

## TWO NEW SPECIES AND TWO NEW REPORTS OF *ULVA* L. (ULVOPHYCEAE) FROM THE COAST OF KARACHI, PAKISTAN

M. T. Amjad and Mustafa Shameel  
Department of Botany, University of Karachi  
Karachi 75270, Pakistan

**ABSTRACT:** Morphology and taxonomy of four species of *Ulva* i.e. *U. anandii* Amjad et Shameel sp. nov., *U. bifrons* Ardré, *U. saifullahii* Amjad et Shameel sp. nov. and *U. taeniata* (Setchell) Setchell et Gardner were described for the first time from Pakistan. Their anatomy has been investigated in detail and compared with the allied species. A taxonomic comment has been written on *U. grandis* Saifullah et Nizamuddin.

**KEY WORDS:** *Ulva* species - Chlorophyta - taxonomy - morphology - anatomy - Pakistan.

### INTRODUCTION

*Ulva* Linnaeus is one of the most common genera of green seaweeds of Pakistan. The first taxonomic study on *Ulva*, from the coast of Karachi, was made by Anand (1940), who described three species i.e. *U. fasciata* Delile, *U. indica* Anand and *U. lactuca* Linnaeus. Later on, Saifullah and Nizamuddin (1977) investigated this genus thoroughly and described eight species i.e. *U. fasciata*, *U. fenestrata* Postels et Ruprecht, *U. grande* Saifullah et Nizamuddin, *U. indica*, *U. lactuca*, *U. reticulata* Forsskal, *U. rigida* C. Agardh and *U. sorensenii* Chapman from Karachi. The occurrence of three species of *Ulva* has also been reported from the coastal areas of Lasbela (Shameel, 1987; Shameel and Afaq-Husain, 1987; Shameel et al., 1989), which is adjacent to the west of Karachi. During a two years' intensive collection of green seaweeds of Karachi, some new species of *Ulva* were collected which are reported here.

### MATERIALS AND METHODS

Algae were collected in attached form or as drift material. Some were mounted on herbarium sheets and some were preserved in 4% formalin-seawater solution. The free hand sections were stained in 0.5% methylene blue and drawn with camera lucida. Specimens are kept in the Seaweed Herbarium (KUH-SW), Seaweed Biology and Phycochemistry Lab., MAHQ Biological Research Centre, University of Karachi.

### RESULTS AND DISCUSSION

Several collection trips were made to various coastal areas around Karachi between August 1988 and August 1990 and four species of *Ulva* were collected for the first time and identified as follows:

1. Mature thalli small, less than 5 cm in height.....2  
Mature thalli large, more than 5 cm in height.....3
2. Fronds 1.5-2.0 cm high, composed of two layers of cells of equal length.....  
.....*U. anandii*  
Fronds 2-5 cm high, composed of two layers of cells of unequal length.....  
.....*U. bifrons*
3. Blades lacunose, perforated.....*U. saifullahii*  
Blades unlacunose, not perforated.....*U. taeniata*

### 1. *ULVA ANANDII* AMJAD ET SHAMEEL SP. NOV.

(Figs.1a,2a-c)

#### MORPHOLOGICAL CHARACTERS:

Thallus very small, bright green, 1.5-2.0 (-3) cm high, 1-2(-3) cm broad, soft tufted, caespitose, with 2-3 fronds emerging from a discoid holdfast, 0.1-0.3 (-0.4) cm in diameter (Figs.1a and 2a); frond surface smooth and undulate, frill like margin; stipe short, hollow, 0.2-0.3 (-0.5) cm long, 0.1-0.2 (-0.3) cm in diameter; fronds adhering well to the paper, become yellowish green after drying on herbarium sheets.

#### ANATOMICAL CHARACTERS:

In surface view cells are squarish or polygonal, 15-18  $\mu\text{m}$  across, chloroplast almost completely filling the cell, each plastid usually contains a single pyrenoid (Fig. 2b). Thallus is composed of two equal rows of rectangular cells (Fig. 2c). In upper part: thallus 61-68 (-82)  $\mu\text{m}$  thick, cells 30-35 (-40)  $\mu\text{m}$  broad, central space 3-7  $\mu\text{m}$  wide, lateral wall 3.5-5 (-7)  $\mu\text{m}$  thick. In middle portion: thallus 102-116 (-119)  $\mu\text{m}$  thick, cells 41-48 (-51)  $\mu\text{m}$  long and 14-18 (-21)  $\mu\text{m}$  broad, central space 7-10  $\mu\text{m}$  wide, lateral wall 5-7  $\mu\text{m}$  thick. In lower part: thallus 122-133 (-136)  $\mu\text{m}$  thick, cells 41-50  $\mu\text{m}$  long and 17-20  $\mu\text{m}$  broad, central space 20-31  $\mu\text{m}$  wide, lateral wall 5-7  $\mu\text{m}$  thick. In stipe region: stipe 136-218  $\mu\text{m}$  thick, cells 24-31  $\mu\text{m}$  long and 10-20  $\mu\text{m}$  broad, lateral wall 7-10  $\mu\text{m}$  thick, central space 68-146  $\mu\text{m}$  wide, hyphae present, 3-10  $\mu\text{m}$  in diameter.

