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LATE CRETACEOUS SILICEOUS SPONGES FROM THE MIDDLE VISTULA RIVER VALLEY (CENTRAL POLAND) AND THEIR PALAEOECOLOGICAL SIGNIFICANCE

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Abstract: Siliceous sponges are extremely abundant in the Upper Campanian-Maastrichtian opokas and marls of the Middle Vistula River Valley, situated in the western edge of the Lublin Basin, part of the Cretaceous German-Polish Basin. This is also the only one area in Poland where strata bearing the Late Maastrichtian sponges are exposed. The presented paper is a taxonomic revision of sponges collected from this region. Based both on existing and newly collected material comprising ca. 1750 specimens, 51 species have been described, including 18 belonging to the Hexactinosida, 15 – to the Lychniscosida and 18 – to Demospongiae. Among them, 28 have not been so far described from Poland. One new genus *Varioporospongia*, assigned to the family Ventriculitidae Smith and two new species *Varioporospongia dariae* sp. n. and *Aphrocallistes calciformis* sp. n. have been described. Comparison of sponge fauna from the area of Podilia, Crimea, Chernihov, and Donbas regions, as well as literature data point to the occurrence of species common in the analysed area and to the basins of Eastern and Western Europe. This in turn indicates good connections between particular basins of the European epicontinental sea during the Campanian–Maastrichtian. Analysis of the taxonomic composition of the Middle Vistula assemblage suggests that the occurring sponge fauna is transitional between the faunas of Eastern and Western Europe, what may be linked with the central location of the Lublin Basin in the European epicontinental sea. The gradual upward decrease of taxonomic diversity of the Hexactinosida and Lychniscosida in the studied succession points to gradual basin shallowing, what is consistent with the global regressive trend by the end of the Cretaceous. The domination of the Hexactinellida over the lithistids in terms of diversity and abundance in the entire section allows us to estimate the maximum depth of the Late Campanian basin as 200–250 m and to constrain the minimum depth during the latest Maastrichtian as about 100 m.

Key words: Sponges, Hexactinosida, Lychniscosida, lithistids, taxonomy, palaeoecology, Upper Cretaceous, Central Poland.

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INTRODUCTION

Rich sponge fauna with a siliceous skeleton existed during the Late Cretaceous in the European continental sea (Wiedenmayer, 1980; Pisera, 1999). The conditions favouring development of sponges at that time were linked with the common marine transgressions which began in the Albian (Hancock & Kauffman, 1979). The acme of sponge development occurred in the Campanian, what corresponded to the global maximum of eustatic rise (Hancock, 1975; Hancock & Kauffman, 1979; Hancock, 1989).

Despite large abundance and high taxonomic variability, larger accumulations of bodlly preserved sponges are not common in the Upper Cretaceous strata. Their distribution is restricted to some areas and stratigraphic intervals only (cf. Hancock, 1976). The largest number of sites with rich and well recognised sponge fauna is known from Western Europe. The presence of sponges in the Upper Cretaceous deposits has also been noted from Central and Eastern Europe. However, sponges in these localities are not known in detail due to their poor state of preservation, which is related to the domination of carbonate-siliceous and chalk facies over limestones.

The Middle Vistula River Valley (Central Poland) is one of the areas in Poland, where the Late Cretaceous sponges are very abundant. For the first time the presence of sponges in this area was noted by Pusch (1837). Later, they were also mentioned by Sujkowski (1931), Pożaryski (1938), and Putzer (1942). Early Cretaceous sponges, commonly occurring in the Albian strata were studied by Hurcewicz (1988). Sponges belong to one of the most common fossil groups also in the Campanian and Maastrichtian

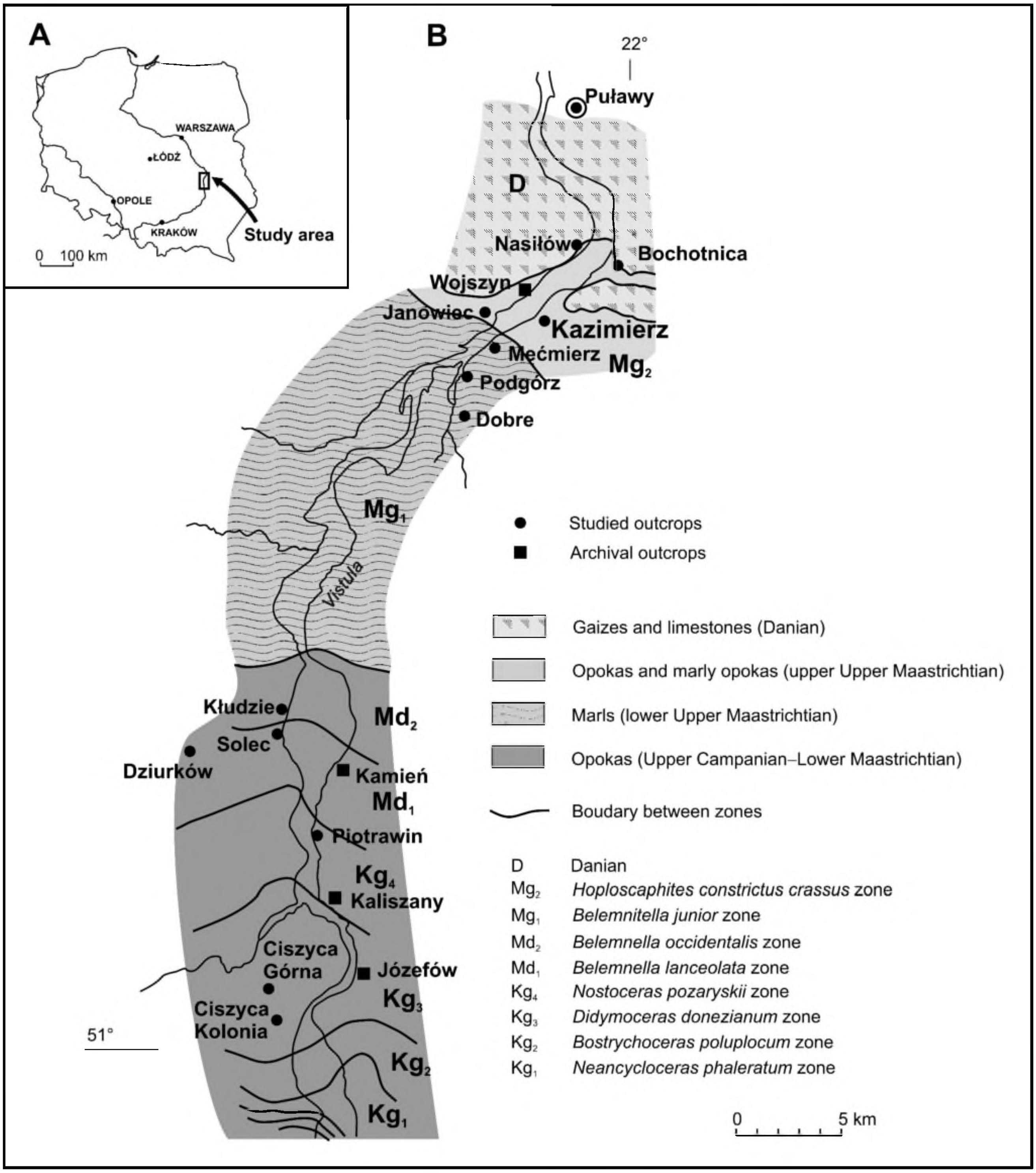

Fig. 1. **A.** Location of studied area on the general map of Poland; **B.** Geological sketch – map of the Middle Vistula River Valley (adopted from: Pożaryski, 1938 and Błaszkiewicz, 1980)

strata. Their taxonomic recognition, however, is poor. Only single specimens have been described from these deposits (Hurcewicz, 1966, 1968).

The Campanian and Maastrichtian sponges from the Middle Vistula River Valley also have a certain palaeoecological significance, because they occur in the beds *in situ*. Additionally, apart from this area, no outcrops with sponges of the Maastrichtian age are known from the area of Poland. Thus, this region is unique for tracing the changes which took place in the sponge assemblages in the Late Cretaceous up to the Cretaceous/Palaeogene boundary, and referring these changes to the bathymetry of the basin by the end on the Cretaceous.

The presented herein taxonomic research of sponges from the Campanian and Maastrichtian deposits from the Middle Vistula River Valley supplements the existing data on the fossil assemblages from this area. It also provides new facts on the occurrence of sponge fauna in the Late Cretaceous in the central part of the Central European Basin, what in turn allows broadening the palaeogeographic ranges of some species earlier known from Western Europe only.

GEOLOGICAL SETTING

The Cretaceous rocks comprising the Albian through Maastrichtian strata are exposed in the western part of the Lublin Basin, in the Middle Vistula River Valley between Annopol and Puławy (Fig. 1A, B). This region was a part of the German–Polish Basin and in the Late Cretaceous was located in the central part of a vast shelf sea in the area of Central Europe.

The study area comprises the northern part of the Middle Vistula River gorge. The exposures (13 sites), in which the sponge fauna have been collected, are situated in the Vistula River Valley along its both sides, at a distance of ca. 50 km (Fig. 1B). The Cretaceous deposits occurring in the study area display poor bedding and dip very gently (ca. 3°) to the NE and NNE (cf. Pożaryski, 1938).

Despite numerous papers (Łopuski, 1911–1912; Mazurek, 1915; Pożaryski, 1938; Kongiel, 1958, 1962; Pożaryska, 1965, 1967; Błaszkiewicz, 1966, 1980; Gaździcka, 1978; Peryt, 1980; Pożaryska & Pugaczewska, 1981; Abdel-Gawad, 1986; Hansen *et al.*, 1989; Marcinowski & Radwański, 1996; Machalski, 1996; Machalski & Jagt, 1998), the detailed correlation of particular lithological successions has not bee established yet. This results from the rather uniform character of the Campanian and Maastrichtian sediments. These exposures, except for Nasiłów and Bochotnica, lack characteristic correlation beds or horizons. In this paper, the biostratigraphic zones based on cephalopods (Błaszkiewicz, 1980) have been used (Fig. 2).

The oldest studied deposits are the Upper Campanian opokas, exposed in the quarries of Ciszyca Kolonia, Ciszyca Górna, and Piotrawin (*Nostoceras pozaryskii* Zone) (Fig. 2). The Campanian deposits pass conformably into macroscopically indistinguishable opokas of the Lower Maastrichtian, known from Dziurków and Solec (*Belemnella lanceolata* Zone) and from Kłudzie (*Belemnella occidentalis* Zone). The younger, soft white marls of the lower Upper Maastrichtian (*Belemnitella junior* Zone) occur at Dobre, Podgórze, and Męćmierz. The upper Upper Maastrichtian (*Haploscaphites constrictus crassus* Zone) is represented by opokas from Kazimierz and Janowiec, and in Bochotnica and Nasiłów, in which the uppermost Cretaceous–Palaeogene strata are exposed. Deposits of the upper Upper Maastrichtian are macroscopically similar to the Upper Campanian and Lower Maastrichtian opokas. The top of the Upper Maastrichtian opokas due to diagenetic processes underwent transformation into a 50–60 cm thick bed of hard limestone. The strongly brecciated top of this bed has earlier been described as a "hardground" (Pożaryska, 1952; Abdel-Gawad, 1986; Hansen *et al.*, 1989). According to recent investigations, these structures are linked with the activity of burrowing organisms (Jelinowska, 1985; Radwański, 1985; Machalski & Walaszczyk, 1987; Machalski, 1998). The opoka is directly overlain by glauconitic sandstone containing numerous phosphatised Cretaceous and Palaeogene fossils. This bed is considered either the uppermost Cretaceous (Kongiel, 1935, 1958; Pożaryski, 1938; Putzer, 1942; Radwański, 1985; Abdel-Gawad, 1986; Machalski & Walaszczyk, 1987) or Palaeogene in age (Pożaryska, 1965, 1967; Krach, 1974, 1981; Błaszkiewicz, 1966, 1979, 1980; Peryt, 1980; Hansen *et al.*, 1989; Machalski, 1998; Żarski *et al.*, 1998; Świerczewska-Gładysz, 2000; Świerczewska-Gładysz & Olszewska-Nejbert, 2006). The bed passes into gaizes with limestones, the so-called siwak, presently assigned either to the Montian (Krach, 1968, 1971, 1974; Pożaryska, 1965; Liszkowski, 1970) or Danian (Peryt, 1980; Hansen *et al.*, 1989; Machalski, 1998, Żarski *et al.*, 1998).

Beside sponges, the most abundant macrofauna include bivalves and snails (Krach, 1931; Pożaryski, 1938; Putzer, 1942; Pożaryska & Pożaryski, 1951; Pugaczewska, 1977; Abdel-Gawad, 1986; 1990). Of stratigraphic significance are belemnites (Nowak, 1913, 1917; Skołozdrówna, 1932; Kongiel & Matwiejówna, 1937; Kongiel, 1962) and ammonites (Łopuski, 1911-12; Nowak, 1913, 1917; Błaszkiewicz, 1966, 1979, 1980; Machalski & Jagt, 1998). Additionally, nautiloids (Łopuski, 1911-1912; Kongiel & Matwiejówna, 1937; Putzer, 1942), brachiopods (Pożaryska & Pożaryski, 1951; Popiel-Barczyk, 1968), corals (Putzer, 1942), echinoids (Kongiel, 1950; Mączyńska, 1972), and bryozoans (Maryańska, 1969) are also present.

MATERIAL

The studied material consists of about 1,750 specimens (collection of UL XX). The specimens have been collected in 13 exposures within the Vistula River Valley: Ciszyca Kolonia, Ciszyca Górna, Piotrawin, Solec, Dziurków, Kłudzie, Dobre, Podgórz, Męćmierz, Kazimierz – two observation points, Janowiec, Nasiłów, and Bochotnica – three observation points (Figs 1B, 2). Part of the specimens have been collected directly from the exposure walls, enabling observation of the preservation stage of sponges in particular beds and their position in the rock, as well as determination of species variability in the sections. Most of the studied material, particularly the larger forms, has been collected from the debris.

For a comparison, museum collections of the Campanian and Maastrichtian sponges housed at the Geological Department of the Łódź University have also been studied. These collections included specimens described by Hurcewicz (1966, 1968) from the south-western part of the Miechów Basin (vicinity of Koniecpol, Miechów and Kraków) and from the Middle Vistula River Valley (UL II, III), undescribed material of H. Hurcewicz from both these regions (UL XVI), an undescribed collection from Ukraine (Donbas region, Crimea, Ivano-Frankivsk region and Chernihov region); (UL XVII) and material collected by myself from Mogilno near Łódź (UL XIX). Additionally, the research included also specimens from the collections of the Geological Museum of Institute of Geological Sciences of the Polish Academy of Sciences in Kraków, containing

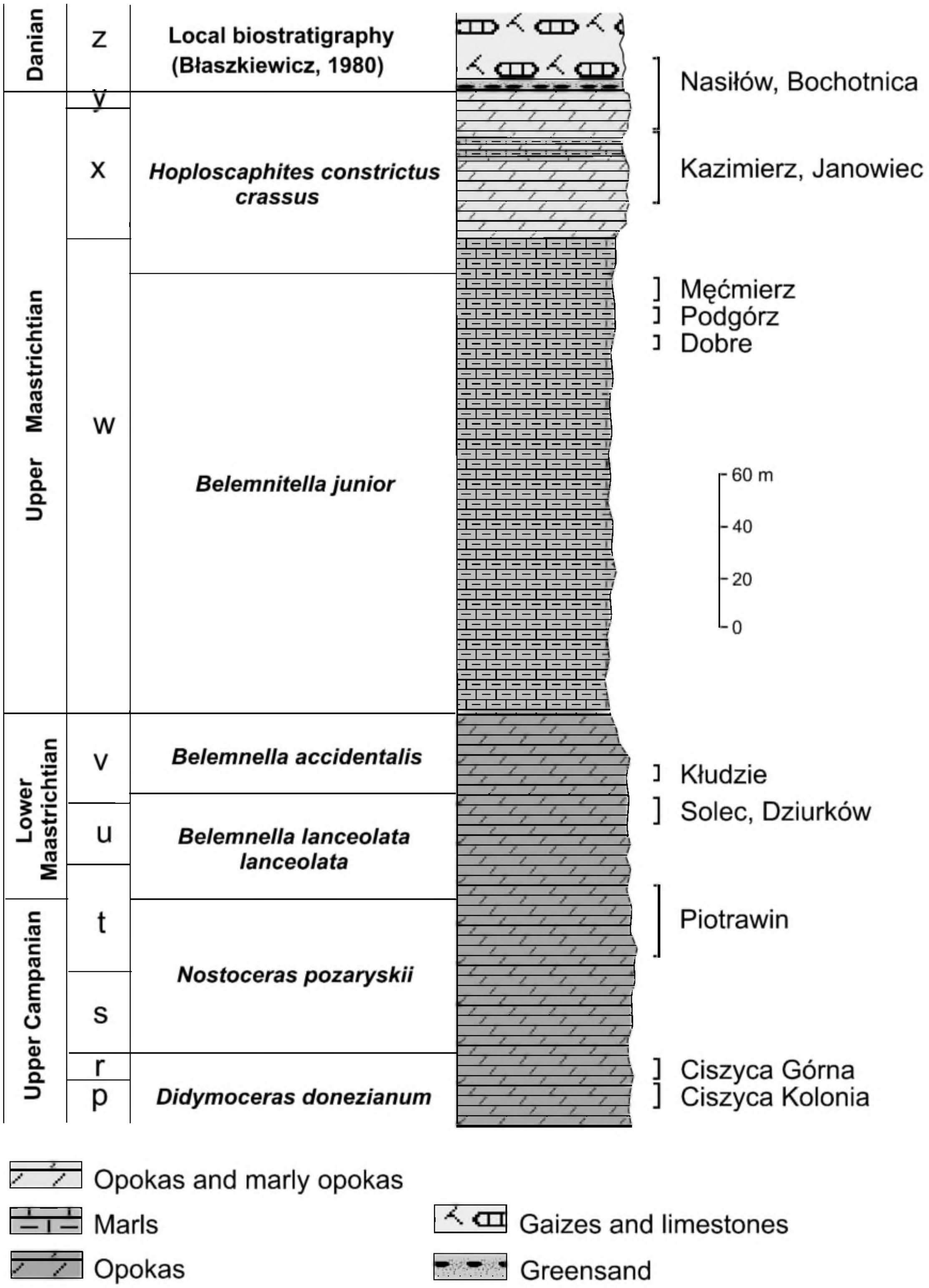

Fig. 2. A schematic lithostratigraphic section of the Upper Campanian–Maastrichtian sediments showing stratigraphic position of the studied outcrops; **p–z** – local litho-faunal horizons after Pożaryski (1938)

Senonian sponges from the vicinity of Kraków (A-1-1), described by Bieda (1933), and ?Santonian sponges from Korzkiew near Kraków (A-1-82), studied by Małecki (1980). Very helpful was also the analysis of specimens from the Cretaceous of the Opole Basin, described by Tarkowski (1991), and the collections of Albian sponges from the northern margin of the Holy Cross Mts. (UL V, VIII, IX), described by Hurcewicz (1984, 1988).

STATE OF PRESERVATION

Typically, the specimens are strongly limonitised. Their siliceous skeleton is usually dissolved. The skeleton is best preserved in the lowermost, massive parts of the sponges. Its fragments are also preserved in specimens, found within irregular cherts (cf. Michniak, 1979). In most sponges voids after dissolved spicules are distinct. The voids are in some cases filled with iron compounds or calcite, what can be noted in material from the topmost part of the Maastrichtian opokas.

The state of preservation varies in particular beds. The best preserved skeletal elements are found in specimens from Piotrawin. Siliceous spicules are very rare in the limestone bed capping the Maastrichtian succession (Nasiłów and Bochotnica), and they are almost entirely absent in the phosphatised specimens from the glauconitic sandstone. Most difficult to study are, however, sponges from marls of the lower Upper Maastrichtian from exposures near Męćmierz, Dobre, and Podgórz. They are extremely strongly limonitised and additionally crushed due to mechanical weathering of the rocks. Some of the sponges cannot be recognised due to complete dissolution of skeleton and lack of clear voids after spicules. Therefore, the number of sponges described in the systematic part does not reflect their real abundance in the particular exposures.

METHODS

Because in some cases it has not been possible to prepare the specimens from the rock, some features have been analysed based on layered images using x-ray computer tomography. Layered images have been made every 2 or 5 mm. Depending on the degree of wall uniformity (i.e. more or less evenly filled with ferruginous hydroxides, variable porosity), details of the anatomic structure of sizes between 1–3 mm could be observed.

In order to prepare out the sponge skeletons, the specimens from marls and opokas with a low content of silica were etched with 10% hydrochloric acid. To remove the silica dispersed in the rock, most specimens from opoka were subject to short (15–30 minutes) etching with 5% hydrofluoric acid. This method, however, caused also slight etching of the spicules; additionally only a thin layer of the skeleton could be observed on the prepared surface. Beside siliceous skeletons, also their goethite and limonite pseudomorphs have been analysed. The voids after dissolved spicules devoid of ferruginous hydroxides have been filled with resin. First the specimens were impregnated under pressure with araldite, and then dissolved in hydrofluoric acid, thus araldite casts of the skeleton were obtained.

The prepared skeletal elements were initially observed under a binocular, and then SEM-viewed. Observation of thin sections in bright-field microscopy allowed determining the skeleton structure. Thin sections have been made particularly from phosphatised specimens from the glauconitic sandstone. Voids after diagenetically dissolved skeleton have also been observed. Loose spicules (or their voids) dispersed in the rock have also been subject to analysis. This has been accomplished by making thin sections of the rock samples collected from particular exposures.

In order to determine the canalisation within the skeleton, transverse and longitudinal cross-sections through the sponge wall have been made. In some cases, series of cross-sections parallel to its surface have also been prepared. Sporadically the canalisation has been analysed using computer tomography. The latter method, due to the generally small diameter of canals, could not be commonly applied.

SYSTEMATIC ACCOUNT

Class HEXACTINELLIDA Schmidt 1870
Order HEXACTINOSIDA Schrammen 1903
Family FARREIDAE Gray 1872
Genus *Chonodictyon* Reid 1959
Type species: *Farrea infundibuliformis* Carter 1873

Remarks: Genus *Chonodictyon* proposed by Reid (1959), as opposed to other sponges with a *Farrea* type of choanosomal skeleton, is characterized by a funnel shape (compare Carter, 1873, pp. 448–449, pl. 17, fig. 1; Schulze, 1887, p. 48).

Chonodictyon (?) cf. *sewerbyensis* Reid 1959
Fig. 3 (A–E)

cf. *1959. *Chonodictyon* (?) *sewerbyensis* sp. nov.: Reid, pp. 9–10, pl. 2, fig. 2.

Material and preservation: One specimen without basal and top parts from Piotrawin. Choanosomal skeleton preserved only fragmentarily.

Description: Funnel-shaped sponge over 10 cm high (Fig. 3A). In upper part, ca. 30 mm in diameter funnel almost cylindrical. In lower part, narrowing rapidly into tube-shaped stalk, ca. 0.8 mm in diameter. Five small knobs (2 determined with aid of X-ray computer tomography – Fig. 2B–E) distributed spirally on its surface. There is a round whole about 5 mm in diameter on a top of each of them. Dictyonal skeleton comprising smooth hexactines. Skeleton comprising generally three layers adjacent to sponge surface. Network in external and middle layer is very regular, with quadrangular or transversely rectangular meshes of the average measure 0.3–0.5 mm x 0.3 mm. In some cases, hexactines oriented less regularly, forming small, several mm^2 areas with slightly disturbed structure. Transverse beams connecting both layers perpendicular, ca. 0.2 mm long. Third, irregular skeleton layer in form of irregular network, with triangular and quadrangular meshes, of variable size (from 0.2 to 0.6 mm in size). Additional layer with irregular distribution of hexactines occurring on external surface, in lower par of sponge. Lack of canalization in skeleton.

Remarks: According to Reid (1959), the only known specimen of *Chonodictyon* (?) *sewerbyensis* Reid generally possesses a bilayered skeleton. Its structure and the size of skeletal elements are analogous to the external and middle layer of the specimen from Poland. In the analyzed specimen the presence of a secondary skeletal layer is problematic. In general, the primary skeletal layer in representatives of Farreidae is represented by the most regular layer lying on the gastral surface. The secondary layers, more or less regular, are added on the dermal surface (Ijima, 1927; Reid, 1964). In turn, due to the pattern of dictyonal strands, Reid (1959) considered the external layer as the primary skeleton in *Chonodictyon* (?) *sewerbyensis*, whereas the layer on the internal surface

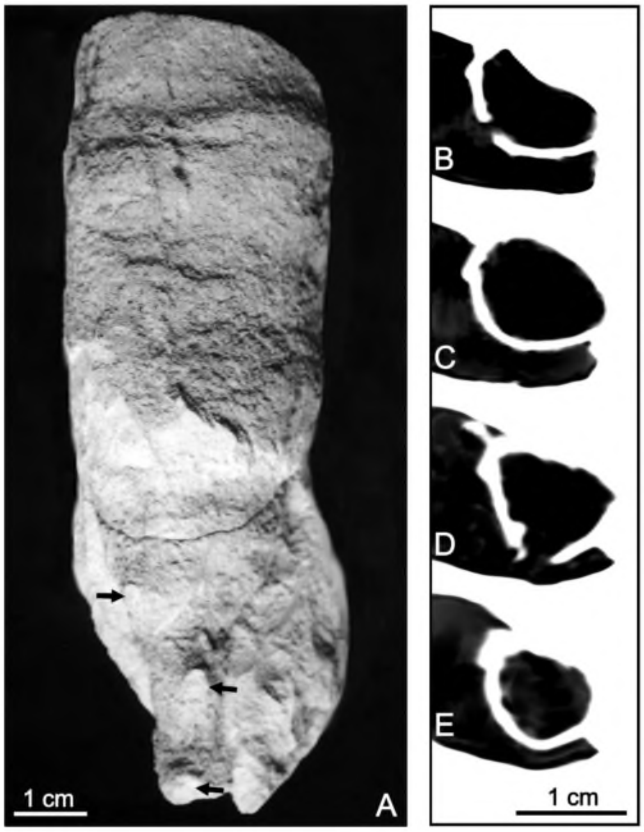

Fig. 3. A–E – *Chonodictyon* (?) cf. *sewerbyensis* (Reid 1959); A – lateral view of entire specimen; lower part with lateral oscula; note casts after spicules on specimen surface; B–E – a series of transverse cross–sections through lower part of specimen; images made every 6 mm by using X–ray tomography; wall of sponge is white; Piotrawin, Upper Campanian (UL XX 3/69)

was considered as the secondary network. The most disturbed network on the gastral surface in the specimen from Poland can also be considered as the secondary layer of the skeleton. The additional layer occurring on the dermal surface in the lower part of sponge can be, as suggested by Reid (1959), a fragment of a layer continuing into the basal skeleton. Due to incompleteness of the holotype of *Chonodictyon* (?) *sewerbyensis*, the construction of its lower part is unknown. The funnel shape of the specimen is unclear, therefore, Reid (1959) with doubt included this species to the genus *Chonodictyon*. The specimen from Poland due to its shape is intermediate between tube-shaped forms observed in representatives of the genus *Farrea* Bowerbank 1862 and funnel-shaped forms of the genus *Chonodictyon*. The lateral openings observed in the lower, narrower part of sponge are most probably the remains of reduced lateral branches, whereas the narrow funnel is a result of intense development of the upper part of the axis. The reduction of lateral tubes is observed also in Recent species, *i.e. Farrea occa* Bowerbank 1862 (see Ijima, 1927, p. 132, pl. 10; Reid, 1964, p. 55, text-fig. 28c). These forms, however, do not show modifications in the upper part of the sponge. The univocal assignment of the analyzed specimen to *Chonodictyon* Reid based on such sparse material is still problematic.

Occurrence: Poland – Middle Vistula Valley (Upper Campanian).

Family EURETIDAE Zittel 1877 emended Reid 1959, 1963b, emended Reiswig & Wheeler 2002

Remarks: Due to the construction of the dictyonal skeleton and lack of canalization, Reid (1959) included i.a. the genera assigned by Schrammen (1912) to two new families: Hapalopegmidae and Callibrochidae to the Euretidae. The classification of fossil Euretidae presented by Reid (2004e) is in some cases controversial and difficult to link with the zoological systematics (Reiswig & Wheeler, 2002).

Genus *Eurete* Semper 1868

Type species: *Eurete simplicissima* Semper 1968

Remarks: Reid (1959, 1963b) considered genera *Endorete* Topsent 1928, *Gymnorete* Ijima 1927, *Heterorete* Dendy 1916 and *Pararete* Ijima 1927 to be a subgenera of *Eurete*.

According to Reiswig and Wheeler (2002), it is only to be accepted for fossil sponges without preserved free spicules, which are diagnostic for the foregoing genera. In Mehl's (1992) opinion, characteristic feature that allows to distinguish fossil representatives of genus *Pararete* and *Eurete* are also the nodes, which in *Pararete* are spherically thickened in the dictyonal skeleton. This criterium is not clear enough, as according to Reiswig and Wheeler (2002); in Eurete "nodes are unswollen but sometimes slightly swollen", and in Pararete "nodes are usually swollen and tubercled".

Eurete formosum Reid 1959

Figs 4 (C–E), 5 (A, B)

*1959. *Eurete formosum* sp. nov.: Reid, pp. 21–22, pl. 2, figs 7, 8; pl. 3, figs 1, 2.

?1961a. *Eurete* cf. *formosum*: Reid, pp. 44–48.

Material and preservation: 109 specimens (1 specimen from Ciszyca Górna, 6 from Piotrawin, 8 from Dziurków, 3 from Kłudzie, 7 from Dobre, 5 from Podgórz, 40 from Kazimierz, 2 from Janowiec, 2 from opoka from Bochotnica, 11 from opoka and 24 from the greensand from Nasiłów). Specimens to a variable degree incomplete. Skeletons typically completely dissolved. Voids after spicules are filled in some cases with iron hydroxides.

Description: Spherical to irregular lumpy sponges, up to 180 mm in diameter (Fig. 4D, E). Some specimens in upper part divided into 2–3 pyramid-like or cylindrical-shaped parths, not exceeding 1/3 of sponge height. Young individuals typically pyramid-shaped, rarely massive, with numerous free peripheral tubes (Fig. 4C). Sponge composed of dividing and alternately connecting again tubes. Tubes thin-walled (1–2 mm), 6–18 mm in diameter. Diameter of tubes increasing with growth of individual. Spaces between tubes of similar diameter as tubes. In peripheral part, tubes terminating loosely or forming joined, curved folds. Basal part in form of incrusting plate, typically attached to other sponges. Dictyonal skeleton (Fig. 5A, B) comprising hexactines with smooth or finely granulose rays. Within wall on gastral surface, skeleton regular, with rectangular meshes, 0.2 mm × 0.3 mm. Towards dermal surface skeletal network irregular, with triangular and quadrangular meshes. On both surfaces network denser with small (0.05–0.1 mm), triangular meshes and multiradiate nodes. Some nodes thickened (Fig. 5B). Round or slightly polygonal canal openings rather regularly distributed on external surface of tubes. Diameter very variable, from 0.1 mm to 0.3 mm. On internal surface canal openings slightly larger, although similarly distributed. Canals (=extradictyonal epirhyses and aporhyses sensu Reid, 1959) developed only within the surface part of dictyonal skele-

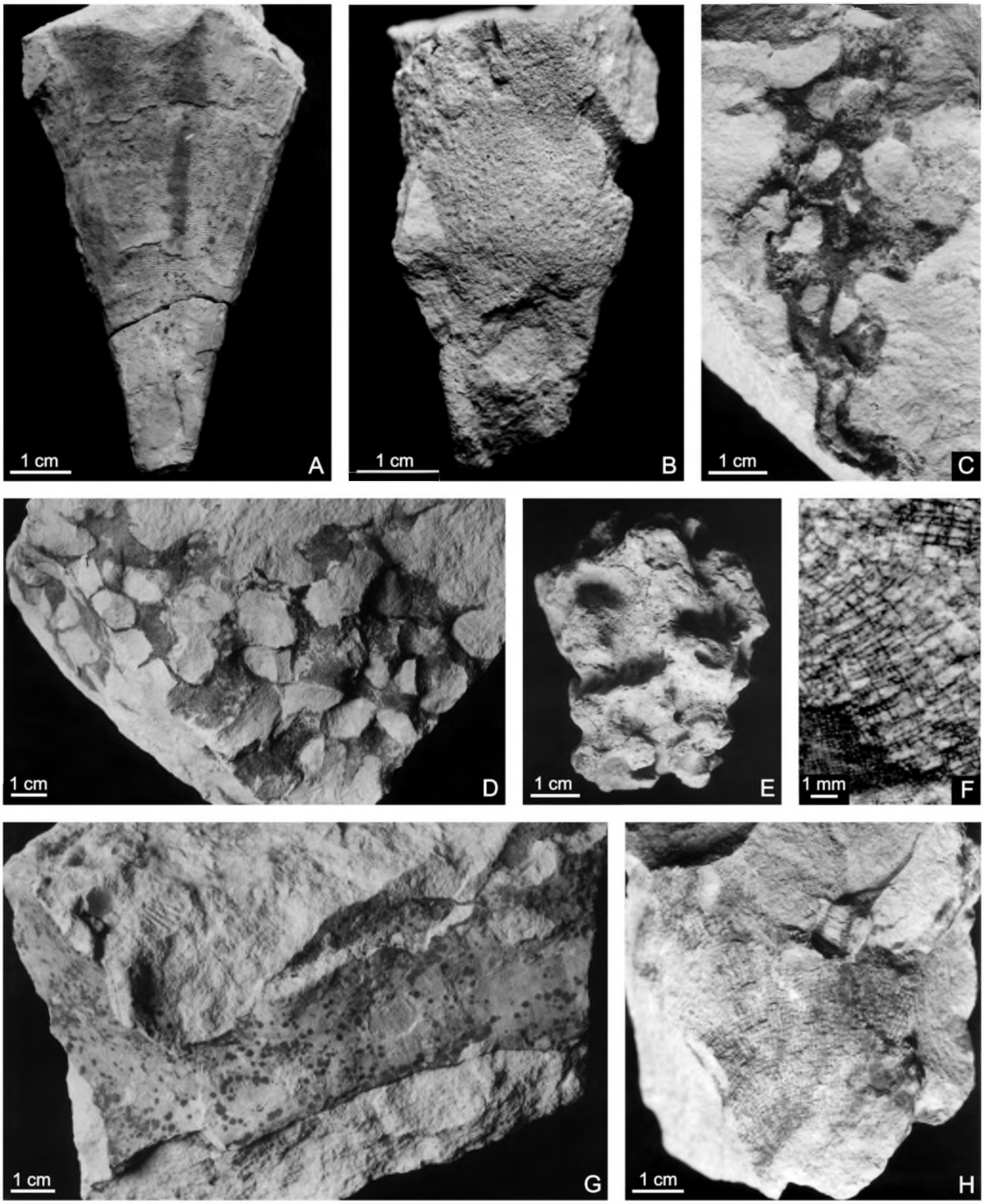

Fig. 4. **A** – *Wollemania araneosa* Schrammen 1912; lateral view; Piotrawin, Upper Campanian (UL XX 0/20); **B** – *Oxyrhizum* cf. *eximium* Schrammen 1912; lateral view; Solec, Lower Maastrichtian (UL XX 3/160); **C–E** – *Eurete formosum* (Reid 1959); C – lateral view; Kazimierz, Upper Maastrichtian (UL XX 1/49); D – lateral view; Kazimierz, Upper Maastrichtian (UL XX 0/297), E – lateral view; Nasiłów, greensand, Upper Maastrichtian (UL XX 0/118); **F, G** – *Eubrochis cribrosus* (Reid 1964); F – casts after dissolved spicules filled with limonite; Nasiłów, opoka, Upper Maastrichtian (UL XX 0/91); G – lateral view; Kazimierz, Upper Maastrichtian (UL XX 0/90). **H** – *Hapalopegma meandrina* Schrammen 1912; fragment of fan-like lobe with limonitized dictional network on sponge surface; Piotrawin, Upper Campanian (UL XX 3/61)

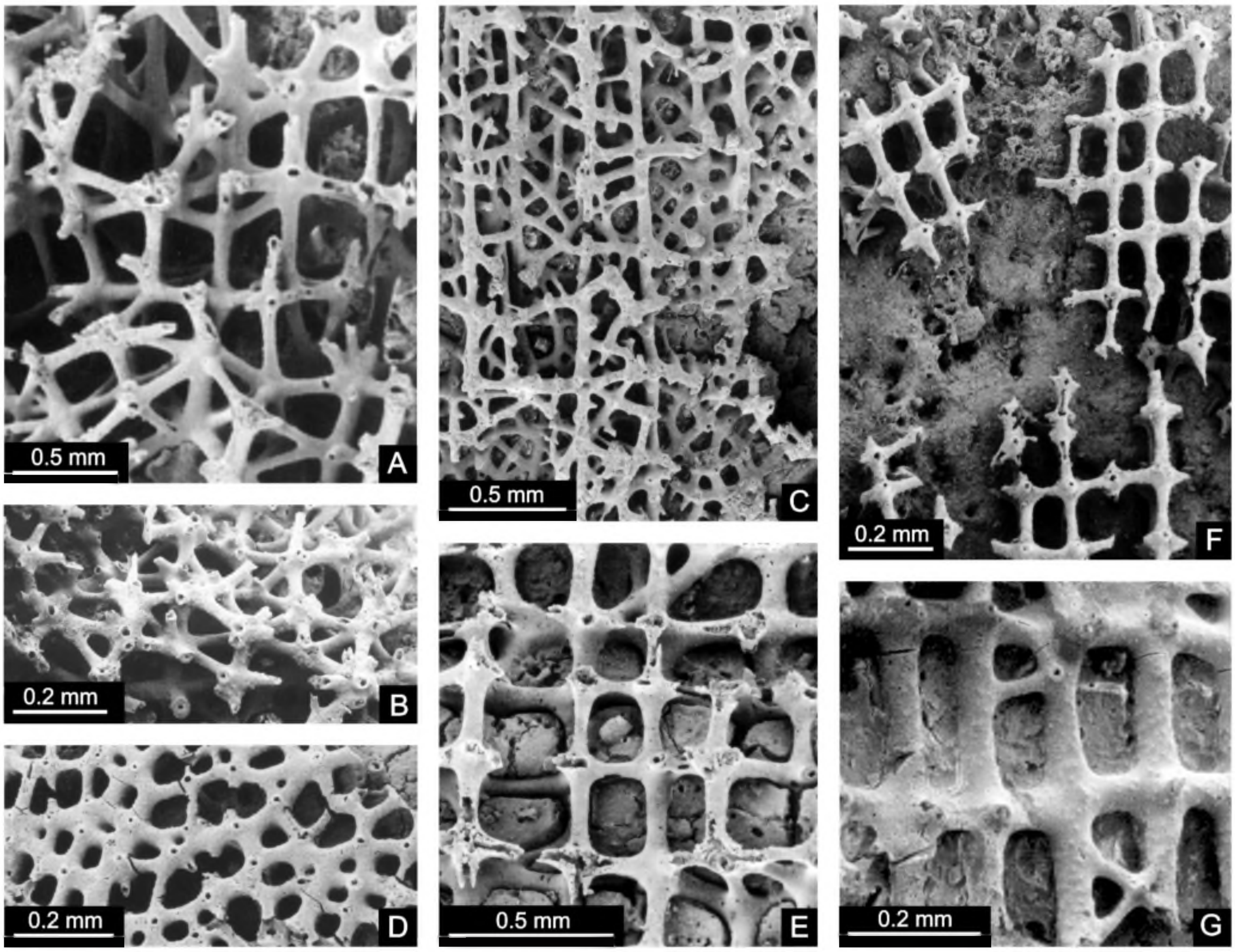

Fig. 5. **A, B** – *Eurete formosum* (Reid 1959); A – dictyonal skeleton; gastral surface network with rectangular meshes visible in right upper corner; Upper Campanian, Piotrawin (UL XX 8/133); B – dermal surface of the skeleton; Kazimierz, Upper Maastrichtian (UL XX 0/188); **C–E** – *Wollemania araneosa* Schrammen 1912; C – choanosomal skeleton; in the background note internal side of secondary network on gastral surface; D – secondary network on dermal surface; E – regular dictyonal skeleton from central part of wall; Piotrawin, Upper Campanian (C – UL XX 7/10; D, E – UL XX 3/69); **F, G** – *Eubrochis cribrosus* (Reid 1964); F – variably oriented fragments of network; Lower Maastrichtian, Dziurków (UL XX 6/19); G – secondary network on dermal surface with additional small hexactines of the next generation; Piotrawin, Upper Campanian (UL XX 8/144)

ton. In young individuals and the youngest parts of sponges, where the secondary network is very thin, canals may not be developed at all.

Remarks: Reid (1959) considered the massive shape as a typical for *E. formosum* based only on two incomplete specimens. The studied material shows a large outgenetic and morphological interspecific variability. Therefore, pyriform or columnar-shaped specimens from the Turonian–Lower Santonian of England described by Reid (1961a) as *Eurete* cf. *formosum* Reid 1959 also seems to be representing the studied species. According to Mehl (1992), some Late Cretaceous species from England with swollen nodes (see Reid, 1959, 1961a), including *E. formosum* Reid may be considered as synonyms of the Recent species *Pararete semperi* (Schulze 1887). The latter species possesses strongly thickened nodes covered with fine processes in their dermal and gastral part (Schulze, 1887, p. 292, pl. 77; Ijima, 1927, pp 193–194, pl. 16, figs 23–29). In *E. formosum*, only some of the multiradiate nodes have a slightly spherical shape. Due to this fact including *E. formosum* to *Pararete* genus and synonymizing with *P. semperi* is questionable.

Occurrence: Poland – Middle Vistula Valley (Upper Campanian–Uppermost Maastrichtian); England (Cenomanian–Lower Senonian).

Genus *Eubrochis* Schrammen 1902
(= *Callibrochis* Schrammen 1912) emended Reid 1963
Type species: *Eubrochis senonica* Schrammen 1902

Emended diagnosis: Funnel-shaped sponges or in shape of dichotomously dividing flattened tubes. Dictyonal skeleton regular, multimesh, without developed canals. On dermal surface one or multilayered secondary dictyonal layer comprising small hexactines. On gastral surface, secondary network irregular, with openings distributed according to meshes of dictyonal skeleton.

Remarks: Schrammen (1912) changed the name *Eubrochis* to *Callibrochis* due to the existence of another genus with the same name, *i.e. Eubrochus* Sollas 1876. The new name was accepted by Mehl (1992), whereas in this paper, following Laubenfels (1955) and Reid (1963b, 1964, 2004e), I accept the old name. In the description of the type species of *Eubrochis senonica*, Schrammen (1902, 1912) noted that the meshes of the dictyonal network are hexagonal, what would point to a farreoidal type of skeleton. Based on specimens from the collection of Schrammen, Reid (1959, p. 4) questioned this description, recognizing in this genus the euretoidal type of skeleton. According to Reid (1963b, 2004e), the genus *Eubrochis* may posses skeletal pores. This comes from the fact that Reid (1963b, 2004e) considered *Oxyrhizum* Schrammen 1912 as a synonym of *Eubrochis*, which, however, is treated herein as a separate taxon. The presented diagnosis of the genus *Eubrochis* is nevertheless broadened to encompass the species *Wollemania* (?) *cribrosa* Reid 1964.

Eubrochis cribrosus (Reid 1964)
Figs 4 (F, G), 5 (F, G)

*1964. *Wollemania* (?) *cribrosa* sp. nov: Reid, p. 66, text-fig. 37.

Emended diagnosis: Sponge comprising dichotomously divided, flattened branches. Wall thickness 3–4 mm. Lack of skeletal canals. Dictyonal skeleton very regular towards dictyonal strands, with large, longitudinally rectangular meshes. On dermal surface, very regular multilayered network with rectangular or quadrangular meshes, composed of secondary small hexactines. On gastral surface, additional hexactines in form of loose irregular network. Within gastral surface, round openings lying above meshes of dictyonal skeleton. Canalization dictyorhysal.

Material and preservation: 52 specimens (4 specimens from Dziurków, 1 from Podgórz, 3 from Męćmierz, 2 from Kazimierz, 1 from opoka from Bochotnica, 31 from opoka and 10 from greensand from Nasiłów). Material lacks specimens with basal part. Skeleton almost completely dissolved, except small fragments of secondary network on dermal surface. Voids after spicules sporadically filled with iron hydroxides.

Comparative material: One specimen from the northern Donbass region (UL XVII).

Description: Sponges comprising flattened widening tubes (Fig. 4F). In upper, wider part tubes dividing dichotomously. Secondary branches slightly larger. Length of particular tubes 60–80 mm, width in lower part ca. 25–30 mm. Wall thickness averagely 3 mm, maximally 4 mm. Planes of successive divisions (at least two) almost parallel. Angle between branching tubes close to a right angle. Dictyonal skeleton (Figs 4F, 5F, G) comprising exceedingly large hexactines, connected in very regular network. Dictyonal beams very faintly diverging towards dermal surface. With growth direction of dictyonal beams network meshes transversely rectangular, averagely 0.5 × 1 mm. Transversely network irregular with small (ca. 0.2–0.5 mm), quadrangular or triangular meshes. Cover comprising small hexactines, joined in very regular network with rectangular or quadrangular meshes (ca. 0.1 mm) on dermal surface (Fig. 4F). In initial growth stages, network mono-layered, later transforms into 2 (3?)-layered. Smaller hexactines of next generation may occur within network. External hexactines with reduced distal radius. General network orientation more or less conformable with sponge growth direction; however, series of different sized hexactines with directions oblique to each other may occur, therefore, with orientations independent of the distribution of dictyonal strands in primary network. Quadrangular or triangular meshes at connection between neighbouring complexes. On gastral surface, secondary network irregular, with triangular of polygonal meshes with diameters ca. 0.15 mm. Round openings, lying above meshes of primary dictyonal skeleton occurring within secondary network, thus forming regular vertical and horizontal rows. Canals not developed within skeleton.

Remarks: The construction of primary dictyonal skeleton and the very characteristic secondary network on dermal surface in specimens from the Cretaceous of Poland and in the single specimen from the Maastrichtian of Donbass Basin indicate their entire concordance with the holotype of *Wollemania* (?) *cribrosa* Reid 1964. The diagnosis of this species was based on a single, damaged specimen. Therefore Reid (1964, p. 66) described the sponge shape as unclear, probably funnel-like. The diagnosis lacks the description of the gastral surface of the choanosomal skeleton, invisible on the holotype. The description presented above supplements the diagnosis of the species. I do not accept the assignment of this species to the genus *Wollemania* Schrammen 1912. Despite the similar construction of the primary dictyonal skeleton in both genera, there are differences in the development of the secondary network on both its surfaces. In the genus *Wollemania*, both surfaces of the dictyonal skeleton are evenly covered by an irregular, mono-layered network composed of secondary hexactines, completely covering meshes of the main skeleton. In turn, the construction of this part of the choanosomal skeleton in the discussed species is similar to the species *Eubrochis senonica* Schrammen 1902, the only known representative of this genus with a funnel shape. In both species, secondary hexactines on the dermal surface fuse into a network with quadrangular or rectangular, generally longitudinal meshes (see Schrammen, 1912, p. 246, text-pl. 10, fig. 3). In *E. senonica*, the network is mono-layered, with a different size of meshes, and the hexactines have plate-like widened rays. The multilayered network distinguishing the species *E. cribrosus* is obviously a modification of the mono-layered network, occurring locally only in the youngest parts of some individuals. Schrammen (1912) noted that in *E. senonica* meshes of the dictyonal skeleton act as "postica", narrowed by the network from randomly oriented hexactines. In the examined individuals of *E. cribrosus*, despite the dissolved skeleton, this feature can be observed perfectly. In the dictyonal skeleton, in the central part of wall in specimens of *E. cribrosa* from Germany there are hexactines of different size, attached to nodes or to rays of primary hexactines (see Schrammen, 1912, text-pl. 10, fig. 2). In the material from Poland and England, due to dissolution of spicules, the observation of such secondary components of the skeleton is not possible.

Occurrence: Poland – Middle Vistula Valley (Maastrichtian); England (Maastrichtian); eastern Ukraine (Lower Maastrichtian).

Genus *Wollemania* Schrammen 1912
Type species: *Wollemania araneosa* Schrammen 1912

Wollemania araneosa Schrammen 1912
Figs 4A, 5 (C–E), 6

*1912. *Wollemania araneosa* nov. sp.: Schrammen, p. 247, text-pl. 10, figs 4–6; pl. 27, fig. 2; pl. 41, fig. 5.

?1960. *Porochonia simplex* (Smith): Defretin-Lefranc, p. 85, pl. 11, fig. 5.

1974. *Wollemania araneosa* Schrammen: Ulbrich, p. 51, pl. 10, fig. 1; pl. 19, fig. 6.

1992. *Wollemania araneosa* Schrammen: Mehl, pl. 12, fig. 7.

1993. *Wollemania araneosa* Schrammen: Jahnke & Gasse, pl. 21, figs 1, 2.

Material and preservation: 29 specimens (19 specimens from Piotrawin, 3 from Dziurków, 1 from Kłudzie, 2 from Dobre, 2 from Podgórz, 2 from Męćmierz). Most specimens complete or only slightly damaged. In some specimens, choanosomal skeleton rather well preserved.

Comparative material: One specimen from the northern Donbas region (UL XVII).

Description: Sponges in the shape of large (over 150 mm height), regular and rather narrow cones or cups (Figs 4A, 6). Most specimens with traces after very thin stalk. Forms with undeveloped

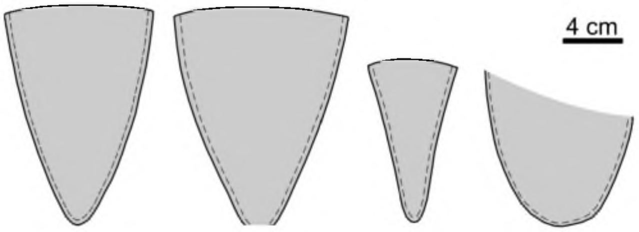

Fig. 6. Shape variability of *Wollemania araneosa* Schrammen 1912

stalk also preserved, with rhizoidal processes growing from different places in lower part of sponge. External and internal surface smooth, without canal openings. Canalization dictyorhysal. Dictyonal skeleton very regular with growth of dictyonal strands, with quadrangular or rectangular meshes (Fig. 5E). Mesh size averagely ca. 0.3 mm × 0.3–0.5 mm. In transverse cross-section, skeleton irregular, with small (ca. 0.1–0.2 mm) quadrangular or triangular meshes. Beams of dictyonal skeleton smooth. Small secondary hexactines attached to beams, particularly in lower part of sponge, near gastral surface. Both surfaces of dictyonal skeleton covered by thin single layer, developed through connection of secondary small hexactines with reduced distal rays. Network meshes of different sizes (averagely 0.05 mm), quadrangular or triangular. On dermal surface rays of secondary hexactines thickened, particularly in lower part (Fig. 5D). On gastral surface, network less dense, with hexactines of different generations (Fig. 5C). Rhizoidal skeleton of same type as secondary dictyonal skeleton, however with larger meshes, averagely 0.07–0.08 mm.

Remarks: The analyzed forms are identical with specimens described by Schrammen (1912) as well as Ulbrich (1974). Based on observations of single individuals from the collection of Schrammen, Mehl (1992) considers specimens assigned by Schrammen (1912) to *W. araneosa* as juvenile specimens of *Eubrochis senonica* Schrammen 1902. According to Mehl (1992), this is testified by a similar pattern of the dictyonal skeleton, which differs only in the size of spicules. Most spicules within individuals of one species may show some variations, however between the species the differences are much more distinct. In *E. senonica*, the spicules are twice as big as in *W. araneosa* (compare Schrammen, 1912, text-pl. 10, figs 4–6; Mehl, 1992, pp. 76–77, pl. 12, figs 6, 7). There are differences also in the construction of the secondary skeleton on both wall surfaces, particularly on the gastral surface. Accepting Mehl's (1992) assumption about the individual development, the network should be more developed in the mature form, therefore, in individuals representing the species *E. senonica*. In this species, in turn, the network on the gastral surface is loose, with spaces above the meshes of the main network, whereas in *W. araneosa* it is dense, with thickened beams. In the analyzed collection, there are small forms (40 mm height) as well as specimens exceeding 150 mm, which are rather not juveniles, as the known specimens of *E. senonica* are ca. 100 mm in height (Schrammen, 1912, pp. 246–247). All specimens, regardless the size, have the same skeleton pattern. Although it is not clear whether the genera *Wollemania* and *Eubrochis* are synonyms, the species are evidently distinct. According to Reid (1962c, 1968a), the species *W. araneosa* is often mistaken with *Porochonia simplex* (Smith 1848), a species belonging to Lychniscosida. According to Reid (1962c), this appears to some poorly preserved specimens, described by Hinde (1883) as *P. simplex*. The similarity between these species is a result of the lack of canals in the very regular wide-mesh dictyonal skeleton in both cases. In turn, *W araneosa* does not posses openings on the dermal surface, which are typical for *P. simplex* (Hinde, 1883, p. 143, pl. 30, fig. 5; Reid, 1962a, pp. 33–34). Most probably the specimens from the Coniacian and Campanian of France, described by Defretin-Lefranc (1960) as *P. simplex*, represent in reality *W. araneosa*. These forms have a completely dissolved skeleton, therefore it is not possible to determine the type of spicules. They do not possess openings in the external part of the dictyonal skeleton.

