

## FOOD HABITS OF TUNAS AND DOLPHINS BASED UPON THE EXAMINATION OF THEIR STOMACH CONTENTS<sup>1</sup>

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TWO TEXT FIGURES

### INTRODUCTION

Although tunas are reported to be commercially present in the Philippines, yet they are still unexploited. They constitute a potential source of food supply and certainly a very promising segment of Philippine fisheries from which to develop overseas export trade. Any attempt, therefore, to study the biology of these fish will reflect to the ways and means to catch them wisely and effectively.

Kishinouye (1917) studied the stomach contents of 141 specimens consisting mostly of yellowfins, albacores, and big-eyed tuna which were taken from the region between the Bonin Island and Iwo Jima. Among the food items he found were many deep-sea species of fishes and some invertebrates. He described the phyllosoma juveniles of spiny lobsters, larval forms of the sunfish (*Mola mola*) and juveniles of big-eyed tuna and albacore. He further noted that these voracious fishes will take the hook even when their stomachs are almost full of food. He remarked: "The digestive powers of the tunas are amazing. It appears that in their stomachs the animals quickly lose their original form, and it is difficult to recover a specimen in perfect condition from the stomach contents."

Nakamura (1936) listed 17 families of fishes represented in the stomachs of 57 yellowfin tuna, *Neothunnus macropterus*, from the Celebes Sea. He found that the most important natural food of this species consists of fishes, followed by squids among the mollusks, and stomatopods among the crustaceans. Most of the fishes that he found belonged to the following genera: *Engraulis*, *Ostracion*, *Balistes*, *Sphyræna*, *Stolephorus*, and *Leiognathus*. Other scombroids were also represented. Like Kishinouye, he doubted if there is a point of satiation in the feeding habits of yellowfin tuna or if it selects any particular food.

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Very little study in the Philippines has been undertaken on the biology of tunas. Wade (1948) made studies of the juvenile forms of tunas and was able to establish their probable spawning areas in this country.

The present paper presents a report on the feeding habits of Philippine tunas caught by trolling based upon the examination of their stomach contents.

### MATERIALS AND METHODS

During the various technical cruises of the research vessels *Spencer F. Baird* and *Theodore N. Gill* of the Philippine Fishery Program, U. S. Fish and Wildlife Service, the former from September, 1947 to June, 1949, caught by trolling, pelagic fishes, mostly tunas. The stomach contents of 304 tunas and 25 dolphins collected by the *Baird*, and those of a yellowfin tuna and one dolphin taken by the *Gill* were saved and examined. The fork lengths and weights of the tunas were taken and the viscera were removed by splitting the belly of the fish. The stomach of each fish was immediately opened and the contents sorted, labelled, and wrapped with cheese-cloth. The specimens were preserved in a 10 per cent formalin solution and later in 70 per cent alcohol. They were later transferred into individual containers.

It was noted that most of the specimens examined had empty stomachs. The tunas were caught from the southern part of the Philippines, particularly in the vicinities of Sulu Sea, Davao Gulf, Busuanga Strait, and Celebes Sea.

The stomach contents were emptied into Petri dishes and the animal components were identified and enumerated. Records of standard or total lengths of fish specimens were taken. The food items and the quantity of each kind taken from each tuna were indexed together with the pertinent data about the fish. The unidentified juvenile fishes, too, were grouped together.

TABLE 1.—Number of stomachs examined for each species of tuna.

Species	No. of stomachs
Yellowfin tuna, <i>Neothunnus macropterus</i> (Temm. and Schl.)	115
Skipjack, <i>Katsuwonus pelamis</i> (Linn.)	115
Oceanic bonito, <i>Euthynnus yaito</i> Kishinouye	75
Dolphin, <i>Caryphæna hippurus</i> Linn.	26

## RESULTS AND DISCUSSION

Fig. 1 gives a graphic representation in percentage of the types of food which these fishes feed on.

