

Revision of the brachiopod *Cyrtina rigauxi* MAILLIEUX, 1909 and description of a new ambocoeliid genus (*Dionacoelia* n. gen.) from the Frasnian of southern Belgium

by Bernard MOTTEQUIN

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Abstract

Cyrtina rigauxi MAILLIEUX, 1909 is transferred to the genus *Acutatheca* STAINBROOK, 1945 thus mentioned for the first time in the Frasnian of the Dinant Synclinorium and Roly "Massif" (Neuville Formation, Lower *Palmatolepis rhenana* Zone). MAILLIEUX (1940, 1941) included *Acutatheca rigauxi* in *Cyrtina demarlei* BOUCHARD (nomen nudum) and *C. heteroclita* (DEFRANCE, 1824). The specimens identified as *Martiniopsis (Elivella) rigauxi* by MAILLIEUX (1940, 1941) [= *Echinocoelia rigauxi* sensu VANDERCAMMEN (1956)] do not belong to *C. rigauxi* MAILLIEUX, 1909. They are redescribed as *Dionacoelia secessus* n. gen., n. sp., a species occurring with certainty in the Ermitage Member of the Moulin Liénaux Formation (*Palmatolepis punctata* Zone).

Key-words: Brachiopods, Spiriferida, *Acutatheca*, *Dionacoelia*, Frasnian, Belgium.

Résumé

L'espèce *Cyrtina rigauxi* MAILLIEUX, 1909 est attribuée au genre *Acutatheca* STAINBROOK, 1945 dont c'est la première mention dans le Frasnien du Synclinorium de Dinant et du "Massif" de Roly (Formation de Neuville, Zone inférieure à *Palmatolepis rhenana*). MAILLIEUX (1940, 1941) a inclus *Acutatheca rigauxi* dans *Cyrtina demarlei* BOUCHARD (nomen nudum) et *C. heteroclita* (DEFRANCE, 1824). Les spécimens déterminés *Martiniopsis (Elivella) rigauxi* par MAILLIEUX (1940, 1941) [= *Echinocoelia rigauxi* sensu VANDERCAMMEN (1956)] n'appartiennent pas à *C. rigauxi* MAILLIEUX, 1909. Ils correspondent à l'espèce *Dionacoelia secessus* n. gen., n. sp. présente avec certitude au sein du Membre de l'Ermitage de la Formation du Moulin Liénaux (Zone à *Palmatolepis punctata*).

Mots-clefs: Brachiopodes, Spiriferida, *Acutatheca*, *Dionacoelia*, Frasnien, Belgique.

Introduction

New collections of Frasnian brachiopods in the Neuville Formation in several localities of the southern flank of the Dinant Synclinorium (Belgium) allowed the revision of

the rare and unrecognized species *Cyrtina rigauxi* MAILLIEUX, 1909a, but also the description of a new genus and species of the Ambocoeliinae.

History of the study

Cyrtina rigauxi was described by MAILLIEUX (1909a, pp. 10-11) from material collected within the Frasnian "Schistes à *Spirifer pachyrhynchus*" at the cemetery quarry at Boussu-en-Fagne (southern border of the Dinant Synclinorium) where the species is very rare according to him (p. 11). MAILLIEUX's drawings represent a typical "Cyrtina". Considering the imperfections of these, we can reasonably admit that the specimen IRScNB a9575 from the collections of the Royal Belgian Institute of Natural Sciences at Brussels bearing the inscription *Cyrtina rigauxi* on its oldest label corresponds to the original illustrations. The same year, MAILLIEUX (1909b, pp. 121-122, 136-137) listed it with the indication "rare" in the "Schistes à *C. [= Camarophoria] formosus*" and in the "Schistes de la Zone à *Sp. pachyrhynchus*". In 1940 (pp. 15, 18, 26, 41), the same author cited the species as *Martiniopsis (Elivella) rigauxi* in the old Belgian Frasnian subdivisions F2e ("Zone à *Leiorhynchus formosus*"), F2g ("calcaire stratifié à *Stromatopores*"), F2i ("Zone à *Reticularia pachyrhyncha*") and F2β ("schistes et calcaires de Bovesse"). This new generic attribution was not accompanied by a discussion.

However, on the basis of handwritten labels of MAILLIEUX dated from 1938, it appears that in MAILLIEUX (1940, 1941): 1 – the specimens with a "Cyrtina" appearance as the specimen IRScNB a9575 are identified as *Cyrtina demarlei* BOUCHARD and *Cyrtina heteroclita* (DEFRANCE, 1824). As noted by BRICE (1988, p. 358), *C. demarlei* BOUCHARD is a nomen nudum and must be replaced by *C. bouchardi* BRICE, 1988. *C. rigauxi* differs from *C. bouchardi* and *C. demarlui* DAVIDSON, 1864 non BOUCHARD by its internal characters. 2 – the specimens ranged in *Martiniopsis (Elivella) rigauxi* do not at all correspond to the original figurations of *Cyrtina rigauxi*. Among them, the specimen figured by VANDERCAMMEN

(1956, pl. 2: 11-13) as *Echinocoelia rigauxi* is accompanied by a handwritten label of MAILLIEUX with the inscription “*Martiniopsis (Elivella) rigauxi* MAILLIEUX – Holotype”.

In his revision of the Ambocoeliidae from the Devonian of Belgium, VANDERCAMMEN (1956, pp. 30-35) described *Echinocoelia rigauxi* on the basis of specimens completely different of MAILLIEUX’s original illustrations but corresponding to those identified as *Martiniopsis (Elivella) rigauxi* by MAILLIEUX (1940, 1941).

Restudy of this old material and of newly collected specimens shows that: 1 – *Cyrtina rigauxi* MAILLIEUX, 1909a is a well established species (see the type paragraph). It belongs to the genus *Acutatheca* STAINBROOK, 1945. 2 – *Martiniopsis (Elivella) rigauxi* in MAILLIEUX (1940, 1941) (non *Cyrtina rigauxi* MAILLIEUX, 1909a) [= *Echinocoelia rigauxi* sensu VANDERCAMMEN (1956)] corresponds to *Dionacoelia secessus* n. gen., n. sp.

To the knowledge of the author, the genus *Acutatheca* STAINBROOK, 1945 (Spinellinae) was only known with certainty from two North American species from the Lower *Palmatolepis rhenana* Zone: *A. propria* STAINBROOK, 1945, the type species from the Independence shales of Iowa and *A. prolifica* COOPER & DUTRO, 1982 from the Sly Gap Fm of New Mexico. DAY & DOWD (2000) listed the genus in the late Frasnian Redknife Fm (northern part of the Western Canadian Sedimentary Basin). XIAN (in XIAN & JIAN, 1978) described *A. lata* (non *vidi*) from the undifferentiated Middle Devonian (Province of Guizhou, Southwest China) but this species needs more information according to TALENT *et al.* (2001, p. 115). In southern Belgium, the genus occurs in the Neuville Fm (Lower *P. rhenana* Zone; southern flank of the Dinant Synclinorium and Roly “Massif”) and could be present within the Les Valisettes (Upper *P. rhenana* Zone; Philippeville Anticlinorium) and Lambermont formations (Upper *P. rhenana* Zone; Vesdre Nappe).

CRICKMAY (1967, p. 10) founded the subgenus *Minutilla* with *Acutatheca (Minutilla) layeri* CRICKMAY, 1967 as type species, but it has been placed in synonymy with *Allanella* CRICKMAY, 1953 by CARTER *et al.* (1994, p. 332).

All measured and/or figured specimens are housed at the Royal Belgian Institute of Natural Sciences at Brussels, where they are registered under the numbers IRScNB a8041, a8046, a9575, a12104 – a12117.

