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SYNOPSIS OF SYNGNATHINE PIPEFISHES USUALLY REFERRED TO THE GENUS *ICHTHYOCAMPUS* KAUP, WITH DESCRIPTION OF NEW GENERA AND SPECIES

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ABSTRACT

One western Atlantic and 17 nominal Indo-Pacific species of syngnathine (tail pouch) pipefishes, commonly referred to the monotypic Indo-Pacific genus *Ichthyocampus* Kaup (type-species *Syngnathus carce* Hamilton Buchanan), are redescribed and/or discussed and four Indo-Pacific species are described as new. *Mannarichthys* gen. nov. is proposed for two species lacking an anal fin (*Ichthyocampus pictus* Duncker and the Atlantic *Ichthyocampus pawneei* Herald). *Phoxocampus* gen. nov., proposed for three species (*Ichthyocampus belcheri* Kaup, *I. diacanthus* Schultz, *Syngnathus tetrophthalmus* Bleeker), is characterized by pointed hooklike posterior tail ring angles and midlateral termination of the lateral trunk ridge. Two species groups with midlateral termination of lateral trunk ridge but without hooklike tail ring angles are referred to *Festucalex* Whitley and *Campichthys* Whitley. *Festucalex* (slender snout; low and entire median snout ridge; pectoral-fin rays usually 12 or more) includes *Syngnathus cinctus* Ramsay, *Ichthyocampus scalaris* Günther, *I. erythraeus* Gilbert, *Festucalex gibbsi* n. sp. (Queensland and New Guinea) and *F. wassi* n. sp. (Samoa). *Campichthys* (deep snout; snout ridge elevated or knobbed; pectoral-fin rays usually 10 or less) includes *Ichthyocampus tryoni* Ogilby, *I. galei* Duncker, *Campichthys tricarinatus* n. sp. (Western Australia) and *C. nanus* n. sp. (Mozambique). *Ichthyocampus cristatus* McCulloch and Waite, a species with strongly elevated snout ridge, variable configuration of the lateral trunk ridge and 8 caudal-fin rays, is referred to the monotypic genus *Stipecampus* Whitley.

Ichthyocampus davaoensis Herald, known only from the juvenile holotype, is provisionally referred to *Siokunichthys* Herald. The postlarval holotype and paratype of *Ichthyocampus bikiniensis* Herald are not referrable to *Ichthyocampus*, and their size (ca. 7-10 mm SL) and state of development precludes placement in any genus of pipefishes at this time. Five nominal Indo-Pacific species are synonymized as follows: *Campichthys tryoni lindemanensis* Whitley (= *Mannarichthys pictus*); *Ichthyocampus kampeni* Weber (= *Phoxocampus tetrophthalmus*); *Ichthyocampus townsendi* Duncker, *I. philippinus* Fowler and *Hippichthys amakusensis* Tomiyama (= *Festucalex erythraeus*).

This synopsis, including all known or available museum specimens, provides a foundation for further study and eventual review of the treated genera. There is evidence that polyphyletic species groups are here included in certain genera, but lack of adequate study material precludes immediate solution of these problems. All genera are diagnosed, each species is illustrated, distribution maps are given for examined materials, and a key is provided for all treated species.

The purpose of this study is to establish a basis for revision of the syngnathine (tail pouch) pipefishes heretofore commonly referred to the genus *Ichthyocampus* Kaup. In establishing this genus, Kaup (1853, 1856) included two species (*belcheri* and *carce*) which represent distantly related genera and subsequent authors have compounded this original error. Duncker (1915), on the basis of differences in body ridge configuration, recognized that two or three species groups were included in *Ichthyocampus* but failed to otherwise discuss the problem. Whitley (1931, 1948b) erected several genera and subgenera to accommodate certain Australian forms previously referred to *Ichthyocampus*, but Whitley's taxa, based on little comparative material, were diagnosed inadequately and were not generally accepted by ichthyolo-

gists. In the most extensive recent treatment, Herald (1953) synonymized Whitley's genera and subgenera with *Ichthyocampus* and, due to the lack of sufficient material, refrained from recognizing intrageneric phyletic lines. Herald described two new species, provided a key to seven Pacific forms (excluding Australia) and tabulated data for 18 nominal species. Munro (1958) recognized eight Australian forms and these, together with Herald's compilation and a recently described species (Tomiyama, 1972), account for 22 nominal taxa currently placed in *Ichthyocampus*. Several species originally described in *Ichthyocampus* were earlier transferred to other genera or synonymized (Table 1), and I have (Dawson, 1977b) referred four others, usually placed in this genus, to *Lissocampus* Waite and Hale. The Indo-Pacific genus *Ichthyocampus* is monotypic and I here treat the remaining nominal species, resurrect three of Whitley's genera and describe two genera and four species as new.

Materials and Methods

Measurements of standard length (SL) were made on a measuring board, graduated in 0.5 millimeter (mm) intervals, and estimated to the nearest 0.5 mm under low-power magnification; other measurements were made with needlepoint dial calipers and read directly to the nearest 0.1 mm. All fin-rays were counted separately. Where possible, counts were made on both pectoral fins and data are presented as total frequency of pectoral-fin rays and as frequency of paired counts, wherein right and left fins had the same number of rays (equivalent counts). Caudal-fin rays are 10 in all species (except 8 in *Campichthys galei* and *Stipecampus cristatus*) and routine counts are not tabulated here; fish with atypical caudal-ray counts were assumed to have regenerated tails and were omitted from data on ring counts and proportional measurements. Bilateral counts of tail rings crossed, wholly or in part, by the lateral trunk ridge were made on most examined material (except *Ichthyocampus* and *Mannarichthys*); ridges ending at or just before posterior margin of last trunk ring are denoted by "0" in descriptions and tabulated data.

Measurements requiring special definition follow: SL—straight-line distance from tip of lower jaw (mouth closed) to articular base of median caudal-fin rays; head length (HL)—tip of lower jaw to rear margin of opercle; snout length—tip of lower jaw to anterior inner margin of bony orbit; snout depth—least vertical dimension of snout posteriad of gape; pectoral-fin length—length of longest ray from articular base to tip; length of pectoral-fin base—straight-line distance between articular bases of upper and lowermost rays; length of dorsal-fin base—distance between outer angles of insertion of anterior and posterior dorsal rays; anal ring depth—least distance between superior and inferior trunk ridges on ring bearing anus (anal ring). Counts of trunk rings begin with that bearing pectoral-fin base and end with that bearing anus; counts of tail rings begin with that following anal ring (usually bearing anal fin) and end with penultimate ring, excluding terminal element bearing caudal-fin base. In cases where anus and anal fin occur on the same ring, the minimum trunk ring count is recorded (e.g. 13 rather than 13.5). Number of subdorsal rings is estimated to the nearest fourth of ring length and expressed by the formula: trunk rings covered + tail rings covered = total rings covered by dorsal-fin base (subdorsal rings); 0-point is defined as juncture of last trunk and 1st tail ring. Color descriptions are from specimens preserved in alcohol. Terminology for type of brood-pouch closure is that of Herald (1959); the term "pectoral-fin base" is synonymous with "pectoral cover plate" of authors.

Where practical, materials examined are listed from west to east; distribution maps show general localities but not necessarily all collections in immediate vicinity of

Table 1. List of nominal species originally described in, or commonly referred to, the pipefish genus *Ichthyocampus*, together with the senior synonym accepted or introduced in this report

Species	Senior Synonym	Source
Ichthyocampus		
annulatus Macleay, 1878	*Micrognathus brevirostris* (Rüppell, 1838)	Herald and Randall, 1972
bannwarthi Duncker, 1915	*Lissocampus bannwarthi* (Duncker, 1915)	Dawson, 1977b
belcheri Kaup, 1856	*Phoxocampus belcheri* (Kaup, 1856)	This report
bikiniensis Herald, 1953	*incertae sedis*	This report
carce (Hamilton Buchanan, 1822)	same	This report
cinctus (Ramsay, 1882)	*Festucalex cinctus* (Ramsay, 1882)	Whitley, 1931
cristatus McCulloch and Waite, 1918	*Stipecampus cristatus* (McCulloch and Waite, 1918)	Whitley, 1948b
davoensis Herald, 1953	*Siokunichthys davoensis* (Herald, 1953)	Smith, 1963
diacanthus Schultz, 1943	*Phoxocampus diacanthus* (Schultz, 1943)	This report
edmonsoni Pietschmann, 1930	*Micrognathus edmonsoni* (Pietschmann, 1930)	Herald, 1953
erythraeus Gilbert, 1905	*Festucalex erythraeus* (Gilbert, 1905)	This report
fatiloquus (Whitley, 1943)	*Lissocampus fatiloquus* (Whitley, 1943)	Dawson, 1977b
filum Günther, 1870	*Lissocampus filum* (Günther, 1870)	Dawson, 1977b
galei Duncker, 1909	*Campichthys galei* (Duncker, 1909)	This report
kampeni Weber, 1913	*Phoxocampus tetrophthalmus* (Bleeker, 1858)	This report
maculatus Alleyne and Macleay, 1877	*Yozia bicoarctata* (Bleeker, 1857)	Whitley, 1948a
nox Snyder, 1909	*Phoxocampus belcheri* (Kaup, 1856)	This report (also Duncker, 1915)
papuensis Sauvage, 1880	*Corythoichthys haematopterus* (Bleeker, 1851)	Dawson, 1977a
pawneei Herald, 1950	*Mannarichthys pawneei* (Herald, 1950)	This report
philippinus Fowler, 1930	*Festucalex erythraeus* (Gilbert, 1905)	This report
pictus Duncker, 1915	*Mannarichthys pictus* (Duncker, 1915)	This report
ponticerianus Kaup, 1856	*Ichthyocampus carce* (Hamilton Buchanan, 1822)	Duncker, 1915
runa (Whitley, 1931)	*Lissocampus runa* (Whitley, 1931)	Dawson, 1977b
scalaris Günther, 1870	*Festucalex scalaris* (Günther, 1870)	This report
townsendi Duncker, 1915	*Festucalex erythraeus* (Gilbert, 1905)	This report
tryoni Ogilby, 1891	*Campichthys tryoni* (Ogilby, 1891)	This report
tryoni lindemanensis (Whitley, 1948b)	*Mannarichthys pictus* (Duncker, 1915)	This report

symbols; depths are reported in meters (m); latitude and longitude are approximations.

The following institutional abbreviations are used in material lists and acknowledgements: AMNH—American Museum of Natural History, New York. AMS—Australian Museum, Sydney. BMNH—British Museum (Natural History). BOC—Bingham Oceanographic Collection, Peabody Museum of Natural History, New Haven. BPBM—Bernice P. Bishop Museum, Honolulu. CAS—California Academy of Sciences, San Francisco. CAS-SU—Stanford University material now housed at CAS. FMNH—Field Museum of Natural History, Chicago. GCRL—Gulf Coast Research Laboratory Museum. HUJ—Hebrew University of Jerusalem. MCZ—Museum of Comparative Zoology. QM—Queensland Museum, Melbourne. RMNH—Rijksmuseum van Natuurlijke Historie. RUSI—J. L. B. Smith Institute of Ichthyology, Rhodes University. SAM—South Australian Museum, Adelaide. UF—Florida State Museum, Gainesville. UG—University of Guam, Agana. UMMZ—Museum of Zoology, University of Michigan. USNM—National Museum of Natural History, Smithsonian Institution. USP—University of the South Pacific, Fiji. WAM—Western Australian Museum, Perth. ZMA—Zoölogisch Museum, Amsterdam.

Remarks

Pipefishes discussed here share the following characters: confluent superior trunk and tail ridges; lateral tail ridge absent; dorsal, caudal and pectoral fins present; dorsal-fin base not elevated; male brood pouch located under tail. Generic differentiation is based largely on configuration of the lateral trunk ridge and presence or absence of anal fin, together with morphological differences in tail (Fig. 1) and head ridges (principally the median snout ridge). Inadequate study material has necessitated provisional treatment of certain species here referred to *Mannarichthys*, *Festucalex*, and *Campichthys*. There is evidence (differences in pouch-egg deposition, ridge configuration or caudal ray counts) that two or more phyletic lines are included in each of these genera. Pending collection of good series, I believe that conservative treatment indicates general affinities and best serves the users immediate interest in nomenclature and identification and I see little present advantage in the establishment of monotypic taxa within these groups of apparently related species. Consequently, 16 of the 18 species discussed here are referred to six genera, of which two (*Ichthyocampus* and *Stipecampus*) are monotypic.

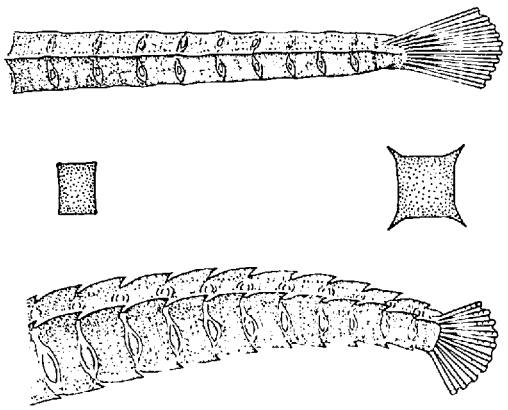

Figure 1. Cross sections and dorsolateral aspects of posterior tail rings and caudal fin. Top: Essentially straight superior and inferior tail ridges typical of most genera treated here. Bottom: Laterally projecting ridges and hooked or pointed posterior ring angles characteristic of subadult and adult specimens of *Phoxocampus*.

Two species described by Herald (1953) do not clearly relate to other forms discussed below. *Ichthyocampus davaoensis* was described as the type-species of the subgenus *Bulbonaricus* from a single immature specimen. I have examined the 33-mm SL holotype (USNM 112295) and find the lateral trunk ridge to end bilaterally without deflection on anterior third of the 1st tail ring. I count 16 + 42 rings, 25 dorsal-fin rays, 11 rays in the right pectoral fin, there is no anal fin, dorsal fin originates on poste-

rior fourth of 2nd tail ring, and there are 7.75 subdorsal rings. The snout is somewhat distorted but there are fleshy processes on either side and these bear the narial apertures; one anteriad near gape, the other dorsolaterad near eye (not shown in Herald's fig. 37). Smith (1963) suggested that these bulbous processes resulted from disease and that the specimen represented a species of *Siokunichthys* rather than *Ichthyocampus*. The specimen may be anomalous but it should be noted that narial apertures are located one above the other in *Siokunichthys* (rather than on a longitudinal axis) and lateral trunk ridge is deflected ventrad near anal ring (straight in *davaoensis*). Absence of anal fin and opercular ridge clearly distinguish this specimen from *Ichthyocampus* and general physiognomy agrees with *Siokunichthys*. Pending collection of additional material, I believe that *Bulbonaricus* should best be treated as a subgenus of *Siokunichthys*. The second of Herald's species, *Ichthyocampus bikiniensis*, was described from two planktonic postlarvae (ca. 7–10-mm SL). Both holotype (USNM 140244) and paratype (USNM 140243) have the dorsal-fin base elevated throughout, with distal portions of pterygiophores protruding above profile of body; pectoral-fin rays appear to articulate with a fleshy peduncle which in turn articulates with 1st trunk ring; anal-fin rays are 4 in the holotype and these articulate with a distinct peduncle protruding below venter; caudal-fin rays 10 in holotype, the fin well developed in both specimens. There are 1.5 + 5.5 subdorsal rings in the holotype and there is a low ridge crossing much of the opercle; there is a row of 3–4 minute spinules on dorsal midline of head and spiny projections on trunk and tail rings. I am unable to determine body ridge configuration in these specimens with any degree of certainty. Dorsal-fin origin on trunk immediately separates this species from *Ichthyocampus* but I am unable to confidently refer *bikiniensis* to any genus of pipefishes.

