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YPRESIAN TELEOST OTOLITHS FROM BELGIUM AND NORTHWESTERN FRANCE

by

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(with 5 figures, 1 table and 4 plates)

ABSTRACT

The otolith-based teleost fauna of the Ypresian of the Belgian Basin contains 51 species of which 3 are new to science: *Gnathophis schepdaalensis*, "genus Neobythitinorum" *angustoides* and "genus Neobythitinarum" *gossei*. The associations are dominated by ophidiids and congrids, reflecting shallow shelf environments with soft, often, muddy bottom, in the tropical to subtropical region.

Two major faunal groups can be distinguished. The lower group, including the otolith associations of the Roubaix Clay, Mons-en-Pévèle Sand and probably the Aalbeke Clay Members, is characterised by the acme of *Glyptophidium polli* (usually more than 80 % of the associations). The upper group, which contains the associations of the Kortemark Silt, Egem Sand, Panisel Sand and Pittem Clay Members, is characterised by the absence of *G. polli* (except for some specimens from the Panisel Sand at Schepdaal) and by the occurrence of frequent "genus Neobythitinorum" *subregularis*. The total number of species in common with post-Ypresian strata is higher in the upper group (42 % in the upper versus 29 % in the lower group).

From the otolith investigation it is obvious that the Roubaix Clay Member is a lateral equivalent of the Mons-en-Pévèle Sand Member and that both are definitely older than the Egem Sand Member. These results corroborate the correlations proposed by STEURBAUT & NOLF in 1986 on the basis of calcareous nannoplankton.

Detailed correlations with the Ypresian of the London-Hampshire Basin cannot be proposed yet, because a revision of English otolith faunas is needed. Comparison with the Ypresian Gan Clay of the Aquitaine Basin indicates that the otolith faunas of both areas are quite different, having only a few species in common. This dissimilarity results from substantial differences in the structure of both basins: in the Aquitaine Basin, which was well exposed to the oceanic realm, pelagic species constitute an important portion of the fauna, whereas in the rather isolated epicontinental Anglo-Paris-Belgian Basin such forms are absent.

Key words: Teleost otoliths, new taxa, Ypresian, Belgian Basin.

SAMENVATTING

De studie van otolieten uit het Ypresien van het Belgisch Bekken laat toe een Teleostei-fauna van 51 soorten te reconstrueren, waaronder 3 nieuwe: *Gnathophis schepdaalensis*, "genus Neobythitinorum" *angustoides* en "genus Neobythitinarum" *gossei*. De associaties worden gedomineerd door Ophidiidae en Congridae, wat wijst op sublittorale milieus met zachte, modderige bodem, in tropisch tot subtropisch gebied.

Twee grote faunistische groepen kunnen onderscheiden worden. De onderste groep die bestaat uit de associaties van de Klei van Roubaix, de Zanden van Mons-en-Pévèle en misschien ook de Klei van Aalbeke, wordt gekenmerkt door de acme van *Glyptophidium polli* (meestal meer dan 80 % van de associaties). De bovenste groep, die de associates van de Silt van Kortemark, de Zanden van Egem, de Zanden van de Panisel en de Klei van Pittem omvat, wordt gekenmerkt door de afwezigheid van *G. polli* (met uitzondering van enkele exemplaren uit de Zanden van de Panisel te Schepdaal) en door het frequent voorkomen van "genus Neobythitinorum" *subregularis*. Het totaal aantal soorten dat gemeenschappelijk is met post-Ypresien afzettingen is ook merkelijk hoger in de bovenste groep (42 % versus 29 % in de onderste groep).

Het onderzoek van de otolieten toont aan dat de Klei van Roubaix en de Zanden van Mons-en-Pévèle laterale equivalenten zijn, en dat beiden duidelijk ouder zijn dan de Zanden van Egem. Deze resultaten bevestigen de correlaties die door STEURBAUT & NOLF in 1986 werden voorgesteld op grond van kalkschalig nannoplankton.

Nauwkeurige correlaties met het Ypresien van het Bekken van London-Hampshire zijn momenteel niet mogelijk, omdat daarvoor een gedetailleerde revisie van de Engelse otolieten-faunas noodzakelijk is. Vergelijkende studies met de Klei van Gan uit het Ypresien van het Bekken van Aquitaine, wijzen op grondige verschillen in otolieten-associaties (slechts enkele soorten gemeenschappelijk). Deze verschillen zijn voornamelijk te wijten aan belangrijke verschillen in de structuur van beide bekkens. In het Bekken van Aquitaine, dat sterk onderhevig was aan oceanische invloeden, vormen de pelagische soorten een belangrijk aandeel in de fauna, terwijl in de faunas van de eerder geïsoleerde epicontinentale bekkens, zoals het Bekken van Parijs, van Zuid-Engeland en het Belgische Bekken deze soorten ontbreken.

Sleutelwoorden: Teleostei-otolieten, nieuwe taxa, Ypresien, Belgisch Bekken.

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RESUME

L'étude des otolithes a permis de reconstruire une faune de téléostéens de 51 espèces pour l'ensemble des terrains yprésiens du Bassin belge. Parmi ces espèces, trois sont nouvelles: *Gnathophis schepdaalensis*, "genus Neobythitinorum" *angustoides* et "genus Neobythitinarum" *gossei*. Les associations sont dominées par les ophidiidés et les congridés, ce qui indique des environnements sublittoraux à fond mou et vaseux, dans une aire tropicale ou subtropicale.

Deux unités fauniques majeures peuvent être distinguées. Un groupe inférieur, incluant les associations d'otolithes de l'Argile de Roubaix, les Sables de Mons-en-Pévèle et peut-être de l'Argile d'Aalbeke, est caractérisé par un acme de *Glyptophidium polli* (généralement plus de 80 % de l'association). Un groupe supérieur, réunissant les associations du Silt de Kortemark, des Sables d'Egem, des Sables du Panisel et de l'Argile de Pittem, est caractérisé par l'absence de *Glyptophidium polli* (sauf à Schepdaal, où quelques exemplaires ont été trouvés dans les Sables du Panisel) et par une assez grande fréquence de "genus Neobythitinorum" *subregularis*. 42 % des espèces du groupe supérieur se retrouvent dans des dépôts post-yprésiens, pour seulement 29 % des espèces du groupe inférieur.

D'après les associations d'otolithes, il est manifeste que l'Argile de Roubaix et les Sables de Mons-en-Pévèle sont des équivalents latéraux, et que ces deux strates sont nettement plus anciennes que les Sables d'Egem. Ces résultats confirment les corrélations proposées par STEURBAUT & NOLF en 1986, sur la base du nannoplancton calcaire.

Les relations précises entre les faunes téléostéennes de l'Yprésien belge et celles du Bassin de London-Hampshire ne peuvent être évaluées ici car cela nécessiterait d'abord une révision poussée du matériel anglais. Une comparaison avec l'Argile de Gan (Bassin d'Aquitaine), également d'âge yprésien, montre de fortes différences entre les deux faunes qui n'ont que fort peu d'espèces en commun. Cela résulte des différences fondamentales dans la structure des deux bassins. Dans le bassin d'Aquitaine, qui fut bien exposé au domaine océanique, les espèces pélagiques constituent une portion importante de la faune, tandis que dans des bassins épicontinentaux plutôt isolés, comme ceux de Paris, d'Angleterre méridionale et de Belgique, de telles espèces font totalement défaut.

Mots-clés: Otolithes de téléostéens, nouveaux taxa, Yprésien, Bassin belge.

INTRODUCTION

Although otoliths are common in several intervals of the Belgian Ypresian, no comprehensive studies have been published. The earliest record of these taxonomically useful calcareous bodies is in CASIER's monograph on the Ypresian fish fauna of Belgium (1946). This study was mainly based on material from the Mons-en-Pévèle Sands around Brussels (= "Forest Sands"), which are poor in otoliths, and so only four otolith-based species were described.

The abundance of otoliths in Upper Ypresian sand around Gent was first noted by CASIER in 1963 during construction works on a new lock along the Ringvaart Canal at Merelbeke (CASIER, 1967, p. 220-221) (see Fig. 3 for locations). Several specimens were collected and stored in the "Koninklijk Belgisch Instituut voor Natuurwetenschappen" without further examination. These specimens have been re-examined for this paper.

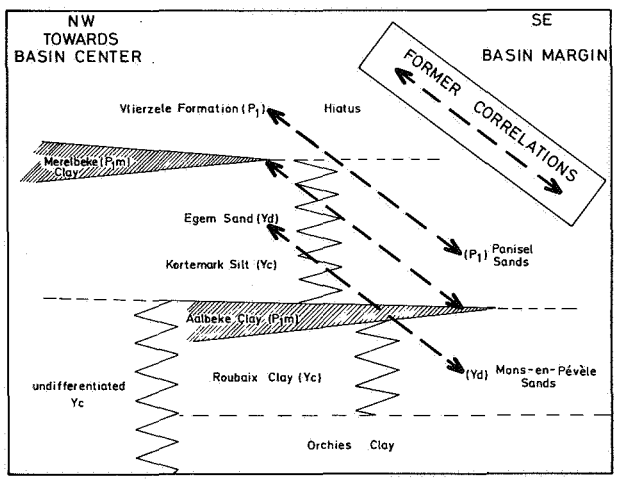

Fig. 1
Simplified correlation scheme for the Belgian Ypresian deposits, compared to the correlations used for the establishment of the Belgian geological map (after STEURBAUT & NOLF, 1986)

A fairly rich otolith fauna of more than 2000 specimens, together with various other fish remains, were collected in 1970 by QUINET, COUPATEZ & WOUTERS in a small outcrop some 13 km northeast of Tournai (Montrœul-au-Bois outcrop). The otolith fauna was not studied by these authors, although 10 unnamed specimens were figured (QUINET *et al.*, 1970, pl. II). The Montrœul-au-Bois material is included in the present study.

The first intensive study of Ypresian otoliths was carried out by NOLF (1971). Two superimposed shell-beds within the Roubaix Clay in the E17 motorway cutting at Kortrijk were sampled, which led to the recognition of 15 otolith-based teleost species. Their stratigraphic significance was discussed in a subsequent paper on the fish fauna of the Middle Eocene Den Hoorn Formation (NOLF, 1973).

In 1974, the Ypresian otoliths of the Belgian Basin were revised in a general faunistic and biostratigraphic study of otolith-based teleosts from the Belgian Eocene (NOLF, 1974, Ph. D. thesis). References to this paper are not cited here because it is doubtful if this mimeographed document can be considered as a publication in the sense of recommendation 8a of the International Code of Zoological Nomencalture.

During the last decade the investigation of Ypresian otoliths has been continued by the present authors, with the help of various other collectors.

GENERAL COMMENTS ON YPRESIAN STRATIGRAPHY

The Ypresian is one of the best studied and internationally accepted stages of the Belgian Tertiary. Its stratigraphy was reviewed by STEURBAUT and NOLF (1986) using calcareous nannoplankton from 50 outcrop and borehole sections. The Ypresian is

considered by STEURBAUT and NOLF (1986, fig. 10) as the time-interval during which all the deposits between the base of the Ieper Clay auct. and the top of the Aalterbrugge Lignitic Horizon (*sensu* HACQUAERT, 1939) were deposited. The deposition of this sequence is believed to have taken place within 6 M.Y., between 51 and 45 million years according to CURRY & ODIN (1982), and between 58 and 52 M.Y. according to BERGGREN *et al.* (1985).

Through detailed lithostratigraphic analysis and calcareous nannoplankton investigation it has been proved that the previously accepted correlations within the Ypresian, used for the establishment of the Belgian geological map, were erroneous (see STEURBAUT & NOLF, 1986, fig. 1; see also Fig. 1 in the present paper). The nummulitic sands from the southern part of the basin (= Mons-en-Pévèle Sand Member), and the overlying stiff clay (= Aalbeke Clay Member) and clayey sand (= Panisel Sand Member) are older and unconnected with their supposed equivalents from northern Belgium, (successively the nummulitic sand at Egem and around Gent (= Egem Sand Member); the stiff clay at Merelbeke (= Merelbeke Clay Member) and the sandy clay to clayey sand at Pittem and Vlierzele (= Vlierzele Formation) (see Fig. 2).

Two formations were distinguished by STEURBAUT and NOLF (1986): a lower Ieper Formation and an upper Vlierzele Formation. The Ieper Formation includes a lower clayey sequence (ascending: Orchies Clay, Roubaix Clay and Aalbeke Clay Members); a middle silty to sandy part (Kortemark Silt and Egem Sand Members) and an upper stiff clay (Merelbeke Clay Member). To the East, the Roubaix Clay Member is represented by its sandy equivalent, the Mons-en-Pévèle Sand Member, whereas the silty to sandy middle part (Kortemark Silt and Egem Sand Members) is replaced by a heterogeneous sand-clay unit with numerous sandstone bands, the Panisel Sand Member (see Fig. 2).

The Vlierzele Formation consists of a locally developed lower clayey to silty part, the Pittem Clay Member, and of yellowish green to grey glauconitic sand with sandstone bands.

Through closely spaced sampling and investigation a very detailed calcareous nannofossil zonation was established and correlated with MARTINI's (1971) standard calcareous nannofossil zonation (STEURBAUT & NOLF, 1986). Eleven units were recognised: units I, II and IIIa were assigned to zone NP11, units IIIb, IV, V, VI, VII and VIII to zone NP12, units IX and X to NP13 and unit XI to NP14. Subsequently STEURBAUT (1988a) demonstrated that most of these nannoplankton-events are recognisable in middle to high latitudes of the northern hemisphere, allowing a very high resolution biostratigraphy.

The Ypresian deposits of the Belgian Basin have also been the subject of other important biostratigraphic investigations. For a general discussion on these investigations the reader should consult WILLEMS, BIGNOT & MOORKENS (1981) and WILLEMS (1982). The literature on the Ypresian fauna and flora was also listed by STEURBAUT and NOLF (1986, p. 119).

DESCRIPTION OF SAMPLE LOCALITIES

The sample localities are listed alphabetically (see Fig. 3 for locations). The stratigraphic position of each sample is given. Species lists are added, with indications, in parentheses, of the number of specimens encountered.

1. Exposures

AALBEKE, Kobbe clay pit (also known as clay pit Vermeulen); map-sheet 29/5; coordinates: x = 68.450, y = 164.300.

Provenance of samples and stratigraphy: 2 otoliths of *Glyptophidium polli* were collected by the late Dr. W. WILLEMS at approximately 3.50 m below surface; Aalbeke Clay Member, Ypresian (see STEURBAUT & NOLF, 1986: 134, fig. 3).

BAILLEUL, brickyard Dubois & Fils (northwestern France); map-sheet 28/5; coordinates: x = 35.625, y = 159.375.

Provenance of samples and stratigraphy: a sample of about 70 kg was collected in the lowermost part of the section; Roubaix Clay Member, Ypresian (see STEURBAUT & NOLF, 1986: 135, fig. 4).

Otoliths: 12 species; *Pterothrissus angulatus* (2), "genus Heterenchelyidarum" *circularis* (2), "genus Congridarum" *validus* (8); *Palaeogadus serratus* (2), *Ampheristus toliapicus* (4), *Glyptophidium polli* (± 650), *Oligopus argutus (13)*, *Centroberyx eocenicus* (12), *Apogon glaber* (37), *Spicara minsterensis* (7), *Xenistius pulcher* (1) and *Cepola* sp. (2).

