UNITED STATES DEPARTMENT OF THE INTERIOR, J. A. KRUG, *Secretary*
FISH AND WILDLIFE SERVICE, ALBERT M. DAY, *Director*

NOTES ON THE PHILIPPINE FRIGATE MACKERELS FAMILY THUNNIDAE, GENUS *AUXIS*

BY CHARLES B. WADE, Aquatic Biologist

Illustrations by Pablo Bravo

Fishery Bulletin 46

From Fishery Bulletin of the Fish and Wildlife Service

VOLUME 51

UNITED STATES GOVERNMENT PRINTING OFFICE • WASHINGTON : 1949

For sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price 10 cents

CONTENTS

Notes on the Philippine Frigate Mackerels, Family Thunnidae, Genus *Auxis*

The frigate mackerel (genus *Auxis*) is a food fish of some importance in the Republic of the Philippines, although it is of little economic importance throughout much of the world. While collecting biological data on the more common commercial fishes of the Philippines for the pelagic fish-studies section of the Philippine Fishery Program of the Fish and Wildlife Service,[1] it was found that the commercial catch of *Auxis* is composed of two species. Inasmuch as the relative importance of each to the catch is not known, this paper is an effort to define the distinguishing characteristics of the two forms as a basis for securing such information. The existence of two species was first suggested by Dr. Earl S. Herald, formerly aquatic biologist, Philippine Fishery Program, while investigating the commercial fisheries of Batangas, Luzon.

The genus *Auxis* is badly in need of systematic revision on a world-wide basis, but, in the absence of adequate museum collections and library facilities, no attempt is made here to clarify the confused taxonomic relationships. Rather than further increase the chaos of species, the names *Auxis tapeinosoma* Bleeker and *Auxis thazard* (Lacépède), as used by Dr. A. W. Herre, formerly ichthyologist, Philippine Fishery Program, in his check-list of Philippine fishes,[2] have been retained as a matter of convenience. This specific nomenclature, while perhaps subject to question, serves to identify the Philippine species of this genus sufficiently for present purposes. Further changes in nomenclature at this time would only add to the confusion which surrounds this genus. It is hoped that the data assembled here will be of value to investigators, and aid in future biological and systematic studies.

[1] A part of the Philippine Rehabilitation Program authorized by the Philippine Rehabilitation Act of 1946, title 50, Apo. U. S. Code, Sec. 1789.

[2] Unpublished manuscript.

Family THUNNIDAE

Genus *AUXIS* Cuvier

Auxis Cuvier, 1829, Règne Animal, Ed. II, II, p. 199 (type *Scomber rochei* Risso=*Scomber thazard* Lacépède)

Body robust, fusiform, almost cylindrical in cross section, only slightly compressed. Head large, tapering rapidly to a pointed snout. Mouth moderate, oblique, end of maxillary not covered by preorbital. Teeth small, pointed, present on jaws. Occasionally few teeth on vomer. Gill rakers, close set, long, and slender. Lateral line without a distinct arch, slightly curved and with small undulations. Caudal peduncle with small lateral keels. Body scaled anteriorly, forming a corselet. Corselet with a posterior prolongation of scales along lateral line. Fins small, first dorsal fin roughly triangular in shape and not continuous or closely adjoining second dorsal. Second dorsal and anal each followed by 8 and 7 finlets.

The genus *Auxis* is found in most tropical and temperate waters throughout the world. In Philippine waters Dr. Herre (1940) has recorded *Auxis thazard* from Nasugbu, and Balayan Bay, Batangas Province, Luzon, and in 1931 from Jolo, Sulu Province. Recent records made by biologists of the Philippine Fishery Program include, in addition to the above localities: Maya, Danao, and Cebu City, Cebu Island; Bohol Island; Zamboanga City, Davao, and Margosatubig, Mindanao; and Iloilo City, Panay Island. Previously *Auxis tapeinosoma* has never been recorded from the Philippines, but during the past year specimens have been collected at Siocon Bay and Zamboanga City, Mindanao, and Batangas Bay, Luzon. Dr. A. W. Herre in his check-list of Philippine fishes places a record of *Auxis thazard* from Culion, Philippines, 1931, in synonomy with *Auxis tapeinosoma*. Undoubtedly,

an expanded program of studying the composition of catches in local markets would reveal their presence throughout most of the Philippines.

Locality records for *Auxis thazard* other than the Philippines include the Hawaiian Islands, Sea of Japan, west coast of North America, the Mediterranean Sea, and the Atlantic Ocean. The second species under consideration, *Auxis tapeinosoma*, has been recorded from Japan and the Dutch East Indies.

Key to the Genus *Auxis* [3]

1a. First dorsal continuous or almost continuous with second dorsal; axillary scales between ventral fins small, about one-half length of fins----------(Thunnidae except *Auxis*)

1b. First dorsal not continuous or almost continuous with second dorsal.

Interspace between fins almost equal to length of head. Axillary scales between ventral fins equal in length to fins Genus *Auxis*

2a. Corselet scales along lateral line 2 to 4 irregular scale rows wide under origin of second dorsal. Corselet abruptly tapering to narrow band of 3 to 4 scales along lateral line at about midway between first and second dorsals. Total gill-raker count of first gill arch 37 to 43----------*Auxis thazard* (Lacépède)

2b. Corselet scales along lateral line in a wide band 7 to 12 irregular scale rows wide under origin of second dorsal. Corselet tapers gradually and evenly throughout length, ends under about second dorsal finlet. Total gill-raker count of first gill arch 44 to 48----------*Auxis tapeinosoma* Bleeker

There is considerable disagreement among taxonomists as to the number of valid species in this genus. Some believe there is a single world-wide species (*Auxis thazard*), while others are of the opinion that one or more additional species are to be found. It is quite evident, however, from the data at hand that two species occur in the Philippines. A survey of the available literature shows that possibly two seemingly similar species occur in the eastern Pacific area. Comparison of two descriptions of specimens of this genus (Meek and Hildebrand 1923; and Fowler 1938) reveals that the authors were describing two entirely different species. Fowler's description based on two specimens from the Galapagos Islands off the west coast of South America agrees with *Auxis tapeinosoma* as defined here, having the elongate posterior prolongation of the corselet along the lateral line and the increased gill-raker count. The description by Meek and Hildebrand based upon a composite collection of six specimens from Woods Hole, Mass., Hawaii, and Java agrees in gill-raker count of the lower gill arch with *Auxis thazard* as named here. The specimen used by Walford (1937) to illustrate *Auxis thazard* is clearly identifiable as *A. tapeinosoma* with its long, posterior extension of the corselet along the lateral line. It is not known whether the eastern Pacific forms are identical with the species occurring in Philippine waters, and a careful study of a considerable number of collections will be necessary before this can be ascertained.

Two additional species of frigate mackerel, *Auxis hira* and *A. maru*, were described from Japanese waters by Kishinouye (1915). The description of the larger of the two Japanese species (*Auxis hira*) agrees very well with specimens of Philippine *Auxis thazard* as determined by Drs. Herre and Herald. Until specimens from Japan are available for comparison *hira* is provisionally placed in synonomy with *thazard*. The second, smaller species from Japan, *Auxis maru*, seems identical with that which Dr. Herre provisionally names *A. tapeinosoma* and is tentatively placed in synonomy with it.

[3] This key adapted from a memorandum to field biologists, Philippine Fishery Program, prepared by Dr. Earl S. Herald.

[4] Fork length is defined as the length from the tip of the snout to the end of the median caudal rays.

