# Diets of Bigeye and Yellowfin Tunas in the Western Tropical Pacific

**Jong-Bin KIM, Dae-Yeon MOON, Jung-No KWON, Tae-Ik KIM and Hyun-Su JO**
*National Fisheries Research and Development Institute (NFRDI), Pusan 619-900, Korea*

**Stomach contents of bigeye tuna, *Thunnus obesus*, and yellowfin tuna, *Thunnus albacares*, caught by longlining in the western tropical Pacific were analyzed to examine their foods and to compare their feeding behavior. The food species of both bigeye and yellowfin tunas were primarily fishes, crustaceans, and cephalopods. A total of 15 fish, 6 crustacean, and 1 cephalopod species were identified from their stomach contents, of which lantern fish (*Myctophum* sp.) was the most important food for both tuna species. No significant differences in species composition of food items between bigeye and yellowfin tunas were observed, indicating that in the same habitat the tunas have a similar feeding behavior. However, while they showed a remarkable similarity in diet composition, significant quantitative differences on the basis of IRI values were observed in several diet species, such as Myctophidae, Alepisauridae, Oplophoridae, Gammaridae, and Onychoteuthidae.**

**Key words :** stomach content, bigeye tuna, yellowfin tuna, lantern fish, index of relative importance (IRI), catch per unit effort (CPUE)

## Introduction

It is well known that food availability is a key factor in determining the abundance and distribution of tunas as a top predator in the pelagic layer of the world oceans. To study the diets and feeding habits of tunas, examination of stomach contents has been carried out since the 1950s. Tuna species previously investigated for feeding ecology were the primary market tunas including yellowfin, *Thunnus albacares*, skipjack, *Katsuwonus pelamis*, bigeye, *Thunnus obesus*, and bluefin tuna, *Thunnus thynnus* (Reintjes and King, 1953; King and Ikehara, 1956; Watanabe, 1958; Alverson, 1963; Nakamura, 1965; Magnuson, 1969; Dragovich, 1970; Dragovich and Potthoff, 1972; Perrin et al., 1973; Kornilova, 1980; Valle et al., 1980; Borodulina, 1982; Manoch and Mason, 1983; Ankenbrandt, 1985; Olson and Boggs, 1986; Pelczarski, 1988; Eggleston and Bochenek, 1989; Roger, 1994), which were caught by various fishing gear types.

Among these species of tunas, bigeye tuna as one of the dominant species in commercial catches by longlining have not been dealt with frequently in feeding studies. Especially, for those occurring in the western Pacific Ocean, the major Korean tuna fishing ground, comprehensive qualitative and quantitative analyses on food items and feeding habits of the tuna have rarely been conducted. Watanabe (1958) described the stomach contents of bigeye tuna in the western equatorial Pacific, but his research was rather qualitative than quantitative. On the other hand, King and Ikehara (1956) described in detail the food species of bigeye and yellowfin tunas caught in the Central and Eastern Pacific. Comparisons of the results between the two researches indicated that diet compositions of the both species were quite different due to different sampling area and season, but both studies observed that fishes, crustaceans, and cephalopods comprised the three major categories of the food for the tunas.

In this paper, we report the food species found in the stomachs of bigeye and yellowfin tunas caught by longlining in the western tropical Pacific. Since these two tuna species are known to aggregate together over wide habitat range, we compare their diets and discuss the relative importance of different food organisms.

## Materials and Methods

All tunas sampled for the present study were caught by longlining during the observer trip by a researcher of the National Fisheries Research and Development Institute (NFRDI) aboard Korean commercial tuna longliners in June 1993 in the western tropical Pacific. The sampling area (Fig. 1) was located between longitudes of 2°38'

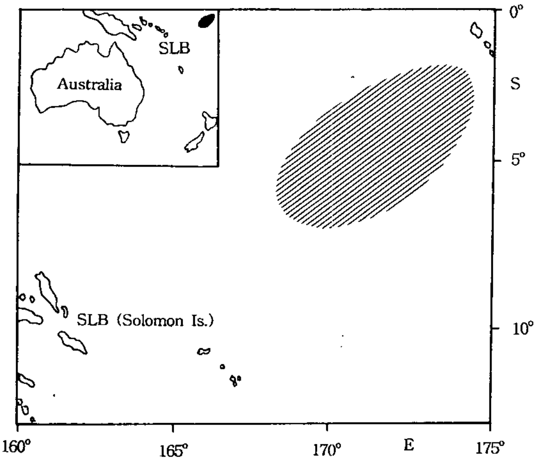



**Fig. 1. Map showing the sampling location in the western tropical Pacific tuna ground.**

and 6°19'S, and latitudes of 168°47' and 173°24'E, northwest to the Solomon Islands.