EGEM, Ampe clay pit-sand pit (Fig. 4); map-sheet 21/1; coordinates: x = 70.150, y = 190.150.

Provenance of samples and stratigraphy: six samples have been studied; the lowermost one was taken by the authors from bed IV of the Kortemark Silt Member, at 1 m above the base of the quarry, in 1987 (= sample a; ± 100 kg) (see STEURBAUT, 1988b, fig. 7); the overlying samples were collected in the Egem Sand Member (see Fig. 4 for locations, see also STEURBAUT, 1988b, fig. 7): sample b from coquina Fo, at the base of bed 4 (± 100 kg collected by the authors), sample c from bed 9 (collected by VAN HINSBERGH), sample d from bed 12 (collected by CROCHARD and by HOVESTADT), sample e from coquina FI (= bed 13) and sample f from coquina FII (= bed 21) (samples e and f of about 1000 kg each were collected by D. NOLF).

Otoliths: the samples from the Egem Sand Member yielded almost identical otolith-associations; 31 species were recognised, among which: *Albula incurvata* (4), *Pterothrissus angulatus* (36), *Pterothrissus protensus* (1), "genus Heterenchelyidarum" *circularis* (2), *Muraenesox cymbium* (1), *Gnathophis schepdaalensis* (1), *Paraconger papointi* (600), "genus Congridarum"

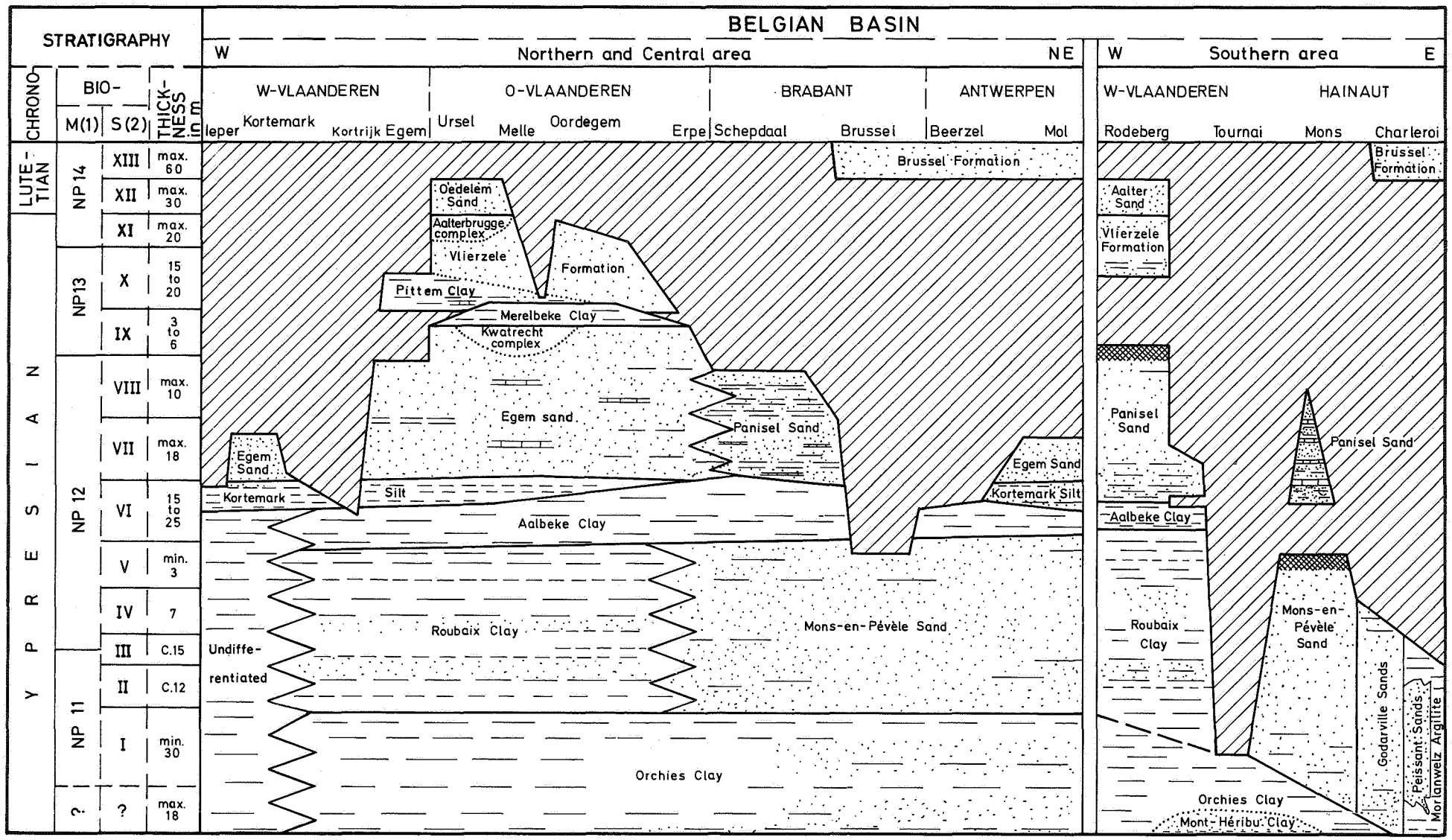

Fig. 2
Correlation of the litho- and biostratigraphic subdivisions of the Ypresian in the Belgian Basin (after STEURBAUT & NOLF, 1986; (1) = MARTINI, 1971; (2) = STEURBAUT in STEURBAUT & NOLF, 1986)

validus (1), "genus Congridarum" *diagonalis* (178), *Palaeogadus serratus* (2), "genus Merlucciinarum" *elegans* (3), *Ampheristus* aff. *lerichei* (1), *Ampheristus* sp. (2), "genus aff. *Sirembo*" *convexus* (9), "genus Sirembinorum" *tumidus* (11), "genus Neobythitinorum" *angustus* (26), "genus Neobythitinorum" *longissimus* (5), "genus Neobythitinorum" *subregularis* (± 1200), "genus Neobythitinarum" *dimidiatus* (1), *Centroberyx eocenicus* (1), *Antigonia angusta* (9), *Platycephalus janeti* (122), "genus Serranidarum" sp. (14), *Apogon* sp. (122), *Lactarius amplus* (2), *Isacia gibbosa* (122), *Xenistius pulcher* (76), "genus Pomadasyidarum" *kokeni* (31), *Cepola* sp. (1), *Trachinus* sp. (1) and *Psettodes* sp. (6).

The lowermost sample from the Kortemark Silt Member contains 12 species: *Pterothrissus angulatus* (1), *Gnathophis schepdaalensis* (1), *Paraconger papointi* (2), "genus aff. *Pseudophichthys*" *guttulus* (2), "genus Congridarum" *validus* (1), "genus Neobythitinorum" *subregularis* (± 100), *Platycephalus janeti* (1), "genus Serranidarum" sp. (2), *Apogon* sp. (6), *Xenistius pulcher* (1) "genus Pomadasyidarum" *kokeni* (2) and *Cepola* sp. (3).

EGEM, village centre; map-sheet 21/1; coordinates: x = 72.120, y = 189.875.

Provenance of samples and stratigraphy: one sample of about 500 kg was taken from the Egem and Member.

Otoliths: 8 species were recognised: *Pterothrissus angulatus* (3), "genus Congridarum" *diagonalis* (4), *Paraconger papointi* (15), "genus Neobythitinorum" *longissimus* (8), "genus Neobythitinorum" *subregularis* (35), *Apogon* sp. (7), *Isacia gibbosa* (13) and *Xenistius pulcher* (5).

EGEM, Ringbeek; map-sheet 21/1; coordinates: x = 73.120, y = 192.000.

Provenance of samples and stratigraphy: a sample of about 1.500 kg was taken from the Egem Sand Member in a pit at the bottom of a drained pond, along the River Ringbeek.

Otoliths: the assemblage is almost identical to these from the Ampe quarry, although less rich; 9 species: *Pterothrissus angulatus* (10), "genus Congridarum" *diagonalis* (29), *Paraconger papointi* (60), "genus Neobythitinorum" *angustoides* (1), "genus Neobythitinorum" *longissimus* (4), "genus Neobythitinorum" *subregularis* (185), *Platycephalus janeti* (3), *Apogon* sp. (9) and *Isacia gibbosa* (89).

ELLEZELLES, map-sheet 30/5; coordinates: x = 102.375, y = 158.950.

Provenance of samples and stratigraphy: a single specimen of *Glyptophidium polli* was found in a road cutting, exposing greenish, glauconitic sandy clay with sandstone fragments and *Nummulites planulatus*; ? Panisel Sand Member.

HALLUIN, clay pit, now abandoned and filled in (northern France); map-sheet 28/8; coordinates: x = 61.300, y = 163.400; "cartes topographiques de France", 1/50.000; map-sheet XXV-3 (Halluin); coordinates: x = 174.110, y = 451.750.

Provenance of samples and stratigraphy: 2 samples have been collected by D. NOLF in 1972; the lowermost one was taken somewhere in the middle of the section, in the uppermost part of bed 1 of

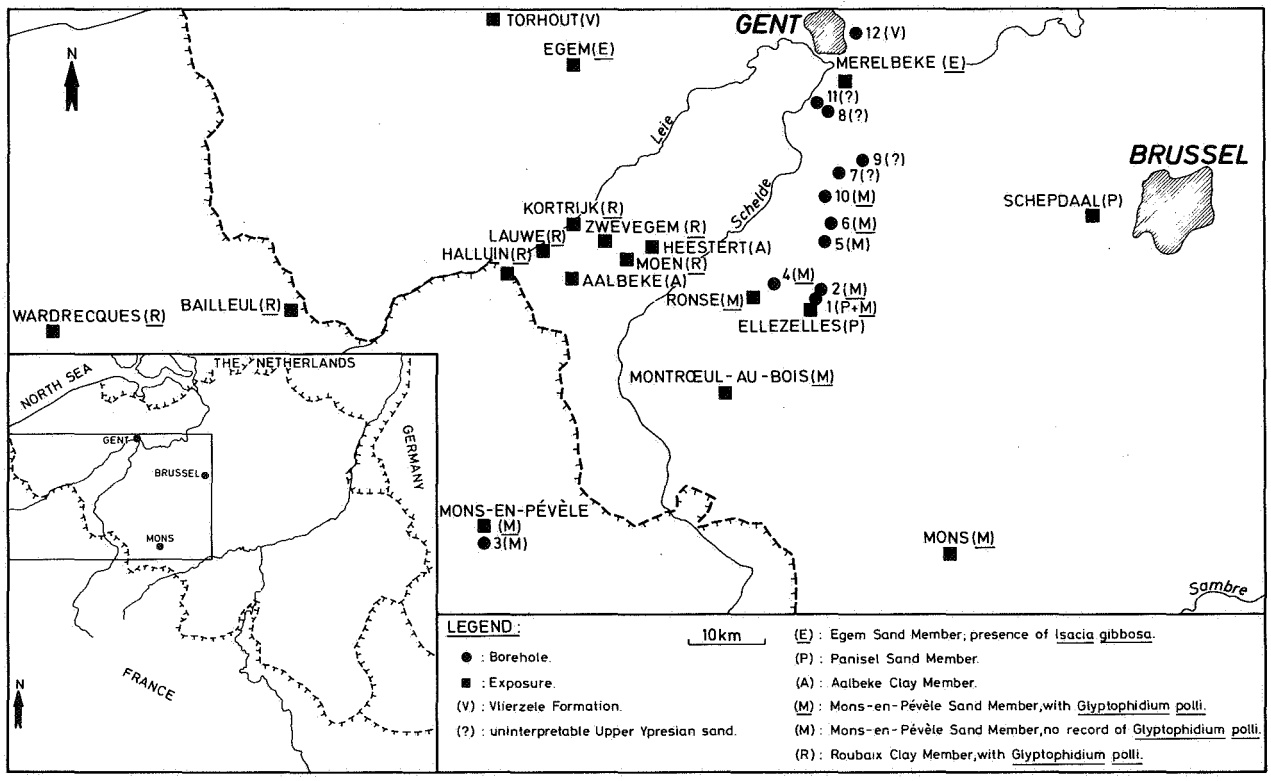

Fig. 3. Location of sampled sites.

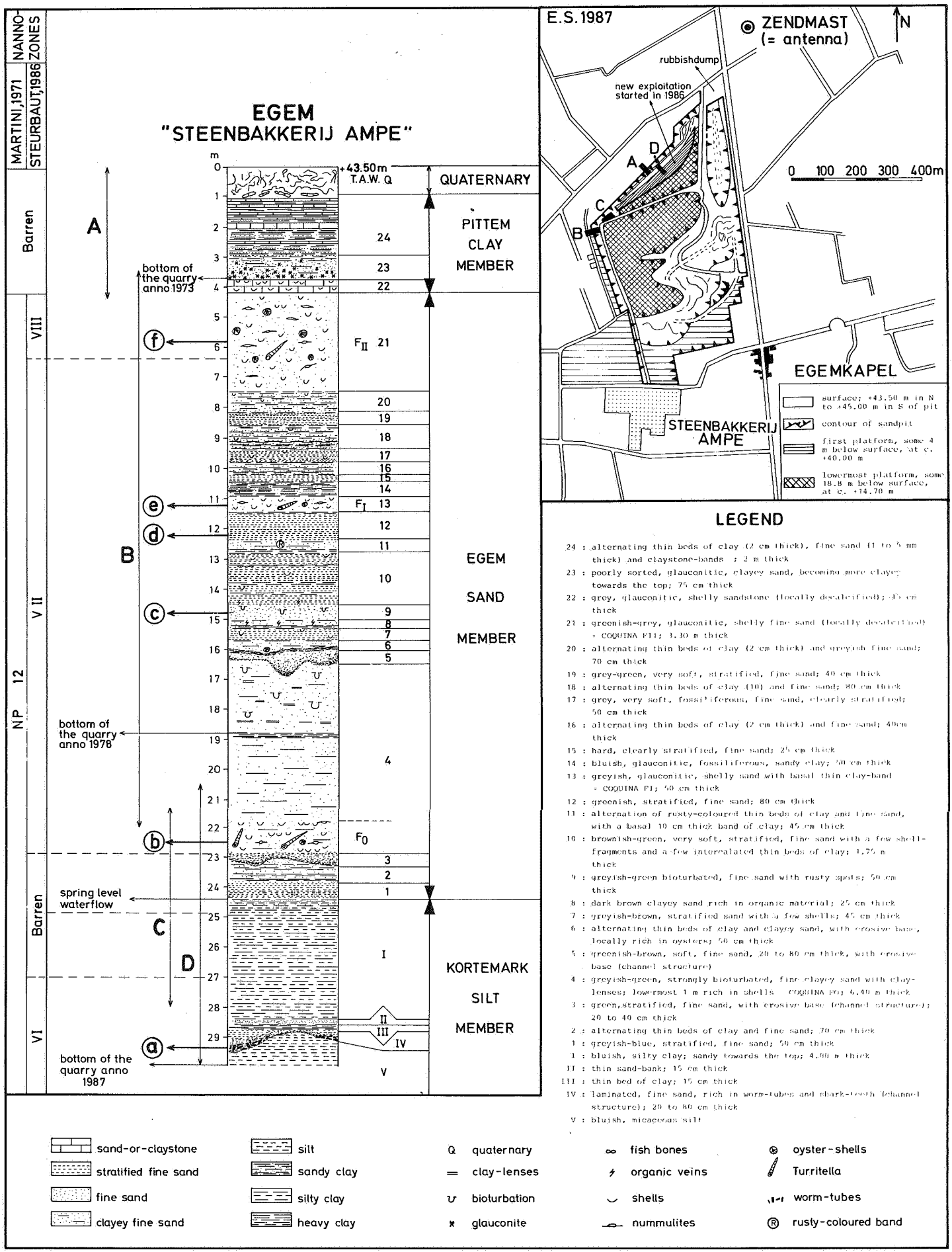

Fig. 4. Location of otolith samples (a to f) in the Egem Sand quarry (after STEURBAUT, 1988b).

