Mediterranean Marine Science

Vol 5, No 1 (2004)

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doi: [10.12681/mms.206](https://doi.org/10.12681/mms.206)

Mediterranean Marine Science
Vol. 5/1, 2004, 19-27

Aspects on the seasonal dynamics and the vertical distribution of the crustacean zooplankton community and the *Dreissena polymorpha* larvae in Lake Trichonis

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Abstract

In Lake Trichonis 9 crustacea species and the molluscan larvae of Dreissena polymorpha were recorded during four seasonal samplings from summer 2002 to spring 2003. Mean integrated values of crustacea abundance ranged from 4.5 to 12.9 ind/L and were mainly dominated by the calanoida Eudiaptomus drieschi. The abundance values recorded, as well as the seasonal dynamics, followed the monoacmic pattern of oligotrophic lakes. However, the presence of Daphnia cucullata, a typical representative of eutrophic lakes, the decrease of the calanoida participation in the crustacea community and the succession in the cladocera community, could probably indicate a tendency towards a change of the trophic condition of Lake Trichonis. Along the vertical axis the maximum abundance of the zooplankton community was recorded in the surface 0-10 m. Mollusca larvae were present in all seasons and their highest abundance was recorded in the surface layer 0-10 m. Temperature, competition and predation seemed to be the main factors regulating vertical distribution.

Keywords: Trichonis lake; Vertical distribution; Copepoda; Cladocera; Greece.

Introduction

Lake Trichonis (38°18'-38°51'N, 21°01-21°42'E) is the largest natural lake in Greece with a surface area of about 98 km^2 and a maximum depth of 57 m. It is a warm monomictic lake, exhibiting stable thermal stratification and it is considered to be oligotrophic to mesotrophic (KOUSSOURIS, 1981, KOUSSOURIS *et al.*, 1993, BERTAHAS *et al.*, 1997, SKOULIKIDIS *et al.,* 1998).

The lake has received a great deal of attention and so there are several studies concerning the physical and chemical characteristics and the water balance of the lake (OVERBECK *et al.*, 1982, TAFAS *et al.*, 1997, DIMITRIOU *et al.*, 2001); the phytoplankton abundance and species composition (see in

TAFAS and ECONOMOU-AMILLI, 1997,) as well as the ichthyofauna (ECONOMOU *et al.*, 1999).

On the other hand, although zooplankton is a critical component in all lake ecosystems, the data concerning this community in Lake Trichonis are very limited (KOUSSOURIS, 1978; 1979; KOUSSOURIS *et al.*, 1993).

In the present study, we attempt to provide information on zooplankton community structure and the possible changes that have taken place since the last study in 1990-1991 (KOUSSOURIS *et al.*, 1993) and on the vertical abundance distribution pattern of crustacean zooplankton in Lake Trichonis and how this alters during a four seasons period (summer 2002-spring 2003). Conclusions regarding the seasonal dynamics of zooplankton, are difficult to be drawn based on seasonal sampling, while the fact that the data resulted from a single sampling station, creates limitation for the generalization of our results.

Materials and Methods

Samples were collected seasonally (3rd of July, 16th of October 2002, 28th of February, 29th of March 2003) from a single station (A), which is situated in the southeastern part of Lake Trichonis and has a depth of 48 m (Fig. 1). The samples were collected using a conical closing plankton net (40cm diameter, 1 m long, 100 μm mesh size). Vertical hauls were conducted at 5 m depth intervals, from 45 m to the surface in all sampling occasions, except in July 2002 where the samples were taken in 10 m intervals from 40 m to the surface. The net was towed at a speed of approximately 0.5 m/s. All samples were taken in the morning (9-11 a.m.) and after the collection were preserved in 4 % formalin.

