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# FOOD HABITS OF BAIT-CAUGHT SKIPJACK TUNA, *KATSUWONUS PELAMIS*, FROM THE SOUTHWESTERN ATLANTIC OCEAN

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## ABSTRACT

Stomach contents of skipjack tuna captured in 1981-82 by live pole-and-line vessels off the southern coast of Brazil were analyzed for the presence of larval and juvenile skipjack tuna. The percentage frequency of occurrence, percent number, and percent volume were evaluated. Of the 1,041 stomachs that were examined for food, 436 were empty. The mean volume of food in all stomachs analyzed was 36.9 mL, of which 18.9 mL was bait and 18.0 mL was prey.

The gonostomatid *Maurolicus muelleri* and the euphausiid *Euphausia similis* were the principal foods. Other important foods were the chub mackerel, *Scomber japonicus*; the frigate tuna, *Auxis thazard*; gempylids; trichiurids; and carangids. In the study area, adult skipjack tuna were not found to feed on their young.

Kruskall-Wallis nonparametric one-way analysis of variance was used to test for differences in the mean volumetric ratios of food items in relation to skipjack size. The percentage of *E. similis* in the diet was found to decrease, while the proportion of *M. muelleri* was found to increase with increasing skipjack size. Seasonal variations in the diet were also examined and discussed.

Apparently the anatomy of their gill raker apparatus allows skipjack to ingest a wide variety of prey types above a minimum size. These variations in the food can be attributed to the number and size of the prey species in an area.


A Brazilian skipjack pole-and-line fishery has been developing in the Rio de Janeiro area since 1979 (Fig. 1). Because skipjack tuna, *Katsuwonus pelamis*, is one of the major tuna species harvested at maximum sustainable yield in the tropical and subtropical oceans (Kearny 1976; Evans et al. 1981), estimation of the fishery potential requires information on the distribution and concentration of its spawning stock. One technique used to determine the existence of a spawning stock is to quantify the distribution of its larvae. Obviously, the presence of large numbers of larvae would indicate a spawning stock occupies an area.

Knowledge of the distribution and abundance of juvenile skipjack tuna is limited. Occasionally, specimens have been found in experimental plankton hauls or in the stomachs of apex predators (Kearny 1976). From ichthyoplankton surveys, Matsuura (1982) and Nishikawa et al. (1978) reported larvae in warm tropical waters north of the study area (Fig. 1), and juvenile skipjack tuna have been found in the stomachs of adult skipjack tuna captured off west Africa and in the Caribbean (Suarez-Caabro and Duarte-Bello 1961; Klawe 1961; Dragovich 1970; Dragovich and Potthoff 1972). Their occurrence in the diet of central and south Pacific skipjack tuna caught by pole-and-line has been used to deduce their distribution and abundance (Waldron and King 1963; Nakamura 1965; Argue et al. 1983).

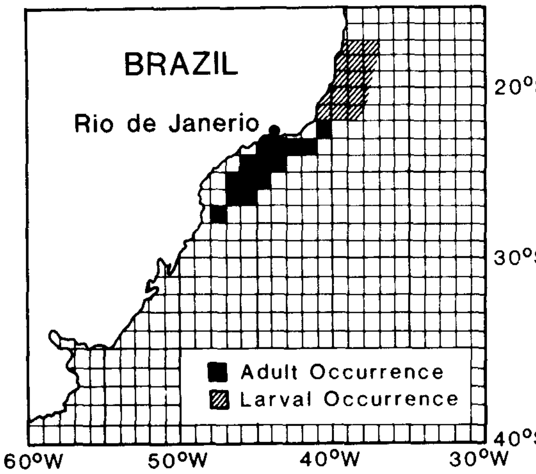


Figure 1.—Solid area indicates fishing localities from where skipjack tuna stomachs were obtained. Hatched area shows larval occurrence (Matsuura 1982).

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Dragovich (1969) reviewed existing information on the food habits of Atlantic skipjack tuna. Since that time food habits have also been reported in studies by Dragovich (1970) and Dragovich and Potthoff (1972) for skipjack from the East and West Atlantic and by Batts (1972) for skipjack in North Carolina waters. Zavala-Camin (1981) examined predator-prey interactions of fishes, including skipjack captured north of the area in this study.

The primary objective of this study was to discover if skipjack tuna feed upon their young. The presence of juveniles in bait-caught skipjack stomachs would verify the study area as a spawning-rearing ground. Knowledge of the prey and their relative importance also contributes to the understanding of prey-predator interactions, which affect population distributions and fluctuations.

## MATERIALS AND METHODS

Stomach samples for this study were collected on a monthly basis from October 1981 to December 1982 from skipjack tuna caught off Rio de Janeiro (Fig. 1). National Marine Fisheries Service (NMFS) personnel collected stomachs from frozen fish transhipped to Puerto Rico, and Superintendencia do Desenvolviemento da Pesca (SUPEDE) personnel sampled fish landed locally in Rio de Janeiro. Fish from the Puerto Rican source were caught within 1 mo prior to sampling; fish from the Brazilian source were sampled 3 to 5 d after the recorded catch date. The sampling design required collecting about 15 stomachs from each 10 cm length group, measured to the nearest cm per month. However, the number of stomachs collected was dependent on the catch-size distribution. Once the stomach was removed from the fish, it was preserved in 10% buffered Formalin[2] and shipped to the Southwest Fisheries Center (SWFC) for analysis.

Stomachs were examined from 1,041 fish between 44 and 81 cm fork length. In the laboratory each stomach was opened. The volume of the food bolus was measured, and the contents were identified to the lowest possible taxon. The taxonomic groupings were then measured by volumetric displacement, and the individuals counted. Whole undigested fish were identified by comparing external characters with those described in published keys or with identified museum specimens from Scripps Institution of Oceanography, La Jolla, CA. Digested animals, particularly juvenile scombrids, were identified by vertebral, gill raker, and fin ray counts, as well as other skeletal characteristics, described by Potthoff and Richards (1970), Miller and Jorgenson (1973), and other published keys. Cephalopods were identified by comparing beak characters with published illustrations, descriptions, and keys (see Wolff 1981). Crustaceans and other invertebrates were identified by specialists from Scripps Institution of Oceanography and SWFC.

The occurrence of bait in the stomachs may have biased the relative importance of fish in the diet. The bait primarily consisted of *Sardinella brasiliensis*, *Harengula jaguana*, and *Engraulis anchoita*; however, other fish families may have been included in the captured bait. The sardines were readily identifiable from their external characters and usually were undigested. The anchovies, in contrast, were often quite digested, creating difficulties in identification. Gary Nelson[3] nevertheless was able to verify these fish as *Engraulis anchoita*. Although the least digested item in the stomach was usually the last meal (bait), stomachs were removed from a few days to 1 mo after capture, and presumably postmortem digestion occurred. As a result, the degree of digestion was not a reliable indication of distinguishing bait from natural prey. The time required for complete gastric evacuation of smelt fed to skipjack tuna is estimated to be 12 h (Magnuson 1969). Although the bait was captured in nets from bays and estuaries (Rinaldo[4]), Matsuura et al. (1978, 1981) have confirmed that a spawning stock of *E. anchoita* does exist in waters inhabited by skipjack tuna. It is unlikely that the sardines served as prey for skipjack. However, I could not distinguish between *E. anchoita* consumed as natural food and as bait. Therefore, although these species were considered bait, some may have been ingested as natural food. Bait was not considered prey, and stomachs containing only these species were treated as empty.

Two methods of analysis were employed to rank the food items in terms of availability and importance to the skipjack tuna:

1) An index of relative importance (*IRI*) was calculated for each prey type in terms of numbers, volumes, and frequencies (Pinkas et al. 1971):

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

[2]Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

[3]G. J. Nelson, Department of Ichthyology, American Museum of Natural History, New York, NY 10024, pers. commun., May 1982.

[4]R. R. Rinaldo, Southwest Fisheries Center La Jolla Laboratory, National Marine Fisheries Service, NOAA, P.O. Box 271, La Jolla, CA 92038, pers. commun., June 1982.

where $N$ = numerical percentage
$V$ = volumetric percentage
$F$ = frequency of occurrence percentage.