#### LATIN DIAGNOSIS:

*Thallus parvus, colore viridi claro, 1.5-2.0 (-3) cm altus, 1-2 (-3) cm latus, mollis, cristatus, caespitosus, 2-3 frondes ex firmum-tenente emergunt; frondes cum superficie levi et margine sicuti segmenta undata; stipes bervis, excavata, 0.2-0.3 (-0.5) cm longus, 0.1-0.2 (-0.3) cm linea media; firmum-tenens discoidum, 0.1-0.3 (-0.4) cm linea media; frondes cartae bene adhaerentes fiunt coloris subflavi-viridis post exsiccationem super cartam harbariam. Ex superficie vista, cellulae sunt quadratae vel polygonales, 15-18  $\mu\text{m}$  trans, contenta cellulam quasi complete implentia, cellula unaquaeque plerumque continent pyrenoidum singulare.*

#### HOLOTYPE:

Amjad-11 (KUH-SW, 19-9-1988), Buleji, Karachi, Pakistan.

#### ECOLOGICAL NOTES:

It occurs in the upper littoral zone on rocky ledges, forming a dense compact mat

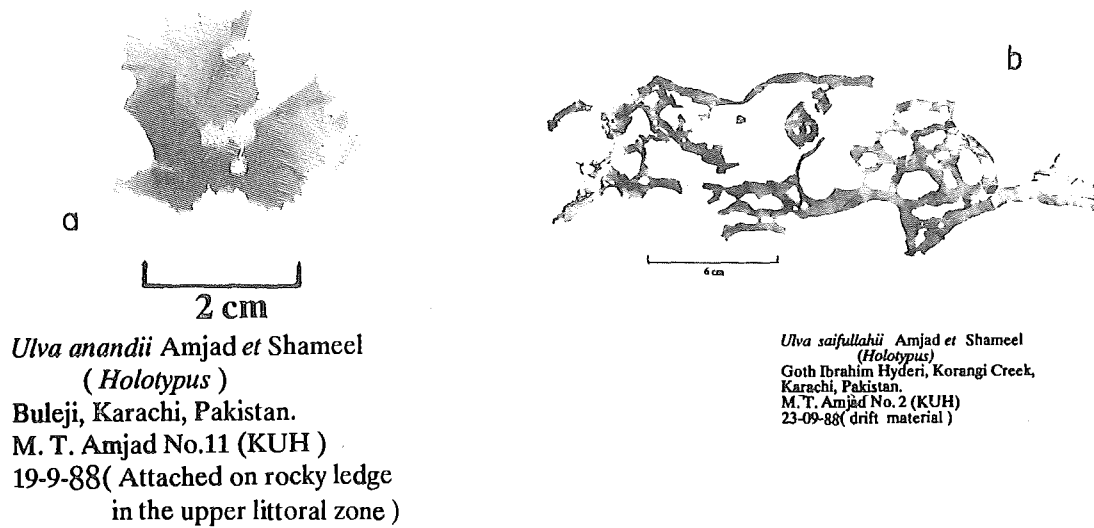


Fig.1. Habit of: (a) *Ulva anandii* Amjad et Shameel (Holotype no.KUH-SW-Amj-11), and (b) *Ulva saifullahii* Amjad et Shameel (Holotype no.KUH-SW-Amj-2).

on the silt covered stones along margin of the rocky ponds in *Ulva-Enteromorpha* belt. It may also extend into *Colpomenia sinuosa* (Roth) Derb. et Sol. belt in the mid-littoral zone, in clusters or as an epiphyte on *Sargassum tenerrimum* J. Ag. in rocky pools. It also grows on the conglomerate rocks along the coast, which are subjected to stormy wave action.

#### LOCAL DISTRIBUTION:

Manora (Leg. Amjad 10-10-1988), Buleji (Leg. Amjad 16-9-1988, 12-11-1988, 23-1-1990), Paradise Point (Leg. Amjad 23-1-1990), Nathiagali (Leg. Amjad 27-12-1989, 23-1-1990), Cape Monze (Shameel 22-3-1967).