DELATTRE *et al.*, 1973 (sample quantity: c. 100kg); the uppermost sample was taken on top of bed 1, about 1.50m above the first one (sample quantity: c. 50kg).

Otoliths: 9 species, "genus Congridarum" *validus* (1), "genus Neobythitinorum" *longissimus* (1), *Glyptophidium polli* (numerous specimens), *Ampheristus toliapicus* (14), "genus Neobythitinorum" *angustus* (1), *Centroberyx eocenicus* (14), "genus Serranidarum" *striatus* (1), *Apogon glaber* (1) and *Spicara minsterensis* (16).

HEESTERT, clay pit in "Kwadestraat": map-sheet 29/6; coordinates: x = 80.550, y = 165.550.

Provenance of samples and stratigraphy: no otoliths were encountered in the Aalbeke Clay Member; for more details see STEURBAUT & NOLF, 1986: 138, fig. 3.

KORTRIJK, E17 motorway cutting; map-sheet 29/5, coordinates: x = 73.860, y = 167.670.

Provenance of samples and stratigraphy: a sample of about 150kg was taken by one of the authors (D. NOLF) at 7.50m below surface; Roubaix Clay Member, Ypresian.

Otoliths: 10 species; *Pterothrissus angulatus* (1), "genus Congridarum" *validus* (2), *Palaeogadus serratus* (1), "genus Dinematichthyinorum" *symmetricus* (1), *Glyptophidium polli* (numerous specimens), *Ampheristus toliapicus* (7), *Centroberyx eocenicus* (18), "genus Serranidarum" *striatus* (1), *Apogon glaber* (19) and *Spicara minsterensis* (8).

LAUWE, clay pit, now filled in; map-sheet 29/5; coordinates: x = 68.000, y = 165.100.

Provenance of samples and stratigraphy: a small sample of about 30kg was taken from the Roubaix Clay Member.

Otoliths: 5 species; *Glyptophidium polli* (numerous specimens), *Ampheristus toliapicus* (3), *Centroberyx eocenicus* (2), *Apogon glaber* (4) and *Spicara minsterensis* (3).

MERELBEKE, construction pit of a new lock on the Ringvaart Canal; map-sheet 22/2; coordinates: x = 106.600, y = 188.850.

Provenance of samples and stratigraphy: the samples were taken from the Egem Sand Member, including new material collected by one of the authors (D. NOLF), and from collections of the "Koninklijk Belgisch Instituut voor Natuurwetenschappen, Brussel".

Otoliths: 13 species: *Pterothrissus angulatus* (1), "genus Congridarum" *diagonalis* (numerous specimens), *Paraconger papointi* (14), "genus Neobythitinorum" *longissimus* (40), "genus Neobythitinorum" *subregularis* (5), "genus Sirembinorum" *tumidus* (1), "genus Neobythitinorum" *angustus* (3), *Platycephalus janeti* (numerous specimens), *Apogon* sp. (6), "genus aff. *Sirembo*" *convexus* (1), *Xenistius pulcher* (3), *Isacia gibbosa* (5) and *Psettodes* sp. (1).

MOEN, west bank of the Bossuit Canal, map-sheet 29/6; coordinates: x = 79.775, y = 164.725.

Provenance of samples and stratigraphy: 2 samples were taken from the Roubaix Clay Member at respectively 0.80m and 5m above the level of the towpath (see STEURBAUT & NOLF, 1986: fig. 3).

Otoliths: both associations are almost identical; 23 species have been identified: "genus Osteoglossidarum" *rhomboidalis* (2), *Pterothrissus angulatus* (3), "genus Heterenchelyidarum" *circularis* (2), "genus aff. *Conger*" sp. (4), *Hildebrandia eocenica* (258), "genus aff. *Pseudophichthys guttulus* (17), "genus Congridarum" *validus* (9), *Argentina* sp. (1), "genus Gadidarum" *eocenicus* (1), *Ampheristus toliapicus* (32), *Glyptophidium polli* (± 820), "genus Sirembinorum" *arcuatus* (4), "genus Neobythitinorum" *angustus* (15), "genus Neobythitinarum" *gossei* (17), *Oligopus argutus* (24), *Centroberyx eocenicus* (30), *Holocentrus sheppeyensis* (6), "genus Serranidarum" *striatus* (1), *Apogon glaber* (3), *Spicara minsterensis* (8), *Xenistius pulcher* (3), "genus Pomadasyidarum" *ovalis* (2) and *Cepola* sp. (30).

MONS, localisation unknown.

Provenance of samples and stratigraphy: collections from the "Koninklijk Belgisch Instituut voor Natuurwetenschappen"; Mons-en-Pévèle Sand Member.

Otoliths: 11 species; *Paranger papointi* (29), "genus aff. *Pseudophichthys*" *guttulus* (3), "genus Congridarum" *validus* (1), *Glyptophidium polli* (numerous specimens), *Ampheristus toliapicus* (5), "genus Neobythitinorum" *angustus* (4), *Platycephalus janeti* (1), *Antigonia angusta* (4), *Spicara minsterensis* (1), "genus Pomadasyidarum" *ovalis* (27) and *Trachinus* sp. (3).

MONS-EN-PEVELE (Northern France); "cartes topographiques de France, 1/50.000"; map-sheet XXV-5 (Carvin); coordinates: x = 653.915, y = 1.309.925.

Provenance of samples and stratigraphy: outcrop in the type-locality of the Mons-en-Pévèle Sand Member.

Otoliths: two otoliths of *Glyptophidium polli* were found.

MONTROEUL-AU-BOIS: map-sheet 37/4; coordinates: x = 98.830, y = 148.370.

Provenance of samples and stratigraphy: a sample of about 800kg was taken by QUINET, COUPATEZ and WOUTERS from the Mons-en-Pévèle Sand Member (see QUINET, COUPATEZ & WOUTERS, 1970).

Otoliths: 7 species; *Pterothrissus angulatus* (1), *Paraconger papointi* (8), "genus Congridarum" *diagonalis* (numerous specimens), "genus Congridarum" *validus* (2), *Glyptophidium polli* (numerous specimens), *Ampheristus toliapicus* (28) and *Spicara minsterensis* (4).

RONSE, Waaienberge (Fig. 5), old railway-cutting; map-sheet 30/5; coordinates: x = 98.525, y = 159.000.

Provenance of samples and stratigraphy: 4 samples from the Mons-en-Pévèle Sand Member have been

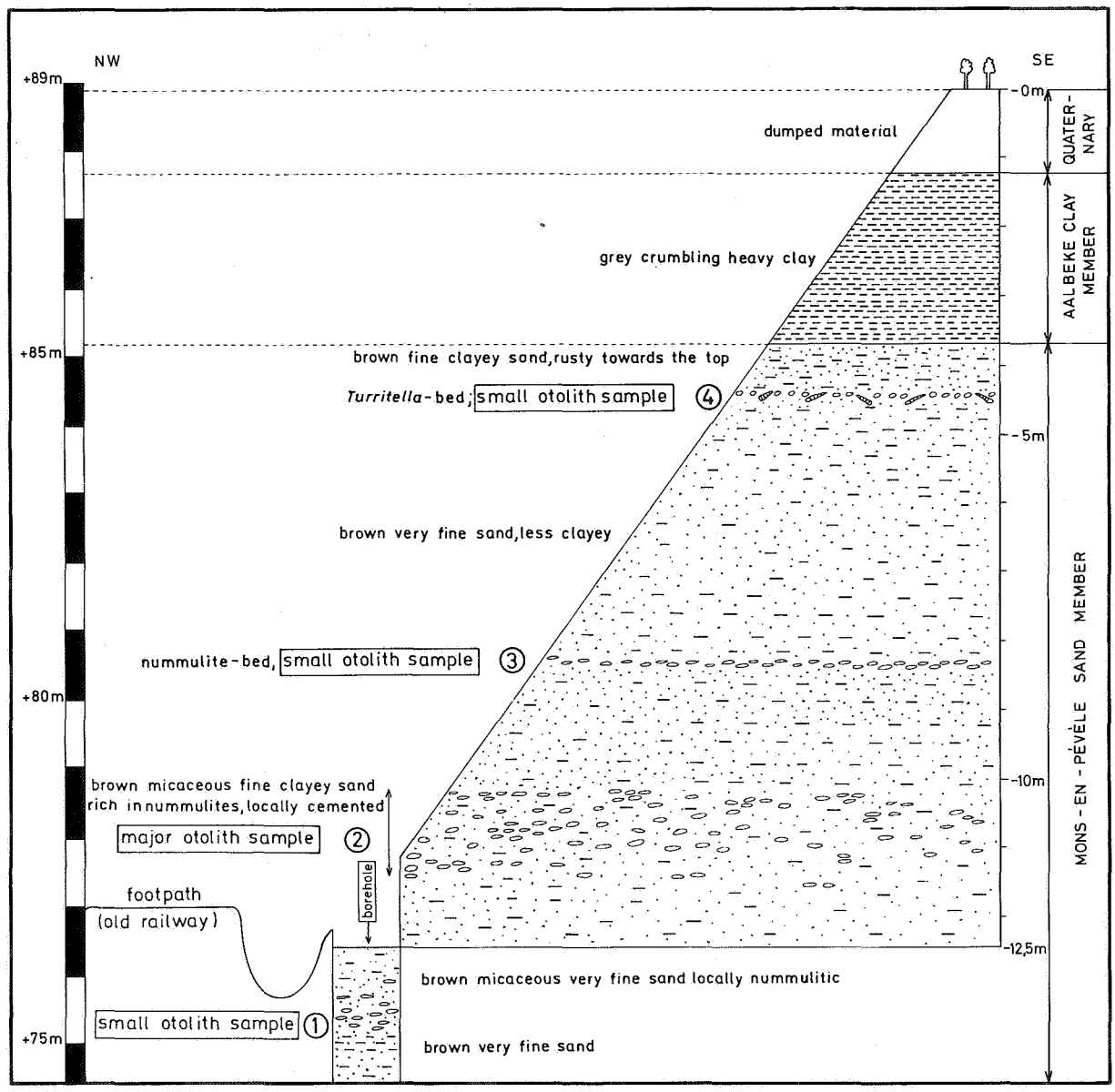

Fig. 5. Stratigraphy of the Ieper Formation in the Waaienberge section (old railway cutting) at Ronse and location of otolith samples.

studied; the major part of the material was collected from a nummulitic bed, some 2 m above the footpath.

Otoliths: the associations from the 4 studied samples are almost identical; 15 species have been identified: "genus Osteoglossidarum" *rhomboidalis* (3), *Albula incurvata* (3), "genus Heterenchelyidarum" *circularis* (2), "genus aff. *Pseudophichthys*" *guttulus* (1), "genus Congridarum" *validus* (1), "genus Gadidarum" *eocenicus* (1), *Ampheristus toliapicus* (144), *Glyptophidium polli* (±3000), "genus Neobythitinorum" *longissimus* (1), "genus Neobythitinorum" *subregularis* (28), *Centroberyx eocenicus* (23), *Platycephalus janeti* (3), *Apogon glaber* (15), *Spicara minsterensis* (80) and *Xenistius pulcher* (4).

SCHEPDAAL, railway cutting; map-sheet 31/2; coordinates: x = 139.000, y = 169.650.

Provenance of samples and stratigraphy: glauconitic clayey sands of the Panisel Sand Member were sampled by Dr. J. HERMAN in 1975 during works on the northern slope of the railway cutting.

Otoliths: 19 species; *Pterothrissus angulatus* (1), *Gnathophis schepdaalensis* (21), *Paraconger papointi* (19), "genus Congridarum" *validus* (2), "genus Congridarum" *diagonalis* (2), "genus Merlucciinarum" *elegans* (1), "genus aff. *Sirembo*" *convexus* (42), *Glyptophidium polli* (29), "genus Neobythitinorum" *longissimus* (1), "genus Neobythitinorum" *subregularis* (10), *Centroberyx eocenicus* (1), *Antigonia angusta* (1), *Platycephalus janeti* (1), *Apogon* sp. (10), *Lactarius amplus* (1),

Xenistius pulcher (18), "genus Pomadasyidarum" *kokeni* (41), "genus Sparidarum" sp. (3) and *Trachinus* aff. *falcatus* (1).

TORHOUT, railway cutting; map-sheet 20/4; coordinates: x = 62.525, y = 197.550.

Provenance of samples and stratigraphy: a sample of about 200 kg was taken from the fossiliferous clayey sands of the Pittem Clay Member.

Otoliths: 9 species, "genus Heterenchelyidarum" *circularis* (1), *Paraconger papointi* (2), "genus Congridarum" *diagonalis* (1), "genus Neobythitinorum" *angustoides* (5), "genus Neobythitinorum" *subregularis* (19), *Apogon* sp. (43), *Xenistius pulcher* (1), "genus Pomadasyidarum" *kokeni* (9) and *Psettodes* sp. (2).

WARDRECQUES (Northern France); "cartes topographiques de France", 1/50.000: map-sheet XXIII-4; coordinates: x = 334.500, y = 602.500.

Provenance of samples and stratigraphy: a sample of about 30 kg was taken from the Roubaix Clay Member.

Otoliths: 3 species; *Hildebrandia eocenica* (1), *Glyptophidium polli* (2) and two unidentified apogonids.

ZWEVEGEM, Knokke clay pit, actually filled in; map-sheet 29/6; coordinates: x = 78.800, y = 165.900.

Provenance of samples and stratigraphy: a sample of about 30 kg was taken from a sandy clay with *Nummulites planulatus*; Roubaix Clay Member.

Otoliths: 2 species, *Hildebrandia eocenica* (3) and *Glyptophidium polli* (several specimens).

2. Boreholes

A. AUGER BORINGS:

1. *Ellezelles*, Hainaut
   map-sheet 30/5; x = 102.375, y = 158.950; +87.50 m
   0.00-0.75 m: clayey sands of the Panisel Sand Member, nummulitic sandstone fragments on top;
   0.75-1.00 m: rusty very fine sand of the Mons-en-Pévèle Sand Member.

2. *Flobecq*, Hainaut
   map-sheet 30/5; x = 104.600, y = 160.400; +75 m
   0.00-0.50 m: Quaternary;
   0.50-2.80 m: very fine sand of the Mons-en-Pévèle Sand Member, locally nummulites and otoliths.

