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POPULATION DYNAMICS AND BIOLOGY OF AQUATIC GASTROPOD, *GYRAULUS CONVEXIUSCULUS* (HUTTON) IN A SMALL POND

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INTRODUCTION

One of the most important features of the ponds, man-made lakes and reservoirs of the south eastern region of West Bengal state of the country, is the abundance of gastropods in littoral zones. The most common and abundant malacofauna comprised of several species belonging mainly to genera *Pila, Thiara, Bellamya and Gabia* among prosobranchs and *Endoplanorbis*, *Lymnaea, and Gyraulus* among pulmonates. A number of species belonging to families Planorbidae and Lymnaedae have got considerable attention because of their role in the transmission of helminthes parasitic diseases.

Gyraulus convexiusculus (Hutton) is one of the most important species of the genus that has been reported to act as intermediate host for several trematode parasites. Inspite of its importance, it is surprising that very little information is available on the population dynamics and biology of the species form its entire range of distribution which includes Iran, Afghanistan and Philippines, besides Indian subcontinent. However, the species of *Gyraulus* occurring in New World has been the subject of ecological studies by some workers (Gillespie, 1969; Ekblad, 1971, 1973), but works on this species too is not as intensive as on some other pulmonates like *Lymnaea* spp. (Berrie, 1965; Borey, 1964, Eisenberg, 1966, 1970),

The present report is a part of the detailed studies on the ecology of some important gastropods of this region and deals with the seasonal fluctuation in the abundance, population cycle and growth rate of *Gyraulus convexiusculus* (Hutton) in a small pond of Calcutta, India.

MATERIAL AND METHODS

The study area

The pond, known as Manohar Das Pukur, is situated in central Calcutta urban area, and is a small water body of about 2 ha. It is primarily meant for recreation/aesthetic purposes but used by a large number of people for various undesirable uses. With the result it was highly eutrophic and covered by dense strands of water hyacinth *Eichhornea* sp. during the entire period of investigation. No commercial or sport fishing operations is carried out.

Study period

The studies were carried out for two consecutive years (annual cycles), 1995-96 and 1996-97, starting from February 1995. The annual cycles were divided into three major seasons *viz.* Premonsoon (March–June), Monsoon (July–September) and Postmonsoon (November–February), each consisting of two parts-early (I) and late (II). These have been designated as PRM-I and PRM-II (premonsoon), M-I and M-II (monsoon) POM-I and POM-II (postmonsoon).

Sample collection and analysis

Samples were collected from littoral zones at three different centres with the help of a 0.5 × 0.5 × 0.5 m wooden frame net covered from all side except one on top (opening/mouth) by mosquito net cloth of 0.5 mm mesh size. This net covered an area of 0.5 m^2. For quantitative collections, the net was placed firmly upside down in the Littoral zone between the water depth of 0.25 to 0.45 m and all macrophytes and top 15 cm layer of soil was excavated by inserting a sharp edged iron sheet, almost of the size of the net mouth. The net was gradually turned up keeping the mouth covered by the iron sheet. The content of net was thoroughly examined and all the gastropods were picked up and fixed in 4% formaldehyde solution. The sorting of the individuals of the species was done in laboratory. The sizes were measured with the help of a dial caliper to nearest 0.1 mm and grouped into separate size classes. The individuals were further grouped into youngones, juveniles and adults. The weight was measured to nearest 100 mg with the help of jeweler's double pan balance. Dry weight measurements were carried out after drying in an oven at 65°C for 4 days.

The rate of population changes or instantaneous rate of population growth 'r' was calculated as

$$R = \ln Nt - \ln No/ t$$

Where NT and No are the numbers in the population at the time of sampling and t days earlier.

Mean biomass was determined by multiplying the number of Individuals in each size class with the mean dry weight of the size class and summing them as already described (Khan and Choudhury, 1984) for another gastropod species.

RESULTS

SYSTEMATIC POSITION

Phylum MOLLUSCA

Class GASTROPODA

Subclass PULMONATA

Order BSOMMATOPHORIA

Family PLANORBIDAE

Genus ***Gyraulus***

Species ***G. covexiusculus***

1894. *Planorbis convexiusculus* Hutton, *J. Asiat. Soc. Beng.*, **18**(12) : 657 (Type Locality Afghanistan).

Salient features : Very small discoidal shell; apex and whorl on same plane, not exceeding 0.5 cm in diameter, greatly depressed, periphery subungulate, obliquely striate. Whorls 4-5 rounded, widely coiled. Coils almost abruptly increasing without transverse ribs, last one relatively large but embracing only a little part of the preceding whorl. When viewed vertically, all whorls are seen. Aperture oval shaped; lips simple. Redula well developed, sharp and pointed; bicuspid central tooth, inner lateral bicuspid, out lateral tricuspid, marginal multicuspid.

Distribution : Asian species, occurs between Iran and Philippines, covering south-east Asia.

