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CHARACEAE FROM KEUPER SEDIMENTS OF THE KOLBARK DISTRICT

(13 Figs.)

Ramienice osadów kajpru okolic Kolbarku

(13 fig.)

Abstract. The presence of a rich charophyte flora was confirmed in the silty Keuper sediments. Ten species of Charophyta are described. A general outline of the present state of knowledge of Triassic charophytes and methods of determination of these are given.

INTRODUCTION

In Keuper rocks at Kolbark, about 40 km N.W. of Kraków, numerous Charophyta were found. The Keuper sediments were deposited in arid climatic conditions, within shallow, isolated basins (A. Szyperko-Śliwczyńska, 1960) and are seen as variegated clays, plum-red and green, somewhat sandy. They lie beneath a complex of Jurassic rocks, represented by conglomerates, marls and limestones and are in places exposed at the surface or occur imediately below a thin Quaternary cover.

In a synthetic profile from the Kolbark district, S. Z. Różycki (1953) distinguished red Keuper clays with pockets of the oolitic Lisów Breccia as the oldest rocks visible on the surface. The presence of these rocks indicates an Upper Keuper age for the clays, in the light of the studies of J. Znosko (1954). J. Znosko described the development of views on the subject of the age of the Lisów Breccia. The change of character of the sediments from Keuper to Rhaetic, as well as the appearance of gravels in the Keuper clays, according to this author is due to tectonic movements of the Eo-Kimmerian phase. Because the Lisów Breccia occurs below the gravels mentioned above, J. Znosko supposed that it is of Keuper age. In later years, J. Znosko (1960) maintained the view that the age of the variegated clays with the Lisów Breccia is Upper Keuper, but emphasized that this problem is not yet finally settled.

Z. Deczkowski and I. Jurkiewicz (1960) presented a stratigraphic scheme of Keuper and Lower Jurassic rocks, occurring in the Kraków-Częstochowa uplands. They assigned to the Lower Keuper silty

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shales, in places marly, layered and with dark, grey, green, reddish or light violet colours, with thin, layered limestones, as well as fine-grained sandstones. The authors assumed the existence of a hiatus in the Upper Keuper but on the other hand assigned the variegated clays with the Lisów Breccia and the Woźniki Limestone to the Rhaetic. A. Szyperko-Śliwczyńska (1961) also supported a Rhaetic age for these sediments. This author drew attention to the age-equivalence of the conglomeratic series of N.E. Poland with series including pockets of the Lisów Breccia, in the Silesia-Kraków area and northern boundary of the Świętokrzyskie Mts.

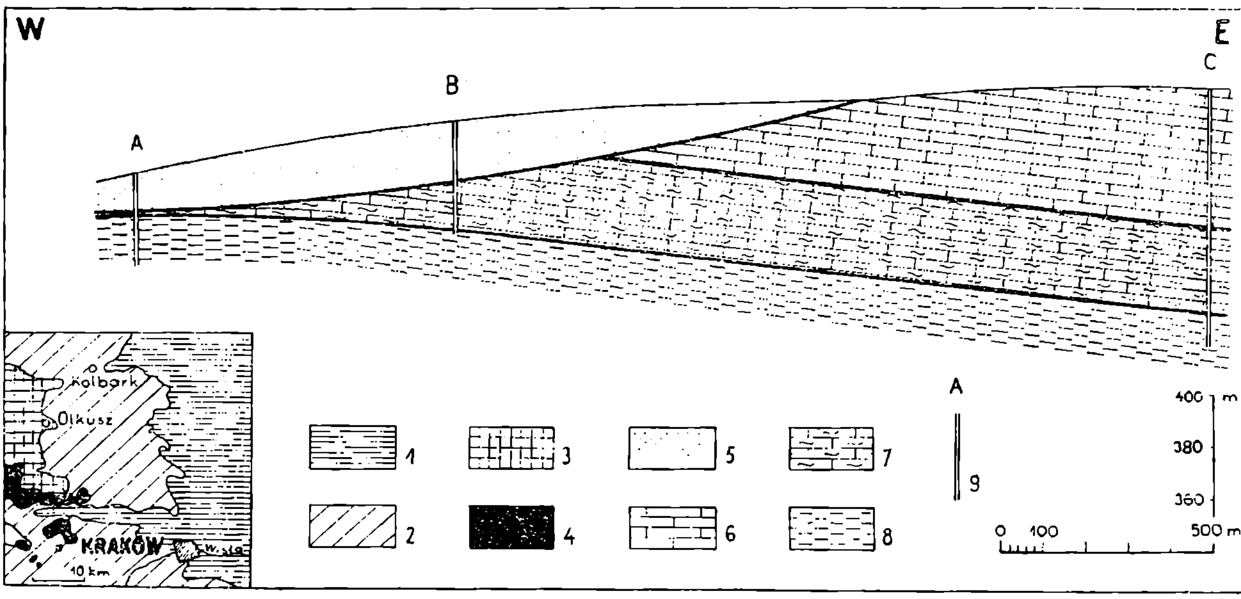


Fig. 1. Geological cross-section Kolbark-Zarzecze. Explanation of sketch-map: 1 — Cretaceous; 2 — Jurassic; 3 — Trias; 4 — Palaeozoic; explanation of cross-section; 5 — Quaternary; 6 — Malm; 7 — Dogger; 8 — Keuper; 9 — borings

Using bore-hole data, S. Połtowicz (1962, 1963) confirmed the presence of Upper Keuper only in the Olkusz and Pilica districts and in the region of the Błędowska Desert. The variegated clays with Charophyta (Kolbark) apparently correspond to the monotonous complex of marly shales, shales and calcareous sandstones, in places containing pockets of the Lisów Breccia, assigned by S. Połtowicz to the upper part of the Upper Keuper. In the profile in the Kolbark district, the presence of conglomeratic pockets has not been confirmed and thus there is no basis for the definition of the age of the variegated clays with Charophyta as Rhaetic.

REVIEW OF PREVIOUS WORK ON TRIASSIC CHAROPHYTA

An interest in Triassic Charophyta as well as their role in the stratigraphy of this period led to the appearance in the last two decades of a series of papers, dealing with stratigraphy of the Trias, based on the flora of Charophyta and presenting descriptions of new forms, characteristic for the Trias. The first work of this type was the monograph of H. Horn af Rantzien (1954), with the descriptions of 3 genera and 11 charophyta species from the Lamellibranch Limestone and Lower

Keuper of S. Sweden. On the basis of changes of charophyta floral assemblages in the profile of boring Höllviken 2, the author distinguished the horizons b, with the characteristic genera Praechara and Aclistochara as well as d and f, corresponding to the occurrence of the genera Stellatochara and Clavatorites.

