

Larvae and Juveniles of Pempherid Fishes, *Pempheris xanthoptera* and *P. japonica*

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Abstract Larval developments of *Pempheris xanthoptera* and *P. japonica* were described on 31 (6.45–22.40 mm SL) and 5 (10.35–35.70 mm SL) specimens, respectively, with particular attention to cartilaginous development. Comparison between the two species indicated that *P. xanthoptera* was discriminated from *P. japonica* by the following key characters: two supracleithral spines (one in *P. japonica*); longer pectoral fin; shorter ventral fin; and absence of melanophore on mid-ventral part of lower jaw and anterolateral region of trunk, and web of ventral fin.

The pempherid fishes, composed of two genera, *Parapriacanthus* and *Pempheris*, are distributed in tropical, subtropical and temperate waters of the Indo-Pacific and the western Atlantic (Tominaga, 1963). In Japanese waters five species occur and inhabit rocky bottoms near shores (Hayashi, 1984). Although the adult morphology of the family has been well studied (Tominaga, 1963, 1968), very little information exists on the larval and juvenile stages. Nakamura (1933) described a 7.0 mm TL larva of *Pempheris japonica* Döderlein, and Uchida (1933) described a sequential development of the species from 6.2 to 26.0 mm TL in detail. Larval characteristics of the family were arranged by Leis and Rennis (1983) with figures of *Pempheris* sp. larvae from 2.3 to 5.5 mm SL.

In recent years, cartilaginous staining techniques developed by Dingerkus and Uhler (1977) have permitted examination of cartilaginous-osteological development of fish larvae (Kohno and Taki, 1983; Kohno *et al.*, 1983, 1984). The very techniques enabled me in this study to identify larval *Pempheris xanthoptera* Tominaga and *P. japonica*, the identity of which were otherwise undeterminable, and thus providing a morphological key to the two species.

The purpose of the present study is to describe the larval and juvenile stages of *Pempheris xanthoptera* based on specimens identified by the cartilage staining technique. Juveniles of *P. japonica* are also described briefly, and the two *Pempheris* species are compared.

Material and methods

Thirty-six specimens used in the present study

were collected by a dip-net from a rocky shore of Kominato, Chiba Prefecture, central Honshu in Japan, during periods from 7 to 11 and 27 to 31 in August, 1981. All the specimens were fixed in 5% formalin. After the measurements had been made and the melanophores recorded, these specimens were cleared and stained following the method of Dingerkus and Uhler (1977). Based on the standard mentioned below, these specimens were identified as *Pempheris xanthoptera* (N=31, 6.45–22.40 mm SL) and *P. japonica* (N=5, 10.35–35.70 mm SL). Measurements were made under a binocular microscope with an ocular micrometer, read to the nearest 0.05 mm. Drawings were made using cleared and stained specimens with the aid of a camera lucida. Terminologies generally follow Russell (1976) and Fahay (1983).

Identification

Thirty-six specimens were determined to fall under the Pempherididae on the basis of such characteristics of the family as 24–26 myomeres, 25 (10+15) vertebrae including urostyle, single, centrally located, short-based dorsal fin and a long-based anal fin (Tominaga, 1968; Leis and Rennis, 1983).

The scattered melanophores on anterolateral region of trunk and ventral fin length distinguished the present specimens into two types. In type A (N=31, 6.45–22.40 mm SL; Fig. 1, top) melanophores were scarcely developed on the anterolateral region of trunk except for some specimens in which one or two melanophores appeared, and the ventral fin was relatively short and barely reached the anus opening. The specimens of type B (N=5, 10.35–35.70 mm SL; Fig. 1,

