

**FISH OTOLITHS FROM THE RUPELIAN OF SAND-PIT ROELANTS
AT HEIDE-BOSKANT (MUNICIPALITY OF LUBBEEK, BELGIUM)
AND THE STRATIGRAPHY OF THE EARLY RUPELIAN, 2. SYSTEMATIC PART**

by

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Gaemers, P.A.M. Fish otoliths from the Rupelian of sand-pit Roelants at Heide-Boskant (municipality of Lubbeek, Belgium) and the stratigraphy of the Early Rupelian, 2. Systematic part. — Meded. Werkgr. Tert. Kwart. Geol., 22 (4): 155-172, 4 figs, 1 pl. Leiden, December 1985.

An otolith fauna of 21 species was found in the lower part of the Rupelian clays. Five new genera are described: *Parvicolliolus*, *Platyonos*, *Umbolota*, *Archilatilus* and *Serratidentex*. Four new species are introduced: *Platyonos limburgicus*, *Umbolota marina*, *Serratidentex sculptus* and "*Callionymus*" *pachyotus*.

Umbolota marina is a marine predecessor of *Lota lota* which is the only living freshwater cod species. Marine ancestors of the latter species have not been found before.

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SYSTEMATIC PART

The generic names of several species in this publication are placed between quotation marks. This notation was introduced in Gaemers (1984) and indicates that these species probably belong to still undescribed fossil genera which are closely related to the given genera.

The following abbreviations are used: OL = otolith length, OH = otolith height, OT = otolith thickness. Incomplete otolith dimensions are placed in parentheses.

Phylum PISCES
Classic ACTINOPTERYGII
Subclassis TELEOSTEI
Ordo GADIFORMES
Familia GADIDAE
Subfamilia GADINAE

Genus *Parvicolliolus* n. gen.

Type species — *Colliolus parvus* Gaemers, 1976.

Diagnosis — A genus of the subfamily Gadinae with small and relatively thick otoliths having a more or less elongated, pear-shaped outline. Rostral end subangular to angular. Caudal point rather sharp to sharp. Pre- and postdorsal angles weakly to strongly developed. Sulcus basically formed as in *Colliolus*, but without deepening of ostium and cauda near the collum; the cristae are less pronounced. Ventral and dorsal rims are rounded; dorsal rim usually even blunt. Outer surface regularly rounded heightwise; thickest part of otolith medially situated or slightly shifted towards ventral side. Ornamentation rather weakly developed: the number of knobs and furrows is small, and the relief is low (low, rounded knobs and shallow furrows).

Derivatio nominis — *Parvus* (Latin) = small. A genus with small otoliths resembling the genus *Colliolus*.

Stratigraphic range — Middle Oligocene-Late Oligocene.

Parvicolliolus minutulus Gaemers, 1978): Rupelian (Berg Sand, Nucula Clay, Waasland Clay (bed 11), Ratum Formation, Kotten Member (lower half of part A)). *Parvicolliolus* n. sp. 1: Rupelian (uppermost top of Waasland Clay (bed 31), lowermost part of Putte Clay (beds 32-37), top of Kotten Member, lower half of part A of Woold Member). *Parvicolliolus parvus* (Gaemers, 1976): Rupelian (largest part of Putte Clay (bed 40 and higher) and Woold Member, lowermost part of Winterswijk Member). *Parvicolliolus* n. sp. 2: Eochattian-Neochattian. *Parvicolliolus* n. sp. 1 and 2 will be described in a forthcoming publication.

Discussion — The above-mentioned species are successive members of one evolutionary lineage. The only large gap in this lineage exists between *P. parvus* and *P. n. sp. 2*, because no otoliths are known yet from the highest part of the Rupelian deposits (largest part of Winterswijk Member and younger, still unnamed members of Middle Oligocene age). It is likely that a still unknown phylogenetic stage, with form and size intermediate between *P. parvus* and *P. n. sp. 2*, will be found in future, for size and shape of these species are distinctly different.

***Parvicolliolus minutulus* (Gaemers, 1978)**

Plate 1, figs 1, 2, 10

1978 *Colliolus minutulus* Gaemers, p. 154, pl. 1, figs 3-6.

1978 genus ? aff. *Gadiculus* sp. Steurbaut & Herman, p. 307, pl. 3, fig. 16.

1981 *Colliolus minutulus* Gaemers, 1978 — Gaemers, p. 118, pl. 1, figs 6, 7.

Material — All sagittas from sand-pit Roelants, Lubbeek; 287 sagittas, 10.55-10.70 m below top of Rupelian, RGM 177 344-177 350; 16 sagittas, 9.80-10.55 m below top of Rupelian, RGM 177 351; 8 sagittas, 9.05-9.80 m below top, RGM 177 352.

OL: 1.91 mm OH: 1.05 mm OT: 0.54 mm OL/OH: 1.82 OL/OT: 3.54

OL: 1.91 mm OH: 0.97 mm OT: 0.50 mm OL/OH: 1.93 OL/OT: 3.74

OL: 1.87 mm OH: 0.78 mm OT: 0.38 mm OL/OH: 1.86 OL/OT: 3.82 (pl. 1, fig. 1)

OL: 1.44 mm OH: 0.78 mm OT: 0.36 mm OL/OH: 1.85 OL/OT: 4.00 (pl. 1, fig. 2)

OL: 1.25 mm OH: 0.70 mm OT: 0.32 mm OL/OH: 1.79 OL/OT: 3.91 (pl. 1, fig. 10)

Systematics — See Gaemers (1978).

Remarks — The largest specimens found of this species are only slightly larger than 2 mm. Several hundreds of otoliths are known (including still undescribed material from the Nucula Clay, etc.), so it is very likely that otoliths of *P. minutulus* could not grow much beyond this size, the more so as the largest specimens show clearly signs of fully grown otoliths: a wide sulcus and a smoothed sculpture on the outer surface and along the rims. The specimen illustrated by Steurbaut & Herman (1978) is a full-grown otolith of this species.

Stratigraphic note — The stratigraphic distribution of the species in sand-pit Roelants proves that *P. minutulus* occurs at least as high as bed 12 of Vandenberghe (1978). The oldest specimens of *Parvicolliolus* n. sp. 1 (the so-called "forme trapue" of *Gadidarum parvus*, described by Steurbaut & Herman, 1978) are known from bed 31. The transition between these two species thus must occur somewhere between bed 12 and bed 31.

Subfamilia GAIDROPSARINAE

Genus *Platyonos* n. gen.

Type species — "*Enchelyopus*" *dorsoplicatus* Gaemers, 1984.

Diagnosis — A genus of the subfamily Gaidropsarinae with small, flat and rather thick otoliths with an elongated, rounded triangular outline. Dorsal rim in front of the rounded middorsal angle clearly concave, and straight behind this angle. A small number of low, rounded knobs are present along the dorsal rim. Inner and outer surfaces slightly convex lengthwise. Larger otoliths have a clear, large dent on the outer surface at the middorsal angle.

