Connecting Anchovies to Pelagic Predators by Their Parasites

Conexión de Anchoas a los Depredadores Pelágicos por sus Parásitos

Connexion Anchois aux Prédateurs Pélagiques par leurs Parasites

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EXTENDED ABSTRACT

Atlantic Spanish Mackerel (SM; *Scomberomorus maculatus*) and Atlantic Sharpnose Shark (AS; *Rhizoprionodon terraenovae*) are migratory, coastal pelagic species that enter the Mississippi Sound as water temperature increases in the early spring and depart as the water temperature decreases in the fall. Both species feed on nektonic invertebrates and teleosts, including the Bay Anchovy (BA; *Anchoa mitchilli*) although to a lesser degree than other teleosts (e.g., Saloman and Naughton 1983, Hoffmayer and Parsons 2003). Bay Anchovy is a numerically abundant forage-fish species that is an estuarine resident, capable of reproducing throughout the year, and link the mesozooplankton community to the higher trophic levels. Examination of the parasite community of BA, particularly those species that are trophically-transmitted to SM and AS, may provide insight into when SM and AS enter the Mississippi Sound and the potential importance BA is to the transmission of these parasites.

We collected BA monthly from January–October 2016 at locations within the central Mississippi Sound by trawl and examined 20 individuals from each location for endohelminths. All identifications of endohelminths were made using a combination of morphological characters and rDNA sequencing. A total of seven parasite species are included in our analyses: two trematode species (*Parahemiurrus anchoviea* and *Pseudobacciger harengulae*) that use BA as the definitive host; two trematode species (cf. *Bucephalus scomberomorous* and *Didymocystis scomberomori*) and one nematode species (*Hysterothylacium fortalezae*) that use SA as the definitive host; and two cestode species (*Phoreobothrium* sp. and *Acanthobothrium* sp.) that use AS as the definitive host. Parasitological terms follow that of Bush et al. (1997). We used correlation analysis to discern if the mean abundance of parasite species that use either SM or AS as the definitive host was correlated with month and mean abundance of their final host. We compared $\log_{10}(X+1)$ transformed abundance data by month with ANOVA and used Bonferroni-adjusted alpha values for all comparisons. The abundance data for definitive hosts came from fishery-independent surveys in Mississippi Sound from 2014 - 2015 (for SM) and 2015 - 2016 (for AS). . We also examined for potential differences in the parasite infra-community monthly and by size class (< 40 mm SL and > 40 mm SL) of the BA host using a UPGMA cluster with SIMPROF profiles approach (Clarke and Gorley 2006). These size classes correspond to size at 50% maturity and 2.5 mo. of age (Zastrow et al. 1991).

Prevalence and mean abundance of the two parasite species that use BA as the definitive host were similar throughout the sampling period but were slightly higher during the summer months. Overall, prevalence and mean abundance for species that mature in either SM or AS were lowest in the winter and early spring months (January–March) and greater April–October (Figure 1). Only *Phoreobothrium* sp. (Cestoda; AS as definitive host) was significantly correlated with month ($r = 0.92$, $p < 0.001$), and no parasite species was correlated with mean monthly abundance of SM or AS. Cluster analysis of the BA infracommunity, including size class as a factor, resolved two significant main clusters (Figure 2). The first cluster resolved large and small fish from January and February with small fish from March, April, and June; the second cluster resolved large fish from March - October with small fish from July - October (small May fish were excluded due to low sample size).

Our results suggested that the increase in prevalence and abundance in the endohelminth community of BA follows the immigration of SM and AS into Mississippi Sound. The mean abundance of all parasite species trophically transferred to SM or AS increased once their definitive host likely entered into the estuary and remained relatively high, although not significantly correlated with the mean catch data of their final hosts. This is not necessarily surprising given that the final hosts move throughout the estuary and the SM and AS catch data are combined from various sampling locations and years in Mississippi Sound. The strong positive correlation of *Phoreiobothrium* sp. with month likely reflects an increase in prevalence of infection of the parasite in copepods (serve as the first intermediate host and are a common prey item of BA) and the accumulation of this parasite in BA. Similarly, the clustering of small BA in the spring with small and large BA in the winter, likely reflects the lack of accumulation of trophically transmitted parasites. Whereas the clustering of small BA in the summer-early fall months with large BA is probably indicative of the small BA foraging on similar prey items while the prevalence of trophically transmitted species is high in their first intermediate hosts. Although BA has only been reported as a minor prey item in previous diet studies of SM and AS (e.g., Saloman and Naughton 1983, Hoffmayer and Parsons 2003), our results suggest that BA is a likely prey item for both species based on the presence of at least two parasite species that mature in both SM and AS and at relatively high prevalence's of those species.