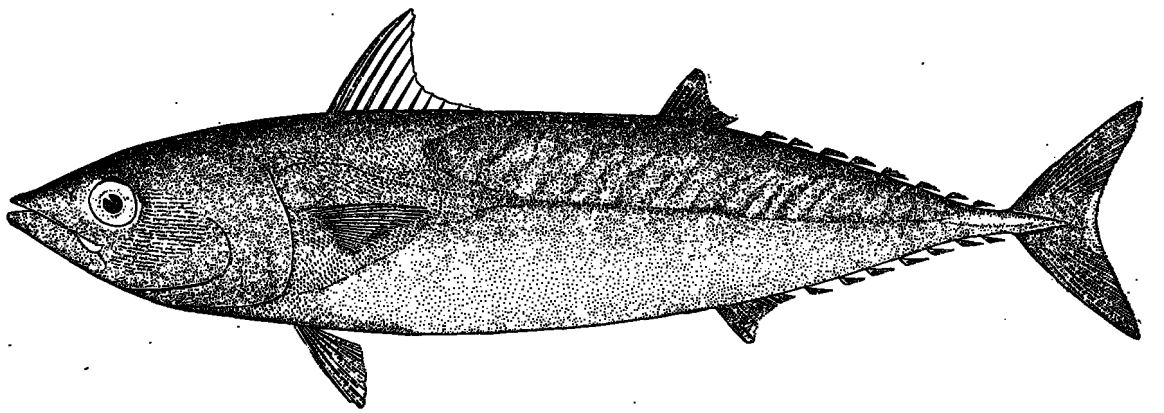

FIGURE 1.—Adult *Auxis thazard* 212 mm. fork length.[4]

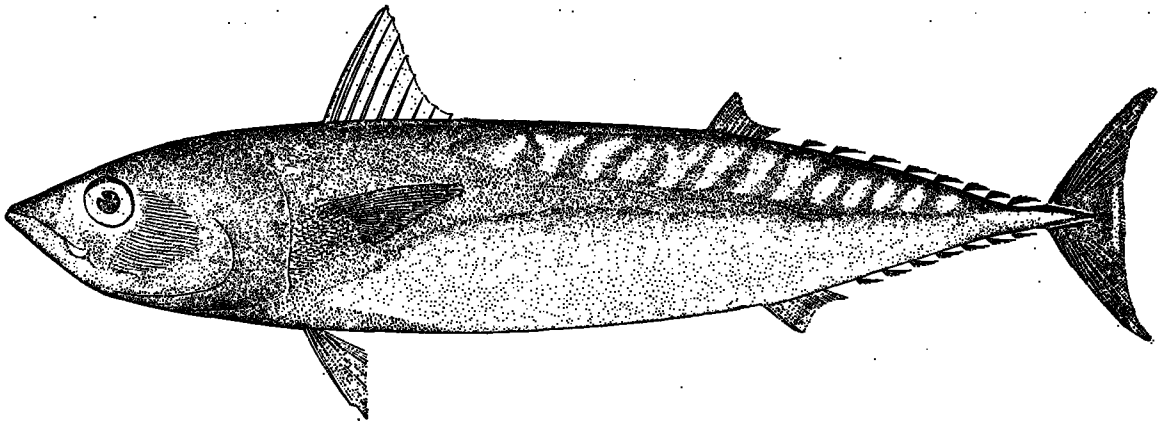

FIGURE 2.—Adult *Auxis tapeinosoma*, 228 mm. fork length.

Auxis thazard (Lacépède)

Scomber thazard Lacépède, 1802, vol. 3, p. 9 (type locality between 6° and 7° S. latitude, off coast of New Guinea).
?*Auxis hira* Kishinouye, 1915, Susan Gakkai Ho. I, p. 23, plate 1, fig. 16 (Japan).

Body robust, sides flattened, slightly compressed. Dorsal outline broadly and evenly curved, ventral outline flattened abdominally. Depth 3.89 to 5.75 in standard length; [5] depth increases gradually as fish becomes larger.

Head large, 3.95 to 4.35 in standard length. Snout short, pointed, longer than eye diameter, 3.3 to 3.6 in head. Mouth moderate, oblique, end of maxillary reaches to or slightly past vertical from anterior edge of pupil. End of maxillary not hidden beneath edge of preorbital. Jaws equal or lower jaw slightly projecting in larger specimens. Single row of small, pointed teeth on both jaws. Palatine teeth absent, occasionally a few small, scattered teeth on vomer. Eyes moderate, placed high on sides of head, 4 to 5.14 in head. Interorbital wider than eye, somewhat flatly rounded. Branchiostegal rays, 7. Gill membranes not united, free from isthmus. Gill rakers, long and slender, 9–10+1+27–32 on first gill arch.

Dorsal fins two, separated by interspace slightly shorter than head length. First dorsal roughly triangular, X to XII (mostly XI to XII). Anterior spine longest, equal to fin base. Second dorsal small, 10 to 12 (mostly 11 to 12) rays. Dorsal finlets, 8. Anal fin small, II, 8 to 11, origin under last ray of second dorsal. Anal finlets, 7 (8 in one specimen). Pectoral fin short, roughly triangular, tip of fin reaches almost to end of first dorsal base. Ventral fins thoracic. Axillary scales equal ventrals in length.

Body naked except for a corselet of scales anteriorly. Corselet scales large and imbricated above pectoral base. Corselet extends posteriorly along lateral line, tapering abruptly to a narrow band about halfway between end of first dorsal and origin of second. Only 2 to 4 irregular scale-rows wide at second dorsal origin. Caudal peduncle small, lateral keels poorly developed. Lateral line without a distinct arch and more or less undulating.

Color of formalin-preserved specimens: dorsally deep brown or blackish becoming slightly paler laterally. Abdomen and lower portion of sides pale, sometimes light brown or gray. Sides above and behind corselet with elongate irregular, oblique black bars. First dorsal light brown along anterior spines. Other fins almost colorless.

The following material was examined: 24 specimens, 103.7 to 367 mm. standard length, Batangas Public Market, Batangas, Luzon, July 1, 1948; 4 specimens, 170 to 204.6 mm. standard length, Zamboanga City Market, Zamboanga, Mindanao, February 28, 1948. A series of measurements adapted from Godsil and Byers (1944) was made on these specimens. A summary of these measurements is given in table 1.

Auxis tapeinosoma Bleeker

Auxis tapeinosoma Bleeker, 1854, p. 408 (Nagasaki, Japan).
? *Auxis maru* Kishinouye, 1915, p. 24, plate 1, fig. 19 (Japan).

Body robust, rounded, almost cylindrical in cross section. Dorsal outline moderately and evenly curved. Ventral outline similar, but slightly flattened in abdominal region. Depth 5.3 to 6.1 in standard length.

5 Standard length is defined as the length from the tip of the snout to the end of the hypural plate.

Head moderate, 4.35 to 4.51 in standard length. Snout short, pointed, slightly longer than eye diameter, 3.3 to 3.5 in head. Mouth moderate, oblique, 2.5 to 2.69 in head. End of maxillary reaching to slightly before or behind vertical from anterior margin of eye. End of maxillary not hidden beneath edge of preorbital. Jaws equal, single row of small, pointed teeth on jaws. Palatine teeth absent, occasionally few small teeth on vomer. Eye moderate, 4.2 to 4.8 in head. Interorbital flattened, width equal eye diameter. Branchiostegal rays, 7.

