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## FORAMINIFERA ASSEMBLAGES IN THE VALANGINIAN OF THE POLISH LOWLANDS

(7 Figs.)

*Zespoły otwornic walanżynu na Niziu Polski*

(7 fig.)

**Abstract.** Studies of Foraminifera assemblages were carried out in the Valanginian of the Polish Lowlands in the Szczecin—Mogilno—Łódź trough, the Kujawy—Pomorze Swell and the marginal trough. On the basis of the lithological and macropalaeontological data of other authors, the Valanginian is divided into three substages: the Lower, Middle and Upper Valanginian. Three Foraminifera assemblages are distinguished. Predominant genera are *Haplophragmoides*, *Trochammina*, and *Lenticulina* in the first assemblage, *Lenticulina* and *Citharina* in the second assemblage and *Lenticulina* and *Epistomina* in the third assemblage. The presence of particular Foraminifera assemblages in the sediments of the Polish Lowlands depends above all on the proportion of sand.

### INTRODUCTION

The purpose of the present account is to demonstrate Foraminifera assemblages in the Valanginian.

These studies include the Szczecin—Mogilno—Łódź trough, the Kujawy—Pomorze Swell and the marginal trough<sup>1</sup> (tabl. I).

The results of these studies are based on microfauna from the following regions: Wiaderno, Łaziska, Dębniak, Śladków, Skotniki, Mieregoiniewice, Szpetal, Dąbrówka, Kukawy, Opoczki, Zakrzewo, Tuchołka, Zychlin, Strzelno, Oświno, Szamotuły, Mogilno, Niemieczkowo, Damasławek, Kłęcko, Pagórki, Dęby Janiszewskie, Kcynia, Koraczewko, Gronowo, Chojnice, Stobno, Myśligoszcz, Modliszewko, Bolkowo, Bodzanów, Magnuszew, Żuromin, Gostynin, Lipno, Płońsk, Bielsk, Biezuń, Iwiczna, Ciepiałów, Sierpc, Warszawa, Przytyk, Dęba, Krzyżanowice, Dzierżanowo.

BSC. A. R a c z y ń s k a, Dr S. M a r e k and Dr J. W i t k o w s k i supplied the author with samples for micropalaeontological analysis. They also made available lithological profiles from the bore-holes studied and provided a considerable amount of information, as to the strati-

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<sup>1</sup> The author employs the division into tectonic units of the area studied after S. M a r e k and A. R a c z y ń s k a.

graphy, palaeogeography and macrofauna of the tectonic units studied by them. To these people, the author offers her gratitude. The author also thanks Prof. Dr O. Pazdrowa, Prof. Dr F. Bieda and Doc. Dr St. Gerockh for constructive criticism during the writing of the present account.

Foraminifera assemblages from sampled lithological profiles in particular tectonic units are shown in Figs. 2—4. In the instance, where the whole profile of the Valanginian is seen in one bore-hole, only this single bore-hole is figured. On the other hand, where the entire Valanginian profile is not seen in a single bore-hole, two or three bore-holes are shown together to give the complete profile. In these figures, the quantitative composition of Foraminifera assemblages in particular sub-stages of the Valanginian is given, as well as occurrences of lamelli-branches and ammonites in the sediments. The CaCO<sub>3</sub> content of the sediments is also noted.

Because not all bore-holes in the regions mentioned are given in Figs. 2—4, the list of Foraminifera from particular assemblages, containing only Foraminifera from the profiles included, would not be complete. Therefore the author will also cite in the text Foraminifera found in other bore-holes, not given in the figures; thus the Foraminifera assemblages given in the text will be complete. In Figs. 5—7, the occurrence of Foraminifera assemblages in the Valanginian is given.

#### STRATIGRAPHY

S. Marek (1961, 1967, 1968) and A. Raczynska (1960, 1961, 1967) are carrying out studies of the Valanginian sediments of the Polish Lowlands. A. Witkowski studied the Lower Cretaceous of the Tomaszów Mazowiecki region. On the basis of lithology and ammonites, these authors distinguished the Lower, Middle, and Upper Valanginian in the area studied by them. The Lower Valanginian, or the zone with *Platylenticeras* sp., and the Upper Valanginian, or zone with *Dichotomites* sp., are characterized by marine sediments. On the other hand, the Middle Valanginian (zone with *Polyptychites* sp.) was a period of shallowing of the basin, with lowered salinity. The Lower Valanginian sediments form a continuation of the Riazanian (Berriasian). It is possible to separate this stage from sediments of the Lower Valanginian in the Polish Lowlands, mainly on the basis of the ostracod *Protocythere pseudopropria emslandensis* Bart., Burri which occurs chiefly in the Riazanian. The Upper Valanginian sediments gradually merge with those of Lower Hauterivian age. The separation of these two stages is very difficult in many cases, because of lithological homogeneity and particularly where identical Foraminifera assemblages are found in both sub-stages.

In Figs. 2—4 are shown the lithological profiles sampled in particular tectonic units. The lower boundary in these profiles, where it was possible to distinguish this, is the boundary between the Berriasian and Lower Valanginian.

#### Lower Valanginian — W<sub>I</sub> — zone with *Platylenticeras* sp.

In the Lower Valanginian of the Szczecin—Mogilno—Łódź basin and in marginal basin, mainly clays and sometimes sandy marls are seen. On the Kujawy Swell, clays predominate in the sub-stage mentioned.

