ROCZNIK POLSKIEGO TOWARZYSTWA GEOLOGICZNEGO
ANNALES DE LA SOCIÉTÉ GÉOLOGIQUE DE POLOGNE

Vol. XLVI — 4: 435—453 Kraków 1976

STEFAN WITOLD ALEXANDROWICZ

SILICOFLAGELLATA FROM THE MIOCENE DIATOMITES OF THE UPPER SILESIA BASIN

(6 Figs.)

Silicoflagellata z mioceńskich diatomitów Zagłębia Górnośląskiego

(6 fig.)

Abstract: Numerous Silicoflagellata have been found in Miocene diatomites, forming intercalations in the Kłodnica Formation (Miocene). Six species occur in that microfossil assemblage, and *Distephanus crux* (Ehrenberg) is the dominant component. Two morphological varieties of that species and various types of aberrant forms have been distinguished on the basis of biometric analysis.

GEOLOGICAL POSITION OF DIATOMITES

In the central part of the Upper Silesia Basin, Middle Miocene deposits overlie Upper Carboniferous and Triassic sediments. Two lithostratigraphic units have been distinguished: the Kłodnica Formation (stage M_3 — Carpathian) and the Skawina Formation (stage M_4 — Badenian — lower part). The Kłodnica Formation comprises a very diversified series of deposits: sandy clays with snails (Cepaea), dark gray clays with fragments of flora and brawn coal intercalations, gray marly clays with a scarce fauna of molluscs (*Ostrea, Cerithium, Neritina*) and foraminifers (*Ammonia*), as well as clays and sands with fresh-water gastropods (*Planorbis*). The Skawina Formation is represented by marly clays with abundant marine fauna of molluscs and foraminifers (Alexandrowicz, 1963, 1969 a).

In the central part of the Kłodnica Formation there is an intercalation of white diatomite, 5 to 40 centimetres thick. It is accompanied by clays with a fauna, characteristic for a brachyhaline environment. In all profiles continental deposits occur above and below these clays. It may be assumed that the clays with a diatomite intercalation were laid down, as a result of a marine ingression that flooded the central part of the Upper Silesia Basin during the Carpathian (A l e x a n d r o w i c z, 1969 b).

The stratigraphic position of the diatomites described and their lithological development permit comparison with diatomites from the Bohate Malkowice in Moravia (C i c h a, S e n e š, T e j k a l, 1967). That locality has been recognized as one of faciostratotypes of the stage M_3 — Carpathian. A more detailed description of diatomites of the Kłodnica Formation has been published in an earlier account (A l e x a n d r o w i c z 1969 b). Samples for examination come from drillings near Imielin, Lędziny and Tychy (about 20 kilometres S and SE of Katowice).

MICROFOSSIL ASSEMBLAGE

In the diatomite four groups of microfossils have been found: Diatomeae, Silicoflagellata, Ebrideae and sponge spicules. The most numerous are diatoms, especially the genera: *Cocconeis, Melosira, Thalassiosira, Denticula,* and *Coscinodiscus*. Silicoflagellata are fairly abundant; in each sample there were about 10—30 skeletons. This is one poorly diversified assemblage of Silicoflagellata. It is composed of the following species:

Distephanus crux (E h r e n b e r g)
D. speculum (E h r e n b e r g)
Dictyocha fibula E h r e n b e r g
Corbisema triacantha (E h r e n b e r g)
Mesocena apiculata (S c h u l z)
M. elliptica E h r e n b e r g

The specimens of Distephanus crux (Ehrenberg) prevail (90 to 95 per cent). Among the remaining forms, specimens of *D. speculum* (E h r e n b e r g) are most frequent.

The Silicoflagellata assemblage of the Upper Silesia Basin resemble those described from the Miocene deposits of the Vienna Basin in Moravia (Ř e h á k o v á, 1967) and in the vicinity of Vienna (B a c h m a n n et al., 1963), as well as that from the Miocene diatomites occurring in Maryland, USA, not far from Washington (T y n a n, 1957). In the four sites compared, the main component of the assemblages is the species *D. crux* (E h r e n b e r g). The presence of other species, as well as the general amount of taxa may vary, depending on differences in salinity of sea water. The assemblage is most abundant in deposits in a sea of normal salinity, eg. in the Badenian clays in the vicinity of Vienna; among others, forms of the genus *Cannopilus* (B a c h m a n n et al., 1963) are present there. Assemblages are poorer and less diversified in diatomites occurring in Moravia, especially in diatomites of the Kłodnica Formation in the Upper Silesia Basin.

The fact that *D. crux* (Ehrenberg) predominates may be due to specific climatic conditions. The four localities, mentioned above, are situated in the temperate climatic zone. In that zone in recent seas Distephanus predominate with respect to *Dictyocha* (Lipps, 1970). On the basis of the proportions of the two genera present, a scheme has been devised for evaluating paleotemperatures of marine basins (Mandra, 1969). The conclusions drawn from the application of this scheme for evaluating the temperature of the Miocene sea of the Western Paratethys (Vienna Basin, Upper Silesia Basin) do not correspond with conclusions drawn from studies of fauna, flora and characteristics of the deposits. It may be only assumed that a great number of representatives of the genus *Distephanus* and the scarcity of *Dictyocha* indicate temperatures not exceeding 20°C.

Skeletons of Silicoflagellata display a great degree of variability in shape and size. That variability made an unequivocal definition of species and even genera difficult. More detailed description of this variability requires further, systematic, biometric studies. In the material examined, *D. crux* (Ehrenberg) was studied in detail in this way.

The definitions of the genera have been accepted according to the taxonomy of Lipps (1970);

Distephanus Stöhr, 1880: skeleton composed of a basal body ring and an apical ring, which is supported by a few bars.

Dictyocha Ehrenberg, 1837: skeleton composed of a quadrilateral basal body ring and an apical bar.

Corbisema Hanna, 1928: skeleton composed of a triangular basal body ring with three bars joining in the centre.

Mesocena Ehrenberg, 1843: skeleton composed of a basal body ring exclusively.

SYSTEMATIC PART

Distephanus crux (Ehrenberg)

Fig. 5 (1—20)

Dictyocha crux Ehrenberg; E. Tynan, 1957, p. 131, pl. 1, figs 3—8; A. Proschkina-Lavrenko, 1959, p. 152, tab. 1, figs. 10—12; A. Bachmann, A. Papp, H. Stradner, 1963, pp. 147—148, Taf. 16, figs 1—10, 12—17, Taf. 21, fig. 1.

Distephanus crux (Ehrenberg); E. Lemmermann, 1901, p. 262, Taf. 2, figs 6, 7; K. Gemeinhardt, 1930, p. 58, Fig. 49; Z. Glezer, 1966, pp. 260—262, Tabl. 18, figs 1—11, Tab. 19, figs 1—6; Y. Mandra, 1968, p. 254, figs 59, 64, 81.

Material: over 400 specimens.

Description: The skeleton is composed of a basal body ring and of an apical ring which is supported by four bars. The basal body ring can be of rhomboidal, square or elliptic shape. Four radial spines grow out of the basal body ring. Two of them, placed in the longer axis of the skeleton, are longer than the two remaining ones. The apical ring is a square and has a rounded central aperture.

