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Seasonal abundance of rotifera in a warm monomictic lake

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Abstract

This communication describes the distribution of rotifera in Lake Manasbal, Kashmir, in relation to some physical and chemical characteristics of water. The lake is a warm monomictic type and remains stratified for eight to nine months. Water is alkaline which is mostly due to the presence of bicarbonates of Ca^{++} and Mg^{++}. Thirty-eight species of rotifera were recorded in the lake during the present investigations. The effects of temperature, transparency, carbonate and bicarbonate concentration and the content of dissolved oxygen and free CO_2 on the population density of the group have been discussed in the paper.

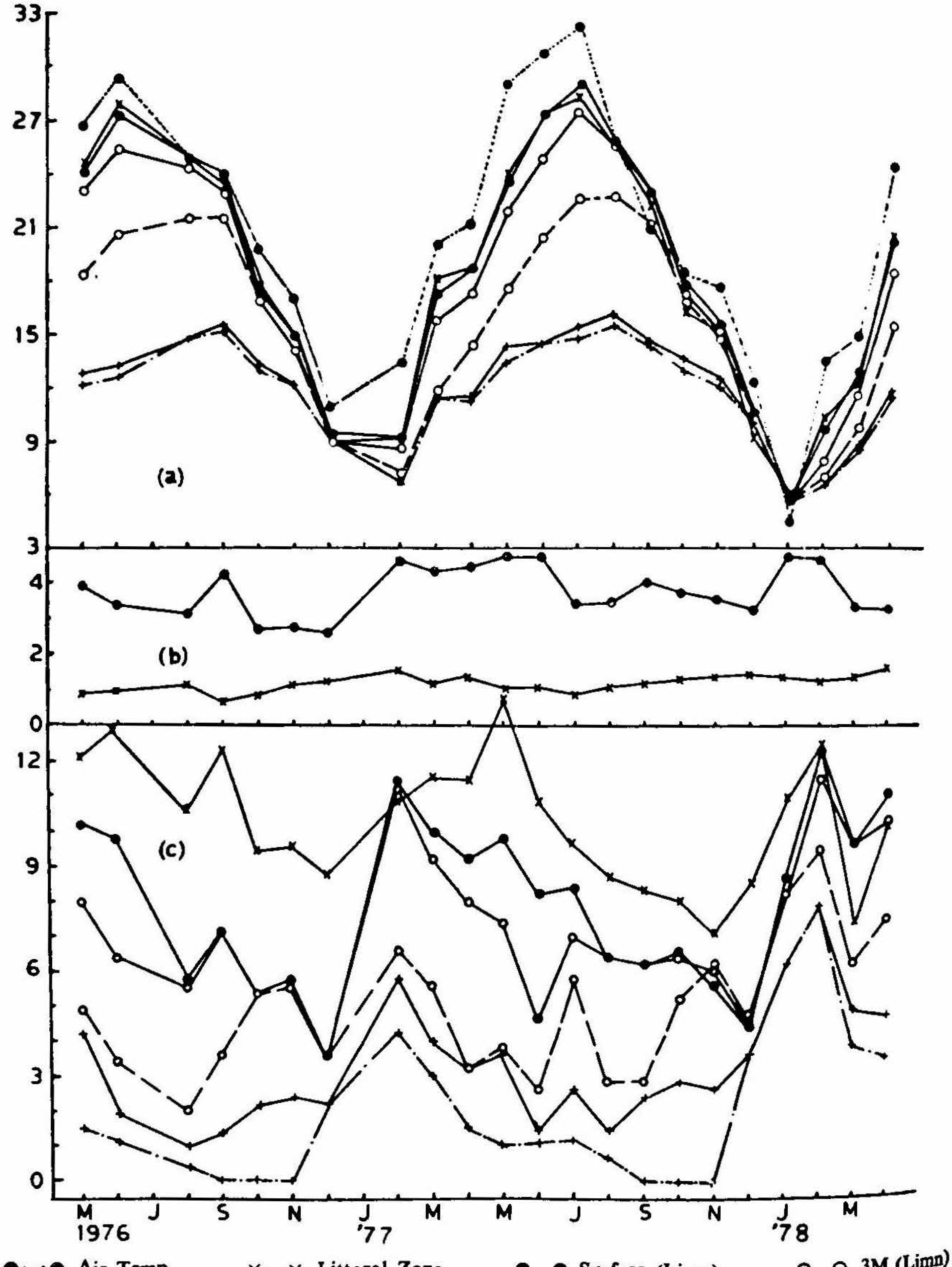
Key words: Lake Manasbal, alkaline, rotifera, bimodal peak.

