Territoriality, courtship and 'prop' use in the tompot blenny *Parablennius gattorugine* from a long-term photographic record.

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Running headline: tompot blenny territoriality and courtship

Abstract

The behaviour of the tompot blenny *Parablennius gattorugine* was studied from a long-term underwater photographic record on a Devon (UK) reef. Repeated observations of individually identifiable fish during 69 dives revealed that male blennies may guard eggs in a particular crevice over subsequent breeding seasons and reside in the same location for up to four years. Resident males were observed wiping eggs with greatly expanded anal glands and defending their territory against rivals, sustaining and then recovering from resultant fighting injuries. Adult-type fighting was also recorded between juveniles within a few weeks of settling from the planktonic larval stage. Our long-term record reveals the complexities of *P. gattorugine* courtship behaviour with further observations in Dorset (UK) showing a male manipulating an empty mollusc shell in an apparent display of prowess while being closely observed by two prospective female mates. Photographs of these extraordinary behaviours in this charismatic benthic species are provided.

Keywords: benthic ecology; competition; observations; reproductive behaviours

Introduction

Shallow-water species make excellent subjects in which to observe the complex behaviours associated with territoriality and courtship in marine teleost fishes. However, monitoring individuals and their interactions in the wild over long periods, even in shallow water, is difficult and such data are often elusive, despite the advent of new biologging technologies.

The tompot blenny *Parablennius gattorugine* Brunnich 1768 is a common fish of shallow, sub-littoral rocky habitats (Maitland & Herdson, 2009) and is widely distributed in Northern Europe (Almada *et al*, 2001). Although visually appealing and charismatic, its biology and behaviour, particularly its reproductive strategy, has been little studied (Dunne & Byrne, 1979; Faria *et al*, 2010). This species is a fractional spawner, (i.e. multiple batches per season, Dunne and Byrne, 1979) with the female laying demersal eggs in the late spring and early summer (Wheeler, 1969; Maitland & Herdson, 2009). The male guards eggs laid by several females in its resident rocky crevice (Zander, 1986), in a similar way to other blenny species (Westernhagen, 1983) and many shallow-water marine teleosts in general (Cody, 1993). Zander (1986) notes "mouthing fighting" attacks by rival male *P. gattorugine* but there appears to be no information on the courtship behaviour of this species in the scientific literature, nor on whether home ranges are retained by males between breeding seasons (Kay & Dipper, 2009).

The reproduction of closely related species *Parablennius tentacularis* (the tentacled blenny) and *Parablennius parvicornis* (the Azorean rock-pool blenny) suggest some consistent patterns throughout the combtooth blenny family (Giacomello & Rasotto,

2005; Oliveira *et al*, 2009 respectively), with descriptions of the mating system of these fishes as resource defence polygyny. Almada *et al* (1995) discuss the courtship behaviour of male blennies at their residences and note that sex-role reversal in courtship can occur when the operational sex ratio is biased towards females. Reproduction in blennies is complex and the courtship behaviour of different species (reviewed by Neat and Lengkeek, 2009) is therefore worthy of further attention, particularly in a species as widespread but little-studied as *P. gattorugine*.

This study demonstrates how underwater observation and photography can reveal intriguing information about reproductive behaviour, particularly when carried out in the same location over extended periods so that the life events of individual animals are recorded. Discussion of blenny behaviour also includes a very unusual record of prop use as a show of male prowess during courtship. Observed examples of tool use in fishes have so far been limited to food capture and access, nest building and egg care in a small number of taxa (see Brown, 2012 for review).

Materials and methods

Sites

1. Devon UK, Wembury Bay, 50.3163 °N, -4.1153 °W: Observations of *P. gattorugine* were made during 69 dives between 2011 and 2014 in a small area of algae-covered rocky reef in which there are several horizontal crevices. The reef is approximately 2 metres tall and water depth at the base of the reef varies between 3 and 8 metres, depending on tidal state. Observations were generally made around high water, as this gave easier swimming access from the shore (approximately 400 metres

away) and better water visibility than at low water. Observations were made at different times throughout the day due to tidal influence.

2. Dorset UK, Swanage, 50.6089 °N, -1.9491 °W: Observations of *P. gattorugine* were made during one dive on 25 September 2011, in an area of seabed with stones and small boulders on a sandy base beneath the main Swanage pier.

Data collection

Dives were made with open-circuit Self Contained Underwater Breathing Apparatus (SCUBA). Photographs were taken with a Nikon digital SLR camera and Sigma 17-70mm zoom lens in a waterproof housing. Lighting was provided by two small electronic flashguns mounted on flexible arms attached to the camera housing.

Areas where blennies were active were approached very slowly to minimise disturbance. Observations were made and photographs taken while resting gently (kneeling or standing) with near-neutral buoyancy on the sandy seabed adjacent to the reef or rocks where the blennies resided. The camera was positioned between 25 and 70 cm away from the blennies depending on visibility. Blennies did not appear disturbed by the presence of the camera, particularly when there was interaction between individuals.