#### GENERAL REMARKS:

This species has been named after Dr. Pyare Lal Anand, who conducted pioneering studies on the marine algae of Karachi. It was initially described by Anand (1940) as *Ulva indica* Anand, but his description included two different plants, small and large forms as he called them. The anatomical studies of the large form revealed that it is *Ulva bifrons* Ardré. Furthermore, he has given no latin diagnosis of *U. indica* and no specimen of this species is available in any Herbarium, even at the University of Punjab, Lahore, where he worked. Therefore, *U. indica* is a mixture of two different species and has been considered as *nomen nudum*. After removal of the large form (*U. bifrons*) the remaining small form of *U. indica* has now been given a new name *U. anandii* after the original collector. It resembles *Ulva californica* Wille in size of the blades and general habitat but differs from it in having a hollow stipe, 2-3 onate to lanceolate blades, squarish cells and one pyrenoid per cell, while *C. californica* posses solid stipe, several cuneate to reniform blades in dense turf like groups, angular cells and upto 4 pyrenoids per cell (Abbott and Hollenberg, 1976).

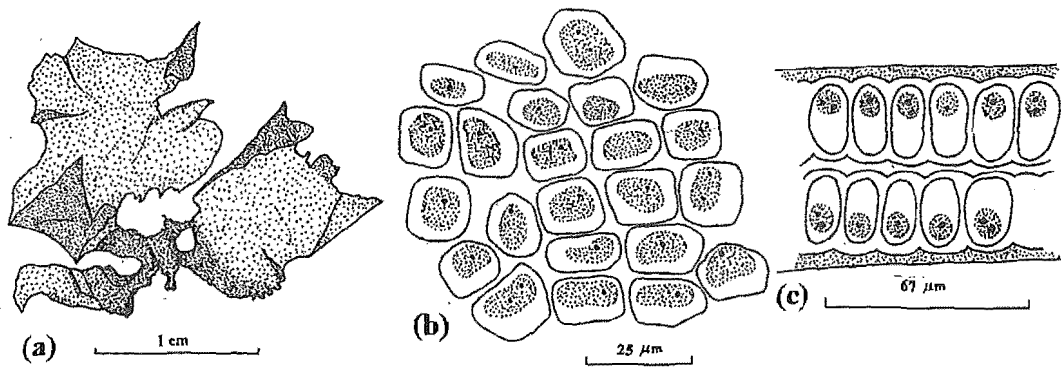


Fig.2. *Ulva anandii* Amjad et Shameel: (a) general habit of the thallus, (b) cells of the thallus in surface view, (c) transverse section from upper part of the thallus.

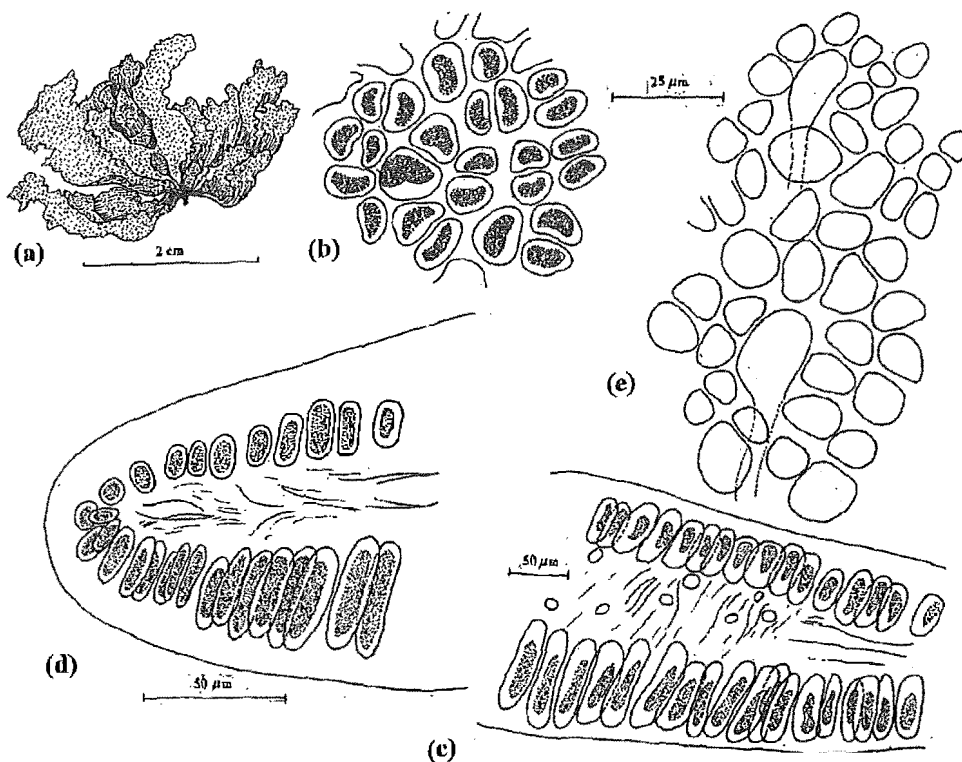


Fig.3. *Ulva bifrons* Ardre: (a) general habit of the thallus (b) cells of the blade in surface view, (c) transverse section from middle portion of the thallus, (d) transverse section from the lower part of the thallus, (e) cells of the stipe region in surface view.