2) The mean volumetric ratio measurement (*MVRM*) was used to illustrate the biomass importance of prey items without the numeric exaggeration implicit in the *IRI* (John Hedgepeth[5]). The *MVRM* was calculated from the volumetric analysis of individual stomachs with each prey item contributing to the total stomach volume. *MVRM* for each food type is expressed as

$MVRM = \bar{r}_j \times 100$ = mean volumetric percentage of prey $j$ to the total volume of $n$ stomachs

where $N$ = number of stomachs in a given strata
$V_{i,j}$ = volume of prey type $j$ in stomach $i$

$$V_i = \sum_{j=1}^{6} V_{i,j} = \text{total volume of stomach } i$$

$$r_{i,j} = \frac{V_{i,j}}{V_i} = \text{ratio of prey } j \text{ to the total volume of stomach } i$$

$$\bar{r}_j = \frac{\sum_{i=1}^{n} r_{i,j}}{n} = \text{mean volumetric ratio of prey } j \text{ to the total volume of } n \text{ stomachs.}$$

Both the *IRI* and the *MVRM*, which examine different aspects of the diet, were used to evaluate seasonal variations in skipjack tuna food habits. The *IRI* presents a biased estimate caused by the numerical percentage; the relative importance of small numerous organisms, like euphausiids, is exaggerated in the *IRI* because of their high numbers, when actually they may represent the same food value as a few large fish. The *MVRM* is an expression of frequency of occurrence and volume without a numeric bias, but does not provide any information on prey abundance. The *IRI* contains information on the availability of the prey in the environment in terms of numbers, while the *MVRM* provides an indication of its energetic importance to the fish.

The *MVRM*s were stratified by fish length and annual quarter (Fig. 2), and tested with the Kruskal-Wallis nonparametric one-way analysis of variance to evaluate differences in diet with changes in size.

[5]J. B. Hedgepeth, Southwest Fisheries Center La Jolla Laboratory, National Marine Fisheries Service, NOAA, P.O. Box 271, La Jolla, CA 92038, pers. commun., April 1982.

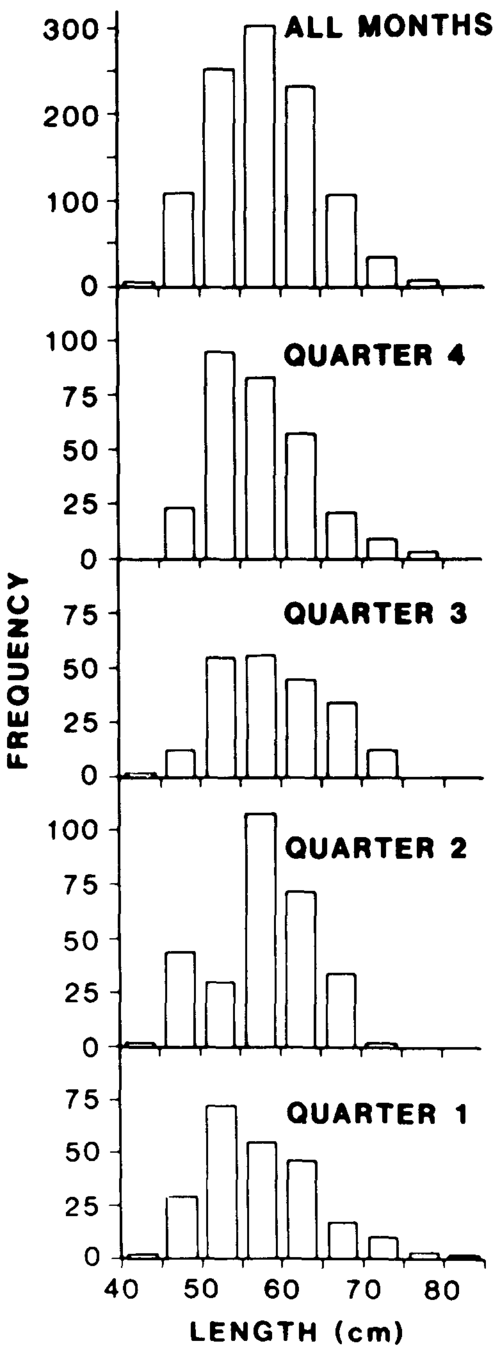


FIGURE 2. - Length-frequency distribution of skipjack tuna from which stomachs were collected.

## RESULTS

### Food Composition

Of the 1,041 stomachs that were examined, 436 were empty. The mean volume of food in all stomachs examined was 36.9 mL, of which 18.9 mL was bait and 18.0 mL was prey. A complete list of the stomach contents in terms of numbers, volume, and frequency is presented in Appendix Table 1. No larval or juvenile skipjack were found in the stomach contents. Overall contributions of each category are presented in Figure 3.

In terms of the *MVRM*, the gonostomatid *Maurolicus muelleri* was the major prey item (*MVRM* = 26.7%). The euphausiid *Euphausia similis*, with the highest *IRI*, was also important (*IRI* = 1,998). These items were major constituents of the diet throughout the year. Other important fishes in terms of both the

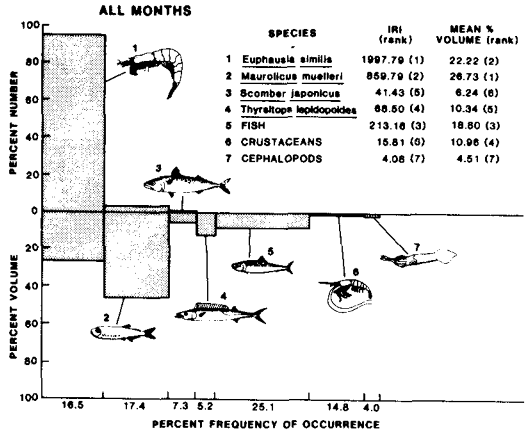


FIGURE 3.—Index of relative importance (IRI) plots for selected food items of skipjack tuna caught during 1982. The food categories are ranked in terms of IRI and MVRM.

