VI. VARIATIONS IN *ACHNANTHES BREVIPES* AGARDH VAR. *ARCTICA* (P. T. CLEVE) KO-BAYASHI

Many diatoms regarded as *Achnanthes* were found in the material collected by Assistant Professor Hiroshi FUKUSHIMA on February 20, 1961 at the Kasumi Rock of the Prince Olav Coast, Antarctica, during the 5th Japanese Antarctic Research Expedition. The writer treated the material with acid, sealed it with pleurax to make permanent slides and took photomicrographs of 141 individuals to examine their variations.

The Kasumi Rock is located on the exposed rocks of the Prince Olav Coast (68°21′ 5 S, 42°13′ 3 E) and the material was collected from the bottom of a pond at Station 1.

According to Dr. FUKUSHIMA (1962), the environmental factors of the pond were as follows:

Air temperature	4.2°C
Water temperature	2.1°C
pH	6.8
RpH	7.1 (at 13 : 15 by Syowa Base Time)
PO_4	0 mg/*l*
SiO_2	20 mg/*l*
NH_3	0 mg/*l*
NO_2	0 mg/*l*

Concentration of chlorine ion was 358 mg/*l* and the pond was located in the fresh water area. Therefore, it is a very interesting fact that marine diatoms were found abundantly in fresh water.

A member of *Achnanthes*, which was found in the above material, should be identified as *Achnanthes brevipes* var. *arctica*. The reasons will be given later.

According to existing record, shells of this variety are long elliptical, with rotundate ends, and central parts often slightly constricted. However, shells of the examined specimens are long elliptical to linear lanceolate; margins parallel or slightly concave; ends rotundate to wedge-shaped. There are many intermediate individuals, being rotundate and wedge-shaped. However, generally speaking, individuals having wedge-shaped ends are more common than those with rotundate ends. Individuals with wedge-shaped ends have not been record-

ed previously.

Shell length is 48-100 μ according to the earlier records, but in this case it ranges from 10 to 89 μ. The histogram is shown in Fig. 1, in which individuals of 40-69 μ length are common. The writer found many individuals, ranging in width from 6 to 15, smaller than the past records where shell width is smaller than that of the records, though this is not very important.

Pseudo-raphe of pseudo-raphate shells occur at the central part in most individuals, but not in some individuals. Striae are 6-9 in 10 μ, each stria consisting of 8-10 spots in 10 μ. According to the existing records, striae are 6-7 in 10 μ and each stria consists of about 5 spots in 10 μ. Striae are almost perpendicular to the pseudo-raphe.

Raphe are almost at the center of raphate shells and striae at the center of shells are almost perpendicular. Ends are rotundate and have radial striae. According to the existing records, striae in 10 μ are about 8, but in the present specimens they are 6-11 in 10 μ.

Raphate shells have a central area which was generally rectangular with its longer transverse side extending to the margin, but the writer found one individual which had short striae (pl. 4, fig. 5; pl. 5, fig. 1). This was the first record of such a shape of central area occurring in this variety. The writer described the shape of the central area as generally rectangular, but a typical shape was hand-drum shape, narrowing at the central nodule and widening toward the margins, as the striae at the central part occur only near the central nodule and not near the margin. Some individuals have 2-3 of such striae around the central nodule while some others have only one stria around the central nodule. Though HUSTEDT considered the central areas important, many individuals having the striae extending to both margins were observed (pl. 4, fig. 7; pl. 5, fig. 3). The point which enabled the writer to distinguish this species from *Achnanthes brevipes* var. *brevipes* which was considered to be closely related to this species, is that the width of the central area is larger than that of the central nodule. Generally, the width of the central area of this species is thought to be broader than that of *Achnanthes brevipes* var. *brevipes*, but as there are no records of the width of the central area of the latter, the writer cannot make a comparison between these two. The width of the central area of the present specimens is 2-7 μ and individuals of 3-4 μ width are more numerous.

There are several individuals with striae of the central part extending to the margin on both sides and with a narrow central area (pl. 4, fig. 7; pl. 5, fig. 3). These individuals resemble *Achnanthes brevipes* var. *brevipes*, although the width of their central area is larger than that of the central nodule. Based on the observation of the individuals of *Achnanthes arctica* and *Achnanthes brevipes* var. *brevipes*, along with many other individuals, the writer regards *Achnanthes arctica* as a variation of *Achnanthes brevipes* and names it as follows:

Achnanthes brebipes Agardh var. *arctica* (P. T. Cleve) Ko-Bayashi Stat. nov.

Synonym—Achnanthes arctica (P. T. Cleve) Cleve-Euler, in A. f. B. **14** (9): 45, pl. 2, fs. 55-56 (1915); Hustedt, in Kryptog. Fl. **7** (2): 423, f. 876 (1933); Cleve-Euler, in K. V. A. Handle. **4** (5): 50, fig. 597 (1953).

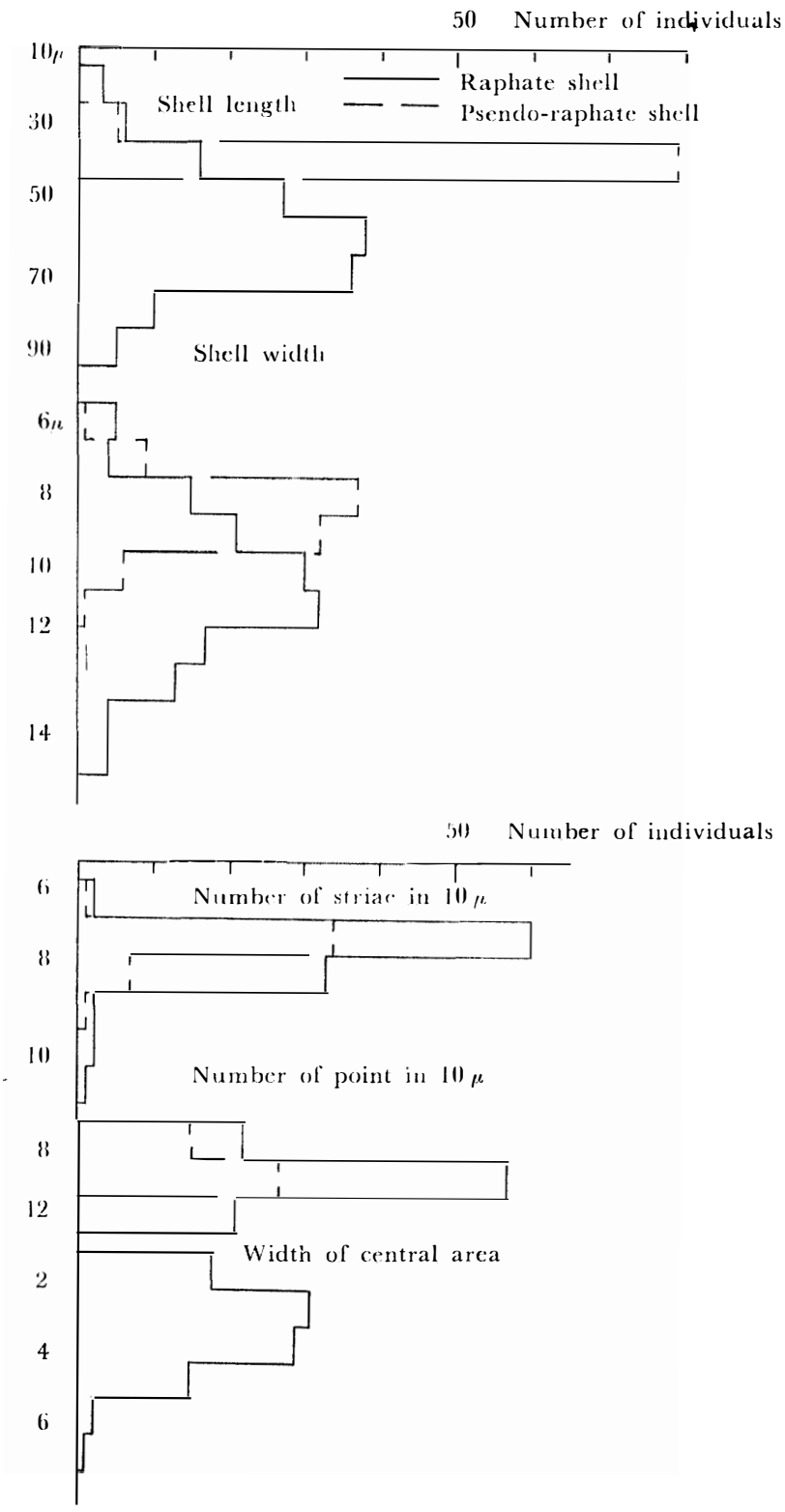

Fig. 1. Dimensions of *Achnanthes brevipes* v. *arctica*.

Achnanthidium arcticum D. T. Cleve, in Diat. Arct. Sea, 25, pl. 4, f. 22a (1873).

Striae of this species consist of a line of spots, but the writer found two individuals, in which some of the striae consist of two lines of small spots (pl. 4, fig. 8; pl. 5, fig. 2). These individuals are, of course, malformed ones, but such malformations are important as they show a relation to the species having regular striae, i. e., 2 or 4 lines of small spots (cf. *Achnanthes longipes*).

According to the earlier records and the writer's investigations, the description of this species is as follows:

Achnanthes brevipes Agardh var. *arctica* (P. T. Cleve) Ko-Bayashi.

Shells elliptical to linear lanceolate; margins straight or slightly concave; ends rotundate or wedge-shaped. Length 10-100 μ; width 6-18 μ. Pseudo-raphate shells having pseudo-raphe at the central part or on the right or left side. Striae almost straight to pseudo-raphe. Number of striae 6-9 in 10 μ. Striae consist of clear spots, 5-10 in 10 μ. Raphe situated at the central part of raphate shells. Striae at the central part of shell are almost straight to raphe, but those at margins are radial. Striae at both ends 6-11 in 10 μ. Striae consist of clear spots 8-12 in 10 μ. Axial area narrow linear; central area hand-drum shape with a longer transverse side, which generally extends to both margins. Width of central joints broader than that of the narrowest part of the central area.

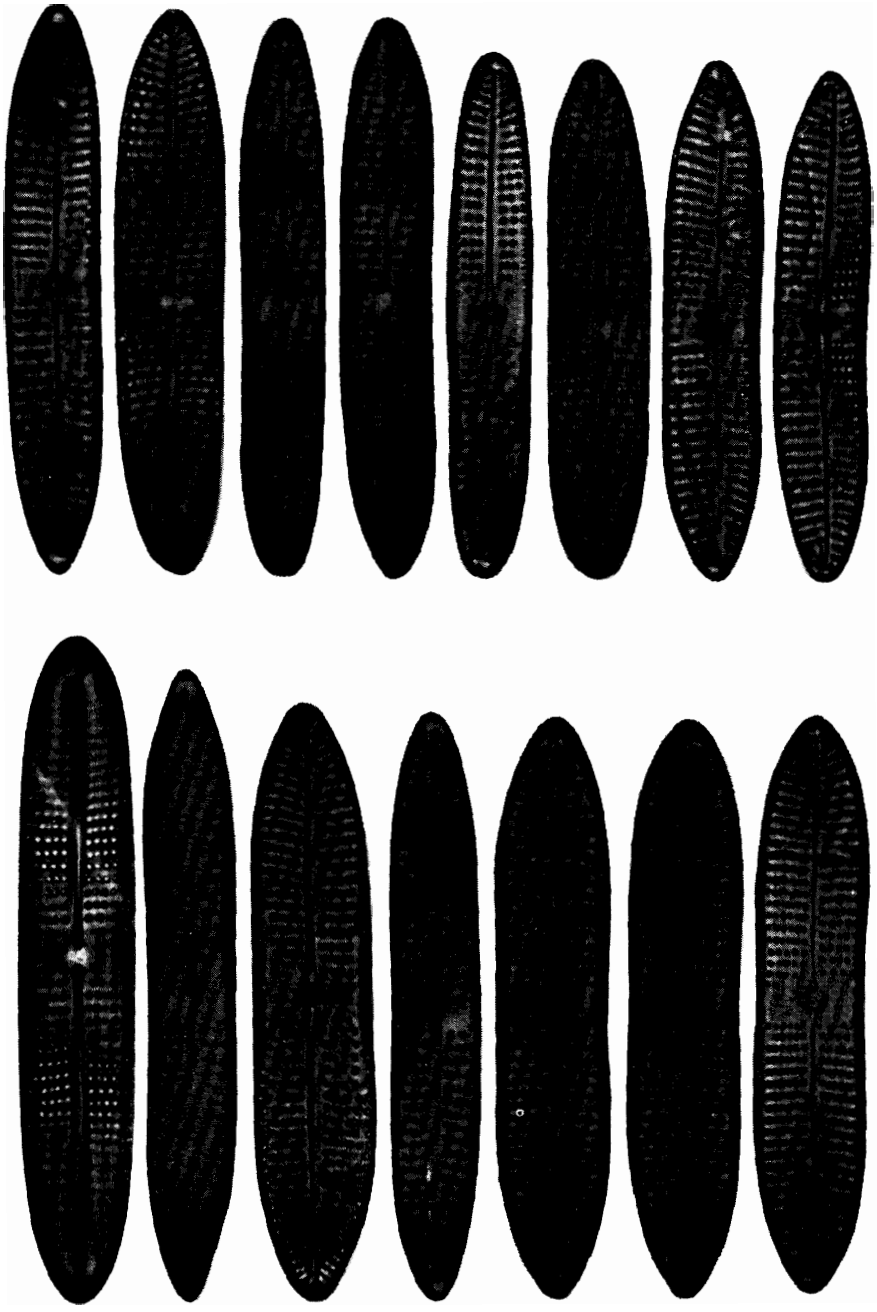

Plate 1. *Achnanthes brevipes* Ag. var. *arctica* (P. T. Cleve) Ko-Bayashi (raphate shells).

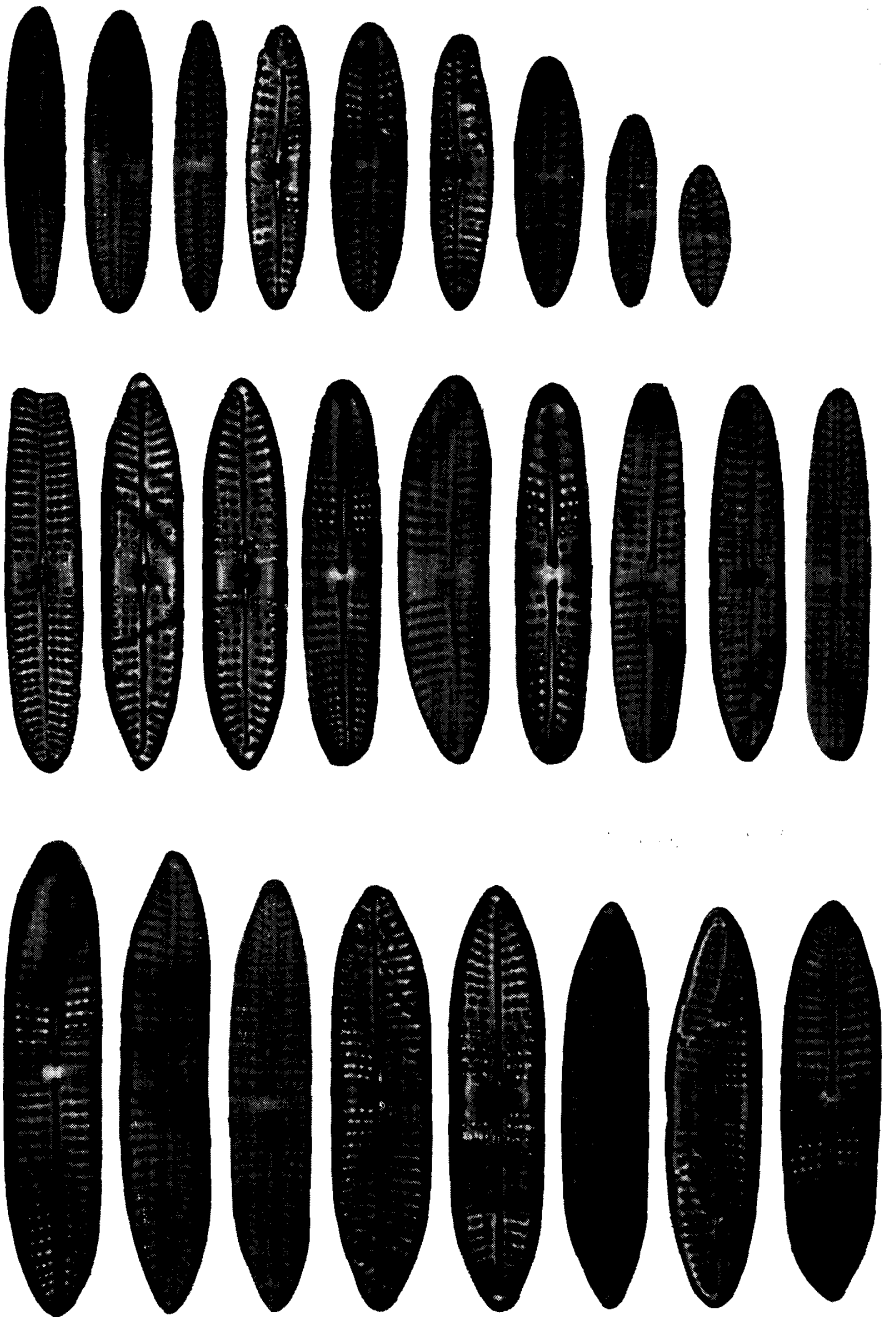

Plate 2. *Achnanthes brevipes* Ag. var. *arctica* (P. T. Cleve) Ko-Bayashi (raphate shells).

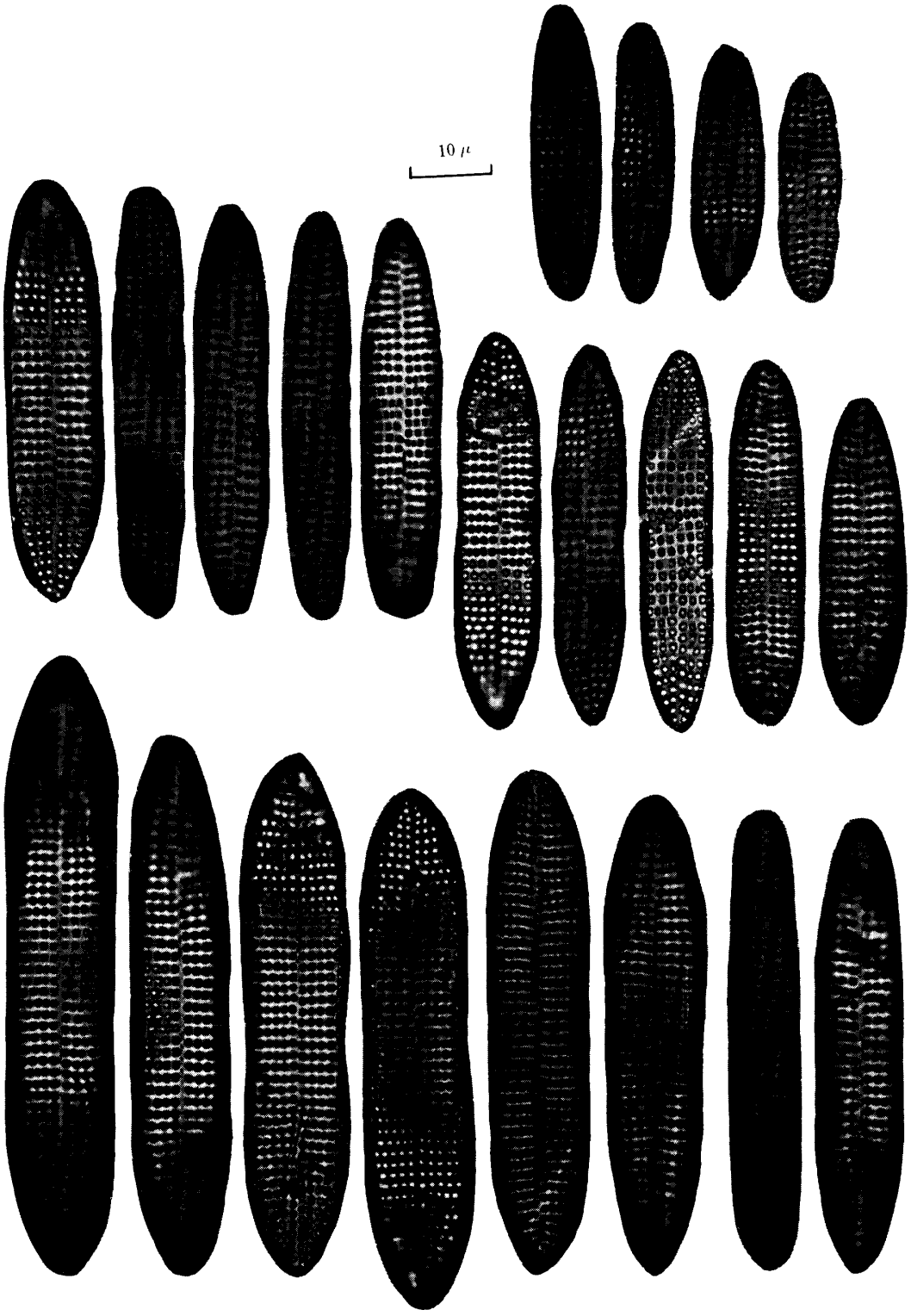

Plate 3. *Achnanthes brevipes* Ag. var. *arctica* (P. T. Cleve) Ko-Bayashi (pseudoraphate shells).

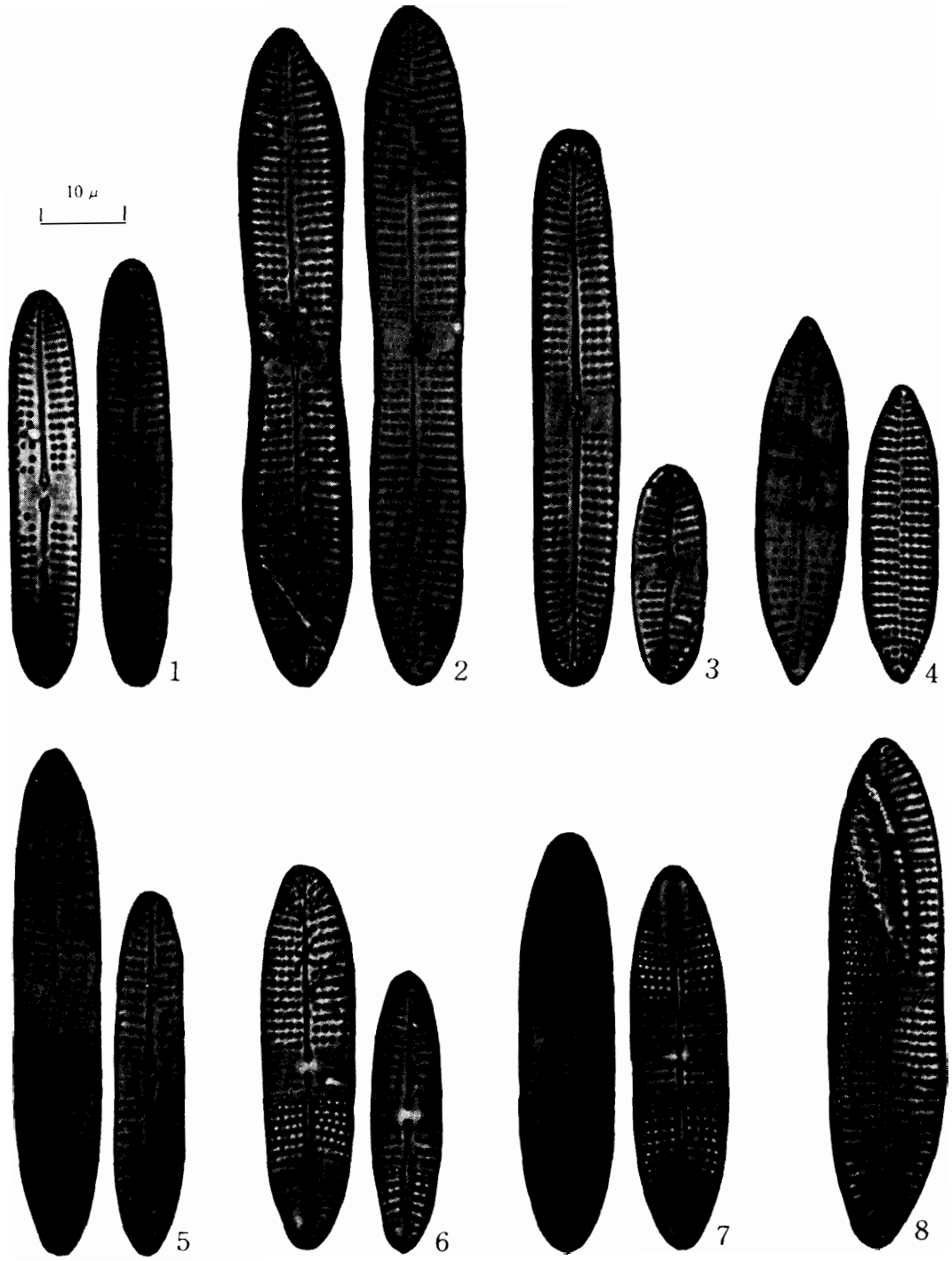

Plate 4. *Achnanthes brevipes* Ag. var. *arctica* (P. T. Cleve) Ko-Bayashi. Individuals with parallel margins (1), with concave margins (2), with broad ends (3), with conical ends (4), with *A. arctica* type central area (5), with wide central area (6), with narrow central area (7), with malformed striae (8).