Derivatio nominis — πλατύς = flat, wide. Named after the flat otoliths. *Onos* is a formerly used genus in which many Recent gaidropsarinid species were included.

Stratigraphic range — Early Oligocene-Middle Oligocene.

Platyonos dorsoplicatus (Gaemers, 1984): Late Tongrian (Bassevelde Sand). *Platyonos limburgicus* n. sp.: Early Rupelian [Nucula Clay, basal part of Waasland Clay (= Kotten Member, part A)].

Discussion — The two species which can be placed in the new genus are successive members of one evolutionary lineage.

When describing the species *P. dorsoplicatus* (Gaemers, 1984) I concluded that it was most closely related to the Recent genus *Enchelyopus*, but the new material and further study of Recent gaidrop-

sarinid otoliths show that this idea can not last. In general outline *Platyonos* resembles the Recent genus *Ciliata* the most. Also the tapering ends (especially the posterior end) of the otoliths seen in ventral or dorsal view are similar in both genera. The shape of the sulcus and the ornamentation along the dorsal rim do not seem to be essentially different in *Ciliata*, *Enchelyopus* and *Onogadus*. The otoliths of *Enchelyopus* and *Onogadus* are distinctly shorter than those of *Platyonos*. *Onogadus* is the only Recent genus known to me having flat otoliths like *Platyonos*.

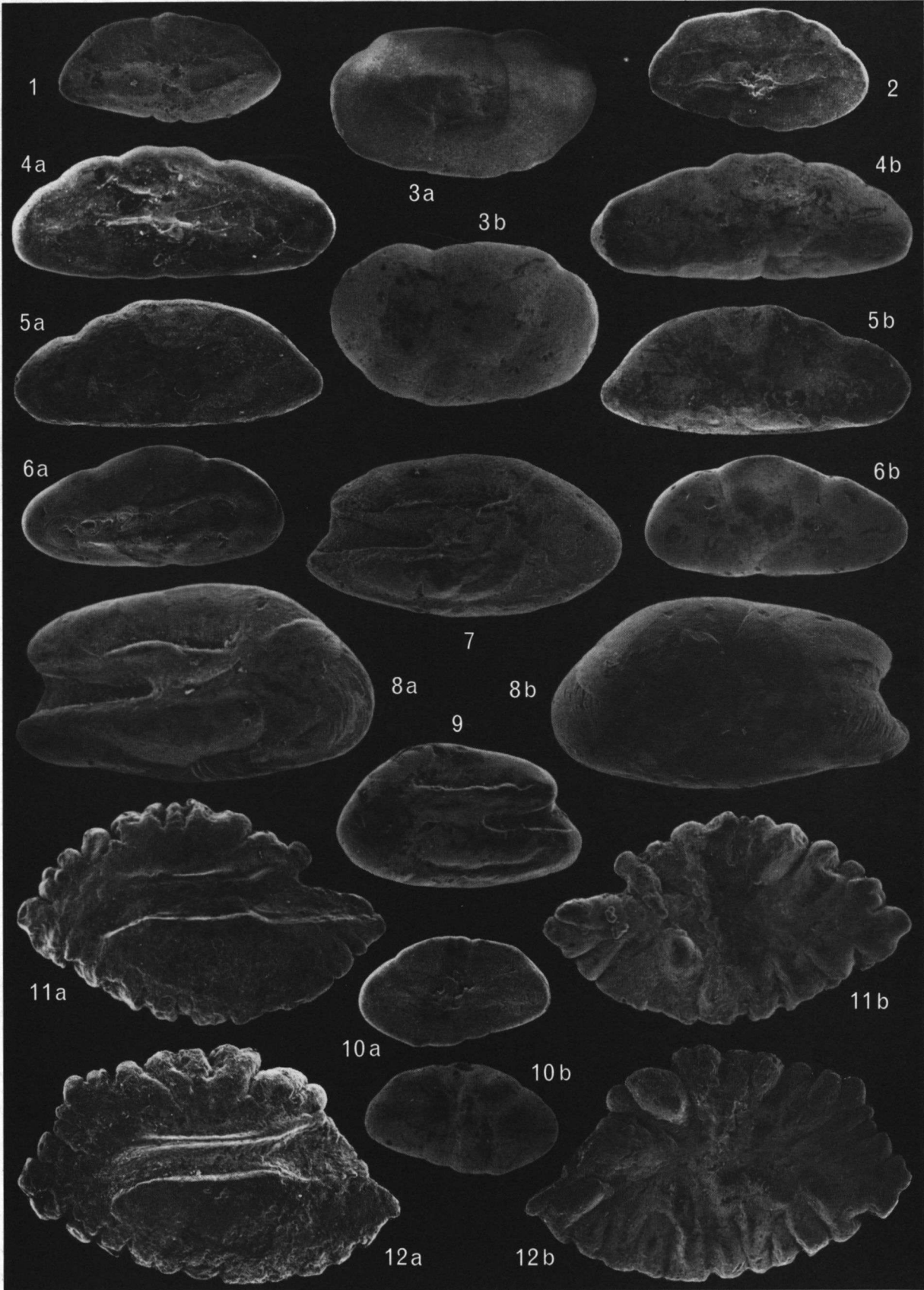
The shape of the outline probably is a more important characteristic than the presence or absence of a lengthwise bend. If this view is correct *Platyonos* should be most closely related to *Ciliata* and represent a forerunner lineage of this genus.

Platyonos is unique among the gaidropsarinids in having a distinct, large dent on the outer surface at the middorsal angle.

