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REMARKS ON THE GENERA *OPHTHALMIDIUM* AND *PALAEOMILIO-*
LINA (FORAMINIFERIDA)

Abstract. — In the light of ambiguities in interpretation of some genera of Miliolidae by various authors a precise definition of *Ophthalmidium* Kübler & Zwingli, 1870, and *Palaeomiliolina* Loeblich & Tappan, 1964 is given on the basis of Jurassic materials from Poland, other countries and literature. Structure of tests and microstructure of walls were investigated. Enlarged photographs in polarized light are presented. Close affinity was stated of the genera in question and both were assigned to one family. A stratigraphic table of species noted from the Triassic and Jurassic is presented and their generic affiliation corrected.

INTRODUCTION

An interest in Miliolidae has recently increased considerably which is reflected in a number of publications on this subject. In 1969, almost simultaneously, two papers appeared presenting emendation of the genus *Ophthalmidium* — one in Italian journal (Zaninetti & Brönnimann), and second in Soviet periodical (Temirbekova). Redefinitions of the genus, descriptions and comparisons extremely differ one from another in the above mentioned papers. Next two other papers appeared in Soviet periodicals, namely one by Azbel (1971) and another by Danitch (1971). Both those papers present still different views about the classification of this genus.

The genus *Palaeomiliolina* is not univocally interpreted as well by micropaleontologists in recent years. These two genera are very common in many profiles of the Middle Jurassic of Poland and their species serve as good index fossils. They are described in detail (Pazdro, 1958, 1959), and their stratigraphic distribution was confirmed (Pazdro, 1960; Bielecka and Styk, 1969), but in the light of controversy of generic and specific concepts by many authors an attempt is needed to solve these problems in a definite way. This is particularly so in the case of stratigraphic purposes when only names of fossils are mentioned without description nor illustration. The

specimens described in the present paper are housed in the Institute of Geological Sciences, Polish Academy of Sciences in Warsaw, and the numbers of specimens given on the plates refer to the collection of this Institute.

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GENUS *OPHTHALMIDIUM* KÜBLER & ZWINGLI, 1870

Review of previous views.—A narrow concept of *Ophthalmidium* is presented by Temirbekova (1969a, b). She accepts the definitions by Cushman (1948), Bogdanovitch (1952, 1959) and Loeblich & Tappan (1964) only in part, and *Spirophthalmidium sensu* Bykova (1948) and *sensu* Bogdanovitch (1952) is regarded as a synonym of *Ophthalmidium*. She treats *Spirophthalmidium* Cushman 1927 as a separate genus, as may be reckoned from her comparative remarks.

As diagnostic features of the *Ophthalmidium*, Temirbekova mentions planispiral coiling of the whole test, length of the second chamber (next after proloculus) as $1/2$ — $1/3$ of whorl, and that of the third one as 1 and $1/3$ of whorl, the remaining one each as $1/2$ of whorl (Text-fig. 1). Test

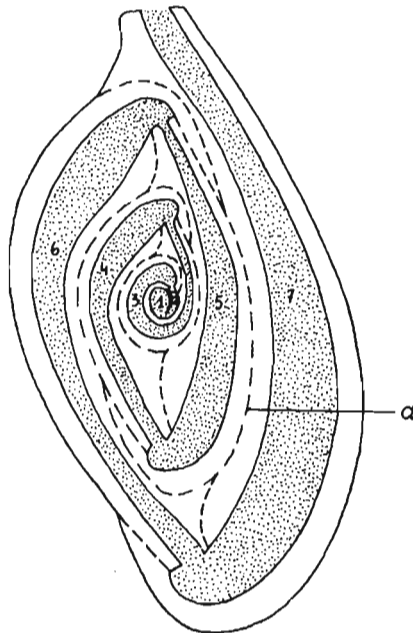


Fig. 1. *Ophthalmidium* sp., longitudinal section, 1—7 chamber numeration, a suture (after U. Temirbekova 1969).

evolute, semi-involute, or involute (Text-fig. 2). She illustrates sections of *O. infraoolithicum* (Terquem), out of which it is clear that each chamber shows its own walls and on the junction two walls may be seen. There is no mention by this author about the plate separating the chambers, as it is

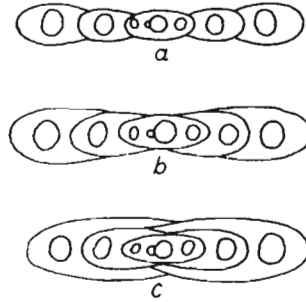


Fig. 2. *Ophthalmidium* cross-sections, a — test evolute, b — halfinvolute, c — involute (after Temirbekova 1969).

the case in other definitions of the genus. This genus should differ from *Spiroloculina* d'Orbigny in lack of tooth in aperture, planispiral coils in microspheric forms, and from *Spirophthalmidium* Cushman in different arrangement of three initial chambers in megalospheric forms. Temirbekova regards thickness of wall as an important diagnostic feature for species.

A complete different emendation of the genus has been given by Zaninetti & Brönniman (1969). They interpret the genus *Ophthalmidium* in a broad sense including as synonyms the following genera: *Hauerina* d'Orbigny, 1839, *Cornuloculina* Burbach, 1886, *Hauerinella* Schubert, 1920, *Spirophthalmidium* Cushman, 1927, *Praeophthalmidium* Knauff, 1966, *Eoophthalmidium* Langer, 1968. According to them the length of chambers in this genus may differ and they may be planispiral or irregularly coiled at the beginning and farther planispiral, evolute or involute, separated one from another by a plate or lack of such a plate between whorls.

It should be mentioned that the synonymy presented in that paper disagrees with the International Code of Zoological Nomenclature because the name *Hauerina* should have the priority and *Ophthalmidium* should be regarded as a younger synonym and should be abandoned. Nevertheless, *Hauerina* is generally accepted as a separate genus having a completely different (sieve-like) aperture.

Danitch (1971) in his interesting monography of Jurassic Miliolidae mentions in the description of *Ophthalmidium* that beside of proloculus and flexostyle (i. e. second chamber according to Wood & Barnard, 1946; Pazdro, 1958) long of 1/2 up to 1 whorl, all other chambers are so arranged that there are less than 2 chambers in one whorl hence one chamber is longer than 1/2 of whorl. He does not give synonyms. He describes sepa-

rately the tests of *Spirophthalmidium* as being planispiral, does not determine the length of flexostyle, and mentions only that it may be situated in other plane than the rest of chambers. The third chamber (second according to his numeration) is as long as one whorl, seldom as a half of whorl. He accentuates the presence of characteristic triangular plates at joining points of chambers. At some species those plates stretch along the chambers (Text-fig. 3). Chambers coil in number of two in each whorl.

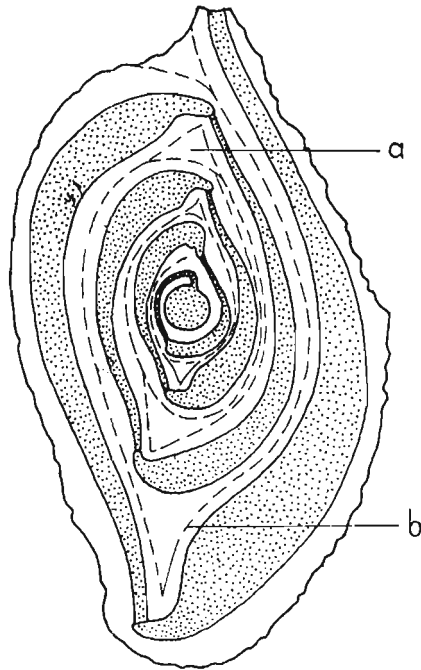


Fig. 3. *Ophthalmidium kaptarenkoae* (Danitch), longitudinal section, a — triangular plate, b — suture (after Danitch 1971); $\times 120$.

This feature seems to be most important to distinguish the *Spirophthalmidium* from the *Ophthalmidium* in the opinion of Danitch.

Azbel (1971) distinguishes *Ophthalmidium* from the *Spirophthalmidium* mainly on the basis of the length of the third chamber (second according to him). In *Ophthalmidium* that chamber is as long as $1/3$ to 1 whorl and this genus occurs in the Triassic and Jurassic, whereas the *Spirophthalmidium* exhibits that chamber as long as 2 to 3 whorls and is a recent form. Azbel sees another analogous pair of genera — *Cornuloculina* in the Jurassic of a length of that chamber $2/3$ up to 1 and a half of whorl, and *Hauerinella* — a recent form, of a length of chamber in question as 2 to 3 whorls.

In the light of such controversies one should go back to the original definition of the generic name, i. e. to Kübler & Zwingli (1870). Unfortu-

nately, out of many well illustrated forms *Ophthalmidium liassicum* has been chosen as the type species for the genus, the holotype of which is an abnormal, probably pathologically deformed specimen. This specimen as well as some others of the collection was investigated again by Wood (1947) who described and illustrated it. *O. carinatum* or its synonym *O. nucleus* would be much better as a type species because its characters are more distinct as given in the description of the new genus by its authors. It was described and illustrated by them several times and is regarded as a common form by others.

Kübler & Zwingli (1870) accentuate in their description of the new genus that it shows the first chamber as a spherical one which differs it from that chamber of *Spiroloculina*, and chambers are wavy and inflated another feature differing it from that genus. They point out the characteristic shape of chambers which are broader at one end and thinner on the other one, and join with thinner end of one chamber the broader termination of the next one. They coil in pairs. The chambers do not join each other directly but are separated by more or less broad "bridges". Second chamber is as long as 1 to 1 and a half of whorl, and chambers may coil along an axis as well as across. Some observations of Kübler & Zwingli were not precise probably because of optical instruments of low precision. E. g., they regarded the second and third chambers together as the second chamber, and the transversal coiling in some species, as may be reckoned from illustrations of *O. gracile*, *O. auris* and *O. multiplex*, points to abnormal forms, or those are optical sections of specimens of *Palaeomiliolina*.

