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The *Platysphinctes* immigration event in the Middle Oxfordian of the Polish Jura Chain (Central Poland)

EWA GŁOWNIAK

Institute of Geology, University of Warsaw, Al. Żwirki i Wigury 93, PL-02-089 Warszawa, Poland. E-mail: sikorka@geo.uw.edu.pl

ABSTRACT

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Ammonites of the subgenus *Platysphinctes*, represented by the species *Perisphinctes* (*Platysphinctes*) *perplanatus* (TINTANT, 1961), both microconchs and macroconchs, were recently found in the Middle Oxfordian of the Częstochowa Upland (Polish Jura Chain, Central Poland). Their appearance marks an invasion of ammonites of Mediterranean affinities into the Submediterranean Province. This episode is represented in the studied succession by a distinct horizon, named herein the Platysphinctes event – horizon, that is located in the upper part of the newly erected Arkelli Subzone of the Plicatilis Zone. An emended description of *Perisphinctes* (*Platysphinctes*) *perplanatus* and a description of a new species, *Perisphinctes* (*Otosphinctes*) *arkelli* sp. nov. are provided.

Key words: Perisphinctidae, Ammonoidea, Upper Jurassic, Polish Jura Chain, biostratigraphy, immigration event, taxonomy.

INTRODUCTION

Unequivocal occurrences of the subgenus *Platysphinctes* TINTANT, 1961 (Family Perisphinctidae) have been documented so far only from the French Oxfordian by TINTANT (1961), who reported a collection consisting of nine monomorphic specimens, from a condensed succession of the Vertebrale Subzone (lower Middle Oxfordian, see Text-fig. 2). He recognised two new species: *Perisphinctes* (*Platysphinctes*) *perplanatus* (TINTANT, 1961), represented by six specimens, and *Perisphinctes* (*Platysphinctes*) *talantiensis* (TINTANT, 1961), documented by a single specimen; and also two representatives of the species *Perisphinctes* (*Platysphinctes*) (?) cf. *cetechovius* NEUMANN. From Poland, a supposed *Platysphinctes* was noted by MALINOWSKA (1970), who described a single specimen from the Upper Oxfordian of the Wieluń Upland in the Polish Jura Chain, but this report should be checked by further work.

During field work in the area of the Częstochowa Upland for my Ph.D. thesis, I collected numerous representatives of the subgenus *Platysphinctes* from the Middle Oxfordian exposed in the quarries of Wysoka and Ogrodzieniec (Text-fig. 1). These ammonites occur in a thin stratigraphical unit, named herein the Platysphinctes event-horizon (or Platysphinctes horizon), which is located in the top part of the Arkelli Subzone of the Plicatilis Zone. The Platysphinctes horizon, known so far only in the Częstochowa Upland, may, should it be recognised in other areas, prove to be a very useful biostratigraphical tool in the Middle Oxfordian.

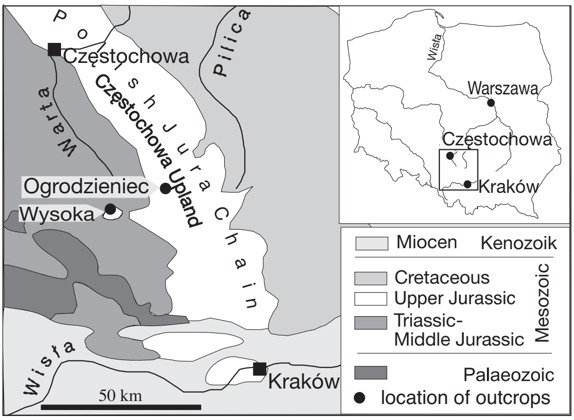

Fig. 1. Location of the Wysoka and Ogrodzieniec Quarries on a geological sketch-map of the Polish Jura Chain

BIOSTRATIGRAPHICAL FRAMEWORK

The Middle Oxfordian of the Polish Jura Chain yields ammonites of the Mediterranean/Submediterranean as well as of the Boreal Provinces. Consequently, depending on the group used, various zonations were formerly proposed for the stratigraphical interval under consideration. MALINOWSKA (1976, 1980) published a scheme based on the Boreal ammonites. At the same time, BROCHWICZ-LEWIŃSKI (1976), making use of the Submediterranean fauna, presented a zonation based on the scheme published some years earlier by CARIOU & *al.* (1971). In the present paper the subdivision of the Middle Oxfordian is based on the phylogeny of the Submediterranean genus *Perisphinctes* (GŁOWNIAK 1997a, 1997b, 1998). As a full account of this zonation will be published elsewhere, only a brief discussion of this scheme is presented herein. The Plicatilis Zone (Text-fig. 2) is characterised by the subgenera *Otosphinctes* BUCKMAN, 1926, *Arisphinctes* BUCKMAN, 1924, and *Kranaosphinctes* BUCKMAN, 1921. In the succeeding Transversarium Zone, these three taxa disappear, except for two species of Mediterranean affinities that range up from below, and are broadly referable to the Submediterranean subgenus *Kranaosphinctes* BUCKMAN, 1921.

The lower boundary of the Transversarium Zone is marked by a mass-occurrence of representatives of the subgenera *Dichotomosphinctes* BUCKMAN, 1926 and *Perisphinctes* WAAGEN, 1869 sensu stricto, the evolutionary descendants of the subgenera characterising the Plicatilis Zone. The subzonal subdivision of both zones is based on the successive chronospecies in the phyletic lineage of the microconch subgenera *Otosphinctes* BUCKMAN, 1926 and *Dichotomosphinctes* BUCKMAN, 1926. The Plicatilis Zone is subdivided into the Paturattensis Subzone, Ouatius Subzone and the Arkelli Subzone. In the Transversarium Zone two subzones, the Buckmani Subzone and the Elisabethae Subzone, are distinguished. At the top of the Elisabethae Subzone the first representatives of the subgenus *Subdiscosphinctes* MALINOWSKA, 1972, appear, interpreted here as arising from the subgenus *Dichotomosphinctes* BUCKMAN, 1926; they range up to the Bifurcatus Zone. Other perisphinctids found in the Middle Oxfordian, representatives of the subgenera *Platysphinctes* TINTANT, 1961 and *Liosphinctes* BUCKMAN, 1925, as well as Mediterranean species of the subgenus *Kranaosphinctes* BUCKMAN, 1921, do not occur regularly in the study area, and they are not used in the construction of the proposed zonation.

A correlation with the zonation of the Middle Oxfordian proposed by CARIOU & *al.* (1971) is shown in Text-fig. 2. Although the index species of the zones are the same in both schemes, the zonal boundaries are newly defined here. The lower boundaries of the Transversarium and Bifurcatus Zones are located stratigraphically below the corresponding boundaries of the equivalent zones in the scheme of CARIOU & *al.* (1971). The base of the Transversarium Zone, defined here by the first appearance of *Peri-*

Głowniak, 1997a

Substage	Zone	Subzone
UPPER OXFORDIAN (pars)	Bifurcatus	Grossouvrei
		Stenocycloides
		Wartae
MIDDLE OXFORDIAN	Transversarium	Elisabethae
		Buckmani
	Plicatilis	* Arkelli
		Ouatius
		Paturattensis

Cariou et al., 1971

Substage	Zone	Subzone
UPPER OXFORDIAN (pars)	Bifurcatus	Grossouvrei
		Stenocycloides
MIDDLE OXFORDIAN	Transversarium	Schilli
		Parandieri
	Plicatilis	Antecedens
		Tenuicostatum or Vertebrale

Fig. 2. Chronostratigraphy and biozonation of the Middle Oxfordian of the Submediterranean Province and tentative correlation with the subdivision for the Submediterranean Province by Cariou & al. 1971; the star in the Arkelli Subzone indicates the position of the Platysphinctes horizon

sphinctes (*Dichotomosphinctes*) *antecedens* SALFELD, 1914, the earliest representative of the subgenus *Dichotomosphinctes* BUCKMAN, 1926, approximately coincides with the last occurrence of *Perisphinctes* (*Otosphinctes*) *arkelli* sp. nov. The stratigraphical shift of the base of the Bifurcatus Zone results from its location at the base of the Wartae Subzone. This boundary, and consequently the base of the Upper Oxfordian, is marked by the first appearance of *Perisphinctes* (*Dichotomoceras*) *wartae* BUKOWSKI, 1887. Full discussion of the zonation and its comparison with other schemes of the Middle Oxfordian proposed recently for the Submediterranean Province will be discused in a separate paper.

DEFINITION OF THE ARKELLI SUBZONE

The base of the Arkelli Subzone, recognised at the top of the Plicatilis Zone (Text-fig. 2), is defined by the first appearance of the index taxon, *Perisphinctes* (*Otosphinctes*) *arkelli* sp. nov. The upper boundary of the subzone is located at the appearance level of *Perisphinctes* (*Dichotomosphinctes*) *antecedens* SALFELD, 1914, the evolutionary descendant of *Perisphinctes* (*Otosphinctes*) *arkelli* sp. nov. *P.* (*D.*) *antecedens* is diagnostic of the succeeding Buckmani Subzone of the Transversarium Zone. Besides the index taxon, the Arkelli Subzone is characterised by *Perisphinctes* (*Otosphinctes*) *magnouatius* ARKELL, 1937, *Perisphinctes* (*Arisphinctes*) *ariprepes* (BUCKMAN, 1924) and *Perisphinctes* (*Kranaosphinctes*) *decurrens* (BUCKMAN, 1923) (which are limited to this subzone); and by *Perisphinctes* (*Otosphinctes*) *ouatius* (BUCKMAN, 1926) and *Perisphinctes* (*Kranaosphinctes*) *kranaus* (BUCKMAN, 1921), which range up from the highest part of the underlying Ouatius Subzone, but only become numerous in the Arkelli Subzone. In addition, *Perisphinctes* (*Arisphinctes*) *helenae* DE RIAZ, 1898 and *P.* (*A.*) *trifidus* (SOWERBY, 1821) still occur in the lowermost part of the Arkelli Subzone, ranging up from the Paturattensis Subzone, but they then disappear. Representatives of the subgenus *Liosphinctes* BUCKMAN, 1925, abundant in the Paturattensis Subzone, less common in the Ouatius Subzone, are very rare in the Arkelli Subzone, being represented by two species that range up from below: *Perisphinctes* (*Liosphinctes*) *laevipickeringius* ARKELL, 1939, which disappears in the basal part of the subzone, and *P.* (*L.*) *cumnorensis* ARKELL, 1939 which ranges higher, but does not reach the upper boundary of the subzone. The species *Perisphinctes* (*Kranaosphinctes*) *gyrus* NEUMANN, 1907, and *P.* (*K.*) *cyrilli* NEUMAN, 1907, two taxa of Mediterranean affinities (BROCHWICZ-LEWIŃSKI 1973, BROCHWICZ-LEWIŃSKI & RÓŻAK 1974) referred to the subgenus *Kranaosphinctes* BUCKMAN, 1921 appear in the highest part of the Arkelli Subzone and range up into the Buckmani Subzone of the Transversarium Zone, where they eventually disappear.

THE PLATYSPHINCTES HORIZON AND ITS PALAEOBIOGEOGRAPHICAL IMPLICATIONS FOR THE MIDDLE OXFORDIAN

The occurrence of *Platysphinctes*, a subgenus represented in the study area by the species *Perisphinctes* (*Platysphinctes*) *perplanatus* (TINTANT, 1961), is limited to the highest part of the Arkelli Subzone, and it disappears directly below the top of the subzone. The beds containing *Platysphinctes* form a distinct stratigraphical unit, named herein the Platysphinctes horizon, which has a constant thickness through the study area of approximately some tens of centimetres, up to a maximum of about 1 m in the sponge bioherms (Text-fig. 3). Taphonomical and sedimentological observations prove that these beds are not condensed, and the appearance in them of *P.* (*P.*) *perplanatus* may be attributed to a short-lived immigration event into the area of central Poland. Representatives of the subgenus *Platysphinctes* constitute 93% of the ammonites found in the Platysphinctes horizon. The other associated ammonites comprise a few Mediterranean and Submediterranean species. The Mediterranean species, *Perisphinctes* (*Kranaosphinctes*) *gyrus* NEUMANN and *P.* (*K.*) *cyrilli* NEUMANN, first appear in the Platysphinctes horizon. The Submediterranean taxa, *Perisphinctes* (*Otosphinctes*) *arkelli* sp. nov. and *P.* (*O.*) cf. *ouatius* BUCKMAN, range up from below, being indicative of the Arkelli Subzone. The Platysphinctes horizon also yields *Perisphinctes* (*Liosphinctes*) *cumnorensis* ARKELL, documenting the highest occurrence of the subgenus *Liosphinctes* in the Plicatilis Zone.