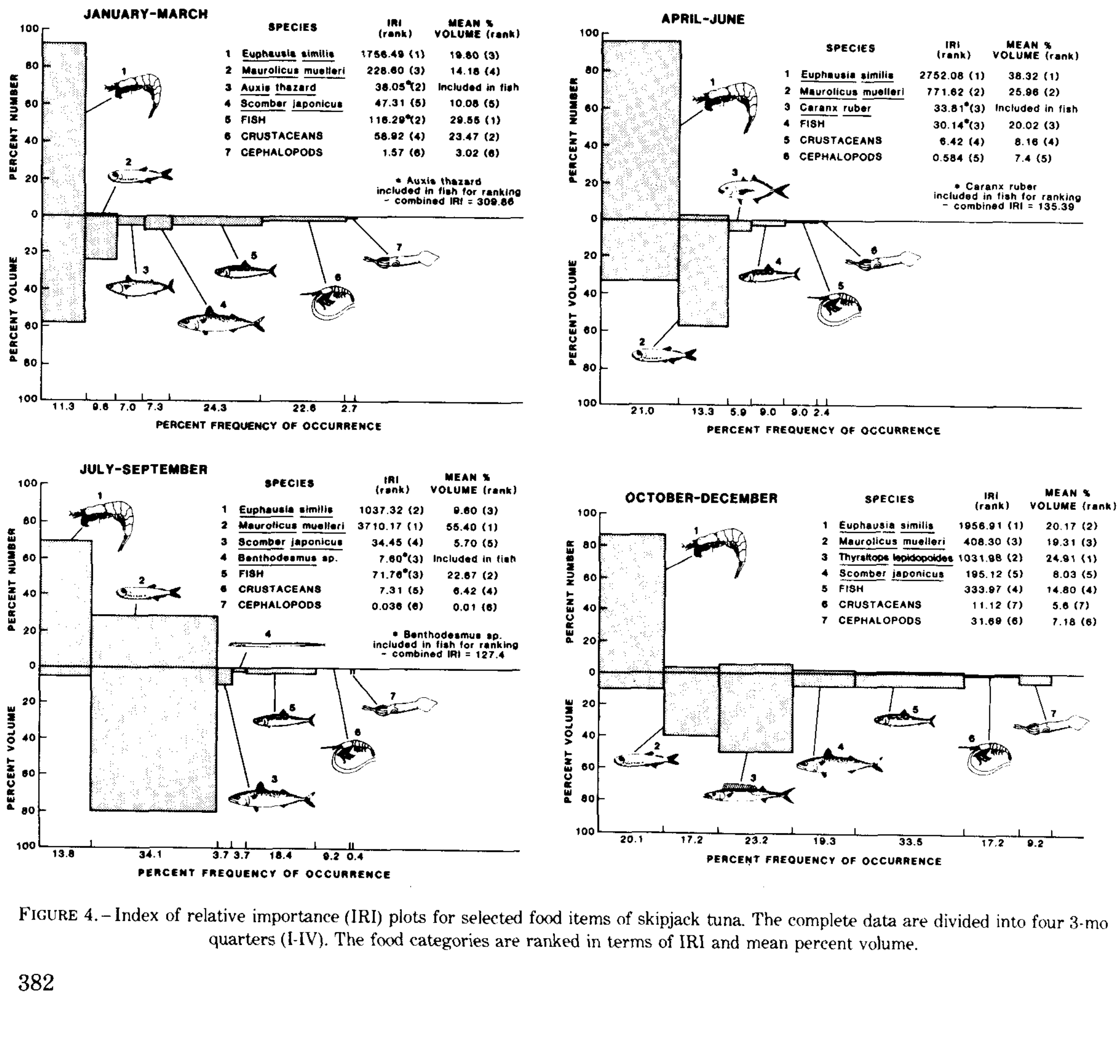


FIGURE 4.—Index of relative importance (IRI) plots for selected food items of skipjack tuna. The complete data are divided into four 3-mo quarters (I-IV). The food categories are ranked in terms of IRI and mean percent volume.

*IRI* and *MVRM* were chub mackerel, *Scomber japonicus*, and *Thyrsitops lepidopoides*[6] (Fig. 3). Crustaceans other than *E. similis* occurred frequently in the stomachs ($F$ = 22.6%), but as a relatively low percentage of the total volume ($V$ = 2.0%). Cephalopods were usually insignificant in the diet (see below). Pteropods, siphonophores, beetles, rocks, and unidentified materials were the constituents of the miscellaneous category (App. Table 1).

## Seasonal Variations

The data were divided into four quarters: January-March 1982 (I), April-June 1982 (II), July-September 1982 (III), October-December 1981 and 1982 (IV). The results (App. Tables 2-6) are illustrated in Figures 4 and 5 both with the *IRI* and the *MVRM* of dominant food items in each quarter. Note that items important in one quarter may be negligible or absent in another. When evaluated in terms of *MVRM*, the prey ranks sometimes did not coincide with those determined by the *IRI* (Figs. 4, 5). Based on the *IRI*, *E. similis* was the dominant food in the first quarter, followed by other fish and *M. muelleri* (Fig. 4). According to the *MVRM*, other fishes, other crustaceans, and *E. similis* were ranked first, second, and third in importance, respectively. The importance of *E. similis* in this quarter based on the *IRI* was exaggerated by their high frequencies of occurrence. *Scomber japonicus* and frigate tuna, *Auxis thazard*, were secondary in importance to *M. muelleri* as the main fish species consumed.

The rankings of the food categories in the second quarter were the same for both the *IRI* and the *MVRM* (Fig. 4). *Euphausia similis* and *M. muelleri* were the dominant food items, followed by *Caranx ruber*.

[6]Identified by Y. Matsuura, Universidade de São Paulo, Instituto Oceanografico, São Paulo, Brazil, October 1984.

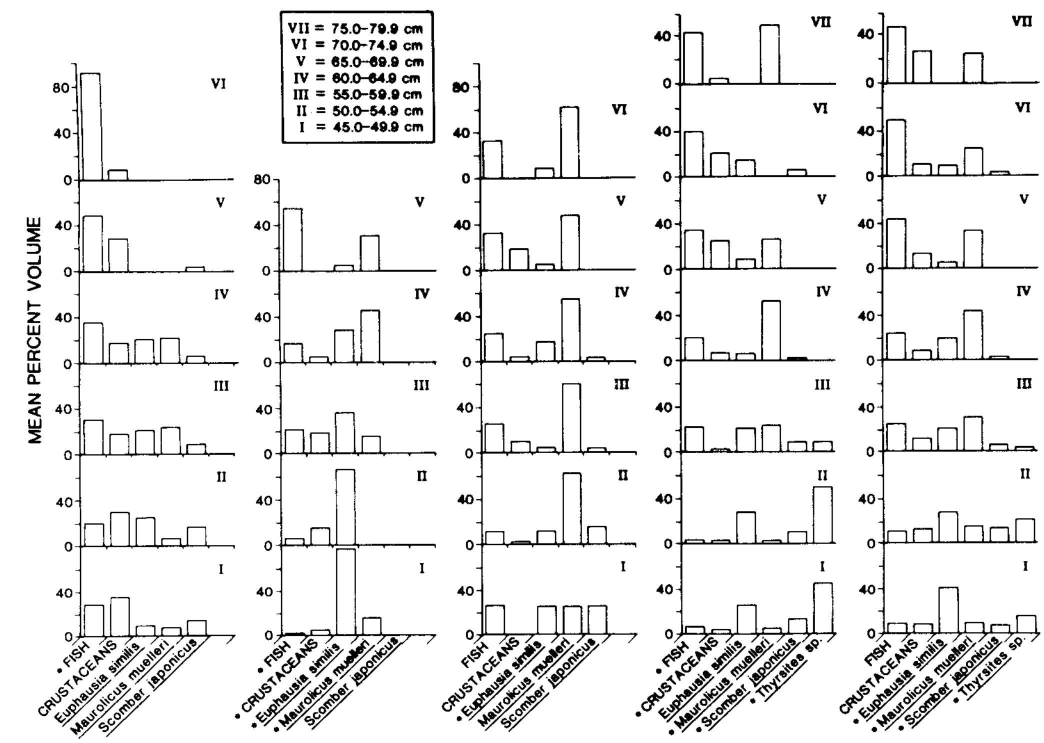


FIGURE 5.—Relative importance based on mean volumetric ratio of selected food items for skipjack tuna grouped by length for each quarter (I-IV) and all months. * indicates a significant difference ($P$ < 0.05) in the mean percent volume of that food item by length when tested with the Kruskal-Wallis nonparametric one-way analysis of variance.

The principal food item in the third quarter based on both measurements was *M. muelleri* (Fig. 4). The ranks for the other items did not correspond. *Euphausia similis* was second in importance according to the *IRI*, but ranked third next to other fish based on the *MVRM*. *Scomber japonicus* and *Benthodesmus* sp. were the predominant species consumed in the fish category.

The *IRI* and *MVRM* ranks in the fourth quarter corresponded with the exception of the principal prey type (Fig. 4). Again, *E. similis* ranked first according to the *IRI*, but *Thyrsitops lepidopoides* was the primary food item based on the *MVRM*. Cephalopods, mainly *Argonauta* sp., were consumed in significant proportions in this quarter (*IRI* = 31.7, *MVRM* = 7.2%).

In summary, *M. muelleri* and *E. similis* predominated in the skipjack tuna diet during all quarters (Fig. 3). With the exception of the second quarter, *S. japonicus* was an important food item. *Benthodesmus* sp., *C. ruber*, *A. thazard*, as well as the cephalopod, *Argonauta* sp., also proved important in specific quarters. The importance of *T. lepidopoides* in Figure 3 was exaggerated by its predominance in the fourth quarter.

## Variations with Size

As might be expected, basic dietary changes occur as the skipjack tuna grow. Nakamura (1965), Alverson (1963), Batts (1972), Dragovich and Potthoff (1972), and Wilson (1982) observed a decrease in the relative importance of crustaceans and an increasing importance of fish in the diet, as the skipjack size increased.

To evaluate the relationship between size and food habits, the skipjack were arbitrarily divided into seven 5 cm groups (Fig. 2). For each prey category the *MVRM*s were stratified by size group and quarter (App. Tables 6-10, Fig. 5). Trends reported in the results for length groups $> 70$ cm may not represent feeding habits of skipjack tuna from the study area because the sample sizes were too small (Fig. 2, App. Table 6).