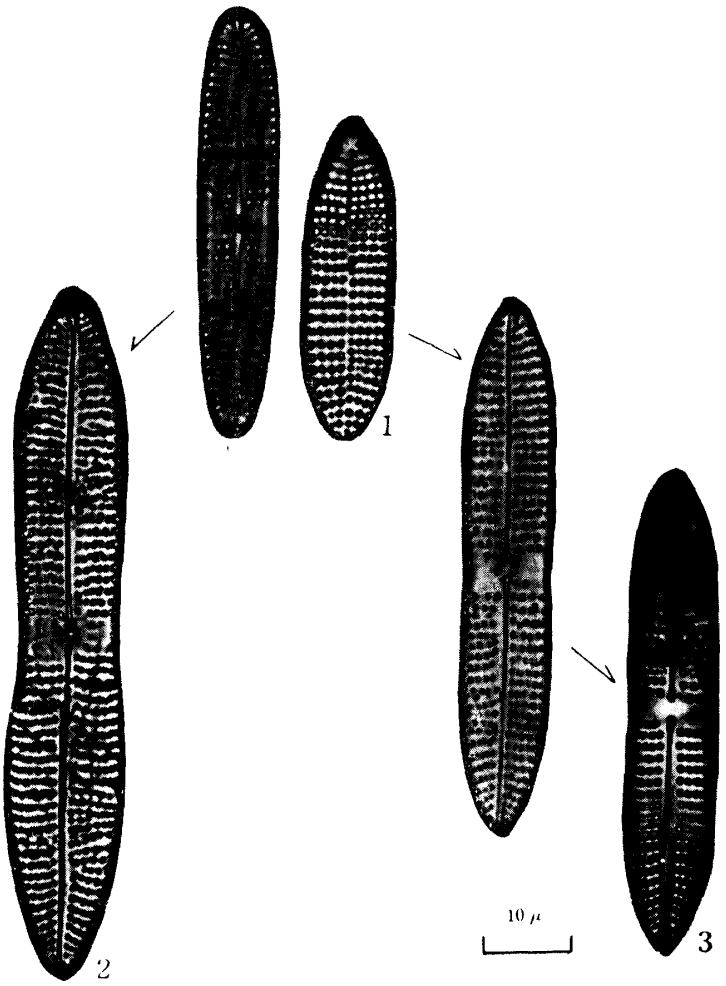

Plate 5. *Achnanthes brevipes* Ag. var. *arctica* (P. T. Cleve) Ko-Bayashi.

Typical form (1), abnormal form (similar to *Achnanthes longipes*) (2), abnormal form similar to *Achnanthes brevipes* var. *brevipes* (3).

VII. VARIATIONS IN *ACHNANTHES LANCEOLATA* (BRÉB.) GRUN. VAR. *DUBIA* GRUNOW

Many individuals of *Achnanthes lanceolata* var. *dubia* were found in two materials (Station 1 and Station 2) collected from South Georgia during the Antarctic Research Expedition of the Tokyo University of Fisheries from 1961 to 1962 by S. S. UMITAKA-MARU under the leadership of Captain Takeharu KUMAGORI. The writer treated these materials with acid, mounted with pleurax to make permanent preparations, and at random took photomicrographs of 208 individuals from the materials of Station 1 and of 262 individuals from the materials of Station 2, and then enlarged each photo to × 2,000 to examine variability of the diatoms.

Achnanthes lanceolata comprises many varieties or forms and many synonyms. The following is the description of main varieties and forms arranged by the writer on the basis of the existing literature:

Achnanthes lanceolata (Bréb.) Grun. var. *lanceolata* Grun., in Arct. Diat. 23(1880); Brun, Alp., 29, pl. 8, f. 20 (1880); van Heurck, Sy. Diat. Belg., 131, pl. 27, fs. 8-11 (1881-1895); De Toni, 485 (1891); Dippel, Diat. Rhein, 23, f. 40 (1905); Schönfeldt, Diat. Germ., 121, pl. 12, f. 240 (1907); Boyer, Diat. Philadel., 59, pl. 16, fs. 10-12 (1916), Synop. N. Am., 234 (1926); Hustedt, Bacill., 207, f. 306 (1930); Kieselal., 408, fs. 363 a-d (1933); in Arch. f. Hydrob. Supp. **15**: 202 (1938); Cleve-Euler, in K. V. A. Handl, **4** (5): 25 (1953).

Synonym—Achnanthidium lanceolatum Bréb. in Kütz. Sp. Alg., 54 (1949).

Shell elliptical to elliptical lanceolate; both ends rotundate; length 8-40 μ; width 4-10 μ. Pseudoraphate shell having narrow lanceolate pseudoraphe; one side of the central area extending to the margin, and refracting light strongly in semicircular shape. Striae strong and radial; number 12-19 in 10 μ. Raphate shell having raphe at the central part. Axial area narrow and linear. Central area rectangular with longer transverse side, but not extending to the margins on both sides. Striae strong and radial; number 12-18 in 10 μ.

Achnanthes lanceolatum Bréb. in Kütz. var. *lanceolata* f. *capitata* O. Müller, in Bot. Jahrb., **100**: 8, pl. 1, fs. 6-7 (1909); Hustedt, Bacill., 208 (1930); Kieselal., 410, fs. 863 g-h (1933).

Shell elliptical lanceolate; both ends strongly extended in a capitate shape.

Achnanthes lanceolatum Bréb. in Kütz. var. *elegans* Cleve-Euler, in D. V. A. Handl., **4** (5): 26, f. 5270 (1953).

Shell lanceolate; points extending in a long rostral shape. Pseudoraphe narrow lanceolate.

Achnanthes lanceolatum Bréb. in Kütz. var. *elliptica* Cleve, in Act. Fauna et Fl. Fenn., **8** (2): 51, pl. 3, fs. 10-11 (1891); Nav. Diat., **2**: 192 (1895); Meister, Kieselal. Schw., 208, f. 306 C (1913); Hustedt, Bacill., 208, f. 306 C (1930), Kieselal., 2: 410, fs. 863 n-o. (1933); Cleve-Euler, in K. V. A. Hand, **4** (5): 26, fs. 527 f-i (1953).

Shell elliptical; striae of raphate shell more delicate than those of pseudoraphate shell.

Achnanthes lanceolatum Bréb. in Kütz. var. *inflata* (A. Mayer) Mills, index Diat., 67 (1933); Cleve-Euler, in K. V. A. Handl., **4** (5): 27, fs. 527 l-n (1953).

Synonym—Achnanthidium lanceolata Bréb. var. inflata A. Mayer, Regensb. Bacil., 81, pl. 14, f. 35 (1913); Beitrage Diat. Bayer, **1**: 27, pl. 2, f. 27 (1917).

Achnanthes lanceolata (Bréb.) Grun. f. *ventricosa* Hustedt, in A. f. H. **10**: 64, pl. 2, f. 32 (1914).

Shell lanceolate, expanding at the central part; both ends not extending. Pseudoraphate shell having wide linear pseudoraphe; central area of raphe asymmetrical; one side extending to the margin.

Achnanthes lanceolata Bréb. var. *rhomboidae* (A. Mayer) Ko-Bayashi St. nov.

Synonym—Achnanthes lanceolatum A. Mayer, in Kryptg. Forshung., **4**: 199, pl. 6, f. 17 (1919); Achnanthes lanceolata var. nipponica Skv., in Phil. J. Sc. **61** (1): 26, pl. 12, f. 13 (1936).

External shape of shell rhombic.

Achnanthes lanceolata Bréb. var. *robusta* Hustedt, in A. f. H., Supp. **15**: 202, pl. 13, fs. 47-49 (1938).

Central area of raphate shell is large; axial area of pseudoraphate shell is narrow linear. Striae coarse; number 8-10 in 10 μ.

Achnanthes lanceolata Bréb. var. *rostrata* (Ostrup) Hustedt, in Abh. Nat. Ver. Brenen **20**: 279, pl. 3, f. 34 (1909).

Synonym—Achnanthes rostrata Ostrup., in Bot. Tidsk., **25**: 53, pl. 1, f. 11 (1902).

Shell elliptical; both ends extending in a rostral shape.

Achnanthes lanceolata Bréb. var. *tenuis* Gonz. et Gand., in Ind. J. Bot., fs. 53 a-b, (1952).

Shell linear and expanding at the central part.

Achnanthes lanceolata Bréb. var. *dubia* Grun., in Arct. Diat., 23 (1880); van

Heurk, Syn. Diat. Belg., 132, pl. 27, f. 1213 (1881-1885); De Toni, Syl. Alg., 486 (1891); Cleve, Nav. Diat., **2**: 192 (1895); Dippel, Diat. Rhein., 24, f. 41 (1905); Schönfeldt, Diat. Germ., 121, pl. 13, f. 240 (1907): Meister, Kieselal. Schw., 99, pl. 13, f. 44 (1913); A. Mayer, Beitr., **1**: 26, pl. 2, f. 25 (1917), in Kryptog. Forshung, **4**: 199, pl. 6, fs. 22 a-b (1919); Cleve-Euler, in K. V. A. Handl., **4** (5): 26, f. 527 j (1953).

Synonym—Achnanthes rostrata Ostrup, in Bot Tidsskr, 25: 253, pl. **1**, f. 11 (1902); Achnanthes lanceolata var. rostrata (Ostrup) Hustedt, Bacill, 208, f. 306 b (1930).

Achnanthes lanceolata var. *crassa* A. Cleve, in Ark. f. Bot., **14** (9); 32, pl. 4, f. 91 (1915).

Shell shape elliptical to rhombic elliptical; ends rather sharply attenuating and then extending in a rostral shape.

***Achnanthes lanceolata* var. *dubia* from South Gergia**

The shell of this variety from South Georgia is generally elliptical. In most of individuals the ends extend remarkably in a rostral shape (pl. 8, fig. 6) but in some individuals the ends do not extend and the shell shape is lanceolate (pl. 6, fig. 4) or elliptical (pl. 6, fig. 3). The individuals which are not extended at the ends are generally small. When the shell of this variety decreases in length as a result of repeated cell division but not in width, the constriction of the ends of the shell becomes indistinct, and finally it disappears forming elliptical individuals are closely related to *Achnanthes lanceolata* f. *elliptica* and the lanceolata individuals to the typical species. For classification of varieties or forms of this species, the external shape of the shells was considered important and extention of the end of the shell was used as a criterion of classification. However, the writer thinks that it is improper to classify them by the properties that change with cell division. A group of individuals which were regarded as a variety until now should be regarded at least as a form. Therefor, the writer treated var. *dubia* which was examined this time as a form.

Achnanthes lanceolata (Bréb.) Grun. var. *lanceolata* f. *dubia* (Grunow) Ko-Bayashi St. nov.

Synonym—Achnanthes lanceolata (Brév.) Grun. var. dubia Grun., in Arct. Diat. 23 (1880).

Among the examined materials there are several malformed individuals differring in extension of the shell ends (pl. 8, fig. 1). This fact suggests that the extension of shell ends is not a strong characteristic.

Straight raphe is found at the central part of raphate shell. Axial area is narrow linear. Many forms varying in width or shape of the axial area were observed (*Pinnularia subcapitata* var. *subcapitata*, etc.). However, no variability was noticed. Axial area of every individual was linear.

As the three central striae are shorter, the central area is rectangular with longer transverse sides (pl. 7, fig. 1). As the striae of the central part of some individuals are not short, their central area is small. In some other individuals

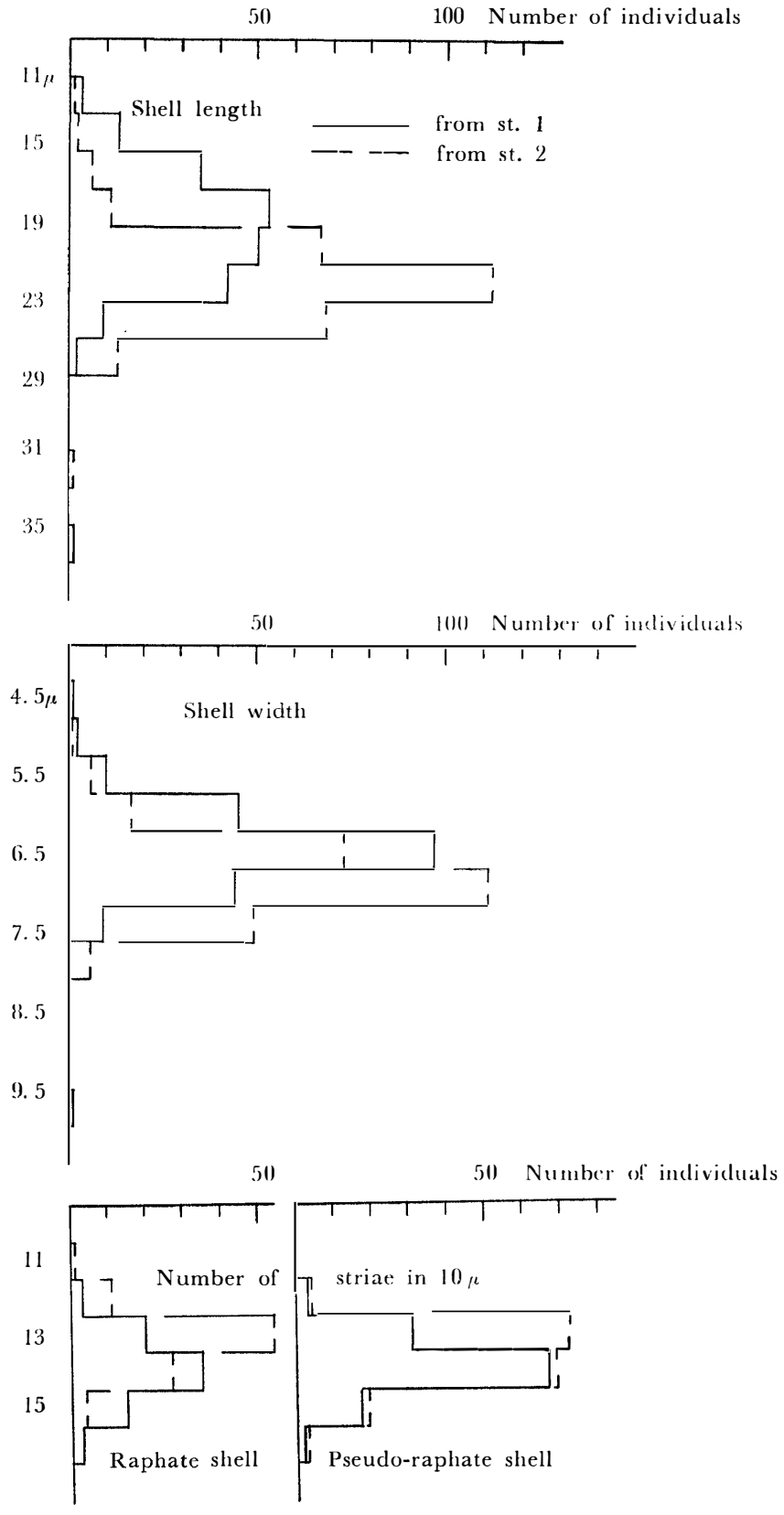

Fig. 2. Dimensions of *Achnanthes lanceolata* var. ***dubia***.

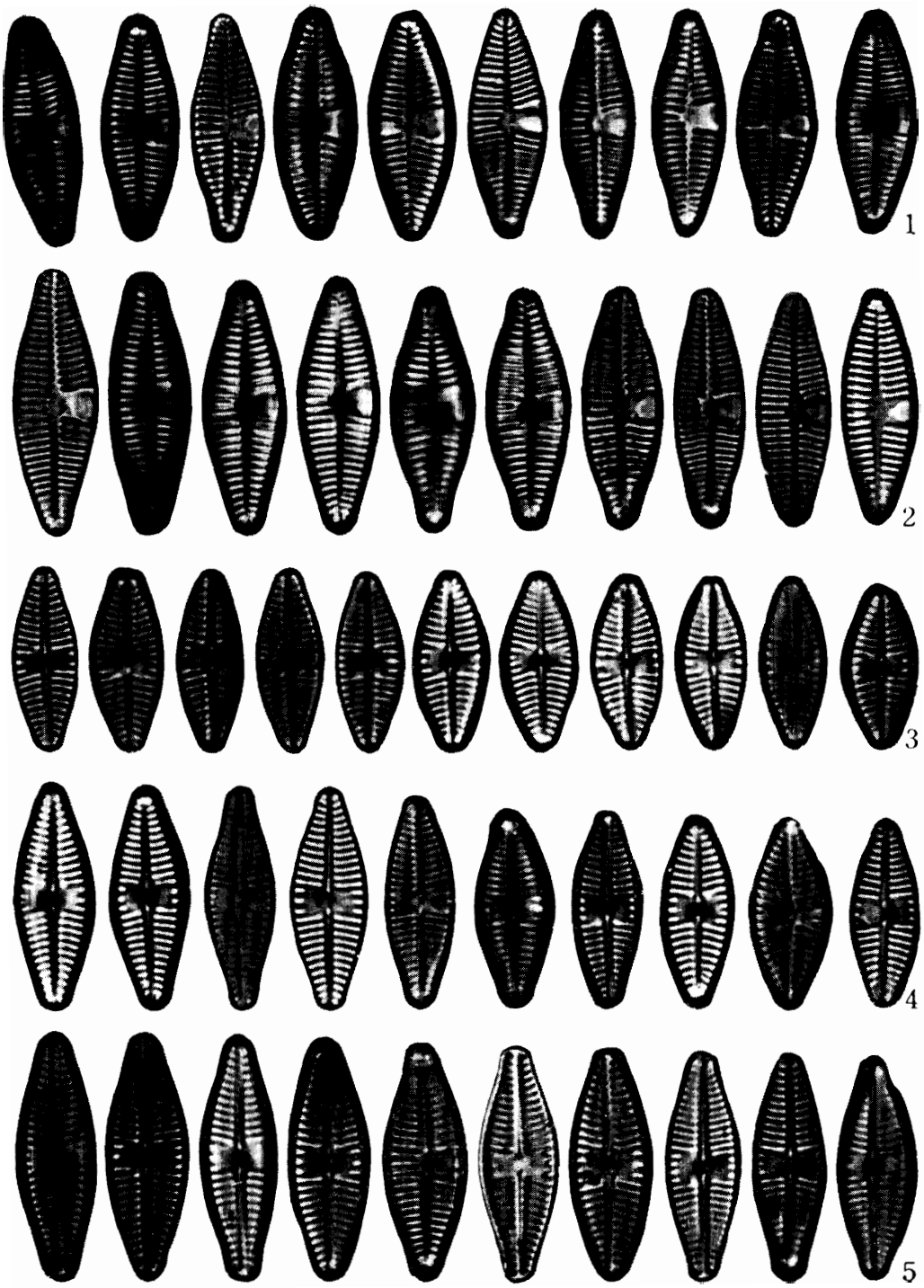

Plate 6. *Achnanthes lanceolata* (Bréb.) Grun. var. *dubia* Grun. (from South Georgia st. 1).

Pseudoraphate shells (1, 2), raphate shells (3-5).

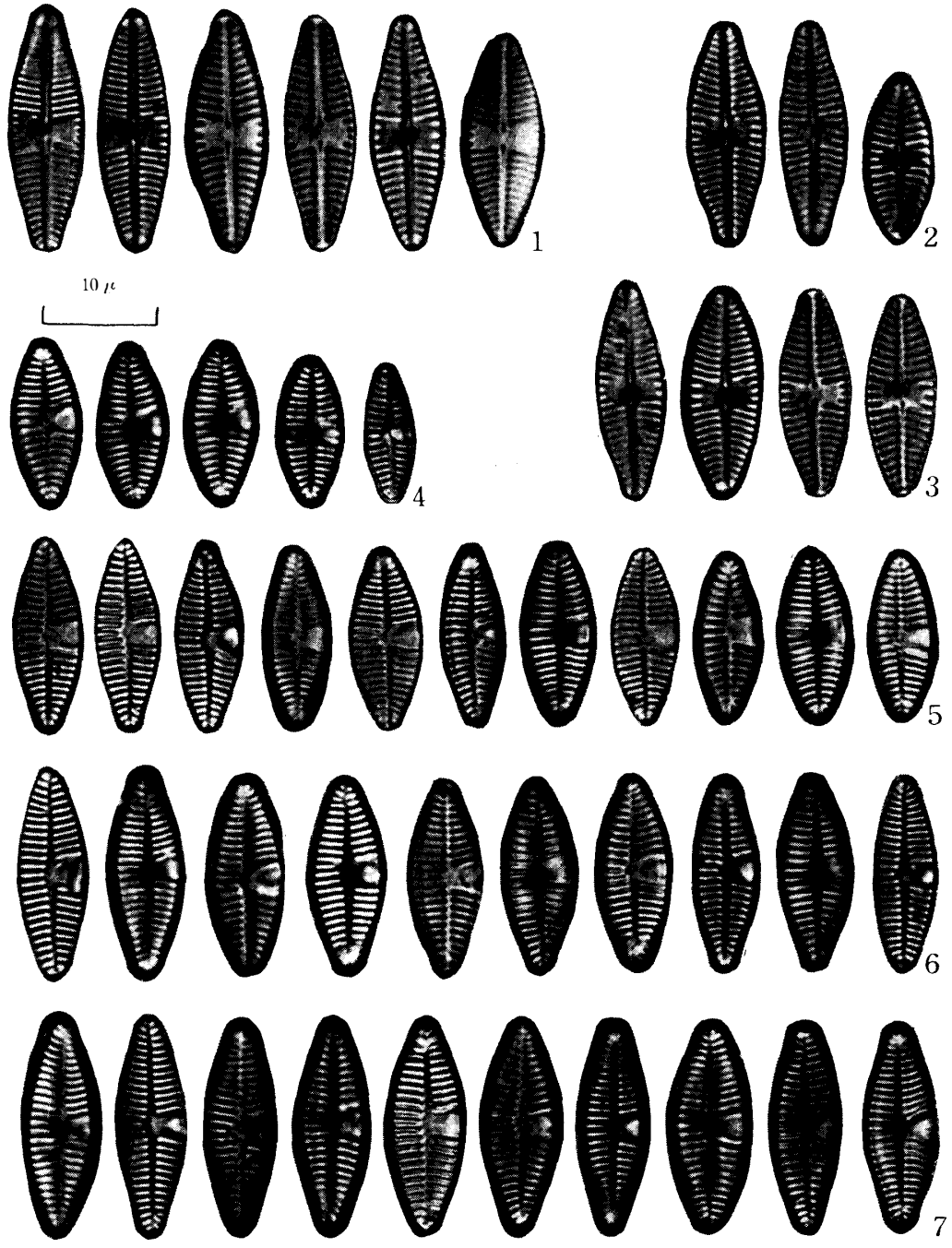

Plate 7. *Achnanthes lanceolata* (Bréb.) Grun. var. *dubia* Grun. (from South Georgia st. 1).

