

NEW OTOLITHS FROM THE TERTIAIRY OF THE NORTH SEA BASIN

by

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Seven new species are described from several locations of different ages. One new genus is established, viz. Merlangiogadus (family Gadidae). Two new species were found in the upper Oligocene of northwestern Germany, viz. Gadichthys undosug and Merlangiogadus decorus. Merlangius bifurcus, Gaidropsarus acuticaudatus and Scorpaena edegemensis are new species found in the Sands of Antwerp at Antwerp and in the Lower Hemmoorian of northwestern Germany. Tripterophycis multituberosus nov. sp. was found in the Upper Hemmoorian of northwestern Germany and Macruridarum irregularis nov. sp. in the Upper Miocene of the Peel region in The Netherlands. With the aid of otoliths, the and of Edagem in Belgium can now be correlated with the Behrendorf (= Lower Hemmoorian) in Germany. Both are Middle Miocene.

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SAMENVATTING

In deze publicatie worden zeven nieuwe soorten beschreven die afkomstig zijn van verschillende vindplaatsen en van verschillende tertiaire formaties. Bij de kabeljauwachtigen is een nieuw genus ingevoerd, namelijk Merlangiogadus. Hiertoe behoren M. cognatus en M. decorus nov. sp. De eerstgenoemde soort werd vroeger tot Merlangius gerekend, maar op grond van afwijkende eigenschappen, die beide soorten bezitten, konden deze soorten niet meer in dit genus ondergebracht worden. Daar Merlangiogadus kenmerken van verschillende kabeljauwen-genera in zich schijnt te verenigen, moet het zeer waarschijnlijk geacht worden, dat in dit genus de stamvader van vele kabeljauwachtigen gevonden zal worden. Deze genera zijn: Merlangius, Micromesistius, Melanogrammus en Trisopterus.

In het Boven-Oligoceen van NW-Duitsland zijn twee nieuwe kabeljauwachtigen gevonden, namelijk Gadichthys undosus en Merlangiogadus decorus. Ook de wijting Merlangius bifurcus en de meun Gaidropsarus acuticaudatus behoren tot

dezelfde familie. Samen met de schorpioenvis *Scorpaena edegemensis* zijn deze nieuwe soorten gevonden in de Zanden van Edegem in Antwerpen. *Merlangius bifurcus* is eveneens aangetroffen in het onderste deel van de Hemmoor-Stufe van NW-Duitsland en in de Zanden van Antwerpen in Antwerpen.

Tripterophycis multituberosus werd gevonden in het bovenste deel van de Hemmoor-Stufe van NW-Duitsland en *Macruridarum irregularis* in het Boven-Mioceen van het Peelgebied. Beide soorten behoren tot families die nauw verwant zijn aan de kabeljauwen en die tegenwoordig in de diepzee leven.

Met behulp van otolieten kunnen de Zanden van Edegem in België nu gecorreleerd worden met het onderste deel van de Hemmoor-Stufe (Behrendorf) in Duitsland. Beide behoren tot het onderste deel van het Midden-Mioceen.

INTRODUCTION

Three small faunas of otoliths were examined:

1. A fauna from the Upper Oligocene of northwestern Germany, collected from boreholes.
2. A fauna from the Lower Hemmoorian of northwestern Germany, also collected from boreholes.
3. A fauna, Upper Miocene to Upper Pliocene in age, from a borehole at Odiliapeel, Peel-region, province of North Brabant, Netherlands.

Moreover three new species from the Sands of Edegem (Antwerp, Belgium) are described together with one new species, *Tripterophycis multituberosus*, from a borehole from the Upper Hemmoorian at Langenklint. It is the first time that a fossil species of this genus was found.

The first fauna, from the Upper Oligocene of northwestern Germany, does not include species that are new for the fauna except the two new species *Gadichthys undosus* and *Merlangiogadus decorus*. The other species mentioned were found earlier by Koken and Weiler.

The second fauna, Lower Hemmoorian in age, has two species which are new for the fauna: *Merlangius bifurcus* nov. sp. and *Sciaenidarum elongatus* Koken; *Gadichthys antwerpiensis* was described as *Merlangius spatulatus* by Weiler (1942 and 1959). The other species mentioned in this publication have already been described by Weiler (1959).

Gadichthys antwerpiensis is one of the most common species in the Sands of Edegem at Antwerp. From the fact that this species also seems to be common in the Lower Hemmoorian (= Behrendorf) of northwestern Germany and that the otoliths of this fish have not yet been found in other deposits of different age, we conclude that the Sands of Edegem were deposited contemporaneously with the Lower Hemmoorian. Therefore we can correlate the Sands of Edegem in Belgium with the Lower Hemmoorian in Germany. Both are Lowermost Middle Miocene in age.

The third fauna, to be exact three small faunas from the Upper Miocene and Lower and Upper Pliocene, is totally new. On the basis of an article by Gaemers & Schwarzahns (in press), the ages of the different samples can be given. This article includes descriptions of the newly established genera *Gadichthys*

and *Colliolus*, together with the species which belong to these genera.

Specimens stored at the Rijksmuseum van Geologie en Mineralogie in Leiden will be marked "Coll. RGM" followed by the collection number of this museum.

Other abbreviations that have been used are: GLSH = Geologisch Landesamt Schleswig-Holstein, Kiel; RGD = Rijks Geologische Dienst, Haarlem; NHMR = Natuurhistorisch Museum, Rotterdam; L = length; H = height; T = thickness of the otolith; L/H = length/height ratio; L/T = length/thickness ratio.

