

Marian A. GASIŃSKI¹

HANTKENINA (FORAMINIFERIDA) IN THE EOCENE
AT BUJAKÓW (POLISH CARPATHIANS)

(Pl. I-II and 11 Figs.)

Otwornice z rodzaju Hantkenina w osadach eocenu Bujakowa
w Karpatach

(Pl. I-II i 11 fig.)

A b s t r a c t. *Hantkenina mexicana* Cushman, *H. liebusi* Shokhina and *H. dumblei* Weinzierl et Applin were described and the degree of variation of size and shape in *H. liebusi* was presented on the basis of 300 specimens measurements. The question of identity of *H. liebusi* and *H. dumblei* remains open. The studied specimens come from the assemblage of Foraminifera of Middle Eocene marls at Bujaków village (Western Polish Carpathians).

INTRODUCTION

The studied microfossils come from variegated marls of Middle Eocene age at Bujaków village, situated in Carpathians between Bielsko and Kęty, about 8 km SSW from Kęty (see Fig. 1). In this area marly Palaeogene and Upper Cretaceous sediments, belonging to the Sub-Silesian series are exposed in fragmentary outcrops. Geological structure of the area is complicated composed of Silesian and Sub-Silesian tectonic units. Fig. 2 presents the lithostratigraphic section of the Sub-Silesian series from the neighbourhood of Bujaków, compiled by Dr W. A. Nowak (Geological Institute, Kraków). Nowak (1954) first reported the discovery of *Hantkenina* in Polish Carpathians.

The studied assemblage of microfossils consists of planktonic Foraminifera, ca. 95% (mostly *Globigerina*, *Globorotalia*, *Globigerapsis*, *Has-tigerina*) and of benthic ones, ca. 5% (mostly calcareous forms). *Hantkenina* comprises ca. 1% of the total assemblage (Fig. 3).

¹ Jagellonian University, Institute of Geological Sciences, 30-063 Kraków, Oleandry 2a.

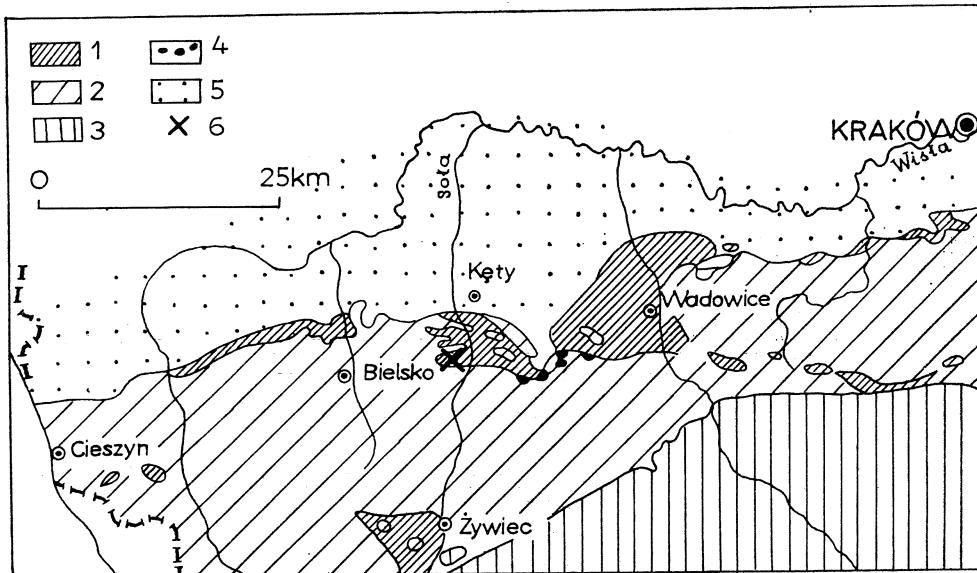


Fig. 1. A fragment of the tectonic map of Western Polish Carpathians (Budowa Geologiczna Polski, IV, Tektonika cz. 3, fig. 40, 1972). 1 — Sub-Silesian nappe; 2 — Silesian nappe; 3 — Magura nappe; 4 — Andrychów klippen; 5 — Miocene; 6 — Bujaków village

Fig. 1. Fragment mapy tektonicznej Polskich Karpat Zachodnich (Budowa Geologiczna Polski IV, Tektonika cz. 3, fig. 40, 1972). 1 — płaszczowina podśląaska; 2 — płaszczowina śląska; 3 — płaszczowina magurska; 4 — skałki andrychowskie; 5 — miocen; 6 — Bujaków