1. Introduction

Seasonal fluctuations in the lacustrine rotifer population have been studied by many workers[1–3]. Save for some taxonomic reports[4–8], the zooplankton in general, and rotifera in particular, of the various fresh water bodies of Kashmir have received very little attention. A detailed limnological survey of Lake Manasbal was undertaken from May 1976 to April 1978 and this paper describes the distribution of rotifera in relation to some physical and chemical characteristics of the lake. The distribution pattern of the total zooplankton and Cladocera has been discussed in earlier communications[9–12].

2. Material and methods

Lake Manasbal (34° 15′ N and 74° 40′ E) is situated about 32 km to the north-north-west of Srinagar at an altitude of 1584 m A.M.S.L. The lake is 2·8 sq.km in area and has a maximum depth of 12·5 m. It is characteristic in having no inlet except for a temporary seasonal irrigational channel which drains into it during spring-autumn



33
27
21
15
9
3
(a)
4
2
0
(b)
12
9
6
3
0
(c)
M J S N J M M J S N J M
1976 '77 '78
●···● Air Temp,
×—× Littoral Zone
●—● Surface (Limn)
○—○ 3M (Limn)
○- - -○ 6M (Limn)
+—·—+ Bottom (Limn).

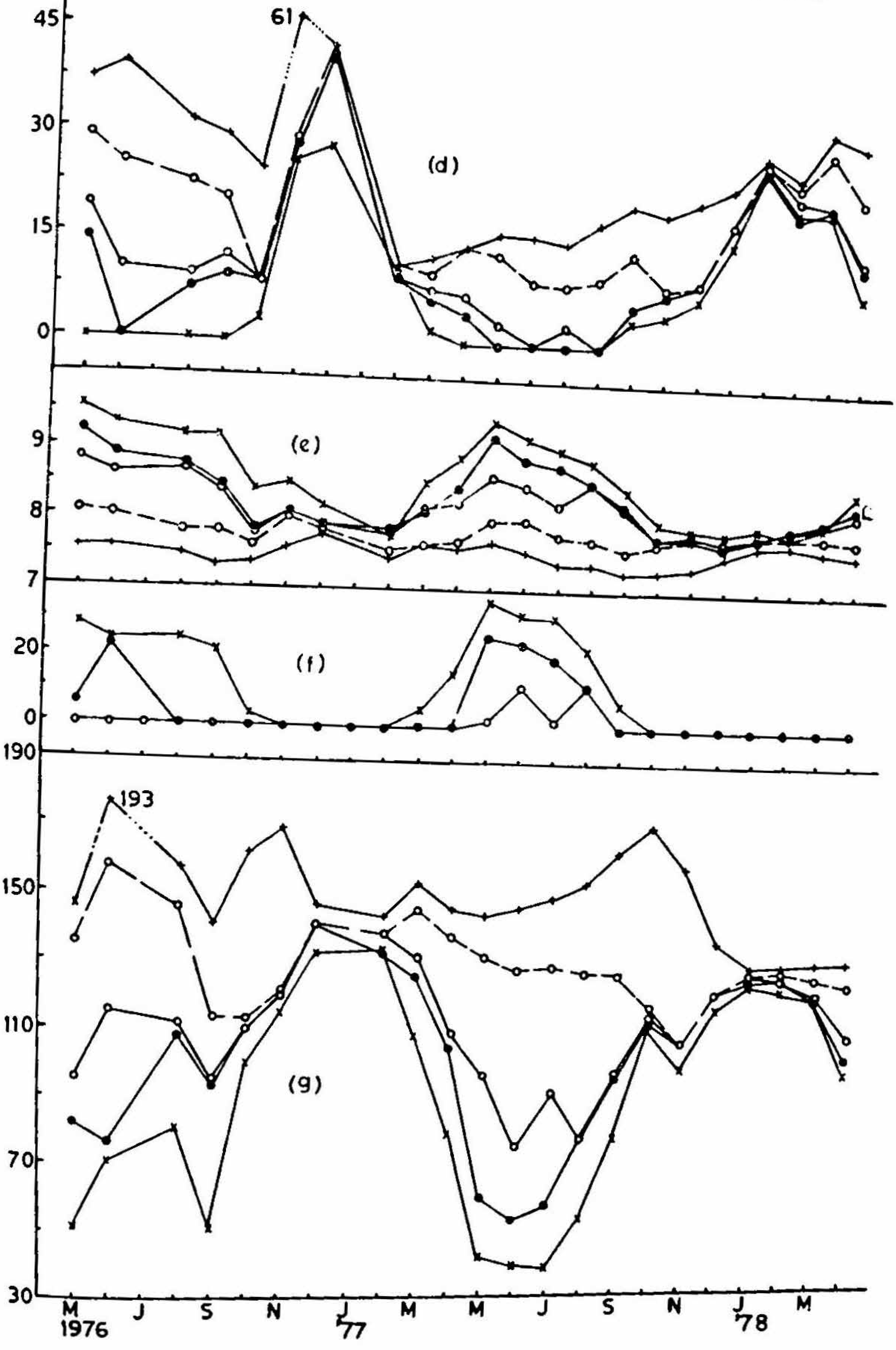


FIG. 1. Seasonal fluctuations in the average values of (*a*) Temperature (°C); (*b*) Transparency (meters); (*c*) Dissolved oxygen (mg/l); (*d*) Free CO_2 (mg/l); (*e*) pH; (*f*) Carbonatse (mg/l) and (*g*) Bicarbonates (mg/l) in the littoral and limnetic zones of Lake Manasbal.

(March–November). Most of the water of the lake oozes from the springs spread over its basin. Excess water from the lake is drained off through a channel into River Jhelum.

For the present study, the lake was divided into two zones—outer shallow littoral zone (depth < 5·0 m) and inner deeper limnetic zone (depth > 5·0 m). In the littoral zone water samples for physico-chemical as well as biological characteristics were taken with the help of a Van-Dorn type water sampler from a depth of 0·5 m at three