Habitat : Occurs abundantly in almost all types of freshwaters, especially with macrophytes.

Host : *G. convexiousculus* acts as intermediate host to several trematode parasites. Larval forms of *Gatrothylase erumenifer, Paramphistomum explanatum, Fassciola elongatus* and other cercariae viz. *C. chugtaii, C. gyraulusi, C. rithorensis and C. furgolensis* have been reported to use the species as their intermediate host (Subba Rao, 1989)

Annual cycle

The life cycle of the species was traced for two consecutive years (1995-96 and 1996-97). The length frequency distribution graph (Figs 1a and 1b) clearly depicted the seasonal and annual patterns of the abundance of the species. In PRM-I of the first annual cycle (1995-96), when the studies commenced, there were two modes visible, first, the older one at a modal length of 3.75 mm size group, forming smaller peak and second one pertaining to young individuals of the population at modal length of 1.75 mm, forming the larger peak. The abundance of smallest size group individuals during this period clearly signified the breeding of the species. During the following period (PRM-II), the two peaks progressed further forming modes at 4.35 and 2.75-mm size groups respectively. During subsequent period (M-I), there was again an abundance of younger individuals forming mode at 1.75 mm size group, indicating second spawning. The oldest mode of earlier period was not seen and the second mode further moved forming peak at 3.25-mm size group. During next period (M-II), the two existing modes progressed forming modes at 3.75 and 2.25-mm size group. No entry of new individuals in the population was noticed during both periods of postmonsoon season and only existing individuals grew forming modes at 4.35 and 2.75 size groups during POM-I and at 4.75 and 3,25 mm in POM-II. POM-II period was characterized by the existence of largest sized individuals in the population. During the next annual cycle (1996-97), almost similar pattern was noticed.

