Oecological Studies on Algal Flora in Lakes Shinji and Nakano-umi I. Distribution of Macroscopic Algae.

By Masaru AKIYAMA & Kazuyoshi NISHIGAMI

(*Received Nov. 10, 1958*)

秋山優・西上一義：宍道湖および中海の藻類相の生態的研究 I. 藻類の分布

The stenohaline marine and fresh-water algae, especially its distribution and the other oecological trends are fairly well known in Japan, but little seems to have been studied regarding the distribution and the other oecological trends of these algae in relation to various salinity.

Recently several observations and informations regarding on these problems have been published by several authors in America. DOTY, M. S. and NEWHOUSE, J. (1954) reported on the distribution of marine algae into estuarine waters, and stated the gradual dropping out of marine species to various salinity range. WOOD, R. D. and PALMATIER, E. A. (1954) reported on the macroscopic algae of the brackish coastal ponds of Rhode Island and analyzed several oecological factors. On the other hand, WOOD, R. D. and STRAUGHAN, J. (1953) observed on the time-intensity tolerance of fresh-water alga *Lemanea fucina* to salinity.

It is well known that Lakes Nakano-umi and Shinzi are famous brackish water areas in Japan. Additionaly the salinity range of these two water systems are extremely difierentiated caused by its geographical factors. The present research has been done concering analysis on the distribution of macroscopic algae in these regions. Twenty two stations are selected from these regions as illustrated by the Fig. 1. A.

Chlorinity range of each station is observed as a gradual variance (Fig. 1. B).

The station 1 and 2 (on the coast of the Japan Sea), which were selected as a control are shown as 100 per cent marine water. Water in Lake Nakano-umi in which stations 3–8 are located includes 40.0–50.0 per cent of marine water. Water in Makata, station 9 and its vicinity includes 15.0–25.0 per cent of marine water caused by the inflow of lower range of brackish water from the River Ôhashi. Lake Shinzi which includes stations 12–22 shows that there is 4.0–5.0 per cent of marine water.

Fig. 1. A.

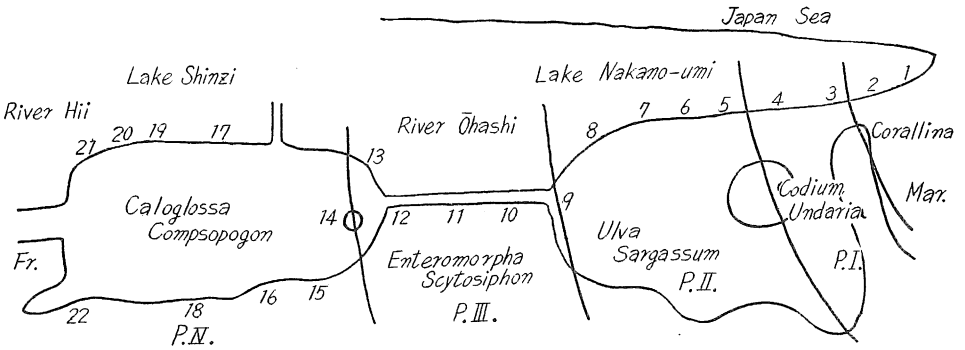


Fig. 1. B.

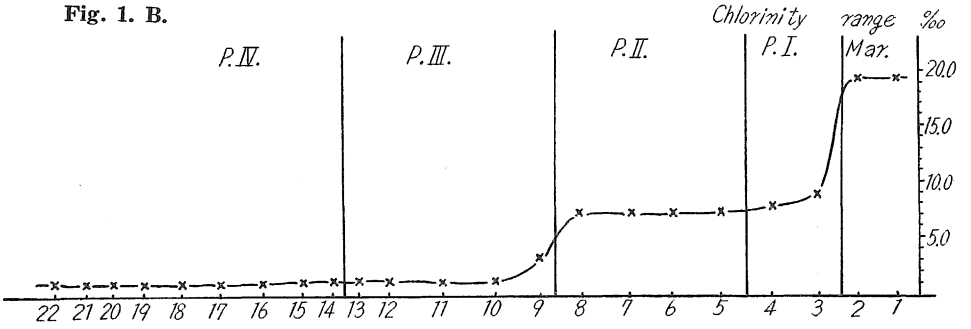


Fig. 1. A. Schema of researched region: Lakes Shinzi and Nakno-umi, Shimane prefecture
1, 2,...22: Station number
I, II, III, IV: Areas of each distributional patterns
Fig. 1. B. Chlorinity range of each stations

図 1 A. 調査地域略図
1, 2,…22: 観測地点
I, II, III, IV: 分布型区
図 1 B. 各観測地点の塩素イオン濃度

The distribution of macroscopic algae in these brackish regions is gradually paralleled with the gradual dropping out of chlorinity range. From this perspective the characteristic patterns of algal distribution in these regions are observed.