A total of 170 stomachs of bigeye tuna and 181 stomachs of yellowfin tuna were examined. Date of capture, number and size of these tunas are indicated in Table 1. Upon hauled aboard, stomachs were removed immediately and put into individual plastic bags labelled for species name, date and time, and sampling location. The stomach samples were frozen immediately at −60℃ for the later study. In the laboratory, the stomachs were thawed over night before examination. Stomachs were then opened, excess water drained off and wet weight of each food item weighed.

Stomach contents were identified under dissecting microscope to the lowest taxonomic category possible. The food species which were too digested to classify or the small fragments which remained were classified as unidentified. Bait used to catch the tunas was not included in the list of prey items found and thus stomachs containing the bait only were treated as empty. Of the stomachs examined, 132 (42 bigeye and 90 yellowfin) contained longline bait only and thus not included in the analysis of stomach contents. These stomachs accounts for about 38% of the total stomachs examined.

The index of relative importance (IRI) was used to determine the importance of each food item based on number, percent frequency of occurrence and percent of weight:

**Table 1. Date of capture, number and size of 351 tunas used for stomach content analysis**

| Date | Number of tunas sampled | Range of Fork length (cm) |
|---|---|---|
| June 2. | B: 5 | 110~143 |
| | Y: 2 | 109~115 |
| June 3. | B: 15 | 108~141 |
| June 4. | B: 19 | 84~157 |
| | Y: 4 | 110~138 |
| June 5. | B: 5 | 112~138 |
| | Y: 1 | 120 |
| June 6. | B: 14 | 112~166 |
| | Y: 3 | 93~105 |
| June 7. | B: 7 | 116~146 |
| | Y: 24 | 94~140 |
| June 8. | B: 8 | 74~149 |
| | Y: 14 | 80~142 |
| June 9. | B: 4 | 74~164 |
| | Y: 8 | 96~158 |
| June 11. | B: 10 | 113~140 |
| | Y: 19 | 72~147 |
| June 13. | B: 12 | 82~151 |
| | Y: 23 | 99~157 |
| June 14. | B: 14 | 108~143 |
| | Y: 5 | 90~36 |
| June 15. | B: 5 | 105~153 |
| | Y: 10 | 74~139 |
| June 16. | B: 9 | 117~152 |
| | Y: 12 | 87~147 |
| June 17. | B: 10 | 113~141 |
| | Y: 19 | 92~148 |
| June 18. | B: 20 | 112~148 |
| | Y: 20 | 86~153 |
| June 19. | B: 9 | 111~155 |
| | Y: 9 | 106~145 |
| June 20. | B: 4 | 114~129 |
| | Y: 8 | 110~137 |

B: bigeye tuna Y: yellowfin tuna

$$IRI=(N+W)F$$

where N=percent number, W=percent weight, and F=percent frequency of occurrence (Olson, 1982).

To investigate the relationship between the size of tunas and their prey, they were grouped into four age classes: ~118 cm (up to age 3), 119~135 cm (age 4), 136~148 cm (age 5), and 149 cm~ (age 6+) for bigeye, ~97 cm (up to age 2), 98~123 cm (age 3), 124~143 cm (age 4), and 144cm~ (age 5+) for yellowfin tuna (Table 2).

For the comparision of vertical distribution between bigeye and yellowfin tunas, catch per unit effort (CPUE),

**Table 2. Comparisons between bigeye and yellowfin tuna stomach contents by weight**

| Species | FL (cm) | Age (years) | Number | TBW (kg) | TSCW (g) | SCWB (g/kg) | SCWF (g/fish) |
|---|---|---|---|---|---|---|---|
| Bigeye | ~118 | 3 | 47 | 879 | 5,621.6 | 6.4 | 119.6 |
| | 119~135 | 4 | 49 | 2,068 | 9,234.0 | 4.5 | 188.4 |
| | 136~148 | 5 | 25 | 1,332 | 4,424.0 | 3.3 | 177.0 |
| | 149~ | 6 | 7 | 581 | 1,943.5 | 3.3 | 277.6 |
| Yellowfin | ~ 97 | 2 | 17 | 196 | 736.4 | 3.8 | 43.3 |
| | 98~123 | 3 | 28 | 514 | 2,423.0 | 4.7 | 86.5 |
| | 124~143 | 4 | 39 | 1,341 | 2,615.0 | 2.0 | 67.1 |
| | 144~ | 5 | 7 | 302 | 970.0 | 3.2 | 138.6 |

FL : fork length, TBW : total body weight, TSCW : total stomach content weight, SCWB : stomach content weight per body weight, SCWF : stomach content weight per fish

