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FORAMINIFERA FROM THE BRACKISH SANTONIAN
DEPOSITS IN THE NORTH SUDETIC BASIN
(WESTERN POLAND)

(3 Figs)

*Otwornice z brakicznych osadów santonu w niecce
północno-sudeckiej*

(3 fig.)

Abstract: The continental deposits of the Santonian, occurring in the NW Sudeten, are an argillaceous sandy formation, containing thin layers of clays with a brackish lamellibranch fauna — *Cyrena cretacea* Dresch. In these clays an assemblage of arenaceous foraminifera dominated by *Verneuilinoides borealis* Tappan was found. There also occurred the foraminifera belonging to *Ammodiscus*, *Ammobaculites*, *Haplophragmoides* and *Trochammina*. The present assemblage contains species occurring in various stages of the Cretaceous, in specific ecological environments. In the North Sudetic basin this assemblage developed in lagoons with almost fresh water (mesohalic zone), in a warm-moderate, wet climate.

INTRODUCTION

The continental deposits of the Santonian occurring in the north-west Sudeten are sandstones and sands with intercalations of kaoline clays and dark gray clays with plant remains and layers of brown coal. The gray clays of that complex contain an accumulation of lamellibranch shells belonging to the species *Cyrena cretacea* Drescher (Milewicz, 1965). This is characteristic of the brackish facies of the Upper Cretaceous. In the clays with *Cyrena* well preserved arenaceous foraminifera and some coprolithes have been found. The assemblage differs markedly from those described from marine facies of Santonian in the neighbouring areas.

The material studied was obtained from boreholes drilled in the vicinity of Bolesławiec, the cores have been described by the author

(Fig. 1). One sample of clays with *Cyrena cretacea* Dresch. derived from Osiecznica (15 km NW from Bolesławiec) was given to author by dr H. Niedzielski.

GEOLOGICAL POSITION OF MICROFAUNA

The Upper Cretaceous deposits in the North Sudetic basin are 600—800 m thick (Fig. 1—I). At the bottom of this section are medium- and coarse-grained sandstones in which a poor Cenomanian