TABLE 1.—*Measurements, in millimeters, and counts of individual specimens of* Auxis thazard (*Lacépède*)

Specimen No.	Standard length	Fork length	Head length	Snout to first dorsal insertion	Snout to second dorsal insertion	Snout to anal insertion
1	103.7	109	24	32	65	69
2	110.5	116.2	28	37	69.5	76
3	115.5	122	28.5	37	73	79
4	118	124	28.5	37.5	74	78
5	121.5	127.5	29.2	37.6	75	80.8
6	123	128.5	29.5	38.6	78	83.2
7	135.4	140.2	32.5	42.1	82.9	91
8	135.5	140.6	33	43	83	90.5
9	137.4	144	33	43.2	84	92
10	139	145	33.5	44.1	85	94
11	142	147.9	33.5	44.5	88	95.2
12	142	147	35	43.8	88	96
13	142.5	148.5	34.7	45.6	89	93.3
14	143.2	149.4	33.5	45.1	88	95.5
15	144.5	150	34	46.2	90.1	95.6
16	144.5	150	33.1	45.2	89	96
17	151	156	35.1	46.8	93.5	101
18	154	159	35.6	49	100.4	100
19	156.7	162	37.5	49	95.2	104
20	170	176.9	40.4	53.1	104	111.9
21	182.8	188.7	43.9	56.8	113	124.1
22	186.4	193	43	58.2	115.1	126.1
23	196	204.6	46.7	62.3	122.7	134.5
24	301.5	315	75.2	109.8	196.5	213.6
25	326.9	337	80.5	106.7	216	240.9
26	334.6	346	80.6	108	213	238.9
27	338	350	83.4	110	231.1	245.5
28	367	377	89.4	119	234.5	264.8

Specimen No.	Depth	Pectoral base to first dorsal insertion	Length first to second dorsal insertion	Pectoral length	Length first dorsal base
1	18	9	33.5	10	16
2	21	11.5	35.2	10.8	18.5
3	23	13	35	12	18
4	23	12.5	37.7	11	17
5	24.9	12.5	38.2	12.8	20.5
6	24	13	39.5	12.5	20.5
7	25.7	14.1	43	14.1	18.2
8	26	14.2	42.6	14.5	19.2
9	28	14	43.5	14	20
10	25.8	15	43.2	14	20.2
11	28.5	15.2	46	14.8	24.5
12	29	16	45	14.8	23
13	27.8	15	46.2	14.2	21.6
14	28.1	15.9	45.9	14.9	21
15	29.1	15.1	45.2	15	20
16	28.2	15	45	14.7	20.5
17	29.2	17	48.2	14.6	22
18	31.1	17.4	48	16.5	22.5
19	32	18.2	49	16.9	26.1
20	31	18	56.4	18.1	23.2
21	34.3	17.8	56.1	20.2	28.7
22	34.2	19.7	58.8	21.6	27.5
23	43.1	21	62.1	21.9	27.9
24	74.2	38	98.2	40.5	39.9
25	84.2	40.1	109.8	47	42.4
26	84.1	42.4	105.5	45.4	44
27	85	42.8	112	51.6	46.9
28	88	47.8	116.2	54.9	48.9

TABLE 1.—*Measurements, in millimeters, and counts of individual specimens of* Auxis thazard (*Lacépède*)—Continued

Specimen No.	Length second dorsal base	Length anal base	Eye diameter	Maxillary length	First dorsal rays
1	5	5.2	6	10	12
2	6	6.2	6.5	12	12
3	6	6	6.5	12	11
4	6.2	6	6.5	12	11
5	7.7	7.2	7	12.1	11
6	7	7.2	7	12	12
7	8.3	8.1	7.2	13	11
8	8	8.2	7.7	13.3	11
9	8.5	8.8	7.5	13.1	11
10	8.8	9	7.5	13.6	11
11	8.6	8.5	7.4	14.2	11
12	9	8.6	7.5	13.8	11
13	9.1	9	7.2	13.2	11
14	9	9.1	7.9	13.4	11
15	9.1	9	7.3	13.8	11
16	9.2	8.5	7.5	14	11
17	9	9.5	8	14.7	11
18	10.5	9.5	8	14.5	11
19	9.5	10.5	7.9	14.7	10
20	11.1	10	8.2	15.7	11
21	11	10.9	9.4	17	12
22	12.5	10.6	9.8	17.1	11
23	10.8	11.2	9.9	18.4	11
24	19.3	16	15	28.8	10
25	18.8	20.3	16.1	30.9	10
26	20	18.1	16.2	30.9	10
27	19.9	20.2	17.4	31	10
28	21	20.4	17.2	33.6	10

Specimen No.	Second dorsal rays	Dorsal finlets	Anal finrays	Anal finlets	Gill rakers
1	11	8	11	7	9+1+29
2	10	8	13	7	10+1+29
3	11	8	10	7	8+1+28
4	11	8	10	7	9+1+29
5	11	8	12	7	10+1+31
6	10	8	13	7	10+1+27
7	11	8	12	7	10+1+30
8	12	8	13	7	10+1+30
9	11	8	13	7	9+1+30
10	12	8	12	7	9+1+32
11	12	8	12	7	10+1+30
12	12	8	12	7	10+1+28
13	11	8	12	7	10+1+30
14	12	8	13	7	10+1+28
15	11	8	14	7	10+1+30
16	12	8	13	7	10+1+30
17	12	8	13	7	10+1+30
18	12	8	13	7	10+1+32
19	10	8	14	7	10+1+30
20	11	8	13	7	9+1+30
21	11	8	14	7	9+1+29
22	11	8	13	7	10+1+30
23	11	8	14	7	8+1+30
24	12	8	13	7	9+1+29
25	11	8	14	7	10+1+31
26	11	8	12	8	9+1+30
27	11	8	13	7	11+1+31
28	11	8	13	7	10+1+29

Gill membranes not united, free from isthmus. Gill rakers long and slender, 10–12+1+31–35.

Dorsal fins two, first dorsal X to XI, roughly triangular, anterior spine longest, almost equal to base of fin. Second dorsal small, 10 to 12 (mostly 11) rays. Dorsal finlets, 7 (8 in one specimen). Anal fin small, II, 10 to 12, origin at vertical through last ray of second dorsal. Anal finlets, 7. Pectoral fin roughly triangular, tip of fin more or less reaches end of first dorsal base, 8.95 to 9.91 in standard length. Ventral fins thoracic, axillary scales long, equal to ventral fin.

Body naked except for corselet of scales anteriorly. Scales large and imbricated above pectoral base. Corselet extends posteriorly along lateral line, tapering gradually and ending under about second dorsal finlet. Corselet, 7 to 12 irregular scale rows wide at vertical through second dorsal origin. Caudal peduncle small, lateral keels poorly developed. Lateral line without distinct arch, more or less undulating.

Color of specimens preserved in formalin: dark brown or black dorsally, slightly lighter laterally. Abdomen and lower part of sides pale. Sides above and behind corselet with elongate, black spots or more or less wavy bars. First dorsal with light brown along anterior spines, remainder of fins more or less colorless.

The following material was examined: 21 specimens, 122 to 231 mm. standard length, Batangas Public Market, Batangas, Luzon, July 2, 1948; 7 specimens, 186 to 199 mm. standard length, Zamboanga Public Market, Zamboanga City, Mindanao, February 28, 1949. A series of measurements similar to those made on *Auxis thazard* were made and are tabulated in table 2.

