm in diam..... 15
15 Pinnae simple and closely distichous near the apex ..... *B. pennatula*
Pinnae simple or branched, loosely distichous.....*B. corticulans*(?)

Bryopsis hypnoides Lamouroux 1809a: 333; 1809b: 135
Synonyms: *Bryopsis arbuscula* C. Agardh 1824: 179. Kützing 1856: 29, t. 84. *Bryopsis corymbosa sensu* Kützing 1856: 29, t. 83. *Bryopsis hypnoides* var. *arbuscula* (Kütz.) Schiffner 1935: 109.

J. Agardh 1887: 27. Ardré 1970: 363. Bφrgesen 1925: 103; 1939: 74; 1946: 34. Chapman 1961: 132. Durairatnam 1961: 26. Feldmann 1936-37: 230. Gayral 1966: 205. Hamel 1930: 68 (392). Lamouroux 1813: 281. Nizamuddin 1991: 121. Pignatti 1962: 48. Setchell & Gardner 1920: 159. Taylor 1928: 92; 1945: 60; 1972: 130; 1979: 130. Trévisan 1845: 74. Vickers 1905: 58.

Figs. 2 (a-h); 20(d)

Thallus tufted arising from a profusely branched, siphonous, cylindrical prostrate system, giving rise to many erect main axes up to 6 cm high and 400-500 μm diam., pinnately, distichously or radially branched. **Pinnae** slender, cylindrical, elongate up to 2 cm in length, distichous or sub-distichous, or radial, adaxial, constricted at the base, apices round. **Pinnae** of the upper part 380-1070 μm long and 100-205 μm diam., L/B 3-7.8. **Pinnae** of the remaining parts 970-1705 μm long and 75-305 μm diam.; L/B 4.7-11.2; development of the pinnae successive. Pinnae longer on one side than the other side. **Chloroplasts** dense, discoid up to 6 μm diam., with a single pyrenoid.

Specimen examined: Sandspit (Leg. Miss Aisha Khan 9-10-1991, M. Nizamuddin 9-10-1991). Goth Mubarak (Leg. M. Nizamuddin 11-10-1963).

Plants grow on upper littoral rocks becoming exposed to the atmosphere at low tides.

Initially pinnae are distichous or sub-distichous but gradually become radial and elongated up to 2 cm in length, shorter pinnae also occur.

Plants are always infested with diatoms and other microscopic algae.

This species differs from that of Canary islands (Bφrgesen, 1925) being more regular than irregular on the main axis.

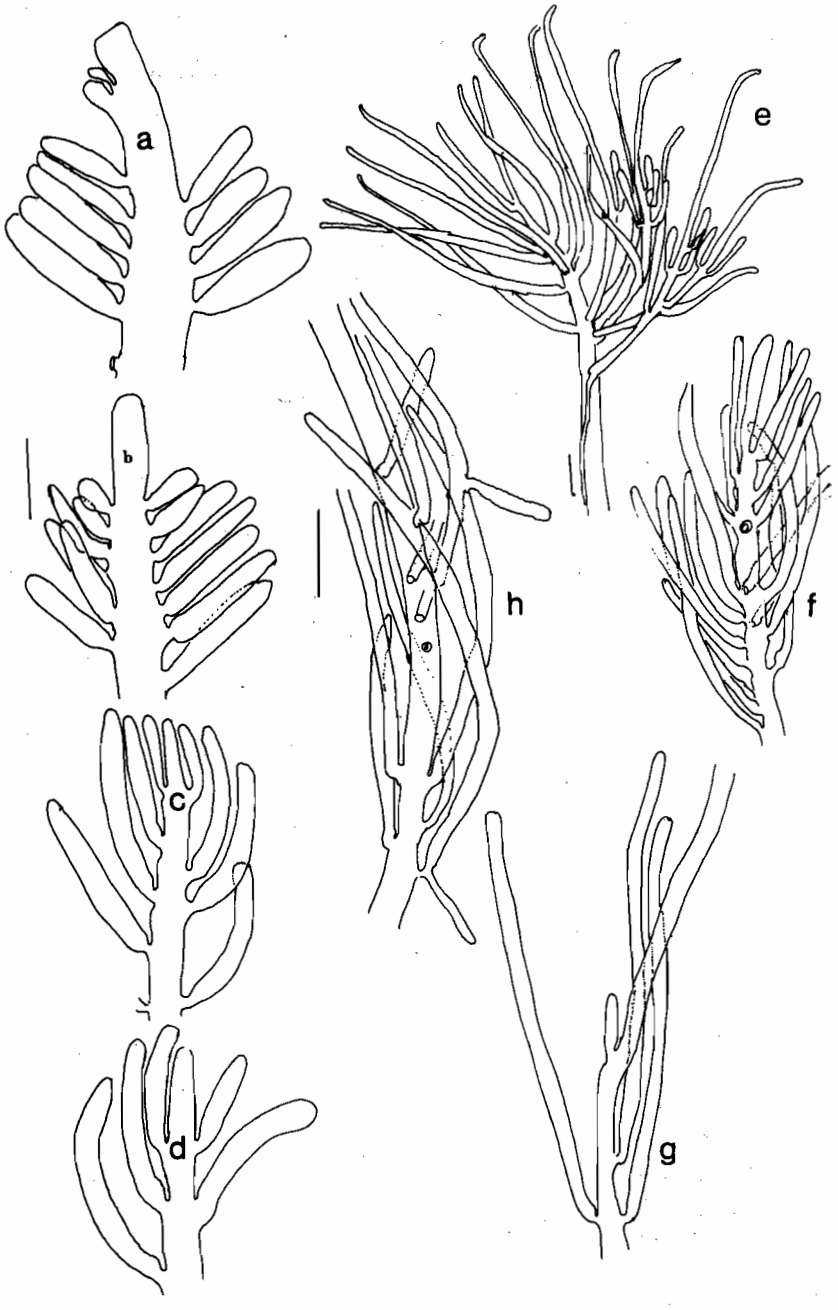

Fig.2. *Bryopsis hypnoides* Lamour. (a-c) Apical parts of three plants from different localities showing apices and development of pinnae. (d) A pinna bearing pinnules and its apex. (e) A part of a plant (after Abbott & Hollenberg 1976). (f) Upper part of a main axis. (g) A pinna bearing pinnules. (h) Middle part of a main axis bearing pinnae and rhizoid. Scale: (a-d) = 200 μm; (e) = 1 mm; (f-h) = 500 μm.

Bryopsis corymbosa J. Agardh 1842: 21
Synonyms: Bryopsis implexa De Notaris 1846: 73. Bφrgesen 1939: 74. Hauck 1885: 473. *Bryopsis alterna* Schousboe in Bornet 1892: 213. *Bryopsis ramosa* Schousboe in Bornet 1892: 213. *Bryopsis elegans* Meneghini in Zanardini 1847: 65.

J. Agardh 1887: 27. Anand 1940: 37. Bφrgesen 1925: 100. De Toni 1889: 433. Feldmann 1936-37: 228. Funk 1955: 21. Gayral 1958: 182. Hamel 1930: 68 (392). Kützing 1849: 492; 1856: 28, t. 81. Levring 1974: 19. Nizamuddin 1991: 116. Pignatti 1962: 50. Schiffner 1935: 114. Trévisan 1845: 74.

Figs. 3(a-j); 4(a-g); 20(a-b)

Thallus tufted, erect arising from a siphonous, cylindrical prostrate system giving rise to many cylindrical erect main axes up to 5 cm high, 360-720 μm diam., distichous pinnate to tripinnate; apices acute or round. **Pinnae** distichous, slender, cylindrical, broadly ovate or elongate, adaxial 2.5 cm long and 240-405 μm diam.; L/B 21-52; apices round or broadly acute, naked below up to 50 μm from the base otherwise remaining part clothed with distichous pinnules. **Pinnules** distichous, sometimes alternate, adaxial, ovate or lanceo late, 405-585 μm long and 150-205 μm diam.; L/B 2.2-3.2, apices round and blunt. **Pinnulets** slender or ovate, up to 3 mm long, uniform in diameter viz., 180 μm; apices round and blunt. **Pinnae** in lower parts simple, slender, cylindrical, elongate, up to 7 mm long and 240-360 μm diam.; apices narrow. **Chloroplasts** dense ovoid 6x9 μm or discoid 6-12 μm with a single pyrenoid.
Specimens examined: Manora (Leg. Miss Hamida Bano 15-12-1966, M. Nizamuddin 6-11-1964, Miss Shahida Belgaumi 2-1-1963, 19-1-1963). Kakar Goth, Sandspit (Leg. Miss Aisha Khan 20-7-1993). Buleji (Leg. M. Nizamuddin 8-1-1989; 19-8-1993. Mrs. Aliya Rehman 20-9-1990). Cape Monze, East (Leg. M. Nizamuddin 16-11-1964 KU 827). Cape Monze (Leg. Nazrul Islam 30-1-1969; Miss Najma Haq 20-5-1969).

Plants grow in mid-littoral region on sandy rocky substrata in association of *B. pennata*. Plants growing in littoral pools are heavily infested with diatoms and other microscopic algae.

The chief characteristic of the species is very irregular ramification, pinnae or pinnules in some places emerging rather densely and regularly distichously, in others much scattered, often with long intervals between them, and either unilaterally or all round the axis (Bφrgesen, 1925). Pakistani specimen posses more regular ramification than irregular.

Bryopsis plumosa (Hudson) C. Agardh 1820: 448
Basionym: Ulva plumosa Hudson 1778: 571.
Synonyms: Fucus arbuscula De Candolle 1806: 72. *Bryopsis arbuscula* Lamouroux 1809a: 333; 1809b: 134. *Bryopsis rosae* J. Agardh 1887: 25.

C. Agardh 1822: 448. J. Agardh 1842: 21. 1887: 24. Ardré 1970: 362. Bφrgesen 1925: 97; 1934: 19. Bornet 1892: 213. Chapman 1961: 132. Feldmann 1936-37: 220. Funk 1927: 328; 1955: 20. Gayral 1958: 180; 1966: 203. Hamel 1930: 61 (385). Hauck 1885: 471. Koster 1941: 242. Kützing 1843: 306; 1849: 493; 1856: 29, t. 83.

Fig.3. *Bryopsis corymbosa* J. Ag. (a-b) Apical parts of two plants from different localities bearing pinnae. (c-f) Pinnae from four different plants bearing distichous and unilateral pinnae. (g) A basal attachment. (h) Apex of a main axis bearing distichous and radial pinnae. i(a') Lower pinnae. (b') Upper pinna. (j) Habit of a plant. (Redrawn after Bøgesen, 1925). Scale: (a-h) = 500 μm; (i) = 200 μm; j = 2.5 cm.

