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Charles S. MANOOCH, III and *Diane L. MASON*

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COMPARATIVE FOOD STUDIES OF YELLOWFIN IN TUNA, *THUNNUS ALBACARES*, AND BLACKFIN TUNA, *THUNNUS ATLANTICUS, (PISCES: SCOMBRIDAE)* FROM THE SOUTHEASTERN AND GULF COAST OF THE UNITED STATES

BADANIA PORÓWNAWCZE NAD POKARMEM TUŃCZYKA ŻÓŁTOPŁETWEGO, *THUNNUS ALBACARES* I TUŃCZYKA CZARNOPŁETWEGO, *THUNNUS ATLANTICUS (PISCES: SCOMBRIDAE)* Z ZATOKI MEKSYKAŃSKIEJ I POŁUDNIOWO-WSCHODNICH WYBRZEŻY STANÓW ZJEDNOCZONYCH AMERYKI PÓŁNOCNEJ

Beaufort Laboratory, North Carolina

Two hundred and six yellowfin tuna, *Thunnus albacares*, and 98 blackfin tuna, *T. atlanticus*, were sampled from sport fisheries in the South Atlantic and the Gulf of Mexico from April 1980 to July 1982. Stomach contents were analyzed by frequency of occurrence, number of food items, and volume.

Invertebrates and fish occurred in the diet of yellowfin relatively equally (85% and 77%). Major invertebrates by frequency of occurrence were cephalopods, 62% and crustaceans, 52%. Fishes were represented primarily by the families: *Scombridae*, 12.2%; *Balistidae*, 11.2%; and *Syngnathidae*, 8.2%. In addition, yellowfin ingested floating materials such as plastics, feathers, seagrasses, and balls of tar.

Invertebrates occurred in 82% of the blackfin stomachs with food, and represented 75% and 31% of the foods by number and volume, respectively. Fish were found in 67% of the stomachs and constituted 26% and 68% of the food number and volume, respectively. The most frequently occurring invertebrates were crustaceans, 67.4% and cephalopods, 36.0%. Fishes were represented primarily by the families: *Balistidae*, 10.1%; *Trichiuridae* 5.6%; and *Carangidae*, 4.5%. In addition, blackfin consumed floating materials, such as plastic and seagrasses.

Statistical comparisons of the diets of the two species indicated no significant correlation. Overall, the diets of the yellowfin and blackfin tunas appear to reflect those of fast, aggressive predators, and also of fish which use their gill apparatus to strain small, near-surface items from the water.

INTRODUCTION

The family *Scombridae* includes many species of pelagic fish that are very important to the world's fisheries. Some, such as the mackerels *Scomberomorus spp.* and *Scomber spp.*, are primarily coastal, migrating north in the spring and summer and south in the fall and winter. Others, including members of the genus *Thunnus*, are usually much larger than the mackerels and are reputed for their more complex, often transoceanic migrations.

Two species of *Thunnus*, the yeloowfin tuna, *T. albacares*, and the blackfin tuna, *T. atlanticus*, are highly esteemed food and sport fishes whose distributions include the southeastern and Gulf coasts of the United States. The yellowfin is the larger and more prized of the two, attaining a weight of at least 176 kg (compared with 19 kg for blackfin).

On the whole, tuna landings in the western Atlantic are sporadic and are much smaller than those made by the large-scale, international hook and line and seine tuna fisheries that operate in the eastern Atlantic and Pacific. The total United States commercial landings of all tunas was 341,149,000 pounds in 1981, 326,860,000 pounds from the Pacific and 14,289,000 from the Atlantic. Only 131,000 pounds were landed in the South Atlantic Region – North Carolina, South Carolina, Georgia, and East coast of Florida (D.S. Fitzsgibbon, pers. commun., U.S. Natl. Mar. Fish. Serv., 2001 Wisconsin Ave. N.W., Washington, D.C. 20235). Of the South Atlantic total, only 5,000 pounds were identified as yellowfin tuna, and none as blackfin, although the 55,000 pounds of unclassified tunas undoubtedly included blackfin. Recreational catches of yellowfin and blackfin tunas tend to be greater than the commercial catches for the southeastern United States. In North Carolina, for instance, anglers fishing from charter boats in 1978 caught approximately 151,000 pounds of yellowfin tuna and 38,000 pounds of blackfin tuna (Manooch, et al., 1981). No information is available for 1981.

Considering the disproportionately large commercial catch of tunas in the Pacific, it is not surprising that many publications pertaining to life histories, population dynamics and exploitation have resulted from research on species in that region. Relatively few studies have been conducted on Atlantic stocks. Dragovich (1969) in his review of food studies on Atlantic tunas mentioned that the papers he read emphasized the need for additional research on the foods and feeding habits of Atlantic stocks. The limited information available from the western Atlantic usually resulted from fish collected aboard scientific vessels that did not operate along the southeastern or Gulf coasts of the

United States, or that operated well offshore of the normal sport fishing grounds (Dragovich, 1969; 1970).

To obtain more data pertinent to the management of pelagic stocks, studies were initiated on oceanic species important to fisheries along the southeastern and Gulf coasts of the United States. Our study is the result of a cooperative effort that included the Oceanic Pelagic Program, SEFC, Miami Laboratory, and the Bioprofiles Task, SEFC, Panama City Laboratory. The objectives were to 1) identify the food habits of yellowfin and blackfin tunas; 2) compare the diets of the species collected from the same geographic area during the same period of time; and 3) determine if changes in the diets occur for different sizes of fish.

METHODS

Of the 206 yellowfin and 98 blackfin stomachs examined, 169 and 55, repectively, were from fish landed at Oregon Inlet or Hatteras, N.C. during the spring, summer and fall of 1980, 1981 and 1982. A few additional samples, indicated in parentheses as yellowfin and then blackfin, were obtained from locations alogong the southeast Atlantic and Gulf of Mexico coasts: South Carolina (31,8), Georgia (3,1), east coast of Florida (0,2), northwest Florida (3,1), Mississippi – Louisiana (0,6), and south Texas (0,25).

Samplers at all locations apportioned their efforts to coincide with local charter boat activities, primarily April through October. Port samplers met boats at the docks as a day's catch was being unloaded. Most fishermen either wanted to save their fish whole for mounting, or to have them filleted and packed on ice or frozen upon returning to the dock. Data were obtained only from the latter group, either in exchange for cleaning the fish, or from fish cleaners who worked at local markets. Fish were measured to the nearest millimeter (FL) and weighed to the nearest tenth of a kilogram. Stomachs and gonads were placed in labeled cloth bags or cheese cloth and preserved in 10% formalin.

In the laboratory, stomach contents were identified to the lowest possible taxon and were enumerated, thus providing the relative number of each food type in the stomachs. Frequency of occurrence of materials was determined by counting every stomach that contained at least one specimen or part of a specific item (taxon). Empty stomachs were excluded. The volume of each taxon was obtained by water displacement and was later converted to weight by a linear regression equation.

Larval and juvenile fish in the stomachs were identified after they had been cleared and stained following the methods discussed by Dingerkus and Uhler (1977) and Taylor and Van Dyke[1]. Crustaceans were identified by Steven G. Morgan and Joseph W. Goy,

[1] Taylor, W.R., and G.C. Van Dyke. 1978. Unpublished manuscript. Staining and clearing small vertebrates for bone and cartilage study. Smithsonian Institution, Washington, DC 20560. 19 pp.

Duke University Marine Laboratory, Beaufort, N.C. Parasites, encountered only occasionally, were separated from food items, counted, identified and preserved. A stomach containing only parasites was considered empty.

