THE PRISTIPOMOIDES (PISCES: LUTJANIDAE) OF GUAM WITH NOTES ON THEIR BIOLOGY AND FISHERY ASPECTS

by

HARRY T. KAMI

A thesis submitted in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE
in
BIOLOGY

University of Guam
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AN ABSTRACT OF THE THESIS OF Harry T. Kami for the Master of Science in Biology, presented November 20, 1972.

Title: The Pristipomoides (Pisces: Lutjanidae) of Guam with notes on their biology and fishery aspects.

Approved: _____
ROBERT S. JONES, Chairman, Thesis Committee

Taxonomic data as well as information on the biology and fishery aspects of four species of deep water snappers, genus Pristipomoides, are presented. The genus is represented in Guam by the following species, P. auricilla (Jordan, Evermann, and Tanaka), P. sieboldii (Bleeker), P. filamentosus (Cuvier and Valenciennes), and P. flavipinnis Shinohara.

Close affinities are found between P. auricilla and P. sieboldii and between P. filamentosus and P. flavipinnis. Sexual dichromatism of P. auricilla and P. filamentosus is described. P. sieboldii and P. flavipinnis displayed no sexual dichromatism.

Limited information on the feeding habits of these snappers indicates that pelagic tunicates are important food items.

Differences in number between the males and females taken of P. auricilla and P. filamentosus were significant, but P. sieboldii and P. flavipinnis showed no

such differences.

Catch rates indicate that the northeastern region of the island is a better fishing area than the northwestern or southwestern regions. However, due to weather exposure, more fishing was done in the two latter regions resulting in larger total catches. Depths from which these snappers were taken ranged from 90 to 360 m, but best catches occurred at depths of 181 to 270 m.

P. auricilla is the most important species of the Pristipomoides fishery in Guam.

TO THE GRADUATE SCHOOL:

The members of the committee approve the thesis of Harry T. Kami presented November 20, 1972.

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TABLE OF CONTENTS

PAGE

LIST OF TABLES

LIST OF FIGURES

PAGE

The *Pristipomoides* (Pisces: Lutjanidae) of Guam With Notes on Their Biology and Fishery Aspects.

INTRODUCTION

Considerable taxonomic confusion exists among the Indo-Pacific *Pristipomoides*. Smith (1954), Abe (1960), and Shinohara (1963) have worked extensively with the genus, but all express a need for further study.

Because of the commercial value of these snappers, it is important that their taxonomy be clarified. More accurate records and fisheries research statistics would result.

Ecological data on the species are virtually non-existent largely because of their deep water habitat (90-360 m). Availability of such data would, obviously, contribute to the development of more efficient fishing methods.

PART I. TAXONOMY

MATERIALS AND METHODS

In the Indo-Pacific, the lutjanid genus *Pristipomoides* is presently represented by five species, *P. auricilla* (Jordan, Evermann, and Tanaka), *P. filamentosus* (Cuvier and Valenciennes), *P. flavipinnis* (Shinohara),

P. sieboldii (Bleeker), and P. typus (Bleeker). Of these species, all but P. typus occur in Guam waters.

This study is based primarily on 1,213 Guam specimens collected with handline by the crew of the Division of Fish and Wildlife exploratory commercial fishing vessel, M/V PANGLAU ORO (Department of Agriculture, Government of Guam). Specimens from other localities were also examined from the United States National Museum (USNM); the Bernice P. Bishop Museum (BPBM); the University of the Ryukyus (UR); the University of Tokyo (UT); Science College Museum in Tokyo (SCM); U. S. Bureau of Commercial Fisheries, Tropical Atlantic Biological Laboratory (TABL); and the personal collection of Dr. T. Abe (TA), Japan.

Detailed counts and measurements, corresponding to the definitions of Hubbs and Lagler (1949), were taken from 124 Guam specimens and a total of 36 specimens from Hawaii, Philippines, Japan, and the Caribbean Islands. However, the counts and measurements of only Guam specimens are presented in this study. With few exceptions, scale and gill raker counts were taken from the left side of the body. Gill

arches from five samples of each species were removed, stained with Alizarin S and photographed. Equal numbers of samples of each species were skeletonized for vertebral counts.

Freshly caught fish were measured prior to marketing. Fork length in millimeters and weight to the nearest quarter pound (113 g) were taken. Regression analysis was used to test length-weight relationships. Standard error and standard deviation were used to analyze the following morphometric and meristic characters; gill raker counts, pored lateral line scale counts, ratio of suborbital width in eye diameter, and ratio of snout length in head length. Analysis of variance was applied to the mean length between species and between sexes within the species for samples from all areas of Guam.

Reliability of sexual dichromatism in P. filamentosus and P. auricilla was determined by predicting the sex of individuals based on the color pattern prior to dissection. Individuals whose gonads were not distinguishable by gross examination were labled as immature.

RESULTS

Pristipomoides Bleeker, 1852

Aphareus Cuvier and Valenciennes, 1830:485 (type-species *Aphareus caerulescens* Cuvier and Valenciennes).

Aprion Cuvier and Valenciennes, 1830:543 (type-species *Aprion virescens* Cuvier and Valenciennes).

Apsilus Cuvier and Valenciennes, 1830:548 (type-species *Apsilus fuscus* Cuvier and Valenciennes).

Chaetopterus Temminck and Schegel, 1844:718 (type-species not specified).

Pristipomoides Bleeker, 1852:575 (type-species *Pristipomoides typus* Bleeker).

Bowersia Jordan and Evermann, 1903:182 (type-species *Bowersia violescens* Jordan and Evermann).

Ulaula Jordan and Thompson, 1911:459-460 (new subgenus; type-species *Bowersia ulaula* Jordan and Evermann).

Arnillo Jordan, Evermann, and Tanaka, 1927:667-668 (type-species *Arnillo auricilla* Jordan, Evermann, and Tanaka).

Description.

Body oblong, robust; interorbital naked, flat; cheek and opercle scaled; three to four rows of scales in a narrow patch on nape, separated by a thin naked

groove from dorsal body scales; two opercular spines, the uppermost spine weak; no distinct pre-opercular notch; base of dorsal and anal fins without scaly sheath; dorsal fin continuous without deep indentation between spinous and soft rays; pectoral fin falcate, longer than head; maxillary naked.

An Artificial Key to the Species of the Genus Pristipomoides known from Guam.

1a. Pored lateral line scales from dorsal edge of gill opening to base of caudal fin 70-74; total number of gill rakers on first gill arch 27-32.

2a. Tongue with tooth patch; vomerine tooth patch diamond shaped, projecting posteriorly; canines near symphysis of upper and lower jaws not greatly enlarged ... sieboldii (Bleeker).

2b. Tongue edentate; vomerine tooth patch in shape of a broad triangle without posterior projection; canines near symphysis of lower jaw greatly enlarged ... auricilla (Jordan, Evermann, and Tanaka).

1b. Pored lateral line scales 60-67; total number of gill rakers on first gill arch 18-27.

2a. Length of upper jaw 2.1-2.4 times into head length; pyloric caeca 4-6 (usually 5); canine

teeth near symphysis of lower jaw greatly enlarged; distance between posterior nostril and anterior margin of eye less than 4 times eye diameter ... flavipinnis Shinohara.

3b. Length of upper jaw 2.4-2.6 times into head length; pyloric caeca 7-9 (usually 8); canine teeth near symphysis of lower jaw not greatly enlarged; distance between posterior nostril and anterior margin of eye less than 4 times eye diameter ... filamentosus (Cuvier and Valenciennes).

Pristipomoides sieboldii (Bleeker)

(Fig. 1)

Chaetopterus sieboldii Bleeker, 1857:20 (original description; type locality, Japan). Regan, 1905:18-19 (description).

Chaetopterus dubius Gunther, 1859:385 (description: locality, Japanese Sea). Jordan and Seale, 1905:265 (in list). Jordan and Snyder, 1906:213 (description).

Bowersia ulaula Jordan and Evermann, 1904:183-184 (original description; holotype, USNM 50661, type locality, Hawaii). Jordan and Evermann, 1905:237-238 (description of holotype).

Ulaula sieboldii (Bleeker), Jordan and Jordan, 1927:49 (description of subgenus).

Pristipomoides filamentosus (Valenciennes), Fowler, 1931b:191-193 (after type of B. ulaula).

Pristipomoides sieboldii (Bleeker), Jordan and Thompson, 1911:462-464 (description). Fowler and Ball, 1925:14 (in list). Fowler, 1928:183 (misindentified, specimen actually P. filamentosus). Fowler, 1929:634 (in list). Fowler, 1931a:22 (in list). Edmondson, 1946:337 (comments). Smith, 1954:490-491 (description and key). Gosline and Brock, 1960:182-186 (description and key). Shinohara, 1966:230-231; 295-296 (description in Japanese and key in English). Kami, Ikehara, and Deleon, 1968:108 (in list).

Specimens examined.

Of the 111 Guam-collected specimens, detailed measurements and counts were taken from 22 specimens (SL 170 to 350 mm). Additional material: Holotype, B. ulaula USNM 50661 (275 mm), Hawaii; USNM 88185 (2, 177 and 185 mm), Hawaii; USNM 151567 (3, 184 to 217), Hawaii; UR 138 (1, 244 mm), Okinawa; uncataloged (2, 269 and 326 mm), Japan.

Description.

Dorsal rays X, 11; anal rays III, 8; pectoral rays ii, 12, ii; pored lateral line scales 71-74; predorsal scales 16-18; scale rows above lateral line to insertion of first dorsal spine 7 or 8; scale rows below lateral line to insertion of first anal spine 14 or 15;

Fig. 1. Pristipomoides sieboldii (Bleeker), SL. 342 mm.

total numbers of gill rakers on first gill arch 28-32 (9-10+1+18-21); pyloric caeca 7-9, vertebrae 24.

The following measurements are per cents of the standard lengths. Body depth 25.3-30.5; head length 28.3-32.9; snout length 7.7-9.1; eye diameter 7.1-10.0; length of upper jaw 9.7-11.0; sub-orbital width 2.2-2.9.

Maxillary terminating below anterior margin of pupil; palatine teeth in broad villiform bands; vomer diamond-shaped patch projecting posteriorly (Fig. 2); upper and lower jaws with an outer row of small canine teeth, canines near symphysis slightly larger than those on side of jaw; upper jaw with an inner, thin band of cardiform teeth along side of jaw, cardiform band much wider near region of symphysis; cardiform band on lower jaw narrow, restricted to area of symphysis; tongue with oval or heart-shaped patch of villiform teeth. (Fig. 3).

Pectoral fin reaching a vertical at base of tenth dorsal spine; pelvic fin not reaching anus; last dorsal ray barely reaching base of caudal fin; last anal ray not reaching base of caudal fin; caudal fin forked.

Color when fresh.

Body light lavender, becoming pale ventrally; scales above lateral line with small, pale blue spot, forming thin length-wise lines; lines becoming indistince toward ventral region; margin of dorsal fin orange with light lavender; anal fin pale; caudal fin dark lavender with light margin.

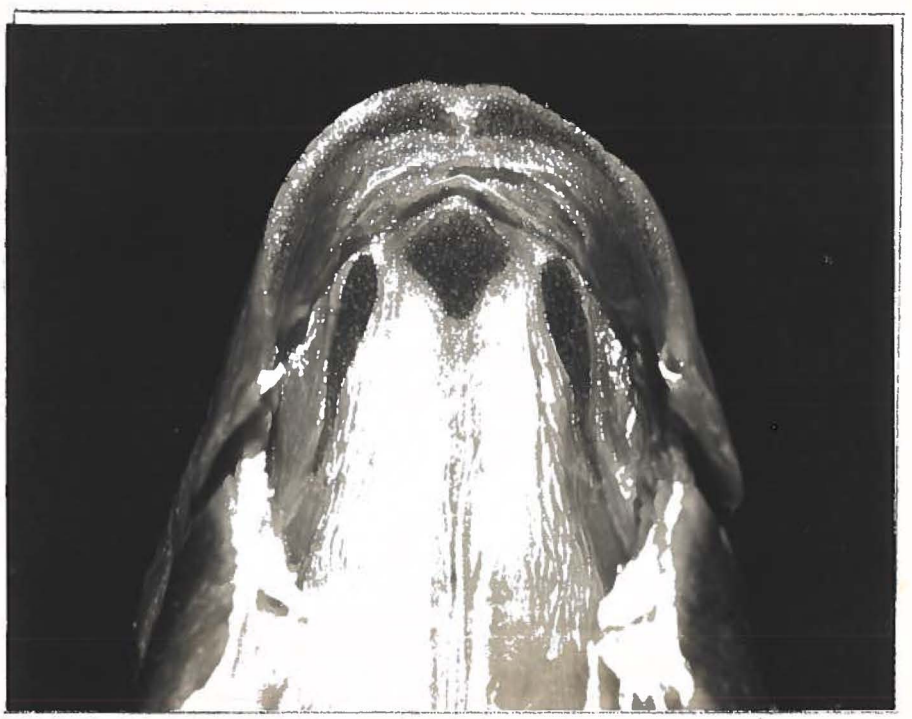


Fig. 2. Palatines and diamond-shaped vomer of *P. sieboldii*.