Stratigraphy

GEOLOGICAL CONTEXT, LITHOSTRATIGRAPHICAL UNITS AND BIOSTRATIGRAPHY (Fig. 1)

The studied specimens come principally from old collections with the indication of the former Frasnian subdivisions F2e, F2g and F2i (see figure 1 for the parallelism between the new and the old Frasnian subdivisions). Only a short description of the formations or members which yielded materials is given here, for more details concern-

ing these units, see BOULVAIN *et al.* (1993, 1999). The Ermitage Member of the Moulin Liénaux Fm consists of greyish-greenish shales with some levels of nodules and thin beds of argillaceous limestone (BULTYNCK & MOURAVIEFF, 1999, p. 39). It is developed on the southern border of the Dinant Synclinorium; its thickness is comprised between 100 m-115 m in the Boussu-en-Fagne – Nismes area. The Bieumont Member corresponds to the base of the Grands Breux Fm. It includes greyish micritic, sometimes bioclastic well-bedded limestones with shaly intercalations in its upper part (BULTYNCK & DEJONGHE, 2002, p. 55). Its thickness is quite variable along the southern border of the Dinant Synclinorium: 37 m at Frasnes-lez-Couvin (COEN-AUBERT, 1994, p. 22); 23 m to 46 m in the Focant borehole (BOULVAIN & COEN-AUBERT, 1997, p. 56) and ± 20 m at Auffe (COEN, 1977, p. 43). The Boussu-en-Fagne Member (Grands Breux Fm) comprises principally greenish shales with calcareous nodules and some levels of nodular to bedded limestones. It attains 81 m in its stratotype (railway cut at Frasnes-lez-Couvin) according to COEN-AUBERT, (1994, p. 22), but it is generally reduced in the vicinity of the mudmounds of the Lion Member. The Neuville Fm is made up of nodular limestones and shales with nodules in the Philippeville Anticlinorium (thickness: 15 m-25 m), but on the southern border of the Dinant Synclinorium where its thickness can attain 110 m in the Han-sur-Lesse area (COEN, 1977, p. 43), it comprises essentially nodular

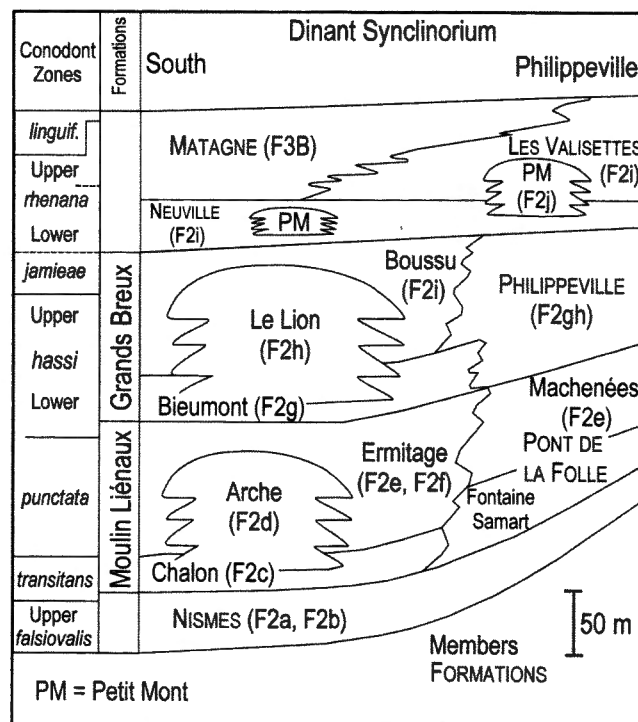


Fig. 1 – Schematic distribution of Frasnian lithostratigraphic units on the southern flank of the Dinant Synclinorium (BULTYNCK *et al.* (2000, fig. 10), modified). The old subdivisions of the Frasnian are indicated between brackets.

shales. The well-developed pinkish-reddish massive mounds within this formation are placed in the Petit Mont Member (F2j).

OUTCROPS (Fig. 2)

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

Outcrop BM-2003-6 is located in the railway cut Couvin-Charleroi south of Frasnes-lez-Couvin and exposes an almost complete succession from the top of the Ermitage Member to the Matagne Fm. It has been described,

among others, by LECOMPTE (1963, p. 25, fig. 21), SANDBERG *et al.* (1992, text-fig. 9) and COEN-AUBERT (1994, pp. 22-23, fig. 3).

Outcrop BM-2003-7 is located in the southern access to the Lion quarry at Frasnes-lez-Couvin. It exposes the top of the Lion Member, the Boussu-en-Fagne Member and the Neuville Fm (partim). It has been already described by LECOMPTE (1963, pp. 23-25, fig. 20), MOURAVIEFF (1974, F4a, b), SANDBERG *et al.* (1992, text-fig. 6) BOULVAIN (1993, p. 99, p. 101, fig. IV.36), COEN-AUBERT (1994, pp. 25-26, figs. 3, 5), VANGUESTAINE *et al.* (1999).

Boussu-en-Fagne, way of the Hermitage. This outcrop has been recently studied for the species of the atrypid genus *Costatrypa* by GODEFROID (1998, pp. 99-101, fig. 3) who detailed the lithological succession (see also LECOMPTE, 1963, fig. 24). It exposes an almost complete succession from the base of the Nismes Fm to the Lion Member (Grands Breux Fm).

Boussu-en-Fagne, cemetery quarry. This section [LECOMPTE (1960, pp. 70-71, fig. 11), COEN-AUBERT (1992)] exposes the top of a mudmound of the Lion Member, the Boussu-en-Fagne Member and the Neuville Fm. In the past, as noted by MAILLIEUX (1914a, p. 87), the dark shales of the Matagne Fm outcropped south of the quarry. COEN-AUBERT, (1994, p. 28, fig. 6) indicated the distribution of the rugose corals and GODEFROID & HELSEN (1998, fig. 2F) studied the atrypid brachiopods.

Topographical map Olloy-sur-Viroin – Treignes 58/5-6

Outcrop BM-2003-8 is located in the railway section between Mariembourg and Nismes. It exposes the Neuville and Matagne formations. In this paper, the base of the Matagne Fm is placed at the first appearance of dark limestones with goniatites and bivalves as proposed by COEN *et al.* (1999, p. 57). MAILLIEUX (1914b, pp. 90-91, fig. 8) gave a sketch of this outcrop. It has been subsequently studied by HELSEN & BULTYNCK (1992) for the conodonts succession and the general distribution of invertebrates, BOULVAIN (1993, pp. 96, 98-99, fig. IV.32) for the sedimentology, COEN-AUBERT, (1994, pp. 28-29, figs. 3, 7) for the rugose corals and GODEFROID & HELSEN (1998, fig. 2H) for the atrypid brachiopods.

Taxonomy

Abbreviations: aa – apical angle; Hi – high of the ventral interarea; L – length of the ventral valve; Ld – length of the dorsal valve; Uld – Unrolled length of the dorsal valve; Ulv – Unrolled length of the ventral valve; T – thickness of the shell; W – width of the shell; Wh – width of the hinge line; Ws – width of the sulcus. The SUI and JG prefixes indicate respectively the Paleontology Repository of the University of Iowa (USA) and J. GODEFROID's outcrops.

Remarks: the ratios are purely indicative and have no statistical value because the number of measured specimens is too low.

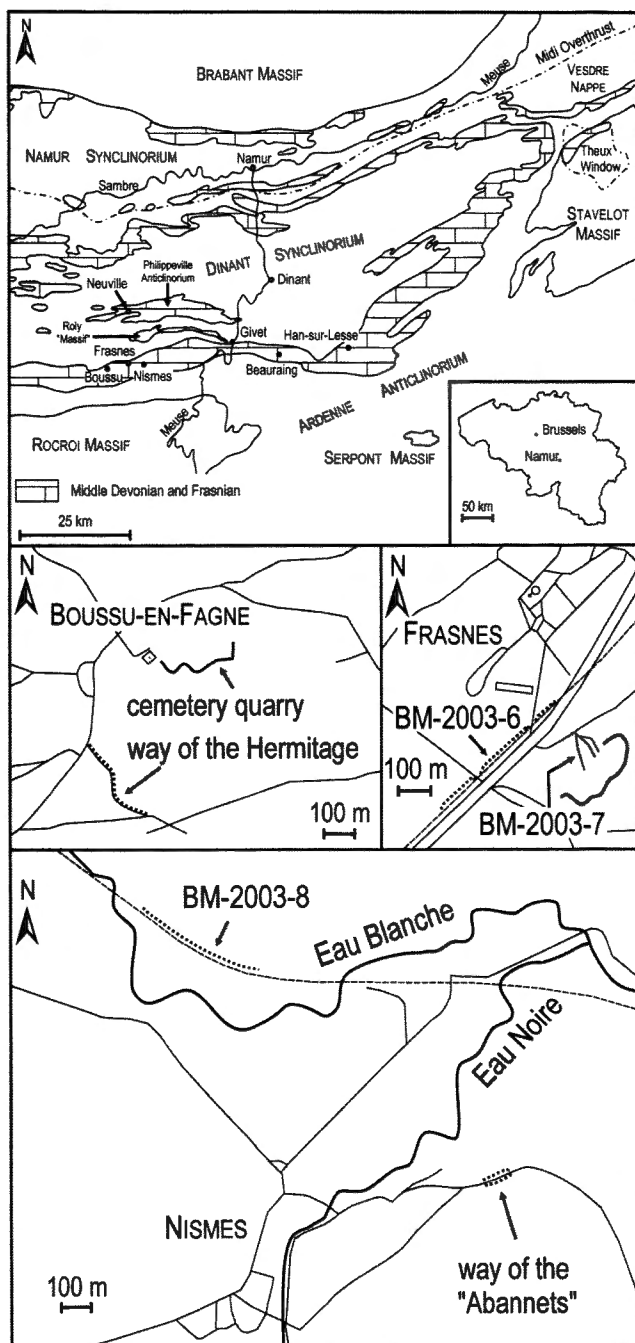


Fig. 2 – Schematic geological map of southern Belgium with location of the fossiliferous localities.

