Pakistan J. Sci. Ind. Res., Vol. 30, No. 7, July 1987

POPULATION STRUCTURE AND SOME ASPECTS OF THE BREEDING BEHAVIOUR OF THREE GASTROPOD SPECIES FROM KARACHI MANGROVES

Sohail Barkati and Nasima M. Tirmizi*

Institute of Marine Sciences, University of Karachi, Karachi

(Received April 23, 1987; revised June 22, 1987)

Seasonal abundance and population structure of three mangrove gastropod molluscs, ***Cerithedia cinqulatus*** (Gmelin), *Holoa Joponica* (Pilsbry) and *Melampus nuxcastanea*(Kurada)were examined from the Karachi coast. Observations were also made on some aspects of the breeding habits of opisthobranch *Haloa* and pulmonate *Melampus* eggs;masses of *Haloa* were collected from the field and those of *Melampus* were spawned in the laboratory. The three species seem to possess long spawning seasons with optimum spawning activity during spring-summer.

Key words: Gastropods; Population; Spawing, Eggmass.

INTRODUCTION

Information on population ecology of marine molluscs from Pakistan is almost non-existent. Some work on growth characteristics and population structure of mussels and oysters was undertaken by Barkati and Ahmed [1] and Asif [2]. Most of the work on gastropods is related to the description of egg masses with a view to ascertain the spawning pattern of species and to provide information on larval types [3-8] and Tirmizi and Zehra [20] A number of publications appeared on the spawning habits and egg masses of opisthobranch molluscs from many parts of the world. Those related to cephalazpidean opisthobranchs include investigations by Ostergaard [9], Amio [10], Baba *et al.* [11] Davis [12] and Hurst [13].

The present communication deals with the population structure and spawning behaviour of three species of mangrove gastropods, viz. *Cerithedia cingulatus* (Prosobranch), *Haloa japonica* (Opisthobranch) and *Melampus nuxcastanea* (Pulmonate).

MATERIAL AND METHODS

Regular field trips were made to various mangrove sites along the Karachi coast from 1983 to 1986. The snail, *Cerithedia cingulatus,* was sampled at monthly intervas from peripheral regions at Sandspit (14 Km north west of Karachi). Collections were made at low tide with the help of a frame of 0.09 m^2 dimension. All snails falling within the frame area were collected and brought back to the laboratory.

Samples of *Haloa Japonica* and *Melampus nuxcastanea* and egg masses of *H. Japonica* were obtained from Sandspit, Port Qasim (30 Km north east) and Clifton (6 Km north east of Karachi); samples were also once obtained from Wazeer Mansion (5 Km north west of Karachi) and Miani Hor. Measurements of shell heights and length and width of egg masses were made to the nearest 0.01 mm. Egg dimensions were noted under Nikon binocular microscope by using ocular micrometer.

Observations

Cerithedia cingulatus. The snail *C. cingulatus* is small sized prosobranch gastropod which prefers herbaceous vegetation. It occurs in the outer region of mangrove mud flats. An allied species, *C. decollata,* was reported to climb on the trees [14]. *C. cingulatus* is occasionally seen sticking to the lower portion of the trunk in Karachi mangroves.

Frequency distribution of snails shell heights for 13 monthly samples, March 1983 to March 1984, are shown in Fig. 1. The snails distribute at an average density of 221 individuals per 0.09 m^2 (2456 per m^2). Number of specimen per square meter, however, varied seasonally from a minimum of 83 in March to 408 snails per 0.09 m^2 in January 1984. Fig. 1 shows that maximum number of small sized individuals (juveniles) were found in June 1983. Samples of July and August also contained small number of juveniles whereas the period of December to April was deprived of them. Spawning in this species, therefore,

*Centre of Excellence in Marine Biology, University of Karachi.

seems to commence in March with the advent of the spring season. The major portion of most of the Sandspit samples consisted of individuals ranging between 4 and 16 mm shell height. Individuals of large size, i.e. greater than 28 mm, though available in most of the months, they were most abundant in December, February and March. Surprisingly, they disappeared completely from the January sample.

It is evident from the histograms that the population of *C. cingulatus* can not be identified into year classes on the basis of size groups because of the absence of distinct modes in the size frequency distribution. It was only in the month of June that two distinct age groups are evident.

Snails placed in glass bowls of 3 litre capacity having fresh aerated sea water, under laboratory conditions for one whole year, did not spawn.