V a r i a t i o n: The skeletons vary in size, and structure. One can distinguish form A, relatively big, with a rhomboidal basal body ring and a small apical ring /Fig. 5 (1—4)/. Form B is represented by smaller specimens; they have a rounded basal body ring and a relatively large apical ring /Fig. 5 (5—9)/. As far as the quantity is concerned, form A comprises 67% of specimens of the assemblage, while form B — 30%. The remaining 3% is represented by specimens with an abnormally shaped skeleton.

B i o m e t r i c a n a l y s i s: 336 specimens have been measured to characterize the population of the species described and to show its differentiation. The measurements were taken with regard to the following elements (Fig. 1):

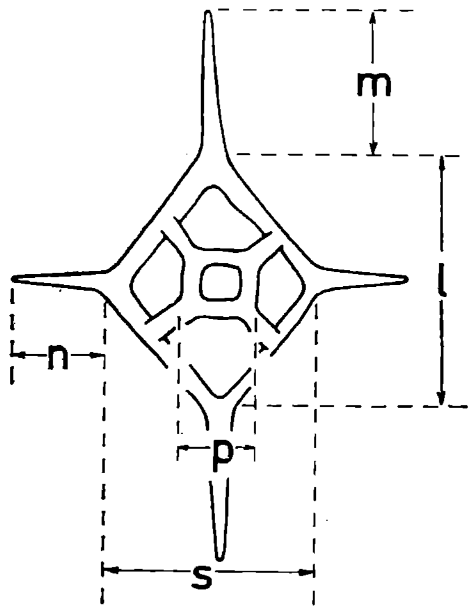

Fig. 1. Elements of the skeleton structure of *Distephanus crux* (E h r e n b e r g). 1 — longest diameter of basal body ring (longest diameter of a rhomb or of an ellipse); s — shortest diameter of basal body ring (shorter diameter of a rhomb or of an ellipse); p — size of apical ring; m — length of radial spine in axis l; n — length of the radial spine in axis s

Fig. 1. Elementy budowy szkieleciku *Distephanus crux* (E h r e n b e r g). 1 — największa średnica pierścienia podstawowego (dłuższa przekątna rombu lub elipsy); s — najmniejsza średnica pierścienia podstawowego (krótsza przekątna rombu lub elipsy); p — wielkość (długość boku) pierścienia apikalnego; m — długość kolca radialnego położonego w osi 1; n — długość kolca radialnego położonego w osi s

l — the longest diameter of the basal body ring (longest diameter of a rhombous or of an ellipse)

s — the shortest diameter of a basal body ring (shortest diagonal of a rhombous or of an ellipse; p — size of the apical ring

m — length of the radial spine, placed in the axis l
n — length of the radial spine placed in the axis s

Coefficients of the shape of the skeleton: $\frac{l}{s}, \frac{p}{l}, \frac{n}{m}$, have been determined. Basic statistical indices have been calculated for each factor, mentioned above: arithmetic average ($\bar{x}$), standard deviation (c), and variation coefficient (v). The calculations have been done for these sets (Table 1) for the whole population — set P (number of specimens N = 336), and for the both forms, mentioned before (sub-set A — form A, N = 231 specimens; sub-set B — form B, N = 105 specimens).

Table - Tabela I

Results of biometric measurements of Distephanus crux /Ehrenberg/ - basic statistical indicators

Wyniki pomiarów biometrycznych Distephanus crux /Ehrenberg/ - podstawowe wskaźniki statystyczne

	P N = 336			A N = 231			B N = 105		
	$\bar{x}$	s	v	$\bar{x}$	s	v	$\bar{x}$	s	v
l	26.95	3.76	13.96	28.34	3.58	12.63	23.92	2.03	8.48
s	24.18	3.59	14.83	24.95	3.87	15.55	22.50	1.98	8.78
p	9.92	1.56	15.72	9.31	1.25	13.42	11.28	1.26	11.16
m	9.30	3.08	37.10	10.45	3.04	28.10	6.76	1.18	17.46
n	5.16	2.00	38.72	5.49	2.22	40.48	4.41	1.22	27.68
$\frac{s}{l}$	0.89	0.06	6.85	0.88	0.06	6.82	0.94	0.05	5.75
$\frac{p}{l}$	0.39	0.08	21.87	0.34	0.07	19.65	0.47	0.06	11.98
$\frac{n}{m}$	0.58	0.17	29.55	0.54	0.17	31.40	0.67	0.14	20.50

Statistical distributions of the five examined factors (l, s, p, m, n) have been made up separately for the two forms: sub-sets A and B. They resemble normal distributions and display only a very weak negative asymmetry (Fig. 2). It proves homogeneity of the examined subsets. The relation between the length (l), and the width (s) of skeletons can be easily observed. In the diagram points corresponding to specimens of form A cover an area different from that covered by points corresponding to specimens of form B; nevertheless, it is difficult to delimit these areas (Fig. 3-I). Correlation coefficients, determined for the sub-sets (for A-forms and for B-forms), represent numerical value of the descri-

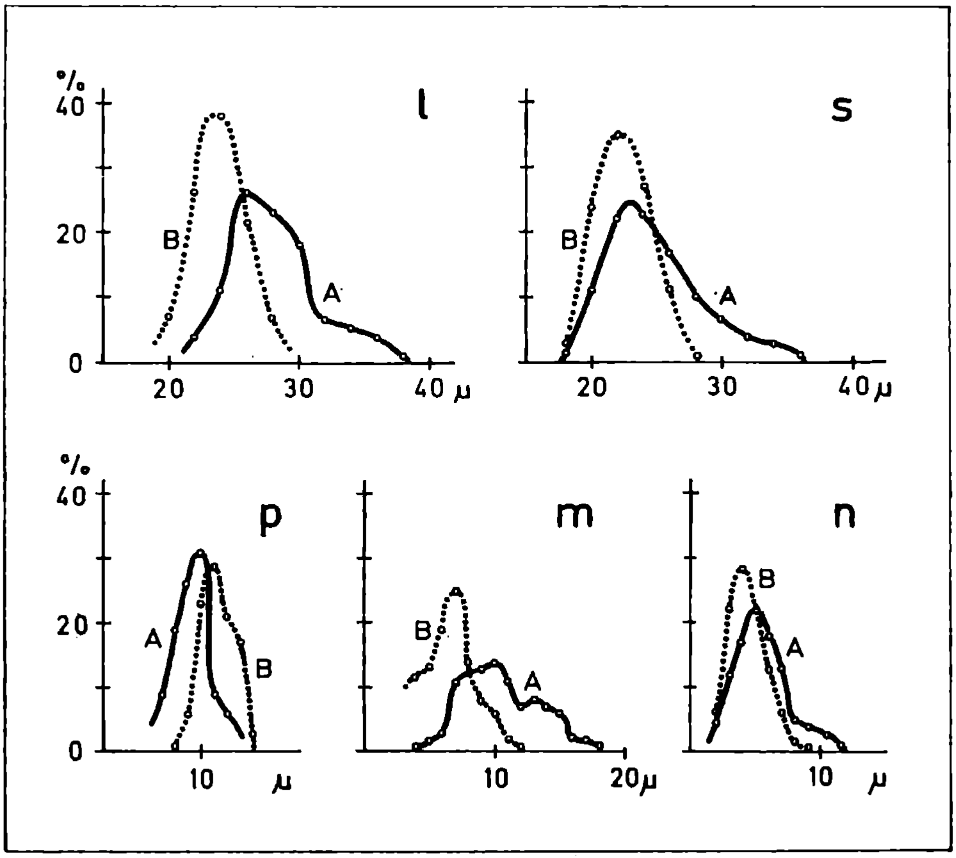

Fig. 2. Statistical distributions of the biometric factors (l, s, p, m, n) for skeletons of *Distephanus crux* (Ehrenberg). A — form A; B — form B

Fig. 2. Rozkłady statystyczne cech biometrycznych (l, s, p, m, n) szkielecików *Distephanus crux* (Ehrenberg). A — forma A; B — forma B

bed relation of l and s. These coefficients are very high, and statistically significant: A — $r = 0{,}87$, B — $r = 0{,}90$. The following equations of linear regression, displaying the character of this relation have been determined for the two sub-sets:

Sub-set A — $l = 0{,}80s + 40{,}35$ $\qquad s = 0{,}94\,l - 13{,}93$

sub-set B — $l = 0{,}92s + 11{,}39$ $\qquad s — 0{,}87\,l + 9{,}42$

In the diagram that illustrates the ratio of the two coefficients $\frac{s}{l}$ and $\frac{p}{l}$ points corresponding to specimens of the two forms do not overlap; it allows an easy discrimination between the sub-sets A and B (Fig. 3 — II) within the whole examined population.

