

A STUDY OF THE LIZARD-FISHES (SYNODONTIDAE) FOUND IN WATERS OF FORMOSA AND ADJACENT ISLANDS

I. SYSTEMATIC REVIEW

by

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Introduction

An ichthyologist working on the Formosan fauna should not be surprised to come across one or more fishes that have not yet been recorded for waters surrounding Formosa and adjacent islands. In the recent reviews of Uranoscopidae by Liang (1955), Scienidae and Echinidae by Chu (1956 and 1957 respectively), Clupeidae by Chu and Tsai (1958), Elasmobranchii by Teng (1959), *Cephalopholis* (Serranidae) by Tsai (1960), and Eleotridae by the senior author (1964), newly recorded fishes are quite common. In addition, some new species have been described in the above-mentioned reviews and in other papers. It is not for the sake of describing new species, as some biologists here might comment or even condemn, but simply because the fish fauna of Formosa has not yet been thoroughly investigated. If one simply examines those reviews of families since 1955, it will be seen that some groups have almost half of the listed species as newly recorded. In a fish collection made in 1959 from I-lan and Lo-tong Districts, and reported by Teng and the senior author (1960) as well as in one from the Tansui River in the northern part of Formosa during 1957 through 1958 by the senior author (MS), there were more than ten newly recorded fishes of about 100 species reported. A similar percentage of previously unrecorded fishes (10 or more percent) is seen in Chu's work (1957) on fishes of the Pescadores and the later work by Liaw (1960) on the same area. Historically, the first report concerning fishes collected in Formosa appeared in Günther's "*Catalogue of Fishes*" in 1850~1857. Since then, Boulenger, Regan, Jordan, Evermann, Richardson, Oshima, Nakamura etc. have published reports on fishes of Formosa. Of those, Jordan and Everman (1902), Jordan and Richardson's (1909) list of Formosan fishes, Oshima's many works on the fresh-water fishes and many reviews of salt water fishes of important economic value, and Nakamura's works on sharks, marlins, and tunas are especially important contributions to the

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knowledge of the fish fauna here prior to the Second World War. A large part of those fishes reported were compiled and listed in Okada and Matsubara's "*Fish and Fish-like Animals of Japan*" in 1938. Only 16 species are reported in Günther's report; 430 species were known in 1938 (after Chen, Johnson T. F., 1956). Following World War II, T. F. Chen and other contemporary ichthyologists in Formosa or abroad have contributed to the study of the Formosan fish fauna. There are 870 species reported in the various journals available in T. F. Chen's personal library and in the libraries of Formosan institutions as can be seen in T. F. Chen's compilation of 1956. As may be seen herein and elsewhere, reviews of some groups of fishes of Formosa are concentrated in the years since 1955. A preliminary estimate of fish species including those having been reported up to date and those already known but not yet reported occurring here should number more than 1000.

Needless to say, reviews of the fish fauna of Formosa are in urgent demand as the above information may indicate. It is the intention of the senior author at least to review the Formosan fishes, family by family or even genus by genus, in the near future. The present report has been written in the hope of initiating interest for work to this end.

Lizard fishes, "Kow-mu"³, or "Kau-bu"⁴ as they are referred to locally, are of economic value in Formosa. The commonest species of those in this report are *Saurida tumbil*, *Saurida undosuqamis*, and *Trachinocephalus myops* which are used by both the inhabitants and by the military. Thus far, *Saurida gracilis*, in addition to the above-mentioned three species, appear in the literature known prior to 1956. In 1959, in Liu and Tung's report, "The reproduction and the spawning ground of the lizard fish, *Saurida tumbil* of Taiwan Strait", *Saurida elongata* is mentioned as having been seen by them, but there are no systematic remarks on it. In this report eight species are described, of which three newly recorded species, *Synodus variegatus*, *Synodus macrops*, and *Synodus fuscus* all belong to the genus *Synodus*, also newly recorded here. As can be seen elsewhere (Norman, 1935; Matsubara & Iwai, 1951), the classification of the lizard-fishes is, in part, very difficult. In the course of this study, we have found that the morphology of scales from different parts of body is a good key character for such classification. Thus, in addition to the first part of this report, i.e., the systematic review, a description of scale morphology and discussion of its possible implication in phylogeny will be presented as the second part.

Materials and Methods

Old and recently collected specimens were used. Old specimens used have been preserved for a long time in the following institutions: The Fish Collection Room of the Department of Zoology, National Taiwan University; Fish Collection of the Insti-

3). Chinese name;

4). Formosan name.

tute of Fishery Biology of the Ministry of Economic Affairs and National Taiwan University; Taiwan Fishery Research Institute, and Taiwan Museum; specimens recently collected for the present study have been added to the Fish Collection of the Department of Zoology, National Taiwan University. Beside the authors, Tung and Yang have collected a large number of the specimens. The majority of lizard-fishes used in our study, however, were taken from Taiwan Strait (Refer to Liu & Tung, 1959, p.6, fig. 4), moved to fish markets at Kaohsiung, Keelung, and Tung-kang and, then, distributed to other large cities. Still others, including some larvae and young, were found mixed with other fishes in beach-seine hauls from along the western coast of Formosa and collected by the authors. The collection in 1956 from the Pescadores and reported by Chu, was obtained in markets there. Other specimens from personal collections made by the senior author while serving in the ROTC on Quemoy in 1959, and, also, while he was a participant in the fish collecting at Botel Tobago in the summer of 1960.

Counts and measurements, taken on the left side of specimens whenever possible, are illustrated, in part, in fig. 1. Membrane along edges of bones was excluded from

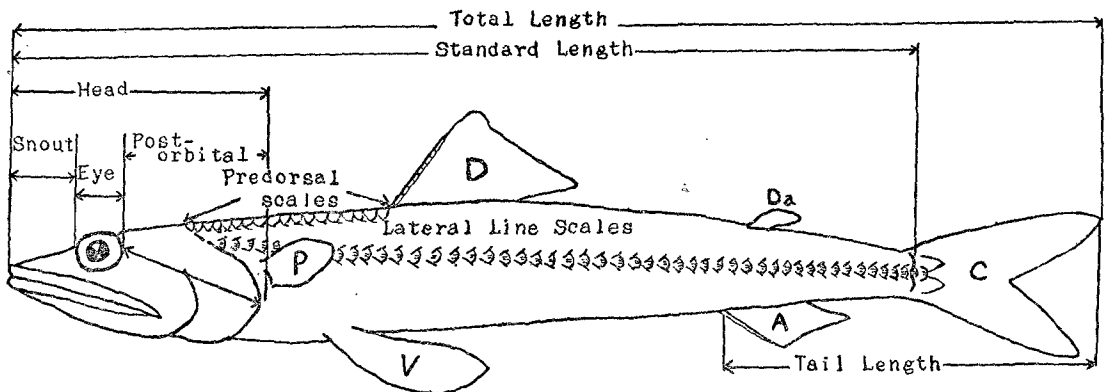


Fig. 1 Lateral view of a lizard fish showing the external morphology for measurement adopted in this report. (A. anal fin; C. caudal fin; D. dorsal fin. Da. adipose fin; P. pectoral fin; V. ventral fin.)

the measurement. Predorsal scales were counted, beginning with the one just in front of the dorsal fin forward to the anteriormost one along the mid-line of the back, those not merging in the mid-line were not included in the count. Lateral-line scales were counted from the first scale at the junction of the suspensorium and skull to

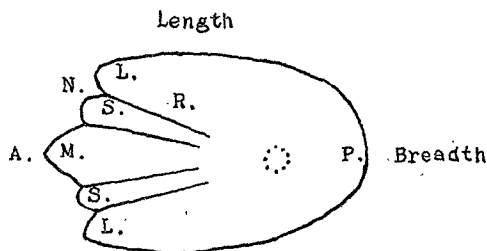


Fig. 2 Scale terminology used in this report (in both Part I and II).