selected stations (stations 1, 2 and 5). In the limnetic zone, these were procured by the same method from 0·5 m, 3·0 m, 6·0 m and 9·0 m depths at two stations (stations 3 and 4). For determination of dissolved O_2 an additional sample was collected from the bottom· Transparency was noted with the help of a 20 cm Secchi disk. For chemical analysis water samples were taken to the laboratory in polyethylene bottles. Dissolved oxygen was fixed on the spot and later analysed according to Winkler's method. pH was determined by Toshniwal digital CL 46 pH meter. Free CO_2, CO_3^- and HCO_3^- were analysed by the mehods of Welch[13] and chloride, total hardness (Complexometric method), PO_4-P (Stannous chloride method), SO_4^- (Turbidimetric method), NO_3-N (Brucine method) and NO_2-N (Sulphanilic acid method) according to Taras[14]. Silicates (Molybdosilicate method) and NH_3-N (Nesslerisation method) were detected by the methods of Mackereth[15]. For the collection of zooplankton a fixed quantity of water procured by sampler from a particular depth was sieved through a standard net having 60 meshes per linear cm. The zooplankton fixed and preserved in 4% formalin was counted in a Sedgwick rafter cell[13].

3. Results

The range of fluctuations of various physico-chemical variables of Lake Manasbal during 1976–78 is shown in Fig. 1 and Table I. The lake is a warm monomictic type, developing a thermocline for a period of eight to nine months, from March/April to November. Water is always alkaline largely because of the presence of bicarbonates of calcium and magnesium. Carbonates appear for a brief period during spring and summer. Dissolved oxygen and free carbon dioxide as also other physical and chemical factors vary in close relationship with the thermal structure of the lake and during the late stages of stagnation (August–November) the hypolimnion experiences anoxic conditions. Nutrients are usually present in small quantities and the lake is in early stages of eutrophication.

