

## Studies on Planktonic Blue-green Algae 9. *Anabaena akankoensis* sp. nov. from Lake Akan, Hokkaido

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**Abstract** A new species from Lake Akan in Hokkaido, *Anabaena akankoensis* is described. The alga is superficially most similar to *Anabaena fusca* Hill, which was described from a Minnesota lake in 1976, but differs in larger dimensions of vegetative cells, heterocytes, and akinetes from the latter.

**Key words:** new species, plankton, blue-green alga, Lake Akan.

The present alga was collected from Lake Akan in August 1966 and reported as *Anabaena circinalis* Rabenhorst in “The species of *Anabaena* from Hokkaido” by the present author (Watanabe, 1971). Because of a paucity of materials an identification of the alga was done tentatively and this problem has long remained in his mind. Replying to a request of the author, Dr. Akihiro Tuji kindly collected some plankton samples lately from the same lake which contained the same alga with enough individuals with akinetes for additional observations. Through detailed observations, the alga has been confirmed to be different from *A. circinalis* and any other related taxa and thus declared to be a new species.

The alga was found to resemble *Anabaena fusca* (Hill, 1976) in some morphological characters such as forms of vegetative cells, heterocytes, and akinetes and relative positions between akinetes and heterocytes. Akinetes are usually developed at both sides of heterocytes, but they are separated from each other by one or two vegetative cells. Both algae have many common morphological characteristics mentioned above, on the other hand they also showed morphological differences which were enough to recognize them as separate species.

Lake Akan is situated in the eastern part of

Hokkaido and the lake is well-known for being inhabited by large beautiful *Cladophora* balls (“marimo”, up to 25 cm in diameter) which have been designated a precious natural product by the Japanese Government. The lake was formed by the natural damming of a river. The altitude of the lake is 420 m, the surface area is 13.3 km,<sup>2</sup> the maximum depth is 42 m, the water is eutrophic and thus has caused water-bloom of *Anabaena mendotae* every summer since 1935 (Negoro, 1937, as *A. flos-aquae* var. *treleasi*).

### Materials and Methods

All samples were fixed with formalin and preserved in the herbarium of the Department of Botany, National Science Museum in Tsukuba (TNS). Specimens examined: 50172 August 4th, 1966, a plankton sample near the river mouth of Sirikomabetsu; 50198 August 11th, 1966; a plankton sample at Kinetanpe; 54054 September 10th, 2002, a plankton sample collected in a harbor for sightseeing boats.

Observations were made with a microscope, Olympus VANOX Type AH-2 with a x100 dry type objective lens and measurements were processed with a video micrometer, Olympus VM-50 and a digital camera, Fujifilm HC-2500.

## Results and Discussions

Vegetative cells of the new species and those of *A. fusca* are superficially similar in shape but differ in dimensions (Tab. 1, Fig. 1). Vegetative cells of the new species and those of *A. circinalis* overlap in dimensions but differ in shape. Cells of the new species are (7.4–)8.3–9.8(–10.5)  $\mu\text{m}$  wide, (6.5–)8.1–10.5(–11.3)  $\mu\text{m}$  long, about 0.8–1.2 in l/w ratio and those of *A. fusca* 5.5–6.5  $\mu\text{m}$  wide, (6.0–)7.0–8.5(–10.0)  $\mu\text{m}$  long, about 1.0–1.8 in l/w ratio. The l/w ratio of *A. fusca* were measured from photographs in the original paper.

Heterocytes of the new species are (9.7–)10.2–11.2(–11.4)  $\mu\text{m}$  wide, (9.5–)10.0–11.7(–12.3)  $\mu\text{m}$  long and those of *A. fusca* are (6.0–)6.5–8.0(–8.5)  $\mu\text{m}$  wide, (6.5–)7.0–8.5(–9.0)  $\mu\text{m}$  long. The forms of heterocytes are almost spherical in both of the alga. But dimensions are discontinuously deviated between them.

Akinetes of the new species are (10.8–)11.4–12.7(–13.0)  $\mu\text{m}$  wide, (23.3–)22.6–33.6(–42.3)  $\mu\text{m}$  long and those of *A. fusca* are (7.5–)8.0–10.0(–12.0)  $\mu\text{m}$  wide, (16–)26–42(–52)  $\mu\text{m}$  long. Width of akinetes deviated between the new species and *A. fusca* (Tab. 1, Fig. 2). The forms of akinetes in both of the algae are cylindrical with rounded ends and slightly curved in longer ones. Relative length of akinetes are longer in *A. fusca* than in the new species. Akinetes develop at both side of heterocytes and at one or two cells distant from heterocytes in both of the new species and *A. fusca*. In contrast they develop at distant positions far from heterocytes in *A. circinalis*.

