

TAXONOMIC STUDIES ON SOME MEMBERS OF DICTYOTALES (PHAEOPHYTA) FROM THE COAST OF PAKISTAN

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Abstract

Coast of Pakistan is represented by 8 genera of the order Dictyotales viz., *Dictyota* Lamx., *Dictyopteris* Lamx., *Dilophus* J.Ag., *Lobophora* J. Ag., *Padina* Adanson, *Spatoglossum* Kütz., *Stoechospermum* Kütz. and *Styopodium* Kütz. A key of the genera is given and the taxonomy and anatomy of *Lobophora*, *Spatoglossum*, *Stoechospermum* and *Styopodium* has been provided.

Introduction

The order Dictyotales is widely distributed along the coast of Pakistan and includes eight genera. The systematic account of this order has never been published from this coast except *Dictyopteris* Lamx. (Nizamuddin & Saifullah, 1967). Børgesen (1934) and Dixit (1967-68) published synoptical lists from the northern part of the Arabian Sea and from Indian coast respectively whereas Misra (1966) published a monograph of the Phaeophyceae from Indian coast. Along the coast of Pakistan a general survey was made by the senior author during 1960-69, who collected a large number of the member of the Dictyotales i.e. *Dictyota* Lamouroux, *Dictyopteris*, Lamouroux, *Dilophus* J. Agardh emend. Nizamuddin et Gerloff (1979), *Lobophora* J. Agardh (= *Pocockiella* Papenfuss), *Padina* Adanson, *Spatoglossum* Kützing, *Stoechospermum* Kützing and *Styopodium* Kützing. The present study deals with a detailed taxonomical and anatomical account of *Lobophora*, *Spatoglossum*, *Stoechospermum* and *Styopodium*.

Materials and Methods

Collections were made from all along the coast of Pakistan. For anatomical studies the materials were fixed in 5% formalin-seawater and the herbarium sheets prepared have been deposited in the Algal Herbarium, University of Karachi.

KEY TO THE GENERA OF THE DICTYOTALES

1. Vegetative growth by means of a single apical cell 2
- Vegetative growth by means of marginal cells 3

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2. Thallus composed of a single layer of large central cells throughout; holdfast discoid, *Dictyota*
Thallus composed of 2 or more layers of large central cells in the lower parts with stoloniferous base *Dilophus*
3. Fronds with distinct midrib *Dictyopteris*
Fronds without midrib 4
4. Thallus dichotomous or subdichotomous without zones 5
Thallus fan-shaped and zonate 6
5. Sporangial sori in longitudinal rows along the margins *Stoechospermum*
Sporangia scattered and embedded in the thallus *Spatoglossum*
6. Apical margin of the fronds enrolled *Padina*
Apical margin not enrolled 7
7. Thalli erect, segments having rough surfaces *Styopodium*
Thalli prostrate having smooth surfaces *Lobophora*

Stoechospermum Kützing 1843: 339

Thallus flat, foliaceous, thickened in the middle, dichotomous, flabellate, divergent; growth marginal; composed of small peripheral cells and large medullary cells; hairs present in groups on the surface; sporangial sori marginal aggregated in parallel rows along the entire margins.

Stoechospermum marginatum (C. Agardh) Kützing 1843: 339 (Fig. 1)

Syn.— *Zonaria marginata* C. Agardh 1824: 266.

J. Agardh 1848: 99; 1894: 40; Børgesen 1932: 67; 1934: 28; 1935: 35; Durairatnam 1961: 33; Kützing 1849: 560; 1859: 17, t. 40; Misra 1966: 161; Nasr 1947: 78.

Thalli erect, tufted patent, linear, ligulate, (–7) 12-30 cm high, attached by rhizoidal holdfasts; dichotomously branched, attenuate, cuneate below; frond flat 6-22 mm broad at the dichotomies. Surface cells polygonal and irregularly arranged; spores rotund, simple or bifid, inrolled and curved; vegetative growth by means of marginal cells. Thallus composed of a single layer of peripheral cells on either surface and of 7(–8) layered of medullary cells. Peripheral cells small, 5-18 μm , X 8-12 μm containing dense chromatophores. In T.S. medullary cells parenchymatous, irregular, 28-184 μm across but in L.S. rectangular and regularly arranged, 28-84 μm X 100-288 μm . Large groups of hairs on either side of the margins but lacking in sporangial sori, margin entire. Sporangia all along the margins, pear-shaped, 65-115 μm X 15-60 μm , developing from the peripheral cells; basal cell of sporangia 4-12 μm broad.