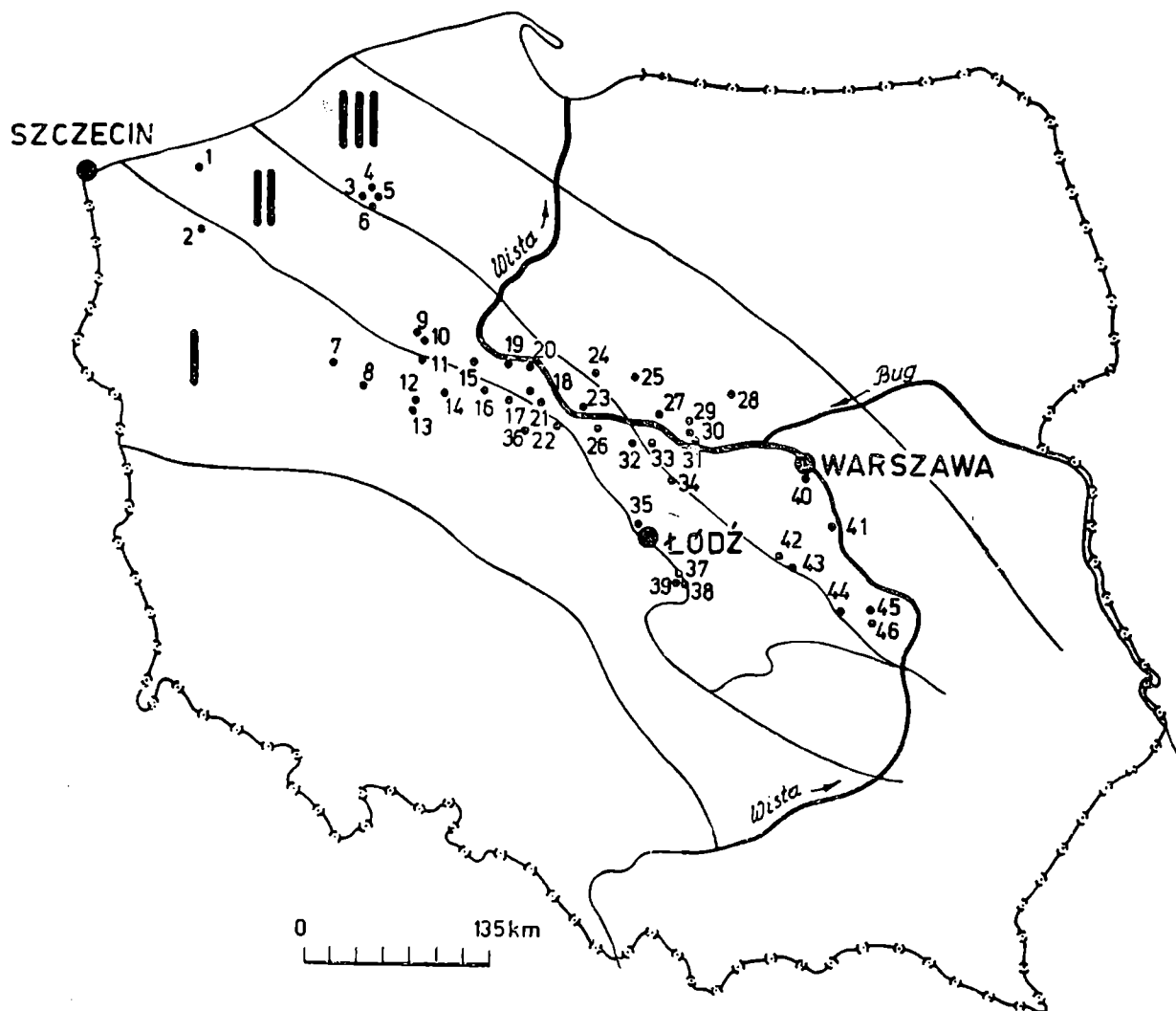


Fig. 1. Map showing distribution of some of the more important profiles of the Valanginian, in relation to structural units of the Polish Lowlands, after S. Marek and A. R a c z y ń s k a. 1 — Kiełpino; 2 — Oświno; 3 — Myśligoszcz; 4 — Stobno; 5 — Chojnice; 6 — Gronowo; 7 — Szamotuly; 8 — Niemeczkowo; 9 — Kcynia; 10 — Koraczewko; 11 — Damasławek; 12 — Klecko; 13 — Modliszewko; 14 — Mogilno; 15 — Tuchołka; 16 — Strzelin; 17 — Pagórki; 18 — Opoczki; 19 — Mierogoniewie; 20 — Ostrowo; 21 — Zakrzewo; 22 — Dęby Janiszewskie; 23 — Szpetal; 24 — Lipno; 25 — Sierpc; 26 — Kukawy; 27 — Bielsk; 28 — Płońsk; 29 — Dzierżanowo; 30 — Bulkowo; 31 — Bodzanów; 32 — Dąbrówka; 33 — Gostynin; 34 — Żychlin; 35 — Śladków; 36 — Ślazewo; 37 — Dębniak; 38 — Wiaderno; 39 — Łazisko; 40 — Iwiczna; 41 — Magnuszew; 42 — Dęba; 43 — Przytyk; 44 — Krzyżanowice; 45 — Ciepiałów; 46 — Bąkowa; I — Szczecin—Mogilno—Łódź trough; II — Kujawo—Pomorze Swell; III — marginal trough

### Szczecin—Mogilno—Łódź trough (Fig. 2)

In the Szczecin—Mogilno—Łódź trough<sup>1</sup>, A. R a c z y ń s k a described numerous lamellibranchs and fairly scarce ammonites in the Lower Valanginian.

<sup>1</sup> The present account includes only the results of studies of Foraminifera found in the Szczecin and Mogilno troughs. In the Łódź trough, studies are as yet inadequate.

Foraminifera are very scarce in the Szczecin trough. Here were found *Glomospirella gaultina* (Berth.), *Trochammina inflata* (Montagu), *Haplophragmoides cushmani* Loeb., Tap., *Lenticulina subalata* (Reuss).

There is an abundant microfauna in the Mogilno trough and, as seen from the species given below, in the Szczecin and Mogilno troughs, an assemblage of agglutinating Foraminifera predominates. In these, the species chiefly represented are: *Haplophragmoides cushmani* Loeb., Tap.\*, *Haplophragmoides C\**, *Haplophragmoides D\**, *Haplophragmoides B*. Besides the forms mentioned above, in this assemblage, specimens belonging to the following species are found: *Trochammina inflata* (Montagu) and *Trochammina kcyniensis* Sztejn\*\*\*.

Fairly scarce specimens of calcareous Foraminifera belong to the species: *Lenticulina subalata* (Reuss), *Vaginulinopsis humilis* (Reuss), *Eoguttulina witoldi* Sztejn\*\* and *Epistomina caracolla anterior* Bart., Brand.\*

### Kujawy Swell (Fig. 3)

In the Lower Valanginian of the Kujawy Swell. S. Marek confirmed the presence of *Platylenticeras* sp., as well as of numerous lamellibranchs. Abundant Foraminifera were also found in sediments of this age.

In the N.W. part of this ridge (Kiełpino region), single specimens of *Glomospirella gaultina* (Berth.) occur. Further to the N.E. of the ridge (Kcynia region), Foraminifera are abundant and agglutinating species, such as the following predominate: *Haplophragmoides cushmani* Loeb., Tap.,\*\* *Haplophragmoides concavus* (Chap.), *Trochammina inflata* (Montagu), *Trochammina kcyniensis* Sztejn\*\*\*, *Lagenammia difflugiformis* (Brady), *Glomospirella gaultina* (Berth.). Relatively few calcareous Foraminifera were found and among these are *Lenticulina subalata* (Reuss) and *Eoguttulina witoldi* Sztejn.

In the northern part of the Kujawy Swell, the same assemblage as on the Pomorze Swell (Tuchółka and Zakrzewo regions) is found. The agglutinating Foraminifera mentioned above occur in the central part of the Kujawy Swell (Zychlin and Śladków) and, in addition to these, there are fairly numerous calcareous Foraminifera: *Lenticulina subalata* (Reuss), *Astacolus diversicostatus* (Liszka), *Vaginulinopsis humilis* (Reuss), *Eoguttulina witoldi* Sztejn\*\*, *Globulina prisca* (Reuss). On the S.W. flank of the Kujawy Swell, in the Tomaszów region (Łazisko, Tomaszów Maz.), calcareous Foraminifera predominate (Fig. 3) in the Lower Valanginian sediments: *Citharina pseudostriatula* Bart., Brand\*\*\*, *Citharina intumescens* (Reuss)\*\*\*, *Citharina duestensis* (Bart., Brand)\*\*\*, *Citharina orthonata* (Reuss), *Lenticulina nodosa* (Reuss), *Lenticulina subalata* (Reuss), *Lenticulina muensteri* (Roem.), *Vaginulinopsis humilis* (Reuss), *Astacolus diversicostatus* (Liszka), *Epistomina* cf. *ornata* Ten Dam, *Epistomina* cf. *cretosa* Ten Dam, *Epistomina tenuicostata* Bart., Brand. On the other hand, among

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\* Index species of Foraminifera for the Lower Valanginian.

\*\* Index species of Foraminifera for the Riazanian, Lower and Middle Valanginian.

\*\*\* An index species of Foraminifera for the Riazanian and Lower Valanginian.

agglutinating Foraminifera, only scarce specimens of the following species were found: *Verneuilioides neocomiensis* (M j a t l.), *Haplophragmoides convexus* (C h a p.), *Glomospirella gaultina* (B e r t h.), *Ammobaculites subcretaceus* C u s h., A l e x., *Trochammina depressa* L o z o.

The presence of two Foraminifera assemblages was confirmed in the Lower Valanginian sediments on the Kujawy—Pomorze Swell. In one of these, representatives of the following species of Foraminifera predominate: *Haplophragmoides convexus* (C h a p.), *Haplophragmoides cushmani* L o e b., T a p., *Trochammina inflata* (M o n t a g u), *Trochammina kcyniensis* S z t e j n. In this assemblage, there are also found calcareous Foraminifera, such as: *Lenticulina subalata* (R e u s s), *Astacolus diversicostatus* (L i s z k a), *Eoguttulina witoldi* S z t e j n, *Vaginulinopsis humilis* (R e u s s). In the second assemblage, species of calcareous Foraminifera predominate: *Citharina pseudostriatula* B a r t., B r a n d, *Citharina orthonata* (R e u s s), *Lenticulina nodosa* (R e u s s), *Lenticulina subalata* (R e u s s), *Vaginulinopsis humilis* (R e u s s), *Astacolus diversicostatus* (L i s z k a), *Conorboides valandisensis* (B a r t., B r a n d). Agglutinating Foraminifera occur sporadically in this assemblage and are represented by: *Haplophragmoides concavus* (C h a p.), *Verneuilioides neocomiensis* (M j a t l.), *Ammobaculites subcretaceus* C u s h., A l e x., *Trochammina depressa* L o z o.

