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Lower Badenian fish otoliths of the Styrian and Lavanttal basins, with a revision of WEINFURTER´s type material

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(With 2 figures, 8 plates and 2 tables)

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Abstract

Study of the Middle Miocene (Badenian) otolith collections in the Landesmuseum Joanneum in Graz, the Landesmuseum Kärnten in Klagenfurt, and the Krahuletz Museum in Eggenburg allowed for the reconstruction of a teleost fauna of 57 taxa, among which *Lethrinus styriacus* is new. The most diversified associations occur in the St. Florian Beds; the Mühldorf Formation provided 18 taxa. Five of those were only recorded from the last named formation. "genus Gobiidarum" *noricus* is reported only from the non-marine younger sediments in the Lavanttal Basin. Skeleton based taxa from the Eastern Styrian Basin (SCHULTZ 2000, 2004, 2006; SCHULTZ & BELLWOOD 2004) were not documented by otoliths from similar taxa in the Western Styrian Basin or the Lavanttal Basin. The associations reflect tropical to subtropical nearshore marine faunas that are quantitatively dominated by gobiids. Although the reconstructed fauna shows most affinities to present-day Atlantic and Mediterranean forms, the number of Indo-Pacific taxa (6) is also relatively high. Eight taxa (*Thrissa floriani*, *Arius nucleus*, *Ambassis* sp., *Gazza hilberi*, *Gerres* sp. 2, "genus Haemulidarum" *lucidus*, *Lethrinus styriacus*, and *Xyrichtys* sp.) have a Badenian record in the Styrian Basin only, and "genus Atherinidarum" *bavayi* occurs in the Lavanttal Basin only.

Keywords: Fish otoliths, palaeoenvironment, Styrian Basin, Lavanttal Basin, Central Paratethys, Austria, Badenian, Middle Miocene.

Zusammenfassung

Die mittel-miozänen (badenienische) Fischfaunen des Weststeirischen Beckens und des Lanvanttal-Beckens wurden anhand der Otolithen in den Sammlungen des Landesmuseums Joanneum in Graz, des Landesmuseums Kärnten in Klagenfurt und des Krahuletz Museums in Eggenburg einer systematischen Revision unterzogen. Insgesamt konnten 57 Taxa nachgewiesen werden, darunter 1 neue Art: *Lethrinus styriacus*. Die artenreichste Assoziation der Otolithen kommt in den St. Florianer Schichten vor, während die Mühldorf-Formation nur 18 Arten beinhaltet. "genus Gobiidarum" *noricus* wurde nur in jüngeren ausgesüssten Ablagerungen des Lavanttales aufgefunden. Ein Nachweis der Formen die im Oststeirischen Becken auf Grund von osteologischem Material bekannt sind (SCHULTZ 2000, 2004, 2006; SCHULTZ & BELLWOOD 2004) war im Weststeirischen Becken und im Lavanttal anhand von Otolithen nicht möglich.

Die nachgewiesenen Otolithen spiegeln eine tropische bis subtropische Seichtwasserfauna mit einer Dominanz von Gobiiden wider. Auf Grund der Anwesenheit der tropischen Fische können die studierten Fundorte mit dem unteren Teil der Weissenegg-Formation im Oststeirischen Becken korreliert werden.

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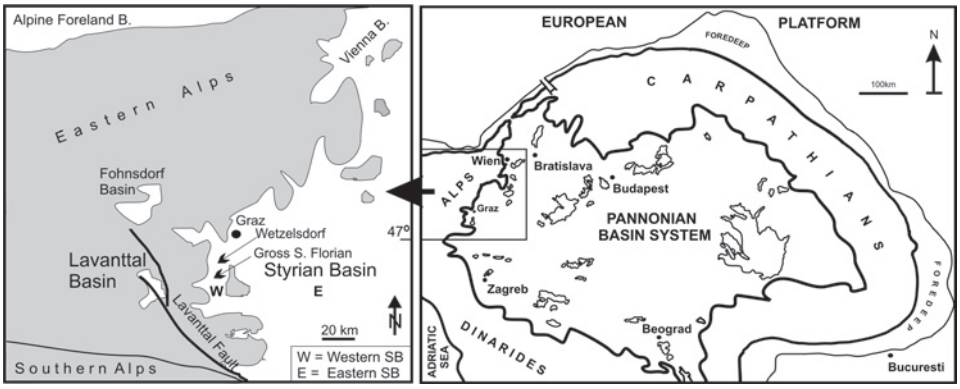

Fig. 1. Position of the Styrian and Lavanttal basins (modified after BECHTEL et al. 2007).

Abgesehen davon, dass die behandelte Otolithenfauna Ähnlichkeiten mit den rezenten Atlantischen und Mediterranen Formen zeigt, ist die Zahl von heute auf den Indo-Pazifik beschränkten Taxa (6) verhältnismäßig hoch. Acht Taxa (*Thrissa floriani*, *Arius nucleus*, *Ambassis* sp., *Gazza hilberi*, *Gerres* sp. 2, "genus Haemulidarum" *lucidus*, *Lethrinus styriacus* und *Xyrichtys* sp.) kommen im Badenium nur im Steirischen Becken und "genus Atherinidarum" *bavayi* nur im Lavanttal vor.

Schlüsselwörter: Pisces, Otolithen, Paläoökologie, Steirisches Becken, Lavanttal-Becken, Zentrale Paratethys, Österreich, Badenium, Mittel-Miozän.

Introduction

The Badenian bony fishes of the Styrian Basin and the Lavanttal Basin are represented by otoliths, and rarely by isolated teeth and skeletal remnants. Results of primary studies on otoliths were published by WEINFURTER (1949, 1952b, c – Mühldorf Formation and overlaying brackish and freshwater beds, Lavanttal, Carinthia; 1952d – different localities, St. Florian Beds, Western Styrian Basin). Otoliths from the claypit Gasselsdorf (Eibiswald Beds, the southern bay of the Western Styrian Basin) were both taxonomically and stratigraphically evaluated by HIDEN & STINGL (1998). An additional species, "*Gobius* (n.) sp." was recently cited from the lower part ("Fish Shales") of the Mühldorf Formation by REISCHENBACHER et al. (2007).

The teeth and tooth plates of sparids and labrids were mentioned by SCHULTZ (in BRZOBOHATY & SCHULTZ 1978) from different localities in the Styrian Basin. Teeth and skeletal remnants of the species *Epinephelus casottii* (COSTA, 1858), *Trigonodon jugleri* (MÜNSTER, 1846) and *Balistes muensteri* SCHULTZ, 2004 were recently mentioned in SCHULTZ (2000 – locality Retznei; 2004 – localities Wiesfleck and Retznei) and in SCHULTZ & BELLWOOD (2004 – localities Wiesfleck, Weissenegg and Retznei). SCHULTZ (2006) described a fragmentary jaw as *Oligodiodon* sp. (porcupinefish) from the Retznei outcrop.

The present paper provides a revision of all otolith material from the Styrian and the Lavanttal basins based on the type material of the various papers of WEINFURTER and of additional unstudied material in the collections of the Joanneum Museum in Graz and the Kärnter Landesmuseum in Klagenfurt.

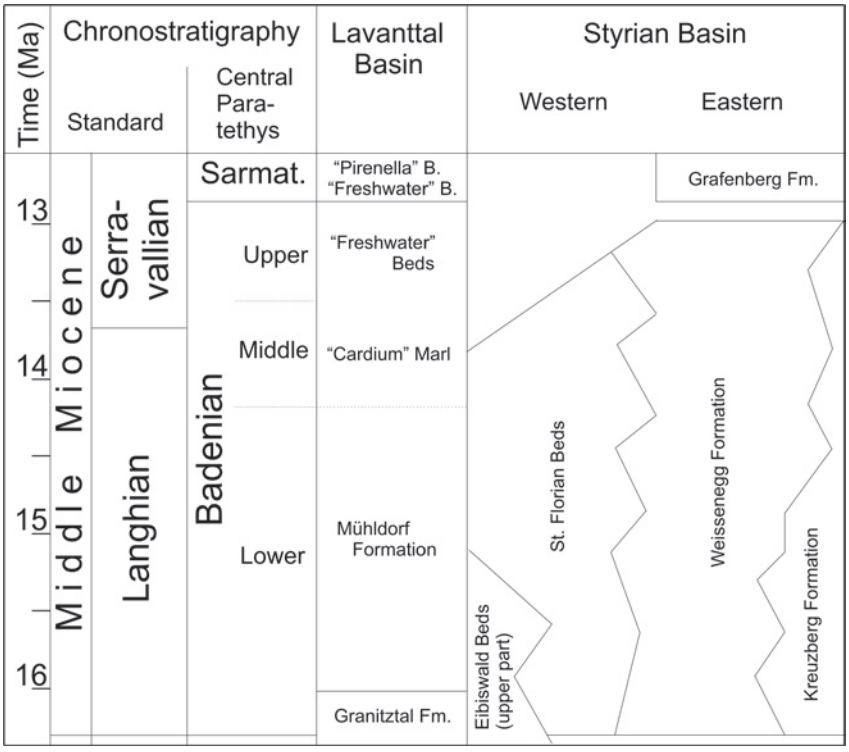

Fig. 2. Simplified stratigraphic chart of the Badenian fill of the Styrian and Lavanttal basins (modified after GROSS et al. 2007; BECHTEL et al. 2007; REISCHENBACHER et al. 2007; RÖGL et al. 2007).

Geological context

The Styrian Basin, palaeogeographically a western part of the Central Paratethys, is situated in the foothills of the Eastern Alps and represents the western part of the Pannonian Basin System belonging to the back-arc basin domain within the Alpine-Carpathian arc (fig. 1). By the Middle Styrian Swell, it is subdivided into the Western and the Eastern Styrian Sub basins. It is filled with Karpatian (Early Miocene) and Badenian (Middle Miocene) mostly marine sediments separated by the "Styrian Tectonic Phase" unconformity (RÖGL et al. 2002; POLESNY 2003; KOVÁČ et al. 2007) and various older and younger non-marine (or reduced marine) deposits.

Sedimentation of the Early Badenian in the Eastern Styrian Basin (Kreuzberg and Weissenegg formations) generally started with silts, fine sands, or conglomerates with *Praeorbulina sicana* and *P. transitoria* in the late NN4 nannoplankton Zone (fig. 2). Stratigraphical higher the corallinacean limestones and the transgressive coral facies (e.g., directly on top of the Karpatian Kreuzkrumpel Formation) with *P. circularis* and nannoplankton of the NN5 Zone were deposited along the shoreline or around basement highs, while deepwater marly and pelitic sediments prevailed in the basin and graben structures (Weissenegg Fm.). During the early Badenian marine sediments reached their

largest extent, whereas during the middle and late Badenian depocenters shifted eastwards (SPEZZAFERRI et al. 2004; RÖGL et al. 2007; GROSS et al. 2007). Tuffs in the clastic sediments overlaying corallinacean limestones in the Retznei section (northeastern part of the Styrian Basin) show a radiometric age of 14.2 ± 0.1 Ma (BOJAR et al. 2004). Many features of sediments (sands, deltaic and limnic complexes) indicate a strong regression at the end of the Badenian time and erosion at the Badenian/Sarmatian boundary (EBNER & SACHSENHOFER 1995).