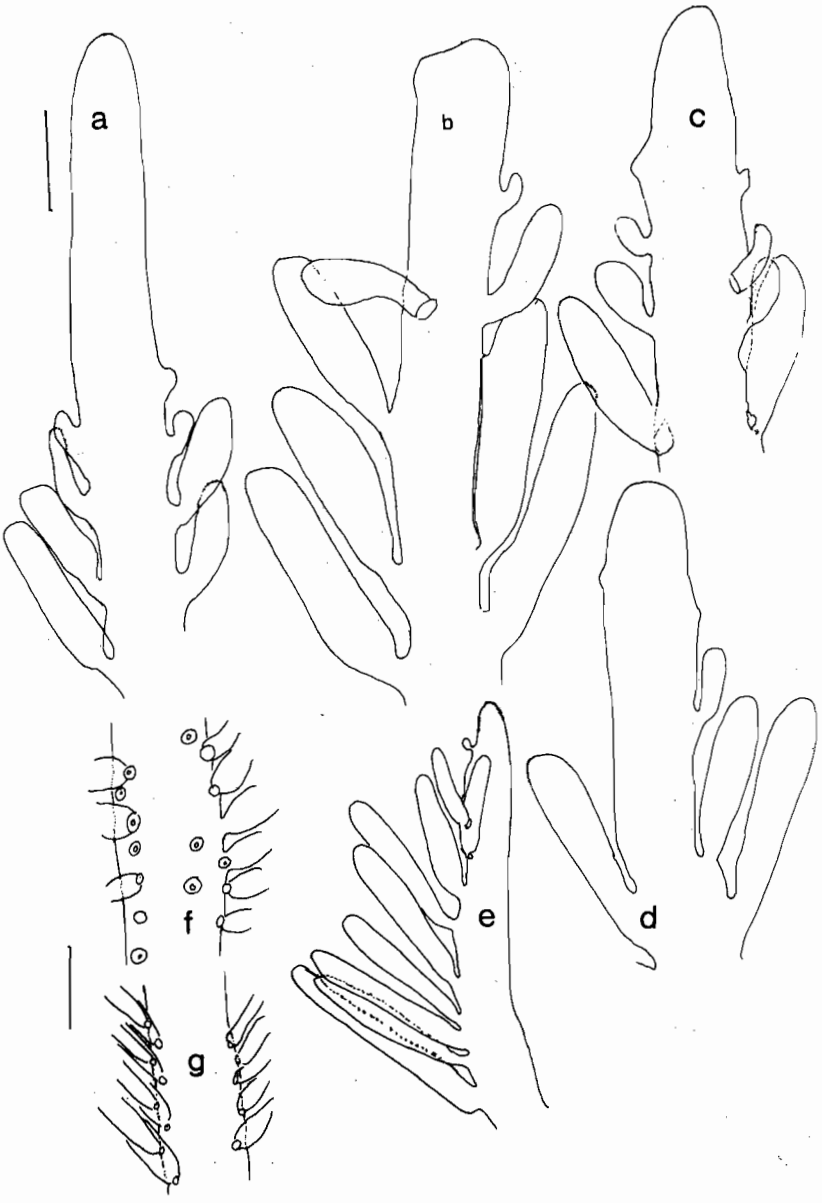

Fig.4. *Bryopsis corymbosa* J. Ag. (a-d) Apices of different plants showing variations. (e) A pinna bearing unilteral pinnules and apex. (f,g) Middle and lower parts of main axes showing arrangement of pinnae respectively. Scale: (a-d) = 200 μm; (e-g) = 500 μm.

Nizamuddin 1991: 130. Ollivier 1929: 101. Pignatti 1962: 35. Schiffner 1916: 197; 1935: 112.

Schiffner & Vatova 1938: 112. Setchell & Gardner 1920: 161. Taylor 1928: 83; 1972: 131; 1979: 131. Trévisan 1845: 75. Womersley 1984: 282. Zanardini 1842: 220; 1847: 51.

Figs. 5(a-k); 22(b)

Thallus tufted, plumose, erect arising from a strongly branched prostrate system, giving rise to erect, siphonous, cylindrical main axes up to 6 cm high and upto 1 mm diam., densely closely pinnate to tripinnate having round or acute apices. **Pinnae** simple or branched, short or long, up to 5 cm long and 230-360 μm diam.; L/B 43-196, distichous, adaxial, naked below, apices round. Basal pinnae simple, short 625-1125 μm long and 150-185 (-235) μm diam.; L/B 4-6.6. **Pinnules** simple, cylindrical, distichous, adaxial. Lower pinnules 500-810 μm long and 100-175 μm diam.; L/B 4.4-6.8. Intermediate pinnules 1-1.5 mm long and (75-) 100-130 μm diam.; L/B 10.5-16. **Chloroplasts** dense, discoid 6-9 μm diam. with a single pyrenoid.

Specimens examined: Manora (Leg. M. Nizamuddin 3-11-1963, 27-10-1992). Buleji (Leg. M. Nizamuddin 5-1-1988, Miss Aisha Khan 19-9-1993). Nathiagali, between Paradise Point and Cape Monze (Leg. Miss Aisha Khan 26-12-1989).

Base of the pinnae is strongly constricted with downwardly hapteroid rhizoids. In lower parts of the main axes pinnae are very close to each other and in some double rows of pinnae were observed near the basal part.

Bryopsis fastigiata Kützing 1843: 251

Synonym: Bryopsis hypnoides var. *flagellata* Schiffner 1935: 110. Schiffner & Vatova 1938: 113.

Hauck 1885: 473. Kützing 1849: 491; 1856: 26, t. 73. Nizamuddin 1991: 138. Pignatti 1962: 49.

Figs. 6(a-d); 20(c)

Thallus tufted, erect arising from a prostrate system, much branched, giving rise to erect main axes up to 4 cm high, elongate, linear, siphonous, cylindrical, (50-) 100-150 (-205) μm diam., alternately pinnate; basally naked; apically narrow linear 35-50 (-75) μm diam. **Pinnae** linear, elongate, alternately distantly arranged, adaxial; constricted at the base, apex round, (310-) 510-1025 μm long and (35-) 50-75 μm diam.; L/B (8-) 11-26. **Chloroplasts** dense, discoid up to 6 μm diam. with a single pyrenoid.

Specimens examined: Kiamari Jetty, Karachi (Leg. Hamied Shaikh 29-2-1968). Manora (Leg. M. Nizamuddin 10-11-1992, 3-11-1963 KU 262). Paradise Point (Leg. M. Nizamuddin 14-9-1993).

The species from the coast of Pakistan resembles that of the Mediterranean coast of Africa in habit but differs in size and branching (absence of pinnulets).

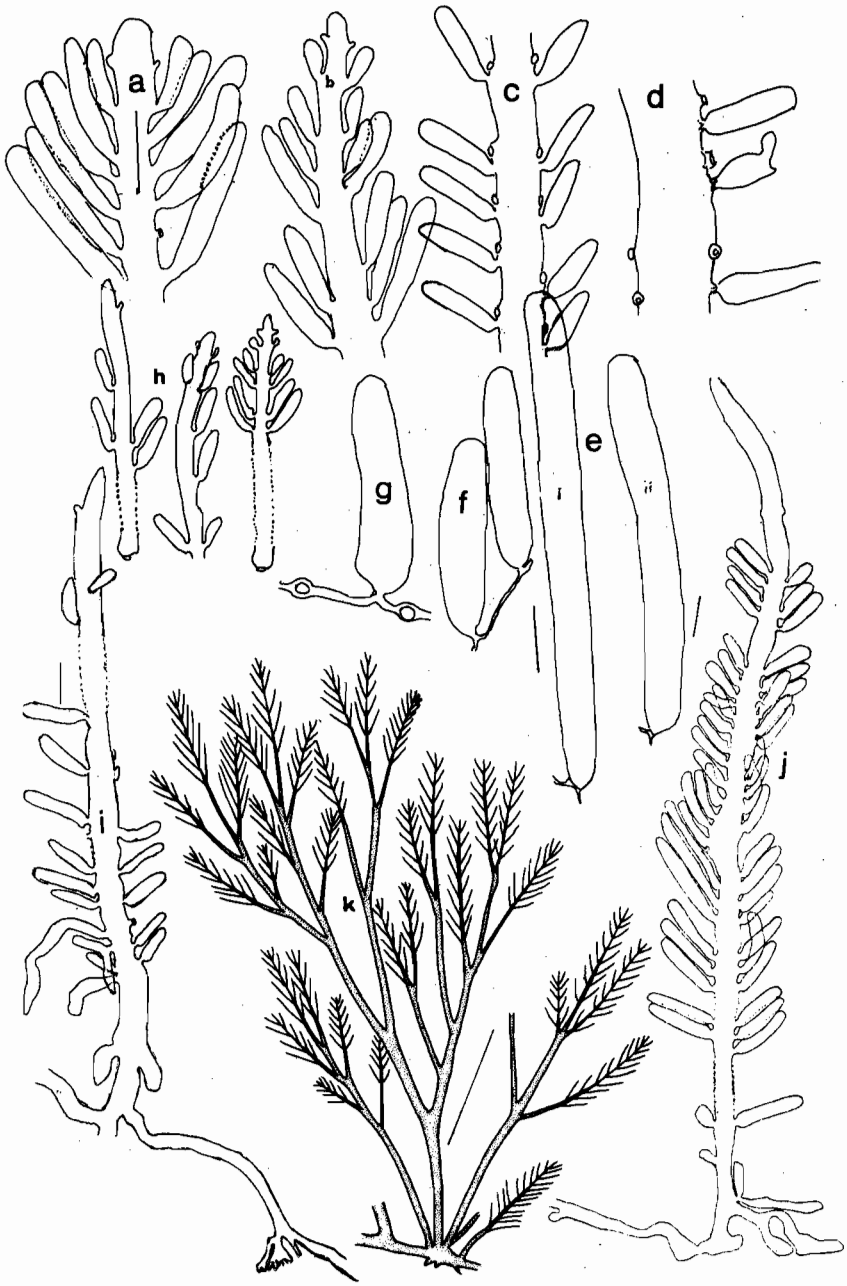

Fig.5. *Bryopsis plumosa* (Huds.) C. Ag. (a) Apex of a main axis. (b) Apex of a pinna. (c-d) Lower parts of main axes. (e) Pinnae from (i) the middle, (ii) the lower part of a main axis. (f) Pinnules from the lower part of a pinna. (g) Pinnules from the basal part of a pinna. (h) Pinnae from different plants. (i) A young plant. (j) A pinna bearing distichous pinnules. (k) Habit of a plant. (Redrawn after Harvey, 1849). Scale: (a, e-g) = 200 μm; (b-d, h-j) = 500 μm; (k) = 1.5 cm.

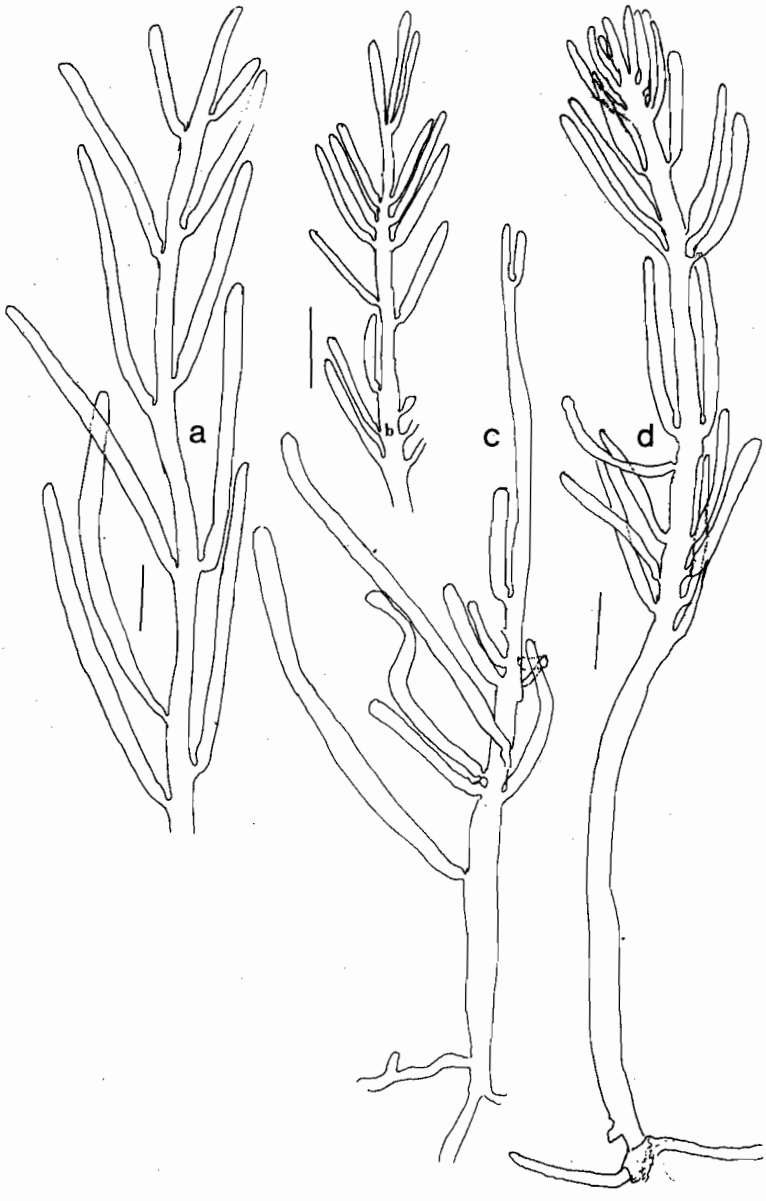

Fig.6. *Bryopsis fastigiata* Kütz. (a-b) Distal part of 2 main axes. (c) A part of a plant (Manora, 10-11-1992). (d) Plant with a basal attachment (Paradise Point, 14-9-1993). Scale: (a) = 200 μm; (b-d) = 500 μm.