Raphate shells (1-3), pseudoraphate shells (4-7), individuals with rectangular central area (1), with elliptic central area (2), with medium size central area (3).

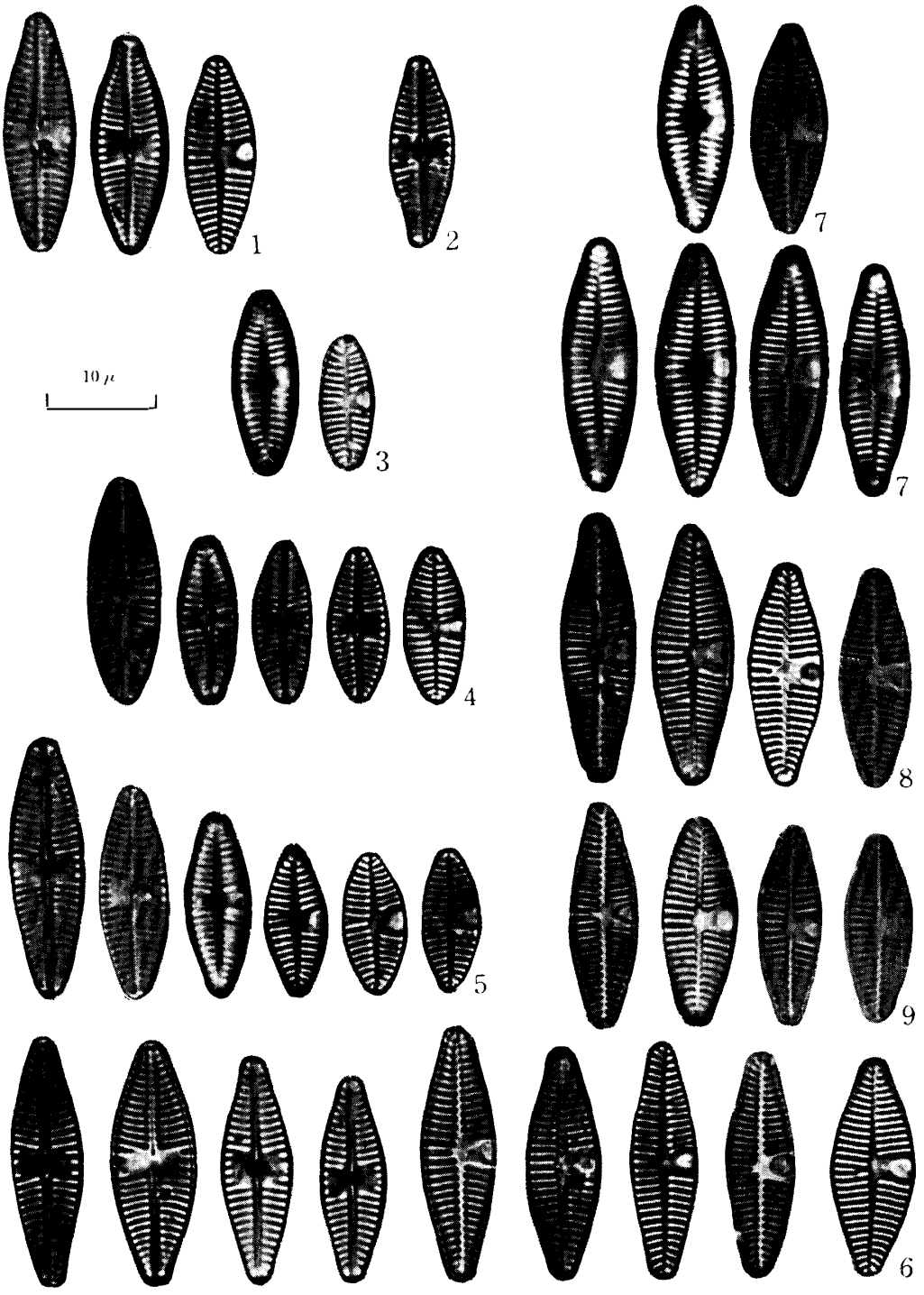

Plate 8. *Achnanthes lanceolata* (Bréb.) Grun. var. *dubia* Grun. (from South Georgia st. 1).

Malformed individuals with different formed cell ends (1). Malfromed individuals (2). Individuals with elliptic shell (3), with lanceolate shell (4), with little rostrate ends (5), with rostrate ends (6), with lanceolate pseudoraphe (7), with linear pseudoraphe and small round central area (8), with linear pseudoraphe and no central area (9).

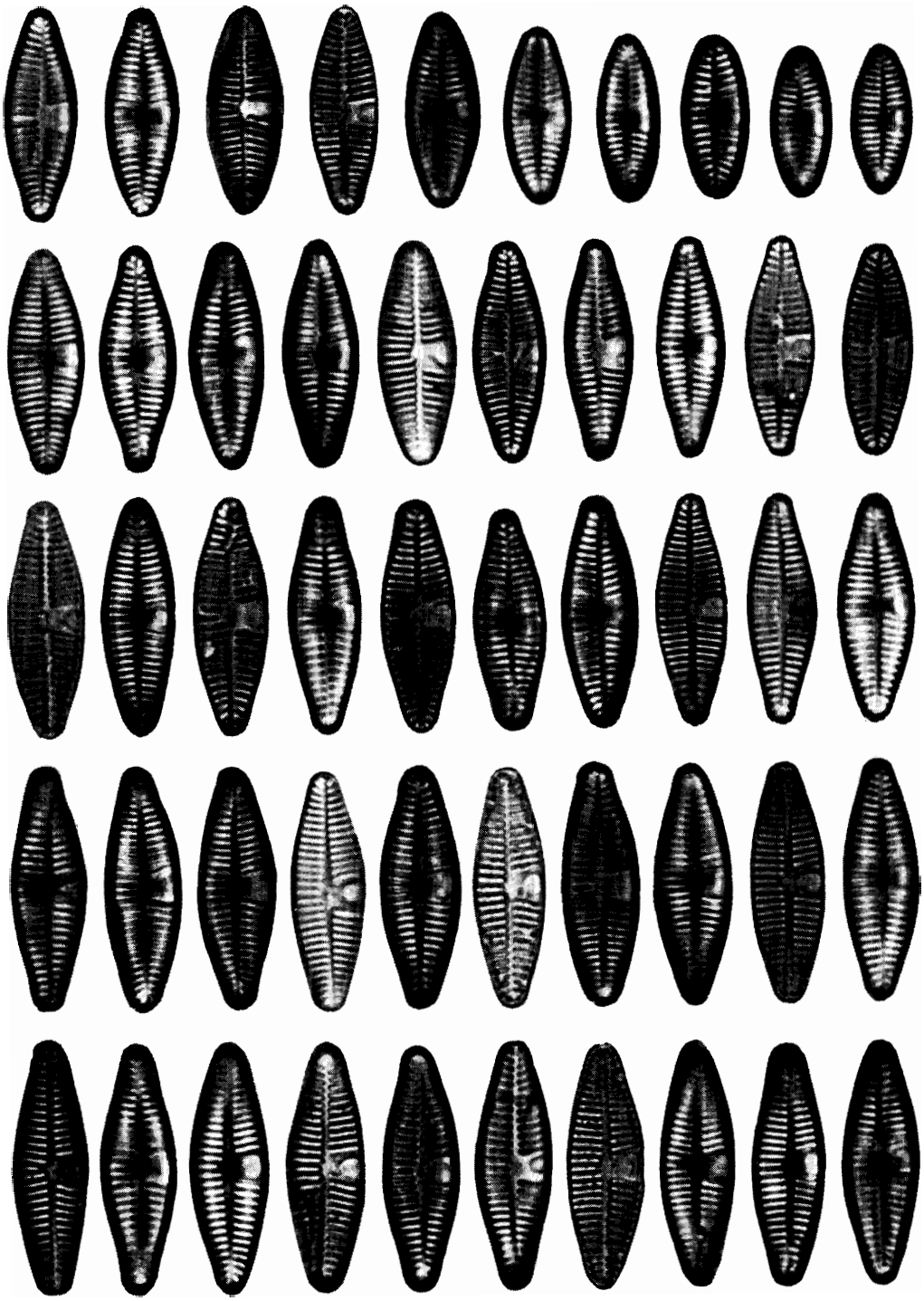

Plate 9. *Achnanthes lanceolata* (Bréb.) Grun. var. *dubia* Grun. (from South Georgia st. 2).

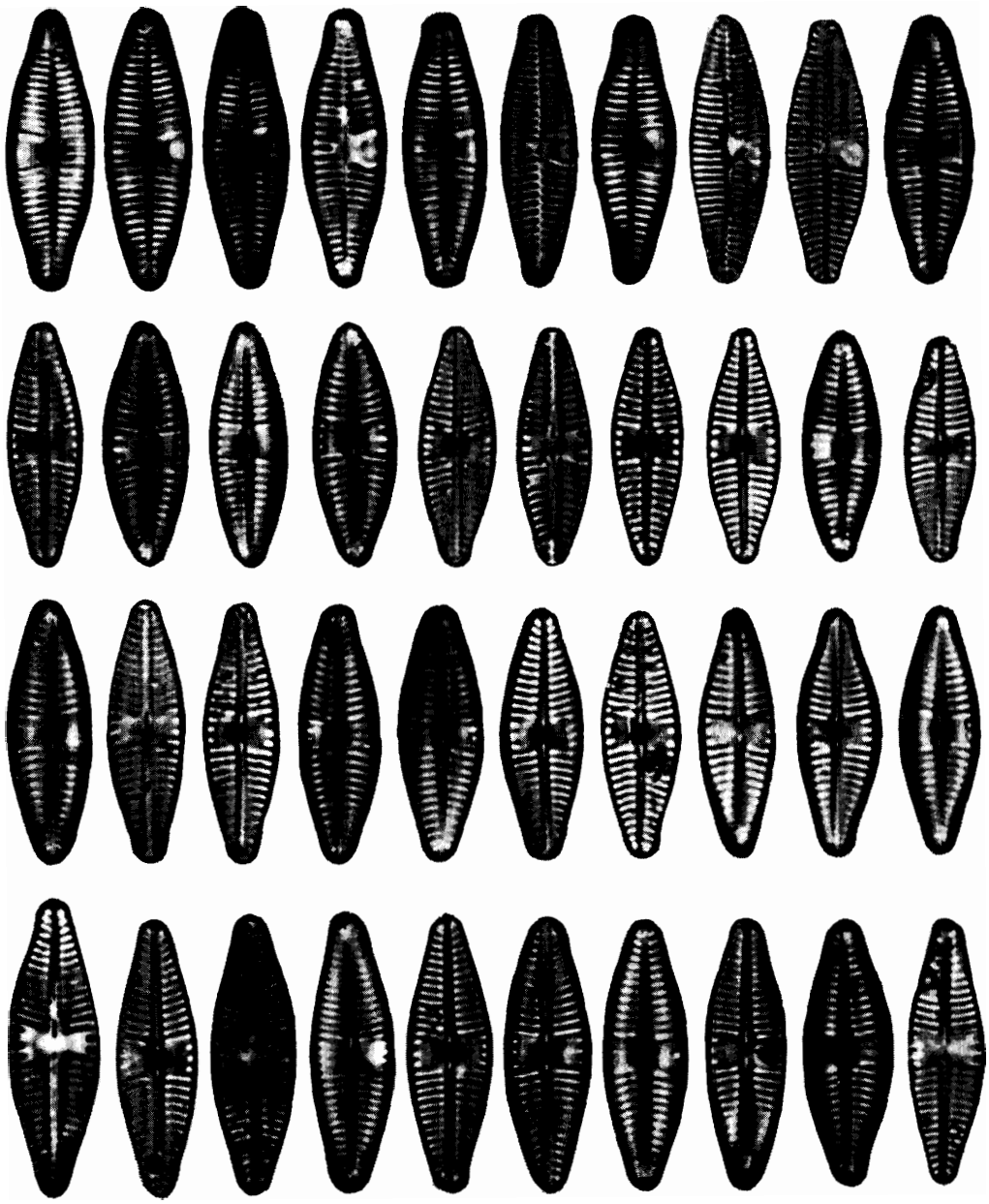

Plate 10. *Achnanthes lanceolata* (Bréb.) Grun. var. *dudia* Grun. (from South Georgia st. 2).

the lengths of the central part are not equal (pl. 7, fig. 2), so their central area is elliptical, not rectangular. However, since many individuals have intermediate shapes, it is better not to classify these individuals by the shape of the central area. Striae are radial. Pseudoraphe occur at the central part of pseudoraphate shells. This pseudoraphe is almost linear. Although most of the individuals are convex in a semicircular shape at one side of the central part (pl. 8, fig. 8), there are some individuals which were not extended (pl. 8, fig. 9) or were extended in a semilanceolate shape (pl. 8, fig. 7). At the central part of the other side of this extension, no striae are found and the central area is convex toward the margin. At this open part, there is a spot which refracted light in "U" shape. Striae are radial.

This species measures as follows: shell length 11-20 μ; width 4.5-7 μ; striae 12-14 in 10 μ.

Measurement of the materials of Station 1 of South Georgia follows: shell length 12-26 μ; width 4.5-7.5 μ; striae 12-16 in 10 μ at raphate shell, 12-16 in 10 μ at pseudoraphate shells, the same number as that of raphate shell.

Measurement of the materials of Station 2 of South Georgia follows: shell length 12.5-31.5 μ; width 5-8 μ; striae 11-15 in 10 μ at raphate shell, 12-16 in 10 μ at pseudoraphate shell, thicker than the raphate shell. During the examination, the writer found individuals larger than the existing records. There were no differences in shape, etc. between the materials of Station 1 and of Station 2.

The following is the description of this variety arranged by the writer based on this examination and the existing records:

Achnanthes lanceolata (Bréb.) Grun. var. *lanceolata* f. *dubia* (Grunow) Ko-Bayashi.

Shell elliptical, rostral, or rhombic lanceolate, ends extended in a rostral shape; points rather acute. Ends of some individuals are not extended, and these individuals are generally smaller.

Shell length 11-32 μ; width 4.5-8 μ; straight raphe at the central part of raphate shell, with narrow linear axial area. Central area is rectangular with longer transverse sides, and sometimes elliptical with longer transverse axial; striae radial and 11-16 in 10 μ.

Linear pseudoraphe at the pseudoraphate shells, some are not extended at one side even at the central part: some are semilanceolate and some others are semi-wide-lanceolate. The other side of pseudoraphe extended to the margin and refracted light strongly in "U" shape. Striae radial and 11-16 in 10 μ, thicker than those of the raphate shell.

VIII. VARIATIONS IN *CYMBELLA CISTULA* (HEMP.) GRUN.

Variations of this species collected from Ozegahara in the central part of Japan have been reported already. But, as this species was found in abundance among the materials collected by the Research Team of the Tokyo University of Fisheries headed by Captain Takeharu KUMAGORI, the writer investigated these materials once more. After treated with acid, the materials were mounted with pleurax for permanent slide preparation, then photomicrographs were taken at random and enlarged ×1,000 to examine their variations.

There were large variations in the external shape of these materials offered by Captain KUMAGORI, while almost no such variations were observed in the materials collected in Japan. There were many individuals having dorsal margins of various angles—some having strongly curved dorsal margins (pl. 14, fig. 1) and others having very slightly curved dorsal margins (pl. 14, fig. 2). Generally, small individuals had strongly curved dorsal margins.

The dorsal margins of most of the individuals were arc-shaped, but some individuals were curved in the shape of "<" (pl. 14, fig. 3). These two types may be divided into separate species; however, as there are also many intermediate types, we regard these types as the same species.

Raphe is also curved in the shape of "<" and the angle of curvature is also varied.

As regards the ventral margin, some individuals have a straight ventral margin (pl. 13, fiig. 4), but in most individuals the ventral margin is concave (pl. 13, figs. 1-2). The degree of concavity is various. The ventral margin of some individuals is straight at the central part (pl. 13, fig. 3) whereas most individuals have a strongly or slightly convex ventral margin (pl. 13, fig. 1). Generally, individuals with a straight ventral margin are smaller in size.

Variation of the shells of this species collected from South Georgia is greater than those collected from Oze. In Japan, larger and smaller individuals are found to be related to each other.

The axial area is narrow linear, but its width does not vary much. The central area is lanceolata elliptical, but its width is variable in many individuals. Striae are radial, consisting of many clear spots. Striae at the central part of ventral margins have 1-5 isolated points. Individuals having 2-3 isolated points are numerous, and those with 3 isolated point are the most abundant. This number is a little larger than that of the materials collected in Oze. Most of

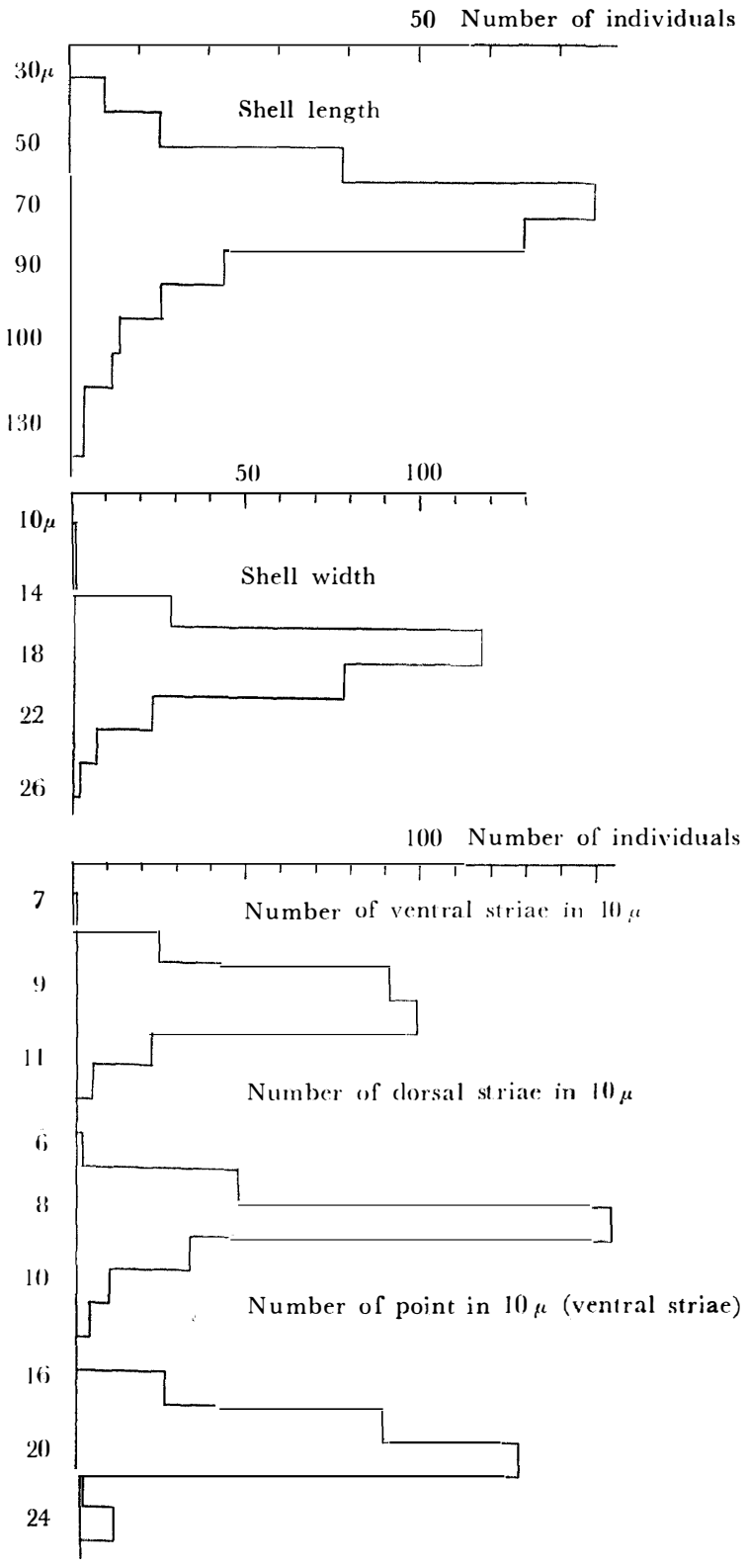

Fig. 3. Dimensions of *Cymbella cistula*.

the individuals from Oze have 1-4 isolated points, and those having 2 are the most abundant.

The individuals from Oze have long and short isolated points, and individuals having short isolated points only are not found. However, in the materials examined this time, most of the individuals have short isolated points only and long isolated points were very few.

The measurement of the materials examined this time is as follows: length 32-134 μ; width 10-25 μ; striae 7-12 in 10 μ on the ventral margin, 6-11 on the dorsal margin; spots constituting the striae at the ventral margin 16-24. Histogram of these values is shown in Fig. 3. The mode of each value is: length 60-69 μ; width 16-17 μ; striae 10 in 10 μ on the ventral margin, 8 on the dorsal margin, spots constituting the 20 striae.

The measured values are almost identical with those in the past records. The only difference is that smaller individuals were found. The ratio of shell length and width is 2.0: 7.1. Individuals of ratio 3.6: 4.1 are numerous, and ratio 3.9 was most common. As the ratio in the materials collected from Oze is 3.5-6.0, the materials examined this time show larger variation. Generally, individuals of longer shells are also wider.

MEISTER (1913) classified the individuals of shell width 3.5-26 μ into the following two species:

a. Shell lanceolate, attenuate from the central part to the end. Ratio of shell length and width 3.5-6

var. *typica* Meister

b. Shell parallel except at the central part. Ventral margins at the central part expanded. Ratio of shell length and width 6.1-7.5

var. *caldostagnensi* P. Prudent

Among the examined materials there are some individuals that ought to be classified as var. *caldostagnensi*, if the classification was based on the ratio of shell length and width. However, the writer considers it unreasonable to use the ratio of shell length and width for the classification of variaties, because there are many individuals resembling the typical type.

Based upon the descriptions by many investigators of the past and the results of the present examination, the writer gives the following description:

Cymbella cistula (Hemprich) Grunow var. *cistula*

Shells semicircular. Raphe slightly or strongly convex. Ventral margin sometimes straight but generally concave. In the latter case, sometimes straight at the central part or slightly convex. Shell length 32-180 μ, width 10-36 μ. Dorsal margin occurring at the central part of shell, axial area narrow linear, central area wide lanceolate, sometimes narrow and sometimes wide. Striae radial and consist of clear spots. Striae 7-12 in 10 μ at the central part of the ventral margin, 6-11 at the dorsal margin. Spots in striae 16-24 in 10 μ, isolated points at the ventral margin of the central area 1-5, in most cases 2-3.

