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Chairman—JOHN MEHOS, *President, Shrimp Association of the Americas; Liberty Corporations, Galveston, Texas*

Marking Shrimp With Biological Stains

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THE U. S. FISH AND WILDLIFE SERVICE initiated tests in 1954 to find a more suitable method for marking shrimp, since mechanical tags had demonstrated severe limitations. As a result, Dawson (1957) reported notable success using biological stains as marking agents in three species of penaeid shrimp.

The use of stains for marking living organisms is not a new device or idea. Loosanoff (1937), Vernon (1937), Feder (1955), and others have reported success in staining various marine animals. Chapman (1957) reported successful use of a trypan blue and titanium dioxide mixture in marking juvenile steelhead, *Salmo gairdneri*. Slack (1955) used machine ink to mark crayfish. Menzel (1955) successfully stained white shrimp, *Penaeus setiferus*, with fast green, one of the stains used by Dawson. Racek (1955) found a method of staining penaeid prawns by immersion in Nile blue sulfate.

Dawson's work is of particular interest because of the stain longevity in living animals. Trypan red and trypan blue stains remained fast and recognizable for over two hundred days. This, and his report of relatively low mortality incident to staining, makes his technique a promising tool with which to study these commercially important crustaceans.

Dawson's work was confined to laboratory experimentation. The problem remained to adapt his technique for field use and to determine whether these stains would remain fast and recognizable under natural conditions. Biscayne Bay, Florida, was chosen as a site for releasing a sizable group of stained pink shrimp, *Penaeus duorarum*, into an operating fishery. The purposes of this initial field experiment were:

- (1) To test the longevity of stains under natural conditions.
- (2) To learn how rapidly shrimp could be stained and what equipment is necessary to stain shrimp in large quantities.
- (3) To learn how readily stained shrimp would be recognized when recaptured in the fishery.
- (4) To study the movement of stained shrimp within the Biscayne Bay area.

The Biscayne Bay Fishery

The waters of Biscayne Bay support a sizable bait fishery, with six to eleven boats operating under permits issued by the Florida State Board of Conservation. The shrimping is confined to a regulatory area (Figure 1) and sale of shrimp taken in this area is for bait purposes only. Higman (1952) and Sieben-

aler (1953) present a history of this fishery, which has been in operation since about 1952.

Prior to May 19, 1958, shrimp were taken in Biscayne Bay by otter trawls and rigid roller-frame trawls. After this date shrimping was restricted by the Florida State Board of Conservation to use of rigid roller-frame trawls only. Channel wing nets are legal and are occasionally used, but they are of minor importance in the bait fishery. Tabb (1958) summarizes the status of this fishery.

Equipment was designed which was portable and could be utilized for subsequent staining experiments. Equipment included a wall tent which housed a staining table and two large plywood shrimp-holding boxes. The larger box, 6 by 2 by 3 feet deep, supplied with running sea water is capable of holding three to four thousand shrimp for staining over a period of six to eight hours. The smaller box, 2 by 4 by 2 feet deep, served as the receptacle for shrimp which had been stained and placed in a trough of running sea water built into the staining table.

A gasoline operated pump furnished sea water at sixteen gallons per minute to the boxes and staining table during the time staining was in progress. As needed, shrimp were dipped out of the large holding box and placed in 12 by 14 inch plastic inserts built into the staining table. Stained shrimp placed in the trough of running sea water flowed down and dropped into a live car. When the live car contained approximately 500 stained shrimp it was taken out and anchored a short distance off the beach ready for transporting to the release site six miles to the south in Biscayne Bay.

Stains and Minor Equipment

Fast green is considerably less toxic than the other three usable stains noted by Dawson and was chosen for the initial work on that basis. All shrimp were stained by injection with a 1 per cent solution of fast green¹, dissolved in artificial sea water (Subow 1931) containing only the essential inorganic salts. Tests indicated artificial sea water is a superior solvent to the filtered natural sea water used by Dawson (1957).

Tuberculin syringes, one quarter cc., half cc., and one cc., were tested throughout staining. The half cc. syringes are superior for this work. No. 27, quarter inch needles proved the most satisfactory of several gauges and lengths tested. Multi-dosage syringes proved of no practical value.

Speed of Staining

Twenty-one students and members of the regular staff of the University of Miami Marine Laboratory participated in the staining phase. We found that anyone without previous experience but with normal finger dexterity can stain 200 to 240 shrimp per hour.