There were no significant differences ($P < 0.05$) in diet and size in the first quarter except in the amount of other fish consumed (Fig. 5, App. Table 7). The *MVRM* of this category increased from 28.7% in skipjack 45.0-49.9 cm to 91.7% in fish 75.0-79.9 cm.

In the second quarter the proportions of other fish, other crustaceans, *E. similis*, and *M. muelleri* significantly changed with size (Fig. 5, App. Table 8). The larger skipjack tuna ate more fish (*MVRM* = 1.7% in the 45.0-49.9 cm size class to *MVRM* = 54.1% in the 75.0-79.9 cm size class) and more *M. muelleri* (*MVRM* = 15.4% to *MVRM* = 30.3%) than the smaller skipjack. As their size increased, skipjack decreased their consumption of *E. similis* from MVRM = 76.9% to *MVRM* = 4.5%. There was a significant difference between size classes ($P < 0.05$) in the *MVRM* of other crustaceans in the diet, but this difference seemed uncorrelated to increases in size.

In the third quarter there were no significant differences in the diet with increasing size except that the *MVRM* of *E. similis* decreased from 25.0% to 8.0% (Fig. 5, App. Table 9).

*Thyrsitops lepidopoides* was eaten by the smaller skipjack (45-59.9 cm) only in the fourth quarter (Fig. 5, App. Table 10). Although there were significant differences ($P < 0.05$) in the diets between the seven size groups during this period, these differences again seemed unrelated to increasing size.

In summary, when the data on *T. lepidopoides* were included with the rest of the fish data, there were no significant differences between size groups in the proportions of other fish consumed throughout the year (Fig. 5, App. Table 6). The *MVRM* of *E. similis* in the diet decreased from 42.5% in skipjack tuna 45.0-49.9 cm to 0.0% in skipjack 75.0-79.9 cm. There were significant differences in the percentages of *M. muelleri* and *S. japonicus* between the size classes. There were no significant differences in the *MVRM* of other crustaceans with changes in size.

As reported in the studies of the food habits of skipjack tuna referred to above, the stomach contents of skipjack from this area indicated the basic dietary changes associated with increasing size: a significant decrease in the proportion of *E. similis*, the predominant crustacean prey, and an increase in proportion of *M. muelleri*, the predominant fish prey.

# DISCUSSION

Several studies have reported that skipjack tuna feed predominantly on euphausiids and gonostomatids. Dragovich and Potthoff (1972) reported that the gonostomatid *Vinciguerria nimbaria* contributed 44.7% by volume to the diet of skipjack tuna from the Gulf of Guinea. Zavala-Camin (1981) reported *M. muelleri* and euphausiids as dominant food items in 36 stomachs of skipjack caught off Brazil. Alverson (1963) reported skipjack tuna captured in the eastern tropical Pacific fed primarily on euphausiids (47% by volume, in 37% of the stomachs), followed in importance by the gonostomatid *Vinciguerria lucetia* (10% by volume). The abundance of euphausiids in the stomachs of skipjack, compared with larger scombrids, may be a result of smaller gill raker gaps in skipjack (Magnuson and Heitz 1971).

The importance of other fishes as food for western Atlantic skipjack tuna observed in this study has been previously reported. Dragovich (1970) found a predominance of fish in the stomachs of skipjack caught off the eastern United States and the Caribbean. Suarez-Caabro and Duarte-Bello (1961) found that fishes constituted 75% of the total volume, followed by squid (23%) and crustaceans (2%), in the stomachs of Cuban skipjack. Zavala-Camin (1981) observed that fish constituted 38.9%, crustaceans 22.2%, and mollusks 2.8% of the total stomach volume of Brazilian skipjack.

## CONCLUSIONS

The multiplicity of prey found in this as well as other studies indicates that tunas are perhaps nonselective feeders, and stomach contents are probably determined by prey availability (Hotta and Ogawa 1955; Alverson 1963; Batts 1972; Perrin et al. 1973; Argue et al. 1983). Therefore, if the larval and juvenile skipjack were available in significant numbers, then one would expect them to occur in the diet of the adults.

Their absence in the diet was caused by two possible results. First, the young remained among the unidentified portion of the stomach contents; however, skipjack tuna have distinctive vertebral characteristics which were probably not discounted in the analysis (Potthoff and Richards 1970). Second, the adults did not spawn in the study area. Young skipjack should be found in the stomach contents of spawning adults (Argue et al. 1983). Goldberg and Au[7] found no evidence of spawning in skipjack collected from the Brazilian fishery. These results are consistent with the absence of larval and juvenile skipjack in the diet of the adults in this study.

The southernmost distribution boundary for larval skipjack tuna is the 24°C surface isotherm (Argue et al. 1983). Matsuura (1982) found no larval skipjack in ichthyoplankton surveys south of lat. 21°S in this area, where temperatures range from 21° to 24°C (Evans et al. 1981).

These results are consonant with those of Argue et al. (1983); juvenile skipjack tuna were absent from samples of adult stomachs taken in subtropical south Pacific waters. The adult skipjack in this investigation did not feed on their young. The absence of cannabilism suggests that larvae and juveniles were not significantly abundant to serve as forage of the adults, and therefore probably do not occur in this cooler southern water.

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# APPENDIX

APPENDIX TABLE 1.—List of prey items and other ingested materials found in the stomachs of 1,041 skipjack tuna caught off southern Brazil, from October 1981 to December 1982.

| Prey items | Numbers No. | Numbers % | Volume mL | Volume % | Occurrence No. | Occurrence % |
|---|---|---|---|---|---|---|
| Crustacea | | | | | | |
| Stomatopoda | 12.0 | 0.003 | 4.5 | 0.024 | 6.0 | 0.576 |
| Mysidacea | | | | | | |
| Eucopiidae | 220.0 | 0.057 | 42.4 | 0.226 | 22.0 | 2.113 |
| Lophogastridae | 24.0 | 0.006 | 1.7 | 0.009 | 3.0 | 0.288 |
| Isopoda | 1.0 | 0.000 | 0.1 | 0.001 | 1.0 | 0.096 |
| Flabellifera | 7.0 | 0.002 | 2.1 | 0.011 | 7.0 | 0.672 |
| Amphipoda | 22.0 | 0.006 | 1.5 | 0.008 | 2.0 | 0.192 |
| Gammaridea | 16.0 | 0.004 | 5.1 | 0.027 | 10.0 | 0.961 |
| Euphausiidae | 139.0 | 0.036 | 3.9 | 0.021 | 15.0 | 1.441 |
| *Euphausia* sp. | 50.0 | 0.013 | 0.6 | 0.003 | 1.0 | 0.096 |
| *Euphausia similis* | 368,632.0 | 94.785 | 4,895.3 | 26.122 | 172.0 | 16.523 |
| *Stylocheiron* sp. | 1.0 | 0.000 | 0.3 | 0.002 | 1.0 | 0.096 |
| Caridea | 3.0 | 0.001 | 2.3 | 0.012 | 3.0 | 0.288 |
| Macrura | | | | | | |
| Scyllaridae | 1.0 | 0.000 | 0.2 | 0.001 | 1.0 | 0.096 |
| Unid. Phyllosoma larvae | 1.0 | 0.000 | 0.1 | 0.001 | 1.0 | 0.096 |