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SYSTEMATIC DESCRIPTIONS

Phylum PISCES
Superclassis TELEOSTOMI (OSTEICHTHYES)
Classis ACTINOPTERYGII
Subclassis TELEOSTEI
Ordo GADIFORMES
Familia GADIDAE Rafinesque, 1810
Genus *Gadichthys* Gaemers & Schwarzahns, 1973

Gadichthys undosus nov. sp.
(Plate 1, fig. 1a-b, 2a-b, 4a-b, Plate 2, fig. 7)

Holotype: Plate 1, fig. 1a-b, coll. RGM 175 650, leg. Dr. W. Hinsch, GLSH.

Locus typicus: Borehole at Neubörnßen, depth 251-257 m, northwestern Germany (Messtischblatt 2527).

Stratum typicum: Upper Oligocene, Neochattian.

Derivatio nominis: named for the undulating dorsal rim.

Diagnosis - A large *Gadichthys* species with a clearly undulating dorsal rim with a distinct postdorsal angle. Rostral as well as caudal end rather pointed.

Description - Otoliths robust and strong. Outline irregularly and narrowly pear-shaped. Dorsal rim undulating and heavily knobbed; pre- and postdorsal angles clearly visible; dorsal rim sharp. Ventral rim with fewer knobs than dorsal rim; regular and smooth shape. Ventral and dorsal rims meet at an angle at the rostral and caudal ends, i.e. both ends are rather pointed. Ventral rim blunt.

Inner surface convex lengthwise, flat across. Sulcus acusticus wide and deep, median or slightly inframedian. Sulcus pseudobiostial. Cauda 1.5 times the length of ostium. Two homomorphic colliculi. Collum long. Furrow under the collum very distinct and deep. Small furrows from dorsal rim traverse the crista superior giving the impression of knobs. The same furrows can sometimes intersect the colliculum of the cauda. Ventral furrow distinct, not far from ventral rim. The minute furrows from the ventral rim traverse the ventral furrow to some extent.

Outer surface concave lengthwise, convex across. Entire surface highly sculptured. Peripheral knobs in obvious pattern nearly perpendicular to the rims. Longitudinal ridge inframedian.

L 9.02 mm	H 4.14 mm	T 1.79 mm	L/H 2.18	L/T 5.04	Holotype
L 4.95 mm	H 2.51 mm	T 0.92 mm	L/H 1.97	L/T 5.38	Neubörnsen, 258-261 m.
L 7.94 mm	H 3.46 mm	T 1.72 mm	L/H 2.29	L/T 4.62	Neubörnsen, 263-264 m.
L 3.78 mm	H 2.15 mm	T 0.91 mm	L/H 1,76	L/T 5.15	Neubörnsen, 262-264 m.
L 6.17 mm	H 3.0 mm	T 1.2 mm	L/H 2.06	L/T 5.15	Neubörnsen, 261-262 m.
L 3.6 mm	H 1.94 mm	T 0.75 mm	L/H 1.86	L/T 4.8	Neubörnsen, 261-262 m.
L 3.12 mm	H 1.85 mm	T 0.71 mm	L/H 1.91	L/T 4.4	Neubörnsen, 261-262 m.

Material - A total of 19 sagittas. One sagitta, Neochattian, Neubörnsen, 251-257 m, coll. RGM 175 650, leg. Dr. W. Hinsch (Holotype). One sagitta (juvenile), Neochattian, Neubörnsen, 258-261 m, coll. RGM 175 651, leg. Dr. W. Hinsch. Three sagittas (broken, one juvenile specimen), Chattian, Neubörnsen, 268-270 m, coll. GLSH. Three sagittas, Neochattian, Neubörnsen, 266-267 m, 2 specimens coll. GLSH, 1 specimen coll. Gaemers, leg. Dr. W. Hinsch. Five sagittas (2 juvenile), Neochattian, Neubörnsen, 263-264 m, coll. GLSH. Five sagittas (3 juvenile), Neochattian, Neubörnsen, 261-262 m, coll. GLSH. One sagitta, Neochattian or Vierland Stufe (= Lower Miocene), Giesselrade, 174,5 - 177,5 m, coll. GLSH.

Distribution - Upper Oligocene, Chattian - Neochattian. ? Lower Miocene.

Discussion - The range of variation of this species is very small and seems mainly to be limited to the rostral end which can be more pointed or less. The length of the collum is also somewhat variable. In juvenile specimens, the dorsal rim is not concave between the pre- and postdorsal angles. Therefore both angles are not very conspicuous in juvenile specimens, especially the postdorsal angle. Thus it will be rather difficult to distinguish these specimens from juveniles of *Gadichthys antwerpiensis* Gaemers, 1971. Surely *G. undosus* is the direct ancestor of *G. antwerpiensis*.

The length/height and length/thickness ratios do not differ from those of *G. antwerpiensis*. A damaged specimen of *G. undosus* clearly shows three year rings (height: 3.32 mm, calculated length: 6.5 - 7.5 mm).

The new species is equal in size to specimens of *G. antwerpiensis* of the same age.

It is striking that juvenile specimens are shorter and compacter than the adult ones. Here we have the phenomenon of allometrical growth.

