FOOD OF TUNAS AND DOLPHINS (PISCES: SCOMBRIDAE AND CORYPHAENIDAE) WITH EMPHASIS ON THE DISTRIBUTION AND BIOLOGY OF THEIR PREY *STOLEPHORUS BUCCANEERI* (ENGRAULIDAE)

THOMAS S. HIDA[1]

ABSTRACT

The results of examining the stomach contents of skipjack tuna (*Katsuwonus pelamis*), bigeye tuna (*Thunnus obesus*), yellowfin tuna (*Thunnus albacares*), kawakawa (*Euthynnus affinis*), common dolphin (*Coryphaena hippurus*), and the little dolphin (*Coryphaena equiselis*) caught by live bait pole-and-line fishing and trolling in the equatorial eastern Pacific and around the Samoa Islands are presented. Fishes, crustaceans, and molluscs were found to be important food items. The presence of the anchovy, *Stolephorus buccaneeri*, among the stomach contents was of particular interest, and information gained on their distribution, size frequency, fecundity, and food habits is presented.

This report is based mainly on observations and stomach sample collections that were made during *Charles H. Gilbert* cruise 116 to the equatorial eastern Pacific in October-November 1969 (Hida, 1970a) and cruise 117 to the Samoa Islands in February-April 1970 (Hida, 1970b). In this study, *Stolephorus buccaneeri* was first found in the stomach contents of bigeye and skipjack tunas caught in the equatorial eastern Pacific and again in the stomach contents of tunas caught around the Samoa Islands. Since there has been no food study made of tunas and dolphins from these areas and very few reports on the distribution and biology of *S. buccaneeri*, it is the intent of this paper to (1) describe the food items of the tunas and dolphins caught in these two geographically distant and environmentally diverse—oceanic versus insular—areas, (2) extend the known distributional range of *S. buccaneeri*, (3) report on biological information obtained from the anchovy specimens. *Charles H. Gilbert* is a U.S. Department of Commerce, NOAA research vessel assigned to the Southwest Fisheries Center, Honolulu Laboratory, National Marine Fisheries Service. Objectives of the cruises were to assess the distribution and abundance of surface swimming tunas, to tag and release skipjack tuna (*Katsuwonus pelamis*) and yellowfin tuna (*Thunnus albacares*) for migration and growth studies, and to collect blood samples of these tunas for subpopulation studies. Tunas and dolphins were caught by live bait pole-and-line fishing and by trolling. Threadfin shad, *Dorosoma petenense*, were transported from Honolulu in baitwells on both cruises and used as chum for the fishing operation. It was the exclusive baitfish used on cruise 116, while on cruise 117 supplementary baitfishes, mostly sardines, *Sardinella melanura* and *Herklotsichthys punctatus*, and a mackerel, *Rastrelliger kanagurta*, were caught in Pago Pago Harbor and used. Since anchovies were not used as live bait on either cruise, the occurrence of *S. buccaneeri* in the stomachs of the tunas examined indicates that this species is a natural food item in this area.

Many studies have been made on the food and feeding habits of tunas in the Pacific. Ronquillo (1953) examined the stomach contents of yellowfin tuna, skipjack tuna, kawakawa (*Euthynnus affinis*), and the common dolphin (*Coryphaena hippurus*) caught in Philippine seas.

[1] Southwest Fisheries Center, National Marine Fisheries Service, NOAA, Honolulu, HI 96812.

Manuscript accepted July 1972.
FISHERY BULLETIN: VOL. 71, NO. 1, 1973.