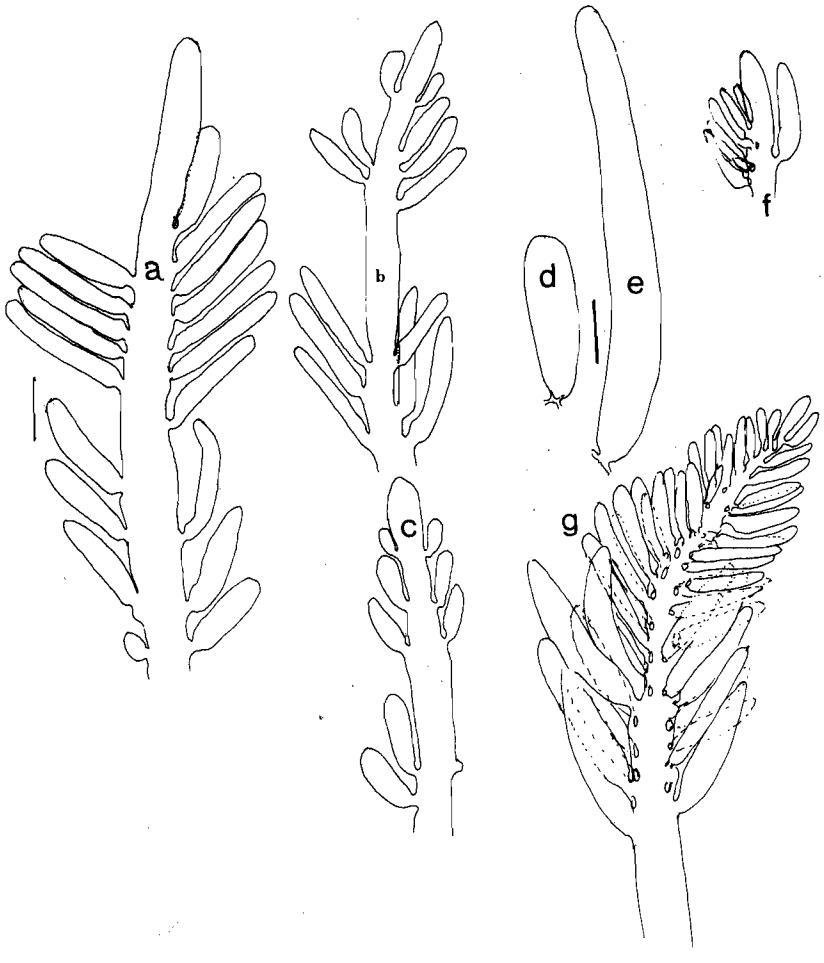

Fig.7. *Bryopsis duplex* De Not. (a) Distal part of a main axis. (b-c) Pinnae from two different plants. *Bryopsis indica* A. & E. Gepps (d) An upper pinna. (e) A lower pinna. (f) Apex of a main axis. (g) Upper part of a main axis. Scale: (a-c,g) = 500 μm; (d-f) = 200 μm.

Bryopsis penicillata Suhr in Seubert 1844: 9,t.1,f.1

Synonyms: *Bryopsis cupressoides* Kützing 1856: 29, t. 79, f.1. *Bryopsis plumosa* f. *penicillata* Koster 1941: 244.

Berthold 1882: 497. Feldmann 1936-37: 224. Funk 1927: 330; 1955: 20. Kützing 1856: 28, t. 78. Pignatti 1962: 47.

Figs. 8(a-g); 21(d)

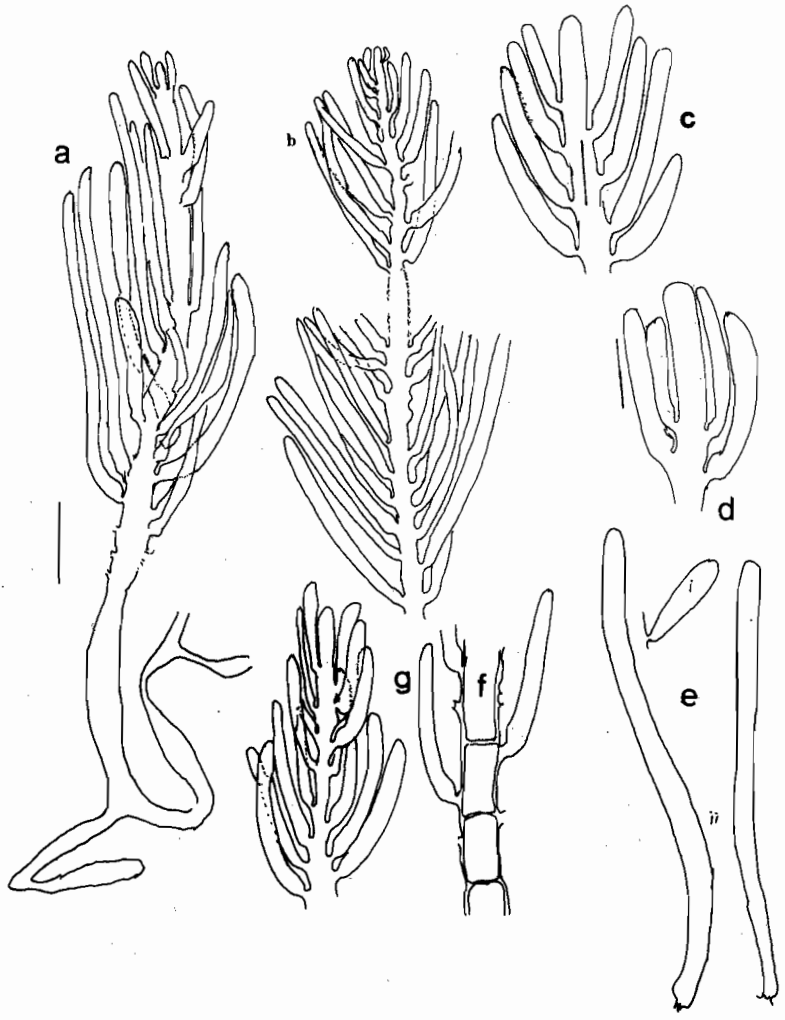

Fig. 8. *Bryopsis penicillata* Kütz. (a) Main axis bearing pinnae and attachment. (b) A part of a pinna with pinnules. (c) Apical part of a pinna. (d) Apical part of a main axis. (e) Pinnae from (i) upper, (ii) lower, parts of a main axis. (f) Basal part of a main axis showing septation. (g) A part of a pinna with pinnules. Scale: (a-b,e-g) = 500 μm; (c,d) = 200 μm.

Thallus tufted, erect up to 3 cm high. **Main axis** erect, cylindrical, siphonous up to 3 cm high and 135-250 μm diam., arising from a siphonous, cylindrical and profusely branched prostrate system. Main axis distally 60-135 μm diam., distichously, pinnately branched; apex projecting. **Pinnae** linear, slender, more than 2 cm long and (75-) 130-305 μm diam., L/B 6-16, subdistichous, mostly alternate (-opposite). Some pinnae alternately branched into pinnules, incurved, slightly constricted at the base;

apex round and projecting; some pinnae produce downwardly directed rhizoids. Pinnules slender, incurved, alternate (-subdistichous) up to 1.2 mm long and 50-150 μm diam.; tips round. Chloroplasts dense, discoid, 2-9 μm diam., with a single pyrenoid.
Specimens examined: Manora (Leg. M. Nizamuddin 21-12-1992).

Plants grow on flat rocky substratum in littoral region.

Bryopsis pakistanica Nizamuddin sp. nov.

Figs. 9(a-f); 21(b)

Thallus tufted, strongly entangled, arising from siphonous, cylindrical, prostrate system giving rise to many erect main axes up to 6 cm high. Main axis erect, siphonous, cylindrical breadth throughout variable, near apical region 150-250 μm diam.; downward 205-460 μm diam., distichously or irregularly pinnate or bipinnate; apex broadly acute and base septate. Pinnae distichous, rarely alternate or in groups of 2 or 3, variable in size (pinnae longer on one side than the other), adaxial, acropetal or irregular in arrangement. Variation in size of pinnae along the main axis, from different/regions (i) 255-510 μm long and 100-150 μm diam., L/B 2-5 (ii) 460-1045 μm long and 125-205 μm diam., L/B 2-8 (iii) 255-360 μm long and 100-150 μm diam., L/B 2-3.5, from the middle region (iv) 635-1150 μm long and 100-180 μm diam., L/B 5-8 (v) 255-1835 μm long and 100-205 μm diam., L/B 1.5-9. Pinnules ovate, adaxial, acropetal, uniform in breadth viz., 125 μm diam., and 175-405 (-610) μm long; L/B (1.5-) 2.5-3.2 (-5). Pinnulets develop successively, adaxial, ovate; apices round, 175-615 μm long and up to 127.5 μm diam., L/B 1.5-5. Pinnae, bearing pinnulets, elongated 6-10 mm long and 255-360 μm diam., L/B 22-39. Cell wall, lamellate up to 6 μm thick. Chloroplasts dense, discoid 6-9 μm diam., with a single pyrenoid.
Holotype: Br. 10; Buleji (M. Nizamuddin 10-11-1992) KU-SW.0002.
Specimens examined: Buleji (Leg. M. Nizamuddin 10-11-1992). Kakar Goth, Sandspit (Leg. Miss Aisha Khan 19-9-1993).

Plants grow in scattered tufts along the fringes of the upper littoral rocky pools or on barnacles or on steep rocky habitats.

Bryopsis pakistanica Nizamuddin *sp.nov.* is characterized by (i) variable diameter throughout, (ii) pinnae distichous, pinnate-tripinnate or irregular or in groups of 2 or 3, (iii) pinnae longer on one side than the other, (iv) pinnules throughout uniform in diameter, (v) pinnae, bearing pinnulets, much longer than the others, (vi) basal parts septate.

Bryopsis pakistanica Nizamuddin *sp.nov.* resembles *B. plumosa* in habit but differs in thickness of main axis as well as in the arrangement of pinnae, pinnules and pinnulets.
Diagnosis: Bryopsis pakistanica Nizamuddin *sp.nov.*; *Bryopsis plumosa* (Huds.) C. Ag. affinis, a qua imprimis differt ramis dispositis et in crassis primero axis. Reproduction ignoto.
Holotypus: Br. 10; Buleji (Leg. M. Nizamuddin 10-11-1992) KU-SW.0002.