For the identification of species the keys of RYLOV (1963), KIEFER (1968), VOIGT and KOSTE (1978) and ALONSO (1996) were used. For the abundance analysis for each sample (total volume 100 ml), five counts of 1

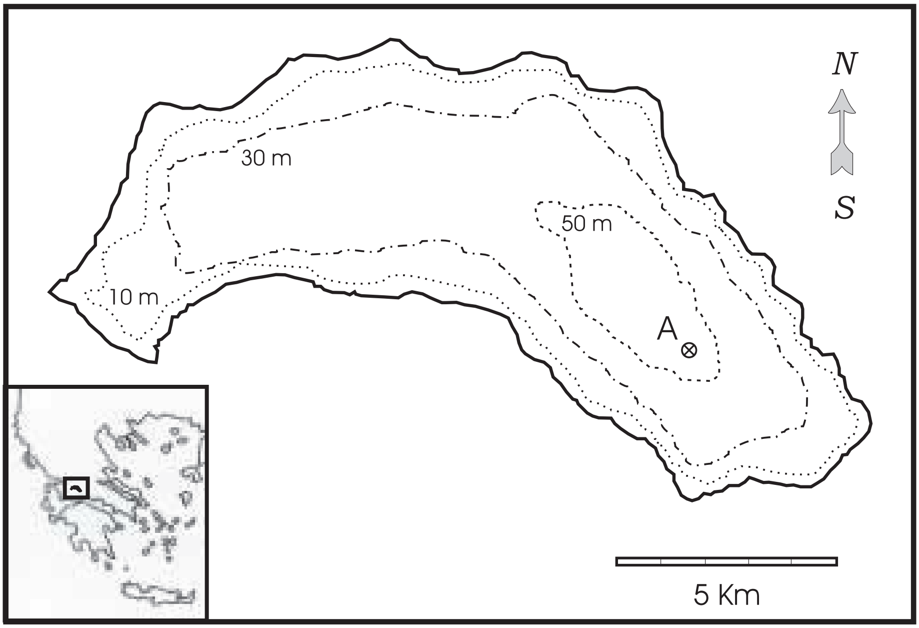

Fig. 1: Lake Trichonis with the sampling station.

ml subsamples were made on a Sedwick-Rafter cell.

Results

Species composition

During the four sampling periods, the zooplankton community (> 100 μm) of Lake Trichonis consisted of 6 cladocera species: *Bosmina longirostris* (O.F. Müller, 1785), *Ceriodaphnia pulchella* Sars, 1862, *Daphnia cucullata* Sars, 1862, *D. galeata* Sars, 1864, *D. longispina* O.F. Müller, 1785 and *Diaphanosoma* sp. Also 3 copepoda species were found: *Eudiaptomus drieschi* (Poppe & Mrázek, 1895), *Macrocyclops albidus* (Jurine, 1820) and *Microcyclops varicans* (Sars, 1863). Finally, one molluscan larvae *Dreissena polymorpha* (Pallas, 1771) was found in our samples. Additionally, although the mesh size of the net used in the present study was not suitable for the collection of rotifers, some species of this zooplanktonic group were also found sporadically in our samples: *Asplanchna priodonta* Gosse, 1850, *Brachionus calyciflorus* Pallas, 1766, *B. c. f. anuraeiformis* (Brehm, 1909), *Euchlanis dilatata* Ehrenberg, 1832, *Hexarthra* sp., *Kellicottia longispina* (Kellicott, 1879), *Keratella cochlearis* (Gosse, 1851), *K. quadrata* (Müller, 1786), *Synchaeta* sp., *Trichocerca capucina* Wierzejski & Zacharias, 1893 and *T. similis* (Wierzejski, 1893).

Seasonal dynamics

The mean integrated values of the crustacean community in the overall water column ranged from 4.5 to 12.9 ind/L, with the maximum values occurring in summer and the minimum in winter (Fig. 2). In summer and autumn copepoda dominated the crustacean zooplankton contributing to the total abundance 43% and 85%, respectively. In winter both cladocera and copepoda contributed 50% to the total abundance, while in spring cladocera outnumbered copepoda (57% and 43%, respectively).