- A. Anterior part
- P. Posterior part
- R. Radius
- M. Median lobe
- S. Sublateral lobe
- L. Lateral lobe
- N. Notch

the last scale on the posterior edge of the hypural. Scale terminology used in this study is presented in fig. 2. Scales from the anterior part of the lateral line were taken within the range of the pectorals, while those from the pectoral region are those covered by the pectorals below the lateral line. From our observations and comparisons, scales within the delimited area, as defined above, do not vary significantly morphologically; thus, each scale from the same delimited area (not exactly in the same position) can be used for the purpose of classifying this group of fishes as occurring here.

Acknowledgement

We are grateful to the following gentlemen for their varied assistance: to Prof. Dr. Yu-hsi Moltz Wang, Chairman of the Department of Zoology, National Taiwan University for his comments and suggestions, as well as encouragement throughout our work, to Prof. H. T. Teng of the same department and director of Taiwan Fisheries Research Institute, to Prof. Dr. F. H. Liu of the same department and director of the Institute of Fishery Biology of National Taiwan University, and Prof. Y. H. Liang of the same department and chairman of the Ichthyology Department of Taiwan Museum for placing specimens and literature at our disposal; to Mr. I. H. Tung of the Institute of Fishery Biology for collecting specimens, photographing scales, and providing specimens from his studies, and for his continuing discussions; and to Mr. H. C. Yang of Taiwan Fisheries Research Institute for the collection of some valuable specimens of newly recorded fishes for this report. Special thanks are due to Mr. L. T. Penny of the Department of Biological Sciences, University of California at Santa Barbara for his generosity and his corrections of the manuscript. Needless to say, without the assistance of the above gentlemen the present report could hardly have been written.

The present study has been carried out without any financial support from any organization. However, Prof. P. H. Chang of the Department of Zoology, National Taiwan University, provided considerable assistance in collecting specimens in some large markets in Formosa, and we would like here to express our heartfelt appreciation for his assistance. We are obliged to Prof. Johnson T. F. Chen of the Department of Biology, Tunghai University for publishing this report.

Key to Formosan Genera of Synodontidae:

- 1a. Two bands of palatine teeth on each side. Ventral finrays 9, second innermost ventral finray only slightly longer than outermost one (always around 1.2-1.3 times longer.) Ventral girdle with a pit at the junction formed by the two lobes, the posterior one rather broad and short.....*Saurida*.
- 1b. One band of palatine teeth on each side. 8 ventral finrays, second innermost ventral finray distinctly longer than outermost one (always 2 or more times longer). Ventral girdle with a pit in each lobe of pelvic bones and with posterior lobe rather

elongate and slender.

- 2a. Snout and eye subequal or the former longer than the latter. Anal fin moderate or short, with 8 to 9 finrays.....*Synodus*.
 2b. Snout distinctly shorter than eye diameter. Anal fin long, with 15-16 finrays...
 *Trachinocephalus*.

***Saurida* Cuvier & Valenciennes**

Saurida Cuvier et Valenciennes, 1849, Hist. Nat. Poiss., XXII, p. 499* Genotype: *Salmo tumbil* Bloch*.....Jordan & Herre, 1907, p. 518.....Weber & De Beaufort, 1913, p. 141. Norman, 1935, p. 123.

Body cylindrical and elongate. Head more or less pointed. Eye moderate, adipose eye-lid present, partly covering eyes. Snout subequal or longer than eye diameter. Nostrils close together. Teeth on both jaws in more than 3 rows, exposed laterally. Lower jaw included. Two bands of palatine teeth on each side. Vomerine teeth present or absent. Opercular apparatus well developed. Gill membranes free. Pseudobranchiae well developed. Scales of moderate size and cycloid. Breadth of scale in anterior part of lateral line shorter, subequal, or only slightly greater than their length. Ventral girdle with a pit at junction formed by two lobes and with posterior lobe rather broad. Dorsal finrays gradually decreasing in length posteriorly. Anal fin short. Caudal fin forked, upper lobe longer than lower one. Tail always longer than one-third the total length.

Key to Formosan Species of *Saurida*:

- 1a. Pectoral fin of moderate, its tip always reaching origin of ventral fin. Lateral line with more than 60 scales.....*S. elongata*.
 1b. Pectoral fin of moderate, its tip always reaching origin of ventral fin. Less than 60 lateral-line scales
 2a. No blackish dots or marks on caudal and dorsal fins. Dorsal fin generally with an elongate finray.....*S. tumbil*.
 2b. Dorsal and caudal fin with dots or marks, dorsal fin without prolonged rays.
 3a. A single row of blackish dots along edge of first dorsal finray and dorsal edge of upper lobe of caudal fin. Other fins without any distinct marks.....*S. undosquamis*.
 3b. Caudal fin with distinct vertical marks or bars and color pattern similar to that of the other fins..... *S. gracilis*.

***Saurida elongata* (Temminck & Schlegel)**

Aulopus elongatus Temminck et Schlegel, Faun. Japan. Poiss., 1846, p. 233, pl. CV, fig. 2; Nagasaki, Japan.

Saurida eso Jordan & Herre, 1907, p. 520, fig. 1; Wakanoura, Kobe, and Tsuruga, Japan.

* Publications followed by an asterisk (*) were not available to the authors.
 ** Species followed by a double asterisk (**) are newly recorded for our region.

.....Jordan, Tanaka, & Snyder, 1913, p. 53 (references).....Jordan & Hubbs, 1925, p. 155; Tokyo and Kobe markets, Mikawa Bay, Toyama, Miyazu, and Noc, Japan.

Saurida microlepis Wu & Wang, 1931, p. 1, fig. 1; Chefoo, China.

Saurida elongata Norman, 1935, p. 133, Text-fig. 18; Coasts of China and Japan.....Okada & Matsubara, 1938, p. 55 (compiled).....Matsubara & Iwai, 1951, p. 20; Mikawa Bay, off. Ogi; Saheki Bay, Mitaziri, Japan; East China Sea.....Matsubara, 1955, p. 244 (compiled).
.....Liu & Tung, 1959, p. 1, fig. 3 North Taiwan.....Chen, T. R. 1960 Quemoy.

Body elongate, cylindrical. Head small, pointed, and slightly depressed. Eye large, adipose eye-lid present, covering nearly half the eye, but leaving a wide slit in middle. Lower jaw shorter than upper one. Teeth on both jaws exposed laterally, those on upper jaw in 3 or 4 rows, the inner row the strongest; those on lower jaw in 5 or 6 rows, the inner row the strongest. Palatine teeth in two bands on each side, outer band long, with 2 or 3 rows of teeth, inner row the largest; inner band in form of a short but broad patch, with 4 or 5 rows of teeth, the inner row the largest. Nostrils close together, anterior ones in a slit with a low rim along posterior edge, posterior ones in a large opening. Cheek, operculum, and area behind occiput scaled, other area of head without scales. Scales on body of moderate size. Hypocoracoid foramen of pectoral girdle located below keel. Posterior process of pelvic girdle broad and expanded, pelvic bone without a foramen. Pectorals short, tip never reaching origin of ventrals. Inner ventral finrays longer, the longest finray about 1.2 times longer than the shortest outer-most one. Dorsal finrays gradually decreasing length towards posterior part of fin. Caudal fin forked, upper lobe longer than lower lobe. Tail about one-third of total length.

Other morphological measurements and counts are listed in table 1.

Color in formalin brownish above, white below. Some scales above on upper body with a pale central part. Pectoral, Dorsal, and Caudal fins with fine blackist pigmentation, more concentrated toward their tips; other fins pale.

Large specimens of this species are not common here, but small or young ones are commonly caught along the western coast of Formosa. Specimens examined range from 78.8 to 335.6 mm in total length. The largest one was collected by Tung from Kaohsiung. Three small specimens were collected by the senior author from Quemoy in 1959. Others from Kaohsiung markets, were collected by Tung and Yang.

