

# The genus *Biernatella* BALIŃSKI, 1977 (Brachiopoda) from the late Frasnian of Belgium

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## Abstract

The genus *Biernatella* (Brachiopoda; Athyridida), characterized by the presence of a diplospirium, is definitely recognized for the first time in the late Frasnian (Lower – Upper *Palmatolepis rhenana* Zones) of the southern flank of the Dinant Synclinorium and of the Philippeville Anticlinorium (southern Belgium). A new species (*B. abunda* n. sp.) from the Neuville Formation (Dinant Synclinorium) is described. In the Philippeville Anticlinorium, *B. abunda* n. sp. occurs in the Neuville Formation and probably at the base of the Les Valisettes Formation but specifically unidentified specimens of *Biernatella* have also been collected near the top of this last formation.

**Key-words:** Brachiopods. *Biernatella*. Late Frasnian. Systematic palaeontology.

## Résumé

Le genre *Biernatella* (Brachiopoda; Athyridida), caractérisé par la présence d'un diplospirium, est formellement reconnu pour la première fois dans le Frasnien terminal (Zones inférieure et supérieure à *Palmatolepis rhenana*) au bord sud du Synclinorium de Dinant et dans l'Anticlinorium de Philippeville (sud de la Belgique). Une nouvelle espèce (*B. abunda* n. sp.) provenant de la Formation de Neuville (Synclinorium de Dinant) est décrite. Dans l'Anticlinorium de Philippeville, *B. abunda* n. sp. est présente dans la Formation de Neuville et probablement à la base de la Formation des Valisettes, mais des fragments indéterminés de *Biernatella* ont également été récoltés près du sommet de cette dernière formation.

**Mots-clefs:** Brachiopodes. *Biernatella*. Frasnien terminal. Paléontologie systématique.

## Introduction

Among the Frasnian macrofauna of the Dinant Synclinorium (Belgium), many smooth and small brachiopods have been determined under the name *Nucleospira lens* (SCHNUR, 1851) by numerous authors [e. g. DUPONT (1882, p. 122, p. 124, p. 126, p. 138, pp. 148-149), DUMON (1929, p. 143, p. 150, p. 159, p. 164, p. 171, p. 175),

MAILLIEUX (1941, p. 11)]. The study of the internal characters (e.g. the existence of a diplospirium) of one of them allowed to confirm the presence of *Biernatella* BALIŃSKI 1977 in the late Frasnian (Neuville, Les Valisettes and Matagne formations) of Belgium, presence already suggested by BALIŃSKI (1995, p. 134).

Until now, the genus *Biernatella* was formally recognized in the Givetian and in the Frasnian from southern Poland by three species: *B. ovalis* BALIŃSKI 1995 (*Klapperina disparilis* - *Mediotaxis falsiovalis* Zones), *B. lentiformis* BALIŃSKI 1995 (*Palmatolepis hassi* - *P. rhenana* Zones) and *B. polonica* BALIŃSKI, 1977 (*P. hassi* - *P. linguiformis* Zones). *Athyris minuta* KLÄHN, 1912 from the Frasnian of the Aachen region (Germany) is transferred to *Biernatella* on the basis of the study of some specimens from HOLZAPFEL's collection housed at the "Institut de Géologie, Université Louis Pasteur" at Strasbourg; it confirms BALIŃSKI's suggestion (2002, p. 300) concerning the generic position of this species. According to KLÄHN (1912, p. 37), *B. minuta* occurs in the Frasnian "Knollenkalke" to the "Matagne-Schiefer"; KREBS & ZIEGLER (1965, p. 737) placed the base of the "Knollenkalke" in the Upper *P. gigas* Zone (see also SARTENAER & HARTUNG, 1992, tab. 1). YUDINA (1996a, p. 317) cited the genus in the late Frasnian of the Liyayel and Sedyu Suites in South Timan. The same year, YUDINA (1996b) included the genus *Sedjulina* LYASHENKO, 1985 (type-species: *Sedjulina timanica* LYASHENKO, 1985) in synonymy with *Biernatella*. BRICE in JOSEPH *et al.* (1980, p. 38) signaled the genus with doubt in the Frasnian of the Pyrenees (France).

All figured and measured specimens are stored at the Royal Belgian Institute of natural Sciences at Brussels, where they are registered under the numbers IRScNB a12015 – a12025.

## Stratigraphy (Fig. 1)

The specimens assigned to the genus *Biernatella* and described in this note have been collected in the late Frasnian Neuville Fm on the southern border of the Dinant Synclinorium [for a detailed description of the

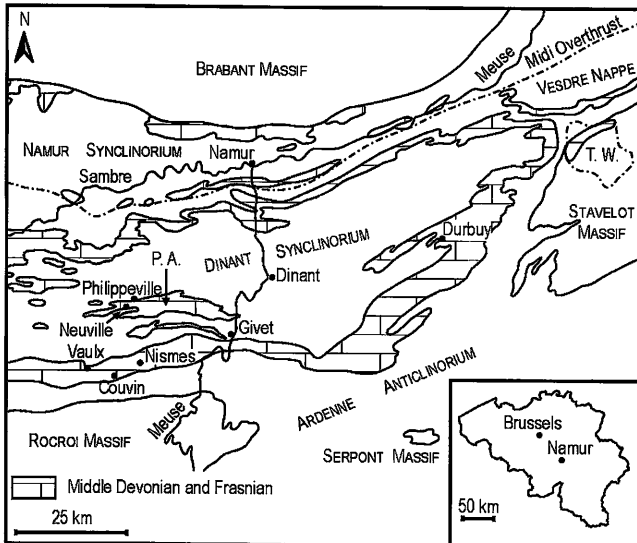


Fig. 1 — Schematic geological map of southern Belgium with location of the fossiliferous localities. P. A.: Philippeville Anticlinorium; T. W.: Theux Window.

formations quoted below, see BOULVAIN *et al.* (1999)]. In this area, the Neuville Fm (Lower *P. rhenana* Zone) is represented by shales with calcareous nodules, but in the Philippeville Anticlinorium, it comprises essentially nodular limestones with levels of nodular shales. Its thickness varies from about twenty meters in the Philippeville Anticlinorium to a hundred meters on the southeastern flank of the Dinant Synclinorium.