TABLE 2.—*Measurements, in millimeters, and counts of individual specimens of* Auxis tapeinosoma *Bleeker*

Specimen No.	Standard length	Body length	Head length	Snout to first dorsal insertion	Snout to second dorsal insertion	Snout to anal insertion
1	122	126.7	27.7	36.5	76.1	83.4
2	129	134.1	29.6	39.7	82.5	89
3	161.9	167.5	38.5	47.3	102.5	112.2
4	186.9	193	41.6	57	118.8	129.4
5	190	196.7	43.1	56.2	122	132
6	191.9	186.1	41.2	54.9	118.1	128.8
7	192	199.5	43.6	57.9	124.2	133
8	192.5	200.8	44.2	59.1	124	135
9	196.2	205	44	58.8	126.4	136.6
10	199.1	207.5	44.1	60.1	125.6	138.1
11	215	221.8	51.9	69.7	137.3	150
12	215	224	52	68.8	140.4	154
13	215.9	222.5	51.4	69	144.2	147.5
14	217	224	52.7	69.2	140.5	150.1
15	217.4	223.5	51.1	67.9	139	152.5
16	218	224.1	52.9	69.2	139.9	153
17	219.8	228	52.8	70.1	145	155.5
18	220.2	227.1	51.8	69.9	142.1	149.1
19	221	228.7	52.2	70.1	144	154
20	221.1	225.8	54	70.4	141	153.2
21	222	229	54.6	73.1	147.5	152.1
22	222.2	230.3	54.4	71.4	145	154.5
23	222.4	230.1	54.9	70	147.8	159.9
24	222.8	231	52.4	67.5	144.9	156.8
25	222.9	228.1	52.1	68	142.2	154
26	225	233	53.9	70.9	145.3	157.9
27	228	235.2	52.9	70	148	161.2
28	231	237	54.2	73.1	152.2	160.2

Specimen No.	Depth	Pectoral base to first dorsal insertion	Length first to second dorsal origin	Pectoral length	Length first dorsal base
1	20.2	11.2	41	12.3	15.2
2	21.1	12.5	45.1	13	19.1
3	30.8	17.2	57	17	19.9
4	35	19.9	64.9	20	23
5	35.8	20.7	67	21.2	22.9
6	35.1	19.5	66.5	20.3	21.8
7	35.9	21	68	21.5	22.4
8	36.6	20	67.1	21.2	25.3
9	38.1	21.6	68.5	22.2	24.3
10	37.6	21.2	68.1	21.9	24.7
11	44.1	25.9	72.2	27.9	26
12	45	25.2	74.4	28.1	27.5
13	43.6	24.1	80.4	27.2	27
14	46.1	25.8	77	28	27.2
15	44	25.2	73.2	26	25.8
16	44.4	25.2	72.6	28	26.1
17	46.4	25.1	78	28.1	25.2
18	47.7	25.9	77	27.8	28.6
19	43.1	24.2	77.5	29	26.8
20	44.3	25	75.2	28.8	29.3
21	48.2	26.8	78.9	28.9	29.2
22	48.9	26	77.1	30	23.1
23	45	25.1	80.4	29.9	29.2
24	47.2	24.6	78.7	29.2	29.5
25	46.7	24.9	77.3	28.5	27.1
26		25.9	79.9	28.3	28.8
27	49	26.1	80.9	28.9	26.8
28	47.1	26.9	83.6	29	27.8

TABLE 2.—*Measurements, in millimeters, and counts of individual specimens of* Auxis tapeinosoma *Bleeker*—Continued

Specimen No.	Length second dorsal base	Length anal base	Eye diameter	Maxillary length	First dorsal rays
1	7	6.1	6.6	11	10
2	8	8.7	7.5	11.8	10
3	9.1	10	9.1	14.1	10
4	10.4	10.3	10.5	16.4	11
5	10.5	10.4	10.2	16.2	10
6	11.7	10.4	11	16.1	10
7	9.5	10.1	10.8	16.3	10
8	10.7	10.6	10	16	10
9	12	11.2	10.1	16.3	10
10	11.9	11.7	10.1	16.5	10
11	15.1	13.2	12.4	19.2	10
12	12.2	11.7	12.1	19.1	10
13	11.1	11.9	12.1	19	10
14	11.1	11.8	12.7	20	10
15	12.5	11.1	12.7	19.2	10
16	13.3	11.3	12.6	19.7	10
17	12	12.5	12.8	19.9	10
18	13.1	12.2	12.6	19.2	10
19	11	11.2	12.4	19	10
20	13.9	13.8	12.1	20.4	10
21	12.7	11.2	12.4	20	10
22	10.3	12.2	12.8	20	9
23	12.9	13.6	13	20.4	10
24	12.5	13.5	12.1	20	10
25	12	11	12.3	19.8	10
26	12.2	12.1	13	20.7	10
27	12.9	11.9	12.2	19.9	10
28	12.9	12.2	12.8	20.1	10

Specimen No.	Second dorsal rays	Dorsal finlets	Anal fin rays	Anal finlets	Gill rakers
1	11	8	12	7	11+1+35
2	11	8	12	7	11+1+33
3	11	8	14	7	11+1+34
4	11	8	13	7	10+1+34
5	11	8	13	7	11+1+32
6	11	8	14	7	
7	11	8	13	7	11+1+33
8	11	8	14	7	11+1+33
9	11	8	12	7	10+1+34
10	11	8	13	7	
11	12	8	13	7	11+1+31
12	11	8	14	7	11+1+35
13	10	8	13	7	11+1+35
14	11	8	13	7	10+1+33
15	11	8	14	7	11+1+35
16	11	8	14	7	11+1+34
17	11	8	13	7	10+1+33
18	11	8	13	7	11+1+34
19	11	8	13	7	11+1+34
20	12	8	14	7	11+1+33
21	11	8	12	7	10+1+35
22	11	8	13	6	10+1+33
23	12	8	14	7	11+1+34
24	11	8	13	[1] 4	10+1+34
25	11	8	14	7	11+1+35
26	11	8	14	7	11+1+34
27	11	8	12	7	11+1+33
28	11	7	14	7	10+1+34

[1] Specimen not deformed; no indication of injury to this part.

Several external characters and one easily accessible internal structure serve to distinguish the two Philippine species, the most obvious of which is the length of the posterior prolongation of the corselet along the lateral line. In *Auxis thazard* the corselet tapers abruptly toward the lateral line, narrowing rapidly to a few irregular scale rows above and below the lateral line about half way between the first and second dorsals. The corselet is 2 to 4 irregular scale rows wide at a vertical through second dorsal. In large specimens (350 to 400 mm. standard length) the corselet tapers less rapidly than in small specimens, but in no case does it extend to below the origin of the second dorsal. In the field it may be difficult to determine the end of the taper of the corselet, especially if the fish is moist or covered with slime. Turning the fish so that the light is reflected at the proper angle or drying the side of the fish will, however, aid in revealing it.

In contrast to the abrupt tapering of the corselet in *Auxis thazard*, the corselet of *A. tapeinosoma* decreases gradually almost the entire length of the body, and ends slightly before or behind the second dorsal finlet. At a vertical through the origin of the second dorsal the corselet is 7 to 12 irregular scale rows wide. The difference between the corselets of the two species is easily seen after a few specimens of each have been examined.

Another character that can be used in the field to separate the two species is the roundness of the body and the general appearance of the fish. The body is almost perfectly rounded, fusiform, cigar-shaped in *Auxis tapeinosoma*, but in *Auxis thazard* the body is definitely compressed, the sides are flattened, not rounded as in *tapeinosoma*. After a few specimens have been handled the feel and appearance of the fish are useful in a rough sorting of the two species.

The total gill-raker count is an excellent means of separating these two forms. Only a slight overlap in count occurs between the species, and the length of the posterior extension of the corselet easily distinguishes the two forms when this occurs. The gill rakers of 161 specimens of *A. thazard* and 55 specimens of *A. tapeinosoma* were counted and in one specimen only did the total count of *A. tapeinosoma* fall within the upper limit of that of *A. thazard*. The total gill-raker count on the first gill arch of *A. thazard* varies from 37 to 43, and with one exception, *A. tapeinosoma* has a count of 44 to 47 (43 in one specimen). Table 3 gives the total gill-raker count on the first gill arch of the two species and table 4 the total count in its component parts.

The two species may be differentiated also by several minor taxonomic characters such as head length, depth, tip of snout to anal origin, and length of first to second dorsal origins. Table 5 is a summary of several proportional measurements between specimens of approximately the same length of the two species.