The pattern I which includes stations 3–4 is characterized by the remaining of such algae as *Codium, Ceramium, Carpopeltis, Condria* and *Undaria et al.* But *Corallina* are not observed. It seems that the Corallina group is conspicuously stenohaline forms. Thirteen to fifteen species are observed in this pattern. The pattern II which includes stations 5–9 is characteristic of gradual disappearance of present algae and of the remaining of such algae as *Porphyra, Gracilaria, Gelidium, Sphaceraria, Sargassum, Colpomenia* and *Ulva et al.* Eight to ten species have been observed in this pattern. The pattern III which includes stations 10–13 is extremely different from pattern I and II. It is due to its lower range of chlorinity. It is characteristic of the remaining 3–4 spp. of marine species such algae as *Enteromorpha* and *Scytosiphon et al.* It seems that such species

as *Scytosiphon lomentarius* J. Ag. and *Enteromorpha* spp. could be expected to be the most remarkably euryhaline forms in this region. On the other hand, the brackish member *Calogrossa* is observed. The pattern IV which includes all the stations in Lake Shinzi is characterized by the appearance of fresh-water members such algae as *Chara*, *Schizomeris*, *Spirogyra* and *Oedogonium et al.*

Above all the appearance of *Compsopogon Oishii* Okam. has an important meaning as the newly found locality of this alga in the coastal region of the Japan Sea. It has an interesting oecological meaning that we have observed the appearance of this alga, a species of current fresh-water, in such a stagnant brackish region.

Relation of chlorinity and distribution of algae are shown in Fig. 2.

Certain members of these algae are inferable as an indicator of distribution pattern in this region. They are as follows:

Pattern I is indicated with the remaining of *Codium* or *Undaria.*

Pattern II is inducated with the remaining of *Ulva* or *Sargassum.*

Pattern III is indicated with the remaining of *Enteromorpha* or *Scytosiphon.*

Pattern IV is indicaled with the appearance of *Calogrossa* or *Compsopogon.*

Indicators of each patterns ara shown in Fig. 1. A. Each systematic groups in these

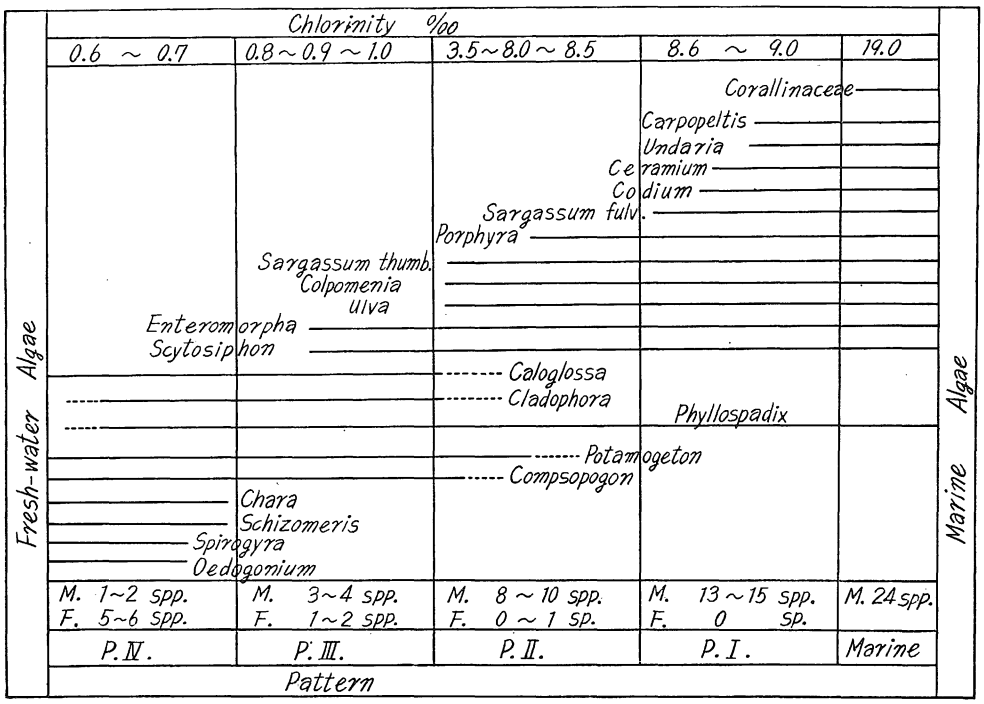
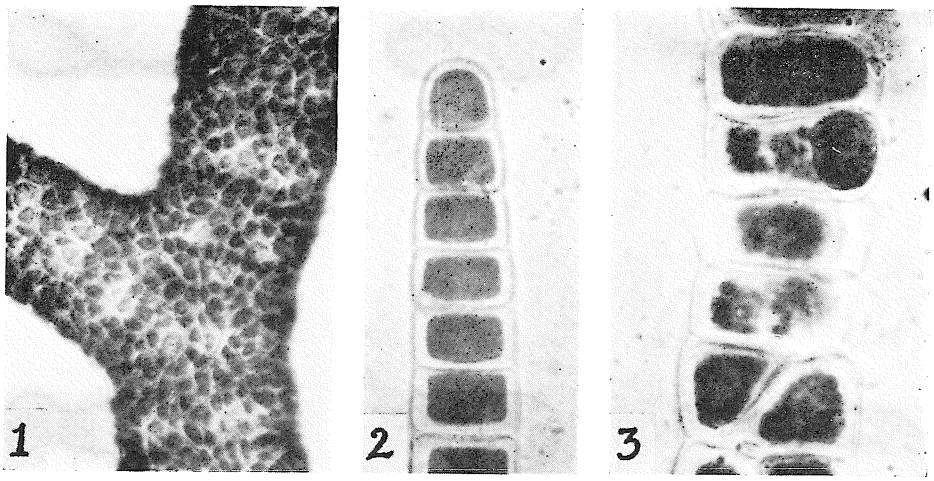


