Abstract

The results of the investigation on the variation of the 10 taxon of the diatoms are reported in the sections 2-11 in detail. This is the summary.

Form of shells is classified into 3 taxon such as those which vary strongly, those which do not vary so strongly, and those which scarcely vary. The taxon which strongly varied were *Achnanthes brevipes* var. *arctica, Achnanthes lanceolata* var. *lanceolata* f. *dubia, Cymbella cistula, Hantzschia amphioxys* var. *recta, Navicula muticopsis* var. *muticopsis* f. *capitata, N. m.* var. *m.* f. *murrayi,* etc. The taxon which were not so varied were *Achnanthes brevipes* var. *intermedia, Pinnularia subcapitata* var. *subcapitata,* etc. The taxon scarcely varied was *Navicula cryptocephala* and *N. molesta.* However, this *Navicula cryptocephala* was varied strongly at the central striae which were long and short alternately or not alternately, although not so strong variation was observed in the outer shape of shells. Thus, variation is sometimes very strong on a certain characteristic, but scarcely found on the other characteristics. And sometimes variation is not found on all the characteristics at a time.

For example, *Cymbella cistula* which was collected from Oze situated in the central part of Japan was not so varied in shell shape, but the same species that was collected from South Georgia of the Antarctic strongly varied in shell shape. It seems from this fact that according to the difference of the growing circumstances or strains, even the same species strongly vary in some cases, and may not vary so strongly in others. Therefore, the writer thinks that it is not enough to examine the materials from only one place in order to study variation. However, in order to assertain the characteristics for standards of classification, like the purpose of this work or to re-arrange the taxon which are classified into many species on the basis of the variable materials at a place, the writer has found that the study of the materials collected from a particular place is fairly effective.

The outer shape of shells, especially that of the ends, is often expressed by "not so extended", or "extended in rostral shape", or "extended in capitate shape" and so on. But actually, there are many intermediate individuals which are very difficult to be distinguished.

There are many individuals consisting of shells of capitate ends or individuals of larger size which are remarkably extended at the ends, but in the same taxa, smaller individuals are generally slightly extended at ends (cf. *Achnanthes lanceolata* var.

lanceolata f. *dubia*, *Navicula muticcopsis* var. *muticopsis* f. *capitata*, *N. m.* var. *m.* f. *murrayi*). On the other hand, constriction of extremely large size of individuals becomes slighter (cf. *Navicula muticopsis* var. *muticopsis* f. *murrayi*).

The smaller the individuals become, the slighter becomes the constriction of shells, because in most cases the shells get shorter but they do not become narrower. The outer shapes of these smaller individuals of short length are simple too.

It is generally considered that individuals are connected with many intermediate ones, except when margins of shells are remarkably parallel, penetrated, extended, constricted or expanded (cf. *Pinnularia subcapitata* var. *subcapitata*).

When shells are extremely large or small, and when the ratio of shell length and width is variable, the individuals are often classified into different varieties (cf. *Cymbella cistula*, etc.). However, as these individuals are almost always connected, it is proper to classify them into species, and not into varieties, even though the size is seen to be far larger than the existing records. But when the size is different and other characteristics, such as distance of striae, are also variable, the above principle should not be applied. It is necessary to take note that the shape of the ends or the margins varied with the size of the shells as mentioned above.

The arrangement of striae of the central part of shells, such as long and short alternately or not alternately, is sometimes considered as a characteristic of varieties, and sometimes as that of species. Much importance is given to this characteristic, as some species (cf. *Navicula cryptocephala*) possess variation in this characteristic.

Distance between the striae is almost always uniform, but sometimes varies remarkably. Therefore, if this characteristic is used as a basis of classification of taxon (cf. *Pinnularia subcapitata* var. *subcapitata*), much care should be taken.

Mention of the direction of striae is generally made except of the central part, but sometimes it is not made at all (*Navicula moresta*).

In some cases, individuals are classified by the shape of width of axial areas, but this characteristic also varies remarkably (cf. *Pinnularia subcapitata* var. *subcapitata*, etc.).

From the above examination, the writer found that the characteristics used as standards of taxonomy vary strongly in some taxon. Therefore, it is necessary for description of new taxa to examine materials as much as possible to ascertain the variation range of the taxa.

During the examination, the writer found many different taxa such as that which is re-arranged to be a different species, that which was a variety of different species (*Achnanthes brevipes* var. *arctica*, *Navicula muticopsis* var. *muticopsis* f. *murrayi*) that which was the taxon which is re-arranged to be a species from a variety (*Achnanthes lanceolata* var. *lanceolata* f. *dubia*, etc.) and also many synonyms.

The writer arranged the confused species which were called by many different names (*Navicula muticopsis* var. *muticopsis* f. *capitata*, *N. m.* var. *m.* f. *murrayi*), and corrected the incomplete descriptions made by many investigators up till now (*Navicula muticopsis* var. *muticopsis* f. *capitata*, *N. m.* var. *m.* f. *murrayi*, *Tropidoneis laevissima*), and discovered many larger and smaller individuals which were not recorded in the literatures.

I. PREFACE

Pennate diatoms are classified into various species, varieties or forms. These classifications are based on their outer shape such as shape of shell ends shape of margins, length, width, shape of axial areas and central areas, shape of striae, directions, distance generally expressed by the number in 10 μ and when the shape of the upper portion of the shell is different from that of the portion below, it is classified on the basis of transverse shape.

However, even when the outer difference is not so remarkable – as for example, a) the ends are not so expanded, b) the ends are expanded in rostral shape or c) the ends are expanded in capitate shape – these are sometimes classified into varieties, or even into species.

Generally, materials are calssified by the following characteristics:

Shell end	rotundate, wedge-shaped
Shell margin	parallel, constricted, inflated
Shell size	specially large, specially small
Axial area	specially wide, specially narrow
Direction of striae	radial specially at ends, convergent, straight to raphes
Central striae	long and short alternately, not alternately
Distance of striae	specially wide, specially narrow

It is the general way of the modern taxonomists to classify into new varieties or species according to the difference of these characteristics even though it is slight. Under such a condition, new varieties and species increased in number, and it is high time to re-arrange these varieties and species in some definite order.

In order to re-arrange these confused diatoms, it is necessary, first of all, to note the range of variation accurately and to examine the above-mentioned standards of classification once more.

However, the writer could not find any paper on a systematic study of variation of diatoms. Even L. GEITLER's famous study, "Der Formwechsel der Pennaten Diatomeen" (1932) has not made the variation of diatoms as a base of classification. Sometimes, however, fragmentary reports on the classification of diatoms are found. For this reason the writer collected the association of diatoms which grew naturally, and examined the variation of diatoms to re-arrange their confused classification of

diatoms.

This tendency is applied to every diatom regardless of the place they grow. For example, the diatoms in Antarctica are often classified into different species or varieties without sufficient descriptions of the characteristics of their forms. In addition, due to the small number of available specimens, the individuals which should be classified into the same fluctuating variation are recorded as different species more frequently than those of the other areas. Therefore, the study of the variation of the diatoms in the Antarctic is important. Most of the materials for this study were what Dr. HIROSHI FUKUSHIMA, Asst. Professor of Yokohama Municipal University, collected from the Antarctic area when he participated in the Japanese Antarctic Research Expeditions 1958–59 and 1960–61.

After acid treatment, the writer mounted the specimens with pleurax, then photomicrographs of about 360 individuals per species were taken, and the individuals of normal size were enlarged size 2,000 times and the variation of the size of the diatoms were investigated. Advantages of the examination by photomicrographs are that first it is objective, and secondarily many individuals can be observed at a time, but at the same time it is a laborious process.

The camera used for this purpose was Olympus Microscopic Camera, the microscope, in most cases, Olympus Microscope and Kyōwa Microscope, and the objective lenses were Zeiss Apochromat X 90.

Following the above method, the writer examined variation of 36 taxon, among which the following 10 were from Antarctica: *Achnanthes brevipes* var. *arctica*, *A. b.* var. *intermedia*, *Achnanthes lanceolata* var. *lanceolata* f. *dubia*, *Cymbella cistula*, *Hantzschia amphioxys* var. *recta*, *Navicula cryptocephala*, *N. muticopsis* var. *muticopsis* f. *capitata*, *N. m.* var. *m.* f. *murrayi*, *Pinnularia subcapitata* var. *subcapitata*, *Tropidoneis laevissima*. The following is the report of the investigation.

The writer sincerely appreciates Dr. FUKUSHIMA's kindness who supplied the materials for the examination and gave many helpful instructions.

II. VARIATIONS OF *ACHNANTHES BREVIPES* AG. VAR. *INTERMEDIA* (KÜTZ.) CLEVE

The materials used for the research were collected by Dr. HIROSHI FUKUSHIMA, from Kasumi Rock (68°21′5S, 42°13′3E), the Antarctic continent, on February 20, 1961, when he joined the Japanese Antarctic Research Expedition 1960–61. The collected materials had been growing together with *Achnanthes brevipes*. Environments at this situation will be described in the paragraph dealing with *Achnanthes brevipes*. As the number of individuals were not large, the writer took photomicrographs of only 86 individuals at random from the permanent slides he prepared. The photomicrographs were enlarged 2,000 times for examination.

According to the traditional records, shells are linear, both ends are slightly wedge-shaped, both margins are parallel and the central parts are a little constricted. In the materials of Kasumi Rock, elliptical shells were most common and linear cells very rare. The margins of most of the shells were slightly inflated, individuals with parallel margins being rare. The ends of most of the shells were rotundate and the typical wedge-shaped shells were not found. Shells with clear constriction at the central area were not found, but shells with a slight constriction at the central area were found.

Sizes of shells were variable from 27μ to 39μ, but 31μ to 34μ were most common. Width of shells was variable from 6μ to 11μ, but 8–9μ was most common. In the pseudoraphe shells were linear pseudoraphes, but they went astray remarkably to right or left.

At the middle of the raphe shells arial areas were linear to linear-lanceolate, central areas were strip-shaped, extending to the margins.

The striae of the pseudoraphe shells were almost radial and consisted of clear spots. Striae were 11–13 in 10μ, and spots were 16–20 in 10μ. Striae of raphe shells were also radial and 12–16 in 10μ, a little coarser than the pseudoraphe shells. Striae consisted of clear spots, 16–20 in 10μ, but these spots were also a little coarser than the pseudoraphe shells.

According to the traditional records, as the striae were 9–10 in 10μ, the materials examined here were coarser, for they were 11–16 in 10μ. The typical species and this variety have been distinguished by the striae numbers in 10μ. In other words, individuals with over 9 striae are var. *intermedia*. The view must be correct, but the size of the spots forming striae should also be regarded as an important factor.

The writer found some individuals in the normal condition which had striae at the central area, not extended to the margins, but existing only around the central nodules (this type with central area is traditionally called *Achnanthes arctica*). The report notes that these special typical types (*Achnanthes arctica* type) with central areas have not previously appeared in the records.

The minimum width of the central areas was 2–3μ and most individuals were 2μ. The minimum width of the central areas of *Achnanthes brevipes* collected at the same place as the materials examined here was 2–7μ and 3–4μ individuals which were most common. The following is a description of this variation according to the traditional records combined with the present observations:

Achnanthes brevipes Agardh var. *intermedia* (Kütz.) Cleve, Nav. Diat., **2**: 193 (1895); Schönfeldt, Diat. Germ., 122, pl. 13, f. 242 (1907); W. & G.S. West in Brit. Antarct. Exp. 1907–09, 280, pl. 26, fs. 126, 127 (1911); Hustedt in Pascher's Süssw. Fl. **10**: 210, f. 310 (1930).

Synonym

Achnanthes intermedia Kütz., Syn. 48, f. 56 (1834); Bacill. 76, pl. 23, f. 6 (1844).

Shells vary from elliptical to linear-elliptical, ends wedge-shaped to rotundate, margins slightly extended or almost parallel, sometime central part of margins constricted. Length 27–39μ, width 6–11μ.

The pseudoraphe shells have narrow linear pseudoraphe, but most of them are situated to the right or to the left side of the central part. Raphae shells have raphe at central part and narrow linear or linear-lanceolate axial area wide and strip-shaped, extending toward the margins.

Striae are radial and consist of clear spots. Striae of pseudoraphe shell are coarser and are 11–13 in 10μ. Spots 16–20 in 10μ. Striae of raphe shells 12–16 in 10μ. Spots 16–24 in 10μ. There were some individuals which had central striae in the raphe shells only at central nodules and not at margins.