3. *Mons-en-Pévèle* (Northern France); "cartes topographiques de France", 1/50.000: map-sheet 25/05 (Carvin); x = 653.410, y = 1.309.625; +100 m
   0.00-0.50 m: Quaternary;
   0.50-1.00 m: brown very fine sand of the Mons-en-Pévèle Sand Member, locally highly nummulitic.

B. BORINGS WITH WATER-INJECTION:

4. *Ronse*, Oost-Vlaanderen
   map-sheet 30/5; x = 99.500, y = 161.250; +75 m
   0.00-9.50 m: Quaternary;
   9.50-11.00 m: grey clayey sand of theMons-en-Pévèle Sand Member; rich in *Nummulites planulatus* and otoliths (including *Glyptophidium polli*).

5. *Schorisse*, Oost-Vlaanderen
   map-sheet 30/5; x = 102.600, y = 166.350; +55 m
   0.00-5.80 m: Quaternary;
   5.80-8.00 m: green clayey sand of the Mons-en-Pévèle Sand Member, rich in shells and nummulites.

6. *Zegelsem*, Oost-Vlaanderen
   map-sheet 30/1; x = 104.050, y = 168.175; +50 m
   0.00-2.90 m: Quaternary;
   2.90-6.00 m: greenish clayey sand of the Mons-en-Pévèle Sand Member, with *N. planulatus* and otoliths (including *G. polli*).

7. *Munkzwalm*, Oost-Vlaanderen
   map-sheet 30/1; x = 104.925, y = 175.175; +25 m
   0.00-5.00 m: Quaternary;
   5.00-6.00 m: greenish glauconitic clayey fine sand; Upper Ypresian sand of uncertain relationship.

8. *Melsen*, Oost-Vlaanderen
   map-sheet 22/5; x = 102.875, y = 182.650; +20 m
   0.00-7.10 m: Quaternary;
   7.10-11.00 m: greenish, glauconitic, clayey fine sand; Upper Ypresian sand of uncertain relationship.

9. *Velzeke*, Oost-Vlaanderen
   map-sheet 30/2; x = 108.025, y = 177.900; +51.50 m
   0.00-0.75 m: Quaternary;
   0.75-1.00 m: greenish, glauconitic, micaceous fine sand; Upper Ypresian sand of uncertain relationship.

10. *St-Denijs-Boekel*, Oost-Vlaanderen
    map-sheet 30/1; x = 103.950, y = 173.800; +27 m
    0.00-4.00 m: Quaternary;
    4.00-10.50 m: greyish green fine sand of the Mons-en-Pévèle Sand Member, rich in *Nummulites planulatus* and otoliths (including *Glyptophidium polli*).

11. *Vurste*, Oost-Vlaanderen
    map-sheet 22/5; x = 102.625, y = 182.325; +14.50 m
    0.00-7.70 m: Quaternary;
    7.70-13.00 m: greyish clayey fine sand; Upper Ypresian sand of uncertain relationship.

12. *Gentbrugge*, Oost-Vlaanderen
map-sheet 22/2; x = 108.325, y = 192.275; + 5 m
0.00-9.00 m: Quaternary;
9.00-10.00 m: glauconitic clayey sand of the Vlierzele Formation.

DESCRIPTION OF NEW, RARE OR POORLY KNOWN SPECIES

A list of all otolith-based teleost species from the Belgian Ypresian is given in Table 1, showing their distribution in the various units investigated.

The classification adopted here is that used by NOLF (1985). This classification is basically that of GREENWOOD, ROSEN, WEITZMAN & MYERS (1966), with many subsequent modifications cited by NOLF (1985, p. 34).

In order to keep the descriptive part as concise as possible, we decided to furnish only drawings of all cited species (except for the poorly preserved *Argentina* sp. from the Roubaix Clay), and sometimes of Recent species on which our generic identification was based. Additional descriptions and comments are given only for new species or for those subject to discussion.

"genus Osteoglossidarum" *rhomboidalis* (STINTON, 1977)

(Pl. 1, Fig. 1)

1977 *Polymixia? rhomboidalis* sp. nov. - STINTON, p. 86, pl. 6, fig. 12;
1988 "genus Osteoglossidarum" *rhomboidalis* (STINTON, 1977) - NOLF, p. 32, pl. 1, fig. 1.

Material and sample localities. — 5 otoliths. Roubaix Clay Member (Moen: 2); Mons-en-Pévèle Sand Member (Ronse: 3).

Discussion. — These otoliths were tentatively attributed to the genus *Polymixia* LOWE, 1836 by STINTON (1977), because of a certain similarity in outline. Most characteristics, however, refer to the family of the Osteoglossidae: presence of a rather wide, supramedial sulcus; ostial and caudal part of the sulcus are of the same height and separated by a shallow notch in the crista inferior and, presence of an angular fold along the crista inferior on the inner face. The latter characteristic, which can be best observed in dorso-ventral sections (see Pl. 1, Fig. 1b), is typical of the Osteoglossidae. See Pl. 1, Figs. 2, 3 and 4 for illustrations of otoliths of the Recent species *Heterotis niloticus* HEMPRICH & EHRENBERG, 1828; *Arapaima gigas* (CUVIER, 1817) and *Osteoglossum bicirrhosum* AGASSIZ, 1829.

Geographic and stratigraphic distribution. — Only known from the Ypresian: England (London Clay), Aquitaine (Gan Clay), Belgium (Roubaix Clay and Mons-en-Pévèle Sand Members).

Albula incurvata STINTON, 1975

(Pl. 1, Fig. 5)

1975 *Albula bartonensis* FROST, 1933 - NOLF, p. 145, pl. , fig. 2;
1975 *Albula incurvata* sp. nov. - STINTON, p. 28, pl. 1, fig. 8a, b.

Material and sample localities. — 6 otoliths. Mons-en-Pévèle Sand Member (Ronse: 3); Egem Sand Member (Egem: 3).

Discussion. — Several otoliths from the Belgian Eocene were initially attributed to *Albula bartonensis* FROST, 1933 by NOLF (1975). However, subsequent investigation by this author has shown that the holotype of *A. bartonensis* is strongly eroded, preventing any significant identification, and that, therefore, this species has to be rejected (NOLF, 1985, p. 122). The Ypresian material is similar to the holotype of the Late Eocene *Albula incurvata* STINTON, 1975. This species is known from various Middle and Late Eocene outcrops of the North Sea Basin. Its occurrence in the Belgian Ypresian represents the earliest record of the species.

"genus Heterenchelyidarum" *circularis* (SHEPHERD, 1916)

(Pl. 1, Figs. 12-14)

1916 *Otolithus* (Apogonidarum) *circularis* - SHEPHERD, p. 181, fig. 154, 3 (two lowermost specimens only);
1934 *Otolithus (Solea) bartonensis* n. sp. - FROST, p. 503, pl. XIV, fig. 11.
1971 *Solea* sp. - NOLF, p. 18, pl., fig. 22;
1975 "genus Soleidarum" *circularis* SHEPHERD-NOLF, p. 149.

Material and sample localities. — 7 otoliths. Roubaix Clay Member (Bailleul: 2, Moen: 2); Mons-en-Pévèle Sand Member (Ronse: 2); Pittem Clay Member (Torhout: 1).

Discussion. — The four syntypes described and figured by SHEPHERD (1916, p. 1181, fig. 154, 3) as *Otolithus* (Apogonidarum) *circularis* belong to two different species (see NOLF, 1975: 149). The two lowermost specimens of the figured series resemble *Panturichthys mauritanicus* PELLEGRIN, 1913, a Recent East-Atlantic heterenchelyid species (Pl. 1, Fig. 18), and are therefore, attributable to this family, and not to soleids as suggested previously. The two uppermost ones are strongly eroded and belong to an unidentifiable species of the genus *Centroberyx*. One of the lowermost specimens, re-figured here on Pl. 1, Fig. 14, was designated by NOLF (1975) as lectotype.

Geographic and stratigraphic distribution. — Belgian Basin: Roubaix Clay and Mons-en-Pévèle Sand Members, Brussel Formation; England: Barton Beds.

Muraenesox cymbium STINTON, 1966

(Pl. 1, Fig. 11)

1966 *Muraenesox cymbium* sp. nov. — STINTON, p. 424, pl. 66, fig. 13.
non 1971 *Muraenesox cybium* STINTON, 1960 - NOLF, p. 12, Pl., 2.

Material and sample localities. — 1 otolith. Egem Sand Member (Egem: 1).

Discussion. — This specimen is somewhat shorter and higher than STINTON's holotype. It seems,

however, that these small differences are attribuable to intraspecific variability. The three eroded specimens from the Roubaix Clay Member at Kortrijk described by NOLF (1971) as *Muraenesox cybium* do not belong to this species, but to "genus Congridarum" *validus* (STINTON, 1966).

Geographic and stratigraphic distribution. — Ypresian of the Belgian Basin and London Clay.

Gnathophis schepdaalensis n. sp.
(Pl. 2, Figs. 1-5)

Material and sample localities. — 23 otoliths. Kortemark Silt Member (Egem: 1), Egem Sand Member (Egem: 1) and Panisel Sand Member (Schepdaal: 21).

Type-material. — Holotype: left otolith (Pl. 2, Fig. 1) (IRSNB P. 5168); 22 paratypes of which 4 are figured (Pl. 2, Fig. 2-5) (IRSNB P. 5169, P. 5170, P. 5171, P. 5172).

Dimensions of holotype. — Length: 3,9 mm; height: 2,4 mm; thickness: 1,0 mm.

Stratum typicum. — Panisel Sand Member at Schepdaal; Ypresian, Belgium.

Derivatio nominis. — *Schepdaalensis, -is, -e* = from the locus typicus Schepdaal.

Diagnosis. — These otoliths are characterised by an elongated oval outline with distinct postdorsal, anterodorsal and anteroventral angles and by the absence of a conspicuous depression in the dorsal area. The external face is convex lengthwise and straight to slightly convex dorsoventrally. It is smooth, but with undulose relief, and occasionally presents a shallow furrow in its posterior part. The inner face is strongly convex in both directions. The sulcus is relatively shallow and is subdivided in a narrow, slightly oblique cauda and a wider and somewhat deeper ostium. Collicula are present.

Discussion. — The specimens show close affinities with the Recent *Gnathophis mystax* (DELAROCHE, 1809) and *Gnathophis catalinensis* (WADE, 1946) (for illustrations see STEURBAUT, 1984, pl. 3, figs. 4-6) and are therefore, attribuable to this genus. They differ from *Hildebrandia eocenica* (SHEPHERD, 1916) (see Pl. 1, Figs. 19-24) in having a more elongated outline with well-developed anterodorsal and anteroventral angles and a much shallower depression in the dorsal area.

Hildebrandia eocenica (SHEPHERD, 1916)
(Pl. 1, Figs. 19-24)

Material and sample localities. — 262 otoliths. Roubaix Clay Member (Moen: 258; Wardrecques: 1; Zwevegem: 3).

Discussion. — These otoliths have many features in common with the Recent *Hildebrandia gracilior* (GINSBURG, 1951) (Pl. 1, Fig. 25) and *Hildebrandia flava* (GOODE & BEAN, 1896) (see NOLF & STEURBAUT, 1983, pl. 1, fig. 10) and may, therefore, be incorporated in the genus. They differ from *Gnathophis schepdaalensis* in having a more rounded outline and a relatively deep depression in the dorsal area. Its occurrence in the Belgian Ypresian represents the earliest record of this species.

Geographic and stratigraphic distribution. — Ypresian (Roubaix Clay Member) and Lutetian (Lede Formation, Meetjesland Formation) of the Belgian Basin; England: Bracklesham Beds and Barton Beds.

"genus aff. *Pseudophichthys*" *guttulus* (STINTON, 1975)
(Pl. 2, Figs. 6-9)

1975 *Promyllantor guttulus* sp. nov. - STINTON, 45, pl. 3;

1976 "genus aff. *Promyllantor*" sp. - NOLF & CAPPETTA, p. 255, pl. 1, fig. 13;

1979 "genus aff. *Pseudophichthys*" *guttulus* (STINTON, 1977) - NOLF & LAPIERRE, p. 88.

Material and sample localities. — 23 otoliths. Roubaix Clay Member (Moen: 17); Mons-en-Pévèle Sand Member (Mons: 3, Ronse: 1); Kortemark Silt Member (Egem: 2).

Discussion. — This is the first Ypresian record of a species which is regularly encountered in the Middle and Upper Eocene of the Anglo-Paris-Belgian Basin. Ypresian representatives of the species are not restricted to the Belgian Basin; we also have a series of 87 specimens from the London Clay at Shinfield. As the preservation of this material is much better than in the Belgian Ypresian, some of these London Clay specimens are figured here (Pl. 2, Figs. 6-8).

"genus Congridarum" *diagonalis* (STINTON & NOLF, 1970)
(Pl. 2, Figs. 15-17)

1970 *Gymnothorax diagonalis* sp. n. - STINTON & NOLF, p. 220, pl., fig. 3;

1975 *Gymnothorax thevenini* (PRIEM, 1906) - STINTON, 1975, p. 35, pl. 2, fig. 4;

1979 "genus? Ophichthyidarum" *diagonalis* STINTON & NOLF, 1970 - NOLF & LAPIERRE, p. 88;

1988 "genus Congridarum" *diagonalis* (STINTON & NOLF, 1970) - NOLF, p. 39, pl. 2, fig. 11 & 12.

Material and sample localities. — Mons-en-Pévèle Sand Member (Montrœul-au-Bois: numerous specimens); Egem Sand Member (Egem: 211; Merelbeke: numerous specimens); Panisel Sand Member (Schepdaal: 2); Pittem Clay Member (Torhout: 1).

Discussion. — See NOLF, 1988, p. 39 for comments on the morphology and relationship of this species.

Geographic and stratigraphic distribution. — Eocene of the Belgian Basin: from the Mons-en-Pévèle Sand Member to the Grimmertingen Sand Member; England: from the Wittering Formation

(Ypresian) to the Barton Beds (Bartonian); Paris Basin: known from the Cuise Sands, "Calcaire Grossier" and the Auvers Formation; Aquitaine Basin: known from the Gan Clay (Ypresian) and the Brihande Marls (Priabonian).

"genus Merlucciinarum" *elegans* (STINTON, 1977)

(Pl. 2, Fig. 11)

1977 *Raniceps elegans* sp. nov. - STINTON, p. 96, pl. 7, fig. 4a, b.

Material and sample localities. — 4 otoliths. Egem Sand Member (Egem: 3); Panisel Sand Member (Schepdaal: 1).

Discussion. — The relationships of this species were commented on by NOLF & STEURBAUT (1989, p. 98).

Geographic and stratigraphic distribution. — Ypresian and Lutetian of the Belgian Basin; Lutetian of Southern England.

"genus Gadidarum" *eocenicus* FROST, 1931

(Pl. 2, Figs. 12-14)

1925 *Otolithus (Solea) guestfalicus*, KOKEN - FROST, p. 161, pl. X, fig. 3 (non *guestfalicus* KOKEN).

1931 *Otolithus (Gadus) eocenicus* FROST, sp. nov. - FROST, p. 106, pl. , fig. 15.

1934 *Otolithus (Gadus) subnotus*, sp. n. - FROST, p. 500, pl. XIV, fig. 1.