Oesterle (1968) has seen the original collection of Kübler & Zwingli but as the specimens were submerged in Canada balsam he was unable to examine them. He supposes that *O. gracile* and *O. auris* are fragments of specimens of *Spirillina* which does not seem to be correct because *Spirillina* never gives such image.

Terquem & Berthelin (1875) did not accept the new genus *Ophthalmidium* maintaining that it does not differ from *Spiroloculina*.

Wood & Barnard (1946) broadly dispute the genera *Ophthalmidium*, *Spirophthalmidium*, *Spiroloculina*, *Hauerina* but they did not solve the problem univocally. Their definition of *Ophthalmidium* slightly differs from that presented by its creators. In both definitions the external character of test is not clear because the descriptions and illustrations are based chiefly on research in transmitted light. The above mentioned authors point out that the tests are flattened, bilaterally symmetrical. Proloculus of megalospheric forms is spherical, and in microspheric ones—elliptical. Second chamber of megalospheric forms in shape of narrow tube of constant diameter as long as 1/2 of whorl and in microspheric ones—a tube widening and then narrowing as long as 3/4 up to 1 whorl. The third chamber of megalospheric forms rapidly widens and then gradually narrows

as long as 1 whorl and in microspheric ones — similar and as long as $2/3$ up to 1 whorl. Next chambers may be longer than $1/2$ of whorl and show a tendency to shortening with growth but rarely beside 2 in whorl. Species are frequently characterized by considerable variability of shape.

It is impossible to cite all the views concerning the genus in question. It is sufficient to state that the divergencies in the definitions of various authors concern chiefly such characters as:

- 1) shape of proloculus — circle or ellipse,
- 2) length of chambers versus coils and their numeration,
- 3) coiling plane — planispiral or partly in varying planes,
- 4) mode of chamber joining — presence or lack of “brigdes”, “floors”, and character of involutness,
- 5) microstructure of wall.

Almost all definitions agree in the following points:

- 1) tests calcareous,
- 2) aperture simple terminal, round or oval, without tooth,
- 3) shape of chambers unequal, chambers (proper, i. e. their chamber bodies), aside of proloculus and a thin tube protruding from it, are wider in their initial part and narrow at aperture.

Majority of authors accept that *Ophthalmidium* exhibits planispiral tests, free non attached, non perforated and porcellaneous walls.

Danitch (1971) considers the following characters as important for *Spirophthalmidium*, which at the present time is regarded as a synonym of *Ophthalmidium*: mode of chamber coiling — planispiral, 2 chambers per whorl, presence of plates at joining points, and partly shape of cross section. The following characters, according to this author, are important at specific stage: shape of test, character of external margin, degree of involutness, shape of section. According to Danitch the character of aperture, of wall surface, sutures, detachment of the last chamber are of no diagnostic value and depend on individual variability.

Azbel (1971) regards the length of the third chamber (according to him — second) as the main diagnostic character for the genus in the investigated group of Miliolidae.

The analysis of the Jurassic *Ophthalmidium* of Poland, comparative materials from other countries and of literature show that the divergencies in the descriptions and conclusions derive from varying methods of observation, various terminology, and disregarding of shape of chambers both internal and external. The shapes usually do not coincide one with another because walls of chambers are not uniformly thick and exhibit the existence of extensions which conceal the coils.

Form and arrangement of chambers. — The shape of the initial chamber among the investigated specimens, and as known from the literature, is spherical or very close to spherical. Information about its elliptical shape

comes probably from the observation of the test surface in cases where sides of proloculus are partly covered by the walls of a pair of the surrounding chambers. The second chamber, named by some authors flexostyle, is a narrow tube of uniform internal diameter, usually shorter than $1/2$ of whorl, the third chamber, named by some — the second, is a tube of interior widened at the beginning and narrowing toward the end of $1/2$ up to 1 whorl in length. Next chambers are of similar character and their length is about $1/2$ of whorl (Text-fig. 4a, b, c). The second chamber connects with the third one forming an angle close to 180° , the third with the fourth one — almost perpendicular in such a way that the narrowed termination (neck) of the older chamber joins the beak-like base of the younger one somewhat on its side (Text-fig. 4). In case of probably microspheric

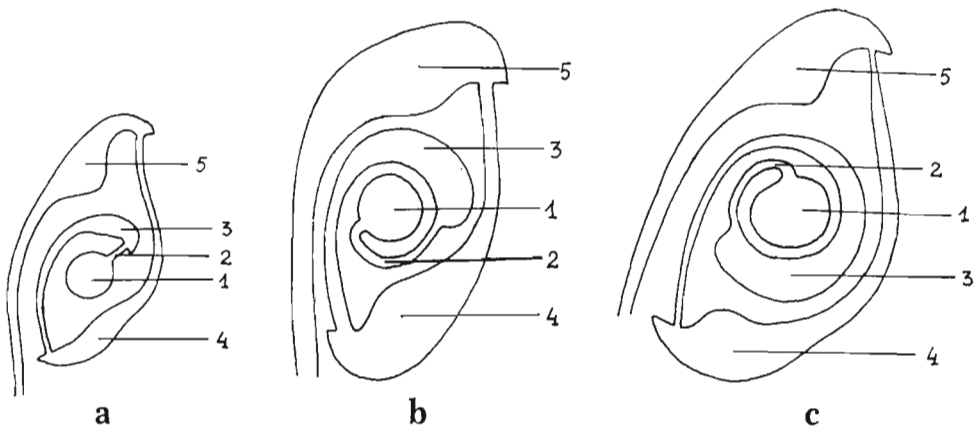


Fig. 4. *Ophthalmidium*, shapes and volutions of chamber bodies, a — *O. carinatum terquemi* Pazdro, length of 3-th chamber $1/2$ of a whorl, $\times 480$, b — *O. carinatum agglutinans* Pazdro, length of 3-th chamber $3/4$ of a whorl, $\times 530$; c — *O. carinatum agglutinans* Pazdro, length of 3-th chamber 1 whorl, $\times 560$; 1—5 chamber numeration.

forms the third chamber is as long as $1/2$ of whorl, it joins the second one in the same manner under almost the right angle.

Chamber walls are unequally thick and may form lateral extensions (e. g. wing-like extensions, *vide* Bykova, 1948), of various width, which may partly or completely encircle preceding whorls (Text-figs 2 and 5). This is the reason why it is impossible to observe the shape and number of chambers in most specimens only on the basis of the test surface. The shape of chamber body may be seen after immersion in a liquid (e. g. immersion oil, xylene, etc.) or in Canada balsam either in transmitted or reflected light and in some cases only in thin sections.

Tests of *Ophthalmidium* may be loosely or tightly coiled thus being either evolute or involute. Chambers possess their own walls and do not use previously constructed walls to which they adhere. They have their own "floors", chambers are tubular, and not trough-shaped. Inaccurate

description and or negligence of chamber image from inside and outside may lead to misunderstandings. For instance, in many specimens of *Ophthalmidium* last chambers easily break away thus making the whole

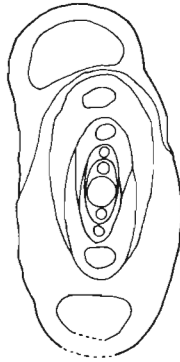


Fig. 5. *Ophthalmidium carinatum terquemi* Pazdro, Częstochowa region, Dogger, cross-section, $\times 485$ (0-72/1).

chamber trough-like in appearance from outside because of wing-like extensions of walls but the chamber body, i. e. the chamber proper, is tubulous (Text-fig. 6).

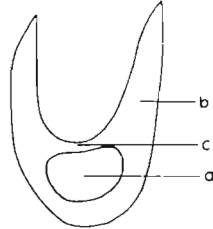


Fig. 6. *Ophthalmidium* sp., cross-section of a single chamber, a — chamber body, b — winglike wall outgrowth, c — chamber floor.

Bykova (1948) has observed, when investigating specimens which she then classified to *Spirophthalmidium carinatum* (Kübler & Zwingli), that the test is involute because of the formation of lateral plates of the test walls, which partly cover the previously formed whorls. She noticed some details as well which were never mentioned by others, namely that those lateral extensions of walls may be also formed on the peripheral margin of chamber joining one another and leaving free space an "additional test cavity" running parallel to the main chamber cavity. This phenomenon has been marked by her only on transversal section. Danitch (1971) illustrated and described this species but he did not mention those additional test cavities. There are no specimens in the material from Poland which would correspond to those of Bykova (1948), and which Dain (in Mitjanina,

1963) renamed as *Spirophthalmidium* ? *pseudocarinatum*, nor such cavities were observed in other forms in an undoubtful way. It seems also that lack of internal wall of chambers, i. e. the floor on drawings of sections in Bykova's paper and in papers by others is simply an omission or a result of a bad preservation state of tests.

Internal sutures i. e. lines of contacts of chamber walls with the previously developed whorl are recognisable only on best preserved specimens. Even slight recrystallisation obscures the sutures and this is the reason that they are marked but on few illustrations. In such cases 2 walls at junction are clearly observable (Pl. XXXIII, Fig. 4, Text-figs 1, 3, 7).