All data were analyzed as percent frequency of occurrence, percent of total number and percent of food volume. Once frequencies, volumes and numbers of the various foods were obtained, an index of relative importance (IRI) was used to estimate the contribution of major food groups to the diet (Pinkas, et al., 1971). The index was calculated as

$$\text{IRI} = (\text{N} + \text{V})\ \text{F}, \text{ where}$$

N = numerical percentage of a food, V = its volumetric percentage and
F = its percentage frequency of occurrence.

The Spearman rank correlation (r_s) was used to evaluate differences in diets of the two species based on IRI values of foods from fish collected in the same geographic area and over approximately the same period of time. Two different equations may be used. One, where there are no ties (rankings are equal for two or more food categories) and the other, where ties do occur. The equation for tied food categories (Fritz, 1974) was used:

$$r_s = \frac{\Sigma x^2 + \Sigma y^2 - \Sigma d^2}{2\ \Sigma x^2\ \Sigma y^2} \quad \text{where}$$

$$\Sigma x^2 = \frac{N^3 - N}{N} - \Sigma Tx,$$

$$\Sigma y^2 = \frac{N^3 - N}{N} - \Sigma Ty,$$

$$T = \frac{t^3 - t}{N},$$

N = numbers of ranks, d = difference between ranks, T = correlation factor for ties and t = number of observations tied at a given rank. Pearsons and Kendall's Tau B Correlation Coefficients, in addition to the Spearman rank, were also derived to evaluate differences in the diets.

RESULTS AND DISCUSSION

Composition of Stomach Contents

Stomach contents of both species could be grouped into four principal categories: fish, cephalopods, crustaceans and miscellaneous non-food items (Tables 1, 2 and Fig. 1). Major representatives of each group will be discussed below under separate headings and will also be analyzed later to identify differences in the diets related to the species of

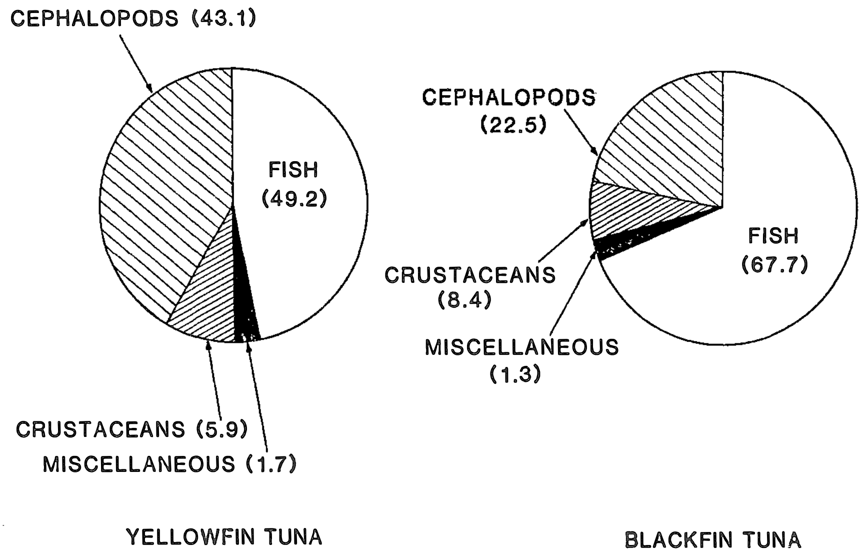

Fig. 1. Major groups of contents found in the stomachs of 196 yellowfin tuna and 89 blackfin tuna, expressed as percent volume

predator and predator size. A graphic presentation of the overall contribution of selected foods to the diet (IRI) plots) is presented in Figure 2.

Fish

Fishes occurred in 77% of yellowfin and 67% of blackfin stomachs that contained food (Tables 1, 2 and Fig. 2) and consisted primarily of older larvae and juveniles often associated with floating *Sargassum*. In all, 23 families were identified. Adult exocoetids,

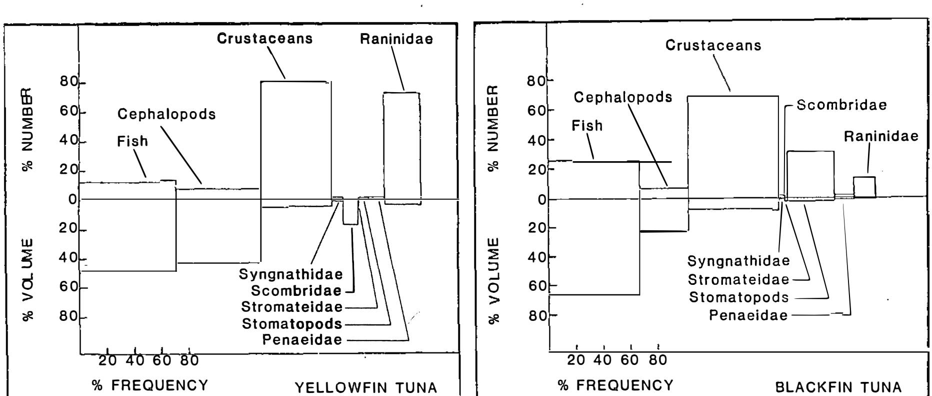

Fig. 2. Index of Relative Importance plots for selected food items of yellowfin and blackfin tuna

Table 1

Stomach contents of 196 yellowfin tunas collected off the southeastern United States and Gulf of Mexico coasts in 1980, 1981 and 1982

Item	Frequency of Occurrence (N=196)	Percent Frequency	Number of Items (N = 5,841)	Percent by Number	Volume (N = 13,316.8)	Percent by Volume
1	2	3	4	5	6	7
Fish	150	76.5	727	12.4	6,546.2	49.2
Unidentifiable fish	103	52.5	301	5.1	1,386.9	10.4
Unidentifiable juvenile fish	11	5.6	73	1.2	81.8	0.6
Family *Clupeidae*	1	0.5	10	0.2	745.0	5.6
Unidentifiable clupeid	1	0.5	10	0.2	745.0	5.6
Family *Exocoetidae*	9	4.6	18	0.3	625.0	4.7
Unidentifiable exocoetid	2	1.0	2	TR	51.0	0.4
Unidentifiable juvenile flyingfish	1	0.5	1	TR	1.0	TR
Unidentifiable adult flyingfish	6	3.1	15	0.3	573.0	4.3
Family *Holocentridae*	1	0.5	1	TR	1.0	TR
Unidentifiable squirrelfish	1	0.5	1	TR	1.0	TR
Family *Syngnathidae*	16	8.2	125	2.1	177.2	1.3
Hippocampus sp.	16	8.2	125	2.1	177.2	1.3
Family *Priacanthidae*	2	1.0	2	TR	10.6	0.1
Pristigenys alta	2	1.0	2	TR	10.6	0.1
Family *Echenidae*	2	1.0	2	TR	1.1	TR
Phtheirichthys lineatus	1	0.5	1	TR	0.6	TR
Remora remora	1	0.5	1	TR	0.5	TR
Family *Carangidae*	8	4.1	17	0.3	72.4	0.5
Unidentifiable carangid	6	3.1	8	0.1	56.4	0.4
Caranx crysos	1	0.5	1	TR	6.0	TR
Decapterus punctatus	1	0.5	8	0.1	10.0	0.1
Family *Acanthuridae*	1	0.5	1	TR	0.5	TR
Acanthurus sp.	1	0.5	1	TR	0.5	TR
Family *Trichiuridae*	1	0.5	1	TR	2.5	TR
Trichurus lepturus	1	0.5	1	TR	2.5	TR
Family *Scombridae*	24	12.2	54	0.9	2,363.0	17.7
Unidentifiable scombrid	22	11.2	50	0.9	2,173.0	16.3
Auxis sp.	2	1.0	4	0.1	190.0	1.4
Family *Stromateidae*	2	1.0	33	0.6	845.0	6.3
Peprilus triacanthus	2	1.0	33	0.6	845.0	6.3
Family *Dactylopteridae*	1	0.5	1	TR	1.5	TR
Dactylopterus volitans	1	0.5	1	TR	1.5	TR
Family *Balistidae*	22	11.5	43	0.7	126.8	0.9
Unidentifiable balistid	2	1.0	2	TR	8.5	0.1
Unidentifiable triggerfish	1	0.5	1	TR	0.3	TR
Unidentifiable tilefish	9	4.6	24	0.4	63.0	0.5
Aluterus sp.	1	0.5	1	TR	1.0	TR
Monacanthus sp.	3	1.5	9	0.1	28.0	0.2
M. hispidus	5	2.5	6	0.1	26.0	0.2

