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The occurrence of some tintinnid protozoans in the plankton of Lake Tiberias*

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With plate 1

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A fairly rich population of tintinnid protozoans was observed, at times, in the course of a large scale study of the phytoplankton of Lake Tiberias in recent years (POLLINGHER, U., & KIMOR, B., in press). The frequency of their occurrence in the samples taken, mostly at monthly intervals, as well as their presence at the permanent stations which covered the greater part of the lake, povided sufficient evidence to indicate that the tintinnids, represented in Lake Tiberias by several species, form an important link in the food chain at the border line between the primary and secondary production.

The detection of tintinnids in the plankton samples specially collected for phytoplankton studies is not surprising. Considering the fact that these minute protozoans feed largely on autotrophic nannoplankton organisms, such as minute algae, bacteria and flagellates, populating the upper water layers of the lake, they are expected to be found mostly in the photic zone. However, our data have shown that some of the tintinnids can also inhabit the deeper water layers.

Loricae of tintinnids were found in our material both in net samples (fine bolting silk-mesh size 50—60 μ) in horizontal and vertical hauls as well as in water samples collected from various depths at several stations from which the plankton was concentrated either by centrifugation or sedimentation.

As most of our material was examined in a preserved state soon after fixation in the field, the loricae and not the animalcules themselves served as the basis for our determination of species, although much useful information could be obtained from a study of living organisms especially in regard to the number of nuclei, number of oral membranelles, and the number and arrangement of longitudinal lines of cilia.

Literature references relating to fresh water tintinnids are scarce. As the species occurring in fresh water bodies do not constitute, according to various authors, more than about 2 % of the known species of this group of ciliates, it is not surprising that most available information relates to the marine forms. From this area, the tintinnids of the Gulf of Eliat and the southern Red Sea have been studied by KOMAROVSKY (1959, 1962) and found to include over eighty species and varieties, most of them circumtropical in distribution. Just to cite a few of the earlier and more recent references to fresh water tintinnids, *Tintinidium fluviatile* is mentioned by KOFOID & CAMPBELL (1929) from reservoirs in California as well as various American and European lakes; *Tintinnopsis ovalis* was reported by the same authors from Hungarian lakes while *Codonella* was widely reported in recent years from several of the great lakes in North America (CHANDLER 1940 and DAVIS 1966)

and from some reservoirs in Europe (SLÁDEČEK & SLÁDEČKOVÂ 1962). Additional references to freshwater tintinnids are from Japan (HADA 1937 and 1939).

The Tintinnina which were recorded in the plankton of Lake Tiberias belong to the two families of Tintinnidae represented by the genus *Tintinnidium* and the *Codonellidae* represented by the genera *Tintinnopsis* and *Codonella.*

All four species and one new sub-species are characterised by loricae with agglutinated foreign bodies or in some cases mucoid in nature as are characteristic of shallow neritic waters.

These species were recorded both in samples collected with nets made of fine mesh as well as in water samples from various depths during the cold water months of the year beginning in November until April. Except for one sporadic occurrence during June, no tintinnids were recorded in the plankton samples collected during the summer months.

The perennial occurrence of tintinnid loricae in mud sediments from the lake bottom is in itself no proof of their continuous existence in the plankton throughout the year. It may well be that this is a form of ooze caused by tintinnid loricae deposited during the period of proliferation in late fall and winter similar to the foraminiferan and radiolarian ooze in the marine plankton. On the other hand, the possibility of a vertical migration to deeper and cooler layers during the hot summer months is not excluded. According to ZEITZSCHEL (1967) the temperature factor is the most important one in the distribution of these protozoans.

This could well explain their occurrence in surface waters in Lake Tiberias during the winter months and their apparent disappearance during the summer months much in the same way as representatives of this and other microplankton groups, notably *Ceratium* and Dinophysaceae of the Dinoflagellates (JÖRGENSEN 1920, 1923) and, lately, Acantharia and Radiolaria known as "epipelagic winter forms" are found at deeper levels in the Mediterranean Sea during the summer (TRÉGOUBOFF & ROSE 1967; KIMOR & WOOD, in preparation; and KIMOR, CIESM Congress 1968).

This pattern of distribution could also be explained on the basis of an inverse correlation between the phytoplankton blooms in Lake Tiberias caused by peridinians in spring and early summer and the disappearance of the tintinnids during the same period. The occurrence of the tintinnids seems to occur at the time of an increase leading to a peak in the development of the characteristic free-living Chlorophyta in the plankton of the lake. As our phytoplankton studies have shown (POLLINGHER & KIMOR, in preparation) the green algae and the peridinians are mutually exclusive when in a state of mass development and as water blooms caused by peridinians each spring set in, the visibility of the water decreases; as a result there is a gradual disappearance of the tintinnids from the plankton.

At the same time it should be taken into account that the appearance of tintinnids in the plankton of Lake Tiberias from November onwards might be link to an increase in the bacterial population following the summer stagnation and the disintegration of accumulated algal blooms. According to EDMONDSON (1957) the smallest planktonic animals make much more use of bacteria than the metazoans and therefore processes which lead, in his words, to the production of bacteria would be expected to affect the composition of the zooplankton by

encouraging the development of bacteria eating protozoans, rotifers, and crustaceans.