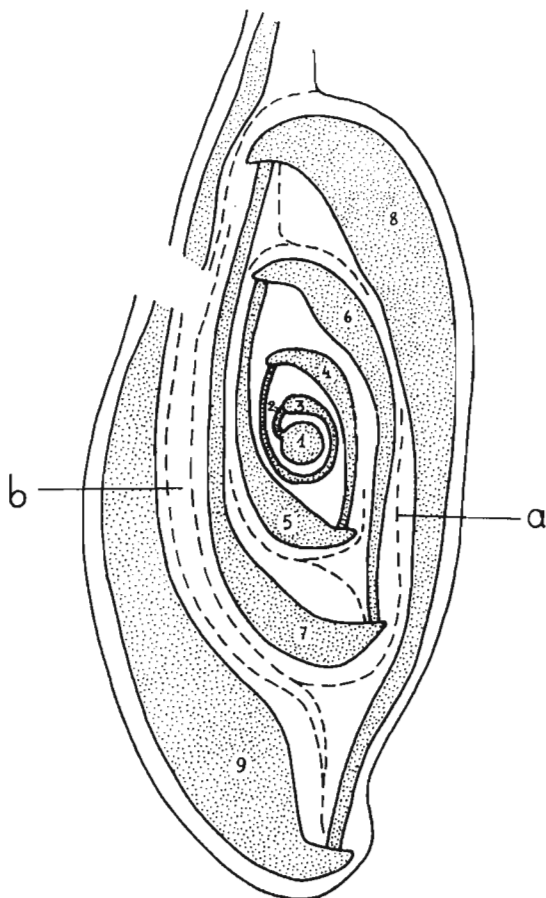


Fig. 7. *Ophthalmidium carinatum terquemi* Pazdro, Częstochowa region, Dogger, longitudinal thin section, a—suture, b—cleavage at the suture, ca 250 \times (0-72/r).

External sutures on the test surface are frequently described and illustrated but they seldom coincide with the internal ones and this is only the case among completely evolute forms. In involute and semi-involute forms the external sutures mark only the range of wing-like extensions of

chamber walls embracing previous whorls (Pl. XXXIII, Figs 1, 4). The broadest extension occur near aperture i.e. at the neck of a chamber and at the beginning of the next chamber. In optical section they give an image of triangular fields separated by a suture (Pl. XXXIV, Fig. 1, Text-figs 3, 7). They are marked by Temirbekova (1969) and Danitch (1971) though in different aspect (Text-figs 1, 3). The width of those plates and wall thickness in the various parts of test are not uniform which is well observable in variability tables by Wood & Barnard (1946) and on illustrations by Danitch (1971). Among definitely evolute specimens the sutures are depressed and chambers are marked on the surface in form of convex rolls. In many cases the chambers are involute at the beginning and the last ones evolute (Pl. XXXIII, Fig. 6).

Test shape. — The analysis of variability of species by Wood & Barnard (1946) shows that the mode of coiling and the length of chambers hence the shape of test as well may vary within wide range even in the same species.

The majority of the investigated specimens of ophthalmiids exhibit planispiral arrangement of chambers among normal individuals regardless of their involutness.

Some deviations from planispiral pattern are frequent among involute forms and rapid changes of coiling plane occur in pathologic specimens (Pl. XXXIII, Fig. 3). Trifonova (1970) described anomalies and great variability of *Ophthalmidium carinatum* Kübler & Zwingli from the Bajocian and Bathonian of Bulgaria ascribing that to a change of mode of life from a free one to attached. No traces of attachments to the substratum were observed among the investigated specimens, nevertheless, many deformations of mode of coiling and in shapes of tests occur (Pl. XXXIII, Fig. 3; Pl. XXXIV, Fig. 2). The causes may be looked for in considerably plasticity of tests, regenerative ability and high mobility of sea water. Bykova (1948) has distinguished a new species on the basis of abnormal specimens from the Upper Callovian of Samarska Luka under the name *Spirophthalmidium monstrosus*. It was accepted as a type species for the genus *Palaeomiliolina* Bogdanovitch by Antonova (1959), and Azbel (1970) has proved that this is a very variable species of *Ophthalmidium*. Deviations from planispiral coiling may be observed among many species and on illustrations by many authors. The observation by Bykova (op. cit.) is confirmed stating that frequent is a tendency to sigmoidal coiling.

Microstructure of wall and mineral composition. — Many authors stress the ability to incorporate mineral particles within the test walls among Miliolidae (partially agglutinated tests, a character of the whole family), but only few of them find it among ophthalmiids. Terquem (1886) has noted that some Jurassic Miliolidae exhibit "arenaceous" test texture. Bykova (1948) names one of her species "areniformae" on the basis of test appearance agglutinated with sand grains although she stated that the walls are

built of calcite crystals. Recently an undoubted ability to incorporate sand grains was stated among some individuals of *Ophthalmidium carinatum* Kübler & Zwingli (Pazdro, 1958; Trifonova, 1970).

The microstructure of walls was seldom studied in Miliolidae. Serova (1961) states that Miliolidae exhibit walls built of three layers, external, middle and internal ones. Both marginal layers are very thin and their calcite crystals are parallel to the wall surface. The intermediate layer is considerably thicker and its crystals are nonarranged, 1 to 2 microns in size. However, Serova did not investigate Jurassic Miliolidae thus she mentioned neither *Spirophthalmidium* nor *Ophthalmidium*. Temirbekova (1969) studied tests of *Ophthalmidium* from the Bajocian of Dagestan and remarked that the walls consist of nonarranged calcite crystals less than 2 microns in size. She presumed that the Jurassic ophthalmids have three layered wall structure as it was described by Serova, but the external thin layers were not preserved. Danitch (1971) remarks that Miliolidae investigated by him exhibit one-layered structure.

Statements of some authors (e. g. Bykova, 1948) that *Spirophthalmidium* (i. e. *Ophthalmidium*) of the Jurassic show radial wall structure come probably from erroneous interpretation of thin sections, or are due to recrystallisation, as it was observed on the specimens from the Jurassic of the Pieniny Klippen Belt of Poland (Pl. XXXIV, Fig. 4).

The Jurassic ophthalmids from Poland are difficult to investigate because of diagenetic changes and small dimensions. Most chambers are filled with pyrite which penetrates the walls in many cases, and makes the preparation of a good thin section difficult. Appearance of some sections, however, confirms the results of Serova and Temirbekova. Wall thickness as measured on peripheral margin of the last chamber (approximately in the middle of its length) and size of crystals vary from species to species. For instance at *Ophthalmidium carinatum agglutinans* Pazdro from the Bathonian of the vicinity of Częstochowa, Middle Poland (Pl. XXXIII, Fig. 6) wall thickness is about 0.010 mm, external layers about 0.002 mm, grain diameter from 0.001 up to 0.003 mm, and in *O. carinatum terquemi* Pazdro from the Bajocian of the same area the wall thickness is about 0.018 mm, external layers about 0.003 mm, grain diameter 0.001—0.002 mm (Pl. XXXIII, Fig. 4).

The following definition of the genus *Ophthalmidium* is proposed on the basis of fossil material and literature:

Family Miliolidae

Genus *Ophthalmidium* Kübler & Zwingli, 1870

Type species: Ophthalmidium carinatum Kübler & Zwingli, 1870, emend. Wood, 1947

Synonyms: *Oculina* Kübler & Zwingli, 1866.

Spirophthalmidium Cushman, 1927 (partim).

Diagnosis. — Test oval, frequently elongated, flattened. Aperture on neck, round, simple, without tooth, frequently surrounded by phialine lip. Test consists of spherical or almost spherical proloculus, second chamber (flexostyle), shorter or longer but never exceeding $1/2$ of whorl with inside shape of narrow tube of uniform diameter, third chamber body broader at the beginning and narrowing toward the end, $1/2$ to 1 whorl in length or slightly more, and next chamber bodies initially broadened but beak-like bent then rapidly narrowing toward the end, about $1/2$ of whorl in length.

Each chamber possesses its own walls enclosing the chamber body (presence of "floor" at junction of chambers), walls form extensions, which may cover previous whorls partly or completely (involute tests), or form plate joining chambers with the preceding whorl (evolute). Wall thickness and width of extensions unequal along the whole length of chamber.

Chambers coiled as a rule in one plane but in some cases slightly deviated.

Comparison. — *Praeophthalmidium* Knauff, 1966, the type species of which is *Ophthalmidium orbiculare* Burbach, 1883, differs from the *Ophthalmidium* in rounded or broadly oval tests shape and length of chambers, which is never smaller than one whorl, and the length of second chamber in shape of narrow tube may exceed 4 whorls. It is why it seems unjustified to regard this genus as synonym of *Ophthalmidium* as it is done by Zaninetti & Brönnimann (1969) and Wetzel (1968). Similar objections may be expressed about the genus *Cornuloculina* Burbach, 1886, and *Hauerinella* Schubert, 1920. Both the last mentioned genera stand very close one to another but differ from the *Ophthalmidium* in the length of chambers. Azbel (1971) does not accept *Praeophthalmidium* but only *Cornuloculina* with a type species *Ophthalmidium orbiculare* and maintains that Knauff (1966) has erroneously evaluated the length of the second chamber of the type species which is in fact $2/3$ to $1/2$ of whorl. He regards the genus *Hauerinella* as similar one but possessing the second chamber as long as 2 to 3 whorls. *Eoophthalmidium* Langer, 1968, differs in round shape and irregular length of chambers. Also *Hauerina* d'Orbigny, 1839, cannot be regarded as a synonym because of its different arrangement and shape of chambers and sievelike aperture. *Spiroloculina* d'Orbigny, 1826, is most similar genus but differs from *Ophthalmidium* in possessing an aperture with a tooth and different shape of chamber body, not so strongly wavy and not so rapidly narrowing toward aperture.