He found that juvenile fish, especially the acronurus larvae of Acanthuridae, were most important in their diet. Also of importance were members of the fish families Trichiuridae, Scombridae, Triacanthidae, Holocentridae, Balistidae, and Monacanthidae, and invertebrates such as squids, larval and juvenile stomatopods, larval crabs and shrimp. Hotta and Ogawa (1955) examined the stomach contents of skipjack tuna caught to the east and south of the main Japanese islands and reported that Scombridae, Engraulidae, Exocoetidae, and Holocentridae were major dietary items. Important invertebrates included squids, crab larvae, euphausiids, and shrimp. Alverson (1963) examined the stomach contents of skipjack and yellowfin tunas caught in the eastern tropical Pacific. He found euphausiids to be the main food items for skipjack tuna, followed by Gonostomatidae, Exocoetidae, and the "red crab," *Pleuroncodes planipes*; and for yellowfin tuna, the "red crab," the swimming crab (Portunidae), Thunnidae, Ostraciidae, Exocoetidae, and Tetraodontidae. Waldron and King (1963) studied the stomach contents of skipjack tuna taken around the Hawaiian, Line, and Phoenix Islands and found that common dietary items were Gempylidae, Scombridae, Mullidae, Chaetodontidae, and Holocentridae. Larval and juvenile skipjack tuna, stomatopod larvae, shrimp, and crab megalops were also important. E. Nakamura (1965), upon examination of the stomach contents of skipjack tuna from the Marquesas and Tuamotu Islands, reported that scombrids, with skipjack tuna constituting a high percentage, were common food items. Serranidae, Lutjanidae, and Gempylidae were of importance as were stomatopods, crab megalops, and squids. It was concluded by Hotta and Ogawa (1955) that the tunas were nonselective in their feeding habits and ate whatever was available in the area.

Although these previous observations covered broad areas of the Pacific, no mention was made of any anchovy that may have been *S. buccaneeri* occurring in the stomach contents. An exception is a report by H. Nakamura (1936) on the food of yellowfin tuna caught in the Celebes Sea that mentioned an anchovy as one of the common food items. The area in which he found tunas containing the anchovy, the frequency of occurrence of the anchovy in tuna stomachs, and the numbers in which it occurred lead me to believe that it may have been *S. buccaneeri*.

METHODS

The stomachs of the troll and pole-and-line caught fish were removed after they were measured and sexed. Stomachs that appeared empty and those of most male tunas were examined in the field and their contents recorded. The rest were placed in muslin bags and preserved in 10% Formalin.[2] One of the objectives of the cruises was to collect 50 skipjack tuna and/or 50 yellowfin tuna blood samples from each school. Therefore, there were four occasions on which 50 stomach samples per school were collected.

In the laboratory, counts were made of the organisms in the stomachs whenever possible. Many of the partially digested fishes were identified by their vertebrae which were prepared by teasing away the muscles when necessary and staining with alizarin red. Skipjack tuna remains were identifiable by skeletons. Enough of the external characters of the anchovy usually remained for identification. Most of the other fishes were identifiable only to family. The stomach contents of the anchovy, which included many crustaceans, were identified by staining the organisms with methylene blue. Many of the copepods were identified to species but other invertebrates were identifiable only to major groups such as the Chaetognatha, Amphipoda, and shrimp.

STOMACH CONTENTS

EQUATORIAL EASTERN PACIFIC

The results of examining 268 skipjack tuna, 44 bigeye tuna (*Thunnus obesus*), 45 yellowfin tuna, 2 common dolphin, and 7 little dolphin (*Coryphaena equiselis*) caught on cruise 116 of the *Charles H. Gilbert* are presented in Table 1. The presence of *S. buccaneeri* in the stomach

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

TABLE 1.—Frequency occurrence of organisms in the stomachs of 268 skipjack tuna, 44 bigeye tuna, 45 yellowfin tuna, and 9 dolphin (2 common and 7 little) examined from cruise 116 of the *Charles H. Gilbert.*

Food items	Predators							
	Skipjack tuna		Bigeye tuna		Yellowfin tuna		Dolphin	
	No.	*%*	*No.*	*%*	*No.*	*%*	*No.*	*%*
Fishes:								
Alepisauridae	2	0.7	--	--	--	--	--	--
Bramidae	3	1.1	1	2.3	1	2.2	--	--
Chaetodontidae	--	--	1	2.3	--	--	--	--
Diodontidae	1	0.4	--	--	--	--	--	--
Engraulidae:								
Stolephorus buccaneeri	35	13.1	20	45.4	--	--	--	--
Exocoetidae	3	1.1	--	--	1	2.2	3	33.3
Gempylidae	4	1.5	4	9.1	4	8.9	--	--
Nomeidae	--	--	1	2.3	1	2.2	--	--
Scombridae:								
Auxis rochei	1	0.4	--	--	--	--	--	--
Katsuwonus pelamis	5	1.9	--	--	--	--	--	--
Sternoptychidae	--	--	1	2.3	--	--	--	--
Zeidae	--	--	1	2.3	--	--	--	--
Unidentified	9	3.4	1	2.3	7	15.6	2	22.2
Chum	100	37.3	20	45.4	22	48.9	--	--
Crustacea:								
Amphipoda	2	0.7	--	--	2	4.4	--	--
Euphausiacea	1	0.4	--	--	--	--	--	--
Shrimp	2	0.7	1	2.3	--	--	--	--
Mollusca:								
Argonauta	6	2.2	--	--	1	2.2	--	--
Heteropoda	1	0.4	--	--	3	6.7	--	--
Squids	22	8.2	6	13.6	8	17.8	2	22.2
Chaetognatha	1	0.4	--	--	--	--	--	--
Stomach empty	136	50.7	15	34.1	17	37.8	5	55.6