Table 1 continued

1	2	3	4	5	6	7
Family *Ostraciidae*	2	1.0	2	TR	0.8	TR
Unidentifiable boxfish	2	1.0	2	TR	0.8	TR
Family *Tetradontidae*	3	1.5	3	0.1	0.9	TR
Unidentifiable puffer	2	1.0	2	TR	0.5	TR
Sphoeroides sp.	1	0.5	1	TR	0.4	TR
Family *Diodontidae*	10	5.1	40	0.7	104.2	0.8
Diodon sp.	9	4.6	39	0.7	101.2	0.8
Chilomycterus p.	1	0.5	1	TR	3.0	TR
Invertebrates	167	85.2	5.114	87.5	6,543.4	49.1
Phylum *Cnidaria*	2	1.0	2	TR	1.5	TR
Class *Scyphozoa*	2	1.0	2	TR	1.5	TR
Phylum *Mollusca*	122	62.2	412	7.0	5,743.8	43.1
Unidentifiable mollusk	1	0.5	1	TR	0.2	TR
Class *Cephalopoda*	122	62.2	411	7.0	5,743.6	43.1
Unidentifiable cephalopod	10	5.1	21	0.4	147.8	1.1
Order *Teuthidida*	99	50.5	364	6.2	5,457.4	41.0
Order *Octopodida*	15	7.7	26	0.4	138.4	1.0
Argonauta argo	15	7.7	26	0.4	138.4	1.1
Phylum *Arthropoda*	102	52.0	4,663	79.8	785.6	5.9
Class *Crustacea*	102	52.0	4,663	79.8	785.6	5.9
Unidentifiable crustacean	4	2.2	4	0.1	2.5	TR
Order *Stomatopoda*	15	7.7	90	1.5	15.7	0.1
Unidentifiable stomatopod	1	0.5	1	TR	0.8	TR
Stomatopod larvae	13	6.6	88	1.5	14.9	0.1
Squilla empusa larvae	1	0.5	1	TR	TR	TR
Order Isopoda	5	2.5	64	1.1	46.7	0.4
Order *Amphipoda*	1	0.5	1	TR	0.2	TR
Suborder *Gammaridea*	1	0.5	1	TR	0.2	TR
Order *Decapoda*	92	46.9	4,504	77.1	720.5	5.4
Unidentifiable decapod	3	1.5	3	0.1	1.0	TR
Unidentifiable decapod larvae	1	0.5	4	0.1	0.5	TR
Suborder *Natantia*	28	14.3	102	1.7	39.5	0.3
Unidentifiable shrimp	4	2.0	6	0.1	8.6	0.1
Family *Penaeidae*	24	12.2	96	1.7	30.9	0.2
Cerataspis monstrosa (larvae)	20	10.2	85	1.5	28.5	0.3
C. petiti (larvae)	5	2.6	5	0.1	1.3	TR
Cerataspis sp. (larvae)	3	1.5	5	0.1	0.6	TR
Sicyonia brevirostris	1	0.5	1	TR	0.5	TR

Continued
Table 1

1	2	3	4	5	6	7
Suborder *Reptantia*	81	41.3	4,395	75.2	679.5	5.1
Unidentifiable crab	1	0.5	1	TR	TR	TR
Unidentifiable *reptantia* (*megalopa*)	5	2.6	20	0.3	0.8	TR
Superfamily *Scyllaridea* (larvae)	1	0.5	1	TR	0.3	TR
Subfamily *Diogeninae*	4	2.0	6	0.1	0.4	TR
Diogenid glaucothoe	3	1.5	5	0.1	0.4	TR
Dardanus sp. glaucothoe	1	0.5	1	TR	TR	TR
Family *Raninidae (megalopa)*	54	27.5	4,258	72.9	541.2	4.1
Family *Dromiidae (megalopa)*	12	6.1	57	1.0	6.1	TR
Family *Portunidae*	14	7.1	53	0.9	98.2	0.7
Unidentifiable portunid crab	3	1.5	7	0.1	2.1	TR
Portunus sayi	4	2.0	8	0.1	15.3	0.1
P. spinicarpus	5	2.5	34	0.6	73.9	0.5
Portunus sp.	3	1.5	4	0.1	6.9	0.1
Subphylum *Urochordata*	2	1.0	37	0.6	12.5	0.1
Class *Ascidiacea*	1	0.5	2	TR	0.5	TR
Class *Thaliacea*	1	0.5	35	0.6	12.0	0.1
Order *Salpida*	1	0.5	35	0.6	12.0	0.1
Miscellaneous	62	31.6	–	–	227.2	1.7
Sargassum	52	26.5	–	–	186.2	1.4
Zostera marina	5	2.6	–	–	4.9	TR
Thalassia testudinum	2	1.0	–	–	1.3	TR
Spartina sp.	3	1.5	–	–	11.0	TR
Unidentifible food	5	2.5	–	–	8.2	0.1
Feather	3	1.5	–	–	1.8	TR
Tar ball	2	1.0	–	–	0.4	TR
White plastic	2	1.0	–	–	1.2	TR
Black/green plastic	1	0.5	–	–	0.2	TR
Blue plastic	1	0.5	–	–	0.1	TR
Clear plastic	1	0.5	–	–	0.2	TR
Clear plastic bag	1	0.5	–	–	12.0	0.1
					100.0	100.0

scombrids and syngnathids were found occasionally in yellowfin, as were syngnathids, serranids, sciaenids and stromateids in blackfin. For all life stages, fish that occurred most frequently in yellowfin tuna were *Scombridae* (12.2%), *Balistidae* (11.2%), *Syngnathidae* (8.2%), *Diodontidae* (5.1%) and *Exocoetidae* (4.6%). Fifty-three percent of stomachs with food contained unidentifiable fish remains. Fish that occurred most often in blackfin tuna stomachs were *Balistidae* (10.1%), *Trichiuridae* (5.6%), *Carangidae* (4.5%) and *Syngnathidae* (4.5%). Unidentifiable fishes were found in 44.9% of the stomachs containing food.

