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MORPHO-ANATOMY OF *STYPOPODIUM ZONALE* (PHAEOPHYCOTA) FROM THE COAST OF KARACHI, PAKISTAN

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Abstract

A brown alga *Stypopodium zonale* (Lamouroux) Papenfuss (*Dictyotales*) was collected from Manora and Buleji, the coastal areas near Karachi (Pakistan) during March 2006-April 2009 and investigated for its morphology, anatomy and reproductive structures. This is the first detailed study on the Pakistani specimens of this species from these points of view, where presence or absence of intercellular spaces, cell-wall thickness of different cells and structure of surface cells were examined. In this connection the apical, middle and basal parts of the thallus were investigated anatomically.

Introduction

Stypopodium zonale is a greenish brown, fan-shaped and flabellate alga which occasionally grows in the littoral poles exposed to lowest tide level at the seashore of Pakistan (Shameel & Tanaka, 1992). Its growth was first noticed at the coast of Karachi by Nizamuddin & Perveen (1986) and later on others (Begum & Khatoon, 1988; Nizamuddin & Aisha, 1996). Only preliminary studies was made on this seaweed by these workers. Therefore, the present investigation was carried out on its morphology and anatomy.

Materials and Methods

The specimens were collected from Manora and Buleji, the coastal areas of Karachi (Pakistan) during March 2006 and April 2009, and preserved in 4% formaldehyde-seawater solution. In order to study internal structures, cross sections (C.S.) were obtained by free hand cutting with shaving blades, which were stained with aniline blue and mounted in glycerine. The semi-permanent slides were sealed with nail polish and examined under microscope (Nikon PFX, Japan). The photographs were taken by Nikon F 601 camera and developed in a photolab with *hp* scanner. The photographic plates were prepared in Adobe photoshop 7.0 with the help of a computer. The herbarium sheets of the materials are deposited in the herbarium (FUU-SWH). Department of Botany, Federal Urdu University of Arts, Science & Technology, Karachi, Pakistan.

Results

The study of collected specimens and their microscopic examination revealed the following taxonomic characters.

***Stypopodium zonale* (Lamouroux) Papenfuss 1940: 205**
Basionym: *Fucus zonalis* Lamouroux 1805: 38.
Synonyms: *Zonaria lobata* C. Agardh 1824: 265, *Stypopodium lobatum* (C. Agardh) Kützing 1859: 25.
References: Taylor, 1960: 232; Durairatnam, 1961: 43; Misra, 1966: 165; Nizamuddin & Perveen, 1986: 128; Begum & Khatoon, 1988: 299; Shameel & Tanaka, 1992: 39; Nizamuddin & Aisha, 1996: 131; Silva *et al*., 1996: 612; Begum, 2010: 284; Abbas & Shameel, 2012: 147.