TABLE 3.—*Total gill-raker counts of* Auxis thazard *and* Auxis tapeinosoma

Total number of gill rakers	*Auxis thazard*	*Auxis tapeinosoma*
37	2	
38	14	
39	39	
40	48	
41	30	
42	23	
43	5	1
44		12
45		17
46		14
47		11
Total number of specimens examined	161	55

TABLE 4.—*Gill-raker counts of* Auxis thazard *and* Auxis tapeinosoma

Specimen	Upper arch				Center	Lower arch								
	8	9	10	11	1	27	28	29	30	31	32	33	34	35
A. thazard	2	70	88	1	161	3	26	53	46	26	5	---	---	---
A. tapeinosoma	---	2	24	29	55	---	---	---	---	---	2	15	26	12

	Upper arch and center gill raker	Lower arch								
		27	28	29	30	31	32	33	34	35
A. thazard	8+1	---	1	---	1	---	---	---	---	---
Do	9+1	1	15	27	22	5	2	---	---	---
Do	10+1	2	10	26	23	21	3	---	---	---
A. tapeinosoma	9+1	---	---	---	---	---	---	2	4	---
Do	10+1	---	---	---	---	---	---	9	9	---
Do	11+1	---	---	---	---	---	1	5	14	11

Juvenile Stages of the Genus *Auxis*

Juvenile forms of the genus *Auxis* have previously been recorded from other parts of the world, but until now nothing has been known of the juvenile forms from the western Pacific. In the Mediterranean, De Buen (1932), Sparta (1933), Sella (1924), and Ehrenbaum (1924) have reported the young of this genus, and Schaefer and Marr (1948) discovered and studied juvenile forms from the west coast of central America. During the course of the first year of field work, the biological staff of the Philippine Fishery Program collected 19 specimens of young

TABLE 5.—*Summary of counts and proportional measurements*[1] *of specimens of* Auxis thazard *and* Auxis tapeinosoma *of approximately equal length*

Item	*A. tapeinosoma* 186–190	*A. thazard* 182–186.4	*A. tapeinosoma* 192–199.1	*A. thazard* 196	*A. tapeinosoma* 122–129	*A. thazard* 118–123	*A. tapeinosoma* 161.9	*A. thazard* 154–156.7
Head	4.4–4.5	4.15–4.35	4.36–5.1	4.2	4.35–4.14	4.16–4.2	4.5	4.19–4.32
Snout to first dorsal	3.28–3.4	3.2–3.21	3.28–3.33	3.15	3.25–3.34	3.15–3.23	3.42	3.14–3.21
Snout to second dorsal	1.56–1.57	1.61–1.66	1.54–1.58	1.6	1.56–1.76	1.57–1.74	1.57	1.48–1.62
Snout to anal	1.44	1.47–1.48	1.42–1.44	1.34	1.45–1.56	1.48–1.51	1.44	1.50–1.54
Depth	5.3–5.31	5.26–5.45	5.14–5.35	4.55	6.05–6.1	4.9–5.3	5.24	4.9–4.95
Pectoral to first dorsal	9.2–9.95	9.5–10.1	9.08–9.42	9.3	10.3–11.5	9.45–10.1	9.38	8.6–8.85
Length first to second dorsal origin	2.8–2.88	3.2–3.24	2.83–2.93	3.15	2.86–2.98	3.12–3.18	2.83	3.2–3.25
Pectoral length	8.95–9.35	8.62–9	8.83–9.12	8.95	9.91–9.93	9.5–10.8	9.5	9.28–9.35
First dorsal base	6.68–8.54	6.15–6.8	7.60–8.6	7.02	6.75–8.1	4.92–7.15	8.1	6.0–6.85
Second dorsal base	15.9–18.1	14.9–16.6	16.3–20.2	19.2	16.2–17.6	15.6–19	17.2	14.6–18.4
Anal base	17.8–18.3	16.7–17.6	17–19	17.3	14.8–21.1	15.9–19.7	16.2	14.9–16.2
Eye	3.71–4.22	4.4–4.66	4.04–4.42	3.71	8.94–4.2	4.17–4.3	3.98	4.45–4.78
Maxillary	2.56–2.66	2.52–2.58	2.67–2.76	2	2.5–2.52	2.32–2.46	2.54	2.46–2.55
First dorsal	10–11	11–12	10	11	10	11	10	10–11
Second dorsal	11	11	11	11	11	10–11	11	10–11
Dorsal finlets	8	8	8	8	8	8	8	8
Anal	13–14	13–14	12–13–14	14	12	10–12–13	14	13–14
Anal finlets	7	7	7	7	7	7	7	7
Gill rakers	10+1+34	10+1+31	11+1+33	9+1+29	11+1+33	9+1+29	11+1+34	10+1+31
Do	11+1+32	8+1+30	11+1+33	----------	11+1+35	10+1+31	----------	10+1+30
Do	----------	----------	10+1+34	----------	----------	10+1+27	----------	----------

[1] All proportional measurements are expressed in millimeters and are into standard length, except the maxillary which is into head length.

Auxis. Four specimens were collected by night-light operations from the research vessel *Spencer F. Baird*, two by the experimental fishing vessel *Theodore N. Gill*, and thirteen were found in the public markets of Menado, Celebes, Dutch East Indies, and Batangas, Luzon, Republic of the Philippines.

Twelve of the preceding juvenile specimens, identified as *Auxis thazard*, were collected from the following localities: 3 specimens, 21.8 to 26 mm. standard length, Minis Island, Pilas Island Group, Sulu Archipelago, lat. 6°36′ N., long. 121°34.5′ E., night light, May 7, 1948, *Spencer F. Baird;* 1 specimen 43.5 mm. standard length, Marigabato Point,

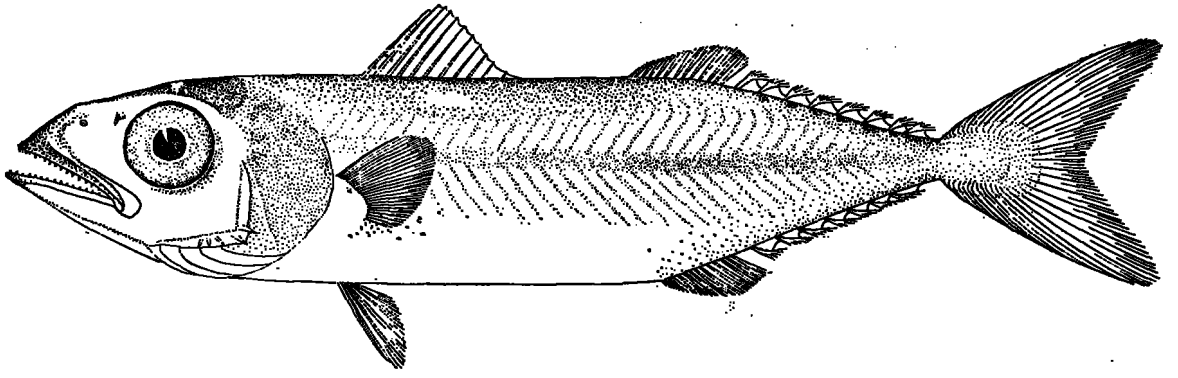

FIGURE 3.—Juvenile *Auxis thazard*, 23.1 mm. fork length.