In the Philippeville Anticlinorium, the Neuville Fm is surmounted by the usually shaly Les Valisettes Fm. However, in the case of the stratotype (Neuville railway section), it contains red to green nodular limestones and shales with calcareous nodules (thickness: at least 90 m in the type area). At Neuville, the base of the Les Valisettes Fm is just below the Upper *P. rhenana* Zone [BULTYNCK *et al.* (1998, p. 48, fig. 12)]. According to COEN as cited by BULTYNCK & DEJONGHE in BOULVAIN *et al.* (1999, p. 6), the Les Valisettes Fm is restricted to the Philippeville Anticlinorium where it was defined at the origin, but nevertheless, it has sometimes been used for designating the shaly episodes between the Neuville and Matagne formations on the southern flank of the Dinant Synclinorium, and between the Neuville and Barvaux formations on the eastern border of this synclinorium [see also the discussion of BULTYNCK & DEJONGHE in BOULVAIN *et al.* (1999, p. 6)]. Numerous reddish-pinkish massive limestone mounds are developed in the Neuville and Les Valisettes formations and are included in the Petit-Mont Member.

The Matagne Fm consists of dark greenish-brown to black shales with some dark limestone beds in the lowermost part. The fauna is characterized by small bivalves (*Buchiola*), brachiopods [mainly *Ryocarhynchus tumidus* (KAYSER, 1872)] and goniatites. Its thickness is about

10 m in the Philippeville Anticlinorium and at least 50 m on the southern flank of the Dinant Synclinorium. According to BULTYNCK *et al.* (1998, p. 62), the base of the formation is below or above the base of the Upper *P. rhenana* Zone in the southern central part of the Dinant Synclinorium, but at Neuville, the formation is comprised in the *P. linguiformis* Zone.

### Systematic palaeontology

Abbreviations: L – length of the pedicle valve, ULd – unrolled dorsal length, ULv – unrolled ventral length, T – thickness of the shell, W – width of the shell, Wh – width of the hinge line.

Order Athyridida BOUCOT, JOHNSON & STATON, 1964  
 Suborder Athyrididina BOUCOT, JOHNSON & STATON, 1964  
 Superfamily Athyridoidea DAVIDSON, 1881  
 Family Athyrididae DAVIDSON, 1881  
 Subfamily Helenathyridinae DAGYS, 1974  
 Genus *Biernatella* BALIŃSKI, 1977

#### Type-species

*Biernatella polonica* BALIŃSKI 1977

#### *Biernatella abunda* n. sp.

Figures 2-7; Table 1

- e. p. 1933 – *Nucleospira lens* – MAILLIEUX, p. 81.  
 1936 – *Nucleospira lens* (Schnur) – MAILLIEUX, pp. 29-30.  
 e. p. 1940 – *Nucleospira lens* (Schnur) – MAILLIEUX, p. 27.  
 e. p. 1941 – *Nucleospira lens* (Schnur) – MAILLIEUX, p. 11.

#### DERIVATIO NOMINIS

*Abundus*, *a*, *um* (Latin, adjective): abundant.

#### TYPES

Holotype: IRScNB a12015 (Fig. 2a-e); Paratypes A: IRScNB a12016 (Fig. 2f-j); B: IRScNB a12017 (Fig. 2k-o); C: IRScNB a12018 (Fig. 3a-e), D: IRScNB a12019 (Fig. 3f-j), E: IRScNB a12020 (Fig. 3k), F: IRScNB a12021 (Fig. 3l), G: IRScNB a12022 (Fig. 3m), H: IRScNB a12023 (Figs. 5, 6A), I: IRScNB a12024 (Fig. 6B). Holotype and paratype C have been collected between 82.5 m – 87 m from the southwestern extremity of the outcrop; paratype A, between 78.5 m – 82.5 m; paratype B, at 97 m; paratypes D, H and I, between 87 m – 97 m; paratypes E, F and G, between 75.5 m – 78.5 m.

#### LOCUS TYPICUS

*Topographic map 1:25000 Chimay – Couvin (57/7-8)*

Eastern side of a short blind road to the north of Vaulx (Figs. 1, 7) [grid references of the northern extremity of the outcrop (Belgian Lambert system): X = 150.050; Y = 84.550]. GODEFROID & HELSEN (1998, p. 271, fig. 2E) described this outcrop and its atrypid brachiopods succession. I consider that the dark grey limestone beds signaled by these authors correspond to the base of the Matagne Fm as defined by COEN *et al.* (1999, p. 57), although they are devoid of goniatites and bivalves.