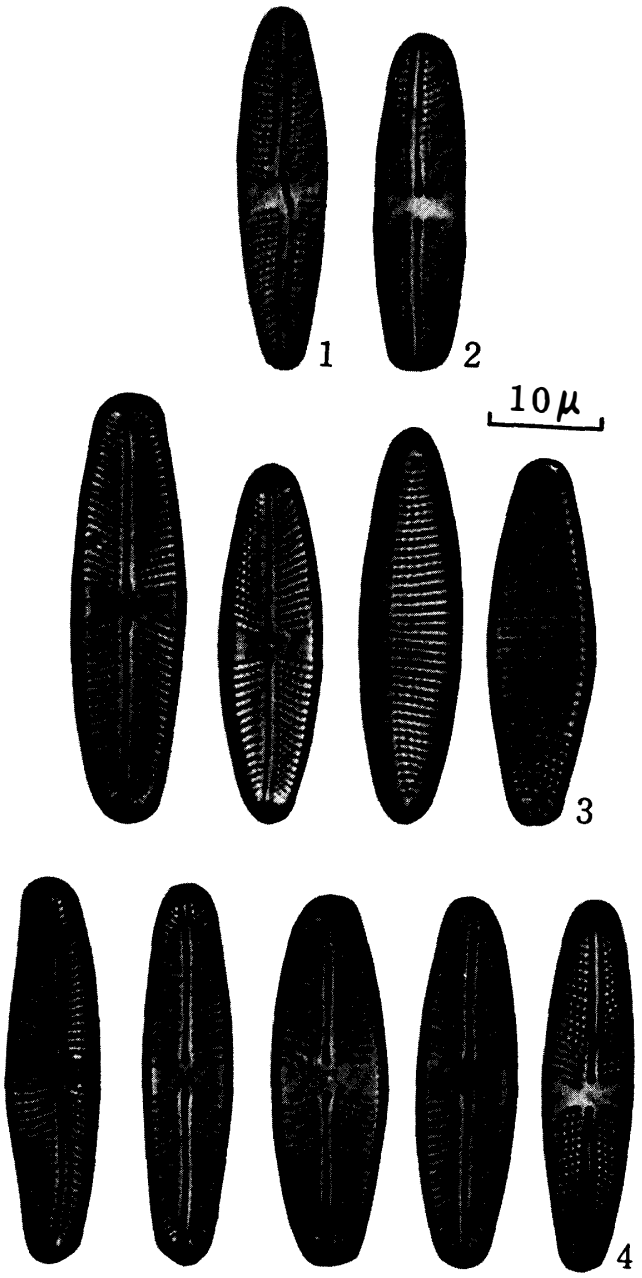

Plate 1. *Achnanthes brevipes* v. *intermedia*.
1: Malformation. 2: Individual which has constricted margins.
3: Typical form. 4: Individuals which have A. arctica type central area.

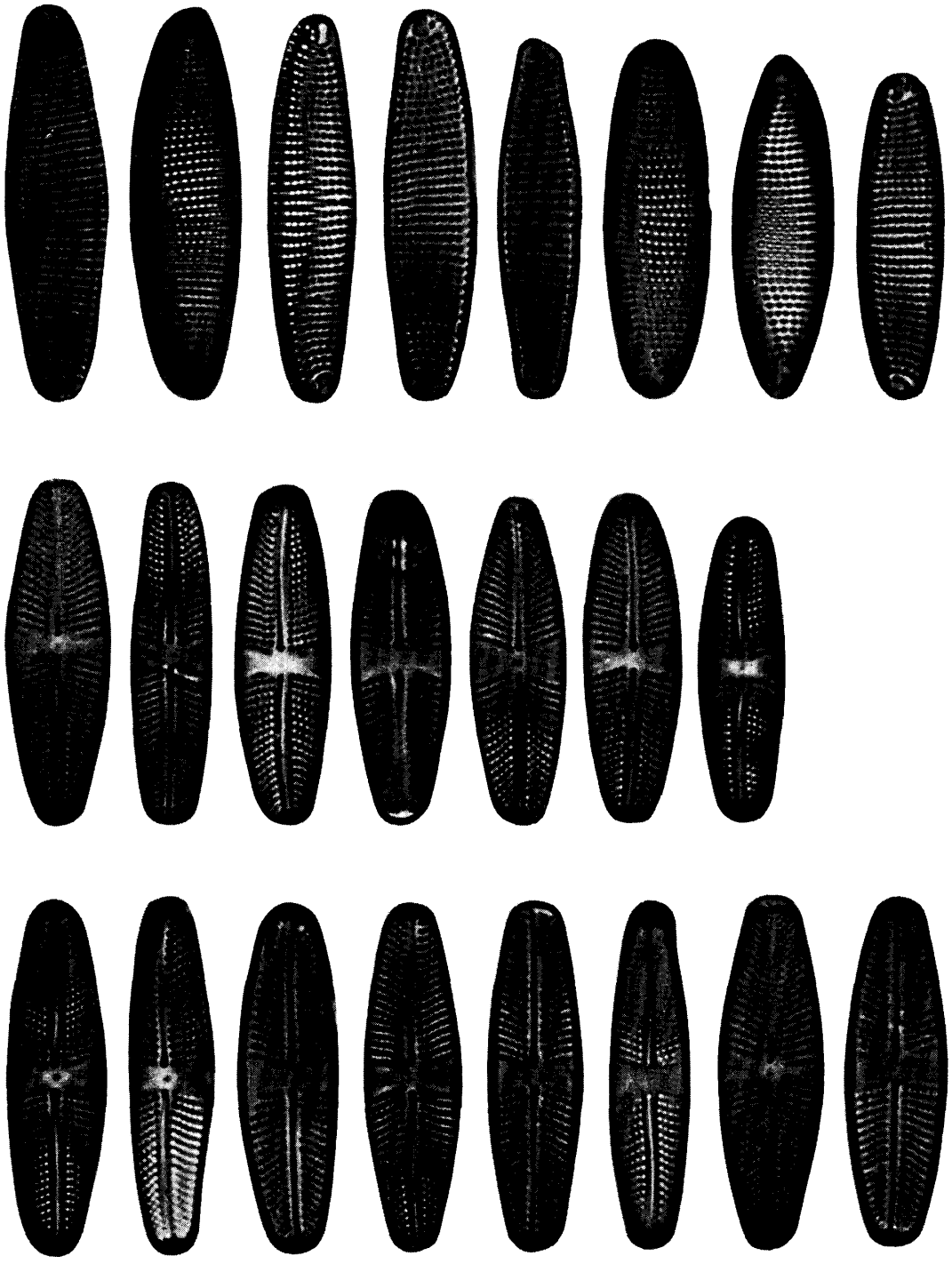

Plate 2. *Achnanthes brevipes* v. *intermedia.*

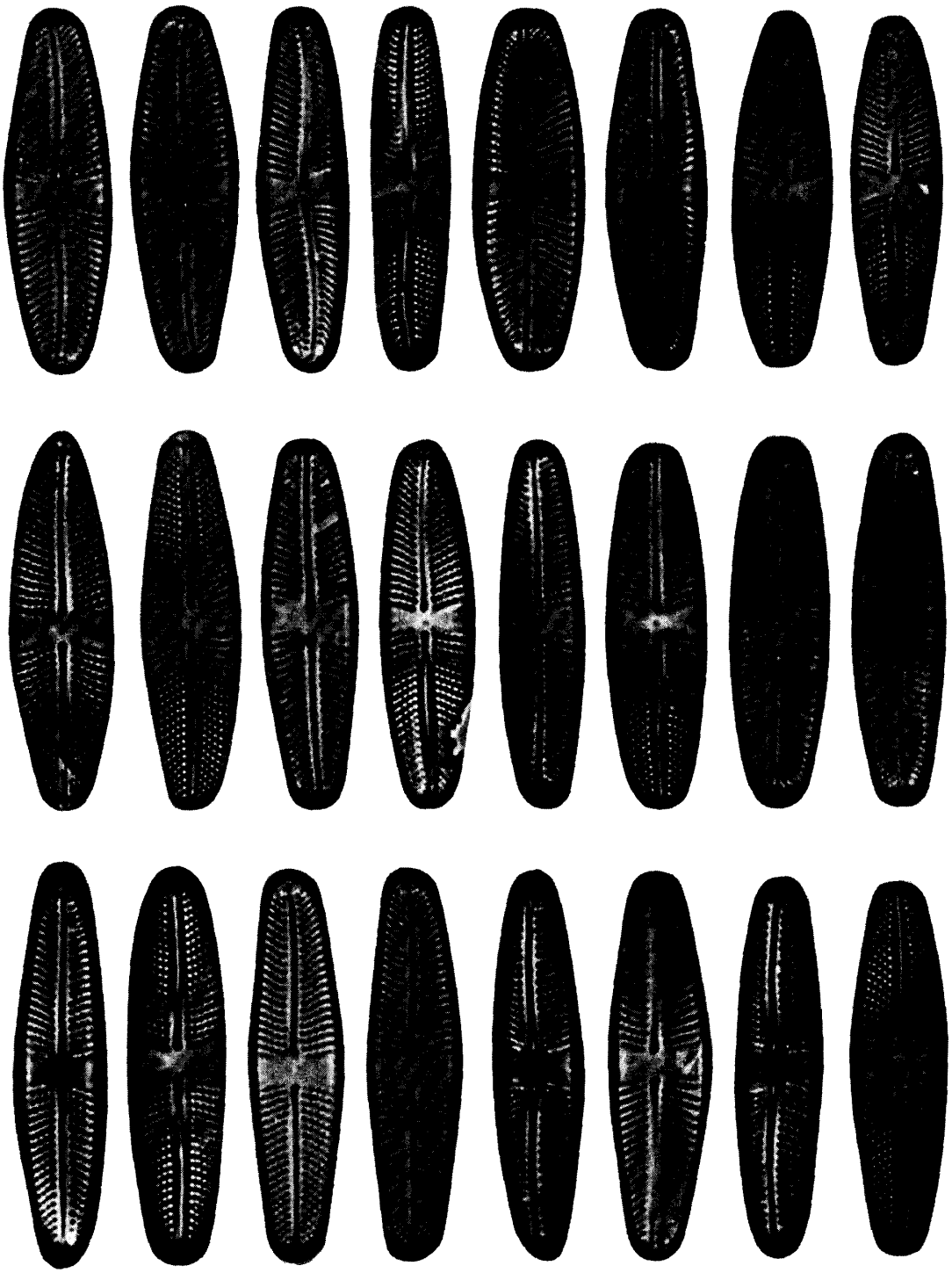

Plate 3. *Achnanthes brevipes* v. *intermedia.*

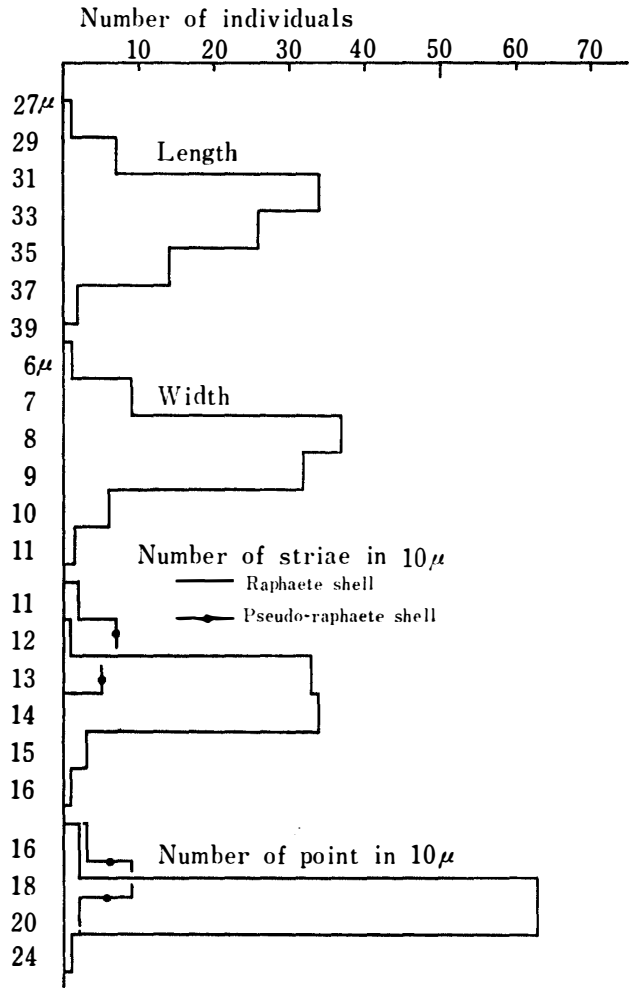

Fig. 1. Dimensions of *Achnanthes brevipes* var. *intermedia*.

III. VARIATIONS OF *NAVICULA MUTICOPSIS* VAN HEURCK VAR. *MUTICOPSIS* F. *MURRAYI* (W. & G. S. WEST) KO-BAYASHI

On the variation of *Navicula muticopsis* van Heurck var. *muticopsis* f. *muticopsis,* the writer reported in Antarctic Record, No. 14, 1962 edition, bearing on the materials collected in East Ongul Island. Now that new materials have been obtained for investigation, he reports the results of his further investigation.

The materials used for this investigation were collected on July 9, 1960 at Bybog Osane in the Antarctic Continent by Dr. TETSUYA TORII, leader of the Wintering Party of the Japanese Antarctic Research Expedition 1959–61. The writer wishes to thank Dr. TETSUYA TORII who kindly offered the materials for investigation.

After acid treatment, the writer mounted the specimens with pleurax, then took photomicrographs of 389 individuals at random. The photos were enlarged 2,000 times in order to examine the variation of the materials.

The naming of the species

The external shapes of *Navicula muticopsis* in the materials collected on the Antarctic Continent, were lanceolate elliptical, and the ends of most of the specimens were very much extended and remarkably capitate, the central parts were considerably dilated. Some of the individuals were linear, and their central parts were inflated. These two types were connected with many intermediate forms. The former was similar to the variety once described by F.E. FRITSCH (1912) as *Navicula globiceps* (Greg.) Ralfs var. *amphicephala* Fritsch (although the external features of this type resembled *Navicula muticopsis* van Heurck var. *gaushii* Heiden & Kolbe, the shape of the central area was different). The latter was similar to the species described by W. and G.S. WEST as *Navicula murrayi* W. & G.S. West or to *Navicula globiceps* (Greg.) Ralfs var. *elongata* Fritsch. The individuals, the shells of which were lanceolate-elliptical with ends extended in rostal shape, were similar to *Navicula murrayi* W. & G.S. West var. *elegance* W. & G.S. West. However, this type was also connected with many intermediate forms to the various types mentioned above.

