

REVISION OF THE SYSTEMATICS AND INTERRELATIONSHIPS  
OF AMERICAN DRUMS *PARALONCHURUS* AND *LONCHURUS*  
(Pisces: Sciaenidae)

Japahuge Jinadasa

Department of Zoology,  
University of Sri Jayewardenapura,  
Nugegoda, Sri Lanka.

Received on 01 - 02 - 94

Accepted on 21 - 10 - 94

This paper is an abbreviated version of the original manuscript edited by Professor Charles F. Cole, of the Ohio State University, Columbus, Ohio, U.S.A. The original version is in the Biological Science Library of the University of Sri Jayewardenapura, Nugegoda, Sri Lanka.

**Abstract**

Based on external and internal morphology, osteology and morphometrics the seven species of *Paralonchurus* Bocourt are grouped into two subgenera, *Paralonchurus* and *Polyclemus*. The monotypic *lonchurus* Bloch was more similar to *P. elegans* and *P. petersi* than to *P. brasiliensis*, *P. dumerili*, *P. goodei*, *P. peruanus* and *P. rathbuni* in most of the characters investigated.

The relationships among the species of *Paralonchurus* and *L. lanceolatus* are determined on the basis of mental pores, mental barbels, snout pores, external morphology, swim bladder and its muscular anatomy, jaw muscles and osteology. The morphology of retractor arcum branchialium (RAB), lower jaw muscles and pharyngeal skeletons are used to demonstrate the relationships of *Paralonchurus* and *Lonchurus* to other euteleostean fishes. Both genera possess primitive euteleostean characters.

**Key Words :** *Paralonchurus* Bocourt, *Lonchurus* Block, Subgenera, Phylogeny.

**1. Introduction**

Species of the family *Sciaenidae* (Teleostei) are usually referred to as drum fishes or croakers, because they are making noises. All species of sciaenidae are demersal fishes and primarily occur in tropical seas, inhabiting prawn fishing grounds. The total production of drum fishes in the world is about 1.12% of the total (FAO, 1992). These fishes have well developed and diversified swim bladders and otoliths. Their morphology together with the number of mental and rostral pores are used to identify, classify and assess the phylogeny of the species of the family sciaenidae (Chao, 1976, Chu, 1963, Trewawas, 1962, Jinadasa, 1978). The most elaborated work on the taxonomy of sciaenid fishes was by Chao (1976). He had worked on the taxonomy of the western

Atlantic species of sciaenidae and classified into species, genera, and tribes based on the morphology of the swim bladder, otolith, mental and rostral pores and barbels. In his study, he had raised the question whether the Atlantic monotypic genus *Lonchurus* Bloch 1793 is related to the genus *Paralonchurus* Bocourt (1869). The genus *Paralonchurus* itself contained seven species, some of which were classified under different genera, namely, *Polycirrhus* Bocourt (1869), *Polyclemus* Berg (1895) and *Genyanemus* Gill (1861).

The objectives of the present study were to assess whether the morphology of the swim bladder, otolith, number of mental and rostral pores and osteology could be used to identify the species of *Paralonchurus* and also to understand their interrelationships with *Lonchurus lanceolatus*. All eight species are distributed on either side of isthmus of Panama, in the Atlantic and Pacific oceans, and no where else.

## 2. Material and Methods

Specimens were obtained from the California Academy of Sciences (CAS), National Museum of Canada, Ottawa (NMC), Smithsonian Sorting Center, National Marine Service Southeast Fishery Center (Tropical Atlantic Biological Laboratory, TABL) and the National Museum of Natural History (USNM). A few alcohol-preserved specimens from each species were made available for dissections and for staining. Three specimens of each species were dissected to study morphology of the alimentary system, kidneys, gonads and swim bladder, olfactory rosette, arcum branchial muscle, breast and barbel muscles. After removal of viscera, five specimens from each of the species were cleared in Tripsin and stained with Alizarine red S following Taylor (1967). These stained specimens were used to study cranial, axial, caudal, appendicular and branchial skeletons. Bones were first investigated in their articulated portion. Some preparations were subsequently disarticulated in 3% KOH solution. Measurements of bones were taken using a dial caliper. Examinations and illustrations were made using a dissecting microscope. In addition to stained specimens from each species, I made superficial examinations of other specimens.

Measurements and counts of these specimens were taken following Lagler (1956) and Hubbs and Lagler (1947). Measurements of head length, greatest body length, pectoral length, predorsal length, preventral length (base of ventral fin to snout tip), caudal peduncle length, caudal peduncle depth, dorsal fin length, anal fin length, snout length, upper jaw length, eye diameter, interorbital space width, longest dorsal spine length, first dorsal ray length, second spine length and first anal ray length were taken to 0.25 mm. using a dial caliper. Fin ray counts, rows of scales above lateral line, lateral line scales, circumcaudal scales and interorbital scales were counted. The number of vertebrae, intermuscular bones, fin elements and hyperossifications were determined from radiograph.

The following abbreviations were used : A. Anal fin, A. L. L. S. Scales above lateral line, B. barbels, D. dorsal fin, L. lateral line scales, P. pectoral fin, V. pelvic fin.

### Soft Anatomy

The relative positions, shapes, and size of the viscera, kidney, and olfactory rosette provide valuable diagnostic characters to identify species of *Paralanchurus* and *Lonchurus*.

### 3. Results

In all species of *Paralanchurus*, the barbels are connected to the branches of the mandibular muscle of the adductor mandibularis ; in *L. lanceolatus*, the two barbels are connected to the branches of the posterior hyoideus muscle and are inserted under the chin on either side of the middle line. Those of *Paralanchurus* are inserted under the chin in the middle line and extend back along the rostrum of the mandibuli. Thus the pair of barbels in *L. lanceolatus* and the barbels in species of *Paralanchurus* are not homologous structures. All species of *Paralanchurus* have morphologically identical mental and rostral pores ; these pores are slightly different in *L. lanceolatus* (Fig. 1.)

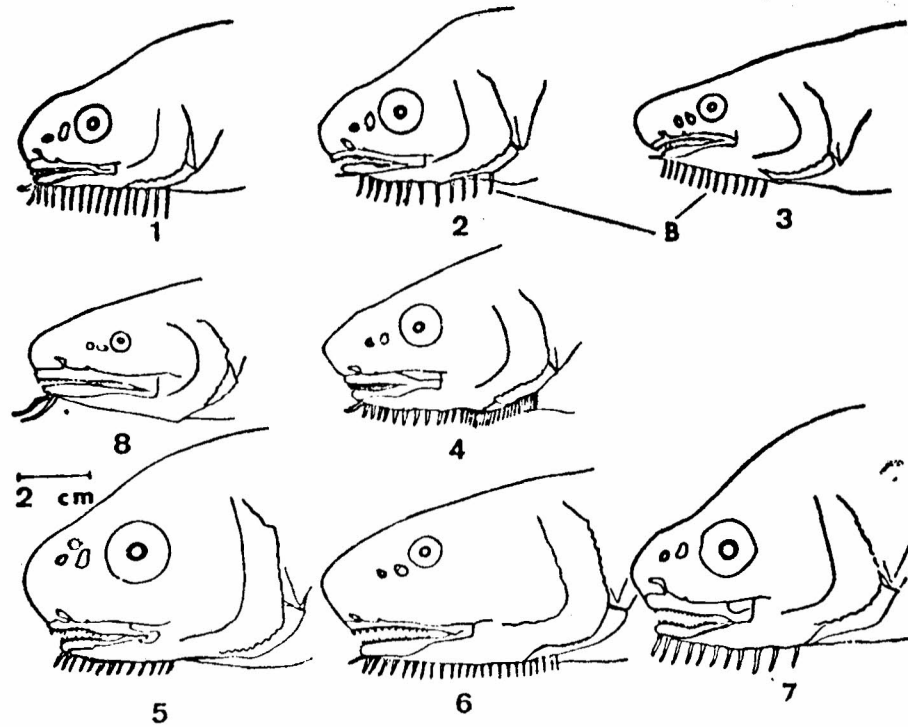


Fig. 1. Left lateral profile of the head and barbels : (1) *P. brasiliensis* (178 mm SL) ; (2) *P. dumerili* (160 mm SL) ; (3) *P. elegans* (185 mm SL) ; (4) *P. goodci* (180 mm SL) ; (5) *P. peruanus* (185 mm SL) ; (6) *P. petersi* (178 mm SL) ; (7) *P. rathbuni* (184 mm SL) ; and (8) *L. lanceolatus* (132 mm SL).



Soft anatomical organs like the olfactory rosette, stomach and alimentary canal, liver and swim bladder are useful to identify species of sciaenids. Olfactory rosette of *P. brasiliensis*, *P. dumerill*, *P. rathbuni*, *P. Peruanus* and *P. goodei* is oval in shape with wide thick olfactory lobes, where as that of *P. petersi*, *P. elegans* and *L. lanceolatus* is also oval in shape but the lobes are thin walled and folded. (Fig. 2). Morphology of kidney and gonads showed no difference among eight species. However, a few specimens of *P. peruanus* examined contained both mature testis and ovary.

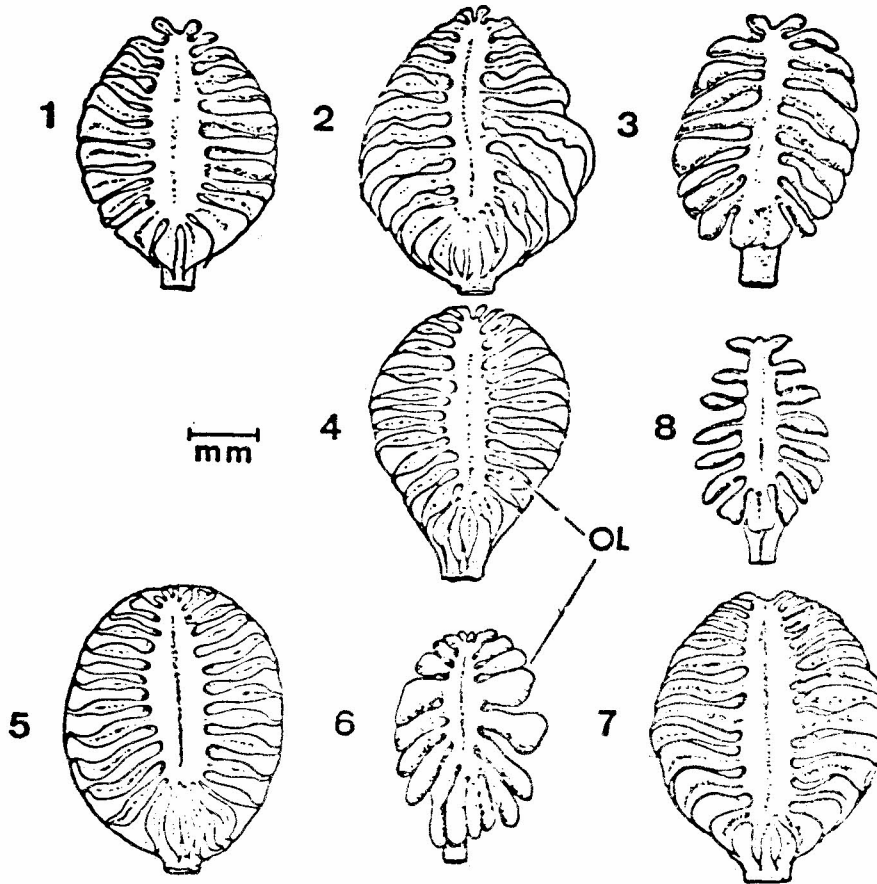


Fig. 2. Dorsal view of the olfactory rosettes : (1) *P. brasiliensis* (178 mm SL) ; (2) *P. dumerilli* (173 mm SL) ; (3) *P. elegans* (185 mm SL) ; (4) *P. goodei* (178 mm SL) ; (5) *P. peruanus* (185 mm SL) ; (6) *P. petersi* (140 mm SL) ; (7) *P. rathbuni* (178 mm SL) ; and (8) *L. lanceolatus* (128 mm SL). OL. Olfactory folds.

All species possess both cycloid and ctenoid scales. In *P. elegans*, *P. petersi* and *L. lanceolatus*, scales are predominately cycloid, in *P. peruanus*, *P. brasiliensis*, *P. dumerilli*, *P. goodei*, and *P. rathbuni* scales are predominately ctenoid.

The stomach is saccular and posteriorly it is club-shaped, lying longitudinally in the body cavity. The esophagus leads to it through the anterior end and the abdomen also leaves the stomach anteriorly but to the right of the esophagus. Intestine is relatively short and about  $\frac{2}{3}$  of the standard length. It makes just one U loop and runs straight to the vent. Anterior end of the stomach has a cap of hepatic caecae, their number and shape are characteristic to species. Stomach and the alimentary canal of the eight species are similar. However, liver showed species specific characters (Fig. 3).

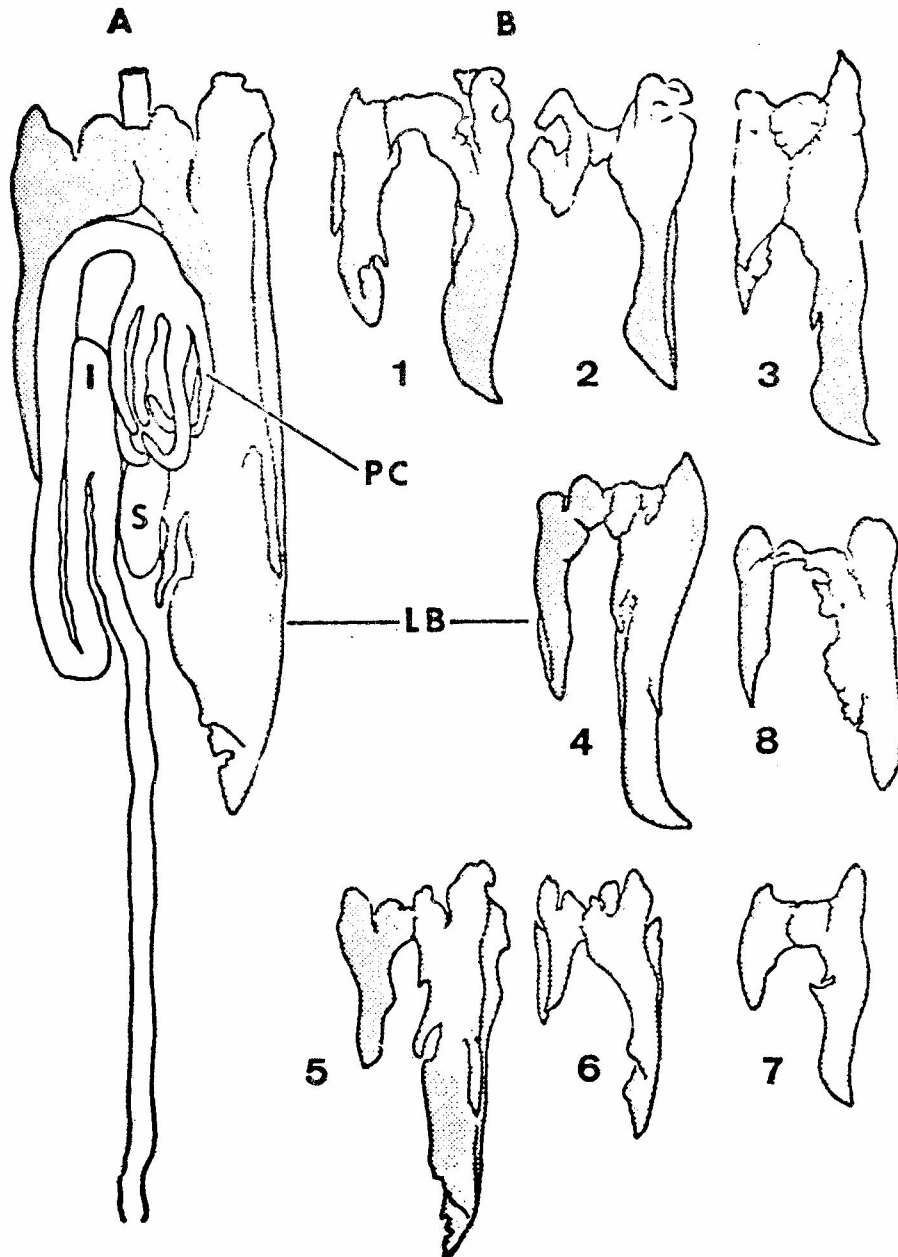


Fig. 3. (A) Ventral view of the intestine, liver, pyloric caeca, and stomach of *P. peruanus*.