Some of the problems involved in the occurrence and distribution of these protozoans in the lake could be elucidated by more specialized methods of research. The use, for example, of fluorescent illumination on board ship according to the method described by FERGUSON WOOD (1962) may reveal the presence of ingested chlorophyll bodies or detritic material as reported by KIMOR & WOOD (in preparation) with regard to some deep-dwelling radiolarians bearing zooxanthellae and Copepods, and Ostracoda feeding on algal cells in some deep water strata of the Mediterranean Sea.

It is also proposed to study the numerical fluctuations of the various species of tintinnids in conjunction with our present research program on the plankton of the lake in order to relate these changes more accurately to known biotic and abiotic factors. In this way it may be possible to identify a niche in the plankton communities that may have a well defined rôle in the food chain relations prevailing in the lake in general and in secondary production in particular.

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Discussion

TONOLLI: In Lake Maggiore twenty years ago *Codonella* was very frequent, and now it has completely disappeared. May you suggest any ecological interpretation to this fact?

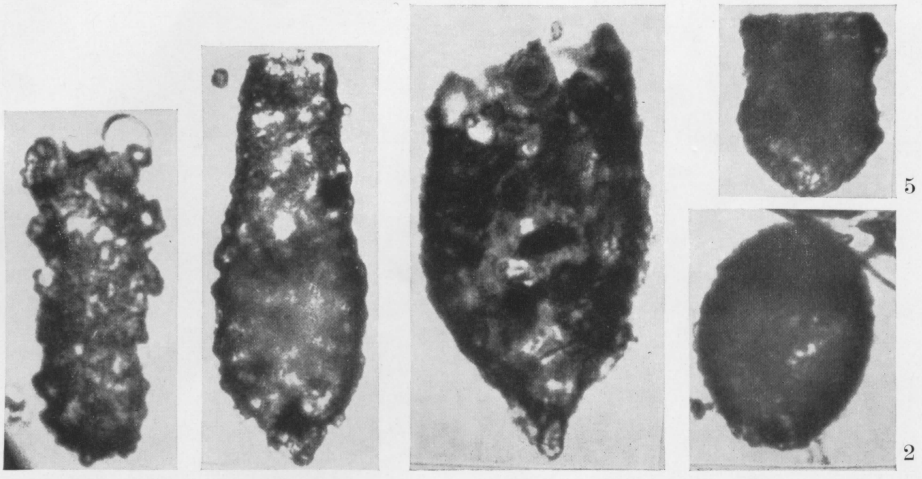
KIMOR: I cannot, but I have similar experience with our plankton studies.

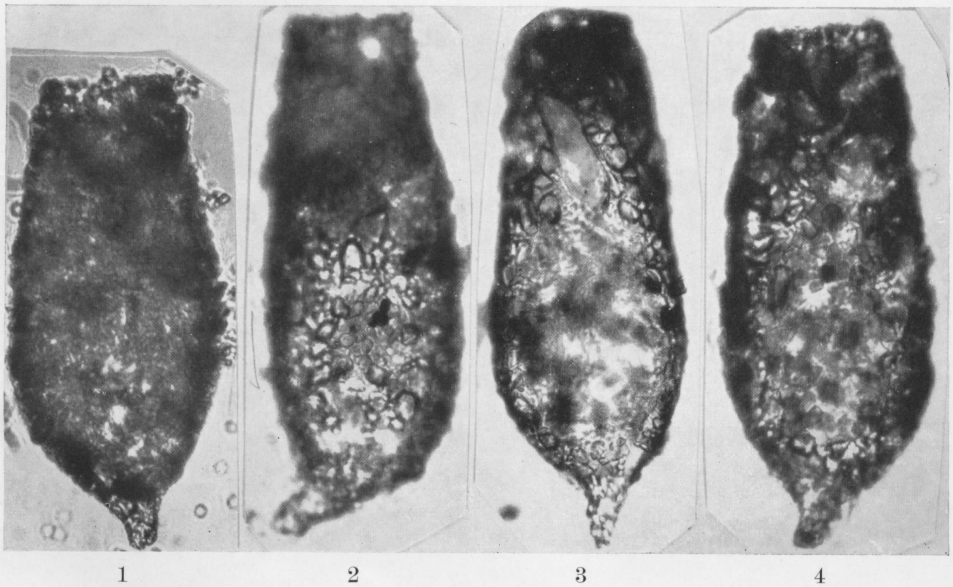
FRYER: How long do the loricae of these animals persist after death of the animal?

KIMOR: It is too early to give a difinite answer in the case of Lake Tiberias but in the marine environment they are known to resist desintegration for considerable periods.

RAHAT: Have the Tintinnids been kept alive or in culture and if so do you have to supply them with debris for their loricas?

KIMOR: A recent paper by KENNETH GOLD describes the isolation and cultivation of a tintinnid species in the laboratory. Foods used to grow them in this case were yeasts and flagellates.





Species of Tintannids occurring in Lake Tiberias: Top: 1. *Tintinnidium fluviatile* Kof. and Camp., 2. *Tintinnopsis ovalis* Daday, 3. *Tintinnopsis amphora* Kof. and Camp., 4. *Tintinnopsis amphora* var. *acuminata,* 5. *Codonella cratera* Leidy. Bottom: 1—4. *Tintinnopsis amphora* var. *acuminata,* several specimens showing the variation in the structure and shape of the lorica.