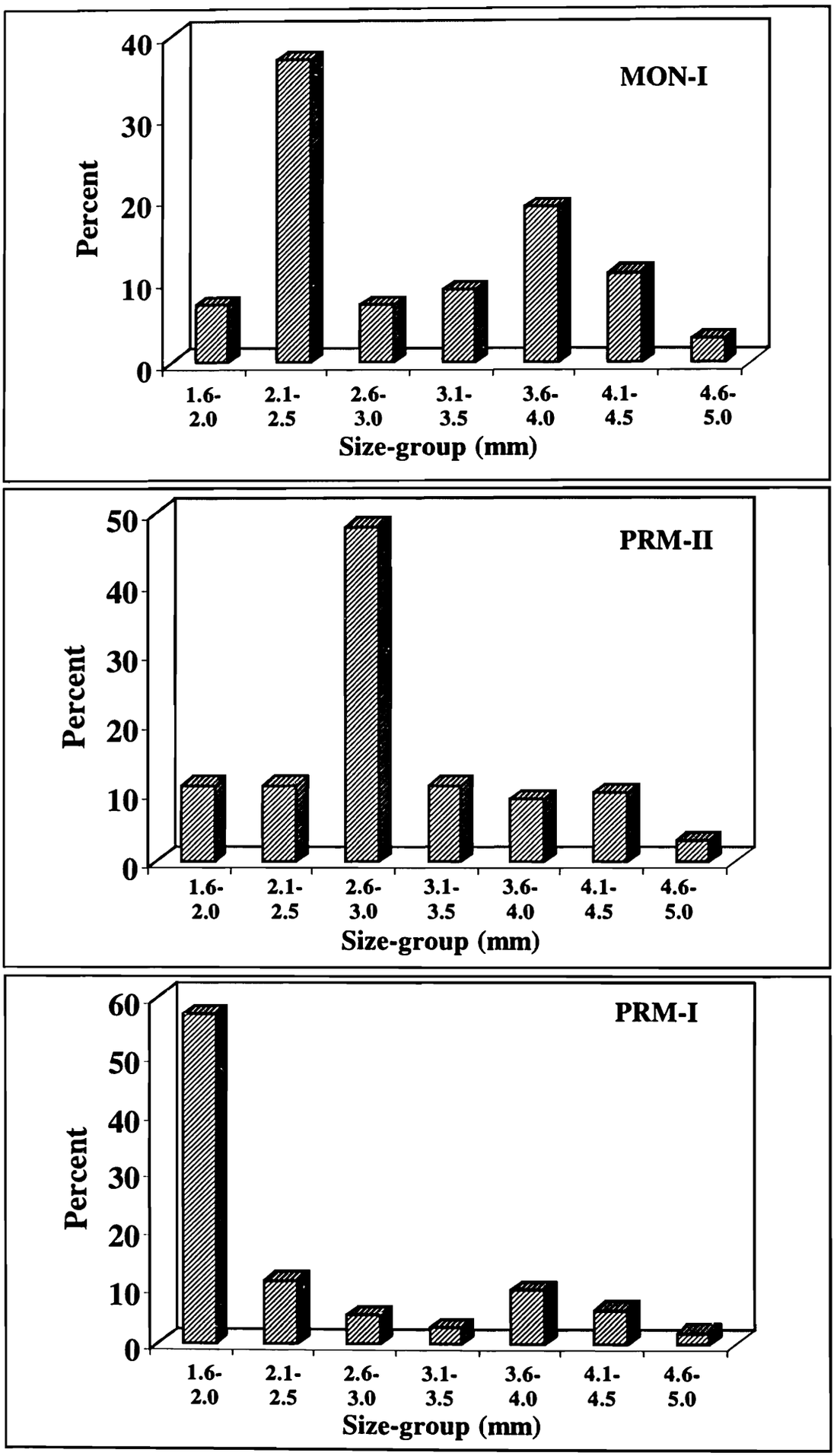

Fig. 1a. Size frequency distribution of *G. convexiusculus* during PRM-I, PRM-II and MON-I of 1995-96.

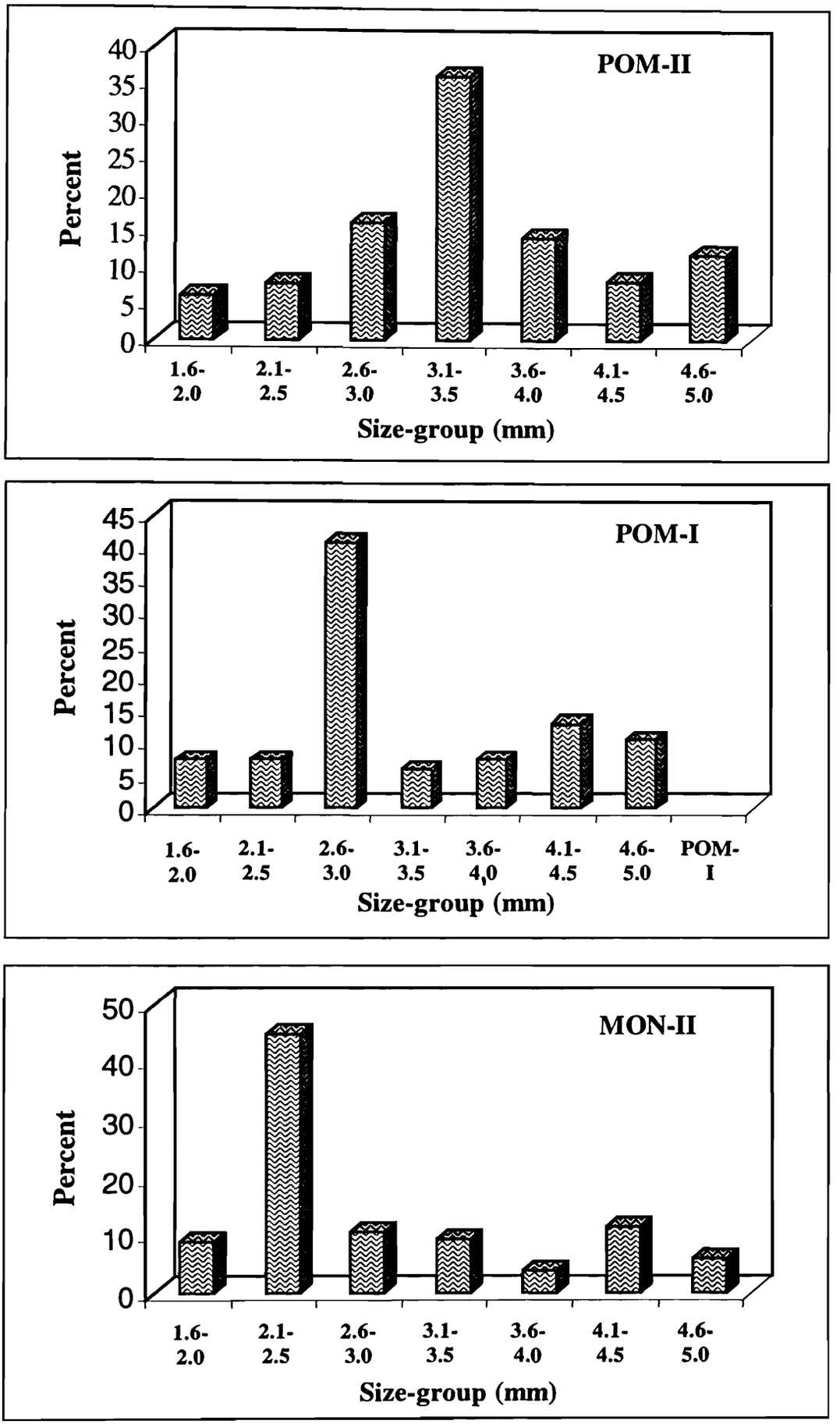

Fig. 1b. Size frequency distribution of *G. convexiusculus* during MON-II, POM-I and POM-II of 1995-96.

