



Presence of dentition in the premaxilla of juvenile *Mullus barbatus* and *M. surmuletus*

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The genus *Mullus* is usually described as lacking teeth in the premaxilla. Contrary to generic descriptions (based on adult specimens), the juveniles of *M. barbatus* and *M. surmuletus* have teeth in the premaxilla; however, the teeth are not visible in specimens >50 mm total length, because they are covered by lip tissue. The number of teeth decrease with juvenile growth and disappears after c. 100 mm total length is attained. © 1997 The Fisheries Society of the British Isles

Key words: *Mullus barbatus*; *M. surmuletus*; premaxilla; teeth; juveniles.

INTRODUCTION

The Mullidae differ from other percoid families in a number of structural features, especially in a pair of highly developed hyoid barbels that appear early in the planktonic state (Gosline, 1984; McCormick, 1993). These specialized barbels are covered with sensory structures and provide a base from which the Mullidae have evolved their ecological peculiarities which assist them to recognize the bottom and to search for prey items once the fish has settled (Gosline, 1984; Uiblein, 1991; McCormick, 1993; Lombarte & Aguirre, 1997). The family Mullidae comprise six genera: *Mullus* Linnaeus 1758, *Upeneus* Cuvier 1829, *Upeneichthys* Bleeker 1855, *Pseudupeneus* Bleeker 1862, *Parupeneus* Bleeker 1863, and *Mulloidichthys* Whitley 1929 (Gosline, 1984; Nelson, 1984; Eschmeyer, 1990). The principal character used for differentiating these genera is the dentition. The separation of the genus *Mullus* from other genera of Mullidae has been based on the absence of teeth in the upper jaw (Günther, 1859; Jordan & Evermann, 1896; Whitehead *et al.*, 1986; Fisher *et al.*, 1987; Ben-Tuvia & Kissil, 1988). However, in the original description of *Mullus auratus* Jordan and Gilbert (1882), the authors noted that teeth on the upper jaw were present. Caldwell (1962) described the development and the gradual disappearance of upper jaw teeth in juvenile *M. auratus* (12.0–106.5 mm standard length, L_S). Also Wirszubski (1953) described this in juveniles of *M. barbatus* (40.0–89.0 mm L_S). Nevertheless, in the keys the character 'without teeth in the upper jaw' continues to be used in order to distinguish the genus *Mullus* from the other genera of the family. This misconception should be rectified, to avoid incorrect determinations. This paper describes the loss of teeth from the premaxilla during the juvenile growth of *M. barbatus* L., and *M. surmuletus* L., and relates this loss with temporal changes in habitat.

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MATERIALS AND METHODS

A total of 39 specimens of *M. barbatus*, ranging from 40 to 120 mm total length (L_T) and 27 of *M. surmuletus*, ranging from 60 to 120 mm L_T was measured using dial callipers on specimens preserved in 70% ethanol after being fixed in 10% formalin. Under a dissection microscope, the premaxilla was removed and cleared from any tissue, and with the aid of a camera lucida the jaws were projected and drawn.

The relationships between total length (L_T) and numbers of teeth (T) in each premaxilla for both species, were determined by fitting an exponential equation $T = ae^{bL_T}$ to the data. Analysis of covariance was used to compare the curves of dentition loss between each premaxilla and between species.

In this paper the juvenile stage is defined as the period from settlement (40–50 mm L_T) until the attainment of first sexual maturity. The size at first sexual maturity for *M. barbatus* was 134.1 mm L_T for females and 110.9 mm for males, and for *M. surmuletus*, was 150.7 mm for females and 138.0 mm for males (Sánchez *et al.*, 1995).