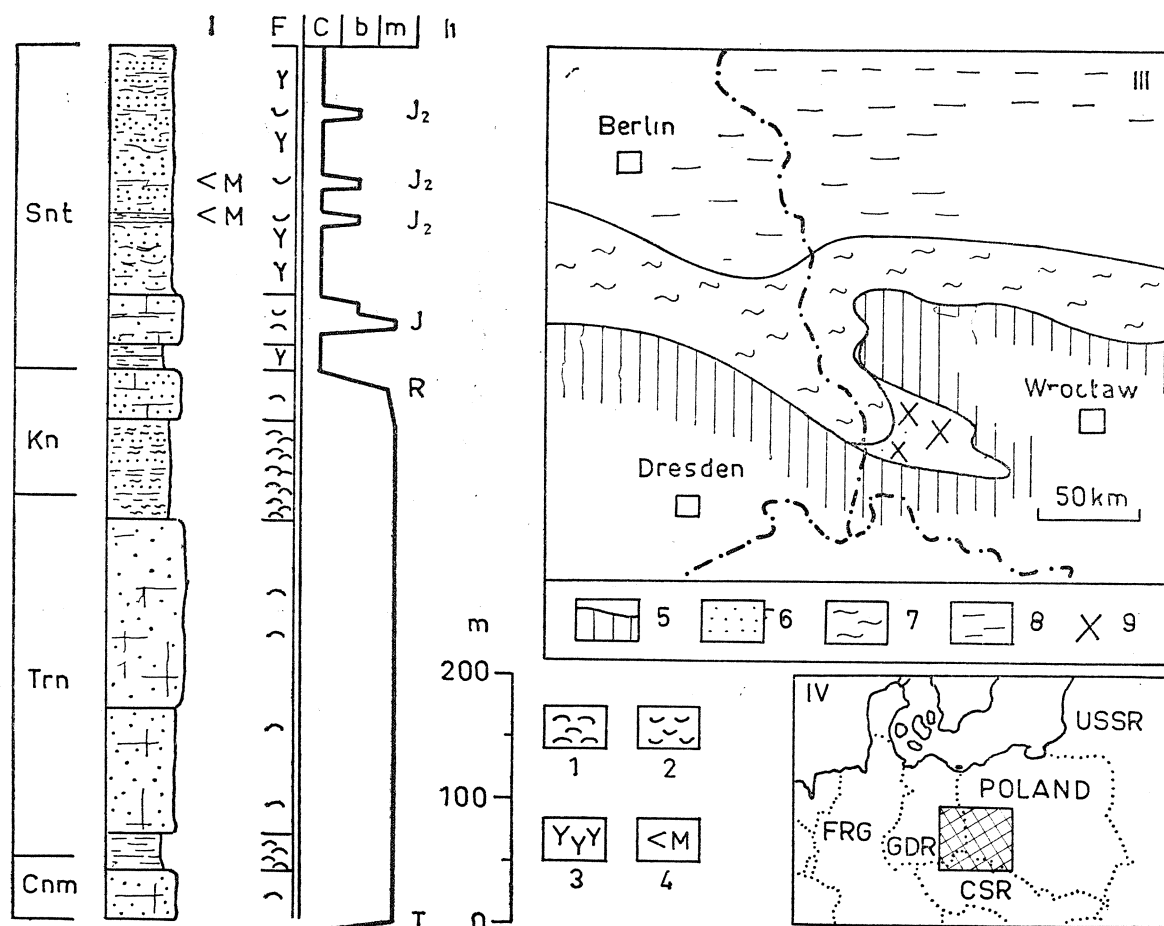


Fig. 1 — Cretaceous in North Sudetic Basin. I — Stratigraphical succession: Cnm — Cenomanian, Trn — Turonian, Kn — Coniacian, Snt — Santonian, F — occurrence of fauna and flora, 1 — marine fauna, 2 — brackish fauna, 3 — land flora, 4 — microfauna. II — Development of the Cretaceous transgression: T — transgression, R — regression, I₁, I₂ — ingressesions, c — continental environments, b — brackish environments, m — marine environments. III — Palaeogeographical map of Santonian in west Poland and east Germany: 5 — sea shore, 6 — paralic deposits in North Sudetic Basin, 7 — sandy-marly deposits, 8 — carbonate deposits, 9 — occurrence of brackish fauna. IV — General map

Fig. 1 — Profil stratygraficzny kredy w niecce północnosudeckiej. I — następstwo warstw; Cnm — cenoman, Trn — turon, Kn — koniak, Snt — santon, F — występowanie fauny i flory, 1 — fauna morska, 2 — fauna brakiczna, 3 — flora lądowa, 4 — mikrofauna. II — rozwój transgresji kredowej: T — transgresja, R — regresja, I₁, I₂ — ingresje, c — warunki lądowe, b — warunki brakiczne, m — warunki morskie. III — mapa paleogeograficzna santonu w zachodniej Polsce i we wschodnich Niemczech: 5 — brzeg morza, 6 — osady paraliczne w niecce północno-sudeckiej, 7 — osady piaszczysto-margliste, 8 — osady wapienne, 9 — występowanie mikrofauny brakicznej. IV — ogólna mapka sytuacyjna

fauna occurs. These are overlain by gray marls and siltstones which represent the Upper Cenomanian and the lower part of the Turonian. These deposits contain, among other fossils: *Rotalipora cushmani* (Morrow), *Pseudovalvulineria cenomanica* Brotzen, *Actinocamax plenus* Blainv. and *Inoceramus labiatus* Schloth. There follows a thick complex of thick-bedded, medium-grained sandstones containing a poor Turonian fauna. These sandstones pass upwards into marly siltstones and clays containing abundant fossils, among others there occur: *Scaphites geinitzi* d'Orb., *Placenticerus orbignyanum* Geinitz, *Inoceramus latus* Sov., *Turritella nodosa* Roem. and foraminifers: *Globotruncana tricarinata* (Quereau), *G. coronata* Bolli. These siltstones belong to the Upper Turonian and lower Coniacian. The Upper Coniacian deposits are developed as white fine-grained sandstones containing scarce fauna: *Peroniceras tricarinatum* d'Orb., *Inoceramus frechi* Flegel and *Inoceramus kleini* Müll. (Alexandrowicz 1971; Milewicz 1963, 1965, 1970).

These deposits are overlain by the continental sediments of the Santonian within which three lithostratigraphic units are discernible (Mazur, Milewicz, 1958; Milewicz, 1965). The lowermost are gray and green clays abounding in carbonized plant fossils. The clays alternate with sandstones and thin layers of brown coal. Above are medium- and coarse-grained sandstones with kaoline cement. They contain locally a poor fauna with: *Cyrena cretacea* Drescher, *Mytilus rackwitzensis* Scupin, *Avicula pectinoides* Reuss, *Natica bulbiformis* Sowerby and *Turritella nodosa* Roem. (Milewicz, 1970). The youngest Santonian units is developed as kaolinic sandstones with intercalations of white and red kaolinic clays. Locally there occur intercalations of gray clays with plant remains and thin layers of brown coals and also intercalations of gray argillaceous shales, containing lamellibranches: *Cyrena cretacea* Drescher, *Cardium pectiniforme* Müll. (Milewicz, 1965, 1970) and foraminifers.

