Pak.J.Bot., 31(1): 199-210, 1999.

DISTRIBUTION AND SEASONAL BIOMASS OF SEAWEEDS ON THE ROCKY SHORE OF BULEJI, KARACHI, PAKISTAN

SHAISTA HAMEED AND MUZAMMIL AHMED

Centre of Excellence in Marine Biology,
University of Karachi, Karachi-75270, Pakistan.

Abstract

Of a total of 41 genera and 66 species of red, green and brown seaweeds collected from the rocky shore of Buleji during August, 1993 to July 1994, highest number of 34 species was observed in January and lowest number of 2 species in July with highest record of 13,833 g/m^2 and lowest 105 g/m^2 fresh weight of seaweeds. Highest fresh weight of 41,313.5 g/m^2 was produced by brown seaweeds. The high-tide zone of the exposed shore showed luxuriant growth of *Ulva fasciata, Jolyna laminarioides, Melanothamnus somaliensis* and *Chaetomorpha antennina*. Comparing the earlier record of some 25 years ago showed a decrease of algal biomass and an increase in species diversity in the same area.

Introduction

Extensive studies on the taxonomy of seaweeds from the coast of Pakistan have been carried out (Bϕrgesen, 1930, 1931, 1932, 1933; Anand, 1940, 1943; Dixit, 1964, 1968; Salim, 1965; Nizamuddin & Gessner, 1970; Saifullah, 1977; Nizamuddin & Parveen, 1986; Saifullah & Nizamuddin, 1992). Ahmed *et al.*, (1982) have dealt with the distribution and abundance of intertidal organisms on some beaches of Makran coast in Pakistan. Saifullah *et al.*, (1984) conducted quantitative ecological studies of seaweeds of Karachi. Similarly extensive surveys on the seaweeds from the coast of Pakistan have been made by Shameel (1987); Begum & Khatoon (1988); Shameel *et al.*, (1989); Shameel & Tanaka (1992); Shaikh & Shameel (1995) and Shameel *et al.*, (1996). Hameed (1996) worked on the zonation patterns and seasonal biomass of intertidal macro-organisms of the rocky ledge of Pacha near Karachi. The present report describes changes in the distribution, abundance and biomass of the seaweeds found on the exposed rocky ledge of Buleji as compared to the studies carried out some 25 years ago by Saifullah (1973) with subsequent reports of Qari (1985) and Qari & Qasim (1988).

Materials and Methods

Buleji is a more frequently visited rocky ledge at a distance of 30 km from Karachi (24° 51' W 66° 48' SW). Meteorological parameters, air and water temperatures (°C), salinity (o/oo), dissolved oxygen (ml/l), pH and tide (m) were noted. The whole shore was divided into three transect lines viz., A, B and C. Transect line A was placed on the left side (looking towards the sea) of the shore which is more sandy and less rocky semi-protected beach. Transect line B was placed in the centre of the rocky ledge which is directly exposed to the open sea. Transect line C was laid on right side of the shore

facing heavy wave action directly from the sea. A one foot^2 (0.304 m^2) iron frame was used as quadrat. An average of 25 quadrats were taken from transect line A, 40 from transect line B and 11 from transect line C. The distance between quadrats was 10 m. All seaweeds within each quadrat were removed from their substrate, placed in prelabelled plastic bags, brought to the laboratory, washed with tap water and fresh weight determined. The dry weight was measured after keeping the samples at 70°C for 24 hours.

Results

Highest fresh weight biomass of seaweeds (13,833.4 g/m^2) was observed in January when dissolved oxygen was high (7.4 ml/l) and salinity (36 o/oo with lowest in May (104.8 g/m^2) when dissolved oxygen was low (3.7 ml/l) and salinity was normal (35 o/oo) indicating that the amount of dissolved oxygen was directly proportional to the abundance of seaweeds on the beach area. During the observation period, 41 seaweed genera (20 red, 13 brown and 8 green) were collected (Table 1). Figures 1A and 1B show seasonal variation in biomasses of red, green and brown seaweeds. The following numbers of seaweeds were collected from Buleji during the study period:

