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THE IDENTIFICATION OF
COMMERCIALY IMPORTANT
BAITFISHES IN THE FIJIAN
SKIPJACK TUNA FISHERY

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THE IDENTIFICATION OF COMMERCIALY IMPORTANT BAITFISHES
IN THE FIJIAN SKIPJACK TUNA FACTORY

by

Wayne J. Baldwin

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ABSTRACT

Descriptive characters useful in the identification of 33 species of commercially important baitfishes employed in the capture of skipjack tuna are given. These species are usually captured in Fiji by bouki-ami net using submerged lights from commercial pole-and-line vessels. The families and number of species investigated include Clupeidae (subfamilies Clupeinae, Dussumieriinae, Spratelloidinae) (11), Engraulidae (8), Atherinidae (3), Apogonidae (2), Lutjanidae (7), and Scombridae (2). In addition a list of 37 families of fishes captured incidentally with the above baitfishes is included. Keys to the genus Stolephorus and subfamilies Clupeinae and Dussumieriinae that are known to occur in Fiji are given. Stolephorus apiensis (Jordan and Seale, 1906) previously placed in synonymy is herein recognized as a valid species. S. oligobranchus Wongratana is recorded for the first time from Fiji. A brief description of each species is included plus a detailed description and figure of S. apiensis.

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INTRODUCTION

In 1971 the Government of Fiji with assistance from the United Nations Development Program and the Food and Agriculture Organization of the United Nations initiated a study to determine the feasibility of developing a commercial skipjack tuna (*Katsuwonus pelamis*) fishery. This investigation (UNDP/FAO, 1974) indicated that the existing baitfish resources are capable of supporting a pole-and-line fishery of 3,700 - 4,600 metric tons or larger and operating at least 10 modern tuna vessels in the 21.4 - 22.9-m size range. An increase in the tuna production beyond this level will depend upon whether the supplies of baitfishes can be increased. A previous commercial venture failed (UNDP/FAO, 1969) in spite of the fact that skipjack tuna was reported to be abundant in the area. Commercial quantities of skipjack tuna were also reported by Uchida and Sumida (1973), and Lee (1973).

The current tuna fishery, established in 1975, has gradually increased in size through the efforts of the Government of Fiji and Ika Corporation to an annual production of 5,900 metric tons in 1981 (Anonymous, 1981b). In 1975 and 1976 the baitfish resources seemed relatively stable and apparently in sufficient quantity to support the demands of this growing pole-and-line fishery. Since 1976 the average baitfish catch per set for the combined Fijian fleet (Ellway and Kearney, 1981; Kearney, 1982) declined consistently with subsequent reduced catches of skipjack tuna. However, in 1981 the baitfish catch increased to 40.92 buckets (73.7 kg) per set and approximately doubled the 1980 catch of 22.3 buckets (40.1 kg) per set (Anonymous, 1981b). Since the catches of skipjack tuna are directly dependent upon the availability of local baitfishes, investigations are in progress by the Fisheries Division, Ministry of Agriculture and Fisheries (MAF), Government of Fiji; and the Institute of Marine Resources (IMR), University of the South Pacific, on the taxonomy and biology of economically important species.

In an effort to provide the necessary data that will lead towards future resource management and utilization and fishery development strategies it is essential to understand the biology, distribution, seasonal availability, etc., of the commercially important baitfishes. The correct identification of species belonging to the families Clupeidae (herrings, sardines), Engraulidae (anchovies), and Atherinidae (silversides) can be difficult to hopelessly confusing. Many species are wide ranging forms subject to geographical variation and morphological changes correlated with growth. In addition, the existing literature is scattered as a result of independent regional studies and not always applicable for identifying baitfishes from distant localities.

This report is the result of studies conducted at the University of the South Pacific from October 1981 to April 1982, in cooperation with IMR personnel involved in baitfish research (Anonymous, 1981a). The primary goal of this study was to conduct investigations on baitfishes and to collate information that will assist in the identification of commercially important species captured in Fiji using the Japanese-style bouki-ami net technique. A critical examination of baitfish samples on the shelves at IMR provided valuable information leading towards a better understanding of baitfish identification and assisted towards solving some long standing taxonomic problems.

MATERIALS AND METHODS

The major portion of the preserved study specimens was collected from 1979 to 1982 by the M.V. *Sunbird* and *Ika #5*, both commercial skipjack tuna vessels, and the 12.2 m IMR research vessel *Nautilus*. Additional specimens were made available for study from the Fisheries Division, MAF, that included anchovies (Engraulidae), various species of fusiliers (Lutjanidae), and clupeids (Clupeidae). In addition, specimens of engraulids and clupeids in the Bernice P. Bishop Museum (BPBM) were examined and pertinent information regarding these is included where applicable.

The method routinely employed for capturing baitfishes by commercial vessels in Fiji is the Japanese-style stick-held dip net, or bouki-ami net, used in conjunction with one or more submerged night lights. The general method of using a bouki-ami net is described by Ben-Yami (1980), Iwasa and Mizuno (1979), and Lee (1973). A scaled-down model of the bouki-ami net was constructed at IMR for use aboard the R.V. *Nautilus*. This equipment and its operation are described by Ram and Southwick (1981).

The various counts listed under each species were made with the aid of a binocular microscope. The dorsal and anal fin ray counts included rudimentary rays. The number of scale rows was usually determined by counting the scales in a longitudinal series along mid-body from the operculum to the base of the caudal fin. In cases where the scales were missing, such as in most of the engraulids and some of the clupeids, the scale pockets were counted. Measurements such as head length and body depth are expressed as a proportion of standard length (SL).

The number of gill rakers on the first gill arch is expressed as the number of rakers on the upper limb plus the number on the lower limb followed by the total. Any gill raker at the center between the upper and lower limbs was included in the count of the lower limb. The width of the preoperculum relative to that of the operculum was measured perpendicular to the preopercular ridge at the level of the lower border of the eye (Lewis et al., 1974).

Each species is listed alphabetically under family followed by the original citation and type locality. Many of these citations were copied from other sources. All counts and proportional measurements are from specimens captured in Fijian waters unless otherwise noted.

BAITFISH FAMILIES

Clupeidae -- herrings and sardines

Subfamily Clupeinae: Approximately 30 ventral scutes present usually with a sharp keel or posteriorly-directed spine; body compressed, snout not projecting; scales cycloid, thin, and deciduous; gill membranes free from isthmus; gill rakers slender, numerous, occasionally quite variable in number; mouth terminal, jaws nonprotractile, maxillary with two supplemental bones; 6-15 branchiostegal rays; teeth small and feeble; dorsal fin located about over center of body; anal fin longer than dorsal fin and usually posterior to dorsal fin; ventral fins opposite dorsal fin.

Species Occurring in Fiji

Amblygaster clupeioides (Bleeker)
A. stym (Walbaum)
Herklotsichthys quadrimaculatus (Rüppell)
Sardinella fijiensis (Fowler and Bean)
S. fimbriata (Valenciennes)
S. jussieu (Lacépède)
S. melanura (Cuvier)

Subfamilies Dussumieriinae and Spratelloidinae: Body subcylindrical to rounded, with or without a silver lateral stripe; no ventral scutes and with belly smooth and rounded; no lateral line, scales cycloid and deciduous; 6-15 branchiostegal rays; gill membranes separate and free from the isthmus; dorsal fin base longer than anal fin base; anal fin notably posterior to dorsal fin.

Species Occurring in Fiji

Subfamily Dussumieriinae:

Dussumieria species A
D. species B

Subfamily Spratelloidinae:

Spratelloides delicatulus (Bennett)
S. gracilis (Schlegel)

Engraulidae -- anchovies

Snout prominent and projecting beyond lower jaw; body elongate, subcylindrical, usually with a silver lateral stripe along sides; scales cycloid and deciduous; no lateral line; 7-19 branchiostegal rays; ventral fins anterior to origin of dorsal fin; maxillary projecting posterior to eye; teeth uniserial and small in size; usually less than 10 ventral scutes located anterior to pelvic fins. *Thryssa baelama* has 13-17 ventral scutes that extend posterior of the pelvic fin base.

Species Occurring in Fiji

Stolephorus apiensis (Jordan & Seale)
S. devisi (Whitley)
S. heterolobus (Rüppell)
S. indicus (Van Hasslet)
S. insularis Hardenberg (= *S. bataviensis*)
S. oligobranchus Wongratana
S. punctifer (Fowler) (= *S. buccaneeri*)
Thryssa baelama (Forskål)

Atherinidae -- silversides

Body subcylindrical to rounded with a broad silvery stripe along sides; no lateral line; scales cycloid; relatively large and firmly attached; 2

dorsal fins widely separated; pelvic fins anterior to dorsal fin origin; mouth terminal with the maxillary not extending posterior to front of eye; abdomen usually rounded.

Important Baitfish Species

Atherinomorus lacunosus (Schneider)
Hypoatherina ovalaua (Herre)
Stenatherina panatela (Jordan & Richardson)

Apogonidae -- cardinalfishes

Body oblong, subcylindrical, brightly colored in some species; two separate dorsal fins, the first with 6-8 spines, the second with 8-14 soft rays; anal fin below second dorsal fin, with 2 spines and 8-18 soft rays; scales usually cycloid and relatively large; lateral line complete or incomplete; preoperculum with a double edge, serrate or entire; operculum with 1-2 spines and a pointed fleshy flap; mouth large, lower jaw occasionally protrudes; small villiform teeth in jaws with anterior teeth enlarged; pelvic fins thoracic.

Important Baitfish Species

Rhabdamia cypselurus Weber
R. gracilis (Bleeker)

Lutjanidae - fusiliers only

(Greenwood et al. [1966] were followed in placing the fusiliers in the family Lutjanidae.)

Body subcylindrical to somewhat compressed and variable in color; a single continuous dorsal fin occasionally with a notch between spinous and soft-rayed portions; anal fin with three spines; pelvic fins below pectoral fin base, with scaly axillary process; scales small, weakly ctenoid, occasionally on median fins; cheeks and operculum with scales; lateral line continuous; most species with enlarged canine teeth in jaws (fusiliers have small pointed teeth).

Important Baitfish Species

Caesio coeruleaureus Lacépède
Dipterygonotus laucogrammicus (Bleeker)
Gymnocaesio gymnopterus (Bleeker)
Pterocaesio diagramma (Bleeker)
P. pisang (Bleeker)
P. tile (Cuvier and Valenciennes)
P. species

Scombridae -- tunas and mackerels

Body elongate and fusiform; snout pointed; adipose eyelid present in *Rastrelliger* and *Scomber*; teeth in jaws strong to weak, no true canines;

two dorsal fins separated by a space; dorsal and anal fins followed by finlets; caudal fin deeply forked; at least two small keels on caudal peduncle; body either covered with small scales or with a corselet of scales behind head.

Important Baitfish Species

Rastrelliger brachysoma (Bleeker)
R. kanagurta (Cuvier)

In addition to the six families and 33 species of economically important baitfishes given above many diverse families of fishes routinely show up in the bouki-ami net collections. Most of these are juvenile inshore fishes that are attracted to the night lights used in the bouki-ami net fishing and individuals that are occasionally swept into the net capture area by surface currents. Random samples made of bait collections taken aboard the *Sunbird* and *Ika #5* from 1979-81 were examined to determine the species composition and frequency of occurrence. This work will be reported in more detail at a later date. The list of families encountered in addition to the six families noted above and the approximate number of species in each are given below. The majority of these are of minor importance as baitfishes for tuna since their frequency of occurrence is quite small when compared to the large volume of small fishes required for pole-and-line fishing. No effort is made by the fishermen to capture these specifically. They occur incidentally in the baitfish catches from time to time and are used along with the preferred bait species accordingly. However, many families represent economically important fishes that are captured by other means as adults by commercial, recreational, and subsistence fishermen in Fiji throughout the year.

<u>Family</u>	<u>Number of Species</u>
Acanthuridae	8
Albulidae	1
Aluteridae	2
Ambassidae	1
Anthiidae	1
Balistidae	1
Belonidae	1
Bleimiidae	3
Bregmacerotidae	1
Canthigasteridae	1
Carangidae	8
Chaetodontidae	6
Echeneidae	1
Fistulariidae	2
Hemiramphidae	2
Holocentridae	7
Lacteriidae	1
Lagocephalidae	1
Leiognathidae	4
Lutjanidae (non fusiliers)	4
Monacanthidae	1
Mugilidae	1
Mullidae	11
Muraenidae	1
Myctophidae	2
Pempheridae	1
Pomacentridae	13
Priacanthidae	1
Scorpaenidae	1
Serranidae	1
Siganidae	6
Sphyraenidae	3
Syngnathidae	1
Synodontidae	4
Tetraodontidae	1
Teraponidae	1
Trichiuridae	1
<hr/>	
Total: 43	139

ENGRAULIDAE

Key to the genus *Stolephorus* known to occur in Fiji

(*Thryssa baelama* may superficially resemble *Stolephorus*. However, it has 30 to 34 anal fin rays and 13 to 17 ventral scutes while *Stolephorus* has 14 to 22 anal fin rays and a maximum of 8 ventral scutes.)

