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Reproductive Activity of Yellowfin Tuna Off Southeastern Australia

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Abstract - Gonad weights and gonad indices from yellowfin tuna *Thunnus albacares* taken between 30°S and 36°30'S off the southeastern coast of Australia were compared with those from the eastern central and southwestern Pacific Ocean. The low gonad weights and gonad indices showed no evidence of spawning during February-October for the sampling period March 1986-April 1988.

The reproductive activity of yellowfin tuna *Thunnus albacares* (Bonnaterre 1788) is believed to be related to season (Collete and Nauen 1983) and sea surface temperature (Cole 1980). The lower limit of water temperature for spawning was considered by Ueyanagi (unpubl. data, and 1978) to be 26°C. Although water temperatures of 26°C are normally found in latitudes north of 20°S off eastern Australia (Suzuki et al. 1978), surface temperatures of 26°C occur regularly between the latitudes 30°S to 36°S (Anon. 1986; Anon. 1987). This area is fished by Japanese and Australian longline fleets targeting yellowfin and bigeye tuna.

Reproduction of yellowfin tuna has been extensively studied in the eastern and central equatorial Pacific and Atlantic oceans (June 1953; Schaefer and Orange 1956; Orange 1961). In the western Pacific, data have been collected by Japanese researchers since 1949 from as far south as 40°S and east to 100°W (Kikawa 1962), although much of the data until 1962 were fragmentary and of limited range in area and season. Kikawa (1966) examined the distribution of maturing yellowfin tuna in different areas of the tuna longline grounds in the Pacific and evaluated the spawning potential using gonad indices and maturity estimates. He determined that in the western south Pacific, spawning

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potential is at its maximum in December/January or in October/November, and at its minimum in April/September or in February/May.

Indirect evidence of yellowfin tuna spawning is available from larval surveys. Nishikawa et al. (1985) sampled from as far south as 44°S close to the coastline of Australia in a study combining data from 1956 to 1981.

This study examines the reproductive activity of yellowfin tuna from southeastern Australian waters based on the gonad index, a reliable indicator of ova development in yellowfin tuna (Shaefer and Orange 1956), and compares the results with other studies.

Samples were obtained from the Australian longline fleet fishing between 30°S and 36°30'S and from anglers at tournament weigh stations within the same area. Samples were collected between March 1986 and April 1988. Fork lengths were measured to the nearest centimeter below. Sex was determined macroscopically and both gonads were removed and weighed to the nearest 0.1 g.

Where gutted fish weights (W) only were available, they were transformed to fork lengths (FL) using the relationship $FL = 42.0217 \times W^{.3218}$ (Diplock, unpubl. data).

The logarithm of gonad weight for males and females was plotted against the logarithm of fork length to investigate departures from linearity indicative of the onset of maturity. The gonad index (GI) was calculated as:

$$GI = (GW/FL^3) \times 10^5$$

where GW = gonad weight (g) and FL = fork length (cm). Data were pooled and mean monthly gonad indices (±1 SD) were plotted.

The relationship between fork length and ovary weight is shown in Fig. 1, and between fork length and testis weight in Fig. 2. The relationships are approximately linear showing no apparent allometry due to the onset of sexual maturity.

Both Cole (1980) and Yanez and Barbieri (1979) considered most yellowfin tuna to be sexually mature at 120 cm FL, so data were partitioned into two subsets at 120 cm FL to separate sexually immature fish in the analysis.

Gonad indices were determined from 234 female yellowfin tuna ranging in size from 67 to 169 cm FL. Ovary weights ranged from 8.5 to 415 g. Mean monthly gonad indices for females are shown in Figs. 3-4 for the length groups 69-119 cm and 120-169 cm FL, respectively. For the smaller size group, the gonad indices ranged from 0.57 to 7.5 and for the large size group from 0.48 to 13.5.

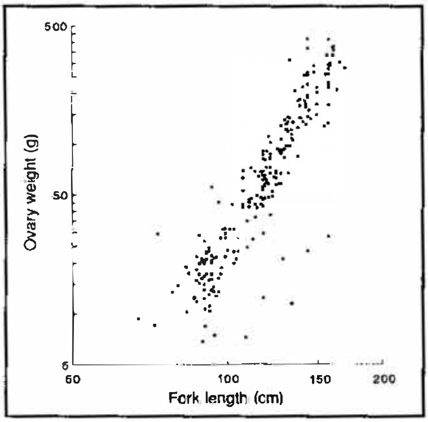

Fig. 1. The distribution of ovary weights (g) of yellowfin tuna against fork length (cm).