Remarks. — The definition of the type species *Ophthalmidium carinatum* Kübler & Zwingli should be specified and the emendation by Wood (1947) should be accepted with such supplement as: the peripheric margins of test are rounded what was already pointed out by MacFadyen (1941), the chambers may be partly involute and the third chamber may be shorter than 1 whorl (Pazdro, 1958). The holotype comes from the Vesulian, i. e.

Upper Bajocian according to the International Terminology and from the Kujavian according to the Polish Classification. Some determinations of the "carinatum" species should be revised. It has been already done by Dain and by Mityanina (1963) in regard to the determinations by Bykova (1948) giving a new name, *O. pseudocarinarum* Dain, instead of previous *O. carinarum* as they correspond to the type form neither in structure nor in age. The same should be done with the determination of this species by Antonova (1958, 1959). Wood and Barnard created (1946) a new species, *O. macfadyeni*, on the basis of forms determined by Mac-Fadyen (1941) as *O. carinarum*. This new species is smaller, more delicate and shows more chambers than the *O. carinarum* proper.

All the species which should be classified to *Ophthalmidium* known from the Triassic and Jurassic are cited in Table 1. Only some very old papers were omitted, the Miliolidae species mentioned in them being described in later publications. Such species as *O. walfordi* Haeusler, *O. triebeli* Franke and *O. bacularis* Issler were omitted as well because of their doubtful systematic position and abnormal appearance. Other species earlier classified to this genus are actually classified to other genera as e. g. *O. orbiculare* Burbach and *O. ovale* Burbach (vide Table 2).

It may be seen in this Table that most forms have been classified as "carinatum" species. This is why its stratigraphic range was so wide. Undoubtedly erroneous determinations are mentioned in brackets and doubtful ones are marked with question mark. Taking into account entirely correct determinations of this species its range can be narrowed to the Bajocian and Bathonian.

Probably many of the species mentioned here will appear to be synonyms under closer examination of their variability.

The differences of synonymy as given by different authors proves that the diagnoses of the species are not clear enough. For example, Pietrzenuk (1961) regards *Spirophthalmidium concentricum* (Terquem & Berthelin) of Franke's paper (1936) and that of Bartenstein & Brand (1937) as synonyms of *Ophthalmidium carinarum* Kübler & Zwingli. Brouwer (1969) includes *O. birmenstorfensis* Kübler & Zwingli and *Spirophthalmidium tenuissimum* Paalzow. Welzel (1968) includes here also *O. northamptonensis* and *O. macfadyeni* Wood & Barnard, whereas Mityanina (1957) includes *Spirophthalmidium carinarum* (Kübler & Zwingli) of Paalzow (1932) into the synonymy of *S. birmenstorfensis* (Kübler & Zwingli).

Possibly Temirbekova (1969) is right raising *Ophthalmidium carinarum porai* Pazdro to the rank of species. *O. carinarum porai*, *O. carinarum terquemi* and *O. carinarum agglutinans* distinguished on the basis of simple statistic methods (Pazdro, 1958) can be easily recognised in other areas thus may be regarded as separate species. The typical *Ophthalmidium carinarum* Kübler & Zwingli best correspond to *O. carinarum agglutinans* Pazdro

form *a* (Pazdro, 1958) as it may be reckoned from a comparison of Polish material with tables and descriptions by Wood (1947). Out of 6 specimens illustrated by him 5 show 9 chambers and only one shows 8 chambers. The holotype fits to the variability of "*agglutinans*" (Figs 9 and 10). Both subspecies agree with the holotype and paratypes in age (Vesulian). But Wood is right stating that there will be no certainty about the affiliation of a given specimen to *O. carinatum* "until a full variational study is made of material from the type locality" (p. 463).

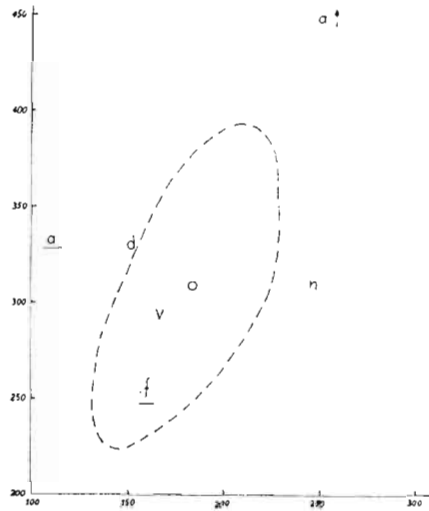


Fig. 8. Point-digram for *Ophthalmidium*. Specimens with 7 chamber. Length indicated by ordinate, width by abscissa, dimensions in microns. Dotted lines encircle the area of variability of *O. carinatum terquemi* Pazdro with median "o", *O. carinatum agglutinans* Pazdro with median "X" and *O. carinatum porai* Pazdro with median "+". Other species indicated as: a *O. areniforme* (Bykova 1948) — figure, a — text; b *O. sagittum* (Bykova 1948); c *O. carinatum* Kübler & Zwingli (after Wood 1947); d *O. cf. birmenstorfensis* Kübler & Zwingli (after Cordey 1962); e *O. caucasicum* (Antonova) (after Danitch 1971); f *O. infraoolithicum* (Terquem) (after Danitch), f (after Temirbekova 1969); g *O. concentricum* (Terquem & Berthelin) (after Mamontova 1956); h *O. minimum* (Wiśniowski) after Danitch; i *O. inopinatum* (Wood & Barnard 1946); j *O. romanovi* (Danitch); k *O. kaptarenkoae* (Danitch); l *O. clarum* (Antonova) after Danitch; m *O. macfadyeni* Wood & Barnard; n *O. northamptonensis* Wood & Barnard; p *O. obscurum* (Ivanova) after Danitch; r *O. saratensis* (Danitch); s *O. strumosum* (Gümbel) after E. Seibold & I. Seibold, 1956; s after Gordon 1965; t *O. stufiensis* (Paalzow); u *O. paraminima* (Ivanova & Danitch) after Danitch; v *O. ivanovae* (Danitch); y *O. subtilis* (Danitch); z *O. cochlear* Danitch.

Measurements of the species of *Ophthalmidium* from the literature of adequate quality of illustrations as compared to those of the vicinity of Czeŝochowa (Pazdro, 1858) are presented on the attached diagrams (Text-figs 8—12). The paper by Danitch (1971) was the best one in this respects. It is a pity he did not investigate the variability ranges which makes comparisons difficult.

The following species mentioned by Danitch (op. cit.) are very close or identical to the Polish subspecies: *Spirophthalmidium caucasicum* Antonova (Pl. XXXIII, Fig. 7) and *S. kaptarenkoae* Danitch with the *Ophthalmidium*

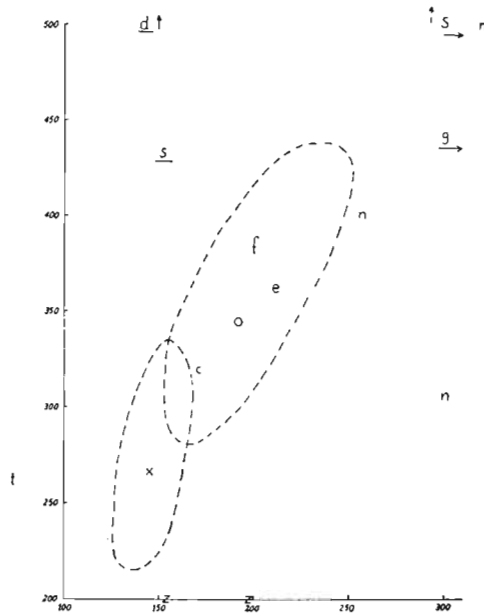


Fig. 9. Point diagram for *Ophthalmidium*. Specimens with 8 chambers. Explanations as for Text-fig. 8.

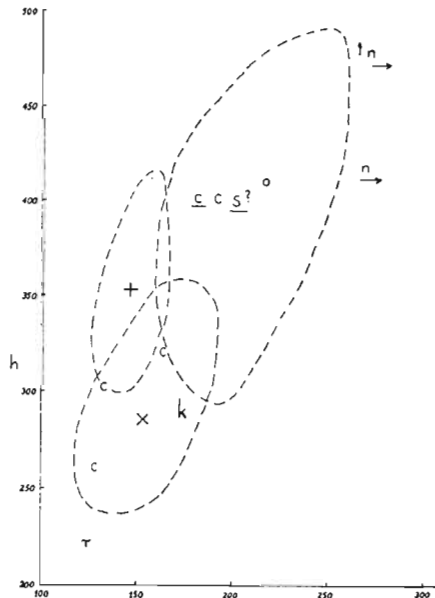


Fig. 10. Point diagram for *Ophthalmidium*. Specimens with 9 chambers. Explanations as for Text-fig. 8.

carinatum agglutinans Pazdro (Pl. XXXIV, Fig. 3), *Spirophthalmidium clarum* Antonova, *S. romanovi* Danitch and *S. subtilis* Danitch with the *Ophthalmidium carinatum porai* Pazdro, and *Spirophthalmidium ivanovae* Da-

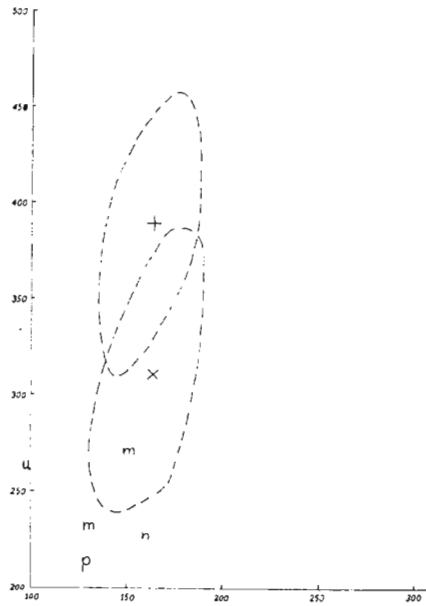


Fig. 11. Point diagram for *Ophthalmidium*. Specimens with 10 chambers. Explanations as for Text-fig. 8.