## 2. *ULVA BIFRONS* ARDRE

(Figs.3a-e)

### REFERENCES:

Ardre 1967: 297, 1970: 339.

### MORPHOLOGICAL CHARACTERS:

Thallus small, dark green, 2-3 (-5) cm high, 1.5-3.5 (-4) cm broad, caespitose, with few to many blades, usually appear like a composite flower (Fig.3a); fronds having smooth surface and undulate margin; stipe small, 0.1-0.2 (-0.3) cm long, 0.1-0.3 (-0.4) cm in diameter; holdfast discoid, 0.2-0.3 (-0.4) cm in diameter; fronds not adhering well to the paper, becoming brownish green after drying on herbarium sheets.

### ANATOMICAL CHARACTERS:

In surface view cells are polygonal, 40-45  $\mu\text{m}$  across, usually contain 2-4 pyrenoids per chloroplast (Fig.3b). Thallus is composed of two unequal rows of rectangular cells. In upper part: thallus 99-105 (-112)  $\mu\text{m}$  thick, larger cells 34-41 (-45)  $\mu\text{m}$  broad, smaller cells slightly smaller in length than these, central space 7-10 (-14)  $\mu\text{m}$  wide, lateral wall 3-7 (-10)  $\mu\text{m}$  thick. In middle portion: thallus 105-123 (-130)  $\mu\text{m}$  thick, two rows of cells having unequal lengths, larger cells 41-44 (-48)  $\mu\text{m}$  long and 14-17 (-24)  $\mu\text{m}$  broad, smaller cells 3/4 in length than these, central space 10-14 (-17)  $\mu\text{m}$  wide, lateral wall 7-10 (-14)  $\mu\text{m}$  thick (Fig.3c). In lower part: thallus 163-180 (-187)  $\mu\text{m}$  thick, two rows of cells of unequal length, larger cells 37-51 (-55)  $\mu\text{m}$  long, smaller cells 1/2 the length of the larger ones, but somewhat equal in breadth *i.e.* 7-24  $\mu\text{m}$  broad, central space 51-58 (-68)  $\mu\text{m}$  wide, lateral wall 10-17  $\mu\text{m}$  thick (Fig.3d). In stipe region: stipe 221-343 (-357)  $\mu\text{m}$  thick, two rows of cells of unequal length, larger cells, 40-51  $\mu\text{m}$  long, smaller cells 1/2 the length of the larger ones, but somewhat equal in breadth *i.e.* 35-45  $\mu\text{m}$  broad, central space 102-258  $\mu\text{m}$  wide, lateral wall 20-31  $\mu\text{m}$  thick, rhizoids present, 10-14  $\mu\text{m}$  in diameter (Fig.3e).

### ECOLOGICAL NOTES:

This species occurs in the upper littoral zone, in small trenches filled with sand particles.

### TYPE LOCALITY:

Sesimbra, Portugal

### LOCAL DISTRIBUTION:

Buleji (*Leg.* Amjad 16-9-1988, 16-9-1989, 23-1-1990), Cape Monze (Shameel 22-3-1967).

### GENERAL REMARKS:

Karachi specimens differ from those of Portugal in composite flower like appearance. Portuguese plants bear 2-3 caespitose blades (Ardre, 1967), while Pakistani plants possess 4-6 and rarely upto 10 such blades, in which small row gradually decreases downwards.

3. *ULVA SAIFULLAHII* AMJAD ET SHAMEEL SP. NOV.  
(Figs. 1b, 4a-d)

**MORPHOLOGICAL CHARACTERS:**

Thallus grass green, 41-58  $\mu\text{m}$  thick, not adhering well to paper, becomes yellowish green on drying, surface smooth, covered with wax like material as part of the thallus, perforated, pores or lacunae mostly polygonal and oval, sometimes round, 1.5-2.7 (-3) cm across (Figs.1b, 4a and b). Most peculiar character is the wavy margin of lacunae, interlacunar distance somewhat equal in breadth, 0.2-0.6 (-1.5 cm).