Fig. 3. Heart-shaped patch of villiform teeth on tongue of P. sieboldii.

Color when preserved.

Body pale; interorbital with few scattered dark spots; dorsal and caudal fins slightly dusky; pectoral, pelvic, and anal fins pale; iris dark.

Remarks.

Pristipomoides sieboldii can be easily distinguished from other Pristipomoides species by its diamond-shaped vomer projecting posteriorly and with either a heart-shaped or an oval patch of villiform teeth on its tongue.

Fowler (1928) included this species in his Fishes of Oceania, however, in subsequent work (1931a), he found them to be specimens of P. microdon (Steindachner). P. microdon is presently considered to be a synonym of P. filamentosus.

Much confusion has stemmed from Fowler (1931b:192) when he erroneously reported P. filamentosus as having a "vomer with broad diamond-like patch of villiform teeth". The type and a second specimen of Serranus filamentosus Cuvier and Valenciennes were examined by Dr. J. Guibé at the Museum National d' Histore naturells, Paris, and he reported the vomer to be triangular (Abe, 1957). Therefore, Fowler's P. filamentosus is clearly synonymous with P. sieboldii.

P. sieboldii reaches 400 mm in fork length, but seldom exceeds this length.

Distribution.

This species is found in the eastern Indian and western, central, and southern Pacific Oceans. In the Indian Ocean, it is recorded from the cost of Kenya, (Smith, 1954). In the western Pacific, it is recorded from Japan (Bleeker, 1857; Gunther, 1859; Regan, 1905), the Ryukyus (Shinohara, 1963, 1966), and Guam (Kami, et al, 1968). In the central and south Pacific, it is recorded from Hawaii (Jordan and Evermann, 1905; Jordan and Synder, 1906; Jordan and Jordan, 1927; Fowler, 1928, 1929, 1931b; Gosline and Brock, 1960), Johnston Island (Fowler and Ball, 1925), and Samoa (Jordan and Seale, 1905).

Pristipomoides auricilla (Jordan, Evermann, and Tanaka)

(Fig. 4)

Arnillo auricilla Jordan, Evermann, and Tanaka, 1927: 668-670 (original description: Holotype, Mus. Cal. Acad. Sci. 348; type locality, Hawaii).

Pristipomoides auricilla (Jordan, Evermann, and Tanaka), Abe, 1960:161-165 (description. Shinohara, 1963:52 (key). Shinohara, 1966:231-233; 295-296 (description in Japanese, key in English). Kami, Ikehara, and Deleon, 1968:108 (in list).

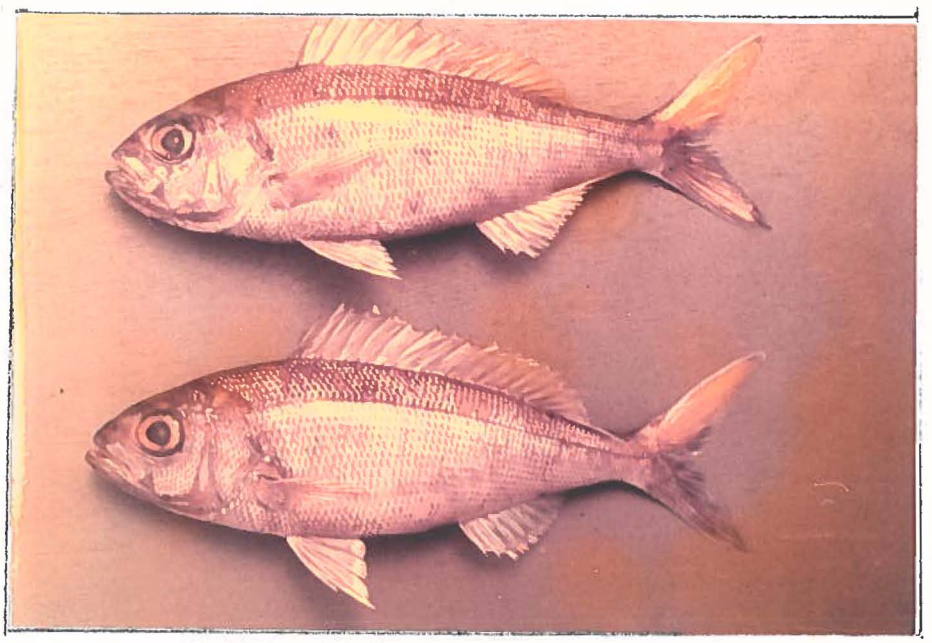


Fig. 4. Pristipomoides auricilla (Jordan, Evermann, and Tanaka), TOP: male, SL 298 mm. BOTTOM: female, SL 302 mm.

Specimens examined.

Of the 778 Guam-collected specimens, detailed measurements and counts were taken from 31 specimens (SL 200-347 mm). Additional material: UR 165 (1, 222 mm), Okinawa.

Description.

Dorsal rays X, 11; anal rays III, 8; pectoral rays ii, 12, ii; pored lateral line scales 70-74; predorsal scales 14-18; scale rows above lateral line to insertion of first dorsal spine 7 or 8; scale rows below lateral line to insertion of first anal spine 15-16; total number of gill rakers on first gill arch 27-32 (8-10+1+ 18-20); pyloric caeca 5-7; vertebrae 24.

The following measurements are in per cents of the standard lengths. Body depth 27.9-31.7; head length 30.8-33.7; snout length 8.4-10.5; eye diameter 7.5-9.6; length of upper jaw 13.0-18.8; suborbital width 2.4-4.3.

Maxillary terminating anterior to margin of eye; palatine teeth in broad villiform band; vomerine teeth in a triangular-shaped, villiform patch with the vertex pointing anteriorly (Fig. 5); upper jaw with an outer row of strong, slightly recurved, canine teeth, canines near symphysis larger than those on side, an inner band of cardiform teeth along side of jaw; cardiform band near symphysis with few, small canines pro-

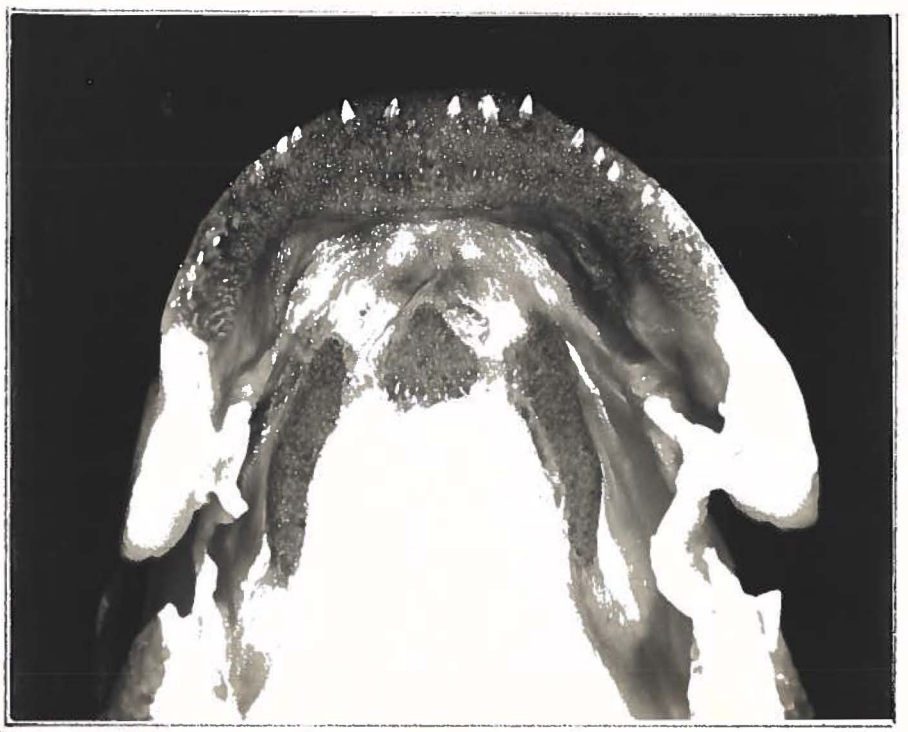


Fig. 5. Palatines and vomer of P. auricilla.

jecting posteriorly; lower jaw with an outer row of strong canines near symphysis and small closely spaced canines on side of jaw, inner band of cardiform teeth with several well developed small canine teeth projecting posteriorly restricted to area of symphysis; tongue edentate.

Pectoral fin reaching a vertical at base of tenth dorsal spine; pelvic fin reaching anus; last dorsal ray reaching base of caudal fin; last anal ray not quite reaching base of caudal fin; caudal fin forked.

Color when fresh.

Body mainly purplish with 17-18 narrow, broken, yellow, chevron-shaped bands; iris yellow; edge of upper lip yellow; two horizontal yellow bands running from snout through eye to operculum, the first originating just above upper lip, the second passing through posterior nostril; a third transverse irregular yellow band between orbits; dorsal fin membrane yellow; pectoral fins pale; anal fin rays dusky, membrane yellow; dorsal lobe of caudal fin yellow with purple margin.

Sexual dichromatism.

Female: Ventral lobe of caudal fin may or may not be tinged with yellow, if tinged, not forming a distinct yellow blotch.

Male: Ventral lobe of caudal fin with much yellow, usually forming a distinct yellow blotch (Fig. 4).

Only large males with fork lengths exceeding 270 mm displayed sexual dichromatism.

Color when preserved.

Tip of upper and lower jaws dusky; head dusky with three pale bands; first band just above upper lip and terminating in front of eye; second band passing through posterior nostrils meeting first band in front of eye; first and second band separated by a narrow, broken, horizontal dark band which extends over anterior nostril; third irregular pale band between orbits; pre- and post-orbital with narrow pale area; body dusky with pale mottling; dorsal and anal rays slightly dusky, membranes clear; pectoral fins pale; pelvic fins slightly dusky.

Remarks.

Based on the above described sexual dichromatism the sex of 284 individuals exceeding 220 mm in fork length was predicted with 81.7% accuracy.

P. auricilla, although first described from specimens taken from Hawaii, is not a common species there. Gosline and Brock (1960), not certain of this species, erroneously synonymized it with P. sieboldii. However, in Guam, it is the most common member of the genus.

All specimens taken from Guam were under 400 mm in fork length except one measuring 410 mm.

Distribution.

This species is recorded from Japan and the Bonin Islands (Abe, 1960), the Ryukyu Islands (Shinohara, 1963, 1966), Guam Island (Kami, et al, 1968), and Hawaii (Jordan, Evermann, and Tanaka, 1927).

Pristipomoides flavipinnis Shinohara

(Fig. 6)

Shinohara, 1963:49-53 (original description; holotype, UR 163, type locality, Okinawa).

Specimens examined.

Of the 211 Guam-collected specimens detailed measurements and counts were taken from 31 specimens (SL 167-427 mm). Additional material: Paratype, UR 164 (1, 297 mm), Okinawa.

Description.

Dorsal rays X, 11; anal rays III, 8; pectoral rays ii, 12, ii; pored lateral line scales 62-67; predorsal scales 13-17; scale rows above lateral line to insertion of first dorsal spine 6-7; scale rows below lateral line to insertion of first anal spine 13-16; total number of gill rakers on first gill arch 22-27, (7-9+1+14-17); pyloric caeca 4-6; vertebrae 24.

The following measurements are in per cents of standard lengths. Body length 20.1-31.5; head length

Fig. 6. Pristipomoides flavipinnis Shinohara, SL. 387 mm.