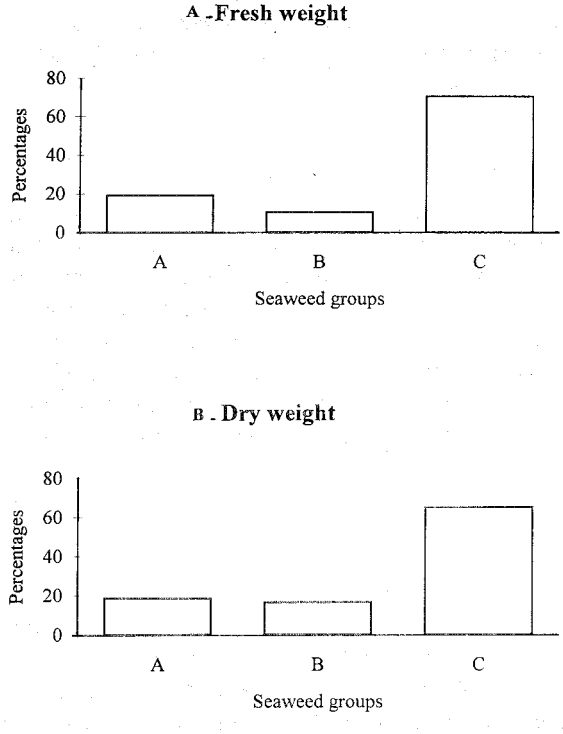

Fig.1. Seasonal variation in biomasses of different seaweed groups at Buleji. A-green, B-red and C-brown seaweeds.

Table 1. Seasonal variation in the fresh weight of seaweeds (g/m^2) during August 1993 to July 1994 at Buleji

Groups	A	S	O	N	D	J	F	M	A	M	J	J	Total
						Fresh weight (g/m^2)							
Green Seaweeds													
Caulerpa faridii	-	-	-	-	62.7	3.8	-	-	-	-	-	-	66.5
C. manorensis	-	-	-	-	32.7	-	-	-	-	-	-	-	32.7
C. racemosa	-	-	26.4	-	-	28.1	-	-	-	-	-	-	54.6
C. scalpelliformis	-	-	-	-	21.5	0.6	-	-	-	-	-	-	22.1
C. taxifolia	-	-	-	-	38.2	177.5	24.0	-	223.6	-	-	-	463.3
C. veravalensis	-	-	-	-	-	21.6	-	-	-	-	-	-	21.6
Chaetomorpha antennina	121.9	96.3	0.5	-	-	-	-	-	-	-	-	-	218.8
C. prostrata	-	-	-	-	1.6	-	-	-	-	-	-	-	1.6
Codium iyengarii	-	-	1.0	169.4	404.6	995.3	867.0	1268.4	982.4	-	-	-	4688.0
C. latum	-	-	-	-	-	-	-	12.5	-	-	-	-	12.5
Enteromorpha intestinalis	-	-	-	-	-	18.0	-	-	-	-	-	-	18.0
E. procera	-	-	-	4.7	-	-	-	-	-	-	-	-	4.7
Halimeda tuna	-	-	184.3	-	112.0	-	-	-	6.8	19.5	-	-	322.5
Udotea indica	-	-	-	8.6	6.2	28.0	-	-	-	-	-	-	42.8
Ulva fasciata	790.5	501.8	334.3	320.3	-	-	-	-	-	-	1212.8	911.6	4071.3
U. rigida	-	-	-	-	-	2.9	4.0	-	-	-	-	-	6.9
Valoniopsis pachynema	-	-	3702	272.7	-	606.2	-	-	-	-	-	-	1249.1
Red Seaweeds													
Acanthophora spicifera	-	-	563.1	134.6	29.3	15.7	1.5	-	-	-	-	-	744.3
Ahnfeltia plicata	-	-	-	-	0.8	-	-	-	-	-	-	-	0.8
Botryocladia leptopoda	-	-	-	-	-	-	32.0	-	-	-	-	-	32.0
Calliblephais fimbriata	-	-	-	-	-	-	-	-	74.4	-	-	-	74.4
Ceramium manorense	7.9	-	-	71.4	263.6	189.3	-	-	-	-	-	-	532.2
Champia globulifera	-	-	-	-	-	26.3	-	-	-	-	-	-	26.3
C. plumosa	-	-	-	-	76.5	-	-	-	-	-	-	-	76.5
Coelarthrum muelleri	-	-	-	-	-	-	-	-	102.7	-	-	-	102.7
Galaxaura oblongata	-	-	-	0.7	-	54.3	-	-	-	-	-	-	55.0
Gelidium folifera	-	0.9	-	0.1	39.5	0.5	0.2	-	-	-	-	-	41.2
G. pusillum	66.6	-	-	24.9	-	-	-	-	35.8	-	-	-	127.3
G. usmanghanii	-	-	6.4	-	-	-	-	-	-	-	-	-	6.4
Gracilaria sp.	-	-	132.9	-	-	-	-	-	-	-	-	-	132.9
G. verrucosa	-	-	-	78.5	-	-	-	-	-	-	-	-	78.5
Halymenia porphyroides	-	-	-	39.3	-	-	214.4	-	-	-	-	-	253.7
Hypnea sp.	-	-	208.6	-	-	72.3	10.9	-	-	-	-	-	291.8
H. musciformis	-	-	10.6	30.7	-	14.4	-	1.0	-	-	-	-	56.6
Jania adherens	-	-	-	-	14.5	-	-	-	0.4	-	-	-	14.9

