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BRIEF COMMUNICATION

Probopyrinella latreuticola parasite infestation frequencies in pelagic *Sargassum*-associated shrimp, *Latreutes fucorum*

LINDSAY M. MARTIN[1,*], JEFFREY M. SCHELL[2] AND AMY N.S. SIUDA[2,3]

[1]TEXAS A&M UNIVERSITY, COLLEGE STATION, TX 77843, USA, [2]SEA EDUCATION ASSOCIATION, WOODS HOLE, MA 02540, USA AND [3]ECKERD COLLEGE, ST. PETERSBURG, FL 33711, USA

*CORRESPONDING AUTHOR: lindsay.martin19@gmail.com

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Bopyrid isopod parasitic infestation of a variety of decapod definitive hosts is common worldwide. We report frequencies of a parasite infestation in the shrimp *Latreutes fucorum* associated with the pelagic macroalgae *Sargassum* in the Gulf of Mexico, Sargasso Sea and Eastern Caribbean. Average *Probopyrinella latreuticola* infestation frequency was 6.7% and did not significantly vary between regions. The presence of the ectoparasite appeared to impact fertility with only one infested individual found carrying eggs. In contrast, across all three regions, 13% (of $n = 4001$) of the non-infested shrimp were carrying eggs. With *L. fucorum* accounting for three quarters of lower trophic level biomass in the pelagic *Sargassum*-associated faunal community, parasite infestation may have negative consequences for ecologically and commercially important populations that rely directly or indirectly on the host as a food source.

KEYWORDS: parasite; shrimp; *Sargassum*; Bopyridae; *Latreutes fucorum*; *Probopyrinella latreuticola*

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Of the known isopod species, ~7.7%, from families Bopyridae and Cryptoniscoidae are parasites of a wide variety of decapods (Williams and Boyko, 2012). Parasite distribution appears to be largely dependent upon intermediate copepod host and definitive shrimp and crab host distributions (Markham, 1986). Parasitic isopods start as free-swimming larvae that latch onto copepods where they feed, eventually growing into a larger, free-swimming secondary stage that searches for and attaches to its final host, typically in the branchial chamber. Many of the parasites appear to have species-specific host relationships (Markham, 2003). Bopyrid parasitism can have many negative effects on hosts, including reduced energy availability, prevention of egg production, castration of female gonads (Anderson, 1977), feminization of males (O'Brien and Van Wyk, 1985) and reduced tolerance to stress (Moles and Pella, 1984).

Little research has been conducted concerning bopyrid parasite infestation of shrimp associated with pelagic *Sargassum* (Markham, 1977). While benthic *Sargassum* is distributed worldwide in shallow tropical and sub-tropical waters, only *Sargassum fluitans* and *Sargassum natans* have a uniquely pelagic lifecycle in nutrient-poor, warm surface waters of the western Atlantic. Pelagic *Sargassum* hosts numerous and sometimes endemic mobile fauna species, including crabs, fish, polychaetes, snails and shrimp (Butler *et al.*, 1983; Huffard *et al.*, 2014). These organisms form the base of a food web that supports juvenile turtles (Coston-Clements *et al.*, 1991), sea birds (Moser and Lee, 2012) and commercially important fish species (Casazza and Ross, 2008). During the course of a wider study of *Sargassum*-associated fauna, the shrimp, *Latreutes fucorum*, was observed carrying an ectoparasitic isopod of the family Bopyridae (Fig. 1).

Individual *Sargassum* clumps and closely associated fauna were simultaneously collected via dipnet (DN) from stations in the Gulf of Mexico between April and July 2015 ($n = 128$ DN from 14 stations), Eastern Caribbean during February and March 2015 ($n = 32$ DN from 10 stations) and Sargasso Sea during April and May 2015 ($n = 87$ DN from 11 stations). Each clump of macroalgae was submerged in fresh tap water to facilitate separation and collection of mobile (not epifauna) fauna. Ethanol-preserved mobile fauna were identified using a dissecting microscope. The 4001 *L. fucorum* represented 78% of the total fauna count. *Latreutes fucorum* presenting with eggs and/or the bopyrid parasite infestation were flagged in the dataset. Identification of the parasite was based on dissection and visual examination of 20% of the infested shrimp from each region (total $n = 52$). Frequencies of parasitized and fertile shrimp were compared between populations of *L. fucorum* for each region [analysis of variance (ANOVA), Tukey's honestly significant difference (HSD)]. The impact of infestation on fertility was assessed using a χ^2 analysis.