In the Western Styrian Subbasin, despite the presence of different coarse clastics at the western border, the Early Badenian is represented by calcareous clays and clayey sands and silts of the St. Florian Beds (an old German name is the "Florianer Tegel") filling the Bay of St. Florian. These beds are palaeogeographically interpreted as lagoonal deposits with rich mollusks, sharks, foraminifera, and otoliths and stratigraphically equivalent to the Weissenegg Formation. To the south, they pass in the upper part of the Eibiswald Beds (sands and clayey silts) interpreted as shallow deltaic deposits of the Eibiswald Bay (HIDEN & STINGL 1998; PILLER et al. 2004; GROSS et al. 2007). Volcaniclastic rocks intercalated within the St. Florian Beds show a radiometric age of 15.75 ± 0.17 Ma (Lower Badenian, HANDLER et al. 2006).

The Lavanttal Basin represents a small pull-apart basin west of the Styrian Basin. It is downfaulted along the Pöls-Lavanttal Fault between the crystalline of the Saualpe and Koralpe and filled with Lower to Middle Miocene sediments (e.g., POLESNY 2003). The marine ingression started in the Lower Badenian and the marine connection to the Central Paratethys ceased during the Middle and Late Badenian (KOVÁČ et al. 2007). The Lower Badenian Mühldorf Formation is separated by an unconformity and mainly consists of grey or brown mudstones and shelly marls with silty and sandy layers and with a lacustrine-brackish fauna at the base and higher with diverse marine molusc, bryozoa, foraminifera, and otolith faunas. In the marine upper part benthic foraminifera assemblages are similar with those of the Lower Lagenidae Zone in the Vienna Basin (RÖGL et al. 2002). Rich nannoplankton assemblages in combination with *Praeorbulina* and ostracods indicate the lower part of the nannoplankton Zone NN5 (REISCHENBACHER et al. 2007). Overlaying younger Badenian and Sarmatian beds are brackish to freshwater (BECHTEL et al. 2007).

Material & Methods

A list of all otolith-based taxa from the Badenian of the Western Styrian Basin and the Lavanttal Basin is given in Table 1. Table 2 provides an alphabetical list of all taxa cited in WEINFURTER'S (1952b, c, d) papers, and their present taxonomical interpretation. Most of the material (from sites in the proximity of Wetzelsdorf and St. Florian, including the types of taxa described by WEINFURTER 1952d) belongs to the collections of the Landesmuseum Joanneum in Graz. The material from Mühldorf in Kärnten (including the type material described by WEINFURTER 1952c) is from the Kärnter Landesmuseum in Klagenfurt, and finally, a small collection of the Lavanttal is from the Krahuletz Museum, Eggenburg. For general matter about otoliths and their morphological nomenclature, the reader is referred to NOLF (1985 and 1995).

Abbreviations

The abbreviation "aff." in the binomina was used in the cases of well-preserved material where specific identity could not be unequivocally determined. The abbreviation "cf." was inserted in cases where the poor preservation of otoliths did not allow an adequate specific identification. Twelve species appear in open nomenclature due to limited or poorly preserved material.

GBW	Geologische Bundesanstalt Wien,
IRSNB	Institut royal des Sciences naturelles de Belgique, Bruxelles,
KME	Krahuletz Museum in Eggenburg,
LMJG	Landesmuseum Joanneum in Graz,
LMKK	Landesmuseum Kärnten in Klagenfurt.

Localities studied

All studied material is from the above cited museum collections. After the study of this material, D. NOLF did a short exploration trip in the area, which is not very appropriate for rapid exploration, due to the exuberant vegetation and the scattered but relatively dense countryside habitations. He sampled a rather indurated silty marl at x = 675.700, y = 196.400, in a steep ravine that runs off northward from the way that runs eastward from the road from St. Josef to Wetzelsdorf, at 500 m from the junction with this road, south of the place marked Bramberg on the topographic map. This sample (about 20 kg) only provided a single *Pomadasys* aff. *incisus* otolith (Coll. IRSNB). For the material in the rather old (mainly before 1950) museum collections, there are no data on the size of the samples or the method of collecting (surface-picked or screenwashed). Therefore, we did not provide data on the number of collected specimens. Based on the small size of many specimens and the great abundance of small gobiid otoliths, it is probable that most specimens came from screenwashed samples. Locality data for the Wetzelsdorf area are from HOLLER (1900), who provides a map and some descriptive data.

Gross Sankt Florian, Kogelbauer.

Österreichische Karte 1/50 000, sheet 189 (Deutschlandsberg),
x = 672.950, y = 186.200
Coll. Landesmuseum Joanneum.

Gross Sankt Florian, Mühlbauer.

Exact location unknown. Coll. Landesmuseum Joanneum, Graz.

Lavanttal, Mühldorf.

Exact location unknown. Coll. Landesmuseum Kärnten in Klagenfurt.

Lavanttal, Weinzettel bei Ober-Aigen.

Exact location unknown. Coll. Landesmuseum Kärnten in Klagenfurt.

Wetzelsdorf, Kreuzschaller.

Österreichische Karte 1/50 000, sheet 190 (Leibnitz), x = 675.450, y = 196.250
Coll. Landesmuseum Joanneum, Graz.

Wetzelsdorf, Rinngraben.

Österreichische Karte 1/50 000, sheet 190 (Leibnitz), x = 675.900, y = 194.250
Coll. Landesmuseum Joanneum, Graz.

Wetzelsdorf, Simihansl.

Österreichische Karte 1/50 000, sheet 190 (Leibnitz), x = 676.300, y = 193.800
Coll. Landesmuseum Joanneum, Graz.

Wetzelsdorf, Thomihiaslgraben.

Österreichische Karte 1/50 000, sheet 190 (Leibnitz), x = 675.400, y = 195.800
Coll. Landesmuseum Joanneum, Graz.

Wetzelsdorf, Wenzelsteffi.

Österreichische Karte 1/50 000, sheet 190 (Leibnitz), x = 675. 550, y = 196.150
Coll. Landesmuseum Joanneum, Graz.

Wetzelsdorf, Winkeltoni.

Österreichische Karte 1/50 000, sheet 190 (Leibnitz), x = 676.000, y = 195.250
Coll. Landesmuseum Joanneum, Graz.

Remarks on taxa requiring comments

***Thrissa floriani* (WEINFURTER, 1952) (1)**

Otoliths of this species, originally described as a percoid by WEINFURTER (1952d), clearly belong to the engraulid genus *Thrissa*; see RIVATON & BOURRET (1999: pl. 2, fig. 15-16) for otoliths of the Recent *Thrissa baelama* (FORSSKAL, 1775) and SMALE et al. (1995: pl. 7, fig. D1-D3 and E1-E3) for respectively *T. setirostris* (BROUSSONET, 1782) and *T. vitrirostris* (GILCHRIST & THOMPSON, 1908).

***Arius nucleus* (WEINFURTER, 1952) (2)**

Otoliths of this species, originally mentioned as generic incertae sedis, are utricular otoliths of an ariid.

"genus Atherinidarum" *bavayi* STEURBAUT, 1984 (3)

This otolith, originally referred to *Dentex* aff. *latior* SCHUBERT by WEINFURTER (1952c) represents the first Paratethys record of "genus Atherinidarum" *bavayi*, an atherinid known from the Aquitaine Basin.

***Tylosurus wetzelsdorfensis* (WEINFURTER, 1952) (4)**

WEINFURTER´s holotype, originally, described as a generic incertae sedis in WEINFURTER (1952d), shows most affinities with the belonid genus *Tylosurus*, see NOLF & GIRONE (2006: pl. 5, figs 1-4) for otoliths of the Recent *Tylosurus acus* (LACEPÈDE, 1803). The fossil species has higher otoliths and a more blunt anterior portion than the Recent form.

***Gazza hilberi* (WEINFURTER, 1952) (5)**

This otolith, referred to a triglid by WEINFURTER (1952d), shows most affinities with those of the Recent leiognathid genus *Gazza*, see RIVATON & BOURRET (1999: pl. 35, figs. 8-9) and SMALE et al. (1995: pl. 75, figs. 1-3) for otoliths of the Recent *Gazza minuta* (BLOCH, 1797).

Sciaenidae indet. (6)

Under the name *Ot.* (Sciaenidarum) *styriacus*, WEINFURTER (1952d) published a strongly eroded sciaenid otolith, non-diagnostic at species or genus level. This specimen certainly does not belong to the American sciaenid genus *Pogonias*, as guessed by SCHWARZHANS (1993: 86) from WEINFURTER's drawing only. This specimen is refigured here (pl. 6, fig. 2), together with another non-diagnostic sciaenid otolith from the Badenian of the Vienna Basin, the holotype of *Ot.* (Sciaenidarum) *kittli* SCHUBERT, 1902. Those two otoliths show some similarity and may be related to each other, but neither is sufficiently well preserved to define a species or even a genus.

"genus Gobiidarum" sp. 2 (7)

The otolith figured here apparently belongs to the same species as the three otoliths figured by BRZOBOHATY et al. (2007: pl. 8, figs 9-11) under the name *Priolepis* sp. This identification was based on the comparison with a picture of a *Priolepis cincta* (REGAN, 1908) otolith published by SMALE et al. (1995: pl. 129, fig. H 1). For a more detailed look at Recent *Priolepis* otoliths, see, e.g., *P. hipoliti* (METZELAAR, 1922) (see pl. 7, fig. 4), which shows that our fossils are too different from *Priolepis* to be assigned to the same genus. Moreover, fishes of the genus *Priolepis* usually do not reach such a large size as those that provided our fossil otoliths. As already stated by BRZOBOHATY et al. (2007: 173), otoliths described as *Gobius* sp. 6 from the Badenian at Gainfarn (BRZOBOHATÝ, 1994: pl. 6, fig. 17, not figs 18-20) and *Gobius praetiosus* PROCHAZKA, 1893 from the Lower Badenian of the Transylvanian Basin (WEILER, 1950: pl. 4, figs 27, ? 25; not PROCHAZKA, 1893) are conspecific with the treated taxon.

***Syacium syacioides* (WEINFURTER, 1952) (8)**

As already stated by SCHWARZHANS (1999), the otoliths described as *Ot.* (Pleuronectidarum) *syacioides* by WEINFURTER (1952d: 480) belong to the genus *Syacium*. They are here compared to those of the Recent *Syacium papillosum* (LINNAEUS, 1758) (pl. 8, fig. 1-2).

***Arnoglossus taureri* (WEINFURTER, 1952) (9)**

The otoliths described as *Solea taureri* by WEINFURTER (1952c: 166) and *Arnoglossus holleri* by WEINFURTER (1952d: 479) are all conspecific, and the generic name *Arnoglossus* is the correct one, see CHAINE (1936: pl. 3) for comparative material of the Recent species *Arnoglossus thori* KYLE, 1913 and *A. laterna* (WALBAUM, 1792).