30.9-34.1; snout length 11.3-12.3; eye diameter 7.2-9.5; length of upper jaw 13.1-14.7; suborbital width 4.1-6.3.

Maxillary terminating slightly anterior to pupil; palatine teeth in narrow villiform band; vomerine teeth in a broad triangular-shaped villiform patch (Fig. 7); upper and lower jaws with an outer row of irregularly spaced canine teeth, canines near symphysis much larger than those on side of jaw; upper jaw with inner band of cardiform teeth, band near symphysis with few small posteriorly projecting canine-like teeth on band; tongue edentate.

Pectoral fin reaching a vertical from base of tenth dorsal spine to base of first soft dorsal ray; pelvic fin reaching anus; last dorsal ray reaching base of caudal fin; last anal ray not reaching base of caudal fin; caudal fin forked.

Color when fresh.

Body lavender-brown becoming pale ventrally; iris yellow; interorbital and snout lavender-brown, mottled with narrow, irregular light yellow streaks; naked groove around temporal scale-patch lavender-brown; scales on body above lateral line with yellow spots forming about five thin horizontal stripes; scales below lateral line with indistinct yellow spots; spiny dorsal fin yellow with broken blotches of yellow on soft dorsal fin; pectoral fin rays light yellow with

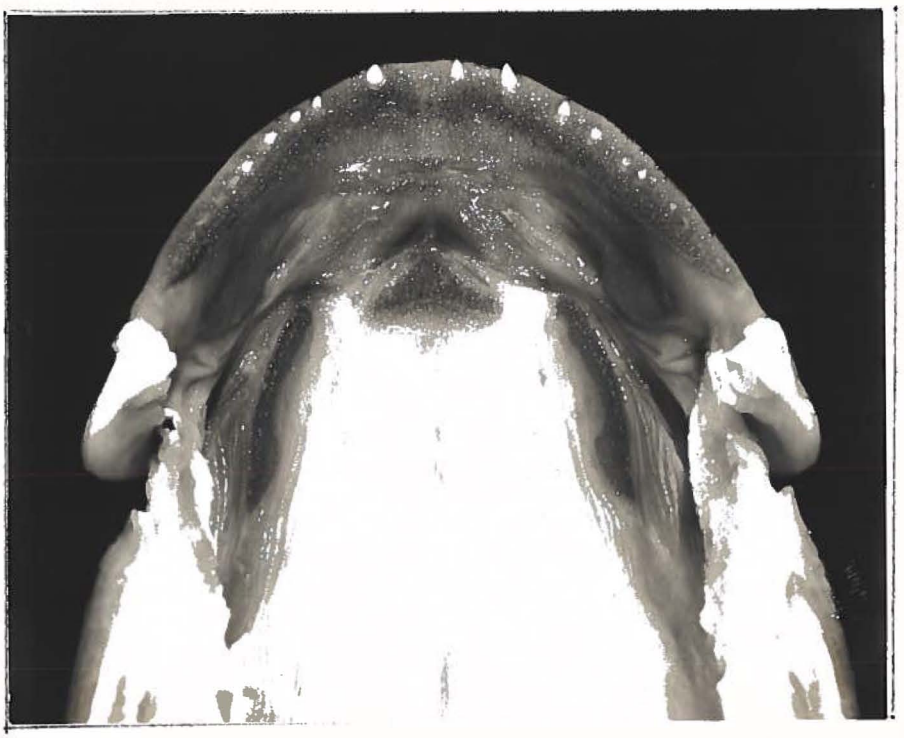


Fig. 7. Palatines and vomer of P. flavipinnis.

clear membrane; pectoral axis yellow; pelvic spine and first ray on fin white, rest of pelvic fin rays yellow; anal fin with yellow blotches on membranes, margin of fin white; caudal fin purplish-brown with yellow margin.

Color when preserved.

Body light grayish brown; edge of scales with dusky margin forming mottling effect; caudal fin pale with slightly dusky margins; pectoral, pelvic, dorsal and anal fins pale.

Remarks.

Comparison of Guam specimens with the paratype of P. flavipinnis from Okinawa leaves no doubt that Guam and Okinawa specimens are conspecific. Although Shinohara (1963) found this species to be rare in the Ryukyus, P. flavipinnis is a relative common species (ranking third in the order of abundance) in Guam waters. Specimens exceeding 400 mm in fork length are frequently taken.

Distribution.

This species is recorded from the Ryukyus (Shinohara, 1963, 1966) and Guam (Kami, et al, 1969).

Pristipomoides filamentosus (Cuvier and Valenciennes)

(Fig. 8)

Serranus filamentosus Cuvier and Valenciennes, 1830: 382-383 (original description; type locality, Bourbon).

Chaetopterus microlepis Bleeker, 1869:80 (original description; type locality, Amboina).

Aprion (Aprion) microlepis Bleeker, 1876-1877:78-79 (description).

Aprion microdon Steindachner, 1876:158-160 (original description; type locality, Hawaii).

Aphareus roseus Castelnau, 1879:373 (original description; type locality, presumably Port Jackson).

Bowersia violescens Jordan and Evermann, 1904:183 (original description; holotype USNM 50660, type locality, Hawaii). Jordan and Evermann, 1905:236 (description of holotype). Jordan and Seale, 1905:265 (in list). Jordan and Snyder, 1906:213 (description).

Apsilus microdon (Steindachner), Jordan and Evermann, 1905:234 (description).

Aprion filamentosus (Cuvier and Valenciennes), Gilchrist and Thompson, 1909:226-227 (description). Gilchrist and Thompson, 1917:345-346 (in list).

Aprion microlepis (Bleeker), Ogilby, 1916:182-183 (statement of synonymy with A. roseus of Castelnau).

Aprion roseus (Castelnau), McCulloch, 1917:173-174 (description).

Pristipomoides filamentosus (Cuvier and Valenciennes), Barnard, 1927:648-649 (description). Kamohara, 1967:65 (description).

Pristipomoides violescens (Jordan and Evermann), Jordan and Jordan, 1927:48 (in list).

Pristipomoides sieboldii (Bleeker), Fowler, 1928:193 (misidentification).

Pristipomoides microlepis (Bleeker), Fowler, 1928:192-193 (description). Fowler, 1929:634 (in list). Fowler, 1931a:22 (in list). Fowler, 1931b:190-191 (description). Smith, 1954:488-489 (key and description). Gosline and Brock, 1969:183-186 (key and description). Kami, Ikehara, and Deleon, 1968:108 (in list).

Pristipomoides microdon (Steindachner), Fowler, 1931b: 187-188 (description in part).

Aprion kanekonis Tanaka, 1935:300-302 (original description; holotype SCM 3687, type locality, Japan).

Aprion (Pristipomoides) microlepis (Bleeker), Weber and deBeaufort, 1936:312-313 (key and description).

Pristipomoides argyrogrammiscus (Cuvier and Valenciennes). Smith 1937:183-185 (description).

Pristipomoides filamentosus roseus (Castelnau), Abe and Takashima, 1956:15-19 (description). Abe, 1957:1155-1163 (description). Abe, 1960:165 (comments). Shinohara, 1963:51 (key). Shinohara, 1966:233-243; 295 (description in Japanese, key in English).

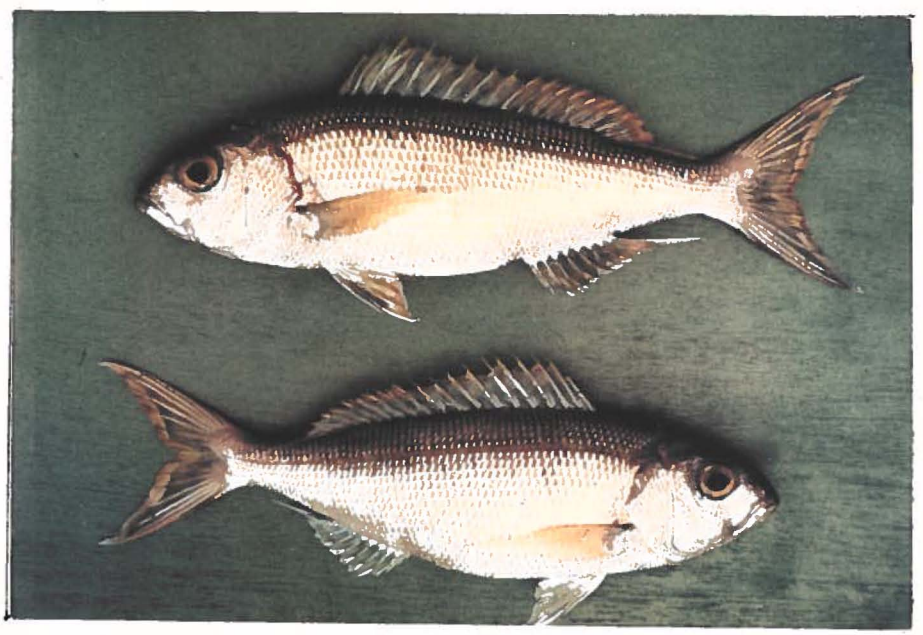


Fig. 8. Pristipomoides filamentosus (Cuvier and Valenciennes), TOP: Male, SL. 388 mm. BOTTOM: female, SL. 362 mm.

Specimens examined.

Of the 213 Guam specimens, detailed measurements and counts were taken from 30 specimens (SL 179-509 mm). Additional material: Holotype, B. violescens, USNM 50660 (456 mm), Hawaii; USNM 196981 (2, 240 and 255 mm), Netherlands Indies; USNM 52738 (1, 386 mm), Hawaii; USNM 51200 (1, 424 mm), Hawaii; UT 18147 (1, 426 mm), Okinawa; UT 18146 (1, 486 mm), Okinawa; UT 146608 (1, 227 mm), Japan; TA 14274 (1, 517 mm) Japan; UR 138 (1, 244 mm), Okinawa; holotype, A. kanekonis, SCM 3687 (1, 188 mm), Japan.

Description.

Dorsal rays X, 11; anal rays III, 8; pectoral rays ii, 12, ii; pored lateral line scales 61-65; predorsal scales 15-18; scale rows above lateral line to insertion of first dorsal spine 7 or 8; scale rows below lateral line to insertion of first anal spine 14-16; total number of gill rakers on first gill arch 22-26 (7-8+1+ 14-17); pyloric caeca 7-9; vertebrae 24.

The following measurements are in per cents of the standard lengths. Body depth 26.2-30.2; head length 28.1-34.6; snout length 9.6-11.5; eye diameter 5.8-10.4; length of upper jaw 11.1-13.7; suborbital width 3.3-5.5.

Maxillary terminating anterior to margin of pupil; palatine teeth in broad villiform band anteriorly,

tapering to a point posteriorly; vomerine tooth patch broadly triangular-shaped (Fig. 9); upper and lower jaws with outer row of unevenly spaced recurved canine teeth, canines near symphysis larger than those on sides; upper jaw with an inner band of cardiform teeth restricted to region of symphysis; tongue edentate.

Pectoral fin reaching a vertical at base of tenth dorsal spine; pelvic fin not reaching anus; last dorsal and anal rays reaching base of caudal fin; caudal fin forked.

Color when fresh.

Body pale lavender becoming silvery ventrally; iris yellow; interorbital and region of snout with narrow, irregular, yellowish streaks and scattered small, blue spots; scales on body with small, light blue spots, forming irregular horizontal lines; blue spots easily discernible above lateral line; spiny dorsal fin with pale yellow margin and yellow blotches, soft dorsal becoming lavender; pectoral fins pale; caudal fin lavender with orange margin.

Sexual dichromatism.

Female: Anal and pelvic fin membranes usually clear without black pigments or yellow tinge (Fig. 10); occasionally anal fin membrane of large females may be slightly dusky but never tinged with yellow.