It may be suggested that the Upper Cretaceous transgression occurred in the Cenomanian (Fig. 1—II, T). It resulted in the development of a bay where a series of marine sediments 400—500 m thick was deposited, during the Cenomanian, Turonian and Coniacian. The sea regressed by the end of the Coniacian (Fig. 1—II, R). However, deposition continued. During the Santonian the North-Sudetic Basin was a flat, near-shore area covered with terrigenous sediments. The sea ingressed a few times over that area. The first ingression (Fig. 1 — II, I₁) brought mixed brackish and shallow sea faunas. The next ones resulted in the development of a bay and of almost fresh water lagoons (Fig. 1 — II, I₂). During these ingressions characteristic assemblages of lamellibranches and foraminifers composed of numerous individuals and a very few species developed.

DESCRIPTION OF FORAMINIFERAL ASSEMBLAGE

Six species of foraminifera occur in the clays with *Cyrena cretacea* Drescher. These are: *Ammodiscus* cf. *parvus* Zasp., *Haplophragmoides rota* Nauss, *Ammobaculites* cf. *inaequalis* Tairov, *Trochammina globosa* Bolin, *T. albertensis* Wick. and *Verneuilinoides borealis* Tappan. The percentages of these species vary very little in particular samples, which were obtained from two horizons in three profiles. The

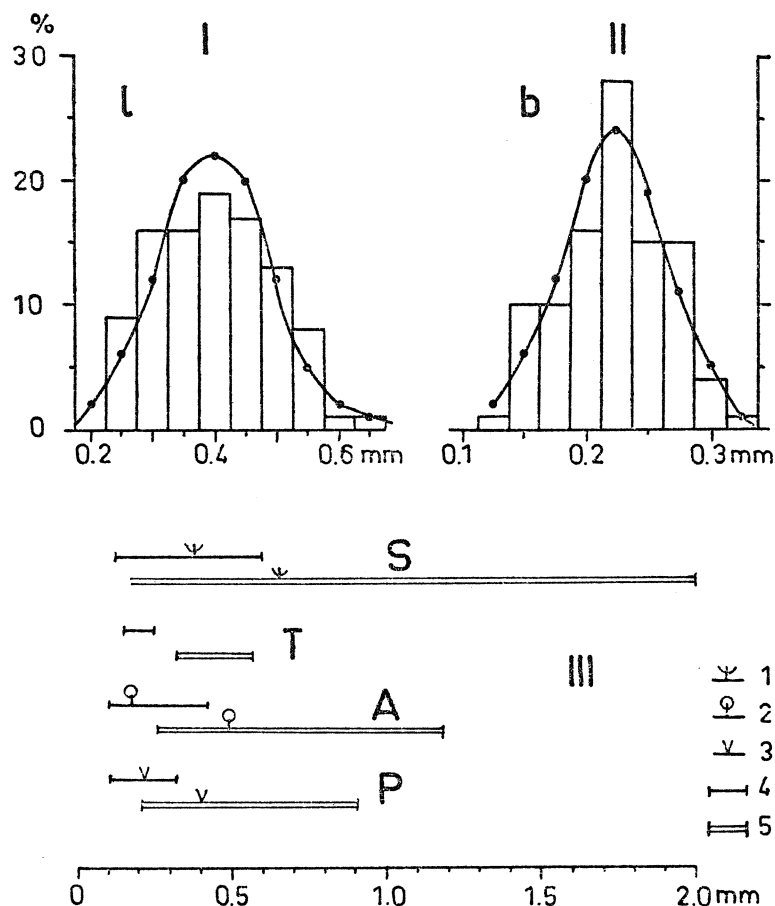


Fig. 2 — Biometric features of *Verneuilinoides borealis* Tappan. I — Statistic distribution (empiric and compensatory) of test lengths (l). II — Statistic distribution (empiric and compensatory) of test greatest widths (b). III — Variability of dimensions of specimens of *Verneuilinoides borealis* Tappan. S — Specimens from West Siberia, T — specimens from Turkmenia, A — specimens from Alaska, P — specimens from Poland. 1 — holotype of *Verneuilinoides borealis* Tappan *assanoviensis* Zaspelova. 2 — holotype of *Verneuilinoides borealis* Tappan, 3 — mean dimensions specimen of *Verneuilinoides borealis* Tappan from Sudeten, 4 — test greatest width variability limits, 5 — test length variability limits