Local distribution — Cape Monze (Leg. Aftab 26-12-1964, M. Nizamuddin, 28-12-1963; 16-11-1964, Perveen 23-10-1970); Gote Mubarak (Leg. M. Nizamuddin 3-4-1965); Gote Manjar (Leg. M. Nizamuddin 29-9-1963), Hawks Bay (Leg. M. Nizamud-

din 20-1-1963; 13-5-1970); Sonmiani Beach (Leg. U. Ghani 4-12-1964); Paradise Point (Leg. Naseem Ara 3-4-1965).

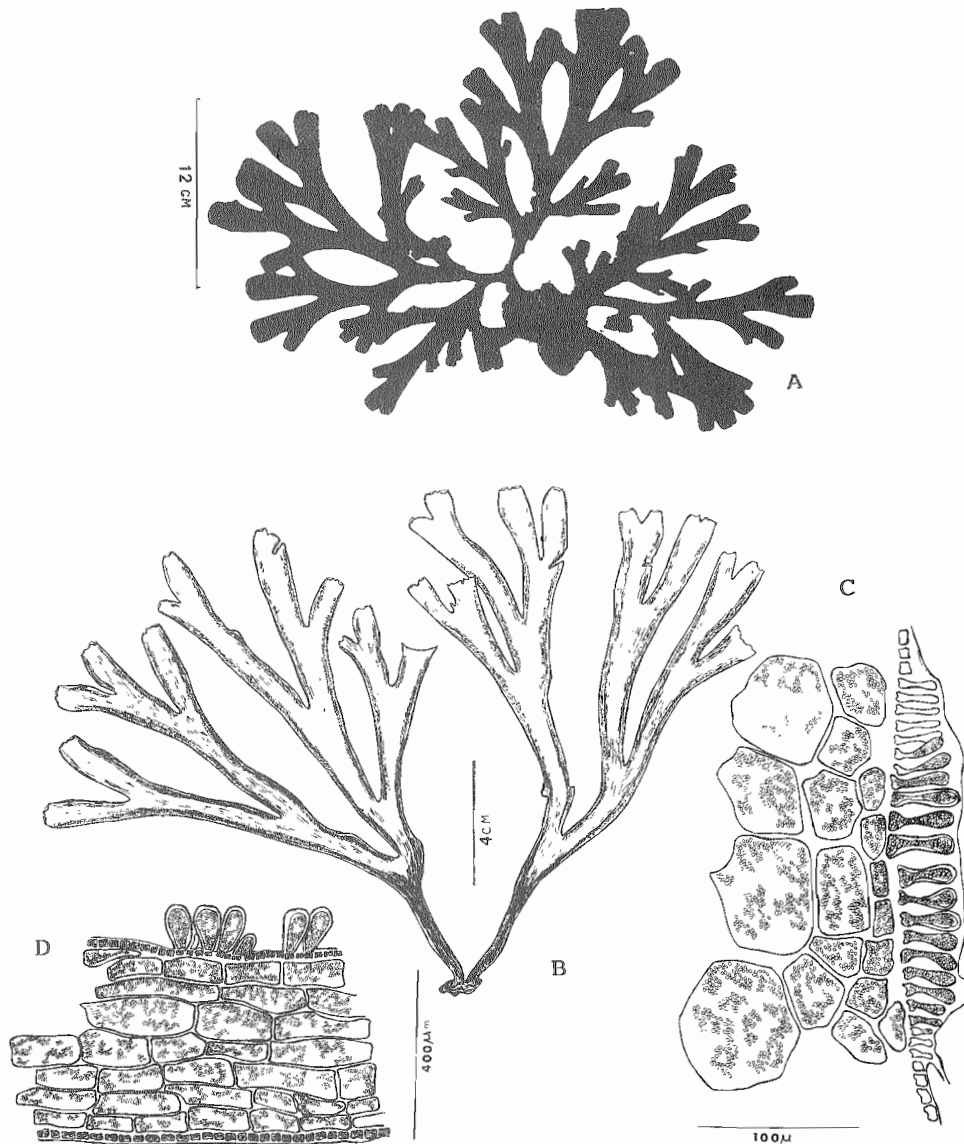


Fig. 1. *Stoechospermum marginatum* (C. Ag.) Kützinger: A & B. Habit of the plant; C.T.S. of the frond showing sporangia; D.L.S. of the frond showing sporangia.

