

A Comparison of Lionfish Feeding Ecology Within the Invaded Region

Una Comparación de la Ecología de Alimentación del Pez León Dentro de la Región Invadida

Une Comparaison de l'Écologie de l'Alimentation du Poisson-lion dans la Région Envahie

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EXTENDED ABSTRACT

Lionfish are now established throughout the Caribbean region, the Gulf of Mexico and the coasts of North, South and Central America (Côté et al. 2013) and forecasts predict that the lionfish invasion will continue extending in South America towards Brazil (Morris and Whitfield 2012). Lionfish were first reported in the 1980s along South Florida and have since spread along the South-East United States coast and throughout the Caribbean region (Johnston and Purkis 2014). Lionfish are principally piscivorous, but are known to also feed on a number of invertebrates and in their native range, they tend to occupy the higher levels of the food chain (Morris 2009). They are opportunistic predators (Whitfield et al. 2007) and possess a variety of feeding strategies (Table 1) which prey species in the Atlantic region are naïve to, resulting in lionfish having higher predation efficiencies in the invaded range compared to that of their native range (Albins and Hixon 2008). Lionfish have been present throughout the invaded Atlantic-Caribbean region across different habitats and for varying time scales. If lionfish feeding ecology differs among islands, the consequent ecological impacts are likely to vary, cautioning against drawing inferences from studies in contrasting habitats and warranting control strategies to be tailored accordingly.

To assess whether lionfish feeding behaviour was similar throughout the invaded range, 11,161 lionfish ranging between 21 to 455 mm total length (TL) were collected and analysed in Bonaire (6,288), Klein Bonaire (2,743) and Curacao (2,130), between October 26, 2009 and November 24, 2013, making this one of the largest and most representative surveys of lionfish diets in their invaded habitat. Trained volunteer lionfish hunters collected all specimens using scuba gear. Collections were achieved using hand nets, pole spears or the use of the Eradicating Lionfish Tool (ELF Tool) and caught specimens were stored in containment devices such as dry bags or the Zookeeper. Lionfish were collected every month of the year, with the smallest sample sizes occurring during December ($n = 221$) and the largest sample sizes in March ($n = 2696$). Collections were achieved between 07:00 to 22:00 with the majority (48%) taking place between 14:00 to 18:00. Subsequent to collection, all specimen were measured and weighed with stomach content and volumetric analysis being performed. To compare this study to other research within the invaded region, further dietary analyses were performed. The contribution of individual prey taxa to the overall diet of lionfish was assessed via percent frequency of occurrence (%F); percent composition by number (%N) and percent composition by volume (%V). Dietary preferences were also assessed to determine whether any prey traits increased vulnerability to lionfish predation and results were compared to other equivalent -scale analyses of stomach contents of lionfish.

Table 1: Lionfish feeding strategies

Feeding Strategy	Description	References
Suction feeding	A common teleostan feeding technique consisting of swift expansion of the buccal and opercular cavities. The lionfish's ability to stretch its mouth and expand its stomach up to 30 times its original size enhances this strategy	Freshwater et al. 2009; Morris 2009
Ambush predation	By remaining motionless and waiting for their prey to come within striking distance lionfish can successfully prey upon small fish and invertebrates	Whitfield et al. 2002
Use of pectoral fins	Using large, outstretched, ornate pectoral fins to corral and corner prey and also to flush benthic invertebrates from the substrate	Ruiz-Carus et al. 2006; Albins and Hixon 2008
Alteration of centre of gravity using bilateral swim bladder muscles	This allows for novel control of their pitch in the water column, and allows them to orient and hover upside down under ledges or on lateral faces of structures	Morris 2009
Jet assisted predatory behaviour	Using water jets enhance the predation efficiency of lionfish since it can potentially disorient prey, leaving them vulnerable to predation. Jets also increase the incidence of head first capture	Nilsson and Bronmark 1999; Albins and Lyons 2012

This research revealed that although lionfish diets throughout the invaded region were similar in terms of composition, there were considerable differences in rankings of dietary importance. Lionfish across all study sites possessed a predominantly fish only diet (Bonaire: 63%, Klein Bonaire: 71% and Curacao: 71%), similar to reports from the Bahamas and other invaded Caribbean islands. Within this study, a total of 10,945 prey items were documented in the 11,161 lionfish stomachs examined in this study, an order of magnitude more than the 1,876 items documented from 1,069 stomachs examined in Bahamas (Morris and Akins 2009). Additionally, within this study, the maximum number of crustacean prey per lionfish was 29, whereas the maximum number of teleost prey was 42, compared to maximums of 50 invertebrates and 21 fishes reported in the Bahamas (Morris and Akins 2009). Based on results from published research, lionfish generally possessed a fish dominated diet in terms of percentage frequency of occurrence (%F) and percentage composition by volume (%V) (Figure 1) however there were still differences amongst the different islands within the introduced range. In terms of %F, fish and invertebrates were more equally represented within lionfish diets in Bermuda, whereas within Curacao, Cuba, and the Bahamas, there was a greater disparity in representation. Similarly, like %F, Bermuda compared to the rest of the introduced region had a higher representation of invertebrates in terms of %V.

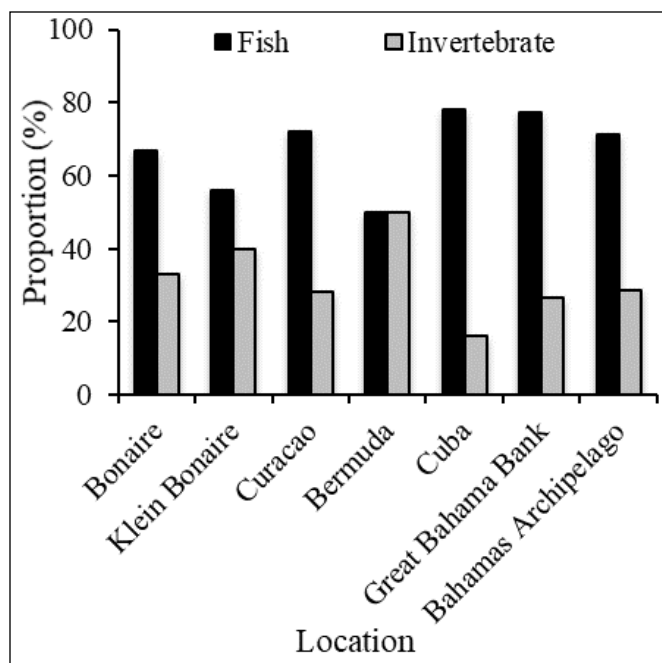


Figure 1. Comparison of lionfish diet composition within the introduced range according to Percentage frequency of occurrence. Black bars indicate the proportion of fish whilst grey bars indicate the proportion of invertebrates in lionfish diets.

The fact that lionfish possess a generalist diet can be a blessing and a curse at the same time. The lack of specialization on any individual or few species means there is limited risk that lionfish will drive an entire species to extinction immediately. However their generalist nature can be dangerous since it means that lionfish are able to exploit more prey species as compared to native predators. The lionfish's successful generalist diet is enabled by their wide repertoire of feeding strategies (Whitfield et al. 2007; Freshwater et al. 2009; Albins and Lyons 2012) coupled with the fact that local prey do not recognize them as predators (Albins and Hixon 2008; Maljkovic and Leeuwen 2008). This research therefore confirms that the feeding behaviours and preferences of lionfish are not uniform throughout their introduced range and reveals the potential implications for ecology if lionfish are not as ubiquitous as represented in other areas of the invaded region.

KEYWORDS: Invasive, species, Caribbean, lionfish, feeding ecology

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