The original description of *Navicula murrayi* stated that the central area has an isolate point. However, the original figure does not illustrate this feature, while the figure of *Navicula murrayi* var. *elegans* clearly shows an isolate point. In this connection, some individuals of *Navicula muticopsis,* as illustrated in the same thesis, had

isolate points and some had none. From observation of many specimens collected in the Ongul Islands, Antarctica, the writer could not find even a single individual which lacked an isolate point. It is thought that elsewhere in Antarctica, strains lacking isolate points may exist. In the thsis mentioned above, W. and G.S. WEST described that they could not find any striae in *Tropidoneis laevissima*. However, the writer found striae on the materials collected on the Antarctic continent. It is considered, therefore, that it is reasonable to believe that W. and G.S. WEST probably overlooked the isolate points.

The diminutive type of this form was almost of the same shape as that of the typical species which W. and G.S. WEST named *Navicula muticiopsis* f. *evoluta,* and the writer found a small number of individuals which were equal to *Navicula muticopsis* var. *muticopsis* f. *muticopsis,* from the photomicrographs taken for this research. Although this typical species was thought to be connected with many others, the writer considers that the above-mentioned types do not belong to the typical species, as their numbers were less, but they represent typical species by themselves.

As the oldest name described in the literatures was *Navicula murrayi,* the writer regarded this form as *Navicula muticopsis* van Heurck var. *muticopsis* f. *murrayi* (W. & G.S. West) and arranged it as follows:

Navicula muticopsis van Heurck var. *muticopsis* f. *murrayi* (W. & G.S. West) Ko-Bayashi

Synonym

Navicula murrayi W. & G.S. West in Brit. Antarc. Exp., 1907–09: 285, pl. 26, f. 129 (1911).

Navicula murrayi W. & G.S. West var. *elegans* W. & G.S. West, in l.c., 285, pl. 26, f. 130 (1911).

Navicula globiceps (Greg.) Ralfs var. *amphicephala* Fritsch, in Nat. Antarc. Exp., 1901–46: 53, pl. 3, f. 154 (1912).

Navicula globiceps (Greg.) Ralfs var. *elongata* Fritsch, in l.c., 53, pl. 3, f. 155 (1912).

Comparing the photomicrographs of 389 individuals the writer has made the following description.

Navicula muticopsis van Heurck var. *mutitopsis* f. *murrayi* (W. & G.S. West) Ko-Bayashi.

Shells are linear and dilated at central part, or lanceolate to elliptical and slightly extended at the ends. Ends are from rostal capitate to typical capitate (in most cases, shells are elliptical lanceolate and ends are extended in capitate shape).

Length of shells 14–58 μ

Width of shells 7–13 μ

Axial areas are linear or narrow lanceolate, and shapes vary from narrow to moderately narrow, although most are rather narrow linear. Central areas are elongate elliptical or rectangular, one margin is large and the other is small and a clear isolate point is found on the small margin. Striae consist of many clear spots and are radial. Number is 12–17 in 10μ.

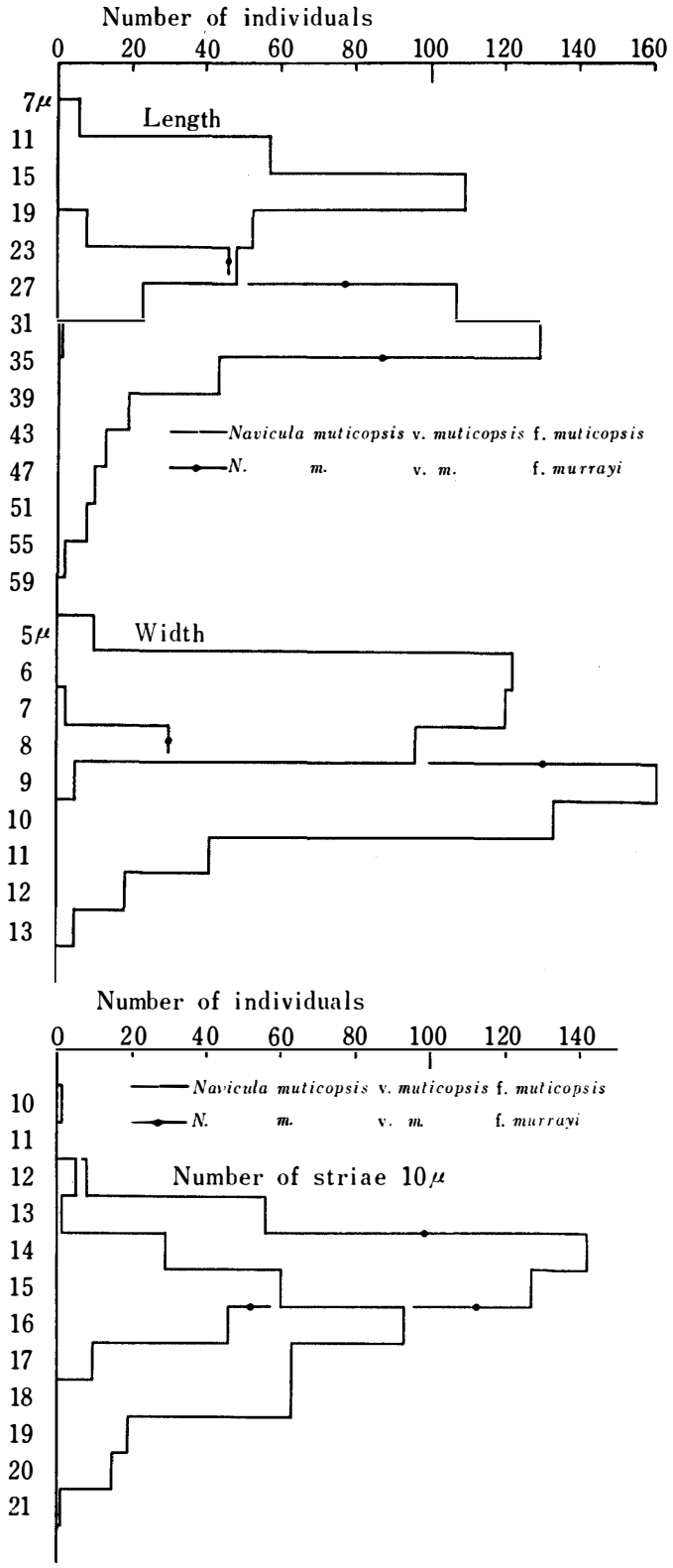

Fig. 2. Dimensions of *Navicula muticopsis* v. *muticopsis* f. *muticopsis* and *N. m.* v. *m.* f. *murrayi*.

Size of shells

The size of shells of the 385 individuals investigated were as follows:

Length was 14–58μ. Individuals of 23–38μ length were numerous and those between 31 and 34μ were most numerous. Width was 7–13μ. Individuals 9 and 10μ wide numerous of which 9μ was the most numerous. Striae number in 10μ was 12–17. 13–16 were numerous and 14 was the most common.

These values were larger than the measurement of typical species (KO-BAYASHI 1962; length of shell: 13–25μ, width: 7–10μ, striae in 10μ: 10–21) and striae were more coarse.

Size of this species and typical species may be compared by the histogram in figure (Fig. 2). There were many individuals which could be distinguished only by size from typical species and these were classified according to forms as stated before. There was a difference of 44μ between the longest individual and the shortest individual, while there was difference of only 5μ between the widest individual and the narrowest one. From this fact, it is concluded that the length of this diatom decreases rapidly as a consequence of repeated cell-division while width does not change to the same extent.

The following is a table which shows traditional scientific names of this species and its size.

Table 1. Measurement of *Navicula murrayi*.

Researcher	Reported year	Length of shells (μ)	Width of shells (μ)	Striae nos. in 10 μ	Traditional scientific name
W. and G.S. West	1911	45	11.5	14	*Navicula murrayi*
〃	〃	31	8.1	15	*N. m.* var. *elegans*
Fritsch	1912	43	10	—	*N. murrayi*
〃	〃	22–25	9.5–10	—	*N. globiceps* f. *amphicephala*
〃	〃	35–38	10–12	—	*N. g.* var. *elongata*

According to Table 1, *Navicula murrayi* is the largest, and then comes *Navicula globiceps* var. *elongata, Navicula murrayi* var. *elegans,* and *Navicula globiceps* f. *amphicephala* in order.

Among the materials the writer investigated, *Navicula murrayi* type and *Navicula globiceps* var. *elongata* type were the largest and then came in order *Navicula murrayi* var. *elegans* type, and *Navicula globiceps* var. *amphicephala* type and then *Navicula muticopsis*. This fact was in accord with the traditional records.

Malformation

The instances of malformation of this species were very few and only 4 individuals were found among 389 examined. Three individuals out of four had shells which did not grow equally at both right and left margins, and in one, margins grew extraordinarily. Therefore, these seemed to be *Cymbella*, but the raphe was straight. The remaining one had a shell which seemed to be *Achnanthes* curved inside at girdle view.

The writer could not find any reason why these 4 malformed individuals grew: they were observed among larger sizes of individuals (14–58μ of length, and 7–13μ of width).

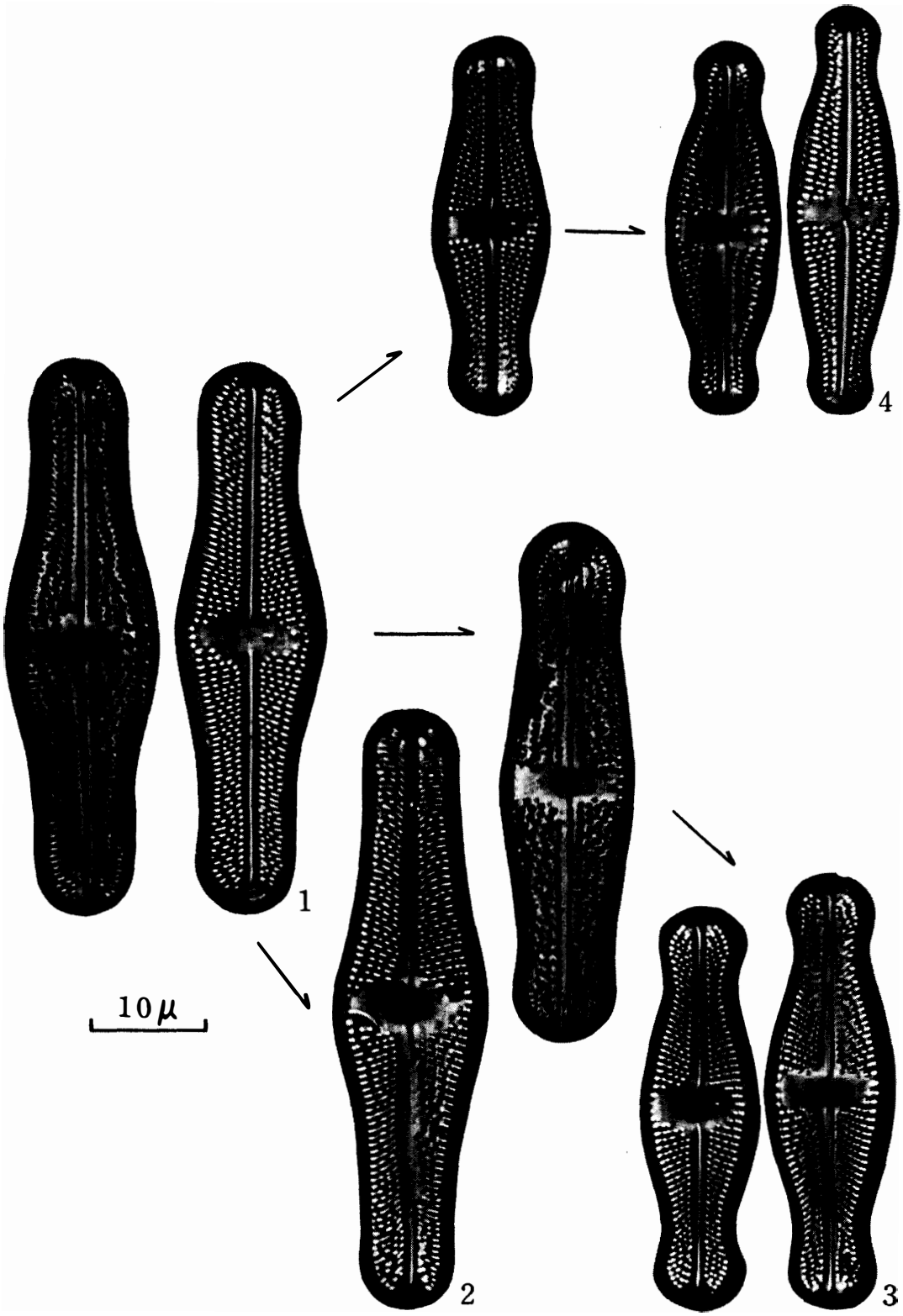

Plate 4. *Navicula muticopsis* var. *muticopsis* f. *murrayi*.
1: *N. murrayi* type. 2: *N. globiceps* var. *elongata* type. 3: *N. globiceps* f. *amphicephala* type. 4: *N. muticopsis* var. *elegans* type.