Although the origin of *Platysphinctes* requires further study, it appears to possess affinities to the Lower Oxfordian subgenus *Prososphinctes* SCHINDEWOLF, 1925 (see systematic part herein), and to the Lower Oxfordian genus *Tenuisphinctes* GYGI, 1998, reported

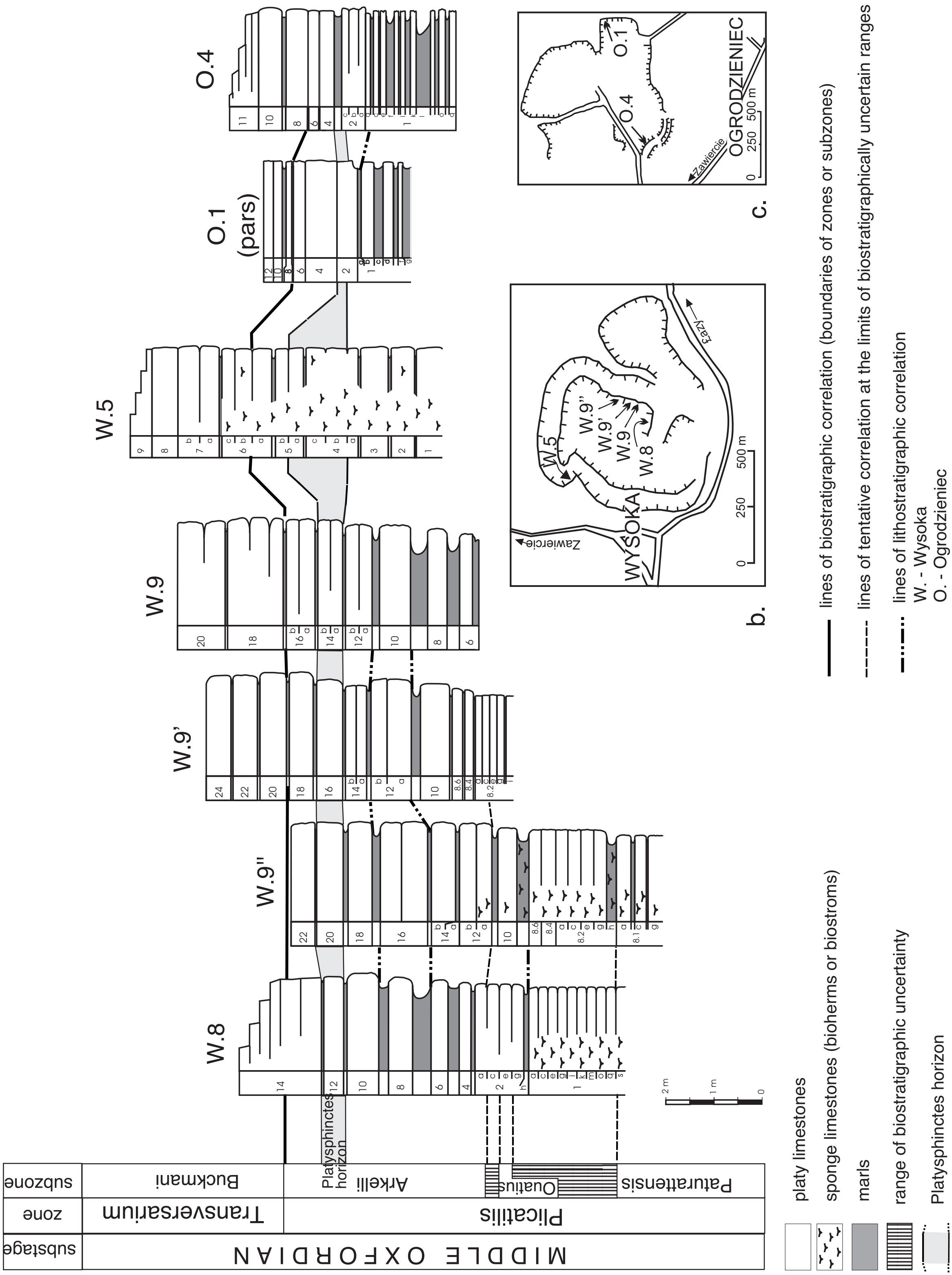

Fig. 3. Correlation of the Middle Oxfordian sections from the quarries of Wysoka and Ogrodzieniec with the stratigraphical position of the Platysphinctes horizon (a), and location of sections in the Wysoka Quarry (b) and in the Ogrodzieniec Quarry (c)

from the Swiss Jura (GYGI 1998), as well as to the Middle Oxfordian taxa *Perisphinctes* (*Prososphinctes*) nov. sp. ?A, *P.* (*?Dichotomosphinctes*) aff. *episcopalis* DE LORIOL, 1901 and *P.* (*?D.*) nov. sp. ? aff. *episcopalis* DE LORIOL, 1901 described by BOURSEAU (1977) from Southern France. These relationships suggest the Mediterranean roots of *Platysphinctes*. These affinities, as well as the Mediterranean character of the two species of the subgenus *Kranaosphinctes* co-occurring with *P.* (*P.*) *perplanatus*, adds further support to the idea that the appearance of TINTANT's taxon in the Polish Jura Chain was the result of an immigration from the Mediterranean areas into the Submediterranean Province. This event more or less coincides with a general reorganisation of the ammonite assemblages in respect of other groups of ammonites, such as those of the superfamilies Stephanocerataceae and Haplocerataceae, which will be discussed elsewhere.

The distribution of *Platysphinctes* in a biogeographical context remains to be determined. However, the affinity of this subgenus to the subgenera *Cubasphinctes* WIERZBOWSKI, 1976, and *Antilloceras* CHUDOLEY & FURRAZOLA-BERMUDEZ, 1968, from the Middle Oxfordian of the Cuban Province (WIERZBOWSKI, 1976) may prove useful in evolutionary studies of *Platysphinctes* and in investigating connections between faunal provinces in the Middle Oxfordian.

PALAEONTOLOGICAL ACCOUNT

Repositories: Museum of the Geology Department of the University of Warsaw, collection no IGPUW/A/36.

Shell terminology

Symbols used in the appendix and in the text for shell characters are as follows: D – diameter (size); D_m – maximum diameter of a complete specimen; D_m – maximum diameter of an adult specimen (final size); $^*D_m$ – maximum diameter of incomplete specimen; D_f – maximum diameter of phragmocone; D_f – maximum diameter of phragmocone of an adult specimen; $^*D_f$ – maximum actual diameter of an incomplete phragmocone; n – number of primary ribs per whorl; U – umbilical width; W – whorl height, W/U – whorl height as fraction of umbilical width; U/D – umbilical width as fraction of diameter; W/D – whorl height as fraction of diameter, W_{n-1}/W – height of preceding whorl (W_{n-1}) as fraction of the next whorl-height (W). Measurements or fractions referred to the maximum diameter of and adult specimen are underlined. Statistics used comprise: $\overline{U/D}$ – mean value of umbilical width as fraction of the diameter, $\overline{W/D}$ – mean value of whorl height as fraction of the diameter; OS – standard deviation.

Coiling of the shell is classified after GEYER (1961), and according to the value of W/U it is referred to evolute, when W/U≤0.50, moderately evolute, when 0.50<W/U≤0.75, or weakly evolute, when 0.75<W/U≤1.0.

The rib types are used after ARKELL (1934, vol. 1, p. xxviii-xxix), whereas the mode of rib-division follows ARKELL (1934, vol. 1, p. xviii) and GEYER (1961, p. 14). The primary, secondary, and intercalatory ribs are distinguished. The types of rib-division are referred to as dichotomous (bifurcation), bidichotomous (Text-fig. 6-3a), polygyrat (Text-fig. 6-3b) or polyschizotomous (Text-fig. 6-1, Text-fig. 6-2). In addition, paradischizotomous rib division (Text-fig. 6-4) is distinguished here to describe the style of rib-division where a free-ending intercalatory rib curves inwards at its extremity, approaching the primary rib just below the point of division, giving the impression of an incipient dischizotomy.

Terms and abbreviations for the septal suture after ARKELL (1934, vol. 1, p. x, xxx), are as follows: suspensive lobe (N), external lobe (E), and lateral lobe (L).

The ratio, used here as a convenient tool for the description of shell-ornamentation, called "rib index" (RI), is defined as the number of secondary and intercalatory ribs per number of primary ribs, per whorl.

Systematic description

Superfamily Perisphinctaceae STEINMANN, 1890
Family Perisphinctidae STEINMANN, 1890
Genus *Perisphinctes* WAAGEN, 1869
Subgenus *Platysphinctes* TINTANT, 1961

TYPE SPECIES: *Platysphinctes perplanatus* TINTANT (1961, Pl. 1, Fig. 1), from the ferruginous oolite of Talant; Vertebrale Subzone of the Transversarium Zone.

REMARKS: TINTANT (1961, pp. 112-115) emphasised the affinities of the subgenus *Platysphinctes* to the Middle Callovian *Choffatia waageni*, and also to the Lower Kimmeridgian group of *Ataxioceras lothari* or A. *inconditius*. However, he attributed this similarity to homeomorphy.

Of the Middle Oxfordian ammonites that occur in the study area, the subgenus *Liosphinctes* BUCKMAN, 1925, is closest to the subgenus *Platysphinctes*. It resembles *Platysphinctes* in the mode of ribbing; both subgenera show occasional complex rib-division, the presence of interacalatory ribs, making their first appearance in early stages of ontogeny, widely spaced and blunt ribbing on the later whorls of macroconchs, and an almost smooth body chamber, except for the weak development of blunt primaries. However, whereas in *Liosphinctes* the ornamentation changes gradually with growth, in *Platysphinctes* it changes in a step-wise manner, at the constrictions. In *Liosphinctes* more widely spaced and blunt ribs develop through the outer one -and-a-half to two whorls of adults, including part of the phragmocone and the body-chamber, in *Platysphinctes* they appear on the adult body-chamber. *Platysphinctes* also differs from *Liosphinctes* in being more evolute on the inner whorls and less evolute on the outer whorls. This is particularly the case with representatives of *Liosphinctes* from the Plicatilis Zone. *Platysphinctes* additionally differs from *Liosphinctes* in the whorl section. In *Platysphinctes* the whorl section is subrectangular, oval or trapezoidal, with flat sloping sides, and a distinct ventro-lateral margin. In *Liosphinctes* the whorl section is mostly oval, with a smoothly rounded ventro-lateral margin and a narrow, rounded venter. The last difference concerns the septal suture; in *Platysphinctes* the suspensive lobe is of equal length or even shorter than the lateral lobe, and is never longer, as it is in *Liosphinctes*. The subgenera *Liosphinctes* and *Platysphinctes* were regarded by former authors (ENAY 1966, BROCHWICZ-LEWIŃSKI 1972) as a dimorphic pair. New material of *Platysphinctes* obtained in the course of this study, both micro- and macroconchs, shows that this statement was an oversimplification resulting of an insufficient knowledge of TINTANT's taxon. The differences between both subgenera indicate that in the Middle Oxfordian they do actually represent separate taxa.