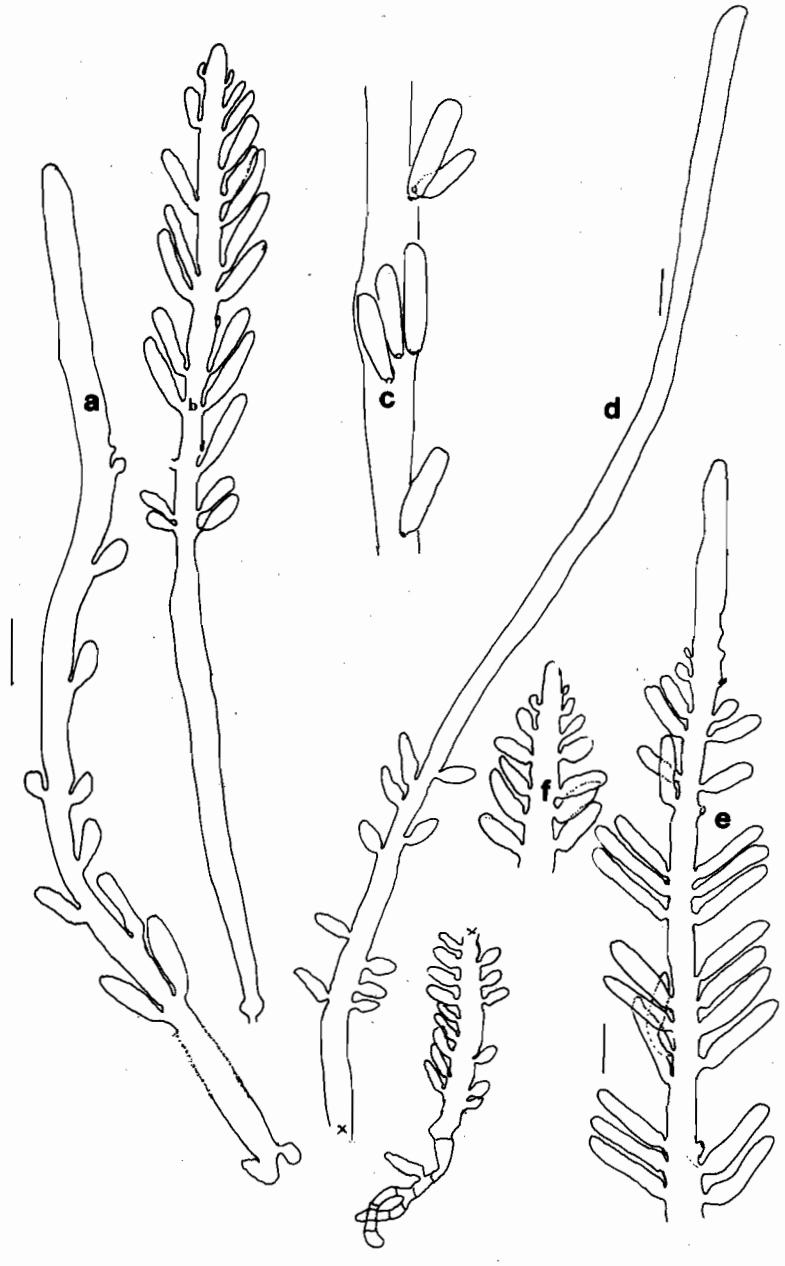

Fig.9. *Bryopsis pakistanica* Nizam. *sp.nov.*. (a-b) Pinnae from two different plants (Kakar Goth, 19-9-93). (c) Lower part of a main axis showing irregular arrangement of pinnae. (d) A main axis bearing elongated naked apical part bearing irregular arrangement of pinnae and septate basal part. (e) Main axis bearing interrupted pinnae. (f) A pinna bearing subopposite pinnules. Scale: (a-f) = 500 μm.

Bryopsis indica A. & E.S. Gepps 1908: 169

Bφrgesen 1940: 44. Dawson 1956: 34. Islam 1976: 18. Taylor 1950: 50. Yamada 1934: 62.

Figs. 7(d-g); 21(a)

Thallus tufted arising from a prostate system up to 15 mm high giving rise to many erect axes. **Main axis** erect, cylindrical, siphonous up to 12 mm high, and 200-255 μm diam., basally naked, upper part densely, compactly and pinnately branched. **Pinnae** in 2-rows on either side of the axis, adaxial, slightly incurved, linear-ovate, constricted at the base; upper pinnae up to 305 μm long and up to 75 μm diam.; L/B 4; lower pinnae up to 1 mm long and up to 230 μm diam.; L/B 4-6. Tips of the main axes and pinnae narrowly rounded. **Chloroplasts** numerous, discoid up to 6 μm diam., with a single pyrenoid.

Type: BM. Lectotype: BM Mauritius, *B. caespitosa* (Leg. Col. Pike May 22 1871 ex herb. Alg. Dickie 1884).

Specimens examined: Cape Monze, East (Leg. M. Nizamuddin 30-12-1964 KU 961). Plants grow on shells and on rocks in littoral pools.

In British Museum there are specimens from Coetiry Island, Indian Ocean collected by J. Stanbury Gardiner during "Sealark Expedition" 1905 labelled as *B. orientalis* n.sp. No. 1 is considered as type but not Harvey No. 99 from Ceylon labelled as *Bryopsis* sp. Mauritius specimen collected by Colonel Pike (May 22, 1871) is labelled as *B. caespitosa* ex herb. Alg. Dickie 1884 has been considered as lectotype.

Bryopsis harveyana J. Agardh 1887: 22

Basionym: Bryopsis plumosa var. *secunda* Harvey 1858: 31, t. 45A, f. 1-3. Bφrgesen 1913: 118.

Synonym: Bryopsis pennata var. *secunda* (Harvey) Collins & Hervey 1917: 62. Silva *et al.* 1987: 103. Taylor 1979: 132.

Bφrgesen 1946: 34. Collins 1909: 405. De Toni 1889: 430. Setchell 1926: 80. Vickers 1905: 58; 1908: 29, pl. 51. Yamada & Tanaka 1938: 60.

Figs. 10(a-d); 11(a-j); 19(b)

Thallus tufted, erect arising from siphonous, cylindrical prostrate system, up to 4 cm high. **Main axis** erect up to 3 cm high, cylindrical, siphonous, 100-105 μm diam., in the apical region and 255-585 μm diam., in the middle region and 355-255 μm in the basal region, attenuated at both ends, distichously, pinnately or bipinnately or unilaterally secundly branched; apex arcuate and tip round. Basal parts may or may not be denuded. **Pinnae** sub-distichous, distichous, or unilateral (2-rows on one side) or irregular, incurved, linear, oblong, lance-ovoid, 380-2550 μm long and (75-) 100-205 μm diam.; L/B 3-7 (-16), constricted at the base, apices narrowly or broadly rounded. Pinnae (or branches) from the lower region elongated and more than 2 cm in length and up to 205 μm diam., or oblong, ovate, distichously, pinnately branched (upwards). **Pinnules** lance-ovoid, cylindrical, alternate, constricted at the base, 560-765 μm long

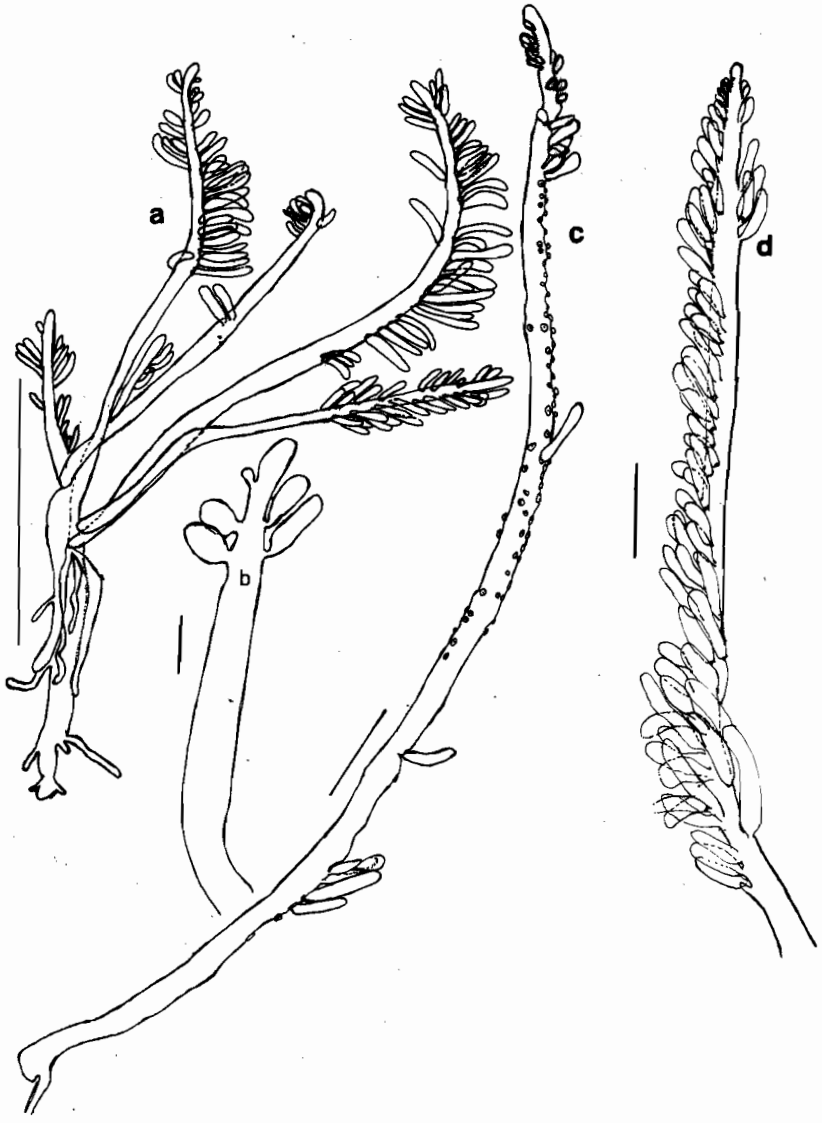

Fig.10. *Bryopsis harveyana* J. Ag. (a) Habit of a thallus (Buleji, 4-10-1994). (b) A young pinna. (c) A pinna with scars of pinnules and pinnules. (d) A pinna bearing pinnules in rows or slightly scattered. Scale: (a) = 1 cm; (b) = 200 μm; (c) = 1.5 mm; (d) = 1.5 cm.

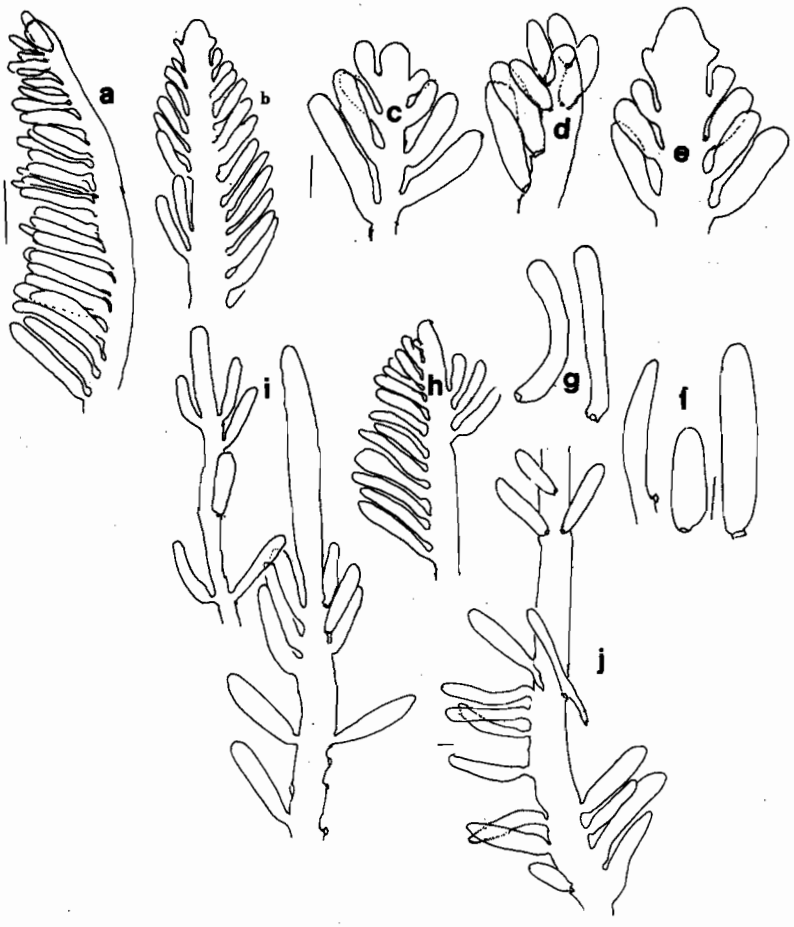

Fig. 11. *Bryopsis harveyana* J. Ag. (a) Main axis secund, bearing unilateral pinnae. (b) Distichous pinnae from the apical region of a main axis. (c-e) Apices of main axes from different plants. (f) Pinnae from the basal part of a main axis. (g) Outer and inner pinnae respectively. (h) Apex of a main axis bearing distichous as well as unilateral pinnae. (i) Apices of pinnae. (j) Main axis bearing irregularly arranged pinnae. Scale: (a-b,g-j) = 500 μm; (c-f) = 200 μm.

and 100-155 μm diam. **Chloroplasts** dense, discoid up to 6 μm diam., with a single pyrenoid.