#### Marginal trough

This includes the Pomorze, Warszawa and Lublin troughs. In the marginal trough (Fig. 4), the presence of the Lower Valanginian is noted in the Pomorze and Warszawa troughs only. Sediments of this age are absent from the Lublin trough.

S. M a r e k found scarce remains of *Platylenticeras* sp. and lamelli-branches in the Lower Valanginian of the marginal trough. Foraminifera are scarce in sediments of this age.

In the N.W. part of the Pomorze trough, where sediments of this age are distinguished on the lithological and macropalaeontological premises, single specimens of *Glomospirella gaultina* (B e r t h.) were found. Further to the S. in this trough specimens of the following Foraminifera species were found: *Glomospirella gaultina* (B e r t h.), *Lenticulina* cf. *muensteri* (R o e m.), *Trochammina inflata* (M o n t a g u), *Lenticulina subalata* (R e u s s).

In the Lower Valanginian of the Warszawa trough, scarce specimens were found: *Ammobaculites* cf. *subcretaceus* C u s h., A l e x., *Trochammina inflata* (M o n t a g u), *Trochammina kcyniensis* S t e j n \*, *Lagenamina difflugiformis* (B r a d y), *Lenticulina subalata* (R e u s s), *Haplophragmoides convexus* (C h a p.), *Globulina prisca* (R e u s s), *Eoguttulina witoldi* S z t e j n \*\*, *Verneuilioides neocomiensis* (M j a t l.). There is an impoverishment of the scarce microfauna in an easterly direction.

Thus in the Lower Valanginian sediments of the marginal trough, a Foraminifera assemblage occurs, in which representatives of agglutinating species predominate: *Haplophragmoides concavus* (C h a p.), *Trochammina inflata* (M o n t a g u), *Trochammina kcyniensis* S z t e j n and *Lenticulina subalata* (R e u s s). Other species of Foraminifera are rarely encountered.

Middle Valanginian —  $W_2$  — zone with *Polyptychites* sp.

In the Szczecin—Mogilno—Łódź (Fig. 2) and Pomorze troughs, the Middle Valanginian (Fig. 4) occurs as fine-grained sandstones with interbedded shales and marls in places. On the Kujawy—Pomorze Swell (Fig. 4) and adjacent Warszawa trough (Fig. 4), there are also sandy sediments with larger inclusions of shales and marls at the top the base. In the remaining part of the marginal trough (Fig. 4), shales and marls with subordinate interbedded sandstones were deposited in the Middle Valanginian.

In the Middle Valanginian of the Szczecin—Mogilno—Łódź trough and on the Kujawy Swell, no ammonites, only lamellibranchs were found. No index fauna has been confirmed in the marginal trough.

Foraminifera are scarce in the Middle Valanginian of the Polish Lowlands and may be found with some difficulty in small amounts in the marl or shale interlayers. In the Szczecin—Mogilno—Łódź trough, Foraminifera were found only sporadically in marls in the part adjacent to the Kujawy Swell (Ślazewo region). On the Kujawy Swell, Foraminifera were found in the lower, silty part of the Middle Valanginian (in the regions of Kcynia, Żychlin, Ślasków). In the part of the marginal trough, adjacent to the Kujawy Swell, Foraminifera occur as on the Kujawy Swell in the lower part of the Middle Valanginian. In the remaining part of the trough, where silty sediments predominate in a Middle Valanginian of reduced thickness, Foraminifera are found in the whole complex of sediments.

The following Foraminifera species were found in the Middle Valanginian: *Glomospirella gaultina* (Berth.), *Haplophragmoides concavus* (Chap.), *Haplophragmoides cushmani* Loeb., Tap.,\*\* *Ammobaculites subcretaceus* Cush., Alex., *Trochammina inflata* (Montagu), *Lenticulina subalata* (Reuss), *Vaginulinopsis humilis* (Reuss), *Globulina prisca* (Reuss). These are the forms most commonly occurring in the Lower Valanginian. In the Middle Valanginian over the whole of the Polish Lowlands, there is a Foraminifera assemblage, in which *Glomospirella gaultina* (Berth.), *Haplophragmoides concavus* (Chap.) and *Lenticulina subalata* (Reuss) are found fairly frequently.

Upper Valanginian —  $W_3$  — zone with *Dichotomites* sp.

In the Upper Valanginian of the Szczecin—Mogilno—Łódź trough, shales and marls with subordinate sandy interlayers were deposited. On the Kujawy Swell sediments of this age are also seen as shales. In the marginal trough sandy marls and shales, with interlayers of organo-detrital and oolitic limestone in the S.E. part, were laid down during the Upper Valanginian.

Szczecin—Mogilno—Łódź trough

In the Szczecin—Mogilno—Łódź trough (Fig. 2), A. R a c z y ń s k a did not find ammonites in the Upper Valanginian; here only lamellibranchs were found.

In the Upper Valanginian sediments, as in the Lower Valanginian, relatively few Foraminifera were found.

Foraminifera are very scarce in the Szczecin trough. In the Upper

Valanginian of this trough (Oświno region), only single specimens of *Lenticulina subalata* (Reuss), *Vaginulinopsis humilis* (Reuss) and *Glomospirella gaultina* (Berth.) were found; on the other hand, no representatives of the genus *Epistomina* were encountered. It is difficult to speak of the existence of any kind of Foraminifera assemblage, since they occur sporadically.

In the Mogilno trough, Foraminifera are more abundant; among agglutinating Foraminifera, the following were found: *Glomospirella gaultina* (Berth.), *Ammobaculites subcretaceus* Cushman, Alex., *Trochammina inflata* (Montagu), *Haplophragmoides concavus* (Chap.). Besides these, here there are species of calcareous Foraminifera: *Epistomina caracolla caracolla* (Roem.)\*\*\*\*, *Epistomina cretosa* Ten Dam\*\*\*\*, *Epistomina tenuicostata* Bart., Brand., *Lenticulina subalata* (Reuss) and *Lenticulina muensteri* (Roem.).

#### Kujawy—Pomorze Swell (Fig. 3)

In the Upper Valanginian of the Kujawy—Pomorze Swell, S. Marek found a rich macrofauna, comprising numerous specimens of lamelli-branches and ammonites, which latter are index forms for this sub-stage.

In the N.W. part of the Pomorze ridge (Kiełpino region), Foraminifera are represented by single specimens of *Glomospirella gaultina* (Berth.) only. Upper Valanginian sediments are absent in the S.E. part of this Swell.

An abundant microfauna is found in the Upper Valanginian of the Kujawy Swell. On the N.E. flank of the northern part of the Kujawy Swell (the Kabat and Toporzysko regions), Foraminifera occur in small quantities. The more important species among these are: *Epistomina caracolla caracolla* (Roem.)\*\*\*\*, *Epistomina ornata* Ten Dam\*\*\*\*, *Lenticulina subalata* (Reuss), *Lenticulina muensteri* (Roem.), *Vaginulinopsis humilis* (Reuss).

To the S.E. of the Kujawy Swell (Żychlin, Ślazewo region), Foraminifera occur in greater quantities. There are the following species: *Epistomina caracolla caracolla* (Roem.)\*\*\*\*, *Epistomina cretosa* Ten Dam\*\*\*\*, *Epistomina ornata* Ten Dam\*\*\*\*, *Lenticulina subalata* (Reuss), *Lenticulina muensteri* (Roem.), *Vaginulinopsis humilis* (Reuss), *Marginulina pyramidalis* Koch,\*\*\* *Citharina seitzi* Bart., Brand.,\*\*\*\* *Astacolus cephalotes* (Reuss), and single specimens of *Haplophragmoides concavus* (Chap.), *Ammobaculites subcretaceus* Cushman, Alex.

