GRAZING IMPACT OF PLANKTONIC CILIATES IN THE MEDITERRANEAN SEA

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Abstract
Ciliate assemblages were studied at 9 stations along the Mediterranean Sea in June 1999. The cell content of all ciliates was examined for *Synechococcus* (Syn) and photosynthetic algae (PN). Tintinnids contained similar quantities of PN and Syn (1.04±0.59 PN tin^{-1}, 0.94±0.87 Syn tin^{-1}) and the same was true for aloricates. Tintinnids ingested more prey than aloricates by a factor of 5. It was estimated that ciliates consumed 26% of primary production in the Western, 41% in the Central and 70% in the Eastern Mediterranean.

Key-words: planktonic ciliates, Mediterranean, grazing, cell content

Introduction
In oligotrophic systems, where nano- and picoplankton are the dominant primary producers, ciliates are expected to be the main grazers. The grazing impact and feeding activity of planktonic ciliates have been investigated in many studies (1). However, a direct method, the determination of the cell content of grazers in seawater samples, has been employed to estimate ingestion and digestion of single species of ciliates (2). This is the first study to report an estimation of the grazing impact of ciliates on the community level in field samples.

Materials and methods
In June 1999, nine off-shore stations were sampled in the Mediterranean Sea along a West-East transect (5° to 35° E). Samples were collected from 1 to 200 m water depth, preserved with borax-buffered formaldehyde (final conc. 2%), stored at 4° C in the dark and examined within 3 months of collection. All ciliates were examined for fluorescent prey. Under blue light, *Synechococcus* (Syn, orange fluorescence) and photosynthetic algae (PN, red fluorescence) were visible in the food vacuoles of ciliates. The ingestion rate of ciliates on PN or Syn (number of prey per ciliate per hour) was calculated according to Dolan and Simek (2).

Results
The ingestion rate (Table 1) showed no difference from station to station along the Mediterranean transect (ANOVA, $p>0.05$). Aloricates and tintinnids presented similar ingestion rates for PN and Syn (ANOVA, $p>0.05$). However, the ingestion rate of tintinnids for either prey was 3-4 times higher than that of aloricates.

Table 1. Ingestion rate (prey cil-1 h-1) of tintinnids and aloricates. Values are averaged for each sampling station

	Tintinnids		Aloricates	
Stations	PN h^{-1}	Syn h^{-1}	PN h^{-1}	Syn h^{-1}
S1	0.48	1.70	0.10	0.20
S2	0.37	0.01	0.18	0.02
S3	1.14	0.14	0.19	0.02
S4	1.05	0.46	0.28	0.16
S5	0.19	0.59	0.12	0.32
S6	0.16	0.10	0.05	0.06
S7	1.11	0.04	0.02	0.02
S8	0.83	0.47	0.23	0.16
S9	0.20	0.17	0.11	0.16
average	**0.61**	**0.41**	**0.14**	**0.13**
SD	0.42	0.53	0.08	0.10

Discussion
Both prey categories (PN and Syn) were present in equal quantities in the food vacuoles of both tintinnids and aloricates. Since the concentration of algae in the field was one order of magnitude lower than that of *Synechococcus* (3), it would be reasonable to suggest that either ciliates show a preference for algae or the digestion rate of these two prey categories is unequal. However, Dolan and Simek (2) measured similar digestion rates for *Synechococcus* and algae in cultures of the ciliate *Strombidium sulcatum*.

In the literature there is contrasting evidence regarding the role of *Synechococcus* in the diet of ciliates. In earlier studies this organism has been reported as poor food for choreotrichs (4). However, according to Christaki *et al.* (5), in a laboratory experiment, *Synechococcus* was directly ingested by *Strombidium sulcatum*, a typical planktonic aloricate ciliate. Coccoid cyanobacteria have been routinely observed in the food vacuoles of nanoplankton-sized aloricate ciliates (6), thus implying that these organisms are suitable for feeding of small-sized ciliates.

Using data on primary production acquired during the same cruise (K. Pagou and O. Gotsis-Skretas, NCMR, unpublished data), we have estimated that the ciliate community consumed 26% of the primary production in the Western, 41% in the Central and 70% in the Eastern Mediterranean Sea daily. The values of primary production consumption found during this study are generally within the range reported in other studies (7, 8).

According to the present study ciliates consume a relatively small part of the picoplankton production (17-36%) which is higher in the Eastern Basin by a factor of 1.5-2 compared to the Western one (9). In contrast, they consume quite an important part of the algal production, especially in the Eastern Mediterranean, where they have the potential to graze 121% of the algal production. Besides, analysis of the ciliate cell content suggests selectivity for algal cells.

Overall, these data underline the crucial importance of ciliates in channeling a part of this small-sized primary production to higher trophic levels, especially in the ultra-oligotrophic Eastern Basin as has also been found in previous studies (10).

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