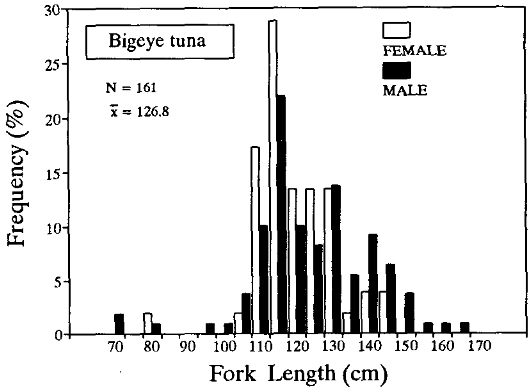
expressed in number of fish caught per 100 hooks, by fishing depth was calculated. The number of fishing hooks used each day ranged from 1100 to 2090 hooks during the study period. The depth of hooks was estimated according to Yoshihara's method (1951). No attempt has been made to apply statistical tests of significance to the data obtained for the present study.

## Results

The sample of bigeye and yellowfin tunas used in this study consisted of 52 males and 109 females (9 were unable to be distinguished), and 70 males and 105 females (6 were unable to be distinguished), respectively. The sampled fish varied in size ranging from 74 cm to 166 cm (mean 126.8 cm) in fork length for bigeye and from 72 cm to 158 cm (mean 117.9 cm) for yellowfin tuna (Fig. 2). In both species, females were generally smaller than males. Since no differences in diet composition between males and females were observed, we presented the results of stomach content analyses for both sexes combined.

As shown in Fig. 3, the food species of both the bigeye and yellowfin tunas were mainly fishes, crustaceans and cephalopods, of which the first was predominant food type comprising 90.9% of the total stomach content weight in bigeye and 80.6% in yellowfin. Cephalopods comprised 6.1% in bigeye and 17.8% in yellowfin, and crustaceans 3.1% and 1.6%, respectively.

Table 2 shows stomach content weight of the both species by age classes. For both species, there was a tendency to increase in the stomach content weight with the increase in the size of tuna. In contrast, the stomach content weight per unit of body weight decreased with the size of the tuna, but this was not obvious for yellowfin. The weight of food contents was remarkably different between the two species. Mean weight of stomach conte-



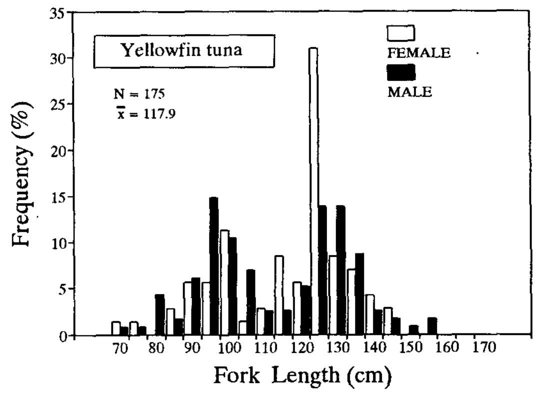




**Fig. 2. Size frequency distribution of bigeye and yellowfin tunas from which stomach samples were taken.**

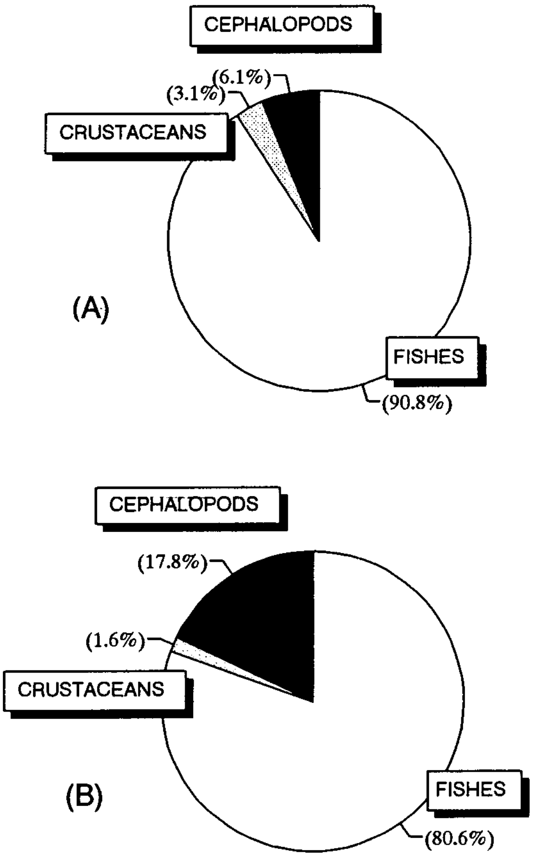



**Fig. 3. Diet composition (in weight) by major prey types in bigeye (A) and yellowfin tuna (B).**

nts in bigeye tuna was 190.7 g and in yellowfin tuna 83.9 g, indicating that bigeye feed voraciously compared to yellowfin. In addition, the mean weight of stomach content per unit of body weight of bigeye was also significantly higher than that of yellowfin.