The present investigations revealed a total of thirty-eight species of rotifera from the lake (Table II). Quantitatively, rotifera formed the second largest group of zooplankton in the lake, copepoda being the first. The seasonal fluctuations in the total rotifera population are shown in Figs. 2 and 3. The monthly fluctuations showed a varied pattern at the three stations of littoral zone and station 2 contained generally larger proportions. At station 1 the rotifer population recorded its peak in May ($20{\cdot}5 \times 10^4$ ind/m^3 in May 1976 and $8{\cdot}73 \times 10^4$ind/m^3 in May 1977). From June onwards it decreased irregularly till the lowest values were observed in October–November ($0{\cdot}17 \times$

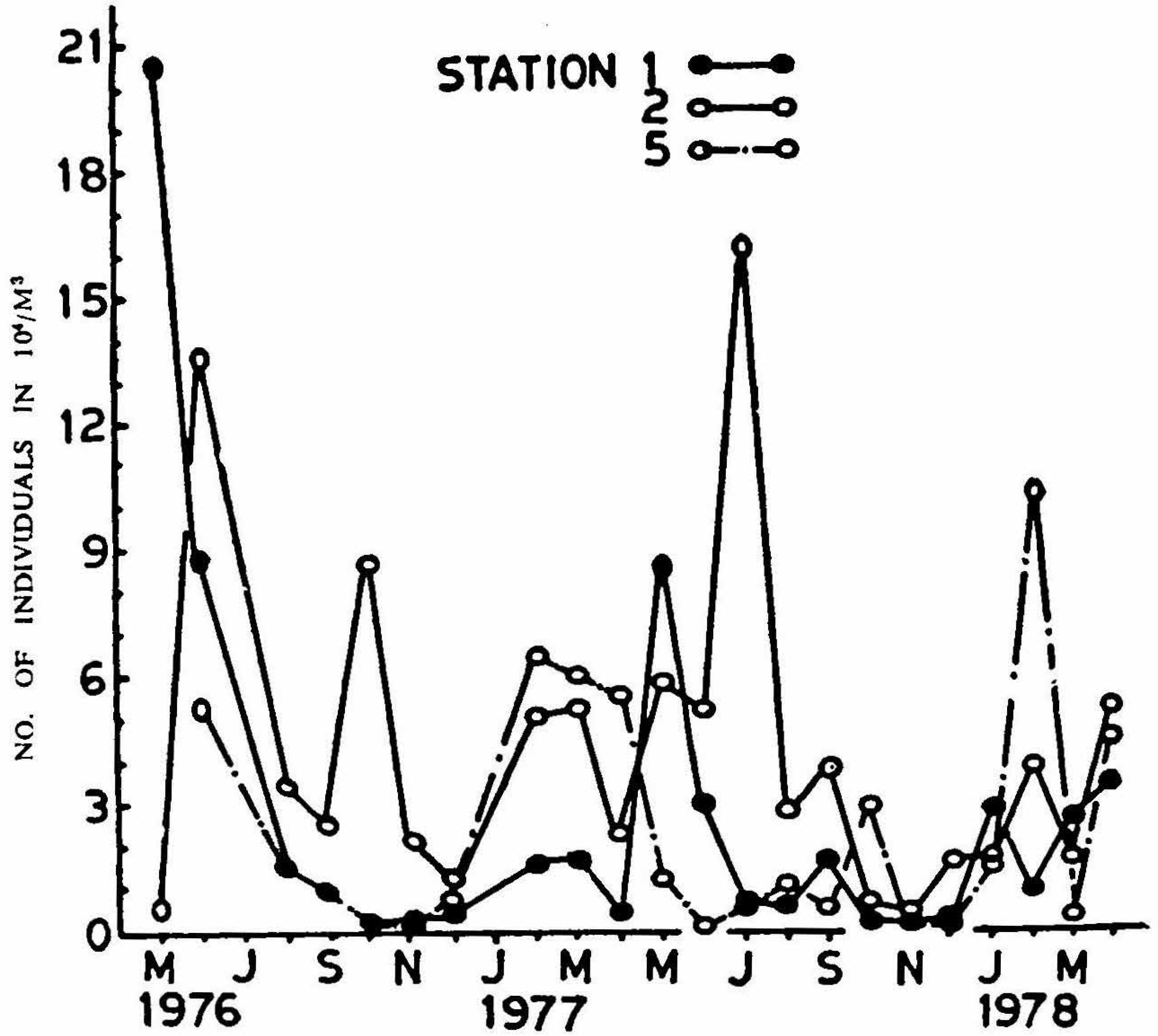
Table I

Mean values of some chemical constituents of Lake Manasbal during 1976–1978

Zone	Littoral		Limnetic			
Parameter	Surface		Surface		9 m	
	1976–77	1977–78	1976–77	1977–78	1976–77	1977–78
Ca+Mg Hardness mg/l	116·50	114·27	124·60	119·50	162·00	154·40
Chloride mg/l	5·37	5·77	4·85	5·54	4·25	5·00
Silicates mg/l	4·40	4·43	4·88	4·98	7·75	8·84
Sulphates mg/l	4·49	3·98	3·89	3·82	2·83	3·38
NO_3-N μg/l	399·00	465·00	348·00	436·00	364·00	600·00
NO_2-N (μg/l)	—	3·60	—	2·70	—	5·00
NH_3-N μg/l	49·80	55·00	28·20	46·00	46·00	90·80
PO_4-P μg/l	6·90	8·70	5·80	8·40	3·80	10·50