(B) Ventral view of the livers : (1) *P. brasiliensis* (178 mm SL) ; (2) *P. dumerili* (163 mm SL) ; (3) *P. elegans* (185 mm SL) ; (4) *P. goodei* (178 mm SL) ; (5) *P. peruanus* (185 mm SL) ; (6) *P. petersi* (140 mm SL) ; (7) *P. rathbuni* (168 mm SL) ; and (8) *L. lanceolatus* (128 mm SL). PC, Pyloric caeca, LB, Liver lobes.

The swim bladder of *Paralonchurus* (Fig. 4) has a central carrot-shaped body tapering posteriorly to a point inside the body vertically above either the vent or anal spines. The bladder is supported at its anterior end by the obliquely and anteriorly directed hypophyses of the third and fourth vertebrae. Laterally on either side of the attachment of the swim bladder is a pair of thin sacs. They bifurcate laterally, the two anterior branches running forward like two horns, their tips are curved and lie on either side of the esophagus and are ventral to the posterior end of the basioccipital, but have no connection to the esophagus or basioccipital. The two posterior branches run parallel to the main body of the swim bladder and end almost at the same level as the swim bladder posteriorly. The main cavity of the swim bladder is continuous from the main bladder with all lateral horns. The swim bladder walls of *P. elegans* and *L. lanceolatus* is very thick and the cavity is large, balloon-like. The location of the posterior ends of the swim bladder and its lateral horns relative to the position of the vent and anal spines are characteristic to species (Table 1).

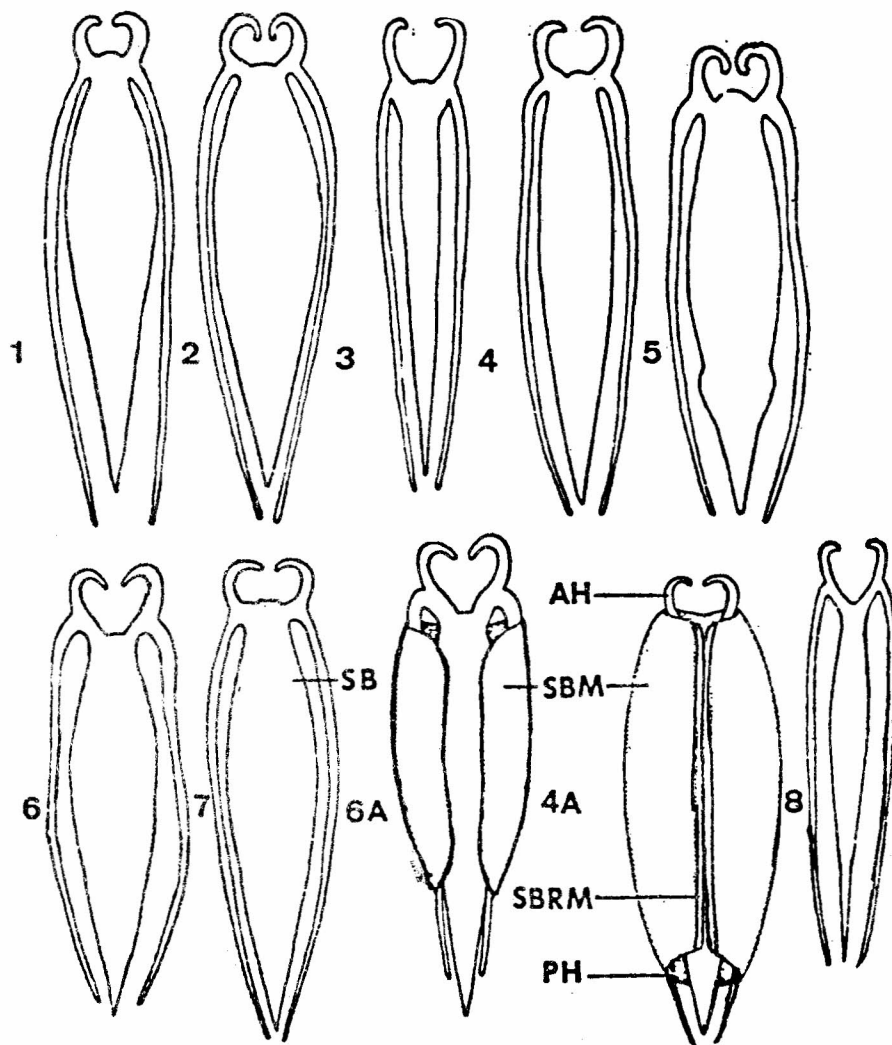


Fig. 4. Ventral view of swim bladders in females : (1) *P. brasiliensis* (178 mm SL) ; (2) *P. dumerili* (163 mm SL) ; (3) *P. elegans* (185 mm SL) ; (4) *P. goodei* (178 mm SL) ; (5) *P. peruans* (185 mm SL); (6) *P. petersi* (140 mm SL); (7) *P. rathbuni* (168 mm SL) ; and (8) *L. lanceolatus* (128 mm SL).

Ventral view of swim bladders in males with swim bladder muscles : (4A) *P. goodei* 178 mm SL) ; and (6A) *P. petersi* (140 mm SL). SB, Swim bladder, AH, Anterior horn of swim bladder, SBM, Swim bladder muscle, PH, Posterior horn of swim bladder, SBRM, Swim bladder red muscle.

The swim bladder muscles of *P. goodei* have a ventral longitudinal strip of red muscles that fastens the two lateral flaps of the swim bladder muscles together. In this species and *L. lanceolatus*, the swim bladder muscle is at its greatest development and length exceeds 3/4 of the length of the swim bladder. The least developed swim bladder muscle is in *P. petersi* and its length is only 1/2 of the length of the swim bladder.

**Table 1. Relative positions of posterior ends of swim bladder and its lateral horns in species of *Paralanchurus* and *Lonchurus*.**

Species	Main swim bladder	Lateral horns
<i>P. brasiliensis</i>	vent	anal spine I
<i>P. dumerili</i>	anal spine I	anal spine II
<i>P. elegans</i>	vent	anal spine I
<i>P. goodei</i>	vent	anal spine I
<i>P. peruanus</i>	anterior to vent	vent
<i>P. petersi</i>	vent	anal spine I
<i>P. rathbuni</i>	anal spine I	anal spine II
<i>L. lanceolatus</i>	vent	anterior to vent

According to Chao (1976) both males and females of *L. lanceolatus* lack swim bladder muscle. However, present investigations indicated swim bladder muscles in males of *L. lanceolatus* are well developed.

Upper and lower jaw muscles of the eight species are identical except that in *P. peruanus*, *P. brasiliensis*, *P. dumerili*, *P. rathbuni* and *P. goodei* are robust where as in *P. petersi*, *P. elegans* and *L. lanceolatus* those are slender (Fig. 5).

Mental and snout pores of all species of *Paralanchurus* are similar, while in *L. lanceolatus*, the middle mental pore is absent (Fig. 5).

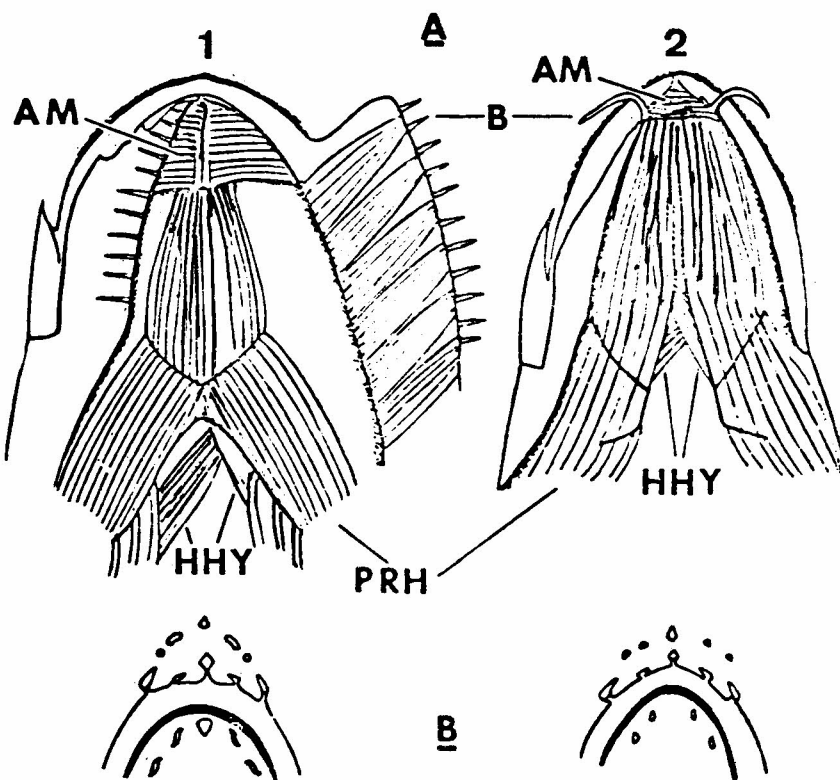


Fig. 5. (A) Ventral view of the superficial muscles under the haws ; right half of *P. peruanus* cut open to show muscular supply to barbels, and

(B) Ventral view of the snout and mental pores : (1) *P. peruanus* (196 mm SL) and (2) *L. lanceolatus* (132 mm SL) AM, Anterior intermandibularis, B, Barbels HHY, Hyohyoideus muscle, PRH, Protractor hyoideus muscle.

Osteological characters are useful to identify species of *Paralanchurus* and *Lonchurus*. For continuity of style and easier reference, all bones for this study are abbreviated and named as in *Sciaenops* study by Topp and Cole (1968), but most of the abbreviations are updated according to Patterson (1973), Greenwood (1973), and Rosen (1973). The osteology of these two genera is compared with that of *Sciaenops* (Topp and Cole, 1968).

The endocranium could be broadly divided into four regions, namely, the olfactory, the orbital, the otic and the occipital region. All bones of the olfactory region are similar to that of *Sciaenops* and their morphology is identical in all species. However, the prefrontal bone in all species is very prominent and a deep notch is visible in *P. brasiliensis*, *P. dumerili*, *P. goodei*, *P. peruanus*, and *P. rathbuni*. It is either absent or highly reduced in the other three species.

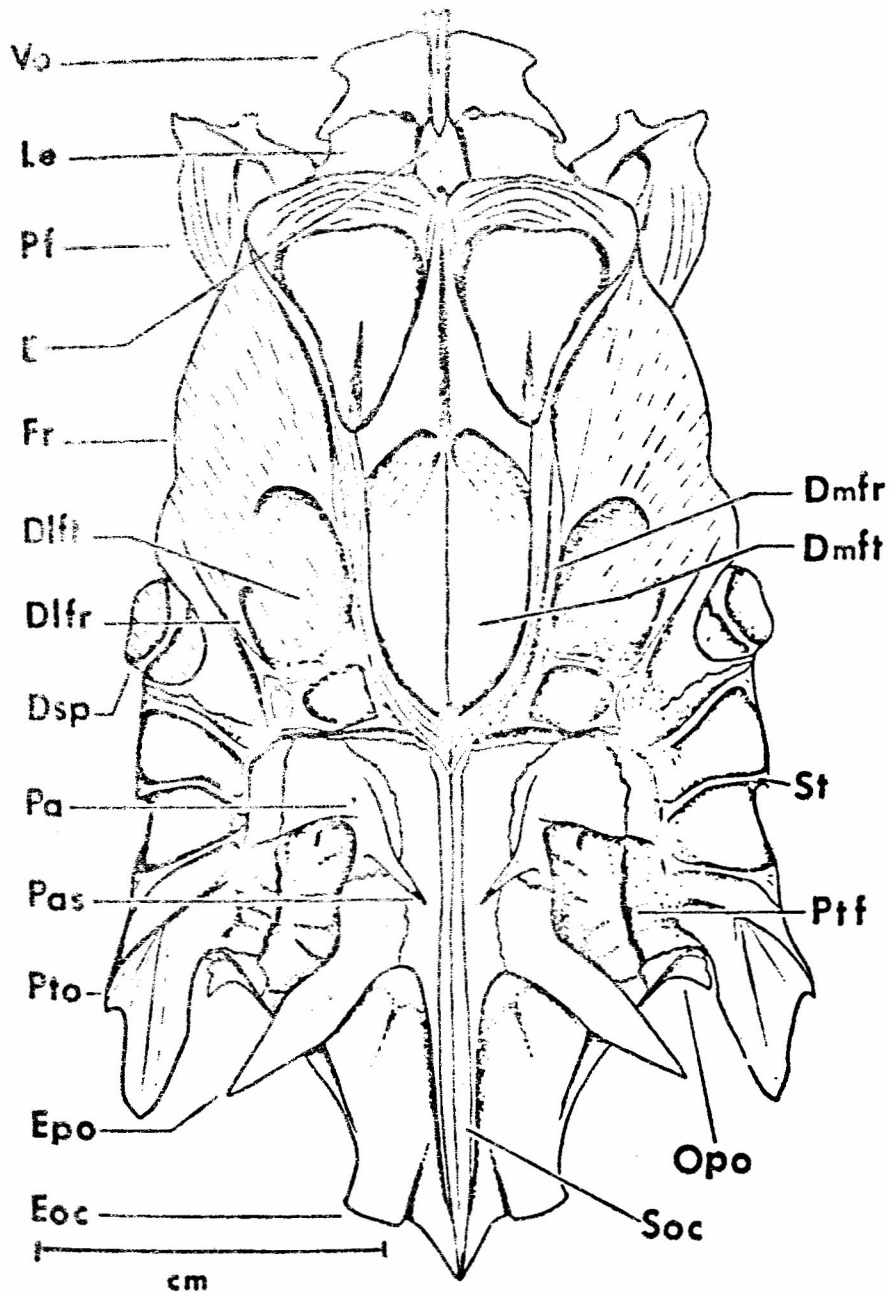


Fig. 6. Dorsal view of the skull : *P. rathbuni* (168 mm SL).