Tables 3 and 4 are detailed lists of all food items found in stomachs of bigeye tuna and yellowfin tuna, respectively. Each food item was analyzed in terms of frequency of occurrence, number, weight and IRI values.

### Fishes

Fishes occurred most frequently in the diet of both species of tunas; 98.4% stomachs of bigeye and 95.6% stomachs of yellowfin tunas. They belong to 15 families, of which 7 were identified to the species level. Among the 15 families only a few made up, by weight, an important portion of the stomach contents of the both species; these were Myctophidae, Alepisauridae, Anotopteridae, Sternoptychidae, Trichiuridae, and Scombridae. The families Gempylidae and Bramidae were observed exclusively in bigeye tuna, while Ostraciidae and Exocoetidae in yellowfin tuna.

The *Myctophum sp.*, called lantern fishes, from the family Myctophidae was predominant in terms of number and weight, which give the highest IRI value of 67.1% among all stomach contents. The same species was also the most important food item in yellowfin with lower IRI value of 44.1%.

For the both tuna species, the second and the third most important fish species in the order of their IRI values were from the family Alepisauridae (lancet fish) and Stenoptychidae (hatchet fishes), respectively. The lancet fish was encountered over half of the stomachs of the both species and this gives higher percent of occurrence than lantern fishes in yellowfin. The remaining fish families constituted relatively minor proportion of stomach contents, some of which were found in a single stomach of the tunas, indicating that they were occasionally consumed by the tunas.

The remarkable differences in the taxonomic composition of prey fish between both tuna species were not observed; the prey fish common to both species were 11 out of 15 families. However, quantitatively bigeye tunas have a much higher number of prey fish in their stomachs than yellowfin tuna; 37 fish (or 150.3 g) in bigeye whereas only 14 fish (or 59.1 g) in yellowfin.

### Crustaceans

Crustaceans had the lowest percentage in the food of bigeye and yellowfin tunas in terms of weight. However, they occurred in 79.9% of bigeye tuna and 49.5% of yellowfin tuna stomachs. Most of the crustaceans were shrimps (families Oplophoridae and Penaeidae) and amphipods (family Gammaridae), and small number of crabs (Brachyuria) and lobster (family Nephropidae) were also found, but their importance is negligible (Tables 3 and 4).