Infested *L. fucorum* individuals were found to be carrying the bopyrid parasite *Probopyrinella latreuticola*, which can be morphologically distinguished from *Probopyrinella heardi*, another bopyrid parasite that has been found on closely related *Latreutes parvulus* hosts (Markham, 1977; Adkinson, 1984). *Latreutes fucorum* did not display any significant differences in infestation frequency between regions (Gulf of Mexico: 7% of $n = 2287$; Caribbean: 7% of $n = 769$; Sargasso Sea: 6% of $n = 945$; $P > 0.05$). We observed ectoparasite infestation in a single individual of each of the two less common shrimp species in the dataset, *Leander tenuicornis* ($n = 151$) and *Hippolyte coerulescens* ($n = 77$). Parasite species identification for these individuals was not possible as indicative morphological

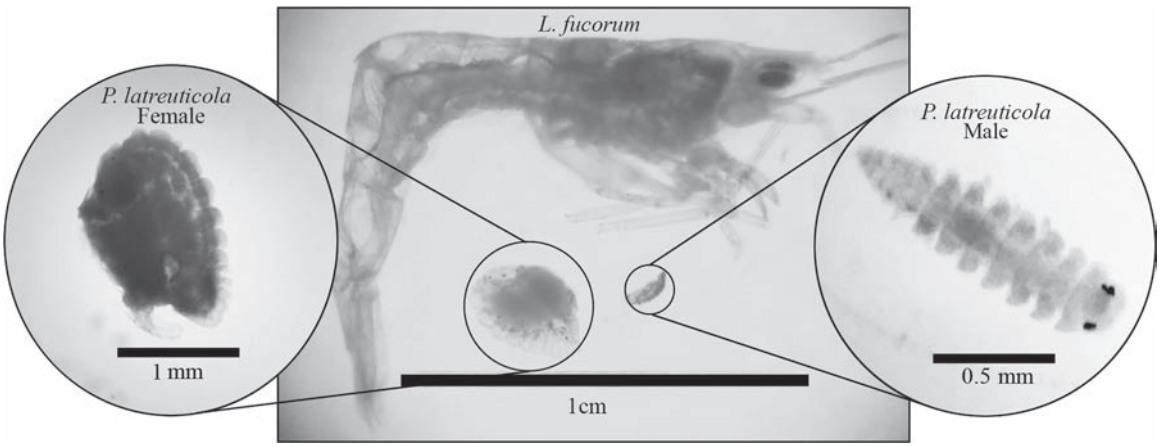

Fig. 1. Individual of *L. fucorum* infested with *P. latreuticola*. Inset images depict female and male parasites.

features of the parasites were damaged during extraction. Frequency of ovigerous *L. fucorum* varied between regions, with the Caribbean (7% of $n = 769$) having significantly ($P < 0.05$) lower frequencies than the Gulf of Mexico (14% of $n = 2287$) or Sargasso Sea (16% of $n = 945$). Only one infested fertile *L. fucorum* was found. Parasite infestation had a highly significant impact on the likelihood of fertility ($\chi^2 = 42.1$, $P < 0.01$).

This report presents novel observations of *P. latreuticola* infestation frequencies in pelagic *Sargassum*-associated *L. fucorum* from three geographic regions. *Latreutes fucorum* was the most infested shrimp species in our study by an order of magnitude, despite low overall infestation (6.7%). The prevalence of bopyrid parasite infestations of decapods is typically low (Chaplin-Ebanks and Curran, 2007; Pralon *et al.*, 2018), similar to those found in this study; however, Jay (1989) found 85% prevalence in females of *Crangon francisorum*. A recent study of 184 192 *Hiipolyte zostericola* in Mexico found a very low bopyrid prevalence of 0.4% but still observed negative effects on growth and fecundity (Romero-Rodríguez *et al.*, 2016). The lack of infested but ovigerous individuals in our study suggests a negative impact on *L. fucorum* fecundity, particularly in the Caribbean region where shrimp fertility was already low.

Shrimp are among the most numerous species in a complex *Sargassum* food web, meaning any change in their numbers due to parasite-caused reductions in survivorship or fecundity could affect ecologically and commercially important species. The lack of difference in infestation frequencies of *L. fucorum* between geographic regions suggests that the interactions between *Sargassum* clumps moving between regions are fluid and rapid enough to prevent localized differences. Conversely, others have found differences in infestation prevalence across time and space in grass shrimp in the Gulf of Mexico (Sheehan *et al.*, 2011). Our findings could suggest long-distance transport of the parasite while in the free-swimming larval stage or while associated with its intermediate host. Pelagic *Sargassum* is undergoing a major shift in diversity resulting from massive atypical blooms of a previously rare form of the algae, 200-fold larger than average, that are ongoing throughout the equatorial Atlantic and Caribbean basin (Gower *et al.*, 2013; Schell *et al.*, 2015). These changes, in both the quantity and type of *Sargassum*, could cause a concurrent shift within the faunal community, threatening not only these unique organisms but also the larger food webs they support. Population changes in shrimp due to secondary effects of parasitic infestations should be included in future studies of *Sargassum* and associated fauna. In particular, the possible results of changing environmental conditions and the impact of parasites on shrimp size and fecundity of both sexes should be examined. As such, the bopyrid isopod infestation of *Sargassum*-associated shrimp represents a common parasite of common species with potentially uncommon and devastating results.

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