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The topmost Cretaceous disciniscan brachiopods, *Discinisca* (*Arquinisca* subgen.n.) *vistulae* sp.n., from the Middle Vistula Valley, Central Poland

ABSTRACT: A new taxon of inarticulate brachiopods, *Discinisca* (*Arquinisca* subgen.n.) *vistulae* sp.n., is established to characterize the specimens of latest Cretaceous age (topmost Maastrichtian: *Tenuipteria argentea* Zone = *Belemnella kazimiroviensis* Zone), and coming from the Nasiłów section, Middle Vistula Valley, Central Poland. This new taxon of the genus *Discinisca* DALL, 1871, is the first recognized specifically within the Cretaceous System, and is regarded to represent a separate subgenus, to embrace the disciniscans featured by their dorsal valves elongated, dome-shaped, and laterally flapped. The appearance of the disciniscan brachiopods within the topmost Cretaceous sequence of the Middle Vistula Valley was convergent with the decline of the Late Cretaceous regressive cycle when extremely shallow-marine areas had evolved to yield environmental conditions the most compatible with life requirements of the present-day representatives of that extant genus. This is thought to have involved a rapid phyletic diversification of the genus *Discinisca*, and its world-wide distribution during the Tertiary.

INTRODUCTION

The aim of the present paper is to report on a new taxon of inarticulate brachiopods of latest Cretaceous age, and whose shells have recently been recognized within a rich assemblage of marine invertebrates collected at the Nasiłów Quarry, north of Kazimierz-on-Vistula in the Middle Vistula Valley, Central Poland (see Text-fig. 1).

The huge quarry at Nasiłów (see RADWAŃSKI 1985, ABDEL-GAWAD 1986, HANSEN & al. 1989), abandoned in last few years, as well as small quarries at Bochothnica, situated just across the Vistula, have both supplied the world-famous exposures of the topmost Cretaceous strata (see POZARYSKI 1938; PUTZER 1942; WIEDMANN 1988, p. 118), precisely of the *Tenuipteria argentea* Zone = *Belemnella kazimiroviensis* Zone of topmost Maastrichtian age (see ABDEL-GAWAD 1986, pp. 79-80).

The section exposed at the Nasiłów Quarry (see RADWAŃSKI 1985, Fig. 47; ABDEL-GAWAD 1986, Fig. 6; HANSEN & al. 1989, Fig. 1) embraces over a dozen

meters of siliceous marls (locally known as "Opoka"), topped with a limestone layer truncated by a hardground, and overlain by a greensand, all of which are of topmost Maastrichtian age. The K/T boundary is placed at the phosphatized residual lag, about 30cm above the hardground (*see also* MACHALSKI & WALASZCZYK 1987, 1988; FRAAYE 1994).

The collected specimens that represent the genus *Discinisca* DALL, 1871, come from the uppermost part of the siliceous marl ("Opoka" facies) sequence, an interval about 1-2 meters below the hardground. The material amounts to several specimens of dorsal valves, of which only three are complete (*see* Pl. 1, Figs 1-3). This *Discinisca* material, although very scanty indeed, may contribute importantly to our knowledge of this genus whose history across the Cretaceous is still poorly known.

The genus *Discinisca* DALL, 1871, ranges probably since the Triassic (*see* MUIR-WOOD 1929, p. 467; ROWELL 1965; LEE 1987, p. 50) till Recent, but all its Mesozoic representatives are weakly recognized and often are of uncertain congenerity (*see* THOMSON 1927, MUIR-WOOD 1929, HERTLEIN & GRANT 1944, ROWELL 1965, LEE 1987). The latter statement concerns also the new report on the Upper Cretaceous specimens from England, presented by WHITTLESEA (1991) who was not quite sure about the generic assignment of the forms he described.