PLATE 1

- Fig. 1 *Parvicolliolus minutulus* (Gaemers, 1978).
Nucula Clay, sand-pit Roelants, RGM 177 346; ca 27 × .
- Fig. 2 *Parvicolliolus minutulus* (Gaemers, 1978).
Nucula Clay, sand-pit Roelants, RGM 177 347; ca 27 × .
- Fig. 3a-b *Diplacanthopoma tortonesei* Nolf, 1977.
Nucula Clay, sand-pit Roelants, RGM 177 364; ca 33 × .
- Fig. 4a-b *Platyonos limburgicus* n. sp. Holotype.
Lowermost 1.8 m of Nucula Clay, sand-pit Mommen, Vliermaal, leg. P.A.M. Gaemers, RGM 177 353; ca 33 × .
- Fig. 5a-b *Platyonos limburgicus* n. sp. Paratype.
Lowermost 1.5 m of Nucula Clay, Bosselaarstraat, Kleine Spouwen, leg. A.W. Janssen, RGM 177 326; ca 27 × .
- Fig. 6a-b *Platyonos limburgicus* n. sp. Paratype.
0.3-1.8 m above base of Nucula Clay, sand-pit Mommen, Vliermaal, leg. A.W. Janssen, RGM 177 357; 40 × .
- Fig. 7 "*Callionymus*" *pachyotus* n. sp. Paratype.
Nucula Clay, sand-pit Roelants, RGM 177 389; 60 × .
- Fig. 8a-b "*Callionymus*" *pachyotus* n. sp. Holotype.
Nucula Clay, 0.3-1.8 m above base, sand-pit Mommen, Vliermaal, leg. A.W. Janssen, RGM 177 387; 60 × .
- Fig. 9 "*Callionymus*" *pachyotus* n. sp. Paratype.
Lowermost 1.8 m of Nucula Clay, sand-pit Mommen, Vliermaal, leg. P.A.M. Gaemers, RGM 177 388; 60 × .
- Fig. 10a-b *Parvicolliolus minutulus* (Gaemers, 1978).
Nucula Clay, sand-pit Roelants, RGM 177 348; ca 27 × .
- Fig. 11a-b *Serratidentex sculptus* n. sp. Holotype.
Nucula Clay, 0.3-1.8 m above base, sand-pit Mommen, Vliermaal, leg. A.W. Janssen, RGM 177 366; ca 27 × .
- Fig. 12a-b *Serratidentex sculptus* n. sp. Paratype.
Nucula Clay, 0.3-1.8 m above base, sand-pit Mommen, Vliermaal, leg. A.W. Janssen, RGM 177 367; 20 × .

All illustrations are made with a Jeol JSM-T20 scanning electron microscope, at 10 KV.



Platyonos limburgicus n. sp.

Plate 1, figs 4-6, text-fig. 3

1984 "*Enchelyopus*" *dorsoplicatus* Gaemers, p. 34, partim (all paratypes), (non pl. 4, fig. 17, text-fig. 4).

Holotype — Plate 1, fig. 4, leg. P.A.M. Gaemers, RGM 177 353.

Locus typicus — Sand-pit Mommen, Vliermaal, province of Limburg, Belgium, co-ordinates: x = 225,0; y = 169,4.

Stratum typicum — Oligocene, Rupelian, Nucula Clay, lowermost 1.8 m.

Derivatio nominis — *Limburgicus* (Latin): named after the Belgian and Dutch provinces of Limburg where the species was found.

Diagnosis — A *Platyonos* species with moderately large otoliths which are relatively thin. The OL/OH and OL/OT ratios show a strong allometric growth: larger otoliths are distinctly more slender and thinner than smaller ones. The ventral rim is sharp.

Paratypes — Sand-pit Roelants, Lubbeek: 8 sagittas, 10.55-10.70 m below top of Rupelian, RGM 177 354, 177 355; 2 sagittas, 10.55-10.70 m below top of Rupelian, coll. P.A.M. Gaemers; 1 fragment of sagitta, 9.05-9.80 m below top of Rupelian, RGM 177 356.

Sand-pit Mommen, Vliermaal, Belgium, Nucula Clay: 2 sagittas, leg. A.W. Janssen, RGM 177 327, 177 357 (ex 177 327); 2 sagittas, coll. T.J. Bor.

Nachtegaalstraat, Kleine Spouwen, Belgium, Nucula Clay: 1 sagitta, leg. A.W. Janssen, RGM 177 325. Bosselaarstraat, Kleine Spouwen, Belgium, Nucula Clay, lowermost 1.5 m: 1 sagitta, leg. A.W. Janssen, RGM 177 326.

Boring Beek II, province of Limburg, The Netherlands, Nucula Clay, 82.50-83.50 m below surface, RGM 177 358.

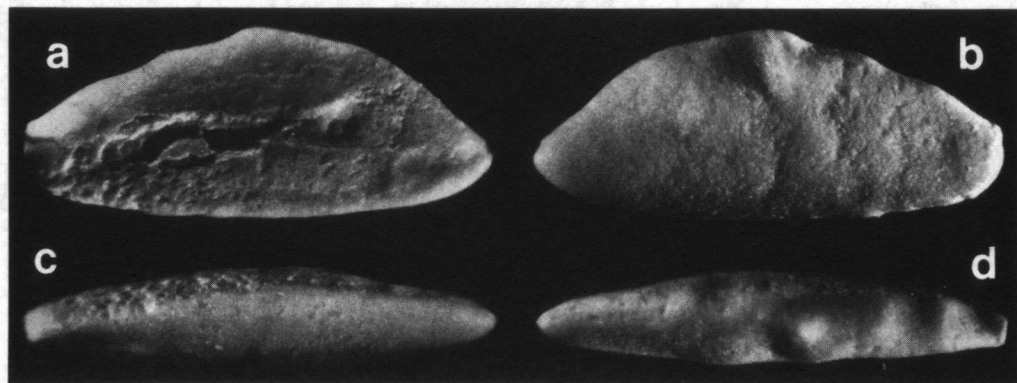


Fig. 3. Paratype of *Platyonos limburgicus* n. sp.
Nucula Clay, sand-pit Roelants, RGM 177 354; 20 ×.
a: inner surface; b: outer surface; c: ventral view; d: dorsal view

OL: ca. 4.00 mm	OH: 1.51 mm	OT: ca. 0.75 mm	OL/OH: ca. 2.65	OL/OT: ca. 5.35
OL: ca. 2.98 mm	OH: 1.20 mm	OT: 0.59 mm	OL/OH: ca. 2.48	OL/OT: ca. 5.05 (text-fig. 3)
OL: 2.01 mm	OH: 0.85 mm	OT: 0.41 mm	OL/OH: 2.36	OL/OT: 4.90 (pl. 1, fig. 5)
OL: 1.68 mm	OH: 0.71 mm	OT: 0.38 mm	OL/OH: 2.37	OL/OT: 4.42 (holotype)
OL: 1.14 mm	OH: 0.55 mm	OT: 0.27 mm	OL/OH: 2.07	OL/OT: 4.22 (pl. 1, fig. 6)

Platyonos dorsoplicatus:

OL: 1.84 mm OH: 0.77 mm OT: 0.47 mm OL/OH: 2.39 OL/OT: 3.91 (corrected measurements)

Description — Up to medium-sized otoliths with a relatively slender outline, usually not bent lengthwise, some adult otoliths are slightly bent lengthwise. Rostrum rounded in smaller specimens and gradually more pointed in ever larger ones. Posterior end rounded in smaller otoliths to bluntly pointed in larger ones. Ventral rim smooth or weakly undulated, nearly straight; it is sharp except in very small specimens. Dorsal rim always more blunt than ventral rim.

Inner surface slightly convex lengthwise. Ostium widens towards the rostral rim and is situated above the rostrum. Area present above ostium, collum and the beginning of the cauda.

