Institut océanographique
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Microzooplankton: the microscopic (micro) animals (zoo) of the plankton

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The plankton encompasses an incredibly diverse group of organisms, ranging in size from viruses to large jellyfish, united only by the fact they are all weak swimmers and so are largely transported by the movement of the water, drifting about in the sea. This set of organisms includes within it the base of the food web in the ocean, the primary producers, or the marine equivalent of plants, the phytoplankton. On land plants are generally large because they require special and complicated structures to obtain water, carry out photosynthesis, and to reproduce. Plants generally have roots, leaves and branches, and often have flowers to form fruits and seeds. In the sea, the large and complicated structures of land plants are not needed. Water is abundant. To access light for photosynthesis it is enough to remain near the surface; there is no need for branches and leaves. Consequently, in the sea 'plants' are small, actually microscopic. Most phytoplankton forms in the sea are between 2 and 200 microns in size, the biggest less than a 1/5th of a millimetre (see Figure 1).

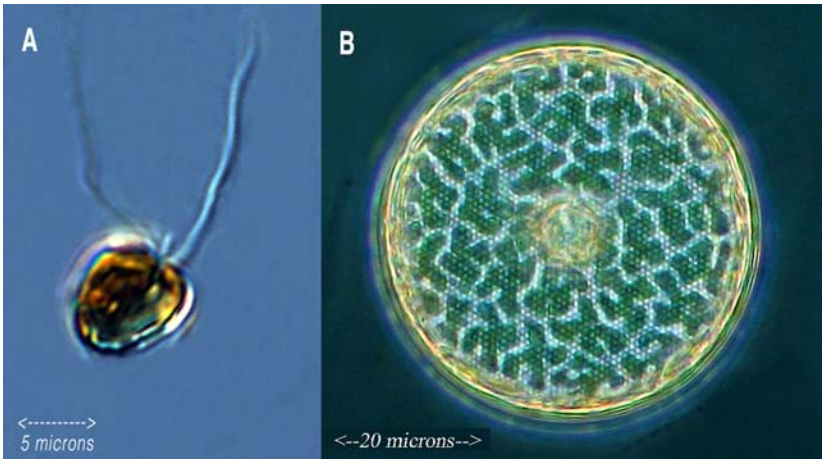

Figure 1. The base of the food web in the sea is phytoplankton, the microscopic plants of the seas. Typical forms are very small flagellates (A) and the larger diatoms (B) like the one on the right. A micron is 1/1000 of a millimetre. [5]

As the plants of the seas are microscopic, it is perhaps not surprising that the herbivores, or grazers of the sea, are also microscopic. The microzooplankton are the organisms which feed on the phytoplankton. The microzooplankton are what is known as a 'functional group', meaning they share an ecological function (in this case grazers on phytoplankton), rather than being a group formed of organisms of close heredity or those found together in one particular place. The microzooplankton groups a large variety of organisms with only two common characteristics of size and apparent function. Microzooplankton are organisms of a size between 20 and 200 microns and are not obviously a phytoplankter (plant) of some kind.

The grazing of microzooplankton is thought to be about 2/3 of the all phytoplankton produced each day. How much phytoplankton is produced in the sea? The volume of phytoplankton produced each day if molded into a single board would form a board 8 cm thick x 30 cm wide and as long as the distance from Earth to the Moon. The grazing of microzooplankton so closely matches the growth of phytoplankton that concentrations of the latter vary relatively little and phytoplankton do not usually accumulate with time. Microzooplankton are themselves grazed on by larger zooplankton such as small crustaceans, typically copepods, krill, and even larval fish.

Most species of the microzooplankton are single cell organisms called “protists”. They are many very different kinds of protists in the microzooplankton. While they are all small and single celled, most are no more closely related to one another than a human is to a house fly and this is evident from the variety of morphologies (see Figure 2). Most species have a characteristic way of capturing their food using, for example, filtering or sticky appendages or attaching feeding tubes. Many can consume prey as large or larger than themselves. The use of new genetic techniques has shown that there may be many more species than those we distinguish based on differences in size, shape and structures.