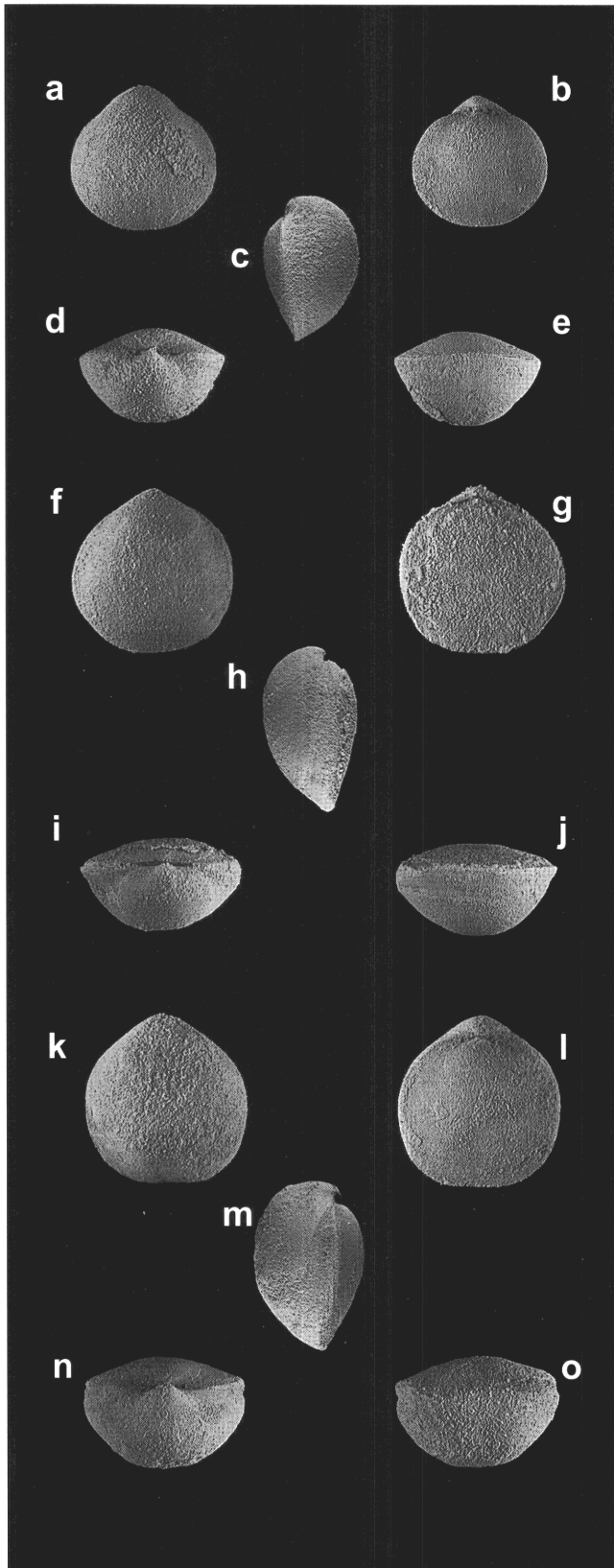


Fig. 2 — *Biernatella abunda* n. sp., Vaulx, Neuville Formation. a-e: holotype, specimen IRScNB a12015; f-j: paratype A, specimen IRScNB a12016; k-o: paratype B, specimen IRScNB a12017. a, f, k: ventral views; b, g, l: dorsal views; c, h, m: lateral views; d, i, n: posterior views; e, j, o: anterior views. All x 2 [except 2b (x 1.8)].

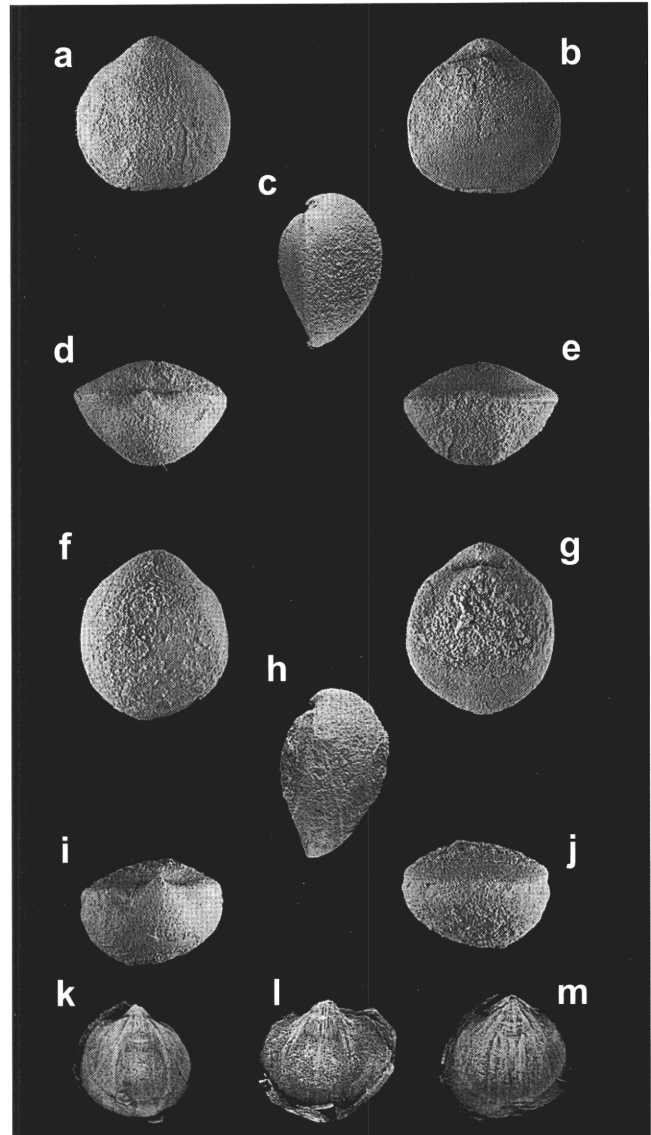


Fig. 3 — *Biernatella abunda* n. sp., Vaulx, Neuville Formation. a-e: paratype C, specimen IRScNB a12018; f-j: paratype D, specimen IRScNB a12019. a, f: ventral views; b, g: dorsal views; c, h: lateral views; d, i: posterior views; e, j: anterior views; k-m: internal cast of three ventral valves: paratype E, specimen IRScNB a12020 (k); paratype F, specimen IRScNB a12021 (l); paratype G, specimen IRScNB a12022 (m). All x 2.

#### STRATUM TYPICUM

Middle and upper parts of the Neuville Fm (Late Frasnian).

#### MATERIAL

It consists of 270 complete specimens, generally in good state of preservation; 53 ventral valves; 3 dorsal valves and 5 internal moulds.

Numerous brachiopods have been collected with *B. abunda* at its locus typicus: *Waiotrypa? pluvia* GODEFROID & HELSEN, 1998, *Iowatrypa circuitionis* GODEFROID & HELSEN, 1998, *Costatrypa variabilis*

(GODEFROID, 1970), *Desquamatia (Desquamatia) alticoliformis* RZHONSNITSKAYA, 1975, *Thomasaria* sp., amboceoliids indet., rhynchonellids (*Navalicia compacta* SARTENAER, 1989 and undescribed species), *Athyris* sp., gypidulids indet., and orthids indet.

#### DIAGNOSIS

A ventribiconvex, relatively equidimensional (W/L: 0.86-1.16) species of *Biernatella* with a rounded to semi-elliptic outline (maximum W observed = 12.6 mm; maximum L = 11.8 mm; maximum T = 7.5 mm), shoulder lines indented or more rarely subrectilinear. Sulcus gen-

erally absent; no fold. Rectimarginate or vaguely undulose anterior commissure.

#### DESCRIPTION

##### External characters

##### General characters

Small-sized shell, 1.28 to 2.03 times wider than high and 1.37 to 1.97 times longer than high. The width/length ratio varies between 0.86-1.16, but usually, the values are comprised between 0.9-1.1. Generally, the specimens are

