

We have a dual research program. In the second phase of our laboratory work, we asked the obvious question "What are the most notable gaps in our knowledge of this animal?" Anatomical information was sparse and sketchy. We called upon Dr. Joseph Young at the University of Tulane, by contract, to furnish us the needed descriptive information. His very excellent atlas of *Penaeus setiferus* is nearly completed.

Data dealing with shrimp tissue were almost non-existent and we asked Dr. Jerome Stein of Texas A. and M. to begin the histological and histochemical studies required. His first rather extensive report will be completed next month. Shrimp tagging in the past has been confined to adults. There was obvious need for a method which would allow us to mark juveniles. The assignment to devise a method was given to Charles Dawson of the University of Texas, and he has developed a staining technique which appears usable for very small shrimp as well as for adults. In the Galveston laboratory we tested Dawson's methods on 25 mm penaeids. The stain was readily discernible two months after the original staining and probably the stain, properly applied, will last several months. It was interesting to note that considerably less mortality occurred in the stained shrimp than in the control group we held in an immediately adjacent tank. Perhaps the stain is a therapeutic agent as well as a marking tool. With this new staining technique we intend to do some field work early next year which could answer several "unknowns" regarding the movement of juveniles.

In the Galveston laboratory we have completed some precise studies relating shrimp growth to temperature. Projects also include a study of shrimp nutrition, of light and oxygen requirements and comparative studies of the particular requirements of brown and pink shrimp as compared to whites. Recently we completed a series of toxicity experiments. In one we found an insecticide (Benzene hexachloride) used extensively by mosquito control groups on the Gulf coast, is toxic to shrimp in dilutions of 1 to 20 million. Mr. Chin of our Galveston staff will report this work.

The crying need is for research designed to answer specifically some of the obvious questions and thereby establish a basis upon which further research may proceed. The Gulf Fishery Investigations, as a matter of policy, will make available in published form information which may be helpful to other researchers in the field, even when a final conclusion may not be possible on the particular subject under discussion. However, our goal is to see many of the basic problems through to a final unqualified conclusion.

Intermittent Shrimp Sampling in Apalachicola Bay With Biological Notes and Regulatory Applications

ROBERT M. INGLE

Assistant Director

Florida State Board of Conservation

ALTHOUGH THE EXACT VALUE has never been conclusively established, it has been frequently believed by laymen, administrators and biologists that the protection of young shrimp is desirable. Recently evidence has been presented (Gunter, 1956) which supports this position. Various methods have been

used to achieve this protection. These include: 1. prohibition of catching or possession of shrimp of small size (count law), 2. establishment of sanctuary areas where no fishing may take place where it can be shown that nursery grounds for shrimp exist. 3. opening and closing of certain areas regularly each year by law (presumably during the time when young shrimp are maturing), 4. mesh size regulation to permit the smaller size shrimp to pass through the cod end of the trawl, and 5. administrative regulation which permits temporary fishing restrictions to be applied and removed geographically and seasonally as indicated by the size and distribution of the shrimp population.

Certain difficulties arise in the case of each of these methods. Some of the shortcomings are summarized in Table 1.

Methods 1, 2 and 3 had been tried in Apalachicola Bay for many years without notable satisfaction by the members of the industry, biologists or administrators.

Legislation in June, 1953, delegated to the Director of Conservation the authority to open and close the Bay. Sampling was begun almost at once and was carried out on an irregular basis from June, 1953, to March, 1955. Very few permanent records were kept, a rigid schedule was not adhered to, and the findings have not been available to the author.

A summary of past regulatory measures is presented in Table 2.

In March, 1955, a schedule was established and regular samplings were started. Weekly samplings were attempted, but due to weather and other factors this was not possible in all weeks. During certain critical periods, samples were obtained daily. Regular reports were filed showing date, location, and time of each sample at fourteen different stations in the Bay. White, pink and brown shrimp were designated in each case and the count (number of shrimp to make a pound) and amount caught was established.

Samples were obtained by dragging a try net (otter trawl) for a period of ten minutes at each station. The mesh of wings of the nets was one inch bar and the cod end was 3/4 inch bar (manufacturers specifications). Although several nets were used in the course of the study none was less than 20 feet in width and none was greater than 24 feet. This difference in gear makes a completely accurate quantitative evaluation of the data impossible. It is not felt, however, that the general abundance trends as presented here were seriously affected. With a few indicated exceptions, all samples were taken during daylight hours.