Haloa japonica. It is small opisthobranch mollusc measuring 15 mm in shell height at the maximum. The aperture of the shell is as long as the shell with deeply sunk spire and thin and papery shell wall. It is commonly known as bubble shell. *Haloa Japonica* occurs near high tide mark at the outer edge of mangroves where it lives in association with the seaweed *Enteromorpha* sp. The species grows favourably on the muddy tidal flats where some water is available even during low tides. *H. Japonica* is markedly seasonal in abundance, being very abundant in some months (January and September, October) and restricted to only few individuals in others.

The average shell size with 95 % confidence limits of *H. Japonica* from Port Qasim (Feb. 1984 to April 1985), Sandspit (Jan 1983 to Nov. 1985) and Clifton (Nov. 1984 to Oct. 1985) are shown in Fig. 2 to 4. It is evident from the figures that the average shell heights of individuals differ significantly during various parts of the year. Samples of low average shell heights are generally encountered in early summer and autumn. The presence of small sized individuals, juveniles, during July to October (early autumn) and March to April (early summer) may therefore be considered responsible for the low average shell heights obtained in the foresaid months. Samples obtained during November-Feburary generally contained relatively large sized individuals. *H. Japonica* from Sandspit and Port Qasim behaved likewise in this respect. The data show that *H. Japonica* is equally abundant in Port Qasim and Sandspit from where hundreds of individuals may be collected in some parts of the year. In Sandspit, they are most abundant from September to November when a total of 1453 individuals were obtained; on the other hand, only 284 individuals were sampled during the rest of the year. From Clifton 124 individuals were collected in four sampling trips during January to March, whereas 177 individuals were obtained in two trips in November 1984 and September 1985 which shows that the species occurred abundantly in autumn or post monsoon period. Similar is the case with the Port Qasim area.

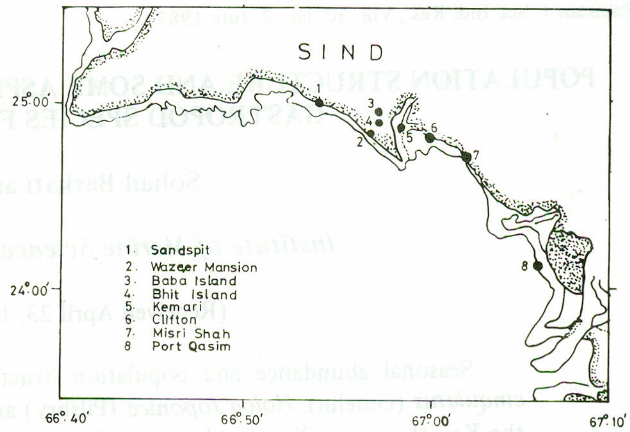

Fig. 1. Map of Sind coast showing sampling sites.

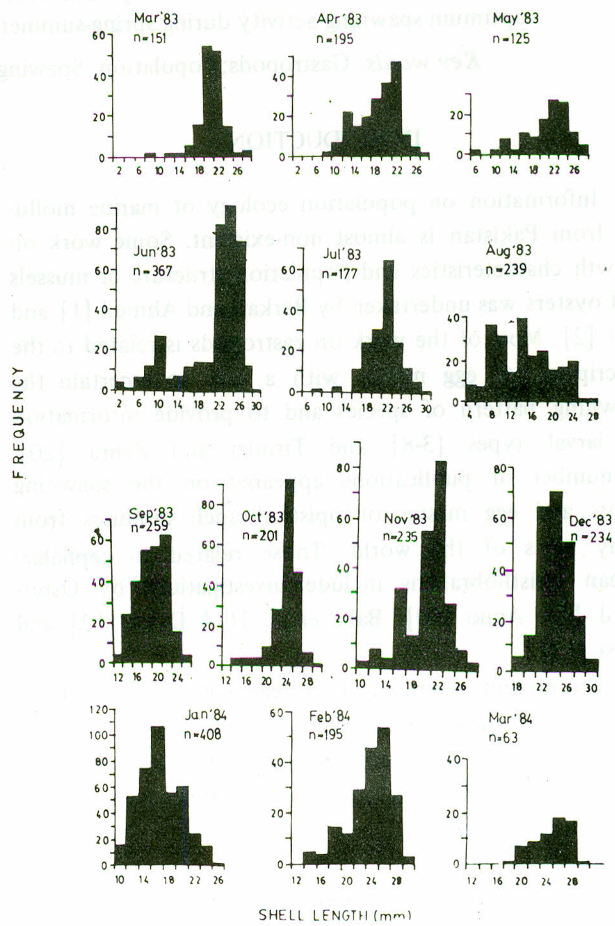

Fig. 2. Shell length frequency distribution of *Cerithedia cingulatus;* March 1983 to March 1984.