Age

From the size-frequency graph (Figs. 1a and 1b) it is clear that there were two spawning in each annual cycle, first during PRM-I and second during MON-I periods. During all other periods modes were at higher size groups. Further, the snails of above 4.75-mm length group were never seen. The contribution of this size class was lowest in the population during all periods of both annual cycles. This indicated the maximum size attained by the species in the pond. The drastic decrease or total absence of this size group in subsequent samples also indicated their elimination from the population. The duration from the appearance of new individuals in the population to the time they attained this maximum size was found to be 12 months (PRM-I to POM-II). This was possibly the maximum life span of the species.

Growth rate of Individuals

Growth rate of individuals was estimated from the mean modal lengths from size-frequency graph (Table 1). The smallest mode of 1995-96 annual cycle at 1.75 mm (PRM-I), which belonged to just reproduced individuals, grew to 4.75 mm at the end of the year in POM-II. Therefore total length increment gained during a full year was approximately 3.00 mm which gave the mean growth rate of 0.5 mm per period.

Table 1. Mean model length during different seasons of *G. convexiusculus.* as derived from length frequency distribution graph.

Season	1st Mode		2nd Mode		3rd Mode	
1995–96	Mean Length (mm)	Length Increment	Mean length (mm)	Length increment	Mean length (mm)	Length increment
PRM-I	3.32	–	1.75	–	–	–
PRM-II	4.25	0.50	2.75	1.00	–	–
MON-I	–	–	3.25	0.50	1.75	–
MON-II	–	–	3.35	0.50	2.25	0.50
POM-I	–	–	4.25	0.50	2.75	0.50
POM-II	–	4.75	4.75	0.50	3.25	0.50
1996–97						
PRM-I	4.25	–	1.75	–	–	–
PRM-II	4.25	0.50	2.25	0.50	–	–
MON-I	4.75	0.50	3.25	1.00	1.75	–
MON-II	–	–	3.75	0.50	2.25	0.50
POM-I	–	–	4.25	0.50	2.75	0.50
POM-II	–	–	4.75	0.50	3.25	0.50

Relative composition

The species occurred throughout the year during both annual cycles and alongwith the prosobranch, *Bellamya bengalensis* (Lamarck) formed the bulk of total gastropod population (Fig. 2). There occurred three other gastropod species in the pond namely *Lymnaea acuminata* (Lamarck), *Indoplanorbis exustus* (Deshayes) and *Thiara lineata* (Gray) but their densities were always very low. The contribution of the species to total gastropod population was considerably higher during major part of the year and varied between 34.66% (PRM-I) and 63.42 % (MON-II) during first annual cycle and between 38.50% and 60.25% during second annual cycle.

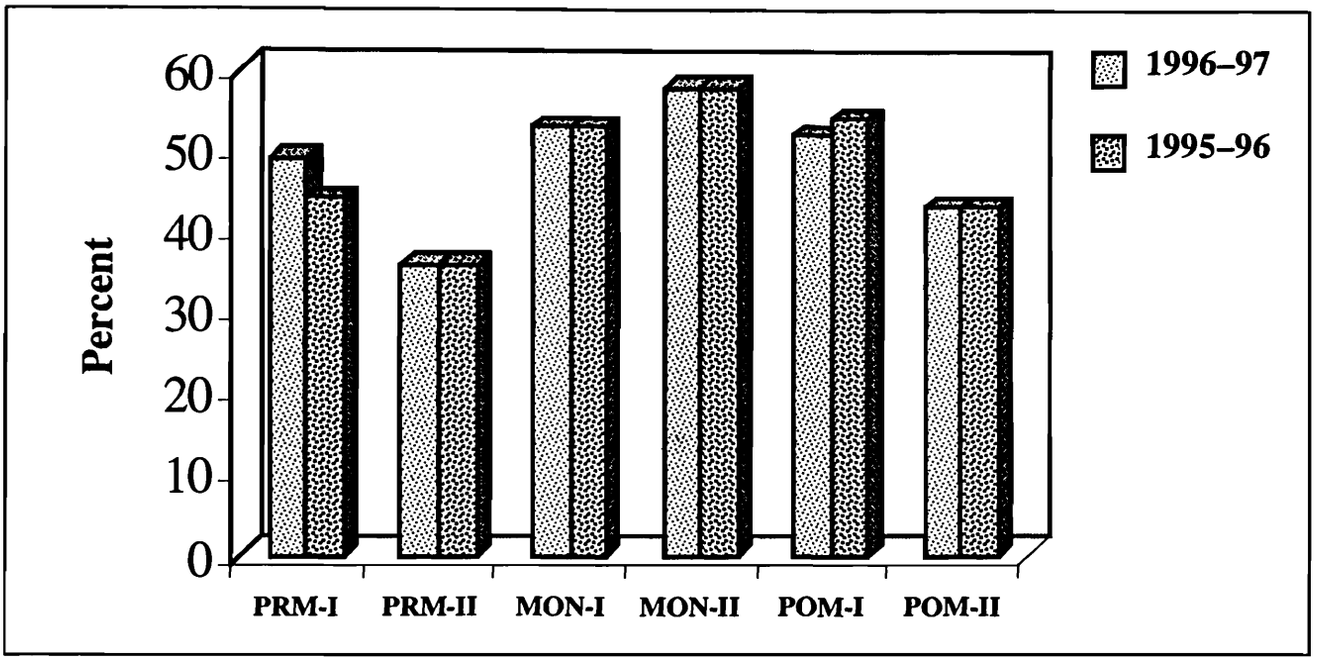

Fig. 2. Seasonal variation in the Relative composition of *G. convexiusculus* to total Gastropos.

