Some Frontiers In Marine Biodiversity Studies

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ABSTRACT

Some frontiers in marine biodiversity studies are introduced. Nano-and pico-planktons, primary productivity, some ecological processes and energy flow pathways, all of which are of crucial importance for our understanding of ecological, environmental and climatic problems, are discussed.

Key words marine biodiversity, nano-picoplankton, primary productivity, energy flow pathway

Since the declaration of the Bali Action Plan (1982), preserving biodiversity has become one of the central problems concerned by all countries over the world. Effective action should be taken on the basis of accurate information. However, our knowledge on the existing species and ecosystems is still very limited, especially in the field of marine biodiversity. With vast area and abundant species, the oceans not only offer great living resources to human beings but also play decisive roles in environmental and climatic changes (SCOR, 1990), and, thus, provide a very important area for biodiversity studies. The objective of this paper is to introduce some frontiers in marine biodiversity studies with special references to the two big problems that must today be confronted by us: living resources and living environments.

1 *Species diversity*

There are more general phyla and more special phyla existing in marine environments than land, fresh water and mutualistic environments. (Vermeij, 1978) and most of the marine species are rarely recorded. It needs to not only go into unusual environments such as deep-sea sediments and hydrothermal vents (Grassle, 1985), even in common environments, many species so far as to phylum Loricifera, (1986) have not been discovered. The author, here, will emphasize a more common and familiar class-microplankton, which plays a fundamental role in energy flow in marine ecosystems but is still poorly known by us. Recent studies revealed that the larger fraction, netplankton ($>20\mu\text{m}$) known in the past, is only a small portion of the total plankton family, and the smaller fractions, nano- ($2\sim20\mu\text{m}$) especially picoplanktons ($<2\mu\text{m}$) which has been ignored before due to the limitation of sample collection and observation methods are more important than netplankton both in biomass and productivity. It seems essentially necessary to recognize the very small species so that we can have a better understanding of marine ecosystems. Studies on nanoplankton have been started in China, and more than 50 species have recorded in some representative regions such as Jiaozhou Bay, Xiamen Harbor. There are many new species, e. g. *Minidiscus subtilis*

Gao, Cheng et China, 1992; *M. ocellatus* Gao, Cheng et Chin, 1992; *M. spinulosus* Gao Cheng et China, 1992; *Cymatosira gibberula* cheng et Gao, 1993; *Rocella marina* Cheng et Gao, 1993; *Cyclotella cryptica* var. *ambigua* chang, Gao et chin, 1992; *Thalassiosira laevis* Gao et Cheng, 1992; *T. binata* var. *minor* Gao et cheng, 1992; *T. binata* var. *bibinata* Gao et cheng, 1992; *Chrysochromulina Chiton* var. *minuta* Gao, Tseng et Guo, 1993; *C. Papillata* Gao, Tseng et Guo, 1993; *Paraphysomonas bisorbulina* Gao, Tseng et Guo, 1993; and *P. simplexocorbata* Gao, Tseng et Guo, 1993.

Works on picoplankton is just started. But it is believed that the principal component of picoplankton is cyanobacteria, which is very small in cell size and nearly unsinking. With special ecological properties, these species are particularly important and need more effort to study.

2 Ecological diversity

There is no need to discuss the structural and functional differences among marine ecosystems in different latitudes, even in certain environments familiar to us. Many ecological processes are never known before. In view of the major problems we are facing today, special attention should be paid to the most common but most dominating ecosystem, the epipelagic ecosystem, for studying the marine material cycling and energy flow.

2.1 Diversity in the composition of primary production

Firstly, primary producer includes not only eukaryote (mainly, phytoplankton) but also prokaryote (mainly, cyanobacteria), and the latter is a significant fraction. Preliminary studies in Jiaozhou Bay indicated that the biomass of cyanobacteria ranged from 200 cells/ml to 10^4 cells/ml, and its production accounted for 15~13% of the total primary production. Secondly, net-, nano-, and picoplankton account for 16~25%, 38~60% and 25~45% respectively of the total biomass, and 11~30%, 35~53%, and 30~55% of the total primary production (Jiao et al., 1993)^①. Thirdly, in the existing state of the products, there are not only the particulate state (the cell itself DOC) but also a substantial part of the production released as dissolved organic carbon (DOC). The proportion of DOC in Jiaozhou Bay ranged from 6.85 to 57.14% of the total production. In the whole euphotic zone, DOC accounted for 17% of the total production on an annual base (Jiao & Wang, 1993). Thus, previous measurement of primary production by ^{14}C method must have induced serious negative errors. Finally, total primary production can be divided into two parts according to their ecological functions, the new production and the regenerated production (Eppley, 1989). The ratio of new production to the total ranges from 10% to 80% owing to the variation of environment conditions.