As shown above, the following species are particularly abundant in the Upper Valanginian sediments of the Kujawy Swell: *Epistomina caracolla caracolla* (Roem.), *Epistomina cretosa* Ten Dam, *Epistomina ornata* Ten Dam, *Lenticulina subalata* (Reuss), *Lenticulina muensteri* (Roem.), *Citharina seitzi* Bart., Brand.

#### Marginal trough (Fig. 4)

In the Pomorze trough, Foraminifera are found only sporadically. Up to now, a few specimens of *Lenticulina subalata* (Reuss) have

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\*\*\*\* Index species of Foraminifera for the Upper Valanginian and Lower Hauterivian.

been distinguished with difficulty (Chojnice region). In the Warszawa trough, numerous Foraminifera of the following species were found: *Glomospirella gaultina* (Berth.), *Ammobaculites subcretaceus* CUSH., Alex., *Lenticulina muensteri* (Roem.), *Vaginulinopsis humilis* (Reuss), *Marginulina pyramidalis* Koch\*\*\*\*, *Epistomina caracolla caracolla* (Roem.)\*\*\*\*, *Epistomina cretosa* Ten Dam\*\*\*\*, *Epistomina tenuicostata* Bart., Brand., *Conorboides hofkeri* (Bart., Brand.). In the Lublin trough, few Foraminifera have been found in Upper Valanginian sediments; these include: *Lenticulina nodosa* (Reuss), *Lenticulina subalata* (Reuss), *Lenticulina muensteri* (Roem.), *Vaginulinopsis humilis* (Reuss), *Epistomina caracolla caracolla* (Roem.)\*\*\*\*, *Epistomina cretosa* Ten Dam\*\*\*\*.

An impoverishment of the microfauna in the N.E. direction is seen in the Warszawa and Lublin troughs. Two Foraminifera assemblages may be distinguished in the Upper Valanginian of the marginal trough. The assemblage in the Warszawa trough comprises the species: *Glomospirella gaultina* (Berth.), *Ammobaculites subcretaceus* CUSH., Alex., *Haplophragmoides convexus* (Chap.), *Lenticulina muensteri* (Roem.), *Vaginulinopsis humilis* (Reuss), *Marginulina pyramidalis* Koch, *Epistomina caracolla caracolla* (Roem.), *Epistomina ornata* Ten Dam, *Conorboides hofkeri* (Bart., Brand.). This is clearly a mixed assemblage. In this assemblage, representatives of the following species predominate: *Lenticulina muensteri* (Roem.), *Epistomina caracolla caracolla* (Roem.), *Epistomina ornata* Ten Dam. Here also occur scarce representatives of species of agglutinating Foraminifera.

In the Lublin trough, there is another Foraminifera assemblage. Here agglutinating Foraminifera are rare, and the following species of calcareous Foraminifera chiefly occur: *Lenticulina muensteri* (Roem.), *Epistomina caracolla caracolla* (Roem.)\*\*\*\*, *Epistomina cretosa* Ten Dam\*\*\*\*, *Conorboides hofkeri* Bart., Brand.

#### CHARACTERISTICS OF FORAMINIFERA ASSEMBLAGES OF THE POLISH LOWLANDS AND TECTONIC UNITS

As seen from considerations given in the previous section, similar Foraminifera assemblages do not occur in all regions in the Polish Lowlands. On the sketch maps (Fig. 5—7), the extents of particular sub-stages of the Valanginian, after S. Marek and A. Raczynska (1967), are shown. On these maps, the extents of the Foraminifera assemblages are also shown. Areas with particular sub-stages of the Valanginian and lying beyond the reach of the Foraminifera assemblages, have not been studied up to now in terms of microfauna.

On Fig. 5, the extents of occurrence of Foraminifera assemblages are related to the Lower Valanginian sediments. In the sediments of this sub-stage, there is a *Haplophragmoides-Trochammina-Lenticulina* assemblage, called by the author assemblage I. This is characterised by the presence of the following species: *Haplophragmoides concavus* (Chap.), *Haplophragmoides cushmani* Loeb., Tap., *Haplophragmoides B*, *Haplophragmoides C*, *Haplophragmoides D*, *Trochammina inflata* (Montagu), *Trochammina kcyniensis* Sztejn, *Lenticulina subalata* (Reuss). In this assemblage, there may be certain quantitative and