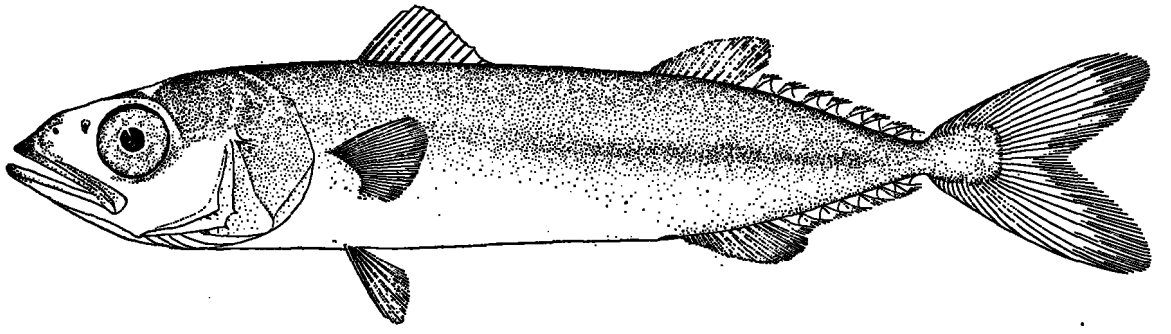

FIGURE 4.—Juvenile *Auxis thazard*, 26 mm. fork length.

southern Mindanao Island, lat. 7°21′ N., long. 124°12′ E., May 11, 1948, night light, *Spencer F. Baird;* 1 specimen 22.6 mm. standard length, Mouth of Sibuguey Bay, Mindanao Island, April 7, 1948, night light, *Theodore N. Gill;* and 7 specimens 45 to 55 mm. standard length, Batangas Public Market, Luzon, April 20 to 30, 1948.

Seven specimens of young *Auxis tapeinosoma* were captured at the following stations: 6 specimens 42 to 75.6 mm. standard length, Menado, Celebes, Dutch East Indies, March 6, 1948, night light, *Spencer F. Baird*, and market collections; 1 specimen 32 mm. standard length, Lamhil Island, near Basilan Island, Zamboanga, Mindanao, April 15, 1948, night light, *Theodore N. Gill.*

Extensive night-light operations carried out under a wide variety of conditions and localities have revealed but relatively few young tuna or tuna-like fishes. Those taken were collected during the first half of May 1948. Both over-water and submerged lights were tested, but for attracting the larger macroplankton and larval fishes it is believed that the under-water light is more satisfactory. A light suspended above the surface of the water seems to be more attractive to the larger fishes. Two lights are used at each station and one or two men operate fine-meshed dipnets at each light. The dipnet bags are made from nylon mosquito netting, which has been found to be durable material under tropical conditions of humidity and heat. The operators constantly dip from the collection of animal life surrounding the light, and after several dips the catch is placed in a pail of seawater and the process repeated. The catch thus brought aboard is closely examined for the young pelagic fishes. An adequate sample from the night light collection is preserved and returned to the shore laboratory for additional study.

Careful study of the juvenile *Auxis* in the collection shows that, as in the case of the adults, they can be separated into two species on the basis of gill-raker counts. These counts are tabulated in tables 6 and 7. The gill rakers correspond to the adults of the two species found in these waters, *A. thazard* and *A. tapeinosoma.* All gill-raker counts were made under 45 to 60 diameter magnification with a wide-field binocular microscope and every nodule indicating the development of a gill raker was tabulated. No doubt some errors may have been made in the gill-raker count of very small specimens, but no difficulty should be experienced in specimens 25 to 30 mm. standard length.

TABLE 6.—*Standard length and gill-raker count of juvenile* Auxis thazard

Standard length (millimeters)	Gill-raker count
21.8	[1] 4+1+18=23
22.6	10+1+30=41
26	7+1+29=37
26	10+1+31=42
43.5	10+1+29=40
44	8+1+29=38
46	8+1+30=39
47	9+1+29=39
47	9+1+29=39
48	9+1+29=39
49	8+1+30=39
55	9+1+29=39

[1] Lesser count possibly is due to the small size of the specimen with undeveloped gill rakers.

Two exceptions to the usual range of gill-raker counts were noted. One juvenile form, with a standard length of 21.8 mm., had a gill-raker count of 4+1+18 for a total of 23 gill rakers. The second example, from an adult fish, had a count of 8+1+22 for a total of 31 gill rakers. It is possible that the gill rakers were not fully developed in the juvenile specimen, or that the gill arch was deformed or injured in some manner to cause this abnormal count. On the other hand, no difficulty was experienced in

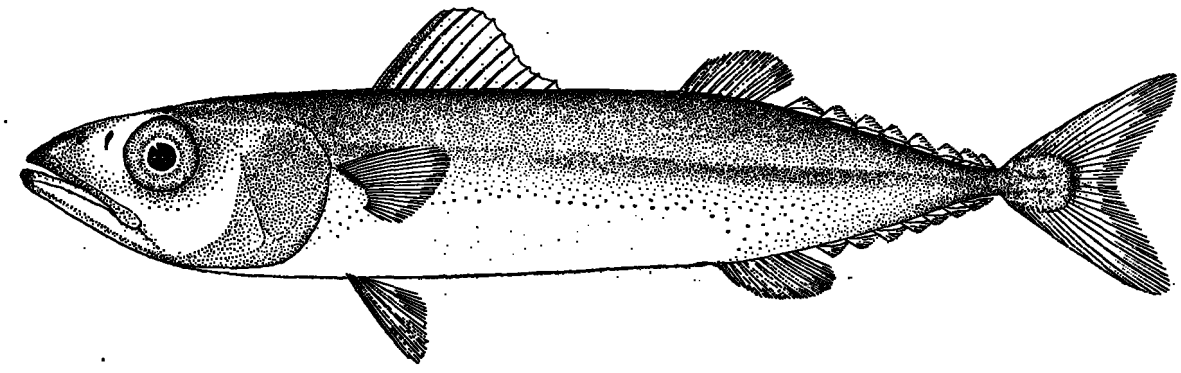

FIGURE 5.—Juvenile *Auxis thazard*, 46.5 mm. fork length.

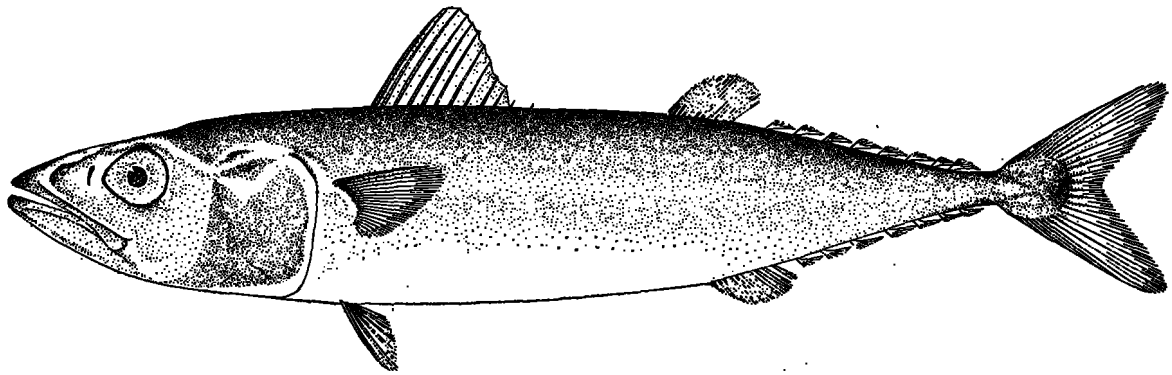

FIGURE 6.—Juvenile *Auxis thazard*, 57.2 mm. fork length.

counting the gill rakers of specimens of similar size and there was no indication of abnormality or injury to the gill arch. The large gill arch from a mature specimen was found in a collection of adult *Auxis* gill rakers made at Batangas, Luzon. Examination of this gill arch showed that it appeared normal in every way. Unfortunately, the specimen was not preserved and is unavailable for study. Since one of the two fundamental differences between the two species of Philippine *Auxis* is the difference in the gill-raker counts, it is possible that a third species may be present in the islands, although extremely rare.

