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Short communication

Evidence of an original scale development during the settlement phase of a coral reef fish (*Acanthurus triostegus*)

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Summary

As the majority of coral reef fishes, the Convict Surgeonfish *Acanthurus triostegus* (Acanthuridae) has a complex life cycle that involves an ontogenetic change in morphology, physiology and behaviour as its pelagic larval stage colonizes the benthic habitat. Few studies are devoted to the changes in skeleton during the settlement phase of coral reef fishes. In the present study, we highlighted an unexpected scales development in *A. trisostegus* just after the reef settlement. At settlement (t_0), *A. triostegus* showed calcified and very thin vertical plates, lying in the dermis on the whole body. During the first 9 days after settlement, thin vertical plates regressed and adult scales began to appear simultaneously. At 12 days post-settlement, the whole body was covered with small scales. Overall, such a rapid skeletal transformation is an example of morphological changes dealing with 'metamorphosis' of coral reef fishes.

Introduction

Most marine organisms (i.e. corals, crustaceans, fishes) have stage-structured life histories with two distinct stages, a relatively sedentary benthic stage (usually juveniles and adults) and a pelagic larval stage capable of long-distance dispersal (for review, see Leis and McCormick, 2002). The transition from pelagic oceanic environment to benthic reef environment, during which the relationship between the organism and its environment changes radically, is a particularly dangerous phase of the life cycle (settlement phase, Leis and McCormick, 2002). Thus, a species-specific change in morphology and physiology, called metamorphosis, occurs at settlement during which fish lose many of the characteristics that enhance survival in the plankton while developing other features suited to their new benthic environment (McCormick, 1999; McCormick et al., 2002). Abrupt and spectacular changes in skeletal structures occurring when a fish takes on its juvenile form were highlighted in lampreys (Youson, 1988), flatfishes (Wagemans et al., 1998), elopomorphs (Pfeiler, 1999) and pearlfishes (Parmentier et al., 2004). However, very few studies are devoted to the changes in skeleton during the settlement phase of common coral reef fishes such as damselfishes (Pomacentridae), wrasses (Laridae), butterflyfishes (Chaetodontidae), angelfishes (Pomacanthidae) or surgeonfishes (Acanthuridae). Recently, skull shape changes were described during the post-settlement ontogeny of two damselfishes (Frédérich et al., 2008) and discussed in relation with feeding strategies. In the present study, we highlight an unexpected scales development in a surgeonfish *Acanthurus triostegus* (Linnaeus, 1758) during the settlement phase.

Materials and methods

The present study was conducted in August 2007 at Rangiroa Atoll (15°07′S, 147°38′W), French Polynesia. Nets were fixed to the reef crest at dusk. All *A. triostegus* larvae reaching the reef during the night were collected at dawn (crest nets; Lecchini et al., 2004). These pre-settlement larvae had no prior experience of settlement habitats (i.e., naïve larvae). The larvae were transferred and subsequently maintained in an experimental aquarium (100 L) filled with running seawater at ambient temperature (28–30°C) and exposed to natural photoperiod. *A. triostegus* were fed *Artemia* sp. nauplii five times a day and were also supplied algal-covered coral rubble as a feeding substratum. The coral rubble was changed every 2 days. A total of 70 *A. triostegus* larvae (SL, 22–25 mm) were captured. Twenty specimens were directly anaesthetized in MS-222 and preserved in 70% ethanol (settling larvae, t_0). The others (50 individuals) were reared in aquarium and five specimens were randomly captured with a hand net every 3 days during a period of 15 days. The fish was anaesthetized and preserved in 70% ethanol. Specimens of each developmental stage (t_0, t_3, t_6,…, t_{15}) were stained with alizarin red S in order to reveal the osseous skeleton (Taylor and Van Dyke, 1985). Specimens were observed with a Leica M10 (Wild, Heerbrugg, Switzerland) binocular microscope and photographed with a Canon Powershot S45 camera (CANON INC., Tokyo, Japan).

Results and discussion

The mortality of *A. triostegus* was low in the aquarium (only three fish dead during the 15-days sampling period). At settlement (t_0), *A. triostegus* larvae showed thin calcified plates, lying in the dermis. The stained fish appeared stripped as a zebra (Fig. 1a). The plates covered the whole body. Each plate had a small denticle in mid height (Fig. 1b). In the posterior region, the denticle of each plate was larger. The plates were broader and their density was very high in the pectoral region (Fig. 1c). These broad plates did not show denticles. After 3 days (t_3), small scales appeared mainly in the posterior region (Fig. 1d,e). The calcified plates regressed on the whole body, except on the head (Fig. 1f). Six days