This species was first reported to occur here by Liu and Tung in 1959; however, no systematic remarks concerning it were given. Our record from the southern part of Formosa seems to be the southernmost limit in the distribution of the present species as far as can be judged from available reports to date. Beside scale counts for the lateral-line (62-66) and predorsal region (23-26) being larger in value than they are in the other species of the genus *Saurida*, the ventrals are rather long, with the longest finray less than 1.25 times in the head length. In this species the anterior margin of the scales from the pectoral region is irregularly divided and lacks a distinct notch. Other morphological characteristics of scales used for taxonomical purposes are de-

scribed in Part II of this work.

Saurida tumbil (Bloch)

Salmo tumbil Bloch, Naturg. Ausl. Fische, IX, 1795, p. 112, Pl. CCCCXXX*.

Saurida tumbil Günther, 1864, p. 399; Red Sea, Indian Ocean, Western Pacific.....Weber & De Beaufort, 1913, p. 142; many East Indian localities.....Norman, 1935, p. 129, text-fig. 16; Manila, Luzon; Zanzibar, Massaus, Red Sea, Muscat, Arabia, India, Singapore, Pinang, Borneo, China, China Sea, and Hong Kong, North Queensland, Indian Seas, New Hebrides.....Okada & Matsubara, 1938, p. 54 (compiled).....Chen, T. p. 1951, p. 193 (references).....Matsubara & Iwai, 1951, p. 20; Wakasa Bay, Saheki Bay, Kochi, Japan; East China.....Herre, 1953, p. 138 (compiled).....Smith, 1953, fig. 177; Natal, Southern Africa.....Matsubara, 1955, p. 244 (compiled).....Munro, 1955, p. 37, Pl. 10, fig. 101;.....Ceylon. Chen, T. F. 1956, p. 54; Kaohsiung, Formosa.....Chu, 1957, p. 14; Pescadore Islands.

Saurida badi Jordan & Seale, 1905, p. 772, Negros, Philippines.

Saurida argyrophanes Jordan & Herre, 1907, p. 519; Japan.

Body elongate, cylindrical. Head slightly compressed anteriorly, cross-section of head nearly oblong with height greater than breadth. Snout obtusely pointed. Nostrils close together, each in a pit, a thin flap at posterior edge of anterior ones. Eyes of moderate size, adipose eye-lid moderate, partly covering eyes, leaving a spindle-shaped slit in middle. Teeth of both jaws exposed laterally, those on upper jaw in 4 rows, the inner row the strongest; those on lower jaw in 5 rows, the inner row the longest. Palatine teeth in 2 bands, outer band with 2 or 3 rows of teeth (anterior part always with 2 rows), the inner row the longest; inner band in form of a broad patch consisting of 5 or 6 rows of teeth with innermost row the longest. Vomerine teeth present or absent, in a patch or separated row on each side if present. Head scaled behind occiput, on cheeks, operculum; other parts scaleless. Body scale of moderate-size. Hypocoracoid foramen of pectoral girdle located below keel. Posterior process of pelvic girdle broad and expanded, pelvic bone without a foramen. Pectorals short or moderate, their tips reaching slightly behind origing of ventrals. Ventrals moderate, inner finrays longer, longest finray 1.1~1.2 times longer than shortest one. Dorsal fin gradually decreasing in height posteriorly, second finray always prolonged and filamentous in males and, sometimes, in females, as well. Anal fin short. Caudal fin deeply forked, upper lobe longer than lower one. Tail shorter than one-third of total length.

Other morphological measurements and counts are listed in table 1.

Color in formalin brown above, white below, sometimes traces of faint dark cross-bands on upper part of body. Dorsal and caudal suffused with tiny dark pigmented spots, especially on lower lobe of caudal. Anal whitish, ventrals white or deeply pigmented, but with marginal edge whitish, Distal portion of pectorals blackish. Scales on upper part of body usually with a pale central part.

This is the commonest lizard-fish in Formosa; more than 40 specimens, 239.1~498.3 mm in total length, were examined. They were collected from markets in Kaohsiung, Taipei, and Keelung and the Pescadore Islands.

Remarks: In two specimens (270 and 300 mm in total length) of this species the pectoral fins are short, their tips not quite reaching the origin of the ventrals. In all others, however, the pectorals reach the origin of ventrals. Since there are less than 60 lateral-line scales and the species is easily separable from *S. elongata*, which has more than 62 lateral-line scales (see table 1.). The anterior margin of scales from the pectoral region is divided into two main portions by a deep notch in *tumkil*, while there are always more than 4 radii without a very distinct notch in the anterior margin in scales from the same region in *elongata*. Additional diagnostic characteristics of scales will be presented in Part II of this study.

In all specimens at our disposal examined, the structure of the palatine teeth is nearer to that in specimens described by Matsubara and Iwai's (1951), i. e., there are two rows of teeth anteriorly, but not three or more rows, as in those of Norman(1935).

Saurida undosquamis (Richardson)

Saurus undosquamis Richardson, Zool. Voy. 'Erebus and Terror, Fishes, 1848, P. 138, Pl. 51, figs. 1~6.*

Saurida undosquamis Günther, 1864, p. 400; northwest Australia.....Norman, 1935, p. 131; many places in the Indian Ocean and from Japan to New South Wales, Australia Okada & Matsubara, 1938, p. 139 (compiled).....Chen, T. F., 1951, p. 193 (references).Matsubara & Iwai, 1951, p. 20; Wakasa Bay, Saheki Bay, Japan.....Herre, 1953, p. 139 (references).....Smith, 1953, p. 113, fig. 176; Southern Africa, Indo-pacific as far south as Knysna.....Matsubara, 1955, p. 243 (compiled).....Chen, T. F., 1956, p. 54; Kaohsiung.

Saurida grandisquamis Günther, 1864, p. 400; Louisiade Islands.....Jordan & Hubbs, 1925, p. 155; Formosa.....Weber & De Beaufort, 1913, p. 141; Aru Islands, Arafura Sea.

Saurida argyrophanes Jordan & Herre, 1907, p. 519; Wakanoura, Nagasaki, Kode, Tokyo, and Kawatana, Japan.....Jordan & Richardson, 1909, p. 165; Kaohsiung, Formosa.Jordan, Tanaka, & Snyder, 1913, p. 53 (compiled).

Saurida macrolepis Tanaka, 1916, XXIX, p. 39.

Body cylindrical, strongly elongate. Head pointed, slightly depressed, dorsal profile flat. Teeth on both jaws distinctly exposed laterally, those on upper jaw in about 4 rows, the inner row the strongest, those on lower jaw in about 5 rows, the inner row the strongest. Palatine teeth in two bands on each side, outer band very long, with two rows of teeth, inner row longer; inner band in a patch with 5 or 6 rows of teeth, inner row larger. Vomerine teeth present or absent. Lower jaw included. Nostrils close together, a broad but very low integumental flap along posterior edge of anterior ones. Eyes of moderate size, adipose eyelid present, partly covering eyes. Head scaled

behind occiput, on cheek and operculum, other parts scaleless. Body covered with large scales. Hypocoracoid foramen of pectoral girdle located below keel. Posterior process of pelvic girdle broad and expanded, pelvic bone without a foramen. Pectorals moderate, their tips reaching far behind origin of ventrals. Inner finrays of ventrals slightly longer than outer ones, the longest about 1.2 times the shortest outermost one. Dorsal fin gradually decreasing in height posteriorly, second or third finray always the longest, but never prolonged into a filament. Upper lobe of caudal fin longer than lower lobe. Tail longer than one-third the total length.

Color in formalin yellowish white, edges of each scale on dorsal half of body blackish. Along lateral line about 10 blackish blotches, very distinct in young specimens, but not so distinct in adults. Fins except anal fin suffused with tiny blackish spots. A row of distinct black spot along anterior edge of dorsal fin and upper edge of upper lobe of caudal fin. A black line usually present along upper edge of upper jaw.