The Staining Operation

Table 1 contains a summary of the staining operation. At the University of Miami Marine Laboratory, Virginia Key, a total of 20,080 individuals, mean carapace length 19.1 mm, were stained between April 24 and May 29, 1958. Shrimp were taken in Biscayne Bay in rigid roller-frame trawls the night before

¹The disodium salt of p,p'-dibenzyl-diethyldiamino-p''-hydroxytriphenyl-carbinol trisulfonic acid anhydride (manufacturer National Aniline Co.).

staining. High winds and inclement weather during the period kept bait shrimp boats ashore for periods of from three to nine days. Thus an operation which could have been accomplished in five to seven days covered a thirty-six day period.

Release of Stained Shrimp

Rounsefell and Kask (1943) stated that one-at-a-time releases "soon result in a ring of predators waiting to gobble up each fish." They recommend releases as a school unit—our experience demonstrated the wisdom of this method. Releases in units of 500 were made in thirteen different locations in Biscayne Bay along a line from Matheson Hammock Beach to Southwest Point on Key Biscayne.

TABLE 1
SUMMARY OF BISCAYNE BAY SHRIMP MARKING

<i>Shrimp Marked</i>			<i>Shrimp Recovered</i>			
Date	Number	Mortality in 6 hrs.	¹ Verified		¹ Unverified	
			Date	Number	Date	Number
4/24	1100	43	5/1	1	5/6	2
4/28	1000	52	5/3	1	5/7	1
4/29	1500	61	5/9	1	5/11	3
4/30	2000	68	5/10	1	5/18	1
5/5	2380	81	5/19	1	5/22	4
5/13	1000	44	5/22	3	5/25	1
5/19	1000	31	5/23	4	6/2	7
5/21	2000	54	5/24	5	6/5	2
5/22	1000	43	5/25	1	6/8	1
5/26	1000	31	5/26	2	6/13	1
5/27	2000	62	5/27	6	6/15	9
5/28	1000	51	6/1	2	6/16	4
5/29	3100	101	6/6	5	6/18	6
			6/9	1	6/19	8
			6/10	2	6/20	1
			6/11	1		
			6/12	2	Total..	51
			6/14	6		
			6/15	2		
			6/16	2		
			6/17	2		
			6/21	1		
			6/29	4		
			7/5	1		
			Total....	57		

Movement of Stained Shrimp

Figure 1 summarizes movement of stained shrimp recovered by the bait fishery. It is of interest to note that nearly all of the movement was to the north toward Bear Cut and the Dodge Islands. This movement agrees with the

¹Verified recoveries include shrimp taken in the fishery, returned, and identified; unverified recoveries include reports by fishermen of stained shrimp noted, but not actually returned for verification.

impression of bait fishermen that pink shrimp populations move out of nursery areas which are to the south, into the areas of grass. Probably as they reach a larger size, they move into the area of mud bottom and from there into the ocean through Bear Cut and Government Cut.