10^4 ind/m³ in October 1976 and $0·07 \times 10^4$ ind/m³ in November 1977). Station 2 recorded the highest population in June–July ($13·62 \times 10^4$ ind/m³ in June 1976 and $16·2 \times 10^4$ ind/m³ in July 1977) and the minimum population density in November–December ($1·17 \times 10^4$ ind/m³ in December 1976 and $0·47/10^4$ ind/m³ in November 1977). The population at station 5 showed fluctuations different from those observed at stations 1 and 2. Here the peak was observed in February ($6·51 \times 10^4$ ind/m³ in February 1977 and $10·53 \times 10^4$ ind/m³ in February 1978). Minimum density was recorded in November ($0·17 \times 10^4$ ind/m³ in November 1976 and $0·10 \times 10^4$ ind/m³ in November 1977). In the second year still lower values ($0·03 \times 10^4$ ind/m³) were recorded in June.

In the two limnetic stations the monthly fluctuations in the rotifer population followed a similar pattern recording a bimodal pattern. At station 3, it started to increase from May–June ($1·06 \times 10^4$ ind/m³ in May 1976) and $0·39 \times 10^4$ ind/m³ in June 1977) till the first peak was recorded in August ($3·11 \times 10^4$ ind/m³ in 1976 and $3·79 \times 10^4$ ind/m³ in 1977). Thereafter the population decreased and the lowest values were recorded in December in the first year ($0·44 \times 10^4$ ind/m³) and in October in the second year ($0·15 \times 10^4$ ind/m³). The population density increased quickly and the second peak was recorded in February ($4·65 \times 10^4$ ind/m³ in 1977 and $5·97 \times 10^4$ ind/m³ in 1978). Whereas in the first year the population decreased from March onwards, in the second year the peak remained till April. At station 4 the two peaks were recorded in August–September ($7·46 \times 10^4$ ind/m³ in September 1976 and $3·46 \times 10^4$ ind/m³ in August 1977) and February ($8·44 \times 10^4$ ind/m³ in February 1977 and $7·03 \times 10^4$ ind/m³ in February 1978) and the minimal numbers were observed in June ($1·24 \times 10^4$ ind/m³