The Cuban forms (WIERZBOWSKI 1976) from the Transversarium Zone and Bifurcatus Zone, the macroconchs of the subgenus *Cubasphinctes* and the microconchs of the subgenus *Antilloceras*, can be compared to the macroconchs and microconchs of the subgenus *Platysphinctes*. *Cubasphinctes* and *Antilloceras* resemble *Platysphinctes* in the appearance of intercalatory ribs, in the occurrence of dischizotomous rib-division in later stages of ontogeny, the fairly numerous constrictions throughout development, the whorl shape and coiling, and in the final size of adults (in *Cubasphinctes* the final size ranges from diameters of 100 mm to 120 mm, in *Antilloceras* from 40 mm to 100 mm, see WIERZBOWSKI 1976). Nevertheless, in the Cuban forms, the ribbing is generally sharp and fine, and simple ribs are present, which are absent in *Platysphinctes*. Moreover, in *Cubasphinctes* and in *Antilloceras* the shell is clearly ornamented on the flank up to the last adult whorl, which never happens in the subgenus *Platysphinctes*. *Cubasphinctes* and

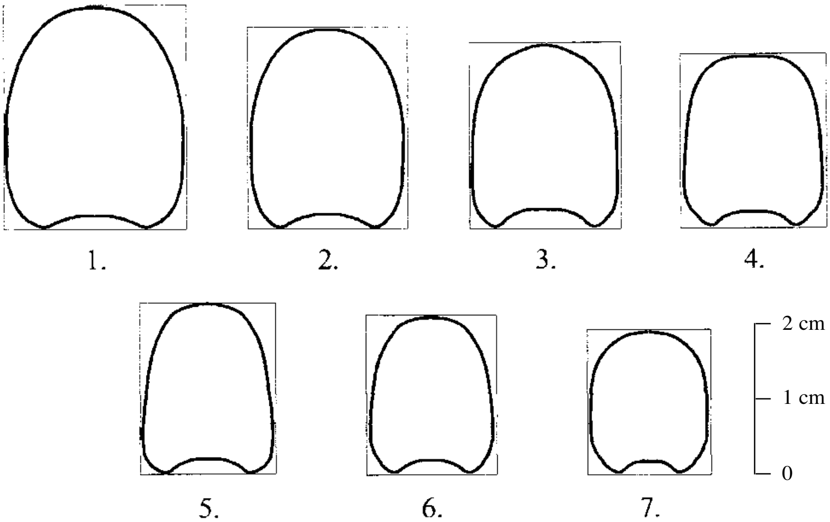

Fig. 4. Whorl section of *Perisphinctes (Platysphinctes) perplanatus* (M) at a given diameter; 1. IGPUW/A/36/5 (Pl. 1, Fig. 1), D = 115 mm; 2. IGPUW/A/36/8 (Pl. 3, Fig. 2), D = 110 mm; 3. IGPUW/A/36/40 (Pl. 1, Fig. 3), D = 90 mm; 4. IGPUW/A/36/49, D = 90 mm; 5. IGPUW/A/36/14, D = 80 mm; 6. IGPUW/A/36/44, D = 65 mm; 7. IGPUW/A/36/45, D = 65 mm

Antilloceras are more densely ribbed on the inner whorls than *Platysphinctes*, and their rib-density curves often show a reduction in rib-number of ribs per whorl at diameters greater than c. 20 mm (WIERZBOWSKI 1976, Text-figs 11-14) or a reduction in rib-number followed by an increase, resulting in a U-shaped rib-density curve (WIERZBOWSKI 1976, p. 193, Text-fig. 17)

Perisphinctes (*Platysphinctes*) *perplanatus* (TINTANT, 1961)

[Pl. 1, Figs 1-3 (M); Pl. 2, Figs 1-3 (M), Pl. 3, Figs 1, 5, 6 (m), Pl. 3, Figs 2-4 (M), Pl. 4, Figs 1-8 (m); Text-figs 4-9; Appendix 1 (M), Appendix 3 (m)]

1961. *Platysphinctes perplanatus* sp. nov.; H. TINTANT p. 115, Pl. 1, Fig. 1.

HOLOTYPE: The holotype, by original designation, is the specimen illustrated by TINTANT (1961, Pl. 1, Fig. 1), from the ferruginous oolite of Talant; Vertebrale Subzone of the Transversarium Zone; housed in the collections of Institute of Geology in Dijon.

EMENDED DIAGNOSIS: Adult macroconchs range in final diameter from 45 mm to 77 mm. Macroconchs reach final diameter at ca. 120 mm. Shell of micro- and macroconchs compressed; with rectangular, oval or trapezoidal whorl section. Coiling moderately evolute, rarely weakly evolute or evolute. Ribs moderately coarse, mostly bifurcate; rib-division commonly paradischizotomous, occasionally bidichotomous, polygyrat, or polyschizotomous. Secondary ribs associated with intercalatories on the venter. Phragmocone and body-chamber with numerous constrictions: 3-4 on the adult body-chamber in microconchs and 3-5 in macroconchs. Stepwise changes of ornamentation at the constrictions. Macroconchs variocostate, the last quarter whorl of the adult body-chamber almost smooth on the flanks, except for the weak development of blunt primaries persisting mainly at the umbilical edge. Microconchs never display this type of ornamentation.

MATERIAL: 29 macroconchs (Appendix 1) and 16 microconchs (Appendix 3) suitable for biometric study; of these 5 macroconchs and 12 microconchs represent adult individuals. Additionally, 24 unregistered whorl-fragments, both macro- and microconchs, including adults.

The material comes from the Wysoka Quarry (Text-fig. 3): section W.5 beds 4b (m), 4c (M-whorl fragment), 5a (M, m-whorl fragment.), W.8 bed 12 (M, m), W.9 bed 14a (M, m), W.9' bed 16 (m), W.9" bed 20 (M, m-whorl fragment) and from the Ogrodzieniec Quarry: section O.1 top of bed 2 (M, m-whorl fragment), bed 3 (m- whorl fragment), section O.4 bed 2c (M, m), 3 (whorl fragments of M & m).

DESCRIPTION: The macroconch IGPUW/A/36/5 (Pl. 1, Fig. 1, Appendix 1) is a complete specimen, representing an adult individual, with final size 121 mm diameter, phragmocone up to 77 mm diameter, and body-chamber 7/8 whorl long. The peristome is constricted. The estimated final sizes of the other adult macroconchs in the collection range from approximately 100 mm (IGPUW/A/36/53, Pl. 3, Fig. 4) to 140 mm (IGPUW/A/36/19). The microconchs display a continuous gradation in size, with the final diameter ranging from 45 mm to 77 mm (Appendix 3); the modal class of the final size is 65 mm-75 mm (Text-fig. 9). The difference in shell-diameter between the smallest microconch (IGPUW/A/36/25, Pl. 4, Fig. 2) and the largest microconch (IGPUW/A/36/27, Pl. 4, Fig. 7) reaches 32 mm, which corresponds to 7/8 of the whorl length. The body-chamber of microconchs starts between diameters of 29 mm and 50 mm, and it occupies the last 3/4 or 7/8 of the whorl. The peristome is marked by a constriction, and bears a pair of lappets, which were preserved in nine specimens.

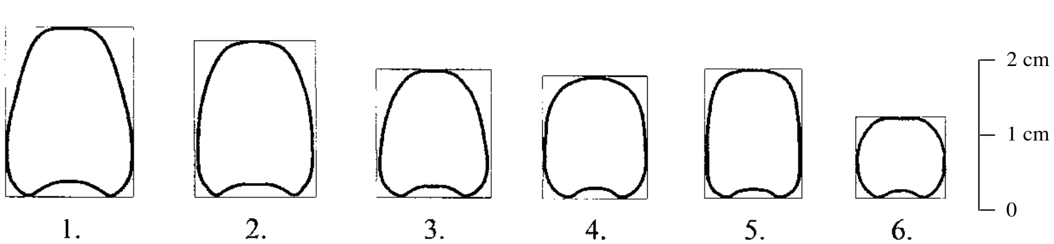

Fig. 5. Whorl section of *Perisphinctes Platysphinctes*) *perplanatus* (m) at a given diameter; 1. IGPUW/A/36/27 (Pl. 4, Fig. 7), D = 75 mm; 2. IGPUW/A/36/28 (Pl. 4, Fig. 8), D = 66 mm; 3. IGPUW/A/36/26 (Pl. 4, Fig. 5), D = 57 mm; 4. IGPUW/A/36/35, D = 62 mm; 5. IGPUW/A/36/32 (Pl. 4, Fig. 3), D = 52 mm; 6. IGPUW/A/36/32 (Pl. 4, Fig. 3), D = 33 mm

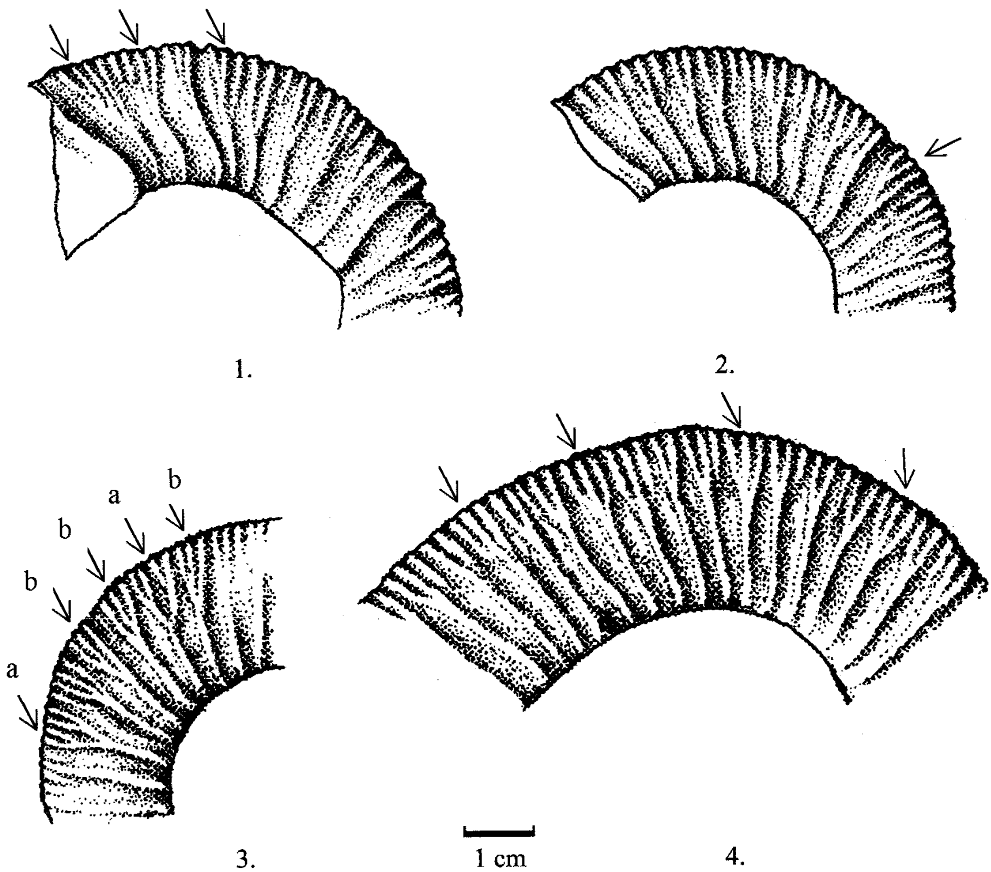

Fig. 6. Types of rib division in *Perisphinctes* (*Platysphinctes*) *perplanatus* (M, m)
Microconchs (arrows indicate polyschizotomous rib division): 1. IGPUW/A/36/27 (Pl. 4, Fig. 7); 2. IGPUW/A/36/28 (Pl. 4, Fig. 8); Macroconchs: 3. IGPUW/A/36/53 (Pl. 3, Fig. 4) (arrows indicate: a – bidichotomous rib-division, b – polygyrat rib-division); 4. IGPUW/A/36/21 (Pl. 2, Fig. 1) (arrows indicate paradischizotomous rib-division)

The inner whorls of macro- and microconchs, up to ca. 35 mm diameter, are rounded-quadrate, then they become compressed, in macroconchs subrectangular, oval or trapezoidal (Text-fig. 4) and in microconchs trapezoidal, rectangular or oval (Text-fig. 5). The coiling of both morphs is moderately evolute in all ontogenetic stages, in macroconchs it occasionally becomes evolute close to the peristome or changes from weakly evolute on the inner whorls to moderately evolute on the outer whorl. The U/D widens slightly with growth, whereas the W/D diminishes slightly. In macroconchs of between 40-48 mm and 95-106 mm diameter the value of $\overline{U/D}$ increases from 0.47 (OS = 0.04) to 0.50 (OS = 0.03), and $\overline{W/D}$ decreases from 0.31 (OS = 0.02) to 0.27 (OS = 0.01) (Appendix 1). In microconchs of between 28-34 mm and 63-77 mm diameter the value $\overline{U/D}$ increases from 0.47 (OS = 0.03) to 0.49 (OS = 0.01), and $\overline{W/D}$ decreases from 0.29 (OS = 0.01) to 0.27 (OS = 0.01) (Appendix 3).