- A. Origin of the anal fin directly below or posterior to the base of the last dorsal fin ray. Muscular portion of the isthmus short, not extending forward to the branchiostegal membrane and having a shield-like expansion on the urohyal.
1. Maxillary short, not reaching past anterior margin of preopercle; no enlarged recurved teeth near distal end of maxillary.
 - a. Maxillary quite short, bluntly rounded at its tip and not reaching posteriorly to the anterior preopercle margin (Figure 1A); anal fin with 14-16 rays; gill rakers 15-20 + 23-26, total 39-44 *S. punctifer*
 - b. Maxillary not as short and reaching posteriorly to the anterior margin of preopercle, tip of maxillary bluntly pointed, gill rakers 15 +18, total 33 *S. oligobranchus*
 2. Maxillary moderately long and bluntly pointed at its tip, and extending to or slightly past anterior margin of preopercle; several enlarged, recurved teeth on distal end of maxillary.
 - a. Preoperculum narrow, one-half to two-thirds width of the operculum; origin of dorsal fin about equidistant between upper caudal base and tip of snout; width of body slightly greater than depth of caudal peduncle; silvery lateral stripe usually sharply demarcated along upper and lower margins becoming indistinct anteriorly *S. heterolobus*
 - b. Preoperculum wide, its width equal to or greater than width of the operculum; origin of dorsal fin one-half to one eye diameter closer to upper base of caudal fin than to tip of snout; width of body equal to depth of caudal peduncle; silvery lateral stripe not as above, usually without a sharp demarcation along upper and lower margins *E. devisi*
- B. Origin of anal fin below central third of dorsal fin base. Muscular portion of the isthmus long, extending forward to or past the margin of the branchiostegal membrane and without a shield-like expansion on the urohyal.
1. Maxillary notably long and slender and reaching margin of opercle (Figure 1F); gill rakers 15-18 + 21-23, total 37-40; dorsal fin rays 16-17, anal fin rays 21-23 *S. insularis*
 2. Maxillary short and relatively blunt, tip of maxillary not reaching to posterior margin of preopercle (Figure 1D); body slender, its depth 5.5-6.0 in SL; anal fin rays 19-20; dorsal fin rays 15-16; gill rakers 16-18 +24-26, total 39-43; posterior frontal fontanelles narrow with straight lateral margins . . . *S. indicus*
 3. Maxillary longer and moderately pointed, tip of maxillary usually reaching posterior margin of preopercle (Figure 1E); body not slender, its depth 4.6-4.9 in SL; anal fin rays 19-22; dorsal fin rays 15-17; gill rakers 21-25 + 28-32, total 49-55; posterior frontal fontanelles somewhat broader and with the lateral margins slightly sigmoid *S. apiensis*

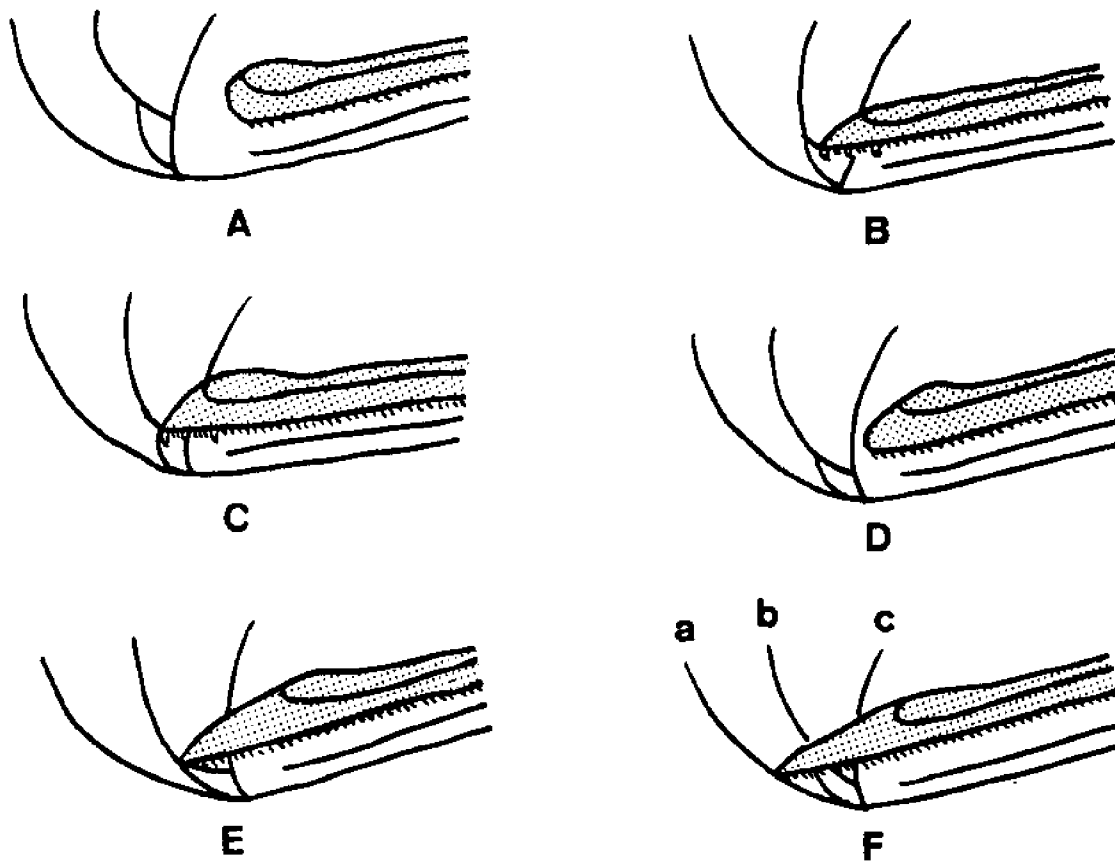


Figure 1. Length and relative shape of the maxillary (stipled portion) in Fijian *Stolephorus* anchovies (a, posterior margin of opercle; b, posterior margin of preopercle; c, anterior margin of preopercle). A, *S. punctifer*; B, *S. heterolobus*; C, *S. devisi*; D, *S. indicus*; E, *S. apiensis*; F, *S. insularis*.

Stolephorus punctifer (Fowler), *Acad. Nat. Sci. Phila., Monogr.* 2, fig. 13, pp. 156-157, 1938 (type locality: Fare Bay, Huaheine Island). (= *S. buccaneeri* Strasburg).

Origin of the anal fin located approximately one eye diameter behind the last dorsal fin ray; a conspicuous silvery lateral stripe along mid-body (dark when preserved); origin of dorsal fin equidistant from tip of snout and base of caudal fin; distance between tip of depressed pectoral fin and base of ventral fin equal to twice diameter of orbit; snout less than diameter of orbit; posterior end of maxillary bluntly rounded or truncate and not reaching anterior border of preopercle (Figure 1A); teeth fine and without enlarged recurved teeth as in *S. heterolobus*; head short, its length contained 4.1-4.7 in SL.

Dorsal fin: 13-15

Anal fin: 14-16

Pectoral fin: 14-15

Gill rakers: 15-20 + 23-26. Total gill rakers: 39-44

Scale rows: 42

Ventral scutes: 4-7

The above measurements and counts were taken from 13 specimens (35.0-69.0 mm SL) collected at Viani, Fiji, aboard the *Sunbird* on May 6, 1981. It is relatively common in the bouki-ami net collections and can be identified with little difficulty by the following characters: anal origin about one eye diameter posterior of last dorsal ray; short, blunt maxillary not reaching anterior edge of preoperculum; a noticeable silvery stripe along mid-body; wide space between tip of pectorals and base of ventral fins; and short, blunt snout about .75 into diameter of orbit. Also, width of body at origin of dorsal fin is greater than the caudal peduncle depth.

The pectoral fin ray, gill raker, and longitudinal scale counts of the Fijian material do not agree exactly with Strasburg's (1960) counts of his Hawaiian material listed as *S. buccaneeri*. He recorded a pectoral fin ray count of 14-17 and a total gill raker count of 41-43. This slight difference can probably be attributed to geographical variation of a wide-ranging species and there appears no reason to question the identification of the Fijian specimens.

Nelson and Whitehead (1981) and Nelson (1983) place *S. punctifer*, *S. purpureus*, *S. heterolobus*, *S. devisi*, and *S. oligobranchus* in the genus *Encrasicholina*. However, for the sake of uniformity, the preference here is to retain these in the genus *Stolephorus* as does Wongratana (1983).

Stolephorus oligobranchus Wongratana, *Jap. Jour. Ichthy.*, vol. 29, no. 4, p. 397, pl. 15, 1983 (type locality: Manila Bay, Philippines).

Location of anal fin slightly posterior to base of last dorsal fin ray; body moderately slender, 5.7 in SL; lateral body stripe indistinct in preserved specimens; origin of dorsal fin about one eye diameter closer to base of caudal fin than to tip of snout; posterior tip of maxillary bluntly pointed and reaching to anterior margin of preopercle; maxillary without enlarged teeth near tip; isthmus not wholly covering the urohyal and with an expanded bony plate anteriorly.

Dorsal fin: 15
Anal fin: 17
Pectoral fin: 14
Gill rakers: 15 + 18. Total gill rakers: 33
Scale rows: 39
Ventral scutes: 5

This is a rare species known previously from three specimens collected in Manila Bay, Philippines (Wongratana, 1983). A single 44.3 mm SL specimen from which the above counts were taken was made available by A.D. Lewis, MAF. It was collected by I.W. Brown, January 30-31, 1978, from Kavala Bay, Kadavu Island, Fiji. It agrees well with Wongratana's brief description and figure of his three Philippine specimens. Due to its close resemblance to *S. devisi* it could easily be overlooked. The above characters will separate *S. oligobranchus* from all known species of *Stolephorus* especially the very low gill raker count and the short maxillary not extending past the anterior margin of the preopercle.

Stolephorus heterolobus (Rüppell), *Neue Wirbelth., Fische*, p. 79, pl. 21, fig. 4, 1835 (type locality: Red Sea).

Origin of the anal fin located just below or slightly posterior to last dorsal ray; body moderately slender, 5.1-6.2 in SL; a conspicuous silvery lateral stripe along mid-body (dark when preserved); origin of the dorsal fin about equidistant from tip of snout to base of caudal fin; snout length equals diameter of orbit; posterior end of maxillary pointed and projecting beyond anterior border of preoperculum (Figure 1B), occasionally a little short of posterior border of preoperculum; several large, recurved teeth near tip of maxillary; greatest width of body equal to caudal peduncle depth.

Dorsal fin: 13-15
Anal fin: 17-20
Pectoral fin: 13-15
Gill rakers: 20-22 + 25-28. Total gill rakers: 45-50
Scale rows: 39-42
Ventral scutes: 5-6

The first record of this species from Fiji was made by Herre (1936) from specimens captured by night light in Suva Harbor. It occurs in the catches taken by bouki-ami net but is not especially common. Kearney (1978) reports a complete lack of *S. heterolobus* in 19 baitfishing localities in Fiji and a scarcity of anchovies in general. The Fijian material consisted of ten specimens (48.0-65.0 mm SL) from the National Marine Fisheries Service, Honolulu, Hawaii, collected at Sausau Bay, Vanua Levu, by R. Lee, June 1973. They compare favorably with the detailed description of *S. heterolobus* by Lewis et al. (1974). Slight variations in meristics and some proportions, i.e., body depth, are no doubt due to size differences and to geographical variation. This species was referred to as species K, the blue morph, in an earlier study by Kearney et al. (1972). It is readily distinguished from other Fijian *Stolephorus* that have the origin of the anal fin below or posterior to the last dorsal fin ray. It differs from *S. punctifer* by a higher gill raker count and the presence of several enlarged, recurved teeth near the tip of the maxillary. The maxillary of *S. punctifer* is also shorter with the tip more rounded than the maxillary of *S. heterolobus*. *S. devisi* closely resembles *S. heterolobus* in a number of characteristics including several enlarged teeth near the tip of the maxillary and a short muscular portion of the isthmus not extending forward to the branchiostegal membrane (Whitehead, 1965, Figure 4a). The width of the preoperculum in relation to the width of the operculum of the two species is quite distinctive. Lewis et al. (1974) separate the two species by the following characters:

- A. Upper jaw 5.7-6.2 in SL; preoperculum narrow, about two-thirds width of operculum; head short and less deep, its length more than 4.0 in SL; body sub-cylindrical, slender, depth usually 6.2-7.0; lateral borders of the posterior frontal fontanelles straight.
..... *S. heterolobus*
- B. Upper jaw 5.1-5.6 in SL; preoperculum larger, its width about equal to or greater than that of the operculum; head long and deep, its length less than 4.0 in SL; body deeper, usually 5.5-6.2 in SL; lateral borders of posterior frontal fontanelles sigmoid.
..... *S. devisi*

Stolephorus devisi (Whitley), *Austr. Zool.*, vol. 9, no. 4, fig. 11, pl. 4, p. 404, 1940 (type locality: Cape York, Australia).

Origin of the anal fin below or slightly posterior to the last dorsal fin ray; body moderately slender, 5.4-6.2 in SL; length of head 4.0 in SL; silvery stripe along mid-body not sharply demarcated at least anteriorly in preserved material; maxillary short, bluntly pointed, not reaching posterior edge of preoperculum (Figure 1C); 2-8 enlarged, recurved teeth near tip of maxillary usually alternating with small teeth; origin of dorsal fin about one eye diameter closer to caudal fin base than tip of snout; snout appears more pointed than in *S. heterolobus* and *S. punctifer* and equal in length to the diameter of orbit; greatest width of body about equal to caudal peduncle depth.

Dorsal fin: 14-15
Anal fin: 18-19
Pectoral fin: 14-15
Gill rakers: 18-22 + 22-27. Total gill rakers: 42-47
Scale rows: not determined. Munro (1967) gives 34-42
Ventral scutes: 5-6

S. devisi is a relatively hardy species and survives reasonably well aboard ship (Smith, 1977; Anonymous, 1980). Separation of this species from *S. punctifer* and *S. heterolobus*, can be made with the following combination of characters: large head, pointed snout, snout length equal to the diameter of the orbit; silver stripe along mid-body less prominent anteriorly in preserved material; 18-19 anal fin rays; several enlarged, recurved teeth on the tip of the maxillary (occasionally lacking); total gill rakers 42-47; width of body at origin of dorsal fin equal to caudal peduncle depth. This species also closely resembles *S. oligobranchus* but the two are easily separated by the number of gill rakers and length of the maxillary. Whitley (1940) gives an anal fin ray count of 20, a pectoral count of 13, and a body depth of 5.6 for his "two inches long" type specimen. These differences can probably be attributed to geographical variation. The detailed description given by Lewis et al. (1974) agrees well with the Fijian specimens with only slight differences in meristics.

Stolephorus insularis Hardenberg, *Nat. Tijdschr. Ned.-Ind.*, vol. 93, p. 260, 1933 (type locality: Batavia).

Anal fin origin below center of dorsal fin base; maxillary long and pointed reaching posterior edge of operculum (Figure 1F); origin of dorsal fin one eye diameter closer to base of caudal fin than to tip of snout; body moderately deep, 4.5-4.8 in SL; teeth on maxillary small and relatively uniform in length; posterior frontal fontanelles narrow with a relatively straight outer margin; body width at origin of dorsal fin about twice in depth; preoperculum evenly rounded below tip of maxillary.