Cephalopods

Cephalopods constituted almost all of the molluscan food of both species. One exception was unidentifiable mollusk tissue – possibly cephalopod – from a yellowfin captured in the Gulf of Mexico. Two groups were represented: *Teuthidida* and *Octopodida*. Teuthoids (squids) were the most important by frequency of occurrence and by volume: 50,5% and 41.0% for yellowfin, 31.5% and 21.5% for blackfin. By comparison, octopodids, represented by the paper nautilus, *Argonauta argo*, appeared in only 7.7% of the yellowfin tuna and 3.4% of the blackfin tuna. Percent volumes of these mollusks were less than 2% for both predators. And whereas over 430 squid were consumed by the tunas, less than 30 paper nautilus were eaten. At least three genera of squids were ingested: *Loligo, Sepioteuthis* and *Illex*. Generic identifications were obtained by comparing saved, pooled samples with reference collection specimens and therefore do not appear in the tables.

Crustaceans

Crustaceans, important foods of both species and second only to fish in overall frequency of occurrence, were identified in 52% of the yellowfin and in 67.4% of the blackfin. The majority were immature stages (larvae, *megalopa* and *glaucothoe*). Due to the small sizes of the animals, the relative percentages of the total food volume – 5.9% for yellowfin and 8.4% for blackfin – were comparatively small. Major taxa in the diet of yellowfin by frequency of occurrence were *Raninidae* (27.5%), *Penaeidea* (12.2%), *Stomatopoda* (7.7%), *Portunidae* (7.1%) and *Dromiidae* (6.1%). For blackfin tuna, the most frequently encountered were *Stomatopoda* (34.8%), *Diogeninae* (16.9%), *Raninidae* (15.7%), *Penaeidae* (14.6%) and *Dromiidae* (12.4%). In all, over 5,000 individuals were enumerated, and on one occasion a single predator contained hundreds of these small, mesopelagic invertebrates.

Our findings of the overall food habits seem to agree closely with those of Dragovich (1970), who described fish, cephalopods and crustaceans as the major foods of yellowfin and skipjack, *Katsuwonus pelamis*, tunas in the Atlantic. He also mentioned that larval and juvenile stages were prevalent for ingested fishes and macrozooplanktonic crustaceans.

Miscellaneous

The very nature of tuna feeding, near-surface straining as well as actively pursuing and capturing larger animals, results in a variety of items being consumed that are probably

Table 2

Stomach contents of 89 blackfin tuna collected off the southeastern United States and Gulf of Mexico coasts 1980 and 1981

Item	Frequency of Occurrence (N=89)	Percent Frequency	Number of Item (N=1,120)	Percent by Number	Volume (N=2,541.7 ml)	Percent by Volume
1	2	3	4	5	6	7
Fish	60	67.4	286	25.5	1,720.8	67.7
Unidentifiable fish	40	44.9	92	8.2	482.8	19.0
Unidentifiable juvenile fish	7	7.9	37	3.3	13.6	0.5
Family *Clupeidae*	3	3.4	66	5.9	315.0	12.4
Unidentifiable clupeids	2	2.2	6	0.5	175.0	6.9
Etrumeus teres	1	1.1	60	5.4	140.0	5.5
Family *Synodontidae*	2	2.2	2	0.2	162.0	6.4
Synodus sp.	2	2.2	2	0.2	162.0	6.4
Family *Batrachoididae*	1	1.1	1	0.1	15.0	0.6
Porichthys porossimus	1	1.1	1	0.1	15.0	0.6
Family *Syngnathidae*	4	4.5	19	1.7	13.9	0.5
Hippocampus sp.	3	3.4	18	1.6	12.7	0.5
Unidentifiable pipefish	1	1.1	1	0.1	1.2	TR
Family *Serranidae*	1	1.1	1	0.1	33.0	1.3
Centropristis sp.	1	1.1	1	0.1	33.0	1.3
Family *Carangidae*	4	4.5	23	2.1	14.5	0.6
Caranx crysos	2	2.2	10	0.9	6.0	0.2
Seriola zonata	1	1.1	12	1.1	8.0	0.3
Vomer setapinnis	1	1.1	1	0.1	0.5	TR
Family *Sparidae*	3	3.4	4	0.4	92.0	3.6
Stenotomus carpinus	3	3.4	4	0.4	92.0	3.6
Family *Sciaenidae*	2	2.2	8	0.7	125.0	4.9
Cynoscion sp.	2	2.2	8	0.7	125.0	4.9
Family *Mugilidae*	1	1.1	1	0.1	27.0	1.1
Mugil sp.	1	1.1	1	0.1	27.0	1.1
Family *Trichiuridae*	5	5.6	7	0.6	164.0	6.4
Trichiurus lepturus	5	5.6	7	0.6	164.0	6.4
Family *Stromateidae*	2	2.2	7	0.6	110.0	4.3
Peprilus burti	1	1.1	5	0.4	60.0	2.4
P. triacanthus	1	1.1	2	0.2	50.0	2.0
Family *Triglidae*	1	1.1	1	0.1	20.0	0.8
Prionotus sp.	1	1.1	1	0.1	20.0	0.8
Family *Balistidae*	9	10.1	17	1.5	133.0	5.2
Unidentifiable balistid	2	2.2	2	0.2	11.0	0.4
Unidentifiable triggerfish	3	3.4	6	0.5	62.0	2.4
Unidentifiable filefish	3	3.4	8	0.7	44.0	1.7
Monacanthus sp.	1	1.1	1	0.1	16.0	0.6

Table 2 continued

1	2	3	4	5	6	7
Invertebrates	73	82.0	834	74.5	787.9	31.0
Class *Cephalopoda*	32	36.0	72	6.4	575.1	22.6
Unidentifiable cephalopod	1	1.1	1	0.1	0.2	TR
Order *Teuthidida*	28	31.5	68	6.1	545.4	21.5
Order *Octopodida*	3	3.4	3	0.3	29.5	1.2
Argonauta argo	3	3.4	3	0.3	29.5	1.2
Class *Crustacea*	60	67.4	762	68.0	212.8	8.4
Unidentifiable crustacean	3	3.4	3	0.3	5.8	0.2
Order *Stomatopoda*	31	34.8	356	31.8	105.9	4.2
Stomatopod larvae	30	33.7	347	31.0	59.4	2.3
Stomatopod post larvae	1	1.1	2	0.2	0.5	TR
Squilla empusa (adult)	2	2.2	7	0.6	46.0	1.8
Suborder *Hyperiidea* (amphipod)	1	1.1	1	0.1	TR	TR
Order *Decapoda*	49	55.1	402	35.9	101.1	4.0
Unidentifiable decapod (larvae)	1	1.1	2	0.2	TR	TR
Suborder *Natantia*	11	12.4	27	2.4	41.5	1.6
Unidentifiable shrimp	2	2.2	2	0.2	2.0	0.1
Section *Penaeidea*	13	14.6	23	2.0	39.3	1.5
Unidentifiable penaeid	1	1.1	3	0.3	7.0	0.3
Cerataspis monstrosa (larvae)	2	2.2	5	0.4	1.4	0.1
C. petiti (larvae)	2	2.2	2	0.2	0.3	TR
Penaeopsis goodei	1	1.1	1	0.1	1.0	TR
Sicyonia brevirostris	5	5.6	10	0.9	15.1	0.6
Sicyonia sp.	2	2.2	2	0.2	14.5	0.6
Section *Caridea*	2	2.2	2	0.2	0.2	TR
Suborder *Reptantia*	40	44.9	373	33.3	59.6	2.3
Unidentifiable megalopa	14	15.7	96	8.6	8.0	0.3
Subfamily *Diogeninae* (glaucothoe)	15	16.9	42	3.8	2.8	0.1
Section *Brachuyra*	25	28.1	235	21.0	48.8	1.9
Unidentifiable zoeae	1	1.1	3	0.3	0.1	TR
Family *Ranimidae* (*megalopa*)	14	15.7	151	13.5	11.2	0.4
Family *Dromiidae* (*megalopa*)	11	12.4	71	6.3	11.8	0.5
Family *Portunidae*	4	4.5	10	0.9	25.7	1.0
Unidentifiable portunid remains	1	1.1	3	0.3	18.0	0.7
Portunus sayi	2	2.2	6	0.5	7.5	0.3
Portunus sp.	1	1.1	1	0.1	0.2	TR
Miscellaneous	14	15.7	–	–	33.0	1.3
Sargassum sp.	11	12.4	–	–	26.6	1.0
Zostera marina	2	2.2	–	–	0.5	TR
Unidentifiable food	3	3.4	–	–	4.9	0.2
White plastic	2	2.2	–	–	1.0	TR
				100.0		100.0

