terior expansion of the bone is fan-shaped and covered with scales.

The upper limb of the V-shaped **dentary** (d) bears a band or patch of teeth. In *Parapriacanthus ransonneti* and *Pempheris poeyi* the teeth are arranged in a single row, numbering about 60 in the former and about 40 in the latter. In *Pempheris sasakii* the teeth, about 60 in number, are set in double rows at the anterior end of the patch but arranged in a single row immediately posteriorad. In *Pempheris japonica* and *P. moluca* they are numerous and arranged in about four rows at the widest part of the patch; the teeth are minute but those in the outermost row near the anterior end of the tooth-band are, as on the premaxillary, markedly large and stout in specimens more than 100 mm in standard length. The teeth of *Pempheris xanthoptera* are fine, numerous, of almost uniform size, and arranged in about four rows at the widest part of the band. Below the band of teeth and just above the anterior end of the articular, the abaxial surface of the dentary is gouged. In *Parapriacanthus ransonneti*, *Pempheris japonica*, *P. poeyi*, and *P. sasakii* the most deeply gouged part is represented by a fenestra (fc), whereas in *Pempheris moluca* and *P. xanthoptera* the fenestra is absent, although the bone is very thin in the gouged part. Below the band of teeth, the upper limb of the bone is divided into adaxial and abaxial thin bony sheets. There is a deep hollow space among the bony sheets and the lower limb of the dentary, and the anterior portions of the articular and of Meckel's cartilage are inserted into this space.

The hinder margin of the ventral limb of the dentary is parallel to the anterior margin of the articular but not in contact with it. There is a wide space between the upper limb of the dentary and the articular.

The mandibular sensory canal runs largely in an open groove. It runs in a short bony tube at the anterior part of the lower limb, and emerges through three pores: the anterior pore opens just below the origin of the tooth-band, the median one opens ventrally, and from the posterior one the canal runs posteriorly without the bony roof. In *Pempheris poeyi* the septum between the median and posterior pores is incomplete. Two discontinuous bony flanges, the anterior one of which is larger, border the dorsal margin of the groove for the sensory canal. Below the anterior end of the anterior flange, a small bony protuberance is present at the ventral border of the groove. Opposite the posterior flange, a bony protuberance similar to the anterior one is present in *Pempheris* but absent in *Parapriacanthus*. Several foramina transmitting the branches of the mandibular branch of the facial nerve are present along the mandibular sensory canal (msc).

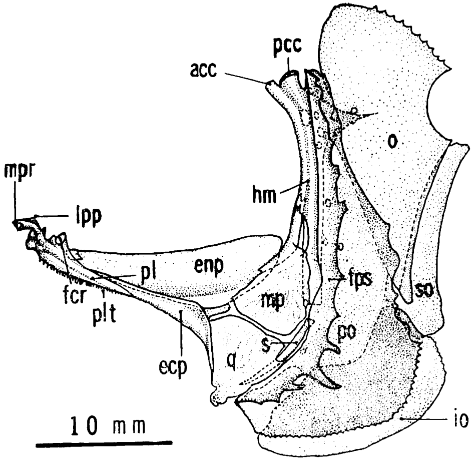
The **articular** (ar) is almost as long as the dentary, sending a long, triangular process forward into the hollow space in the dentary. The articular facet for the quadrate is concave and transverse. At the ventral edge of the anteriorly extending process of the articular, a narrow horizontal flange runs adaxially, with Meckel's cartilage lying on its dorsal surface. The branches of the trigeminal and facial nerves run along the adaxial surface of Meckel's cartilage. The mandibular sensory canal traverses the articular, and near the middle of its course at the dorsal border a bony flange overhangs the canal. At the base of the flange the bone is pierced to transmit the facial nerve into the canal. Opposite the flange and the ventral border of the canal, a small, low, bony protuberance is present. Posteriorly the canal is bent upward, passes through the retroarticular process, and enters the preopercular sensory canal.

The **coronomeckelian** (sar) (sesamoid articular, angular) is sharply pointed anteriorly. Its posteroventral corner is covered by the endosteal process (ed) of the articular. A stout tendon from the adductor mandibulae muscles attaches to the anterior end of the bone.

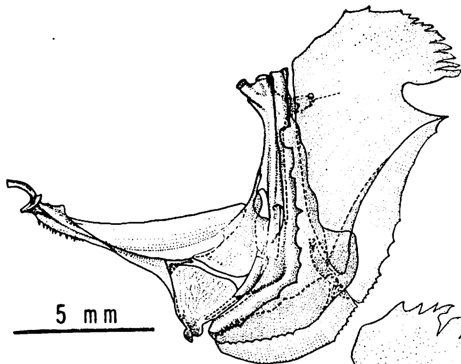
The triangular abaxial surface of the **angular** (an) forms the ventroposterior corner of the lower jaw and to this surface the ligament binding the lower jaw to the interopercle attaches. The adaxial surface is wider than the abaxial surface, and covers the articular below the retroarticular process.

SUSPENSORIUM (Fig. 8)

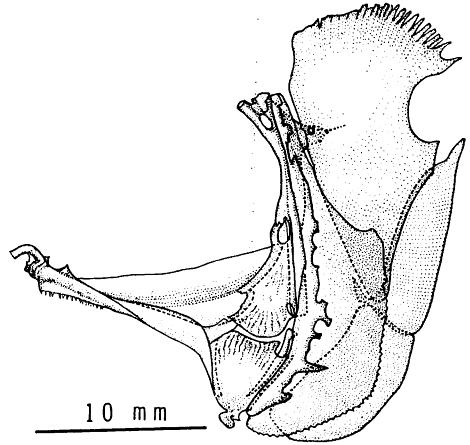
The **palatine** (pl) bears a band of teeth



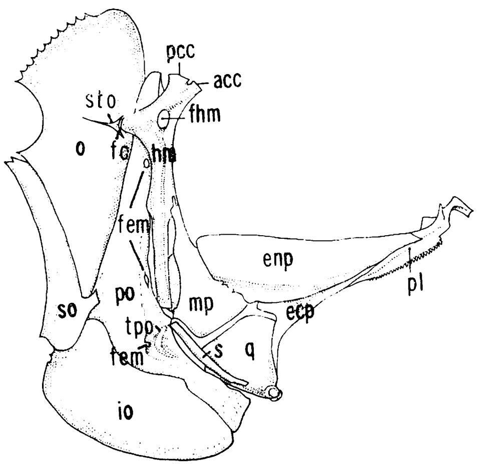
Pempheris japonica: abaxial view



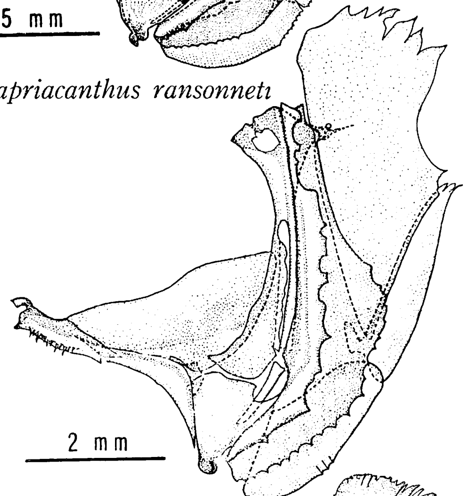
Parapriacanthus ransonneti



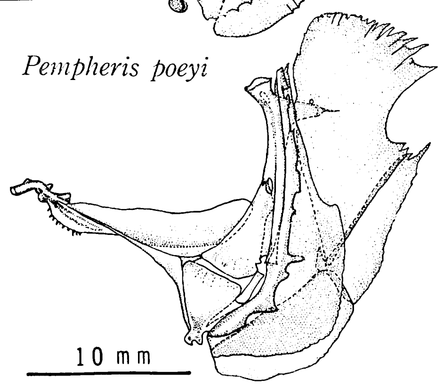
Pempheris moluca



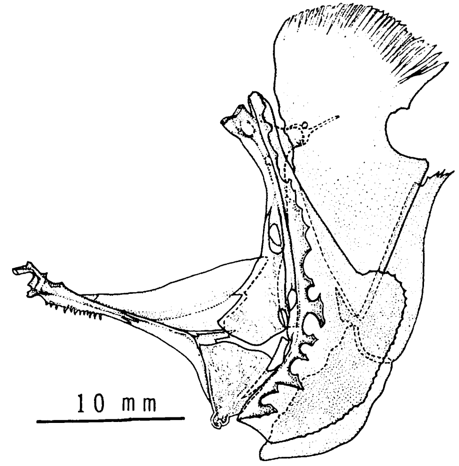
Pempheris japonica: adaxial view



Pempheris poeyi



Pempheris sasakii



Pempheris xanthoptera

Fig. 8.