The abundance of cladocera ranged from 1.6 ind/L in autumn to 5.3 and 4.9 ind/L in summer and spring, respectively (Fig. 2). In summer and autumn their community consisted almost exclusively of *Diaphanosoma* sp. (80% and 99%, respectively), while in winter and spring *Bosmina longirostris* was the only cladoceran found. *Daphnia* species contributed 20% to the cladocera community only in summer (Fig. 4).

The copepod community abundance (Fig. 2) ranged from 2.2 ind/L in winter to 9.0 ind/L in autumn and consisted exclusively of the calanoida *Eudiaptomus drieschi*, with the developmental stages (nauplii and

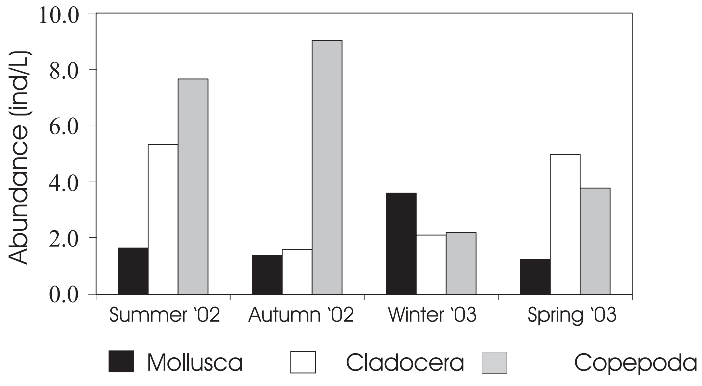

Fig. 2: Mean integrated values of the abundance (ind/L) of copepoda, cladocera and mollusca larvae in the overall water column in Lake Trichonis during four sampling periods.

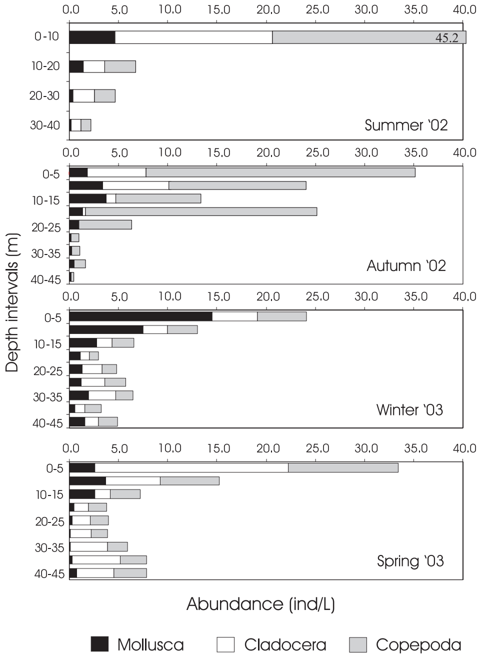

Fig. 3: Vertical distribution of the abundance (ind/L) of copepoda, cladocera and mollusca larvae in Lake Trichonis during four sampling periods.

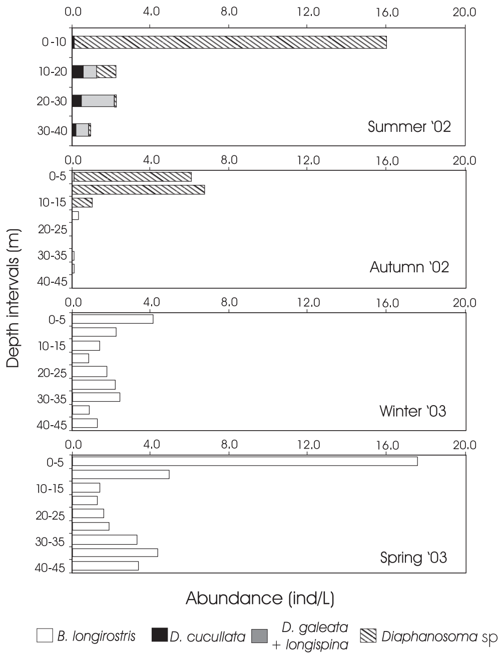

Fig. 4: Vertical distribution of the abundance (ind/L) of the cladocera community in Lake Trichonis during four sampling periods.