Geographical distribution:- Ceylon, West coast of India (Bombay), coast of Pakistan and Red Sea.

S. marginatum grows in sub-littoral region associated with the other members of the Dictyotaceae. Specimens from the coast of Pakistan agree with the type description as well as with that of Ceylon described by Durairatnam (1961) but differs in the absence of hairs in the sporangial sori, along the margin, but not confined near the dichotomy, whereas Misra (1966) reported the occurrence of hairs only in the oogonial sori.

Spatoglossum Kützing 1843: 339

Thalli erect, foliaceous, flat, cuneate, ecostate, irregularly, subpalmately segmented; growth marginal; margin plane. Frond composed of large medullary cells and small peripheral cells; tetrasporangia scattered on either surface; dioecious; oogonia dispersed; antheridial sori small and scattered.

The coast of Pakistan is represented by two species, *Spatoglossum aspermum* J. Agardh and *S. variabile* Figari et De Notaris.

KEY TO THE SPECIES

1. Frond smooth, thin cells sub-irregularly arranged, parenchymatous to 6 layered thick cryptostomat lacking *S. aspermum*
Frond rough, thick, cells regularly arranged, parenchymatous, 7-12 layered in thickness, cryptostomat present *S. variabile*

Spatoglossum aspermum J. Agardh 1894: 36 (Fig. 2)

Børgesen 1935: 35; De Toni 1895: 247;

Durairatnam 1961: 34; Misra 1966: 160.

Fronds erect, 16-30 cm high, palmate, smooth, thin, flat, membranous, cuneate, sub-dichotomously, irregularly branched, bearing several flat, thin cuneate segments, margins slightly denticulate above but much more dense on the lower parts. Segments 6 layered thick — a single layer of small peripheral cells on either surface and medulla of 4 layered cells (innermost layers consist of large cells). Peripheral cells palisade-like, 20-92 μm x 20-68 μm in dimension, meristematic, containing dense chromatophores. Medullary cells sub-regularly arranged or somewhat rectangular, 40-80 μm x 52-144 μm in dimension containing dense chromatophores. Surface cells quadrate more or less in rows. Tuft of uniseriate hairs on either surface of the segments. Sporangial sori scattered, embedded in the peripheral layers, 80-120 μm long, 45-90 μm broad, with distinct basal cells (15-25 μm long). Antheridial and oogonial sori not observed.