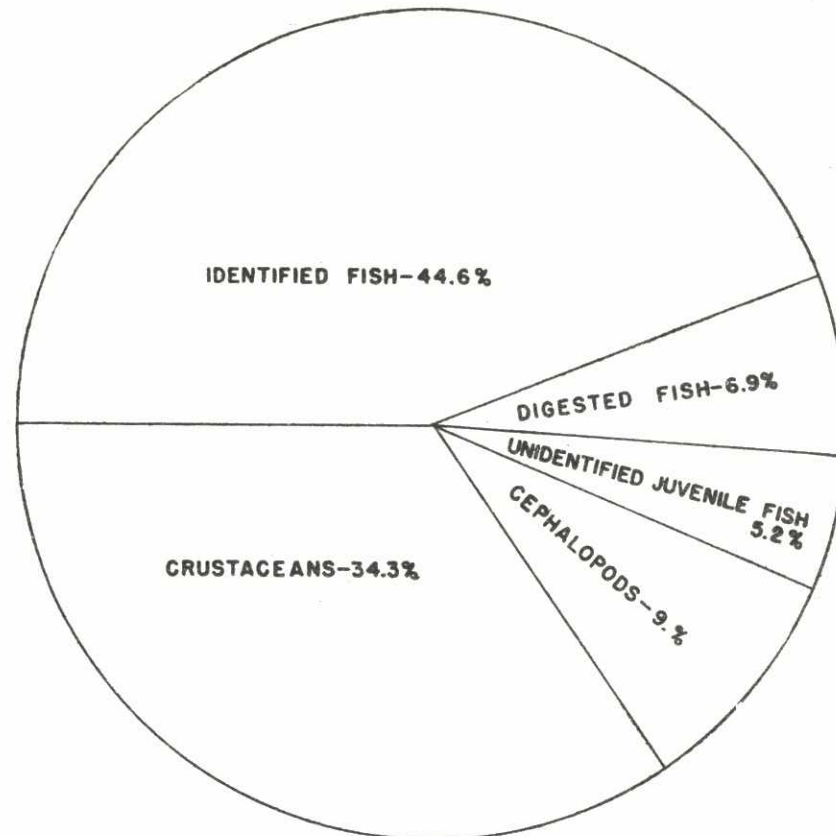


FIG. 1. Percentage of food items of Philippine tunas and dolphins determined on the basis of numbers found in the stomachs.

**IDENTIFIED FISHES.**—Fishes identified as to their respective families, genera, or species including seven tests of pelagic tunicates.

**FISH REMAINS.**—Unidentified fishes due to either partial or complete mutilation. The skulls and the vertebral columns were used in enumerating them.

**JUVENILE FISHES.**—Unidentified larvæ and juveniles which would be studied separately.

**CEPHALOPODS.**—Squids were the most common of the mollusks; however, some baby octopuses and paper nautilus (*Argonauta*) were recovered. Some pteropods were included in this group.

**CRUSTACEANS.**—The megalopa larva of crab was second only to the larval and juvenile stomatopods. Zoea larvæ were also found in fair quantities as well as some shrimps, amphipods, phyllosoma larvæ of spiny lobster, some barnacles, and young crabs.

The analyses revealed the following kinds of fish and other organisms recovered from the stomachs of these pelagic species. Fig. 2 gives a graphic representation in percentage of the different orders included in the identified fishes recovered.