Description of new species

Order Perciformes BLEEKER, 1859

Family Lethrinidae REGAN, 1913

***Lethrinus styriacus* nov. spec.**
(pl. 7, figs 7-9)

T y p e m a t e r i a l : Holotype: a right otolith (pl. 7, fig. 7); from Gross Sankt Florian, Mühlbauer (Landesmuseum Joanneum in Graz 62 082/41), one paratype from Wetzelsdorf, Winkeltoni (LMJG, nr. 55 863) (pl. 7, fig. 8), and one paratype from Gross Sankt Florian, Mühlbauer (LMJG 62 082/41) (pl. 7, fig. 9).

D i m e n s i o n s o f t h e h o l o t y p e : Length: 4.8 mm, height: 3.0 mm, thickness: 0.9 mm.

T y p e l o c a l i t y : Gross Sankt Florian, Mühlbauer, St. Florian Beds.

E t y m o l o g y : *Styriacus*, a, um (Latin) = from Styria, alludes to the type area where the species occurs.

D i a g n o s i s : This species is characterised by globally elliptical, biaculeate otoliths with crenulated margins. The outer face is concave in all directions, with the strongest concavity in the antero-posterior direction. The inner face has a very smooth surface and is strongly convex in all directions. The sulcus is constituted by a rather wide ostium, especially in its dorsal part, and a narrower cauda that is about twice as long as the ostium and has a general antero-dorsal/postero-ventral orientation. There is a marked depression in the dorsal area, just above the caudal crista superior and accentuating this crest. The holotype shows no ventral furrow, but in the two paratypes some traces of a ventral furrow are visible. Although not perfectly preserved in any of the available specimens, there is a well marked rostrum, a clear excissura, and a small but rather strong antirostrum.

R e m a r k s : Lethrinids are reef-associated fishes represented by many species in the present-day Indo-West Pacific realm. An abundant iconography of the otoliths of Recent lethrinids can be found in NOLF (1993: p. 232, fig. 7), SMALE et al. (1995: pls 92-93) and RIVATON & BOURRET (1999: pls 46-52). Otoliths of our fossil species differ from most of them by their rather regular elliptical outline with acculeate ends.

Conclusions

Systematics

Fifty-seven taxa based on otoliths of bony fishes were identified in the Lower Badenian sediments of the Western Styrian Basin and the Lavanttal Basin. Among them, the genus *Xyrichtys* is documented for the first time from deposits older than the Pliocene. The most diversified associations occur in the St. Florian Beds; the Mühldorf Formation pro-

vided 18 taxa. Five of those were only recorded from the last named formation. "Genus Gobiidarum" *noricus* is reported only from the non-marine younger sediments in the Lavanttal Basin (tab. 2). Skeleton-based taxa from the Eastern Styrian Basin (SCHULTZ 2000, 2004, 2006; SCHULTZ & BELLWOOD 2004) were not documented by otoliths from similar taxa in the Western Styrian Basin or the Lavanttal Basin.

Palaeoenvironment

Based on an actualistic analysis, the otolith associations are indicative of exclusively marine shallow-water fish faunas with dominant demersal and benthopelagic taxa (33 taxa). We did not attach much importance to the quantitative composition of each of the associations because little is known of how these old museum collections were collected (and about eventual lost material). Gobiid otoliths neverthelless seem to constitute a dominant portion in each of the associations that are documented by significant numbers of specimens, e. g., for the Wetzelsdorf sites, gobiid otoliths are represented by 91 % at Ringraben, by 81 % at Winkeltoni, 56 % at Kreuzsholler, 29 % at Thomihiaslgraben and 18 % at Wenzelsteffi.

In the marine upper part of the Mühldorf Formation, this high portion of bottom fishes contrasts with the interpretations of prevailing suboxic condition in the bottom waters during the deposition (REISCHENBACHER et al. 2007). Reef-associated groups are represented by a relatively high number of taxa (*Apogon imberbis*, *Lethrinus*, *Pristigenys*, and approximately *Tylosurus*, *Hemiramphus*, *Serranus*, *Syacium*, *Xyrichthys*). This is in agreement with the presence of small riffs and coral carpets along the Styrian Basin margins in the Early Badenian. Fishes living in somewhat deeper water are individually very scarce (*Phycis blennioides*, *Trigla lyra*, *Hoplobrotula*), and bathypelagic fishes are completely absent. Pelagic (*Bregmaceros*, *Thrissa*, *Tylosurus*) and a poorly diversified amount of mesopelagic fishes (Myctophidae) are rare. This indicates an environment that was only poorly exposed to the deeper waters of the open sea. The myctophids however, are more diversified (3 genera) than the ones of shallow-water assemblages of Middle and Upper Badenian age in the Vienna Basin (e.g. Kienberg – BRZOBOHATÝ et al. 2007; Devínská Nová Ves, Rohožník – HOLEC 1973, 1975). This can be interpreted as resulting from a deep connection of the Central Paratethys with the Mediterranean during the Early Badenian (e.g. BRZOBOHATÝ 1995).

Climate

Climatic requirements of fishes of the St. Florian Beds show clearly tropic-subtropic climate (3 genera, *Thrissa*, *Lethrinus*, *Syacium*, are tropic and others tropic or subtropic). The mesopelagic myctophids exhibit a wider climatic range. This is also supported by data on molluscs (HARZHAUSER et al. 2003), echinoderms (KROH 2007), and sharks (HIDEN 1995) in the Early Badenian of the area under study. The extant *Phycis blennioides* lives mainly in warm temperate waters, including the Mediterranean. Other gadoids requiring cooler waters were not found; this feature was also noted by WEINFURTER (1952d). In the southern basins of the Central Paratethys, the first occurrence of diversified gadoids begins stratigraphically higher – in the Upper Lagenidae Zone (BRZOBOHATÝ 1978; BRZOBOHATÝ et al. 2007). The presence of tropic fishes proves that the studied localities in the St. Florian Beds and the Mühldorf Formation stratigraphi-

Families	Taxa		Iconography
Heterenchelyidae	*Panturichthys subglaber* (SCHUBERT, 1906)		BNK, 2007, pl. 1, figs 6-8
Congridae	*Ariosoma balearicum* (DELAROCHE, 1809)		pl. 1, figs 1-3
	Rhynchoconger pantanellii (BASSOLI & SCHUBERT, 1906)		pl. 1, fig. 4
Clupeidae	Clupeidae		-
Engraulidae	*Thrissa floriani* (WEINFURTER, 1952) **(1)**	*	pl. 1, figs 6-7
Ariidae	*Arius nucleus* (WEINFURTER, 1952) **(2)**	*	pl. 1, fig. 5
Synodontidae	*Saurida germanica* (WEILER, 1942)		BNK, 2007, pl. 1, figs 12-13
Myctophidae	*Hygophum murbani* (WEINFURTER, 1952)		pl. 2, figs 1-2
	Diaphus regani TAANING, 1932		pl. 2, figs 7-9
	Diaphus sp.		-
	Notoscopelus cf. *mediterraneus* (KOKEN, 1891)		-
Bregmacerotidae	*Bregmaceros albyi* (SAUVAGE, 1880)		pl. 2, figs 5-6
Carapidae	*Carapus* aff. *acus* (BRÜNNICH, 1768)		pl. 2, figs 3-4
Ophidiidae	***Hoplobrotula acutangula*** (KOKEN, 1884)		pl. 3, fig. 2
Phycidae	*Phycis blennioides* (BRÜNNICH, 1768)		pl. 3, fig. 1
Atherinidae	"genus Atherinidarum"***bavayi*** STEURBAUT, 1984 (3)	*	pl. 3, fig. 5
Belonidae	*Tylosurus wetzelsdorfensis* (WEINFURTER, 1952) **(4)**		pl. 3, fig. 4
Hemiramphidae	*Hemiramphus miocenicus* (WEINFURTER, 1952)		pl. 3, fig. 7
Triglidae	***Trigla*** aff. ***lyra*** LINNAEUS, 1758		pl. 4, fig. 10
Ambassidae	*Ambassis* sp.	*	pl. 3, fig. 6
Serranidae	*Serranus integer* (SCHUBERT, 1906)		pl. 4, figs 6-7
Priacanthidae	*Pristigenys rhombicus* (SCHUBERT, 1906)		BNK, 2007, pl. 4, fig. 13
Apogonidae	*Apogon* aff. *imberbis* LINNAEUS, 1758		pl. 3, fig. 3
Sillaginidae	*Sillago schwarzhansi* STEURBAUT, 1984		pl. 4, figs 8-9
Carangidae	*Trachurus* aff. *picturatus* (BOWDICH, 1825)		BNK, 2007, pl. 7, figs 13-15
Leiognathidae	*Gazza hilberi* (WEINFURTER, 1952) **(5)**	*	pl. 5, fig. 1
Gerreidae	*Gerres* sp. 1		pl. 5, fig. 5
	Gerres sp. 2	*	pl. 5, figs 2-3
Haemulidae	*Brachydeuterus speronatus* (BASSOLI, 1906)		BNK, 2007, pl. 5, figs 1-10
	Pomadasys aff. *incisus* (BOWDICH, 1825)		BNK, 2007, pl. 5, fig. 11
	"genus Haemulidarum" *lucidus* (BASSOLI, 1906)	*	pl. 5, fig. 6
Lethrinidae	*Lethrinus styriacus* n. sp.	*	pl. 7, figs 7-9
Sparidae	*Boops boops* (LINNAEUS, 1758)		pl. 5, fig. 8
	Dentex aff. *maroccanus* VALENCIENNES, 1830		BNK, 2007, pl. 5, figs 12-14
	Diplodus cf. *puntazzo* (CETTI, 1777)		BNK, 2007, pl. 6, fig. 1
	Lithognathus mormyrus (LINNAEUS, 1758)		pl. 5, fig. 7
	Spondyliosoma cantharus (LINNAEUS, 1758)		BNK, 2007, pl. 6, figs 10-12
	Pagellus erythrinus (LINNAEUS, 1758)		BNK, 2007, pl. 6, figs 8-9
Sciaenidae	*Sciaena* sp.		pl. 6, fig. 4
	[Sciaenidae ind.] (6)		pl. 6, figs 1-2
Polynemidae	"g. Polynemidarum" *huyghebaertae* STEURBAUT, 1984		pl. 5, fig. 4
Cepolidae	*Cepola rubescens* LINNAEUS, 1766		pl. 6, fig. 3
Labridae	*Xyrichtys* sp.	*	pl. 6, fig. 6
Trachinidae	*Trachinus vipera* CUVIER, 1829		pl. 6, fig. 5
Gobiidae	*Deltentosteus telleri* (SCHUBERT, 1906)		BNK, 2007, pl. 8, figs 2-5
	Gobius aff. *multipinnatus* (VON MEYER, 1852)		BNK, 2007, pl. 8, figs 6-8
	Lesueurigobius aff. *vicinalis* (KOKEN, 1891)		BNK, 2007, pl. 8, figs 12-14
	? *Oxyurichthys* sp.		pl. 7, figs 1-3
	"genus Gobiidarum" *noricus* WEINFURTER, 1952	L	pl. 8, fig. 12
	"genus Gobiidarum" sp. 1		pl. 7, fig. 5-6
	"genus Gobiidarum" sp. 2 (7)		pl. 7, fig. 10
	[Gobiidae ind.]		-
Citharidae	***Citharus linguatula*** (LINNAEUS, 1758)		pl. 8, fig. 3
Paralichthyidae	*Syacium syacioides* (WEINFURTER, 1952) **(8)**		pl. 8, fig. 4
Bothidae	*Arnoglossus taureri* (WEINFURTER, 1952) **(9)**		pl. 8, figs 8-10
Soleidae	*Buglossidium frequens* STEURBAUT, 1984		pl. 8, figs 5-6
	Dicologlossa hexophthalma (BENNETT, 1831)		pl. 8, fig. 11
	Cynoglossus leuchsi WEINFURTER, 1952		pl. 8, fig. 7

cally correspond to a lower part of the Weissenegg Formation in the Eastern Styrian Basin. In the upper part of this formation, a deposition of red algal and corallinaceous limestones terminated in connection with a cooling, as indicated by isotopic studies (BOJAR et al. 2004).