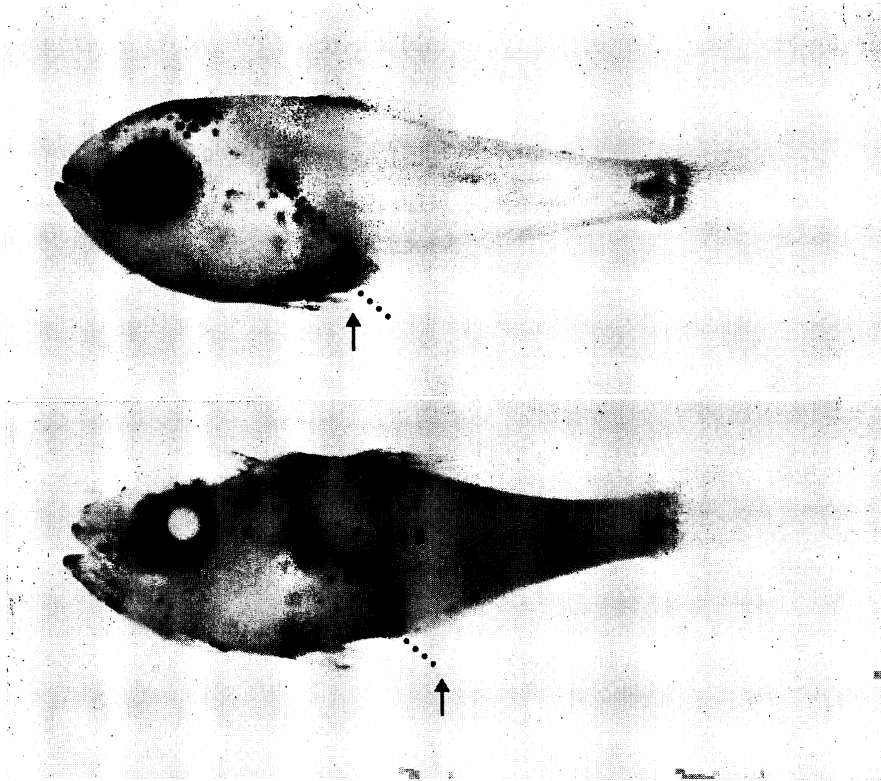


Fig. 1. Two types of pempheridid larvae. Top, type A (*Pempheris xanthoptera*), 9.90 mm SL. Bottom, type B (*P. japonica*), 10.35 mm SL. Arrows indicate the tip of ventral fin, and dotted lines show the anus opening.

bottom) meanwhile possessed well-developed melanophores on the anterolateral region of trunk, and the ventral fin was long and extended over the anus opening.

The number of dorsal and anal fin elements in the present specimens is tabulated by types in Table 1. The pterygiophore count was fewer by one than the fin ray count in the dorsal fin and by two in the anal fin, because the anteriormost pterygiophore supported two rays in the dorsal fin and three rays in the anal fin. The appearance of stay proved the completion of pterygiophores in number (cf. Kohno and Taki, 1983). Table 2 shows, on the other hand, the number of dorsal and anal fin elements in the pempheridids appearing in Japanese waters. Based on Tables 1 and 2, all the specimens examined, which possessed 33–41 anal pterygiophores, would be distinguished from *Parapriacanthus ransonneti* (19–25 in anal pterygiophores), *Pempheris oualensis* (43) and *P. nyctereutes* (43–47). Although six specimens of

type A had still incomplete anal pterygiophores in number (Table 1), it seems reasonable to consider that these specimens are the same species as other ones of type A. It should be mentioned that the distribution of *P. oualensis* is limited to the Ryukyu Islands and that of *P. nyctereutes* is in Sagami Bay and southward in Japan (Hayashi, 1984). The specimens of types A and B were therefore considered to be *P. xanthoptera* or *P. japonica*.

The distinction between *Pempheris xanthoptera* and *P. japonica* could be made by the number of dorsal pterygiophores as follows: the dorsal pterygiophores are less than 15 in number in the former and more than 15 in the latter, though they are overlapped at 15 (Table 2). Frequency distribution of the specimens in terms of dorsal pterygiophore count is shown by each type in Fig. 2, in which type A specimens possessed 13 or 14 dorsal pterygiophores and those of type B had 15 or 16 ones. Thus type A was identified as *P. xanthoptera* and type B as *P. japonica*.

Description

Pempheris xanthoptera. In a 6.55 mm SL specimen (Fig. 3A) body was more slender in comparison with adult. Head was round and mouth relatively large. Teeth on both upper and lower jaws appeared already. Upper jaw reached below iris. Eye was large. Nostril was a single pit. Three spines were developed on bony flange of preopercle, and posterior edge of preopercle

was armored with three preopercular spines, of which the central one was the most rigid. Two small supracleithral spines were noticed on supracleithrum. Number of myomeres was $9+14=23$, and all the specimens possessed $10+15=25$ vertebrae including urostyle. Although dorsal fin of 6 spines and 9 soft rays were complete in number, membranous finfold remained on dorsal contour posterior to dorsal fin and continued to

Table 1. Acquisition of fin ray and pterygiophore counts in two types of pempheridids dealt with in the present study. Asterisk indicates incompleteness in number.

