

ANATOMICAL STUDIES ON *IYENGARIA* BØRGESEN (PHAEOPHYCOTA) FROM KARACHI COAST OF PAKISTAN*

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Abstract: A commonly growing brown seaweed, *Iyengaria stellata* (Børgesen) Børgesen [= *Rosenvingia stellata* Børgesen] was collected during March 2007 and April 2009 from mid-littoral rocks at Manora and Buleji, the coastal areas of Karachi. The multiprotuberant and globular thalli were investigated for their morphology, anatomy and reproduction. Their large, prominent and distantly arranged protuberances (stellata) were studied in detail. Patches of thick-walled, dark brown hypodermal cells, vertically elongated, thin-walled cells below hypodermis, intercellular spaces in the hypodermal cells, and 20 – 25 layers of cells in the thalli were observed which were not noticed by the previous workers. During collection survey a new species, *Iyengaria nizamuddinii* Abbas et Shameel was observed which is characterised by small and closely arranged protuberances, absence of patches of thick-walled dark brown cells, lack of vertically elongated thin-walled cells and intercellular spaces. It was also morphologically and anatomically investigated.

Keywords: Algae, Phaeophycota, *Iyengaria*, morphology, anatomy, reproduction

Introduction

In 1928 seaweed was described for the first time under the name *Rosenvingia stellata* from Dwarka Port of Gujarat, India [1], which is not far away from Karachi (Pakistan). Soon after, it was transferred to the genus *Colpomenia* (Endlicher) Derbès et Solier under the name *C. stellata* on the basis of its globular thalli [2]. Later on, Børgesen [1] realized that its thalli are not hollow but have long, very prominent and profusely arranged protuberances and thus placed it under a newly created genus *Iyengaria* [3]. It was also described taxonomically from the coast of Karachi [4], which was followed by further studies [5,6]. Apart from Karachi, its presence was also reported from the coastal areas in the Balochistan province of Pakistan [7-12], but there was no adequate information available on its internal structure. Therefore, the present study was undertaken to investigate in detail its external and internal structures as well as its reproductive organs. During the collection survey another species, *Iyengaria nizamuddinii* Abbas et Shameel, *sp. nov.* was observed, which was also

taxonomically and anatomically investigated.

Materials and Methods

The specimens of both the species of *Iyengaria* were collected during March 2007 and April 2009 from mid-littoral rocks at Manora and Buleji, the coastal areas of Karachi (Pakistan). The specimens were brought to the laboratory and preserved in 4% formaldehyde-seawater solution after thorough washing. Some of them were used for herbarium preparations, which are deposited in the Herbarium (FUU-SWH), Department of Botany, Federal Urdu University of Arts, Science and Technology, Karachi. The remaining the specimens were used for general and microscopic observations. In order to study internal details, cross sections (C.S.) of the algal material were obtained free hand with the help of shaving blades, stained in aniline blue and mounted in glycerine. The slides were sealed with nail polish and examined under a Nikon PFX microscope, the seaweed sections were photographed with the help of a Nikon F601 camera.

Results and Discussion

The collected specimens on general observation and microscopic investigation

* Dedicated to Prof. Dr. Mohammed Nizamuddin on his 80th birthday on 11-1-2010, due to his numerous valuable contributions on the taxonomy of brown algae of Karachi Coast.

revealed the presence of two species, which may be distinguished as follows:

1. Thalli up to 23 cm in diameter; protuberances 6-15 mm long, closely packed.....*I. nizamuddinii* (2)
 2. Thalli more than 23 cm in diameter; protuberances 4-7 mm long, distantly arranged.....*I. stellata* (1)
1. ***Iyengaria stellata* (Børgesen) Børgesen 1939:91**

Basionym:

Rosenvingea stellata Børgesen 1928: 1.

Synonyms:

Colpomenia stellata (Børgesen) Børgesen 1930: 168, *C. capensis* Levring 1938:20.

Misapplied name: *Colpomenia sinuosa* (Mertens ex Roth 1806: 327) Derbès et Solier in Castagne 1851: 95 forma *tuberculata* (Saunders 1898: 164) Setchell et Gardner 1903: 242, *sensu* [13].

References: [1: 1, 2:168, 3: 91, 13: 4, 14: 118, 15: 12, 16: 6, 4: 316, 7: 513, 8: 295, 5: 301, 6: 26, 9: 40, 10: 227, 17: 631, 11: 52, 12: 86].

Morphological characters: Thalli greenish brown or olive green in colour, globular, surface smooth; large and distantly arranged protuberances (*stellata*) present on the thalli, margins entire; attached with the help of a compact, solid, small, rhizomatous disc; *stellata* solid, 6-15 mm long, enveloped in a thin covering from inner side of the thallus; inner portion of thalli hollow; thallus 12-30 cm in diameter (Fig. 1).