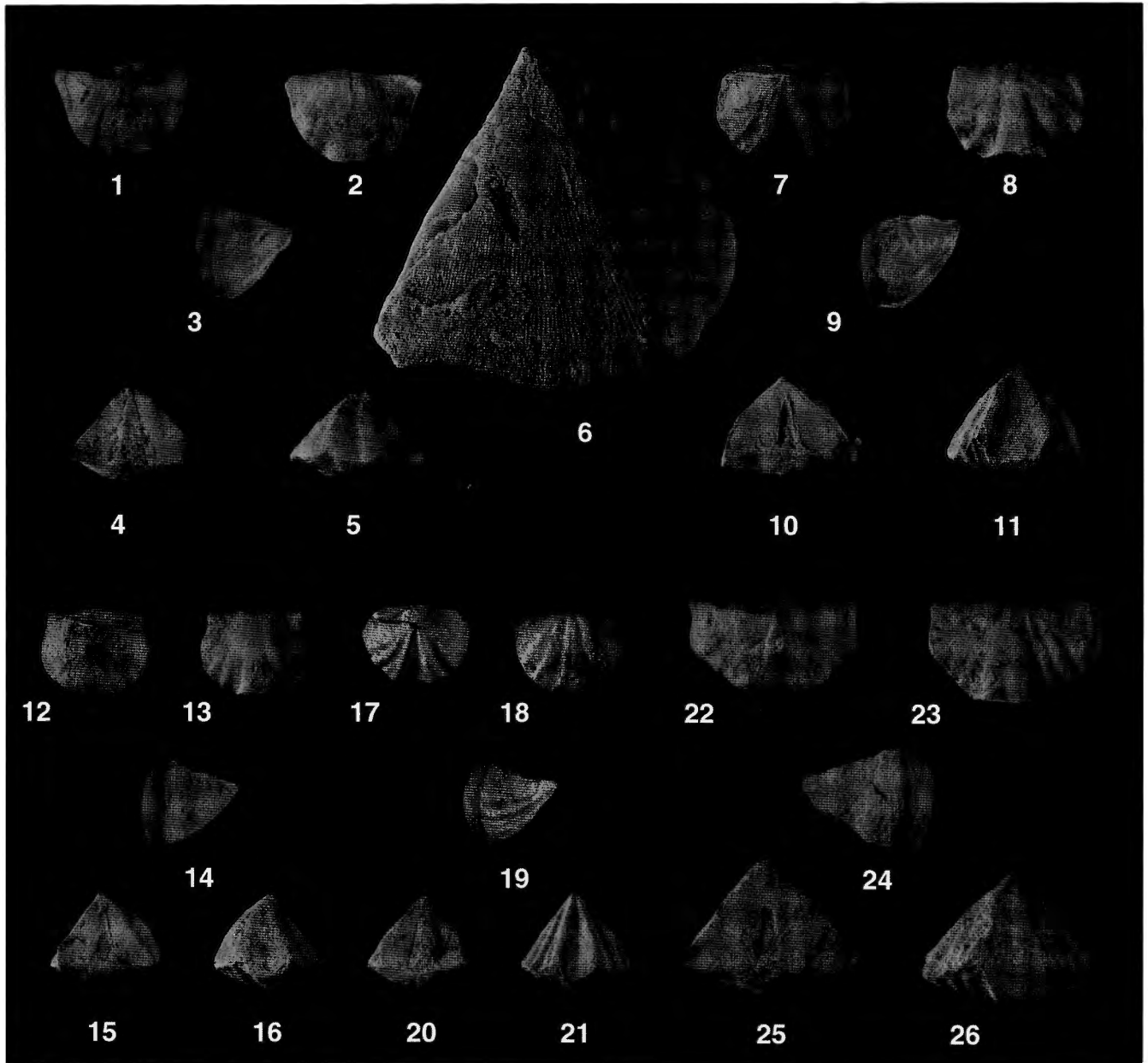


Fig. 3 – *Acutatheca rigauxi* (MAILLIEUX, 1909a). 1-6: Lectotype, specimen IRScNB a9575; 7-11: specimen IRScNB a12104; 12-16: specimen IRScNB a12105; 17-21: specimen IRScNB a12109; 22-26: specimen IRScNB a12110. All x 1.5 [except 6 (x 5)]. 1, 7, 12, 17, 22: ventral views; 2, 8, 13, 18, 23: dorsal views; 3, 9, 14, 19, 24: lateral views; 4, 10, 15, 20, 25: posterior views; 5, 11, 16, 21, 26: anterior views; 6: detail of the micro-ornament.

Order Spiriferida WAAGEN, 1883
 Superfamily Spinelloidea JOHNSON, 1970
 Family Spinellidae JOHNSON, 1970
 Subfamily Spinellinae JOHNSON, 1970
 Genus *Acutatheca* STAINBROOK, 1945

TYPE SPECIES

Acutatheca propria STAINBROOK, 1945

Acutatheca rigauxi (MAILLIEUX, 1909a)
 Figures 3, 4, 9; Table 1

* 1909a — *Cyrtina Rigauxi* nov. sp. MAILLIEUX, p. 10-11, figs. a-c.

- e. p. 1909b — *Cyrtina Rigauxi* MAILLIEUX – MAILLIEUX, p. 122, p. 137 (non p. 121, p. 136 = *Dionacoelia secessus* n. gen., n. sp.).
- e. p. 1909c — *Cyrtina Rigauxi* MAILLIEUX – MAILLIEUX, p. 260 (only the specimens from the “Zone à *Sp. pachyrhynchus*”, the others correspond to *Dionacoelia secessus*).
- 1912 — *Cyrtina rigauxi* MAILLIEUX – ASSELBERGHS, p. 12.
- Non 1925 — *Cyrtina Rigauxi* MAILLIEUX – MAILLIEUX in ASSELBERGHS & MAILLIEUX, p. 162 (= *Dionacoelia secessus*).
- Non 1929 — *Cyrtina Rigauxi* MAILLIEUX – DUMON, p. 150 (= *Dionacoelia secessus*).
- Non 1940 — *Martiniopsis (Elivella) Rigauxi* (MAILLIEUX)

- MAILLIEUX, p. 18, p. 26 (= *Dionacoelia secessus*); p. 41 (= *Adolfia?* sp.).
- Non 1941 — *Martiniopsis (Elivella) Rigauxi* (MAILLIEUX) — MAILLIEUX, p. 6 (= *Dionacoelia secessus*).
- ? 1954 — *Cyrtina rigauxi* MAILLIEUX — DAHMER & QUIRING, p. 474, pp. 477-478.
- Non 1956 — *Echinocoelia rigauxi* (MAILLIEUX, 1909) — VANDERCAMMEN, pp. 30-35; pl. 2: 11-15; figs. 24-28 (= *Dionacoelia secessus*).
- Non 1967 — *E.* (= *Echinocoelia*) *rigauxi* (Maillieux) — CALDWELL, p. 606 (= *Dionacoelia secessus*).
- 1978 — *Cyrtina rigauxi* MAILLIEUX — FICNER & HAVLÍČEK, p. 88.
- Non 1990 — *Echinocoelia rigauxi* MAILLIEUX (1909) — GOLDMAN & MITCHELL, pp. 85-86 (= *Dionacoelia secessus*).

MATERIAL

Thirteen complete specimens in relatively good state of preservation.

TYPES

We designate as lectotype the specimen IRScNB a9575. Considering the imperfection of MAILLIEUX's original drawings, this specimen can be reasonably considered as the model for these. The dimensions and the slightly asymmetric outline agree with the illustrations. At present, this specimen is the only one that can be considered as the model for MAILLIEUX's description. If it would turn out that it is really the only one, it would be considered as the holotype by monotypy. A certainty about this is, however, highly improbable. As noted in the introduction, the so-called holotype designated by MAILLIEUX (in collection) and figured by VANDERCAMMEN (1956, pl. 2: 11-13) does not correspond to the original illustrations as noted by VANDERCAMMEN himself (1956, p. 30) and is transferred here in *Dionacoelia secessus* n. gen., n. sp. Even its provenance is doubtful, because any similar specimen has been collected within the Boussu-en-Fagne Member or within the Neuville Fm exposed in this quarry.

LOCUS TYPICUS

Boussu-en-Fagne, cemetery quarry (MAILLIEUX, 1909a, p. 11) (Province of Namur, Belgium) (see Fig. 2).

STRATUM TYPICUM

“Schistes à *Spirifer pachyrhynchus*” (MAILLIEUX, 1909a, p. 11) [= “F2i” (MAILLIEUX, 1914a, p. 86)]. This old Frasnian subdivision corresponds at the locus typicus to the upper part of the Grands Breux Fm (Boussu-en-Fagne Member) and to the Neuville Fm. Nevertheless, the Neuville Fm must be considered as the stratum typicum according to the occurrences of the species in other outcrops.