E. ethmoid, Eoc. Exoccipital, Epo. Epioccipital (epiotic), Fr. Frontal, Dlft. Dorsolateral frontal troughs, Dlfr. Dorsolateral frontal ridge, Dsp. Dermosphenotic, Dmfr. Dorsomesial frontal ridge, Le. Lateral ethmoid, Pf. Prefrontal, Opo. Opisthotic, Ptf. Posttemporal fossa, St. Supratemporal intertemporal, Vo. Vomer, Pa. Parietal, Pas. Parietal spine. Soc. Supraoccipital.



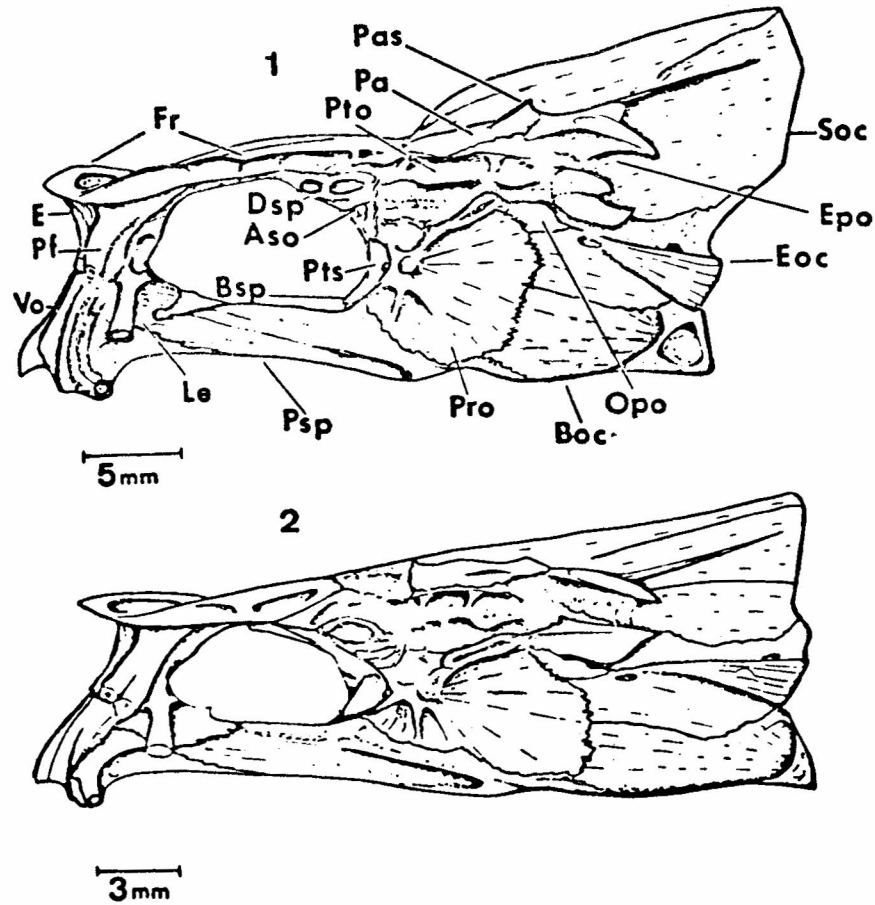


Fig. 7. Lateral view of the skulls : (1) *P. peruanus* (196 mm SL) ; and *P. petersi* (178 mm SL). Boc. Basioccipital, Bsp. Basisphenoid, Dsp. Dermosphenotic, Aso. Autosphenotic, E. Ethmoid, Fr. Frontal, Epo. Epioccipital, Eoc. Exoccipital, Le. Lateral ethmoid, Pf. Prefrontal, Pa, Parietal, Pas. Parietal spine, Psp. Parasphenoid, Pto. Pterootic, Pts. Pterosphenoic, Soc. Supraoccipital, Vo. Vomer.

In the orbital region, the paired sclerotic bone is semicup shaped, the anterior bone is smaller than the posterior one. In *P. brasiliensis*, *P. dumerili*, *P. goodei*, *P. peruanus* and *P. rathbuni*, these two bones cover more than  $\frac{2}{3}$  of the corneal perimeter ; In *P. elegans*, *P. petersi*, and *L. lanceolatus*, these bones are reduced to two crescent and cover less than  $\frac{1}{3}$  of the corneal perimeter. The largest bone in the endocranium is the frontal, which is also in the orbital region (Fig. 6 & 7). It is highly canalised in all species. The dorsal ridges of the canals are hyperossified in *P. brasiliensis*, *P. dumerili*, *P. good*, *P. rathbuni* and *P. peruanus*, where as these ridges are thin and are not hyperossified in *P. elegans*, *P. petersi* and *L. lanceolatus*. The chain of tubular

suborbital dermal bones border the posterior and posteroventral borders of the orbit. The groove in these bones houses the infraorbital laterosensory canal. These characters of the series of suborbitals are identical in all species of *Paralonchurus* and *Lonchurus*. However, their height is greater than the length of the suborbital chain in *P. brasiliensis*, *P. dumerili*, *P. peruanus*, *P. rathbuni* and *P. goodei*, where as the posterior vertical height is half the length in *P. elegans*, *P. petersi* and *L. lanceolatus*. (Fig. 8).

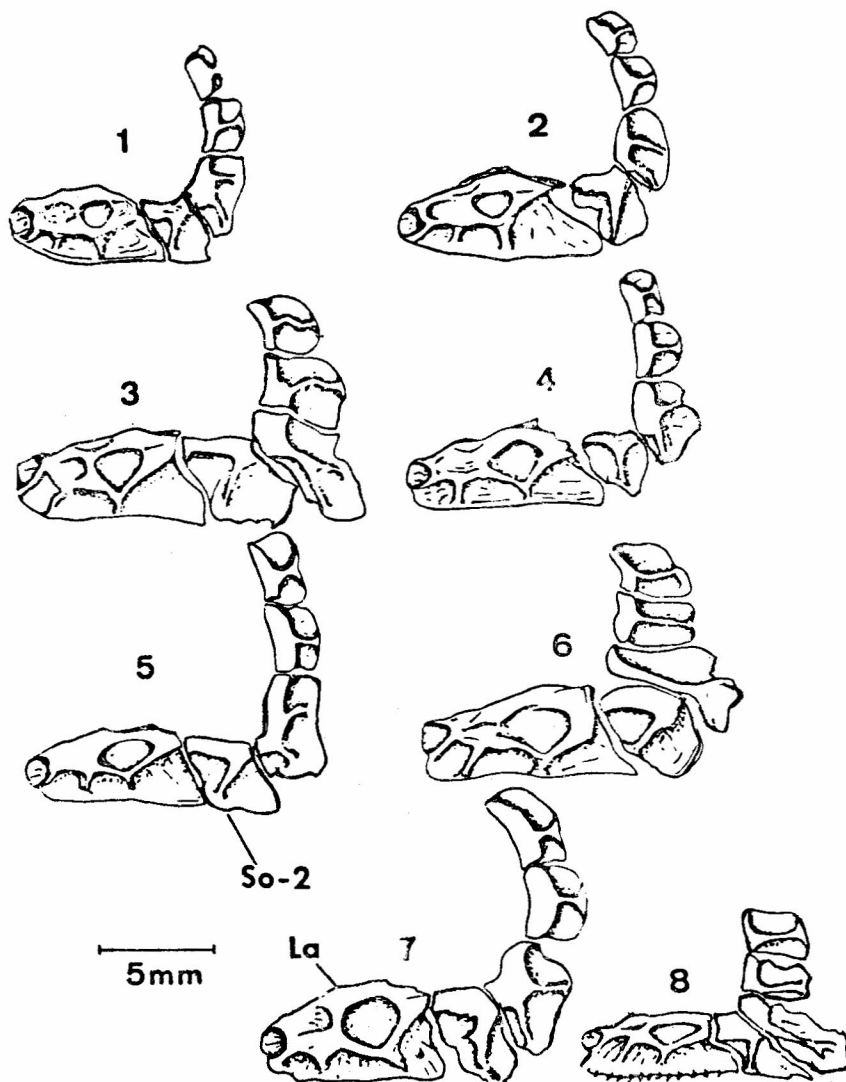


Fig. 8. Lateral view of left suborbitals : (1) *P. brasiliensis* (179 mm SL) ; (2) *P. dumerili* (163 mm SL) ; (3) *P. elegans* (196 mm SL) ; (4) *P. goodei* (178 mm SL) ; (5) *P. peruanus* (185 mm SL) ; (6) *P. petersi* (140 mm SL) ; (7) *P. rathbuni* (168 mm SL) ; and (8) *L. lanceolatus* (128 mm SL). So-2. Suborbital two La. Lacrimal.

The otic region of the endocranium in *P. brasiliensis*, *P. dumerili*, *P. peruanus*, *P. goodei* and *P. rathbuni* is enlarged to house the ponderous otoliths; in *P. elegans*, *P. petersi* and *L. lanceolatus* this region is relatively thin and less balloon-like to house their relatively thin elongate otoliths. The otic capsule is made up of prootic, pterotic, epiotic (=epioccipital) and opisthotic bones. Prootic is the largest of the series. Prootic is a balloonlike cupshaped bone bordering the posteroventral rim of the orbit and resting on the parasphenoid ventrally, the basioccipital ventrolaterally, the exoccipital posteriorly and the intercalar posteriorly. On the outside anterodorsally it borders the anterior hyomandibular facet. Ventral to this facet is the foramen for the facial branch of the V<sup>th</sup> cranial nerve, branches of which supply the barbels in species of *Paralonchurus* and *L. lanceolatus*. Anterodorsal to the former antecedent facet on the inside of the orbit is a pair of large foramina. Through the dorsal foramen emerges the trigeminal nerve (v), ophthalmic superficialis ramus (vii), deep ophthalmic ramus (v) and mandibular ramus (v); through the lower, emerges the buccalis of the facialis nerve (vii). In addition to these, there is a number of small foramina on the inside of the orbit for blood vessels. Internally, the prootic houses the trigemino facial chamber. The complete cranial skeleton investigated for *P. elegans*, *P. peruanus* and *P. goodei* indicated the typical perciform pattern elucidated by Patterson (1964).

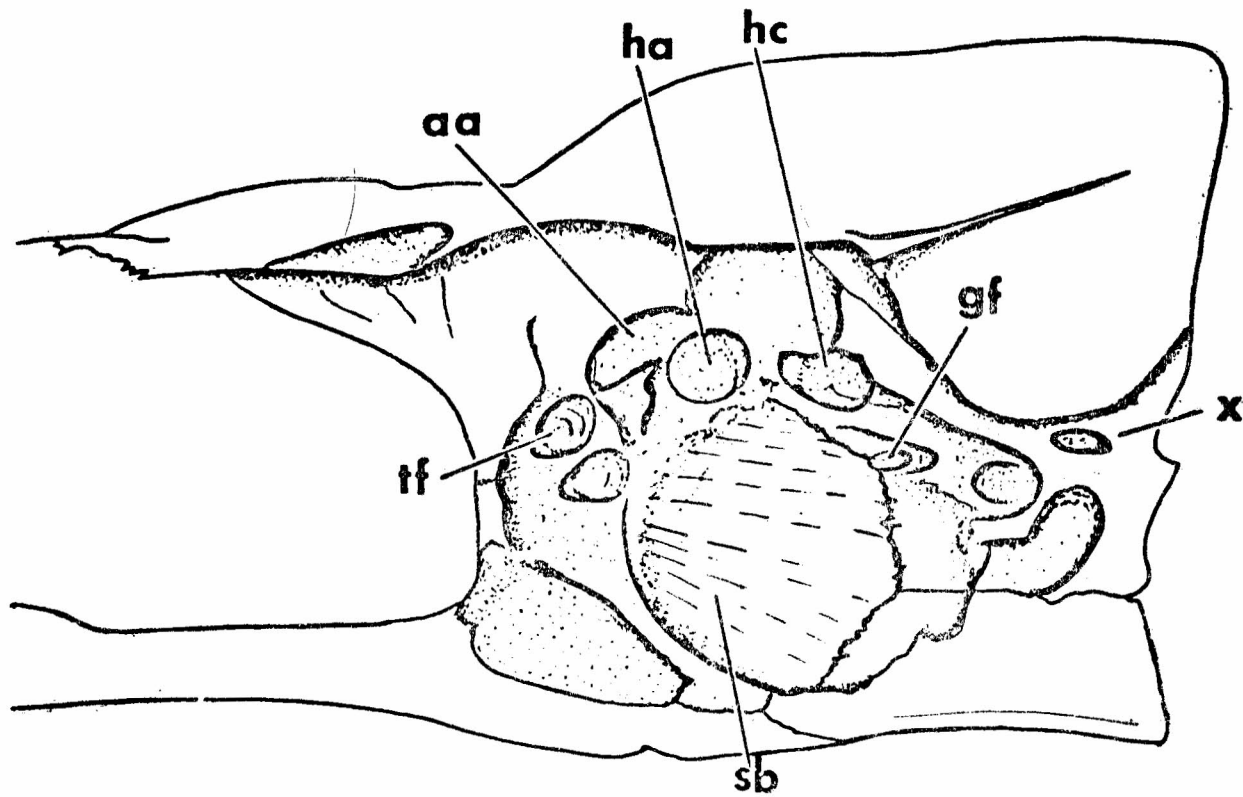
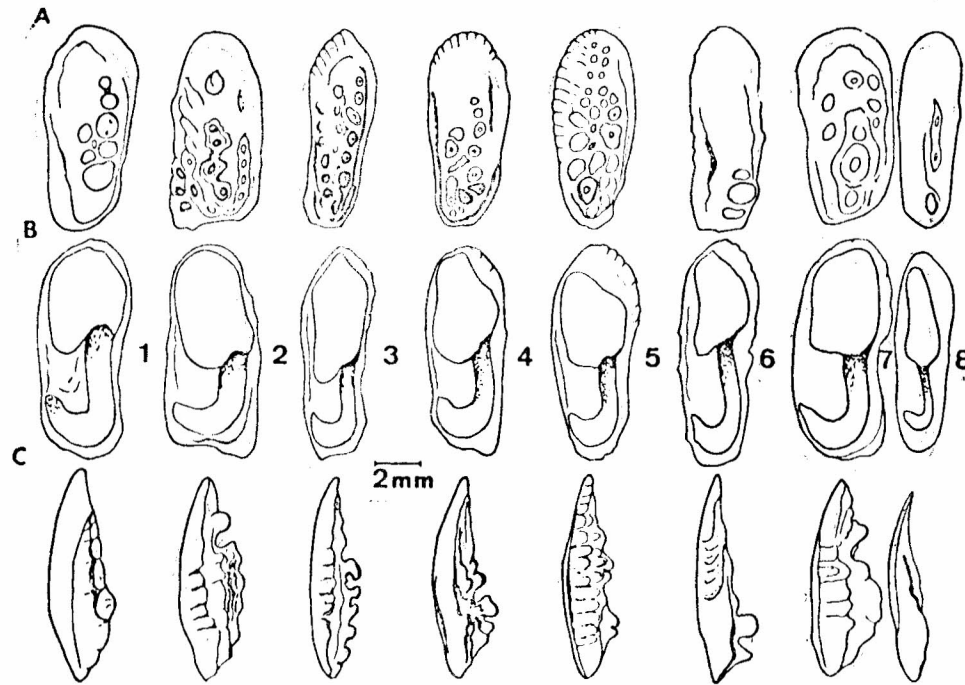


Fig. 9. Posterior endocranial vault, median sagittal view : *P. peruanus* (196 mm SL).