The presence of a postdorsal angle and a rostral end more or less pointed because the dorsal rim is flat near the rostral end indicates the close relationship with the genus *Colliolus*. The shape of the wide and deep sulcus with the peculiar long collum and with the distinct ventral bend of the cauda toward the ventral rim characterize the genus *Gadichthys*. This genus is established in Gaemers & Schwarzhans (1973, in press).

The history of the genus *Gadichthys* is already reasonably complete: *Gadichthys benedeni verticalis* Gaemers & Schwarzhans, 1973 (in press). Upper Pliocene.

Gadichthys benedeni (Leriche, 1926). Lower Pliocene.

Gadichthys miocenicus (Heinrich, 1969). Upper Miocene.

Gadichthys antwerpiensis (Gaemers, 1971). Lowermost Middle Miocene.

Gadichthys undosus nov. sp. Upper Oligocene.

Remarks - Heinrich (1969) published *G. miocenicus* as *Merlangius spatulatus miocenicus* nov. sp. after Weiler (1942), who had added the otoliths of *G. antwerpiensis* from the Middle Miocene to the species *Merlangius spatulatus* (Koken, 1891). The latter species is only known from the Upper Oligocene to date, and has a more slender shape. Heinrich placed *G. antwerpiensis* together with the Upper Miocene species *G. miocenicus*, but it is easy to distinguish between the two species. There is an even greater resemblance between *G. miocenicus* and *G. benedeni* than between the former and *G. antwerpiensis*.

Genus *Merlangiogadus* nov. gen.

Type species: *Otolithus (Merlangus) cognatus* Koken, 1891; p. 89, Pl. V, fig. 1 (non Pl. III, fig. 5)

Derivatio nominis: named after the genus *Merlangius*, because of the great resemblance.

Diagnosis and discussion - The outline of this genus shows the closest resemblance to that of *Merlangius* and *Micromesistius*: the postdorsal angle is in the same place, the posterior end is clearly pointed and the dorsal rim is straight between the pre- and postdorsal angles. A remarkable difference is that the anterior end is usually rounded in contrast to the truncated anterior end of *Merlangius*. The anterior end of *Micromesistius* is slightly truncated. The rounded anterior end seems to be an old characteristic in the family of the Gadidae (*Merlangius bifurcus* nov. sp. also has a more rounded anterior end; this species is the oldest *Merlangius* known).

Sulcus acusticus median or very slightly suprmedian in contrast to *Merlangius*, *Micromesistius*, *Melanogrammus* and *Trisopterus* (again *Merlangius bifurcus* is an exception with a median sulcus). The sulcus is deep and filled with thick colliculi; the cauda is characteristically bent toward the ventral rim: (both are seen in *Trisopterus* but not in *Merlangius*, *Micromesistius* or *Melanogrammus*). Ventral part of the outer surface is obviously thicker than dorsal part (as in *Trisopterus* and *Melanogrammus*, but in contrast to *Merlangius* and *Micromesistius* which have thinner otoliths).

The otoliths are moderately bent along the long axis (thus similar to *Melanogrammus* and in contrast to *Trisopterus*, which is markedly bent, and *Merlangius* and *Micromesistius*, which are very slightly bent).

Only two known species belong to this genus:

Merlangiogadus cognatus (Koken, 1891) - Lowermost Middle Miocene - Upper Miocene.

Merlangiogadus decorus nov. sp. - Upper Oligocene.

Remark - The evolution within this genus shows an alteration from slender otoliths to robust ones. The highest specimens of *Merlangiogadus cognatus* are Upper Miocene in age (Heinrich, 1969, pl. XI, fig. 2a-b).

Merlangiogadus decorus nov. sp.
(Plate 1, fig. 5a-b, 6a-b, 7a-b)

Holotype: Plate 1, fig. 6a-b, coll. RGM 175 652, leg. Dr. W. Hinsch, GLSH.

Paratypes: Plate 1, fig. 7a-b, coll. RGM 175 653, leg. Dr. W. Hinsch, GLSH; plate 1, fig. 5a-b, coll. GLSH.

Locus typicus: Borehole at Neubörnsen, depth 258-261 m, northwestern Germany (Messtischblatt 2527).

Stratum typicum: Upper Oligocene, Neochattian.

Derivatio nominis: named for the elegant form of the sagittas.

Diagnosis - A slender *Merlangiogadus* species with a fairly pointed rostral end. The postdorsal angle is found at about two-thirds of the length of the otolith calculated from the rostral end, which is usually well-rounded.

Description - Medium-sized, slender otoliths. Outline very long and thin with a sharply pointed caudal end. Ventral part of rostral end barely developed so that the rostral end is usually well-rounded. Ventral rim very regularly bent. Dorsal rim straight between pre- and postdorsal angles and slightly concave between postdorsal angle and caudal end. Ventral rim more heavily knobbed than dorsal rim. Ventral rim blunt, dorsal rim sharp.

Inner surface distinctly convex lengthwise, slightly convex to flat across. Sulcus acusticus wide, median or somewhat suprmedian. Sulcus pseudobio-ostial. Cauda and ostium filled with two homomorphic colliculi. Collum rather long. Cauda two times the length of ostium. Small furrows from dorsal rim traverse big area. These furrows can rib the crista superior and sometimes also the colliculum in the cauda. Small furrows from ventral rim up to distinct ventral furrow.

Outer surface concave lengthwise and convex across. Entire surface heavily knobbed. Knobs on ventral part most pronounced. Long axis of knobs usually perpendicular to the rims. Longitudinal ridge situated in ventral part (infra-median).