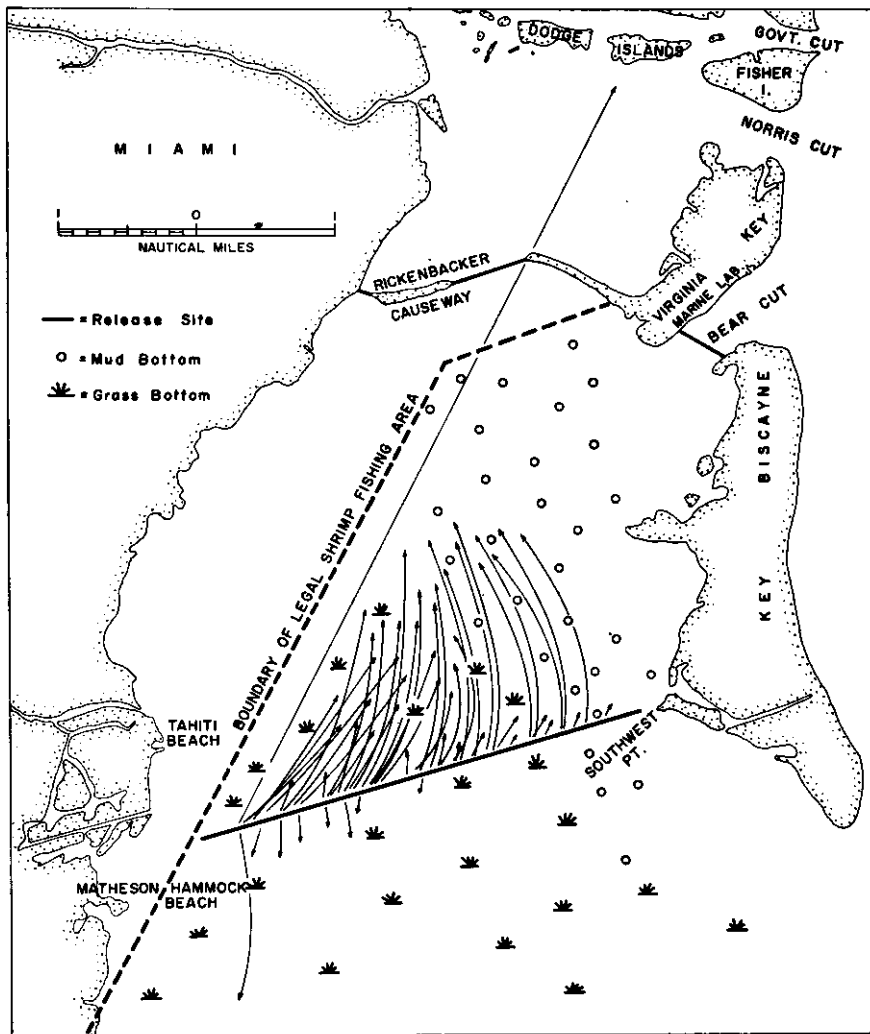


FIG. 1 ARROWS DEPICT MOVEMENT OF INDIVIDUAL SHRIMP FROM RELEASE SITE TO POINT OF RECAPTURE.

Analysis of shrimp recoveries required a knowledge of fishing effort with respect to the release site. Periodic observations of the nightly fishing and in-

interviews of bait fishermen indicated fishing effort north and south of the release site was approximately equal.

Recovery of Marked Shrimp

Table 1 summarizes reports of stained shrimp recovered in Biscayne Bay. A total of 108 stained shrimp were reported taken by bait fishermen, 0.5 per cent of the 19,358 released alive. Fifty-seven of this number were verified by actual return of the stained animals. Several comments are pertinent here:

(1) Lack of personnel limited the coverage of landings in Biscayne Bay.

(2) All shrimp recovered, including the last five verified recoveries June 29 and July 5, remained clearly marked, with no detectable fading in the stained area.

(3) Because of the manner in which live shrimp for bait purposes are handled, it is difficult to note stained shrimp passing through a bait fishery. The live animals are handled rapidly in the early morning hours to insure delivery in good condition to retail bait houses.

(4) It was difficult to keep an active interest among bait fishermen for this project, yet we obtained reasonably good information on the actual point of capture for most verified recoveries.

(5) Biscayne Bay was closed to otter trawl fishing May 19 (rigid roller-frame shrimping continued as usual). This probably materially reduced the number of stained shrimp recoveries. Since there was clearly a general movement of shrimp northward in the Bay, shrimp with a long "out time" simply were unavailable when they reached the mud bottom area of the Bay where otter trawls had normally fished.

Conclusions

(1) Fast green can be used successfully to mark pink shrimp in a bait fishery.

(2) Stained animals were readily recognized but recovery requires more effort than would be needed for shrimp tagged with a mechanical device.

(3) Shrimp recovered with a maximum possible "out time" of 73 days and a minimum of 37 days showed no evidence of stain fading. It is reasonable to assume that this stain will be recognizable over a considerably longer period than has been demonstrated here.

(4) Large quantities of shrimp may be easily stained without prohibitive mortality by inexperienced personnel.

(5) General movement of shrimp in Biscayne Bay, Florida, for the period covered was north and northeastward toward outlets to the ocean.

(6) There is presently no commercial fishery for pink shrimp in areas contiguous to Biscayne Bay. Although some effort for recovery of stained shrimp was made in the lower Keys and Tortugas fishery, no stained shrimp from Biscayne Bay were recovered. This lends some evidence that Biscayne Bay populations are not subject to exploitation in their mature stages.

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Fish Inspection in Canada

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ABOUT FIFTY YEARS AGO the Government of Canada set sail into the uncharted sea of fish inspection. During periods of temporary doldrums, succeeding gen-