

Notes on the Fishes of the Genus *Siphamia* (Apogonidae), with a Record of *S. versicolor* from the Ryukyu Islands

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Specimens of a small apogonid fish referable to *Siphamia versicolor*, new to the fauna of the Ryukyu Is., were compared with the types of *Siphama versicolor*, *S. elongata*, *S. cuprea*, *S. fuscolineata* and *S. majimai*. In the course of the study, it was found necessary to revise the former classification of *Siphamia* which had been chiefly based on superficial characters such as the color pattern. The present paper attempts to analyze the nature and origin of the differences which exist among the sympatric as well as the allopatric individuals and to determine to what extent the differences are taxonomically essential.

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Genus *Siphamia*, "Hikari-ishimochi Zoku", new Japanese name

Siphamia WEBER, 1909, p. 168. Type by monotypy, *Siphamia tubifer* WEBER. (For synonymy see SCHULTZ, 1940, p. 408*).

This genus is well characterized among the family Apogonidae by the presence of the longitudinal muscle bundles along each side of the anal base**.

* SMITH (1955) recognized *Adenapogon* and *Scopelapogon* as distinct from *Siphamia*.

** These bundles were termed "subcutanen Röhren" by WEBER (1913, p. 244). He regarded them as hollow tubes communicating with the air bladder and hydrostatic in function. McCULLOCH (1921, p. 132) and FOWLER and BEAN (1930, p. 142) used the term "silvery canal". LACHNER (1953, p. 412) described them as "silvery ventral gland". Recently IWAI (1958) revealed that they are neither hollow tubes nor glands, but longitudinal muscle bundle lying just beneath the dermis, and suggested that they may form an element of the luminous system and serve to diffuse the light from the luminous organ.

Table 1. Comparison of characters of three species of *Siphamia*.

Species	<i>versicolor</i>	<i>majimai</i>	<i>elongata</i>
First dorsal fin	VII (rarely VI)	VI	VII
Predorsal rayless pterygiophores	1	1	2
Striae on longitudinal muscle bundle	present	present	absent
Branchial arch	normal; sometimes expanded laterally	projected antero-ventrally in adults	normal
Duct communicating with alimentary canal and luminous organ	present	present	?
Distribution	Philippines, Marshalls and Ryukyus	Amami I. (a northern island of Ryukyus)	Philippines
The three species listed above have the following characters in common with each other: vertebrae 24 (10+14, urostyle counted as one); margin of preopercle serrated; palatine teeth present; pseudobranchiae present; lateral line complete.			

Siphamia versicolor (SMITH and RADCLIFFE)

“Hikari-ishimochi”, new Japanese name

Amia versicolor SMITH and RADCLIFFE, in RADCLIFFE 1911, p. 257, fig. 3 (*holotype*, Cataingan Bay, Masbate I., Philippines; *paratypes*, various localities of Philippines*).—FOWLER, 1918, p. 63 (listed).—FOWLER, 1927, p. 273 (listed).

Siphamia versicolor, FOWLER and BEAN, 1930, p. 142 (redescription on types).—HERRE, 1933, p. 8 (Dumaguete, Negros I., Philippines; faunal record).—HERRE, 1934, p. 42 (Cebu, Cebu I. and Dumaguete, Negros I., Philippines; faunal record).—HERRE, 1953, p. 325 (listed).—LACHNER, 1953, p. 418, fig. 69 (key, note).—IWAI, 1958, p. 267, figs. 1 and 2 (luminous organ). *Siphamia cuprea* LACHNER, 1953, p. 423, fig. 72 (*holotype*, Cataingan Bay, Masbate I., Philippines; *paratypes*, various localities of Philippines).

Siphamia fuscolineata LACHNER, 1953, p. 425, fig. 73 (*holotype*, Bikini Lagoon; *paratypes*, Bikini Lagoon and off Bikini I.).

Siphamia ovalis LACHNER, 1953, p. 427, fig. 74 (*holotype*, Bubuan I., Philippines; *paratypes*, Bubuan I. and Sirun I., Philippines).

Materials studied:

Paratype of *S. versicolor*; one of U. S. Nat. Mus. 112269, 30.5 mm in standard length (*Albatross* Collection, taken together with holotype; see FOWLER and BEAN, 1930, p. 143).