The ribbing is moderately coarse, somewhat finer on the inner whorls than on the outer ones. It consists of straight, prorsiradiate ribs. The ribs mainly bifurcate, and intercalatory ribs appear on the venter. In macroconchs they are recognised as early as a diameter of 57 mm, and in microconchs as early as a diameter of 33 mm.

In macroconchs the number of primary ribs increases from 30-35 to 45-50 per whorl between 25-80 mm diameter (Text-fig. 7). Usually at more than 80 mm diameter, but sometimes already at 40-50 mm and sometimes not before 115 mm, the ribs become more widely spaced on the flanks, which is reflected in a descending rib-density curve. There is no significant discontinuity in rib-density curves among the specimens studied.

In microconchs the primary ribs vary in number from 25 to 40 per whorl at a diameter of about 20 mm (Text-fig. 8). As the diameter increases, the rib-density curves of the majority of specimens rise gently, reflecting an increase in rib-number of about 10-15 ribs per whorl between the inner and the outer adult whorl. In some specimens the number of ribs remains approximately constant to the end of the last whorl, resulting in a flat rib-density curve. As in the case of the macroconchs, the rib-density curves of microconchs do not display any discontinuities.

Constrictions are frequent; with 2-3 per whorl on the phragmocone and 3-5 on the adult body-chamber in macroconchs; and with 2 per whorl on the phragmocone, and 3-4 on the adult body-chamber in microconchs. They are linked to points of abrupt changes in the shell ornamentation.

Changes of ornamentation in the course of ontogeny tend principally towards an increase in the

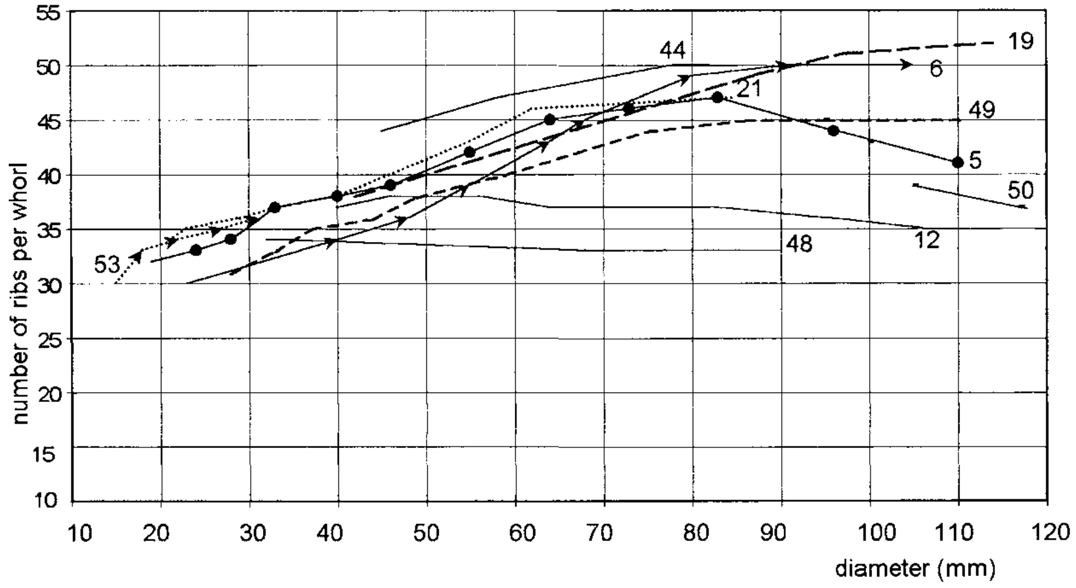

Fig. 7. Rib-density curves of *Perisphinctes* (*Platysphinctes*) *perplanatus* (M); the specimens are numbered by only the last component of their full registration numbers

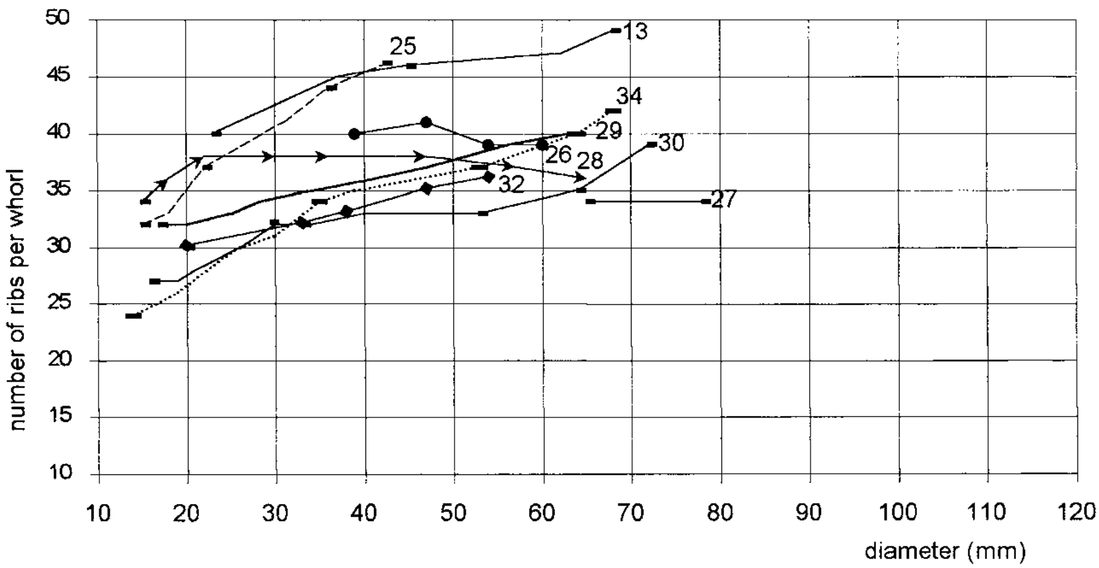

Fig. 8. Rib-density curves of *Perisphinctes* (*Platysphinctes*) *perplanatus* (m); the specimens are numbered by only the last component of their full registrationnumbers

number of intercalatories on the venter and, at the same time, toward a reduction of the distinctness of the ribs at the points where they divide. The modification of the whorl-surface is especially well shown by macroconchs, in which, based on RI the following sequence of ornamentation types can be distinguished:

Type Ia: Primary ribs bifurcate regularly at distinct point of division. Every third or fourth pair of secondary ribs is associated with one intercalatory rib. RI values vary from 2.0 to 2.3.

Type Ib: Ribs mostly bifurcate, occasionally paradischizotomous rib division appears (Text-fig. 6-4). Points of rib-division are slightly indistinct (IGPUW/A/36/21, Pl. 2, Fig. 1). Every pair of secondary ribs is associated with one, occasionally with two intercalatory ribs. RI values vary from 2.4 to 3.3.

Type Ic: Bifurcation is commonly accompanied by paradischizotomous rib-division (Text-fig. 6-4), occasionally polygyrat (Text-fig. 6-3b) or bidichotomous rib-division also occurs (Text-fig. 6-3a). The primary ribs become more widely spaced on the flank, the points of rib-division are indistinct (IGPUW/A/36/12, Pl. 2, Fig. 2). Every pair of secondary ribs is associated with two, rarely with one intercalatory. RI values vary from 3.4 to 4.0.

Type II: Last quarter of the body-chamber almost smooth, except for the weak development of blunt primaries, persisting mainly at the umbilical edge (IGPUW/A/36/5, Pl. 1, Fig. 1). The ribs on the venter remain fine and feeble up to the final aperture. RI values vary from 3.8 to 5.0, and are exceptionally as low as 3.1 (e.g. IGPUW/A/36/2 – Pl. 2, Fig. 3).

Ornamentation of type Ia characterises early juvenile macroconchs, type Ib corresponds to the middle or late juveniles, type Ic to the late juveniles, and type II is associated with the mature stage of growth and is accompanied by the crowding of the last septa on the phragmocone.

The ontogenetic changes of shell-ornamentation in microconchs of *Perisphinctes* (*Platysphinctes*) *perplanatus* are not sufficiently distinct, especially in juveniles, to allow differentiation of the types of ornamentation, recognised in the macroconchs. The juvenile microconchs are characterised by ribs bifurcating at slightly indistinct points of rib-division, by the presence of intercalatories on the venter, and by the appearance of paradischizotomous rib-division. RI values range from 2.0 to 3.0. On the body-chambers of adult microconchs, with the highest values of RI, the primary ribs strengthen on the lower half-of the flank, and divide indistinctly at 2/3 or 3/4 of the distance up the flank (IGPUW/A/36/28, Pl. 4, Fig. 8). Ribs mainly bifurcate, but sometimes show paradischizotomous rib-division mode. Polyschizotomous rib-division may develop next to the constrictions (Text-figs 6-1, 6-2). Intercalatory ribs vary in number between specimens, with RI values ranging from a minimum 2.0 to a maximum of 3.8. Adults have lappeted peristomes. The last few ribs preceding the peristome are approximated, sometimes also flexuous (IGPUW/A/36/28, Pl. 4, Fig. 8).

The infra-specific variability in macroconchs is expressed by the wide range of diameters at which the particular types of ornamentation appear in ontogeny. Type Ib ornamentation appears at diameters of 57 mm (IGPUW/A/36/53, Pl. 3, Fig. 4) and above, but not exceeding 110 mm (IGPUW/A/36/6, Pl. 3, Fig. 3); in the majority of specimens it is first noted between 66 and 88 mm diameter. Type Ic ornamentation was found already at 65 mm (IGPUW/A/36/53, Pl. 3, Fig. 4), but most commonly it starts between 85 mm (IGPUW/A/36/40, Pl. 1, Fig. 3) and 92 mm; it was rarely first found at 100 mm (IGPUW/A/36/5, Pl. 1, Fig. 1). Two specimens (IGPUW/A/36/2, Pl. 2, Fig. 3 and IGPUW/A/36/43, Pl. 1, Fig. 2) do not display the type Ic morphology, and the characters of type Ib are immediately followed by those of type II. Type II ornamentation was found to appear first between 93 mm (IGPUW/A/36/43, Pl. 1, Fig. 2) and 110 mm diameter (IGPUW/A/36/5, Pl. 1, Fig. 1).

Ornamentation in microconchs differs mainly in the number of intercalatories and, particularly in the adult stage of growth, in the distinctness of the ribs on the upper half of the flank. At one extreme of variability there is IGPUW/A/36/25 (Pl. 4, Fig. 2), with no intercalatory ribs thorough ontogeny (RI=2), characterised by slight weakening of division-points on the adult body chamber. The specific status of this species is supported by the compressed, oval whorl section, and by numerous (4) constrictions on the body-chamber. At the other extreme there is IGPUW/A/36/26 (Pl. 4, Fig. 5), with every pair of secondaries associated with one, occasionally with two, intercalatories on the body-chamber, and with RI = 3.3. An even higher RI value (3.8) occurs in the final part of the body-chamber of IGPUW/A/36/27 (Pl. 4, fig. 7). In both the last-mentioned microconchs the ribs on the body-chamber become more widely spaced and strengthen on the lower half of the flank, becoming indistinct above mid-flank. Other specimens in the collection are intermediate in respect of the rib distinctness on the adult body-chamber and the value of RI.

In macro- and microconchs the suspensive lobe is usually shorter than the lateral lobe, rarely of equal length. The external and the lateral lobes are usually of equal length, rarely the external one is somewhat longer than the lateral one. The difference between the lobe length is insignificant. The formula of the septal suture is as follows: EL>L = N (D = 70-87 mm); EL = L = N (D = 75 mm); EL = L>N (D = 39 mm).