1934 *Otolithus (Gadus) eocenicus* - FROST, p. 500, pl. XIV, fig. 2.

1957 *Gadus subnotus* FROST - STINTON, p. 19, pl. 2, fig. 5.

1965 *Microgadus eocenicus* (FROST in WHITE, 1931) - STINTON, p. 404, pl. 31, fig. 14 and pl. 33, fig. 41.

1966 *Microgadus eocenicus* (FROST) - STINTON, p. 428, pl. 66, figs. 18-19.

1977 *Microgadus subnotus* (FROST, 1934) - STINTON, p. 91, text-fig. 18e.

1985 "genus Gadidarum" *eocenicus* (FROST, 1931) - NOLF, p. 62.

1989 "genus Gadidarum" *eocenicus* (FROST, 1931) - NOLF & STEURBAUT, p. 108, fig. 12J-K.

Material and sample localities. — 2 otoliths. Roubaix Clay Member (Moen: 1); Mons-en-Pévèle Sand Member (Ronse: 1).

Discussion. — The relationships of "genus Gadidarum" *eocenicus* have been discussed in NOLF & STEURBAUT (1989, p. 108). This species, which is widely distributed in the London Clay, is very rare in the Belgian Ypresian and the available material is rather poorly preserved. Therefore, two additional London Clay specimens are figured here (Pl. 2, Fig. 12-13), to give a better idea of the otolith morphology in this species.

Geographic and stratigraphic distribution. — Ypresian of the Belgian Basin; Thanetian and Ypresian of Southern England.

Ampheristus sp.

(Pl. 2, Fig. 20)

Material and sample localities. — 2 otoliths, Egem Sand Member (Egem: 2).

Discussion. — These otoliths are attributable to the genus *Ampheristus* because of similarities with the type-species *A. toliapicus* (Pl. 2, Fig. 21). Both species, however, show substantial differences in outline and external face, which in *Ampheristus* sp. is strongly convex, both in dorso-ventral and antero-posterior directions. *Ampheristus* sp. also differs from *Ampheristus* aff. *lerichei* (STINTON & NOLF, 1970) (Pl. 2, Fig. 28) in having a less downturned cauda and in the configuration of the dorsal rim. It probably represents a new species, but having only two poorly preserved specimens, does not allow its nominal introduction.

"genus Neobythitinorum" *angustoides* n. sp.

(Pl. 3, Figs. 4-5)

Material and sample localities. — 6 otoliths. Egem Sand Member (Egem: 1); Pittem Clay Member (Torhout: 5).

Type-material. — Holotype: right otolith (Pl. 3, Fig. 4) (IRSNB P. 5201); 5 paratypes of which 1 is figured (Pl. 4, fig. 5) (IRSNB P. 5202).

Dimensions of holotype. — Length: 2,7 mm; height: 1,9 mm; thickness: 1,1 mm.

Stratum typicum. — Pittem Clay Member at Torhout, Vlierzele Formation, Ypresian, Belgium.

Derivatio nominis. — *Angustoides, -es, -e* = resembling *angustus*, refers to the resemblance and the close relationships of this species with "genus Neobythitinorum" *angustus* (STINTON, 1970).

Diagnosis. — These otoliths are characterised by a massive predorsal process, a flat to slightly concave external face and an undivided sulcus. The inner face is relatively convex. The anterior and posterior rims are rounded. The ventral furrow is well-developed and is close to the ventral rim. The sulcus, which shows no subdivision in ostium and cauda, is completely filled in with a single colliculum. It opens in the anterior rim through a narrow ostial canal.

Discussion. — This species is most closely related to "genus Neobythitinorum" *angustus*. Otoliths of the latter, however, have a well individualised cauda, a spinous posterior end and a less well-developed predorsal process. This new species also shows rather close relationships to otoliths of the Middle and Upper Eocene species "genus Neobythitinorum" *aequalis* (STINTON & NOLF, 1970), which however are markedly shorter and present a more pointed posterior end.

"genus Neobythitinarum" *gossei* n. sp.

(Pl. 2, Figs. 24-27)

Material and sample localities. — 17 otoliths. Roubaix Clay Member (Moen: 17).

Type-material. — Holotype: a right otolith (Pl. 2, Fig. 26) (IRSNB P. 5193); 16 paratypes of which 3 are figured (Pl. 2, Figs. 24, 25 and 27) (IRSNB P.5191, P.5192, P.5194).

Dimensions of the holotype. — Length: 7,8mm; height: 3,6mm; thickness: 1,6mm.

Stratum typicum. — Roubaix Clay Member at Moen, Ypresian, Belgium.

Derivatio nominis. — In honour of Ir. J. P. GOSSE, Koninklijk Belgisch Instituut voor Natuurwetenschappen, Brussel.

Diagnosis. — The otoliths of "genus Neobythitinarum" *gossei* are elongate, with sharp posterior and anterior ends. The dorsal rim is almost straight over most of its length. The ventral rim is uniformely curved. The external face is smooth, and almost flat, except for a central swelling. The inner face is convex in both directions. The sulcus is narrow and straight and is connected to the ostial rim by an ostial canal. It is subdivided in ostium and cauda. The ostium is twice as long as the cauda, which is slightly downturned. Collicula are present.

Discussion. — This species belongs to a fossil genus of the subfamily Neobythitinae, perhaps closely related to *Ampheristus*.

Centroberyx eocenicus (FROST, 1933)

(Pl. 3, Fig. 13)

Synonymy. — see NOLF, 1988, p. 69.

Material and sample localities. — 111 otoliths, Roubaix Clay Member (Bailleul: 12; Halluin: 14; Kortrijk: 18; Lauwe: 2; Moen: 30); Mons-en-Pévèle Sand Member (Ronse: 23; borehole 2: 2; borehole 6: 2; borehole 10: 6); Egem Sand Member (Egem: 1); Panisel Sand Member (Schepdaal: 1).

Discussion. — For comments on the morphology and taxonomy of this species see NOLF, 1988.

Geographic an stratigraphic distribution. — Known from various Ypresian outcrops of Europe: Belgium (throughout the Ieper Formation), England (London Clay), Aquitaine Basin (Gan Clay) and Paris Basin (Cuise Sands).

"genus Serranidarum" sp.

(Pl. 3, Figs. 26-28)

Material and sample localities. — 16 otoliths. Kortemark Silt Member (Egem: 2); Egem Sand Member (Egem: 14).

Discussion. — These otoliths differ from "genus Serranidarum" *striatus* (FROST, 1934) (Pl. 3, Figs. 16-17) in shape, especially in the configuration of the dorsal rim and in having a cauda which is more downturned posteriorly. They may represent a new species. However, better preserved material is required for specific identification.

Geographic and stratigraphic distribution. — Only known from the Ypresian of the Belgian Basin.

Apogon sp.

(Pl. 3, Figs. 20-21)

Material and sample localities. — 203 otoliths. Kortemark Silt Member (Egem: 6); Egem Sand Member (Egem: 138, Merelbeke: 6); Panisel Sand Member (Schepdaal: 10), Pittem Clay Member (Torhout: 43).

Discussion. — *Apogon* sp. differs from *Apogon glaber* STINTON, 1966 (Pl. 4, Figs. 1-2; see also NOLF, 1988, pl. 10, fig. 14-18) by its somewhat more elongate shape.

Geographic and stratigraphic distribution. — Only known from the Ypresian of the Belgian Basin.

Isacia gibbosa (STINTON, 1980)

(Pl. 4, Figs. 4-9)

1980 *Parapristipoma gibbosum* sp. nov. - STINTON, p. 254, Pl. 16, fig. 26a, b.

Material and sample localities. — 229 otoliths. Egem Sand Member (Egem: 224; Merelbeke: 5).

Discussion. — These otoliths have many characteristics in common with the Recent *Isacia conceptionis* (CUVIER, 1830) (Pl. 4, Figs. 17-18), but are considered distinct, being more compressed. There seems to be only superficial resemblance with the genus *Parapristipoma* to which they were erroneously attributed by STINTON (1980).

Geographic and stratigraphic distribution. — Only known from the Egem Sand Member in Belgium and from the Wittering Formation in England; both are considered to be correlatives on the basis of nannoplankton investigation.

"genus Pomadasyidarum" *ovalis* (STINTON, 1957)

(Pl. 4, Fig. 13)

1966 *Xenistius aculeatus* sp. nov. - STINTON, p. 444, pl. 68, fig. 3.

Material and sample localities. — 29 otoliths. Roubaix Clay Member (Moen: 2); Mons-en-Pévèle Sand Member (Mons: 27).

Discussion. — These otoliths differ from "genus Pomadasyidarum" *kokeni* (LERICHE, 1905) (Pl. 4, figs. 19-20) by the absence of a medial angle in the dorsal rim, and by the posterior end of the cauda which is less downturned. There also seems to be considerable differences to the genus *Xenistius*. Its attribution to that genus, as suggested by STINTON (1966), is doubtful; see Pl. 4, Fig. 21 for illustration of the otolith of the Recent *Xenistius californiensis* (STEINDACHNER, 1875).

Geographic and stratigraphic distribution. — Early Ypresian of Belgium and Southern England.

"genus Sparidarum" sp.

(Pl. 4, Figs. 15-16)

Material and sample localities. — 3 otoliths. Panisel Sand Member (Schepdaal: 3).

Discussion. — The general shape and configuration of the sulcus refer to the family of the Sparidae. However, the specimens are too poorly preserved to allow a more precise identification.

Geographic and stratigraphic distribution. — Only known from the Ypresian of the Belgian Basin.

Cepola sp.

(Pl. 4, Figs. 25-27)

Material and sample localities. — 36 otoliths.

Roubaix Clay Member (Bailleul: 2; Moen: 30); Kortemark Silt Member (Egem: 3); Egem Sand Member (Egem: 1).

Discussion. — Otoliths of this species are relatively thin, with a slightly hollow, nearly flat inner face. They have a lozenge-shaped outline with the ventral angle of the lozenge in slightly premedial position. By this feature, they differ from *Cepola robusta* NOLF, 1988 from the Ypresian of the Aquitaine Basin, which shows a slightly convex outer face and a more oval outline. They also markedly differ from the holotype of *Cepola densa* (FROST, 1934) (refigured by NOLF, 1988, pl. 12, fig. 12) which has a very unusual outline and may therefore be an abnormal otolith. Careful examination of the relationships of this holotype with other London Clay cepolid material is required before a decision can be made about the specific status of the Belgian material. For this reason this taxon is kept here in open nomenclature.

***Psettodes* sp.**

(Pl. 4, Fig. 24)

Material and sample localities. — 9 otoliths. Egem Sand Member (Egem: 6, Merelbeke: 1); Pittem Clay Member (Torhout: 2).

Discussion. — These otoliths are somewhat similar to *Psettodes oedelemensis* NOLF, 1973 (NOLF, 1973, pl. III., figs. 5-6) from the Lutetian of the Belgian Basin. However better preserved material is needed for specific identification.

Doubtful species and synonyms

A few taxa, described and figured by CASIER (1946) and NOLF (1971) were known only from poorly preserved material at the time of publication. The present investigation, which is based on newly collected and better preserved material, has shown that some of these taxa can be synonymised with previously described species. These are:

- *Dentex* (?) *dubius in* CASIER (1946, p. 136) = *Pterothrissus* cf. *angulatus* STINTON, 1966;
- *Dentex* sp. *in* NOLF (1971, p. 17) = fragment of an unidentifiable percoid otolith;
- Gadidé ind. *in* CASIER (1946, p. 134) = *Platycephalus janeti* (PRIEM, 1911);
- *Muraenesox cybium in* NOLF (1971, p. 12) (non *Muraenesox cymbium* STINTON, 1966) = "genus Congridarum" *validus* STINTON, 1966;
- *Ogilbia* sp. *in* NOLF (1971, p. 9) - "genus Neobythitinorum" *subregularis* (SCHUBERT, 1916);
- *Rhomboplites casieri in* NOLF (1971, p. 17) = "genus Serranidarum" *striatus* (FROST, 1934);
- *Solea* sp. *in* NOLF (1971, p. 18) = "genus Heterenchelyidarum" *circularis* (SHEPHERD, 1916);
- *Trachurus* (?) sp. *in* CASIER (1946, p. 144) = fragment of an unidentifiable perciform otolith.

CONCLUSIONS

The otolith fauna of the Ypresian of the Belgian Basin contains 51 species of which 3 are new to science: *Gnathophis schepdaalensis,* "genus Neobythitinorum" *angustoides* and "genus Neobythitinarum" *gossei.* Some of the 9 species left in open nomenclature may be new (e.g. *Cepola* sp., *Ampheristus* sp. and "genus Serranidarum" sp.) but additional investigation, based on better preserved or adult material is needed to confirm this.

The Ypresian otolith fauna already shows a good relationship with the Recent fauna at the generic level. 28 species (nominal and in open nomenclature) (= 55 %) are attribuable to Recent genera. At least some of the remaining 23 species, e.g. some of the gadiform and ophidiiform species belong to extinct genera.

The fauna is dominated by 2 families, in abundance as well as in diversity: the ophidiids (13 species, c. 60 % of total number of specimens) and the congrids (7 species, c. 15 % of total number of specimens). Both taxa reflect neritic environments with soft, muddy bottoms, in a tropical to subtropical area. They occur in all lithostratigraphic units (members) investigated, but generally with different species and in different ratios. These units, which are characterised by slightly different otolith associations, are discussed below (see also Tab. 1).

Roubaix Clay Member (27 species)

The middle part of the Roubaix Clay Member contains several shell and nummulite beds, rich in otoliths. These beds were sampled in 7 localities. The otolith associations are quite similar. Some small differences are recorded, but these are mainly due to differences in sample quantities.

The association of the Roubaix Clay Member is dominated by the ophidiid *Glyptophidium polli* (more than 80 % of the association). It is further characterised by the occurrence of frequent *Hildebrandia eocenica* (c. 5 %), *Apogon glaber* (c. 4 %) and *Centroberyx eocenicus* (3 %). Twenty seven species were recognised of which 9 have not been recorded elsewhere in the Belgian Basin. Of these 9, only 2 are not extremely rare: *Oligopus argutus* and "genus Neobythitinarum" *gossei,* representing respectively 2 and 1 % of the association.

The abundance of ophidiids (c. 90 %) and congrids (c. 6 %) indicates a neritic environment with a soft, muddy bottom. The presence of *Argentina* sp. may indicate somewhat deeper environments, between 50 and 100 m depth, but with little communication with the oceanic realm (total absence of mesopelagic fishes, e.g. stomiiforms and myctophids).

Mons-en-Pévèle Sand Member (21 species)

The association of the Mons-en-Pévèle Sand Member is very similar to that of the Roubaix Clay Member. It is also strongly dominated by *Glyptophidium polli* (up to 90 % in the Ronse associations). Among the remaining species, only 2 are frequent: *Ampheristus toliapicus* (c. 5 %) and *Spicara minsterensis* (c. 3 %). Not a single species is restricted to this unit, all the species identified are known from the Roubaix Clay Member, or from overlying units.

The abundance of ophidiids and the presence of congrids, trachinids, platycephalids and the genera *Paraconger* and *Albula* indicate shallow neritic environments with a soft bottom, in a tropical to subtropical area.