SL (mm)	Dorsal fin			Anal fin		
	spines	soft rays	pterygiophores	spines	soft rays	pterygiophores
Type A (<i>Pempheris xanthoptera</i>)						
6.45	5	10	14	3	27*	35*
6.55	6	9	14	3	28*	34*
7.40	6	9	14	3	32*	39*
7.80	5	10	14	3	32*	39*
7.80	5	10	14	3	30*	35*
8.00	5	10	14	3	34	37
8.15	6	9	14	3	29*	35*
8.30	6	9	14	3	34*	40
8.30	6	9	14	3	35*	37
8.55	6	9	14	3	36	37
8.70	6	9	14	3	37	38
8.75	6	9	14	3	32	33
8.80	6	9	14	3	35	36
8.95	6	9	14	3	36	37
9.35	6	9	14	3	36	37
9.85	6	8	13	3	39	40
9.90	6	8	13	3	37	38
10.30	6	9	14	3	37	38
10.40	6	9	14	3	37	38
11.30	6	9	14	3	36	37
11.95	6	9	14	3	37	38
11.95	6	9	14	3	39	40
12.15	6	9	14	3	38	39
12.30	6	9	14	3	39	40
13.20	6	9	14	3	36	37
14.15	6	9	14	3	38	39
16.45	6	9	14	3	37	38
17.70	6	9	14	3	38	39
18.05	6	9	14	3	37	38
18.10	6	9	14	3	36	37
22.40	6	9	14	3	40	41
Type B (<i>P. japonica</i>)						
10.35	6	11	16	3	35	36
14.55	6	10	15	3	35	36
14.85	6	11	16	3	36	37
17.30	6	11	16	3	36	37
35.70	6	11	16	3	37	36

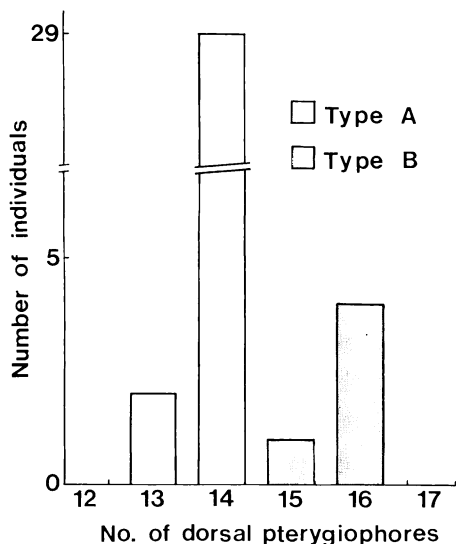


Fig. 2. Frequency distribution of number of dorsal pterygiophores in two types of pempheridids.

caudal fin. Anal fin of 3 spines and 28 soft rays was not fully developed, and anal finfold continued to caudal fin. Ten pectoral fin rays were recognized. Ventral fin was complete with 1 spine and 5 soft rays.

Generally, melanophores were not heavily developed, and thus body was whitish in formalin. Several melanophores were developed on midbrain. One melanophore appeared on opercle, trunk just posterior to opercle, cleithral symphysis and dorsal contour anterior to dorsal fin. Web of ventral fin was pigmented with several melanophores. No peritoneal melanophore was developed. Although trunk was not pigmented, one internal melanophore was developed.

A 7.80 mm SL specimen (Fig. 3B) possessed four spines on bony flange of preopercle and three preopercular spines. Number of these spines were subject to individual variation, ranging from

three to five. The number was not associated with size of specimens. Two supracleithral spines were observed. Myomere count was $9+15=24$. Number of dorsal fin rays was 15 of 5 spines and 10 soft rays, and that of anal ones was incomplete and counted as 33 of 3 spines and 30 soft rays. Dorsal finfold was separated from caudal fin and diminished in size, and anal finfold was also separated from caudal fin. Number of pectoral fin rays was 13.

Midbrain was heavily pigmented. One melanophore appeared on both upper and lower jaw tips. Each side of 1st to 5th dorsal fin ray bases was pigmented with one melanophore. Several melanophores were developed on web of ventral fin. Peritoneal melanophores appeared. Two melanophores were present on ventral abdominal region anterior to anus. One melanophore was developed on caudal peduncle.

In an 8.95 mm SL specimen (Fig. 3C) nostril was constricted at the central portion. Four spines were developed on bony flange of preopercle and four were on posterior edge of preopercle. Two supracleithral spines were present. Myomere count was not available in specimens larger than 8.80 mm SL. Dorsal fin consisted of 6 spines and 9 soft rays. Dorsal finfold was considerably diminished in size. Anal fin ray count was 39 of 3 spines and 36 soft rays and complete in number. The smallest specimen having complete anal fin ray count was 8.00 mm SL (Table 1). Pectoral fin ray count was 14.