The remaining forms are poorly represented in collections; they are most often known from only a few localities and data on habitat and distribution are largely inadequate. Some species frequent shallow coraliferous habitats; others are known only from moderate depth (to about 90 m) and one, *Ichthyocampus carce*, is euryhaline. I believe that a number of additional species of *Festucalex* and *Campichthys* will be found when these deeper Indo-Pacific waters are more thoroughly collected with the aid of SCUBA or dredging and trawling gear designed for small fishes.

Key to Adult and Subadult Syngnathine (tail pouch) Pipefishes with Confluent Superior Trunk and Tail Ridges and Well Developed Caudal Fin

1a. Dorsal-fin origin on tail, 0.5 or more rings behind anal ring 2
1b. Dorsal-fin origin on trunk, at or (usually) in advance of rear margin of anal ring 4
2a. Lateral trunk ridge distinctly confluent with inferior tail ridge; trunk rings 8–10 ..... *Urocampus**
2b. Lateral trunk ridge not distinctly confluent with inferior tail ridge; trunk rings 11–16 3
3a. Pectoral-fin rays 9–11; anal fin absent; opercular ridge obsolete; HL 13 or more in SL ..... *Siokunichthys**
3b. Pectoral-fin rays 14–16; anal fin present; opercle with complete longitudinal ridge; HL 11 or less in SL ..... *Ichthyocampus carce*
4a. Lateral trunk ridge deflected ventrad near anal ring 5
4b. Lateral trunk ridge not deflected ventrad, ends at or caudad of rear margin of anal ring 8
5a. Anal fin present 6
5b. Anal fin absent 7
6a. Lateral trunk ridge confluent with inferior tail ridge; dorsal-fin base elevated anteriad; trunk rings 12–17 ..... *Lissocampus**
6b. Lateral trunk ridge not confluent with inferior tail ridge; dorsal-fin base not elevated; trunk rings 19–20 ..... *Stipecampus cristatus*†
7a. Trunk rings 13–14; pectoral-fin rays 5–7; dorsal-fin rays 18–22; total subdorsal rings 4–6 (Indo-Pacific) ..... *Mannarichthys pictus*

* Not treated here.

7b. Trunk rings 18; pectoral-fin rays 11–12; dorsal-fin rays 26–28; total subdorsal rings 10–11 (Western Atlantic) ..... *Mannarichthys pawneei*

8a. Superior and inferior tail ridges produced progressively laterad toward caudal fin (Fig. 1); posterior angles of tail rings produced as free hooklike projections ... 9

8b. Superior and inferior tail ridges not produced progressively laterad; tail rings without hooklike projections 11

9a. Lateral trunk ridge ends between tail rings 12–20; total rings 44–46; pectoral-fin rays 12–14, modally 13 ..... *Phoxocampus tetrophthalmus*

9b. Lateral trunk ridge ends anteriad of 6th tail ring 10

10a. Lateral trunk ridge ends on 1–5 (usually 3rd–4th) tail rings; total rings 45–48; pectoral-fin rays 11–13, modally 12 ..... *Phoxocampus belcheri*

10b. Lateral trunk ridge ends on 0–1 tail rings (usually on last trunk ring); total rings 41–43; pectoral-fin rays 13–15, modally 14 ..... *Phoxocampus diacanthus*

11a. Snout ridge a low subcontinuous crest; pectoral-fin rays usually 12 or more (91%); snout long (1.7–2.6 in HL) and slender (depth 2.5–6.5 in length) 12

11b. Snout ridge distinctly elevated and platelike or with 2–3 knoblike projections or crests; pectoral-fin rays usually 10 or less (98%) (except 12–13 in *Stipecampus*); snout short (2.6–3.6 in HL) and deep (depth 1.4–2.3 in length) 16

12a. Principal ridges of last 1–2 tail rings expanded somewhat laterad, each usually with 1–6 minute knobs or spinelike projections; trunk rings 16–18, usually 17; total rings 36–39; usually with persistent pale bar between eye and opercle ..... *Festucalex cinctus*

12b. Ridges of last 1–2 tail rings not modified; without pale bar behind eye 13

13a. Total rings 56–59; trunk rings 18–20, usually 19; dorsal-fin rays 25–26; lower parts of head spotted; venter of trunk banded ..... *Festucalex scalaris*

13b. Total rings 46–53; trunk rings 18 or less; dorsal-fin rays 24 or less; coloration not as above 14

14a. Pectoral-fin rays 16–17; trunk rings 14–15; total rings 46–47; snout length 1.7–1.8 in HL ..... *Festucalex wassi*

14b. Pectoral-fin rays 14 or less; trunk rings 16 or more; total rings 48–53; snout length 2.1–2.6 in HL 15

15a. Trunk rings 16; pectoral-fin rays 11–12; subdorsal trunk rings 0.5–1.0; lateral trunk ridge ends on 0–1 tail rings (usually on last trunk ring) ..... *Festucalex erythraeus*

15b. Trunk rings 18; pectoral-fin rays 13–14; subdorsal trunk rings 1.5–2.0; lateral trunk ridge ends on 2nd–3rd tail ring ..... *Festucalex gibbsi*

16a. Trunk rings 19–20; total rings 58–62; dorsal-fin rays 26–29; snout ridge strongly elevated, platelike ..... *Stipecampus cristatus*†

16b. Trunk rings 17 or less; total rings 52 or less 17

17a. Snout ridge subcontinuous, elevated and platelike; trunk rings 16–17, usually 16; total rings 49–52 ..... *Campichthys tryoni*

17b. Snout ridge usually with 2–3 knoblike projections or crests, not elevated throughout 18

18a. Caudal-fin rays 8; trunk rings 16; total rings 48–51; pectoral-fin rays 7–8, usually 8 ..... *Campichthys galei*

18b. Caudal-fin rays 10; trunk rings 15 or less; total rings 45 or less 19

19a. Trunk rings 15; total rings 45; pectoral-fin rays 10–11 ..... *Campichthys tricarinatus*

19b. Trunk rings 13; total rings 39–40; pectoral-fin rays 8–9 ..... *Campichthys nanus*

Ichthyocampus Kaup

Ichthyocampus Kaup, 1853:231 (type-species: *Syngnathus carce* Hamilton Buchanan, 1822, by monotypy).

Diagnosis.—Superior and inferior ridges of trunk continuous with corresponding ridges of tail (Fig. 2); lateral trunk ridge deflected ventrad near anal ring but not confluent with inferior ridge; venter of trunk V-shaped, with median longitudinal keel; dorsum somewhat depressed between superior ridges; ridges distinct but not strongly notched or indented between rings; scutella without longitudinal ridge or keel. Median dorsal snout ridge entire, not strongly elevated, terminates on interorbital, not confluent with orbital ridges; low frontal, prenuchal and nuchal ridges present; orbital ridge not strongly expanded laterad; suborbital ridge prominent, extends posteroventrad to near margin of opercle; opercle with complete median longitudinal ridge and radiating striae above and below; head rather well ornamented with short irregular low ridges or striae; pectoral-fin base with median longitudinal ridge and a shorter ridge above. Head and body devoid of spines or serrae, without dermal flaps; margins of principal ridges smooth to finely granular. Dorsal-fin origin on tail, fin base

† *Stipecampus cristatus* will key out in two places in key, depending on configuration of lateral trunk ridge.

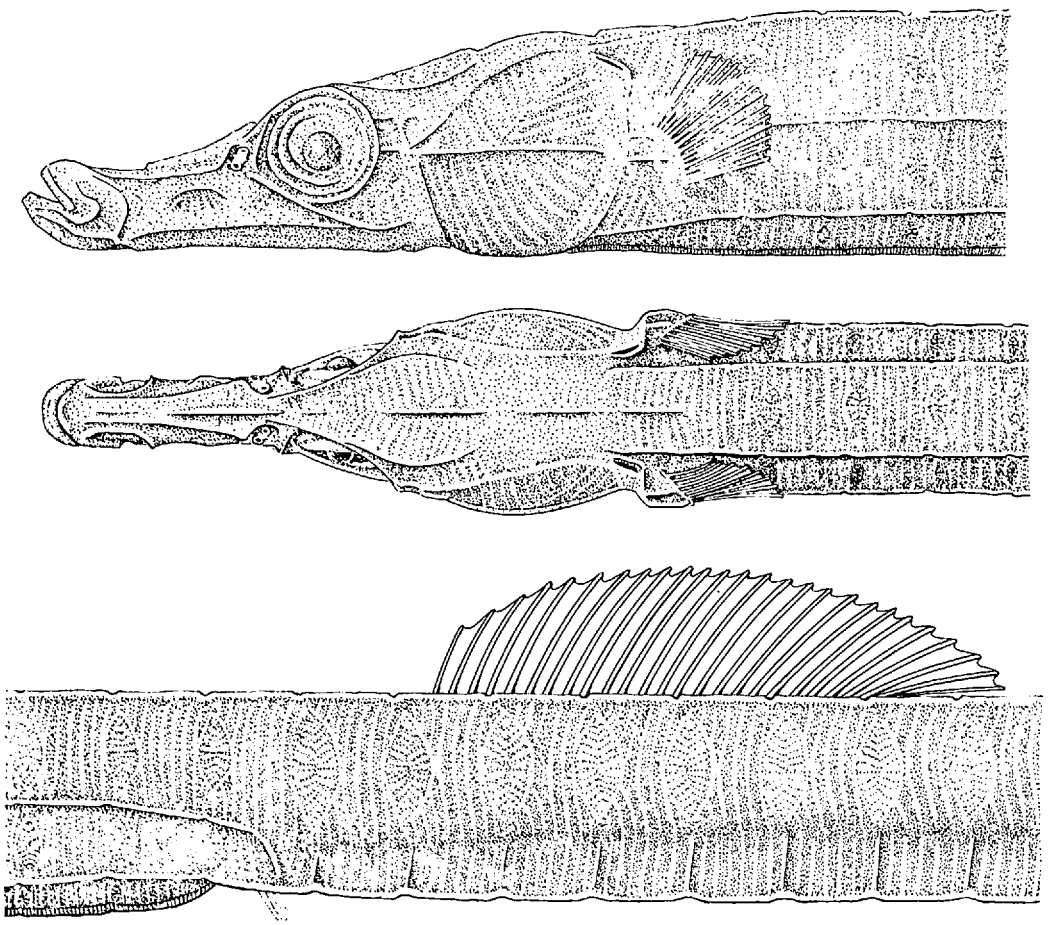

Figure 2. *Ichthyocampus carce*. Top to bottom.—Lateral and dorsal aspects of head and anterior trunk rings. Posterior trunk and anterior tail rings, illustrating ridge pattern, dorsal and anal fins, and brood-pouch plates (from 82-mm SL, male; GCRL 14829).

not elevated, membrane closely bound to fin-rays; anal-fin rays 2; caudal-fin rays 10. Brood pouch under tail; pouch protective plates present; brood-pouch eggs in up to 5–6 transverse rows (usually in single layer) covered by protective folds which meet or overlap on ventral midline; eggs not in continuous gelatinous matrix; pouch closure the everted type. Without odontoid processes in jaws (Dawson and Fritzsche, 1975); nares bilaterally 2-pored; neuromasts indistinct under low magnification. Maximum size at least 120-mm SL; euryhaline.

Comparisons.—Body ridge configuration, in combination with complete opercular ridge, a minute but distinct anal fin and dorsal fin located entirely on tail, distinguishes *Ichthyocampus* from other syngnathine genera. General appearance, dorsal-fin position, lateral and inferior ridge configuration and other characters are similar to those of certain species (*Syngnathus spicifer* Rüppell, *S. djarong* Bleeker) formerly referred to *Bombonia* Herre. In these forms, superior trunk and tail ridges are interrupted near rear of dorsal fin rather

than continuous as in *Ichthyocampus*. Dorsal fin location entirely on tail immediately separates *Ichthyocampus* from other genera treated here.

Nomenclature.—Kaup (1853) mentioned four nominal species in his original treatment of *Ichthyocampus* and I here comment on each in the order given by Kaup: (a) *Ichthyocampus belcheri*—name only, a *nomina nuda* subsequently validated by Kaup (1856); (b) *Ichthyocampus carce* (= *Syngnathus carce* Hamilton Buchanan, 1822)—the only available name according to Articles 11, 12 and 16 of the International Code of Zoological Nomenclatures; (c) *Syngnathus platygnathus* Kuhl (misprinted "Kp.") and van Hasselt Ms.—a *nomina nuda* treated by Kaup as a junior synonym of *Ichthyocampus carce*. I find Kuhl and van Hasselt's specimen (RMNH 3853) to represent a species of *Coelonotus* Peters; (d) *Ichthyocampus pondicerianus*—name only, a *nomina nuda* based on *Typhlus ponticerianus* Bibron Ms. This was subsequently validated as *Ichthyocampus ponticerianus* by Kaup (1856) and later synonymized with *I. carce* by Günther (1870). I have examined the syntype collected by M. Piller (RMNH 3861) and find it conspecific with *I. carce*.

Duncker (1912) recognized *Syngnathus carce* as the type-species of *Ichthyocampus* but Jordan's (1919) incorrect type-selection of *I. belcheri* has been followed by a number of authors. Bleeker's (1849) genus *Hippichthys* (type-species, *H. heptagonus* Bleeker) has been treated as a senior synonym of *Ichthyocampus* by Whitley (1948a, 1948b), Matsubara (1955), Tomiyama (1972) and others. I have recently shown (Dawson, 1977a) that *Hippichthys* was based on a specimen with discontinuous superior ridges, conspecific with *Syngnathus djarong* Bleeker, 1853.

Remarks.—*Ichthyocampus*, apparently monotypic, is here considered most closely related to *Hippichthys* (including *djarong* and *spicifer*). In addition to a number of shared characters, these forms apparently occupy similar habitats and are most commonly reported from estuarine or low salinity waters.

Ichthyocampus carce
(Hamilton Buchanan)
Figure 3

Syngnathus carce Hamilton Buchanan, 1822:13, 362 (India, Ganges River system).
Ichthyocampus ponticerianus Kaup, 1856:31 (India; Indonesia).

Diagnosis.—Diagnostic features are those of the genus.