L 7.07 mm H 2.69 mm T 1.4 mm L/H 2.63 L/T 5.05 Holotype.

L +7.5 mm H 2.92 mm T 1.7 mm L/H 2.57 L/T 4.41 Neubörnsen, 251-257 m.

L 5.51 mm H 2.1 mm T 1.05 mm L/H 2.62 L/T 5.25 Neubörnsen, 268-269 m.

Material - One sagitta, Neochattian, Neubörnsen, 258-261 m, coll. RGM 175 652, leg. Dr. W. Hinsch, GLSH (Holotype). One sagitta, Neochattian, Neubörnsen, 251-257 m, coll. RGM 175 653, leg. Dr. W. Hinsch, GLSH (paratype). One sagitta, Chattian, Neubörnsen, 268-269 m, coll. GLSH (paratype).

Distribution - Upper Oligocene, Chattian - Neochattian.

Discussion - This species is an ancestor of the more robust *Merlangiogadus cognatus*.

Other species from the Upper Oligocene of northwestern Germany, coll. GLSH:

Colliolus aff. *friedbergi* (Chaine & Duvergier, 1928).

One sagitta, Neubörnsen, 251-257 m, Neochattian. This specimen is thicker than the Miocene ones. Other differences do not exist.

Colliolus sculptus (Koken, 1891) (Plate 2, fig. 2,3)

Syn. *Otolithus (Gadus) elegans sculpta* Koken, 1891, p. 93, plate IV, fig. 2. Twenty-one sagittas (many fragments; 17 juvenile specimens), Sierhagen, 121-124,5 m. Two sagittas, Hemmelsdorf, 156-160 m, Chattian (1 sagitta from coll. GLSH to coll. Gaemers). Fifteen sagittas, Neubörnsen, 273-276 m, Chattian. Three sagittas, Neubörnsen, 273-274 m, Chattian. Three sagittas, Neubörnsen, 272-273 m, Chattian. Seven sagittas (2 juvenile specimens), Neubörnsen, 271-272 m, Chattian (1 sagitta from coll. GLSH to coll. RGM 175 661). Four sagittas (2 juvenile specimens), Neubörnsen, 268-270 m, Chattian.

? *Trisopterus* sp.

One fragment of sagitta, Neubörnsen, 272-273 m, Chattian. Two sagittas (fragments), Neubörnsen, 271-272 m, Chattian. Three sagittas (fragments), Neubörnsen, 258-261 m, Neochattian.

Dentex nobilis Koken, 1891

Two sagittas, Neubörnsen, 272-273 m, Chattian. One sagitta (eroded), Neubörnsen, 271-272 m, Chattian. One sagitta, Neubörnsen, 266-267 m, Neochattian. One sagitta, Hemmelsdorf, 156-160 m, Chattian.

Brotulidarum occultus (Koken, 1891)

Syn. *Ophidiidarum occultus* Koken, 1891, p. 104, pl. VI, fig. 1, 1a. One sagitta, Neubörnsen, 268-270 m, Chattian.

Trigla asperoides Schubert, 1906

One sagitta, Neubörnsen, 258-261 m, Neochattian.

Genus *Merlangius* Oken, 1891

Merlangius bifurcus nov. sp.
(Plate 2, fig. 1a1b)

Gadus pseudaeaglefinus Newton, 1891, p. 94, pl. X, fig. 6, 7.

Merlangus pseudaeaglefinus (Newton, 1891) - Weiler, 1942, p. 80, pl. IX, fig. 10a-b.

Merlangius pseudaeaglefinus (Newton, 1891) - Gaemers, 1971, p. 244, pl. I, fig. 13a-b, pl. V, fig. 6a-b.

Holotype: Plate 1, fig. 13a-b, plate V, fig. 6a-b in Gaemers, 1971; coll. RGM 175 654, leg. Gaemers & Cadée.

Locus typicus: E-3 tunnel, right bank of Scheldt River, Antwerp, Belgium.

Stratum typicum: Lowermost Middle Miocene, Sands of Edegem.

Derivatio nominis: named for small bifurcated furrows.

Diagnoses - A big, thin *Merlangius* species, highly sculptured. Small furrows in dorsal and ventral part bifurcated, on inner as well as outer surface. Caudal end of the otolith barely pointed.

Description - Otoliths big and thin. Outline very regular and very long and thin; almost symmetrical with respect to the long axis. All rims very knobby with deep indentations, especially at ventral rim. This rim has more pronounced and bigger knobs than dorsal rim. Dorsal rim sharp, ventral rim fairly sharp.

Postdorsal angle very weakly developed. Caudal point broken, but cannot have been very sharp. Rostral part with a tendency toward oblique truncation. Inner surface very slightly convex lengthwise as well as across. Small furrows traverse almost the entire inner surface: from the dorsal rim across the whole area, the crista superior (which therefore appears knobbed) and the colliculum in the cauda; from ventral rim across the ventral furrow up to and including the crista inferior (along the cauda); from caudal rim into the ostium. The small furrows are bifurcated in many cases in the dorsal and ventral parts and on the inner as well as outer surface. Sulcus acusticus wide and partly filled with two thin, homomorphic colliculi. Sulcus median and pseudobiostial. Collum short. Cauda nearly two times the length of ostium.

