Marine Biodiversity Records, page 1 of 4. © Marine Biological Association of the United Kingdom, 2011
doi:10.1017/S1755267211000856; Vol. 4; e88; 2011 Published online

'Following the leader': first record of a species from the genus *Lutjanus* acting as a follower of an octopus

PEDRO HENRIQUE CIPRESSO PEREIRA, RODRIGO LIMA GUERRA DE MORAES, JOÃO LUCAS LEÃO FEITOSA AND BEATRICE PADOVANI FERREIRA

Departamento de Oceanografia, CTG, Universidade Federal de Pernambuco (UFPE), Avenida Arquitetura, s/n, Cidade Universitária, Recife, PE, 50670-901, Brazil

*This is the first record of an octopus (*Octopus insularis*) being followed by a* Lutjanus *species (*Lutjanus jocu*). The interaction was observed within the limits of the Fernando de Noronha Marine National Park, north-western Brazil and lasted for approximately 30 minutes, covering a distance of 40 metres. Similar food preferences and benthic foraging habits between the species appear to have motivated the occurrence of this behaviour.*

Keywords: *Lutjanus jocu*, *Octopus insularis*, Fernando de Noronha, feeding association, foraging behaviour

Submitted 13 March 2011; accepted 18 August 2011

INTRODUCTION

One of the most common foraging associations between reef fish is the nuclear–following behaviour. This association is characterized by an interaction between two species, one nuclear and the other known as a 'follower' (Strand, 1988). The core of the association is formed by one or more individuals of the nuclear species and they are responsible for leading the foraging association, thus making possible the formation and maintenance of the interaction (Itzkowitz, 1974; Strand, 1988).

This association involves species that cause bottom disturbance when foraging and others that opportunistically feed on exposed prey (Fricke, 1975; Sazima *et al.*, 2007). It is a common interaction for carnivorous reef fish in which mullids, muraenids, and ophichthids usually act as nuclear species (Karplus, 1978; Dubin, 1982; Lukoschek & McCormick, 2000; Sazima *et al.*, 2007; Araújo *et al.*, 2009). However, this function can be assigned to other reef animals, such as turtles (Sazima *et al.*, 2004), octopuses (Strand, 1988; Machado & Barreiros, 2008), sea stars (Gibran, 2002), and hermit crabs (Sampaio *et al.*, 2007). These interactions play a significant role on the reef trophodynamics, as they are a frequent and widespread means for the follower species to prey on items that would be otherwise unavailable (Lukoschek & McCormick, 2000).

Octopuses are generalist predators with a broad diet (Leite *et al.*, 2009) mostly composed of small molluscs and crustaceans (Mather, 1991; Hanlon & Messenger, 1996; Vincent *et al.*, 1998; Smith, 2003). Juvenile snappers also feed mainly either on benthic or water column crustaceans, while adults inhabit deeper areas predating benthonic fish and invertebrates such as brachyuran crabs (Rooker, 1995; Rojas-Herrera *et al.*, 2004; Claro & Lindeman, 2004; Pimentel & Joyeux, 2010).

This study aimed to describe the behavioural interactions between a species of octopus (*Octopus insularis*) and a juvenile *Lutjanus* at Fernando de Noronha Archipelago. Ecological, social outcomes and the motivation for the occurrence of this interaction have been assessed.

Corresponding author:
P.H. Pereira
Email: pedrohcp2@yahoo.com.br

MATERIALS AND METHODS

The observation took place while snorkelling during October 2010 in Sueste Bay, at Fernando de Noronha Archipelago (03°50′09″S–32°25′09″W). Fernando de Noronha is an oceanic archipelago approximately 345 km off the north-eastern Brazilian coast, tropical West Atlantic, comprising a main island and 19 small islets totalling 26 km² (Maida & Ferreira, 1997). Most of the land and the shallow waters around the archipelago are part of a National Marine Park, a no-take area—where the study site is located, and the remainder is an Environmental Preservation Area where some fishing is allowed (Ferreira *et al.*, 1990).

Sueste Bay, located on the windward side of the main island, is a shallow inlet with an inner protected reef flat and an outer reef slope leading to deeper waters. Depths in the area vary between 1 and 5 m, the flat and the slope are built by a sandy bottom and irregular rocky patches sparsely to thickly covered by brown foliose algae, red coralline algae, and stony corals (Maida & Ferreira, 1997; Sazima *et al.*, 2004).