ingested by accident along with natural foods. Yellowfin tuna had the most diverse assemblage of non-food items (31.6% frequency): plants (*Sargassum, Zostera, Thalassia* and *Spartina*), feathers, globs of tar and plastics. Miscellaneous items occurred in only 15.7% of the blackfin, represented by *Sargassum, Zostera* and plastic. *Sargassum* was most frequently encountered, 26.5% of the stomachs with food, and usually occurred in tunas captured off North Carolina. This percentage is similar to that of 37.8% for *Sargassum* removed from the digestive tracts of skipjack tuna captured earlier from approximately the same geographical area (Batts, 1972).

Other studies also revealed a dominance of fish, squid and crustaceans in tuna diets for the Atlantic and Pacific. Reintjes and King (1953) investigated the food habits of 1,097 yellowfin from the Central Pacific and found that fish occurred in 70.4% of the stomachs; squid in 55.4%; and crustaceans (mostly immature, pelagic stages) in 66.9%. Alverson (1963) found fish, squid and crustaceans occurring in 53.8%, 23.9% and 76.1% of the yellowfin he examined from the Pacific. Similar occurrences were reported for yellowfin from the Atlantic (Dragovich 1970), and for skipjack tuna (Alverson, 1963; Nakamura, 1965; Batts, 1972), bluefin tuna, *T. thynnus,* (Pinkas, et al., 1971) and albacore, *T. alalunga* (Pinkas, et al., 1971) from the Pacific.

COMPARATIVE DIETS

Since temporal and spatial variations in the diets were so great (data collected over a period of three years, and from several widely different geographical locations), we believed that only by analyzing small, discrete samples could we detect important differences in the diets. To achieve this comparison, we used only stomach contents of the two species collected together off Oregon Inlet on 10 different days from May through September, 1981 (Table 3).

Index of Relative Importance

Indices of Relative Importance (IRI), which present the combined contributions of volume, frequency of occurrence, and numbers of each food item to the diet (Table 3), showed that, surprisingly, invertebrates were important foods for both species. The first five categories (ranks) for yellowfin were *Teuthidida* (mainly squids), unidentifiable fish, *Raninidae, Scombridae* and unidentifiable crustaceans. For blackfin, unidentifiable fish, *Teuthidida, Raninidae, Stomatopoda* and unidentifiable crustaceans were the major contributors to the diet. Obvious differences were more clupeids and unidentifiable diogenid crabs in blackfin, and more scombrids and squids in yellowfin. Other items were also different, but their respective IRI values were relatively small (i.e., exocoetids for yellowfin = 9.7; for blackfin = 0.0).

Correlation Coefficients.

Data from Table 3, ranked by IRI values, were then used to obtain quantitative comparisons of local food habits of the two species. Three different measures were used:

Table 3

Frequency of occurrence, numeric and volumetric percentages, IRI values and rankings of stomach contents from 45 yellowfin tuna and 35 blackfin tuna captured simultaneously off Oregon Inlet in 1981. Numbers are in parentheses

Item	Yellowfin Tuna					Blackfin Tuna				
	Percent Frequency (N = 45)	Percent by Number (N = 439)	Percent by Volume (N = 2,427.2 ml)	IRI	Rank	Percent Frequency (N = 35)	Percent by Number (N = 416)	Percent by Volume (N = 653.1 ml)	IRI	Rank
Unidentifiable fish	55.5	10.9	9.3	1,121.2	28.0	54.3	11.1	18.0	1,580.1	29.0
Clupeidae				0.0	4.5	5.7	15.1	30.6	260.5	24.0
Exocoetidae	4.4	0.5	1.7	9.7	19.0				0.0	5.5
Syngnathidae	6.7	7.3	1.4	58.3	23.0	5.7	4.1	1.9	34.2	21.0
Priacanthidae	2.2	0.2	0.0	0.4	9.5				0.0	5.5
Carangidae	4.4	0.7	1.9	11.4	20.0	5.7	5.0	2.0	39.9	22.0
Scombridae	13.3	1.6	13.9	206.2	26.0				0.0	5.5
Stromateidae				0.0	4.5	2.9	0.5	7.7	23.8	20.0
Balistidae	6.7	0.7	0.7	9.4	18.0				0.0	5.5
Diodontidae	2.2	0.5	3.5	8.8	17.0				0.0	5.5
Teuthidida	68.9	22.3	61.4	5,766.9	29.0	37.1	5.3	35.2	1.502.6	28.0
Octopodida	4.4	0.5	0.8	5.7	15.0	2.9	0.2	0.5	2.0	15.5
Unidentifiable crustaceans	8.9	13.9	1.9	140.6	25.0	28.6	9.9	1.2	317.5	25.0
Stomatopoda	13.3	9.1	0.3	125.0	24.0	42.9	14.9	1.2	690.7	26.0
Amphipoda				0.0	4.5	2.9	0.2	0.0	0.6	12.5
Unidentifiable *Natantia*	2.2	0.4	0.1	1.1	11.0	2.9	0.2	0.0	0.6	12.5
Cerataspis monstrosa	2.2	1.1	0.1	2.6	13.0				0.0	5.5
C. petiti				0.0	4.5	2.9	0.2	0.0	0.6	12.5
Sicyonia brevirostris				0.0	4.5	5.7	0.7	0.1	4.6	18.0
Caridea				0.0	4.5	2.9	0.2	0.0	0.6	12.5
Unidentifiable *Reptantia*				0.0	4.5	2.9	0.7	0.0	2.0	15.5
Scyllaridea	2.2	0.2	0.0	0.4	9.5				0.0	5.5
Diogeninae	2.2	0.7	0.0	1.5	12.0	22.9	6.3	0.2	148.9	23.0
Raninidae	17.8	13.9	0.3	252.8	27.0	28.6	23.1	1.2	695.0	27.0
Dromiidae	4.4	0.9	0.0	4.0	14.0	8.6	1.4	0.1	12.9	19.0
Unidentifiable *Portunidae*	2.2	3.4	0.4	8.4	16.0				0.0	5.5
Portunus spinicarpus	4.4	3.2	1.9	22.4	22.0				0.0	5.5
P. sayl				0.0	4.5	2.9	0.7	0.1	2.3	17.0
Salpida	2.2	8.0	0.5	18.7	21.0				0.0	5.5

Spearman Rank Correlation Coefficient (Fritz, 1974); Kendall Rank Coefficient (Bray and Ebeling, 1975); and Pearson Product-moment Correlation Coefficient (Goodall 1973). The first two require no assumption of normality with regard to the distribution of the two predator species, whereas the latter does. Cailliet and Barry (1978), who compared the three methods of analyzing diets that have different distributions of prey items, found that the Spearman and Kendall correlation coefficients are somewhat unpredictable when there are 1) a large number of ties, 2) a considerable nonoverlap of prey items, and 3) high prey richness and evenness (i.e., diversity). They felt that the Pearson method was best. Although our data have a fairly low richness and evenness, there are relatively few ties (2 for yellowfin and 3 for blackfin) and there is a fairly good overlap in the diets. For these reasons all three methods of measuring diet similarity are probably appropriate. Qualitatively, both species feed extensively on epipelagic and mesopelagic fishes and invertebrates. Eleven of the 28 food categories occurred in the stomachs of both species, and 6 of the 10 most important categories to blackfin also ranked in the top 10 for yellowfin. The obvious conclusion is that both species have similar diets when they occur together off the coast of North Carolina. Statistically, however, the correlation coefficients were all non-significant at the 0.05 (0.344; 29 df) level. The correlation coefficients were Spearman: 0.2273 Kendall: 0.1451; and Pearson: 0.2273.