Paratype of *S. cuprea*; one of U. S. Nat. Mus. 112094, 22 mm in standard length (*Albatross* Collection, taken together with holotype; see LACHNER, 1953, p. 423).

Paratypes of *S. fuscolineata*; three of U. S. Nat. Mus. 142281, 20.5, 21 and 26 mm in standard

* Among the original paratypes the specimens which were taken by seine at Canmahara Bay (between Burias and Luzon), those taken by dredge in deep water, and some of those taken with lights are referable to *S. elongata* or *S. argentea*. For this reason, they should be excluded from the paratypes of *S. versicolor*.

length (taken together with holotype; see LACHNER, 1953, p. 425).
Zool. Inst. Univ. Tokyo 52308; 106 specimens, 14 to 33 mm in standard length; taken from subtidal zone of coral reefs, at Gushichan V., Okinawa I., Ryukyu Is.; July, 1963. These specimens, which had been quite the same in habit and habitat when living, were collected within a period of a few days in a limited area.

Dorsal usually VII—I, 9; anal usually II, 8; pored scales in lateral line to caudal base 20 to 23. Frequency distributions of the specimens of the Ryukyu Is. are given in Table 2. Vertebrae constantly 24 (10+14, urostyle counted as one).

Table 2. Frequency distributions of the fin-ray and scale counts in specimens of *S. versicolor* of the Ryukyu Is. (Zool. Inst. Univ. Tokyo 52308).

Dorsal fin	VI-I, 9	VII-I, 8	VII-I, 9	?
Number of individuals	5	4	94	3
Anal fin	II, 7	II, 8	II, 9	I?, 8
Number of individuals	2	98	5	1
Lateral line scales	20	21	22	23
Number of individuals	1	8	9	1

Luminous organ. The structure of the luminous organ agrees with IWA1's description (1958), except for the presence of the duct which connects the organ with the intestine*.

Color when alive. The body is uniformly dark reddish brown; the vertical fins are rosy. When the fish is frightened, the ground color turns light and longitudinal stripes appear.

Color in formalin. The coloration of the specimens of the Ryukyu Is. is subject to marked variation. The extreme color patterns are: (1) the body is light-colored and speckled with round black dots (each dot is represented by a single large melanophore); and (2) the body is uniformly dark (as a result of the dispersal of the pigment granules in each large melanophore). The specimens with intermediate color patterns have longitudinal dark stripes of various widths (Fig. 1). The diameter of the melanophores on the body proper may reach 140 μ (usually 90 to 100 μ) excluding the dendritic branches. Fine vertical striae are present on the ventral longitudinal muscle bundle. Each stria is composed of a uniserial chain of small melanophores which are 20 to 60 μ in diameter excluding the dendritic branches (Fig. 2A).

Habitat, habit, sexual differences, etc. The individuals of the Ryukyu Is. inhabit the subtidal zone of coral reefs. They are only found living among the spines of *Diadema*, a long-spined sea urchin, which lies in quiet water less than 5 m in depth.

* Such a duct has been reported in *S. majimai* by IWA1 (1959).

The males and females more than 20 mm in standard length have matured gonads. Like the majority of apogonid fishes, the adult males protect the eggs, which are about 0.8 mm in diameter, in their mouths. Translucent gelatinous substance is attached to mass of the eggs, which may have to do with the buccal incubation.

The male has a conical papilla just behind the anus. No other marked sexual differences can be observed in form or color. The lateral expansion of the mouth, which is found in some of the preserved adult specimens, does not seem to be connected with the buccal incubation of eggs by the male, because the gonadal examination revealed that this deformation occurs irrespective of sex.

Distribution. The Philippines, Marshalls and Ryukyus.