Dorsal fin: 16-17
Anal fin: 21-23
Pectoral fin: 13-15
Gill rakers: 15-18 + 21-23. Total gill rakers: 37-40
Scale rows: 37-38
Ventral scutes: 5-6

This species is relatively common in the Fiji bouki-ami net collections and closely resembles *S. apiensis*. It is distinct from *S. apiensis* by the longer and more pointed maxillary and in having less gill rakers. The low gill raker count will also separate *S. insularis* from other Fijian *Stolephorus* except for *S. oligobranchus*. The latter species has the lowest gill raker count of any known *Stolephorus*. The gill raker counts of *Thryssa baelama* are similar to *S. insularis* but the former species has a short maxillary and a posteriorly located anal fin with 30-33 rays as opposed to 20-22 in the latter. *T. baelama* also has a low spine anterior to the dorsal fin base.

The upper and lower ranges of pectoral and fin ray counts are quite similar to that given for the Fijian material (Table 1) but the means express a variation that may be statistically significant in larger samples.

There appears to be some geographical variation at least in the number of anal and pectoral fin rays of *S. insularis* from Fiji compared with specimens from Cochin, India (Table 2). The greatest meristic variation among *Stolephorus* appears to be in the number of gill rakers as given in Table 2.

Stolephorus indicus (Van Hasslet), *Algemein Konst-Letterbode*, p. 329, 1823 (type locality: Java).

Origin of anal fin under center of dorsal fin base; maxillary short and relatively blunt reaching to or just past anterior border of preoperculum (Figure 1D); teeth on maxillary small and uniform in size; body slender, depth 5.5-6.0 in SL; width of body at origin of dorsal fin slightly less than twice in depth; posterior frontal fontanelles narrow with relatively straight lateral borders; hind border of preoperculum evenly rounded.

Dorsal fin: 15-16
Anal fin: 19-20
Pectoral fin: 13-15
Gill rakers: 16-18 + 24-26. Total gill rakers: 39-43
Scale rows: 39
Ventral scutes: 3-5

This wide ranging species seems to be relatively common in the bouki-ami net collections. It is also reported to be quite fragile with heavy die-offs following handling (Anonymous, 1980). The combination of characters including the slender body, length and shape of the maxillary, and number of gill rakers serve to identify this species with some confidence. It will probably be most often confused with *S. devisi* since they both are quite slender but the two are easily separated by the posterior position of the anal fin, longer maxillary with several enlarged recurved teeth near the tip, and lower number gill rakers in the latter species. There is a notable difference in the total number of gill rakers of the Fijian and Indonesian specimens when compared with specimens from the Philippines, India, and East Indies (Table 2), however the sample sizes are not large enough to be statistically significant. This variation in the total number of gill rakers is also apparent in *S. insularis*, *S. devisi*, and *S. heterolobus* as with a lesser variation in the mean number of anal fin rays.

TABLE 1. RANGE IN COUNTS OF *STOLEPHORUS* SPP. COLLECTED IN FIJI

	Dorsal	Anal	Pectoral	Pelvic	Gill Rakers			Scale Rows	Ventral Scutes
					Upper	Lower	Total		
<i>S. apiensis</i>	15-17	19-22	13-14	7	21-25	28-32	49-55	34-36	1-4
<i>S. devisi</i>	13-15	18-19	14-15	7	18-22	22-27	42-47	39-40	5-6
<i>S. heterolobus</i>	13-15	17-20	13-16	7	20-22	27-28	47-49	40-43	6
<i>S. indicus</i>	15-16	19-20	13-15	7	16-18	24-26	39-43	39	3-5
<i>S. insularis</i>	16-17	21-23	13-15	7	15-18	21-23	37-40	37-38	5-6
<i>S. oligobranchus</i>	15	17	14	7	15	18	33	39	5
<i>S. punctifer</i>	13-15	14-16	14-15	7	15-20	23-26	39-44	42	4-7

TABLE 2. MEAN ACCOUNTS OF *STOLEPHORUS* SPP. FROM VARIOUS LOCALITIES

	Sample Sizes	Dorsal	Anal	Pectoral	Gill Rakers			Scale Rows	Ventral Scutes
					Upper	Lower	Total		
<i>S. apiensis</i>	20	16.0	21.0	13.4	22.0	29.9	51.9	35.7	3.1
<i>S. dentlei</i>	10	14.6	18.3	14.1	19.6	24.4	44.1	39.7	5.1
	10	14.5	19.0	13.6	18.9	22.9	41.8	38.2	5.4
<i>S. heterolobus</i>	10	14.1	16.5	13.8	21.2	26.4	47.7	40.6	5.1
	5	14.0	18.0	14.2	20.4	27.2	47.6	41.0	6.0
	8	14.4	16.4	14.0	21.4	24.9	46.2	41.4	5.2
<i>S. indicus</i>	10	15.3	19.2	14.0	17.2	25.0	42.2	39.0	4.0
	1	17	20	14	17	24	41	39	4
Philippines (BPBM 26469)	8	15.5	19.4	13.9	15.5	23.8	39.2	38.8	4.4
Madras, India (BPBM 20557)	3	15.0	19.7	15.3	15.6	23.3	39.0	39.3	4.3
Cochin, India (BPBM 27504)	1	15	20	14	15	22	37	39	4
Ambon, E. Indies (BPBM 19216)	6	15.4	19.6	14.0	16.6	23.2	39.8	39.0	4.2
<i>S. insularis</i>	13	16.1	20.8	14.0	15.1	21.1	36.2	37.7	5.9
	10	15.8	22.1	13.1	15.4	20.7	36.1	36.6	6.2
<i>S. oligobranchus</i>	1	15	17	14	15	18	33	39	5
<i>S. punctifer</i>	12	13.8	14.6	14.2	17.7	26.5	42.2	42.0	5.3

Stolephorus apiensis (Jordan and Seale), *Bull. U.S. Bur. Fish.*, vol. 25 (1905), p. 187, fig. 3, 1906 (type locality: Apia, Western Samoa).

Origin of anal fin below center of the dorsal fin base; maxillary moderately long and pointed and reaching to the posterior preopercular margin but never reaching the opercular margin (Figure 1E); origin of dorsal fin about one eye diameter closer to caudal fin base than to tip of snout; body moderately deep, 4.6-4.9 in SL; head 3.6 in SL; teeth on maxillary small and relatively uniform in length; posterior frontal fontanelles slightly sigmoid; body width at origin of dorsal fin about twice in depth; preoperculum evenly rounded below tip of maxillary.

Dorsal fin: 15-17

Anal fin: 19-22

Pectoral fin: 13-14

Gill rakers: 21-25 + 28-32. Total gill rakers: 49-55

Scale rows: 34-36

Ventral scutes: 1-4 (occasionally 0)

Questions have been raised regarding the identity of *S. apiensis* and its separation from *S. commersonii* Lacépède. Herre (1936) first listed *S. apiensis* from Fiji. He reported eight specimens, 38-60 mm SL, from Suva Harbor and one 56 mm specimen from the Mbureta River, Ovalau Island. Fowler (1941) placed it in the synonymy of *S. commersonii* and since then it has not been recognized as a valid species by authors. In existing literature (Ronquillo, 1968; Whitehead, 1967b; Tiews et al., 1970; Dalzell and Wankowski, 1980) *S. apiensis* will key out closest to *S. insularis*. The original description and figure of *S. apiensis* in Jordan and Seale (1906) were taken from a "three inch" holotype and 12 "fine" paratypes captured inside the reef at Apia, Western Samoa. A series of freshly preserved specimens of *S. apiensis*, 31 (40.3-64.7 mm SL), collected January 28, 1983, from Fagaloa Bay, Upolu Island, Western Samoa, agreed in all respects with the Fijian specimens. Fagaloa Bay is approximately 10 km east of Apia Harbor, the type locality of *S. apiensis*. Similar inshore habitats are also typical for *S. apiensis* captured in Fiji usually in shallow water of several meters, or less, in depth. A description and figure of the Fijian material is given in Appendix A.

Counts and measurements were taken from the 61.4 mm SL holotype of *S. apiensis*, USNM 51720, by Dr. Bruce Collette, National Museum of Natural History. They agree well with the Fijian specimens but unfortunately the posterior tips of both maxillaries are damaged. The holotype has 21 + 29 gill rakers on the first gill arch, 4 ventral scutes, and no indication of two parallel lines of pigment on the back between the occiput and the dorsal fin.

The significant differences between *S. apiensis* and *S. commersonii* are given below. These counts and measurements were taken from 20 *S. apiensis*, USP 3306, 62.1-70.7 mm SL, Laucala Bay, Viti Levu, Fiji, and 16 *S. commersonii* BPBM 27503, 86.7-96.6 mm SL, Cochin, India.

	Dorsal Fin Rays	Mean Anal Fin Rays	Gill Rakers	Gill Raker Length (in thousands)	Ventral Scutes
<i>S. apiensis</i>	15-17	21.0	21-25+28-32	043-052	0-4
<i>S. commersonii</i>	15-16	19.8	16-19+22-26	034-041	4-7

In addition to the above, *S. commersonii* has two parallel lines of pigment on the back between the head and dorsal fin. This was lacking in all *S. apiensis* examined. There is also a slight difference in the length of the maxillary but this is best observed by direct comparison. The tip of the maxillary of *S. apiensis* does not extend past the posterior margin of the preopercle while the tip of the maxillary of *S. commersonii* usually extends slightly beyond the posterior preopercle margin and occasionally to the margin of the opercle. No consistent differences in the shape of the posterior frontal fontanelles were observed.

The above counts agree well with those reported by Rao (1966) for a series of *S. commersonii* collected on the east coast of India. The upper and lower gill rakers counted on 119 and 321 individuals gave a range of 17-21 and 22-26, below that for *S. apiensis*. In addition, specimens of *S. commersonii* from East Africa examined by Losse (1968) also agree with the above counts as with the elongate maxillary reaching to the opercular margin. Further studies are advisable and larger series of both species from other localities with a wide range in sizes should be examined to determine the degree of variability due to size differences and geographical location. Some variability is apparent among *S. devisi*, *S. heterolobus* and *S. indicus* from several different localities when compared to specimens from Fiji (Table 2). This is especially apparent in the number of gill rakers, anal fin rays, and ventral scutes.

Twelve specimens of *Stolephorus* closely resembling *S. apiensis* were located on the shelves at the National Marine Fisheries Service, Honolulu, Hawaii. Of these, seven (47.0-70.1 mm SL) are from Ponape and five (63.0-73.7 mm SL) from Lele Harbor, Kosrae (Kusaie), both locations in Micronesia between 3,000 to 3,500 kilometers NW of Fiji. They are almost identical to the Fijian *S. apiensis* in all respects except they have more gill rakers. The Fijian specimens have 21-25 + 28-32 gill rakers with a total of 49-55 compared to the Ponape-Kosrae specimens having a count of 24-27 + 32-36 with a total of 56-63. As noted previously, some geographical variation is apparent in the number of gill rakers of some species of *Stolephorus*. The specimens from Ponape and Kosrae may possibly represent *S. apiensis* with a high gill raker count or perhaps an undescribed species closely resembling the former. Until additional specimens are made available for further study the Ponape and Kosrae specimens will be referred to as *S. apiensis* even though the total number of gill rakers are significantly higher than in the Fijian and Western Samoan specimens.

Five additional specimens from Kosrae, BPBM 2877, 58.7-71.1 mm SL, also closely resemble the Fijian *S. apiensis* but have a gill raker count of 22-26 + 32-34 with a total of 55-60. In addition they have more dark pigment on the body especially on the back between the head and dorsal fin. Two specimens have narrow, parallel lines of pigment characteristics of *S. commersonii* while two have a single, wide band of pigment from head to near dorsal fin origin. In the latter specimens the scales are still intact while they are missing in the former two. The fifth specimen has the typical imbricate pattern of pigment on the back similar to that found in most *Stolephorus* anchovies and the scales are missing on the upper back. As with the above specimens from Kosrae these will also be referred to as *S. apiensis*.

Thryssa baelama (Forskål), *Descript. Animal.*, p. 72, 1775 (type locality: Djedda, Red Sea).

Origin of anal fin about one eye diameter posterior to dorsal fin base; body moderately deep, 4.3 to 4.5 in SL; a single, small, blunt spine at origin of dorsal fin; tip of maxillary moderately pointed and extending posteriorly to just beyond articulation of lower jaw; color of back and upper sides dull gray to brown; length of base of anal fin greater than head length; abdominal scutes extending from origin of anal fin to between pectoral fins.

Dorsal fin: 14
Anal fin: 30-34
Pectoral fin: 13
Gill rakers: 16-17 + 20-23. Total gill rakers: 35-41
Scales: 38
Ventral scutes: 5-7 + 8-10. Total ventral scutes: 13-17

Adult and juvenile *T. baelama* are easily distinguished from other Fijian Engraulidae by the long anal fin located posterior to the dorsal fin base, the small spine anterior of the dorsal fin origin, greater number of ventral scutes, and darker body coloration. The scales are much more firmly attached than in species of *Stolephorus*. Studies conducted in Papua New Guinea (Lewis et al., 1974) demonstrated they can be "dry scooped" and placed in buckets with minimum water. This was necessary to prevent them from leaping out of the bucket. They are a wide ranging species but apparently do not occur in sufficient numbers to be classified as a major bait species.

CLUPEIDAE

Provisional key to the herrings and sardines with ventral scutes, subfamily Clupeinae, occurring in Fiji

(Round herrings, subfamilies Dussumieriinae and Spratelloidinae that lack ventral scutes are treated elsewhere and are not included in this key. *Potamalosa richmondia* (Macleay, 1879) is not included since the Fiji records reported by Fowler [1949, 1959] are open to question.)