2.2 Diversity in the ecological processes and energy flow pathways

Although the importance of biogenic elements C, N, P for primary production has been generally understood, little is known about the diversity of nutrient dynamical processes. Taking nitrogen as an example, all forms of nitrogen can be classified as oxidized and reduced nitrogen. Differences in the existing form state if nitrogen affect not only the growth rate but also the composition of primary producer. Recent studies have showed the inhibition of nitrate uptake in the presence of ammonium (Jiao, 1993). Further studies indicated that

^① Jiao N. Z. et al., 1993. Size-fractionated characteristics of marine primary production process. (unpublished).

the smaller the cell size was, the more preferable for ammonium, and in contrast, nitrate was mainly uptaken by larger cells (Jiao, 1993 unpublished). This phenomenon means that, for a given nitrogen-limited region, changing the proportion of reduced nitrogen to oxidized nitrogen would change the composition of the size structure, and then might change the structure of food chain. If it is supplied mainly by reduced nitrogen, the smaller cells would ultimately win in interspecific competition. This means that more energy would cycle within the lower trophic levels, and thus, the function of the ecosystem would somewhat be reduced. This is a sensitive ecological problem and needs thorough studies to ascertain. Another important concept related to nutrient diversity is new production which is technically the fraction of primary production supported by oxidized nitrogen (in pelagic ecosystem). New production is not only a functional index of ecosystem, but also a measurement of net carbon flux from the air to the ocean, and therefore an estimation of the capability of the ocean to regulate climate changes (SCOR, 1990). The level of new production is affected by many factors including the composition and proportion of nitrogen sources, planktonic organisms, and size structure of primary producer etc. Generally, new production is lower in pelagic waters than in coastal waters.

Fig. Pathways of energy flow in plankon community (after Moloney & Field, 1991)

Recent achievement in marine food web studies indicates that the energy flow pathway is very complicated and the outline we described in the past is so rough and simple that a great of valuable information has been ignored. For example, from primary producer to secondary, there are different pathways for energy flow (Fig.), and different pathways have different efficiencies. A portion of energy from netphytoplankton production may preserve more than 10% when it reaches the trophic level of mesozooplankton. While the same portion of energy contributed by picoplankton, perhaps, remains only 1% when it reaches the same trophic level. This tells us the importance of investigating the process diversity for the understanding of ecosystem functions.

The photosynthetically produced DOC is not gone forever. A substantial portion of DOC will be taken up by free-living heterotrophic bacteria and transformed into the DOC pool again. Traditional ideas take heterotrophic bacteria as decomposer, but in view of these

facts, they are also a producer. These DOC formed by bacteria can not be grazed directly by metazoan due to their extremely small size, but can only be transferred by protozoan (Fig.). This forms a DOC -bacteria-protozoan food chain called microbial food loop (Azam et al., 1983), establishing the third food chain model besides the two typical models, the grazing food chain and the detritus food chain. Investigation results show that the contribution of bacteria to marine ecosystem is undoubtedly important. In oligotrophic oceans, bacterial biomass is 2~3 times greater than phytoplankton, and accounts for 26~62% of the total DOC (Cho et al., 1990). The secondary productivity of bacteria is up to 71~726mg m³.d (Fuhrman et al., 1980; Wheeler et al., 1986).

3. Summary

Marine biodiversity is a new area for studying nutrient cycling and energy transfer in the oceans and our knowledge about it is still very limited. The development of society needs to develop and utilize the ocean. Among numerous urgent works including preserving the developed economical species, an important aspect is to understand the structure and function of marine ecosystems and the role of biodiversity it from the basic links. We can utilize the ocean scientifically only on the basis of a comprehensive knowledge. The basic links are just the decisive points for material cycling and energy flow. Those aspects discussed above are not only important but also the breakthrough points for understanding marine ecosystems in a relatively short period. We have already had a stepping stone and we will make further progress in marine biodiversity in the near future.

REFERENCES

- Azam F, Fuhrman J A. 1983. The ecological role of water column microbes in the sea. *Mar. Ecol. Prog. Ser.*, **10**: 257~263
- Baker A N, Loricifera E G. 1986. A new class of Echinodermata from New Zealand. *Nature*, **321**: 862~864
- Cho B C, Azam F. 1990. Biogeochemical significance of bacterial biomass in the ocean's euphotic zone. *Mar. Ecol. Prog. Ser.*, **63**:253~257
- Eppey R W. 1989. New production; history, methods, problems. in: *Productivity of the Ocean: Present and Past*. Berger W H, John Wiley, Sons Limited (N.Y.) eds. 85~97
- Fuhrman J A, Azam F. 1980. Bacteria plankton secondary production estimates for coastal waters of British Columbia, Antarctica and California. *Appl. Environ. Microbio.*, **39**(6): 1085~1095
- Gao Yu. 1993. Some new species of nanoplankton in Jiaozhou Bay. In: Liu R ed. *Ecology and Living resources of Jiaozhou Bay*. Academia Press, 203~219
- Gao Yahui, Cheng Zhaodi. 1992. A new species and two new varieties of *Thalassiosira*. *J. Xiamen U.*, **31**(3):291~294
- Gao Yahui, Cheng Zhaodi. 1992. Two new species of *Minidiscus* and a new variety of *Cyclotella*. *J. Xiamen U.*, **31**(1):74~77
- Grassle J F. 1985. Hydrothermal vent animals: Distribution and biology. *Science*, **229**: 713~717
- Jiao N Z, Wang R. 1993. Light-dependences of size-fractionated photosynthesis and PDOC release of natural phytoplankton assemblages. *Proceedings of INMBSCS* (Guangzhou China), 45
- Jiao N Z. 1993. Interactions between ammonium and nitrate uptake by natural microplankton assemblages. *Chinese J. Oceanol. Limnol.*, **11**(2): 97~108
- Moloney C L, Field J G. 1991. The size-based dynamics of plankton food webs. *J. Plankton Res.*, **13**

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(5):1003~1038

SCOR. 1990. JGOFS science plan. *JGOFS Report*. 5:1~51

Vermeij G J. 1978. Biogeography and adaption: Patterns of Marine life. *Harvard University Press*, Cambridge, MA.

Wheeler P A, Kirchman D L. 1986. Utilization of inorganic and organic nitrogen by bacteria in marine systems. *Limnol. Oceanogr.*. 31(5): 998~1009