Aalbeke Clay Member (1 species)

No otoliths were recorded from the Aalbeke Clay Member, except for 2 specimens of *Glyptophidium polli* encountered by the late Dr. W. WILLEMS in a sample from the stratotype. As the Aalbeke Clay is known to be almost completely decalcified and as the material came from a very small sample (for foraminifera) there may be some doubt about this record. On the other hand, if the occurrence of *G. polli* is found to be *in situ* it must have been abundant in this unit, or at least, at certain levels of it.

Kortemark Silt Member (12 species)

A sample of about 50 kg was taken from the uppermost part of the Kortemark Silt Member at Egem. Twelve species were identified, which are all known from under- or overlying units. The association is characterised by the dominance of "genus Neobythitinorum" *subregularis* (c. 50 %) and by the occurrence of frequent *Apogon* (c. 8 %). These occurrences, together with the presence of serranids, pomadasyids and platycephalids indicate shallow neritic environments.

Egem Sand Member (32 species)

The Egem Sand Member contains the richest and most diverse otolith association of the Belgian Ypresian. 32 species have been recognised, of which 3 have not been found elsewhere in the Belgian Basin: *Muraenesox cymbium*, *Ampheristus* sp. and *Isacia gibbosa*. The association is dominated by "genus Neobythitinorum" *subregularis* (c. 45 %) and to a lesser degree by *Paraconger papointi* (c. 22 %). Common species are "genus Congridarum" *diagonalis* (c. 5 %), *Isacia gibbosa* (c. 4 %) and *Apogon* sp. (c. 4 %). The rather high percentages of pomadasyids, apogonids and platycephalids indicate shallow neritic environments, probably nearshore.

Panisel Sand Member (19 species)

The Panisel Sand Member at Schepdaal is rather rich in otoliths both in terms of abundance and diversity. 19 taxa were recorded, of which only one seems to be restricted to this unit: "genus Sparidarum" sp. The bulk of the association consists of several taxa with almost equal importance: "genus aff. *Sirembo*" *convexus* (c. 20 %), "genus Pomadasyidarum" *kokeni* (c. 20 %), *Glyptophidium polli* (c. 15 %), *Paraconger papointi* (c. 10 %), *Xenistius pulcher* (c. 10 %) and "genus Neobythitinorum" *subregularis* (c. 5 %). The high number of pomadasyids suggests a shallow neritic environment.

Pittem Clay Member (9 species)

The Pittem Clay Member is very poor in otoliths. The only known otolith record is from a railway cutting at Torhout. Nine species are recognised, which are all known from underlying units. The association is dominated by *Apogon* sp. (c. 60 %). "genus Neobythitinorum" *subregularis* (c. 25 %) and "genus Pomadasyidarum" *kokeni* (15 %) also occur frequently. The abundance of apogonids and pomadasyids indicates a shallow neritic environment.

DISCUSSION

The distribution of otolith-based teleost species in the Ypresian of the Belgian Basin is shown in Table 1. Two major faunal groups can be distinguished. The first one ("lower group") is made up of the associations of the Mons-en-Pévèle Sand and the Roubaix Clay Members which are very similar. The association of the Aalbeke Clay Member is probably also attributable to this group. The "lower group" is characterised by the acme of *Glyptophidium polli*, representing at least 80 % of specimens in the associations and by the presence of "genus Osteoglossidarum" *rhomboidalis*, *Apogon glaber*, *Spicara minsterensis* and "genus Pomadasyidarum" *ovalis*. The second group ("upper group") includes the associations of the Kortemark Silt, Egem Sand, Panisel Sand and Pittem Clay Members. Its main characteristics are: absence of *Glyptophidium polli* (except for some specimens from the Panisel Sand at Schepdaal); occurrence of frequent "genus Neobythitinorum" *subregularis*; presence of several species which are known from post-Ypresian deposits (42 % in the "upper group", versus 29 % in the "lower group"). Some slight differences occur in the various associations of the "upper group". The reasons for these differences are not known. They may be the result of different sample sizes in the various units, but may also be due to slight differences in environment (water depth, salinity, temperature, etc.) or have a wider significance reflecting the changing palaeobiogeographic affinities of the fauna in the area.

The study of the otoliths provides substantial complementary information about correlations within the Ypresian of the Belgian Basin. From the otolith investigation it is obvious that the nummulitic sand of southern Belgium (Mons-en-Pévèle Sand Member) is a lateral equivalent of the Roubaix Clay Member, and that this sand is definitely older than the nummulitic sand of northern Belgium

(Egem Sand Member). These results corroborate the correlations proposed by STEURBAUT & NOLF (1986) on the basis of calcareous nannoplankton. However, it must be emphasised that the recognition of the acme of *Glyptophidium polli* in the Mons-en-Pévèle Sand and Roubaix Clay Members, which contrasts strongly with its absence in the Egem Sand Member, was the initial datum which led to our present ideas on stratigraphic relationships within the Belgian Ypresian (see Fig. 1 and 2), even before the nannoplankton was studied.

It may be surprising not to find any comparison with the faunas of the English Ypresian, which indeed has provided rich otolith associations (studied by FROST (1925) and STINTON (1966, 1975, 1977, 1978, 1980, 1984). Such comparative analysis has been omitted deliberately because it would require an exhaustive revision of all English material. At the moment only the type material of FROST's and STINTON's publications has been revised (NOLF, 1985), with the exception of that in STINTON's 1984 paper. The study of the stratigraphic distribution of otoliths in the English Eocene not only requires revision of the figured specimens; it also requires study of material from all localities mentioned by these English otolith workers, as well as the integration of these localities in a modern stratigraphic scheme of the English Ypresian, as recently published by KING (1981). It is evident that such work is beyond the scope of the present paper.

A second area where Ypresian otoliths have been thoroughly studied is the Aquitaine Basin. Seventy otolith-based species have been described from the Ypresian Gan Clay of Aquitaine (NOLF, 1988), but only 9 of these are represented in the Belgian Ypresian and one in the Belgian Lutetian. This striking dissimilarity in otolith fauna between the two areas is mainly due to differences in palaeogeographic conditions. Conditions in the epicontinental Anglo-Paris-Belgian Basin contrasted strongly with those in the Aquitaine Basin, which was more directly exposed to the oceanic realm.

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TABLE 1

TELEOST OTOLITHS FROM THE YPRESIAN OF THE BELGIAN BASIN		ILLUSTRATION	Roubaix Clay (R)	Mons-en-Pévèle Sand (M)	Aalbeke Clay (A)	Kortemark Silt (K)	Egem Sand (E)	Panisel Sand (P)	Pittem Clay (Pi)	Post-Ypresian Strata (X)
OSTEOGLOSSIDAE	"genus Osteoglossidarum" rhomboidalis (STINTON, 1977)	Pl. 1, fig. 1	R	M	-	-	-	-	-	-
ALBULIDAE	Albula incurvata STINTON, 1975	Pl. 1, fig. 5	-	M	-	-	E	-	-	X
PTEROTHRISSIDAE	Pterothrissus angulatus STINTON, 1966	Pl. 1, figs. 7-10	R	-	-	K	E	P	-	-
	Pterothrissus protensus STINTON, 1975	Pl. 1, fig. 6	-	-	-	-	E	-	-	X
HETERENCHELYIDAE	"genus Heterenchelidarum" circularis (SHEPHERD, 1916)	Pl. 1, figs. 12-14	R	M	-	-	E	-	Pi	X
MURAENESOCIDAE	Muraenesox cymbium STINTON, 1966	Pl. 2, fig. 11	-	-	-	-	E	-	-	-
CONGRIDAE	"genus aff. Conger" sp.	Pl. 2, fig. 29	R	-	-	-	-	-	-	-
	Hildebrandia eocenica (SHEPHERD, 1916)	Pl. 1, figs. 19-24	R	-	-	-	-	-	-	X
	Gnathophis schepdaalensis n. sp.	Pl. 2, figs. 1- 5	-	-	-	K	E	P	-	-
	Paraconger papointi (PRIEM, 1906)	Pl. 1, figs. 15-17	-	M	-	K	E	P	Pi	-
	"genus aff. Pseudophichthys" guttulus (STINTON, 1975)	Pl. 2, figs. 6- 9	R	M	-	K	-	-	-	X
	"genus Congridarum" validus (STINTON, 1966)	Pl. 2, figs. 18-19	R	M	-	K	E	P	-	-
	"genus Congridarum" diagonalis (STINTON & NOLF, 1970)	Pl. 1, figs. 15-17	-	M	-	-	E	P	Pi	X
ARGENTINIDAE	Argentina sp.	-	R	-	-	-	-	-	-	-
GADIDAE	Palaeogadus serratus STINTON, 1966	Pl. 2, fig. 10	R	-	-	-	E	-	-	-
	"genus Merlucciinarum" elegans (STINTON, 1977)	Pl. 2, fig. 11	-	-	-	-	E	P	-	-
	"genus Gadidarum" eocenicus (FROST, 1931)	Pl. 2, figs. 12-14	R	-	-	-	-	-	-	-
OPHIDIIDAE	Ampheristus aff. lerichei (STINTON & NOLF, 1970)	Pl. 2, fig. 28	-	M	-	-	E	-	-	X
	Ampheristus toliapicus KONIG, 1825	Pl. 2, fig. 21	R	M	-	-	-	-	-	-
	Ampheristus sp.	Pl. 2, fig. 20	-	-	-	-	E	-	-	-
	"genus aff. Sirembo" convexus STINTON, 1977	Pl. 2, figs. 22-23	-	-	-	-	E	P	-	X
	"genus Sirembinorum" tumidus (NOLF, 1973)	Pl. 3, fig. 9	-	-	-	-	E	-	-	X
	"genus Sirembinorum" arcuatus (STINTON, 1966)	Pl. 3, fig. 1	R	-	-	-	-	-	-	-
	Glyptophidium polli (CASIER, 1946)	Pl. 2, figs. 6- 7	R	M	A	-	-	P	-	-
	"genus Neobythitinorum" angustoides n. sp.	Pl. 3, figs. 4- 5	-	-	-	-	E	-	Pi	-
	"genus Neobythitinorum" angustus (STINTON, 1977)	Pl. 3, fig. 3	R	M	-	-	E	-	-	-
	"genus Neobythitinorum" longissimus NOLF, 1980	Pl. 2, fig. 30	R	M	-	-	E	P	-	-
	"genus Neobythitinorum" subregularis (SCHUBERT, 1916)	Pl. 3, fig. 8	R	M	-	K	E	P	Pi	X
	"genus Neobythitinarum" dimidiatus (SCHUBERT, 1916)	Pl. 3, fig. 2	-	-	-	-	E	-	-	X
	"genus Neobythitinarum" gossei n. sp.	Pl. 2, figs. 24-27	R	-	-	-	-	-	-	-
BYTHITIDAE	Oligopus argutus (STINTON, 1966)	Pl. 3, figs. 10-11	R	-	-	-	-	-	-	-
	"genus Dinematichthyinorum" symmetricus (FROST, 1934)	Pl. 3, fig. 12	R	-	-	-	-	-	-	-
BERYCIDAE	Centroberyx eocenicus (FROST, 1933)	Pl. 3, fig. 13	R	M	-	-	E	P	-	-
HOLOCENTRIDAE	Holocentrus sheppeyensis (FROST, 1934)	Pl. 3, figs. 14-15	R	-	-	-	-	-	-	-
CAPROIDAE	Antigonia angusta STINTON & NOLF, 1970	Pl. 3, figs. 18-19	-	M	-	-	E	P	-	X
PLATYCEPHALIDAE	Platycephalus janeti (PRIEM, 1911)	Pl. 3, figs. 22-25	-	M	-	K	E	P	-	X
SERRANIDAE	"genus Serranidarum" striatus (FROST, 1934)	Pl. 3, figs. 16-17	R	-	-	-	-	-	-	-
	"genus Serranidarum" sp.	Pl. 3, figs. 26-28	-	-	-	K	E	-	-	-
APOGONIDAE	Apogon glaber STINTON, 1966	Pl. 4, figs. 1- 2	R	M	-	-	-	-	-	-
	Apogon sp.	Pl. 3, figs. 20-21	-	-	-	K	E	P	Pi	-
LACTARIIDAE	Lactarius amplus POMEROL, 1973	Pl. 4, fig. 10	-	-	-	-	E	P	-	X
EMMELICHTHYIDAE	Spicara minsterensis (FROST, 1934)	Pl. 4, fig. 14	R	M	-	-	-	-	-	-
POMADASYIDAE	Isacia gibbosa (STINTON, 1980)	Pl. 4, figs. 4- 9	-	-	-	-	E	-	-	-
	Xenistius pulcher (FROST, 1934)	Pl. 4, figs. 11-12	R	M	-	K	E	P	Pi	X
	"genus Pomadasyidarum" ovalis (STINTON, 1957)	Pl. 4, fig. 13	R	M	-	-	-	-	-	-
	"genus Pomadasyidarum" kokeni (LERICHE, 1905)	Pl. 4, figs. 19-20	-	-	-	K	E	P	Pi	X
SPARIDAE	"genus Sparidarum" sp.	Pl. 4, figs. 15-16	-	-	-	-	-	P	-	-
CEPOLIDAE	Cepola sp.	Pl. 4, figs. 25-27	R	-	-	K	E	-	-	-
TRACHINIDAE	Trachinus sp.	Pl. 4, fig. 22	-	M	-	-	E	-	-	-
	Trachinus aff. falcatus FROST, 1934	Pl. 4, fig. 23	-	-	-	-	-	P	-	?
PSETTODIDAE	Psettodes sp.	Pl. 4, fig. 24	-	-	-	-	E	-	Pi	-

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EXPLANATION OF THE PLATES

All specimens are deposited in the collections of the "Institut royal des Sciences naturelles de Belgique, Bruxelles" (IRSNB), unless otherwise specified. The following abbreviations are used in the text: A = anterior view, E = external face, I = inner face, L = left otolith, P = posterior view, R = right otolith, V = ventral view. The abbreviations F and A in the right corner of each compartment of the plates indicate if the figured specimens in that compartment are fossils (= F) or belong to Recent species (A from "actual").

PLATE 1

Fig. 1 : "genus Osteoglossidarum" *rhomboidalis* (STINTON, 1977)
1a = R.I.; 1b = R.A.; 1c = R.V.; Mons-en-Pévèle Sand Member, Ronse. (IRSNB P.5149)

Fig. 2 : *Heterotis niloticus* HEMPRICH & EHRENBERG, 1828
R.I.; Recent, Nile. (Coll. FROST)

Fig. 3 : *Arapaima gigas* (CUVIER, 1817)
3a = L.P.; 3b = L.I.; Recent, Amazone. (Coll. FITCH)

Fig. 4 : *Osteoglossum bicirrhosum* AGASSIZ, 1829
R.I.; Recent, freshwater, Brasil. (Coll. FITCH)

Fig. 5 : *Albula incurvata* STINTON, 1975
R.I.; Egem Sand Member, Egem, sandpit Ampe. (IRSNB P.5150)

Fig. 6 : *Pterothrissus protensus* STINTON, 1975
R.I.; Egem Sand Member, sandpit Ampe. (IRSNB P.5151)

Fig. 7-10 : *Pterothrissus angulatus* (STINTON, 1966)
7-9 = L.I.; 10 = R.I.; Egem Sand Member, Egem, sandpit Ampe. (IRSNB P.5152; P.5153; P.5154; P.5155).