DESCRIPTION

External characters

General characters

The small-sized shell is wider than long (W/L: 1.06-

1.68), ventribiconvex and with a subtrapezoidal or semi-elliptical outline. The width is measured near the mid-length or at the hinge line. The lateral commissures are slightly deviated ventrally near the front. Small ears are developed in front of the mucronate points. The frontal border is flat; the lateral margins are rounded or straight.

Ventral valve

It is subpyramidal; in lateral view, its upper surface is plane to slightly curved. In posterior view, the flanks slope moderately towards the lateral commissure. Beginning at the beak, the sulcus is wide (Ws/W: 0.36-0.55), shallow to moderately deep and delimited by two costae more or less marked. The tongue is subtrapezoidal or rounded, low and perpendicular to the commissural plane or in a position close to this latter. The beak is straight or slightly incurved. The interarea is high (Hi/Whl: 0.56-0.72), well defined, procline to catacline at the base. In some cases, it becomes slightly apsacline to the top. The narrow delthyrium is partially closed by a deltidium. The shoulder lines are rectilinear; the apical and shoulders angles are identical and vary between 79°-104°.

Dorsal valve

It is wider than long with a subtrapezoidal or subelliptical outline. In posterior view, its upper surface is slightly inflated except near the cardinal extremities where it is inclined to become flat. In lateral profile view, its upper surface is slightly incurved. The interarea is linear, orthocline and flat. The fold begins in the posterior half of the valve (at a variable distance from the apex) or at mid-length; its top is flattened and slightly furrowed.

Ornamentation

There are 3 (4?) low lateral ribs that originate near the posterior margin; the most external ones are very difficult to see. The largest specimen displays two very low costae in its sulcus. The micro-ornamentation consists of capillae without base of spines that increase by intercalation and bifurcation and rare thickened growth lines.

Dimensions (Table 1)

Internal characters (Fig. 4)

Ventral valve

Impunctate shell. The dental plates are short, divergent and support small and simple teeth. The central apical cavity is large and poorly filled in. The myophragm is short and protruding.

Dorsal valve

The cardinal process is smooth. Two small apical cavities are delimited by the crural plates that form an angle of $\pm 90^\circ$. The dental sockets are relatively deep. A very short and low myophragm is present anteriorly to the cardinal process. No spiral cones have been observed in the sectioned specimen.

Table 1

Specimen	Dimensions (mm)									aa
	W	L	Ld	ULv	ULd	T	Wh	Hi	Ws	
a9575	13.95	9.5	9.5	11	10	10.05	13.95	7.45	5.85	97°
a12104	13.95	9.5	9.5	11	10	10.25	12.5	7	6.35	104°
a12105	11.35	8.9	8.9	10	10	9.6	10	6.6	4.9	81°
a12106	9.9	5.7	5.7	6	/	6.7	9.9	5.3	3.8	98°
a12108	9.9	9.3	9.3	8	10	8.6	9	6.5	5.4	80°
a12109	11.2	8.1	8.1	10	9	9.5	/	6.9	4	79°
a12110	17.8	10.6	10.6	12	8.5	13.9	17.8	11.3	6.6	88°

DISCUSSION AND COMPARISON

Cyrtina rigauxi is ranged in the genus *Acutatheca* because it externally displays a hemipyramidal ventral valve, a delthyrial cover and a similar micro-ornamentation. Internally, it lacks a delthyrial plate and a median septum.

A. propria STAINBROOK, 1945 is poorly known and its holotype (SUI 20914) could be a juvenile specimen according to STAINBROOK (1948, p. 777). The paratype bearing the old number M.A.S. 913 is missing in the collections of the Paleontological Repository of the University of Iowa at Iowa City (USA). Therefore, it is difficult to compare *A. rigauxi* validly with STAINBROOK's species. *A. rigauxi* differs from *A. prolifica* COOPER & DUTRO, 1982 by its less inflated dorsal valve, its lower tongue, the presence of mucronate points, a less curved interarea and less defined ventral costae. Moreover, the ventral myophragm is less prominent than in *A. prolifica*.

ASSELBERGHS (1912, p. 12; 1936, p. 257, p. 313) cited *Cyrtina* cf. *rigauxi* (without figuration) in the "Assise de Bovesse" [= Bovesse Fm, *falsiovalis* to *hassi* s. l. conodont Zones (GOUWY & BULTYNCK, 2000, fig. 16)], but he noted that he did not observe the "fines stries rayonnantes" on the single specimen at his disposal.

STRATIGRAPHIC RANGE AND GEOGRAPHIC DISTRIBUTION (Fig. 9)

The species occurs in the Neuville Fm in the Boussu-en-Fagne – Nismes area (southern flank of the Dinant Synclinorium) and in the Roly "Massif" (outcrop Sautour 6147, Petit Mont Member of the Neuville Fm) where it is always very rare. It is found in the following localities (the number of specimens is put between brackets):

- BM-2003-6 (1): between 4.85 m – 6 m above the base of the Neuville Fm.
- BM-2003-7 (1): between 4.3 m – 4.5 m above the base of the Neuville Fm.
- BM-2003-8 (2): between 4 m – 4.4 m below the top of the Neuville Fm.
- JG-1995-5 (1): corresponds to the outcrop BM-2003-8, bed 77 of the log of HELSEN & BULTYNCK (1992, fig. 5); Neuville Fm.

- Olloy 575 (5): corresponds to the outcrop BM-2003-8 (F2i).
- Couvin 6158B (1): cemetery quarry at Boussu-en-Fagne (F2i).
- Sautour 6147 (2): Roly, "Le Rondtienne" (F2j).

Superfamily Ambocoelioidea GEORGE, 1931

Family Ambocoeliidae GEORGE, 1931

Subfamily Ambocoeliinae GEORGE, 1931

Genus *Dionacoelia* n. gen.

DERIVATIO NOMINIS

Dionantum (Latin): Dinant. Reference to the Dinant Synclinorium (southern Belgium).

TYPE SPECIES

Dionacoelia secessus n. gen., n. sp.

DIAGNOSIS

Shell small, smooth, plano-convex or clearly ventribiconvex, generally longer than wide. Ventral sinus and dorsal fold present. Anterior commissure parasulcate or unipli-cate. Ventral beak erect to suberect. Narrow delthyrium partially closed by a deltidium. Micro-ornament consisting of capillae composed by a succession of segments with spines bases at their anterior margin, and concentric growth lines. Short dental plates; small and stout teeth; short myophragm; triangular muscle field moderately excavated in the valve floor. Cardinal process trilobed; shaft continuous with the myophragm; internal crests of the dental sockets well-developed; crural plates lacking; muscle field defined by two lateral ridges; 4 to 7 whorls by laterally oriented spiral cones.

DISCUSSION AND COMPARISONS

VANDERCAMMEN (1956, p. 30) placed the type species in the genus *Echinocoelia* COOPER & WILLIAMS, 1935 while modifying their diagnosis. Now, according to COOPER & WILLIAMS (1935, p. 844), *Echinocoelia* possesses only concentric undulations and is characterized internally by vestigial dental plates and a bilobed myophore. After JOHNSON & TROJAN (1982, p. 128), dental lamellae are