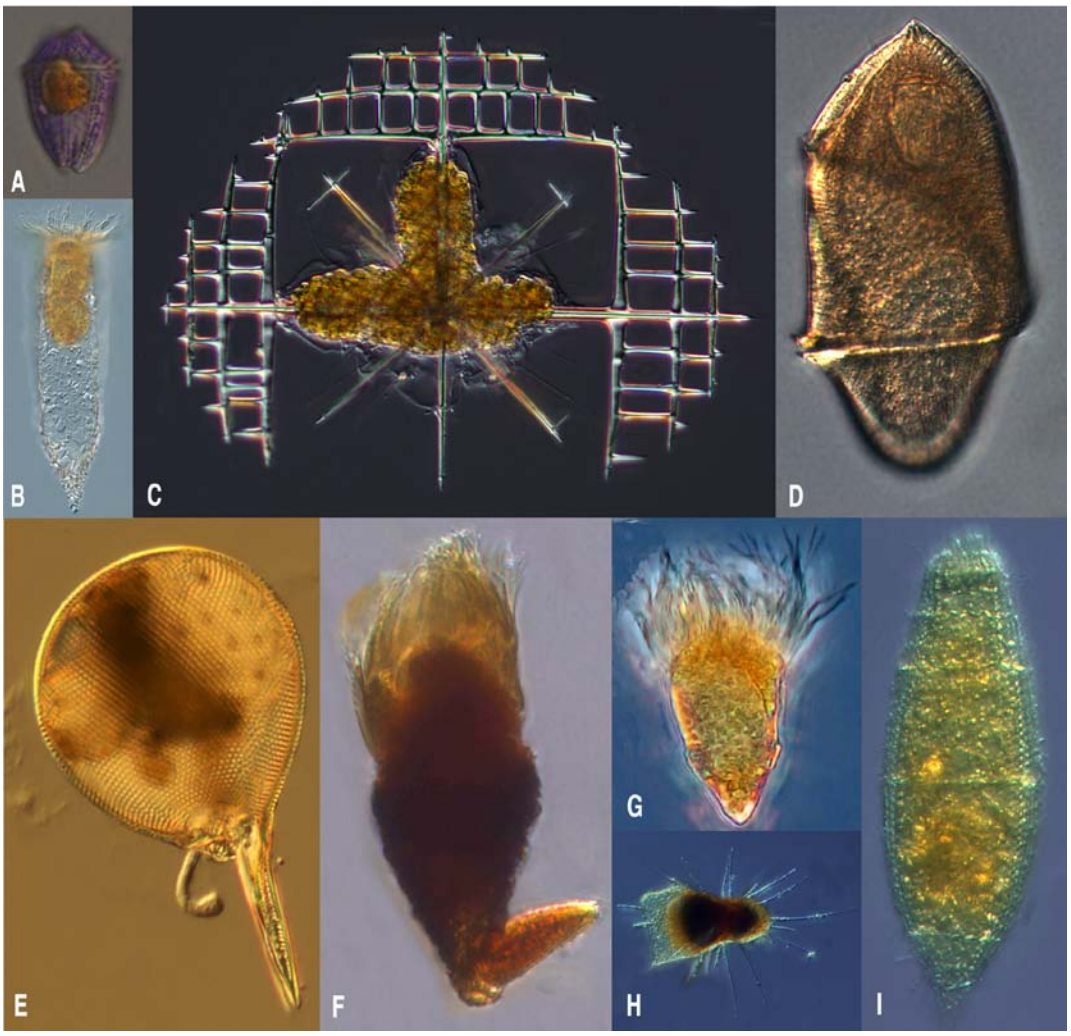

Figure 2. Microzooplankton groups protist organisms of very different morphologies. Major groups are dinoflagellates (A & D), ciliates (B, F, G & I), and different types of radiolarians (E & H) and acantharians (C). What they have in common is that all are 50-200 microns in size and all feed on phytoplankton and small other organisms, including other microzooplankton. [5]