Table 1 (Cont'd)

Groups	A	S	O	N	D	J	F	M	A	M	J	J	Total
J. caillacea	4.7	22.2	9.9	83.7	267.0	764.1	25.2	-	339.2	83.5	324.9	36.5	1960.8
H. musciformis	-	-	10.6	30.7	-	14.4	-	1.0	-	-	-	-	56.6
Jania adherens	-	-	-	-	14.5	-	-	-	0.4	-	-	-	14.9
J. capillacea	4.7	22.2	9.9	83.7	267.0	764.1	25.2	-	339.2	83.5	324.9	36.5	1960.8
Laurencia sp.	-	-	-	2.5	37.8	29.2	-	4.4	1.3	-	-	-	75.1
L. obtusa	-	-	-	-	-	-	29.9	-	-	-	-	-	29.9
L. pinnatifida	41.6	23.7	-	498.7	-	-	-	-	-	-	-	-	564.0
L. platyclada	-	-	-	64.1	-	-	-	-	-	-	-	-	64.1
Melanothamnus somaliensis	-	504.0	-	-	-	-	-	-	-	-	-	-	504.0
Plocamium cartilagineum	-	-	-	-	-	2.6	-	-	-	-	-	-	2.6
Sarcodia dichotoma	-	-	-	-	-	-	71.9	-	4.3	-	-	-	76.2
Sarconema furcellatum	-	-	-	-	-	-	-	-	-	1.8	-	-	1.8
Scinaia indica	-	-	-	-	-	28.8	-	-	-	-	-	-	28.8
Solieria robusta	-	-	-	-	-	-	107.3	6.6	95.0	-	-	-	209.0
Brown Seaweeds													
Colpomenia sinuosa	-	-	3.0	12.4	34.7	746.3	427.1	401.6	-	-	-	-	1625.1
Cystoseira sp.	-	-	-	-	1.4	-	-	-	-	-	-	-	1.4
Dictyota sp.	-	-	-	864.4	413.1	155.7	17.9	12.8	1.9	-	-	-	1465.8
D. dichotoma	-	-	-	51.6	39.7	145.8	-	-	225.6	-	-	-	462.7
D. indica	-	-	6.8	-	-	-	-	-	-	-	-	-	6.8
Hydroclathrus hydroclathrus	-	-	-	-	-	-	-	27.1	-	-	-	-	27.1
Lyengeria stellata	-	-	174.3	2113.1	1988.2	2657.5	64.7	980.9	456.2	-	-	-	8434.9
Jolyna laminarioides	59.5	207.3	-	-	-	-	-	-	-	-	-	-	266.9
Lobophora variegata	-	-	-	-	-	5.2	-	28.7	-	-	-	-	33.9
Padina pavonia	-	-	63.2	4.9	55.4	27.7	4.8	74.3	18.8	-	-	-	249.2
P. tetrastromatica	-	-	5.2	69.9	28.9	200.6	74.2	74.2	-	-	-	-	452.8
Pockoceilla sp.	-	-	13.2	-	-	-	-	-	-	-	-	-	13.2
Sargassum sp.	0.8	-	-	-	-	-	-	-	-	-	-	-	0.8
S. boveanum	-	-	-	19.1	99.7	40.6	-	26.4	-	-	-	-	185.8
S. crassifolium	-	-	-	-	-	-	298.6	-	-	-	-	-	298.6
S. filiformis ?	-	-	-	-	1834.0	350.2	4430.7	8899.9	548.5	-	-	-	16063.4
S. tenerrimum	-	-	533.7	83.0	24.0	73.3	-	8.1	6.4	-	-	-	728.5
Spatoglossum vaiabile	-	-	10.1	54.3	48.1	43.1	57.2	6.3	35.0	-	-	-	254.0
Stoechospermum marginatum	-	-	216.3	769.9	960.7	272.7	5.4	-	-	-	-	-	2225.1
Stokeyia indica	-	-	-	-	339.7	6035.3	976.5	942.1	224.0	-	-	-	8517.5
Total:	1093.5	1356.1	2874.1	5847.5	7276.0	13833.4	7745.4	12775.3	3382.3	104.8	1537.8	948.1	58774.3