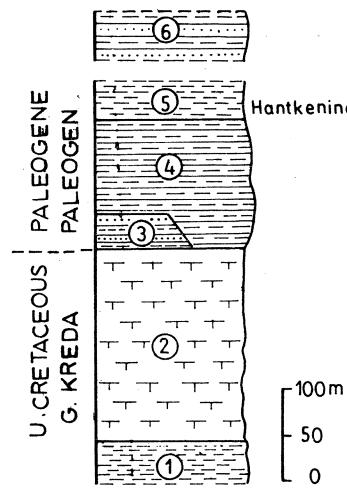


Fig. 2. Position of marls with *Hantkenina* in the sequence of beds in the Sub-Silesian series (after W. A. Nowak, in S. Geroch, 1967, fig. 67). 1 — variegated shales (Turonian-Lower Senonian); 2 — variegated marls (Upper Senonian); 3 — dark shales, sandstones and conglomerates of Istebna Beds (Paleocene); 4 — green-brown shales, marls, glauconitic sandstones, variegated marls (Paleocene-Eocene); 5 — variegated marls, partly marls with *Hantkenina* (Middle and Upper Eocene); 6 — micaceous sandstones and marly shales of Krosno Beds (Oligocene)

Fig. 2. Pozycja margli z *Hantkenina* w profilu jednostki podśląskiej (wg W. A. Nowak, 1958, S. Geroch, 1967, fig. 67). 1 — pstry łupki (turon-senon dolny); 2 — pstry margele (senon górny); 3 — ciemne łupki, piaskowce i zlepieńce — warstwy istebniańskie (pałeocen); 4 — zielonobrunatne łupki, margele, piaskowce glaukonitowe, pstry margele (pałeocen-eocen); 5 — pstry margele, częściowo margele z *Hantkenina* (eocen środkowy i górny); 6 — piaskowce mikowe i margliste łupki — warstwy krośnieńskie (oligocen)

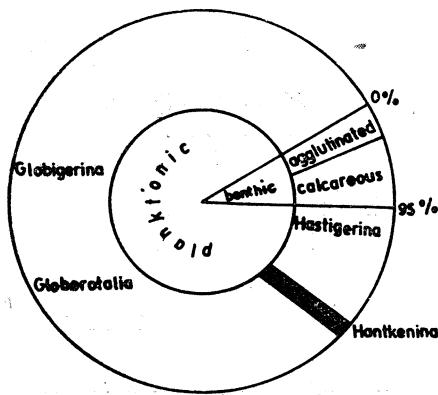


Fig. 3. Foraminiferal assemblage from *Hantkenina* marls at Bujaków (diagram)

Fig. 3. Diagram ilustrujący skład ilościowy otwornic w próbce marglu z Bujakowa

INCOMPLETE LIST OF SPECIES:

<i>Rhabdammina</i> sp.	R ²
<i>Hyperammina</i> sp.	F
<i>Ammodiscus siliceus</i> (Terquem)	F
<i>Glomospira charoides</i> (Parker et Jones)	R
<i>Reophax pilulifer</i> Brady	R
<i>Cribrostomoides subglobosus</i> Sars	F
<i>Haplophragmoides walteri</i> (Grzybowski)	F
<i>Recurvooides</i> sp.	R
<i>Trochamminoides coronatus</i> Brady	R
<i>Ammobaculites agglutinans</i> (d'Orbigny)	R
<i>Vulvulina eocaena</i> Montagne	R
<i>Textularia agglutinans</i> d'Orbigny	F
<i>Clavulinooides</i> cf. <i>midwayensis</i> Cushman	R
<i>Dorothia</i> sp.	R
<i>Nodosaria annulifera</i> Cushman et Bermudez	R
<i>Nodosaria</i> cf. <i>hochstetteri</i> Schwager	R
<i>Chrysalgonium tenuicostatum</i> Cushman et Bermudez	F
<i>Lagena crebra</i> Mathes	R
<i>Nuttallides trümpyi</i> (Nuttall)	C
<i>Hastigerina micra</i> Cole	C
<i>Globorotalia broedermanni</i> Cushman et Bermudez	F
<i>Globorotalia densa</i> (Cushman)	A
<i>Globigerina boweri</i> Bolli	A
<i>Globigerina eocaena</i> Gümbel	A
<i>Globigerina yeguensis</i> Weinzierl et Applin	A
<i>Subbotina linaperta</i> (Finlay)	A
<i>Truncorotaloides topilensis</i> Cushman	F
<i>Globigerapsis kugleri</i> (Bolli, Loeblich et Tappan)	F
<i>Globigerapsis mexicana</i> (Cushman)	R
<i>Globigerapsis rubiformis</i> (Subbotina)	R
<i>Globigerinita corpulenta</i> (Todd)	F
<i>Hantkenina mexicana</i> Cushman	F
<i>Hantkenina liebusi</i> Shokhina	C

² R — rare; F — frequent; C — common; A — abundant.