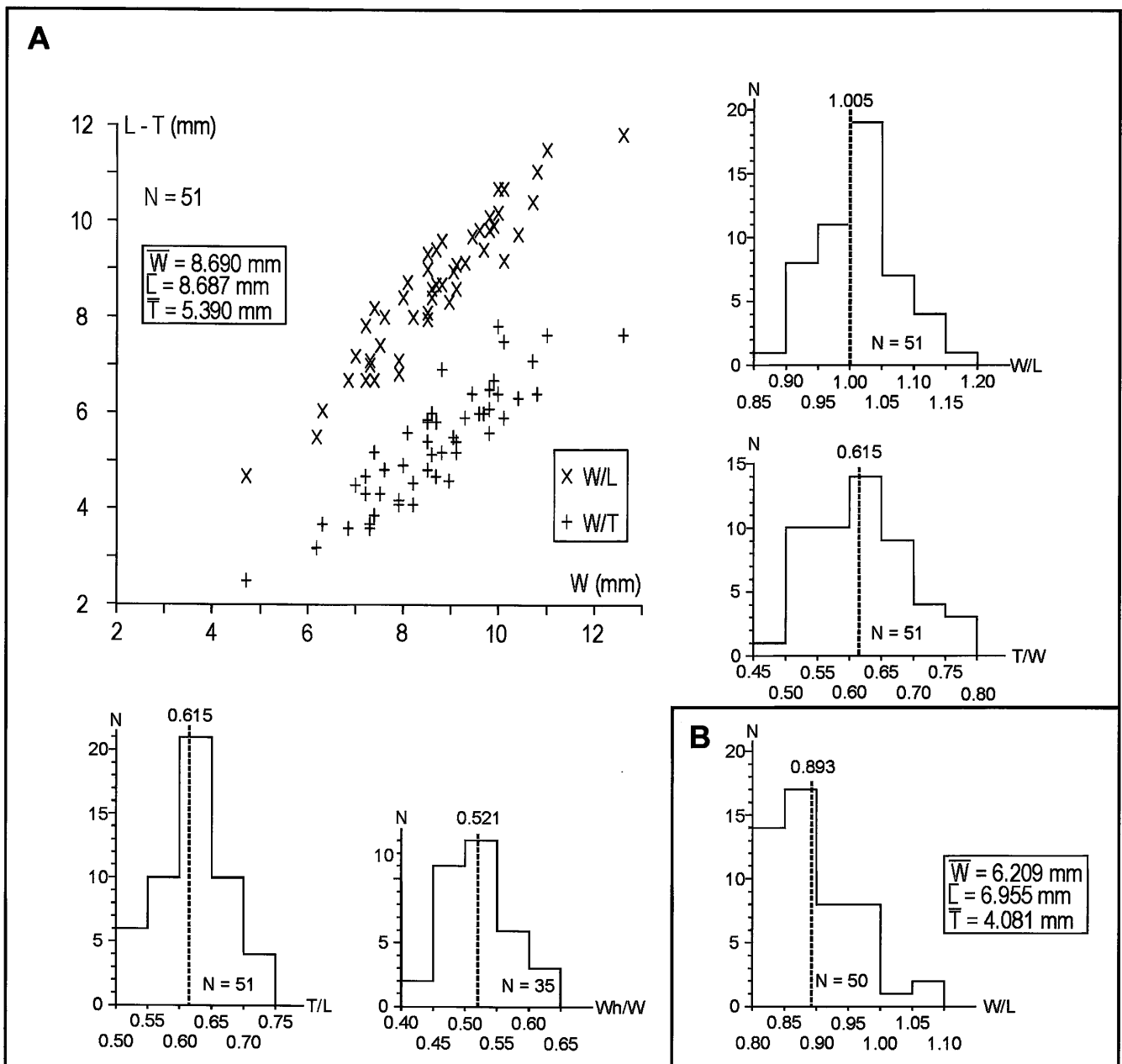


Fig. 4A — *Biernatella abunda* n. sp.

Scatter diagram plotting width/length and width/thickness and four frequency diagrams with indication of the mean.

Fig. 4B — *Biernatella* sp.

Locality Durbuy 8319 (Marche road, 1300 m to the south of Barvaux). Frequency diagram.