In addition to many melanophores on midbrain, two melanophores appeared on each side of forebrain. Both jaw tips were pigmented. One melanophore was developed on cleithral symphysis and two were on both sides of ventral abdominal region. Peritoneal melanophores were well developed, and several abdominal melanophores appeared. Both sides of 1st to 4th dorsal

Table 2. Counts of dorsal and anal fins in pempheridid species appearing in Japanese waters (after Tominaga, 1968). The number of pterygiophores, which was determined by the method described in the text, is shown in parentheses.

Species	Dorsal fin	Anal fin
<i>Parapriacanthus ransonneti</i>	IV-VI, 8-10 (11-15)	(II)-III, 18-23 (18-24)
<i>Pempheris japonica</i>	VI-(VII), 10-12 (15-18)	III, 33-39 (34-40)
<i>P. xanthoptera</i>	(V)-VI, 8-10 (12-15)	III, 34-41 (35-42)
<i>P. oualensis</i>	VI, 9 (14)	III, 41 (42)
<i>P. nyctereutes*</i>	VI, 9-10 (14-15)	III, 41-45 (42-46)

* This species is a senior synonym of *P. sasaki* (see Hayashi, 1984).

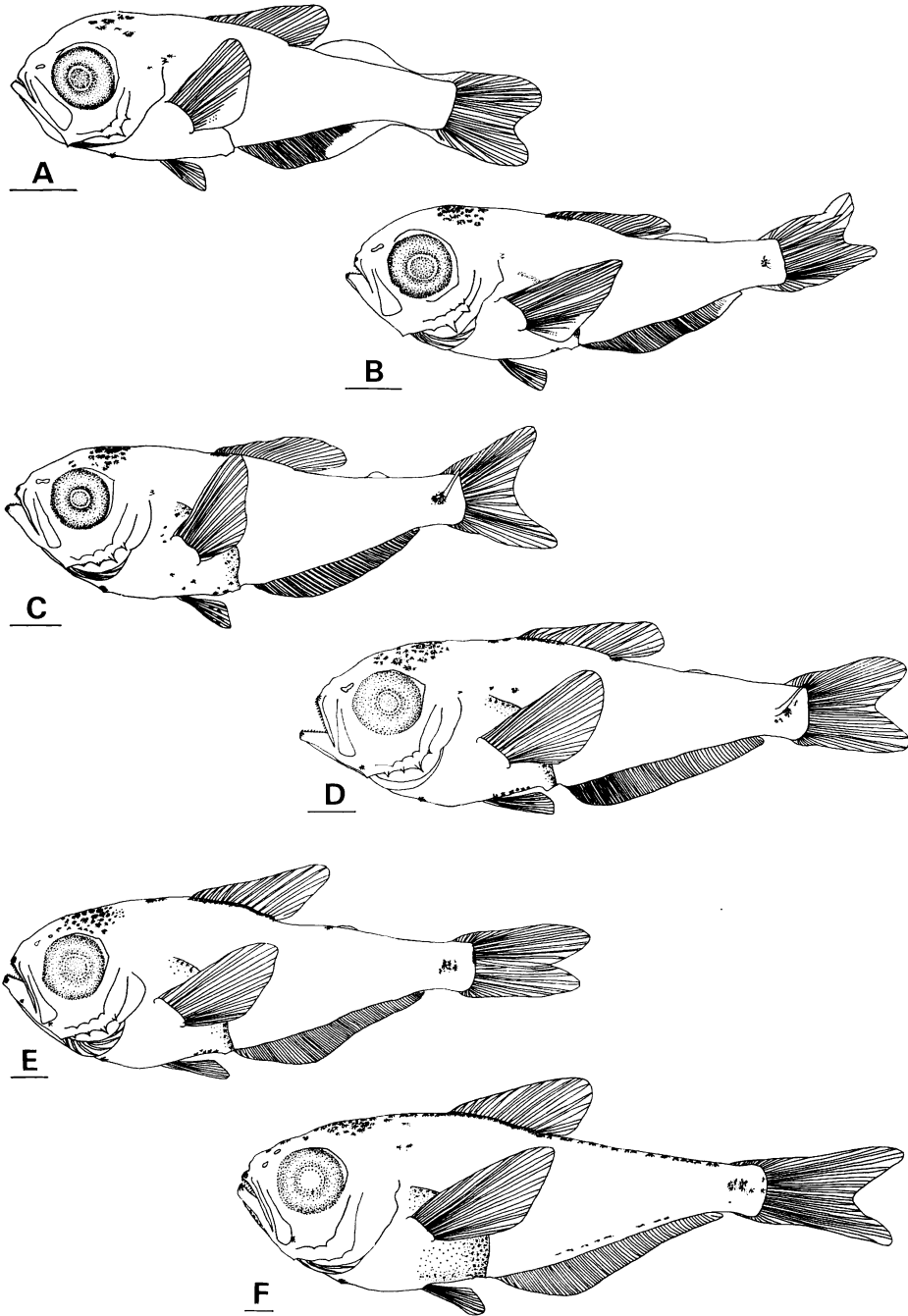


Fig. 3. Larvae and juveniles of *Pempheris xanthoptera*. A, 6.55 mm SL. B, 7.80 mm SL. C, 8.95 mm SL. D, 10.40 mm SL. E, 12.30 mm SL. F, 18.10 mm SL. Scales indicate 1 mm.