(plt) along its oral border. The teeth are arranged in a single row throughout in *Parapriacanthus ransonneti* and *Pempheris sasakii*; in irregular double rows anteriorly and in a single row posteriorly in *Pempheris poeyi*, *P. moluca*, and *P. xanthoptera*. The teeth are set in five or six irregular rows at the widest part near the anterior end, and the patch of teeth gradually decreases in width posteriorly in *Pempheris japonica*. The total number of teeth is about 15 in *Parapriacanthus ransonneti*, *Pempheris poeyi*, and *P. sasakii* about 20 in *Pempheris xanthoptera*, about 40 in *Pempheris moluca* and much more numerous in *Pempheris japonica*. The maxillary process (mpr) of the palatine is crooked and capped by cartilage. It is longer in *Parapriacanthus* than in *Pempheris*. From the dorsalmost surface of the crooked process (lpp), the palatine-premaxillary ligament originates. On the dorsal surface behind the maxillary process there are two bony protuberances (fcr) and to these the prevomer and lateral ethmoid attach. A thin bony flange of the palatine extending posteriorly from the posterior bony protuberance serves as the floor of cartilage, and overlies the anterior end of the endopterygoid.

The **ectopterygoid** (ecp) (pterygoid) is formed of a crooked main body and a thin bony plate extending posteriorly from the angle of the bone to the cartilage between the endopterygoid and quadrate. The bone meets the palatine in a suture anteriorly. The endopterygoid fits against a groove on the dorsal edge of the ectopterygoid. The ventral limb of the main body of the bone is shorter than the dorsoanterior limb and lies along the anterior edge of the quadrate; the posterior margin of the ventral limb is overlapped abaxially by the anterior margin of the quadrate.

The **endopterygoid** (enp) (mesopterygoid) is concave to line the eye-ball except for a small ventral area which lies flush with the surfaces of the ecotopterygoid and quadrate. The posteroventral edge of the vertical portion is covered by the metapterygoid. No teeth are present on the bone.

The **metapterygoid** (mp) is a cancellous bone. Its dorsal process articulates with the anterior process of the hyomandibular in a suture. There is a fenestra bounded by the dorsal process of the metapterygoid and the shaft of the hyomandibular. The posterior part of the metapterygoid is divided into two sheets, leaving a hollow space between them, and through this space the hyoidean artery runs. The abaxial sheet of the metapterygoid fits against the lateral face of the shaft of the hyomandibular, slightly overlapping the anterior portion of the latter. The ventroposterior end of the adaxial sheet is notched in front of the ventral end of the shaft of the hyomandibular. The metapterygoid is separated from the quadrate by a line of cartilage.

The **quadrate** (q) is cancellous in texture except for the solidly ossified anterior and posterior rims and the condyle for the articular. The anterior edge of the bone is bevelled to fit the ectopterygoid, and the laterally expanded posterior edge is slightly grooved to receive the preopercle. The excavation on the adaxial surface for the symplectic is long and deep. The posterior process of the quadrate behind the excavation is short, and ends ventral to the dorsal edge of the body of the bone.

The **symplectic** (s) is the widest at the dorsal edge of the quadrate. The dorsal end of the symplectic is attached to the thickened

Fig. 8. The suspensorium and opercular bones of the Pempheridae. acc, anterior condyle of hyomandibular for cranium; ecp, ectopterygoid; enp, endopterygoid; fcr, bony protuberances for prevomer and lateral ethmoid; fem, foramina for external mandibular branch of facial nerve; fhm, foramen for hyomandibular trunk of facial nerve; fo, facet of opercle for posterior process of hyomandibular; fps, flange of preopercle overhanging preopercular sensory canal; hm, hyomandibular; io, interopercle; lpp, surface for palatine-premaxillary ligament; mp, metapterygoid; mpr, maxillary process of palatine; o, opercle; pcc, posterior condyle of hyomandibular for cranium; pl, palatine; plt, teeth on palatine; po, preopercle; q, quadrate; s, symplectic; so, subopercle; sto, strut of opercle extending from facet of opercle; tpo, thickening of preopercle for attachment of symplectic and interhyal.

anterior edge of the preopercle, and separated from the hyomandibular by cartilage.

The **hyomandibular** (hm) has two condyles for the cranium at the dorsal end. The anterior condyle (acc) fits into a facet formed by the prootic and sphenotic, and the posterior one (pcc) into a facet on the pterotic. The condyles are filled and capped by cartilage. They are widely separated from each other and the level of the anterior head is higher than that of the posterior one in *Parapriacanthus ransonneti*, *Pempheris japonica*, and *P. moluca*. They are in contact with, but distinct from each other in *Pempheris poeyi* and *P. xanthoptera*, whereas in *Pempheris sasakii* they are continuous. Posterior to the posterior condyle, a vertical crest runs downward and the preopercle fits against this crest. On the adaxial surface below the condyles for the cranium, there is a large foramen (fhm) from which the hyomandibular trunk of the facial nerve enters the bone. The hyomandibular trunk of the facial nerve runs ventrally through a bony tube in the shaft of the hyomandibular and emerges through a foramen situated on the postero-abaxial face of the shaft slightly above its ventral end. Below the foramen (fhm) the posterior margin of the shaft is overlain by the flange of the preopercle. The posterior face of the hyomandibular is grooved and the preopercle fits against the groove.

A pair of **sclerotic bones** lie embedded in the anterior and posterior wall of the eyeball. They are semicircular and the anterior one is slightly larger.

OPERCULAR BONES (Fig. 8)

The **preopercle** is traversed throughout its length by the groove for the preopercular sensory canal. The groove is overhung by a bony flange (fps). The edge of the flange is ornamented with irregularly spaced spines, the largest of which is at the angle of the bone. The spines are low and blunt all along the edge in *Parapriacanthus ransonneti* and *Pempheris poeyi*. Those of the ventral half of the edge are strong and pointed, but those of the dorsal half are weak and irregular-shaped in *Pempheris japonica*. They are complicated in shape (bicuspid, tricuspid, or mushroom-shaped), and subject to individual variation in shape, size and number in *Pempheris xanthoptera*. In *Pempheris sasakii* and *P. moluca* they are similar in shape to those of *Pempheris xanthoptera* but less complicated. Above the angle of the bone the anterior edge extends as a thin bony sheet overlying the ventral end of the shaft of the hyomandibular. The bony sheet of the preopercle meets the metapterygoid on the shaft of the hyomandibular in *Pempheris moluca* and *P. xanthoptera*. Below the shaft of the hyomandibular the adaxial surface of the preopercle is thickened and the dorsal ends of the symplectic and interhyal attach against this thickening (tpo). Two or three foramina (fem) on the adaxial face of the bone transmit the external mandibular branches of the facial nerve to the sensory canal. The posterior and ventral rims of the preopercle have fine fringes at the ventral rim, but no stout projections or spines. The posteroventral expansion of the preopercle partly overlaps the opercle, subopercle and interopercle.

The **opercle** (o) expands dorsally beyond the level of the dorsal ends of the preopercle and hyomandibular. The dorsoposterior rim is fringed, and below the fringe the posterior margin is deeply concave. The facet (fo) for the opercular process of the hyomandibular is supported by a strut (sto) which extends posteriorly for a short distance on the adaxial surface and does not reach the posterior margin of the opercle. Just above the articular facet, the opercle is perforated by a small foramen which gives passage to a branch of a nerve, probably the facial.

The **interopercle** (io) is thick and well ossified dorsally and anteriorly but thin ventrally. The adaxial surface of the anterior thickening is bound by a ligament to the coronomeckelian, and the adaxial surface of the dorsal thickening by a ligament to the posterior end of the epihyal. The bone is overlain by the preopercle except for the narrow ventral portion, and slightly overlies the ventroanterior portion of the subopercle. In *Parapriacanthus ransonneti* the ventroposterior rim of the interopercle is fringed. The ventral rim of the interopercle of *Pempheris poeyi* is also slightly fringed.