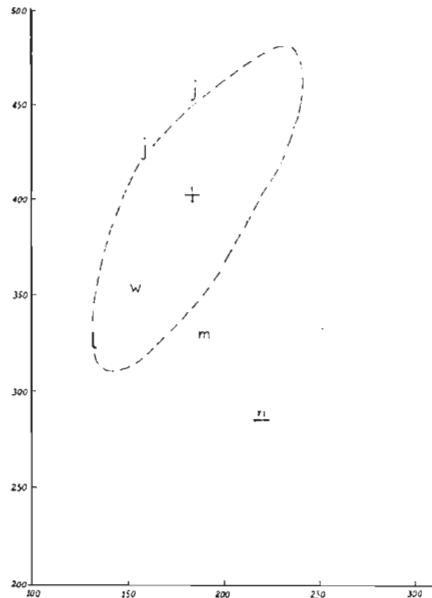


Fig. 12. Point diagram for *Ophthalmidium*. Specimens with 11 chambers. Explanations as for Text-fig. 8.

nitch with the *Ophthalmidium carinatum terquemi* Pazdro, which are concordant even within the range limited to the Upper Bajocian. Other species of "*Spirophthalmidium*" described by Danitch differ greatly both in dimensions and other characters (e. g. sharp peripheric margin).

Differences between the species of the Polish Jurassic and some other ones were dealt with in previous paper (Pazdro, 1958). *Ophthalmidium cochlear* Danitch is similar to *O. northamptonensis* Wood & Barnard but it is considerably smaller.

Distribution.— According to Azbel (1971) *Ophthalmidium* occurs in the Triassic and Jurassic and *Spirophthalmidium* is a recent form. According to those authors who regard *Spirophthalmidium* a synonymy of *Ophthalmidium* this genus ranges from the Triassic to recent times. It seems that Azbel is right, but this must be proved by detailed investigations of recent material and phylogenetic connections with older forms should be studied as well.

Genus *Palaeomiliolina* Loeblich & Tappan, 1964

The authorship of this name and the type species are questionable. Loeblich & Tappan (1964) maintained that Antonova did not present a type species thus the authorship should legally belong to them. In fact Antonova (1959) did present the type species, *Spirophthalmidium monstruosum* Bykova, hence the authorship should belong to her, although she mentions Bogdanovitch as an author. The latter author mentioned this name as a hypothetical one, not based on any species.

In any case both type species have been classified previously by their authors to *Spirophthalmidium* (*Ophthalmidium* in present concept), which points to a great similarity of both genera, although later on they were classified to different families (Loeblich & Tappan, 1964).

The type species *Spirophthalmidium monstruosum* selected by Antonova (1959) was a subject of a detailed study by Azbel (1970), who has for her disposal 85 specimens from the original collection of Bykova. In result of her investigations this author classified this species to *Ophthalmidium*. She did not observe the varying planes of chamber arrangement, but a great variability and numerous specimens with anomalous changes of coiling plane. Such anomalies may be observed also among other species of *Ophthalmidium* (Pazdro, 1958; Trifonova, 1970). Many authors admit deviations from planispirality in *Ophthalmidium* (Bykova, 1948; Bogdanovitch, 1952; Pazdro, 1958) although not to such an extent as it is done by Zaninetti & Brönnimann (1969). Such forms undoubtedly constitute transitions inbetween both genera.

In the light of the above it seems justified to regard *Spirophthalmidium occultum* Antonova 1958 as a type species for *Palaeomiliolina* Loeblich & Tappan, 1964. An assignment of this genus to another family than *Oph-*

thalmidium seems to be groundless. The mineral composition, microstructure of wall, shape of chambers and their bodies and connections between them, shape of aperture are identical in both genera. They differ in distinct, and constant coiling in varying planes, chamber arrangement of *Palaeomiliolina* (Pl. XXXIII, Figs 8—9; Pl. XXXIV, Figs 5—6).

A reversion to assign those forms to the genus *Quinqueloculina* or *Sigmolilina* or *Massilina* as it was done by Danitch (1971) does not seem to be justified. The latter author has even the type species of *Palaeomiliolina* included to *Quinqueloculina*. These genera differ in the character of aperture, shape of chamber body and mode of junction. Nevertheless, all the described genera belong to a great family Miliolidae.

The genus *Paleomiliolina* was common in the Jurassic. Some species which may be classified to *Quinqueloculina* d'Orbigny because of the development of a tooth in the aperture, as e. g. *Q. jurassica* Bielecka & Styk, 1966, begun to appear in the Upper Jurassic.

Spiroloculina michalskii Wiśniowski and *S. difficilis* Wiśniowski are transitional forms between the genera *Ophthalmidium*, *Spiroloculina* and *Massilina*, what was mentioned by Bielecka (1960). In the light of the above considerations they should be classified to *Palaeomiliolina*, although Lutze (1960) has classified them to *Ophthalmidium*.

The concept of *Palaeomiliolina* should be precised as follows:

Genus *Palaeomiliolina* Loeblich & Tappan, 1964

Type species: *Spirophthalmidium occultum* Antonova, 1958

Diagnosis. — Tests oval, proloculus spherical, second chamber in shape of narrow tube of uniform diameter (flexostyle), the following chambers with chamber bodies broader at base and narrowing toward aperture similar to chambers of *Ophthalmidium*, as long as 1/2 of whorl, in varying planes, sigmoidally, or quinqueloculine-like coiled. In transversal section the tests are almost triangular or ellipsoidal with one side more convex than the other. Chambers form own walls, with "floors" as in *Ophthalmidium*. Peripheric margins may be rounded or sharp, even keeled. Terminal apertures simple, round without tooth, on short neck, surrounded frequently with phialine lip.

Comparison. — The genus in question differs from *Quinqueloculina* d'Orbigny, 1826, *Sigmolilina* Schlumberger, 1887 and from *Massilina* Schlumberger, 1893, first of all in lack of tooth in aperture, in shape of chamber bodies and their junctions, and in less constant arrangement of chambers. Many Jurassic forms classified by various authors to *Quinqueloculina* belong rather to abnormal regenerated ophthalmides.

Remarks. — The species known from the Triassic and Jurassic which should be classified to *Palaeomiliolina* are listed in Table 3. As it is the case of *Ophthalmidium*, here also many species need a revision and re-

search using modern methods. Unfortunately the study of variability range of the species of *Palaeomiliolina* is more difficult than that of *Ophthalmidium*, because counting of the number of chambers is impossible without previous sectioning of almost each specimen. For comparative reasons a scatter diagram of *Palaeomiliolina czestochowiensis* and *P. raviensis* (Pazdro, 1959) is presented regardless of the number of chambers (Text-fig. 13). The dimensions of some specimens of species sufficiently clearly pre-

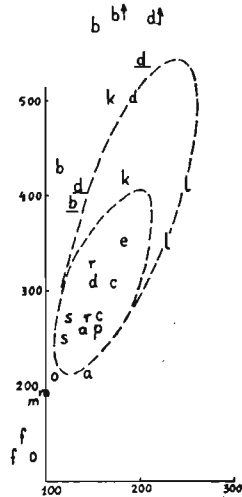


Fig. 13. *Palaeomiliolina*, point diagram, length indicated by ordinate, width by abscissa, dimensions in microns. Dotted lines encircle the area of variability of *P. czestochowiensis* and *P. raviensis* (Pazdro) after Pazdro 1959. Other species indicated as: *a* *P. calloviana* (Danitch 1971); *b* *P. michalski* (Wiśniowski) after Bielecka 1960, *b* after Wiśniowski 1890; *c* *P. czestochowiensis* (Pazdro) after Danitch 1971; *d* *P. difficilis* (Wiśniowski) after Bielecka 1960, *d* after Wiśniowski 1890; *e* *P. dorsetensis* (Cifelli, 1959); *f* *P. frumenta* (Danitch); *k* *P. costata* (Danitch), *l* *P. moldaviensis* (Danitch), *m* *P. micra* (Danitch), *o* *P. occulta* (Danitch), *p* *P. pruniformis* (Danitch), *r* *P. raviensis* (Pazdro) after Danitch, *s* *P. nodosa* (Danitch).

sented in the literature are plotted as well. The best descriptions and illustrations are given by Danitch (1971) and this paper was the main source of data.

Undoubtedly many species will appear to be synonyms under closer investigation. *Palaeomiliolina calloviana* (Danitch), *P. occulta* Antonova and *P. frumenta* (Azbel and Danitch) are very close to *P. raviensis* (Pazdro) in external appearance but usually smaller. *P. dorsetensis* (Cifelli) agrees with it in appearance and dimensions.