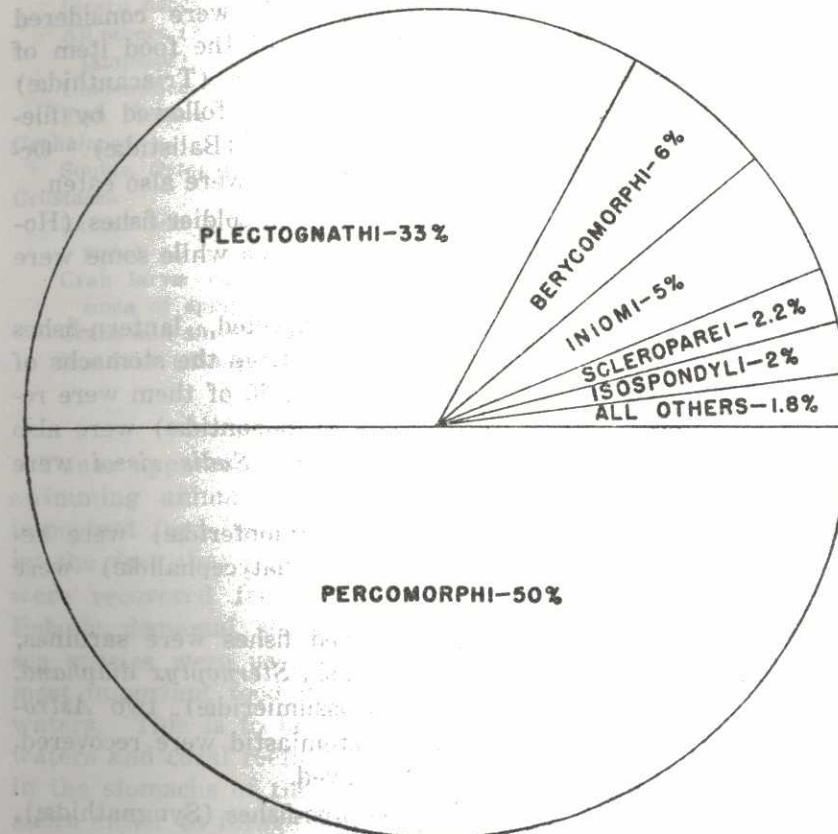


FIG. 2. Percentage of identified fish food items recovered from stomachs of Philippine tunas and dolphins.

**PERCOMORPHI.**—The *Acronurus* larvæ of the surgeon fish (Teuthididæ) were apparently the most common percomorph encountered. A collection of these larvæ and juveniles ranging from 10 mm to 45 mm in standard length was saved for further study. It is possible that some of these larvæ are those of other related species. Juveniles of the cutlass-fish, *Trichiurus*,

were occasionally found in quantities in some of the stomachs examined. Juveniles of both the pelagic and deep-sea species such as *Auxis*, *Caranx*, *Decapterus*, *Gempylus*, bramids, and chiasmodontids were found very often. Other percomorphs including the group of fishes which normally live near the shore and among the coral reefs were recovered. Among these were *Caesio*, *Siganus*, goat fishes (Mullidæ), butterfly-fishes (Chaetodontidæ), damsel fishes (Pomacentridæ), a wrass (Labridæ), and a parrot-fish (Scaridæ).

**PLECTOGNATHI.**—The plectognaths which were considered useless and poisonous, form a great bulk of the food item of these wanderers of the sea. The horn-fishes (Triacanthidæ) were the most common forms of this group followed by file-fishes (Monacanthidæ), and trigger-fishes (Balistidæ). Occasionally, *Tetraodon*, *Ostracion*, and *Diodon* were also eaten.

**BERYCOMORPHI.**—Those recovered were all soldier-fishes (Holocentridæ). Most of these were *Holocentrus* while some were *Myripristis*.

**INIOMI.**—Contrary to what was expected, lantern-fishes (Myctophidæ) were recovered only twice from the stomachs of tunas. However, in one *Euthynnus yaito*, 65 of them were recovered. Some juvenile lizard-fishes (Synodontidæ) were also seen. Five *Lestidium philippina* and two *Sudis rissoi* were saved.

**SCLEROPAREL.**—Flying gurnards (Dactylopteridæ) were recovered occasionally, and flat-heads (Platycephalidæ) were recorded twice.

**ISOSPONDYLI.**—Most of the soft-rayed fishes were sardines, *Sardinella*, and the deep-sea hatchet fish, *Sternoptyx diaphana*. However, a few round herrings (Dussumieridæ), two *Astro-nesthes*, one *Omosudis lowei*, and a stomiastid were recovered. A pair of chauliodontid jaws were saved.

**ALL OTHERS.**—This group included pipe-fishes (Syngnathidæ), cornet-fishes (Fistularidæ), shrimp-fishes (Centriscidæ), gar-fishes (Belonidæ), half-beaks (Hemiramphidæ), flying-fishes (Exocoetidæ), sea-moths (Pegasiidæ), an antigonid, and a *Leptocephalus* larva.

Table 2 indicates the various types of food consumed by tunas and dolphins and gives an adequate picture of the relative importance of each food in the diet.

TABLE 2.—Food classes consumed by tunas and dolphins, their total frequency of occurrence and percentage of occurrence

Fish	Total No. occurring	Frequency of occurrence	Percentage of occurrence
Spiny-rayed fishes (Percomorphi) .....	1,248	347	25.23
Horn-fishes, file-fishes, trigger-fishes, etc. (Plectognathi) .....	823	187	13.60
Squirrel fishes (Holocentridæ) .....	149	46	3.34
Flying gurnard and flat-heads (Scleroparei) .....	55	28	2.04
Herring-like fishes (Isospondyli) .....	52	52	1.82
Lizard fishes, lantern fishes (Iniomi) .....	127	21	1.53
All others (Flying fishes, pipe fishes, Hemiramphids) .....	51	18	1.31
Unidentified larval fishes .....	294	69	5.01
Fish Remains .....	389	121	8.81
Cephalopoda			
Squids, <i>Octopus</i> and <i>Argonauta</i> .....	504	113	8.22
Crustacea			
Larval and juvenile sea-mantis (Stomatopoda) .....	884	161	11.71
Crab larvæ (Zoea, megalopa, and phyllosoma of spiny lobster) .....	836	155	11.27
Crabs and shrimps .....	129	47	3.42
Sea fleas (Amphipoda) .....	72	37	2.69
	5,613		100.00