contents of 13.1% of the skipjack tuna and 45.4% of the bigeye tuna examined was of particular interest. Of the invertebrates, squids were most frequently found in the contents. Many of the stomachs examined were empty.

This study revealed that only a few varieties of organisms were eaten in the oceanic environment, which contrasted markedly with Ronquillo's (1953) work showing a great diversity of organisms eaten in an environment influenced by land. The fact that *S. buccaneeri* was found only in the stomachs of tunas from two schools that were close to each other suggests that it was not widespread in this area.

SAMOA ISLANDS

Table 2 shows the results of examining 205 skipjack tuna, 23 kawakawa, 24 yellowfin tuna, and 1 common dolphin which were caught on cruise 117 of the *Charles H. Gilbert. S. buccaneeri* occurred very frequently in the stomachs examined. Other fishes occurring frequently belonged to the families Acanthuridae and Holocentridae. Stomatopod larvae, of the invertebrates, occurred most frequently in the contents. Many of the stomachs examined were empty.

The variety of organisms eaten around the Samoa Islands was limited. However, a comparison of the studies shows a greater diversity ingested around Samoa than in the equatorial eastern Pacific, probably because of the proximity to the islands. The distribution of *S. buccaneeri* was found to be widespread in this area. Their frequency of occurrence in the stomachs suggested that they were an important forage for the tunas and dolphins here.

TABLE 2.—Frequency occurrence of organisms in the stomachs of 205 skipjack tuna, 23 kawakawa, 24 yellowfin tuna and 1 common dolphin, examined from cruise 117 of the *Charles H. Gilbert.*

Food items	Predators							
	Skipjack tuna		Bigeye tuna		Yellowfin tuna		Common dolphin	
	No.	*%*	*No.*	*%*	*No.*	*%*	*No.*	*%*
Fishes:								
Acanthuridae	45	22.0	1	4.3	4	16.7	--	--
Balistidae	13	6.3	2	8.7	1	4.2	--	--
Bramidae	--	--	--	--	1	4.2	--	--
Carangidae	3	1.5	--	--	--	--	--	--
Chaetodontidae	11	5.4	--	--	1	4.2	--	--
Dactylopteridae	1	0.5	--	--	--	--	--	--
Engraulidae:								
Stolephorus buccaneeri	38	18.5	4	17.4	6	25.0	1	100
Exocoetidae	5	2.4	--	--	--	--	--	--
Gempylidae	13	6.3	--	--	--	--	--	--
Holocentridae	61	29.8	2	8.7	2	8.3	--	--
Molidae	1	0.5	--	--	--	--	--	--
Monacanthidae	3	1.5	1	4.3	--	--	1	100
Mullidae	2	1.0	--	--	--	--	--	--
Ostraciidae	1	0.5	--	--	--	--	--	--
Pomacentridae	--	--	--	--	1	4.2	--	--
Scombridae:								
Katsuwonus pelamis	19	9.3	--	--	--	--	--	--
Unidentified	8	3.9	--	--	--	--	--	--
Siganidae	8	3.9	--	--	--	--	--	--
Synodontidae (?)	6	2.9	--	--	--	--	--	--
Tetraodontidae	2	1.0	--	--	--	--	--	--
Chum	66	32.2	--	--	--	--	--	--
Unidentified	36	17.6	2	8.7	2	8.3	1	100
Crustacea:								
Amphipoda:								
Phronima sp.	--	--	--	--	1	4.2	--	--
Crab megalops	2	1.0	2	8.7	--	--	--	--
Phyllosoma larvae	1	0.5	--	--	--	--	--	--
Shrimp	--	--	1	4.3	--	--	--	--
Stomatopod larvae	7	3.4	3	13.0	1	4.2	--	--
Mollusca:								
Squids	20	9.8	--	--	1	4.2	--	--
Stomach empty	64	31.0	14	60.8	10	41.7	--	--

NOTES ON *STOLEPHORUS BUCCANEERI*

DISTRIBUTION

Strasburg (1960) described *S. buccaneeri* from Hawaii and proposed the common name, roundhead. His holotype was a specimen taken in a nearshore bait seine haul close to Lehua Island. He also found a few specimens in the stomach contents of kawakawa caught about a mile offshore from Oahu. Matsui (1963) found this species in the bait samples he obtained around the island of Maui.