Outer surface slightly convex lengthwise; in larger specimens it may be flat. The ventral and dorsal views show a gradual tapering from the thickest part of the otolith towards posterior and anterior ends. Thickest part of otolith more towards the anterior end.

Discussion — The larger number of *Platyonos* otoliths available now render it possible to split off the Rupelian form as a separate species from the Late Tongrian *P. dorsoplicatus* (Gaemers, 1984). Although only one otolith is known from the latter species, it is clear now that it belonged to an adult fish: the rostrum of the holotype of *P. dorsoplicatus* is markedly and sharply pointed and this is also the case in the largest otoliths of *P. limburgicus*. Therefore the maximum size of *P. dorsoplicatus* otoliths can have been only slightly larger than the holotype. The next conclusion is that *P. limburgicus* could grow much larger than *P. dorsoplicatus*, to a size about twice the length of the latter species.

Small corrections of the otolith length and height turned out to be necessary after remeasuring the holotype of *P. dorsoplicatus*. These also affect the OL/OH and OL/OT ratios. Therefore the corrected data are given here.

Subfamilia LOTINAE

Genus *Umbolota* n. gen.

Type species — *Umbolota marina* n. sp.

Diagnosis — A genus of the subfamily Lotinae with small, rather thin otoliths, moderately but clearly bent lengthwise without being twisted. The sulcus is wide and shallow with a regular shape. Rostrum clearly pointed. Posterior rim truncated. Posterior end of cauda ending at the posterior rim. Outer surface with a central, rather large swelling (= umbo).

Derivatio nominis — *Umbo* (Latin) = lump, swelling. *Lota* is the name of the Recent genus which is supposed to be the closest relative.

Stratigraphic range — Middle Oligocene.

Umbolota marina n. sp.: Early Rupelian [Nucula Clay, bed 9 of Vandenberghe (1978)].

Discussion — The general shape of *Umbolota* otoliths resembles that of the Gaidropsarinae, Lotinae and Merlucciinae. The general shape, size and depth of the sulcus together point to a position of this genus within the Lotinae. This subfamily contains only three living genera: *Brosme*, *Lota* and *Molva* (see Gaemers, 1976), of which *Brosme* and *Lota* are monospecific. *Molva* contains three living species. Otoliths of all five living species of Lotinae are available to me for comparison. The only two species showing good agreement in the shape of the outline — including details as the truncated posterior rim — are *Lota lota* (Linné, 1758) and *Molva molva* (Linné, 1758). The latter species, however, has a deeper and wider sulcus the cauda of which ends at the dorsal rim or at the transition of dorsal and posterior rims. Thus the detailed characteristics of the sulcus resemble most closely those of *Lota lota*.

Important points differentiating *Umbolota* from *Lota* (and the other Recent lotinids) are the presence of a central umbo on the outer surface and the absence of a lengthwise twist. The thickest part of *Umbolota* otoliths is at the centre where the umbo is situated; in adult otoliths of *Lota*, on the contrary, the central part is the thinnest portion. These differences are important enough to classify *Umbolota* as a separate genus. *Umbolota* is considered to be a forerunner lineage of the Recent genus *Lota* and it may be the immediate forerunner lineage.

***Umbolota marina* n. sp.**

Text-fig. 4

Holotype — Text-fig. 4, leg. A.W. Janssen & P.A.M. Gaemers, RGM 177 359.

Locus typicus — Sand-pit Roelants, Heide-Boskant, municipality of Lubbeek, province of Limburg, Belgium.

Stratum typicum — Oligocene, Rupelian, Nucula Clay [bed 9 of Vandenberghe (1978)], 10.55-10.70 m below top of Rupelian.

Derivatio nominis — *Marinus*, -a (Latin) = marine. This species obviously lived in the sea, whereas *Lota lota* lives in fresh water.

Diagnosis — An *Umbolota* species with small otoliths having a clearly elongated outline. The truncated posterior end consists of two large, pronounced knobs. Dorsal rim slightly undulating and/or having a series of low, rather wide knobs.

Paratype — Sand-pit Roelants, Lubbeek: 1 fragment of sagitta, 10.55-10.70 m below top of Rupelian, RGM 177 360.

OL: 5.17 mm OH: 2.10 mm OT: 0.80 mm OL/OH: 2.46 OL/OT: 6.46 (holotype)

Description — Medium-sized, thin otoliths with a slender outline, moderately bent lengthwise. Rostrum sharply pointed and protruding. A shallow excisura is present where the crista superior begins. Antirostrum is small. The dorsal rim is rather regularly curved and rather blunt; it has slight undulations and/or a series of low, rather wide knobs. Middorsal angle insignificant and rounded.

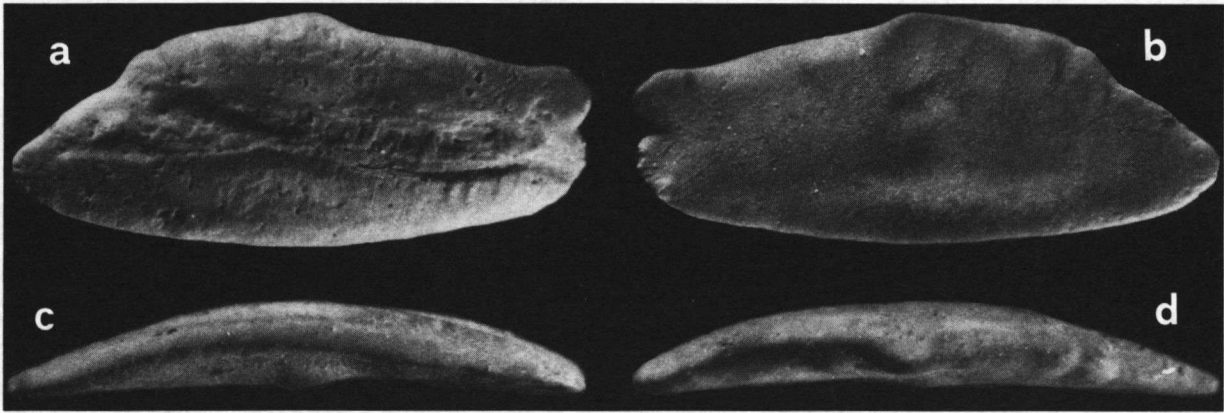


Fig. 4. Holotype of *Umbolota marina* n. sp.
Nucula Clay, sand-pit Roelants, RGM 177 359; 15 ×.
a: inner surface; b: outer surface; c: ventral view; d: dorsal view

Anterior part of dorsal rim somewhat rounded, its posterior part is nearly straight. Posterior end truncated, consisting of two large, pronounced knobs. The ventral rim is regularly and gently curved and sharp; it is smooth or has a few very low knobs.

