

"Green" tuna, a color problem which occasionally is a serious cause for rejection, appears to be an oxidative phenomenon. With the use of spectrophotometric methods it has been shown that the pink color of cooked tuna flesh is due to the presence of *hemochromes* derived from myoglobin or hemoglobin in the raw tissue. The hemochromes are probably denatured globin hemochromes in which nicotinamide may play an important role. Oxidation leads to the formation of *hemichromes* which are tan. These can be reduced by simple reducing agents to the hemochromes. The "green" of off-color tuna is at least in part *hemichrome* since "green" tuna samples can be reduced to pink under appropriate conditions.

Royal Red Shrimp—A New South Atlantic Resource

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FOLLOWING THE 1955 FALL meeting of the Fishery Advisory Committee favorable consideration was given to an industry-sponsored request for shrimp exploration off the south Atlantic coast. A sum of \$60,000 was allocated from Saltonstall-Kennedy funds to be used for chartering a vessel suitable for exploratory work, hiring a crew, and providing the necessary gear and operating funds. This sum was sufficient to carry out a short range program, lasting through June, 1956. The programming was carried out under the supervision of the Service's Gulf Exploratory Fishing office.

While steps were being taken to obtain and rig a vessel, a comprehensive review of previous offshore investigations in the area under consideration was undertaken, both by reviewing the meager literature, the rather extensive unpublished station records from previous Service work in this region, and State reports on localized projects, and by personally interviewing large numbers of fishermen and fleet owners that fish the south Atlantic coast the year around.

It was found that previous work had extensively covered the continental shelf out to 100 fathoms without extending the known shrimping areas or, with the exception of finding scattered, small rock shrimp (*Sicyonia brevirostris*) beds, had not succeeded in locating new species for possible commercial exploitation. Other points of interest were that commercially valuable stocks of fish were disappointingly small or absent and that practically all previous exploratory work had been accomplished in the winter and spring, with little summer or fall coverage.

On the encouraging side, examination of the depth-temperature data collected in recent years by the Service's *M/V T. N. Gill* between Cape Canaveral and Cape Hatteras revealed several areas having depth-temperature patterns very similar to those in the Gulf of Mexico red shrimp grounds. A few bottom samples from these depths were similar to the red shrimp bottom off Dry Tortugas. Further, it was found that scattered individual specimens of red shrimp (*Hymenopenaeus robustus*) had been collected many years ago along the east coast as far north as Georges Bank, which suggested that this species might be found in greater concentrations. Therefore, with only four months time to carry out the program, deep water exploratory coverage was given primary emphasis. To

provide supplementary information on shallower water, the Service's M/V *George M. Bowers* was employed during January, February, and March.

In February, the M/V *Pelican*, a 70-foot, 170 H.P. steel-hulled shrimp trawler, was obtained on a bare boat charter. A larger winch, gallows frame, loran, and deep-water depth recorder were installed, and a crew was recruited.

"Maximum effort" fishing plans were formulated to obtain as much exploratory coverage as possible from Cape Canaveral to Cape Hatteras, with the intention of following up promising leads as they might present themselves. The initial trip, of a semi-shakedown nature, resulted in 13 drags being made between Ft. Pierce and St. Augustine in 20 to 235 fathoms, with eight out of nine drags in the theoretical red shrimp depths successful in catching small quantities of this species. April, May, and June were spent expanding coverage to the north, and by the end of June an area off St. Augustine, in depths of 160 to 200 fathoms, had been located that yielded catches of good commercial promise. Although several efforts were made to tow against the Gulf Stream current, only one short period of apparent slack current permitted successful counter-current dragging, and all other dragging efforts were made running with the current.

Of course, considerable information concerning trawlable bottom was acquired by this time. At the expense of five complete rigs lost, as well as some 5,000 feet of trawling wire, it was found that loose slab rock was encountered immediately north of St. Augustine, in red shrimp depths, and off Jacksonville and northward slab rock concentrations prohibited trawling with standard shrimp trawls. A single successful drag off Savannah in May in 182 to 250 fathoms caught 13 pounds of red shrimp, showing possible concentrations at least that far north. Since time did not allow extensive gear experimentation, the remainder of May and June were spent obtaining more information of commercial aspects of red shrimp fishing between Cape Canaveral and St. Augustine.

