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New Developments in the Larval Pink Shrimp Study of Dry Tortugas

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Survival of Stained, Tagged, and Unmarked Shrimp in the Presence of Predators

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Abstract

The survival rate of tagged, stain-marked, and unmarked shrimp held in tanks of sea water has been compared. Predaceous fish were introduced into the tanks and predation upon the three groups of shrimp compared. Unmarked shrimp and shrimp marked with biological stains survived at approximately the same rate with respect to each other with or without predators present; tagged shrimp incurred excessive mortality exclusive of predation and highly variable mortality with predators present.

DETERMINATION OF MORTALITY rates in populations of marine shrimp presents a challenging problem. Estimation of these important parameters using commercial fishery statistics has not yet proved feasible whereas their measurement by means of mark-recapture experiments promises an immediate solution. Successful application of the mark-recapture technique requires, in the case of any species, knowledge of the extent to which the experimental animals are affected by the type of mark employed. This is particularly significant in the case of shrimp since they are comparatively delicate organisms.

In the first large-scale effort to apply the mark-recapture method in studying the dynamics of shrimp populations, Lindner and Anderson (1956) made extensive use of tags to determine growth and migratory patterns in the white shrimp, *Penaeus setiferus*. These tags consisted of two celluloid (Petersen type) discs affixed, one on each side of the shrimp, by passing a nickel pin mid-laterally through the first abdominal somite. Although this method has since been used by others, very few observations concerning the effect of tagging on the behavior and survival of individual shrimp have been reported. Lindner and Anderson (1956) and Iversen and Jones (1961) note that mortality due to tagging appears to be inversely related to size of shrimp tagged, their experiments having been characterized by proportionately fewer returns of small shrimp. From observations of captive pink shrimp, *Penaeus duorarum*, tagged with discs, the present authors conclude that attachment of such tags results in considerable loss of swimming efficiency.

Recognizing the major disadvantages of the tagging method, Menzel (1955) introduced and Dawson (1957) developed a method with fewer limitations, namely, marking with biological stains. The utility of the stain-marking method in shrimp migration studies has been demonstrated by Costello (1959) and Costello and Allen (1960). In anticipation of employing this technique in large-scale experiments to measure shrimp mortality, several preliminary experiments comparing the relative survival rates of stained, tagged, and unmarked shrimp were conducted. Large fish were introduced into some of these experiments to determine the comparative degree to which predation might influence (under natural conditions) the survival of individuals in each of the three categories.

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Experimental Procedure

The experiments were conducted in two adjoining concrete tanks (each 18 x 6 x 3 feet and referred to as the "north" and "south" tanks) located at Virginia Key, Florida. Sea water drawn from the 7-foot level of a nearby estuary was continuously circulated through each tank at the rate of about 0.8 gallons per minute.

In an effort to retard cannibalism during experiments, tank bottoms were covered with 1 inch of clean sand to provide a hiding place for the shrimp. Locked screens covered the tanks and prevented disturbance of test animals. Over the experimental period, salinity ranged from 34 to 37 parts per thousand and temperature from 22.8° to 25.5° C.

Trypan blue (Harleco) and fast green FCF (National Aniline) in 0.25 per cent aqueous solutions were the stains employed. In experiments where this was tested, differential survival between groups of shrimp, each marked with one type of stain, proved insignificant. Staining methods followed those suggested by Costello (1959).

Tags (Petersen type, plastic, 0.8 mm thick, 8 mm in diameter) were attached with nickle wire in the manner described by Lindner and Anderson (1956).

First Experiment

Six hundred recently captured pink shrimp were measured individually and separated into four size groups. Selecting shrimp at random, three at a time, 200 were stained with biological dyes, 200 were tagged, and 200 were left unmarked. Like groups of 300 shrimp were placed in both tanks so that each

TABLE 1
DESCRIPTION AND RESULTS OF EXPERIMENTS COMPARING TWO METHODS OF MARKING SHRIMP

Tank	Number of Shrimp	Size Total length in mm and number	Sex	Number of shrimp Unmarked	Number of shrimp Tagged	Number and kind of predators	Number of shrimp surviving after 10 days	Number of shrimp surviving after 10 days
				Unmarked	Tagged		Unmarked	Tagged
		First experiment						
		92.5-95.5 (72)						
North	300	96.5-100.0 (78)	½ ♀	100	100	4 mangrove snappers ¹	40	49
		100.5-104.2 (72)	½ ♂					12
South	300	105.0-108.5 (78)	Same	100	100	None	88	84
		Same						68
		Second experiment						
		96.5-100.0 (75)						
North	300	100.5-104.2 (75)	All ♀	100	100	None	87	93
		105.0-108.5 (75)						66
South	300	109.0-113.0 (75)	Same	100	100	None	86	94
		Same						57
		Third experiment						
		92.5-95.5 (36)						
North	150	96.5-100.0 (39)	All ♀	50	50	None	49	46
		100.5-104.2 (36)						23
South	150	105.0-108.5 (39)	Same	50	50	1 red grouper ² 1 black grouper ²	33	34
		Same						17

¹Total lengths ranged from 285 to 355 mm.