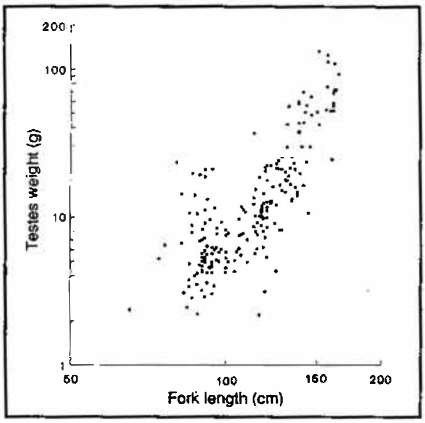

Fig. 2. The distribution of testes weights (g) of yellowfin tuna against fork length (cm).

Gonad indices were determined from 204 males ranging in size from 65 to 165 cm FL. Testes weights ranged from 2.9 to 133.2 g. Mean monthly gonad indices for males are shown in Figs. 5 and 6 for the length classes 65-119 cm and 120-165 cm FL, respectively. Gonad indices range from 0.14 to 3.1 for the smaller size class and from 0.22 to 3.87 for the larger.

Knudsen (1977) considered that a gonad index of 30 or greater for female yellowfin tuna indicated that spawning was imminent (i.e., within one month) but did not correlate gonad index with fish size (Knudsen's index scaling factor was adjusted from 10^8 to 10^5 to allow comparison). No females in the present study showed a gonad index higher than 13.5.

Orange (1961) presented minimum gonad indices for yellowfin tuna ovaries which could be considered to be maturing. Values ranged from 14 for fish of 80-89.9 cm to 23 for fish of 160-169.9 cm, as he noted that fish with immature ovaries or in a sexual resting stage have slightly higher average gonad indices as body length increases. He concluded that a female, when reasonably well advanced toward sexual maturity, has a higher index than that of any females which are immature or in a resting stage. All the gonad indices for both size groups of yellowfin tuna off southeastern Australia fall well below the minimum maturation indices defined by the above authors.

In the western Pacific Ocean, Kikawa (1959) examined yellowfin tuna gonad indices for the region 10°S to 30°S and 130°E to 110°W using the gonad index (Gonad Weight/L^3) x 10^4. Adjustment of the scaling

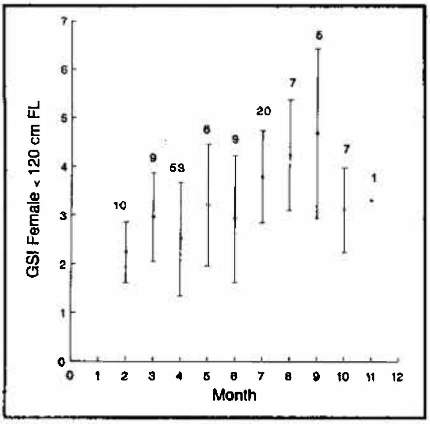

Fig. 3. Mean monthly gonad indices (± one standard deviation) for female yellowfin tuna less than 120 cm fork length. Superscripts show sample sizes.

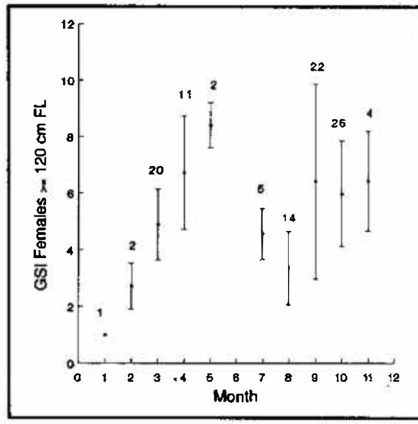

Fig. 4. Mean monthly gonad indices (± one standard deviation) for female yellowfin tuna greater than or equal to 120 cm fork length. Superscripts show sample sizes.

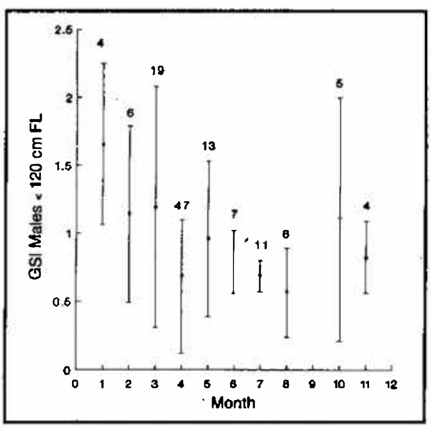

Fig. 5. Mean monthly gonad indices (± one standard deviation) for male yellowfin tuna less than 120 cm fork length. Superscripts show sample sizes.

