PROTOZOAN AND METAZOAN SYMBIONTS OF SELECT DECAPOD CRUSTACEANS

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ABSTRACT

Three species of decapods: Callinectes sapidus, Menippe mercenaria, and Clibanarius vittatus, were examined for protozoan and metazoan symbionts. An examination for endosymbionts revealed two cysts, probably trematode metacercariae, in C. sapidus. Anasakine nematodes, probably of the genus Contracaecum or Thynnascaris, were found in C. vittatus. Also, two species of polychaete annelids were found in a symbiotic relationship with C. vittatus. An examination for ectosymbionts revealed a wide variety of protozoans, such as the ciliate Zoothamnium sp., on both C. sapidus and C. vittatus.

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INTRODUCTION

Decapods are the most commercially important of the crustacean shellfishes. This endeavor is specifically concerned with the protozoan and metazoan symbionts present in three species of decapods: the portunid brachyuran, Callinectes sapidus (the blue crab), the xanthid brachyuran, Menippe mercinaria (the stone crab), and the anomuran decapod, Clibanarius vittatus (the striped hermit crab). The term symbiosis is used to imply a close relationship between one species of organism, known as a host, and another species, known as a symbiont. The term parasitism is a specific type of symbiosis and is used to imply a metabolic dependency of a parasitic symbiont upon a host. Since most protozoan and metazoan symbionts have only recently attracted the attention of researchers, little is known about their incidence, and even less is known about the host-symbiont relationships in which they are involved. For example, it is not known whether the symbionts here studied technically derive nourishment directly from the host crab, whether they are an obvious detriment to the host crab, or whether they have an even less dependent relationship with the host crab.

At this initial stage in the study of decapod symbioses, it is most practical to identify and to survey their geographic incidences and intensities. These study surveys of diseases could provide an ecological basis for ellucidating host-symbiont relationships, and permit the study of diseases which each symbiont can potentially cause. The effects of parasitic diseases upon commercially important decapods is pertinant to their respective fisheries.

This fisheries industry in the Gulf of Mexico is of prime economic importance to the Gulf States. For example, in 1974, the Gulf States catch of shellfishes and finfishes comprised 26% of the value of total U. S. landings and exceeded the catch of all other areas in total volume. In that same year, Texas fishermen caught 40.3 million pounds of crabs (C. sapidus and M. mercenaria) valued at about 5.3 million dollars (U. S. National Marine Fisheries Service, 1976). These statistics emphasize the positive effect which the crab industry has upon the Texas economy. Perhaps one of the most astounding facts about serious protozoan and metazoan diseases of decapods is that biologists have only recently discovered their significance as mortality factors. For example, it has long been known by the fishermen of the Chesapeake Bay area that the "sick crab disease" was a serious detriment to their crab industry; but only recently have researchers found the disease to be caused by the protozoan parasite Nosema. The economic significance of the crab fisheries should compel more interest in and financial support of research on shellfish diseases (Sprague, 1970).

The paucity of past research is evident by the relative scarcity of literature dealing with symbionts of decapod crustaceans. A review of the literature on protozoan and metazoan symbionts of the blue crab, C. sapidus, reveals that a variety of symbionts have been reported. Among these is the microsporidian protozoan Ameson michaelis, which is considered to elicit one of the most harmful diseases of blue crabs (Overstreet, 1978). This protozoan's life cycle has been experimentally established. It is the only known life cycle of a blue crab symbiont. Several metazoan symbionts are known to utilize blue crabs as a second intermediate host in their life cycles. The microphallid trematode, Levinseniella capitanea, is commonly found among the gonads or the diverticula of the hepatopancreas. It is the largest microphallid known. A second species of trematode Microphallus basodactylophallus, also utilizes blue crabs as a second intermediate host. This parasite, when hyperparasitized by a haplosporidian protozoan, causes a condition known as "pepper crab". This condition harms neither crab nor man but detracts from the aesthetic appeal of its crab host (Overstreet, 1978; Sprague, 1970).

Several symbiotic barnacles have been occasionally found on blue crabs. Among these are Balanus venustus niveus, which establishes itself on the carapace and legs of the blue crab; Octolasmis muelleri, which is confined mainly to the gills; and Loxothylacus texanus, which externally appears as a protrusion under the crab's abdomen (Brunenmeister, et al., 1975; Harris, et al., 1970; Ragan, et al., 1973). Most of the authors cited consider barnacles to range between being fouling organisms and true parasites.

To the author's knowledge, there have been no previous works dealing with the symbiotic fauna of M. mercenaria or C. vittatus.

