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Some Characters of Trichonotidae, with Emphasis to Those Distinguishing It from Creediidae (Perciformes: Trachinoidei)

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Abstract An osteological study of two species of the family Trichonotidae reveals numerous differences with members of the family Creediidae. Distinguishing characters include the following: trichonotids possess a flat pelvis base (not bowl-shaped) with oblique lateral flanges, a rodlike ectopterygoid that lacks a fanlike base, a dentary shelf that is notched anteriorly, a well-developed postmaxillary process, six infraorbitals, pleural ribs that arise from larger epipleural ribs, a hypurapophysis, and a large predorsal bone. Available evidence supports the view that these two families are monophyletic taxa with a marked gap in morphological characters between them. However, similarities in such bones as the ectopterygoid and mesopterygoid suggests that these two families are relatively closely related.

The Indo-West Pacific family Trichonotidae contains one genus, *Trichonotus* Bloch et Schneider (1801), and six species (Shimada and Yoshino, 1984). Of the two other genera recognized in the family by Nelson (1984), *Trichonotops* Schultz (1960: 276) is a junior synonym of *Trichonotus*, and *Lesueurina* Fowler (1908) is a valid leptoscopid genus (personal communication, Peter Last). The synonymy of *Trichonotus* is as follows:

Trichonotus Bloch et Schneider

Trichonotus Bloch and Schneider, 1801: XXXVI, 179 (type species *Trichonotus setiger* Bloch et Schneider, fixed by monotypy; the specific name is spelled *setigerus* in some recent literature, a spelling, as noted in McCulloch [1929: 333], that was used on the plate [plate 39] of the original description).

Taeniolabrus Steindachner, 1867 (type species *Taeniolabrus filamentosus*).

Trichonotops Schultz, 1960 (type species *Taeniolabrus marleyi* Smith, 1936).

Trichonotids and creediids (in the sense of Nelson, 1985) are sand-diving fishes which are thought to be relatively closely related and a few authors, even if only provisionally, recognize all the species in the family Trichonotidae (Schultz, 1943, 1960; Tinker, 1978; Jhingran, 1982). However, there is little comparative morphological information, especially osteological, available on trichonotids. The object of this paper is to note some of the many differences between trichonotids and creediids which support their recognition as distinct taxa, and their rank as separate families. The characters studied should be useful in future studies of the phylogenetic relationships of the trichonotids, creediids, and percophids, and in determining whether these three families form a monophyletic group as postulated.

Materials and methods

The following material from the Australian Museum, Sydney (AMS), J.L.B. Smith Institute of Ichthyology, Grahamstown (RUSI), and Smithsonian Institution, Washington, D.C. (USNM) was examined. *Trichonotus marleyi*: RUSI 4509, 4 specimens (1 cleared and stained); RUSI 17300, 5 specimens (2 cleared and stained). *Trichonotus setiger*: AMS 1A·6238, 10 specimens; USNM 265627, 2 cleared and stained specimens (both broken in half). The smaller of the 2 USNM specimens, approximately 85 mm SL in glycerin, from the Moluccas, Indonesia, was utilized in the drawings (made with the aid of a camera lucida).

Characters of Trichonotidae

Nelson (1985) gives a list of 21 characters (=character state of some authors) or character combinations that all creediids share and that distinguish them from other taxa. Characters for the same features in *Trichonotus marleyi* and *T. setiger* are given below. Most are shown in Figs. 1–3. All but characters 3 and 12 distinguish trichonotids from creediids, at least in some