Description.—Dorsal-fin rays 22–27; rings 14–15 + 37–40 = 51–55; total subdorsal rings 4.5–5.5; dorsal-fin origin always on tail, 1.0–2.5 ($\bar{x}$ = 1.73) rings behind 0-point; pectoral-fin rays 14–16; equivalent paired pectoral-fin ray counts modally 14; see Tables 2–5 and 7–9 for additional counts and proportional data.

Mainly brownish; dorsum medium brown, without bars or distinctive markings; eye with circlet of brown bars and narrower pale interspaces; sides of head brownish, shaded or mottled with tan, some specimens with irregular brownish bars on lower half of opercle; venter of head brownish in males, the snout often tan; females with irregular scattering of dark brown spots or blotches on venter and ventrolateral portions of snout; trunk with indistinct brown bars (about ⅓ ring width) between each ring, best indicated on lower half of trunk, rings plain, spotted or mottled between; each trunk ring with pale spot or blotch on or just above inferior ridge; side of tail with indications of 8–10 diffuse tan bars or blotches; inferior tail ridge with small alternating blotches of brown and tan or white; venter of trunk brown, shading to dark brown or near black on midline; margins of brood pouch folds pale, folds elsewhere freckled with white or tan spots, venter of

Figure 3. Top.—*Ichthyocampus carce* (Hamilton Buchanan), GCRL 14830 (98-mm SL, female), Ceylon. Middle.—*Mannarichthys pictus* (Duncker), USNM 216264 (91-mm SL, female), Farquhar Group. Bottom.—*Mannarichthys pawneei* (Herald), BOC 3327 (22-mm SL, holotype), Bahama Islands.

tail otherwise brownish. Dorsal, pectoral and anal-fin rays narrowly edged with brown; caudal fin dark brown with narrow pale or white margin, occasionally spotted or mottled. Color description from Ceylon specimens (GCRL 14830, USNM 216304).

Remarks.—Brood pouch below 14–20 ($\bar{x}$ = 16.6) tail rings in 14 examined males, 77–120-mm SL; smallest male with eggs in pouch was 78 mm; a 118-mm specimen had pouch below 20 tail rings and eggs were deposited below 17, approximately 280 eggs in pouch.

Hamilton Buchanan failed to designate type-material and there has been no subsequent neotype selection. I therefore designate an adult female from Calcutta (BMNH 1889.2.1.4077–9) as the neotype of *Syngnathus carce*. This fish has 15 rays in the left pectoral fin and 16 in the right; measurements (mm) follow: SL 99.5; HL 10.8, snout length 4.6; snout depth 1.6; length of dorsal-fin base 8.0; anal ring depth 3.1; pectoral-fin length 1.9; length of pectoral-fin base 1.3; see Tables 2–5 and 7–8 for counts.

Among examined material, six lots with adequate data are all recorded from rivers or estuaries; Weber and de Beaufort (1922) report *Ichthyocampus carce* from the "sea" and this may well be a euryhaline species. The species is known from Bombay, India eastward to the Celebes (Fig. 4).

Material examined.—Fifty-six specimens, 39–120-mm SL, including neotype. NEOTYPE. BMNH 1889.2.1.4077–9 (99.5-mm SL, female), Calcutta, India, F. Day. OTHER MATERIAL. INDIA, Bombay: USNM 197536; W. Bengal: AMS I. 105,

Table 2. Frequency distributions of trunk and tail rings of treated species of *Ichthyocampus, Mannarichthys, Phoxocampus, Festucalex, Campichthys,* and *Stipecampus*

Genus	Trunk Rings								Tail Rings																	
Species	13	14	15	16	17	18	19	20	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
Ichthyocampus																									
carce		5	46*																	13	21	14*	3		
Mannarichthys																									
pictus	1	35*															6	16	5	3*	1		1	4	
pawneei						2*								1	1*										
Phoxocampus																									
belcheri				107*	10							19	43*	49	6										
tetrophthalmus				26*							7	12*	7												
diacanthus			6*	14					10*	10															
Festucalex																									
cinctus				1	24	14*													1	10*	16	12			
scalaris						1	9*	3													6	6*	1		
erythraeus				7*											1	2		2	1*	1					
gibbsi						3*									2*	1									
wassi		2	2*												4*										
Campichthys																									
tryoni				17	2*											1	14	4*							
tricarinatus			1*										1*												
nanus	2*								1*	1															
galei				7*											1	4	1*	1							
Stipecampus																									
cristatus							2*	4														1*	2	2	1

* Primary type.

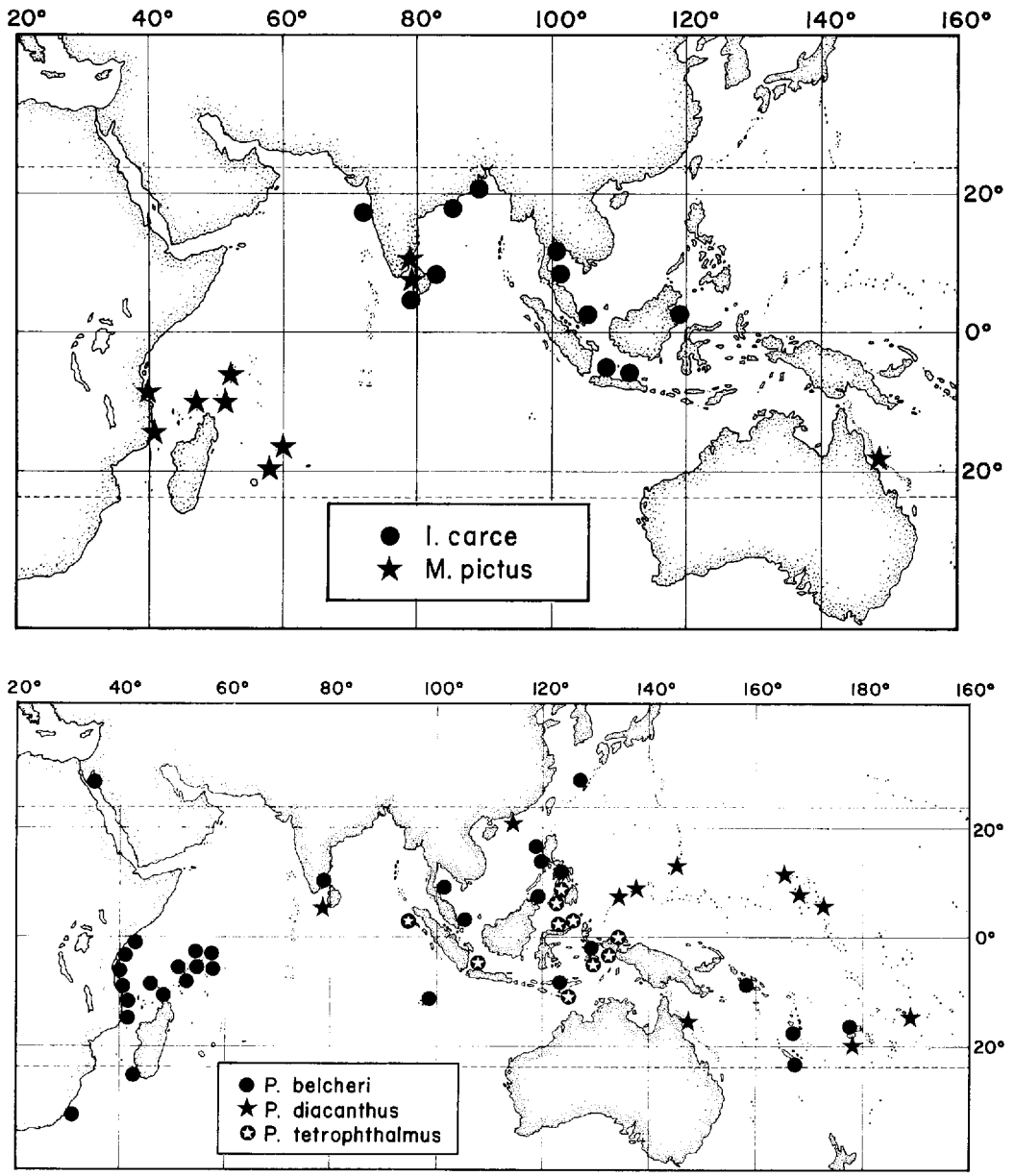

Figure 4. Indo-Pacific distribution of species of *Ichthyocampus, Mannarichthys* and *Phoxocampus* based on examined material.

BMNH 1889.2.1.4007–9, RMNH 8820; Orissa: CAS-SU 41784; Ceylon: GCRL 14829, 14830, RMNH 20903, USNM 216303, 216304, 216305; MALAYSIA, Singapore: BMNH 1970.7.22.80, RMNH 26432; THAILAND: ANSP 62183, 87346, CAS 36584, USNM 109797; INDONESIA: BMNH 1874.8.14.43–4, FMNH 51598, 51599, RMNH 3861, UMMZ 171829, ZMA 114.121; "East Indies": RMNH 7239; Loc. unknown: BMNH 1867.11.28.352, BMNH uncat.

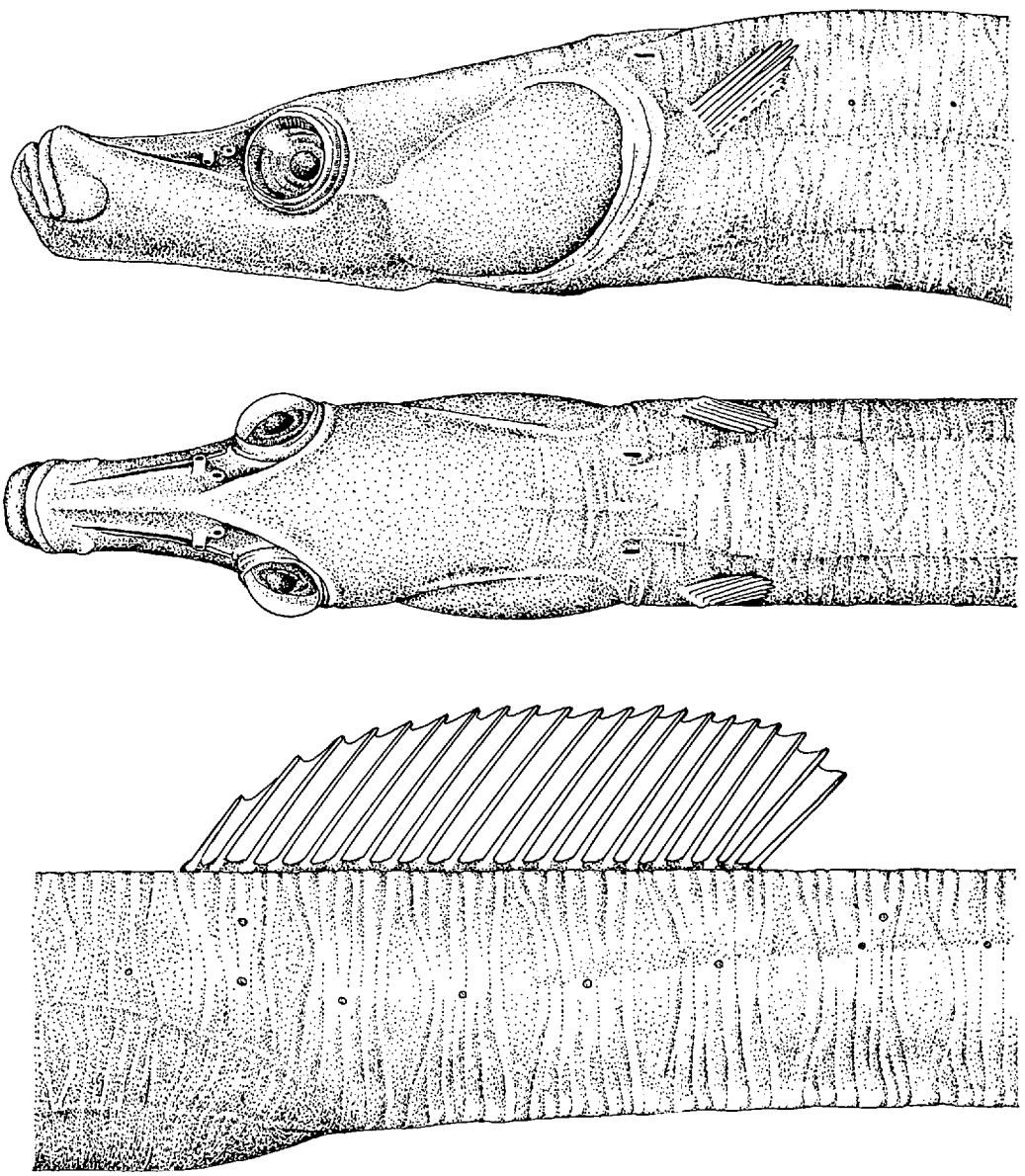

Figure 5. *Mannarichthys pictus.* Top to bottom.—Lateral and dorsal aspects of head and anterior trunk rings. Posterior trunk and anterior tail rings, illustrating ridge pattern and dorsal fin (from 76-mm SL male; AMS IB. 1909–1916).

Mannarichthys new genus

Type-species: *Ichthyocampus pictus* Duncker, 1915.

Diagnosis.—Superior trunk and tail ridges continuous; inferior trunk and tail ridges continuous or interrupted near anal ring (in *pawneei*); lateral trunk ridge deflected ventrad near anal ring, discontinuous or confluent with inferior tail ridge; venter of trunk somewhat V-shaped, without median

Table 3. Frequency distributions of total rings of treated species of *Ichthyocampus, Mannarichthys, Phoxocampus, Festucalex, Campichthys,* and *Stipecampus*

Genus	Total Rings																					
Species	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
Ichthyocampus																								
carce													1	14	20	14*	2							
Mannarichthys																								
pictus										7	15	5	3	1			1*	4						
pawneei											1	1*												
Phoxocampus																								
belcheri							18	40*	47	12														
tetrophthalmus						7	12*	7																
diacanthus			4	8*	8																			
Festucalex																								
cinctus															1	6	14*	18						
scalaris																		1	3	7*	2			
erythraeus										1	2		2	1*	1									
gibbsi												2*	1											
wassi								2	2*															
Campichthys																								
tryoni											1	12	4	1*										
tricarinatus							1*																	
nanus	1*	1																						
galei										1	4	1*	1											
Stipecampus																								
cristatus																				1*	1	1	2	1

* Primary type.

longitudinal keel; dorsum of trunk and tail flat to slightly rounded; superior ridges little indented between rings; posterior angles of rings not pointed. Median dorsal snout ridge entire, not strongly elevated or platelike, confluent posteriad with anterior supraorbital ridges (Fig. 5); opercular and other head ridges little developed, vestigial or obsolete; no ridges on pectoral-fin base; devoid of spines, serrae and dermal flaps. Total rings 48–55; dorsal-fin origin on trunk, fin base not elevated, membrane closely bound to fin rays; dorsal-fin rays 18–28; pectoral-fin rays 5–11; anal fin absent; caudal rays 10. Brood pouch (unknown in *pawneei*) under tail; without odontoid processes in jaws; nares 2-pored bilaterally. Maximum size at least 91 mm SL. Indo-Pacific and Western Atlantic; marine.