Photographs were examined in order to identify individual *P. gattorugine*, from the patterns of markings on their skin. Markings on the head were used, as this is the easiest part of a blenny to photograph when it is residing in a crevice. The pattern of markings on the side of the head beneath the eyes was found to be particularly easy to recognise and could be used to identify individual blennies with a high degree of certainty (Fig. 1).

The gender of generally larger and darker *P. gattorugine*, including those occupying crevices, was confirmed as male by the observation of an anal/bulb gland on each of the front two fin-rays of the anal fin (Zander, 1975; Giacomello & Rasotto, 2005). Anal glands were enlarged and particularly obvious when the males were guarding eggs (see Fig. 2). Female blennies were generally paler and slightly smaller, and did not have visible anal glands. They often had a prominent pale patch mark beneath the eye (e.g. Fig. 6a, b). In addition to identifying individual blennies, photographs were used to record behaviour and, for the Dorset observations, to track the relative positions of blennies and the mollusc shell manipulated by the male. The mollusc shell was examined and measured after the blennies had left the area, and movements were measured relative to the length of the shell (80 mm) on photographs.

Results

Male occupancy of residences

Male *P. gattorugine* (n = 5) demonstrated long-term occupancy of three particular crevice locations on the Devon reef between 2011 and 2014 (Fig. 3). Crevice locations A and B were adjacent parts of the same horizontal fissure, approximately 80 cm apart, while crevice location C was 120 cm along the reef from B and 40 cm higher up the reef. Individual males typically occupied the same location over at least two years. Where this extended over three or four years, there were intervening changes in occupancy during that time.

Territoriality of *P. gattorugine* males

Aggression was observed between rival male *P. gattorugine* and appeared to be in competition for occupancy of crevices. Damage around a blenny's mouth occurred on at least two occasions, before subsequently healing (Fig. 4). Mouth and fin damage, with portions missing from pectoral, dorsal and caudal fins, was also observed on other individuals. The timing of mouth damage first being observed and changes in occupancy (Fig. 3), confirms that these wounds resulted from fights between males over territory. On occasion, male blennies were observed emerging from their resident crevice to confront a male conspecific that was moving around the reef. A typical encounter would involve the two blennies facing each other a few cm apart (see Fig. 5a) for between 5 seconds and 1 minute before the visiting blenny swam away.

'Mouthing attacks" as reference by Zander (1986) were only seen very occasionally. Observations by the author (PN) in both Devon and Dorset, and those reported by other divers indicate that attacks involve males attempting to bite the side of the head (operculum area), mouth area or the fins of their rival. In September 2014, bouts of aggression were observed between juvenile *P. gattorugine*, approximately 25 mm long (see Fig. 5b), in the same area of Devon reef where the observations on adults were made. Juvenile *P. gattorugine* settle from the plankton when around 18 mm long (Dunne and Byrne, 1979; Fives, 1986).

Courtship and reproduction

Male *P. gattorugine* were seen guarding eggs between April and July in their resident crevices on the Devon reef (Fig. 3). Eggs were attached to the crevice's floor, ceiling or both. Individuals were regularly observed wiping their anal/bulb glands across the eggs as the male blenny wriggled within the crevice. In many cases, eggs in different parts of the egg mass were clearly at different stages of development and had been

laid at different times. Females were on occasion observed within the resident crevices between April and June (Fig. 3) but were never seen in the same crevice on the next dive, even on subsequent days. Females within resident crevices often appeared to be laying eggs on the crevice floor or ceiling, with the male in close attendance (see Fig. 6a). On other occasions, females were observed outside a resident crevice while the male watched from the crevice entrance (see Fig. 6b). No examples of a female entering a crevice after such an encounter were observed, and the male often chased off the female.

A remarkable example of *P. gattorugine* courtship was observed at Swanage, Dorset. Two male blennies were first seen engaged in an aggressive encounter, with a female blenny approaching the males. Later, the male blenny that dominated this aggressive encounter moved an empty shell of a whelk (*Buccinum undatum*) around the seabed, with a series of head movements. While the male was moving the shell, two female blennies approached the male and appeared to watch this activity. One of these female blennies was the same individual that had approached the males during the aggressive encounter (a timeline of observations with example photographs is given in Table I). In total, the whelk shell was moved on 10 separate occasions. There were two main spells of shell movement by the male; the first was associated with the close approach of a female blenny to the male and the second was associated with the close approach of that female plus another (Fig. 7).

Discussion

Information on the breeding and territorial behaviour of *P. gattorugine* is currently sparse and direct observations of this complex behaviour are difficult and time

consuming to record. In particular, there are no details on the long-term retention of territory by males or courtship behaviour. The observations reported here show that individual blennies can be reliably recognised over several years using photographic records of distinctive skin markings around the head. Where the position and layout of resident crevices permit regular close-up photography, the long-term residence of individuals can then be recorded.

