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| Title | Maturation process of the Picasso triggerfish (Balistidae : Rhinecanthus aculeatus) from Okinawa Island(Digest_要約) |
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Abstract

Patterns of social structure, habitat use by different life-stages and maturation process were studied in local populations of the Picasso triggerfish (Balistidae: *Rhinecanthus aculeatus*) at four sites at Okinawa Island.

Sesoko Island and Odo were continuously observed between October 2012 and November 2013, while Bise and Ikei Island were sampled between September and November 2013 (>200 h underwater observations). Each site contained three ontogenetic habitats: a shallow settlement habitat, an assemblage and an adult habitat. Fish in assemblages were unmated and termed as floaters (bachelors) due to their non-territorial behaviour. At Sesoko Island, 67 adults and several floaters were recognized individually.

R. aculeatus followed a stepwise ontogenetic pathway with juveniles, floaters and adults filling distinct niches in the reef. Independent of location, a similar pattern of spatial distribution, habitat use and timing in habitat shift was observed. Ontogenetic habitat shifts were size-mediated and directly affected abundances in each ontogenetic habitat. According to the environmental habitat analysis, the shallow settlement habitats were opposed from the assemblages and adult habitats by their positive correlation with rock with turf. The physical variable “distance from the shore” best explained the environmental variation in ontogenetic habitats with assemblages and adult habitats occurring in deeper and heterogeneous reef areas.

In addition, there was a sequential onset of behaviour during ontogeny with high vigilance (hovering) and small home ranges during early life stages and a subsequent replacement of feeding by swimming at the floater stage resulting in larger home ranges. As territoriality was adapted, fish spent most time for searching food thereby patrolling within a large home range (i.e. territory).

With increased size (ca. 70–90 mm SL), juveniles relocated to assemblages, where they stayed for a prolonged time. Assemblages may function as transient habitat, which better fits the demands of the fish at this development stage (e.g. shelter opportunities, low predation risk, food abundance/diversity, and evaluation for free space or available mates in the adult habitat). Floaters were always unmated and never guarded eggs, thus the final recruitment from the assemblage into the adult habitat was in accordance with reproduction. In total, 6 floaters from the assemblage at Sesoko Island were relocating to the adult habitat during the spawning season 2013, where some of them started with reproduction. On the other hand, the Blackspotted triggerfish (*Rhinecanthus verrucosus*) was excluded from the adult habitat of *R. aculeatus* and reproduced within the assemblage at Sesoko Island. Assemblages of the sister species *R. verrucosus* may therefore function as a permanent habitat when both *Rhinecanthus* species co-occur.

Based on logistic regression techniques, the recruitment of floaters into the adult habitat occurred at median sizes between 126 mm and 147 mm SL, which was similar to the size at which 50% of individuals have reached maturity obtained from histological sections of gonads (males: ca. 136 mm SL, females: ca. 124 mm SL). Additionally, males matured almost one year later than females (males: ca. 2.9 years, females: ca. 2.1 years).

Key reproductive parameters further revealed that *R. aculeatus* is a multiple batch spawner with an asynchronous oocyte development in females. The spawning season lasted from Mai to October, with a spawning peak during June and July at Okinawa Island.

R. aculeatus has previously been reported as a species with a harem mating system and the data from this study suggests a high environmental potential for polygyny despite the absence of female aggregation. Males defended site-attached females (“female defence polygyny”), rather than resources that females are attracted to. Females had non-overlapping home ranges and competed for better territories irrespective of the presence of males. Territorial arrangements suggested, that the mating system in this species involved a mixture of polygyny, monogamy and potential female promiscuity.

Females exclusively paired with larger males and male size was intimately linked to higher number of females (polygyny). Male-male competition and the ability of females to reject unflavoured males resulted in size-dependent access to multiple females, and plasticity in the mating system was expressed in a high density population. An increase in the proportion of monogamous territories over the course of the reproductive season was positively correlated with the adult sex ratio

(increased male density relative to females), and facultative monogamy was enhanced under a less-female biased sex-ratio. A comparison between female and male mating success (number of matings) and the adjustment of the mating status over time revealed that polygyny was advantageous and the optimal mating system for the males. Females achieved higher number of matings when pairing with larger males, but mating success was not negatively affected by the actual mating status, and females did not attempt to escape polygyny. Polygyny is therefore considered as the primary mating system in *R. aculeatus*.