Outer surface flat lengthwise, slightly convex across. Entire surface highly sculptured. Knobs with long axis more or less perpendicular to the rims. Clusters of small knobs along the long axis. Longitudinal ridge situated in ventral part (inframedian).

L + 8.0 mm H 3.1 mm T 1.05 mm Holotype, Sands of Edegem.

L 14.75 mm (broken) H 7.0 mm T 2.28 mm Paratype, Bokelrehm, Behrendorf.

Material - One sagitta (fragment), Sands of Antwerp, E - 3 route, Berchem-Borgerhout, Antwerp, coll. NHMR. One sagitta, Sands of Edegem, Antwerp, coll. RGM 175 654 (holotype). One sagitta (broken), Behrendorf (= Lower Hemmoorian), Bokelrehm, depth 159 m, northwestern Germany, coll. GLSH. One sagitta (fragment), Sands of Edegem, Terhagen, Belgium, coll. RGM 175 655. One sagitta (eroded), Behrendorf (= Lower Hemmoorian), Bevern 3, depth 200 m, northwestern Germany, coll. GLSH.

Distribution - Middle Miocene; Sands of Edegem - Sands of Antwerp, Lower Hemmoorian.

Discussion - Former identification: *Merlangius pseudaeaglefinus*. The principle differences with respect to this species are the following: the Pliocene *P. pseudaeaglefinus* has an obvious point at the caudal end. The rostral end is distinctly truncated. The postdorsal angle is clearly developed. These three characteristics are all much less pronounced in *M. bifurcus*. The shape of the recent species *M. merlangus* is even more pronounced. Thus in the evolution of this sequence we find a development from little differentiation to very pronounced forms.

Species found in the Lower Hemmoorian (Behrendorf) of northwestern Germany, in coll. GLSH:

Colliolus friedbergi (Chaine & Duvergier, 1928)

Two sagittas, Bevern 3, 200 m. Four sagittas, Bramstedtlund, 143-144 m.
One sagitta, Vaale, 206-207 m.

Gadichthys antwerpiensis (Gaemers, 1971)

Syn. *Merlangus spatulatus* in Weiler, 1942

Two sagittas, Vaale, 208-209 m, one sagitta, Vaale, 206-207 m. One sagitta, Bokelrehm, 159 m.

Merlangius bifurcus nov. sp.

One sagitta (broken), Bokelrehm, 159 m. One sagitta (eroded), Bevern 3, 200 m.

Corvina speciosa (Koken, 1884)

One sagitta, Bramstedtlund, 143-144 m.

Sciaenidarum elongatus Koken, 1884

One sagitta, Bramstedtlund, 144-150 m.

Sciaenidarum teutonicus Weiler, 1942.

One sagitta, Bevern 3, 200 m.

Umbrina gibberula (Koken, 1884)

One sagitta (eroded), Vaale, 208-209 m.

Genus *Gaidropsarus* Rafinesque, 1810

Gaidropsarus acuticaudatus nov. sp.

(Plate 2, Fig. 4a-b)

Holotype: plate 2, fig. 4a-b, coll. RGM 175 658, leg. M. van den Bosch.

Locus typicus: E-3 tunnel, right bank of Scheldt River, Antwerp, Belgium.

Stratum typicum: Lowermost Middle Miocene, Sands of Edegem.

Derivatio nominis: named for the distinctly pointed caudal end.

Diagnosis - A thin *Gaidropsarus* species with highly elongated, oval outline. Caudal end of otolith very pointed. Outer surface with indistinct relief of small furrows and knobs approximately in radial pattern.

Description - Thin otolith. Outline highly elongated and oval. Ventral rim very regular, without knobs. Dorsal rim undulating due to barely pronounced knobs. Pre- and postdorsal angles indistinct. Caudal end of otolith very pointed, rostrum much less pronounced.

Inner surface convex lengthwise and across. Sulcus acusticus pseudobio-ostial. Two homomorphic colliculi. Cauda 1.5 times the length of ostium. Collum narrow and long. Lower rim of cauda with pronounced convex bend toward ventral side. Sulcus median. Ventral furrow obvious along the entire ventral rim, located some distance from this rim. Area long and shallow.

Outer surface quite concave lengthwise, slightly convex across. Relief indistinct with an approximately radial pattern of small and shallow furrows and knobs.

L 4.39 mm H 1.55 mm T 0.56 mm L/H 2.83 L/T 7.84.

Material - One sagitta, Sands of Edegem, E-3 tunnel, right bank of Scheldt River, Antwerp, coll. RGM 175 658.

Distribution - Lowermost Middle Miocene, Sands of Edegem.

Discussion - There are many similarities between the new species and *Gaidropsarus bergensis* (Gaemers 1972) from the Middle Oligocene of Berg, Belgium (syn. *Onos bergensis*). In contrast to *G. acuticaudatus*, this species has a triangular less elongated outline and rounded instead of pointed ends. The relationship between these species is very close in any case.

For the list of species of the Sands of Edegem and the Sands of Antwerp, see Gaemers, 1971.

Familia SCORPAENIDAE Risso, 1826
Genus *Scorpaena* Linnaeus, 1758

Scorpaena edegemensis nov. sp.
(Plate 2, fig. 6a-b)

Agonus primus Koken, 1891 - Gaemers, 1971, p. 248, pl. III, fig. 10a-b, pl. IV, fig. 8a-b.

Holotype: plate 2, fig. 6a-b, coll. RGM 175 656, leg. V. W. M. van Hinsbergh.