MATERIALS AND METHODS

Blue crabs were obtained from three collection sites: Galveston (East Jetty), Port Aransas (Red Fish Bay), and Port Isabel (Laguna Madre). Stone crabs were obtained from only Galveston (East Jetty). Hermit crabs were obtained from Galveston (Mud Flats), and Port Aransas (Red Fish Bay). The crabs were captured either with a dip net, with a tide trap, or by hand. At each collection site, the salinity of the water was measured and recorded (Table 1).

A systematic examination of each crab was performed. The carapace widths of blue crabs and stone crabs were recorded. The size range of the blue crabs selected were those of eatable, marketable size. An external examination of the carapace and abdomen for ectosymbionts was done. The gills, hepatopancreas, gut, and gastric mill were extripated, dissected, and examined for symbionts. The symbionts found were then identified using a compound microscope and appropriate taxonomic keys.

RESULTS

A total of 20 Callinectes sapidus (blue crabs) were collected from three collection sites - Galveston (East Jetty), Port Aransas (Red Fish Bay), and Port Isabel (Laguna Madre) - on three respective dates (Table 1). A total of 12 crabs were collected from Galveston (East Jetty) where the salinity was $28^{o}/_{oo}$; a total of 4 crabs were collected from Port Aransas (Red Fish Bay) where the salinity was $30^{o}/_{oo}$; and a total of 4 crabs were collected from Port Isabel (Laguna Madre) where the salinity was $32^{o}/_{oo}$. Approximately 70 to 80 crabs total were surveyed, from which 20, ranging from 120mm to 165mm in carapace width, were subsampled. None of the 70 to 80 crabs displayed externally visable signs of barnacles or microsporidians.

An examination of the gut of C. sapidus revealed two cysts of an unidentified larval helminth. It was present in 17% (2 of 12) of the crabs collected from Galveston (East Jetty). The spherical cyst measured 200 to 230 microns in diameter and displayed a thick cyst wall (23 microns). These cysts are presently unidentified, but

Crab species	East Jetty Galveston		Mud Flats Galveston		Red Fish Bay Port Aransas		Laguna Madre Port Isabel		Total
	N*	Date / Salinity	N	Date / Salinity	N	Date / Salinity	N	Date / Salinity	N
Callinectes sapidus	12	27 Sep 78 / 28 °/oo		—	4	5 Nov 78 / 30 °/oo	4	18 Nov 78 / 32 °/oo	20
Menippe mercenaria	3	27 Sep 78 / 28 °/oo		—		—		—	3
Clibanarius vittatus		—	13	18 Dec 78 / 28 °/oo	14	5 Nov 78 / 32 °/oo		—	57
			17	27 Jan 79 / 20 °/oo	13	10 Mar 79 / 30 °/oo			
Total N	15		30		31		4		80

Table 1. Distribution of crabs collected, date of collection, and salinity of water at each collection sites.

*N = Number of crabs collected.

are believed to be those of trematode metacercariae.

A close examination of the carapace and abdomen of blue crabs collected revealed a wide variety of ectosymbionts. Ectosymbiotic nematodes were present on all of the blue crabs examined. In two cases, the nematodes infested the gills. There was a average of nine nematodes per individual gill on the infested crabs. Many species of ectosymbiotic protozoans were also present. These were microscopic and very active. Colonies of the ciliate Zoothamnium sp. were identified, and their feeding habits were observed.

A total of 3 Menippe mercenaria (stone crabs) were collected from only one location, Galveston (East Jetty) on September 27 (Table 1). The salinity of the water was $28^{o}/_{oo}$.

Upon close examination of the stone crabs, no endosymbionts were found. While examining the carapace, many microscopic ectosymbiotic protozoans were observed.

A total of 57 Clibanarius vittatus (striped hermit crabs) were collected from two locations: Galveston (Mud Flats), and Port Aransas (Red Fish Bay). The number of crabs collected from each location and the respective salinities are shown in Table 1. A total of 30 crabs were collected from Galveston (Mud Flats) where the mean salinity was $28.5^{o}/_{oo}$; a total of 27 crabs were collected from Port Aransas (Red Fish Bay) where the mean salinity was $31^{o}/_{oo}$. Collections took place on two dates for each site.

The incidence of anasakine nematodes, probably of the genus Contracaecum or Thynnascaris, in C. vittatus is shown in Table 2. From Galveston (Mud Flats), the incidence was 54% on 18 December 1978, and 13% on 27 January 1979. From Port Aransas (Red Fish Bay), the

Collection Sites	Date Incidence
Mud Flats Galveston	18 Dec.78 7/13 (54%)
	27 Jan.79 2/17 (13%)
Red Fish Bay Port Aransas	5 Nov.78 2/14 (14%)
	10 Mar.79 2/13 (15%)

Table 2. Incidence of anasakine nematodes in *Clibanarius vittatus*.

incidence was 14% on 5 November 1978, and 15% on 10 March 1979. The highest incidence, 54%, occured in crabs collected from Galveston (Mud Flats) in December.

