Invasive Lionfish Decrease Shelter-use in the Presence of Native Spiny Lobster

El Invasivo Pez León Disminuye el Uso de Refugios en Presencia de la Langosta Espinosa Nativa

L'invasif Poisson Lion Diminue l'Utilisation de Refuges en Présence de la Native Langouste Épineuse

CHRISTINA HUNT[1,2], CALLUM HUDSON[1,2], JOSHUA WILLIAMS[2], FRANKIE NOADES[2,3], and JOCELYN CURTIS-QUICK[4], DAN EXTON[2]
[1]*Department of Zoology — University of Oxford, UK.*
christina.hunt@zoo.ox.ac.uk, callum.hudson@wadham.ox.ac.uk,
[2]*Operation Wallacea Ltd, Lincolnshire, UK.*
dan.exton@opwall.ac.uk,
[3]*School of Environment and Life Sciences — University of Salford, UK.*
F.noades@edu.salford.ac.uk
[4]*Department of Natural Resources and Environmental Sciences — University of Illinois, USA.*
jocelyncq@googlemail.com

EXTENDED ABSTRACT

Introduction

Lionfish (*Pterois volitans* and *P. miles*) have become invasive throughout the tropical western Atlantic (Schofield, 2010), with *P. volitans* widely distributed across the region (Betancur-R et al. 2011). Most lionfish research has focused on their consumptive effects on native reef fish (Albins and Hixon 2013). Although there have been a few studies on their consumptive effects on invertebrates (e.g Layman et al. 2014) and on their non-consumptive effects (e.g Kindinger and Albins 2017), much less is known about these topics.

Lionfish often shelter around biotic and abiotic structures on the reef (Claydon et al. 2012), thus there is potential for competition between lionfish and other shelter-using organisms. Spiny lobster (*Panulirus argus*) are an economically important species in the western Atlantic (Cochrane and Chakalall 2001) and are caught using traps because of their propensity to use shelter to avoid predation (Eggleston et al. 1990). It has been suggested that lionfish may be detrimental to the lobster fishery because they are one of the most abundant by-catch fish and lobster catches are lower when a lionfish is present in the trap (Lazarre et al. 2014).

The aim of this study was to test whether the presence of lionfish alters the activity and shelter use behaviour of spiny lobster and vice versa.

Methods

Lionfish (assumed to be *Pterois volitans* (Betancur-R et al. 2011)) and spiny lobster (*Panulirus argus*) were studied in Tela bay, Honduras from June-August 2019.

We investigated the potential for shelter competition by conducting *ex-situ* laboratory experiments. Lionfish (n=24) and lobster (n = 24) were collected from a shallow reef and acclimatised in separate tanks in the laboratory for 24 hours prior to experiments. Trials were conducted in a tank measuring 245 × 54 × 24 cm (length x width x depth), filled with natural, unfiltered seawater to a depth of 17 cm. A single shelter with internal dimensions of 18 x 16 x 15 cm (width x height x depth) was placed at one end of the tank. Trials were filmed for 60 seconds every hour over a 24-hour period using an infrared trail camera. For each video, the proportion of time spent active and proportion of time spent inside the shelter were recorded. We conducted three treatments: lionfish alone (n = 12), lobster alone (n = 12) and lionfish-lobster together (n =12). Each individual was only used once. Following the trials, lionfish were humanely culled whilst lobsters were telson-clipped (to prevent re-capture of the same individual) before being released at the site of capture.

Activity and shelter-use were recorded as continuous proportions, therefore we analysed the differences between 'alone' and 'together' trials using beta regression.

Results

In the presence of a lobster, lionfish activity did not change ($p > 0.05$) but lionfish shelter use decreased significantly ($p = 0.0059$) from a median proportion of 0.81 in the 'alone' trials to 0.17 in the 'together' trials (Figure 1). Conversely, in the presence of a lionfish, lobster activity increased significantly ($p = 0.015$) from a median proportion of 0.11 in the 'alone' trial to 0.29 in the 'together' trial but lobster shelter use did not change ($p > 0.05$).

Discussion

Prior to this study, little was known about how lionfish impact the behaviour of native species, or how native species may impact the behaviour of lionfish. Through *ex-situ* shelter-use experiments we have demonstrated a two-way relationship between lionfish and spiny lobster, whereby both species influence the behaviour of one another but in different ways.

Lobsters became more active in the presence of lionfish. Increased activity can reduce the scope for growth in other crustaceans (Parslow-Williams et al. 2002), so if the increased activity in lobsters is sustained over long periods then it may result in a reduction in growth rates. In the absence of shelter, spiny lobster will remain motionless in the presence of a predator (Weis et al. 2008), suggesting that increased activity may attract predators and potentially increase predation risk. This effect of lionfish on lobster activity was not reciprocated; lionfish spent the same proportion of time active in both the 'alone' and 'together' treatment.

Lobster shelter use was not affected by the presence of lionfish. This suggests that the decline in lobster catch when a lionfish is present in a trap (Lazarre et al. 2014) is not the result of lionfish presence causing a reduction in the time that lobsters spend sheltering. Our finding that lionfish reduce their shelter use in the presence of lobsters may be beneficial for lobsters because in areas of low shelter availability, lionfish may vacate shelters if lobsters are present.

Our study only tested individuals, rather than groups, of each species, so we suggest that further research should test the effects of varying numbers of lionfish and lobster competing for a single shelter. Similar experiments should also be conducted *in-situ* using natural reef shelters.