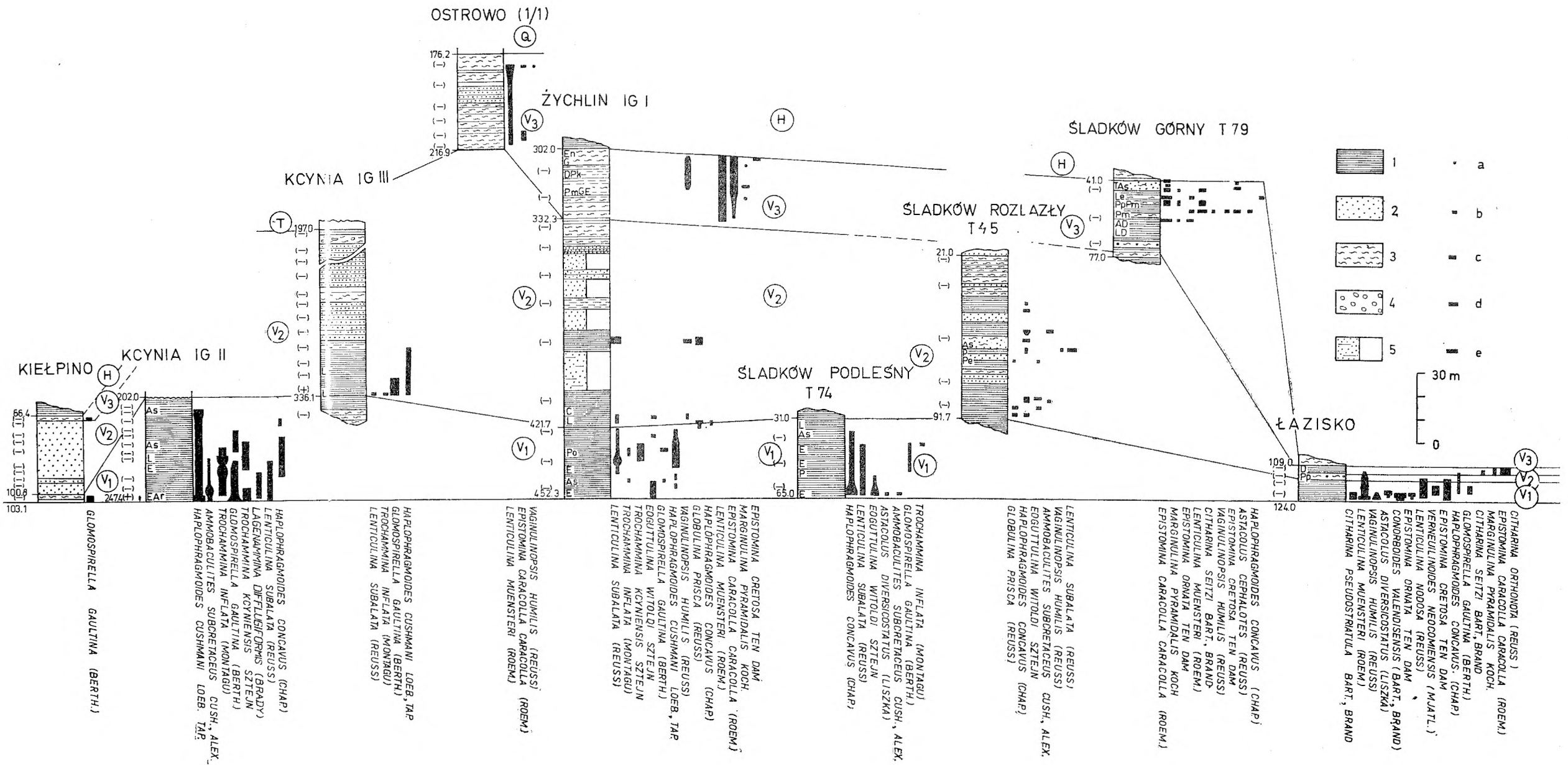


Fig. 3. Occurrence of Foraminifera in sampled bore-holes of the Kujawy-Pomorze ridge. 1 — shales; 2 — sands, sandstones; 3 — marly shales; 4 — gravels; 5 — lithology interpreted on basis of geophysical measurements in bore-hole; a — 1-4 specimens; b — 5-10 specimens; c — 11-30 specimens; d — 31-60 specimens; e — 61-100 specimens; + — +HCl; - - -HCl; L — *Leda*; Ar — *Arca*; As — *Astarte*; E — *Exogyra*; P — *Pinna*; T — *Trigonia*; C — *Corbula*; Pe — *Pecten*; Pp — *Polyptychites petschorensis* (Bog.); A — *Astieria*; Le — *Leopoldia* sp.; G — *Grammatodon*; Pm — *Polyptychites cf. michalskii* (Bog.); D — *Dichotomites bidichotomus* (Leym.); En — *Endemoceras noricum* (Roem.); Po — *Polyptychites* sp.; Pk — *Polyptychites cf. keyserlingi* (Neum., Uhl.); V<sub>1</sub> — Lower Valanginian (*Platylenticeras* zone); V<sub>2</sub> — Middle Valanginian (*Polyptychites* zone); V<sub>3</sub> — Upper Valanginian (*Dichotomites* zone); H — Hauterivian; T — Tertiary; Q — Quaternary.

Lithological profile after S. Marek and A. Raczyńska

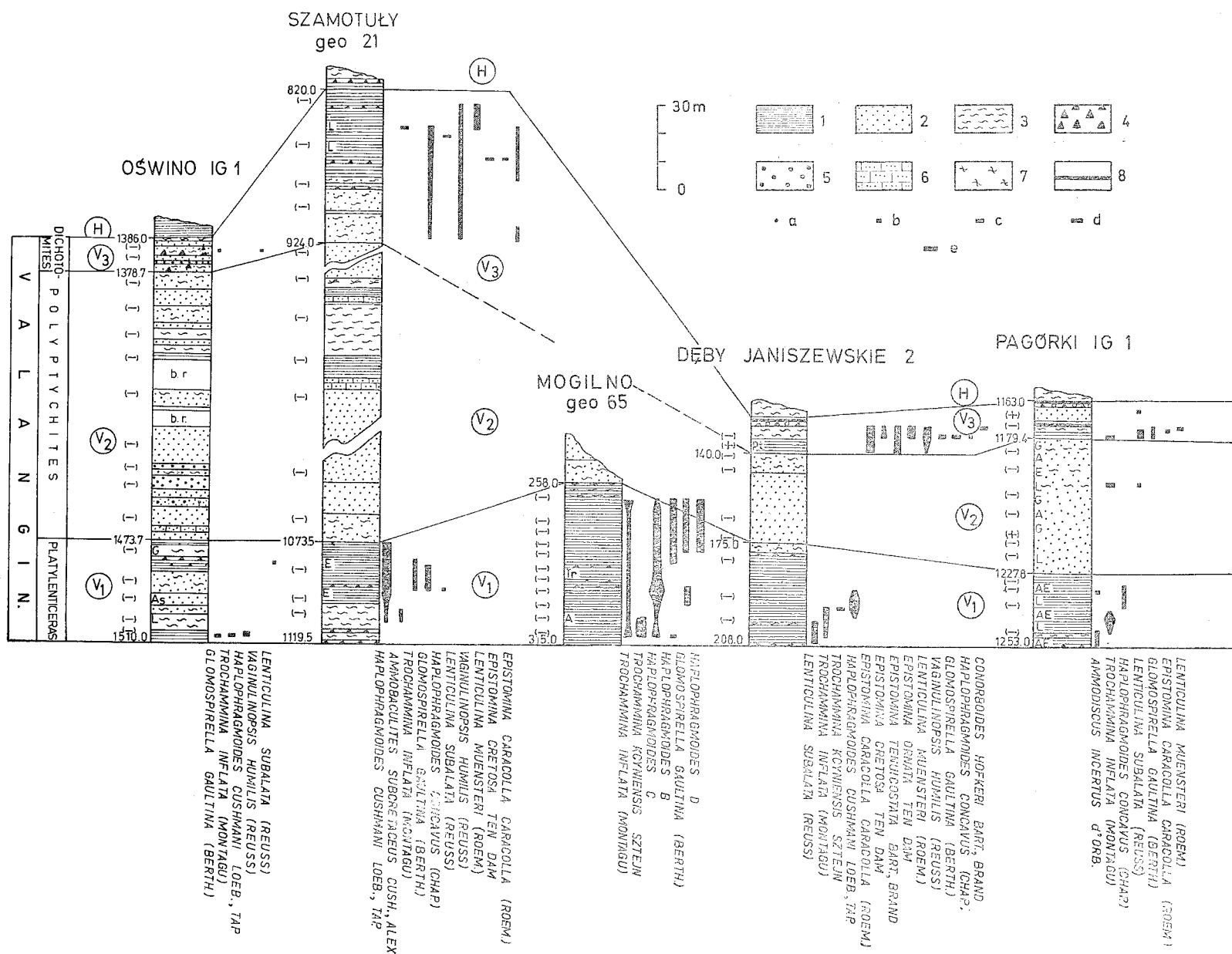


Fig. 2. Occurrence of Foraminifera in sampled bore-holes of the Szczecin—Mogilno—Łódź trough. 1 — shales; 2 — sands, sandstones; 3 — marly shales; 4 — siderites; 5 — gravels, coarse-grained sandstones; 6 — sandy limestones; 7 — stigmara; 8 — siderite; b.r. — absence of core; a — 1—4 specimens; b — 5—10 specimens, c — 11—30 specimens; d — 31—60 specimens; e — 61—100 specimens; + — +HCl; — — —HCl; Pt — *Polyptychites* sp. (*tardiscissus* Koenen); As — *Astarte*; Tr — *Terebratula*; O — *Ostrea*; E — *Exogyra*; L — *Leda*; G — *Grammatodon*; V<sub>1</sub> — Lower Valanginian (*Platylenticeras* zone); V<sub>2</sub> — Middle Valanginian (*Polyptychites* zone); V<sub>3</sub> — Upper Valanginian (*Dichotomites* zone); H — Hauterivian. Lithological profile after A. Raczyńska

qualitative variations. This depends upon the part of the tectonic unit from which the Foraminifera assemblage under consideration comes.

In the Baltic zone of the Pomorze Swell and Pomorze trough, the presence of several single specimens of *Glomospirella gaultina* (Berth.) was detected in Lower Valanginian sediments, recognized on the basis of lithology and macrofauna. To the S.E., both in the Pomorze and Szczecin Troughs, in addition to the *Glomospirella gaultina* (Berth.), scarce specimens of the following are also found: *Haplophragmoides concavus* (Chap.), *Haplophragmoides cushmani* Loeb., Tap., *Trochammina inflata* (Montagu), *Lenticulina subalata* (Reuss). In the S. part of the Pomorze Swell, the N. and central part of the Kujawy Swell, as well as the adjacent part of the Warszawa trough, numerous Foraminifera species may be distinguished: *Haplophragmoides concavus* (Chap.), *Haplophragmoides cushmani* Loeb., Tap., *Haplophragmoides* B., *Haplophragmoides* C, *Haplophragmoides* D, *Trochammina inflata* (Montagu), *Lenticulina subalata* (Reuss), and *Glomospirella gaultina* (Berth.), *Ammobaculites subcretaceus* Cush., Alex., *Vaginulinopsis humilis* (Reuss), *Astacolus diversicostatus* (Liszka), *Conorboides va-*