COMPARATIVE DIETS BY PREDATOR SIZE

Differences in stomach contents by fish size may of course be attributable merely to the availability of food in the environment, but they may also be attributable either to a change in food preference, or to the ability of the predator to capture and swallow certain organisms as it increases in size. Our objectives of comparing diets by tuna size were to determine if near-surface feeding was related to tuna size and to ascertain if basic changes in the diets occurred as the fish grew larger.

Different studies throughout the world's oceans generally suggest that as tunas grow larger, the diet changes. Reintjes and King (1953) reported that the overall high occurrence of crab larvae, stomatopod larvae, squid and juvenile fishes indicates a preference by Pacific yellowfin tuna for small food items. These authors further explain that small tuna feed predominately on crustacean larvae; medium-size fish feed on fish, crustacean larvae, and squid; and large yellowfin mainly consume fish and squid. These findings were substantiated by Nakamura (1965) and Batts (1972) for skipjack tuna whose diets reflected a decline in crustaceans and a subsequent higher percentage of fish, as tuna size increased.

To accomplish our evaluations, we first grouped the fish into size classes (mm FL) (Tables 4 and 5). Next, selected food groups – fish, adult fish, juvenile fish, invertebrates, squid, larval crustaceans and plants – were established to demonstrate food size (i.e., adult fish vs. larval crustaceans) and materials that we believed to be consumed on or near the surface (i.e., floating plants). Contents are presented as percent frequency of occurrence (Tables 4 and 5).

Table 4

Selected food items consumed by different sized yellowfin tuna, expressed as percent frequencies of occurrence

	Fish Size (mm FL)			
Contents	501–700	700–900	901–1.100	>1.100
Fish	77.8	81.8	75.0	73.8
Adult fish	5.5	10.9	15.0	9.5
Juvenile fish	16.7	12.7	36.4	11.9
Invertebrates	77.8	89.1	76.3	85.7
Squid	44.4	34.5	56.3	64.3
Larval Crustaceans	38.9	70.9	35.0	35.7
Plants	55.5	32.7	30.0	14.3

Yellowfin Tuna

Size of food items showed little change as fish size increased or decreased (Table 4). The three key food categories – adult fish, juvenile fish and larval crustaceans – neither steadily increased nor decreased in occurrence as tuna size increased. This finding is contrary to that of Dragovich (1970), who found that the frequency occurrence of fish in stomachs of yellowfin increased with fish size. However, he discovered no relationship between squid in the diet and tuna size. In our study, the occurrence of floating plants decreased for the larger size classes, indicating that perhaps smaller individuals fed more extensively near the surface.

Blackfin Tuna

The size of prey items and feeding proximity to the surface appeared to change with fish size. As fish size increased, large food items (i.e., adult fish) generally occurred more frequently, and small food items (i.e., larval crustaceans and juvenile fish) occurred less frequently (Table 5). And, surface feeding, as suggested by the incidental ingestion of floating plants, decreased as fish attained larger sizes.

VOLUMES OF CONTENTS RELATED TO SPECIES AND FISH BODY WEIGHT

Since the quantity and types of foods ingested by fishes are often converted into caloric equivalents for energetics studies, we present frequencies of the range of food volumes for the two species (Table 6). The displacement volume for yellowfin averaged 67.9 ml (72.2 g), compared with 28.6 ml (29.6 g) for blackfin tuna. Volumes of stomach

Table 5

Selected a food items consumed by different sized blackfin tuna, expressed as percent frequency of occurrence

Contents	Fish Size (mm FL) <500	501–700	701–900	901–1.100
Fish	50.0	57.4	87.1	100.0
Adult fish	0.0	7.4	25.8	0.0
Juvenile fish	50.0	16.7	9.7	0.0
Invertebrates	100.0	90.7	64.5	100.0
Squid	50.0	31.5	25.8	100.0
Larval crustaceans	100.0	66.7	38.7	0.0
Plants	50.0	14.8	9.7	0.0

contents of yellowfin and blackfin varied from 0.1 to 745.0 ml and from 0.1 to 257.5 ml, respectively. The largest volumes were found in a 40 kg yellowfin and in a 8.8 kg blackfin. The volume range for yellowfin from the Pacific was similar, 0.1 to 1,000 ml (Reintjes and King, 1953). The extremes in our data were much greater than those

Table 6

Frequencies of food volumes by species of tuna

Volume Range (ml)	Yellowfin Tuna		Blackfin Tuna	
	Number	Percent	Number	Percent
0.1– 10.0	64	32.6	46	51.7
10.1– 50.0	67	34.2	26	29.2
50.1–100.0	24	12.2	10	11.2
100.1–150.0	15	7.7	3	3.4
150.1–200.0	9	4.6	3	3.4
200.1–250.0	6	3.1	–	–
250.1–300.0	3	1.5	1	1.1
300.1–350.0	3	1.5	–	–
350.1–400.0	1	0.5	–	–
400.1–450.0	1	0.5	–	–
450.1–500.0	1	0.5	–	–
500.1–550.0	–	–	–	–
550.1–600.0	–	–	–	–
600.1–650.0	–	–	–	–
650.1–700.0	1	0.5	–	–
700.1–750.0	1	0.5	–	–
Totals	196	99.9	89	100.0

described by Dragovich and Potthoff (1972) – 0.1 to 20.0 for skipjack,, and 0.1 to 60.0 ml for yellowfin tunas collected off the west coast of Africa. In our study, approximately 33% of the yellowfin had food volumes exceeding 50 ml, a proportion similar to that of the 29% found by Reintjes and King (1953). By comparison, Dragovich (1970) noted volumes of less than 20 ml for 85% of the yellowfin from the Atlantic. We found that only 19% of the blackfin, a much smaller species, had contents over 50 ml.

To determine the relationship of volume to fish body weight, we first derived the following equation for converting volume in milliliters to volume in grams:

$$Vol_g = -1.4009 + 1.0846\,(Vol_m l),\ N = 25,\ r = 0.999.$$

Comparisons were then made between estimates of stomach contents and the body weights of some of the tunas selected at random. Percentages of food weight to fish weight varied from trace (< 0.002) to 2.02 for yellowfin and from 0.02 to 3.20 for blackfin tuna. Only 10% of the yellowfin had contents exceeding 1% of fish body weight, whereas 20% of the blackfin tuna had contents exceeding this percentage. Usually our observations were well below 1% as were those of Dragovich (1970).