Palaeogeography

Taxa inhabiting the present-day Atlantic or the Eastern Atlantic–Mediterranean region dominate, but the number of taxa with the present-day Indo-Pacific distribution is also relatively high (*Thrissa*, *Diaphus regani*, *Hoplobrotula*, *Ambassis*, *Gazza*, *Sillago*, *Lethrinus*, *Oxyurichthys*). However, five of those taxa are already known in the European region before the beginning of the Middle Miocene and can be considered as descendants from earlier established residents.

The non neglectable Indo-Pacific component, the tropical to subtropical affinities of the association, and the presence of nine taxa (*Thrissa floriani*, *Arius nucleus*, "g. Atherinidarum" *bavayi*, *Ambassis* sp., *Gazza hilberi*, *Gerres* sp. 2, "genus Haemulidarum" *lucidus*, *Lethrinus styriacus*, and *Xyrichtys* sp.) representing the Badenian record from the Styrian Basin only (tab. 1), support a specific nature of the West Styrian otolith association among known Central Paratethys ones. However, a comparison with contemporaneous faunas from different areas is not evident. Otolith associations from the Transylvanian Basin and the Carpathian Foredeep in Moravia represent bathymetrical deeper fish assemblages. In the Vienna Basin, only a small fauna is reported from the Lower Lagenidae Zone (Niederleis, SCHUBERT 1906). More than 20 species (43 %) of the Styrian taxa occur contemporaneously in the Korytnica Clay (Carpathian Foredeep, southern Poland, RADWAŃSKA 1992). In contrast to the assemblages under study, the Korytnica otoliths have a markedly higher number of non-termophyllic gadoids, which agrees with a marginal northern position of the Korytnica Bay in the Central Paratethys (HARZHAUSER et al. 2003; BRZOBOHATÝ et al. 2007; KROH 2007; HARZHAUSER & PILLER 2007).

Outside the Paratethys, in the Mediterranean, contemporaneous neritic otolith associations are scarce. In fact, they are only well documented from Burdigalian/Langhian boundary sediments in the Vallés-Penedés area, Catalunya, Spain, (HOEDEMAKERS & BATTLORI 2005) where quite similar faunas have been found. Thirteen (28 %) of the nominal species from the Styrian Basin also occur in this last region.

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◀ Table 1. List of teleost species represented by otoliths in the Badenian of the Styrian and Lavanttal basins. Numbers in brackets behind taxon names indicate problematic taxa discussed in the text. Bold taxa are refer to taxa recorded from Mühldorf only, taxa occurring in the Lavanttal only are marked by a bold L. Asterisks mark taxa that are recorded from the Badenian of the Styrian Basin only. BNK, 2007 = BRZOBOHATÝ, NOLF & KROUPA, 2007.

WEINFURTER (1952b, 1952c, 1952d) (1)	This paper
Apogon imberboides WEINFURTER, 1952d	*Apogon* aff. *imberbis* LINNAEUS, 1758
Arnoglossus holleri WEINFURTER, 1952d	*Arnoglossus taureri* (WEINFURTER, 1952)
? *Box insignis* (PROCHAZKA) (in WEINFURTER, 1952 d)	indeterminata (Percoidei)
Chrysophris doderleini SCHUBERT & BASSOLI (in W., 1952 d)	indeterminata (Percoidei)
Centropriscus integer SCHUBERT (in WEINFURTER, 1952 d)	*Serranus integer* (SCHUBERT, 1906)
Cepola praerubescens BASSOLI & SCHUBERT (in W., 1952c, 1952d)	*Cepola rubescens* LINNAEUS, 1766
Chirodorus miocaenicus WEINFURTER, 1952d	*Hemiramphus miocenicus* (WEINFURTER, 1952)
Clupea aff. *testis* (KOKEN) (in WEINFURTER, 1952c)	Clupeidae indet.
Clupea sp. (in WEINFURTER, 1952d)	Clupeidae indet.
Congermuraena moravica (SULC, 1932) (in WEINFURTER, 1952c)	*Ariosoma balearicum* (DELAROCHE, 1809)
? *Cottus germanicus* WEILER (in WEINFURTER, 1952c)	*Saurida germanica* (WEILER, 1942)
Cynoglossus leuchsi WEINFURTER, 1952d	*Cynoglossus leuchsi* WEINFURTER, 1952
Dentex latior SCHUBERT (in WEINFURTER, 1952d)	*Brachydeuterus speronatus* (BASSOLI, 1906)
Dentex aff. *latior* SCHUBERT (in WEINFURTER, 1952c)	"genus Atherinidarum" *bavayi* STEURBAUT, 1984
Dentex nobilis KOKEN (in WEINFURTER, 1952d)	indeterminata (Percoidei)
Eucitharus rhenanus (KOKEN) (in WEINFURTER, 1952c)	*Citharus linguatula* (LINNAEUS, 1758)
Fierasfer nuntius KOKEN (in WEINFURTER, 1952c, 1952d)	*Carapus acus* (BRÜNNICH, 1768)
Gobius noricus WEINFURTER, 1952 b	"genus Gobiidarum" *noricus* (WEINF., 1952)
Gobius carinthiacus WEINFURTER, 1952 b	Gobiidae indet.
Gobius aff. *pretiosus* PROCHAZKA (in WEINFURTER, 1952b, 1952d)	Gobiidae indet.
Gobius telleri SCHUBERT (in WEINFURTER, 1952c, 1952d)	*Deltentosteus telleri* (SCHUBERT, 1906)
Gobius pretiosus PROCHAZKA (in WEINFURTER, 1952c)	Gobiidae indet.
Gobius vicinalis KOKEN (in WEINFURTER, 1952c, 1952d)	*Lesueurigobius* aff. *vicinalis* (KOKEN, 1891)
Mugil sp. (in WEINFURTER, 1952d)	indeterminata (Perciformes)
Ot. (Congridarum) *pantanellii* (BASSOLI & SCHUBERT) (in W., 1952c)	*Rhynchoconger pantanellii* (B. & SCH., 1891)
Ot. (inc. sed.) *hassovicus* KOKEN (in WEINFURTER, 1952 d)	*Sillago schwarzhansi* STEURBAUT, 1984
Ot. (inc. sed.) *nucleus* WEINFURTER, 1952d	*Arius nucleus* (WEINFURTER, 1952)
Ot. (inc. sed.) *wetzelsdorfensis* WEINFURTER, 1952d	*Tylosurus wetzelsdorfensis* (WEINFURTER, 1952)
Ot. (Ophidiidarum) *joachimicus* (KOKEN) (in WEINFURTER., 1952c)	*Hoplobrotula acutangula* (KOKEN, 1884)
Ot. ?(*Pagellus*) *gregarius* (KOKEN) (in WEINFURTER., 1952c)	*Dentex* aff. *maroccanus* VALENCIENNES, 1830
Ot. (Percidarum) *floriani* WEINFURTER, 1952d	*Thrissa floriani* (WEINFURTER, 1952)
Ot. (Pleuronectidarum) *syacioides* WEINFURTER, 1952d	*Syacium syacioides* (WEINFURTER, 1952)
Ot. (Sciaenidarum) *styriacus* (WEINFURTER, 1952d)	Sciaenidae indet.
Ot. (*Smaris*) *elegans* (PROCHAZKA) (in WEINFURTER, 1952 d)	indeterminata (Percoidei)
Ot. (Sparidarum) *gregarius* KOKEN (in WEINFURTER, 1952 d) (erroneous reference to iconography in WEINFURTER, 1952 d)	*Dentex* aff. *maroccanus* VALENCIENNES, 1830
Ot. (Sparidarum) *gregarius papyraceus* WEINFURTER, 1952 d	indeterminata (Percoidei)
Ot. (*? Xenodermichthys*) *catulus* SCHUBERT (in W., 1952c, 1952d)	*Bregmaceros albyi* (SAUVAGE, 1880)
Phycis simplex (KOKEN) (in WEINFURTER, 1952d)	*Phycis blennioides* (BRÜNNICH, 1768)
Pristipoma arcuata (BASSOLI & SCHUBERT) (in WEINFURTER, 1952d)	*Pomadasys* aff. *incisus* (BOWDICH, 1825)
Scopelus debilis austriacus (KOKEN) (in WEINFURTER, 1952c, 1952d)	*Diaphus* sp. indet.
Scopelus mediterraneus (KOKEN) (in WEINFURTER, 1952d)	*Notoscopelus* cf. *mediterraneus* (KOKEN, 1891)
Scopelus pulcher (PROCHAZKA) (in WEINFURTER, 1952c, 1952d)	*Diaphus* sp. indet.
Scopelus tenuis murbani WEINFURTER, 1952d	*Hygophum murbani* (WEINFURTER, 1952)
Serranus noetlingi KOKEN (in WEINFURTER, 1952d)	indeterminata (Percoidei)
Serranus sp. (in WEINFURTER, 1952c) (= htp. of *Serranus noetlingi muhldorfensis* WEINFURTER, 1949)	*Lithognathus mormyrus* (LINNAEUS, 1758)
Solea kokeni BASSOLI & SCHUBERT (in WEINFURTER, 1952d)	*Arnoglossus taureri* (WEINFURTER, 1952)
Solea latior SCHUBERT (in WEINFURTER, 1952d)	indeterminata (Soleidae)
Solea subglaber SCHUBERT (in WEINFURTER, 1952c, 1952d)	*Panturichthys subglaber* (SCHUBERT, 1906)
Solea subvulgaris SCHUBERT (in WEINFURTER, 1952d)	indeterminata (Soleidae)
Solea taureri WEINFURTER, 1952c	*Arnoglossus taureri* (WEINFURTER, 1952)
Sphyraena cf. *hansfuchsi* SCHUBERT (in WEINFURTER, 1952d)	*Saurida germanica* (WEILER, 1942)
Trachinus biscissus KOKEN (in WEINFURTER, 1952d)	*Trachinus vipera* CUVIER, 1829
Trigla asperoides SCHUBERT (in WEINFURTER, 1952c)	*Trigla* aff. *lyra* LINNAEUS, 1758
Trigla cf. *asperoides* SCHUBERT (in WEINFURTER, 1952d)	indeterminata (Triglidae)
Trigla (?) *hilberi* WEINFURTER, 1952d	*Gazza hilberi* (WEINFURTER, 1952)
Trigla rhombica Schubert (in WEINFURTER, 1952d)	*Pristigenys rhombicus* (SCHUBERT, 1906)
Umbrina gibberula (KOKEN) (in WEINFURTER, 1952d)	*Sciaena* sp.

