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Palaeoichthyological observations in the Lower Freshwater Molasse (Upper Oligocene to Lower Miocene) of the surroundings of Ulm (Württemberg, Germany), with remarks on the forerunners of the genus *Tinca* CUVIER (Teleostean fishes, Cyprinidae).

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Abstract

The study of the pharyngeal teeth collected in two fossiliferous localities in the nearby vicinity of Ulm, Eggingen-Mittelhart (Uppermost Oligocene) and Ulm-Westtangente (Agenian) has shown that by the Uppermost Oligocene, the degree of molarisation of the pharyngeal teeth of *Tarsichthys* sp. was more advanced than previously supposed. This observation leads one to compare the morphology of these teeth with that of Uppermost Oligocene and Lower to Middle Miocene pharyngeal teeth hitherto referred to the genera *Tarsichthys* TROSCHEL, *Palaeotinca* OBRHELOVÁ and *Tinca* CUVIER.

Key words: Cyprinidae, Lower Freshwater Molasse, Uppermost Oligocene (MP 30), Lower Miocene (MN 2a), Ulm, pharyngeal teeth.

Zusammenfassung

Die Untersuchung von Cypriniden-Schlundzähnen zweier Fundstellen in der Umgebung von Ulm, Eggingen-Mittelhart (oberstes Oligozän) und Ulm-Westtangente (Agenium), hat gezeigt, dass die Molarisierung der Schlundzähne von *Tarsichthys* sp. bereits im obersten Oligozän einen höheren Grad erlangt hatte als bisher vermutet. Auf Grund dieser Beobachtung wurde die Morphologie dieser Zähne mit derjenigen von Zähnen weiterer oberoligozäner bis mittelmiozäner Fundstellen verglichen. Diese Zähne wurden bisher den Gattungen *Tarsichthys* TROSCHEL, *Palaeotinca* OBRHELOVÁ und *Tinca* CUVIER zugeordnet.

Résumé

L'étude des dents pharyngiennes provenant de deux gisements fossilifères des environs d'Ulm, Eggingen-Mittelhart (Oligocène terminal) et Ulm-Westtangente (Agénien) a montré que dès l'Oligocène terminal, la molarisation des dents pharyngiennes de *Tarsichthys* sp. atteignait un degré supérieur à ce qu'on pensait précédemment. Cette observation conduit à comparer la morphologie de ces dents à celle des dents pharyngiennes de l'Oligocène terminal et du Miocène inférieur rapportées jusqu'à présent aux genres *Tarsichthys* TROSCHEL, *Palaeotinca* OBRHELOVÁ et *Tinca* CUVIER.

1. Introduction

Among the rich vertebrate fauna collected during excavations made from 1985 to 1987 by the staff of the Staatliches Museum für Naturkunde Stuttgart (SMNS) in the sand quarry of Eggingen-Mittelhart, at 1.9 km from Eggingen (WERNER 1994), pharyngeal teeth of Cyprinid fishes were found (Fig. 1). They were preserved in a blackish to dark brownish marl called "Schokolademergel" by WERNER. This marl belongs to the basal layers of the Lower Freshwater Molasse ("Untere Süßwasser-Molasse"). According to WERNER (1994), who studied the rodents and lagomorphs from this locality, the "Schokolademergel" belongs to the Oligo-Miocene transition and, more precisely, to the upper part of the MP 30 mammal-zone.

Excavations were also made in 1987 by the staff of the Staatliches Museum für Naturkunde Stuttgart (SMNS) at about 4 km NW of Ulm centre, during the construction of a new road called "Ulm-Westtangente". According to HEIZMANN et al. (1989), the fossiliferous locality is situated on the western slope of the Eselsberg hill