### *Anabaena akankoensis* sp. nov.

Trichomata irregulariter curvata, cum vagina mucosa circumdans. Spirae fere 80–100  $\mu\text{m}$  latae. Cellulae citriformes, profunde indentatae, vesiculis gaseosis includentes, 7.4–10.5  $\mu\text{m}$  latae, 6.5–11.3  $\mu\text{m}$  longae. Heterocytes sphaericae, 9.7–11.4  $\mu\text{m}$  latae, 9.5–12.3  $\mu\text{m}$  longae. Akineta cylindrica, apice sphaerica, interdum leviter curvata, plerumque uni-, interdum usque ad tri-seri-

Table 1. Differences in dimensions ( $\mu\text{m}$ ) of vegetative cells, heterocytes, akinetes among the related taxa.

Species	Vegetative cells			Heterocytes			Akinetes			Source of data
	width min max mean:sd	length min max mean:sd	no	width min max mean:sd	length min max mean:sd	no	width min max mean:sd	length min max mean:sd	no	
<i>akankoensis</i>	7.4–10.5 (9.0:0.8)	6.5–11.3 (9.3:1.2)	50	9.7–11.4 (10.7:0.5)	9.5–12.3 (10.8:0.9)	12	10.8–13.0 (12.0:0.7)	23.3–42.3 (28.1:5.5)	29	Watanabe present study
<i>fusca</i>	5.5–6.5	6.0–7.0–8.5–10.0	—	6.0–6.5–8.0–8.5	6.5–7.0–8.5–9.0	—	7.5–8.0–10.0–12.0	16–26–42–52	—	Hill 1976
<i>circinalis</i>	8–14	—	—	8–10	—	—	16–18	up to 34	—	Geitler 1932
<i>circinalis</i>	7–8–11	7–9	—	as wide as the vegetative cells	—	—	15–21	20–28	—	Komarkova-Legnerova & Eloranta 1992

alia, ab heterocyti uni- vel di-cellulis distantia, ad heterocytum vulgo ad latera utraque vel raro ad unilaterale efferentia heterocytæ, 10.8–13.0  $\mu\text{m}$  lata, 23.3–42.3  $\mu\text{m}$  longa, 1.5–3.4-pro longiora quam latiora.

Iconotypus: Figurae 3.

Locus typicus: in lac Akan, Hokkaido, Japoniæ.

*Anabaena akankoensis* sp. nov.

Trichomes more or less irregularly twisted, with thick mucilaginous sheath. Coils about 80–100  $\mu\text{m}$  wide. Cells lemon shaped, deeply indented, with gas vesicles, 7.4–10.5  $\mu\text{m}$  wide, 6.5–11.3  $\mu\text{m}$  long. Heterocytes spherical, 9.7–11.4  $\mu\text{m}$  wide, 9.5–12.3  $\mu\text{m}$  long. Akinetes cylindrical, with rounded ends, sometimes slightly curved, mostly one and up to three in series occasionally, at one or two cells distant from heterocytes, both side or scarcely one side of heterocytes, 10.8–13.0  $\mu\text{m}$  wide, 23.3–42.3  $\mu\text{m}$  long, 1.5–3.4 times longer than wide.

Iconotype: Figure 3.

Type locality: in Lake Akan, Hokkaido, Japan.

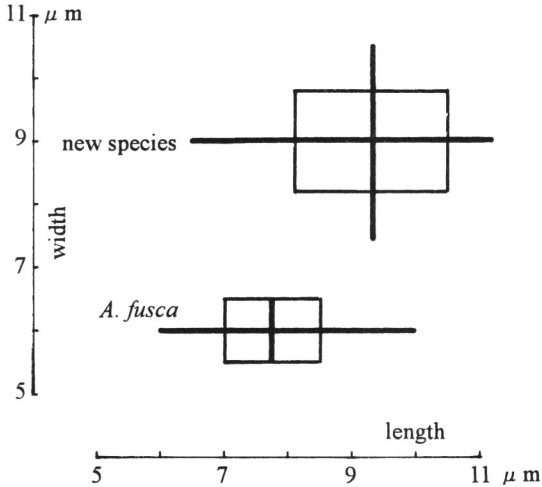


Fig. 1. Graphic analysis of width and length of vegetative cells in the new species and *Anabaena fusca*. Solid lines (vertical and horizontal) indicate ranges, and the crossing point represents the mean value. A square around the crossing point shows the extent of the standard deviation in the case of the new species. But Hill did not show statistics, the crossing point represents the central position of the square which circumscribes most of the measured cells in the case of *A. fusca*.

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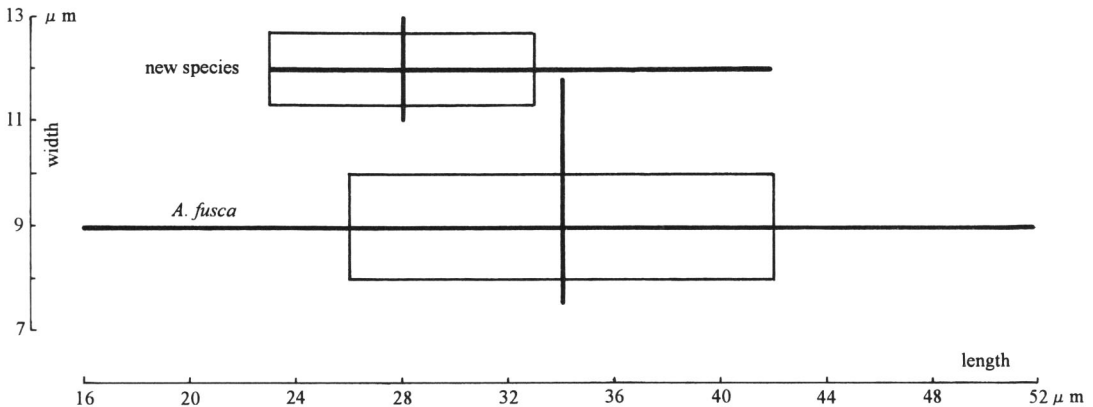