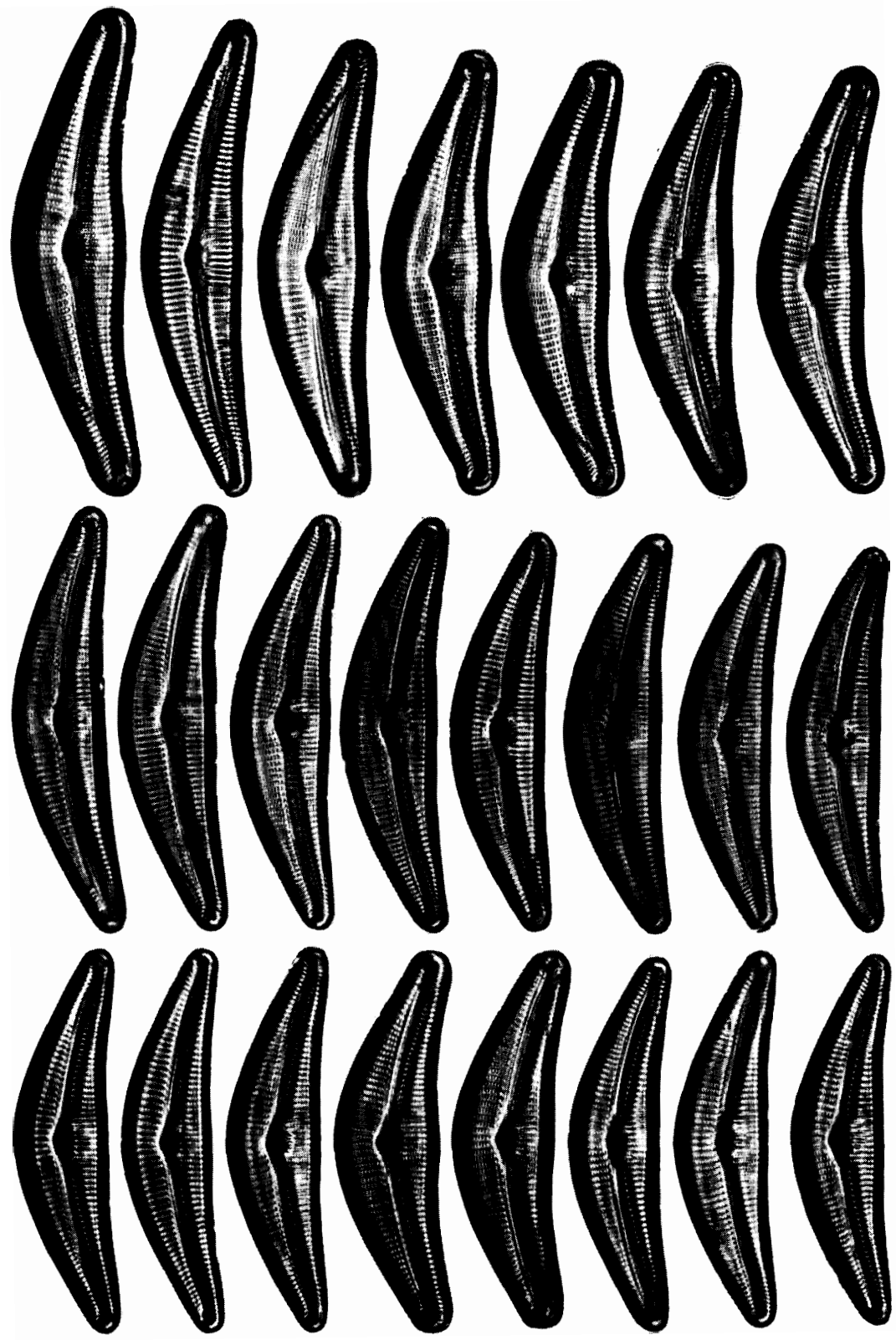

Plate 11. *Cymbella cistula* (Hemp.) Grun.

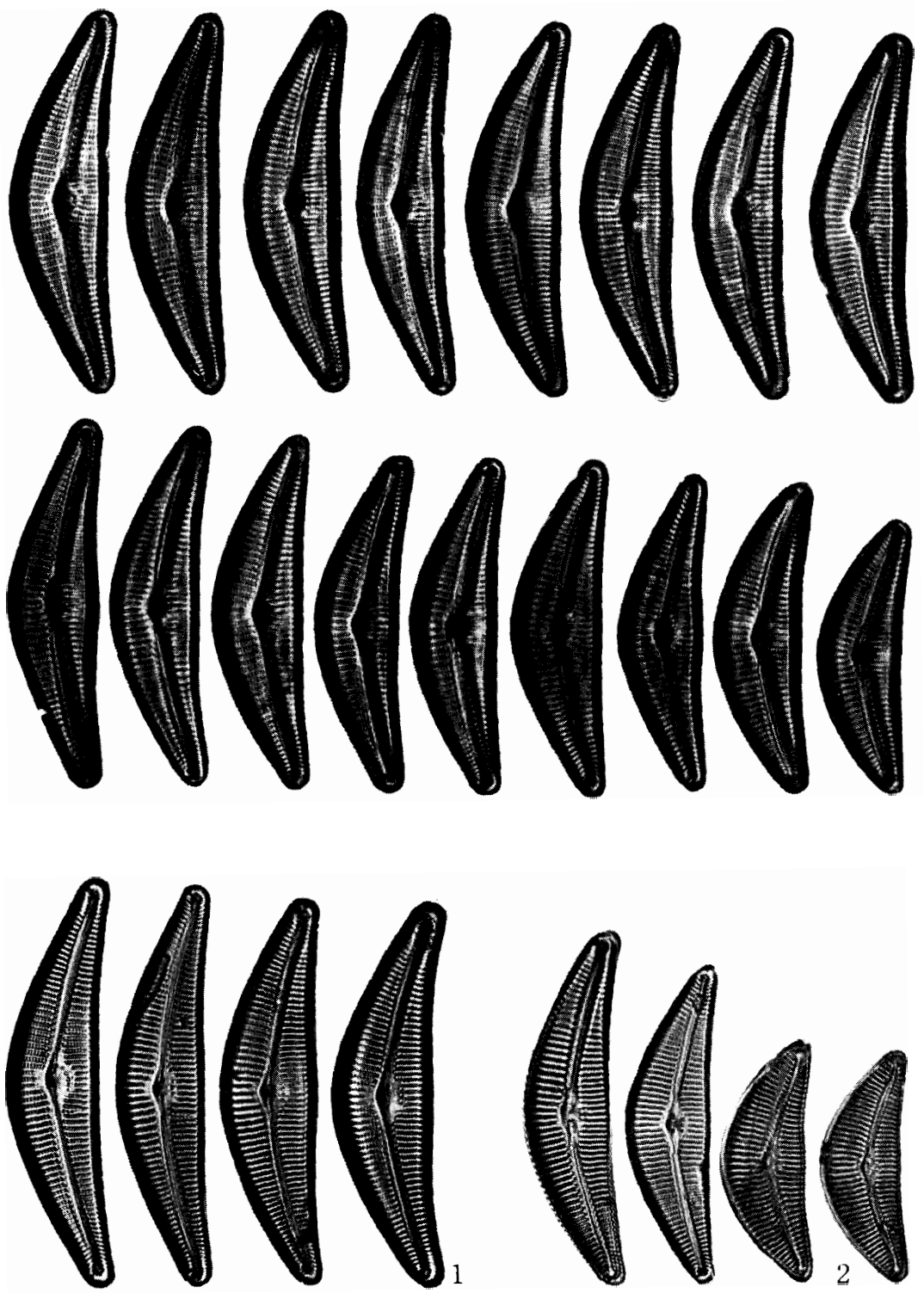

Plate 12. *Cymbella cistula* (Hemp.) Grun.
Individuals with large central area (1), with small central area (2).

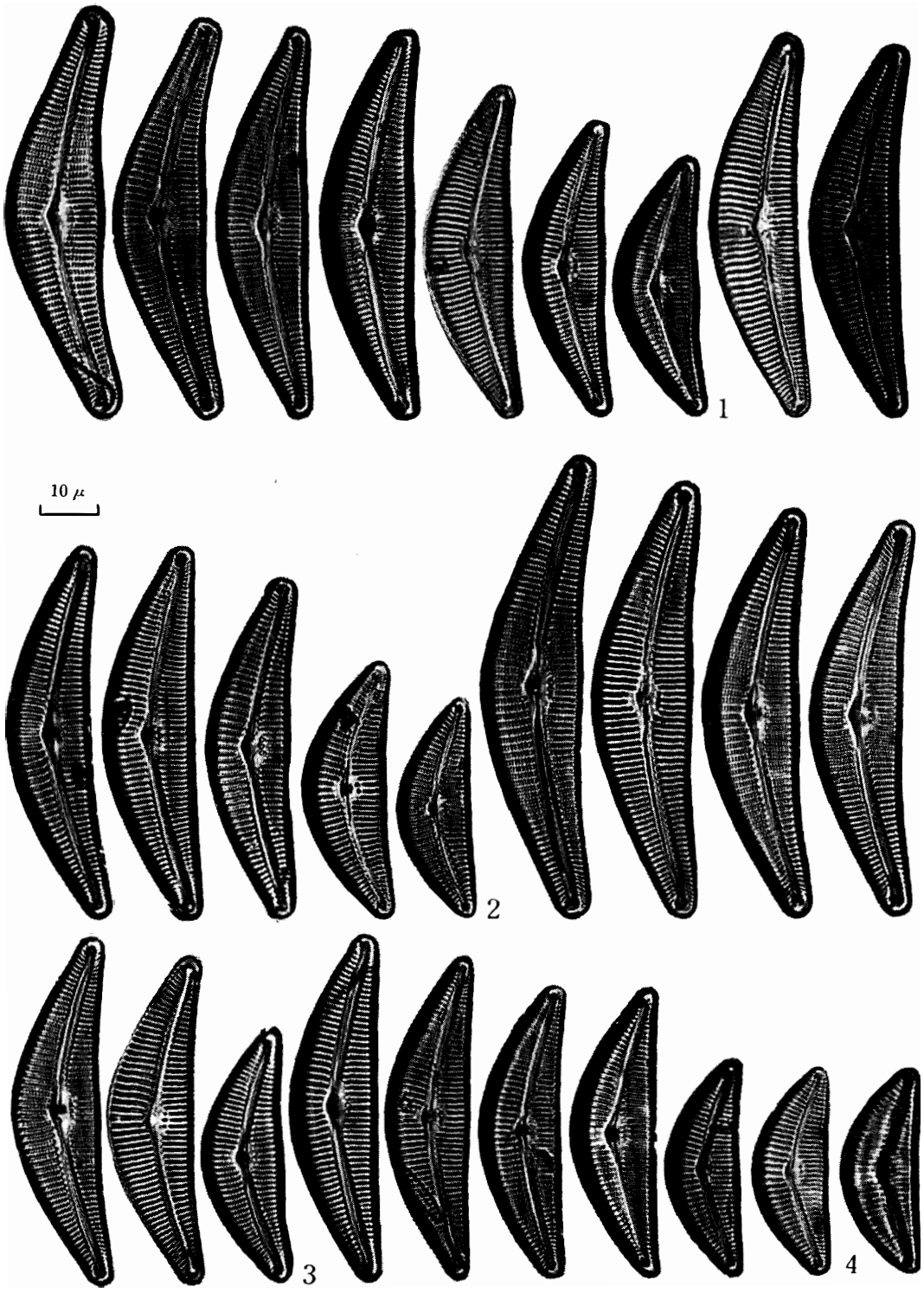

Plate 13. *Cymbella cistula* (Hemp.) Grun.

Individuals with stlongly convexed ventral margin (1), with concaved ventral margin (2), with straight middle part ventral margin (3), with straight ventral margin (4).

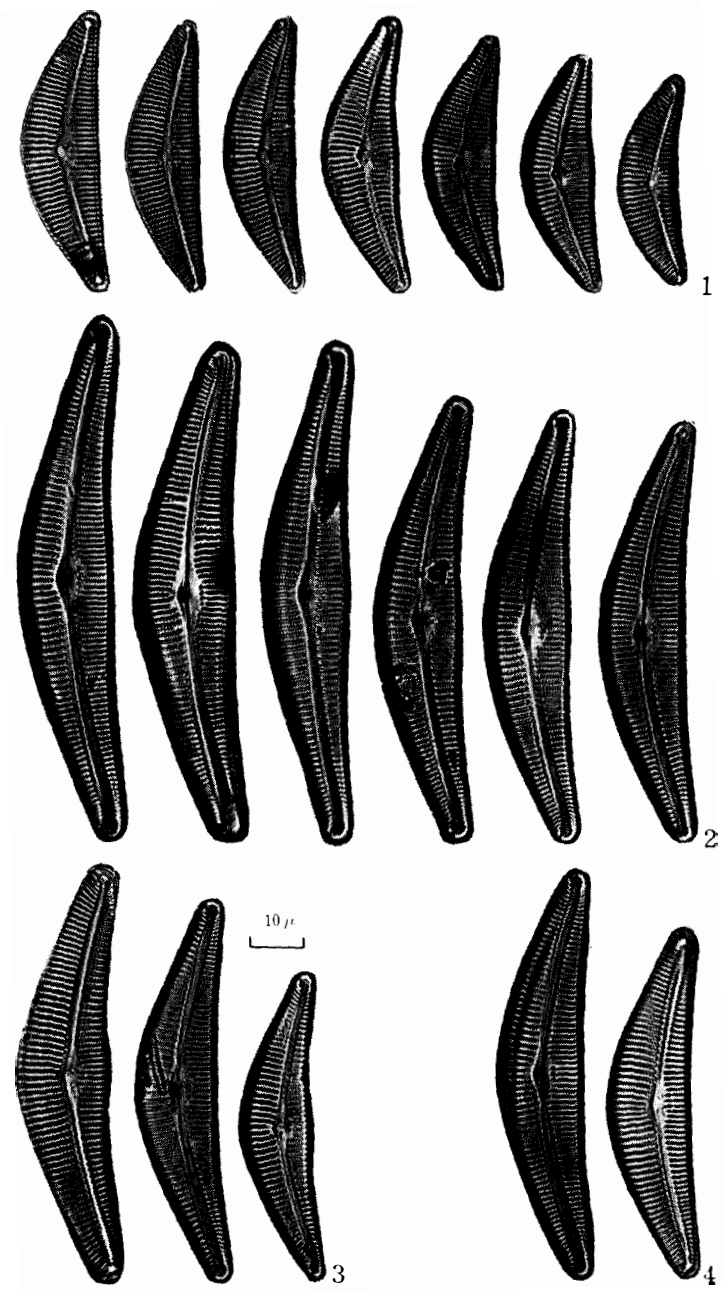

Plate 14. *Cymbella cistula* (Hemp.) Grun.

Individuals with strongly curved dorsal margin (1), with slightly curved dorsal margin (2), "<" shaped dorsal margin (3), with large isolated points (4).

IX. VARIATIONS IN *HANTZSCHIA AMPHIOXYS* (SHR.) GRUN. VAR. *RECTA* O. MÜLL.

Hantzschia amphioxys is the species distributed all over the world including Antarctica and is often found as a dominant species near the Syowa Base (FUKUSHIMA 1958). The writer studied the material collected by Dr. FUKUSHIMA from East Ongul Island in February, 1959. The writer treated this material with acid and mounted with pleurax and made permanent preparations. Photomicrographs were taken of 321 individuals of *Hantzschia amphioxys* at random to examine the variation.

The dorsal margins of the shells of some *Hantzschia amphioxys* in the above material are almost straight but others are rather concave. The latter was greater in number than the former one. Ventral margins of the shells of some individuals are almost straight, but in some others they are slightly concave. The number is nearly equal. Ends of all shells are protruded, and some are protruded in a rostral shape.

As *Hantzschia amphioxys* is generally classified into many varieties or forms, an attempt was made to determine to what variety or form these individuals belong. Investigations showed that the individuals with straight dorsal and ventral margins were similar to *Hantzschia amphioxys* (Ehr.) Grun. var. *recta* O. Müller*, but the individuals with straight dorsal margins but concave ventral margins, or the individuals with concave dorsal margins but straight ventral margins, or the individuals with concave dorsal but extended ventral margins, should be defined as *Hantzschia amphioxys* var. *recta*, since their protrusion was too variable in shape to be a criterion of classification.

Among the materials examined, the writer found a small quantity of typical var. *amphioxys* which had concave dorsal margins and extending ventral margins, and the individuals similar to *Hantzschia amphioxys* var. *linearis* (O. Müller) Cleve-Euler, having parallel dorsal margins and ventral margins slightly curved in the shape of "<", had rather long shells.

The number of striae in the individuals similar to *Hantzschia amphioxys* and

* M. PERAGALLO, who found individuals with such shells at Antarctica, classified them as *Hantzschia amphioxys* (Ehr.) Grun. var. *antarctica* M. Peragallo, but this is easily distinguished from the individuals of East Ongul Island which have 28–30 striae in 10 μ.

Table 1. The measurement of *Hantzschia amphioxys*.

Specific name	Author	Length μ	Width	Keels in 10 μ	Striae in 10 μ
a. a.	van Heurck (1885)	45–75		7	16
	De Toni (1891–2)	80	8–10	7	15–20
	Dippel (1904)	37–70	9–11	6–7	14–16
	Müller (1909)	42–62	8–10		
	Schönfeldt (1909)				
	Hustedt (1909)		4–5	7	14–20
	Meister (1913)				
	Boyer (1916)	60		8	16–18
	Boyer (1927)	60–80		8	16–18
	Hustedt (1930)	20–100	5–10	5–8	13–20
	Cleve-Euler (1955)	30–70	8–10	6–7	14–17
a. c.	Müller (1909)	33–56	6	8	20–22
l.	Müller (1909)	143–172	10–12	8	14

a. a.: *Hantzschia amphioxys* var. *amphioxys* f. *amphioxys* a. c.: *H. a.* v. *amphioxys* f. *capitata*
l.: *H. a.* v. *linearis*

Hantzschia amphioxys var. *linearis* was 18–23 in 10 μ. (20–22 were the most common).

Table 1 shows the measurement of these two varieties based on the existing records. The individuals of the East Ongul Island were different from the above two in their measurements, but similar to HUSTEDT's description. It is necessary to investigate further the measurement of var. *amphioxys* and var. *linearis* in detail, and it is not known yet whether var. *amphioxys* type individuals and var. *linearis* type individuals are to be classified as var. *amphioxys* and var. *linearis*. However, it is a fact that among the strains of *Hantzschia amphioxys* var. *recta* of East Ongul Island, individuals of var. *amphioxys* type or var. *linearis* type were found, though small in number. The writer will decide whether or not these individuals are to be regarded as fluctuations of var. *recta* after other strains have been fully examined. Here, types of var. *amphioxys* and var. *linearis* have not been referred to.

Among the materials examined this time, there were some small individuals with the capitate ends curved like bow, while these individuals were similar to the forma described as *Hantzschia amphioxys* f. *capitata* O. Müll., J. Pantocsec (1902) as already the name of capitata has been used as a variety in her "Resultate des Balatonsees I. Section Anhang die Bacillarien des Balatonsees", it is not proper to use a name both for a variety and for a form. Therefore, the writer would change the form which O. MÜLLER named forma *capitata* into the following nomenclature:

Hantzschia amphioxys (Ehr.) Grun. var. *amphioxys* f. *müilleri* Ko-Bayashi nom.

nov.

Synonym—Hantzschia amphioxys (Ehr.) Grun. f. capitata O. Müller, in Bot. Jahrb. **43** (4): 34, pl. 2, f. 26 (1909).

This forma is generally small, as is clear in the histogram of Fig. 4. In the histogram of the shell length of *Hantzschia amphioxys* of East Ongul Island there are two modes—one between 40 and 45 μ and the other between 80 and 85 μ. The former is mainly of the forma *capitata* type and the latter is mainly of the var. *recta* type. According to the illustrations or this hystogram, the forma *capitata* type individuals may be defined as unrelated ones. However, this is out of the question, since the writer recognizes the capitata type individuals as a forma *capitata.*

The shapes of the individuals collected from East Ongul Island are illustrated (pl. 15). The arrow indicates that these shapes are related to many intermediate ones and the dotted arrow indicates that the shapes seem to be unrelated to many intermediate ones but some relationship may be found in future studies. In other words, there are individuals ranging in shape between *Hantzschia amphioxys* var. *recta* type and var. *amphioxys* type and *linearis* type, but a certain relation will be found in future between f. *capitata* type individuals and many intermediate individuals. In addition, the writer found some malformed individuals with two ends protruded differently.

Based on the observation of this variety at East Ongul Island and the existing descriptions, the writer describes as follows:

Hantzschia amphioxys (Ehr.) Grunow var. *recta* O. Müller, in Bot. Jahrb. **43** (4): 34, pl. 2, f. 26 (1909), Cleve-Euler, in K. V. A. Handl. **3** (3): 51 (1952).

Shell rhombic, ventral margin and dorsal margin both straight, or slightly concave. Margins generally straight, but sometimes slightly convex like a bow. Both ends extended in a rostral shape. Length 20-120 μ, width 3-11 μ. Number of kiel 4-10 in 10 μ, with wide interval at the central part. Striae consist of delicate lines, number 18-25 in 10 μ.

Size of *Hantzschia amphioxys* (Ehr.) Grun. var. *recta*

According to the records up to the present, length of this species is 20-49 μ; width 3-8 μ; kiel 8-9 in 10 μ; and striae 20-25 in 10 μ.

On the other hand, length of the materials of East Ongul Island is 60-120 μ, longer than that in the above records. Individuals of 75-90 μ length are most numerous, and the mode is 80-85 μ. Width is 8-11 μ, also broader than that in the records, and individnals of 9 μ width are most numerous.

Number of kiel in 10 μ is 4-10, 5-7 being the most common. Individuals coarser than the existing records are also found.

Number of striae in 10 μ is 18-23, 19-21 being the most common. Mode is 20. Individual coarser than those of the existing records are found.