Inner surface clearly convex lengthwise. The sulcus is long, wide and only slightly sunken. It consists of a distinct shorter ostium and a longer cauda, separated by a small, but distinct collum. The narrowing of the collum is obvious; it is slightly more marked along the crista inferior than along the crista superior. The ostium is open along the rostral rim and widens gradually towards this rim. The cauda is narrow and very elongated, it is closed at its posterior end. Ostial and caudal colliculum large and regularly shaped. Cauda somewhat closer to the ventral rim than ostium. Cristae low but fairly sharp and distinct. A shallow area is present above ostium, collum and a small part of the cauda. Ventral furrow close to and parallel to the ventral rim; it is most strongly developed in the middle part.

Outer surface about flat lengthwise, but when the umbo is left out of consideration it is slightly concave. A rounded, rather large and regular swelling (umbo) is present in the centre. Ornamentation more developed on dorsal than on ventral part. It consists of a pattern of knobs and furrows perpendicular to the rims. Size and relief of the knobs and furrows are rather variable. The ventral part can be nearly smooth. A narrow concavity parallel to the ventral rim is present below the umbo. The thickest part of the otolith is clearly situated at the umbo.

Remarks — The outer surface of the holotype is slightly eroded and the lower knob of the posterior rim is slightly damaged. The paratype is a central fragment (about one third) of a sagitta of which the outer surface is perfectly preserved and well-ornamented everywhere, also showing secondary knobs and furrows on the umbo; its inner surface, however, is strongly damaged.

Discussion — The well-differentiated details on the holotype of *Umbolota marina* indicate that it belonged to an adult fish. This means that this species was much smaller than the Recent *Lota lota*. Such size differences are not exceptional; otoliths of many Rupelian cods and other fishes belonging to forerunner lineages of Miocene to Recent species were markedly smaller than otoliths of the succeeding lineages.

As far as I know the find of *Umbolota marina* is the first solid evidence that forerunners of *Lota lota* were marine fishes.

Subfamilia MERLUCCIINAE
Genus *Palaeogadus* von Rath, 1859

? *Palaeogadus* sp.
Text-fig. 5

Material — Sand-pit Roelants, Lubbeek: 3 fragments of sagittas, 10.55-10.70 m below top of Rupelian, RGM 177 361-177 363.

Description — Several otolith fragments were found belonging to three different specimens. The characteristic knob pattern on the outer surface shows that they belong to the Gadidae, but they can not be assigned to one of the other gadid species found. The fragments, however, are too small a part of the (large) otoliths and their inner surface is always damaged (to such a degree that the sulcus is missing), so they can not be identified with certainty. They may belong to *Palaeogadus*, but not to *P. compactus*, because of their stronger and more regular ornamentation. *P. emarginatus* is considered to be a fair possibility; this species has a similar ornamentation.

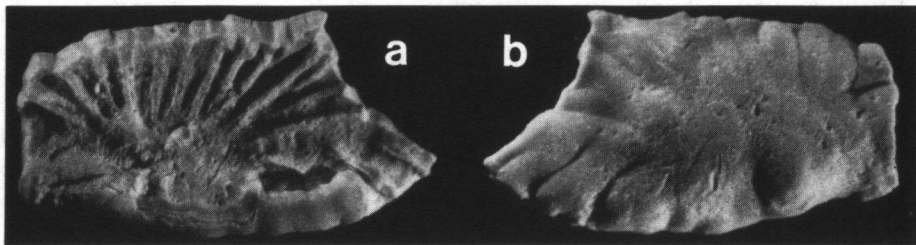


Fig. 5. ? *Palaeogadus* sp.
Nucula Clay, sand-pit Roelants, RGM 177 361; 15 × .
a: inner surface; b: outer surface.

Familia BYTHITIDAE
Genus *Diplacanthopoma* Günther, 1887

Diplacanthopoma tortonesei Nolf, 1977
Plate 1, fig. 3

Material — Sand-pit Roelants, Lubbeek: 1 sagitta, 10.55-10.70 m below top of Rupelian, RGM 177 364.

OL: 140 mm OH: 0.81 mm OT: 0.44 mm OL/OH: 1.73 OL/OT: 3.18

Description — One small sagitta of this species was found. Its sulcus is remarkable as it seems to consist of two imprints with a different orientation and position. The only logical explanation that I can think of is a partial rotation and shift of the otolith during its growth, after which a new sulcus started to form.

Ordo PERCIFORMES
Familia BRANCHIOSTEGIDAE

Genus *Archilatilus* n. gen.

Type species — *Trigla elliptica* Koken, 1884.

Diagnosis — A genus of the family Branchiostegidae with thick, strong, moderately elongated, oval otoliths, poorly ornamented with a few large, low knobs along the dorsal and posterior rims; no or a few small, low knobs along the ventral rim. The posterior end of the cauda is widened and bent towards the ventral rim in larger otoliths, giving the sulcus a dumb-bell-shaped appearance. The ventral rim is regularly bent.

Derivatio nominis — ἀρχαῖος (Greek) = old. *Latilus* is a recent genus in the family Branchiostegidae.

Stratigraphic range — Early Oligocene-early Middle Miocene.

Archilatilus ellipticus (Koken, 1884): Early Oligocene (Yrieu Sands, Aquitaine, France), Late Tongrian (Bassevelde Sand, Belgium), Rupelian (Berg Sand, Nucula Clay and Boom Clay, Belgium; Brinkheurne Formation and base of Winterswijk Member, The Netherlands), Eochattian (Söllingen, Federal Republic of Germany). *Archilatilus ringelei* (Nolf, 1977): early Middle Miocene, Oxlundian (Zonderschot Sand, Belgium).

Discussion — Dr. T. Abe (Tokyo, Japan) kindly sent me a nice pair of large otoliths of *Branchiostegus japonicus* (Houttuyn, 1782) which immediately clarified the familial position of Koken's Oligocene species. These otoliths have a well-developed, thick anterocaudal pseudocolliculum and the shape of the sulcus in common (for definition of this type of pseudocolliculum see Gaemers, 1985). The most obvious difference is found in the outline: *Branchiostegus* has otoliths which are about equally long and high (see text-fig. 6), whereas *Archilatilus* is elongated. The new genus clearly shows more resemblance with the Recent *Lopholatilus chamaeleonticeps* Goode & Bean, 1879 in the shape of its outline (see fig. 18L in Wigley & Stinton, 1973).