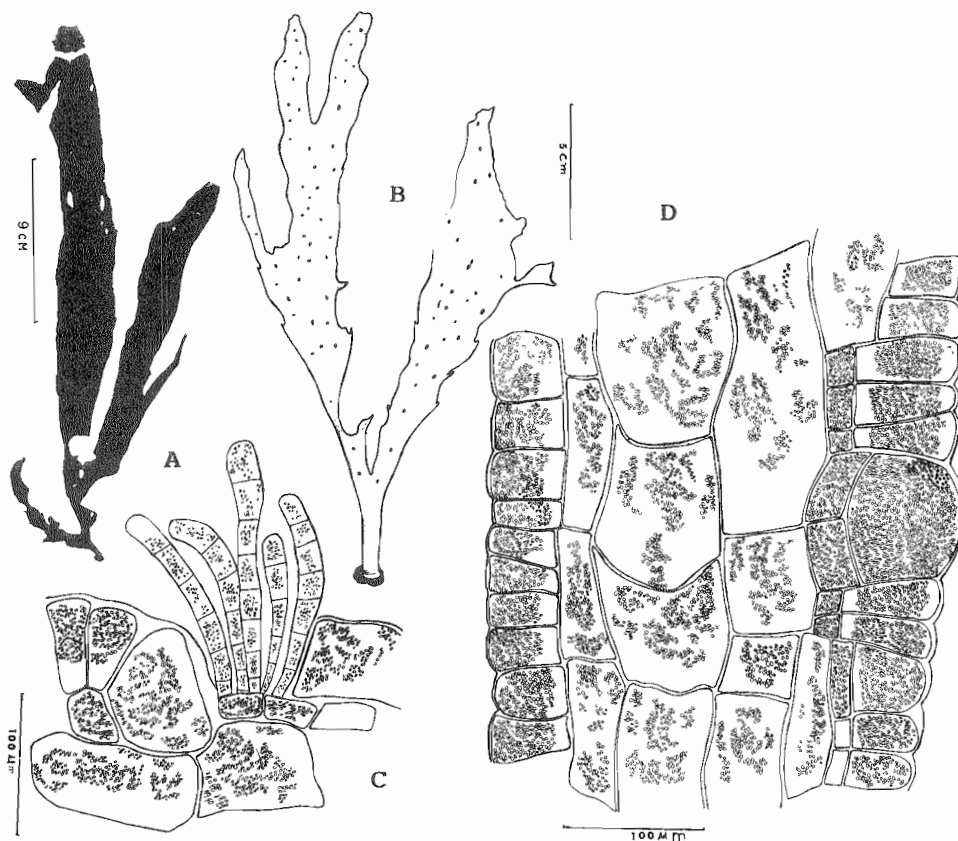


Fig. 2. *Spatoglossum asperum* J. Ag.: A & B. Habit of the plant; C.T.S. of the frond showing cluster of hairs; D.T.S. of the frond showing developing sporangium.

Local distribution — Manora (Leg. M. Nizamuddin 13-11-1963, Perveen 23-2-1970); Cape Monze (Leg. M. Nizamuddin 28-12-1963, 13-4-1964, 23-3-1965); Gote Manjar (Leg. M. Nizamuddin 28-12-1963).

Geographical distribution — Mauritius Islands, Ceylon, west coast of India (Bombay) and Pakistan.

This species was described by J. Agardh (1894) from Ceylon coast based on Ferguson's collection no. 54. Pakistani specimens agree with the type description as well as with Durairatnam's figure and description. The species generally grows in the sublittoral region.

Spatoglossum variabile Figari et De Notaris 1853: 28. t.1.f.4. (Fig. 3)

Syn.: *Spatoglossum lubricum* Figari et De Notaris 185: 28, f. 1; Kutzing 1859:20, tab. 48.

J. Agardh 1894: 36, De Toni 1895: 247; Misra 1966: 159; Nasr 1947: 78; Nizamuddin and Gessner 1970: 6.

Thalli erect, 10-35 cm high, flat, subdichotomously branched; segments flat, linear, cuneate below, 2-4 cm broad, 2-5 μm thick, surface rough; proliferations from the margins as well as from the surface of the segments also composed of 7-12 layers of cells in thickness — single peripheral layer on either side of the segments and 5-10 layers of medullary cells. Peripheral cells small, 20-70 μm x 20-55 μm in dimension containing dense chromatophores. Medullary cells large parenchymatous, irregular but sub-medullary cells regular rectangular towards the peripheral layers, 8-64 μm x 8-104 μm in dimension. Cryptostomata scattered all over the surface. Sporangial sori round, scattered on either surface, embedded in the peripheral layers, Antheridial and oogonial sori not observed.

Local distribution: Cape Monze (Leg. M. Nizamuddin 28-12-1963, 21-11-1964); Manora (Leg. M. Nizamuddin 3-11-1963; Perveen 23-2-1970; Gote Manjar (Leg. M. Nizamuddin 29-9-1963).

Geographical distribution:— Arabian Sea, Red Sea and Malayan Archipelago. Specimens from Pakistan coast agree with the type description. It grows in mid- to sub-littoral regions and common along the coast. On exposure to atmosphere specimens turn greyish-green.

S. variabile resembles *S. aspermum* in habit but differs in roughness, thickness, proliferations and presence of cryptostomata.

Styopodium Kützing 1843: 341

Thalli erect, stipitate, attached by rhizoidal holdfast. Frond fan-shaped to strap-shaped, divided in 15 segments. Segments transversally zonate, growth marginal at the tips; 4-10 layered thick; medulla of irregular cells; sporangial sori irregularly arranged bordering the hair zones, producing 4 spores.

Along the coast of Pakistan a single species, *S. zonale* (Lamx.) Papenfuss, is found growing.