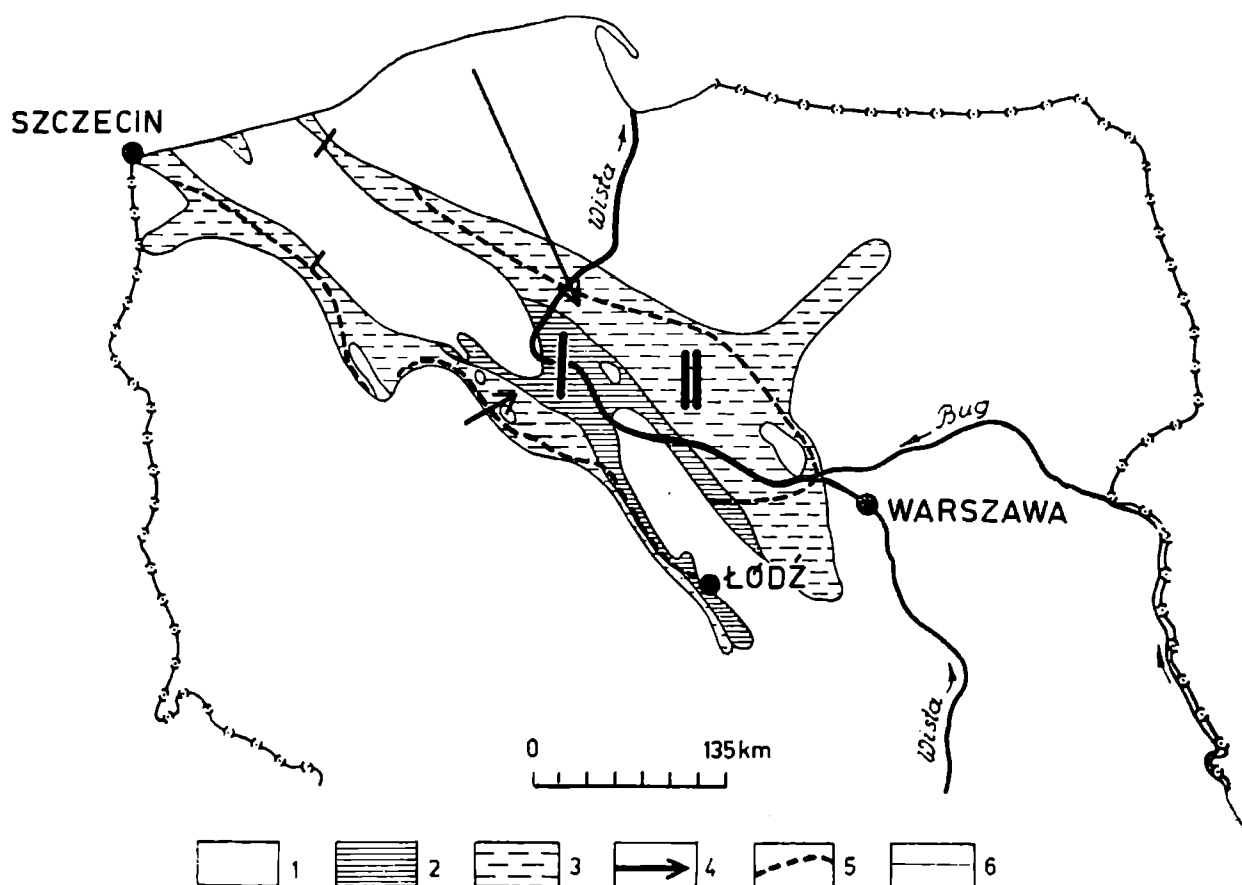


Fig. 5. Range of occurrence for Foraminifera assemblages of the Lower Valanginian of the Polish Lowlands (distribution of the Lower Valanginian after A. Raczynska and S. Marek). 1 — areas without Lower Valanginian epicontinental sediments; 2 — shales; 3 — shales and marly shales, occasionally sandy; scale horizontal; 4 — direction in which sand-content of sediments decreases; 5 — limit of ranges for Foraminifera assemblages; 6 — limit of extent of Lower Valanginian sediments; I — *Haplophragmoides-Trochammina-Lenticulina* assemblage of Foraminifera; II — *Lenticulina-Citharina* assemblage of Foraminifera

*lendisensis* Bart., Brand. Thus here is a typical *Haplophragmoides-Trochammina-Lenticulina* assemblage.

In the E. part of the Warszawa trough, there is a poorer microfauna; many species known from the Kujawy Swell are not found in the E. part of the Warszawa trough. Among the more commonly occurring Foraminifera species found here are: *Haplophragmoides concavus* (Chap.), *Trochammina inflata* (Montagu), *Lenticulina subalata* (Reuss).

On the S.W. flank of the Kujawy Swell, the place of the *Haplophragmoides-Trochammina-Lenticulina* assemblage is taken by another Foraminifera assemblage. This latter is the *Lenticulina-Citharina* assemblage, called by the author, assemblage II, and characterised by the predominant species: *Lenticulina subalata* (Reuss), *Lenticulina nodosa* (Reuss), *Lenticulina muensteri* (Roem.), *Citharina orthonata* (Reuss), *Citharina rudicostata* Bart., Brand., *Citharina pseudostriatula* Bart., Brand. Agglutinating Foraminifera are represented by *Verneuilinoides neocomiensis* (Mjatl.), as well as scarce specimens of *Trochammina depressa* Lozo, *Haplophragmoides concavus* (Chap.), *Glomospirella gaultina* (Berth.).

There exists an interdependence between the distribution of particular Foraminifera species in the Lower Valanginian sediments of the Polish Lowlands and the decrease in sand-content of these sediments<sup>1</sup>. The further to the S.E. and S. the sediments, the lower the sand-content and the greater the number of species and specimens of Foraminifera. Gradually towards the S.E., the number of species of calcareous Foraminifera increases, so that these constitute almost the entire thanatocoenosis in the Tomaszów Mazowiecki region.

A comparison of distributions of Foraminifera species, in the Lower Valanginian of the Polish Lowlands in a W.-E direction, gives interesting results, Agglutinating Foraminifera predominate in the Mogilno trough. On the Kujawy Swell and adjacent part of the marginal trough, the proportions of agglutinating and calcareous Foraminifera are more or less equal. In the E part of the Warszawa trough, agglutinating Foraminifera again predominate. This fact might perhaps be explained by the presence of a higher sand-content in the sediments of the Mogilno trough and especially in the E part of the Warszawa trough. On the Kujawy Swell, where the shaly sediments are less sandy, there is a greater number of Foraminifera species and, at the same time, the number of species of calcareous Foraminifera increases to the extent that they make up about half of the whole assemblage.

On Figs. 2—4, the CaCO<sub>3</sub>-content of the sediments is given<sup>2</sup>. As seen in all cases the Lower Valanginian sediments of the Polish Lowlands are not calcareous. Thus, in the Lower Valanginian, there is no possibility of proving a relationship between the presence or absence of certain Foraminifera species and the lime-content of the sediments.

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<sup>1</sup> The samples received by the author for micropalaeontological analysis had already been sieved. Thus it was not possible for the author to study the sand-content of the sediments. The author bases the consideration relating to the decrease in percentage quartz in the sediment on the data of S. Marek and A. Raczyńska.

<sup>2</sup> The author uses data on CaCO<sub>3</sub>-content of the sediments after S. Marek and A. Raczyńska.

On Fig. 6 is shown the occurrence of Foraminifera in relation to the sediments of Middle Valanginian age. In the sediments of this sub-stage, Foraminifera are scarce and belong to the *Haplophragmoides-Trochammina-Lenticulina* assemblage. The following species occur: *Haplophragmoides concavus* (Chap.), *Haplophragmoides cushmani* Loeb., Tap., *Trochammina inflata* (Montagu), *Lenticulina subalata* (Reuss), *Glomospirella humilis gaultina* (Berth.), *Vaginulinopsis* (Reuss), *Eoguttulina witoldi* Szejn.

