

Notes on the systematics, morphology and biostratigraphy of holoplanktic Mollusca, 26¹. An unexpected pteropod occurrence (Euthecosomata, Limacinidae) in euryhaline Early Oligocene mollusc assemblages in the Belgian province of Limburg

ARIE W. JANSSEN

Naturalis Biodiversity Center, P.O. Box 9517, NL-2300 RA Leiden, The Netherlands;
ariewjanssen@gmail.com [corresponding author]

JOS LENAERTS

Demerstraat 8, 3730 Hoeselt, Belgium; jos_lenaerts@telenet.be



JANSSEN, A.W. & LENAERTS, J., 2019. Notes on the systematics, morphology and biostratigraphy of holoplanktic Mollusca, 26. An unexpected pteropod occurrence (Euthecosomata, Limacinidae) in euryhaline Early Oligocene mollusc assemblages in the Belgian province of Limburg. – *Basteria* 83 (4-6): 102-108. Leiden.

Published 9 November 2019

The pteropod species *Limacina ernstkittli* Janssen, 2012, described from the Chattian (Late Oligocene) of northern Germany and Malta, is recorded from euryhaline deposits of Rupelian (Early Oligocene) age in Belgium. Its occurrence in near coastal, not fully marine assemblages, anticipating earlier records with at least 5 mA, is surprising. Critical notes are provided regarding the introduction of the name Borgloon Formation in 1988 without the designation of a type locality / type section; we recommend to replace it by the name Atuatuca Formation which was coined in 1976 and being accompanied by a fully described type locality and type section.

Key words: Pteropoda, *Limacina ernstkittli*, Oligocene, Atuatuca Formation, Borgloon Formation, Alden Biesen Member.

INTRODUCTION

Deposits of the Early Oligocene (Rupelian) so-called ‘Tongeren Group’ in Belgium are currently (Maréchal, 1994;

National Commission for Stratigraphy Belgium, 2019) formally subdivided into three formations: the Sint-Huibrechts-Hern Formation, the Zelzate Formation and the Borgloon Formation. The two first mentioned units include predominantly sediments deposited in marine environments, although the ‘Neerrepen Sand Member’ of the Sint-Huibrechts-Hern Formation includes the so-called ‘Neerrepen Soil’ at its top (Buurman & Jongmans, 1975), indicating a tidal, very near-coastal, or even terrestrial environment. The few available fossils (Naturalis collections) from lower parts of the Neerrepen Sands, however, include more than one species of Pectinidae bivalve molluscs, indicating a fully marine depositional environment (see also Deville, 1996).

The Zelzate Formation is mainly found in the western provinces of Belgium, whereas both the Sint-Huibrechts-Hern and the Borgloon formations are well developed more to the east, near the cities of Tienen and Tongeren. In this paper we discuss the remarkable history of the naming of the Borgloon Formation, and discuss the presence of *Limacina ernstkittli* in its Alden Biesen Member.

RESULTS & DISCUSSION

Atuatuca Formation/Borgloon Formation

The ‘Borgloon Formation’, first described in Dutch language as ‘Formatie van Borgloon’, was introduced by P. Laga (*in* Maréchal & Laga, 1988: 169) without designation

¹ For nr 25 in this series see *Basteria* 82 (4-6): 110-112, 2018.

of a type locality or type section. In the description type sections are only given for the members of the formation, which are the Henis Member ('Lid van Henis') and the Oude Biezen Member ('Lid van Oude Biezen') in the area around the city of Tongeren (Limburg province), and the Boutersem Member ('Lid van Boutersem'), inclusive of the Hoogbutsel Bed ('Laag van Hoogbutsel') and the Kerkom Member ('Lid van Kerkom') more to the west (Vlaams Brabant province). None of these type sections, however, is situated in the municipality of Borgloon.