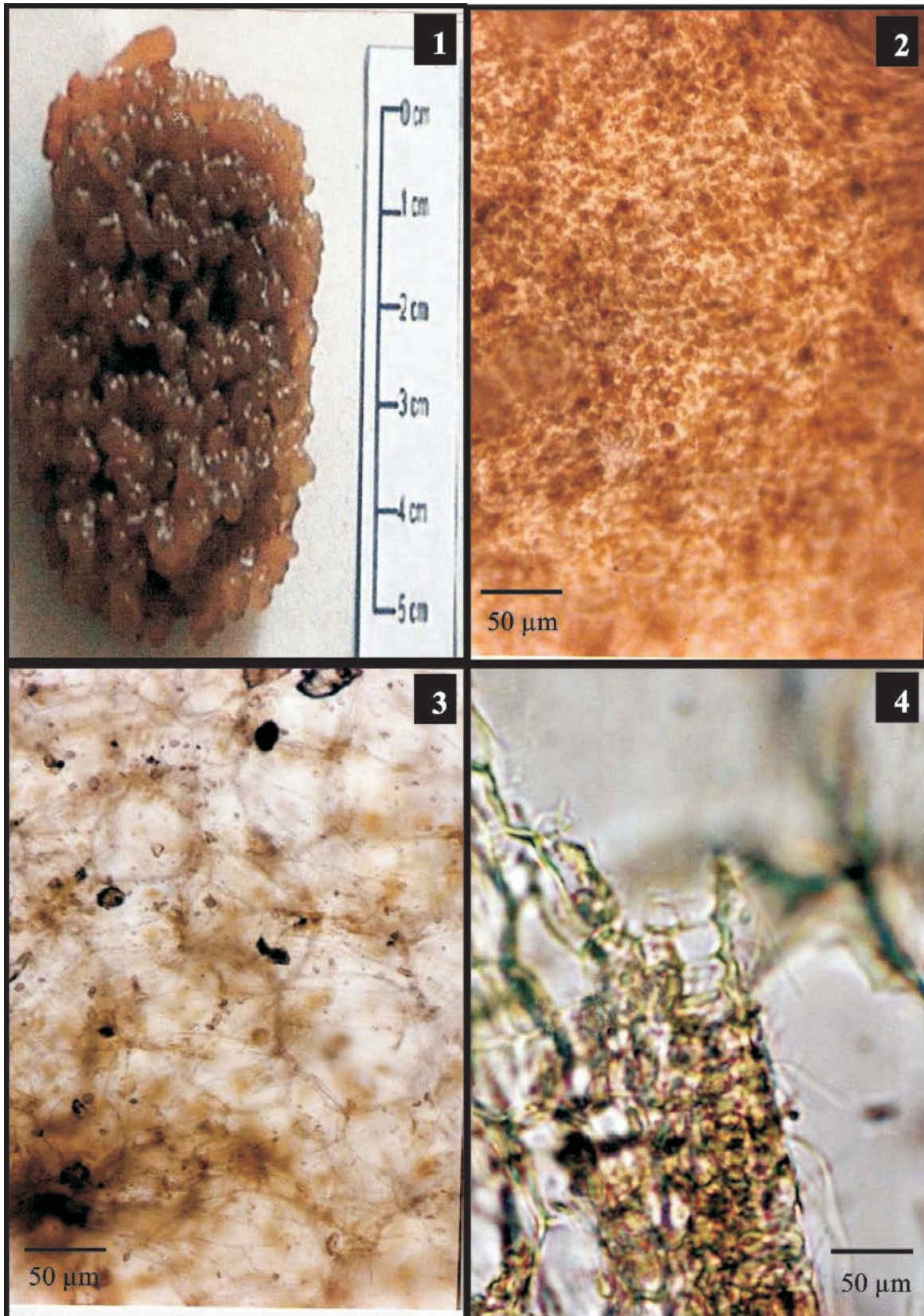
Anatomical features: Globular and multiprotuberant (*stellata*) thallus composed of 25- 30 layers, containing cells of different sizes and shapes. In surface view: dorsal surface composed of very small, dark brown, closely packed cells, sporangial sori scattered on the thallus surface,

cells 2.5-5.0 μm in length and 2.5-7.5 μm in breadth (Fig. 2); ventral surface consists of large, thin-walled, loosely arranged cells with one or a few phaeoplasts, 12.5-55.0 μm in length and 17.5-45.0 μm in breadth (Fig. 3).