Occurrence: Poland – Middle Vistula Valley (Upper Campanian–Lower Maastrichtian); north-western Germany (Upper Campanian); eastern Ukraine (Lower Maastrichtian); ?France (Coniacian and Campanian).

Genus *Oxyrhizum* Schrammen 1912
Type species: *Oxyrhizum eximium* Schrammen 1912

Remarks: Reid (1963b, 2004e) synonymized the genus *Oxyrhizum* with *Eubrochis* Schrammen 1902. According to me, this is unjustified. *Oxyrhizum* is characterized by the presence of openings within the secondary dictyonal layer covering the dermal surface of the main dictyonal skeleton. Their presence, contrary to the case of *Eubrochis* (see Reid, 2004e) and a few other representatives of the family Euretidae, is independent of the individual development, which is also testified by their even distribution on the entire surface.

Oxyrhizum cf. *eximium* Schrammen 1912
Fig. 4B

cf.* 1912. *Oxyrhizum eximium* nov. sp.: Schrammen, p. 249, pl. 29, figs 11, 12; pl. 41, fig. 4.

Material and preservation: One specimen without basal part from Solec. Skeleton completely dissolved, however with distinct voids after choanosomal skeleton.

Description: Sponge in shape of narrow cone, ca. 60 mm high (Fig. 4B). Dermal surface with oval openings, elongated with the longer sponge axis. Average size ca. 0.8 mm × 0.6 mm. Openings distributed rather irregularly; in some cases, however, distributed more or less alternately in longitudinal rows. Smaller (averagely 0.4–0.6 mm), round openings occurring randomly between them. Dictyonal skeleton composed of large hexactines forming regular network with longitudinally elongated rectangular meshes (ca. 0.3 mm × 1 mm) in growth direction. In transverse cross-section, skeleton meshes triangular, averagely ca. 0.1 mm in size. Dictyonal strands diverging at very small angle towards dermal surface. Canals within main dictyonal skeleton not developed. Monolayered secondary network comprising small, irregularly connected hexactines on dermal surface. Gastral surface with similar network, however with larger meshes, with openings lying in rows above meshes of the main dictyonal skeleton.

Remarks: The described specimen differs from the holotype of *O. eximium* in the occurrence of larger oval openings on the dermal surface and in the presence of openings also in the network on the gastral surface. Dictyonal skeleton within wall is very regular, but because of the fact that it is visible only on a restricted area, it is difficult to determine whether there are less regularly connected hexactines within it, as was described by Schrammen (1912).

Occurrence: Middle Vistula Valley (Lower Maastrichtian).

Genus *Hapalopegma* Schrammen 1912
Type species: *Hapalopegma fragile* Schrammen 1912

Remarks: According to Reid (1963b,1964), Cretaceous genus *Hapalopegma* Schrammen is a synonym of *Eurete* Semper 1868. Linking both genera is, however, problematic, due to very sparse fossil material and lack of knowledge of loose spicules in representatives of the genus *Hapalopegma* Schrammen. Regnard (1925) assigned *Hapalopegma* to the family Leptophragmidae Schrammen 1912. However, the lack of canals developed in the dictyonal skeleton of *Hapalopegma* excludes relationship in this group of sponges, which are characterized by diplorhysis. Laubenfels (1955) placed the genus *Hapalopegma* in the family Dactylocalycidae Gray 1867. The regular multimesh skeleton of *Hapalopegma* is inconsistent with the characteristics of this family, which according to Laubenfels (1955) has an irregular skeleton with triangular meshes.

Hapalopegma meandrina Schrammen 1912
Fig. 4H

*1912. *Hapalopegma meandrina* nov. sp.: Schrammen, p. 258, text-pl. 9, fig. 13; pl. 27, fig. 13.
?1912. *Hapalopegma fragilis* nov. sp.: Schrammen, p. 258, text-pl. 9, fig. 15; pl. 27, fig. 12.
?1925. *Hapalopegma fragilis* Schrm.: Regnard, pl. 21, fig. 7.
1993. *Hapalopegma meandrina* Schrammen: Jahnke & Gasse, pl. 10, fig. 1.
?1993. *Hapalopegma fragilis* Schrammen: Jahnke & Gasse, pl. 17, fig. 3.

Material and preservation: 11 specimens (1 specimen from Ciszyca Górna, 6 from Piotrawin, 1 from Dziurków, 1 from Męćmierz, 2 from Kazimierz). All specimens without basal and top parts. Apart from singular spicules, choanosomal skeleton is entirely dissolved. Voids after spicules well visible, typically filled with iron hydroxides.

Comparative material: One specimen from the northern Donbas region (UL XVII).

Description: Sponge in lower part built of thin-walled (ca. 2 mm thick) and tightly spaced, small (up to 15 mm) tubes. With growth tubes developing into wide (over 60 mm) flattened lobes ca. 5–6 mm thick, the largest exceeding even 100 mm in length (Fig. 4H). Within lobes spongocoel of same shape. Opening of spongocoel not preserved on any specimen. Narrowing of some lobes in apical part, points that opening was possibly smaller than maximal width of entire lobe. Choanosomal skeleton comprising very large hexactines with smooth rays. Dictyonal strands diverging at very small angle towards dermal surface. With growth of dictyonal strands, skeleton very regular, with meshes typically longitudinally rectangular, 1.3–1.4 mm × 0.7–0.8 mm (Fig. 4H). Rarely meshes quadrangular (averagely 1 mm). Locally, particularly in lower parts of lobes, network less regular due to deformation of some rays. Terminations of rays connected directly with neighbouring nodes or with dictyonal beams of other hexactines. Transversely meshes small (0.2–0.5 mm), quadrangular or triangular. Free rays of hexactines on both surfaces of dictyonal skeleton not reduced. Lack of canalization within skeleton.

Remarks: According to Schrammen (1912), the species *H. meandrina* is represented by forms composed of tightly spaced sinuous tubes. The analyzed specimens show modifications of this construction. Tubes in upper part widen fan-like and attain shapes of flattened lobes, which recall lobes of *H. fragilis* Schrammen 1912. Taking into account that both species were known hitherto from single specimens, it should not be excluded that the diagnostic differences pointed out by Schrammen (1912) may be a result of preservation or specific variability. The dictyonal skeleton in *H. meandrina* and *H. fragilis* has the same pattern and comparable dimensions. According to Moret (1926), the new species recognized by him from the Cenomanian of France is closely related to *H. fragilis*. It differs in the tube-like elongations of the lobes. Due to the lack of individuals with an intact upper part of lobes in the analyzed material, it is not possible to compare these species. In the synonymy of the species *Callibrochis senonensis* (Schrammen 1902) (= *Eubrochis senonica* Schrammen 1902) presented by Mehl (1992), *H. fragilis* is considered a synonym of this species. Therefore, it is not clear why *H. fragilis* is not discussed by Mehl (1992, p. 76). In turn, *H. meandrina* (not indicated in the synonymy) is considered to represent damaged specimens assigned to *C. senonensis*. Linking these species is not justified due to completely different shape of the respective individuals (funnel- shaped in *Eubrochis senonica*), which is difficult to explain by post mortem deformation or growth of individual. From among species with a multimesh dictyonal skeleton, the genus *Hapalopegma* differs in the complete lack of secondary cover layer composed of small hexactines. If Mehl's (1992) suggestion is to be accepted, one has to assume that during fossilization this part of the skeleton must have been completely destroyed, or that we are dealing with juvenile forms in which the secondary network is not yet developed. The numerous analyzed material excludes these interpretations. No specimen bears a thickened network of the wall surfaces or its traces in form of voids after spicules, which are easily observed after dissolution of such layer in specimens representing other species.

Occurrence: Poland – Middle Vistula Valley (Lower Campanian–Maastrichtian); ?France (Cenomanian); north-western Germany (Campanian); eastern Ukraine (Lower Maastrichtian).

Family CRATICULARIIDAE Rauff, 1893 emended Reid 1963, 1964; emended Mehl 1992; emended Pisera 1997

Remarks: Reid (1963b, 1964) considered the euretoidal type of skeleton and diplorhysis with epirhyses and aporhyses distributed in quadrunx as the most important features distinguishing this family from other Hexactinosida. This assumption, however, has several exceptions due to the fact that some canals may run through the wall (Reid, 1963b, p. 227; Reid, 1964, pp. 104–106, text-figs 56, 59). My observations indicate that in Craticulariidae there is an arrangement of canal openings in vertical rows, whereas the distribution in horizontal rows may be less distinct. Determining the type of canalization only on the basis of canal openings, distribution on the wall surface without analyzing the canal pattern is uncertain. Mehl (1992) changed the definition of Craticulariidae because of exclusion of the Recent genus *Leptophragmella* Reid 1963, in which diarhysis were determined (see Mehl, 1992; Reiswig & Mehl, 1994). Mehl (1992) accepted the erroneous theory of Moret (1924) that the development of diplorhysis is linked with the radial folding of wall. The subsequent suplementation of the diagnosis of Craticulariidae was given by Pisera (1997), who generally accepted the diagnosis of Reid (1963b, 1964).

Genus *Leptophragma* Zittel 1877
emended Reid 1963, 1964
Type species: *Scyphia murchisoni* Goldfuss 1831

Remarks: Schrammen (1912) included the genus *Leptophragma* Zittel to a separate family Leptophragmidae Schrammen 1912. Laubenfels (1955) emended the diagnosis of this family and changed its name into Leptophragmatidea. The family was based on the genus *Laocoetis* Pommel 1872, with the "densely perforated skin" as one of the most characteristic features. At present, the dermal skeleton is not known in representatives of *Leptophragma* Zittel. Due to the type of canalization, this genus was assigned by Reid (1963b, 1964) to the family Craticulariidae Rauff 1893. This view is accepted herein.

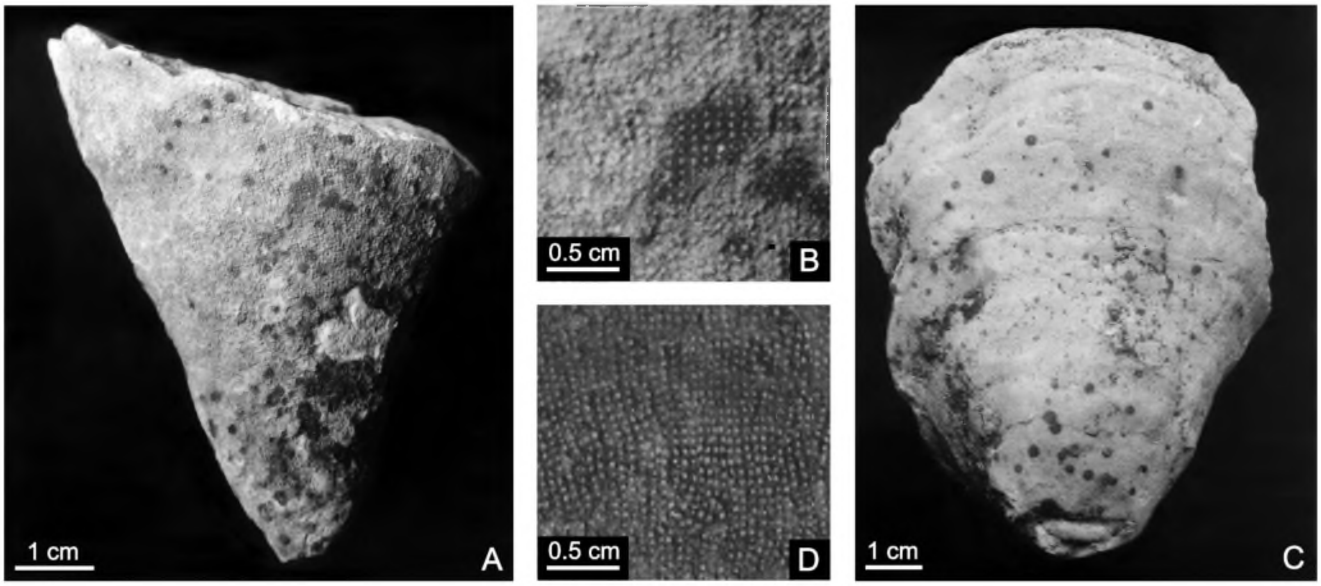

Fig. 7. **A, B** – *Leptophragma murchisoni* (Goldfuss 1831); A – lateral view; B – fragment of external surface with canal openings; Kazimierz, Upper Maastrichtian (UL XX 0/70); **C, D** – *Leptophragma micropora* Schrammen 1912; C – lateral view; D – fragment of external surface with canal openings; Kazimierz, Upper Maastrichtian (UL XX 7/50)

Leptophragma murchisoni (Goldfuss 1831)

Figs 7 (A, B), 8 (D, E)

*1826–1833. *Scyphia Murchissonii* nobis: Goldfuss, p. 219, pl. 65, fig. 8.
1841. *Scyphia Murchisoni* Goldfuss: Roemer, p. 9.
1864. *Cribrospongia Murchisoni* Goldfuss: Roemer, p. 10.
1877. *Leptophragma Murchisoni* Goldfuss: Zittel, p. 48. pl. 3, fig. 1.
1883. *Leptophragma Murchisoni* Goldfuss: Hinde, p. 102.
1910–1912. *Leptophragma Murchisoni* Goldfuss sp: Schrammen, p. 235, text-pl. 9, fig. 6; pl. 32, figs 1, 2.
1926. *Leptophragma Murchisoni* Goldfuss: Moret, p. 217.
v1933. *Leptophragma striatopunctata* Roemer: Bieda, pp. 23–24.
1962. *Leptophragma Murchisoni* Goldfuss: Lagneau-Hèren- ger, pp. 163–164, text-fig. 5b; pl. 2, fig. 2.
1964. *Leptophragma murchisoni* (Goldfuss): Reid, text-fig. 55.
1964. *Leptophragma murchisoni* (Goldfuss): Giers, p. 221.
v1968. *Leptophragma murchisoni* (Goldfuss): Hurcewicz, p. 61, pl. 14, figs 1a, b.
1961. *Leptophragma* cf. *micropora* Schrammen: Nestler, p. 27, pl. 5, figs 6–8.
1974. *Leptophragma murchisoni* (Goldfuss): Ulbrich, p. 54, pl. 2, fig. 1.
1977. *Leptophragma murchisoni* (Goldfuss): Khmilevsky, p. 44, text-fig. 2; pl. 3, fig. 2.
1992. *Leptophragma murchisoni* (Goldfuss): Mehl, p. 84.
1993. *Leptophragma murchisoni* Goldfuss: Jahnke & Gasse, pl. 12, figs 1, 2, 5; pl. 15, fig.1.

Material and preservation: 58 specimens (3 specimens from Ciszyca Kolonia, 4 From Ciszyca Górna, 20 from Piotrawin, 3 from Dziurków, 2 from Solec, 1 from Kłudzie, 4 from Dobre, 6 from Podgórz, 4 from Męćmierz, 11 from Kazimierz). Five specimens are almost complete, whereas the remaining are to a various degree damaged. Specimens typically strongly deformed by compaction. Dictyonal skeleton in some cases rather well preserved.

Comparative material: Collections UL III and A-1-1; 1 specimen from Kraków-Bonarka (UL XVI), 1 specimen from Ivano-Frankivsk area (UL XVII); 2 specimens from Mogilno near Łódź (UL XIX).

Description: Thin-walled (up to 3 mm thick), funnel-shaped sponges (Fig. 7A). The largest fragment indicates that they reached over 200 mm in height. Forms with narrow cups with rather massive stalk, terminated with short, wide rhizoidal processes. In wide forms, rhizoidal processes long, whereas stalk short and narrow or in some cases not developed at all. Both surfaces covered with small (0.25–0.4 mm in diameter), round canal openings, separated by skeletal bands of similar width (Fig. 7B). Canal openings distributed in horizontal and vertical rows; typically 256–272/cm^2 (16 × 16–17 rows). Forms with smaller number of pores (minimally 120/cm^2) rather rare. Canals straight, with craticularid distribution, running into over half of wall width. Dictyonal skeleton comprising small, smooth hexactines (Fig. 8D, E). Meshes typically triangular and quadrangular, averagely 0.15–0.2 mm. Rectangular meshes also present in subgastral part. Dictyonal strands diverging towards dermal surface. In outer parts of wall, dictyonal skeleton more dense and in form of network with triangular meshes and regular, multiradiate nodes. Nodes typically slightly thickened. Hexactine rays in this part of skeleton with fine tubercles. On dermal surface, network beams very thickened, cortex not developed. Basal skeleton identical as outer surface of dictyonal skeleton. Longitudinal canals in stalk and rhizoidal processes not numerous.

Differentiation: Specimens in form of regular and rather narrow cups on a massive and long stalk dominate in Kazimierz. In Piotrawin, in turn, wider forms with short and thin stalk or without stalk are present. In the remaining exposures, due to poor preservation, the determination of shape is problematic.

Remarks: In references, distinguishing *L. murchisoni* is based most of all on the number of canal openings on unit of area. Different authors, however, accept different ranges for this species. It seems that this fact is linked not only with specific variability but also with the accuracy of measurements. According to Schrammen (1912), individuals of this species posses only 50 "ostia" per 0.5 cm^2. For the same specimens, Mehl (1992) gave the range of 90–288/cm^2. Bieda (1933) assumed that among the specimens pre-

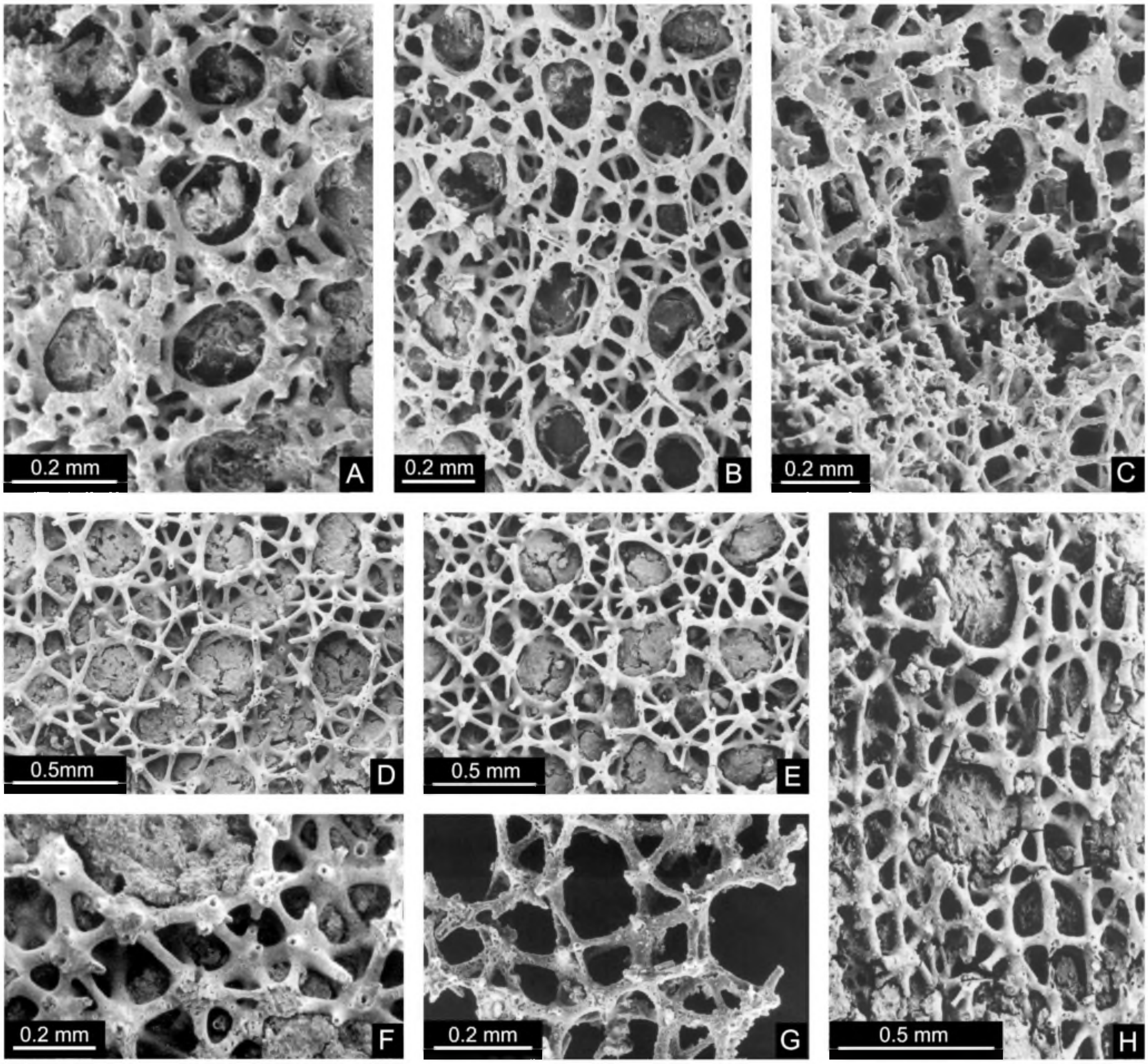

Fig. 8. **A–C** – *Leptophragma micropora* Schrammen 1912; A – internal side of gastral part of the dictyonal skeleton with aporhyses; B – subdermal part of the dictyonal skeleton; C – basal skeleton covering dictyonal network in lower part of sponge (dictyonal network visible in upper part); Piotrawin, Upper Campanian (A, B – UL XX 8/108; C – UL XX 0/261); **D, E** – *Leptophragma murchisoni* (Goldfuss 1831); D – subgastral part of the dictyonal skeleton with aporhyses; E – subdermal part of the dictyonal skeleton with epirhyses; Upper Campanian, Piotrawin (D, E – UL XX 2/20); **F** – *Pleurostoma scyphus* Pocta 1883; gastral surface of the dictyonal skeleton; Kazimierz, Upper Maastrichtian (UL XX 3/123); **G, H** – *Pleurostoma dichotoma* (Schrammen 1902); G – araldite pseudomorph of dictyonal skeleton with canals from the central part of wall (cast made from specimen UL XX 6/150); H – dermal surface of the dictyonal skeleton; Kazimierz, Upper Maastrichtian (UL XX 6/150)

sented by Schrammen (1912) as *L. murchisoni* are also individuals representing a different species, and those with numerous small pores were assigned by him to *L. striatopunctata* (Roemer 1841), similarly as specimens from the Cretaceous of the vicinity of Kraków, with 320–360 openings per 1 cm^2. Ulbrich (1974) gave a similar density of pores, averagely 310–360/cm^2, for the Lower Campanian specimens of *L. murchisoni* from the Ilsenburg. Observations of the material from the Middle Vistula Valley, as well as of the comparative specimens, indicate that representatives of this species present a very large variability in relation to the number of canal openings per 1 cm^2 of area. Therefore, taking into account also other morphological features, the specimens mentioned above are assigned to *L. murchisoni*. To this species belong also specimens from Rügen with 420 canal openings per 1 cm^2, assigned by Nestler (1961) to *Leptophragma* cf. *micropora* Schram- men 1912. Contrary to *L. micropora*, these individuals have canal openings distributed in very regular horizontal and vertical rows. Including *L. pusilla* Schrammen 1902 to the synonymy of *L. murchisoni* (see Mehl, 1992) seems to be unjustified. The former species is characterised by a tube-like shape, uncommon in the population of *L.*

murchisoni, as well as by a skeleton with larger meshes (Schrammen, 1902, p. 22, pl. 3, fig. 6; Schrammen, 1912, p. 236, pl. 32, figs 6, 7, text-pl. 9, fig. 6). The specimen from the collection of Schrammen, assigned by Janke and Gasse (1993) to *L. pusilla*, should also be excluded from the species, as its choanosomal skeleton contains lychniscs. Moreover, according to Reid (1964, p. 104), *L. pusilla* contains long aporhyses, which may run through entire wall (compare Schrammen, 1912, pl. 32, figs 6, 7), as well as a radial distribution of the dictyonal strands (see Reid, 1964, p. 112). Based on the density of canal openings, Mehl (1992) assumed that *L. glutinata* (Quenstedt 1878) and *L. membranacea* (Quenstedt 1878), described by Lagneau-Hèrenger (1962, pp. 56–57) from the Albian of France, represent the wide spectrum of *L. murchisoni*. However, the very regular dictyonal skeleton in *L. glutinata* and *L. membranacea* poses some objections, as such skeleton occurs in *L. murchisoni* only in the sub- gastral part. The construction of the outer parts of the skeleton is also different, particularly in *L. glutinata*, where multiradiate nodes are not present (Lagneau-Hèrenger, 1962, p. 56, text-pl. 8, fig. 2). Mehl (1992) did not discuss these differences in the species included within the synonymy of *L. murchisoni*.

Occurrence: Poland – Middle Vistula Valley (Upper Campanian–Upper Maastrichtian), Kraków area (Upper Campanian), Łódź area (Campanian); England (Cenomanian and Senonian); southern France (Senonian); Ukraine (Cenomanian, Campanian–Maastrichtian); north-western Germany (Campanian).

Leptophragma micropora Schrammen 1912
Figs 7 (C, D), 8 (A–C)

?1883. *Leptophragma fragilis* Roemer: Hinde, p. 103.
*1912. *Leptophragma micropora* nov. sp.: Schrammen, pp. 237–238, text-pl. 9, fig. 1; pl. 32, figs 4, 5; pl. 43, fig. 2.
v1980. *Leptophragma micropora* Schrammen: Małecki, p. 414, pl. 43, fig. 5a, b.

Material and preservation: 68 specimens (1 specimen from Ciszyca Kolonia, 2 from Ciszyca Górna, 31 from Piotrawin, 2 from Dziurków, 3 from Solec, 3 from Kłudzie, 3 from Dobre, 5 from Podgórz, 4 from Męćmierz, 15 from Kazimierz). Among the analysed specimens, 8 are almost complete. All are strongly deformed due to compaction. In some specimens, the skeleton is very well preserved in the lower part of the sponge.

Comparative material: Collection A-1-82; unpublished specimen from Kraków-Podgórze, assigned by Bieda to *Leptophragma fragilis* Roemer (A-1-1); one specimen from the northern Donbas region (UL XVII).

Description: Shape of sponges very variable, from regular cups to wide bowls, in some cases with folded wall (Fig. 7C). Margin of some cups turned outwards. Largest specimens exceed 150 mm in height. Forms typically with stalk, in some cases, rhizoidal processes grow directly from lower part of individual. Round canal openings on both wall surfaces, distributed in vertical rows. Horizontal arrangement disturbed. Canal openings on dermal surface very small, 0.15–0.2 mm in diameter (Fig. 7D). Skeletal bands separating them of similar width. On internal surface, canal openings slightly larger, whereas skeletal bands very narrow, typically twice as small as diameter of openings. Number of canal openings on both surfaces similar, 480–520 per cm^2. Diplorhysis short and straight. Epirhyses and aporhyses in form of independent longitudinal series, typical of craticularid type of canalization. Dictyonal skeleton within wall comprising smooth hexactines, forming rather regular network with prevalence of quadrangular and rectangular meshes (0.2 mm x 0.2–0.25 mm in size). In subdermal and subgastral part, network less regular, with triangular and quadrangular meshes, with diameters not exceeding 0.1 mm. Some nodes within network with many rays, of irregular shapes, because terminations of rays of some hexactines join together not in the central part of the neighbouring knot, but link in its vicinity with a ray running from the knot. Both on dermal and gastral surface network beams with fine tubercles and strongly thickened, due to which meshes are very small (0.04–0.06 mm in size). Cortex not present. Construction of basal skeleton similar as in *L. murchisoni*. Skeleton additionally thickened by randomly distributed small hexactines.

Differentiation: In the analysed *L. micropora*, there is an analogy to the variability of *L. murchisoni* from different exposures, *i.e.* specimens from Piotrawin are wide and in some cases have a folded wall. Forms without stalks are also numerous. Specimens from Kazimierz in turn are much narrower and more regular on thick stalk.

Remarks: Similarly as in *L. murchisoni* the diagnostic feature in this case is the density of canal openings. Schrammen (1912) stated that the number of both "ostia" and "postica" in *L. micropora* is 120–150 per 0.5 cm^2, thus per 1 cm^2 it would be only 240–300. It is problematic whether these numbers, similarly as in the case of *L. murchisoni*, are correct. When comparing these data with the individual illustrated by Schrammen (1912, pl. 32, fig. 1), these numbers seem far too small. It is notable that, applying the same counting method, this author stated trice the number of canal openings in *L. micropora* in comparison to *L. murchisoni*. In relation to the data from the diagnosis presented by Schrammen (1912), Nestler (1961) assigned the specimens of *Leptophragma* cf. *micropora* from Rügen (with 210 "ostia" per 0.5 cm^2) as more fine-porous in comparison to the type specimens. Specimens from Rügen still have a smaller number of pores in comparison to the specimens from Poland. In the specimens from Rügen, the regular distribution of canal openings in horizontal and vertical rows indicates that they represent *L. murchisoni*. Ulbrich (1974) points out that two specimens assigned by him to *L. murchisoni* due to the number of pores (360–400/cm^2) and wall thickness are transitional forms between *L. murchisoni* and *L. micropora*, therefore distinguishing both species is controversial. Taking into account measurements of the number of pores carried out within this research, this character is considered one of the diagnostic features of this species. Schrammen (1912) stated that a less regular pore arrangement and a tendency to develop a thinner wall with ear-shaped folds also distinguish this species. According to this author, the variability of shapes in individuals of this species is linked with the process of evolution. In evolutionary younger forms, folded walls are not very pronounced. In the material analysed herein, the first mentioned feature is very distinct. The shape of individuals is, however, closer to *L. murchisoni*. The observed species variability within *L. micropora* in particular exposures is analogous to the changes observed in the population of *L. murchisoni*, what indicates influence of the environment, and not evolution of the species. Due to general features of the skeleton and the size and distribution of canal openings the specimens from England, described by Hinde (1883) as *L. fragilis* (Roemer) (non *Leptophragma fragile* Sollas, 1883, p. 545, pl. 20, figs 10, 11), recall *L. micropora*. Most probably the specimens from the Lviv opoka of *Cribrospongia fragilis* Roemer, mentioned by Siemiradzki (1909), represent *L. micropora*. Synonymizing *L. micropora* with the species *Scyphia fragilis* described by Roemer (1841) is a result of macroscopic resemblance of the two taxa. After Schrammen's (1912) revision, *Scyphia fragilis* Roemer was included to *Callodictyon* Zittel 1877 within Lychniscosida.

Occurrence: Poland – Middle Vistula Valley (Upper Campanian–Upper Maastrichtian), Kraków area (?Santonian and Campanian); north-western Germany (Santonian–Campanian); eastern Ukraine (Lower Maastrichtian); England (Senonian) – according to Reid (1968a).

Genus *Laocoetis* Pomel, 1872
(= *Craticularia* Zittel 1877, *Paracraticularia* Schrammen 1936, *Thyridium* Laubenfels 1955, *Laocoetis* Mehl 1992)
Type species: *Laocoetis crassipes* Pomel 1872

Laocoetis fittoni (Mantell 1822)
Fig. 9I

*1822. *Millepora Fittoni* nov. sp.: Mantell, p. 106, pl. 15, fig. 10.
1848. *Brachiolites digitatus*: Smith, p. 365, pl. 16, fig. 2.
1864. *Dendrospongia fenestralis* nov. sp.: Roemer, p. 21, pl. 8, fig. 6.
1883. *Craticularia Fittoni* (Mantell): Hinde, p. 94, pl. 23, figs 2–2b.
1926. *Craticularia Fittoni* (Mantell): Moret, p. 214.
1962. *Paracraticularia fittoni* (Mantell): Lagneau-Hèrenger, p. 53.
1963. *Paracraticularia fittoni* (Mantell): Wagner, p. 209, pl. 28, fig. 7.
non v1968. *Paracraticularia fittoni* (Mantell): Hurcewicz, pp. 60–61, pl. 14, fig. 4 (=*Pleurostoma dichotoma* Schrammen).
1964. *Craticularia fittoni* (Mantell): Reid, text-fig. 54.
1974. *Craticularia fittoni* (Mantell): Ulbrich, p. 52.
v1980. *Paracraticularia fittoni* (Mantell): Małecki, pl. 1, fig. 1.
v1980. *Paracraticularia subseriata* (Roemer): Małecki, pl. 1, figs 2, 4; pl. 2, fig. 1.
v1980. *Strefinia convoluta* (Hinde): Małecki, pl. 2, fig. 6.
v1980. *Rhizopoterionopsis pruvosti* Defretin-Lefranc: Małecki, pl. 3, fig. 3.

Material and preservation: 1 incomplete specimen from Piotrawin and 1 fragment from Dobre. Skeleton apart from small fragment in subdermal part is entirely dissolved. Voids after spicules poorly visible.

Comparative material: Collection A-1-82.

Description: Sponge built of tube-like branches, 10–25 mm in diameter (Fig. 9I). Wall thickness ca. 2 mm. Dichotomously divided branches irregularly attached to each other. Openings slightly narrower than diameter of branches due to margin diverging inwards present on their apical parts. Some branches with blind lateral protrusions. On both surfaces, canal openings round, 1–1.5 mm in diameter. Canal openings distributed in regular horizontal and vertical rows, averagely 30–40/cm^2. Canals straight, perpendicular to wall, with pattern typical for the genus. Dictyonal skeleton comprising hexactines with smooth or finely granulose rays. In subdermal part, hexactines in form of irregular network with triangular meshes, 0.1–0.2 mm in diameter.

Remarks: The individuals representing the species *L. fittoni* typically possess bifurcating branches, which do not link with each other again. The specimens from the Cretaceous of the Middle Vistula Valley, similarly as those from Korzkiew, represent the rare cases where some branches link again with each other, due to which the sponges attain an irregular shape (compare Hinde, 1883; Reid, 1964, p. 57). All analyzed specimens of this species assigned by Małecki (1980) to different taxa (see synonymy) have the same pattern and identical distribution of canal openings on the external surface. Their skeleton composes hexactines, in contrast to *Strefinia convoluta* Hinde 1883 and *Rhizopoterionopsis pruvosti* Defretin-Lefranc 1960, which represent Lychniscosida. The specimen assigned by Hurcewicz (1968) to *L. fittoni* (Mantell) represents in reality *Pleurostoma dichotoma* (Schrammen 1902).

Occurrence: Poland – Middle Vistula Valley (Upper Campanian–Maastrichtian), Kraków area (?Santonian); France (Valanginian); Spain (Aptian); north-western Germany (Cenomanian and Lower Campanian), England (Aptian–Coniacian); France (Cenomanian); southern France (Campanian) – after Hèrenger (1946).

Genus *Pleurostoma* Roemer 1841
emended Zittel 1877, emended Reid 1963
(=*Typhlopleura* Schrammen 1902)
Type species: *Pleurostoma radiatum* Roemer 1941

Remarks: The diagnosis of this genus presented by Roemer (1841) was based on the type species *Pleurostoma radiata* Roemer 1841, which is characterised by a bilateral flattening. Zittel (1877), relating to the species *P. bohemicum*, emended the diagnosis to encompass forms with a flattened body with lateral branches. Due to this, Schrammen (1912) synonymized the earlier described *Typhlopleura* Schrammen 1902 with *Pleurostoma*, which in turn was assigned to the new family Leptophragmidae Schrammen 1912. Laubenfels (1955) distinguished a new family Pleurostomatidae, erroneously characterised by the presence of twisting, branching canals. In turn, *Typhlopleura* was erroneously included within the family Botryosellidae Schrammen 1912. This view is completely wrong, because the discussed genus possesses well developed canals, whereas the family Botryosellidae is characterised by a wall with rare canals or is completely devoid of them. Considering the classifications of Laubenfels (1955), Reid (1964) claimed, that the genus *Typhlopleura* represents Craticulariidae Rauff 1893. In the systematic presented by Reid (1963b, 1964), *Typhlopleura* has not been specified as a distinct genus, as a wide definition of genus *Pleurostoma* proposed by Reid (1963b) includes characteristic feature of type species *Typhlopleura dichotoma*. However, Reid (2004e) included genus *Typhlopleura* to subfamily Chonelasmatinae Schrammen 1912 (Euretidae) that includes fossile genera, which opposite to Craticularidae, lack of canalization. The opinion though seems erroneous. The diagnosis of *Typhlopleura* by Reid (2004e) is inconsistent with the Schrammen's descriptions (1902, 1912) as well as with my own observations. According to him, "exterior with skeletal pores in radiating, longitudinal series piersing only fine cortical meshwork; interior as in *Eubrochis* Schrammen". The *Eubrochis* has regular dictyonal skeleton with large rectangular meshes without canalization, while the discussed genus has an irregular skeleton with small triangular meshes, with straight canals, distributed in regular series. The canal openings in both surfaces are arranged in regular longitudinal and vertical rows, which does not respond with the diagnosis of the subfamily Chonelasmatinae Reid (2004e).

Pleurostoma dichotoma (Schrammen 1902)
Figs 8 (G, H), 9 (A, B)

*1902. *Typhlopleura dichotoma* nov. sp.: Schrammen, p. 24, pl. 1, fig. 3.
1910–1912. *Pleurostoma dichotoma* Schrammen: Schrammen, p. 239, pl. 30, fig. 10.
non 1933. *Pleurostoma dichotomum* Schrammen: Rauff, p. 31, pl. 1, fig. 14a, b [=*Guetardiscyphia sp.*).
?1933. *Pleurostoma radiatum* Roemer: Rauff, p. 31, pl. 1, fig. 13.
1926. *Pleurostoma irregularis* nov. sp.: Moret, pp. 218–219.
v1968. *Paracraticularia fittoni* (Mantell): Hurcewicz, p. 60, pl. 14, fig. 4.
partim v1968. *Craticularia virgatula* Schrammen: Hurcewicz, pp. 59–60.

Material and preservation: 88 specimens (6 specimens from Piotrawin, 1 from Solec, 2 from Dziurków, 6 from Kłudzie, 3 from Dobre, 2 from Podgórz, 2 z from Męćmierz, 24 from Kazimierz, 1 from Janowiec, 1 from opoka from Bochotnica, 18 from opoka and 22 from greensand from Nasiłów). Most specimens are strongly damaged. Material from the glauconitic sandstone is represented by broken off fragments. Dictyonal skeleton sporadically preserved, mainly on dermal surface.

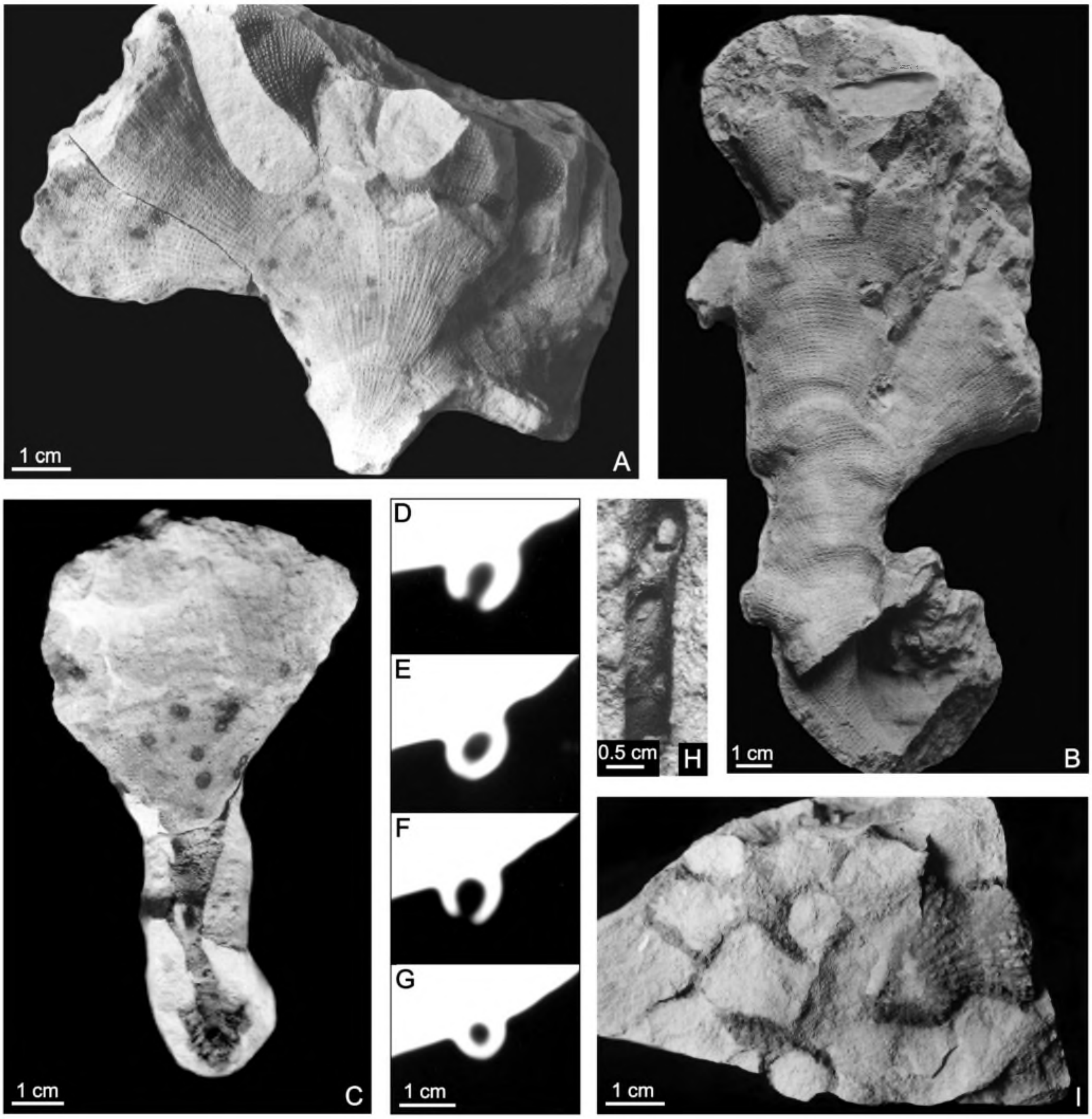

Fig. 9. **A, B** – *Pleurostoma dichotoma* (Schrammen 1902); A – morphotype with shortened axial part; Kazimierz, Upper Maastrichtian (UL XX 3/110); B – morphotype with distinct axial part; Nasiłów, opoka, Upper Maastrichtian (UL XX 1/205); **C–H** – *Pleurostoma scyphus* Počta 1883; C – lateral view; D–G – a series of transverse cross–sections through lower part of sponge; images made by using X–ray tomography; wall of sponge is white; H – imprint of lateral, narrow margin with 3 oscula; Kazimierz, Upper Maastrichtian (C–G – UL XX 3/126; H – UL XX 7/69); **I** – *Laocoetis fittoni* (Mantell 1822); lateral view; exposed internal surface with imprints of canal openings; Piotrawin, Upper Campanian (UL XX 7/50)

Comparative material: Collection UL II; 1 specimen from Zabierzów near Kraków (UL XVI), 1 specimen from southern Donbass region and 1 specimen from Crimea (UL XVII).

Description: Thin-walled sponge with strongly flattened body with numerous lateral lobes (Fig. 9A, B). Lobes alternately growing from main trunk in plane of flattening. Lobes widened fan-like, folded or even spirally coiled. Additional oscula, occurring on narrow margins of sponge round or slightly oval, with longer diameter 3–5 mm. On margin of lobes, oscula arranged every ca. 7–10 cm, in axial part very rare, situated in irregular distances. Both surfaces covered by longitudinal rows of small canal openings, arranged very regularly in horizontal and vertical rows. On fan-like folds the longitudinal rows radially dispersed and new rows of openings appear in between. Canal openings on dermal surface round, ca. 0.5 mm in diameter. In marginal parts of folds, openings become longitudinally elliptical, with longer diameter up to 0.6 mm. Openings separated by ca. 0.5 mm wide longitudinal skeletal bands. Transverse bands typically slightly narrower. Canal openings on gastral surface slightly larger, whereas skeletal bands between them slightly narrower, therefore, their number is analogous as on dermal surface, 100–168/cm^2 (10–12 × 10–14 rows). Openings leading to straight, perpendicular to wall, blind canals. Dictyonal skeleton within wall comprising small smooth hexactines, connected into rather irregular network with rectangular and quadrangular meshes, 0.1–0.2 mm (Fig. 8G). On dermal surface skeleton thickened with triangular meshes and multiradiate nodes (Fig. 8H). Basal part in form of irregular lump with strongly thickened skeleton with structure identical as external dictyonal skeleton.

Differentiation: Due to the general morphology of sponges, two extreme morphotypes can be distinguished:

Type 1 (Fig. 9A) – Lateral lobes rather rare (typically 3–4), very large and wide. Lobes growing from axial part very closely to each other, therefore main trunk is strongly shortened, in some cases even indistinct. Width of sponge much exceeds its height (largest individual representing type 2 is ca. 150 mm wide and ca. 100 mm high). Forms of this type occur in all exposures except for Nasiłów and Bochotnica.

Type 2 (Fig. 9B) – Lateral lobes numerous, rather small. Lobes growing at considerable distances from each other, grouping more densely only within apical part of sponge. The flat axial part is distinct, in form of trunk. Body height much exceeds its width (largest individual representing type 1 is ca. 200 mm high and ca. 130 mm wide). Forms typical for opokas from Nasiłów and Bochotnica. The determination of the shape of specimens from the glauconitic sandstone from Nasiłów is impossible due to fragmentary preservation.

Remarks: The juvenile specimen with only one well developed lateral lobe and incipient new lobes indicates that the lobes developed one after another towards the top with growth of axial part. They were formed due to protrusion of wall along a narrow margin of the flattened body, the shape of which in the initial development stage was close to *P. radiata* Roemer 1841 (compare Reid, 1964, p. 64). The spongocoel did not branch, only formed recesses within the lobes. The diagnosis of *P. dichotoma* does not univocally state where is the opening of the spongocoel. Most probably it would be located in the apical part of the highest lobe. However, none of the analysed specimens shows the presence of a fissure-like opening, analogous as in *P. radiata*. This might result from poor preservation, it should not be excluded, however, that the opening underwent narrowing, and its functions were taken over by the additional oscula. This phenomenon is observed in the representatives of some species of the genus *Guetardiscyphia* Fromentel 1860 (compare Wagner, 1963, pp. 212–214). The analysed material indicates a high polymorphism of the species. Three specimens described by Schrammen (1902, 1912) represent the type with a distinct, flattened central part. In turn, the only specimen described by Moret (1926) as a new species *P. irregularis* belongs to forms with a shortened axial part, due to which Moret (1926) considered that the branches divide dichotomously. All features of this new species given by Moret (1926) are typical of *P. dichotoma*. To *P. dichotoma* belongs also the specimen assigned by Hurcewicz (1968) to *Paracraticularia fittoni* (Mantell 1822). This individual possesses characteristic flattened fan-like branches. The margin with secondary oscula is damaged. Similarly, to *P. dichotoma* may belong the phosphatized specimen from the Turonian of Westphalia, described by Rauff (1933) as *P. radiatum* Roem. This twisted individual resembles the lateral lobes of *P. dichotoma*, contrary to the shovel-shaped *P. radiatum*. Due to the general outline, particularly of forms with a distinct axial part, *P. dichotoma* is similar to *P. bohemica* Zittel 1877. The assignment of the latter species to the genus *Pleurostoma* Roemer is, however, doubtful due to the alternate arrangement of canal openings on the dermal surface (compare Počta, 1883, p. 21, text-fig. 7, pl. 2, fig. 7; Frič, 1889, p. 102, fig. 138; Scupin, 1912–13, p. 261, pl. 15, fig. 14). Regular, alternate distribution of canal openings is also present on the surface of a strongly damaged individual from the Turonian of Westphalia, assigned by Rauff (1933, pp. 31–32, pl. 1, fig. 14) to *P. dichotoma*. Specimens of *P. dichotoma* from the Upper Cretaceous of Poland, as well as the examined specimens from the Maastrichtian of the Crimean Peninsula and Donbas region possess, similarly as the holotype of *P. dichotoma*, canal openings very regularly distributed in horizontal and vertical rows. Therefore, the discussed specimen from Germany should be excluded from *P. dichotoma*.

Occurrence: Poland – Middle Vistula Valley (Upper Campanian–Maastrichtian); Kraków area (Campanian); north-western Germany (Campanian); southern France (Santonian), Ukraine (Maastrichtian); England (Senonian) – according to Reid (1968a).

Pleurostoma scyphus Počta 1883
Figs 8 (F), 9 (C–H)

*1883. *Pleurostoma scyphus* nov. sp.: Počta, p. 21, pl. 2, fig. 4; text-fig. 8.

1977. *Pleurostoma scyphus* Počta: p. 74, pl. 2, figs 1, 3.

1977. *Pleurostoma zaszkiewiensis* Khmilevsky, nov. sp.: Khmilevsky p. 46, pl. 1, figs 2, 3; pl. 3, figs 1, 3; text-fig. 3.

Material and preservation: 5 specimens from Kazimierz. Three specimens are almost complete. Choanosomal skeleton preserved fragmentarily, without the dermal surface preserved.

Description: Funnel-shaped sponges, up to ca. 100 mm in height (Fig. 8F). Lower, narrower part slightly flattened. Narrower margins with oval oscula every ca. 6 mm with larger diameter ca. 3 mm (Fig. 9C–H). On opposite margins, oscula distributed alternately (feature determined on the basis of computer tomography cross-sections). Outer surface with small, round canal openings. Separating them skeletal bands of similar width. Canal openings distributed in longitudinal rows. With widening of sponge, new rows appear in between. Arrangement in horizontal rows less distinct. Distribution of canal openings on gastral surface more regular, in form of vertical and horizontal rows. Diameter of openings slightly larger here, with narrower skeletal bands in between. Averagely 168–196 openings per 1 cm^2 on both surfaces (14 × 12–14 rows). Craticularid type of canalization. Dictyonal skeleton within wall comprising very fine, smooth hexactines in form of rather irregular network with quadrangular and triangular meshes. Mesh size 0.1–0.2 mm. On gastral surface, network with triangular meshes and with multiradiate, slightly spherically thickened nodes.

Remarks: Morphology of specimens from Poland is identical with that of the holotype of *P. scyphus* as well as that of specimens from Ukraine, assigned by Khmilevsky (1977) to this species as *P. zaszkiewiensis*. The construction of the present fragments of the choanosomal skeleton in the analysed specimens is similar to both species of *Pleurostoma* from Ukraine. Due to the very general information on the skeleton of *P. scyphus* presented by Počta (1883), the comparison with specimens from the Czech Republic is not possible. Analysing the illustration of the holotype of *P. scyphus*, Khmilevsky (1977) indicated that the typical number of “ostia” is ca. 200/0.5 cm^2. Therefore, Khmilevsky (1977) included to *P. scyphus* specimens with a similar density of canal openings, whereas forms with a smaller number of canal openings (84–90/0.5 cm^2) were distinguished as a separate species *P. zaszkiewiensis*. According to the carried out calculations, concordant with the results of Rauff (1933), the specimen of *P. scyphus* presented by Počta (1883) possesses only ca. 72 canal openings per 0.5 cm^2. Due to the very few hitherto described individuals of *P. scyphus*, it is difficult to state univocally the characteristic for this species extreme values of this parameter. In relation to this feature, specimens assigned by Khmilevsky (1977) to the new species *P. zaszkiewiensis* are closer to the holotype. Therefore the differences in the density

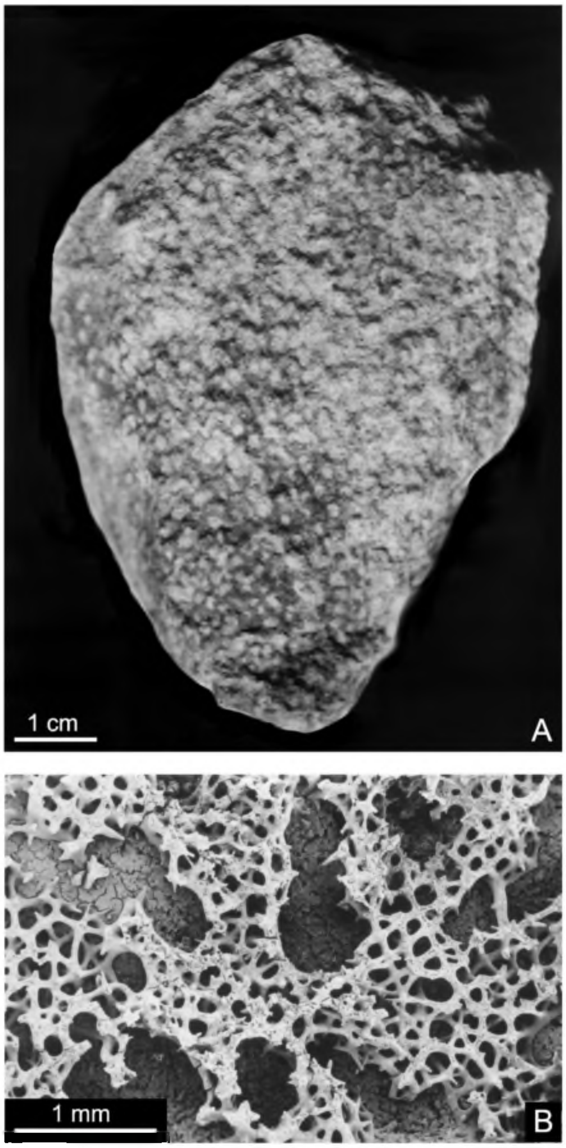

Fig. 10. **A, B** – *Polyopesia leavis* (Schrammen 1912); A – lateral view; B – internal side of dermal part of the dictyonal skeleton with canal openings; Piotrawin, Upper Campanian (A – UL XX 3/13; B – UL XX 8/100)

of canal openings cannot be the basis to distinguish the species *P. zaszkiewiensis* Khmilevsky. Počta (1883) defining *P. scyphus* stated that "ostia" are distributed in a "quincunx", whereas this feature is not univocally visible on the illustration of the holotype. In the same way, Rauff (1933) described the distribution of canal openings on the dermal surface in specimens, which were assigned by him to *Pleurostoma* cf. *scyphus*, however in this case there is no certainty whether the described lower fragment of the individual belongs to a form with a funnel-shaped termination. In the case of specimens analysed herein, the distribution of canal openings in longitudinal rows is notable, whereas their arrangement in relation to each other in a horizontal direction is less distinct, depending on the individual as well as part of sponge surface. The identical morphology of the dermal surface is present on specimens of this species from Ukraine, described as *P. zaszkiewiensis* Khmilevsky (1977, pl. 1, fig. 3; pl. 3, figs 1, 3), whereas the specimens assigned by Khmilevsky (1977, pl. 2, fig. 3) to *P. scyphus* have canal openings distributed in regular horizontal and vertical rows.