LITERATURE CITED

Albins, M.A. and M.A. Hixon. 2013. Worst case scenario: potential long-term effects of invasive predatory lionfish (*Pterois volitans*) on Atlantic and Caribbean coral-reef communities. *Environmental Biology of Fishes* **96**:1151 - 1157.

Betancur-R, R., A. Hines, A., Acero, G. Orti, A.E. Wilbur, and D.W. Freshwater. 2011. Reconstructing the lionfish invasion: insights into Greater Caribbean biogeography. *Journal of Biogeography* **38**:1281 - 1293.

Claydon, J.A.B., M.C. Calosso, and S.B. Traiger. 2012. Progression of invasive lionfish in seagrass, mangrove and reef habitats. *Marine Ecology Progress Series* **448**:119 - 129.

Cochrane, K.L. and B. Chakalall, B. 2001. The spiny lobster fishery in the WECAFC region - an approach to responsible fisheries management. *Marine and Freshwater Research* **52**:1623 - 1631.

Eggleston, D.B., R.N. Lipcius, D.L. Miller, and L. Cobacetina. 1990. Shelter scaling regulates survival of juvenile Caribbean spiny lobster *Panulirus argus*. *Marine Ecology Progress Series* **62**:79 - 88.

Kindinger, T.L. and M.A. Albins. 2017. Consumptive and non-consumptive effects of an invasive marine predator on native coral-reef herbivores. *Biological Invasions* **19**:131 - 146.

Layman, C.A., Z.R. Jud, and P. Nichols. 2014. Lionfish alter benthic invertebrate assemblages in patch habitats of a subtropical estuary. *Marine Biology* **161**:2179 - 2182.

Lazarre, D., D.J. Die, J. Morris, and L. Akins, L. 2014. Lionfish Bycatch in the Florida Keys Commercial Spiny Lobster Fishery. *Proceedings of the Gulf and Caribbean Fisheries Institute* **66**:208 - 209.

Parslow-Williams, P., C. Goodheir, R.J.A. Atkinson, and A.C. Taylor. 2002. Feeding energetics of the Norway lobster, *Nephrops norvegicus* in the Firth of Clyde, Scotland. *Ophelia* **56**:101 - 120.

Schofield, P.J. 2010. Update on geographic spread of invasive lionfishes (*Pterois volitans* Linnaeus, 1758 and *P. miles* Bennett, 1828) in the Western North Atlantic Ocean, Caribbean Sea and Gulf of Mexico. *Aquatic Invasions* **5**: S117 - S122.

Weis, H.M., E. Lozano-Alvarez, and P. Briones-Fourzan. 2008. Circadian shelter occupancy patterns and predator-prey interactions of juvenile Caribbean spiny lobsters in a reef lagoon. *Marine Biology* **153**:953 - 963.

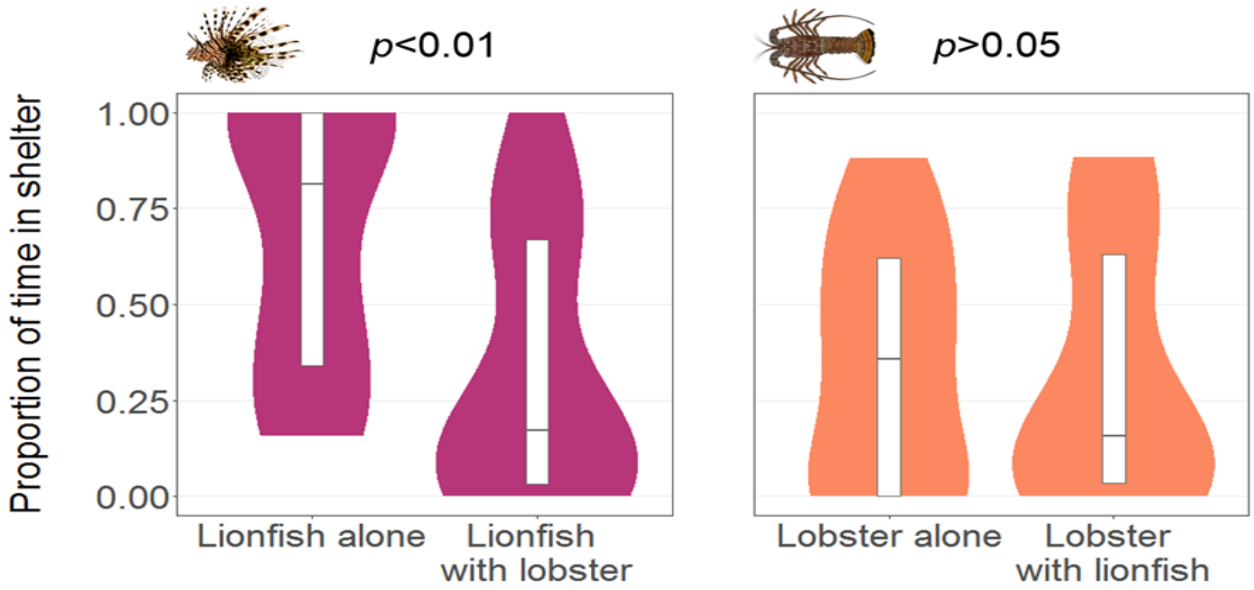

Figure 1. Proportion of time that lionfish and lobster spent inside the shelter in the 'alone' and 'together' treatments. Violin plots represent the spread of the data and are scaled so that all violins have the same area. Boxplots show the median and inter-quartile range. The whiskers and outliers are not plotted. n =12 for all treatments.