In the description of the Borgloon Formation in Maréchal & Laga (1988) the name 'Atuatuca Formation', introduced for the same stratigraphical sequence in the Tongeren area by Janssen et al. (1976) is given as an earlier synonym '*that cannot be retained*', for which opinion, however, not a single reason was given. This is the more curious as the name 'Atuatuca Formation' not only was introduced twelve years anticipating the introduction of the name 'Borgloon Formation', but, contrary to 'Borgloon Formatie', its introduction was accompanied by a fully described type locality and type section, with detailed information on its stratigraphical context. The Roman name of Tongeren is 'Atuatuca Tungrorum' and the authors of the formation preferred that name as the name 'Tongeren' was already in use in lithostratigraphy. However, the authors of the 'Atuatuca Formation' were not Belgian and the study that led to the introduction of a new formation was not initiated by the Belgian Geological Survey.

In our copy of Maréchal & Laga (1988) a six page additional text is included (Anonymous, undated) in Dutch language, containing critical notes on the Maréchal & Laga (1988) paper, by participants of the 'National Commission for Stratigraphy'. On the first page of these notes the second paragraph under 'General observations' reads (translated): 'For all lithostratigraphical units always a stratotype has to be indicated'. A paragraph on page 2 reads: 'The old lithostratigraphical names have to be treated in a similar way as fossil-nomenclature: priority, authorship, emendations etc.'. Another paragraph on the same page reads: 'Useless replacement of units which have been in use for years' and one of the given examples is: 'Formatie van Borgloon = Atuatuca Formatie'. In spite of its poor definition and these critical notes the name Borgloon Formation is still in use (Maréchal, 1994; Laga et al., 2001; Vandenberghe et al., 2004; Marquet et al., 2008; National Commission for Stratigraphy Belgium, 2019).

We herewith invite the National Commission for Stratigraphy Belgium, and the Geological Survey of Belgium, to reconsider the formal name of the formation.

The Alden Biesen Member and its mollusc fauna

Originally described as 'Sable de Vieux-Joncs' by Ortlieb & Dollfus (1873: 43ff) this unit was named after the 'Alden

Biesen Castle' in the former municipality of Rijkhoven, nowadays Bilzen, north of the city of Tongeren. For extensive information (in Dutch language) on 'Alden Biesen' see the website Wikipedia (2019). In the course of time various similar names have been in use for the same unit, such as 'Sables et Marnes de Vieux-Joncs', or, in Dutch: 'Zanden van Oude Biezen', 'Zanden en Mergels van Oude Biesen', and translations thereof in French and/or English. The name of the castle, originally spelled as 'Alden Biesen' was frequently applied as 'Oude Biesen', 'Oude Biezen', 'Alde Biesen' or 'Vieux-Joncs'.

The occurrence of this member in the Tongeren area and more to the west was recorded in detail by an extensive auger-drilling project, executed during the 1970's by members of the Dutch society WTKG, (van Hinsbergh et al., 1973; Cadée et al., 1976; Janssen et al., 1976; Kruissink et al., 1978; Bor et al., 1980). All borehole data collected during this project received formal archive numbers of the Geological Survey of Belgium.

The mollusc fauna of the Alden Biesen Member has been described in a number of papers, ever since the first half of the 19th century (e.g., Nyst, 1836, 1845-46; Rutot, 1873; Glibert & de Heinzelin de Braucourt, 1954; Janssen, 1963) and was recently revised by Marquet et al. (2008).

The various deposits of the member were laid down in a system of near-coastal environments, such as lagoons and/or coastal lakes. Tidal influences, together with influx of euhaline water, as well as freshwater run-off from the mainland caused a typically euryhaline environment (often, but incorrectly, classified as 'brackish' or, in French, 'saumâtre'), with faunal elements tolerating considerable changes in salinity, such as species of the mollusc families Corbiculidae, Potamididae and Thiaridae, with incidental occurrences of fully marine species, as well as a number of freshwater (Planorbidae, Lymnaeidae) and terrestrial (*Pomatias*, *Vallonia*, *Microstela*, *Vertigo*, *Gastrocopta*) gastropod taxa. Most of the outcrops of the member yield extremely large quantities of gastropod individuals, but most of the terrestrial species seem to be restricted to more clayey/marly intervals. One such occurrences, in an outcrop in the village of Kleine Spouwen (Nachtegaalstraat) has yielded quite a number of small terrestrial gastropod shells, mainly collected there by Mr C. Karnekamp of Diepen (NL) (Karnekamp, 1990). Apart from the molluscs further studies have been published on palynology (Bremer, 1975), bony fish otoliths (van Hinsbergh, 1980) and sharks and rays (Bor, 1980) that led to similar conclusions on palaeoecology.