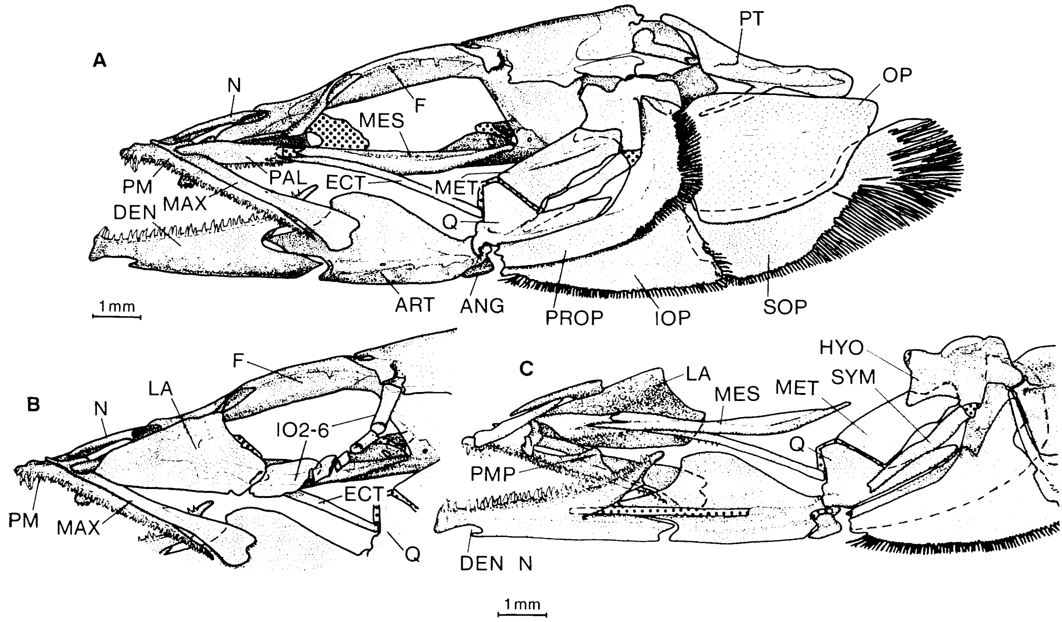

Fig. 1. *Trichonotus setiger* showing skull in lateral view (left side with infraorbital bones not included) (A), orbit area with infraorbital bones shown (B), and medial view of right side (C). Abbreviations: ANG, angular; ART, articular; DEN, dentary; DEN N, dentary notch; ECT, ectopterygoid; F, frontal; HYO, hyomandibular; IO, infraorbitals; IOP, interopercle; LA, lachrymal (=first infraorbital); MAX, maxilla; MES, mesopterygoid; MET, metapterygoid; N, nasal; OP, opercle; PAL, palatine; PM, premaxilla; PMP, postmaxillary process of premaxilla; PROP, preopercle; PT, posttemporal; Q, quadrate; SOP, subopercle; SYM, symplectic. Cartilage shown by large dots.

detail. The characters for some of the features in *Hemerocoetes* (Percophidae), a member of the other family to which creediids are thought to be most closely related, are also given; an osteological study of the five species of *Hemerocoetes* is underway.

The characters of the Trichonotidae are as follows (in the same order as in Nelson, 1985):

1. Lower jaw, not upper, with fleshy extension and bony part extending forward past upper jaw (Fig. 1).

2. Symphysis of lower jaw with ventral and smaller dorsal projection or knob; a ventral knob present in some species of *Hemerocoetes.*

3. Lower jaw bordered by broad cirri; jaw cirri never in *Hemerocoetes.*

4. Lateral line along mid-body; similar in *Hemerocoetes.*

5. Premaxilla with well-developed, rounded postmaxillary process; process very well developed in *Hemerocoetes* but dorsal margin flat.

6. Eye normal, not creediid-like; bony interorbital space very narrow.

7. Eye with dorsal iris flap, consisting of numerous elongate strands extending over lens. Several groups of benthic fishes have a dorsal iris flap (*Champsodon capensis* has a ventral one), but the striated one in *Trichonotus* is unique.

8. Hinder portion of orbit over point of jaw articulation. Trachinoid families are divided in having the orbit anterior, as in creediids, or over or posterior to the jaw articulation; the state in *Hemerocoetes* is similar to that of *Trichonotus.*

9. Infraorbital series consisting of six bones (including the lachrymal) (presumably the primitive pattern), lachrymal much larger than others; infraorbitals 3–6 consist of variously elongated tubes with the sixth (dermosphenotic?) being the longest. *Hemerocoetes* with four, possibly sometimes five, infraorbitals.

10. Gillrakers elongate, but only on anterior limb of first arch, others as spiny stubs as are all rakers in creediids and *Hemerocoetes.*