Juvenile *Auxis* can be distinguished from the young of *Neothunnus* and *Euthynnus*, commonly found in Philippine waters, by the wide interspace between the first and second dorsal fins and the absence of a wholly or partly black first dorsal. From *Katsuwonus*, another genus of the same family, young *Auxis* can be distinguished by the wide interspace between the fins. In coloration the first dorsal of *Auxis* and *Katsuwonus* are somewhat similar both having a lightly pigmented or colorless fin. Although light in color, the first dorsal of *Katsuwonus* possesses more pigment than that of *Auxis*. Distally the first dorsal of *Katsuwonus* is more or less light brown or tan in color, while in *Auxis* the color is confined to a few scattered chromatophores along several of the anterior rays.

The young of two genera of the family Scombridae, possibly, can be also confused with young *Auxis*. These genera, *Rastrelliger* and *Pneumatophorus*, while possessing the wide interspace between the dorsal fins, have only 5 dorsal and anal finlets in contrast to 8 dorsal and 7 anal finlets of *Auxis*. Although there is little chance of confusing juvenile *Auxis* with the remaining two genera of Scombroid fishes found in the Philippines, *Acanthocybium* and *Scomberomorus*, it is well to point out that each of these two genera possess 9 dorsal and anal finlets, and the interspace between the two dorsal fins is greatly reduced.

Except for the fact that the small specimen (32 mm. standard length) of *Auxis tapeinosoma* has its full complement of gill rakers, one would suppose that the larger juvenile specimens of *Auxis thazard* were the same species with the gill rakers not fully

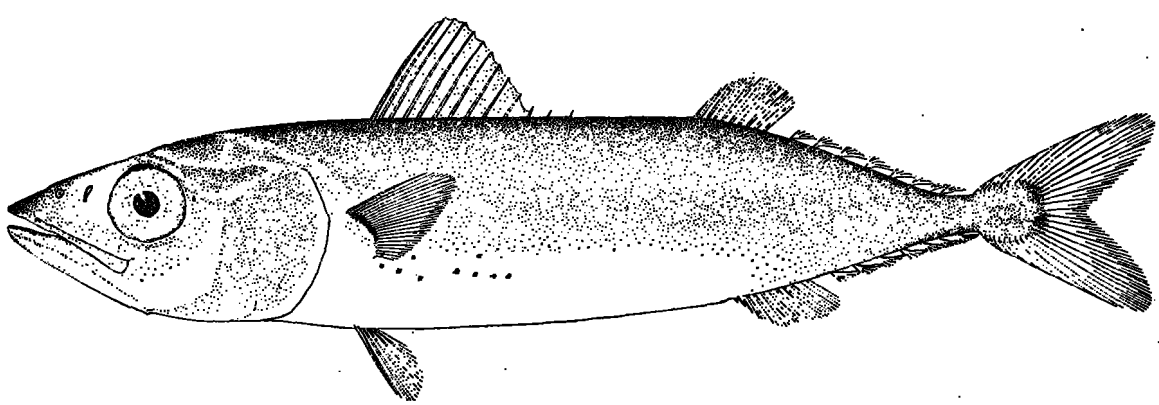

FIGURE 7.—Juvenile *Auxis tapeinosoma*, 33 mm. fork length.

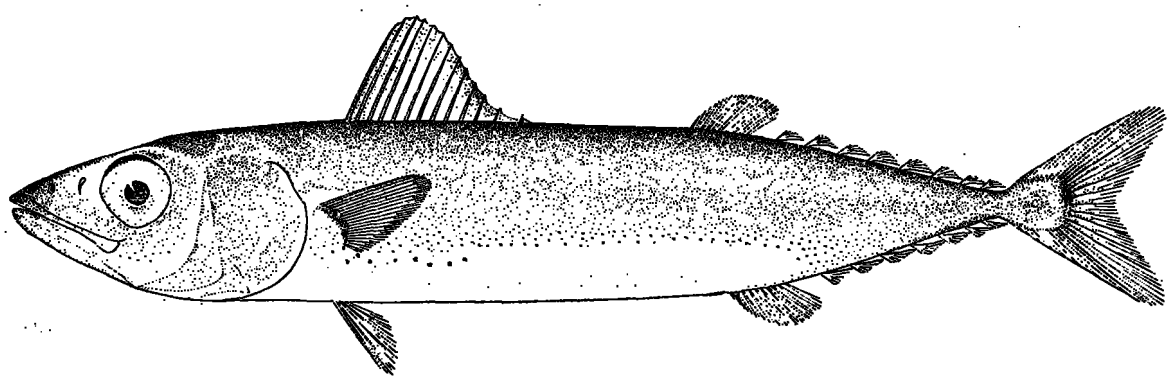

FIGURE 8.—Juvenile *Auxis tapeinosoma*, 44 mm. fork length.

developed. Counts made on both species (tables 6 and 7) show that this cannot be so, for the two counts widely overlap in the standard lengths of the two species. On the basis of present knowledge, it would seem that the supposition of Schafer and Marr (1948) is correct, that possibly they had the juvenile forms of two species. They list two specimens (52 and 54 mm. total length) with a total gill-raker count of 48 and 46, well within the limits of the total count for that of *tapeinosoma*. They also recorded total gill-raker counts of 39, 41, and 42 for specimens 42, 48, and 68 mm. in total lnegth, which fall within the limits of those for *Auxis thazard*, as here defined. Schaefer and Marr also refer to two adult specimens of *Auxis* from Culion, Republic of the Philippines, and from the gill-raker counts, it is possible that they also belong to two species. The specimen with the gill-raker count of 12+35=47 is most likely *A. tapeinosoma*, and the second specimen with a count of 11+32=43 gill rakers seems to be *A. thazard* as classified in this paper.

TABLE 7.—*Standard length and gill-raker count of juvenile* Auxis tapeinosoma

Standard length (millimeters)	Gill-raker count
32	10+1+35=46
42	11+1+34=46
48	10+1+34=45
51.5	10+1+35=46
58.5	10+1+34=45
61	10+1+34=45
75	10+1+36=47

The color pattern of the young of both species is essentially the same, although in specimens of equal size *tapeinosoma* is slightly darker in color and the pattern more widely distributed. In the smaller specimens of both species the most pronounced areas of pigmentation are on the upper jaw, tip of lower jaw, tip of snout, around the posterior-ventral margin of the eye, the operculum, dorsally on head between the eyes, dorsally along midline of back, along midline of sides, along base of anal fin, and around base of urostyle. Large chromatophores in the peritoneum are visible through the thin body wall especially behind and below the base of the pectoral fin. The pigmentation of the first dorsal fin is slightly more in *Auxis tapeinosoma* than in *thazard*. In the latter species the first dorsal is colorless except for a slight pigmentation along the edge of the anterior rays, while in the former the anterior interspinous membranes are lightly pigmented, especially distally. As the two species increase in size the localized areas of pigmentation gradually spread until finally the color reaches the midline of the sides anteriorly and to the anal base posteriorly. A faint longitudinal dark band extends along midline of sides, bordered above and below by slightly less pigmented areas. The head also becomes progressively more pigmented as the fish increases in size. The fins remain unpigmented except the first dorsal which becomes lightly tinged with brown especially distally on the posterior interradial membranes in *thazard*, and similar but darker in *tapeinosoma*.

In the smaller specimens the dorsal and ventral outlines are distinctly angulated. Both outlines are flat and almost parallel to one another from the posterior part of the head to beneath the second dorsal fin. At this point the outlines bend abruptly toward the caudal region. The dorsal outline of the snout is distinctly angular. Both the dorsal and ventral outline become more broadly and evenly rounded as the fish increase in size.