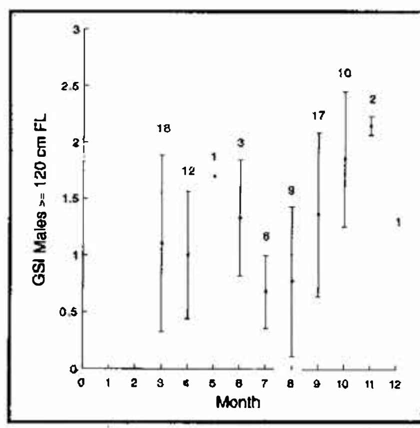

Fig. 6. Mean monthly gonad indices (± one standard deviation) for male yellowfin tuna greater than or equal to 120 cm fork length. Superscripts show sample sizes.

factor to 10^6 allows comparison of indices with this and the previously cited studies. For the most southerly region examined, 20°S to 30°S covering the south Coral Sea, Kikawa found female gonad indices ranging from approximately 5 to 12 in the months August-October and several of 28-30 in the months August-November. Kikawa's data pooled for all years show that a small proportion of the samples have gonad indices greater than 30 in November and December. Kikawa (1962) considered that spawning may take place as far south as 30°S.

In a later study Kikawa (1966) used gonad indices to evaluate yellowfin tuna spawning in the western Pacific south to 28°S. He showed some spawning (i.e., gonad index > 21) to take place as far south as 27°S. He considered fish with gonad indices greater than 16 to be mature. For the most southerly subdivision (12°S to 28°S) Kikawa showed mature fish were present in all months sampled (August-January). The minimum ovary weight for a ripe fish of the 105-cm length class was approximately 200 g with a mean ovary weight of 280 g for the group. This corresponds to a gonad index of 24.2. For fish in the 165-cm size class, the minimum ripe ovary weight was 1,380 g with a mean ovary weight of 1,800 g corresponding to a gonad index of 30.7. Gonad weights from southeastern Australia shown in Fig. 1 are lower than those found by Kikawa (1966) by a factor of 3. Kikawa's data for nonspawning or resting stage yellowfin tuna, however, were similar to those from this study.

June (1953) clearly distinguished between spawning and nonspawning fish. The maximum gonad weight for a nonspawning fish of 173 cm (95 kg) was approximately 500 g corresponding to a gonad index of 10. Spawning fish of 165 cm showed gonad weights of 1,500-2,500 g. It is clear from the gonad weights and gonad indices that the female yellowfin tuna sampled from southeastern Australia lie with those classified by June as nonspawning.

The concept of a "critical value" of gonad index was introduced by Cayré and Laloë (1986) to distinguish spawning skipjack determined by ova diameters. It would appear that a gonad index from 15 to 20 would provide an adequate minimum "critical value" to define spawning condition for female yellowfin tuna.

Yanez and Barbieri (1980) considered that male yellowfin tuna in the Atlantic Ocean with a GSI of 8 or more to be in spawning condition and gave average values for fish in resting condition of 1.4 for fish of 61-110 cm FL and of 2.6 for fish of 121-176 cm FL. These correspond well with the values shown in Figs. 5-6 indicating that males in the present study are in resting condition.

The distribution of larval yellowfin tuna as shown by Nishikawa et al. (1985) and Suzuki et al. (1978) also indicates the absence of spawning activity off southeastern Australia at any time of the year.

Although large yellowfin tuna can be found in the study area throughout the year, it would appear that they are most probably in feeding and not breeding aggregations. It is also possible that the perceived low level of reproductive activity results from sampling longline catches. Koido and Suzuki (1989) noted that in the western tropical Pacific, longline-caught fish are less sexually developed than fish taken by purse seine and that, unlike the latter, there are no regular seasonal changes in sexual maturity in longline samples.

McPherson (1988) indentified spawning yellowfin tuna in the Coral Sea during the last quarter of the year and Koido and Suzuki (1989) considered that the main spawning season in the western tropical Pacific extended from November to April. The low longline catch rates over the austral summer months are therefore consistent with a spawning-related migration from the fishing grounds, as suggested by Kikawa (1962).

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