Hollow posterior portion of the prootic together with the anterior enlarged portion of the basioccipital houses the otoliths and its saccular chamber, sb, Fig. 9). This chamber is highly balloon like in *P. brasiliensis*, *P. dumerili*, *P. goodei*, *P. peruanus* and *P. rathbuni*, relatively less so in *P. elegans*, *P. petersi* and *L. lanceolatus*; correspondingly, the otoliths of former species are stouter than those of the latter species. The myodomes in species of *Paralonchurus* and *L. lanceolatus* are similar to those of *Sciaenops* and extends to the basioccipital (Fig. 9).

Otoliths in these species fall into two groups : (1) Heavy, thick, wide oval with a dome-shaped ostium, anterior end semicircular, many circular concretions in *P. brasiliensis*, *P. dumerili*, *P. goodei*, *P. peruanus* and *P. rathbuni*, and (2) Light, thin, narrow oval with an elongated ostium, anterior end pointed, a few concretions in *P. elegans*, *P. petersi* and *L. lanceolatus*. The nature and the arrangement of concretions and the nature of the cauda are characteristic to species.



**Fig. 10.** Outer view of right otoliths (A), Inner view of right otoliths (B) and Lateral view of right otoliths : (1) *P. brasiliensis* (178 mm SL); (2) *P. dumerili* (163 mm SL) (3) *P. elegans* (196 mm SL); (4) *P. goodii* (178 mm SL); (5) *P. peruanus* (185 mm SL); (6) *P. petersi* (178 mm SL); (7) *P. rathbuni* (168 mm SL); and (8) *L. lanceo latus* (128 mm SL).

1. *P. brasiliensis*. (Fig. 10) A, B, C). One row of prominent circular concretions, the posterior ones are larger. The cauda is rectangular with a blunt tip that does not extend to the ventral margin, slightly crenulate.
2. *P. dumerili* (Fig. 10 A, B, C) One row of concretions arranged in a U and a middle ridge of concretions, all concretions are equal in size. The cauda is J-shaped and blunt.
3. *P. elegans* (Fig 10A, B, C). One dorsal row of concretions, cauda rectangular with a pointed tip, anterior end crenulate, ostium pear-shaped.
4. *P. goode* (Fig 10A, B, C). Scattered concretions, generally very few; cauda rectangular tip, anterior and crenulate.
5. *P. peruanus* (Fig. 10A, B, C). Two to three rows of dome-shaped concretions ; the cauda is J-shaped tip bulge conc-shaped.
6. *P. petersi* (Fig. 10 A, B, C). Only two to three concretions, cauda J-shaped tip pointed.
7. *P. rathbuni* (Fig. 10A, B, C). Scattered concretions with an anterior semicircular row, cauda J-shaped, blunt.
8. *L. lanceolatus* (Fig. 10 A, B, C). A few concretions in a row, cauda J-shaped tip pointed, ostium pear-shaped.

The occipital region has the following bones : epioccipital, exoccipital, basioccipital and supraoccipital. The epioccipital bone is a hollow cap bone on the posterior dorsal tip of the auditory capsule. The posterior epioccipital process of this bone is prominent and forked in *P. brasiliensis*, *P. dumerili*, *P. goodei*, *P. peruanus* and *P. rathbuni*, where as it is neither prominent nor forked in *P. elegans*, *P. petersi* and *L. lanceolatus*.

The exoccipital bones lie on either side of the foramen magnum (Fig. 7). In this bone, the exoccipital process is highly developed in the former five species, where as it is reduced in the latter three species. Supraoccipital bone is the single most prominent median bone in the occipital region. The dorsal supraoccipital crest is elevated from the skull proper, becoming an highly elevated sail-like ridge in *P. brasiliensis*, *P. dumerili*, *P. peruanus* and *P. rathbuni*. It is slightly less elevated in *P. goodei* and the elevated sail-like process is absent in *P. elegans*, *P. petersi* and *L. lanceolatus*. The shape of the supraoccipital crest and the angle that its tip make with the posterior end of the basioccipital are characteristic of species.

Basioccipital (Fig. 7) is the posteriormost bone in the ventral ridge or the keel of the endocranium. It is hollow dorsally with two oval depressions towards anterior 2/3 that house, the otolith (sagittae). This bone is more balloon like in the former five species and less so in other species.

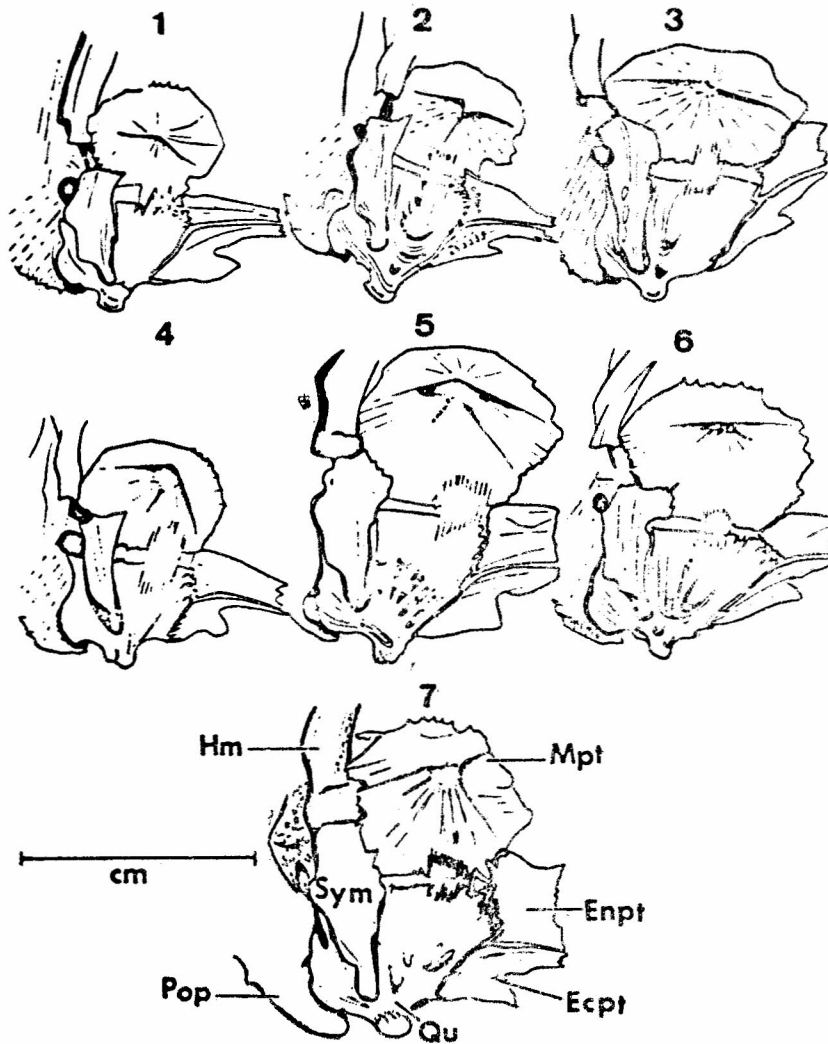


Fig. 11. Innerview of left cheek bones : (1) *P. brasiliensis* (178 mm SL) ; (2) *P. dumerili* (163 mm SL) ; (3) *P. elegans* (196 mm SL) ; (4) *P. goodei* (178 mm SL) ; (5) *P. peruanus* (196 mm SL) ; (6) *P. petersi* (140 mm SL) ; (7) *rathbuni* (178 mm SL) ; and *L. lanceolatus* (128 mm SL). Hm Hyomandibular, Mpt. Metapterygoid, Enpt. Endopterygoid, Ecpt. Ectopterygoid, Sym, Symplectic, Qu. Quadrate, Pop. Preopercle, Ecpt. Ectopterygoid.

The palatine, pterygoid, quadrate and hyomandibular complex (Fig. 11) in *P. brasiliensis*, *P. dumerili*, *P. peruanus*, *P. goodei* and *P. rathbuni* is robust and short relative to their facial structure. In these species with shorter jaws, the length and the height of the metapterygoid is about equal. In the other three species with longer jaws, the length of the metapterygoid is about one and one half of the height.



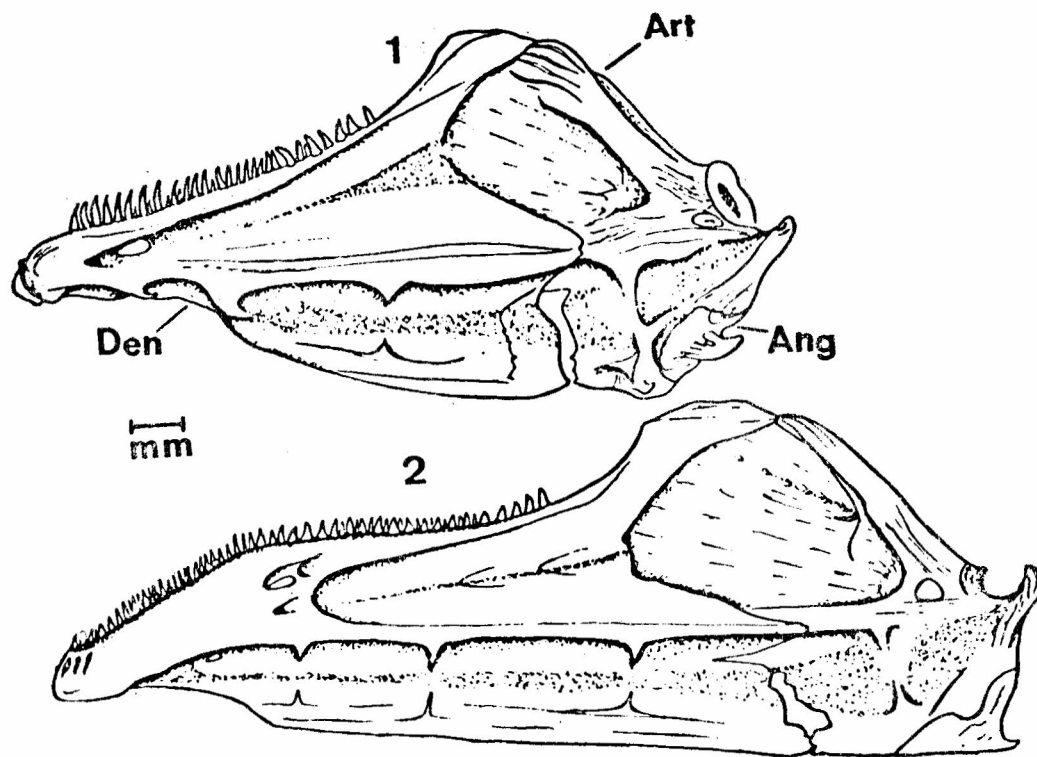


Fig. 12. Outer lateral view of the lower jaws : (1) *P. rathbuni* (168 mm SL) ; and (2) *L. lanceolatus* (128 mm SL).  
Ang. Angular, Art, Articular, Den Dentary.

The dentary is the most prominent bone in the lower jaw, forked posteriorly and pointed anteriorly. The anterior tip is deflected in *P. elegans*, *P. petersi* and *L. lanceolatus*, where as it is straight in other species. The articular bone of the lower jaw is robust in *P. brasiliensis*, *P. dumerili*, *P. goodei*, *P. peruanus* and *P. rathbuni* and (Fig. 12) it is slender and lean in the other species. The sesamoid articular lies posteriorly against the ectosteal. The ectosteal elevates sharply, in *P. brasiliensis*, *P. dumerili*, *P. goodei*, *P. peruanus* and *P. rathbuni*.

The angular one is an obliquely elongate triangular cap of bone on the posteroventral corner of the lower jaw. A prominent posterolateral spur is directed posteriorly in *P. brasiliensis*, *P. dumerili*, *P. goodei*, *P. peruanus* and *P. rathbuni* but is rudimentary in the other species. This spur is connected to the tip of the opercle by connective tissue.

The upper jaw consists of two bones, namely, maxilla and premaxilla.

**Maxilla.** Three morphological parts as it does in *Sciaenops*. The head or maxillary knob of Dharmarajan (1936) is grooved mesially to articulate with the expanded portion of the vertical limb of the premaxilla. The horizontal shank has a proximal notch for the palatine and a rectangular trough as long as 1/4 of the maxilla in *P. elegans*, *P. petersi* and *P. rathbuni*. It is not well demarcated in *P. dumerili* and *P. peruanus*, is semicircular in *P. brasiliensis*, and is rectangular deep half the length of the maxilla in *L. Lanceolatus*. In between the notch and the trough is the anterior ascending process of the maxilla and its shape varies from rectangular to circular in these species. The distal scoop is semicircular in *P. elegans*, *P. petersi* and *L. lanceolatus* but is rectangular and not deflected in the other species. In the articulated position, the maxilla is deeply inclined to the premaxilla in all species except in *L. lanceolatus*, in which the condition is similar to that of *Sciaenops*. All species have a pivoted articulation with the rostral portion of the prevomer to produce a protrusible premaxilla.