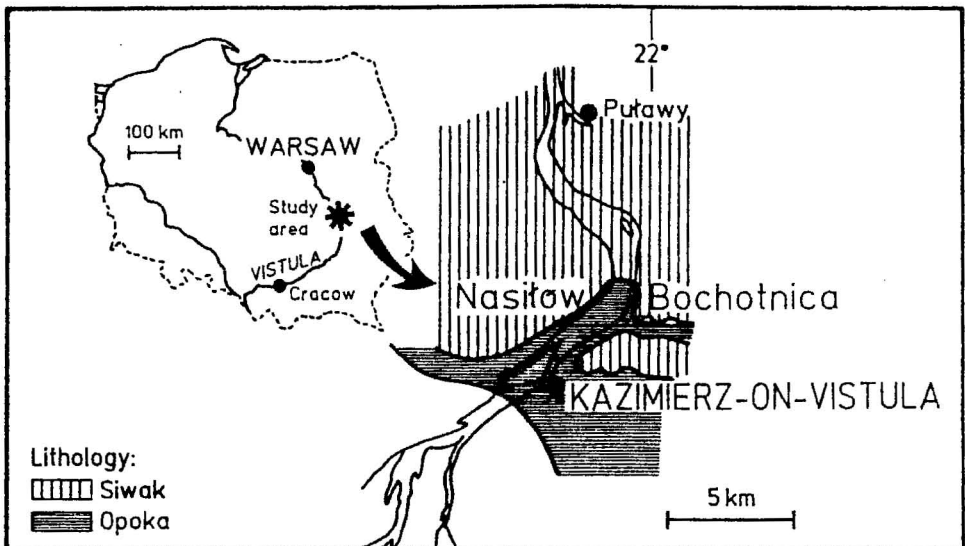


Fig. 1

Geologic sketch-map of the Kazimierz-on-Vistula region in the Middle Vistula Valley, and its location in Poland, to show the emplacement of the Nasitow section that yields the studied inarticulate brachiopods, *Discinisca* (*Arquinisca* subgen.n.) *vistulae* sp.n.

(For location compare ABDEL-GAWAD 1986, Fig. 1; HANSEN & *al.* 1989, Fig. 1A)

The occurrence of the unidentifiable species of the genus *Discinisca* in the Kazimierz-on-Vistula sections was first reported, both from the "Opoka" facies and the greensand, by POŻARYSKA & POŻARYSKI in their geological field-guide to the region (POŻARYSKA & POŻARYSKI 1951, p. 22).

The studied specimens, extracted from a relatively soft siliceous chalk, have their outer surface intact, with well discernible minute details (brep-hic-shell margin, growth lines, striation). Of all the hitherto known modern and ancient *Discinisca* species they differ so distinctly that they are herein postulated to represent a new species of a separate rank at the subgenus level, to which the introduced name is *Discinisca* (*Arquinisca* subgen.n.) *vistulae* sp.n.

TAXONOMIC PROBLEMS OF THE FOSSIL *DISCINISCA*

A general feature of the extant genus *Discinisca* DALL, 1871, is to bear corneous (chitinophosphatic) shells whose dorsal valves are of an outline more or less circular, as viewed vertically, and conical to almost flat or even concave, as viewed laterally and/or antero-posteriorly.

The studied topmost Cretaceous *Discinisca* differ from both the stratigraphically older (?Triassic and Jurassic; see THOMSON 1927, MUIR-WOOD 1929, LEE 1987) and younger (Tertiary to Recent) species of the genus. The Cretaceous forms are as yet practically unknown (see THOMSON 1927, p. 132; MUIR-WOOD 1929; WHITTLESEA 1991).

The Tertiary to Recent forms are classified in a quite reasonable number of species, amounting to about thirty (see DAVIDSON 1888; DALL 1920; THOMSON 1927; HERTLEIN & GRANT 1944; COOPER 1977; RADWAŃSKA & RADWAŃSKI 1984, 1989). The recognized species are diversified in their sculpture to a rather remarkable extent, if one takes into account their very low morphological potential. Generally, within the Tertiary to Recent forms, the three groups of species are distinguishable (see DALL 1920; THOMSON 1927; MUIR-WOOD 1929; STENZEL 1965; RADWAŃSKA & RADWAŃSKI 1984, p. 259, and 1989, p. 71), as appears from the features of their shells:

(i) Large, lamellose, flexible, without radial sculpture (that is, smooth); here, the type species of the genus, *D. lamellosa* (BRODERIP, 1834) belongs;

(ii) Large, less lamellose, with feeble irregular radiations, more solid; exemplified by *D. strigata* (BRODERIP, 1834);

(iii) Small, with regular radial sculpture, not lamellose, solid.

