

Diatoms *Bolewskia reymanownae* gen. nov. et sp. nov., *Protorhaphoneis stanislai* gen. nov. et sp. nov., and *Xanthiopyxis polonica* sp. nov. from the Przeworno marbles in Poland

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ABSTRACT. Preliminary reports (Kwiecińska & Siemińska 1973, 1974, Siemińska 1980, 1981) on diatom and other remnants found in the graphitic marble layers in Przeworno (Lower Silesia, Poland) are now followed by detailed description of three selected diatom species found there. As the Przeworno marbles are Proterozoic this discovery shifts the age of diatoms by ca. 430 million years from the Middle Cretaceous.

KEY WORDS: fossil diatoms, Bacillariophyceae, Proterozoic, Lower Silesia

INTRODUCTION

One of the authors (B. K.) has studied the morphology of graphite crystals in hundreds of samples taken from various kinds of rocks in Poland. Some years ago, in two black marble layers in the white marble quarry at Przeworno (50°41'N, 17°11'E) near Strzelin (Lower Silesia) she found – at first by chance – some minute remains of diatoms revealed by transmission electron microscope (TEM). She then spent many hours searching patiently, but successfully, for more specimens.

Proterozoic age of the marbles was confirmed by Oberc (1966, 1975) on the basis of geology and tectonics; Professor Oberc still maintains his opinion. Previously, these marbles were regarded by Bederke (1935) as Middle or Lower Devonian because they sink under the well dated Middle or Lower Devonian Layers of Jegłowa.

So far only preliminary reports have been published on the diatom fragments and other nanofossils found (Kwiecińska & Siemińska 1973, 1974, Siemińska & Kwiecińska 1976, Siemińska et al. 1980, Siemińska 1980, 1981). Then, the second author (J. S.) searched for com-

parable specimens through special publications and many phycological, micropaleontological, paleontological and geological journals, and compared illustrations in the rich Iconotheca of Algae collection (W. Szafer Institute of Botany, Polish Academy of Sciences, Kraków). Now, the two authors have decided to describe the first three taxa from this material.

MATERIAL AND METHODS

The graphite crystals and other organic remnants were detached from fresh fractures of the pieces of rock by conventional shadowed carbon replicas. The triafol or cellulose acetate matrix techniques were used. Besides, later, the crumbs of marble were dissolved in hydrochloric acid and the double distilled water washed residue was examined.

As specimens for the study only photographs taken in the transmission electron microscope, applying a magnification of at least $\times 6000$ ($\times 5000$), were available. The structural details of the diatom remnants were studied on hard and soft copies of the same negatives. Most of the photographs were made by one of the authors (B. K.), but some by Professor F. Kaczmarzki (F.K.).

SYSTEMATHIC DESCRIPTIONS

***Bolewskia* Kwiecińska et Siemińska gen. nov.**

Valva recta, cylindrica ?, alta (cum longissima axi pervalvari), parte inferiore limbi sine ornamento. In parte limbi relique ornamentum in duobus ordinibus poroidalium areolarum opposite sitis.

Genus maritimum, extinctum, aetatis proterozoicae, descriptum ex strato graphitoso marmorum in Przeworno in Silesia Inferioris Poloniae apparentium.

Genus in honorem clarissimi professoris mineralogiae Andreae Bolewskii nominatum.

Typus generis: Bolewskia reymanownae Kwiec. et Siem.

Genus incertae sedis propter frustulam integram nondum inventam, cum aetatis paleogenae Riedelia Jousé videtur nexum geneticum habens.

Valve straight, cylindrical ?, high (with very long pervalvar axis). Basal part of the valve mantle without ornamentation. The remaining part of the mantle with ornamentation consisting of two rows of poroid areoles disposed opposite each other along the mantle sides.

Genus marine, extinct.

Age. Proterozoic. Described from a graphitic marble layer from Przeworno (Lower Silesia in Poland).