Population Structure

The juveniles of the species formed the most consistent and sizable part of the population throughout the year (Fig. 3). The contribution of youngones was higher only during the breeding periods. The mean annual ratio of youngones, juveniles and adults were 26.5 : 38.0 : 35.5 during first annual cycle and 21.8 : 42.8 : 35.4 during second annual cycle.

Population density

During first annual cycle, its mean density varied between 187 individuals/m^2 in PRM-I to 57 individuals/m^2 in POM-II with an annual mean of 119.16/m^2. There were two period of increased occurrence, first in PRM-I and second in MON-I. Both the peaks were due to the entrance of newly bred individuals in the population. During second annual cycle the density varied between 260 (PRM-I) and 85 (POM-II) individuals/m^2 with annual mean of 157 individuals/m^2. A bimodal pattern of increased density was observed during both annual cycles (Fig. 4).

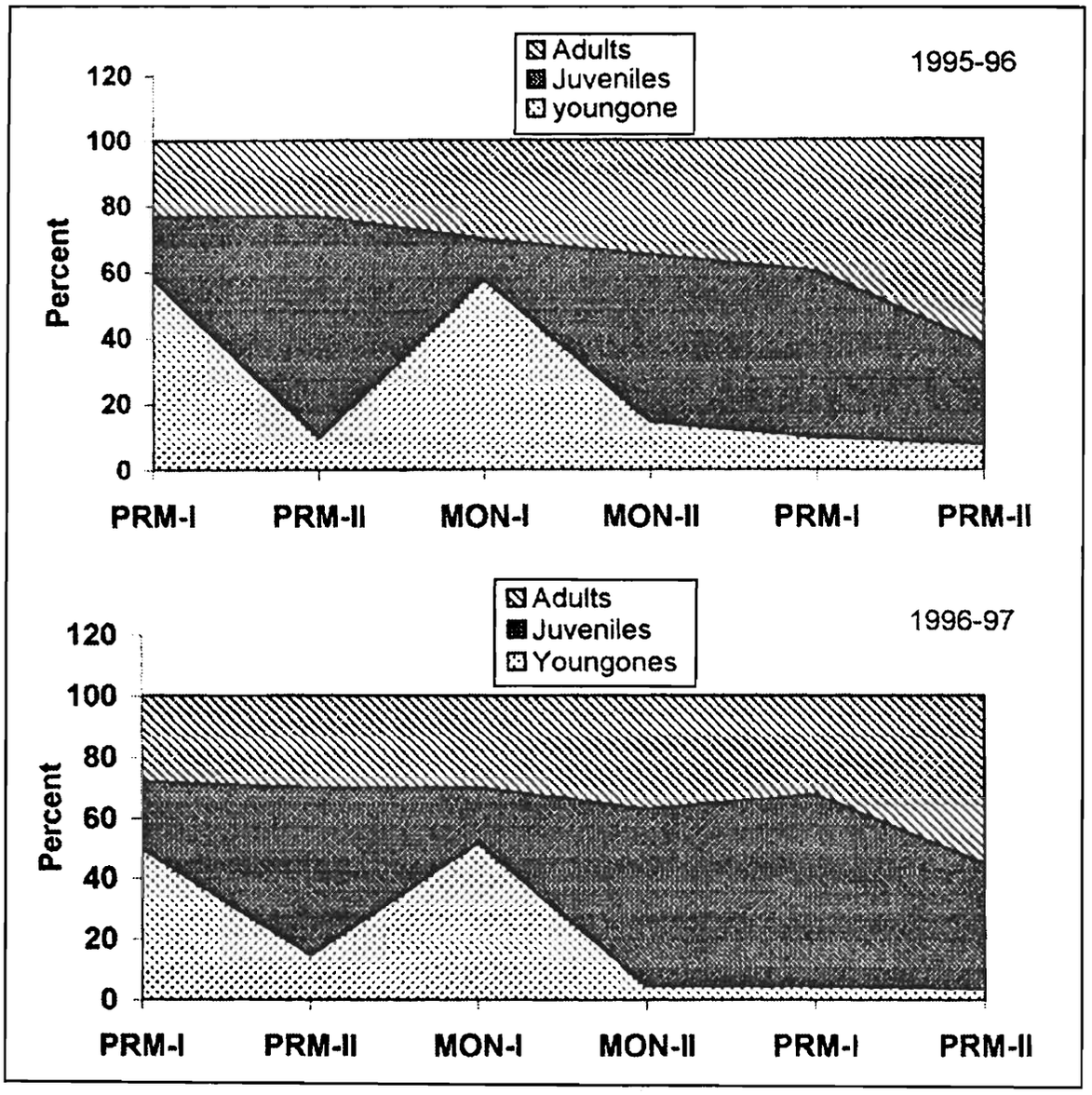

Fig. 3. Seasonal variations in the population structure of *G. convexiusculus.*

Biomass

Highest biomass (Fig. 5) was recorded in PRM-I of 1996-97. Inspite of wide variations in mean individual weight, the pattern of total standing crop biomass generally followed density trends. This was due to the availability of a large number of individuals during the period when the mean individual weights were low i.e. breeding period. However, the bimodal pattern of fluctuation was not clear as in case of density.

Rate of population change

Table 2 gives the rate of population change 'r' in number and biomass during different period of the two annual cycles. The analysis revealed that except during the two breeding period (PRM-I and MON-I), the growth rate in number was negative throughout the year. The rate of change in biomass gave a slightly different picture. Contrary to the rate of change in number, the values for biomass increased progressively excepting between PRM-II and MON-I, the intervening period between two spawning period.