Among the crustacean preys, most important one based on the IRI values was the family Oplophoridae in bigeye and the Gammaridae in yellowfin. The family Penaeidae occurred in high numbers in the stomachs of bigeye

**Table 3. Composition of the stomach contents of bigeye tuna by occurrence, number, weight and IRI**

| FOOD ITEM | Occurrence | (%) | Number | (%) | Weight | (%) | IRI | (%) |
|---|---|---|---|---|---|---|---|---|
| Fishes | | | | | | | | |
| Myctophidae | | | | | | | | |
| *Myctophum sp.* | 102 | 79.7 | 3439 | 62.0 | 8835.4 | 41.7 | 8264.9 | 67.1 |
| Alepisauridae | | | | | | | | |
| *Alepisaurus brevirostris* | 81 | 63.3 | 288 | 5.2 | 4665.3 | 22.0 | 1721.8 | 14.0 |
| Sternoptychidae | | | | | | | | |
| *Argyropelecus aculeatus* | 57 | 44.5 | 837 | 15.1 | 1234.5 | 5.8 | 930.1 | 7.6 |
| Anotopteridae | | | | | | | | |
| *Anotopterus pharao* | 23 | 18.0 | 90 | 1.6 | 1719.1 | 8.1 | 174.6 | 1.4 |
| Trichiuridae | | | | | | | | |
| *Benthodesmus sp.* | 15 | 11.7 | 25 | 0.5 | 1003.1 | 4.7 | 60.8 | 0.5 |
| Nemichthyidae | 14 | 10.9 | 20 | 0.4 | 27.4 | 0.1 | 5.5 | 0.0 |
| Gempylidae | 2 | 1.6 | 8 | 0.1 | 124.8 | 0.6 | 1.1 | 0.0 |
| Balistidae | | | | | | | | |
| *Monacanthus sp.* | 1 | 0.8 | 1 | 0.0 | 26.2 | 0.1 | 0.1 | 0.0 |
| Carangidae | 1 | 0.8 | 1 | 0.0 | 216.3 | 1.0 | 0.8 | 0.0 |
| Scombridae | 3 | 2.3 | 5 | 0.1 | 279.9 | 1.3 | 3.2 | 0.0 |
| Berycidae | 1 | 0.8 | 2 | 0.0 | 94.0 | 0.4 | 0.3 | 0.0 |
| Engraulididae | | | | | | | | |
| *Engraulis australis* | 2 | 1.6 | 2 | 0.0 | 19.6 | 0.1 | 0.2 | 0.0 |
| Bramidae | | | | | | | | |
| *Brama japonica* | 3 | 2.3 | 3 | 0.1 | 64.8 | 0.3 | 0.9 | 0.0 |
| Unidentified fishes | 45 | 35.2 | | | 933.5 | 4.5 | | |
| Crustaceans | | | | | | | | |
| Oplophoridae | 74 | 57.8 | 542 | 9.8 | 518.7 | 2.4 | 705.2 | 5.7 |
| Penaeidae | 16 | 12.5 | 67 | 1.2 | 81.1 | 0.4 | 20.0 | 0.2 |
| Gammaridae | 12 | 9.4 | 26 | 0.5 | 8.2 | 0.0 | 4.7 | 0.0 |
| Nephropidae juvenile | 3 | 2.3 | 4 | 0.1 | 5.5 | 0.0 | 0.2 | 0.0 |
| Phyllosoma larvae | 2 | 1.6 | 4 | 0.1 | 9.2 | 0.0 | 0.2 | 0.0 |
| Brachyuria | 1 | 0.8 | 1 | 0.0 | 0.8 | 0.0 | 0.0 | 0.0 |
| Unidentified crab larvae | 1 | 0.8 | 8 | 0.1 | 4.7 | 0.0 | 0.1 | 0.0 |
| Unidentified shrimps | 11 | 8.6 | | | 22.9 | 0.1 | | |
| Cephalopods | | | | | | | | |
| Onychoteuthidae | 68 | 53.1 | 143 | 2.6 | 1098.5 | 5.2 | 414.2 | 3.4 |
| Unidentified octopuses | 19 | 14.8 | 28 | 0.5 | 133.6 | 0.6 | 16.3 | 0.1 |
| Unidentified squids | 7 | 5.5 | | | 49.7 | 0.2 | | |
| Total | 128 | 100 | 5544 | 100 | 21176.8 | 100 | 12325.2 | 100 |