The behaviour was photographed and video-recorded between 10 00 and 13 00 hours. The focal animal methodology by Altmann (1974) was used, and the total length (TL) of the fish recorded on the interaction was visually estimated and recorded on plastic sheets.

RESULTS AND DISCUSSION

The present work represents the first record of a species from the genus *Lutjanus* following an octopus. During ~30 minutes, a 25 cm (TL) dog snapper (*Lutjanus jocu*) individual was sighted following an *Octopus insularis* specimen (Figure 1A). At the start of the interaction, the octopus was actively swimming being closely followed by the snapper, and after a few minutes moving about 40 m, the former stopped over a rock, and *L. jocu* stood nearby performing circular swimming movements around it. Several other reef fish species participated in these interactions, being attracted to the octopus hunting, including: *Caranx latus*, *Cephalopholis fulva*, *Haemulon parra*, *Haemulon chrysargyreum*, and *Halichoeres radiatus* (Figure 1B).

Previous registered work on 'following' activities involving octopuses and other reef fish (e.g. Diamant & Shpigel, 1985; Strand, 1988; Forsythe & Hanlon, 1997; Sazima *et al.*, 2007) are mainly of groupers from the genus *Cephalopholis*, *Mycteroperca* and *Epinephelus*. Despite all the records on this behaviour involving a *Lutjanus* species with sharks (Sazima *et al.*, 2007), morays (Santos & Castro, 2003) and snake eels (Araújo *et al.*, 2009), it has never been sighted following an octopus.

Furthermore, the dog snapper may also play a role as the nuclear species in the association. It was observed being followed by the jack *Caranx crysos* in Rio Formoso Estuary, north-eastern Brazil, in an interaction that lasted ~10 minutes (P.H.C. Pereira and R.L.G. Moraes, personal observations). Sazima *et al.* (2007) registered that up to 20% of the fish species recorded joining nuclear–following associations acted both as nuclear and as attendants in the interaction.

An extensive description of the foraging behaviour of *O. insularis* was reported by Leite *et al.* (2009), also in the Fernando de Noronha Archipelago. When foraging, octopuses present several coloration patterns and behavioural tactics to ambush prey under rocks and inside reef crevices (Mather, 1991). One of these is to insert its tentacles inside holes or to embrace rocks making prey flee into its mantle, avoiding them from escaping the attack (Forsythe & Hanlon, 1997; Sazima *et al.*, 2007; Leite *et al.*, 2009) (Figure 1C). This kind