Male: Anal and pelvic fin membranes dusky, large

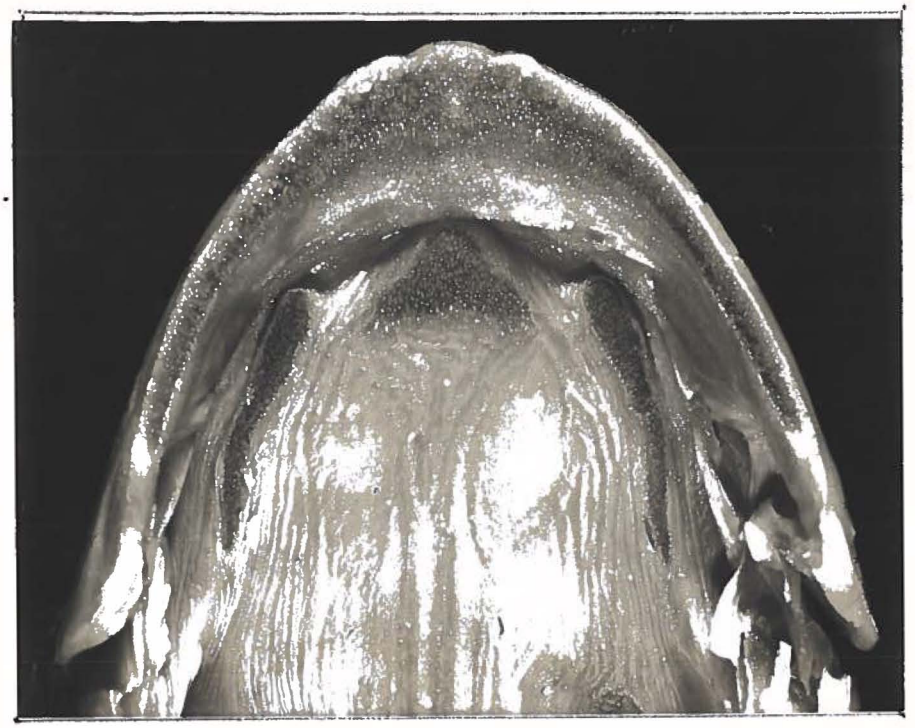


Fig. 9. Palatines and vomer of P. filamentosus.

males with orange-yellow tinge between first and second anal spines and between the last two rays (Fig. 10); membrane of small individuals not pigmented.

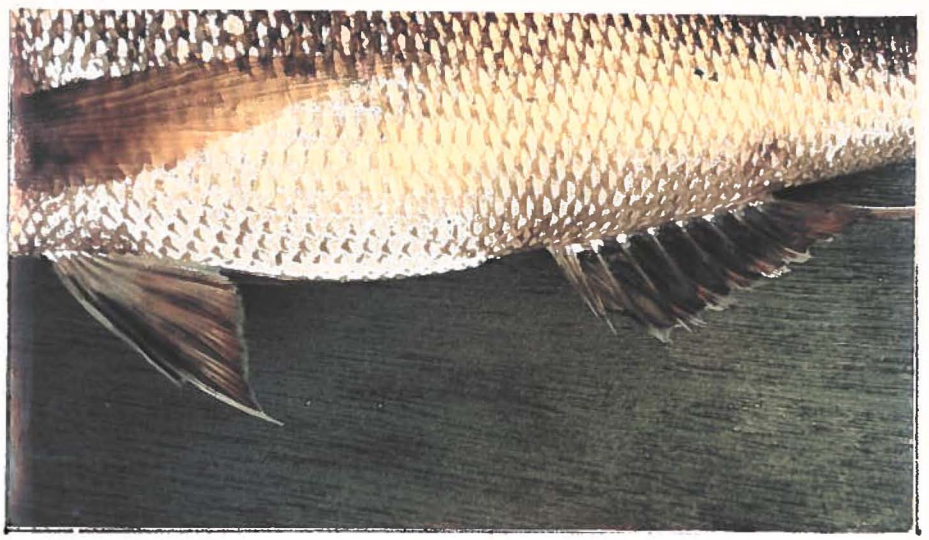
Sexual dichromatism is apparently displayed only by large adults and not by juveniles and subadults. With experience the sex of large adults can be readily recognized by the markings of the anal fin membrane.

Color when preserved.

Body light brown with pale belly; interorbital and snout flecked with small dark spots; dorsal and caudal fins dusky; pectoral and pelvic fins pale; iris dark.

Remarks.

The sex of 143 individuals, fork length 200-600 mm, was predicted with 89.5% accuracy. The sex of five large females, FL 368-527 mm, was predicted incorrectly because of dark pigmentation on their anal fin membrane, however, closer examination revealed that they lacked the yellow tinge. A few of the individuals which showed only slight pigmentation and lacked any trace of yellow were predicted as females; however, dissection showed them to be males. Four small individuals, FL 200-288 mm, were predicted correctly as immature, but two individuals, FL 310 and 330 mm, predicted as females were found to be immature upon dissection.



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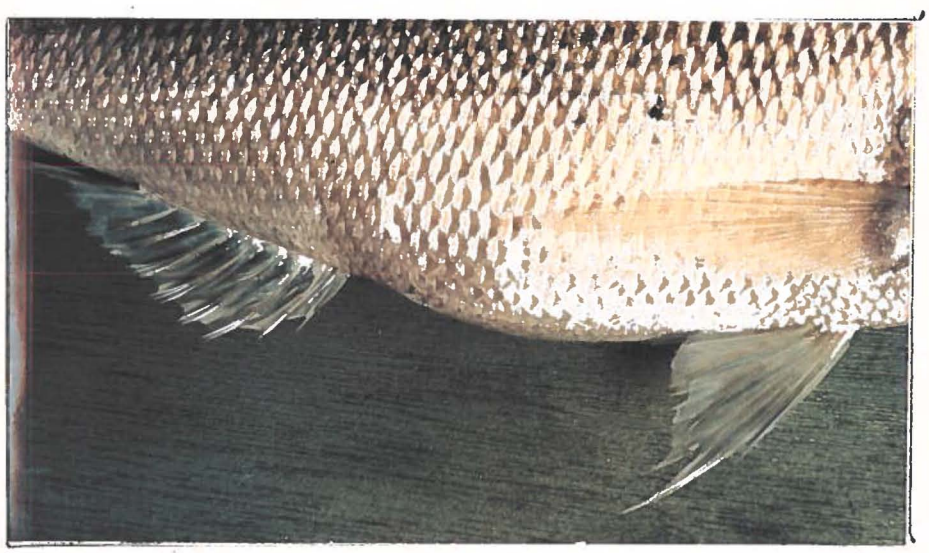


B

Fig. 10. Sexual dichromatism of P. filamentosus. A: male, pelvic and anal fins with dark pigmentations, B: female, pelvic and anal fins without pigmentation.

The morphometric data of Guam specimens show very close similarities to those of the type and a second specimen of Serranus filamentosus Cuvier and Valenciennes, as presented by Abe (1957).

Barnard (1927:649) in discussing P. filamentosus from the Natal coast, reported that "the palatine teeth are quite obsolete in the Natal fish". However, Smith (1937) examined the same Natal specimen and reported the presence of palatine teeth, but he erroneously assigned this specimen as P. argyrogrammicus (Cuvier and Valenciennes).

Examples of P. filamentosus (USNM 19959) as listed by Fowler (1931b) were examined. This lot contained seven specimens, three were found to be Etelis marshi Jordan and Evermann, and four were not members of the genus Pristipomoides.

Abe and Takashima (1956) assigned the subspecific epithet roseus, to a specimen taken near the Bonin Islands. The name roseus was derived from Aphareus roseus Castelnau and is only provisional as expressed by these authors. Abe (1957) reported on two additional specimens of the subspecies. Although provisional, the assignation of subspecific epithet would seem unwarranted for no clearly defined differences were shown between P. filamentosus and the subspecies.

Examination of the holotype of Bowersia violescens

Jordan and Evermann, clearly showed that B. violescens is synonymous with P. filamentosus.

The holotype of Aprion kanekonis Tanaka, standard length 188 mm, was examined and found to be a juvenile P. filamentosus. Presumably, the specimen was taken in the coastal waters of Japan, [Tanaka (1935) reported that the specimen was obtained from the Nagasaki market].

Examples of P. microdon (Steindachner) of Fowler (1931b) were examined and found to be specimens of P. filamentosus and Tropidinius amoenus (Snyder). T. amoenus has been previously placed in the genus Pristipomoides by Tomiyama (1956) and Smith (1961), but recently, Shinohara (1966) placed it in the genus Tropidinius Poey.

The wide range in the lateral line scale count (47 to 60, plus 4 or 5 more on caudal base) given by Fowler (1931b) for P. microdon, leads one to suspect the validity of his count. Steindachner (1876) described Aprion microdon as having 70 pored scales in the lateral line with 4 or 5 more on the base of caudal.

P. filamentosus is the largest species in the genus, reaching 750 mm in fork length.

Distribution.

P. filamentosus is widely distributed and has been recorded from Bourbon (Cuvier and Valenciennes, 1830),

South Africa (Gilchrist and Thompson, 1909; Barnard, 1927), Bonin Islands (Abe and Takashima, 1956), the Ryukyu Islands (Shinohara, 1963, 1966), and Japan (Kamohara, 1967).

This species has also been recorded by its junior synonyms from Amboina (Bleeker, 1869; Weber and de Beaufort, 1936), New South Wales (Castelnau, 1879; McCulloch, 1917), Africa (Smith, 1954), Philippines (Fowler, 1931b; Herre, 1953), Hawaii (Jordan and Evermann, 1904; Jordan and Seale, 1905; Jordan and Snyder, 1906; Fowler, 1928, 1929, 1931b; Gosline and Brock, 1960), Samoa (Jordan and Seale, 1905), Guam (Kami, et al., 1968), and Japan (Tanaka, 1935).

RELATIONSHIPS

Based on gill raker counts, pored lateral line scale counts, ratio of suborbital width to eye diameter and ratio of snout length to head length (Figs. 11, 12, 13, and 14), close affinities are shown between P. auricilla and P. sieboldii, and between P. flavipinnis and P. filamentosus.

In the Indo-Pacific region, the Pristipomoides may possibly be subdivided into three species-related groups, auricilla and sieboldii; flavipinnis and filamentosus; and typus (Bleeker), an Indo-Pacific

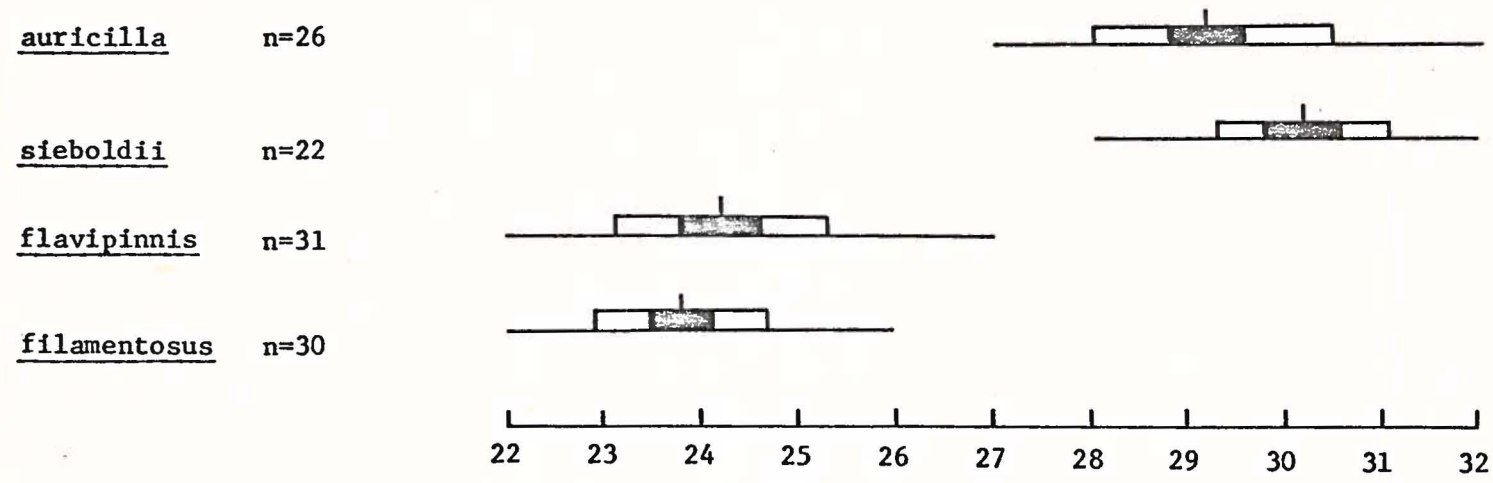


Fig. 11. Total number of gill rakers on first gill arch. Base line represents range, white bar one standard deviation, black bar twice standard error on either side of mean which is represented by a vertical line on black bar.