Tunas apparently do not choose their food. They eat any swimming animal available. Fish evidently form the most important food item of tuna (fig. 1). This is clearly shown by the fact that 51 families of fishes representing 11 orders were recovered from the stomachs of these pelagic fishes. Pelagic, demersal, shore and coral reef fishes as well as deep-sea species were used as food. Spiny-rayed fishes form the most important food item of tuna and dolphins in Philippine waters. This is to be expected since they are found in open waters and coral reefs. The presence of shore and reef fishes in the stomachs of these tuna indicates that they go near the shore either to forage or to follow their prey of small pelagic fishes and later eat whatever fishes that are found in the area. This is probably the reason why tuna are caught in fish corrals specially constructed for this purpose along the coasts of Batangas and Zamboanga Peninsula.

Among the juvenile fishes which frequently appeared besides the *Acronurus* larvæ were *Caranx*, *Holocentrus*, *Gempylus*, *Auxis*, *Dactyloptena*, *Trichiurus*, balistids, monacanthids, tetraodontids, triacanthids, chaetodontids, and bramids.

The most important single item of food of these pelagic species both in number of occurrence and number of individuals consists of the juveniles and larvæ of sea mantis (Stomatopoda). These are followed by the pelagic forms of squids among the mollusks and crab larvæ such as zoea and megalopa, among the crustaceans.

Some pelagic and deep-sea fishes which were either rare or encountered for the first time from the Philippine waters were recorded. Most of these specimens were partially digested and in a few cases only certain morphological characteristics of the body, namely, skull and dentition, were used to assign them to their respective families. However, almost perfect specimens of *Sudidæ*, *Bramidæ*, *Tetragonuridæ*, *Antigonidæ*, *Seriola nigrofasciata*, *Zanclus canescens*, *Gemphylus serpens*, and *Xiphasia setifer* were saved. Table 3 shows a list of these fishes.

TABLE 3.—Rare and deep-sea fishes found in the stomachs of Philippine tunas and dolphins

Name of fish	No. recovered	Species from which recovered
Astronesthidæ (?)	2 (partly mutilated)	<i>E. yaito</i> .
50 mm S.L.		
Chauliodontidæ (?)	1 (jaws only preserved)	<i>K. pelamis</i> .
	(some in good condition)	
<b>Sudidæ</b>		
<i>Lestidium philippina</i> (Fowler)	2	<i>N. macropterus</i> .
50-99 mm S.L.	2	<i>K. pelamis</i> .
<i>Sudis rissoi</i> Bonaparte*	2 (skinned)	<i>E. yaito</i> .
240 mm S.L.		
<b>Bramidæ</b>		
<i>Collybus drachme</i> Snyder*	3	<i>N. macropterus</i> .
23.72 mm S.L.	3	<i>K. pelamis</i> .
Unidentified	3	<i>N. macropterus</i> .
10-55 mm S.L.	10	<i>K. pelamis</i> .
<b>Teuthididæ</b>	225 (plenty in very good condition)	<i>N. macropterus</i> .
<i>Acronurus</i> larva	113	<i>K. pelamis</i> .
10-45 mm S.L.	6	<i>E. yaito</i> .
	4	<i>C. hippurus</i> .
<b>Tetragonuridæ</b>		
<i>Tetragonurus cuvieri</i> *		
Risso 33 mm S.L.	1 (excellent condition)	<i>N. macropterus</i> .
<b>Stomatidæ</b>	1 (partly digested)	<i>K. pelamis</i> .
83 mm S.L.		

\* First record in Philippine waters, to be reported later.

TABLE 3.—Rare and deep-sea fishes found in the stomachs of Philippine tunas and dolphins—Continued.