tuna but was found in a single stomach of yellowfin tuna. Crustaceans occurred more frequently than cephalopods but their quantitative importance is lower because of their relatively small size. The number of crustaceans observed per stomach in bigeye was much smaller than in yellowfin.

### Cephalopods

Cephalopods, consisted primarily of squids and octopuses, occurred in 61.7% of bigeye and 59.3% of yellowfin tuna stomachs (Tables 3 and 4). However, the identification of this prey type to lower taxonomic category was particularly difficult since many external features are easily digested. Therefore, we could identify only one family of cephalopod, the Onychoteuthidae, which considered as the most important cephalopod item in both species of tunas. Squids of this family were encountered in more than half of the stomachs of the both species. Es-

**Table 4. Composition of the stomach contents of yellowfin tuna by occurrence, number, weight and IRI**

| FOOD ITEM | Occurrence | (%) | Number | (%) | Weight | (%) | IRI | (%) |
|---|---|---|---|---|---|---|---|---|
| Fishes | | | | | | | | |
| Myctophidae | | | | | | | | |
| *Myctophum sp.* | 37 | 40.7 | 753 | 46.9 | 1930.5 | 28.6 | 3072.9 | 44.1 |
| Alepisauridae | | | | | | | | |
| *Alepisaurus brevirostris* | 48 | 52.7 | 237 | 14.8 | 1316.0 | 19.5 | 1807.6 | 26.0 |
| Sternoptychidae | | | | | | | | |
| *Argyropelecus aculeatus* | 23 | 25.3 | 96 | 6.0 | 410.6 | 6.1 | 306.1 | 4.4 |
| Anotopteridae | | | | | | | | |
| *Anotopterus pharao* | 15 | 16.5 | 35 | 2.2 | 409.6 | 6.1 | 137.0 | 2.0 |
| Scombridae | 12 | 13.2 | 73 | 4.5 | 327.3 | 4.9 | 124.1 | 1.8 |
| Trichiuridae | | | | | | | | |
| *Benthodesmus sp.* | 5 | 5.5 | 52 | 3.2 | 138.7 | 2.1 | 29.2 | 0.4 |
| Balistidae | | | | | | | | |
| *Monacanthus sp.* | 8 | 8.8 | 9 | 0.6 | 52.5 | 0.8 | 12.3 | 0.2 |
| Engraulididae | | | | | | | | |
| *Engraulis australis* | 5 | 5.5 | 10 | 0.6 | 54.5 | 0.8 | 7.7 | 0.1 |
| Carangidae | 1 | 1.1 | 1 | 0.1 | 26.5 | 0.4 | 0.6 | 0.0 |
| Ostraciidae | | | | | | | | |
| *Lactoria diaphana* | 5 | 5.5 | 6 | 0.4 | 9.9 | 0.1 | 2.8 | 0.0 |
| Exocoetidae | | | | | | | | |
| *Danichthys cribrosus* | 1 | 1.1 | 4 | 0.2 | 87.7 | 1.3 | 1.7 | 0.0 |
| Nemichthyidae | 1 | 1.1 | 1 | 0.1 | 0.8 | 0.0 | 0.1 | 0.0 |
| Berycidae | 1 | 1.1 | 1 | 0.1 | 24.1 | 0.4 | 0.6 | 0.0 |
| Unidentified fishes | 26 | 28.6 | | | 647.8 | 9.6 | | |
| Crustaceans | | | | 13.3 | | 1.5 | | 5.3 |
| Gammaridae | 38 | 41.8 | 83 | 5.2 | 21.3 | 0.3 | 229.9 | 3.3 |
| Oplophoridae | 14 | 15.4 | 72 | 4.5 | 48.5 | 0.7 | 80.1 | 1.2 |
| Penaeidae | 1 | 1.1 | 3 | 0.2 | 2.6 | 0.0 | 0.2 | 0.0 |
| Brachyuria | 4 | 4.4 | 5 | 0.3 | 4.5 | 0.0 | 1.3 | 0.0 |
| Nephropidae juvenile | 4 | 4.4 | 4 | 0.2 | 1.0 | 0.0 | 0.9 | 0.0 |
| Phyllosoma larvae | 3 | 3.3 | 3 | 0.2 | 5.7 | 0.1 | 1.0 | 0.0 |
| Unidentified crab larvae | 18 | 19.8 | 42 | 2.6 | 17.3 | 0.3 | 57.4 | 0.8 |
| Unidentified shrimps | 2 | 2.2 | | | 7.6 | 0.1 | | |
| Cephalopods | | | | 7.1 | 17.8 | | | 15.7 |
| Onychoteuthidae | 47 | 51.6 | 108 | 6.7 | 937.9 | 13.9 | 1063.0 | 15.3 |
| Unidentified octopuses | 7 | 7.7 | 7 | 0.4 | 194.8 | 2.9 | 25.4 | 0.4 |
| Unidentified squids | 10 | 11.0 | | | 66.7 | 1.0 | | |
| Total | 91 | 100.0 | 1635 | 100.0 | 6744.4 | 100.0 | 6961.9 | 100 |

pecially, the Onychoteuthidae appeared to be the third most important diet item in yellowfin tuna and formed a more important part of yellowfin diet than that of bigeye. The remaining octopuses and squids occurred in very small quantities in both tuna species. The number of specimens encountered in stomachs of the tunas was similar in both species.

### Relationship between the size of tunas and their prey

Fig. 4 illustrates the relationship between the size of tunas and IRI values (%) of the three food types, i.e. fishes, crustaceans and cephalopods. Fishes made up the most important part of the diets of both tuna species. Following fishes, crustaceans appeared to be the second most important diet to bigeye, while they formed the least important part of the yellowfin diet.

The percentage of crustaceans increased progressively with the increase in size in the small to medium size