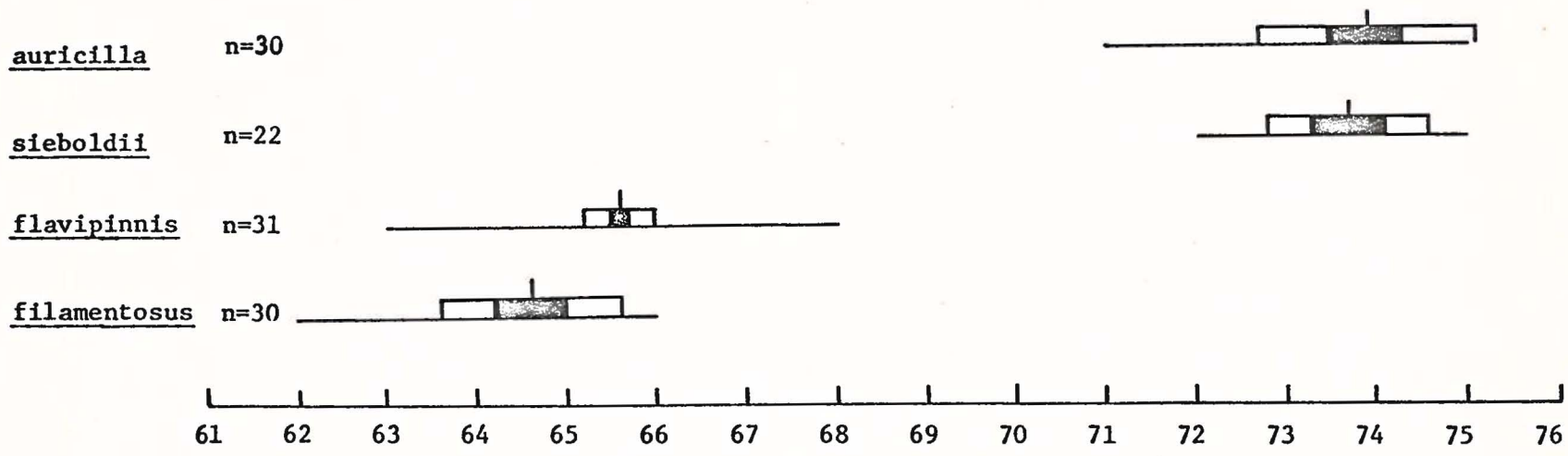


Fig. 12. Pored lateral line scales. Base line represents range, white bar one standard deviation, black bar twice standard error on either side of mean which is represented by a vertical line on black bar.

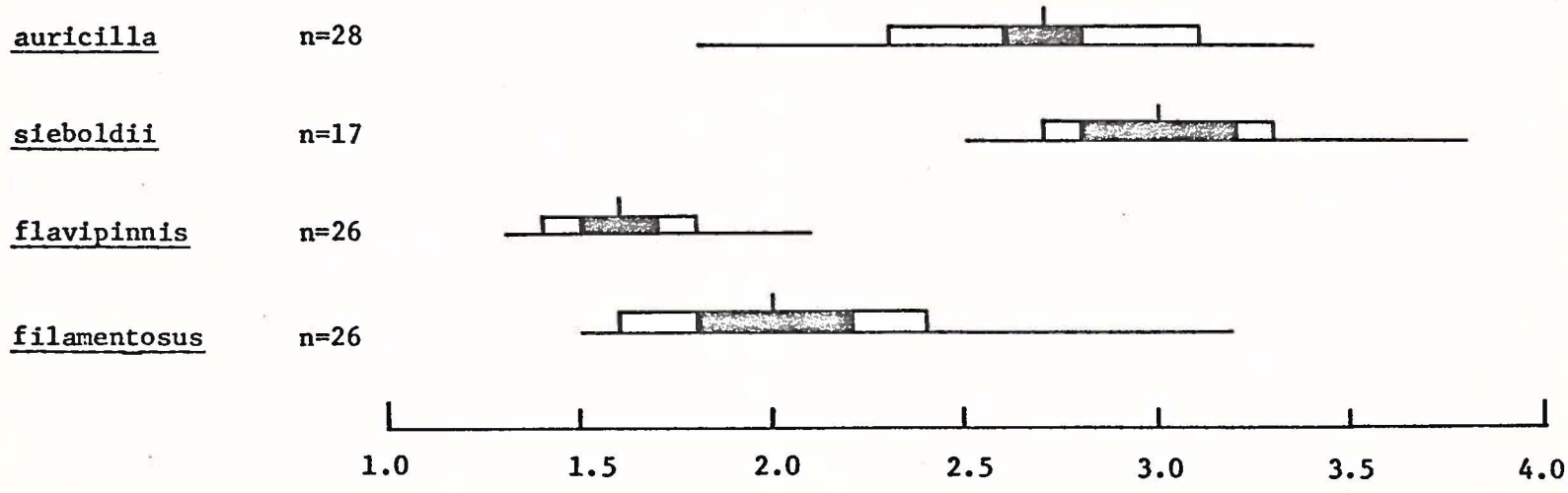


Fig. 13. Ratio of suborbital width to eye diameter. Base line represents range, white bar one standard deviation, black bar twice standard error on either side of mean which is represented by vertical line on black bar.

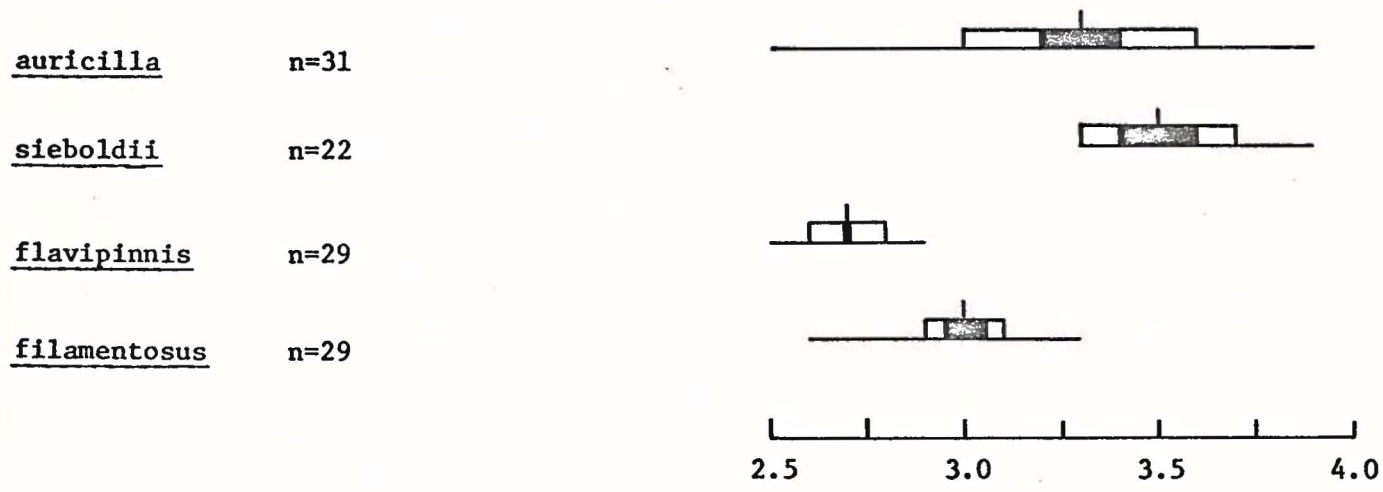


Fig. 14. Ratio of snout length to head length. Base line represents range, white bar one standard deviation, black bar twice standard error on either side of mean which is represented by vertical line on black bar.

species which is absent from Guam.

Regression analysis of length-weight showed this relationship to be linear for all of the species with a correlation coefficient, r of 0.9 for all of the species.

Differences in fork length among species caught in the fishery (Fig. 15), were subjected to analysis of variance and found to be significant at the .05 level. P. auricilla was found to be the smallest member of the Guam Pristipomoides fishery with a mean fork length of 306.0 mm. The largest member was P. filamentosus with a mean fork length of 420.5 mm. P. sieboldii and P. flavipinnis were intermediate with fork lengths of 336.5 and 375.8 mm. The differences in the fork length between the sexes of the four species were not significant at the .05 level.

Five specimens of the western Atlantic Pristipomoides [P. aquilonaris (Good and Bean), 2; P. freemani Anderson, 1; P. macropthalmus (Müller and Troschel), 2], were examined and found to have fewer (52-58) pored lateral line scales than the Guam Pristipomoides.

The Indo-Pacific species, P. typus, though unrecorded from Guam, also has fewer pored lateral line scales than those species present in Guam. The pored lateral line scale counts of three examples of P. typus were 52, 53, and 54.

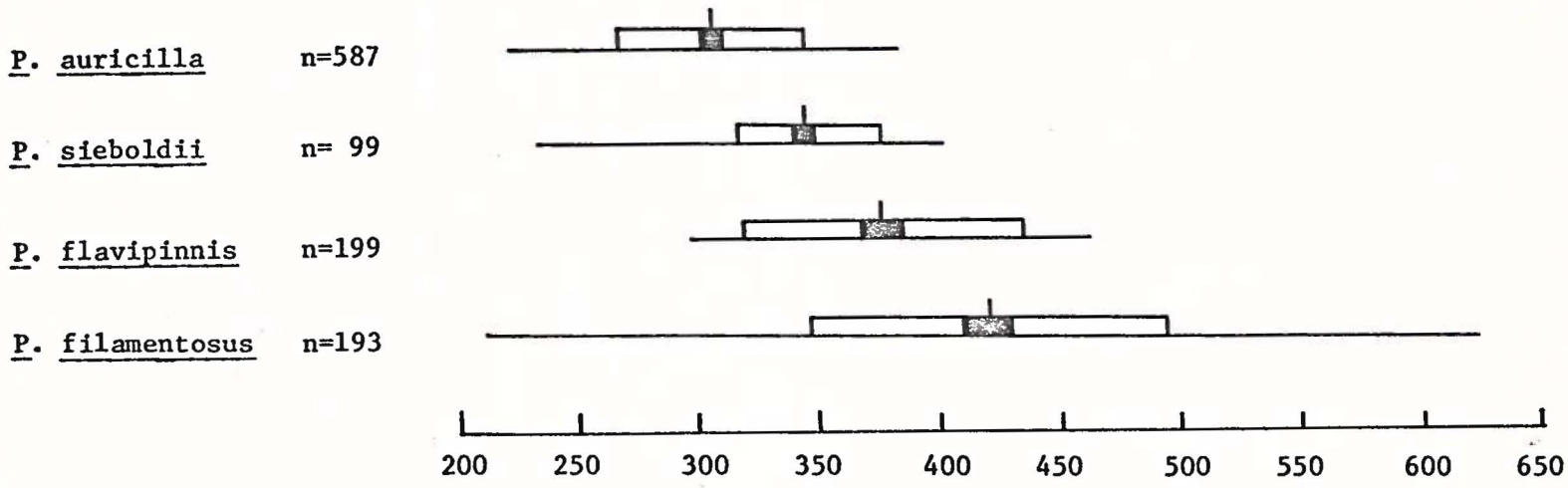


Fig. 15. Mean fork length between species. Base line represents range in mm, white bar one standard deviation, black bar twice standard error on either side of mean which is represented by vertical line on black bar.

PART II. BIOLOGY AND FISHERY ASPECTS

MATERIALS AND METHODS

This part of the study was based on results of a commercial fishing project conducted by the Guam Division of Fish and Wildlife, Department of Agriculture. The project was funded by Federal Aid to Commercial Fisheries under PL 88-309. Because the primary objectives of the fishing project were to determine the potential for a handline fishery and to train local men as commercial fisherman, biological data gathering was secondary. Under these circumstances, the data were of limited use biologically and in most cases could not be subjected to standard statistical analyses.

Information on catch rates, areas, and depth fished was obtained from a fishing log kept by Captain Richard K. Sakamoto, of the M/V PANGLAU ORO, a 37-foot, wooden sampan. These data, based on over 3,000 line hours of fishing, cover a period from January 1967 to June 1970.

Unit of effort was measured in terms of line hours fished. A line hour is defined as one hour of fishing with one handline. In actual practice, two or three handlines were usually used simultaneously.