45 specimens from 109.9 to 405.6 mm in total length were examined. They were collected from Kaohsiung, Taipei, and Keelung markets. They are very common in the southern part of Formosa, but rather rare in the northern part. Young specimens were collected from Kaohsiung, but are not uncommon along the western coast of Formosa.

Remarks: 1). Vomerine teeth in specimens we examined are either present or absent, while in specimens of Norman's (1955) and Matsubara and Iwai's (1951), vomerine teeth are entirely absent. 2). Hypocoracoid foramen of pectoral girdle is located below keel in numerous specimens dissected by Tung and us for the purposes of osteological study and examination of the foramen location. This finding is, however, different from that of Matsubara and Iwai (1951), in which the foramen was described as being above the keel. 3). Scales tend to differ among species, those scales from the pectoral region in which the anterior margin is divided into two portions by only one radius, such scales are important characters for the identification of this species from other species of genus *Saurida*.

Saurida gracilis (Quoy & Gaimard)

Saurus gracilis Quoy & Gaimard, Voy. 'Uranie Zool.', 1824, p. 224; Sandwich Islands; Isle De France.*

Saurida nebulosa Günther, 1864, p. 399; Madagascar, Amboyna, Sandwich Islands.

Saurida gracilis Jordan & Richardson, 1909, p. 163; Kaohsiung, Formosa.....Weber & De Beaufort, 1913, p. 143, fig. 53; many East Indian localities.....Norman, 1935, p. 127; Natal; Madagascar; Zanzibar; Mombasa; Maldives; Andaman Islands; Amboina; North Celebes; Goram; Hawaiian Islands; Vavau Island, Tonga; Micronesia; Indian Seas; New Guinea; New South Wales; New Hebrides.....Chen, T. F., 1951, p. 193 (references).....Herre, 1953, p. 138 (references).....Schultz, 1953, p. 32, Pl. 6, fig. A; Bikini Atoll, Rongelap Atoll, Rongerik Atoll, Eniwetok Atoll, Likiep Atoll, Rota Island.....Smith, 1953, p. 113, fig. 178; Indo-pacific as far south as Natal.....Munro,

1935, p. 36, pl. 10, fig. 100; Ceylon.....Chen, T. F., 1956, p. 54 (after Jordan & Richardson).

Body elongate and cylindrical. Head pointed, slightly depressed, profile convex dorsad. Nostrils close together, posterior edge of anterils with an elongate flap. Interorbital space broad, eye moderate, adipose eye-lid present, but scarcely covering eyes. Teeth on both jaws in 4 or 5 rows, laterally exposed, inner rows enlarged. Upper jaw longer than lower one. Two bands of palatine teeth on each side, outer band 4 times as long as inner one, outer band with 2 rows of teeth, with some enlarged teeth anteriorly, inner band with 2 or more rows, subequal. Cheek and operculum scaled. Body scaled beginning behind occiput. Scales of body of moderate size. Pectorals short, tips exceeding behind origin of ventrals. Inner ventral finrays longer, the longest one about 1.4 times longer than shortest outermost one. Dorsal finrays decreasing in length posteriorly. Caudal fin deeply forked. Tail shorter than 2.8 times in total length.

Other morphological measurements and counts are listed in table I.

Color in formalin darkish brown, belly white, scales except those from belly with dark edge; about 10 or more oblique dark purple bands crossing sides of body. Head dark brown, numerous dark brown blotches or bands crossing chin, ending at upper lip and color becoming blackish there. All fins with small or large spots in series. Adipose fin with a basal and a distal black spot. Fins in living specimens with yellowish background.

One specimens, 136 mm in total length, from Botel Tobago (Lan-yü) was collected by the senior author on August 15, 1960, in coral reefs of Hung-t'ao, Botel Tobago. Other are specimens preserved for a long time in the Fish Collection Room of the Department of Zoology, National Taiwan University, which were apparently collected from some localities on Formosa Island.

Remarks: Color pattern as described above is characteristic for this species. In addition, the anterior margin of scales from the pectoral region has three notches leading to three radii. Each of the two medial and two lateral lobes thusly formed are symmetrical, the lateral lobes significantly larger than the medial ones.

Trachinocephalus Gill

Trachinocephalus Gill, Proc. Acad. Nat. Sci. Philad. Suppl. 1861, p. 53, orthotype, *Saurus myops* (Cuvier et Valenciennes).....Jordan & Herre, 1907, p. 514.....Norman, 1935, p. 121.....Fowler, 1936, p. 339.

Body elongate, cylindrical. head blunt, sloping abruptly downward in front of eyes, snout shorter than eye diameter. Interorbital space deeply concave. Adipose eye-lid poorly developed. Teeth on both jaws in 2 or 3 rows, not exposed laterally. One band of palatine teeth on each side. Vomerine teeth absent. Operculum prolonged backward, edge generally covering the base of pectorals. Pseudo-branchiae well developed. Scales moderate and cycloid. Ventrals exceedingly large and long, longest finray 3 or more

times longer than the shortest. Ventral girdle with a pit in each of the two pelvic bone lobes, posterior lobe rather elongate and slender. Anal fin long, with 15 to 16 finrays. Caudal fin deeply forked, lobes subequal. Anus nearer to origin of ventrals than to that of caudal.

Trachinocephalus myops (Foster)

Salmo myops Forster in Bloch and Schneider, Syst. Ichth., 1801, p. 421; St. Helena.*

Saurus trachinus Temminck et Schlegel, 1846, p. 231, pl. CVI, fig. 2; Japan.

Saurus myops Günther, 1864, p. 398; Cuba, Jamaica, Japan, Amboina, Pinang, Mauritius, Port Jackson.....Cunningham, 1910, p. 95.....Weber & De Beaufort, 1913, p. 145; Nias; Lombok; Ceram; Gebe; Sumatra; Banka; Bali; Celebes; Batjan; Amboina; Ternate; Philippines.

Trachinocephalus myops Jordan & Herre, 1907, p. 514; Nagasaki, Tokyo, Wakanoura, Japan.....Jordan & Richardson, 1909, p. 167; Kaohsiung, Formosa...Jordan, Tanaka, & Snyder, 1913, p. 54; Warm parts of coast of Japan.....Jordan & Hubbs, 1925, p. 155; Tobe market, Tokyo and Kobe markets, Mikawa Bay, Miyazu, Misaki, Japan...Norman, 1935, p. 121, text-fig. 13; many localities in the Atlantic, Indian, and Pacific Oceans.....Fowler, 1936, p. 339, fig. 159; Pacific Ocean, Japan...Okada & Matsubara, 1938, p. 53 (compiled).....Chen, T. F., 1951, p. 192 (references).....Herre, 1953, 137 (references).....Smith, 1953, p. 113; Knysna to Natal and beyond.....Matsubara, 1955, p. 243 (compiled).....Munro, 1955, p. 36, pl. 10, fig. 98; Ceylon.....J. T. F. Chen, 1956, p. 54; Keelung, Kaohsiung, Formosa.....Chu, 1957, p. 14; Pescadore Islands.

Body cylindrical and long. Head stout, interorbital space deeply concave. Eyes near tip of head and dorsad longer than snout, profile in front of eyes bent abruptly downward, longer than snout. Nostrils narrowly separated, anterior nostrils with a marginal low rim and a posterior elongate flap, posterior ones in a pit. Jaws subequal, or lower jaw slightly included, teeth on both jaws not exposed laterally, those on upper jaw with 2 rows of teeth, the inner row larger; those on lower jaw with 3 rows, the inner row largest. Palatine teeth in one band on each side, each band composed of 2 rows of teeth, inner row always larger. No vomerine teeth. Opercular apparatus well developed. Operculum large, protruding backward, covering base of pectorals. Head scaled on cheek, preoperculum, upper part of operculum and behind occiput, other part naked. Scales on body large. Pelvic bone with a foramen in each side, posterior process of pelvic girdle slender and long. Pectorals short, tip reaching far behind origin of ventrals. Ventrals large, broad, and long, longest finray about 3 times longer than shortest outer-most one. Dorsal finrays gradually decreasing in length posteriorly. Anal long. Caudal fin deeply forked, lobes subequal. Anus nearer to the origin of ventrals than to that of caudal. Tail about 2.2 times in total length.