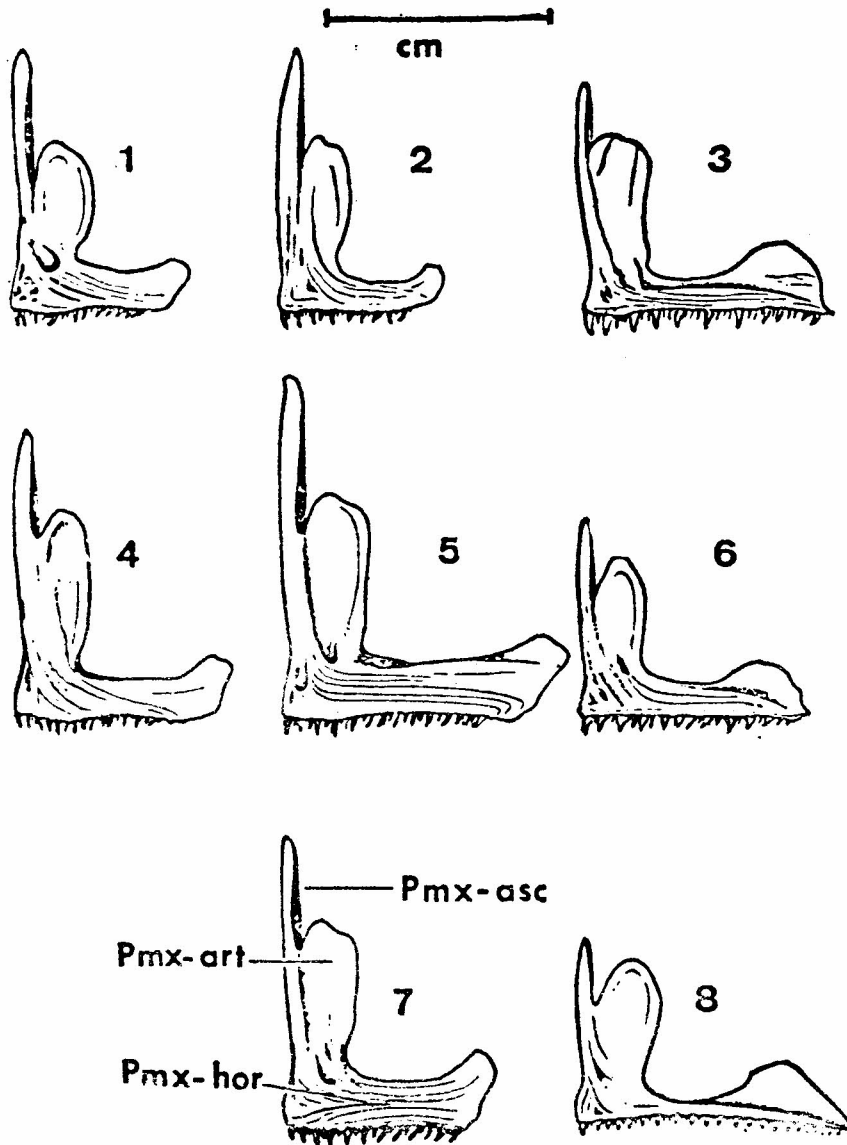


Fig. 13. Anterior view of left premaxillae: (1) *P. brasiliensis* (178 mm SL); (2) *P. dumerili* (163 mm SL); (3) *P. elegans* (185 mm SL); (4) *P. goodei* (178 mm SL); (5) *P. peruanus* (196 mm SL); (6) *P. petersi* (140 mm SL); (7) *P. rathbuni* (168 mm SL); and (8) *L. lanceolatus* (128 mm SL). Pmx-asc. Ascending limb of premaxilla, Pmx-art. Articular facet of premaxilla, Pmx-hor. Horizontal limb of premaxilla.

Premaxilla is a L shaped bone and has two parts (Fig 13) the medial ascending limb and the horizontal lateral limb. Two-thirds of the ascending limb is expanded to articulate with the maxillary groove; in species other than

*P. elegans*, *P. petersi* and *L. lanceolatus*, the horizontal limb is  $\frac{2}{3}$  of the ascending limb. In *P. elegans*, it is shorter ; in *P. petersi*, it is slightly longer ; and in *L. lanceolatus* it is about twice the length of the ascending limb. The rostral cartilage lies posteroventral to the tip of the ascending limb.

The end of the lateral limb is expanded to prevent maxillary dislocation in *P. brasiliensis*, *P. dumerili*, *P. goodei*, *P. peruanus* and *P. rathbuni*. It is deflected and a ridge at the deflection prevents maxillary dislocation in *P. elegans*, *P. petersi* and *L. lanceolatus* ; the condition in the latter species are similar to those of *Sciaenops* and *Otolithus ruber* (Dharmarajan 1936).

The premaxilla is toothed. In *P. brasiliensis*, *P. dumerili*, *P. goodei*, *P. peruanus* and *P. rathbuni*, the tooth patch is wide and triangular with six to eight rows of teeth and the teeth extend until the inflection. In *P. elegans*, *P. petersi* and *L. lanceolatus*, it is narrow and triangular with four to six rows extending almost to the tip of the horizontal limb.

Premaxillary teeth are generally villiform but the front teeth are relatively larger. These teeth are further enlarged and are conical in *P. elegans*, *P. petersi* and *L. lanceolatus* and they interlock the lowerjaw. All teeth are bent backward with brown tips ; the total number of teeth in the front is higher in the former three species than the rest.

Hyoid region connects the lower jaw elements to the neurocranium, provide skeletal support to the tongue and offer skeletal support and protection to the gill arches. The cartilage bones in this region are paired hyomandibular symplectic, interhyal, epihyal, ceratohyal, upper hypohyal, lower hypohyal, and the median basihyal ; the dermal bones are the unpaired urohyal, seven pairs of branchiostegal rays, the paired preopercle, the paired opercle, ce paired interopercle, and the paired subopercle. Hyomandibular which is a hammer-shaped bone is primarily responsible for the suspension of the branchio-cranium from the neurocranium. It articulates with the posterodorsal pterotic, the anterodorsal prootic and the autosphenotic as in *Sciaenops*.

The dorsal border of this bone is semicircular and either slightly dentate in *P. elegans* and *P. petersi* and smooth in *L. lanceolatus*. It is conical with a pointed dorsal spinous tip in the other species. The anterior and the posterior condyles are prominent and the bone is hyperossified to support the relatively jaws in the latter species.

The trailing hyomandibular shaft (symplectic process of *Sciaenops*, Topp and Cole 1968 ; rodlike process of *Otolithus ruber*, Dharmarajam 1936) is grooved posteriorly to receive the leading end of the preopercle (Fig. 11). Medially through its foramen emerges the hyomandibular branch of the facial nerve.

The vertical height of the hyomandibular exceeds its length in *P. brasiliensis*, *P. dumerili*, *P. goodei*, *P. peruanus* and *P. rathbuni*; the vertical height is less than its breadth in *P. elegans*, *P. petersi* and *L. lanceolatus*. The difference in the vertical heights of the two groups is due to stouter heads in the former species and leaner heads in the latter. The antroventral border of the hyomandibular blade articulates with the metapterygoid, the posteroventral border articulates with the opercular; these are supplied by the branches of facial nerve.

Symplectic is an anteriorly curved, vertically elongated triangular bone, its trailing end articulates in the medial posterior ventral socket of the quadrate; its anterodorsal end firmly interlocked with the posteroventral border of the metapterygoid; the posterodorsal tip is supported by the hooklike butt of the preopercle; its dorsal end is relatively enlarged and semicircular in *P. elegans*, *P. petersi* and *P. peruanus*, triangular and pointed in the other species.

Interhyal is a dumbbell-shaped cylindrical bone connecting the hyomandibular to the ventral elements of the hyomandibular arch; its proximal end lies in the intercartilage between the symplectic and the hyomandibular; its distal end firmly articulates in the socket on the posterodorsal end of the epihyal.

Branchioskeleton bones such as basibranchial, hypobranchial, ceratobranchia, epibranchial and epibranchial bones are similar in *P. brasiliensis*, *P. dumerili*, *P. goodei*, *P. peruanus* and *P. rathbuni*. These bones are lean and also similar in *P. elegans*, *P. petersi* and *L. lanceolatus*.

Total number of vertebrae varied from 25-29. The number of precaudal vertebrae ranged from 10-12 and that of caudal from 15-18. These numbers and their morphology are not characteristics of species. In all species the first five pairs of pleural ribs have intermuscular bones, copleural. In large specimens of *P. peruanus* (200 mm >) pleural ribs are hyperossified and club shaped.

The median and paired fins showed species specific characters. However, eight species do not fall into two clear groups based on the morphology of the fins. Three predorsal bones of *P. brasiliensis*, *P. dumerili*, *P. goodei*, *P. peruanus* and *P. rathbuni* are located under the sail-like backwardly directed superacccipital. In large specimens of *P. peruanus* (200 mm >) these predorsals are hyperossified and co-ossified to form a plate of bone.

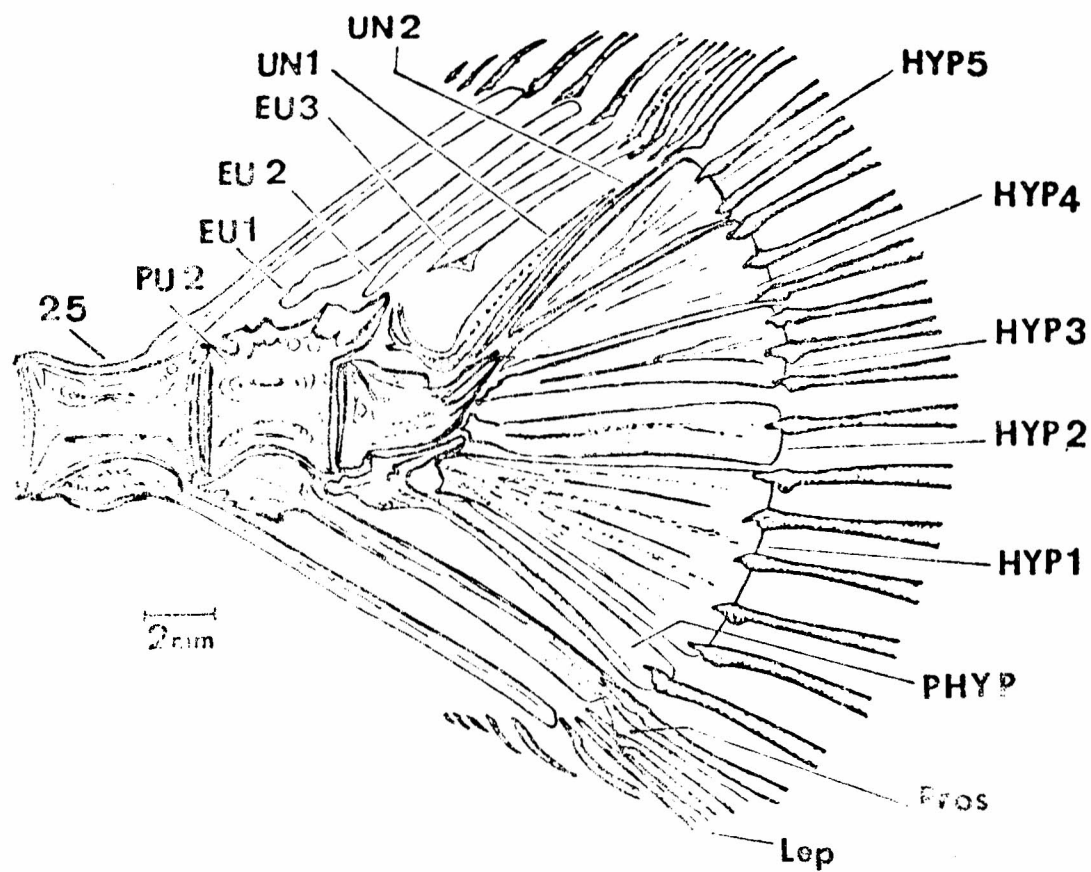


Fig. 14. Lateral view of caudal skeleton ; *P. rathbuni* (168 mm SL). PHYP, Parhypural, Lep, Lepidotrichs, Pros, Procurrent spur, Hyp 1-5. Hypurals, PU 2. Second pereural vertebra, EU 1-3, Epiurals, UN 1-2. Uroneurals.

The caudal skeleton contains characters considered most primitive among perciform fishes retaining the maximum number of fin elements as in *Kuhlia*, *Chaetodon*, *Polydactylus* (Gosline (1961)). The last three vertebra support the caudal skeleton. The following caudal elements are present (Fig. 14) cartilage bones are the two pairs of uroneurals (UN), one parahypural (PHYP), five free hypurals (HYP) and three epurals (EU). Dermal bones are the 15 branched fin rays and the 18 to 22 unbranched fin rays. The neural and haemal spines of the antepenultimate vertebrae oppose each other at the posterior end of the vertebrae. These spines are cylindrical and distally are laterally compressed. They extend posteriorly to the level of unbranched lepidotrichs. The haemal spine of the antepenultimate (UP 3) vertebra is autogenous and has a proximal oval head; in *P. peruanus* it is anteroventrally excavated. The haemal spine of the penultimate vertebra (PU 2) is also autogenous and its head is irregular in shape in *P. brasiliensis* and *P. dumerili*; its outer border is spinous but in the other species it is smooth.

The neural spine of the second pleural (penultimate) vertebra is reduced to the low stud: in *P. brasiliensis*, *P. petersi* and *P. rathbuni* it is branched and spinous. In the other species it is unbranched and smooth. It extends obliquely backward and its distal end lies vertically above the anterior 1/3 of the urostylar vertebra. This neural spine is dorsally and posteriorly cradled by three epurals. The first one lies middorsally; the second one at the posterior end; the third one dorsal to the middle of the first uroneural. In all species the last half vertebra is upturned as the urostyle, it is excavated middorsally to house the stegural part of the first uroneural. Among primitive acanthopterygian sthis half centrum supporting all hypurals is formed by all fused caudal centra. (Rosen 1973).

The appendicular skeleton of all eight species is very closely similar to Sciaenops. However, the morphology of the cleithrum showed specific characters to species. The cleithrum has a wide, short limb that is posteriorly directed and a long narrow, pointed trailing limb. These two limbs make an angle of 128° in *P. brasiliensis*; 120° in *P. dumerili*, *P. peruanus* and *L. lanceolatus*; 118° in *P. elegans* and *P. petersi*; 125° in *P. goodei* and *P. rathbuni*. The tips of the trailing limbs are connected mesially by connective tissue at the angle of which housed the pelvic girdle. The trailing limb is groove posteroventrally and it houses the anterior half of the scapular ventrodorsally, the corocoid head medially and the trailing end of the corocoid ventrally. The anterior edge of cleithra of *P. goodei* is much heavy and makes a 90° angle with the vertebral axis; the anterior margins of the cleithra are concave in *P. elegans*, *P. petersi*, and *L. lanceolatus*; they are vertically elongate crescents in the other species.

From the above findings, it is clear that swim bladder, otolith, mental and rostral pores, barbels and osteological characters could be used to identify the species of *Paralonchurus* and *Lonchurus*. It is clear that five species of *Paralonchurus*, namely, *P. brasiliensis*, *P. dumerili*, *P. goodei*, *P. peruanus* and *P. rathbuni* form one natural group; *P. elegans* and *P. petersi* another, which shows very close relationships to *Lonchurus lanceolatus* than to the former group.

Therefore, I have divided the genus *Paralonchurus* Bocour 1869 into two subgenera, namely, *Paralonchurus* and *Polyclemus*.

#### Genus *Lonchurus* Bloch 1793

*Lonchurus* Bloch, 1793 : 143 (type-species : *Lonchurus barbatus* Bloch, by monotypy, plate 360).

*Lonchiurus* Bloch (French translation in Lacau, 1797, pt. 10 : 119 (unjustified emendation of *Lonchurus* Bloch, 1793 : 143).

Body narrow, elongate, lanceolate. Scales predominantly ctenoid. Eye small about 9 to 10.5 in head; suborbital length exceeds height; lachrymal serrate. Head conical, low; snout pointed, five upper pores, five lower pores mouth inferior. Lower jaw with two barbels, four pores. Nasal dentated, not elevated above orbit; hyomandibular height less than breadth; supra-occipital crest low; no parietal spine. Horizontal premaxillary limb deflected, length about twice vertical premaxillary limb length. Premaxillary teeth villiform, in bands, anterior teeth conically enlarged, tooth patch extending to horizontal limb end. Maxillae extend one eye diameter beyond postorbit. Gill rakers slender, equal to one eye diameter. Swim bladder simple, carrot-shaped, tapering to a point near vent, lumen reduced, less than one eye diameter; two short anterior horns and two long posterior horns; all males possess well developed swim bladder muscles forming a tube encircling the viscera. Anterior intermandibularis reduced, less than 1/3 of the jaw length. Eleven trunk vertebrae, 18 caudal vertebrae. Pelvic fin with a long filament; pectoral long, extend to second dorsal end. Sagittae thin, five times in head length, narrow, about 10 to 15 in head length; ostium elongate oval.