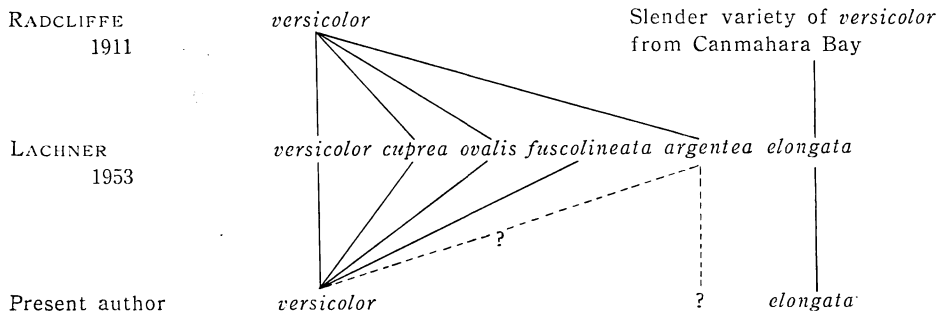
Discussion. As shown in Figure 1, the widths of the dark longitudinal bands represent those of the areas where the pigment granules in the melanophores are dispersed. The melanophores of the dark specimens are not more densely distributed than those of the light ones, nor are those on the dark zone of the striped specimens more numerous than those on the light zone (the distribution density of melanophores is about 400/cm² in all cases). The variation in the widths of stripes in preserved specimens is caused by the different states of the melanophores at the time of fixation. It is well known that when a fish dies from suffocation it becomes lighter, because of the concentration of the pigment granules in the melanophores. Furthermore, the living individuals are uniformly dark, and yet when they are frightened the body suddenly becomes light and simultaneously the stripes appear. This phenomenon can possibly be ascribed to differences in the innervation and/or responsiveness of the melanophores on the dark zones from those on the light zones. In spite of the various color patterns, all the specimens from the Ryukyu Is. (Zool. Inst. Univ. Tokyo 52308) belong to a single species, *Siphamia versicolor*.

From the paratypes of *S. versicolor*, *S. cuprea* and *S. fuscolineata*, which were examined, and the original description of *S. ovalis*, it is clear that the character which distinguishes them from each other is the respective color pattern; and each color pattern of the above forms can be seen among the specimens of the Ryukyu Is. Now, it may be reasonable to conclude that the differences of color pattern in the four forms mentioned above cannot be specific ones. The paratypes of *S. fuscolineata* of the Marshall Is. are different from the specimens of the Philippines (the paratypes of *S. versicolor* and *S. cuprea*) and those of the Ryukyus in having a more pointed snout. Careful statistical studies of a large number of specimens from various localities may demonstrate the existence of several geographically distinct races. On the other hand, *S. elongata* is saliently distinct from *S. versicolor*; the differences are shown in Table 1 and the description below. Unfortunately I have not examined the specimens of *S. argentea*; judging from the description, it is closely allied to, or the same as, *S. versicolor*.

S. mossambica SMITH (1955) from East Africa also seems to be closely related to *S. versicolor*. SMITH made no attempt to differentiate his new species from other

species of *Siphamia*, but the following accounts were made in his original description: "...a stained and cleared specimen, only 24 mm in length, which shows 10+15 vertebrae,...There are nine simple tubules in the lateral line, ending below the front of the second dorsal, and no clear indication of any lateral line beyond that point, except one or two rudimentary tubules on middle of peduncle....Pseudo-branchiae apparently absent."

The different ways in which three authors have treated the *versicolor* complex can be summarized as follows:



Siphamia majimai MATSUBARA and IWAI

"Majima-kuro-ishimochi"

Siphamia majimai MATSUBARA and IWAI, 1958, p. 603, figs. 1 to 3 (Amami I.)—IWAI, 1959, p. 545, figs. 1 and 2, pl. 7 (luminous organ).

Materials studied. **Holotype**; Mar. Biol. Inst. Kyoto Univ. 1746. **Paratypes**; Mar. Biol. Inst. Kyoto Univ. 1747. For the data of the specimens see MATSUBARA and IWAI (1958, p. 603).

Dorsal VI-I, 9; and II, 8; pored scales in lateral line to caudal base 23 or 24; vertebrae 24 (10+14, urostyle counted as one).

I am able to confirm the accuracy of the original description, except for the position of the anterior nostril which is actually nearer to the tip of the snout than to the eye. "Vertebrae 23" in the original description might have been determined without counting the urostyle as one; the radiographs of the holotype and the all paratypes show the vertebrae to be constantly 24 in number when the urostyle is counted as one.