Fig. 2. Remaining and appearance of chief members of each patterns
図 2 各分布型内における主要出現藻類

Phot.



Phot. Compsopogon Oishii Okam. found in Lake Shinzi
1. middle portion of thallus.
2. young apical portion
3. monospores and monosporangium

写真 宍道湖産オオイシソウ顕微鏡写真
1. 葉状体の中央部
2. 若い先端部
3. 単胞子と単胞子のう

patterns are shown in the Fig. 3. The diminuation of specific component of *Rhodophyceae* is more remarkable than the another groups. It is inferable that the variable proportion of the diminuation of each group may be caused by their adaptivities to chlorinity. The distribution of *Calogrossa* in brackish region is usually owing to its essential oecological habits, but the appearance of certain species of such algae as marine species *Scytosiphon*, *Enteromorpha* and fresh-water species *Compsopogon* in Lake Shinzi has an important oecological meaning. Up to this time, however, nothing has been observed regarding *Scytosiphon* from such a low range of chlorinity. Although the appearance of fresh-water species *Compsopogon Oishii* Okam. in brackish estuary region was reported in Japan, no report has been made in such a stagnant brackish region.

Oecological habits, the epiphytic substtata and the bottom types of these algal habitats, are about the same with a marine region. Some interesting trends have been observed on the distribution of the *Scytosiphon* and *Enteromorpha* types. The zonal distribution of these algae are common in marine region. In Lake Nakano-umi, *Enteromorpha* is located in the upper zone compared with the position of *Scytosiphon* the same as in marine regions. On the contorary, it is observed that the distributional zone of *Scytosiphon* is located in the upper rather than the *Enteromorpha* zone in Lake Shinzi. But the factors

Fig. 3.