The differences between the forms A and B, calculated according to basic statistical indices: $\bar{x}$ and s, are important for all the five factors. Appropriate tests, calculated for differences (t_d), considerably exceed critical values. The latter are: 2,0 — 2,6 — 3,3 (on confidence levels .0,5 — — .01 — .001) for the analysed number of specimens N_A and N_B. The test indices t_d assume the following values: $t_{d\,l} = 14{,}50$; $t_{d\,s} = 7{,}80$; $t_{d\,p} = 13{,}70$; $t_{d\,n} = 15{,}20$; $t_{d\,n} = 5{,}60$. Similar and significant statistical differences can be observed among the shape coefficients. The calculations

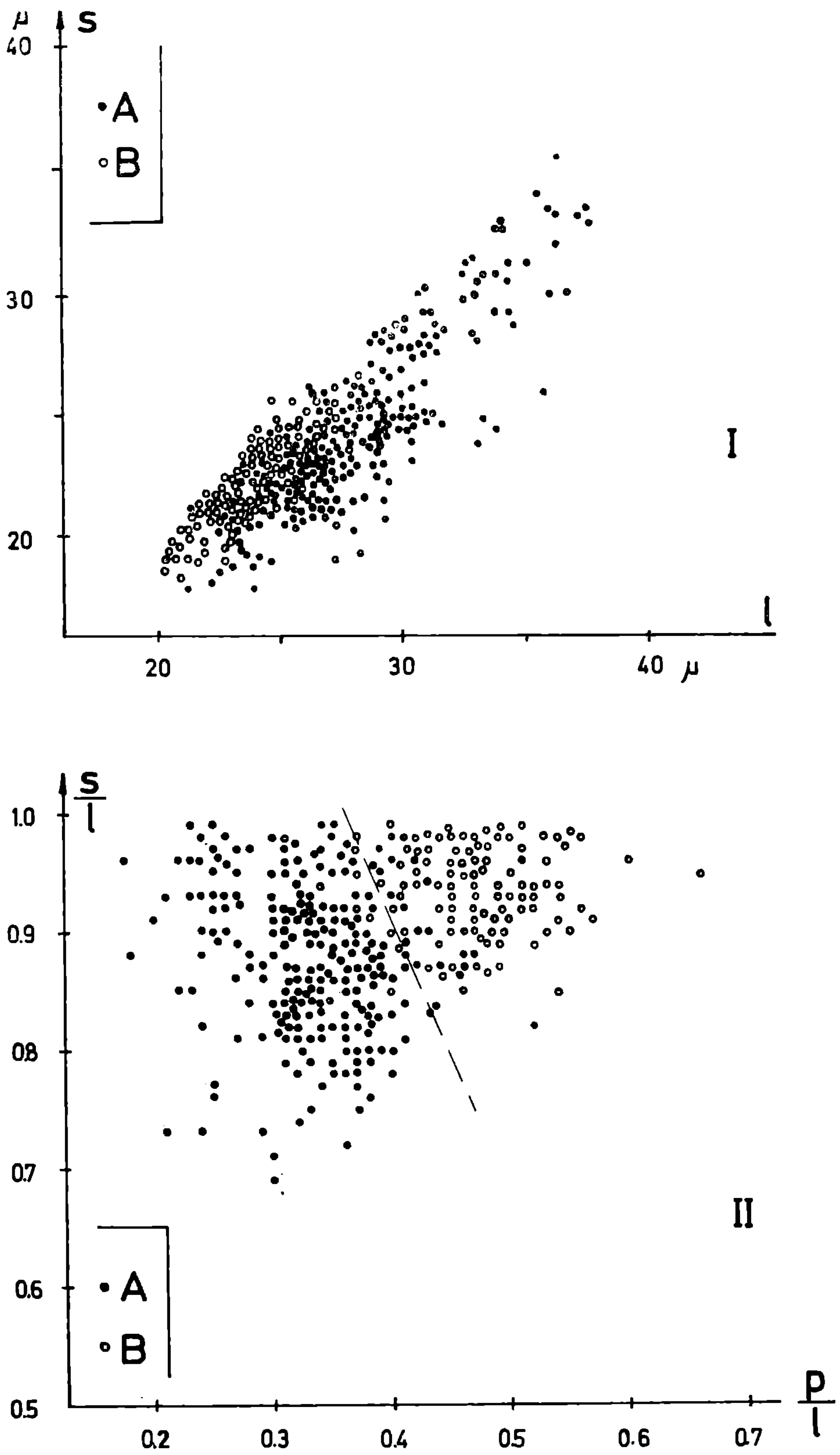

Fig. 3. Biometric characteristics of forms A and B of the species *Distephanus crux* (Ehrenberg). I — relation between l and s; II — relation between $\frac{s}{l}$ and $\frac{p}{l}$

Fig. 3. Charakterystyka biometryczna form A i B gatunku *Distephanus crux* (Ehrenberg). I — zależność pomiędzy l i s; II — zależność pomiędzy $\frac{s}{l}$ i $\frac{p}{l}$

quoted above indicate that the two distinguished forms (form A and form B) differ from each other in size of individual elements of the skeleton.

The analysis of standarized values and „nature index" defined by P e r k a l, provided some particularly interesting data. It allowed separation of factors of the greatest diagnostic value; they made possible differentiation of the whole population into two sub-sets. The standarized values of each factor are calculated according to the dependence: $x_{ni} = \frac{\bar{x}_i - \bar{x}_p}{s_p}$ where $\bar{x}_i$ is the arithmetic mean of a given factor in the sub-set (A or B), $\bar{x}_p$ is the arithmetic mean of that factor in the whole population, and s_p is the standard deviation of that factor in the whole set. The sum of standarized values of all factors for each of the examined forms (A and B), divided by the number of factors (k), is an index de-sub-set comprising specimens with factors bigger than the averages in the sub-set comprising specimens with factors bigger than the averaes in the population (P), and negative values — for the sub-set with smaller factors (Table 2). While we subtract the index w from each standarized va-

Table - Tabela 2

Standarized values /X_n/ and "nature index" /z/ of biometric features of Distephanus crux /Ehrenberg/