fin ray bases were pigmented. One melanophore existed on caudal peduncle. Melanophores on web of ventral fin were well developed.

Although a 10.40 mm SL specimen (Fig. 3D)

possessed two supracleithral spines, upper one was buried under skin and not visible externally.

Four spines were observed on bony flange and on posterior edge of preopercle. Dorsal fin was

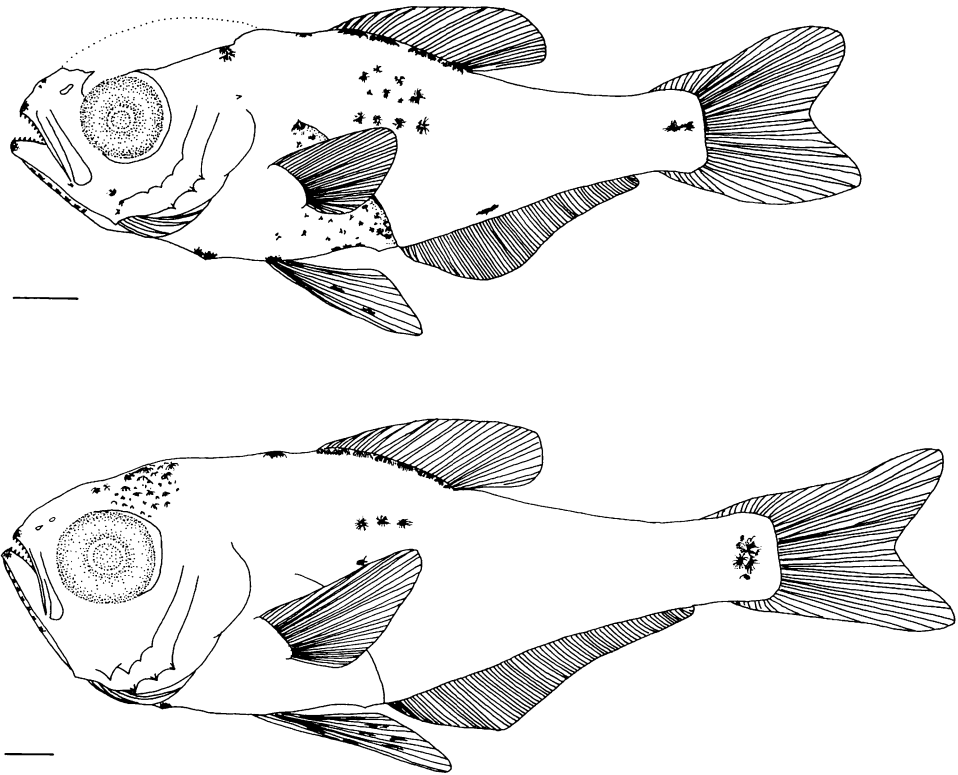


Fig. 4. Juveniles of *Pempheris japonica*. Top, 10.35 mm SL. Bottom, 14.85 mm SL. Scales indicate 1 mm.

composed of 6 spines and 9 soft rays and anal fin was of 3 spines and 37 soft rays. A small dorsal finfold still remained. Pectoral fin ray count was 14.

Midbrain and forebrain were heavily pigmented. Melanophores were developed on both jaw tips. One melanophore appeared on lower jaw angle and cleithral symphysis. Two melanophores were developed on dorsal contour anterior to dorsal fin, and both sides of 1st to 7th dorsal fin ray bases were pigmented. Two melanophores appeared on anterolateral region of trunk. Ventral abdominal region was heavily pigmented. One melanophore appeared on dorsal contour posterior to dorsal fin. Caudal peduncle was pigmented. Peritoneal melanophores were present, and web of ventral fin was pigmented.