- A. Two orange-yellow spots, one above the other, on the shoulder in fresh specimens; supramaxillary not paddle-shaped and with the lower margin

- considerably longer than the upper margin (Figure 2A); total number of gill rakers 46-49; 3-5 longitudinal striae on the frontal-parietal wedge; anterior transverse grooves of the mid-body scales not interrupted (Figure 3A). *Herklotsichthys quadrimaculatus*
- B. No orange-yellow spots on the shoulder in fresh specimens; supramaxillary paddle-shaped with the upper and lower margins about equal in length (Figure 2B); total number of gill rakers 44-267; 7-14 striae on the frontal-parietal wedge; anterior transverse grooves on the mid-body scales interrupted (Figure 3B).
1. Midventral ridge weakly keeled, scutes not sharp and prominent *Amblygaster*
 - a. A single row of 14-20 round spots along upper sides from operculum to the caudal peduncle; depth of body 4.5-5.4 in SL; gill rakers 13-16 + 38-41, total 52-57 *A. sirm*
 - b. No single row of round spots along upper sides; depth of body 3.7-4.4 in SL; gill rakers 13-14 + 31-32, total 44-45 *A. clupeoides*
 2. Midventral ridge strongly keeled, scutes sharp and notably prominent *Sardinella*
 - a. Caudal fin notably dark at tips of upper and lower lobes (occasionally lacking on lower caudal lobe); in Fijian material 3-4 narrow, dark lines on upper body from head to caudal peduncle; depth of body 3.6-4.0 in SL; gill rakers on lower limb 50-58 *S. melanura*
 - b. Caudal fin without dark tips as above; usually without 3-4 narrow dark lines on upper body; depth of body 3.0-4.4 in SL; gill rakers on lower limb 47-163.
 - i. Tip of the dorsal fin dark (anterior six rays); depth of body 3.0-3.2 in SL; gill rakers on lower limb 148-163. *S. fijiensis*
 - ii. Dorsal fin without a dark tip; depth of body 3.0-4.4 in SL; gill rakers on lower limb 47-81.
 - (a) Lower gill rakers 69-81; body depth 3.0-3.5 in SL; dorsal fin dark at its base; snout length less than diameter of orbit *S. fimbriatus*
 - (b) Lower gill rakers 47-61; depth of body 3.2-4.4 in SL; dorsal fin not dark at its base; snout length not less than orbit *S. jussieu*

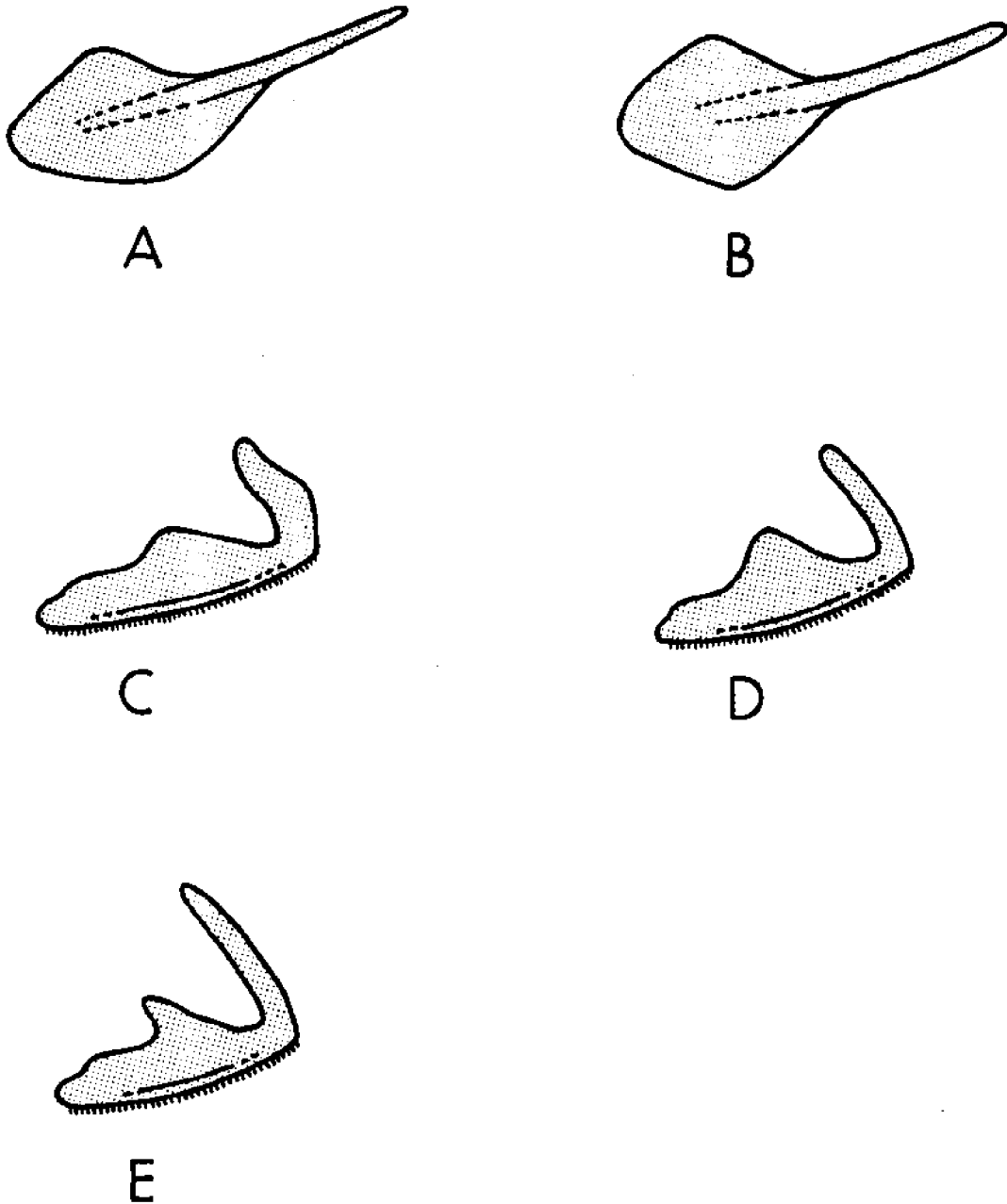


Figure 2. A, supramaxillary of *Herklotsichthys quadrimaculatus*; B, supramaxillary of *Sardinella* spp.; C, maxillary of *Atherinomorus lacunosus*; D, maxillary of *Hypoatherina ovalaua*; E, maxillary of *H. panatela*.

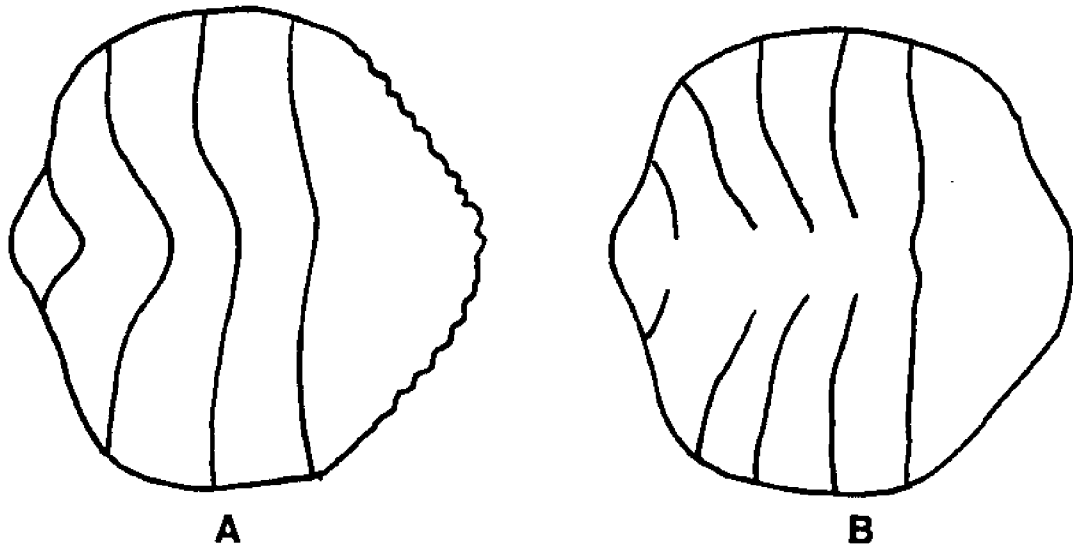


Figure 3. Representative scales on midbody anterior to the dorsal fin. A, *Herklotsichthys quadrimaculatus*; B, *Sardinella marquesensis*.

Subfamily Clupeinae

Herklotsichthys quadrimaculatus (Rüppell), *Neue Wirbelth. Fische*, p. 78, pl. 21, fig. 3, 1835 (type locality: Massaua).

In fresh material there are two golden spots, one above the other, on the shoulder (usually missing in preserved material); depth of body 3.4-4.2 in SL; supramaxillary not paddle-shaped, the lower edge of the expanded portion of second supramaxillary longer than upper edge (Figure 2A); 3-5 longitudinal striae on the frontal-parietal wedge; last two anal rays not notably enlarged as in *Sardinella*; snout length equals diameter of orbit; no prominent ridge of teeth on palatines and pterogoids. Anterior transverse grooves of the mid-body scales not interrupted and posterior margin of scales toothed (Figure 3A).

Dorsal fin: 17-19

Anal fin: 16-20

Pectoral fin: 15-16

Pelvic fin: 8

Gill rakers: 14-16 + 32-34. Total gill rakers: 46-49

Scale rows: 43-46

Ventral scutes: 18-19 + 12-13. Total ventral scutes: 30-32

This is a wide ranging species of herring known to occur from East Africa to Hawaii. Details regarding the occurrence of this species in Hawaii are currently under study and will be reported later. It is relatively common in Fiji and makes up about 3 percent of the total baitfish catches (Anonymous, 1980). When fresh it is easily identified because of the two golden spots on the shoulder but these may be indistinct or lost in

preserved specimens. It is distinguished from *Amblygaster* and *Sardinella* by the shape of the supramaxillary, number of gill rakers, number of longitudinal striae on the frontal parietal wedge, and by the anterior transverse grooves of the mid-body scales not interrupted. In addition, *H. quadrimaculatus* usually has an evenly dusky coloration on the dorsal and caudal fins with occasionally a dark area on the anterior dorsal fin rays. *H. quadrimaculatus* also has wing-shaped median predorsal scales beneath the normal paired and overlapping scales which are quite distinct from other slender-bodied herrings.

The two orange-yellow humeral spots are quite noticeable in fresh material examined from Fiji and Hawaii. Losse (1968) reported two color variants of East African specimens which he identified as *H. punctatus* form A and form B. Form A had a yellow to orange mid-lateral line with dark pigmentation on the anterior dorsal rays and form B had a narrow blue lateral band with a broad silver band above it from operculum to caudal base and without dark pigmentation on the dorsal fin. According to Wongratana (1983) form A is *H. spilura* (Guichenot) but form B was not mentioned by the author.

Amblygaster sirm (Walbaum), *Artedi Pisc.*, vol. 3, p. 38, 1792 (type locality: Arabia).

Body with a series of 14-20 dark, round spots along upper side from gill opening to caudal peduncle. These spots are often lacking in Fijian specimens less than 50 mm SL. Origin of dorsal fin about equidistant from tip of snout and base of caudal fin; supramaxillary paddle-shaped with the upper and lower margins about equal in length; axillary side of the pectoral fin with a dark streak on the upper fin rays; caudal fin dusky overall; depth of body 4.5-5.4 in SL.

Dorsal fin: 17-19

Anal fin: 17-19

Pectoral fin: 16-18

Pelvic fin: 8

Gill rakers: 13-16 + 38-41. Total gill rakers: 52-57

Scale rows: 41-44

Ventral scutes: 14-18 + 13-15. Total ventral scutes: 28-32

The above counts were taken from ten specimens (104-160 mm SL) collected in Fiji by bouki-ami net. In addition to the above characters *A. sirm* has the belly somewhat more rounded and with the ventral scutes not as prominent as in *Sardinella* or *Herklotsichthys*. This is a relative character best used when material is on hand for direct comparison. The combination of coloration, counts, and body depth will distinguish this species from other Fijian clupeids. *A. sirm* is of some importance to the pole-and-line fishery and at times will dominate the bait catches (Anon., 1980). The counts given above when compared to that of Chan (1965) show only slight differences. Little information appears to be available on their performance as baitfish except that Lee (1973) reports they are relatively hardy.

Amblygaster clupeioides (Bleeker), *Jour. Indian Arch.*, vol. 3, p. 73, 1849
(type locality: Makassar).

The caudal fin coloration is overall evenly dusky without a distinct darker coloration near the tip of the fin; there is a prominent dark spot slightly less than the diameter of the orbit on the shoulder; supramaxillary paddle-shaped with the upper and lower edges similar in shape and length (Figure 2B); material examined in Fiji had a noticeable "chevron-like" pattern of darker color on the upper sides and back; depth of body at origin of dorsal fin 4.4 in SL.

Dorsal fin: 18-19
Anal fin: 18-19
Pectoral fin: 16-18
Pelvic fin: 8
Gill rakers: 13-14 + 31-32. Total gill rakers: 44-45
Scale rows: 42-44 (Chan, 1965).
Ventral scutes: 15-17 + 12-13. Total ventral scutes: 27-30

There seems to be some confusion regarding the identification of this species in using Chan's (1965) key to the genus *Sardinella*. The gill raker counts of the Fijian material are closer to *Sardinella leiogaster* than to *Amblygaster clupeioides* as noted above. However, of the four specimens examined, 77.5 to 102.0 mm SL, the body was slightly more elongate than that of the former species. Until additional material and more information are available the Fijian specimens are herein referred to as *Amblygaster clupeioides*.

Sardinella melanura (Cuvier), *Regne Animal*, ed. 2, vol. 2, p. 318, 1829
(type locality: Zamboanga).

The posterior third of the caudal fin is quite dark and with a moderately abrupt demarcation between the dark and light; supramaxillary paddle-shaped with the upper and lower edges about equal in length (Figure 2B); dorsal fin origin about one dorsal fin base length closer to tip of snout than to base of caudal fin; three to four narrow dark lines running along upper sides from head to base of caudal fin; depth of body 3.0-4.0 in SL.