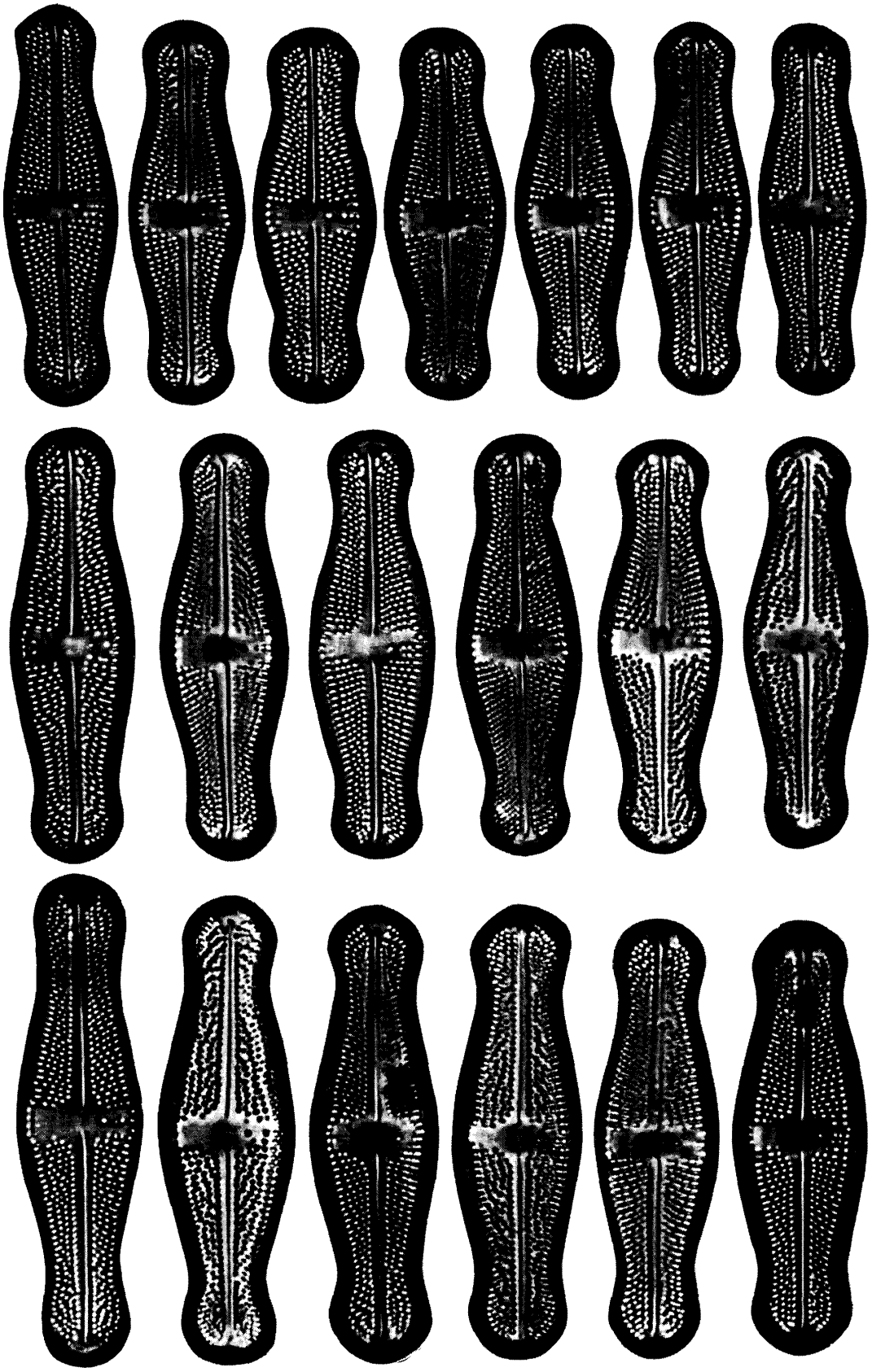

Plate 5. *Navicula muticopsis* var. *muticopsis* f. *murrayi* (*N. globiceps* type).

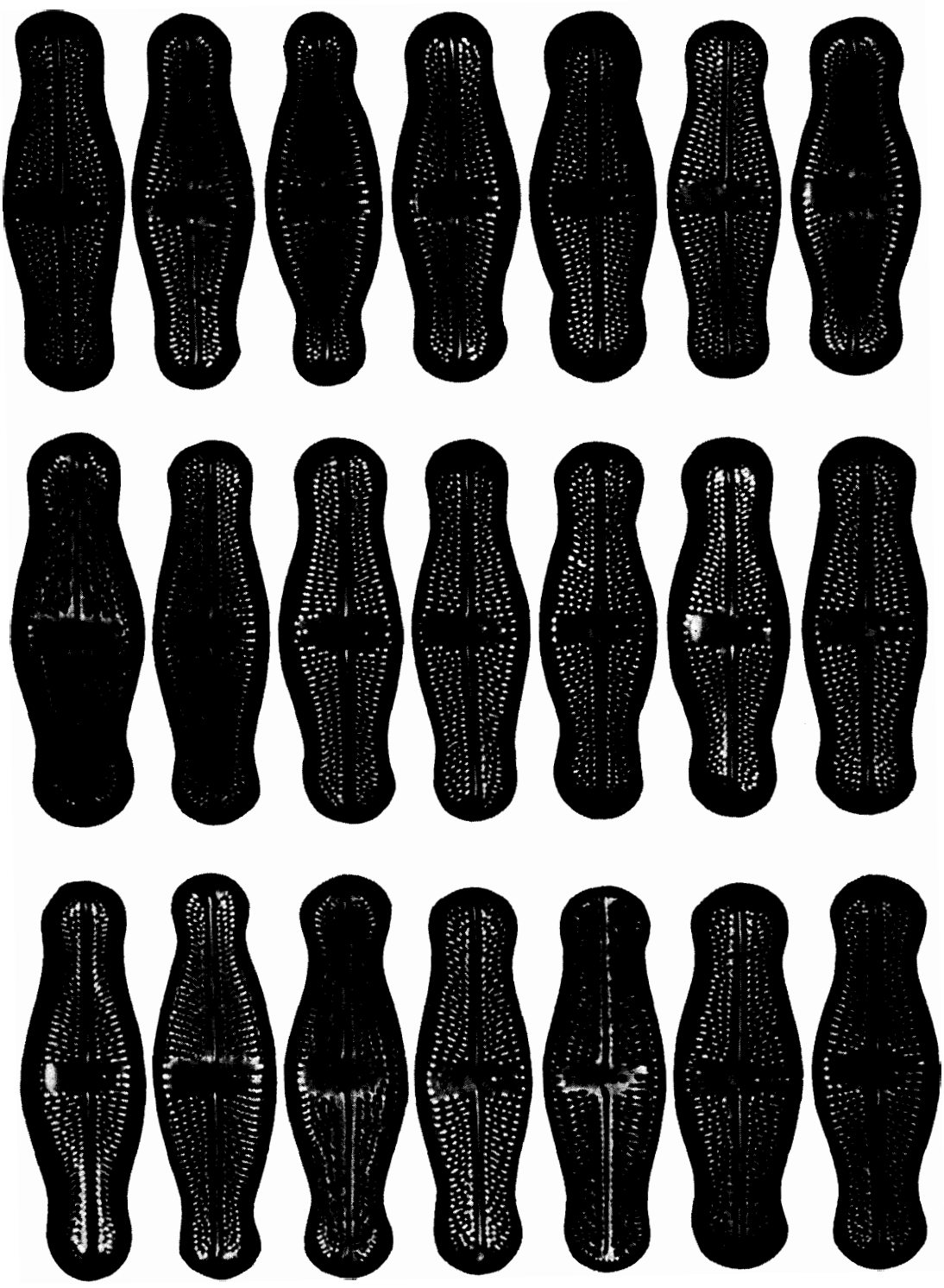

Plate 6. *Navicula muticopsis* var. *muticopsis* f. *murrayi* (*N. globiceps* type).

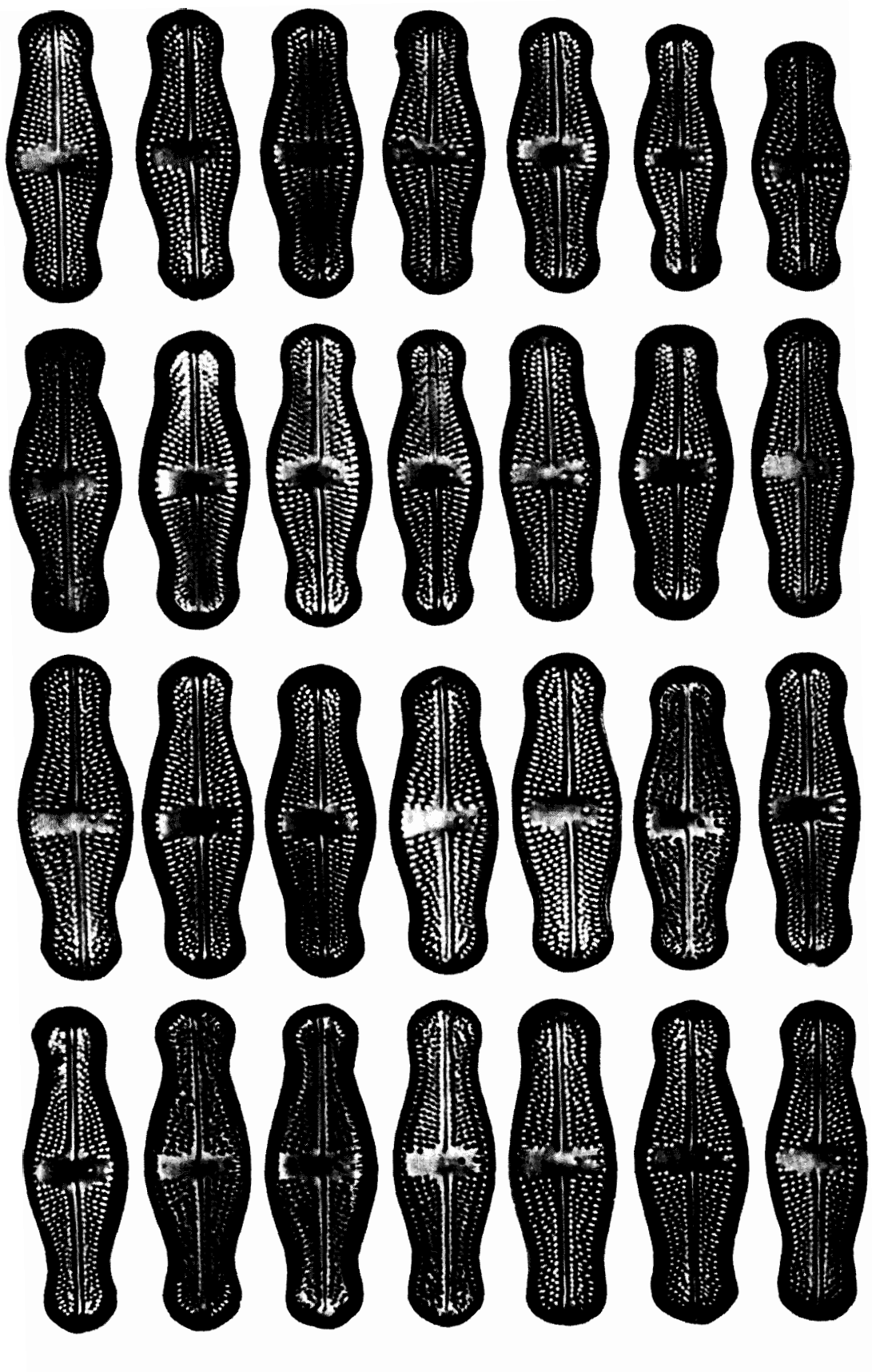

Plate 7. *Navicula muticopsis* var. *muticopsis* f. *murrayi* (*N. globiceps* type).