Styopodium zonale (Lamx.) Papenfuss 1940: 205 (Fig. 5)

Syn. *Fucus zonalis* Lamouroux 1805: 38, Pl. 25, f. 1.

Durairatnam 1961: 34; Misra 1966: 165; Taylor 1960: 232.

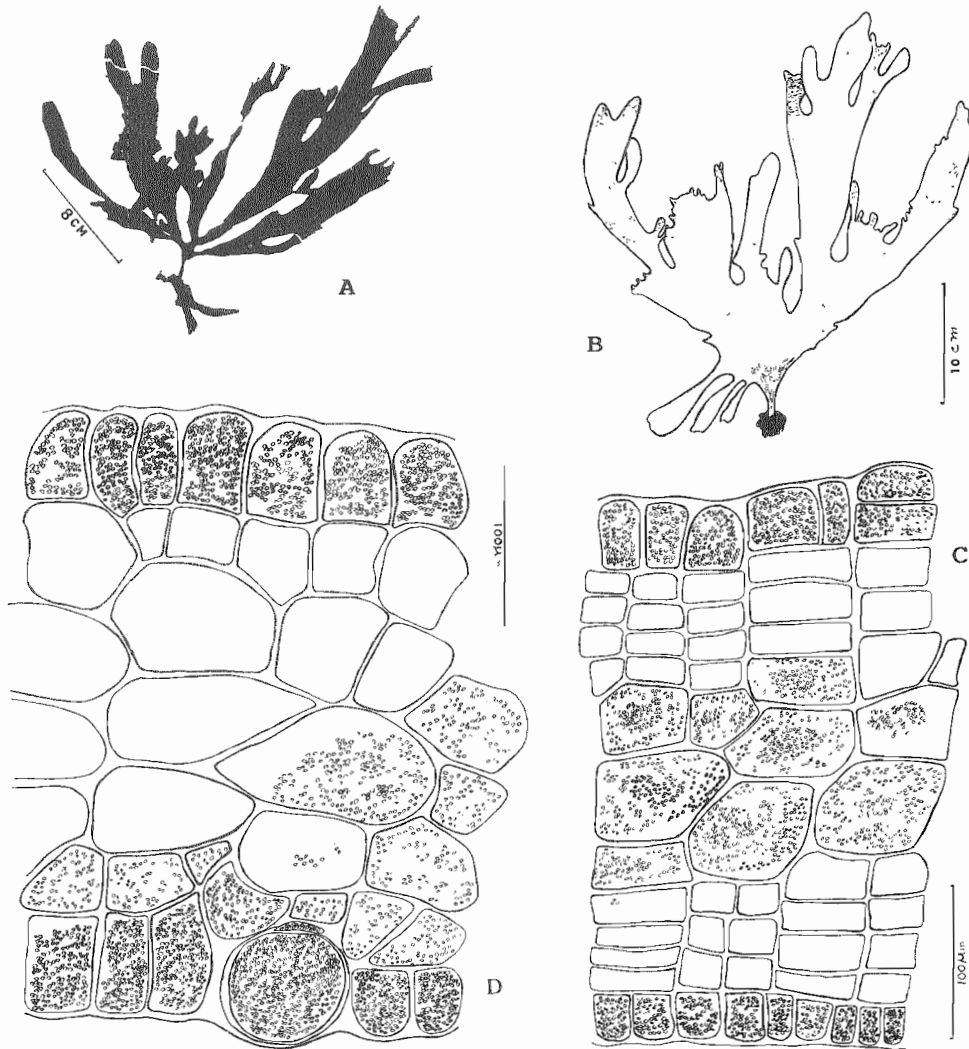


Fig. 3. *Spatoglossum variable* Fig. et De Not.: A & B. Habit of the plant; C.T.S. through mature part of the plant; D.T.S. through young part of the frond showing sporangium and tissues.