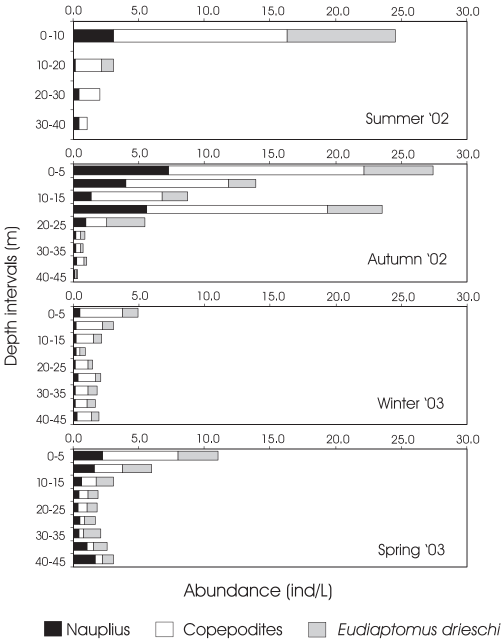

Fig. 5: Vertical distribution of the abundance (ind/L) of the copepoda community in Lake Trichonis during four sampling periods.

copepodites) dominating in all the sampling periods with 10-26% and 36-61%, respectively (Fig. 5).

Mollusca larvae *(Dreissena polymorpha)* were present in all seasons and their abundance ranged between 1.2 ind/L in autumn and spring and 3.6 ind/L in winter (Fig. 2).

Vertical distribution

The maximum abundance of the zooplankton community was recorded in the surface 0-5 or 0-10 m depth layer in all sampling periods (Fig. 3). This was very pronounced in summer when 77% of the community was found within the surface 0-10 m depth layer. In autumn high abundance was also found in the 15-20 m depth layer, while in spring, although maximum densities were found in the upper 0-5 m depth layer, an increase of the total zooplankton abundance in the deepest sampling layers between 30 and 45 m was also found.

For the cladocera community the highest abundance values were also recorded in the surface layer of 0-10 m (Fig. 4). This was especially profound in summer and autumn when the majority of the community was concentrated in this depth (75% and 89% of the total cladocera, respectively). In autumn the vertical distribution of the community stopped in the 15-20 m depth layer. In winter there were small differences in the abundance distribution of cladocera on the vertical axis, while in spring except for the high abundance recorded in the surface 0-5 m depth layer, there was an increase of abundance in the deeper layers. Difference in the species participation occurred only in summer when the layer of 0-10 m was occupied by *Diaphanosoma* sp., while below 10 m and especially below 20 m *Daphnia* species dominated.

Almost the same general pattern, as for cladocera, was also the case for the vertical distribution of copepods (Fig. 5). In summer there was a sharp decrease of abundance below 10 m, while in autumn a decrease of abundance with increasing depth was noticed with the exception of the layer 15-20 m. In autumn only few copepoda were found below 25 m, while in winter there were small differences in the abundance with depth. Finally, in spring after the decrease of abundance with depth in the upper layers (0-20 m), a slight increase of abundance in the deeper layers (below the 20-25 m layer) was noticed. The described patterns were shaped mainly by the distribution of the developmental stages which, as mentioned above, dominate the copepod community.

As for the mollusca larvae the highest abundance was recorded in the surface layer 0-10 m followed by a decrease with depth, both in summer and in winter. However, in autumn and spring higher abundance values were found at the 10-15 and the 5-10 m depth layer, respectively (Fig. 3).