The abundance of *S. buccaneeri* in Hawaiian waters is not known. This is largely because the Hawaiian skipjack tuna fishermen use the anchovy, *Stolephorus purpureus*, as their principal baitfish. These two fish are almost identical and therefore difficult to distinguish from one another. Anchovies regurgitated on deck and found in the stomach contents of tunas are assumed to be their baitfish. At times, however, Hawaiian skipjack tuna fishermen have reported seeing skipjack tuna feeding on what they refer to as "offshore nehu" (liberal translation of the Japanese term used), which more than likely is *S. buccaneeri*. The distribution of *S. purpureus* is inshore while that of the *S. buccaneeri* seems to be generally offshore. It is therefore proposed that another common name of *S. buccaneeri* might be offshore nehu.

Besides Hawaii, Whitehead (1967) gave the distribution of the *S. buccaneeri* as the Red Sea,

Persian Gulf, Comoro Islands, east coast of Africa, Formosa, Hong Kong, Japan, the Philippines, Palau, southern India, and Singapore. He stated that they were very common in Hong Kong, Japan, and Hawaii.

Additional notes on the distribution of *S. buccaneeri* are given below; occurrences discussed are shown in Figure 1.

S. buccaneeri was first noticed on cruise 116 in the stomach contents of 4- to 12-kg bigeye tuna that were caught from a "boiling" school (see Scott, 1969) at lat 4°N and long 119°W. It was found again the next day in the stomach contents of skipjack tuna caught at lat 5°N on long 119°W, about 700 miles from Clipperton Island, the closest land. This occurrence is of interest because this species previously had been recorded only near land masses.

On cruise 117, *S. buccaneeri* was observed to be a common organism eaten by skipjack and yellowfin tunas, kawakawa, and dolphin caught around the Samoa Islands. Although it was very often eaten by tunas close to shore, it was neither seen nor caught while baiting in the inshore areas. Similarly, Robert E. K. D. Lee (pers. comm.) has found it eaten by yellowfin tuna and kawakawa caught near shore in the Fiji area but has not observed it during baiting operations in inshore waters.

In May of 1971 on cruise 53 of the *Townsend Cromwell*, *S. buccaneeri* juveniles were collected under a night light while the vessel was anchored in a depth of 25 m on Condor Reef in the Caroline Islands.

An estimated 20 kg of *S. buccaneeri* were caught in a close-to-surface haul made with a modified Cobb pelagic trawl (see Higgins, 1970 for a description of this trawl) 160 miles east of Agrihan Island in the Mariana Islands on cruise 55 of the *Cromwell* in November 1971. It was present in five other trawl hauls, in the stomach contents of a wahoo, *Acanthocybium solandri*, caught northwest of Ponape, and in several skipjack tuna caught by trolling north of Namorik during the same cruise.

John Naughton, National Marine Fisheries Service, Honolulu, informed me that several schools of yellowfin and skipjack tunas fished by the Hawaiian fishing vessel *Anela* around Majuro and Arno Atolls in April 1972 were feeding on schools of an anchovy resembling *S. buccaneeri*.

Wilson[3] cited that two Palauans trolling between Angaur and Peleliu Islands observed and sampled a school of kawakawa feeding on *S. buccaneeri*.

The occurrence of *S. buccaneeri* as discussed here in the equatorial eastern Pacific, Samoa Islands, Caroline Islands, Mariana Islands, Palau Islands, Marshall Islands, and Fiji in conjunction with previous records shows it to be a widespread Indo-Pacific (including eastern Pacific) species. Because it occurs in great abundance locally, such as at Fiji and the Samoa Islands, it is to be expected that details of its occurrence will be more likely noted.