RESULTS

The relationship between L_T and number of teeth (T) in each premaxilla in *M. barbatus* [Fig. 1(a)] was for the left side $T = 183.4e^{-0.054L_T}$ ($r^2 = 0.8466$) and for the right side $T = 193.7e^{-0.055L_T}$ ($r^2 = 0.9686$). For both premaxillae, the number of teeth decreased progressively through ontogenetic development from 40 to 90 mm L_T , by which size the majority of teeth had disappeared. No difference was found between the number of teeth in each premaxilla ($t = -0.0599$, d.f. = 37, and $P < 0.0025$). The relationship for both sides was $T = 188.5e^{-0.055L_T}$ ($r^2 = 0.9177$). In *M. surmuletus* [Fig. 1(b)] the relationship for the left premaxilla was $T = 68.8e^{-0.046L_T}$ ($r^2 = 0.4210$), and for right was $T = 39.0e^{-0.035L_T}$ ($r^2 = 0.7602$). No difference was found between the number of teeth present in each premaxilla ($t = 0.9717$, d.f. = 15, and $P < 0.0025$). The relationships for both premaxillae was $T = 58.0e^{-0.048L_T}$ ($r^2 = 0.7065$). The slope comparison for the global species model (both sides) showed that there were no significant differences between species ($t = -0.3758$, d.f. = 53, and $P < 0.0025$).

MULLUS BARBATUS

Teeth were not obvious in any specimen > 50 mm L_T . In all cases the teeth were present but not visible because the upper lip covers them. Specimens of 40–49 mm L_T have 15–23 small, freely movable, canine teeth in a single row in each premaxilla. These varied in size and pointed posteroventrally toward the back of the mouth. In a 45-mm specimen, the left premaxilla had 23 teeth plus three sockets in positions 1, 3 and 6 from the posterior end [Fig. 2(a)]. Between 50–59 mm, the specimens had seven to 15 canine teeth in a single row on each premaxilla. In a 50-mm specimen, the left premaxilla had 15 teeth plus five sockets in positions 1, 3, 6, 18 and 19 [Fig. 2(b)]. In 60–69-mm specimens, there were two to 11 teeth in each side. In a 60-mm specimen, the left premaxilla had 11 teeth plus five sockets in positions 2, 3, 6, 15 and 16 [Fig. 2(c)]. From 70 to 79 mm, there were three to six teeth in each premaxilla. In a 70-mm specimen, the left premaxilla had six teeth plus seven sockets in positions 1, 3, 7, 9, 11, 12 and 13 [Fig. 2(d)]. An 81-mm specimen had two canine teeth on the right premaxilla and three on the left plus four sockets in positions 1, 3, 5 and 6 [Fig. 2(e)]. In the other five specimens belonging to the 80–89-mm range, no teeth