Observations on the Devon reef showed that individual male *P. gattorugine* were regularly found occupying the same locations over more than one breeding season. One male was found in the same area of reef for four consecutive breeding seasons, although the exact location changed during that time. This contrasts with the population of the intertidal blenny *Lipophrys pholis* studied by Almada *et al* (1992) where the territories of the breeding males were temporary and established each breeding season. The long-term retention of residences by male *P. gattorugine*, plus some shifts and exchanges, along with the injuries sustained in territorial fighting, all demonstrate that competition between males over territory is intense. Observation of adult-type fighting between juvenile *P. gattorugine* within a few weeks of their settling from the planktonic larval stage suggests that territoriality is important from a very early age. It is noteworthy that, although the studied Devon reef is very exposed to wave action from the south and west, occupancy of the *P. gattorugine* individuals remained largely unchanged over the winter of 2013-2014 when south-west England was battered by a succession of severe storms that caused notable coastal damage and large movements of sediments (Hiscock, 2014).

Male *P. gattorugine* guarding eggs on the Devon reef had enlarged and very obvious anal glands when they were guarding eggs. In other blenny species, the anal glands of males produce pheromones which attract females (Barata *et al*, 2008) and

mucus containing anti-microbial compounds that, when applied to eggs, will improve their survival (Giacomello *et al*, 2006; Pizzolon *et al*, 2010). The observations of male *P. gattorugine* wiping expanded glands across the rafts of eggs in the current study, suggest their functions include an egg-maintenance role in this species. Observations reported here are consistent with previous reports of fractional spawning by female *P. gattorugine* (Dunne and Byrne, 1979) and of males guarding eggs laid by several females in a resident crevice (Zander 1986). Polygamy among related blenny species is well known, with a single male attempting to ensure a number of females lay eggs in his resident crevice and a female laying eggs in the resident crevices of several different males (Giacomello & Rasotto, 2005).

Courtship interactions in *P. gattorugine* appear to be complex. On the Devon reef, visits by females to resident male crevices were brief, with no female ever seen in a male's residence on consecutive days. Females appeared to display to males near their residences but these interactions regularly resulted in the male chasing the female away. Neat and Lengkeek (2009) note that male selectivity, with aggression towards females or rejection from the nest site, is commonly exhibited by other blenny species. In some species, the peacock blenny (*Salaria pavo*) and the Azorean rock-pool blenny (*Parablennius parvicornis*) for example, some smaller males adopt alternative reproductive tactics (Oliveira *et al*, 2001; Ros *et al*, 2006). These 'sneaker' males enter the nests of resident males from which they steal fertilisations. There is no record of male 'sneaker' behaviour in *Parablennius gattorugine* but, in this little-studied species, it is an intriguing question whether some of the small blennies chased away by resident males (such as on the Devon reef) are 'sneaker' males rather than females.

241 In the Dorset observations, a bout of aggression between two male *P.*
242 *gattorugine* was observed by a female for part of its duration. Following the bout, the
243 dominant male manipulated a whelk shell with at least ten separate movements across
244 the seabed. This activity (outlined in Fig. 7) received the attention of one female (the
245 individual that had observed the aggressive bout) then also a second female. There
246 was no food (mollusc or hermit crab) within the shell and it is concluded that the
247 manipulation of the shell by the male represented use of a prop to display prowess to
248 the females. This appears to be the first record of prop use by teleost fish in courtship.
249 Fish have been observed using tools to access and capture food (with anvils and water
250 jets) and in nest building and care and transport of eggs. This is, as yet, limited to a
251 few observations in a small number of groups, not including blennies (reviewed in
252 Brown, 2012).
253 A further surprising aspect of the Dorset observations was that courtship
254 behaviour occurred in September, well after the expected spring to early summer
255 breeding season of this species (Dunne & Byrne, 1979; Zander, 1986; Maitland &
256 Herdson, 2009; Devon observations this study). It is not clear whether there is late
257 summer spawning in *P. gattorugine* or whether courtship behaviour occurs as part of
258 territoriality outside the egg-laying period. Territorial behaviour and male-female
259 interactions in this species have also been observed by the author (PN) at Swanage,
260 Dorset in September 2009 and at St Agnes, Cornwall in October 2013.
261 This study provides good evidence of territoriality and long-term retention of
262 territory in a small number of *P. gattorugine*. Detailed data have only been collected
263 in a single location, although the conclusions are consistent with general observations
264 in other areas where this species is found. A number of observations support the
265 conclusion that courtship in this charismatic species is complex. The use of a prop to

display prowess in courtship is intriguing and merits further investigation under controlled conditions in what would no doubt prove an interesting avenue for future work.

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