COMPARISON: *P.* (*P.*) *perplanatus* (M) displays affinities to Lower Oxfordian *Perisphinctes* (*Prososphinctes*) *consociatus* BUKOWSKI, 1887 (see BUKOWSKI, 1887, Pl. 29, Fig. 4; Pl. 30, Figs 11, 12), the type species of the subgenus *Prososphinctes* SCHINDEWOLF, 1925. As in *P.* (*P.*) *perplanatus*, BUKOWSKI's species possesses numerous constrictions in the adult and loses ribbing on the body-chamber. It differs from TINTAN's species in the inner whorls, which are finely and densely ribbed, and it lacks constrictions. Moreover, it is less evolute throughout ontogeny, and has a more compressed shell than *P.* (*P.*) *perplanatus*.

The macroconchs of *Tenuisphinctes* (*Tenuisphinctes*) *kruegeri* GYGI, 1998 (see GYGI, 1998, Pl. 1, Fig. 1; Pl. 2, Fig. 3) and the microconchs of *Tenuisphinctes* (*Eichiniceras*) *rolandi* GYGI, 1998 (see GYGI, 1998, Pl. 9, Fig. 3; Pl. 11, Fig. 4; Pl. 12, Fig. 4), two taxa of the genus *Tenuisphinctes* GYGI, 1998 described recently from the Lower Oxfordian of the Swiss Jura, are also similar to *P.* (*P.*) *perplanatus* (M, m). These two taxa resemble *P.* (*P.*) *platysphinctes* in their evolute coiling, in possessing constrictions, and in the presence of intercalatory ribs. GYGI's forms, however, may be distinguished from *Platysphinctes* by the more compressed shell, high-oval whorl section, fine and dense ribbing, and the lower position of the points of rib-division, especially on the inner and middle whorls. In addition, in *Tenuisphinctes* (*Tenuisphinctes*) *kruegeri* the ribs become progressively less distinct already on the phragmocone, rather than only on the body-chamber, as in *P.* (*P.*) *perplanatus*.

Among the Middle Oxfordian forms closely related to *Perisphinctes* (*Platysphinctes*) *perplanatus* are *Perisphinctes* (?*Dichotomosphinctes*) aff. *episcopalis* DE LORIOL, 1901 (BOURSEAU 1977, Pl. 2, Figs 3-4) and *Perisphinctes* (?*Dichotomosphinctes*) nov. sp. ? aff. *episcopalis* DE LORIOL, 1901 (BOURSEAU 1977, Pl. 2, Figs 1-2), described from Southern France. Both the latter forms resemble the microconchs of *Perisphinctes* (*Platysphinctes*) *perplanatus* in the compressed and oval whorl section and in a moderately coarse style of ribbing, characterised by the presence of intercalatory ribs and by weakening of the ribs at the points where they divide. The only significant difference between *P.* (*P.*) *perplanatus* and the French species is the fact that BOURSEAU's forms develop fewer constrictions.

In the Middle Oxfordian material of BOURSEAU (1977), *Perisphinctes* (*Prososphinctes*) nov. sp. ?A (BOURSEAU 1977, Pl. 3, Figs 2, 3a-b) also resembles *P.* (*P.*) *perplanatus* (M). Both forms have in common the occurrence of constrictions, a similar style of ribbing; the presence of intercalatory ribs and the loss of ribbing on the body-chamber. However, BOURSEAU's species differs from *P.* (*P.*) *perplanatus* (M) in its more compressed shell, high-oval whorl section, less evolute coiling, and the lower position of the points where the ribs divide.

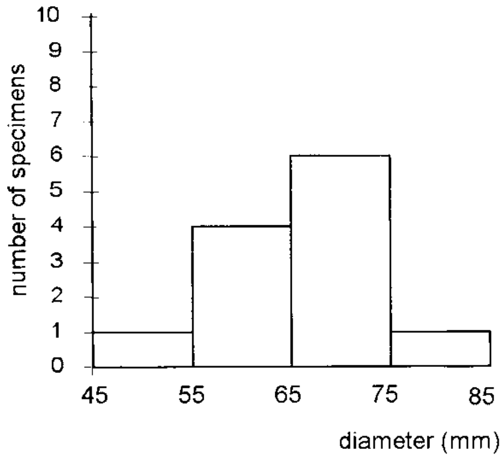

Fig. 9. Histogram of diameters of adult microconchs of *Perisphinctes* (*Platysphinctes*) *perplanatus*

OCCURRENCE: Vertebrale Subzone of the Plicatilis Zone of France (Bourgogne), Middle Oxfordian (Platysphinctes horizon) of the Polish Jura Chain, Poland.

Subgenus *Otosphinctes* BUCKMAN, 1926
Perisphinctes (*Otosphinctes*) *arkelli* sp. nov.
(Pl. 5, Figs 1-4; Text-fig. 10, Appendix 2)

non 1917. *Perisphinctes rotoides* sp. nov.; RONCHADZÉ, p. 11, Pl. 1, Fig. 8.

1937. *Perisphinctes* (*Dichotomosphinctes*) *rotoides* RONCHADZÉ; W.J. ARKELL, vol. 4, p. 90 (*pars*), Text-fig. 23-3, Pl. 16, Figs 1a,b; 2 a,b; 3 a,b; 5; 7; ?*non* Pl. 16, Figs 4 a,b; 6 a,b.

1937. *Perisphinctes* (*Dichotomosphinctes*) *antecedens* SALFELD; W.J. ARKELL, vol. 4, p. 83 (*pars*), Text-fig. 19 (3), Pl. 15, Fig. 5 only.

1966. *Perisphinctes* (*Dichotomosphinctes*) *rotoides* RONCHADZÉ; R. ENAY, p. 467, 471 (*pars*), Text-figs 137-1; 137-2, 137-5, Text-fig. 138-1, Pl. 27, Fig. 10 a-c; Pl. 27, Fig. 11a, b only.

1976. *Perisphinctes* (*Dichotomosphinctes*) *rotoides* RONCHADZÉ; W. BROCHWICZ-LEWIŃSKI, Pl. 3, Fig. 2.

1977. *Perisphinctes* (*Dichotomosphinctes*) *rotoides* RONCHADZÉ; J.P. BOURSEAU, p. 51, Text-fig. 20, Pl. 1, Fig. 6, Pl. 4, Figs 3, 8.

1981. *Perisphinctes* (*Dichotomosphinctes*) *rotoides* RONCHADZÉ transitional form to *P.* (*D.*) *antecedens* SALFELD; W. BROCHWICZ-LEWIŃSKI, Pl. 4, Fig.1 a, b.

HOLOTYPE: IGPUW/A/36/96 (Pl. 5, Fig.1) from the Arkelli Subzone of the Plicatilis Zone of the Wysoka Quarry, section W. 9" bed 12a.

DERIVATION OF THE NAME: In honour of W. J. ARKELL – the eminent student of Middle Oxfordian perisphinctids.

PARATYPES: Fourteen specimens: IGPUW/A/36/88, 97, 103 (Pl. 5, Fig. 2; Appendix 2), 104-105, 138 (Pl. 5, Fig. 3; Appendix 2), 140-142, 144 (Pl. 5, Fig. 4; Appendix 2), 145, 146, 306, 310. They come from the Wysoka Quarry (Text-fig. 3): section W. 5 beds 4b, 5b, 6a, 6b, 6c; W.8 bed 11; W.9 beds 16, 16a; W. 9" beds 12a-holotype, 12b, 16, and from the Ogrodzieniec Quarry: section O.4' bed 3.

DIAGNOSIS: microconchs, maximum diameter of adults 72 mm to 110 mm. Coiling evolute or moderately evolute; shell robust to compressed, with oval or subrectangular whorl-section. Ribbing moderately coarse and moderately spaced on the flank, straight, occasionally, close to the final peristome, flexuous on the flank. Parabolic structures absent or occasional, developed as oblique ribs on the inner whorls, and, on the outer whorl, as a zigzag rib pattern on the venter, or, rarely, as parabolic nodes. Constrictions rare.

DESCRIPTION: The holotype is a slightly distorted specimen, with a partially damaged phragmocone and no discernible septa. The final diameter is 88 mm. It represents a mature individual, as indicated by the lappets at the peristome, and by the flexural inflexion of the last ribs. The whorl section changes gradually from subcircular on the inner whorls, to oval, slightly higher than wide, on the body-chamber. The coiling is moderately evolute,

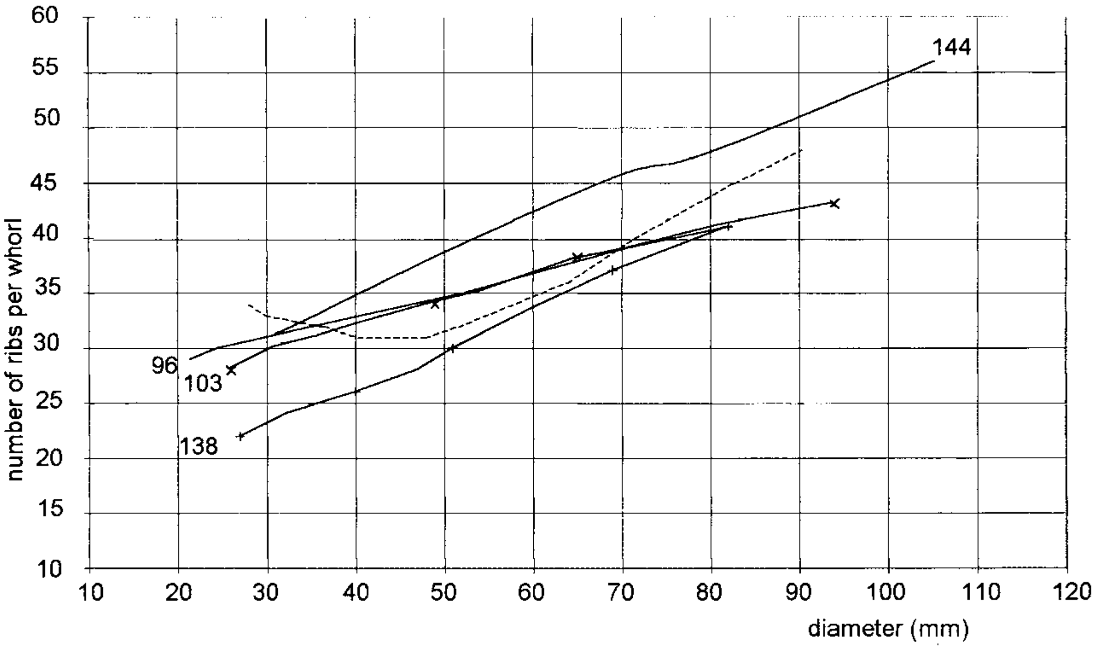

Fig. 10. Comparison of rib-density curves of *Perisphinctes* (*Otosphinctes*) *arkelli* sp. nov. (continuous lines) and of the holotype of *Perisphinctes rotoides* RONCHADZÉ (strippled line); the specimens of *P.* (*O.*) *arkelli* sp. nov. are numbered by only the last component of their full registration numbers

with U_m/D_m = 0.51, W_m/D_m = 0.27 and W_m/U_m = 0.52 at the final diameter of 88 mm (Appendix 2).

The paratypes are complete specimens, all of them adult. Their maturity is indicated by the presence of lappets, which are present in eight specimens, and by the approximation and, in some cases, the flexural inflexion of the last few ribs. The final diameter ranges from 72 mm to 110 mm. The difference between the largest and the smallest specimens corresponds to 3/4 of the whorl length. The body-chamber begins between 47 mm to 90 mm diameter, and it is 3/4 to 5/8 as long as the last whorl.

Coiling is moderately evolute to evolute at all growth stages. Between 72 and 110 mm diameter $\overline{U_m/D_m}$ = 0.53 (OS = 0.02), $\overline{W_m/D_m}$ = 0.25 (OS = 0.02), and W_m/U_m ranges from 0.40 to 0.55.