Wartości znormalizowane /X_n/ i współczynniki przyrodnicze /z/ cech biometrycznych Distephanus crux /Ehrenberg/

		l	s	p	m	n	w
X_n	A	+0.370	+0.214	-0.397	+0.373	+0.165	+0.145
	B	-0.806	-0.468	+0.872	-0.824	-0.375	-0.320
z	A	+0.225	+0.069	-0.542	+0.228	+0.020	-
	B	-0.486	-0.148	+1.192	-0.504	-0.055	-
/z_A - z_B/		0.711	0.217	1.734	0.832	0.075	-

lue, we get the so called, „nature index" of Perkal ($z = x_{ni} - w$). Its value shows directly how each factor participates in differentiations of the examined sub-sets. Differences between the sub-sets are shown by means of those factors for which the difference of „nature index": $z_A - z_B$ exceeds the critical value defined by the formula: $z_k = \frac{2}{\pi}\sqrt{\frac{k-1}{k}}$

In our case $z_k = 1{,}02$. This value is exceeded by differentiation of the factor p and, thus, of size of the apical ring, which is 1,734 (Table 2). That factor allows, in a statistically important way, separation of forms corresponding to form A and form B within the whole population (P). As far as other factors are concerned, the length of skeletons (l) and the length of the radial spine placed in the longer axis of the skeleton (m) are of not so great discriminating importance.

The interpretation of biometric studies and of the statistic analysis permits the conclusion that the species *Distephanus crux* (Ehrenberg) displays an evident differentiation into two forms. Co-occurrence of specimens of the two forms in deposits of the same age (in the same layer) does not justify the possibility of separation of two sub-species (Mayr, 1969). They cannot be aberrant, since the quantitative participation of A-forms and of B-forms totally amounts to 97 percent, and their ratio is approximately 2 : 1. The main point of such a dimorphic differentiation is not clear, but that phenomenon may be quite common, since forms A and B, found in Upper Silesia and biometrically separated, may corrrespond to forms observed, among others, by Tynan (1957) in the material from Miocene deposits in the Washington area.

Aberrant forms: The second type of variation observed within the species under description is due to abnormal shaping of skeletons. It can observed in individual specimens, which will be regarded as aberrant forms. On the whole, they represent only about 3% of the population. The aberrances are of a twofold character: they are connected with the size of skeletons or details of their structure. A similar variation, due to occurrence of individual forms with anomalous shaping within big populations, was observed by Eisenack (1971) in the fossil Dinoflagellata.

The first type of aberrance („aberrance I") was distinguished on the grounds of a statistical analysis. In our population there occur single specimens that differ from the mean values of individual factors in size. The confidence level .01 has been accepted as the critical value that gives grounds for regarding a specimen as an anomalous one. It means that, most likely (with the 99% probability), the size of a given factor cannot be contained in the variation of the general population. The accepted level of probability in standarized values corresponds to value of the factors that are not contained in the interval: $\bar{x} \pm 2{,}58s$. The analysis of individuality of the aberrant forms was carried out basing on „curve of shape", applied to botanical studies by Jentys-Szaferowa (1959). The zero values of individual standarized factors (Fig. 4) have been taken as a reference level. Three types of aberrant forms may be distinguished: I — 1. Large skeletons, with remerkably increased standarized values of l and s (2,70—4,73) and with a small value of $\frac{p}{l}$ The „curve

of shape" indicates an aberrance related to form A /Fig. 5 (10, 11)/.
I — 2. Skeletons somewhat smaller than the mean (the standarized values of l and s are negative), conspicuous for abnormally large dimensions of the apical ring p (2,60—3,20). The basal body ring is rounded in shape, and the „curve of shape" indicates a direct connection of that

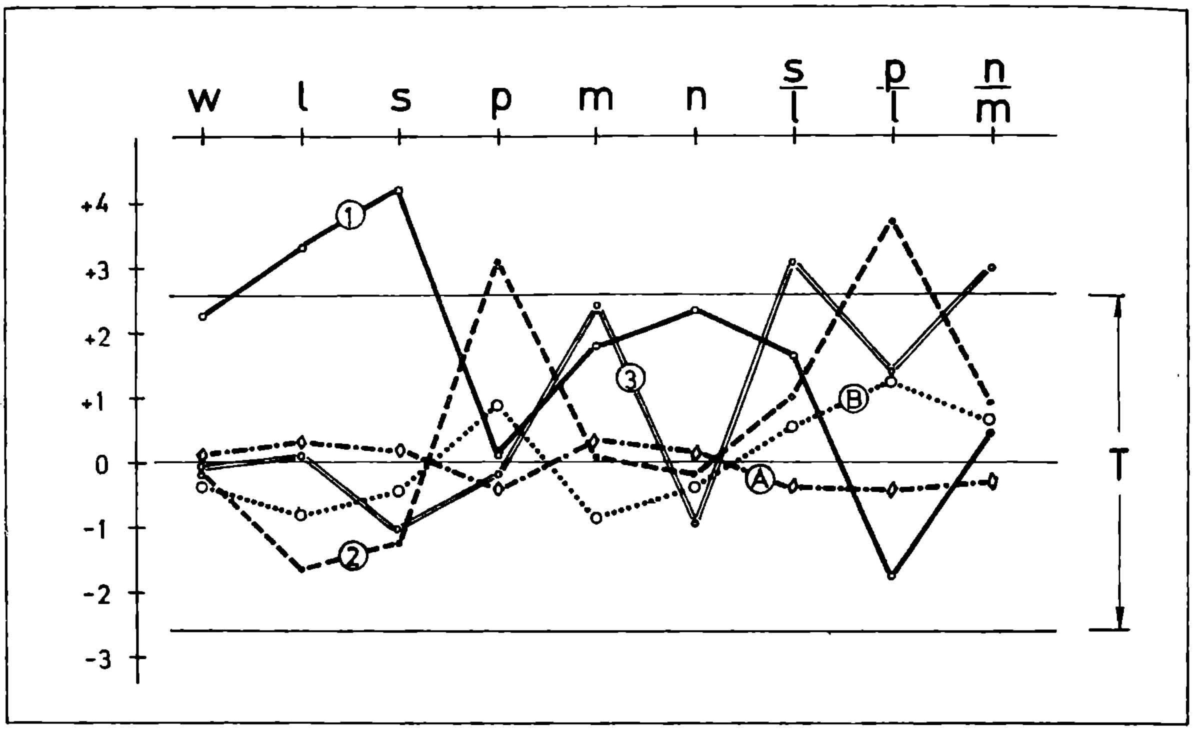

Fig. 4. „Curves of shape" of aberrant forms („aberrance I") of *Distephanus crux* (Ehrenberg). A — form A; B — form B; 1 — aberrance I — 1; 2 — aberrance I — 2; 3 — aberrance I — 3; T — variation range of standarized factors within the limits: $\bar{x} \pm 2s$. For others symbols see Fig. 1

Fig. 4. „Krzywe kształtu" form aberantnych („aberancja I" szkielecików *Distephanus crux* (Ehrenberg). A — forma A; B — forma B; 1 — aberancja I — 1; 2 — aberancja I — 2; 3 — aberancja I — 3; T — zakres zmienności cech znormalizowanych w granicach $\bar{x} \pm 2s$. Inne symbole objaśnione na fig. 1

aberrance with form B /Fig. 5 (12)/. Such specimens strongly resemble *D. crux* (Ehrenberg) var. *mesophtalma* Lemmermann (Lemmermann 1901; Bachmann et al., 1963).
I — 3. Skeletons with the diameters l and s are not very differrent from the mean values. They are characterized by a unagual length of radial spines. It is expressed by a very low coefficient $\frac{n}{m}$ (—2,94), due to considerable length of the longer spine (m), in relation to the shorter one (n). These forms are in the shape of an elongated rhomb with small values of $\frac{s}{l}$ /Fig. 5 (13)/. They correspond to the specimens: *D. crux* (Ehrenberg) fa. *longispina* Schulz (Bachmann et al., 1963).

