

Morphological Characteristics of the Diatom Flora of Lake Waiau: Variation and Speciation¹

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ABSTRACT: The diatom species inhabiting Lake Waiau, Hawaii, over a period of several thousand years have been identified. An unusually high incidence of morphological variation was found. A new species, *Stauroneis maunakeäensis* was discovered.

LAKE WAIU, A SHALLOW heart-shaped water body less than 1 hectare in area, is located at 3969 meters on the summit plateau of Mauna Kea on the island of Hawaii. In 1966, Woodcock, Rubin, and Duce found more than 7.5 meters of sediments on the lake bottom, the first 2 meters of which were sampled. There was sufficient organic matter present to permit carbon dating. The sediment core contained remnants of diatom populations spanning a period of over 5000 years. The contemporary population was surveyed recently and compared with sediment core populations. The survey revealed an exceptionally high incidence of morphological variance and led to the discovery of a new, possibly endemic *Stauroneis*.

METHODS

The first 2 meters of the lake bottom were sampled with a piston corer (Woodcock *et al.* 1966); sections of these cores were made available to the author. The contemporary sediment was sampled by means of a hollow pipe pushed into the lake bottom and returned to the surface. Samples were also obtained by divers filling glass jars with sediment at the lake bottom. The samples, each consisting of approximately 0.25 g of sediments, were digested overnight at 65.5°C

in 5 ml concentrated nitric acid. They were centrifuged (5000 rpm for 3 min), the acid decanted, and the samples washed five times. The acid-free sediment was then resuspended in 5 ml demineralized water; 0.05 ml was removed and diluted in order to obtain an evenly spread grid. An aliquot of 0.05 ml was removed from this mixed sample and dropped on a 200-mesh copper grid coated with a collodion film. The grid was viewed on an Hitachi HS-8-1 electron microscope and the species identified.

RESULTS AND DISCUSSION

Diatom species found at Lake Waiau, Hawaii, were typically smaller and more highly silicified than their counterparts in other localities. Eight of the twelve cosmopolitan species were notably shorter and the number of striae/10 μm was atypically large in seven species (Table 1). Of the thirteen species identified in Lake Waiau, eight were found in core sediments that range in age from 200 to 6000 years. Six of the eight species from the sediment core persist in contemporary populations with five more recent species. All of the cosmopolitan species found at Lake Waiau were typically heteromorphic and have been reported to possess highly variable lengths. Size is typically excluded as the definitive characteristic of a species among diatomists because environmental conditions can greatly modify it (Hustedt 1930). Temperature, light, and the nutrient regime are all extreme at Lake Waiau (Massey 1978). Increased silicification may

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TABLE 1
LENGTH AND SILICIFICATION OF THE DIATOM SPECIES OF LAKE WAIAU

SPECIES	LENGTH (μm)		STRIAE/10 μm	
	Lake Waiau	Worldwide	Lake Waiau	Worldwide
<i>Achnanthes hauckiana</i>	12.7	9-31	10-12	10-12
<i>Amphora costata</i>	27.5	50-100	14-16	9-12
<i>Cocconeis placentula</i>	5.3	10-70	*	20-26
<i>Fragilaria lapponica</i>	12.8	12-40	12	6-9
<i>Hantzschia amphioxys</i> var. minor	14.8	25-30	23-24	23-24
<i>Melosira italica</i> var. subarctica	13.8	2-18	†	18-22
<i>Navicula divergens</i>	36.2	38-45	12	13-20
<i>Navicula radiosa</i>	36.2	40-120	15	10-12
<i>Nitzschia frustulum</i>	11.2	20-40	28-30	20-22
<i>Nitzschia vitrea</i> var. salinarum	34.8	35-80	28-30	28-30
<i>Rhopalodia musculus</i>	20.9	35-60	23-25	15-16
<i>Stauroneis kriegeri</i>	23.3	20-23	27-29	26

NOTE: Worldwide data are from Peragallo and Peragallo (1897), Schmidt (1874), and Van Heurck (1896).

*Only one valve available for identification.

† Unable to observe.

also be a response to the extreme environment characteristic at Lake Waiiau, as evidenced by the increased number of striae/10 μm .