W. M. Demin (1955) described two species of charophyta from the Trias of the Russian platform and confirmed the occurrence of one of them, *Chara donbassica* only in the upper part of the profile (horizon with ostracods). The second species described by this author. *Chara karpinskia,* occurs in the whole Triassic profile, though it is characteristic for the lower part only (horizon with agglutinating Foraminifera). *Charophyta* were also found in the Keuper (Unterer Steinmergel and Rote Wand) of Germany (C. A. Wicher, 1957) and two species from the genus *Stellatochara* were described in the Lower Keuper of Thuringia by P. Reinchardt (1963).

L. J. Saidakovsky (1960, 1962, 1966) gave descriptions of new genera and a number of species of charophytes from the Trias of the southern part of the Russian platform. In his work published 1966—67, he mentioned the great stratigraphic significance of Charophyta. On the basis of the changes in the Charophyta flora, this author distinguished 8 biostratigraphic horizons in the profile of the southern part of the Russian platform. Of these, the first (0) corresponds to the Upper Permian and the eigth (VII) to the Rhaetic. Horizons I and II were called the *Spaerochara* zones. Likewise horizon III is the *Porochara* zone. IV the *Stenochara* and *Maslovichara* zones, and V the *Stellatochara* zone. In horizon VI, very poor in organic remains, a scarce Charophyta flora occurs. The poor state of preservation permitted the recognition of only the following within this horizon: *Stellatochara* sp., *Maslovichara* sp., *Stenochara* sp., *Cuneatochara* sp. and *Porochara* sp., Horizon VI (Saidakovsky, 1966) corresponds to the Keuper; the author named horizon VII the Clavatoraceae zone.

The confirmation by many authors of the presence of Charophyta in the Polish Keuper sediments (J. Znosko, 1955; O. Styk, 1958; A. Szyperko-Śliwczyńska, 1961; E. Odrzywolska-Bieńkowa, 1962; H. Jurkiewicz, 1965) evidences their distribution in rocks of this age and indicates the possibility of zoning the Keuper sediments on the basis of Charophyta assemblages.

METHODS OF DETERMINATION

Almost exclusively oospores of Charophyta are found as fossils. They are preserved because of the existence of a cover of the oospore and a calcareous sheath called the gyrogonite. Vegetative organs, on the other hand, are rarely preserved.

In the determination of fossil charophytes, elements of the external morphology of the gyrogonite and internal structure are analyzed. Some authors, (R. Peck, 1957; H. Johnson, 1961; W. P. Maslov, 1963) provided the key to the determination of genera.

Greatest significance as specific characteristics have the following external elements; form of gyrogonite, its size, morphology of the apical and basal poles, number of convolutions visible in side view, their width near the equator and the change in width at the top and base, as well as the angle of inclination of the spirals to the equator (equatorial angle).

Besides the specific characteristics noted above, attention is given to the following elements of the gyrogonite; location of the maximum diameter, number of turns of convolutions around the gyrogonite, the nature of their surface (concavity or convexity), the presence of intercellular ridges as well as the shape of the apical and basal openings.

Size of the gyrogonite is defined by the length of the polar axis, measured from the apical pole to the basal pole, given the symbol LPA by H. Horn af Rantzien (1956), as well as the length of the greatest equatorial diameter (LED) H. Horn af Rantzien, to define the form of the gyrogonite introduced the isopolar index (ISI) as a percentage, expressing the ratio of the length of the polar axis LPA to the greatest equatorial diameter LED. In a case where the greatest equatorial diameter divides the gyrogonite into parts of differing length, the author employs the anisopolar index ANI as a percentage, which is the ratio of the distance of the top from the greatest equatorial diameter (AND) to the length of the polar axis LPA. The significance of the anisopolar index according to W. P. Maslov (1966) is to decrease the difficulty of exact location of the greatest equatorial diameter. To define the form of the gyrogonite, Russian workers employ the ratio h/d, corresponding to LPA/LED of H. Horn af Rantzien, but this is not expressed as a percentage. W. M. Demin (1967) proposes use of a spirality index given by the ratio of the length of the polar axis to the width of the spirals, and, for definition of the form of the gyrogonite, the formula:

$$c = \frac{a^2 - b^2}{a}$$

where a = length of polar axis, b = greatest equatorial diameter.

Some authors, in descriptions of species also give colour of the gyrogonite. However, as W. P. Maslov (1963) emphasizes, this feature depends chiefly on secondary factors (for example, pirytization) and has no influence on the systematic position of forms studied.

In descriptions of each species are given measurements of several selected specimens, the arithmetic means of these values, the range of variability on the basis of several measurements, the ranges of variability given by the authors of the species, as well as dimensions of the holotypes. The following elements were employed as measurements; length of polar axis, length of greatest equatorial diameter, number of spirals (z) seen in side views, width of convolutions in central part of gyrogonite, diameter of apical aperture, as well as the equatorial angle. The value of isopolar index, ISI, was also computed. For two species, represented by greater number of specimens, histograms of size frequency and of numbers of convolutions (z) seen in side view (Figs. 6 and 12) are given.

PALAEONTOLOGICAL DESCRIPTION

Type Charophyta
Class Charophyceae Maslov, 1963
Order Charales Mädler, 1952
Family Characeae Richard, 1815
Subfamily Maslovicharoideae Saidakovsky, 1966
Genus *Maslovichara* Saidakovsky, 1962

Maslovichara gracilis Saidakovsky
Fig. 2

1962 *Maslovichara gracilis* Saidakovsky; Saidakovsky L. J.; p. 1143, d. I, Fig. 1, 2.
1966 *Maslovichara gracilis* Saidakovsky; Saidakovsky L. J.; p. 122, Pl. II, d. 3, 4.

Material: 27 well preserved specimens.
Description: Gyrogonites oval in form, with top characteristically in the form of a calyx composed of five convolutions, forming a constriction in the apical part, and later widening and flaring outwards at the point of maximum width. Base with conical shape. Greatest diameter in central part of gyrogonite. In side view, 9—11 turns of convolutions visible, slightly concave, more rarely flat, divided distinctly by a fairly high intercellular ridge. Spiral coils of constant width for entire length of gyrogonite, completing about two turns at constant angle to equatorial axis; only near apical pole, this angle increases. On top, pentagonal apical opening found; this markedly larger than also pentagonal basal opening.
Comparison: This species displays a certain similarity to *M. incerta,* from which it differs in shape of the base, slimness of form and size. *M. sokolovi* exhibits a form similar to that of *M. gracilis,* but has smaller dimensions, a larger equatorial angle and a markedly smaller diameter of the apical aperture.
Remarks: To this species were assigned specimens (Fig. 2b, c) displaying a shape of base somewhat different from that of the holotype. It does not seem appropriate to distinguish a new taxon on this basis, because of the problematic individualism of these forms, particularly since the morphology of the basal pole is less important as a diagnostic feature than morphology of the apical pole. The specimens described display to a certain extent intermediate features of the species *M. gracilis* and *M. incerta.*