**ANATOMICAL CHARACTERS:**

Cells are polygonal in surface view, irregularly arranged and not isodiametric (Fig.4c), chloroplast parietal with 4 scattered round pyrenoids. Thallus is composed of two rows of compact oval cells, and central space is lacking (Fig.4d). Thallus 41-58  $\mu\text{m}$  thick; cells 10-24  $\mu\text{m}$  long, 10-17  $\mu\text{m}$  broad at broader end and 10-14  $\mu\text{m}$  broad at the narrower end; lateral wall 7-10  $\mu\text{m}$  thick.

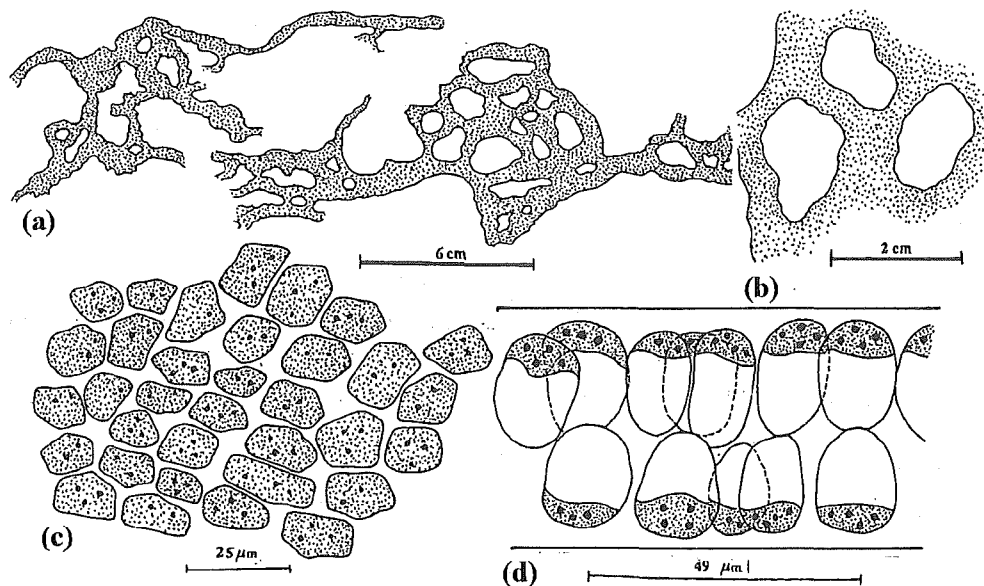


Fig.4. *Ulva saifullahi* Amjad et Shameel: (a) habit of the thallus, (b) a part of the thallus, magnified, (c) cells of the thallus in surface view, (d) transverse section from upper part of the thallus.

**LATIN DIAGNOSIS:**

*Thallus clore viridi acuto, 41-58  $\mu\text{m}$  latus, cartae non bene adhaerens, fit coloris subflavi-viridis post exsiccationem superficies levis, cum materia uti cera tectus, perforatus, foramina variis gaudent formis: polygonali, ovali vel rotunda. Character proprium est margo undata lacuniarum, spatia inter poralia aliquantum respectu latitudine equalia. Ex superficie vistae, cellulae sunt polygonales et irregulariter juxtapositae, nonisodiametricae, chloroplastum peripherale cum 4 pyrenoidis sparsis et rotundis.*

**HOLOTYPE:**

Amjad-2 (KUH-SW, 23-9-1988), Goth Ibrahim Hyderi, Korangi Creek, Karachi, Pakistan.

**ECOLOGICAL NOTES:**

This species occurs in the sub-littoral zone, growing on objects under water and has always been collected as drift.

**LOCAL DISTRIBUTION:**

Dhari (*Leg.* Amjad 6-9-1988), Goth Ibrahim Hyderi (*Leg.* Amjad 23-9-1988), Thermal Power Station, Korangi Creek (*Leg.* Amjad 6-9-1989, 3-10-1989, 12-10-1989).

**GENERAL REMARKS:**

This species has been named after Prof. Dr. S.M. Saifullah, Department of Botany, University of Karachi, who has made good contributions on the Ulvales and Dictyotales of Pakistan, mangroves and marine phytoplankton. *Ulva saifullahii* resembles *Ulva reticulata* Forsskål in morphology but differs in surface and texture of thallus, shape, size and margin of lacunae, shape and dimensions of cells and number of pyrenoids per cell (Table I). It also resembles *Ulva beytensis* Thivy et Sharma in morphology, but differs in size of the perforations, thickness of the thallus and intact margin of the lacunae (Thivy and Sharma, 1966; Krishnamurthy and Joshi, 1968).