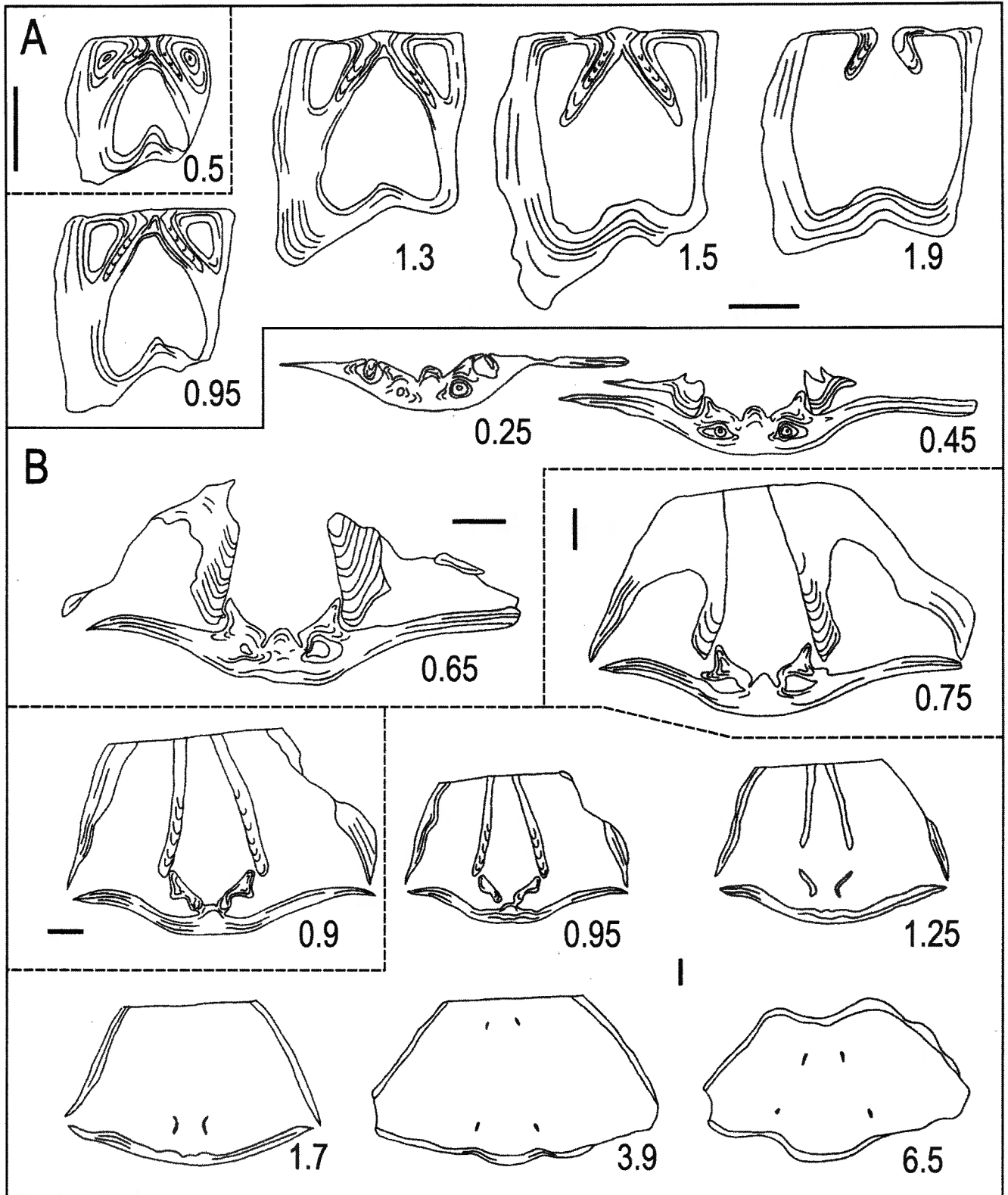


Fig. 4 – *Acutatheca rigauxi* (MALLIEUX, 1909a). Specimen IRScNB a12107. Transverse serial sections. Distances are in mm from the top of the ventral (A) or dorsal umbo (B). Scale bar = 1 mm.



Fig. 5 – *Dionacoelia secessus* n. gen., n. sp. 1-5: holotype, specimen IRScNB a12111; 6-10: paratype A, specimen IRScNB a12112; 11-15: paratype B, specimen IRScNB a12113; 16-20: paratype D, specimen IRScNB a8041; 21: paratype E, specimen IRScNB a12115; 22: paratype F, specimen IRScNB a8046; 23-27: paratype G, specimen IRScNB a12116; 28-32: paratype H, specimen IRScNB a 12117. All x 1.5. 1, 6, 11, 16, 23, 28: ventral views; 2, 7, 12, 17, 24, 29: dorsal views; 3, 8, 13, 18, 25, 30: lateral views; 4, 9, 14, 26, 31: posterior views; 5, 10, 15, 20, 27, 32: anterior views; 21: internal mould of a ventral valve; 22: internal view of a dorsal valve.

lacking in all known species, but VOGEL *et al.* (1989, p. 39) mentioned vestigial plates in their species *E. similior*. Nevertheless, *Dionacoelia* clearly differs from *Echinocoelia* by the presence of well-developed dental plates, a trilobed cardinal process and its micro-ornamentation consisting essentially of capillae.

From *Ambocoelia* HALL, 1860, the new genus is distinguished by the presence of dental plates and a trilobed cardinal process.

Dionacoelia does not display the same micro-ornamentation as *Swaicoelia* HAMADA, 1968. Moreover, the latter genus has no dental plates and possesses a boss-shaped cardinal process.

SPECIES ATTRIBUTED TO THE GENUS

Until now, only the type species is attributed to the genus. *Ambocoelia walheimensis* KLÄHN, 1912 could belong to the new genus but its internal characters are unknown. The specimen figured by KLÄHN (1912, pl. 2: 6) has not been found in the collections of the Institute of Geology at Strasbourg.

Dionacoelia secessus n. gen., n. sp.

Figures 5-9; Table 2

DERIVATIO NOMINIS

Secessus, us (Latin): hermitage, deserted site. Allusion to the Ermitage Member, the stratum typicum of the species.

TYPES

Holotype: IRScNB a12111; Paratypes A: IRScNB a12112; B: IRScNB a12113; C: IRScNB a12114; D: IRScNB a8041 [VANDERCAMMEN (1956, fig. 28, pl. 2: 14)]; E: IRScNB a12115; IRScNB a8046 [VANDERCAMMEN (1956, fig. 27)]; G: IRScNB a12116; H: IRScNB a12117.

Holotype: Boussu-en-Fagne, way of the Hermitage (collected at 30.6 m above the base of the Ermitage Member); paratype A: Couvin [41(6159 pp.)]; paratypes B, C, D, E: Olloy (463); paratype F: Beauraing (8725); paratype G: Han-sur-Lesse (6246); paratype H: Agimont (6363).

LOCUS TYPICUS

Boussu-en-Fagne, way of the Hermitage (province of Namur, Belgium) (see Fig. 2).

STRATUM TYPICUM

Ermitage Member of the Moulin Liénaux Fm (Middle Frasnian).

MATERIAL

Seven complete and 4 fragmented specimens; 13 ventral valves and 2 dorsal valves.

DESCRIPTION

External characters

General characters

The shell is generally longer than wide (W/L: 0.87-1.04), plano-convex to clearly ventribiconvex with a rounded subpentagonal outline. The hinge line is shorter than the width; maximum width near mid-length. The anterior commissure is parasulcate or uniplicate. The anterior margin is straight; lateral commissures ventrally deviated near the front.

Ventral valve

In posterior view, its upper surface is dome-shaped; the flanks slope in steep gradient towards the lateral commissure. In lateral profile view, the convexity is generally very important [ULv/L: 1.36-1.64 (7 measured specimens)]. The sulcus is wide (Ws/W: 0.41-0.53), poorly defined, very shallow and with a flattened bottom. The tongue is more or less perpendicular to the commissural plane and subrounded to subtrapezoidal. The interarea is concave, moderately high (Hi/Wh: 0.28-0.38), apsacline or catacline at the base and then, becoming apsacline. The narrow delthyrium is almost entirely closed by deltidium without foramen (Fig. 6.6). The shoulder lines are subrectilinear to concave. The apical angle varies between 76°-93°.

Dorsal valve

Low or almost flat, wider than long (w/Ld: 1.18-1.36) and

Table 2

Specimen	Dimensions (mm)									aa
	W	L	Ld	ULv	ULd	T	Wh	Hi	Ws	
Holotype a12111	12.6	13.2	10.7	18	11	8.8	9.9	3.7	5.2	91°
A a12112	13.3	12.8	10.4	17	11	9.3	11.2	4.3	6	93°
B a12113	11.7	13.4	9.3	21	9	8.9	9.5	2.9	5.4	76°
C a12114	11	12.0	/	19	9	7.7	/	2	4.9	86°
D a8041	11.7	12.2	9.4	19	10	8.4	7.05	2	5.45	85°
G a12116	14	14.6	10.3	24	10	9	1.7	3	7.3	84°
H a12117	13.3	14.3	10.3	21	10	9.1	11	3.8	7	86°