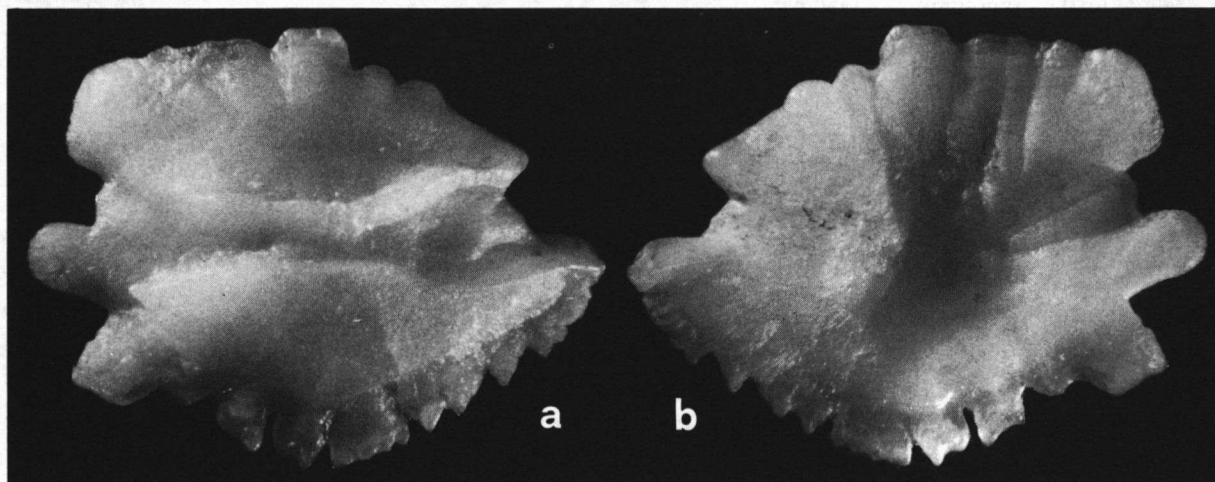


Fig. 6. *Branchiostegus japonicus* (Houttuyn, 1782).
Recent, Tsushima Island, Southern Japan, coll. P.A.M. Gaemers, leg. T. Abe; 7.5 ×
a: inner surface; b: outer surface.

Lopholatilus differs from *Archilatilus* by having thinner otoliths with a stronger ornamentation and with a midventral angle; this gives the *Lopholatilus* otoliths a more advanced appearance. It is likely that the *Lopholatilus* lineage has descended from *Archilatilus*. *Archilatilus ringelei* probably is the final evolutionary stage of the *Archilatilus* lineage: the full-grown otoliths of this species are clearly more thickset than those of *A. ellipticus*. Thickset full-grown otoliths are characteristic for the end of a lineage (Gaemers, 1976).

The classification of *A. ellipticus* in the Triglidae by Koken (1884, 1891), Nolf (1977), Steurbaut & Herman (1978) and Steurbaut (1984) is understandable, because the sulcus in this family is similar in several important respects to that in the Branchiostegidae: dumb-bell shaped with a widened caudal end and the presence of an antero-caudal pseudocolliculum. The sulcus of triglids however runs more obliquely (with the caudal end more towards the dorsal rim), and the antero-caudal pseudocolliculum is less developed. Moreover Triglidae have always triangular otoliths, whereas Branchiostegidae have oval to about circular otoliths.

The inclusion of *A. ellipticus* in the Scorpaenidae by Gaemers (1984) also turns out to be incorrect. The outline and the sulcus of otoliths of *Pontinus macrocephalus* (Sauvage, 1882) indeed resemble those of the former species in broad outline fairly well, but in addition to the less deep and wide posterior part of the cauda the antero-caudal pseudocolliculum is much thinner and much less conspicuous in *Pontinus*.

The Miocene species "genus Triglidae" *giganteus* Nolf, 1977 (erroneously called "*Lepidotrigla*" *elliptica* in the discussion of "*Pontinus*" *ellipticus* in Gaemers, 1984, p. 40) and "*Lepidotrigla*" *postdorsalis* Steurbaut, 1979 (p. 68, pl. 7, fig. 11; pl. 12, fig. 12) also belong to the Branchiostegidae, but they are more closely related to the recent *Branchiostegus japonicus*: all three species have fading and disappearing cristae towards the posterior end of the cauda.

Archilatilus ellipticus (Koken, 1884)

1984 "genus aff. *Lepidotrigla*" *cadonati* Steurbaut, p. 72, pl. 17, fig. 7-13.

1984 "*Pontinus*" *ellipticus* (Koken, 1884) — Gaemers, p. 40, pl. 3, fig. 2.

For further synonymy see Gaemers (1984).

Material — Roelants sand-pit, Lubbeek: 3 sagittas (poorly preserved), 10.55-10.70 m below top of Rupelian, RGM 177 365.

Remarks — For good photographs of otoliths of this species see Gaemers & van Hinsbergh (1978, pl. 15, figs 1-7).

Familia SPARIDAE

Subfamilia DENTICINAE

Genus *Serratidentex* n. gen.

Type species — *Sparus gibbosus* Rafinesque, 1810.

Diagnosis — A genus of the subfamily Denticinae with rather elongated, thin and fragile otoliths which are strongly ornamented with many small but well-developed knobs and furrows along all rims and

on both outer and inner surface. The rostrum is very protruding. The ostium is nearly as long as the cauda, in large otoliths it may even be somewhat longer than the cauda. A clear, sharp antirostrum is present except in very small and very large otoliths.

Derivatio nominis — *Serratus* (Latin) = serrate, indented. Named after the numerous small knobs and furrows giving the outline of the otoliths a serrated appearance.

Stratigraphic range — Early Oligocene-Recent.

Serratidentex sculptus n. sp.: Late Tongrian (Bassevelde Sand), Rupelian. *Serratidentex krefeldensis* (Schwarzahns, 1974): Chattian A and B. *Serratidentex gibbosus* (Rafinesque, 1810): Recent.

Discussion — In my opinion the genus *Dentex* is a receptacle of various genera of Denticinae. In his revision of Mediterranean and tropical African Atlantic Denticinae Poll (1971) already arranged the species in four subgenera, viz. *Dentex*, *Viridentex*, *Cheimerius* and *Polysteganus*. Nolf (1979) used the same division and figured and described otoliths of all species except one: *Viridentex acromegalus* (Osorio, 1909). This division however proves to be insufficiently elaborate when studying the otoliths in detail. The subgenera should have to be raised in rank to genera.

As a general remark I would say that subgenera better should be abolished completely in taxonomy, seeing that there are no good criteria to distinguish genera and subgenera; moreover, in course of time subgenera are usually elevated to genera when taxonomic work is progressing: it seems that taxonomists only need the subgenus concept as a temporary compromise in order to accustom to new genus names).

But I am also of the opinion that the number of genera needs enlargement. The introduction of the genus *Opsodentex* by Fowler (1925) for *Dentex macropthalmus* for instance can be defended with the help of several otolith characteristics. The most important ones are that the ostium in *Opsodentex* is widest at the rostral rim, in *Polysteganus* (the most closely related recent genus) a narrowing occurs towards this rim; furthermore the end of the cauda in *Opsodentex* is only slightly bent towards the ventral rim, in *Polysteganus* it is clearly bent.