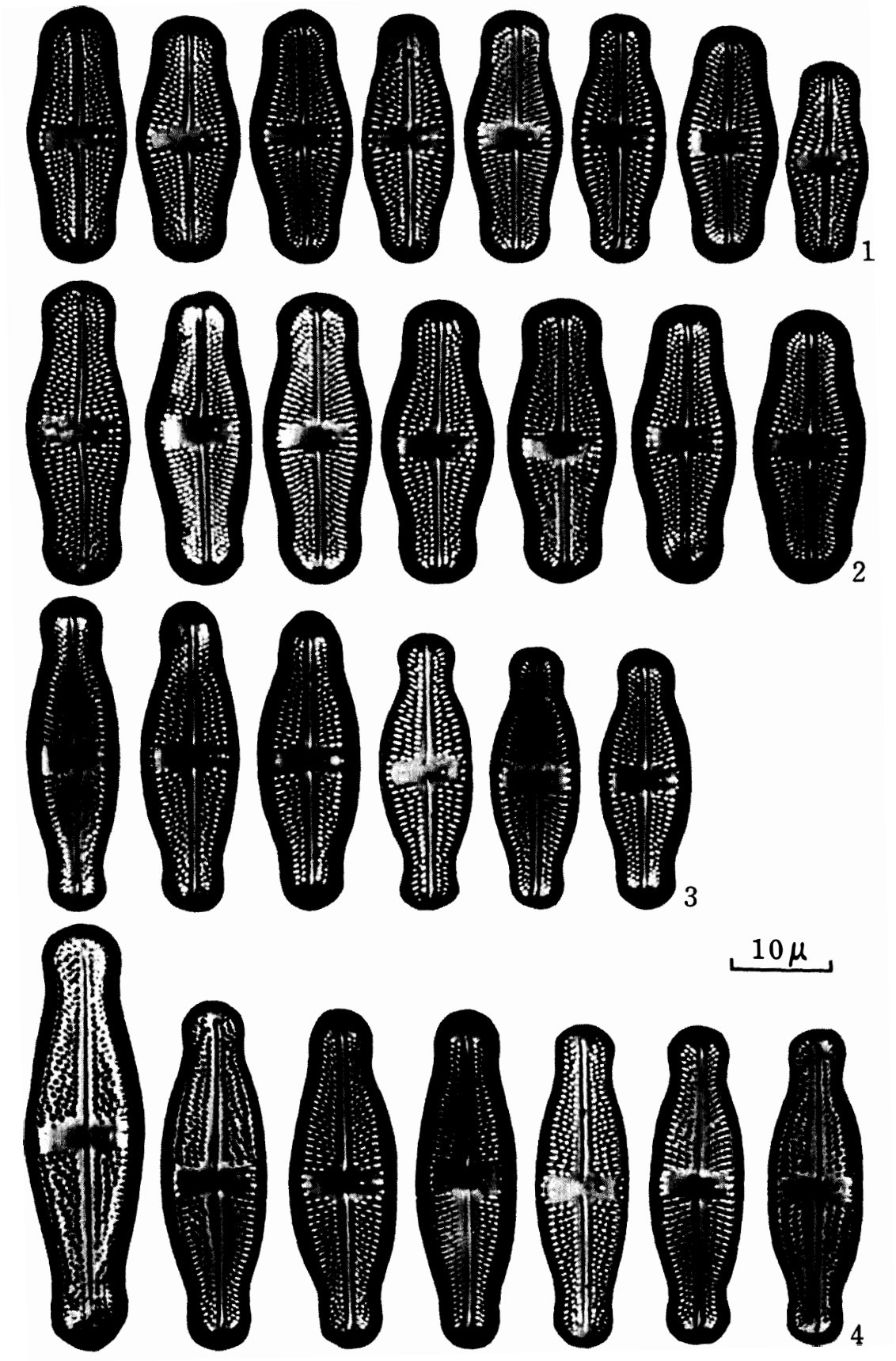

Plate 8. *Navicula muticopsis* var. *muticopsis* f. *murrayi*.
1,2: *N. muticopsis* f. *evoluta* type. 3,4: *N. murrayi* var. *elegans* type.

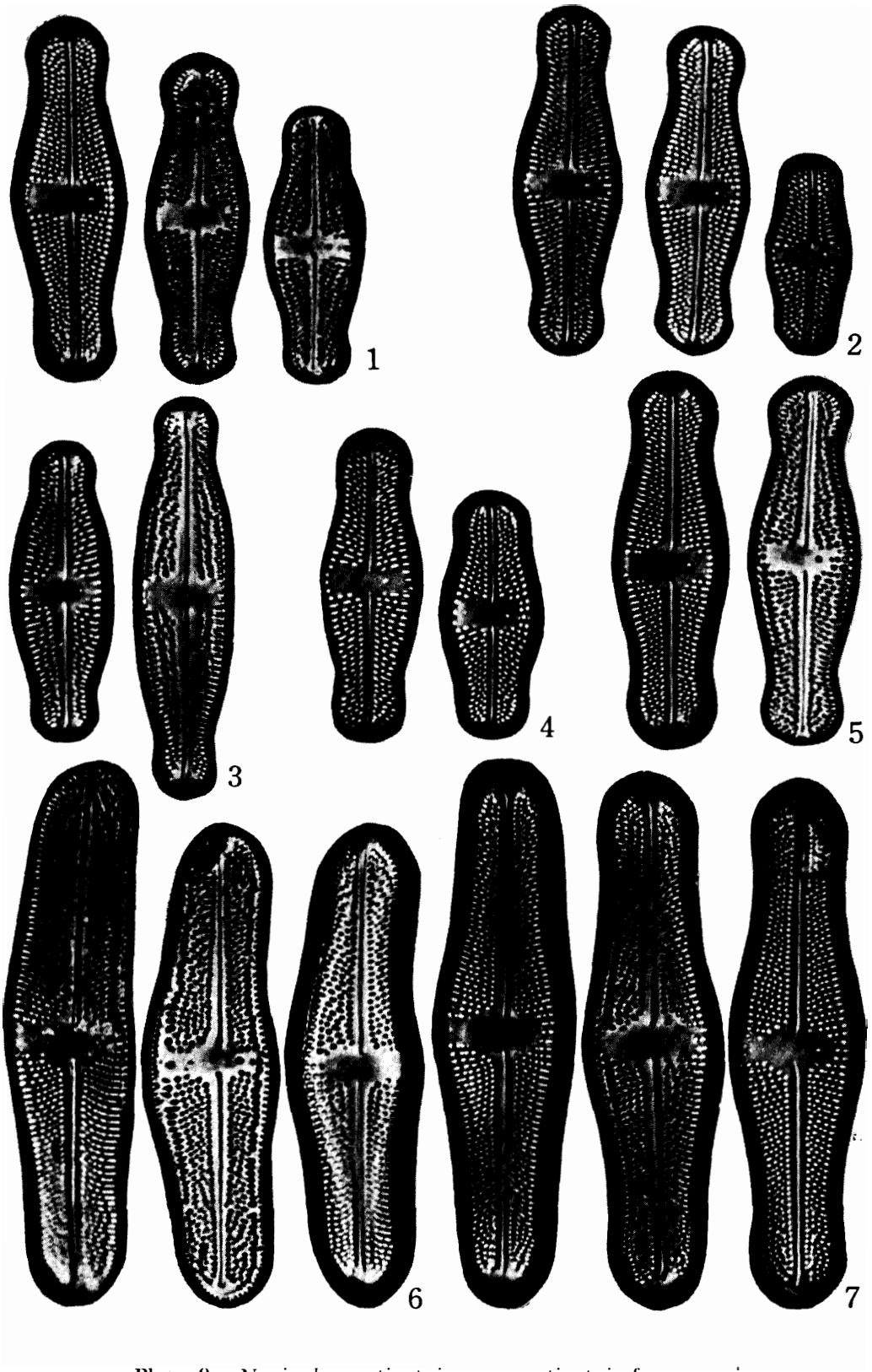

Plate 9. *Navicula muticopsis* var. *muticopsis* f. *murrayi*.
1: Quadrate central area type. 2: Oblong central area type. 3: Lanceolate axial area type. 4: Linear axial area type. 5: Linear-lanceolate axial type. 6: Abnormal form. 7: Typical form of *Navicula murrayi*.

IV. VARIATIONS OF *PINNULARIA SUBCAPITATA* GREGORY

The writer made investigations on the materials collected in January, 1962 in lat. 54°13′S and in long. 36°33′W by the Research Organization of the Tokyo University of Fisheries, headed by Professor TAKEHARU KUMAGORI. He treated the materials with acid, and mounted them with pleurax to make permanent slides. Photomicrographs of 380 individuals were taken at random and then variation was examined.

Classification of *Pinnularia subcapitata*

This species has been classified into many varieties or forms. The varieties or forms mentioned below are identified and described in the existing literature.

Pinnularia subcapitata Gregory var. *subcapitata* f. *subcapitata,* Gregory, in Q.J.M.S., 4:5, pl. 1, f. 30 (1856); Cleve, Nav. Diat., **2**:75 (1895); Schönfeldt, Diat. Germ., 169, pl. 12, f. 194 (1907); Boyer, Diat. Philad. 105, pl. 29, f. 20 (1916), in Proc. Acad. N.S. Philad., 88, Sup. 432 (1927); Hustedt, in Süssw. Fl. **10**: 311, f. 571 (1930), in A.f.H., Sup. **15**: 288 (1938), in Expl. Parc. Nat. Alb., **8**: 101, pl. 8, fs. 6–15 (1949); Cholnoky, in Nova. Hedw., **2** (1–3): 113 (1960).

Synonym

Navicula subcapitata Greg. van Heurck, Synop. 78 (1885).

Shells vary from linear to linear lanceolate. Shell margins are parallel or slightly curved and ends are slightly capitate. Length: 20–50μ, width: 5–8μ, axial areas are narrow linear and central areas are extended to the margins, long and narrow or elliptical in shape. Numbers of striae are 11–13 in 10μ. Central part is radial and the ends are constricted.

Pinnularia subcapitata Gregory var. *subcapitata* f. *constricta* Hustedt in Arch. f. Hydrob. Sup., **15**: 288 (1938).

External shape of shells is the same as the typical species, but can be distinguished by its constricted middle part.

Pinnularia subcapitata Gregory var. *hilseana* (Janisch) O. Müll. f. *hilseana,* Shönfeldt, Diat. Germ. 169 (1907); A. Mayer, Bay., **1**: 35, pl. 3, fs. 27, 28 (1917); Hustedt, in Süssw. Fl. **10**: 317 (1930), in Expl. Parc. Nat. Alb., **8**: 101 (1949); Cleve-Euler, in K. Sv. Vet. Hand., **5** (4); 65, fs. 1090 n-r (1955); Cholnoky, in Nova. Hedw., **2** (1–3): 113 (1960).

Synonym

Navicula hilseana Janisch. A. Schmidt, Atlas pl. 45, f. 65 (1876).

Ends are constricted and extended in capitate shape.

Pinnularia subcapitata Gregory var. *hilseana* (Janisch) O. Müll. f. *undulata* O. Müll. Hustedt, in Süssw. Fl., **10**: 317 (1930).

Margins are expanded three times.

Pinnularia subcapitata Gregory var. *subrobusta* A. Cleve-Euler, in Soc. Sc. Com. Biol., **4** (14): 61, f. 95 (1934), in K. Sv. Vet. Hand., **5** (4): 65, f. 1090 h (1955).

Shell margins are parallel or slightly penetrated. Ends are extended in rostral shape.

Pinnularia subcapitata Gregory var. *lapponica* A. Cleve-Euler, in Soc. Sc. Fen. Com. Biol., **4** (14): 61, f. 94 (1934), in K. Sv. Vet. Handl., **5** (4): 65, fs. 1090 i-m (1955).

Shell margins are slightly extended.

Pinnularia subcapitata var. *paucistriata* Grun. in van Heurck's Synopsis 79, pl. 6, f. 23 (1881–85); Cleve, Nav. Diat., **2**: 75 (1895); Schönfeldt, Diat. Germ., 169 (1907); A. Meyer, Diat. Bayerns **1**: 35 (1917); Hustedt, in Süssw. Fl., **10**: 317 (1930), in A.f.H. Sup., **15**: 288, pl. 23, f. 15 (1938); Cleve-Euler, in K. Sv. Vet. Hand., **5** (4): 65, fs. 103 OB (1955).

Shell ends are round and not extended, but they are a little rostral. Striae are short and axial areas are slightly wide lanceolate.

CLEVE-EULER describes a new variety, namely var. *distans* (K.S. Vet. Handl., **5** (4): 65). In the description, he states that this variety resembles var. *paucistiata,* although a little larger, and striae are less in number. The dimensions of these two varieties are as follows:

	Length μ	Width μ	Number of striae in 10 μ
var. *paucistriata*	17–25	4.2–5	11–14
var. *distans*	25–35	–6.8	10

According to the above-mentioned values it seems that these two varieties are related, and it is not satisfactory to classify them only by their measurement values. Therefore, the writer regards var. *distans* as a synonym of var. *paucistriata.*

Pinnularia subcapitata Gregory var. *ceylonica* Skv. in Ann. Roy. Bot. Gard. Peradeniya (Ceylon J. Sc. Ser. A.), **11** (3): 256, pl. 33, f. 3 (1930).

Shells are linear and ends are round and not extended. Length: 30–80μ, width: 6–7μ. Striae are a little shorter and axial areas are slightly wide rhombic-lanceolate. Number of striae is 18 in 10μ. Although resembling var. *paucistriata,* this variety is larger and the striae are thicker.

Variation in the shape of shells

Arranging the photomicrographs of the materials collected at South Georgia in order, the writer observed the following variations of the shape of the shells:

External shapes of the shells were linear or lanceolate linear, and both ends were extended in sub-capitate rostral shapes. Some variation was also observed in the exten-

sion of the ends, but this was not so remarkable, and the shape of ends could be regarded as sub-capitate rostral.

The margins were almost parallel or slightly inflated. There were many materials in which it could not be ascertained whether the margins were parallel or inflated. Among the 380 individuals examined there were five individuals in which both margins were slightly constricted. However, the degree of constriction was different. It was easy to distinguish in the shape of the typical individuals whether both margins were extended or parallel, or constricted, but as most of them were linked by various intermediate forms, the writer thought it unsuitable to classify the varieties or the species into the following three groups according to shapes. 1) margins are slightly inflated, 2) margins are parallel and 3) margins are slightly constricted.

Axial areas were linear or narrow as already mentioned in the literature. Among these types of individuals, many individuals were found somewhat having wide lanceolate areas. The typical individuals of these two types could be easily distinguished but there were many intermediate forms which could not be distinguished.