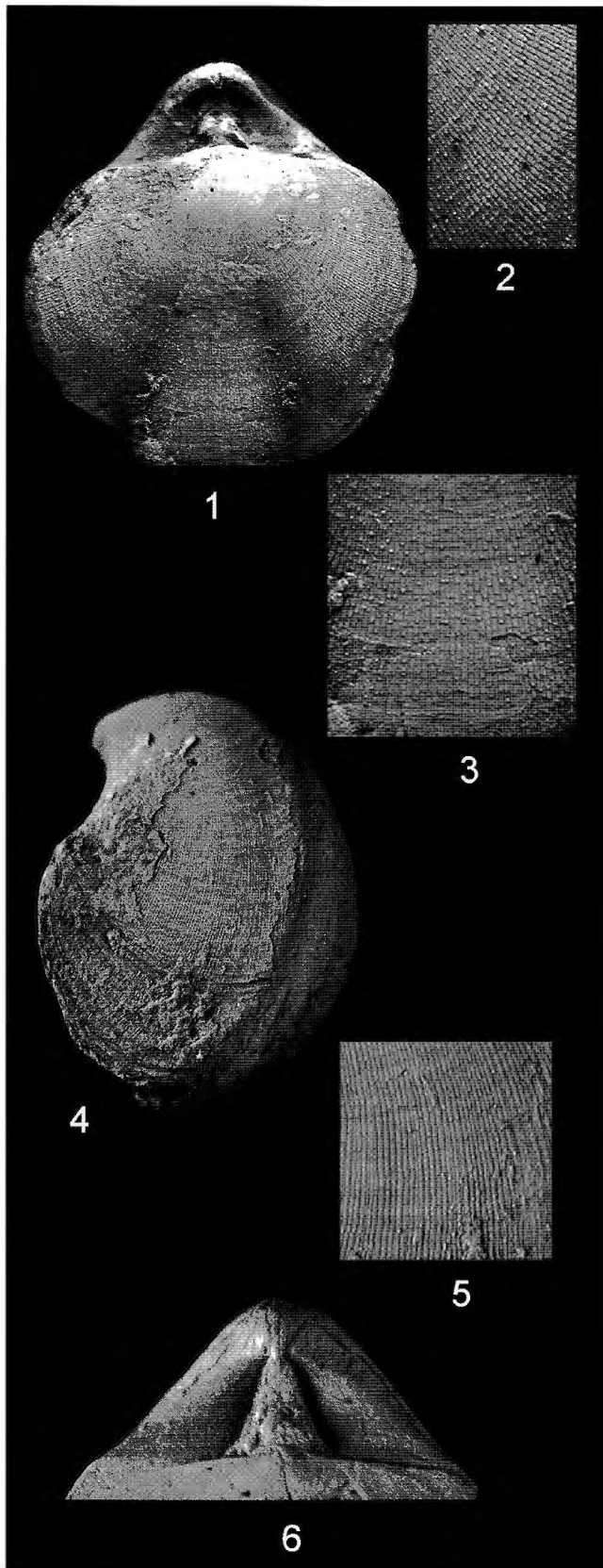


Fig. 6 – *Dionacoelia secessus* n. gen., n. sp. 1-3: paratype D, specimen IRScNB a8041 details of the micro-ornament; 4-5: paratype B, specimen IRScNB a12113, details of the micro-ornament; 6: paratype G, specimen IRScNB a 12116, detail of the delthyrial cover. 1, 4, 6: x 5; 2, 3, 5: x 10.

has a semi-elliptical outline. The fold occurs near mid-length; it is low, but well-defined by two lateral grooves and flattened or rounded at the frontal margin. The inter-area is anacline, plane and attains a high of ± 1 mm.

Ornamentation (Fig. 6.1-6.5)

The shell is entirely smooth, only micro-capillae are present. They increase by bifurcation and intercalation and are cut again by concentric microlines. In the best preserved specimens, the micro-capillae are not continuous, but constituted by a succession of segments with spines bases at their anterior margin (see BALIŃSKI (1975) for the consequences of the changes of the micro-ornamentation in the ambocoeliids).

Dimensions (Table 2)

Internal characters (Figs. 7-8)

Ventral valve

The dental plates are short but not vestigial, thickened posteriorly and support small and stout teeth. They form an angle comprised between 21° - 31° (only two specimens!). A delthyrial plate is lacking; the central apical cavity is large and less filled in than the lateral apical cavities. A short myophragm is present in the umbonal part of the valve. The triangular muscle field is moderately excavated in the valve floor and its length corresponds to 28% of the unrolled length of the internal mould (one specimen!).

Dorsal valve

The cardinal process is trilobed and non striated unlike the sketch in VANDERCAMMEN (1956, fig. 27) on the basis of the specimen IRScNB a8046; it constitutes the posterior part of a smooth ridge (shaft) which continues more anteriorly by the myophragm. The dental sockets are relatively deep and opened laterally; their internal crests are well-developed. The crural plates are lacking. The muscle field is defined by two low crests and divided by a prominent myophragm. The laterally oriented spiral cones comprise at least 4 whorls (1 sectioned specimen), but according to VANDERCAMMEN (1956, p. 34), the specimen with the old number A. V. 5192 displayed 7 coils.

DISCUSSION

As noted in the synonymy of *Acutatheca rigauxi*, most of the citations of this species concerns *Dionacoelia secessus* n. gen., n. sp.

STRATIGRAPHIC RANGE AND GEOGRAPHIC DISTRIBUTION (Fig. 9)

Dionacoelia secessus n. gen., n. sp. is a rare species and has been collected principally and according to the old labels in the Ermitage Member (*partim*, F2e) of the Moulin Liénaux Fm, but also in the Bieumont (F2g) and Boussu-en-Fagne (F2i) members of the Grands Breux Fm and in the Neuville Fm (F2i). Nevertheless, the presence of the species in the F2g and F2i is unreliable until

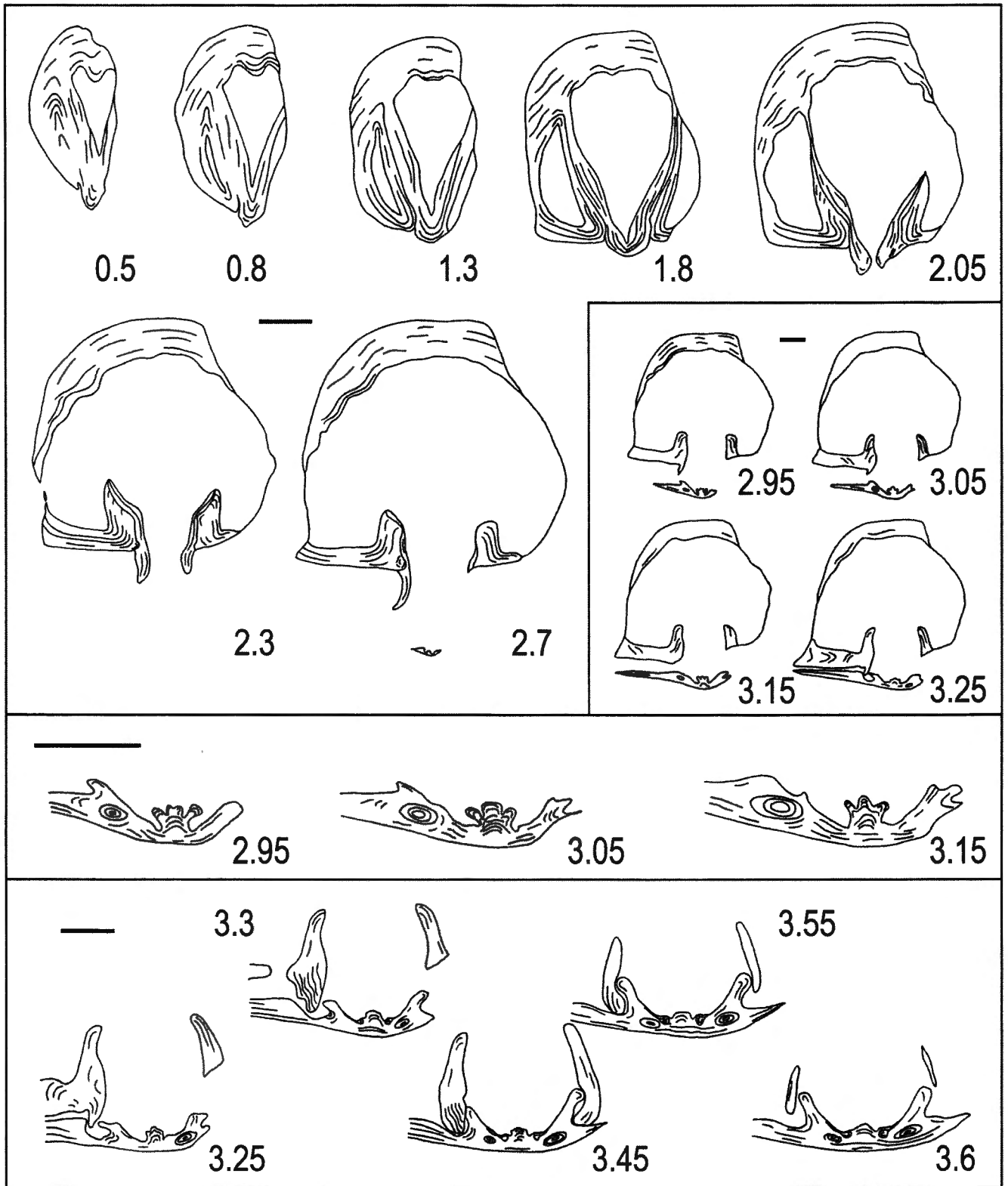


Fig. 7 – *Dionacoelia secessus* n. gen., n. sp. Paratype C, specimen IRScNB a12114. Transverse serial sections. Distances are in mm from the top of the ventral umbo. Scale bar = 1 mm.