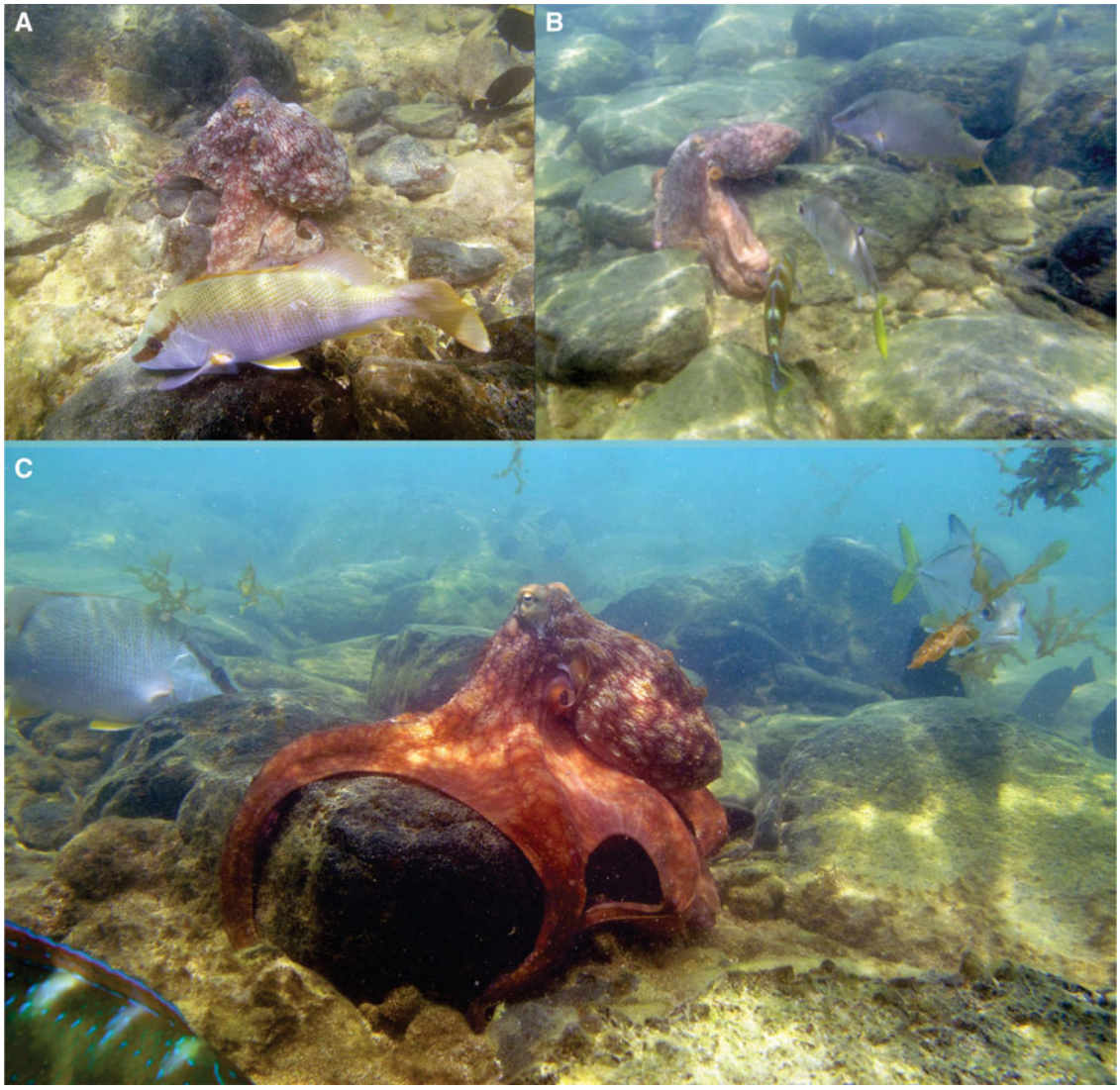

Fig. 1. (A) 'Following' behaviour of a juvenile *Lutjanus jocu* with *Octopus insularis*; (B) other reef fish participating in the interaction; and (C) octopus foraging behaviour which attracts 'follower' fish.

of behaviour also exposes hidden prey to their followers, which were otherwise unavailable for them.

Juvenile *Lutjanus* feed mainly on planktonic and benthic crustaceans while adults feed on fish and invertebrates (Rooker, 1995; Rojas-Herrera *et al.*, 2004; Claro & Lindeman, 2004; Pimentel & Joyeux, 2010). The great presence of benthic invertebrates in stomach contents of juvenile snappers indicates a benthic foraging habit (Pimentel & Joyeux, 2010). So, as the octopus efficiently feeds on hidden benthic prey, the chance to get an effortless meal missed by the predator is in fact worthwhile for the snapper, sparing the endeavour of searching and ambushing the prey.

It was also observed that the coloration exhibited by *L. jocu* during the interaction, with a distinct diagonal black stripe crossing the eye from the operculum to the snout, is similar to that seen on *Lutjanus alexandrei* on multi-specific foraging schools with grunts (Pereira *et al.*, in press) and on *Epinephelus fasciatus* when interacting with octopuses (Diamant & Shpigel, 1985). Not yet addressed herein, this pattern can be associated with social and feeding communication involving less energetic costs (Hurd, 1997).

Octopuses are of great importance as a fishing resource worldwide (Caddy & Rodhouse, 1998), and are traditionally captured outside the no-take area on the Fernando de Noronha Archipelago (Leite *et al.*, 2008). It is known that areas with greater protection status marine protected areas (MPAs) achieve higher abundances of many different species—fish and invertebrates (Floeter *et al.*, 2006; Ferreira & Maida, 2007; Francini-Filho & Moura, 2008). This great abundance of snappers and octopuses in Fernando de Noronha MPA promotes more encounters and interacting time between them, favouring the association to occur. Besides that, inside MPAs the reef fish behaviour is more spontaneous, reacting positively to the lack of fishing pressure and fewer divers, becoming less frightened (Kulbrick, 1998; Jouvenel & Pollard, 2001), making the sighting of the interaction feasible.