More species are similar to *P. czestochowiensis* (Pazdro). These are *P. costata* Antonova, *P. moldaviensis* (Danitch) and *P. pruniformis* (Danitch). It should be mentioned, however, that *P. raviensis* (Pazdro) in Danitch's paper (1971) is rather *P. czestochowiensis* (Pazdro) because of sharp peripheric margins, whereas those of *P. raviensis* are rather rounded.

The specific name "*jurassica*" of the last mentioned paper was given to forms classified by Danitch to *Massilina*, actually to *Palaeomiliolina*, may lead to controversies such as e. g. being taken for a homonym of *Quinqueloculina jurassica* Bielecka & Styk, 1966. It seems, however, that the existence of a tooth in the latter form allows to classify them to the proper *Quinqueloculina*. *Massilina jurassica* Danitch has no tooth and may be assigned to *Palaeomiliolina*, particularly so because the former genus is regarded as a synonym of *Quinqueloculina* by many authors. Many Triassic and Jurassic species of "*Quinqueloculina*" and "*Triloculina*" created by older authors are omitted here because in most cases they are so dimly defined that their systematic position is highly doubtful.

Distribution. — According to Antonova (1958, 1959) *Palaeomiliolina* occurs from the Bajocian up to the Kimmeridgian, but it seems probable that it has appeared already in the Triassic.

Table 1

Stratigraphical distribution of the genus *Ophthalmidium* in Triassic and Jurassic systems
(Middle Jurassic stratigraphy as that of international nomenclature)

Species	Distribution	Triassic	Liasic	Bajocian	Bathonian	Callovian	Oxfordian	Kimmeridgian
<i>O. longiscatum</i> Terquem & Berthelin (<i>Spiroloculina</i> 30)		30						
<i>O. triadicum</i> (Kristan) (<i>Spirophthalmidium</i> 29)		29						
<i>O. triadicum</i> (Langer) + (<i>Sigmoilina</i> 32)		32						
<i>O. granum</i> Styk (49)		49						
<i>O. aspera</i> "Terquem & Berthelin" (<i>Spiroloculina</i> 3)			3					
<i>O. lateseptatum</i> (Burbach) (1; <i>Spirophthalmidium</i> 3, 17)			1, 3, 17					
<i>O. mamontovae</i> (Antonova & Kalugina) (<i>Spirophthalmidium</i> 1)			1					
<i>O. minutum</i> Fuchs 19			19					
<i>O. macfadyeni</i> Wood & Barnard (57)			57					
<i>O. northamptonensis</i> Barnard & Wood (57)			57					
<i>O. nubeculariformis</i> Haesler (52, 57)			52,					

cont. Table 1

Species	Distribution	Trias- sic	Lias- sic	Bajo- cian	Batho- njan	Callo- vian	Oxfor- dian	Kimme- ridgian
<i>O. concentricum</i> (Terquem & Berthelin) (<i>Spirophthalmidium</i> 1, 3, 13, 17, 18, 36, 46, 47)			1, 3, 17, 18, 36, 46	3, 18	13, 3, 18	47, 3		47?
<i>O. carinatum</i> Kübler & Zwingli (10, 23, 31, 35, 40, 45, 50, 51, 52, 56, 59; <i>Spirophthalmidium</i> 11, 18, 24, 25, 41; <i>Palaemiliolina</i> 1)			10? 35? 45? 52?	18, 31, 40, 44, 50, 51, 56	18, 31, 44, 50, 51	18? 31? 59?	"1", 18? "11", 23? "24", "25", "41"	"1". "24", "25"
<i>O. carinatum terquemi</i> Pazdro (8, 42, 44)				8, 42, 44	8, 42, 44, 22			
<i>O. carinatum agglutinans</i> Pazdro (8, 42, 44; <i>Spirophthalmidium</i> 22)				8, 42, 44, 22	8, 42, 44, 50			
<i>O. carinatum porai</i> Pazdro (8, 42, 44; <i>O. porai</i> 50)				8, 42, 44, 50	24, 16, 50			
<i>O. infraoolithicum</i> (Terquem) (50; <i>Spirophthalmidium</i> 1, 24, 25, 16)				1, 24, 25, 16, 50	24, 16, 50			
<i>O. caucasicum</i> (Antonova) (50; <i>Spirophthalmidium</i> 1, 16, 24)				1, 16, 25, 50	1, 16, 24, 50			
<i>O. clarum</i> (Antonova) (50; <i>Spirophthalmidium</i> 1, 16, 24)				1, 16, 24, 50	1, 16, 24, 50			
<i>O. cochlear</i> Danitch (16)				16	16			
<i>O. saratensis</i> (Danitch) (<i>Spirophthalmidium</i> 16)				16	16			
<i>O. obscurum</i> (Danitch) (<i>Spirophthalmidium</i> 16)				16	16			
<i>O. protensis</i> (Danitch) (<i>Spirophthalmidium</i> 16)				16	16			
<i>O. romanovi</i> (Danitch) (<i>Spirophthalmidium</i> 16)				16	16			
<i>O. paraminima</i> (Ivanova & Danitch) (<i>Sigmoilina</i> 16)				16	16			
<i>O. ivanovae</i> (Danitch) (<i>Spirophthalmidium</i> 16)				16				
<i>O. angustum</i> (Kasimova) (<i>Ophthalmidium</i> 26)				26				
<i>O. negricus</i> (Kasimowa) (26)				26				
<i>O. postconcentricum</i> (Kasimowa) (<i>Spirophthalmidium</i> 26)				26				

cont. Table 1

Species	Distribution	Triassic	Liasic	Bajocian	Bathonian	Callovian	Oxfordian	Kimmeridgian
<i>O. strumosum</i> (Gümbel) (21, 23, 34, 39, 48, 54; <i>Spirophthalmidium</i> 4)							4, 21, 34, 39, 48	23, 34, 54
<i>O. stufense</i> (Paalzow) (54; <i>Spirophthalmidium</i> 16, 18, 15, 22, 25, 4, 37, 41)							4, 15, 16, 18, 22, 25, 37, 41,	16, 54
<i>O. tenuissimum</i> (Paalzow) (54; <i>Spirophthalmidium</i> 4, 16, 18, 36, 41)							4, 16, 18, 36, 41	54
<i>O. subpandum</i> (Lloyd) (<i>Spiroloculina</i> 33)								33

Explanations to tables 1—3: arabic numbers refer to paleontological and stratigraphical papers, ? — doubtful determinations, “ ” — erroneous determinations, + — homonyms.

1—Z. Antonova 1958, 1959, 1961; 2—A. Azbel 1970, 1971; 3—H. Bartenstein & E. Brand 1937; 4—M. Bastien & J. Sigal 1962; 5—W. Bielecka 1960; 6—W. Bielecka & O. Styk 1966; 7—W. Bielecka & O. Styk 1967, 1968; 8—W. Bielecka & O. Styk 1969; 9—W. Bielecka & Kuznetzova 1969; 10—J. Brouwer 1969; 11—E. Bykova 1948; 12—T. Chabarova 1961; 13—R. Cifelli 1959; 14—W. Cordey 1962; 15—L. Dain 1961; 16—M. Danitch 1971; 17—A. Franke 1936; 18—K. Frentzen 1941; 19—W. Fuchs 1970; 20—J. Garbowska 1970; 21—W. Gordon 1965; 22—A. Grigelis 1961, 1971; 23—J. Groiss 1966, 1967; 24—E. Hoffman 1967; 25—O. Kaptareko-Tschernousova 1963; 26—H. Kasimowa & D. Aleva 1967; 27—W. Knauff 1966; 28—L. Koehn-Zaninetti 1969; 29—E. Kristan 1957; 30—E. Kristan-Tollman 1964; 31—J. Kübler & H. Zwingli 1870; 32—W. Langer 1968; 33—A. Lloyd 1962; 34—G. Lutze 1960; 35—M. Macfadyen 1941; 36—E. Mamontova 1956; 37—P. Michailova & E. Trifonova 1967; 38—J. Mitjanina 1957, 1963; 39—H. Österle 1968; 40—R. Paalzow 1922; 41—R. Paalzow 1917, 1932; 42—O. Pazdrowa 1958; 43—O. Pazdrowa 1959; 44—O. Pazdrowa 1960; 45—E. Pietrzenuk 1961; 46—Ch. Rouget & J. Sigal 1970; 47—R. Said & M. Barakat 1958; 48—E. Seibold & I. Seibold 1955, 1956, 1960; 49—O. Styk 1972; 50—U. Temirbekova 1969; 51—E. Trifonova 1970; 52—E. Wezel 1968; 53—R. Wernli 1971; 54—B. Winter 1970; 55—T. Wiśniowski 1890; 56—A. Wood 1947; 57—A. Wood & T. Barnard 1946; 58—L. Zaninetti & P. Brönnimann 1969; 59—J. Ziegler 1959.