Much of the gear used for this work was of the same design and construction used on the M/V *Oregon* for red shrimp exploration in the Gulf of Mexico. (A report on the Gulf work is now in press and will appear shortly in *Commercial Fisheries Review*.) Generally speaking, 40-foot flat shrimp trawls were used for all exploratory dragging. These were towed on 5-foot trawl doors using a 25- or 35-fathom bridle on a single trawl warp. We tried to anticipate some of the special problems of dragging in the strong Gulf Stream current and designed and built a modified beam trawl, much like the Blake trawl—that would fish properly on either side. This net has been used several times with some success, but there has been no apparent advantage to it over the standard flat trawl.

As soon as areas of commercial promise were located, larger trawls were used, including 56-, 70-, and 80-foot nets. The rigging arrangement on the *Pelican* made it most advisable to run these larger nets on a single warp and bridle also. Early trials with these larger nets brought in catches of only slightly greater poundage than were made using 40-foot trawls.

By the end of June, results indicated the possibility of extensive and commercially profitable deep-water shrimping grounds off the northeastern Florida Coast, and additional Saltonstall-Kennedy funds were provided to extend the work for another year. At this time the vessel charter was changed to the M/V *Combat*, which probably could be considered the best equipped shrimp boat in the Gulf of Mexico. The *Combat* has a 96-foot wood hull, a 500-horsepower main engine, emersion freezing equipment with a large refrigerated

hold, complete electronic equipment including loran, radio, and depth recorder, and a large New England trawling winch with heavy gallows frames on port and starboard quarters. In seaworthiness, power, equipment, and rigging, the vessel was ideally suited to the job, permitting fishing activities to be continued when smaller vessels would be forced by weather to head in to port.

First successful attempts to trawl against strong current conditions were made during the shakedown cruise in July. It was found that the 2.5 to 3.5 knot ground speeds that could be made dragging against the current yielded, on the average, much better catches than were made towing the minimum speed of 4 to 4.5 knots with the current. Four days of round-the-clock fishing off St. Augustine, using a 40-foot trawl, caught 21 boxes (100 pounds of headed shrimp per box) of 21-30 count red shrimp. Drags were made of three to four hour duration, alternately with the current and counter-current. Most catches ran from 200 to 450 pounds of heads-on shrimp. The best catch yielded 560 pounds of shrimp, from a four hour counter-current tow. Highest catches were made immediately below 29°58.5' north latitude, in 170 to 190 fathoms. To the north of this point slab rock and coral prohibited trawling.

Use of larger commercial trawls gave slightly better catches but the poundage increases did not seem commensurate to the 40-foot nets. Experimental fishing using two 40-foot nets simultaneously has been tried, and has proved moderately successful. Further work on this is now underway, though there is an apparent drawback in that at least one additional fisherman will have to be added to crews working two rigs.

In September and October emphasis was placed on more closely delineating potentially profitable areas, and at this time two commercial shrimpers tried working the St. Augustine grounds. However, following the turbulent seas that accompanied the passing of Hurricane Flossie, the large concentrations off St. Augustine apparently dispersed, and commercial efforts were discontinued. The largest catch in that area by the *Combat*, during this period, was 280 pounds of shrimp from a three hour tow. Working to the south, in the offings of Daytona Beach, concentrations of up to 400 pounds per drag were located, but with a definite size groupings of shrimp that had not been encountered previously either on the east coast or during some five years of deep-water dragging in the Gulf of Mexico. In late September and mid-October catches of red shrimp were about equally divided by weight into 21-30- and 51-70-count. In the Gulf of Mexico, small *H. robustus* have been caught in insignificant quantities throughout most of the year, causing speculation that perhaps this species spawns throughout the year. To further this theory was the fact that many catches contained individuals in every size grouping from about 10 or 15 count on down to 50 to 70 count. This size demarcation on the east coast indicates that there might well be a seasonal factor to their spawning, and also raises the question of the advisability of fishing in areas where young shrimp predominate. Since work on the east coast has been under way less than nine months, the seasonal picture is still far from complete.

In November, the *Combat* concluded a three-week trip concerned with deep-water exploration in the Cape Fear to Cape Hatteras area. Although bad weather greatly restricted fishing operations, 14 fishing stations were made in 125 to 250 fathoms. Most of the drags yielded a few red shrimp but the quantities were disappointingly small. The best catch was three pounds of heads-on shrimp. Of interest, however, were small numbers of other penaeid

shrimp, identifications of which have not been made as yet. It is planned to investigate this area again next Spring.