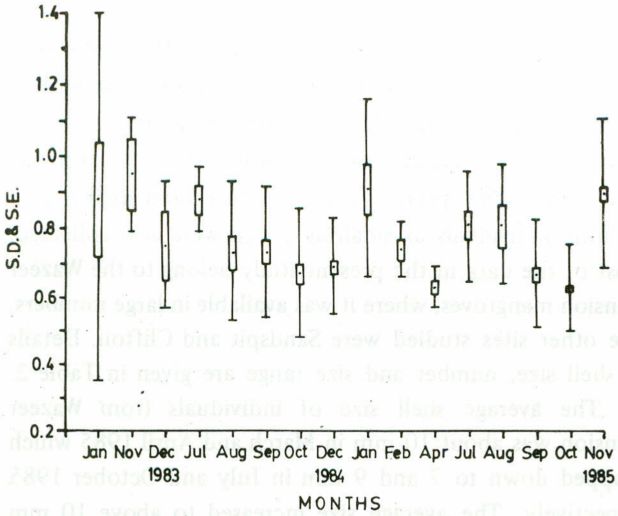

Fig. 3. Variation in mean monthly shell length (points) of *Haloa Japonica* from Sandspit during January 1983 – November 1985; standard deviations (vertical lines) and 95 % confidence limits (bars) of mean values are shown.

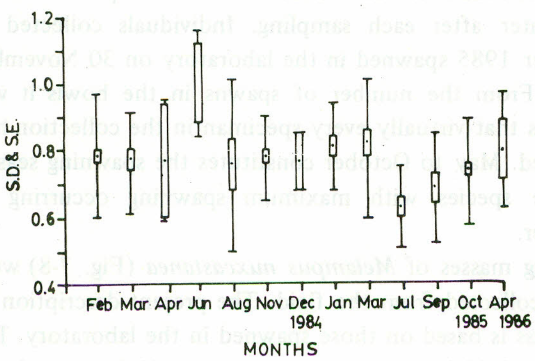

Fig. 4. Variation in mean monthly shell length (points) of *Haloa Japonica* from Port Qasim during February 1984 – April 1986; standard deviations (vertical lines) and 95 % confidence limits (bars) of mean values are shown.

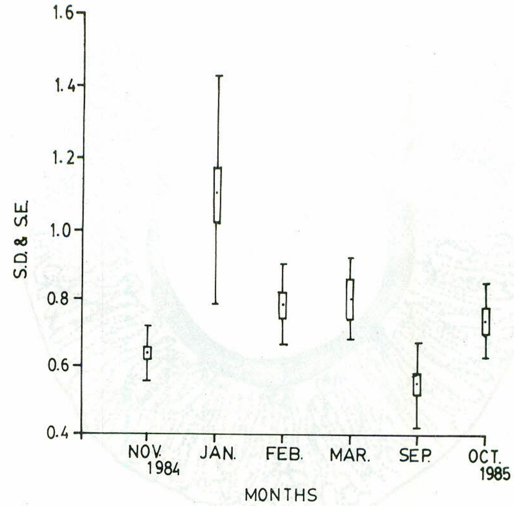

Fig. 5. Variation in mean monthly shell length (points) of *Haloa Japonica* from Clifton during November 1984 – October 1985; standard deviations (vertical lines) and 95 % confidence limits (bars) of mean values are shown.