Table 2

Stratigraphical distribution of the genus *Praeophthalmidium* Knauff, 1966 *)

Species	Distribution	Triassic	Liassic
<i>P. orbiculare</i> (Burbach) (27, 45, <i>Ophthalmidium</i> 1, 3, 10, 17, 18, 52)			1, 3, 10, 17, 18, 27, 45, 52
<i>P. ovale</i> (Burbach) (27, (<i>Ophthalmidium</i> 3, 10, 17, 52)			3, 10, 17, 27, 52
<i>P. exiguum</i> Koehn-Zaninetti (<i>Ophthalmidium</i> 28, 57)		28, 57	

*) Explanations — see Table 1

Table 3

Stratigraphical distribution of the genus *Palaeomiliolina* in the Jurassic and Triassic systems *

(Middle Jurassic stratigraphy as that of international nomenclature)

Species	Distribution	Triassic	Liasic	Bajocian	Bathonian	Callovian	Oxfordian	Kimmeridgian
? <i>P. tori</i> (Zaninetti & Bronnimann) (<i>Ophthalmidium</i> 58)		58						
? <i>P. inconstans</i> (Terquem) 19			19					
<i>P. nucleiformis</i> (Kristan Tolmann) (<i>Quinqueloculina</i> 19, 30)		30	19					
<i>P. czestochowiensis</i> (Pazdro) (8, 53; <i>Miliolina</i> 43, 44; <i>Quinqueloculina</i> 16)					8, 16, 16, 43, 43, 44, 44, 53 53			
<i>P. rawiensis</i> (Pazdro) (8, 53; <i>Mi- liolina</i> 43, 44; <i>Quinqueloculina</i> 16)				16, 43, 44, 53	8, 43, 44, 16			
<i>P. occulta</i> Antonova (1; <i>Spiroph- thalmidium</i> 1, <i>Quinqueloculina</i> 16)				1, 16	1, 16			
<i>P. micra</i> Antonova (1; <i>Sigmoilina</i> 16)				1, 16	1, 16			
<i>P. compressa</i> (Terquem & Berthe- lin) (<i>Quinqueloculina</i> 47)				47	47			
<i>P. dorsetensis</i> (Cifelli) (<i>Massilina</i> 13)					13			
<i>P. pruniformis</i> (Danitch) (<i>Sigmoi- lina</i> 16)				16	16			
<i>P. amphoroidale</i> (Danitch) (<i>Sig- moilina</i> 16)				16	16			
<i>P. quinqueluculinoides</i> (Danitch) (<i>Sigmoilina</i> 16)						16		
<i>P. deprimata</i> (Danitch) (<i>Sigmoili- na</i> 16)						16		
<i>P. nodosa</i> (Danitch) (<i>Sigmoilina</i> 16)						16		
<i>P. calloviana</i> (Danitch) (<i>Sigmoili- na</i> 16)						16		
<i>P. costata</i> Antonova (1; <i>Sigmoilina</i> 16; <i>Spirophthalmidium</i> 24)						1, 16, 24		
<i>P. jurassica</i> (Danitch) (<i>Massilina</i> 16)						16		

cont. Table 3

Species	Distribution	Trias- sic	Lias- sic	Bajo- cian	Batho- nian	Callo- vian	Oxford- ian	Kimme- ridgian
<i>P. kanevi</i> (Kaptarenko) (<i>Spirophthalmidium</i> 25)						25		
<i>P. difficilis</i> (Wiśniowski) (<i>Spiroloculina</i> 5, 55)						5, 55	5	
<i>P. michalski</i> (Wiśniowski) (<i>Spiroloculina</i> 5, 55; <i>Ophthalmidium</i> 34, 37)						5, 34, 37, 55	5, 34	
<i>P. semisphaeroidalis</i> (Danitch) (<i>Quinqueloculina</i> 16)							16	
<i>P. frumenta</i> (Azbel & Danitch) (<i>Quinqueloculina</i> 16)							16	
<i>P. fussiformis</i> (Danitch) (<i>Sigmoilina</i> 16)							16	
<i>P. microcostata</i> (Danitch) 16)							16	
<i>P. egmontensis</i> (Lloyd) (<i>Quinqueloculina</i> 23, 33)								23, 33

* Explanations — see Table 1

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OLGA PAZDRO

UWAGI O RODZAJACH *OPHTHALMIDIUM* I *PALAEOMILIOLINA*
(FORAMINIFERIDA)

Streszczenie

W literaturze z ostatnich lat stwierdzono wiele sprzeczności w ujmowaniu niektórych gatunków otwornic przez różnych autorów. W 1969 r. ukazały się dwie prace Temirbekovej na temat rodzaju *Ophthalmidium* Kübler & Zwingli, 1870, w których rodzaj ten jest ujęty bardzo wąsko. Za przynależne do tego rodzaju uważa ona tylko te gatunki, które mają skorupki zwinięte planispiralnie, mają następną po prolokulusie komorę długą na 1/2 do 1/3 skrzętu, trzecią na 1 i 1/3 skrzętu, dalsze po 1/2 skrzętu. W tym samym roku zupełnie odmienną emendację rodzaju podają Zaninetti & Brönnimann. Autorzy ci ujmują rodzaj *Ophthalmidium* bardzo szeroko uznając za jego synonimy rodzaje *Hauerina*, *Cornuloculina*, *Hauerinella*, *Spirophthalmidium*, *Eophthalmidium*. Uważają, że długość komór u tego rodzaju może być rozmaita, a ich ułożenie kłębkowate.

Danitch (1971) przyjmuje, że rodzaj *Ophthalmidium* ma wszystkie komory ułożone planispiralnie i poza pierwszymi dwiema, tj. prolokulusem i fleksostylem wszystkie dłuższe niż 1/2 skrzętu. Wyróżnia osobno rodzaj *Spirophthalmidium* i podaje, że tu tylko trzecia komora (druga według jego numeracji) może mieć długość pełnego skrzętu, a wszystkie następne 1/2 skrzętu. Również Azbel (1971) odróżnia rodzaj *Ophthalmidium* od *Spirophthalmidium* głównie na podstawie trzeciej komory (też oznaczając ją jako drugą), ale uważa, że ma ona u *Ophthalmidium* długość od 1/3 do 1 skrzętu, gdy u *Spirophthalmidium* od 2 do 3 skrzętów. Uważa ponadto, że *Ophthalmidium* jest formą triasową i jurajską, a *Spirophthalmidium* dzisiejszą.

Rozbieżności w poglądach różnych autorów dotyczą głównie następujących cech: 1) kształtu prolokulusa (koło lub elipsa), 2) płaszczyzny zwinięcia skorupki, 3) długości komór w stosunku do skrzętu i ich numeracji, 4) sposobu stykania się komór, występowania „mostków”, charakteru inwolucji, 5) mikrostruktury ścianki.

Również rodzaj *Palaeomiliolina* Loeblich & Tappan, 1964 nie jest jednoznacznie

ujmowany przez wszystkich autorów, a nawet przez niektórych nie jest uznawany.

Podstawą zaliczenia obydwóch rodzajów do rodziny Miliolidae było stwierdzenie jednakowej mikrostruktury ścian, bardzo zbliżonej struktury skorupki, jednakowego kształtu wnętrza komór i ujść. Najlepszym dowodem bliskiego pokrewieństwa tych rodzajów jest zaliczanie tych samych gatunków do jednego lub drugiego rodzaju przez różnych autorów (vide Tabele 1, 2, 3). Na tabelach podano w ujęciu stratygraficznym wszystkie gatunki notowane w triasie i w jurze, które były dostatecznie jasno przedstawione w dostępnej literaturze, a które zdaniem obecnej autorki należy zaliczyć do omawianych rodzajów.

Rodzina Miliolidae

Rodzaj *Ophthalmidium* Kübler & Zwingli, 1870

Gatunek typowy: *Ophthalmidium carinatum* Kübler & Zwingli, 1870, emend. Wood, 1947

Synonimy: *Oculina* Kübler & Zwingli, 1866

Spirophthalmidium Cushman, 1927 (partim)

Diagnoza. — skorupki o zarysie owalnym, wydłużonym, ujście na szyjce, proste, okrągłe, bez zęba, często otoczone wałeczkowatą wargą. Prolokulus kulisty, fleksostyl (druga komora) o prześwicie wąskiej rurki nie przekraczającej 1/2 skrętu; trzecia komora o wnętrzu zwężającym się ku ujściu, długości od 1/2 do 1 skrętu lub nieco więcej; następne komory o wnętrzu w początkowej części rozszerzonym, ale dziobowato wyciągniętym, oraz raptownie zwężającym się ku ujściu, długości około 1/2 skrętu. Każda komora ma swe własne ściany otaczające jamę komory, tworzące wypustki, które mogą przykrywać wcześniej powstałe skręty całkowicie lub częściowo, lub tworzyć płytkę łączącą komory z poprzednim skrętem. Grubość ścian i szerokość wypustek nie są jednakowe na całej długości komory. Zasadniczo komory są zwinięte w jednej płaszczyźnie, ale mogą być z niej lekko wychylone.

Porównanie. — Rodzaj *Praeophthalmidium* Knauff, 1966, różni się od rodzaju *Ophthalmidium* kolistym lub szeroko owalnym zarysem skorupki i długością komór, które nigdy nie są krótsze niż 1 skręt, a długość drugiej komory może przekraczać 4 skręty. Rodzaj *Eoophthalmidium* Langer, 1968, ma okrągłe skorupki i nieregularną długość komór. Rodzaj *Hauerinella* Schubert, 1920, ma drugą komorę długą na 2 do 3 skrętów. Rodzaj *Hauerina* d'Orbigny, 1839, ma inny układ i kształt komór, a ujście sitowate. Rodzaj *Cornuloculina* Burbach, 1886, ma drugą komorę długości 2/3 do 1 i 1/2 skrętu (vide Azbel, 1971). Najbardziej podobny morfologicznie jest rodzaj *Spiroloculina* d'Orbigny, 1826, ale ma inny kształt wnętrza komór i ujścia z zębem.

Rodzaj *Palaeomiliolina* Loeblich & Tappan, 1964

Gatunek typowy: *Spirophthalmidium occultum* Antonova, 1958.