Comparisons.—The combination of dorsal-fin origin on trunk, absence of anal fin and lateral trunk ridge deflected ventrad near anal ring distinguishes *Mannarichthys* from other syngnathine genera with continuous superior body ridges. The confluent snout and supraorbital ridges somewhat resemble the condition in *Stipecampus* but the snout ridge is not greatly enlarged (thick, strongly elevated, and platelike in *Stipecampus*).

Etymology.—Named *Mannarichthys* in reference to the Gulf of Mannar, original locality of the type-species *Ichthyocampus pictus*.

Remarks.—In the absence of adequate material, I provisionally refer *Ichthyocampus pawneei* Herald to this genus. This unique Atlantic species may eventually require separate generic treatment.

Mannarichthys pictus (Duncker)
Figure 3

Ichthyocampus pictus Duncker, 1915:95 (W. Ceylon, Gulf of Mannar).
Campichthys tryoni lindemanensis Whitley, 1948b:78 (Queensland, Australia).
Ichthyocampus tryoni lindemanensis, Munro, 1958:88 (new combination).

Diagnosis.—Trunk rings 13–14; pectoral-fin rays 5–7; total subdorsal rings 4.25–5.75; lateral trunk ridge not confluent with inferior tail ridge.

Description.—Dorsal-fin rays 18–22; rings 13–14 + 34–41 = 48–55; subdorsal rings 0–1.0 + 3.5–5.5 = 4.25–5.75; dorsal-fin origin at or in advance of 0-point; pectoral-fin rays 5–7, modally 6; equivalent paired pectoral-fin ray counts modally 6; see Tables 2–9 for additional counts and proportional data.

Ground color tan, markings brown; generally without prominent or distinctive markings; caudal fin shaded with brown, other fins pale; eye with circlet of alternating brown bars and pale interspaces; side of snout, dorsum of head and upper third of opercle mottled or streaked with brown; suborbital and lower portion of opercle with indication of brown stripe; trunk with dorsum and upper third of side mottled, remainder of side mainly tan with indistinct streaks of brown; venter of trunk with indications of median brown stripes; perianal region brown; tail mottled, darkest on dorsum and upper part of side. Color description from USNM 216264 (Fig. 3). Some specimens marked with narrow brown streaks on head and body, some with diffuse pale bars crossing dorsum and upper part of sides; occasional specimens with brown flecks on dorsal-fin rays; margins of brood-pouch folds often dark brown, folds otherwise plain or with narrow longitudinal brown streaks.

Comparisons.—See key, diagnoses and remarks under *M. pawneei*.

Remarks.—Brood pouch below 11–13 ($\bar{x}$ = 12.2) tail rings in 11 egg-bearing males 54–82-mm SL; a 50-mm male without eggs had pouch folds and plates developed through 11 rings; a 58-mm specimen had a single

Table 4. Frequency distributions of pectoral-fin rays and paired (equivalent) pectoral ray counts of treated species of *Ichthyocampus*, *Mannarichthys*, *Phoxocampus*, *Festucalex*, *Campichthys*, and *Stipecampus*

Genus	Pectoral-fin Rays													Paired Pectoral Counts											
Species	5	6	7	8	9	10	11	12	13	14	15	16	17	5	6	7	8	9	10	11	12	13	14	15	16	17
Ichthyocampus																										
carce										23	28*	21*											9	7	7	
Mannarichthys																										
pictus	8*	44	12											1*	17	2										
pawneei							4*	1												1*						
Phoxocampus																										
belcheri							14	152*	37											3	66*	14				
tetrophthalmus								3	32*	8												13*	3			
diacanthus									8	26*	5											2	11*	2		
Festucalex																										
cinctus								22	45*	6												8	18*	2		
scalaris							1*	12	3												5	1				
erythraeus							10	7												5	3					
gibbsi									5*	1												2*				
wassi												5*	3												2*	1
Campichthys																										
tryoni			3	30*	5											1	14*	2								
tricarinatus						1*	1*																			
nanus				2*	2*																					
galei			1	13*													6*									
Stipecampus																										
cristatus								14	5												5	2				

* Primary type.

Table 5. Frequency distributions of dorsal-fin rays of treated species of *Ichthyocampus, Mannarichthys, Phoxocampus, Festucalex, Campichthys,* and *Stipecampus*

Genus	Dorsal-fin Rays													
Species	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Ichthyocampus														
carce							1	5	20	15*	4	1		
Mannarichthys														
pictus			6*	9	13	6	2							
pawneei											2		1*	
Phoxocampus														
belcheri					15	28*	63	18	2					
tetrophthalmus					4	16*	6							
diacanthus					1	3	8*	3	5					
Festucalex														
cinctus						1	2	6	7	9*	11	3	1	
scalaris										5*	2			
erythraeus			2	3	3	1								
gibbsi						2*			1					
wassi							2	2*						
Campichthys														
tryoni		6	7	4*										
tricarinatus		1*												
nanus			1	1*										
galei	4	3*												
Stipecampus														
cristatus											2	3	2	1

* Primary type.

layer of approximately 92 eggs in maximum of 4 transverse rows throughout a 12 ring pouch; eggs not in gelatinous matrix; pouch closure the everted type.

Distal deflection of the lateral trunk ridge varies both bilaterally and between individuals. Among 27 specimens (54 ridge deflections), 12 ridges ended well above inferior ridge with ventral deflection approximating 30°, 17 ended closer to inferior ridge with deflection of about 45° and 21 stopped just above inferior ridge with deflection approaching 80°; three ridges, evidently unilateral anomalies, united with the inferior ridge.

Examined materials indicate west to east increase in tail ring counts (Table 10) and slightly lower dorsal-fin ray counts in the few fish from India and Ceylon. West-east variation in tail ring frequencies had been observed in a number of Indo-Pacific pipefishes (Dawson, 1976, 1977a) and present intraspecific trends are not considered unusual.

Deflection of the right lateral trunk ridge almost reaches inferior ridge in the holotype, whereas the left deflection stops well short of the inferior ridge. This specimen retains indications of a pale blotch dorsad on snout and dark stripe on venter of trunk; dorsal-fin rays are flecked with brown. Measurements (mm) of the (apparently female) holotype follow: SL 57.5, HL 4.6, snout length 1.4, snout depth 0.9, length of dorsal-fin base 4.3, anal ring depth 1.4, pectoral-fin length 1.0, length of pectoral-fin base 0.4; see Tables 2–8 for counts.

Whitley (1948b) described *Campichthys*

Table 6. Frequency distributions of subdorsal trunk rings of treated species of *Ichthyocampus*, *Mannarichthys*, *Phoxocampus*, *Festucalex*, *Campichthys*, and *Stipecampus*

Genus	Subdorsal Trunk Rings										
Species	2.50	2.25	2.00	1.75	1.50	1.25	1.00	0.75	0.50	0.25	0.00
Ichthyocampus											
carce											
Mannarichthys											
pictus							7	7	17*	5	1
pawneei					1		2*				
Phoxocampus											
belcheri			2	1	15	17	53*	26	14	1	
tetrophthalmus			8	12*	6	1					
diacanthus	3	1	10	4*	2						
Festucalex											
cinctus			4*	3	12	8	9	1	5		
scalaris	2	5*	3	1							
erythraeus							3	5*	1		
gibbsi			2	1*							
wassi							1*	1	1	1	
Campichthys											
tryoni						4	7*	3	2	2	
tricarinatus							1*				
nanus							1*				
galei							2	4*	1		
Stipecampus											
cristatus						2	3	3	2*		

* Primary type.

tryoni lindemanensis from five specimens collected over *Zostera* flats at Lindeman Is., Queensland and inadvertently listed *Ichthyocampus tryoni* Ogilby as its junior synonym. He stated that the holotype (AMS IA. 6134) had 8 pectoral-fin rays, "11?" caudal-fin rays, 1 + 5 subdorsal rings and "anal overgrown by brood pouch." Whitley also discussed variations between "males" and "females" in his four paratypes (AMS IB. 1909–1910). I have examined these specimens and find the holotype to have 6 (2) pectoral rays, 10 caudal rays, 0.25 + 4.75 subdorsal rings and there is no trace of anal fin. The paratype series contains two specimens (including only mature male) which are conspecific with the holotype and two specimens of "*Ichthyocampus*" *tryoni*. I find the holotype and two paratypes of *Campichthys tryoni lindemanensis* to agree with *Mannarichthys pictus* in external morphology, residual coloration and counts and I consider these forms to be conspecific.

Among examined material, 9 collections were from reef or coral habitats in depths of 0–9.1 m. The species is known from the western Indian Ocean, India, Ceylon and Australia (Fig. 4).

Material examined.—Thirty-eight specimens, 40–91-mm SL, including holotype. HOLOTYPE. BMNH 1892.5.28.3 (53.5-mm SL, presumably female), Ceylon, Gulf of Mannar, J. R. Henderson. OTHER MATERIAL. KENYA: GCRL 14896, USNM 216263, 216265; MOZAMBIQUE: RUSI 4652, 4653, 4654, 4655 (loc. uncertain, probably Mozambique), 4656; ALDABRA IS.: USNM 216306; FARQUHAR GROUP: USNM 216264; AMIRANTE IS.: ANSP 108995, 110019, 110046; MAURITIUS: BPBM 20084, RUSI 74–95; ST. BRANDON SHOAL (Cargados Carajos Shoals): USNM 216183; INDIA: CAS-SU 41785, FMNH

75855; AUSTRALIA, Queensland: AMS IA. 6134 (holotype of *Campichthys tryoni lindemanensis*), AMS IB. 1909 (2 paratypes of *C. t. lindemanensis*).

Mannarichthys pawneei (Herald)
Figure 3

Ichthyocampus pawneei Herald, 1950:269 ("Guen" (= Green) Cay, Bahamas).
Ichthyocampus pawnei Herald, 1953:239; 1959: 471 (misspelling).

Diagnosis.—Trunk rings 18, pectoral-fin rays 11–12; total subdorsal rings 10.75–11; lateral trunk ridge confluent with inferior tail ridge.

Description.—Dorsal-fin rays 26–28; rings 18 + 31–32 = 49–50; subdorsal rings 1.0–1.5 + 9.25–10.0 = 10.75–11.0; pectoral-fin rays 11–12; see Tables 2–8 for additional counts. Measurements (mm) of holotype follow: SL 22.2, HL 2.6, snout length 0.8, length of dorsal-fin base 4.5.

Median dorsal snout ridge originates on anterior third of snout and angles rather strongly dorsad to reach maximum elevation above nares; orbital ridges somewhat elevated dorsad; posterior supraorbital and median dorsal head ridges vestigial; faint ridge, angled slightly dorsad, crosses about ¾ of upper third of opercle. Inferior trunk ridge ends near anal ring; lateral trunk ridge confluent with inferior tail ridge; principal trunk and tail ridges distinct but not elevated; superior ridges faintly indented between rings. Narial apertures rather large; neuromasts not visible under low magnification.

Holotype brownish, with some scattered microchromatophores but without distinctive markings; dorsal and pectoral fins pale or hyaline; caudal fin pale with some minute brown spots. A 22-mm SL fish (AMNH 20545) has dorsum of snout pale and head elsewhere with light to moderate shading of minute to rather large brown chromatophores; there are indications of about 11 pale bands (about one ring wide) crossing dorsum and sides between bases of pectoral and caudal fins, banding most distinct on tail where rather dark brownish interspaces extend over 2–3 rings; caudal fin mainly pale with median brown blotch, other fins hyaline.

Remarks.—Herald (1950) reported 26 dorsal-fin rays, "8?" caudal rays, 10.5 subdorsal rings and 17 trunk rings in the holotype. My counts show 28 dorsal and 10 caudal rays, 11 subdorsal and 18 trunk rings, with anus impinging on the 19th. Superior body ridges are superficially smooth but traces of 3–5 minute marginal projections are visible on some rings under ×60 magnification; these may be vestiges of spiny postlarval ridges common to many pipefishes.

Absence of anal fin, dorsal-fin origin on trunk and the confluent snout and supraorbital ridges clearly distinguish this species from *Ichthyocampus* and suggest close relationship with *Mannarichthys pictus*. The opercular ridge is lacking in examined *M. pictus* but I have not seen small specimens and a ridge (similar to that of *pawneei*) may occur in juveniles. The confluent lateral trunk and inferior tail ridge of this Atlantic species differs from *M. pictus* wherein lateral ridge is variably deflected but not distinctly confluent with an interrupted inferior ridge. Despite these differences I consider *Ichthyocampus pawneei* best referred to *Mannarichthys* pending collection of additional material.

The five known specimens are evidently planktonic juveniles and all were taken at the surface during the months of January and February; two (AMNH) were dipnetted at night, water column depths were 12.2–15.2 and 24.4–74.7 m.

Material examined.—Five specimens, 18–22-mm SL, including holotype. HOLOTYPE. BOC 3327 (22-mm SL, juvenile), Bahama Is., Green Cay, "surface," 27 Feb. 1927, sta. 6, R/V PAWNEE. OTHER MATERIAL. Bahama Is.: AMNH 30545 (off New Providence). AMNH 34413 (off Conception Is.). UF 14000 (off Cat. Is.). UF 18251 (Little San Salvador Is.).

Phoxocampus new genus

Type-species: *Ichthyocampus belcheri* Kaup, 1856.

Table 7. Frequency distributions of subdorsal tail rings of treated species of *Ichthyocampus*, *Mannarichthys*, *Phoxocampus*, *Festucalex*, *Campichthys*, and *Stipecampus*

Genus / Species	Subdorsal Tail Rings													
	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50 - - 9.25	- - 10.00	
Ichthyocampus														
carce								4	17*	25	5	2		
Mannarichthys														
pictus				1	3	6	19*	6	1					
pawneei													1	2*
Phoxocampus														
belcheri				2	5	12	21	51*	16	13	7	2		
tetrophthalmus		1	5*	10	7	4								
diacanthus	1	3	10*	4		2								
Festucalex														
cinctus				3	3*	15	9	7	3	1	1			
scalaris			1	1	3*	2	2	1	1					
erythraeus				1	1	2	1	2*		2				
gibbsi				1			2*							
wassi							2*			2				
Campichthys														
tryoni		1	4	5*	4	4								
tricarinatus				1*										
nanus						1*	1							
galei		2	3*	1	1									
Stipecampus														
cristatus						2		2*	1	4	1			

* Primary type.