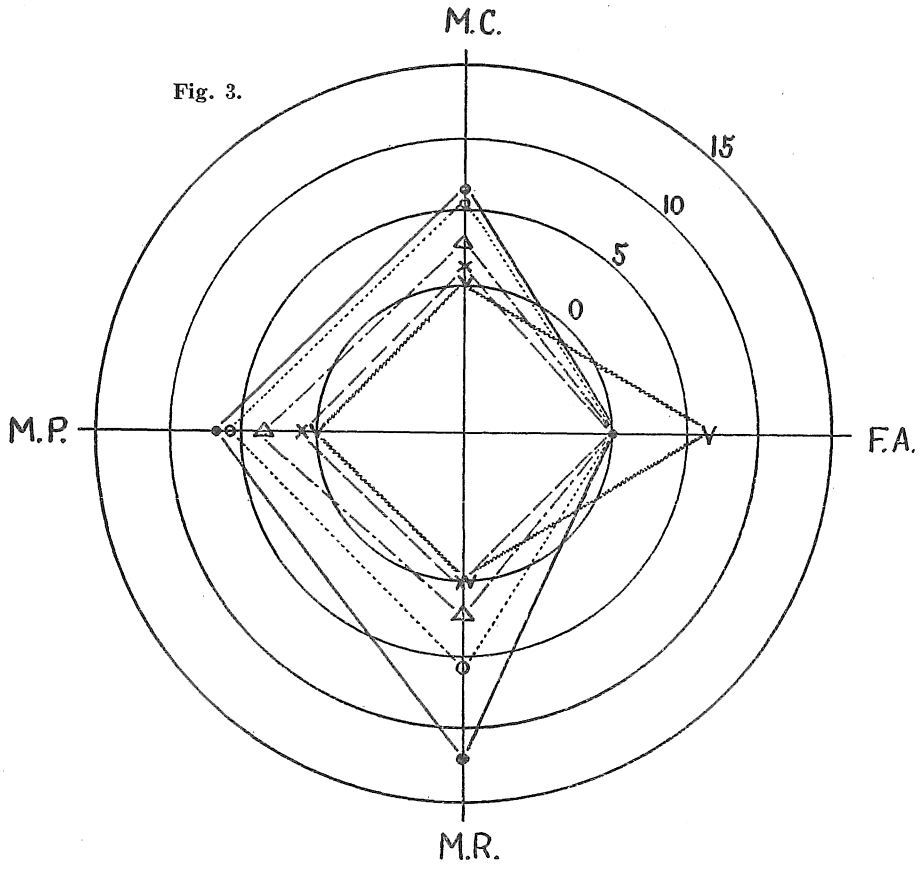


Fig. 3.: Quantative variation of algal components of each patterns
M. C.: Marine chlorophyceae, M. P.: Marine Phaeophyceae,
M. R.: Marine Rhodophyceae, F. A.: Fresh-water algae.
Concentric circles indicate amount of Species appeared.

——●—— Marine region
·····○····· Pattern I
·—·—△—·—· Pattern II
— — — x — — — Pattern III
~~~~~~~~~~V~~~~~~~~~~ Pattern IV

図 3. 各分布型内における種構成の比較図
M. C.: 海産緑藻類. M. P.: 海産褐藻類
M. R.: 海産紅藻類. F. A.: 淡水藻.
同心円上の数字は出現種数を示す.

are unknown. The epiphytic substrata of *Compsopogon* are such plants as *Potamogeton* (fresh-water *Phanerogamae*) and *Phyllospadix* (marine water *Phanerogamae*). The juvenile stage of this alga was collected in September, 1958. The oecological trends in Lake Shinzi are characterized by the appearance of *Compsopogon* and *Calogrossa*.

We wish to express our thanks to Dr. Y. YAMADA for his constant guidance in the
~~~~~~~~~~

course of the present work. Thanks are also to be offered to Dr. H. HIROSE for his valuable suggestions on the distribution of *Compsopogon Oishii* Okam. in this country. Thanks are also due to Mr. S. KAWASHIMA of the Hokkaido Prefectual Office for his cooperations of identifying the species of marine algae in these regions, and are also due to Mr. H. OKABAYASHI of Hygienic Laboratory of Shimane Prefecture for his cooperations in chlorinity determinations.

Résumé

Oecological observation especially on the algal distribution in brackish lakes Nakano-umi and Shinzi have been made. The distribution of macroscopic algae are gradually paralleled with a gradual dropping out of chlorinity range of this region. These regions are characterized by four patterns of algal distribution. The patterns and each of the indicators are shown in the Fig. 1. A.

The proportion of diminuation of specific component in *Rhodophyceae* is more remarkable than the other systematic groups. The distribution of fresh-water alga *Compsopogon Oishii* Okam. is reported as a newly found locality in the coastal region of the Japan Sea.

摘　　要

中海および宍道両汽水湖における藻類分布の観察をおこなった。

藻類の分布状態は，この水系における塩素イオン濃度の変化と，ほぼ平行的な関係が認められた。

この地域は，図 1. A. に示されるように，分布上4型に分けることができる。

淡水化にともなう生育種数の減少度は，緑藻および褐藻に比較し，紅藻が最も著しい。

宍道湖を，淡水産オオイシソウの日本海沿岸地区における新産地として報告する。

Literature

AKIYAMA, M. 1958 Oecological observation of Compsopogon Oishii Okam. found in Lake Shinzi. (in press)

DOTY, M. and J. NEWHOUSE 1954 The distribution of marine algae into estuarine waters. Amer. J. Bot. 41 : 508-515.

FRITCSH, F. E. 1956 The structure and reproduction of the algae. Cambridge Univ. Press.

KAMIYA, T. 1955 The new locality of Compsopogon Oishii Okam. and a consideration of its distribution in Japan. Hokuriku no Syokubutsu (in Japanese)

OKAMURA, K. 1951 Icones of Japanese algae. Kazama Shobo (in Japanese)

SMITH, G. M. 1950 The fresh water algae of the United States. McGraw-Hill book Co. New York.

WOOD, R. D. and J. STRAUGHAN 1953 Time-intensity tolerance of Lemanea fucina to salinity. Amer. J. Bot. 40: 381–384.

WOOD, R. D. and E. A. PALMATIER, 1954 Macroscopic algae of the coastal ponds of Rhode Island. Amer. J. Bot. 41.