Diagnoza. — skorupki o zarysie owalnym. Komora początkowa kulista; druga komora wykształcona jako wąska rurka; następne komory mają wewnętrzne rozszerzone w początkowej części, zwężające się ku ujściu, podobne do komór *Ophthalmidium*,

długość 1/2 skrętu, zwinięte są kłębkowato, sigmoidalnie lub kwinkwelokulinowo. W przekroju poprzecznym zarys skorupki jest zbliżony do trójkąta lub elipsy o jednej stronie bardziej wypukłej niż druga. Komory mają „podłogi” jak *Ophthalmidium*. Ujście terminalne, proste, okrągłe bez zęba, położone na krótkiej szyjce, otoczone często wałeczkowatą wargą.

Porównanie. — Rodzaje *Quinqueloculina* d'Orbigny, 1926, *Sigmoilina* Schlumberger, 1887, *Massilina* Schlumberger 1893 mają zęby w ujściach, inny kształt wnętrza komór i ich połączeń i bardziej stałe ich ułożenie.

ОЛЬГА ПАЗДРО

ПРИМЕЧАНИЯ НА ТЕМУ ФОРАМИНИФЕР РОДА *OPHTHALMIDIUM* И РОДА *PALAEOMILIOLINA*

Резюме

В литературе последних лет было высказано много противоречивых взглядов относительно распространения некоторых видов фораминифер. В 1969 г. появились две работы Темирбековой на тему рода *Ophthalmidium*, в которых этот род рассматривается очень узко. Указанный автор относит к нему единственно такие виды, у которых раковинка свернута планиспирально, а длина следующей за пролокулюм камеры составляет 1/2 до 1/3 оборота, длина третьей камеры 1 и 1/3 оборота, а длина дальнейших — по 1/2 оборота. В том же году совершенно другую трактовку рода *Ophthalmidium* представили Занинетти и Брэнниманн. Они рассматривают этот род очень широко и его синонимами считают роды *Hauerina*, *Cornuloculina*, *Hauerinella*, *Spirophthalmidium*, *Praeophthalmidium*, *Eoophthalmidium*. По мнению этих авторов, длина камер у этого рода может быть разная, а их расположение клубкообразное.

Денич (1971) считает, что у рода *Ophthalmidium* все камеры располагаются планиспирально и, кроме двух первых — пролокулюма и флексоцилия, они длиннее 1/2 оборота. Этот автор рассматривает отдельно род *Spirophthalmidium* и указывает, что у него единственно третья камера (вторая по счету этого автора) может достигать длину полного оборота, а все остальные 1/2 оборота. Также и Азбел (1971) различает виды *Ophthalmidium* и *Spirophthalmidium*, главным образом по третьей (тоже считая ее второй) камере, однако он принимает, что у *Ophthalmidium* длина этой камеры составляет от 1/3 до 1 оборота, а у *Spirophthalmidium* — от 2 до 3 оборотов. Кроме того, он считает, что *Ophthalmidium* является триасовой и юрской формой, а *Spirophthalmidium* современной формой.

Противоречия во взглядах разных авторов касаются, главным образом, следующих признаков: 1) форма пролокулюма (круг или эллипс), 2) плоскость навивания раковины, 3) длина камер по отношению к обороту и их нумерация, 4) способ соприкосновения камер, наличие „мостиков”, характер инволютности, 5) микроструктура стенки.

Род *Palaeomiliolina* тоже вызывает разногласия у разных авторов, а некоторые из них и вовсе отрицают его выделение.

Отнесение рассматриваемых двух родов к семейству Miliolidae основывается на одинаковой микроструктуре стенок, очень сходной структуре раковин, одинаковой форме внутренних полостей камер и устьев. Лучшим доказательством близкого сходства этих родов является тот факт, что одни и те же виды разными авторами относятся то к одному, то к другому роду. (см. таблицы 1, 2, 3). В таблицах приведены в стратиграфической последовательности все виды, отмеченные в триасе и юре и довольно четко охарактеризованные в доступной литературе, которые, по мнению автора, относятся к рассматриваемым родам.

На основании детального изучения обильной милиолидовой фауны доггера Польши, главным образом из окрестностей г. Ченстохова, ознакомления с литературой и сравнительным материалом из разных стран, предлагается принять следующий порядок определения родов.

Семейство Miliolidae

Род *Ophthalmidium* Kübler & Zwingli, 1870

Типовой вид: *Ophthalmidium carinatum* Kübler & Zwingli, 1870, emend. Wood, 1947.

Синонимы: *Oculina* Kübler & Zwingli, 1866

Spirophthalmidium Cushman, 1927 (partim)

Диагноз. — Раковинки овальной, удлинённой формы, устье на шейке, простое, округлое, без зуба, часто окаймленное валикообразной губой. Пролокулюм шарообразный, флексогиль (вторая камера) с просветом узкой трубки, не превышающей 1/2 оборота; третья камера, сужающаяся к устью, длиной от 1/2 до 1 оборота или немногим больше; следующие камеры с внутренней полостью вначале расширенной, но клювообразно вытянутой, потом резко сужающейся к устью, длиной около 1/2 оборота. Все камеры обладают собственными стенками, охватывающими полость камеры, образующие оборки, которые полностью или частично перекрывают ранее образованные обороты или пластинки, соединяющие камеру с предыдущим оборотом. Толщина стенок и ширина оборок неодинаковы по всей длине камеры. Как правило, камеры свернуты в одной плоскости, но могут слегка отклоняться.

Сравнение. Род *Praeophthalmidium* Knauff, 1966 отличается от рода *Ophthalmidium* шарообразным или широким овальным очертанием раковины и длиной камер, которые всегда длиннее 1 оборота, а длина второй камеры может превышать 4 оборота. Род *Еоophthalmidium* Langer, 1968 характеризуется округлой раковинкой и нерегулярной длиной камер. Род *Hauerinella* Schubert, 1920 характеризуется длиной второй камеры на 2 до 3 оборотов. Род *Hauerina* d'Orbigny, 1839 отличается другим расположением и формой камер и обладает решетчатым устьем. У рода *Cornuloculina* Vurbach, 1886 длина второй камеры 2/3 до 1 и 1/2 оборота (Азбел, 1971). Наибольшее морфологическое сходство проявляет род *Spiroloculina* d'Orbigny, 1826, но отличается другой формой полости камер и устьем с зубом.

Род *Palaeomiliolina* Loeblich & Tappan, 1964

Типовой вид: *Spirophthalmidium occultum* Antonova, 1958.

Диагноз. — Раковины овального очертания. Начальная камера шарообразная, вторая камера в виде узкой трубки, следующие камеры расширенные в началь-

ной части, сужаются к устью. Они сходны с камерами *Ophthalmidium*, характеризуются длиной 1/2 оборота, свернуты по клубкообразному, сигмоидальному или квинквелокулиновому типу. В поперечном сечении раковина имеет очертание близкое к треугольнику или эллипсу, с одной стороной более выпуклой чем вторая. В камерах наблюдается „пол”, как у *Ophthalmidium*. Устье терминальное, простое, округлое без зуба, располагается на короткой шейке, окружено часто валикообразной губой.

Сравнение. — Роды *Quinqueloculina* d'Orbigny, 1926, *Sigmoilina* Schlumberger, 1887, *Massilina* Schlumberger, 1893 обладают зубами в устьях, характеризуются другой формой полости камер и их соединений, а также более выдержанным их расположением.

EXPLANATION OF PLATES

Plate XXXIII

Ophthalmidium carinatum terquemi Pazdro, 1958

Częstochowa region, Dogger

- Fig. 1. *a, b*, normal specimens in reflected light ca. 105×; 0-72/22a, *b*.
 Fig. 2. abnormal specimen in reflected light; ca. 105×; 0-72/22c.
 Fig. 3. abnormal specimens, ca. 50×; 0-72/22e.
 Fig. 4. axial thin section, crossed nicols, ca. 420×; 0-72/2.

Ophthalmidium carinatum agglutinans Pazdro, 1958

Częstochowa region, Dogger

- Fig. 5. normal specimen in reflected light, ca. 105×; 0-72/22d.
 Fig. 6. axial thin section, crossed nicols, ca. 450×; 0-72/5.

Ophthalmidium caucasicum (Antonova, 1959)

USSR, Dogger

comparison material

- Fig. 7. Specimen in reflected light; ca. 170×; 0-72/9.

Palaeomiliolina rawiensis (Pazdro, 1959)

- Fig. 8. axial thin section, crossed nicols, ca. 450×; 0-72/4.

Palaeomiliolina czestochowiensis (Pazdro, 1959)

- Fig. 9. axial thin section, crossed nicols, ca. 320×; 0-72/17.

Plate XXXIV

Ophthalmidium carinatum agglutinans Pazdro, 1958

Częstochowa region, Dogger

Fig. 1. slightly damaged specimen, ca. 500×; 0-72/7a.

Fig. 2. regenerated specimen, ca. 270×; 0-72/7b.

Fig. 3. normal specimen, ca. 155×; 0-72/3.

Ophthalmidium sp.

Pieniny Mountains, near Szczawnica, Aalenian

Fig. 4. recrystallized specimen, ca. 270×; 0-72/12.

Palaeomiliolina rawiensis (Pazdro, 1959)

Częstochowa region, Dogger

Fig. 5. normal specimen, ca. 360×; 0-72/16.

Palaeomiliolina czestochowiensis (Pazdro, 1959)

Częstochowa region, Dogger

Fig. 6. normal specimen, ca. 315×; 0-72/20.

All figures — optical sections in transmitted light