(1) evaluation of the species described previously to WEINFURTER (1952 b, c and d) concern the Styrian material cited by WEINFURTER only, not necessary the primary type material of the concerned species. In the first column, spelling is the original one used by WEINFURTER.

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◄ Table 2: Alphabetic list of the taxa cited by WEINFURTER (1952b, c, d) from the Styrian and Lavanttal basins.

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Explanation of the Plates

All figured fossil specimens are deposited in the collections of the Landesmuseum Joanneum, Graz (LMJG), the Kärnter Landesmuseum, Klagenfurt (LMKK), and the Krahuletz Museum, Eggenburg (KME). Some additional comparative specimens from the Institut royal des Siences naturelles de Belgique (IRSNB) and from the Geologische Bundesanstalt Wien (GBW) are also figured. The Recent otoliths are part of the reference collection of Recent otoliths of the IRSNB. The latter collection is arranged in systematic order without numbering. Therefore, such specimens, when figured, bear only the notation "coll. IRSNB". The annotations F and R in the upper right corner of each compartment of the plates indicate if the figures in that compartment are fossils (F) or Recent (R). Recent species occuring as fossils are labeled with [(F)]. The annotations a, b and c in each compartment of the plates are used to indicate respectively ventral, inner (= mesial) and posterior views. Figures with only numbers and no letter show inner views. The scale bar in each compartment equals 1 mm. In the captions, L stands for left otolith and R for right otolith.

Plate 1

Figs 1-3. *Ariosoma balearicum* (DeLaroche, 1809), L, Wetzelsdorf, Winkeltoni (LMJG 2362, coll. 76970).

Fig. 4. *Rhynchoconger pantanellii* (Bassoli & Schubert, 1906), L, Lavanttal, Mühldorf (coll. LMKK).

Fig. 5. *Arius nucleus* (Weinfurter, 1952), R, Gross Sankt Florian, Mühlbauer, Holotype (LMJG 62 082/8).

Figs 6-7. *Thrissa floriani* (Weinfurter, 1952), Gross Sankt Florian, Mühlbauer, 6 = L, holotype (LMJG 62 082/10), 7 = R, paratype (LMJG 62 082/11).

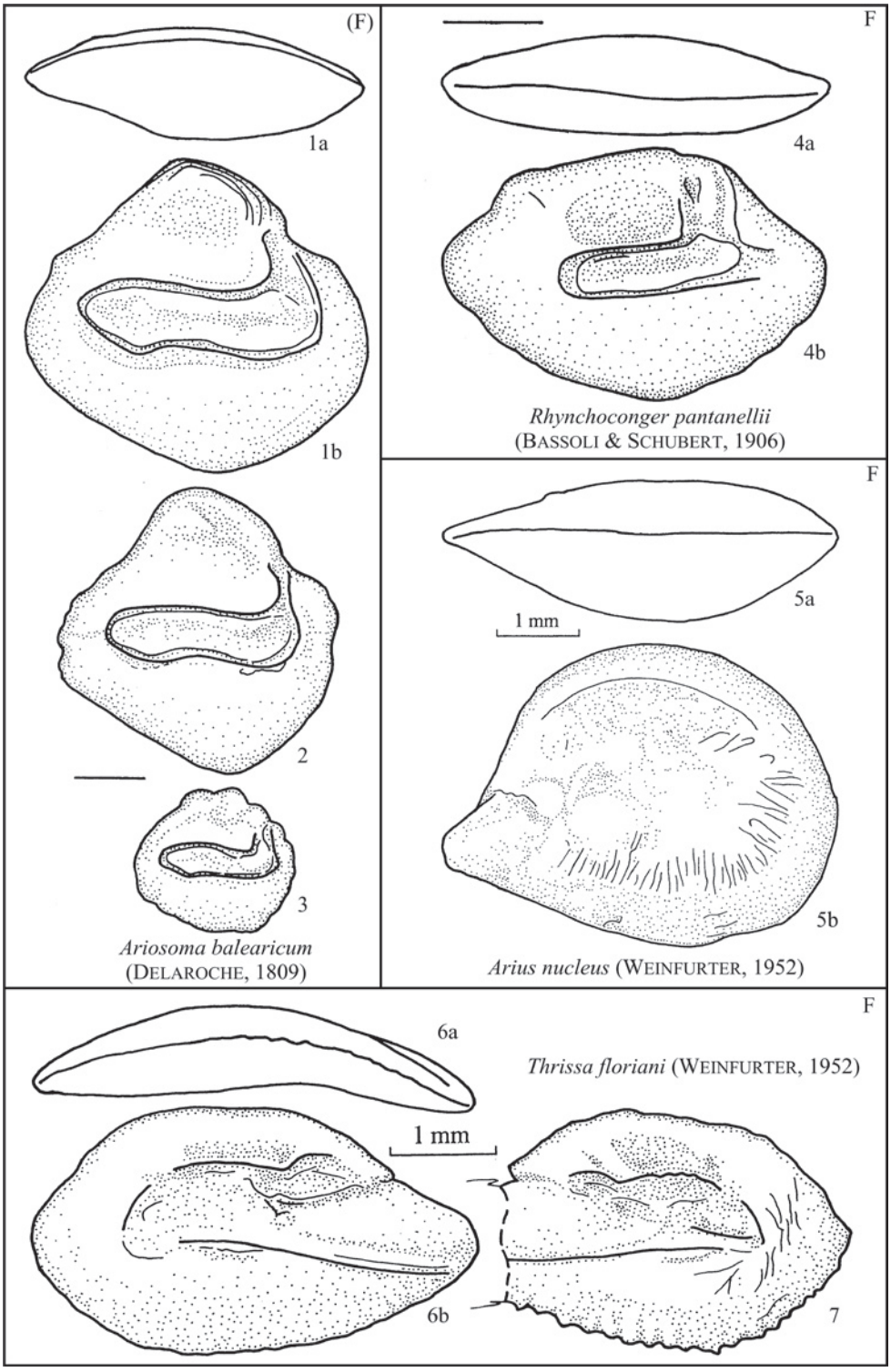

(F)
1a
1b
2
3
Ariosoma balearicum
(DELAROCHE, 1809)
F
4a
4b
Rhynchoconger pantanellii
(BASSOLI & SCHUBERT, 1906)
F
5a
1 mm
5b
Arius nucleus (WEINFURTER, 1952)
F
6a
Thrissa floriani (WEINFURTER, 1952)
1 mm
6b
7

Plate 2

Figs 1-2. *Hygophum murbani* (WEINFURTER, 1952), 1 = L, Brno – Královo Pole, Czech Republic (IRSNB P 6600), 2 = R, Wetzelsdorf, Thomihiaslgraben, Holotype (LMJG 62 082/14).

Figs 3-4. *Carapus* aff. *acus* (BRÜNNICH, 1768), R, Wetzelsdorf, Winkeltoni (LMJG no 2362, coll. 76 970).

Figs 5-6. *Bregmaceros albyi* (SAUVAGE, 1880), 5 = R, 6 = L, Lavanttal, Mühldorf (coll. LMKK).

Figs 7-9. *Diaphus regani* TAANING, 1932, L, Wetzelsdorf, Winkeltoni (LMJG 76971 or 55863).

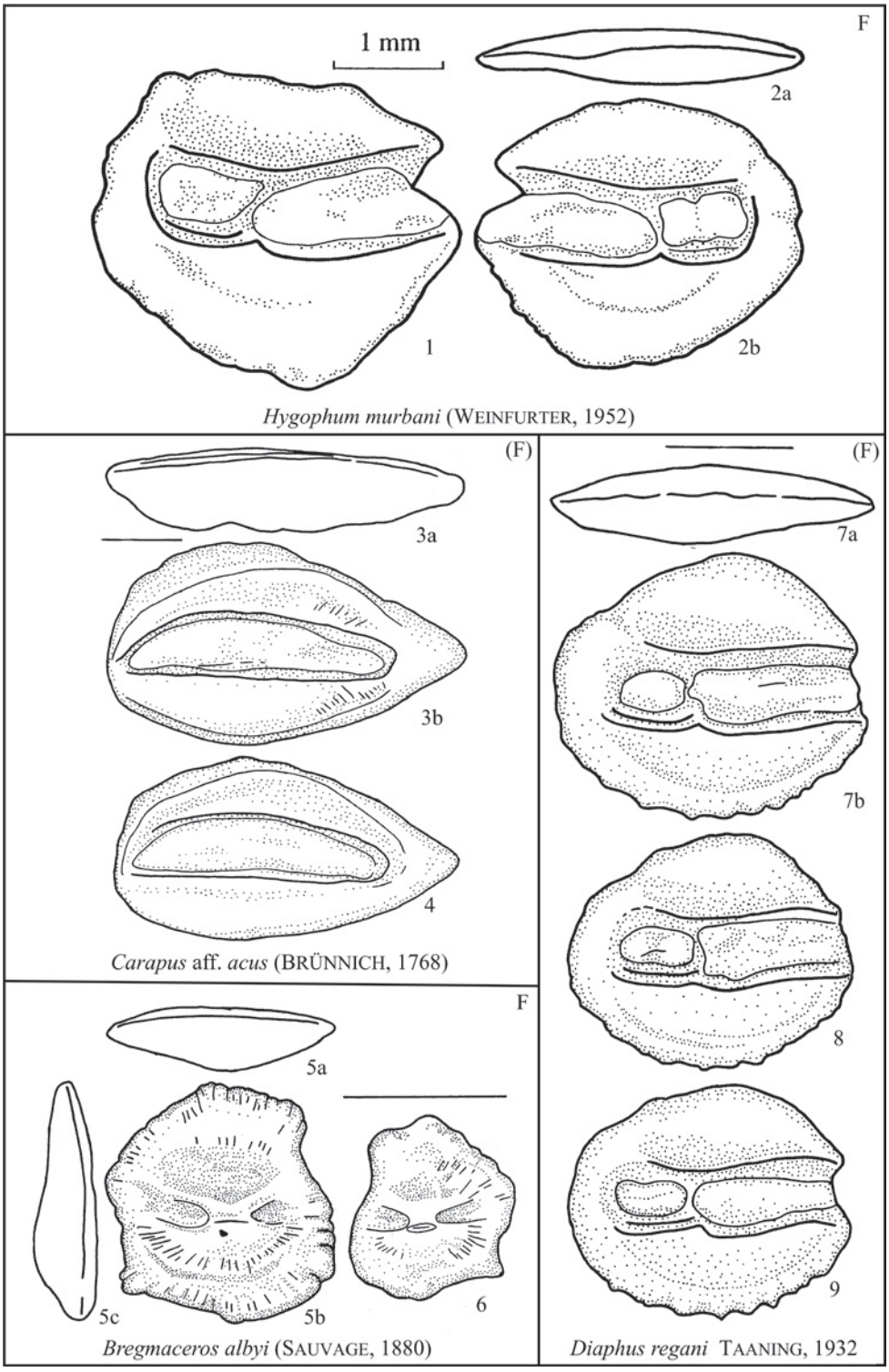

F
1 mm
2a
1
2b
Hygophum murbani (WEINFURTER, 1952)
(F)
3a
3b
4
Carapus aff. acus (BRÜNNICH, 1768)
F
5a
5c
5b
6
Bregmaceros albyi (SAUVAGE, 1880)
(F)
7a
7b
8
9
Diaphus regani TAANING, 1932

Plate 3

Fig. 1. *Phycis blennioides* (BRÜNNICH, 1768), R, Wetzelsdorf, Wenzelsteffi (LMJG 62082/28).