No species are known to be characteristic of tropical alpine lakes. Generally, cosmopolitan forms are prevalent and the number of tropical species is relatively limited (Gessner 1955, Thomasson 1956). It has been suggested that this is due primarily to difficulties in colonization in these high-mountain ecosystems (James and Hubbick 1969). This may explain the low species diversity found in Lake Waiiau.

A new species, *Stauroneis maunakeäensis*, was found both in core sediment and in recent populations. This diatom species was most closely related to *Stauroneis nana*, however important differences were found. First, the basic morphology is inconsistent with the description of this species (Hustedt 1957). The *Stauroneis* species from Lake Waiiau is linear to slightly convex in valve view with curved ends. *Stauroneis nana* is described as elliptical-lanceolate with slightly protracted, bluntly rounded ends. The stauros was described as sharply expanded (Patrick and Reimer 1966), while *Stauroneis maunakeäensis* has a basically linear central area that curves slightly toward the valve margins. The size range of *Stauroneis maunakeäensis* is the same as that found for *Stauroneis nana*.

The author has therefore distinguished this organism as a new species (Figure 1). A type specimen has been deposited at the Bernice P. Bishop Museum, Honolulu, Hawaii.

The morphological variance observed provides an intriguing basis for consideration of Lake Waiiau as a highly selective environment.

Stauroneis maunakeäensis sp. nov.

Valve linear with parallel to slightly convex sides. Apices are curved. Axial area narrow and slightly curved. Raphe straight, filiform. Striae strongly radiate near the center of the valve and straighten toward the apices. Striae, 20 in 10 μm . Length, 9-12 μm . Breadth, 3-3.5 μm .

Valva est linearis, lateribus vel parallelis vel paulatim convexis. Apices rotundi sunt. Area axiale est angusta et curva aliquantum. Rraphe est recta et fili forma. Striae prope centrum valvae certe radiant et ad apices recta fiunt. Striis, 20/10 μm . Longitudo, 9-12 μm . Latitude, 3-3.5 μm .

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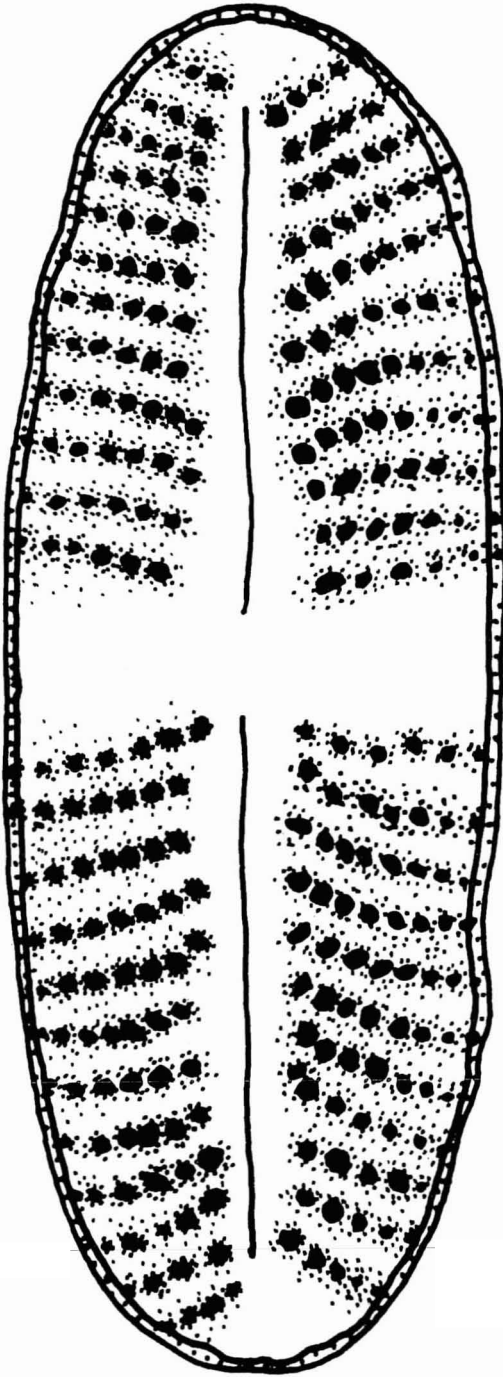


FIGURE 1. *Stauroneis maunakeäensis* sp. nov.

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