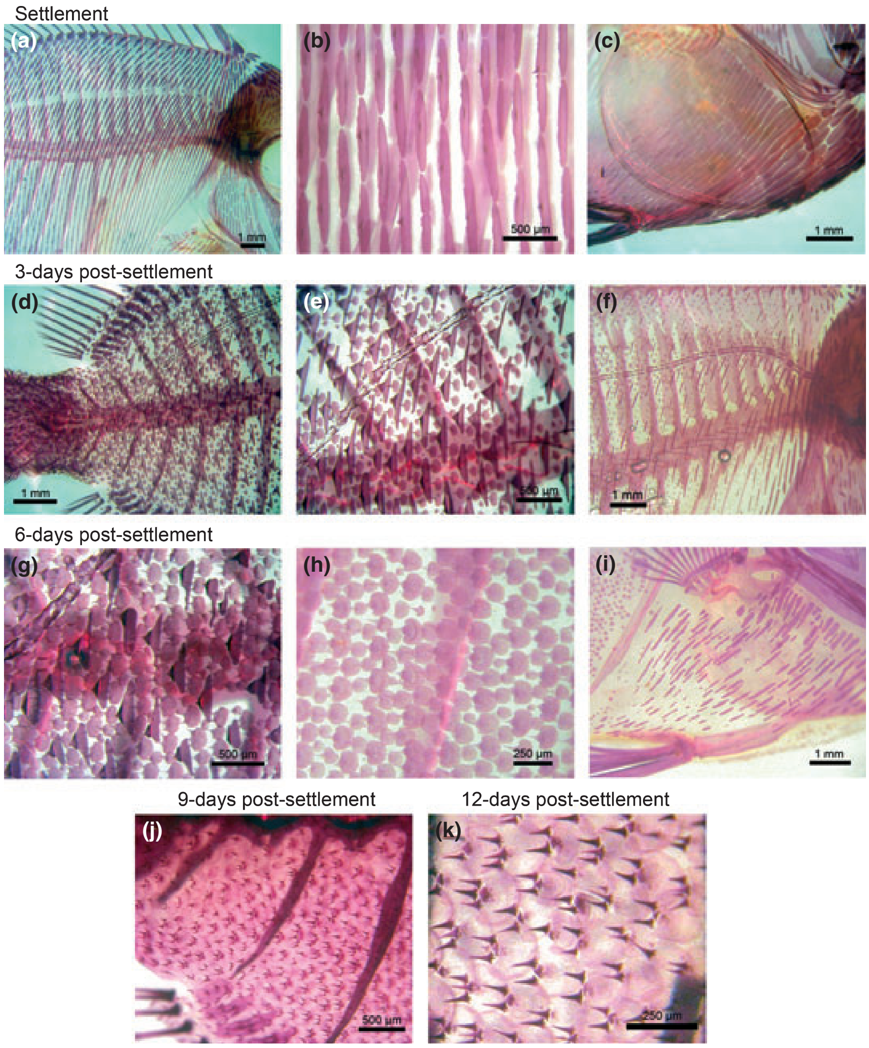

Fig. 1. Photographs of red-stained *Acanthurus triostegus* in lateral view at different ontogenetic stages: at settlement (t_0) (a–c), 3-days post-settlement (d–f), 6-days post-settlement (g–i), 9-days post-settlement (j) and 12-days post-settlement (k). a, b, e, f, h and k, view of the central region of the body. c and i, view of the pectoral region. d and g, view of the posterior region

post-settlement (t_6), the squamation had extended anteriorly, but some regressing plates were always present in the posterior part of the body (Fig. 1g). The density of small scales had increased (Fig. 1h). In the pectoral region and on the head, the plates have regressed (Fig. 1i). Nine days post-settlement (t_9), small scales have appeared on the head. The posterior and the central regions of the body were covered with small scales (Fig. 1j). All plates have almost disappeared on the pectoral region. At 12 days post-settlement (t_{12}), the whole body was covered with scales (Fig. 1k). No change was observed from 12 to 15 days post-settlement.

Apparently, the plates did not transform into scales. The plates disappearance and the scales appearance occurred as two parallel phenomena during the post-settlement ontogeny. Besides small scales appeared after the complete regression of the plates in the pectoral region. This unexpected scales development (replacement) was rapid (6–9 days). Such a skeletal transformation is an example of morphological changes dealing with ‘metamorphosis’ of demersal coral reef fishes. According to their rapid replacement during the settlement phase, the plates appear as a specialization to pelagic life in *A. triostegus*. Their functional role remains, nevertheless, unknown. However, the high density of such plates in the pectoral region is probably responsible for the silver aspect of the larvae, allowing camouflage in the pelagic environment. This metamorphosis occurs after reef settlement. The ‘first’ contact with the coral reef during the settlement phase could be an environmental signal inducing this skeletal change (McCormick, 1999), but the role of varied factors (biotic and abiotic) should be investigated in more details. Further histological studies of these structures should clarify their entity. Finally, the skeletal development of other Acanthuridae should be studied to verify if such morphological changes is anecdotic or widespread in the family.

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