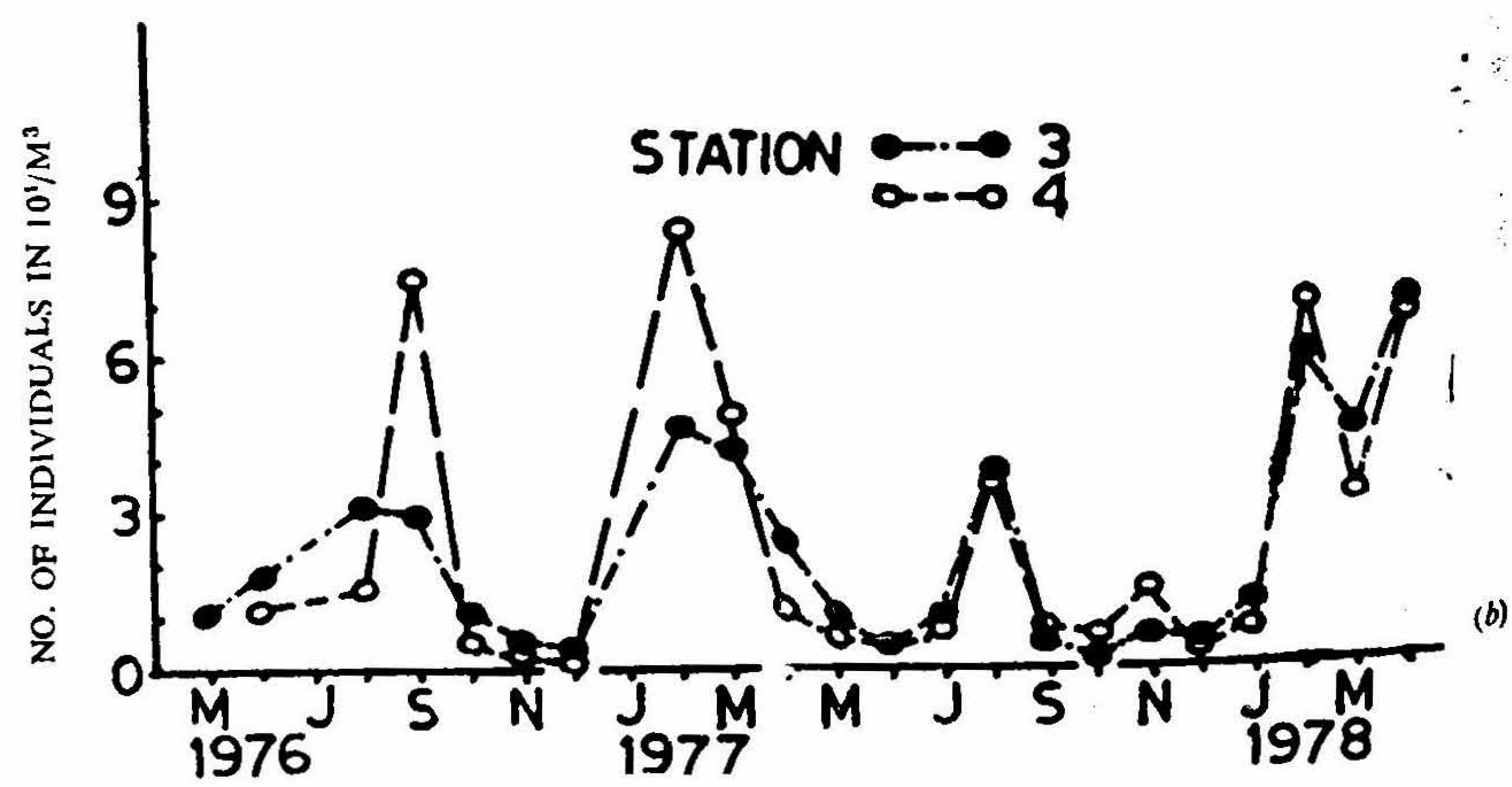


FIG. 2. (a) Population density of rotifera in the littoral zone of Lake Manasbal. (b) Mean population density of rotifera in the limnetic zone of Lake Manasbal.