Locus typicus: testpit for E-3 tunnel, right bank of Scheldt River, Antwerp, Belgium

Stratum typicum: Lowermost Middle Miocene, Sands of Edegem.

Derivatio nominis: named after the Sands of Edegem, in which this species is found.

Diagnosis - A medium-sized *Scorpaena* species with an obvious and sharp excisura. Sulcus acusticus inframedian. The dorsal rim is regularly formed and rounded, so that the length/height ratio is rather small for this genus.

Description - Medium-sized, rather thin otoliths. Outline oblong oval, with an obvious and sharply incised excisura ostii. Rostrum very pointed and big. Antirostrum much smaller but in any case distinct, at least when the otolith is not eroded. Caudal end usually properly pointed. Dorsal and ventral rims both with many irregular knobs which differ considerably in size. None the less both are entirely regular in shape. Dorsal rim much more curved than ventral rim.

Inner surface highly convex lengthwise, slightly convex across. Deep sulcus acusticus inframedian. In adult specimens ostium somewhat larger than cauda, in juvenile specimens ostium shorter than cauda. Ostium wider than cauda. End of cauda slightly bent toward ventral rim. Area well-developed. Ventral furrow distinct and irregular due to incisions of the irregular knobs. Ventral furrow extends further along caudal rim and posterior part of dorsal rim up to the area.

Outer surface concave lengthwise, flat or slightly convex across. Entire surface highly sculptured by irregular knobs in a more or less radial pattern.

L 6.85 mm	H 3.05 mm	T 0.93 mm	L/H 2.25	L/T 7.25	Holotype
L 6.91 mm	H 3.0 mm	T 0.88 mm	L/H 2.4	L/T 7.85	
L 7.55 mm	H 3.15 mm	T 1.11 mm	L/H 2.4	L/T 6.8	
L 4.92 mm	H 2.3 mm	T 0.81 mm	L/H 2.14	L/T 6.07	
L 3.34 mm	H 1.65 mm	T 0.57 mm	L/H 2.02	L/T 5.86	

Material - A total of 6 sagittas, Sands of Edegem, testpit for E-3 tunnel, right bank of Scheldt River, Antwerp, Belgium. One sagitta, coll. RGM 175 656, leg. V. W. M. van Hinsbergh (holotype). Four sagittas, coll. RGM 175 657. One sagitta coll. Gaemers.

Distribution - Lowermost Middle Miocene, Sands of Edegem.

Discussion - There are many similarities between the new species and the recent species *Scorpaena scrofa* L. The length/height ratio of the latter varies from 2.4 to 3 (measured from photographs in Chaina & Duvergier, 1934), and is thus much bigger. The dorsal rim is less regular than that of *S. edegemensis*. It also

resembles *S. colorata* (Gilbert), but the length/height ratios vary from 1.85 to 2.05. Other differences with respect to *S. edegemensis* are: sulcus median; excisura, rostrum and antirostrum are much less pronounced.

There are fewer similarities with the recent species *S. porcus* and *S. ustulata*. Most probably *S. edegemensis* is an ancestor of *S. scrofa*.

Familia MORIDAE

Genus *Tripterophycis* Boulenger, 1902.

Tripterophycis multituberosus nov. sp.

(Plate 2, fig. 5a-b)

Holotype: plate 2, fig. 5a-b, coll. RGM 175 659, leg. Dr. W. Hinsch, GLSH.

Locus typicus: Borehole at Langenklint, depth 145 m, northwestern Germany.

Stratum typicum: Lowermost Middle Miocene; Oxlund (= Upper Hemmoorian).

Derivatio nominis: named for the heavily knobbed outer surface.

Diagnosis - A heavily knobbed *Tripterophycis* species. Caudal point relatively short. Part of dorsal rim between pre- and postdorsal angles long.

Description - Very fragile otolith, formed like a spool. Outline elongated with both ends pointed, especially the caudal end. Dorsal rim between rostral and predorsal angle concave. Predorsal angle very weakly pronounced. Part of dorsal rim between pre- and postdorsal angles long and straight (when we ignore the undulation formed by the external knobs). Dorsal rim between postdorsal angle and caudal point concave. Ventral rim very regular and smooth. Knobs of outer surface can be seen under this rim, when the inner surface is placed horizontally.

Inner surface flat. Sulcus acusticus very deep, inframedian and pseudobistial. Ostium triangular and obviously shorter than cauda. Cauda widened in posterior part of otolith. Cauda-dorsal and caudo-ventral points are somewhat broken. Sharp crista inferior and crista superior along cauda. Ostial colliculum covers almost entire ostium. Caudal colliculum thread-like; weakly and regularly bent toward ventral rim. Heteromorphic colliculi. Area and ventral field very unimportant and narrow.

Outer surface highly sculpture. Knobs are very pronounced, with an irregular pattern of small and big knobs. Nearly all furrows between knobs perpendicular to long axis.

L 3.1 mm H 1.07 mm T 0.95 mm L/H 2.9 L/T 3.26.

Material - One sagitta, Oxlund (=Upper Hemmoorian), langenklint, depth 145 m, northwestern Germany, coll. RGM 175 659, leg. Dr. W. Hinsch, GLSH (holotype).

Distribution - Lowermost Middle Miocene; Upper Hemmoorian.