<i>Hantkenina dumblei</i> Weinzierl et Applin	F
<i>Eponides umbonatus</i> Reuss	C
<i>Cibicides cushmani</i> Nuttall	C
<i>Pleurostomella</i> sp.	R
<i>Aragonaria</i> sp.	R
<i>Anomalinoidea granosus</i> (Hantken)	F

The occurrence of species: *G. densa*, *T. topilensis*, *G. yeguaensis*, *G. kugleri* defines the above assemblage as a Middle Eocene.

SYSTEMATIC DESCRIPTION³

Superfamily: Globigerinacea Carpenter, Parker et Jones, 1862

Family: Hantkeninidae Cushman, 1927

Subfamily: Hantkenininae Cushman, 1927

Genus: *Hantkenina* Cushman, 1925

Hantkenina mexicana Cushman

Fig. 11 (42—46) pl. II fig. 6

Hantkenina mexicana n. sp. Cushman, 1925, p. 3, pl. 2, fig. 2;

Hantkenina mexicana Cushman, 1927, p. 160, fig. 18;

Nuttall, 1930, p. 284, pl. 23, fig. 13, 17; Shokhina, 1937, pp. 432—433, pl. 2, fig. 5—8, p. 433, text-fig. 55; Rey, 1938, pp. 322—323, 328, 331, pl. 22, fig. 4—5, p. 328, text-fig. c; Subbotina, 1953, pp. 131—132, p. 131, text-fig. 6; Ramsay 1962, pp. 81—82, pl. 16, fig. 1; Samanta, 1973, p. 473, pl. 7, fig. 16—17;

Hantkenina liebushi Shokhina, 1937, p. 428, text-fig. 9—10, 16—19, p. 429, fig. 25, p. 431, fig. 36—37.

M a t e r i a l: 50 well preserved specimens

D i m e n s i o n s (according to fig. 4): R=0,50—over 1 mm

G=0,25 mm (average)

H/d = 1,73, H/h = 1,44, H/R = 0,52

D e s c r i p t i o n. Test planispiral, involute, chambers of the last whorl are stellate in arrangement, distinctly separated. (There are the specimens with a visible penultimate whorl.) In the last whorl one can see 5—6 chambers increasing rapidly in size as added. Chambers are triangular in outline and convex in the part near the umbilical depression, and are compressed near the periphery.

Spines are situated in the prolongation of the chamber axis. They are of different length, and either equals the height of a chamber or shorter or very rare longer than chamber. Sutures vary from straight through more or less curved to sigmoidal. The aperture is an interiomarginal equatorial slit, bordered by a non-porous apertural flange. The surface of the test is perforate (except the apertural flange and spines). Pores are densely and regularly distributed.

³ According to Loeblich A. and Tappan H., 1964.

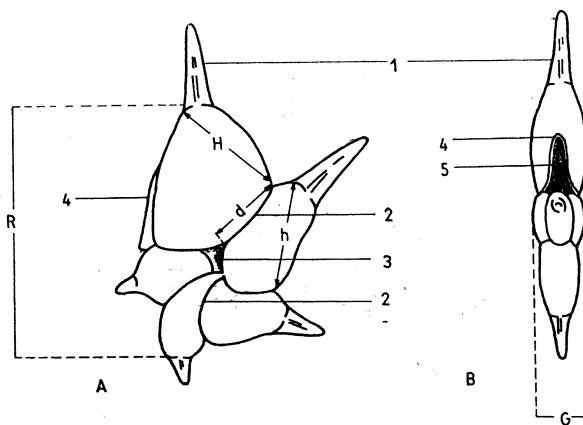


Fig. 4. *Hantkenina liebusi* — sketch. A — side view; B — apertural view; 1 — spine; 2 — sutures; 3 — umbilical depression; 4 — apertural flange; 5 — aperture; R — max. diameter (without spines); H — the height of the last chamber; h — the height of the chamber before the last one; d — breadth (width) of the last chamber; G — thickness of the test

Fig. 4. *Hantkenina liebusi* — rys. schematyczny. A — widok z boku; B — widok od strony ujściowej; 1 — kolec; 2 — szwy 3 — zagłębienie umbonalne; 4 — listewka ujściowa; 5 — ujście; R — większa średnica (bez kolców); H — wysokość ostatniej komory; h — wysokość przedostatniej komory; d — szerokość ostatniej komory; G — grubość skorupki

Remarks. *H. mexicana* differs from *H. liebusi* in the arrangement of chambers and spines and in thickness of test (see the description of *H. liebusi*). The length of spines as a taxonomic feature is not essential, because (as it was mentioned above) is a changeable feature.

Hantkenina liebusi Shokhina

Fig. 9 (1—20), fig. 10 (21—35), fig. 11 (36—38) pl. I, fig. 1—7, pl. II, fig. 1—5

Pullenia kochi (Hantken) Liebus (non *Siderolina kochi* Hamtken); Liebus A. 1911, p. 942, pl. 11, fig. 9, 10.