Diagnosis.—Superior and inferior ridges of trunk continuous with corresponding ridges of tail; lateral trunk ridge not deflected ventrad near anal ring, terminates midlaterally between last trunk ring and 20th tail ring; venter of trunk somewhat V-shaped, without median longitudinal keel; dorsum usually depressed between superior trunk ridges; dorsum, sides and venter distinctly concave between margins of superior and inferior tail ridges; superior trunk ridges distinctly notched or indented between rings; superior and inferior ridges of tail angled progressively laterad toward caudal fin, well notched between rings and with posterior angles of each ring produced to a pointed or hooklike projection (Fig. 1); scutella without longitudinal ridge or keel. Median dorsal snout ridge not strongly elevated, terminates on interorbital, not confluent with orbital ridges; snout ridge thin, usually edged with several low emarginations or short points, without bony knobs or spines, infrequently entire; lateral snout ridge present, sometimes developed as a short broad-based spine; orbital, postorbital, supraopercular, nuchal, prenuchal and frontal ridges distinct to somewhat elevated (in *diacanthus*); opercular ridge usually angled dorsad, may cross entire opercle or restricted to anterior third in some adults; pectoral-fin base crossed by superior and inferior ridges. Simple dermal flaps often present on principal head ridges, on eye and along posterior margin of opercle; margins of head and body ridges usually finely granular, occasionally smooth or minutely denticulate, not serrate. Total rings 41–48; dorsal-fin origin on

Table 8. Frequency distributions of total subdorsal rings of treated species of *Ichthyocampus, Mannarichthys, Phoxocampus, Festucalex, Campichthys,* and *Stipecampus*

Genus	Total Subdorsal Rings												
Species	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00	6.25	6.50 - - 10.75	11.00
Ichthyocampus													
carce				4	17*	25	5	2					
Mannarichthys													
pictus			2	9	12*	7	4	2	1				
pawneei												1	2*
Phoxocampus													
belcheri					6	15	22	40*	28	12	4	2	
tetrophthalmus						4*	12	10	1				
diacanthus				1	1	6*	3	4	4	1			
Festucalex													
cinctus					1	4	11	12	9*	3		1	
scalaris									1	5*	2	3	
erythraeus			1	2		1	2*	1	2				
gibbsi								1	1*		1		
wassi						1	2*	1					
Campichthys													
tryoni		1	7	8*	2								
tricarinatus				1*									
nanus					1	1*							
galei	2	3*		2									
Stipecampus													
cristatus						2*	2	1	2	2	1		

* Primary type.

trunk, fin base not elevated, membrane closely bound to fin rays; dorsal-fin rays 20–24; pectoral-fin rays 11–15; anal-fin rays 3–4; caudal-fin rays 10. Brood pouch under anterior 10–14 tail rings; pouch protective plates present; brood-pouch eggs in 1–2 layers of 2–4 transverse rows, covered by protective folds which barely meet on ventral midline; eggs not deposited in continuous gelatinous matrix; pouch closure the semi-BPC type. Without odontoid processes in jaws; nares 2-pored bilaterally; neuromasts usually distinct under low magnification. Maximum size at least 87-mm SL. Indo-Pacific; marine.

Comparisons.—The laterally produced superior and inferior tail ridges and hooklike posterior angles of tail rings separate *Phoxocampus* from other genera wherein lateral ridge ends on middle of side without deflection ventrad. Compared with *Festucalex,* there are fewer tail rings (96% with 31 or less against 89% with 33 or more). Pectoral-fin rays are 12 or more in 95% of examined *Phoxocampus*, whereas this count is 10 or less in 98% of examined *Campichthys*; see diagnoses for additional differences.

Etymology.—From the Greek *phoxos* (pointed) + *kampos* (a sea-animal), in allusion to the pointed distal angles of tail rings.

Remarks.—Among 150 examined specimens, lateral trunk ridges terminated on the same ring bilaterally in 67%, longer right or

Table 9. Number of specimens measured and standard length range, together with range and mean ($\bar{x}$) for selected proportional characters in species of *Ichthyocampus*, *Mannarichthys*, and *Phoxocampus*

Character	*Ichthyocampus carce*		*Mannarichthys pictus*		*Phoxocampus belcheri*		*Phoxocampus tetrophthalmus*		*Phoxocampus diacanthus*	
	Range	$\bar{x}$	Range	$\bar{x}$	Range	$\bar{x}$	Range	$\bar{x}$	Range	$\bar{x}$
No. of specimens	35		27		47		21		13	
Standard length (mm)	58.5–117.0	94.1	55.0–91.0	66.8	29.0–72.5	54.8	44.5–75.0	58.2	39.0–86.5	57.5
Head length in SL	8.5– 10.9	9.4	10.2–14.2	11.2	7.1– 9.4	8.4	7.3– 8.2	7.8	6.4– 7.9	7.2
Snout length in HL	2.2– 2.8	2.5	2.7– 3.3	3.0	2.4– 3.1	2.7	2.5– 3.0	2.7	2.2– 2.6	2.4
Snout depth in snout length	2.4– 3.9	3.2	1.4– 2.0	1.7	1.8– 2.8	2.4	1.8– 2.6	2.2	2.4– 2.9	2.6
Length of dorsal-fin base in HL	1.1– 1.6	1.3	0.8– 1.3	1.1	1.0– 1.4	1.2	1.1– 1.3	1.3	1.2– 1.5	1.3
Anal ring depth in HL	2.9– 5.2	3.7	2.1– 3.5	2.8	2.4– 3.8	2.9	2.1– 3.0	2.7	2.5– 3.6	2.8
Pectoral-fin length in HL	5.5– 8.8	6.3	3.7– 6.5	5.0	3.9– 5.4	5.0	4.0– 5.0	4.6	4.1– 5.4	4.7

left ridges were about equally distributed in the remainder; the usual difference was one ring, maximum difference was two rings. Anal-fin rays are difficult to enumerate, apparently most commonly 3 in *P. belcheri*, often 4 in congeners. Snout often angled dorsad to about 30° above lateral midline, this is a common condition in adult *P. diacanthus* but angled snouts also occur in the other species.

Phoxocampus belcheri (Kaup)
Figure 6

Ichthyocampus belcheri Kaup, 1856:117 ("China").
Ichthyocampus nox Snyder, 1909:598 (Naha, Okinawa).
Ichthyocampus kampeni not of Weber, Fowler, 1934:397 (New Hebrides); Herre, 1936:82 (Fiji); Inger, 1957:357 (North Borneo).
Hippichthys nox, Matsubara, 1955:429 (compiled in key).

Diagnosis.—Total rings 45–48, usually 46–47; pectoral-fin rays modally 12; lateral trunk ridge ends on tail rings 1–5, usually on 3rd–4th; opercular ridge usually incomplete in adults.

Description.—Dorsal-fin rays 20–24; rings 16–17 + 29–32 = 45–48; subdorsal rings 0.25–2.0 + 3.5–5.5 = 4.75–6.50; pectoral-fin rays 11–13; equivalent paired pectoral-fin ray counts modally 12; see Tables 2–9 and 11 for additional counts and proportional data.

Ground color infrequently pale, usually tan to dark brown, markings in shades of brown; dorsal and pectoral-fin rays plain or flecked with brown; caudal fin brown, with narrow pale margin; eye with circlet of alternating brown bars and pale interspaces. Males usually with pale bar on suborbital and another on anterior third of opercle, bars often continued ventrad as series of elongate pale blotches; some specimens with indications of similar bars on rear margin of opercle and below pectoral-fin base, these may continue on venter of 1st trunk ring. Head usually plain in females but some with 1–3 faint pale bars on suborbital and faint

Table 10. Geographic variation in frequencies of tail rings and dorsal-fin rays in *Mannarichthys pictus*

	Tail Rings								Dorsal-fin Rays				
Locale	34	35	36	37	38	39	40	41	18	19	20	21	22
Kenya		1	3							1	1	1	1
Mozambique	2	3								3	1	1	
Mozambique ?	4	5								1	6	2	
St. Brandon Sh.	1									1			
Aldabra Is.		3								2	1		
Farquhar Gp.			1								1		
Amirante Is.		3								1	2		
Mauritius		1	1									1	1
India				2	1			2	5	1			
Ceylon				1*					1*				
Australia							1	2			1	1	

* Primary type.

bar on anterior third of opercle. Dorsum of body plain or with indications of 10–11 diffuse pale bars between head and caudal fin; bars often continued on upper third of side; trunk often with indications of brown bars between each ring on venter and lower part of side; brood pouch folds plain or finely striped with brown; body otherwise plain or mottled.

Comparisons.—*Phoxocampus belcheri* is best separated from congeners by the number of tail rings crossed by the lateral ridge. This ridge ends before the 2nd tail ring in all *P. diacanthus*, on or beyond the 13th ring in *P. tetrophthalmus* but ended on 2nd–5th (usually 3rd–4th) ring in all but one of 253 examined ridges in *P. belcheri* (Table 11). This species has the highest total ring frequency (modally 47 against 45 or less), the lowest modal count of pectoral-fin rays (12 against 13–14) and frequency of subdorsal tail rings averages somewhat higher (4.5 against 3.4–3.7). *Phoxocampus belcheri* lacks the rather strongly elevated head ridges of *P. diacanthus* and markings of males (pale suborbital and opercular bars) are similar to those of male *P. tetrophthalmus*. The opercular ridge usually ends near middle or anterior third of opercle in adult *P. belcheri*, whereas ridge completely crosses opercle in most *P. tetrophthalmus*.

Remarks.—Brood pouch below 10–14 rings in 21 males 46–57-mm SL; the smallest egg-bearing male was 48 mm; a 62-mm fish contained a single layer of 58 eggs in maximum of 4 transverse rows in the filled 13 ring pouch; eggs deposited in two rows in 3 other examined males. Herald (1953) reported that pouch protective plates were lacking in this species and that this constituted a notable difference from *P. tetrophthalmus*. Although little enlarged and often partly concealed by pouch folds, I find protective plates in all mature males.

Counts of tail rings and dorsal-fin rays (Table 12) do not show distinct clinal variation and I find no geographic trends in preserved coloration.

Syntypes (BMNH uncat.) consist of a male and female and I select the latter, 61.5-mm SL, as the lectotype of *Ichthyocampus belcheri*. This specimen has some damage to dorsal and caudal fins, the opercular ridge crosses proximal third of opercle, some dermal flaps persist on head and color pattern has faded. Measurements (mm) follow: Head length 7.2, snout length 2.5, snout depth 1.1, length of dorsal-fin base 6.5, anal ring depth 2.6, pectoral-fin length 1.6, length of pectoral-fin base 1.0; see Tables 2–9 and 11 for counts. Kaup (1856) states that these specimens were "procured in China" and there is no other information on the type-locality.

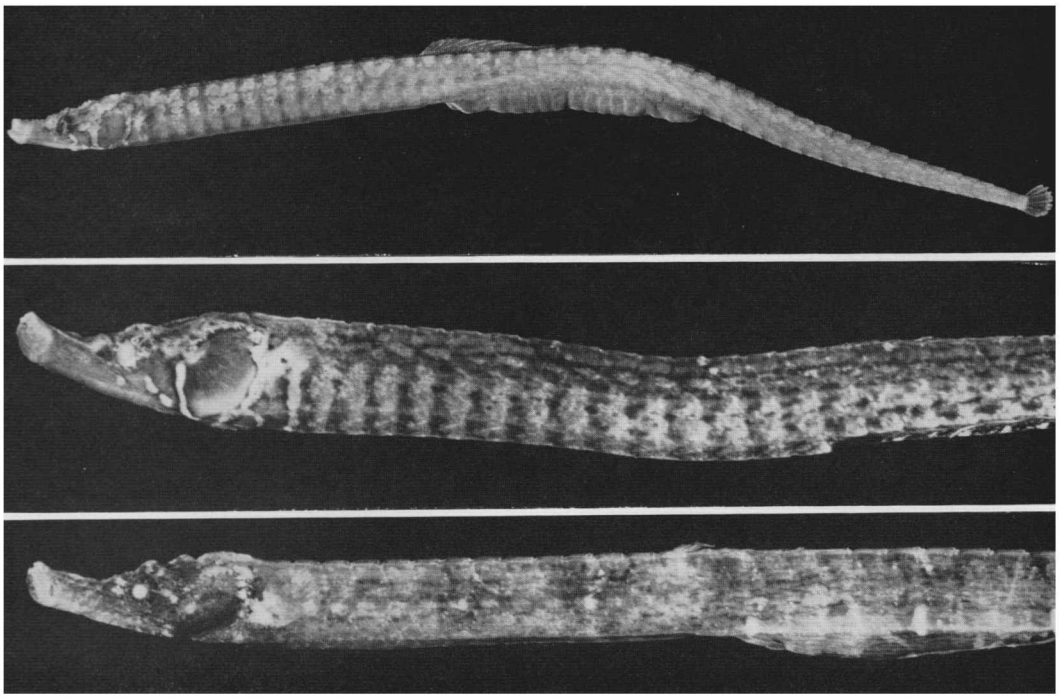

Figure 6. Top.—*Phoxocampus belcheri* (Kaup), GCRL 14898 (61-mm SL male), Kenya. Middle.—*Phoxocampus tetrophthalmus* (Bleeker), RMNH 26091 (62-mm SL male), Celebes. Bottom.—*Phoxocampus diacanthus* (Schultz), GCRL 14538 (64-mm SL male), Samoa.

Duncker (1915) synonymized *Ichthyocampus kampeni* Weber (= *tetrophthalmus*) with *P. belcheri* and Weber and de Beaufort (1922) were the first to clearly distinguish these species. Unfortunately, subsequent literature includes several misidentifications and, where specimens were available for examination, these are noted in synonymy above. Fowler's (1934) New Hebrides record of *kampeni* was based on information supplied by G. P. Whitley for a collection of *belcheri* from Vila harbor (AMS IA. 780).

This species is apparently most common in shallow reef collections. Among 14 lots with adequate data, 7 were taken in depths of 0–2-m, 4 in 0–5-m and one from the 0–9-m range; two SCUBA collections were from 9.1–15.2 and 12.2–15.2 m. *Phoxocampus belcheri* is known from the northern Red Sea to Fiji (Fig. 4). It is sympatric with *P. tetrophthalmus* in Indonesia and the Philippines and is apparently replaced by *P. diacanthus* in the central Pacific.

Material examined.—One hundred thirty-two specimens, 17–72-mm SL, including lectotype and paralectotype. LECTOTYPE. BMNH uncat. (61.5-mm SL, female), China, E. Belcher. PARALECTOTYPE. BMNH uncat. (88-mm SL, male), data as for lectotype. OTHER MATERIAL. RED SEA, Israel: HUJ F4795; Loc. uncertain: HUJ E62/4028; INDIAN OCEAN, Kenya: GCRL 14898, RUSI 4672, 4675, 4677, USNM 216260, 216262; Zanzibar: RUSI 4665, 4673; Mozambique: RUSI 4014, 4018, 4659, 4662, 4667, 4668, 4669, 4671, 4676; S. Africa: RUSI 4674; Madagascar: UMMZ 186036, USNM 216259; Aldabra Is.: BMNH 1975.5.28.1; Amirantes: RUSI 4657, USNM 216261; Seychelles: ANSP 108994, 108997, 110024, 110028, 110030, 110031, 110054, 110057, RUSI 4658, 4661, 4666, 4678; India: FMNH 75854; Cocos-Keeling Is.: ANSP 128418, 128425; Loc. uncertain: RUSI 4670; PACIFIC OCEAN, Malaysia: BMNH 1952.12.16.18–20; Thailand: CAS 24851, 24852; Philippine Is.: CAS 20396, 30493, 36836, CAS-SU 27683, USNM 137297, 137298, 137300, 168414; Indonesia: FMNH

Table 11. Frequency distributions of tail rings crossed by lateral trunk ridge of treated species of *Phoxocampus*, *Festucalex*, *Campichthys*, and *Stipecampus*

Genus	Tail Rings Crossed by Lateral Trunk Ridge																		
Species	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Phoxocampus																				
belcheri		1	7	140*	100	5														
tetrophthalmus														1	2	2	14	28*	4	3
diacanthus	18*	16																		
Festucalex																				
cinctus		2	33*	43*	4															
scalaris		6*	15	1																
erythraeus	15*	4																		
gibbsi			2*	2*																
wassi			1*	6*	1															
Campichthys																				
tryoni		2	30*	4																
tricarinatus			2*																	
nanus	2*	2																		
galei		12*	2*																	
Stipecampus																				
cristatus	15	5	1*																	

* Primary type.