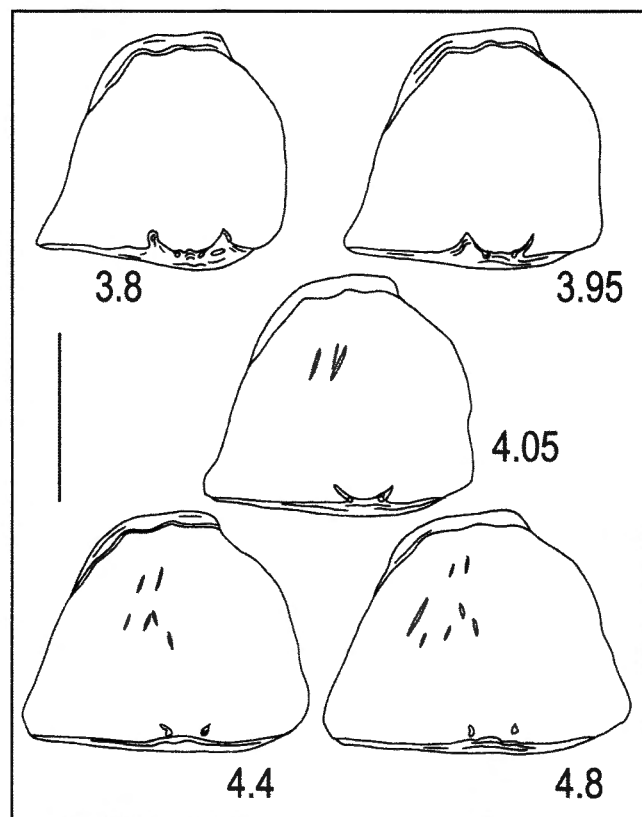


Fig. 8 – *Dionacoelia secessus* n. gen., n. sp. Paratype C, specimen IRScNB a12114. Transverse serial sections. Distances are in mm from the top of the ventral umbo. Scale bar = 5 mm.

new material has been collected from these levels, but to date, no specimen has been collected in the Boussu-en-Fagne Member and in the Neuville Fm. *D. secessus* n. gen., n. sp. is found in the following localities of the southern border of the Dinant Synclinorium (the number of specimens is put between brackets):

- Agimont [without number] (1): Givet, way from the station to the fortified town of Charlemont (F2e).
- Agimont 6363 (1): Givet, between Charlemont and Condé (F2e).
- Couvin 41 [6159 pp.] (5): Boussu-en-Fagne, way of the Hermitage (F2e).
- Couvin 57 (2): Frasnes, way of Nismes, south of the Lion quarry (F2e).
- Couvin 6158 (1): Boussu-en-Fagne, cemetery quarry (F2i).
- Olloy 463 (14): Nismes, way of the “Abannets” (F2e).
- Han-sur-Lesse 7221 (1): 300 m to the north of Ave (F2e).
- Han-sur-Lesse 6246 (2): 1800 m east of Genimont (F2g).
- Beauraing 8725 (1): Givet road, near the frontier (F2i).

Conodont Zones	Formations	Frasnian succession on the southern flank of the Dinant Synclinorium	
linguif.		MATAGNE	<i>Dionacoelia secessus</i> ----- ?
Upper rhenana			
Lower rhenana	PM	NEUVILLE	
jamieae	Grands Breux	Boussu-en-Fagne	
Upper hassi			
Lower hassi		Bieumont	
punctata	Moulin Liénaux	Ermitage	
		Arche	
transitans		Chalon	
Upper falsiovalis		NISMES	
PM = Petit Mont			Members FORMATIONS

Fig. 9 – Stratigraphic ranges of *Dionacoelia secessus* n. gen., n. sp. and *Acutatheca rigauxi* (MAILLIEUX, 1909a) within the Frasnian of the southern border of the Dinant Synclinorium. Dashed line means a need of confirmation for a reported occurrence.

Conclusion

About one century after its description by MAILLIEUX (1909a), *Cyrtina rigauxi* is reviewed and assigned to the genus *Acutatheca* STAINBROOK, 1945. It is a rare species misidentified as *Cyrtina demarlei* BOUCHARD and *C. heteroclitia* (DEFRANCE, 1824) by MAILLIEUX (1940, 1941) from the Neuville Fm (Lower *P. rhenana* Zone). *Martiniopsis (Elivella) rigauxi* in MAILLIEUX (1940, 1941) (= *Echinocoelia rigauxi* sensu VANDERCAMMEN, 1956) corresponds to *Dionacoelia secessus* n. gen., n. sp. (Ambocoeliidae). This latter occurs with certainty in the Moulin Liénaux Fm (Ermitage Member; *P. punctata* Zone).

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References

- ASSELBERGHS, E., 1912. Description d'une faune frasnienne inférieure du bord nord du bassin de Namur. *Bulletin de la Société belge de Géologie, de Paléontologie et d'Hydrologie, Mémoires*, **26**: 1-47.
- ASSELBERGHS, E., 1936. Le Dévonien du bord nord du Bassin de Namur. *Mémoires de l'Institut géologique de l'Université de Louvain*, **10**: 229-327.
- ASSELBERGHS, E. & MAILLIEUX, E., 1925. Comptes rendus de la cinquième session extraordinaire de la Société Géologique et Minéralogique de Bretagne tenue dans le terrain dévonien de l'Ardenne, entre Charleville et Gembloux du 13 au 19 avril 1925. *Bulletin de la Société Géologique et Minéralogique de Bretagne*, **6**: 128-168.
- BALIŃSKI, A., 1975. Secondary changes in micro-ornamentation of some Devonian ambocoeliid brachiopods. *Palaeontology*, **18** (1): 179-189.
- BLAINVILLE H.M. (DUCROTAY DE), 1824-1830. Dictionnaires des Sciences naturelles. 32 (1824): Mollusques: 1-567; Atlas, 2^o partie: Zoologie, pl. 1-118 (1830). Paris.
- BOULVAIN, F., 1993. Sédimentologie et diagenèse des monticules micritiques "F2J" du Frasnien de l'Ardenne. *Service Géologique de Belgique, Professional Paper*, **260**: 1-427.
- 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.
- BOULVAIN, F., COEN, M., COEN-AUBERT, M., BULTYNCK, P., CASIER, J.-G., DEJONGHE, L. & TOURNEUR, F., 1993. Les formations frasnienne du Massif de Philippeville. *Service Géologique de Belgique, Professional Paper*, **1993/1**: 1-37.
- BOULVAIN, F. & COEN-AUBERT, M., 1997. Le sondage de Focant: lithostratigraphie et implications structurales. *Memoirs of the Geological Survey of Belgium*, **43**: 1-74.
- BRICE, D., 1988. Brachiopodes du Dévonien de Ferques. In: BRICE, D. (Editor), Le Dévonien de Ferques. Bas-Boulonnais (N. France). Paléontologie – Sédimentologie – Stratigraphie – Tectonique. *Biostratigraphie du Paléozoïque*, **7**: 323-395.
- BULTYNCK, P., COEN-AUBERT, M., GODEFROID, J., 2000. Summary of the state of correlation in the Devonian of the Ardennes (Belgium-NE France) resulting from the decisions of the SDS. *Courier Forschungsinstitut Senckenberg*, **225**: 91-114.
- BULTYNCK, P. & DEJONGHE, L., 2002. Devonian lithostratigraphic units (Belgium). In: BULTYNCK, P. & DEJONGHE, L. (Editors), Guide to a revised lithostratigraphic scale of Belgium. *Geologica Belgica*, **4** (1-2): 39-69.
- BULTYNCK, P. & MOURAVIEFF, N.A., 1999. Formation du Moulin Liénaux. In: BOULVAIN *et al.*, 1999: 38-49.
- CALDWELL, W.G.E., 1967. Ambocoeliid Brachiopods from the Middle Devonian rocks of northern Canada. In: H. OSWALD, D.H. (Editor), International Symposium on the Devonian System, volume 2: pp. 601-616. Alberta Society of Petroleum Geologists. Calgary, Alberta, Canada.
- CARTER, J.L., JOHNSON, J.G., GOURVENNEC, R. & HOU, H.-F., 1994. A revised classification of the spiriferid brachiopods. *Annals of Carnegie Museum*, **63** (4): 327-374.
- COEN, M., 1977. La Klippe du Bois Niau. *Bulletin de la Société belge de Géologie*, **86** (1-2): 41-44.
- COEN, M., CASIER, J.G., HELSEN, S. & MOURAVIEFF, N.A., 1999. Formation de Matagne. In: BOULVAIN *et al.*, 1999: 57-60.
- COEN-AUBERT, M., 1992. La Carrière du Cimetière à Boussu-en-Fagne. *Annales de la Société Géologique de Belgique*, **115** (1): 23-24.
- COEN-AUBERT, M., 1994. Stratigraphie et systématique des Rugueux de la partie moyenne du Frasnien de Frasnes-les-Couvins (Belgique). *Bulletin de l'Institut royal des Sciences naturelles de Belgique, Sciences de la Terre*, **64**: 21-56.
- COOPER, G.A. & DUTRO, J.T., Jr., 1982. Devonian Brachiopods of New Mexico. *Bulletins of American Paleontology*, **82-83**: 1-215.
- COOPER, G.A. & WILLIAMS, J.S., 1935. Tully Fm of New York. *Geological Society of America Bulletin*, **46**: 781-868.
- CRICKMAY, C.H., 1953. New Spiriferidae from the Devonian of western Canada. Published by the author. Calgary. 11 pp.
- CRICKMAY, C.H., 1967. The method of indivisible aggregates in studies of the Devonian. Published by the author. Calgary. 22 pp.
- DAHMER, G. & QUIRING, H., 1954. Oberdevon in der Antiklinale zwischen den Steinkohlenbecken des Rubagon und des Carrion in Ostasturien. *Neues Jahrbuch für Geologie und Paläontologie, Monatshefte*, **1953**: 473-479.
- DAVIDSON, T., 1864-1865. A monograph of the British fossil Brachiopoda. *Palaeontographical Society*, **3** (6): 1-131.
- DAY, J. & DOWD, H., 2000. Late Devonian (Late Frasnian) brachiopod sequence in the Redknife and Kakisa formations (equatorial carbonate platform, upper Mackenzie River valley, southern N.W.T., Canada). *Abstracts with programs, Geological Society of America*, **32** (4): 10.
- DEFRANCE, J.L.M., 1824 (-1828). In: BLAINVILLE H.M. (1824-1830).
- 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.
- FICNER, F. & HAVLÍČEK, V., 1978. Middle Devonian brachiopods from Čelechovice, Moravia. *Sborník geologických věd, paleontologie*, **21**: 49-106.
- GEORGE, T.N., 1931. *Ambocoelia* Hall and certain similar British Spiriferidae. *Quarterly Journal of the Geological Society*, **87** (1): 30-61.
- GODEFROID, J., 1998. Le genre *Costatrypa* COPPER, 1973 (Brachiopoda, Atrypida) dans le Frasnien du sud de la Belgique. *Bulletin de l'Institut royal des Sciences naturelles de Belgique, Sciences de la Terre*, **68**: 97-114.
- GODEFROID, J. & HELSEN, S., 1998. The last Frasnian Atrypida (Brachiopoda) in southern Belgium. *Acta Palaeontologica Polonica*, **43** (2): 241-272.
- GOLDMAN, D. & MITCHELL, C.E., 1990. Morphology, systematics, and evolution of Middle Devonian Ambocoeliidae (Brachiopoda), western New York. *Journal of Paleontology*, **64** (1): 79-99.
- GOUWY, S. & BULTYNCK, P., 2000. Graphic correlation of Frasnian sections (Upper Devonian) in the Ardennes, Belgium. *Bulletin de l'Institut royal des Sciences naturelles de Belgique, Sciences de la Terre*, **70**: 25-52.
- HALL, J., 1860. Observations on the genus *Ambocoelia*. Thirteenth Annual Report for the Regents of the University, pp. 71-72.