Hantkenina liebusi nov. sp. Shokhina, 1937, pp. 427—432, text-fig. 1—8, 11—15, 20—24, 26—35, 38—49.

Hantkenina liebusi Shokhina; Rey 1938, pp. 326—329, pl. 22, fig. 7—9, pl. 329, text-fig. a, b; Vašiček 1951, p. 121, pl. 4/14, fig. 4; Subbotina 1953, pp. 132—133, pl. 1, p. 133; fig. 11 a—b, Toumarkine et Bolli 1975, p. 175, pl. 1, fig. 6, 7, 14, 15,

Hantkenina cf. *mexicana* Cushman; Shokhina 1937, p. 433, text-fig. 50, 51.

Hantkenina longispina Cushman; Rey 1938, p. 328, p. 328, text-fig. e, pl. 22, fig. 1, 2; Subbotina 1953, p. 137, pl. 1, fig. 8, 9 a—b, 10 a—b.

Hantkenina (*Applinella*) *liebusi* Shokhina; Brönnimann 1950, p. 410—411, pl. 56, fig. 1, 2, 18, 19, 23, p. 406, text-fig. 2;

Hantkenina (*Aragonella*) *liebusi* Shokhina, Ramsay 1962, p. 83, pl. 16, fig. 6, 7.

Hantkenina aragonensis Nuttall; Premoli Silva et Luterbacher 1966, p. 1192, fig. 5.

Material: about 500 specimens, 300 used for statistic

Dimensions: $R = 0,40 — 0,70$ mm (adult specimens)

$G = 0,20$ mm (average)

mean magnitudes:

$$\begin{array}{lll} H/h = 1,29, & \sigma = 0,25, & (V = 19,1) \\ H/h = 1,36, & \sigma = 0,27, & (V = 19,6) \\ H/R = 0,51, & \sigma = 0,07, & (V = 12,9) \end{array}$$

$$\bar{X} = X_0 + l \left[\frac{\sum f_i (X_i - X_0)}{N} \right]$$
$$S = \sqrt{l \left[\frac{\sum f_i (X_i - X_0)^2}{N} - \left(\frac{\sum f_i (X_i - X_0)}{N} \right)^2 \right]}$$
$$V = \frac{S \times 100}{\bar{X}}$$

σ — standard deviation, V — coefficient of variation (according to Perkal 1958, Heller 1968).

Description. Test planispiral, involute or almost involute (the penultimate whorl can be seen more frequently than in *H. mexicana*). The chambers of the last whorl are slightly leaned towards the front of test. The last whorl has generally 5—6 chambers with a great degree of growth. The chambers are very closely connected with each other, thus the outline of the test is less stellate. This feature is changeable, from specimens with distinct interchamber incisions (although not so big as in *H. mexicana*) to specimens with a complete fusion of the neighbouring chambers, which eliminates the interchamber incisions. The chambers are more depressed than in the previous species, however we can distinguish more convex part half-way of the chambers height and more flat parts: one near the umbilical depression, another on the periphery of the test.

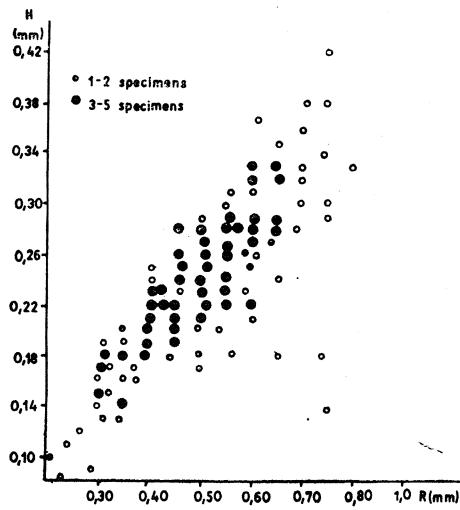


Fig. 5. *H. liebusi* — diagram showing the relation H/R . For symbols see fig. 4

Fig. 5. Diagram ilustrujący stosunek H/R u *H. liebusi*. Objasnienie patrz fig. 4

Thickness in the middle of a chamber height = 0,23 mm⁴

Thickness of the part close to umbilical depression = 0,21 mm⁴

Thickness of the circumferent part = 0,16 mm⁴

Spines are situated in the prolongation of sutures and are slightly inclined towards the front of the test. They are of different length, non-porous (pl. II, fig. 4) and are hollowed out inside to about half of their length. Sutures are of variable shape, from straight to sigmoidal.

The shape of the aperture and porosity is similar to that of *H. mexicana*.