Discussion

The species composition of the crustacean zooplankton community found in Lake Trichonis during the present study showed some differences compared to the one recorded by KOUSSOURIS *et al.* (1993). Thus, in the present study only one calanoida species was recorded, while KOUSSOURIS *et al.* (1993) reported three including *Eudiaptomus drieschi.* In large lakes like Trichonis zooplankton populations can be separated along the horizontal axis (WETZEL, 2001), so, since the present data came from one station, this could be the reason why the other species were not encountered. On the other hand, the presence of the two cladocera species *Daphnia cucullata* and *Diaphanosoma* sp. should be considered as new for the zooplankton fauna of the lake. Among these two new species, the presence of *Daphnia cucullata* was interesting, since it is a typical representative in eutrophic lakes in Europe (GLIWICZ & LAMPERT, 1990).

As far as the seasonal dynamics of the crustacean community are concerned, they should be considered with caution, since they derive from four seasonal samplings. Nevertheless, they seem to have followed the monoacmic pattern recorded in oligotrophic lakes (SOMMER *et al.*, 1986), following in time the peak of the phytoplankton biomass (TAFAS & ECONOMOU-AMILLI, 1997). At the same time, the dominance of calanoida in the crustacean community is characteristic of oligotrophic ecosystems (McNaught, 1975). Still, their participation in the crustacean community has decreased from 50-100% (KOUSSOURIS *et al.*, 1993) to 42-85% in the present study, while cladocera increased their participation (from 0-49% to 14-57%, respectively). This could probably indicate a tendency towards a change in the trophic condition of the lake, since the calanoida participation is considered to decrease with increasing trophic conditions (GANNON & STEMBERGER, 1978). However, the abundance values recorded in the present study were within the range of values recorded in other large oligotrophic lakes [Lake Ohrid: copepoda 2.5-12 ind/L, cladocera <1 ind/L (STANKOVIC, 1960); Lake Tavropou: copepoda 3-20 ind/L, cladocera 0.4-16 ind/L (TSEKOS *et al.*, 1992); Lake Bracciano: copepoda 3-17,5 ind/L, cladocera: 0-3 ind/L (FERRARA *et al.*, 2002)]. Additionally, the cladocera community was mainly characterized by the presence of *Diaphanosoma* sp. and *Bosmina longirostris*. The succession of these species followed the one described by GELLER & MÜLLER (1985) for eutrophic lakes. Thus, *Diaphanosoma* as a highly efficient bacteriofeeder was present in summer, while *Bosmina* as a low efficient bacteriofeeder was present in autumn and spring, preceding *Daphnia* and following *Diaphanosoma*.

The mollusca *Dreissena polymorpha* is a very common species in European lakes and the duration of the planktonic phase of its larvae differs among lakes increasing from North to South (LEWANDOWSKI, 1982). In Lake Trichonis the planktonic larvae were present in all four seasons. This long duration was also encountered in Lake Ohrid (STANKOVIC, 1960). In both lakes the temperature never drops below 9 °C which seems to be the key factor for this prolonged planktonic stage, since geographically between these two lakes there are lakes where temperatures during winter are much lower and the duration of the planktonic phase of this species is shorter (Lake Megali Prespa: SERAFIMOVA-HADZISCE, (1959); Lake Volvi: ZARFDJIAN, (1989); Lake Mikri Prespa: MICHALOUDI, 1997).

The vertical distribution of the zooplankton community in general showed a clear concentration in the upper layers of the water column, which is typical of deep stratified lakes. Temperature, oxygen concentration, light, predation and the distribution of food are some of the factors that influence the vertical distribution of zooplankton species (eg. GOPHEN, 1972; ORCUTT & PORTER, 1983; GELLER, 1986; LEVY, 1990; HANAZATO, 1992). Unfortunately, the only information concerning the above factors comes from bibliographical data. So, Lake Trichonis has been considered as an oligotrophic lake by many previous reports (KOUSSOURIS, 1981, KOUSSOURIS *et al.*, 1993, TAFAS *et al.*, 1997, SKOULIKIDIS *et al.*, 1998) having low concentrations of nutrients (P-PO_4: 3-14 mg/L, N-NO_3: 41-147 mg/L), low chlorophyll-a concentrations (2.3-4.3 mg/m^3) and high water transparency (Secchi disk: 7-13 m). It is a warm lake (10-30 °C) and has a prolonged period of thermal stratification, starting in April and lasting through early November (KOUSSOURIS *et al.*, 1993, TAFAS *et al.*, 1997). TAFAS *et al.* (1997) reported that at the peak of the stratification period (June and July), the upper boundary of metalimnion was generally between 10-13 m of depth and the lower was located between 18-20 m, while in late October the metalimnion extended between 21 and 24 m.