51961, RMNH 21168, 27555, 27556, USNM 216312, ZMA 112.597 (4 "syntypes" of *Ichthyocampus kampeni*); Ryukyu Is.: USNM 62945 (holotype of *I. nox*); Solomon Is.: CAS 19956; New Caledonia: CAS 19955; New Hebrides: AMS IA.780; Fiji Is.: CAS-SU 24911, USP 3355.

Phoxocampus tetrophthalmus (Bleeker)
Figure 6

Syngnathus tetrophthalmus Bleeker, 1858:467 (original description; Cocos Islands, Novaselma).

Ichthyocampus kampeni Weber, 1913:114 (in part, original description; Indonesia and New Guinea).

Ichthyocampus belcheri, Duncker, 1915:95 (in part, misidentification).

Diagnosis.—Total rings 44–46; pectoral-fin rays modally 13; lateral trunk ridge ends on tail rings 13–19, usually on 16–17; opercular ridge usually complete in adults.

Description.—Dorsal-fin rays 20–22; rings 16 + 28–30 = 44–46; subdorsal rings 1.25–2.0 + 3.0–4.0 = 5.0–5.75; pectoral-fin rays 12–14; equivalent paired pectoral-fin ray counts modally 13; see Tables 2–9 and 11 for additional counts and proportional data.

Head ridges distinct but not prominent; opercular ridge crosses at least ¾ of opercle, ridge complete in 88% of examined material.

Ground color light tan to dark brown; dorsal, anal and pectoral-fin rays usually flecked with brown; caudal fin brownish with narrow pale margin; eye with circlet of alternating dark bars and pale interspaces. Males with one or two narrow pale bars on suborbital and a slightly broader bar crossing anterior third of opercle; often with pale bar along posterior margin of opercle and another below pectoral-fin base; bars often continue on venter and unite with those of opposite side. Females usually without distinct pale bars, sides and dorsum of head mainly brownish; venter often pale with irregular brown spots or blotches on snout. Dorsum and upper third of side plain or with 9–11 diffuse pale bars between head and caudal-fin base; males with indications of dark bars crossing venter and lower half of side between each trunk ring, bars usually absent in females; body elsewhere plain, mottled or streaked with brown.

Table 12. Geographic variation in frequencies of tail rings and dorsal-fin rays in *Phoxocampus belcheri*

Locale	Tail Rings				Dorsal-fin Rays				
	29	30	31	32	20	21	22	23	24
RED SEA									
Israel		1						1	
Loc. uncertain			1					1	
INDIAN OCEAN									
Kenya		3	14	2	1	4	11	3	
Zanzibar		2	1				2		
Mozambique		2	6	1		1	6	2	1
S. Africa		1					1		
Madagascar		2	3		1	1	2	1	
Aldabra Is.			1				1		
Amirante Is.			2		1		1	1	
Seychelles Is.	1	11	14		2	4	21	6	1
India		1					1		
Cocos-Keeling Is.		2			1	1			
Loc. uncertain		4	7	2	1	3	9	1	
PACIFIC OCEAN									
Malaya	1	1					2	1	
Thailand		2				2			
"China"		2*				1*		1	
Philippine Is.		6	4		3	6	1		
Indonesia		9	1		5	4	1		
Ryukyu Is.			1			1			
Solomon Is.	1								
New Caledonia		1					1		
New Hebrides	1	2					3		
Fiji Is.			1	1			1		

* Lectotype.

Comparisons.—This species is separable from congeners by the number of tail rings crossed by the lateral ridge (13–19 against 0–5) and several less distinctive features. Preserved coloration is very similar to that of *P. belcheri* but *P. tetrophthalmus* differs in counts of pectoral-fin rays (modally 13 against 12 in *belcheri*) and subdorsal tail rings ($\bar{x}$ = 3.6 against 4.5), and the opercular ridge is usually longer in *P. tetrophthalmus*. The lower frequency of subdorsal tail rings is shared with *P. diacanthus*, but total ring count is higher in *P. tetrophthalmus* (44–46 against 41–43), there are fewer pectoral-fin rays (modally 13 against 14 in *diacanthus*) and head ridges (except opercular) are much more prominent in *P. diacanthus*.

Types.—In a report on Cocos Island fishes, Bleeker (1858) described *Syngnathus andersonii* from a 49-mm male specimen (p. 465) and *S. tetrophthalmus* from a 61-mm, presumably female, specimen (p. 467). These descriptions were not diagnostic and Günther (1870) synonymized *S. andersonii* with *S. tetrophthalmus* and noted that he had examined the "type of *S. tetrophthalmus*" from Bleeker's collection. Duncker (1915) examined this specimen (BMNH 1867.11.28. 355), found it to be conspecific with *Micrognathus brevirostris* (Rüppell), and referred both *Syngnathus andersonii* and *S. tetrophthalmus* to the synonymy of *Micrognathus brevirostris*. My examination of this fish, now 58-mm SL, confirms Duncker's identification, but I do not consider it to be the unique type of *Syngnathus tetrophthalmus*.

Hubrecht (1879) listed two specimens of *Syngnathus tetrophtalmus* (sic) in the Auction Catalog (p. 51, no. 221, A series) but did not mention *S. andersonii*. These specimens consist of a 47-mm SL male (RMNH 7227) labeled "*Syngnathus tetrophthalmus*," and a 65-mm SL female (originally also RMNH 7227, now RMNH 18388) with a recent external label notation "*Ichthyocampus kampeni*." The male, conspecific with *Micrognathus brevirostris* (Rüppell), agree closely in size and meristic features with Bleeker's description and is here considered to be the unique type of *Syngnathus andersonii*. The female, conspecific with *Ichthyocampus kampeni* Weber, agrees with the description of *Syngnathus tetrophthalmus* in counts of tail rings, dorsal-fin rays and total subdorsal rings, but I count 16 rather than 17 trunk rings and 13 rather than 15 or 16 pectoral rays. Both specimens are pencil-marked and were presumably models for Bleeker's Atlas illustrations (Whitehead et al. 1966).

Although diagnosed inadequately, consecutive descriptions of *S. andersonii* and *S. tetrophthalmus* in the same publication indicate that Bleeker recognized two similar but distinct species. This conclusion is sub-

stantiated by Plate 450 of Bleeker's unpublished Atlas. There is no doubt that the illustration of *Syngnathus andersonii* (Fig. 3, total length 49 mm) was drawn from RMNH 7227. The illustration of *Syngnathus tetrophthalmus* (Fig. 13, total length 65.5 mm), showing continuous superior and inferior body ridges and lateral ridge crossing some 17 tail rings, was evidently drawn from RMNH 18388. The British Museum specimen (BMNH 1867.11.28.355) approaches the 61-mm TL reported for the type of *S. tetrophthalmus* and it is possible that the types of *S. andersonii* and *S. tetrophthalmus* were conspecific and that the type of the latter species was sent to London. In view of the unpublished Atlas illustrations, however, I conclude that the British Museum fish is most likely the Sangir Islands specimen listed by Bleeker (1868) and that the type of *Syngnathus tetrophthalmus* is the figured Leiden specimen (RMNH 18388). Whitehead et al. (1966) note that Bleeker usually retained types of senior synonyms (of clupeoids) in his own collection and that Leiden types of junior synonyms were sometimes combined in the same jar with senior synonyms. Available evidence indicates that Bleeker retained the unique types of *S. andersonii* and *S. tetrophthalmus*, and that the specimens were combined under the latter name after *S. andersonii* was synonymized with *S. tetrophthalmus* by Günther (1870).

Weber's syntypes of *Ichthyocampus kampeni* consisted of 8 specimens from four collections. One lot from Karakelang Is. (Siboga Expdn. Sta. 131) included one *I. kampeni* (ZMA 112.596) and 4 *Phoxocampus belcheri* (ZMA 112.597). Herald (1953) noted the inclusion of two species in the type-material and that the illustration accompanying the original description (Weber, 1913: 114, fig. 40) was of a specimen of *belcheri* rather than *kampeni*. Herald designated a female specimen from New Guinea (ZMA 112.599; now 55-mm SL) as the lectotype of *Ichthyocampus kampeni* Weber.

Remarks.—Brood pouch below 13–15 tail rings in 8 males 53.5–75-mm SL; eggs in single layer and in maximum of 4 rows across pouch. Available specimens do not indicate distinct geographic trends in counts or preserved coloration.

One fish among five collected at Paleleh, Indonesia (RMNH 21091) is atypical and has been omitted from tables of meristic data. This 64.5-mm SL male has the lateral ridge extending through 7 rings on each side, pectoral-fin rays are 12 bilaterally, there appear to be only 2 anal-fin rays and opercular ridge crosses anterior third of each opercle; there is no evidence of wound or regeneration. Pectoral-fin ray counts and opercular ridge configuration are typical of *P. belcheri*, whereas number of subdorsal tail rings (3.25) is most common in *P. tetrophthalmus* and coloration does not differ obviously from other specimens in the sample. Tail ring coverage by the lateral ridge is two more than any examined *P. belcheri* and 6 less than other *P. tetrophthalmus*. Status of this fish is uncertain but it may well be a hybrid of these sympatric species.

The type-material of *Ichthyocampus kampeni* is recorded from "reef" collections; there are no other data on habitat or depth of capture. The species is known from Indonesia, Philippine Is., and New Guinea (Fig. 4).

Material examined.—Thirty specimens, 16–75-mm SL, including holotype. HOLOTYPE. RMNH 18388 (65-mm SL; pencil-marked and matching unpubl. Atlas Pl. 450, fig. 13), Cocos Islands (Kokos Eilanden), Nova-selma. OTHER MATERIAL. INDONESIA: RMNH 12425, 20097, 21088, 21090, 21091, 21092, 21098, 21099, ZMA 112.596, 112.598, 112.600 (3 paralectotypes of *Ichthyocampus kampeni*); PHILIPPINE IS.: CAS 20397, 32287, 36837, CAS-SU 40121, GCRL 14900, USNM 164346; NEW GUINEA: RMNH 27588, ZMA 112.599 (lectotype of *I. kampeni*).

Phoxocampus diacanthus (Schultz)
Figure 6

Ichthyocampus diacanthus Schultz, 1943:75, pl. 8 (Tutuila Is., Samoa).
Ichthyocampus diacampus, Kami, 1971:226 (misspelling, Guam).

Ichthyocampus kampeni, Kami, 1971:226 (misidentification).

Diagnosis.—Total rings 41–43; pectoral-fin rays modally 14; lateral trunk ridge ends on last trunk ring or 1st tail ring; opercular ridge incomplete in adults.

Description.—Dorsal-fin rays 20–24; rings 15–16 + 26–27 = 41–43; subdorsal rings 1.5–2.5 + 2.75–4.0 = 4.5–6.0; pectoral-fin rays 13–15; equivalent paired pectoral-fin ray counts modally 14; see Tables 2–9 and 11 for additional counts and proportional data.

Head ridges usually prominent in subadults and adults (Fig. 7); dorsal rim of orbit often expanded laterad and frontal ridge usually somewhat elevated; opercular ridge usually terminates on anterior ⅔ of opercle.

Two general color patterns are represented in study material: pale to near white with few brown markings; brown to dark brown with pale to near white markings. Pale fish with brown shading on venter and side of snout, suborbital and lower half of opercle; venter of trunk plain brownish or mottled, occasionally with indication of diffuse brown bars on each ring; dorsum of body plain or with 8–9 small brown blotches between head and caudal-fin base; body otherwise pale or with a few indistinct brown flecks or spots; fins hyaline. Dark specimens with snout pale to white anteriad, dorsum of head pale to mottled brown, side of head mainly brown with irregular scattering of white flecks or spots; dorsum of body and upper third or half of side crossed by 8–9 narrow, diffuse, pale bars between head and caudal-fin base, the last usually circling tail as a pale band; sides usually with pale spot on inferior ridge opposite pale bars dorsad, spots somewhat elongate on brood pouch folds; pectoral-fin base with pale blotch, side elsewhere plain, streaked or mottled; dorsal and pectoral fins hyaline or rays narrowly margined with brown streaks; caudal fin brown with pale or white margin. Dr. J. E. Randall (BPBM) provided the following life color notes on a specimen from Palau (BPBM 9578): "Grayish brown with white blotch on pectoral base, 8 (blotches) along upper ridge of body and a white bar across margin of 2nd to 3rd from last tail segments: 2 smaller white spots on operculum and 2 below pectoral base on lower ridge; dorsal hyaline; caudal dark brown, basal ⅔ flecked with white and whitish on outer ⅓."

Comparisons.—Number of tail rings crossed by the lateral ridge separates *Phoxocampus diacanthus* from all *P. tetrophthalmus* and 99% of *P. belcheri* examined (Table 11). This species further differs in number of total rings (41–43 in *diacanthus* against 44–48), in higher pectoral-fin ray counts (modally 14 against 12 or 13), in the better development of head ridges (except opercular) of most adults and in several proportional characters (Table 9); see *P. belcheri* and *P. tetrophthalmus* for further comparisons.

Remarks.—A 60-mm SL male had an empty pouch below 14 tail rings; a 64-mm male had pouch below 12 rings with double layer of eggs in maximum of 3 transverse rows below the 9 anterior rings; a 70-mm fish had 4 transverse egg-rows.

Trunk rings are 15 in specimens from Palau, Samoa and Fiji; 16 rings occur in all other collections. Study materials do not indicate distinct geographic trends in meristic features or preserved coloration.

All examined material is from rock or reef habitats. One specimen is recorded from a tidepool; depths for six SCUBA samples follow: 4.6–8.0 m (2 collections), 6.1–15.2 m, 10.7–15.2 m, 18.3–24.4 m (2 collections). These data suggest that *P. diacanthus* usually frequents somewhat greater depths than its congeners. There is one specimen from Ceylon (21.3–24.4 m), but remaining material is from Pacific Ocean localities (Fig. 4).