The occurrence of the observed behaviour was motivated primarily by the overlap of food preferences between the involved species. Despite the snapper being capable of acquiring benthic prey unattended, the advanced foraging behaviour tactics exhibited by the octopus can provide an additional facilitated means of capturing its feed. In addition, species with a more inquisitive nature, like serranids and lutjanids (Diamant & Shpigel, 1985), are more prone to perform this kind of behaviour.

ACKNOWLEDGEMENTS

We would like to thank Laís Chaves, Peter Wirtz and Tatiana Leite for reviewing and improving the manuscript, and CNPq and CAPES for financial support.

REFERENCES

Altmann J. (1974) Observational study of behavior: sampling methods. *Behavior* 49, 227–265.

Araújo M.E., Pereira P.H.C., Feitosa J.L.L., Gondolo G., Nottingham M. and Pimenta D. (2009) Feeding behavior and follower fishes of *Myrichthys ocellatus* (Anguilliformes: Ophichthidae) in the western Atlantic. *Neotropical Ichthyology* 7, 503–507.

Caddy J.F. and Rodhouse P.G. (1998) Cephalopod and groundfish landings: evidence for ecological change in global fisheries? *Reviews in Fish Biology and Fisheries* 8, 431–444.

Claro R. and Lindeman K.C. (2004) *Biología y manejo de los pargos (Lutjanidae) en el Atlántico occidental*. La Habana, Cuba: Instituto de Oceanología, CITMA, 472 pp.

Diamant A. and Shpigel M. (1985) Interspecific feeding associations of groupers (Teleostei: Serranidae) with octopuses and moray eels in the Gulf of Eilat (Aqaba). *Environmental Biology of Fishes* 13, 153–159.

Dubin R.E. (1982) Behavioral interactions between Caribbean reef fish and eels (Muraenidae and Ophichthidae). *Copeia* 1982, 229–232.

Ferreira B.P. and Maida M. (2007) Características e perspectivas para o manejo da pesca na Área de Proteção Ambiental Marinha da Costa dos Corais. In Prates A.P. and Blanc D. (eds) *Áreas aquáticas protegidas como instrumento de gestão pesqueira*. Brasília: MMA/SBF, pp. 39–49.

Ferreira L.M., Jesus F. and Silva H.A. (1990) Plano de manejo do Parque Nacional Marinho de Fernando de Noronha. *IBAMA/FUNATURA, Occasional Publications*, 253 pp.

Floeter S.R., Halpern B.S. and Ferreira C.E.L. (2006) Effects of fishing and protection on Brazilian reef fishes. *Biological Conservation* 128, 391–402.

Forsythe J.W. and Hanlon R.T. (1997) Foraging and associated behaviour by *Octopus cyanea* Gray, 1849 on a coral atoll, French Polynesia. *Journal of Experimental Marine Biology and Ecology* 209, 15–31.

Francini-Filho R.B. and Moura R.L. (2008) Dynamics of fish assemblages on coral reefs subjected to different management regimes in the Abrolhos Bank, eastern Brazil. *Aquatic Conservation* 18, 1166–1179.

Fricke H.W. (1975) The role of behaviour in marine symbiotic animals. In Jennings D.H. and Lee D.L. (eds) *Symbiosis*. Cambridge: Cambridge University Press, pp. 581–594.

Gibran F.Z. (2002) The sea basses *Diplectrum formosum* and *D. radiale* (Serranidae) as followers of the sea star *Luidia senegalensis* (Asteroidea) in southeastern Brazil. *Brazilian Journal of Biology* 62, 591–594.

Hanlon R.T. and Messenger J.B. (1996) *Cephalopod behaviour*. Cambridge: Cambridge University Press.

Hurd P.H. (1997) Cooperative signalling between opponents in fish fights. *Animal Behaviour* 54, 1309–1315.

Itzkowitz M. (1974) A behavioural reconnaissance of some Jamaican reef fishes. *Zoological Journal of the Linnean Society* 55, 87–118.

Jouvenel J.Y. and Pollard D.A. (2001) Some effects of marine reserve protection on the population structure of two spearfishing target-fish species, *Dicentrarchus labrax* (Moronidae) and *Sparus aurata* (Sparidae), in shallow inshore waters, along a rocky coast in the northwestern Mediterranean Sea. *Aquatic Conservation: Marine and Freshwater Ecosystems* 11, 1–9.

Karplus I. (1978) A feeding association between the grouper *Epinephelus fasciatus* and the moray eel *Gymnothorax griseus*. *Copeia* 1978, 164.