Other morphological measurements and counts are listed in Table I.

Color in formalin brownish gray above, yellow below. Upper part of body with many undulating blackish lines, these ascending on to dorsum, sometimes these lines

becoming ocelli-shaped marks or irregular veri-form lines. The veriform marks extending to dorsal half of head. About 10 cross-bands on sides of body, but always obscure in large specimens. Top of chin with blackish spots. Adipose fin white.

27 specimens from 76.9 to 360 mm, in total length were examined. they are very common here. A few small or young specimens were collected from Kaohsiung by the senior author.

Remarks: Coloration of larvae of the present species is described in the following: "Pigment at base of anal fin consisting of pairs of superficial small spots at the base of the last 5 to 8 rays. A row of discrete melanophores along lateral line. Melanophore concentrations forming a dark spot at base of adipose dorsal fin and a prominent dark patch at caudal base" (taken from the key by Gibbs, 1959, p. 236). The smallest specimen (76.9 mm) we have already has a color pattern similar to that in the fully matured ones. Scales from pectoral region are oblong, and the breadth is two times as long as their length. In other species of the same family, the breadth of scales from the same region scarcely exceeds 1.5 times the scale length. Scales from other regions are also characteristic for this species and will be discussed in detail in Part II of this study.

Synodus Gronow

Synodus Gronow, in Scopoil, Introd. Hist. Nat., 1777, p. 449; Type, *Esox synodus* Linnaeus*.

.....Jordan & Herre, 1907, p. 516.Norman, 1935, p. 102.Fowler, 1936, p. 341.

Body elongate, cylindrical. Head pointed, slightly compressed. Eyes moderate, adipose eye-lid absent or poorly developed. Nostrils narrowly separated. Profile of snout distinctly concave, snout longer than eye diameter. Teeth on both jaws not exposed laterally. One band of palatine teeth on each jaw. Vomerine teeth absent. Lower jaw included. Opercular apparatus well developed. Pseudobranchiae well developed. Scales cycloid. Breadth of scale in anterior part of lateral line about 1.5 times longer than length. Ventrals large and long. Ventral girdle with a pit in each lobe of pelvic bone and with posterior lobe rather elongated and slender. Inner finrays of ventrals longer, the longest one more than 2.5 time the shortest. Anal always with 8-15 finrays. Caudal deeply forked, subequal. Tail shorter than one-third total length.

Key to Formosan Species of *Synodus*:

- 1a. Peritoneum white. Posterior laminar process of pelvics lobate and strong. Pyloric appendages more than 10.
- 2a: Lateral line scales of 60-64. Depth of caudal peduncle greater than eye diameter.
..... *Synodus variegatus*.
- 2b. Scales of lateral line 45-55. Caudal peduncle low, its depth slightly less than to more than eye diameter..... *Synodus fuscus*.
- 1b. Peritoneum black. Posterior laminar process of pelvics long and slender. Pyloric appendages less than 10. Scales of lateral line 49-55. Caudal peduncle low, slightly

less than to more than eye diameter.....*Synodus macrops*

Synodus variegatus (Lecépède)**

Salmo variegatus Lacepede, Hist. Nat. Poissons, vol. 5, p. 157, pl. 3, fig. 3, 1803; Ile De France.*

Saurus lucius Temminck et Schlegel, 1846, p. 232, pl. 106, fig. 1; Shimabara, Japan.

Saurus varius Günther, 1865, p. 395.

Synodus japonicus Jordan & Herre, 1907, p. 516; Wakanoura, Nagasaki, Japan.

Saurus variegatus Weber & De Beaufort, 1913, p. 147, fig. 54; Java, Sumatra; Baru; Nias; Singapore; Celebes; Sangi; Sulu; Archip; Ternate; Helmahera; Gebe; Batjan; Amboina; Binonka; Nusa laut; Banda; Goram; Tiur; New Guinea; Bali; Flores Strait; Philippines.

Synodus veriegatus Norman, 1935, p. 106; Dumaguete, Oriental Negros Province, Negros; many localities in the Indian and Pacific Oceans.....Okada & Matsubara, 1938, p. 54 (compiled).....Herre, 1953, p. 140 (references).....Schultz, 1953, p. 39, pl. 3, B; Bikini Atoll, Rongelap Atoll, Rongerik Atoll, Likiep Atoll, Guam.....Smith, 1953, p. 112, pl. 6, fig. 174; Southern Africa...Matsubara, 1955, p. 242 (compiled)...Kamohara, 1955, p. 2; Takara-shima, Tokara Islands, Japan.

Body cylindrical, long, fusiform. Head pointed, flattened dorsad, interorbital space concave. Eyes convex, profile above eyes distinctly convex. Snout broader than long. Jaws subequal, two rows of flat teeth on both jaws, sometimes visible laterally but never exposed. teeth on palatine in one band on each side, about 3 rows of teeth, inner row the strongest. No vomerine teeth. Nostrils in a pit and close together, anterior nostrils with a low rim becoming a pointed thin flap toward posterior edge. Head scaled behind occiput, on cheek and operculum, body scales of moderate size. Pectorals short, tip reaching behind origin of ventral fin. Inner ventral finrays longer, the longest one more than 2.5 times longer than outer-most one. Dorsal finrays gradually decreasing in length posteriorly. Caudal fin deeply forked, subequal. Tail shorter than one-third total length.

Other morphological measurements and counts are listed in Table I.

Color in formalin brownish gray above, yellowish white below. About nine dark gray cross-bands crossing on dorsal half of body, these broken on lower side and forming 8 or 9 blotches running along the side just below lateral line. Chin with 3 dark cross-bands, head irregularly spotted. Dorsal and pectorals with dark spots in vertical series, adipose fin brown, irregularly spotted, other fins hyaline. Larva transparent in life, yellowish white in formalin. With 10 rhomboid black marks along side of body in the midline the last one very large, almost covering caudal base. Two continuous blackish bands crossing dorsal midline or body; one at end of dorsal fin, the other through adipose fin. About 7 or 8 obscure marks crossing dorsal midline of body. Chin with three bands, but only three black spots visible along lower jaw. 6 blackish patches along mid-line of ventral profile. A band crossing caudal fin, other fins hyaline.

17 specimens from 51.2-235 mm. in total length were examined. This species is not very common here, yet larvae and young ones are often caught in shallow waters along the coastal region. One larva and several young specimens were collected by the senior author from Kaohsiung in 1960. Large specimens were collected from Taipei, Keelung, and Kaohsiung markets.

Remarks: The color pattern is remarkably different from that of other species of the same genus. Scales from anterior part of the lateral line have at least two radii which divide the anterior margin into three parts a median lobe and two lateral lobes, with the former exceedingly larger than the latter lobes.

Synodus fuscus Tanaka**

Synodus fuscus Tanaka, 1917, p. 37;.....Okada & Matsubara, 1938, p. 54 (compiled).....Schultz, 1953, p. 31 (references).....Matsubara, 1955, p. 242 (compiled).

Body long, subcylindrical, slightly depressed anteriorly. Head pointed and strongly depressed, its breadth two times greater than its height. Both jaws subequal. Teeth on both jaws in two or three rows, innermost row strongest, with the inner-most row of upper jaw partially covering lower jaw and exposed laterally. One band of palatine teeth on each side, each with three rows of minute teeth, the inner-most one of these the largest. Vomerine teeth absent. Nostrils separated, both in a pit, a thin flap behind edge of anterior ones. Cheek, operculum and occiput scaled, other part of head naked. Body covered with moderately sized scales. Pectorals short, their tips reaching behind origin of ventral fin. Inner finrays of ventrals longer, the longest finray three times longer than the outer-most one. Dorsal finrays decreasing in length posteriorly. Length from anal origin to tip of caudal fin less than one-third the total length. Caudal deeply forked, lobes subequal. Peritoneum brownish, Pyloric caeca 13.