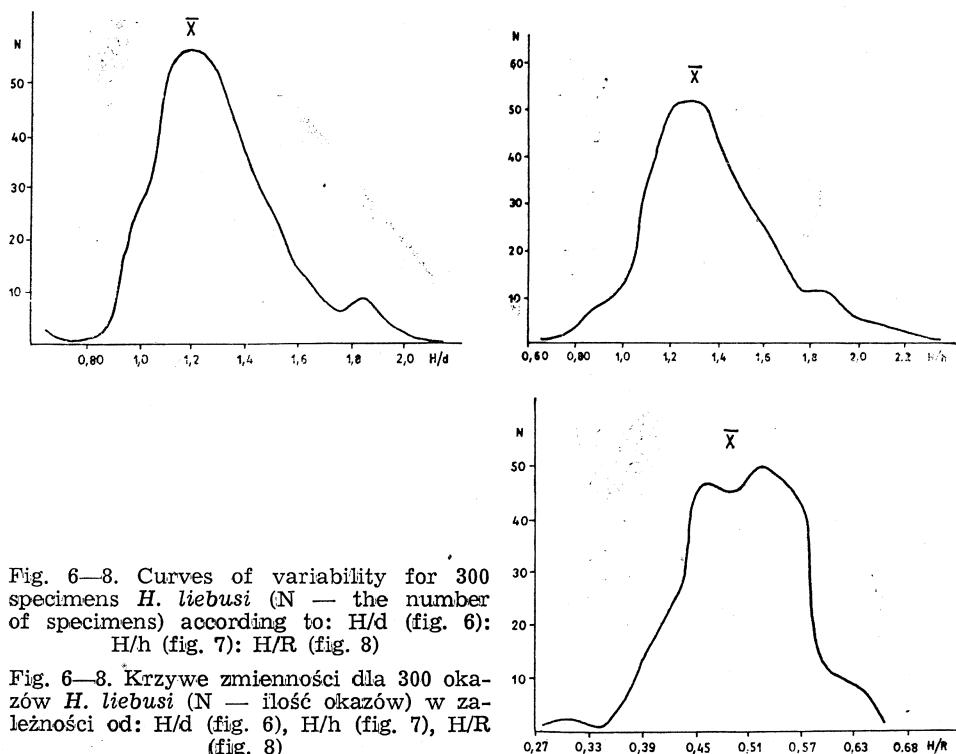


Fig. 6—8. Curves of variability for 300 specimens *H. liebusi* (N — the number of specimens) according to: H/d (fig. 6); H/h (fig. 7); H/R (fig. 8)

Fig. 6—8. Krzywe zmienności dla 300 okazów *H. liebusi* (N — ilość okazów) w zależności od: H/d (fig. 6), H/h (fig. 7), H/R (fig. 8)

Remarks. *H. liebusi* Shokhina is a species of great variability. Already Shokhina mentioned, that some features are very variable (a size of the last chamber, a differentiation of sizes of the last whorl chambers, a shape of sutures). Variability of those features was observed in the investigated material. We must stress, that Shokhina's treatment of *H. liebusi* is too broad. Illustrations in her work rather suggest, that some specimens distinguished as *H. liebusi* nov. sp. belong to *H. mexicana* Cushman (vide synon.). Those features as: chambers slightly inclined towards the front of the test, the spines situated at the anterior

⁴ mean magnitudes.

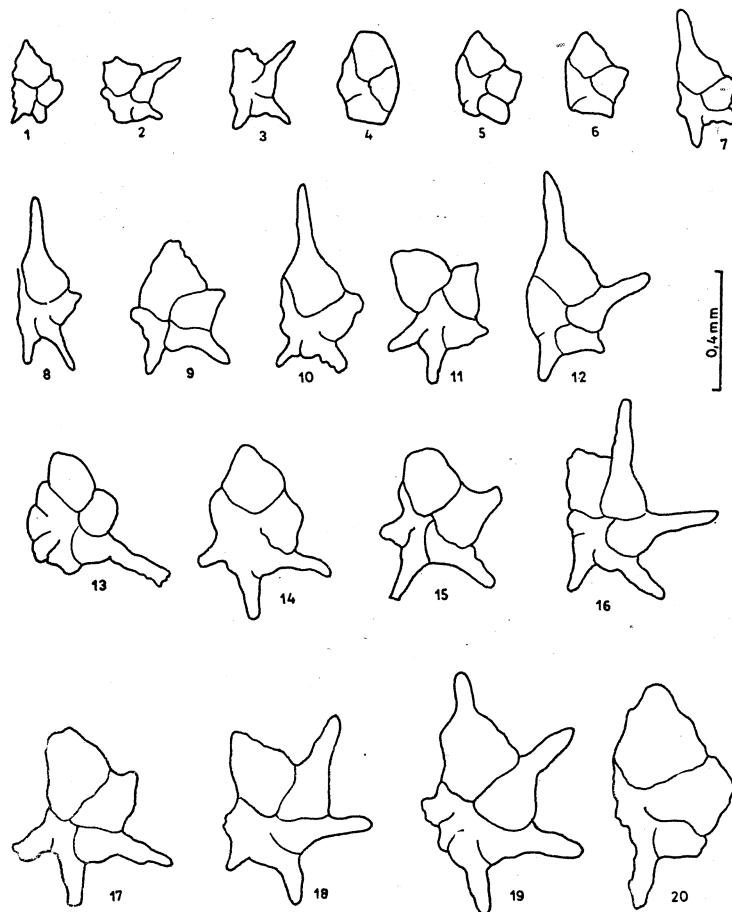


Fig. 9. *Hantkenina liebusi* Shokhina (1—20)