Specimens examined: Manora (Leg. M. Nizamuddin 21-12-1992). Miss Farida 9-2-1962). Buleji (Leg. M. Nizamuddin, 4-10-1994, upper littoral pools). Cape Monze, East (Leg. M. Nizamuddin 21-11-1964).

Plants grow in tufts in sandy rocky mid-littoral pools and on rocks exposed to the atmosphere at low tide.

Pakistani species resembles *B. harveyana* J. Ag. of Vickers (1908) and that of Børgesen (1946) but differs from their findings in thickness as well as in the arrangement of pinnae.

Bryopsis caespitosa Suhr in Kützing 1849: 490

Kützing 1856: 26, t. 72 (as *cespitosa*). Nizamuddin 1991: 145.

Figs. 17(f-h); 19(c-d)

Attaching organs generaly hapteroid. **Thallus** tufted with erect axes up to 5 cm high, siphonous, cylindrical up to 510 μm diam.; L/B 5.6-9.4; naked below, pinnately distichously branched above, lower part of the main axes rarely branched. **Pinnae** distichous (-subopposite), abaxial (below), adaxial (above), acropetal; upper pinnae broadly ovate with rounded ends, up to 700 μm long and up to 130 μm diam., strongly constricted at the base; lower pinnae slender with rounded ends up to 2 mm long and 125-200 (-250) μm diam., becoming dumble-shaped, L/B 3-5. Apex of the main axis broadly round. **Chloroplasts** discoid up to 2 μm diam., or ovoid 9-15 x 6-9 μm.
Specimens examined: Manora (Leg. M. Nizamuddin 27-10-1992).

Plant grows in lower littoral region in association of *Caulerpa taxifolia* (Vahl) C. Ag. and *Stokeyia indica* Thivy and Doshi as epilithic or epizooic. Exposed to the atmosphere at the low tide viz., 0.3 cm. Few were found growing in the mid-littoral region also.

Bryopsis aishae **Nizamuddin** ***sp.nov.***

Figs. 12(a-k); 19(a)

Thallus erect arising from a prostrate system, up to 5 cm high, pinnately and distichously branched. **Main axis** erect up to 4 cm high, siphonous, cylindrical 350-460 μm diam. bearing pinnae of variable sizes and forms. Apical region bearing pinnate, distichous, adaxial and broadly ovate pinnae, constricted at the base; apices broadly rounded, 0.8-2.6 mm long and 175-230 μm diam.; L/B 4.5-14.2. **Pinnae** from middle parts adaxial, distichous, 7-15 mm long and 175-305 μm diam.; pinnae of the lower parts slender, cylindrical, sub-patent, incurved, distichous 0.6-1.8 mm long and 125-255 μm diam., constricted at the base; apices either acuminate or round. Pinnules distichous, abaxial, ovate, constricted at the base and apices round, 375-750 μm long and 150-250 μm diam.; L/B 2-3.5. **Chloroplasts** dense, discoid 3-6 μm diam., or ovoid 9 x 3 μm.
Holotype: Br. Buleji (Leg. Miss Aisha Khan 9-9-1991, KU-SW0003; upper littoral rocks).
Specimens examined: Buleji (Leg. Miss Sabiha Noreen 12-10-1983, Miss Laila 8-9-1994, upper littoral region). Cape Monze (Leg. Muntahir Aleem 30-4-1969, drift).

Bryopsis aishae Nizamuddin *sp.nov.*, is characterized by adaxial pinnae in apical as well as in the middle parts but pinnae and pinnules are slender and subpatent in the lower parts and irregularly disposed pinnae (scars, Fig. 12k).

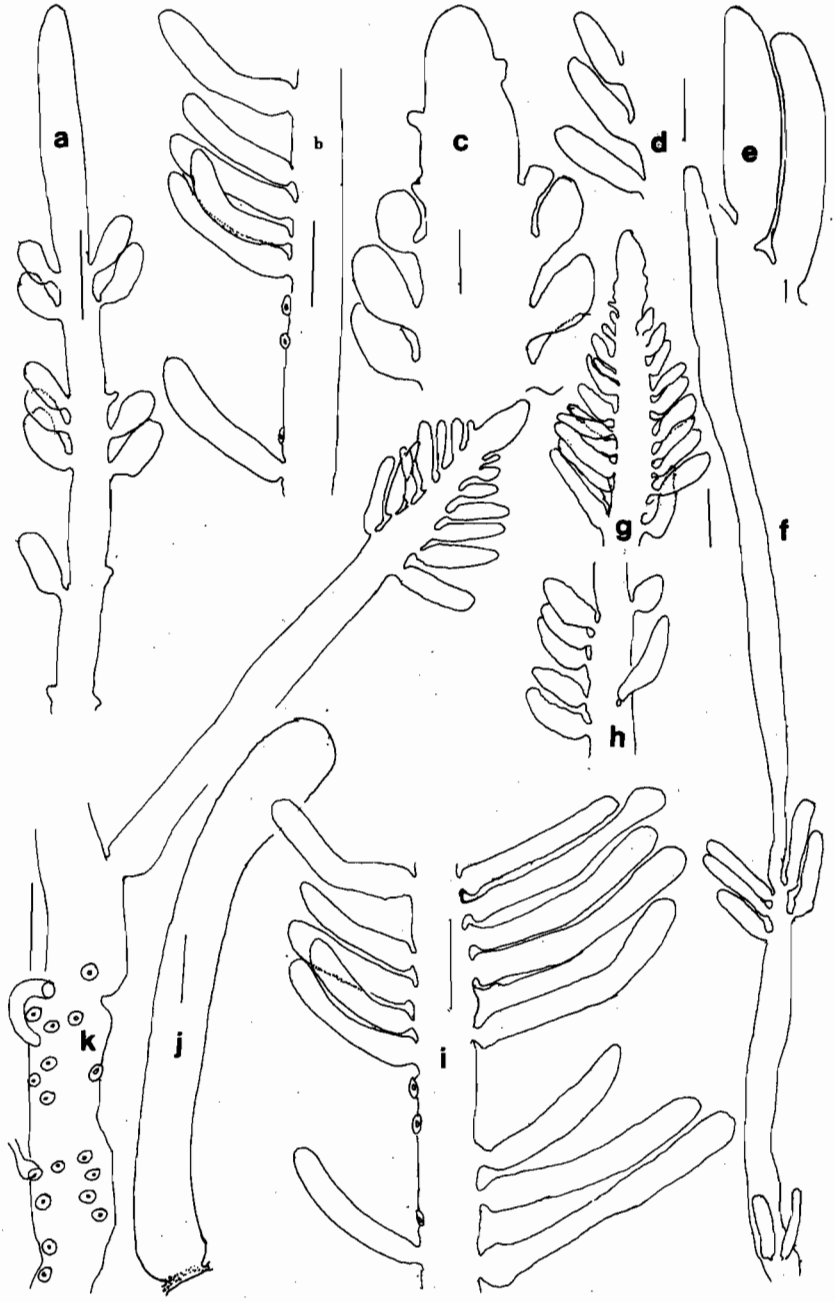

Fig.12. *Bryopsis aishae* Nizam. *sp.nov.* (a) Apical part of a pinna. (b) A part of a main axis bearing unilateral pinnae. (c) Distal part of a main axis bearing pinnae. (d) Pinnae from near the apex of a main axis. (e) Pinnae from the middle of a main axis. (f) Distal part of a main axis. (g) A pinna bearing pinnules. (h) A pinna from the middle of a main axis bearing pinnules. (i) Lower part of a main axis bearing sub-patent pinnae. (j) A pinna from the middle of a main axis. (k) A part of a main axis bearing a pinna with pinnules and scattered scars of pinnae below. Scale: (a-b,f,g-j) = 500 μm; (c-e,k) = 200 μm.

Bryopsis aishae Nizamuddin *sp.nov.* resembles *B. pakistanica* in habit and thickness but differs in size, form and arrangement of pinnae, pinnules and pinnulets.
Diagnosis: Bryopsis aishae Nizamuddin *sp.nov.*; *Bryopsis pakistanica* Nizamuddin acmulans, differt rami crassis, formis, staturis et dispositis. Reproductio ignoto.
Holotypus: Br. 1; Buleji (Leg. Miss Aisha Khan 9-9-1991) KU-SW0003. *Superus littoralis petraeus.*

Bryopsis manorensis Nizamuddin *sp.nov.*

Figs. 13(a-f); 21(c)

Thallus erect arising from a prostrate system producing erect main axes generally up to 6 cm high, siphonous, cylindrical, 125-205 μm diam. above and up to 625 μm diam., below, attenuated above, pinnately branched. Pinnae linear, elongate, cylindrical, mostly simple, distichous (-unilateral), adaxial, incurved, up to 2.5 cm long and 225-275 μm diam., below but 60-100 μm long and 25-37.5 μm diam., above; in rows of three along the lower part of the main axis (just below the middle part of the main axis); apices round. Occasionally one or two oblong or ovate pinnae occur on the main axis which are up to 660 μm long and 265 μm diam., Pinnules rarely few, distichous, adnate, slender or ovate. Apical part of the main axis extremely elongated up to 4 cm long, cylindrical, 180-300 μm diam., naked; tip broadly rounded. Chloroplasts dense (-scattered), discoid 6-7.5 μm diam., or ovoid 9 x 6 μm with 1-2 (-4) pyrenoids.

In slender forms apical pinnae 305-895 μm long and 50-102 μm diam., L/B 5-11 whereas lower pinnae 1.2-7 mm long and 75-125 μm diam., L/B 9-92. Pinnules distichous, adnate 500-815 μm long and 50-70 μm diam., L/B 7-16.
Holotype: Br. 11-KU 1185; Manora (Leg. M. Nizamuddin 30-10-1963) KU-SW0004.
Specimens examined: Manora (Leg. M. Nizamuddin 30-10-1963 KU 1171, KU 1182, KU 1185; 10-12-1988, 2-1-1963, 19-1-1963).

Plant grows on littoral sandy rocks in association of *Polyphysa parvula* (Solms-Laub.) Schnetter & B-Meyer, *Udotea indica* A. & E. Gepps and *Chaetomorpha spiralis* Okam. and *C. prostrata* Anand.
Bryopsis manorensis Nizamuddin *sp.nov.*, is characterized by thin main axis, attenuated below, extremely elongated apical part, furcation near the apical region (Fig. 13f), pinnae mostly simple, long as well as short.

Bryopsis manorensis Nizamuddin *sp.nov.*, resembles *B. fastigiata* in habit and thickness of main axis but differs in size and arrangement of pinnae.
Diagnosis: Bryopsis manorensis Nizamuddin *sp.nov.*; quoad habitum et crassum ad *Bryopsis fastigiata* Kütz., accedit sed ab ea differt in staturo et disposito pinnae. Reproductio ignoto.
Holotypus: Br. KU 1185; Manora (Leg. M. Nizamuddin 30-10-1963) KU-SW0004. Ejectus.