**4. *ULVA TAENIATA* (SETCHELL) SETCHELL ET GARDNER  
(Figs. 5a-c)**

**BASIONYM:**

*Ulva fasciata* f. *taeniata* Setchell 1901: *Phyc. Bot. Amer.* No. 862.

**SYNONYMS:**

*Ulva fasciata* sensu Harvey 1858: 58, *Ulva fasciata* f. *taeniata* Setchell et Collins 1903:10

**REFERENCES:**

Setchell and Gardner 1920 a: 286, 1920 b: 273; Smith 1944: 48; Chapman 1956: 387; Abbott and Hollenberg 1976: 87; Saifullah and Nizamuddin 1977: 522; Womersley 1984: 149.

**MORPHOLOGICAL CHARACTERS:**

Thallus composed of segments, light green, 8-60 (-70) cm high; holdfast discoid, 0.2-0.3 (-0.5) cm in diameter; stipe small 0.2-0.6 (-1.5) cm long, flattened, sometimes furcate, producing two to several elongate blades (Fig.5a); fronds adhering well to the paper, becoming yellowish green after drying, spirally coiled, margin more or less spiny, usually wavy, surface smooth and spirally folded; segments narrow at the base 0.2-0.8 (-1.5) cm broad, in the middle 1-6 (-8) cm broad, tapering at the tip 0.3-3 (-5) cm broad.

**ANATOMICAL CHARACTERS:**

Cells are arranged in small rows in surface view or irregular, more or less isodiametric (Fig.5b), 10-15  $\mu\text{m}$  across in the upper and middle parts of the thallus, becoming 20-24  $\mu\text{m}$  across near the base; pyrenoids are usually 1-3 per chloroplast but 1-2 per plastid in the basal part. Thallus is composed of two rows of compact rectangular cells (Fig.5c). In upper part: thallus 75-102 (-116)  $\mu\text{m}$  thick, cells 27-37  $\mu\text{m}$  long and 14-17  $\mu\text{m}$  broad, central space 7-17  $\mu\text{m}$  wide, lateral wall 10-14  $\mu\text{m}$  thick. In middle portion: thallus 75-119 (-130)  $\mu\text{m}$  thick, cells 27-41  $\mu\text{m}$  long and 14-17 (-20)  $\mu\text{m}$  broad, central space 10-20 (-24)  $\mu\text{m}$  wide, lateral wall 10-17  $\mu\text{m}$  thick. In lower part: thallus 116-153  $\mu\text{m}$  thick, cells 34-41 (-45)  $\mu\text{m}$  long and 14-24  $\mu\text{m}$  broad, central space 17-51 (-59)  $\mu\text{m}$  wide, lateral wall 10-17  $\mu\text{m}$  thick, space filled with thickened material. In stipe region: stipe 108-286 (-316)  $\mu\text{m}$  thick, cells small, 24-31  $\mu\text{m}$  long and 14-17  $\mu\text{m}$  broad, lateral wall 17-24  $\mu\text{m}$  thick, central space 24-187 (-228)  $\mu\text{m}$  wide, rhizoids present in the central space, 7-10  $\mu\text{m}$  in diameter.

**ECOLOGICAL NOTES:**

This species grows on the fringes of the upper and mid-littoral pools, sometimes on bare rocks. Its segments or blades appear twisted or spiral, because of the waves passing in a pool.