In the southern part of the Dutch province of Limburg correlatable deposits occur under the common names of 'Cerithiumclay' or 'Valkenburg Deposit' and formally named 'Goudsberg Member of the Tongeren Formation' (website DinoLoket, 2019), and outcropping near the vil-

lages of Walem and Valkenburg (Spaink, 1963; Janssen, 1963; Cadée & Vaessen, 1975; Buurman & Langeraar, 1975).

A pteropod from the Alden Biesen Member

The monograph of Marquet et al. (2008) included the mollusc assemblages of both the Alden Biesen Member and the Boutersem Member. From the investigated localities together ninety mollusc species were recorded and systematically revised. Twenty-five of these were bivalves and sixty-five were gastropod species.

Among the material from the Alden Biesen Member were a few specimens of a small, sinistrally coiled gastropod shell that the authors were unable to identify. As various further terrestrial species were present they compared the shell (with a height of less than 2 mm) with Clausiliidae species, but the morphology of the shell does not agree with species of that family. They also suggested that it could belong to a pupilloidean or even to another Stylommatophora species. The species was included in the monograph (Marquet et al., 2008: 75, pl. 21, figs 2a-h) with the denomination ‘unidentified genus and family’.

The second author of the 2008 monograph (who also is second author of the present paper) accidentally noted a certain resemblance of the sinistral Belgian shell with sinistral pteropod specimens illustrated in Rayner et al. (2009). Contact with Dr Dietrich Kadolsky (Bonn, Germany), who specialises on fossil terrestrial gastropods, acknowledged that the Belgian shells were not landsnails and it was suggested that they might be pteropods indeed. This led to a first contact with the present first author, who recognised the shells as pteropods and even was able to identify them as:

Limacina ernstkittli A.W. Janssen, 2012

Figs 1-12

Limacina sp. — Moths et al., 1997: 25.

Limacina (*Limacina*) sp. — Moths et al., 1997: pl. 19 fig. 2.

Limacina sp. and *L. gramensis* — Janssen, 2004: 15, pl. 3 figs 20a-b; Gatt, 2006: 200.

Unidentified genus and family — Marquet et al., 2008: 75 (excl. syn.), pl. 21 figs 2a-h.

Limacina ernstkittli Janssen, 2012b: 299, pl. 4 figs 2-4; pl. 22 figs 9-11.

Non:

Opisthobranchiata spec. indet. (linksgewonden) — Spaink, 1963: 47.

Type locality. — Kobrow (Germany, Mecklenburg-Vorpommern), gravel pit circa 2 km ssw of Sternberg; reworked boulder of so-called ‘Sternberger Gestein’ (Late Oligocene, Chattian).