Depth of anterior part of body increased, and proportion became similar to that of adult in a specimen of 12.30 mm SL (Fig. 3E). Nostril was divided into two ones. Supracleithral spine was reduced and not perceived externally. Four

spines were present on bony flange of preopercle and posterior edge of preopercle. Dorsal finfold was still present. Dorsal fin was composed of 6 spines and 9 soft rays and anal fin was of 3 spines and 39 soft rays. Pectoral fin ray count was 17.

Midbrain, forebrain and both jaw tips were heavily pigmented. One melanophore appeared on mandibular and lower jaw angle. Peritoneal and ventral abdominal melanophores were present. One melanophore was observed on cleithral symphysis and on dorsal contour posterior to dorsal fin, and two were present on dorsal contour anterior to dorsal fin. All fin ray bases of dorsal fin were pigmented in each side. Several melanophores were present on caudal peduncle and caudal fin base. No melanophore was developed on web of ventral fin.

Spines on bony flange of preopercle and posterior edge of preopercle became low and blunt in an 18.10 mm SL specimen (Fig. 3F). No supracleithral spine was developed. Dorsal fin

consisted of 6 spines and 9 soft rays and anal fin of 3 spines and 36 soft rays. Sixteen pectoral fin rays were counted.

Dorsal contour of body including head region and dorsal fin base was heavily pigmented with many melanophores, and melanophores on dorsal contour posterior to dorsal fin formed a single line. Both jaw tips were pigmented, and one melanophore appeared on posterior edge of maxilla and cleithral symphysis. Four melanophores were observed on mid-ventral part of lower jaw. Two melanophores appeared on anterolateral region of trunk. Peritoneal melanophores were well developed. Eight melanophores were present on interspine base of anal fin. Caudal peduncle was pigmented. No melanophore was developed on web of ventral fin.

Pempheris japonica. Descriptions were made on only two specimens of *Pempheris japonica* because of scarce of specimens.

The head region was damaged in a 10.35 mm SL specimen (Fig. 4, top). Body was slightly slender with 17 dorsal fin rays of 6 spines and 11 soft rays and 36 anal fin rays of 3 spines and 33 soft rays. Head, eye and mouth were relatively large. Pectoral fin was relatively small with 27 fin rays. Ventral fin was long and extended over the anus with 1 spine and 5 soft rays. Dorsal finfold disappeared already. One supracleithral spine was perceived. Four spines were developed on bony flange of preopercle and three were on posterior edge of preopercle.

Both upper and lower jaw tips were heavily pigmented. Seven melanophores were present on mid-ventral part of lower jaw. Two melanophores were observed on cleithral symphysis and three were on ventral abdominal region anterior to anus. Peritoneal melanophores were well developed. One melanophore was present on dorsal contour anterior to dorsal fin and four were on each side of dorsal fin base. Eleven melanophores were conspicuously developed on anterolateral region of trunk, but the location of which was obviously a little backward when comparing with that in *Pempheris xanthoptera*. One melanophore was present on interspine base of anal fin and two were on caudal peduncle and on caudal fin base. Web of ventral fin was pigmented with two melanophores.

In a specimen of 14.85 mm SL (Fig. 4, bottom) no remarkable change occurred with an exception

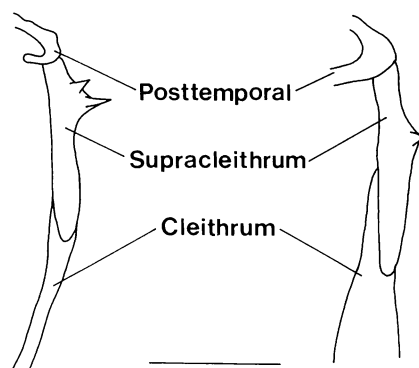


Fig. 5. Shoulder girdle of *Pempheris xanthoptera* (left, 10.30 mm SL) and *P. japonica* (right, 10.35 mm SL), showing supracleithral spines. Scale indicates 0.5 mm.

that supracleithral spine became extinct. Both jaw tips, midbrain and forebrain were well pigmented. Seven melanophores were present on mid-ventral part of lower jaw. One melanophore was observed on cleithral symphysis and dorsal contour anterior to dorsal fin. Four melanophores appeared on anterolateral region of trunk. Each side of dorsal fin base and caudal peduncle were pigmented. Melanophores on web of ventral fin were well developed.

Comparison of two *Pempheris* species

Although the number and size of specimens dealt with in the present study were restricted within narrow limits, some differences were noticed between two *Pempheris* species, *P. xanthoptera* and *P. japonica*.