In summary, yellowfin and blackfin tuna appear to be fast, aggressive predators capable of capturing swift, relative large prey. On the other hand, they utilize their gill apparatus to strain small, near-surface items from the water. During feeding, non-food materials (inorganic as well as organic) are ingested, probably incidental to normal prey. The variability of specific food organisms within the major categories (fish, cephalopods and crustaceans) in the diets suggests that tunas are non-selective feeders. This is undoubtedly a factor in their wide geographic distribution, and one would expect, therefore, for the diets of such well-traveled fish to berather cosmopolitan.

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Charles S. Manooch III i Diane L. Mason

BADANIA PORÓWNAWCZE NAD POKARMEM TUŃCZYKA ŻÓŁTOPŁETWEGO (*THUNNUS ALBACARES*) i TUŃCZYKA CZARNOPŁETWEGO (*THUNNUS ATLANTICUS*) (*PISCES: SCOMBRIDAE*) Z ZATOKI MEKSYKAŃSKIEJ I POŁUDNIOWO-WSCHODNICH WYBRZEŻY STANÓW ZJEDNOCZONYCH

STRESZCZENIE

Dane pochodzą z 206 tuńczyków żółtopłetwych (*Thunnus albacares*) i 96 czarnopłetwych (*Th.atlanticus*), uzyskanych w połowach sportowych u wybrzeży południowych Stanów Zjednoczonych i Zatoki Meksykańskiej w okresie od kwietnia 1980 do lipca 1982 r. Zawartość żołądków przebadano pod kątem częstości występowania poszczególnych składników pokarmowych, ich ilości i objętości.

Bezkręgowce i ryby występowały w pokarmie tuńczyka żółtopłetwego i czarnopłetwego prawie jednakowo (85% i 77%). Większość bezkręgowców pod względem częstości występowania, to głowonogi (62%) i skorupiaki (52%). Ryby były reprezentowane głównie przez przedstawicieli rodzin: *Scombridae* – 12%, *Balistidae* – 11,2% i *Syngnathidae* – 8,2%. Ponadto zwłaszcza tuńczyki żółtopłetwe zjadały różny materiał unoszący się w wodzie, jak plastyk, pióra, pływające glony i bryły smoły. Bezkręgowce występujące u 82% tuńczyków czarnopłetwych (*Th. atlanticus*) stanowiły 77% ilości składników pokarmowych i 31% objętości masy pokarmowej. Ryby występowały u 67% osobników i stanowiły 26% ilości składników a 68% objętości. Z bezkręgowców najczęstsze były skorupiaki (67,4% i głowonogi 36,0%). Ryby były reprezentowane głównie przez rodziny: *Balistidae* – 10,1%, *Trichiuridae* –5,6% i *Carangidae* – 4,5%. Również czarnopłetwe tuńczyki zjadały przypadkowo pływające materiały, jak: plastyki, glony morskie.

Statystyczne porównanie diet obu gatunków nie wykazało istotnej korelacji. Ogólnie dieta tuńczyków żółto- i czarnopłetwych jest taka, jak pokarm silnych agresywnych drapieżników, oraz taka jak pokarm ryb, które odcedzają przez aparat filtrowy skrzeli małe obiekty występujące przy powierzchni wody.

Ryby występujące u 77% żółtopłetwego i 67% u czarnopłetwego tuńczyka były głównie młodszymi lub starszymi larwami występującymi wśród pływających kęp *Sargassum*. Ogólnie rekrutowały się z 23 rodzin. Dorosłe *Exocoetidae, Scombridae* i *Syngnathidae* występowały sporadycznie u żółtopłetwego tuńczyka, podobnie jak *Serranidae, Sciaenidae* i *Stromateidae* u czarnopłetwego.

U tuńczyków żółtopłetwych różnego wieku najczęstsze były: *Scombridae* (12,2%), *Balistidae* (11,2%), *Syngnathidae* (8,2%), *Diodontidae* (5,1%). 53 żołądków zawierało trudne do zidentyfikowania szczątki ryb. Ryby które najczęściej występowały u czarnopłetwych tuńczyków były to: *Balistidae* (10,1%), *Trichiuridae* (5,6%), *Carangidae* (4,5%) i *Syngnathidae* (4,5%). 44,9% żołądków zawierało trudne do zidentyfikowania szczątki.

Spośród mięczaków, niemal wyłącznie spotykano u obu gatunków głowonogi. Dwie ich grupy były reprezentowane, *Teuthidida* i *Octopodida*. Kałamarnice były częstsze, ilościowo jak objętościowo, 50,5% i 40,0% u żółtopłetwego a 31,5% i 21,5% u czarnopłetwego (ilościowo i objętościowo).

Skorupiaki, ważny pokarm obu gatunków, zajmują drugie miejsce za rybami pod względem częstości występowania. Oznaczono je u 52% tuńczyków żółtopłetwych i 67% u czarnopłetwych. Przeważały stadia niedojrzałe stadiów *megalopa* i *glaucothoe*. U żółtopłetwego byli to przedstawiciele: *Raninidae* (27,5%), *Panaeidae* (12,2%), *Stomatopoda* (7,7%), *Portunidae* (7,1%) i *Dromiidae* (6,1%). U czarnopłetwego najczęstszymi były: *Stomatopoda* (34,8%), *Diogeninae* (16,94%), *Raninidae* (15,7%), *Peanaeidae* (14,6%) i *Dromiidae* (12,4%).

Sam charakter odżywiania się tuńczyka, odcedzanie wody tuż przy powierzchni i aktywna pogoń za większymi organizmami sprawia, że w pokarmie występują różnorodne składniki przypadkowo. Tuńczyk żółtopłetwy zawierał najbardziej różnorodny zestaw niejadalnych obiektów (31,6% przypadków) takich jak: rośliny (*Sargassum, Zostera, Thalassia* i *Spartina*), pióra, bryłki smoły i plastyki. Obce ciała spotyka się u czarnopłetwego tuńczyka tylko w 15,7% przypadków, stanowią je: Sargassum, Zostera i plastyki. Sargassum spotykane było w żołądkach pełnych (26,5%) i występowało zwykle u ryb łowionych w Północnej Karolinie.

Wskaźniki względnej wartości (IRI), które stanowią połączenie objętości pokarmu, częstości występowania i ilości poszczególnych składników w pokarmie wykazują, że bezkręgowce stanowią poważne źródło pożywienia dla obu gatunków. W pierwszym rzędzie są to kalmary dla żółtopłetwego a nieoznaczone ryby a po nich kalmary dla czarnopłetwego.

Różnice w pokarmie zależą w dużej mierze od dostępności pokarmu w środowisku ale istnieje niewątpliwie i znaczna preferencja drapieżcy w stosunku do ofiar.

Wielkość składników pokarmu tuńczyka żółtopłetwego wykazuje minimalne zależności w stosunku do wielkości drapieżcy a w diecie występują zarówno dorosłe ryby jak i młodociane a także larwy skorupiaków a więc drobnych zwierząt. Natomiast u czarnopłetwego w miarę wzrostu ryb zaznacza się przewaga większych składników tj. dorosłych ryb.

Ponieważ ilość i rodzaj pokarmu wchłanianego przez ryby są często przeliczane na wartości kaloryczne w badaniach energetycznych, wobec tego przedstawiamy zakresy objętości pokarmu dla obu gatunków. Objętości treści żołądków wynoszą średnio 67,9 ml (972,2 g) dla żółtopłetwego i 28,6 ml (29,6 g) dla czarnopłetwego, a zakresy objętości zmieniają odpowiednio w granicach od 0,1 do 745,0 ml i od 0,1 do 257,5 ml. Największą objętość treści znaleziono u tuńczyka żółtopłetwego ważącego 40 kg i czarnopłetwego 8,8 kg. W niniejszych badaniach co najmniej 33% tuńczyków żółtopłetwych miało objętość treści pokarmowej przekraczającą 50 ml.