The other type of aberrance („aberrance II") shows in simplifications or additional complications in structure of the skeleton, in disappearance

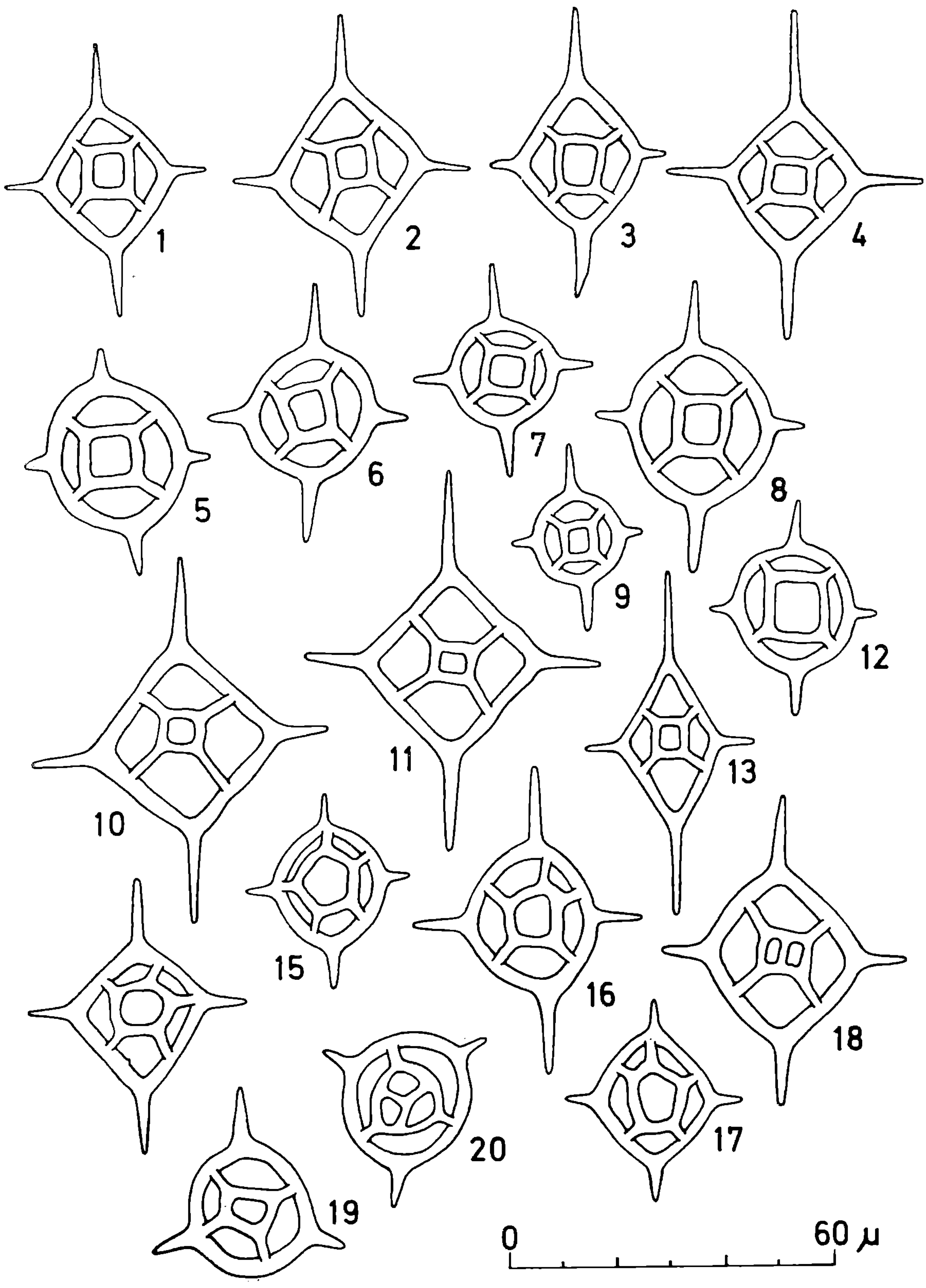

Fig. 5. Silicoflagellata of the Miocene diatomites in the Upper Silesia Basin: 1—20 — *Distephanus crux* (E h r e n b e r g); 1—4 — form A; 5—9 — form B; 10, 11 — aberrance I — 1; 12 — aberrance I — 2; 13 — aberrance I — 3; 14—17 — aberrance II — 1; 18 — aberrance II — 2; 19 — aberrance II — 3; 20 — aberrance II — 4

Fig. 5. Silicoflagellata z diatomitów mioceńskich Zagłębia Górnośląskiego. 1—20 — *Distephanus crux* (E h r e n b e r g); 1—4 odmiana (forma) A; 5—9 — odmiana (forma) B; 10, 11 — aberancja I — 1; 12 — aberancja I — 2; 13 — aberancja I — 3; 14—17 — aberancja II — 1; 18 — aberancja II — 2; 19 — aberancja II — 3; 20 — aberancja II — 4

of some elements or in appearance of additional ones. The following types can be distinguished in the examined material:

II — 1. Forms whose apical ring is supported by five, and not four, bars /Fig. 5 (14—17)/. These are usually small skeletons of a rhomboid outline (5 specimens). Such an anomalous form of *D. crux* (Ehrenberg) was presented by Mandra (1969) in a photomicrograph.

II — 2. Forms with apical aperture divided into two openings by a thin cross-bar /Fig. 5 (18)/. A rhomboid outline of the basal body ring; the size is not very different from the mean values (1 specimen).

II — 3. Forms of an oval or circular outline, with three (and not four) radial spines, set up towards each other at an angle of 110°—140°. One of the spines is longer, and the two others — somewhat smaller /Fig. 5 (19)/. The apical ring is regularly shaped (2 specimens).

II — 4. Forms of a circular outline, with three radial spines of equal length. The apical ring is round and it joins the basal body ring by means of three bars /Fig. 5 (20)/. The aperture in the apical ring is divided into 3 small openings (1 specimen).

Distephanus speculum (Ehrenberg)

Fig. 6 (1—8)

Dictyocha speculum Ehrenberg; Tynan, 1957, p. 132, pl. 1, Figs. 11—20; Proschkina-Lavrenko, 1959, pp. 154—155, tabl. 1, Figs. 13—24; Bachmann et al., 1963, pp. 149—150, Taf. 17, Figs 23, 25—27; *Distephanus speculum* (Ehrenberg); Lemmermann, 1901, p. 263, Taf. 11, Fig. 11; Gemainhardt, 1930, pp. 61—62, Fig. 53; Glezer, 1966, pp. 263—271, tabl. 19, Figs 7—9, tabl. 20, Figs. 1—11, Tabl. 21, Figs. 1—6; Mandra, 1968, pp. 254—255, figs. 61, 62, 69, 76, 79, 83.

Material: 12 specimens.

Description: The basal body ring is hexagonal and has six radial spines. One pair of spines is longer than the two others. The apical ring is round or hexagonal and it joins the basal body ring by means of six bars. The apical aperture is quite large rounded /Fig. 6 (1—3)/.