Morphological characters

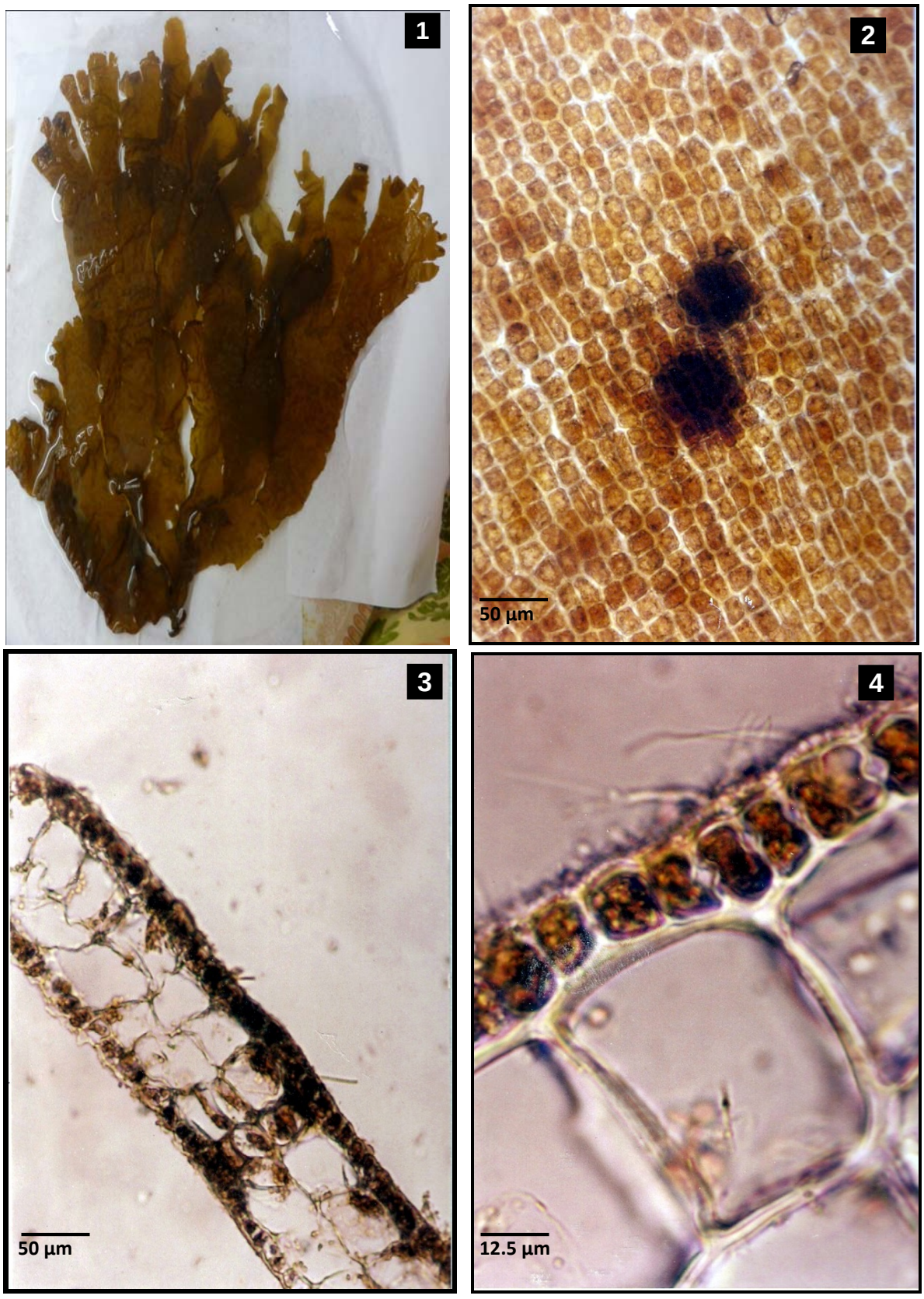
Thalli greenish brown in colour, erect; 5–30 cm long, 10–25 cm broad at the apex, 5–10 cm broad at the middle and 2–4 cm broad at the base; fan-shaped and flabellate thalli broad at the apex and gradually become narrow at the base; broadly obtuse apex, base atenuate, margins highly undulate, surface rough or slightly shrunken; zonation present all over the surface from apex to the base, zones 1-6 cm apart; reproductive organs scattered on the dorsal surface of the thalli; attached with the help of a compact, small, rhizomatous holdfast, 1–5 mm long and 1–3 mm broad (Fig. 1).