Two intergrading morphotypes are distinguished in the studied material. The *robust morphotype* (Pl. 5, Figs 1-3) is represented by rather robust shells, with the whorl section changing from subcircular to oval, slightly higher than wide, on the outer whorls. The *compressed morphotype* (Pl. 5, Fig. 4) posses-ses a rather compressed shell with an subrectangular to oval whorl-section, where the height exceeds the width. In the *robust morphotype* the ribbing is moderately coarse, the primaries are almost rectiradiate, the ribs bifurcate and the secondaries, less clear than the primaries, pass straight across the venter, curving slightly backwards close to the peristome. The rib-number rises gently from 20-30 at 25 mm diameter to 40 ribs per whorl at 70 mm (Text-fig. 10). Parabolic structures appear rarely. On the phragmocone they are represented by oblique ribs, on the outer whorl they appear occasionally as a zigzag pattern of secondary ribs on the venter. Parabolic nodes occur in the final part of the body-chamber, but they are extremely rare. Constrictions are occasional or absent. In the *compressed morphotype* the ribs are finer, more densely spaced and more prorsiradiate than in the *robust morphotype*. The rib-number increases from approximately 30-40 at 30 mm diameter to 49-55 at 100 mm (Text-fig. 10). The ribs bifurcate and the secondaries, almost as prominent as the primaries, cross over the venter, describing a shallow sinus towards the aperture. Parabolic structures are missing on the outer whorl, and on the phragmocone they are represented by rare oblique ribs. Constrictions are not common, with one or two appearing occasionally on each whorl.

DISCUSSION: According to a recent study, the holotype of *P. rotoides* RONCHADZÉ (1917, Pl. 1, Fig. 2) is an early evolutionary representative of the subgenus *Dichotomoceras* BUCKMAN, 1919 that occurs in the Schilli Subzone of the Transversarium Zone (GYGI & PERSOZ 1986, p. 440, 442). Consequently, the English forms from the Plicatilis Zone referred by ARKELL (1937, vol. 4, p. 90) to RONCHADZE's species, as well as forms from France and Poland later also referred by other authors to the same species (see the synonymy of *Perisphinctes* (*Otosphinctes*) *arkelli* sp. nov. in this paper) represent a separate species, which is described here as *Perisphinctes* (*Otosphinctes*) *arkelli* sp. nov. In the present paper, *Perisphinctes* (*Otosphinctes*) *arkelli* sp. nov. is assigned to the subgenus *Otosphinctes* BUCKMAN, 1926, and not to the subgenus *Dichotomosphinctes* BUCKMAN, 1926. *P.* (*O.*) *arkelli* sp. nov. displays features of the subgenus *Otosphinctes*, such as the relatively small final size of specimens, the secondary ribs passing straight across the venter with a more or less marked backward inflexion close to the peristome, the secondaries less prominent than the primaries, and the presence of parabolic structures. These features make the new species distinct from representatives of the subgenus *Dichotomosphinctes* BUCKMAN, 1926.

Perisphinctes (*Otosphinctes*) *arkelli* sp. nov. [=*Perisphinctes* (*Dichotomosphinctes*) *rotoides* *sensu* ARKELL, 1937 *non* RONCHADZÉ, 1917] differs from *Perisphinctes rotoides* RONCHADZÉ, 1917 in the uniform increase in the number of primary ribs per whorl, so that its rib-density curve rises gently at all diameters, whereas in *P. rotoides* the rib-density curve is U-shaped between diameters of 20 mm to 60 mm (Text-fig. 10). There is also a significant difference between the two forms in the style of ribbing on the venter. In *P.* (*O.*) *arkelli* sp. nov. the secondary ribs are less prominent than the primaries and pass straight across the venter, usually curving slightly backwards close to the peristome, with only occasionally a shallow sinus towards the aperture; whereas in *Perisphinctes rotoides* RONCHADZÉ the secondary ribs are as prominent as the primaries and describe a prominent sinus on the venter.

From the microconchs of *Perisphinctes* (*Otosphinctes*) *ouatius* (BUCKMAN, 1926) and *Perisphinctes* (*Otosphinctes*) *magnouatius* ARKELL, 1937, *Perisphinctes* (*Otosphinctes*) *arkelli* sp. nov. is distinguished by its larger final size and by less common parabolic structures.

Perisphinctes (*Otosphinctes*) *arkelli* sp. nov., particularly its *compressed morphotype*, displays considerable affinity to *Perisphinctes* (*Dichotomosphinctes*) *antecedens* SALFELD, 1914. There is no significant difference between them in respect of the type of coiling, whorl-section, pattern of ribbing and changes of rib-density on the whorl, indicating that they are closely related forms. *P.* (*O.*) *arkelli* sp. nov. differs from *P.* (*D.*) *antecedens* in its smaller final diameter with no specimens of intermediate size between both species, in the rare presence of parabolic nodes (these are completely absent in *P.* (*D.*) *antecedens*), and in some details of the ribbing, such as the secondary ribs being less prominent, less distinct on the venter, and also in being straight or arched backwards on the venter, only occasionally forming a shallow sinus towards the aperture (such a sinus is always clearly defined in *P.* (*D.*) *antecedens*).

OCCURRENCE: England, France, Poland, the Arkelli Subzone of the Plicatilis Zone and the lowermost Buckmani Subzone of the Transversarium Zone, of the Middle Oxfordian.

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I. Specimen's number, number of plate and figure	II. Location of the specimen (Text-fig. 3)	III. D_m:D_f [1)] *Dm:Df or *D_f [mm]	IV. D_m [1)] D [mm]	V. U and W [1)] measured at diameter given in the column IV			VI. W_{n-1}/W [1)]	VII. D[mm]:n
				U/D	W/D	W/U		
IGPUW/A/36/1	W.9".20	*80:71	67	0.42	0.31	0.75	-	36:32 60:45 43:36 71:47 50:40 78:47
IGPUW/A/36/2 Pl. 2, Fig. 3	W.9".20	*120:72	42	0.59	0.29	0.52	-	21:29 49:34 26:29 57:39 30:30 67:39 37:32 75:42
IGPUW/A/36/3	W.9".20	106:?	-	-	-	-	-	70:47 95:48 85:48
IGPUW/A/36/5 Pl. 1, Fig. 1	W.9"20	121:77	121 76 41	0.49 0.50 0.44	0.25 0.31 0.29	0.52 0.63 0.67	0.71 -	24:33 83:47 33:37 96:44 64:45 100:41
IGPUW/A/36/6 Pl. 3, Fig. 3	W.9".20	*105:75	104 74 45	0.52 0.49 0.49	0.28 0.28 0.33	0.54 0.58 0.68	0.72 - -	23:30 64:42 40:34 68:45 48:36 91:50 55:39 105:50
IGPUW/A/36/7	W.9.14a	*95:60	95 85 45	0.46 0.47 0.47	0.26 0.30 0.29	0.57 0.65 0.62	- - -	22:28 54:44 26:30 63:48 30:31 85:49 46:39 95:49
IGPUW/A/36/8 Pl. 3, Fig. 2	W.9.14a	103:62	101	0.49	0.28	0.55	0.64	95:45 100:43
IGPUW/A/36/11	W.9.14a	*122:82	-	-	-	-	-	———
IGPUW/A/36/12 Pl. 2, Fig. 2	W.9.14a	*107:67	105 44	0.53 0.45	0.27 0.32	0.50 0.70	0.68 -	40:37 95:36 70:37 106:35
IGPUW/A/36/14	W.9.14a	81:40	77 61	0.49 0.46	0.28 0.29	0.58 0.64	- -	42:43 62:48 45:45 74:51 53:46 80:50
IGPUW/A/36/15	W.8.12	* 74:44	73	0.49	0.27	0.55	-	22:31 42:35 27:32 51:37 30:32 57:39 35:34 68:42
IGPUW/A/36/16	W.8.12	*65:42	63 40	0.48 0.42	0.28 0.35	0.60 0.82	- -	46:42 65:44 55:44
IGPUW/A/36/17	W.8.12	82:?	-	-	-	-	-	67:47 83:51
IGPUW/A/36/19	W.8.12	*122:86	106 45	0.54 0.47	0.26 0.31	0.49 0.67	0.46 -	42:38 97:51 87:49 114:52
IGPUW/A/36/21 Pl. 2, Fig. 1	W.5.5a	95:57	80 40	0.49 0.45	0.27 0.30	0.56 0.67	- 0.42	21:34 40:38 23:35 55:43 29:36 62:46 33:37 85:47
IGPUW/A/36/39	W.8.12	89:?	-	-	-	-	-	24:33 48:43 28:35 63:46 34:40 87:45
IGPUW/A/36/40 Pl. 1, Fig. 3	W.8.12	* 90:?	87 48	0.50 0.46	0.29 0.33	0.57 0.73	- -	———
IGPUW/A/36/42	W.8.12	96:57	-	-	-	-	-	96:45
IGPUW/A/36/43 [2)] Pl. 1, Fig. 2	O. [3)]	*105:87	105 45	0.46 0.47	0.28 0.31	0.62 0.67	- -	27: 29 47:35 34:30 92:50 39:33 105:44
IGPUW/A/36/44 [2)]	O. [3)]	*80:48	77 44	0.52 0.45	0.27 0.29	0.52 0.65	0.62 -	45:44 65:50 49:47 78:50 58:47 82:50
IGPUW/A/36/45 [2)]	O. [3)]	*74:46	45	0.47	0.29	0.62	0.54	32:25 54:33 36:24 61:36 42:26 72:39

IGPUW/A/36/46[2]	O.[3]	*90:74	73	0.48	0.29	0.60	-	32:33 57:40 37:34 65:41 42:35 75:42 51:37 87:42
IGPUW/A/36/47[2]	O.[3]	*78	-	-	-	-	-	36:33 57:40 42:34 66:41 48:38 77:43
IGPUW/A/36/48[2]	O.[3]	*90:68	-	-	-	-	-	32:34 77:33 68:33 90:33
IGPUW/A/36/49[2]	O.[3]	*110:80	105 68 40	0.35 0.51 0.50	0.25 0.28 0.30	0.45 0.54 0.60	- 0.53 -	28:31 67:42 33:33 75:44 37:35 86:45 49:38 111:45
IGPUW/A/36/50[2]	O.[3]	*117:82	105 40	0.48 0.45	0.28 0.35	0.57 0.78	- -	105:37 117:37
IGPUW/A/36/51	O.4.2c	81:52	75 51	0.52 0.51	0.27 0.27	0.51 0.54	0.59 -	74:48 82:49
IGPUW/A/36/53 Pl. 3, Fig. 4	W.5.5a	*77:?	75	0.47	0.31	0.66	0.65	15:30 22:34 18:33 31:36
IGPUW/A/36/343	O.1.2(top)	81:45	46	0.50	0.30	0.61	0.57	33:37 75:43
D_m = (95 mm - 106 mm): U_m/D_m = 0.50 (OS = 0.03), W_m/D_m = 0.27 (OS = 0.01), W_m/U_m = (0.45; 0.49) i (0.50 - 0.62)							W_{n-1}/W = (0.46 - 0.72)	
D = (67 mm - 77 mm): $\overline{U/D}$ = 0.49 (OS = 0.03), $\overline{W/D}$ = 0.29 (OS = 0.02) W/U = (0.51 - 0.63); 0.75							W_{n-1}/W = (0.53 - 0.65)	
D = (40mm - 48 mm): $\overline{U/D}$ = 0.47(OS = 0.04), $\overline{W/D}$ = 0.31 (OS = 0.02) W/U = (0.52 - 0.73); (0.78; 0.80)							W_{n-1}/W = (0.42 - 0.57)	

Appendix 1. Location and biometrical data of macroconchs of *Perisphinctes* (*Platysphinctes*) *perplanatus*. [1] shell diameter and/or phragmocone diameter of an adult specimen, if state of preservation permits them to be measured, are underlined. [2] specimens collected by undergraduate students of the Institute of Geology, University of Warsaw. [3] specimens collected loose