Fig. 11 : *Muraenesox cymbium* STINTON, 1966
11a = L.V.; 11b = L.I.; Egem Sand Member, Egem, sandpit Ampe. (IRSNB P.5156).

Fig. 12-14 : "genus Heterenchelyidarum" *circularis* (SHEPHERD, 1916)
12a = L.I.; 12b = L.V.; Roubaix Clay Member, Bailleul. (IRSNB P.5157); 13 = L.I.; Mons-en-Pévèle Sand Member, Ronse. (IRSNB P.5158); 14 = R.I.; Barton Clay. Lectotype. (Coll. Brit. Mus. Nat. Hist., P.31997)

Fig. 15-17 : *Paraconger papointi* (PRIEM, 1906)
15 = L.I.; 16-17 = R.I.; Egem Sand Member, Egem, sandpit Ampe. (IRSNB P.5159; P.5160; P.5161)

Fig. 18 : *Panturichthys mauritanicus* PELLEGRIN, 1913
18a = L.I.; 18b = L.V.; Recent, off Mauritania. (Coll. IRSNB)

Fig. 19-24 : *Hildebrandia eocenica* (SHEPHERD, 1916).
19-21 = R.I.; 22-24 = L.I.; Roubaix Clay Member, Moen. (IRSNB P.5162; P.5163; P.5164; P.5165; P.5166; P.5167)

Fig. 25 : *Hildebrandia gracilior* (GINSBURG, 1951)
L.I.; Recent, Caraibean Sea. (Coll. IRSNB)

PL.1

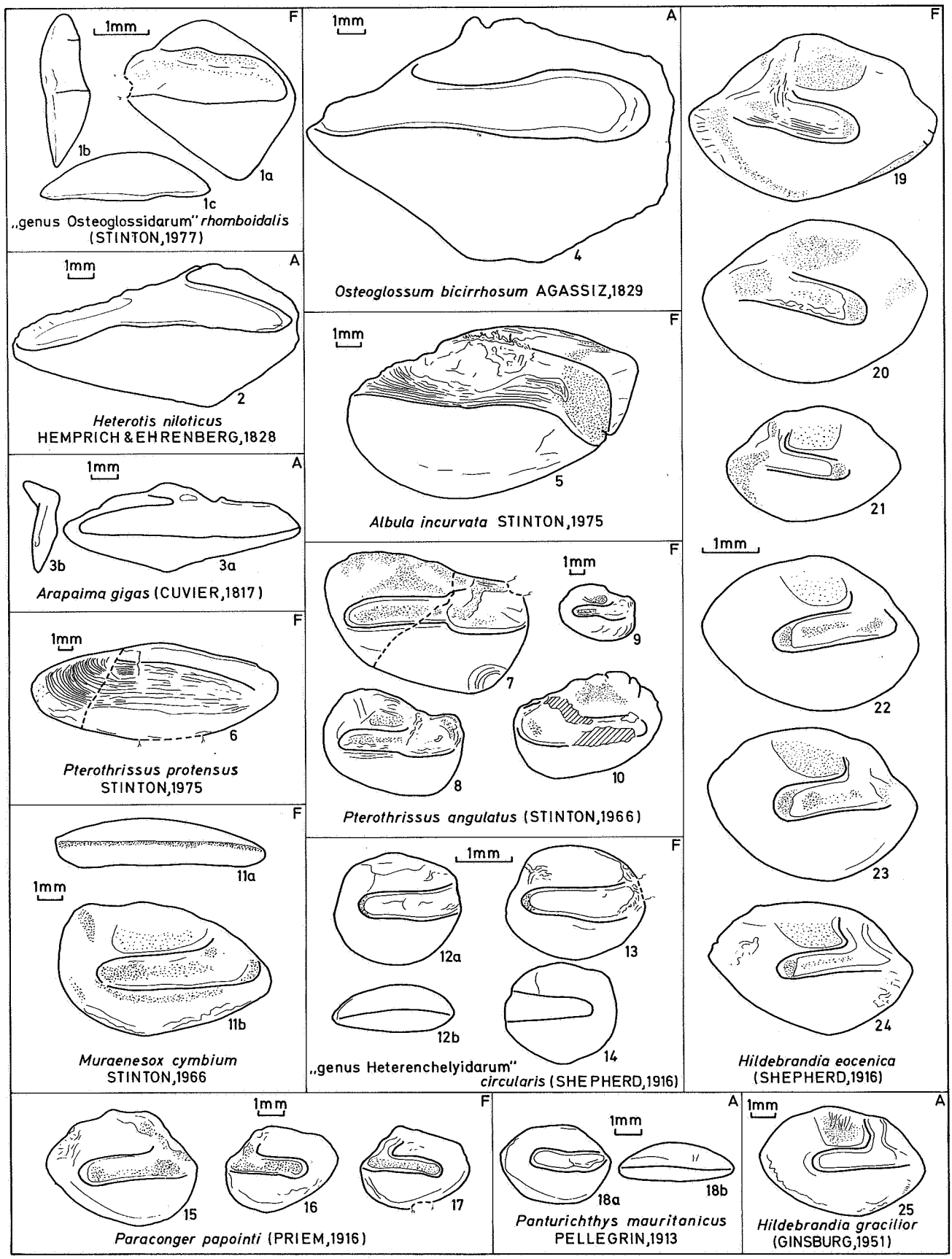

1mm
F
1a
1b
1c
„genus Osteoglossidarum" rhomboidalis (STINTON,1977)
A
2
Heterotis niloticus HEMPRICH & EHRENBERG,1828
3a
3b
Arapaima gigas (CUVIER,1817)
6
Pterothrissus protensus STINTON,1975
11a
11b
Muraenesox cymbium STINTON,1966
4
Osteoglossum bicirrhosum AGASSIZ,1829
5
Albula incurvata STINTON,1975
7
8
9
10
Pterothrissus angulatus (STINTON,1966)
12a
12b
13
14
„genus Heterenchelyidarum" circularis (SHEPHERD,1916)
19
20
21
22
23
24
Hildebrandia eocenica (SHEPHERD,1916)
15
16
17
Paraconger papointi (PRIEM,1916)
18a
18b
Panturichthys mauritanicus PELLEGRIN,1913
25
Hildebrandia gracilior (GINSBURG,1951)

PLATE 2

Fig. 1-5 : *Gnathophis schepdaalensis* n. sp.
1a = L.I.; 1b = L.V.; Panisel Sand Member, Schepdaal. Holotype. (IRSNB P.5168); 2 = L.I.; 3-5 = R.I.; Panisel Sand Member, Schepdaal. Paratypes. (IRSNB P.5169; P.5170; P.5171; P.5172)

Fig. 6-9 : "genus aff. *Pseudophichthys*" *guttulus* (STINTON, 1975);
6-7 = L.I.; 8 = R.I.; London Clay, Shinfield. (IRSNB P.5173; P.5174; P.5175); 9 = R.I.; Roubaix Clay Member, Moen. (IRSNB P.5176)

Fig. 10 : *Palaeogadus serratus* STINTON, 1966
L.I.; Egem Sand Member, Egem, sandpit Ampe. (IRSNB P.5177)

Fig. 11 : "genus Merlucciinarum" *elegans* (STINTON, 1977)
R.I.; Egem Sand Member, Egem, sandpit Ampe. (IRSNB P.5178)

Fig. 12-14 : "genus Gadidarum" *eocenicus* FROST, 1931
12 = R.I.; 13a = R.I.; 13b = R.A.; 13c = R.V.; London Clay, Shinfield. (IRSNB P.5179; P.5180); 14 = R.I.; Roubaix Clay Member, Moen. (IRSNB P.5181)

Fig. 15-17 : "genus Congridarum" *diagonalis*. (STINTON & NOLF, 1970)
15 = L.I.; 16 = L.I.; 17 = R.I.; Egem Sand Member, Egem, sandpit Ampe. (IRSNB P.5182; P.5183; P.5184)

Fig. 18-19 : "genus Congridarum" *validus* STINTON, 1966
R.I.; Roubaix Clay Member, Bailleul. (IRSNB P.5185; P.5186)

Fig. 20 : *Ampheristus* sp.
20a = L.V.; 20b = L.I.; Egem Sand Member, Egem, sandpit Ampe. (IRSNB P.5187)

Fig. 21 : *Ampheristus toliapicus* (KÖNIG, 1825)
21a = R.V.; 21b = R.I.; Roubaix Clay Member, Moen. (IRSNB P.5188)

Fig. 22-23 : "genus aff. *Sirembo*" *convexus* STINTON, 1977
22a = L.V.; 22b = L.I.; 23 = L.I.; Egem Sand Member, Egem, sandpit Ampe. (IRSNB P.5189; P.5190)

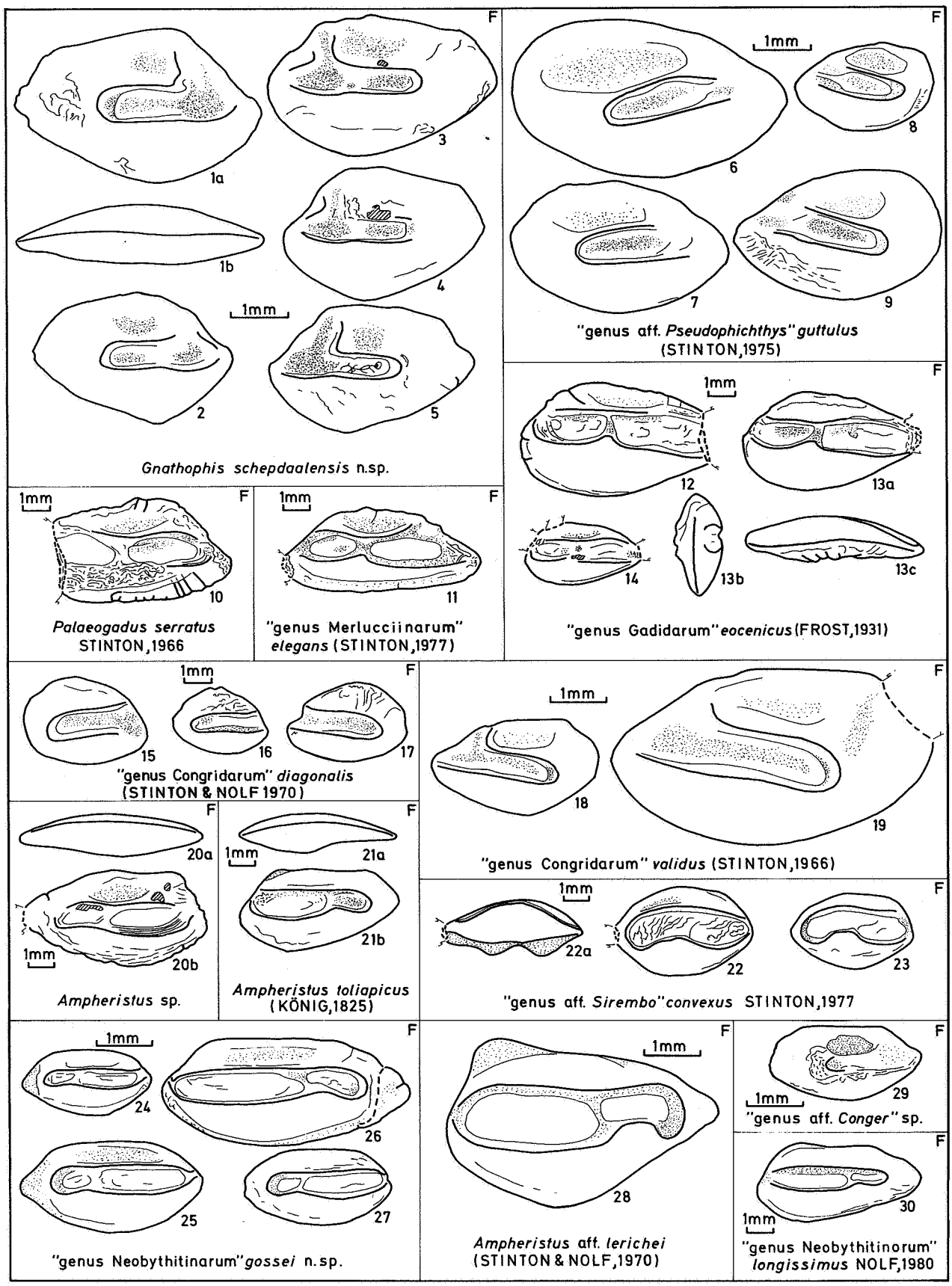
Fig. 24-27 : "genus Neobythitinarum" *gossei* n. sp.
24-25 = L.I.; Roubaix Clay Member, Moen. Paratypes. (IRSNB P.5191; P.5192); 26 = R.I.; Roubaix Clay Member, Moen. Holotype. (IRSNB P.5193); 27 = L.I.; Roubaix Clay Member, Moen. Paratype. (IRSNB P.5194)

Fig. 28 : *Ampheristus* aff. *lerichei* (STINTON & NOLF, 1970)
R.I.; Egem Sand Member, Egem, sandpit Ampe. (IRSNB P.5195)

Fig. 29 : "genus aff. *Conger*" sp.
L.I.; Roubaix Clay Member, Moen. (IRSNB P.5196)

Fig. 30 : "genus Neobythitinorum" *longissimus* NOLF, 1980
R.I.; Egem Sand Member, Egem, sandpit Ampe. (IRSNB P.5197)

PL.2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1a
3
1b
4
1mm
2
5
Gnathophis schepdaalensis n.sp.
1mm
F
6
8
7
9
"genus aff. Pseudophichthys" guttulus
(STINTON,1975)
1mm
F
12
13a
14
13b
13c
"genus Gadidarum" eocenicus (FROST,1931)
1mm
F
10
Palaeogadus serratus
STINTON,1966
1mm
F
11
"genus Merlucciinarum"
elegans (STINTON,1977)
1mm
F
15
16
17
"genus Congridarum" diagonalis
(STINTON & NOLF 1970)
1mm
F
18
19
"genus Congridarum" validus (STINTON,1966)
F
20a
1mm
20b
Ampheristus sp.
F
1mm
21a
21b
Ampheristus toliapicus
(KÖNIG,1825)
1mm
F
22a
22
23
"genus aff. Sirembo" convexus STINTON,1977
1mm
F
24
26
25
27
"genus Neobythitinarum" gossei n.sp.
1mm
F
28
Ampheristus aff. lerichei
(STINTON & NOLF,1970)
F
1mm
29
"genus aff. Conger" sp.
F
1mm
30
"genus Neobythitinorum"
longissimus NOLF,1980

PLATE 3

Fig. 1 : "genus Sirembinorum" *arcuatus* STINTON, 1977
1a = L.V.; 1b = L.I.; Roubaix Clay Member, Moen. (IRSNB P.5198)

Fig. 2 : "genus Neobythitinarum" *dimidiatus* (SCHUBERT, 1916)
2a = R.V.; 2b = R.I.; Egem Sand Member, Egem, sandpit Ampe. (IRSNB P.5199)

Fig. 3 : "genus Neobythitinorum" *angustus* (STINTON, 1977)
3a = R.V.; 3b = R.I.; Egem Sand Member, Egem, sandpit Ampe. (IRSNB P.5200)