Fig. 2 — Cechy biometryczne *Verneuilinoides borealis* Tappan. I — rozkład statystyczny (empiryczny i wyrównany) długości skorupki (l). II — rozkład statystyczny (empiryczny i wyrównany) największej szerokości skorupki (b). III — różnicowanie wielkości okazów *Verneuilinoides borealis* Tappan. S — okazy z zachodniej Syberii (*Verneuilinoides borealis* Tappan *assanoviensis* Zasp.), T — okazy z Turkmenii, A — okazy z Alaski, P — okazy z Polski, 1 — holotyp *Verneuilinoides borealis* Tappan *assanoviensis* Zasp., 2 — holotyp *Verneuilinoides borealis* Tappan, 3 — okaz średni *Verneuilinoides borealis* Tappan z Sudetów, 4 — zakres zmienności największej szerokości skorupki, 5 — zakres zmienności długości skorupki

dominant component of this assemblage are foraminifera belonging to *Verneuilinoides* which constitute 85—95% of total assemblage. Of the remaining forms the most numerous are those belonging to *Trochammina* (4—8%). Less frequent are specimens of *Haplophragmoides* (1—6%). *Ammodiscus* and *Ammobaculites* were found only as single specimens.

Ammodiscus cf. *parvus* Zaspelova 1948

Fig. 3 — 1 A, B

Ammodiscus parvus Zaspelova, 1948, Trudy VNIGRI n. s. Vyp. 31, p. 195, pl. 1, fig. 2.

Remarks: Five quite well preserved specimens were found. The tests are small, flattened, very fine arenaceous. The spiral suture is shallow and not distinctly visible. The second chamber is planispirally coiled increasing gradually, slowly in size. It consists of 3—5 whorls. The periphery is rounded. The longest diameter of the tests is 0,24—0,27 mm, the shortest one is 0,20—0,25 mm, and the thickness is 0,05—0,06 mm. These specimens correspond to the original description of *Ammodiscus parvus* Zasp. but the material is too scarce to allow definite identification.

Haplophragmoides rota Nauss 1947

Fig. 3 — 2 A, B, 3 A, B, 4 A, B

Haplophragmoides rota Nauss, 1947, J. Paleont. Vol. 21, N. 4, p. 332, pl. 49, fig. 1, 3. — Tappan, 1962, U. S. Geol. Surv. Prof. Pap. N. 236-C, Pt. 3, p. 134, pl. 31, fig. 16—18. — Podobina, 1966, Foram. wierchn. mieła Zap.-Sib. Nizm. p. 27—29.

Remarks: Thirty specimens of this species, variously preserved, have been found, of these twelve well preserved. The dimensions of these specimens vary: the longest diameter is 0,24—0,44 mm, the shortest one is 0,21—0,38 mm, the thickness is 0,08—0,15 mm. The tests are involute, flattened, the final whorl consists of 7—8 triangular chambers. The periphery is rounded, slightly lobulate in outline, especially in the two or three last chambers. The specimens from the Bolesławiec area agree in every detail with the diagnosis of the holotype and the original description.

Occurrence: *Haplophragmoides rota* Nauss was described from the brackish deposits of the Santonian-Campanian of Canada (Nauss, 1947), where it occurs as the only component of the assemblages or accompanies a few arenaceous and calcareous foraminifera and some ostracoda. It was also found in similar assemblages of the Upper Cretaceous deposits of Alaska (Tappan, 1962) and in the Turonian deposits of Western Siberia (Podobina, 1966).