Bryopsis duplex De Notaris 1844: 320
Synonyms: Bryopsis balbisiana Lamouroux 1813: 282, Pl. 7, f. 2 (*nom. dub.*). J.

Agardh 1842: 18. Ardré 1970: 361. Bφrgesen 1925: 98. Chapman 1961: 131. Feldmann 1936-37: 225. Gayral 1958: 177. Koster 1941: 226. Kützing 1843: 306. Ollivier 1929: 101. Pignatti 1962: 53. Zanardini 1847: 51. ***Bryopsis balbisiana*** var. *disticha* J. Agardh 1842: 18. ***Bryopsis disticha*** (J. Ag.) Kützing 1856: 27, t. 76. Berthold 1882: 497. Funk 1927: 301; 1955: 31. Hamel 1930: 63 (387). Hauck 1885: 474. Schiffner 1926: 296. ***Bryopsis intricata*** Meneghini 1845b: 385.

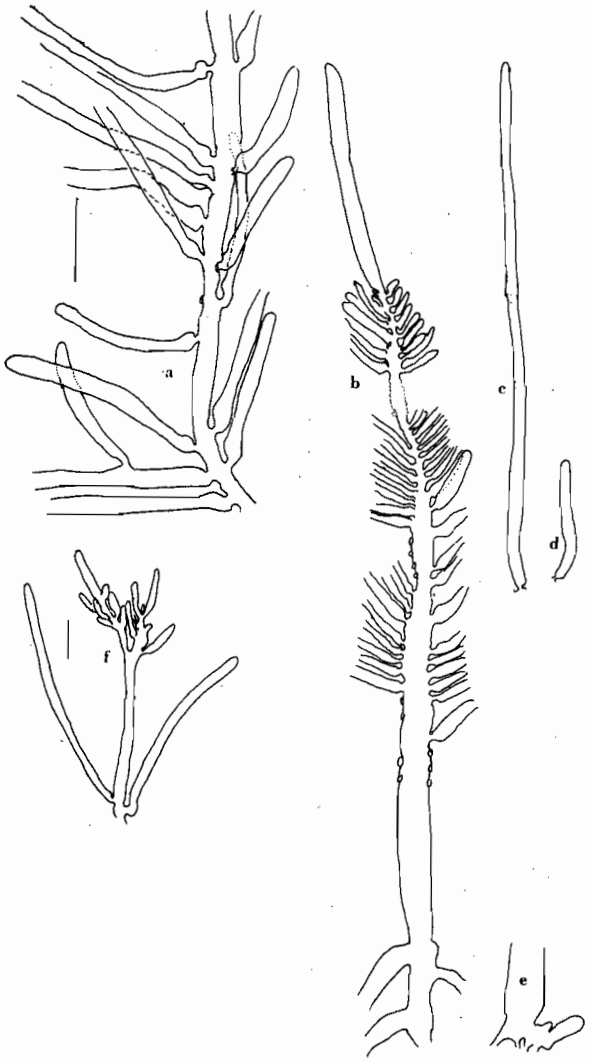

Fig. 13. *Bryopsis manorensis* Nizam. *sp.nov.*. (a) Branching pattern in the middle of a main axis. (b) A single plant. (c) A long pinna. (d) A short pinna. (e) A basal attachment. (f) Distal part of a main axis bearing alternate pinnae and furcation. Scale: (a-f) = 500 μm.

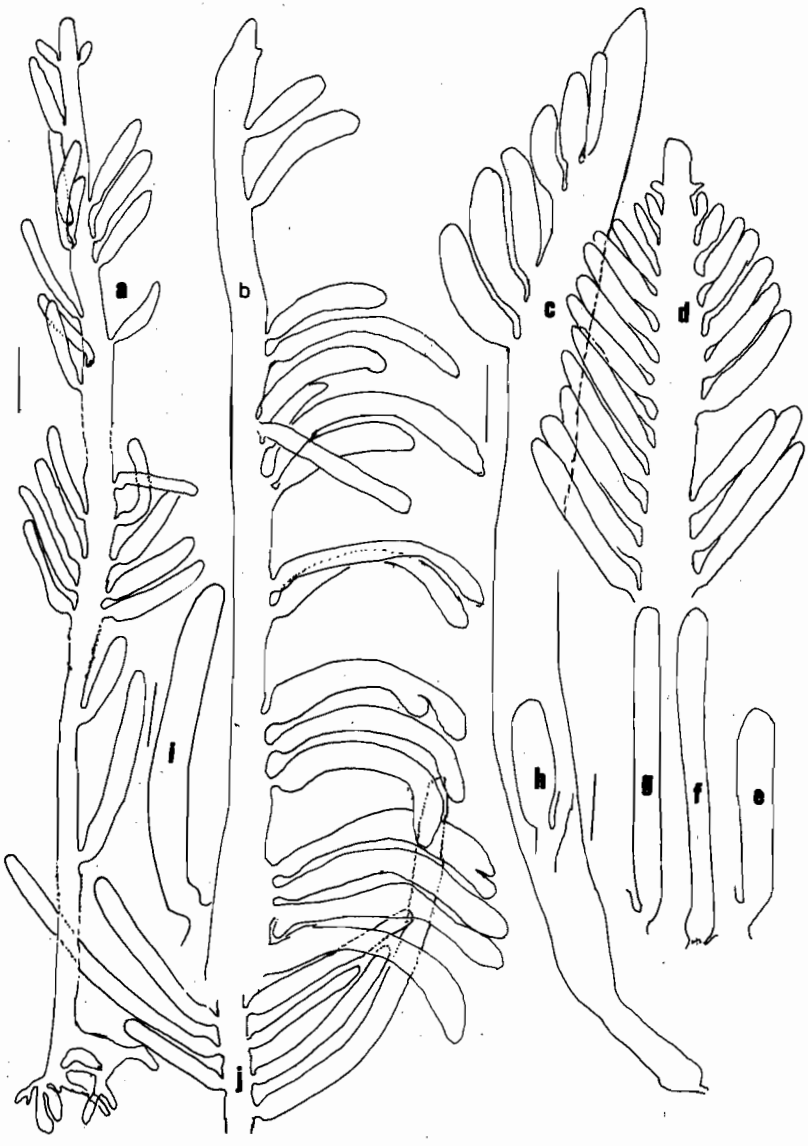

Fig.14. *Bryopsis pennata* Lamour. (a) Habit of a single plant. (b) A part of a main axis bearing secund abaxial pinnae. (c) A pinna bearing unilateral adaxial pinnule. (d) Upper part of a main axis. (e-g) Upper pinnae. (h-i) Lower pinnae. (j) Lower part of a main axis with pinnae. Scale: (a-b,d,j) = 500 μm; (c,e-i) = 200 μm.

Ardissone 1886: 151. De Toni 1889: 429. Nizamuddin 1991: 123. Pignatti 1962: 38. Schiffner 1935: 112. Schiffner & Vatova 1938: 110. Trévisan 1845: 74.

Figs. 7(a-c)

Thallus tufted, erect arising from prostrate system up to 8 cm high. **Main axes** erect up to 7 cm high, cylindrical up to 510 μm diam., furcate, pinnately branched, naked below but pinnate near the base. **Pinnae** distichous, or unilateral, linear, adaxial, cylindrical 970-1402 μm long and 150-180 μm diam., L/B 6-9 close together, intermediate ones variable in length, 970-1400 μm long and 155-180 μm diam., L/B 6-9; apices acutely rounded. **Chloroplasts** dense, discoid 6-9 μm diam., with a single pyrenoid.

Specimens examined: Paradise Point (Leg. M. Nizamuddin 14-9-1993 pp. 1-4). Cape Monze, near Mazar (Leg. M. Nizamuddin 1-5-1965, littoral pools).

Bryopsis pennata Lamouroux 1809a: 333; 1809b: 134 J. Agardh 1847: 6; 1887: 23. Ardré 1970: 303. Bǿrgesen 1936: 67. Collins 1909: 405. Dawson 1956: 34; 1961: 428. Durairatnam 1961: 25. Egerod 1952: 370. Feldmann 1936-37: 221. Taylor 1928: 93; 1979: 132. Vickers 1905: 58; 1908: 30. Zanardini 1842: 220.

Figs. 14(a-j); 15(a-h,l-n); 22(a)

Thallus mat-forming giving rise to many erect axes, up to 7 cm high, cylindrical, siphonous. **Main axes** erect, siphonous, cylindrical 2.5-7 cm high and 250-510 μm diam., gradually increasing in diameter above, pinnate (-bipinnate), distichous above, generally naked below, apical region, 175-250 μm diam., and apices round. **Pinnae** distichous (-unilateral excurved), adaxial, pinnate, incurved, apically sub-distichous but downwardly distichous, ovate, up to 1.2 mm long and 120-230 μm diam.; L/B 5.11. Ultimate pinnae ovate up to 360 long and up to 120 μm diam., in between there are slender, elongate pinnae reaching up to 1 mm long and up to 150 μm diam., apices round. Some pinnae (bearing pinnules) up to 1.5 cm long and 250-380 μm diam., L/B 50-100. **Pinnules** distichous, ovate, adaxial up to 400 μm long and 250-380 μm diam., L/B 13-33. **Chloroplasts** ovoid 12 x 9 μm with one pyrenoid.

Specimens examined: Manora (Leg. M. Nizamuddin 30-10-1963 KU 1183, 3-11-1963 KU 261, 30-4-1966 KU 1194-96 as var. *secunda* (Harvey) Collins & Hervey; 11-10-1992). Buleji (Leg. M. Nizamuddin 8-1-1989; 11-10-1992; 19-8-1993. Mrs. Aliya Rehman 20-9-1990. Miss Aisha Khan 4-4-1993). Paradise Point (Leg. M.A. Moid, Feb., 1962. M. Nizamuddin 14-9-1993 nos. pp. 6-8). Cape Monze, near Mazar (Leg. M. Nizamuddin 1-5-1969 KU 887). Cape Monze, East (Leg. M. Nizamuddin 30-12-1964 KU 956. Qayum Akhtar 28-12-1965). Cape Monze (Leg. Qayum Akhtar 28-12-1965). Goth Mubarak (Leg. M. Nizamuddin 11-10-1963). Goth Manjar (Leg. M. Nizamuddin 29-9-1963 upper littoral). Kund (Leg. M. Nizamuddin 9-10-1963 KU 1059).

Specimens from Kund bear slender main axes up to 360 μm diam., below, to 300 μm in the middle and 125-155 μm diam., in apical region; lower part pinnate.