Thallus erect 14-30 cm high, strap-shaped, irregularly branched, segmented. Segments flat, upper part 2-6 cm broad, cuneate below, lower part 2-8 mm broad; margin smooth, dark, concentric zones on either surface, perforated; 4-10 layers of cells in thickness, peripheral layers of small cells $20-23 \mu\text{m} \times 12-30 \mu\text{m}$ containing dense chromatophores. Medulla 2-layered thick in apical parts but 4-8 layered in mature parts, cells regular, variable in size, rectangular, $22-66 \mu\text{m} \times 20-60 \mu\text{m}$ in dimension; cell wall $5-10 \mu\text{m}$ thick. Growth marginal at the tips of the segments. Sporangial sori scat-

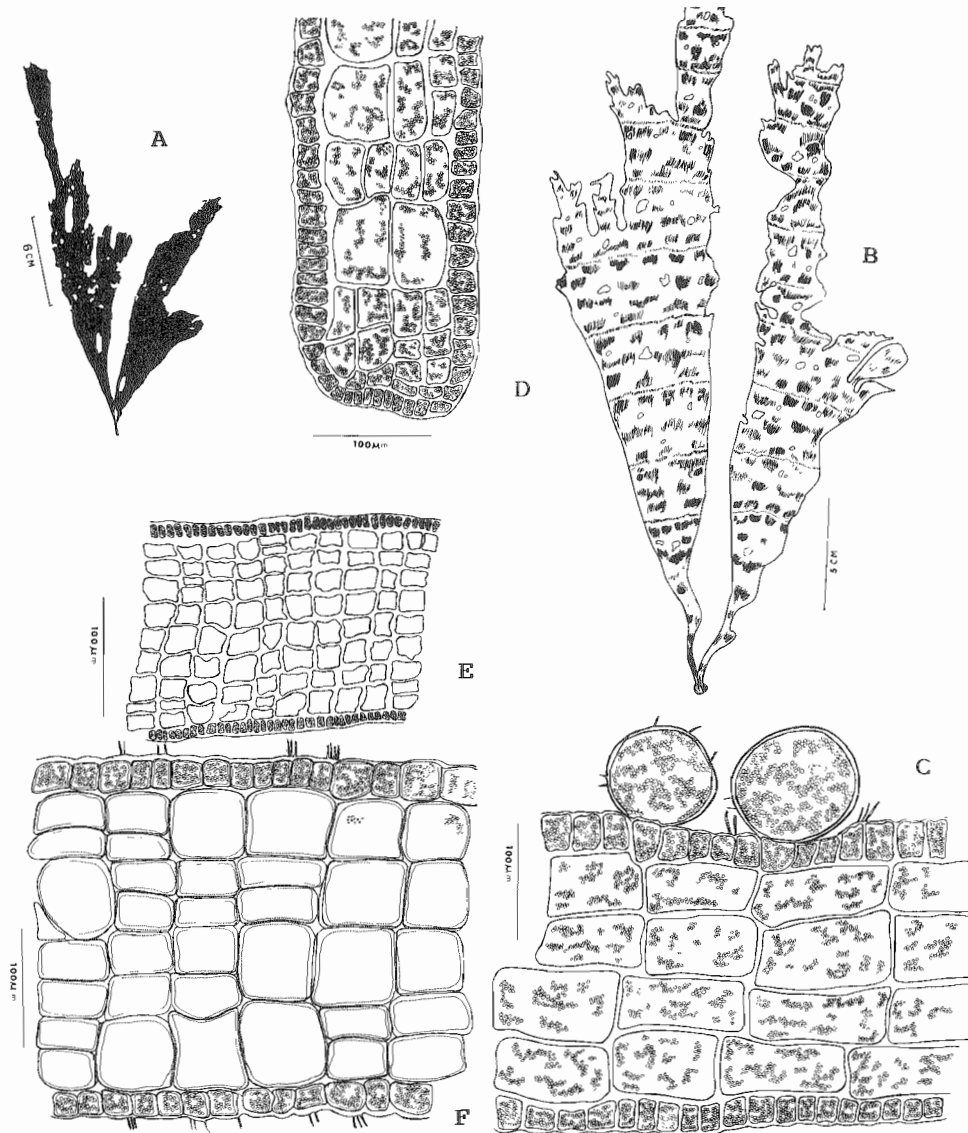


Fig. 4. *Stypodium zonale* (Lamx.) Papenfuss: A & B. Habit of the plant; C.T.S. through the middle part of the plant showing sporangia; D.T.S. through marginal part of the frond showing tissues. E.T.S. through mature part of the frond showing tissue; F.L.S. through mature part of the frond showing tissues.

tered above the rows of hairs, on both surfaces, round 45-95 μm in diameter, without paraphysis producing 4 spores.