The individuals which had narrow linear axial areas could be identified as typical species, and those which had wide lanceolate axial areas could be identified as var. *paucistriata* (some authors state that the characteristics of var. *paucistriata* are that the shell ends are not extended, or slightly extended, while others state that the characteristics of var. *paucistriata* are that the axial areas are somewhat wide lanceolate, the striae short, regardless of the shape of shells). Judging from the important characteristics of var. *paucistriata* such as variation in the width of axial area, it is believed that var. *paucistriata* should be considered as a synonym of var. *subcapitata,* as there still remains doubt about the identification of var. *paucistriata.* The writer has arranged them as follows:

Pinnularia subcapitata Gregory var. *subcapitata*

Synonym

Pinnularia subcapitata Gregory var. *paucistriata* Grun.

Pinnularia subcapitata Gregory var. *distans* Cleve-Euler.

Length of shells was 30–40μ. Individuals of 35–38μ width were most numerous and among them, individuals 37μ broad were most abundant. It has already been stated in the records that the length of shells is 20–50μ. Apart from that, no new fact was discovered from the materials of this research.

Width of shells was 4.5–5.5μ. Among these, individuals of 5μ width were most numerous. Existing records state that the width of the shells is 5–8μ. The writer found only a few individuals having narrow shells. Among the materials investigated, the difference of width between the narrowest and the widest individuals was only 1μ. Therefore, the writer has assumed that the length of shells of these individuals decreases as a result of cell-division, but that width does not change so remarkably.

Number of striae in 10μ was 10–13. According to previous records, it is 11–13. The writer found some individuals in which the distances between the coarse striae were greater. The individuals of wide axial areas — so-called var. *paucistriata* — had also 10–13 striae in 10μ, According to CLEVE-EULER, the individuals which have 10 striae in 10μ should be indentified as var. *distans,* and those which have more striae should be indentified as var. *paucistriata.* But since there were no special characteristics

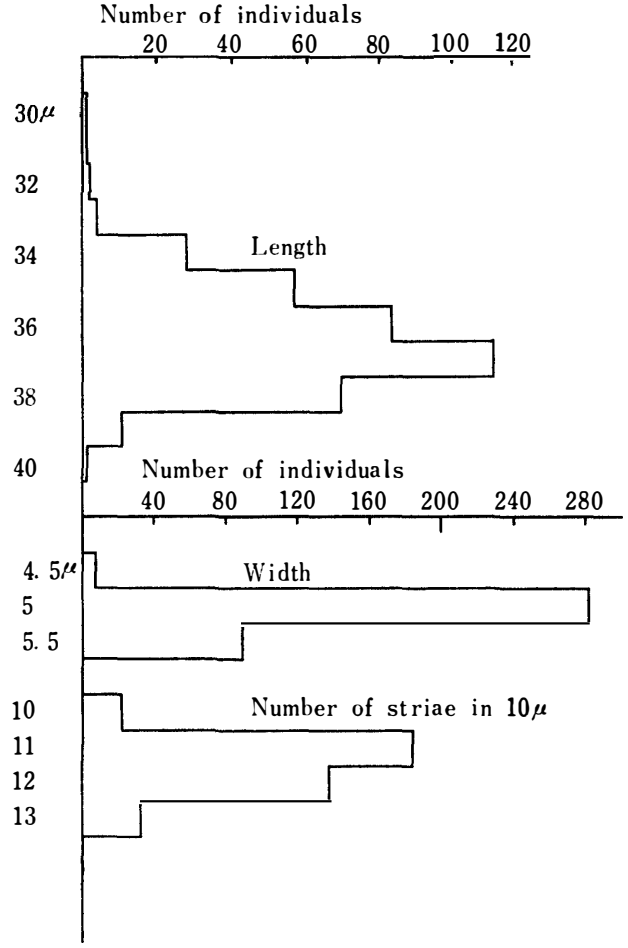

Fig. 3. Dimensions of *Pinnularia subcapitata*.

to distinguish these two varieties from the materials collected at South Georgia, var. *distans* should be indentified as a synonym of typical species as the writer described before.

Out of the materials which were investigated, the writer could not find even a single individual which had an elliptical central area. All individuals were long and narrow in shape.

HUSTEDT (1949), after investigations of diatoms at Albert National Park in Africa, stated that the external shapes of *Pinnularia subcapitata* from this district varies a great deal, and actually he observed such variations. The shape at the terminal portions of these individuals varied from elliptical to rostral or to capitate rostral. Further, he stated that there were also many individuals which had either an elliptical central area or were extended to both margins in long and narrow shape, and some were extended to one margin only. There were no explanations accompanying HUSTEDT's illustrative figures. The author found that the shape of the axial area had many variations from narrow to wide as was found in material from South Georgia.

According to HUSTEDT's observation, it seems possible to explain many variations of

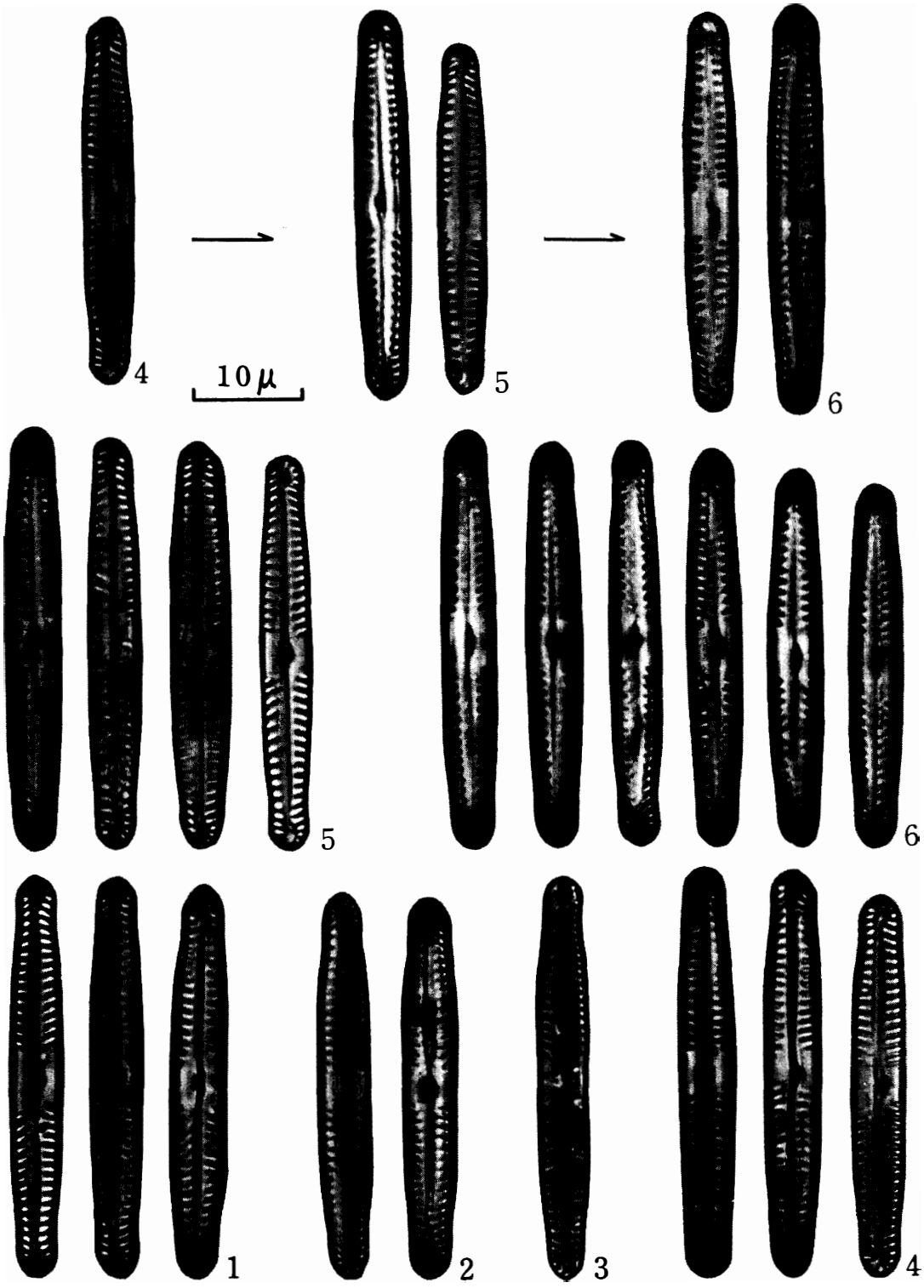

Plate 10. *Pinnularia subcapitata* v. *subcapitata.*
1: Individuals which have parallel margins. 2: Individuals which have slightly constricted margins. 3: Individuals which have constricted margins. 4: Individuals which have narrow axial area. 5: Individuals which have slightly wide axial area. 6: Individuals which have widely axial area.

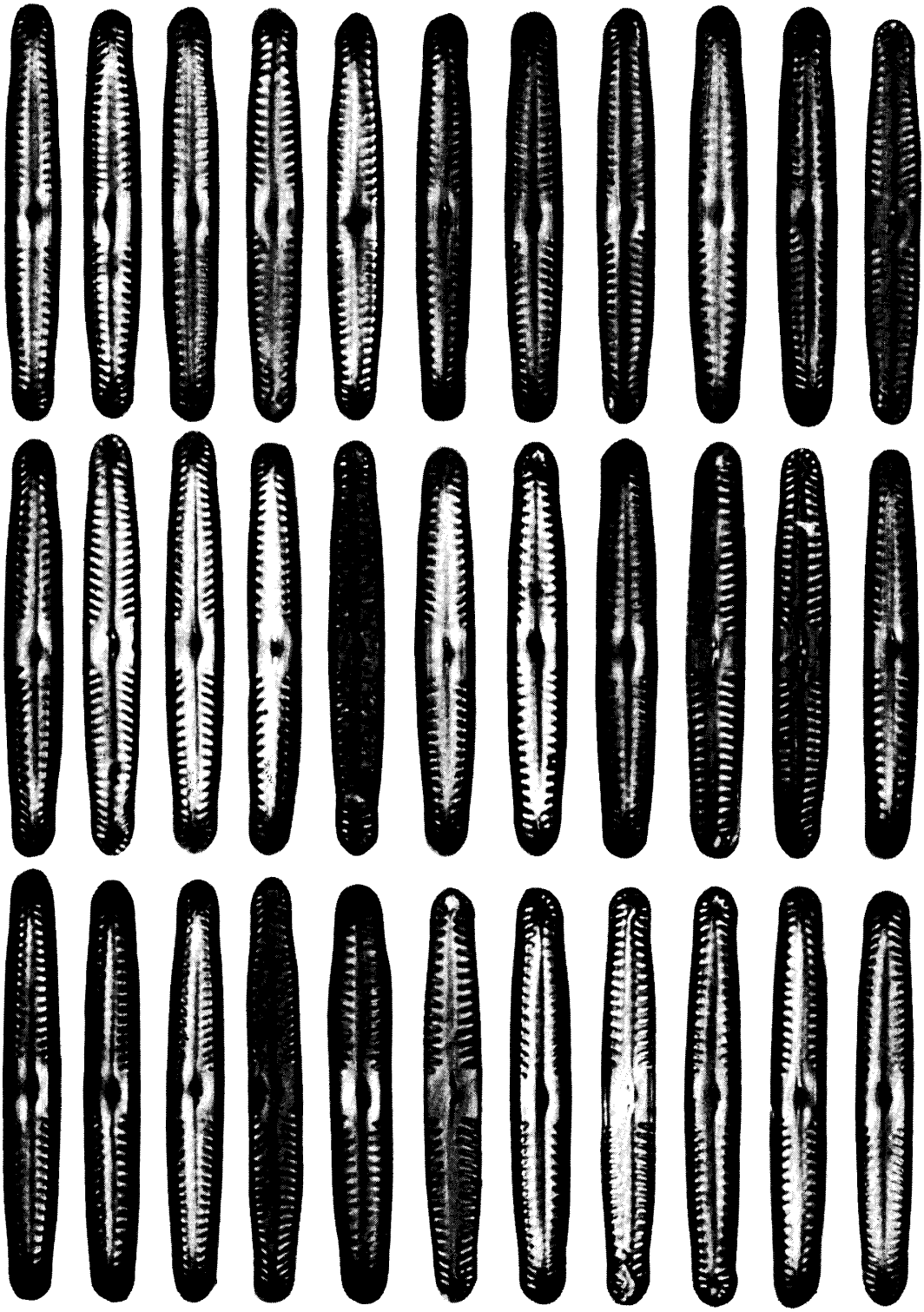

Plate 11. *Pinnularia subcapitata* v. *subcapitata*.