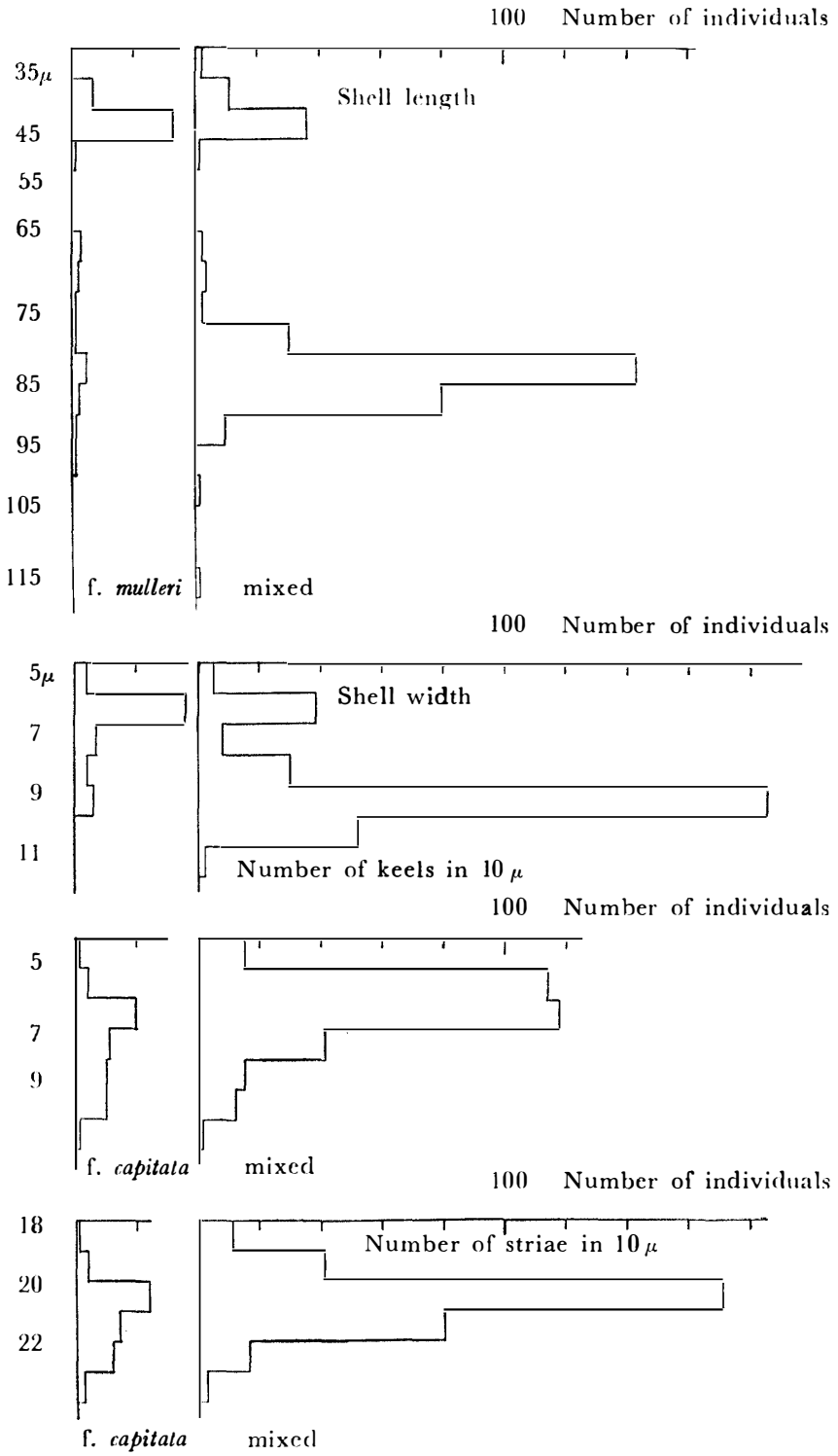

Fig. 4. Dimensions of *Hantzschia amphioxys*.

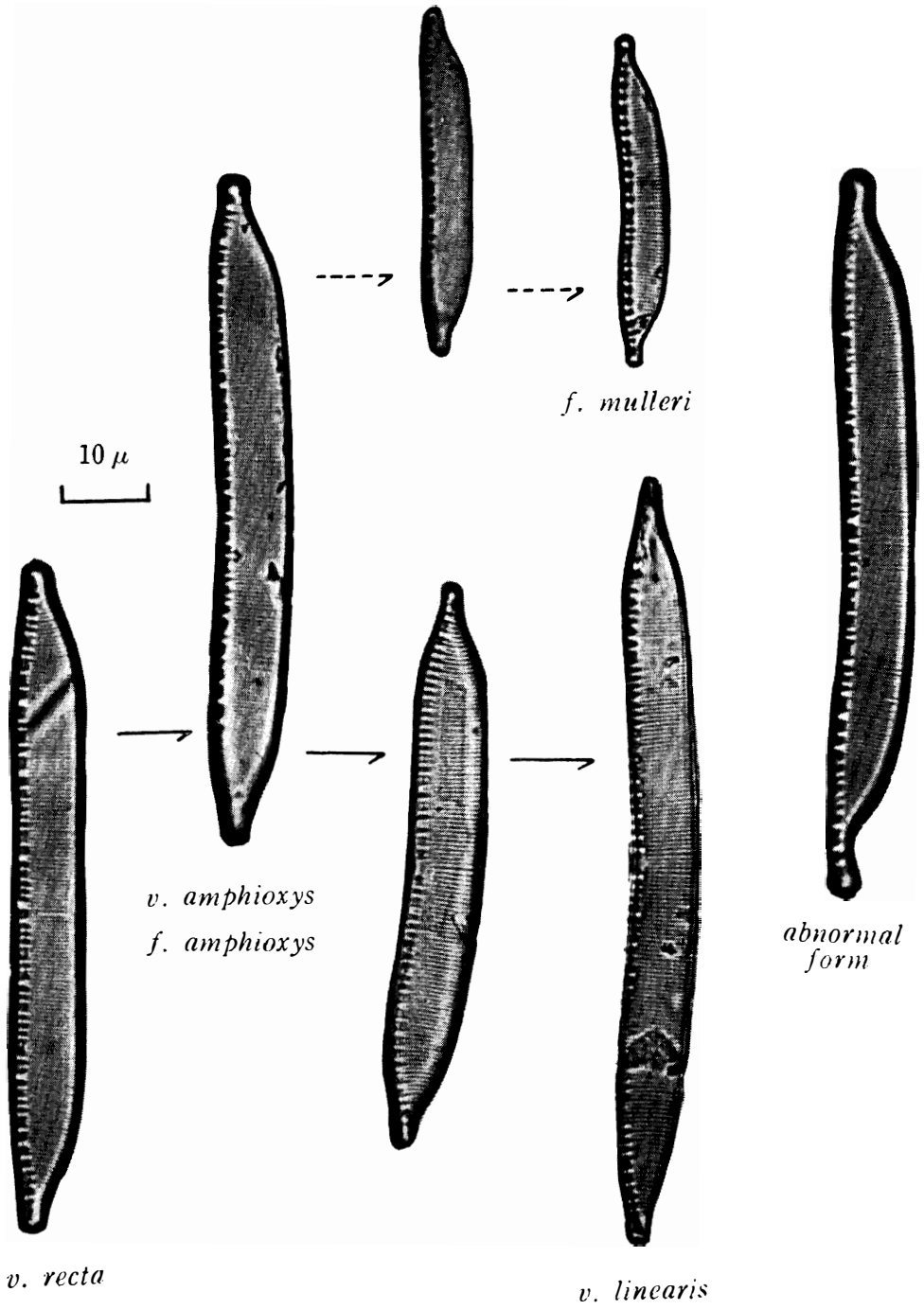

Plate 15. *Hantzschia amphioxys* (Ehr.) Grun.

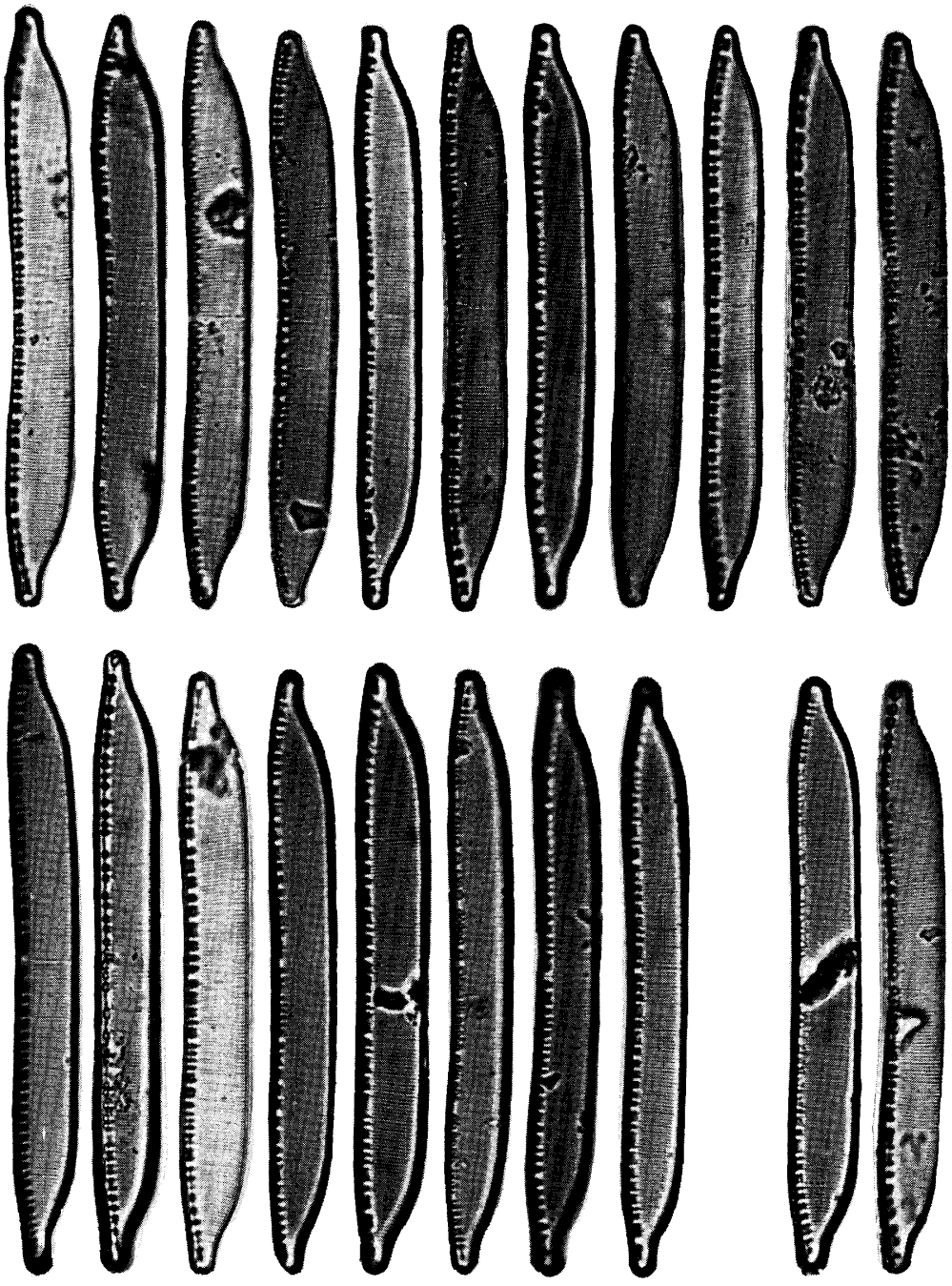

Plate 16. *Hantzschia amphioxys* (Ehr.) Grun. var. *recta* O. Müll.

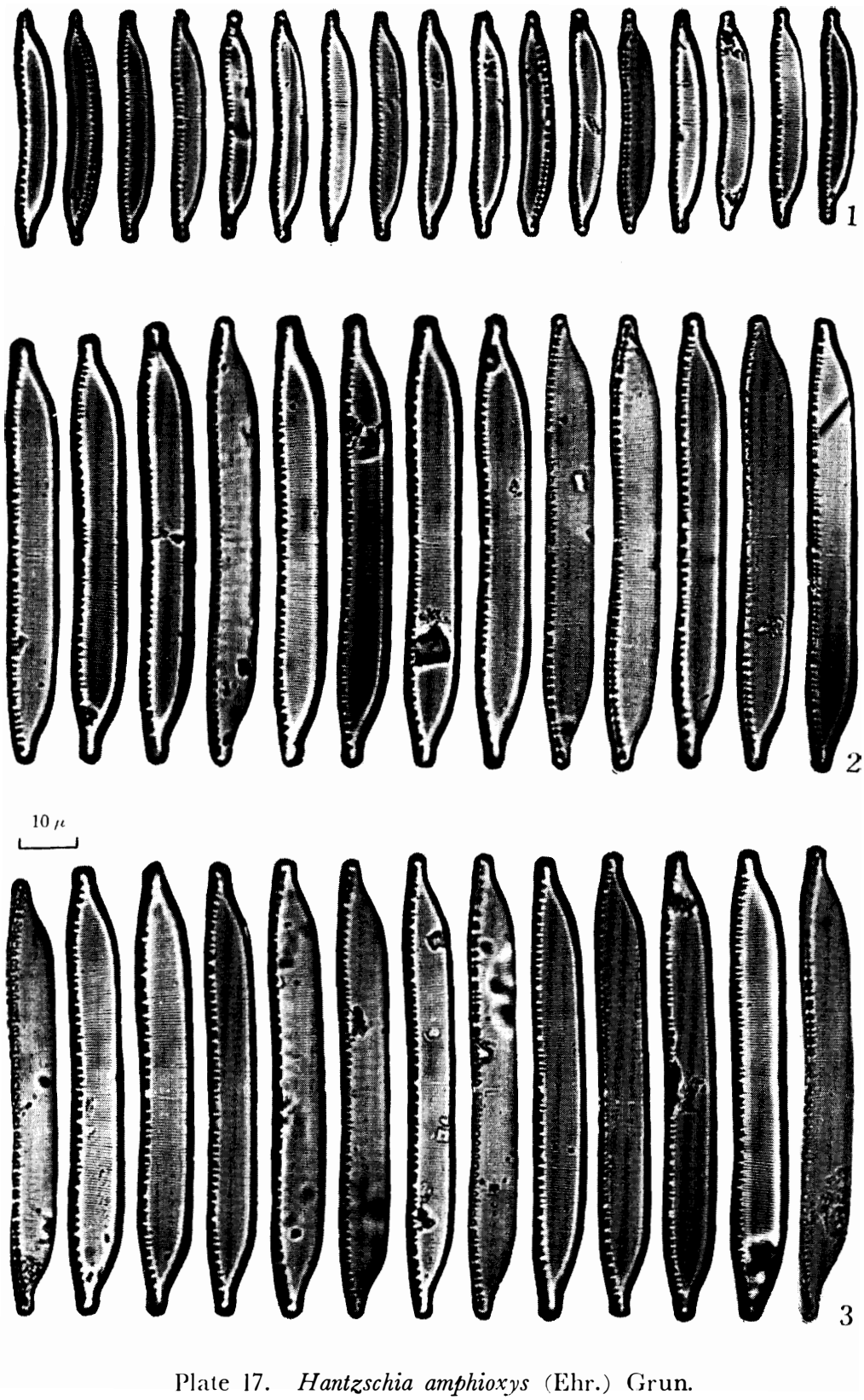

Plate 17. *Hantzschia amphioxys* (Ehr.) Grun.
Var. *amphioxys* f. mulleri Ko-Bayashi (1), var. *recta* O. Müll (2, 3).

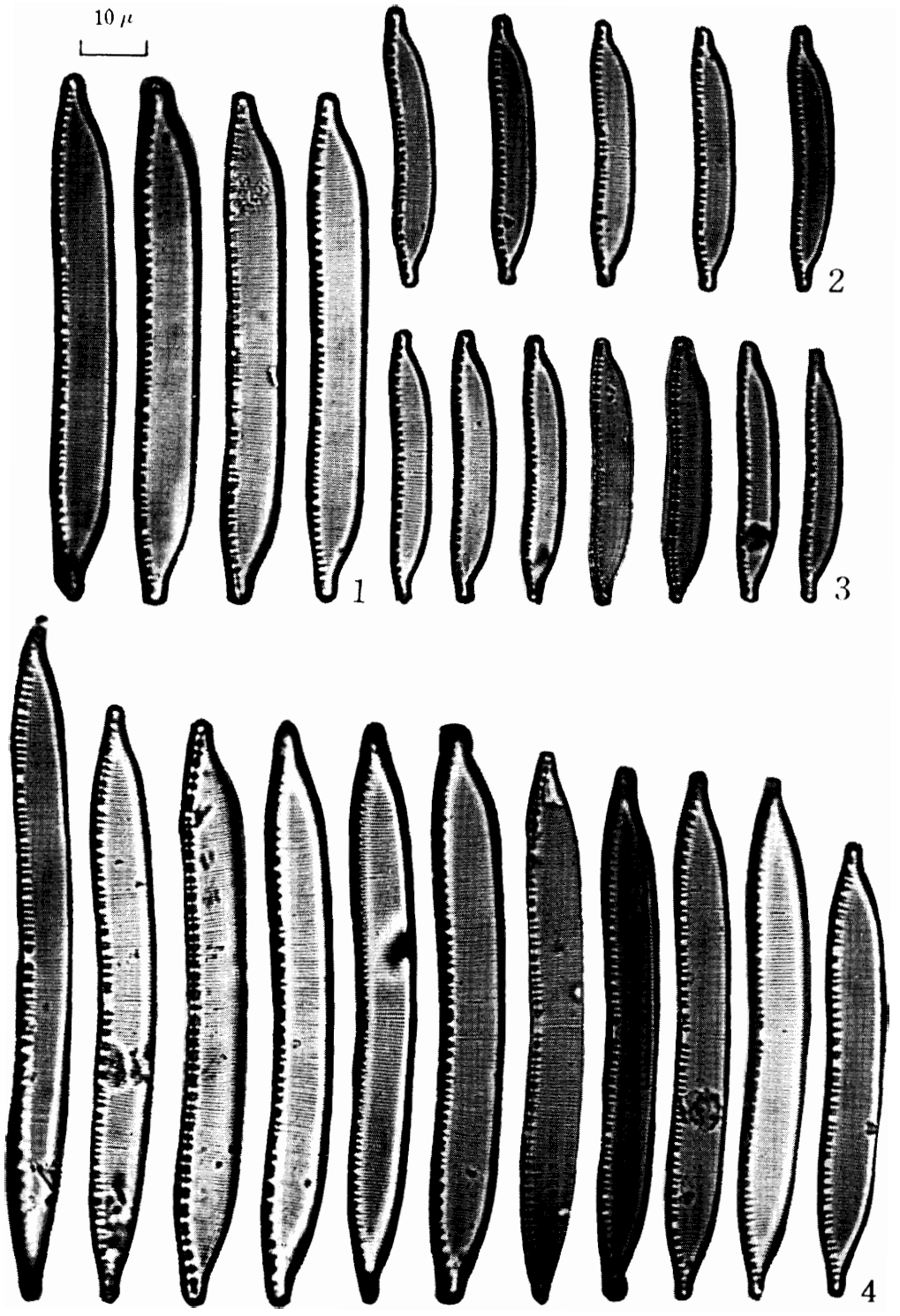

Plate 18. *Hantzschia amphioxys* (Ehr.) Grun.
Var. *recta* O. Müll (1), var. *amphioxys* f. mulleri Ko-Bayashi (2, 3), var. *linearis* (O. Müll.) Cleve (4).

X. VARIATIONS IN *NAVICULA CRYPTOCEPHALA* KÜTZ.

The materials used for this study were collected from the ice free area called the Kasumi Iwa (67° 57′ S, 47° 29′ E), on the Prince Olav Coast by Dr. FUKUSHIMA during the 5th Japanese Antarctic Research Expedition.

The variation of the present species was examined on photomicrographs of 358 individuals enlarged 2,000 times. These materials were made into permanent preparations after acid treatment. Some of these photomicrographs are shown in Plates 19-20.

In the ice free area of Antarctica, the so called Kasumi Iwa has many hollows filled with water. It was observed by Dr. FUKUSHIMA that among these ponds, the ones situated near the coast, as far as 15 m above sea level, contained a good deal of salt and that the hydrogen sulphide contents of these ponds was so high that the bottom was black.

Pennate diatom *Navicula cryptocephala* was propagated in a large quantity on the bottom of the ponds that contained salt. It was one of the dominant species in most of the ponds.

Systematic position

Shapes of the present species which were found mixed in the materials collected from the so called Kasumi Iwa are as follows:

Shell lanceolate, the ends protruded in a slighty rostrate shape. The length of the shell 16-32 μ, the width 5-8 μ. Axial area narrow and linear. Central area elliptical. Striae radiate in the middle, convergent at the ends of the shell. Most of the central striae alternate lengthwise, long and short. The present writer observed that the central striae, in some cases, alternate only on one side of the shell, but in other cases they were not so. Striae number 17-22 in 10 μ. If we take into consideration the fact that the central striae are alternately long and short, the diatom from the Kasumi Iwa is to be identified as *Navicula cryptocephala* var. *intermedia.*

As regards *Navicula cryptocephala* var. *intermedia,* some workers treat it as a taxa of *Navicula cryptocephala,* while others as a taxa of *Navicula salinarum.*

Navicula cryptocephala Kütz. var. *intermedia* Grun., in van Heurck, Synop. Diat. Belg., pl. 8, f. 10 (1880); Treat, Diat. 180 (1896); Hustedt, Bacill. 295, f.

497 (1930); Mills, Index, Diat. 1017 (1934); Hustedt, in Arch. f. Hydrob. Supp. **15**: 261 (1938), in Expl. Parc. Nat Alb. 8; 92 (1949).

Navicula salinarum Grun. var. *intermedia* (Grun.) Cleve, in Nav. Diat **2**: 19 (1895); Ø strup, Danske Diat. 83 (1910); Meister, Kieselal. Schw. 142, pl. 21, f. 22 (1913); Mills, Index, Diat. 1141 (1934); Cleve-Euler, in K. V. A. Handl, **4** (5): 159 (1953).

Navicula salinarum and *Navicula cryptocephala* are much alike, but they can be distinguished by the fact that the striae of the former are arranged medianly alternate long and short but in the latter they are not so. As regards the width of the shell in the former the shell is a little wider than that of the latter.

The reason why the present species is considered a taxa of *Navicula salinarum* may be explained by that great importance was attached to the nature of alternation of the central striae in their length. A careful study of the photomicrographs of the materials from the Antarctic reveals that there are many kinds of striae arrangement as follows: central striae alternation on both sides of the raphe, the one on one side of the raphe, or no alternation on either side. Alternation is clear in some specimens but not clear in others. Judging from the fact that the individuals with alternating striae on one side of the raphe were abundantly found, the nature of this median striae alternation in this does not seem stable.

The width of the shell of *Navicula salinarum* and its taxon (excluding var. *intermedia*) has been hitherto reported as 7-12 μ. The width of the shells of var. *intermedia* examined this time is 5-8 μ. Considering the width of the shell, the present writer thinks it improper to include this taxa var. *intermedia* in *Navicula salinarum*. Besides, the valvar width of the present taxa is quite similar in nature to *Navicula cryptocephala*.

From the above, var. *intermedia* is apparently an intermediate form between *Navicula salinarum* and *Navicual cryptocephala*. However, the writer regards the present specimen as *Navicula cryptocephala* var. *intermedia*, taking of the feature of the valvar width as important and neglecting the unstable nature of striae alternation in the middle part of the shell.

But the present writer thinks it improper to decide the position of different varieties on the basis of the nature of striae, because the nature of the alternation of long and short median striae is unstable as mentioned above. *Navicula cryptocephala* var. *intermedia* should be treated as a synonym of *Navicula cryptocephala* var. *cryptocephala*.

Variation

As regards the materials examined this time, shells lanceolata, with ends protruded somewhat rostrately. Examining the photomicrographs taken this time, the present writer found that the nature of valvar shape of this species is stable and no variation of valvar shape is observed. It requires further study to find out if the absence of variation valvar shape is characteristic to the Antarctic specimens.

