

Introduction of the Marquesan Sardine, *Harengula vittata* (Cuvier and Valenciennes), to Hawaiian Waters

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A PROGRAM of introduction of the Marquesan sardine was undertaken by the Bureau of Commercial Fisheries, Hawaii Area, at the request of the Hawaii Division of Fish and Game. The objective was to introduce a species of fish to the Hawaiian Islands that would be suitable as tuna bait in order to supplement the somewhat tenuous supply of the nehu, *Stolephorus purpurus* Fowler. The stimulus for the request and the subsequent program stemmed from the fact that the fish fauna of the Hawaiian Islands is notable for the number of endemic species and the absence of many forms that are common in the central Pacific islands to the south. Gosline (1955) proposed that the migration route of shore fishes to Hawaii is from the south and that Johnston Island, some 600 miles south of the Hawaiian chain, is the stepping stone. He suggests that the failure of many forms to reach Hawaii can be attributed to the large over-water distance to be traversed in crossing first to Johnston Island and then to Hawaii, to possible ecological screening of fishes at Johnston Island, and finally to the possibility that the Hawaiian Islands do not offer the necessary habitat for certain of the absent forms, especially in regard to species missing in Hawaii but found at Johnston Island.

The Marquesan sardine was first recorded as tuna bait by Royce (1954), who found them to be abundant and accessible in the Marquesas and suitable for tuna fishing. Additional factors suggested that they would be a useful and successful species in Hawaii. They were found along the surf line in the Marquesas but generally along rocky, sandy, sheltered beaches, a habitat not usually frequented by the nehu. (Thus, it did not seem likely that they would compete directly with the nehu.) The Marquesas are high, volcanic islands as are the Hawaiian Islands and,

with the exception of the scarcity of coral in the Marquesas, appear to represent the same general type of environment as the Hawaiian Islands.

Negative factors relative to the introduction are the somewhat cooler water temperatures in Hawaii and the fact that our seasons are reversed.

Ordinarily, such an expensive project as transferring a marine fish from 10° south of the Equator to 20° north of the Equator would not be undertaken without an extensive investigation of the fish's life history to evaluate the chances of successful introduction and to weigh thoroughly the possibility that the species might do harm in the new area. The possibility of harm seemed remote, and the expense not critical because a program of introduction could be incorporated in an investigation of the Marquesas area by the Pacific Oceanic Fishery Investigations (now known as the Bureau of Commercial Fisheries, Hawaii Area).

The several releases in Hawaiian waters (Table 1) were made as close to shore as operationally feasible and in habitat situations that were regarded as suitable for the Marquesan sardine. Examination of the gonads of the sardines in Marquesas waters suggested that nearly all of the individuals brought to Hawaii were young, mature adults.

In lieu of an extensive recovery program, wide publicity was given to the releases and a special poster, which included a photograph of the sardine, was widely distributed throughout Hawaii wherever fishermen were likely to congregate. The poster was especially directed to tuna fishermen because they use fine mesh nets when fishing for the nehu. Relying primarily on tuna fishermen for recoveries has several obvious advantages and one serious disadvantage, for one would expect that the Marquesan sardine would not be most abundant in the same habitat as the nehu.

It is not the purpose of this discussion to

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TABLE 1
RECORDS OF THE MARQUESAN SARDINE (*Harengula vittata*) IN HAWAIIAN WATERS

RELEASES				RECOVERIES			
Date	Locality	Estimated number	Fork length (mm.) range and mean	Date	Locality	Number	Fork length (mm.) range and mean
12-17-55	Barbers Point, Oahu	11,000	66-115 (88)				
9-26-56	Hanauma Bay, Oahu	7,000	76-127 (101)	9-27-56	Kalihi Channel, Oahu	1	106
3-22-57	Pokai Bay, Oahu	27,000	78-116 (94)	3-26-57	Kaneohe Bay, Oahu	1	90
				3-27-57	Kalihi Channel, Oahu	1	90
				4- 8-57	Kaneohe Bay, Oahu	4	87-93 (91)
				6- 4-57	Kaneohe Bay, Oahu	1	103
				9- 9-57	Barbers Point, Oahu	6	120-145 (134)
12-14-57	Ewa, Oahu	31,000	90-111 (99)				
2-25-58	Ewa, Oahu	53,000	72-123 (98)	2-28-58	Honolulu Harbor, Oahu	4	82-101 (92)
				4-29-58	Pearl Harbor, Oahu	3	108-114 (111)
5- 2-58	Ewa, Oahu	8,000	47-134 (102)	6-27-58	Honolulu Harbor, Oahu	1	102
6-23-58	Maunalua Bay, Oahu	3,000	84-115 (101)	6-30-58	Kaneohe Bay, Oahu	1	105
				7- 5-58	Kihei, Maui	10	Not examined
				9-10-58	Port Allen, Kauai	6	67-72 (70)
				9-23-58	Kaneohe Bay, Oahu	1	62
				9-25-58	Hanalei Bay, Kauai	6	74-84 (80)
				10- 2-58	Port Allen, Kauai	6	43-84 (71)
				10- 7-58	Kihei, Maui	29	37-61 (52)

evaluate the program completely to date; the passage of time will furnish definitive information in this respect. The pattern of recoveries in Table 1 however does permit optimism. The first release yielded no recoveries and the second was followed the next day by a single recovery.

There were no additional recoveries until a few days after the next release on March 22, 1957, about six months later. It is significant that this planting was nearly three times as large as its predecessors and was followed by a number of recoveries culminating in the capture of six

large adults off Barbers Point by a fisherman, using a gill net. This recapture was significant because (1) the fish recaptured were larger than any planted in Hawaiian waters (in fact the largest were longer than any measured in Marquesan waters), and (2) examination of the specimens suggested that they were very close to spawning. There were no additional recoveries for another six months and these followed close on the heels of an additional release, as did the two recoveries in June, 1958.

In July, September, and October, 1958, there were recoveries that did not fall into the usual pattern. First, the sardine was reported from Kauai and Maui where they had not been planted, and, perhaps more significant, some of the specimens were very small in size, strongly suggesting that there had been successful reproduction.

Of 1,300 fish measured in the Marquesas during the spring of 1958, only 81 were smaller than 75 millimeters. Considering only the last two stockings, only 3 of 50 fish measured were less than 75 millimeters and these were planted in May of 1958. For these small specimens to have originated from the stockings would require both that the fish did not grow during their three or four months' stay in Hawaii, and

that there was a highly improbable statistical accident. In view of the growth evinced by the six specimens taken off Barbers Point on September 9, 1957, this seems remote.

In summary, substantial numbers of Marquesan sardines have been released in Hawaiian waters; there have been numerous casual recoveries by commercial fishermen in Hawaii, all indicating that the individuals released were healthy. Finally, there is now at hand good evidence that the species has spawned. To the writer's knowledge, this is the first successful introduction of a purely marine fish species; perhaps the success is not unexpected because of the general impoverishment of the Hawaiian marine fauna and the attendant vacant niches. This type of faunal impoverishment has generally been the basis of the numerous successful fresh water introductions of exotic fishes.

REFERENCES

- GOSLINE, W. A. 1955. The inshore fish fauna of Johnston Island, a central Pacific atoll. *Pacif. Sci.* IX(4): 442-479.
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