Serratidentex clearly can be distinguished from all other known Recent Denticinae by its more fragile and thinner otoliths having a stronger ornamentation. The ostium in this genus is distinctly longer than in the other Denticinae. The otoliths of *Serratidentex gibbosus* show most resemblance with those of *Dentex dentex*. This was also observed by Nolf (1979). They have the elongated outline and the long, protruding rostrum in common. The otoliths of *Dentex dentex* differ from those of *S. gibbosus* by the absence of a (clear) antirostrum, a less developed ornamentation, a somewhat shorter ostium and a less developed middorsal angle. Good photographs of *S. gibbosus* otoliths as well as of several other denticinids can be found in Chaine (1937). Many of the drawings in Nolf (1979) unfortunately are insufficiently accurate and detailed.

The special position of *Serratidentex* may also be demonstrated by the fact that Schwarzahns (1974) described *S. krefeldensis* in the genus *Serranus*, thus placing this species in the family Serranidae. The shape and orientation of the sulcus as well as the pentagonal shape of the outline make it clear however that this species is a sparid. Schwarzahns described this species from Chattian A deposits. In the RGM-collections some specimens are present from sediments of Chattian B age of Krefeld-Gellep (leg. F. von der Hocht).

It is still difficult to be certain if the much smaller Oligocene species belong to the same evolutionary lineage as the Recent *S. gibbosus*, because of the wide stratigraphic gap and the large difference in size. As a final judgment can not yet be passed on this by lack of sufficient data I want to follow the rule of Occam's razor by choosing the most simple solution: one lineage for the present data.

Serratidentex sculptus n. sp.

Plate 1, figs 11, 12

1978 *Serranus noeltingi* Koken, 1891 — Müller, p. 124, pl. 3, fig. 5; pl. 8, fig. 5.

1978 *Sparidarum* sp. 2 Gaemers & van Hinsbergh, p. 32, pl. 11, fig. 6.

1980 *Sparidarum* sp. van Hinsbergh, p. 213, pl. 2, fig. 14.

1984 *Sparidarum* sp. Gaemers, p. 42, pl. 4, fig. 2.

Holotype — Plate 1, fig. 11, leg. A.W. Janssen, RGM 177 366.

Locus typicus — Mommen sand-pit, Vliermaal, province of Limburg, Belgium, co-ordinates: x = 225,0; y = 169,4.

Stratum typicum — Oligocene, Rupelian, Nucula Clay, 0.3-1.8 m above base.

Derivatio nominis — *Sculptus* (Latin) = sculptured, engraved. Named after the strongly ornamented otoliths.

Diagnosis — A *Serratidentex* species with small, thin otoliths which are very fragile, having a relatively thickset outline. Predorsal angle in larger otoliths always distinct, but not pronounced.

Paratypes — Roelants sand-pit, Lubbeek: 8 broken sagittas and fragments, 10.55-10.70 m below top of Rupelian, RGM 177 385; 1 fragment, 10.55-10.70 m below top of Rupelian, coll. P.A.M. Gaemers; 1 fragment, 9.80-10.55 m below top of Rupelian, RGM 177 386.

Mommen sand-pit, Vliermaal, Belgium, Nucula Clay, 0.3-1.8 m above base: 28 sagittas, leg. A.W. Janssen 1978, RGM 177 367-177 371. Bosselaarstraat, Kleine Spouwen, Belgium, Nucula Clay, lowermost 1.5 m: 6 sagittas, leg. A.W. Janssen 1972/73, RGM 177 372-177 374. Mommen sand-pit, Vliermaal, Belgium, Nucula Clay: 23 sagittas, coll. T.J. Bor; 20 sagittas, coll. P.A.M. Gaemers; 1 sagitta, coll. V.W.M. van Hinsbergh, leg. M.C. Cadée.

Boring Beek II, province of Limburg, The Netherlands, Nucula Clay (all sagittas broken, or fragments), 81.5-82.5 m below surface: 1 sagitta, RGM 177 375; 82.5-83.5 m below surface: 6 sagittas, RGM 177 376; 83.5-84.5 m below surface: 2 sagittas, RGM 177 377; 84.5-85.5 m below surface: 1 sagitta, RGM 177 378; 85.5-86.5 m below surface: 1 sagitta, RGM 177 379; 86.5-87.0 m below surface: 1 sagitta, RGM 177 380; 87.5-88.5 m below surface (caving): 1 sagitta, RGM 177 381.

Boring Beek III, province of Limburg, The Netherlands, Nucula Clay (fragments), 82.5-83.5 m below surface: 1 sagitta, RGM 177 382; 83.5-84.5 m below surface: 1 sagitta, RGM 177 383; 84.5-85.5 m below surface: 1 sagitta, RGM 177 384.

Ruisbroek, Belgium, Bassevelde Sand: 1 broken sagitta, leg. T.J. Bor, RGM 177 293; 4 eroded and broken sagittas, lower sample, leg. P.A.M. Gaemers, RGM 177 294; 1 broken sagitta, higher sample, leg. P.A.M. Gaemers, RGM 177 295.

Berg, Galgeberg exposure, Belgium, Atuatuca Formation, Sands and Marls of Oude Biesen, clay level in the upper part of the alternating sandy and clayey deposits, 1.2-1.3 m: 1 sagitta, leg. A.W. Janssen, RGM 176 561.

Clay-pit 1050 m E and 1100 m S of the church of Schelle, Belgium, Boom Clay Formation, Waasland Clay, *Corbula gibba subpisum* level: 1 sagitta, leg. A.W. Janssen, RGM 176 116.

Clay-pit "De Vlijt", Winterswijk, The Netherlands, Brinkheurne Formation, Woold Member: 1 sagitta, coll. V.W.M. van Hinsbergh.

OL: 2.40 mm OH: 1.48 mm OT: 0.36 mm OL/OH: 1.62 OL/OT: 6.67 (holotype)
(OL: 3.34 mm) OH: 2.15 mm OT: 0.47 mm (pl. 1, fig. 12).

Description — Small, thin and fragile otoliths with a relatively thickset outline, moderately bent lengthwise. Rostrum pointed and protruding, and usually broken. Excisura sharp and fairly deep. Antirostrum well-developed but less pointed than rostrum. Dorsal rim rather regularly rounded in small otoliths; in larger otoliths post- and predorsal angles are present, with postdorsal angle usually more strongly developed. Posterior end clearly pointed. Ventral rim strongly and regularly bent. All rims have many well-developed knobs which are fanciful in shape. The outline still is regularly shaped because the height of the knobs is rather uniform. The furrows between the knobs vary more strongly in depth.

Inner surface clearly convex lengthwise. The median sulcus is straight apart from the posterior part of the cauda which is moderately bent towards the ventral rim. The ostium is slightly shorter than the cauda. Crista superior conspicuous: high and narrow, but still rounded; disappearing towards the posterior end of the cauda. Crista inferior along entire sulcus, but less developed. Area large. Ventral furrow absent or vague. Ornamentation strongly developed on posterior and dorsal parts; it is always capricious and very detailed.