There are two groups which account for most of the individuals of the microzooplankton and probably most of the grazing in the plankton: ciliates and dinoflagellates. Commonly they occur in concentrations of about 2000 per litre of seawater. Like other protists, they reproduce by division. Ciliates can divide once every 8 hours while dinoflagellates rarely divide more often than once a day. They do not usually form dense populations because they are themselves preyed on by other planktonic organisms.
In the microzooplankton, many species are known to practice 'mixotrophy' – meaning that they have alternative ways of feeding themselves. These organisms can profit from both photosynthesis (like a phytoplankter) and grazing (like a herbivore) at the same time. Some eat phytoplankton but do not digest all of it, they keep the chloroplasts, the part of the phytoplankton responsible for photosynthesis and thereby become themselves part animal and part plant. Others are found always with 'symbionts' algal cells which live inside them or attached to the cell. There are even 'phytoplankton' which occasionally eat microzooplankton to obtain nutrients or eat other phytoplankton to obtain their chloroplasts (see Figure 3).

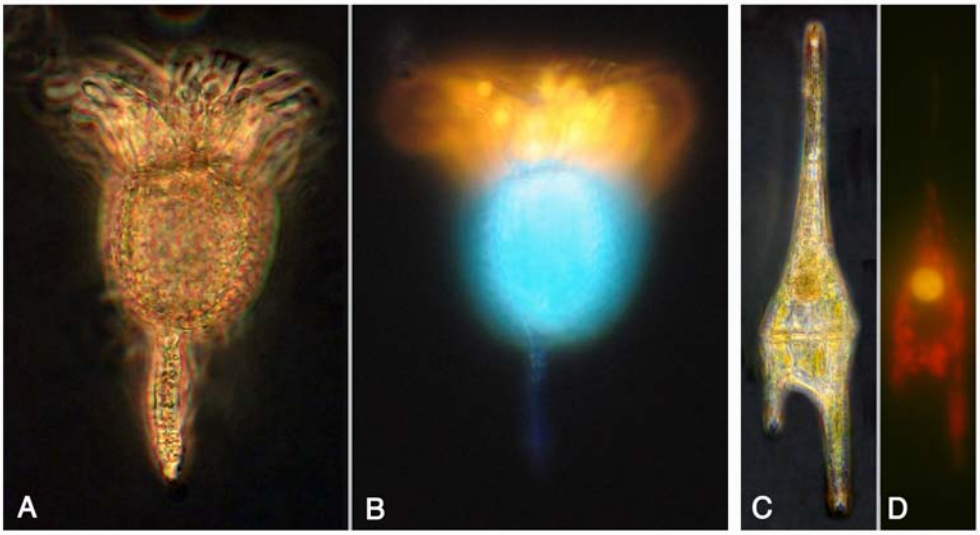

Figure 3. Mixotrophy and symbiosis are very common in the microzooplankton and some phytoplankton occasionally eat microzooplankton. A & B show a microzooplankton species which carries small algae attached on the outside – A is a view using normal light and B using ultraviolet light which makes the cell appear blue and reveals the orange pigment of symbiotic algae. C & D show a species classified as phytoplankter – C is view using normal light and D using ultraviolet light revealing its abundant chlorophyll as red spots and the orange remains of a ciliate which it ate. [5]

In summary, microzooplankton fufill a simple function in the sea as the first link in the food web, consuming most of the primary production in the world ocean each day. However this simple role is played by a group of very diverse organisms which use a wide range of individual strategies and structures.

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For more information:

[1] Anderson R.A. (2008). Moon Board. *Limnology and Oceanography Bulletin*, 17, 8-10.
(available at http://aslo.org/bulletin/issues.html)
[2] Calbet A. & Landry M.R. (2004). Phytoplankton growth, microzooplankton grazing, and carbon cycling in marine systems. *Limnology and Oceanography*, 49, 51-57.
(available at http://aslo.org/lo/toc/index.html)
[3] Flynn K.J., Stoecker D.K., Mitra A., Raven J.A., Glibert P.M., Hansen P.J., Graneli E., Burkholder J.M. (2012). Misuse of the phytoplankton-zooplankton dichotomy: the need to assign organisms as mixotrophs within plankton functional types. *Journal of Plankton Research,* doi: 10.1093/plankt/fbs062.
(available at http://plankt.oxfordjournals.org/content/by/section/Horizons)
[5] Observatoire océanologique de Villefranche-sur-Mer: Gallery of the images:
http://www.obs-vlfr.fr/gallery2/main.php?g2_itemId=81884