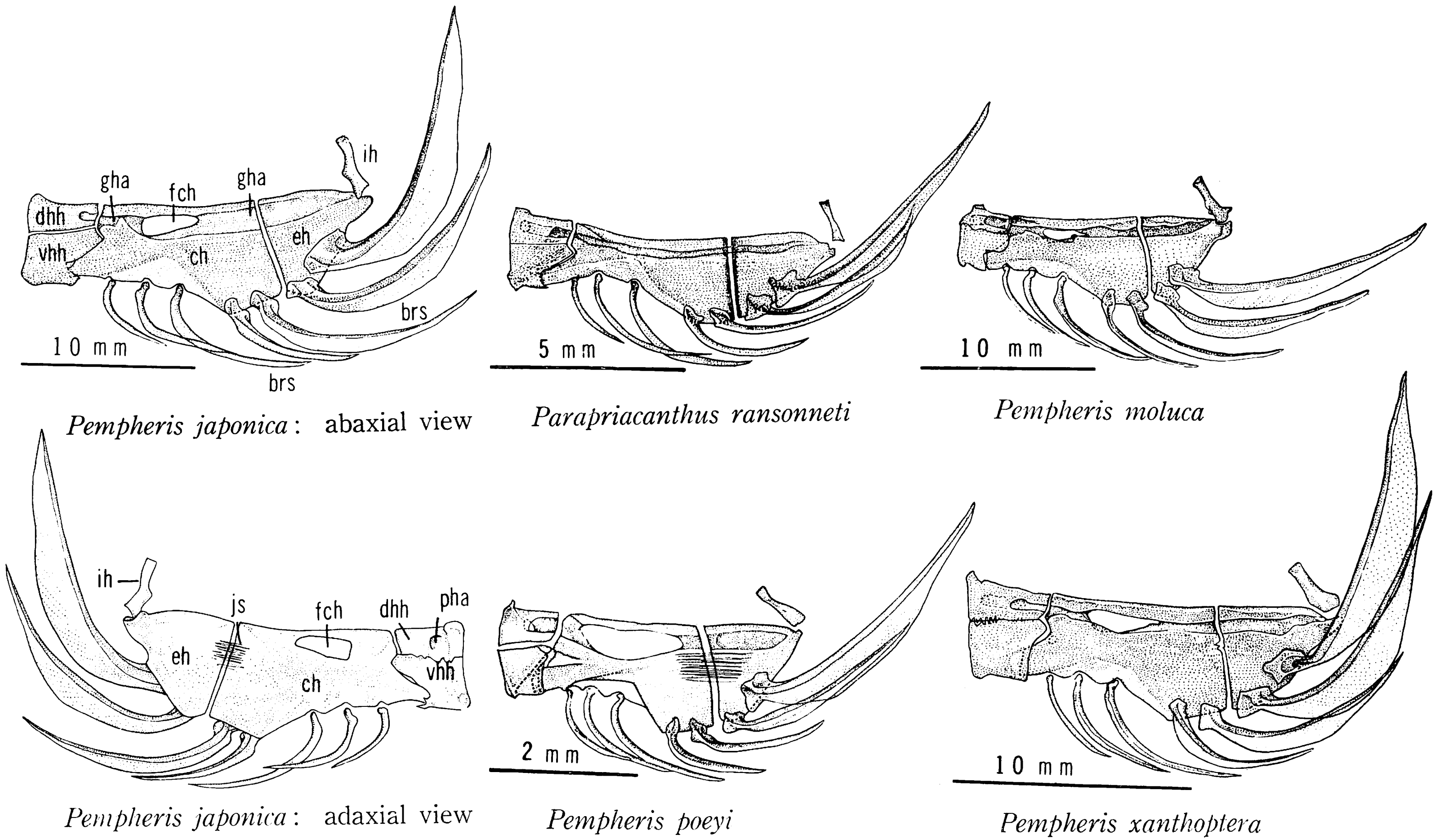


Fig. 9, The hyoid arch of the Pempheridae. brs, branchiostegals; ch, ceratohyal; dhh, dorsal hypohyal; eh, epihyal; fch, foramen on ceratohyal; gha, groove for hyoidean artery; ih, interhyal; js, suture between ceratohyal and epihyal; pha, pore for hyoidean artery; vhh, ventral hypohyal.

The **subopercle** (so) is partly overlain by the preopercle and interopercle anteriorly, and by the opercle dorsoanteriorly. The bone is very thin. A pointed process of the bone extends upward in front of the opercle. The anterior part of the posteroventral rim is serrated in *Parapriacanthus ransonneti*.

The ventral and posterior rims of the preopercle, opercle, interopercle, and subopercle are thin and without stout bony spines or projections. Moreover, there are irregular areas not or incompletely ossified along the rims of the bones.

HYOID ARCH (Fig. 9)

The hyoid arch as a whole is slenderer in *Parapriacanthus* than in *Pempheris*. The dorsal and ventral hyopohyals, ceratohyal, and epihyal are cancellous in texture.

The dorsal **hypohyal** (dhh) is smaller than the ventral one (vhh). The hyoidean artery from the ceratohyal enters an open groove on the abaxial surface of the dorsal hypohyal, and passes anteriorly through the bone to emerge on its adaxial surface. The dorsal hypohyal is bound to the lateral face of the first basibranchial by a ligament. Two hypohyals and the ceratohyal are connected with each other by synchondrosis.

The **ceratohyal** (ch) is traversed on its abaxial surface by the groove (gha) for the hyoidean artery. In *Pempheris* the bone is perforated by a fenestra (fch) situated in the course of the groove, whereas the fenestra is absent in *Parapriacanthus*. Anterior to the attaching surface of the fourth branchiostegal, the ventral edge of the ceratohyal is thin and not cancellous, and bears slight notches on which the anterior three branchiostegals are inserted. The ceratohyal is separated from the epihyal by a transverse interspace of cartilage, and above the middle of the junction, two bones are connected by a strongly jagged suture (js) on the adaxial surface.

The groove for the hyoidean artery traverses the **epihyal** (eh) and reaches the dorsal edge of the bone just anterior to the facet for the interhyal. The posterior end of the epihyal is bluntly pointed.

The **interhyal** (ih) is thickened ventrally. On the ventral part of its anterior edge is a groove in which the hyoidean artery passes. The dorsal end of the bone reaches just above the protuberance of the preopercle.

There are seven **branchiostegals** (brs) increasing in length and width posteriorly. The anterior three are attached to the ventral margin of the ceratohyal, the next two originate from the abaxial surface of the same bone, and the posterior two originate from the abaxial surface of the epihyal.

At the anterodorsal end of the **urohyal** (Fig. 10) are a pair of facets (fbb), which are connected with the first hypobranchials. Under the facets is an attaching surface (sl) for a pair of ligaments from the ventral hypohyals of the two sides. Behind the anteroventral angle, the bone is slightly projected laterally along the ventral rim in *Pempheris*. In *Parapriacanthus ransonneti* there is a pair of thin bony projections (spr) which originate from the anteroventral angle of the bone, and extend lateroposteriorly.

BRANCHIAL ARCHES (Fig. 11)

The **basihyal** (bh) (glossohyal) is rod-shaped and filled with cartilage. It is slightly expanded anteriorly, toothless, and embedded in the tongue. Its posterior end rests on the crooked dorsal surface of the first basibranchial.

There are three **basibranchials** (bb) which are longer posteriorly, toothless, and tightly united with each other by synchondrosis. The first basibranchial is bent downward anteriorly, lies between the anterior ends of the dorsal hypohyals, and gives insertion to them.

The hypo-, cerato-, and epibranchials are thin, slender and grooved longitudinally, and in these grooves gill filaments are inserted. The gill rakers of the outer and inner rows rest on their convex surfaces.

The **hypobranchials** (hb) are three on either side, belonging to the first to third branchial arches; they decrease in length posteriorly. The first hypobranchial is united with the articular surface extending over the first and second basibranchials, and its ventral projection fits into the groove below the articular surface. On the ventral surface near the proximal end of the first hypobranchial is an articulating facet for the urohyal. The first

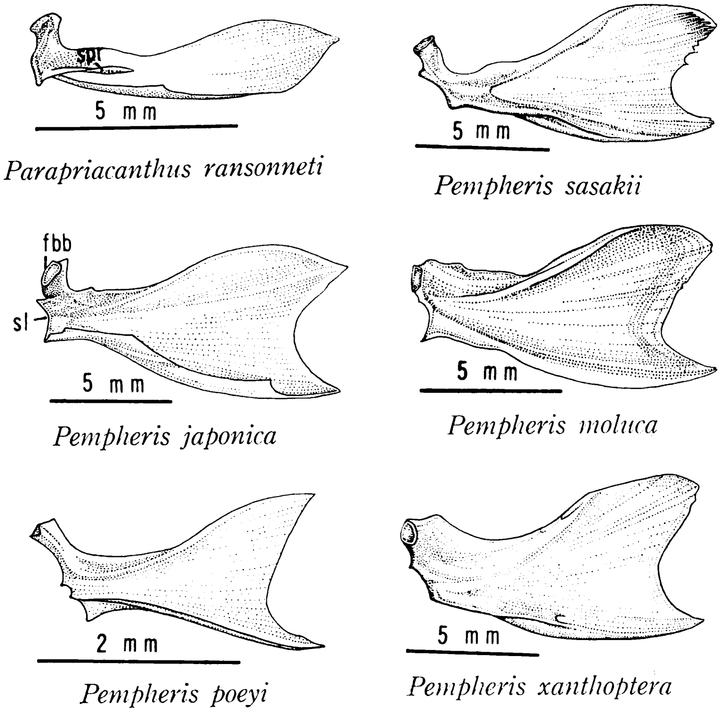


Fig. 10. The urohyal of the Pempheridae. fbb, facet for hypobranchial; sl, attaching surface for ligament from ventral hypohyal; spr. bony projection originating from anteroventral angle of urohyal.