- HAMADA, T., 1968. *Swaicoelia*, a new ambocoeliid genus (Brachiopoda) from North Thailand. *Contributions to the Geology and Palaeontology of Southeast Asia*, **5**: 1-12.
- HELSEN, S. & BULTYNCK, P., 1992. Conodonts and megafauna from two sections at Nismes and Mariembourg (Frasnian of the southern flank of the Dinant Synclinorium, Belgium). *Annales de la Société Géologique de Belgique*, **115** (1): 145-157.
- JOHNSON, J.G., 1970. Great Basin Lower Devonian Brachiopoda. *Geological Society of America, Memoir*, **121**: 1-421.
- JOHNSON, J.G. & TROJAN, W.R., 1982. The *Tecnocyrtina* Brachiopod fauna (?Upper Devonian) of Central Nevada. *Geologia et Palaeontologia*, **16**: 119-150.
- KLÄHN, H., 1912. Die Brachiopoden der Frasn-Stufe bei Aachen. *Jahrbuch der Königlich Preussischen Geologischen Landanstalt*, **33**: 1-39.
- LECOMPTE, M., 1960. Compte rendu de la session extraordinaire de la Société Géologique de Belgique et de la Société belge de Géologie, de Paléontologie et d'Hydrologie du 25 au 28 septembre 1959. *Annales de la Société géologique de Belgique, Mémoires*, **83**: 1-134.
- LECOMPTE, M., 1963. Livret-Guide des Excursions C-D, VIe Congrès International de Sédimentologie Hollande-Belgique, 1963, Bruxelles, 49 pp.
- MAILLIEUX, E., 1909a. Note sur quelques brachiopodes du Frasnien belge. *Bulletin de la Société belge de Géologie, de Paléontologie et d'Hydrologie, Procès-verbaux*, **23**: 9-13.
- MAILLIEUX, E., 1909b. Etude comparative de la répartition des espèces fossiles dans le Frasnien du bord méridional du bassin dinantais et dans les niveaux synchroniques du Boulonnais. *Bulletin de la Société belge de Géologie, de Paléontologie et d'Hydrologie, Mémoires*, **23**: 115-147.
- MAILLIEUX, E., 1909c. Note sur les *Cyrtina* dévoniennes du bord sud du bassin de Dinant. *Bulletin de la Société belge de Géologie, de Paléontologie et d'Hydrologie, Procès-verbaux*, **23**: 256-260.
- MAILLIEUX, E., 1914a. Nouvelles observations sur le Frasnien et en particulier sur les paléorécifs de la plaine des Fagnes. *Bulletin de la Société belge de Géologie, de Paléontologie et d'Hydrologie, Mémoires*, **27**: 67-104.
- MAILLIEUX, E., 1914b. Nouvelle contribution à l'étude des récifs coralligènes du Frasnien. *Bulletin de la Société belge de Géologie, de Paléontologie et d'Hydrologie, Procès-verbaux*, **28**: 82-93.
- 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 *Spiriferidae* et des *Spiriferinidae* dans le Dévonien de l'Ardenne. *Bulletin du Musée royal d'Histoire naturelle de Belgique*, **17** (13): 1-6.
- MOURAVIEFF, N.A., 1974. Excursion F. In: BOUCKAERT, J. & STREEL, M. (Editors), Guidebook of the International Symposium on Belgian micropaleontological limits from Emsian to Viséan, Namur September 1st to 10th 1974. Service Géologique de Belgique, Bruxelles, 13 pp.
- SANDBERG, C.A., ZIEGLER, W., DRESEN, R. & BUTLER, J. L., 1992. Conodont Biochronology, Biofacies, Taxonomy, and event Stratigraphy around Middle Frasnian Lion Mudmound (F2h), Frasnes, Belgium. *Courier Forschungsinstitut Senckenberg*, **150**: 1-87.
- STAINBROOK, M.A., 1945. Brachiopoda of the Independence Shale of Iowa. *Geological Society of America Memoir*, **14**: 1-74.
- STAINBROOK, M.A., 1948. Age and Correlation of the Devonian Sly Gap beds near Alamogordo, New Mexico. *American Journal of Science*, **246**: 765-790.
- TALENT, J.A., GRATSIANOVA, R.T. & YOLKIN, E.A., 2001. Latest Silurian (Pridoli) to middle Devonian (Givetian) of the Asia-Australia hemisphere: rationalization of brachiopod taxa and faunal lists; stratigraphic correlation chart. *Courier Forschungsinstitut Senckenberg*, **236**: 1-221.
- VANDERCAMMEN, A., 1956. Révision des Ambocoeliinae du Dévonien de la Belgique. *Bulletin de l'Institut royal des Sciences naturelles de Belgique*, **33** (43): 1-51.
- VANGUESTAINE, M., PARDO-TRUJILLO, A., COEN-AUBERT, M., ROCHE, M. & BOULVAIN, F., 1999. Evolution of organic debris and palynomorph preservation in two late middle Frasnian sections, southern Dinant Synclinorium border, Belgium. *Bollettino della Società Paleontologica Italiana*, **38** (2-3): 317-330.
- VOGEL, K., XU, H.-K. & LANGENSTRASSEN, F., 1989. Brachiopods and their relation to facies development in the Lowe rand Middle Devonian of Nandan, Guangxi, South China. *Courier Forschungsinstitut Senckenberg*, **110**: 17-59.
- WAAGEN, W.H., 1883 (1883-1885). Salt Range fossils. Part 4 (2): Brachiopoda. *Memoirs of the geological Survey of India, Palaeontologia Indica*, **13** (1): 329-770.
- XIAN S.-Y & JIAN Z.-L., 1978. Brachiopoda, Early Ordovician-Carboniferous. In: Atlas of Palaeontology of Southwest China: Guizhou Province. Vol. 1, Cambrian-Devonian. Geological Publishing House, Beijing. pp. 251-337. [in Chinese].

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