KEYWORDS: Spanish Mackerel, Atlantic Sharpnose Shark, endohelminths, trophic

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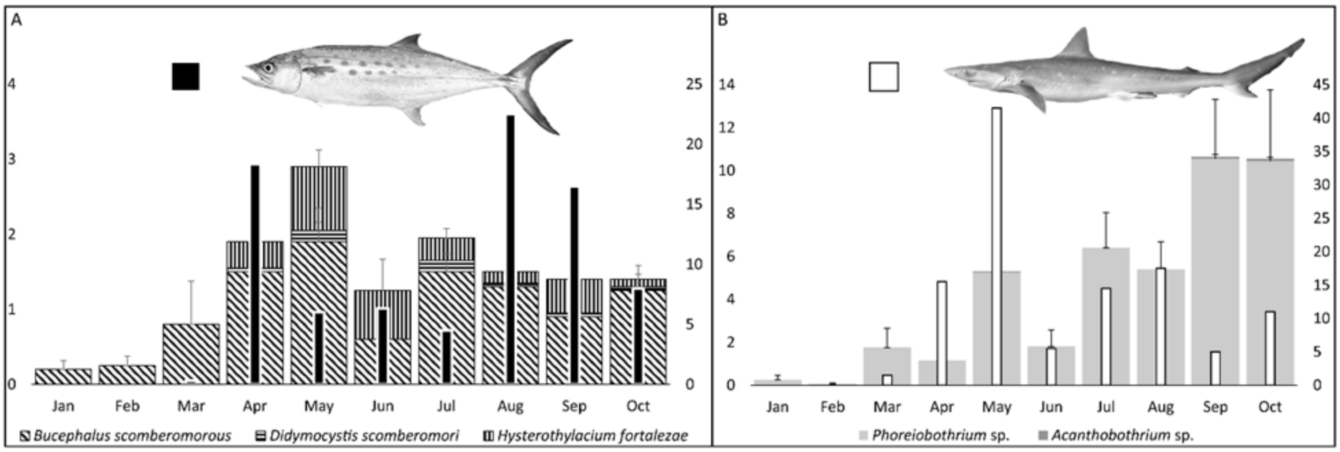

Figure 1. Stacked histogram displaying mean monthly abundance data for parasite species isolated from Bay Anchovy (primary y-axis) and two-year mean monthly abundance for the definitive host (secondary Y-axis); black bars represent Atlantic Spanish Mackerel and white bars represent Atlantic Sharpnose Shark. A: Parasite species that use Atlantic Spanish Mackerel as the definitive host; B: Parasite species that use Atlantic Sharpnose shark as the definitive host. Bars on abundance data represent standard error.

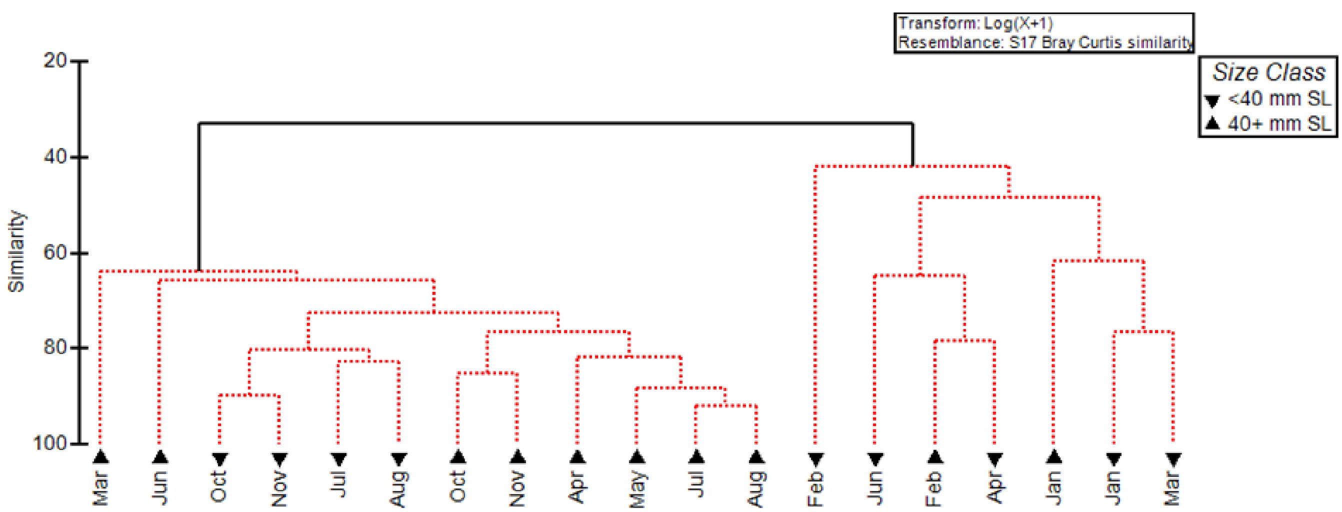

Figure 2. Cluster analysis dendrogram of mean monthly parasite abundance revealing two significant main clusters based on SIMPROF profile analysis. Dashed lines indicate non-significant structure in the clusters whereas solid line indicate significant main clusters.