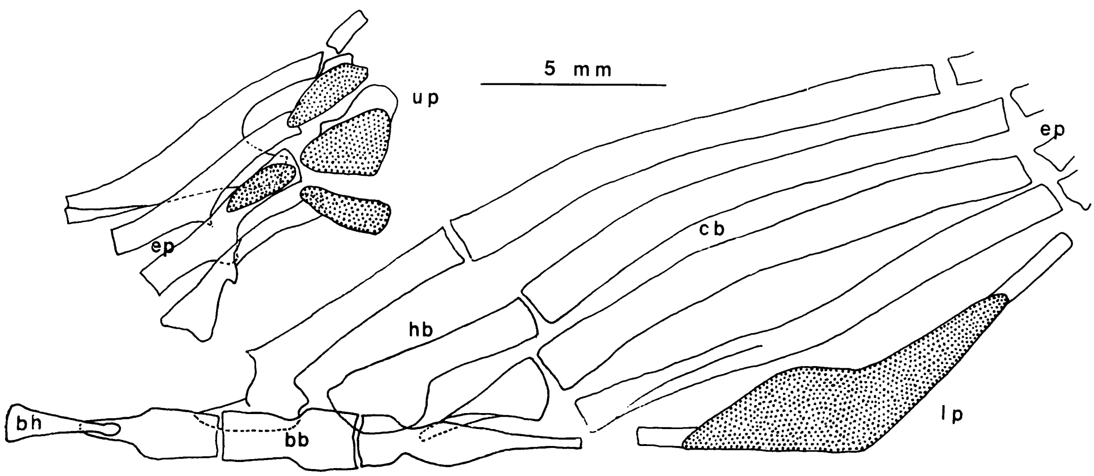


Fig. 11. The branchial arch of the *Pempheris japonica*. bb, basibranchials; bh, basihyal; cb, ceratobranchials; ep, epibranchials; hb, hypobranchials; lp, lower pharyngeal; up, upper pharyngeals. Dotted areas represent the tooth-patches. Gill rakers omitted.

hypobranchial is bound to the dorsal hypohyal and the second hypobranchial by ligaments. The second hypobranchial is connected with the second and third basibranchials. The proximal end of the third hypobranchial is pointed and joined by cartilage with its counterpart of the opposite side below the third basibranchial. The third hypobranchial is connected with the third basibranchial by a ligament.

The **ceratobranchials** (cb) are four in number, belonging to the first to fourth branchial arches successively, and are of nearly the same length. The fourth ceratobranchial originates from the posterior end of the third basibranchial, and its anterior, proximal portion is bevelled along the adaxial side. Behind this bevelled part the gill slit opens for a short distance between the fourth ceratobranchial and lower pharyngeal.

The **lower pharyngeal** (lp) is made up of a roughly triangular tooth-plate which is contiguous with that of the counterpart along the median line, a short anterior shaft, and a long posterior one. The teeth on the adaxial and median portion of the tooth-plate are larger and more coarsely distributed than those on the remaining portion.

The **epibranchials** (eb) are four in number, and in each bone the posterior wall of the groove for the gill filaments extends dorsally as a triangular bony wing. The third epibranchial has a small tooth-plate on the oral surface. The gill slit is closed behind the fourth epibranchial.

The upper pharyngeals (up) are four in number. The first upper pharyngeal (suspensory pharyngeal) is rod-shaped and toothless. Its adaxial end attachces to the cranium behind the foramen for the internal carotid artery. Each of the upper pharyngeals of the second and third branchial arches has a tooth-plate and a toothless haft extending adaxially. The fourth upper pharyngeal is made up of only a tooth-plate. The tooth-plates of the second to fourth upper pharyngeals and that of the third epibranchial form a contiguous patch of teeth, which is opposed to that of the lower pharyngeal. The teeth on the third upper pharyngeal are larger and more coarsely distributed than those on the second and fourth upper pharyngeals and those on the third epibranchial.

GILL RAKERS

The gill rakers are attached in double (outer and inner) rows to the hypo-, cerato-, and epibranchials, except the third hypobranchial and the fourth epibranchial, both of which are without inner rakers. The gill rakers in the inner row of the fourth ceratobranchial are few and arranged along the short gill slit behind the fourth branchial arch.

The gill rakers in the outer row of the first branchial arch are blade-like, and are equipped with fine teeth along the edge of their oral side. Those on the posterior (distal) half of the ceratobranchial are the longest. The gill rakers in the outer row of the second branchial arch are also blade-like, but far shorter than those in the outer row of the first arch. Those on the remaining rows are club-shaped or granular, with fine teeth on their surfaces.

A minute raker intervenes between each two of the rakers of usual size in the inner row of the first arch and the outer and inner rows of the second and third arches in *Pempheris moluca* and *P. xanthoptera* (Fig. 12). Such intervening minute rakers are absent in *Parapriacanthus ransonneti*, *Pempheris japonica*, *P. poeyi*, and *P. sasakii* (Tominaga, 1963). The numbers of gill rakers

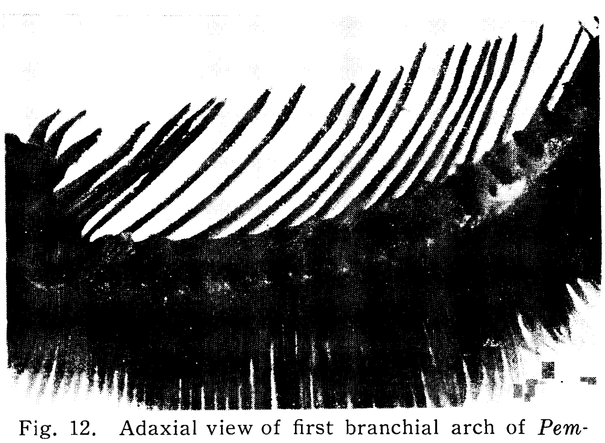


Fig. 12. Adaxial view of first branchial arch of *Pempheris xanthoptera*, showing intervening minute rakers.

Table 2. Gill rakers of the Pempheridae.

	1st branchial arch		2nd branchial arch		3rd branchial arch		4th branchial arch	
	outer row	inner row	outer row	inner row	outer row	inner row	outer row	inner row
Parapriacanthus ransonneti	17+1+7	16+0+4	16+1+3	13+1+3	15+1+1	12+1+1	13+1+1	10
Pempheris japonica	21+1+11	17+1+7	18+1+8	15+1+4	15+1+1	10+1+3	11+1+2	6
Pempheris poeyi	19+1+6	14+0+3	15+1+3	14+1+1	15+1+1	10+0+1	11+1+1	6
Pempheris sasakii	20+1+9	16+0+6	18+1+4	15+1+2	14+1+4	12+0+3	13+1+2	7
*Pempheris moluca**	18+1+7	14+1+3	14+1+4	15+1+2	13+1+2	11+1+2	14+1+2	7
*Pempheris xanthoptera**	20+1+8	16+0+4	15+1+4	14+0+2	13+1+2	11+0+3	12+1+2	8
〃 (juvenile)* ca. 20 mm	19+1+8	15+0+4	16+1+5	15+0+2	15+1+1	12+0+2	15+0+0	5

* Intervening minute rakers are omitted from the counts.

in each species are shown in Table 2.

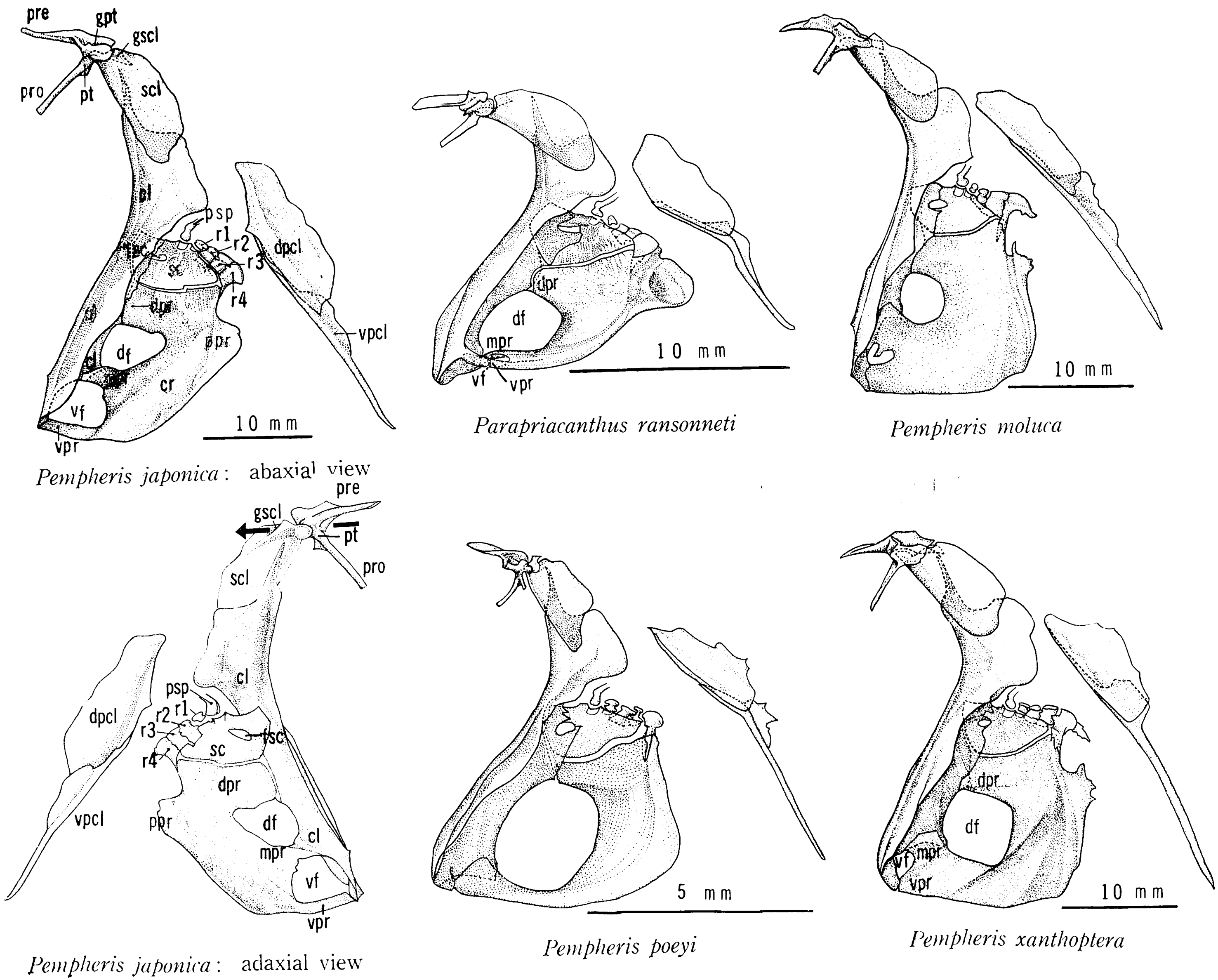
SHOULDER GIRDLE (Fig. 13)