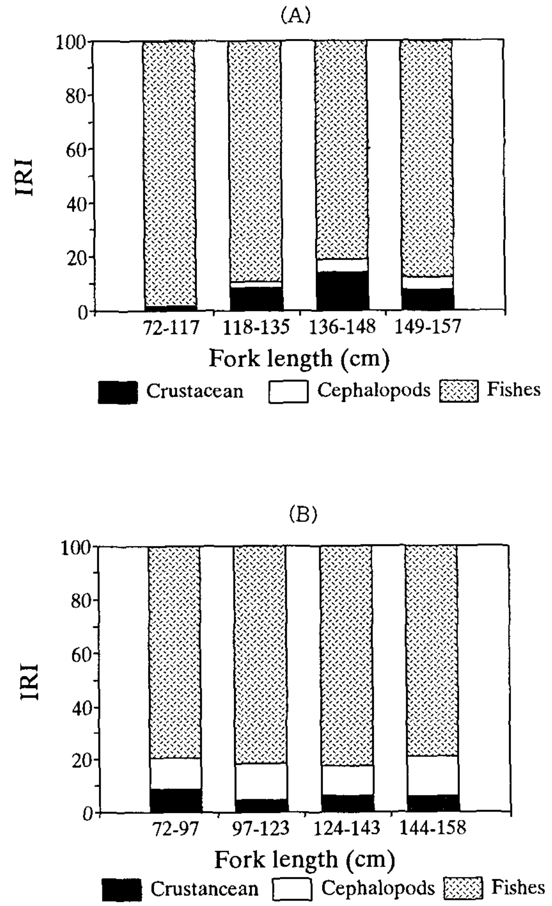



**Fig. 4. Changes in IRI values of major prey types consumed by each size class of bigeye (A) and yellowfin tunas (B).**

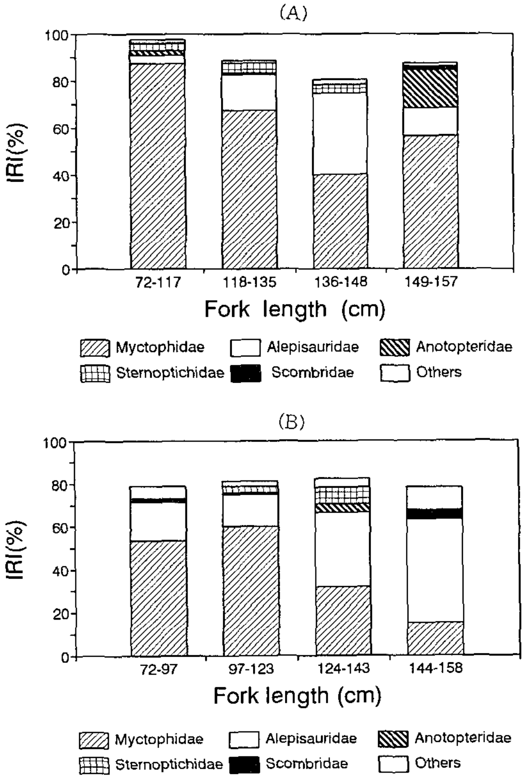



**Fig. 5. Changes in IRI values of major fish species consumed by each size class of bigeye (A) and yellowfin tunas (B).**

classes (72~117 cm, 118~135 cm and 136~148 cm) of bigeye. The percentage of cephalopods also increased with the size, while that of fishes decreased in three size classes. In contrast, predation by yellowfin tuna on crustaceans and cephalopods did not increase with increasing fish size, and food share of the three categories in yellowfin tuna was fairly constant throughout all the size classes.

Fig. 5 shows the changes in IRI values (%) of major prey fish species by each size class of the tunas. The lantern fish (family Myctophidae) constituted the most important part of bigeye diets. In the small to medium size classes of bigeye, the increasing percentage of lancet fish (family Alepisauridae) was apparent with the increase in fish size. The daggertooth (family Anoptoteridae) appeared to be the second most important diet in the large size of bigeye (149~157 cm) but this species was almost absent in the other three size classes.

Yellowfin showed somewhat different figure from bigeye; in the first two size classes of yellowfin lantern fishes were dominant followed by lancet fish, but the contrary may be said for the next two size classes.

## Vertical Distribution of bigeye and yellowfin tuna

Fig. 6 presents catch per unit effort (CPUE) of the tunas observed by depth in the western tropical Pacific fishing grounds. The tunas were fished by longlining at depths of about 170 m to 290 m. After setting, longline hauling took about 12 hours from around 1 pm through 1 am, and about 40% of fish hooked were hauled aboard from 6 to 9 pm. CPUEs of bigeye and yellowfin varied by depth, but the pattern of the change was opposite each other; bigeye CPUE was 0.1 fish/100 hooks at 140m and increased with depth to 1.4 fish/100 hooks at 260 m, while yellowfin CPUE decreased with water depth from 1.9 fish/100 hooks at 170 m

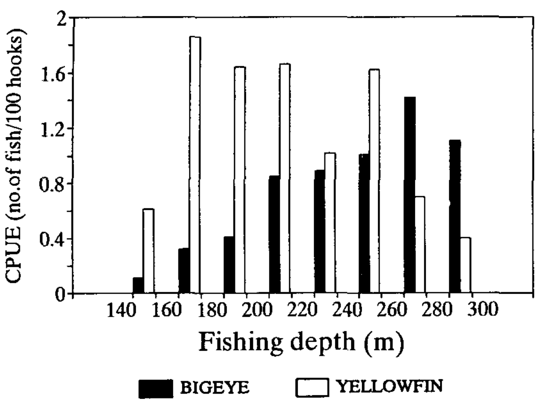



**Fig. 6. Changes in CPUEs (number of fish/100 hooks) of bigeye and yellowfin tunas by fishing depth.**

to 0.4 fish/100 hooks at 290 m.