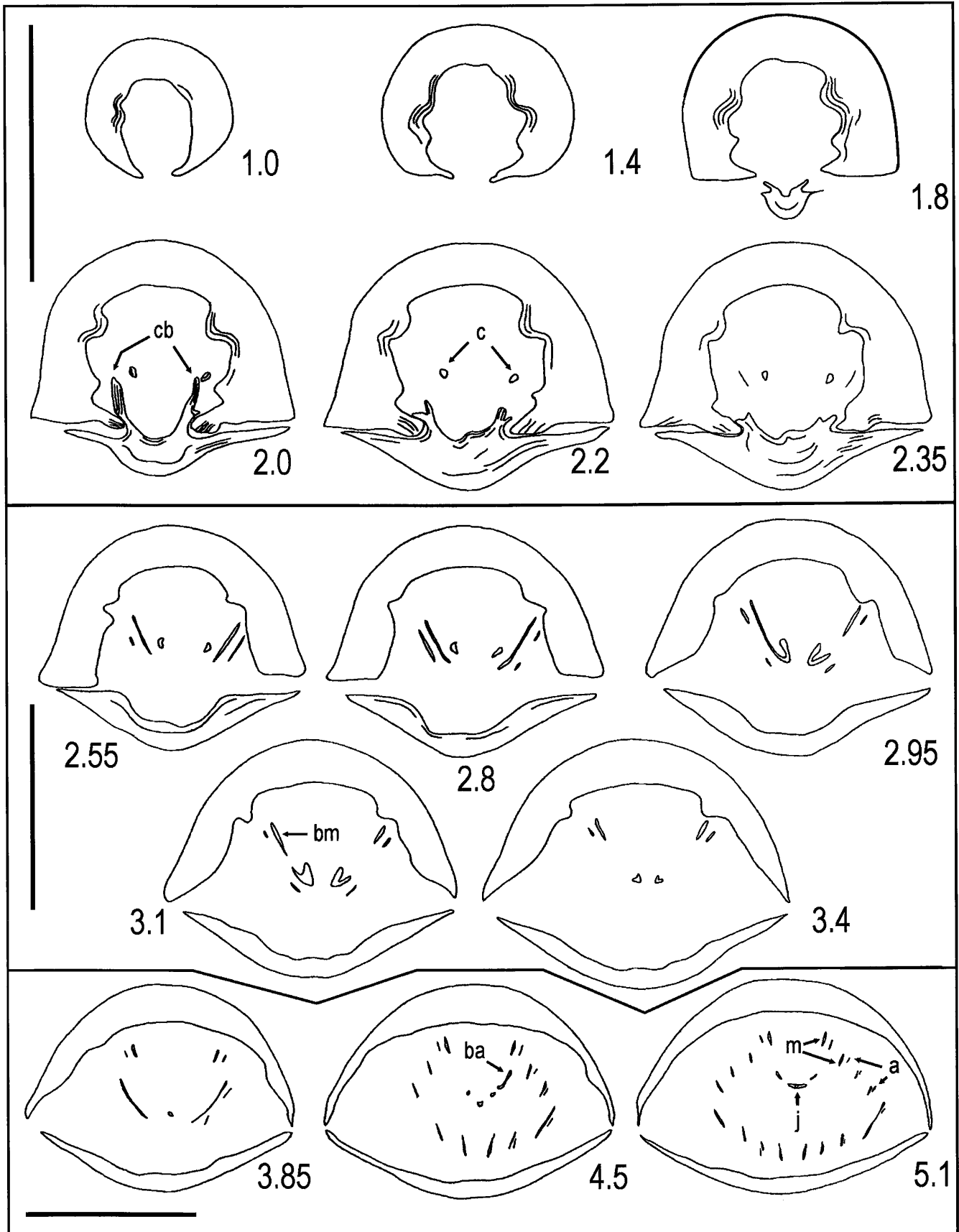
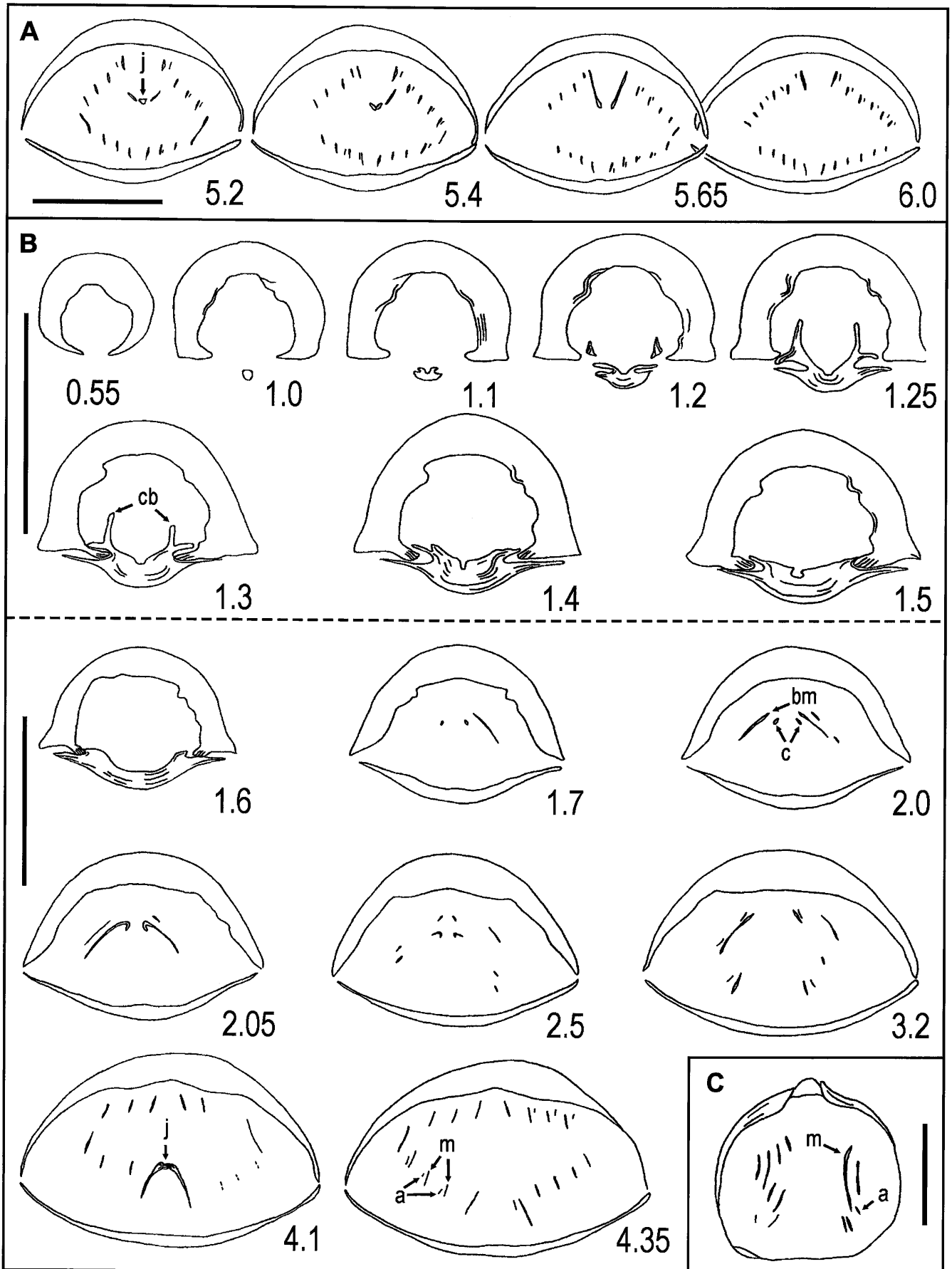


Fig. 5 — *Biernatella abunda* n. sp. Paratype H. Specimen IRScNB a12023. Transverse serial sections. Distances are in mm from the top of the ventral umbo. Scale bar = 5 mm. Measurements: width = 9.8 mm; length = 10.1 mm; thickness = 7 mm. Abbreviations: a: accessory lamellae; ba: beginning of accessory lamella; bm: base of main lamella, c: crura; cb: crural bases; j: jugum; m: main lamellae.



clearly ventribiconvex. The outline is subcircular to semi-elliptic; the front margin is rounded to straight. The hinge line is shorter than the maximal width ( $Wh/W: 0.43-0.64$ ), which is located near the midlength. The anterior commissure is rectimarginate or vaguely uniplicate (slight undulation dorsally directed).

#### Ventral valve

In lateral view, the upper surface of the valve is evenly convex, except in the umbonal area where the convexity becomes more pronounced. The flanks moderately to strongly slope towards the lateral commissure. The beak is incurved but not in contact with the beak of the dorsal valve. The interarea is low, clearly delimited, strongly apsacline and concave; the delthyrium is opened. The umbo is prominent, the shoulder lines are indented or more rarely subrectilinear. The apical angle varies between  $96^{\circ}-130^{\circ}$ , but the values comprised between  $100^{\circ}-120^{\circ}$  are most common.

Some specimens display a sketch of a poorly defined sulcus near the anterior border. In this case, the front margin is slightly indented.

#### Dorsal valve

The valve is subcircular to semi-elliptic, devoid of fold and slightly inflated. The flanks gently slope towards the lateral commissures. Maximum valve thickness is attained in its posterior part or near the mid-length. From this point, the valve curves gently towards the frontal commissure. The interarea is flat, anacline and poorly developed.

#### Ornamentation

Concentric growth lines are generally visible on the surface of the valves, principally near the commissures where they are closely spaced. A single specimen shows microlines ( $\pm 19$  microlines/mm).