Some authors (MUIR-WOOD 1929, HERTLEIN & GRANT 1944, STENZEL 1965) distinguish only two major groups of fossil *Discinisca* (having or not having radial sculpture), which are regarded as being of either subgeneric (STENZEL 1965) or generic rank (COOPER 1977).

Of the distinguished groups, the latter (group *iii*) comprises species whose shells are furnished with more or less distinct ribs, the pattern of which

evidently enlarges the morphological potential and, thus, bears the more precise taxonomic consequences.

Nevertheless, it should be remembered, that almost all fossil *Discinisca* species are represented by a very limited number of, or even by single, specimens and thus neither the specific variability nor elucidation how the studied specimens fall into the center of this variability can be recognized to a reasonable extent. The morphological variability of the fossil species known from a greater number of specimens, as exemplified by the two Tertiary (Oligocene, and Miocene) species studied by the Authors (RADWAŃSKA & RADWAŃSKI 1984, 1989), is well advanced, and the specimens of extreme features depart far from those averagely shaped. Such extreme variants, if found alone, may easily be estimated as non-conspecific.

The studied topmost Cretaceous forms bear their dorsal valves devoid of ribs and any other sculptural elements. They evidently fall into the groups (*i* and/or *ii*) of species having shells smooth or almost smooth, thus, of a very low morphological potential, and whose taxonomic distinction involves serious problems (*see* HERTLEIN & GRANT 1944; RADWAŃSKA & RADWAŃSKI 1984, 1989; LEE 1987; WHITTLESEA 1991). The most pronounced distinction of the studied topmost Cretaceous forms is their more or less elongated outline, which combined with a dome-shaped lateral section, a laterally flapped poise, position of the apex, and to some extent the size, make up a set of features differing them markedly from all stratigraphically older and younger congeners.

SYSTEMATIC ACCOUNT

Phylum **Brachiopoda** DUMÉRIL, 1806

Class **Inarticulata** HUXLEY, 1869

Order **Acrotretida** KUHN, 1949

Suborder **Acrotretidina** KUHN, 1949

Superfamily **Discinacea** GRAY, 1840

Family **Discinidae** GRAY, 1840

Subfamily **Disciniscinae** SCHUCHERT & LEVENE, 1929

Genus *Discinisca* DALL, 1871

TYPE SPECIES: *Discinisca lamellosa* (BRODERIP, 1834); *OD* DALL, 1871
[*Orbicula lamellosa* of BRODERIP (1834, p. 142)]

Subgenus *Arquisca* subgen.n.

DIAGNOSIS: Disciniscans of relatively larger size, with shells elongated, of dorsal valves domed highly and flapped laterally, bearing the apex eccentric much posteriorly, and very feeble striation propagating from the apical part (brephic-shell margin), better developed posteriorly and postero-laterally.

DERIVATION OF THE NAME: To combine a part of the name *Discinisca* with a reference to the much advanced, dome-like (in Latin: *arquatus*, or *arcuatus*) transverse outline of dorsal valves.

SPECIES INCLUDED: Exclusively, the herein established new species, *Discinisca (Arquinisca) vistulae* sp.n.

Discinisca (Arquinisca subgen.n.) vistulae sp.n.
(Pl. 1, Figs 1–3)

HOLOTYPE: The specimen (dorsal valve) presented in Pl. 1, Figs 1a-1c.

PARATYPES: Two specimens (dorsal valves) presented in Pl. 1, Figs 2a-2d and 3a-3b.

DERIVATION OF THE NAME: In reference to the River Vistula, along which the section yielding the new taxon is exposed.

TYPE LOCALITY: Nasiłów near Kazimierz-on-Vistula, Central Poland.

TYPE HORIZON: Topmost Maastrichtian (Tenuipteria argentea Zone = Belemnella kazimiroviensis Zone).

DIAGNOSIS: As for the newly established subgenus, plus an indistinct indentation in the middle of the posterior margin in the dorsal valve that tends to be shaped triangularly at the apex posteriorly; brephic shell almost circular, slightly elongated anteriorly.

MATERIAL: Several specimens of dorsal valves, kept in the collection of the Department of Paleontology, Faculty of Geology, University of Warsaw.