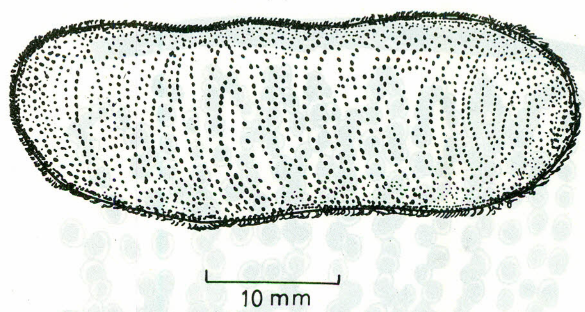

Fig. 6. Egg mass of *Haloa Japonica.*

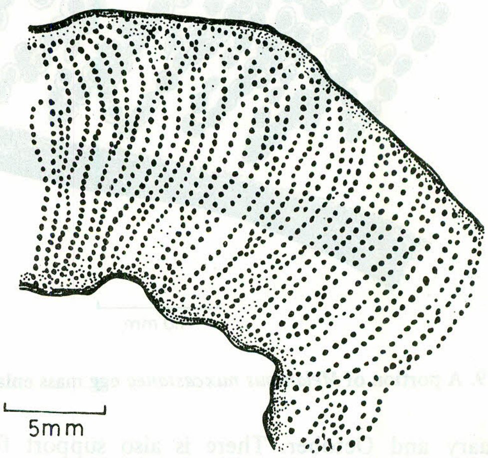

Fig. 7. A portion of *Haloa Japonica* egg mass enlarged.

Egg Mass of *Haloa Japonica.* Spawns of *Haloa Japonica* were collected from the field on many occasions (Table 1). The spawns are usually found attached to seaweeds or on the mud surface in the upper tidal zone along with their adults. The spawn (Fig. 5-6) consisted of slightly curved tubes with rounded ends, white in colour and of clear jelly. The spawn measured on an average 25.3 mm long (SD=1.28, N=20) and 5.6 mm wide (SD = 0.15, N = 20). Capsules are arranged on egg string embedded in gelatinous material. Each capsule contained single almost spherical egg, measuring on an average 122 μm in diameter (SD = 0.113, N = 22). The egg capsule wall ranged from 160 to 200 μm ($\bar{x}$ = 175 μm, SD = 0.22, N = 22). The number of eggs per spawn ranged from 2413 to 9452 ($\bar{x}$ = 4868, SD = 2046).

Haloa Japonica seems to breed all the year round as its egg masses may be collected in all seasons, with the exception of June and July. Concurrent to this is the fact that there are periods when relatively more masses are available suggesting that spawning in this species may get intensified

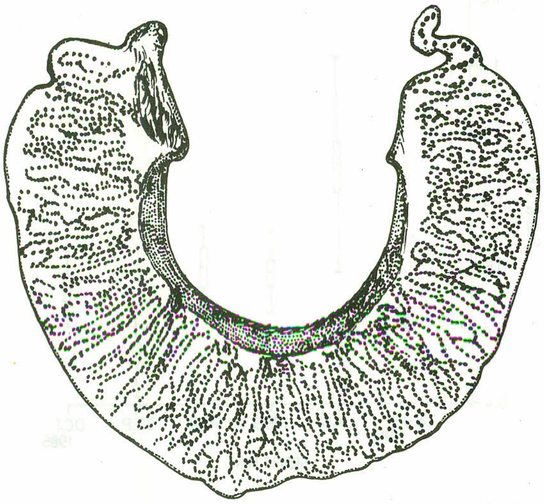

Fig. 8. Egg mass of *Melampus nuxcastanea.*

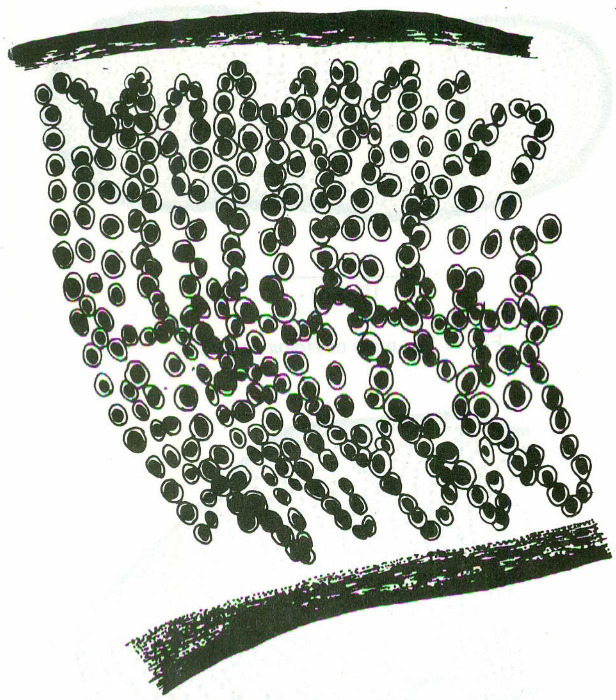

Fig. 9. A portion of *Melampus nuxcastanea* egg mass enlarged.

in January and October. There is also support for this inference in the shell size distribution pattern of the species which shows continuous recruitment to the population with a maximum number of small sized individuals (3-4 mm shell height) in August. In December 1985 a large number of eggmasses were seen on the mud flats of Misri Shah (11 Km north east of Karachi).

