TABLE 2.

Influence of well and surface water and fertilizer formulation on the relative levels of organic and inorganic phosphorus in pond soils (average of two ponds throughout growing season).

	Phosphorus			
	Organic		Inorganic	
	4 - 24 - 2	12 - 24 - 2	4 - 24 - 2	12 - 24 - 2
Well water	134a*	132a	335b	307b
Surface water	335b	200a	219a	361b

*Values tabulated under phosphorus fraction followed by the same letter are not significantly different from each other at the five percent level.

PARASITIC BARNACLES IN MISSISSIPPI ESTUARIES WITH SPECIAL REFERENCE TO *LOXOTHYLACUS TEXANUS* BOSCHMA IN THE BLUE CRAB *(CALLINECTES SAPIDUS)*[1]

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INTRODUCTION

Non parasitic cirripedia of the order Thoracica are generally recognized as fouling organisms on any solid substrate wherever there is estuarine water capable of supporting them. Parasitic cirripedia are less well known. The Rizocephlan genus *Loxothylacus* is common in several Gulf Coast Crabs.

Loxothylacus texanus may be of considerable importance as a parasite in the blue crab *(Callinectes sapidus).* This speices supplies the multi-million dollar crab fishery of the Atlantic and Gulf Coasts. Catastrophic depletion on the Atlantic Coast in the last few years has centered attention on possible causes of this loss.

In the Gulf of Mexico Crab fishery commercial production (Lyles, 1967) has generally increased, although considerable annual fluctuation is evident. Economic factors have probably been the major cause of fluctuations. However, commercial fishery production does not correctly reflect fishing pressure on the blue crab population. An extensive "sports" fishery and shrimp trawls take large quantities of crabs that are not recorded. Shrimp fishermen usually discard crabs by methods which probably kill them. Fishing mortality is likely to increase.

Reinhard (1950) noted Daugherty's observation of a 16.4 per cent infestation of blue crabs by *Loxothylacas texanus* in the Rockport area in 1948-49. In 1965, I found that up to 50 percent of the crabs taken in some hauls were parasitized by *Loxothylacus.* Although this was an unusual occurrence and crabs with sacculinid parasites are usually relatively rare, the possibility of heavy infestation which could appreciably deplete the blue crab population does exist. Since the beginning of our Cooperative Estuarine inventory and study in 1966, I have observed the occurrence of *Loxothylacus* in Mississippi's estuaries. The rate of infestation has been negligable during this period, but some interesting observations have been made. This work has been done as a Federal Aid project under Public Law 88-309.

THE STUDY AREA

Mississippi Sound is located along the Northern Gulf Coast east of the Mississippi Delta between Mobile Bay and Lake Ponchartrain. A series of barrier islands with

[1]This study was conducted in cooperation with the U. S. Department of Interior Bureau of Commercial Fisheries under P. L. 88-309 (Project Number 2-25-R)

relatively deep passes extends along the southern limit. The largest embayments are Biloxi Bay and Bay St. Louis. Most of the average fresh water discharge of 31,220 CFS comes from four estuarine systems. From east to west they are Pascagoula, Biloxi Bay, Bay St. Louis and Pearl River. Additional low salinity water enters the sound from Mobile Bay on the east and Lake Ponchartrain on the west. Large variations, typical of Gulf Coast estuaries occur in many environmental factors. We have taken monthly samples at about fifty fixed stations in this area since 1966. These samples include trawl and seine hauls which catch considerable numbers of the blue crab and its congener, *Callinectes similis*. Mud crabs of the family Xanthidae have been taken but the collection is not representative of the population because most of the mud crabs live in protected spots.

OCCURRENCE OF *LOXOTHYLACUS SPP.*

Crabs infested with sacculinid parasites are altered sexually. Both males and females acquire adult female characteristics prior to the appearance of the externa. Since growth of infested blue crabs is inhibited, adult characteristics are acquired at a time when they are much smaller than normal adults. Consequently they are readily recognized. Since 1965, I have collected 87 specimens (Table 1) from 36 to 81 mm carapace width.

TABLE 1
Distribution of parasitized blue crabs by month and size, Mississippi Estuaries 1965-1968.

Month Int.-mm	1	2	3	4	5	6	7	8	9	10	11	12	TOTAL
35-39				1				1	1				3
40-44		1		2			1	1	1	1			7
45-49				4	1		9	1	1		3		19
50-54				7	2	1	2		3	2	6		23
55-59				2		1	9		1		2		15
60-64							10		1	1			12
65-69							2	1			1		4
70-74							1						1
75-79							2						2
80-84							1						1
TOTAL		1		16	3	2	37	4	8	4	12		87

Specimens have been taken in all months except January, March and December. Only one specimen, with a very small externa, has been found in February.

Table 1 includes 32 specimens taken in July, 1965 in three trawl hauls. Half of the blue crabs taken in some of these hauls were parasitized.