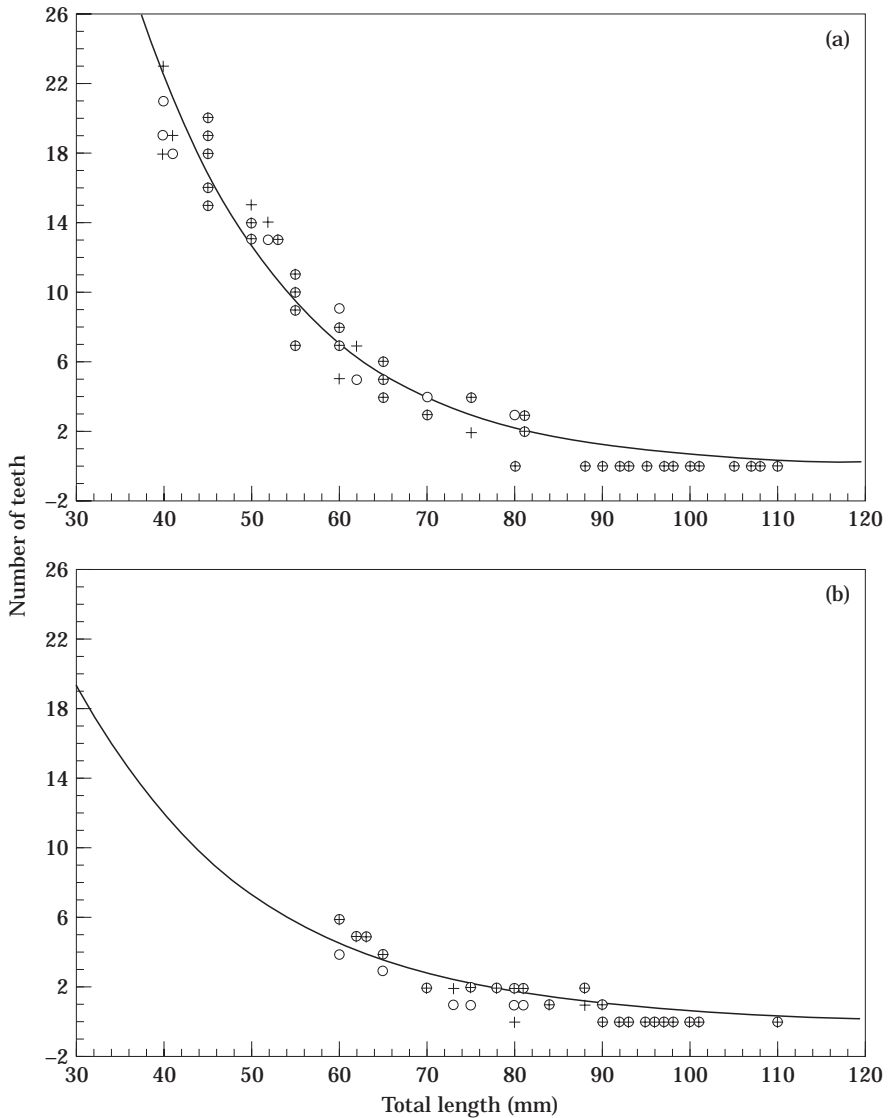


FIG. 1. Relationship between number of teeth in each premaxilla and total length of fish: (a) *M. barbatus*, and (b) *M. surmuletus*. +, Right premaxilla observed; o, left premaxilla observed.

were evident. Neither teeth nor tooth sockets were evident in specimens of 90 mm and larger.

In the range from 40 to 59 mm, the row of teeth covered almost all the premaxillary tooth insertion area [Fig. 2(a)]. The first teeth to disappear were those close to the anterior edge of the premaxillary [Fig. 2(b)]. Subsequently, teeth began to disappear randomly [Fig. 2(c)]. In the range of 70–79 mm, the teeth at the distal edge of the premaxillary were lost [Fig. 2(d)]. Finally, only a few of the more posterior premaxillary teeth remained [Fig. 2(e)]. As the juvenile fish grew, the empty sockets became less evident especially those closer to the anterior edge of the premaxilla.

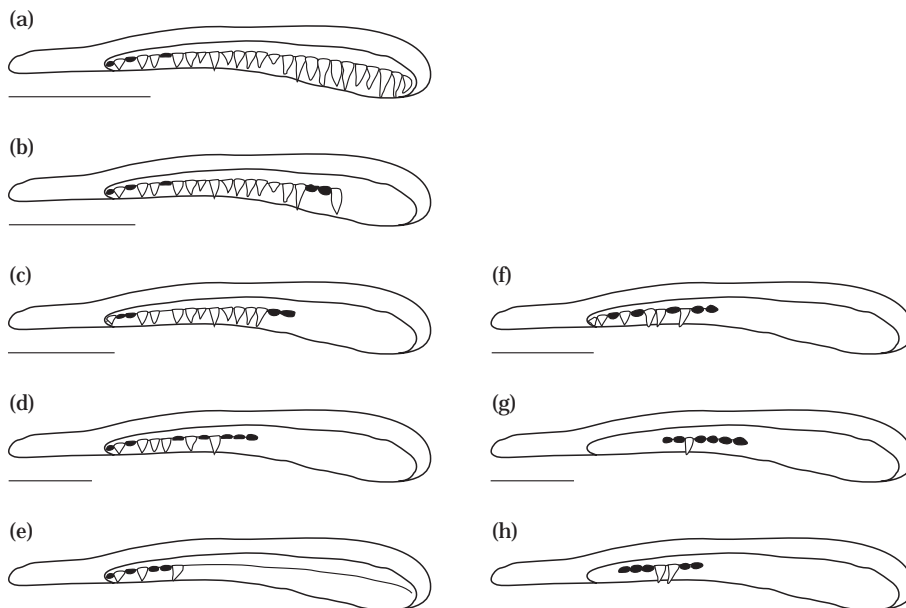


FIG. 2. Ventral view of dissected left premaxilla of: *M. barbatus* (a) 45 mm, (b) 50 mm, (c) 60 mm, (d) 70 mm, (e) 81 mm; and *M. surmuletus* (f) 60 mm, (g) 73 mm, (h) 88 mm. The drawing shows sockets (in black) and teeth. Bars=0.1 mm.