Dimensions: The longest diameter: 25—40 μm, the shortest diameter: 24—28 μm; the diameter of the apical ring: 12—22 μm; the length of bigger spines: 15—22 μm, the length of smaller spines: 4—8 μm.

Variation and aberrances: This species displays great variability, and its forms have been described several times in literature. Individual specimens of *D. speculum* (Ehrenberg) have been found in the examined material. They display deviations from the normal structure of skeleton. The types of aberrances are:

1. Pentagonal forms whose rounded basal body ring has five radial spines /Fig. 6 (7)/. Such forms correspond with the definition of *D. speculum* (Ehrenberg) var. *pentagonus* Lemmermann (Lemmer-

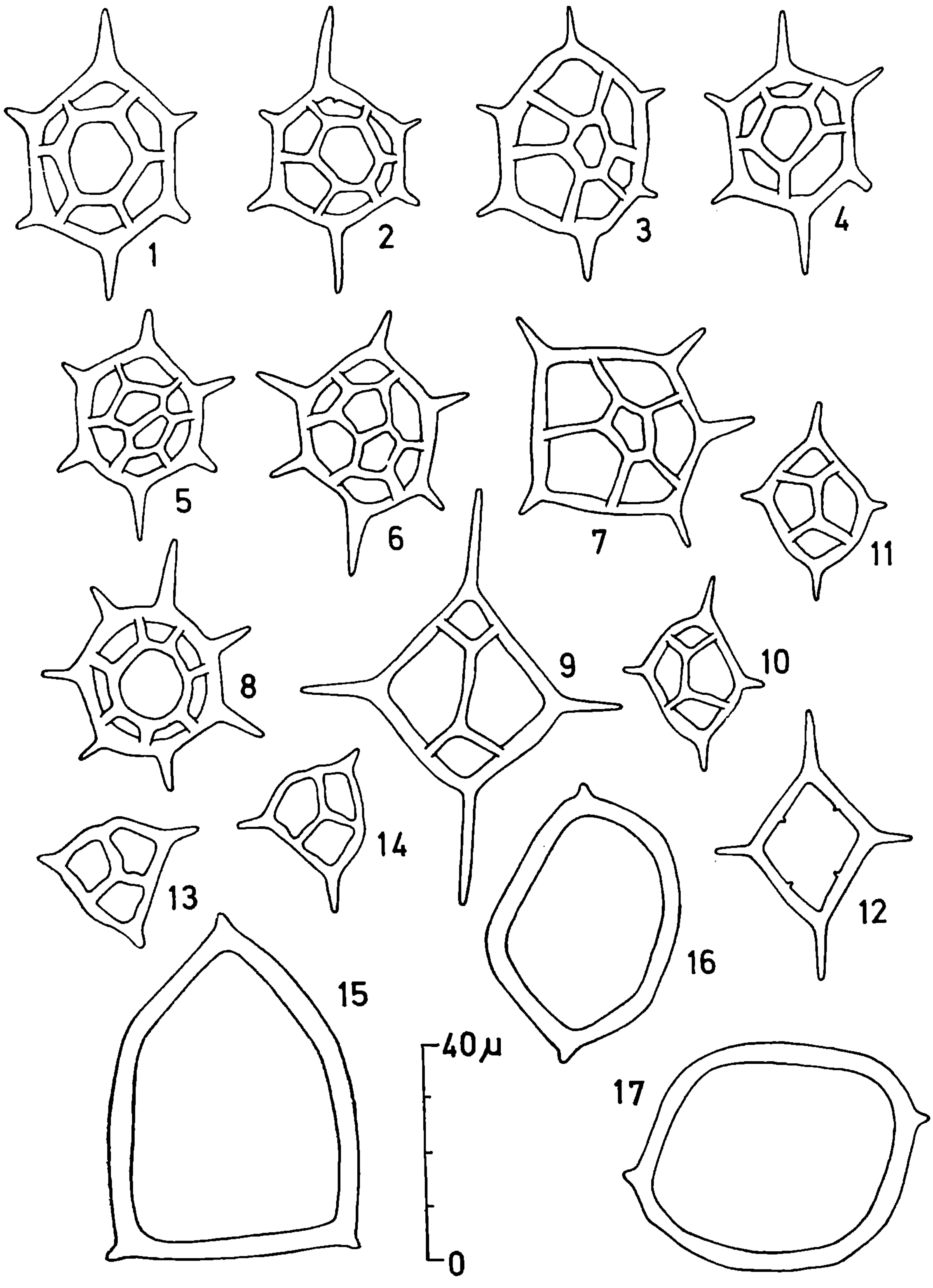

Fig. 6. Silicoflagellata of the Miocene diatomites in the Upper Siesia Basin. 1—8 — *Distephanus speculum* (Ehrenberg); 1—3 — typical forms; 4 — aberrance 2; 5, 6 — aberrance 3; 7 — aberrance 1; 8 — aberrance 4; 9—12 — *Dictyocha fibula* Ehrenberg; 9—11 — typical forms; 12 — aberrant forms; 13, 14 — *Corbisema triacantha* (Ehrenberg); 15, 16 — *Mesocena elliptica* Ehrenberg emend. Deflandre; 17 — *Mesocena apiculata* (Schulz)

Fig. 6. Silicoflagellata z mioceńskich diatomitów Zagłębia Górnośląskiego. 1—8 — *Distephanus speculum* (Ehrenberg); 1—3 — formy typowe; 4 — aberancja 2; 5, 6 — aberancja 3; 7 — aberancja 1; 8 — aberancja 4; 9—12 — *Dictyocha fibula* Ehrenberg; 9—11 — formy typowe; 12 — forma aberantna; 13—14 — *Corbisema triacantha* (Ehrenberg); 15, 16 — *Mesocena elliptica* Ehrenberg emend. Deflandre; 17 — *Mesocena apiculata* (Schulz)

mann 1901; Gemeinhardt 1930; Glezer 1966; Mandra 1958).
2. Hexagonal forms whose apical ring is supported by five and not six bars /Fig. 6 (4)/. Other factors are the same as of typical specimens.
3. Hexagonal forms with the apical ring divided into 2 pentagonal segments. Each of the latter is supported by three bars /Fig. 6 (5, 6)/. Analogous forms were described as *Dictyocha speculum* Ehrenberg form 1 by Tynan (1957). The same type of aberrance is also represented by specimens regarded as intermediate between the described species and the genus *Cannopilus* (Proschkina-Lavrenko 1959), and by specimens of *D. speculum* (Ehrenberg) var. *cannopiloides* (Proschkina-Lavrenko), quoted by Glezer (1966).
4. Forms with seven radial spines, with a circular outline of the basal body ring and of the apical ring /Fig. 6 (8)/. The two rings are connected by 7 bars. That form corresponds to *D. speculum* (Ehrenberg) var. *septentarius* Ehrenberg (Lemmermann 1901; Gemeinhardt 1930; Glezer 1966).