Dorsal fin: 16-17
Anal fin: 18-19
Pectoral fin: 13-15
Pelvic fin: 8
Gill rakers: 29-33 + 50-58. Total gill rakers: 79-91
Scale rows: 39-42
Ventral scutes: 16-18 + 12-13. Total ventral scutes: 28-30

A single 100.0 mm SL Fijian specimen was available for study. It was captured by seine at Levuka, 25-26 November 1982, along with a large collection of *Herklotsichthys quadrimaculatus*. It is apparently most common inshore on sandy beaches and near jetties. Additional specimens in the B.P. Bishop Museum gave counts which are similar to the single Fijian specimen (Table 3). According to Chan (1965) this species and *S. nigricaudata*

TABLE 3. COMPARISON OF THE COUNTS OF *SARDINELLA NIGRICAUDA* AND *S. MELANURA*

	N	SL in mm	Dorsal	Anal	Pectoral	Gill Rakers			Scale Rows	Ventral Scutes
						Upper	Lower	Total		
<i>S. nigricauda</i> ⁴	1	99.5	16	19	14	31	68	99	39	16+12
<i>S. melanura</i>										
Fiji*	2	42.0-44.0								
New Hebrides*	26	39.5-73.5	16-18	18-19	14-15	?	37-43	?	36-41	17-18 + 11-13
Fiji	1	100.0	17	19	14	27	56	83	40	17+13
Tahiti										
(BPBM 11576)	6	82.5-102.5	16-17	18-19	15	29-33	50-58	79-91	39-42	16-18 + 12-13
(BPBM 25761)	10	78.0-113.5	16-17	18-20	13-15	25-33	48-58	74-91	38-41	16-17 + 12-14
Apia										
(BPBM 25318)	10	68.0-97.0	16-17	18-21	14-15	25-36	52-70	86-104	38-42	15-17 + 12-13
Pago Pago										
(BPBM 25315)	2	102.0-103.0	16-17	20-21	14-15	33-38	62-70	95-108	40	16-17 + 12
(BPBM 15003)	1	76.0	16	19	15	28	54	82	40	16+12

*Chan, 1965

are distinct from all other Indo-Pacific *Sardinella* by the characteristic caudal fin coloration and number of gill rakers. In addition, Chan (ibid) describes *S. nigricaudata* from a single 99.5 mm SL specimen collected in the New Hebrides based primarily on a gill raker count of 31 + 68. The Tahitian and Fijian material examined had gill raker counts intermediate between Chan's *S. melanura* and *S. nigricaudata* (Table 3). Samoan specimens of *S. melanura* had counts ranging from 25-38 + 52-70. In addition, Whitehead (1967a) reported a gill raker count on the lower limb of 45-57 for Red Sea specimens and 52-60 for three specimens from the Indian Ocean, in both cases approaching the count given for *S. nigricaudata*. Lazarus (1977) concluded that *S. nigricaudata* is a junior synonym of *S. melanura* and that Chan's *S. nigricaudata* is *S. melanura* with a high gill raker count. The body proportions, meristics, and coloration are quite similar for the above two species and with the exception of the number of gill rakers they would be quite difficult, if not impossible, to separate by the remaining characters. How much importance should be assigned to the number of gill rakers? The counts given in Table 3 for the Fijian, Tahitian, Samoan, and the New Hebrides specimens suggest a highly variable character subject to change with growth and showing some geographical variation.

In their study of the Marquesan sardine, *S. marquesensis*, Nakamura and Wilson (1970) demonstrated the number of gill rakers on the lower limb of the first gill arch increased with size by a range of 20 to >90. This suggests that a similar variation in the number of gill rakers should best be anticipated for other species of *Sardinella*. Also, Raja and Lazarus (1975) found a similar variation in the number of gill rakers on the lower limb of *S. dayi* from the Indian Ocean. In specimens 20-130 mm SL the number of gill rakers ranged from 40-130 and there appears to be some geographical variation in this character plus differences in head length, pectoral fin length, body depth, caudal fin length, and fin ray counts.

Sardinella fijiensis (Fowler and Bean), *Proc. U.S. Nat. Mus.*, vol. 63, art. 19, pp. 1-27, 1923 (type locality: Fiji Islands).

The tip of the dorsal fin is dusky to dark; pelvic fins below anterior third of dorsal fin base; gill rakers long and numerous, easily observed through open mouth; body depth at dorsal origin 3.3 in SL; supramaxillary paddle-shaped with upper and lower edges about equal in length (Figure 2B).

Dorsal fin: 17-18
Anal fin: 17-18
Pectoral fin: 15-16
Pelvic fin: 9
Gill rakers: 95-120 + 148-163. Total gill rakers: 249-267
Scale rows: 40-41
Ventral scutes: 17-18 + 12-13. Total ventral scutes: 30

Four specimens (122 to 131 mm SL) collected in Fiji were examined. There is some doubt as to the correct identification of these due to differences in gill raker counts and dorsal fin coloration. In Chan's (1965) key, the Fijian material best keys out to *S. aurita* due to the gill raker counts given and coloration of the dorsal fin. It appears that *S. fijiensis*

was overlooked by Chan (1965) since there is no mention of it in his revision of the genus *Sardinella*. The number of gill rakers given for *S. longiceps* (145-258 on the lower limb) also approaches the counts for the Fijian material. Fowler and Bean's (1923) original description of *S. fijiensis* notes the dusky coloration of the dorsal fin but gives the number of gill rakers as 50 + 70, far below the above four specimens. It is quite probable that the number of gill rakers will increase with size as reported for *S. marquesensis* (Nakamura and Wilson, 1970) and for *S. dayi* (Raja and Lazarus, 1975). Additional specimens should be examined to clarify the above with special note to other characters.

Sardinella fimbriata (Valenciennes), *Hist. Nat. Poissons*, vol. 20, p. 359, pl. 600, 1847 (type locality: Malabar).

Since no material was available for study the following counts and measurements were taken from Chan (1965).

Body moderately deep, 3.0-3.5 in SL; caudal fin evenly dusky or dark edged; origin of dorsal fin closer to snout than to base of caudal fin; a dark spot at the bases of the first five dorsal fin rays; snout length less than the diameter of the orbit.

Dorsal fin: 17-19
Anal fin: 17-21
Pectoral fin: 14-16
Pelvic fin: 8
Gill rakers on the lower limb: 69-81
Scale rows: 39-43
Ventral scutes: 17-18 + 12-15

This species is included here since there are at least two records from Fiji (Whitley, 1927; Weber and De Beaufort, 1913). No specimens were obtained while in Fiji or from the Bishop Museum, Honolulu, Hawaii. *S. fimbriata* may be distinguished from *S. fijiensis* by having fewer gill rakers. *S. melanura* has the tips of the caudal fin dark and *Amblygaster sirm* has the characteristic row of round spots along the upper body, both lacking in *Sardinella fimbriata*. It differs from *Amblygaster clupeoides* by having a greater number of ventral scutes and more gill rakers on the lower limb. It differs from *Sardinella jussieu* by having a shorter snout and more gill rakers on the lower limb. Any material from Fiji approaching the above description should be preserved for further study.

Sardinella jussieu (Lacépède), *Hist. Nat. Poissons*, vol. 5, pp. 469, 474, pl. 11, fig. 2, 1803 (type locality: Mauritius).

No Fijian specimens of *S. jussieu* were on hand for direct examination. The following information was taken from Chan (1965).

Caudal fin evenly dusky with at most a darker coloration on the upper and lower edges; a single dark spot on shoulder; orbit 1.1-1.2 in length of snout; mid-body scales with one continuous transverse groove preceded by 2-7 interrupted transverse grooves; depth of body at origin of the dorsal fin 3.2-4.4

Dorsal fin: 17-18
Anal fin: 17-20
Pectoral fin: 14-16
Pelvic fin: 8
Gill rakers on lower limb: 47-61
Scale rows: 42-45
Ventral scutes: 17-18 + 14-16

Literature records place this species in Fiji (Gunther, 1880; Whitley, 1927; Fowler, 1959; Chan, 1965). According to Chan (1965) it most closely resembles *S. sindensis* but differs primarily in the greater number of gill rakers on the lower limb (58-72). There are small differences in proportional measurements but these tend to overlap. As noted by Chan (1965) additional studies on both species are recommended for a better understanding of geographical variation and changes in meristics (i.e., number of gill rakers) with size. *S. sindensis* has not been recorded from Fiji, however, its distribution is not well known due to difficulties in identification. Specimens suspected of being this species or *S. jussieu* should be preserved for further study.

Subfamily Dussumieriinae

The two species of *Dussumieria* encountered in Fiji are differentiated by the following characters:

1. Gill rakers 12-16 + 28-31; dorsal fin rays 21-22; body depth 4.0-4.2 in SL; scale rows 54-58; adipose eyelid with an opening; caudal fin with a dark margin *D. species A*
2. Gill rakers 11-12 + 21-22; dorsal fin rays 18-20; body depth 5.8-5.6 in SL; scale rows 58-61? adipose eyelid without an opening; caudal fin without a dark margin *D. species B*

Dussumieria Species A.

Body relatively deep, 4.0-4.2 in SL; caudal fin with a distinct dark margin; abdomen somewhat rounded without ventral scutes; jaws with small conical teeth; a prominent imbricate pattern of pigment on upper sides and back.

Dorsal fin: 21-22 (\bar{x} = 21.1)
Anal fin: 14-17 (\bar{x} = 15.4)
Pectoral fin: 14-16 (\bar{x} = 14.9)
Pelvic fin: 8
Gill rakers: 12-16 + 28-31. Total gill rakers: 42-45
Scale rows: 54-58

This form is quite distinct from *D. species B* in the deeper body, caudal fin coloration, and counts. The ventral curvature of the body is much more convex than in *D. species B*. Also, when placed side-by-side, *D. species A* has a prominent imbricate pattern of pigment on the back and upper sides that is much less prominent in *D. species B*. However, regional variation and method of preservation may possibly influence the degree of pigmentation.

Dussumieria Species B.

Body slender and elongate, depth at origin of dorsal fin 5.8-6.0 in SL; caudal fin overall light to medium dusky; abdomen somewhat rounded without ventral scutes; no prominent imbricate scale pattern on upper sides and back, jaws with small teeth.

Dorsal fin: 18-20 (\bar{x} = 18.7)
Anal fin: 14-16 (\bar{x} = 15.0)
Pectoral fin: 13-15 (\bar{x} = 13.6)
Pelvic fin: 8
Gill rakers: 11-12 + 21-22. Total gill rakers: 32-34
Scale rows: 58-61?

There are at least two distinct forms of *Dussumieria* in Fiji that are herein referred to as *D. species A* and *D. species B*. Whitehead (1963) chose to place all three of the recognized species of *Dussumieria* (*D. acuta*, *D. elopsoides*, and *D. productissima*) into a single, highly variable species, *D. acuta*. The identification of the two Fijian *Dussumieria* leaves some question since they do not appear to be any of the above. Some significant differences are apparent between the two forms. *D. species A* has a greater number of dorsal fin rays and gill rakers than *D. species B*. The body is more slender and elongate in *D. species B* and the caudal fin is without the prominent dark margin. In addition, the ventral curvature of the body is less convex and usually without the prominent, pigmented imbricate pattern on the upper body as in *D. species A*, at least in the Fijian material.

There is also a significant difference in the development of the adipose eyelid of specimens examined in the Bishop Museum. A series of seven *D. species B* (144-161 mm SL), BPBM 25277, from Christmas Island had the adipose eyelid without an opening, the orbit being completely covered. Six specimens of *D. species A* (122.5-138.0 mm SL), BPBM 21275, from the Persian Gulf, and two (133.0-135.0 mm SL), BPBM 27552, from Cochin, India, had the adipose eyelid with an opening over the upper half of the orbit.

Specimens of both species taken from the USP collection were sent to P.J.P. Whitehead, British Museum (Natural History), January 1982, for further study.

A number of juvenile *Dussumieria* captured by bouki-ami net show some variability in body depth and coloration. Specific identification was not attempted but several had low gill raker counts of 8 + 20 with a total of 28-30 suggesting ontogenetic variation in meristics. Each also had an opaque body and a dark crescent of pigment beneath the margin of the opercle but lacked other significant markings. The degree of coloration of the caudal fin is also variable.

Seven Christmas Island specimens of *D. species B*, BPBM 25277, had only traces of pigment possibly due to method of preservation or time of day when captured. These examples were mostly light overall and lacked coloration on the caudal fin.

Subfamily Spratelloidinae

Spratelloides delicatulus (Bennett), *Proc. Comm. Zool. Soc. London*, vol. 1, p. 168, 1831 (type locality: Mauritius).

Body subcylindrical with the abdomen notably rounded and lacking ventral scutes; origin of dorsal fin closer to tip of snout than to base of caudal fin; body with a series of fine, parallel, horizontal lines evident upon close inspection; enlarged scales on the caudal fin with two short, parallel spots each; supramaxillary paddle-shaped with the upper and lower margins similar in shape but with the lower margin occasionally longer; maxillary reaches anterior margin of orbit or slightly beyond.

Dorsal fin: 11-12
Anal fin: 10
Pectoral fin: 11-12
Pelvic fin: 8
Gill rakers: 9-11 + 27-30. Total gill rakers: 37-41
Scale rows: 37-38

One of the most important baitfishes used for skipjack tuna fishing in the tropical Pacific Ocean in numbers captured. It is a small, round-bodied fish that is dark above and silvery below. It differs from *S. gracilis* by the lack of a distinct silvery lateral stripe, reduced number of anal fin rays, and less longitudinal scale rows along the body. Fine, narrow, parallel lines on the upper body are quite apparent upon close inspection especially under low magnification. Also, the characteristic elongate spots on the enlarged scales of the caudal fin are diagnostic but these may become indistinct in juveniles.

Spratelloides gracilis (Schlegel), *Fauna Jap., Poiss.*, p. 238, pl. 108, fig.2, 1846 (type locality: SE coast of Nagasaki, Japan).

Body subcylindrical with the abdomen narrowly rounded and lacking ventral scutes, depth 7.5 in SL; origin of dorsal fin closer to tip of snout than to caudal fin base; body with a prominent silvery lateral band from head to base of caudal fin; supramaxillary paddle-shaped with the upper and lower margins similar in shape but with the lower margin occasionally longer. Maxillary reaches anterior margin of orbit; anal fin positioned posterior of dorsal fin base by the length of one anal fin base; last anal fin ray elongated; pelvic fins located below mid-dorsal fin base.