11. Dorsal fin single but with some rays

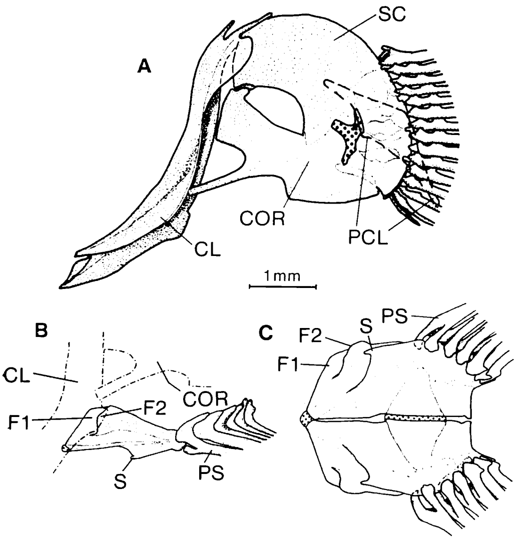

Fig. 2. *Trichonotus setiger* showing pectoral skeleton (A), pelvic skeleton in lateral view with outline of portion of pectoral skeleton (dashed line) (B), and pelvic skeleton in ventral view (C). Abbreviations: CL, cleithrum; COR, coracoid; F1, flange on pelvis which articulates medially with the cleithrum; F2, flange on pelvis which articulates laterally with the cleithrum; PCL, postcleithrum; PS, pelvic spine; S, spur on pelvis; SC, scapula.

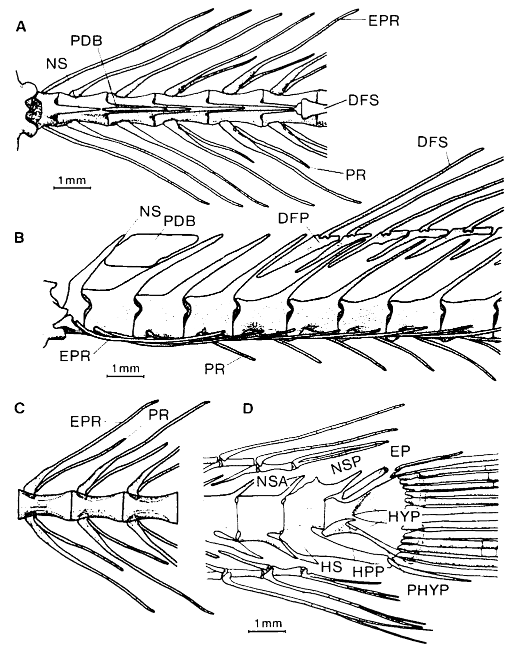

Fig. 3. *Trichonotus setiger* showing anterior vertebral column and ribs in dorsal view (A), lateral view (B), and portion of abdominal region in ventral view (C), and caudal skeleton (D). Abbreviations: DFP, dorsal fin pterygiophore (first); DFS, dorsal fin spine (first); EP, epural; EPR, epipleural rib; HPP, hypurapophysis; HS, haemal spine; HYP, hypural plate; NS, neural spine; NSA, neural spine of antepenultimate vertebra; NSP, neural spine of penultimate vertebra; PDB, predorsal bone; PHYP, parhypural; PR, pleural rib.

spinous, anterior few spines highly elongate in males (this may not be true of all trichonotid species), dorsal soft rays unbranched as in creediids.

12. Pectoral fin rays in *Trichonotus* spp. 12–15 (Shimada and Yoshino, 1984), 13 or 14 in cleared and stained specimens examined with most rays branched (creediids have 9–17 and the rays are unbranched in most species).

13. Postcleithrum present, not attached to cleithrum, lying primarily beneath actinosts; crescentric with central prominence on concave side facing coracoid (Fig. 2).

14. Subopercle, interopercle, and preopercle incised; slits more closely spaced than in creediids.

15. Interpelvic distance about equal to or greater than base length of each fin; relative distance much greater in *Hemerocoetes*.

16. Pelvis entirely different from that of creediids, not bowl-shaped; with oblique flanges and solid ventral surface with heavy central portion (Fig. 2). Basipterygia converge anteriorly to a point but anterior margin of pelvis not concave as in creediids; well-developed, dorsally and laterally projecting flange on anterior portion articulating with cleithra (cleithrum runs between main flange and a side-strut). Anteriorly directed spur on outwardly directed flange at margin of basipterygia anterior to where pelvic spine articulate with basipterygia (homologous with iliac spur?).

17. Mesopterygoid similar to that of creediids except that posterior end not strongly curved upwards to contact neurocranium.

18. Ectopterygoid similar to that of creediids in being rodlike and not attached nor adjacent to other bones, except for anterior portion; dissimilar in being toothed (at least in *T. setiger*) and, except for *Creedia partimsquamigera*, in lacking a fanlike

base (differs from *C. partimsquamigera* in having shaft ending adjacent to anterior margin of quadrate just above point of articulation with lower jaw and not near metapterygoid and entire base of metapterygoid adjacent to quadrate). In *Hemerocoetes*, the rodlike ectopterygoid ends at antero-dorsal corner of quadrate but is otherwise as in *Trichonotus*.