Fine vertical striae made up of uniserial small melanophores are present on the ventral longitudinal muscle bundle. In some specimens the pigment granules of the melanophores of striae are fully dispersed and, in consequence, the ventral longitudinal muscle bundle is uniformly dark.

Distribution. Amami I., a northern island of the Ryukyus.

Siphamia elongata LACHNER, 1953, p. 419, fig. 70 (*holotype*, Canmahara Bay, between Burias and Luzon, Philippines; *paratypes*, Canmahara Bay, Jolo and Sulu Archipel., Mindanao Sea, Philippines).

(The elongate and spindle-shaped form of *S. versicolor* from Canmahara Bay, Philippines, RADCLIFFE, 1911, p. 258).

Materials studied. Paratype of *S. elongata*; one of U. S. Nat. Mus. 112099, 25.5 mm in standard length (*Albatross* Collection, taken together with the holotype; see LACHNER, 1953, p. 425).

Dorsal VII-I, 9; anal II, 8; scales in lateral line to caudal base 22 to 23; vertebrae 24 (10+14, urostyle counted as one).

This species is saliently distinct from the preceding two species in having two predorsal rayless pterygiophores, and in the absence of fine vertical striae on the ventral longitudinal muscle bundle (absence of the uniserial small melanophores, Fig. 2B).

Distribution. The Philippines.

1. **First dorsal fin and its fin-ray support elements** (Fig. 3).

Although the number and arrangement of the fin-ray support elements are quite the same in three species, *S. majimai* differs from *S. elongata* and the majority of *S. versicolor* in having six spines in the first dorsal fin instead of seven. The difference in the numbers of spines in the first dorsal fin is due to the first pterygiophore of the dorsal fin, which bears only one spine in *S. majimai* and rarely in *S. versicolor* (less than 5%), while it bears two spines in *S. elongata* and in the majority of *S. versicolor*. Two predorsal rayless pterygiophores are present in *S. elongata*; the anterior one is in front of the neural spine of the first vertebra, and the posterior one between the neural spines of the first and second vertebrae. In *S. versicolor* and *S. majimai*, the predorsal rayless pterygiophore is single, and corresponds in position to the anterior one of *S. elongata*. The relationships between the dorsal fin-rays and their supporting elements can be expressed as follows, by a formula modified from that of SMITH and BAILEY (1961), in which each antecedent zero indicates one predorsal, and the succeeding numeral shows the number of spines borne by the first pterygiophore:

<i>Siphamia majimai</i>	0 - - - - 1 -
<i>S. versicolor</i>	0 - - - - 2 -
	rarely 0 - - - - 1 -
<i>S. elongata</i>	0 - 0 - - - 2 -
<i>(Apogon semilineatus</i>	0 - 0 - 0 - 2 -)

2. **Facial bones** (Fig. 4).

Teeth of both jaws are larger and stouter in *versicolor* than in *majimai*. There

are a few serrations on the edge of the interopercle in *versicolor*, but these are absent in *majimai*.

3. Branchial and hyoid arches (Fig. 5).

The most outstanding feature of *S. majimai* is that there is a wide interspace between the basihyal (glossohyal) and the first basibranchial. The presence of the interspace brings about a forward elongation of the branchial arch, and the tip of the arch forms the antero-ventral projection of the chin, which gives the characteristic physiognomy to the adult specimens of this species (Fig. 3B). In *S. versicolor*, the basihyal (glossohyal) is just in front of the following branchial components, as is usually seen in many other fishes.

The spicules on the branchial bones and gill rakers are stouter and less densely distributed in *versicolor* than in *majimai*. There is a fairly well developed gill raker on the first hypobranchial in *versicolor*, while there is none in *majimai*. The outer angle of the first hypobranchial is sharply pointed in *versicolor*, but this is not the case in *majimai*. The basibranchials of *versicolor* are slenderer in shape than those of *majimai*. The number of the branchiostegals is usually seven in both species (five on the ceratohyal, two on the epihyal), although originally it was described and figured as eight (six on the ceratohyal, two on the epihyal) in *majimai* and very exceptionally eight branchiostegals are seen in *versicolor* of the Ryukyus.