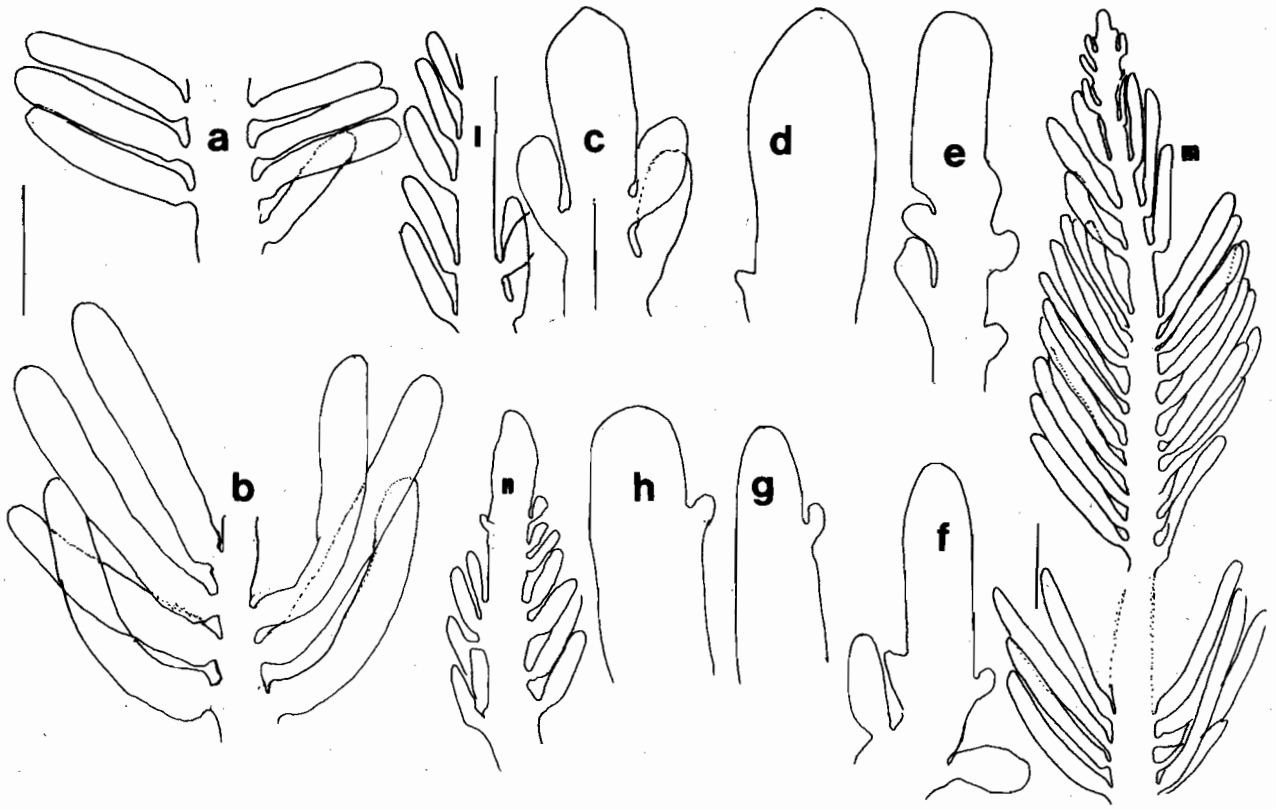

Fig.15. *Bryopsis pennata* Lamour. (a,b) Parts of main axes bearing abaxial and adaxial pinnae from upper and lower parts respectively. (c-h) Apices of different plants showing variations in shape and form (Buleji, 19-8-1993). (l) Lower part of a main axis. (m) A part of a main axis. (n) Apex of a pinna. Scale: (a-b,l-n) = 500 μm; (c-h) = 200 μm.

Specimens from Kund (no. KU 929) bear linear-lanceolate pinnae, lower ones broader than the upper ones.

Along the coast of Karachi it grows in association of *Stokeyia indica, Sargassum* spp., and coralline algae.

Bryopsis qasimensis Nizamuddin sp.nov.

Figs. 17(a-b); 22(c)

Thallus heterotrichous having branched prostrate system giving rise to many erect axes. **Main axes** erect up to 6 cm high cylindrical up to 260 μm diam., attenuated at both ends; apex smooth and round, may or may not be projecting, apical portion 50-102 μm diam., distichously or sub-distichously branched. **Pinnae** slender, thin, acropetal, adaxial, distichous or sub-distichous, 380-1020 (-1275) μm long and 50-75 (-102) μm diam.; L/B 5-15 (-25). **Chloroplasts** numerous, discoid 15-25 μm diam., with 1-2 pyrenoids.

Holotype: Br. 15 P.N.S. Qasim (Leg. M. Nizamuddin 13-1-1963) KU-SW0005. Lithophilic.

B. qasimensis Nizamuddin *sp.nov.*, is characterized by thin main axis, attenuated at both ends bearing slender, distichous, sub-opposite or alternate, acropetal pinnae.

B. qasimensis resembles *B. caespitosa* in habit but differs in thickness of main axis as well as in the arrangement of pinnae.

Diagnosis: *Bryopsis qasimensis* Nizamuddin *sp. nov.*, quoad habitum ad *Bryopsis caespitosa* Suhr in Kütz. accedit sed ab ea differt essentialiter in crasso primero axis et dispositio pinnae. Reproductio ignoto.

Holotypus: Br. 15; P.N.S. Qasim (Leg. M. Nizamuddin 13-1-1963). KU-SW0005.*Lithophilus*.

Bryopsis pennatula J. Agardh 1847: 6

Synonym: Bryopsis pennata var. *minor* J. Agardh 1887: 23. Anand 1940: 38.

Chapman 1956: 484. Dawson 1953: 106. Hollenberg & Abbott 1966: 14. Kützing 1849: 492; 1856: 27, t. 76, f. II. Setchell & Gardner 1920: 158.

Figs. 16(a-c)

Thallus heterotrichous, siphonous, cylindrical giving rise to many erect axes. **Main axis** erect up to 5 cm high, cylindrical up to 450 μm diam., pinnately, distichously branched, apex smooth, flat or conical. **Pinnae** broadly ovate, adaxial, constricted at the base, closely distichous near the apex, 760-1020 μm long and 255-330 μm diam.; L/B 2.5-3.1, apices broadly rounded. **Chloroplasts** discoid up to 3 μm diam, with one pyrenoid.

Specimens examined: Manora (Leg. M. Nizamuddin 30-10-1963 KU nos. 1170, 1184; 30-4-1966 KU 1194; 11-4-1964 KU 1168). Kakar Goth, Sandspit (Leg. Miss Aisha Khan 27-10-1992). Buleji (Leg. Mrs. Aliya Rehman 20-9-1990). Cape Monze, West (Leg. M. Nizamuddin 16-3-1966 KU 1024).

Fig.16. *Bryopsis pennatula* J. Ag. (a) Main axis with attachment, a pinna with pinnules. (b-c) Main axes of two plants (Buleji, 9-10-1991). Scale: (a) = 500 μm; (b-c) = 200 μm.

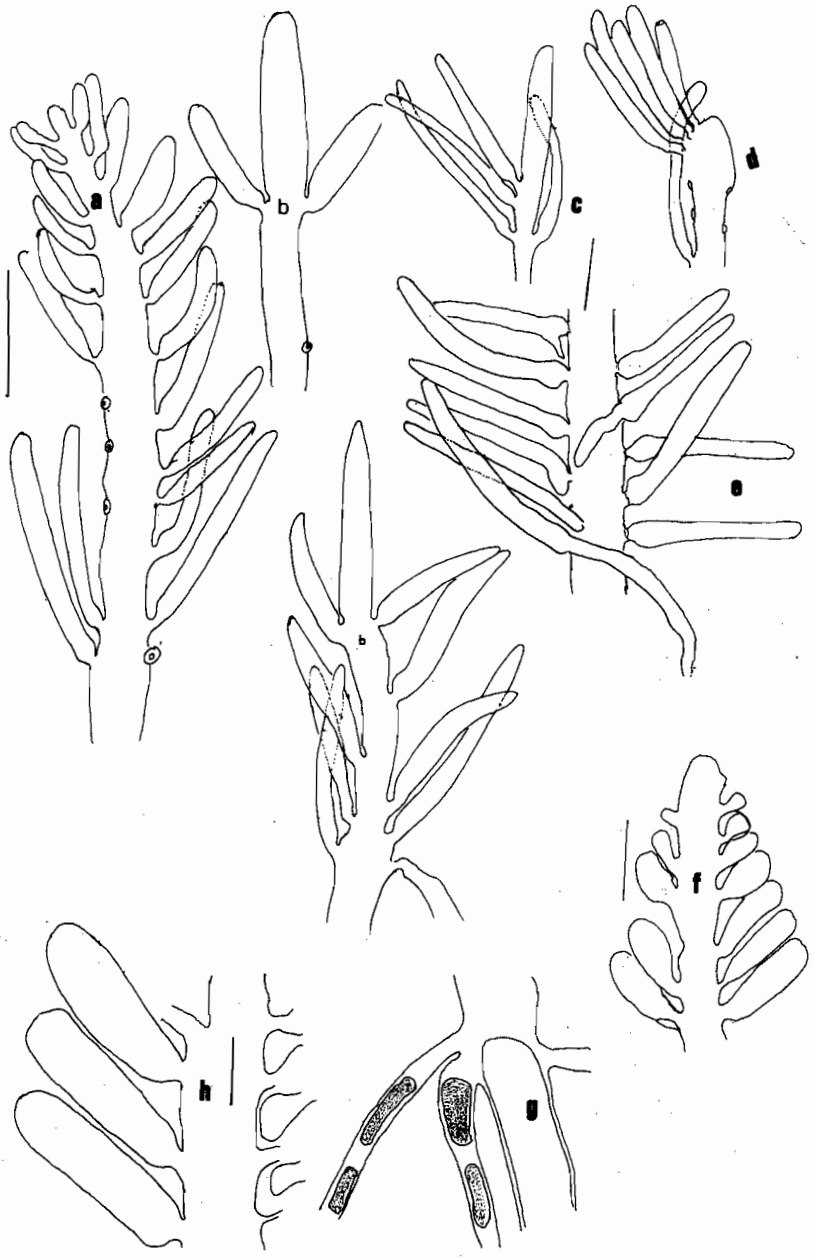

Fig.17. *Bryopsis qasimensis* Nizam. *sp.nov.* (a) Upper part of a main axis. (b) Upper part of a main axis with an elongate apical part. Scale: (a) = 500 μm; (b) = 200 μm. *Bryopsis corticulans* Setchell (c) A part of pinna. (d) Apex of a main axis. (e) Middle part of a main axis. Scale: (c-e) = 500 μm *Bryopsis caespitosa* Suhr (f) Distal part of a main axis. (g) Basal part of a main axis. (h) Middle part of a main axis. Scale: (f) = 200 μm; (g-h) = 500 μm.

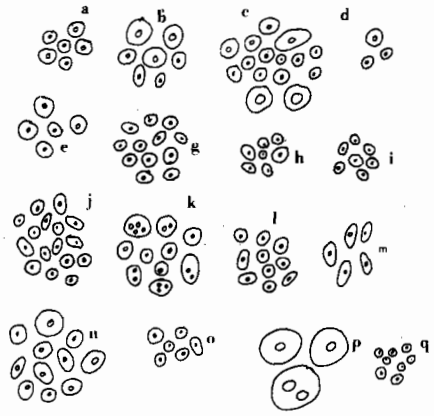

Fig.18. Chloroplasts (a) *Bryopsis hypnoides*. (b) *Bryopsis corymbosa*. (c) *Bryopsis plumosa*. (d) *Bryopsis fastigiata*. (e) *Bryopsis duplex*. (g) *Bryopsis penicillata*. (h) *Bryopsis pakistanica*. (i) *Bryopsis harveyana*. (j) *Bryopsis aishae*. (k) *Bryopsis manorensis*. (l) *Bryopsis pennata*. (m) *Bryopsis pennatula*. (n) *Bryopsis caespitosa*. (o) *Bryopsis corticulans*. (p) *Bryopsis qasimensis* (q) *Bryopsis indica*.