The occurrence of Upper Valanginian Foraminifera in relation to sediments is given in Fig. 7. In the sediments of this sub-stage, a *Lenticulina-Epistomina* assemblage is found. This assemblage is termed by the author assemblage III. The *Lenticulina-Epistomina* assemblage is characterized by the presence of: *Lenticulina subalata* (Reuss), *Lenticulina muensteri* (Roem.), *Epistomina caracolla caracolla* (Roem.), *Epistomina cretosa* Ten Dam, *Epistomina tenuicostata* Bart., Brand. The list of species making up the *Lenticulina-Epistomina* assemblage may require alterations. This assemblage may display certain variations. These are slight qualitative and quantitative variations, de-

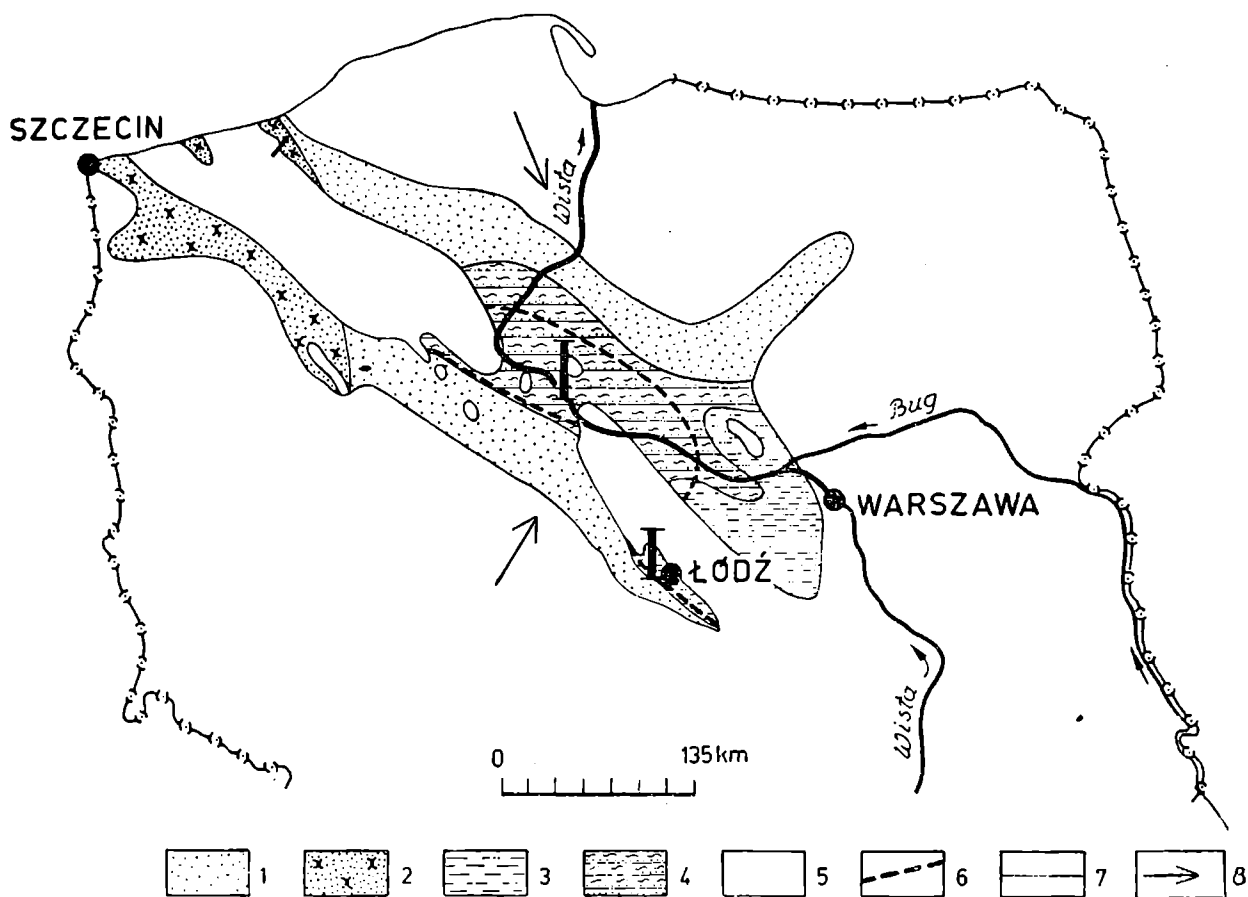


Fig. 6. Range of occurrence for Foraminifera assemblages of the Middle Valanginian of the Polish Lowlands (distribution of the Middle Valanginian based on data of A. Racyńska and S. Marek). 1 — fine-grained sandstones, with subordinate coarse-grained sandstones; 2 — sandstones with pockets of rhizoidal, marly shales; 3 — shales and marly shales; 4 — sandstones at top and base with silty and marly shale pockets; 5 — areas without Valanginian epicontinental sediments; 6 — limit of range for Foraminifera assemblage; 7 — limit of extent of Valanginian sediments; 8 — direction in which sand-content of sediments decreases; I — *Haplophragmoides-Trochammina-Lenticulina* assemblage of Foraminifera; scale horizontal

pending on the part of the tectonic unit, from which the Foraminifera assemblage under consideration comes.

In the N.W. part of the Pomorze Swell (Trzebiatów synclinorium, for example, in the Kiełpino region) only a few specimens of *Glomospirella gaultina* (Berth.) were found. In the Szczecin and Pomorze troughs, scarce specimens of the species *Lenticulina subalata* (Reuss) and *Vaginulinopsis humilis* (Reuss) were found. Only in the Mogilno trough do agglutinating Foraminifera occur in fairly large quantities. These are *Ammobaculites subcretaceus* Cush., Alex., *Haplophragmoides concavus* (Chap.), *Trochammina inflata* (Montagu). Agglutinating Foraminifera are rare in the remaining part of the Polish Lowlands, occupied by Upper Valanginian sediments. In the Mogilno trough, besides those species mentioned above, the following species, scarce but characteristic for the *Lenticulina-Epistomina* assemblage, were found: *Lenticulina subalata* (Reuss), *Lenticulina muensteri* (Roem.), *Epistomina cretosa* Ten Dam, *Epistomina tenuicostata* Bart., Brand, *Epistomina caracolla caracolla* (Roem.).

On the other hand, in the central part of the Kujawy Swell and the adjacent part of the Warszawa trough, numerous specimens of the