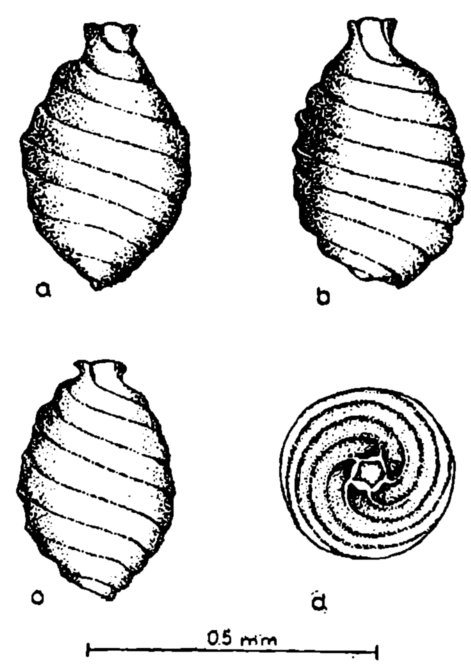


Fig. 2. *Maslovichara gracilis* Said. a, b, c — view from side; d — view from above

Occurrence: Boring Kolbark I, Keuper, variegated clays.
Stratigraphy: Horizons III, IV and V of the Trias in the southern part of the Russian platform.

Stellatochara maedleri Horn af Rantzien, 1954
Fig. 3

1953 *Stellatochara maedleri* Horn af Rantzien; Horn af Rantzien H.; Pl. I, Fig. 4.

1954 *Stellatochara maedleri* Horn af Rantzien; Horn af Rantzien H.; p. 41, Pl. III, Figs. 1—5.
1966 *Stellatochara maedleri* Horn af Rantzien; Saidakovsky L. J.; p. 117, Pl. I, d. 3, 4.

Material: 4 well preserved specimens.
Description: Gyrogonite oval in form, with relatively small apical projection and rounded base. Maximum diameter in central part of gyrogonite. In side view, 8—9 convolutions visible, slightly concave or flat. Width of spiral coils approximately constant over entire length of gyrogonite. Spirals make about two turns around gyrogonite with constant angle to equatorial axis; only near apical pole this angle varies and rising coils leave apical projection with pentagonal aperture of fairly large diameter. Basal aperture pentagonal, like apical aperture, though with fairly small diameter.

Table 1

Range of variability of Maslovichara gracilis

No	LPA μ	LED μ	ISI %%	z	Width of spi-rals μ	Diame-ter of apical ope-ning μ	Equa-tor. angle
1	470	310	152	10	48	38	16
2	432	300	144	11	45	40	15
3	460	310	148	9	48	40	15
4	472	292	162	9	48	33	15
5	432	297	146	9	47	40	14
6	450	285	158	10	47	38	15
Range of varia-bility	432-472	285-310	144-162	9-11	45-48	33-40	14-16
Mean	453	299	152	-	47	38	15
Holo-type	438	273	161	10	43	35	15
Range of varia-bility accor-ding to L. J. Saida-kovsky	420-485	250-357	136-168	9-11	41-48	32-40	15

Comparison: The species described above exhibits a marked similarity to *S. schneiderae*. The difference is seen above all in the size of the diameter of the apical aperture as well as in width of the spiral coils. *S. maedleri* has a diameter of apical aperture large by comparison with that of *S. schneiderae*, while on the other hand the width of spirals is smaller. *S. schneiderae* displays a high apical projection, which is usually fairly small in *S. maedleri*. The character of the base is also different for both species. *S. maedleri* has a rounded basal pole, while *S. schneiderae* has a flat base. The species described differs from *Stellatochara maedleri* forms in having larger dimensions, a larger equatorial angle and a more clearly defined apical projection.

Occurrence: Boring Kolbark I, Keuper, variegated clays.

Stratigraphy: Horizon *f* of the Trias of southern Sweden (Höllviken boring) as well as horizons III, IV and V of the Trias of the southern part of the Russian platform.

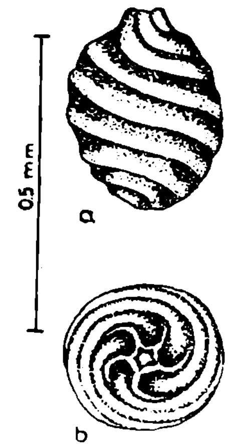


Fig. 3. *Stellatochara maedleri* H. af R. a — view from side; b — view from above

Table 2

Range of variability of Stellatochara maedleri

No	LPA μ	LED μ	ISI %%	z	Width of spirals μ	Diameter of apical opening μ	Equator. angle
1	335	255	131	9	42	50	16
2	350	274	128	8	40	55	16
3	356	280	127	8	42	45	15
4	380	290	131	–	–	45	14
Range of variability	335–380	255–290	127–131	8–9	40–42	45–55	14–16
Mean	355	275	129	8	41	49	15
Holotype	336	243	LED/LPA 70	9	42	30	c. 13
Range of variability according to Horn af Rantzien	294–350	230–266	LED/LPA 70–83	8–9	40–45	45–60	c. 15

Stellatochara donbassica (Demin)

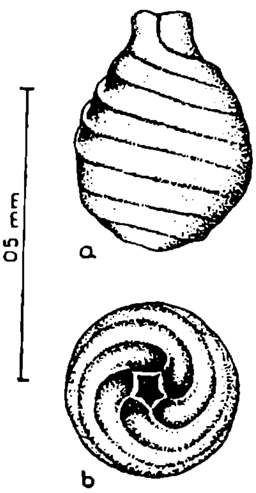
Fig. 4

1956 *Chara donbassica* Demin; Demin W.M.; p. 56, Pl. I, Figs. 9—11.

1966 *Stellatochara donbassica* (Demin) Saidakovsky; Saidakovsky L.J.; p. 118, Pl. I, d. 5, 6.

Material: 6 well preserved specimens.

Description: Gyrogonite oval in form, frequently spherical, char-



acterized by high apical projection as well as rounded base. Largest diameter in central part of gyrogonite. In side view, 7—8 turns of spiral visible. Convolutions not markedly concave, making one turn round gyrogonite without change in angle of inclination to equatorial axis; only near apical pole does this angle increase and spirals leave on top pentagonal apical opening. On basal pole, basal opening of fairly small size found.