This genus is distributed in Western Atlantic and Eastern Pacific oceans, almost on either side of isthmus of Panama.

Swim bladder simple, carrot-shaped, all males with a well developed swim bladder muscle, these encircle viscera completely. Olfactory rosette elongate oval, lamellae loosely arranged. Pyloric caeca short.



Nasals meet along the middle line, outer margin dentate. Hyomandibular length exceeds height. Suborbital length exceeds height, lacrymal serrate. Epioccipital not forked; supraoccipital crest low and supraoccipital angle less than 90. Horizontal premaxillary limb deflected, length about twice vertical limb length. Second preural neural spine reduced to a stud with two to three spines. Sagitta thin, elongate, a few concretions, osteum oval, elongate, cauda J-shaped.

*L. lanceolatus* is brownish dorsally, paler lateral and ventral sides; pectoral fins black, other fins brownish; no vertical bars. This species is distributed in the western Atlantic Ocean (Fig. 15), known only along the coast of Surinam; resembles *P. elegans*, frequently caught along with it by trawlers. Spawns near river mouths (Puyo 1949).

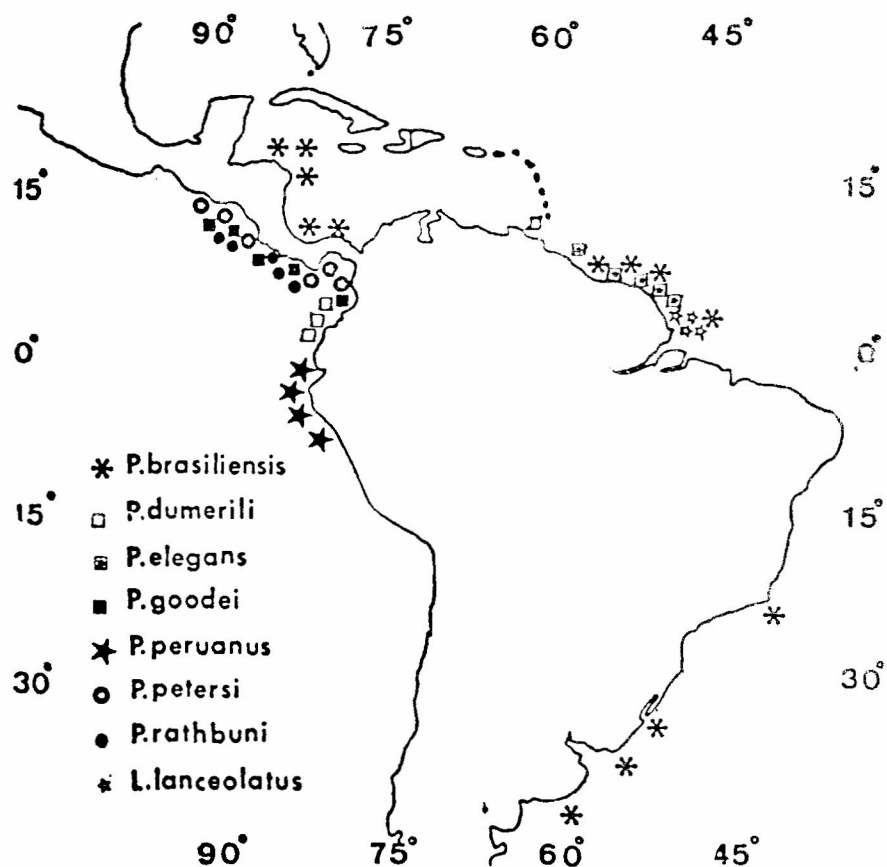


Fig. 15. The distributions of the species of *Paralanchuru* and *L. lanceolatus*.

Genus *Paralonchurus* Bocourt 1869

*Paralonchurus* Bocourt, 1869 : 21 (type-species : *Paralonchurus petersil*), by monotypy.

*Polycirrhus* Bocourt, 1869 : 23 (type-species : *Polycirrhus dumerili* Bocourt), by monotypy.

*Polyclemus* Berg, 1895 : 54 (substitute name for *Polycirrhus* Bocourt 1869. Type species *Polyclemus brasiliensis* (Steind) Berg).

*Zonoscion* Jordan and Evermann, 1895 : 401 (type-species : *Polycirrhus rathbuni* Jordan and Bollman, 1889 : 162), subsequent designation by author.

*Zaclemus* Gilbert in Jordan and Evermann, 1895 : 405 (type-species *Paralonchurus goodei* Gilbert, 1896), by subsequent designation by author.

Body narrow elongate or deep oblong, rounded or laterally compressed in profile. Head wide, nape mostly steep, snout mostly blunt extending beyond premaxilla, five upper and five lower pores on snout. Upper lip fleshy, dentate lower jaw with five pores, two rows of dentary barbels, some times extending into interopercular, crowded at chin, 11 to 60 in each row. Eye small, seven to ten times in head, or large five to six in head. Nasal rectangular, sometimes elevated over orbit, lacrymal not serrate. Prefrontal epioccipital prominent. Horizontal premaxillary limb inflected or deflected. Premaxillary teeth vill form, in bands, sometimes anterior row of teeth conically enlarged. Gill rakers short tubeclelike, about four in eye, or long slender, about half in eye. Swim bladder simple carror-shaped, tapering to a point near vent, lumen larger than eye diameter ; two short anterior horns and two long posterior horns ; all males with a well developed swim bladder muscle encircling the viscera. Anterior intermandibularis muscle large, half of jaw length. Ten to eleven trunk vertebrae, 15 to 18 caudal vertebrae (Table II). Pelvic fin with a short filament about one in eye ; pectorals long, extend beyond vent or short filament about one in eye ; pectorals long, extend beyond vent or short not reaching vent. Sagitta ellipsoidal, ostium dome-shaped or oval ; J-shaped, a few to many concretions. Seven species, two in the western Atlantic Ocean, five in the eastern Pacific Ocean ; confined primarily to tropics.

## KEY TO SUBGENERA

1. Body not deep, elongate, caudal fin pointed ; no vertical trunk bars ; pectoral fin long, reaching vent or beyond ; scales predominantly cycloid ..... *Paralonchurus*.
2. Body deep, oblong ; caudal double truncate ; 4 to 5 faint or bright vertical trunk bars ; pectoral fins short, do not reach vent ; scales ctenoid ..... *Polyclemus*.

SUBGENUS *PARALONCHURUS*

Body not deep ; clongate ; rounded in profile ; no vertical bars on trunk ; nape gently sloping. Pectoral fins long, extending to vent or beyond. Caudal pointed. Scales prominently cycloid. Eye diameter seven to ten times in head length, suborbital length exceeds suborbital height. Hyomandibular height less than its breadth. Supraoccipital crest low ; parietal spine absent. Premaxillary horizontal limb deflected, occupied more than half of maxilla when articulated ; maxilla excluded from the gape of mouth ; premaxillary teeth villiform in bands ; anterior row of teeth conicaly enlarged ; teeth patch extend to the end of horizontal limb. Twenty or less loosely arranged olfactory lamellae. Sagitta ellipsoidal ; thin ; its thickness four times in length ; narrow ; width three times in length ; a few concretions ; osteum clongate oval.

SUBGENUS *POLYCLEMUS*

Body deep ; oblong ; laterally compressed in profile ; 4 to 9 faint or bright vertical bars on trunk ; nape steeply sloping. Pectorals short ; do not reach vent. Caudal double truncate. Scales prominently ctenoid. Eye diameter five to six times in head length suborbital height exceeds suborbital length. Hyomandibular height greater than its breadth. Supraoccipital crest high ; saillike ; parietal spine present. Premaxillary horizontal limb inflected ; occupies about half of maxilla when articulated ; maxilla included in the gape of mouth. Premaxillary teeth villiform in bands ; no prominently enlarged teeth ; teeth patch extend to the base of inflection. Twenty or more tightly arranged olfactory lamellae. Sagitta ellipsoidal and stout ; its thickness three

times in length ; width two to two and a half times in length ; many concretions ; osteum dome-shaped.

KEY TO SPECIES OF *PARALONCHURUS*

1. (a) Body narrow, elongate ; caudal fin lanceolate ; nape gentle ; no vertical body bars ; cycloid scales prominent ; eye small about seven to ten times in head ; front teeth conicaly enlarged ; 5 to 6 pyloric caeca ..... 2.
- (b) Body deep, oblong ; caudal fin double truncate ; nape steep ; 4 to 9 vertical body bars ; ctenoid scales prominent ; eye moderate to large, about 5 to 6 times in head ; front teeth not conically enlarged ; 8 to 11 pyloric caeca ..... 3.
2. (a) Head conical, low ; pectoral long, reaching midanal or more ; pelvic base begins below pectoral rays 7 to 9 ; interopercle free of barbel ..... *P. elegans*.

- (b) Head blunt, low ; pectoral short, reaching vent or first anal spine ; pelvic base below first pectoral ray; interopercle with 3 to 5 barbels ..... *P. petersi*.
3. (a) First dorsal, 9 spines ; second dorsal, 1 spine and 22 to 26 soft rays 5 to 6 dark vertical bars ..... *P. dumeril*.
- (b) First dorsal, 10 spines ; second dorsal, 1 spine and 23 to 32 soft rays ..... dark verticle ————— ..... 4.
4. (a) A row or evenly spaced stout barbels along the inner edge of dentary and a fringe of crowded barbels in the interopercle, all barbels more than 30 ; 4 to 5 faint vertical bars ..... *P. goodei*.
- (b) A row of evenly spaced slender barbels along the inner edge of dentary sometimes extending into interopercle, all barbels less than 30 ; 5 to 9 dark vertical bars .....5.
5. (a) First arch with 11 or more gill rakers in the lower arch ; seven or more in the upper arch ; second dorsal with 23 to 27 soft rays ..... *P. peruanus*.
- (b) First arch with less than 11 gill rakers in the lower arch 6 or less in the upper arch ; second dorsal with 26 to 32 soft rays ..... 6.
6. (a) 7 to 9 dark vertical bars ; eye small, about 5 in head ; 12 to 19 barbels in the inner edge of dentary and half of interopercular ; 27 to 32 soft dorsal rays ..... *P. brasiliensis*.
- (b) 5 to 6 faint vertical bars ; eye large about 4.5 in heads ; 11 to 13 barbels only in the inner edge of dentary ; 26 to 29 soft dorsal rays ..... *P. rathbuni*.

*Paralonchurus brasiliensis* (Steindachner) 1875

Basted Croaker

*Genyanemus brasiliensis* Steindachner, 1875 ; 476 (original description, Para, Santos).

*Polyclemus brasiliensis* Berg, 1895-54 (original description, Mar de la Plata) ; Bocseman 1948 ; 367 (Surinam).

*Micropogon ornatus* Gunther, 1880 : 13 (original description, Mouth of Rio de la Plata).

*Polycirrhus brasiliensis*. Jordan Bigenmann, 1886 (1889) ; 415 (Brazil).

*Paralonchurus brasiliensis*. Meek and Hildebrand, 1925 : 675 (Brazil, Uruguay, Argentina).

*Paralonchurus* sp. (nearest *P. rathbuni*), Lowe-McConnell, 1962 : 695.

*Distribution* : The demersal fish fauna off Guyana (=British Guiana) has been divided into four zones by bottom types (Lowe-McConnell 1962). Sciaenid fishes predominated in the inshore zone making up over 75% of the catch by weight (Lowe-McConnell 1962). The depth of this zone ranged from 40 to 60 m, with soft sandy mudbottoms and brown water. This region was influenced by the river water, and the distance did not exceed 35 to 40 miles from the coast. *Paralonchurus* sp. were common in this zone. In a similar study off El Salvador, *Paralonchurus goodei* forms about one percent by weight of the by-catch in shrimp trawlers, *P. rathbuni* forms an insignificant percentage by weight. Both these species are caught in the depth range of 12 to 30 m (Miller 1975). Distributional patterns and habitats of all the other species of *Paralonchurus* and *Lonchurus* are unknown.

*P. brasiliensis*, *P. elegans*, and *L. lanceolatus* are western Atlantic species ; *P. dumerill*, *P. goodei*, *P. peruanus*, *P. petersi* and *P. rathbuni* are eastern Pacific species. Most of these species are concentrated on the tropical seas confined to 15.00 N and 15.00 S. However, *P. brasiliensis* in addition to this zone is distributed up to the coast of Argentina (Berg 1895) ; thus this species has the widest range of distribution. *P. elegans* and *L. lanceolatus* are confined only to the northeastern coast of Brazil. Of the eastern Pacific species, *P. petersi* and *P. rathbuni* are the most northern species ; *P. peruanus*, the most southern species, is confined to the coast of Peru. The other species are confined to the Central American coast from Nicaragua to Ecuador (Fig. 15)

All the species are distributed on the continental shelf within the depth range of 10 to 60 m. Occasionally, mature specimens of *P. goodei* were reported in the lagoons of El Salvador, similarly mature specimens of *P. brasiliensis* were reported in the lagoons of Honduras.

The continental shelf from northeastern Brazil to southern Brazil slopes gently to about 140 m. Average distance is about 75 miles from the coast. The gradient averaging 1-2/1000 in northeastern Brazil (Rocha *et. al.* 1975), to 1-2 m/km in southern Brazil (Barreto *et. al.* 1975). The continental shelf in the eastern Pacific around El Salvador is wide and slopes gently (Miller 1975). The continental shelf of northern, eastern and southern Brazil shows four sedimentological zones. The inner region up to about 10 m contains soft

mud, the middle region up to about 60 m contains soft mud, the outer region up to about 140 m contains gravel. At the end of this zone is the fourth zone- the coral ridge (Summerhays *et. el.* 1975). Many sciaenids are confined to the soft sandy mud region which is influenced by the fresh water from rivers ; most of the soft bodied invertebrate fauna like polychaete worms, shrimps, mollusks, echinoderms and bryozoans are concentrated in this region (Lowe-Mc Connell 1962 ; Barreto *et. al.* 1975). These are the major foods of sciaenids.

All species of *Paralanchurus* and *L. lanceolatus* fed primarily on polychaete worms and shrimps linking the distributions of the bottom animal fauna and these fish species. The depth of capture indicates that *P. dumerili*, *P. goodei*, *P. petersi* and *P. rathbuni* are the most inshore species ; *P. elegans*, and *L. lanceolatus* are the most offshore species ; *P. brasiliensis* and *P. peruanus* appear to inhabit both inshore and offshore waters. *P. elegans* and *L. lanceolatus* being the deepest inhabitants have their swim bladder much more reduced than the swim bladder in the other species. The former two species may glide over the bottom using their long pectoral fins. The other species of *Paralanchurus* are relatively shallow water inhabitants and have large swim bladders. They may not be able to glide since their pectoral fins are short.