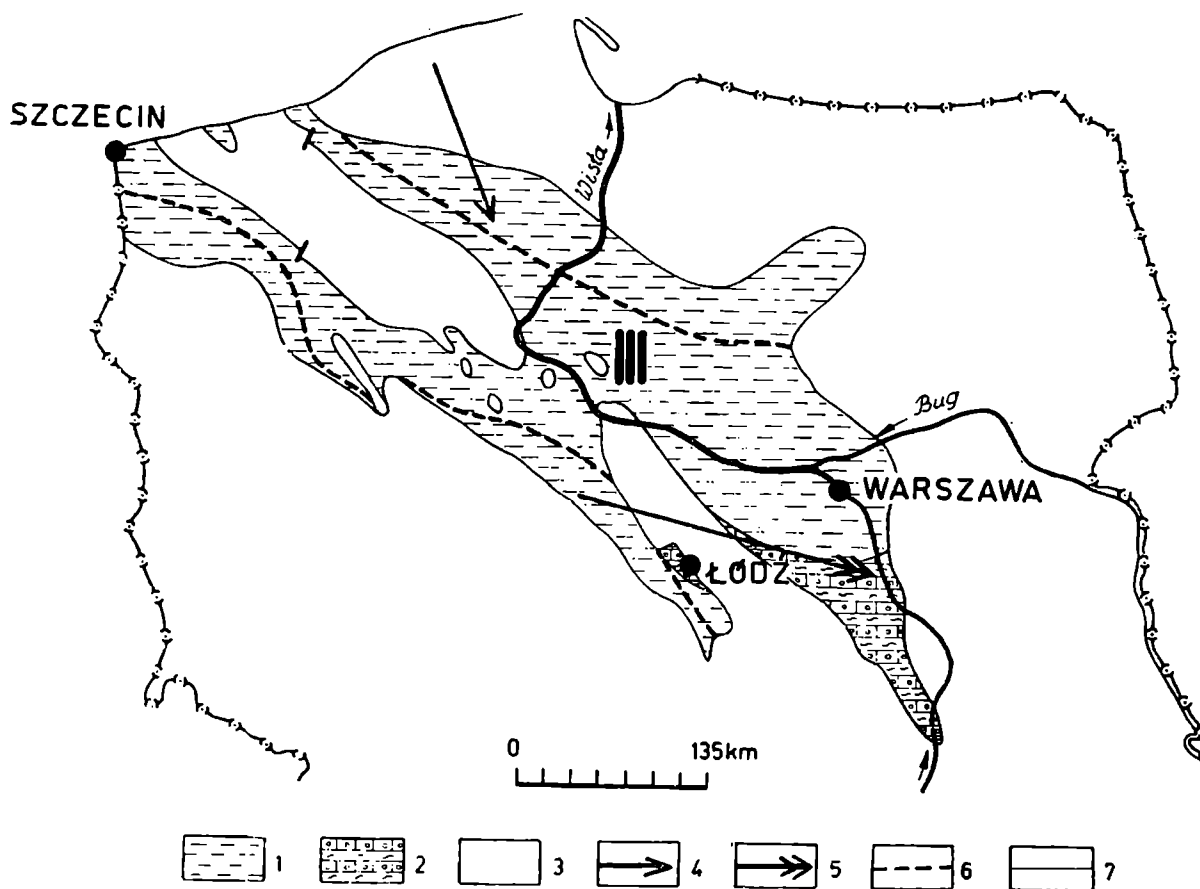


Fig. 7. Range of occurrence for Foraminifera assemblages of the Upper Valanginian of the Polish Lowlands (distribution of the Upper Valanginian based on data of A. Raczynska and S. Marek). 1 — shales and marly shales, in places sandy; 2 — shales and marly shales with pockets of marly, organodetrital and oolitic limestones; 3 — areas without Upper Valanginian epicontinental sediments; 4 — direction in which sand-content of sediment decreases; 5 — direction in which lime-content of sediments increases; 6 — limit of range of Foraminifera assemblage; 7 — limit of extent of Upper Valanginian sediments; III — *Lenticulina-Epistomina* assemblage of Foraminifera

following species were found: *Lenticulina subalata* (R e u s s), *Lenticulina muensteri* (R o e m.), *Epistomina caracolla caracolla* (R o e m.), *Epistomina cretosa* T e n D a m, *Vaginulinopsis humilis* (R e u s s), as well as very scarce specimens of *Haplophragmoides concavus* (C h a p.), *Ammobaculites subcretaceus* C u s h., A l e x.

In the N. part of the Kujawy Swell and adjacent part of the Warszawa basin, hardly any agglutinating Foraminifera were found and calcareous forms occur almost exclusively: *Lenticulina subalata* (R e u s s), *Lenticulina muensteri* (R o e m.), *Epistomina caracolla caracolla* (R o e m.), *Epistomina cretosa* T e n D a m. Likewise, there is an absence of agglutinating Foraminifera in the Lublin trough, where only *Lenticulina subalata* (R e u s s), *Lenticulina muensteri* (R o e m.), *Lenticulina nodosa* (R e u s s), *Vaginulinopsis humilis* (R o e m.), *Epistomina caracolla caracolla* (R o e m.), and *Epistomina cretosa* T e n D a m are found.

In the Upper Valanginian of the Polish Lowlands, as in the Lower Valanginian, there is an interdependence between the distribution of particular Foraminifera species and the direction of decrease in sand-content of the sediments. The sediments become less sandy in a S.E. and S direction. With decrease in sand-content of the sediments, the number of species and specimens of Foraminifera increases. The number of species of calcareous Foraminifera increases gradually in a N.W.—S.E. direction. In the Lublin trough, these species constitute practically the entire thanatocoenosis.

A comparison of the distribution of Foraminifera species in the Upper Valanginian of the Polish Lowlands, from W. to E., gives interesting results. Agglutinating Foraminifera are relatively abundant in the Mogilno trough, while in the central part of the Kujawy Swell, they are partly replaced by calcareous forms and are practically absent from the Warszawa trough. This phenomenon may be explained as resulting from a slight increase in the carbon content of the sediments from W. to E.

#### CONCLUSIONS

The data given above show that several conclusions may be drawn on the basis of the vertical and horizontal distribution of Foraminifera in the Valanginian.

In the Polish Lowlands, the presence of a large number of Foraminifera species, of wide stratigraphic range, has been demonstrated. Besides these, there is a certain number of index species. In the Lower Valanginian, the following are index species: *Haplophragmoides B*, *Haplophragmoides C*, *Haplophragmoides D*, *Epistomina caracolla anterior* B a r t., B r a n d. *Eoguttulina witoldi* S z t e j n and *Haplophragmoides cushmani* L o e b., T a p. are index species for the Riazanian and Lower and Middle Valanginian. For the Riazanian and Lower Valanginian *Trochammina kcyniensis* S z t e j n is an index form. Index species for the Upper Valanginian and Lower Hauterivian are: *Epistomina caracolla caracolla* (R o e m.), *Epistomina cretosa* T e n D a m, *Epistomina ornata* T e n D a m, *Citharina seitzi* B a r t., B r a n d., *Marginulina pyramidalis* K o c h.

In the Valanginian sediments, three Foraminifera assemblages may be recognized: I — a *Haplophragmoides-Trochammina-Lenticulina*

assemblage in the Lower and Middle Valanginian, II — a *Lenticulina-Citharina* assemblage in the Lower Valanginian and III — a *Lenticulina-Epistomina* assemblage in the Upper Valanginian.

In the Valanginian of the Polish lowlands, the presence of particular Foraminifera species in the sediments depends primarily on the sand-content. In sandy sediments, Foraminifera are absent. As the sand-content of the shales and marls decreases, progressively more species of calcareous Foraminifera appears; in sediments with a low sand-content, calcareous Foraminifera predominate.

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## STRESZCZENIE

W opracowaniu niniejszym przedstawiono zespoły otwornic walanżynu na Niżu Polski. Badania objęły swym zasięgiem nieckę szczecińsko-mogileńsko-łódzką, wał kujawsko-pomorski, nieckę brzeźną. Przedstawiono zespoły otwornic na tle wybranych profilów litologicznych. Stratygrafia walanżynu została opracowana na podstawie danych litologicznych, makro- i mikrofaunistycznych. Dane makrofaunistyczne i litologiczne czerpano od A. R a c z y ń s k i e j i S. M a r k a. Wśród badanych otwornic wyróżniono trzy zespoły: I — haplófragmoidesowo-trochaminowo-lentikulinowy, II — lentikulinowo-citarinowy i III — lentikulinowo-epistominowy. Obecność poszczególnych gatunków otwornic w wymienionych zespołach może ulegać pewnym wahaniom, zależy to od tego, z jakiej części jednostki tektonicznej pochodzi rozpatrywany zespół otwornic. Wahaniom może również ulegać ilość okazów otwornic w poszczególnych gatunkach. W walanżynie na Niżu Polski obecność poszczególnych gatunków otwornic w osadzie jest uzależniona przede wszystkim od stopnia zapiaszczenia. W miarę zwiększania się stopnia zapiaszczenia iłowców i mułowców pojawia się coraz mniej gatunków otwornic wapiennych, w osadach o nieznacznym stopniu zapiaszczenia dominują otwornice wapienne. Węglanowość osadów ma również wpływ na występowanie poszczególnych gatunków otwornic. W miarę zwiększania się węglanowości osadów pojawia się większa ilość otwornic wapiennych. W całym walanżynie na Niżu Polski występuje stopniowo w kierunku z północnego-zachodu na południowy wschód coraz więcej gatunków otwornic, a także wzrasta liczebność okazów. Porównanie rozmieszczenia otwornic w walanżynie dolnym w kierunku z zachodu na wschód daje ciekawe wyniki. W niecce szczecińsko-mogileńsko-łódzkiej oraz we wschodniej części niecki warszawskiej dominują otwornice zlepieńcowate. Natomiast na wale kujawskim i w przylegającej do niego części niecki brzeźnej ilość gatunków otwornic wapiennych i zlepieńcowatych jest mniej więcej równa. W walanżynie górnym, w kierunku z zachodu na wschód zanikają otwornice zlepieńcowate. W walanżynie na Niżu Polski obok licznych otwornic o dużym zasięgu stratygraficznym stwierdzono pewną ilość form przewodnich.

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