Anatomical features

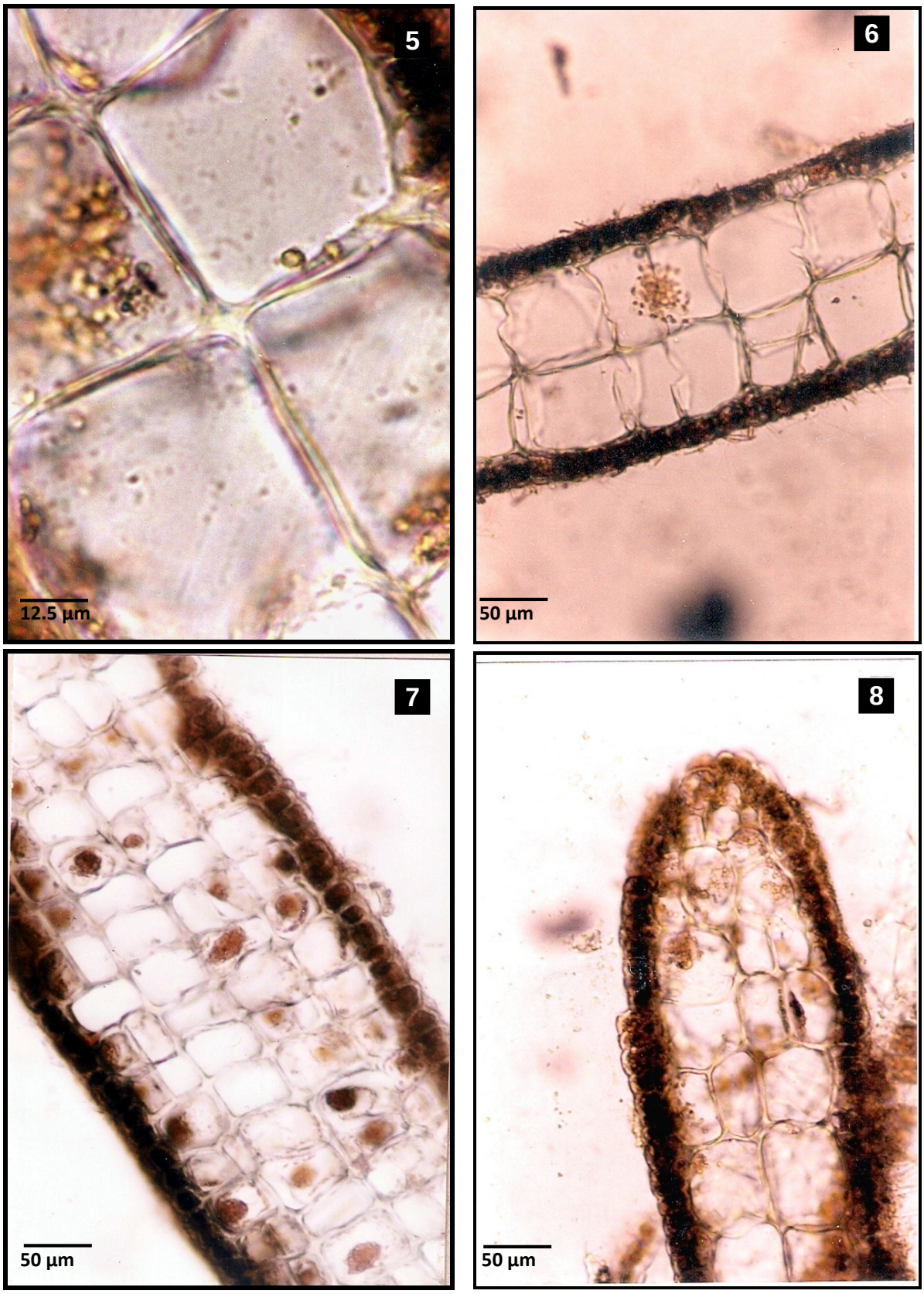
In surface view: dark brown in colour; surface cells small, cubical or slightly rounded, mostly rectangular; arranged in vertical rows; cells 10–20 µm in length and 7.5–15.0 µm in breadth (Fig. 2).

In the apical portion: thallus width 25 µm containing 4–6 layers (Fig. 3); outer and inner peripheral layers consist of small, cubical or quadratic, thin walled cells, with dense phaeoplasts, 10–15 µm in length and 7.5–12.5 µm in breadth (Fig. 4); cortical region consists of 2–4 layers, cortical cells large, cubical or slightly elongated, poor in contents, thick-walled, intercellular spaces present, in some cells one large elongated phaeoplast present, cells arranged in regular tiers, but at some places cells polygonal or isodiametric and arranged in irregular manner, 20.0–27.5 µm in length and 15–40 µm in breadth.

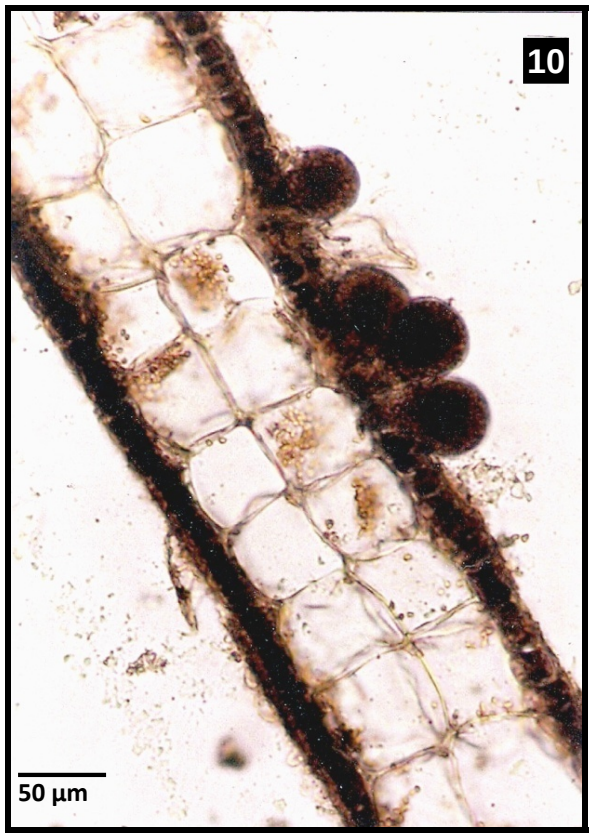
In the middle part: thalli composed of 4–6 layers; upper and lower peripheral cells small, thin walled, cubical or squarish, 12.5–22.5 µm in length and 10.0–17.5 µm in breadth; cortical region consists of 2–4 layers, cells large, thick walled with intercellular spaces (Fig. 5); arranged in regular tiers, near the margin or at some places towards the epidermis the cortical cells become smaller and polygonal in shape, at these places cortical region consists of 6 layers, 50–75 µm in length and 37.5–50.0 µm in breadth (Fig. 6).