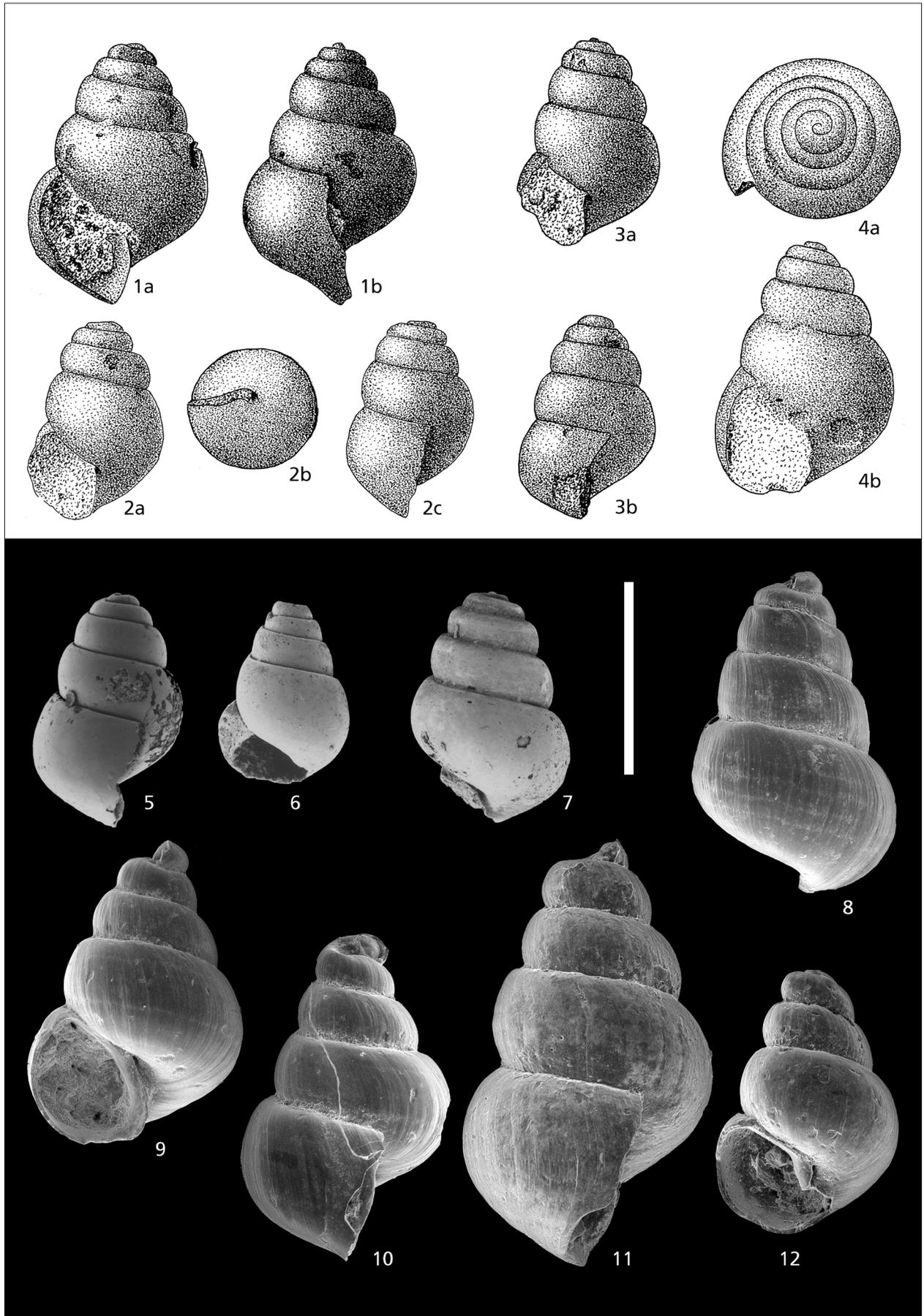
Type material. — Holotype RGM.569842; paratypes: from the type locality: RGM.396632 (1 specimen); circa 20 predominantly juvenile specimens in coll. H. Moths (Geesthacht, Germany); many specimens from Late Oligocene Globigerina Limestone Formation of Malta, as specified in Janssen (2012b: 299-300).

Description (from Janssen, 2012b: 300). — ‘Shell sinistral, elongately conical, approximately one and a half times as high as wide, consisting of somewhat more than five convex whorls, slowly and gradually increasing in diameter, separated by incised sutures. The shell is small (holotype: H = 1.34, W = 0.90 mm, paratype illustrated Fig. 4a-b: H = 1.30, W = 0.94 mm). The body whorl occupies circa ¾ of the shell height, the relatively small aperture less than half. Growth lines are invisible, even on the specimens in shell preservation. The abaxial apertural margin is curved gradually, situated obliquely when seen in a lateral view (opisthocline); there are no apertural reinforcements. The base is perforated by a very small umbilicus (Fig. 2b)’.