#### SYSTEMATICS

Trewavas (1962) drew the attention of sciaenid taxonomists to the structure and complexity of swim bladders as generic characters. In addition, the structures of sagittae, snout and mental pores and barbels have come to dominate recent sciaenid generic descriptions (Chao 1976; Chao and Miller 1975 ; Mohan 1969 ; Trewavas 1964 ; Chu, Lo and Wu 1963).

The swim bladder in *Paralanchurus* and *Lonchurus* is simple without many lateral branches. It has a central subconical body that runs ventral to the kidneys and dorsal to the visceral organs. Its anterior end lies ventral to the third and fourth precaudal vertebrae and the posterior end tapers to a posterior apex above the anal fin. On either side of end slightly posterior to the anterior end are single lateral stumps that each bifurcate into two horns. The two anterior horns run forward laterally and curve under the basioccipital region with the two curved tips from each side lying on either side of the esophagus to which they have no connection. The two posterior horns run on either side of the main swim bladder and taper posteriorly near its posterior end. The anterior and the posterior horns each have a lumen 1/10 of the diameter of the lumen of the main swim bladder, and the lumen is continuous. The main body of the swim bladder is reduced in *P. elegans* and *L. lanceolatus* and is further reduced to a thick ridge with a fine reduced lumen in females of *L. lanceolatus*. The sagittae of *P. brasiliensis*, *P. dumerili*, *P. peruanus* and *P. rathbuni* are thick, robust and fusiform with an enlarged oval ostium.

The sagittae of *P. elegans*, *P. petersi* and *L. lanceolatus* are thin, narrow, and elongated with an oval clongate osteum. The sagittae of *P. goodei* is intermediate in shape and thickness between these two forms. There are ten sensory pores distributed in two tiers on the snout and upper lip in all species of *Paralanchurus* and *Lonchurus*. There are five mental sensory pores in all species of *Paralanchurus* and only four mental pores in *L. lanceolatus*.

There is a row of barbels on each ramus of the lower jaw in all species of *Paralanchurus*. The anterior barbels of each row are crowded near the anterior border of to central mental pore and they demonstrate monopodial type of branching. In *L. lanceolatus* there are only two mental barbels and each originates from the anterior border of the most anterior of the lateral pair of mental sensory pores. Barbels in all species of *Paralanchurus* are supplied by the muscles from the mandibular portion of the adductor mandibularis, while the two barbels in *L. lanceolatus* are supplied by two muscle bundles from the protractor hyoideus. Thus, the barbels in *Paralanchurus* and *Lonchurus* may not be homologous. Soft dorsal rays are less than 34 in species of *Paralanchurus* but higher than 35 in *L. lanceolatus*.

#### INTERRELATIONSHIPS

Presently, phylogeny and relationships of sciaenids are assessed on the morphology of swim bladder, otolith, barbels, snout and mental pores (Chu, Lo and Wu 1963 ; Chao and Miller 1975 ; Chao 1976 ; Mohan 1969 ; Trewavas 1962, 1964).

According to these authors, other morphological and osteological characters of sciaenids change heavily within a given taxon. The descriptive morphology and osteology of the species of *Lonchurus* and *Paralanchurus* in the previous sections indicated similar results. Most of these characters change much more than the swim bladder, otolith, barbels and pores. Therefore, I believe that the taxonomic characters presently being used by workers in sciaenid taxonomy are most suitable for use. The swim bladder of the species of *Lonchurus*, *Paralanchurus* and *Pachypops* have been the same morphological pattern. This is similar to the pattern of the tribe *Pseudotolithini* of the tropical west Africa (Trewavas 1962) and to the genus *Bahaba* of the sciaenids of China (Chu, Lo and Wu 1963). All the other swim bladder patterns of the sciaenids in Chinese waters are much more complex than those of the Atlantic sciaenids. According to Chu, Lo and Wu (1963), all sciaenids in Chinese waters are evolved from a form similar to *Sciaena*. *Sciaena* has a complex swim bladder which suggests that the sciaenids with simple bladder in the Atlantic Ocean are more likely have evolved. The morphology of the swim bladder demonstrated a general closeness among the species of *Paralanchurus* and *L. lanceolatus* (Fig. 4). In *L. lanceolatus* its lumen is extremely reduced and the swim bladder wall is extremely thick. In *P. elegans*, the lumen is larger than that of *L. lanceolatus* but smaller than the other species of

*Paralonchurus*; all the remaining species of *Paralonchurus* have an identical swim bladder lumen. The size of the swim bladder muscle of male *L. lanceolatus*, *P. elegans* and *P. goodei* has reached the highest development (Fig. 4). The swim bladder muscle of male *P. brasiliensis*, *P. dumerili*, *P. peruanus*, and *P. rathbuni* are less developed than the former three species. In *P. petersi*, the swim bladder muscle is the least developed (Fig. 4). The females of all species lack swim bladder muscles. The comparative morphology of the swim bladders of the eight species is very similar suggesting a very close relationship.

Morphology of the otoliths is much more variable than swim bladder within a given taxon (Chu, Lo and Wu 1963; Chao 1976). I found two morphological forms of otoliths among the eight species within the basic *Lonchurus* pattern of otolith (Chao 1976). In *P. brasiliensis*, *P. dumerili*, *P. goodei*, *P. peruanus* and *P. rathbuni*, the osteum is stout, dome-shaped and the otoliths are ellipsoidal and stout (Fig. 10). In *P. elegans*, *P. petersi* and *L. lanceolatus*, the osteum is slender, pear-shaped and the otoliths are narrow and elongate (Fig. 10). These shapes can be related to the morphology of the skulls. These otoliths are similar to the *Sciaena*-form of otoliths for sciaenids in Chinese waters.

Each species of *Paralonchurus* and *Lonchurus* has five identical marginal pores (Fig. 5). There are five rostral pores in *Lonchurus* which are not prominent. According to Chao (1976), this condition of rostral pores is due to its bottom living. There are three prominent rostral pores in the seven species of *Paralonchurus*. In addition to these pores, in *P. brasiliensis*, *P. dumerili*, *P. goodei*, *P. peruanus* and *P. rathbuni* there are two much more reduced rostral pores on either side of the former pores indicating their close relationships. These two pores were ignored by Chao (1976).

*Lonchurus* has four mental pores which are similar to that of *Michthys* a 'four-pore' form of the mental pores found in sciaenid fishes in Chinese waters. All seven species of *Paralonchurus* have five mental pores as found in *Sciaena* form of mental pores of the sciaenid fishes in Chinese waters.

There are only two mental barbels in *L. lanceolatus* - one on either side of the tip of the lower jaw (Fig. 1) and an anterior pair of mental pores is found at the base of each. Many barbels exist in all species of *Paralonchurus* and the first three pairs are situated in a tuft on either side of the central mental pore. In *P. goodei* the barbels are unique. The barbels in the mandibular region are conical and robust and only one barbel exists at a point (Fig. 1). Those barbels on the interopercular are thin and crowded and there are two to three barbels at a point. Barbels extend more than half the length of the interopercular. These two types of barbels in *P. goodei* indicate that it may not be closely related to the other six species of *Paralonchurus*. There are no interopercular barbels in *P. elegans*, *P. peruanus* and *P. rathbuni*, and in *P. petersi*



the interopercular barbels are confined to its anterior tip (Fig. 1). In *P. brasiliensis* and *P. dumerili* the interopercular barbels extend half of the interopercular (Fig. 1). This type of barbel distributional pattern may indicate close phylogenetic relationships among the species of each group. No sciaenids in Chinese waters or in the eastern Atlantic Ocean possess the combination of swim bladder, otolith, pores and barbel characteristics found in the species of *Paralanchurus* and *Lonchurus*.

Sciaenids with a single mental barbel are found in the Indowest Pacific (Chu, Lo and Wu 1963), and on both sides of the Atlantic and in the eastern Pacific (Trewavas 1964). However, sciaenids with many barbels are distributed in the western Atlantic and eastern Pacific Oceans. This type of distributional patterns may indicate their phylogenetic relationships.

A limited external examination of a few specimens of *Pachypops furcroides* revealed many small barbels similar in type and distribution to those found in *Paralanchurus*. I did not examine the bladder. Chao (1976) examined the swim bladder of *Pachyurus* and found it to be different from *Lonchurus* leading to suspect that *Pachyurus* may not be related to *Lonchurus-Paralanchurus*. *Pachypops*, however may be related. I agree in general with Chao's (1976) conclusion that *Lonchurus* and *Paralanchurus* are close genera and worthy of a supragenus *Lonchurus* based on swim bladder, otolith, pores and barbels. I further add that in my osteological study of variation with the two genera and my study of the soft parts. I found no additional characters that would be useful at the suprageneric level. The genera are separated based primarily on mental pore barbel musculature differences and that barbels between the two genera are not homologous.

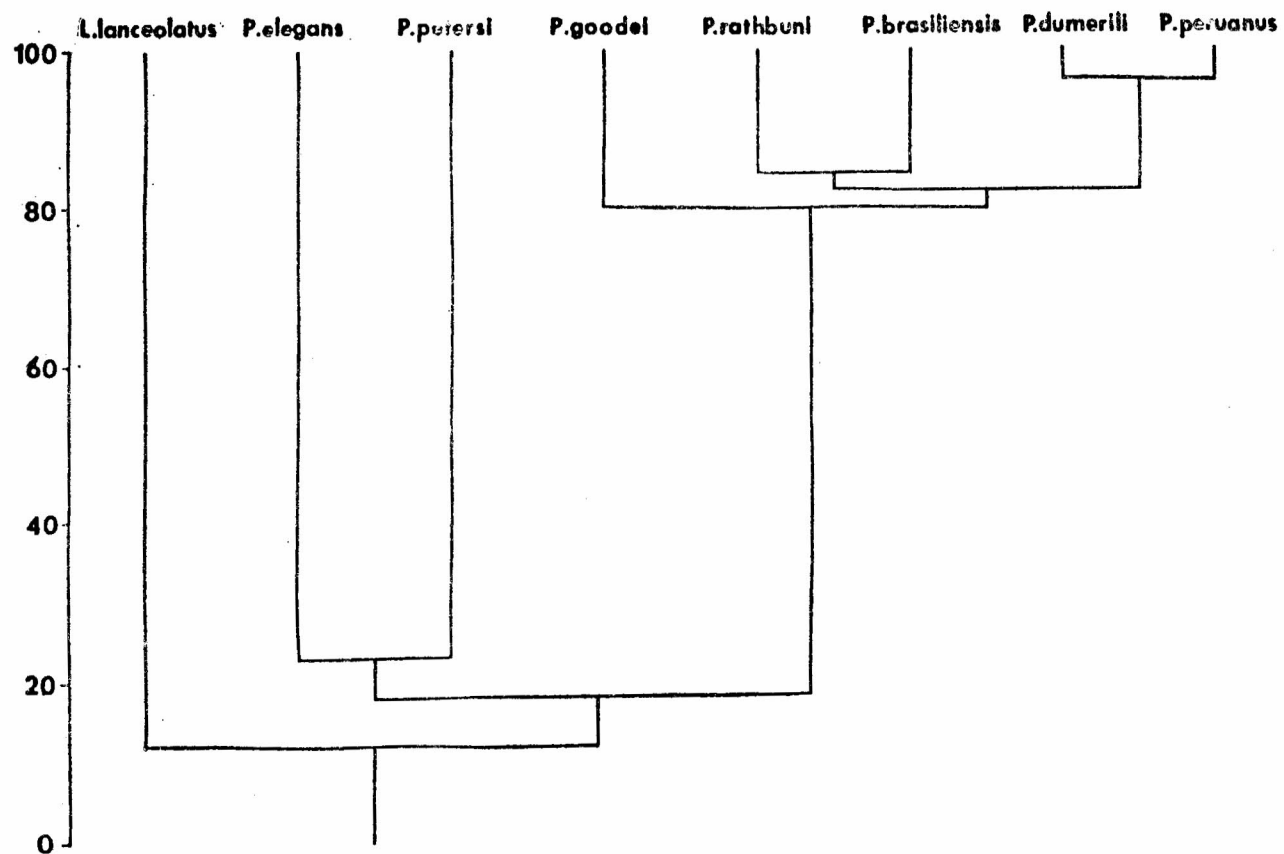


Fig. 16. A phenogram. The figures on the ordinate indicate degrees of similarities (or differences) between taxa listed on the abscissa.

I randomly chose 25 characters out of all the characters discussed in the previous sections. These were studied for similarities (or dissimilarities) among the eight species. The total similar characters (or dissimilar) in each species was converted into percentage similarities (or dissimilarities). These values are represented in the phenogram (Mayr 1969). These characters show three natural groups as shown in the phenogram (Fig. 16) *P. Elegans*, *P. petersi* and *L. lanceolatus* are more closely related (the difference in the characters between the two groups is about 12%) than *P. elegans*, *petersi* and *P. goodei*, *P. petuanus* and *P. rathbuni* (the difference in the characters between these two groups is about 56%).

The same 25 characters were used to construct a star-type phenogram (Mayr: 1969) to demonstrate characters shared by any one pair of species. This demonstrated that a pair of species formed among the species of *P. elegans*, *P. petersi* and *L. lanceolatus* or among the species of *P. brasiliensis*, *P. dumerili*, *P. goodei*, *P. peruamus* and *P. rathbuni* share more similar characters than a pair of species formed between the two groups (Fig. 17).

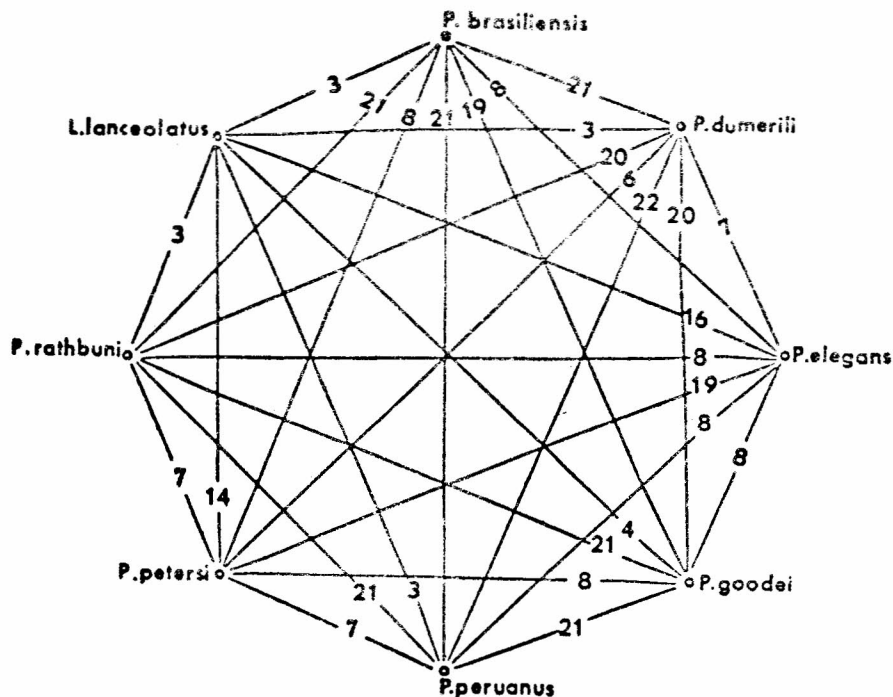


Fig. 17. A star-type phenogram of the seven species of *Paralonchurus* and *L. lanceolatus*. Figures indicate numbers of characters (in a total of 25) shared by each pair of species

The proposed phylogeny (Fig. 18) of the two genera is based on the morphological affinities on barbels, jaw muscle, sensory pores, and osteological characters. *L. lanceolatus* is different from the other species by its lower jaw musculature, barbels, pores and protrusibility of the upper jaw. *P. elegans* and *P. petersi* are different from the rest of the species *Paralonchurus* in the absence of parietal spine, pear-shaped osteum, conical enlarged premaxillary teeth, predominant cycloid scales. *P. elegans* and *P. petersi* are different in the barbel distributions and second preural neural spine. *P. goodei* is unique among the other four species due to its two types of barbels and reduced dorsal exoccipital process. *P. brasiliensis* and *P. rathbuni* both have elaborated second preural neural spines than *P. dumerili* and *P. peruanus*, *P. rathbuni* has an elaborated strgural part than *P. brasiliensis* and it does not bear interopercular barbels. *P. peruanus* is different from *P. dumerili* by its caudal, skeleton and barbel arrangement.