Fig. 4-5 : "genus Neobythitinorum" *angustoides* n. sp.
4a = R.V.; 4b = R.I.; Pittem Clay Member, Torhout. Holotype. (IRSNB P.5201); 5 = R.I.; Pittem Clay Member, Torhout. Paratype. (IRSNB P.5202)

Fig. 6-7 : *Glyptophidium polli* (CASIER, 1946)
6a = L.V.; 6b = L.I.; 7 = L.I.; Roubaix Clay Member, Moen. (IRSNB P.5203; P.5204)

Fig. 8 : "genus Neobythitinorum" *subregularis* (SCHUBERT, 1916)
R.I.; Panisel Sand Member, Schepdaal. (IRSNB P.5205)

Fig. 9 : "genus Sirembinorum" *tumidus* NOLF, 1973
R.I.; Egem Sand Member, Egem, sandpit Ampe. (IRSNB P.5206)

Fig. 10-11 : *Oligopus argutus* (STINTON, 1966)
L.I.; Roubaix Clay Member, Moen. (IRSNB P.5207; P.5208)

Fig. 12 : "genus Dinematichthyinorum" *symmetricus* (FROST, 1934)
R.I.; Roubaix Clay Member, Kortrijk. (IRSNB P.1837)

Fig. 13 : *Centroberyx eocenicus* (FROST, 1933)
R.I.; Roubaix Clay Member, Moen. (IRSNB P.5210)

Fig. 14-15 : *Holocentrus sheppeyensis* (FROST, 1934)
14 = L.I.; 15 = R.I.; Roubaix Clay Member, Moen. (IRSNB P.5211; P.5212)

Fig. 16-17 : "genus Serranidarum" *striatus* (FROST, 1934)
16 = L.I.; Roubaix Clay Member, Moen. (IRSNB P.5213); 17 = R.I.; London Clay, Shinfield. (IRSNB P.5214)

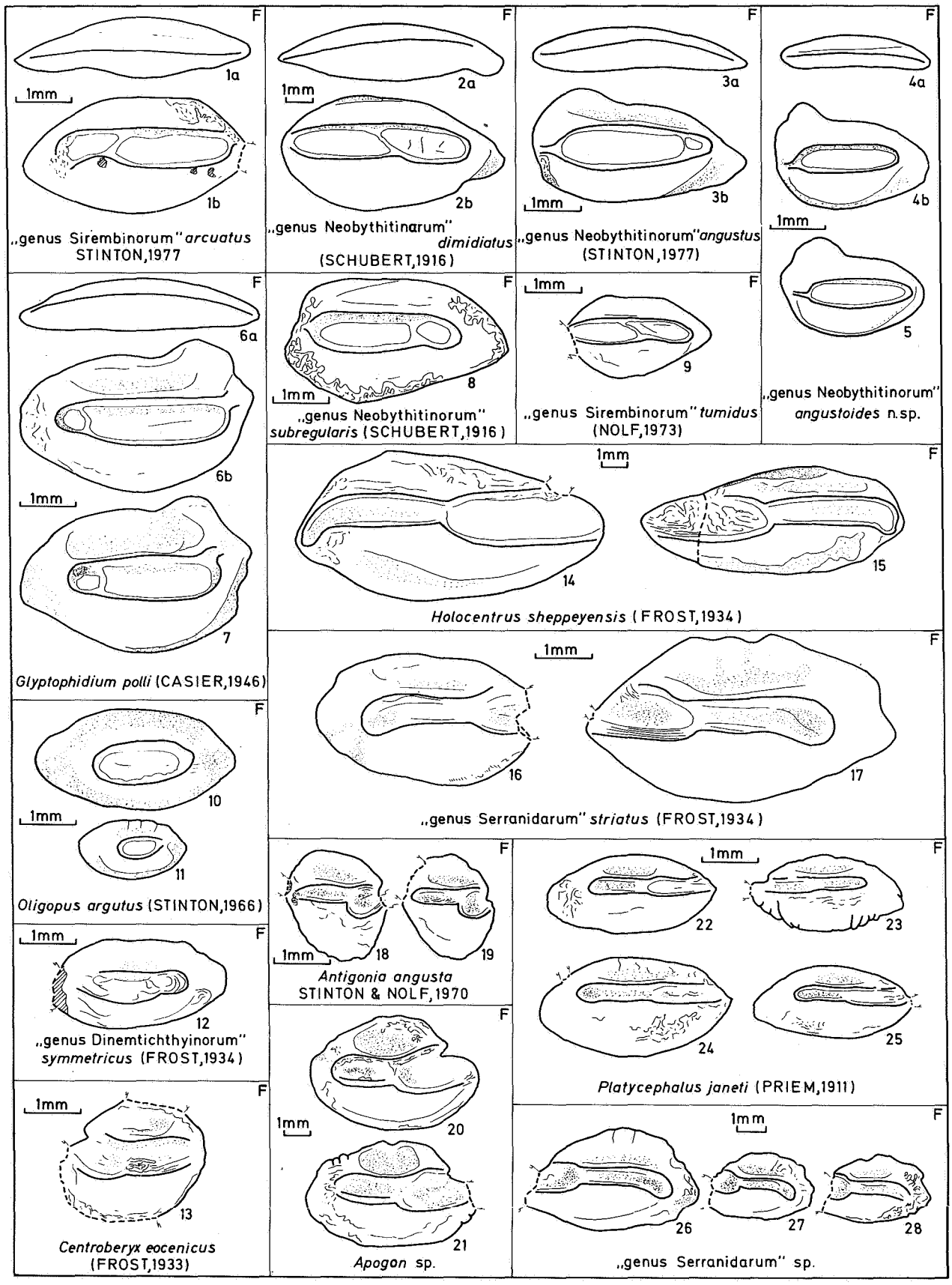
Fig. 18-19 : *Antigonia angusta* STINTON & NOLF, 1970
L.I.; Egem Sand Member, Egem, sandpit Ampe. (IRSNB P.5215; P.5216)

Fig. 20-21 : *Apogon* sp.
L.I.; Egem Sand Member, Egem, sandpit Ampe. (IRSNB P.5217; P.5218)

Fig. 22-25 : *Platycephalus janeti* (PRIEM, 1911)
22 = L.I.; 23 = R.I.; 24-25 = L.I.; Egem Sand Member, Egem, sandpit Ampe. (IRSNB P.5219; P.5220; P.5221; P.5222)

Fig. 26-28 : "genus Serranidarum" sp.
R.I.; Egem Sand Member, Egem, sandpit Ampe. (IRSNB P.5223; P.5224; P.5225)

PL.3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1a
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„genus Sirembinorum" arcuatus STINTON,1977
2a
1mm
2b
„genus Neobythitinarum" dimidiatus (SCHUBERT,1916)
3a
1mm
3b
„genus Neobythitinorum" angustus (STINTON,1977)
4a
4b
1mm
5
„genus Neobythitinorum" angustoides n.sp.
6a
6b
1mm
7
Glyptophidium polli (CASIER,1946)
8
1mm
„genus Neobythitinorum" subregularis (SCHUBERT,1916)
1mm
9
„genus Sirembinorum" tumidus (NOLF,1973)
1mm
14
15
Holocentrus sheppeyensis (FROST,1934)
10
1mm
11
Oligopus argutus (STINTON,1966)
1mm
16
17
„genus Serranidarum" striatus (FROST,1934)
1mm
12
„genus Dinemtichthyinorum" symmetricus (FROST,1934)
18
1mm
19
Antigonia angusta STINTON & NOLF,1970
1mm
22
23
24
25
Platycephalus janeti (PRIEM,1911)
1mm
13
Centroberyx eocenicus (FROST,1933)
1mm
20
21
Apogon sp.
1mm
26
27
28
„genus Serranidarum" sp.

PLATE 4

Fig 1-2 : *Apogon glaber* STINTON, 1966
L.I., Roubaix Clay Member; 1 = Moen (IRSNB P. 5226); 2 = Bailleul (IRSNB P. 5227)

Fig. 3 : *Lactarius lactarius* (SCHNEIDER, 1801)
L.I.; Recent, off Queensland, Australia. (Coll. FITCH)

Fig. 4-9 : *Isacia gibbosa* (STINTON, 1980)
4-6 = L.I.; 7-9 = R.I.; Egem Sand Member, Egem, Ringbeek. (IRSNB P. 2089; P. 2090; P. 2091; P. 2092; P. 2093; P. 2094)

Fig. 10 : *Lactarius amplus* (POMEROL, 1973)
L.I.; Egem Sand Member, Egem, sandpit Ampe. (IRSNB P. 5228)

Fig. 11-12 : *Xenistius pulcher* (FROST, 1934)
11 = L.I.; 12 = R.I.; Egem Sand Member, Egem, sandpit Ampe. (IRSNB P. 5229; P. 5230)

Fig. 13 : "genus Pomadasyidarum" *ovalis* (STINTON, 1957)
R.I.; Mons-en-Pévèle Sand Member, Mons. (IRSNB P. 5231)

Fig. 14 : *Spicara minsterensis* (FROST, 1934)
L.I.; Roubaix Clay Member, Moen. (IRSNB P. 5232)

Fig. 15-16 : "genus Sparidarum" sp.
R.I.; Panisel Sand Member, Schepdaal. (IRSNB P. 5233; P. 5234)

Fig. 17-18 : *Isacia conceptionis* (CUVIER, 1830)
17 = R.I.; 18 = L.I.; Recent, off Peru. (Coll. IRSNB)

Fig. 19-20 : "genus Pomadasyidarum" *kokeni* (LERICHE, 1905)
19 = L.I.; 20 = R.I.; Panisel Sand Member, Schepdaal. (IRSNB P. 5235; P. 5236)

Fig. 21 : *Xenistius californiensis* (STEINDACHNER, 1875)
L.I.; Recent, off California. (Coll. IRSNB)

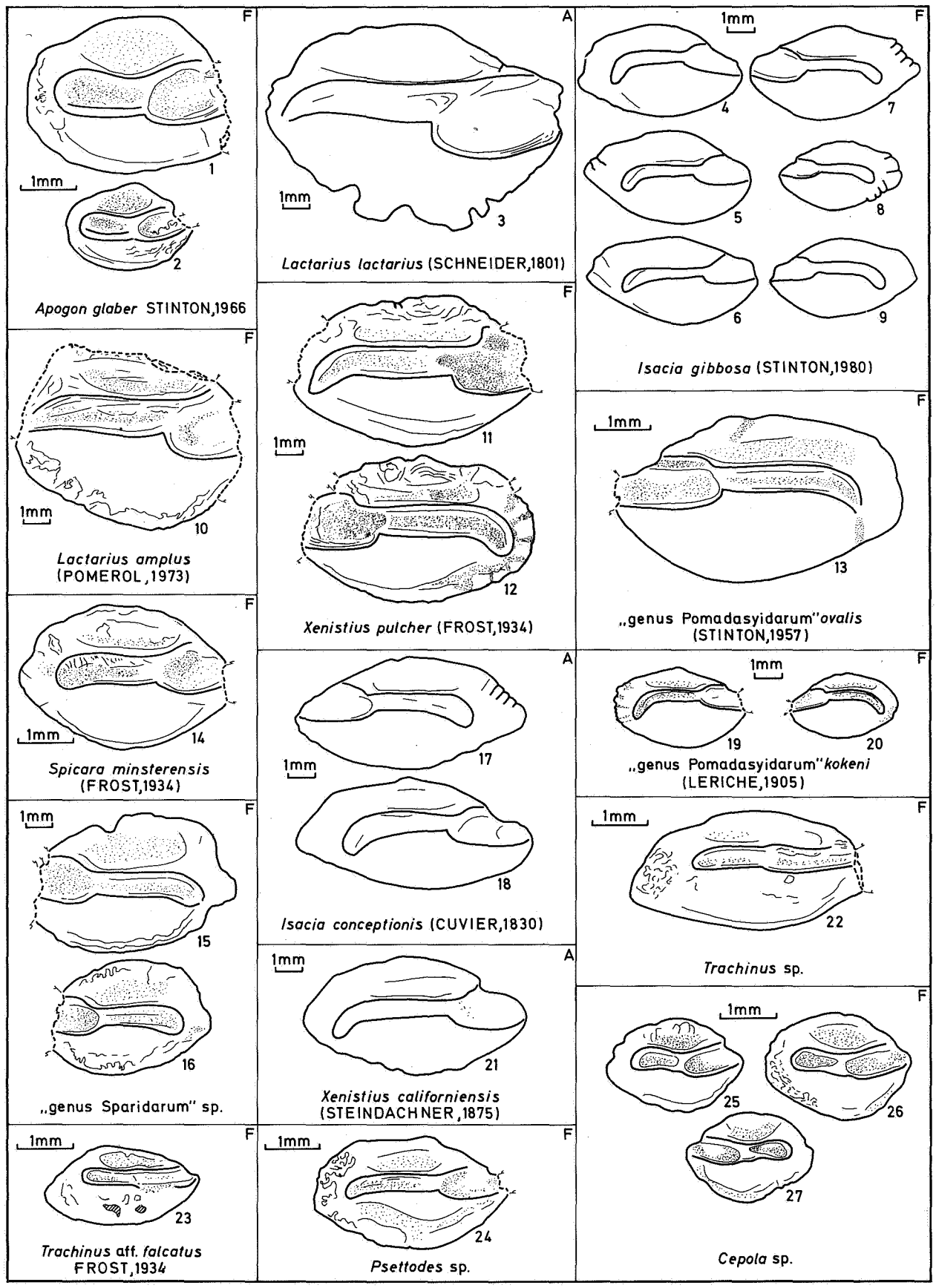
Fig. 22 : *Trachinus* sp.
L.I.; Egem Sand Member, Egem, sandpit Ampe. (IRSNB P. 5237)

Fig. 23 : *Trachinus* aff. *falcatus* FROST, 1934
L.I.; Panisel Sand Member, Schepdaal. (IRSNB P. 5238)

Fig. 24 : *Psettodes* sp.
L.I.; Egem Sand Member, Egem, sandpit Ampe. (IRSNB P. 5209)

Fig. 25-27 : *Cepola* sp.
25-26 = L.I.; 27 = R.I.; Roubaix Clay Member, Moen. (IRSNB P. 5239; P. 5240; P. 5241)

PL. 4


F
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1
2
Apogon glaber STINTON,1966
A
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3
Lactarius lactarius (SCHNEIDER,1801)
1mm
F
4
7
5
8
6
9
Isacia gibbosa (STINTON,1980)
F
1mm
10
Lactarius amplus
(POMEROL, 1973)
F
1mm
11
12
Xenistius pulcher (FROST,1934)
F
1mm
13
„genus Pomadasyidarum" ovalis
(STINTON,1957)
F
1mm
14
Spicara minsterensis
(FROST,1934)
A
1mm
17
18
Isacia conceptionis (CUVIER,1830)
F
1mm
19
20
„genus Pomadasyidarum" kokeni
(LERICHE,1905)
F
1mm
15
16
„genus Sparidarum" sp.
A
1mm
21
Xenistius californiensis
(STEINDACHNER, 1875)
F
1mm
22
Trachinus sp.
F
1mm
23
Trachinus aff. falcatus
FROST,1934
F
1mm
24
Psettodes sp.
F
1mm
25
26
27
Cepola sp.