Podsumowując można powiedzieć, że tuńczyki żółto- i czarnopłetwe są drapieżnikami zdolnymi do chwytania szybkich, stosunkowo dużych ofiar, ale z drugiej wykorzystują swój cedzący aparat skrzelowy do pobierania i znacznie mniejszego pokarmu z wód przypowierzchniowych. Głównym pokarmem są ryby, głowonogi i skorupiaki. Ogólnie można przyjąć, że ich sposób odżywiania nie wykazuje dużej selektywności, co wpływa zapewne też na ich szeroki zasięg występowania.

Charles S. MANOOCH III, Diane L. MASON

СРАВНИТЕЛЬНЫЕ ИССЛЕДОВАНИЯ КОРМА ТУНЦА ЖЕЛТОЛАСТОВОГО (THUNNUS ALBACARES) И ТУНЦА ЧЕРНОЛАСТОВОГО (THUNNUS ATLANTICUS) (PISCES: SCOMBRIDAE) ИЗ МЕКСИКАНСКОГО ЗАЛИВА И ЮГО-ЗАПАДНОГО ПОБЕРЕЖЬЯ США

РЕЗЮМЕ

Исследовали 206 желтоластовых (Thunnus albacares) и 96 черноластовых (Th.atlanticus) тунцов, полученных из спортивных отловов на территории южного побережья США и Мексиканского залива в период с апреля 1980 до июля 1982 гг. В содержимом желудков исследовали частоту присутствия отдельных кормовых компонентов, а также их количества и объёмы.

Беспозвоночные и рыба присутствовали в корме желтоластового тунца в почти одинаковых количествах (85 и 77%). Среди беспозвоночных чаще всего встречались головоногие (62%) и ракообразные (52%). Рыбу представляли собой представители семейств: Scombridae - 12%, Balistidae - 11,2% и Syngnathidae - 8,2%. Кроме того, особенно у желтоластового тунца наблюдался различный, плавающий материал - (пластмасса, перья, плавающие водоросли, глыбы смолы). Беспозвоночные, присутствующие у 82% черноластовых тунцов, составляли 77% общего количества кормовых компонентов и 31% общего объёма кормов. Рыба присутствовала у 67% особей и составляла она 26% общего количества компонентов и 60% объёма корма. Среди беспозвоночных чаще всего встречались ракообразные (67,4%) и головоногие (36,0%). Рыбы представляли собой главным образом представители семейств: Balistidae - 10,1%, Trichiuridae - 5,6% и Carangidae - 4,5%. В желудках черноластовых тунцов находились также случайно плавающие материалы: пластмасса, морские водоросли.

На основании статистического сравнения диеты обоих видов тунца не установлено значимой корреляции. В общем диета желто- и черноластовых тунцов является характерной для строго агрессивных хищников, а также для корма рыбы, которая отцеживает через фильтровый аппарат жабр мелкие объекты, присутствующие при поверхности воды.

Рыба присутствующая у 77% желто- и 67% черноластовых тунцов представляла собой прежде всего личинки разного возраста, находящиеся среди плавающих кочек Sargassum и принадлежащие к 23 семействам. Взрослые: Exocoetidae, Scombridae и Syngnathidae встречались нерегулярно у желтоластового, так как: Serranidae, Sciaenidae и Stromateidae у черноластового тунцов.

У различных по возрасту желтоластовых тунцов чаще всего встречались: Scombridae (12,2%), Balistidae (11,2%), Syngnathidae (8,2%), Diodontidae (5,1%). В 53 желудках находились неидентифицированные остатки рыбы. У черноластовых тунцов чаще всего встречались: Balistidae (10,1%), Trichiuridae (5,6%), Carangidae (4,5%) и Syngnathidae (4,5%). Неидентифицированные остатки установлено для 44,9% желудков.

У обоих видов среди моллюсков встречались почти исключительно головоногие, представлявшие собой две группы: Teuthidida и Octopodida. Кальмары встречались чаще у желтоластового тунца как по количеству так и по объёму (50,5% и 40,0%), а у черноластового соответственно 31,5% и 21,5%.

Ракообразные - важнейший корм обоих видов - занимают второе место за рыбой по частоте присутствия. Найдено их у 52% желто- и 67% черноластовых тунцов. Превосходство имели несозревшие стадии megalopa и galucothoe. У желтоластового тунца были это представители: Raninidae (27,5%), Panaeidae (12,2%), Stomatopoda (7,7%), Portunidae (7,1%) и Dromiidae (6,1%). У черноластового тунца чаще всего встречались: Stomatopoda (34,8%), Diogeninae (16,94%), Raninidae (15,7%), Peanaeidae (14,6%) и Dromiidae (12,4%).

Из-за самого характера питания у тунцов, т.е. отцеживания воды при поверхности и активной погони за большими организмам, в кроме встречаются различные, случайные компоненты. У желтоластового тунца наблюдался наиболее дифференцированный состав несъедобных объектов (31,6% случаев таких как: растения (Sargassum, Zostera, Thalassia и Spartina) перья, глыбы смолы и пластмасса). У черноластового тунца посторонние вещества, встречались примерно для 15,7% случаев и представляли собой: Sargassum, Zostera и пластмассу. Sargassum встречалось в полных желудках (26,5%) и присутствовало обычно у рыбы из ловли в Северной Каролине.

Показатели относительной ценности IRI представлявшие собой соединение объёма корма, частоты присутствия и количества отдельных компонентов в корме показали, что беспозвоночные - это серьёзный источник корма для обоих видов. У желтоластового тунца первое место занимают кальмары, а у черноластового - неидентифицированная рыба и затем кальмары.

Различия в корме в большей степени зависели от доступности данного корма в среде, но наблюдалось также значительное преимущество хищника к жертве.

Величина компонентов корма у желтоластового тунца в незначительной степени зависела от величины хищника, так как в диете встречались взрослая рыба и молодёжь, а также личники ракообразных, т.е. мелких животных. Тогда как у черноластового тунца по мере увеличения возраста рыбы наблюдалось превосходство компонентов корма большего размера, т.е. взрослой рыбы.

Ввиду того, что количество и вид корма употребляемого рыбой для энергетических исследований составляют в пересчёте на калорийную ценность, в настоящей работе представлены пределы объёмов корма для обоих видов тунца. Содержимое желудков у желтоластового тунца составляло в среднем 67,8мл (972,2 г) и у черноластового - 28,6 мл (29,6 г), а колебания объёмов составляли пределы 0,1 - 745,0 мл и 0,1 - 257,5 мл соответственно. Самый большой объём содержимого желудка наблюдался у желтоластового тунца весом в 40 кг и у черноластового - весом в 8,8 кг. В проведенных исследованиях по крайней мере 33% желтоластовых тунцов имело свыше 50 мл содер-

На основании проведенных исследований установлено, что желто- и чернопластовые тунцы это хищники, способные ловить скоростные, относительно большие жертвы, но также они пользуются цедильным жаберным аппаратом для улавливания мелкого корма из приповерхностной воды. Основным кормом являются: рыба, головоногие и ракообразные. В общем способ питания не отличается большой селективностью, благодаря чему тунцов можна встретить на большой территории.

Authors address:
Dr. Charles S. Manooch, III
Diane L. Mason
Southeast Fisheries Center
Beaufort Laboratory
Beaufort, North Carolina 28516–9722
U.S.A.

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