Discussion - This new species is similar in many respects to the recent species *T. gilchristi* Boulanger. The recent species differs from the fossil one because of: 1. the very weakly sculptured outer surface, 2. shorter part of dorsal rim between pre- and postdorsal angles, 3. dorsal rim bent.

The genus *Tripterophycis* is quite similar to *Physiculus*. This genus has a humped dorsal part, so that the length/height ratio of the otoliths is much smaller than that of *Tripterophycis*. Both genera differ merely in this respect. All the other genera of the *Physiculus* group do not differ very much from each other. Differentiation is only a matter of shifting the accent, not an essential

distinction. Thus identification of the genus can be quite difficult.

Familia MACRURIDAE Bonaparte, 1838

Macruridarum irregularis nov. sp.
(Plate 2, fig. 8a-b)

Holotype: Plate 2, fig. 8a-b, coll. RGM 175 660, leg. RGD, Haarlem.

Locus typicus: Borehole at Odiliapeel, 45H/47, depth 58-59 m, province of North Brabant, Netherlands.

Stratum typicum: Upper Miocene.

Derivatio nominis: named for the irregularly formed knobs on the ventral rim.

Diagnosis - A long species with distinct and sharp excisura ostii. Caudal end of the otolith is much closer to dorsal part than to ventral part. Ventral rim with irregular knobs.

Description - Otolith rather big for a species of the Macruridae. Outline elongated and oval. Excisura ostii distinct and sharp. Rostrum bigger than antirostrum, both clearly developed. Caudal end pointed, situated much closer to dorsal part than to ventral part. Dorsal rim sharp, regularly formed and with small, barely pronounced knobs along the whole length. Pre- and postdorsal angles very weakly developed. Ventral rim sharp; sculptured by big, somewhat irregular knobs.

Inner surface flat. Sulcus acusticus median, pseudobiostial. Ostium and cauda equally long. Sharp groove traverses ostium from excisura to the middle of the colliculum. Colliculi small and oval. Collum long. Clear furrow along ventral side of collum. Area big and shallow. Indistinct ventral furrow incised by small furrows; situated rather far from ventral rim.

Outer surface slightly convex lengthwise and convex across. Sculptured by a radial pattern of knobs and small furrows. The furrows usually do not reach the centre of the outer surface.

Longest furrow beginning at excisura ostii.

L 3.02 mm H 1.46 mm T 0.37 mm L/H 2.07 L/T 8.16.

Material - One sagitta, Odiliapeel, 58-59 m, 45H:47, North Brabant, Netherlands, coll. RGM 175 660, leg. RGD.

Distribution - Upper Miocene.

Other otoliths from borehole Odiliapeel, 45H47, province of North Brabant, Netherlands (leg. RGD, Haarlem).

Upper Miocene:

Colliolus friedbergi (Chaine & Duvergier, 1928). Two sagittas, 59-60 m, coll. RGM 175 662. Three sagittas, 58-59 m, coll. RGM 175 664. Four sagittas, 57-58 m, coll. RGM 175 666.

Trisopterus nov. sp. Gaemers & Schwarzhan, 1973. Three sagittas, 57-58 m, coll. RGM 175 667.

Merluccius aff. vulgaris Fleming, 1828. One sagitta (fragment), 59-60 m, coll. RGM 175 663.

Trachinus verus Koken, 1884. One sagitta, 58 - 59 m, coll. RGM 175 665.

Upper Miocene or Lower Pliocene:

Merluccius triangularis Weiler, 1942. One sagitta, 55-56 m, coll. RGM 175 668.

Lower Pliocene:

Gadichthys benedeni (Leriche, 1926). One sagitta (broken and eroded), 54-55 m, coll. RGM 175 669. Thirteen sagittas, 51-52 m, coll. RGM 175 671. Ten sagittas, 50 - 51 m, coll. RGM 175 672.

Trisopterus sp. One sagitta (fragment), 50 - 51 m, coll. RGM 175 673.

Merlangius pseudaeaglefimus (Newton, 1891). One sagitta (fragment), 52 - 53 m, coll. RGM 175 670. One sagitta, 50 - 51 m, coll. RGM 175 674.

Merluccius sp. One sagitta (fragment), 50 - 51 m, coll. RGM 175 675.

Upper Pliocene:

Gadichthys benedeni verticalis Gaemers & Schwarzahns, 1973. Twenty-six sagittas, 49-50 m, coll. RGM 175 676.

Merlangius pseudaeaglefimus (Newton, 1891). Three sagittas, 49 - 50 m, coll. RGM 175 677.