Fig. 2. *Hoplobrotula acutangula* (KOKEN, 1884), R, Lavanttal, Mühldorf (coll. LMKK).

Fig. 3. *Apogon* aff. *imberbis* LINNAEUS, 1758, L, Gross Sankt Florian, Mühlbauer, holotype of *Apogon imberboides* WEINFURTER, 1952 (LMJG inv. nr. 62 082/1).

Fig. 4. *Tylosurus wetzelsdorfensis* (WEINFURTER, 1952), L, Wetzelsdorf, Wenzelsteffi, holotype (LMJG 62082/7).

Fig. 5. "genus Atherinidarum" *bavayi* STEURBAUT, 1984, R, Lavanttal, Mühldorf (coll. LMKK).

Fig. 6. *Ambassis* sp., L, Gross Sankt Florian, Mühlbauer, (LMJG 62082/39).

Fig. 7. *Hemiramphus miocenicus* (WEINFURTER, 1952), R, Gross Sankt Florian, Kogelbauer, holotype (LMJG 62082/13).

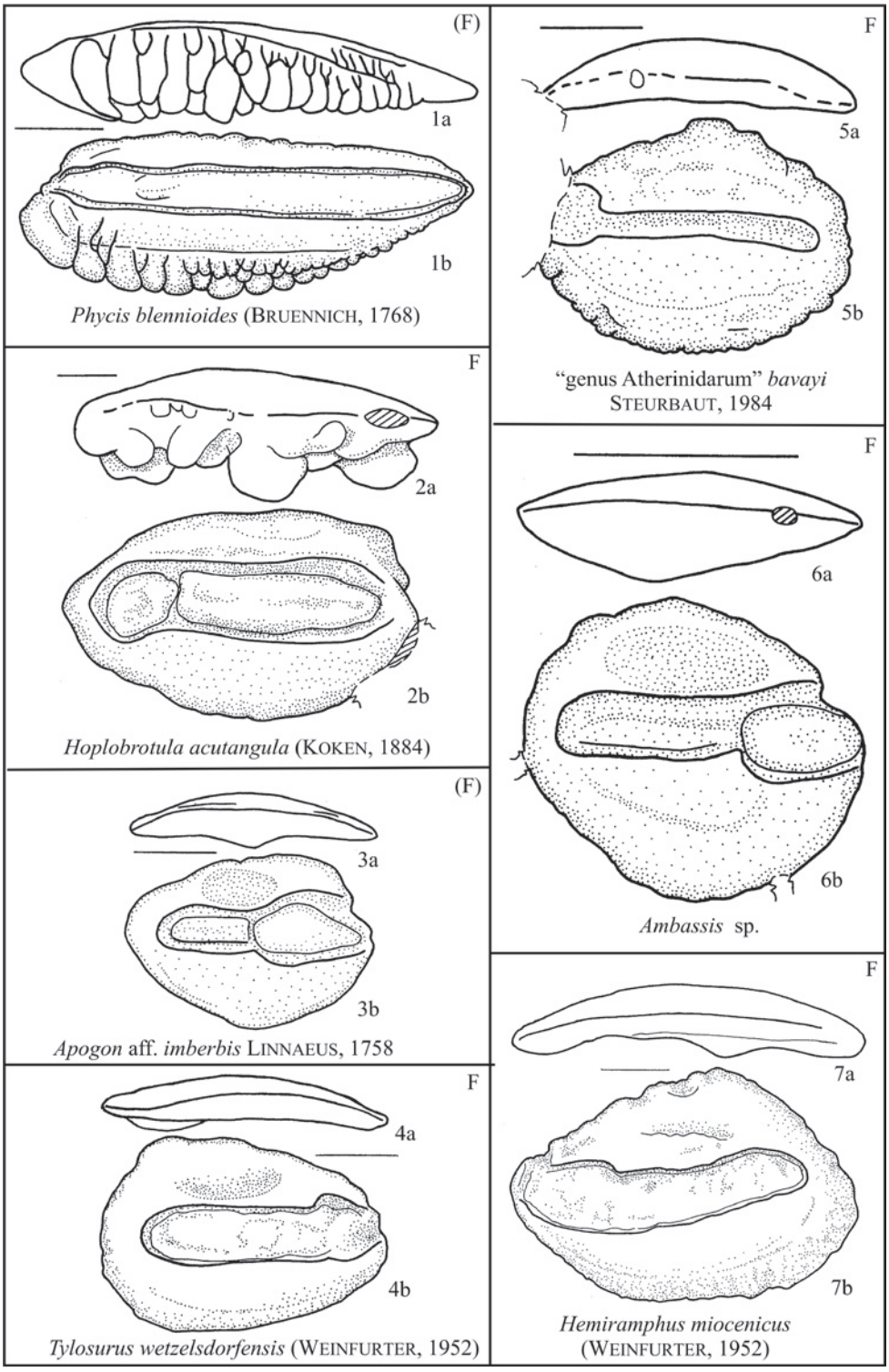

(F)
1a
1b
Phycis blennioides (BRUENNICH, 1768)
F
2a
2b
Hoplobrotula acutangula (KOKEN, 1884)
(F)
3a
3b
Apogon aff. imberbis LINNAEUS, 1758
F
4a
4b
Tylosurus wetzelsdorfensis (WEINFURTER, 1952)
F
5a
5b
"genus Atherinidarum" bavayi
STEURBAUT, 1984
F
6a
6b
Ambassis sp.
F
7a
7b
Hemiramphus miocenicus
(WEINFURTER, 1952)

Plate 4

Figs 1-5. *Trigla lyra* LINNAEUS, 1758, L, Recent, 1-2 = eastern Atlantic, off Casablanca, Morocco, 3 = Mallorca, 4-5 = Mediterranean, Côte d'Azur, France (coll. IRSNB).

Figs 6-7. *Serranus integer* (SCHUBERT, 1906), 6 = R, Wetzelsdorf, Winkeltoni (LMJG coll. nr. 55863), 7 = L, Steinabrunn, holotype (GBW 1906/01/13).

Figs 8-9. *Sillago schwarzhansi* STEURBAUT, 1984, L, 8 = Wetzelsdorf, Thomihieslgraben (LMJG coll. nr. 55861), 9 = Wetzelsdorf, Winkeltoni (LMJG coll. nr. 55863).

Fig. 10. *Trigla* aff. *lyra* LINNAEUS, 1758, L, Lavanttal, Mühldorf (coll. LMKK).

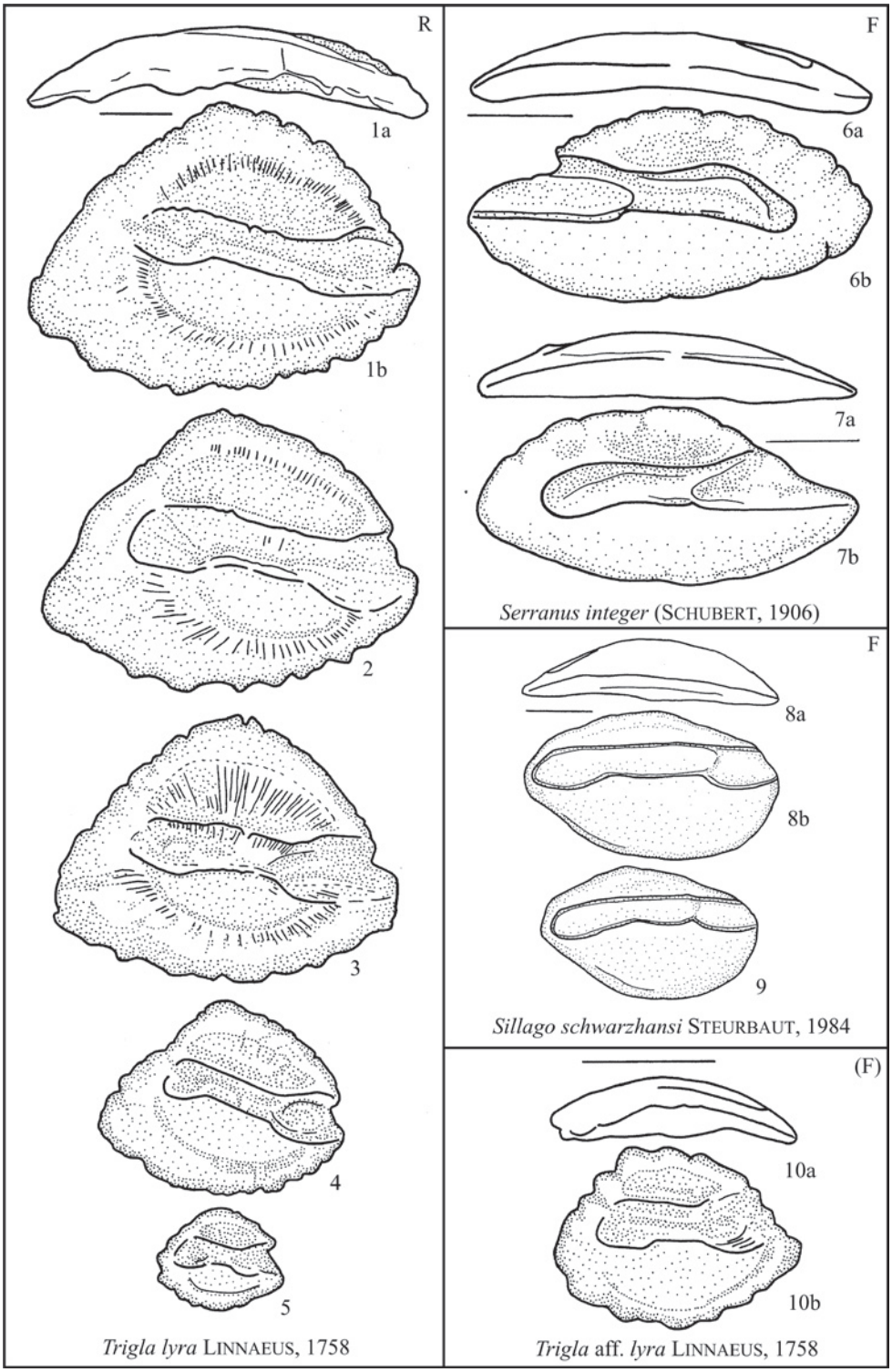

R
1a
1b
2
3
4
5
Trigla lyra LINNAEUS, 1758
F
6a
6b
7a
7b
Serranus integer (SCHUBERT, 1906)
F
8a
8b
9
Sillago schwarzhansi STEURBAUT, 1984
(F)
10a
10b
Trigla aff. lyra LINNAEUS, 1758

Plate 5

Fig. 1. *Gazza hilberi* (WEINFURTER, 1952), L, Gross Sankt Florian, Mühlbauer, holotype (LMJG 62 082).