Occurrence: Poland – Middle Vistula Valley (Upper Maastrichtian); Czech Republic (Senonian); Ukraine (Upper Maastrichtian).

Family CRIBROSPONGIIDAE Roemer 1864
Genus *Polyopesia* Schrammen 1902
emended Schrammen 1912, emended Reid 1961
Type species: *Polyopesia angustata* Schrammen 1902

Remarks: Schrammen (1912) identified the genus *Polyopesia* with the genus *Hexactinella* Carter 1885, what was accepted by some authors (see Defretin-Lefranc, 1960; Brimaud and Vachard, 1986b). According to Reid (1961b), this is not correct, as *Hexactinella* possesses schizorhysis, whereas *Polyopesia* has labyrinth-like diplorhysis (Reid, 1964, text-fig. 52c).

Polyopesia leavis (Schrammen 1912)
Fig. 10 (A, B)

*1912. *Hexactinella leavis* nov. sp.: Schrammen, p. 224, pl. 26, figs 5, 8, 9; pl. 42, fig. 5.

Material and preservation: 18 specimens (5 from Dziurków, 13 from Piotrawin). Three specimens are almost complete, the remaining are to a large degree damaged. Subdermal skeleton well preserved in some specimens.

Description: Sponges over 120 mm high, funnel- or cup-shaped (Fig. 10A) on short stalk with long rhizoidal processes. Wall thickness ca. 4 mm. External surface covered by canal openings, which are evenly spaced, however without distinct arrangement. Canal openings round, oval or irregular, ca. 1–2 mm in diameter, averagely 12–20 per 1 cm^2. In lower part of sponge, openings generally smaller and more densely packed. Skeletal bridges occurring between canal openings, 1–2 mm wide and strongly convex. Internal surface with round canal openings, ca. 1.8–2.3 mm in diameter, distributed rather irregularly, more or less alternately, averagely 10–16 per 1 cm^2. Epirhyses straight, perpendicular to wall, leading to chambers branching between aporhyses and situated on internal part of wall. Epirhyses rarely terminating blindly directly below gastral surface. Aporhyses leading to small, irregularly distributed holes within wall, from which run canals with small openings (0.3–0.5 mm) on dermal surface. These small openings occur on the apical part of small tubercles, situated on the skeletal bridges. Distances between small openings variable, 0.1–0.7 mm. Dictyonal skeleton comprising small hexactines, forming rather regular skeleton with quadrangular and square meshes, ca. 0.15–0.2 mm in size. Towards both surfaces skeleton becomes irregular, with triangular or quadrangular meshes (Fig. 10B). Hexactine beams smooth, in surface parts with small singular spines. Small secondary hexactines attached to skeletal beams occurring in lower part of sponge. Dictyonal cortex not developed. Beams of surface hexactines strongly thickened (0.05–0.07 mm), therefore meshes rounded, averagely ca. 0.1 mm in size. External beams long, not reduced. Skeleton within rhizoidal processes dense and thickened, comprising long filaments surrounding singular longitudinal canals.

Differentiation: Five specimens possess additional rhizoidal processes, growing from sponge even 40 mm above the stalk. This suggests that the lower part of the sponge was buried during growth.

Remarks: The specimens of *P. leavis* from Poland do not reveal any essential differences in relation to the skeletal structure, shape and morphology of both surfaces in comparison to the holotype (Schrammen, 1912, pl. 26, figs 8, 9). Some examined specimens possess less numerous accessory terminations of the aporhyses on the dermal surface. According to Schrammen (1912), the epirhyses are tube-shaped and terminate blindly below the gastral surface. In the studied material, most epirhyses run into internal chambers. This is concordant with the observations of Reid (1961b, p. 746; 1964, p. 106), according to whom *Polyopesia* is characterized by a labyrinth-shaped development of epirhyses and aporhyses. Chambers observed in specimens of *P. leavis* from the Vistula Valley are irregularly branching and do not compose a continuous subgastral canalization system as in *P. angustata* Schrammen 1902 (compare Reid, 1964, text-fig. 52c).

Occurrence: Poland – Middle Vistula Valley (Campanian–Lower Maastrichtian); north-western Germany (Campanian); England and Ireland (Senonian) – according to Reid (1968a).

Family APHROCALLISTIDAE Gray 1867
Genus *Aphrocallistes* Gray 1858
Type species: *Aphrocallistes beatrix* Gray 1858

Aphrocallistes alveolites (Roemer 1841)
Figs 11 (A–F), 12 (A)

*1841. *Scyphia alveolites*: Roemer, p. 8, pl. 3, fig. 6.
1883. *Aphrocallistes alveolites* Roemer: Hinde, p. 106.
1912. *Aphrocallistes alveolites* Roemer: Schrammen, p. 219, text-pl. 11, fig. 5; pl. 25, figs 8–10; pl. 31, fig. 3.
v1933. *Aphrocallistes alveolites* Roemer: Bieda, p. 21, pl. 2, fig. 2.
1961. *Aphrocallistes alveolites* (Roemer): Nestler, pp. 28–29, pl. 6, figs 1–4.
1964. *Aphrocallistes alveolites* (Roemer): Giers, p. 220.
v1968. *Aphrocallistes alveolites* (Roemer): Hurcewicz, pp. 64–65.
1974. *Aphrocallistes alveolites* (Roemer): Ulbrich, p. 57, pl. 11, figs 3, 5.
1974. *Aphrocallistes alveolites* (Roemer): Khmilevsky, pp. 37–38, pl. 1, figs 1, 2.

Material and preservation: 46 specimens (3 from Piotrawin, 5 from Dziurków, 2 from Kłudzie, 1 from Podgórz, 1 from Męćmierz, 4 from Kazimierz, 4 from opoka and 1 from greensand from Bochotnica, 12 from opoka and 14 from greensand from Nasiłów). Specimens damaged to a variable degree. Choanosomal skeleton preserved fragmentarily. In specimens from the glauconitic sandstones, skeleton completely dissolved.

Comparative material: Collections UL III and A-1-1; 2 specimens from Kraków-Bonarka (UL XVI).

Description: Rather thick-walled (2–4 mm) sponges comprising central stalk (up to 120 mm high) without terminal opening, from which grow branches or laterally flattened lobes distributed in a star-like pattern (Fig. 11A–D). Typically, three irregular lobes widening towards the top and 10–23 mm thick are developed. Lobe margin smooth or with small rounded appendixes. In some cases, longer branches also present, typically straight, cylindrical, 10–25 mm in diameter and up to ca. 50 mm long. Rarely, branches dichotomously or irregularly divided. Terminations of branches typically narrowed and rounded. Some branches sheared, with a terminal sieve plate (Fig. 11E, F). Sieve plate thinner than wall (ca. 1.5–2 mm thick), with irregular pores, up to 1.8 mm in size. On both surfaces, round canal openings, 0.7–1.5 mm in diameter, separated by narrow (ca. 0.1–0.2 mm) skeletal bands. Canal openings regularly distributed, alternately, in a honeycomb pattern, averagely 60–120 per 1 cm^2. Diarhysis perpendicular to wall. Choanosomal skeleton in central part of barrier separating the neighbouring canals comprising hexactines, forming a network with nodes possessing shifted rays. All rays lie more or less in one plane adjacent to the canal. Network mono-layered with triangular meshes (0.5–0.1 mm) without distinct dictyonal beams. Three-D skeleton with multiradiate nodes occurs only in outer parts of skeleton and in seam between barriers. Cortex developed on both surfaces of dictyonal skeleton (Fig. 12A).

Remarks: Hitherto, *A. alveolites* was described only as a branching form, despite the fact that some earlier known fragments of individuals indicate the presence of lobes (Ulbrich, 1974, pl. 11, fig. 5). The Polish material univocally points to the large polymorphism in this species, common in *Aphrocallistes* Gray. The presence of both lobes and branches was also noted in other fossil species, such as *A. verrucosus* Lagneau-Hèrenger (1962, p. 82, pl. 16, fig 2, text-pl. 12, fig. 5), *A. polytretos* Rigby (Rigby & Jenkins, 1983, p. 4, figs 3–10, 14) and *A. cylindrodactylus* Schrammen. In relation to the shape and surface morphology, the species closest to *A. alveolites* is the Tertiary *A. lobatus* (Pommel) [= *Badinskia lobata* Pomel 1872; non *Aphrocallistes lobatus* Schrammen 1912]. Its axial part is flattened into longitudinal lobes in a star-like pattern, which may terminate with cylindrical branches. The number of lobes in this case varies from 4 to 9 (Pomel, 1872, pp. 85–86, pl. 2, figs 7–9). Brimaud and Vachard (1986b, p. 427, pl. 6, fig. 2) also described singular oscula located on the cluster-shaped terminations of lobes in this species. The sieve plate in *A. lobatus* was not observed. Despite these differences, the very close relationship of these species is not excluded, taking also in account the fact that the secondary oscula and the terminal sieve plate in other species of *Aphrocallistes* occurs occasionally (compare *Aphrocallistes cylindrodactylus* Schrammen). The wall structure of *A. lobatus* indicates the presence of very thin barriers between the canals (Pomel 1872, pl. 2, fig. 7; Moissette *et al.* 1984, pl. 1, fig. 2), similarly as in *A. alveolites*. Based on the very sparse information about the skeletal structure in this species (compare Moissette *et al.* 1984, pl. 1, fig. 2a, b) it is not possible to state whether hexactines with deformed rays occur within the skeletal bands between the canals, what is typical of *A. alveolites* (compare Reid, 1964, p. 108; Ulbrich, 1974, p. 57).

Occurrence: Poland – Middle Vistula Valley (Lower Campanian–Upper Maastrichtian), Kraków area (Campanian); north-western Germany (Campanian); Rügen (Lower Maastrichtian); Russia – Volgograd region (Coniacian), Ulyanovsk region (Santonian – Campanian); Ukraine – southern Donbas region (Upper Campanian), western Podilia (Lower and Upper Maastrichtian); England and Ireland (Campanian–Maastrichtian) – according to Reid (1968a).

Aphrocallistes cylindrodactylus Schrammen 1912
Figs 11 (G–L), 12 (B, C), 13

*1912. *Aphrocallistes cylindrodactylus* nov. sp.: Schrammen, p. 220, text-fig. 1; text-pl. 11, fig. 6.
1912. *Aphrocallistes lobatus* nov. sp.: Schrammen, p. 222, text-fig. 2; pl. 26, fig. 1.
v1968. *Aphrocallistes kazimierzensis* nov. sp.: Hurcewicz, pp. 66–67, text-fig. 14; pl. 15, figs 1, 2.
v1968. *Aphrocallistes bochotnicensis* nov. sp.: Hurcewicz, pp. 67–69, text-fig. 15; pl. 16, figs 1, 2.
v1968. *Aphrocallistes mammillaris* nov. sp.: Hurcewicz, p. 69, pl. 16, fig. 3.
1974. *Aphrocallistes cylindrodactylus* Schrammen: Khmilevsky, p. 38, text-fig. 2; pl. 1, figs 3, 4; pl. 2, fig. 3.
1974. *Aphrocallistes* cf. *bochotnicensis* Hurcewicz: Khmilevsky, p. 39, text-fig. 3.
v1980. *Aphrocallistes lobatus* Schrammen: Małecki, pl. 2, fig. 7.
v1980. *Aphrocallistes coronatus* sp. nov.: Małecki, pp. 414–415, text-fig. 4; pl. 3, fig. 2.
v1980. *Becksia soekelandi* Schlüter: Małecki, pl. 9, fig. 2.
1985. *Mastophorus kazimierzensis* (Hurcewicz): Radwański, p. 73, pl. 45, fig. A.

Material and preservation: 192 specimens (1 from Ciszyca Kolonia, 2 from Ciszyca Górna, 36 from Piotrawin, 19 from Dziurków, 1 from Solec, 10 from Kłudzie, 1 from Dobre, 2 from

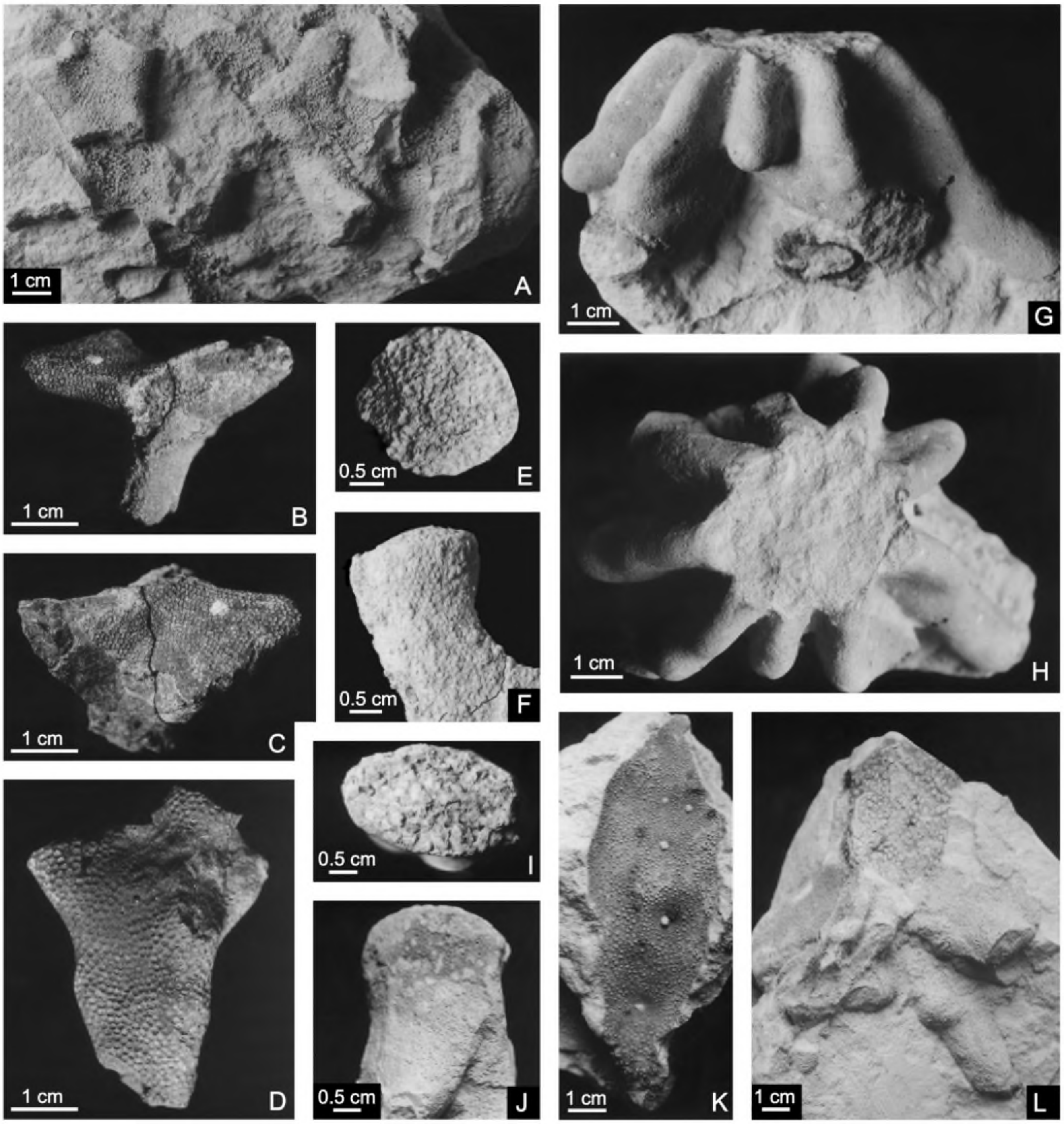

Fig. 11. **A–F** – *Aphrocallistes alveolites* (Roemer 1841); A – branched morphotype; Nasiłów, opoka, opoka, Upper Maastrichtian (UL XX 4/55); B – top view of lobe–like morphotype; C – lateral view of lobe–like morphotype; D – central stalk with broken off branches; Nasiłów, greensand, Upper Maastrichtian (B, C – UL XX 0/54; D – UL XX 4/56); E – apical part of branch with sieve plate; F – lateral view of single branch; Kłudzie, Lower Maastrichtian (E, F – UL XX 8/38); **G–L** – *Aphrocallistes cylindrodactylus* Schrammen 1912; G – lateral view; H – top view; sieve plate not visible, covered by rock; Nasiłów, opoka, Upper Maastrichtian (UL XX 0/50); I – single branch; apical part terminating with sieve plate; J – lateral view; Piotrawin, Upper Campanian (UL XX 2/94); K – imprint of lower surface of branch with secondary oscula; Nasiłów, opoka, Upper Maastrichtian (UL XX; 1/130); L – lateral view; sieve plate visible in place where lobes are broken off; Piotrawin, Upper Campanian (UL XX 1/67)

Podgórz, 2 from Męćmierz, 17 from Kazimierz, 1 from Janowiec, 9 from opoka and 2 from greensand from Bochotnica, 24 from opoka and 67 from greensand from Nasiłów). Most specimens are damaged to a variable degree. Skeleton in most cases dissolved. Only the dictyonal cortex is preserved.

Comparative material: Collections UL III and A-1-82; 5 specimens from Józefów (UL XVI); 4 specimens from Mogilno near Łódź (UL XIX).

Description: Funnel-shaped sponges up to 120 mm high, on short stalk, with 7–9 lateral, radially distributed lobes (Figs 11G, H, L, 13). Funnel, up to 50 mm in diameter, with rounded margin bent inside. Margin connected to cup-shaped, rather thick-walled sieve

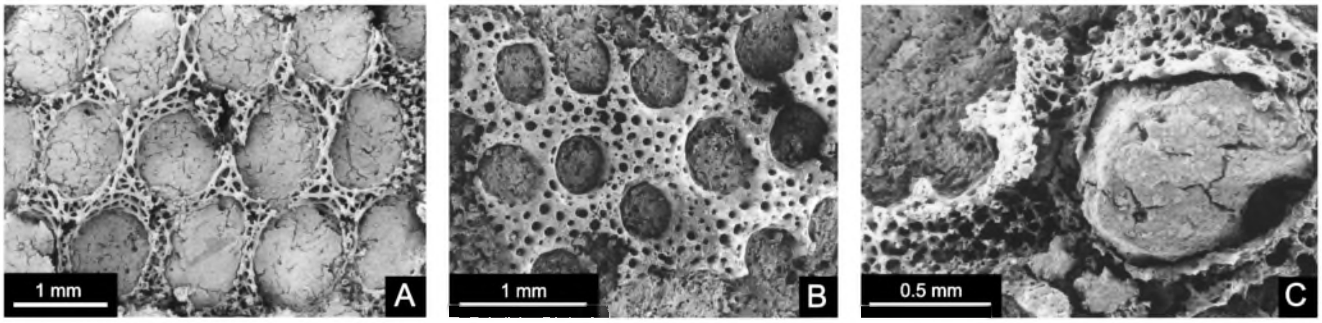

Fig. 12. **A** – *Aphrocallistes alveolites* (Roemer 1841); cortex on dermal surface; Kazimierz, Upper Maastrichtian (UL XX 9/13); **B, C** – *Aphrocallistes cylindrodactylus* Schrammen 1912; B – cortex on dermal surface; C – internal part of the skeleton of the sieve plate; Piotrawin, Upper Campanian (B – UL XX 8/112; C – UL XX 8/110)

plate. In transverse cross-section, plate round or polygonal. Sieve plate fused with the internal margins of lobes, closing it completely. Outer margin of flattened lateral lobes with rounded protrusions or short finger-like branches. Wall in both lobes and branches up to 1–2 mm thick. Long (up to 120 mm) cylindrical branches, 10–20 mm in diameter, may grow from lower part of lobes or directly from funnel. Branches typically straight, although in some cases twice dichotomously branching forms are also present. Termination of branches blind and rounded, sporadically sheared and with sieve plate (Fig. 11I, J). Small tubercles terminating with small oscular opening occur on lower surface of some lobes and lower branches. Tubercles distributed at irregular distances, from 0.5 to 20 mm. Singular oscula occurring also on apical part of short branches, growing in some specimens below lobes in lowermost part of sponge (Fig. 11K). Basal part in form of irregular, thick process with thickened skeleton without canalization. Basal processes in some cases occurring on apical parts of finger-like protrusions directed downwards, growing from the lowermost branches. Sponge surface covered by randomly but densely distributed round canal openings, 0.3–0.5 mm in diameter. Skeletal bands separating canals of similar width. Averagely 120–210 canal openings per 1 cm^2. Canals perpendicular to sponge surface and running through the wall. Singular canals on inwards bent funnel margin. Sieve plate riddled, with pores of various sizes, 1–3 mm. Pores polygonal. Thickened skeletal bands on plate surface have additional processes directed towards the openings, thus the pore outline is very irregular. Sieve plate on apical part of branch similarly constructed. Choanosomal skeleton comprising smooth hexactines, forming irregular network with quadrangular or triangular meshes, ca. 0.1–0.2 mm in size (Fig. 12C). Dictyonal bands parallel to canals. Dermal surface covered by very thick cortex (Fig. 12B). Cortex surface covered with knobs after reduced external rays. Network within sieve plate irregular, with triangular, small (0.1 mm) meshes and multiradiate, thickened nodes.

Differentiation: Specimens from Piotrawin have shorter branches and a narrowed lower part with numerous tubercle-like protrusions. Individuals from other exposures have very long, often dichotomously divided branches, and the lower part of sponge without short protrusions.

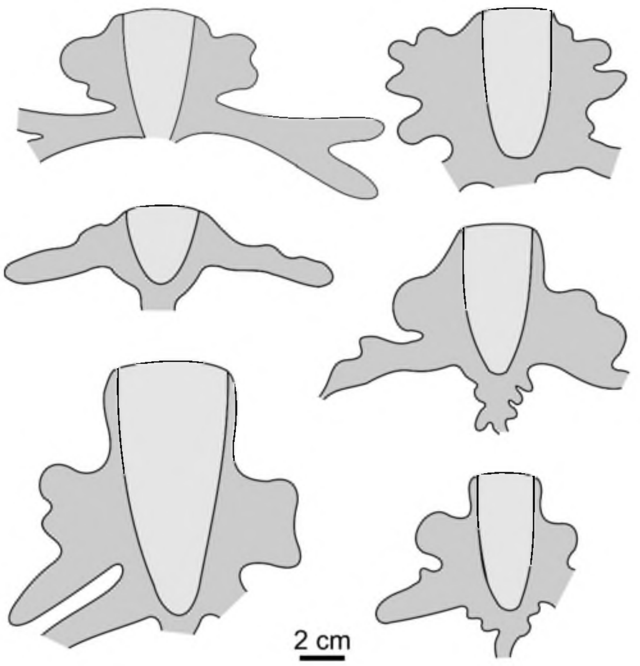

Fig. 13. Shape variability of *Aphrocallistes cylindrodactylus* Schrammen 1912; figures showing longitudinal cross-section through sponge; the sieve plate is marked in grey

Remarks: *A. cylindrodactylus* is characterized by a very large specific variety. Its lobe-like fragments are described as *A. lobatus* Schrammen 1912. According to Reid (1964, p. 61), these lobes may be variously distributed in relation to the sponge axis, *i.e.* longitudinally to transversely. They can also occur in a regular, star-like pattern (Reid, 1964, p. 64), which is typical of specimens from Korzkiew and from the Middle Vistula Valley. Contrary to the hitherto known representatives of this species, besides lobes some individuals may possess long, straight or dichotomous branches. Similarly as in some Recent representatives *Aphrocallistes* (see *A. beatrix orientalis* Ijima 1927 – Okada, 1932, pp. 51–52 or *A. bocagei* Wright 1870 – Schulze, 1887, pl. 83, fig. 1) some downwards directed finger-like branches served as supports. Furthermore, the characteristic feature of the studied individuals is the presence of small oscular openings in the lower surface of some lobes and branches (Hurcewicz, 1968, pl. 16, fig. 1a; Khmilevsky, 1974, p. 39). Both in the Recent and fossil species of *Aphrocallistes*, additional oscula, if developed, are located in the apical part of branches (Bowerbank, 1869, p. 325; Okada, 1932, p. 51, pl. 4, fig. 1; Brimaud & Vachard, 1986b, p. 427, pl. 6, fig. 2). Terminally located oscula in *A. cylindrodactylus* appear sporadically. In the studied material, the sieve plate was observed in the apical part of a lateral branch for the first time in this species. According to Reid (1964, p. 129), the sieve plate in *A. cylindrodactylus* is a structure analogous to the terminal plate in the Recent *A. beatrix* (Grey, 1858, pl. 11, fig. 2; Schulze, 1887, p. 314). Despite the apical location of these plates in the discussed species, these structures are not considered homologous herein. The sieve plate in *A. cylindrodactylus* developed as a result of connecting several internal sieve

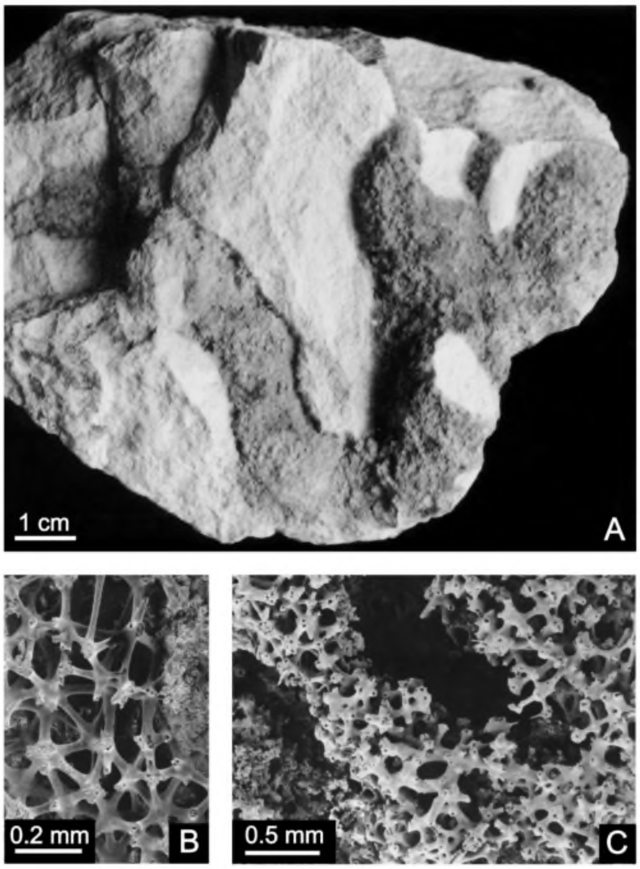

Fig. 14. A–C – *Aphrocallistes vistulae* Hurcewicz 1968; A – lateral view; B – dictyonal skeleton; C – dermal surface of the dictyonal skeleton; Kazimierz, Upper Maastrichtian (A – UL XX 0/273, B – UL XX 0/213, C – UL XX 0/212)

plates. This is testified by the complete fusion of margins of its particular parts with the internal lobe margins. In some specimens, the particular parts of the plate may not be fused with each other. In these cases, the longitudinal narrow wall skeleton bands occur between the skeleton typical of the sieve plate. Due to the large polymorphism of this species, in studies based only on few specimens, representatives of *A. cylindrodactylus* were erroneously assigned to new taxa (Hurcewicz, 1968; Małecki, 1980). The specimens' shape, resulting from damage, was considered by some authors diagnostic for new taxa. Specimens presented by Małecki (1980, text-fig. 4) as *A. coronatus* have partly broken off lobes, similarly as forms assigned by this author to *Becksia soekelandi* Schlüter 1868. In the latter specimens, moulds of small hexactines without lychniscs are visible, what excludes them from the Lychniscosida. Only the specimens representing *A. mammillaris* Hurcewicz 1968 is a fragment of the lower part of a sponge with tubercle-like fingers and belongs to *A. cylindrodactylus* discussed here. In the diagnosis of *A. bochotnicensis* nov. sp., Hurcewicz (1968) noted that this species is characterized by the lack of a "spongocoel" (she applied this term to the concave sieve plate) and the occurrence of two systems of branching. These observations result from the incomplete preservation of the holotype (crushed specimen) and the fragmentary preservation of the sieve plate. The strong flattening of branches in *A. kazimierzensis* Hurcewicz 1968 results from compaction. Hurcewicz (1968) considered the number of canal openings per unit of area as a specific feature. According to Hurcewicz (1968, p. 71, tabl. 4), the number of "ostia" in *A. kazimierzensis*, similarly as in *A. bochotnicensis*, and contrary to *A. cylindrodactylus*, is ca. 100 per 1 cm^2. Based on measurements carried out in this study on specimens from the UL III and personal collections, the density of canal openings is 120–220 per 1 cm^2, what suggests a much wider range for *A. cylindrodactylus* (Schrammen, 1912: 100/0.5 cm^2; Khmilevsky, 1974: 90–100/cm^2). Radwański (1985) assigned specimens of *A. cylindrodactylus* from Nasiłów to the species *Mastophorus kazimierzensis* (Hurcewicz). This suggestion, despite some similarities in the shape to *Mastophorus arboreus* Schrammen (1924, p. 54, pl. 14, fig. 3) is completely wrong, as the skeleton in the latter species is composed of tetraclones.

Occurrence: Poland – Middle Vistula Valley (Upper Campanian–uppermost Maastrichtian), Kraków area (?Santonian), Łódź area (Campanian); north-western Germany (Campanian); Ukraine (Upper Maastrichtian); England and Ireland (Campanian–Maastrichtian) – according to Reid (1968a).

Aphrocallistes vistulae Hurcewicz 1968
Fig. 14 (A–C)

*1968. *Aphrocallistes vistulae* nov. sp.: Hurcewicz, p. 70, pl. 17, fig. 1.

1974. *Aphrocallistes vistulae* Hurcewicz: Khmilevsky, p. 39, pl. 1, fig. 5a, b; pl. 2, fig. 2a, b, w.

Material and preservation: 29 specimens (18 from Kazimierz, 5 from opoka and 6 from greensand from Nasiłów). Most specimens are incomplete and strongly attached to the rock. Typically skeleton almost completely dissolved. In some cases, skeleton replaced by goethite or buried in silica within cherts.

Comparative material: Collection UL III.

Description: Sponge comprising rather thick-walled (3–4 mm), dichotomously divided branches, reaching 15–25 mm in diameter and 150 mm in length (Fig. 14A). First division leads always to the formation of two main branches. Each one divides then into two short branches, of which only one divides further. Planes of the subsequent divisions are approximately perpendicular to each other. Termination of branches straight or slightly widened, with margin bent inwards, narrowing the opening to 10–15 mm. In some cases, branch-like protrusions without terminal opening occur. Both surfaces with round canal openings, 0.4–0.6 mm in diameter, separated by skeletal bands of comparable width or even wider. Canal openings distributed irregularly or alternately, averagely 40–60 per 1 cm^2. Canals straight, perpendicular to wall. Dictyonal skeleton comprising smooth hexactines, forming irregular network with quadrangular and triangular meshes, ca. 0.1 mm in size (Fig. 14B). Some nodes of multiradiate character. Dictyonal strands parallel to canals. Skeleton more dense closer to both external surfaces. Hexactine rays thickened on dermal surface (Fig. 14C). Loose, outer rays not reduced. Dictyonal cortex lacking.

Remarks: In the description of this species, Hurcewicz (1968) noted that the number of "ostia" is only ca. 32 per 1 cm^2. A similar density was stated for this species by Khmilevsky (1974), despite the fact that sizes of canal openings and skeletal bands on the specimens from Podilia illustrated by him are identical as in the case of Polish specimens. Measurements carried out in this study on the holotype and collected material indicate a more dense distribution of the canal openings in this species. According to Hurcewicz (1968), the "composition of the parenchymal and cortical skeleton is identical as in *A. kazimierzensis* Hurcewicz" (=*Aphrocallistes cylindrodactylus* Schrammen). Contrary to the latter species, *A. vistulae* Hurcewicz does not have a developed cortex (see also Khmilevsky, 1974, p. 39, pl. 1, fig. 5). Additionally, comparing to species with a similar body plan, such as the Recent *A. ramosus* Schulze (1887, pp. 319–320, pl. 86, fig. 1) and the Albian *A. macroporus* Lagneau-Hèrenger (1962, p. 83, pl. 16, fig. 3, text-pl.

12, fig. 6), *A. vistulae* has wide skeletal bands between the canals. A similar type of skeleton is observed in the branching *A. hurcewiczae* (Trestian, 1972, pp. 34–35, pl. 6, figs 2, 3, text-fig. 1) from the Cenomanian of Moldova and in the Albian *A. verrucosus* (Lagneau-Hérenger, 1962, pp. 82–83, pl. 16, fig. 2; text-pl. 12, fig. 5) from France. The first species has small, numerous (110–120/cm^2) canal openings and branches dividing in one plane. The second, in turn, comprises lobes, from which grow branches ending with a wide terminal opening.

Occurrence: Poland – Middle Vistula Valley (Upper Maastrichtian); Ukraine (Upper Maastrichtian).

Aphrocallistes caliciformis sp. nov.
Fig. 15 (A–C)

Holotype: UL XX 7/49; Fig. 15A.

Etymology: *calyx* (Latin) – calyx; referring to the calyx-like form of the body.

Material: 15 specimens from Piotrawin.

Dimensions: Up to 120 mm high and ca. 90 mm in diameter.

Diagnosis: Funnel-shaped sponges on short stalk, with wall folded in longitudinal, radially arranged lateral lobes, with smooth margin or with small rounded protrusions. Upper part of sponge cylindrical or slightly widened. Both surfaces covered with alternately distributed round canal openings, 0.7–1.5 mm in diameter. Diarhysis perpendicular to wall. Dictyonal skeleton irregular, with meshes averagely ca. 0.15–0.25 mm in diameter. Dictyonal cortex lacking.

Preservation: All specimens are strongly attached to the rock. Three are almost complete. Choanosomal skeleton is some cases well preserved.

Description: Funnel-shaped sponges with short stalk (Fig. 15A). Thick wall, ca. 2 mm, folded into longitudinal, radially arranged lateral lobes. Upper part of sponge without folds, cylindrical or slightly widening towards the top, ca. 60 mm in diameter. Lateral lobes ca. 10 mm thick, in some cases, narrower at the base. Their external margin smooth or with short rounded protrusions. Both surfaces covered with alternately arranged round canal openings, ca. 0.7–1.2 mm in diameter, averagely 35–60 per 1 cm^2. Skeletal bands separating openings 0.3–0.5 mm wide. Diarhysis perpendicular to wall. Canals very rare in marginal part of sponge. Basal part in form of very long (up to 70 mm) protrusion with thickened and dense network. Additional supports, growing from apical parts of finger-shaped branches developed in lower part of sponge may be present. Supports with skeleton identical as in the main basal protrusion (Fig. 15C). Choanosomal skeleton comprising smooth or finely granulose hexactines (Fig. 15B). Spicules form irregular network with quadrangular, triangular or polygonal meshes, averagely ca. 0.12–0.25 mm in size. Thickness of skeletal beams averagely ca. 0.04 mm. Part of nodes of multiradiate character. Lack of dictyonal cortex on both surfaces. On dermal surface, external rays strongly reduced and skeletal beams strongly thickened. On gastral surface, skeleton dense but without thickened rays. Here small secondary hexactines occur. Dictyonal strands parallel to canals.

Remarks: Due to the radially folded wall, *A. caliciformis* sp. nov. is close to the lobe-like individuals of *A. cylindrodactylus* Schrammen. However, in comparison to this species, *A. caliciformis* sp. nov. has a smooth upper part of sponge without folds and margin not bent inwards. Furthermore, there is a lack of the characteristic of *A. cylindrodactylus* cup-shaped sieve plate closing sieve plate the funnel. The dictyonal skeleton is similar in both species, although in *A. caliciformis* sp. nov. there is no cortex. The new species has much larger, alternately distributed canal openings, three times less per 1 cm^2 of area than in *A. cylindrodactylus*. The distribution and size of canal openings in *A. caliciformis* sp. nov. are on the other hand similar as in *A. alveolites*. In comparison to the latter species, the skeletal bands separating the canals are wider and with a 3–D structure. This structure of the skeletal network differs *A. caliciformis* sp. nov. also from the Recent funnel-shaped species from the genus *Aphrocallistes* (compare Ijima, 1927, pp. 122, 293, text-fig. 35; Reid, 1964, p. 108, text-fig. 49; Mehl, 1992, p. 64). The structure of basal processes in *A. caliciformis* sp. nov. indicates that, similarly as in *A. cylindrodactylus*, they were inserted in the deposit and could develop in those places where the finger-like protrusions, acting as supports, touched the sea bed.

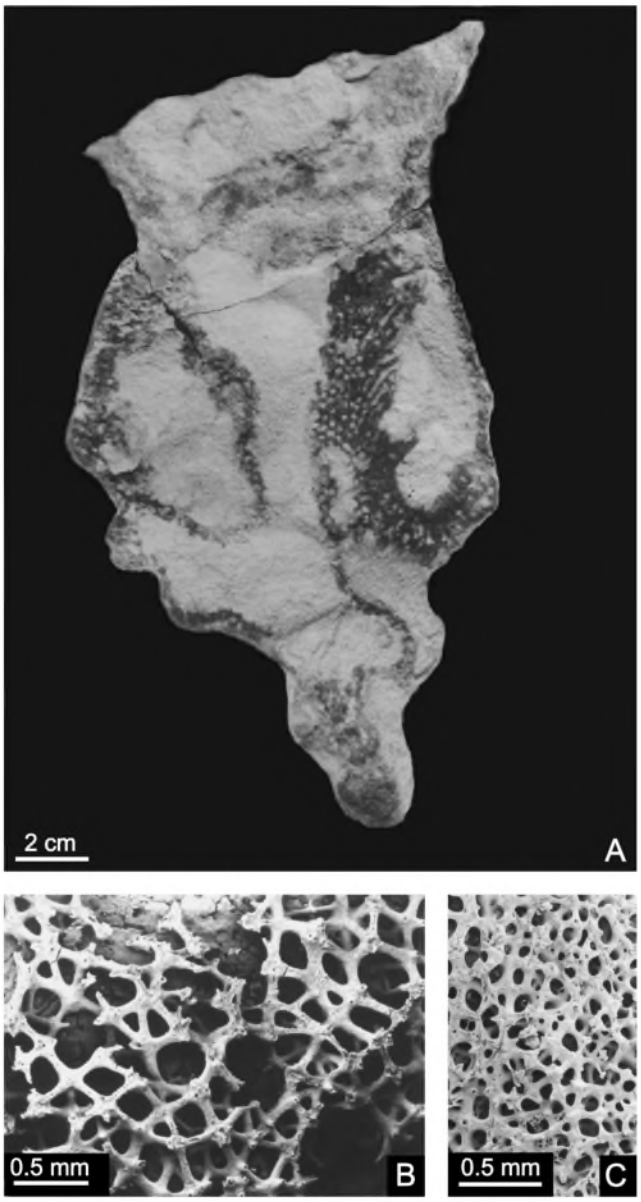

Fig. 15. A–C – *Aphrocallistes caliciformis* sp. nov.; A – holotype; lateral view; Piotrawin, Upper Campanian (UL XX 7/49); B – dictyonal skeleton; paratype, Piotrawin Upper Campanian (UL XX 8/111); C – basal skeleton; paratype, Piotrawin, Upper Campanian (UL XX 8/113)

Type locality: Poland, Middle Vistula Valley, Piotrawin.

Stratigraphic distribution: Upper Campanian.

Aphrocallistes sp.
Fig. 16 (A–C)

Material and preservation: 2 specimens from Piotrawin. External surface of sponges, apart from small fragments, is invisible due to strong fusion with the rock. Choanosomal skeleton in some cases well preserved.

Description: Sponges in the shape of narrow funnels, over 180 mm high. Diameter in upper part ca. 90 mm. Sponge wall, ca. 1–2 mm thick, protruding into radially arranged short, finger-like protrusions (Fig. 16C). In some cases, protrusions divide dichotomously at their base. Protrusions cylindrical, 4–6 mm in diameter, up to 15 mm long; in lower part of sponge, slightly smaller in diameter and typically also shorter (ca. 10 mm). Dermal surface with round canal openings, 1–2 mm in diameter, randomly distributed. Openings leading to straight canals, running through wall. Skeletal bands averagely 0.2 to 0.4 mm wide. Basal part in form of thick, wide plate. Lower part of sponge with additional supporting protrusions with dense dictyonal skeleton. Dictyonal skeleton comprising hexactines with smooth rays. In gastral part, spicules form a regular network with longitudinally rectangular meshes, 0.2 mm × 0.25–0.3 mm (Fig. 16A). Towards dermal surface, skeleton less regular, with slightly smaller (ca. 2 mm) triangular and quadrangular meshes. In subdermal part, network strongly disturbed, with multiradiate nodes. Beams thickened on dermal surface (Fig. 16A–C). Network meshes small (ca. 0.1 mm) and rounded. Additionally, small secondary hexactines with non-thickened rays also present.

Remarks: Among fossil species characterized by a funnel shape, the analyzed specimens are distinguished by the numerous, rather regularly, densely arranged finger-like protrusions of more or less even length. The skeletal network in *Aphrocallistes* sp. is dominated by rectangular or quadrangular meshes on the gastral surface. This skeleton structure was not observed in other funnel-shaped species *A. caliciformis* sp. nov. and *A. cylindrodactylus* Schrammen, which occur in the Upper Campanian deposits of the same locality. The outline of the analyzed specimens is on the other hand similar to the Recent species *A. beatrix* Gray (see Gray, 1858, p. 224; Okada, 1932, p. 51, pl. 45, fig. 1; Mehl, 1992, p. 64) and *A. bocagei* Wright – according Reiswig (2002) junior synonym of *A. beatrix* (see Schmidt, 1870, pp. 17–18, pl. 2, fig. 1; Schulze, 1887, p. 313, pl. 83, figs 1, 2). In the analyzed individuals, the skeleton surrounding the diarhysis, contrary to the other mentioned species, is multilayered with well-visible dictyonal connections. Despite the evident differences in relation to the known species of *Aphrocallistes* Gray, the material is too poorly preserved to propose a new taxon.

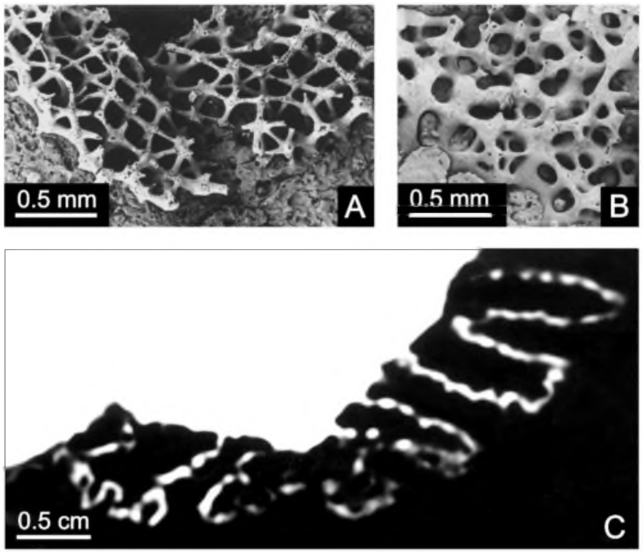

Fig. 16. A–C – *Aphrocallistes* sp.; A – subgastral part of the choanosomal skeleton; B – dermal surface of the dictyonal skeleton; C – transverse cross–section through lower part of sponge attached to rock; image made by using X–ray tomography; wall of sponge is white; Piotrawin, Upper Campanian (UL XX 7/34)

Occurrence: Middle Vistula Valley (Upper Campanian).

Family TRETODICTYIDAE Schulze 1886
Genus *Hexactinella* Carter 1885 emended Reid 1963
Type species: *Hexactinella ventilabrum* Carter 1885

Remarks: In the characteristics of *Hexactinella* Carter, Reid (1963b) noted the shizorhysal type of canalization. Based on this, he excluded the genus *Polyopesia* Schrammen 1902, characterized by labyrinth-like diplorhysis from the synonymy of *Hexactinella*. Within the genus *Hexactinella*, Reid (1963b) distinguished the nominative subgenus *Hexactinella*, which included funnel- and tongue-shaped forms, and the subgenus *Parahexactinella*, including forms comprising branching tubes. Several species assigned to the genus *Hexactinella* are known from the Cretaceous deposits (*Hexactinella digitata* Regnard 1925, *Hexactinella alpina* Lagneau-Hèrenger 1962; *Hexactinella nymphaea* Defretin-Lefranc 1960). Diagnoses of these taxa, however, do not give assumptions to classify them to the genus *Hexactinella* Carter. According to Reid (1964) the species *H. digitata* Regnard 1925, is a synonym of *Craticularia fittoni* (Mantell 1822) [=*Laocoetis fittoni* (Mantell)]. In turn, the canalization of the mentioned species indicates the genus *Polyopesia* Schrammen.

Hexactinella sp.
Fig. 17 (A–C)

Material and preservation: 2 specimens from Piotrawin. External surface of specimens is tightly attached to the rock and only its fragments are visible. Dictyonal skeleton, apart from some fragments of the external surface, is generally dissolved.

Comparative material: One specimen from Kamień (UL XVI).

Description: Sponges in the shape of very wide, asymmetric cups with rounded margins (Fig. 17A, C). Stalk short and massive. Larger radius of cup in the largest individual ca. 70 mm. Wall thickness from 7 to 12 mm. Round or comma-shaped canal openings, ca. 1–1.5 mm wide, on external surface. Openings distributed evenly without any arrangement, averagely 20 per 1 cm^2. Skeletal bands between them slightly convex, 1.5–2 mm wide. On internal surface, canal openings slightly narrower, from 1 to 2.5 mm, round, polygonal or comma-shaped, 9–12 openings per 1 cm^2. On a one specimen, a trend for a longitudinal arrangement is observed. Openings separated by skeletal bands, 2–3.5 mm wide. Bands strongly convex, therefore, internal surface is very uneven, crimpled. Labyrinth-like schizorhysis very well developed; average diameter 1 mm (Fig. 17B). Skeletal bands between canals within wall ca. 0.5 mm thick. Dictyonal skeleton comprising smooth hexactines, in subdermal part in form of an irregular network with triangular and quadrangular meshes, ca. 0.1–0.2 mm in size. Dictyonal cortex lacking, however on dermal surfaces network beams distinctly thicker.

Remarks: With regard to the shape and structure of both surfaces the described specimens recall the Recent species *H. ventilabrum* Carter (Carter, 1885, p. 397, pl. 14, figs 1, 2; Schulze, 1887, pl. 96,

figs 2, 3; Ijima, 1927, pp. 232, 233). However, they have better developed labyrinth-like canals. The linear arrangement of openings on the internal surface is observed in *H. lingua* (Ijima, 1927, pp. 242–246, pl. 18, figs 11–17, text-figs 27, 28). The sparse material and its poor state of preservation does not allow observation of all diagnostic features of the skeleton and the specific variability within this taxon. Therefore, it is impossible to state whether the analyzed specimens represent one of the Recent taxa or a new species.
Occurrence: Middle Vistula Valley (Upper Campanian).

Order LYCHNISCOSIDA Schrammen 1903
Family VENTRICULITIDAE Smith 1848
emended Zittel 1877, emended Mehl 1992

Remarks: Mehl (1992), defining the family Ventriculitidae, accepted the erroneous concept of Moret (1926) about the formation of diplorhysis due to folding of the thin wall.

Genus *Rhizopoterion* Zittel 1877
emended Schrammen 1912, emended Reid 1962, emended Mehl 1992

Type species: *Siphonia cervicornis* Goldfuss 1826

Remarks: Diagnosis of this genus was often modified because of the problem with distinguishing the genera *Rhizopoterion* Zittel 1877 and *Ventriculites* Mantell 1822. Reid (1962c) considered the development of canals as the most important feature distinguishing these two genera. According to him, *Rhizopoterion* is characterised by the presence of epirhyses, whereas in *Ventriculites* these are partially replaced by extradictyonal furrowing.

Based on the specimens from Schrammen's collection, Mehl (1992) questioned Reid's (1962c) diagnosis, accepting rather the characteristics of these genera presented by Schrammen (1912). Mehl (1992) did not, however, indicate univocal differences between the two genera. This comes probably from the fact that, according to Reid (1962c), the species *Scyphia oeynhausii* Goldfuss 1831, the junior synonym of *Rhizopoterion cribrosus* (Phillips 1829), was wrongly identified, *i.e.* by Schrammen (1912), with *Ventriculites choanoides* (Mantell 1815) [=*V. radiatus* Mantell 1822]. Therefore, the diagnoses of the genus *Ventriculites*, presented by Schrammen (1912) and Mehl (1992), are based on a species, which, according to Reid (1962c), also represents the genus *Rhizopoterion*. One of the controversial features in *Rhizopoterion* is the canalization. According to Zittel (1877), in the upper part the canals are radial, lower they become diagonal, and they run longitudinally in the stalk and rhizoidal processes. Schrammen (1912) noted, what was also accepted by Mehl (1992), that in representatives of *Rhizopoterion* the canals are solely radial. According to Reid (1962c), in turn, they can be radial or labyrinthic. Reid (1962c), however, did not present the course of the labyrinthic canals precisely. In *R. cribrosus*, Ulbrich (1974) described the epirhyses as straight canals, perpendicular to the wall. In turn, the aporhyses are supposed to be connected with the longitudinal canals running within the wall and beneath the dermal surface. Besides the specimens of *R. cribrosus* from different sites from Poland, I was able to examine herein the specimens of *R. solidum* Schrammen 1912 from the Cretaceous of the Middle Vistula section, as well as from the Campanian and Maastrichtian of Russia and Ukraine. Additionally, specimens of *R. tubiforme* Schrammen 1912 from the Campanian of Russia and Poland (forms from the vicinity of Kraków, described by Bieda (1933) as *Ventriculites multicostatus* Roemer were also analysed. In representatives of all analysed species, the final parts of the aporhyses are diagonal and join with the subdermal canals, which are parallel to the ribs on the external surface. Such canal system is also present on the photograph of the specimen from Saratov, assigned by Sinzov to *Ventriculites pedaster* Eichwald 1871 (Sinzov, 1878, pl. 10, fig. 4). It was also observed on specimens of this species from Saratov and Korzkiew, housed in the UL collection. The second canal system, according to Ulbrich (1974) lying in the central part of the wall or closer to the gastral surface, was observed in the analysed material only in *R. cribrosus*. In the remaining species, these canals are present only in the lowermost part. This might, however, be a consequence of the poor state of preservation resulting from the strong compaction of the wall and from the phosphatization or strong limonitization of some specimens. Both canal systems are independent of the canals running in the stalk and rhizoidal processes. The longitudinal canals were not described previously by other authors, despite the fact that subdermal canals are visible on some illustrations of specimens representing the species of this genus (Schrammen, 1912, pl. 34, fig. 1; Hurcewicz, 1968, pl. 20, fig. 4). The occurrence of these canals seems to be an easy to identify diagnostic feature for *Rhizopoterion*. Mehl (1992) characterising genus *Rhizopoterion* pointed out the secondary network occurring within the spongocoel in cylindrical fragments. In the analysed specimens, this filling is not present or appears only in the lowermost part of the spongocoel. It seems thus that the presence of this structure, being an additional reinforcement, is a variable feature of a questionable taxonomic value.