The author wishes to express his appreciation to conservation agents H. Griswold, W. Henderson, G. Warren and General Agent O. Clark. Special acknowledgment is made of the cooperation of Mr. Joseph Martina, whose interest and diligence were of great value.

Although the sampling is continuing, this report applies only to findings made up to October 1, 1956.

Results

The findings are voluminous and will not be provided here in detail. Complete files are maintained in the office of the State Board of Conservation in Tallahassee and are available for reference.

The following are the salient results of the study:

1), Three species of commercial shrimp were taken. These were the white

TABLE 1
METHODS OF PROTECTING SMALL SHRIMP WITH DISCUSSION OF EACH DEFICIENCIES

METHOD	DESCRIPTION	DEFICIENCIES
1.	Size limit (count law)	<ol style="list-style-type: none"> 1. Fishermen catch all sizes, can cull out small ones which, because they die, are lost to later production. 2. When small ones are caught inadvertently, fishermen argue that they should be kept inasmuch as they are already dead.
2.	Sanctuary areas	<ol style="list-style-type: none"> 1. Although certain restricted areas may be located where small shrimp almost always predominate, they may be found in larger areas seasonally. A firmly established sanctuary would, therefore, be too small at certain times, or, if it encompassed the largest area needed, would be too large at others. 2. Fishermen contend that after shrimp leave bays many scatter, migrating to inaccessible bottoms.
3.	Open and closed seasons	<ol style="list-style-type: none"> 1. Rigid dates would fail to accommodate to annual variations. Some years shrimp would mature and move offshore before the inshore waters were opened, in other years development of the young might be retarded and fishing would be permitted while the shrimp were still undersized.
4.	Mesh size regulation	<ol style="list-style-type: none"> 1. Likelihood that many small shrimp still will be blocked from escaping when tows are long and nets are full of shrimp, fish and other animals and plants. 2. Possibility that in some cases mortality still might be high among the escaping shrimp. 3. In a restricted, inshore area, multiple escapements from trawls might be made by the same shrimp. This would increase the probability of being killed. 4. As mesh size increases, legal sized shrimp begin to escape. 5. Optimum size of mesh which will retain legal sized shrimp still will capture up to 66% of the smaller sizes.
5.	Temporary restrictions based upon sampling	<ol style="list-style-type: none"> 1. Expense for regular sampling involving employees, boats, and trynets. 2. Responsibility of biologists and administrators to be cognizant of weekly findings and almost daily availability to make decisions on opening and closing of specified areas. 3. Enabling and permissive legislation giving biologists and administrators liberal authority is a prerequisite.

TABLE 2
REGULATION OF APALACHICOLA BAY FOR SHRIMP FISHING, 1937-1956

DATE	ACTION TAKEN	BASIS	REMARKS
Feb. 1, 1952	Closed	Statute	This regime was followed each year after 1937
April 1, 1952	Opened	"	
August 1, 1952	Closed	"	
Oct. 1, 1952	Opened	"	
Feb. 1, 1953	Closed	"	
April 1, 1953	Opened	"	
June 30, 1953	Opened	"	
August 4, 1953	Closed	Night	
Sept. 8, 1953	Opened	By popular request	
Aug. 6, 1954	Closed	Sampling	
Aug. 29, 1954	Opened	Sampling	
Aug. 13, 1955	Closed	Based on Sampling	
Oct. 3, 1955	Opened	Based on Sampling	
Dec. 10, 1955	Closed	" "	
April 18, 1956	Opened	" "	
Aug. 18, 1956	Closed	" "	
Sept. 8, 1956	Opened	" "	
Sept. 19, 1956	Opened (night only) (night & day)	" "	Only south part of Bay open
			Under new law, the Director can open and close
			Sampling not rigidly scheduled
			" "
			" "

shrimp, *Penaeus setiferus*, the brown shrimp, *Penaeus aztecus*, and the pink, or spotted shrimp, *Penaeus duorarum*. Monthly summaries of abundance and size of each of these species are provided in Tables 3, 4, and 5. The ranges expressed under "Remarks" refer to the largest counts and smallest counts of entire samples, not to sizes of individual shrimp.