Name of fish	No. recovered	Species from which recovered
<b>Omosudidæ</b>		
<i>Omosudis lowei</i> Günther	1 (partly digested)	<i>K. pelamis</i> .
82 mm. S.L.		
<b>Sternoptychiidæ</b>		
<i>Sternotyz diaphana</i> Hermann	4 (some in fair condition)	<i>N. macropterus</i> .
15-39 mm S.L.	25	<i>K. pelamis</i> .
	1	<i>E. yaito</i> .
<b>Antigonidæ</b>		
<i>Antigonia</i>	1 (in good condition)	<i>N. macropterus</i> .
36 mm S. L.		
<b>Carangidæ</b>		
<i>Seriola nigrofasciata</i> (Ruppell)	1 (in good condition)	<i>N. macropterus</i> .
47 mm S. L.		
<b>Chiasmodontidæ</b>	4 (in good condition)	<i>N. macropterus</i> .
30-47 mm S.L.	3	<i>K. pelamis</i> .
<b>Zanclidæ</b>		
<i>Zanclus canescens</i> Linn.	3 (in good condition)	<i>C. hippurus</i> .
20-60 mm S.L.		
<b>Gempylidæ</b>	3 (in good condition)	<i>N. macropterus</i> .
<i>Gempylus serpens</i> C.&V.	12	<i>K. pelamis</i> .
35-170 mm S.L.	1	<i>E. yaito</i> .
<i>Rexia solandri</i> (Cuvier)	1 (some in fair condition)	<i>C. hippurus</i> .
78-124 mm. S. L.	9	<i>N. macropterus</i> .
		<i>K. pelamis</i> .
<b>Xiphasiidæ</b>		
<i>Xiphasia setifer</i> Swainson	1 (in good condition)	<i>N. macropterus</i> .
240-322 mm S.L.	1	<i>E. yaito</i> .
	1	<i>C. hippurus</i> .

TABLE 4.—List of organisms recovered from the stomach of tunas and dolphins

Name of fish	<i>N. macropterus</i>	<i>K. pelamis</i>	<i>E. yaito</i>	<i>C. hippurus</i>	Total
<b>Order Isospondyli:</b>					
<b>Clupeidæ</b>		5	4	1	10
<i>Sardinella</i>		8			8
<b>Dussumieriidæ</b>				2	2
<b>Sternoptychiidæ</b>					
<i>Sternotyz diaphana</i> Hermann	4	24	1		29
<b>Astronesthidæ</b>			2		2
<i>Astronesthes</i>					
<b>Stomiidæ</b>		1			1
<b>Order Iniom:</b>					
<b>Synodontidæ</b>	5	28		1	34
<b>Sudidæ</b>					
<i>Lestidium philippina</i> (Fowler)	2	2			4
<i>Sudis rissoi</i> Bonaparte			2		2
<b>Myctophidæ</b>	1	21	65		87

TABLE 4.—List of organisms recovered from the stomachs of tunas and dolphins—Continued