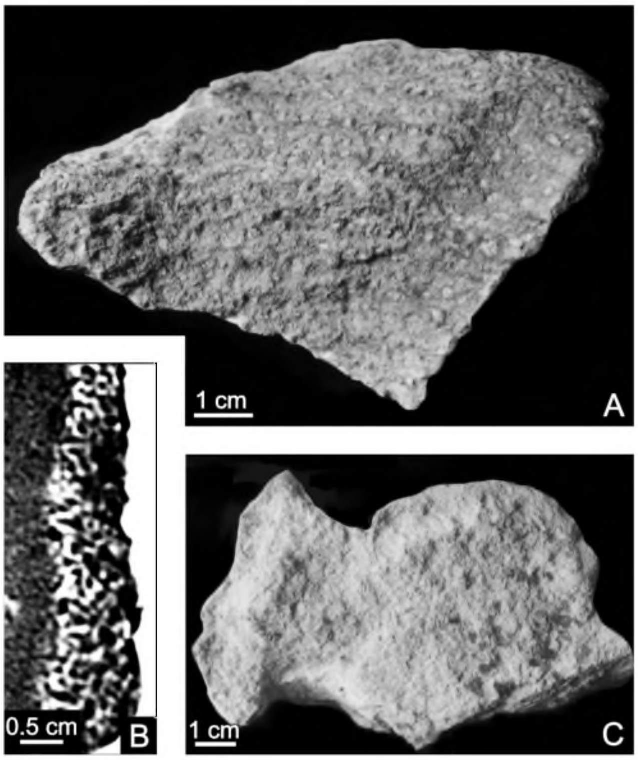

Fig. 17. A–C – *Hexactinella* sp.; A – fragment of gastral surface with canal openings; Kamień, Lower Maastrichtian (UL XVI Ka/8); B – transverse cross–section through sponge wall showing schizorhysis; image made by using X–ray tomography; wall of sponge is white; C – lateral view; Piotrawin, Upper Campanian (B – UL XX 3/13; C – UL XX 7/35)

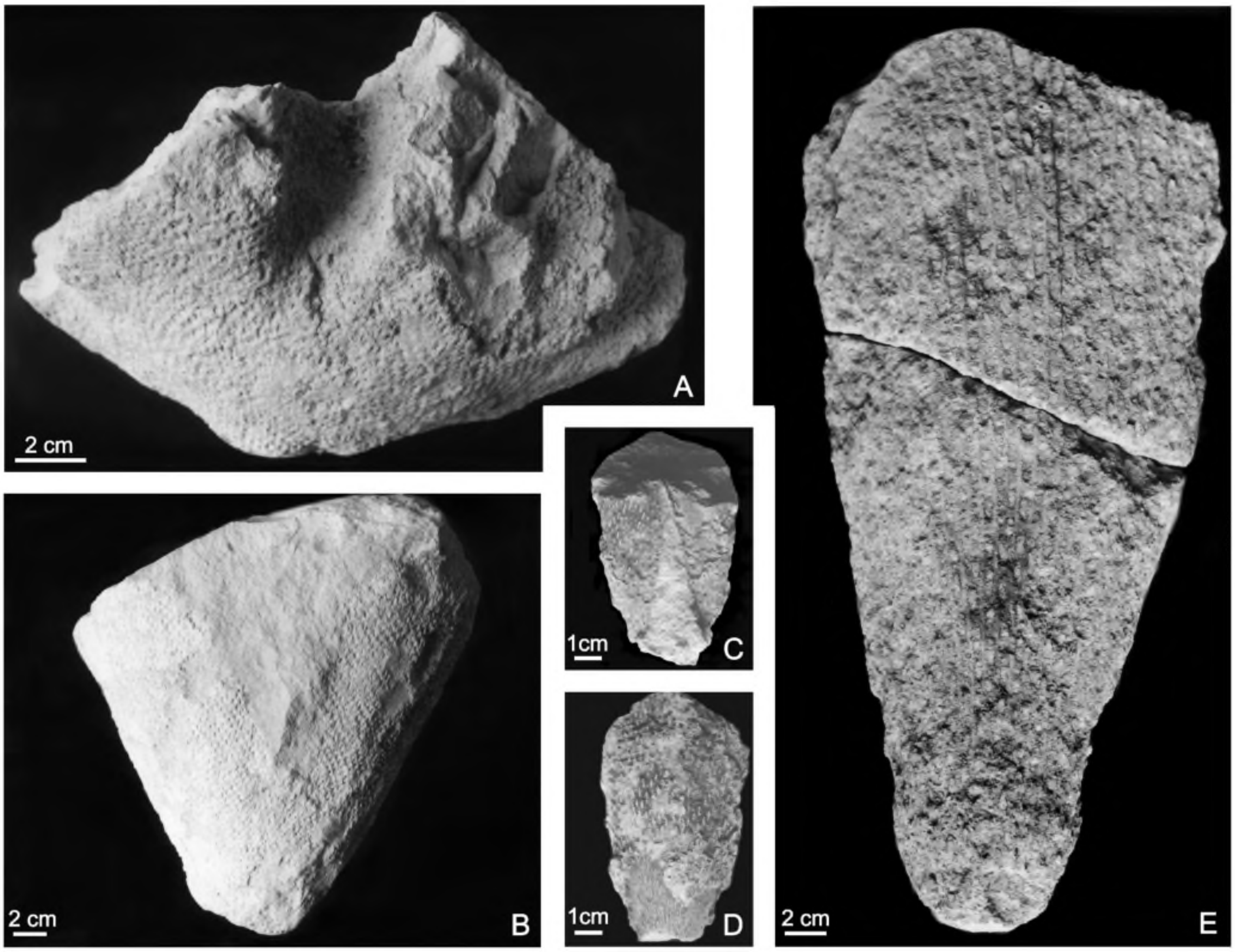

Fig. 18. **A–D** – *Rhizopoterion cribrosus* (Phillips 1829); A – lateral view; Kazimierz, Upper Maastrichtian (UL XX 7/104); B – lateral view; Nasiłów, opoka, Upper Maastrichtian (XX 7/103); C–D – fragment of folded upper part of sponge (holotype specimen of *R. coniforme* Hurcewicz 1968, pl. 21, fig. 3a); Kazimierz, Upper Maastrichtian (UL III/48); **E** – *Rhizopoterion solidum* Schrammen 1912; lateral view; Piotrawin, Upper Campanian (UL XX 0/3)

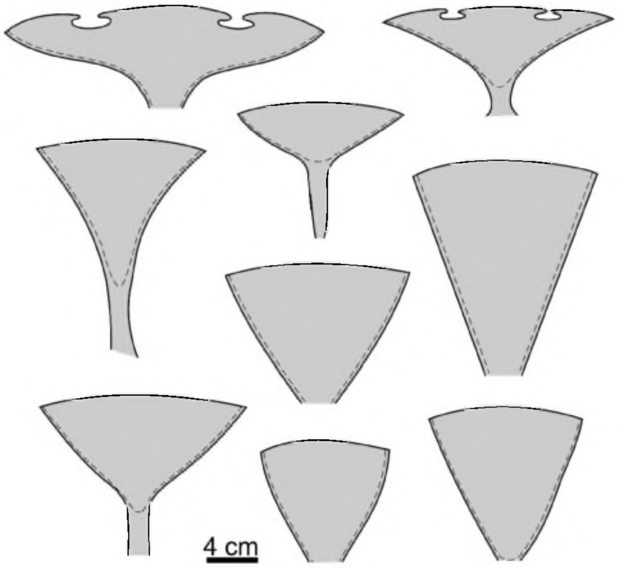

Fig. 19. Shape variability of *Rhizopoterion cribrosus* (Phillips 1829)

Rhizopoterion cribrosus (Phillips 1829)
(= *Ventriculites radiatus* Mantell 1822, *sensu* Schrammen 1912)
Figs 18 (A–D), 19, 20 (A–F)

*1829. *Spongia cribrosa*: Phillips, pl. 1, fig. 7.
1826–1833. *Scyphia Oeynhaussi* nobis: Goldfuss, p. 219, pl. 65, fig. 7.
1841. *Scyphia Oeynhaussi* Goldfuss: Roemer, p. 7.
1864. *Retiospongia radiata* Mantell: Roemer, p. 15, pl. 6, fig. 2.
1870. *Retiospongia radiata* A. Roemer: F. Roemer, p. 302, pl. 32.
1883. *Ventriculites cribrosus* Phillips, sp.: Hinde, p. 113, pl. 26, figs 2, 2a.
1883. *Ventriculites infundibuliformis* Woodward: Hinde, p. 112, pl. 26, figs 1, 1a.
1878. *Ventriculites radiatus* Mantell: Quenstedt, p. 449, pl. 136, figs 24–32.
1912. *Ventriculites radiatus* Mantell: Schrammen, p. 265, text-pl. 13, figs 3–6; pl. 36, figs 1–3, 7.
?1912. *Ventriculites cylindratus* nov. sp.: Schrammen, pp. 267–268, pl. 36, figs 4–6, text-pl. 14, fig. 10.
v1933. *Ventriculites radiatus* Mantell: Bieda, p. 25.
?1960. *Ventriculites cribrosus* (Phillips): Defretin-Lefranc, p. 58.

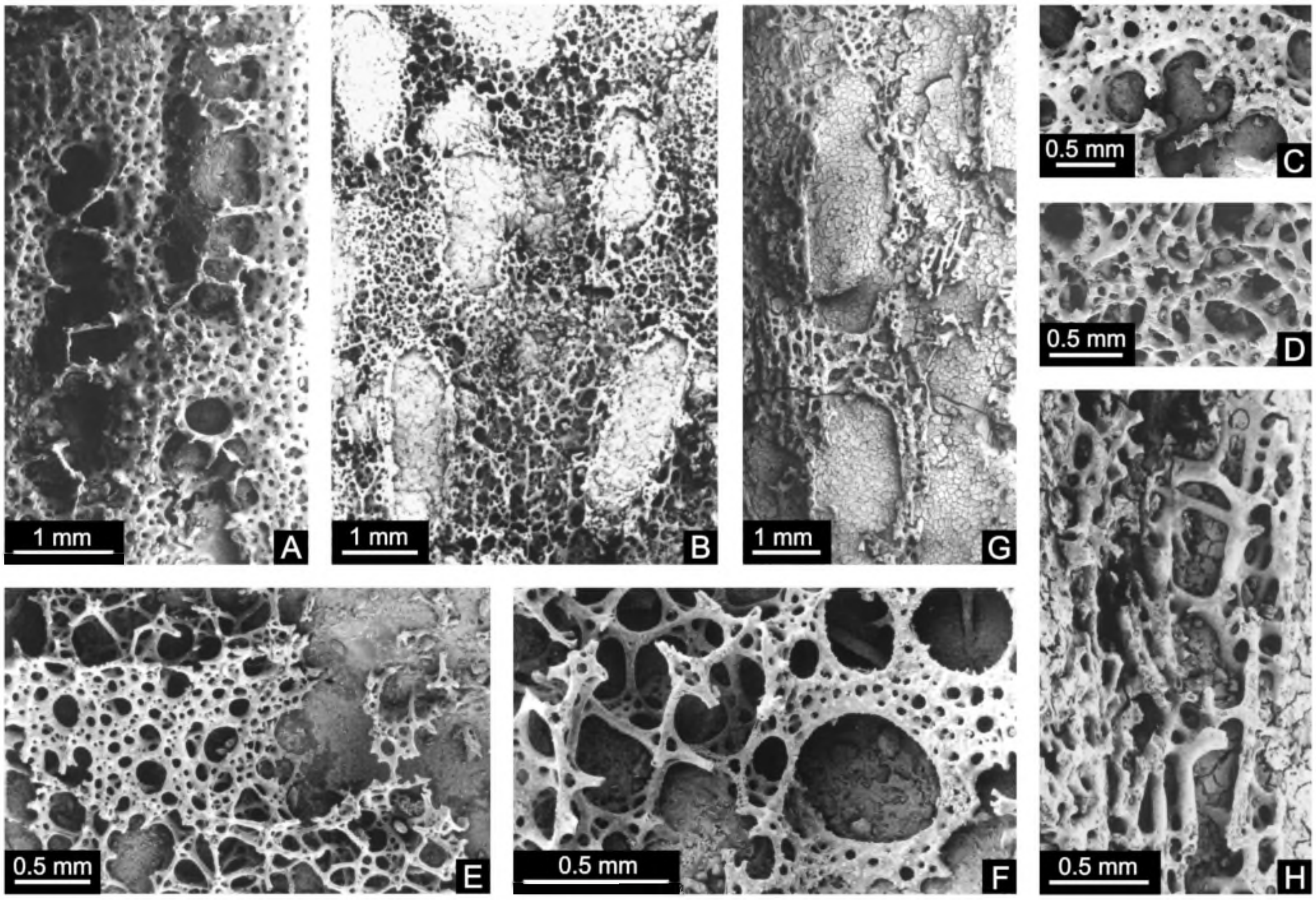

Fig. 20. **A–F** – *Rhizopoterion cribrosus* (Phillips 1829); A – cortex on dermal surface; note canal openings; Nasiłów, opoka, Upper Maastrichtian (UL XX 1/208); B – dictyonal subdermal skeleton; note canal openings; C – cortex on gastral surface; Piotrawin, Upper Campanian (UL XX 7/22); D – siliceous filaments on gastral surface in lower part of spongocoel; Nasiłów, greensand, Upper Maastrichtian (UL XX 4/50); E – canal in dictyonal skeleton covered with synapticular membrane; F – detail of dictyonal skeleton; Nasiłów, opoka, Upper Maastrichtian (E, F – UL XX 0/155); **G, H** – *Rhizopoterion solidum* Schrammen 1912; G – dermal surface of choanosomal skeleton with synapticular filaments; note canal openings; H – synapticular filaments on dermal surface; Piotrawin, Upper Campanian (UL XX 7/25)

1961. *Ventriculites radiatus* Mantell: Nestler, pp. 56–58, text-fig. 16; pl. 3, figs 1–4.

v1968. *Ventriculites radiatus* Mantell: Hurcewicz, p. 71, pl. 19, figs 1–3; pl. 20, fig. 4.

v1968. *Ventriculites convolutus* Hinde: Hurcewicz, p. 73, pl. 20, fig. 1.

partim v1968. *Ventriculites successor* Schrammen: Hurcewicz, p. 74, text-fig. 16; pl. 20, fig. 2.

partim v1968. *Rhizopoterion coniforme* nov. sp.: Hurcewicz, p. 78, pl. 21, fig. 3; non text-fig. 17 [=*Rhizopoterion solidum* Schrammen].

partim v1968. *Orthodiscus fragilis* Schrammen: Hurcewicz, p. 80 (partim), pl. 17, fig. 3.

1974. *Rhizopoterion cribrosus* Phillips: Ulbrich, p. 60, pl. 11, fig. 4.

v1980. *Ventriculites radiatus* Mantell: Małecki, pl. 3, figs 5, 7, 8.

v1980. *Ventriculites cylindratus* Schrammen: Małecki, pl. 3, fig. 6.

v1980. *Ventriculites mamillaris* Smith: Małecki, pl. 4, fig. 5.

v1980. *Orthodiscus fragilis* Schrammen: Małecki, pl. 5, figs 3, 4.

v1980. *Rhizopoterion tubiforme* Schrammen: Małecki, p. 415, pl. 4, fig. 1.

v1991. *Ventriculites radiatus* Mantell: Tarkowski, p. 91, pl. 2, figs 3, 4.

1992. *Ventriculites choanoides* (Mantell): Mehl, pp. 127–128, pl. 20, fig. 4.

Material and preservation: 362 specimens (6 from Ciszyca Kolonia, 4 from Ciszyca Górna, 14 from Piotrawin, 4 from Dziurków, 1 from Kłudzie, 1 from Solec, 4 from Dobre, 1 from Podgórz, 10 from Męćmierz, 26 from Kazimierz, 5 from Janowiec, 17 from opoka and 8 from the glauconitic sandstone from Bochotnica, 61 from opoka and 201 from the glauconitic sandstone from Nasiłów). Most of the specimens, particularly these from opoka from Nasiłów and Kazimierz, are complete. Material from the glauconitic sandstone includes crushed fragments of the walls and stalks. The skeleton in some specimens is rather well-preserved.

Comparative material: Collections UL III, A-1-1 and A-1-82; 2 specimens from Wojszyn, 1 from Kaliszany, 1 from Józefów (UL XVI); 2 specimens from the Crimean and 2 from Donbas region (UL XVII).

Description: Funnel- or goblet-shaped sponge with a massive stalk (Figs 18A, B, 19). Stalk, of variable length, with a rosette of dichotomously branching long rhizoidal processes. Maximal height (without stalk) up to 200 mm. Diameter of the largest specimen ca. 300 mm. Wall thickness up to 10 mm. Upper margin of large, wide specimens often with ear-shaped additional folds (Fig. 18A, 19). External surface with longitudinally elongated, elliptical canal openings, of diameter varying in each specimen from 0.7 × 1.3 to 2.5 × 4 mm. Openings alternate quincuncially in longitudinal rows. Longitudinal, sinusoidal, flat ribs between openings, ca. 0.8–1.5 mm wide. Transverse skeletal bands between canal openings of similar width, of the same height as longitudinal ribs, or slightly lower, thus giving the external surface a net-like pattern. Rounded canal openings on internal surface, 1–2 mm in diameter, more or less regularly alternately distributed, ca. 10–20/cm^2. Epirhyses long, straight, perpendicular to wall, ending blindly below internal surface. Aporhyses at first straight or slightly diagonal downwards, in terminal part divergent, joining with longi- tudinal canals, 0.5–0.7 mm in diameter, running below dermal surface of wall. These canals sinusoidally bent, sub-parallel to ribs on dermal surface. Below skeletal bands, the neighbouring canals may join each other. Aporhyses can also join with the second canal system, which lies randomly in the central part of wall or closer to gastral surface. Stalk surface covered with oval openings leading to diagonal, then turning into longitudinal canals running to the rhizoidal processes. Dictyonal skeleton irregular, with mesh diameter 0.3–0.4 mm. In subdermal part, highly complex, with locally developed synapticulae (Fig. 20B). Dictyonal beams generally smooth, only near the dermal surface thickened and densely covered with small knobs. Both surfaces covered with synapticular cortex, more massive on the external surface (Fig. 20A, C). Openings in cortex numerous, with variable diameter (0.03–0.2 mm), randomly distributed. From outer, not connected lychniscal rays, occurring on both surfaces, grow siliceous filaments, partly covering the canal openings. Canal walls covered with thin synapticular siliceous membrane (Fig. 20E, F). Basal skeleton composed of longitudinal synapticular filaments, growing in lower part of cups. Thick, chaotically tangled synapticular filaments may also appear on gastral surface in lower part of conical parts (Fig. 20D).

Differentiation: Specimens of the species from Nasiłów and Bochotnica, particularly from the upper opoka beds are represented by sponges with conical or cuplike upper part (Fig. 18B). In contrast, specimens from the remaining sites are usually characterised by wide sponges with almost plate-like upper part (Fig. 18A). Moreover, forms from the glauconitic sandstone and from opoka in Nasiłów and Bochotnica are characterised by a thick cover of siliceous filaments on the gastral surface, which almost completely covers the canal openings (visible mainly as moulds).

Remarks: When revising the genera *Rhizopoterion* Zittel and *Ventriculites* Mantell, Reid (1962c) assumed that many authors erroneously identified *R. cribrosus* (Phillips) with *V. radiatus* (Mantell). This was the case with specimens from the Upper Cretaceous of Germany. The specimens analysed herein are identical with the material from Germany, and on the other hand, fulfil all the criteria presented by Reid (1962c) for *Rhizopoterion.* The crucial feature allowing the distinction between *R. cribrosus* and *V choanoides* is the canal system in the wall. Additionally, the arrangement of spicules in the dictyonal skeleton may also be helpful. Hinde (1883), to the assignments of which Reid (1962c) refers, noted that in *V. radiatus* the skeleton is extremely regular, with square-shaped meshes, whereas in *V. infundibuliformis* Woodward [= *Rhizopoterion cribrosus* (Phillips)] it is irregular. The irregular skeleton was described in the synonyms of *R. cribrosus* by Schrammen (1912), Nestler (1961), Hurcewicz (1968), Mehl (1992) and Ulbrich (1974). According to Mehl (1992), the new species *V. cylindratus*, *V. fistulosus* and *V. successor* described by Schrammen (1912) may be junior synonyms of *V. choanoides* (= Rhizopoterion *cribrosus sensu* Reid 1962c). Analysing the rich material from different sites in Poland and Russia, it can be assumed that *R. cribrosus* is an extremely polymorphic species, therefore Mehl's (1992) opinion, particularly in relation to *V cylindratus* seems to be just. Mehl (1992) accepted that *R. cribrosus*, and possibly also the new species of *Rhizopoterion* described by Schrammen (1912) are synonyms of *R. cervicorne* (Goldfuss). The holotype of this species, similarly as the specimens presented by Frič (1889, p. 106, fig. 147) and Mehl (1992, pl. 20, fig. 6), is represented by small fragments of the lower part of the sponge (Goldfuss, 1826–1833, p. 18, pl. 6, fig. 11). In representatives of the genus *Rhizopoterion* Zittel, this part of the sponge is almost identical. The diagnosis of *R. cervicorne* lacks specific features allowing a univocal definition of this species. In Polish literature, the morphotypes of *R. cribrosus* are assigned to many different species (see synonymy). In Małecki (1980), the illustrated sponges from Santonian deposits of Korzkiew have not been described, thus this author's opinion is not justified. The analysis of specimens from Małecki's collection and comparison to additional material from Korzkiew indicated no differences in the sponge architecture allowing to assign them to separate taxa. It seems that when distinguishing separate species, Małecki (1980) based mainly on the shape of specimens and size of canal openings, that is on features, which in representatives of the family Ventriculitidae are extremely variable. Hurcewicz (1968) assigned specimens of *R. cribrosus* (Phillips) to four different species (see synonymy), despite the obvious similarities in the skeleton architecture. These wrong assignments are linked with attributing a large taxonomic meaning to some very variable morphological features. Moreover, these assignments resulted also probably from the small group of the analysed specimens and their poor preservation state. The presented holotype of *R. coniforme* (Hurcewicz, 1968, pl. 21, fig. 3) is a fragment of a furrowed wall of a very large specimen of *R. cribrosus* (Fig. 18C, D). In such furrow, the external surface lies within it, imitating thus the gastral surface. Therefore the description of the holotype contains erroneous information about the narrow conical shape of the sponge and the spongocoel. Large oval "postica" are in reality "ostia". A similar erroneous description occurs in the case of the specimen assigned to *V.* cf. *successor* Schrammen (Hurcewicz, 1968, pl. 20, fig. 2). The "internal" surface of the illustrated specimen with the diagnostic oval "postica" is the imprint of the external surface. Small fragments of the sponge wall are only preserved in central part of the mould. Hurcewicz (1968, p. 73) questioned the distinctness of skeleton of the main and the basal part, assuming a continuous transition between them (see Defretin-Lefranc, 1960; Reid, 1962c). In fact, the two structures are quite distinct. The synapticular basal skeleton surrounds the base of main part of body with a dictyonal skeleton. *Ventriculites radiatus* is one of the most frequently cited Upper Cretaceous sponges. It seems highly probable that the specimens, particularly from the Campanian and Maastrichtian may represent *R. cribrosus*. Older papers contain only a macroscopic description of the specimens (Počta, 1883, p. 32; Frič, 1889, p. 105, fig. 142; Leonhard, 1897, p. 32, pl. 3, fig. 4; Wollemann, 1901, p. 53; Wollemann, 1902, p. 9; Giers, 1964). Another description of their internal structure is very unclear (Sinzov, 1871–1872, p. 55; Defretin-Lefranc, 1960, pp. 56–58, pl. 3, figs 1–4, text-fig. 6; Hèrenger, 1944, p. 106; Lagneau-Hèrenger, 1962, p. 92, text-pl. 14, fig. 1). In the case of these specimens, the specific assignment based solely on descriptions is doubtful or even impossible. Therefore, the oldest synonymy has been quoted after Reid (1962c).

Occurrence: Poland – Upper Middle Vistula Valley (Campanian–Lower Maastrichtian), Opole area (Turonian–Coniacian), Kraków area (?Santonian); northern-western Germany (Turonian–Campanian); England and Ireland (Senonian); Isle of Rügen (Lower Maastrichtian); Crimea (Maastrichtian); northern Donbas region (Maastrichtian); ?France (Turonian).

Rhizopoterion solidum Schrammen 1912
Figs 18 (E), 20 (G, H), 21

*1912. *Rhizopoterion solidum* nov. sp.: Schrammen, pp. 271–272, text-pl. 13, fig. 8; text-pl. 14, fig. 8; pl. 34, fig. 6.

non v1968. *Rhizopoterion solidum* Schrammen: Hurcewicz, pp.

77–78, pl. 20, fig. 3 [=*Leiostracosia orthogoniopora* (Defretin-Lefranc)].
partim v1968. *Orthodiscus fragilis* Schrammen: Hurcewicz, pp. 81(partim); non pl. 17, figs 2, 3 [=*Rhizopoterion cribrosus* (Phillips)].
partim v1968. *Rhizopoterion coniforme* nov. sp.: Hurcewicz, pp. 76–78 (partim), text-fig. 17; non pl. 21, fig. 3 [=*Rhizopoterion cribrosus* (Phillips)].
non 1960. *Rhizopoterion solidum* Schrammen: Defretin-Lefranc, pp. 61, text-fig. 17; pl. 4, fig. 5 [= ?*Rhizopoterion cribrosus* (Phillips)].
1993. *Rhizopoterion solidum* Schrammen: Jahnke & Gasse, pl. 16, fig. 3.

Material and preservation: 26 specimens (2 from Ciszyca Kolonia, 7 from Ciszyca Górna, 6 from Piotrawin, 4 from Dziurków, 1 from Solec, and 2 from Kłudzie).

Most specimens are represented by narrow cones with destroyed peak and the basal part. Numerous fragments of discs are also preserved. The choanosomal skeleton is sporadically visible in some specimens but generally very poorly preserved.

Comparative material: Collection UL III; 1 specimen from Crimea, 1 from northern Ukraine (Chernihov region) and 2 from northern Donbas region (UL XVII).

Description: Thick-walled sponges (ca. 1–1.5 cm), funnel-shaped, on thick short stalk with massive rhizoidal processes. Lower conical part (Fig. 18E), could attain ca. 250 mm height, and diameter of plate-like upper part could reach 400 mm. Rounded, straight ribs, 1–1.5 mm wide on external surface. Ribs bifurcate extremely rarely. Flat furrows between ribs. In lower part, furrows ca. 2 mm wide, higher, they widen to 3 mm. Alternate canal openings in furrow bottom. Just above stalk openings small (ca. 1.5–2 mm), in shape of ellipse or as rounded squares. Higher, they become longer, oval-shaped, and larger (2–3 mm x 9 mm). Length of the canal openings on some fragments of the sponges upper part reaches even 11 mm. Flat and very wide (ca. 3–5 mm) transverse skeletal bands separating openings within the furrows. Internal side without ribs, with round or slightly elliptical canal openings, distributed rather regularly and alternately. Similarly as on external side, their size gradually increases, from 2 mm to 6 mm. Transverse skeletal bands ca. 5 mm wide, longitudinal skeletal bands ca. 2 mm wide. Number of canal openings on both surfaces in conical part averagely 4–6/cm^2. Epirhyses straight, perpendicular to wall (Fig. 21). In the lower part, they reach approximately the middle of the wall. Higher, they are longer and end beneath gastral surface. Aporhyses at first perpendicular to wall. In terminal part, aporhyses with branches, which diagonally join with longitudinal canals running below the rib surface. In conical part, aporhyses also have short side canals, which reach the longitudinal canals within the wall. In fragments of plate-like parts, canals not visible, this, however, may be linked with the preservation state, particularly with strong compression of wall. Stalk surface covered with elongated openings leading to diagonal canals, which then become longitudinal and form a concentric cluster. These canals continue to the rhizoidal processes. Dictyonal skeleton composed of large, poorly spiny lychniscs. Within wall, skeleton rather regular, with prevalence of longitudinally rectangular meshes, 0.2–0.4 mm × 0.5 mm. In external parts, skeleton irregular, with smaller (ca. 0.3 mm) meshes of different size. Dictyonal beams in this part thicker, with granulated surface. Dermal surface with very porous synapticular cortex. Above cortex occur thick, devoid of axial filaments, longitudinal thick siliceous filaments with rather rare and irregularly placed transverse junctions (Fig. 20G, H). On gastral side, cortex very thin with large pores. Similarly as on the dermal side, it is covered with siliceous filaments, which are tangled more randomly, without distinct longitudinal orientation. Canal wall covered with very porous thin siliceous membrane. Skeleton of stalk and rhizoidal processes composed of thin synapticular filaments, appearing on external surface slightly above stalk.

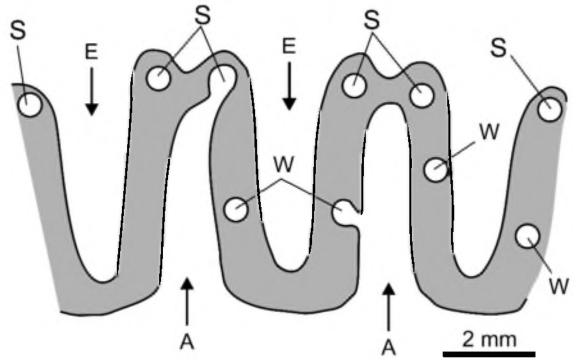

Fig. 21. *Rhizopoterion solidum* Schrammen 1912; specimen no. 0/221; schematic canalization on transverse cross–section of wall; E – epirhyses, A – aporhyses, S – subdermal longitudinal canals; W – longitudinal canals in central part of wall

Remarks: Individuals of *Rhizopoterion solidum* described by Schrammen (1912), in comparison to specimens from Poland, Russia and Ukraine, have smaller dimensions of canal openings on both surfaces. According to Schrammen (1912), the "ostia" have dimensions 1–1.5 mm × 2–2.5 mm, and "postica" 2 mm. The holotype, however, as well as the remaining specimens from Germany are generally incomplete (Schrammen, 1912, p. 217). The specimens are represented by lower, conical parts, where the dimensions of canal openings are the smallest, similarly to those, which occur in analogous parts of the specimens from the Middle Vistula River Valley. According to Schrammen (1912) and Mehl (1992), the tube-like spongocoel in *R. solidum* is filled by a loose network, composed of siliceous filaments. In the investigated specimens such filaments cover both surfaces of the sponge. Within the spongocoel they are typically not present or they fill it only in the lowermost part. In the comparative material from Russia and Ukraine, such network is present only on one specimen. Schrammen (1912) did not note the presence of a dictyonal cortex on the gastral surface in *R. solidum*. In the analysed specimens, due to skeleton dissolution, it is present only occasionally. Moreover, the cortex is masked by covering filaments. Collection UL III contains two specimens from Piotrawin representing *R. solidum*. One of the specimens (III/71), due to large canal openings on the gastral surface, was included by Hurcewicz (1968) to *Orthodiscus fragilis* Schrammen 1924. The second specimen (III/72) is described as the paratype of *R. coniforme* Hurcewicz 1968, on which the skeleton of this species was described (Hurcewicz, 1968, p. 79, text-fig. 17). In turn, the specimen referred by Hurcewicz (1968) to *R. solidum* in reality belongs to *Leiostracosia orthogoniopora* (Defretin-Lefranc 1960). Defretin-Lefranc (1960) included to *R. solidum* two poorly preserved fragments from the Upper Turonian of France, based on "almost quadrangular" canal openings on the external surface. The dermal surface of the illustrated specimens lacks, however, longitudinal grooves and convex ribs (Defretin-Lefranc, 1960, pl. 4, fig. 5) typical for *R. solidum*. Similarly is in *R. cribrosus* (Phillips), the canal openings are small, oval and separated by flat skeletal bands. The remaining information in the description of this material does not bear features characteristic for *R. solidum*.

Occurrence: Poland – Middle Vistula Valley (Upper Campanian–Lower Maastrichtian); northern-western Germany (Campanian); Ukraine – Crimea (Campanian–Maastrichtian), northern Donbas region (Upper Campanian–Lower Maastrichtian), northern Ukraine (Lower Campanian); England (Senonian) – according to Reid (1968a).

Genus *Lepidospongia* Roemer 1864
Type species: *Lepidospongia denticulata* Roemer 1864

Lepidospongia rugosa Schlüter 1870
Fig. 22 (A, B)

*1870. *Lepidospongia rugosa* nov. sp.: Schlüter p. 140.
1872. *Lepidospongia rugosa* Schlüter: Schlüter, pp. 27–28, pl. 1, figs 1–4.
1877. *Lepidospongia rugosa* Schlüter: Zittel, p. 53.
1902. *Lepidospongia Brandesi* nov. sp.: Schrammen, p. 11, pl. 3, figs 1, 2.
1912. *Lepidospongia rugosa* Schlüter: Schrammen, p. 269, text-pl. 13, fig. 2; pl. 35, figs 7, 8.
partim v1968. *Lepidospongia fragilis* Schrammen: Hurcewicz, p. 80, pl. 16, fig. 4.
1974. *Lepidospongia rugosa* Schlüter: Ulbrich, p. 61.
1988. *Lepidospongia rugosa* Schlüter: Gasse *et al.*, figs 6, 9, 10.
1992. *Lepidospongia rugosa* Schlüter: Mehl, pp. 124–125.

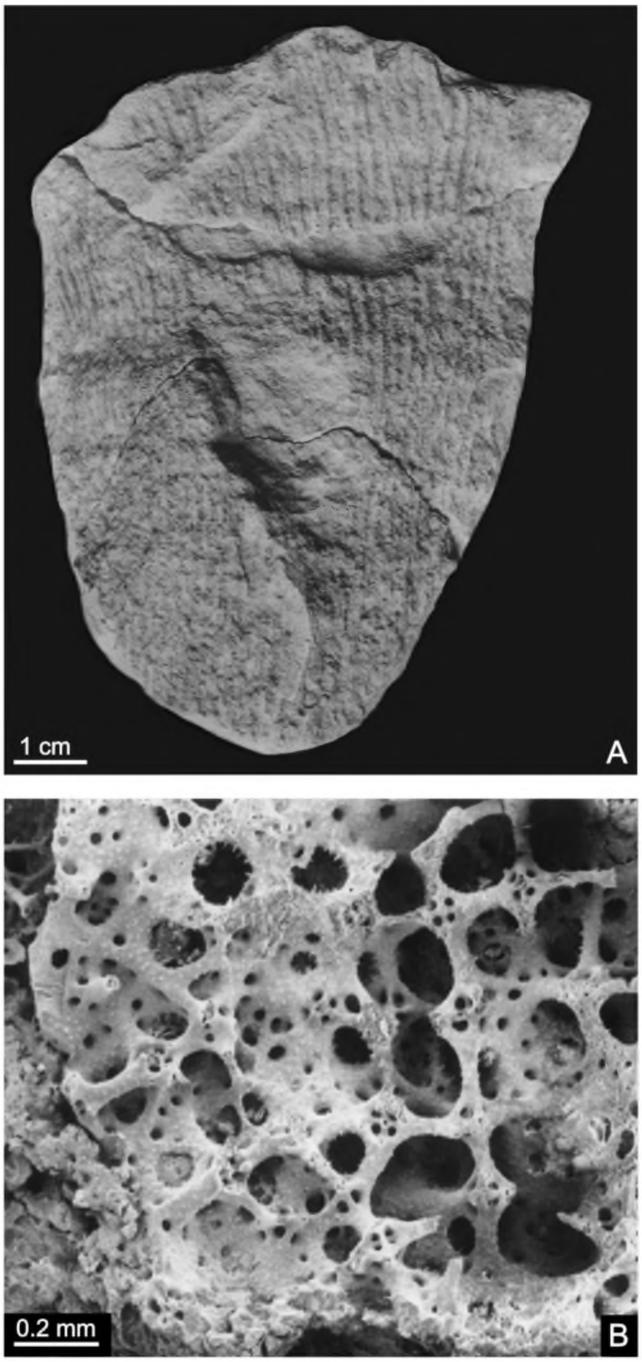

Fig. 22. A, B – *Lepidospongia rugosa* Schlüter 1870; A – later view; B – dictyonal subdermal skeleton; in the background note internal surface of dermal cortex; Piotrawin, Upper Campanian (A – UL XX 0/128; B – UL XX 8/129)

Material and preservation: 4 specimens from Piotrawin and 1 from Kazimierz. The specimens are damaged, without basal part; internal part strongly cemented to the deposit, only partly visible. Choanosomal skeleton fragmentarily preserved.

Comparative material: Collection UL III.

Description: Narrow cup-shaped sponges, up to ca. 140 mm high (Fig. 22A). Wall thickness 4–5 mm. External surface with slightly rounded longitudinal ribs, ca. 2 mm wide, in some cases dichotomously bifurcating. Slightly narrower grooves between ribs, with round or slightly elongated canal openings, ca. 1 mm in diameter. Density ca. 24/cm^2. Very narrow transverse skeletal bands separate the openings. Canal openings on internal side and canalization in wall impossible to determine due to poor state of preservation. Dictyonal skeleton comprising lychniscs with smooth rays or with singular spines. Network rather regular, with quadrangular meshes, ca. 0.25 mm in diameter (Fig. 22B). Subgastral skeleton rather less regular. Thickened dictyonal rays with densely packed, very fine spines. Gastral surface with cover formed by non-porous siliceous plates, ca. 1–2 mm wide. Dermal surface with synapticular, fine-porous cortex (Fig. 22B).

Remarks: The analyzed specimens are identical with specimens of *L. rugosa* described from Germany. The species was previously not noted from Poland. In turn, Hurcewicz (1968) included 8 specimens from the Campanian of southern Poland to *L. fragilis* (Schrammen 1902). In both species, the morphology of the external surface is similar; in *L. rugosa*, however, the siliceous plates occurring on the gastral surface are porous (compare Schrammen, 1912, p. 270, text-pl. 13, figs 1, 2; Bieda, 1933, pp. 29–30, pl. 2, fig. 1). Two specimens analyzed by Hurcewicz (1968) have a very well visible gastral surface with concentric massive plates characteristic of *L. rugosa*. The illustrated specimen no. III/194 (see Hurcewicz, 1968, pl. 16, fig. 4) has a completely dissolved siliceous skeleton, replaced by iron hydroxides, therefore the structure of the plates on the gastral surface is difficult to determine. Their concentric pattern, however, points rather to *L. rugosa*, as the plates of *L. fragilis* are arranged in indistinct horizontal and vertical rows (Schrammen 1912, p. 270). In the remaining material from the UL collection, details of skeleton structure on the internal surface are not recognisable and therefore it is not sure which species they represent.

Occurrence: Poland – Middle Vistula Valley (Upper Campanian and Upper Maastrichtian), northern-western Germany (Lower Campanian and Upper Campanian); England (Senonian) – according to Reid (1968a).

Genus *Sporadoscinia* Pomel 1872
emended Zittel 1877, Mehl 1992
Type species: *Scyphia retiformis* Roemer 1841

Remarks: Initially, *Sporadoscinia* Pomel was included to the family Ventriculitidae Smith (Zittel, 1877; Dunikowski, 1889; Hinde, 1883). Schrammen (1912) described a separate family Sporadoscinidae. This classification was adapted by Bieda (1933), Lagneau-Hèrenger (1962), Zhuravleva (1962) and Hurcewicz (1968). Laubenfels (1955) erroneously included *Sporadoscinia* to the family Callodictyidae Zittel 1877. In the diagnosis of Callodictyidae, Laubenfels (1955) stated that the skeletal network is very thick and the meshes serve as "prospores", "apopores" or both. In representatives of *Sporadoscinia* Pomel, the skeletal meshes are rather small, and the canalization is well developed. The skeleton structure testifies thus for the inclusion of *Sporadoscinia* Pomel to Ventriculitidae (see Defretin-Lefranc, 1960; Ulbrich, 1974; Mehl, 1992). According to the diagnosis of Mehl (1992), *Sporadoscinia* Pomel, contrary to other taxa of this family, has bifurcating aporhyses.

Sporadoscinia decheni (Goldfuss 1831)
Figs 23 (A, B), 24, 25 (A, B)

1826–1833. *Sporadoscinia Decheni* nobis: Goldfuss, p. 219, pl. 65, fig. 6.
1912. *Sporadoscinia Decheni* Goldfuss: Schrammen, p. 280, pl. 37, figs 6, 7.
1943. *Sporadoscinia decheni* Goldfuss: Lachasse, p. 51.
1960. *Sporadoscinia decheni* (Goldfuss): Defretin-Lefranc, p. 73, pl. 7, fig. 2.
1962. *Sporadoscinia decheni* (Goldfuss): Lagneau-Hèrenger, p. 94, text-pl. 14, fig. 4; pl. 16, fig. 7.
partim v1968. *Ventriculites* cf. *successor* Schrammen: Hurcewicz pp. 74–75.
1974. *Sporadoscinia decheni* (Goldfuss): Ulbrich, p. 62.
1977. *Ventriculites stellatus* Schrammen: Khmilevsky, pp. 42–43, pl. 1, fig. 1.
1992. *Sporadoscinia decheni* (Goldfuss): Mehl, p. 130.

Material and preservation: 107 specimens (5 from Piotrawin, 1 from Kłudzie, 7 from Kazimierz, 1 from Janowiec, 2 from opoka and 4 from the glauconitic sandstone from Bochotnica, 35 from opoka, and 52 from the glauconitic sandstone from Nasiłów). Some specimens are complete or only slightly damaged. Material from the glauconitic sandstone contains only small fragments of the cup walls. Choanosomal skeleton typically completely dissolved, preserved only in few cases. Basal skeleton is best preserved.

Comparative material: Collections UL III and A–1–82; 1 specimen from Zbyczyce near Koniecpol (UL XVI).

Description: Cup-like sponges (Figs 23A, 24), up to 200 mm high, typically on a massive stalk with long rhizoidal processes. Forms with thin stalk or without stalk quite rare. Wall thickness averagely 3–5 mm. Canal openings on external surface in shape of irregular polygons, which size variable, depending on the individual and on the position on sponge. Average size of 1.5–2 mm openings presents average density of 20–35/cm^2. In lower part of sponge, polygons generally largest, 12–18/cm^2. Skeletal bands between openings rather wide. In some cases, particularly near cup margin, canal openings small (ca. 1 mm), round, even 40/cm^2. Here skeletal bands are very narrow. Canal openings evenly but randomly cover entire wall surface. Sporadically, just above stalk, openings may be arranged in indistinct longitudinal rows. On internal surface, longitudinal, oval canal openings alternately arranged; average size 1–1.5 mm × 2–2.5 mm; density 12–20/cm^2. A similar case occurs with variability of canal openings size on external surface, where the smallest, almost round openings lie in the upper part of cup. Long, straight epirhyses perpendicular to wall, leading to a canal system, 0.7–1 mm in diameter, parallel to gastral surface. Canals run between aporhyses, with which they are linked by short lateral branches. Aporhyses at first straight bifurcate once or twice and terminate just below dermal surface. Stalk surface with rows of longitudinally elongated or fissure-like canal openings, leading to numerous, densely packed longitudinal canals. Dictyonal skeleton very irregular, meshes 0.1 to 0.3 mm (Fig. 25B). In subdermal and subgastral parts, skeleton additionally displaced by synapticules. Lychnisc rays smooth or with small spines. Both surfaces of dictyonal skeleton covered by very thick synapticular cortex (Fig. 25A), with randomly distributed very small pores (maximal diameter up to 0.07 mm). Cortex with pointed processes pointed to centre of canal openings, giving them an irregular outline. Canals, including subgastral canals, covered inside by finely porous synapticular membrane, slightly thinner than cortex on wall surface. Skeleton of stalk and rhizoidal pro-

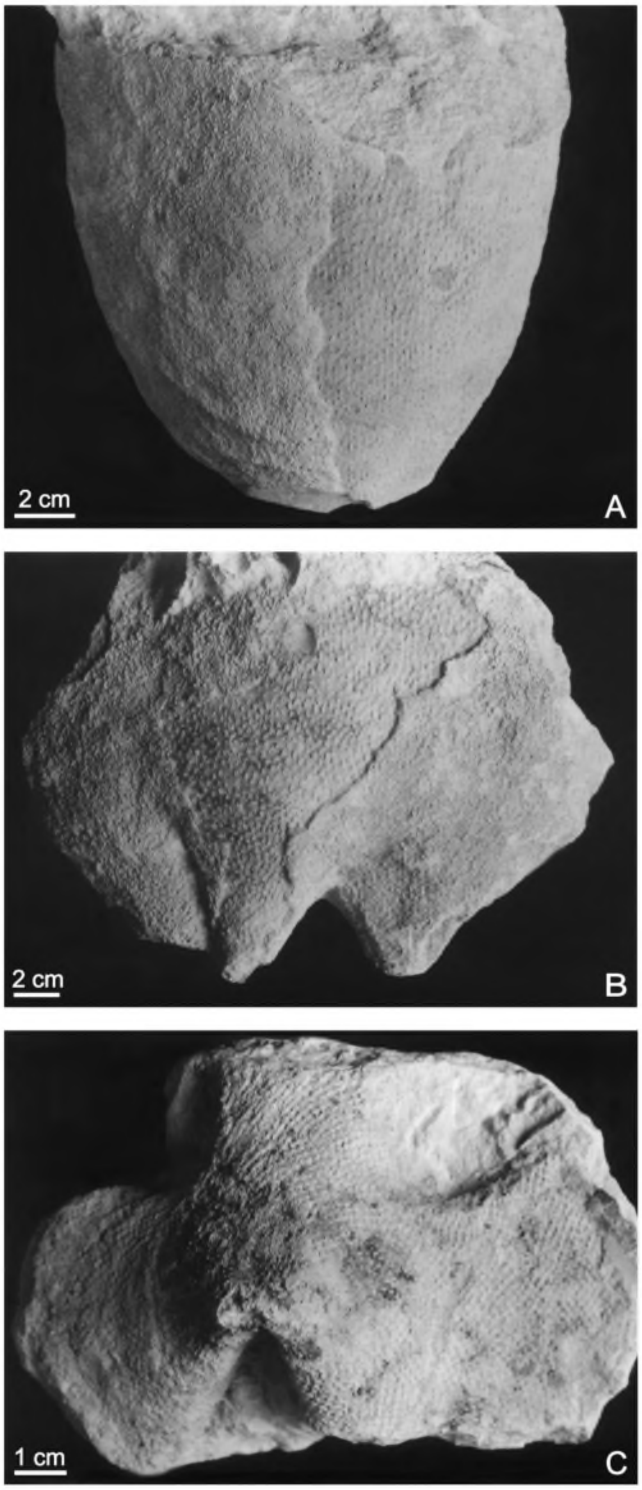

Fig. 23. **A, B** – *Sporadoscinia decheni* (Goldfuss 1831); A – lateral view; B – lateral view of specimen with two broken stems; Nasiłów, opoka, Upper Maastrichtian (A – UL XX 9/1; B – UL XX 1/18); **C** – *Sporadoscinia alcynoides* (Mantell 1822); view of external surface of sponge; Nasiłów, opoka, Upper Maastrichtian (UL XX 1/8)

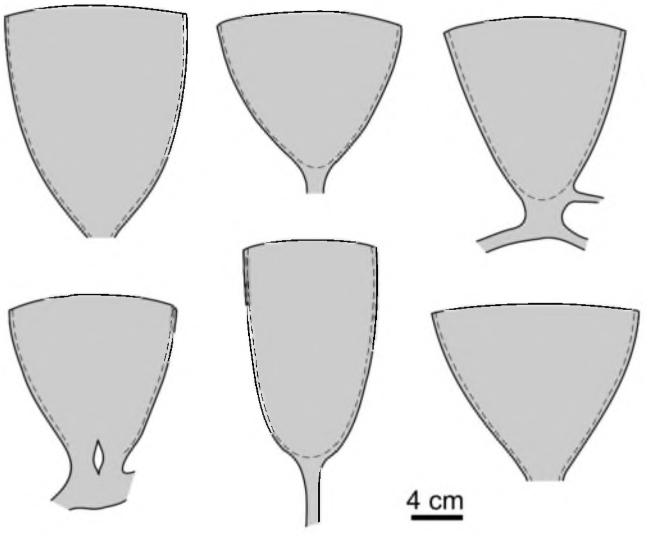

Fig. 24. Shape variability of *Sporadoscinia decheni* (Goldfuss 1831)

cesses comprising synapticular filaments surrounding the longitudinal canals.

Differentiation: Individuals with 2 or 3 short stalks were determined in material from opokas from Nasiłów (Fig. 23B)

Remarks: *S. decheni* is characterized by irregularly distributed polygonal canal openings on external surface. The sizes of these openings, similarly as in other species of *Sporadoscinia* are very variable. Therefore their density also varies. Schrammen (1912) counted 3–5/0.5 cm^2, whereas Mehl (1992) for the same specimens observed 16/cm^2. According to Defretin-Lefranc (1960), the density is 9–25/cm^2, and Ulbrich (1974) noted 25– 35/cm^2. Specimens from the Cretaceous of the Middle Vistula Valley generally posses rather small, densely packed canal openings, averagely 20–35/cm^2. Forms with similar openings were, according to me, often erroneously assigned to other species. From the Upper Maastrichtian of Ukraine, Khmilevsky (1977) described *Ventriculites stellatus* Schrammen 1902. The illustration showing the dermal surface of one of the specimens indicates polygonal canal openings (Khmilevsky, 1977, pl. 1, fig. 1a). However, there are no diagnostic for *V. stellatus* star-like thickenings, around which the canal openings are concentrically arranged (compare Schrammen, 1902, p. 11, pl. 2, fig. 5; Schrammen, 1912, p. 267, pl. 37, figs 4, 5; Ulbrich, 1974, p. 59, pl. 11, fig. 2; Mehl, 1992, p. 128, text-fig. 32). The size and arrangement of canal openings in the discussed specimens is identical as in representatives of *S. decheni*. To *S. decheni* belong also two specimens from Janowiec (no. III/84, 85), assigned by Hurcewicz (1968) to *Ventriculites* cf. *successor* Schrammen. They are represented by moulds of the internal surface with well visible traces of canal openings. Wall fragments are preserved only occasionally. In *S. decheni*, the canalization is a problematic feature. According to Ulbrich (1974) and Mehl (1992), the aporhyses can bifurcate several times. In the analyzed material, the aporhyses bifurcate maximally twice. The state of preservation, however, does not preclude a higher number of bifurcations of some aporhyses. Moreover, Mehl (1992) suggests that aporhyses run directly through the wall. On some specimens from the Middle Vistula section, there are small round openings of the aporhyses on the dermal surface. It seems, however, that they are visible due to effacement of the external surface of the specimens. Straight or divided epirhyses terminate according to Ulbrich (1974) and Mehl (1992) just below the gastral surface. It seems, however, that they are linked with the system of subgastral canals, developed similarly as in *S. venosa* and *S. teutoniae* (compare Ulbrich, 1974, pp. 62–63).

Occurrence: Poland – Middle Vistula Valley (Upper Campanian–Uppermost Maastrichtian), Kraków area (?Santonian); France (Albian–Lower Senonian); northern-western Germany (Lower Campanian); Ukraine (Maastrichtian).

Sporadoscinia alcynoides (Mantel 1822)
Figs 23C, 25 (C–F), 26

*1822. *Ventriculites alcynoides*: Mantell, p. 176.
1841. *Scyphia cribrosa* Phillips: Roemer, p. 9, pl. 4, fig. 2.
1870. *Cylindrospongia angustata* A. Roemer: F. Roemer, p. 309, pl. 30, figs 7, 8.
?1871–1872. *Ventriculites spinosus* nov. sp.: Sinzov, pp. 54–55, pl. 10, figs 1–3.
1878. *Ventriculites angustatus* Roemer: Quenstedt, p. 437, pl. 136, figs 2–4, 7, 10–12, 14.
1883. *Ventriculites alcynoides* Mantell: Hinde, p. 114.
1897. *Ventriculites angustatus* (Roemer): Leonhard, p. 31.
1912. *Leiostracosia alcynoides* Mant. sp.: Schrammen, p. 284.
1960. *Leiostracosia alcynoides* (Mantell): Defretin-Lefranc, p. 77, pl. 8, fig. 1.
partim v1968. *Sporadoscinia micrommata* Roemer: Hurcewicz, p. 84.

Material and preservation: 20 specimens (7 from Kazimierz, 11 from opoka and 2 from the glauconitic sandstone from Nasiłów). Two specimens are almost complete. Three are partly damaged. The remaining specimens are wall fragments. Choanosomal skeleton on some specimens very well preserved.

Comparative material: Collection UL III.