- 2.) No seabobs (*Xiphopeneus kroyeri*) were encountered during this study, although they have been produced commercially in waters offshore.
- 3.) No rock shrimp (*Sicyonia*) were encountered, although they have been produced commercially in waters offshore.
- 4.) In a few instances drags were made in the day time and followed by duplicate drags, in the same locality, at night. The results, as expected, showed a nocturnal periodicity for brown shrimp. Duplicate day and night sampling was not made during times of occurrence of small sized browns. No information is therefore available as to whether the small shrimp of that species is less photo-sensitive than the large ones. At the time the night trawls were made, pink shrimp were rare in the Bay and no comparative results were obtained on that species.
- 5.) Shrimp sizes and abundance are summarized in Tables 3, 4 and 5. In these tables the following definitions obtain: rare, less than ten; few, 10-55; common, 55-100; abundant 100 and over; legal, 45 and under; illegal, 46 and above. All counts per pound refer to shrimp with heads on.

TABLE 3
SIZES AND ABUNDANCE OF WHITE SHRIMP, *Penaeus setiferus*

1955			
MONTH	AVE. SIZE	AVERAGE ABUNDANCE	REMARKS
March	Legal	Few	Range 25-40 Most were 40 count and under. Ave. count 36
April	Legal	Few	Average count 30-35. Range 25-40
May	Legal	Few	Average count 25-30
June	—	None	—
July	Illegal	Rare	Ave. count 85-95. Range 70-110. Five samples had counts of 100 or more
August	Illegal	Common	Ave. count 90-95. Range 50-110
September	Illegal	Abundant	Many samples were legal by the end of the month. Ave. count for month 59. Range 40-110
October	Legal	Few	Bay was opened Oct. 3. Ave. count for month 39. Range 30-70
November	Illegal	Rare	Two samples in East Bay were of 100 and over count and were extremely abundant. Ave. count all other stations was 62. Range 55-100
December	Illegal	Rare	Only 3 samples yielded any shrimp. All were 100 and over count and rare. Most samples were negative.

January	—	—	No samples taken
February	Illegal	Rare	Only seven shrimp caught during month. These averaged 78 count. Many samplings were negative.
March	Legal	Rare	All counts were 39-41 except one which was 36. Several samplings were negative.
April	Legal	Few	Average count 40. Very narrow range of variation in count. Few tries were negative.
May	Legal	Rare	With exception of one sample of count 80, all other samples averaged 27. Range 25-80.
June	Legal	Rare	Only one white shrimp was caught during month. It was 30 count.
July	Illegal	Few	Average count 80. Average number caught 14. Range 60-100
August			Average 63 count. Range 30-100
1st half	Illegal	Common	
August			
2nd half	Illegal	Abundant	Ave. count 66. Range 35-100. A few samples were negative.
September			
1st half	Illegal	Abundant	Ave. count 48. Range 30-70. Many tries were negative.
September			
2nd half	Legal	Abundant	Ave. count 43. Range 15-80. Many tries were negative. Those that were positive had such large amounts of shrimp that the ave. catch was classed abundant. Bay was opened for fishing.

DISCUSSION

Penaeus setiferus

The white shrimp appear to fit a seasonal pattern as follows:

1. *Winter*. A few small individuals stay in the Bay during the cold months (November-February). The slow growth of small shrimp which winter in the bays has been well established (Lindner and Anderson, 1956; Gunter, 1950; Williams, 1955) and is further demonstrated here by the sustained small size of individuals caught during November, December and February.
2. *Spring*. During early spring there is apparently a fairly rapid growth and a movement offshore (March-June). The offshore migration was particularly noticeable during the month of June. Only one shrimp was caught in the Bay during that month in 1956 and none were caught in 1955. There may have been recruitment of very small juveniles during June which were not caught because of the relatively large size of the trawl mesh.
3. *Summer*. Although the growth of white shrimp in the summer has been shown to be rapid (Lindner and Anderson, 1956; Williams, 1955), the size of the shrimp caught increased relatively slowly in Apalachicola Bay.

TABLE 4
SIZES AND ABUNDANCE OF *Penaeus aztecus*

1955			
MONTH	AVE. SIZE	AVERAGE ABUNDANCE	REMARKS
March	—	None	—
April	—	None	—
May	Illegal	Abundant	Average 82 count. Size range 65-95. Present in all stations.
June	Illegal	Common	Average 51 count. Range 25-80.
July	Legal	Few	Average 40 count. Range 25-90. Average number per drag 23.
August	Legal	Few	Average 39 count. Range 25-50. Several samplings were negative. Ave. 13 shrimp per drag.
September	—	None	—
October	—	None	—
November	—	None	—
December	—	None	—
1956			
January	—		No samples taken
February	—	None	—
March	—	None	—
April	—	None	—
May	—	None	Only one set of samples taken during early part of month.
June	Illegal	Few	Average count 52. Range 40-55
July	Illegal	Few	Ave. count 47. Range 35-60. Several trawls were negative.
August	Illegal	Rare	Ave. count 55. Although trawls were made almost daily during much of the month, only four samples contained brown shrimp.
September (day)	Illegal	Rare	Ave. count 54. Many samples neg.
September (night)	Legal	Few	Ave. count 31. Encountered shrimp in each drag. Average 15 per drag.