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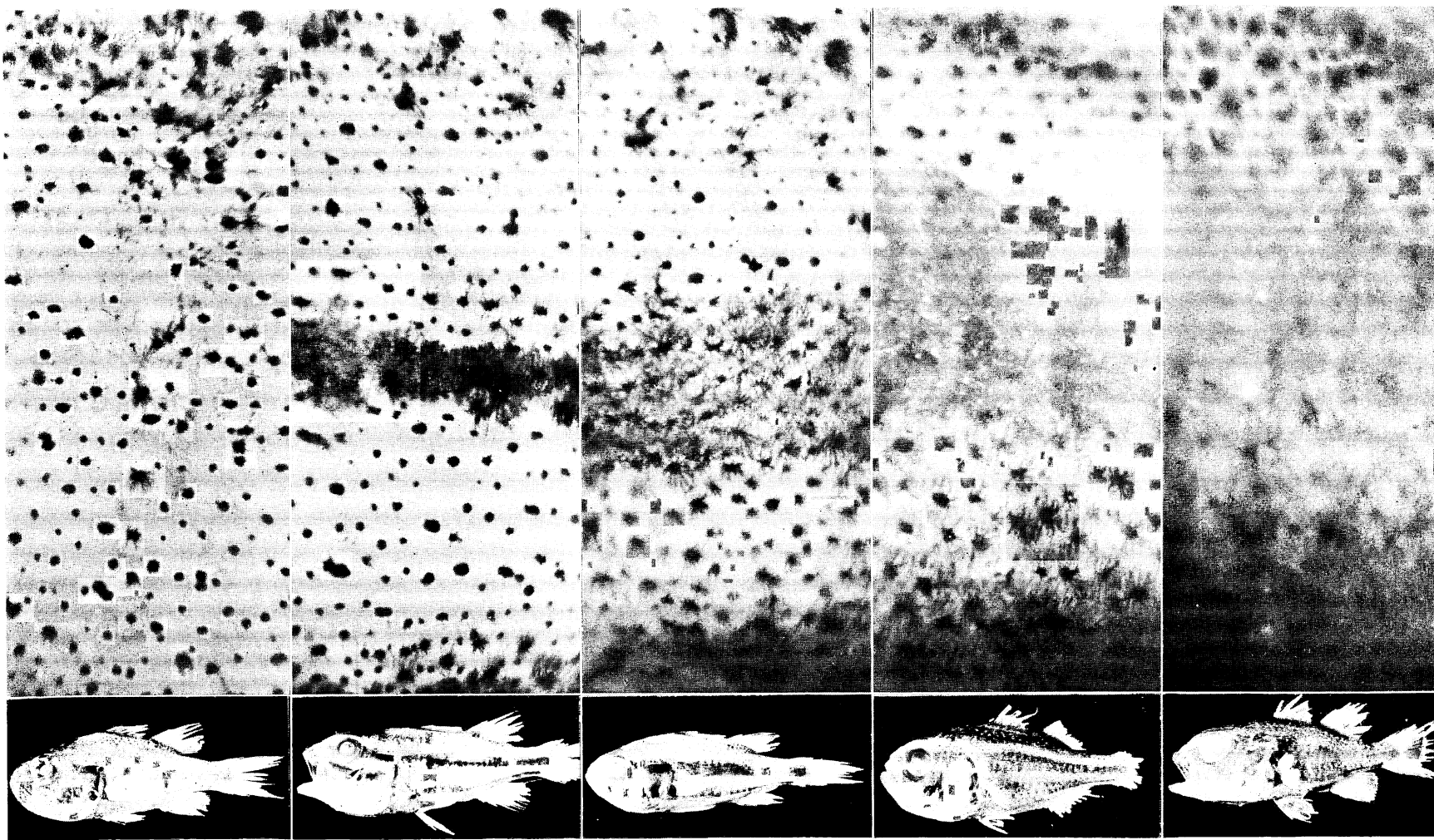


Fig. 1. Magnified narrow vertical areas between the origin of the second dorsal fin and the origin of the anal fin of five specimens (below) of *Siphamia versicolor* of the Ryukyu Is. (Zool. Inst. 52308), showing that the width of the dark band is that of the longitudinal area where the pigment granules of the melanophores are dispersed.