Discussion. — The gastropod *Limacina ernstkittli* (Pteropoda, Limacinidae) was described on the basis of specimens from Late Oligocene ‘Sternberger Gestein’ from northern Germany, that appeared to be identical with specimens from deposits of similar age in Malta, in the centre of the Mediterranean. So far these two occurrences have been the

Figs 1-12. *Limacina ernstkittli* A.W. Janssen, 2012. **Fig. 1.** Holotype, Kobrow (Germany, Mecklenburg-Vorpommern), ‘Sternberger Gestein’ (Oligocene, Chattian); RGM.569842 (leg./don. H. Moths), a: apertural view, b: lateral view. **Figs 2-7.** Paratypes. **2.** Baħar-iċ-Ċaġħaq 1 (Malta), Middle Globigerina Limestone Member, 1.50-2.00 m above C 1 (Oligocene, Chattian); RGM.569720, a: apertural view, b: umbilical view, c: lateral view. **3.** Same locality data; RGM.569722, a: apertural view, b: lateral view. **4.** Same locality data; RGM.569721, a: apical view, b: apertural view. **5.** Semi-adult specimen; Dingli 1 (Malta); base of Middle Globigerina Limestone Member, C 1 main phosphorite level (Oligocene, Chattian), RGM.516172, lateral view. **6.** Damaged specimen, Xrob-il-Għaġin 2 (Malta), Upper Globigerina Limestone Member (reworked), RGM.516173, apertural view. **7.** Semi-adult specimen, aperture damaged, Xewkija 1a (Malta, Gozo), base of Middle Globigerina Limestone Member, C 1 phosphorite level, RGM.516174, lateral view. **Figs 8-10.** Rijkhoven, Bilzen municipality (Belgium), near Castle Alden Biesen, outcrop 93W567 IXa at coördinates x=231.60, y=170.72 (=50.8410°N, 5.5274°E), 0.30-1.20 m below surface, Alden Biesen Member, RGM.607236. **8, 9.** Apertural views. **10.** Dorsal view. **Figs 11-12.** Tongeren, Berg (Belgium), Galgeberg outcrop at coördinates x = 230.1 and y = 164.9 (= 50.7891°N, 5.5049°E), Alden Biesen Member, RGM.607237. **11.** Apertural view. **12.** Lateral view.

Figs 1-7 from Janssen (2012b: pls 4 and 22); Figs 8-12 from Marquet et al. (2008: pl. 21 fig. 2). Magnifications adjusted, bar length is 1 mm for all figures.



only ones known. The observation of this species in the Alden Biesen Member is surprising for two reasons:

- 1 Pteropoda and other holoplanktic molluscs do not normally live in near-shore environments but prefer more open oceanic, deeper water conditions. Their occurrence in the euryhaline Alden Biesen Member assemblage is highly unexpected and can only be explained by supposing that specimens were incidentally transported from more open-sea-areas by wave or wind action. Similar events have been recorded for present-day pteropods, e.g. from the Red Sea and the Mediterranean (Singer, 1994: 8; Janssen, 2007: 153; 2012a, fig. 12).
- 2 The occurrence of the species in the Alden Biesen Member, of early Rupelian age, predates the Late Oligocene (Chattian) localities in Germany and Malta with at least 5 million years. Intermediate occurrences are so far unknown and the species is not found in the well-studied pteropod fauna of, for instance, the only slightly younger Boom Clay of the North Sea Basin. Also the geographical distribution of the species during the Late Oligocene is curious: North Sea Basin and Mediterranean, although no direct connection between these basins was available. The species is also not found in well-investigated Chattian sediments of the Aquitaine Basin, sw France. This might be explained by as yet incompletely known existences of the species.