Supracleithral spines. Two spines were developed on supracleithrum in *Pempheris xanthoptera*, meanwhile one supracleithral spine was observed in *P. japonica* (Fig. 5). Of the two supracleithral spines, the upper one was buried under skin and not perceived externally in a 10.40 mm SL specimen of *P. xanthoptera*, and these spines completely disappeared in larvae larger than 12.30 mm SL. In *P. japonica*, on the other hand, a 10.35 mm SL specimen which was the smallest examined possessed only one supracleithral spine, and in specimens larger than 14.55 mm SL this spine was not observed. Although no examination was made on specimens smaller than 10.35 mm SL in *P. japonica*, the number of supracleithral spines in the species seemed to be

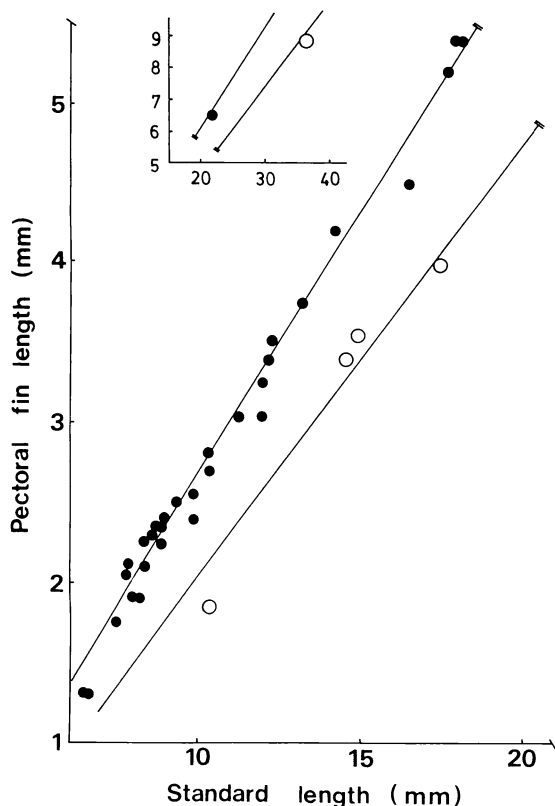


Fig. 6. Relationship between standard length and pectoral fin length in *Pempheris xanthoptera* (solid circles) and *P. japonica* (open circles). *P. xanthoptera*: $Y=0.33X-0.61$. *P. japonica*: $Y=0.27X-0.65$.

stable and not to show variation, i.e. even in smaller specimens one supracleithral spine would be expected to occur. If so, the two species would be distinguished from each other by the number of supracleithral spines at least in larvae smaller than about 10 mm SL. It should be noted that Uchida (1933) figured an 8.9 mm TL larva of *P. japonica* with one spine on upper part of opercle (his figure 6B), but no comment was made on that.

Pectoral and ventral fin lengths. The pectoral fin length was longer in *Pempheris xanthoptera* than in *P. japonica* (Fig. 6). Covariance analysis of the two regression lines showed a highly significant difference both in slopes and adjusted mean values at 1% level. The ratios of the pectoral fin length to SL were 19.3–29.9% in *P. xanthoptera* (29% in adult; Tominaga, 1963) and 17.9–24.9%

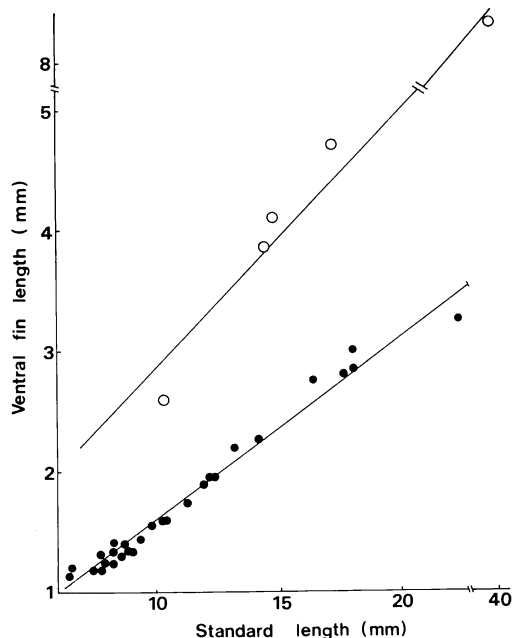


Fig. 7. Relationship between standard length and ventral fin length in *Pempheris xanthoptera* (solid circles) and *P. japonica* (open circles). *P. xanthoptera*: $Y=0.15X+0.08$. *P. japonica*: $Y=0.22X+0.72$.

in *P. japonica* (26%). On the contrary, the ventral fin length was shorter in *P. xanthoptera* than in *P. japonica* (Fig. 7). This character was also significantly different both in slopes and adjusted mean values at 1% level. The ratios of the ventral fin length to SL were 15.1–18.3% in *P. xanthoptera* (15% in adult; Tominaga, 1963) and 23.1–27.6% in *P. japonica* (18%).