from the high-tide zone, 11 green, 17 red and 20 brown; from the mid-tide zone, 8 green, 18 red and 16 brown; and from the low-tide zone, 13 green, 18 red and 15 brown seaweeds. Table 2 shows the seasonal variation in biomass m^2/month of fresh and dry weights of seaweeds.

Only *Jania capillacea* was available during the entire study period except March. There were no green seaweeds on the ledge in May, June and July except some *Ulva fasciata* which occurred in June and July and *Halimeda tuna* in March. There was no red seaweed during May-July except *J. capillacea* and *Sarcodia dichotoma*. Brown seaweeds were totally absent during May, June and July. Monthly fluctuations among the total number of different groups of seaweeds and of the total number of seaweed species are shown in Figs. 2A and 2B. Figures 3A and 3B represent monthly variation in the fresh and dry weights of seaweeds in different tidal zones.

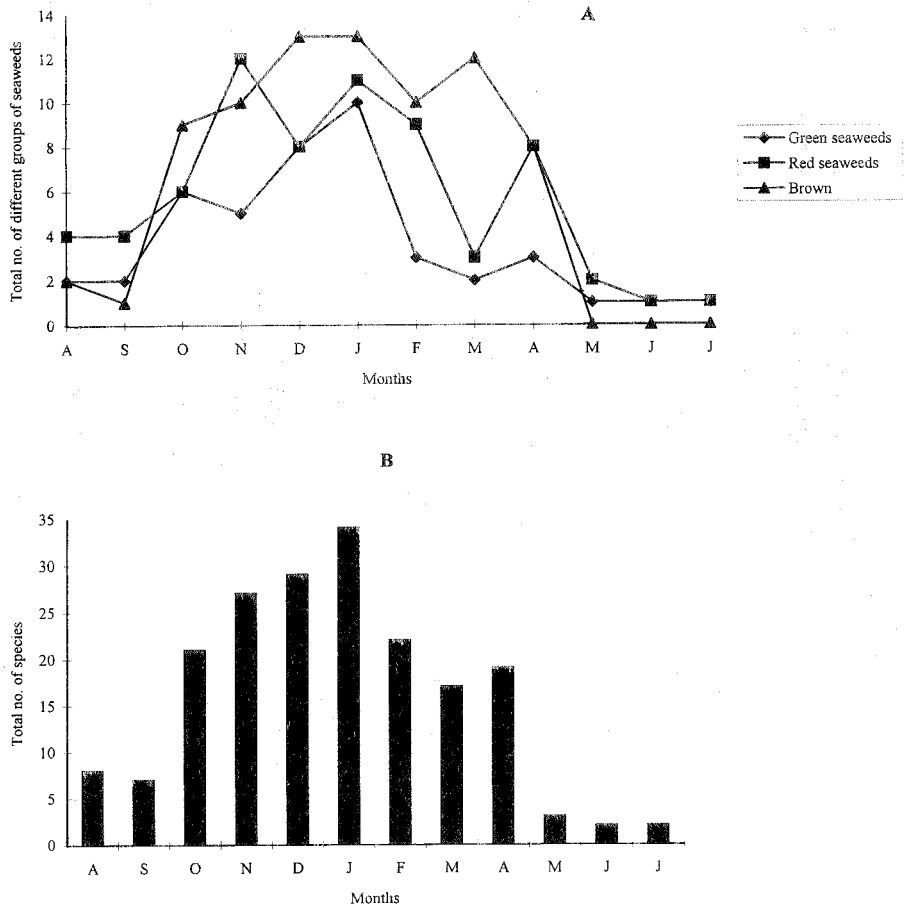

Fig.2. A. Monthly fluctuation among the total number of different groups of seaweeds. B. Seasonal variation in the total number of seaweed species at Buleji.