## Discussion

Both species of tunas appeared to utilize a variety of food, which maght be classified into the three major categories including fishes, cephalopods and crustaceans, of which the first one constituted the bulk of the stomach contents. These results are consistent with those published earlier by Watanabe (1958), but comprehensive quantitative comparisons between the present study and previous research were difficult since Watanabe's study was rather qualitative than quantitative. Taxonomic differences in diets between the two studies were also observed. According to Watanabe (1958), the most important fish families observed in the stomachs of bigeye and yellowfin tunas were Acinaeidae and Chiasmodontidae, which were not found in the present study at all. King and Ikehara (1956) indicated that food items of major importance to both species of tunas caught in the Central and Eastern Pacific were pomfret (family Bramidae) and snake mackerel (family Gempylidae), but only few individuals of these species were found in our study. The lantern fish from the family Myctophidae was the most important diet among all stomach contents observed by us, but in the previous research this fish was either not observed at all or listed as a diet of minor importance. This taxonomic difference in food composition between our study and previous research may be partially explained by the different sampling area and time of the year. Comparatively shorter sampling period might have also caused the difference, in addition with lower diversity of fish species preyed upon by tuna. While only 15 families were represented in the present study carried out for one month, 48 and 39 fish families were reported by King and Ikehara (1956) and Watanabe (1958), respectively, in their research conducted for about 3 years. It has been suggested that the food of tunas depend on the distribution of prey and vary by region and by time of the year (Watanabe, 1958 and Borodulina, 1982).

As previous research recognized, bigeye and yellowfin tunas seem to eat animal materials whatever available around them and thus no significant differences in species composition of food items between the two species were observed. The only taxonomic difference observed is that the Gempylidae and Bramidae exclusively occurred in bigeye tunas and the Ostraciidae and Exocoetidae in yellowfin tunas. While they showed a remarkable similarity in diet composition, significant quantitative differences between the two tuna species on the basis of IRI values were observed in several diet specie such as Myctophidae, Alepisauridae, Oplophoridae, Gammaridae, and Onychoteuthidae. The most important five food items of bigeye tuna in the order of their IRI values were Myctophidae, Alepisauridae, Sternoptychidae, Oplophoridae, and Onychoteuthidae. However, in yellowfin tuna the Onychoteuthidae was ranked for the third most important diet and the Gammaridae for the fifth, which was quantitatively negligible in bigeye tuna. In addition, bigeye tuna devoured twice more food than yellowfin of the corresponding size, which is not consistent with the results obtained by Pelczarski (1988) from tunas caught in the Atlantic. The reason that bigeye tuna appeared to be more voracious consumers compared to yellowfin is not clear from the results of the present study. However, it is assumed that bigeye might require more energy for swimming into deeper water layers relative to yellowfin (Holland et al.,1990; Boggs, 1992), which is supported by the CPUE results of our study, and they may have more chance to prey on vertically migrating fish species, such as lantern fishes, at night when they move up to the subsurface (Roger and Grandperrin, 1976; Collette and

Nauen, 1983; Roger, 1994). In our study, bigeye consumed three times more lantern fishes than yellowfin. The lower number of lantern fish in the stomachs of yellowfin may be explained by the feeding behavior of this species during daytime, indicating that yellowfin tuna feed more actively in the daytime than at night, which is supported by other researches (Watanabe, 1958; Roger and Grandperrin, 1976; Collette and Nauen, 1983). Alternatively, the reproductive state of tuna should also be considered in association with their feeding habits as suggested by Itano (1996) in the yellowfin study.

In both species of tunas, the larger fish contained more food in their stomachs than the smaller one and ontogenetic changes in their diet composition were also observed. However, since the results of our study were based on relatively small sample size during the short-term sampling period, further studies with long-term sampling protocol would be necessary for unbiased results in feeding habits of the tunas and to clarify seasonal changes in food composition of the tunas in the western tropical Pacific. The information obtained from the current research, including major food items which might be used to determine where feeding concentrations of tunas occur, would be useful to fishermen for more effective fishing operations of tunas.

## Acknowledgements

We thank to the crew members of Haengbok 513 for their assistance in collecting stomach samples during the observer trip.

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Received March 11, 1997
Accepted September 2, 1997

# 서부 열대 태평양의 눈다랑어와 황다랑어의 먹이에 관한 연구

김종빈 · 문대연 · 권정노 · 김태익 · 조현수
국립수산진흥원 원양자원과

눈다랑어와 황다랑어의 먹이의 종류와 섭이 습성을 비교하기 위하여 서부 열대 태평양에서 연승어업으로 어획된 이들 다랑어의 위내용물을 조사하였다. 눈다랑어와 황다랑어의 먹이는 주로 어류, 두족류, 갑각류이었다. 이들 두 종의 다랑어에서 동정된 먹이생물의 총 종수는 어류가 15종, 갑각류 6종 그리고 두족류가 1종이었으며 그 중 가장 중요한 먹이는 샛비늘치류인 Myctophum sp였다. 황다랑어와 눈다랑어의 먹이를 분석해본 결과 먹이의 종류에 있어서는 두 종간에 큰 차이가 없었으며 이것으로 보아 같은 해역에 서식하는 다랑어류는 먹이 습성이 유사함을 알 수 있었다. 그러나, 먹이 가운데 몇몇 종(Myctophidae, Alepisauridae, Oplophoridae, Gammaridae, and Onychoteuthidae)의 경우 그 중요도에 있어서 두 다랑어간에 현저한 차이를 보였다.