Description: Funnel-shaped sponges of different width, up to 120 mm high (Fig. 23C). Short stalks are short, 10–20 mm in diameter, with a rosette of dichotomously bifurcating in one plane, very long rhizoidal processes. Wall thickness – 3–5 mm. Canal openings on external surface round, with unevenly ragged margin (Fig. 25C). Diameter of openings averagely 1–1.5 mm, maximally 2 mm depending on individual. Openings regularly arranged alternately, separated by flat skeletal bands, of a more or less stable width ca. 1–1.2 mm. Density averagely 14–25/cm^2. At funnel base canal openings become longitudinally elongated, on stalk they are fissure-like. On internal surface, canal openings round, ca. 0.75–1 mm in diameter; in lower part, slightly larger and oval; on some specimens poorly visible. Most probably they were partly covered by siliceous filaments developed above the cortex (only indistinct moulds are visible). Canals at first rather wide, then narrow and within wall their diameter is averagely 0.5–0.7 mm (Fig. 26). Long straight epirhyses perpendicular to wall. Epirhyses terminate below internal surface or run into elongated chambers, passing below internal surface between aporhyses. Aporhyses with marginal short branches, running perpendicularly or slightly diagonally to the closest epirhyses occurring below or above. Terminations of aporhyses are typically bifurcate and end blindly below dermal surface or are connected with neighbouring epirhyses. Dictyonal skeleton comprising lychniscs with smooth or slightly spinose rays (Fig. 25E, F). Spicules in subdermal part with very densely spaced, short spines. Skeleton within wall rather regular, with prevalence of longitudinally rectangular meshes, 0.18–0.2 mm × 0.25–0.3 mm. In external parts, skeleton less regular. On both surfaces, as well as on canal walls a fine-porous (maximal pore diameter up to 0.25 mm) synapticular cortex occurs (Fig. 25C, D). Surface of cortex finely granulose. Basal skeleton similar as in other Ventriculitidae, *i.e.* synapticular filaments without axial canals, ca. 1 mm in diameter. Numerous longitudinal canals within basal skeleton.

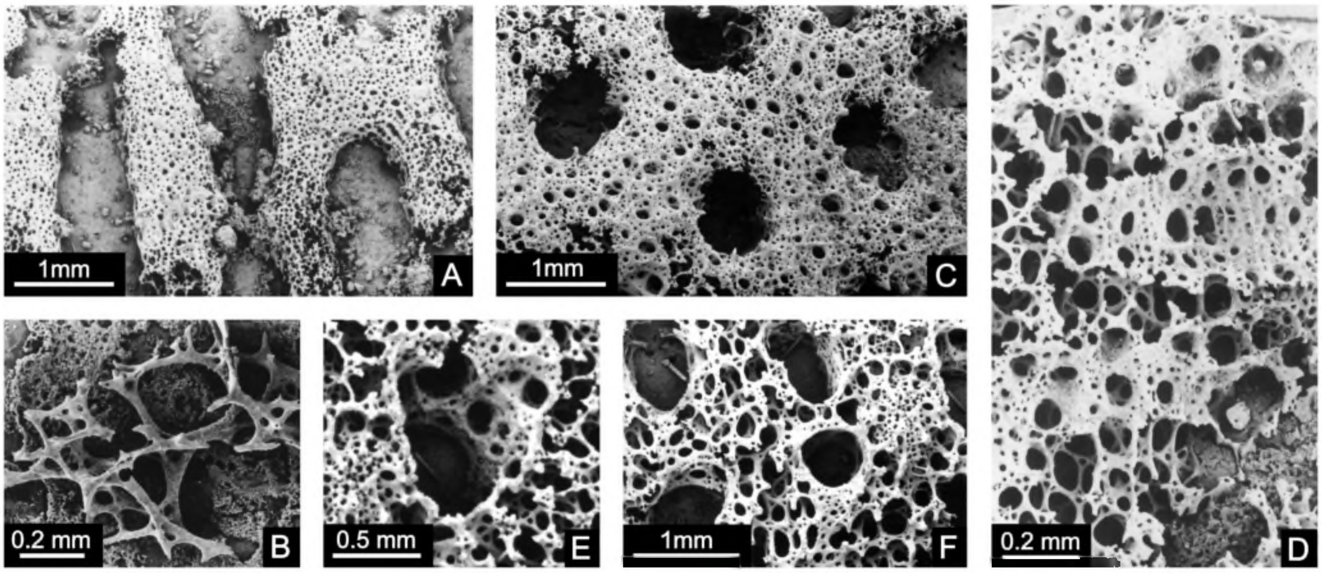

Fig. 25. **A, B** – *Sporadoscinia decheni* (Goldfuss 1831); A – cortex on gastral surface with canal openings; B – dictyonal skeleton; Nasiłów, opoka, Upper Maastrichtian (UL XX 0/252); **C–F** – *Sporadoscinia alcynoides* (Mantell 1822); C – cortex on dermal surface with canal openings; D – dictyonal skeleton with synapticular membrane covering canals (transverse cross–section through wall; E – note connection of lateral branch of aporhyses with epirhyses; F – dictyonal skeleton with canals; Kazimierz, Upper Maastrichtian (UL XX 3/123)

Remarks: Schrammen (1912) assigned this species to *Leiostracosia* Schrammen 1902. This assignment was based on the regular arrangement of round canal openings on the external surface. The main criterion, however, distinguishing *Leiostracosia* from other Ventriculitidae is the structure of the gastral surface. This surface was not present in specimens analyzed by Schrammen (1912), thus could not be examined. The descriptions of synonyms of this species cited by Schrammen (1912) and accepted by me do not supply information about the occurrence of grooves on internal side. Internal surface is best visible on the specimen presented by Quenstedt (1878, pl. 136, fig. 12), where round canal openings are arranged alternately, identically as in the case of Polish specimens. Moreover, in *Leiostracosia* there are straight canals perpendicular to the wall. On cross-sections, transverse to sponge axis the canals in *Sporadoscinia alcynoides* may imitate this arrangement. However, on cross-sections longitudinal and tangential to sponge surface the aporhyses bifurcate, what is a characteristic feature for *Sporadoscinia* Pomel. *Sporadoscinia alcynoides*, due to arrangement of canal openings on external surface, is close to *S. eutactopora* Defretin-Lefranc 1960 and *S. zippei* (Reuss 1846). From *S. eutactopora*, the species differs in much larger canal openings on dermal surface (compare Defretin-Lefranc, 1960, p. 74, pl. 7, figs 5, 6). *Sporadoscinia zippei*, in turn, possesses rhomb-like canal openings of dermal surface (compare Reuss, 1846, pl. 18, fig. 5). Defretin-Lefranc (1960) included one specimen from the Upper Turonian of France to *Leiostracosia alcynoides* (Mantell). The size and distribution of canal openings on both surfaces of this specimen as well as the structure of the choanosomal skeleton is identical as in specimens of *S. alcynoides* from the Cretaceous of Poland. The presence of fine-porous cortex on both surfaces of the French specimen does not testify for the assignment to *Leiostracosia* Schrammen, which is characterized by the lack of a gastral cortex. According to the description of Defretin-Lefranc (1960), the poorly exposed gastral surface bears alternately arranged oval pores, which lie in the bottoms of grooves, and the longitudinal ribs "seem to be more distinct than pointed out by Quenstedt". The presence of such grooves and ribs is very doubtful, as there are no illustrations of this element. Defretin-Lefranc (1960) stated moreover that the grooves occur also on the gastral surface in specimens assigned by her to *Leiostracosia impressus* Smith 1848 (=*Ventriculites impressus* Smith), whereas the photographs do not reveal this feature (Defretin-Lefranc, 1960, pl. 8, figs 2, 4). It seems, therefore, that the discussed specimen from France, described as *Leiostracosia alcynoides* (Mantell), belongs in reality to *S. alcynoides*, erroneously assigned by Defretin-Lefranc (1960) after Schrammen (1912) to *Leiostracosia* Schrammen. Also specimens from Saratov, described by Siznov (1871–1872) as the new species *Ventriculites spinosus*, have morphology of both surfaces similar to *S. alcynoides*. According to Siznov (1871–1872), this species is characterized by numerous processes on the dermal surface. The processes, however, cannot be considered as a specific feature, because they are probably the remnants of broken-off rhizoidal processes, which grown in the upper part of the sponge during their covering by sediment. The lack of canalization description does not allow the univocal assignment of Sinzov's

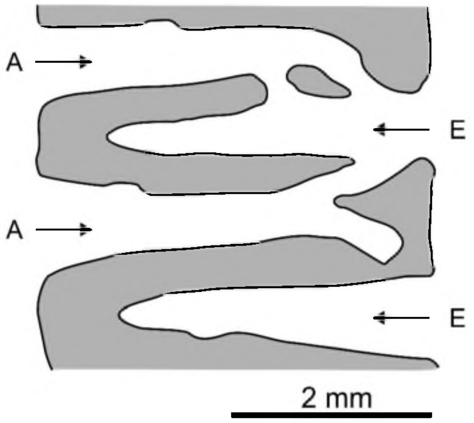

Fig. 26. *Sporadoscinia alcynoides* (Mantell); specimen no 3/123; schematic canalization on longitudinal cross–section of wall; E – epirhyses, A – aporhyses

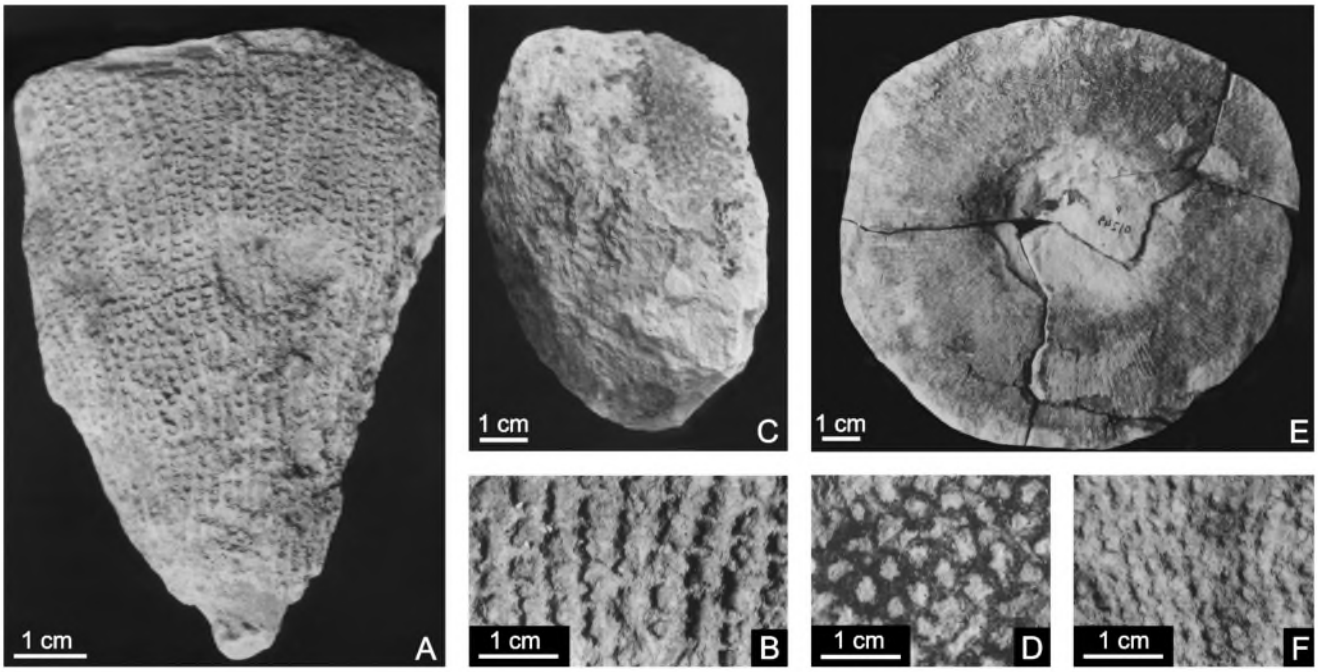

Fig. 27. **A, B** – *Leiostracosia orthogoniopora* (Defretin–Lefran 1960); A – lateral view; B – detail of dermal surface with canal openings; Nasiłów, opoka, Upper Maastrichtian (UL XX 9/139); **C, D** – *Leiostracosia robusta* (Schrammen 1902); C – lateral view; D – detail of dermal surface with canal openings; Piotrawin, Upper Campanian (C – UL XX 6/172; D – UL XX 6/52); **E, F** – *Leiostracosia punctata* Schrammen 1912; E – view of internal surface of sponge; F – detail of dermal surface with canal openings; Piotrawin, Upper Campanian (E – UL XX 0/248; F – UL XX 3/2)

(1871–1872) specimens to *S. alcynoides*. Most specimens of *S. alcynoides* described here are represented by narrow funnels, cones or even cylinders. Specimen no. III/143 from Witkowice, assigned by Hurcewicz (1968) to *S. micrommata* (Roemer 1841) and the unpublished specimens from Bonarka are representatives of the narrow-cone morphotype. Material from the Vistula Valley is characterized by wide funnel-shaped forms.

Occurrence: Poland – Middle Vistula Valley (Upper Maastrichtian); Opole area (Turonian), Miechów area (Campanian); northern-western Germany (Upper Turonian); France (Upper Turonian); ?Russia – Saratov area (Santonian); England (Middle Turonian–Santonian) – according to Reid (1968a).

Genus *Leiostracosia* Schrammen 1902
Type species: *Leiostracosia punctata* Schrammen 1902

Remarks: Schrammen (1902) initially assigned the genus *Leiostracosia* to Ventriculitidae and next to the new family Sporadoscinidae (Schrammen, 1912). The structure of the choanosomal skeleton and the development of canals points, however, to the assignment of *Leiostracosia* to the family Ventriculitidae (see Laubenfels, 1955; Defretin-Lefranc, 1960; Mehl, 1992) and this view is accepted here. The definition of *Leiostracosia* presented by Schrammen (1902, 1912) univocally indicates that the dictyonal cortex is developed only on the dermal surface. The gastral surface is in turn characterized by a secondary network, comprising siliceous filaments without axial canals ("deckgespinst" according to Schrammen, 1902, 1912; "superficial mesh- work", according to Reid, 1964). Characterising the genus *Leiostracosia*, Moret (1926, p. 226) erroneously stated that its representatives possess a gastral cortex. This erroneous statement was further accepted by Defretin-Lefranc (1960, p. 77).

Leiostracosia punctata Schrammen 1902
Figs 27 (E, F), 28 (A–C)

*1902. *Leiostracosia punctata* nov. sp.: Schrammen, p. 12, pl. 3, fig. 3.
1912. *Leiostracosia punctata* Schrammen: Schrammen, p. 285, text-pl. 14, fig. 12; pl. 35, figs 1, 2.
1962. *Leiostracosia punctata* Schrammen: Lagneau-Hérenger, p. 97, text-pl. 14, fig. 2.

Material and preservation: 31 specimens (2 from Ciszyca Górna, 20 from Piotrawin, 9 from Dziurków). All specimens are incomplete. The lower pipe-like parts are separated from the wide upper parts, which typically are preserved only fragmentarily. In some specimens, the dictyonal skeleton and cortex on dermal surface are very well preserved. Skeleton on gastral surface was recognised only on one specimen.

Description: Thin-walled sponges (1.5–3 mm thick), funnel- or umbrella-shaped, on short stalks terminating with rhizoidal processes. Cylindrical or slightly cone-like lower part maximally 150 mm high. Upper part flat or with margin turned down, diameter up to 220 mm (Fig. 27A). External surface with round canal openings, arranged in longitudinal and transverse rows, with horizontal rows less distinct (Fig. 27B). On lower conical part and on stalk, canal openings very small (ca. 0.3–0.5 mm). In upper part, canal openings larger, averagely 0.7 mm, in some cases, even 1–1.5 mm. Separating them longitudinal skeletal bands convex, 0.5 to 1 mm wide. Transverse bands of similar width or slightly narrower. Average density of canal openings on 1 cm^2 varies from 20 to 36. Radial flat ridges on internal surface, 1–1.5 mm wide. Ridges bifurcate, secondary ridges at first half the width of primary ridges, then attain initial width. Grooves between ridges, ca. 1 mm wide, with round canal openings on bottom, ca. 1 mm in diameter, separated by transverse skeletal bands of similar width. Canal openings arranged in longitudinal and transverse rows; average

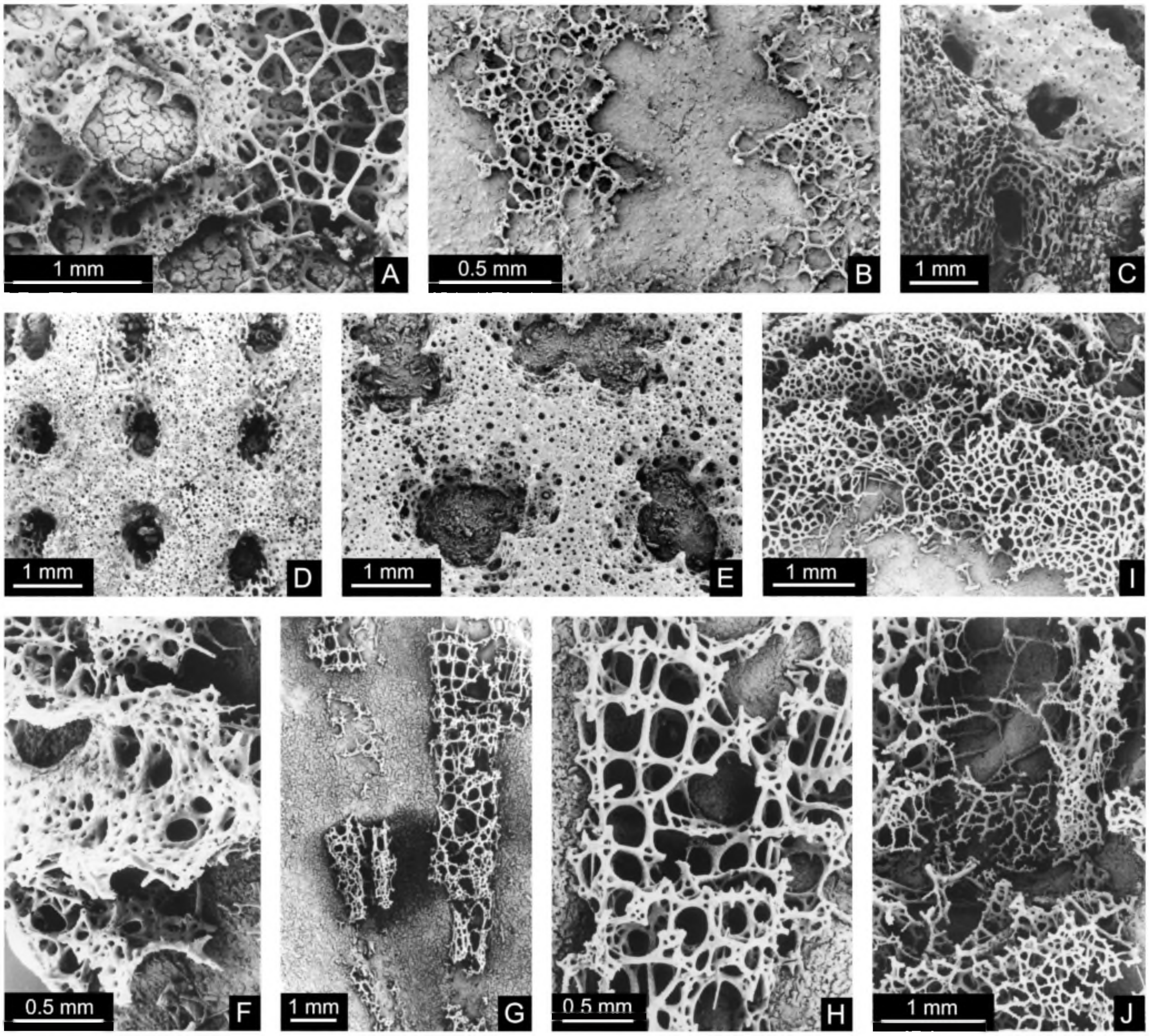

Fig. 28. **A–C** – *Leiostracosia punctata* Schrammen 1912; A – subdermal dictyonal skeleton; note internal surface of dermal cortex; B – gastral side with irregular dictyonal skeleton on rib surface (furrow filled with sediment between them); C – synapticular filaments of basal skeleton (left lower corner), covering dermal cortex visible in right upper corner; Piotrawin, Upper Campanian (UL XX 6/58); **D–J** – *Leiostracosia orthogoniopora* (Defretin-Lefran 1960); D – dermal side of the lower part of specimen with cortex and longitudinally elongated oval canal openings; in some cases fragments of synapticular filaments of the basal skeleton are visible; E – dermal side of upper part of specimen with dermal cortex and transversely elongated canal openings; F – synapticular membrane covering canal; G – dictyonal skeleton within ribs of the gastral side; note irregular network of ribs surface and fragment of deeper located regular skeleton in upper part; H – detail of skeleton within ribs with terminal parts of epirhyses; I – secondary network on gastral surface, comprising siliceous filaments; note dense, multilayered network stretched over ribs and furrows to the left; note skeleton of longitudinal rib to the right (transversely oriented on photograph); neighbouring furrows filled with loose network of thin filaments; J – detail of secondary network on gastral surface; note siliceous filaments running from lichnisc rays; Kazimierz, Upper Maastrichtian (UL XX 7/59)

density 20–25/cm^2. Diplorhysis in independent longitudinal series. Epirhyses long, pointed, perpendicular to wall, terminating below surface of ridges of internal surface. Aporhyses shorter than epirhyses, terminate below longitudinal skeletal bands of dermal surface. Numerous, densely packed longitudinal canals in stalk and rhizoidal processes. Dictyonal skeleton comprising lychniscs with rays possessing singular, fine spines. Within wall, they compose a rather regular network, mainly with longitudinally rectangular meshes, 0.25–0.3 mm × 0.3–0.4 mm. Towards both surfaces network becomes very irregular with quadrangular meshes of various sizes, 0.2–0.4 mm (Fig. 28A, B). In these parts of skeleton, skeletal beams with fine processes instead of spines. Dermal surface with very thick, fine-porous synapticular cortex, with cone-like processes on surface, being remainders after reduced external rays (Fig. 28C). Directly below cortex, spicules very massive, with thickened rays and nodes. Thick synapticular filaments preserved also in external parts of epirhyses. On gastral surface, siliceous filaments with fine, sparse granulation. Filaments run from dictyo-

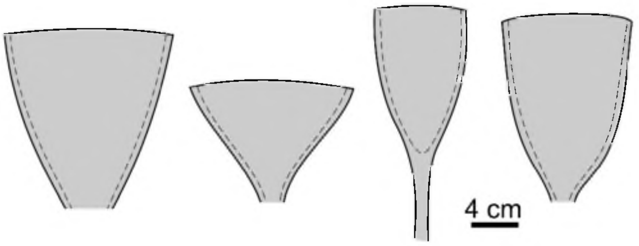

Fig. 29. Shape variability of *Leiostracosia orthogoniopora* (Defretin-Lefranc 1960)

nal rays of lychniscs and link in a very delicate network with rounded, small (ca. 0.05–0.1 mm) meshes. Basal skeleton comprising synapticular filaments, growing above cortex in lower parts of sponge (Fig. 28C). Such filaments may also be developed on gastral surface in bottom of spongocoel.

Remarks: In all described specimens of this species, the morphology of internal surface seems to be identical. There are, however, differences in the size of canal openings on internal surface. The holotype of *L. punctata* (Schrammen, 1902, pl. 3, fig. 3) has canal openings with the diameter of 0.3 mm, and density from 20 to 25/cm^2, whereas in the paratype (Schrammen, 1912, pl. 35, fig. 2) the canal openings are wider and more densely arranged. In specimens from Poland, the size of openings as well as their density are very variable. This is observed both within the particular populations as well as on different parts of the sponge in a single individual. The sparse material (5 specimens) described by Schrammen (1902, 1912) is represented mainly by the lower, cone-like parts of sponges, where canal openings are generally smaller than in the upper part, and the skeletal bands separating them are wider. It seems that the characteristic feature of *L. punctata* is the regular arrangement of canal openings in vertical and horizontal rows on both internal and external surfaces

Occurrence: Poland – Middle Vistula Valley (Upper Campanian–Lower Maastrichtian); France (Albian); northern-western Germany (Campanian); England (Lower Senonian) – according to Reid (1968a).

Leiostracosia robusta (Schrammen 1902)
Fig. 27 (C, D)

*1902. *Pachylepisma robusta* nov. sp.: Schrammen, p. 14, pl. 1, fig. 2.

1912. *Leiostracosia robusta* Schrammen: Schrammen, p. 285, text-pl. 13, fig. 12; pl. 35, figs 4–6.

?1960. *Leiostracosia brandesi* Schrammen: Defretin-Lefranc, pp. 78–79, pl. 8, figs 5, 7; non fig. 6 [cf. *Ventriculitidae*].

Material and preservation: 16 specimens (4 from Ciszyca Kolonia, 5 from Ciszyca Górna 1 from Piotrawin, 6 from Dziurków). One specimen is almost complete. The remaining material comprises fragments of different sizes. Choanosomal skeleton, except fragments of cortex on dermal surface, is almost completely dissolved. Free voids after spicules filled with iron hydroxides.

Description: Cup-shaped sponges, 130 mm high, with thick (6 mm) wall (Fig. 27C). Irregular, round canal openings on external surface, 2–3 mm in diameter (Fig. 27D). Canal openings arranged regularly on entire surface. In some specimens, visible indistinct arrangement in vertical rows; average density – 9/cm^2. Slightly convex skeletal bands between openings, 1.5–2 mm wide. Wide (ca. 2–3 mm), flat ribs on internal surface, in some cases bifurcating into two narrower ribs, which gradually widen and reach again primary width. Ribs separated by grooves, 1.5 to 2 mm wide. Grooves with round or slightly oval canal openings, 1.5–2 mm wide, arranged in vertical and horizontal rows; density 6 to 9/cm^2. Diplorhysis straight, perpendicular to wall. Long, pointed epirhyses terminating below surface of ridges on gastral surface. Aporhyses short, cylindrical, terminating close to dermal surface. Dictyonal skeleton comprising large lychniscs, in form of regular network with longitudinally rectangular meshes; average mesh size 0.3 mm × 0.4 mm. In subdermal part, skeleton more irregular. Very porous synapticular cortex on dermal surface. In this part, external spicule rays partly reduced and in form of cone-like spines. On gastral surface, dictyonal skeleton irregular, without developed cortex.

Remarks: The analysed specimens, due to the shape of individuals and size of canal openings on both surfaces match the diagnosis of *L. robusta*. However, the ribs on the gastral surface in some individuals from Poland are much wider (compare Schrammen, 1912, pl. 35, fig. 6). According to Schrammen (1912), the dictyonal skeleton is irregular. In the analysed specimens, this skeleton is observed in the external parts of the walls, whereas in its central part the network is regular, similarly as in other species of *Leiostracosia*. The external surface of specimens from the Cretaceous of Poland is very similar to two specimens from the Coniacian of France. Defretin-Lefranc (1960) assigned these to *L. bran- desi* Schrammen 1912. The canal openings in this species are, however, much smaller, with a irregular or fissure-like shape (see Schrammen, 1912, p. 288, pl. 35, fig. 3). The poor state of preservation of the internal surface in the discussed specimens does not allow a univocal assignment to *L. robusta*.

Occurrence: Poland – Middle Vistula Valley (Upper Campanian–Lower Maastrichtian); northern-western Germany (Campanian); ?France (Coniacian); England (Lower Senonian) – according to Reid (1968a).

Leiostracosia orthogoniopora (Defretin-Lefranc 1960)
Figs 27 (A, B), 28 (D–J), 29

*1960. *Porocyclus orthogonioporus* nov. sp.: Defretin-Lefranc, pp. 69–70, text-fig. 20; pl. 6, figs 1, 2.

v1968. *Rhizopoterion solidum* Schrammen: Hurcewicz, pp. 77–78, pl. 20, fig. 3.

1978. *Schizorhabdus libycus* Zittel: Khmilevsky, p. 23, pl. 1, fig. 1a, b; pl. 2, figs 2–4; pl. 3, figs 1, 2.

1978. *Schizorhabdus sp.*: Khmilevsky, p. 25, pl. 2, fig. 1.

1979. *Rhizopoterion cervicorne* Goldfuss: Khmilevsky, pp. 43–44, pl. 1, figs 1, 6; pl. 2, figs 1–3; pl. 3, figs 1–3.

Emended diagnosis: Cup-like sponges with stalk. Canal openings on external surface arranged in longitudinal rows. In lower part, canal openings round, in upper part, transversely rectangular, with width up to 2 mm. Canal openings on internal surface round and small (diameter ca. 1 mm). Canal openings in bottom of deep, longitudinal grooves, 1–2 mm wide. Diplorhysis cylindrical, perpendicular to wall. Dictyonal skeleton comprising lychniscs, form a regular network within wall. Synapticular cortex developed only on dermal surface. Gastral surface covered with network of irregularly polygonal meshes, formed by tingled siliceous filaments, growing from rays of dictyonal spicules.

Material and preservation: 123 specimens (3 from Dobre, 3 from Podgórz, 3 from Męćmierz, 23 from Kazimierz, 1 from Janowiec, 1 from opoka and 1 from the glauconitic sandstone from Bochotnica, 8 from opoka and 123 from the glauconitic sandstone from Nasiłów). Eleven specimens, apart from a damaged or broken off stalk, are almost complete. Sponges from glauconitic sandstone are very crushed. Choanosomal skeleton in some specimens very well preserved.

Comparative material: Collection UL III.

Description: Cup-like sponges, ca. 200 mm high, on massive, long (up to 80 mm) stalk (Figs 27A, 29). Wall thickness – ca. 5–8 mm. On external surface canal openings arranged in longitudinal rows (Fig. 28D, E). In lower part of sponge canal openings irregular or longitudinally oval, diameter 0.7–1 mm, upwards become wider and gradually attain shape of irregular, transversely elongated rectangles, with average size ca. 1 mm × 1.5–2 mm (Fig. 27A, B). Skeletal bands between canal openings flat, band-like. Longitudinal bands of rather even width (ca. 1–1.5 mm), transverse bands of similar width or slightly narrower. Radial deep grooves on internal surface, 1–2 mm wide. Convex, slightly narrower (1–1.5 mm) ridges between grooves; ridges bifurcate randomly. Canal openings, alternately arranged every 1–1.5 mm on bottom of grooves. Canal openings round or slightly oval, 1–1.5 mm in diameter. Canal openings longitudinally elongated to fissure-like on stalk surface, leading to diagonal, then longitudinal canals within stalk. Diplorhysis arranged in longitudinal series. Long, cylindrical epirhyses perpendicular to wall and terminating below ridges on gastral surface. Aporhyses short, straight, with terminations under longitudinal skeletal bands of dermal surface. Dictyonal skeleton within wall comprising lychniscs with smooth or very finely granulated rays, forming a regular network with quadrangular and longitudinally rectangular meshes (0.25 mm × 0.38 mm) (Fig. 28G). Lychniscs with variable orientation in external parts of wall, giving network an irregular pattern. Very thick synapticular cortex on dermal surface, with fine, sparsely spaced pores (Fig. 28D, E). Cortex also covering walls of epirhyses (Fig. 28F). Very delicate, fine-meshed network of thin siliceous filaments only in terminations of epirhyses. No cortex on gastral surface and on walls of aporhyses. Siliceous filaments with fine and dense spines running from gastral dictyonal lychniscs occurring on surface of ridges; fusing into secondary network, spreading also above the grooves (Fig. 28I, J). Meshes of secondary network as irregular polygons, 1–2 mm in diameter. In lower part of cup, in some cases, secondary network comprising several layers, with empty, vesicular spaces in between. Thinner siliceous filaments, however, with longer spines, forming very loose network infilling grooves. Filaments composing stalk growing above synapticular cortex in lower part of cup on its external surface.

Differentiation: Individuals with narrow and medium cups dominate. Rare specimens with very wide cups are solely from Kazimierz.

Remarks: In terms of morphology, the analysed specimens recall specimens from France. Specimens studied by Defretin-Lefranc (1960) have a dissolved siliceous skeleton, thus their description was based on secondary infillings of voids after spicules. The arrangement and size of elements of the main dictyonal skeleton in these specimens agrees with these features observed on the material analysed herein. However, Defretin-Lefranc (1960) stated that the cortex is “fine-porous, lacking strongly thickened rays”, at the same time not pointing, to which surface of sponge does this statement refer. Based on the illustration (see Defretin-Lefranc, 1960, text-fig. 20) it seems that this description probably applies to the subdermal skeleton. There is no data about the gastral surface of the dictyonal skeleton. Defretin-Lefranc (1960) erroneously assigned *L. orthogoniopora* to the genus *Porocyclus* (= *Ubiquiradius* de Laubenfels 1955, erroneously included by that author to Hexactinosida. Both *Leiostracosia* and *Ubiquiradius* posses grooves on the internal surface and may have similarly arranged canal openings. The diagnostic feature of *Ubiquiradius* is thick cortex developed on both surfaces. In turn, in representatives of *Leiostracosia* the cortex covers only the dermal surface. This difference was overlooked by Defretin-Lefranc (1960) in the diagnoses of the genera in question. The analysed specimens lack a dictyonal cortex on the gastral surface. On the other hand, they posses a secondary network comprising siliceous filaments typical for *Leiostracosia.* The network construction in specimens of *L. orthogoniopora* from Poland is most similar to that in *L. robusta* (Schrammen 1902) (compare Schrammen, 1912, text-pl. 13, fig. 12). Hurcewicz (1968) included to *Rhizopoterion solidum* Schrammen one poorly preserved specimen of *L. orthogoniopora*, based on the characteristic rectangular “ostia”, however, omitting the fact that they are transversely elongated in relation to the sponge axis, whereas in *R. solidum* the “ostia” are elongated parallel to the sponge axis. Due to this, and also taking into account the presence of grooves on the gastral surface, the discussed specimen is assigned to *L. orthogoniopora.* The specimens from the Upper Maastrichtian of Podilia described by Khmilevsky (1978, 1979) as *Schizorhabdus libycus* Zittel 1877, *Schizorhabdus* sp. and *Rhizopoterion cervicorne* (Goldfuss 1826) also belong to *L. orthogoniopora.* In all cases, these specimens are damaged, without the upper part. There are several inconsistencies in their descriptions. The illustrated longitudinally elongated canal openings in specimens assigned to *R. cervicorne* (Khmilevsky, 1979, pl. 3, fig. 3), according to that author lead to diagonal canals, typical for *Rhizopoterion* Zittel. The photographs, however, show only the stalk surface (compare Khmilevsky, 1979, pl. 1, fig. 1; pl. 2). The described canalisation in this part of the sponge is typical for all representatives of Ventriculitidae. In the upper part of cup, in turn, occur transversely rectangular canal openings and grooves on internal surface, not included in the description of these specimens (see Khmilevsky, 1979, pl. 1, fig. 1). The presented “paragastral cortex”, considered as a structure comprising pentactines, is in reality a secondary network of siliceous filaments, identical as in the Polish specimens (Khmilevsky, 1979, pl. 1, fig. 6). In turn, the specimens with a very long stalk were considered by Khmilevsky (1978) as representatives of the problematic genus *Schizorhabdus* Zittel (type species *S. libycus* Zittel is known only from a fragment of the lower part of individual – see Zittel 1877, p. 51; Lagneau-Hérenger, 1953, pp. 123–125, pl. 1, 2). All these specimens represent only the lower, small fragments of cups, where the canal openings are irregularly round. The arrangement of canal openings, presence of grooves on internal surface as well as skeleton structure are typical for *L. orthogoniopora*. It is noteworthy that all the specimens included by Khmilevsky (1978, 1979) to different species, and considered herein as synonyms of *L. orthogoniopora*, occur simultaneously in the same exposures and similarly as the Polish specimens are from the Upper Maastrichtian.

Occurrence: Poland – Middle Vistula Valley (Upper Campanian–Lower Maastrichtian); France (Coniacian); Ukraine – Podilia (Upper Maastrichtian).

Genus *Varioporospongia* gen. nov.
Type species: *Varioporospongia dariae* sp. nov.

Derivation of name: *varius* (Latin) – various, *porus* (Latin) – pore; referring to various type of canal openings on dermal surface.

Diagnosis: Trumpet-shaped, thin-walled sponges. On dermal surface canal openings longitudinally oval, 2–5 mm in size, arranged at various distance in relation to each other, in indistinct longitudinal rows. On gastral surface, canal openings longitudinally oval or fissure-like, regularly alternately arranged in longitudinal rows. Diplorhysal canalization with straight epirhyses, perpendicular to wall. Aporhyses in form of internal chambers within wall, from which short canals run through wall. Small accessory openings randomly distributed on dermal surface. Dictyonal skeleton irregular, comprising lychniscs. Thick synapticular cortex on both surfaces. Basal skeleton comprising synapticular filaments.

Remarks: The genus *Varioporospongia* gen. nov., similarly as genus *Sporadoscinia* Pommel, 1872, has alternately arranged oval canal openings on gastral surface and an irregular dictyonal skeleton with thick cortex on both surfaces. Contrary to *Sporadoscinia, Varioporospongia* has rare longitudinally oval canal openings on

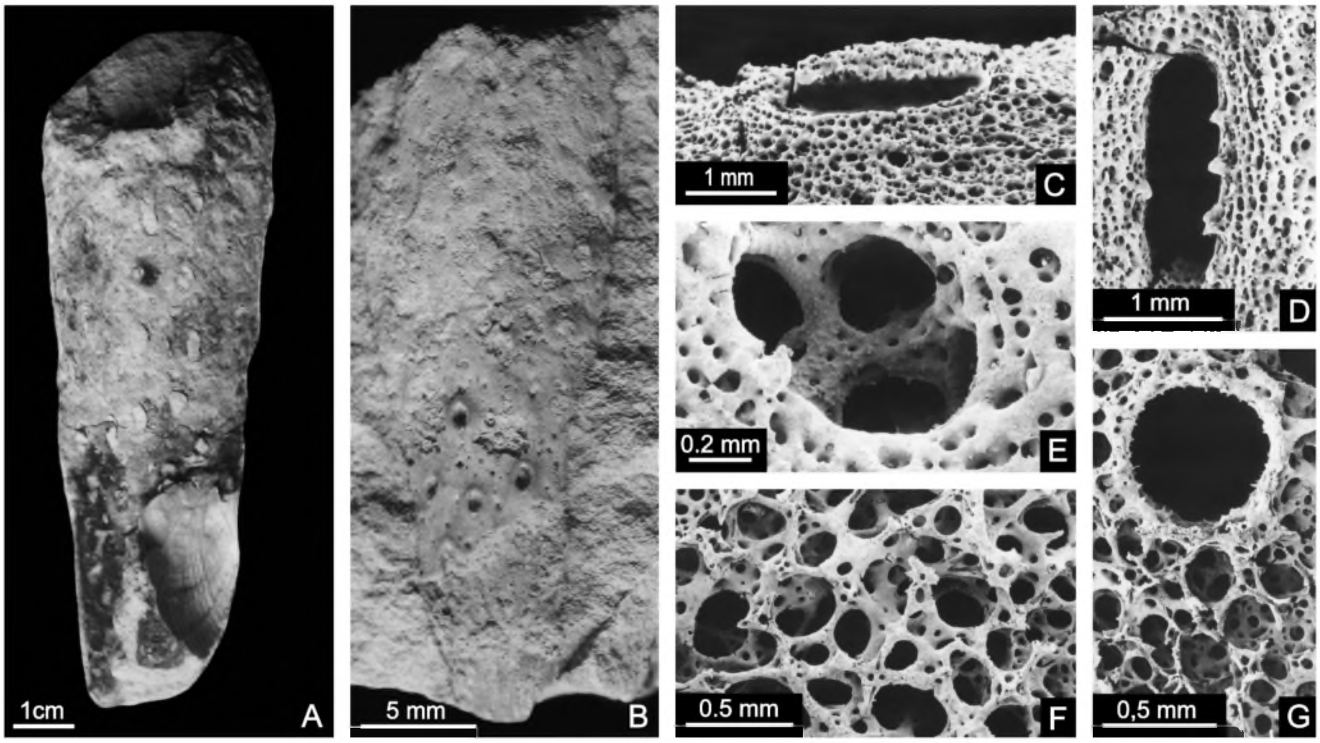

Fig. 30. A–G – *Varioporospongia dariae* sp. nov. A – holotype; lateral view; Kazimierz, Upper Maastrichtian (UL XX 7/67); B – paratype, lateral view; Nasiłów, opoka, Upper Maastrichtian (UL XX 1/78); C – dermal surface of the dictyonal skeleton; note canal opening with crater–shaped margin; D – gastral surface of the dictyonal skeleton; note canal opening in centre; E – accessory opening of aporhyses on dermal surface; note branching of canal; F – dictyonal skeleton with synapticules; G – subdermal skeleton; note spiny surface of the internal margin of the input opening of canal; Kazimierz, Upper Maastrichtian (paratype, UL XX 1/170)

dermal surface, between which occur randomly numerous accessory openings of aporhyses.

Varioporospongia dariae sp. nov.

Figs 30 (A–F), 31

Holotype: UL XX 7/67; Fig. 30A.
Etymology: Named from my daughter Daria.
Material: 15 specimens (3 specimens from Kazimierz, 9 from opoka and 2 from greensand from Nasiłów).
Dimensions: about 110 mm high and 35 mm in diameter.
Diagnosis: As for the genus.
Preservation: No specimen with the basal skeleton is present. Six specimens represent moulds of external surface with small wall fragments. Choanosomal skeleton, besides dictyonal cortex, preserved only fragmentarily.

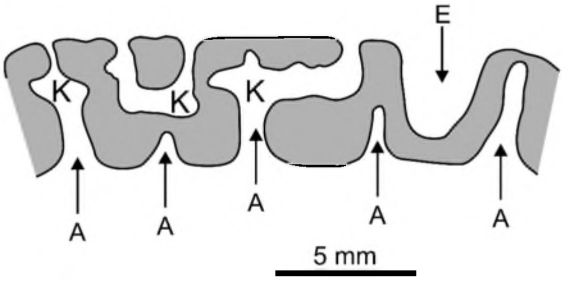

Fig. 31. *Varioporospongia dariae* sp. nov.; a synthetic scheme of canalization on transverse cross–sections, based on specimen no. 1/170; E – epirhyses, A – aporhyses; K – internal chamber

Description: Narrow cone- or trumpet-shaped sponges, 110 mm high (Fig. 30A, B). Wall thickness 3–4 mm. Upper part of largest specimens with wide folds. Stalk thin, long (about 60 mm), most probably with rhizoidal processes. Longitudinal oval canal openings on external surface, of variable size even in one individual (from 1.8 mm × 2 mm to 3 mm × 5 mm). Lack of relation between size of canal openings and position on external surface. Margin of openings slightly jutting, crater-like (Fig. 30B, C). Canal openings randomly distributed on entire surface in indistinct longitudinal rows. Canal openings on internal surface longitudinally oval, 1–1.5 mm × 2.5–4 mm (Fig. 30D). In lower part of sponge, typically strongly elongated or fissure-like, regularly alternately arranged; density 12–14/cm^2. Diplorhysal canalization (Fig. 31). Epirhyses wide, chamber-like, running perpendicular to wall and ca. 2/3 to its width. Aporhyses running to internal chambers, situated in central part of wall. Short canals running from chambers directly through wall, forming additional openings on dermal surface (Fig. 30E). Openings round or slightly elongated, 0.5–1.5 mm in diameter, randomly distributed, averagely 25–35/cm^2. Longitudinal canal openings on stalk surface leading to longitudinal canals. Skeleton comprising lychniscs with smooth rays or singular delicate spines. Lychniscs composing very irregular network, with 0.25–0.3 mm meshes (Fig. 30F, G). In subdermal and subgastral part, network deformed with numerous synapticulae. In these parts and in vicinity of canals, lychnisc rays thickened and finely granulated. Very porous, synapticular cortex on both surfaces (Fig. 30C–E). Pores in cortex of various size, maximal diameter ca. 0.2 mm. On gastral surface, cortex with numerous processes running towards centre of canal openings. Canal walls covered with thin siliceous synapticular membrane. Numerous fine spines occasionally occuring on its surface near canal openings. Basal skeleton comprising synapticular filaments growing from lower part of sponge forming thick cover above cortex.

Remarks: Due to poor preservation of the specimens (dissolved skeleton and wall compaction) it was not possible to determine the shape and distribution of the internal chambers. It seems, however, that they do not form a continuous canalisation. Rhizoidal processes are not preserved, but the construction of basal skeleton, typical for Ventriculitidae, observed within stalk indicates their presence.

Type locality: Kazimierz, Middle Vistula Valley.

Stratigraphic distribution: Upper Maastrichtian.

Family CALLODICTYIDAE Zittel 1878
emended Reid 2004

According to Reid (2004f), the characteristic feature of the Callodictyidae family is dictyonal skeleton without canals or with shallow epirhyses or aprhyses. Because of that, Reid (1962c, 2004f) encounted to the family some morfologically diversed genera, amongst other part of Becksiidae Schrammen 1912. The systematic position of other Becksiidae representatives, which Reid (1957, 1962c, 2004f) included to Dactylocalycidae Gray 1867, erroneously placing the latter family in Lychniscosida (compare Reiswig, 1991, 2002).

Genus *Brachiolites* Smith 1848 emended Reid 1962
Type species: *Brachiolites fenestratus* Smith 1848

Remarks: According to Reid (1962c), the definition of the genus *Plocoscyphia* Reuss 1846, presented by Zittel (1877) is not concordant with the diagnosis of this genus given by Reuss (1845–1846), based on the species *Plocoscyphia labirynthica* Reuss 1846. Zittel's (1877) definition in turn, is identical with the diagnosis of the genus *Brachiolites* Smith 1848. Therefore, part of the species described as *Plocoscyphia* Reuss *sensu* Zittel (1877) represents in reality the genus *Brachiolites* Smith 1848.

Brachiolites cf. *centunculus* (Schrammen 1912)
Fig. 32 (H)

cf.* 1912. *Plocoscyphia centuncula* nov. sp.: Schrammen, p. 301, pl. 40, fig. 5, text-pl. 14, fig. 2.

Material and preservation: 4 fragments from the glauconitic sandstone from Nasiłów. Choanosomal skeleton known only from casts.

Description: Probably lump-like sponge, comprising bifurcating and fusing again tubes, with wall thickness 1.5–2 mm. Tube diameter 10–12 mm. External margins of tubes occasionally fused, forming sinuous lamellae on sponge surface. Space between tubes longitudinal, 5–9 mm wide. Dictyonal skeleton regular, comprising lychniscs. Network meshes (ca. 0.3 mm) quadrangular. Dermal surface of tubes with synapticular cortex with randomly distributed round pores of various size, maximal diameter up to 0.7 mm. No cortex in deeper parts of sponge. On gastral surface skeleton less regular, also without cortex. Canals within wall not developed.

Remarks: The general body plan and skeleton of the described specimens recalls the species *B. centuncula* (Schrammen 1912) from the Campanian of north-western Germany. The poor state of preservation does not allow detailed analysis of their structure. The described fragments differ from other co-occurring species of Lychniscosida with a similar construction (representing *Cyclostigma* Schrammen) in the presence of a well developed cortex and large size of tubes.

Occurrence: Middle Vistula River Valley (uppermost Maastrichtian).

Genus *Cyclostigma* Schrammen 1912
Type species: *Plocoscyphia acinosa* Schrammen 1902

Remarks: In the characteristics of the genus *Cyclostigma*, Schrammen 1912, p. 303) stated that the surface of these sponges is covered by small hexactines. Reid (1964, p.126) stated that among these secondary hexactines with solid nodes occur also hexactines with small octaedrs or even hexactines with nodes partly filled, with traces after. My investigations confirm the observations of Reid (1964). Lychniscs are very common in the secondary network of *C. maeandrina* Schrammen 1912 and *C. lobata* Schrammen 1912. Reid (2004f) found the secondary hexactines not a very important diagnostic feature and based on the general morphological structure, considered *Cyclostigma* as the subgenus *Callicylix* Schrammen 1912. However, only *C. maeandrina* and *C. lobata* have the tubes' layout consistent with the *Callicylix* diagnosis. To distinct from type speciec *Callicylix farreides* Schrammen, these species do not have a central cavity. *Callicylix acinosa* however, with perforated bridges arround tubes openings (compare Schrammen, 1912) responds rather to the diagnosis of *Centrosia* Schrammen 1902 (compare Schrammen, 1912; Reid, 2004f). In type species *Centrosia incrustans,* described by Schrammen (1902), tubes openings, joined by smaller tubular bridges, are difficult to identify. The feature was considered in the latter diagnosis of the genus (Schrammen, 1912). The specimen presented by Schrammen (1912), which was afterwards demonstrated by Reid (2004f), differs from holotype and possibly represents the *Cyclostigma acinosa*. In the case, settling the relation between the genera *Cyclostigma*, *Callicylix* and *Centrosia* requires further examination, considering all the taxon's repre- sentatives.

Cyclostigma acinosa (Schrammen 1902)
Figs 32 (A, D), 33A, 34 (C–E)

*1902. *Plocoscyphia acinosa* nov. sp.: Schrammen, p. 17, pl. 4, fig. 2.

1912. *Cyclostigma acinosa* Schrammen: Schrammen, p. 303.

?1912. *Centrosia incrustans* Schrammen: Schrammen, pl. 39, fig. 1.

Material and preservation: 36 specimens (21 from Piotrawin, 1 from Dziurków, 14 from the glauconitic sandstone from Nasiłów). All specimens are to a various degree incomplete. The specimens from opokas are tightly fixed to the rock. Most specimens from opokas possess a well preserved primary dictyonal skeleton. Fragments of the secondary network, comprising hexactines, are found sporadically. In specimens from the glauconitic sandstone, besides single spicules, the entire skeleton in completely dissolved. Lack of basal skeleton.

Description: Funnel-shaped sponges, averagely 70–100 mm high. Width very variable. Widest, large individuals of diameter up to 150 mm. Distinct stalk in lower part of sponge. Wall width ca. 10 mm. Wall comprising thin-walled tubes (1 mm), 4–7 mm in diameter. Short lateral tubes running outwards from the growing upwards main system of bifurcating and fusing again tubes. In lower part of sponge, lateral tubes strongly shortened. Openings of lateral tubes, 3–7 mm in diameter, on external surface irregularly round or elongated. At upper cup margin, tube margins not fused or partly fused. Spaces between tubes in form of narrow fissures.

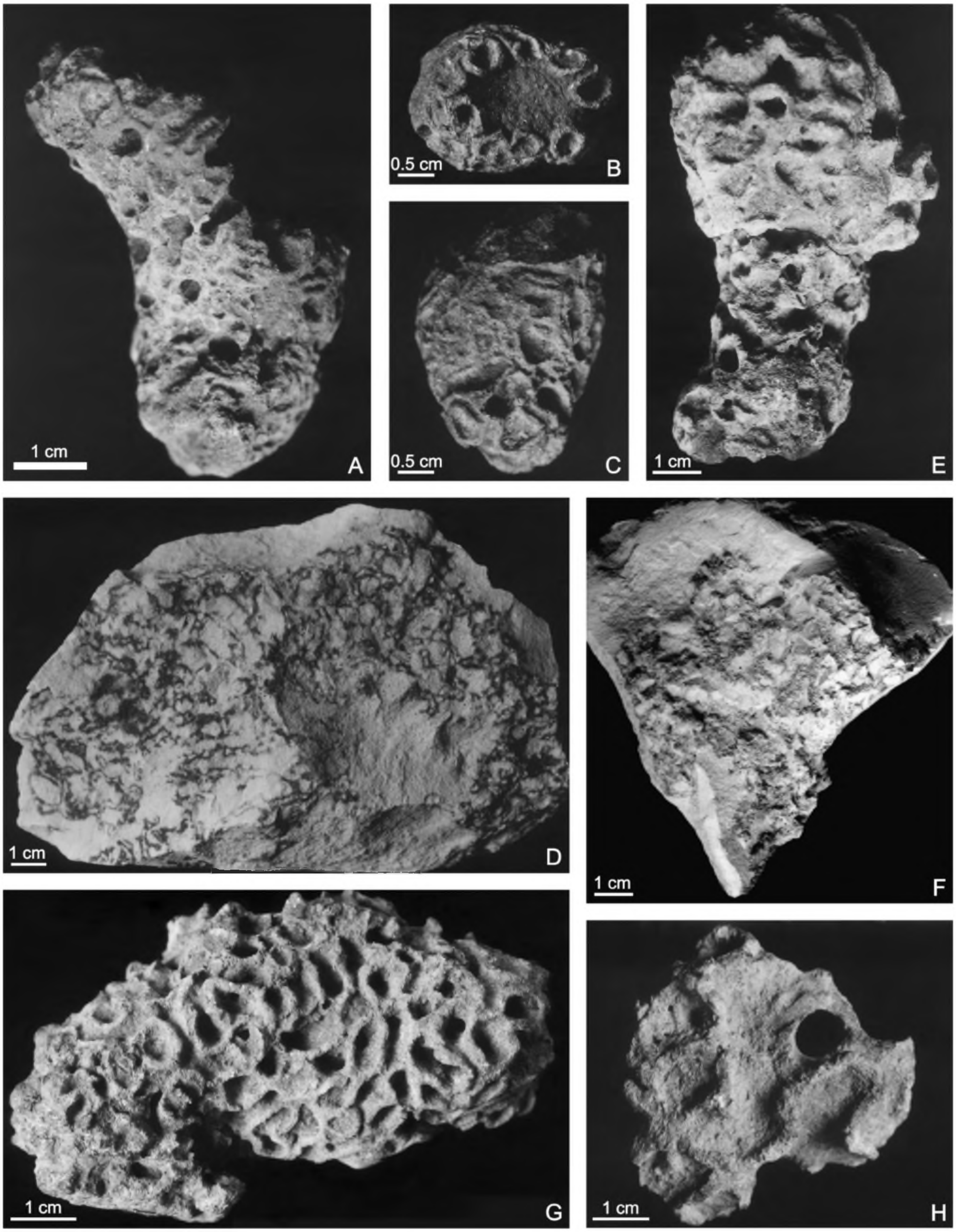

Fig. 32. **A–D** – *Cyclostigma acinosa* (Schrammen 1902); A – lateral view of large specimen; B – upper view of small specimen; C – lateral view; Nasiłów, greensand, Upper Maastrichtian (A – UL XX 4/54; B, C – UL XX 4/53); D – fragment of external surface; Piotrawin, Upper Campanian (UL XX 0/128); **E** – *Cyclostigma maeandrina* Schrammen 1912; lateral view; Nasiłów, greensand, Upper Maastrichtian (UL XX 4/51), **F, G** – *Cyclostigma lobata* Schrammen 1912; F – lateral view; Kazimierz, Upper Maastrichtian (UL XX – 0/1); G – fragment of specimen with one lobe preserved Nasiłów, greensand, Upper Maastrichtian (UL XX 9/2); **H** – *Brachiolites* cf. *centunculus* Schrammen 1912; fragment of external surface; Nasiłów, greensand, Upper Maastrichtian (UL XX 4/52)

In remaining part of cup, tube walls linked through skeletal bridges; average width 2–3 mm. Round or oval openings, 1–3 mm in diameter, on bridges, arranged at variable distances (1–1.5 mm). Openings with jutting thickened margin. Narrow spaces (ca. 1.5 mm) below perforated bridges forming internal labyrinth (= intercavaedia according to Reid, 1964) within tubes. On internal surface of cup, labyrinth with longitudinal oval or fissure-like openings, lying between concave walls of tubes of the main system. No canals developed within dictyonal skeleton. Dictyonal skeleton very regular, comprising spiny lychniscs. Meshes quadrangular or rectangular, 0.2–0.3 mm × 0.3 mm. Towards dermal surface, orientation of lychniscs disturbed, thus skeleton gradually becoming less regular. Within network, large polygonal meshes (0.4–0.5 mm) occurring between generally small triangular meshes (0.1–0.2 mm). No cortex on dermal surface. On tube margins, network beams thick, with massive short spines. Lychniscs well visible here. External rays of lychniscs poorly reduced, and in form of tapering spines. Small secondary hexactines on gastral surface of dictyonal skeleton within terminal parts of tubes, forming irregular network with triangular meshes of average size 0.1 mm.