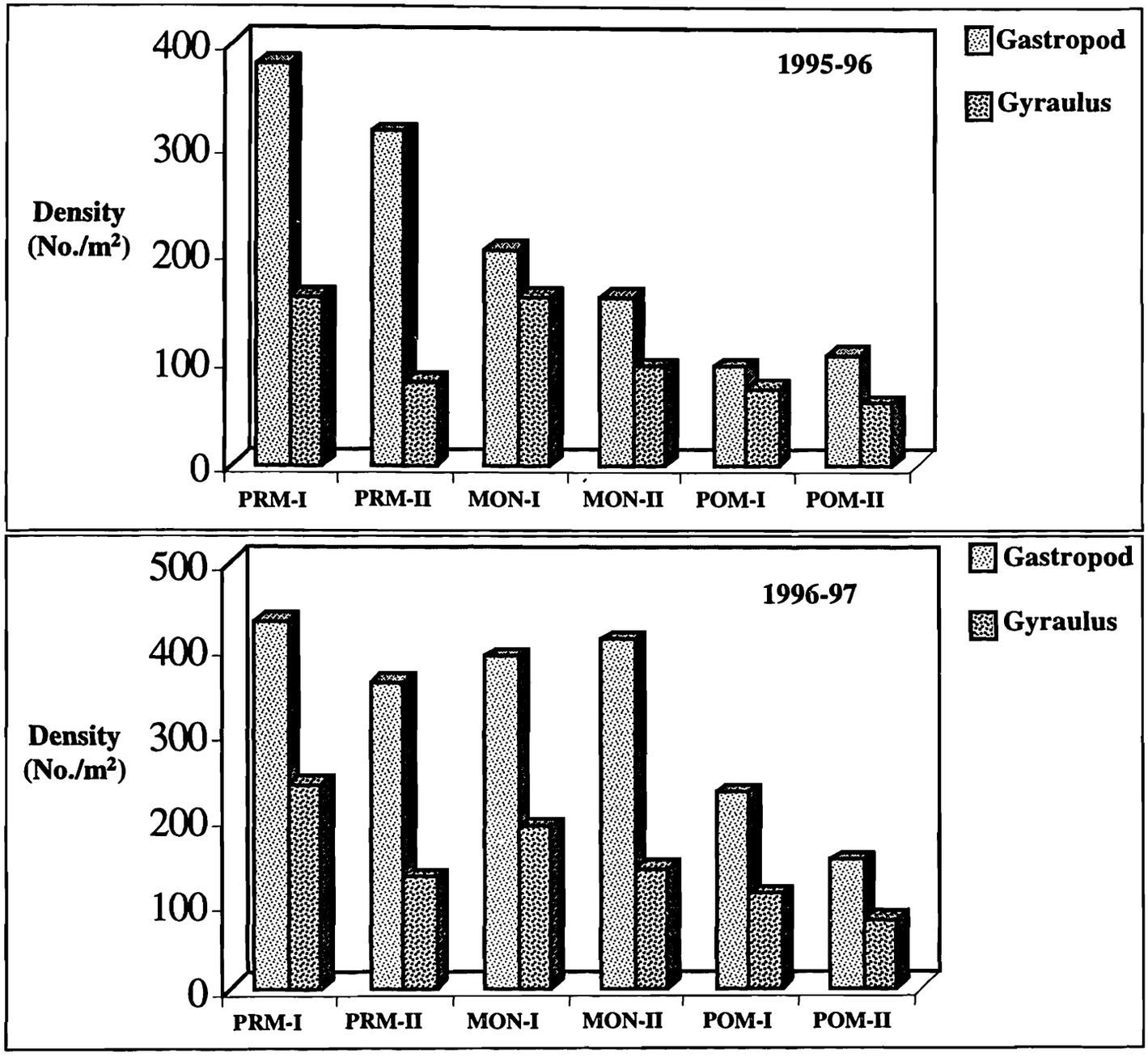

Fig. 4. Seasonal variations in the density of *G. convexiusculus.*

DISCUSSION

The gastropod community of the pond was always dominated by two species viz., *G. convexiusculus* and *Bellamya bengalensis* and both together formed nearly 82.6 and 83.46 % of the total gastropod population during the two annual cycles respectively. The other three species, which occurred in the pond, contributed very little. It appears that dominance of *G. convexiusculus* was a salient feature of this pond, as this species is known