Considering the above information, temperature seemed to be the factor affecting the vertical distribution of *Diaphanosoma* sp. The species was present during the summer and autumn when the lake was stratified and temperature in the epilimnion and metalimnion ranged from 15 to 25 °C, while in the hypolimnion it was much lower (TAFAS *et al.*, 1997). *Diaphanosoma* species are considered as thermophilous (KOROVCHINSKY, 1992) while in Greek lakes this genus is present at temperatures higher than 10-15 °C, with an optimum at 25 °C (ZARFDJIAN, 1989; MICHALOUDI *et al.*, 1997). Thus, in Lake Trichonis the low temperature in the hypolimnion excluded the species from that water layer. *Daphnia*, on the other hand, which is not so well adapted to the high temperatures of the epilimnion (SOMMER, 1989) was found to be present below 10 m. Competition could be another factor affecting the vertical distribution of *Daphnia*. Calanoida, in general, are efficient filter feeders (WETZEL, 2001) and they compete with other filter feeders such as *Daphnia*. Thus, during the summer period in Lake Trichonis the two filter feeders (*Daphnia* and *Eudiaptomus drieschi*) were separated in the vertical axis, probably in order to avoid competition. A similar strategy was also recorded in Lake Mikri Prespa, even though it is a much smaller lake (MICHALOUDI, 1997). Predation may also be considered as an important factor, since a great deal of zooplanktivorous fish species have been recorded in Lake Trichonis (ECONOMOU *et al.*, 1999). Thus, predation could account for the restriction of *Daphnia* in deeper layers of water especially during the daytime, as has been found by ZARFDJIAN (1989) and GELLER *et al.* (1992). Any of the above mentioned factors could also have influenced the vertical distribution of *Bosmina longirostris* and *Eudiaptomus drieschi*, but at the moment with the available data no assumption could be made. Nevertheless, copepods during winter can create resting eggs or enter diapause and stay near the bottom of the lake (WETZEL, 2001), thus although there is no available information about *E. drieschi*, the slight increase of its abundance in the deeper layers during winter and spring could probably be attributed to parameters concerning the life cycle of this species.

The vertical distribution of the mollusca larvae showed practically a restriction to the water layer of 0-20 m. The same pattern recorded by ZARFDJIAN (1989) in Lake Volvi, especially during the stratification period. Furthermore, the tendency towards an abundance increase in the deeper layers recorded in the present study could be owed to the ontogeny of the species, which descends to deeper layers in order to turn to the benthic phase of its life (MICHALOUDI, 1997; ZARFDJIAN, 1989).

In conclusion, according to our data it seems that Lake Trichonis holds the main characteristics of oligotrophic lakes and at the same time exhibited features of eutrophic lakes indicating probably a tendency towards a change in its trophic condition. A more detailed research could confirm the present trophic state of the lake and establish the trophic interactions that take place in the water of the biggest lake in Greece. As for the vertical distribution, the majority of the zooplanktonic organisms were concentrated in the water layer 0-20 m, which was especially pronounced during stratification. The factors that could account for the distribution of the species in the vertical axis were temperature, competition and probably predation.

References

ALONSO, M., 1996. Crustacea. Branchiopoda. En: Fauna Ibérica. vol.7. Ramo, M.A et. al. (Eds.). Museo National de Ciencias Naturales. CSIC. Madrid. 486pp.

BERTAHAS. I., FOTIS, G. & KOUSSOURIS, TH., 1997. Trophic status evaluation, pollution sources and pollution loads in Trichonis Lake, Western Greece. Proceedings of the 5th Hellenic Symposium of Oceanography and Fisheries, 2: 329-332.