Preopercular spines are present on the fish up to, at least, 30 mm. standard length. On one small

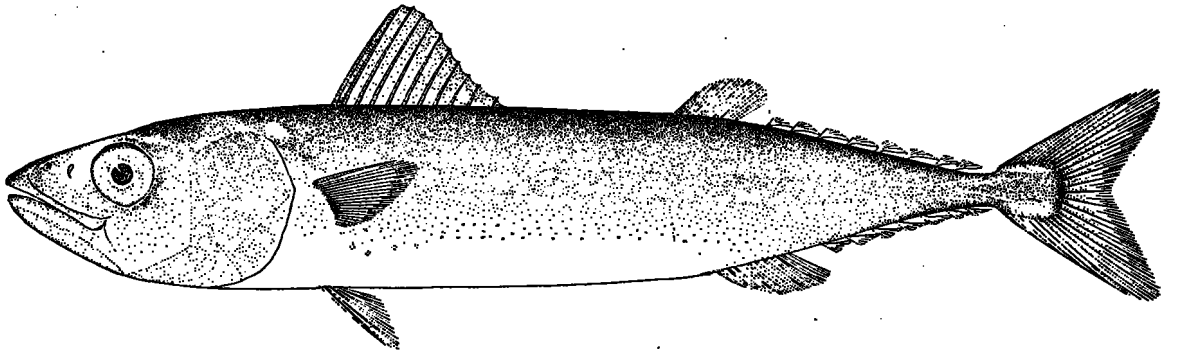

FIGURE 9.—Juvenile *Auxis tapeinosoma*, 54 mm. fork length.

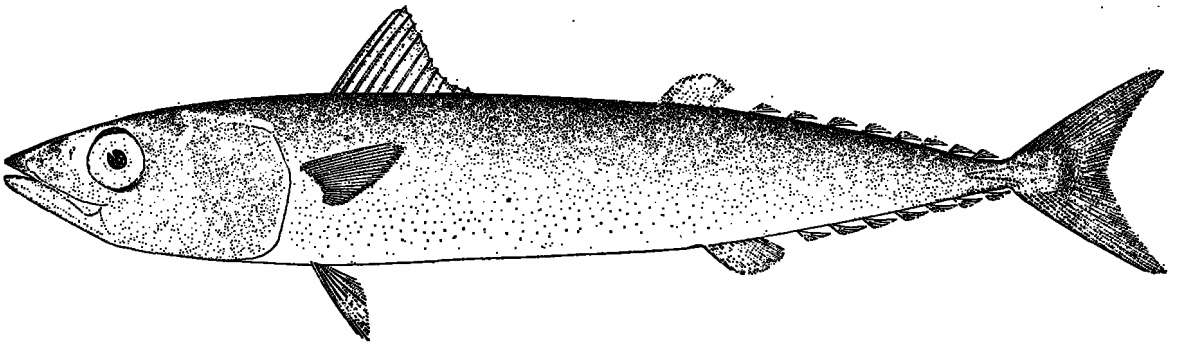

FIGURE 10.—Juvenile *Auxis tapeinosoma thazard*, 79 mm. fork length.

specimen of 21.3 mm. five spines are visible, but on a 25.6-mm. specimen only three spines were seen. In the larger specimens spines are not visible, being concealed in the tissue covering the preoperculum. Schaefer and Marr (1948) counted 9 preopercular spines in stained specimens.

A single row of small, conical, pointed teeth is present on each jaw. Philippine specimens are similar in this respect to those from the eastern Pacific with about 20 teeth on each side of the upper jaw, and about 25 on each side of the lower jaw. A few minute granulations are present on the palatines, but there is no evidence of teeth on the vomer of either species.

SUMMARY

The genus *Auxis* family Scombridae is a food fish of some importance in the Republic of the Philippines. Until recent investigations by biologists of the Philippine Fishery Program of the Fish and Wildlife Service, it was thought that the commercial catch was composed of only one species. It can now be shown that two species are present, *Auxis thazard* and *Auxis tapeinosoma*. The two species can be readily distinguished by the differences in gill-raker counts and the structure of the corselet. In *A. thazard* the total gill-raker count of the first gill arch is 37 to 43, and in *A. tapeinosoma* it is mostly 44 to 47 (43 in one of 55 specimens). The posterior prolongation of the corselet along the lateral line tapers abruptly in *thazard* and is only 2 to 4 scale rows wide below the origin of the second dorsal, while in *tapeinosoma* it tapers evenly and gradually throughout its length, being 7 to 12 irregular scale-rows wide under the origin of the second dorsal.

Juvenile forms of the genus *Auxis*, previously unknown from the Indo-Pacific region, have been collected and identified as to species. As with the adults, they can be separated into two species on the basis of gill-raker counts. These counts correspond to the adults of the two species found in Philippine waters, *A. thazard* and *tapeinosoma*. One juvenile and one adult specimen with lower gill-raker counts point to the possibility that perhaps a third species may be found, although it seems to be extremely rare. No attempt has been made to revise the confused systematic status of this genus, since neither adequate collections nor library are available for study. Rather, it is hoped that the data assembled here will aid future research on this genus.

LITERATURE CITED

DE BUEN, FERNANDO.
1932. Formas ontogénicas de peces (nota primera). Inst. Español de Oceanog., Notos y Resumenes. II, 57, pp. 1–38.

EHRENBAUM, ERNST.
1924. Scombriformes. Rept. Danish. Oceanog. Exped. 1908–1910 to Medit. and Adjacent Seas, vol. 2 (Biology), no. 8, A. 11, pp. 1–42.

FOWLER, HENRY W.
1938. The fishes of the George Vanderbilt South Pacific Expedition, 1937. Acad. Nat. Sci. Philadelphia. Monograph No. 2, pp. 1–307, pls. I–XII, figs. 1–31.

GODSIL, HARRY C. and BYERS, ROBERT D.
1944. A systematic study of the Pacific tunas. Calif. Div. Fish and Game. Fish Bull. 60, pp. 1–131. Sacramento.

HERRE, ALBERT W.
1934. The Fishes of the Herre Philippine Expedition of 1931. Published privately, Hong Kong.

GÜNTHER, ALBERT.
1860. Catalogue of fishes in the British Museum. Vol. II, pp. 1–548, London.

KISHINOUYE, KAMAKICHA.
1915. Contributions to the study of mackerels, seerfishes, and tunnies (Japanese). Suisan Gakkwai Ho (Proc. Sci. Fish. Assoc.) I, pp. 1–24.

KISHINOUYE KAMAKICHA.
1923. Contributions to the comparative study of the so-called scombroid fishes. Jour. College of Agric. Imp. Univ., Tokyo, vol. 8, no. 3, pp. 293–475.

MEEK, SETH E. and HILDEBRAND, SAMUEL F.
1923. The marine fishes of Panama. Field Mus. Nat. Hist.. Zool. Ser., vol. XV, pp. 1–330, pls. I–XXIV.

SCHAEFER, MILNER B. and MARR, JOHN C.
1948. Juvenile *Euthynnus lineatus* and *Auxis thazard* from the Pacific Ocean off Central America. Pacific Science, vol. 2, no. 4.

SELLA, M.
1924. Caratteri differenziali dei giovana stadi di *Orcynus thynnus* Ltkn., *O. alalonga* Risso, Auxis bisus Bp. R. Accad. Naz. dei Lincei, Cl. di Sci. Fis., Mat e Nat., Rend. Vol. 33, pp. 300–305.

SPARTA, A.
1933. Osservazioni compiute nello Stretto de Messina sul comportemento dei pisci e cefalopodi all'azione di sorgenti luminose. R. Comitat. Tallasogr. Ital. Mem. 206, pp. 1–22.

WALFORD, LIONEL A.
1937. Marine game fishes of the Pacific Coast from Alaska to the Equator. Univ. California Press., pp. 1–205, pls. I–LXIX. Berkeley.