Fig. 4. *Stellatochara donbassica* (Demin) Said. a — view from side; b — view from above

Table 3

Range of variability of Stellatochara donbassica

No	LPA μ	LED μ	ISI %%	z	Width of spirals μ	Diameter of apical opening μ	Equator. angle
1	437	312	140	8	48	55	11
2	417	300	140	7	55	-	12
3	417	292	143	7	50	55	14
4	412	288	143	8	50	-	12
Renge of variability	412–437	288–312	140–143	7–8	48–55	55	11–14
Mean	421	298	141	-	51	55	12
Holotype	362	260	140	8	50	45	13
Range of variability according to L. J. Saidakovsky	320–400	220–270	140–148	7–8	40–50	45–55	10–15

C o m p a r i s o n: The species described above differs from all other species of the genus *Stellatochara* in having a characteristic spherical form and a high apical projection.

R e m a r k s: The size of specimens from boring Kolbark I, assigned to this species, is not in the limits of variability, given by L. J. S a i d a k o v s k y (1966). Generally they are larger, but the presence of definite specific characteristics in these specimens suggests their assignment to *S. donbassica*.

O c c u r r e n c e: Boring Kolbark I, Keuper, variegated clays.

Stratigraphy: Horizons IV and V of the Trias in the southern part of the Russian platform.

Stellatochara schneiderae Saidakovsky

Fig. 5, 6

1962 *Stellatochara schneiderae* Saidakovsky; Saidakovsky L. J.; d. 1, fig. 1.

1966 *Stellatochara schneiderae* Saidakovsky; Saidakovsky L. J.; p. 120, Pl. I, d. 14—16.

Material: 54 well preserved specimens.

Description: Gyrogonites oval in form leaving apical projection of fairly variable height in particular specimens as well as flat base. Maximum diameter usually occurs somewhat below central part of gyrogonite. In side view, 8—9 convolutions visible. Spiral coils usually →

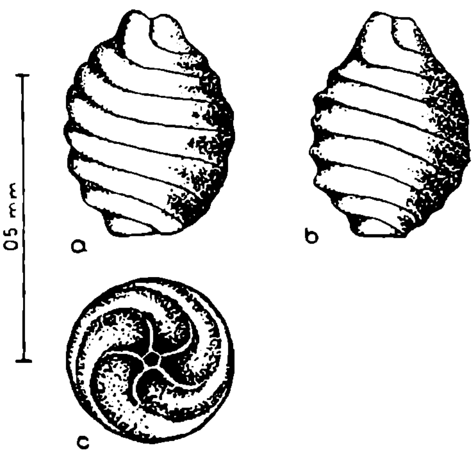


Fig. 5. *Stellatochara schneiderae* Said. a, b — view from side; c — view from above

Table 4

Range of variability of Stellatochara schneiderae

No	LPA μ	LED μ	ISI %%	z	Width of spi-rals μ	Diame-ter of apical ope-ning μ	Equa-tor. angle
1	375	260	144	8	57	40	19
2	395	305	130	8	60	40	19
3	360	285	126	8	48	35	15
4	370	290	128	8	60	-	18
5	405	305	133	9	55	37	16
Range of varia-bility	360-405	206-305	126-144	8-9	48-60	35-40	15-19
Mean	381	289	132	-	56	32	17
Hola-type	362	360	140	8	50	25	17
Range of varia-bility accor-ding to L.J. Saida-kovsky	340-400	250-314	128-140	8-9	40-60	25-40	15-20

concave, divided by fairly low though well defined intercellular ridges, make about two turns around gyrogonite. Spiral coils of constant width, have constant equatorial angle; only in the apical part does this angle clearly become larger. Apical opening usually pentagonal and relatively small. On the basal pole, there is an even smaller basal opening.

C o m p a r i s o n: *S. schneiderae* displays a similarity to *S. maedleri*, from which it differs in having a flat base, greater width of apical opening.

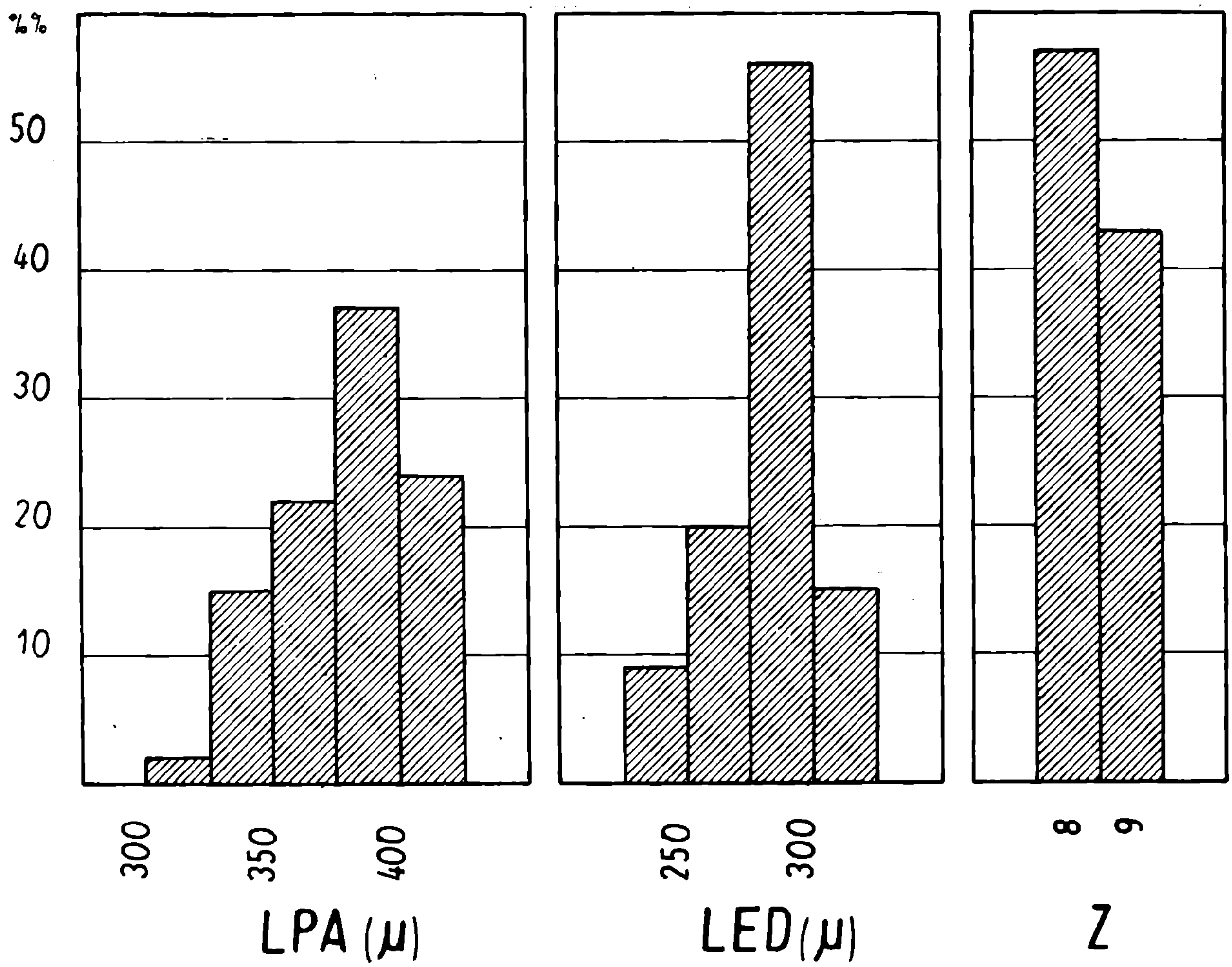


Fig. 6. *Stellatochara schneiderae* S a i d. Histograms: length of polar axis of gyrogonite (LPA), length of greatest diameter (LED) and number of spirals (z) visible in side view; on basis of 54 specimens

R e m a r k s: The information given in the table relating to measurements of several specimens, does not give a true variability of forms. On the basis of measurements from 54 specimens were obtained the ranges of variability LPA 324—417, LED 242—317, z 8—9 (Fig. 6).