To date, three commercial vessels have worked the red shrimp grounds off northeastern Florida, and their results have provided interesting and valuable supplementary information. In early August, the first commercial boat made several unsuccessful attempts at trawling in the Gulf Stream current using two trawling warps. The principal problem was twisting and fouling of the doors, net, and wires during setting operations. Following this, in early September, one of the Sahlman Seafood Company boats that had been rigged with a large Hathaway winch, and using a tipping gallows frame device that had been developed on the first boat, made four short trips off St. Augustine. They were able to trawl successfully using two warps in the conventional manner, and several good catches were made using large, commercial trawls. In mid-September, their catches averaged some 400 to 500 pounds of headed shrimp per day. However, following the bad weather that accompanied Hurricane Flossie and the dispersal of shrimp off St. Augustine, this vessel also discontinued deep-water fishing.

The third vessel to work this area was an off-shore trawler, the *Sarah J.*, based in New Bern, N. C. Their work was carried out during the second and third weeks in November, while the *Combat* was engaged in exploratory trawling off Cape Lookout. The reports received tell of their catching very large quantities of small (approximately 50-60 count) red shrimp in 175 to 250 fathoms off New Smyrna to Cape Canaveral.

To summarize the information we have to date, good trawling bottom and fishable concentrations of red shrimp have been found from Daytona Beach northward to St. Augustine, where bad bottom is the limiting factor. Good bottom but smaller concentrations of red shrimp extend south of Daytona Beach to off Ft. Pierce. North of St. Augustine, small catches of shrimp show that they range extensively along the coast, at least to Cape Hatteras, but bad bottom has greatly restricted exploratory coverage. There also appears to be a seasonal factor on the average size of the individual shrimp. It must be recognized, however, that this tentative summary is based on only eight and one-half months of work, and that as further work is carried out, the picture might change considerably.

As a fishery resource, red shrimp provide a new, tasty variety to the existing shrimp industry. Several trial servings of this species have been made in the Gulf area during the last few years, with enthusiastic results from both seafood restaurants and individuals. On the other hand, the smoother, softer texture of red shrimp apparently requires some special processing, handling, and cooking techniques, which could be disadvantageous if the initial market offering did not take this into consideration. There is also a 10 per cent smaller meat yield per pound of heads-on shrimp. This is due to a proportionately slightly larger head and a slightly greater water loss following processing. Our information on this is incomplete, however, and the Service's Technological Section is currently carrying on studies that will closely define yield and quality versus handling.

To attempt to delineate the magnitude of the new grounds, in terms of continuing yield, would certainly be most premature at this time. Perhaps the most significant accomplishment has been the addition of a third area where commercially profitable catches of this species of shrimp have been

made. (East of the Mississippi Delta and southwest of Dry Tortugas in the Gulf of Mexico.) By next summer, when some repeat seasonal coverage has been made, a much better picture should be available. Also, it is very probable that within the next few months intensive commercial fishing will be carried out on these grounds, providing some early tangible data on commercial possibilities.

DISCUSSION

Exploratory Fishing and Technology Session

Discussion Leader: LAWRENCE W. STRASBURGER

Discussion Panel: FRED JUNE, LEO LEVINSON,
E. A. FIEGER, PHILLIP S. WOOD

A New Federal Fishing Laboratory on the Gulf

CHARLES BUTLER

- Q. Strasburger: How many people will you have at the Pascagoula Laboratory?
- A. Butler: The personnel will be designed around the program, but will have three people initially. A qualified director will work in the area to find out what are first priority projects. We will also have a chemist and a bacteriologist.
- Q. June: Considering the rapid deterioration of shrimp on boats, would it not be useful to investigate the possibility of some pre-processing of the product on the shrimping grounds; that is putting gear aboard the vessels which would make available to the market a better product?
- A. Butler: That is, in effect, what we were trying to do a number of years back with freezing at sea. We also tried with fin fishes to develop techniques for filleting and freezing the fillets in a package at sea. But there are two problems, the amount of manpower aboard the vessel, and the degree of skill involved. It is asking a lot of the fishermen, who know only how to fish, to do these other types of work. In the Gulf there is difficulty with refrigerated vessels because the personnel do not know how to handle refrigeration equipment. If you go to the next stage of asking them to do something with the product which involves shore processing knowledge, that is a big order for the small crew of a shrimp boat. With a larger vessel you have a still bigger investment, more people involved, and hence larger expenses. So we feel that by the application of good practices of handling and sanitation we can best get a product back to shore. On the basis of work that has been done on fin fishes, we think that this can be done. If it proves unprofitable or unfeasible, we then have to find another solution.