Table 2. Monthly variation in the biomass per m^2/month of seaweeds during the study period August 1993 to July 1994 at Buleji

Biomasses	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.
Fresh weight	60.6	8.35	14.07	270.4	346.1	606.1	390.7	607.7	135.6	4.47	88.2	42
Dry weight	15.4	16.70	23.7	70.4	74.3	93.4	59.1	70.1	25.8	3.37	27.5	8

Table 3. Seasonal fluctuation in Shannon-Weiner (S) and Evenness (E) Indices of seaweed groups at Buleji

Seaweed groups	Indices	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.
Green	S	0.30	0.30	0.60	0.60	0.60	0.60	0.47	0.30	0.47	0	0	0
	E	1.00	1.00	0.70	0.86	0.66	0.63	1.00	1.00	1.00	0	0	0
Red	S	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.47	0.60	0.30	0	0
	E	1.00	1.00	0.70	0.55	0.66	0.57	0.63	1.00	0.66	1.00	0	0
Brown	S	0.30	0	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0	0	0
	E	1.00	0	0.63	0.60	0.54	0.54	0.60	0.55	0.66	0	0	0
Among all seaweed groups	S	0.45	0.41	0.46	0.45	0.46	0.47	0.43	0.34	0.44	0	0	0
	E	0.94	0.86	0.98	0.94	0.97	0.99	0.90	0.73	0.92	0	0	0

Highest fresh weight of seaweeds was recorded in the high-tide zone due to the preponderance of *U. fasciata, Jolyna laminarioides, Chaetomorpha antennina, Melanothamnus somaliensis, Stokeyia indica, Caulerpa racemosa, Sargassum tenerrimum, Valoniopsis pachynema, Stoechospermum marginatum, Gelidium usmanghani* and *Gracilaria folifera*. Dense growth of seaweeds was noted on the lowermost part of the seaward covered ledge (transect line C) of the shore characterized by *M. somaliensis*, *U. fasciata* and *C. antennina* which showed high incidence (35%) as compared to the algae occurring on the low (34%) and the mid-tide (31%) zones (Fig. 4). Maximum dry weight of seaweeds was also found in the high-tide zone (Fig. 3A). Highest fresh weight was recorded in January due to the presence of *I. stellata, C. iyengarii, S. indica, V. pachynema, C. sinuosa, J. capillacea, C. racemosa, S. tenerrimum, P. tetrastromatica* and *Dictyota* sp.

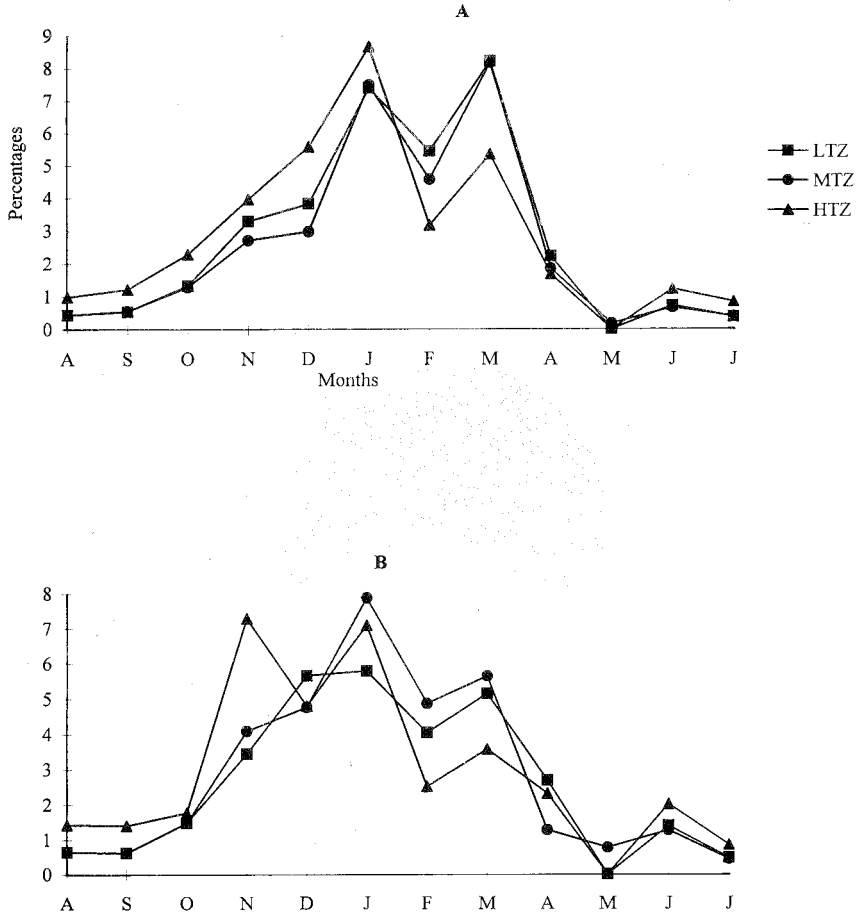

Fig.3. Monthly variation in the biomasses of all seaweed groups in different tide zones at Buleji (A-Fresh weight, B-Dry weight). LTZ-low-tide zone, MTD-mid-tide zone and HTZ-high-tide zone.