Dictyocha fibula Ehrenberg

Fig. 6 (9—12)

Dictyocha fibula Ehrenberg; Lemmermann, 1901, p. 260, pl. 10, Fig. 24; Gemeinhardt, 1930, p. 47, Fig. 39a; Proschkina-Lavrenko, 1959, p. 152, tabl. 1, Figs. 4—6; Bachmann et al., 1963, pp. 148—149, Taf. 17, fig. 21; Glezer, 1966, pp. 247—252, tabl. 13, figs. 6—9, tabl. 14, figs. 1—9; Mandra, 1968, pp. 251—252, figs. 14—18.
Material: 7 specimens.
Description: The basal body ring is tetragonal, in the shape of a rhomb; in some specimens it is somewhat rounded and has four radial spines. Along the larger diameter of the rhomb there runs an apical cross-bar, supported by four bars /Fig. 6 (9—11)/.
Dimensions: The longest diameter: 24—35 µm, the shortest diameter: 20—30 µm; the length of the apical cross-bar: 9—18 µm; the length of spines: 8—20 µm.
Variation and aberrances: The species is characterized by a differentiated size of skeletons and radial spines, and by a variable shape of the basal body ring. There have been found, as well, two aberrant specimens with a completely reduced apical part /Fig. 6 (12)/. They correspond with the definition of *Dictyocha fibula* Ehrenberg fa. *mesocenoides* Deflandre /Bachmann et al., 1963/.

Corbisema triacantha /Ehrenberg/
Fig. 6 (13, 14)

Dictyocha triacantha Ehrenberg; Lemmermann, 1901, Taf. 10, fig. 18.
Corbisema triacantha /Ehrenberg/; Deflandre, 1950, p. 54; Bachmaann et al., 1963, p. 151, Taf. 17, figs. 28—33.
Material: 4 specimens.
Description and dimensions: The basal body ring has a triangular outline, somewhat rounded. Short radial spines appear on corners. The apical part consists of three bars, converging towards the centre. The length of side of the basal body ring is 18—22 μm. The species resembles *Corbisema trigona* /Zittel/ Deflandre, distinguished in the Miocene diatomites of Maryland by Tynan /1957, pp. 130—131, pl. 1, Fig. 1, 2/.

Mesocena apiculata /Schulz/
Fig. 6 (17)

Mesocena apiculata /Schulz/; Tynan, 1957, p. 134, pl. 1, fig. 10; Bachmann et al., 1963, p. 152, Taf. 19, Figs. 60—62.
Material: 2 specimens.
Description and dimensions: The basal body ring has a triangular outline with two sides slightly convex. Very small radial spines appear at apices. The length of sides amounts from 40 to 62 μm.

Mesocena elliptica Ehrenberg emend. Deflandre
Fig. 6 (15, 16)

Mesocena elliptica Ehrenberg emend. Deflandre; Bachmann et al., 1963, pp. 151, 152, Taf. 18, figs. 46, 53, Taf. 19, figs. 54—59, Taf. 21, Figs. 4—8; Glezer, 1966, pp. 283—285, Tab. 29, Figs. 1—7, Tabl. 30, Figs. 1—5.
Material: 3 specimens.
Description and dimensions: The skeleton consists of an oval basal body ring with two very small radial spines. The longest diameter aggregates about 43—53 μm.

Academy of Mining and Metallurgy
Institute of Geology and Mineral Resources
30-059 Kraków, al. Mickiewicza 30

translated by
E. Smolak

REFERENCES
WYKAZ LITERATURY

Alexandrowicz S. W. (1963), Stratygrafia osadów mioceńskich w Zagłębiu Górnośląskim. *Inst. Geol. Pr.* 39, Warszawa.

Alexandrowicz S. W. (1969a), „Karpat" i „Baden" w schemacie stratygraficznym miocenu Zagłębia Górnośląskiego. *Spraw. Pos. Kom. Nauk. PAN Oddz. Kraków*, 12, 2, p. 550—553, Kraków.

Alexandrowicz S. W. (1969b), Miocene Diatomites in the Eastern Part of the Upper Silesian Coal Basin. *Bull. Acad. Pol. Sci. ser. geol.-geogr.* 17, 2, p. 115—122, Warszawa.

Bachmann A., Papp A., Stradner H. (1963), Mikropaläontologische Studien im „Badener Tegel" von Frättingsdorf N.Ö. *Mitt. Geol. Ges. Wien*, 56, 1, p. 117—210, Wien.

Cicha I., Seneš J., Tejkal J. (1967), Die Karpatische Serie. Chronostrat. und Neostrat. Miozän M_3, p. 40—49. Vyd. Slov. Ak. Vied, Bratislava.

Deflandre G. (1950), Contribution à l'étude des Silicoflagellidés actuels et fossiles. Microscopie 2, 2, p. 1—82, Paris.

Eisenack A. (1971), Anomalien bei fossilen Dinoflagellaten. *Paläont.* Z. 45, 1—2, p. 75—78, Stuttgart.

Gemeinhardt K. (1930), Silicoflagellatae. In: Rabenhorst L., Kryptogamenflora, 10, p. 1—87, Leipzig.

Glezer Z. I. — Глезер З.И. (1966). Кремневые жгутиковые водоросли (Силикофлагеллаты). Флора Споровых Раст. СССР, 7, Москва.

Jentys-Szaferowa J. (1959), Graficzna metoda porównywania kształtów roślinnych. *Nauka pol.* 7, 3 (27), p. 79—110, Warszawa.

Lemmermann E. (1901), Silicoflagellatae. *Ber. dtsch. Botan. Ges.* 19, p. 247—271, Berlin.

Lipps J. H. (1970), Ecology and Evolution of Silicoflagellates. *Proc. North. Americ. Paleont. Convent.* Pt.G, p. 965—993.

Mandra Y. T. (1968), Silicoflagellates from the Cretaceous, Eocene and Miocene of California, U.S.A., *Proc. Calif. Acad. Scienc.* 34, 9, p. 231—297, San Francisco.

Mandra Y. T. (1969), Silicoflagellates: A New Tool for the Study of Antarctic Tertiary Climates. *Antarct. J.U.S.* 4, 5, p. 171—174, San Francisco.

Mayr E. (1968), Principles of Systematic Zoology. McGraw-Hill Book Co. New York.

Proschkina-Lavrenko A. I. — Прошкина-Лавренко А.И. (1959), Современные и ископаемые силикофлагеллаты и эбридеи Черноморского бассейна. Труды Бот. С. II-Споров. раст. 12, pp. 142-167, Москва.

Řeháková Z. (1967), Die fossilen Diatomeen der Karpatischen Serie aus der Vortiefe in Mähren und aus dem Wiener Becken. Chronostrat. und Neostrat. Miozän M_3 pp. 257—268. Vyd. Slov. Ak. Vied, Bratislava.

Tynan E. J. (1957), Silicoflagellates of the Calvert formation (Miocene) of Maryland. Micropaleontology 3, 2, pp. 127—136, New York.

STRESZCZENIE

W centralnej części Zagłębia Górnośląskiego, w obrębie warstw Kłodnickich, zaliczonych do środkowego miocenu (piętro M_3 — Karpatien) występują wkładki diatomitów (S. Alexandrowicz, 1969b). Utworzyły się one w czasie krótkotrwałej ingresji morza (S. Alexandrowicz, 1963, 1969a). W diatomitach występują cztery grupy mikroskamieniałości: Diatomeae, Silicoflagellata, Ebridae i spikule gąbek. Zespół Silicoflagellata jest jednolity i mało zróżnicowany, obejmuje on 6 gatunków. Dominującym jego składnikiem jest gatunek *Distephanus crux* (E h r e n b e r g), którego udział wynosi 90—95% zespołu.