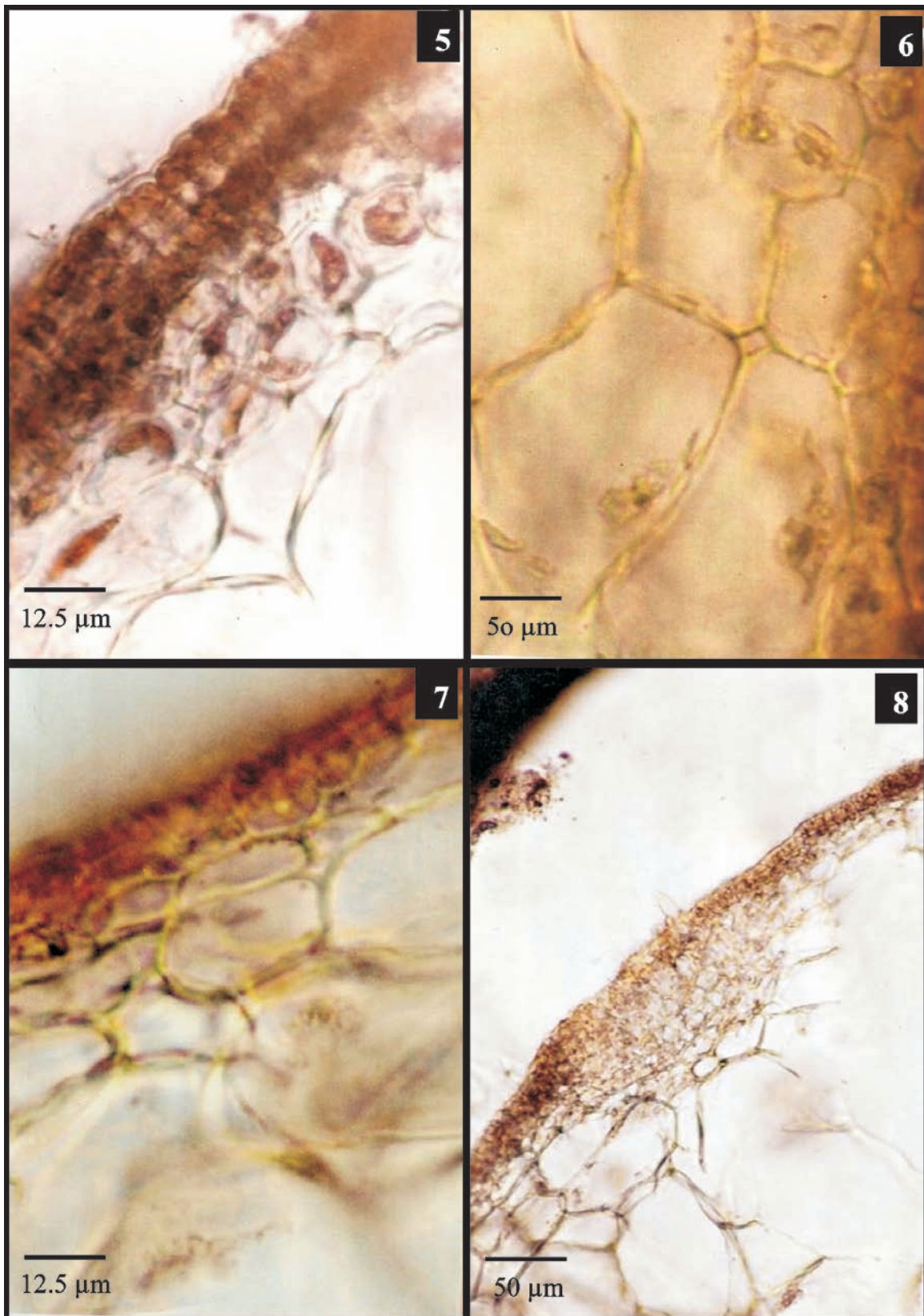
Peripheral layer contains small, cubical or slightly elongated, thin-walled cells with dense phaeoplasts, 7.5-15.0 μm in length and 7.5-10.0 μm in breadth (Fig. 4); below the epidermis 2-3 layers consist of small, polygonal or isodiametric, thick-walled cells (Fig. 5), cell-wall thickness 2.5 μm , poor in contents with prominent phaeoplasts, intercellular spaces present between these cells (Fig. 6), sometimes small, tangentially elongated cells are present (Fig. 7), 10.0-62.5 μm in length and 10.0-32.5 μm in breadth. Just below the epidermis there are small groups or patches of polygonal or isodiametric thick-walled cells, intercellular spaces absent, these groups were present at specific distances in the protuberances (*stellata*), cells 7.5-40.0 μm in length and 12.5-50.0 μm in breadth (Figs. 8, 9); below these small cells, at some places 1-2 layers consist of horizontally elongated, large, thin-walled cells, without intercellular spaces, poor in contents, 175-250 μm in length and 50-75 μm in breadth (Fig. 10), below them horizontally arranged cells of medulla, consisting of 5-6 layers of large, irregularly arranged, thin-walled cells, without intercellular spaces, poor in contents, 50.0-62.5 μm in length and 32.5-60.0 μm in breadth (Fig. 11).

From inner side of the thallus, protuberances (*stellata*) are enveloped with a thin covering; *stellata* consist of 5-6 layers; peripheral layer consists of small, cubical, thin-walled cells, with dense phaeoplasts, 5-7 μm in length and 5.0-5 μm in breadth; below the epidermis, 2-3 layers consist of small, thick-walled cells, intercellular spaces present, poor in contents, 12.5-50.0 μm in length and 7.5-12.5 μm in breadth (Fig. 12); at some places horizontally elongated, palisade like cells are present (Fig. 13).