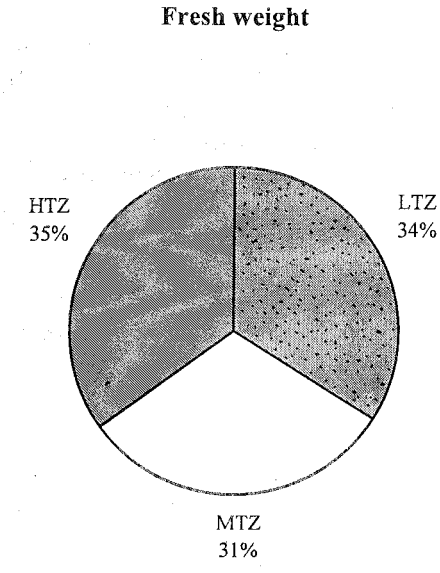

Fig.4. Percentage incidence of seaweed biomasses in different tide zones during the period August 1993 to July 1994 at Buleji.

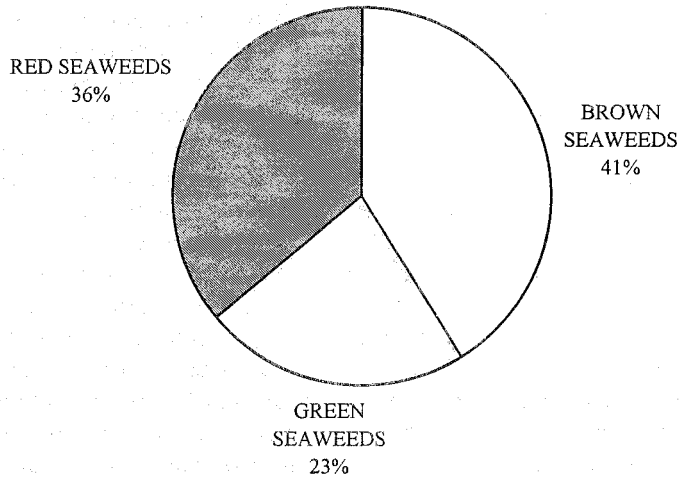

Fig.5. Percent incidence among different groups of seaweed species during the observed period.

Highest dry weight was found in the mid-tide zone (Fig. 3B) due to the absence of *C. iyengarii* which retains high amount of water in its thalli. The percent indices among different groups of seaweeds are given in Fig. 5. For biomass, the pre-monsoon season (37,736.4 g/m^2) was more productive than the post-monsoon (15,997.6 g/m^2) and the monsoon (5040.3 g/m^2) seasons. Highest values of species diversity (Shannon-Weiner Index; 0.47) and relative diversity/homogeneity (Evenness Index; 0.99) were recorded in January (Table 3).

Discussion

Of the 41 genera and 66 species of seaweeds collected during one year study, 8 green, 13 brown and 20 red sea weeds were recorded. It is interesting to note that Saifullah (1973) reported 48 species of drift and attached seaweeds from the rocky ledge of Buleji. In the present study, an average of 23 quadrats per month or 277 quadrats during the study period of 1993-1994 were taken where Saifullah (1973) took an average of 5 quadrats per month or 28 quadrats during his 6 month's study period where a fewer number of species from Buleji were reported. Qari (1985) and Qari & Qasim (1988) found 21 edible seaweeds from the rocky ledges of Manora and Buleji. Recently, Hameed (1996) has reported 85 species comprising of 19 green, 23 brown and 43 red algae from the rocky bench of Pacha.

During the present study, the brown algae formed the highest fresh/wet weight which mainly comprised of *S. filiformis, S. indica, I. stellata, S. marginatum, C. sinuosa, Dictyota* sp., *S. tenerrimum, D. dichotoma, P. tetrastromatica* and *S. crassifolium* as compared to green and red algae. Saifullah (1973) found a dominance of *I. stellata, P. tetrastromatica, D. divericata, Taonia* sp. and *Sargassum* sp., at Buleji. The difference in occurrence of seaweed species in the two studies may be due to pollution and overexploitation of seaweed resources from the area under study.