Differentiation: Small, slender individuals are typical for glauconitic sandstones from Nasiłów, whereas large wide cups occur in opokas.

Remarks: Besides a thick cover of hexactines on the internal surface, Schrammen (1912) noted the presence of small hexactines attached in some cases to the external rays of lychniscs on the dermal surface. In the analysed specimens the secondary small hexactines are sporadic, therefore it is difficult to state whether their lack on the dermal surface, as well in deeper parts of tubes is a result of individual variability or poor preservation. According to Schrammen (1912), two types of tubes occur in *C. acinosa*. The larger ones (described as the internal system) were considered by Schrammen (1912) as cavaedia, surrounded by small tubes (external system). Cross-sections tangential to the cup surface made during this analysis as well as the presence of non-fused tubes in the uppermost part of cup indicate the presence of only one system of large tubes. In this case, the cavaedial system is represented by the narrow fissures between them, erroneously referred by Schrammen (1912) to tubes. The holotype of *C. acinosa* is a narrow funnel-like sponge. Material from the Cretaceous of Poland also contains large and wide individuals. A fragment of such form is most probably the specimen assigned to *Centrosia incrustans* Schrammen 1902 (Schrammen, 1912, pl. 39, fig. 1). The dictyonal skeleton of the discussed species *Centrosia incrustans* and *C. acinosa* has a very similar construction, and the diagnostic hexactines cover is probably not preserved. Mehl (1992, p. 112) suggests the assignment of the discussed specimen to *Pachychlaenium megastoma* (Roemer) = *Tremabolites megastoma* (Roemer). On its surface, there are large chambers, around which lie concentrically small openings (Schrammen, 1912, pl. 39, fig. 1). The shape and size of these elements recall the analyzed specimens of *C. acinosa*, but are competently different from those on the holotype of *Centrosia incrustans* (compare Schrammen, 1902, p. 16, pl. 4, fig. 6), as well as on *Tremabolites megastoma* (Roemer 1841).

Occurrence: Poland – Middle Vistula Valley (Upper Campanian and uppermost Maastrichtian); northern-western Germany (Campanian); England and Ireland (Senonian) – according to Reid (1968a).

Cyclostigma maeandrina Schrammen 1912
Figs 32E, 33 (C, D), 34 (A, B)

*1912. *Cyclostigma maeandrina* nov. sp.: Schrammen p. 304, text-pl. 14, fig. 4; pl. 40, fig. 6.

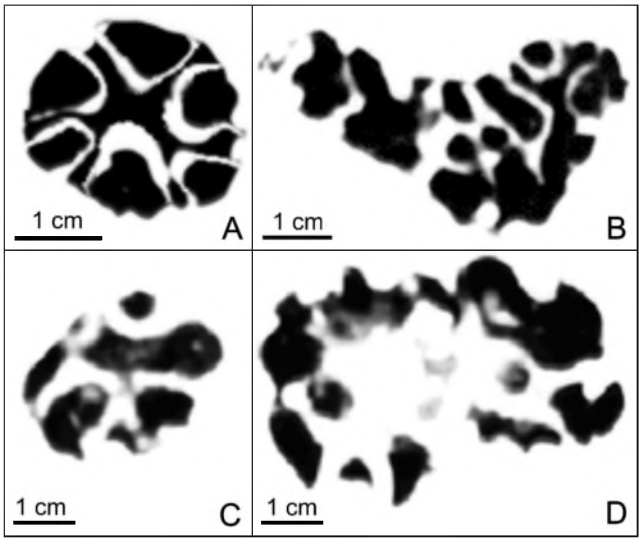

Fig. 33. **A** – *Cyclostigma acinosa* (Schrammen 1902); transverse cross–section through lower part of sponge; note cross–sections of longitudinal tubes of the main canalization system with lateral outlets; **B** – *Cyclostigma lobata* Schrammen 1912; transverse cross–section through sponge lobe; **C, D** – *Cyclostigma maeandrina* Schrammen 1912; C – cross–section through lower part with symmetric pattern of tubes; D – cross–section through upper part; all images made by using X–ray tomography; wall of sponge is white; Nasiłów, green- sand, Upper Maastrichtian (A – UL XX 4/54; B – UL XX 4/52; C, D – 4/51)

Material and preservation: 17 specimens (1 from z Ciszyca Górna, 11 from Piotrawin, 2 from Dziurków, 3 from the glauconitic sandstone from Nasiłów). Apart from one complete specimen, the remaining specimens are strongly destroyed. Specimens from opokas are strongly attached to the rock. The skeleton is typically well preserved, excluding the surface layer of hexactines. In phosphatized specimens, only small fragments of the dictyonal skeleton are preserved on the dermal surface.

Description: Club-shaped sponges. Height of best preserved specimen ca. 100 mm, width of upper part ca. 50 mm. Sponge body comprising rather thick-walled (1.5–2 mm) tubes, 7–9 mm in diameter. In stalk, tubes arranged radially. In upper parts of sponge tubes, bifurcating and fusing again, loosing a symmetric pattern. Tube openings on sponge surface round, 7–9 mm in diameter. Between openings spaces of similar sizes, reaching to a system of wide (3–9 mm in diameter) spaces between tubes. Tube margin in some cases fused, on remaining bridges sporadic single small openings. Dictyonal skeleton comprising fine-spinous lychniscs, forming within wall a very regular network with quadrangular and rectangular meshes, 0.2–0.4 mm × 0.2–0.3 mm. In surface parts of tubes, orientation of lychniscs disturbed. Irregular network comprising secondary lychniscs and hexactines on gastral surface of dictyonal skeleton. Spicules half as small as primary dictyonalia. Thickened network beams in peripheral parts of tubes on dermal surface. Network meshes round, of variable size, maximally up to 0.4 mm. External rays partly reduced, in form of cone-like processes. Lychniscs well visible; only in lower parts of sponge, where accumulation of silica is highest, poorly visible. Lack of canals in dictyonal skeleton.

Remarks: The macroscopic structure of the analysed sponges is identical with the description of *C. maeandrina* presented by Schrammen (1912). The hitherto not described feature of this species is the radial pattern of tubes within stalk. According to Schrammen (1912), the secondary hexactines occur also on the

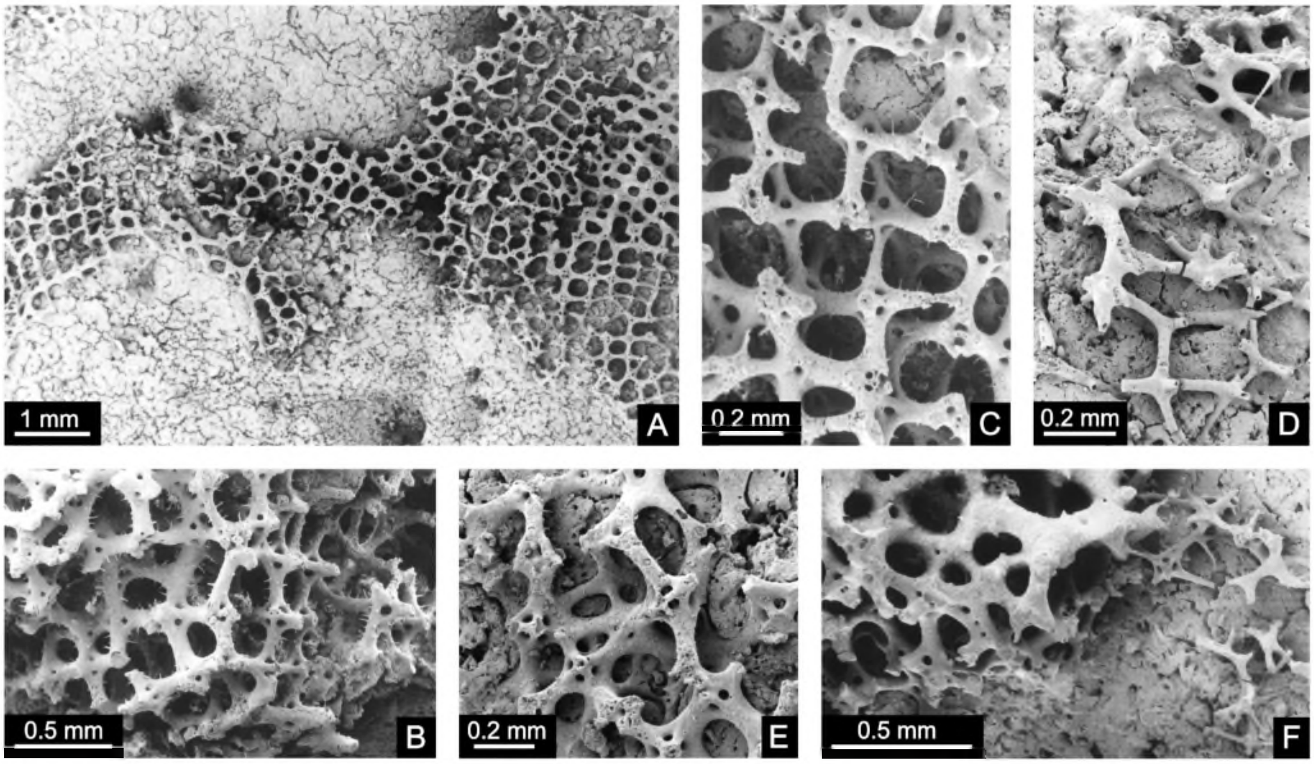

Fig. 34. **A, B** – *Cyclostigma maeandrina* Schrammen 1912; A – choanosomal skeleton; note fragment of dermal surface with thicknened beams to the right; B – irregular subdermal skeleton; Piotrawin, Upper Campanian (UL XX 1/168); **C–E** – *Cyclostigma acinosa* (Schrammen 1902); C – regular dictyonal skeleton from central part of wall; D – gastral surface of dictyonal skeleton with secondary network comprising small hexactines; E – subdermal dictyonal skeleton with irregular pattern of lichniscs; Piotrawin, Upper Campanian (UL XX 8/115); **F** – *Cyclostigma lobata* Schrammen 1912; to the left fragment of secondary network comprising hexactines on gastral surface; to the right – dermal surface of dictyonal skeleton; Nasiłów, opoka, Upper Maastrichtian (UL XX 1/3)

dermal surface. Their lack in the analysed material may be a result of poor preservation.

Occurrence: Poland – Middle Vistula Valley (Upper Campanian and Lower Maastrichtian); northern-western Germany (Campanian); England (Senonian) – according to Reid (1968a).

Cyclostigma lobata Schrammen 1912

Figs 32 (F, G), 33B, 34F

*1912. *Cyclostigma lobata* nov. sp.: Schrammen, pp. 304– 305, text-fig. 4.

Material and preservation: 47 specimens (9 from Kazimierz, 6 from opoka and 30 from the glauconitic sandstone from Nasiłów). All specimens are to a variable degree incomplete. In material from opokas, the dictyonal skeleton is poorly preserved, present only on some specimens. In phosphatised specimens, apart from small fragments on the dermal surface, the skeleton is completely dissolved.

Description: Irregularly bulbous sponges. Lower part in form of stalk, upper part divided into several (3–5), to a variable degree flattened longitudinal lobes. In largest reconstructed specimen, stalk 55 mm long, ca. 20 mm in diameter. Upper part of specimen ca. 90 mm in diameter. Sponges built of thin-walled (ca. 1–1.2 mm thick) tubes, 0.4–0.5 mm in diameter, bifurcating and fusing again. On sponge surface, tube openings round or elongated, 4–8 mm in diameter. Margins of neighbouring tubes in some cases fused, with openings remaining separate. Irregular, elongated chambers between tube openings, 2–6 mm × 8–10 mm. Chambers leading within sponge to branching spaces between tubes, 3–4 mm in diameter. Dictyonal skeleton comprising lychniscs with rays possessing singular short spines. In central part of wall, network very regular, with quadrangular or rectangular meshes, 0.2–0.3 mm × 0.2–0.25 mm. Single small hexactines in some cases attached to beams of dictyonal skeleton. Skeleton with thickened beams less regular in external parts of wall. Locally, on gastral surface, small secondary hexactines and lychniscs, chaotically oriented, comprising irregular network with polygonal meshes of variable size (averagely ca. 0.1–0.2 mm). Long oxeas (up to 2 mm) attached to this network. Well developed cortex on dermal surface of external parts of tubes. Lychniscs typically invisible within cortex. External rays strongly reduced, in form of short cone-like processes. Fine spines on cortex surface. Round pores in cortex numerous, average size 0.3–0.4 mm. Canals in dictyonal skeleton not developed. Basal skeleton in form of incrusting plate built of synapticular filaments.

Remarks: In the pattern of tube openings on the sponge surface, the species *C. lobata* is similar to *C. maeandrina* (Schrammen 1912), from which it differs in its lobe-like body, smaller dimension of tubes and better developed cortex. In the analysed material, secondary spicules are dominated by lychniscs. The poor state of preservation, like in other species of genus *Cyclostigma* Schrammen 1912, does not allow to determine in which part of the body the secondary network was developed.

Occurrence: Poland – Middle Vistula River Valley (Upper Maastrichtian); northern-western Germany (Campanian).

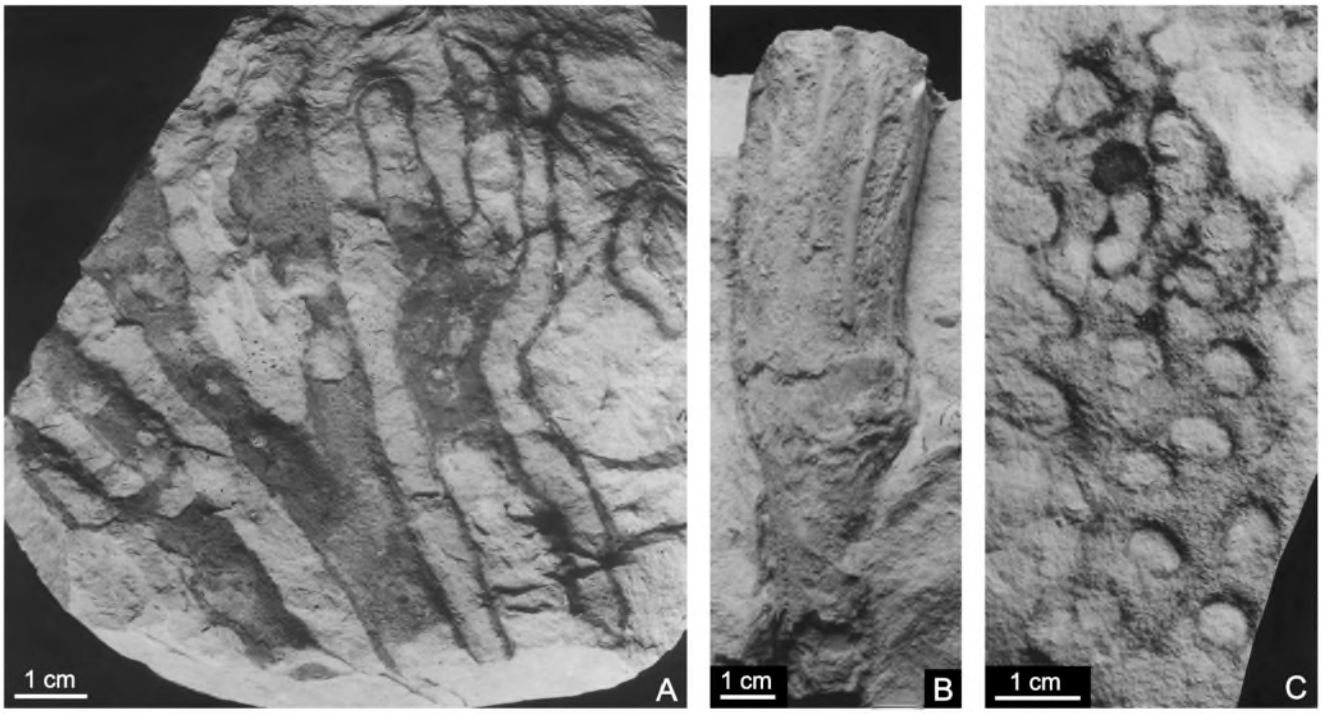

Fig. 35. **A, B** – *Coeloptychium sebachi* Zittel 1876; A – fragment of lower surface of discoidal part of specimen; B – lower conical part of specimen; Piotrawin, Upper Campanian (A – UL XX 3/46; B – UL XX 7/30); **C** – *Tremabolites megastoma* (Roemer 1841); fragment of upper surface of specimen; Piotrawin, Upper Campanian (UL XX 7/40)

Genus *Tremabolites* Zittel 1877
Type species: *Manon megastoma* Roemer 1841

Remarks: In Russian literature, the genus *Etheridgia* Tate 1864 is identified with *Tremabolites* Zittel (Sinzov, 1878 p. 6; Zhuravleva, 1962, p. 44; Trestian, 1973, p. 10). The genera, however, should be treated separately, as *Etheridgia* is characterised by a deep central cavity (see Tate, 1864, pp. 42–43, pl. 5, fig. 4). Schrammen (1912) included genus *Tremabolites* to a new family Camero- spongidae. According to Mehl (1992), genus *Tremabolites* is related to the present-day genus *Neoaulocystis* Zhuravleva 1962 (see also Krautter, 2002). Reid (2004f) included both of these genera to Callodictyonidae, to a new subfamily Callicyclinae, uniting spon- ges composed of dividing and anosmosing tubes with or withouth peripheral capsule.

Tremabolites megastoma (Roemer 1841)
Figs 35 (C); 36 (H)

*1841. *Manon megastoma* nov. sp.: Roemer, p. 3, pl. 1, fig. 9.
1845–1846. *Manon megastoma* Roemer: Reuss, p. 77, pl. 20, fig. 1; pl. 63, fig. 9.
1870. *Camerospongia megastoma* A. Roemer: F. Roemer, p. 307, pl. 33, fig. 6.
1872. *Camerospongia megastoma* (Roemer): Schlüter, pp. 19, 27.
1877. *Tremabolites megastoma* (Roemer): Zittel, p. 56.
1878. *Maeandroptychium polymorfum* nov. sp.: Sinzov, pp. 10–11, pl. 1, fig. 7; pl. 2, fig. 1.
1883. *Tremabolites megastoma* (Roemer): Počta, p. 37.
1897. *Tremabolites megastoma* Roemer: Leonhard, p. 36.
1912. *Tremabolites megastoma* Roemer: Schrammen, p. 317, text-pl. 15, figs 7, 8; pl. 39, figs 3–5.
1912. *Tremabolites leonhardi* nov. sp.: Schrammen, p. 317.
1912–1913. *Tremabolites megastoma* Roemer: Scupin, p. 266.
1942. *Tremabolites megastoma* Roemer: Hèrenger , pp. 165–166, text-figs 6a-d; pl. 2, fig. 4.
1960. *Tremabolites megastoma* (Roemer): Defretin-Lefranc, p. 93, pl. 14, fig. 3.
1962. *Tremabolites megastoma* (Roemer): Lagneau-Hèrenger, p. 115, text-pl. 17, fig. 5.
1974. *Tremabolites megastoma* (Roemer): Ulbrich, pp. 65–66.
v1980. *Tremabolites megastoma* (Roemer): Małecki, pl. 10, fig. 2.
non 1984. *Tremabolites megastoma* (Roemer): Hurcewicz, p. 333, pl. 136, fig. 3 [=*Brachiolites* sp.]
v1991. *Tremabolites megastoma* (Roemer): Tarkowski, pp. 93–94, pl. 4, figs 4, 7.
1992. *Pachychlaenium megastoma* (Roemer): Mehl, p. 112, text-fig. 2; pl. 18, fig. 2.

Material and preservation: One incomplete specimen from Piotrawin. Lower part strongly attached to sediment. Preserved very small fragments of dictyonal skeleton and moulds of external siliceous membrane.

Comparative material: Collections UL IX and A-1-82; specimens from the Upper Cretaceous of the Opole region from the collection of R. Tarkowski.

Description: Analysed fragment belongs to a disc-like sponge, most probably ca. 120 mm in diameter. Sponge comprising irregularly connected thin-walled tubes (1–2 mm), ca. 5 mm in diameter. Upper, strongly flattened part covered by finely-porous siliceous membrane. Round or slightly elongated openings, 6–8 mm in diameter, occurring within membrane (Fig. 35C). Openings irregularly distributed. Dictyonal skeleton comprising lychniscs with smooth rays, forming very regular network with quadrangular or rectangular meshes, 0.3 mm × 0.25–0.4 mm (Fig. 36H). Canals in choanosomal skeleton not developed.

Remarks: *T. megastoma* was hitherto known from pre-Campanian deposits from southern Poland. The described specimen in

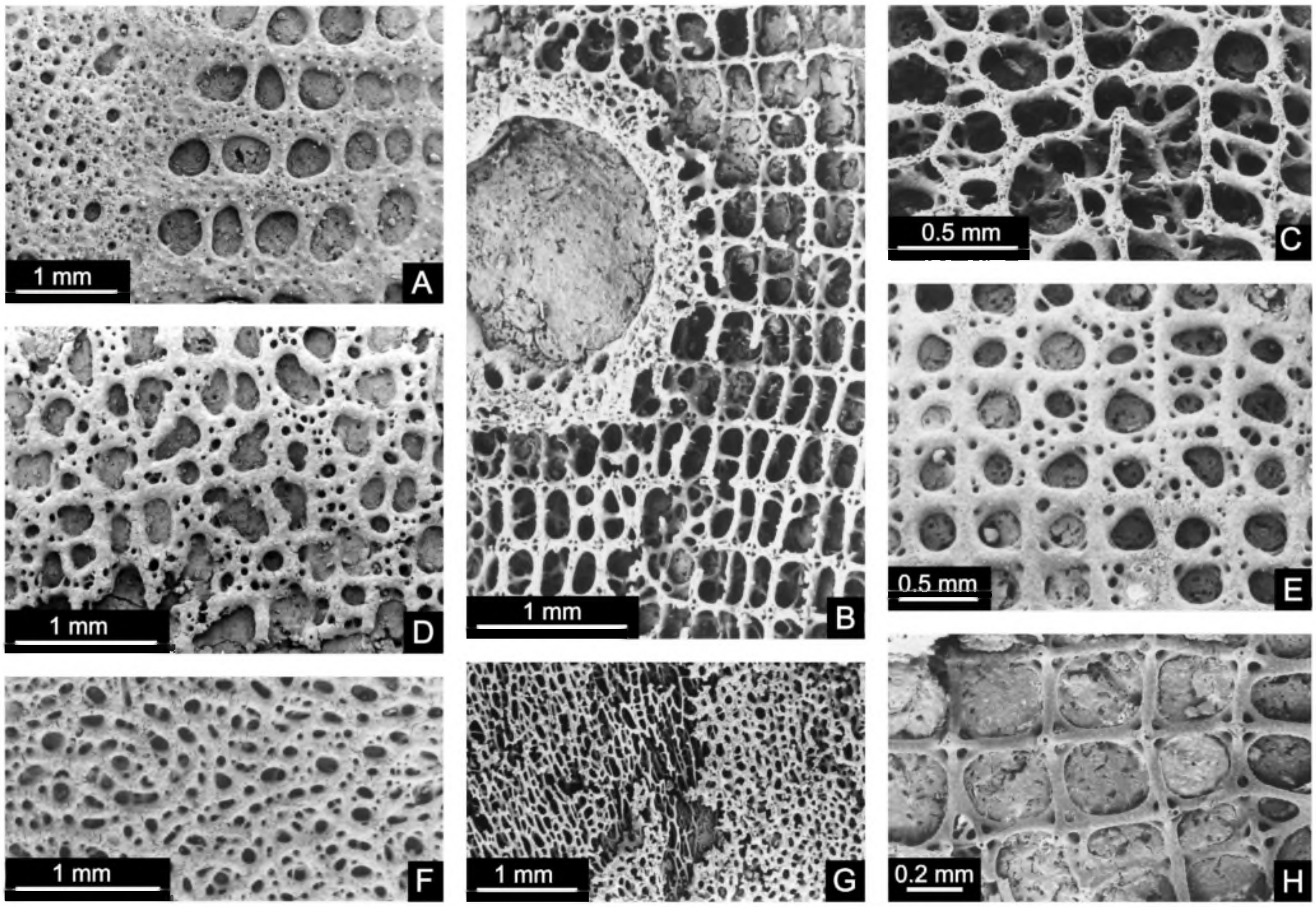

Fig. 36. A–G – *Coeloptychium seebachi* Zittel 1876; A – gastral diaphragm with fragments of fine- and coarse-meshed strands; B – regular dictyonal skeleton; note secondary osculum to the right; C – irregular subdermal skeleton; D – dermal surface of dictyonal skeleton (lower surface of folds); E – dictyonal skeleton with synapticules in upper part of the discussed folds; F – synapticular diaphragm on lateral surface of discus; G – synapticular filaments on surface of lower, con–shaped part; Piotrawin, Upper Campanian (A, F – UL XX 7/53; B, C, E – UL XX 7/1; D – UL XX 3/51; G – UL XX 7/3); **H** – *Tremabolites megastoma* (Roemer 1841); choanosomal skeleton; Piotrawin, Upper Campanian (UL XX 7/40)

relation to older representatives of this species from the Opole and Korzkiew (Tarkowski, 1991; Małecki, 1980,) has distinctly smaller openings in the upper membrane (diameter of these openings in individuals from Korzkiew reaches even 20 mm). Schrammen (1912) considered forms occurring in Middle Turonian deposits (see Reuss, 1845–46; Roemer, 1870; Leonhard, 1897), possessing "grooves" wider than tubes on the lower part of the sponge, to represent a new species *T. leonhardi* Schrammen 1912. The variable width of grooves in the discussed specimens seems to be an ontogenic feature, therefore the attitude of Mehl (1992) questioning the distinguishing of a separate species seems justified. The description of *Maeandroptychium polymmorfum* Siznov 1878 contains all characteristic features of *T. megastoma*. The variable shape of specimens from Saratov described by Siznov (1878) is linked probably not only with polymorphism within the species but also with the poor preservation of the fossils (compare Sinzov; 1878, pp. 10–11, pl. 1, fig. 7; pl. 2, fig. 1), which are represented by phosphatised and redeposited specimens.

Occurrence: Poland – Middle Vistula Valley (Upper Campanian), Opole area (Upper Turonian), Kraków area (?Santonian); Spain (Aptian–Albian); France (Aptian–Santonian); Czech Republic (Cenomanian); Russian – Saratov area (Santonian); northern-western Germany (Turonian–Campanian).

Family COELOPTYCHIDAE Roemer 1864
emended Reid 2004
Genus *Coeloptychium* Goldfuss 1826
emended Mehl 1992
[=*Myrmecipotychium* Schrammen 1912]
Type species: *Coeloptychium agaricoides* Goldfuss 1826

Remarks: Mehl (1992) and Reid (2004f) considered *Myrmecipotychium* Schrammen 1912 as the synonym of *Coeloptychium*. This view, earlier presented by Fritsche (1920, p. 103), is followed here.

Coeloptychium seebachi Zittel 1876
Figs 35 (A, B), 36 (A–H)

*1876. *Coeloptychium seebachi* nov. sp.: Zittel, p. 68, pl. 2, figs 5–7; pl. 3. figs 8, 9; pl. 5, fig. a.
1878. *Coeloptychium seebachi* Zittel: Quenstedt, p. 521, pl. 140, figs 3, 4.
?1883. *Coeloptychium seebachi* Zittel: Hinde, p. 148.
1912. *Coeloptychium seebachi* Zittel: Schrammen, p. 331.
1989. *Coeloptychium seebachi* Zittel: Gasse *et al.*, p. 206, pl. 5. figs 1, 2.

Material and preservation: 19 specimens (1 from Ciszyca Górna and 18 from Piotrawin). The specimens are incomplete to a variable degree. None of them possesses the basal part. Dictyonal skeleton in most specimens is well preserved. Siliceous membrane on upper and lateral part of disc was observed only in one specimen. In the remaining specimens, it is dissolved, and the upper part of discs is strongly attached to the sediment.

Description: Mushroom-like sponges. Discoid upper part up to ca. 300 mm. Lower part in shape of empty cone, ca. 140 mm high, set on short stalk. Furrows and folds present on conical surface. Disc margin undivided, flat, slightly sloping inwards. Upper surface of disc smooth and slightly concave. Radially distributed folds on lower surface, 10–15 mm wide, separated by slightly narrower grooves. Six primary folds in central part of disc (number of secondary and primary folds based on fragments and calculated for complete disc). Primary folds once or twice dichotomously divided. Number of secondary folds 35–48. Folds and grooves disappearing at disc margin, forming wide (maximally up to 10 mm) and almost smooth border. Round openings, 2–3 mm in diameter, irregularly placed (every 8–15 mm) on fold ridges. Lack of distinguishable canals in dictyonal skeleton. Dictyonal skeleton comprising large spiny lychniscs, regularly placed within wall. Network meshes rectangular, 0.2 mm × 0.3–0.4 mm. In subdermal part, skeleton less regular with small meshes (ca. 0.2 mm). Thin synapticular cortex with numerous irregular pores on dermal surface. Pores large (up to 0.5 mm), chaotically distributed. Cortex surface covered with small processes. On upper surface of folded wall, lychniscs with strongly thickened rays, covered with small processes. Lychniscs composing regular network with almost round meshes (0.20–0.25 mm). Synapticules present in some places of network. Upper part of disc covered by siliceous synapticular membrane. Finely porous bands on fold ridges within membrane. Network with larger, round meshes (ca. 0.3–0.5 mm) above grooves between bands. Transverse skeletal bands separating pores of similar width, longitudinal bands narrower, ca. 0.1–0.25 mm. Disc margin covered with dense synapticular siliceous filaments in form of dense network with small oval meshes. Skeleton of conical part comprising rather regularly joined, thickened lychniscs. Both surfaces covered by siliceous filaments forming thick layer of loose network with small round meshes (0.2–0.15 mm). On external surface, filaments more massive, and network more compact. Longitudinally oriented filaments of basal skeleton in lower part of stalk.

Remarks: According to Mehl (1992, pp. 117–120), species of the genus *Coeloptychium* Goldfuss are characterised by a large ontogenic variability, and some of the species with small dimensions represent in reality juvenile forms of other larger species. The unquestionable and stable specific feature is the number of primary folds on the disc (Zittel, 1876; Gasse *et al.*, 1989; Mehl, 1992). Schrammen (1912) pointed out the large similarity between juvenile specimens of *C. seebachi* and mature individuals of *C. deciminum* Roemer 1841. According to me, this similarity can be observed in the skeleton structure, particularly of the gastral diaphragm. However, *C. seebachi* has only 5–6 primary folds (Zittel, 1876, p. 68; Gasse *et al.*, 1989, pl. 2; Mehl, 1992, p. 118), whereas in specimens of *C. deciminum*, typically there are 8–10 folds (Zittel,1876, p. 62; Gasse *et al.*, 1989, pl. 2; Mehl, 1992, p. 118) or even a larger number of folds was observed (see Rietschel, 1967, fig. 1; Bieda, 1933, p. 35). *Coeloptychium rude* Zittel 1876 also resembles *C. seebachi* in its shape and dimensions. This species, however, possesses a coarse-mesh diaphragm and 9 primary folds (Zittel, 1876, pp. 71–72; Schrammen, 1912, pp. 332–333; Gasse *et al.*, 1989, pl. 2; Mehl, 1992, p. 118).

Occurrence: Poland – Middle Vistula Valley (Upper Campanian); northern-western Germany (Campanian); ?England (Senonian).

Class DEMOSPONGEA Sollas 1875
"LITHISTIDA"

Remarks: The orders discussed below are traditionally assigned to the Lithistida. This is a polyphyletic group (Lévi, 1991; Wiedenmayer, 1994; Pisera, 1999, 2002), including sponges with a choanosomal skeleton comprising articulating spicules linked with each other without cementation, forming a rigid skeleton. Reid (2004) proposed to distinguish three orders of lithistid sponges because, according to him, they probably have had separate origins.

Order TETRALITHISTIDA Lagneau-Hérenger 1962
emended Reid 2004
Suborder TETRACLADINA Zittel 1878
Family SIPHONIIDAE d'Orbigny 1851
emended De Laubenfels 1955, emended Reid 2004
Genus *Phymatella* Zittel 1878
Type species: *Eudea intumescens* Roemer 1864

Phymatella bulbosa Zittel 1878
Figs 37 (H, I), 38F

*1878. *Phymatella bulbosa* nov. sp.: Zittel, p. 74, pl. 2, fig. 1.
1901. *Pseudoplocoscyphia meandrina* nov. sp.: Schrammen, p. 5, pl. 2, fig. 1; pl. 4, fig. 2.
1910. *Phymatella bulbosa* Zittel: Schrammen, p. 75, text-pl. 4, fig. 8; pl. 1, fig. 9; pl. 3, fig. 2.
1926. *Phymatella bulbosa* Zittel: Moret, p. 148, pl. 13, fig. 5.
1966. *Phymatella bulbosa* Zittel: Hurcewicz, p. 29, text-fig. 5; pl. 3, fig. 7.
partim v1966. *Phymatella irregularis* nov. sp.: Hurcewicz, pp. 30–32; non text-fig. 6; non pl. 3, figs 5, 6 [=*Phymatella sphaeroides* Schrammen].
1974. *Phymatella bulbosa* Zittel: Ulbrich, p. 18, pl. 1, figs 5, 6.
1993. *Phymatella bulbosa* Zittel: Jahnke & Gasse, p. 8, pl. 9, figs 5, 6.

Material and preservation: 12 specimens from opoka and 9 from greensand from Nasiłów. Specimens damaged to a variable degree. Surface poorly preserved. Choanosomal skeleton in some cases well preserved. Dermal spicules lacking.

Comparative material: Collection UL II; one specimen from Zbyczyce near Koniecpol (UL XVI).

Description: Sponges irregularly ovate or spherical, about 120 mm high (Fig. 37H). Surface covered with additional, variably developed, bulges and depressions, irregularly, often asymmetrically arranged. All studied individuals have a thin (max. 10 mm in diameter) stalk, over 70 mm long. In upper part of sponge tube-like, spongocoel up to 10–15 mm in diameter. Below (at about 2/3 of the sponge height), spongocoel divides into several irregular branches of variable length and width (Fig. 37I). Branches may divide again, forming a complex labyrinth inside the sponge. Epirhyses straight, 1.0–1.6 mm in diameter. Aporhyses wider (1.6–2.3 mm) and most probably winding. Choanosomal skeleton dense, comprising tetraclones (Fig. 38F). Clones smooth, 0.25–0.35 long, terminating with large zygomes. In stalk, tetraclones modified with one clone much longer that the remaining.

Remarks: In this species, the pattern of canals is problematic. Ulbrich (1974) noted that the shape of aporhyses in *P. bulbosa* is analogous to the representatives of *P. tuberosa* (Quenstedt 1878) described by him. Thus, according to Ulbrich (1974), they are straight, whereas Schrammen (1910) described the canals in *P. tuberosa* as winding. In the material studied herein, due to the poor state of preservation, the determination of their pattern is uncertain, however it seems that the shape of aporhyses corresponds to Schrammen's (1910) description. In specimens from Germany, the

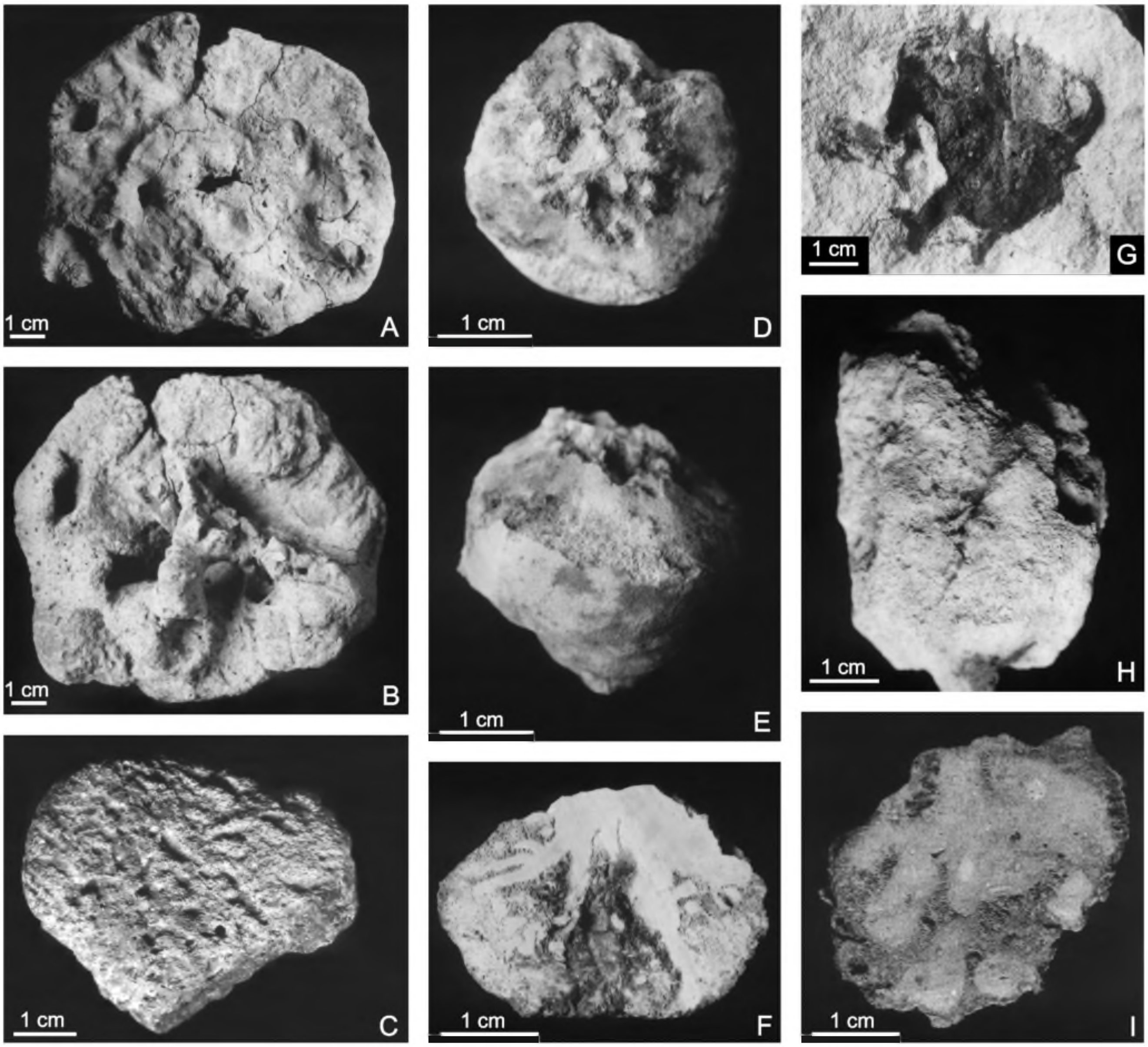

Fig. 37. **A, B** – *Turonia variabilis* Michelin 1847; A – lower surface; B – upper surface with borings; Nasiłów, greensand, Upper Maastrichtian (UL XX 2/62); **C** – *Phyllodermia antiqua* (Schrammen 1910); lateral view; Nasiłów, greensand, Upper Maastrichtian (UL XX 2/37; **D–G** – *Callopegma acaule* Zittel 1878; D – top view with openings of aporhyses, E – lateral view; F – longitudinal cross-section with aporhyses; G – specimen with numerous basal protrusions; Piotrawin, Upper Campanian (D, E – UL XX 0/43; F – UL XX 1/98; G – UL XX 7/83); **H, I** – *Phymatella bulbosa* Zittel 1878; H – lateral view; Nasiłów, opoka, Upper Maastrichtian (UL XX 1/227); I – longitudinal cross–section through lower part of specimen with branching spongocoel; Nasiłów, greensand, Upper Maastrichtian (UL XX 2/39)

lower part of the sponge has large bulges and the central spongocoel divides there. In the studied material, the division is observed in the upper part of the sponge. The bulges are well developed in this part, whereas the lower part is rather smooth. According to Hurcewicz (1966), some individuals of this species have no central cavity. The specimen described by Hurcewicz (1966) is missing from the UL collection. In turn, on another unillustrated specimen, assigned by Hurcewicz to *P. bulbosa* Zittel, the spongocoel is very distinct and with a narrow opening in the apical part. The fragment of an individual no. II/31 from Gnatowice, assigned by Hurcewicz (1966) to the new species *Phymatella irregularis* also belongs to *P. bulbosa*. This specimen, designated as the holotype, is not illustrated. A silicified sponge no. II/1252 from Skrajniwa has damaged surface and is considered here as *P. sphaeroides* Schrammen 1910. This is indicated by the shape and the spongocoel structure: Hurcewicz (1966, pp. 30–32) erroneously noted that the spongocoel is not developed in her species *P. irregularis*.

Occurrence: Poland – Middle Vistula River Valley (Upper Maastrichtian), Koniecpol area (Lower Campanian); northern-western Germany (Lower–Upper Campanian); France (Senonian).

Genus *Aulaxinia* Zittel 1878
Type species: *Siphonocoelia sulcifera* Roemer 1864

Aulaxinia sulcifera (Roemer 1864)
Fig. 38 (C–E)

*1864. *Siphonocoelia sulcifera* nov. sp.: Roemer, p. 30, pl. 11, fig. 7.

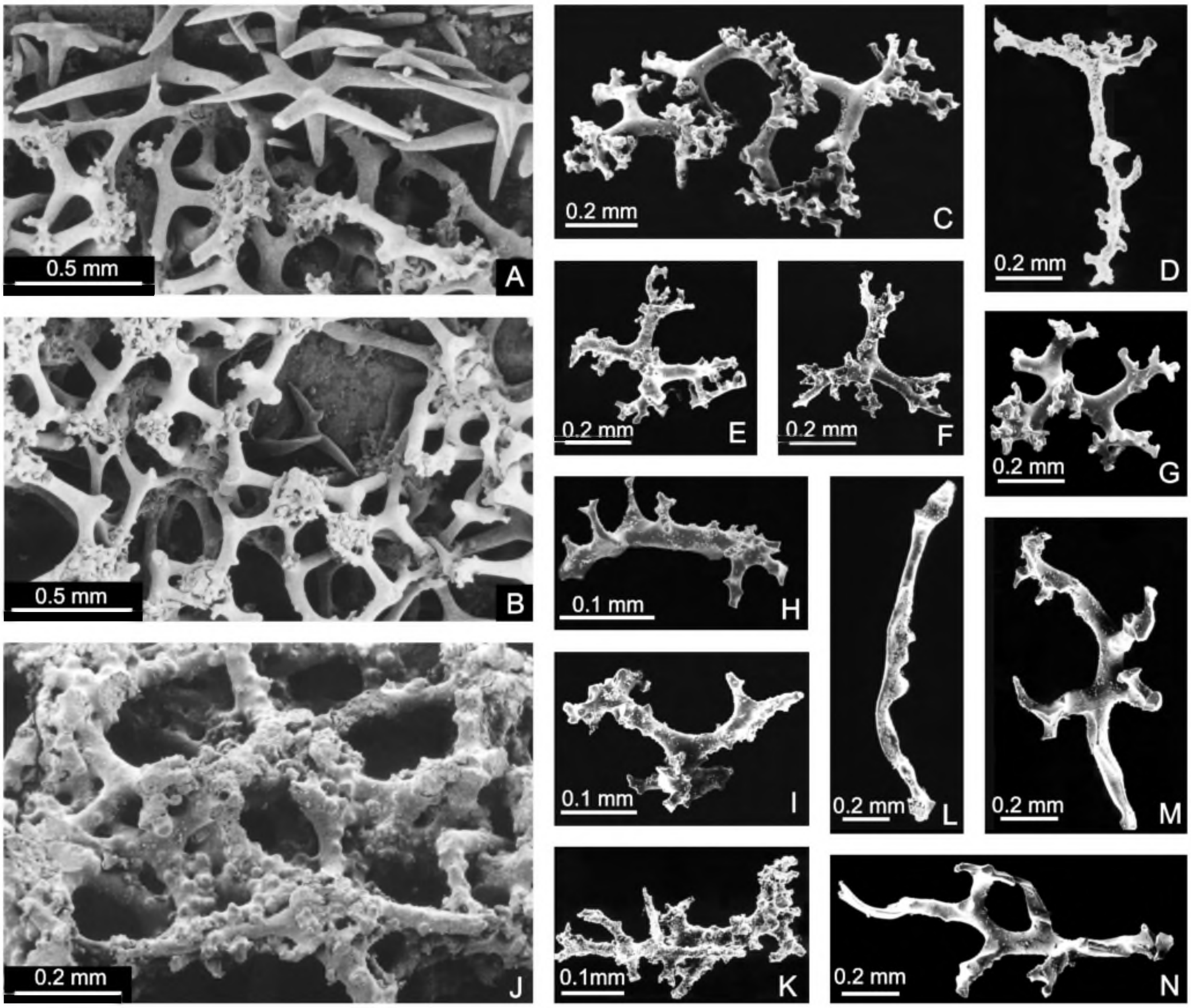

Fig. 38. A, B – *Turonia variabilis* Michelin 1847; A – choanosomal skeleton and dermal orthodichotriaenes; B – choanosomal skeleton; note small dichotriaen within canal; Janowiec, Upper Maastrichtian (UL XX 9/165); **C–E** – *Aulaxinia sulcifera* (Roemer 1864); C – fragment of choanosomal network; D–E – single tetraclones; Piotrawin, Upper Campanian (UL XX 3/39); **F** – *Phymatella bulbosa* Zittel 1878; single tetraclone; Nasiłów, opoka, Upper Maastrichtian (UL XX 1/227); **G** – *Callopegma acaule* Zittel 1878; single tetraclone; Piotrawin, Upper Campanian (UL XX 1/98); **H, I** – *Verruculina tenuis* (Roemer 1841); single choanosomal rhizoclones of variable shapes; Dziurków, Lower Maastrichtian (UL XX 8/121); **J, K** – *Verrucuculina milliaris* (Reuss1846); J – goethite pseudomorph of choanosomal skeleton; Piotrawin, Upper Campanian (UL XX 1/228); K – single rhizoclones; rhizoclone to the left with fine, sharp spines, to the right – with rounded spines; Piotrawin, Upper Campanian (UL XX 3/17); **L** – *Pachycothon giganteum* (Roemer 1864); single helaklone; Piotrawin, Upper Campanian (UL XX 3/18); **M, N** – *Homalodora plana* Schrammen 1910; M–N – strongly elongated megaclones from stalk; Piotrawin, Upper Campanian (UL XX 1/174)

1878. *Aulaxinia sulcifera* (Roemer): Zittel, p. 138, pl. 8, fig. 4.
1889. *Aulaxinia sulcifera* Roemer sp.: Griepenkerl, p. 18.
1910. *Aulaxinia sulcifera* (typica) Roemer: Schrammen, p. 78, pl. 1, figs 2, 3; non fig. 1 [=*Aulaxinia fallax* Schrammen].
1961. *Aulaxinia sulcifera* (Roemer): Nestler, p. 24, pl. 4, figs. 5–8.
1962. *Aulaxinia sulcifera* (Roemer): Lagneau-Hèrenger, p. 127, text-fig. 2.
partim v1966. *Aulaxinia sulcifera* (Roemer): Hurcewicz, p. 35, pl. 3, fig. 3; non fig. 2 [=*Aulaxinia fallax* Schrammen].
1974. *Aulaxinia sulcifera* (Roemer): Ulbrich, p. 19, pl. 1, fig. 4.
1993. *Aulaxinia sulcifera* (Roemer): Gruber, p. 36, pl. 7, fig. 4; pl. 24, fig. 3.
2002. *Aulaxinia sulcifera* (Roemer): Pisera, figs 17a , 18.

Material and preservation: 10 specimens (7 from Piotrawin, 2 from Dziurków, 1 from Solec). All specimens are strongly limonitized. Most of them have a damaged apical part. Choanosomal skeleton rather well-preserved.

Comparative material: Collection UL II.

Description: Cylindrical or narrow conical sponges with sheared apical part and gradual transition to stalk. Largest specimens 120 mm high and 22 mm in diameter. Sponge surface covered with regularly arranged, longitudinal furrows, 1–2.5 mm wide, separated by flat, 1–3 mm wide ridges. Width of furrows and ridges vary with individual. Ridges with canal small (0.4–0.5 mm) openings arranged in rows. Canal openings of similar size also occur on the bottom and sides of furrows, however distributed in less distinct rows. Longitudinal canals, 1–2 mm wide, run along the sponge and pass directly in the apical part or to a shallow (about 3 mm deep), central depression. Choanosomal skeleton consists of smooth tetraclones with poorly branched zygomes (Fig. 38C, E). Average length of clones is 0.25–0.35 mm. Some desmas within stalk are modified and with one clone longer, reaching even 0.7 mm in length (Fig. 38D).

Remarks: Contrary to the holotype of *A. sulcifera*, specimens from Poland have a poorly developed or completely lacking spongocoel. This situation is often encountered (Schrammen, 1910; Nestler, 1961; Ulbrich, 1974; Gruber, 1993) and interpreted as a juvenile state. Most probably this is rather individual variability, otherwise most representatives of this species would be represented by juvenile forms. Regular distribution of furrows is characteristic for *A. sulcifera*. Some specimens assigned to this species by Hurcewicz (1966, pl. 3, fig. 2) have, however, irregularly arranged furrows; the surface of this specimen (no. II/4) not visible on the photograph is almost completely smooth, devoid of furrows. These forms represent the species *A. fallax* Schrammen 1910, known also from the Lower Maastrichtian of Poland.

Occurrence: Poland – Middle Vistula Valley (Upper Campanian–Lower Maastrichtian), Miechów area (Lower Maastrichtian); Spain (Aptian); northern-western Germany (Campanian); Isle of Rügen (Lower Maastrichtian); England (Upper Senonian) – according to Hinde (1883).

Genus *Turonia* Michelin 1847
Type species: *Turonia variabilis* Michelin 1847

Turonia variabilis Michelin 1847
Figs 37 (A, B), 38 (A, B)

*1840–1847. *Turonia variabilis* nov. sp.: Michelin, p. 125, pl. 35, figs 1–8.
1878. *Turonia variabilis* Michelin: Zittel, p. 150.
1910. *Turonia variabilis* Michelin: Schrammen, p. 86, pl. 3, figs 8, 9; pl. 11, figs 1–3.
1926. *Turonia variabilis* Michelin: Moret, p. 152, pl. 12, fig. 10.
v1966. *Turonia variabilis* Michelin: Hurcewicz, p. 42, pl. 8, figs 1a, b.
v1966. *Turonia variabilis* aff. *variabilis* Michelin: Hurcewicz, p. 43, text-fig. 10; pl. 8, fig. 2.
1993. *Turonia variabilis* Michelin: Gruber, p. 40, pl. 7, figs 7, 8.
2002. *Turonia variabilis* Michelin: Pisera, fig. 17b.

