PRELIMINARY STUDY ON THE SPAWNING SEASON OF THE OPAKAPAKA, *PRISTIPOMOIDES FILAMENTOSUS*

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ABSTRACT

As part of the survey and assessment program of the Northwestern Hawaiian Islands, the National Marine Fisheries Service has been studying the distribution, apparent abundance, and biology of commercially valuable bottomfish. This study deals with the reproductive cycle of the opakapaka, *Pristipomoides filamentosus*, one of the most important snappers in the Hawaiian fishery. The results showed that the development of ova within the paired ovaries is heterogeneous. Stages of maturation, determined from the development of ova in the most advanced mode in the distribution of random ova diameters, showed a positive relationship with the gonadal somatic indices. The gonadal somatic index peaked in August with spawning possibly taking place in September.

opakapaka
reproduction
Northwestern Hawaiian Islands

INTRODUCTION

The opakapaka or pink snapper, *Pristipomoides filamentosus* Cuvier and Valenciennes, which has been fished intensively around the Hawaiian Archipelago for decades, is the most important bottomfish in terms of landed weight and cash value. This snapper is prized for its good taste and pleasing appearance (Brooks Takenaka, Assistant Manager, United Fishing Agency, Honolulu, Hawaii, personal communication, January 1980).

There is a limited amount of literature on the life history and biology of the opakapaka. Most papers written about the opakapaka deal with the fishery.

In 1976, the National Marine Fisheries Service (NMFS), Honolulu Laboratory initiated a resource assessment program for the Northwestern Hawaiian Islands (NWHI). Part of the program deals with the bottomfish resource and its interaction with the ecosystem. This study examines the spawning behavior of the opakapaka.

METHODS

For a major part of the resource assessment program, the NOAA ship Townsend Cromwell was used to survey the bottomfish resource in the NWHI. The opakapaka with other bottomfishes were caught on handline gear using four hooks (No. 26) per line. The lines were retrieved by four powered gurdies on the starboard rail. Opakapaka were usually caught between 40 and 120 fathoms.

The fish landed were measured for fork length (FL) and standard length (SL) in millimeters and weighed to the nearest 10 g. Otoliths, gonads, and stomach content samples were removed and retained for further studies. Samples were preserved in 4% formaldehyde and seawater. No quantitative observations were taken on the preserved ovarian material until 6 or more months had passed and shrinkage had been stabilized.

Homogeneity

A pair of ovaries was examined for homogeneous development of the ova. A No. 5 cork borer with an inside diameter of 10.026 mm was used to extract core samples from the anterior, middle, and posterior regions of both ovaries. Each of the core extended from the outer surface of the ovary to the centrally located lumen and was divided into an outer layer, central layer located adjacent to the lumen, and a middle layer, thus providing a total of 18 subsamples. Developing ova were teased from each of the 18 subsamples and 200 randomly selected ova were measured.

Spawning seasonality

For the spawning season of the opakapaka, 21 ovaries collected between February 1978 and June 1979 were examined. Maturity of the ovary was determined by examining the middle core sample. Four hundred randomly selected ova were classified according to stage of maturity from the three layers of the cored sample. The mean of the last two advanced modes were taken to determine ovarian maturation state.

Developmental stages of the ova

The developmental stages, determined on the basis of physical appearance (Uchiyama and Shomura, 1974), are described as follows:

1) Primordial

Primordial ova are found in all the ovaries, usually ovoid in structure and transparent. No ova diameters were measured.

2) Early developing ova

Ova are transparent to translucent with the beginning of opaque yolklike matter in the ovum. The shape of the ova is usually ovoid or wedgelike. Size range: 0.15 to 0.39 mm in diameter.

3) Developing ova

Ova are completely opaque and ovoid. Size range: 0.16 to 0.67 mm in diameter.

4) Advanced developing

Ova are ovoid and have a translucent margin. The fertilization membrane has formed. Size range: 0.39 to 0.60 mm in diameter.

5) Early ripe

Ova are usually round or spherical. The yolk material is translucent and the oil globules have formed. Size range: 0.47 to 0.58 mm in diameter.