Material examined.—Twenty-one specimens, 28–86-mm SL, including holotype. HOLOTYPE. USNM

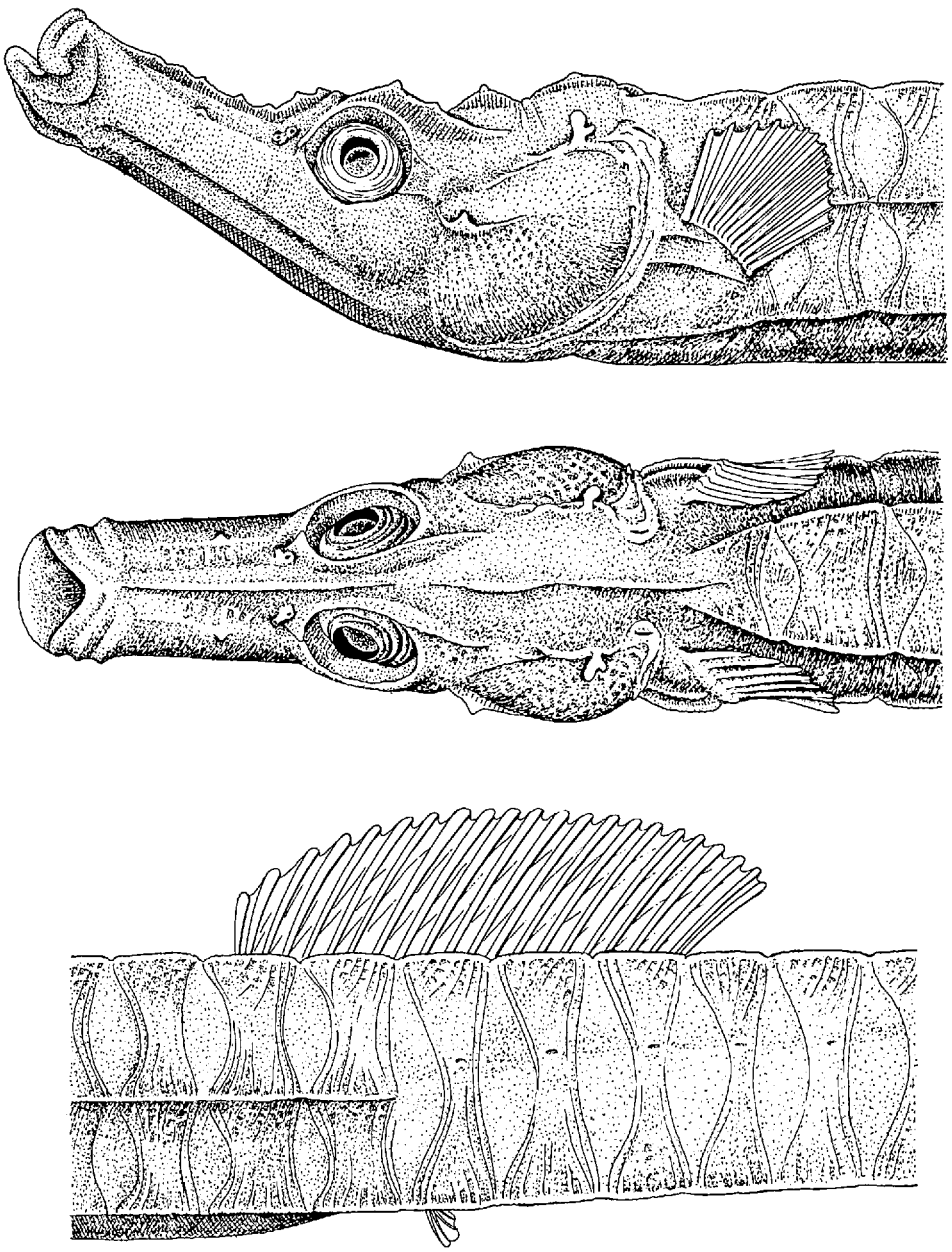

Figure 7. *Phoxocampus diacanthus.* Top to bottom.—Lateral and dorsal aspects of head and anterior trunk rings. Posterior trunk and anterior tail rings, illustrating ridge pattern and fin positions (from 69-mm SL female, holotype; USNM 116091).

116091 (69-mm SL, female), Samoa, Tutuila Is., reef at Alofau, 3 June 1939, L. P. Schultz. OTHER MATERIAL. INDIAN OCEAN, Ceylon: ANSP 134864; PACIFIC OCEAN, Hong Kong: BPBM 18842; Caroline Is.: BPBM 9578, CAS-SU 24853; Mariana Is.: BPBM 8758, UG 4248; Australia, Queensland: AMNH 35890, 35891, ANSP 119437, 119438; Marshall Is.: BPBM 18587, USNM 140236, 141196, 166817; Fiji Is.: USNM 216258; Samoa Is.: GCRL 14538.

Festucalex Whitley

Festucalex Whitley, 1931:312 (type-species: *Syngnathus cinctus* Ramsay, 1882, by original designation).

Diagnosis.—Superior and inferior ridges of trunk continuous with corresponding ridges of tail; lateral trunk ridge not deflected ventrad near anal ring, terminates midlaterally between last trunk ring and 5th tail ring; venter of trunk V-shaped, ridged but without median longitudinal keel; dorsum flat to somewhat depressed between superior trunk ridges; dorsum and sides of tail flat or depressed between margins of superior and inferior tail ridges; superior trunk ridges notched or indented between rings, margins straight or convex between; superior and inferior tail ridges not angled progressively laterad toward caudal fin, indented between rings; posterior angles of tail rings not produced as free hooklike projections; principal ridges of last 1–2 tail rings simple or edged with knobs or spinelike emarginations; scutella without longitudinal ridge or keel. Median dorsal snout ridge not strongly elevated, terminates on interorbital, not confluent with orbital ridges; ridge thin, usually entire or with one or two low emarginations, without separate knoblike projections or crests. Lateral snout ridge small, vestigial or obsolete; supraopercular ridge present or obsolete; orbital ridge somewhat elevated dorsad; median dorsal head ridges usually low, occasionally vestigial or obsolete; opercular ridge angled dorsad, usually low, indistinct, and restricted to anterior third or half of opercle, infrequently obsolete; remainder of opercle finely sculptured by radiating striae; pectoral-fin base with or without ridges in adults. With or without dermal flaps on principal head and body ridges; eye without flaps; margins of head and body ridges smooth to finely denticulate, not serrate. Total rings 46–59; dorsal-fin origin on trunk, fin base not elevated, membrane closely bound to fin rays; dorsal-fin rays 18–28; pectoral-fin rays 11–17; anal-fin rays 4; caudal-fin rays 10. Brood pouch under anterior 12–17 tail rings; pouch protective plates little enlarged or obsolete; brood-pouch eggs in single layer of 1–5 transverse rows covered, in part, by protective folds which fail to meet on ventral midline (unknown in *erythraeus*); eggs separate or in gelatinous matrix; pouch closure the semi-BPC type. Without odontoid processes in jaws; nares minute, 2-pored bilaterally; neuromasts usually distinct under low magnification. Maximum size at least 180-mm SL. Indo-Pacific; marine.

Comparisons.—Among genera with lateral ridge ending on middle of side without deflection ventrad, *Festucalex* agrees with *Campichthys* in lacking the laterally produced tail ridges, etc., of *Phoxocampus*. In *Festucalex*, the median snout ridge is low and more or less continuous, whereas it is an elevated platelike process or a series of 2–3 knoblike projections or crests in *Campichthys*. The snout is relatively longer in *Festucalex* (1.7–2.6 in HL against 2.6–3.3 in *Campichthys*) and more slender (snout depth 2.5–6.5 in snout length against 1.4–2.3). In addition, pectoral-fin rays are more numerous in *Festucalex* (12 or more in 91% against 10 or less in 98% of examined *Campichthys*), and dorsal-fin rays and subdorsal rings are usually more numerous in *Festucalex* (Tables 4, 5, 8).

Remarks.—Among 71 examined specimens, lateral trunk ridges terminated on the same ring bilaterally in 84.5%; of the remainder, 11.3% were longer on the right side; maximum difference was one ring.

In his diagnosis of *Festucalex*, Whitley (1931) stated, "No tooth-like spines on posterior tail-rings." This is evidently an error since the type-species is characterized by the presence of knobs or spinelike emarginations on the last 1–2 tail rings. Although Whitley stated that he had seen the type of *Syngnathus cinctus*, he may well have examined another species (see remarks under *cinctus*).

Material examined includes few males

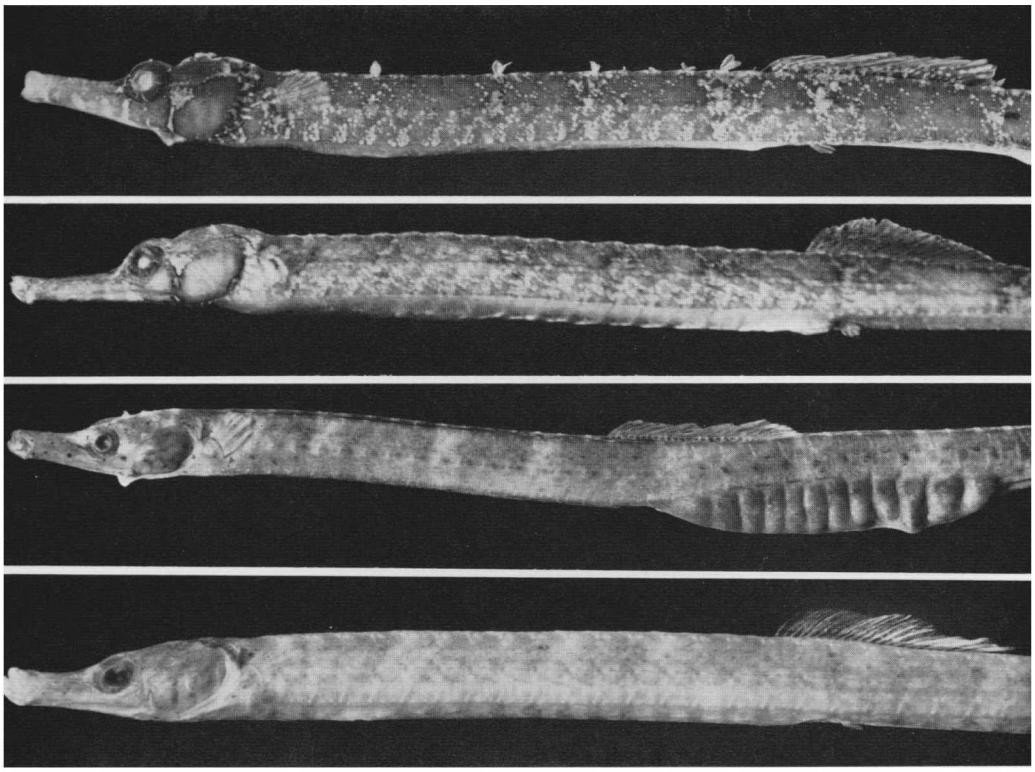

Figure 8. Upper.—*Festucalex cinctus* (Ramsay), New South Wales. Top: AMS I.18783–003 (108-mm SL male). Bottom: AMS IA.4118 (107-mm SL female). Lower.—*Festucalex scalaris* (Günther), Western Australia, AMS I.18177–001. Top: (108-mm SL male). Bottom: (99-mm SL female).

with eggs intact but two different types of egg deposition are indicated. Eggs are essentially separate in *F. cinctus* and *F. scalaris* whereas they are included in a more or less continuous gelatinous matrix in *F. gibbsi* and *F. wassi*. The latter condition is similar to that found in *Corythoichthys* (Dawson, 1977a), and this difference suggests two phyletic lines among species here included in *Festucalex*. In the absence of good series of males of each species, I consider the present treatment best justified by available data.

Festucalex cinctus (Ramsay)
Figure 8

Syngnathus cinctus Ramsay, 1882:111 (Port Jackson, New South Wales).
Ichthyocampus cinctus, Ogilby, 1908:5 (Moreton Bay).
? *Ichthyocampus cinctus*, Duncker, 1909:240 (compiled).
Festucalex cincta, Whitley, 1931:312 (type-species of *Festucalex* Whitley, 1931).
Festucalex cinctus, Whitley and Allan, 1958:60 (emendation).

Diagnosis.—Trunk rings 16–18, modally 17; total rings 53–56; pectoral-fin rays 12–14, modally 13; pectoral-fin base protruding laterad, without ridges in adults; head length more than 7 in SL; snout length 2 or more in HL; principal ridges of last 1–2 tail rings modified, usually with projecting knobs or spinelike emarginations; usually with persistent pale postorbital bar; lower parts of head not spotted with brown.

Description.—Dorsal-fin rays 21–28; rings 16–18 + 36–39 = 53–56; subdorsal rings

0.5–2.0 + 3.5–5.25 = 4.75–6.5; pectoral-fin rays 12–14; equivalent paired pectoral-fin ray counts modally 13; see Tables 2–8, 11 and 13 for additional counts and proportional data.

Median dorsal snout ridge (Fig. 9) begins near rear of upper jaw, ridge low anteriad but angled dorsad just before nares; ridge mainly entire but often with 1–2 shallow emarginations; lateral snout ridge vestigial or obsolete; interorbital distinctly concave between rather high orbital ridges; median dorsal head ridges protrude slightly above profile of head; postorbital ridge low; supraopercular ridge vestigial or obsolete; opercular ridge indistinct, infrequently obsolete; pectoral-fin base protrudes laterad as a bluntly conical projection, without ridges in adults but juveniles may have faint indication of single low ridge. Superior body ridges indented between rings, usually convex between indentations; superior and inferior ridges expanded laterad on last 1–2 tail rings, occasionally entire but usually edged with 1–6 knobs or spinelike projections (Fig. 9); venter of trunk slightly V-shaped, essentially flat in lateral aspect. Dermal flaps present or absent on head and body; flaps typically unbranched, the margins entire or frilled, often broadly rounded or leaflike. Flaps may occur as follows: single flap ventrolaterad bilaterally on anterior third of snout; small flap dorsad on orbital ridge, another, somewhat larger, on postorbital ridge; larger rounded flaps on opercular ridge and laterad above posterior third of opercle; enlarged broad-based rounded flap on frontal ridge; flaps on superior ridge near middle of all but posterior 5–6 tail rings, every 4th flap usually enlarged and flaps small on intervening rings; arrangement similar along lateral ridge, but only the enlarged flaps seem to occur or persist posteriad along lateral midline of tail; flaps may occur infrequently between lateral and superior ridges.

Snout pale with brownish shading on upper part of side and dorsum; remainder of head and body dark brown, markings pale or tan. Eye with a few radiating narrow pale lines. Side of head with narrow pale bar at anterior margin of opercle, irregular pale blotch on postorbital and irregular scattering of small pale spots and blotches on upper half of opercle as well as on side and dorsum of head posteriad; opercle margined behind by irregular series of elongate pale spots and blotches which continue along ventral margin to more or less unite with pale postorbital bar. Body with 14–15 diffuse tan bars crossing dorsum between head and caudal-fin base, bars continued on side but often indistinct and poorly defined; sides and dorsum with irregular scattering of small pale spots and blotches, most abundant ventrad on side of trunk; brood pouch folds mottled and faintly streaked, venter elsewhere plain brown; flaps hyaline, peppered with brown microchromatophores; dorsal-fin rays spotted with brown; pectoral and anal-fin rays edged with brown streaks; caudal fin brown with pale margin. Color description from recently collected male (Fig. 8). Remaining study material is largely faded but the characteristic pale postorbital bar and largely pale posterior opercular margin usually persist.