Local distribution: Manora (Leg. Perveen 22-3-1970).

Geographical distribution:- Ceylon, coast of west India, coast of Pakistan, South African coast, Canary Islands, West Indies, Brazil, Venezuela, Bermuda and Florida.

The absence of paraphyses in sporangial sori agree with the findings of Papenfuss (1940) and of W. v. Bosse (1913). Pakistani specimens are generally strap-shaped rather fan-shaped but in general features agree with that of Duriratnam (1961). This species is rarely found along this coast in littoral pools exposed to the lowest tide level but according to Taylor (1960) this species was dredged from 55 meter depth.

Lobophora J. Agardh 1884: 36

Thalli erect or decumbent, ecostate, lobed, flat, margin entire, zonate, concentric; growth marginal; three layered in thickness: a single peripheral layer, 2-3 or more layers of cortex and a single layered medulla. Cells in vertical rows in T.S. Sori scattered bearing reproductive organs, with 8 spores. Paraphyses lacking in sporangial sori. Antheridial and oogonial sori not observed.

The genus is characterized by the medullary structures rather presence or absence of paraphyses in sporangial sori. *Lobophora variegata* (Lamouroux) Womersley was collected from this coast.

Lobophora variegata (Lamouroux) Womersley 1967: 221 (Fig. 5)

Syn.: *Dictyota variegata* Lamouroux 1809: 331. *Gymnosorus nigrescens* (Sonder) J. Agardh 1894: 12; Lucas 1936: 86; De Toni 1895: 228. *Spatoglossum nigrescens* Kutzing 1849: 561; 1859: 20; t. 49. *Zonaria variegata* Børgesen 1939: 82. *Zonaria nigrescens* Sonder 1846: 8. *Pocockiella nigrescens* (Sonder) Papenfuss 1943: 467. *Pocockiella variegata* (Lamx.) Papenfuss 1943; 467; Chapman 1963: 36; Dixit 1969: 17; Duriratnam 1961: 34; Hackett 1969: 88; Misra 1966: 164; Taylor 1960: 231.

Richardson 1975: 102; Islam 1976: 38.

Thallus procumbent to erect, 3-6 cm high, fan-shaped, lobed by splitting, 1-4 cm broad, light brown to blackish brown, margin entire attached by uniseriate rhizoids developing from the base of the segments or from the lower surface of the segments; growth marginal. Frond or segments composed of three tissues- central large radial cells, (Medulla) 20-40 μm x 15-40 μm in transverse section, 24-66 μm x 22-88 μm in longitudinal section containing dense chromatophores; sub-medullary cells quadrate 2-3