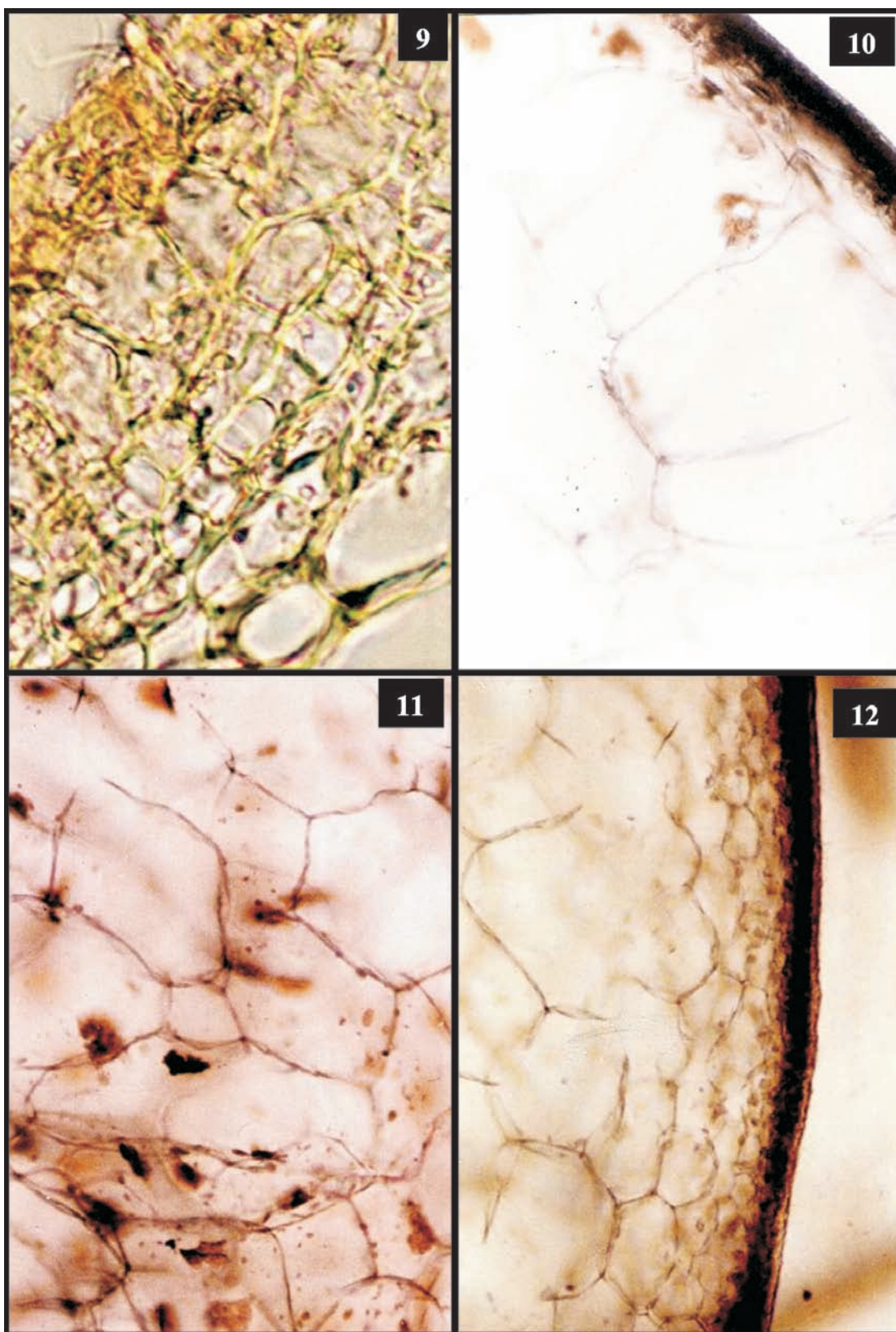
Reproductive structures: Plurilocular sporangia



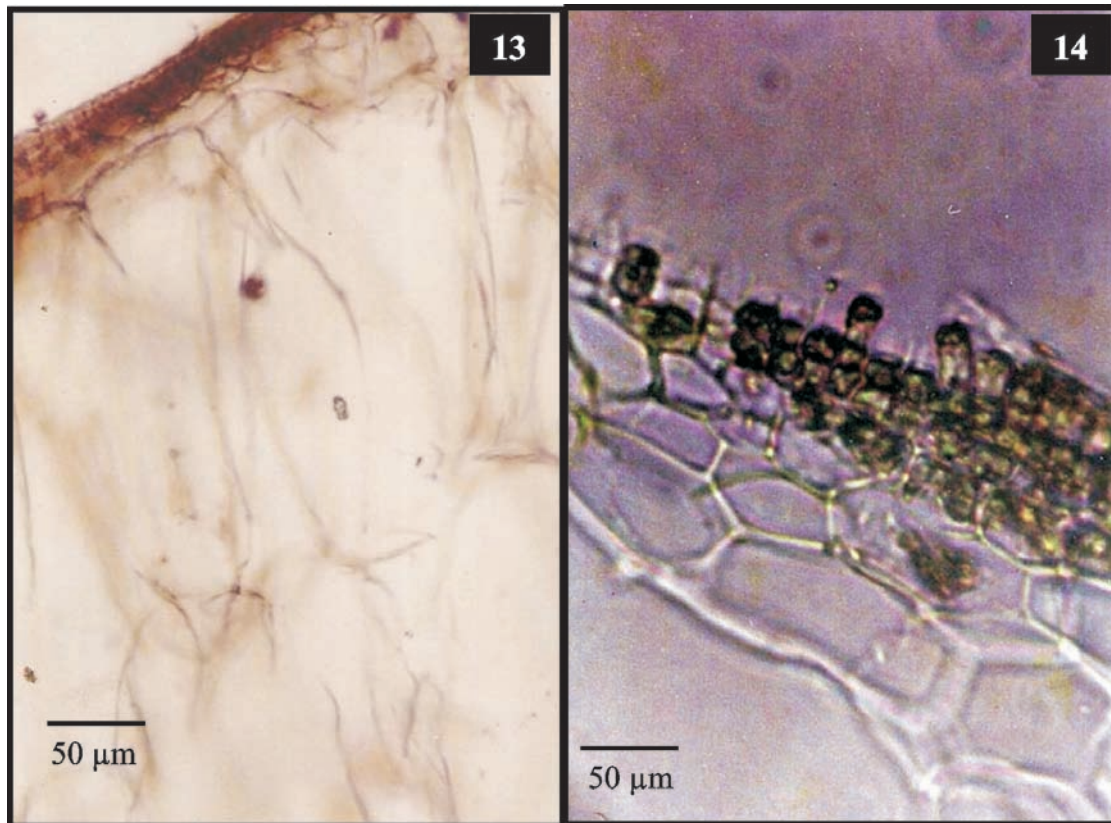
Figures 1-4. *Iyengaria stellata*: 1. Habit of the thallus , 2. Dorsal surface of the thallus 3.Ventral surface of thallus, 4. Peripheral cells slightly elongated.