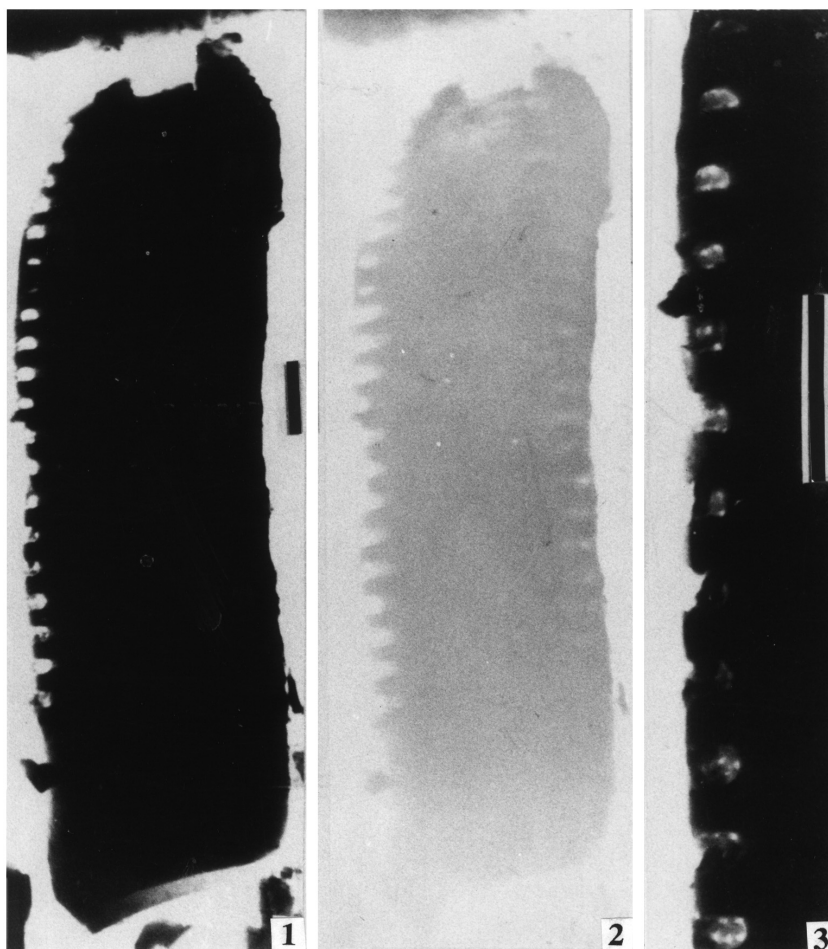
The genus is named in honour of Professor Andrzej Bolewski Ph. Dr, the distinguished Polish mineralogist.

The type species. *Bolewskia reymanownae* Kwiec. et Siem.

The genus is not quite certain as only one incomplete valve was found. It seems to be related to the paleogenic genus *Riedelia* Jousé et Sheshukova 1971 because of the pattern of ornamentation.

***Bolewskia reymanownae* Kwiecińska et Siemińska sp. nov.**

Valva recta, cylindrica ?, in apice orbiculata ?, ca. 12 μm alta, ca. 3 μm lata. Pars inferior limbi valvae in longitudine ca. 3 μm sine ornamento. In parte reliqua limbi ornamentum in duobus ordinibus areolarum transverse prolatarum poroidalium; areolae 2–3 in 1 μm



Figs 1–3. *Bolewskia reymanownae* (TEM. Scale bars = 1 μm): **1, 2** – Hard and soft positives of a valve (negative BK No. 14477); **3** – Enlarged fragment of the valve (negative BK No. 14478)

apparent. Ordines areolarum opposite siti. Areolae ca. 0.3–1 (sub valvae apice ca. 2) μm longae, ca. 0.3 μm latae. In superficie interna areolarum valvae veli cum poroidalibus; poroides in duobus regularibus ordinibus in longitudine areolarum positae; poroides 1–2 in 0.1 μm apparentes ca. 30 μm diam. habent.

Iconotypus: Figs 1–3 (negatives BK No. 14477 and No. 14478 stored in the Phycological Department of the W. Szafer Institute of Botany, Polish Academy of Sciences in Kraków).

Una valva defectiva in strato graphitoso marmorum in Przeworno in Silesia Inferioris Poloniae inventa, aetatis proterozoicae.

Species in honorem clarissimae professoris Mariae Reymanównae nominata.

Positio ordinum areolarum cum *Riedelia mirabilis* Jousé iuncta videtur et ab eo diametribus satis minoribus, deficiente processu in valvae apice et deficiente poro isolato diversa.