#### Dimensions (Fig. 4A, Table 1)

#### Internal characters (Figs. 5-6)

#### Ventral valve

The shell is thickened in its umbonal part. The teeth are simple, short and unsupported by dental plates. The muscle field is small, delimited in its posterior part by two lateral ridges of high relief, and in its anterior part, by a

low transverse ridge. Mantle canals are deeply impressed on the internal face of the valve (Fig. 3m).

#### Dorsal valve

The dental sockets are shallow with well-differentiated inner socket ridges. The diplospiralium is similar to the one mentioned in *B. polonica* by BALIŃSKI (1977, figs. 2-4). Out of seven sectioned specimens, the diplospiralium is only fairly well present in paratype H (Figs. 5, 6A). Surprisingly, however, the brachidium of the specimen is turned  $180^{\circ}$  dorso-ventrally resulting in a dorsally directed jugum and dorso-laterally directed spiralia. Whether the disposition of the diplospiralium is a pathologic feature or is the result of a post-mortem displacement cannot be resolved at present. It is noteworthy that the external characters of the paratype as well as the rest of its internal details are in accordance with the species. The paratype I reveals a normal disposition of the brachidium (see Fig. 6B). The spiral cones comprise at least six whorls.

#### DISCUSSION

*B. abunda* n. sp. is close to *B. polonica* BALIŃSKI, 1977 (pp. 179-183, pl. 9: 1-4; pl. 10: 1-5, figs. 2-4), but differs by its greater maximal size, its more indented shoulder lines (umbo usually well defined), and its less narrow hinge line.

*B. abunda* n. sp. is differentiated from *B. ovalis* BALIŃSKI, 1995 (p. 142, figs. 7 A-C, G-M, O-Q, S-T, 8A) by its greater maximal width, its shell that is always ventribiconvex and its more rounded outline.

*B. abunda* n. sp. is distinguished from *B. lentiformis* BALIŃSKI, 1995 (p. 142, p. 144, figs. 8 B-C, 9-11) by its more ventribiconvex shell, its more inflated ventral valve, its greater size and less dense concentric microlines ( $\pm 19$ /mm versus 32/mm in the Polish species).

*B. abunda* n. sp. attains clearly greater shell dimensions and possesses a more ventribiconvex profile than *B. timanica* (LYASHENKO, 1985, p. 18, pl. 2: 1-4).

*B. abunda* n. sp. differs from *B. minuta* (KLÄHN, 1912, p. 29, pl. 2: 7) by its greater size, its more inflated ventral valve and its outline less developed in length.

#### STRATIGRAPHIC RANGE AND GEOGRAPHIC DISTRIBUTION (Fig. 7)

*Biernatella abunda* n. sp. occurs in the middle and upper parts of the Neuville Fm (southern central border of the Dinant Synclinorium: Vaulx - Nismes area). It is



Fig. 6A — *Biernatella abunda* n. sp. Paratype H. Specimen IRScNB a12023. Distances are in mm from the top of the ventral umbo. Scale bar = 5 mm. Abbreviations: see Fig. 5.

Fig. 6B — *Biernatella abunda* n. sp. Paratype I. Specimen IRScNB a12024. Measurements: width = 9.8 mm; length = 9.8 mm; thickness = 6.3 mm. Scale bar = 5 mm.

Fig. 6C — *Biernatella abunda* n. sp. Specimen IRScNB a12025. Specimen sectioned parallel to the commissural plane (Mailieux's collection, Couvin 92, Nismes road, west of the second Terniat). Scale bar = 5 mm.

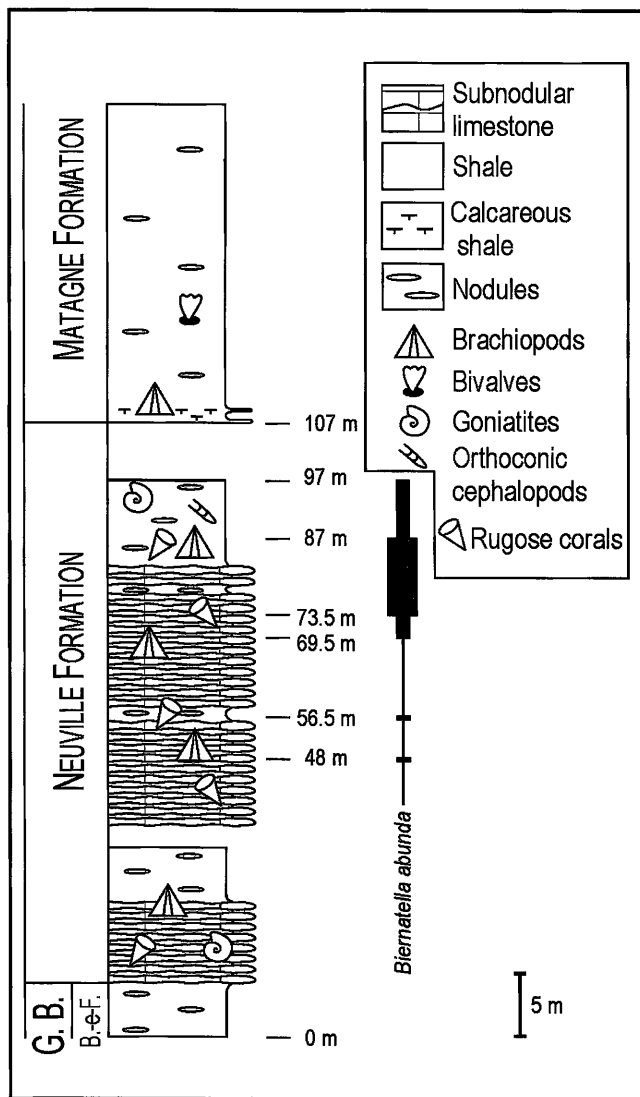


Fig. 7 — *Biernatella abunda* n. sp. in its locus-typicus (Vaulx section) [after GODEFROID & HELSEN (1998, fig. 2E), modified]. Measures of length are given on the right of the log; the point zero corresponds to the southwestern extremity of the outcrop. The vertical scale concerns only the lithologic column. Abbreviations: G. B.: Grands Breux Formation; B.-e-F.: Boussu-en-Fagne Member.

also present in the Philippeville Anticlinorium (see below). Further studies are necessary to ascertain its presence to the east of Givet.