Opisywany zespół Silicoflagellata wykazuje bardzo duże podobieństwo do zespołów opisanych z osadów miocenu na Morawach, w okolicy Wiednia oraz w Stanie Maryland w USA (Ř e h á k o v á 1967, B a c h m a n n et al., 1963, T y n a n 1957). Dominujący udział form z gatunku *D. crux* (E h r e n b e r g), przy nielicznym występowaniu przedstawicieli rodzaju *Dictyocha*, może wynikać z określonych warunków klimatycznych (M a n d r a 1969). Wszystkie cztery cytowane stanowiska leżą w strefie klimatu umiarkowanego. Uwzględnienie wniosków, wypływających z badań nad fauną, florą i osadami polskiego miocenu, a także z porównania zespołu Silicoflagellata ze współczesnymi zespołami tych mikroskamieniałości prowadzi do wniosku, że temperatura morza mioceńskiego w Zagłębiu Górnośląskim nie przekraczała 20°C.

Szkieleciki Silicoflagellata wykazują bardzo dużą zmienność budowy i wielkości. Ocena taksonomicznego znaczenia tej zmienności wymaga przeprowadzenia studiów biometrycznych i statystycznych. Badania takie zostały przeprowadzone na gatunku *D. crux* (E h r e n b e r g), który w opisywanym materiale jest bardzo licznie reprezentowany. Definicje rodzajów zostały przyjęte według systematyki zestawionej przez L i p p s a (1970).

Distephanus crux (E h r e n b e r g), tabl. 1, fig. 1—20. Okazy są zgodne z definicją gatunku i z jego opisami, podanymi przez wielu autorów. Na podstawie zróżnicowania kształtu pierścienia podstawowego (fig. 1) i wyników pomiarów 336 okazów można wyróżnić dwie odmiany tego gatunku: forma A — szkieleciki dość duże z pierścieniem podstawowym w kształcie rombu i z małym pierścieniem apikalnym (tabl. 1, fig. 1—4); forma B — szkieleciki stosunkowo małe, o zaokrąglonym kształcie pierścienia podstawowego i z dużym pierścieniem apikalnym (tabl. 1, fig. 5—9). Ilościowo forma A obejmuje 67% populacji gatunku, forma B — 30%, a pozostałe 3% przypada na okazy o anomalnej budowie szkielecika.

Analiza biometryczna gatunku została przeprowadzona na podstawie pomiarów 5 elementów, oznaczonych symbolami: *l, s, p, m, n* (fig. 1) i współczynników ilorazowych: $\frac{s}{l}$, $\frac{p}{l}$, $\frac{n}{m}$, Podstawowe wskaźniki statystyczne tych elementów zostały obliczone dla całego zbioru (P — 336 okazów), oraz dla podzbiorów obejmujących formy: A i B (A — 231 okazów, B — 105 okazów). Wyniki przedstawione są na tabeli 1. Rozkłady statystyczne pięciu badanych cech, zestawione oddzielnie dla formy A i formy B są zbliżone do rozkładów normalnych (fig. 2). Bardzo wyraźna i statystycznie istotna zależność zaznacza się między wielkościami *l* i *s* w obu podzbiorach. Wyraża się ona współczynnikami korelacji liniowej: $r_A = 0{,}87$; $r_B = 0{,}90$ (fig. 3 — I). Na wykresie ujmującym dwa współczynniki ilorazowe: $\frac{s}{l}$ i $\frac{p}{l}$, punkty odpowiadające okazom dwóch wydzielonych odmian wyraźnie się rozdzielają (fig. 3 — II). Różnice między odmianami A i B, obliczone według wskaźników statystycznych: $\bar{x}$ i s są istotne dla wszystkich pięciu cech. A zatem wydzielone odmiany (forma A i forma B) różnią się od siebie istotnie, pod względem wielkości poszczególnych elementów szkielecików.

Analiza wartości znormalizowanych i wskaźników Perkala pozwoliła na ocenę wartości diagnostycznej cech, służących do zróżnicowania populacji na podzbiory A i B. Różnica w wielkości tzw. „współczynnika przyrodniczego" Perkala (z) jest istotna jedynie dla cechy p (wielkość pierścienia apikalnego) i przekracza ona wartość krytyczną, która wynosi 1,02 (tabela II). Cecha ta ma więc decydujące znaczenie dla rozróżniania form A i B w obrębie gatunku *D. crux* (Ehrenberg).

Inny typ zmienności populacji wyraża się obecnością pojedynczych okazów o nienormalnie wykształconych szkielecikach. Są to formy aberantne. W opisywanym materiale wydzielono dwa rodzaje aberancji: „aberancja I" — okazy o wymiarach wyraźnie odbiegających od wielkości średnich, „aberancja II" — okazy o anomalnej budowie szkielecików. Pierwszy rodzaj aberancji został wydzielony na podstawie analizy statystycznej. Należą tu okazy o cechach, których wartości znormalizowane nie mieszczą się w granicach $\bar{x} \pm 2s$ (a zatem z prawdopodobieństwem 99% nie należą one do zbioru ogólnego). Ocena indywidualności tych form została przeprowadzona na podstawie „krzywej kształtu" (fig. 4), zdefiniowanej przez Jentys-Szaferową (1959). Należą tu następujące formy aberantne:

I — 1. Formy wybitnie duże, o dużych wartościach l i s, (fig. 5 (10, 11)).
I — 2. Formy o wybitnie dużym pierścieniu apikalnym, (fig. 5 (12)).
I — 3. Formy o nierównej długości kolców radialnych, (fig. 5 (13)).

Drugi rodzaj aberancji obejmuje następujące formy anomalne:

II — 1. Formy o pięciu beleczkach łączących oba pierścienie, (fig. 5 (14—17)).
II — 2. Formy z przedzielonym okienkiem apikalnym, (fig. 5 (18)).
II — 3. Formy z trzema kolcami radialnymi, (fig. 5 (19)).
II — 4. Formy z trzema kolcami radialnymi i rozdzielonym okienkiem apikalnym, (fig. 5 (20)).

Wymienione aberancje zastępują wydzielenia taksonomiczne o randze niższej niż gatunek (podgatunek, varietas) opisywane przez różnych autorów.

Distephanus speculum (Ehrenberg), fig. 6 (1—8). Okazy są zgodne z definicją gatunku i opisami cytowanymi przez wielu autorów. W badanym materiale wyróżniono następujące formy aberantne:

1. Formy pięcioboczne z pięcioma kolcami radialnymi, (fig. 6 (7)).
2. Formy sześcioboczne z pięcioma beleczkami interradialnymi, (fig. 6 (4)).

3. Formy sześcioboczne z rozdzielonym pierścieniem apikalnym, (fig. 6 (5, 6)).
4. Formy z siedmioma kolcami radialnymi (fig. 6 (8)).

Dictyocha fibula Ehrenberg, fig. 6 (9—12)). Okazy są zgodne z definicją gatunku, o zróżnicowanej wielkości, fig. 6 (2—11). Występują też formy aberantne o zredukowanej części apikalnej, fig. 6 (12).

Corbisema triacantha (Ehrenberg), fig. 6 (13, 14). Okazy są zgodne z definicją gatunku i z opisami cytowanymi w literaturze.

Mesocena apiculata (Schulz), fig. 6 (17). Okazy nie odbiegają od form typowych, opisywanych przez różnych autorów.

Mesocena elliptica Ehrenberg emend. Deflandre, fig. 6 (15, 16). Okazy odpowiadają definicji gatunku i jego opisom.

Akademia Górniczo-Hutnicza
Instytut Geologii i Surowców Mineralnych
30-059 Kraków, al. Mickiewicza 30