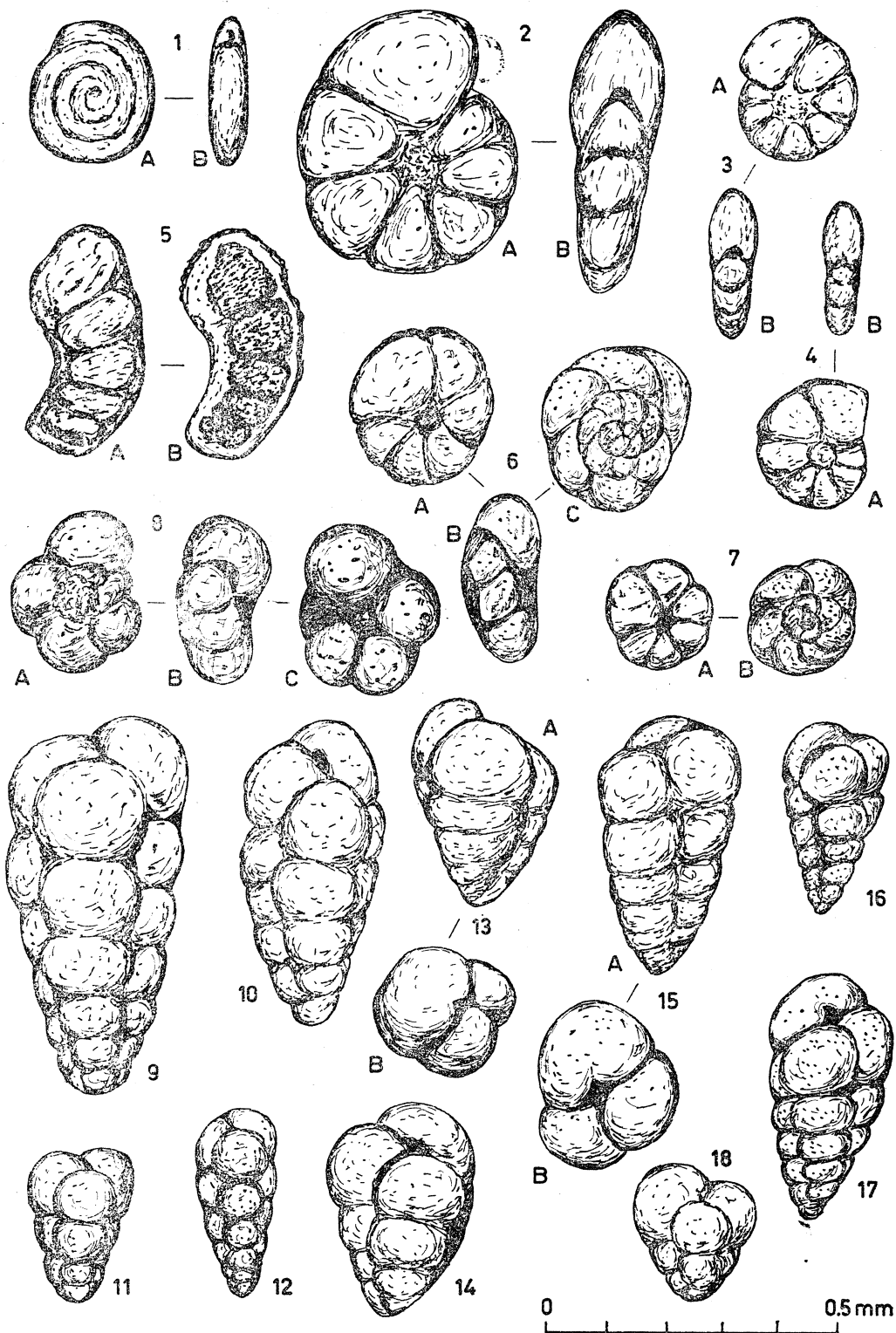


Fig. 3. Foraminifera from Santonian deposits of North Sudetic Basin. 1 — *Ammodiscus* cf. *parvus* Zaspelova, 2—4 — *Haplophragmoides* *rota* Nauss, 5 — *Ammobaculites* cf. *inaequalis* Tairov, 6—7 — *Trochammina* *albertensis* Wickenden, 8 — *Trochammina* *globosa* Bolin, 9—18 — *Verneuilinoides* *borealis* Tappan

Fig. 3. Otwornice z osadów santonu niecki północno-sudeckiej. 1 — *Ammodiscus* cf. *parvus* Zaspelova, 2—4 — *Haplophragmoides* *rota* Nauss, 5 — *Ammobaculites* cf. *inaequalis* Tairov, 6—7 — *Trochammina* *albertensis* Wickenden, 8 — *Trochammina* *globosa* Bolin, 9—18 — *Verneuilinoides* *borealis* Tappan

Ammobaculites cf. *inaequalis* Tairov 1961

Fig. 3 — 5 A, B

Ammobaculites inaequalis Tairov, Aleksejeva 1972, Aglut. Foram. Niznemieł. otłoz. Zapad. Turkm. Izd. Nauka, p. 20—21, pl. 1, fig. 11—12.