Other morphological measurements and counts are listed in Table I.

Color in formalin brown dorsad, yellow ventrad. Pocket of each scale of dorsal half of body with tiny blackish marginal pigmented spot, middle portion of each scale dark, and forming about 6 longitudinal but obscure lines. 9 dark, but not very significant cross-bands along dorsal midline of body. Dorsal fin with dark spots, adipose fin dark, edge of caudal fin, pectoral base, and area near base of pectorals, suffused with black pigmentation. Other fins hyaline.

Taiwan Fishery Research Institute, Collection No. 3416 (190.3 mm) in total length was collected from Kaohsiung on January 1, 1958, The other specimen from the same Institute (Collection No. 4246, 3006 mm. in total length) was collected from Formosan Bank on January 9, 1960. These two specimens were caught by means of otter trawl and collected by Yang for the first time in Formosa.

Synodus Macrops Tanaka**

Synodus macrops Tanaka, 1917, p. 37;.....Okada & Matsubara, 1938, p. 54 (compiled).....Schultz, 1953, p. 31 references Matsubara, 1955, p. 242 (compiled).

Body long, slightly depressed, cross-section narly oblong. Head pointed, upper jaw extending forward, profile above snout strongly concave, lower jaw slightly shorter than upper jaw. Teeth not exposed laterally, several rows on both jaws, the inner ones strongest. Palatine teeth in a band on each side, composed of two rows anteriorly, becoming a single row posteriorly, the inner row the stronger. Nostrils separated, a pointed thin flap with serrated border at posterior adge of anterior nostrils. Eyes large, adpose eye-lid lacking. Scales on cheek, operculum, and occiput, other part of head naked. Body covered with moderately sized scales. Tip of pectoral fin reaching behind origin of ventrals. Inner finrays of ventrals longer, the longest finray about three times longer than shortest outer-most one. Dorsal decreasing in length psoteri- orly, but first ray never elongate. Length from anal origin to tip of caudal less than one-third the total length. Caudal fin deeply forked. lobes subequal. Peritoneum black- ish, pyloric caeca 3.

Other morphological measurements and counts are listed in Table I.

Color in formalin yellowish brown, four dark marks appearing X or T shapes along the midline of each side of body. All fins hyaline.

One large specimen, 201.5 mm. in total length was collected from a Taipei market, while 4 small specimens, 80.4 to 130.1mm in total length, were collected from Formosan Bank by means of bottom trawling. These four small specimens were collected by Yang. Remarks: The T or X-shaped dark brown marks along the median line of the side of body are present in all five of our specimens. Scales from the anterior part of the lateral line have no distinguishable radii, which in the other two species of the same genus, these same scales have at least two radii in scales from the same part. In *fuscus*, however, the three lobes.....one median and two lateral lobes.....formed by the two radii present, are subequal in scales from this same area; this character, in addition to the coloration, can be used it distinguish this species from *variegatus*.

Table

Items	Species			
	<i>Saurida undosquamis</i>	<i>Saurida tumbil</i>	<i>Saurida elongata</i>	<i>Saurida gracilis</i>
D	11~12(12)	11~12(12)	11~12(12)	11
A	11~12(11)	11~12(11)	11~12(11)	9~10
P	14~15(14)	14~15(14)	14~15(15)	12~13
V	9	9	9	9
Scale in lateral line	48~53(51)	56~60(58)	62~66(65)	50~52
Predorsal Scale	17~20(18)	20~23(21)	23~26(25)	16~17
Head into T. L	4.81~5.50(4.88~5.30)	4.74~5.45(4.81~5.27)	4.10~5.34(4.57~5.11)	4.71
Head into S. L	3.91~4.50(3.97~4.31)	3.82~4.42(3.85~4.23)	3.93~4.32(4.00~4.26)	3.67
Eye into H.	4.93~5.96(5.12~5.74)	4.61~5.92(4.81~5.59)	5.19~6.23(5.30~6.16)	4.78
Snout into H.	4.01~4.60(4.15~4.49)	3.52~4.56(3.78~4.42)	3.05~4.58(3.58~4.32)	4.09
Interorbital length into H.	4.09~6.33(4.69~6.15)	4.05~5.95(4.81~5.03)	4.37~5.50(4.83~5.39)	4.83
Postorbital length into H.	1.32~1.74(1.60~1.66)	1.29~1.74(1.51~1.71)	1.07~1.78(1.54~1.74)	1.70
Longest dorsal ray into H.	1.05~1.55(1.19~1.43)	0.65~1.31(0.88~1.24)	1.26~1.60(1.36~1.56)	1.27
Longest anal ray into H.	1.98~2.89(2.18~2.82)	2.00~2.97(2.40~2.84)	2.31~3.05(2.39~2.87)	2.65
Longest Pectoral ray into H.	1.30~1.94(1.47~1.89)	1.55~2.01(1.62~1.90)	1.53~2.25(1.71~2.23)	2.22
Longest Ventral ray into H.	1.32~1.58(1.46~1.50)	1.49~1.79(1.52~1.76)	1.07~1.45(1.19~1.25)	1.46
Depth of caudal peduncle into H.	3.33~4.49(3.61~4.33)	3.06~4.01(3.45~3.87)	3.70~4.37(3.89~4.29)	3.93

1

Trachinocephalus myops	Synodus variegatus	Synodus macrops	Synodus fuscus
12~13(12)	12	10~11	9
15~16(15)	8~ 9(8)	8~ 9	9
12	12~13(12)	11~12	12
8	8	8	8
55~58	60~64	52~56	49~55
18~19	22~24	15	17~18
3.89~ 4.71(4.06~ 4.52)	3.63~ 4.31(3.64~ 4.14)	4.25~ 5.42(4.35~ 5.29)	4.18~ 4.31
3.19~ 3.81(3.21~ 3.63)	3.18~ 3.62(3.24~ 3.52)	3.40~ 3.84(3.46~ 3.80)	3.51~ 3.86
4.47~ 5.97(5.01~ 5.91)	4.38~ 6.69(4.61~ 6.57)	3.52~ 4.38(3.66~ 4.34)	4.64~ 5.08
7.00~ 8.54(7.47~ 8.21)	3.80~ 4.84(4.07~ 4.69)	3.79~ 4.47(3.84~ 4.42)	3.60~ 3.81
7.29~11.93(8.43~10.17)	6.59~11.80(6.76~11.38)	12.25~17.14(12.41~16.11)	8.85~10.72
1.07~ 1.54(1.19~ 1.43)	1.47~ 1.62(1.53~ 1.57)	1.79~ 1.86(1.80~ 1.86)	1.67~ 1.73
1.25~ 2.00(1.34~ 1.78)	1.95~ 2.38(1.99~ 2.37)	1.68~ 1.90(1.68~ 1.86)	1.92~ 1.97
3.00~ 4.34(3.35~ 4.21)	3.74~ 4.50(3.91~ 4.41)	3.07~ 4.08(3.25~ 4.01)	3.87~ 4.13
2.21~ 2.91(2.47~ 2.85)	2.92~ 3.41(3.02~ 3.27)	2.34~ 2.72(2.38~ 2.70)	2.69~ 2.72
1.02~ 1.33(1.08~ 1.26)	1.31~ 1.55(1.34~ 1.40)	1.20~ 1.54(1.20~ 1.46)	1.34~ 1.41
3.80~ 4.69(3.93~ 4.39)	5.33~ 6.21(5.40~ 6.10)	5.73~ 6.21(5.90~ 6.16)	6.05~ 6.88

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Explanation of Plates and Figures.

Plate I

Figure a. *Saurida elongata* (Temminck & Schlegel)

Figure b₁. *Saurida tumbil* with moderate pectoral fins their tips reaching behind origin of ventral fins.

Plate II

Figure b₂. *Saurida tumbil* with short pectoral fins their tips not quite reaching origin of ventral fins.