MULLUS SURMULETUS

Teeth were not evident in any specimen of *M. surmuletus*. In a range from 60 to 69 mm L_T , the first teeth to disappear were those close to the anterior edge of the premaxillary [Fig. 2(f)]. In the range of 70–89 mm, the teeth at the distal edge of the premaxillary were lost, and only one or two teeth remained at the middle edge of the premaxillary [Fig. 2(g) and (h)].

The specimens of 60–69 mm had four to six canine teeth in a single row on each premaxilla. In a 60-mm specimen, the left premaxilla had six teeth plus five sockets in positions 3, 5, 8, 10 and 11 [Fig. 2(f)]. In the range of 70–79 mm there were one or two teeth in each premaxilla. In a 73-mm specimen, the left premaxilla had one tooth plus six sockets [Fig. 2(g)]. From 80 to 89 mm there were one or two teeth in each premaxilla. In a 88-mm specimen, the left premaxilla had two teeth plus five sockets [Fig. 2(h)]. In specimens >90 mm, neither teeth nor tooth sockets were evident.

DISCUSSION

The transition from a pelagic phase to a benthic-oriented juvenile and adult phase involves a major change in the physical characteristics of the fish's environment. This change in habitat is coincidental with a rapid change in the morphology of the fish, associated with changes in the sensory stimuli perceived by the fish, and in their variation in feeding methods (Uiblein, 1991; McCormick & Molony, 1992; McCormick, 1993; Lombarte & Aguirre, 1997). In juvenile red mullets, the presence of teeth on the upper jaw near the tip of the snout suggests that these teeth are used for seizing active prey, as indicated by the high

proportion of active animals in the stomachs of both species (Frogliola, 1988; N'Da, 1992; Guillen & Martinez, 1995). In adults, the absence of teeth in the upper jaw suggests its mechanism of suction feeding and its habit of ploughing up the substratum (Gosline, 1984), as indicated by the benthic animals with low mobility in the stomachs of both species (Frogliola, 1988; N'Da, 1992).

In *M. barbatus*, upper jaw teeth were evident only in specimens of <50 mm, considering the number of teeth and sockets in the insertion zone of specimens between 40–49 mm, the maximum number of teeth must be 26 per premaxilla. For both species, the number of teeth in the upper jaw decreased rapidly as juveniles grew, and disappeared by 90 mm. The regression models were good estimators of the teeth loss rates for the studied range. For *M. barbatus* the model predict that the teeth loss occurs after 95 mm, and for *M. surmuletus* after 90 mm (estimated value <1). The relationship between dentition loss and increasing body size of juvenile *M. barbatus* and *M. surmuletus* was in general agreement with the observations of other investigators (Wirszubski, 1953; Caldwell, 1962). The results suggest that complete tooth loss for these *Mullus* species occurs at 90–100 mm. No difference was found between the number or position of teeth in opposite premaxillae. No interspecific differences between the dentition loss rates were noted, whereas, there were differences between the presence of teeth and the dentition loss tendency. *M. barbatus* had more teeth and they extended further anteriorly than *M. surmuletus* and they had a slightly different disposition on the premaxilla for the same size class (Fig. 2).

Since Linnaeus (1758), *Mullus* has been described as without teeth in the premaxilla. However, according to Wirszubski's (1953) study of *M. barbatus*, Caldwell's (1962) of *M. auratus*, and the present study of *M. barbatus* and *M. surmuletus*, the juveniles of this genus have small canine teeth in the premaxilla. Hence, including the character 'without teeth in the upper jaw' in a key will result in misidentification, especially in fish of <50 mm, where the teeth are visible. Conversely, using the character 'teeth present in the upper jaw' (as in Hose & Moore, 1977), the misinterpretation would lie with specimens >100 mm. Because of this it would be convenient to modify the character 'without teeth' to 'small canine teeth in the premaxilla either not evident (in specimens >100 mm L_T), or hardly visible (in specimens <50 mm L_T)'.

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