One might suppose that more than one species is involved here, but the morphology of the shells does not support this. When comparing the illustrations in Marquet et al. (2008) and those in Janssen (2012b) there seems to be a difference in size (the largest specimen from the Alden Biesen Member has a shell height of 1.9 mm, whereas the largest specimen in the type series remains below 1.4 mm shell height. In both cases, however, the shell has circa 5 whorls and similar proportion.

The fragmentary specimen recorded by Spaik (1963: 47) as ‘Opisthobranchiata spec. indet. (linksgewonden)’ was, with a query, included as a synonym of the present species by Marquet et al. (2008: 75). That actual specimen, now in the Naturalis collections, was located by the collection manager, Mr Ronald Pouwer. It does not belong to this species. As it shows clear spiral ornamentation it rather belongs to a planorboid gastropod.

ACKNOWLEDGEMENTS

We thank Dietrich Kadolsky (Bonn, Germany) for his opinions and Robert Marquet (Antwerpen, Belgium) for his permission to use his images, and Kristiaan Hoedemakers, editor of ‘Palaeontos’ for providing the high resolution files. Ronald Pouwer (Naturalis Biodiversity Center, Leiden, NL)

located a fragmentary specimen recorded in 1963 by G. Spaik that appeared not to belong to a pteropod species. We are also grateful to Martin C. Cadée and Victor W.M. van Hinsbergh (both Leiden, NL), as well as to reviewers Ronald Pouwer and Robert Marquet, for critically reading the manuscript and helpful edits and comments.

REFERENCES

- ANONYMOUS, undated. Bemerkingen bij het voorstel voor de lithostratigrafische indeling van het Paleogeen: 1-6. [Text additional to the paper of MARÉCHAL & LAGA (1988)].
- BOR, T.J., 1980. Elasmobranchii from the Atuatuca Formation (Oligocene) in Belgium. — Mededelingen van de Werkgroep voor Tertiaire en Kwartaire Geologie 17 (1): 3-16.
- BOR, T.J., CADÉE, M.C. & JANSSEN, A.W., 1980. Een Noord-Zuidprofiel door Oligocene afzettingen in de gemeenten Stevoort, Kozen en Sint-Truiden (België, provincie Limburg). — Mededelingen van de Werkgroep voor Tertiaire en Kwartaire Geologie 17 (1): 17-40.
- BREMER, R.P.L., 1975. A preliminary report on the palynological investigation of the Middle Oligocene (Henis Clay and Sands and Marls of Oude Biezen) in the Tongeren-Valkenburg area, Belgium and The Netherlands. — Mededelingen van de Werkgroep voor Tertiaire en Kwartaire Geologie 12 (3): 77-92.
- BUURMAN, P. & JONGMANS, A.G., 1975. The Neerrepen Soil, an Early Oligocene podzol with a fragipan, and gypsum concretions from Belgian and Dutch Limburg. — Pédologie, Bulletin de la Société Belge de Pedologie 25 (2): 105-117.
- BUURMAN, P. & LANGERAAR, W.D., 1975. Depositional features in Oligocene tidal sediments of Valkenburg, province of Limburg, The Netherlands, with the description of a new lithostratigraphical unit: Valkenburg Deposit. — Mededelingen van de Werkgroep voor Tertiaire en Kwartaire Geologie 12 (2): 57-72.
- CADÉE, M.C., HINSBERGH, V.W.M. VAN & JANSSEN, A.W., 1976. Een profiel door Tertiaire en Kwartaire afzettingen tussen Tongeren en Waltwilder (België, provincie Limburg). — Mededelingen van de Werkgroep voor Tertiaire en Kwartaire Geologie 13 (2): 35-58.
- CADÉE, M.C. & VAESSEN, L.M.B., 1975. Lithostratigrafische beschrijving van Oligocene afzettingen in een wegnijding bij Valkenburg, Limburg. — Mededelingen van de Werkgroep voor Tertiaire en Kwartaire Geologie 12 (2): 50-56.
- DEVILLE, J., 1996. Paleontological study of the Neerrepen Sands in the Francart Quarry (Tongeren, Belgium). — Natuurwetenschappelijk Tijdschrift 75: 75-97.