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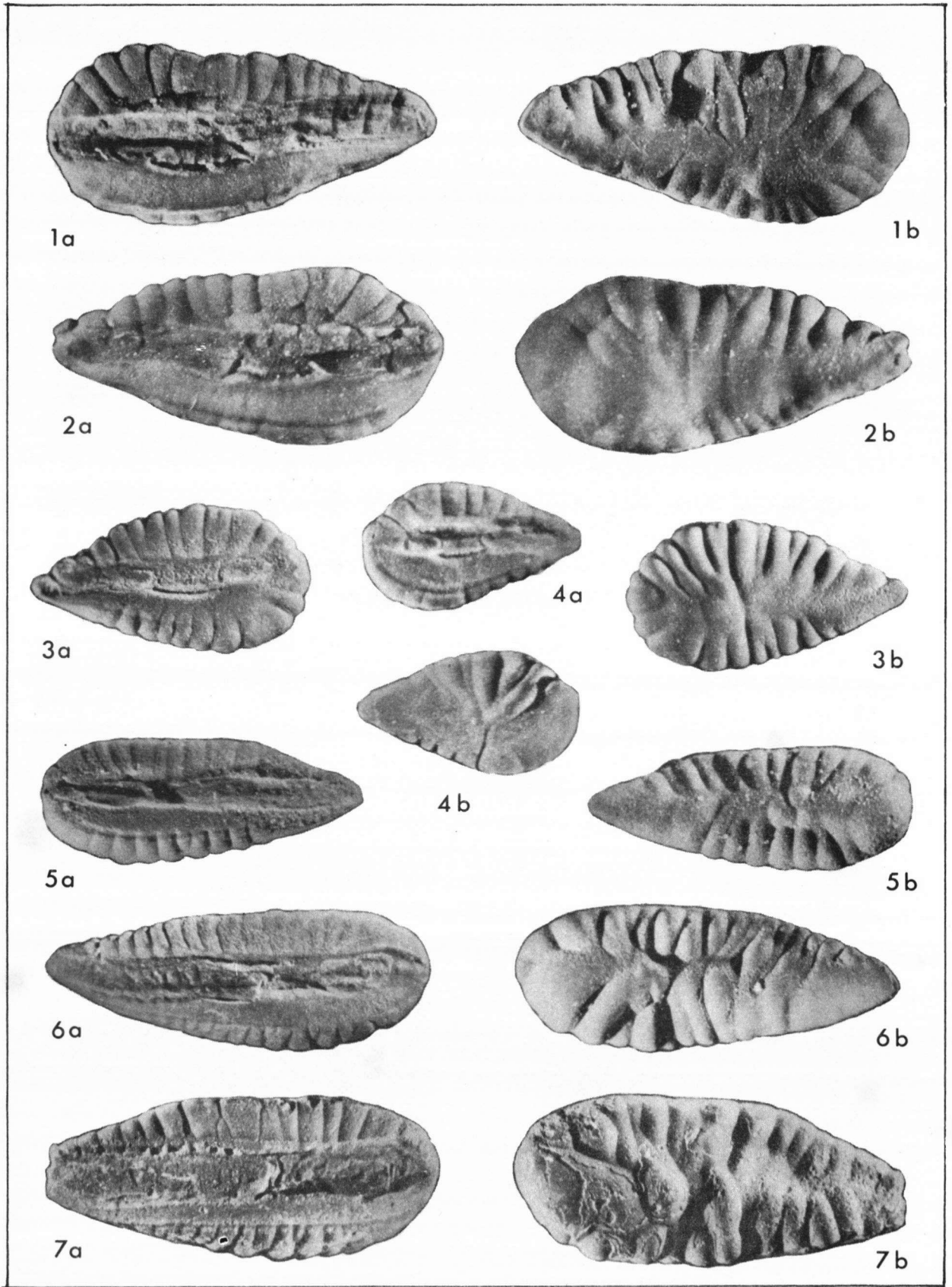
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EXPLANATION OF PLATE 1

- Fig. 1a-b *Gadichthys undosus* nov. sp., holotype, Neubornsen, Neochattian. Coll. RGM 175 650, 7½ x.
- Fig. 2a-b *Gadichthys undosus* nov. sp., paratype, Neubornsen, Neochattian. Coll. GLSH, 7 x.
- Fig. 3a-b *Gadichthys undosus* nov. sp., paratype, Neubornsen, Neochattian. Coll. RGM 175 651, 10 x.
- Fig. 4a-b *Gadichthys undosus* nov. sp., paratype, Neubornsen, Neochattian. Coll. GLSH, 10 x.
- Fig. 5a-b *Merlangiogadus decorus* nov. sp., paratype, Neubornsen, Chattian. Coll. GLSH, 10 x.
- Fig. 6a-b *Merlangiogadus decorus* nov. sp., holotype, Neubornsen, Neochattian. Coll. RGM 175 652, 10 x.
- Fig. 7a-b *Merlangiogadus decorus* nov. sp., paratype, Neubornsen, Neochattian. Coll. RGM 175 653, 10 x.

plate 1



EXPLANATION OF PLATE 2

- Fig. 1a-b *Merlangius bifurcus* nov. sp., paratype, Bokelrehm, Lower Hemmoorian, Coll. GLSH, 5 x.
- Fig. 2a-b *Colliolus sculptus* (Koken), Neubörnsen, Chattian. Coll. RGM 175 661, 10 x.
- Fig. 3a-b *Colliolus sculptus* (Koken), Neubörnsen, Chattian. Coll. GLSH, 10 x.
- Fig. 4a-b *Gaidropsarus acuticaudatus* nov. sp., holotype, Antwerp, Sands of Edegem. Coll. RGM 175 658, 10 x.
- Fig. 5a-b *Tripterophycis multituberosus* nov. sp., holotype, Langenklint, Upper Hemmoorian. Coll. RGM 175 659, 15 x.
- Fig. 6a-b *Scorpaena edegemensis* nov. sp., holotype, Antwerp, Sands of Edegem. Coll. RGM 175 656, 10 x.
- Fig. 7a-b *Gadichthys undosus* nov. sp., paratype, Neubörnsen, Neochattian. Coll. GLSH, 10 x.
- Fig. 8a-b *Macruridarum irregularis* nov. sp., holotype, Odiliapeel, Upper Miocene. Coll. RGM 175 660, 15 x.

plate 2