19. Most pterygiophores of the closely-spaced dorsal fin spines in pairs between the neural spines (Fig. 3); a one-to-one relation between soft rays of dorsal and anal fins and pterygiophores and between pterygiophores and neural and haemal spines except that the anal fin rays and pterygiophores commence considerably anterior to development of haemal spines and, as in creediids and *Hemerocoetes*, the first two anal rays articulate with the first pterygiophore (first ray in *Trichonotus* spp. is spinous). No free pterygiophores between last spine and first soft ray as in *T. elegans*, which has only three dorsal spines (Shimada and Yoshino, 1984); all dorsal spines, unlike the soft rays, attached to their pterygiophores well in advance of distal end and last spine and first soft ray attached to separate pterygiophores.

20. Two sets of ribs, epipleurals arising from anterior portion of vertebral centra, directed posteriorly, and extending to lateral line, and the weaker pleurals arising from posterior or ventral side of base of epipleurals and, as defined, lining abdominal cavity. Epipleurals commence on first vertebra and pleurals at third or fourth vertebra. In *T. marleyi* some of the pleural ribs attach to the epipleurals a short distance from the centra, but most attach to the base of the epipleurals. The attachment of weaker pleurals to or partially to epipleurals, rather than having the opposite relationship, is unusual in fish; the pleurals attach to the epipleurals, a considerable distance from the centra in a few, also in at least some gobiesocids (Springer and Fraser, 1976), platycephalids (Regan, 1913; Quast, 1965), and notothenoids (Eakin, 1981). *Hemerocoetes*, like creediids, possesses only epipleurals.

21. Hypural bones not as fused as in Creediidae. Parhypural narrow but distinct, and hypurapophysis well developed.

The following additional 13 characters were observed in the two species of *Trichonotus* examined. The first eight were employed in the analysis of creediid interrelationships (Nelson, 1985); all but ii, v, vi, and vii differ from creediids and only *Schizochirus insolens* shares vi and vii. The last four characters differ from creediids. The above mentioned characters are as follows:

i. Lateral-line scales with a deep notch on posterior margin.

ii. Posterior tip of maxilla broad and indented.

iii. Teeth on dentary and premaxilla (where they are especially well developed), across vomer, on palatine, and, at least in *T. setiger*, along much of ectopterygoid.

iv. Urohyal short, ending at about ventral origin of fourth gill arch, rodlike posteriorly (i.e. not expanded in dorso-ventral plane and bladelike as in creediids).

v. One well developed, elongate epural.

vi. Anal rays branched, except for first element which is spinous.

vii. Pelvic fin rays I,5; 4 or all 5 soft rays branched and fin rays elongate, especially in males.

viii. Branched caudal fin rays 11.

ix. Branchiostegal rays 7 (as in creediids and *Hemerocoetes*), 1 on epihyal and 6 on ceratohyal.

x. Ventral shelf of dentary notched at anterior end, creating a hooklike appendage in lateral view (Fig. 1).

xi. Pronounced flange on lateral side of lower limb of cleithrum with well-developed spur at end projecting laterally and anteriorly but not reaching as far forward as cleithral symphysis (creediids lack the flange, except *S. insolens*, and the spur).

xii. Anterior margin of coracoid with deep indentation, with upper and lower margins forming an acute angle, and lower limb elongate and rodlike, terminating at lateral flange of cleithrum immediately above where pelvis articulates with cleithrum (creediids, with, at most, a relatively shallow indentation on anterior margin of coracoid, with upper and lower margins, when indentation apparent, forming a right or an obtuse angle and lower limb attached to posterior expansion of cleithrum a variable distance above point of articulation with pelvis).

xiii. Well-developed median plate (predorsal bone) between distal halves of first two neural spines (Fig. 3), not present in creediids or *Hemerocoetes*.

The color pattern in various species of *Trichonotus* is shown in Clark and Doubilet (1983), Masuda *et al.* (1984), Shen and Lin (1984), and Shimada and Yoshino (1984). Interestingly, reduction in squamation occurs in one species of trichonotid (Shimada and Yoshino, 1984) and in five species of creediid (Nelson and Randall, 1985).