The **posttemporal** (pt) has dorsal and ventral limbs, the former being a little longer than the latter. The dorsal limb (pre) is flattened at its anterior tip to be bound to the epiotic. The ventral limb (pro) extends forward and its tip is hidden in a dorsal view of the skull, because its attaching surface on the intercalar is ventral and anterior in position. On the abaxial surface of the bone between the bases of the limbs, the sensory canal (gpt) enters from the posterior supratemporal, pierces the bone, and passes on to the supracleithrum posteriorly. On the adaxial surface, at the junction of the two limbs, the posttemporal has a facet for the supracleithrum.

The **supracleithrum** (scl) is thickened along the anterior margin but very thin posteriorly. The anterior thickening is excavated from behind on the adaxial surface, and from the excavation Baudelot's (basioccipital-supracleithrum) ligament originates. A rounded condyle at the dorsal end of the supracleithrum articlates with a shallow facet on the adaxial side of the posttemporal. The sensory canal (gscl) from the posttemporal runs through the bone near the dorsal end, emerges posteriorly from the adaxial side, and is continuous with the first pored scales in the lateral line. The posteroventral margin of the bone is concave *Pempheris poeyi* and *P. xanthoptera*, whereas it is nearly straight in *Pempheris sasakii*, and convex in *Parapriacanthus ransonneti*, *Pempheris japonica* and *P. moluca*. The bone covers the dorsoanterior process of the cleithrum in outer view.

The **cleithrum** (cl) (clavicle of ichthyologists) is thickened along the anterior rim. Posteriorly the cleithrum is composed of two bony sheets below the level of the scapular foramen. The adaxial sheet of the bone lies flush with the scapula. The abaxial sheet is folded back upon the adaxial one, bordering the posterior border of the branchial opening and projecting over a groove for the muscles of the pectoral fin. The abaxial sheet extends dorsally and ends in a sharp process. The broad wing posterior to the process is thin and the dorsal postcleithrum attaches to its adaxial face. The ventral end of the bone meets its counterpart of the opposite side on the median line. The attaching surface for the ventral process of the coracoid is located at the ventralmost end of the cleithrum in the species of *Pempheris*, whereas it is on the abaxial sheet as a posteriorly directed wing in *Parapriacanthus ransonneti*.

The **scapula** (sc) (hypercoracoid) is perforated by the scapular foramen (fsc). Abaxially, the anterior portion of the scapula is covered by the adaxial sheet of the cleithrum, which borders the anterior margin of the foramen. In adaxial view, the foramen is located near the center of the bone. At the posterodorsal corner of the bone there is a saddle-shaped facet with which the dorsalmost ray of the pectoral fin articulates by a cartilage. A similar, but smaller, faces is opposite to the first radial of the pectoral fin (psp).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cl
psp
r1
r2
r3
r4
fsc
sc
dpcl
dpr
ppr
vpcl
df
mpr
cr
vf
vpr
10 mm
5 mm
Pempheris japonica: abaxial view
Parapriacanthus ransonneti
Pempheris moluca
Pempheris japonica: adaxial view
Pempheris poeyi
Pempheris xanthoptera

Fig. 13.

The ventral edge of the bone is separated from the coracoid by a line of cartilage.

The **coracoid** (cr) (hypocoracoid) has dorsal (dpr), median (mpr), and ventral processes (vpr), all of which join the cleithrum at their tips, and there are two fenestrae (df and vf) each bounded by the cleithrum and two of the processes of the coracoid. In *Parapriacanthus ransonneti* the dorsal fenestra opens across the sagittal plane but the ventral one opens across the horizontal plane because the ventral process turns dorsolaterally and joins the bony wing on the abaxial sheet of the cleithrum. The thoracic luminous duct runs through the ventral fenestra of *Parapriacanthus*. In the species of *Pempheris*, both of the fenestrae open in the same sagittal plane. In *Pempheris japonica* the dorsal fenestra is almost as large as the ventral one. In *Pempheris poeyi*, *P. sasakii*, *P. moluca*, and *P. xanthoptera* the dorsal fenestra is much larger than the ventral one; in *Pempheris moluca* the ventral fenestra is heart-shaped, and in *Pempheris poeyi* it is represented only by a small slit between the bones. The posterior process (ppr) of the coracoid is well developed in *Parapriacanthus* and *Pempheris* except *Pempheris poeyi*, in which it is indistinct. The posterior process is indented in *Pempheris sasakii*, *P. moluca*, and *P. xanthoptera*, whereas it is entire in *Parapriacanthus ransonneti* and *Pempheris japonica*. The posteroventral portion of the coracoid is expanded in *Pempheris poeyi*, *P. sasakii*, *P. moluca*, and *P. xanthoptera*, and in these species the ventral margin of the coracoid is united with its fellow of the opposite side forming a sharp keel along the median ventral line of the abdomen, to near the origin of the pelvic fin. In *Pempheris japonica* the coracoid is in contact with its fellow only at the anterior end of the ventral process, and in *Parapriacanthus ransonneti* only at the anterior end of the median process. In the latter two forms the median line of the abdomen is bluntly rounded.

The four **pectoral radials** (actinosts) increase in size downward. The first radial (r1) lies embedded and separated by cartilage from the scapula and the second radial. The second radial (r2) is tightly united with the scapula and third radial. It sends from the proximal end a bony wing which covers the adaxial surface of the scapula. Between the second and third radials there is usually a small interosseous space. The third radial (r3) is united with the second and fourth ones, and has, like the second, a proximal wing which covers the adaxial surface of the scapula. The fourth radial (r4) rests on the cartilage separating the scapula from the coracoid. It sends a ventroanteriorly directed wing to the adaxial surface of the coracoid. In *Parapriacanthus ransonneti* the posteroventral margin of the fourth radial is in contact and supported by the posterior process of the coracoid, whereas in *Pempheris japonica*, *P. sasakii*, *P. moluca*, and *P. xanthoptera* it is separated from the process by a notch. In *Pempheris sasakii*, *P. moluca*, and *P. xanthoptera* the posterodorsal portion of the bone is extended posteroventrally.

The **dorsal postcleithrum** (dpcl) is thickened along its anterior edge. It articulates with the adaxial face of the posterior wing of the cleithrum. The **ventral postcleithrum** (vpcl) is a slender rod with a thin posterior expansion of the bony plate at the dorsal end where it is covered by the adaxial face of the dorsal postcleithrum.

The shapes and dispositions of the bones of the shoulder girdle are traceable on the radiographs, although the superimposed image of the right and left girdles greatly obscures the details of structures.

The radiographed image of the cleithrum

Fig. 13. The shoulder girdle of the Pempheridae. cl, cleithrum; cr, coracoid; df, dorsal fenestra between cleithrum and coracoid; dpcl, dorsal postcleithrum; dpr, dorsal process of coracoid; fsc, scapular foramen; gpt, groove for sensory canal on posttemporal; gscl, groove for sensory canal on supracleithrum; mpr, median process of coracoid; ppr, posterior process of coracoid; pre, process of posttemporal for epiotic; pro, process of posttemporal for intercalar; psp, spine of pectoral fin; pt, posttemporal; r1~r4, radials of pectoral fin; sc, scapula; scl, supracleithrum; vf, ventral foramen between cleithrum and coracoid; vpcl, ventral postcleithrum; vpr, ventral process of coracoid.