APPENDIX TABLE 1.— *Continued.*

| Prey items | Numbers No. | Numbers % | Volume mL | Volume % | Occurrence No. | Occurrence % |
|---|---|---|---|---|---|---|
| Brachyura | 5.0 | 0.001 | 0.7 | 0.004 | 1.0 | 0.096 |
| Portunidae | 1.0 | 0.000 | 0.1 | 0.001 | 1.0 | 0.096 |
| Unid. megalops | 102.0 | 0.026 | 32.0 | 0.171 | 27.0 | 2.594 |
| Unid. zooea | 555.0 | 0.143 | 30.2 | 0.161 | 24.0 | 2.305 |
| Unid. Decapoda | 7.0 | 0.002 | 0.6 | 0.003 | 2.0 | 0.192 |
| Unid. Crustacea | 96.0 | 0.025 | 11.0 | 0.059 | 26.0 | 2.498 |
| Mollusca | | | | | | |
| Gastropoda | 1.0 | 0.000 | 0.1 | 0.001 | 1.0 | 0.096 |
| *Cavolina* sp. | 101.0 | 0.026 | 6.0 | 0.032 | 7.0 | 0.672 |
| Cephalopoda | | | | | | |
| Teuthoidea | 4.0 | 0.001 | 26.0 | 0.139 | 4.0 | 0.384 |
| Thysanoteuthidae | 2.0 | 0.001 | 10.0 | 0.053 | 1.0 | 0.096 |
| Ommastrephidae | 35.0 | 0.009 | 55.1 | 0.294 | 18.0 | 1.729 |
| Loliginidae | 2.0 | 0.001 | 10.5 | 0.056 | 2.0 | 0.192 |
| Histioteuthidae | 1.0 | 0.000 | 1.0 | 0.005 | 1.0 | 0.096 |
| Onychoteuthidae | 13.0 | 0.003 | 6.0 | 0.032 | 2.0 | 0.192 |
| Octopoda | | | | | | |
| Argonautidae | | | | | | |
| *Argonauta* sp. | 20.0 | 0.005 | 75.9 | 0.405 | 11.0 | 1.057 |
| Unid. Cephalopoda | 4.0 | 0.001 | 1.3 | 0.007 | 3.0 | 0.288 |
| Insecta | | | | | | |
| Coleoptera | 2.0 | 0.001 | 2.0 | 0.011 | 2.0 | 0.192 |
| Siphonophora | 1.0 | 0.000 | 0.9 | 0.005 | 1.0 | 0.096 |
| Algalmidae | 8.0 | 0.002 | 6.6 | 0.035 | 8.0 | 0.768 |
| Pisces | | | | | | |
| Gonostomatidae | | | | | | |
| *Maurolicus muelleri* | 13,438.0 | 3.455 | 8,619.3 | 45.994 | 181.0 | 17.387 |
| Synodontidae | 8.0 | 0.002 | 16.0 | 0.085 | 3.0 | 0.288 |
| Paralepididae | 1.0 | 0.000 | 0.5 | 0.003 | 1.0 | 0.096 |
| Myctophidae | 43.0 | 0.011 | 62.3 | 0.332 | 5.0 | 0.480 |
| Exocoetidae | 2.0 | 0.001 | 2.0 | 0.011 | 2.0 | 0.192 |
| *Exocoetus volitans* | 1.0 | 0.000 | 56.0 | 0.299 | 1.0 | 0.096 |
| Scomberesocidae | | | | | | |
| *Scomberesox saurus* | 8.0 | 0.002 | 105.0 | 0.560 | 6.0 | 0.576 |
| Belonidae | 2.0 | 0.001 | 5.0 | 0.027 | 2.0 | 0.192 |
| Macrorhamphosidae | 5.0 | 0.001 | 6.9 | 0.037 | 4.0 | 0.384 |
| Sygnathidae | 1.0 | 0.000 | 1.0 | 0.005 | 1.0 | 0.096 |
| Holocentridae | 3.0 | 0.001 | 4.0 | 0.021 | 1.0 | 0.096 |
| *Holocentrus* sp. | 3.0 | 0.001 | 9.0 | 0.048 | 1.0 | 0.096 |
| Carangidae | 1.0 | 0.000 | 1.0 | 0.005 | 1.0 | 0.096 |
| *Selene vomer* | 8.0 | 0.002 | 17.0 | 0.091 | 8.0 | 0.768 |
| *Decapterus punctatus* | 2.0 | 0.001 | 46.0 | 0.245 | 2.0 | 0.192 |
| *Caranx ruber* | 70.0 | 0.018 | 360.0 | 1.921 | 17.0 | 1.633 |
| Mullidae | 11.0 | 0.003 | 25.0 | 0.133 | 6.0 | 0.576 |
| Scombridae | 16.0 | 0.004 | 2.5 | 0.013 | 3.0 | 0.288 |
| *Auxis thazard* | 474.0 | 0.122 | 223.7 | 1.194 | 23.0 | 2.209 |
| *Scomber japonicus* | 1,474.0 | 0.379 | 978.7 | 5.223 | 77.0 | 7.397 |
| *Sarda sarda* | 81.0 | 0.021 | 127.0 | 0.678 | 8.0 | 0.768 |
| Gempylidae | 176.0 | 0.045 | 100.7 | 0.537 | 20.0 | 1.921 |
| *Thyrsitops lepidopoides* | 2,617.0 | 0.673 | 2,348.4 | 12.532 | 54.0 | 5.187 |
| Trichiuridae | 11.0 | 0.003 | 12.0 | 0.064 | 4.0 | 0.384 |
| *Benthodesmus* sp. | 19.0 | 0.005 | 80.9 | 0.432 | 8.0 | 0.768 |
| Unid. Perciforms | 24.0 | 0.006 | 63.7 | 0.340 | 16.0 | 1.537 |
| Balistidae | 1.0 | 0.000 | 5.0 | 0.027 | 1.0 | 0.096 |
| Monacanthidae | 27.0 | 0.007 | 19.8 | 0.106 | 19.0 | 1.825 |
| Ostraciidae | 1.0 | 0.000 | 0.5 | 0.003 | 1.0 | 0.096 |
| Molidae | | | | | | |
| *Ranzania* sp. | 3.0 | 0.001 | 13.0 | 0.069 | 1.0 | 0.096 |
| Triglidae | 1.0 | 0.000 | 1.0 | 0.005 | 1.0 | 0.096 |
| *Peristedion* sp. | 1.0 | 0.000 | 1.0 | 0.005 | 1.0 | 0.096 |
| Unid. fish | 289.0 | 0.074 | 163.5 | 0.872 | 94.0 | 9.030 |
| Unid. material | 1.0 | 0.000 | 26.4 | 0.141 | 5.0 | 0.480 |
| Empty | | | | | 436.0 | 41.882 |
| Total | 388,912.0 | | 18,739.9 | | 1,041.0 | |

APPENDIX TABLE 2.—List of prey items and other ingested materials found in the stomachs of skipjack tuna caught during Quarter I.