Material and preservation: 34 specimens (2 from Piotrawin, 1 from Dziurków, 4 from Janowiec, 8 from Kazimierz, 3 from opoka, and 16 from greensand from Nasiłów). Specimens from the opoka have the upper part firmly attached to the rock. Both choanosomal and dermal spicules well preserved in some individuals. In phosphatized specimens from the glauconitic sandstone, casts of spicules well visible.

Comparative material: Collection UL II.

Description: Irregular lens-like or conical sponges, without central spongocoel, up to 70 mm high and 110 mm wide. Sub-division into lower and upper part distinct (Fig. 37A, B). In most specimens, irregular knobs or finger-like protrusions of variable size occur on upper surface. They are distributed rather randomly and no central process is observed. Lower part typically strongly flattened and plate-like, rarely in form of wide cone with rounded base. Surface of lower part of sponge covered with thick wrinkles, in some cases, lying concentrically around numerous, randomly distributed protrusions. Protrusions massive, 4 to 12 mm in diameter. On upper surface, occur openings of aporhyses, 0.5–1 mm in diameter. On lower surface, openings of epirhyses much smaller, not exceeding 0.5 mm, visible only in specimens with effaced dermal skeleton. Epirhyses and aporhyses long and straight. Central spongocoel replaced by irregularly branching, canals wide (10–20 mm). Some openings occur on upper surface. Choanosomal skeleton dense, comprising tetraclones with smooth clones (Fig. 38B). Thickness of clones 0.06–0.08 mm, length 0.25–0.35 mm. Largest desmas with clones reaching 0.45 mm situated near canals. Massive spiny zygomes developed on terminations of clones. Network nodes large, shapeless or elongated, developed from fusion of 6–9 zygomes. Small ortodichotriaenes inserted in canal walls. Dermal skeleton comprising very fine, tightly packed rhizoidal elements and overlapping orthodichotriaenes of different sizes with clads from 0.2 to 0.6 mm long (Fig. 38A). Oxeas present between them. Dermal spicules forming thick layer (ca. 1.5 mm) covering lower part of sponge, including the supporting protrusions. On upper surface, this layer is very thin.

Remarks: The studied specimens are identical with earlier described representatives of *Turonia variabilis*. Four specimens assigned by Hurcewicz (1966) to *Turonia* aff. *variabilis* are also included here to the synonymy of this species. The shape of the latter specimens is within the variability range of this extremely polymorphic species. According to Hurcewicz (1966), the unusual presence of dichotriaenes within the canals does not fall beyond the characteristics of *Turonia variabilis*. Dichotriaenes located in the terminal parts of canals occur also in the analyzed material as well as in specimens described by Gruber (1993).

Occurrence: Poland – Middle Vistula River Valley (Upper Campanian–Upper Maastrichtian), Koniecpol area (Lower Campanian), Miechów area (Upper Campanian); France (Senonian); northern-western Germany (Lower and Upper Campanian).

Genus *Callopegma* Zittel 1878
Type species: *Callopegma acaule* Zittel 1878

Remarks: According to Zittel (1887), the genus *Callopegma* is characterized by a depressed upper surface. This shape is, however, observed only in some species, *i.e. C. depressa* (Roemer 1864) and *C. pessagnoi* Howell 1966. Other species have flat (*C. plana* Lagneau-Hèrenger 1962), rounded (*C. ficus* Hinde 1883) apical part, or display a large individual variability within one species (*C. acaule* Zittel 1878).

Callopegma acaule Zittel 1878
Figs 37 (D–G); 38G, 39

*1878. *Callopegma acaule* nov. sp.: Zittel, p. 139, pl. 2, fig. 6; pl. 8, fig. 5.
1883. *Callopegma obconicum* nov. sp.: Hinde, p. 61, pl. 11, figs 3, 3b.
1910. *Callopegma acaulis* Zittel: Schrammen, p. 81, text-pl. 4, fig. 9; pl. 4, figs 3, 4.
1937. *Callopegma obconicum* Hinde: Oakley, pl. 32, figs 7, 8.
1961. *Callopegma acaule* Zittel: Nestler, p. 18, pl. 2, fig. 8.
1964. *Callopegma acaule* Zittel: Giers, p. 218.
partim v1966. *Callopegma acaule* Zittel: Hurcewicz, p. 39, text-fig. 9; pl. 1, fig. 5.
1974. *Callopegma acaule* Zittel: Ulbrich, p. 21, pl. 2, fig. 3.
1993. *Callopegma acaule* Zittel: Gruber, p. 37, pl. 1, figs 5–8; pl. 7, figs 5, 6; pl. 24, fig. 4.
2002. *Callopegma acaulis* Zittel: Pisera, fig. 17d, e.

Material and preservation: 52 specimens from Piotrawin. Most specimens are complete, except for the damaged apical part, which is strictly attached to the rock. Choanosomal skeleton poorly preserved, dermal spicules known only from casts.

Comparative material: Collection UL II; one specimen from Szczepanowice near Miechów and one from Józefów (ULVI).

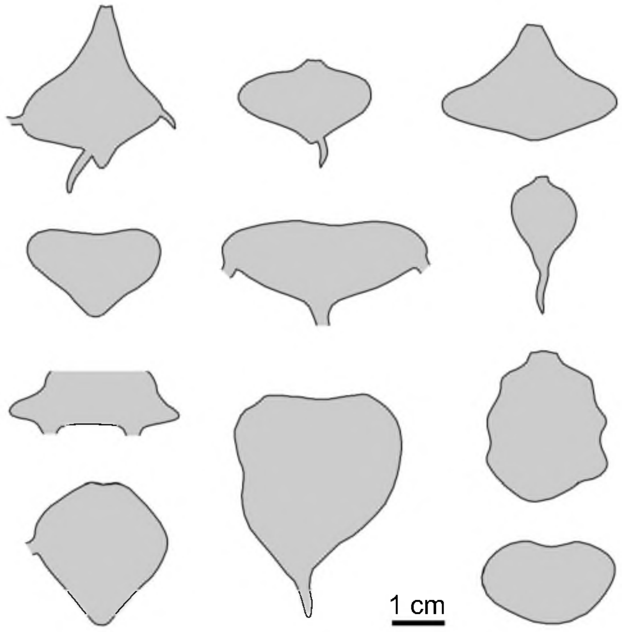

Fig. 39. Shape variability of *Callopegma acaule* Zittel 1878

Description: Low conical or hemispherical sponges without spongocoel. Upper surface convex, flat or slightly depressed, on which centrally or slightly symmetrically lies a narrow, pointed tip, up to 10 mm high (Figs 37D–G, 39). Most of specimens small, averagely 30–40 mm high and 30–50 mm in diameter. Smallest specimen 10 mm in diameter, largest up to 90 mm. Some specimens with ring-like contractions. Sponges without stalk, singular basal processes growing directly from lower part of body (Figs 37G, 39). Processes typically short and massive, rarely longer and branching at the ends. Canals straight or slightly winding, running from base and sides of sponge and forming a concentrated axial bunch in the upper part (Fig. 37F). Canal openings, 2–3 mm in diameter, located on the tip. In flattened forms bunch typically not developed or marked only within the pointed tip (if the latter is developed). Neighbouring canals often fuse with each another, thus their number decreases. If such fusion takes place near the tip, the joint opening is oval or irregular. Not all canals are fused, therefore the complex openings, situated in the central part of the sponge, occurs with openings of single canals and other smaller complex openings (Fig. 37D). Epirhyses and their openings not visible. Choanosomal skeleton consists of massive tetraclones (Fig. 38G). Clones smooth, 0.2–0.35 mm long, articulating in massive zygomes, forming large spherical nodes. The smallest desmas occur generally in the surface part. Around canals, particularly their terminal parts, occur numerous, parallel oxeas. On dermal surface dichotriaenes small (clads maximum 0.5 mm long) and densely packed.

Differentiation: Basal processes may be located only within one, lowermost point at the sponge base, or are very numerous in the entire lower part of sponge. The centrally located processes are typically vertical, anchoring the sponge within the deposit. In some cases, peripheral processes are also developed, typically grouped on one pole. They probably served as supports for individuals growing on an uneven ground. There are also forms with almost horizontal rhizoidal processes, growing radially from the widest part of the sponge, which most probably developed after burial of the lower part of the individual in mud.

Remarks: Most of the known specimens of *C. acaule* do not display a distinct depression in the apical part (compare Nestler, 1961; Ulbrich, 1974; Gruber, 1993). According to Schrammen (1910), *C. obconicum* Hinde 1883 (with a convex upper surface) is the juvenile form of *C. acaule* 1878. Also according to Hurcewicz (1966), shape of specimens and development of central cavity is dependant on their ontogenetic age. However, observation of Hurcewicz (1966) was incorrect, because they based also on specimens from the genus *Siphonia* Goldfudss, well recognizable due to their large canal openings on the dermal surface, erroneously assigned to *C. acaule*. The collection analysed herein, including numerous specimens of different sizes, does not display a correlation between the size and the shape of the apical part. Some of the described specimens, due to the shape are close to the representatives of *Jerea* Lamouroux 1821, particularly to the small species *Jerea acuta* Courtiller 1861, known from the Upper Cretaceous of France. Lack of distinct canal openings on the surfaces of some representatives of this species and their incomplete description (compare Moret, 1926, p. 160, pl. 12, fig. 5), suggests that they might be erroneously assigned specimens of *Callopegma acaule*.

Occurrence: Poland – Upper Campanian Middle Vistula River Valley, Koniecpol area (Lower Campanian); northern-western Germany (Santonian, Lower and Upper Campanian); Isle of Rügen (Lower Maastrichtian); England (Senonian).

Genus *Siphonia* Goldfudss 1826
emended Zittel 1878, emended Reid 2004
Type species: *Siphonia pyriformis* Goldfudss 1826

Siphonia tubulosa (Roemer 1841)
Fig. 40 (A, B)

*1841. *Scyphia tubulosa* nov. sp.: Roemer, p. 8, pl. 3, fig. 10.
?1889. *Siphonia ovalis* nov. sp.: Griepenkerl, p. 20, pl. 3, fig. 3.
1910–1912. *Siphonia tubulosa* Roemer: Schrammen, p. 93, text-pl. 4, fig. 11; pl. 2, figs 6–8.
?1924. *Siphonia ovalis* Griepenkerl: Schrammen, p. 138.
1926. *Siphonia pyriformis* forma *tubulosa* Roemer: Moret, p. 168, pl. 12, fig. 3.
1961. *Siphonia pyriformis tubulosa* (Roemer): Nestler, p. 20, pl. 2, figs 7–9; pl. 3, figs 1–3.
1963. *Siphonia pyriformis tubulosa* (Roemer): Wagner, pp. 178–180.
v1966. *Siphonia tubulosa* (Roemer): Hurcewicz, pp. 51–52, text-fig. 11; pl. 4, figs 1, 2; pl. 5, figs 1, 2.

Material and preservation: One specimen with destroyed apical and basal part, from the glauconitic sandstone from Nasiłów. Skeleton completely dissolved. Visible casts of choanosomal desmas.

Comparative material: Collection UL II.

Description: Club-shaped sponge, over 60 mm high and 44 mm wide in widest part (Fig. 40A). Narrow, very deep spongocoel with a diameter 4 mm (Fig. 40B). Shallow, very short, straight or winding furrows occur on sponge surface in the apical part. Irregularly round canal openings, 1–1.5 mm in diameter, and randomly distributed, every 0.5–1.5 mm. Tube-shaped epirhyses, ca. 1 mm in diameter, run obliquely downwards into sponge. Wider aporhyses directed obliquely upwards. Canal openings invisible on spongocoel wall. Choanosomal skeleton consists of tetraclones with smooth clones, 0.2–0.3 mm long and massive zygomes. Nodes irregularly spherical.

Remarks: The described specimen, similarly as the holotype, has a deep and narrow central cavity. It differs, however, in this respect from representatives of *S. tubulosa* from Miechów Basin,

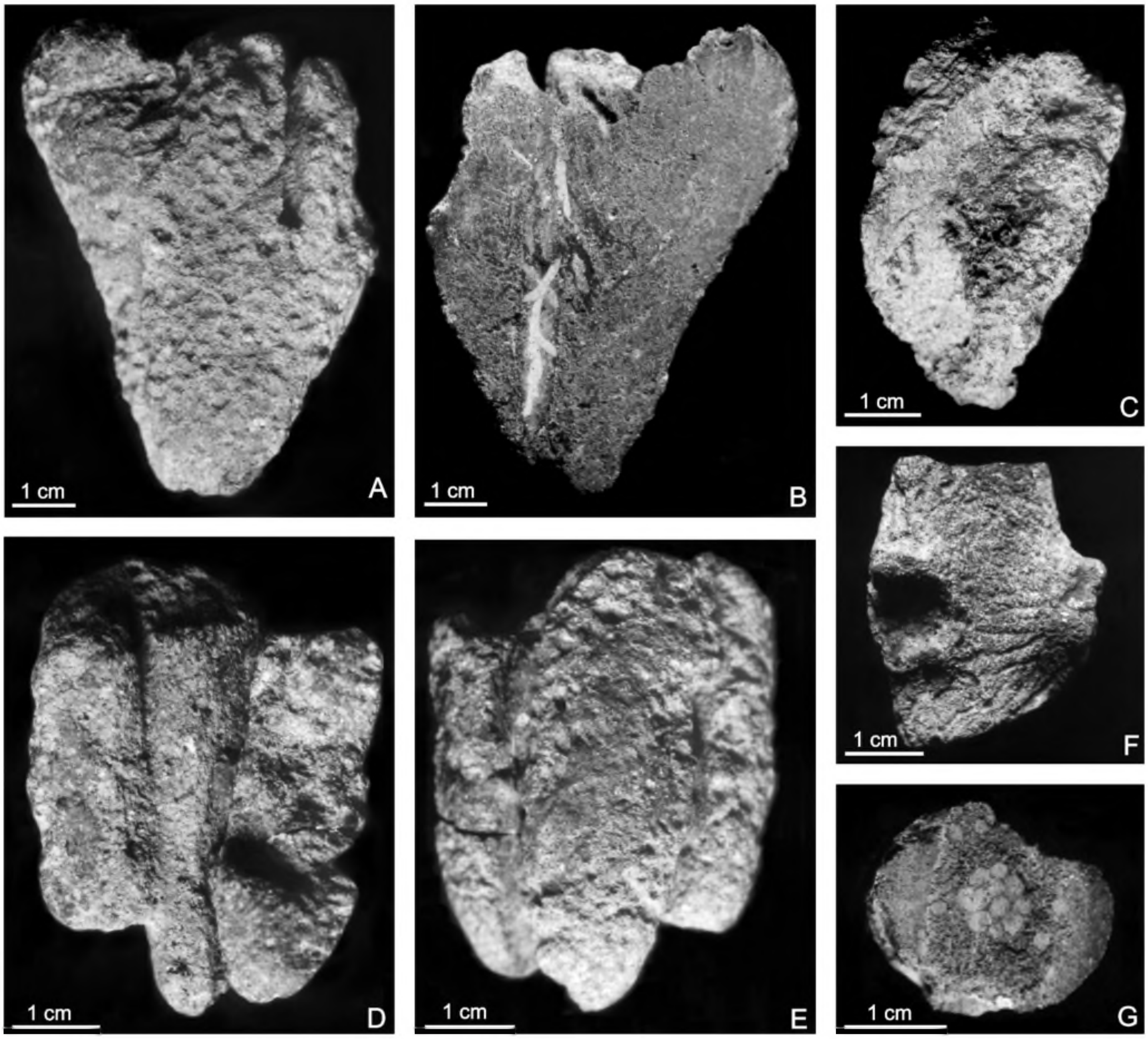

Fig. 40. **A, B** – *Siphonia tubulosa* (Roemer 1841); A – lateral view; B – longitudinal cross–section; activity of burrowing animals visible within deposit filling the spongocoel; Nasiłów, greensand, Upper Maastrichtian (UL XX 2/78); **C** – *Ragadinia rimosa* (Roemer 1864); Nasiłów, greensand, Upper Maastrichtian (UL XX 2/92); **D, E** – *Colossolacis plicata* Schrammen 1910; D – view of internal surface; E – view of external surface; Nasiłów, greensand, Upper Maastrichtian (UL XX 2/44); **F** – *Acrochordonia ramosa* Schrammen 1901; lateral view; Nasiłów, greensand, Upper Maastrichtian (UL XX 2/48); **G** – *Jerea* sp.; transverse cross–section with aporhyses; Nasiłów, greensand, Upper Maastrichtian (UL XX 2/48)

which are characterised by large sizes and a deep and wide spongocoel (Hurcewicz, 1966). Schrammen (1910) included *S. ovalis* Griepenkerl to the synonymy of *S. tubulosa*. However, later, Schrammen (1924) again distinguished the species *S. ovalis*, although without any justification. The macroscopic features of the specimens described by Griepenkerl (1889) suggest very close similarity to the forms here discussed; however, due to the lack of knowledge about the skeleton of *S. ovalis*, synonymizing this species with *S. tubulosa* is problematic.

Occurrence: Poland – Middle Vistula River Valley (uppermost Maastrichtian), Koniecpol area (Lower Campanian); northern-western Germany (Turonian and Senonian), Isle of Rügen (Lower Maastrichtian); France (Senonian).

Genus *Jerea* Lamouroux 1821 emended Zittel 1878
Type species: *Jerea pyriformis* Lamouroux 1821

Jerea sp.
Fig. 40 (G)

Material and preservation: One specimen from greensand from Nasiłów. Specimen with strongly effaced surface, particularly in the apical part. Singular fragments of choanosomal desmas and their casts are preserved. Lack of dermal spicules or their casts.

Description: Cylinder-shaped sponge, slightly narrower in the apical and basal parts. Tip most probably rounded. Height of sponge at least 50 mm, width ca. 20 mm. Spongocoel not developed. Epirhyses long, perpendicular to sponge surface. Aporhyses straight, 5–2 mm in diameter, run longitudinal. In axial part, 10 tightly packed aporhyses form bunch. Aporhyses located close to sponge surface, between epirhyses, arranged concentrically every ca. 2 mm, forming a single ring (Fig. 40G). Choanosomal skeleton comprising small smooth tetraclones. Clones 0.2–0.35 mm long, terminating with poorly branching zygomes.

Remarks: The studied specimen is assigned to *Jerea* Lamouroux due to the type of desmas and the characteristic distribution of longitudinal aporhyses in a central bunch. As a result of poor state of preservation, the determination of the specific assignment is not possible.

Occurrence: Middle Vistula River Valley (uppermost Maastrichtian).

Family THEONELLIDAE Lendenfeld 1903
emended Pisera & Lévi 2002
Genus Schrammen 1901
Type species: *Acrochordonia ramosa* Schrammen 1901

Remarks: The genus *Acrochordonia* is assigned to the suborder Tetracladina Zittel. Pisera (2002) included the genus to family Phymatellidae Schrammen. According to Reid (2004), *Acrochordonia* represents the family Theonellidae Lendenfeld due to the presence of tuberculate tetraclones. In genus *Acrochordonia* dichotriaenes are present, while phyllotriaenes and discotriaenes are typical for Theonellidae. Reid (2004) claimed it does not exclude the genus from the considered family, as phyllotriaenes of *Cladodermia* Schrammen are slightly modified dichotriaenes. Because of the form of desmas, the genus *Acrochordonia* was erroneously considered a representative of the Dicranocladina Schrammen 1924 by Lagneau-Hérenger (1962), followed by Hurcewicz (1966) and Gruber (1993).

Acrochordonia ramosa Schrammen 1901
Fig. 40 (F)

*1901. *Acrochordonia ramosa* nov. sp.: Schrammen, p. 7, pl. 1, fig. 8; pl. 5, fig. 1.
1910–1912. *Acrochordonia ramosa* Schrammen: Schrammen, p. 96, text-pl. 6, fig. 10; pl. 4, figs 5, 6.
1926. *Acrochordonia ramosa* Schrammen: Moret, p. 175, text-fig. 68; pl. 16, fig. 10.
1993. *Acrochordonia ramosa* Schrammen: Gruber, p. 32, pl. 4, figs 6, 7.

Material and preservation: 5 fragments from greensand from Nasiłów. Sporadically, fragments of singular choanosomal desmas are preserved; their casts are well recognisable.

Description: Sponges in shape of branch, 15–18 mm in diameter (Fig. 40F). Largest fragment is 30 mm long. One specimen possesses a cylindrical, truncated tip with a 3 mm opening surrounded by furrows. Openings of the inhalant canals (max. 0.5 mm) randomly distributed on sponge surface. Exhalant canal openings (ca. 1 mm) are placed within bottom of bowl-like depressions (diameter 8–9 mm). These occur in apical part of lateral swellings. Around them, on sponge surface occur radially shallow furrows, 20–30 mm long. Their pattern is less regular where neighbouring furrow systems overlap. Pattern of aporhyses and epirhyses within sponge invisible. Choanosomal skeleton comprising verrucal desmas, with clones ca. 0.5–0.6 mm long. Verrucae small and rounded, irregularly and sparsely distributed. Desmas typically with 4 variably branching clones. Clone endings with fork-like protrusions, forming small zygomes. Zygomes connected in irregular nodes of variable size. Network compact, with 0.25–0.35 mm meshes.

Remarks: The analyzed specimens are assigned to the species *A. ramosa* despite the lack of the dermal skeleton and poor state of preservation of the choanosomal skeleton. This is possible due to the very characteristic morphology of this species, expressed in the branch-like shape and radial furrows around openings of aporhyses grouped in depressions. All these features are well visible on 2 specimens. The remaining 3 fragments possess only well visible furrows, whereas the openings of aporhyses are not preserved due to incomplete preservation of the branches. According to Schrammen (1910), the bowl-like depressions with canal openings occur only on the lateral side of the branches. Due to the poor preservation of the analysed fragments, it is not possible to state if the opening in the apical part of one of the described specimens also contains openings of aporhyses. In specimens assigned by Wagner (1963, p. 187) to *A. ramosa* the openings of the exhalant canals as well as furrows are not visible. Due to lack of preserved dichotriaenes, the assignment of these forms to the discussed species is questionable. Similarly, lack of the characteristic features does not allow a univocal assignment of the specimen from Zbyczyce, described by Hurcewicz (1966, pp. 106–107) as *Acrochordonia* cf. *ramosa* to this species.

Occurrence: Poland – Middle Vistula River Valley (uppermost Maastrichtian); north-western Germany (Campanian); France (Santonian).

Genus *Colossolacis* Schrammen 1910
Type species: *Colossolacis plicata* Schrammen 1910

Colossolacis plicata Schrammen 1910
Figs 40 (D, E), 41D

*1910. *Colossolacis plicata* nov. sp.: Schrammen, pp. 103– 104, text-pl. 5, fig. 1; pl. 8, fig. 5; pl. 9, figs 1, 2.
1974. *Colossolacis plicata* Schrammen: Ulbrich, p. 26.
1993. *Colossolacis plicata* Schrammen: Jahnke & Gasse, pl. 13, figs 3, 4; pl. 16, figs 2, 5, 6.

Material and preservation: 3 fragments from greensand from Nasiłów. Skeleton completely dissolved. Casts of choanosomal desmas very well visible. Single casts of dermal spicules preserved.

Description: The best preserved sponge fragment is a 50 mm long and 35 mm wide lobe, 15 mm thick, divided by furrows into 3 secondary lobes, variably fused with each other (Fig. 40D, E). The central, largest part widens in form of wedge. Lateral lobes smaller, lying slightly oblique in relation to the central lobe, thus the external surface of the entire fragment is slightly convex, and internal is concave. Large (0.6–2 mm), round canal openings, irregularly distributed on external surface. On internal surface, canal openings 1–2 mm in diameter. Epirhyses divide into irregular canals parallel to the dermal surface. Canals visible in form of furrows in parts with effaced surface. Aporhyses wide, winding, oriented more or less transversely to wall. Choanosomal skeleton comprising tetraclones, clones 0.25–0.6 mm long (Fig. 41D). Some clones with smooth surface, other with tubercular surface. Massive zygomes developed on terminations of clones. Dermal spicules represented by large (0.7–0.8 mm), strongly bifurcating phyllotriaenes.

Remarks: According to Schrammen (1910) and Ulbrich (1974), *C. plicata* has a skeleton comprising tetraclones with smooth clones. On the other hand, the skeleton of the syntype from Schrammen's collection, illustrated by Jahnke & Gasse (1993), comprises smooth desmas as well as those with small tubercles. This differentiation of the clones surfaces is observed also on casts of the skeleton in the specimens analysed herein.

Occurrence: Poland – Middle Vistula River Valley (uppermost Maastrichtian); north-western Germany (Campanian).

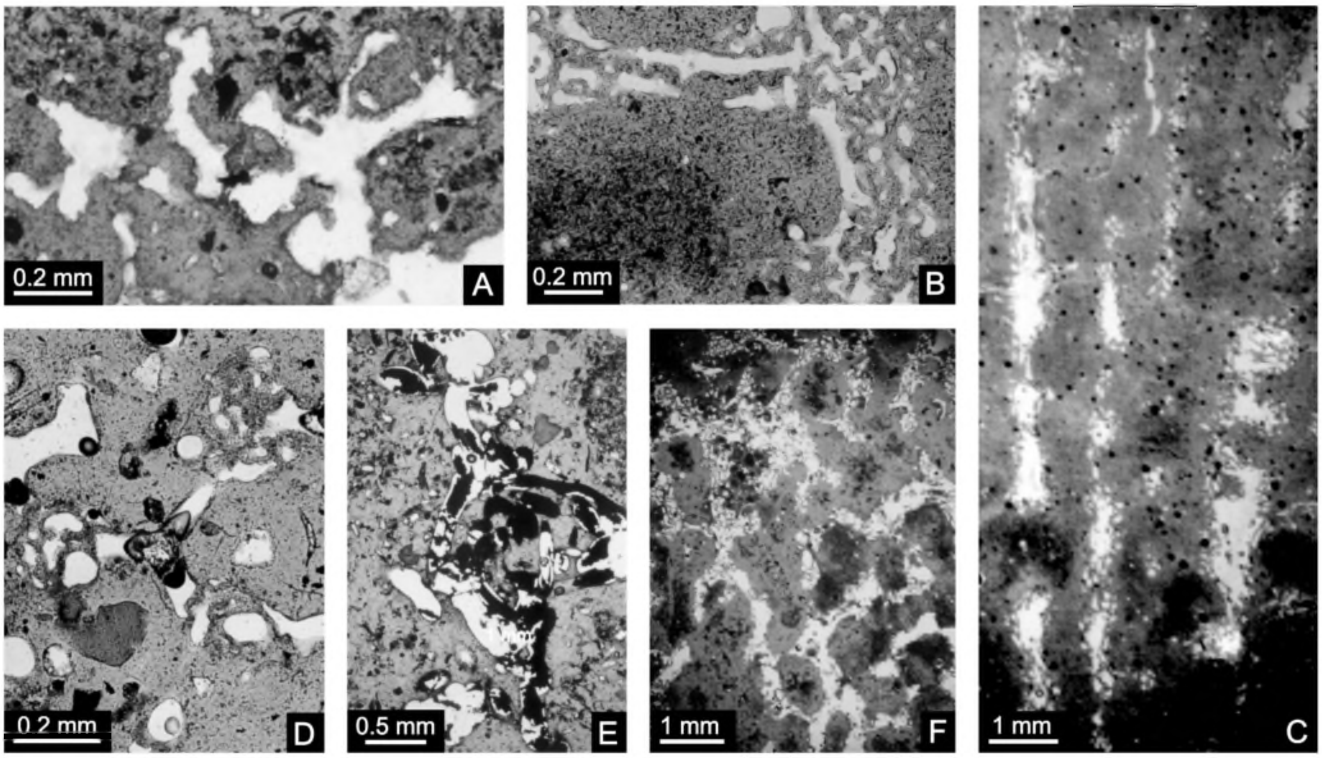

Fig. 41. **A–F** – Casts of desmas are observed in phosphatized specimens from the greensand; Nasiłów, Upper Maastrichtian; **A** – *Phyllodermia antiqua* Schrammen 1910; single phyllotriaen and fragments of tetraclones (UL XX 2/38); **B–C** – *Seliscothon* sp.; rhizoclones distributed in radial filaments and detail of skeleton (UL XX 2/58); **D** – *Colossolacis plicata* Schrammen 1910; single tetraclone (UL XX 2/45); **E** – *Pachycothon giganteum* (Roemer); heloclones; casts after dissolved spicules partly filled with non–transparent minerals (UL XX 2/34); **F** – *Verruculina miliaris* (Reuss); choansosomal skeleton – rhizoclones distributed in tangled filaments (UL XX 2/52)

Genus *Phyllodermia* Schrammen 1924
Type species: *Discodermia antiqua* Schrammen 1901

Remarks: Schrammen (1924) included Recent forms with discotriaenes to the genus *Discodermia* Bocage 1869, whereas the fossil species with phyllotriaenes were distinguished as a new genus *Phyllodermia*. According to Reid (2004), in the *Discodermia*, apart from discotriaenes phyllotriaenes may be found, but there are no rhizoclonids that are present in *Phyllodermia*. It is unclear why Gruber (1993), who, despite accepting the genus *Phyllodermia* Schrammen 1924 with its type species *Discodermia antiqua* Schrammen, included this species to *Discodermia* Bocage.

Phyllodermia antiqua (Schrammen 1901)
Figs 37 (G), 41 (A)

*1901. *Discodermia antiqua* nov. sp.: Schrammen, p. 5, pl. 1, figs 2–4; pl. 4, fig. 3.

1910. *Discodermia antiqua* Schrammen: Schrammen, s. 97, text-pl. 5, fig. 4; pl. 8, figs 1, 2, pl. 7, figs 5–7.

1926. *Discodermia antiqua* Schrammen: Moret, p. 176, pl. 15, fig. 5.

1946. *Discodermia antiqua* Schrammen: Hèrenger, p. 287.

non 1963. *Phyllodermia antiqua* (Schrammen): Wagner, p. 188.

1967. *Discodermia antiqua* Schrammen: Kempen, pp. 28–33, text-figs 1–4; pl. 1, figs A, B; pl. 2, figs A–C.

1993. *Discodermia antiqua* Schrammen: Gruber, p. 41. pl. 8, figs 2, 3.

2002. *Phyllodermia antiqua* (Schrammen): Pisera, figs 20b, 21a, b.

Material and preservation: 4 specimens from greensand from Nasiłów. One specimen is almost complete, one only slightly damaged. Spicules completely dissolved. In some specimens spaces after dermal spicules are well recognizable, whereas the spaces after choanosomal spicules are less distinct.

Description: Shapeless, lumpy sponges, narrowing downwards (Fig. 37C). Height of the largest specimen 60 mm, width in apical part 55 mm. Canal openings, ca. 0.7–1 mm in diameter, randomly distributed on entire surface. Epirhyses not recognizable. Short furrows, 1.5–2 mm wide, visible on specimens with damaged surface. Furrows winding and in some cases bifurcating, chaotically distributed, without any clear orientation. Large (1.5–2.5 mm), randomly distributed openings located between furrows. Openings lead to aporhyses starting directly below sponge surface, running diagonally or perpendicularly to wide (6–8 mm in diameter) canals. This system of irregularly connected canals replaces the central spongocoel, Singular oscula located asymmetrically in apical part. Choanosomal skeleton comprising tetraclones with clones 0.3–0.4 mm long. Clone surface covered with small tubercles. Small zygomes developed on terminations of clones. Sponge surface smooth on casts of dermal skeleton. Skeleton possessed tightly packed, large and bifurcating phyllotriaenes with clads, ca. 0.6–0.8 mm long (Fig. 41A), as well as small and irregularly cut siliceous plates.

Remarks: The features recognised in specimens from Poland fully correspond to the diagnosis of *P. antiqua*. This is a polymorphic species. Due to the development of the exhalation system, the analysed material is closer to specimens from Germany (Schrammen, 1901, 1910). Wagner (1963) described two specimens as *P. antiqua*, however their skeleton comprises only small dichotriaenes and the phyllotriaenes are missing. This excludes these specimens from the genus *Phyllodermia*.

Occurrence: Poland – Middle Vistula River Valley (uppermost Maastrichtian); north-western Germany (Lower and Upper Campanian); France (Santonian); Pyrenées (Campanian); The Netherlands (in a form of erratics).

Genus *Ragadinia* Zittel 1878
Type species: *Cupulospongia rimosa* Roemer 1864

Ragadinia rimosa (Roemer 1864)

*1864. *Cupulospongia rimosa* nov. sp.: Roemer, p. 51, pl. 17, figs 8a-d.
1878. *Ragadinia rimosa* Roemer: Zittel, p. 152, pl. 10, figs 4a-f.
1883. *Ragadinia rimosa* Roemer: Hinde, p. 82.
1884. *Ragadinia rimosa* Roemer: Počta, p. 41, pl. 2, fig. 14.
1910. *Ragadinia rimosa* Roemer: Schrammen, p. 100, text-pl. 5, fig. 3; pl. 8, figs 6, 7; pl. 7, fig. 4; pl. 10, fig. 5.
1926. *Ragadinia rimosa* Roemer: Moret, p. 185.
v1933. *Ragadinia rimosa* Roemer: Bieda, p. 18.
1960. *Ragadinia rimosa* (Roemer): Defretin-Lefranc, p. 113, text-fig. 35; pl. 19, fig. 1.
1963. *Ragadinia rimosa* (Roemer): Wagner, p. 190, text-fig. 6d.
v1966. *Ragadinia rimosa* (Roemer): Hurcewicz, p. 63, text-fig. 16; pl. 13, figs 1a-b.
1974. *Ragadinia rimosa* (Roemer): Ulbrich, p. 26.
non v1980. *Ragadinia rimosa* (Roemer): Małecki, p. 424, pl. 12, figs 2a-b [=*Polyopesia angustata* Schrammen].
2002. *Ragadinia rimosa* (Roemer): Pisera, fig. 20a.

Material and preservation: One specimen from greensand from Nasiłów. Surface of specimen is in some places strongly damaged. Spicules dissolved. Only casts of choanosomal spicules are visible.

Comparative material: Collections UL II and A-1-1.

Description: Sponge in the shape of an asymmetric leaf, with one margin strongly bent inwards. Height of specimen 50 mm, width, in upper part 30 mm. Wall thickness ca. 10 mm. On external surface furrows running radially from base onto bent upper margin. Furrows ca. 1–1.5 mm wide, at a distance of ca. 2–3 mm. Round canal openings, 0.6–0.7 mm in diameter on furrow bottom. On internal surface, canal openings slightly larger, grouped in the bottom of small (2–3 mm), cup-shaped depressions. Between them occur short, longitudinal ridges and furrows, lying in a pattern difficult to recognize due to poor preservation. Epirhyses invisible within wall. Aporhyses irregularly branching. Choanosomal skeleton comprising tetraclones. Their casts indicate that they were largely covered by tubercles. Clones averagely 0.25–0.35 mm long. Clone terminations strongly branching, fusing to form a fine-mesh network with irregular nodes.

Remarks: The described specimen, in relation to the known representatives of this species from the Campanian of Poland, is characterised by considerably wide furrows on the external side, like in specimens of Schrammen (1910). The specimen included by Małecki (1980) to *R. rimosa* represents in fact the species *Polyopesia angustata* Schrammen, 1902. Its skeleton is not preserved, however casts of hexactines are visible in some cases.

Occurrence: Poland – Middle Vistula River Valley (uppermost Maastrichtian), Koniecpol, Miechów and Kraków area (Lower and Upper Campanian); Czech Republic (Cenomanian); France (Cenomanian and Senonian); north-western Germany (Lower and Upper Campanian); England (Senonian).

Family PLINTHOSELLIDAE Schrammen 1910
Genus *Plinthosella* Zittel 1878
Type species: *Plinthosella squamosa* Zittel 1878

Remarks: According to Zittel (1878), the choanosomal desmas in the type species *Plinthosella squamosa* are modified tetraclones. The axial canal in plates on dermal surface was not observed, therefore, the plates are typically described as acrepidial. Ulbrich (1974) considered them as discotriaenes. Lévi (1991) stated that the desmas in *Plinthosella* are erroneously considered as tetracrepidial and he included Plinthosellidae to Dicranocladina Zittel as synonym of Neopeltidae Sollas 1888. According to Pisera (2000, 2002), it is incorrect as the young desmas in a specimen of *Plinthosella magna* Pisera 2000 display tetractine geometry, while desmas of Neopeltidae are monocrepidial.

Plinthosella squamosa Zittel 1878
[=*Phinthosella* Počta 1884]

*1878. *Plinthosella squamosa* nov. sp.: Zittel p. 89, pl. 2, fig. 10; pl. 10, fig. 5.
1883. *Plinthosella squamosa* Zittel: Hinde, p. 85, pl. 20, fig. 2.
1884. *Phinthosella squamosa* Zittel: Počta, p. 42.
1910. *Plinthosella squamosa* Zittel: Schrammen, p. 114, text-pl. 6, fig. 11; pl. 4, figs 7–9.
1926. *Plinthosella squamosa* Zittel: Moret, p. 202.
1961. *Plinthosella squamosa* Zittel: Nestler, p. 23, pl. 3, figs 4–7; pl. 4, figs 1–4.
v1966. *Plinthosella squamosa* Zittel: Hurcewicz, p. 73.
?v1966. *Plinthosella elegans* n. sp.: Hurcewicz, pp. 73–75, text-fig. 21; pl. 13, fig. 2.
1974. *Plinthosella squamosa* Zittel: Ulbrich, p. 31.
2002. *Plinthosella squamosa* Zittel: Pisera, fig. 19.

Material and preservation: 5 specimens (1 from Piotrawin, 1 from Dziurków, 2 from Solec, 1 from Kłudzie). All specimens are strongly fused with the surrounding rock. Apical part not preserved. Singular choanosomal and dermal spicules preserved. Spicules casts well recognisable.

Comparative material: Collection UL II.

Description: Irregularly spherical sponges, max. 35 mm in diameter. Spongocoel not developed. Short basal processes visible on one specimen. Loose choanosomal skeleton comprising large tetraclones with well developed zygomes. One clone is reduced to a rounded tubercle-like process. Remaining clones are 0.35–0.45 mm long and 0.05–0.12 mm thick, covered by tubercles lying in a regular ring-like pattern. In central part of desmas, where tubercles are largest, the pattern is irregular. Sponge surface covered by plates overlapping in an imbricate pattern. Plates with irregular, quadrangular shape. Average length ca. 1 mm, the largest reach up to 2 mm. Both plate surfaces flat, or external surface slightly convex due to slight thickening of plate in central part. In basal parts, plates lying in layers.

Remarks: The analyzed material recalls the know descriptions of this characteristic species. Hurcewicz (1966) distinguished a new species *P. elegans*, characterized by a "form of an inverted cone". The conical shape of the lower part of the sponges also should not be considered a diagnostic feature, as among the specimens assigned by Hurcewicz (1966) to *P. squamosa* are forms with shapes similar to that of her species *P. elegans*. According to Hurcewicz (1966), dermal skeleton of *P. elegans* includs "vermiform", elongated cortical megascleres. The presence of vermiform desmas is not confirmed herein. Therefore these forms might probably represent *P. squamosa*.

Occurrence: Poland – Middle Vistula River Valley (Upper Campanian and Lower Maastrichtian) ,Wolbrom (Cenomanian), Koniecpol area and Miechów area (Lower Campanian); north-

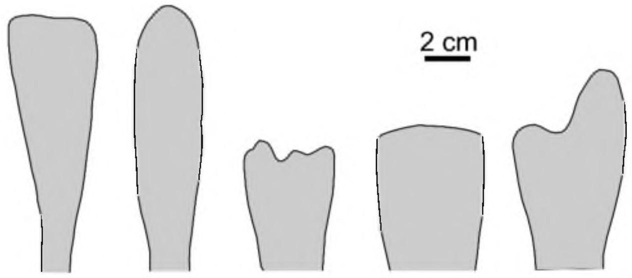

Fig. 42. Shape variability of *Homalodora plana* Schrammen 1910

western Germany (Lower and Upper Campanian); Rügen (Lower Maastrichtian); Czech Republic (Turonian); southern England (Senonian).

Order MONALITHISTIDA Lagneau-Hèrenger 1962
Suborder RHIZOMORINA Zittel 1878
Family SCLERITODERMATIDAE Sollas 1888

Genus *Verruculina* Zittel 1878
Type species: *Manon micrommata* Roemer 1841

Remarks: Taxa previously incorporated in the genus *Verruculina* Zittel were assigned by Schrammen (1924, p. 90) to 7 genera from five families. The taxonomy of this group still remains an open issue. In relation to some genera, the diagnostic features pointed out by Schrammen (1924) are either indistinct or controversial. All genera distinguished by Schrammen (1924) were considered as synonyms of *Verruculina* by Brimaud and Vachard (1986a). Reid (2004) included only *Chondriophylum* Schrammen 1924 and Amphichondrium Schrammen 1924 to *Verruculina* Zittel, the others, however were classified as *Amphithelion* Zittel 1878.

Verruculina tenuis (Roemer 1841)
Figs 38 (H, I)

*1841. *Manon tenue* nov. sp.: Roemer, p. 3, pl. 1, fig. 7.

1845–1846. *Manon tenue* Roemer: Reuss, p. 78, pl. 20, fig. 2.

1864. *Chenendopora tenuis* (Roemer): Roemer, p. 43, pl. 15, fig. 4.

1870. *Chenendopora tenuis* (Roemer): Roemer, p. 301, pl. 31, figs 6–8.

1883. *Verruculina pustulosa* nov. sp.: Hinde, p. 39, pl. 3, figs 2, 2a.

?1884. *Amphitelion tenue* Roemer: Počta, pp. 23–24.

?1897. *Amphitelion tenue* Roemer: Leonhard, p. 37.

1878. *Chenendopora tenuis* (Roemer): Quenstedt, p. 324, pl. 31, figs 6–8.

1910. *Verruculina tenuis* (Roemer): Schrammen, p. 136.

1924. *Chondriophylum tenue* (Roemer): Schrammen, p. 126, pl. 3, fig. 13.

1926. *Verruculina tenuis* (Roemer): Moret, p. 83.

?v1933. *Verruculina* cf. *tenuis* (Roemer): Bieda, p. 8.

1962. *Verruculina tenuis* (Roemer): Lagneau-Hèrenger, p. 178, text-pl. 29, fig. 1c.

1964. *Verruculina tenuis* (Roemer): Giers, p. 221.

v1968. *Verruculina tenuis* (Roemer): Hurcewicz, p. 24, pl. 6, figs 1a-b.

v1968. *Verruculina seriatopora* (Roemer): Hurcewicz, p. 19, text-fig. 5; pl. 2, figs 1, 2; pl. 6, fig. 2.

1974. *Verruculina tenuis* (Roemer): Ulbrich, p. 48, pl. 8, fig. 5; pl. 9, figs 1, 2; pl. 18, fig. 6.

Material and preservation: 7 specimens (6 from Piotrawin, 1 from Dziurków). Strongly limonitized specimens with single choanosomal desmas. Morphology of both sides well recognizable on imprints.

Comparative material: Collections UL II and A-1-1.

Description: Cup-, plate- or leaf-shaped sponges, most probably without stalk. Wall can be additionally folded, thus the shape of some individuals is extremely irregular. Wall ca. 3–5 mm thick. Largest individual ca. 70 mm high. Canal openings on external surface situated in apical part of small verrucae. Openings ca. 0.2–0.3 mm in diameter, very densely spaced (150–300/cm^2). Verrucae with openings on internal surface are larger, 0.5–1 mm in diameter and ca. 0.5 mm high, distributed randomly on entire surface, although most densely in central part; averagely 12–18 verrucae/cm^2. Choanosomal skeleton comprising winding longitudinal fibres, ca. 0.5 mm wide, which at uneven distances are connected with one another by transverse fibres. Fibres comprising small (0.2–0.3 mm long) strongly branching rhizoclones with spines (Fig. 38H, I). Sporadically slightly longer (ca. 0.3–0.5 mm), poorly branching, almost straight or arc-like rhizoclones are also present.

Remarks: The Polish specimens of *V. tenuis* are distinguished by the rather small number of canal openings on the external surface. Their maximal number, 400–500/cm^2, was noted in representatives of this species from the Lower Campanian of Germany (Ulbrich, 1974). The state of preservation of the analyzed specimens does not allow tracing the canalization within the wall. It seems, however, that similarly as in the case of *V. miliaris* (Reuss), the openings in the apical part of verrucae on the internal surface, described as “postica” (Hurcewicz, 1966), represent oscula. Specimens assigned by Hurcewicz (1966) to *V. seriatopora* (Roemer 1841) are also included to the synonymy of *V. tenuis*. According to Hurcewicz (1966), they differ from representatives of *V tenuis*, collected in the same exposure, in the structure of “ostia” and wall thickness. However, the wall thickness in both cases varies between 3 and 5 mm. Specimens assigned by Hurcewicz (1966) to *V seriatopora* are also characterized by an effaced surface; therefore their verrucae seem to be flatter. To the largest degree the verrucae are damaged in the peripheral part of sponge, due to which the margin of some specimens seems to be smooth and resembles that of *V. seriatopora* (see Moret, 1926). The rhizoclones in specimens from the Miechów Basin are ca. 0.2 mm long. Only the largest reach 0.3 mm (Hurcewicz, 1966, p. 20, text-fig. 5). These dimensions are typical of *V. tenuis*, whereas the desmas of *V. seriatopora* are averagely 1.5 to 2 times larger. The lack of preserved spicules in specimens from the vicinity of Kraków does not allow their univocal assignment to *V. tenuis*.

Occurrence: Poland – Middle Vistula River Valley (Upper Campanian), Koniecpol and Kraków area (Lower Campanian); Spain (Aptian); France (Senonian); north-western Germany (Turonian, Santonian and Campanian); England (Senonian); ? Czech Republic (Cenomanian).

Verruculina miliaris (Reuss 1846)
Figs 38 (J, K), 41 (F)

*1845–1846. *Manon miliare* nov. sp.: Reuss, p. 78, pl. 19, figs 10, 11.

1883. *Verruculina miliaris* Reuss: Hinde, p. 39, pl. 3, figs 3, 3a.

1910. *Verruculina miliaris* Reuss: Schrammen, p. 139.

1924. *Sporodothelion dissipatum* nov. sp.: Schrammen, pp. 120–121, pl. 3, fig. 4.

1924. *Sporodothelion miliare* Reuss: Schrammen, p. 121.

1926. *Verruculina miliaris* Reuss: Moret, p. 82.

?v1933. *Verruculina* cf. *miliaris* (Reuss): Bieda, p. 9.
v1968. *Verruculina miliaris* (Reuss): Hurcewicz, p. 22, pl. 4, figs 1, 2 b; p. 17, fig. 5.

Material and preservation: 13 specimens (9 from Piotrawin, 4 fragments from greensand from Nasiłów). Specimens destroyed to a variable degree. Specimens from opoka strongly limonitized with few choanosomal desmas preserved. Spicules preserved as casts in specimens from glauconitic sandstone.
Comparative material: Collections UL II and A-1-1.
Description: Ear- or irregular cup-shaped sponges, with rounded margin. Margin straight, folded or subdivided into smaller (up to 20 mm wide) rounded lobes. Wall 7–9 mm thick. Largest specimen ca. 90 mm high and 120 mm wide. External surface covered by small verrucae, 0.5–0.6 mm in diameter, with canal openings in apical part. Verrucae densely spaced in short, arc-like or undulating rows, separated from each other at ca. 0.2–0.3 mm; 60–110 verrucae/cm^2. Thin epirhyses (0.2–0.4 mm) densely lying under dermal surface in deeper part of wall connected into a loose system of anastomosing canals reaching deeply into wall. On upper surface, oscula occur in apical part of crater-like verrucae, 1–2 mm in diameter at base and 2–3 mm high. Oscula distributed irregularly on entire surface, at very variable (3–7 mm) distances; averagely 5–12 oscula/cm^2. Aporhyses slightly wider than epirhyses, ca. 0.5–0.6 mm in diameter, spreading out radially from shallow cavities occurring within verrucae and sub-dividing several times under the gastral surface. Choanosomal skeleton comprising poorly branching rhizoclones, 0.3–0.4 mm long and 0.025–0.040 mm wide (Fig. 38J, K). Rhizoclones to a variable degree covered by cone-shaped or rounded spines. In most massive desmas, spines short and slightly tapering. Rhizoclones compose irregularly connected fibres, ca. 0.4 mm wide (Fig. 41F).
Remarks: According to the data presented by Schrammen (1910), the number of verrucae on the external surface in *V. miliaris* is 40–60/cm^2. Individuals from the collection of UL II and the author's collections are characterized by more numerous verrucae. The morphology of both surfaces in specimens described by Bieda (1933) as *V.* cf. *miliaris* (Reuss) is identical with the forms analysed herein, therefore despite the lack of well preserved spicules these specimens are included to this species. The known specimens of *V. miliaris* indicate a variable wall thickness. At first Schrammen (1910) determined it at 5 mm, but later (Schrammen 1924) assigned the species to thick-walled forms, that is having a wall exceeding 6 mm in thickness. According to Hinde (1883), the wall is 5–8 mm thick. Specimens from France (Moret, 1926) have a similar thickness to the specimens from the author's collection, ca. 8 mm. The thinnest wall (2–4 mm) was noted in specimens from the Miechów Basin (Bieda, 1933; Hurcewicz, 1968). Even after taking into account the effect of compaction in relation to the most thin-walled specimens, differences in wall thickness are large and similarly as in the case of *V. tenuis* (Reuss) this feature cannot be a taxonomical feature on genus level as proposed by Schrammen (1924). Specimens from England described by Hinde (1883) as *V. miliaris* (Reuss) were assigned by Schrammen (1924) to the type species *Sporodothelion dissipatum* nov. nom. of the new genus *Sporodothelion*. The diagnosis of *S. dissipatum* presented by Schrammen (1924) lacks characteristic features enabling to distinguish it from *V. miliaris* [=*Sporodothelion miliare* (Reuss) – Schrammen (1924)]. Specimens from the Czech Republic [*Amphitelion miliare* Reuss sp. – Počta (1884) and *Manon miliare* Reuss – Frič (1869)], due to poor preservation and vague description cannot be included to *Verruculina miliaris* Reuss.
Occurrence: Poland – Middle Vistula River Valley (Upper Campanian and uppermost Maastrichtian), Koniecpol and Kraków area (Lower Campanian); Germany (Cenomanian and Turonian), England (Senonian); France (Senonian).

Family SELISCOTHONIDAE Schrammen 1910
Genus *Seliscothon* Zittel 1878
Type specimen: *Spongia plana* Phillips 1835

Seliscothon sp.
Fig. 41 (B, C)

Material and preservation: One fragment from greensand from Nasiłów. Specimen phosphatized with completely dissolved desmas. Well visible casts after choanosomal spicules.
Description: The analyzed specimen is a flat fragment, 35 mm long. Wall 13 mm thick. Canal openings not visible on external surface covered by longitudinal furrows. Internal surface damaged, with poorly visible small (0.5–0.6 mm) canal openings. Epirhyses straight, directed obliquely downwards. Aporhyses invisible. Skeleton comprising spiny rhizoclones, 0.5–0.6 mm long. Desmas loosely branching, straight or arc-shaped. Rhizoclones connected in long and thin fibres (about 0.25 mm), separated from one another at 0.6–0.7 mm (Fig. 41B, C). Fibres connected with each other at irregular distances by transverse rhizoclones. Fibres on dermal side of wall run almost parallel to surface. Fibres lying above are slightly bent towards gastral surface.
Remarks: Due to poor state of preservation of the analyzed specimen its species assignment is not possible. The skeleton type and dimensions of rhizoclones are closest to those of *S. planum* (Phillips 1835). This species is common in the Upper Cretaceous and known from the Campanian of Poland.
Occurrence: Poland – Middle Vistula River Valley (uppermost Maastrichtian).

Order MEGALITHISTIDA Reid 2004
Suborder HELOMORINA Schrammen 1924

Remarks: According to Reid (1968c), heloclones are homologous with megaclones. Therefore, Wiedenmayer (1994) included to the suborder Megamorina Zittel 1878 also the genera assigned previously to the suborder Helomorina Schrammen 1910. According to Reid (2004), distinguishing the two suborders is justified, as heloclones are barely lithistid in character than megaclones.

Suborder MEGAMORINA Zittel 1878
Family PLEROMATIDAE Sollas 1888
Genus *Homalodora* Schrammen, 1910
Type species: *Spongia ramosa* Mantell 1822

Homalodora plana Schrammen 1910
Figs 38 (M, N), 42, 43 (A)

*1910. *Homalodora plana* nov. sp.: Schrammen, p. 59, pl. 17, figs 3, 4.
1924. *Homalodora plana* Schrammen: Schrammen, p. 159, pl. 6, fig. 9.
v1966. *Homalodora plana* Schrammen: Hurcewicz, p. 93, text-fig. 28; pl. 14, figs 1–5.
1974. *Homalodora plana* Schrammen: Ulbrich, pp. 35–36, pl. 4, fig. 5; pl. 19, fig. 4.