Valve right, cylindrical ?, rounded ? at the apex, ca. 12 mm high, ca. 3 mm wide (in diameter ?). Basal part of the valve mantle, at a length of ca. 3 μm , without ornamentation (girdle?). The remaining part of the mantle with ornamentation in the form of two rows of transversally elongated poroid areoles, 2–3 areoles in 1 μm . Areoles are disposed opposite each other along the valve mantle. The second row of areoles is visible only on the soft copy of the negative (Fig. 2). Areoles are 0.3–1 (at the apex of the valve ca. 2) μm long, ca. 0.3 μm wide. On the internal surface of the areoles poroidal velum (cribrum) is visible (Fig. 3); poroids are disposed in two regular rows along the areoles.

Only one, not quite complete valve was found in the graphitic marble layer in Przeworno (Lower Silesia in Poland).

Age. Proterozoic.

Derivation of name. The species is dedicated to the late Professor Maria Reymanówna the Polish illustrious palaeobotanist.

Concerning the pattern of disposition of areoles the species refers to the extinct *Riedelia mirabilis* Jousé (in Jousé & Sheshukova 1971) described from the Pacific Eocene-Oligocene sediments; as there are only drawings and rather bad light microscope photographs of the species published, the submicroscopic structure of areoles cannot be compared. *Bolewskia reymanownae*, however, greatly differs from the Jousé species, being ten times smaller, having no apical process, and no isolate pore at the apex.

***Protorhaphoneis* Kwiecińska et Siemińska gen. nov.**

Valva lanceolata ? (cum extremitatibus deletis). Areolae magnae, rotundatae, alternatim in uno ordine in longitudine marginum valvae sitae.

Genus marinum, extinctum, aetatis proterozoicae, descriptum ex strato graphitoso marmorum in Przeworno, Silesia Inferioris Poloniae, apparentium.

Typus generis: *Protorhaphoneis stanislai* Kwiec. et Siem.

Genus cum *Rhaphoneis* Ehr. ut videtur nexum geneticum habens.

Valve lanceolate ? (destroyed on both apices). Areoles coarse, nearly circular, occurring alternately in a single row along each valve margin.

Genus marine, extinct.

Age. Proterozoic. Described from a graphitic marble layer from Przeworno, Lower Silesia in Poland.

Type species. *Protorhaphoneis stanislai* Kwiec. et Siem.

Since only one destroyed valve was found, the description of the genus is not complete. The alternating disposition of coarse, round areoles and the lack of spines on the margin of the valve refer the genus to *Rhaphoneis* Ehr. It differs from *Rhaphoneis* in not having the additional row of areoles on the valve mantle.

***Protorhaphoneis stanislai* Kwiecińska et Siemińska sp. nov.**

Valva lanceolaris ? cum extremitatibus deletis. Rudimentum ca. 15 μm longum, 10 μm latum. Area oblongata 3 μm lata. Areolae rotundatae, ca. 2–2.5 μm diam., alternatim in uno ordine in longitudine marginum valvae sitae, ca. 2 areolae in 10 μm apparent.

Iconotypus Fig. 4 (negative BK without number stored in the Phycological Department of the W. Szafer Institute of Botany, Polish Academy of Sciences in Kraków).

Unum exemplar deletum in strato graphitoso marmoris in Przeworno in Silesia Inferioris Poloniae inventum, aetatis proterozoicae.

Species in honorem doctoris Stanislai Kwiecińskii defuncti viri unius ex auctricibus nominatum.

Valve lanceolate ?, destroyed on both apices, consists of a very thin sheet of silica of uniform thickness (in some places the valve mantle is secondarily folded). The preserved remnant is ca. 25 μm long, 10 μm wide. Axial area 3 μm wide. Areoles nearly circular, ca. 2–2.5 μm in diameter, ca. 2 in 10 μm , occurring alternately in a single row along each valve margin. In two of the areoles apiculi-like remains

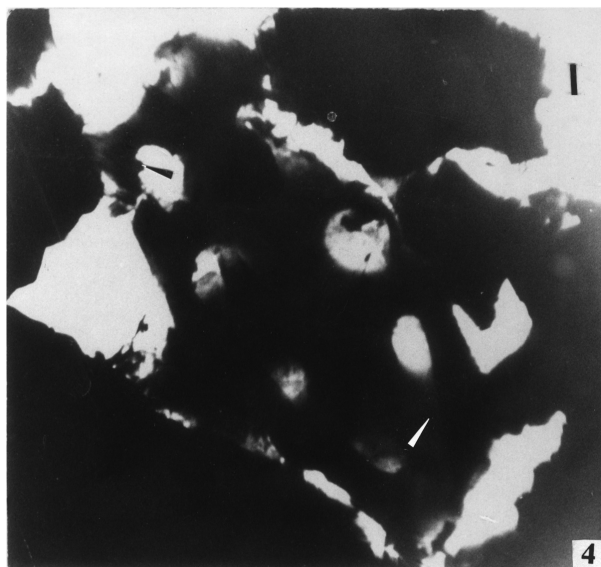


Fig. 4. *Protorhaphoneis stanislai* (TEM. Scale bar = 1 μ m; negative BK without number). Black arrows = apiculi ?; white arrow = secondary folding of the valve mantle

directed towards the center are visible. There are no additional areoles (pores) along the valve mantle.