Plate II

Figure c. *Saurida undosquamis* (Richardson)Figure d. *Saurida gracilis* (Quoy & Gaimard)

Plate III.

Figure e. *Trachinocephalus myops* (Schneider)Figure f₁. A young of *Synodus variegatus* (Lacepede)Figure f₂. An adult of *Synodus variegatus* (Lacepede)

Plate IV

Figure g. *Synodus fuscus* TanakaFigure h. *Synodus macrops* Tanaka

Plate I

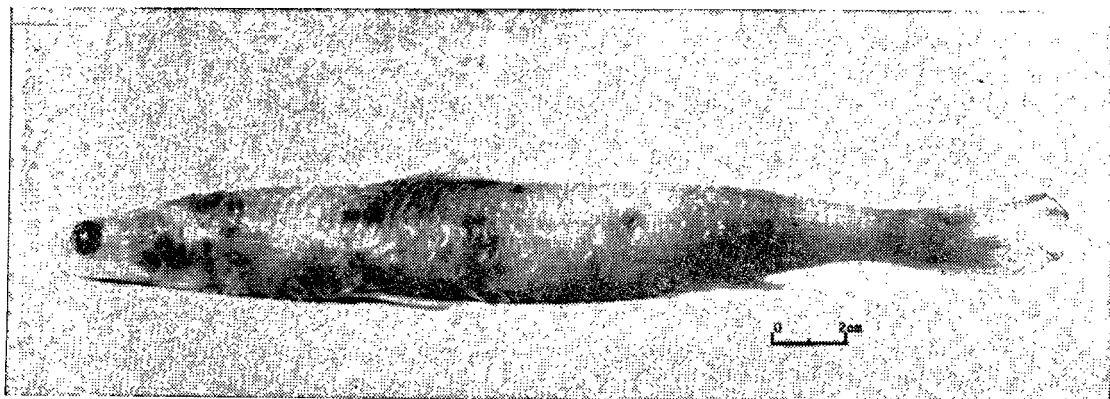


Figure a.

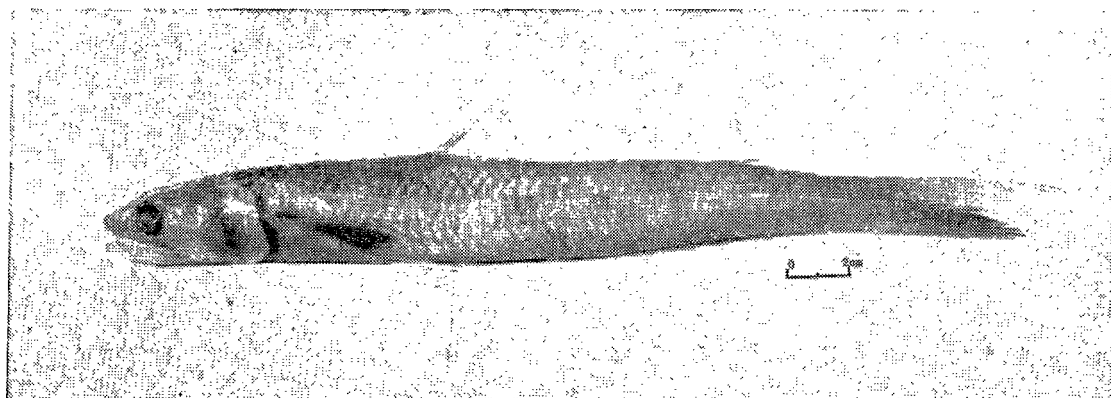


Figure b1.

Plate II

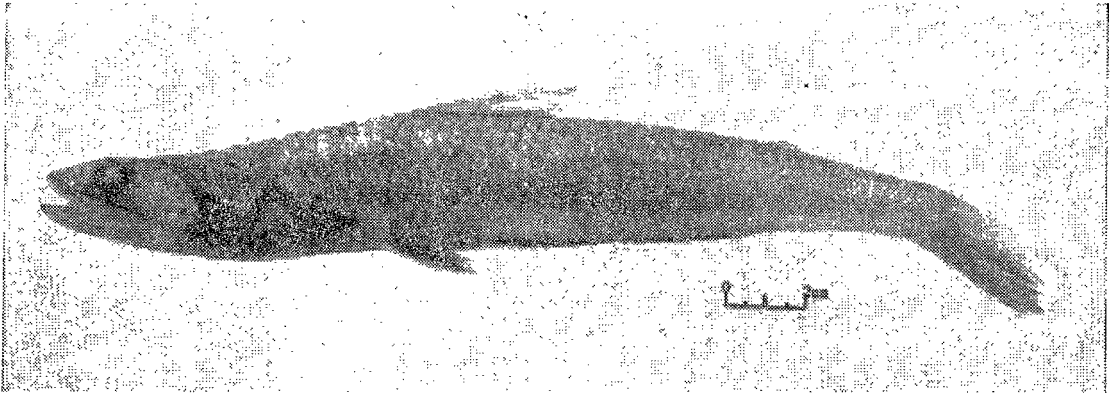


Figure b2.

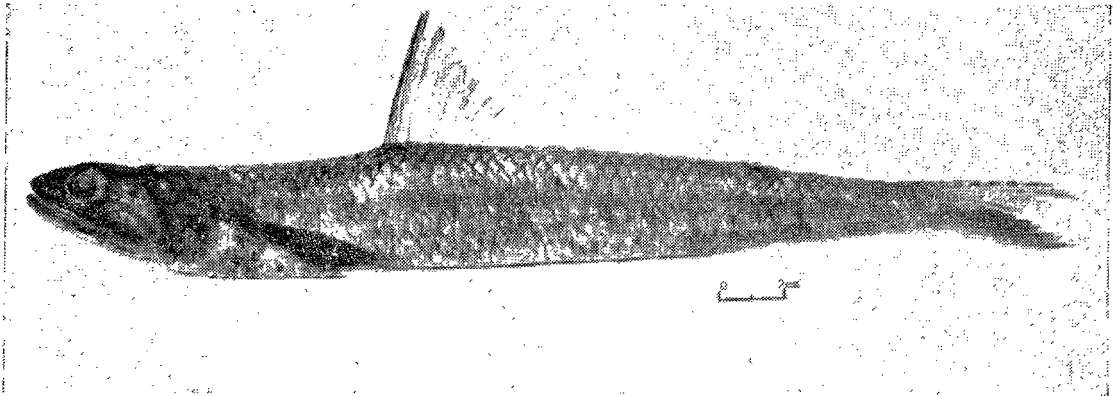


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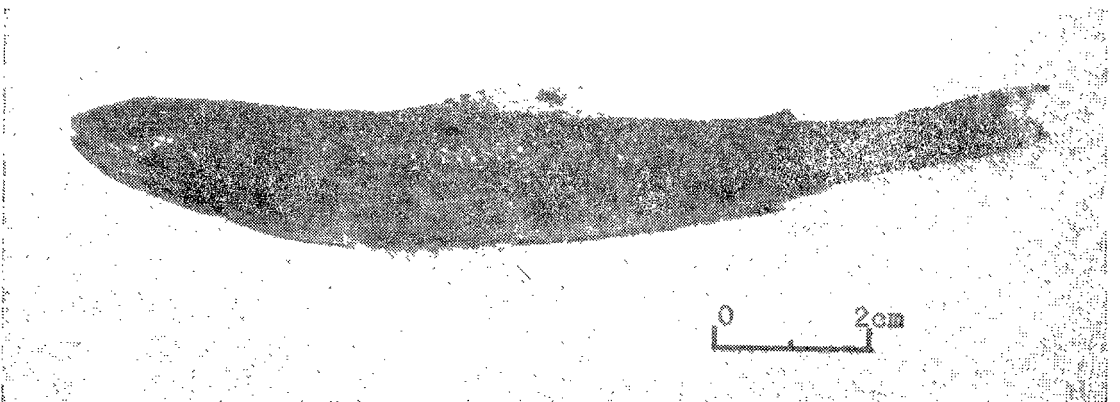


Figure d.