MEASUREMENTS: The holotype (Pl. 1, Figs 1a-1c) is 12.03 mm long, 9.0 mm wide, and 7.0 mm high; the largest paratype (Pl. 1, Figs 2a-2d) is 12.15 mm long, 7.0 mm wide, and 7.0 mm high.

DESCRIPTION: The dorsal valves are elongated antero-posteriorly, with the length/width ratio ranging from about 1.3 (see Pl. 1, Fig. 1a) to about 2.0 (see Pl. 1, Fig. 2a). Transverse outline, as seen abposterioy, is highly dome-like (see Pl. 1, Figs 1c and 2c), and the valves are conspicuously flapped laterally (see Pl. 1, Figs 1b, 2b, and 2d). The apex is placed eccentrically, much pushed posteriorly. The posterior margin is more or less flattened, and tends to be slightly indented (see Pl. 1, Figs 1a, 2a, and 3a); when it is indented more strongly, a concavity appears to shape the posterior part of the valve more or less triangularly (see Pl. 1, Figs 1c and 2c). In specimens with a more advanced triangularity of the posterior part, a crack is present along the mid-line (see Pl. 1, Figs 1a and 1c), what it is feature of diagenetic (compactional) rather than morphological nature.

At the apex, the valves are completely smooth, just down to one of the more strongly pronounced growth lines which indicates the distal margin of the postlarval (brephic) shell (arrowed in Pl. 1, Figs 1a-1c, 2a, 2c-2d, and 3a), similarly as in some referenced specimens of other species (comp. CHUANG 1977, Fig. 11; RADWAŃSKA & RADWAŃSKI 1984, p. 255 and Pl. 2, Figs 1a, 1c). The brephic shell is almost circular, slightly elongated anteriorly. As seen from the pattern of growth lines, the shell elongation anteriorly progresses during the growth of the studied specimens.

The outer surface of the post-brephic part of dorsal valves is sculptured with very fine, almost indiscernible striation, propagating from the brephic-shell margin, mainly onto the posterior and postero-lateral parts of the valve (better visible only in the holotype; see Pl. 1, Fig. 1a). Some corrugations locally appear either on the left (see Pl. 1, Fig. 2b) or the right side (see Pl. 1, Fig. 3b) of the valve.

The growth lines are well pronounced, and they tend to gather into bands, one or a few lines of which become thicker (as if swollen) to mark distinctly the termination of successive bands. Such bands, distributed at almost equal distances from the brephic-shell margin, number five to seven in particular specimens (comp. Pl. 1, Figs 1a and 2d). The smaller paratype, bearing five bands, is regarded to be juvenile (Pl. 1, Figs 3a-3b).

All the collected valves are very thin, about 0.1 mm, and easily disintegrate and/or peel-off along the growth lines, primarily along the above-indicated bands. Thus, their inner surface cannot be studied. In fragmented specimens, no muscle scars were observable.

All the collected valves are well lustrous allover their surface. The color of the studied specimens varies from pale brown, often fading yellowish, to heavily dark brown, chocolate-like, and almost black. The darker colors accentuate the margin of successive bands (in black-and-white photos better readable only in the holotype; see Pl. 1, Figs 1a and 1b)*.

REMARKS: A more or less distinct feature of the posterior margin of dorsal valves in the newly established species, *Discinisca* (*Arquinisca* subgen.n.) *vistulae* sp.n., to be indented is noted in all the collected specimens; it is thus included into the diagnosis of the species. This feature is, however, rarely reported in other *Discinisca* species. In the present-day species *D. strigata* (BRODERIP) it was recognized as a tendency rather, and in some specimens only, but its diagnostic value was questioned (see DAVIDSON 1888, pp. 202-203; HERTLEIN & GRANT 1944, pp. 37-38). In the Oligocene species *D. steiningeri* RADWAŃSKA & RADWAŃSKI, 1989, from the outskirts of the Vienna Basin in Austria, this feature seems to be of a phenotypic nature as it appears in specimens with their posterior margin relatively long, but is absent from those of a more circular outline (see RADWAŃSKA & RADWAŃSKI 1989, p. 73).