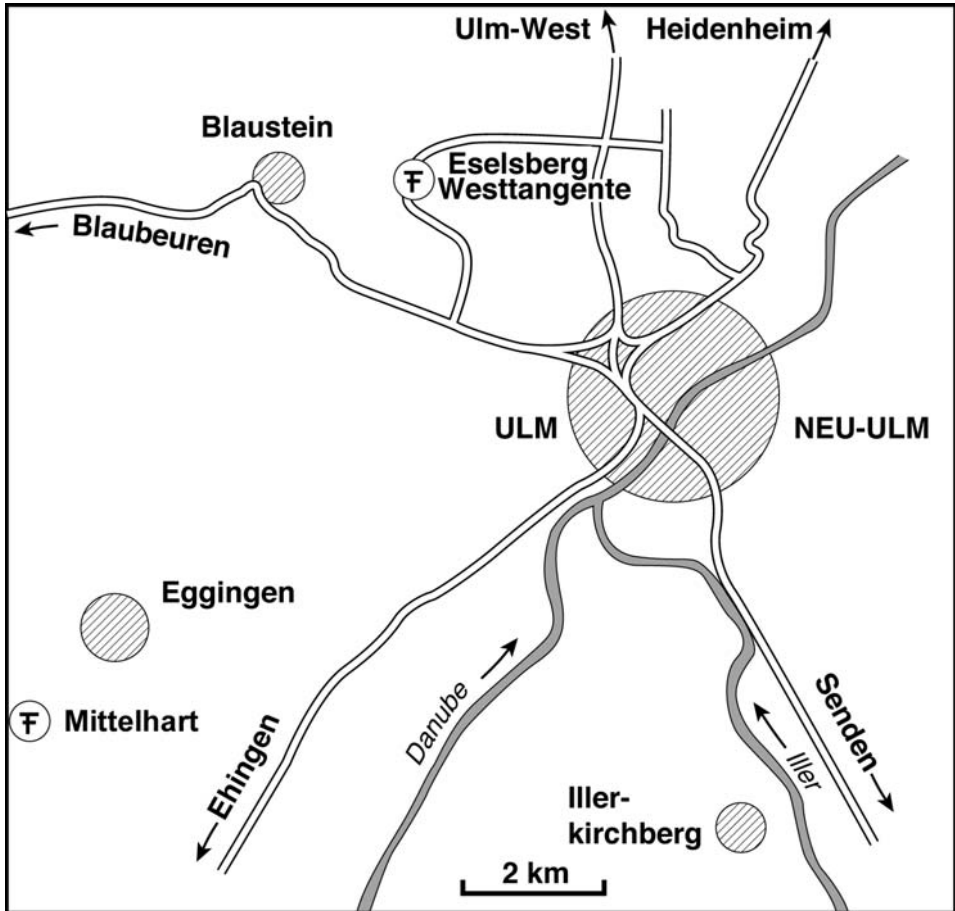


Fig. 1. Map showing the location of the two fossiliferous localities (Eggingen-Mittelhart and Ulm-Westtangente) of the Lower Freshwater Molasse studied in the present paper.

(Fig. 1). The fossiliferous level is a 35 cm thick calcareous marl which belongs to the Lower Freshwater Molasse (“Untere Süßwasser-Molasse”). It has yielded a rich diversified vertebrate fauna including more than 45 mammal species, bird, reptile and amphibian remains, together with pharyngeal teeth of Cyprinid fishes. The composition of the mammal fauna demonstrates that this locality can be assigned to the MN 2a mammal-zone, i.e. to the Middle Aagenian.

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2. Isolated pharyngeal teeth from the uppermost Oligocene (MP 30) of Eggingen-Mittelhart

Three specimens of pharyngeal teeth from Eggingen-Mittelhart are figured. The first one (SMNS 89579/1, Fig. 2A) comes from a left pharyngeal bone. Its distal end is hook-shaped. Under the hook, an elongated sulcus is present: the masticatory area (“Kaufläche” of RUTTE 1962). It makes a 33° angle with the longitudinal axis of the crown. The second tooth (SMNS 89579/2, Fig. 2B) comes from a right pharyngeal bone. It is both larger and stronger and has a more reduced hook. Although its morphology differs somewhat from that of the first specimen, its masticatory area describes the same angle with the longitudinal axis of the crown. The third tooth (SMNS 89579/3, Fig. 2C) is also from a right pharyngeal bone. It has a rather compressed crown which ends in a well developed hook. Its masticatory area has an angle of 58° with the longitudinal axis of the crown.