Remarks: The two specimens found are very similar to the species described from the Aptian deposits of Azerbeidjan and Turkmenia. The dimension of these are: length 0,40 and 0,45 mm, width 0,14 and 0,18 mm, thickness 0,11 and 0,13 mm. The tests are arcuately bent and distinctly flattened. The earliest portion consists of the proloculum and two or three chambers increasing rapidly in size. The uniserial part is wider and it widens slightly as added. It consists of four chambers separated by slightly depressed sutures. The specimens described resemble the species *Ammobaculites parvispira* Ten Dam and *Ammobaculites elongatus* Bolin, but they differ in being smaller and in having more distinctly flattened tests of arcuate shape.

Trochammina albertensis Wickenden 1932

Fig. 3 — 6 A, B, C, 7 A, B

Trochammina albertensis Wickenden 1932, Trans. Royal Soc. Canada s. 3, Vol. 26, sec. 4, p. 90, pl. 1, fig. 9. — Cushman, 1946, U.S. Geol. Surv. Prof. Pap. N. 206, p. 50, pl. 15, fig. 7. — Tappan 1962, U. S. Geol. Surv. Prof. Pap. N. 236-C, pt. 3, p. 152—153, pl. 39, fig. 13—14.

Remarks: In the material studied more than thirty well preserved specimens of this species were found. The dimension of the tests vary, the longest diameter is 0,20—0,34 mm, the shortest diameter is 0,18—0,28 mm, the thickness is 0,10—0,15 mm. In the spiral side of the tests two to three whorls are distinctly visible, the final one consists of five to six chambers. In this side of the tests the sutures are markedly curved and bent backwards while in the umbilical side they are slightly depressed and radial. In the last whorl the chambers increase rapidly in size. The umbilicus of variable size is open. The appearance of the specimens from Bolesławiec agrees with the definition and descriptions of this species by the authors quoted above. They differ from similar forms: *Trochammina gatesensis* Steckl et Wall and *Trochammina ruthefordi* Steckl et Wall in having a lower number of chambers in the last whorl and in the distinct bending of sutures in the spiral side of the tests.

Occurrence: *Trochammina albertensis* Wickenden was described from the Upper Cretaceous deposits of North America (USA, Canada and Alaska). It appears in the assemblages dominated by arenaceous foraminifera.

Trochammina globosa Bolin 1956

Fig. 3 — 8 A, B, C

Trochammina globosa Bolin, 1956, J. Paleont. vol. 30, N. 2, p. 289, pl. 38, fig. 8—9, text-fig. 7.

Remarks: More than twenty well preserved specimens of this species were found. The appearance of these agrees with the original definition of holotype. The specimens are small, their dimensions vary little. The longest diameter is 0,20—0,34 mm, the shortest diameter is 0,20—0,29 mm, the thickness is 0,21—0,26 mm. The test consist of two and half whorls. The spiral side is almost completely flat, the umbilicus is small and strongly depressed. The final whorl consists of four to four and half chambers. The chambers are almost sphaerical, the sutures are depressed, the periphery is rounded, lobulate in outline. Our specimens resemble the forms described by Podobina (1966) as *Trochammina bohmi* Franke, but are twice smaller.

Occurrence: *Trochammina globosa* Bolin was described from the Cenomanian deposits of Minnesota, USA. It occurs there in assemblages of arenaceous foraminifera: *Haplophragmoides*, *Ammobaculites* and *Trochammina*, with an admixture of planctonic forms. This assemblage is believed to be indicative of brackish environments (Bolin 1956).

Verneuilinoides borealis Tappan 1957

Fig. 2 — 9, 10, 11, 12, 13 A, B, 14, 15 A, B, 16, 17, 18

Verneuilinoides borealis Tappan, 1957, U.S. Nat. Mus. Bull. N. 215, p. 206, pl. 66, fig. 10—18. — Tappan, 1962, U.S. Geol. Surv. Prof. Pap. N. 236-C, pt. 3, p. 142—143, pl. 34, fig. 1—9. — Aleksejeva 1972, Aglut. Foram. Nizniemieł. otłoż. Zapad. Turkm. Izd. Nauka, p. 35—36, pl. 3, fig. 7, 8

Verneuilinoides borealis Tappan *assanoviensis* Zaspelova, Subbotina 1964, Trudy VNIGRI, Vyp. 234, p. 200—202, pl. 29, fig. 1—5, pl. 30, fig. 1—7, pl. 31, fig. 1—13, pl. 32, fig. 1—6.