Figs 2-3. *Gerres* sp. 2, L, Gross Sankt Florian, Mühlbauer (LMJG 62082).

Fig.4. "genus Polynemidarum" *huyghebaertae* STEURBAUT, 1984, L, Wetzelsdorf, Wenzelsteffi (LMJG nr 55865).

Fig. 5. *Gerres* sp. 1, R, Wetzelsdorf, Wenzelsteffi (LMJG 55863).

Fig. 6. "genus Haemulidarum" *lucidus* (BASSOLI, 1906), R, Wetzelsdorf, Wenzelsteffi (LMJG 62 082/29).

Fig. 7 *Lithognathus mormyrus* (LINNAEUS, 1758), R, Wetzelsdorf, Kreuzschaller (LMJG 5331).

Fig. 8 *Boops boops* (LINNAEUS, 1758), R, Wetzelsdorf, Winkeltoni (LMJG coll. nr. 55 863).

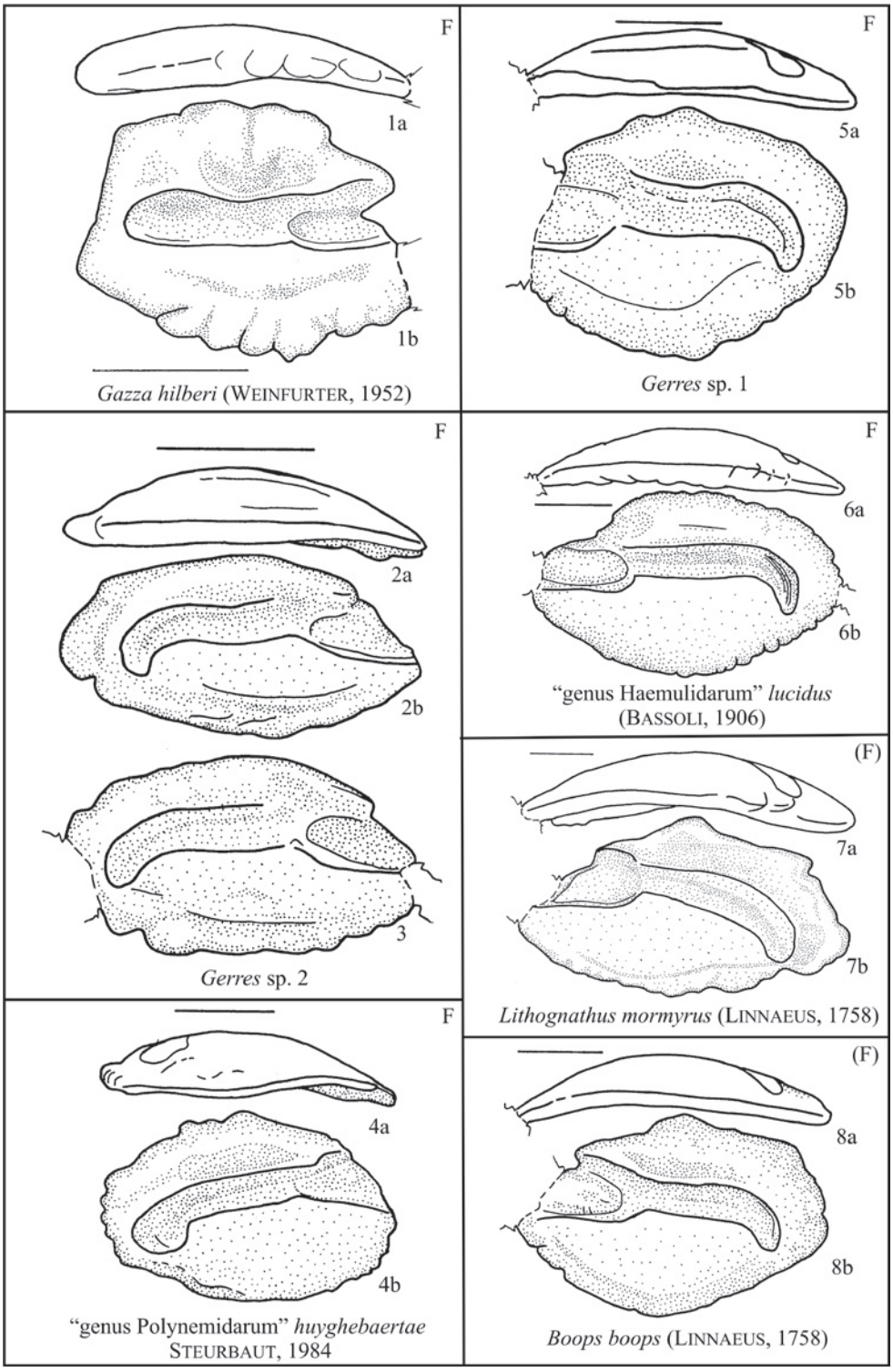

F
1a
1b
Gazza hilberi (WEINFURTER, 1952)
F
5a
5b
Gerres sp. 1
F
2a
2b
3
Gerres sp. 2
F
6a
6b
"genus Haemulidarum" lucidus
(BASSOLI, 1906)
(F)
7a
7b
Lithognathus mormyrus (LINNAEUS, 1758)
F
4a
4b
"genus Polynemidarum" huyghebaertae
STEURBAUT, 1984
(F)
8a
8b
Boops boops (LINNAEUS, 1758)

Plate 6

Figs 1-2. Sciaenidae ind., 1 = L, holotype of *Ot.* (Sciaenidarum) *kittli* SCHUBERT, 1902 (GBW 1860/1/50/2), Kienberg, Czech Republic, 2 = R, holotype of *Ot.* (Sciaenidarum) *styriacus* (WEINFURTER, 1952), Wetzelsdorf, Kreuzschaller (LMJG 62 082/4).

Fig. 3. *Cepola rubescens* LINNAEUS, 1758, R, Lavanttal, Mühldorf (coll. LMKK).

Fig. 4. *Sciaena* sp., R, Wetzelsdorf, Wenzelsteffi (LMJG 62 082/19).

Fig. 5. *Trachinus vipera* CUVIER, 1829, R, Wetzelsdorf, Wenzelsteffi (LMJG 62 082/18).

Fig. 6. *Xyrichtys* sp., R, Wetzelsdorf, Winkeltoni (LMJG nr. 2362, coll. 76970).

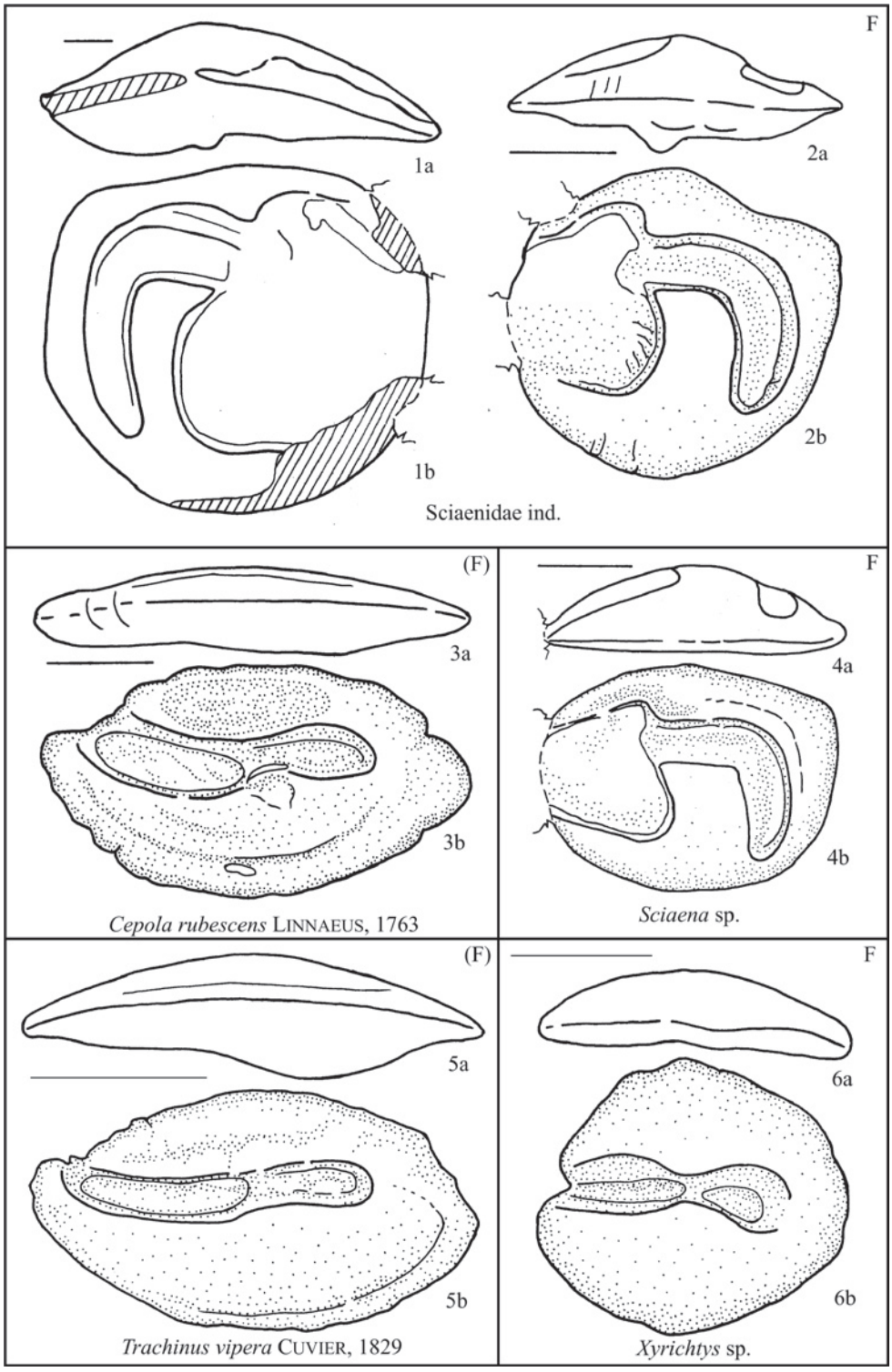

F
1a
1b
2a
2b
Sciaenidae ind.
(F)
3a
3b
Cepola rubescens LINNAEUS, 1763
F
4a
4b
Sciaena sp.
(F)
5a
5b
Trachinus vipera CUVIER, 1829
F
6a
6b
Xyrichtys sp.

Plate 7

Figs 1-3. ? *Oxyurichthys* sp., 1-2 = L, 3 = R, Wetzelsdorf, Winkeltoni (LMJG nr. 2362, coll. 76970).