DIMITRIOU, E., ZACHARIAS, I. & KOUSSOURIS, TH., 2001. Study of the water balance of Trichonis lake catchment, Final Report, pp. 111. In: Actions for the protection of calcareous bogs/fens in Trichonis Lake, edited by Zacharias, I. and Koussouris, Th. Technical Report, NCMR/IIW.

ECONOMOU, A., BARBIERI, R., DAOULAS, CH., PSARRAS, TH., STOUMBOUDI, M., BERTAHAS, H., GIAKOUMI, S. & PATSIAS, A., 1999. Threatened endemic fish species of inland waters in Western Greece and Peloponesse – distribution, abundance, threats and protection measures. NCMR 341 pp.

FERRARA, O., VAGAGGINI, D. & MARGARITORA, F. G., 2002. Zooplankton abundance and diversity in Lake Bracciano, Latium, Italy. Journal of Limnology, 61(2): 169-175.

GANNON, J. E. & STEMBERGER, R. S., 1978. Zooplankton (especially crustaceans and rotifers) as indicators of water quality. Transactions of American Microscopy Society, 97(1): 16-35.

GELLER, W., 1986. Diurnal vertical migration of zooplankton in a temperate great lake (L. Constance): A starvation avoidance mechanisms? Archiv fur Hydrobiologie/Supplement, 74(1): 1-60.

GELLER, W. & MÜLLER, H., 1985. Seasonal variability in the relationship between body length and individual dry weight as related to food abundances and clutch size in two coexisting *Daphnia* species. Journal of Plankton Research, 7(1): 1-18.

GELLER, W., PINTO-COELHO, R. & PAULI, H.-R., 1992. The vertical distribution of zooplankton (Crustacea, Rotatoria, Ciliata) and their grazing over the diurnal and seasonal cycles in Lake Constance. Archiv fur Hydrobiologie, 35: 79-85.

GLIWICZ, Z. M. & LAMPERT, W., 1990. Food thresholds in *Daphnia* species in the absence and presence of blue-green filaments. Ecology, 71(2): 691-702.

GOPHEN, M., 1972. Zooplankton distribution in Lake Kinneret (Israel), 1969-1970. Israel Journal of Zoololy, 21: 17-27.

HANAZATO, T., 1992. Direct and indirect effects of low-oxygen layers on lake zooplankton communities. Archiv fur Hydrobiologie, 35: 87-98.

KIEFER, F., 1968. Versuch einer Revision der Gattung *Eudiaptomus* Kiefer (Copepoda Calanoida). Mem. Ist. Ital. Idrobiol., 24: pp. 9-160.

KOROVCHINSKY, N. M., 1992. Sididae and Holopediidae: (Crustacea: Daphniiphormes). The Hague: SPB Academic Publishing. III. Guides to the identification of the microinvertebrates of the continental waters of the world 3, 82pp.

KOUSSOURIS, TH., 1978. Plankton observations in three lakes of Western Greece. Thalassographica, 2: 115-123.

KOUSSOURIS, TH., 1979. Dominating planktonic rotatoria in some lakes of western Greece. Biologia Gallo-hellenica, 12: 135-140.

KOUSSOURIS, TH., 1981. Environmental studies of a large, deep, oligotrophic lake (Lake Trichonis, Western Greece). M.Sc. dissertation, University of Salford, England, 56p.

KOUSSOURIS, TH., BERTAHAS, I., DIAPOULIS, A., PAKOS, V. & GRITZALIS, K., 1993. Limnological and hydrobiological characteristics of Lake Trichonis. p. 1-37. In: Limnological, ichthyological and fisheries investigation of Lake Trichonis, edited by Ch. Daoulas, Technical Report, NCMR, TEE/144.

LEVY, D. A., 1990. Reciprocal diel vertical migration behavior in planktivores and zooplankton in British Columbia lakes. Canadian Journal of Fisheries and Aquatic Sciences, 47: 1755-1764.