Figs. 1-4. *Stypopodium zonale*: **1.** Habit of the thallus. **2.** Surface view of the thallus, **3.** C.S. of apical portion of the thallus, **4.** Peripheral cells.



Figs. 5-8. *Stypopodium zonale*: **5.** C.S. of thallus showing inter-cellular spaces, **6.** C.S. of middle part of thallus, **7.** C.S. of basal portion, **8.** C.S. of margin.



Figs. 9-10. *Stypopodium zonale*: **9.** Two-layered peripheral region, **10.** Sporangia arising from peripheral cells.

In the basal portion: thalli consist of 4–6 (-7) layers; upper and lower peripheral cells small, thin walled, with dense phaeoplasts, cubical or squarish, 10–25 µm in length and 10.0–12.5 µm in breadth. Cortical region consists of 2–4 (-5) layers, cortical cells large, thick walled, cubical or slightly elongated, intercellular spaces present, poor in contents, cell-wall thickness 5.0–7.5 µm in breadth (Fig. 7). Margin of the thalli consists of 6–7 layers, irregularly arranged thick walled cells, poor in contents, intercellular spaces present, 25–75 µm in length and 37.5–50.0 µm in breadth (Fig. 8). In the basal and middle portion, at some places near the margin some peripheral cells divide into two and form two layered peripheral region, 7.5–12.5 µm in length and 7.5–10.0 µm in breadth (Fig. 9).

Reproductive structures

Tetrasporangia scattered on both surfaces of thallus, on dorsal surface number of sporangia high, and on ventral surface less number of sporangia present; sporangia occur in a group of 2 – 8, arise from peripheral cells; dark brown, rounded or oval, 12.5–75.0 µm in length and 25.0–42.5 µm in length (Fig. 10).

Type locality: Dominican Republic.

Habitat: Collected as drift material at Manora (*Leg.* Alia Abbas 6-4-2009); Goth Haji Ali, Buleji (*Leg.* Alia Abbas 15-3-2006, 17-3-2007, 29-11-2008, 27-1-, 13-2-, 7-3- & 31-3-2009).

Local distribution: Karachi: Manora and Buleji.

Distribution in the Indian Ocean: Kenya, Madagascar, Pakistan, Singapore, South Africa, Sri Lanka and Tanzania. Pakistan and Sri Lanka.

Discussion

Stypopodium (Kützing) J. Agardh is a genus of the family Dictyotaceae (Order Dictyotales, class Dictyophyceae, phylum Phaeophycota; *fide* Shameel 2012). There is a varied controversy among its constituent species. The synonymy of *S. lobatum* to the present species is due to Howe (1918). Although the occurrence of *S. zonale* has been widely recorded in the Indian Ocean from Pakistan to South Africa, but Silva *et al*. (1996) are of the opinion that the records of *S. zonale* from the Indian Ocean need to be examined in view of the finding by Verlaque & Boudouresque (1991) that *Zonaria schimperi* Kützing is referable to *Stypopodium.* Structure and type of phaeoplast play an important role in resolving evolutionary relationships among brown algae (Phillips *et al.,* 2008).

In the present study, presence or absence of intercellular spaces, cell-wall thickness of different cells and structure of surface cells were examined in the

internal structure of *S. zonale*. Furthermore, the apical, middle and basal parts of the thallus were also investigated anatomically. All these characters were not studied by previous workers (Nizamuddin & Perveen, 1986; Nizamuddin & Aisha, 1996). This species resembles *S. australasicum* in many ways, and many people consider the two to be synonymous (N' Yeurt & Payri, 2006), but Verlaque & Boudouresque (1991) support Allender & Kraft (1983) in keeping the two separate. Therefore, the present specimens were considered to belong to *S. zonale*.

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