| Prey items | Numbers | | Volume | | Occurrence | |
|---|---|---|---|---|---|---|
| | No. | % | mL | % | No. | % |
| Crustacea | | | | | | |
| Mysidacea | | | | | | |
| Eucopiidae | 112.0 | 0.0076 | 9.3 | 0.253 | 8.0 | 2.658 |
| Lophogastridae | 19.0 | 0.013 | 1.5 | 0.041 | 2.0 | 0.664 |
| Isopoda | 1.0 | 0.001 | 0.1 | 0.003 | 1.0 | 0.332 |
| Flabellifera | 1.0 | 0.001 | 0.1 | 0.003 | 1.0 | 0.332 |
| Amphipoda | 20.0 | 0.014 | 0.5 | 0.014 | 1.0 | 0.332 |
| Euphausiidae | 49.0 | 0.033 | 2.3 | 0.063 | 4.0 | 1.329 |
| *Euphausia similis* | 144,070.0 | 97.624 | 2,125.9 | 57.878 | 34.0 | 11.296 |
| Caridea | 1.0 | 0.001 | 0.5 | 0.014 | 1.0 | 0.332 |
| Brachyura | | | | | | |
| Unid. megalops | 80.0 | 0.054 | 22.6 | 0.615 | 17.0 | 5.648 |
| Unid. zooea | 549.0 | 0.372 | 28.6 | 0.779 | 19.0 | 6.312 |
| Unid. Decapoda | 4.0 | 0.003 | 0.1 | 0.003 | 1.0 | 0.332 |
| Unid. Crustacea | 47.0 | 0.032 | 8.3 | 0.226 | 13.0 | 4.319 |
| Mollusca | | | | | | |
| Gastropoda | | | | | | |
| Pteropoda | | | | | | |
| *Cavolina* | 68.0 | 0.046 | 2.2 | 0.060 | 1.0 | 0.332 |
| Cephalopoda | | | | | | |
| Teuthoidea | 2.0 | 0.001 | 2.0 | 0.054 | 2.0 | 0.664 |
| Thysanoteuthidae | 2.0 | 0.001 | 10.0 | 0.272 | 1.0 | 0.332 |
| Ommastrephidae | 5.0 | 0.003 | 1.1 | 0.030 | 2.0 | 0.664 |
| Loliginidae | 1.0 | 0.001 | 8.0 | 0.218 | 1.0 | 0.332 |
| Octopoda | | | | | | |
| Argonautidae | | | | | | |
| *Argonauta* sp. | 2.0 | 0.001 | 0.3 | 0.008 | 2.0 | 0.664 |
| Insecta | | | | | | |
| Coleoptera | 1.0 | 0.001 | 1.0 | 0.027 | 1.0 | 0.332 |
| Pisces | | | | | | |
| Gonostomatidae | | | | | | |
| *Maurolicus muelleri* | 1,346.0 | 0.912 | 838.0 | 22.815 | 29.0 | 9.635 |
| Belonidae | 1.0 | 0.001 | 3.0 | 0.082 | 1.0 | 0.332 |
| Holocentridae | 3.0 | 0.002 | 4.0 | 0.109 | 1.0 | 0.332 |
| Carangidae | | | | | | |
| *Selene vomer* | 6.0 | 0.004 | 9.0 | 0.245 | 6.0 | 1.993 |
| Mullidae | 2.0 | 0.001 | 8.0 | 0.218 | 1.0 | 0.332 |
| Scombridae | 15.0 | 0.010 | 1.5 | 0.041 | 2.0 | 0.664 |
| *Auxis thazard* | 427.0 | 0.289 | 189.7 | 5.165 | 21.0 | 6.977 |
| *Scomber japonicus* | 504.0 | 0.342 | 225.2 | 6.131 | 22.0 | 7.309 |
| Gempylidae | 76.0 | 0.051 | 48.5 | 1.320 | 11.0 | 3.654 |
| Unid. Perciforms | 9.0 | 0.006 | 7.0 | 0.191 | 5.0 | 1.661 |
| Monacanthidae | 13.0 | 0.009 | 9.5 | 0.259 | 8.0 | 2.658 |
| Ostraciidae | 1.0 | 0.001 | 0.5 | 0.014 | 1.0 | 0.332 |
| Triglidae | 1.0 | 0.001 | 1.0 | 0.027 | 1.0 | 0.332 |
| *Peristedion* sp. | 1.0 | 0.001 | 1.0 | 0.027 | 1.0 | 0.332 |
| Unid. fish | 137.0 | 0.093 | 76.5 | 2.083 | 35.0 | 11.628 |
| Unid. material | 1.0 | 0.001 | 26.3 | 0.716 | 4.0 | 1.329 |
| Total | 147,577.0 | | 3,673.1 | | 301.0 | |

APPENDIX TABLE 3.—List of prey items and other ingested materials found in the stomachs of skipjack tuna caught during Quarter II.

| Prey items | Numbers | | Volume | | Occurrence | |
|---|---|---|---|---|---|---|
| | No. | % | mL | % | No. | % |
| Crustacea | | | | | | |
| Stomatopoda | 1.0 | 0.001 | 1.0 | 0.016 | 1.0 | 0.345 |
| Mysidacea | | | | | | |
| Eucopiidae | 97.0 | 0.055 | 31.9 | 0.508 | 9.0 | 3.103 |
| Lophogastridae | 5.0 | 0.003 | 0.2 | 0.003 | 1.0 | 0.345 |
| Isopoda | | | | | | |
| Flabellifera | 2.0 | 0.001 | 1.5 | 0.024 | 2.0 | 0.690 |
| Amphipoda | 2.0 | 0.001 | 1.0 | 0.016 | 1.0 | 0.345 |
| Gammaridea | 6.0 | 0.003 | 0.4 | 0.006 | 3.0 | 1.034 |
| Euphausiidae | 2.0 | 0.001 | 0.2 | 0.003 | 2.0 | 0.690 |
| *Euphausia similis* | 171,843.0 | 97.352 | 2,104.3 | 33.485 | 61.0 | 21.034 |
| Caridea | 1.0 | 0.001 | 0.8 | 0.013 | 1.0 | 0.345 |
| Macrura | | | | | | |
| Scyllaridae | 1.0 | 0.001 | 0.2 | 0.003 | 1.0 | 0.345 |
| Brachyura | | | | | | |
| Unid. megalops | 1.0 | 0.001 | 0.5 | 0.008 | 1.0 | 0.345 |
| Unid. zooea | 1.0 | 0.001 | 0.2 | 0.003 | 1.0 | 0.345 |
| Unid. Decapoda | 3.0 | 0.002 | 0.5 | 0.008 | 1.0 | 0.345 |
| Unid. Crustacea | 30.0 | 0.017 | 1.2 | 0.019 | 2.0 | 0.690 |
| Mollusca | | | | | | |
| Gastropoda | | | | | | |
| Pteropoda | | | | | | |
| *Cavolina* sp. | 33.0 | 0.019 | 3.8 | 0.060 | 6.0 | 2.069 |
| Cephalopoda | | | | | | |
| Teuthoidea | | | | | | |
| Ommastrephidae | 6.0 | 0.003 | 8.5 | 0.135 | 5.0 | 1.724 |
| Onychoteuthidae | 13.0 | 0.007 | 6.0 | 0.095 | 2.0 | 0.690 |
| Siphonophora | | | | | | |
| Algalmidae | 8.0 | 0.005 | 6.6 | 0.105 | 8.0 | 2.759 |
| Pisces | | | | | | |
| Gonostomatidae | | | | | | |
| *Maurolicus muelleri* | 4,287.0 | 2.429 | 3,548.0 | 56.458 | 38.0 | 13.103 |
| Synodontidae | 8.0 | 0.005 | 16.0 | 0.255 | 3.0 | 1.034 |
| Myctophidae | 24.0 | 0.014 | 61.3 | 0.975 | 4.0 | 1.379 |
| Sygnathidae | 1.0 | 0.001 | 1.0 | 0.016 | 1.0 | 0.345 |
| Carangidae | | | | | | |
| *Selene vomer* | 2.0 | 0.001 | 8.0 | 0.127 | 2.0 | 0.690 |
| *Decapterus punctatus* | 2.0 | 0.001 | 46.0 | 0.732 | 2.0 | 0.690 |
| *Caranx ruber* | 70.0 | 0.040 | 360.0 | 5.729 | 17.0 | 5.862 |
| Scombridae | | | | | | |
| *Auxis thazard* | 46.0 | 0.026 | 30.0 | 0.477 | 1.0 | 0.345 |
| *Scomber japonicus* | 8.0 | 0.005 | 6.0 | 0.095 | 2.0 | 0.690 |
| Unid. Perciforms | 1.0 | 0.001 | 12.0 | 0.191 | 1.0 | 0.345 |
| Balistidae | 1.0 | 0.001 | 5.0 | 0.080 | 1.0 | 0.345 |
| Monacanthidae | 4.0 | 0.002 | 4.1 | 0.065 | 3.0 | 1.034 |
| Unid. fish | 9.0 | 0.005 | 18.1 | 0.288 | 6.0 | 2.069 |
| Total | 176,518.0 | | 6,284.3 | | 290.0 | |

APPENDIX TABLE 4.—List of prey items and other ingested materials found in the stomachs of skipjack tuna caught during Quarter III.