I. Specimen's number, number of plate and figure	II. Location of the specimen (see Text-fig. 3)	III. D_m:D_f[1] *Dm:Df or *D_f [mm]	IV. D_m[1], D [mm]	V. U and W[1] measured at a diameter given in column IV U/D	 W/D	 W/U	VI. W_{n-1}/W[1]	VII. D[mm]:n
IGPUW/A/36/96 HOLOTYPE Pl. 5, Fig.1	W.9".12a	88:?	88 47	0.51 0.50	0.27 0.27	0.52 0.54	0.59 -	22:29 62:37 25:30 71:39 53:35 83:41
IGPUW/A/36/103 PARATYPE Pl. 5, Fig.2	W.8.11	94:60	94 52	0.51 0.50	0.26 0.26	0.50 0.52	0.58 -	26:28 54:35 31:30 65:38 36:31 71:39 40:32 81:41 49:34 94:43
IGPUW/A/36/138 PARATYPE Pl. 5, Fig.3	W.5.4b	84:54	84 44	0.51 0.45	0.27 0.28	0.52 0.62	0.59 -	27:22 51:30 32:24 61:34 40:26 69:37 47:28 82:41
IGPUW/A/36/144 PARATYPE Pl.5, Fig.4	W.5.6a	104:73	104 61	0.58 0.57	0.23 0.25	0.40 0.44	0.62 0.60	31:31 64:42 36:33 70:46 42:36 80:48 48:39 90:52 56:41 105:56

Appendix 2. Location and biometrical data of holotype and paratypes of *Perisphinctes* (*Otosphinctes*) *arkelli* sp. nov. figured in this paper. [1] shell – diameter and/or phragmocone – diameter of an adult specimen, if state of preservation permits them to be measured, are underlined

I. Specimen's number, number of plate and figure	II. Location of the specimen (Text-fig. 3)	III. D_m:D_f [1)] *Dm:Df or *D_f [mm]	IV. D_m [1)], D [mm]	V. U and W [1)] measured at a diameter given in column IV			VI. W_{n-1}/W [1)]	VII. D[mm]:n
				U/D	W/D	W/U		
IGPUW/A/36/13	W.9.14a	65:43	65	0.49	0.29	0.59	0.63	19:40 37:45 23:40 45:46 27:44 62:47 33:43 68:49
IGPUW/A/36/25 Pl. 4, Fig. 2	W.5.4b	45:27	44 20	0.48 0.50	0.29 0.30	0.57 0.60	0.48 -	15:32 23:40 18:33 31:41 20:35 36:44 22:37 42:46
IGPUW/A/36/27 Pl. 4, Fig. 7	W.9.14a	77:47	77	0.49	0.26	0.53	-	65:34 78:34
IGPUW/A/36/28 Pl. 4, Fig. 8	W.8.12	66:40	66 28	0.48 0.43	0.29 0.28	0.59 0.67	0.53 -	15:34 36:38 18:36 40:40 22:38 47:38 26:40 57:37 30:38 65:36
IGPUW/A/36/29 Pl. 3, Fig. 6	W.8.12	64:41	64 30	0.48 0.47	0.28 0.30	0.58 0.64	- 0.55	17:32 41:36 20:32 47:37 25:33 56:39 28:34 63:40
IGPUW/A/36/30 Pl. 3, Fig. 1	W.8.12	72:44	70 30	0.51 0.47	0.26 0.30	0.50 0.64	0.67 -	19:27 34:32 21:28 53:33 26:30 64:35 30:32 72:39
IGPUW/A/36/31	W.8.12	71:50	71	0.50	0.27	0.54	-	71:40
IGPUW/A/36/32 Pl. 4, Fig. 3	W.8.12	53:35	53 32	0.47 0.47	0.30 0.31	0.64 0.67	- -	20:30 38:33 24:32 47:35 27:33 54:36
IGPUW/A/36/34 Pl. 4, Fig. 6	W.8.12	70:41	66 39 28	0.51 0.49 0.50	0.27 0.28 0.28	0.53 0.58 0.57	- - -	14:24 35:34 19:26 39:35 24:29 47:35 26:30 53:37 30:31 68:42
IGPUW/A/36/35	W.8.12	62:42	59	0.52	0.25	0.48	-	34:35 52:45 45:40 58:45
IGPUW/A/36/36	W.8.12	66:45	66	0.49	0.26	0.53	-	45:36 61:38 50:37 67:39
IGPUW/A/36/38 Pl. 4, Fig. 4	W.8.12	63: ?	63	0.49	0.28	0.58	0.50	———————
IGPUW/A/36/23	W.9'.16	*55:38	55 29	0.51 0.52	0.27 0.31	0.53 0.60	0.60 -	18:33 42:37 25:34 55:39
IGPUW/A/36/26 Pl. 4, Fig. 5	W.5.4b	57:40	55 34	0.45 0.41	0.31 0.29	0.68 0.71	0.47 -	39:40 54:39 47:41 60:39
IGPUW/A/36/33 Pl. 3, Fig. 5	W.8.12	56:?	33	0.48	0.30	0.62	-	18:33 39:34 30:34 47:35
IGPUW/A/36/52 Pl. 4, Fig. 1	O.4.2c	56:33	54 34	0.50 0.47	0.28 0.29	0.55 0.62	- -	25:38 50:42 45:42
D_m = (63 mm - 77 mm): $\overline{U_m/D_m}$ = 0.49 (OS = 0.01), $\overline{W_m/D_m}$ = 0.27 (OS = 0.01) W_m/U_m = (0.50 - 0.59)							W_{n-1}/W = (0.53 - 0.67)	
D = (28 mm - 34 mm): $\overline{U/D}$ = 0.47 (OS = 0.03), $\overline{W/D}$ = 0.29 (OS = 0.01) W/U = (0.57 - 0.71)							W_{n-1}/W = 0.55	

Appendix 3. Location and biometrical data of microconchs of *Perisphinctes* (*Platysphinctes*) *perplanatus*. [1)] shell – diameter and/or phragmocone – diameter of an adult specimen, if state of preservation permits them to be measured, are underlined

PLATE 1

1-3 – *Perisphinctes* (*Platysphinctes*) *perplanatus* (TINTANT, 1961)
1 – IGPUW/A/36/5; macroconch; Wysoka, W.9" bed 20
2 – IGPUW/A/36/43; macroconch; Ogrodzieniec, collected loose
3 – IGPUW/A/36/40; macroconch; Wysoka, W.8 bed 12

All figures natural size; arrows indicate end of the phragmocone

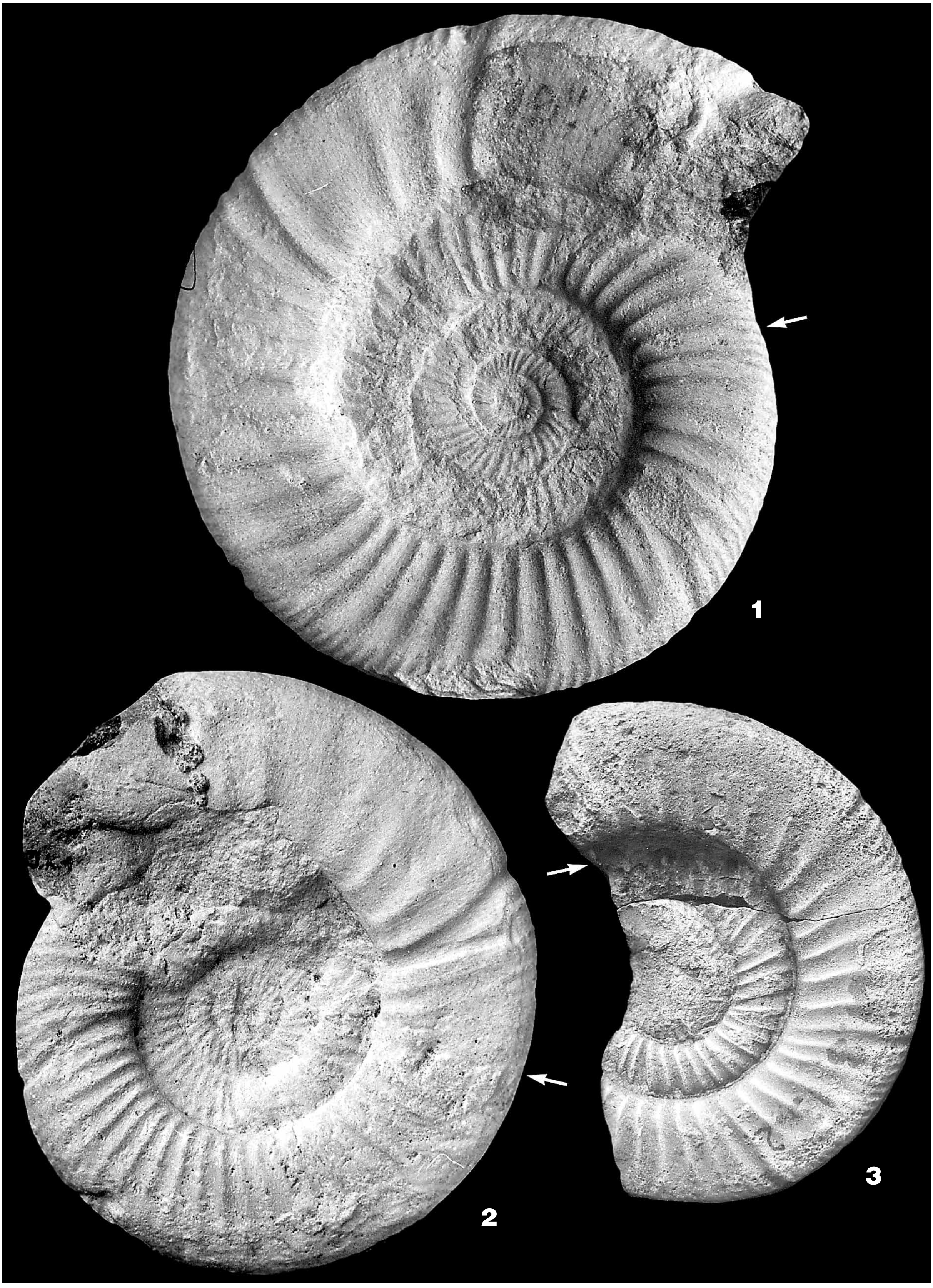
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PLATE 2

1-3 – *Perisphinctes* (*Platysphinctes*) *perplanatus* (TINTANT, 1961)
1 – IGPUW/A/36/21; macroconch; Wysoka, W.5 bed 5a
2 – IGPUW/A/36/12; macroconch; Wysoka, W.8 bed 12
3 – IGPUW/A/36/2; macroconch; Wysoka, W.9”. bed 20

All figures natural size; arrows indicate end of the phragmocone


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PLATE 3

1-6 – *Perisphinctes* (*Platysphinctes*) *perplanatus* (TINTANT, 1961)
1 – IGPUW/A/36/30; microconch; Wysoka, W.8 bed 12
2 – IGPUW/A/36/8; macroconch; Wysoka, W.9 bed 14a
3 – IGPUW/A/36/6; macroconch; Wysoka, W.9” bed 20
4 – IGPUW/A/36/53; macroconch; Wysoka, W.5 bed 5a
5 – IGPUW/A/36/33; microconch; Wysoka, W.8 bed 12
6 – IGPUW/A/36/29; microconch; Wysoka, W.8 bed 12