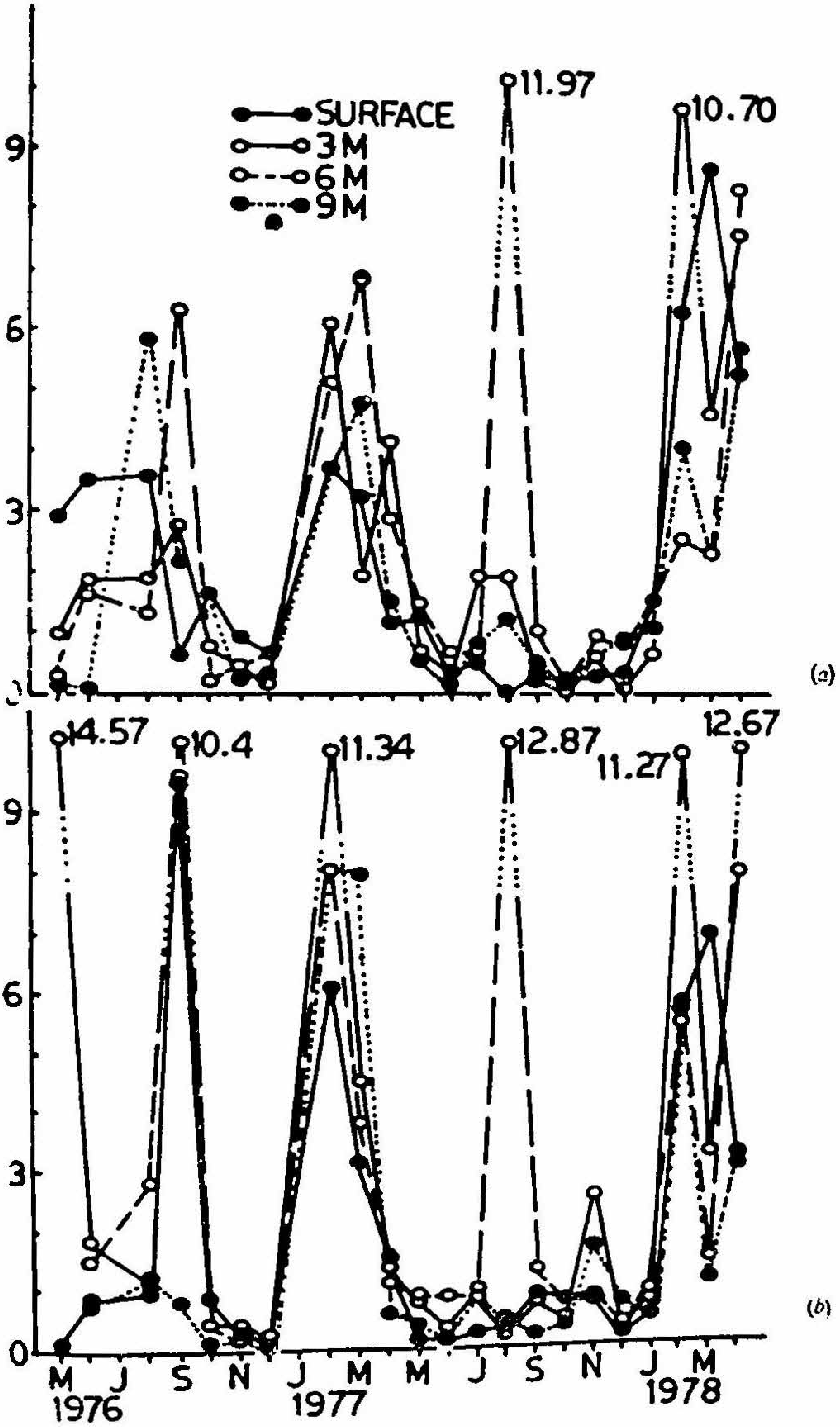


FIG. 3. Vertical distribution of rotifera in the limnetic zone of Lake Manasbal. (*a*) Station 3 and (*b*) Station 4.

Table II

List of rotifer sp. recorded during the present investigation

Class	Monogononta
Order	Ploima
Family	Synchaetidae
	1. *Polyarthra vulgaris* Carlin
	2. *Synchaeta oblonga* Ehrn.
	3. *S. pectinata* Ehrn.
	4. *Euchlanis dilatata* (Ehrn).
	5. *E. parva* Rousellot.
Family	Brachionidae
	6. *Trichotria tetractis* Ehrn.
	7. *Keratella cochlearis* Gosse
	8. *K. quadrata* Muller
	9. *Anuraeopsis fissa* Gosse
	10. *Brachionus quadridentata* Hermann
	11. *B. plicatilis* Muller
	12. *Notholca acuminata* Ehrn.
	13. *Mytilina ventralis* Ehrn.
	14. *M. mucronata* (Muller)
	15. *Platyias patulus* (Muller)
	16. *P. quadricornis* (Ehrn.)
	17. *Colurella* sp.
Family	Asplanchnidae
	18. *Asplanchna priodonata* Gosse
Family	Trichocercidae
	19. *Trichocerca longiseta* (Schrank)
	20. *T. porcellus* (Gosse)
	21. *Trichocerca* sp.
	22. *Trichocerca* sp.
Family	Lecanidae
	23. *Monostyla bulla* (Gosse)
	24. *M. quadridentata* (Ehrn.)
	25. *M. closterocerca* Schmarda
	26. *M. lunaris* (Ehrn.)
	27. *Lecane luna* (Muller)
	28. *L. ohionsis* Herrick
	29. *L. elasma*
Family	Notommatidae
	30. *Cephalodella* sp.
	31. *Monommata* sp.
	32. *Scaridium* sp.

Family	Proalidae
	33. *Proales* sp.
Family	Dicranophoridae
	34. *Dicranophorus* sp.
Order	Flosculariaceae
Family	Testudinellidae
	35. *Filinia longiseta* (Ehrn)
	36. *F. terminalis* (Plate)
Family	Conochilidae
	37. *Conochilus* sp.
Class	Bdelloidea
Order	Bdelloida
Family	Philodinidae
	38. Unidentified *bdelloid* sp.

in June 1976 and $0 \cdot 38 \times 10^4$ ind/m^3 in June 1977) and December ($0 \cdot 12 \times 10^4$ ind/m^3 in 1976 and $0 \cdot 38 \times 10^1$ ind/m^3 in 1977). At both these stations the rotifer plankton preferred generally the middle layers of the water column (Fig. 3).