Melampus nuxcastanea. The shell of *Melampus nuxcastanea* is medium sized, hard in texture and with a conical spire. It occurs high in the intertidal area of mangrove where they usually aggregate around the base of mangrove plants. The species grows to a maximum shell size of 14 mm; individuals as small as 2 mm were also collected. Most of the data in the present study belong to the Wazeer Mansion mangroves, where it was available in large numbers. The other sites studied were Sandspit and Clifton. Details of shell size, number and size range are given in Table 2.

The average shell size of individuals from Wazeer Mansion was about 10 mm in March and April 1985 which dropped down to 7 and 9 mm in July and October 1985 respectively. The average size increased to above 10 mm again in January and February 1986. The presence of a considerable number of juveniles in July sample had clearly brought down the average shell size of the samples.

Individuals of *M. nuxcastanea* were kept in aerated sea water after each sampling. Individuals collected in October 1985 spawned in the laboratory on 30 November 1985. From the number of spawns in the bowls it was obvious that virtually every speciman in the collection had spawned. May to October constitutes the spawning season of the species with maximum spawning occurring in October.

Egg masses of *Melampus nuxcastanea* (Fig. 7-8) were never collected from the field. The present description of egg mass is based on those spawned in the laboratory. The spawn of *Melampus nuxcastanea* is a U-shaped tubular structure, white in colour, with egg capsules attached on a visible string. Spawn measured on an average 21.2 mm long (SD = 1.91, N = 12) and 2.39 mm wide (SD = 0.05, N = 12). The eggs are either oval or spherical 93 μm in diameter (SD = 14.1, N = 22). The number of eggs per spawn ranged from 2693 to 3210 ($\bar{x}$ = 2909, SD = 200, N = 22).

DISCUSSION

Opisthobranch molluscs deposit their eggs enclosed in capsules which in turn are contained in various types of egg masses. Hurst [13] mentioned four types of spawns in Opisthobranchs. The spawns of *Haloa Japonica* belong to type C of Hurst's classification. She provided information on three cephalaspidean opisthobranchs. The present descrimption of *H. Japonica* conforms to the general pattern described for opisthobranch gastopods. Ostergaard [9] mentioned the egg mass of two species of family Atyidae from Hawaiian Island , viz. *Haminoea crocata* and *Atys semistriatus.* His description of *H. crocata* compares favourably with the present one. The diameter of egg. (122 μm) in the present study was, however, larger than that of *H. crocata* (80 μm) studied by Ostergaard [9]. The egg mass of the pulmonate *Melampus nuxcastanea* is described here for the first time as we failed to find any information on its spawn in the literature.

Observations on breeding seasons of the three species studied, showed that none of them breed in winter months; either they start breeding with the onset of the spring season or with rising temperature. It is, however, certain that *Haloa Japonica* did not spawn in June and July as their spawns were never collected in these months during the 1983-86 period . While discussing the breeding habits of marine invertebrates of Pakistan coast, Ahmed [15] categorised them into four types of spawners as monsoon, winter-spring, spring-summer and year-round spawners. On the basis of the size frequency distribution and availability of egg masses it may be stated that the three species here studied may be classified as spring-summer spawners with individual specimens might be spawning any time during the year.

Table 1. Seasonal occurrence of egg masses of *Haloa japonica* from five localities during 1983-86. Localities abbreviated as C, Clifton; MS, Misri Shah; PQ, Port Qasim; Sp, Sands Pit, WM, Wazir Mansion.

Locality	Date		Year	Egg masses
PQ	January	7	1985	9
SP	January	8	1985	24
SP	January	14	1984	10
MS	January	14	1985	3
C	January	16	1985	19
SP	January	19	1984	4
PQ	January	21	1985	9
MS	January	28	1985	5
SP	February	5	1986	7
PQ	February	25	1984	5
PQ	March	6	1985	17
C	March	11	1985	3
WM	March	31	1985	2
PQ	April	20	1986	6
PQ	May	25	1985	4
SP	August	30	1984	1
PQ	September	5	1985	17
SP	September	26	1984	7
C	September	30	1985	8
SP	October	13	1985	38
MS	October	14	1985	34
SP	October	26	1983	7
SP	October	28	1984	9
PQ	November	7	1984	13
SP	November	21	1984	6
SP	November	30	1983	2
PQ	December	22	1984	22

Table 2. Characteristics of the shells of *Melampus nuxcastanea* from various localities.