- GATT, M., 2006. Il-Geologija u l-Paleontologija tal-Gzejjer Maltin: i-x, 1-265 (volume 1); i-viii, 267-470 (volume 2). Il-Pjetà, Malta.
- GLIBERT, M. & HEINZELIN DE BRAUCOURT, J. DE, 1954. L'Oligocène inférieur belge. In: Volume Jubilaire Victor Van Straelen, directeur de l'Institut Royal des Sciences Naturelles de Belgique 1925-1954, volume 2: 279-438.
- HINSBERGH, V.W.M. VAN, 1980. Fish otoliths from euryhaline Oligocene deposits in Belgium (Atuatuca Formation) and the Netherlands (Goudsberg Deposits) and their paleoecological importance. — Mededelingen van de Werkgroep voor Tertiaire en Kwartaire Geologie 17 (3): 199-223.
- HINSBERGH, V.W.M. VAN, JANSSEN, A.W. & VAESSEN, L.M.B., 1973. Een profiel door Oligocene en Kwartaire afzettingen ten westen van het dorp Kleine Spouwen (België, provincie Limburg). — Mededelingen van de Werkgroep voor Tertiaire en Kwartaire Geologie 10 (1): 9-28.
- JANSSEN, A.W., 1963. Gastropoda uit de Belgische 'Sables de Vieux Joncs' en de Nederlandse 'Cerithiumklei' (Oligocene), 1-2. — Basteria 27 (1-2): 18-28; 27 (3-4): 29-44.
- JANSSEN, A.W., 2004. Fossils from the Lower Globigerina Limestone Formation at Wardija, Gozo (Miocene, Aquitanian), with a description of some new pteropod species (Mollusca, Gastropoda). — The Central Mediterranean Naturalist 4 (December 2003): 1-33.
- JANSSEN, A.W., 2007. Holoplanktonic Mollusca (Gastropoda) from the Gulf of Aqaba, Red Sea and Gulf of Aden (Late Holocene-Recent). — The Veliger 49 (3): 140-195.
- JANSSEN, A.W., 2012a. Late Quaternary to Recent holoplanktonic Mollusca (Gastropoda) from bottom samples of the eastern Mediterranean Sea: systematics, morphology. — Bollettino Malacologico 48, Supplemento 9: 1-104.
- JANSSEN, A.W., 2012b. Systematics and biostratigraphy of holoplanktonic Mollusca from the Oligo-Miocene of the Maltese Archipelago. — Bollettino del Museo Regionale di Scienze Naturali, Torino 28 (2) ["2010"]: 197-601.
- JANSSEN, A.W., HINSBERGH, V.W.M. VAN & CADÉE, M.C., 1976. Oligocene deposits in the region North of Tongeren (Belgium) with the description of a new lithostratigraphical unit: the Atuatuca Formation. — Mededelingen van de Werkgroep voor Tertiaire en Kwartaire Geologie 13 (3): 75-115.
- KARNEKAMP, C., 1990. *Microstele gerardae* sp. nov. (Gastropoda, Pupillidae) from the Late Tongrian (Oligocene) of northeastern Belgium. — Contributions to Tertiary and Quaternary Geology 27 (4): 113-116.
- KRUISSINK, E.C., HINSBERGH, V.W.M. VAN & JANSSEN, A.W., 1978. Een Oost-West profiel door Oligocene afzettingen in de gemeente Borgloon (België, provincie Limburg). — Mededelingen van de Werkgroep voor Tertiaire en Kwartaire Geologie 15 (1): 3-18.
- LAGA, P., 1988. Formatie van Borgloon. In: MARÉCHAL, R. & LAGA, P. (eds). Voorstel lithostratigrafische indeling van het Paleogeen. Nationale Commissies voor Stratigrafie, Commissie Tertiair: 169-180. Brussels.
- LAGA, P., LOUWYÉ, S. & GEETS, S., 2001. Paleogene lithostratigraphic units (Belgium). In: BULTYNCK, P. & DEJONGHE, L. (eds). Guide to a revised lithostratigraphic scale of Belgium. — Geologica Belgica 4 (1-2): 135-152.