### Remarks

Many Frasnian smooth and small brachiopods such as ambocoeliids or juveniles of rhynchonellids and pentamerids have formerly been identified as *Nucleospira lens* (SCHNUR, 1851). Nearly all the citations of this species in the Ardennes are without description. That is why I voluntarily limited myself to some of MAILLIEUX's cita-

Table 1

specimen IRScNB	Dimensions (mm)					
	W	Wh	L	ULv	ULd	T
a12015	9.8	5.85	9.7	15	9	6.45
a12016	10.85	4.55	11.2	16	11	6.35
a12017	10.8	5.9	11.4	18	11	7.5
a12018	9.95	4.7	10	16	10	6.8
a12019	9.6	5.5	11	17	11	6.7

tions for the establishment of the synonymy, because only his material is easily accessible.

In MAILLIEUX's collection, several localities from the Durbuy area yielded *Biernatella* specimens from the former Frasnian subdivision "F2i" (Schistes à *Spirifer pachyrhynchus*). They are characterized by small size (maximum W = 7.9 mm; maximum L = 8.15 mm; maximum T = 5.65 mm) and an outline more developed in length (W/L: 0.8-1.06) than the one of *B. abunda* (Fig. 4B). Until additional material collected in place is available, I identify these specimens as *Biernatella* sp. [a species close, indeed conspecific with *B. minuta* (KLÄHN, 1912)].

*Nucleospira lens* is signaled in the "Schistes de Barvaux-sur-Ourthe" by MAILLIEUX (1939, p. 4; 1941, p. 11). This identification concerns some specimens collected in the outcrop Aye 4816, and I assign them to *Biernatella* sp. As mentioned by SARTENAER (1974, p. 11), the limits used by MAILLIEUX for the "Schistes de Barvaux-sur-Ourthe" are fuzzy and many species listed by him have never been collected in the Barvaux Fm as defined by COEN in BOULVAIN *et al.* (1999, pp. 61-65). It is very likely that they come from a lower stratigraphic level ("F2i").

MAILLIEUX (1938, p. 23; 1941, p. 11) cited *Nucleospira lens* (SCHNUR, 1851) in the Middle Couvinian of the Ardennes (former subdivisions Co2a, Co2b and Co2c). One specimen from Calbeau's collection housed at the RBINS from the locality Couvin 8707 ("Chemin de Boussu") could belong to this species as described by BIERNAT (1966, pp. 140-143, pl. 24, figs. 1-16, text-fig. 49), but an accurate study of this species is outside the scope of this note. According to BULTYNCK *et al.* (2001, p. 8), outcrop Couvin 8707 shows the upper part of the Jemelle Fm and maybe the transition to the Lomme Fm (Late Eifelian, *Tortodus kockelianus kockelianus* – *Polygnathus ensensis* Zones).

### The genus *Biernatella* in the Philippeville Anticlinorium

*Biernatella abunda* n. sp. is recognized in the Neville railway section (southern border of the Philippeville Anticlinorium) at the top of the Neville Fm [see the description of this outcrop in BULTYNCK *et al.* (1998, p. 29, p. 34, p. 39, figs. 10-13) and GODEFROID & HELSEN



(1998, pp. 265-266, fig. 2I)] where it is accompanied by *Navalicia compacta* and by an unidentified rhynchonellid species as observed at Vaulx (locus typicus of *B. abunda*). Numerous fragments of *Biernatella* have been collected at the base of the Les Valisettes Fm and most probably they belong to *B. abunda* n. sp. They are associated with small chonetids and *Buchiola*, the characteristic bivalve genus of the Matagne Fm, already mentioned from the top of the Neuville Fm by BULTYNCK *et al.* (1998, p. 53, figs. 11-12). Some fragments of *Biernatella* collected at the top of the Les Valisettes Fm cannot be identified because of their preservation. They are associated with cyrtospiriferids, productids, rhynchonellids and small rugose corals.

## Conclusions

BALIŃSKI (1995, p. 134) suggested that "They (biernatellid brachiopods) may be present in Frasnian samples of

E. Maillieux's collection housed at the Institut royal des Sciences naturelles de Belgique (...)". This short paper confirms BALIŃSKI's point of view by describing *Biernatella abunda* in the late Frasnian of the Philippeville Anticlinorium and southern central flank of the Dinant Synclinorium. Further research is necessary to confirm or infirm the presence of the genus in earlier deposits from southern Belgium.