The first young individuals appeared in July. Presumably these were produced offshore during June when mature shrimp are almost non-existent in the Bay. In July the count of all shrimp taken averaged about 90. The legal count of 45 was not reached until October in 1955, and the third week of September, 1956.

It is assumed that the reason for this apparently slow development was recruitment of juvenile shrimp which tended to mask the rapid growth of the larger individuals.

It was not possible in the present study to find evidence of two or more separate and distinct spawnings. It seemed rather that spawning proceeded throughout the summer until October.

The present methods were sufficiently gross that separate spawnings might have taken place without being discovered and this possibility

TABLE 5
SIZES AND ABUNDANCE OF *Penaeus duorarum*

1955			
MONTH	AVE. SIZE	AVERAGE ABUNDANCE	REMARKS
March to November December	— Illegal	None Rare	No pink shrimp encountered during this period. Three drags positive out of eleven made. Average count 70.
1956			
January	—	—	No drags made
February	Illegal	Rare	Two drags positive out of 13 drags made. Ave. count 90. Ave. number caught 5.
March	Illegal	Rare	Six drags of 15 were positive. Ave. count 51. Ave. number caught (of positive drags) was 9.
April	Legal	Few	Two drags of 17 made were positive. Ave. count 35. One sample had 4 shrimp and other had 50.
May	Legal	Rare	Two drags of eleven were positive. These two drags were both of 25 count and 2 shrimp each.
June July	— Legal	None Rare	6 drags of 50 were positive. Ave. count 45. Ave. number caught in positive samples 2.
August	Illegal	Rare	Two samples of 33 were positive. Both positive samples taken during first part of month. Count of one sample 70, the other 25. Both samples contained 2 shrimp.
August (night)	Legal	Few	Ave. count 38. Ave. number caught 14. All drags (9) were made 8/23-/56 in Eastern end of Bay (Porters Bar-Cat Point). They were not encountered at any other time although drags were made on several nights (see brown shrimp data).
September	—	None	—

should be kept in mind in view of evidence that multiple spawnings or at least multiple entries into the bays do exist (Gunter, 1950).

4. *Fall*. Recruitment of juvenile shrimp apparently continued until the onset of cooler weather (about the middle of September to the first of October). The count is high after the larger individuals migrate out of the Bay in late summer and fall, leaving the smaller sizes. The offshore fall migration of adults has been well established by others (Lindner and Anderson, 1956; Williams, 1955) and is evidenced by the offshore

activity of the Apalachicola commercial fleet in the fall.

The findings of this study are in general agreement with established theories of white shrimp biology. Abundance trends are similar to those noted in Alabama (Loesch, 1954 and 1955). A small sized, apparently slow growing, and not very abundant population winters in the Bay. This has been noted by others (e.g., Weymouth, Lindner and Anderson, 1933; Lindner and Anderson, 1956). Beginning in March, growth seems to be rapid. Then, in June, all large shrimp leave the Bay, presumably to spawn.

Earlier spawnings may take place and very small shrimp may enter the Bay earlier as a result, but the nets used in this study were probably too gross to catch them. At any rate very small shrimp, presumably from the spring spawning, appear in the Bay in July and August.

If we assume that shrimp of small size can double their weight in 7-10 days' time (Gunter, 1956), then the findings indicate that steady recruitment of juveniles probably takes place from June or July to October or November to elevate the count of shrimp caught. This belief is bolstered by the wide size ranges encountered.

The high count may also be sustained by the migration out of the Bay and into more saline water of the larger individuals as suggested by other workers (e.g., Weymouth *et al.*, 1933; Gunter, 1950).

By the end of September or the first part of October, recruitment apparently slows to the point that growth of already-present shrimp is able to reduce the count to legal limits.

There seems to be a brief period in the fall when the Bay has enough legal sized shrimp to permit trawling. Within about one month or less, the larger shrimp move offshore and out of the Bay fishery leaving the smaller ones behind. This results in an elevated count and closure of the Bay.