SIZE

Most of the anchovies found in the stomach contents were in poor condition. The caudal fin and snout of many specimens were so badly digested that their standard lengths could only be estimated. The *S. buccaneeri* found in the bigeye tuna stomachs ranged from 30 to 57 mm in standard length (SL). Those found eaten by the skipjack tuna ranged from 20 to 58 mm. Those caught on cruise 117 of the *Charles H. Gilbert* near Samoa ranged from 23 to 78 mm. The samples from Condor Reef measured 15 to 30 mm while those from the trawl hauls caught close to the Mariana Islands ranged from 14 to 70 mm. The small postlarvae were semitransparent when alive and turned whitish when preserved in Formalin. They were identified by their exposed urohyal plate and posterior extent of their maxilla.

The presence of large numbers of postlarvae more than 100 miles from land, and adults as far as 700 miles from land, strongly suggests that this species is capable of completing its life cycle in an oceanic environment.

[3] Wilson, P. T. Observations of various tuna bait species and their habitats in the Palau Islands. Unpublished manuscript. Marine Resources Division, Trust Territory of the Pacific Islands, Saipan, Marianas 96950.

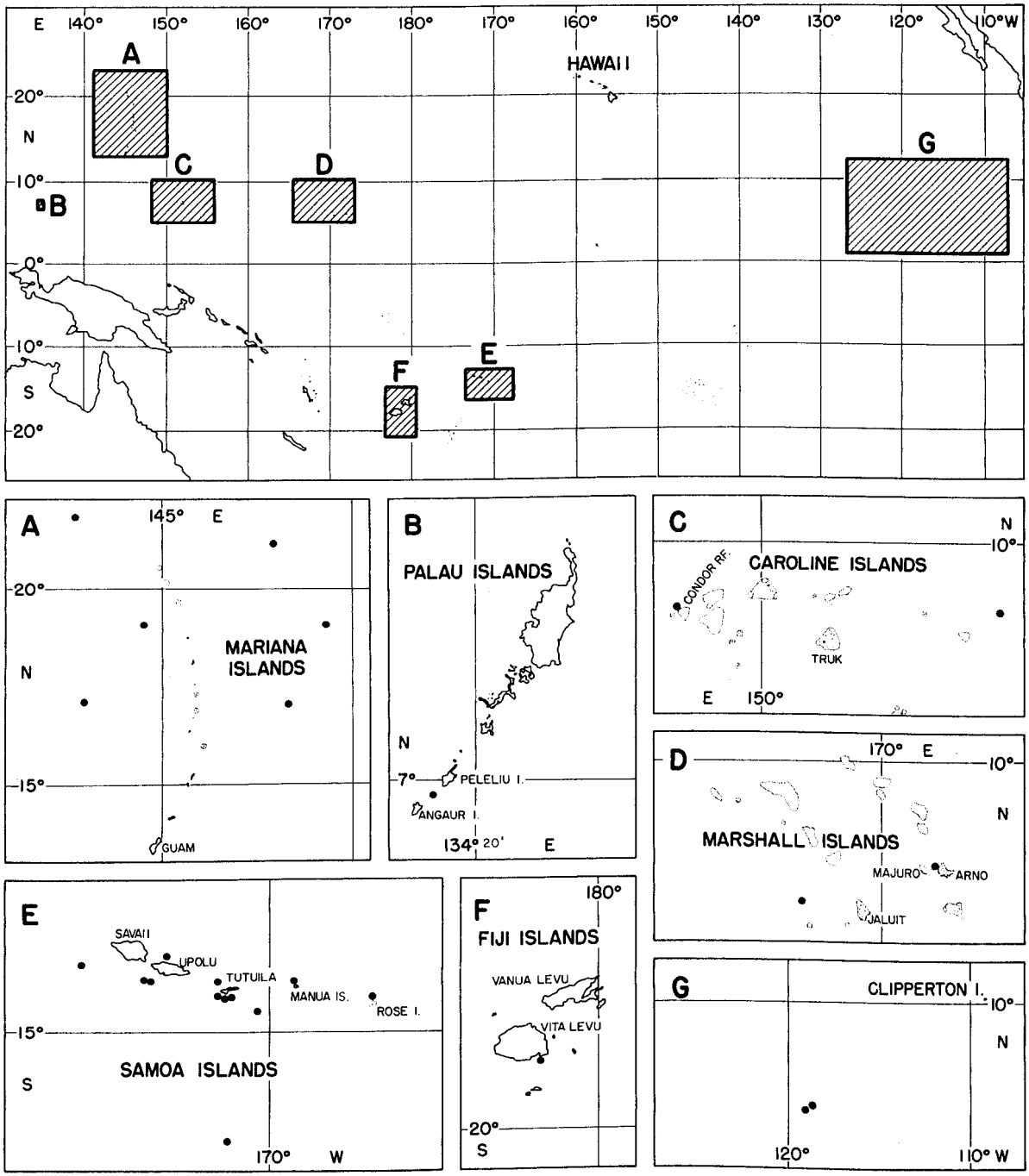

FIGURE 1.—The distribution of *Stolephorus buccaneeri* in the Pacific covered in this study.