Discussion: Two of the three pharyngeal teeth described above are similar to those from the Oligocene of Switzerland that we have recently described as *Tarsichthys* sp. (GAUDANT et al. 2002, pl. 1). However, the third specimen exhibits a more widened

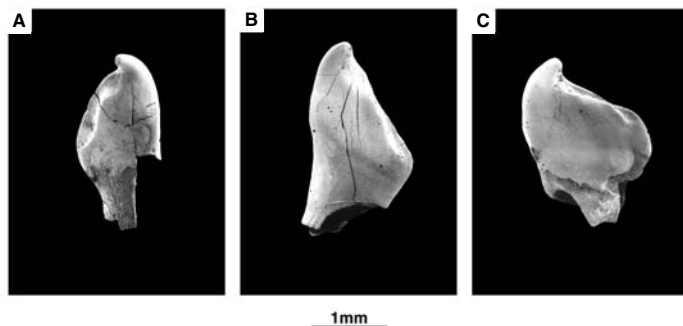


Fig. 2. *Tarsichthys* sp., pharyngeal teeth; Uppermost Oligocene, Eggingen-Mittelhart. A: Left tooth; SMNS 89579/1. B: Right tooth; SMNS 89579/2. C: Right tooth; SMNS 89579/3.

shape and a somewhat larger angle between the masticatory area and the longitudinal axis of the crown. These features fit rather well with the teeth from the Lower Miocene (Ottungian?) of Dukla mine, Sokolov, Czech Republic, described by OBRHELOVÁ (1969, 1970) as *Palaeotınca egeriana* OBRHELOVÁ.

3. Pharyngeal bone and teeth from the Lower Miocene (Agenian, MN 2a) of Ulm-Westtangente

The material collected at the foot of the Eselsberg hill during the construction of the Westtangente includes a pharyngeal bone and isolated pharyngeal teeth of Cyprinids. According to the identified mammal species, this locality can be assigned to the MN 2a mammal-zone (HEIZMANN et al. 1989).

SMNS 56443 is a left pharyngeal bone (Fig. 3A, B). It exhibits a regularly rounded postero-ventral outline and an almost straight vertical branch, the length of which is about 3/4 that of the horizontal branch. It bears five pharyngeal teeth ending distally in a hook: three rather large anteriorly and two smaller posteriorly. This situation is similar to that already found in a pharyngeal bone of *Tarsichthys macrurus* (AGASSIZ) from the Uppermost Oligocene of Rott, near Bonn, Germany (GAUDANT 2002). As in the Upper Oligocene specimen, the three large teeth are interpreted as the anterior teeth of the main row (tooth positions 5, 4 and 3), whereas the small teeth are considered as belonging to a lateral row (tooth positions 1a and 2a). The robust anterior tooth (tooth position 5) is shorter than the second one (tooth position 4) which is also robust whereas the third one (noted 3) is more slender. The two smaller ones (tooth positions 1a and 2a) are also slender.

The isolated pharyngeal teeth collected at the same place all have a hook-shaped distal end. The first one (SMNS 85977/1, Fig. 4A) has a rather compressed crown. Beneath the hook a curved masticatory area describes a 35° angle with the longitudinal axis of the crown.

The second pharyngeal tooth (SMNS 85976/1, Fig. 4B) possesses a reduced eroded hook. Unlike the first tooth, its rather straight masticatory area forms a 50° angle with the crown axis.

The third pharyngeal tooth (SMNS 85977/2, Fig. 4C) ends distally in a small hook. Its curved masticatory area lies at 50° to the crown axis.