Name of fish	<i>N. mac-ropterus</i>	<i>K. pela-mis</i>	<i>E. yaito</i>	<i>C. hip-purus</i>	Total
Order Anodes:					
<i>Leptocephalus</i> larva		1			1
Order Syngnathiformes:					
Belontiidae				3	3
Heramphangidae		2	2	3	7
Exocoetidae	12	3		4	19
Order Solenichthyes:					
Fistulariidae		2			2
Centriscidae	1				1
Syngnathidae	3	3	1	1	8
Order Berycomorphi:					
Holocentridae	24	115	3	7	149
Order Zeomorphi:					
Antigonidae		1			1
Order Percomorphi:					
Priacanthidae	5	4	1	1	11
Lactariidae	5				5
Carangidae	39	44	5	3	91
<i>Caranx sexfasciatus</i> Q. & G.	11			1	12
<i>Decapterus</i>	9	7	21	3	40
<i>Seriola nigrofasciata</i> (Rüppell)	1				1
<i>Megalaspis cordyla</i> Linn.	1	1	1		2
Menidae					
<i>Mene maculata</i> (Bl. & S.-bn.)			23		23
Bramidae	6	13			19
Coryphaenidae					
<i>Coryphaena hippurus</i> Lac.		1		3	4
Lutjanidae					
<i>Caesio</i>		1	8		9
Polynemidae	1				1
Mullidae	25	13		32	70
Scatophagidae	2				2
Chaetodontidae	15	23	1		39
Pomacentridae	8	12	1		21
Scaridae				1	1
Chiasmodontidae	4	3			7
Zanclidae					
<i>Zanclus cornutus</i> Linn.				3	3
Teuthidae			4		4
<i>Acronurus</i> larvæ	225	132	6	4	367
Uranoscopidae	1				1
Labridae	1				1
Siganidae		1	1		2
Gempylidae					
<i>Gempylus serpens</i> C. & V.	3	12	1	2	18
<i>Rezia solandri</i> Cuvier	3	9			12
Trichiuridae	33	186		90	309
Scombridae					
<i>Euthynnus yaito</i> Kishinouye		4			4
<i>Auxis</i>	15	97	1	11	124
Tuna-like (juvenile)	16	21		1	38
Xiphasiidae					
<i>Xiphasia setifer</i> Swainson	1		1	1	3
Tetraodonidae					
<i>Tetraodon curieri</i> Risso	1				1
Blenniidae	3				3
Order Scleroparei:					
Platycephalidae	1		1		2
Dactylopteridae	14	34	1	4	53
Order Hypostomides:					
Pegasidae	2				2
Order Plectognathi:					
Triacanthidae	419	68	2		489
Balistidae	91	22		5	118
Ostracodontidae	26	2	1	1	30
Tetraodontidae	50	19	1	3	73
Diodontidae	3	2			5
Monacanthidae	51	37	12	5	105
<i>Pseudaluteres nasicornis</i> (Schlegel)	3				3
Digested Fishes	151	177	50	11	389
Unidentified Juvenile Fishes	66	226	2		294
Invertebrates:					
Phylum Mollusca					
S. O. Pteropoda	23				23
S. O. Decapoda (squids)	224	237			461

TABLE 4.—List of organisms recovered from the stomachs of tunas and dolphins—Continued

Name of fish	<i>N. mac-ropterus</i>	<i>K. pela-mis</i>	<i>E. yaito</i>	<i>C. hip-purus</i>	Total
S. O. Octopoda (Argonautidae) paper nautilus	16	4			20
Phylum Arthropoda					
Order Cirripedia (barnacle)	3				3
Order Amphipoda	32	40			72
Order Stomatopoda	527	257	89	11	884
Order Decapoda					
Zoea larva of crab	201	7			208
Megalopa larva of crab	274	118	200	4	596
Shrimps	96	29			125
Crabs	2	2			4
Phyllosoma larva of spiny lobster (Palinuridae)	9	23			32
Phylum Chordata:					
Subphylum Tunicata					
Class Thaliacea (Empty Test)	7				7

## SUMMARY

The stomachs of 115 yellowfin tunas, 115 skipjacks, 75 oceanic bonitos, and 26 dolphins were examined. These were collected mostly by the research vessel *Spencer F. Baird*, of the Philippine Fishery Program, U. S. Fish and Wildlife Service during the period from September, 1947 to June, 1949.

Fish form the most important item of the diet of these wanderers of the sea. These are either pelagic, demersal, shore, or coral reef fishes. The juveniles of fishes constitute the more common article of the diet. These are best represented by the *Acronurus* larvæ (Teuthidae).

The otherwise Plectognathic fishes not utilized as food for the table were found to be an important food item of these species and indicate that these wanderers of the sea go near the shore and coral reefs to forage there.

Of the larger fish included in the food items, a few specimens of *Auxis* about 250 mm F.L. were found in the stomachs of yellowfins 674 mm in fork length.

Rare and deep-sea fishes were seen in the stomachs of these species. Some of them were in good condition. Among these are three newly recorded from Philippine waters that will be described later.

Pelagic invertebrates also form an important food item of the tunas. In fact, the larvæ and juveniles of Stomatopoda form the most important single item of food both in numbers of individuals and number of occurrences. Other invertebrates found eaten are squids and juvenile octopuses among the mollusks, and crab larvæ such as zoea and megalopa. Shrimps and young crabs were also recorded.

These pelagic fishes are seemingly nonselective, that is, they are voracious eaters. They would eat any living organism available.

Fifty-one families of fishes, representing 11 orders, were recorded from the stomachs of these pelagic species in Philippine waters.

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## ILLUSTRATIONS

## TEXT FIGURES

- FIG. 1. Percentages of food items of Philippine tunas and dolphins determined on the basis of numbers formed in the stomachs.
2. Percentages of identified fish food items recovered from stomachs of Philippine tunas and dolphins.