Material and preservation: 25 specimens (1 from Ciszyca Górna, 22 from Piotrawin, 1 from Solec, 1 from Kłudzie). Specimens are crushed and incomplete. Choanosomal skeleton poorly preserved, dermal skeleton lacking.
Comparative material: Collection UL II.
Description: Strongly flattened sponges, shovel-shaped, 45 mm wide and up to 120 mm long (Fig. 42). In most cases, with straight upper margin and triangular or rectangular outline. Rarely margin is convex, with rounded and narrower tip. In some cases, upper

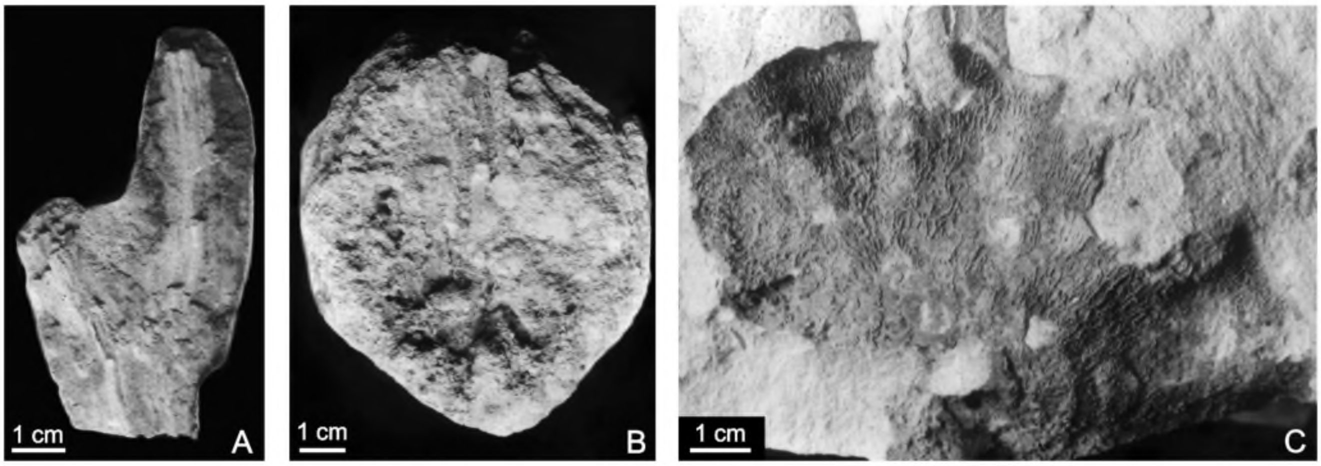

Fig. 43. **A** – *Homalodora plana* Schrammen 1910; lateral view; note longitudinal aporhyses in parts with destroyed surface; Piotrawin, Upper Campanian (UL XX 7/89); **B** – *Homalodora ficus* Schrammen 1910; lateral view; note longitudinal aporhyses in parts with destroyed surface; Piotrawin, Upper Campanian (UL XX 3/21); **C** – *Verruculina tenuis* (Roemer 1841); imprint of lower surface with fragments of limonitized wall; Dziurków, Lower Maastrichtian (UL XX 8/121)

part of body divided into 2 lobes of uneven width; their length may also differ (Fig. 43A). Downwards body passing gradually into long stalk, round in cross-section. Canal openings with very variable diameter (0.5–1.1 mm) randomly distributed on surface; averagely ca. 90–100 openings per 1 cm^2. In some cases, particularly in the lower part, much less openings per unit of area (ca. 40). Epirhyses straight, directed slightly diagonally to sponge base. Beam of parallel aporhyses, 2–3 mm in diameter, passing through entire body including stalk. Towards the top, number of canals gradually increases. Their openings are located in apical part of sponge. In individuals with straight upper margin, openings distributed along the entire margin. Choanosomal skeleton comprising irregularly distributed megaclones, 0.7–0.9 mm thick. Length of megaclones 0.6–0.9 mm, width similar or slightly smaller (0.5–0.7 mm). Strongly elongated megaclones in stalk, reaching up to 1.2 mm, lying linearly (Fig. 38M, N). Longitudinally oriented numerous oxeas occur in skeletal bands between the aporhyses, ca. 0.5–1 mm wide.

Remarks: In comparison to the known representatives of this species, also from the area of Poland, the described individuals have much wider canals, particularly the aporhyses, reaching up to 3 mm. Typically in *H. plana* Schrammen such canals do not exceed 1.5 mm in width.

Occurrence: Poland – Middle Vistula River Valley (Upper Campanian and Lower Maastrichtian), Koniecpol area (Lower Campanian); north-western Germany (Lower and Upper Campanian).

Homalodora ficus Schrammen 1910
Fig. 43 (B)

*1910. *Homalodora* nov. sp.: Schrammen, p. 60, pl. 17, fig. 2.
v1933. *Doryderma (Homalodora) ficus* Schrammen: Bieda, p. 13, pl. 1, figs 1, 2.
v1966. *Homalodora ficus* Schrammen: Hurcewicz, p. 95, pl. 20, figs 2a-b.
1966. *Homalodora pusilla*: Hurcewicz, p. 95, pl. 17, figs 3a-b.
1974. *Homalodora ficus* Schrammen: Ulbrich, p. 36, pl. 4, fig. 7.

Material and preservation: One damaged specimen and one fragment from Piotrawin. Singular choanosomal desmas preserved sporadically.

Comparative material: Collections UL II and A-1-1.

Description: Fig-shaped sponges, 80 mm wide and ca. 95 mm high (Fig. 43B). Trace of thin stalk visible at base. Several longitudinal shallow furrows of variable length run from apical part. Canal openings distributed randomly on entire surface. Dimensions very variable, from 0.4 to 1.5 mm. Epirhyses of similar diameter directed diagonally downwards. Very wide aporhyses (3–4 mm) in form of beam running through entire length of sponge. In narrowing uppermost part of body neighbouring canals fuse, thus their number decreases within apical part. Fine mesh choanosomal skeleton comprising small megaclones (0.5–0.8 mm long).

Remarks: Like in the case of *H. plana* Schrammen, the analysed specimens of *H. ficus* are distinguished by their particularly wide canals. In the known representatives of this species, this width does not exceed 2 mm (see data from synonymy). The individuals of *H. ficus* from Germany represent also smaller forms, whereas the specimens from Poland are generally larger, with the Vistula River Valley specimens being the largest. The specimen assigned by Hurcewicz (1966) to *H. pusilla* Schrammen 1910 belongs also to *H. ficus*. The only specimen of *H. pusilla* described by Schrammen (1910, pp. 60–61, pl. 17, fig. 5) has a distinct depression (ca. 5 mm deep) in the apical part with "postica" of similar diameter as the "ostia" in its bottom. The dimensions of exhalant and inhalant canal openings in the specimen described by Hurcewicz (1966) reveal a strong disproportion, typical of *Homalodora ficus* Schrammen. The depression in the apical part is very shallow. The outline of Hurcewicz's specimen is similar as in the specimen of *Homalodora ficus* described by Bieda (1933), as well as in some examples of this species from the UL collection.

Occurrence: Middle Vistula River Valley (Upper Campanian); Koniecpol area (Lower and Upper Campanian); north-western Germany (Campanian)

Family CARTERELLIDAE Schrammen1901
(= Isoraphiniidae Schrammen 1924)
Genus *Pachycothon* Schrammen 1901
Type species: *Cupulospongia gigantea* Roemer 1864

Pachycothon giganteum (Roemer 1864)
Figs 38 (L), 41 (E)

*1864. *Cupulospongia gigantea* nov. sp.: Roemer, p. 51, pl. 18, fig. 1.

1901. *Pachycothon giganteum* nov. sp.: Schrammen, p. 12, pl. 3, fig. 2; pl. 5, fig. 3.
1910. *Pachycothon giganteum* Roemer.: Schrammen, p. 130, text-pl. 8, fig. 3; pl. 17, fig. 6.
1926. *Pachycothon giganteum* (Roemer): Moret, p. 130, text-fig. 52; pl. 2, fig. 2; pl. 10, fig. 9.
v1933. *Pachycothon giganteum* (Roemer): Bieda, p. 16.
v1966. *Pachycothon giganteum* (Roemer): Hurcewicz, p. 81, text-pl. 25; pl. 22, fig. 1.
1974. *Pachycothon giganteum* (Roemer): Ulbrich, p. 50, pl. 9, fig. 3; pl. 18, fig. 2.

Material and preservation: 4 specimens (1 damaged specimen and 1 fragment from Piotrawin, 2 fragments from greensand from Nasiłów). Surface of specimens, particularly of the internal surface is poorly preserved. Sporadically singular choanosomal desmas are present. Spaces after spicules are very well visible.
Comparative material: Collection UL II.
Description: Sponge in shape of wide and flat funnel, over 200 mm in diameter. Preserved fragment of stalk 70 mm long and 25 mm in diameter, with irregularly distributed longitudinal furrows. Wall thickness 12–15 mm. Canalization within skeleton not developed. Choanosomal skeleton comprising heloclones, 0.1–0.13 mm thick and 1.2–2.4 mm long (Figs 38L, 41E). Heloclones straight, slightly arch-like bent or sinusoidal. Surface smooth or with small and rare protrusions in central part. Desmas with zygomes on their terminations in form of small depressions and protrusions. In lower part of funnel, heloclones more delicate and chaotically distributed, forming a dense, ca. 1 mm thick cover. Desmas larger within wall and most probably also on internal surface. Desmas forming network with large (1–1.5 mm) meshes. Radial concentrations of spicules, comprising several (2–8), more or less parallel heloclones fuse in the network nodes. Desmas linearly arranged longitudinally within stalk.
Remarks: The analysed specimens are identical as *P. giganteum* (Roemer). Hurcewicz (1966) noted that in specimens from the Miechów Basin there are winding canals with diameters smaller than the network meshes. In both specimens from the Cretaceous of the Vistula River Valley, as well as in the material described by Hurcewicz (1966) such canals are not visible.
Occurrence: Poland – Middle Vistula River Valley (Upper Campanian–uppermost Maastrichtian), Koniecpol and Kraków area (Lower Campanian); north-western Germany (Turonian, Santonian and Campanian); France (Senonian).

Order and Suborder INCERTAE SEDIS
Genus *Ophiraphidites* Carter 1876
Type species: *Ophiraphidites tortuosus* Carter 1876

Remarks: Schrammen (1910) assigned genus *Ophiraphidites* Carter to a new family Ophiraphididae, included to Tetraxonia – suborder unknown. It was later distinguished into a separate sub-order Ophirabdophora Schrammen 1924. The same genus was included by Moret (1926) to the suborder Megamorina Zittel. In turn, Lagneau-Hèrenger (1962) placed it among representatives of the new family Monaxophora, representing the sub-order Tetractinellida Marschall. De Laubenfels (1955) recognized the family Ophiraphidae Schrammen and included it to the order Choristida Sollas 1888. According to Lévi (1991), the megascleres composition in modern representatives of the genus *Ophiraphidites* indicates their close connection with the family Pachastrellidae Carter 1875, included to the non-lithistid Demospongia. According to Reid (1968c), the ophirabds, heloclones and mega- clones are homologue spicules and the family Pachastrellidae Carter is the ancestral group for the order Megamorina (Reid, 1970). Lévi (1991) indicated also the presence of Recent forms with megascleres transitional between *Ophiraphidites* Carter and *Costifer* Wilson, which according to him is a modern representative of the family Isoraphiniidae Schrammen 1924, included to the suborder Megamorina. Reid (2004) included sponges with ophirabds to the family Cephaloraphiditidae Reid 1968, order uncertain.

Ophiraphidites infundibuliformis Schrammen 1899

*1899. *Ophiraphidites infundibuliformis* nov. sp.: Schrammen, p. 5, pl. 1, fig. 1; pl. 2, fig. 6.
1910. *Ophiraphidites infundibuliformis* Schrammen: Schrammen, p. 121, text-pl. 7, fig. 5; pl. 14, fig 7.
1926. *Ophiraphidites infundibuliformis* Schrammen: Moret, p. 133, text-fig. 53, pl. 2, fig. 3; pl. 10, figs 7, 13.
1974. *Ophiraphidites infundibuliformis* Schrammen: Ulbrich, p. 49.
1984. *Ophiraphidites infundibuliformis* Schrammen: Moissette *et al.*, p. 591, pl. 1, figs 4, 5; pl. 2, figs 1–3.

Material and preservation: 2 poorly preserved fragments from Piotrawin. Spicules completely dissolved. Casts after choanosomal spicules very well visible.
Description: Cup-shaped sponges with thin stalk. Better preserved part of sponge 60 mm high, stalk 6 mm long. Walls ca. 1.5–3 mm thick. External surface with randomly distributed round canal openings, 0.5–1 mm in diameter, ca. 25–30/cm^2. Canalization comprising straight canals, perpendicular to wall. In lower part of sponge, canals slightly diagonal and longer. Canals visible also in upper part of stalk. Due to poor preservation it is impossible to state if the canals run along the entire stalk. Choanosomal skeleton comprising ophirabds, ca. 1.5–2.5 mm long and very thin 1–2 mm long oxeas. On cross-sections parallel to cup surface, the ophirhabds are distributed densely, more or less concentrically around canals. In external (preserved) parts of stalk, only oxeas are present.
Remarks: Due to poor preservation, dermal spicules or their casts were not observed in the analyzed material. The dimensions of ophirabds are slightly smaller than in specimens from Germany (3.5 mm – Ulbrich, 1974). They are similar to specimens from France (Moret, 1926).
Occurrence: Poland – Middle Vistula River Valley (Upper Campanian); north-western Germany (Lower and Upper Campanian); France (Senonian, Eocene); Algeria (Miocene); northern Carolina (Eocene) – according to Moissette *et al.* (1984).

DISTRIBUTION OF SPONGES IN THE UPPER CAMPANIAN AND MAASTRICHTIAN DEPOSITS OF THE MIDDLE VISTULA RIVER VALLEY

The sponges observed in the exposures are evenly distributed in the particular beds. Lump-shaped sponges, as well as some conical specimens of small sizes or without stalk typically occur in life position. Large cup-shaped sponges in turn generally lie on one side. These specimens may have slightly crushed stalks, however, no sponges completely torn apart from the rhizoidal processes were observed. The radial rhizoidal processes occur in the sediment parallel to bedding. In exceptional cases, in some beds of the Upper Campanian opokas from Piotrawin, the presence of crushed fragments of different specimens, accumulated by currents has been noted. Likewise, thin sections from this exposure reveal also the presence of isolated small skeletal

Lithostratigraphical units / Species	Upper Campanian opokas	Lower Maastrichtian opokas	lower Upper Maastrichtian marls	upper Upper Maastrichtian opokas	uppermost Maastrichtian opokas
Aphrocallistes caliciformis	■				
Coeloptychium seebachi	■				
Callopegma acaule	■				
Verruculina miliaris	■				
Verruculina tenuis	■	■			
Homalodora plana	■	■			
Cyclostigma maeandrina	■	■			
Cyclostigma acinosa	■	■			
Rhizopoterion solidum	■	■			
Leiostracosia punctata	■	■			
Leiostracosia robusta	■	■			
Polyopesia leavis	■	■			
Wollemania araneosa	■	■	■		
Leptophragma murchisoni	■	■	■	■	
Leptophragma micropora	■	■	■	■	
Hapalopegma meandrina	■	■	■	■	
Eubrochis cribrosus		■	■	■	■
Leiostracosia orthogoniopora			■	■	■
Aphrocallistes vistulae				■	■
Varioporospongia dariae				■	■
Phymatella bulbosa					■
Turonia variablis	■	■	?	■	■
Aphrocallistes alveolites	■	■	■	■	■
Aphrocallistes cylindrodactylus	■	■	■	■	■
Pararete formosum	■	■	■	■	■
Pleurostoma dichotoma	■	■	■	■	■
Sporadoscinia decheni	■	■	■	■	■
Rhizopoterion cribrosus	■	■	■	■	■

Fig. 44. Occurrence of the selected sponges species in the Upper Campanian and Maastrichtian deposits from the Middle Vistula River Valley; rare species, known only from single examples (less than 5), were omitted

fragments of Hexactinosida and Lychniscosida. In the remaining beds of opokas and marls as well as in the limestone capping the Cretaceous succession, the sponges do not display any damage apart from deformations caused by compaction.

The taxonomic composition in particular parts of the succession is variable (Figs 44–46). The sponge assemblage from the oldest part of the analysed succession, *i.e.* in Upper Campanian opokas (Ciszyca Kolonia, Ciszyca Górna, Piotrawin) shows the highest taxonomic diversity. It contains 34 species, including 14 Hexactinosida, 10 Lychniscosida and 10 lithistids. Numerous are sponges of the species *Leptophragma murchisoni* (Goldfuss) and *Leptophragma micropora* Schrammen with wide cups on a short stalk or without stalk. *Aphrocallistes cylindrodactylus* Schrammen, represented mainly by forms with short branches, is also common. *Rhizopoterion cribrosus* (Phillips), *Rhizopoterion solidum* Schrammen, *Leiostracosia punctata* Schrammen, *Leiostracosia robusta* (Schrammen), *Cyclostigma acinosa* (Schrammen), *Cyclostigma meandrina* Schrammen, *Wollemania araneosa* Schrammen and *Polyopesia leavis* (Schrammen) are rather common. None of the mentioned species dominates over the others. A characteristic species, not occurring higher in the succession is *Coeloptychium seebachi* Zittel. Lithistids, despite relatively high species diversity, are not abundant. The most common are *Homalodora plana* Schrammen, *Verruculina milliaris* (Reuss) and *Verruculina tenuis* (Roemer). Only in the uppermost Campanian sediments (the last 5–6 m of the succession) *Callopegma acaule* Zittel is common.

Many specimens from the Upper Campanian deposits have additional basal processes. They appear on the lowermost branches in sponges of the genus *Aphrocallistes*. In representatives of *Polyopesia leavis* (Schrammen), *Callopegma acaule* Zittel and *Pachycothon giganteum* (Roemer) basal processes occur in higher parts of the sponge, which indicates partial burial during the growth of the animal.

Opokas of the Lower Maastrichtian (Dziurków, Solec, Kłudzie) contain 23 species, including 11 Hexactinosida, 7 Lychniscosida and 5 lithistids. Like in the Campanian strata, there are no dominating taxa. *Rhizopoterion cribrosus* (Phillips), *Aphrocallistes cylindrodactylus* Schrammen, *Eurete formosum* Reid, *Leiostracosia punctata* Schrammen, *Leiostracosia robusta* (Schrammen), as well as *Leptophragma murchisoni* (Goldfuss) and *Leptophragma micropora* Schrammen belong to numerously represented species. Common species not noted in the higher part of the succession is *Rhizopoterion solidum* Schrammen. The Lower Maastrichtian deposits are the oldest strata in the succession in which single specimens of *Eubrochis cribrosus* (Reid) occur. Compared to the Upper Campanian deposits, lithistids are much less common. The most numerous are *Aulaxinia sulcifera* (Roemer), *Plinthosella squamosa* Zittela and *Homalodora plana* Schrammen.

Marls of the lower Upper Maastrichtian (Dobre, Podgórz, Męćmierz) contain only 12 species of sponges (10 Hexactinosida and 2 Lychniscosida). However, this number is evidently lowered due to the very small abundance of specimens collected in all marl exposures. The most commonly observed species are *Leptophragma murchisoni* (Goldfuss), *Leptophragma micropora* Schrammen and *Rhizopoterion cribrosus* (Phillips). In the analysed succession of the Middle Vistula River Valley, these strata contain *Wollemania araneosa* Schrammen for the last time, and *Leiostracosia orthogoniopora* (Defretin-Lefranc) for the first time.

In the lower part of the Upper Maastrichtian opokas (Kazimierz, Janowiec), sponges are very common. This interval contains *Aphrocallistes vistulae* Hurcewicz, *Cyclostigma lobata* Schrammen, *Varioporospongia dariae* sp. nov. and *Sporadoscina alcynoides* (Mantell). *Rhizopoterion cribrosus* (Phillips), *Leiostracosia orthogoniopora* (Defretin-Lefranc), *Eurete formosum* Reid and *Pleurostoma dichotoma* (Schrammen) belong to numerously represented species. In comparison with the lower part of the analysed section, *Leptophragma murchisoni* (Goldfuss) and *Leptophragma micropora* Schrammen are less common, have narrower cone-shaped forms and more massive stalks than in older strata. Lithistids are represented by only one, however rather abundant species *Turonia variabilis* Michelin. A total of 18 species, including 10 Hexactinosida, 7 Lychniscosida and 1 lithistid has been noted from this interval. On some sponges from the lower part of the Upper Maastrichtian opokas there occur bryozoans from the genus *Onychocella* Julien (see Ziegler, 1964; Maryańska, 1969) and the bivalve *Dimiodon nilssoni* (Hagenov) (see Jelinowska, 1985). These organisms typically occur on the internal side of wide cups and are partly overgrown by the sponge skeleton.

In the upper part of the opokas representing the uppermost Maastrichtian (Nasiłów, Bochotnica) the sponges are extremely abundant, and their number increases towards the top. The sponge fauna shows, however, a rather low taxonomic diversity. A total of 14 species, including 6 Hexactinosida, 6 Lychniscosida and 2 Tetracaldina have been noted. The decreased taxonomic diversity is connected with the absence of thin-walled species such as *Leptophragma murchisoni* (Goldfuss), *Leptophragma micropora* Schrammen and *Hapalopegma meandrina* Schrammen. *Rhizopoterion cribrosus* (Phillips) is clearly dominant. Additionally, *Sporadoscinia decheni* (Goldfuss), *Aphrocallsites cylindrodactylus* Schrammen, *Aphrocallistes alveolites* (Roemer), *Eubrochis cribrosus* (Reid), *Pleurostoma dichotoma* (Schrammen) and *Eurete formosum* Reid occur commonly. The Tetracladina, apart from the species *Turonia variabilis* Michelin, are represented by *Phymatella bulbosa* Zittel.

In the uppermost part of the Upper Maastrichtian opokas, representatives of Ventriculitidae such as *Rhizopoterion cribrosus* (Phillips), *Leiostracosia orthogoniopora* (Defretin-Lefranc), *Sporadoscinia decheni* (Goldfuss) and *Sporadoscinia alcynoides* (Mantell) typically have narrower cups in comparison to specimens from the lower part of the succession. The skeleton is also more massive in these forms, what is manifested by more intensive development of a secondary network on the wall surfaces. A more compact form is observed in specimens representing *Pleurostoma dichotoma* (Schrammen) and *Aphrocallistes cylindrodactylus* Schrammen.

The presence of numerous phosphatized fragments of sponges has been noted also in Danian glauconitic sandstones (Nasiłów, Bochotnica). A total of 26 sponge species, typical for the Upper Cretaceous assemblages, has been recognized. Based on the analysis of material filling the bodily preserved sponges two various-aged taphonomical groups of fossils have been distinguished (Świerczewska-Gładysz, 2000; Świerczewska-Gładysz & Olszewska-Nejbert, 2006). The first older group of sponges lived during sedimentations of siliceous chalk similar to the Maastrichtian deposits exposed in Nasiłów and Bochotnica. It contains all species known from the upper part of the Upper Maastrichtian and one lithistid species – *Phyllodermia antiqua* (Schrammen). These species, apart of *Aphrocallistes vistulae* Hurcewicz, *Sporadoscinia alcynoides* (Mantell) and *Varioporospongia dariae* sp. nov., also occur in the second sponge group, filled with opoka enriched in glauconite. The second younger group contains sponge species which do not occur in the Upper Maastrichtian opokas. They include 3 species of Lychniscosida *i.e. Cyclostigma acinosa* (Schrammen), *Cyclostigma maeandrina* Schrammen and *Brachiolithes* cf. *centunculus* (Schrammen) as well as 8 species of lithistids such as (*Siphonia tubulosa* (Roemer), *Colossolacis plicata* Schrammen, *Ragadinia rimosa* (Roemer), *Jerea* sp., *Acrochordonia ramosa* Schrammen, *Pachycothon giganteum* (Roemer), *Verruculina miliaris* (Reuss) and *Seliscothon* sp.

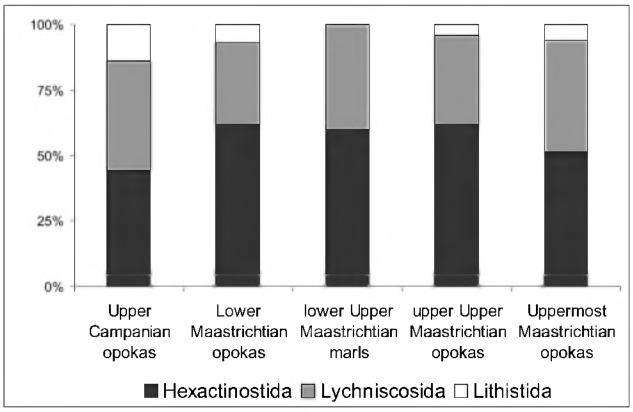

Fig. 45. Composition of sponge assemblages in the Upper Campanian and Maastrichtian deposits from the Middle Vistula River Valley

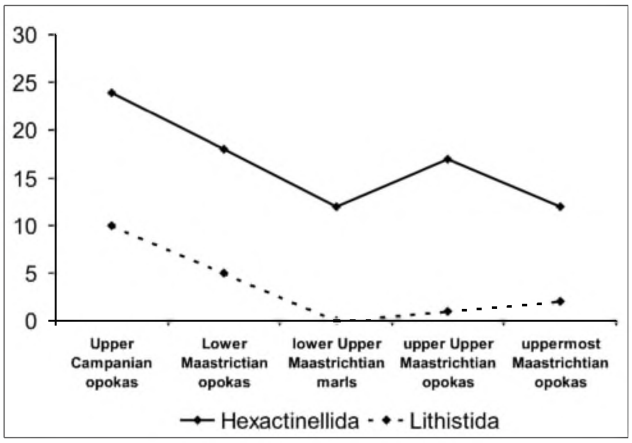

Fig. 46. Species diversity changes of lithistid and hexactinnellid sponges in the Upper Campanian and Maastrichtian deposits from the Middle Vistula River Valley

COMPARISON OF THE STUDIED SPONGE ASSEMBLAGE WITH OTHER LATE CRETACEOUS SPONGE FAUNAS

Sponge species occurring in the Middle Vistula River section are generally typical for the sponge assemblages known from the upper stages of the Upper Cretaceous in Western Europe. Some of the analysed species show a wider stratigraphic extent, including the lower stages of the Upper Cretaceous, and in rare cases also some stages of the Lower Cretaceous in Spain and France. Only *Ophiraphidites infundibuliformis* Schrammen has been noted from younger deposits, which apart from the Upper Cretaceous localities in Germany and France has been found also in the Palaeogene and Neogene of France, Algeria and northern Carolina (*vide* Moissette *et al.*, 1984).

The detailed recognition of the stratigraphic and palaeogeographic ranges of the studied species poses problems linked with the rather small number of localities with the Late Cretaceous sponge fauna, as well as imprecise age determinations of some fossils pointing to the Senonian.

All the lithistids species described in this paper have been also recognised in Germany. They are particularly common in the Campanian of Lower Saxony (Zittel, 1878; Roemer, 1864; Griepenkerl, 1889; Schrammen, 1910, 1924) and the Sub-Hercynian Basin (Ulbrich, 1974). Moreover, *Callopegma acaule* Zittel and *Aulaxinia sulcifera* (Roemer) have been noted from the Lower Maastrichtian chalk deposits from Rügen (Nestler, 1961). Ten of the analysed species occur in the Coniacian-Campanian rocks of France (*cf* Moret, 1926; Hèrenger, 1946; Lagneau-Hèrenger, 1951, 1962). Some of them have also been noted in the Upper Cretaceous of England (*cf* Hinde, 1883; Oakley, 1937).

Likewise, most of the analysed species representing Hexactinosida and Lychniscosida are characteristic for sponge fauna of Western Europe, particularly from the carbonate deposits of the Campanian of north-western Germany (Zittel, 1876, 1877; Goldfuss, 1826-33; Roemer, 1841, 1864; Schrammen, 1902, 1912; Ulbrich, 1974; Mehl, 1992) and Coniacian-Maastrichtian of England (Smith, 1848; Hinde, 1883; Reid, 1957, 1959, 1961a, 1961b, 1962c, 1968a). Species known from these two areas include *Rhizopoterion cribrosus* (Phillips), *Rhizopoterion solidum* Schrammen, *Lepidospongia rugosa* Schlüter and *Leiostracosia robusta* (Schrammen). Some of them have been also described from the Maastrichtian of Rügen (Nestler, 1960) and from the upper Upper Cretaceous of Ireland (Reid, 1968a) and France (Moret, 1926; Defretin-Lefranc, 1960; Lagneau-Hèrenger, 1942, 1962).

Rare species from the Upper Cretaceous of Western Europe, hitherto known only from single specimens, include *Leiostracosia orthogoniopora* (Defretin-Lefranc) described from France, *Hapalopegma meandrina* Schrammen from Lower Saxony, and *Eubrochis cribrosus* (Reid) from England. Till present, rare specimens of the species *Eurete formosum* Reid have been found only in England. My investigations have shown that the restricted palaeogeographic distribution of these species has been caused by the insufficient recognition of the sponge fauna from Central and Eastern Europe.

Very few species of Lychniscosida and Hexactinosida have been described from the Upper Cretaceous stages of Eastern Europe (Sinzov, 1871–72, 1878; Kravtsov, 1968; Khmilevsky, 1974, 1977, 1978, 1979; Pervushov, 1992). Furthermore, most of them have been considered to represent new taxa, what would suggest large faunal distinctness of the eastern and south-eastern part of the Late Cretaceous basin. From the rarely occurring species known also from Western Europe, the most common is *Aphrocallistes alveolites* (Roemer), also found in the upper Upper Cretaceous of Volgograd region, Ulyanovsk region, southern Donbas and western Podilia (Khmilevsky, 1974). *Aphrocallistes cylindrodactylus* Schrammen, *Leptophragma murchisoni* (Goldfuss) and *Pleurostoma scyphus* Počta are also known from the latter area (Khmilevsky, 1974; 1977). Moreover, the Lviv Basin is the only region besides Poland where *Aphrocallistes vistulae* Hurcewicz occurs (Khmilevsky, 1974).

Analysis of the comparative collection of sponges from the Ukraine and Russia has enabled to point out within the Late Cretaceous sponge fauna of Eastern Europe also other species known from the Middle Vistula River Valley and Western Europe. In Donbas and north Ukraine, *Pleurostoma dichotoma* (Schrammen), *Rhizopoterion cribrosus* (Phillips) and *Rhizopoterion solidum* Schrammen occur. In the Campanian and Maastrichtian of Donbas the presence of *Leptophragma micropora* Schrammen, *Eubrochis cribrosus* (Reid), *Wollemania araneosa* Schrammen and *Hapalopegma meandrina* Schrammen has also been documented.

Literature studies of earlier sponges' descriptions from Eastern Europe show that the cosmopolitan species *Tremabolites megastoma* (Roemer) occurs also within the phosphatised specimens from the Santonian in the vicinity of Saratov. The numerous occurrence of *Leiostracosia orthogoniopora* (Defretin-Lefranc) in Maastrichtian deposits points out the similarities of sponge assemblages of the Ukraine and Middle Vistula River Valley. Due to the lack of data on the representatives of the lithistids in the Campanian and Maastrichtian of Eastern Europe it is not possible to compare the studied collection with sponges from that area.

The wide palaeogeographic distribution of many species indicates the good connection between particular parts of the Central European Basin in the Late Cretaceous. Undoubtedly, due to the rather central position of the studied area in this basin, the occurring assemblage was transitional in character between the Campanian and Maastrichtian fauna of Western and Eastern Europe.

PALAEOECOLOGICAL INTERPRETATION OF THE STUDED SPONGE ASSEMBLAGE

The sponge assemblage from the Upper Campanian and Maastrichtian strata of the Middle Vistula River Valley is dominated by representatives of the Hexactinosida and Lychniscosida (Fig. 45). Changes in the taxonomic composition observed in consecutive strata of the section are gradual (Fig. 44), like in the case of other organisms, particularly molluscs (see Pożaryski, 1938).

The pattern of taxonomic distribution of sponges in the studied succession does not correspond to their evolution. This is indicated by the fact that some species observed in the Upper Campanian opokas such as *Cyclostigma acinosa* (Schrammen), *Cyclostigma maeandrina* Schrammen, *Pachycothon giganteum* (Roemer), *Verruculina miliaris* (Reuss) appear once again in the succession among the phosphatized sponges redepositing from the uppermost Maastrichtian sediments (Świerczewska-Gładysz, 2000; Świerczewska-Gładysz & Olszewska-Nejbert, 2006). *Callopegma acaule* Zittel, occurring in the study area only in Upper Campanian strata, has also been noted from the Lower Maastrichtian of Rügen (Nestler, 1961).

The diversity of the Hexactinellida species decreases in younger strata (Fig. 46). However, such species as *Rhizoporterion cribrosus* (Phillips), *Sporadoscinia decheni* (Goldfuss), *Aphrocallistes cylindrodactylus* Schrammen, *Aphrocallistes alveolites* (Roemer), *Eurete formosum* Reid and *Pleurostoma dichotoma* (Schrammen) were still quite abundant. These species, except *Eurete formosum* Reid, were cosmopolitan forms in the Central European Basin (see systematic descriptions) and they probably tolerated a relatively wide range of environmental parameters. Moreover, the present-day representatives of *Aphrocallistes* Gray and *Eurete* Semper belong to forms appearing also in shallower seas (Schulze, 1899; Ijima, 1927; Austin, 2003; Freese & Wing, 2003), unfavourable for most Recent representatives of the Hexactinosida. Therefore, it seems likely that the observed changes in taxonomic composition of sponges is a result of gradual environmental changes and in the latest Cretaceous the conditions were less favourable for hexactinellid sponges.

The growth of the Hexactinellida may be hampered by different factors, such as higher sedimentation rate, low nutrient content, increase of turbulence, higher temperature of water and basin shallowing (Pisera, 1997; Krautter, 1997, 1998; Duarte *et al.*, 2001; Bell & Barnes, 2003).

The increasing content of glauconite in the Upper Maastrichtian opokas (Pożaryska, 1952) points to low sedimentation rate by the end of the Cretaceous. This condition was favouring the development of hexactinellid sponges (Duarte *et al.*, 2001; Leys *et al.* 2004). Moreover, most probably low sedimentation rate caused small sediment's condensation and accumulation of fossils in the upper part of the uppermost Maastrichtian opokas. Even if we assume that the number of specimens in these deposits is overestimated in comparison to the lower part of the succession, it remains unquestionable that by the end of the Maastrichtian the conditions had been favourable for the development of some of the mentioned sponge species. Modern Hexactinellida are characterised by a very low growth rate (Leys & Lauzon, 1998; Gutt *et al.*, 2003). Large dimensions of representatives of some species observed among the analysed sponges may indicate that they developed in very favourable conditions and could reach a late individual age. In this case, the stress caused by insufficient nutrient supply should not be taken into account, because this factor would have influenced the entire sponge population. The increase of turbulence would also have been catastrophic for all species of the Hexactinellida, which are indicator of low energy water environments (Pisera, 1997; Krautter, 1997, 1998; Duarte *et al.*, 2001; Bell & Barnes, 2003). Sponges representing this group were well adapted to passive filtration, and often have a thin wall covering a large surface (Krautter, 1998). This morphology excludes their occurrence in high-energy environments. It seems thus likely that decrease of species number in the succession resulted from gradual shallowing of the basin (see also Pożaryski, 1960; Abdel-Gawad, 1986; Hakenberg & Świdrowska, 2001). Its depth during the Campanian and Maastrichtian remains, however, an open question.

Depending on the established criterion, the depth of the entire Middle European Basin in the Late Cretaceous is estimated from several tens to several hundreds of meters (*vide* Scholle, 1974; Hancock, 1975; Zijlstra, 1995). Based on the analysis of deposits, fauna and flora, and palaeogoegraphic assumptions, it is commonly accepted in the range of 100–600 m (Hancock, 1975) or between 50 m and 200–300 m (Scholle, 1974; Hăkansson *et al.*, 1974; Kennedy & Garrison, 1975). Bathymetric interpretations of particular basins, apart from sedimentological data, are based on fossils, including sponges (see Defretin-Lefranc, 1960; Nestler, 1961; Reid, 1962a, 1968b; Wagner, 1963; Ulbrich, 1974, Gasse *et al.*, 1991; Termier & Termier, 1981). The application of fossil sponges in determining basin bathymetry meets, however, many problems. The distribution of sponges is not only controlled by bathymetry but depends on many factors, usually related to each other. Beside the parameters mentioned earlier, the development of sponges depends also on the type of substrate, available space, space competition, water temperature and chemistry and the reproduction rate (Krautter, 1997, 1998; Bell & Barnes, 2003). Moreover, sponge groups common in the Late Cretaceous, at present show lower taxonomic diversity, which restricts the comparison of the analysed fauna with modern taxa. This particularly applies to the Lychniscosida, which at present are represented only by two genera (Mehl, 1992). Representatives of this group are known solely from tropical seas; from depths down to about 500 m (see Bowerbank, 1869; Ijima, 1927; Soest & Stentoft, 1988). According to Defretin-Lefranc (1960), fossil Lychniscosida are typical for deeper facies than the Hexactinosida. This pattern does not find confirmation in the case of fossil sponge assemblages from other exposures (Wagner, 1963; Ulbrich, 1974), including those from the Upper Cretaceous of the Middle Vistula Valley. The presence of similar amount of Lychniscosida and Hexactinosida (Fig. 45) indicates similar ecological requirements of these groups.

Most present species of the Hexactinosida occur generally at 200–600 m (Schulze, 1887; Ijima, 1927; Schmidt, 1870; Vacelet, 1969; Messing *et al.*, 1990; Conway, 2000; Conway *et al.*, 2000; Conway *et al.*, 2001, Krautter *et al.*, 2001, Leys *et al.* 2004).). Some of them have been noted also at large depths down to several hundreds of meters (Tabachnick, 1988). Sporadically, *i.e.* near Barbados (Soest & Stentoft, 1988) as well as within the prodelta of the Fraser River in British Columbia (Conway *et al.*, 2004), these sponges may concentrate at shallower depths, however not shallower than ca. 140–150 m. Very few taxa of the Hexactinellida, among which the Hexactinosida are extremely rare, live in shallow regions of the Arctic and Antarctic (Koltun, 1967, 1970). An extremely shallow-water (below 20 m) occurrence of the Hexactinosida has been observed near Indonesia (Ijima, 1927). In turn, hexactinellid sponges have been noted at 15–35 m, in some cases even at 5 m, in the fiords of British Columbia (Austin, 2003, Leys *et al.* 2004). The development of Hexactinellida in shallow waters is possible only in specific conditions. Most probably the key role is played here by the continuous influx of water from deeper parts of the basin (Austin, 2003). Only some species (see Reid, 1968b), including the representatives of *Aphrocallistes* Gray, *Eurete* Ijima and *Eurete* Semper tolerate small depths. It should be note, however, that these sponges are noted mainly in deeper waters (Lévi & Lévi, 1989; Templado *et al.*, 1993; Krautter *et al.*, 2001; Conway *et al.*, 2004) down to the abyssal zone (Schulze, 1887; Ijima, 1927; Okada, 1932; Launbenfels, 1932; Koltun, 1967; Reiswig 2002). Generally, the highest taxonomic diversity of the Hexactinosida is just above 200 m (Schulze, 1887; Ijima, 1927). Below that, the number of species decreases, and at the depth above 80 m these sponges occur only sporadically.

Using sponges as bathymetric indicators, the depth of the particular basins of Western Europe during the Late Cretaceous most commonly oscillate between 100 and 350 m (Defretin-Lefranc, 1960; Nestler, 1961; Reid, 1962a, 1968b; Wagner, 1963; Ulbrich, 1974; Gasse *et al.*, 1991; Termier & Termier, 1981). These values are relatively high for a shelf sea, but rather low in comparison to the present-day occurrence of Hexactinosida and Lychniscosida. Therefore, the presence of present-day Hexactinellida in the bathyal and abyssal zones is sometimes considered an effect of migration of these sponges from shallow to deeper zones of sea (Nestler, 1961). This hypothesis lacks, however, evidence (Pisera, 1997). Both the morphology and life functions of the Hexactinellida are adapted to deep-water conditions (Tabachnick, 1991). One of the main factors restricting the range of the Hexactinellida is the nourishing with colloidal nutrients (Reiswig, 1990), prevailing in the oligotrophic, deeper parts of the basin.

Based on the domination of Hexactinosida and Lychniscosida in the assemblage, Reid (1968b) determined the depth of the Late Cretaceous sea in England at 100–250 m. Due to significant analogies in the composition of the analysed fauna with assemblages described from England and Ireland (see Reid, 1968a) and the presence of numerous benthic fauna in the Middle Vistula River section, typical of a shelf basin, it is justified to narrow the depth of the basin to values suggested by Reid (1968b), accepting the maximal sea depth for the Late Campanian (200–250 m) and the minimal – for the latest Maastrichtian (about 100 m). The proposed bathymetric data are not inconsistent with the preferences of lithistids, which represent a marginal group in the analysed assemblage. Present-day lithistids live mainly in shallower zones (Sollas, 1888; Vacelet & Vasseur, 1977; Lévi & Lévi, 1989; Soest, 1990; Ja Sim, 1990; Lévi, 1991); they may, however, occur also in deeper conditions (see Vacelet, 1969; van Soest & Stentoft, 1988; Lévi & Lévi, 1988; Messing *et al.*, 1990; Lévi, 1991; Krautter, 1997; Kelly 2000, 2002; Schlacher-Hoenlinger *et al.*, 2005).

Due to scarce information about sponge fauna from the Upper Maastrichtian marls it is not clear what was the basin depth during their deposition. The mass occurrence of very thin-walled species of the genus *Leptophragma* Zittel in these marls may be connected with periodical sea deepening at the beginning of the Late Maastrichtian (see Pożaryski, 1960; Hakenberg & Świdrowska, 2001).

Observations of the basal elements of studied sponges indicate that they lived on soft ground. Most of Hexactinellida possess well-developed basal processes, anchoring the sponges in silty sediment. The present-day representatives of this group, although preferring clayey bottom, but may also occur on solid ground (Messing *et al.*, 1990), especially the representatives of Hexactinosida (Tabachnick, 1991). Such basiphytal Hexactinosida have been described from Cretaceous hardground horizons (Reid, 1962b). Among the analysed sponges, an incrusting basal plate has been observed only in two species (*Eurete formosum* Reid and *Cyclostigma lobata* Schrammen), however, it is always attached to skeletal fragments of other sponges. Such type of settling is typical of basiphytal species living in basins with silty bottom (Koltun, 1967; Tabachnick, 1988; Conway *et al.*, 2000). The present-day representatives of lithistids colonise mainly rocky substrate (Vacelet & Vasseur, 1977; Lévi, 1991; Messing *et al.*, 1990). However, basal protrusions have been observed in some species of lithistids occurring in the succession, including representatives of *Turonia variabilis* Michelin from the topmost part of the Upper Maastrichtian opokas. Their shape resembles the rhizoidal processes of the Hexactinellida and undoubtedly they played the same role. This fact points to the adaptation of these sponges to life on soft sediment.

DISCUSSION

The presented interpretation pointing to a gradual sea shallowing by the end of the Cretaceous is consistent with the conclusions of Abdel-Gawad (1986), based on the analysis of gastropods and bivalves co-occurring with the sponges. According to the author, the suggested depth of 100–150 m (particularly the higher value) for the interval encompassing the Late Campanian to the early Late Maastrichtian is acceptable in terms of ecological requirements of sponges. There is, however, a discrepancy in the estimated depths of the basin at the end of the Cretaceous. The presence of diversified Hexactinellida at an extremely low number of lithistid species in the Upper Maastrichtian opokas, is in contradiction with the depths between 20 and 80 m suggested by Abdel-Gawad (1986) for that interval. The sponge assemblage living at such depths could contain single Hexactinellida; these, however, belonged rather to the lithistids, which is observed not only in present-day sponge assemblages, but also in fossil assemblages from shallow-water facies of the Upper Cretaceous (Defretin-Lefranc, 1960; Wagner, 1963; Reid, 1962a, 1962b; Ulbrich, 1974). Small depths (20–80 m) also do not find sedimentological confirmation. Opokas are considered in the Vistula section to represent sediments deposited in the deepest part of the basin (Hakenberg & Świdrowska, 2001). There are also no crushed fossils and traces of wave action and storm washouts in beds of opoka from the uppermost Maastrichtian. The sponges are preserved in life positions or lie on one side, without signs of transport. These features differ the Upper Maastrichtian opokas of the Vistula River section from the contemporary shallow-water facies from Denmark and the Netherlands (see Zijlstra, 1995; Molenaar & Zijlstra, 1997). The sea bottom during the sedimentation of the opokas must have been below the storm wave base. The mass occurrence Hexactinellida indicates depths around 100 m, but not less than 80 m.

According to Abdel-Gawad (1986), the stage of maximum shallowing of the basin (0–10 m) happened during sedimentation of limestone, ending the Cretaceous succession in the study section. The suggested conditions assumed high turbulence, the negative influence of which on the development of Hexactinellida has already been discussed. The preservation state as well as the taxonomic composition of sponges in the limestone is identical as in the underlying opokas. The deposition of the Maastrichtian opokas was terminated by an erosional stage, which caused the washing out of the topmost part of these deposits. This is evidenced by sponge specimens filled with a deposit identical with the Upper Maastrichtian opoka occurring in the glauconitic sandstone (Świerczewska-Gładysz, 2000; Świerczewska-Gładysz & Olszewska-Nejbert, 2006). Among specimens redeposited to the glauconitic sandstone, there occur sponges which can be linked with the entirely removed opoka containing a higher content of glauconite. Most probably this glauconitic opoka corresponds to the Żyrzyn Beds, the youngest Upper Cretaceous deposits recognised in the Lublin Basin (see Pożaryska, 1965). The Żyrzyn Beds are completely eroded in the studied profile (Hansen *et al.* 1989; Machalski, 1998; Świerczewska-Gładysz, 2000; Świerczewska-Gładysz & Olszewska-Nejbert, 2006).

The recognition of the bathymetric conditions during the sedimentation of rich in glauconite, carbonate facies is problematic. The rather high number of lithistid species may indicate progressing shallowing. However, the proportions between the Hexactinellida and lithistids, crucial for environment interpretation, are difficult to determine. Due to complete removal of these beds it is not apparent if all sponges co-occurred in the same horizons or if they developed throughout the entire sedimentation of these deposits. Some analogies in the taxonomic composition of the sponge assemblages with the sponge fauna of the Upper Campanian are also not clear. Beside the high taxonomic variability unknown from other intervals of the analysed succession, the two assemblages share four species. The presence of *Verruculina miliaris* (Reuss) and *Pachycothon giganteum* (Roemer) is restricted solely to these assemblages, whereas single specimens of *Cyclostigma acinosa* (Schrammen) and *Cyclostigma maeandrina* Schrammen have also been noted in the Lower Maastrichtian. The earlier discussion points out that the bathymetry during the development of these assemblages must have been different. The only feature common for the two environments is the periodically more intense action of sea currents which could have been favourable for the development of these sponge species. Water currents are the important factor influencing the regional distribution of the present-day sponges (Krautter, 1998).

The presented data indicate that changes in sponge assemblages observed in the succession of the Upper Campanian and Maastrichtian strata were linked with gradual shallowing of basin which is consistent with all-world regression towards the Cretaceous close (Hancock, 1975; Hancock & Kaufman, 1979; Hancock, 1989). By the end of the Maastrichtian and in the early Danian, more intense current action must have caused washing out of the topmost Cretaceous deposits and sponge exhumation (Świerczewska-Gładysz, 2000; Świerczewska-Gładysz & Olszewska-Nejbert, 2006). Shallow-water, high-energy conditions in the Danian prevented further development of hexactinellid sponges. They were replaced by the lithistids, what is evidenced by abundant desmas in siwak deposits (Pożaryska, 1952).

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Streszczenie

PÓŹNOKREDOWE GĄBKI KRZEMIONKOWE Z DOLINY ŚRODKOWEJ WISŁY (POLSKA CENTRALNA) I ICH ZNACZENIE PALEOEKOLOGICZNE

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W opokach i marglach górnego kampanu i mastrychtu w profilu doliny środkowej Wisły (Fig. 1, 2) gąbki o szkielecie krzemionkowym należą do najliczniej spotykanych skamieniałości. W skałach tych występują one masowo *in situ*, co jest rzadkością w przypadku gąbek z górnej kredy z obszaru Polski. Jest to również jedyny znany rejon występowania gąbek późnomastrychckich w Polsce.

Zły stan zachowania okazów, typowy dla gąbek z facji opok górnokredowych spowodował, że w opracowaniu taksonomicznym zastosowano różnorodne, w tym także nowe w przypadku gąbek, metody badawcze. W opisach niektórych okazów wykorzystano serie zdjęć warstwowych, które wykonano techniką rentgenowskiej tomografii komputerowej. Budowa szkieletów gąbek została, między innymi, opracowana na podstawie igieł wypreparowanych przez nadtrawianie okazów słabo stężonym kwasem fluorowodorowym, jak również w oparciu o araldytowe odlewy pustek po rozpuszczonych igłach.

W części systematycznej, na podstawie własnej kolekcji liczącej około 1750 okazów, opisano 51 gatunków, w tym 18 z podrzędu Hexactinosida (Fig. 3–17), 15 z podrzędu Lychniscosida (Fig. 18–36) oraz 18 z gromady Demospongea (Fig. 37–43). Zaproponowano dwa nowe gatunki: *Aphrocallistes caliciformis* sp. nov. (Fig. 15 A–C) oraz *Varioporospongia dariae* sp. nov. (Fig. 30 A–F, 31). Drugi z wymienionych gatunków został zaliczony do nowego rodzaju *Varioporospongia*, który włączono do rodziny Ventriculitidae Smith. Przeprowadzono również rewizję taksonomiczną archiwalnych kolekcji gąbek (por. Hurcewicz, 1966, 1968), pochodzących z tych samych warstw profilu górnego

kampanu i mastrychtu doliny środkowej Wisły. Spośród 5 nowych gatunków Hexactinosida i Lychniscosida zaproponowanych przez Hurcewicz (1968) tylko jeden gatunek *Aphrocallistes vistulae* Hurcewicz wydaje się być nowym taksonem. Pozostałe 4 zostały uznane za młodsze synonimy *Aphrocallistes cylindrodacylus* Schrammen i *Rhizopoterion cribrosus* (Phillips). Kolejnych 8 gatunków Hexactinellida opisanych przez Hurcewicz (1968) zaliczono do 5 gatunków, wśród których tylko jeden, *Aphrocallistes alveolites* (Roemer), okazał się zgodny z poprzednim oznaczeniem.

W badanym zespole stwierdzono 27 gatunków Hexactinellida, które nie były dotąd notowane na terenie Polski. Wszystkie wyróżnione gatunki Lithistida, za wyjątkiem *Colossolacis plicata* Schrammen, były natomiast wcześniej opisane z kampanu okolic Krakowa i Miechowa (por. Bieda, 1933; Hurcewicz, 1966, 1968). Z profilu Wisły znany był dotąd tylko jeden z nich, *Turonia variabilis* Michellin.

Badania porównawcze kolekcji gąbek z terenu byłego ZSRR oraz dane z literatury pozwoliły na stwierdzenie 13 gatunków wspólnych dla badanego terenu i obszaru wschodniej Europy. Większość z nich została odnotowana na terenie Ukrainy i Rosji po raz pierwszy. Za wyjątkiem gatunku *Aphrocallistes vistulosa* Hurcewicz, znanego wyłącznie z profilu doliny środkowej Wisły i Ukrainy, pozostałe występują również w górnej kredzie zachodniej Europy. Jednakże niektóre z nich (*Leiostracosia orthogoniopora* (Defretin-Lefranc, *Hapalopegma meandrina* Schrammen, *Eubrochis cribrosus* (Reid)) w tej części Europy są gatunkami rzadkimi, znanymi jedynie na podstawie pojedynczych egzemplarzy.

Szeroki zasięg paleogeograficzny powyższych gatunków wskazuje na dobre połączenie poszczególnych akwenów europejskiego morza epikontynentalnego podczas późnej kredy. Z racji centralnego położenia basenu lubelskiego w tym zbiorniku, skład gatunkowy badanego zespołu z profilu środkowej Wisły ma charakter przejściowy między fauną gąbkową z osadów kredy zachodniej i wschodniej Europy.

Stopniowo malejące ku górze badanego profilu zróżnicowanie gatunkowe Hexactinosida i Lychniscosida (Fig. 44) wskazuje na powolne spłycenie zbiornika, co jest zgodne z ogólnoświatową regresją u schyłku kredy. Powszechna w całym profilu dominacja gatunkowa a także liczebna przedstawicieli Hexactinellida (Fig. 45, 46) pozwala przyjąć maksymalną głębokość zbiornika w późnym kampanie na około 200–250 m. Minimalna głębokość zbiornika w czasie sedymentacji opok najwyższego mastrychtu wynosiła około 100 m.