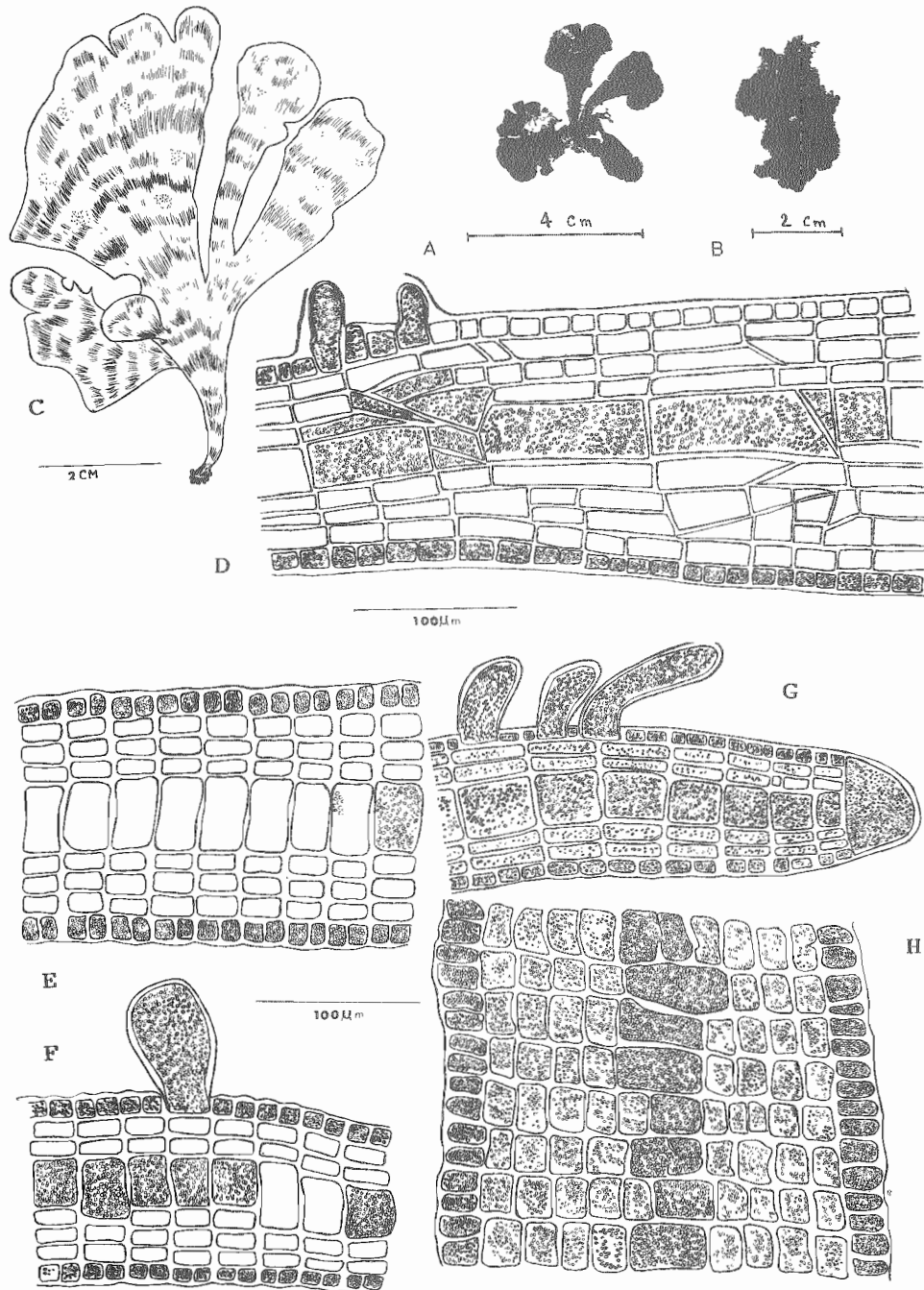


Fig. 5. *Lobophora variegata* (Lamx.) Womersley: A, B & C. Habit of the plant; D.L.S. through the plant showing sporangia and abnormal type of cell division; E.T.S. of the frond showing regular arrangement; F.T.S. of the frond showing sporangia; G.T.S. of the frond showing marginal initial cell and sporangia; H.T.S. of the lower parts of the frond showing tissues.

(–5) layered on either side of the central cells (medulla), 8-16 μm \times 20-28 μm in T.S. & 8-12 μm \times 116 μm in L.S., and a single layer of peripheral cells on either side, 8-16 μm in diameter in T.S. and 10-15 μm \times 12-25 μm in L.S. containing dense chromatophores. Septate paraphyses growing on the surface but lacking in sporangial sori. Sporangia pear-shaped covered by distinct indusium (in young stage) scattered on both surfaces, producing 8 spores. Antheridial and oogonial sori not observed.

Local distribution:- Cape Monze (Leg. Fatima 27-5-1970, M. Nizamuddin 28-12-1963; 13-4-1964; 16-11-1964; 21-11-1964).

Geographical distribution:- Ceylon, Maldive Islands, coast of Pakistan, west coast of India, Japan, Equador, Mexico, eastern coast of America, Pacific ocean, Jamaica, Australia and tropical seas.

The specimens from the coast of Pakistan resemble those of Ceylon (Durairatnam 1961) and with those of Jamaica (Chapman, 1963).

Along the coast of Karachi *L. variegata* grows on the margin of the mid-littoral rocky pools in association of *Valonionopsis pachynema* (Martens) Børgesen in protected conditions. Taylor (1960) reported it from a depth of 85 m.

Acknowledgements

Authors are indebted to Prof. Dr. J. Gerloff for valuable suggestions and for critically going through the manuscript. Thanks also due to the Director, Botanischer Garten und Botanisches Museum, Berlin for the use of Library and Herbarium facilities.

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(Received for publication 31 August 1985)