angle of the chambers, periphery slightly lobate, little thickness of the test, do not show a great variation, and were used in this paper as diagnostic feature for *H. liebusi*. Analysis of variation by statistical method is used basing on measurements of 300 specimens according to fig. 4 and mathematical and graphic interpretations (fig. 5—8). Of course, some features (given in the description) could not be measured, because of the technical reasons, e. g. chambers tangentially arranged. The greatest difficulty in measurements was caused by the poor state of preservation of specimens. A number of specimens had broken chambers and spines, and it was also difficult to asses certain points of measurements (e. g. a point when a chamber ends and spine begins).

Hantkenina dumbblei Weinzierl et Applin

Fig. 11 (39—41) pl. I, fig. 8

Hantkenina dumbblei n. sp. Weinzierl et Applin, 1929, p. 402, pl. 43, fig. 5 a—b;
Hantkenina dumbblei Weinzierl et Applin; Rey 1938, p. 329, text-fig. c, d, pl. 22, fig.
10, 11; Postuma 1971, pp. 222—223; Toumarkine et Bolli 1975, p. 175, pl. 1, fig. 4, 5.
Hantkenina (Applinella) dumbblei Weinzierl et Applin, Brönnimann 1950, pp. 408—
410, pl. 55, fig. 17—18, 22—24, pl. 56, fig. 5.

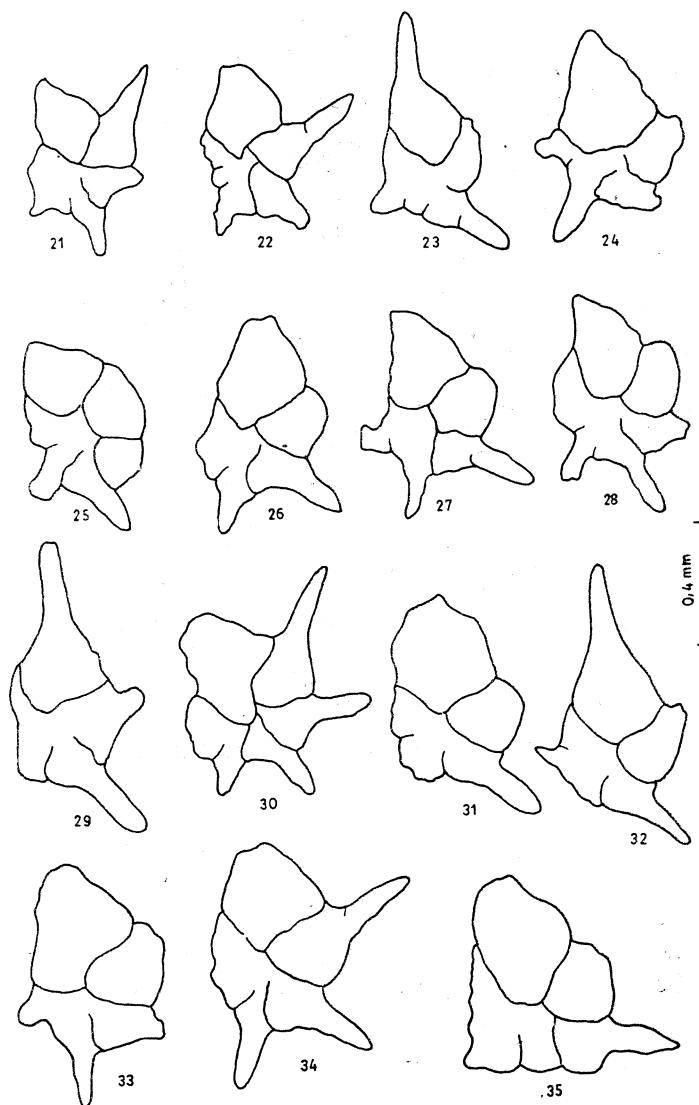


Fig. 10. *Hantkenina liebusi* Shokhina (21—35)