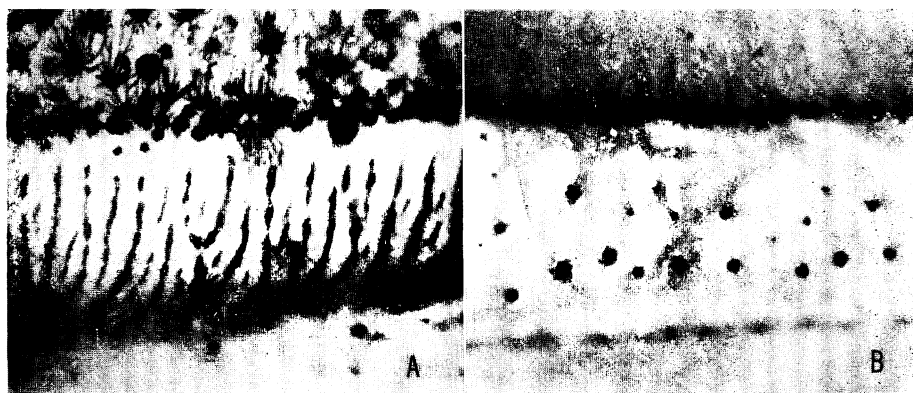


Fig. 2. Melanophores on the longitudinal muscle bundle.

A, *Siphamia versicolor* (presence of striae, each made up of uniserial small melanophores). B, *S. elongata* (absence of striae).

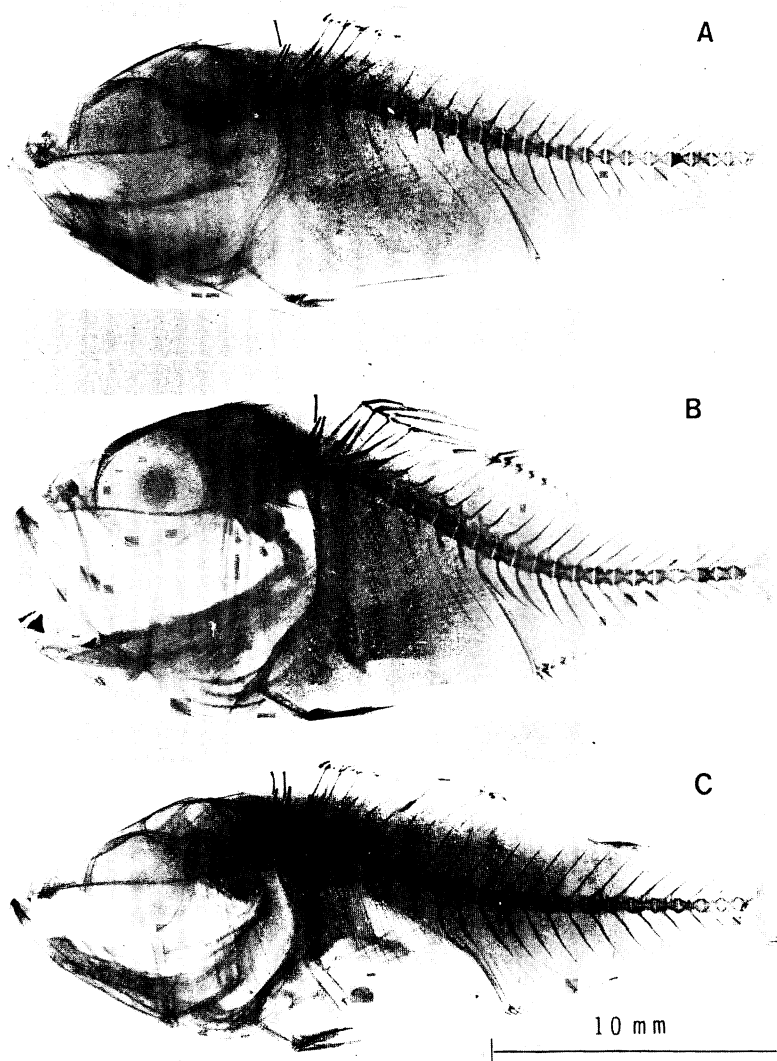


Fig. 3. Radiographs of 3 species of *Siphamia*.