O c c u r r e n c e: Boring Kołbark I, Keuper, variegated clays.

S t r a t i g r a p h y: Horizons III, IV and V of the Trias of the southern part of the Russian platform.

Porochara brotzeni (H o r n af R a n t z i e n)

Fig. 7

1954 *Aclistochara brotzeni* H o r n af R a n t z i e n; H o r n af R a n t z i e n H.; p. 52, Pl. IV, Figs. 5—10.

1961 *Porochara brotzeni* (Horn af Rantzien) Grambast; Grambast L.; p. 10.

1966 *Porochara brotzeni* (Horn af Rantzien) Grambast; Saidakovsky L. J.; p. 134.

Material: 4 well preserved specimens.

Description: Gyrogonites oval in form with flattened top and base in shape of gently rounded cone. Greatest diameter situated somewhat below central part of gyrogonite. In side view, 9 turns of spiral visible. Convolutions slightly concave, divided by fairly low intercellular ridges, maintain constant width and make about 2 turns around gyrogonite. Angle of inclination of spiral to equatorial axis approximately constant over entire length of gyrogonite. On top is apical opening of relatively large size, pentagonal or round. Basal opening pentagonal in shape.

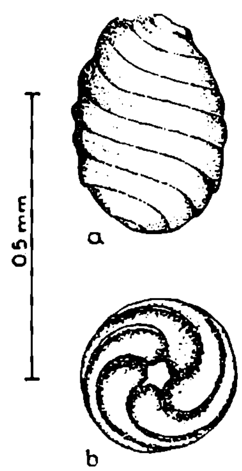


Fig. 7. *Porochara brotzeni* (H. af R.) Grambast. a — view from side; b — view from above

Table 5

The range of variability of Porochara brotzeni

No	LPA μ	LED μ	ISI %%	z	Width of spirals μ	Diameter of apical opening μ	Equator. angle
1	380	280	136	9	57	60	20
2	420	294	143	9	47	55	20
3	405	297	136	9	52	62	16
4	397	288	138	9	54	-	16
Range of variability	380–420	280–297	136–143	9	52–57	55–62	16–20
Mean	400	290	138	-	52	59	18
Holotype	384	280	LED/LPA 70	9	50	50	15
Range of variability according to Horn af Rantzien	364–420	266–300	LED/LPA 70–73	9–10	42–56	50–80	15–20

C o m p a r i s o n. The species described differs from the most closely comparable species *P. triassica* in having a greater number of spiral coils visible in side view, greater diameter of apical opening and shape of the base.

O c c u r r e n c e: Boring Kolbark I, Keuper, variegated clays.

S t r a t i g r a p h y: Horizon b of the Trias of Skania (Boring Höllviken 2) as well as horizon III, IV and V of the Trias of the southern part of the Russian platform.

Porochara triassica (S a i d a k o v s k y)

Fig. 8

1960 *Aclistochara triassica* S a i d a k o v s k y; S a i d a k o v s k y L. J.; p. 55, Pl. I, Fig. 3a, b.

1961 *Porochara triassica* (S a i d a k o v s k y) G r a m b a s t; G r a m b a s t L.; p. 201.

1966 *Porochara triassica* (S a i d a k o v s k y) G r a m b a s t; S a i d a k o v s k y L. J.; p. 133, Pl. IV, Fig. 5, 6.

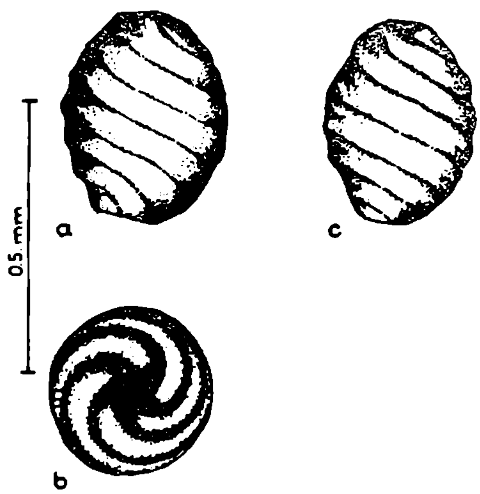


Fig. 8. *Porochara triassica* (S a i d.) G r a m b a s t. a, c — view from side; b — view from above

M a t e r i a l: 15 well preserved specimens.

D e s c r i p t i o n: Gyrogonites oval, sometimes ellipsoidal, symmetrical, exhibiting flat top and base with outline flat or somewhat rounded. Maximum diameter found in central part of gyrogonite. In side view, 7—8 slightly concave spirals, divided by fairly low intercellular ridges. Convolutions, making about one turn around gyrogonite, have constant width and display fairly low changes in angle of inclination to equatorial axis. In apical part, this angle is greater than equatorial angle while at the basal pole, it is somewhat smaller. On top of gyrogonite is found pentagonal apical opening, markedly larger than also pentagonal basal opening.

C o m p a r i s o n: The species described differs from *P. brotzeni* in its smaller number of spirals, visible in side view, smaller diameter of apical aperture and shape of basal pole.

O c c u r r e n c e: Boring Kolbark I, Keuper, variegated clays.

S t r a t i g r a p h y: Horizons III, IV and V of the Trias of the southern part of the Russian platform.

Table 6

Range of variability of Porochara triassica

No	LPA μ	LED μ	ISI %%	z	Width of spirals μ	Diameter of apical opening μ	Equator. angle
1	380	273	139	8	50	40	20
2	324	258	126	8	45	45	.22
3	364	282	129	7	55	-	20
4	415	292	142	7	55	38	21
5	405	297	136	7	55	45	24
Range of variability	324–415	258–297	126–142	7–8	45–55	38–45	20–24
Mean	378	280	134	-	52	42	21
Holotype	390	273	143	8	55	-	23
Range of variability according to L.J. Saidakovsky	350–415	240–330	126–144	7–8	45–55	35–45	20–25

Porochara urusovi Saidakovsky

Fig. 9

1966 *Porochara urusovi* Saidakovsky; Saidakovsky L. J.; p. 132, Fig. 2a, b.