Plate III

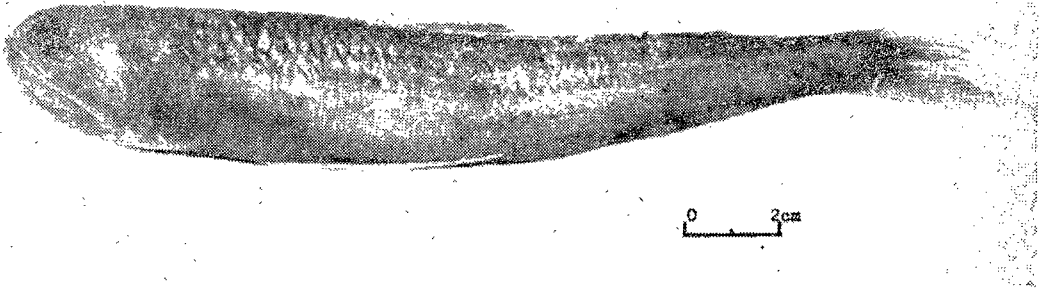


Figure e.

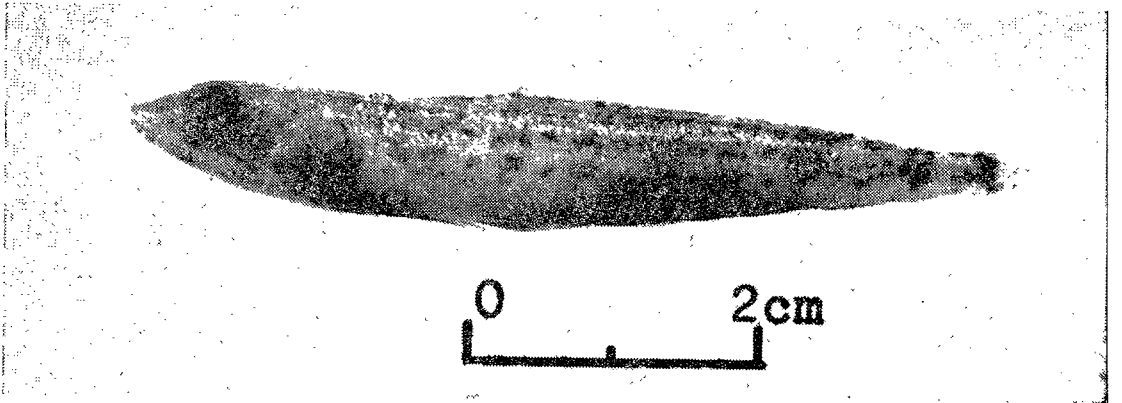


Figure f1.

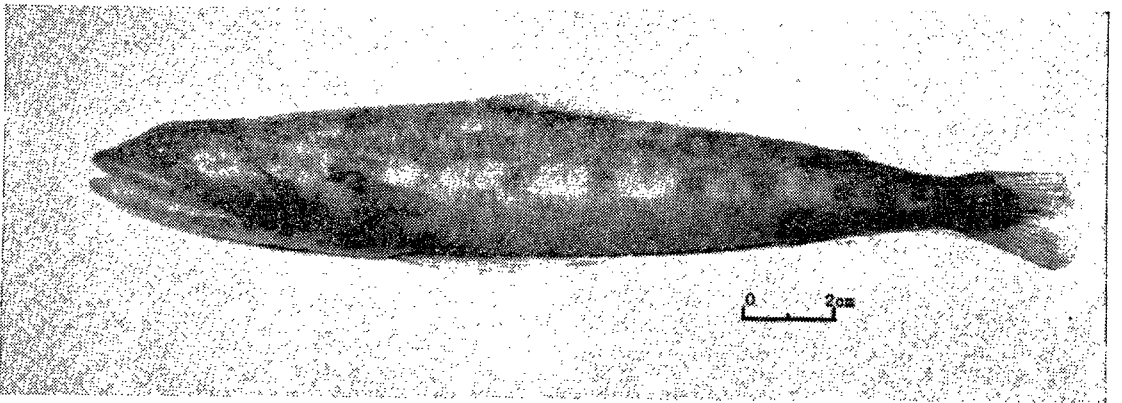


Figure f2.

Plate IV

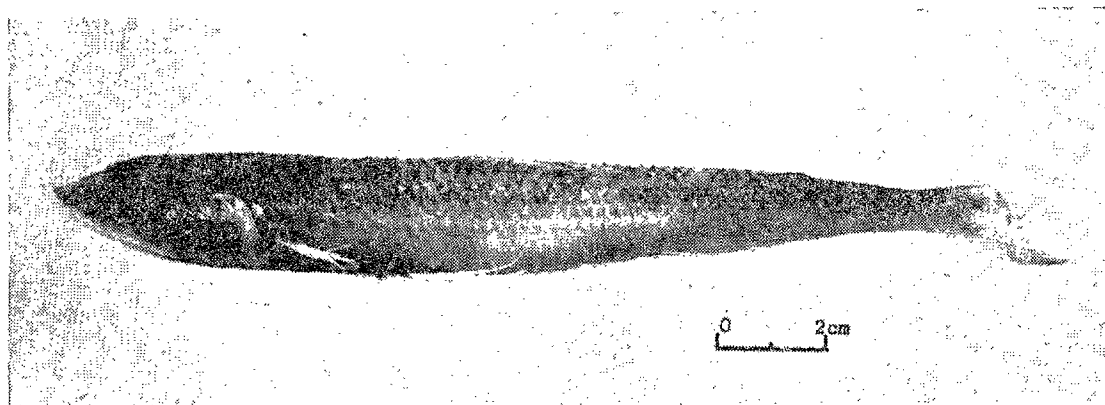


Figure g.

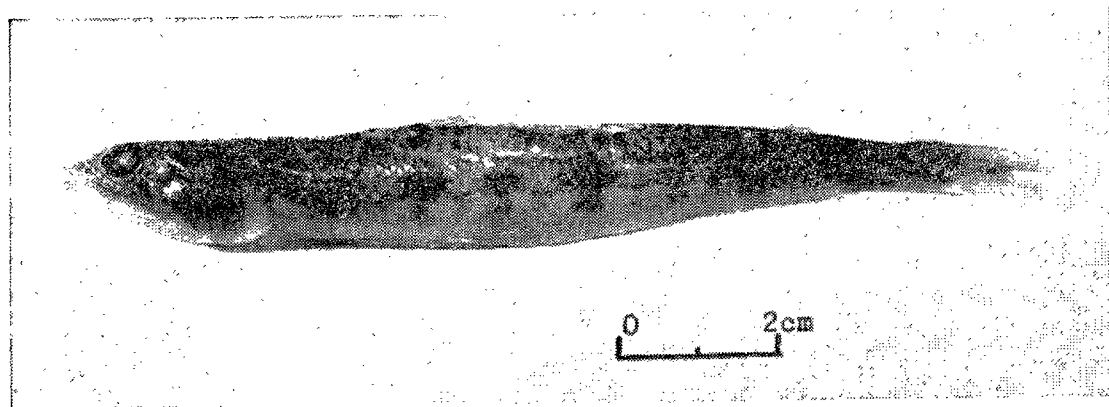


Figure h.

臺灣產合齒科魚類的研究

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合齒科魚類（俗稱狗母）為臺灣重要經濟魚類之一，但至今缺乏有系統的研究報告。筆者等自民國四十九年秋以來，經過不斷的採集以及仔細的觀察，共獲該魚類八種，其中三種為臺灣未曾記載者（有*者）。經筆者等研究發現，除外形和骨骼等之特徵外，魚體上各部位之鱗片形態，如其溝數，缺刻形狀及構成前緣之葉數和形狀等，對本科魚類分類及系統發生上均有重要的價值。本文僅先討論本科魚類的分類，至於鱗片的形態以其對分類及系統發生的價值的探討，則將於另文發表。