J. Mar. Biol. Ass. U.K. (2000), **80**, 379–380
Printed in the United Kingdom

Commensalism between a liparid fish (*Careproctus* sp.) and stone crabs (Lithodidae) photographed *in situ* using a baited camera

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The commensal relationship between a snailfish, tentatively identified as *Careproctus* sp. (Osteichthyes: Liparidae), and the lithodid crab *Paralomis formosa* (Crustacea: Lithodidae) was photographed *in situ* using a baited camera vehicle, deployed at depths of 625–1525 m around Shag Rocks and South Georgia in the Southern Ocean. The series of time-lapse photographs taken clearly showed that the small liparid fish 'hitched rides' on the crabs, presumably attaching to the dorsal carapace and legs of the crabs by means of their ventral sucking disk. Liparid fish of 20–90 mm total length, corresponding to juveniles and adult sizes, were observed on the crabs and indicate that *Careproctus* sp. is closely associated with *P. formosa* for the whole of the life cycle of the fish. Such an association may provide the snailfish with protection from potential predators as well as a means of transport towards food-falls but at no apparent cost to the crabs.

Snailfish of the family Liparidae (Teleostei: Scorpaeniformes) are found throughout the world's oceans at depths ranging from the intertidal zone to the deepest trenches. Little is known about the biology and behaviour of the deep sea forms (Stein, 1980), though some fecundity and diet analyses have been conducted on a few species (e.g. Wenner, 1979; Stein, 1980; Merrett, 1983). Egg masses of *Careproctus* spp. have been found in the branchial cavities of stone crabs (Anomura: Lithodidae) of the genus *Paralithodes* in the North Pacific (Rass, 1950; Vinogradov, 1950; Hunter, 1969; Parrish, 1972; Peden & Corbett, 1973). Other lithodid genera (*Lithodes, Paralomis* and *Paralithodes*) were found to be hosts for various species of *Careproctus* in subsequent studies from the South Pacific and South Atlantic (Campodónico & Guzmán, 1977; Balbontín et al., 1979; Melville-Smith & Louw, 1987). There is some debate over the precise definition of this association and whether it should be termed a parasitic or a commensal relationship, since the host crab experiences some compression and even localized necrosis of the gills (Love & Shirley, 1993; Somerton & Donaldson, 1998).

These previous records of the relationship between *Careproctus* spp. and lithodid crabs were obtained from trawl or trap-caught specimens of crabs and only described the eggs or post-larval stages of liparid fish found inside the crabs. The present study, however, reports on unique photographs taken *in situ* that reveal the commensal relationship between a species of *Careproctus* and lithodid crabs from the Southern Ocean, where *Careproctus* sp. were observed attached to and 'hitching rides' on the stone crabs.

During September 1997, an autonomous baited camera vehicle, the Aberdeen University Deep Ocean Submersible (AUDOS; see Bagley et al., 1999), was deployed at 12 stations around Shag Rocks and South Georgia in the Southern Ocean to investigate the abundance and biology of scavenging fauna at depths of 625–1525 m. The camera was loaded with Ektachrome 200 ASA colour positive film and photographs were taken at 1-min intervals over 7–13 h periods, covering an area of sea-floor of approximately 4 m^2. Bait was attached onto a graduated cross suspended beneath the camera and consisted of squid (*Illex argentinus*), myctophid fish, or icefish (*Champsocephalus gunnari*).

The most common and abundant scavenging species encountered in all AUDOS deployments was the lithodid stone crab, *Paralomis formosa* Henderson, 1888. Less common were two other species of stone crabs, *P. spinosissima* Birstein & Vinogradov, 1972 and *Lithodes santolla* (Molina, 1782). The arrival times of *P. formosa* to the baited camera indicated locally dense aggregations or a clumped distribution of this lithodid. However, in almost all deployments at depths of 625–1487 m, snailfish were clearly seen attached to the dorsal carapace or legs of some of the crabs (Figure 1). The most frequent association was with *P. formosa*, less commonly with *L. santolla*, but was never observed with the very spiny *P. spinosissima*.

