## P-II2

### VERTICAL PARTITIONING OF THE WATER COLUMN BY A CILIATED PROTOZOAN POPULATION IN RELATION TO PREY AVAILABILITY

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ABSTRACT

An analysis of the vertical distribution of the ciliated protozoan population at oligotrophic and eutrophic sites, under stratified summer conditions, revealed a vertical "partitioning" of the water column associated with the distribution of the nanophytoplankton crop.

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The ciliated protozoans represent an important part of the microzooplankton stock in the northern Adriatic, especially under stratified summer conditions and at eutrophic western sites (Revelante et al., 1985)
The vertical distribution of dominant species of ciliated protozoans throughout the water column was analyzed over two diurnal periods at an eutrophic western site off the Po River delta, and an oligotrophic site off the Istrian peninsula. The two sites had a majority of extant protozoan species in common but different dominants and size class structure. The two data sets provide inferences about the response of dominant species to differences in trophic state and oceanographic water column structure.

Each site was sampled at 4 hour intervals over 48 hours at 7 depths. The physical and chemical characteristics of the water column were determined with the same frequency. Whole water samples for microzooplankton analyses were collected with Van Dohrn bottles, preserved with Lugol's solution, and concentrated for Utermohl enumeration by a sequential 72 hour settling procedure.

Physically and chemically both the eutrophic (station 10) and oligotrophic (station 6) sites were characterized by:

a) a shallow, well mixed (and less saline) surface layer of less than 5 meters;

b) a deeper, moderate pycnocline at 10-15 meters; and,

c) a nutricline located at some depth within the bottom layer.

The pycnocline appeared to separate the water column into two distinct strata at about 15 meters, with the surface stratum capped by a thin low salinity layer.

The microzooplankton enumeration showed a pronounced water column partitioning by the ciliated protozoan stock into two pronounced maxima: one at the surface, and a second at some depth below the pycnocline. At the eutrophic site the sub-surface maximum was more pronounced with over 70% of all protozoans in the water column concentrated in the layer, compared with 20% at the surface and about 10% at intermediate (i.e. 5 - 20 m) depths. In contrast at station 6 about 50% of the stock was concentrated in the 0 - 5 m surface layer, 10 - 20% in the intermediate 5 - 20 m, and about 40% below 20 m. The sub-surface protozoan maxima were associated with maximum nanophytoplankton chlorophyll a concentrations, as well as the highest nano/micro phytoplankton chlorophyll a ratios, indicating a close predator/prey relationship.

The sub-surface ciliated protozoan and nanophytoplankton maxima form a dense layer in the bottom stratum, with the highest concentrations at 20 meters at the eutrophic site, and somewhat shallower (15 meters) at the oligotrophic site. Some species were concentrated in a single thin layer, but other species were more diffuse being collected over 10 - 15 meters. At both sites the ciliated protozoans and nanophytoplankton were located just above the top of the nutricline, which is assumed to reflect a dynamic balance between available nutrients and underwater light levels. At the oligotrophic site high nutrient concentrations only occured in a thin bottom layer at 30 meters, and the nutricline (and nanophytoplankton/protozoan stocks) occurred at 15 meters atop a slightly stable bottom stratum. In contrast, at the eutrophic site high nutrient concentrations occurred throughout a thicker bottom layer (20 - 30 meters), but the bottom stratum was well mixed with little change of density with depth. Here the nanoplankton were at 20 meters.

Thus the higher phytoplankton standing crops and their presumed protozoan grazers were associated with higher concentrations of nutrients, from freshwater Po River discharge at the surface, and from the region of the nutricline in the lower stratum of the water column. Noteworthy: an associated subsurface oxygen maximum indicated that the nanophytoplankton population was actively growing in the sub-surface chlorophyll maximum.

The species composition of the two ciliate maxima differed between the two sites. The surface maxima are dominated at both sites by two species, Strombidium ovale and Strombidium delicatulum(?): S. ovale was the clear dominant under oligotrophic conditions, and S. delicatulum (?) under eutrophic conditions. The sub-surface maxima at both sites were characterized by sets of species restricted to the lower stratum of the water column, appearing only sporadically (if at all) in surface layers. Additional partitioning by species occured in the bottom layer, with some species such as Halteria grandinella, Strombidium conicum, Eutintinnus franknoi and Strombidium delicatulum (?) concentrated in the upper part of the stratum associated with high nanophytoplankton crops. At station 6 the sub-surface maximum was dominated by Tontonia gracillima, S. ovale, and S. delicatulum (?). The protozoan biomass in the lowest layer was mainly contributed by Stenosemella nivalis at both sites, but at station 6 this species was restricted to a thin layer at 30 meters. The deeper near sediment positioning of this species may be related to sediment particle availability for lorica building.

During the 48 hour observational series of diurnal changes there was no clear indications of vertical migration within this group of microzooplankton species.

In summary:

a) there are two, clearly defined ciliated protozoan maxima in the northern Adriatic water column; at the surface, and at some sub-surface depth below the pynocline;

b) the sub-surface maximum was associated with a sub-surface nanophytoplankton maximum; and,

c) the presumed protozoan/nanoplankton predator/prey community at sub-surface depths is shallower at eutrophic sites, apparently responding to a shallower nutricline.