A lack of observable muscle scars on the inner surface of dorsal valves may not result from the paucity of the material collected, but it may be a primary feature. In the Tertiary species, studied by the Authors, these scars are well developed in thicker valves (much thicker than anyone of the species under description), while in the thinner ones, the juveniles including, they are hardly discernible (see RADWAŃSKA & RADWAŃSKI 1984, pp. 256-258; and 1989, p. 75).

* Such color-banding in ancient *Discinisca* species has only once been reported (4 to 5 bands), by MUIR-WOOD (1929, p. 465, Fig. 42/4-5) in her *D. ferroviae* from the Eocene of England, and referred by her as of primary pigmentation of the shell. The latter statement does not seem to be true, because in Recent *Discinisca* species the coloration, if present, is displayed by radial stripes, not concentric rings, as observable (see BRODERIP 1834, Pl. 23, Fig. 1*; HERTLEIN & GRANT 1944, p. 37 and Pl. 2, Fig. 10) on the type material of *D. strigata* (BRODERIP).

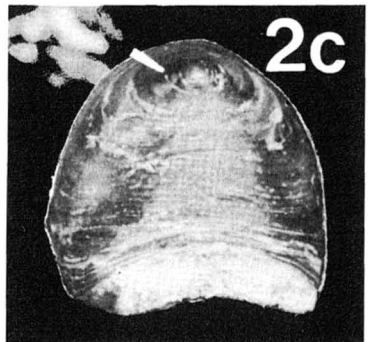
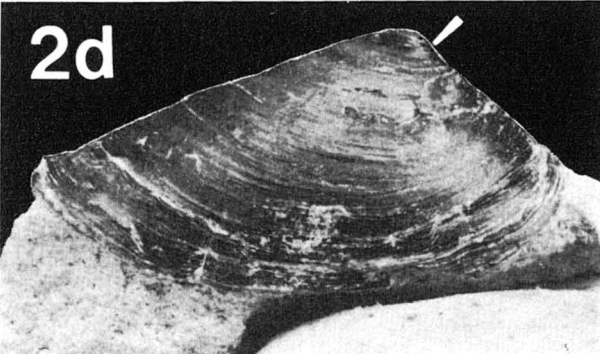
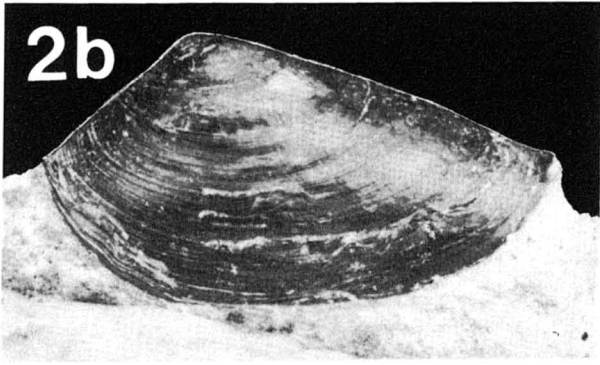
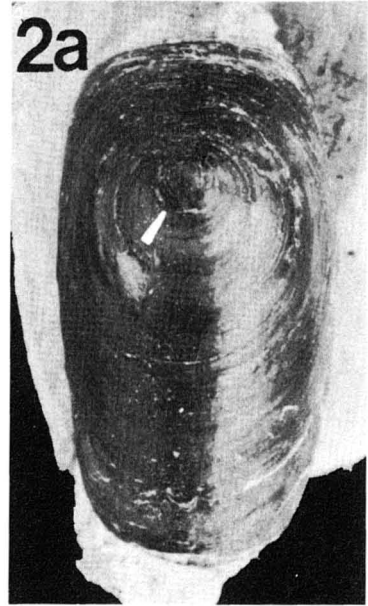
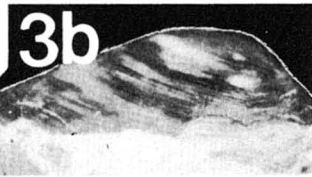
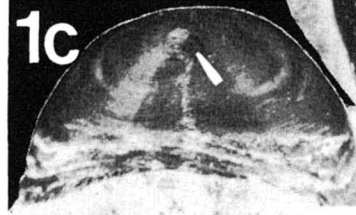
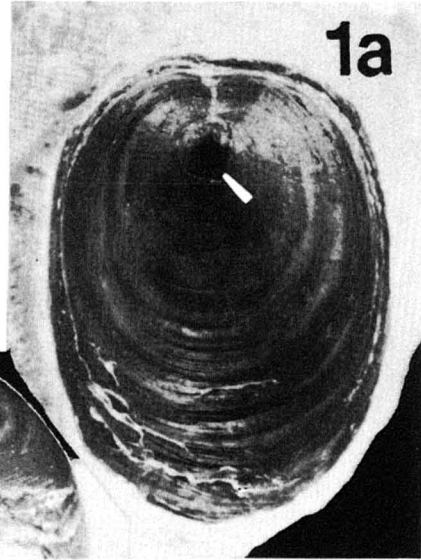
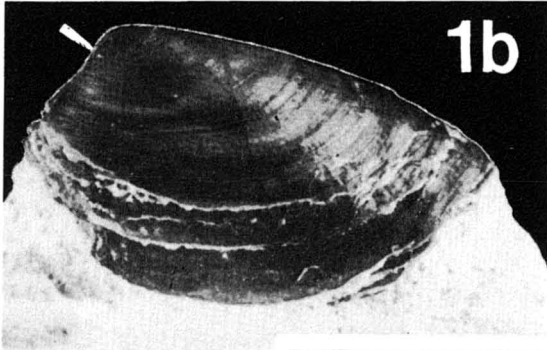
PLATE 1