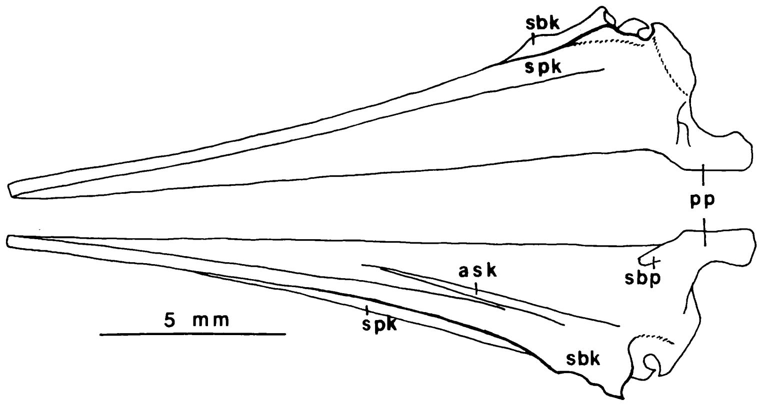

Fig. 14. Pelvic girdle of *Pempheris japonica*. Upper figure, dorsal view; lower figure, ventral view. ask, accessory subpelvic keel; pp, postpelvic process; sbk, subpelvic ekkl; sbp, subpelvic process; spk, suprapelvic keel.

and coracoid of *Parapriacanthus dispar* is like that of *Parapriacanthus ransonneti*. That of *Pempheris analis* indicates that the ventral process of the coracoid turns dorsolaterally as in *Parapriacanthus*. Those of *Pempheris compressa*, *P. klunzingeri*, and *P. multiradiata* are similar to that of *Pempheris japonica* in having a large ventral fenestra between the cleithrum and coracoid, as well as a slender posteroventral portion of the coracoid. In *Pempheris poeyi*, *P. sasakii*, *P. moluca*, and *P. xanthptera*, the radiographed image of the ventral fenestra is obscure and its existence and shape can be observed only after removal of the soft tissues. On radiographs, the ventral fenestra is also indistinct and the posteroventral portion of the coracoid is also expanded in *Pempheris mexicana*, *P. nyctereutes*, *P. oualensis*, *P. otaitensis*, *P. malabarica*, *P. vanicolensis*, *P. nesogallica*, *P. itoi*, and *P. schwenkii*. In these forms the ventral edge of the expanded coracoid is believed to form a sharp keel along the median ventral line of the abdomen.

The main shafts of the dorsal and ventral postcleithra are bent sigmoidally in *Parapriacanthus ransonneti*, *P. dispar*, and *Pempheris analis*. They are slightly bent in *Pempheris poeyi*, and are nearly straight in the remaining species of *Pempheris*.

The dorsal fenestra between the coracoid and cleithrum is traversed by the pelvic girdle in *Pempheris poeyi*, *P. mexicana*, *P. nyctereutes*, *P. sasakii*, *P. oualensis*, *P. otaitensis*, *P. moluca*, *P. malabarica*, *P. vanicolensis*, *P. nesogallica*, *P. itoi*, *P. schwenkii*, and *P. xanthoptera*, and in these forms the pelvic girdle is held between the posteroventral expansions of the coracoid close to where it forms an articular head for the pelvic fins. In *Parapriacanthus ransonneti*, *P. dispar*, and *Pempheris analis* the pelvic girdle traverses also the lower portion of the dorsal fenestra, but the posterior half of the pelvic girdle is free from the coracoid. In *Pempheris japonica*, *P. compressa*, *P. klunzingeri*, and *P. multiradiata*, the pelvic girdle traverses the median anterior process of the coracoid below the dorsal fenestra.

In the holotype of *Pempheris muelleri*, the thoracic portion is damaged, and none of the characters of the shoulder girdle could be observed on its radiograph.

PELVIC GIRDLE (Fig. 14)

The pelvic girdle is a slender bone, with its anterior end joined to the cleithrum by cartilage. The bone is equipped with suprapelvic, (spk), subpelvic (sbk) and accessory subpelvic keels (ask) on the shaft and postpelvic (pp) and subpelvic (sbp) processes. The bone is united by cartilage with its conuterpart at the adaxial face of the postpelvic process and the anterior end, and a narrow median interosseous space is formed between the bones of the two sides. In *Parapriacanthus ransonneti* and *Pempheris japonica*, the

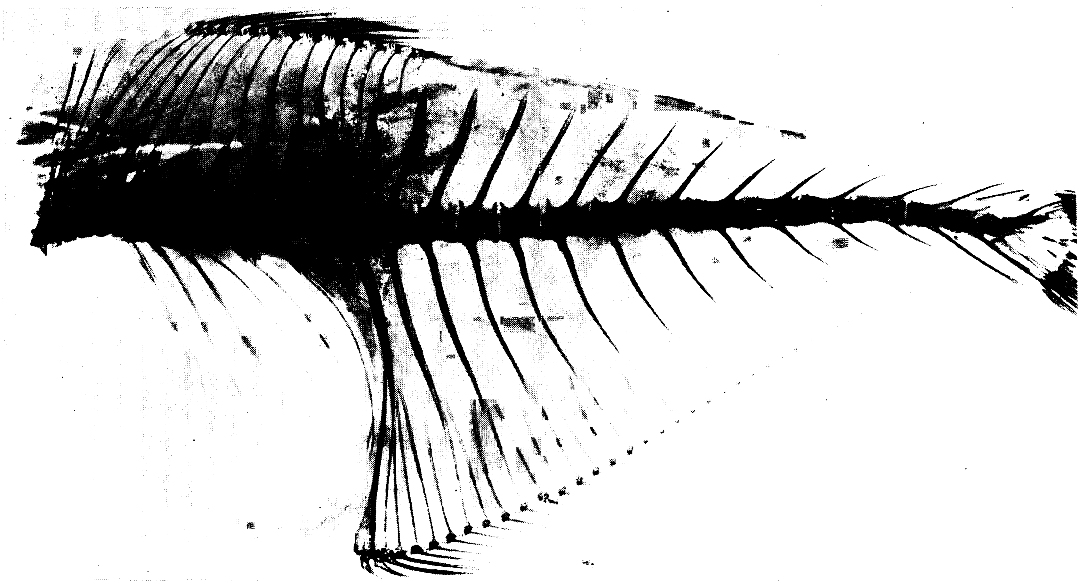

Fig. 15. Radiograph of axial skeleton, ribs, and pterygiophores of vertical fins of *Pempheris xanthoptera*. First rib was torn off.

subpelvic keel is larger and extends more anteriorly than the accessory subpelvic keel, whereas in *Pempheris sasakii*, *P. moluca*, and *P. xanthoptera* the former is smaller than the latter. The postpelvic and subpelvic processes are longer and slenderer in *Parapriacanthus ransonneti* than in the species of *Pempheris*. The disposition of the bone in relation to the coracoid is described above. The pelvic fin has a spine and five branched soft-rays; however, in some specimens of *Parapriacanthus ransonneti*, the spine is replaced by an unbranched articulate ray (Tominaga, 1963).

One to several scales between the lateral border of the pelvic spine and the body are, however, modified to form an axillary process which is often indistinct.

VERTEBRAE (Fig. 15)

The number of the vertebrae is constantly 25 (10+15) including the urostylar vertebra. Günther (1860 : 508) and Boulenger (1902 : 202, ? original) reported that the number of vertebrae in *Pempheris otaitensis* was 24 (10 +24, including the urostylar vertebra), and since then, this number has been repeatedly cited by many ichthyologists as one of the characters of the Pempheridae. However, Dr. P. H. Greenwood of the British Museum (Natural History) kindly informed me that the vertebral number of Günther's specimen is actually 10+15 including the urostylar vertebra.

On the anterodorsal surface of the first vertebra (atlas), a pair of condyles fit into the exoccipital condyles. These expand dorsally like the exoccipital condyles. The concave face articulating with those of the basioccipital is on the anteroventral surface. The first neural spine is not fused with the centrum of the first vertebra.

At the hinder end of each of the anterior three vertebrae, a pair of bony wings expand laterodorsally to clasp the next vertebra. The parapophyses begin from the third vertebra, on which they are very small.

The floors of the haemapophyses of some abdominal (precaudal) vertebrae are modified to form lamellar bony expansions. They form the contiguous ventral wall of the bony tube investing the haemal canal, and are tightly united ventrally with the air bladder. In *Pempheris sasakii*, *P. schwenkii*, and *P. xanthoptera* the haemapophyses of the fourth to seventh vertebrae are modified to form the lamellar expansions; in *Pempheris japonica* and *P. klunzingeri*, those of the fifth to the seventh; in *Pempheris moluca* and *P. vanicolensis* those of the fourth to the sixth;

in *Pempheris multiradiata*, those of the fifth and sixth; in *Parapriacanthus ransonneti*, those of the sixth and seventh. In *Pempheris poeyi* no haemapophysis is modified to form a lamellar expansion. The haemal arches of the eighth to tenth vertebrae are normal in all the species and the haemapophyses are longer posteriorly.

In the fifth to tenth vertebrae, the side walls of the neural arch are as high as the height of the centra and slant forward, each overhanging that of the preceding vertebra. The height of the neural arches decreases posteriorly and the neural pre- and post-zygapophyses are more or less developed in the caudal vertebrae. The haemal pre- and postzygapophyses are absent or vestigial in the caudal vertebrae.