| Prey items | Numbers | | Volume | | Occurrence | |
|---|---|---|---|---|---|---|
| | No. | % | mL | % | No. | % |
| Crustacea | | | | | | |
| Mysidacea | | | | | | |
| Eucopiidae | 10.0 | 0.046 | 0.8 | 0.020 | 4.0 | 1.843 |
| Isopoda | | | | | | |
| Flabellifera | 2.0 | 0.009 | 0.3 | 0.007 | 2.0 | 0.922 |
| Euphausiidae | 88.0 | 0.401 | 1.4 | 0.034 | 9.0 | 4.147 |
| *Euphausia* sp. | 50.0 | 0.228 | 0.6 | 0.015 | 1.0 | 0.461 |
| *Euphausia similis* | 15,414.0 | 70.236 | 196.3 | 4.796 | 30.0 | 13.825 |
| Unid. Crustacea | 5.0 | 0.023 | 0.4 | 0.010 | 4.0 | 1.843 |
| Mollusca | | | | | | |
| Cephalopoda | | | | | | |
| Teuthoidea | 1.0 | 0.005 | 3.0 | 0.073 | 1.0 | 0.461 |
| Pisces | | | | | | |
| Gonostomatidae | | | | | | |
| *Maurolicus muelleri* | 6,239.0 | 28.429 | 3,289.2 | 80.369 | 74.0 | 34.101 |
| Exocoetidae | 2.0 | 0.009 | 2.0 | 0.049 | 2.0 | 0.922 |
| *Exocoetus volitans* | 1.0 | 0.005 | 56.0 | 1.368 | 1.0 | 0.461 |
| Macrorhamphosidae | 2.0 | 0.009 | 2.9 | 0.071 | 2.0 | 0.922 |
| Carangidae | 1.0 | 0.005 | 1.0 | 0.024 | 1.0 | 0.461 |
| Mullidae | 6.0 | 0.027 | 9.0 | 0.220 | 3.0 | 1.382 |
| Scombridae | | | | | | |
| *Scomber japonicus* | 45.0 | 0.205 | 374.0 | 9.138 | 8.0 | 3.687 |
| *Sarda sarda* | 6.0 | 0.027 | 4.0 | 0.098 | 2.0 | 0.922 |
| Trichiuridae | 11.0 | 0.050 | 12.0 | 0.293 | 4.0 | 1.843 |
| *Benthodesmus* sp. | 19.0 | 0.087 | 80.9 | 1.977 | 8.0 | 3.687 |
| Unid. Perciforms | 4.0 | 0.018 | 35.0 | 0.855 | 3.0 | 1.382 |
| Monacanthidae | 1.0 | 0.005 | 1.0 | 0.024 | 1.0 | 0.461 |
| Unid. fish | 39.0 | 0.178 | 22.8 | 0.557 | 21.0 | 9.677 |
| Total | 21,946.0 | | 4,092.6 | | 217.0 | |

APPENDIX TABLE 5.—List of prey items and other ingested materials found in the stomachs of skipjack tuna caught during Quarter IV.

| Prey items | Numbers | | Volume | | Occurrence | |
|---|---|---|---|---|---|---|
| | No. | % | mL | % | No. | % |
| Crustacea | | | | | | |
| Stomatopoda | 11.0 | 0.026 | 3.5 | 0.075 | 5.0 | 2.146 |
| Mysidacea | | | | | | |
| Eucopiidae | 1.0 | 0.002 | 0.4 | 0.009 | 1.0 | 0.429 |
| Isopoda | | | | | | |
| Flabellifera | 2.0 | 0.005 | 0.2 | 0.004 | 2.0 | 0.858 |
| Amphipoda | | | | | | |
| Gammaridea | 10.0 | 0.023 | 4.7 | 0.100 | 7.0 | 3.004 |
| Euphausiidae | | | | | | |
| *Euphausia similis* | 37,305.0 | 87.017 | 468.8 | 9.996 | 47.0 | 20.172 |
| *Stylocheiron* sp. | 1.0 | 0.002 | 0.3 | 0.006 | 1.0 | 0.429 |
| Caridea | 1.0 | 0.002 | 1.0 | 0.021 | 1.0 | 0.429 |
| Macrura | | | | | | |
| Scyllaridae | | | | | | |
| Unid. Phyllosoma larvae | 1.0 | 0.002 | 0.1 | 0.002 | 1.0 | 0.429 |
| Brachyura | 5.0 | 0.012 | 0.7 | 0.015 | 1.0 | 0.429 |
| Portunidae | 1.0 | 0.002 | 0.1 | 0.002 | 1.0 | 0.429 |
| Unid. megalops | 21.0 | 0.049 | 8.9 | 0.190 | 9.0 | 3.863 |
| Unid. zooea | 5.0 | 0.012 | 1.4 | 0.030 | 4.0 | 1.717 |
| Unid. Crustacea | 14.0 | 0.033 | 1.1 | 0.023 | 7.0 | 3.004 |
| Mollusca | | | | | | |
| Gastropoda | | | | | | |
| Pteropoda | | | | | | |
| Cavoliniidae | 1.0 | 0.002 | 0.1 | 0.002 | 1.0 | 0.429 |
| Cephalopoda | | | | | | |
| Teuthoidea | 1.0 | 0.002 | 21.0 | 0.448 | 1.0 | 0.429 |
| Ommastrephidae | 24.0 | 0.056 | 45.5 | 0.970 | 11.0 | 4.721 |
| Loliginidae | 1.0 | 0.002 | 2.5 | 0.053 | 1.0 | 0.429 |
| Histioteuthidae | 1.0 | 0.002 | 1.0 | 0.021 | 1.0 | 0.429 |
| Octopoda | | | | | | |
| Argonautidae | | | | | | |
| *Argonauta* sp. | 18.0 | 0.042 | 75.6 | 1.612 | 9.0 | 3.863 |
| Unid. Cephalopoda | 4.0 | 0.009 | 1.3 | 0.028 | 3.0 | 1.288 |
| Insecta | | | | | | |
| Coleoptera | 1.0 | 0.002 | 1.0 | 0.021 | 1.0 | 0.429 |
| Siphonophora | 1.0 | 0.002 | 0.9 | 0.019 | 1.0 | 0.429 |
| Pisces | | | | | | |
| Gonostomatidae | | | | | | |
| *Maurolicus muelleri* | 1,566.0 | 3.653 | 944.1 | 20.130 | 40.0 | 17.167 |
| Paralepididae | 1.0 | 0.002 | 0.5 | 0.011 | 1.0 | 0.429 |
| Myctophidae | 19.0 | 0.044 | 1.0 | 0.021 | 1.0 | 0.429 |
| Scomberesocidae | | | | | | |
| *Scomberesox saurus* | 8.0 | 0.019 | 105.0 | 2.239 | 6.0 | 2.575 |
| Belonidae | 1.0 | 0.002 | 2.0 | 0.043 | 1.0 | 0.429 |
| Macrorhamphosidae | 3.0 | 0.007 | 4.0 | 0.085 | 2.0 | 0.858 |
| Holocentridae | | | | | | |
| *Holocentrus* sp. | 3.0 | 0.007 | 9.0 | 0.192 | 1.0 | 0.429 |
| Mullidae | 3.0 | 0.007 | 8.0 | 0.171 | 2.0 | 0.858 |
| Scombridae | 1.0 | 0.002 | 1.0 | 0.021 | 1.0 | 0.429 |
| *Auxis thazard* | 1.0 | 0.002 | 4.0 | 0.085 | 1.0 | 0.429 |
| *Scomber japonicus* | 917.0 | 2.139 | 373.5 | 7.964 | 45.0 | 19.313 |
| *Sarda sarda* | 75.0 | 0.175 | 123.0 | 2.623 | 6.0 | 2.575 |
| Gempylidae | 100.0 | 0.233 | 52.2 | 1.113 | 9.0 | 3.863 |
| *Thyrsitops lepidopoides* | 2,617.0 | 6.104 | 2,348.4 | 50.074 | 54.0 | 23.176 |
| Unid. Perciforms | 10.0 | 0.023 | 9.7 | 0.207 | 7.0 | 3.004 |
| Monacanthidae | 9.0 | 0.021 | 5.2 | 0.111 | 7.0 | 3.004 |
| Molidae | 1.0 | 0.001 | 0.5 | 0.014 | 1.0 | 0.332 |
| *Ranzania* sp. | 3.0 | 0.007 | 13.0 | 0.277 | 1.0 | 0.429 |
| Unid. fish | 104.0 | 0.243 | 46.1 | 0.983 | 32.0 | 13.734 |
| Unid. material | 0.0 | 0.000 | 0.1 | 0.002 | 1.0 | 0.429 |
| Total | 42,871.0 | | 4,689.9 | | 233.0 | |

APPENDIX TABLE 6.—Mean volumetric ratio of selected food items of skipjack tuna divided into 5 cm length groups for all months. Data are $\bar{r}$ ± SD with (*n*) in parentheses. Range is 0-100%.