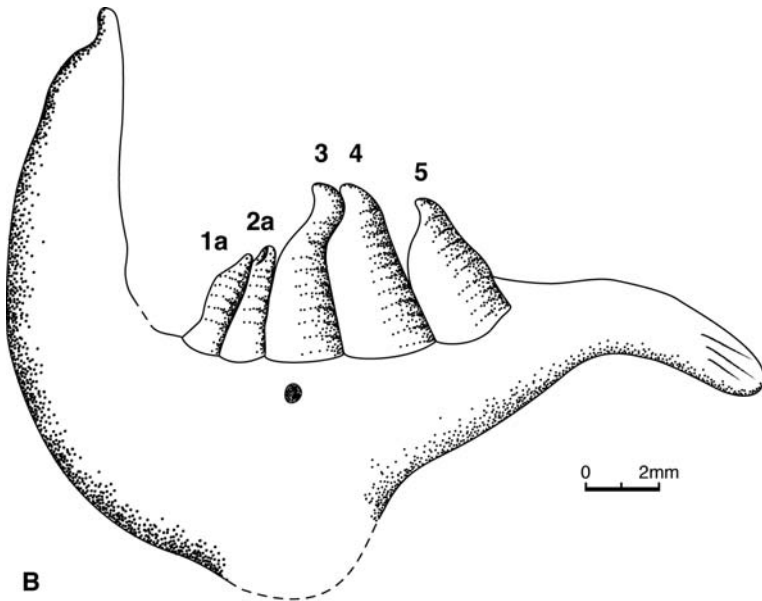
It should be noted that, although some differences exist, especially in the more arched shape of the masticatory area, these pharyngeal teeth agree rather well with those of the coeval *Tarsichthys* from La Chaux (Switzerland) although none of the teeth from this locality has a masticatory area angled to the longitudinal axis of the crown at more than 45° (GAUDANT et al. 2002).

4. Comparison with other pharyngeal teeth from the Uppermost Oligocene and Lower to Middle Miocene

The study of the pharyngeal teeth of Cyprinids found in the Uppermost Oligocene of Eggingen-Mittelhart, near Ulm, has shown that their variability is larger than previously supposed for Upper Oligocene representatives of the genus *Tarsichthys* TROSCHEL, especially when the pharyngeal teeth from the Lower Freshwa-



A



B

Fig. 3. *Tarsichthys* sp., left pharyngeal bone; Lower Miocene (Agenian, MN 2a), Ulm-West-tangente. A: View of specimen SMNS 56443. B: Interpretative drawing of the same specimen.

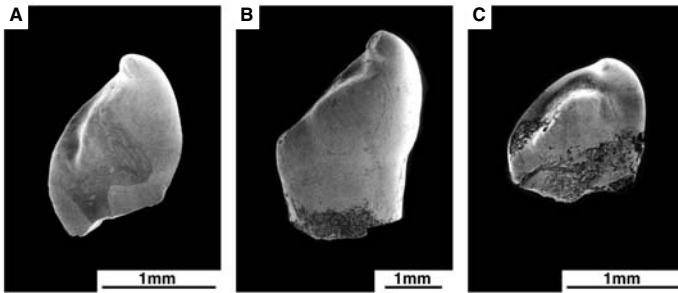


Fig. 4. *Tarsichthys* sp., pharyngeal teeth; Lower Miocene (Agenian, MN 2a), Ulm-Westtangent. A: Left tooth; SMNS 85977/1. B: Left tooth; SMNS 85976/1. C: Left tooth; SMNS 85977/2.

ter Molasse of Switzerland, Upper Oligocene and Lower Miocene in age (GAUDANT et al. 2002), are taken into account. For this reason it appeared useful to compare these teeth with those found in several Upper Oligocene and Lower to Middle Miocene fossiliferous localities from Germany.

Rott. – The pharyngeal teeth collected when washing and screening the Uppermost Oligocene sediments of the research borehole Rott II generally exhibit a rather slender shape and a well developed hook (GAUDANT 2002, pl. 13). Their masticatory area generally forms an angle with the longitudinal axis of the crown ranging from 20 to 40°, although it sometimes may reach up to 48°. According to MÖRS (1996), this fossiliferous level belongs to the upper part of the MP 30 mammal-zone. Consequently, it is coeval with Eggingen-Mittelhart.