The law, as it existed from 1937 to 1953, probably was adequate for opening the Bay for fall shrimping, although annual variations would have been neglected. But no provision was made for the protection of the diminished number of small shrimp which winter in the Bay, unless the meager population of inferior size prevented shrimping because of impracticality.

The 1937-53 law allowed shrimping of the small number of large shrimp in the late spring. This practice has also been permitted, at times, since 1953. These shrimp presumably form part of the summer spawning population (Lindner and Anderson, 1956) and if numbers of spawners were deemed to be critical, should be protected.

Penaeus aztecus

The seasonal pattern set by the brown shrimp was not as consistent as that shown by the white shrimp. However, a few general observations were made. These follow:

1. *Winter.* Between September 1, 1955, and June, 1956, only three samples, all taken on the same day in February, 1956, were positive for brown shrimp. The abundance in each case was rated rare and the counts of all three were 70.
2. *Spring.* Brown shrimp were not found during the early spring (March and April). Small shrimp entered the Bay abundantly in May, 1955. If these were the results of the year's first spawning, then it must be assumed that brown shrimp spawn in this area before the white shrimp.

In 1956, this spring appearance was delayed a month but the shrimp were larger, being about the same count as those encountered in June of the previous year. This would indicate that spawning had taken place at about the same time in both years but that the younger individuals either did not enter the Bay as early, or, if they did, they were not encountered by drags which were made. The latter is quite possible inasmuch as only nine stations were visited during May, all of them early in the month and on the same day.

3. *Summer and Fall.* During the summer, the count and abundance of shrimp caught goes down. The decrease in count probably means that the shrimp are growing. The count is legal in September, after which the numbers diminish rapidly. In September, 1955, none were found and in the same month, 1956, very few were encountered except in the distal parts of the estuary at night, in deeper, saltier water.

The decrease in numbers might be explained in two ways: 1. an actual decrease in numbers due to mortality or migration to offshore waters, or 2. a greater negative reaction to light with increased size resulting in a greater tendency toward nocturnal periodicity. In the second alternative, an explanation could be found for the great numbers of small brown shrimp taken in the daytime earlier in the year.

It has already been established that adult brown shrimp may be relatively abundant and yet not be caught in the daytime. The present alternate night and day trawls confirm this fact.

Night and day trawls in the spring, directed toward small brown shrimp, might give an indication of degree of nocturnal periodicity in the immature stages.

From September, 1955, to April, 1956, inclusive, no brown shrimp were encountered in the Bay. This corresponds with the findings of other workers (e.g. Gunter, 1950; Williams, 1955).

In May of 1955, small (average count 82) brown shrimp entered the Bay in abundance. In 1956, only one set of samples was taken during May, during the first week. It is quite possible that the same sudden appearance of immature brown shrimp in May occurred in 1956, also.

At any rate, the count of both years was the same for June, indicating the same spawning time in 1955 and 1956. Abundance trends are similar to those given for Alabama (Loesch, 1954 and 1955).

In North Carolina young adults appear suddenly in the estuaries in June (Williams, 1955). Williams states that these young shrimp had been on the nursery ground in shallow water for about two months before moving into deeper, fishable waters.

Since the primary and most consistent nursery grounds in Apalachicola Bay are north of Gorrie bridge where samples were seldom taken, no information is available as to whether the young which were first caught in the Bay in May and June had just entered from outside or whether they were moving from more shallow nursery grounds to deeper water as they grew.

In Alabama, as in North Carolina, the very small brown shrimp are found in shallow water, i.e., two to three feet (Loesch, 1954).

By July the young shrimp were legal sized (or nearly so) and by the beginning of September appeared to be leaving the Bay. The expression "appeared to be" is used because night samples were often positive when

duplicate samples, taken during the day, were negative.

It is reasonably certain that the shrimp did leave the Bay, at least by the middle of September, 1956. After several night samples showed the advisability of doing so, the Bay was opened for night shrimping on September 8, 1956. Before the fleet could take advantage of the opening most of the shrimp had departed, making it unprofitable to fish.

Night trawls taken during winter months will yield information as to the true or apparent absence of brown shrimp from the Bay during the winter.

Penaeus duorarum

There was hardly a discernible pattern of any kind with the pink shrimp. None were found from March until December, 1955.

1. *Winter.* Rare, small and illegal sized pink shrimp were found in the Bay from December, 1955, until March, 1956. The count appeared to decrease during that period.
2. *Spring.* A continued decrease in count was seen from March to May, 1956. Although few were encountered, those shrimp taken in April and May were legal.
3. *Summer.* The rare individuals captured during July and August, 1956, had a wide range of sizes. None were taken during June.
4. *Fall.* In 1955, none were caught from September to December. In 1956, none were encountered in September, the last month covered by this report.