All figures natural size; arrows indicate end of the phragmocone

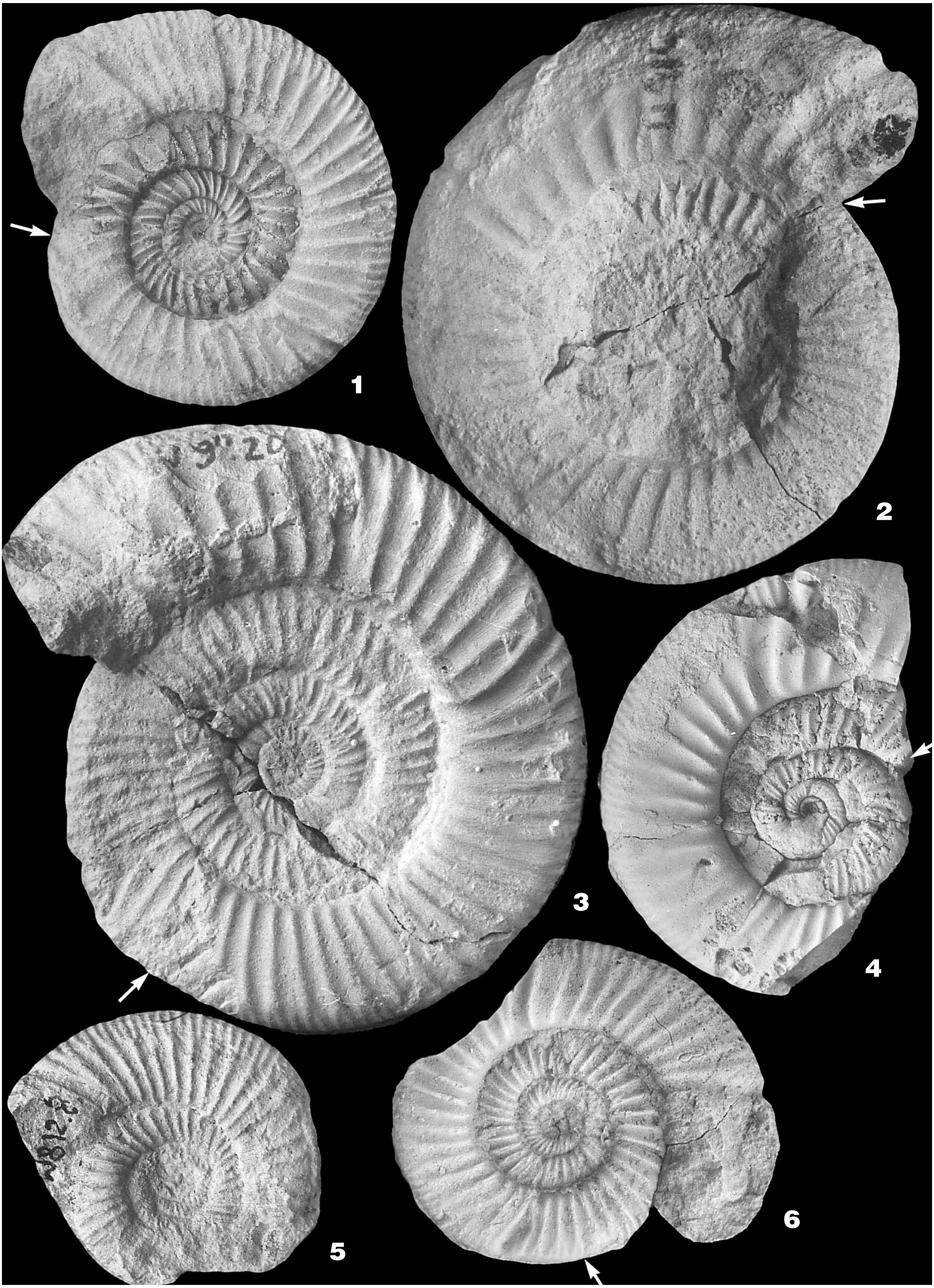

PLATE 4

1-8 – *Perisphinctes* (*Platysphinctes*) *perplanatus* (TINTANT, 1961)
1 – IGPUW/A/36/52; microconch; Ogrodzieniec, O.4. bed 2c
2 – IGPUW/A/36/25; microconch; Wysoka, W.5 bed 4b
3 – IGPUW/A/36/32; microconch; Wysoka, W.8 bed 12
4 – IGPUW/A/36/38; microconch; Wysoka, W.8 bed 12
5 – IGPUW/A/36/26; microconch; Wysoka, W.5 bed 4b
6 – IGPUW/A/36/34; microconch; Wysoka, W.8 bed 12
7 – IGPUW/A/36/27; microconch; Wysoka, W.9 bed 14a
8 – IGPUW/A/36/28; microconch; Wysoka, W.8 bed 12

All figures natural size; arrows indicate end of the phragmocone

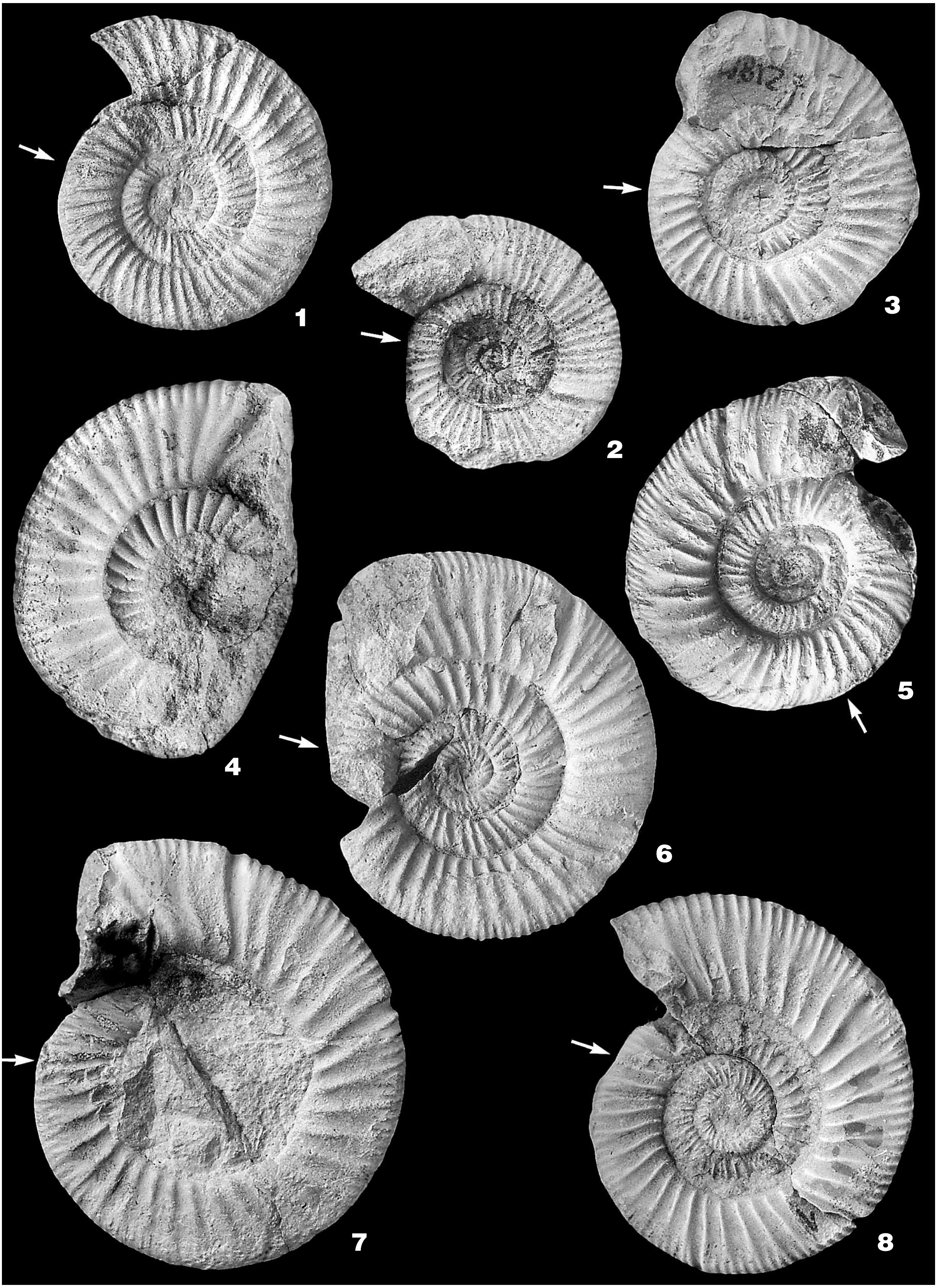
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PLATE 5

1-4 – *Perisphinctes* (*Otosphinctes*) *arkelli* sp. nov.

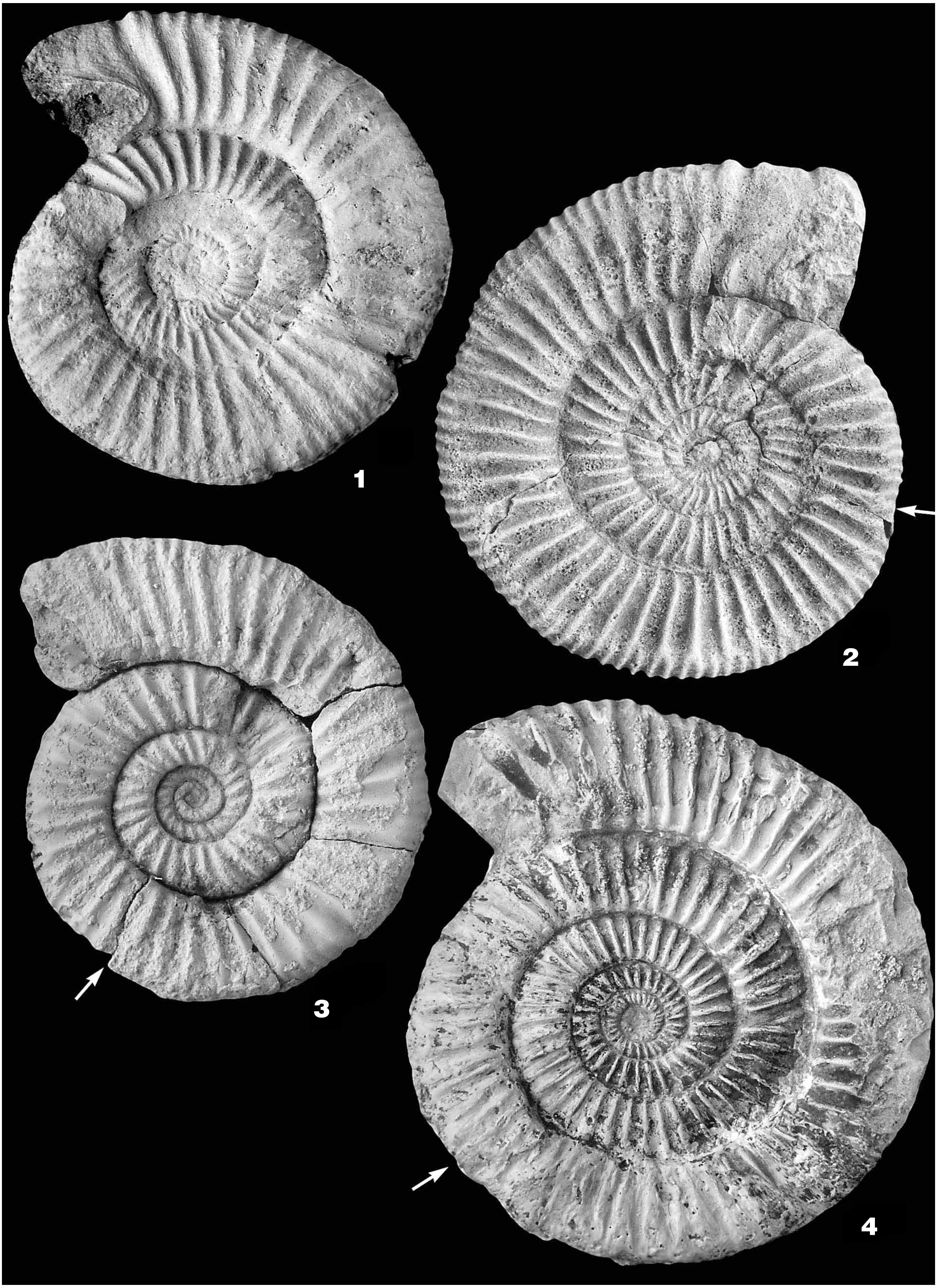
1 – IGPUW/A/36/96, holotype (*robust morphotype*); Wysoka, W.9" bed 12a

2 – IGPUW/A/36/103, paratype (*robust morphotype*); Wysoka, W.8 bed 11

3 – IGPUW/A/36/138, paratype (*robust morphotype*); Wysoka, W.5 bed 4b

4 – IGPUW/A/36/144, paratype (*compressed morphotype*); Wysoka, W.5 bed 6a

All figures natural size; arrows indicate end of the phragmocone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