FECUNDITY

Ova of 32 specimens of *S. buccaneeri* obtained from tuna stomach contents were measured: Specimens were 38-55 mm SL. From each subsample, diameters of 30 or more of the ova from the most advanced mode were taken. Their distribution ranged from 0.4 to 0.8 mm and peaked at 0.5 mm. The ova were opaque, granulated, and classified as maturing.

Since there are no previous estimates of fecundity, ova from the most advanced mode from two *S. buccaneeri* ovaries were counted. This method was based on the assumption that all of the ova in this mode constituted a single spawning. A 44-mm specimen contained 595 ova in her left ovary and 830 in her right, a total of 1,398. A 39-mm individual had 340 ova in her left ovary and 454 in her right, a total of 794.

FOOD STUDY

The examination of 58 stomach contents of *S. buccaneeri* recovered from tuna stomachs showed that crustaceans were important in their diet, as shown in Table 3. Only one stomach was found empty. The stomachs of *S. buccaneeri* in this study contained primarily calanoid copepods and other organisms. The copepods that were abundant in one or more anchovy stomachs from the equatorial eastern Pacific were *Candacia truncata* and *Euchaeta marina*. The cyclopoid copepod, *Oncaea venusta*, was common in one stomach. Copepods found in abundance in one or more anchovy stomachs taken from tunas caught from the Samoa Islands were *Candacia bispinosa* (?) *C. catula, C. truncata, Centropages gracilis, Euchaeta marina* and *Temora discaudata*. *C. truncata* and *E. marina* were the only two species that were abundant in both areas. Not unexpectedly, the close-to-shore samples from Samoa were represented by more species than those of the oceanic equatorial eastern Pacific. It should be noted, however, that there were many copepodites and badly digested specimens in the equatorial eastern Pacific samples, while those from the Samoa Islands were larger and in much better condition for identification purposes. Hiatt (1951) examined the stomach contents of the nehu, *S. purpureus*, caught from five major baiting areas in Hawaii and concluded that nehu were selective feeders in that they took the crustacean elements in the plankton. He found important food items to be copepods, ghost shrimp (*Lucifer*), barnacle nauplii, shrimp larvae, and crab larvae.

ACKNOWLEDGMENTS

I am indebted to Peter Whitehead of the British Museum (Natural History) for his identification and verification of *S. buccaneeri* samples. Thanks are also due to the crew members and scientific personnel of *Charles H. Gilbert* who were instrumental in collecting the samples.

LITERATURE CITED

ALVERSON, F. G.
1963. The food of yellowfin and skipjack tunas in the Eastern Tropical Pacific Ocean. Bull. Inter-Am. Trop. Tuna Comm. 7:293-396.

HIATT, R. W.
1951. Food and feeding habits of the nehu, *Stolephorus purpureus* Fowler. Pac. Sci. 5:347-358.

HIDA, T. S.
1970a. Surface tuna schools located & fished in equatorial eastern Pacific. Commer. Fish. Rev. 32(4):34-37.
1970b. Surface tuna-school fishing & baiting around Samoa Islands. Commer. Fish. Rev. 32(12):37-41.

HIGGINS, B. E.
1970. Juvenile tunas collected by midwater trawling in Hawaiian waters, July-September 1967. Trans. Am. Fish. Soc. 99:60-69.

HOTTA, H., AND T. OGAWA.
1955. On the stomach contents of the skipjack, *Katsuwonus pelamis*. Bull. Tohoku Reg. Fish. Res. Lab. 4:62-82.

MATSUI, T.
1963. Population of anchovy baitfish (*Stolephorus*) in the vicinity of Maui, Hawaiian Islands. M.S. Thesis, Univ. Hawaii, Honolulu, 98 p.