- MARÉCHAL, R., 1994. A new lithostratigraphic scale for the Palaeogene of Belgium. — Bulletin de la Société Belge de Géologie 102 (1-2) (1993): 215-229.
- MARÉCHAL, R., & LAGA, P. (eds.), 1988. Voorstel lithostratigrafische indeling van het Paleogeen. Nationale Commissies voor Stratigrafie, Commissie Tertiair: 1-208. Brussels.
- MARQUET, R., LENAERTS, J., KARNEKAMP, C., & SMITH, R., 2008. The molluscan fauna of the Borgloon Formation in Belgium (Rupelian, Early Oligocene). — Palaeontos 12: 1-100.
- MOTHS, H., MONTAG, A., GRANT, A., & ALBRECHT, F., 1997. Die Molluskenfauna des oberoligozänen 'Sternberger Gesteins', 2. Neogastropoda, Euthyneura. — Erratica, Monographien zur Geschiebekunde 3: 3-58.
- NYST, [P.] H., 1836. Recherches sur les coquilles fossiles de Houssel et de Kleyn-Spauwen (province du Limbourg). — Messenger des Sciences et des Arts de la Belgique, ou Nouvelles Archives Historiques, Littéraires et Scientifiques 4: 139-180.
- NYST, P.H., 1845-1846. Description des coquilles et des polyptiers fossiles des terrains tertiaires de la Belgique: 1-434 (volume 1 = 1845); 435-675, errata 2 pp., atlas 48 pls (volume 2 = 1846). Bruxelles.
- ORTLIEB, J., & DOLLFUS, G., 1873. Compte-rendu de géologie stratigraphique de l'excursion de la Société Malacologique de Belgique dans le Limbourg belge, les 18 et 19 Mai 1873. — Annales de la Société Malacologique de Belgique 8: 39-57.
- RASMUSSEN, L.B., 1968. Molluscan faunas and biostratigraphy of the marine younger Miocene formations in Denmark, 2. Paleontology. — Danmarks Geologiske Undersøgelse (2) 92: 1-265.
- RAYNER, D., MITCHELL, T., RAYNER, M., & CLOUTER, E., 2009. London Clay fossils of Kent and Essex, 228 pp. Medway Lapidary & Mineral Society, Rochester.
- RUTOT, A., 1873. Rapport au point de vue paléontologique de l'excursion entreprise les 18 et 19 Août [*sic!* Compare title of ORTLIEB & DOLLFUS, 1873 above], aux environs de Tongres par les membres de la Société Malacologique de Belgique. — Annales de la Société Malacologique de Belgique 8: 58-69.
- SINGER, B.S., 1994. An explosion of the pelagic population in the Gulf of Aqaba. January '94. — Levantina 80: 8-10.

- SPAINK, G., 1963. De “Cerithiumklei” van het Krekelbos. — *Basteria* 27 (3-4): 45-48.
- VAN DEN BERGHE, N., VAN SIMAEYS, S., STEURBAUT, E., JAGT, J.W.M., & FELDER, P.J., 2004. Stratigraphic architecture of the Upper Cretaceous and Cenozoic along the southern border of the North Sea Basin in Belgium. — *Netherlands Journal of Geosciences / Geologie en Mijnbouw* 83 (3): 155-171.
- Websites (all accessed May 2019)*
- DinoLoket, 2019. Data informatie over de Nederlandse ondergrond. Goudsberg Formation. <https://www.dinoloket.nl/goudsberg-member-nmtfg>
- National Commission for Stratigraphy Belgium, 2019. <https://ncs.naturalsciences.be/paleogene-neogene/2103-borgloon-formation-bo>
- Wikipedia, 2019. Alden Biesen. <https://nl.wikipedia.org/wiki/Alden-Biesen>