Usually a single *Careproctus* sp. was seen on a stone crab, though one crab had three snailfish passengers. Approximately 5.5% of all the stone crabs observed were carrying liparid fish. Small individuals of *Careproctus* sp. <50 mm total length (TL) tended to stay on one stone crab and were followed through consecutive frames for up to 56 min, remaining attached to the same crab over this period. This excluded the possibility that the snailfish were merely photographed swimming above the crabs. Larger fish were more mobile and were seen to swap host crabs or settle onto the sea-floor, but the majority (82%) of all snailfish occurrences were in association with *P. formosa*. Occasionally larger liparids were seen swimming freely around the bait and from the photographs, it appeared that *Careproctus* sp. predated on amphipods that were also attracted to the bait.

Taxonomy of the Liparidae relies on detailed meristic characters, such as the pattern of cephalic pores and teeth structure (see Andriashev & Stein, 1998), which cannot be discerned from photographs alone. Three species of *Careproctus* have been described from South Georgia (Andriashev & Stein, 1998); therefore, in the absence of any reference specimens, the snailfish observed could only be tentatively identified as *Careproctus* sp. This genus has a ventral sucking disk with which the fish can attach to the crabs. The spiny carapace of *P. spinosissima* probably precludes such attachment, hence snailfish were not seen associated with this particular species. Juvenile to adult sized *Careproctus* sp. (20–90 mm TL) were photographed attached to

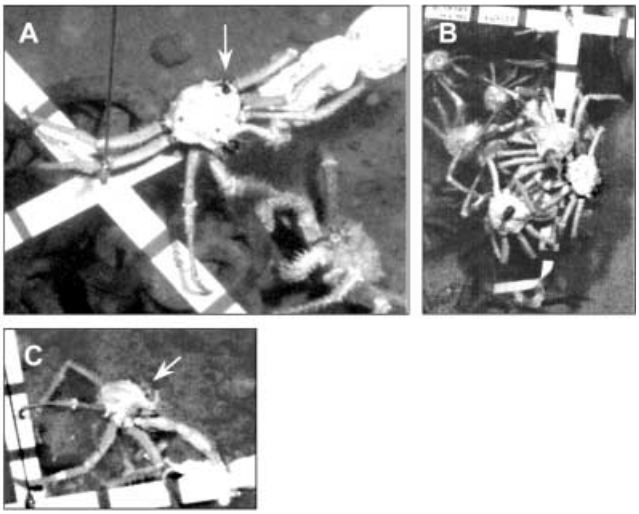

Figure 1. Baited camera photographs taken around South Georgia showing the commensalism between *Careproctus* sp. and lithodid crabs: (A) a passenger juvenile liparid (arrow) on the dorsal carapace of *Paralomis formosa* with a second species of lithodid, *P. spinosissima*, on the sea-floor; (B) *P. formosa* aggregation at the bait with two *Careproctus* sp. 'hitching' on two of the stone crabs; (C) *P. formosa* carrying a *Careproctus* sp. (60 mm length; arrow). Each division on the graduated cross represents 10 cm.

the stone crabs (Figure 1A,C). However, it is not known if one species of liparid is commensal on both *P. formosa* and *L. santolla*, or if two distinct species of host-specific liparids were present.

Like other liparid–lithodid pairs, *Careproctus* sp. from South Georgia probably deposits its eggs inside the gill chambers of *P. formosa*, although this remains to be confirmed. Hence this particular association extends throughout the whole of the life cycle of the liparid. It appears that the early and adult phases of *Careproctus* sp. are commensal, where they act as passengers but cause no obvious damage or benefit to the carrier crabs. 'Hitching' by the liparids may significantly save on energy expenditure, particularly as these fish are not considered to be good swimmers (Lampitt et al., 1983). However, during the reproductive period of the fish the relationship may change to a parasitic one, where the developing embryos may cause damage to the gills of the host crab (Love & Shirley, 1993; Somerton & Donaldson, 1998).

It would be interesting to discover whether this *Careproctus* sp.–*P. formosa* relationship is generally applicable to those analogous partnerships reported from other areas of the world. The commensalism between liparids and lithodids could not have been revealed by conventional sampling techniques, such as trawling or trapping, as the liparids would be dislodged from their crab hosts. This study illustrates the importance of *in situ* observations in understanding interspecific interactions.

We are grateful to Steve Addison for his technical support on AUDOS. Our thanks to the scientists and crew on board the FV 'Argos Galicia' during the 1997 South Georgia Groundfish Survey. Dr Nigel Merrett (British Natural History Museum) kindly helped in the tentative identification of photographed specimens. This study was partly funded by the Government of South Georgia and is dedicated to the late Martin White.

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Submitted 29 September 1999. Accepted 10 December 1999.