Remarks: This species is the main component of the Santonian assemblage from Bolesławiec. More than 500 well preserved specimens were found. The tests are elongate, consisting of three chamber series situated along a straight or slightly bent axis. In the small specimens the chamber size strongly increases, particularly the width. In large test the chambers increase in size gradually. The shape of the chambers is variable, in early stages they are rounded trapeziform, twice as wide as high. In the last whorls the chambers become spherical and almost izometric. They are separated by distinct, depressed sutures. The dimensions of the tests are most variable. These specimens agree in every detail with the original diagnosis and the descriptions by the authors quoted above.

Biometric analysis: The mass occurrence of specimens belonging to *Verneuilinoides borealis* Tappan permitted the author to undertake the biometric studies of the tests in order to establish and to compare

the Bolesławiec populations with those described from other areas. The longest diameter and the width of hundred specimens were measured, these were chosen at random from 500 well preserved forms. The random distributions of both dimensions are normal (Fig. 2 — 1, II). This conclusion has been corroborated by the χ^2 test which pertains to the significance of differences between the distributions: theoretical-normal and empirical-observed. For the distribution of the length $\chi^2 = 6,18$, and for the distribution of its greatest width $\chi^2 = 8,79$. Both these values are much lower than the critical values at significance levels: .05—.01—.001 which are respectively: 12,6—16,8—22,5. This mean that the differences between the distributions studied and the theoretical normal distribution are insignificant. The normal distribution of the features mentioned above indicates that the sample studied represents statistically a uniform population.

The length of the tests (l) varies between 0,23 and 0,91 mm (extreme values). The basic statistic coefficients of the set are as follows: arithmetical mean — $\bar{x} = 0,40 \pm 0,009$ mm, standard deviation — $s = 0,09$ mm, variability factor — $v = 23,18$. As the normal distribution has been ascertained it is likely that 95% of the population displays the test length contained within the interval: 0,22—0,58 mm ($\bar{x} \pm 2s$). The greatest width of the tests (b) is 0,11—0,32 mm (extreme values), and the features of the statistic set are as follows: $\bar{x} = 0,22 \pm 0,004$ mm, $s = 0,04$ mm, $v = 19,42$. The normal distribution suggests that 95% of the set is contained between 0,14—0,30 mm. The relation width/length of the tests b/l is: $\bar{x} = 0,56 \pm 0,01$, $s = 0,10$, $v = 17,51$. The number of chambers in a row varies between 4—9, mean 5—6.

The results of the measurements of the tests *Verneuilioides borealis* Tappan from Bolesławiec indicate that, as to dimensions are concerned, these specimens agree well with typical forms described from the Grandstand Formation (Albian of Alasca — Tappan, 1957). The ranges of variability expressed by extreme values of the length of tests in both sets correspond with each other almost completely. The dimensions of the holotype differ slightly from the mean dimensions of the Bolesławiec specimens. Though this specimen is slightly longer and less wide, it falls within the limits of variability of the population studied (fig. 2—III).

The specimens of *Verneuilioides borealis* Tappan described from the Upper Aptian of west Turkmenia (Aleksjeva, 1972) display very little variability. Their dimensions agree with those of the Bolesławiec specimens. The sizes of the two specimens, as given by Aleksjeva, agree almost ideally with the mean statistic parameters of the set studied here (fig. 2—III).

Verneuilioides borealis Tappan *assanoviensis* Zaspjelova, which was described from the Albian of west Siberia, is larger. The size of the holotype of this subspecies was not given in the text, but the

measurements show that the figured specimen (Subbotina, 1964, pl. 29, fig. 1) is about one and half times larger than the mean value of the set from Bolesławiec. The size variability of the Siberian specimens is considerable; it generally agrees with the variability of the Polish and Alaskan material, but there are also some relatively large forms the tests of which are 1—2 mm long. The lack of statistic data concerning the biometrical features of the tests precludes the author from making satisfactory comparisons. It seems that the subspecies described from west Siberia differs from *Verneuilinoides borealis* Tappan represented by specimens from Alaska, Turkmenia and Poland only in its size limits, which are wider (fig. 2—III). Perhaps this is not a sufficient reason for creating the subspecies *Verneuilinoides borealis* Tappan *assanoviensis* Zaspelova.

Occurrence: This species occurs in the Albian deposits of various parts of the World. It is usually the dominant component of microfaunistic assemblages. Within the Albian-Cenomanian deposits of west Siberia the zone with *Verneuilinoides assanoviensis* Zaspelova was distinguished (Kiprijanova, 1961) where this species has its mass occurrence and is almost the only component of the foraminiferal assemblage.