Kulbrick M. (1998) How the acquired behaviour of comercial reef fishes may influence the results obtained from visual censuses. *Journal of Experimental Marine Biology and Ecology* 222, 11–30.

Leite T.S., Haimovici M. and Lins J.E. (2008) A pesca de polvos no arquipélago de Fernando de Noronha, Brasil. *Boletim do Instituto de Pesca de São Paulo* 34, 271–280.

Leite T.S., Haimovici M. and Mather J. (2009) *Octopus insularis* (Octopodidae) evidences of a specialized predator and a time-minimizing hunter. *Marine Biology* 156, 2355–2367.

Lukoschek V. and McCormick M.I. (2000) A review of multispecies foraging associations in fishes and their ecological significance. *Proceedings of the 9th International Coral Reef Symposium* 1, 467–474.

Machado L.F. and Barreiros J.P. (2008) A previously undescribed following association between juvenile dusky grouper, *Epinephelus marginatus* (Serranidae) and *Octopus vulgaris*. *Cybium* 32, 187–188.

Maida M. and Ferreira B.P. (1997) Coral reefs of Brazil: an overview and field guide. *Proceedings of the 8th International Coral Reef Symposium* 1, 263–274.

Mather J. (1991) Foraging, feeding and prey remains in middens of juvenile *Octopus vulgaris* (Mollusca: Cephalopoda). *Journal of Zoology* 224, 27–39.

Pereira P.H.C., Feitosa J.L.L. and Ferreira B.P. (in press) Mixed-species schooling behavior and protective mimicry involving coral reef fish from the genus *Haemulan*. *Neotropical Ichthyology*.

Pimentel C.R. and Joyeux J.-C. (2010) Diet and food partitioning between juveniles of mutton *Lutjanus analis*, dog *Lutjanus jocu* and lane *Lutjanus synagris* snappers (Perciformes: Lutjanidae) in a mangrove-fringed estuarine environment. *Journal of Fish Biology* 76, 2299–2317.

Rojas-Herrera A.A., Mascaró M. and Chiappa-Carrara X. (2004) Hábitos alimentarios de los peces *Lutjanus peru* y *Lutjanus guttatus* (Pisces: Lutjanidae) en Guerrero, México. *Revista de Biología Tropical* 52, 959–971.

Rooker J.R. (1995) Feeding ecology of the schoolmaster snapper *Lutjanus apodus* (Walbaum), from south-western Puerto Rico. *Bulletin of Marine Science* 56, 881–894.

Sampaio C.L., Medeiros P.R., Ilarri M.I., Souza A.T. and Grempel R.G. (2007) Two new interspecific associations of the hairy blenny *Labrisomus nuchipinnis* (Teleostei: Labrisomidae) on the South Atlantic. *JMBA2—Biodiversity Records*, published on-line.

Santos F.B. and Castro R.M.C. (2003) Activity, habitat utilization, feeding behaviour, and diet of the sand moray *Gymnothorax ocellatus* (Anguilliformes, Muraenidae) in the south-western Atlantic. *Biota Neotropica* 3, 1–7.

Sazima C., Grossman A., Bellini C. and Sazima I. (2004) The moving gardens: reef fishes grazing, cleaning, and following green turtles in SW Atlantic. *Cybium* 28, 47–53.

Sazima C., Krajewski J.P., Bonaldo R.M. and Sazima I. (2007) Nuclear–follower foraging associations of reef fishes and other animals at an oceanic archipelago. *Environmental Biology of Fishes* 80, 351–361.

Smith C.D. (2003) Diet of *Octopus vulgaris* in False Bay, South Africa. *Marine Biology* 143, 1127–1133.

Strand S. (1988) Following behavior: interspecific foraging associations among Gulf of California reef fishes. *Copeia* 1988, 351–357.

and

Vincent T.L.S., Scheel D. and Hough K.R. (1998) Some aspects of the diet and foraging behavior of *Octopus dofleini* (Wülker, 1910) in its northernmost range. *Marine Ecology* 19, 13–29.

Correspondence should be addressed to:
P.H.C. Pereira
Departamento de Oceanografia, CTG
Universidade Federal de Pernambuco (UFPE)
Avenida Arquitetura, s/n, Cidade Universitária
Recife, PE, 50670-901, Brazil
email: pedrohcp2@yahoo.com.br