Figures 5-8. *Iyengaria stellata*: **5.** Thick-walled hypodermal cells, **6.** Hypodermal cells, **6.** Hypodermal cells with intercellular spaces, **7.** Tangentially elongated hypodermal cells, **8.** Group of small, thick walled cells below epidermis.



Figures 9-12. *Iyengaria stellata*: **9.** Enlarged view of thick walled cells, **10.** Thin walled elongated cells below hypodermis, **11.** Medullary cells, **12.** C.S. of protuberance, stellatum.



Figures 13-14. *Iyengaria stellata*: 13. Palisade like cells in stellata, 14. Plurilocular sporangia arising from peripheral cell.

present on the surface of protuberances (stellata), arising from peripheral cells, dark brown in colour, consist of many chambers, present in groups, elongated, cylindrical, 25-50 µm in length and 10-25 µm in breadth (Fig. 14).

Habitat: Benthic on rocks of mid-littoral region at Manora (*Leg. Alia Abbas 6-4-2009*), Goth Haji Ali, Buleji (*Leg. Alia Abbas 17-3-2007*, 18-3-2008, 24-1 & 31-3-2009).

Type locality: Dawarka, Gujarat, India.

Local distribution: Karachi: Manora, Hawkes Bay, Buleji, Paradise Point and Cape Monze; Balochistan: Gadani, Sonmiani, Sur Bunder, Gawader and Jiwani.

Geographical distribution: India, Iran, Kuwait, Pakistan, Papua New Guinea, Saudi

Arabia and South Africa.

Remarks: This seaweed commonly grows at the coast of Karachi during spring and summer (family Scytosiphonaceae, order Scytosiphonales, class Laminarophyceae, phylum Phaeophycota; *vide* [18]. It was misidentified as *Colpomenia sinuosa* forma *tuberculata* (Saunders) Setchell *et* Gardner by Anand [13], who reported very early its occurrence at the rocky ledges of Manora (Karachi) forming a belt and developing a community [19]. This nomenclature was also supported by Salim [20]. So far, this was the only known species of the genus *Iyengaria* Børgesen, being its type species. It is not only reported from the Arabian Sea but also from very distant areas of South Africa and Papua New Guinea [21,22]. This species has very large, prominent, and distantly arranged protuberances (stellata), which were not investigated before by previous workers and similarly the presence of

patches of thick walled cells below epidermis were also not reported earlier [4-6,14]. Number of cellular layers in the thallus was described as 8-10 by previous workers, but this study showed the presence of 20-25 layers.

2. *Iyengeria nizamuddinii* Abbas *et* Shameel, *sp. nov.*

Latin diagnosis: *Thallus viridi-brunneus, globulosus, solidus, usque ad 23 cm diameter; parvus solidus, levis projectio, arcte contiguas circum paginate, 4-7 mm longus; thallus basilis excavatus, affixus ad substratum parvidiscus; cellula thallus 18-23 stratus compositus, cellula hypodermicus. Cellula hypodermicus atrobrunneus, neque vertically elongatus, segmentum tenuis muratus, ad spatio intercellular nullo necubi.*

Morphological characters: Thalli greenish brown, globular, solid; small, solid and closely packed protuberances (stellata) develop on surface of the thalli; basal region of the protuberances enveloped in a covering; basal part of thalli hollow; attached to the substratum with the help of a small disc; up to 23 cm in diameter; protuberances 4-7 mm long; surface of protuberances smooth, margins entire (Fig. 15).

Anatomical features: In surface view: dorsal surface composed of very small, dark brown, rounded or cubical cells, 2.5-7.5 μm in length and 2.5-5.0 μm in breadth (Fig. 16); ventral surface contains large, polyhedral, loosely arranged cells, with a prominent single phaeoplast, 75-110 μm in length and 60-115 μm in breadth (Fig. 17).