²Total lengths were 311 and 413 mm.

contained 100 stained shrimp, 100 tagged shrimp, and 100 unmarked shrimp. After 6 hours, four mangrove snappers, *Lutjanus griseus*, were placed in the north tank. The south tank acted as a control. Both tanks were checked daily for dead shrimp and loose tags. After 10 days each tank was drained and the number of survivors in each category recorded.

Examination disclosed that one snapper stomach was empty, one contained several pieces of shrimp, another pieces of shrimp with some blue stain, and the last one a piece of shrimp with a pair of tags attached. The stomach contents analysis is considered important only as an indication of feeding activity since subsequent experiments demonstrated the ability of these species to either pass or regurgitate tags taken into the stomach.

Second Experiment

The physical environment in the north and south tanks was apparently identical. To test the validity of using one tank as a control for the other, experiment 2 followed procedures already described in experiment 1, except that no predaceous fish were added to either tank.

Third Experiment

This experiment differed from the first in that one half as many shrimp (300) were used and that as predators a red grouper, *Epinephelus morio*, and a black grouper, *Mycteroperca bonaci*, replaced the four snappers. Stomachs of the two groupers at the experiment's termination contained, in one case, three partially digested shrimp and no tags, and in the other, two shrimp and one pair of tags.

Discussion:

Specifications and results of the three experiments are summarized in Table 1. From these may be drawn the following inferences concerning relative survival (under natural conditions) of stained, tagged, and unmarked shrimp:

1. Whether predators be present or absent, tagged shrimp may be expected to suffer higher mortality than either stained or unmarked shrimp. [Comparing it with that of the unmarked (control) group, mortality due to tagging in the 10-day period ranged from 20 per cent (first experiment, south tank) to 52 per cent (third experiment, north tank).]
2. Tagged shrimp may be expected to be proportionately more vulnerable to predation than stained shrimp.
3. If reasonable care is taken during marking operations, shrimp marked with biological stains may be expected to survive at essentially the same rate as unmarked shrimp whether or not predators are present. [Shrimp marked with biological dyes, in fact, survived at a slightly better rate than unmarked shrimp, perhaps due to some prophylactic effect of the stains.]

Due to the limited scope of these experiments, the results must be considered preliminary. They do indicate, however, that a more successful application of the mark-recapture method in shrimp population studies can be achieved if the experimental shrimp are marked with biological stains, rather than "mechanical" tags.

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Three Aspects of the Economic Problems of the Shrimp Industry

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Abstract

In the Gulf area in the past few years the operators of shrimp craft have been faced with acute economic problems that have prompted members of the industry to seek governmental action to stabilize the market situation. In 1959 the market price for shrimp declined sharply, and vessel owners, confronted with the continuing high costs of vessel operations, found it difficult to meet their financial obligations. In 1961 the scarcity of shrimp in certain areas of the Gulf reduced the volume of landings to a level at which vessel operators in many instances found it unprofitable to continue their shrimping activities.

A detailed study of the performance of the vessels in the shrimp fleet in 1959 reveals that the economic problems arising out of the sharp decline in prices adversely affected broad segments of the industry. Affected were not only large firms but small ones as well, shrimping operations of essentially all types, vessels operating out of all of the principal port areas, and vessels engaged in a variety of fishing patterns. The shortage in the supply of shrimp in 1961 has likewise broadly affected the industry because of the participation of a large number of shrimp vessels in the rotation of operations to various grounds as the availability of shrimp makes this feasible. The impact of these changing market and supply conditions on essentially every segment of the shrimp industry, and the nature of these changes, has shown that any measures of market control must take into account conditions over a number of years, and the continuing likelihood of unpredictable conditions of scarcity and abundance in the supply of shrimp. If the needs of a growing consumer market are to be met, control measures should be flexible enough to permit the continuing flow of an adequate quantity of shrimp into the channels of trade.

IN THE REPORT to you today on the findings from the economic study of the shrimp industry which has been carried out at the University of Florida under