Taketo NAKANO*: **Some epiphytic algae growing on the spikes of *Typha*****

中野武登*: ガマの穂上に生育する着生藻類

We have only a little information concerning subaerial epiphytic algae growing on barks or leaves, with the exception of algae of the Trentepohliaceae (Barkman 1958, Vischer 1960, Skvortzov 1967, Cox & Hightower 1972, Wylie & Schlichting 1973, Graham et al. 1981, etc.).

In the course of a taxonomic investigation of subaerial epiphytic algae, I found macroscopic green colonies of algae developing on the spike of *Typha* (Typhaceae) in several localities of Hiroshima Prefecture, Japan. Since nothing has been known of the epiphytic algae growing on reproductive organs of the flowering plants, I prompted a study of those colonies in laboratory culture. As a result, considerable numbers of algal species were detected. This paper deals with algae obtained from those colonies in culture.

Materials and methods Five samples of spike were collected from *Typha latifolia* L. and *T. angustifolia* L. at three localities (Mihara, Higashi-hiroshima and Kure) in Hiroshima Prefecture, in November, 1982. Colonies scrapped from the surface of the spike were added to 125 ml Erlenmeyer flasks containing 50 ml each of sterile Bold's Basal Medium (1N BBM: Bischoff & Bold 1963). These culture vessels were placed in the culture room at 22±1°C under the illumination of approximate 3000 lux on a cycle of 12 hr light and 12 hr darkness. After 2–3 weeks, good algal growth appeared in the flakes. Unialgal and axenic cultures were obtained by the method of Wiedeman et al. (1964). All unialgal and axenic isolates were maintained on agar slant containing 3N BBM (Brown & Bold 1964). Identification of the algae was usually made on these isolates.

Results and discussion *Typha latifolia* L. and *T. angustifolia* L., from which samples were collected, were growing in abandoned paddy fields or in shore of irrigation ponds. They produce both male and female spikes on the same stem

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Tab. 1. Epiphytic algae collected from the surface of spikes of *Typha*.

Sample No.	1	2	3	4	5
Locality	Mihara	Mihara	Mihara	Higashi-hiroshima	Kure
Habitat	O	H	H	O	H
	Ap	Ap	Ap	Ip	Ap
Algal species Host	Ta	Tl	Tl	Ta	Ta
CYANOPHYCEAE					
Phormidium fragile	·	·	·	·	+
CHLOROPHYCEAE					
Bracteacoccus minor	·	+	+	·	·
Chlorella luteoviridis	+	+	+	+	+
C. vulgaris	+	+	·	+	+
Chlorococcum echinozygotum	·	·	+	·	·
C. sp.	·	+	·	·	·
Desmococcus vulgaris	·	+	+	·	·
Keratococcus braunii	·	+	·	+	·
Klebsormidium flaccidum	·	+	·	·	·
Stichococcus bacillaris	+	+	+	+	+
Tetracystis fissurata	·	+	+	·	·
Trebouxia glomerata	·	+	+	·	·
XANTHOPHYCEAE					
Monodus subterranea	·	+	+	·	·

O : Open field, H : Hollow, Ap : Abandoned paddy field, Ip : Irrigation pond, Ta : *Typha angustifolia*, Tl : *T. latifolia*.

in summer. In autumn, male flowers located over a female spike fall and disappear, and the female spike produces many seeds. The fruiting spike which is long cylindrical and reddish-brown is an aggregate of many seeds with long, fine hairs. In late autumn to early winter, the spike fluffs whitely and seeds are dispersed by wind.

Macroscopic colonies of epiphytic algae were found abundantly on fruiting spikes in late autumn. These algae formed dry paste- and crust-like colonies on the surface of the spike (Fig. 1). They were green to dark green in color.

The size of colonies was different among spikes even in the same habitat and also different among habitats. Colonies developing on the spike of *Typha* growing in hollow areas between hills were usually larger than those in open fields.

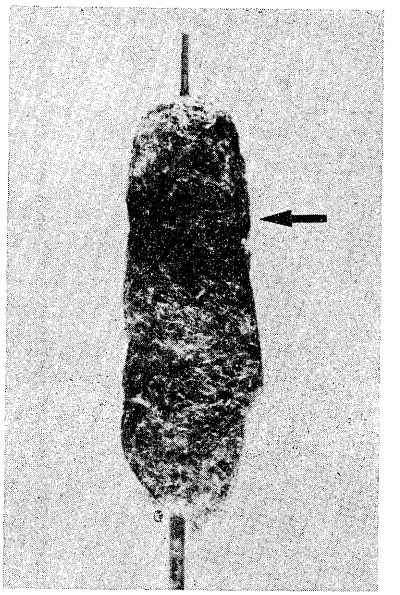

Fig. 1. Algal colony growing on a spike of *Typha*

Of the 13 taxa identified, 11 were of the Chlorophyceae, one of the Xanthophyceae and one of the Cyanophyceae. The associative relationship between algal species and hosts is shown in Tab. 1. The most predominant algae were *Stichococcus bacillaris*, *Chlorella luteoviridis* and *C. vulgaris*. The spike of *Typha* growing in hollow areas had more algal species than that in open fields. Many taxa of algae were isolated especially from a spike of *Typha latifolia* collected at Mihara (sample no. 2). All of the algae found in this study have also been reported from aerial habitats in Japan as well as various other areas of the world, with the exception of *Chlorella luteoviridis* and *Trebouxia glomerata*, the former being a taxon so far reported from aquatic habitats and the latter being as a phycobiont of lichens. These two species were newly found in Japan (Fig. 2).