The handlines are made up with a braided dacron mainline and five to nine swiveled branchlines, each with a single hook (Fig. 16). Depending on the strength of the current, a one or two kilogram sinker was used to weight the mainline. Before the first branched line, a chum bag was usually attached. The chum bag is a piece of cloth sewn into a cone shape with a loose flap. Chum consisting of fish scraps mixed with bread or poultry feed is stuffed into the bag and the flap tucked over it. A hard jerk on the line releases the chum and attracts fish to the baited hooks.

Flesh of frozen skipjack tuna, Katsuwonus pelamis Kishinouye cut into strips of 2-3 cm wide and 8-9 cm long, was mostly frequently used as bait. However, whenever the tuna bait supply became short, other types of bait, such as frozen smelt and squid, were used.

Normally, a crew of three fished for four to five days during a trip. Night fishing was attempted on several occasions but resulted mainly in catches of commercially valueless oilfish (Family Gempylidae). Because of the nearness of the fishing grounds to port, travel time was minimal and enabled movement to new locations within a half day.

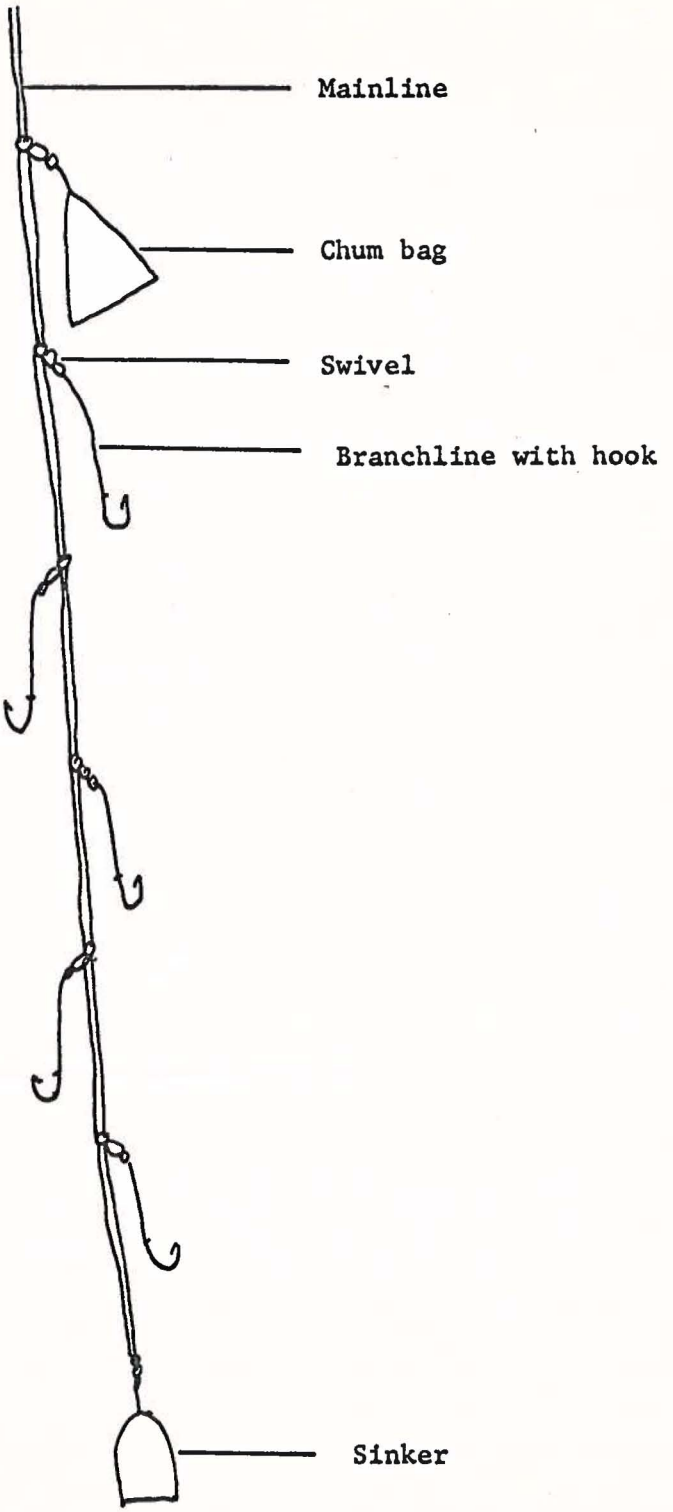
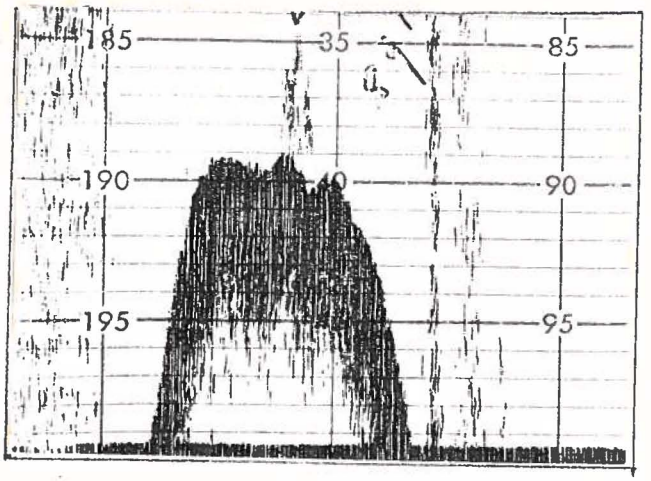


Fig. 16. Diagram of handline showing mainline, chum bag, branchline with hook, and sinker.

Sharp outcroppings on sloping bottoms were the primary areas fished. It is common knowledge among commercial fishermen that deep water snappers are taken from such areas. When a likely area was indicated by fathometer tracings (Fig. 17), it was then tested by drift fishing around the outcroppings. If the catch proved to be good, the vessel was anchored in a position so that the outcroppings could be fished. Because of the steep sloping topography of the ocean bottom, setting the anchor and especially retrieving it was a difficult operation. More often than not, the anchor would be lost. Therefore, if the catch was fair but not considered productive enough to anchor, fishing was continued by drifting repeatedly over the area.

The depth from which the snappers were taken varied according to whether the vessel was at anchor or adrift. Even while at anchor the vessel would swing from deep to shallow and back depending on current and wind direction. Because of the precipitousness of the ocean bottom, even a shift of a few meters in the vessel's position resulted in changes as much as 110 meters in depth, and these depth changes are magnified when the vessel is adrift. Therefore, it was not possible to keep a precise record of the depth from which each snapper was caught. Only the range of the



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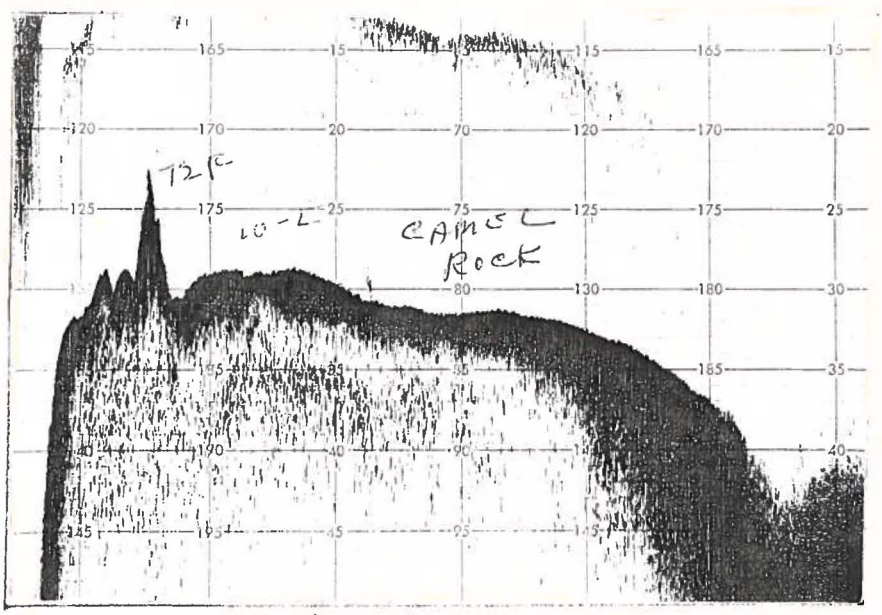

B

Fig. 17. Fathometer tracings of outcroppings from the northwestern region. A. Crest of outcropping at 160 m (89 fathoms). B. Point of pinnacle at 150 m (72 fathoms).

depth fished or the depth at which the vessel was anchored was recorded by the captain.

Because of imprecision in recording depths from which snappers were taken during drift fishing, difficulties were encountered in analyzing the data. After much discussion with the captain, it was decided that the most reliable and representative depth from which most of the snappers were taken would be the mid-depth of each drift. To determine the mid-depth, the range between the shallowest and the deepest recorded depths was divided into half and the mid-ranged was added to the shallowest recorded depth of each drift. (Example: If the shallowest depth is 30 fathoms and the deepest is 100 fathoms, then this results in a range of 70 fathoms. The mid-range is 35 and is added to the shallowest depth, resulting with a mid-depth of 65 fathoms). No distinction was made between drift and anchor fishing, and the data on depth obtained from the two were combined and treated together.

It should be noted that the headline fishery is not limited to Pristipomoides species only. The fishery also includes other commercially important snappers, such as Aphareus rutilans Cuvier and Valenciennes, Etelis carbunculus Cuvier and Valenciennes, E. marshi (Jenkins), and Tropidinius zonatus Cuvier and Valenciennes, as well as species of the Carangidae and Serranidae. The data presented here, represent infor-

mation on the biology and fishery aspects of Pristipomoides only.

For purposes of this study, fishing areas around Guam were divided into four regions: the northwestern, southwestern, northeastern, and southeastern regions (Fig. 18).

Because most of the fishing grounds were less than a kilometer from shore, fishing activities in these regions depended largely on coastal weather conditions. About twice as much time was spent fishing the protected southwestern and northwestern regions than the other more exposed regions. Along the northeastern region, fishing was concentrated along a small area between Ritidian Point and Pati Point (Fig. 18). Except for two days, the southeastern region remained unfished and was not included in this study.

Three offshore banks, Galvez, Rota, and "45°" Banks were also fished when sea conditions were favorable. Galvez Bank is located about 32.8 kilometers from shore in the southwestern region and the Rota and "45°" Banks are located eleven and five kilometers from shore, respectively, along the northeastern region.

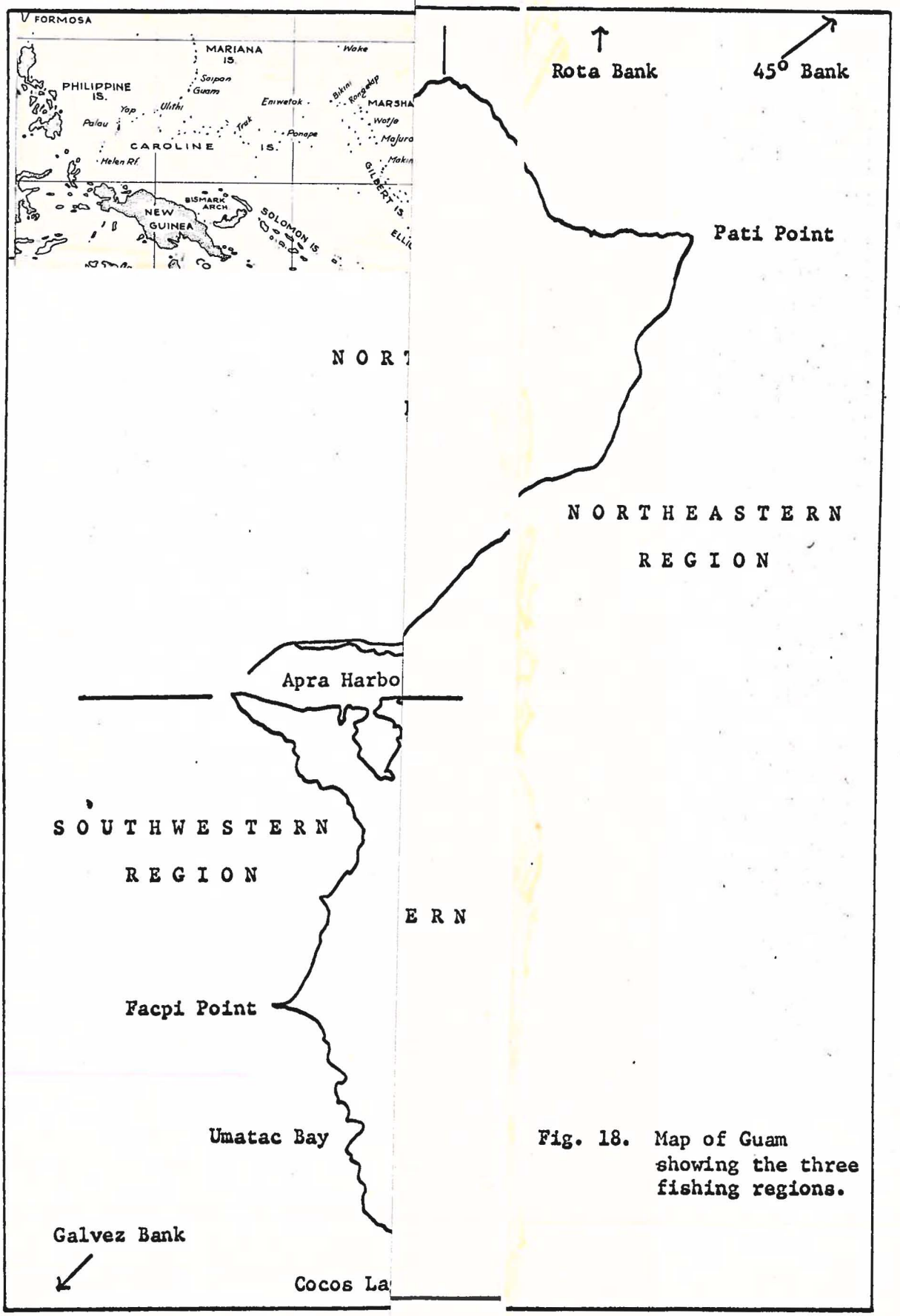

Fig. 18. Map of Guam showing the three fishing regions.