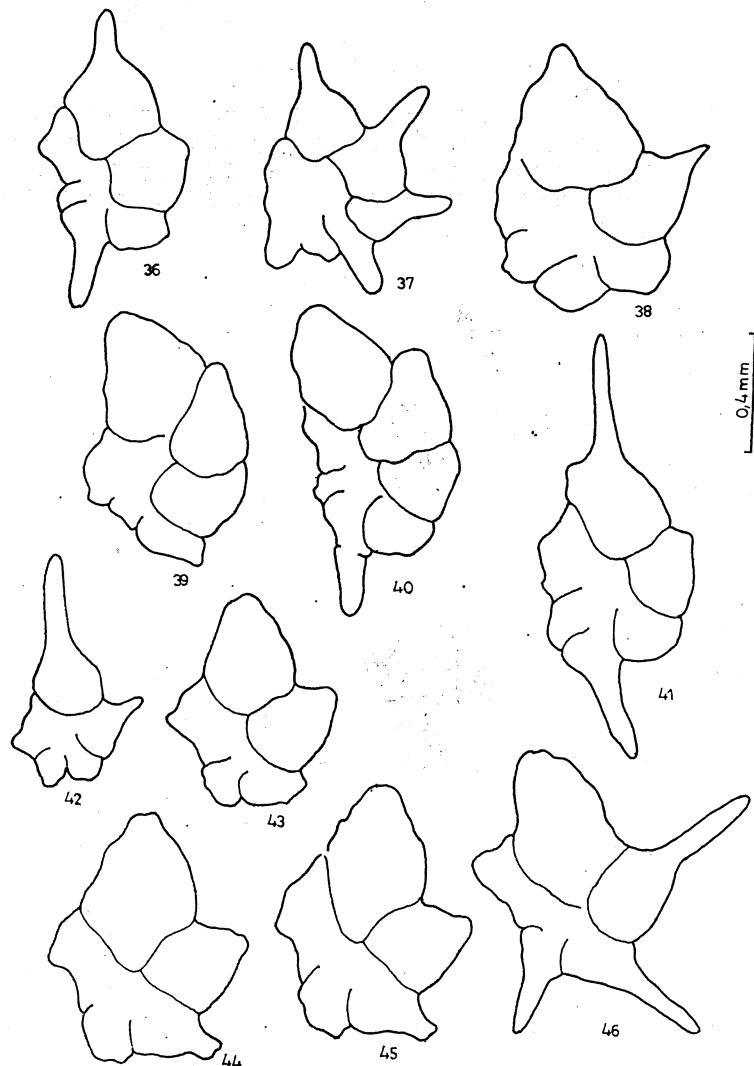


Fig. 11. *Hantkenina liebusi* Shokhina (36—38); *Hantkenina dumblei* Weinzierl et Applin (39—41); *Hantkenina mexicana* Cushman (42—46)

Material: about 50 specimens

Dimensions: $R = 0,60 — 0,90$ mm (adult specimens)

$G = 0,20$ mm (average)

mean magnitudes: $H/d = 1,30$, $H/h = 1,37$, $H/R = 0,51$

Description. Test planispiral, involute, also (as in *H. liebusi*) the penultimate whorl can be seen more frequently than in *H. mexicana*. All other features are similar as in *H. liebusi*, but the longitudinal axes of chambers are distinctly more tangential than in *H. liebusi*. (Remarks in discussion).

DISCUSSION

Apart from the problem of variability another arises from identification of species. In American and West European literature we rarely find the description of *H. liebusi* Shokhina. In publications concerning the Middle Eocene microfauna reference has been made to the species *H. dumblei* Weinzierl et Applin described from North America (Coastal Domes, Texas). Shokhina mentions *H. dumblei*, but her description is based on the literature only. She does not mention any finding of the species in question in samples of Eocene sediments from Caucasus. The descriptions of *H. liebusi* and *H. dumblei* are so similar, that it is difficult to assess the real differences between these species. However, we may infer from the literature, that *H. dumblei* has spines and chambers more inclined in the direction of coiling. Both species are typical for the Middle Eocene this causes further difficulty in identifying the Bujaków specimens as *H. liebusi* or *H. dumblei*. While describing the holotype, Shokhina distinguishes it from *H. dumblei* by the way of coiling of test. According to Shokhina, the last chamber of *H. liebusi* partly covers the first chamber of the last whorl, while in case of *H. dumblei* the first chamber of the last whorl uncovered and is oriented at right angle to the last chamber. Recently, Samanta (1973) describing *H. dumblei* has suggested, that the specimen used for the description of the holotype by Weinzierl et Applin was damaged (the last chamber broken). Rey (1938) expressed the opinion, that *H. liebusi* and *H. dumblei* can be distinguished through a comparison of size relation of the final chamber to the preceding one. But already Shokhina emphasise that the size relation, mentioned above, is particularly variable in *H. liebusi*. In specimens from Bujaków this size relation also showed a great variability.