Melanophores. Melanophores were developed in many parts of body in both species (see Descriptions). Their distribution on three parts of body were compared between the two species. Appearance or disappearance of these melanophores are summarized by species in Fig. 8.

Pempheris japonica usually possessed melanophores on mid-ventral part of lower jaw, but the melanophores were first acquired at 17.55 mm SL in *P. xanthoptera*. In *P. xanthoptera*, all but four specimens smaller than about 15 mm SL usually lacked melanophores on anterolateral region of trunk, and those larger than this size usually possessed some melanophores there. On the other hand, *P. japonica* larger than 8–9 mm

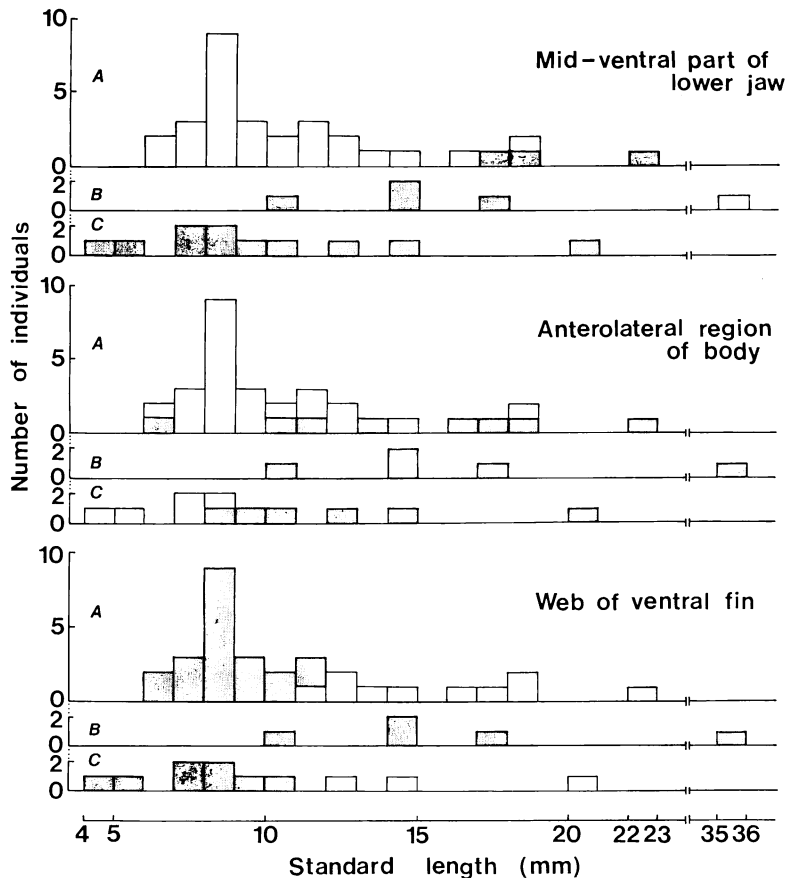


Fig. 8. Comparison of distribution of melanophores on three selected parts of body by size classes in *Pempheris xanthoptera* (A) and *P. japonica* examined in this study (B) and that reported by Uchida (1933) (C). Open and shade areas represent specimens in which melanophores were absent and present, respectively.

SL were characterized by heavily pigmented anterolateral region of trunk with many melanophores. Moreover, the locations of the melanophores were different between the species as mentioned in Description. In *P. xanthoptera*, melanophores on web of ventral fin disappeared at 11.30 mm SL and were not observed in specimens larger than 12.25 mm SL. On the other hand, all specimens examined in the present study possessed many melanophores on web of ventral fin in *P. japonica*. However, Uchida (1933) mentioned that melanophores on web of ventral fin were hardly developed in specimens larger than 15 mm TL, though a 26 mm TL specimen seemed to possess them in his figure 6F.

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- 軟骨染色法で同定した標本にもとづきミナミハタンボとツマグロハタンボの仔稚魚を記載し、両種の比較を行った。その結果ミナミハタンボは以下の諸形質でツマグロハタンボと区別されることが判明した：上擬鎖骨は2棘（ツマグロハタンボでは1棘）；長い胸鱗と短い腹鱗；下顎中央腹面、軀幹前側部および腹鱗に黒色素胞を欠く。
- (東南アジア漁業開発センター)