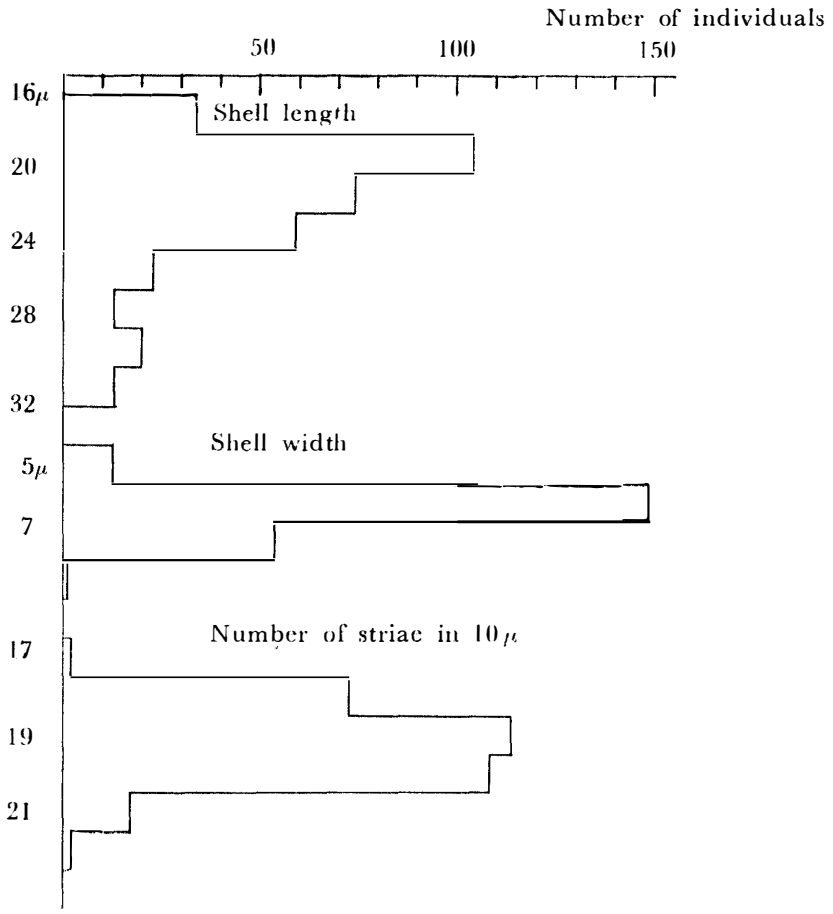

Fig. 5. Dimensions of *Navicula cryptocephala* v. *intermedia*.

Length of shells of the present species 16-32 μ. According to the past papers, length of shells 20-40 μ. So the materials examined this time are smaller than ordinary ones.

The histogram of the length is shown in Fig. 5. Specimens of 18-23 μ length were numerous. Among the rest, those of 18-20 μ in length were many.

Valvar width of the present species 5-8 μ, almost the same as that of the ordinary species which have 5-8 μ width. The histogram is shown in Fig. 5. Specimens of 6 or 7 μ in width were predominant.

Length of shells of this species is 16-32 μ, and width is mostly 6 or 7 μ. From this fact, it is supposed that this species becomes shorter but does not vary in width in spite of cell division. According to the records, striae in 10 μ of the typical species are 16-18. Striae of *Navicula cryptocephala* vary with varieties. For example, var. *exilis* has about 19 striae and var. *veneta* 14-16. Among the materials examined this time, the number ranges from 17 to 22. There were some individuals which had many striae. Histogram is shown in Fig. 5. Most of the individuals have 18-20 striae. The individuals with 19 striae were most numerous, and this number is larger than that in the previous records.

Striae at the central part are, as described before, of almost the same length,

long and short alternately, or long and short alternately on one side, thus being non-uniform at central part.

There was no malformation on the exterior of shells or in the striae of the materials examined.

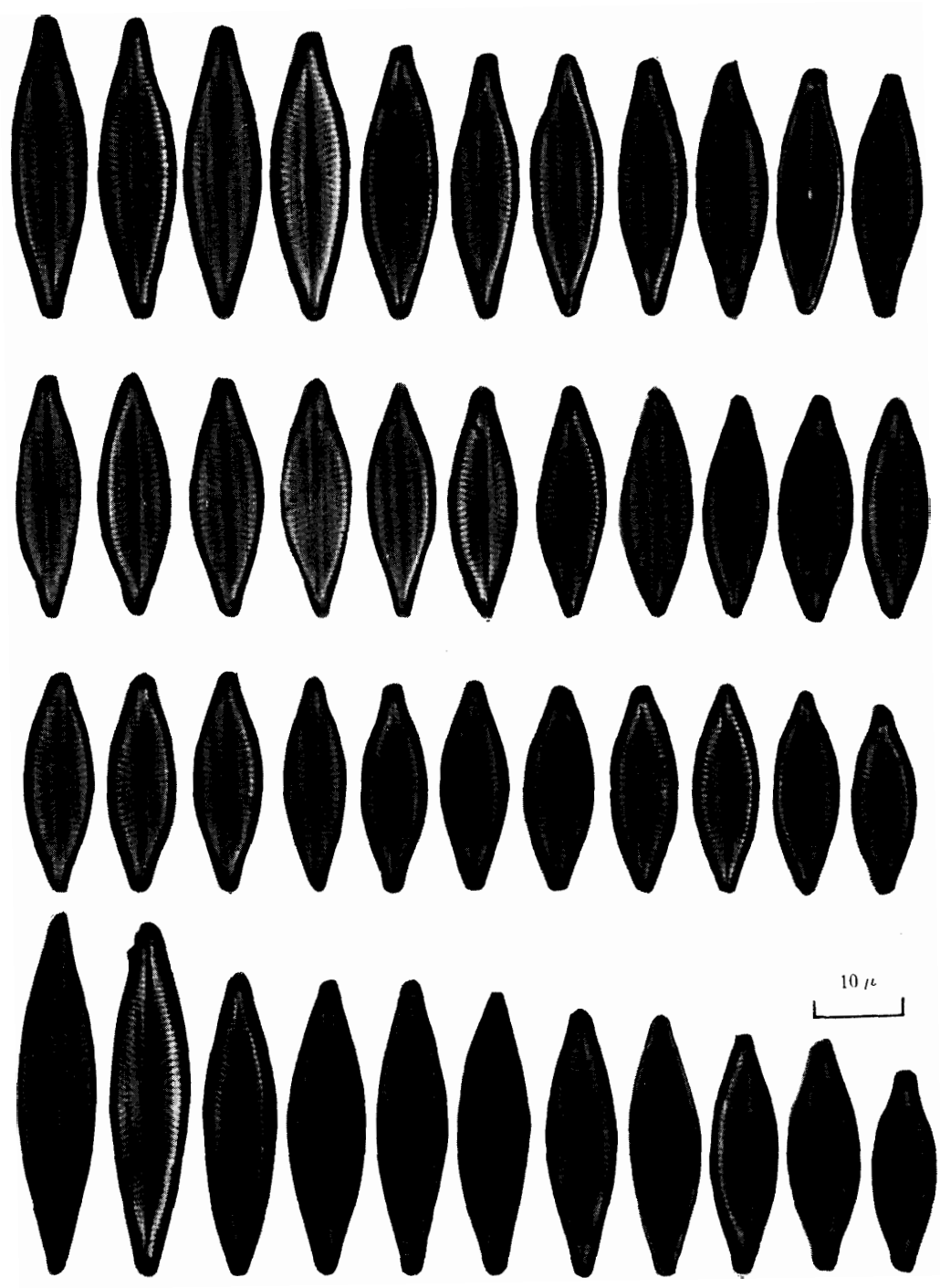

Plate 19. *Navicula cryptocephala* Kütz.

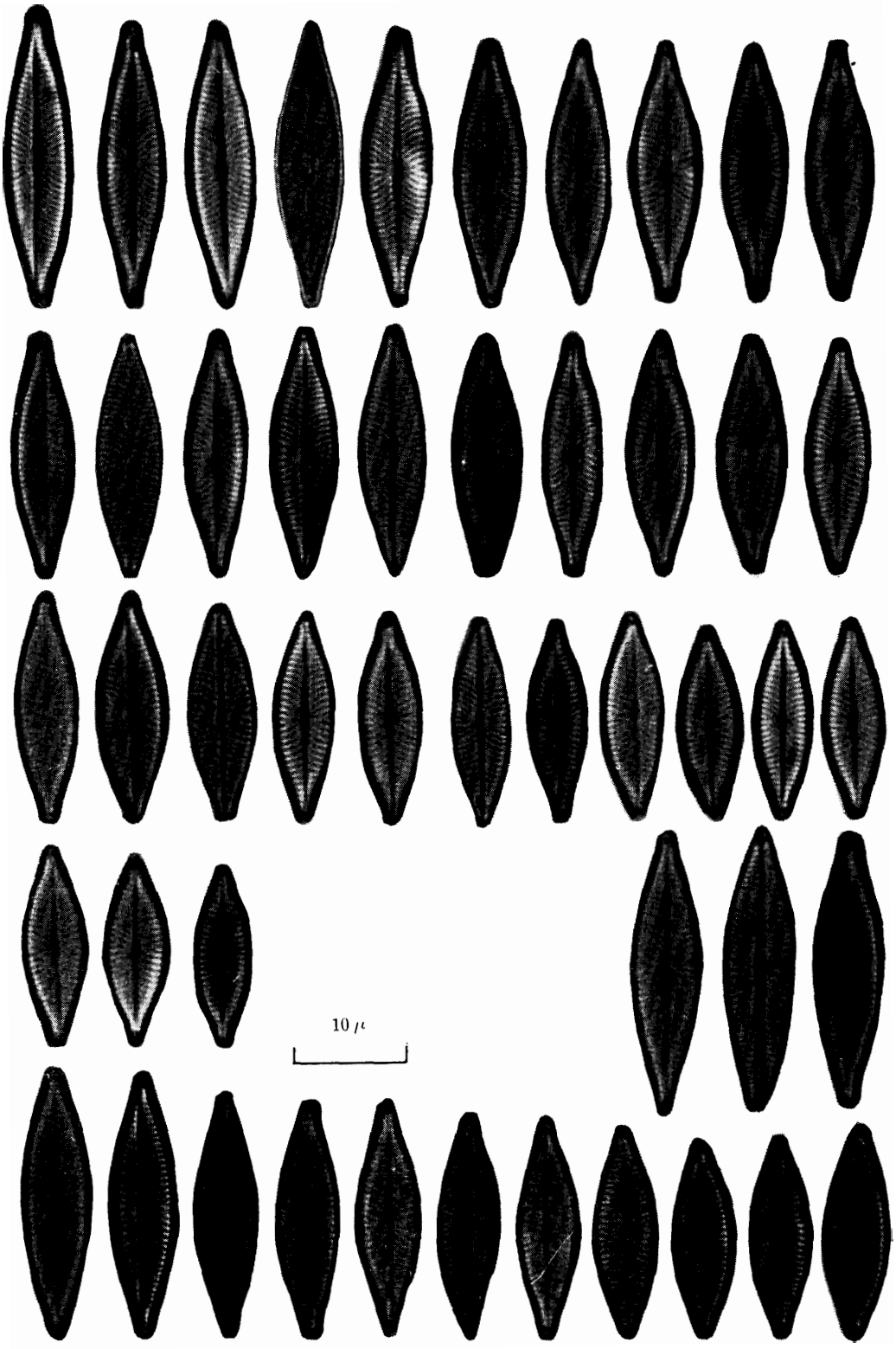

Plate 20. *Navicula cryptocephala* Kütz.

XI. VARIATIONS IN *NAVICULA MOLESTA* KRASSKE

Dr. FUKUSHIMA collected this species from around the Syowa Base of the Ongul Islands, Antarctica, when he visited there as a member of the 3rd Japanese Antarctic Research Expedition.

The photomicrographs of the collected materials were taken at random and enlarged ×2,500 to examine variations of this species.

Navicula molesta was first detected in 1938 at Spitzbergen in the Arctic region but has not been found since then. HUSTEDT described this species, based on KRASSKE's original specimen. The following is the description given by the writer on the basis of the description of HUSTEDT and KRASSKE.

Navicula molesta Krasske, in Arch. f. Hydrob. **33**: 528, pl. 11, f. 20 (1938); Hustedt, Kieselar. **2**: 252, f. 1379 (1962).

Shells narrow elliptical lanceolate, forming a short narrow rostral, slightly capitate shape. Length 11 μ, width 4-5 μ. Raphe straight and as thin as thread. Axial areas narrow linear, with no central area. Striae of the central part vertical to raphe or slightly radial. Striae approx. 22 in 10 μ at the central part, and approx. 30 in 10 μ at the ends.

The external shape of shells of this species collected from the Ongul Islands is lanceolate radial as was described by KRASSKE and HUSTEDT, but there are some individuals having both margins slightly triundulate (pl. 25, fig. 5). There are also individuals having one margin slightly triundulate. The writer found some connection among them. Therefore, it is better not to classify variations of species by their shape.

There were many individuals with rostrate ends (pl. 25, fig. 9), or with ends intermediate between rostal and rounded.

According to the description of materials collected in Spitzbergen, raphes are straight and as thin as thread. Axial areas are narrow linear. Most individuals have almost no central area just as the description of the Spitzbergen specimens (pl. 25, fig. 1). But some individuals were extended slightly at the central areas in an elliptical shape (pl. 25, fig. 2), and one individual was round (pl. 25, fig. 3). There were many individuals with striae vertical to raphe at the central part (pl. 24, fig. 2). Individuals with radial striae were also found. There

were many transitional types—some with striae vertical to raphe and some others with radial striae. HUSTEDT also described these types. Both ends are slightly astrictive. Striae at the central part of most individuals are almost of the same length. Individuals having long and short striae in alternation are rarely found.

This species shows variation in shell shapes as mentiond above, but variation in striae is stronger.

According to the writer and earlier investigators description of this sepecies is as follows:

Navicula molesta Krasske.

Shells lanceolate elliptical, ends extended in a rostral or rostral capitate shape. Length 23-25 μ, width 5-7 μ. Raphe as thin as thread, axial area narrow linear. Almost no central area, or narrow elliptical. Striae at the central part vertical to raphes, or slightly radial. Ends astrictive. Striae at the central part 18-22 in 10 μ.

HUSTEDT reported the length of this species as 17 μ, but during the investigation, the writer found individuals having 20-27 μ length. Among these individuals, 23-25 μ long individuals were common and 24 μ long individuals were most abundant (fig. 6). Width was 5-7 μ, while it is 4-5 μ according to HUSTEDT. Most of the individuals were 6-7 μ wide, 7 μ wide individuals being most abundant (fig. 6). Length and width are larger than those of the individuals found at Spitzbergen, however, the writer thinks it unnecessary to classify into variations or species by this difference.

HUSTEDT noted that the number of striae in 10 μ of the central part is 22, however, among the materials examined this time, it is 18-22. Individuals between 17 and 21 were many, most of the individuals having (fig. 6). The number of striae is smaller than that in HUSTEDT's record 5. In other words, intervals of striae are larger. But the writer thinks it is unnecessary to classify into variations or species by these characteristics.

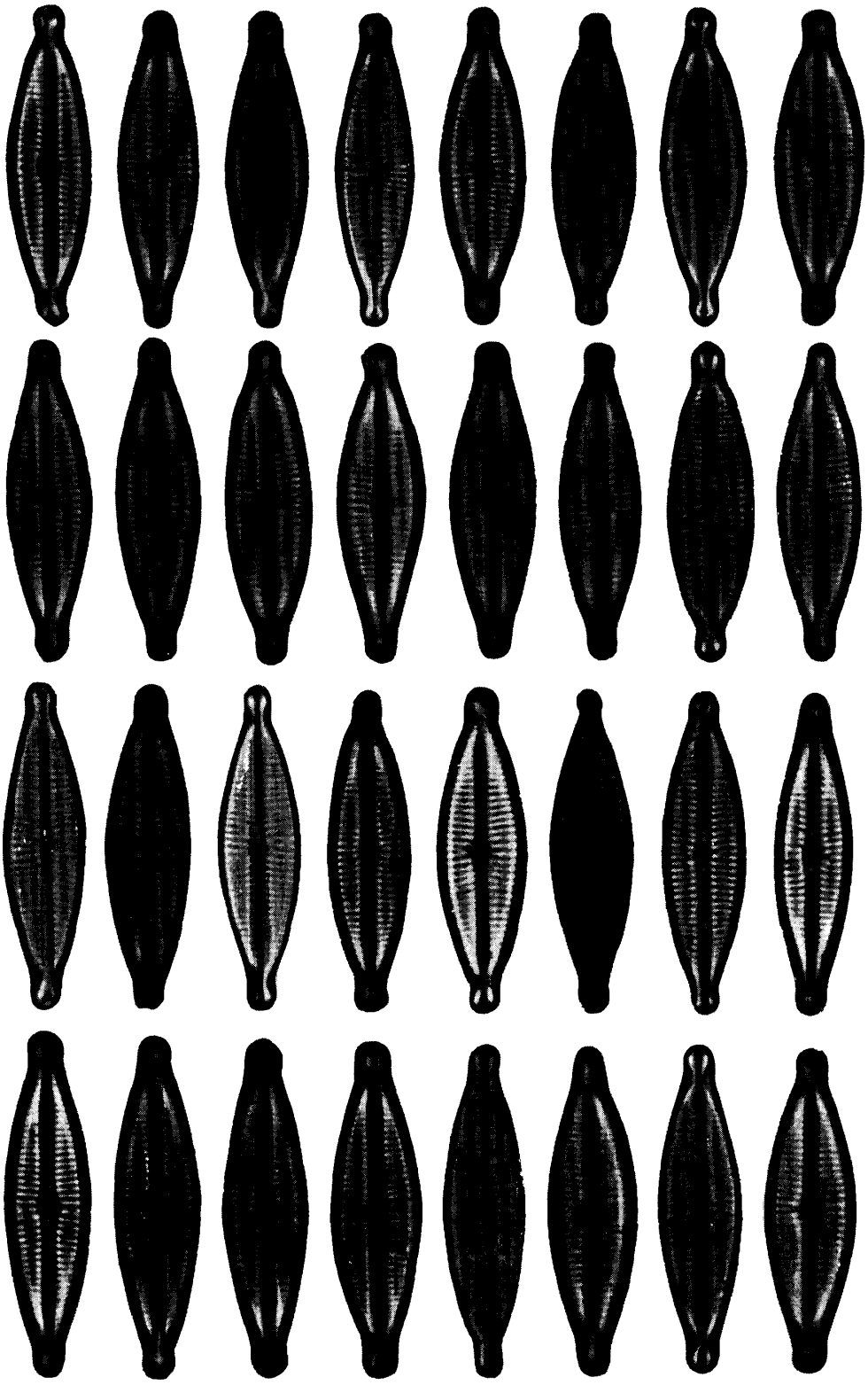

Plate 21. *Navicula molesta* Krasske.

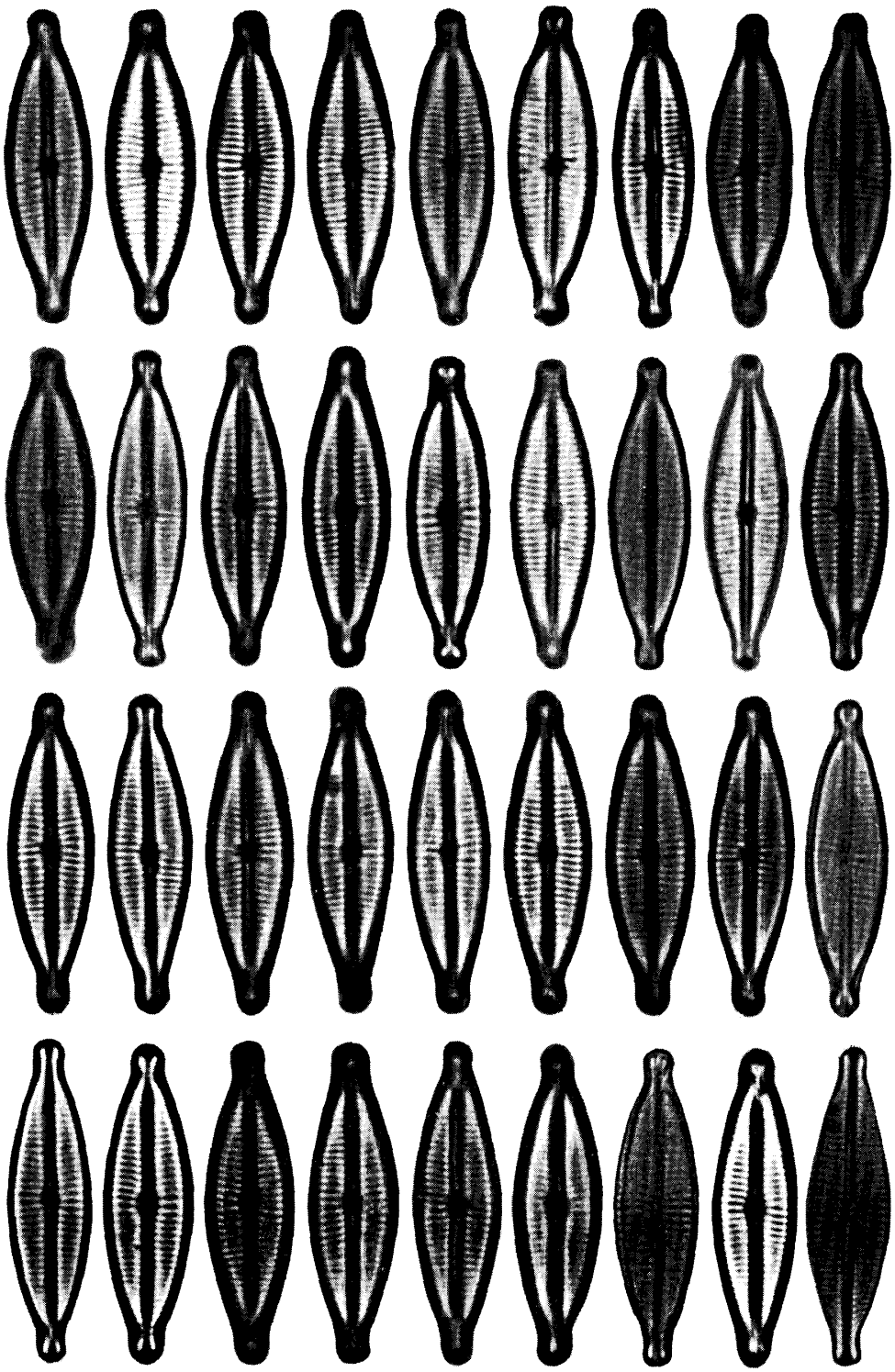

Plate 22. *Navicula molesta* Krasske.