4. Discussion

During the Yale North India Expedition, Edmondson and Hutchinson[4] reported eight species of rotifera from Lake Manasbal. In a survey of various freshwater bodies, Sharifa-Akhtar[16] recorded ten species from the same lake. She, however, could not find two species, *Actinurus neptunius* and *Mytilina ventralis*, reported by Edmondson and Hutchinson[4]. During the present investigation, thirty-eight species belonging to eleven families of rotifera were recorded from the lake (Table II). Since the earlier reports are based on random collections, the periodic influx of other species during the recent years cannot be ascertained with certainty. It is, however, evident that some of the species have completely disappeared and have been replaced by other allied ones. Change in the species composition of rotifera in the lake may be attributed to the change in the physics and chemistry of the water. This is confirmed by comparison of the data of Zutshi *et al*[17] with the present data.

In aquatic ecosystem the physical and chemical characteristics of water are greatly responsible for the abundance and behavioural pattern of the biota[18–22]. Our data from Lake Manasbal reveal that *Polyarthra* sp., *Synchaeta* sp., *Asplanchna* sp., *Monostyla* sp. and *Keratella* sp. are perennial, whereas *Brachionus* sp., *Filinia* sp., *Anuraeopsis* sp., *Notholca* sp., *Proales* sp. and *Bdelloid* sp. are seasonal in their occurrence. Whereas *Brachionus* sp. and *Anuraeopsis* sp. contribute to the late summer-early autumn peak and are warm stenothermal, *Notholca* sp., *Proales* sp., *Filinia* sp. and *Bdelloid* sp. contribute to the late winter-early spring peak and are cold stenothermal forms.

The littoral zone of the Lake Manasbal contains generally larger populations than the limnetic zone throughout the year. The monthly fluctuations in the population density in littoral zone are irregular, varying from station to station, and appear to be related to its shallowness and the overgrowth of the macrophytes in this zone, as also reported by Welch[19].

The bimodal type of annual cycle of rotifer population, reported by Zankai and Ponyi[2] and Gophen[3], is well marked in the limnetic zone of Lake Manasbal, where the two peaks are found in late summer-early autumn and again in late winter-early spring. Campbell[18] reports the distribution of rotifers to be closely related to dissolved oxygen, carbon dioxide and pH changes in water. Davis[20] also found pH to be an important factor in the distribution of rotifera. Lake Manasbal is a warm monomictic type[23] and the seasonal changes in various gases and solids in water as also their vertical distribution are closely related to the thermal structure of the lake. The abundance and vertical distribution of rotifera in the lake seem to be closely governed by environmental conditions. Soon after the attainment of peak in August–September, the rotifer population shows a quick decline and the minimum values are recorded in December. This may be due to the fact that with a decrease in the atmospheric temperature in autumn, the thermal stratification weakens and this results in the mixing of the hypolimnetic waters, which are rich in CO_2 and dead organic matter, with the upper, well oxygenated and more alkaline, waters. This results in a decrease in dissolved oxygen, pH and transparency values, as is evident from the data of October–December (Fig. 1).

During winter circulation, the rotifer population, although very small, does not prefer any particular depth due to the almost uniform environmental conditions throughout the whole water column and at times may record higher number of individuals in the lower layers. As soon as the temperature increases towards the late winter, the other variables being already favourable, rotifer population increases and records the late winter–early spring peak.

With the onset of thermal stratification the vertical distribution of rotifera varies considerably. From spring onwards the surface water experiences high temperatures and becomes more alkaline due to the appearance of carbonates. There follows an abrupt decline in the rotifer population and the group migrates downwards. After the alkalinity decreases again in summer, a considerable increase in the population is recorded. But as the surface layers continue to have high temperature, the group concentrates in the middle layers; the hypolimnion with very large quantities of CO_2 at this time generally harbours very small population.

It may be concluded that the most important factor in the seasonal abundance and vertical distribution of rotifera in Lake Manasbal is the thermal structure of the lake which governs both the concentration of the other physico-chemical factors, as also their influencing capacity on the abundance of rotifera.

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