In the present study the central rocky ledge of Buleji (transect lines B and C) was found to be the richer than east Buleji (sandy shore; TLA). Earlier Saifullah (1973) had also stated that the central Buleji area was more productive than eastern Buleji area, because the former locality is mostly rocky having different kinds of habitats like shallow pools, boulders, crevices and sheltered areas which provide protection and substratum for attachment to many algae. The eastern part of Buleji, is however, sandy and does not provide suitable substratum for the growth of epilithic algae.

Highest fresh weight of seaweeds was observed from the high-tide zone exposed to the open sea indicating that high-tide zone provides enriched conditions favourable to high biological productivity than low and mid-tide zones as also reported by Rao & Sreermulu (1964). During the winter season higher biomass (26,956.9 g/m^2) was recorded as compared to other seasons. Saifullah (1973) had earlier pointed out that the winter is the most favourable period for growth of both littoral and sublittoral algae. During the study period seasonal distribution of algae showed that the pre-monsoon season was more fertile than the post-monsoon and monsoon seasons. Saifullah (1973) had pointed out that at Buleji production of seaweeds would be low during the south-west monsoon season but high during the northeast monsoon season. According to Hameed (1996) the early northeast monsoon season was conducive for the optimum growth of seaweeds (57,211.3 g/m^2) at Pacha. In the present study, Shannon Weiner Index (species diversity) was found to be very high (average o.86 in six months) as compared to that given by Saifullah *et al.*, (1984; 0.78 in six month's observation period). In the present study an average value of 0.6 of Evenness Index was higher than o.21 as reported by Saifullah *et al.*, (1984). The difference in species diversity and Evenness Indices may be due to the large area covered in the present study.

During the one year study at Buleji 58,774.3 g/m^2 of seaweed biomass was collected. Saifullah (1973) reported high seaweed biomass (98,797.82 g/m^2) from 28 quadrats (six month's study period; 3,528.49 g/m^2 per quadrat) while 29,387.15 g/m^2 (212.95 g/m^2 per quadrat) from 138 quadrats (in six months) of algal biomass was recorded in the present study. The difference in biomass (69,410.67 g/m^2) shows a drastic decrease in biomass at Buleji which may have resulted due to pollution and overexploitation by the public and scientific personnel who are using large quantities of seaweeds in their research.

At Buleji, as found in the present study, in the beginning of September, a very complex community of green, brown and red algae appeared on the TLC of the exposed rocky ledge. In this competition, balance was attained among *C. antennina, U. fasciata, L. pinnatifida, M. somaliensis* and *J. laminarioides*. But at the end of September the belt started to lose colour and subsequently turned into a white belt presumably due to total absence of *C. anteninna* (from November to July) and *U. fasciata* (from December to May). During this period a complete decay of *C. antennina* and *U. fasciata* was observed on the exposed rocky ledge. Ahmed (1992) had earlier noted that at Buleji, at the end of September, the thick green carpet of *U. fasciata* and *Enteromorpha* sp., transformed into a snow-white covering indicating decay of seaweeds. The present observations on the Buleji area reveal that algal biomass at Buleji has decreased over the years despite the fact that there is not much commercial exploitation.

Acknowledgement

The work was conducted for the research project "Living Marine Resources of Pakistan, Arabian Sea". The financial support provided by the Project Office of the Naval Research, USA is gratefully acknowledged. The authors are thankful to Prof. Dr. Mustafa Shameel, Director, Marine Sciences and Professor of Department of Botany, University of Karachi for his kind help in the identification of seaweeds. The authors are also thankful to Prof. Dr. M. Nizamuddin for providing the literature.

References

Ahmed, M. 1992. Glaciers or seaweeds. News Bulletin of Centre of Excellence in Marine Biology, University of Karachi. 3: 7.

Ahmed, M., S. H. N. Rizvi and M. Moazzum. 1982. The distribution and abundance of intertidal organisms on some beaches of Makran coast in Pakistan (North Arabian Sea). *Pakistan J. Zool.*, 14: 175-184.

Anand, P. L. 1940. Marine algae from Karachi. I. Chlorophyceae. *Punjab Univ. Publ. Bot. Soc.*, 52 pp.