Material: 13 well preserved specimens.

Description: Gyrogonites oval, often symmetrical, with flattened top and base, with maximum diameter situated in centre of gyrogonite. In side view, visible 7—8 turns of slightly concave convolutions, divided by wide intercellular ridges slightly rounded at the ends and in the shape of ribs. Angle of inclination of spiral to equatorial axis is constant throughout whole length of gyrogonite; only near basal pole undergoes slight decrease. Spiral coils of constant width make about one turn around gyrogonite. Apical opening, pentagonal or circular, is larger than pentagonal basal opening.

Comparison: The characteristic feature, differentiating the species *P. urusovi* from other species of the genus *Porochara*, is the presence of high intercellular ridges. This species also has a relatively small diameter of apical aperture, by comparison with the closely similar *P. brotzeni*.

Occurrence: Boring Kolbark I, Keuper, variegated clays.

Stratigraphy: Horizons IV and V of the Trias of the southern part of the Russian platform.

Table 7

Range of variability of Porochara urusovi

No	LPA μ	LED μ	ISI %%	z	Width of spi-rals μ	Diame-ter of apical ope-ning μ	Equa-tor. angle
1	400	312	128	7	62	40	14
2	392	300	131	7	60	40	16
3	375	300	125	7	57	40	15
4	425	320	133	7	65	40	16
5	389	291	134	7	62	35	17
Range of varia-bility	375–425	291–320	125–134	7	57–65	35–40	14–17
Mean	396	305	130	-	61	39	16
Holo-type	375	285	125	7	60	-	15
Range of varia-bility accor-ding to L.J. Saida-kovsky	340–430	270–320	125–135	7–8	55–68	30–40	12–18

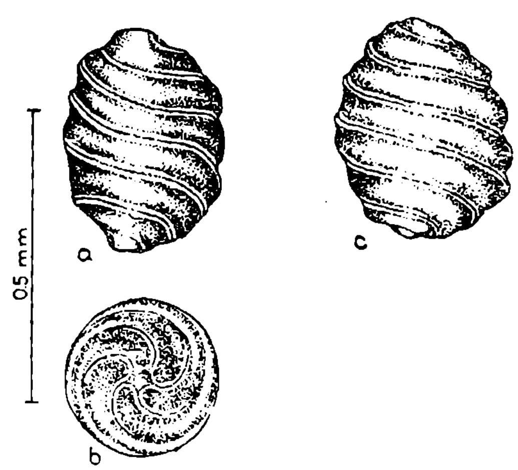


Fig. 9. *Porochara urusovi* Said. a, c — view from side; b — view from above

Porochara belorussica Saidakovsky

Fig. 10

1966 *Porochara belorussica* Saidakovsky; Saidakovsky L. J.; p. 135, Pl. IV, Fig. 1, 2.

Material: 5 well preserved specimens.

Description: Gyrogonites oval, symmetrical, with flat top and base, with maximum diameter situated in central part. In side view, visible

Table 8

Range of variability of Porochara belorussica

No	LPA μ	LED μ	ISI %%	z	Width of spirals μ	Diameter of apical opening μ	Equator. angle
1	340	292	116	7	60	-	13
2	347	292	118	7	60	30	9
3	334	295	113	7	60	-	12
Range of variability	334–347	292–295	113–118	-	-	-	9–13
Mean	340	293	116	-	60	-	11
Holotype	327	281	115	7	60	-	10
Range of variability according to L.J. Saidakovsky	300–370	260–320	115	6–7	60	30–40	10–12

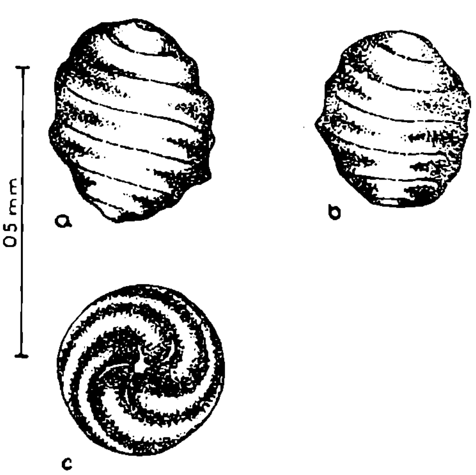


Fig. 10. *Porochara belorussica* S a i d. a, b — view from side; c — view from above

6—7 turns of definitely concave convolutions, divided by distinct, wide intercellular ridges. Spiral coils of constant width make about one turn around gyrogonite. Angle of inclination of spiral to equatorial axis is fairly small and changes slightly at the apical pole, where it increases somewhat. Apical opening is circular, as distinct from usually pentagonal and smaller basal opening.

C o m p a r i s o n: *P. belorussica* differs from other species of the genus *Porochara* chiefly in having smaller dimensions, barrel-shaped form and small equatorial angle. *P. belorussica* exhibits a similarity to *P. ukrainica*, from which it differs in dimensions (it is smaller), smaller number of spiral turns visible in side view, as well as size of equatorial angle.

O c c u r r e n c e: Boring Kolbark I, Keuper, variegated clays.
S t r a t i g r a p h y: Horizons II and III of the Trias of the southern part of the Russian platform.

Stenochara maedleri (H o r n af R a n t z i e n)
Figs. 11, 12

1953 *Praechara maedleri* H o r n af R a n t z i e n; H o r n af R a n t z i e n H.; Pl. I, Fig. 9.
1954 *Praechara maedleri* H o r n af R a n t z i e n; H o r n af R a n t z i e n H.; p. 62, Pl. I, Figs. 6—8.
1962 *Stenochara maedleri* H o r n af R a n t z i e n; G r a m b a s t L.; p. 66.
1966 *Stenochara maedleri* H o r n af R a n t z i e n; S a i d a k o v s k y L. J.; p. 126, Pl. II, d. 13, 14.