Dorsal fin: 12-13
Anal fin: 13-14
Pectoral fin: 12-13
Pelvic fin: 8
Gill rakers: 11-13 + 35-39. Total gill rakers: 46-52
Scale rows: 45-47

The above counts were taken from five specimens in the B.P. Bishop Museum, BPBM 14885 (57.0-67.0 mm SL), collected at Lord Howe Island, since no adult Fijian material was on hand for study. It is occasionally abundant in some areas in Fiji. The counts are in agreement with other descriptions (Fowler,

1959; Weber and De Beaufort, 1913). The silvery lateral band is diagnostic, along with the meristics given above, plus the shape of the supramaxillary and the length and posterior location of the anal fin.

ATHERINIDAE

Atherinomorus lacunosus (Schneider), *Syst. Ichthyol. Bloch*, 112, 1801 (type locality: New Caledonia).

Body subcylindrical, its greatest width equal to body depth at anal fin origin; depth of body 4.2-5.5 in SL; diameter of orbit greater than length of snout; dentary without a prominent elevation posteriorly; maxillary process short, its length less than the diameter of the orbit and with the posterior process quite low (Figure 2C); anus located between posterior third of pelvic fin rays; eye large, 2.0-2.3 in head length; a prominent lateral band along body from head to base of caudal fin with its greatest width about 1.7 in postorbital length of head; several rows of vertically elongate spots below lateral band; a distinct concavity of the posterior body edge of the preoperculum. (*A. lacunosus* = *Pranesus pinguis* [Lacépède]).

Dorsal fin: V to VI-I, 9-11
Anal fin: I, 13-15
Pectoral fin: I, 15-16
Pelvic fin: I, 5
Gill rakers: 4-5 + 21-22. Total gill rakers: 25-27
Scale rows: 44-45

Juveniles and adults are easily determined by the relatively large eye and short snout, the posterior elevation on the dentary, the posterior process of the premaxillary low with its base longer than the height, and with the counts given above. It is sometimes common in the bouki-ami net collections, depending upon collection locality, and makes up about 2 percent of the baitfish catches (Anonymous, 1980) in Fiji.

Hypoatherina ovalaua (Herre), *Publ. Field Mus. Nat. Hist., zool. ser.*, vol. 18, no. 12, p. 401, 1935 (type locality: Fiji).

Body elongate, subcylindrical, its greatest depth 5.7 to 6.0 in SL; dentary with a less prominent elevation posteriorly; premaxillary process moderately long, about equal in length to diameter of orbit, posterior process low with its base about equal to its height (Figure 2D); anus between or slightly posterior to tips of pelvic fin rays; a prominent lateral band along sides, its greatest width 2.5 to 3.2 in postorbital length of head; a single row of very small spots below lateral band; a distinct concavity on anterior bony ridge of preoperculum; no dark spot anterior to eye.

Dorsal fin: VII-I, 8-10
Anal fin: I, 10-11
Pectoral fin: I, 14-15
Pelvic rays: I, 5
Gill rakers: 4-7 + 22-25. Total gill rakers: 26-31
Scale rows: 42-44

Ten specimens, 61.0 to 71.00 mm SL, were examined. They evidently do not reach as large a size as *Atherinomorus lacunosus*. *H. ovalaua* can be identified by the characters given above plus the presence of a small oval space between the two premaxillary processes. The row of small spots running below the lateral stripe seems diagnostic at least in the Fijian specimens. In addition there seems to be a consistent narrow, elongate spot on the upper caudal fin base where the lateral stripe terminates.

Hypoatherina panatela (Jordan and Richardson), *Bull. U.S. Bureau Fish.*, vol. 27, pp. 233-287, 1908 (type locality: Babuyan Island, Philippines).

Body elongate, subcylindrical, its depth 6.5-7.0 in length; snout length equal to diameter of orbit; ascending median process of premaxillary long and greater in length than the diameter of the orbit (Figure 2E); dentary with a prominent elevation posteriorly; a prominent lateral band from head to base of caudal fin, its width 1.8-2.0 in postorbital length of head and 2.0 in diameter of orbit; several rows of vertically elongate spots below the lateral band; a small but distinct black spot anterior to eye becoming less prominent in young; anus located below tips of pelvic fins or slightly posterior.

Dorsal fin: VI-VII-I, 9
Anal fin: I, 11-12
Pectoral fin: I, 16-18
Pelvic fin: I, 5
Gill rakers: 5-6 + 21-24. Total gill rakers: 27-29
Scale rows: 44-46

This species is probably not as commonly captured as *H. ovalaua* and *Atherinomorus lacunosus* in the bouki-ami nets. The dark spot anterior to the eye is diagnostic but is less prominent in smaller specimens (33.5 mm SL). Also, the shape of the premaxillary, length of snout, and meristics given above will further identify this species.

APOGONIDAE

Rhabdamia cypselurus (Weber), *Notes Leyden Mus.*, vol. 31, no. 2, p. 167, 1909 (type locality: Ceram).

An apogonid with fine teeth on the vomer and palatines; maxillary reaching to anterior half of pupil; depth of body 4.0 in SL; head length 2.7 in SL; tips of pelvic fins reach anus; margins of preopercle smooth; scales ctenoid; lateral line complete; body coloration light tan; a dark conspicuous spot on sides of snout anterior to eye.

Dorsal fin: VI-I, 9
Anal fin: II, 9
Pectoral fin: 14-15
Pelvic fin: I, 5
Gill rakers: 5 + 11. Total gill rakers: 16

A suitable series was not available in Fiji for study. The above description and meristics were taken from Schultz et al. (1953). This species is easily distinguished from *R. gracilis* by the dark bar anterior to the eye and

fewer number of gill rakers. It apparently is not as common in the bouki-ami net collections as *R. gracilis*.

Rhabdamia gracilis (Bleeker), *Nat. Tijds. Ned.-Ind.*, vol. 10, p. 371, 1856 (type locality: Ternate).

An apogonid with fine teeth on the vomer and palatines; maxillary reaching to anterior half of pupil; depth of body 4.0 in SL; head length 2.8 in SL; pectoral fin reaches to 4th anal ray; tips of pelvic fins reach anus; margins of preopercle smooth; scales ctenoid; lateral line complete; body coloration generally light tan without conspicuous markings; a dusky vertical mark at caudal fin base; no conspicuous dark spot anterior to eye.

Dorsal fin: VI-I, 9
Anal fin: II, 12
Pectoral fin: 13
Pelvic fin: I, 5
Gill rakers: 6 + 20. Total gill rakers: 26

A relatively common species taken in the bouki-ami net collections. In some areas it is at times taken in abundance and will comprise up to 24.8 percent of the baitfish catch (Anonymous, 1981b). It rarely exceeds 50.0 mm SL and is considered an excellent baitfish. It is relatively easy to distinguish from *R. cypselurus* by the lack of a prominent dark spot anterior to eye and having a higher number of gill rakers. There are a number of juvenile apogonids that routinely occur in the bouki-ami net collections (W. Baldwin, in preparation) but the above two species can be separated from the other apogonids by body and fin coloration, body shape, and meristics.

LUTJANIDAE

Gymnocaesio gymnopterus (Bleeker), *Nat. Tijds. Ned.-Ind.*, vol. 10, p. 372, 1856 (type locality: Ternate).

Body elongate, depth 5.5 in SL; no scales on the first dorsal fin; axil of pectoral dark; upper and lower lobes of caudal fin dark at tips, base of fin dusky; maxillary with two lateral extensions as in *Pterocaesio*.

Dorsal fin: X, 14
Anal fin: III, 11
Pectoral fin: 23
Pelvic fin: I, 5
Gill rakers: 7 + 26. Total gill rakers: 33
Scale rows: 80-83

It is evidently distinct from other Fijian fusiliers by the lack of scales on the first dorsal; two lateral extensions on the maxillary, elongate body, high gill raker count, and dark tips on the caudal fin.

Pterocaesio diagramma (Bleeker), *Ned. Tijds. Dierk.*, vol. 2, p. 180, 1865 (type locality: Amboina).

Body moderately elongate, its depth 4.4 in SL; scales on lower base of dorsal fin (not developed in juveniles); maxillary with two lateral extensions; axil of pectoral fin dark; tips of upper and lower caudal lobes dark; body with several light streaks (indistinct in material examined).

Dorsal fin: X, 15
Anal fin: III, 11
Pectoral fin: 20
Pelvic fin: I, 5
Gill rakers: 8 + 26. Total gill rakers: 34
Scale rows: 73

The above description and counts were taken from a 59.0 mm SL specimen from New Caledonia since no Fijian material was on hand. The several light bands on body, the dark caudal lobes, maxillary with two lateral extensions, number of gill rakers, and body depth will help to distinguish this form from other Fijian *Pterocaesio*.

Caesio coeruleureus (Lacépède), *Hist. Nat. Poissons*, vol. 3, pp. 85-86, 1802 (type locality: Moluccas).

Body moderately deep, not slender and elongate, depth 3.6 in SL; a light band on sides of body from head to base of caudal fin and equal in width to diameter of orbit; axil of pectoral fins dark above; fine teeth on vomer, none on palatines; maxillary with a single lateral process; caudal fin with a dark area on each lobe running from base of fin to tips of rays; dorsal fin scaled for most of its height in adult specimens.

Dorsal fin: X, 15
Anal fin: III, 12
Pectoral fin: 21
Pelvic fin: I, 5
Gill rakers: 7-9 + 26-28. Total gill rakers: 35-36
Scale rows: 48-70 (Munro, 1967)

The single lateral process on the maxillary will separate this species from other fusiliers examined. In addition the light band along the body and the caudal fin coloration are characteristic of *C. coeruleureus*. The characteristic scalation on the dorsal fin of *Caesio* spp. was not a useful character for identifying juvenile specimens since these scales had not yet developed.

Dipterygonotus leucogrammicus (Bleeker), *Jour. Indian Arch.*, vol. 3, p. 71, 1849 (type locality: Makassar).

Body elongate, 5.1 in SL; maxillary with two lateral extensions; several wavy lines along upper sides; caudal fin light, without dark markings; last 3-4 spines of first dorsal short and free, not connected by a membrane.

Dorsal fin: XIV, 10
Anal fin: III, 10
Pectoral fin: 17
Pelvic fin: I, 5
Gill rakers: 7 + 20. Total gill rakers: 27
Scale rows: 80

The only specimen available for study was a 68.0 mm SL specimen from New Caledonia from which the above counts were taken. The free dorsal spines, elongate body, light caudal fin, body with several light, wavy lines, and the maxillary with two lateral extensions are diagnostic for this species.

Pterocaesio pisang (Bleeker), *Nat. Tijds. Ned.-Ind.*, vol. 4, p. 113, 1853 (type locality: Batavia).

Body moderately deep, not elongate, depth 3.8-4.0 in SL; body evenly colored with no light bands, usually yellowish-orange when preserved; tips of caudal fin dusky; axil of pectoral without dark color; maxillary with two lateral extensions.

Dorsal fin: X, 14
Anal fin: III, 12
Pectoral fin: 20
Pelvic fin: I, 5
Gill rakers: 9 + 24. Total gill rakers: 33
Scale rows: 73

The combination of body coloration, meristics, lack of a dark area on axil of pectoral, and dusky tips of the caudal fin will separate this species from other fusiliers in Fiji. These characters were apparent in six specimens, 64-80 mm SL, collected in Fiji.

Pterocaesio tile (Cuvier and Valenciennes), *Hist. Nat. Poissons*, vol. 6, p. 428, 1830 (type locality: Caroline Archipelago).

Body relatively elongate, its depth 5.0 in SL; body uniform dusky above and light below without noticeable light stripes in preserved material; caudal fin light dusky color down each lobe to tips; axil of pectoral dark on upper pectoral base; maxillary with two lateral extensions. The following counts were taken from Schultz et al. (1953).

Dorsal fin: XI-XII, 17-22
Anal fin: III, 13-14
Pectoral fin: 22-24
Pelvic fin: I, 5
Gill rakers: 7-8 + 26-28. Total gill rakers: 33-36
Scale rows: 77-78

The uniform body coloration and high number of dorsal rays will separate this species from other Fijian fusiliers. The dorsal counts reported by Munro (1967, p. 302) are X, 14-15 and much lower than those of Schultz et al. (1953). The pectoral fin ray count of 22-24 is high when compared to other fusiliers except for *Gymnocaesio gymnopterus* and provides an additional diagnostic character.

Pterocaesio sp.

Body moderately deep, its depth 4.5 in SL; dorsal fin scaled to one-half its height; several light, narrow bands on body and onto snout; axil of pectoral dark; caudal fin dusky with the tips of the lobes dark; maxillary with two lateral extensions.

Dorsal fin: X, 15
Anal fin: III, 11
Pectoral fin: 21
Pelvic fin: I, 5
Gill rakers: 9 + 27. Total gill rakers: 36
Scale rows: 70

The above counts were taken from a single 88.0 mm SL specimen from Lambasa, Fiji. The meristics are helpful but may overlap counts for other Fijian *Pterocaesio* and the separation of this species from others of the genus is far from satisfactory. Additional material should be examined in detail.

SCOMBRIDAE

Rastrelliger kanagurta (Cuvier), *Regne Animal*, ed. 2, vol. 2, p. 197, 1829 (type locality: India).

The genus *Rastrelliger* is distinguished by the following characters (Jones and Silas, 1962a; Matsui, 1967): body compressed; body and cheeks covered with small scales; maxillary reaching posterior edge of eye; teeth small and rounded, without crenulations; vomer and palatines without teeth; gill rakers long, numerous, feather-like, visible when mouth is opened; spinous first dorsal and soft-rayed portion of dorsal fin separated by a distance equal to length of base of former; anal fin with a rudimentary spine in adults; caudal fin deeply forked.

Jones and Silas (1962b) recognized two species from the Indian Ocean, *R. kanagurta* and *R. brachysoma*, both apparently common in the Indo-Pacific. Matsui (1967) describes a third form, *R. faughni*, from the Philippines and Taiwan, and Lewis et al. (1974) report its occurrence in Papua New Guinea and New Britain. A fourth species, *R. neglectus* is recognized by Druzhinin

and Myint (1970). It was formerly placed in the synonymy of *R. brachysoma* by authors but apparently differs in several salient characters. The separation of the above four species is given in a field key by Druzhinin and Myint (ibid.).