RESULTS

Catch data by species: By regions.

In the northeastern region, P. filamentosus was the dominant species and made up 39.5% of the total catch from this region (Fig. 19). P. auricilla and P. flavipinnis were of about equal importance to the fishery and contributed 20.3% and 23.2%, respectively, to the catch. P. sieboldii made up 16.9% of the catch and ranked last in importance in this region.

In the northwestern region, P. auricilla was the dominant species and made up 64.0% of the total catch from this region (Fig. 19). P. sieboldii ranked second with 21.2%. Both P. filamentosus and P. flavipinnis were less significant to the fishery here.

P. auricilla was overwhelmingly dominant in the southwestern region, making 89.3% of the catch. Other members of the genus were surprisingly scarce (Fig. 19).

The catch rates (fish taken per line hour) of the three regions are shown in Fig. 20. Except in a few cases, the catch rates tend to follow the total catch figures. Differences in catch rate versus total catch are most likely due to the differences in fishing effort expended at the two regions. About twice the effort was expended in the northwestern region than the northeastern region.

Catch data by species: Regions combined.

The combined regional catch data showed that, of

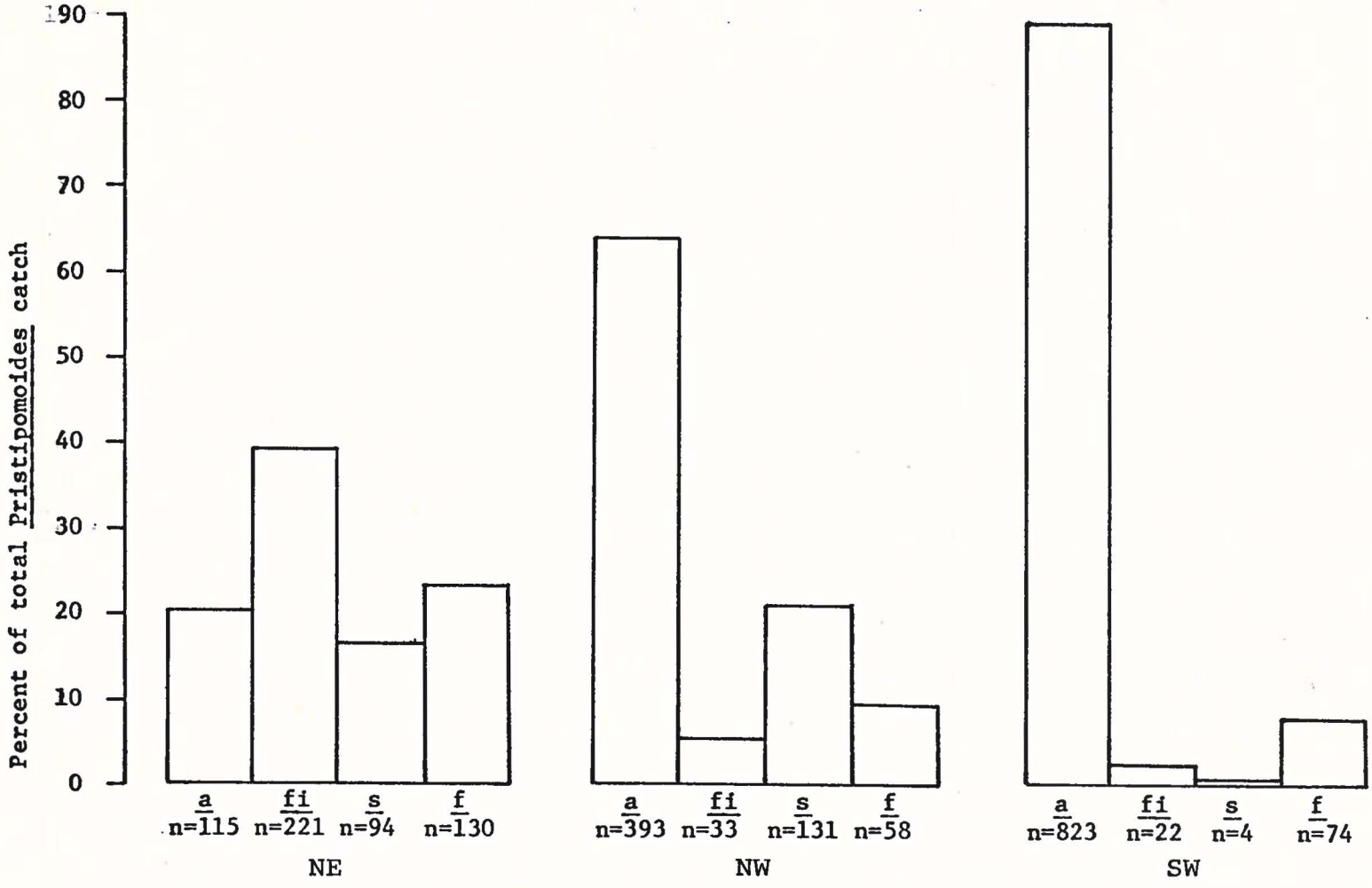

Fig. 19. Total catch by species: By regions.

a = P. auricilla s = P. sieboldii

fi = P. filamentosus f = P. flavipinnis

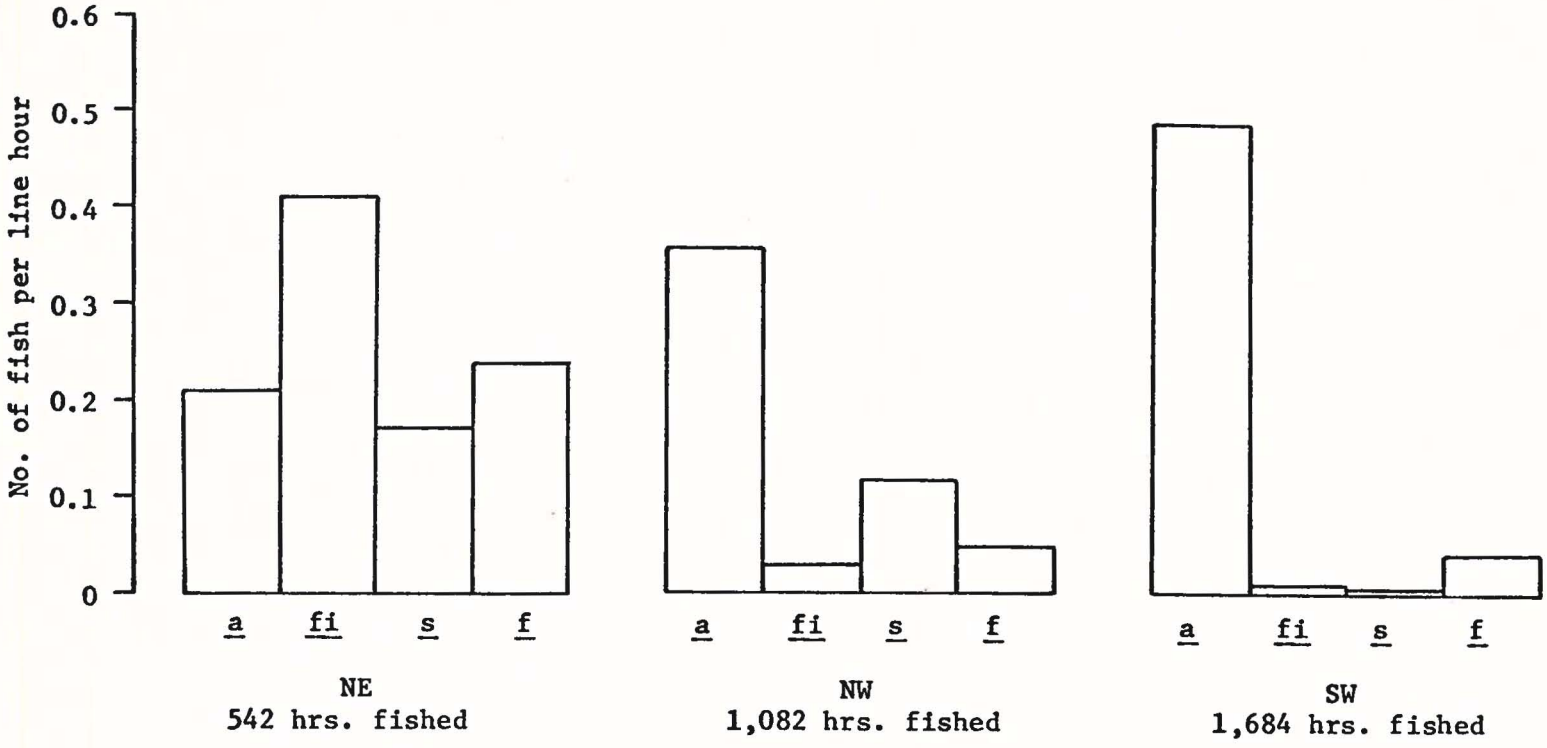

Fig. 20. Catch rate of species: By regions.

a = P. auricilla

fi = P. filamentosus

s = P. sieboldii

f = P. flavipinnis

the genus Pristipomoides, P. auricilla was the most important species to the fishery and made up 63.3% of the catch (Fig. 21). The other three species, P. filamentosus, P. flavipinnis, and P. sieboldii were of secondary importance and comprised 13.2%, 12.5% and 10.9%, respectively.

Besides Pristipomoides, eight other species, Aphareus rutilans, Caranx lugubris Poey, Epinephelus sp., Etelis carbunculus, E. marshi, Gymnosarda unicolor (Rüppell), Lutjanus bohar (Forskal), and Tropidinius zonatus are important to Guam's bottom handline fishery.

Catch records for a thirty-month period compiled by Ikehara, Kami, and Sakamoto, (1970), showed that the combined weight of these eight species amounted to 14,102 lbs. and 1,700 individuals. The Pristipomoides catch for the same period was 2,345 lbs. and consisted of 1,170 individuals. The weight and individuals of Pristipomoides represent 14.2% of the total weight and 40.8% of the total numbers taken.