to occur in low numbers in other ponds of the region where such studies were carried out. Raut (1981), while studying the population dynamics of gastropods from this region reported that structure of gastropod biocoenosis varied from pond to pond and from season to season. Out of 5 ponds studied, he observed the dominance

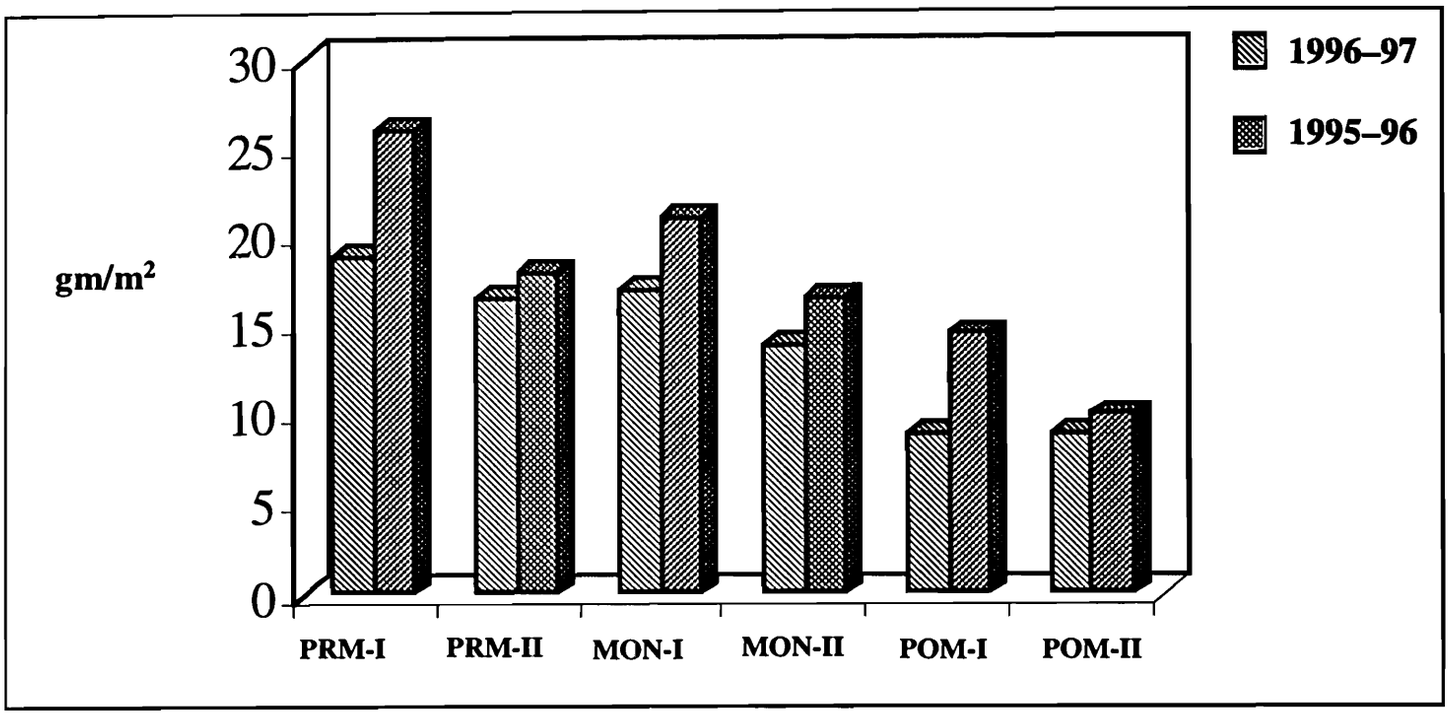

Fig. 5. Seasonal variations in the biomass (gm/m²) of *G. convexiusculus.*

Table 2. Population density, mean individual weight, biomass and rate of population change (r) of *G. convexiusculus.*