6) Ripe ova

Ova are transparent and contain oil globules. No ovary in the ripe condition was collected.

7) Residual ova

Ova are degenerating and show signs of shrinking.

RESULTS

Homogeneity of development

In the test of homogeneity, ovary No. 14 was selected and the ova diameters in the developing stage from each of the 18 sites were compared. The frequency distributions of the diameters were skewed to the right of the mean. A Kruskal-Wallis non-parametric test (Sokal and Rohlf, 1969) was used to test the homogeneity of locations for the distributions of ova diameters for the 18 sites. The results showed that the locations of the 18 distributions differed significantly ($X^2 = 191.45$, df = 17, $P = 0.05$). The development of the ovary in the opakapaka is therefore heterogeneous. Heterogeneous development of large ovaries were also demonstrated in the bigeye tuna, *Thunnus obesus*, by Yuen (1955), in the albacore, *T. alalunga* by Otsu and Uchida (1959), and in the swordfish, *Xiphias gladius*, by Uchiyama and Shomura (1974).

Spawning season

The gonadal somatic index (GSI), because it can be easily calculated, can be used to reduce time-consuming and tedious examination and measurement of the ova, provided it can be shown to have a positive relationship with stages of maturity (Table 1). To explore this possibility, a test was conducted initially to determine whether fish size was related to the GSI; however, no significant correlation was obtained ($r = 0.025$; $df = 20$; $P > 0.05$), indicating that fish size was not associated in any way to the GSI. A test between fish size and stages of maturity also showed no significant correlation ($r = 0.212$; $df = 20$; $P > 0.05$). When GSI was plotted against stages of maturity, however, there was an indication of a positive trend. A test of the relationship between GSI and stages of maturity showed a significant positive correlation ($r = 0.540$; $df = 20$; $P < 0.01$), but because only two samples past the early developing stage were available, the relationship cannot be accepted as conclusive (Figure 1). It would appear, however, that as females mature, the weight of the ovary not only increases faster than the total body weight, but also rises and falls in relation to development, spawning, and redevelopment.

To determine the spawning cycle of the opakapaka, GSI was plotted against the month of capture. The results show that it reached its lowest level in March and peaked in August (Figure 2). The opakapaka, therefore, appears to have one spawning period each year in early fall, probably in September (Table 1).

DISCUSSION

By examining conditions and occurrence of the early ripe and advanced developing ova throughout the 18 sites, it was possible to determine visually that development of the ovary in the opakapaka was heterogeneous. Of the total 18 subsamples from one fish, only six subsamples had ova in the advance developing stage and two subsamples had ova in the early ripe stage.

In the test for homogeneity of location, developing ova were used because of their consistency throughout the 19 subsamples.

TABLE 1. FORK LENGTHS, GONAD WEIGHTS, GONADAL SOMATIC INDICES, AND STAGES OF MATURATION OF 28 OPAKAPAKA SAMPLED BETWEEN FEBRUARY 1978 AND JUNE 1979