Fig. 4. *Priolepis hipoliti* (METZELAAR, 1922), L, Recent, Caribbean, off Tobago (coll. IRSNB).

Figs 5-6. "genus Gobiidarum" sp. 1, L, Wetzelsdorf, Winkeltoni (coll. LMJG).

Figs 7-9. *Lethrinus styriacus* n. sp., R, 7 and 9 = Gross Sankt Florian, Mühlbauer, 7 = holotype (LMJG 62 082/41), 9 = paratype (LMJG 62 082/41), 8 = Wetzelsdorf, Winkeltoni, paratype (LMJG, nr. 55 863).

Fig. 10 "genus Gobiidarum" sp. 2, R, Wetzelsdorf, Thomihiaslgraben (LMJG, nr. 55 861).

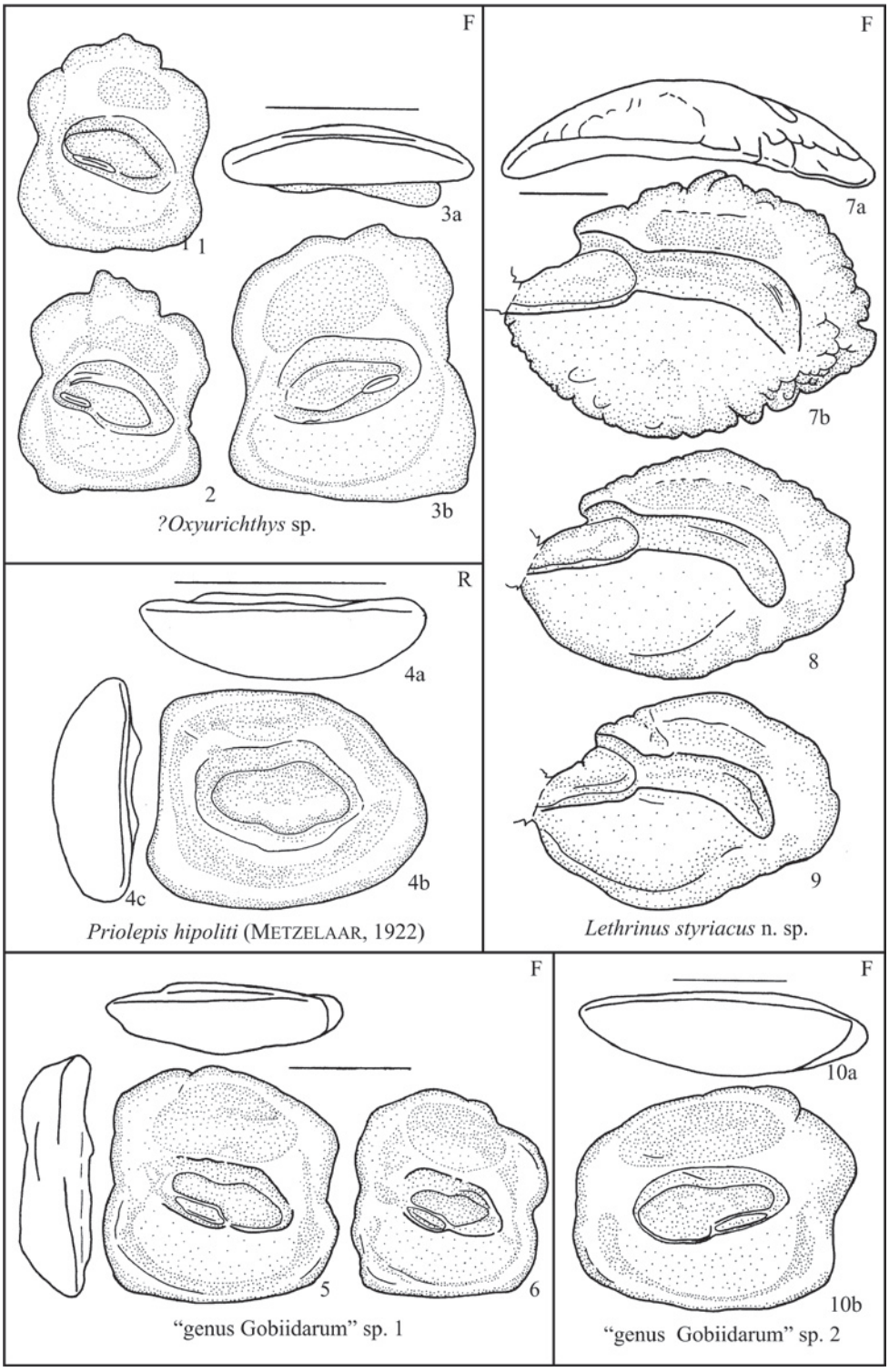

F
1
3a
2
3b
?Oxyurichthys sp.
R
4a
4c
4b
Priolepis hipoliti (METZELAAR, 1922)
F
7a
7b
8
9
Lethrinus styriacus n. sp.
F
5
6
"genus Gobiidarum" sp. 1
F
10a
10b
"genus Gobiidarum" sp. 2

Plate 8

Figs. 1-2. *Syacium papillosum* (LINNAEUS, 1758), 1 = L, 2 = R, Recent, Atlantic, USA (coll. IRSNB).

Fig. 3. *Citharus linguatula* (LINNAEUS, 1758), R, Lavanttal, Mühldorf (coll. LMKK).

Fig. 4. *Syacium syacioides* (WEINFURTER, 1952), R, Gross Sankt Florian, Mühlbauer, holotype (LMJG 62082/2).

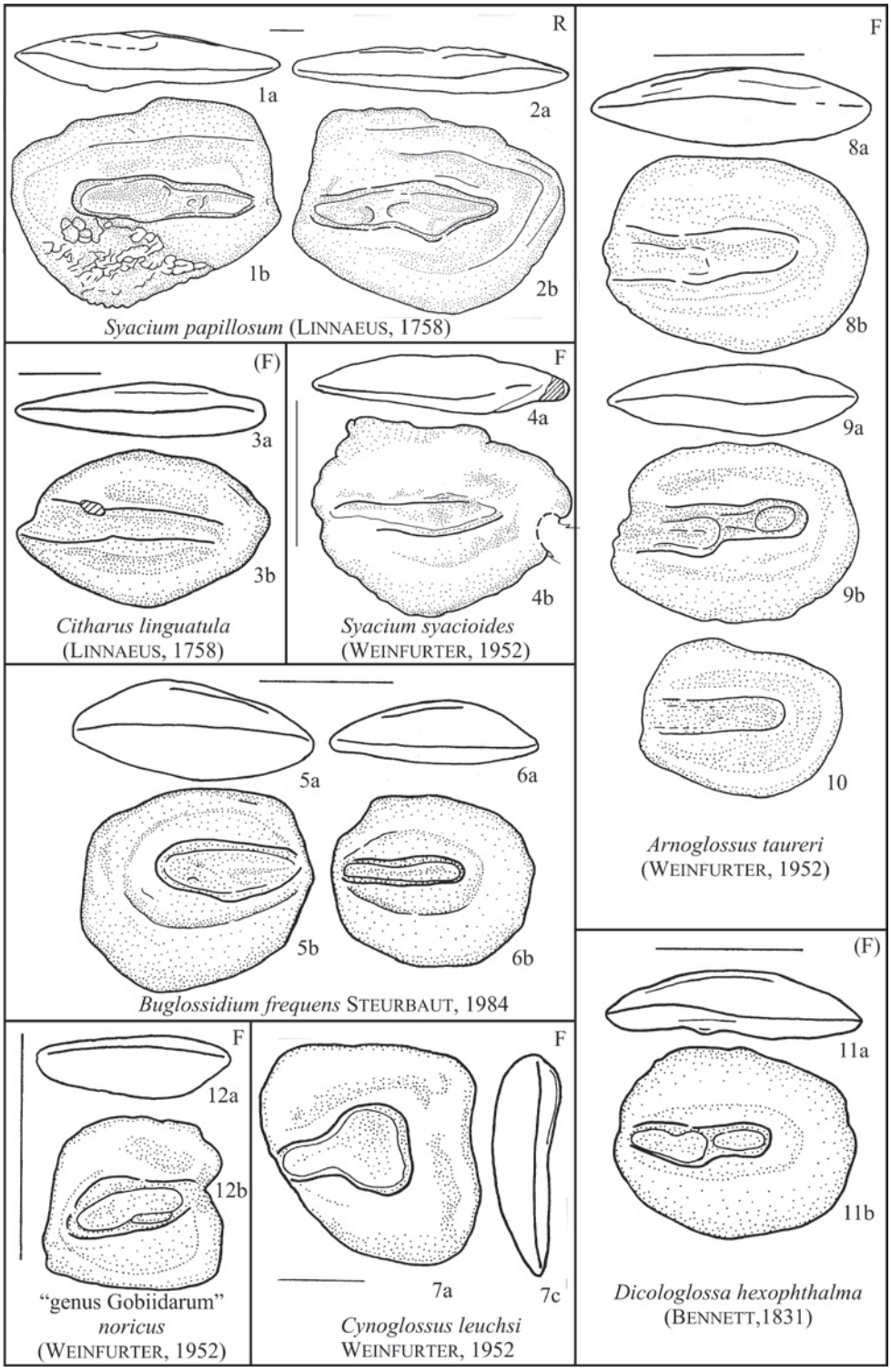
Figs 5-6. *Buglossidium frequens* STEURBAUT, 1984, 5 = L, 6 = R, Wetzelsdorf, Winkeltoni (LMJG nr. 2362, coll. 76970).

Figs 7. *Cynoglossus leuchsi* WEINFURTER, 1952, R, Wetzelsdorf, Winkeltoni, holotype (LMJG 62082/5).

Figs 8-10. *Arnoglossus taureri* (WEINFURTER, 1952), R, 8 and 10 = Lavanttal, Mühldorf, 8 = holotype, 10 = paratype (coll. LMKK), 9 = Wetzelsdorf, Kreuzschaller, holotype of *Arnoglossus holleri* WEINFURTER, 1952 (LMJG 62 082).

Fig. 11. *Dicologlossa hexophthalma* (BENNETT, 1831), R, Gross Sankt Florian, Mühlbauer, (LMJG 62 082/84).

Fig. 12 "genus Gobiidarum" *noricus* WEINFURTER, 1952, R, Lavanttal, Weinzettel bei Ober-Aigen, holotype (coll. KME).


R
1a
2a
1b
2b
Syacium papillosum (LINNAEUS, 1758)
F
8a
8b
9a
9b
10
Arnoglossus taureri
(WEINFURTER, 1952)
(F)
3a
3b
Citharus linguatula
(LINNAEUS, 1758)
F
4a
4b
Syacium syacioides
(WEINFURTER, 1952)
5a
6a
5b
6b
Buglossidium frequens STEURBAUT, 1984
(F)
11a
11b
Dicologlossa hexophthalma
(BENNETT,1831)
F
12a
12b
"genus Gobiidarum"
noricus
(WEINFURTER, 1952)
F
7a
7c
Cynoglossus leuchsi
WEINFURTER, 1952