Discussion

Some 27 characters or character complexes are listed above which distinguish trichonotids from creediids. Both taxa are relatively compact groups with a substantial gap between them; their monophyly and distinctiveness as two separate families, as generally accepted based on external morphology, is reinforced. Specialized or postulated derived characters in trichonotids relative to creediids include the following: numbers 1 (lower jaw elongate with fleshy extension), 7 (dorsal iris flap with many strands), 10, 11, 20 (pleurals attached to epipleurals), x, and xiii (single large predorsal bone). In creediids the characters are specialized or derived relative to trichonotids in the following features: numbers 1 (fleshy extension on upper jaw), 4, 5 (postmaxillary process absent or feeble), 9, 16, 17 (posterior end of mesopterygoid curved upwards), 18 (ectopterygoid with fanlike base in most species), and 21 (hypurapophysis absent). A relatively close relationship is suggested in their sharing the following characters (in order of deemed importance as indicators of this relationship): mesopterygoid largely free, not bordered by ectopterygoid for most of its length, forming floor of orbit; ectopterygoid largely free, rodlike; lower jaw bordered by cirri; most of gill cover heavily incised. *Hemerocoetes* shares some characters with creediids (e.g. no pleural ribs or predorsal bone) and some with trichonotids (e.g. hypurapophysis present and similar mesopterygoid). There is one character-complex, apparently derived, which is shared in at least creediids, trichonotids, and *Hemerocoetes* (and probably in other percophids); although differing in detail, in all three taxa the mesopterygoid and ectopterygoid are largely free of one another and of other bones with the mesopterygoid forming the floor of the orbit and the ectopterygoid being rodlike. Pending the completion of an osteological study of *Hemerocoetes*, it would be premature to state which of these three taxa are each other's closest relatives. Mugiloidids and the one cheimarrhichthyid are usually classified close to the above groups. However, based on McDowall's (1973) osteological study, *Cheimarrichthys* at least is not as close to creediids, trichonotids, and *Hemerocoetes* as the latter are to one another; in *Cheimarrichthys* the triangular ectopterygoid appears to be bordered by the palatine and a flat mesopterygoid for much of its length. Unfortunately, the comparative osteology of leptoscopids, a candidate for being a closely related family, is not known.

Depending on the character, various species of creediids are morphologically most similar to trichonotids. According to Shimada and Yoshino (1984), *Trichonotus* has the following meristic characters: dorsal rays III–VII, 39–46; anal rays I, 34–42; lateral-line scales 52–59; vertebrae (for three species) 49–56. In the relatively high number of meristic characters (and in having only one epural) it is more similar to *Tewara*, *Crystallodytes*, *Chalixodytes*, and *Apodocreedia* than to other creediids (which are thought to be more primitive—Nelson, 1985). In body depth, *Trichonotus* is more similar to *Creedia*, *Crystallodytes*, *Chalixodytes*, and *Apodocreedia* than to other creediids. However, *Schizochirus insolens*, the most divergent creediid (e.g. in having four large converging anterior anal fin pterygiophores and a relatively deep body) and presumed most primitive species, shares or comes closest to *Trichonotus* in the following characters: branched anal rays; maxilla tip expanded and forked with a small postmaxillary process (shared with some *Creedia*); and posterior tip of mesopterygoid not strongly upturned. *Creedia partimsquamigera* seems to lack a fanlike base to the ectopterygoid, but the point of contact with the quadrate is different from that found in *Trichonotus*. Indeed, the metapterygoid and quadrate are at a different angle than that found in creediids (it is more vertical in creediids, perhaps related to the more anteriorly placed eye). The assumed divergence of *S. insolens* in a few characters from other creediids and *Trichonotus* may be a relatively simple evolutionary step. As suggested by the converging anal fin pterygiophores behind the abdominal cavity in *S. insolens*, its relatively deep body and low number of vertebrae and lateral-line scales may all be the result of truncation in the mid-section of the body.

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ベラギンポ科とトビギンポ科の識別を主眼とする形態学的考察

Joseph S. Nelson

ベラギンポ科2種の骨学的研究の結果，トビギンポ科の仲間とは多数の相違点があることが明らかになった．両者の識別形質を次に要約する．ベラギンポ科魚類は，斜位の側面突出縁をもつ扁平な（窪み型でない）腹鰭基底，扇状基底部を欠いた棒状外翼状骨，前面に切り込みのある歯骨床，よく発達した後主上顎骨突起，6個の眼下骨，より大きい上肋骨から生ずる肋骨，1個の下尾骨側突起，および大きな前背鰭骨を有する．これまで得られた知見からはこれらの2科は形態学的には大きな相違はあるものの，単系統分類群であることが支持される．しかし，外翼状骨や中翼状骨のような骨格にみられた類似性からは，これら2科が比較的近縁な関係にあることが示唆される．