Separation of *R. kanagurta* and *R. brachysoma* is confusing and near impossible when identifying juvenile specimens such as those usually collected in the bouki-ami nets since they lack adult coloration at this size. The above authors distinguish the two species as follows:

<i>R. kanagurta</i>	<i>R. brachysoma</i>
Body depth 23%-27% in fork length	Body depth 28.6%-34% in fork length
Depth of body 4.0-4.8 in SL	Depth of body 3.7-4.0 in SL
Head length greater than body depth	Head length less than body depth
Snout pointed	Snout short and bluntly rounded
Anterior margin of first dorsal dusky	Outer margin of first dorsal conspicuously black
Scales behind pectoral fin deciduous	Scales on body not deciduous
Dark stripes or spots along upper half of body	No dark stripes or regular rows of spots on upper body
Gill rakers 17-21 + 33-42	Gill rakers 17-22 + 35-42
Length of intestines 3.0-3.4 in SL	Length of intestines 1.3-1.7 in SL
Number of bristles on one side of longest gill raker 105-160	Number of bristles 150-240

Forty-four juvenile *R. kanagurta*, 19.0-115.0 mm SL, captured by bouki-ami net from various localities in Fiji were examined. The number of gill rakers and their length in relation to the diameter of the eye show considerable variation (Figures 4 and 5). The total number of gill rakers on the first gill arch increase linearly with growth in sizes examined ($r = 0.78$). The length of the gill rakers, measured at the center of the gill arch and expressed as percent of eye diameter, also increases linearly with growth ($r = 0.87$). These ontogenetic changes add to the confusion in the correct identification of juvenile *Rastrelliger* as do similar changes in other fishes (i.e., *Sardinella* spp.).

R. faughni has not been reported as far east as Fiji but this species may possibly occur in the area.

Meristic variations within a given species are known to be influenced by a number of environmental factors including temperature, dissolved oxygen concentration, salinity, carbon dioxide concentration, light intensity, and exposure to x-rays (Johnson and Barnett, 1975). They also report an inverse correlation between meristic characters and food supply in mid-water fishes. The increasing gill raker length in relation to the eye diameter is not as surprising since various structures change in size and shape with age. In this case not only do the gill rakers increase in length with growth but the eye diameter similarly becomes proportionately smaller in relation to the rest of the body as the fish continues to grow.

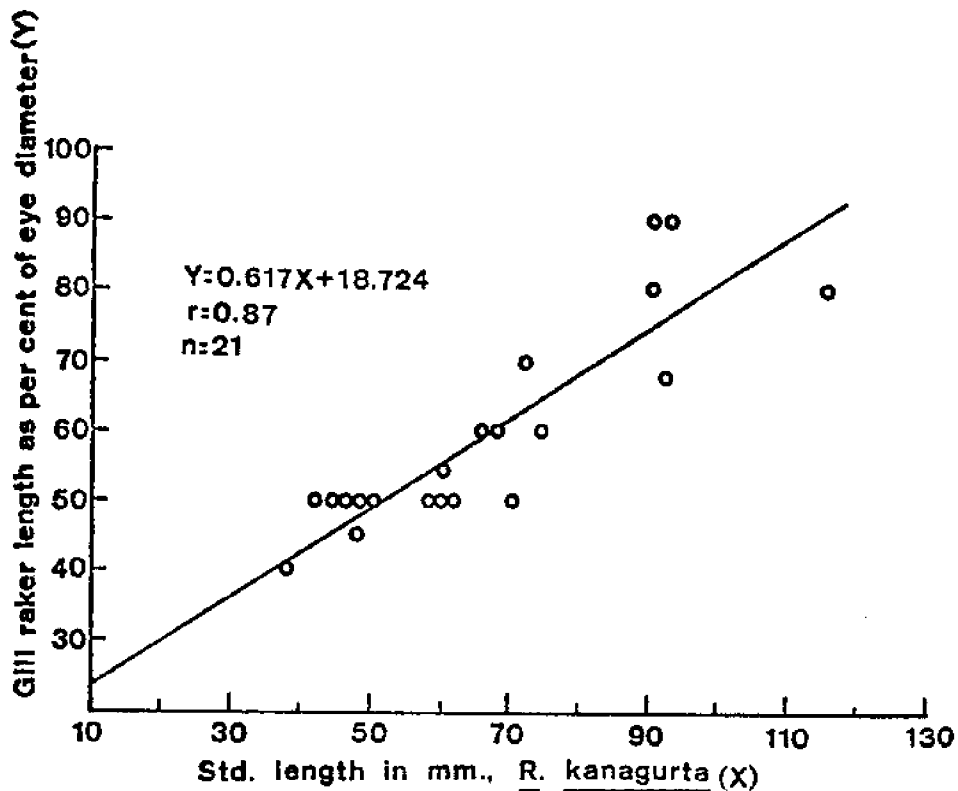


Figure 4. The relationship of gill raker length, expressed as percent of eye diameter, to standard length of juvenile *Rastrelliger kanagurta* collected by bouki-ami net in Fiji

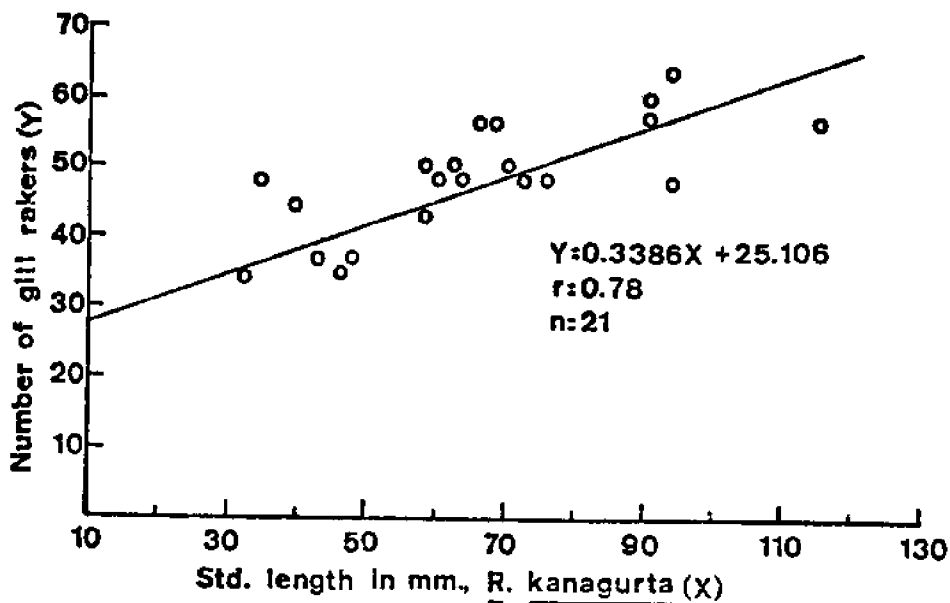


Figure 5. The relationship of the total number of gill rakers on the first gill arch to standard length of juvenile *Rastrelliger kanagurta* collected by bouki-ami net in Fiji

DISCUSSION

The foregoing information will hopefully be of value in reducing the number of errors in the identification of baitfishes encountered in the Fijian skipjack tuna fishery. In Fiji, baitfishes are routinely captured using the Japanese-style bouki-ami net method employing one or more submerged lights. This method is selective in that the species of fishes captured are primarily those that are attracted to lights. Beach seine or rounded-haul net methods used mainly during daylight hours would no doubt include other species not normally taken in the bouki-ami nets including *Stolephorus apiensis*. This species apparently remains close to shore and is found mostly in sheltered habitats too shallow for the commercial bouki-ami nets. It probably represents an additional species of baitfish currently underutilized due to the selectivity of gear employed for baitfish capture. Species of clupeids such as *Herklotsichthys quadrimaculatus* may be more abundant than indicated from bouki-ami net capture records since they are not always taken with light attraction methods. They can also be captured in seines during the day but they are somewhat "skittish" in the nets when crowded, often resulting in injuries followed by heavy mortalities.

The use of meristics is especially useful in the identification of tropical clupeids and engraulids since the number of salient characteristics appears to be limited within these groups. With some exceptions, coloration and body form are somewhat similar in the closely related species (i.e., *Stolephorus* spp.) and tend to overlap thereby reducing their value as diagnostic characters especially in juveniles and older preserved material. The number of longitudinal scale rows shows little variation within the clupeids and engraulids studied but individual scale characteristics provide excellent diagnostic characters in *Sardinella* and *Herklotsichthys*. Specific scale characteristics are not normally used in the *Stolephorus* anchovies since the scales are usually lacking in preserved material.

Significant variations relating to geographical locality and size occur in selected meristics of some clupeids such as the number of dorsal and anal fin rays, and especially the number of gill rakers on the first gill arch. For example, Nakamura and Wilson (1970), reported a range in the number of gill rakers on the lower limb of 20 to >90 in *Sardinella marquesensis* in sizes from 30 to 120 mm SL. This was also demonstrated for *S. dayi* by Raja and Lazarus (1975). Since the number of gill rakers, when used in combination with other characters, provides one of the most useful characters for identifying clupeids and engraulids one must be cognizant of this variability if errors in identification are to be reduced. It would be useful to record the counts of a series of juvenile to adult sizes of all species from a wide range of localities.

There appear to be significant differences in the live coloration of some species of clupeids and engraulids that are useful in the identification of schools of baitfishes while collecting. Kearney et al. (1972) and Lewis et al. (1974) observed the difference in the body color of *Stolephorus devisi* and *S. heterolobus* in Papua New Guinea which they originally termed the "gold morph" and "blue morph." The single row of dark spots along the upper sides of preserved specimens of *Amblygaster sirm* usually appear golden

in color when alive. The two golden shoulder spots of *Herklotsichthys quadrimaculatus*, a prominent characteristic when alive, are lost upon preservation and other less visible characters must be used for identification. Strasburg (1960) also noted a difference in the live coloration between *Stolephorus punctifer* and *S. purpureus*. The former species was noted as being purplish blue while *S. purpureus* was described as greenish or brownish.

Some behavioral differences between species of clupeids and engraulids have been noted by Kearney et al. (1972), Lewis et al. (1974), and Smith (1977), that will be useful for identifying schools of baitfishes. The behavior of baitfishes under a nightlight and their response to dimming of the light, as well as their reaction when confined in a bait net while bucketed aboardship, will be quite variable depending upon the species or combination of species involved. Lewis et al. (1974) and Smith (1977) noted the zig zag echo sounder trace characteristic of *S. punctifer* and the typical tail "flicking" activity of *S. devisi* under a surface light. These and other observations of baitfish behavior, ecology, and life histories will be of considerable help in understanding baitfish resources, improved capture and holding methods, and optimum use at sea.

REFERENCES CITED

- Anonymous. 1980. *Annual Report*. Fisheries Division, Ministry of Agriculture and Fisheries, Suva, Fiji. 99 pp.
- Anonymous. 1981a. Progress report (June-November, 1981) tuna baitfish research. University of the South Pacific, Institute of Marine Resources. Unpublished report. 3 pp.
- Anonymous. 1981b. *Annual Report*. Fisheries Division, Ministry of Agriculture and Fisheries, Suva, Fiji. 95 pp.
- Ben-Yami, M., ed. 1980. Tuna fishing with pole and line. *Fishing Manuals*. Food and Agriculture Organization of the United Nations. 150 pp.
- Chan, W.L. 1965. A systematic revision of the Indo-Pacific clupeid fishes of the genus *Sardinella* (Family Clupeidae). *Japanese Journal of Ichthyology* 12(3/6):105-118 and 13(1/3):1-39.
- Dalzell, P.J., and J.W.J. Wankowski. 1980. The biology, population dynamics of exploited stocks of three baitfish species, *Stolephorus heterolobus*, *S. devisi*, and *Spratelloides gracilis* in Yasbel Passage New Ireland Province Papua New Guinea. Department of Primary Industry, Port Moresby. 125 pp.
- Druzhinin, A.D., and D.T.T. Myint. 1970. A morphometric study of *Rastrelliger* spp. from the Mergui Archipelago, Berina. *Indo-Pacific Fisheries Council* 13(2):49-58.
- Ellway, C.P., and R.E. Kearney. 1981. *Changes in the Fijian bait fishery*. Skipjack Survey Assessment Programme Technical Report No. 5. South Pacific Commission, Noumea, New Caledonia. 24 pp.

- Fowler, H.W. 1941. Contributions to the biology of the Philippine Archipelago and adjacent regions. *Bull. U.S. Nat. Mus.* 100(13):1-879.
- Fowler, H.W. 1959. *Fishes of Fiji*. New Zealand: Avery Press Limited. 670 pp.
- Fowler, H.W., and B.A. Bean. 1923. Description of eighteen new species of fishes from the Wilkes Exploring Expedition preserved in the United States National Museum. In *Proc. U.S. Nat. Mus.* 63(19):1-27.
- Greenwood, P.H., D.E. Rosen, S.H. Weitzman, and G.S. Myers. 1966. Phyletic studies on teleostean fishes, with a provisional classification of living forms. *Bull. Am. Mus. Nat. Hist.* 131(4):341-455.
- Gunther, A. 1880. Report on the shore fishes. In *Zoology of the voyage of H.M.S. Challenger* 1(6):1-82.
- Herre, A.W. 1936. *Fishes of the Crane Pacific Expedition*. Field Mus. Nat. Hist., Zool. Vol. 21, No. 353. 472 pp.
- Iwasa, K., and S. Mizuno. 1979. *Report of feasibility study 1978 on skipjack pole-and-line fisheries in the Micronesian waters*. Report No. 18. Japanese Marine Fisheries Research Center. 47 pp.
- Jones, S., and E.G. Silas. 1962a. A systematic review of the scombroid fishes of India. In *Symposium on Scombroid Fishes Held at Mandapam Camp from January 12-15, 1962. Part 1.*, pp. 1-105. Mar. Biol. Assoc. India.
- Jones, S., and E.G. Silas. 1962b. Mackerel from the Andaman Sea. In *Symposium on Scombroid Fishes Held at Mandapam Camp from January 12-15, 1962. Part 1.*, pp. 255-282. Mar. Biol. Assoc. India.
- Johnson R.K., and M.A. Barnett. 1975. An inverse correlation between meristic characters and food supply in mid-water fishes: Evidence and possible explanation. *Fish. Bull.* 73(2):284-298.
- Jordan, D.S., and A. Seale. 1906. The fishes of Samoa. *Bull. U.S. Bur. Fish.* 25:173-455.
- Kearney, R.E. 1978. *Interim report of the activities of the skipjack survey and assessment programme in the waters of Fiji* (26 January-18 February, 28 March-10 April, 1978). Prelm. Co. Rpt. No. 5. Skipjack Survey and Assessment Programme. 13 pp.
- Kearney, R.E. 1982. *An assessment of the skipjack and baitfish resources of Fiji*. Final Rpt. No. 1. Skipjack Survey and Assessment Programme. 43 pp.
- Kearney, R.E., A.D. Lewis, and B.R. Smith. 1972. *Cruise report Tagula 71-1, survey of skipjack tuna and bait resources in Papua New Guinea waters*. Res. Bull. No. 8. Department of Agriculture, Stock and Fish., Port Moresby. 145 pp.