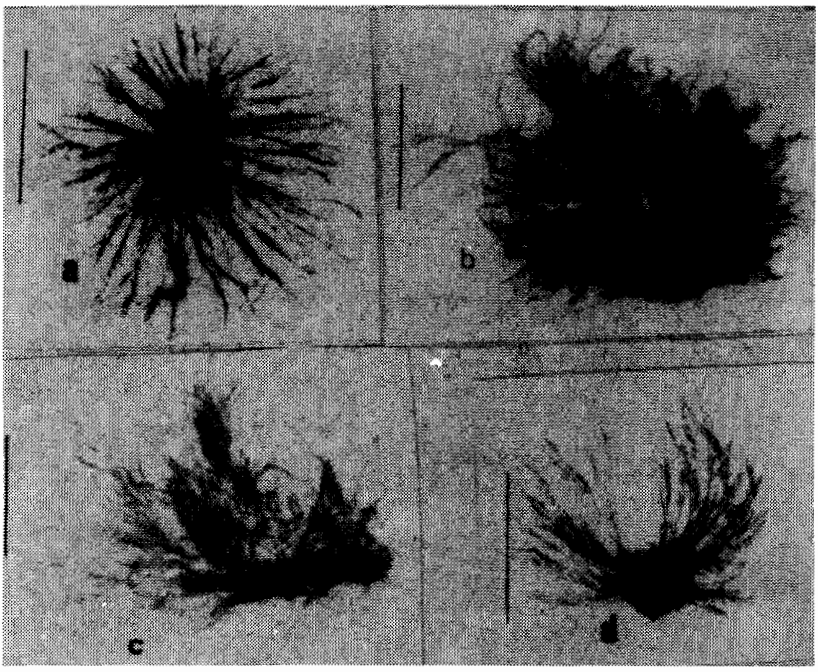

Fig.19. (a) *Bryopsis aishae* Nizam. *sp.nov.* Habit of the thallus. Upper littoral rocks. Buleji (Leg. Miss Aisha Khan 9-9-1991). Scale: 4 cm. (b) *Bryopsis harveyana* J. Ag. Habit of the thallus. Mid-littoral rocky ledge. Manora (Leg. M. Nizamuddin 21-12-1992). Scale: 3 cm. (c) *Bryopsis duplex* De Not. Habit of the thallus Cape Monze, near Mazar (Leg. M. Nizamuddin 1-5-1965 KU 887). Scale: 3.8 cm. (d) *Bryopsis caespitosa* Suhr. Habit of the thallus. Mid-littoral rocky flat. Manora (Leg. M. Nizamuddin 27-10-1992). Scale: 4 cm.

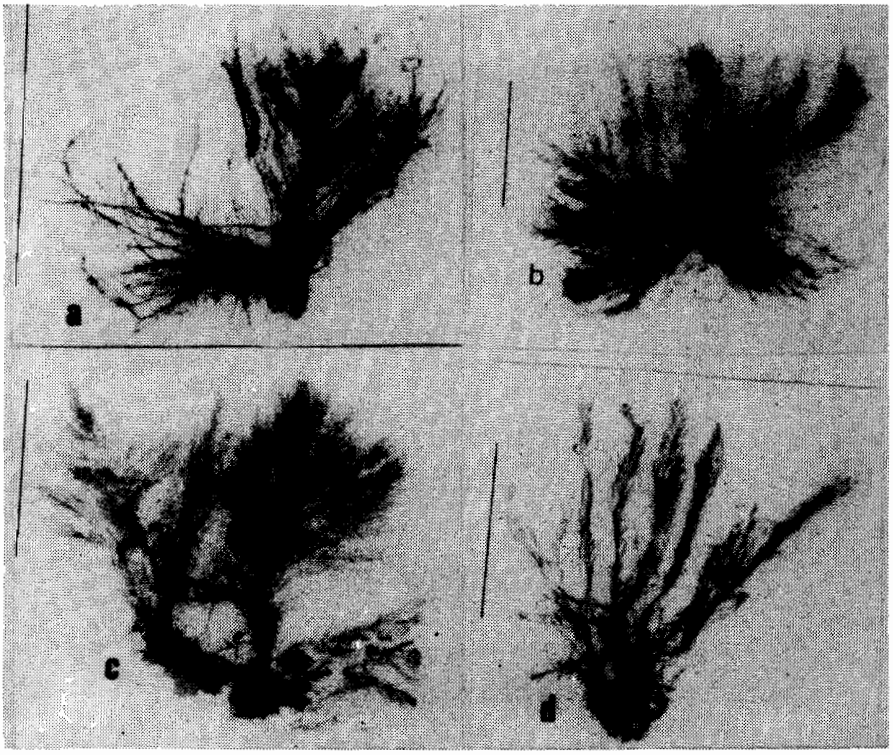

Fig.20. (a) *Bryopsis pennatula* J. Ag. Habit of the thallus. Upper-littoral rock. West of Kakar Goth, Sandspit (Leg. Miss Aisha Khan 20-7-1993). Scale: 5.5 cm (b) *Bryopsis corymbosa* J. Ag. Habit of the thallus. Drift. Cape Monze (Leg. Nazrul Islam 30-1-1969). Scale: 3 cm. (c) *Bryopsis fastigiata* Kütz. Habit of the thallus. Lowest tide mark. Kiamari Jetty (Leg. Hamied Shaikh 29-2-1968). Scale: 2 cm. (d) *Bryopsis hypnoides* Lamour. Habit of the thallus. Mid-littoral rocky pool fringe. Goth Mubarak (Leg. M. Nizamuddin 11-10-1993). Scale: 3.1 cm.

Pakistani specimens are thicker than the Californian specimens but agrees in thickness with those of New Zealand (Chapman, 1956) in diameter of the main axis but differs in thickness of the pinnae.

Bryopsis corticulans (?) Setchell 1899: P.B.A. NO. 626:

Abbott & Hollenberg 1976: 111. Collins 1909: 404. Dawson 1953: 106. Scagel 1967: 72. Smith 1944: 73.

Figs. 17(c-e); 22(d)

Thallus heterotrichous having branched cylindrical, prostrate system giving rise to many erect main axes. **Main axes** erect up to 2 cm high, cylindrical 360-430 μm diam.,

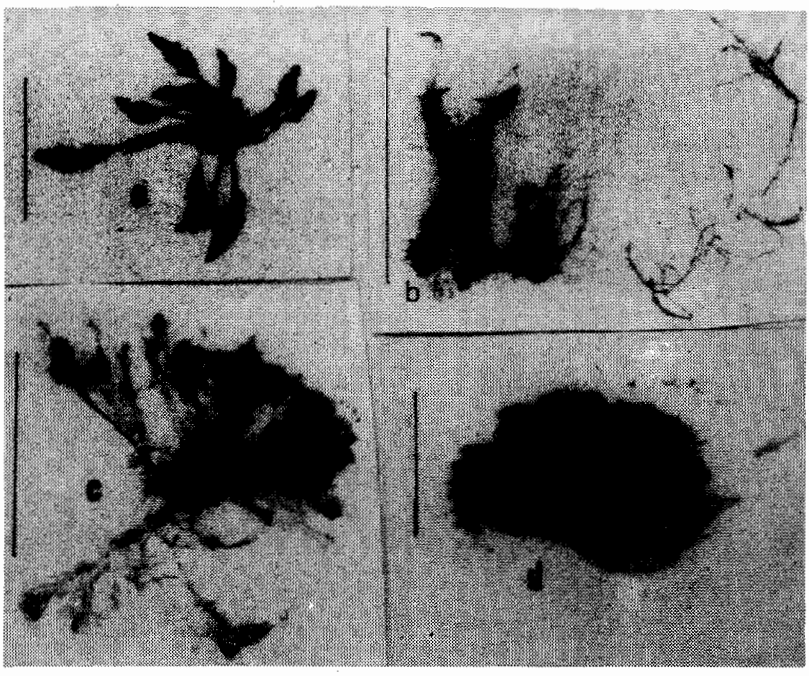

Fig.21. (a) *Bryopsis indica* A. & E. Gepps. Habit of the thallus. Littoral pool. East of Cape Monze (Leg. M. Nizam. 30-12-1964 KU961). Scale: 8 mm. (b) *Bryopsis pakistanica* Nizam. *sp.nov.* Habit of the thallus. Upper littoral rocky pool. Buleji (Leg. M. Nizamuddin 10-11-1992). Scale: 5.5 cm. (c) *Bryopsis manorensis* Nizam. *sp.nov.* Habit of the thallus. Drift. Manora (Leg. M. Nizamuddin 30-10-1963 KU1185). Scale: 2.5 cm. (d) *Bryopsis penicillata* Menegh. Habit of the thallus. Sublittoral rocky pool. Manora (Leg. M.T. Amjad 21-12-1992). Scale: 2.5 cm.

and tips broadly rounded up to 200 μm diam., bipinnately branched. **Pinnae** slender, cylindrical, distichous or sub-alternate, simple or branched. Simple pinnae 0.7-3 mm long and 100-155 μm diam.; L/B 7-19. Branched pinnae 5 (-7) mm long and up to 155 μm diam., bearing pinnules. **Pinnules** distichous or subalternate, adaxial, slender up to 1 mm long and up to 100 μm diam.; L/B 10. **Chloroplasts** dense, numerous, discoid up to 6 μm diam.

Specimens examined: Manora (Leg. M. Nizamuddin 8-2-1963).

Occurrence of this species along the coast of Pakistan is very rare. Collected once as epiphyte on *Codium iyengarii* Bφrg.

Manora specimens are smaller and slender than those of Californian specimens (Abbott & Hollenberg, 1976). Pinnae and pinnules are distichous as well as sub-alternate rather completely alternate (Scagel, 1967).

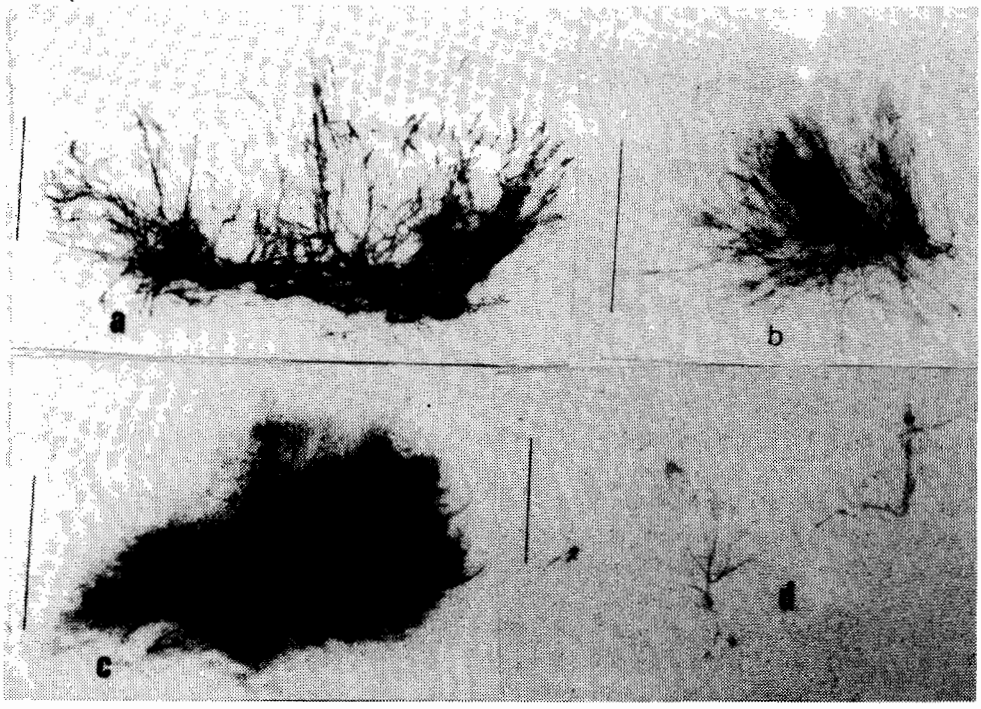

Fig.22. (a) *Bryopsis pennata* Lamour. Habit of the thallus. Lower littoral pool. Manora (Leg. M. Nizamuddin 11-10-1992). Scale: 3.3 cm. (b) *Bryopsis plumosa* (Huds.) C. Ag. Upper littoral rocks. Nathiagali, west of Paradise Point (Leg. Miss Aisha Khan 26-12-1989). Scale: 3.3 cm. (c) *Bryopsis qasimensis* Nizamuddin *sp.nov.* Habit of the thallus. P.N.S. Qasim (Leg. M. Nizamuddin 13-1-1963). Scale: 1.5 cm. (d) *Bryopsis corticulans*(?) Setchell. Habit of the thallus. Sublittoral pool. Manora (Leg. M. Nizamuddin 8-2-1963). Growing as epiphyte on *Codium iyengarii* Bφrg. Scale: 1 cm.

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