Only one, not quite complete valve was found in the graphitic marble layer in Przeworno (Lower Silesia in Poland).

Age. Proterozoic.

The species is dedicated to Ass. Prof. Stanisław Kwieciński Ph. D., Polish physicist, the late husband of one of the authors.

The species seems to be very close to four Miocene species of *Rhaphoneis* which have only a single row of areoles along the valve margins (Andrews 1975): *Rh. biseriata* Grunow with linear valves and 4.5–5 circular areoles in 10 μ m, and the other three species having lanceolate valves: *Rh. moravica* (Grunow) Andrews with 4.5 circular areoles in 10 μ m, *Rh. wicomicoensis* Lohman with 4 transversely elongated oval areoles, and *Rh. immunis* Lohman with 5.5 areoles in 10 μ m and an additional single row of smaller areoles 8(6–7) in 10 μ m situated at the margin of the valve (on the valve mantle), clearly visible under the light microscope (Andrews 1975, 1976). All four species have much larger valves than *P. stanislai*.

An additional row of smaller areoles is to visible in SEM micrographs of some other species of *Rhaphoneis*, e.g. *Rh. gemmifera* Ehr. (Andrews 1975, figs 56, 57 and 60), *Rh. diam-*

antella Andrews (Andrews 1975, figs 61 and 62), and also of the type species, *Rh. amphicerus* (Ehr.) Ehr. (Round et al. 1990). *P. stanislai* differs from them in not having the additional row of areoles on its valve mantle.

Though none of the four initially compared species (*Rh. biseriata*, *Rh. moravica*, *Rh. wicomicoensis* and *Rh. immunis*) has been studied in the electron microscope, it appears from their drawings that they all have a small pore field (or pseudocellus) at both apices of the valves, a feature which is connected with the genus. From the SEM micrographs of *Rh. amphicerus* (Round et al. 1990) and also *Rh. gemmifera* (Andrews 1975, fig. 70), it is clear that the presence of two internal labiate processes, each situated close to the small apical pore field, is also important feature of the genus *Rhaphoneis*. The small pore fields and the internal labiate processes cannot be discussed in *P. stanislai* since both the valve ends are lacking; its remnant, however looks too primitive to have possessed them.

Yet, it is not certain if the above-mentioned species (*Rh. biseriata*, *Rh. moravica*, *Rh. wicomicoensis* and *Rh. immunis*) can be treated as *Rhaphoneis* because all of them have opposite, instead of alternating, areoles. According to Andrews (1990) transverse striae in *Rhaphoneis* "are usually misaligned or show only a fortuitous alignment over part of the valve". Whether they belong to *Delphineis* Andrews 1977 (Andrews 1981), or *Lancineis* Andrews 1990 separated from *Rhaphoneis*, or to the newly described *Neodelphineis* Takano 1982 (Round et al. 1990) or to *Adoneis* Andrews and Rivera 1987 cannot be decided without studying them in the electron microscope.

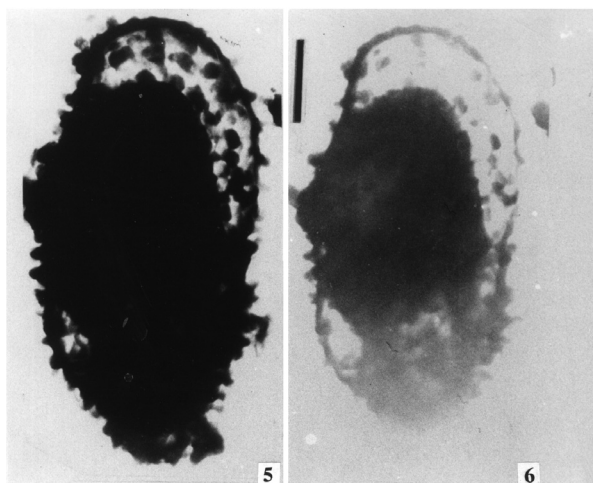
***Xanthiopyxis polonica* Kwiecińska et Siemińska sp. nov.**

Valvae late ellipsoideae, convexae, 5–6 μ m longae, ca. 3 μ m latae. Limbus valvae non satis devolutus. Superficies valvae dense papillaris. Valvae interdum asymetricae, in una extremitate stenoticae.