ECOLOGICAL CONDITIONS

The assemblage of arenaceous foraminifera found in gray clays with *Cyrena* (Fig. 1—I₂, M) has a very characteristic composition. It is dominated by one species while other ones are scarce. The same concerns the lamellibranch assemblage which accompanies the foraminifera. The species *Cyrena cretacea* Drescher, which is typical of brackish facies, abounds and is often the only representative of macrofauna. In some places it is accompanied by scarce specimens belonging to *Cardium pectini-forme* Müll. This composition of the assemblages indicates low salinity of waters in the basin corresponding to the mesohalic zone (Hiltermann, 1949; Remane, Schlieper, 1958) and especially to the zone characterized by the occurrence of the smallest number of species, which lies in waters of salinity 5—9‰. Diversification of fauna follows a slight increase of salinity typical of pleohalic and polyhalic zones. Such conditions existed probably during the deposition of the sandstones which *Cyrena*, *Avicula*, *Natica* and *Turritella* (Fig. 1—I₁).

The clays with *Cyrena cretacea* Drescher are slightly calcareous and contain an insignificant admixture of fine quartz grains, some coalified plant detritus and small pyrite crystals. The lithologic character of these clays and their dark gray colour indicate that this sediment developed at the bottom of a shallow basin with quiet water and poor oxidation of the bottom water. The deposition of terrigenous material was

slow and limited to very fine grades. These deposits developed probably in small lagoons and near-shore lakes. The contact with the bay in the western part of the North Sudetic Basin was limited (Fig. 1—III).

The clays containing brackish fauna belong to the continental deposits developed in conditions of a quick, discontinuous sedimentation. The presence of sandstones with kaolinic cement, kaolinic clays and clays with brown coal intercalations indicates a near-shore, paralic character of this formation. It developed immediately after the regression of the sea in the area which was periodically covered by sand- and clay-material brought down by rivers. During the periods of slower terrigenous deposition a lush growth of land plants developed creating conditions for peat and swamp deposition. The sea ingressed locally a few times resulting in development of lagoons and low salinity lakes. In these basins sands with lamellibranches and gastropods (Fig. 1—I₁) and clays with lamellibranchs and foraminifera (Fig. 1—I₂) developed.

The climatic conditions in which the described assemblages of microfauna developed are well established (Cieśliński, Witwicka, 1962; Cieśliński, 1964). During the Coniacian and Santonian in the Polish territory the climate was warm-moderate and wet. The Cretaceous sea of the North Sudetic Basin was situated in the moderate climatic zone, out of reach of coral reefs; the mean temperature was probably only slightly lower than 20°C.

The foraminifera assemblage containing *Verneuilinoides borealis* Tappan, occurring in the brackish deposits of the Santonian in West Poland is very similar to those from the Aptian, Albian and Cenomanian of West Siberia, Turkmenia, Alaska and Canada. This type of microfauna is considered by many authors as characteristic of brackish deposits. A different interpretation was suggested by Scheibnerova (1971). After having analysed the regional differentiation of the Cretaceous microfauna of the World this author suggested that the assemblages similar to that dealt with here developed in cold climatic zones, i.e. in the seas of the boreal bioprovince in the northern hemisphere and in the Australian one in the southern hemisphere.

The results of the present study agree with the former interpretation. The foraminifera of the described species occur in deposits of various stages of the Cretaceous, at least from the Aptian to the Santonian, and the favourable conditions for their development may occur in some particular ecological environments.

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STRESZCZENIE

W północno-zachodnich Sudetach występują lądowe osady santonu. Jest to piaszczysto-ilasta formacja paraliczna, w której występują cienkie wkładki węgla brunatnych oraz wkładki ilów z fauną małżów, typowych dla środowiska brakicznego (iły z *Cyrena cretacea* Dresch.). W ilach tych znaleziono zespół otwornic aglutynujących, w którym dominuje ilościowo gatunek *Verneuilinoides borealis* Tappan. Nielicznie występują otwornice z rodzajów: *Ammodiscus*, *Ammobaculites*, *Haplophragmoides* i *Trochammina*. Analiza biometryczna gatunku *Verneuilinoides borealis* Tappan pozwoliła na dokładne porównanie okazów z Polski z okazami opisanymi z Alaski i Turkmenii, a także z okazami *Verneuilinoides borealis assanoviensis* Zaspelova, opisanymi z zachodniej Syberii. Omawiany zespół otwornic obejmuje gatunki występujące w różnych piętrach kredy, w specyficznych warunkach ekologicznych. W Sudetach zespół ten rozwijał się w przybrzeżnych lagunach i zalewach o słabym zasoleniu wody (strefa mezohalinowa), w warunkach klimatu ciepło-umiarkowanego, wilgotnego.

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