A, *S. versicolor* (one of Zool. Inst. Univ. Tokyo 52308). B, *S. majimai* (paratype; one of Mar. Biol. Inst., Kyoto Univ. 1747). C, *S. elongata* (paratype; one of U. S. Nat. Mus. 112099). The predorsal rayless pterygiophores, 1st two neural spines and 1st dorsal spine are shaded black to emphasize the differences among the species. In B, the basihyal (glossohyal), dorsal hypohyal and 1st basibranchial are also shaded black.

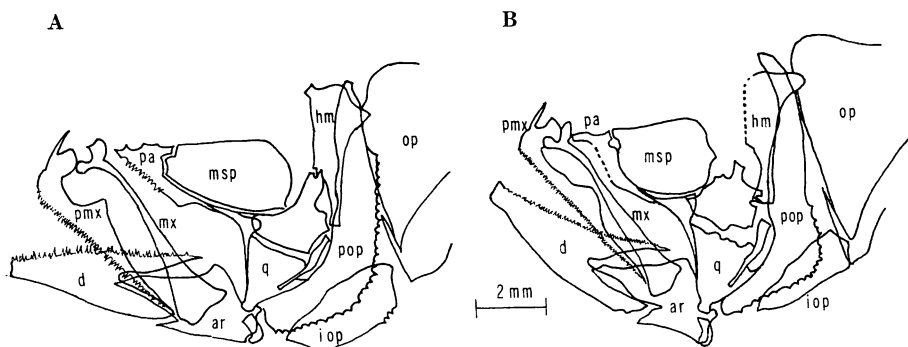


Fig. 4. Facial bones of 2 species of *Siphamia*.

A, *S. versicolor* (one of Zool. Inst. Univ. Tokyo 52308, standard length 25.5 mm). **B**, *S. majimai* (paratype; one of Mar. Biol. Inst. Kyoto Univ. 1747, standard length 22.5 mm). *ar*, articular; *d*, dentary; *hm*, hyomandibular; *iop*, interopercle; *msp*, mesopterygoid; *op*, opercle; *pa*, palatine; *pmx*, premaxillary; *pop*, preopercle; *q*, quadrate.

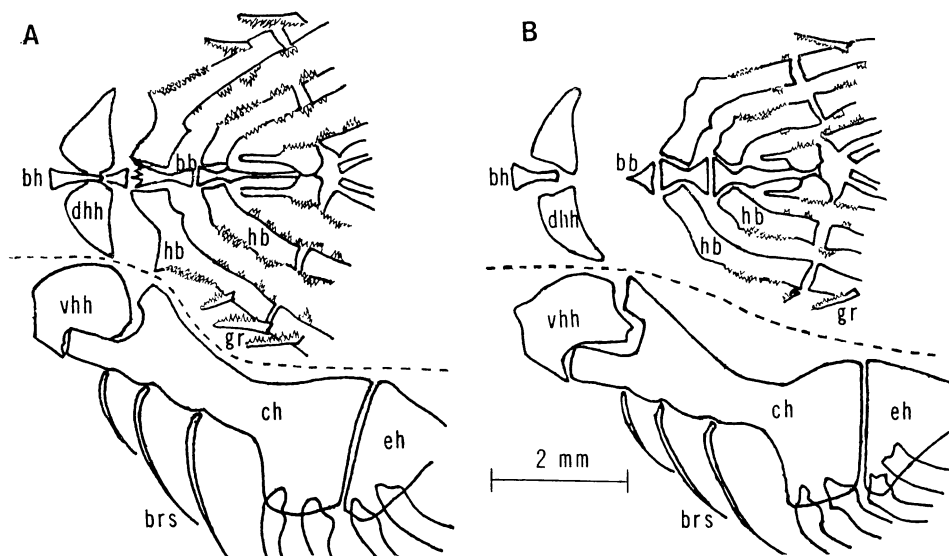


Fig. 5. Dorsal view of the branchial arch (above) and lateral view of the hyoid arch (below) of 2 species of *Siphamia*.

A, *S. versicolor* and **B**, *S. majimai*; the materials are the same as in fig. 4. *bb*, basibranchials; *bh*, basihyal (glossohyal); *brs*, branchiostegals; *ch*, ceratohyal; *dhh*, dorsal hypohyal; *eh*, epihyal; *gr*, gill rakers; *hb*, hypobranchials; *vhh*, ventral hypohyal.

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