**TYPE LOCALITY:**

Monterey, California, USA

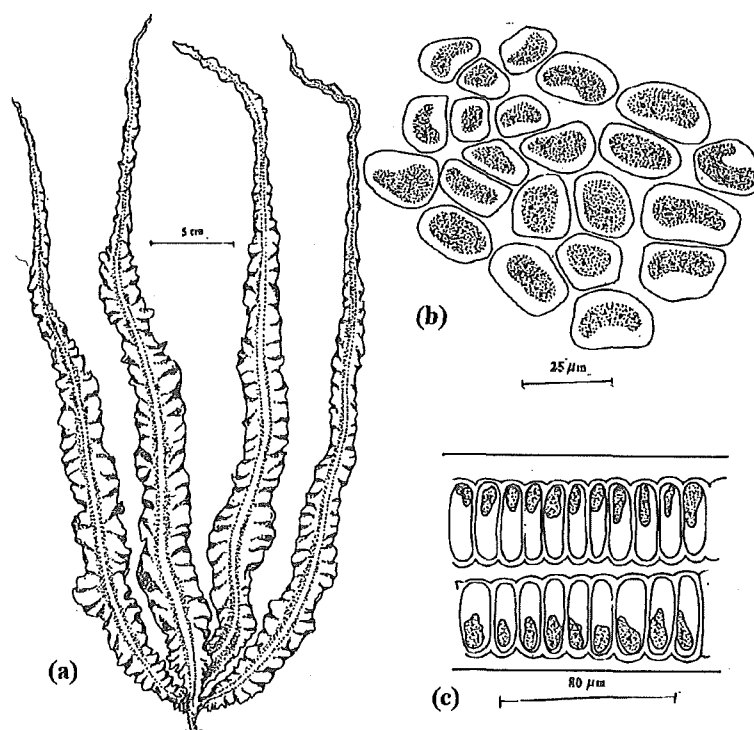


Fig.5. *Ulva taeniata* (Setchell) Setchell et Gardner: (a) habit of the thallus, (b) cells of the thallus in surface view, (c) transverse section from upper part of the thallus.



## LOCAL DISTRIBUTION:

Manora (*Leg.* Amjad 11-11-1988, 30-11-1988, 11-11-1989), PNS Qasim (*Leg.* Nizamuddin 13-1-1965, Shameel 18-12-1967), Sandspit (*Leg.* Amjad 30-9-1988, 11-11-1989, 20-11-1989), Kaka Pir (Nizamuddin 1-1-1963), Paradise Point (Nizamuddin 12-02-1965, Shameel 22-3-1965), Cape Monze (Nizamuddin 13-4-1964, 28-12-1964, 23-3-1965, 3-4-1965).

Table I: Comparative features of *Ulva reticulata* and *Ulva saifullahii* from Karachi coast.

Features	<i>Ulva reticulata</i>	<i>Ulva saifullahii</i>
<b>Thallus:</b>		
Colour in living	dark green	grass green
Colour after drying	light green	yellowish green
Adherence to herbarium sheet	slight adherence	no adherence
Surface	no waxy sheath	bears waxy sheath
Texture	thick (63.5 $\mu\text{m}$ at upper part)	thin (53 $\mu\text{m}$ at upper part)
<b>Lacunae (pores):</b>		
Shape	variable <i>i.e.</i> circular, oval, oblong or rectangular	mostly polygonal and oval, sometimes round
Margin	having tiny set of teeth at varying intervals	somewhat wavy
Size	1.0 - 3.2 cm	1.5 - 2.7 cm
Interlacunar distance	highly variable (0.5 - 3.0 cm)	less variable (0.2 - 1.5 cm)
<b>Cells:</b>		
Shape in surface view	isodiametric and polygonal	polygonal, not isodiametric
Shape in T.S.	square in upper and middle parts, rectangular in lower and stipe regions	somewhat oval
Length	24.5 $\mu\text{m}$ (in upper part)	18 $\mu\text{m}$ (in upper part)
Breadth	20.5 $\mu\text{m}$ (in upper part)	14 $\mu\text{m}$ (in upper part)
Pyrenoids	2 - 3 per cell	4 per cell

**GENERAL REMARKS:**

*Ulva taeniata* resembles *Ulva fasciata* Delile in possessing linear, lanceolate, elongated segments, but differs in texture, lower spiral part and twisted segments. That is why Harvey (1858) confused it with *U. fasciata* and Setchell (1901) considered it as *U. fasciata f. taeniata*. Later on Setchell and Gardner (1920 a,b) raised it to the specific level, as *U. taeniata*. Saifullah and Nizamuddin (1977) also considered the Karachi plants as *U. fasciata f. taeniata*. The specimens from Karachi exactly resemble those of California, USA (Abbott and Hollenberg, 1976) and South Australia (Womersley, 1984). A comparison of morphological and anatomical features of both these species of *Ulva* has been presented in Table II, which clearly indicates that *U. taeniata* is an independent species and not a form of *U. fasciata*. *Ulva taeniata* also resembles *Ulva stenophylla* Setchell et Gardner in habit but differs in having divided fronds from near the base, while the later possesses simple fronds.

Table II: Comparative features of *Ulva fasciata* and *Ulva taeniata* from Karachi coast.