The lack of any particular pattern in occurrence of the pink shrimp is not unique to Apalachicola Bay. Studies in Alabama indicated its occurrence as "sporadic" and in such small numbers that a pattern was not identifiable (Loesch, 1954).

It is hoped that as the present study continues and more information is available, consistencies will begin to appear which will allow interpretation. It is thought that night trawlings taken throughout the year will be especially instructive. In the meantime, possible explanations for the rather meagre, transitory and unpredictable nature of the pink shrimp population might be found in the conclusions of others.

It has previously been noted that *P. duorarum* prefers waters of a rather high salinity and extensive vegetation for cover (Hildebrand, 1955). Since the salinity of Apalachicola Bay is subject to frequent and relatively great fluctuations in salinity (Ingle and Dawson, 1951), migration in and out of the Bay might be a response to favorable and unfavorable salinities.

Pink shrimp also prefer calcareous sediments, whereas the white and brown seem to seek muddy bottoms (Hildebrand, 1955). The absence of calcareous sediments in the Bay might help to explain the paucity of pink shrimp.

SUMMARY

1. Biological notes are provided for white, brown, and pink shrimp.
2. The information on the white and brown shrimp is in general agreement with the findings by other workers in different localities.
3. Scanty numbers and lack of seasonal pattern made difficult any interpretation of data on pink shrimp. Possible explanations for small population

and unpredictable appearance are advanced. It is suggested that night trawlings might be instructive.

4. The history of shrimp regulation in the Bay is provided. Shortcomings of a rigid open and closed season are presented.
5. A system of continuous checking has been in use for a year and a half. The findings of this study have been used to regulate the fishery as follows:
 1. Bay was opened at night only when size of brown shrimp was legal.
 2. Bay was opened for day fishing when size of white shrimp was legal.
 3. Bay was closed when size of brown and white shrimp was illegal.

The chief asset of this method of regulation is flexibility. Such flexibility is needed when dealing with three separate species all of which have different habits and periodicities and which may mature at different times. Also, since the maturation of shrimp is probably a result of many inter-acting factors, the migration, growth, reproduction and other processes cannot be expected to follow a rigid schedule. A system of continual sampling allows for regulatory accommodation to developments on the shrimp beds.

REFERENCES

- GUNTER, GORDON
1950. Seasonal population changes and distributions as related to salinity, of invertebrates of the Texas coast, including the commercial shrimp. *Pub. Inst. Mar. Sci.* 1 (2): 7-52.
1956. Principles of Shrimp Fishery Management. *Proc. Gulf and Carib. Fish. Inst.* 8: 99-106.
- HILDEBRAND, HENRY H.
1955. A study of the fauna of the pink shrimp (*Penaeus duorarum* Burkenrood) grounds in the Gulf of Campeche. *Publ. Inst. Mar. Sci.* 4 (1): 169-332.
- IDYLL, CLARENCE P.
1950. Report on the present status of the Franklin County shrimp industry.
- INGLE, R. M. AND CHARLES E. DAWSON
1951. Variations in salinity and the Florida oyster. *Salinity variation in Apalachicola Bay. Proc. Gulf and Caribbean Fisheries Institute* 3: 35-42.
- LINDNER, MILTON J. AND WILLIAM W. ANDERSON
1956. Growth, migrations, spawning and size distribution of shrimp *Penaeus setiferus*. *Fish. Bull. of U.S. Fish and Wildlife Service* 56: 554-645. (*Fishery Bull.* 106).
- LOESCH, HAROLD
1954. *In* Report of Seafood Division, Department of Conservation, Montgomery, Alabama. Report of Fiscal Year 1953-1954.
1955. *In* Report of Seafood Division, Dept. Cons. Montgomery, Alabama. Report of Fiscal Year 1954-1955.
- WEYMOUTH, F. W., M. J. LINDNER AND W. W. ANDERSON
1933. Preliminary report on the life history of the common shrimp *Penaeus setiferus* (Linnaeus) *Bull.* 14, U.S. Dept. Comm. Bur. Fish.
- WILLIAMS, AUSTIN B.
1955. A contribution to the life histories of the commercial shrimp (*Penaeidae*) in North Carolina. *Bull. Mar. Sci. Gulf and Caribbean* 5 (2): 116-146.