NAKAMURA, E. L.
1965. Food and feeding habits of skipjack tuna (*Katsuwonus pelamis*) from the Marquesas and Tuamotu Islands. Trans. Am. Fish. Soc. 94:236-242.

TABLE 3.—The stomach contents of *Stolephorus buccaneeri* found in tuna stomachs in the equatorial eastern Pacific and the Samoa Islands (A = abundant, C = common, P = present). [The numbers examined are in parentheses.]

Food items	Samoa Islands			Equatorial eastern Pacific	
	Skipjack tuna (10)	Yellowfin tuna (6)	Kawakawa (4)	Bigeye tuna (23)	Skipjack tuna (15)
Copepoda:					
Calanoids:					
Candacia bispinosa (?)	A	--	--	--	--
Candacia catula	A	P	--	--	--
Candacia simplex	P	--	--	--	--
Candacia truncata	A	--	--	--	A
Candacia sp.	--	--	P	--	--
Centropages gracilis	A	--	--	--	--
Centropages sp.	--	--	P	--	--
Eucalanus sp.	--	--	P	--	--
Euchaeta concinna	P	--	--	--	--
Euchaeta marina	A	--	--	A	--
Euchaeta sp.	--	--	P	P	P
Lucicutia flavicornis	P	--	--	--	--
Nannocalanus minor (?)	--	P	--	--	--
Pleuromamma xiphias	P	--	--	--	--
Scolecithricella ctenopus	P	--	--	--	--
Scolecithrix danae (?)	C	--	--	--	--
Temora discaudata	A	P	--	--	--
Temora sp.	--	--	P	--	--
Undinula darwini	P	--	--	--	--
Unidentified calanoids	P	P	P	C	A
Cyclopoids:					
Copilia mirabilis	P	--	--	--	--
Copilia sp.	--	--	P	--	--
Corycaeus limbatus (?)	--	P	--	--	--
Corycaeus speciosus	P	--	--	P	--
Corycaeus vitreus (?)	P	--	--	--	--
Corycaeus sp.	P	P	--	P	P
Farranula concinna (?)	P	--	--	--	--
Farranula gibbula (?)	P	P	--	--	--
Farranula sp.	--	P	P	P	--
Microsetella rosea	P	P	--	--	--
Microsetella norvegica (?)	--	P	--	--	--
Oncaea conifera	--	--	--	P	--
Oncaea venusta	--	--	--	C	--
Oncaea sp.	P	P	--	P	P
Sapphirina gastrica (?)	P	--	--	--	--
Sapphirina sp.	P	--	P	P	--
Unidentified cyclopoids	--	P	P	A	C
Amphipoda	P	--	--	--	--
Mysidacea	--	--	--	P	--
Shrimp juvenile	C	P	P	P	P
Crab megalops	--	--	P	--	--
Chaetognatha	A	P	P	P	P
Gastropod larvae	P	P	--	--	--
Heteropoda:					
Atlanta inclinata	P	--	--	--	--
Atlanta sp.	P	--	--	--	--
Bivalve larvae	--	P	--	--	--
Ostracoda	P	P	--	--	--
Polychaeta	P	--	--	--	--
Pteropoda:					
Creseis virgula	--	--	--	--	P
Unidentified fish	P	--	P	--	--

NAKAMURA, H.
1936. The food habits of yellowfin tuna *Neothunnus macropterus* (Schlegel) from the Celebes Sea. Trans. Nat. Hist. Soc. Formosa 26(148):1-8. (English transl. in U.S. Fish Wildl. Serv., Spec. Sci. Rep. Fish. 23, 8 p., 1950).

RONQUILLO, I. A.
1953. Food habits of tunas and dolphins based upon the examination of their stomach contents. Philipp. J. Fish. 2(1):71-83.

SCOTT, J. M.
1969. Tuna schooling terminology. Calif. Fish Game 55:136-140.

STRASBURG, D. W.
1960. A new Hawaiian engraulid fish. Pac. Sci. 14: 395-399.

WALDRON, K. D., AND J. E. KING.
1963. Food of skipjack in the central Pacific. FAO (Food Agric. Organ. U.N.) Fish Rep. 6:1431-1457.

WHITEHEAD, P. J. P.
1967. The clupeoid fishes of Malaya. A synopsis with keys to all Indo-Pacific genera. J. Mar. Biol. Assoc. India 9(2):223-280.