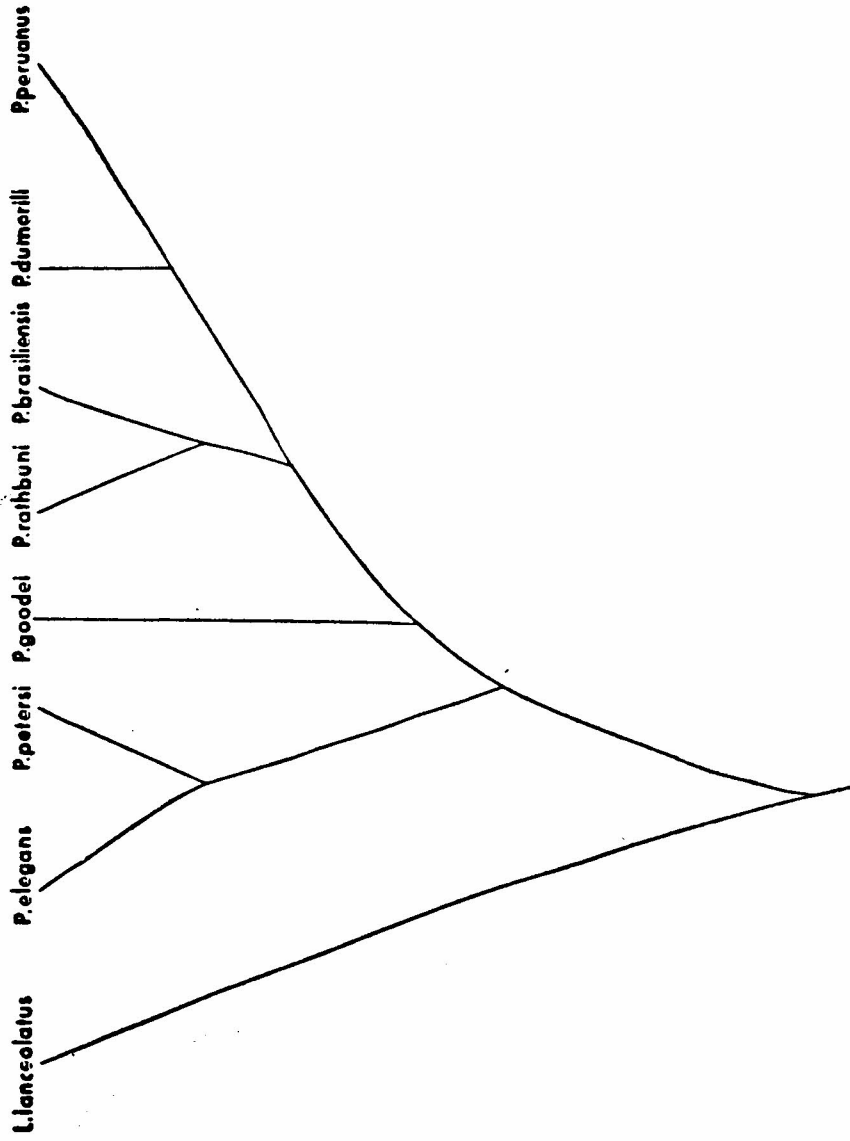


Fig. 18. The proposed phylogeny of *Lonchurus* and *Paralonchurus*.

**Table 2.** The summary of characters distinguishing the genus *Paralonchurus*, its sub-genera and the genus *Lonchurus*.

Character	genus <i>Paralonchurus</i>		<i>Lonchurus</i>
	subgenera		
	<i>Polyclemus</i>	<i>Paralonchurus</i>	
Body shape	oblong	elongated	elongated
Caudal fin	blunt	pointed	pointed
Body bars	present	absent	absent
Barbels	many	many	two
Scales	mainly ctenoid	mainly cycloid	mainly ctenoid
Mantal pores	5	5	4
Swim bladder	well developed	well developed	reduced
Pyloric caecae	well developed	reduced	reduced
Olfactory lamellae	tightly arranged	loosely arranged	loosely arranged
Refractor arcum branchialium muscle	present	present	present
Dorsal spines	10 to 11	11	11
Dorsal rays	22 to 32	30 to 34	35 to 40
Suborbitals	height exceeds length	length exceeds height	length exceeds height
Hyomandibular	"	"	"
Urohyal	divergent	convergent	convergent
Premaxilla	horizontal arm inflected	horizontal arm deflected	horizontal arm inflected
Front teeth	normal	enlarged, conical	enlarged, conical
Preopercular	elongated	semicircular	semicircular
Interopercular	conical	rectangular	rectangular
Frontal ridge	hyperossified	not hyperossified	hyperossified
Parietal spine	present	absent	absent
Epioccipital	forked	not forked	not forked
Ventral fin	barely reach	reach anal fin	reach dorsal fin
Supraoccipital	saillike	not saillike	not saillike
Exoccipital-process	present	absent	absent
Posttemporal-limbs	divergent	convergent	convergent
Sagittae	thick, fusiform	thin, fusiform	thin, fusiform
Concretions	many	few	few
Osteum	dome shaped	oval	oval
Haemal spine- ossification	present	absent	absent

### ACKNOWLEDGEMENTS

I am very grateful to my Committee Chairman, Professor Charles, F. Cole University of Massachusetts, for suggesting this research problem to me and for his guidance, help and critical manuscript reviews. Sincere appreciations are extended to the other Committee Members, Dr. Roger J. Reed, Dr. Michael R. Ross and Dr. David J. Klingener of the University of Massachusetts.

I extend my special thanks to Professor T. J. Andrews of the Zoology Department for his continual valuable advice and criticism during this study. I also wish to thank Dr. Bruce B. Collette of NMFS, Washington, D. C. for his valuable suggestions and criticism.

I am obliged to the Institute of International Education of the United States Educational Foundation in Sri Lanka for the financial support during my four-year stay in the United States, without which I could not have come to the US for graduate studies. This manuscript emerged out of first part of Ph.D. dissertation.

My thanks are also extended to Misses Mary Ellen Huber and Doris Jimenez for their friendship and help.

My wife Violet deserves far more than simple gratitude for encouragement preparing data sheets and typing the first draft of this manuscript.

Gunther, A. 1860. Catalogue of the fishes in the collection of British Museum. Vol. 2. Taylor and Francis, London. 584 p.

\_\_\_\_\_, 1880. Report on the shore fishes produced during the voyage of H. M. S. Challenger in the year 1873-1876, Zool. Chall. Expt. pt. 6, 32 p.

Jinadasa, J. 1987. The Biology of the Sciaenid genera *Paralonchurus* Bocourt and *Lonchurus* Bloch. Ph. D. Dissertation, 262p, University of Massachusetts, Amherst, Massachusetts, USA.

Jordan, D. S. 1885. A list of the fishes known from the Pacific coast of tropical America from the Tropic of Cancer to Panama. Proc. U. S. Nat. Mus. VIII. g 252.

\_\_\_\_\_. 1895. A list of the fishes known from the Pacific coast of tropical America from the Tropic of Cancer to Panama. Proc. U. S. Nat. Mus. VIII.

\_\_\_\_\_. and C. H. Ballman. 1889. Scientific results of explorations by the U. S. Fish. Comm. steamer A batros. Proc. U. S. Nat. Mus. 12 : 149-183.

\_\_\_\_\_. and C. H. Eigenmann. 1886 (1889). A review of the Sciaenidae of America and Europe. Rept. U. S. Fish Comm. for 1889 : 343-451.

\_\_\_\_\_. and B. W. Evermann. 1895 (1895). A check list of the fishes and fishlike vertebrates on North America. Rept, U. S. Fish Comm. 21 : 207-584.

\_\_\_\_\_. and \_\_\_\_\_. 1898. The fishes of North and Middle America. Bull U.S. Nat. Mus. No. 47, pt. 2, 1392-1490.

Jordan, D. S., B. W. Evermann, and H. W. Clark. 1928. Check list of the fishes and fishlike vertebrates of North and Middle America.

- Lower Mc Connell, R. H. 1962. The fishes of the British Guiana continental shelf. Atlantic coast of South America, with notes on their natural history. J. Linn. Soc. (Zool.) 44(301) : 669-700.
- . 1966. The sciaenid fishes of British Guiana. Bull. Mar. Sci. 16 : 20-57.
- Mayr, E. 1969. Principles of systematic zoology. Mc Graw-Hill Book Company, New York. 428 p.
- Meek, S. E. and S. F. Hildebrand. 1925. The marine fishes of Panama. Field Mus. Nat. Hist. Publ. No. 226. Zool. Ser. XV : 661-693.
- Miller, G. T., and S. C. Jorgenson. 1973. Meristic characters of some marine fishes of the Western Atlantic Ocean. Fish. Bull. 71(1) : 301-312.
- Miller, M. C. 1975. Proyecto para evaluation de la captura pasque-ra de la flota camaronera en la costa Sal Informe Technico. Mini. de. Agri. 29 p.
- Patterson, C. 1964. A review of the mesozoic acanthopterygian fishes with special reference to those of English chalk. Phil Trans. Roy. Soc. London Ser. B. 247 (739) : 213-482.
- , 1973. Interrelationships of holosteans. Supplement No. 1, J. of Linn. Soc. (Zool.) 53 : 233-306.
- Puyo, J. 1949. Peissons de la Buyane Francaise, Vol. XII. Faune de l'empire Francaise off Rech. Sci, Outre, Mer, Paris, 280p.
- Rocha, J. J., D. Milliman, C. I. Santana, and M. A. Vicalvi. 1975. Southern Brazil . Contributions to sedimentology No. 4. Upper continental margin sedimentation off Brazil : 117-150. E. Schweizerbart sche verlagsbuchhandlung. Germany.
- Rosen, D. E. 1973. Interrelationships of higher Euteleostean fishes, Supplement No. 1, J. of Linn, Soc. (Zool.) 50 : 397-514.
- Steindachner, F. 1875. Ichthyologische Beitrage II. ii, iibereinige nene Fischarten von der Ostund West-kiiste sub-Amerikus Sitzber, Akad. Wiss. Wiem. 71(1) : 433-480.
- Summerhays, C. P., P. N. Coutinon, A. M. C. Franca, and J. P. Ellis, 1975. Salvador to Portalezn Northern Brazil. Contributions to sedimentology, upper con inental margin sedimentation off Brazil. 4 : 44-78. R. Schweizerbart sche Verlagsbuchhandlung,, Germany.
- Taylor, W. L. 1967. An enzyme method of clearing and staining small vertebrates. Proc. U. S. Nat. Mus. 122 (3596) 17 p.
- Topp, R. W. and C. F. Cole. 1968. An osteological study of the sciaenid genus *Sciaenops* Gill (Teleostei, scianeidae). Bull. Mar. Sei. 18 : 902-945
- Trewavas, E. 1962. A basis for classifying the sciaenid fishes of tropical West Africa. Ann. Mag. Nat. Hist. Ser. 13, 5 : 167-176.
- . 1964. The sciaenid fishes with a single mental barbel. Copeia. 1964 . 107-117.
- and P. K. Talwar. 1872. On the generic relationships of the sciaenid fish *Bola chaptis* Hamilton, with a description of species from Berma. J. Fish. Biol. (1972 4 : 11-16.



## LITERATURE CITED

- Berg, C. 1895. Enumeracion sistematicaly sinonmica de los peces de las cpstos Argentinay Grugaya. An. Mus. Nac. Buenos Aires 4 : 1-121.
- Bloch, N. E. 1785-1795. Naturgeschichte der auslandischen Fische. Berlin. Edition by Ronigl. Akad. Kuns. J. Morino and Comp. Vol. 1, 1790 and Vol. 2, 1793 : 143-144. (French translation in Laveau, 1797, Ichthyologie, on histoire naturelle, generale et part caliere des poissons, Avec des figures enluminees, dessinees l' apres nature. 12 pt. in 6 vols., 452 pls. Berlin, chez l' auteur.
- Bocourt, M. 1869. Description de quelques reptiles et poissons nouveaux appartient a la faune tropicale de l' Amerique. Nouv. Arch. Mus. Hist. Nat Paris. 5 : 19-24.
- Boeseman, M. 1948. On new. little known or otherwise intereting Surinam fishes, Proc. Kon. Ned. Akad. Wet, Amsterdam. 51(3) : 316-371.
- Chao, L. N. 1976. Aspects of systematics, morphology, life history and feeding of western Atlantic Sciaenidae. Ph. D. dissertation. Coll. of William and Mary, Virginia 342 p.
- Chao, L. N., and R. V. Miller, 1975. Two new species of sciaenid fishes (tribe : Sciaenii) from the caribbean sea and adjacent waters. Bull. Mar. Sci. 25 : 259-271.
- Chu, Yuan-Ting, Le Yun-Lin, and Wu Han-Ling. 1963. Monographs of fishes of China Sci. Tech. Press. Shanghai ii+100 p.
- Dharmarajan, M. 1936. The ————— of *Otolithus ruber* (Bl. andScha.) Part I, The endo skeleton, J. of Roy. Asiatic Soc. Bengal Sci. 2(1) : 1-72.
- Food and Agricultural Organization of the U. N. 1992. Fisheries Statistical Year Book. Vol. 57, FAO, Rome.
- Ford, E. 1937. Vertebral variation in Teleostean fishes. J. of Mar. Biol. Assoc. U. K. 22(1): 1-60.
- Gill, T. 1861, Revision of the genera of North American Sciaenidae Proc. Acad. Nat. Sci. Philadelphia 13 : 79-89.
- Gilbert, C. H., and L. C. Starks. 1904. The fishes of Panama Bay. Memo of Cali. Aead Sci. IV : 134-137.
- Cosline, W. A. 1961. The perciform caudal skeleton. Copeia. 1961 (3) : 265-269.
- Green, M. 1941. The cranial and appendicular oststeology of *Aplodinotus grunieus*. Radine sque. Trans Kansas Acad sci. 44 : 400-413.
- Greenwood, P. H. 1973. Interrelationships of Os. morphs. Suppliment No. 1 J. of Linn. Soc. (Zool) 53 : 307-33.