The picture of the holotype and illustrations in papers referring to *H. dumblei* do not show such feature. E. g. Vašiček (1971) indicates, that *H. dumblei* is bigger than *H. liebusi* but the growth of the successive chambers is gradual. According to Rey (1938) the difference between *H. liebusi* and *H. dumblei* can be seen while comparing the shapes of sutures of both species. In Rey's opinion the sutures of *H. liebusi* are sigmoidal and of *H. dumblei* are rectilinear. Shokhina (1937) assesses that the shape of sutures of *H. liebusi* is very variable. *H. liebusi* from Bujaków have both sigmoidal and rectilinear sutures.

According to Brönnimann (1951) in the case of *H. liebusi*, the spines are situated in the prolongation of the sutures. Majzon's opinion (1960) on this question is similar.

Jenkins (1960) in his description of *H. australis* Finlay from New Zealand compares it to *H. liebusi* and *H. dumblei*. From his comparison it is evident, that *H. dumblei* has spines inclined towards the front of

the test, while *H. liebusi* has spines only slightly bent in this direction. Jenkins sees here an important difference between those two species, but in most instances specimens have the spines broken and this inclination of spines is difficult to observe. It seems that the inclination of spines is strongly correlated with the inclination of chambers towards the front of the test, this is regarded as typical for *H. dumblei* (Postuma, 1971). Tangential arrangement of chambers is used in this paper as a diagnostic feature for separating *H. liebusi* from *H. dumblei*.

Many authors deal with *Hantkenina* but their descriptions do not provide sufficient information, which could be used as the ground for distinguishing *H. liebusi* from *H. dumblei* (Brönnimann, 1950, Crespin, 1958, Ramsay, 1962, Dieni, Proto-Decima, 1964, Bratu, 1969, Martinez, 1969, Samanta, 1973).

Very interesting is Berggren's opinion (1966), who identifies *H. liebusi* with *H. dumblei* (as synonyms).

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STRESZCZENIE

Z pstrych margli wieku eoceńskiego z miejscowości Bujaków (fig. 1,2) opisano otwornice z rodzaju *Hantkenina*. Wyróżniono trzy gatunki: *H. mexicana* Cushman, *H. liebusi* Shokhina i *H. dumblei* Weinzierl et Applin. W opisie gatunków starano się przedstawić te cechy, które nie wykazują dużej zmienności.

Do cech charakterystycznych dla *H. liebusi* (odróżniających ten gatunek od *H. mexicana*) należą: mniejsza płatowatość skorupki, tzn. mniejsze wcięcia międzykomorowe; usytuowanie kolca w położeniu blisko przedniego szwu każdej komory, nachylenie komór ostatniego zwoju w kierunku zwinięcia skorupki, mniejsza grubość skorupki (vide opis *H. liebusi*).

W opisie *H. liebusi* przedstawiono zakres zmienności wewnętrzgatunkowej na podstawie analizy statystycznej 300 okazów w oparciu o pomiary wykonane według fig. 4. (fig. 5—8). W części dyskusyjnej przedstawiono poglądy według różnych autorów na temat identyczności lub odrębności gatunków: *H. liebusi* i *H. dumblei*, nawiązując do analizy materiału z Bujakowa. W pracy wyróżniono *H. dumblei* na podstawie większego nachylenia komór ostatniego zwoju w kierunku zwinięcia skorupki, chociaż szereg cech tego gatunku mieści się w zmienności *H. liebusi*.

Do opisów gatunków starano się włączyć elementy ultrastruktury skorupki (pl. II). Dołączono diagram (fig. 3) i listę gatunków otwornic oznaczonych z pelagicznej mikrofauny śródziemnego eocenu margli z Bujakowa.

EXPLANATION OF PLATES = OBJAŚNIENIA PLANSZ

Plate — Plansza I

- Fig. 1—7. *Hantkenina liebusi* Shokhina (fig. 5, 6 — the apertural sight):
Fig. 1—7. *Hantkenina liebusi* Shokhina (fig. 5, 6 — widok od strony ujściowej):
Fig. 8. *Hantkenina dumblei* Weinzierl et Applin

Plate — Plansza II

Fig. 1—5. *Hantkenina liebusi* Shokhina (fig. 2 — the structure of the test's surface, pores are exposed, fig. 3, 5 — aperture — arrows point to the apertural flange, fig. 4 — a fragment of the chamber with spine)

Fig. 1—5. *Hantkenina liebusi* Shokhina (fig. 2 — struktura powierzchni skorupki, uwidocznione pory, fig. 3, 5 — ujście — strzałki wskazują listewkę ujściową, fig. 4 — fragment komory z kolcem)

Fig. 6. *Hantkenina mexicana* Cushman

SEM — photomicrographs were made in the Laboratory of Electron Microscopy Zoological Institute of Jagellonian University by using Scanning Electron Microscope JEOL-JSM-35.