The centrum of the first vertebra (atlas) is deeper than the succeeding vertebrae and longer than the second. The centrum of the second vertebra (axis) is the shortest, and the succeeding three centra markedly increase in length posteriorly. In *Pempheris* the centra of the vertebrae posterior to the fifth one gradually increase in length to the 19th; the 19th to 22nd centra are of the same length and the longest of the series. In *Parapriacanthus* all centra except some anterior and posterior ones are approximately equal in length. The ratio of the mean length of the centra of the 11th to 22nd vertebrae (anterior 12 caudal vertebrae) to that of the fifth to tenth vertebrae (posterior six abdominal vertebrae) is about 1.0 in *Parapriacanthus ransonneti*, 1.1 to 1.3 in *Pempheris analis*, *P. japonica*, *P. compressa*, *P. klunzingeri*, *P. multiradiata*, and *P. poeyi*, and greater than 1.3 in the remaining species of *Pempheris*. The centra of the 22nd to 24th vertebrae of both *Pempheris* and *Parapriacanthus* decrease in length posteriorly.

Te neural spines are pointed at their tips, except for the 23rd and 24th. The first neural spine, which is not ankylosed with the centrum, is short and slender. The third to tenth neural spines have anterior and posterior thin processes or wings. The neural spines increase in length from the first to the fourth. Those behind the fourth decrease in length to the seventh or eighth, which is the shortest of those of the abdominal vertebrae behind the fourth. From the eighth, the neural spines increase again in length posteriorly to the 12th or 13th, which is the longest of the spines; those behind the longest spine gradually decrease in length posteriorly to the 22nd. The 23rd (penultimate) spine is almost twice as long as the 22nd and reaches the dorsoanterior end of the caudal-fin base. The 24th is short, irregular in shape, and situated below the first epural.

The haemal spines are pointed at their distal tips, except for the last three (13th to 15th). The first haemal spine is not stouter and longer than the second one in *Parapriacanthus ransonneti*, *P. dispar*, *Pempheris analis*, *P. multiradiata*, and *P. poeyi*. In the remaining species of *Pempheris* the first one is stouter and longer than the second one, and its tip is inclined forward. Those behind the second decrease in length posteriorly to the 12th. Thirteenth to 15th are long and are tightly attached to, but not coalesced with, the centra. Their distal ends are truncate unlike the preceding ones, and support the rays of the caudal fin.

RIBS AND EPIPLEURALS

The ribs are eight in number on either side, attaching to the third to tenth vertebrae. The anterior two or three originate from the centra, and the posterior five from the haemal arches in *Pempheris*. In *Parapriacanths* the anterior four ribs originate from the centra.

The epipleurals are eight to ten on either side. The first two are attached to the centra of the first and second vertebrae. The third to the seventh originate from the ribs of the third to seventh vertebrae. The eighth to the tenth arise from the haemal arches of the eighth to tenth vertebrae, but are often absent.

DORSAL FIN

In the following descriptions of the dorsal and anal fins, the term "pterygiophore" indicates a set of basal, median and distal radials which may or may not be fused to form a single ossification.

The predorsal rayless pterygiophores are three in number and slightly expanded at their distal ends. The first one is inserted in front of the first neural spine, the second between the first and second neural spines, and the third between the second and third neural spines. In *Pempheris poeyi* each of the predorsals is segmented near its proximal end.

The number of the pterygiophores of the dorsal fin equals with the total number of the spines and soft-rays. It ranges from 13 (*Pempheris poeyi*) to 17 (*Pemperis japonica* and *P. multiradiata*). In *Parapriacanthus ransonneti*, *P. dispar*, *Pempheris mexicana*, and *P. muelleri* the most common number is 14, whereas in *Pmpheris compressa* and *klunzingeri* it is 16. In *Pempheris analis*, *P. nyctereutes*, *P. sasakii*, *P. oualensis*, *P. otaitensis*, *P. moluca*, *P. malabarica*, *P. vanicolensis*, *P. nesogallica*, *P. itoi*, *P. schwenkii*, and *P. xanthoptera* the mode of the number is 15.

Each of the basal radials is a bony shaft which is expanded bilaterally and provided with thin median anterior and posterior bony flanges. The proximal tips of the basal radials are truncate and capped with cartilage.

The first basal radial of the dorsal fin is inserted between the second and third neural spines and behind the third predorsal rayless pterygiophore. The first dorsal spine rests on the first basal radial, and the second spine articulates with the first distal radial and

Table 3. Dorsal and anal fins of the Pempheridae.

	Dorsal fin	Anal fin	Anal pterygiophores between 1st and 2nd haemal spines
Parapriacanthus			
ransonneti	IV～VI, 8～10	(II)～III, 18～23	2～3
dispar	VI, 8	III, 22～23	3
Pempheris			
analis	VI, 9	III, 31～33	4
klunzingeri	V, 10～11	III, 37～39	6～7
compressa	VI, 10～11	III, 33～38	6～7
japonica	VI～(VII), 10～12	III, 33～39	5～6
multiradiata	V, 12	III, 37	4*
poeyi	IV, 9	III, 24	4
mexicana	V, 9**	III, 35	6
muelleri	V, 9	III, 33	6
nyctereutes	VI, 9	III, 43～44	7
sasakii	VI, 9～10	III, 41～45	6～8
oualensis	VI, 9	III, 41	6
otaitensis	VI, 9	III, 40	6
moluca	(V)～VI, 9	III, 41～44	7～8
malabarica	VI, 9	III, 43	6～7
vanicolensis	VI, 8～9	III, 40～41	6～7
nesogallica	VI, 9～10	III, 38～39	6
itoi	VI, 9	III, 43～44	7
schwenkii	VI, 9	III, 36	6
xanthoptera	(V)～VI, 8～10	III, 34～41	5～6

* The first anal pterygiophore, which is usually situated in front of the first haemal spine, is inserted in this specimen between the first and second haemal spines, and is not included in the count.

** Cf. p. 83.

also rests on the second basal radial in all the species of *Pempheris* except *Pempheris poeyi*. In *Parapriacanthus ransonneti* and *Pempheris poeyi* the distal radial is absent in the first pterygiophore, the anteriormost spine of the dorsal fin rests on the second basal radial, and the second spine is attached to the distal radial of the second pterygiophore.

Each of the succeeding pterygiophores is made up of the basal and distal radials, and to each of the distal radials a spine or a soft-ray of the dorsal fin is articulated, except the last pterygiophore which lacks the distal element. The last soft-ray is attached to the distal radial of the penultimate pterygiophore, and rests on the last basal radial.

The dorsal fin-ray formula of each of the species is shown in Table 3.

The second pterygiophore only is inserted between the third and fourth neural spines in *Pempheris poeyi*, *P. muelleri*, and *P. mexicana*, whereas in the remaining species of *Pempheris* and *Parapriacanthus* the third is also inserted in the same interspace together with the second. Each of the interspaces between each neighboring two of the fourth to ninth neural spines is usually occupied by a single pterygiophore. In occasional cases, two pterygiophores are inserted into one of two neighboring interspaces, and none into another. There are two pterygiophores between each neighboring two of the ninth to 11th neural spines in the species of *Pempheris*. Most of the specimens of *Parapriacanthus ransonneti* and one of the two specimens of *P. dispar* have one pterygiophere between the ninth and tenth neural spines, and two between the tenth and 11th. There are two pterygiophores between the ninth and tenth, and one between the tenth and 11th in a few specimens (less than 10 per cent of individuals) of *Parapriacanthus ransonneti* and the other one of *P. dispar*.

ANAL FIN

The number of the pterygiophores of the anal fin (=number of soft-rays +2) is more variable from species to species than that of the dorsal fin. In *Parapriacanthus ransonneti* and *P. dispar* the number is less than 30, whereas it is more than 30 in the species of *Pempheris* excluding *Pempheris poeyi* in which, as in the species of *Parapriacanthus*, it is less than 30. The number of pterygiophores is less than 40 in most of the specimens of *Pempheris analis*, *P. compressa*, *P. japonica*, *P. multiradiata P. mexicana*, *P. muelleri*, *P. schwenkii*, and *P. xanthoptera*, whereas it is more than 40 in those of the remaining species of *Pempheris*. The counts of the anal fin-rays and the pterygiophores are given in Table 3.

The basal element of the first pterygiophore bears two spines. The third spine of the anal fin is articulated with the distal radial of the first pterygiophore and rests on the basal radial of the second pterygiophore. The first pterygiophore is in front of the first haemal spine, except in one specimen of *Pempheris multiradiata*, in which the first pterygiophore is inserted posterior to the first haemal spine. The first pterygiophore is straight or slightly bent forward in *Parapriacanthus ransonneti*, *P. dispar*, *Pempheris analis*, *P. poeyi*, *P. mexicana*, *P. sasakii*, *P. schwenkii*, and *P. xanthoptera*, whereas it is bent backward in *Pempheris compressa*, *P. klunzingeri*, *P. japonica*, *P. nyctereutes*, *P. oualensis*, *P. otaitensis*, *P. moluca*, *P. malabarica*, *P. vanicolensis*, *P. nesogallica*, and *P. itoi*.