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Revelante, N., M. Gilmartin and N. Smodlaka, 1985. The effects of Po River induced eutrophication on the distribution and community structure of ciliated protozoan and micrometazoan populations in the northern Adriatic Sea. J. Plank. Res., 7(4): 461-471.



## P-III1

### COPEPODES LES PLUS IMPORTANTS OU CARACTÉRISTIQUES DE LA BAIE DE PALMA, 1982

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De mars à novembre 1982 on a réalisé, tous les deux mois, des prises d' echantillons sur cinq stations dans la baie de Palma (pêches horizontales et obliques),(fig. 1).

L' analyse de ces échantillons montre que les copépodes* constituent le groupe dominant avec un pourcentage annuel de 57.05 % du zooplancton.

Parmi les 72 espéces identifiées, nous ne considérons que celles dont le pourcentage global est supérieur à 1 %.

Par ordre d' importance décroissante, nous pouvons signaler les espèces suivantes: *Acartia clausi** (14.60 %), espèce permanente dont la période de plus grande abondance se situe de mars à mai; en surface et dans les zones très proches de la côte on a observé des densitées importantes avec un maximum de 1209 individus m-3. *Temora stylifera** (12.72 %), également permanente a montré son maximum au mois de setembre. *Clausocalanus furcatus*** (11.94 %) est plus frequent dans les pêches obliques bien qu'on ait trouvé aussi des concentrations importantes en surface; elle s'est rélévée comme une espèce permanente pendant toute la période d' étude mais sa plus grande abondance se situe au mois de juillet. *Paracalanus parvus** (7.22 %) est fréquent dans toute la zone mais un peu plus abondante sur les stations les plus prôches de la côte. Les plus grandes densités s' observent pendant la période chaude. *Oithona plumifera* (4.17 %) est plus abondante sur les stations les plus éloignées de la côte et en profondeur; elle est permanente et sa période d' abondance maximale s' observe de juillet à novembre. *Centropages ponticus** (4.04 %), n' est pas permanente et les plus grandes concentrations s' observent en saison chaude et uniquement en surface. *Isias clavipes* (3.00 %) est spécialement abondante au mois de mai. *Calocalanus pavo* (1.79 %) est mieux représenté en automne. *Oncaea media* (1.74 %) a sa période de plus grande abondance de setembre à novembre. *Oithona helgolandica* (1.46 %) est plus fréquente en surface et en saison froide. *Clausocalanus arcuicornis* (1.13 %) est plus abondante en hiver. *Nannocalanus minor* (1.24 %), typique de la période chaude, est mieux répresénté dans les pêches obliques. *Centropages typicus* (1.1 %) est surtout fréquente en mai. *Ctenocalanus vanus* (1.1 %) est tipiquement hivernale (abondance maximale debut mars) et plus abondante dans les pêches obliques (fig.2: *, **:*Clausocalanus spp.*).

La diversité spécifique minimale (indice de Shannon ) est au mois de mai et la maximale en novembre.

Du point de vue qualitatif, notamment pour les espèces dominantes, nos résultats coincident avec ceux de Massutí (1942). Ils s' accordent aussi avec ceux de Gelabert (1985) à l' exception de quelques différences comme la rareté de *Paracalanus parvus* ou la plus grande abondance de *Clausocalanus arcuicornis*.

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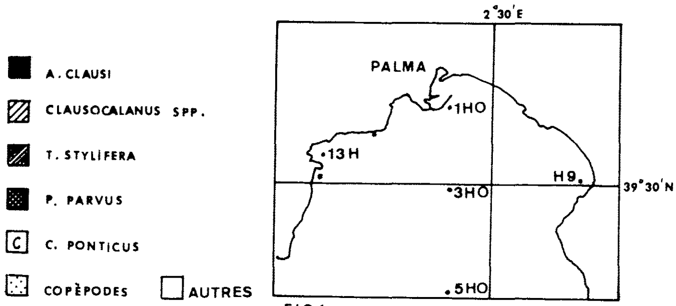


FIG1

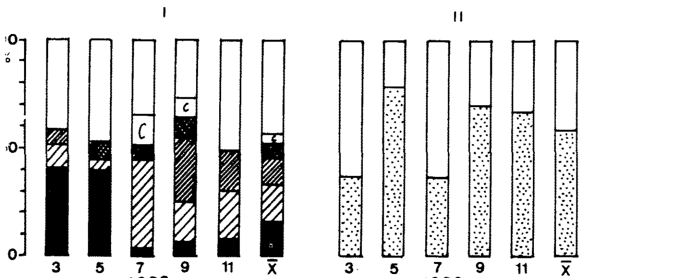


FIG 2

Fig. 1: Carte des stations. O: pêche horizontale, H: pêche oblique. Fig. 2: Variations saisonnières des principales espèces de copépodes (%), (I) et du pourcentage des copépodes / zooplancton (II)