Sample No.	Date of Catch	Fork Length (cm)	Fish Weight (kg)	Preserved Gonad Weight (g)	Gonadal Somatic Index[1]	Maturity[2]
1	10/25/78	70.1	5.28	58.61	1.11	Dev.
2	8/09/78	60.4	3.72	--	--	Dev.
3	8/11/78	71.4	5.58	58.84	1.05	Dev.
4	10/25/78	72.7	5.05	37.16	0.74	Imma.
5	--	58.7	3.69	64.00	1.73	Adv. Dev.
6	8/09/78	66.2	4.66	--	--	Dev.
7	8/09/78	63.1	4.00	54.68	1.37	Dev.
8	9/13/78	62.1	4.00	96.22	2.41	Imma.
9	8/11/78	72.22	5.88			
10	9/13/78	52.0	2.52	89.44	3.55	Resid.
11	9/17/78	76.3	6.49	136.16	2.10	Adv. Dev.
12	9/17/78	48.7	2.02	33.61	1.66	Dev.
13	9/19/78	--	--	20.81	--	Dev.
14	8/24/78	67.1	5.45	223.42	4.10	Early Ripe
15	10/ /78	54.0	2.18	35.81	1.64	Adv. Dev.
16	10/ /78	52.0	2.49	36.38	1.46	Adv. Dev.
17	10/ /78	59.0	2.81	14.09	0.50	Adv. Dev.
18	10/ /78	58.0	2.36	--	--	Adv. Dev.
19	3/05/78	57.3	3.00	11.12	0.37	Imma.
20	3/05/78	55.4	2.90	10.99	0.38	Imma.
21	10/ /78	71.0	5.53	152.8	2.76	Adv. Dev.
22	3/06/78	73.5	6.30	40.85	0.65	Imma.
23	2/26/78	52.6	2.17	10.34	0.48	Imma.
24	3/06/78	64.0	5.40	25.57	0.47	Imma.
25	2/26/78	68.3	5.30	28.78	0.54	Imma.
26	6/02/79	45.6	2.10	38.01	2.10	Dev.
27	5/18/79	94.7	6.90	74.70	1.37	Dev.
28	5/23/79	74.9	--	--	--	Dev.

[1]Gonadal somatic index = $\frac{\text{gonad weight}}{\text{fish weight}} \times 100$

[2]Dev. = developing ova; Imma. = immature ova; Adv. Dev. = advanced developing ova; and Resid. = residual ova.

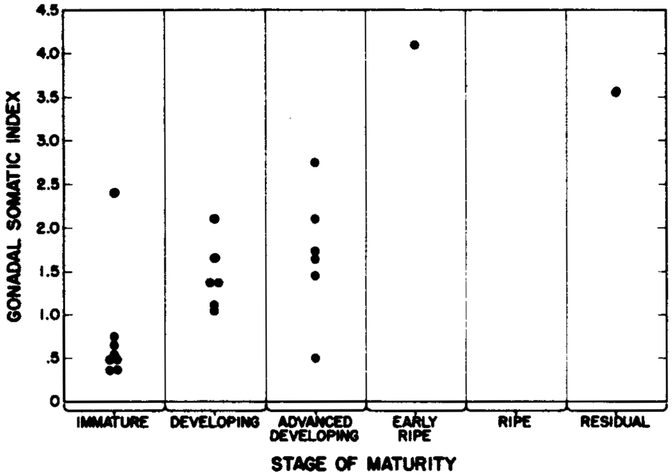

Figure 1. Relationship between stages of maturity and gonadal somatic index in the opakapaka, Pristipomoides filamentosus

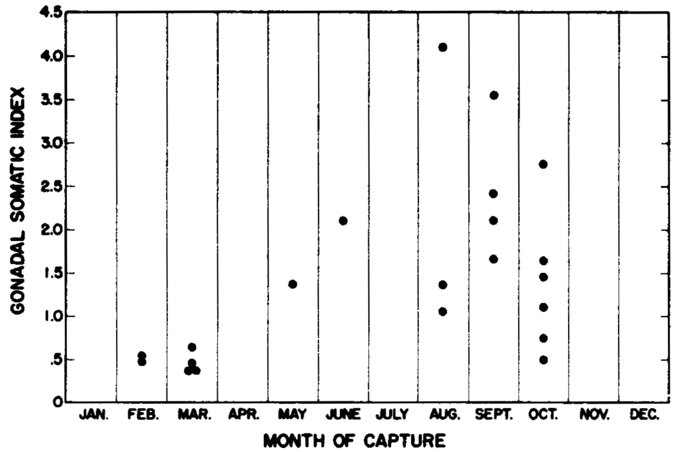

Figure 2. Relationship between month of capture and gonadal somatic index in the opakapaka, Pristipomoides filamentosus

FUTURE RESEARCH NEEDS

More opakapaka need to be sampled between November and July, including a wide range of gonads to determine minimum size of spawning and sexual maturity. It is important that ripe ovaries be obtained to better understand ovary development, fecundity, and spawning cycles.

SUMMARY

Preliminary results show that the opakapaka ovaries develop heterogeneously.

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