The pterygiophores posterior to the second one are made up of basal and distal radials, except the posteriormost one, which lacks the distal element. The second to penultimate basal radials are slender and rod-like, each having anterior and posterior thin bony flanges. Their proximal tips are truncate. The last basal radial is thin and short. Several anterior distal radials are made up of a pair of ossicles.

In *Parapriacanthus ransonneti*, *P. dispar*, *Pempheris analis*, *P. multiradiata*, and *P. poeyi*, which have a weak and straight first haemal spine, only two to four pterygiophores are inserted between the first and second haemal spines, and none of them are in contact with the first haemal spine. In the remaining species of *Pempheris*, which have a stout and anteriorly inclined first haemal spine, five to eight pterygiophores are present between the first and second haemal spines, and tips of the

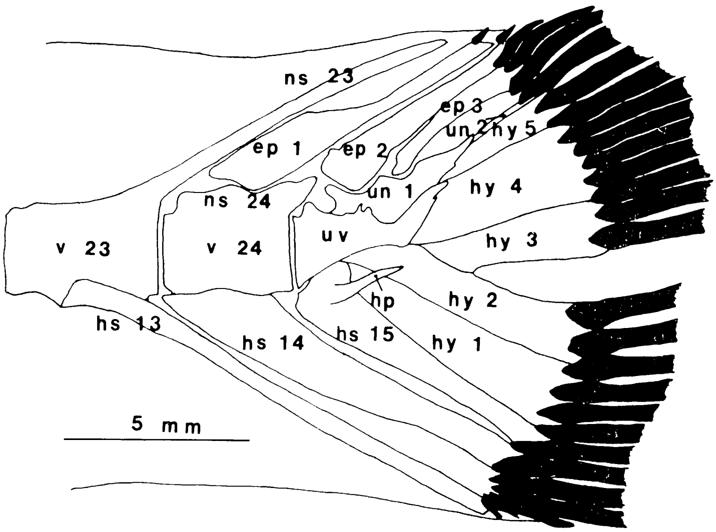

Fig. 16. Caudal fin skeleton of *Pempheris japonica*. ep 1~3, 1st to 3rd epurals; hp, hypuropophysis; hs 13~15, 13th to 15th haemal spines; hy 1~5, 1st to 5th hypurals; ns 23 and 24, 23rd and 24th neural spines; un 1 and 2, 1st and 2nd uroneurals; uv, urostylar vertebra; v 23 and 24, 23rd and 24th vertebrae.

second to the fourth or the second to the sixth pterygiophores are in contact with the postero-ventral edge of the first haemal spine.

The average number of the pterygiophores in each of the spaces between neighboring two of the second to the tenth haemal spines is less than three in *Parapriacanthus ransonneti*, *P. dispar*, and *Pempheris poeyi*, whereas in the remaining species of *Pempheris* it is more than three.

The last soft-ray of the anal fin articulate with the distal radial of the penultimate pterygiophore and rests on the last basal radial. The distal radial is absent in the last pterygiophore. The last basal radial is inserted in front of or behind the 11th haemal spine.

CAUDAL FIN (Fig. 16)

The branched rays of the caudal fin are constantly 15(8+7), with a long unbranched ray above and another one below. Three to seven vestigial rays are in front of each of the unbranched rays. The most anterodorsal vestigial ray originates from the first epural and just posterior to the 23rd neural spine. The most anteroventral one is supported by the 13th haemal spine.

There are three **epurals** (ep 1~3) which decrease in length posteriorly and support the unbranched rays anterodorsal to the main portion of the caudal fin. The **first uroneural** (un 1) is notched to receive the proximal ends of the second and third epurals. The **second uroneural** (un 2) supporting the second dorsal unbranched ray counted from behind is present in *Pempheris japonica*, whereas the second uroneural is absent in *Pempheris xanthoptera*. To observe the second uroneural, the complete disarticulation of the caudal fin elements is necessary. In the remaining species its presence or absence is not yet made clear.

The **urostylar vertebra** (uv) is simple in all species of *Parapriacanthus* and *Pempheris*. The five **hypurals** (hy 1~5) are separated from each other in *Pempheris analis*, *P. compressa*, *P. klunzingeri*, *P. japonica*, *P. multiradiata*, *P. poeyi*, *P. nyctereutes*, *P. sasakii*, *P. oualensis*, *P. otaitensis*, *P. moluca*, *P. malabarica*, *P. vanicolensis*, *P. nesogallica*, *P. itoi*, *P. schwenkii*, and *P. xanthoptera*, whereas in *Parapriacanthus ransonneti*, *P. dispar*, *Pempheris mexicana*, and *P. muelleri*, the first hypural is fused with the second, and the third with the fourth. The first and second hypurals are widely separated from each other in *Pempheris analis*, *P. klunzingeri*, *P. compressa*, and *P. multiradiata*. There is a deep notch between the second and third hypurals in *Parapriacanthus ransonneti*, *P. dispar*, *Pempheris analis*, *P. klunzingeri*, *P. compressa*, *P. japonica*, *P. oualensis*, *P. otaitensis*, whereas the notch is very shallow or absent in *Pempheris poeyi*, *P. mexicana*, *P. muelleri*, *P. nyctereutes*, *P. sasakii*, *P. moluca*, *P. malabarica*, *P. vanicolensis*, *P. nesogallica*, *P. itoi*, *P. schwenkii* and *P. xanthoptera*.

The **hypuropophysis** (hp) is slender and pointed in all species of *Parapriacanthus* and *Pempheris* except *Pempheris poeyi*, in which it is short and blunt.

The 13th and 14th haemal spines are separated from each other at their tips, and a mass of cartilage supporting several anteroventral unbranched rays occupies the space between them.

AIR BLADDER

The air bladder is absent in *Pempheris poeyi*, but in *Parapriacanthus* and other species of *Pempheris* it is present.

It is simple in *Parapriacanthus ransonneti*, *Pempheris japonica*, and *P. sasakii*, whereas it is divided into an anterior smaller chamber and a posterior larger one by a constriction in *Pempheris moluca* and *P. xanthoptera*. Cuvier (1831 : 303) reported that the air bladder of *Pempheris oualensis* is constricted. The shape of the air bladder, as traced on the radiographs, is simple in *Pempheris klunzingeri* and *P. nyctereutes* and divided into two by a constriction in the type specimens of *Pempheris otaitensis*, *P. moluca*, *P. vanicolensis*, and *P. nesogallica*.

ALIMENTARY CANAL (Fig. 17)

The **stomach** (st) is thick-walled and V-shaped. The number of **pyloric caeca** (p 1～10) is ten in *Parapriacanthus ransonneti* and *Pempheris japonica*, and nine in *Pempheris poeyi*, *P. sasakii*, *P. moluca*, and *P. xanthoptera*. Cuvier (1831 : 303) reported the pyloric caeca of *Pempheris oualensis* as being six to seven. In *Parapriacanthus ransonneti* the fifth and sixth pyloric caeca counted from the left are short and directed forward, and each of their anterior tips is connected by a duct (dl) with the thoracic luminous duct (Haneda and Johnson, 1962 a, b). All the pyloric caeca are finger-like and directed posteriorly in *Pempheris*. In *Pempheris klunzingeri*, they number ten, and the fifth and sixth ones counted from the left are themselves transformed to a V-shaped luminous duct which is embedded in translucent thoracic muscle (Haneda et al., 1966).

The **intestine** (int) is short and winds on the right side of the stomach. The mode of winding of the alimentary canal is simple in all of the specimens dissected.

LUMINESCENT ORGAN SYSTEM

As reported by Haneda and Johnson (1958), *Parapriacanthus ransonneti* is a luminescent fish. The structure of the luminescent organ system has been described in detail by these authors (1962 a, b). Its luciferin-luciferase system cross-react with that of an apogonid. fish, *Apogon ellioti* (Haneda et al., 1958; Johnson et al., 1961). *Parapriacanthus unwini* and *P. elongatus* have also been reported to have the luminous ducts similar to those of *P. ransonneti* (Haneda, 1967).

Pempheris klunzingeri is also luminescent, and its luminescent organ system is essentially similar in structure to that of *Parapriacanthus* (Haneda et al., 1966). *Pempheris analis* may be a luminescent fish (cf. Waite, 1910 : 376; Tominaga, 1963 : 276), with a Y-shaped pigmented area in front of the anus which probably representes the pigmented layer of the luminous duct.

Mutual Relationships

RELATIONSHIP BETWEEN *PARAPRIACANTHUS* AND *PEMPHERIS*

When *Parapriacanthus ransonneti* and *Pempheris moluca* are chosen for comparison of the two genera, it is felt unconvincing that these two forms belong to a single family, because there are so many marked differences between them.

First, *Pempheris moluca* differs from *Parapriacanthus ransonneti* in having the peculiar, *Beryx*-like body form. The following three transformations would be necessary to induce the body form of *Pemphiris moluca* from that of *Parapriacanthus ransonneti*: (1)