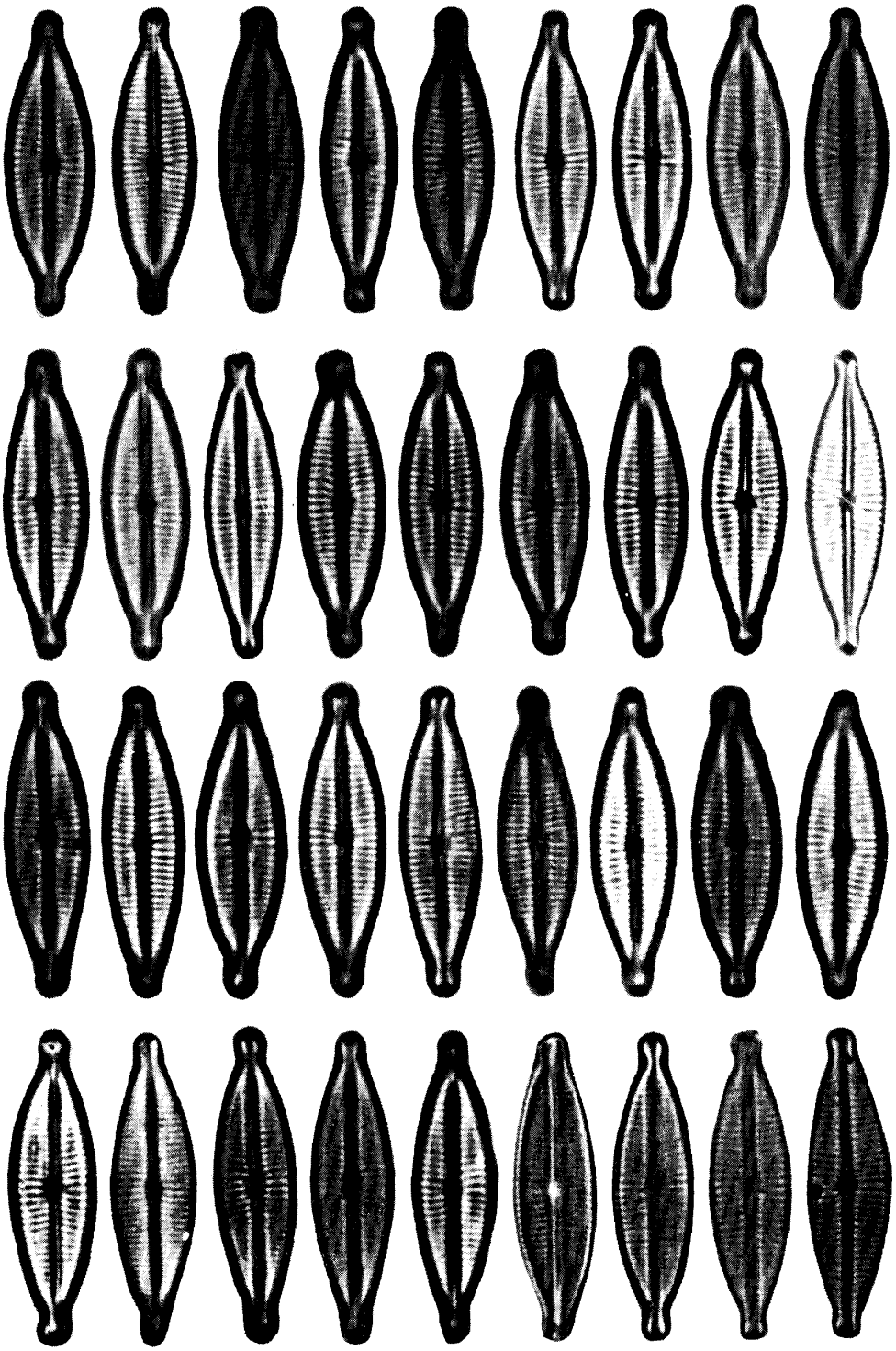

Plate 23. *Navicula molesta* Krasske.

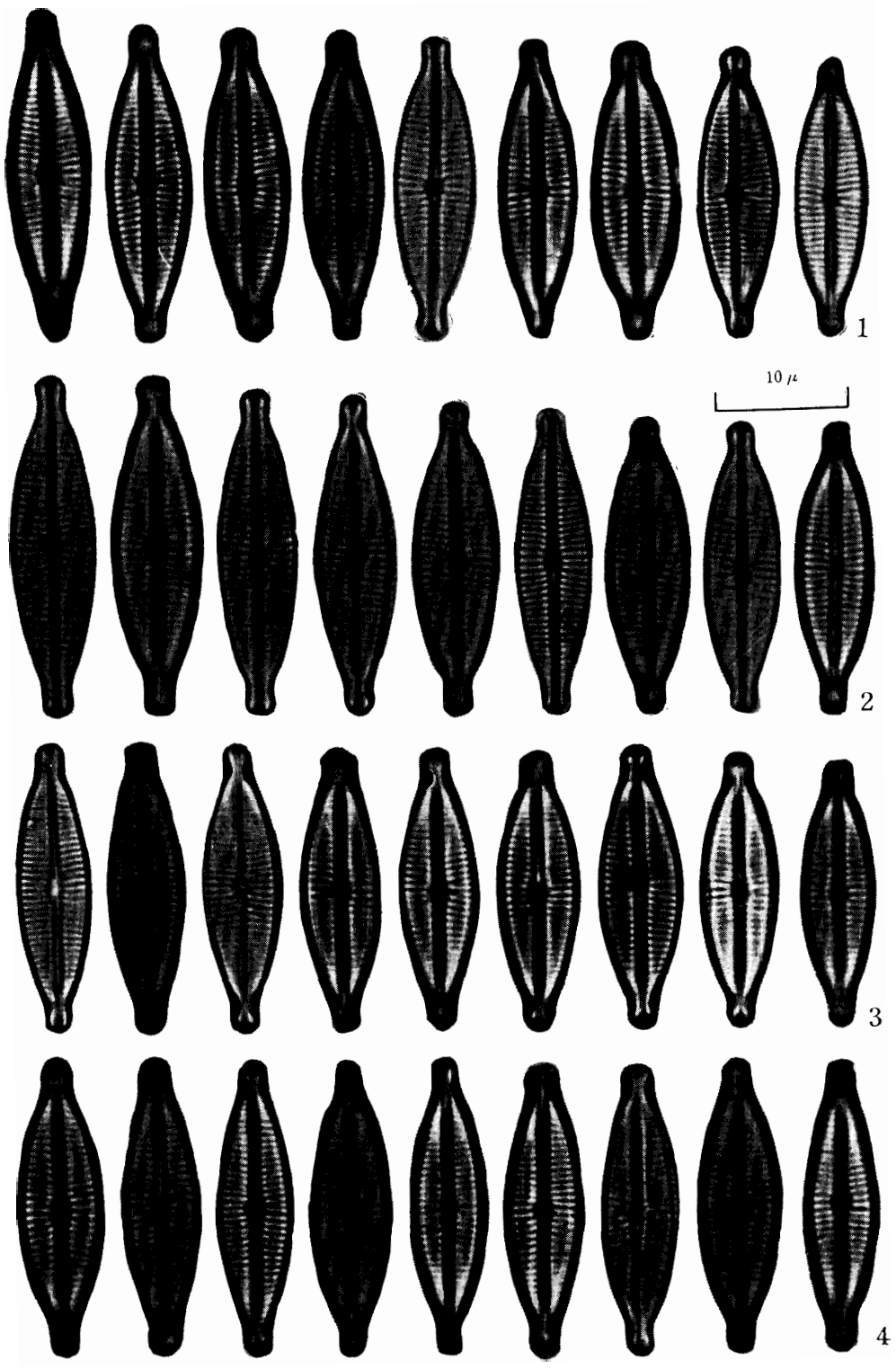

Plate 24. *Naviculta molesta* Krasske.

Striae radiate in the middle part of the shell (1), striae are perpendicular to the raphe in the middle (2), striae are perpendicular to the raphe on the one side of the raphe, radiate on the other side, in the middle part of the shell (3, 4).

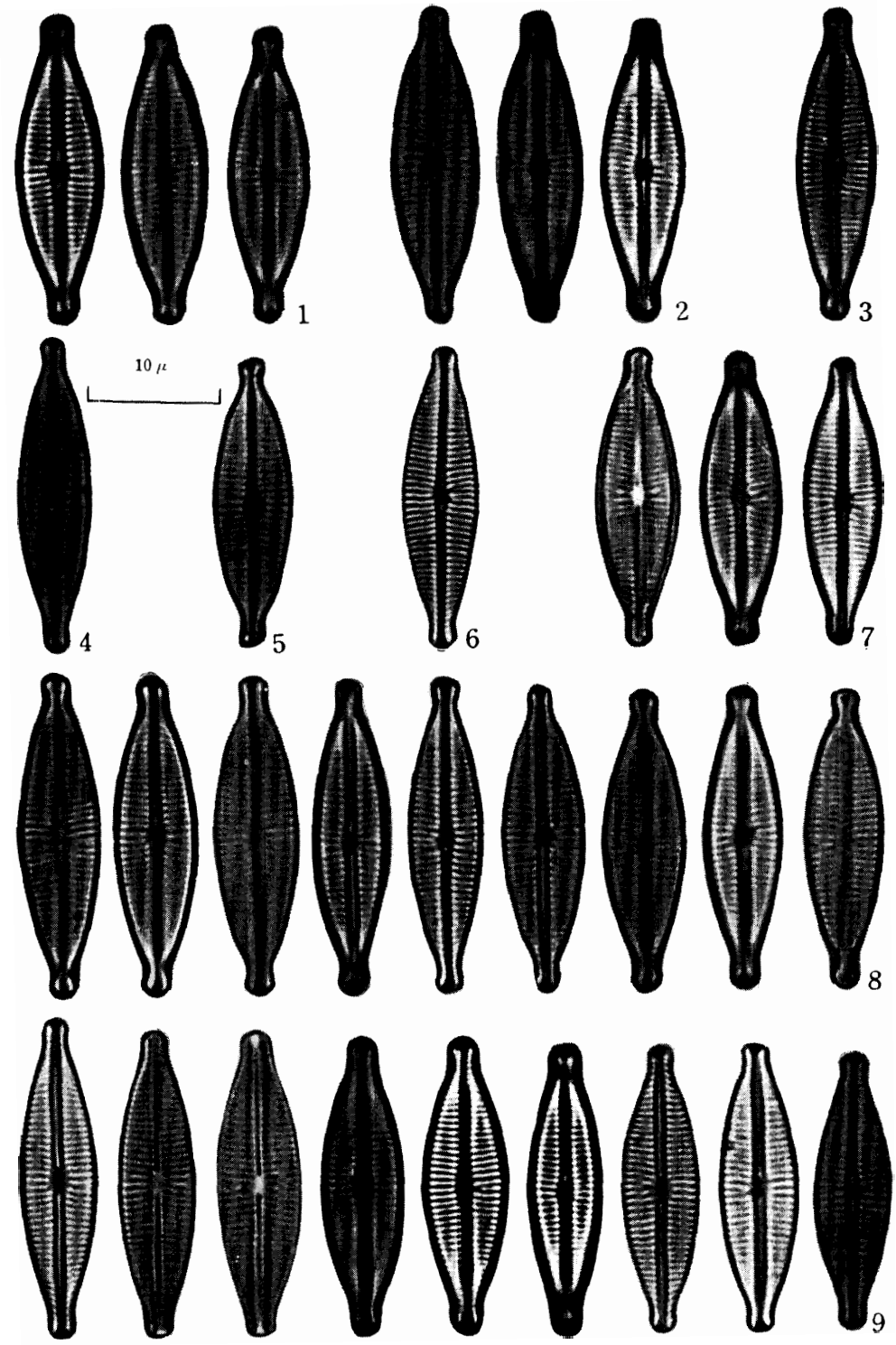

Plate 25. *Navicula molesta* Krasske.

Striae are arranged alternate long and short in the middle part of the shell (1), individuals with capitata ends (2), with rostral ends (3), with round central area (4), with poles one is rostrate and the other is capitate (5), with both margins triundulate (6), with one margin slightly triundulate (7), with elliptic central area (8), with no central area (9).

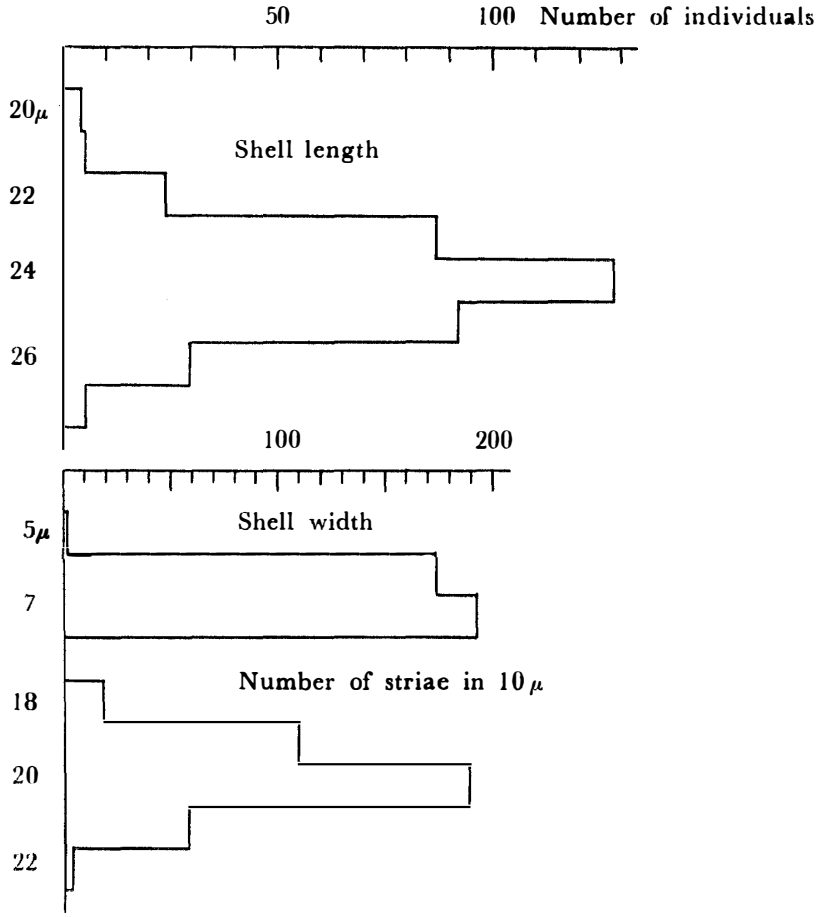

Fig. 6. Dimensions of *Navicula moelsta*.

XII. VARIATIONS IN *NAVICULA MUTICOPSIS* VAN HEURCK

Navicula muticopsis van Heurck var. *muticopsis* f. *muticopsis* was first reported by VAN HEURCK as a new species among the materials collected by the Belgian Antarctic Reseach Expedition from 1897 to 1899. Afterwards, this species was found in many places of the Antarctic region. It is abundant and very common on wet land and in the waters of this region. W. and G. S. WEST (1911) reported much of this species in the sand of penguin rookeries. This species is one of the most common diatom in the Antarctic.

The writer examined the materials collected by Dr. FUKUSHIMA who participated in the 3rd Japanese Antarctic Research Expedition. The materials were collected in a bottle. After treated with acid, these materials were mounted with pleurax, and 365 photomicrographs were taken at random to investigate their variability. The photos were taken by Zeiss' apochromat (×90) object lens.

Arrangement by literature

Varieties and species of *Navicula muticopsis* hitherto recorded are as follows:

Navicula muticopsis van Heurck var. *muticopsis* forma *muticopsis*, van Heurck, in Result, Voyage du S. Y. "Belgica", 12, pl. 2, f. 181 (1909); W. & G. S. West, in Rep. Sc. Invest. Brit. Antarc. Exp. 1907-9, **1** (7): 283, pl. 26, f. 181 (1911); Fritsch, in Nat. Ant. Exp. 1901-04 Nat. Hist., **6**, 51 (1912).

Shells sub-elliptical, with margins extended or rather parallel. Ends extended strongly in a rostral shape. Length 13-25 μ, width 6-11 μ. Raphe occur at the central part and straight. Striae consist of coarse spots and radial, number 13-14 in 10 μ. Axial area rather wide and lanceolate. Central area rectangular, with large width and small length.

Navicula muticopsis van Heurck var. *muticopsis* forma *evoluta* W. & G. S. West, in Rep. Sc. Brit. Antarc. Exp. 1907-9, **1** (7): 284 (1911); Carlson, in Wess. Erg. Schw. Südpol.-Exp. 1901-3, **4** (14): 14, pl. 1, f. 20 (1913).

Ends are slightly protruded as compared with the typical species.

Navicula muticopsis van Heurck var. *muticopsis* forma *reducta* W. & G. S. West,

Rep. Sc. Invest. Brit. Antarc. Exp. 1907-9, **1** (7): 284 (1911); Carlson, in Wiss. Erg. Schw. Südpol.-Exp. 1091-4, **4** (14): 14, pl. 1, f. 21 (1913).

Smaller than the typical species and generally short. The ends are slightly protruded as compared with the previous forma *evoluta*.

Navicula muticopsis van Heurck var. *muticopsis* forma *capitata* Carlson, in Wiss. Erg. Schwed. Südpol.-Exp. 1901-3, **4** (14): 15, pl. 1, f. 19 (1913).

Stronger than the typical species in the extension of ends and capitate. One margin is slightly convex and the other is straight. This is not mentioned in CARLSON's original description, but is recognized in his pictures. MILLS (1933) regarded this species as a synonym of *Navicula dicephala*, but the latter can be clearly discriminated from the former by the fact that it has no isolated point in the central area.

Navicula muticopsis van Heurck var. *gausii* Heiden and Kolbe: Deut. Südpol.-Exp. 1901-3, **8**: 623, pl. 3, f. 71 (1928).

Shell elliptical and are stlongly extended at the central part. Ends are strongly extended and sub-capitate rostrate. Length 30-31 μ, width 12-14 μ, striae 14-16 in 10 μ.

Navicula muticopsis van Heurck var. *gausii* Heiden and Kolbe forma *semicruciata* Heiden and Kolbe, Deut. Südpol.-Exp. 1901-3, **8**: 623, pl. 3, 72 (1928).

Similar to the above var. *gausii*, one side lacks striae at the central part.

The following is a key to the above varieties and species:

I. Ends not so strongly protruded
   var. *muticopsis* forma *muticopsis*
   1. Protruded ends capitate
      var. *muticopsis* forma *capitata* Carlson
   2. Protruded ends not capitate
      a. Ends not protruded and subrostrate
         var. *muticopsis* forma *evoluta* W. & G. S. West
      b. Cell rather small and ends not so protruded
         var. *muticopsis* forma *reducta* W. & G. S. West

II. Ends strongly protruded
   1. Striae at the central part existing at both margins
      var. *gausii* Heiden and Kolbe f. *gausii*
   2. Striae at the central part existing at one margin only
      var. *gausii* Heiden and Kolbe
      f. *semicruciata* Heiden and Kolbe

Variability of the materials of East Ongul Island

The writer arranged many literatures publised up to the present and examined them carefully in view of classifications of the materials of East Ongul Island on the basis of photomicrographs.

The materials shown in Plates 26 and 27 are the species which are rostral subcapitate at the ends and which are to be classified as *Navicula muticopsis* var. *muticopsis* forma *muticopsis*.

The materials shown in Plate 28 are protruded at the ends in a capitate shape and the species which shall be classified as *Navicula muticopsis* var. *muticopsis* forma *capitata*. This species is markedly convex at one margin and slightly extended or straight at the other margin. In the above two columns are the materials which lack striae at the central part of one margin.

The materials shown in Plate 29 are the species which can be classified as *Navicula muticopsis* var. *muticopsis* forma *evoluta* or forma *reducta*.

The materials shown in Plate 30 are of the species which lacks striae at the central part of one margins. These materials are found among the typical species and also among forma *capitata*. In other words, these shapes are found in every variety and form. Therefore, HEIDEN and KOLBE has classified these materials lacking striae at the central part of one margin as forma *semicruciata*, although the writer thinks it unnecessary to differentiate the two.

In Plate 31, the arrow above indicates the forma *evoluta*, was derived from *Navicula muticopsis* var. *muticopsis* forma *muticopsis*, and then forma *reducta* appeared. The arrow below indicates that from var. *muticopsis* forma *muticopsis* was derived forma *capitata*, and the middle arrow indicates that var. *gausii* forma *semicruciata* appeared in the same way.

The writer arranged the forms of *Navicula muticopsis* var. *muticospsis* as *Navicula muticopsis* var. *muticopsis* forma *evoluta*, although there are many individuals which could not be determined whether they should be regarded as the typical forms of species. As the examined materials are related to one another, the writer thinks it better not to divide them into species.

Size of *Navicula muticopsis* var. *muticopsis* forma *muticopsis* of East Ongul Island and size of *Navicula m.* var. *m.* forma *capitata*

Table 2. Dimensions of *Navicula muticopsis* var. *muticopsis* forma *muticopsis*

	Length μ	Breadth μ	Striae in 10 μ
W. & G. S. West (1911)	14.6–23	8–9.1	13–14
Fritsch (1912)	13 –25	7–9	
Fritsch (1912A)	24	10	
Carlson (1913)			

In Fig. 1 the histogram of shell lengths of 365 individuals is on the left and that of forma *capitata* on the right. According to this histogram, forma *capitata* is somewhat large but is not actually considered as a large type. Length ranges from 8 to 32 μ, and individuals of 14-20 μ are the most numerous.

According to the existing records, the length ranges from 13-25 μ as shown in Table 1, but the writer found larger and smaller individuals than those of the records.

Histogram of shell width is shown in Fig. 7. On the right is the histogram of forma *capitata*. Judging from this, forma *capitata* is broader than the typical species. According to the existing records, width is 7-10 μ, but it is 6-11 μ in this case.

Histogram of the number of striae in 10 μ is shown in Fig. 7, with the histogram of all examined individuals on the left and that of forma *capitata* on the right. Striae in 10 μ range from 10 to 21, and individuals of 14-18 are the most numerous. According to the existing records, it was 13-14, but the writer has found coarser and thicker individuals. Although forma *capitata* is slightly coarser than the typical species, still they cannot be divided.

Judging form the above data, forma *capitata* is supposed to be larger and coarser than the typical species. However, it is impossible to distinguish them only by measurement, hence they should be distinguished by shape.

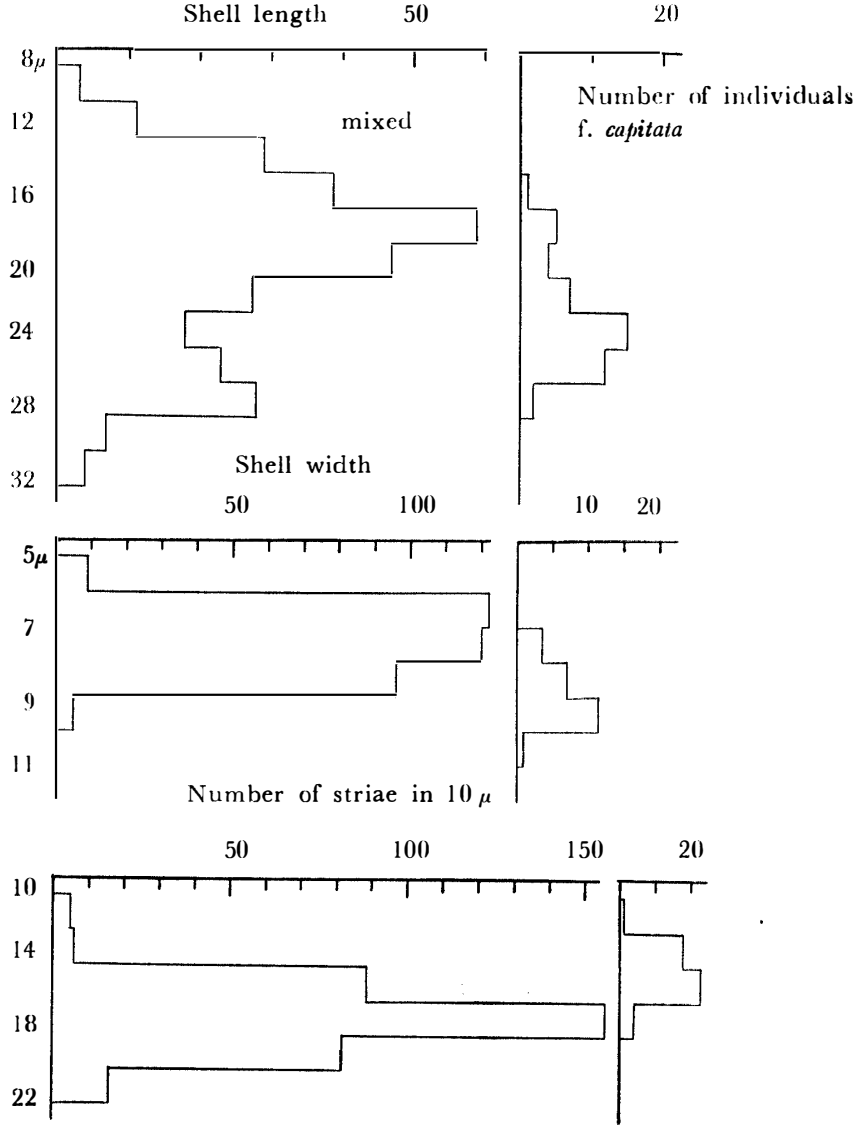

Fig. 7. Histograms on dimensions of *Navicula muticopsis*.