Season	Density (No/m²)	Rate of Change (r)	Mean Individual weight (W)	Biomass (gm/m²)	Rate of Change (r)
1995–96					
PRM-I	187		0.105	19.035	0.0048
PRM-II	125	0.0066	0.141	17.620	0.0086
MON-I	170	0.0050	0.110	18.700	0.0025
MON-II	111	0.0070	0.128	14.208	0.0017
POM-I	65	0.0087	0.142	9.230	0.0011
POM-II	57	0.0011	0.152	8.660	
1996–97					
PRM-I	258		0.105	27.09	
PRM-II	152	0.0086	0.128	19.45	0.0032
MON-I	199	0.0044	0.108	21.49	0.0027
MON-II	150	0.0046	0.116	17.46	0.0012
POM-I	110	0.0051	0.125	14.96	0.0017
POM-II	73	0.0067	0.136	9.93	0.0024

of *B. bengalensis* followed by *L. accuminata* in three ponds and dominance of *L. accuminata* followed by *B. bengalensis* in two ponds. Similarly, *B. bengalensis* was also found to dominate in a large man made lake (Khan and Choudhury, 1984). Not only in this part of the country but in general, different aquatic habitats are characterised by different gastropod community structure. Herman (1968), after surveying 562 habitats of New York, found that the three common species of the region, *Lymnaea palustris, Gyraulus parvus* and *Physa integra* do not commonly exist together. Rout (1981) further observed that there existed a strong competition for food and shelter within the community between the dominant species. However, during present investigation, there was no apparent competition either for food or shelter between the two dominant species, *B. bengalensis* and *G. convexiusculus*. This was probably possible due to niche segregation. While *B. bengalensis* generally occupied the bottom of littoral zone, *G. convexiusculus* was mostly found attached with the macrophyte *Eichhornia* sp. The other two gastropods, *Lymnaea accuminata* and *Indoplanorbis exustus* were also inhabitants of floating and submerged macrophytes but it appears that during competition, the density of these two species was heavily suppressed by *G. convexiusculus*. The latter species was able to utilize the resources of the habitat in a better way. The phenomenon supported the competitive exclusion principle that no two species of almost similar requirements can flourish together in same niche.

The seasonal variation in the abundance of the species followed a bimodal pattern with peaks in early postmonsoon and early monsoon. It has earlier been reported that in this region of the country, there is atleast one period of abundance in any gastropod species in a year (Annandale and Sewell, 1921; Raut, 1980). Bimodal pattern of abundance has also been observed in case of *Bellamya bengalensis* (Khan and Choudhury, 1984) but the period of abundance was different. In the absence of any other report on this species, its period of abundance in the region can not be generalized particularly when great variations have been reported in the life cycle patterns of gastropod between different habitats (Russell-Hunter, 1964).

Among the factors affecting the natural populations of gastropods, temperature and rainfall have been reported to play an important role, besides food supply. The population density of *G. convexiusculus* was not found to be very much affected by the temperature variations. Contrary to temperate waters or colder regions of the country, where cessation of growth or mass mortality during winter period occurs (Clampitt, 1970; Ekblad, 1973), the gastropod population of this region of the country do not appear to be affected markedly by temperature, as already reported (Khan and Choudhury, 1984). This is probably due to comparatively little variation in mean daily temperature over major part of the year. Except for a brief period during POM-II, the mean monthly temperature fluctuated around 30°C (mean of daily maximum and minimum). During postmonsoon period of late December and early January moderate drop in temperature occurs but it lasts only for a brief period of time.

Rainfall affected the population of the species considerably. The breeding during MON-I period corresponded well to other gastropods where normal breeding occurs just after monsoon (Annadale

and Sewell, 1922; Raut, 1981). The second breeding of the species during PRM-I was probably influenced by some other factors including the physiology of the species. Since no other account of its breeding is available, at present it can not be definitely said whether the twice in a year breeding was influenced by some local factor or the species normally breeds twice in a year. Further studies are required to understand the breeding behaviour of the species.

SUMMARY

Various aspects of the life cycle and population dynamics of freshwater pulmonate gastropod *Gyraulus convexiusculus (Hutton)* were studied in a small pond of Calcutta (West Bengal) for two years. The species occurred abundantly throughout the year and contributed about 34-65% to total gastropod population. Alongwith *Bellamya bengalensis* (Lamarck), it constituted the bulk of total gastropod density. The density of other three gastropods, *Lymnaea acuminata* (Lamarck), *Indoplanorbis exustus* (Deshayes) and *Thiara lineata* (Gray), which also occurred in the pond, was greatly reduced. Although significant variations in the density of the species between seasons and between two years were noticed, the pattern was almost similar during both years. Two peak periods of abundance were recorded, first in early premonsoon, and second in early Monsoon, both due to the abundance of newborn individuals. Excepting this period, juveniles always dominated the population composition.

Length frequency analysis revealed clear progressive modes during different seasons. The abundance of newly born individuals during early premonsoon and early monsoon signified the two breeding of the species in a year. The species grew upto 4.75 mm in length and its estimated life span was around 12 months.

The rate of population change (r) in numbers showed that except immediately after recruitment during the two periods, the population growth rate was negative during rest of the period. However, the change in mean weight continued to be positive because of progressive and rapid increase in individual weight

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