Sampling Dates		Number of Individuals	Shell Size range (mm)	Mean	S.D.
		Wazeer Mansion			
March	18, 1985	31	8-12	1.0	0.0960
March	31, 1985	670	9-14	11.4	0.525
April	13, 1985	103	7-12	12.0	0.1050
July	10, 1985	352	1-15	7	0.441
October	31, 1985	265	6-11	9.0	0.17
January	29, 1986	163	8-13	12	0.146
February	15, 1986	383	8-13	10	0.134
		Sands Pit			
January	9, 1983	18	6-8	7.5	0.0605
April	27, 1985	320	1-11	4.28	0.229
June	25, 1986	50	3-5	4.56	0.088
		Clifton			
February	18, 1986	68	4-8	6	0.090
March	03, 1986	84	5-8	6	0.11

Size frequency histograms of *Cerithdia cingulatus lack* distrinct modes and therefore classed as unimodal. However this cannot be taken as the population is composed of only one year class individuals. In June two distinct age groups are evident. Absence of clear modes in the histograms may have developed due to long spawning season of the species due to which adjacent year classes overlapped. Working in Thai mangals, Shokita *et al.* [16] showed a trimodal distribution in a Potamidid snail *Terbralia palustris,* whereas Soemodiharjo and Kastoro [17] mentioned bimodal distribution in an Indonesian population of the same species; this is, however, a giant snail species. Walne [18] was not able to distinguish the modes of different year classes at size below 3.0 cm in the slipper limpet *Crepidula fornicata,* whereas williams [19] has shown a polymodal frequency distribution in an archaegastropod *Gibbula umbilicalis* from Wales. It is quite possible that the separation of year classes on size frequency distribution may not be possible in small sized species.

Acknowledgements. This Research Project on "Mangrove fauna (invertebrate) of Karachi, Sind coast" was financed by the Pakistan Agricultural Research Council. The authors wish to thank Mr. Iqbal Hussain, Mr. Anis Karim, Miss. Rukhsana Choudhry and Qudsia Khursheed for help in collecting, measuring and statistical treatment of data.

REFERENCES

1. S. Barkati and M. Ahmed, Pakistan J. Zool., **6**, 31 (1974).
2. M. Asif, Pakistan J. Sci. Ind. Res., 22, 46 (1979).
3. S. Barkati and M. Ahmed, The Veliger, **24**, 355 (1982).
4. S. Barkati and M. Ahmed, The Veliger, **26**, 30 (1983).
5. S. Barkati and M. Ahmed, The Veliger, **26**, 316 (1984).
6. S. Barkati and M. Ahmed, Pakistan J. Sci., Ind. Res., **28**, 229 (1984).
7. S. Barkati and M. Ahmed Karachi Univ. J. Sci., **12**, 91 (1984).
8. S. Barkati and M. Ahmed, Pakistan J. Zool., **17**, 387 (1985).
9. J.M. Ostergaard, Pacific Sci., 4, 75 (1950).
10. M. Amio, J. Shimonoseiki Coll. Fish, **4**, 239 (1955).
11. K. Baba, I. Hamatani and K. Hisai, Publ. Seto Mar. Biol. Lab., V, 209 (1956).
12. C.C. Davis, Malacologia, **5**, 299 (1967).
13. A. Hurst, The Veliger, **9**, 255 (1967).
14. D.S. Brown, Proc. Malacol. Soc. Lond., **39**, 263 (1971).
15. M. Ahmed, Proc. 1st Pakistan Cong. Zoll., **55**, (1980).
16. S. Shokita, S. Limsakul and C. Karnjanagesorn, Mangrove Estuarine Ecology in Thailand, Japanese Ministry of Education, Science and Culture, **39** (1985).
17. S. Soemodiharjo and W. Kastoro, Marine Research in Indonesia, 131 (1977).
18. P.R. Walne, Fish. invest., Lond., Ser. II, XX, **6**, 50 pp. (1956).
19. E.E. Williams, J. Anim. Ecol., **33**, 433 (1964).
20. N.M. Tirmizi and I. Zehra, Pakistan J. Zool., **15**, (1983).