Mainz-Weisenau. – According to TOBIEN (1988), the rodents and lagomorphs from the Lower Hydrobia beds (“Untere Hydrobien-Schichten”) of the Heidelberger Zementwerke quarry at Mainz-Weisenau indicate that the fossiliferous level belongs to the MN 2a mammal-zone (Middle Agenian = Middle Aquitanian). The teeth of *Tarsichthys* TROSCHEL found in this locality exhibit an angle between the masticatory area and the longitudinal axis of the crown which generally ranges from 36 to 55°, although it may reach 60° in exceptional circumstances.

It should be added that the two pharyngeal teeth from the “Cerithien-Schichten” of the Galgenberg, near Alzey, figured by WEILER (1963, figs. 71–72) exhibit a similar morphology as their masticatory area makes a 45 to 55° angle with the longitudinal axis of the crown.

Ravolzhausen. – The Upper Hydrobia beds (“Obere Hydrobien-Schichten”) are Upper Burdigalian in age according to REICHENBACHER (2000) who takes into account both the study of the nannoplankton by MARTINI (1987) and a reevaluation of the biostratigraphical results obtained by TOBIEN (1987) based upon mammal remains. A revision of the pharyngeal teeth described by WEILER (1960) as *Tinca francofurtana* KINKELIN, from the brick clay of Ravolzhausen, near Hanau, has shown that they have a masticatory area angled at 44 to 60° to the longitudinal axis of the crown.

Reexamination of the pharyngeal tooth from Frankfurt-Niederrad which forms the holotype of the species *Tinca francofurtana*, shows that this molariform specimen (KINKELIN 1884, pl. 3, fig. 13) exhibits a rounded hook and a masticatory area

describing an angle of 68° with the longitudinal axis of the crown. This unique tooth can be usefully compared to those of the Lower Miocene (Ottangian?) species *Palaeotinca egeriana* OBRHELOVÁ (OBRHELOVÁ 1969, 1970). The pharyngeal teeth of this species collected in the Dukla mine, near Sokolov (Czech Republic), are characterized by their rather molariform shape and a masticatory area which forms generally a 55 to 65° angle – although it can sometimes exceed 70° – with the longitudinal axis of the crown (GAUDANT et al. 2002, fig. 5).

Steinheim am Albuch. – The Middle Miocene locality of Steinheim am Albuch which belongs to the MN 7 mammal-zone has yielded a rich collection of isolated pharyngeal teeth belonging to *Tinca micropygoptera* AGASSIZ (GAUDANT 1989). In this species, the molarisation of the pharyngeal teeth is already complete, as shown by the fact that the masticatory area and the longitudinal axis of the crown make an angle ranging from 75 to 90° .

5. Conclusion

To conclude, the evolution of the forerunners of the recent genus *Tinca* CUVIER was characterized by the progressive molarisation of their pharyngeal teeth. It is rather difficult to precise about this process when studying isolated pharyngeal teeth. This is because the characters of these teeth differ significantly according to their position on the pharyngeal bones. Contrary to the condition in mammal teeth, there is no decisive criterion with which to determine with certainty the position of any isolated pharyngeal tooth on the pharyngeal bone which was bearing it.

In Upper Oligocene and Aquitanian (= Agenian) localities, the genus *Tarsichthys* TROSCHEL is represented by rather molariform teeth together with less numerous more slender teeth. These later specimens having a small masticatory area/longitudinal axis inter-angle (less than 30°) were probably the posterior ones, noted as tooth position 1 (RUTTE 1962). Molariform teeth probably occupied a median position on the pharyngeal bone (tooth position 2, 3 and eventually 4). Only the anterior teeth (tooth position 4 or 5 according to the total number of teeth in the row) differ in their morphology as they have frequently a more or less globular shape.

Pharyngeal teeth of Burdigalian (= Ottangian?) age exhibit a somewhat different morphology characterized by an increased molarisation, as shown by *Palaeotinca egeriana* OBRHELOVÁ (OBRHELOVÁ 1970). In this species, the pharyngeal teeth are intermediate in shape between those of *Tarsichthys* and *Tinca*.

Finally, the molarisation of the whole series of teeth (except for the anterior one) characterizes the genus *Tinca* which appeared during the Middle Miocene.

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