M a t e r i a l: 80 well preserved specimens.
D e s c r i p t i o n: Gyrogonites elongated, with top accentuated in form of slight, more or less distinct projection and rounded base, sometimes somewhat drawn out. Maximum diameter in centre of gyrogonite. In side view visible 9—11 turns of concave convolutions, divided by fairly

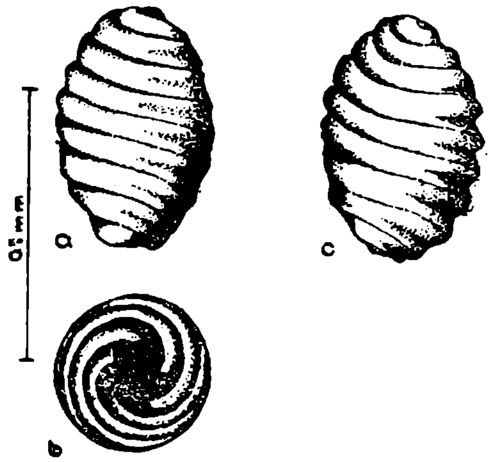


Fig. 11. *Stenochara maedleri* (H. af R.) G r a m b. a, c — view from side; b — view from above

low intercellular ridges. Spiral coils have constant width and constant angle of inclination to equatorial axis throughout entire length of gyrogonite. These coils make more than 2 turns round gyrogonite. On top, pentagonal opening found. On basal pole, spirals meet around fairly small basal opening.
C o m p a r i s o n: *S. maedleri* has smaller dimensions, less elongate form and more pronounced poles than *S. elongata*. The species described differs from others of the genus *Stenochara* in having elongate form, in the position of maximum diameter of the gyrogonite and in the prominent poles.
R e m a r k s: On the basis of measurements of 80 specimens, the following ranges of variability were obtained; LPA 365—485, LED 242—317, Z 9—11 (Fig. 12).
O c c u r r e n c e: Boring Kolbark I, Keuper, variegated clays.
S t r a t i g r a p h y: Zone b of the Trias of Skania (Höllviken boring) as well as Upper Permian and horizons I, II, IV and V of the Trias of the southern part of the Russian platform.

Table 9

Range of variability of Stenochara maedleri

No	LPA μ	LED μ	ISI %%	z	Width of spirals μ	Diameter of apical opening μ	Equator. angle
1	435	285	152	9	62	32	15
2	435	280	155	10	48	40	16
3	440	282	156	9	53	-	17
4	401	255	158	9	45	35	15
5	455	298	153	10	55	40	17
Range of variability	401–455	255–298	152–158	9–10	45–62	32–40	15–17
Mean	433	280	155	-	53	37	-
Holotype	457	297	LED/LPA 61	11	50	30	15
Range of variability according to Horn af Rantzien	343–470	221–300	LED/LPA 59–70	9–12	42–56	25–40	15

Stenochara elongata (Saidakovsky)

Fig. 13

1963 *Praechara elongata* Saidakovsky; Saidakovsky L. J.; d. 1, Fig. 15.
1966 *Stenochara elongata* (Saidakovsky); Saidakovsky L. J.; p. 129, Pl. II, d. 15, 16.

Material: 3 well preserved specimens.

Description: Gyrogonites spindle-shaped in form, with indistinct, flattened poles, have greatest diameter situated in central part. In side view, visible 10 turns of convolutions, slightly concave, separated by distinct intercellular ridges, make about two turns around gyrogonite. Width and angle of inclination of spiral coils are approximately constant throughout entire length of gyrogonite. On apical pole is fairly small, pentagonal or circular opening, larger than the basal opening.

Comparison: Most closely comparable to *S. elongata* is *S. maedleri*, from which the species differs in its elongate, spindle-like form and size. The strongly elongate and spindle-like shape permit the separation of *S. elongata* from all other species of the genus *Stenochara*.

Occurrence: Boring Kolbark I, Keuper, variegated clays.

Stratigraphy: Horizons III, IV and V of the Trias of the southern part of the Russian platform.

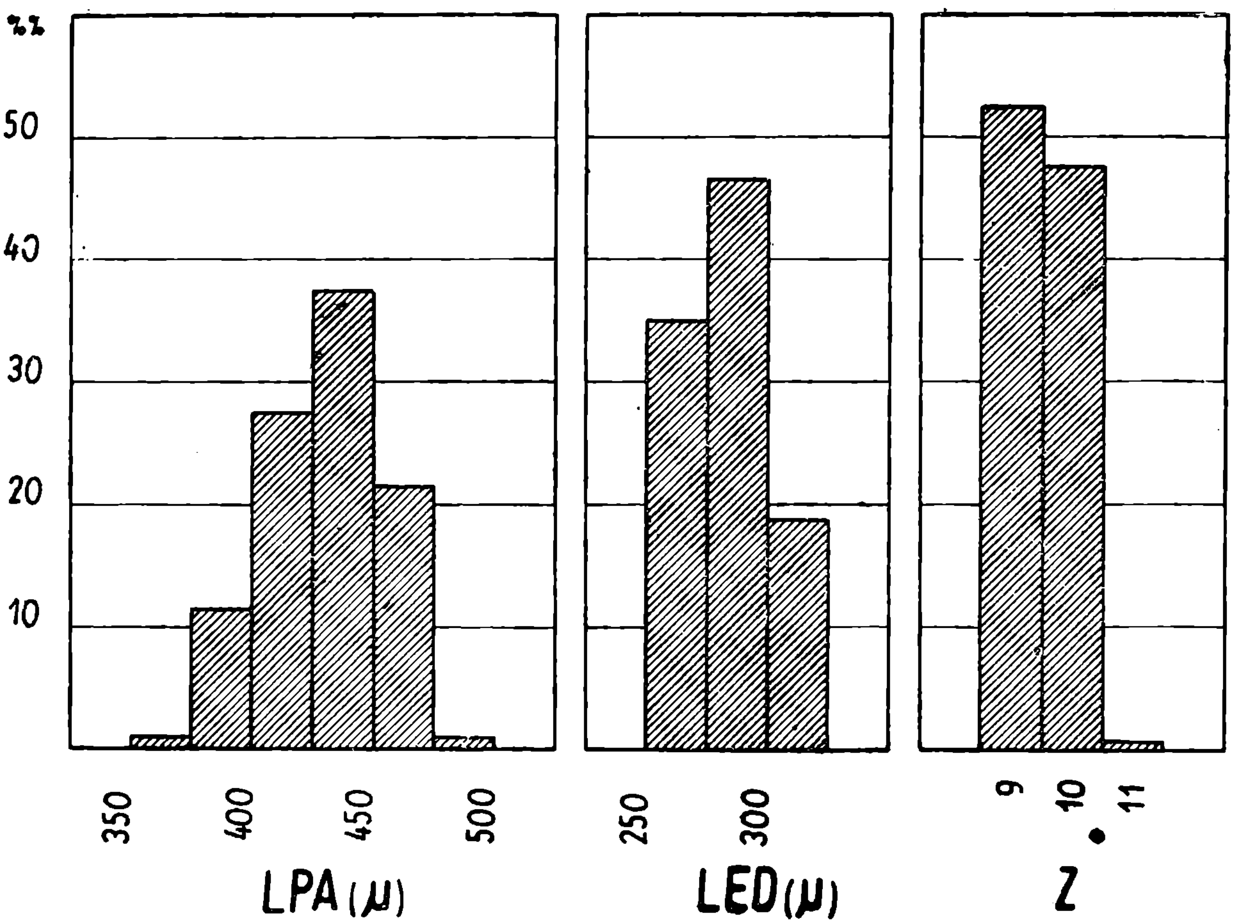


Fig. 12. *Stenochara maedleri* (H. af R.) Gramb. Histograms: length of polar axis of gyrogonite (LPA), length of greatest diameter (LED) and number of spirals (z) visible in side view; on basis of 80 specimens