- Lazarus, S. 19-7. A redescription of *Sardinella melanura* (Cuvier) (Clupeidae: Pisces) with remarks on the species *Sardinella nigricaudata* Chan. *Indian Jour. Fish.* 24(1-2):220-222.
- Lee, R. 1973. Live bait research. Skipjack tuna fishing project in Fiji. *South Pacific Island Newsletter* (9):26-30. Noumea, New Caledonia.
- Lewis, A.D., B.R. Smith, and R.E. Kearney. 1974. *Studies on tunas and baitfish in Papua New Guinea waters - II.* Res. Bull. No. 11. Department of Agriculture, Stock and Fish. Port Moresby. 111 pp.
- Losse, G.R. 1968. The elopoid and clupeoid fishes of East African coastal waters. *Jour. E. Afr. Nat. Hist. Soc.* (27):22-115.
- Matsui, T. 1967. Review of the mackerel genera *Scomber* and *Rastrelliger* with description of a new species of *Rastrelliger*. *Copeia* 1:71-83.
- Munro, I.S.R. 1967. *The fishes of New Guinea.* Department of Agriculture, Stock and Fish. Port Moresby. 650 pp.
- Nakamura, E.L., and R.C. Wilson. 1970. The biology of the Marquesan sardine, *Sardinella marquesensis*. *Pacific Science* 24:359-376.
- Nelson, G. 1983. *Anchoa argentivittata*, with notes on other Eastern Pacific anchovies and the Indo-Pacific genus *Encrasicholina*. *Copeia* (1):48-54.
- Nelson, G., and P.J.P. Whitehead. Reflections on clupeoid evolution. (Abstract). Inter. Confr., Systematics and Evolution of Indo-Pacific Fishes, 7-11 September, 1981. Sydney, Australia. 1 p.
- Raja, B.T.A., and S. Lazarus. 1975. A description of *Sardinella dayi* Regan (Pisces: Clupeidae) of Indian seas with remarks on its close similarity with *Sardinella maderensis* (Lowe) and *Sardinella jussieui* (Valenciennes). *Indian Jour. Fish.* 22(1-2):113-125.
- Ram, N., and G. Southwick. Interim report on the design and construction of fishing gear for the tropics. University of the South Pacific, Institute of Marine Resources. Suva, Fiji. Unpublished report. 26 pp.
- Rao, M.B. 1966. A new species of *Stolephorus* Lacépède from the east coast of India (Pisces: Engraulidae). *Ann. Mag. Nat. Hist.* 13(9):101-110.
- Ronquillo, I.A. An illustrated key to the genus *Stolephorus*. Unpublished manuscript on file at the National Marine Fisheries Service, Honolulu, Hawaii. 31 pp.
- Schultz, L.P., and Collaborators. 1953. Fishes of the Marshall and Marianas Islands. *Bulletin U.S. National Museum*, Vol. 1., No. 202. 685 pp.
- Smith, B.R. 1977. Appraisal of the live-bait potential and handling characteristics of the common tuna bait species in Papua New Guinea. In *Collection of Tuna Baitfish Papers*, ed. R.S. Shomura, pp. 95-103. NOAA Technological Report, National Marine Fisheries Service Circular 408.

- Strasburg, D.W. 1960. A new Hawaiian engraulid fish. *Pacific Science* 14(4):395-399.
- Tiews, K., I.A. Ronquillo, and L.M. Santos. 1970. On the biology of anchoview (*Stolephorus Lacépède*) in Philippine waters. In *Proc. Indo-Pacific Fisheries Council* 13(2):20-48.
- Uchida, R.N., and R.F. Sumida. 1973. Tuna: pole-and-line fishing trails in central and western Pacific. *Mar. Fish. Rev.* 35(1-2):31-41.
- UNDP/FAO. 1969. *UNDP/FAO South Pacific tuna mission*. United Nations Development Program/Food and Agriculture Organization of the United Nations. Various pagination.
- UNDP/FAO. 1974. *Local tuna fishery, Suva, Fiji*. Economic feasibility of a local skipjack fishery. Technical Report 2. United Nations Development Program/Food and Agriculture Organization of the United Nations. 30 pp.
- Weber, M., and L.F. de Beaufort. 1913. *The fishes of the Indo-Australian Archipelago*. Vol. 2. Leiden: E.J. Brill. 404 pp.
- Whitehead, P.J.P. 1963. A revision of the recent round herrings (Pisces: Dussumieriidae). *Bull. Brit. Mus. (Nat. Hist.), Zool.* 10(6):307-380.
- Whitehead, P.J.P. 1965. A review of the elopoid and clupeoid fishes of the Red Sea region. *Bull. Brit. Mus. (Nat. Hist.), Zool.* 12(7):225-281.
- Whitehead, P.J.P. 1967a. The clupeoid fishes described by Lacépède, Cuvier & Valenciennes. Supplement 2. *Bull. Brit. Mus. (Nat. Hist.), Zool.* 180 pp.
- Whitehead, P.J.P. 1967b. Indian Ocean anchovies collected by the *Anton Bruun* and *Te Vega*, 1963-64. *Jour. Mar. Biol. Assoc. India* 19(1):13-37.
- Whitley, G.P. 1927. A check-list of fishes recorded from Fijian waters. *Jour. Pan-Pac. Res. Inst.* 2(1):3-8.
- Whitley, G.P. 1940. Illustrations of some Australian fishes. *Aust. Zool.* 9(4):397-428.
- Wongratana, T. 1983. Diagnosis of 24 new species and proposal of a new name for a species of Indo-Pacific clupeoid fishes. *Jap. Jour. Ichthy.* 29(4):385-407.

APPENDIX

APPENDIX A. Description of *Stolephorus apiensis* (Jordan and Seale).
USP 3306, 45(62.5-70.7), Laucala Bay, Viti Levu, Fiji,
May 26, 1972 (Figure 6)

Body depth at origin of dorsal fin 184-212; caudal peduncle depth 095-108; width of body 089-122; head length 242-267; postorbital head length 120-141; snout length 051-066; eye diameter 059-072; tip of snout to dorsal origin 519-560; tip of snout to anal origin 597-655; inter-orbital width 054-062; maxillary length 198-224; pectoral fin length 140-169; pelvic fin length 099-119; length dorsal fin base 142-170; length anal fin base 184-235; width silvery lateral stripe 040-058.

Number of predorsal scales 18-20; longitudinal scale rows 34-36; transverse scale rows 9; ventral scutes 0-4; gill rakers 21-25 + 28-32, total gill rakers 49-55; dorsal fin rays 15-17; anal fin rays 19-22; pectoral fin rays 13-14; pelvic fin rays 7; caudal fin rays 19; branchiostegal rays 11, vertebra 39 (one alizarin stained specimen).

Head moderately long, its length one eye diameter greater than body depth and 3.5-4.0 in SL. Interorbital convex with a narrow central ridge from snout to occiput, least interorbital width equal to diameter of eye. Length of snout equal to diameter of eye and 4.0-4.5 in length of head. Posterior frontal fontanelles moderately narrow with the lateral borders straight to slightly sigmoid in shape, the exact shape is somewhat variable. Maxillary long and slender, usually reaching to posterior margin of preoperculum. Tip of maxillary pointed and with fine teeth uniform in size but smaller anteriorly. Ventral margin of maxillary relatively straight. Gill rakers long, slender, flattened with small spinules along interior margin. Length of longest gill raker 0.7-0.8 of eye diameter. Muscular portion of isthmus extending forward to branchiostegal membrane and without a ventral expansion on the urohyal. Branchiostegal membrane free from isthmus. Eye round, 3.7-4.0 in length of head. Origin of dorsal fin 0.5-1.0 eye diameter closer to upper base of caudal fin than to tip of snout. Origin of anal fin below central third of dorsal fin base, distance from tip of snout to origin of anal 1.6-1.7 in SL. Length of anal fin base equal to depth of body and 4.2-4.7 in SL. Base of pelvic fin one eye diameter anterior to origin of dorsal fin, its length equal to postorbital length of head. Axillary scale at base of pelvic nearly reaching tip of fin. Base of pectoral fin 0.5-1.0 eye diameter closer to tip of snout than to anus. Axillary scale not reaching tip of fin by 0.5 eye diameter. Tip of pectoral fin 0.7 eye diameter short of pelvic fin base. Caudal fin deeply forked, its longest rays equal to length of head. Scales thin, deciduous, with 4-5 dorsoventral grooves. Ovarian eggs elliptical with an elongate knob at one end. Major axis of egg 1.0 mm.

Freshly preserved specimens light straw color with a faint silvery lateral stripe from base of caudal fin to head. Lateral stripe indistinct and without dark pigment along upper and lower margins. Back with a distinct imbricate pattern from head to upper base of caudal fin. Top of head posterior to eyes having a distinct bilobed blotch and with a line of dark pigment extending down to about mid-eye level. A dusky blotch on back extending back to about one eye diameter posterior to occiput. Tip

of snout dusky with some scattered pigment on tip of lower jaw. Pelvic and anal fins without pigment. Pectoral fins usually with scattered pigment along upper three or four rays. Dorsal with scattered pigment on rays. Caudal fin evenly dusky with an elongate vertical spot at base of lower rays and a similar diagonal spot at base of upper caudal rays. A narrow line of dark pigment on underside of caudal peduncle posterior to anal fin base. Peritoneum mostly light with scattered dark pigment dorsally.

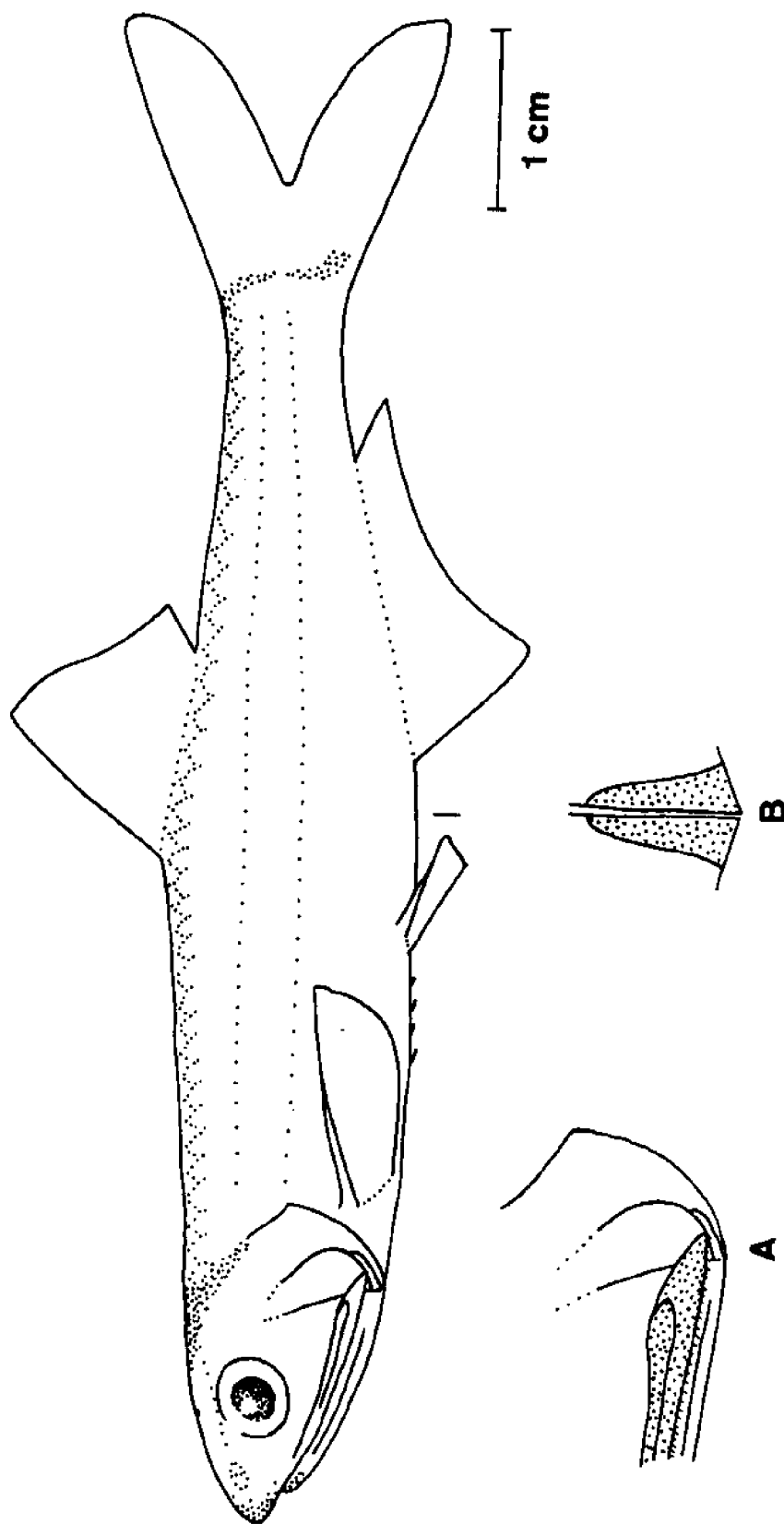


Figure 6. *Stolephorus apiensis* (Jordan and Seale, 1906), 68.5 mm SL, USP 3306, collected in Laucala Bay, Viti Levu, Fiji, May 26, 1972. A, length and shape of the maxillary (stippled portion) and relation to the posterior preopercular margin; B, relative shape of the posterior frontal fontanelles.