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## References

- BALIŃSKI, A., 1977. *Biernatella* – a new Devonian double-spired brachiopod. *Acta Palaeontologica Polonica*, **22** (2): 175-186.
- BALIŃSKI, A., 1995. Devonian Athyridoid brachiopods with double spiralia. *Acta Palaeontologica Polonica*, **40** (2): 129-148.
- BALIŃSKI, A., 2002. Frasnian-Famennian brachiopod extinction and recovery in southern Poland. *Acta Palaeontologica Polonica*, **47** (2): 289-305.
- BIERNAT, G., 1966. Middle Devonian brachiopods of the Bodzentyń Syncline (Holy Cross Mountains, Poland). *Palaeontologica Polonica*, **17**: 1-162.
- BOUCOT, A., JOHNSON, J. G. & STATON, R. D., 1964. On some atrypoid, retzoid, and athyridoid Brachiopoda. *Journal of Paleontology*, **38**: 805-822.
- BOULVAIN, F., BULTYNCK, P., COEN, M., COEN-AUBERT, M., LACROIX, D., LALOUX, M., CASIER, J.-G., DEJONGHE, L., DUMOULIN, V., GHYSEL, P., GODEFROID, J., HELSEN, S., MOURAVIEFF, N. A., SARTENAER, P., TOURNEUR, F. & VANGUESTAINE, M., 1999. Les formations du Frasnien de la Belgique. *Memoirs of the geological Survey of Belgium*, **44**: 1-126.
- BULTYNCK, P., CASIER, J.-G., COEN-AUBERT, M. & GODEFROID, J., 2001. Pre-conference field trip (VI): Couvin-Philippeville-Wellin area, Ardenne (May 11-12, 2001). In: JANSEN, U., KÖNIGSHOF, P., PŁODOWSKI, G. & SCHINDLER, E. (Editors), 15<sup>th</sup> International Senckenberg Conference. Mid-palaeozoic Bio- and Geodynamics, The North Gondwana – Laurussia Interaction: 1-44.
- BULTYNCK, P., HELSEN, S. & HAYDUCKIEWICH, J., 1998. Conodont succession and biofacies in upper Frasnian formations (Devonian) from the southern and central parts of the Dinant Synclinorium (Belgium) – (Timing of facies shifting and correlation with late Frasnian events). *Bulletin de l'Institut royal des Sciences naturelles de Belgique, Sciences de la Terre*, **68**: 25-75.
- COEN, M., CASIER, J. G., HELSEN, S. & MOURAVIEFF, N. A., 1999. Formation de Matagne. In: BOULVAIN *et al.*, 1999: 57-60.
- DAGYS, A. S., 1974. Triassic brachiopods (Morphology, classification, phylogeny, stratigraphical significance and biogeography). Sibirskoe Otdelenie Izdatel'stvo "Nauka". Novosibirsk, pp. 1-387 (in Russian).
- DAVIDSON, T., 1881. On genera and species of spiral-bearing Brachiopoda from specimens developed by Rev. Norman Glass: with notes on the results obtained by Mr. George Maw from extensive washing of the Wenlock and Ludlow shales of Shropshire. *Geological Magazine* (new series, Decade II) **8** (1): 1-13.
- DUMON, P., 1929. Etude du Frasnien en Belgique. *Publication de l'Association des Ingénieurs de l'Ecole des Mines de Mons*, **30** (2): 119-230.
- DUPONT, E., 1882. Terrain dévonien de l'Entre-Sambre-et-Meuse. Les îles de Roly et de Philippeville. *Bulletin du Musée d'Histoire naturelle de Belgique*, **1**: 88-160.
- GODEFROID, J., 1970. Caractéristiques de quelques Atrypida du Dévonien belge. *Annales de la Société géologique de Belgique*, **93** (1): 87-126.
- GODEFROID, J. & HELSEN, S., 1998. The last Frasnian Atrypida (Brachiopoda) in southern Belgium. *Acta Palaeontologica Polonica*, **43** (2): 241-272.
- JOSEPH, J., BRICE, D. & MOURAVIEFF, N., 1980. Données paléontologiques nouvelles sur le Frasnien des Pyrénées centrales et occidentales: implications paléogéographiques. *Bulletin de la Société d'Histoire naturelle de Toulouse*, **116** (1-2): 16-41.
- KAYSER, E., 1872. Neue Fossilien aus dem Rheinischen Devon. *Zeitschrift der deutschen geologischen Gesellschaft*, **24**: 691-700.
- KLÄHN, H., 1912. Die Brachiopoden der Frasn-Stufe bei Aachen. *Jahrbuch der Königlich Preussischen Landensanstalt und Bergakademie zu Berlin*, **33**: 1-39.
- KREBS, W. & ZIEGLER, W., 1965. Über die Mitteldevon/Oberdevon-Grenze in der Riffazies bei Aachen. In: Das Mitteldevon

- des Rheinischen Schiefergebirges. Ein Symposium. *Fortschritte in der Geologie von Rheinland und Westfalen*, **9**: 731-754.
- LYASHENKO, A. I., 1985. Novye Verkhnedevonskie Brakhiopody iuzhnogo Timana. In: V. D. IL'INA & V. V. LIPATOVA (Editors), *Stratigraficheskie issledovaniia prirodnykh rezervuarov nefiti i gaza*. Ministerstvo Geologii SSSR; Vsesoiuznyi Nauchno-Issledovatel'skii Geologorazved. Neftianoi Institut. Sbornik Nauchnykh trudov. Moscow. pp. 9-18 (in Russian).
- MAILLIEUX, E., 1933. Terrains, roches et fossiles de la Belgique. Deuxième édition. Patrimoine du Musée royal d'Histoire naturelle de Belgique, 217 pp.
- MAILLIEUX, E., 1936. La faune des Schistes de Matagne. *Mémoires du Musée d'Histoire naturelle de Belgique*, **77**:1-74.
- MAILLIEUX, E., 1938. Le Couvinien de l'Ardenne et ses faunes. *Mémoires du Musée d'Histoire naturelle de Belgique*, **83**: 1-57.
- MAILLIEUX, E., 1939. La faune des schistes de Barvaux-sur-Ourthe. *Bulletin du Musée royal d'Histoire naturelle de Belgique*, **15** (53): 1-8.
- MAILLIEUX, E., 1940. Contribution à la connaissance du Frasnien moyen (Assise de Frasnes) de la Belgique. *Bulletin du Musée royal d'Histoire naturelle de Belgique*, **16** (14): 1-44.
- MAILLIEUX, E., 1941. Répartition des Brachiopodes dans le Dévonien de l'Ardenne. *Bulletin du Musée royal d'Histoire naturelle de Belgique*, **17** (30): 1-14.
- RZHONSNITSKAYA, M. A., 1975. Biostratigrafiia Devona okrain Kuznetskogo Basseina, Tom 2, Opisanie brachiopod, Chast'1 Pentamerida i Atrypida. *Trudy Vsesoiuznyi Ordena Lenina Nauchno-Issledovatel'skii Geologicheskii Institut*, **244**: 1-232 (in Russian).
- SARTENAER, P., 1974. Que sont les Schistes de Barvaux-sur-Ourthe? *Bulletin de l'Institut royal des Sciences naturelles de Belgique*, **50** (5): 1-18.
- SARTENAER, P., 1989. Deux genres Rhynchonellides nouveaux d'âge frasnien moyen résultant du brisement de *Calvinaria*
- STAINBROOK, 1945. *Bulletin de l'Institut royal des Sciences naturelles de Belgique, Sciences de la Terre*, **59**: 61-77.
- SARTENAER, P. & HARTUNG, W., 1992. Die Biozonierung der Oberen Frasnes-Stufe (Frasnes-Knollenkalke und Frasnes-Schiefer) am Nord-Abfall des Hohen Venns mit Hilfe von Rhynchonelliden. *Senckenbergiana lethaea*, **72**: 49-60.
- SCHNUR, J., 1851. Die Brachiopoden aus dem Uebergangsgebirge der Eifel. Programm der vereinigten höhern Bürger- und Provinzial-Gewerbeschule zu Trier für das Schuljahr 1850-1851. Lintz. Trier. 16 p.
- YUDINA, Y. A., 1996a. Frasnian atrypoid brachiopods from South Timan. In: COPPER, P. & JIN, J. (Editors). *Brachiopods. Proceedings of the Third International Brachiopod Congress, Sudbury, Ontario, Canada, 2-5 September 1995*. A. A. Balkema, Rotterdam & Brookfield, 317-318.
- YUDINA, Y. A., 1996b. Rod *Biernatella* (Brackhiopody) v pozdnem frane yuzhnogo Timana. *Paleontologicheskii Zhurnal*, **1996** (2): 43-44 (in Russian).

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