LEWANDOWSKI, K., 1982. The role of early developmental stages in the dynamics of *Dreissena polymorpha* (Pall.) (Bivalvia) populations in lakes. I. Occurrence of larvae in the plankton. Ekol. Pol., 30(1-2): 81-109.

McNAUGHT, D. C., 1975. A hypothesis to explain the succession from calanoids to cladocerans during eutrophication. Verh. Intern. Verein. Limnol., 19: 724-731.

MICHALOUDI, E., 1997. Composition, abundance and biomass of the zooplanktonic organisms in Lake Micri Prespa (Macedonia, Greece). Doctoral dissertation. Aristotle University, Thessaloniki, 199p.

MICHALOUDI, E., M. ZARFDJIAN & ECONOMIDIS, P. S., (1997). The zooplankton of Lake Mikri Prespa. Hydrobiologia, 351: 77-94.

ORCUTT, J. D. & PORTER, K., 1983. Diel vertical migration by zooplankton: Constant and fluctuating temperature effects on life history parameters of *Daphnia*. Limnology and Oceanography, 28(4): 720-730.

OVERBECK, J., ANAGNOSTIDIS, K. & ECONOMOU-AMILLI, A., 1982. A limnological survey of three Greek lakes: Trichonis, Lyssimachia and Amvrakia. Archiv fur Hydrobiologie, 95: 365-394.

RYLOV, V. M., 1963. Fauna of U.S.S.R. Crustacea. Freshwater Cyclopoida, Zool. Inst. Akad. Sci. U.S.S.R, New series no. 35, III, 3, 399pp.

SERAFIMOVA-HADZISCE, J., 1959. Particularités du zooplancton du lac de Prespa et apercu de la composition du zooplancton des grands lacs de la peninsule des Balcans. Rec. Trav. Stat. Hydrobiol., Ohrid, 6(12): 1-18.

SKOULIKIDIS, N. T., BERTAHAS. I. & KOUSSOURIS, T., 1998. The environmental state of freshwater resources in Greece (rivers and lakes). Environmenal Geology, 36 (1-2): 1-17.

SOMMER, U., 1989. Plankton Ecology. Succession in Plankton Communities. Springer-Verlag, 364pp.

SOMMER, U., GLIWICZ, Z. M., LAMPERT, W. & DUNCAN, A., 1986. The PEG-model of seasonal succession of planktonic events in fresh waters. Archiv fur Hydrobiologie, 106(4): 433-471.

STANKOVIC, S., 1960. The Balcan lake of Ohrid and its living world. Uitgeverijdr. W. Junk-Den Haag, 357pp.

TAFAS, T. & ECONOMOU-AMILLI, A., 1997. Limnological survey of the warm monomictic lake Trichonis (central western Greece). II. Seasonal phytoplankton periodicity – a community approach. Hydrobiologia, 344: 141-153.

TAFAS, T., DANIELIDIS, D., OVERBECK, J. & ECONOMOU-AMILLI, A., 1997. Limnological survey of the warm monomictic lake Trichonis (central western Greece). I. The physical and chemical environment. Hydrobiologia, 344: 129-139.

TSEKOS, I., ECONOMIDIS, P. S., CHARITONIDIS, S., SINIS, A., NIKOLAIDES, G., PETRIDIS, D., MOUSTAKA, M., ZARFDJIAN, M. & KOKKINAKIS, A., 1992. Hydrobiological study of the man-made lake Tavropou, Karditsa. Final report, Ministry of Agriculture.

VOIGT, M. & KOSTE, W., 1978. Rotatoria. Die radertiere Mitteleuropa, ed. Geb. Borntrager, Berlin, vol. I, 673pp., vol. II, 476pp.

WETZEL, R. G., 2001. Limnology. 3d ed., Academic Press, 1006pp.

ZARFDJIAN, M. 1989. Seasonal variations and spatial distribution of planktic invertebrates in Lake Volvi (Macedonia, Greece). Doctoral Dissertation, Univ. of Thessaloniki, Greece, 249 pp.