In C.S., thalli consist of 18-25 layers; peripheral layer composed of small, dark brown, rounded or cubical or slightly elongated, thin-walled cells, with dense phaeoplasts, 7.5-10.0 μm in length and 5-10 μm in breadth (Fig. 18); below the peripheral layer, 3-5 layered region consists of small, tangentially or horizontally elongated polygonal or hexagonal, thin-walled cells, poor

in contents, intercellular spaces absent, 10.0-32.5 μm in length and 10-25 μm breadth (Fig. 19). At some places; beside these cells, below peripheral layer 3-4 layers composed of large, thin-walled cells, with prominent single or dense phaeoplasts, polygonal, 10.0-57.5 μm in length and 12.5-50.0 μm in breadth (Fig. 20); below these cells the rest of thallus consists of large, parenchymatous, thin-walled cells, poor in contents, polygonal, intercellular spaces absent, size of the cell gradually increases towards the center, 25.0-87.5 μm in length and 25-90 μm in breadth (Figs. 21 & 22); in the edges of protuberances (stellata), below the small polygonal cells, long palisade-like, vertically elongated, thin-walled cells present, poor in contents, intercellular spaces absent, 100-175 μm in length and 50-75 μm in breadth (Fig. 23).

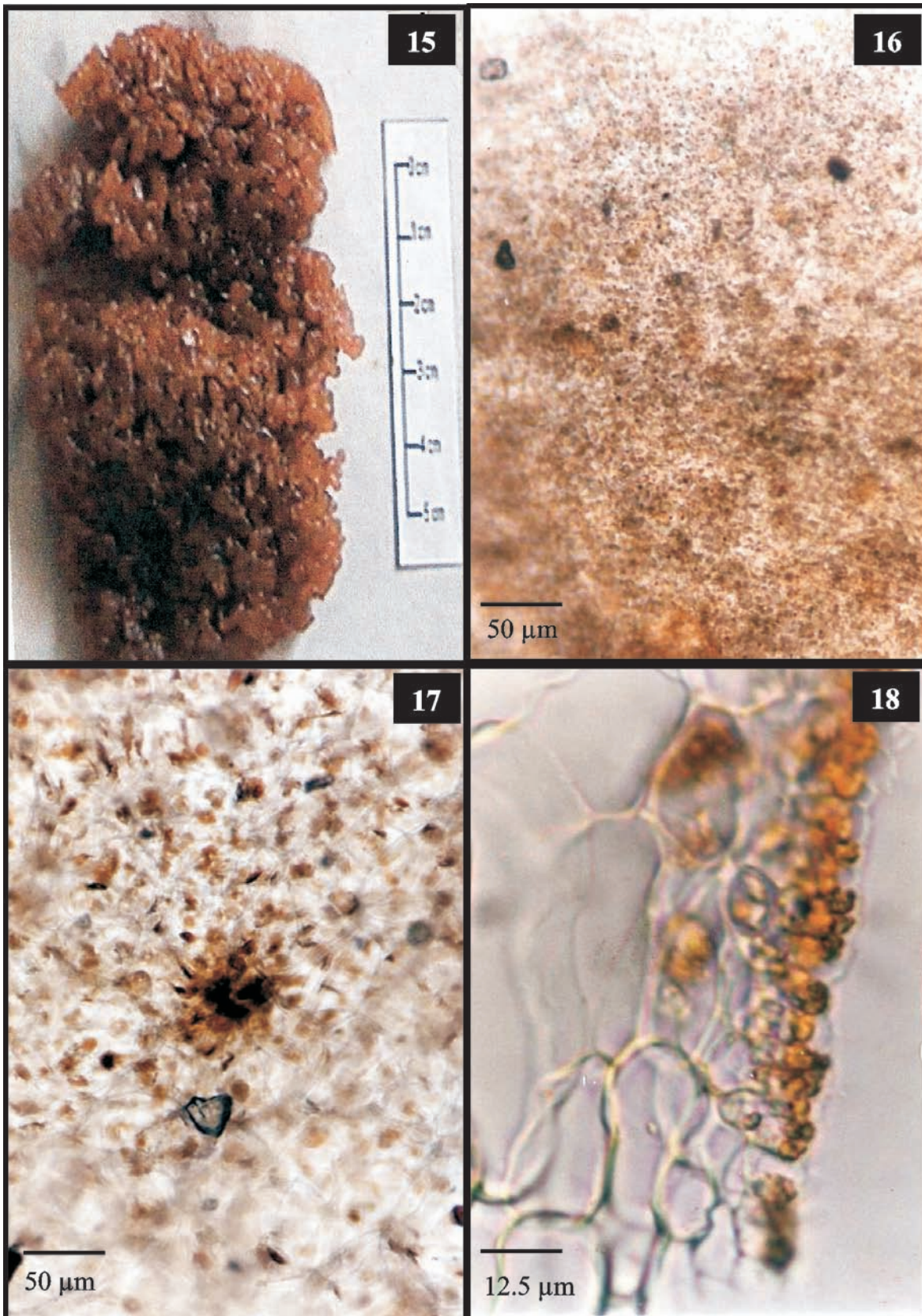
Reproductive structures: Plurilocular sporangia found in a sorus on the dorsal surface of the thallus; plurilocular sporangia dark brown, elongated, arising from peripheral layer, 10.0-60.0 μm in length and 5.0-12.5 μm in breadth (Fig. 24).