| Length cm (*n*) | Other fish | Other crustaceans | *Euphausia similis* | *Maurolicus muelleri* | *Scomber japonicus* | *Thyrsitops lepidopoides* |
|---|---|---|---|---|---|---|
| 45.0-49.9(67) | 9.51 ± 22.5 | 9.51 ± 25.4 | 42.50 ± 48.1 | 10.35 ± 29.5 | 8.57 ± 23.6 | 16.64 ± 36.4 |
| 50.0-54.9(155) | 10.53 ± 27.7 | 12.62 ± 30.9 | 26.73 ± 43.6 | 13.99 ± 33.4 | 12.44 ± 29.5 | 20.05 ± 38.5 |
| 55.0-59.9(162) | 24.81 ± 39.4 | 11.80 ± 29.5 | 20.40 ± 39.5 | 29.49 ± 43.6 | 5.62 ± 19.6 | 2.70 ± 14.2 |
| 60.0-64.9(147) | 23.48 ± 39.2 | 8.03 ± 24.7 | 18.83 ± 36.5 | 42.90 ± 48.2 | 2.12 ± 12.2 | — |
| 65.0-69.9(55) | 42.80 ± 47.6 | 12.43 ± 31.7 | 4.73 ± 18.7 | 32.18 ± 45.9 | 0.27 ± 2.0 | — |
| 70.0-74.9(13) | 48.30 ± 48.1 | 9.88 ± 27.9 | 8.57 ± 21.9 | 23.36 ± 43.7 | 2.20 ± 79.2 | — |
| 75.0-79.9(4) | 47.50 ± 55.0 | 27.50 ± 48.6 | — | 25.00 ± 50.0 | — | — |
| Total (603) | 18.80 ± 35.5 | 10.96 ± 28.6 | 22.22 ± 40.0 | 26.73 ± 42.8 | 6.24 ± 21.1 | 10.34 ± 27.9 |

APPENDIX TABLE 7.—Mean volumetric ratio of selected food items of skipjack tuna divided into 5 cm length groups for Quarter I. Data are $\bar{r}$ ± SD with (*n*) in parentheses. Range is 0-100%.

| Length cm (*n*) | Other fish | Other crustaceans | *Euphausia similis* | *Maurolicus muelleri* | *Scomber japonicus* |
|---|---|---|---|---|---|
| 45.0-49.9(12) | 28.70 ± 33.4 | 35.15 ± 42.5 | 9.18 ± 28.7 | 7.48 ± 25.9 | 13.89 ± 38.4 |
| 50.0-54.9(53) | 19.87 ± 36.8 | 29.64 ± 43.5 | 24.48 ± 43.3 | 6.09 ± 19.6 | 16.12 ± 33.5 |
| 55.0-59.9(45) | 30.23 ± 40.9 | 17.69 ± 33.9 | 20.81 ± 38.9 | 22.96 ± 38.1 | 7.98 ± 25.2 |
| 60.0-64.9(36) | 34.79 ± 44.1 | 16.96 ± 35.4 | 20.14 ± 38.9 | 20.92 ± 40.1 | 19.84 ± 46.5 |
| 65.0-69.9(4) | 48.61 ± 56.2 | 28.24 ± 47.9 | — | — | 3.71 ± 7.4 |
| 70.0-74.9(3) | 91.67 ± 14.4 | 8.33 ± 14.4 | — | — | — |
| 75.0-79.9(2) | — | — | — | — | — |
| Total (155) | 29.55 ± 41.0 | 23.47 ± 38.9 | 19.80 ± 38.9 | 14.18 ± 32.1 | 10.08 ± 27.3 |

APPENDIX TABLE 8.—Mean volumetric ratio of selected food items of skipjack tuna divided into 5 cm length groups for Quarter II. Data are $\bar{r}$ ± SD with (*n*) in parentheses. Range is 0-100%.

| Length cm (*n*) | Other fish | Other crustaceans | *Euphausia similis* | *Maurolicus muelleri* | *Scomber japonicus* |
|---|---|---|---|---|---|
| 45.0-49.9(26) | 1.65 ± 8.4 | 5.00 ± 20.3 | 76.92 ± 43.0 | 15.38 ± 36.8 | — |
| 50.0-54.9(12) | 5.82 ± 11.5 | 14.72 ± 33.0 | 65.71 ± 48.6 | — | — |
| 55.0-59.9(35) | 20.89 ± 38.7 | 18.13 ± 36.4 | 35.65 ± 49.9 | 14.71 ± 33.9 | 0.14 ± 0.80 |
| 60.0-64.9(45) | 16.33 ± 36.2 | 4.67 ± 18.5 | 28.92 ± 45.7 | 45.54 ± 49.7 | 0.32 ± 2.1 |
| 65.0-69.9(23) | 54.07 ± 49.1 | — | 4.49 ± 20.8 | 30.29 ± 46.8 | — |
| Total (141) | 20.02 ± 38.1 | 8.16 ± 25.2 | 38.32 ± 48.6 | 25.96 ± 43.3 | 0.14 ± 1.3 |

APPENDIX TABLE 9.—Mean volumetric ratio of selected food items of skipjack tuna divided into 5 cm length groups for Quarter III. Data are $\bar{r}$ ± SD with (*n*) in parentheses. Range is 0-100%.

| Length cm (*n*) | Other fish | Other crustaceans | *Euphausia similis* | *Maurolicus muelleri* | *Scomber japonicus* |
|---|---|---|---|---|---|
| 45.0-49.9(4) | 25.81 ± 49.5 | — | 25.00 ± 50.0 | 24.19 ± 48.4 | 25.00 ± 50.0 |
| 50.0-54.9(27) | 11.17 ± 32.0 | 1.24 ± 6.4 | 11.21 ± 32.0 | 61.56 ± 48.5 | 14.81 ± 36.2 |
| 55.0-59.9(36) | 24.88 ± 41.3 | 9.22 ± 27.9 | 3.67 ± 16.2 | 59.05 ± 47.0 | 3.17 ± 16.8 |
| 60.0-64.9(31) | 24.09 ± 40.5 | 3.39 ± 17.9 | 16.51 ± 29.9 | 53.76 ± 46.6 | 2.26 ± 12.6 |
| 65.0-69.9(17) | 31.80 ± 46.4 | 17.65 ± 39.3 | 3.89 ± 9.8 | 46.67 ± 48.8 | — |
| 70.0-74.9(5) | 31.27 ± 45.5 | — | 8.00 ± 17.9 | 60.73 ± 53.8 | — |
| Total (120) | 22.87 ± 40.1 | 6.42 ± 23.6 | 9.6 ± 25.5 | 55.40 ± 47.39 | 5.70 ± 22.7 |

APPENDIX TABLE 10.—Mean volumetric ratio of selected food items of skipjack tuna divided into 5 cm length groups for Quarter IV. Data are $\bar{r}$ ± SD with (*n*) in parentheses. Range is 0-100%.

| Length cm (*n*) | Other fish | Other crustaceans | *Euphausia similis* | *Maurolicus muelleri* | *Scomber japonicus* | *Thyrsitops lepidopoides* |
|---|---|---|---|---|---|---|
| 45.0-49.9(25) | 5.86 ± 13.8 | 3.43 ± 11.0 | 25.49 ± 39.6 | 4.26 ± 16.9 | 12.30 ± 25.1 | 44.60 ± 48.4 |
| 50.0-54.9(63) | 3.30 ± 13.4 | 2.77 ± 13.0 | 27.84 ± 43.4 | 2.91 ± 16.3 | 10.69 ± 25.1 | 49.33 ± 47.0 |
| 55.0-59.9(46) | 22.45 ± 37.5 | 3.25 ± 15.3 | 21.48 ± 40.2 | 24.01 ± 42.9 | 9.40 ± 22.5 | 9.49 ± 25.7 |
| 60.0-64.9(35) | 20.51 ± 35.4 | 7.29 ± 22.1 | 6.55 ± 19.5 | 52.48 ± 49.9 | 1.71 ± 85.6 | — |
| 65.0-69.9(11) | 34.11 ± 44.1 | 24.59 ± 40.2 | 8.26 ± 27.4 | 25.45 ± 43.9 | — | — |
| 70.0-74.9(5) | 39.31 ± 53.8 | 20.69 ± 44.4 | 14.29 ± 31.9 | — | 5.71 ± 12.8 | — |
| 75.0-79.9(2) | 45.00 ± 63.6 | 5.00 ± 7.1 | — | 50.0 ± 70.7 | — | — |
| Total (187) | 14.80 ± 16.5 | 5.6 ± 19.5 | 29.17 ± 37.8 | 19.31 ± 38.9 | 8.03 ± 21.2 | 24.91 ± 27.7 |