Discinisca (*Arquinisca* subgen.n.) *vistulae* sp.n.

Topmost Maastrichtian, Nasilów Quarry near Kazimierz-on-Vistula, Central Poland

All photos taken $\times 5$; arrowed is the brephic-shell margin

- 1a-1c — **Holotype:** 1a — Top view (*note*, striation of the posterior and postero-lateral parts of the valve, and distinct banding of growth lines), 1b — Left-side view, 1c — Posterior view
 2a-2d — **Paratype:** 2a — Top view (*note*, indistinct "ghosts" of striation on the right side), 2b — Left-side view (*note*, indistinct "ghosts" of striation, and patchily distributed corrugations of the valve); 2c — Posterior view, 2d — Right-side view (*note*, banding of growth lines)
 3a-3b — **Juvenile specimen (paratype):** 3a — Top view, 3b — Right-side view (*note*, stronger corrugations descending abapically, almost to the lower margin of the valve)



The newly established species is characterized by the shell relatively large, furnished with feeble striation, and by these features it approaches some Tertiary and present-day species of the genus, particularly those of the above-mentioned group (ii), the present geographic distribution of which is confined to the western coasts of the Americas (see DALL 1871, 1920; HERTLEIN & GRANT 1944; COOPER 1977). In the Miocene, however, this very group is represented in Europe, as demonstrated by the discussed species *D. steiningeri* from Austria (see RADWAŃSKA & RADWAŃSKI 1989, p. 71).

PALEOBIOLOGIC INTERPRETATION

A few features displayed by *Discinisca* (*Arquinisca* subgen.n.) *vistulae* sp.n. worth to be commented in the terms of the paleobiology of the species.

Firstly, the banding of the growth lines, that is their conjoining into distinct bands distributed at almost equal distances all over the dorsal valves is observable in all the collected specimens. The number of bands amounts five to seven, the figure of which is assumed to be connected with the annual periods of growth. This number corresponds to the recognized length of life in the present-day brachiopods, both articulate and inarticulate (see WILLIAMS & ROWELL 1965, p. H55), although the only available data on the *Discinisca* species, viz. *D. strigata* (BRODERIP) from the Mexico coast, were formerly interpreted by PAINE (1962) as related to an annual lifespan. In the studied specimens *D. (Arquinisca* subgen.n.) *vistulae* sp.n. the discussed banding is not, in any case, referable to seasonal changes typical of temperate climatic zone, as all faunal assemblages contained in the section are indicative of much warmer climatic conditions (see RADWAŃSKI 1985, ABDEL-GAWAD 1986, HANSEN & al. 1989). On the other way, it is of note, that the tropical and/or subtropical climatic conditions are these which typify the geographic distribution of the present-day *Discinisca* species (see DAVIDSON 1852, 1888; DALL 1871, 1920; THOMSON 1927; MUIR-WOOD 1929; HERTLEIN & GRANT 1944; STENZEL 1965; COOPER 1973, 1977, 1982; RADWAŃSKA & RADWAŃSKI 1984, 1989; LEE 1987).