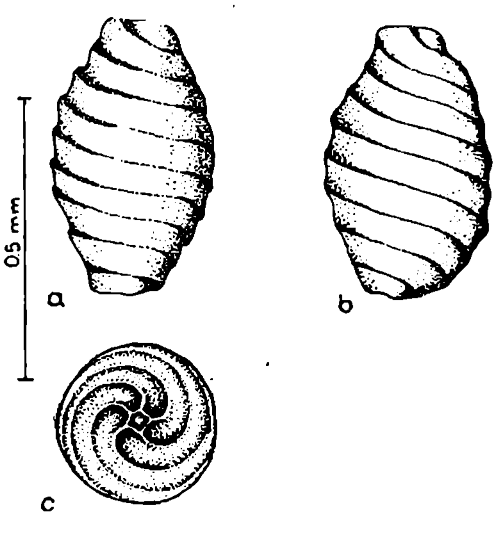


Fig. 13. *Stenochara elongata* (Said.) Said. a, c — view from side; b — view from above

Table 10

Range of variability of Stenochara elongata

No	LPA μ	LED μ	ISI %%	z	Width of spirals μ	Diameter of apical opening μ	Equator. angle
1	500	302	165	10	52	42	15
2	480	275	174	10	52	37	18
3	450	275	164	10	55	42	16
Range of variability	450-500	275-302	164-174	-	52-55	37-42	15-18
Mean	477	284	168	10	53	40	16
Holotype	510	276	180	11	60	-	16
Range of variability according to L. J. Saidakovsky	480-530	250-310	160-190	9-11	50-60	-	10-18

CONCLUDING REMARKS

The Charophyta species described from Kolbark occur chiefly in the highest biostratigraphic horizons of the Trias of the southern part of the Russian platform. Exceptions are: *Stenochara maedleri* (H. af. R.) present in horizons from 0 to V as well as *Porochara belorussica* (S a i d.), occurring only in horizons II and III. In the profile of bore-hole Höllviken (Skania) the species *Stenochara maedleri* (H. af R.) and *Porochara brotzeni* (H. af R.) occur in horizon b, (the zone with *Praechara* and *Aclistochara*) by H. H o r n af R a n t z i e n (1954), while *Stellatochara maedleri* (H. af R.) is present in horizon d (zone with *Stellatochara* and *Clavatorites*). This evidences the fairly limited range of some species in the stratigraphic profile. The confirmation of a rich and varied Charophyta flora in sediments of the Polish Keuper indicates the possibility of distinguishing Charophyta assemblages, characteristic for particular parts of the Keuper (Rhaetic), the more so since the series charophytes has marker significance.

I. D ą b s k a (1964), describing the Recent Charophyta flora of Poland confirmed the relation of particular species to a definite environment. As the most important ecological factors, the author mentioned: lithological character of substratum, movement of water and substratum, periodic drying up of the basin, lighting, temperature, salinity, concentration of CO_2 in the water, pH of the water, the presence of hydrogen sulphide and iron. Charophyta play the role of palaeoecological indices, characteristic for lacustrine and fluvial continental facies, of which the sediments of the Polish Keuper are made up to a marked degree. H. Horn af Rantzien (1954), R.E. Peck (1957), J.H. Johnson (1961), W.P. Maslov (1963, 1966) and others, confirming the connection between charophytes and facies particularly land facies, draw attention to the existence of forms living in a lagoon environment and even a marine environment. As an example, numerous authors give the recent species, *Chara baltica.*

The confirmation, on the one hand, of an association of definite forms with definite facies and, on the other hand, of a fairly large variation of facial conditions, of the kind in which Charophyta could live, indicates that they may to a certain extent characterize different facies, which has great significance particularly for the types of sediments, in which charophytes are the sole organic remains.

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1954), a także w triasie południowej części platformy rosyjskiej (W. M. Demin, 1956; L. J. Sajdakowski, 1960, 1962, 1966, 1967), świadczy o ich znacznym rozprzestrzenieniu w utworach tego wieku i wskazuje na możliwość rozpoziomowania osadów kajpru na podstawie zespołów charofitów.

W miejscowości Kolbark położonej w odległości około 40 km na północny-zachód od Krakowa w utworach kajpru stwierdzona została obecność ramienic. Osady kajpru wykształcone jako iły pstre, wiśniowoczerwone i zielone, nieco piaszczyste, przykryte są kompleksem utworów jurajskich reprezentowanych przez zlepieńce, margle i wapienie.

Opisano następujące gatunki ramienic:
Maslovichara gracilis Sajdakowski
Stellatochara maedleri Horn af Rantzien
S. donbassica (Demin) Sajdakowski
S. schneiderae Sajdakowski
Porochara brotzeni (Horn af Rantzien) Grambast
P. triassica (Sajdakowski) Grambast
P. urusovi Sajdakowski
P. belorussica Sajdakowski
Stenochara maedleri (Horn af Rantzien) Grambast
S. elongata (Sajdakowski) Sajdakowski

Największe znaczenie jako cechy diagnostyczne mają następujące elementy morfologii zewnętrznej: forma wapiennej otoczki oospory, jej wielkość, kształt bieguna apikalnego i bazalnego, ilość zwojów spiralnych widocznych w położeniu bocznym, ich szerokość w pobliżu równika i zmiana szerokości na wierzchołku i podstawie, wielkość kąta ekwatorialnego, usytuowanie maksymalnej średnicy okazu, ilość obrotów zwojów spiralnych wokół okazu, charakter ich powierzchni (wklęsłość lub wypukłość), obecność przegród międzykomorowych oraz kształt otworu apikalnego i bazalnego.

Gatunki ramienic opisane z Kolbarku występują przeważnie w wyższych (III, IV, V) poziomach biostratygraficznych triasu południowej części platformy rosyjskiej. Pewien wyjątek stanowią: *Stenochara maedleri* (Horn af Rantzien) obecna w poziomach od 0 do V oraz *Porochara belorussica* Sajdakowski, występująca jedynie w poziomach II i III. W profilu otworu Höllviken II (Skania) gatunki: *Stenochara maedleri* (Horn af Rantzien) oraz *Porochara brotzeni* (Horn af Rantzien) występują w poziomie b (zona z *Aclistochara* i *Praechara*), natomiast *Stellatochara maedleri* obecna jest w poziomie d (zona z *Clavatorites* i *Stellatochara*).