Outer surface slightly concave length- and heightwise. It has, especially towards the rims, a strong relief, more regular than on the inner surface. The pattern consists of more or less radiating furrows and knobs. The knobs are strongly rounded, the furrows sharp and deep.

Variability — The shape of the dorsal rim is highly variable with regard to position and development of the pre- and postdorsal angles. Furthermore there is a strong allometric growth: small otoliths are clearly more thickset than larger ones.

Discussion — *Serratidentex sculptus* can be distinguished from its descendant *S. krefeldensis* by its smaller maximum size and more thickset outline.

Familia CALLIONYMIDAE

Genus *Callionymus* Linnaeus, 1758

"*Callionymus*" *pachyotus* n. sp.

Plate 1, figs 7-9

Holotype — Plate 1, fig. 8, leg. A.W. Janssen, RGM 177 387.

Locus typicus — Mommen sand-pit, Vliermaal, province of Limburg, Belgium, co-ordinates: x = 225,0; y = 169,4.

Stratum typicum — Oligocene, Rupelian, Nucula Clay, 0.3-1.8 m above base.

Derivatio nominis — *παχύς* (Greek) = strong, thick; *τό οὖς, ὠτός* (Greek) = ear. Named after the very thick otoliths.

Diagnosis — A *Callionymus*-like species with small, very thick otoliths having an oval to rounded triangular outline. A large and massive, clearly bounded thickening is present below a large part of the sulcus. Rostrum, antirostrum and excisura are large.

Paratypes — Mommen sand-pit, Vliermaal, Belgium, Nucula Clay, lowermost 1.8 m: 1 sagitta, leg. P.A.M. Gaemers, RGM 177 388. Pit Roelants. Lubbeek: 10.55-10.70 m below top of Rupelian: 2 sagittas, RGM 177 389, 177 390.

OL: 1.05 mm OH: 0.59 mm OT: 0.33 mm OL/OH: 1.78 OL/OT: 3.18 (holotype)

OL: 0.91 mm OH: 0.50 mm OT: 0.30 mm OL/OH: 1.82 OL/OT: 3.03 (pl. 1, fig. 7)

OL: 0.71 mm OH: 0.44 mm OT: 0.23 mm OL/OH: 1.61 OL/OT: 3.09 (pl. 1, fig. 9).

Description — Small, very thick otoliths with an oval to rounded triangular outline. Rostrum short, rounded to somewhat pointed, but always distinct. V-shaped or U-shaped excisura rather deep and wide. Antirostrum wide, short and rounded. Dorsal rim blunt and only slightly undulating. Post-dorsal angle rounded but distinct. Dorsal rim between antirostrum and postdorsal angle straight or slightly convex. Posterior end rounded. Ventral rim gently curved, regular or somewhat undulating. Ventral rim sharper than dorsal rim.

Inner surface slightly convex lengthwise. Medial sulcus straight, running parallel to the long axis. Ostium and cauda clearly separated. Ostium deep and widening towards the rim. Cauda much shallower, especially its foremost part; it has no or only a vague boundary at its posterior end. Ostium always distinctly longer than cauda: it is up to 1.5 times the length of the cauda. Crista superior well-developed: it is a high, rounded to somewhat pointed crest overhanging the area. This crista is irregularly shaped. Crista inferior inconspicuous. It pales into insignificance beside the large, massive and high thickening below a large part of the sulcus. This thickening is clearly bounded, especially along its ventral side. Area long and narrow. Ventral furrow indistinct and irregular, close to the ventral rim.

Outer surface saucer-shaped lengthwise. The raised borders are rather steep; the central part is flat or concave. This surface is smooth or has a few large, low knobs and a few very indistinct furrows.

Discussion — Otoliths of four Recent *Callionymus* species are available for comparison: *C. grossi* Ogilby (Townsville, Australia), *C. lyra* Linné (North Sea and Atlantic coasts of Europe), *C. nasutus* McCulloch (Townsville, Australia) and *C. phaeton* (Günther) (Casablanca, Morocco). Their sulcus, cristae and general outline resemble those of the fossil species so much that the latter can be classified as callionymid. All these species however differ from "*C.*" *pachyotus* by having clearly triangular otoliths with sharp angles; a supramedial, obliquely running sulcus; a smaller rostrum, antirostrum and excisura; an ostium two to three times the length of the cauda; no or only a narrow thickening below the sulcus; and finally much thinner otoliths.

These differences are so fundamental that "*C.*" *pachyotus* must be included in another genus, but unfortunately no otoliths of other Recent callionymid genera are known to me. Therefore it still remains uncertain if the fossil species belongs to another Recent genus of the family or to an extinct, fossil genus.

The otoliths of "*C.*" *pachyotus* resemble most those of *C. lyra*, because the latter species is the only recent *Callionymus* known having a narrow thickening below the sulcus and a poor ornamentation.

Schwarzhan (1973) described the species *Callionymus schuermanni* from the Early Oligocene Hückelhoven Beds of the Lower Rhine District in the Federal Republic of Germany. This species shows

much more resemblances with the Recent *Callionymus* species in the shape of the outline (the otoliths are clearly triangular with a pointed posterior end) and in the size of rostrum, excisura and antirostrum. Thus it can be concluded that *C. schuermanni* and "*C.*" *pachyotus* belong to different evolutionary lineages and different genera.

Ordo PLEURONECTIFORMES

Familia BOTHIDAE

Genus *Citharus* Röse, 1793

Citharus rhenanus (Koken, 1891)

- 1891 ? *Rhombus rhenanus* Koken, p. 107, pl. 5, fig. 11.
1942 ? *Eucitharus rhenanus* (Koken, 1891) — Weiler, p. 71, pl. 4, fig. 37; pl. 5, fig. 2, 3.
1972 *Eucitharus belgicus* Gaemers, p. 80, pl. 1, fig. 2; pl. 3, fig. 5, 6.
1977 *Citharus belgicus* (Gaemers, 1972) — Nolf, p. 60 (non pl. 17, fig. 17, 18).
1983 *Citharus belgicus* (Gaemers, 1972) — Müller, p. 70.
1984 *Citharus belgicus* (Gaemers, 1972) — Gaemers, p. 45, pl. 4, fig. 13, 14.

Material — Roelants sand-pit, Lubbeek: 3 sagittas, 10.55-10.70 m below top of Rupelian, RGM 177 391.

Discussion — The large number of *Citharus belgicus* otoliths from the Berg Sand at Borgloon present in the van Hinsbergh collection show a wide variability in shape. The outline of the otolith of ? *Rhombus rhenanus* illustrated by Koken (1891) is within the range of variability of these specimens, so that *Citharus belgicus* has to be considered a junior synonym of *C. rhenanus*.

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