Anand, P. L. 1943. Marine algae from Karachi. II. Rhodophyceae. *Punjab Univ. Publ. Bot. Soc.*, 76 pp.

Begum, M. and N. Khatoon. 1988. Distribution of and some ecological notes of Phaeophyta from the coast of Karachi. *Pak. J. Bot.*, 20: 291-304.

Bφrgesen, F. 1930. Some Indian green and brown algae especially from the shore of presidency of Bombay. *I. Journ. Bot. Soc.*. Vol. IX.

Bφrgesen, F. 1931. Some Indian Rhodophyceae especially from the shore of the pesidency of Bombay. *Kew Bull.*, 1-24.

Bφrgesen, F. 1932. Some Indian Rhodophyceae especially from the shore of the presidency of Bombay. *Kew Bull.*, 113-134.

Bφrgesen, F. 1933. Some Indian green and brown algae especially from the shore of the presidency of Bombay. 3 *Journ. Ind. Bot. Soc.*, Vol. XII.

Dixit, S. C. 1964. Species list of Indian marine algae determined by Borgesen. *J. Uni. Bombay*, 32: 28.

Dixit, S. C. 1968. Species list of Indian marine algae-II. *J. Uni. Bombay*, 38: 9-24.

Hameed, S. 1996. *Zonation patterns and seasonal biomass of intertidal macro-organisms of the rocky ledge of Pacha near Karachi (Arabian Sea)*. M. Phil. Thesis, Centre of Excellence in Marine Biology, University of Karachi. 180 pp.

Nizamuddin M. and F. Gessner. 1970. The marine algae of the northern part of the Arabian Sea and of the Persian Gulf. "Meteor" Forsch. Ergebnisse. D: 42.

Nizamuddin, M. and S. Parveen. 1986. Taxonomic studies on some members of Dictyotales (Phaeophyta) from the coast of Pakistan. *Pak. J. Bot.*, 18: 123-135.

Qari, R. 1985. *Seasonal variation in biomass and biochemical composition of some edible seaweeds from Karachi coast*. M. Phil. Thesis, Centre of Excellence in Marine Biology, University of Karachi. 234 pp.

Qari, R. and R. Qasim. 1988. Seasonal changes in the standing crop of intertidal seaweeds from the Karachi coast. Marine Science of the Arabian Sea. Proc. Int. Conf. (Eds.) M. F. Thompson and N. M. Tirmizi. 449-456.

Rao, M. U. and T. Sreeramulu. 1964. An ecological study of some intertidal algae of the Visakhapatnam coast. *J. Ecol.*, 52: 595-616.

Saifullah, S. M. 1973. A preliminary survey of the standing crop of seaweeds from the Karachi coast. *Bot. Mar.*, 16: 139-144.

Saifullah, S. M. 1977. Studies on marine algae from Pakistan: Ulvales. *Bot. Mar.*, 20: 521-536.

Saifullah, S. M. and M. Nizamuddin. 1992. Two most abundant species of *Ulva* and *Enteromorpha* from coast of Jeddah, Saudi Arabia. *Pakistan J. Mar. Sci.*, 1: 23-28.

Saifullah, S. M., S. S. Shahid and D. Khan. 1984. Quantitative ecological studies of seaweeds of Karachi. *Biologia*, 30:33-43.

Salim, K. M. 1965. The distribution of marine algae along Karachi coast. *Bot. Mar.*, 8: 183-198.

Shaikh, W. and M. Shameel. 1995. Taxonomic study of brown algal community growing on the coast of Karachi, Pakistan. *Pak. J. Mar. Sci.*, 4: 9-38.

Shameel, M. 1987. A preliminary survey of seaweeds from the coast of Lasbela., Pakistan. *Bot. Mar.*, 30: 511-514.

Shameel, M., K. Aisha and S. H. Khan. 1996. A preliminary survey of seaweeds from the coast of Makran, Pakistan. *Bot. Mar.*, 39: 223-230.

Shameel, M., S. A. Hussain and S. S. Husain. 1989. Addition to the knowledge of seaweeds from the coast of Lasbela, Pakistan. *Bot. Mar.*, 32: 177-180.

Shameel, M. and J. Tanaka. 1992. A preliminary checklist of marine algae from the coast and inshore waters of Pakistan. Cryptogamic Fauna of Pakistan. *Nat. Sci. Mus.*, Tokyo, 1: 64.

(Received for publication 11 November 1998)