Except for Tropidinius zonatus, most of the other eight species exceeded 10 lbs. in individuals weight. A catch of a few individuals of the other species may outweight a catch consisting of numerous Pristipomoides. For

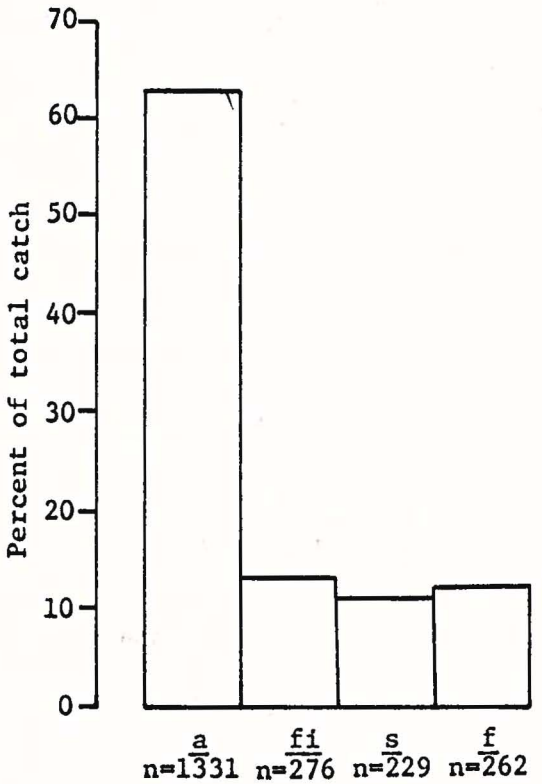

Fig. 21. Total catch by species: Region combined.

a = P. auricilla
fi = P. filamentosus
s = P. sieboldii
f P. flavipinnis

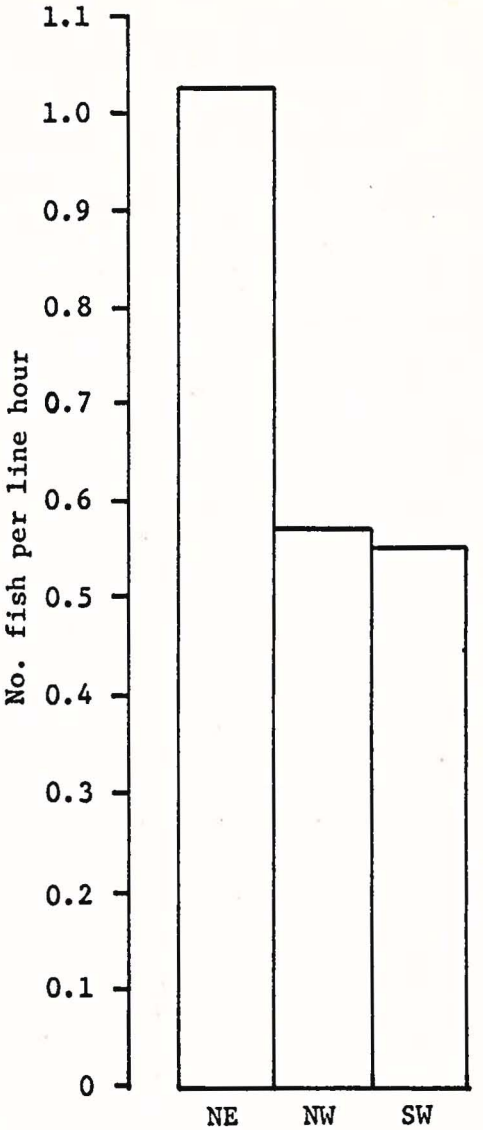

Fig. 22. Catch rate by regions: Species combined.

example, four Etelis carbunculus with a total weight of 85 lbs. would often outweigh a catch of 100 or more Pristipomoides. However, Pristipomoides is important to the fishery because it is taken consistently, while the other species are not.

Catch data by regions: Species combined.

Based on the total catch by regions, the north-eastern region showed the highest catch rate of 1.03 f./l.h. (Fig. 22). However, because this region is exposed to prevailing winds, fishing efforts were restricted to periods of favorable weather conditions. These conditions resulted in fishing efforts of about half that of the northwestern region and about a third of the effort expended in the southwestern region.

The northwestern and the southwestern regions showed almost identical catch rates of 0.57 and 0.55 f./l.h., respectively, about half the catch rate of the northeastern region.

Catch by depths.

As explained previously, the depth from which these fishes were taken is based on the calculated mid-depth. The mid-depths were grouped into three depth zones of 90 m increments each (Table 1). Because hardly anything is known about the bottom topography of the areas fished, and because the number of hours

Table 1. Catch rate of *Pristipomoides* species by depth

Depth fished (m)	Hours fished	*auricilla* Actual catch	*auricilla* f./1.h.	*filamentosus* Actual catch	*filamentosus* f./1.h.	*sieboldii* Actual catch	*sieboldii* f./1.h.	*flavipinnis* Actual catch	*flavipinnis* f./1.h.
91-180	281	23	.08	13	.05	0	0	7	.02
181-270	1974	985	.50	251	.13	153	.08	215	.11
271-360	1040	325	.31	12	.01	76	.07	40	.04
	3295	1333		276		229		262	

fished at the various depths were biased by catch success, it was not possible to apply the relationship of catch with depth to regions, much less carry out comparisons between regions. Therefore, the information presented in Table 1 is based on combined regional catch by depth data.

The depths from which P. auricilla, P. filamentosus, and P. flavipinnis were taken ranged from 90 to 360 m. However, the greatest number taken and the best catch rates of these three species occurred at the 181 to 270 m depth zone. P. sieboldii was taken from depths of 181 to 360 m. with most of them taken from 181 to 270 m. No P. sieboldii was taken from depths less than 180 m. The catch rate of this species was rather consistent throughout its range of occurrence.

Stomach analyses.

Data available on food habits were disappointing. Food items were found in only five P. auricilla, five P. filamentosus, one P. sieboldii, and six P. flavipinnis.

Because of the depth (90-360 m) at which most of the snappers were hooked, stomachs were usually everted and the contents expelled before the fishes were brought to the surface. Occasionally, some of the stomach contents were lodged on the gill rakers.

These items as well as items from the few intact stomachs were preserved and examined. The volume of food was measured by water displacement. Loss of food items greatly limited the study on the food habits of these snappers.

Of the five specimens of P. auricilla examined, a small cod-like fish, Bregamaceros macclellandi Thompson (Family Bregmacerotidae), was the only item found in one; and a pelagic tunicate, Pyrosoma sp. (Family Pyrosomatidae), was the sole food item of another. Two others contained a mixture of items: One, equal amounts of salps (Family Salpidae) and unidentifiable material resembling cotton; the other, a large amount of Pyrosoma sp. mixed with fish remains. Stomach contents in the last specimen were also of cotton-like matter that could not be identified.

A wide variety of organisms were used as food by P. filamentosus. Three of the five stomach samples contained mixtures consisting largely of Pyrosoma sp. and salps mixed with lesser amounts of larval squids, polychaets, ascidians, stomatopods, fish, and heteropods. The organisms found mixed with the pelagic tunicates varied with each of the samples. Of the other two samples, one contained a mixture of the galatheid crustacean (Munida sp.) and Pyrosoma, while the other contained only Pyrosoma.

Small, benthic fishes were the major food items of P. flavipinnis. Specimens of Champsodon vorax Gunther (Family Champsodontidae), Dactyloptena sp. (Family Dactylopteridae), Trigla sp. (Family Triglidae), flathead (Family Platycephalidae), an unidentified larval fish, and the remains of an eel-like fish mixed with crab fragments, were recovered from four of the six stomachs examined. Of the other two stomach samples, one contained Pyrosoma, while the other had larval squids.

A single stomach sample from P. sieboldii was examined which contained a mixture of many organisms, however, fish remains formed the bulk of the contents. Other items mixed with the fish flesh were Pyrosoma and small amounts of crab megalops, copepods, shrimps, larval squids, polychaets, and material that could not be identified.

Even though only a limited number of stomachs were examined, the frequency and the amount of Pyrosoma and salps ingested seemed to indicate that pelagic tunicates are important food sources for these snappers. In the Gulf of Mexico, Pyrosoma is referred to as "tapioca" by commercial fishermen, and is known as food of red snappers,[probably Lutjanus aya (Bloch)] (Anon, 1970). Pelagic tunicates are also utilized as food

by other fishes. Yount (1958) found salps in the stomach of the butterfly fish, Chaetodon unimaculatus Bloch, taken from Hawaii. He also reported that Thompson (1948), Fraser (1949), Reintjes and King (1953), found pelagic tunicates in the stomachs of other fishes and pelagic turtles.

Sex ratio

More females of P. auricilla were taken than males, but more males of P. filamentosus were taken than females. These differences between the number of males and females taken were found to be significant at the 0.05 level (X^2 test, Table 2). No significant differences were found between the number of males and females taken of P. sieboldii and P. flavipinnis.

Seven percent of the P. filamentosus and nine percent of the P. aurcilla examined were immature and the sex could not be determined by gross examination. No immature specimens of P. sieboldii and P. flavipinnis were recorded.

CONCLUSIONS

The Pristipomoides fishery in Guam is based on four species: P. auricilla, P. filamentosus, P. flavipinnis, and P. sieboldii. Of these four species, P. auricilla is the most common and frequently taken species.

Table 2. Sex ratio of *Pristipomoides* species

Sex	*filamentosus* No.	X^2	*auricilla* No.	X^2	*sieboldii* No.	X^2	*flavipinnis* No.	X^2
Female	77		357		52		93	
		4.28		10.10		0.23		0.07
Male	106	d.f. = 1	276	d.f. = 1	58	d.f. = 1	87	d.f. = 1
Immature	14		69		0		0	
TOTAL	197		684		110		180	

Although the northeastern region showed the highest catch per unit effort (f./l.h.), it is questionable whether the f./l.h. truly reflects the productivity of the region because of the infrequency of fishing here.

It is quite possible that the f./l.h. of the northeastern region is a reflection of initial harvesting rate of an unexploited stock. With sustained fishing efforts comparable to those expended at the other two regions, there might be a reduction in stocks and thus a reduction in the f./l.h.

The predominance of P. auricilla and scarcity of the other three species in the southwestern region has no obvious explanation and points out the need for further study on the ecology of deep water fishes.

Vertical distribution of these snappers overlaps considerably. Depths from which P. auricilla, P. filamentosus, and P. flavipinnis were taken ranged from less than 100 m to 360 m. However, P. sieboldii was consistently caught in deeper waters and was not taken from depths of less than 181 m.

Based on the stomach contents, P. auricilla appears to feed in mid-water on pelagic tunicates and other organisms, which are transported by current passing the outcroppings. P. filamentosus and P. sieboldii seem to feed on pelagic tunicates as well as benthic

organisms on the outcroppings. P. flavipinnis preys mainly on small fish and crustaceans that inhabit the slopes of the outcroppings and seemed to be generally more piscivorous than the others.

RECOMMENDATIONS

The following recommendations are made so that meaningful data can be obtained in future studies of the ecology and biology of deep water fishes.

1. The fishing program should be designed to obtain ecological and biological data per se, rather than to obtain maximum catch.
2. A trained biologist should participate in all data gathering cruises.
3. The research vessel should be equipped with triangulation equipment and instruments capable of obtaining precise physical and chemical parameters such as depth, temperature, salinity, etc., of the area fished. This would indicate specific location and description of pinnacles.
4. Cruises should be scheduled (weather permitting) to obtain data during all seasons.
5. The fishing methods should be consistent and an effort made to fish an equal number of hours at each depth and each region.

6. Turn-over in crew should be minimized.
7. Efforts should be made to obtain food chain organisms of the areas fished and to prevent the loss of food items from the captured fish.
8. The recording of data should be designed so that analyses can be carried out by computers.

SUMMARY

1. Close affinities were found between Pristipomoides auricilla and P. sieboldii and between P. filamentosus and P. flavipinnis.
2. Sexual dichromatism was found in P. auricilla and P. filamentosus but not in P. flavipinnis or P. sieboldii.
3. Significant differences in the mean length between species were observed. P. auricilla was the smallest member of the genus, and P. filamentosus was the largest. No significant differences were found in the fork length between sexes of the four species.
4. The northeastern region of Guam appears to be the most productive fishing ground for Pristipomoides.
5. P. auricilla is the most abundant species of Pristipomoides in Guam, while P. sieboldii is

the least abundant.

6. The depths from which these snappers were taken ranged from 91 to 360 m. However, catch rates were better at depths of 181 to 270 m. P. sieboldii was not taken from depths shallower than 181 m.

7. Examination of contents of a limited number of stomachs indicated that P. flavipinnis is piscivorous, while the other three species feed on pelagic tunicates as well as a variety of pelagic and benthic organisms.

8. Significantly more females of P. auricilla were taken than males, and more male of P. filamentosus were taken than females. However, differences between the number of males and females taken of P. sieboldii and P. flavipinnis were not significant.

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