The intensity of anasakines in C. vittatus is shown in Table 3. Intensities ranged from 1.0 to 4.1 anasakines per infected host examined. The crabs collected from Galveston (Mud Flats) in December had the highest intensity of worms per infected host examined as well as the highest incidence.

Also found in a symbiotic relationship with hermit crabs were two species of polychaete annelids. They were of the Subclass Errantia, one species probably belonging to the Family Phyllodocidae. The other polychaete is presently unidentified. The polychaetes were found on two different hermit crabs from Galveston (Mud Flats), one on each of the dates collected. Both of the polychaetes were found between the carapace and the gills of the crab. They were very active when mechanically stimulated.

DISCUSSION

The three decapods selected for this survey; the portunid brachyuran, Callinectes sapidus, the xanthid brachyuran, Menippe mercenaria, and the anomuran decapod, Clibanarius vittatus, each have different ecological niches. C. sapidus is well adapted for swimming, and consequently occupies a diverse ecological niche. Blue crabs have the ability to withstand great changes in salinity, ranging from hypersaline seawater to fresh stream water. Their diet consists mainly of fish, benthic invertebrates (including other crabs), and some vascular plants. Blue crabs are preyed upon by such fish as Red Snapper, Trout, Drum, and Redfish. M. mercenaria is not adapted for swimming, and mainly

Collection Sites	Date Collected	No. Worms/Total No. infected host	No. Worms/Total No. hosts examined
Mud Flats Galveston	18 Dec. 78	29/7 (4.1)	29/13 (2.2)
	27 Jan. 79	5/2 (2.5)	5/17 (.27)
Red Fish Bay Port Aransas	5 Nov. 78	3/2 (1.5)	3/14 (.21)
	10 Mar. 79	2/2 (1.0)	2/13 (.23)

Table 3. Intensity of anisakine nematodes in *Clibanarius vittatus*.

inhabits mud flats, oyster reefs, and rocks along the base of a jetty (Brunenmeister, et al., 1975). Stone crabs' diet consists mainly of oysters, snails, and clams. Their massive claws are used to crack the shells of their prey. Stone crabs have not been commercially exploited as have blue crabs due to their limited availibility along the Texas coast. C. vittatus is one of the most common decapods along the Gulf coast. Hermit crabs are very tolerant to changes in salinity and temperature. They are mainly scavengers feeding upon fish, squid, and any leftovers from fishermen (Moffett, 1974). With the divergence of ecological niches displayed by these three decapod species, one would expect to find considerable differences among their symbiotic faunas.

The purpose of this survey was to identify the symbionts associated with each specific host crab. After such a survey, the relationships between the symbiont and host can be experimentally addressed. Conclusions drawn from other research endeavors, such as physiological studies, could possibly be effected by symbioses, since it is uncertain what type of stresses these symbionts impose upon host crabs.

In the examinations of blue crabs, only 10% (2 of 20) were infected with endosymbionts. The most harmful disease of blue crabs, effected by the microsporidian protozoan Ameson michaelis, was not found in any of the crabs examined. Neither were any of the symbiotic barnacles, such as the rhizocephallan Loxothylacus texanus, found in these crabs. Two encysted helminths were found in two of the blue crabs collected from Galveston (East Jetty). The incidence of these cysts was apparently lower than the incidences of similar cysts previously reported. Since blue crabs are such a commercially important species, attempts should be made to understand the effects that these symbionts have upon them. Symbionts can potentially cause massive mortalities, reduced growth rates, and reduced aesthetic quality. This reduction in overall quality directly affects the crab fishery.

Hermit crabs are one of the most common decapods found along the Gulf coast. Therefore, they obviously play an important role in local ecologies. Hermit crabs are also very popular in home salt water aquaria, Symbiology of hermit crabs is a relatively unexplored area of biology. Since hermit crabs are common in home salt water aquaria, symbionts which cause some type of harm to the crab might also harm other fish or shellfish inhabiting the same aquarium. Information derived from research can possibly avoid this. In examining the hermit crabs collected, anasakine nematodes were observed. These symbionts are well documented in other decapods, such as shrimps (Norris, et al., 1976), but are less known from anomurans. Since anasakines are common among many decapods and are possibly harmful to man, attempts should be made to examine the incidences and intensities of these potentially pathogenic organisms.

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