Mud crabs with a sacculinid parasite were first recognized in samples collected from the Laboratory pier. The parasite has been tentatively identified as *Loxothylacus panopaei* but further study is necessary to confirm this identification. *Rithropanopaeus harrisii* and *Eurypanopaeus depressus* are known hosts to this species. I have found both of these crabs with a sacculinid externa. The extent of infestation in Mississippi Sound is not known. We have seen specimens with externa only in October and November.

The 34 infested blue crabs taken in July 1965 (Figure 1) show a multimodal size distribution. Whether this indicates infection at different sizes or moulting after the externa dropped off is uncertain. One specimen collected by Mrs. Curtis of Biloxi did moult in an aquarium. The cast was 48 mm across the carapace and the soft crab had a carapace width of 52 mm. The scar left by the externa when it dropped off was present in the cast but was not evident in the soft crab.

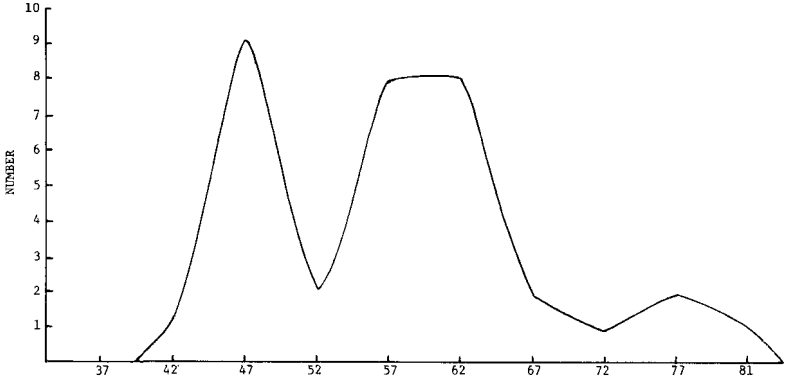

Figure 1. Carapace width frequency distribution of 34 parasitized blue crabs *(Callinectes sapidus)* collected in July, 1965, Biloxi Bay, Mississippi.

AREAL DISTRIBUTION

No parasitized crabs have been observed from the Pascagoula area. Mr. Hugh Swingle (Personal communication) reports that he has not seen parasitized crabs in his collections in Mobile Bay during the last year. Most of our specimens have been taken on soft mud bottoms in Biloxi Bay. Collections often recur at the same stations.

HOST SELECTIVITY

Although thousands of *Callinectes similis* have been included in our samples, we have not found a specimen with *Loxothylacus.* Williams (1966) noted that *Callinectes similis* was not affected by *Loxothylactus* although this parasite was found in *Callinectes ornatus* from Biscayen Bay. Dr. Gordon Gunter (Personal communication) saw *Loxothylacus* in *Callinectes ornatus* on the Florida west coast but did not find it in *Callinectes sapidus.* C. E. Dawson (Personal communication) has observed the parasite in *Callinectes sapidus* in Appalachicola Bay.

The lack of specimens from Pascagoula and Mobile may be the result of failure to sample the right spots but this seems unlikely. In general, parasite populations seem

to fluctuate locally. Whether environmental factors in these heavily polluted areas prevented survival of the larvae is a matter of speculation.

FOULING

Since crabs with externae are unable to moult, specimens with large or decaying externa are often heavily fouled by a variety of fouling organisms. This is to be expected and many observations of this phenomenon in normal adult crabs have been reported. Among the parasitized crabs collected in Biloxi Bay in 1965, I found several with oysters growing on the ventral side. Occasionally an oyster grows on the carapace of an old crab, but this seems to be the first observation of ventral fouling by oysters. The size of the oysters indicates that the crabs had not accomplished an ecdysis for at least a month.

SUMMARY

Increasing fishing mortality in the Gulf and catastropnic depletion of Atlantic blue crab populations have called attention to all factors that might decrease crab populations. Although *Loxothylacus texanus* does not pose any evident problem at this time, heavy local infestation indicates the possibility that it could become a serious problem.

Loxothylacus texanus has not been observed in *Callinectes similis.* Ventral oyster fouling of parasitized blue crabs was observed in Mississippi estuarine waters. No adults of normal size have been observed with the parasite. *Loxothylacus texanus* apparently infests juvenile blue crabs only in Mississippi waters.

The occurrence of *Loxothylacus* in *Eurypanopeus depressus* and *Rhithropanopeus harrissii* in Mississippi waters was observed.

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GROWTH OF THREADFIN SHAD IN BULL SHOALS RESERVOIR

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ABSTRACT

Threadfin shad, *Dorosoma petenense,* were first introduced into Bull Shoals Reservoir in 1961. Based on fish collected in 1966 and 1967, weighted average calculated total lengths of females at the end of each successive year of life were 66, 118, 134 and 141 millimeters, and of males 64, 118 and 123 millimeters. Growth of threadfin shad in Bull Shoals was slower than in more southern and temperate regions, but life span was longer. A strong year class in 1964 was indicated by the presence of a relatively high number of 2-year-old fish in 1966 and 3-year-old fish in 1967.

The ratio of females to males in cove rotenone samples was 3.8 to 1, while in midwater trawl samples the ratio was 1.0 to 1. Threadfin shad comprised 80 percent of the total shad population by number, but only 17 percent by weight.