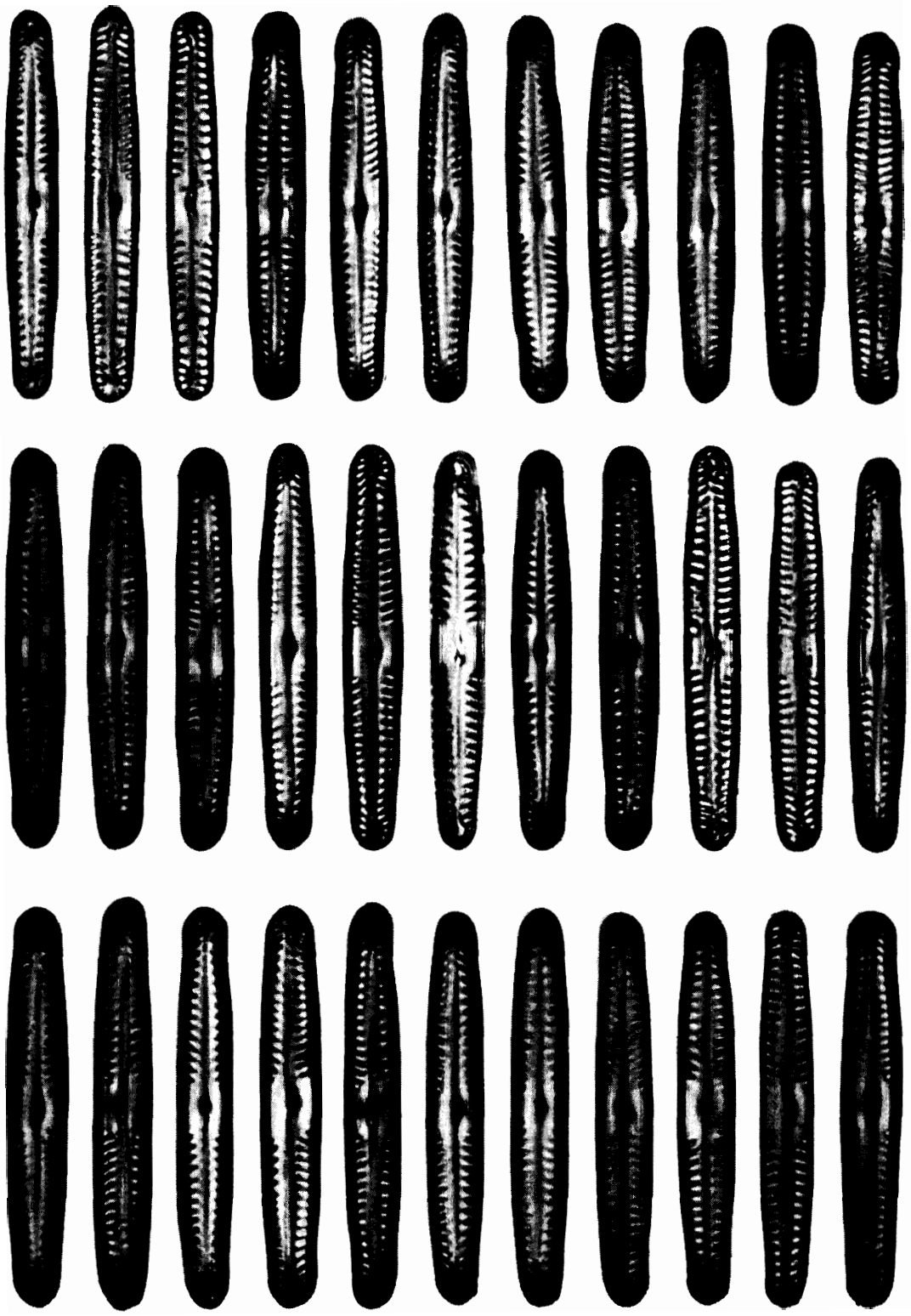

Plate 12. *Pinnularia subcapitata* v. *subcapitata*.

the species noted in the early pages of this report, but HUSTEDT himself did not try to do so. Here, the writer states only that the two varieties, var. *paucistriata* and var. *distans* are regarded as synonyms of typical species, based on the observation of the materials from South Georgia. It is intended to give further explanation after making further explanations.

The following is the key to those varieties or species so far recorded.

I. Both ends are remarkably constricted to capitate shape.
  1. Both margins are parallel
     var. *hilseana* (Janisch) O. Müll. f. *hilseana*
  2. Both margins are elevated three times
     var. *hilseana* (Janisch) O. Müll. f. *undulata* O. Müll.

II. Both ends are slightly constricted or hardly extended.
  1. Striae are short and thick (16 in 10μ)
     var. *ceylonica* Skv.
  2. Striae are not short and not thick (10–14 in 10μ)
    A. Both ends are extended in rostral form
       var. *subrobusta* Cleve-Euler
    B. Both ends are slightly extended
       var. *lapponica* Cleve-Euler
    C. Both ends are only slightly extended
      a. Both margins are almost parallel
         var. *subcapitata* Greg. f. *subcapitata*
      b. External portion of margins are constricted
         var. *subcapitata* Greg. f. *constricta* Hust.

Taking into consideration the various forms of *Pinnularia subcapitata* described in the literature and also those investigated here, the writer has arranged them as follows:

Pinnularia subcapitata Gregory var. *subcapitata* f. *subcapitata.*

Shells were linear or linear lanceolate, both margins were parallel or slightly inflated or slightly constricted. Both ends were extended in sub-capitate rostral shape, length: 20–50μ, width: 4.5–8μ. Striae were radial at central part and convergent at both ends. As the length of striae varied considerably, axial area also varied from narrow to wide lanceolate. Striae number was 10–13 in 10μ. Central area was elliptical and extended to both margins in long and narrow shape.

The writer investigated 380 individuals of *Pinnularia subcapitata* collected at South Georgia but he could not find any malformed individuals. It was very rare that even one malformed individual could not be found out of almost 400 individuals.

V. VARIATIONS OF *TROPIDONEIS LAEVISSIMA* W. & G. S. WEST

Tropidoneis laevissima W. & G.S. West was collected by the British Antarctic Expedition team from Clear Lake, Green Lake and McMurdo Sound in Ross Island. It was recognized and regarded as a new species by W. and G.S. WEST. W. and G.S. WEST stated that this species was found in fresh water and in a few lakes containing large concentrations of salt. In both cases it was found in large quantities, and it was one of the most important diatoms collected in the Antarctic continent. This species has not been reported since then. However, FUKUSHIMA (1962) states that this species is spread in quantites on Kasumi Rock and on Shin-nan Rock of the Antarctic continent.

The materials used for this study were collected by Dr. HIROSHI FUKUSHIMA, assistant professor of Yokohama Municipal University, on Kasumi Rock of the Antarctic continent, on the 20th of February, 1961. According to FUKUSHIMA, these materials were attached to prophyritic diorite at the bottom of a pond on Kasumi Rock St. 7. *Stauroneis laevissima* was the dominant species in this place. The pond contained a good deal of salt (Cl^- 5,176 mg/ℓ). The bottom was black because of the presence of hydrogen sulphide.

The variation of the present species was examined by the photomicrographs of the specimens taken, permanent preparations of 250 individuals were made. The specimens were mounted with pleurax after the acid treatment. Photomicrographs were taken using a Zeiss 90 X apochromat, and then enlarged fifteen hundred times.

Variation in shape

The external features of the species is as follows:

Tropidoneis laevissima W. & G.S. West, in Rep. Sc. Invest. Brit. Antarct. Exp., 1907–09, 1 (7): 281, pl. 26, fs. 115–120 (1911).

Shell usually linear, sometimes linear-elliptic. The ventral and the dorsal sides are parallel or slightly convex sometimes; the central portions of both sides are swollen rarely, and in this case the ends are narrower than those, the central portions of which are not swollen. The ends broadly rounded and rarely rostrate. The length of the shell 27–98μ, the width 5–9.5μ. The raphe is situated in the middle of the shell, and is straight. Axial area is narrow and linear. Central area extends to the valvar margins, forming a stauros.

Striae slightly radial at the central part; slightly convergent at the ends but sometimes vertical to raphe. Striae are as dense as 20–28 in 10μ, usually 22–26 in 10μ. Girdle view is truncate oblong with a constriction in the middle part.

W. and G.S. WEST state that the shell is linear elliptic, but a considerable portion of the materials collected for the present study, from Kasumi Rock, are linear (Pl. 13, Fig. 1), some of them are linear-elliptic and very rarely rhomboid-lanceolate (Pl. 13, Fig. 3).

The comparison between the materials of two different shapes, linear and rhomboid-lanceolate, may tempt students to establish a variety or a forma. However, closer examination shows that these are the extremes, and that the division of a variety or of a forma would be incorrect.

Individuals, the shells of which are swollen in the central portion are rarely found, and the individuals of this kind usually have narrow ends (Pl. 13, Fig. 2). One may be tempted to include these extremely-shaped individuals in another variety, although the present author considers separation unnecessary. Valvar ends of most individuals are broadly rounded, rarely rostrate (Pl. 13, Fig. 4).

FUKUSHIMA (1962) calls the individuals with twice-undulated valvar margins forma *nagatae*. However, individuals which are identical with this species are not found.

As mentioned above, much variation is observed in the valvar shape of the present species.

W. and G.S. WEST state that the stauros-shaped central area is "very narrow," while in the materials examined here, individuals with simply a "narrow" central area are more numerous though there were individuals with a "very narrow" central area.

Some individuals with "slightly wide" central area are also found. Considerable variation is observed in the width of the stauros.

Size of the shell

W. and G.S. WEST state that the length of the shell is 49–98μ. The length measuered by the present author on 250 idividuals was 27–79μ, smaller than that described by W. and G.S. WEST. The histogram of the measurement is shown in Fig. 4. The mode is 35–40.

W. and G.S. WEST indicate that the width of the shell is 8–9.5μ. However the width of the specimens examined here is 5–9μ, and thus smaller. The histogram is shown in Fig. 4. The mode is 7μ; individuals 6–7.5μ wide are many.

Concerning striae, W. and G.S. WEST state they could not find them in spite of careful focusing at about 2,000 times magnification, using a Leitz-made oil immersion lens. However, this author observed 20–28 striae in 10μ. Considerable variation in the number of striae was observed. The histogram is shown in Fig. 4. Specimens with 22–26 striae were dominant. The mode was 24. Striae slightly radiate in the middle; slightly convergent at the ends but sometimes almost perpendicular to the raphe.

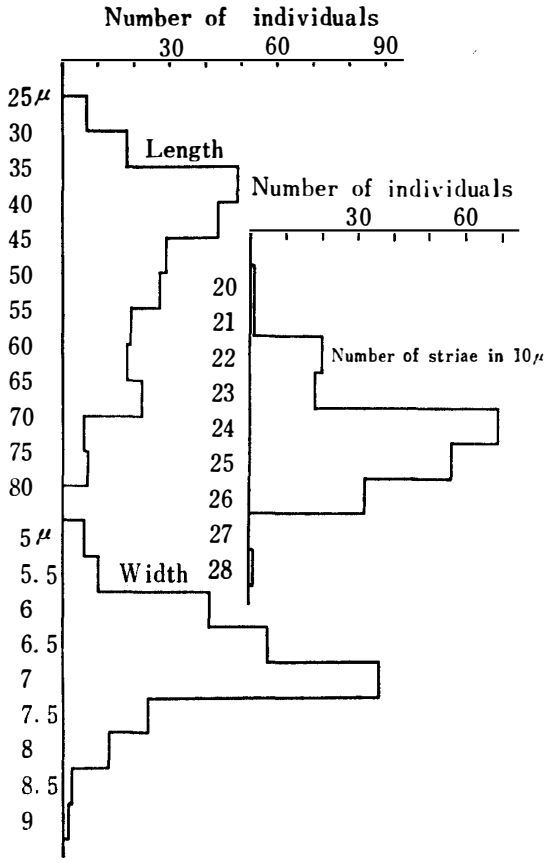

Fig. 4. Dimensions of *Tropidoneis laevissima*.

(Manuscript received February 26, 1963)

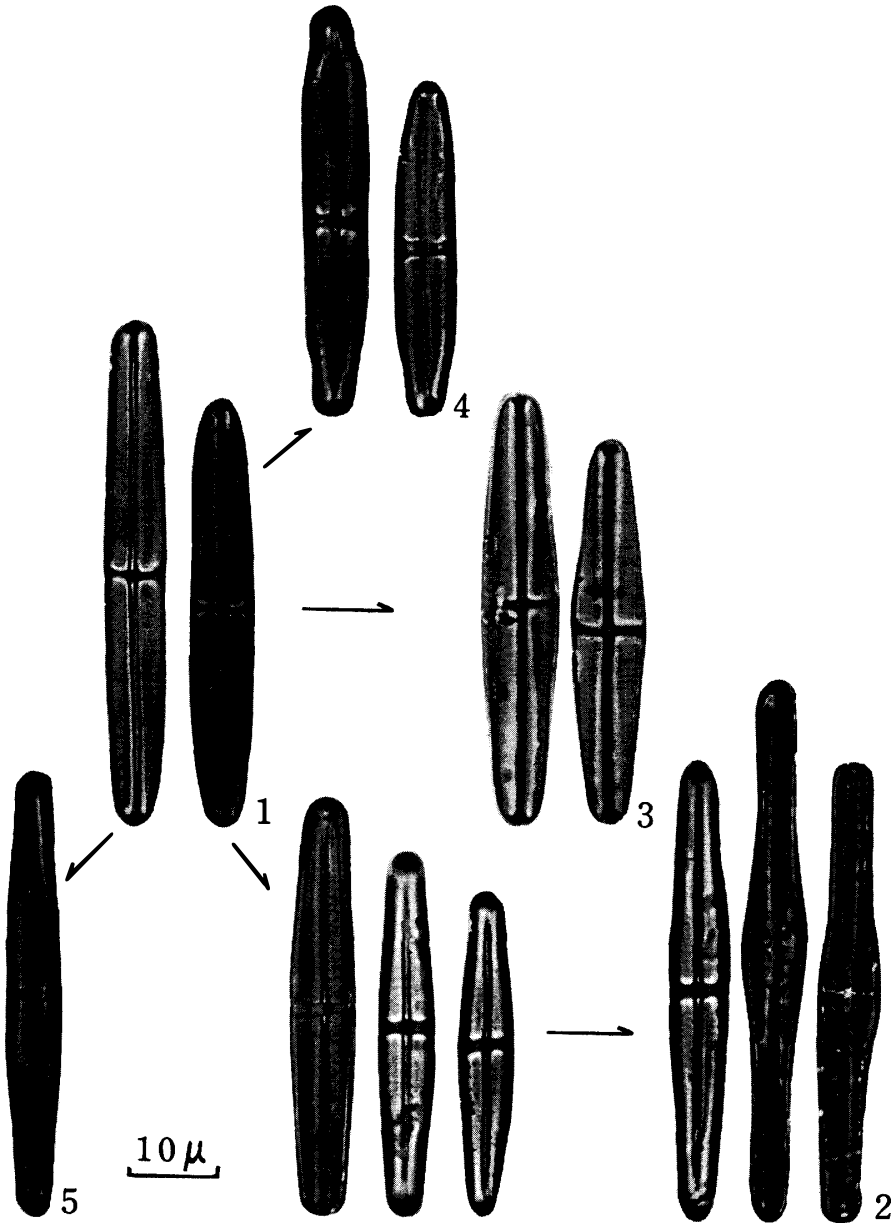

Plate 13. *Tropidoneis laevissima* v. *laevissima* f. *laevissima*.
1: Typical form. 2: Individuals which have inflated margins. 3: Individuals which have rhombic lanceolate shell. 4: Individuals which have rostrate shell ends. 5: Individual which has constricted margins.