Since any typical species corresponding to *Navicula muticopsis* var. *gausii* were not found among the examined materials, the writer cannot refer to its variation. However, their variation is recognized.

From the points of view as mentioned in page 25, *Navicula muticopsis* should be divided into var. *muticopsis* forma *muticopsis*, var. *muticopsis* forma *capitata* and var. *gausii*. The following is the key to the above-mentioned species:

I. Shell margins slightly extended or parallel
  1. Ends protruded in a sub-rostral or rostral shape
     var. *muticopsis* f. *muticopsis*
  2. Ends protruded in a capitate shape
     var. *muticopsis* f. *capitata* Carlson

II. Shell margins strongly extended
     var. *gausii* Heiden and Kolbe

(*Manuscript received December 14, 1964*)

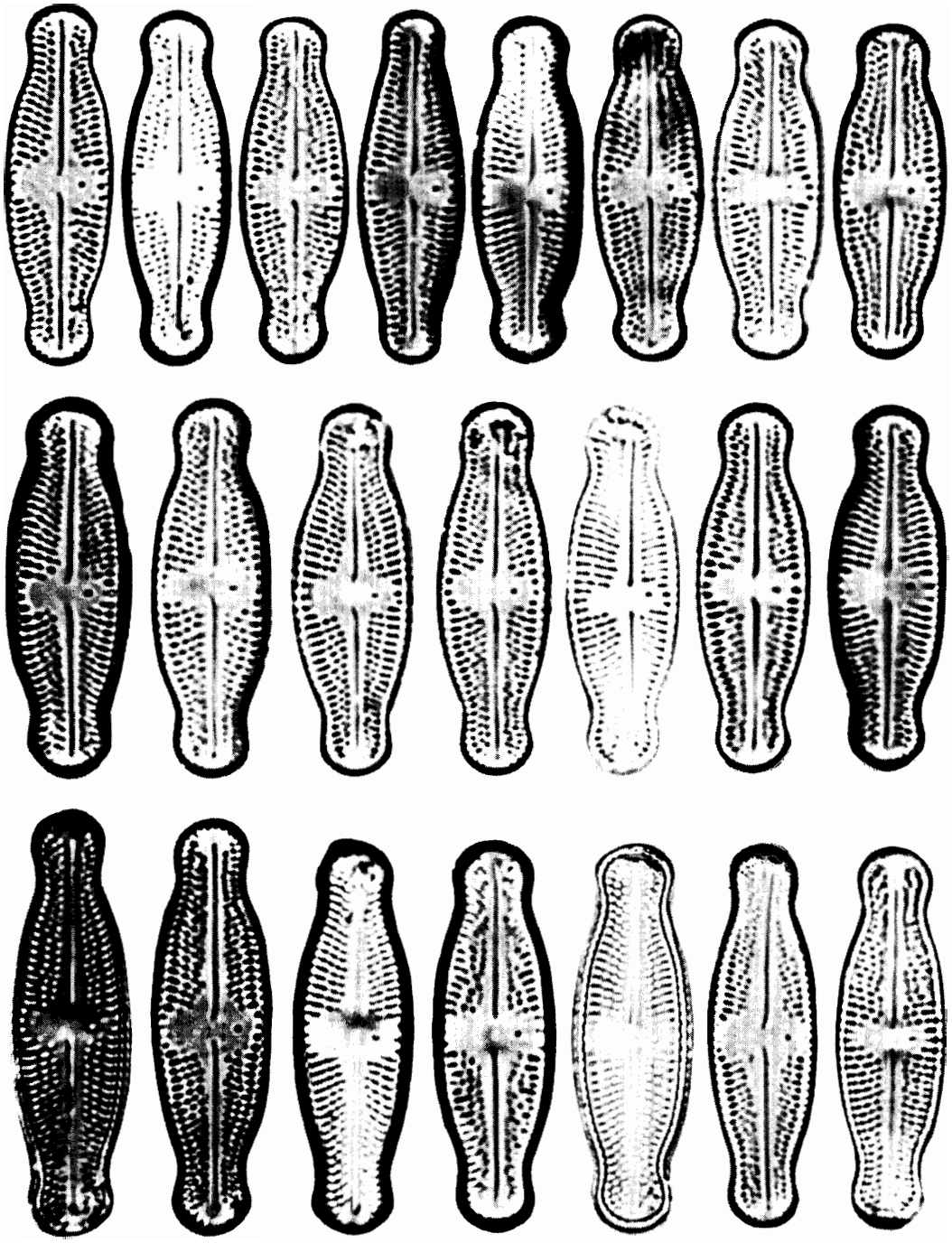

Plate 26. *Navicula muticopsis* van Heurck var. *muticopsis*.

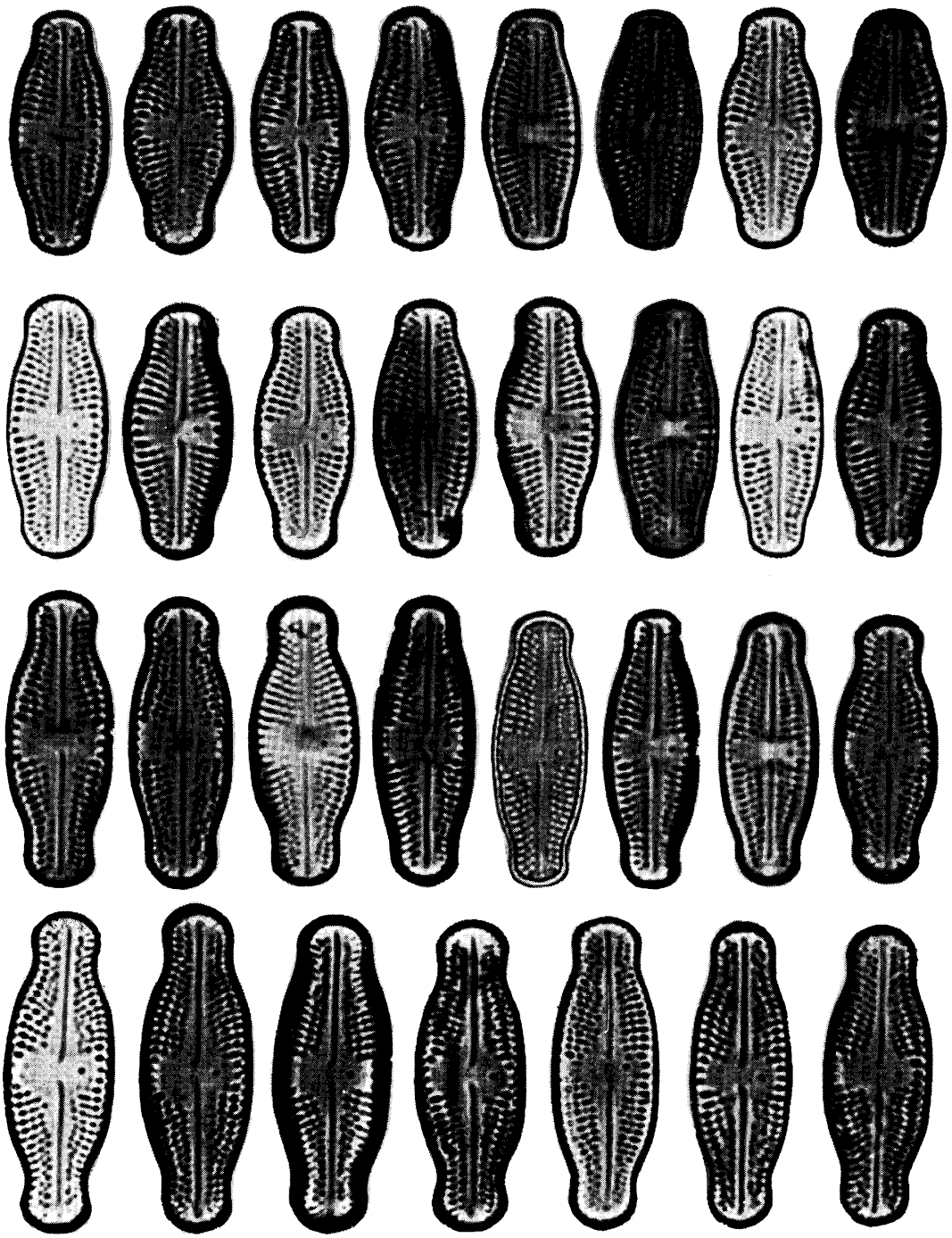

Plate 27. *Navicula muticopsis* van Heurck var. *muticopsis.*

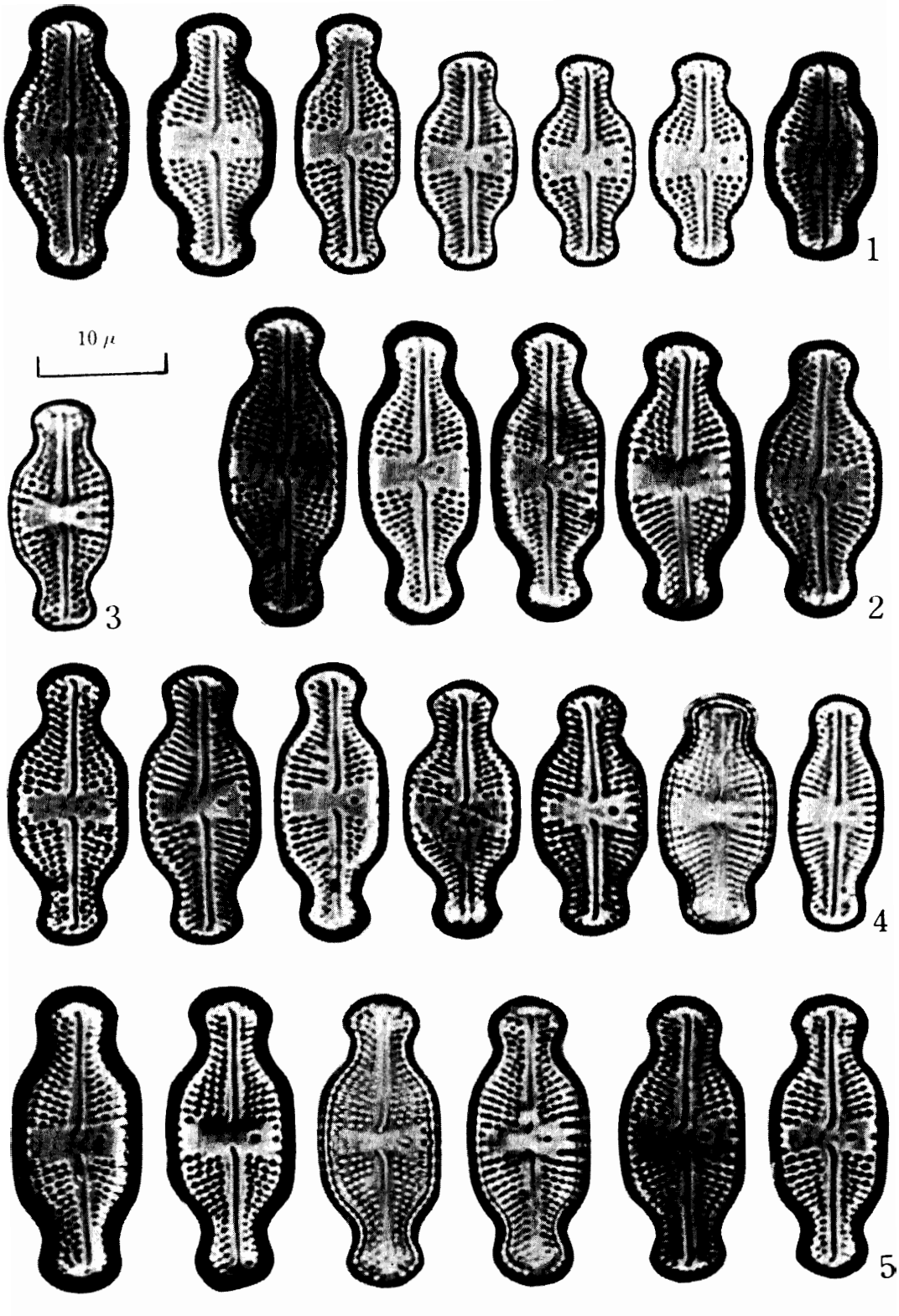

Plate 28. *Navicula muticopsis* van Heurck var. *muticopsis*.
F. semicruciata type (1, 2), typical form (3-5).

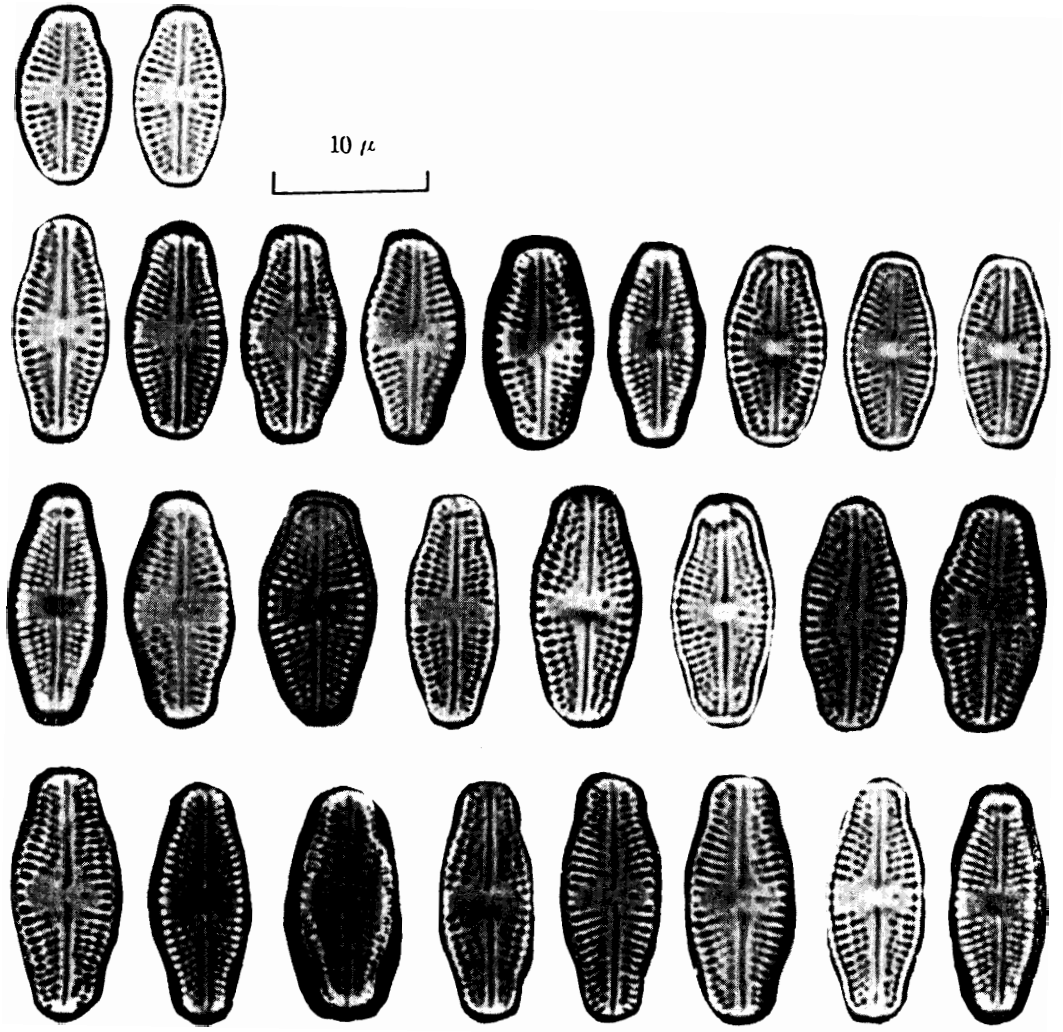

Plate 29. *Navicula muticopsis* van Heurck var. *muticopsis* (f. evoluta or f. reducta type).

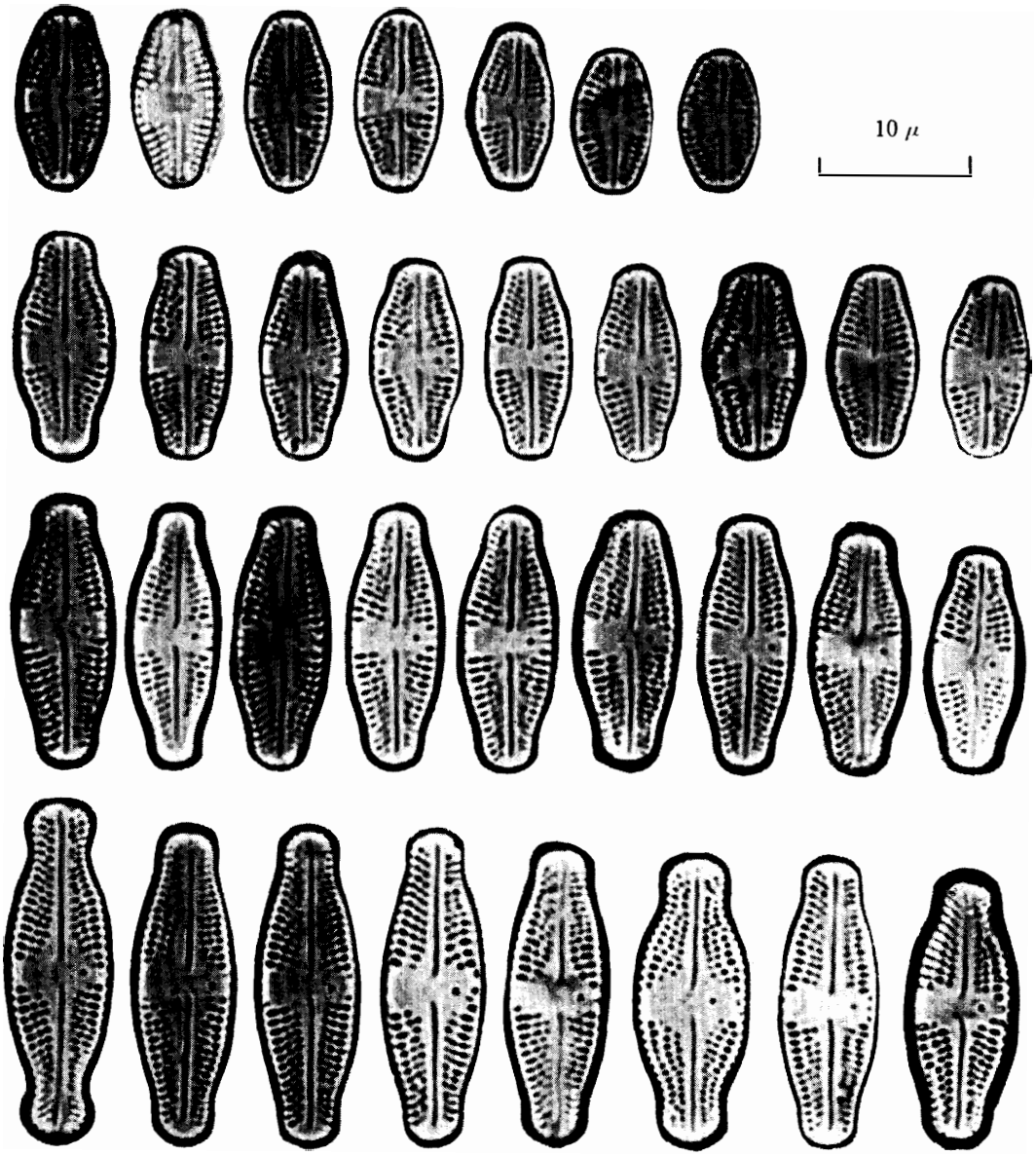

Plate 30. *Navicula muticopsis* van Heurck var. *muticopsis* (f. semicruciata type).

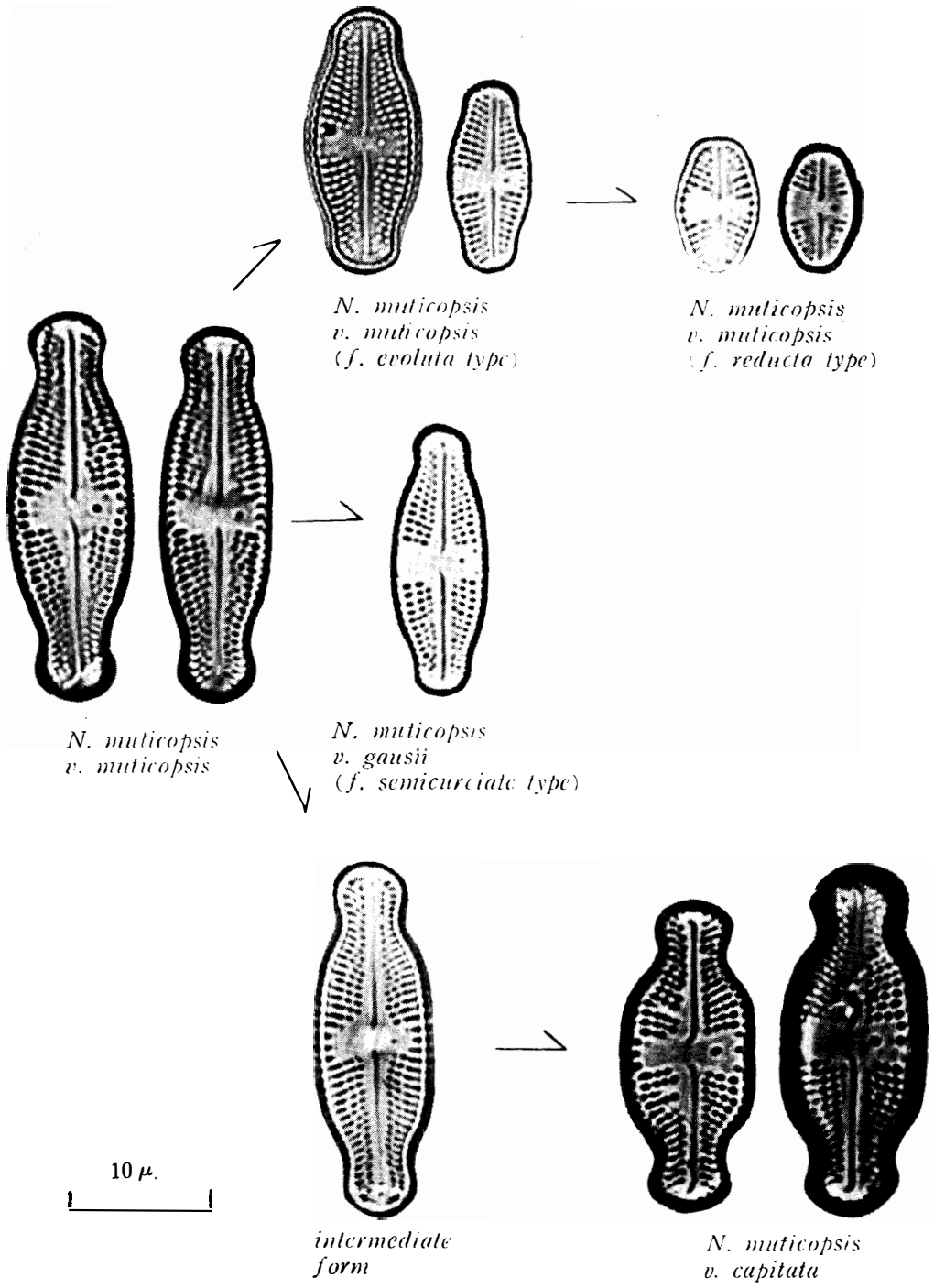

Plate 31. *Navicula muticopsis* van Heurck.