Features	<i>Ulva fasciata</i>	<i>Ulva taeniata</i>
<b>Thallus:</b>		
Colour in living	dark green	light green
Colour after drying	brownish green	yellowish green
Adherence to herbarium sheet	not adhering well	adhering well
Surface	bears waxy sheath	no waxy sheath
Texture	thin (75-209 $\mu\text{m}$ , from tip to base)	thick (94-264 $\mu\text{m}$ , from tip to base)
<b>Segments:</b>		
Nature	straight	spirally coiled
Shape	broad at the base, gradually tapering towards the tip	broad in the middle, narrow at the tip but not tapering
<b>Basal portion:</b>		
Margin	having no folds but teeth like structures	bearing spiral folds
Texture	thin	very thick
Stipe	bifurcated	not bifurcated
<b>Anatomy:</b>		
Lateral wall	7 - 19 $\mu\text{m}$ thick	10.5-21.5 $\mu\text{m}$ thick
Central space	7.0 - 116.5 $\mu\text{m}$ wide (from tip to stipe)	12.0 - 16.0 $\mu\text{m}$ wide (from tip to stipe)
<b>Cells:</b>		
Length	13.5 - 27.5 $\mu\text{m}$	30 - 39 $\mu\text{m}$
Breadth	13.5 - 20.5 $\mu\text{m}$	14 - 17.5 $\mu\text{m}$

5. *ULVA GRANDIS* SAIFULLH ET NIZAMUDDIN

This species was named by Saifullah and Nizamuddin (1977) as *U. grande* on the basis of its very large thalli (40-180 cm long and 30-80 cm broad), but as an adjectival specific epithet it must correspond with the gender of the generic name, therefore the correct specific epithet should be *U. grandis*. This species appears to be endemic to the coast of Arabian Sea, so far it has not yet been reported from anywhere else. Recently it is also reported from the coast of Jeddah, Saudi Arabia (Saifullah and Nizamuddin, 1992). It is not very abundant at Karachi and has so far been collected only from the breakwater of Keamari Harbour and Manora Island.

## ACKNOWLEDGEMENTS

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## REFERENCES

- Abbott, I.A. and G.J. Hollenberg. 1976. *Marine Algae of California*. Stanford University Press, Stanford, California, USA, Pp.1-827.
- Anand, P.L. 1940. *Marine Algae from Karachi*. I. *Chlorophyceae*. Punjab University Botanical Publications, Lahore, Pakistan : 1-52.
- Ardre, F. 1967. Une Ulve à thalle remarquable des Côtes du Portugal. *Revue Algologique* N.S, 8:292-297.
- Ardre, F. 1970. Contribution a l'étude des algues marines du Portugal. I. La flora. *Portugese Acta Biologica* 10: 1-423.
- Chapman, V.J. 1956. The marine algae of New Zealand. I. Myxophyceae and Chlorophyceae. *Journal of Linnean Society of London* 55: 333-501.
- Collins, F.S. 1903. The Ulvaceae of North America. *Rhodora* 5: 1-131.
- Harvey, W. H. 1858. Nereis boreali-americana. III. Chlorospermeae. *Smithsonian Contribution to the Knowledge* 10: 1-140.
- Krishnamurthy, V. and H. V. Joshi. 1969. The species of *Ulva* L. from Indian waters. *Botanical Journal of Linnean Society* 62: 123-130.
- Saifullah, S.M. and M. Nizamuddin. 1977. Studies of the marine algae from Pakistan: Ulvales. *Botanica Marina* 20: 521-535.
- Saifullah, S.M. and M. Nizamuddin. 1992. Two most abundant species of *Ulva* and *Enteromorpha* from coast of Jeddah, Saudi Arabia. *Pakistan Journal of Marine Sciences* 1: 23-28.
- Setchell, W.A. 1901: Notes on algae-I. *Zoe* 5: 121-129.
- Setchell, W. A. and N. L. Gardner, 1920 a. Phycological contributions-I. *University of California Publication in Botany* 7: 279-324.
- Setchell, W.A. and N. L. Gardner. 1920 b. The marine algae of the Pacific coast of North America. II. Chlorophyceae. *University of California Publication in Botany* 8: 139-375.
- Shameel, M. 1987. A preliminary survey of seaweeds from the coast of Lasbela, Pakistan. *Botanica Marina* 30: 511-515.

- Shameel, M. and S. Afaq-Husain. 1987. Survey of algal flora from Lasbela coast. *In*: I. Ilahi and F. Hussain (eds.): Modern trends of plant science research in Pakistan. *Proceeding of National Conference of Plant Scientists 3*: 292-299.
- Shameel, M., S. Afaq-Husain and S. Shahid-Husain. 1989. Addition to the knowledge of seaweeds from the coast of Lasbela, Pakistan. *Botanica Marina 32*: 177-180.
- Smith, G. M. 1944. *Marine Algae of the Monterey Peninsula, California*. Stanford, California, USA. Pp. 1-622.
- Thivy, F. and H. C. Sharma. 1966. *Ulva beytensis* sp. nov. from Gujarat. India. *Current Sciences 35*: 150-151.
- Womersley, H. B. S. 1984. *The Marine Benthic Flora of Southern Australia-I*. D.J. Woolman, Govt. Printer, Australia, Pp. 1-329.