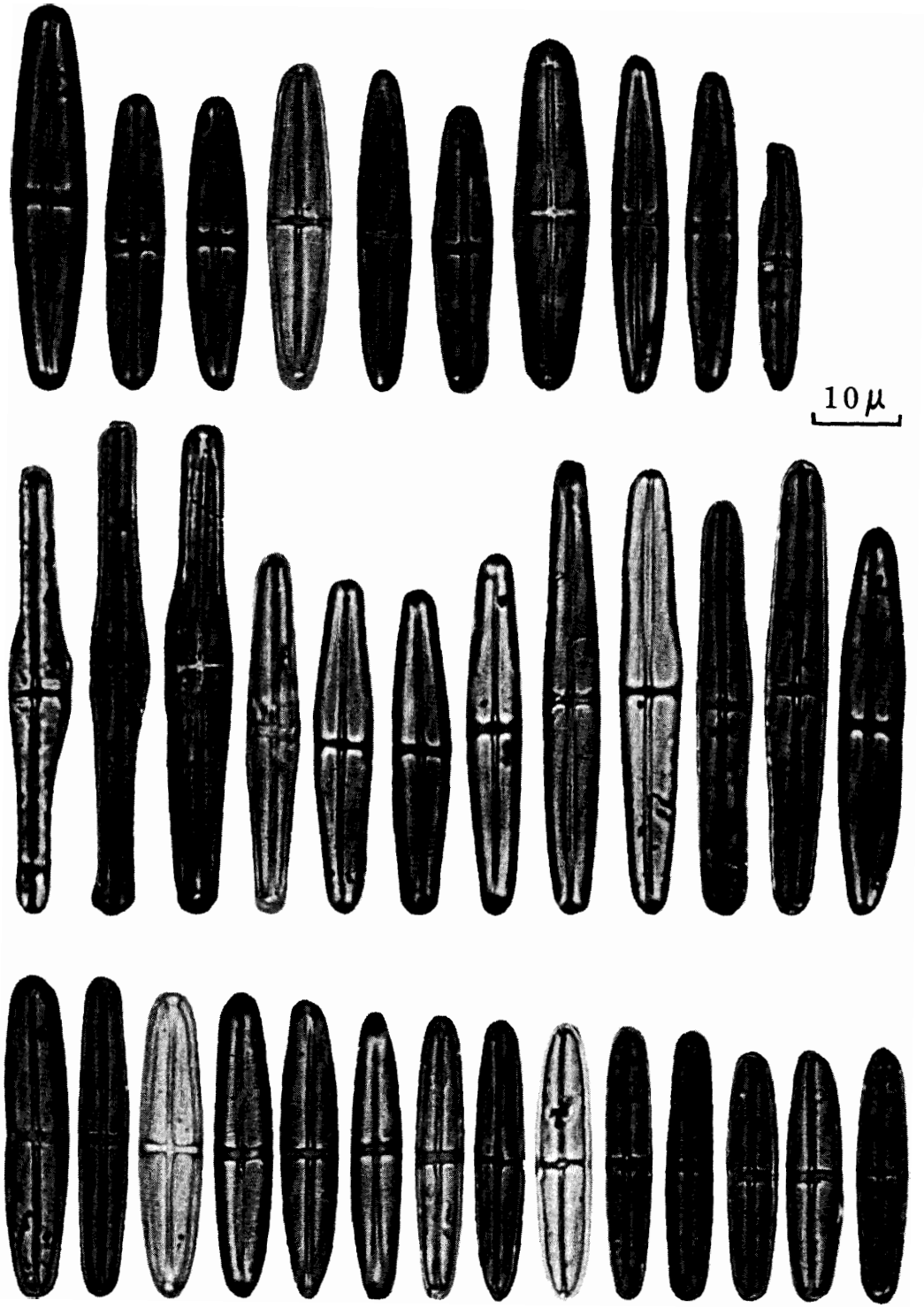

Plate 14. *Tropidoneis laevissima* v. *laevissima* f. *laevissima*.

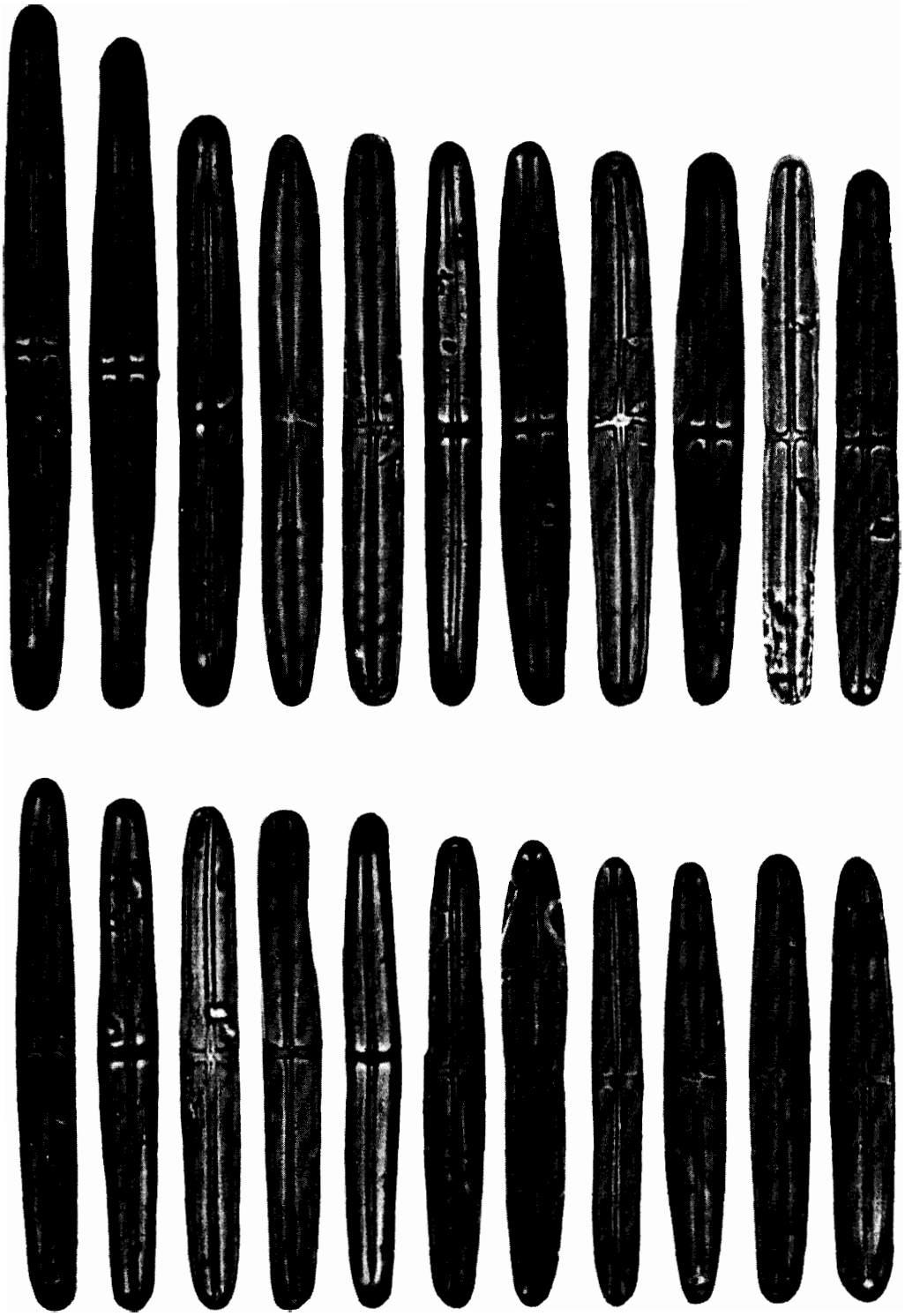

Plate 15. *Tropidoneis laevissima* v. *laevissima* f. *laevissima*.

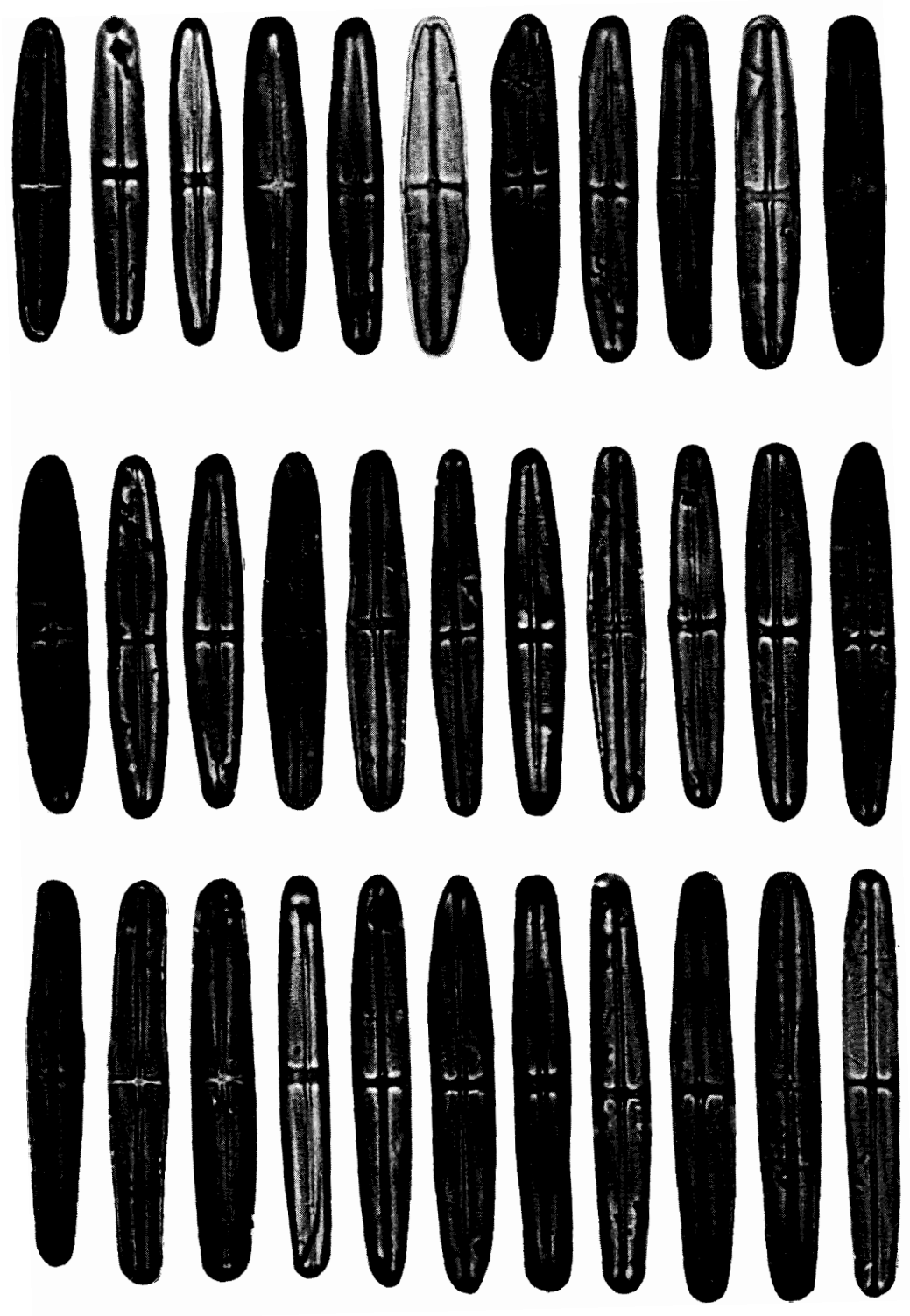

Plate 16. *Tropidoneis laevissima* v. *laevissima* f. *laevissima*.