Habitat: Benthic on rocks of mid-littoral region at Goth Haji Ali, Buleji (*Leg. Alia Abbas* 17-3-2007, 24-1-2008, 7-3- & 31-3-2009).

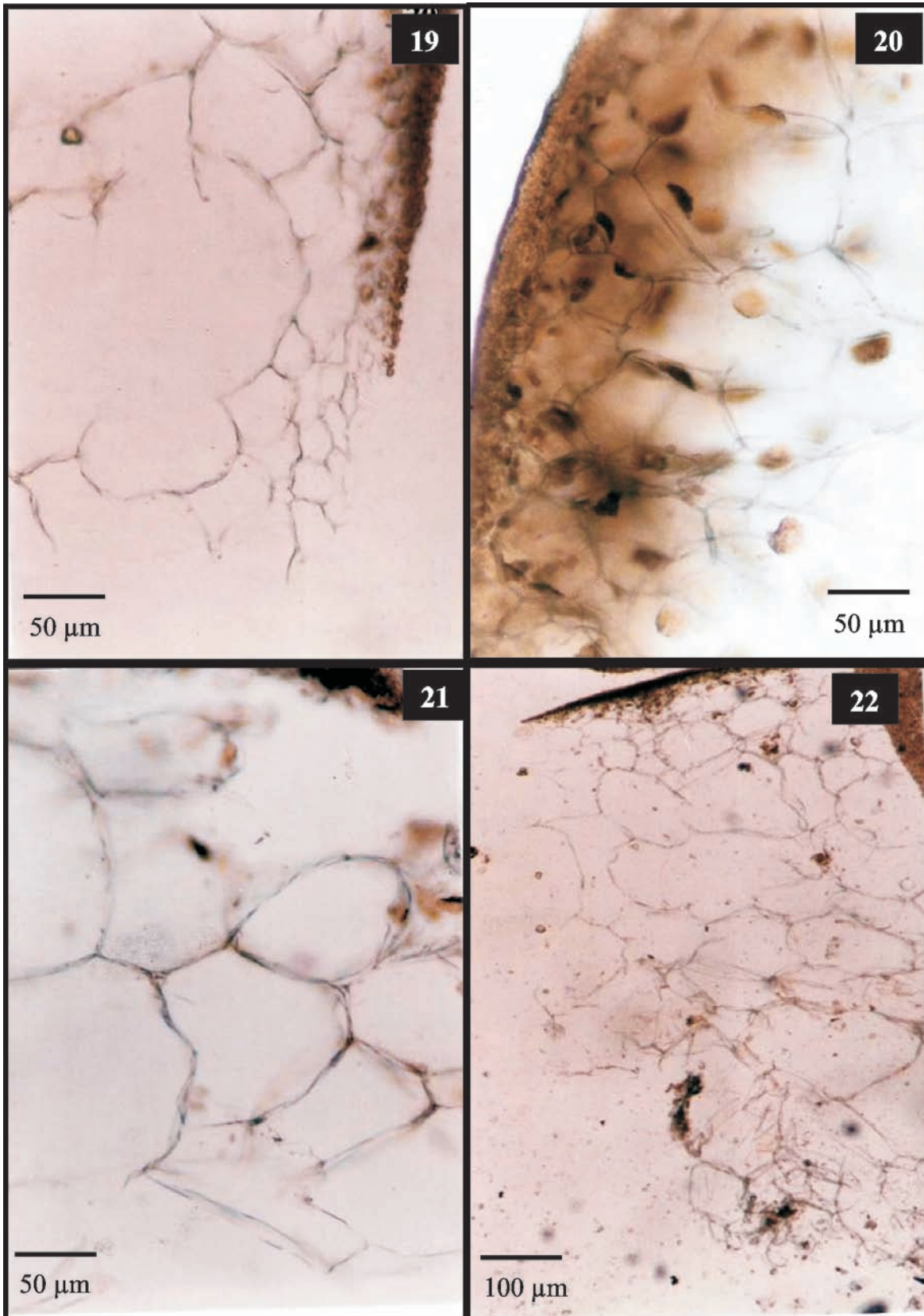
Type locality: Buleji, Karachi, Pakistan (FUU-SWH 25).

Local distribution: Karachi: Buleji.