Secondly, regardless the banding, the pattern of growth lines shows a nearly circular, slightly quadrangular outline of the brachial shell (but, with a posteriorly eccentric apex), and an elongation commences successively when the neanic shell is formed. Thus, the elongation which realizes to a variable extent (comp. Pl. 1, Figs 1a and 2a) may be interpreted as acquired during the individual growth of the specimens, and as dependant on the morphology of the substrate to which the growing specimen has adhered. The feature of elongation remains, however, typical of the whole population studied and is taken as diagnostic of the species.

Thirdly, as a consequence of the above statement, an elongated, and laterally flapped shape of the shells in *Discinisca* (*Arquinisca* subgen.n.) *vistulae* sp.n. is thought to conform well to more or less oblong objects to which they adhered. As such objects are not present with the studied specimens, it is

inferred that they were either lost (detached) or not preservable, that is they were soft. The most likely, these were the aquatic plants, either kelp or seagrasses, with elongated fronds or stems, and the presence of which is clearly shown by a remarkable content of herbivorous gastropods in that past biotope (see ABDEL-GAWAD 1986, p. 206 and Table 11 in p. 209). In such a scenery the studied population of *Discinisca* (*Arquinisca*) *vistulae* sp.n. could easily find a protected habitat, similarly as is preferred by the present-day species *D. strigata* (BRODERIP) in intertidal populations reported by PAINE (1962).

AN ENVIRONMENTAL AND EVOLUTIONARY REMARK

The present-day life requirements in the majority of the *Discinisca* species are consistent with conditions offered by inter- and shallow subtidal environments (see DAVIDSON 1852, 1888; DALL 1920; THOMSON 1927; MUIR-WOOD 1929; HERTLEIN & GRANT 1944; STENZEL 1965; RADWAŃSKA & RADWAŃSKI 1984, 1989; LEE 1987). Such very environment is well manifested by the topmost Maastrichtian strata of Nasilów, as exemplified by the presence of the burrows attributable to the ghost crab *Ocypode*, and by the associated invertebrates (see RADWAŃSKI 1985, ABDEL-GAWAD 1986). The herein postulated extremely shallow-marine environmental conditions coincided with the final stages of the topmost Cretaceous regressive cycle.

It is to note, that all occurrences of “*Discinisca*” in the Upper Chalk of Norfolk, eastern England, as reported by WHITTLESEA (1991, p. 72), come from horizons situated above major erosion surfaces produced during regressive phases of the Late Cretaceous (Campanian — low-Lower Maastrichtian). At Nasilów, the studied *Discinisca* specimens are yielded by deposits preceding the major erosion surface that terminates the regressive cycle of the topmost Maastrichtian. In both cases, however, the relation of the *Discinisca* occurrence to the shallow-marine conditions, associated with the seafloor upheaval, preceding or subsequent to an erosional event, is evident.

Finally, it is thought that the global rise of the extreme shallow-marine environments by the Cretaceous decline and the K/T junction has certainly accelerated the expansion of the biotopes favorable for *Discinisca*, what enabled the phyletic diversification of this genus, formerly very underrepresented in the earlier Mesozoic biotopes, and a common settlement (or, persistence) of its stocks in various shallow-marine facies all over the world during the Tertiary (see HERTLEIN & GRANT 1944; STENZEL 1965; RADWAŃSKA & RADWAŃSKI 1984, 1989; LEE 1987).

Acknowledgements

A discussion on the Cretaceous disciniscan brachiopods, kindly offered by Mr. Paul S. WHITTLESEA, of Norwich (England), is gratefully acknowledged, the same as all information on Late Cretaceous disciniscans from the Hannover area, spontaneously supplied by Dr. John W.M. JAGT, of Maastricht (The Netherlands), and from the Stevns Klint area, did by Dr. Marianne B. JOHANSEN, of the University of Copenhagen (Denmark). All these disciniscans, recently discovered from the chalk sequence in various countries of western Europe, and still undescribed, remain remarkably distinct, by their minute size and smooth surface, from these herein presented from the Middle Vistula Valley.

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