Iconotypus: Figs 5, 6 (negative BK No. 14475 stored in the Phycological Department of the W. Szafer Institute of Botany, Polish Academy of Sciences in Kraków).

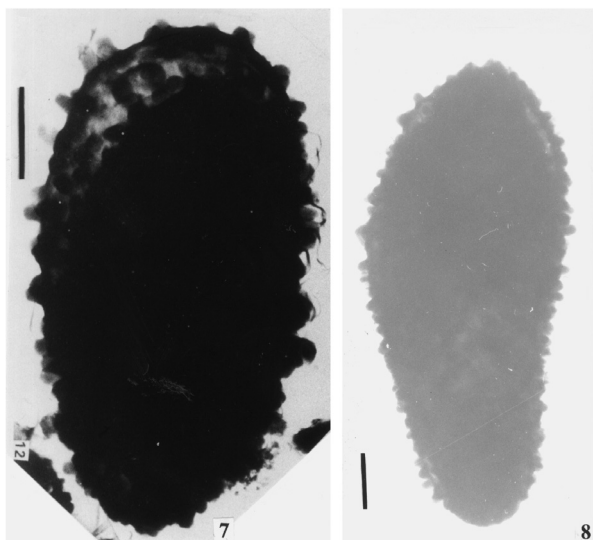
Alique exemplaris in strato graphitoso marmoris in Przeworno in Silesia Inferioris Poloniae, apparentis, inventa, aetatis proterozoicae.

Valvae in forma et ornamento Xanthiopyxis hystericis Forti aetatis miocoenae italicae similes, sed 10-plo minores sunt.



Figs 5, 6. *Xanthiopyxis polonica* (TEM. Scale bar = 1 μ m. Hard and soft positives of the negative BK No. 14445)

Valves elliptic, convex, 5–6 μ m long, ca. 3 μ m wide, with dense, short mamillary processes on the surface (Figs 5–7). Valve mantle not developed. Sometimes the valves unsymmetrical (Figs 7, 8, negatives BK No. 14441 and No. 7794), narrower at one end.



Figs 7, 8. *Xanthiopyxis polonica* (TEM. Scale bars = 1 μ m): 7 – (negative BK No. 14441); 8 – assymetric specimen (negative FK No. 7794)

Several specimens were found in the graphitic marble layers from Przeworno (Lower Silesia in Poland).

Age. Proterozoic.

The valves are similar in shape and ornamentation to the *X. hystrix* Forti known

from the Italian Miocene (Proshkina-Lavrenko 1949) but they are ten times smaller.

CONCLUSION

Following the systematical Bacillariophyta classification of F.E. Round and R.M. Crawford (in Round et al. 1990) the first of the described species, *Bolewskia reymanownae*, is assigned to the Coscinodiscophyceae class, the Bidulphiophycidae subclass, the Hemiaulales Round and Crawford order and the Hemiaulaceae Heiberg family. The family comprises fossil and recent genera.

Concerning *Protorhaphoneis stanislai* – taking into account very thin and uniform silica sheet and only a single row of large areoles along each valve margin – we may suppose that it is the precursor of the genus *Rhaphoneis* Ehr., and all of the family Rhaphoneida-ceae Forti, including *Diplomenora* Blazé 1984 (after Round et al. 1990), *Sceptroneis* Ehrenberg 1844, and *Perissonoe* Andrews et Stoelzel 1984 (in addition to the already mentioned genera *Lancineis*, *Delphineis*, *Neodelphineis* and *Adoneis*). The family comprises fossil and recent marine shallow water species.

The third of the newly described species, *Xanthiopyxis polonica*, belongs to the spores (organ genera). All the species of the genus are extinct, till now known from the marine Miocene deposits.

The occurrence of the described species in the calcitic marbles in Przeworno assigned to the Proterozoic, shifts the age of diatoms by ca. 430 million years earlier than their previous first occurrence in the Middle Cretaceous.

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