In this study, *Trebouxia glomerata* was isolated from two samples collected at Mihara. A few reports of free-living *Trebouxia* (including *Pseudotrebouxia*) have been made (Ahmadjian 1967, Nakano 1971a, 1971b, Tschermak-Woess 1978). In my observation of wild samples, some *Trebouxia* cells contaminated by fungal hyphae together with many free-living cells, were found in algal colonies. However, it is not clear whether these cells occur as a phycobiont in a wide range of associations with lichen fungi or not.

The passive dispersal of aquatic and aerial micro-organisms was reported by many investigators (Maguire 1959, 1963, Proctor 1959, Schlichting 1960, Stewart

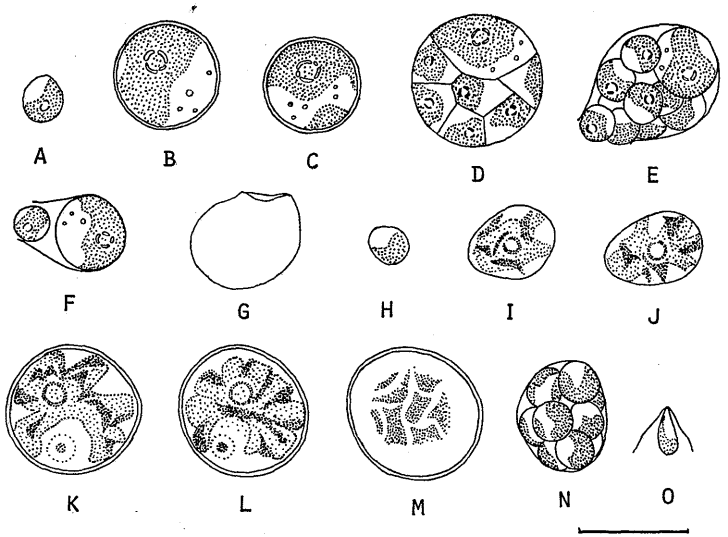

Fig. 2. *Chlorella luteoviridis* Chodat (A-G) and *Trebouxia glomerata* (Warén) Ahmadjian (H-O). Both were obtained from algal colonies developing on the spike of *Typha*. A. Young cell. B, C. Adult cells. D. Sporangium. E, F. Liberation of autospores. G. Empty mother cell wall. H-J. Young cells. K, L. Optical section of adult cells. M. Surface view of an adult cell. N. Aplanosporangium. O. Zoospore. Scale bar: 10 μm.

& Schlichting 1966, Revill et al. 1967, etc.). They pointed out that microorganisms are passively transported by wind, rain, insects or birds. It is supposed that epiphytic algae growing on the surface of spikes are carried by these transporters. The fruiting spike of *Typha* is a dense aggregate of seeds with fine hairs, and such a structure is considered to offer a suitable space to keep the moisture which is necessary for the growth of algae. In fact, epiphytic algae form large colonies on the spike of *Typha* in a short period. Both the structure of the spike and the growing habitat of *Typha* are considered to be important factors for the colonization of algae on the surface of spike. More species of algae were isolated from the spike of *Typha* growing in abandoned paddy fields located in hollow areas between hills which are more humid than open fields. Moreover, in those habitats, algal colonies of larger size were observed. In early winter, seeds of *Typha* are dispersed by wind, and epiphytic algae are to be transfered together with seeds to other places. The ways in which the algae migrate to the surface of the spike is schematically shown in

Fig. 3. The spike of *Typha* seems to play an important role as a relay place for the dispersal, distribution and growth of subaerial algae.

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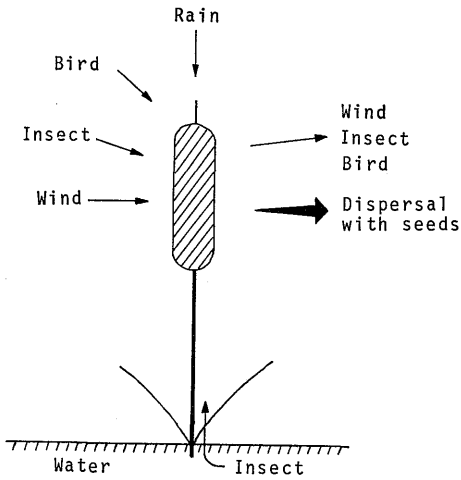

Fig. 3. Hypothetical origin and dispersal of algal colonies on the surface of the spike of *Typha*.

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広島県内の放棄水田や溜池周辺に生育するガマ（*Typha latifolia* L.）とヒメガマ（*T. angustifolia* L.）の穂（果期の雌花群）の表面に着生する藻類について調査を行った。穂の上部から側面にかけて発達していた着生藻類のコロニーから藻体を分離・培養した結果，緑藻類11種，黄緑色藻類１種，藍藻類１種を見出した。高頻度で出現した種は *Stichococcus bacillaris, Chlorella luteoviridis, C. vulgaris* であった。ほとんどの種はこれまでに好気的条件下から報告されているものであったが，*Chlorella luteoviridis* と *Trebouxia glomerata* の２種はそれぞれ水中からと，地衣類の共生藻類として報告されているものである。なお，これら２種は日本新産である。微小藻類は雨，風，昆虫，鳥等によって運ばれ，分布域を拡げることが知られているが，ガマの穂は水分条件が微小藻類の生育に適しているため，これら藻類の散布，分布等の中継地点として重要な役割を果しているものと考えられる。