Fig. 2. Graphic analysis of width and length of akinetes in the new species and *Anabaena fusca*. Notation are the same with those in Fig. 1.

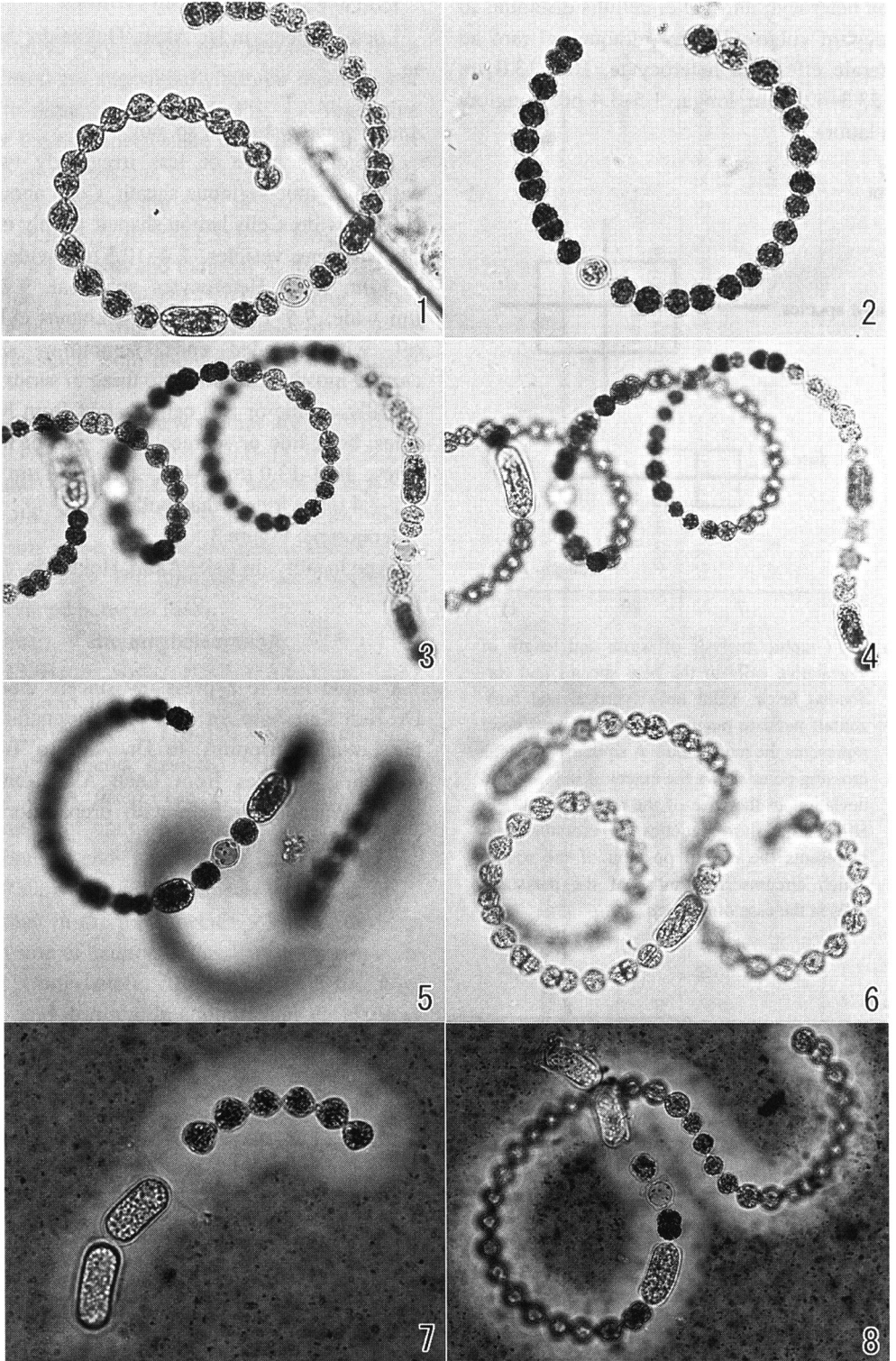


Fig. 3. *Anabaena akankoensis* sp. nov., 1. young akinete are developing at both side of a heterocyte and at 2 cells distant from the heterocyte., 2. a trichome with young heterocytes., 3-6. different forms of trichomes., 7, 8. black ink revealed trichomes are covered with a thick mucilaginous sheath. ( $\times 550$ )

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