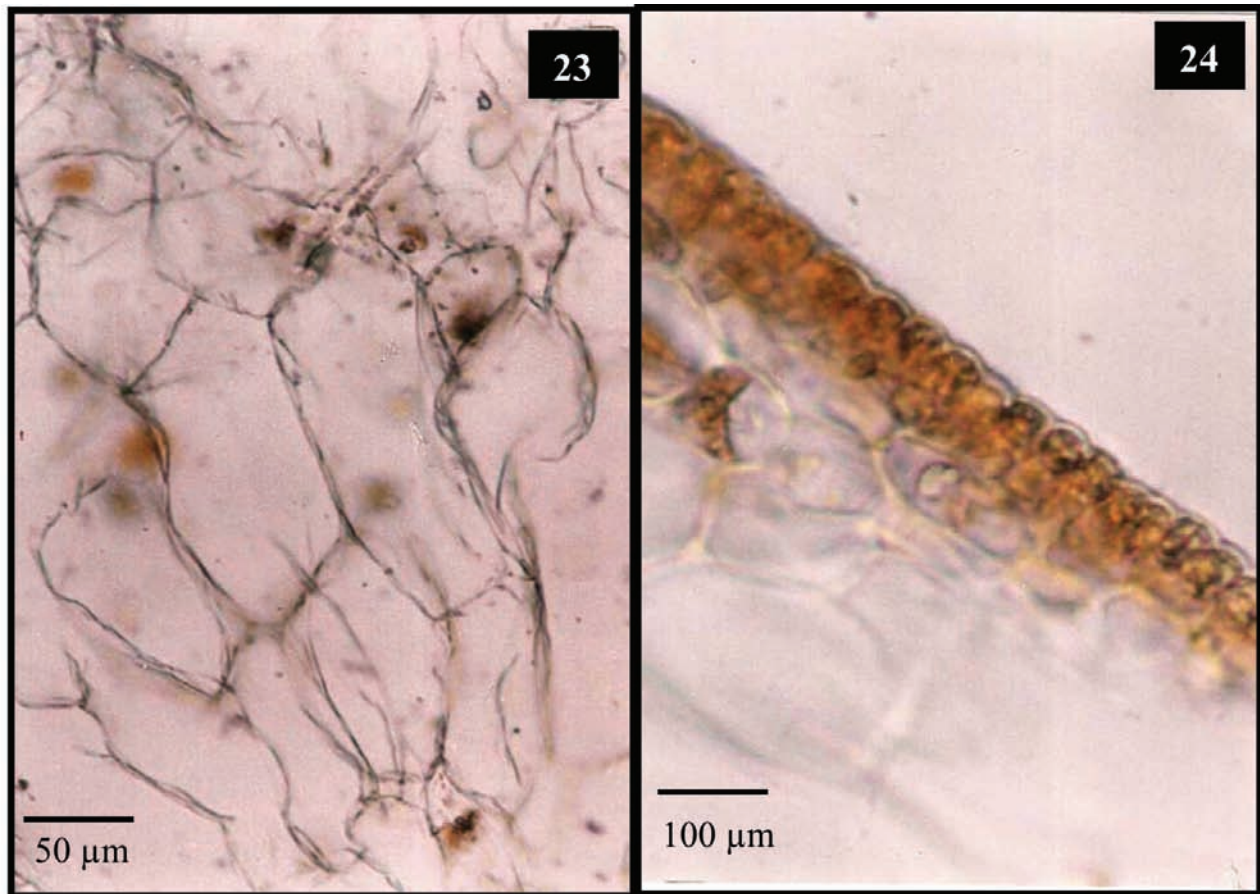
Remarks: This species differs from the type species *I. stellata* in having very small (4-7 mm) and closely packed protuberances (stellata), absence of patches of thick-walled dark brown hypodermal cells, lacking vertically elongated thin-walled cells below hypodermis and no intercellular spaces anywhere in the thallus. Below the large and long cells, vertically elongated cells are present in *I. stellata*, which bear large (6-15 mm) and distantly arranged protuberances. Small patches of dark coloured and thick-walled cells and intercellular



Figures 15-18. *Iyengaria nizamuddinii*: 15. Habitat of the thallus, 16. Dorsal surface of the thallus, 17. Ventral surface of thallus, 18. Peripheral cells.



Figures 19–22. *Iyengaria nizamuddinii*: 19. Small hypodermal cells, 20. Large, thin-walled hypodermal cells, 21. Large, thin-walled cells below hypodermis, 22s. Large polygonal central cells.



Figs. 23-24. *Iyengaria nizamuddinii*: **23.** Slightly elongated cells in the edges of protuberances, **24.** Plurilocular sporangia arising from peripheral cells.

spaces are also present in the hypodermal cells in *I. stellata*. In the present species intercellular spaces are absent in all kind of cells, vertically elongated cells are not prominent anywhere, and the thalli are composed of 18-25 layers of cells, whereas *I. stellata* has 25-30 layers. This new species has been named after Prof. Dr. Mohammed Nizamuddin, the pioneering phycologist of Pakistan and a world authority on the taxonomy of Phaeophycota.

While studying the life form of brown algae in nature and culture, some doubt had been expressed by certain researchers about distinction of the genus *Iyengaria* from *Colpomenia* [23, 24]. During the course of this study it was observed that individuals of both these genera grow side by side in the same habitat and under similar

ecological conditions in the coastal areas of Karachi (Pakistan). Therefore, they cannot be considered as ecotypes. Furthermore, the present investigation revealed that *Iyengaria* not only differs in morphology from *Colpomenia* [4, 25] but is remarkably different from it in anatomy of the thallus [19]. The differences found in these genera appear to be genetical. There remains no doubt that they are two distinct genera.

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