Comparisons.—The modified posterior tail rings, characteristic head markings (pale postorbital bar and opercular margin), and the usually abundant dermal flaps separate *Festucalex cinctus* from all congeners. It approaches *F. scalaris* in total ring counts but that species has brown spotting on lower parts of head and venter of body is typically barred (head not spotted in *cinctus*, venter plain).

Remarks.—Brood pouch below 12–17 rings in 13 males 88–120-mm SL; smallest egg-bearing male examined was 99 mm; a 116-mm male contained 29 eggs in single 2-row layer under 11 anterior rings of 12 ring pouch; a 120-mm fish had 30 eggs similarly arranged under 12 rings of 14 ring pouch. Pouch protective plates distinct; pouch folds barely meet on midline of egg-filled pouch.

Projections occur on posterior 1–2 tail rings in both sexes and were present in most examined juveniles; where spines or knobs are lacking, close examination will show superior and inferior ridges to be somewhat enlarged; frequency of projections ranges from 0–6, most commonly 4–5; study material shows no distinct relationship between SL and frequency of projections.

Among 36 specimens, preserved for 45–90 years, the pale postorbital bar was distinct in 33, the essentially pale posterior opercular margin was evident in 30 and counts of residual body bars ranged from 13–16. A largely faded specimen from Albany Passage, Queensland (AMS IA.3739) appears to have atypical residual markings in that the postorbital bar is somewhat wider than usual, a similar bar crosses opercle and posterior opercular margin is not distinctly pale. The only other Queensland record appears to be that of Ogilby (1908), but I have not seen the specimen. A 69-mm SL fish (BMNH 1912.11.28.97), collected by the Challenger Expedition in the Arafura Sea is provisionally referred to *F. cinctus*. This specimen, not included in tabulations, has one or two spinelike processes on the posterior tail rings and agrees with *F. cinctus* in general appearance and most counts. It differs in having 20 trunk rings (2 more than any examined *cinctus*), dermal flaps are mainly slender and elongate rather than broad and rounded, and there is no trace of the characteristic head markings. Although closely related to *F. cinctus*, this extralimital specimen may well represent an undescribed form.

Syntypes of *Syngnathus cinctus* (registered 1882 as AMS I.12897) apparently consisted of a male and "young female," but J. R. Paxton (AMS) advises that these must be considered lost. The Museum Register bears the following written notation for the type-material: "number found detached from specimens, specimens missing, A. R. McCulloch, August 1908." McCulloch (1929) reported "Type in Austr. Mus." and Whitley (1931) stated "Type in Austr. Mus. seen," but there is no subsequent Register notation that the specimens were found and they are not now in the AMS collection. I therefore select a 105-mm SL male (AMS I.19107–00) as the neotype of *Syngnathus cinctus*. This fish has typical residual markings; brood pouch extends below 15 tail rings; eggs are lost but pouch contains two rows of membranous egg-compartments; lateral ridge crosses two tail rings on the right side and 2.25 rings on the left. Measurements (mm) follow: Head length 14.2, snout length 6.5, snout depth 1.3, length of dorsal-fin base 12.4, anal ring depth 4.7, pectoral-fin length 3.2, length of pectoral-fin base 2.4; see Tables 2–8, 11 and 13 for counts.

Ramsay (1882) stated that type-material was dredged in 17 fathoms (31.1 m); among examined material, one lot is labeled "dredged" and another "trawled" but there are no other data on depth or method of capture. The species is known only from Queensland and New South Wales, Australia (Fig. 10).

Material examined.—Forty-four specimens 45–124-mm SL, including neotype. NEOTYPE. AMS I.19107–00 (105-mm SL, male), Port Jackson, New South Wales, Australia, 20 March 1886. OTHER MATERIAL. AUSTRALIA, New South Wales: AMS I. 189, 2484–2491, 18783–003, AMS IA. 2655, 3625, 3628, 3897, 3934, 4118, 4651, 5134, 5423, 5448, AMS IB. 556 (taken with neotype), 558, 561, 562, 563, 2417, GCRL 15224, QM I.435; Queensland: AMS IA. 3739.

Festucalex scalaris (Günther)

Figures 8 and 9

Ichthyocampus scalaris Günther, 1870:177 [Freycinet's Harbor (Western Australia)].
Festucalex scalaris, Whitley and Allan, 1958:60 (new combination).

Diagnosis.—Trunk rings 18–20, modally 19; total rings 56–59; pectoral-fin rays 12–13, modally 12; pectoral-fin base without ridges in adults, rounded and somewhat protruding laterad; head length more than 7 in SL; snout length 2 or more in HL; ridges of last 1–2 tail rings not modified; lower part of

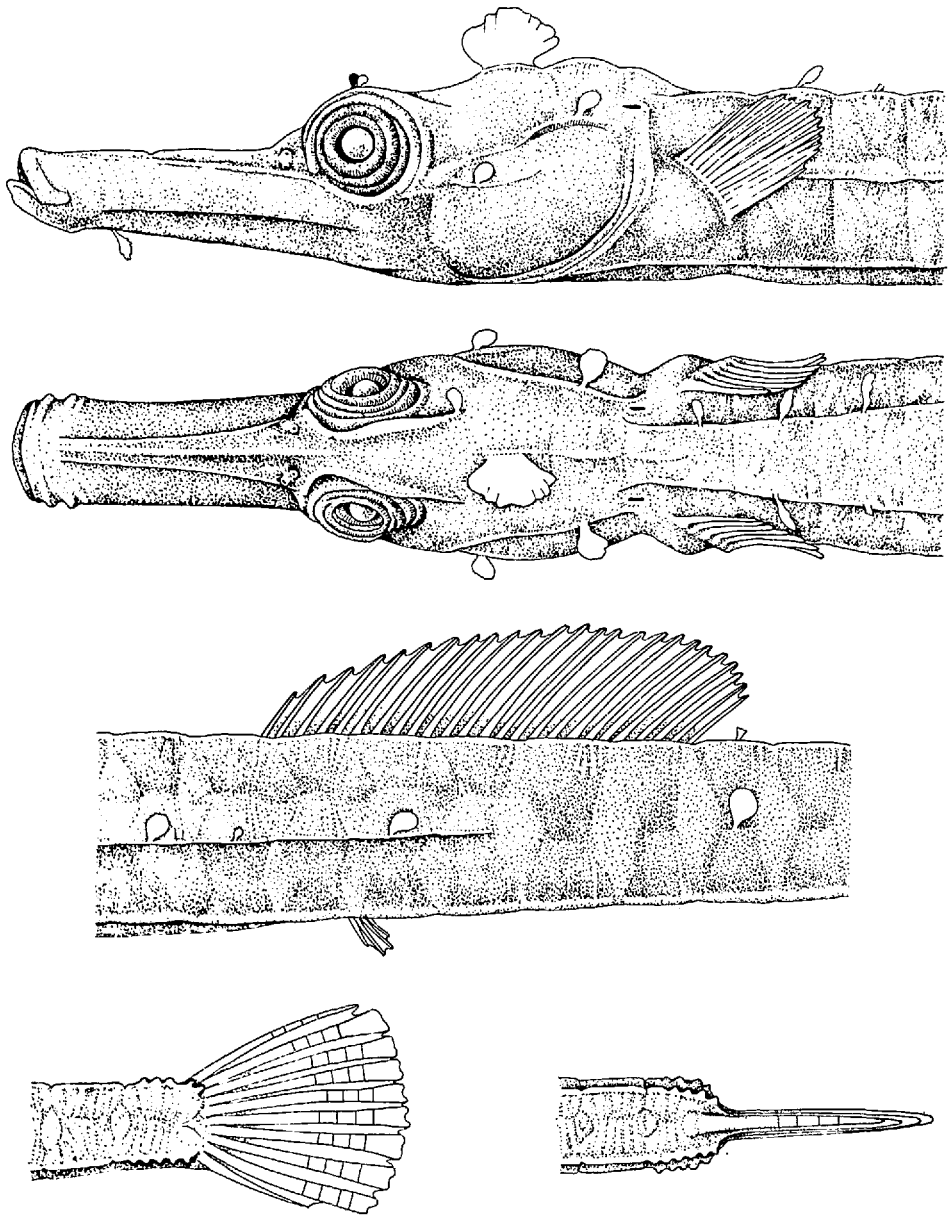

Figure 9. *Festucalex cinctus.* Upper pair.—Lateral and dorsal aspects of head and anterior trunk rings; note dermal flaps. Middle.—Posterior trunk and anterior tail rings, illustrating ridge pattern, fin positions and dermal flaps (from 84-mm SL female; AMS IB. 556). Bottom.—Lateral and dorsal aspects of posterior tail rings and caudal fin, illustrating knoblike projections on principal ridges (from 105-mm SL male; AMS I. 12486).

head spotted; venter usually barred; without pale postorbital bar.

Description.—Dorsal-fin rays 25–26; rings 18–20 + 38–40 = 56–59; subdorsal rings 1.75–2.5 + 3.25–4.75 = 5.75–6.5; pectoral-fin rays 12–13; equivalent paired pectoral-fin ray counts modally 12; see Tables 2–8, 11 and 13 for additional counts and proportional data.

Median dorsal snout ridge begins at rear of upper jaw, ridge low throughout, entire and without emarginations; lateral snout ridge obsolete; orbital ridges not strongly elevated dorsad, interorbital broadly concave between; median dorsal head ridges, scarcely protruding above profile of head; postorbital ridge low; supraopercular ridge vestigial or obsolete; opercular ridge indistinct, infrequently obsolete; pectoral-fin base without ridge in adults and subadults, protrudes laterad as low rounded projection. Dorsum little depressed between superior body ridges; ridges little indented between rings, straight between indentations; venter of trunk slightly V-shaped, essentially flat in lateral aspect; ridges of last 1–2 tail rings not modified. Dermal flaps absent from trunk and tail in subadults and adults; one or two flaps on frontal ridge, single flaps on opercular and supraopercular ridges; flaps small, usually subtriangular rather than broadly rounded.

Dorsum of snout light tan, head otherwise mainly tan to light brown; lower half of snout, suborbital, lower half of opercle and venter of head with irregular scattering of small to minute brown spots; without pale postorbital bar or pale markings on posteroventral margin of opercle. Dorsum and sides with 13–14 indistinct brownish bars between head and caudal-fin base; bars 2–4 rings wide, separated by narrower (1–2 ring) pale or tan interspaces; these markings plain, blotched, or with fine brown reticulations; pectoral-fin base, side and venter of anterior 3–4 trunk rings with or without scattered brown spots. Venter of trunk with brown bars on each ring which may continue on lower half of side; interspaces restricted to narrow pale lines in some specimens, whereas others have alternating subequal pale and brown bars; venter of tail with indications of narrow bars and broad pale interspaces; pouch folds plain or mottled brown. Dorsal and pectoral fins hyaline or fin-rays spotted with brown; caudal fin brownish with pale spots or blotches.

Comparisons.—*Festucalex scalaris* is separated from congeners by the combination of high trunk ring counts (18–20 against 18 or less) and high total ring counts (56–59 against 56 or less), together with spotted head and barred venter and the absence of modified posterior tail rings. It most closely approaches *F. cinctus* in a number of counts (Tables 2–8) but differs in coloration, some proportional characters (Table 13) and lacks the modified tail rings of *F. cinctus*.

Remarks.—Brood pouch below 15–16 tail rings in three males 120–157-mm SL; the 120-mm fish had 23 separate eggs in a single 2-row layer under anterior 11 rings of 15 ring pouch. Pouch protective plates largely concealed by fleshy bases of pouch folds.

Extant syntypes apparently consist of three dried specimens, ca. 83–119.5-mm SL (BMNH 1858.12.27.53–56). A dried female (ca. 180-mm SL) also collected by the HERALD, but lacking locality data (BMNH 1858.12.27.73), may be one of the five original specimens, but total length (ca. 7.25 inches) exceeds that of the largest ("7 inches long") reported by Günther. I therefore select the largest specimen from BMNH 1858.12.27.53–56 as the lectotype of *Ichthyocampus scalaris*. This female retains traces of bars on venter and broad bars crossing dorsum and upper part of sides, there seem to be only 11 rays in the relatively well preserved left pectoral fin; see Tables 2–8 and 11 for other counts.

Study material provides no information on method of capture, depth or habitat.

Table 13. Number of specimens measured and standard length range, together with range and mean ($\bar{x}$) for selected proportional characters in species of *Festucalex*

Character	*cinctus*		*scalaris*		*erythraeus*		*gibbsi*		*wassi*	
	Range	$\bar{x}$	Range	$\bar{x}$	Range	$\bar{x}$	Range	$\bar{x}$	Range	$\bar{x}$
No. of specimens	31		6		5		3		4	
Standard length (mm)	63.0–124.0	95.1	99.0–164.0	129.0	51.5–79.0	52.4	50.5–59.5	56.0	69.5–74.0	71.5
Head length in SL	7.9– 9.5	8.6	8.8– 9.7	9.3	8.0– 8.8	8.4	7.5– 7.9	7.7	6.1– 6.7	6.4
Snout length in HL	2.0– 2.3	2.1	2.1– 2.5	2.3	2.1– 2.6	2.4	2.1– 2.4	2.2	1.7– 1.8	1.8
Snout depth in snout length	3.4– 5.5	4.4	2.8– 4.4	3.4	2.5– 3.9	3.2	3.2– 4.0	3.7	5.1– 6.5	5.9
Length of dorsal-fin base in HL	1.0– 1.5	1.3	1.0– 1.3	1.2	1.2– 1.7	1.3		1.3	1.5– 1.8	1.6
Anal ring depth in HL	2.9– 4.3	3.6	3.0– 3.3	3.2	3.1– 3.8	3.5	2.8– 3.5	3.1	3.5– 4.4	3.9
Pectoral-fin length in HL	3.8– 5.9	4.8	4.3– 5.3	4.8	4.2– 5.3	4.7	4.8– 5.5	5.1	3.3– 5.7	4.7

Duncker (1909) reported a specimen (not seen here) from a "Salzwasser-Lagune" at Lagoon Point, presumably Lagoon Point on Peron Peninsula in Freycinet Reach. Literature and present data indicate that all known specimens have been collected in Western Australia between 22.5° and 26.5° S. Lat. (Fig. 10).

Material examined.—Fourteen specimens, ca. 80–180-mm SL, including lectotype and paralectotypes. LECTOTYPE. BMNH 1858.12.27.53–56 (ca. 119.5-mm SL, dried female), Freycinet's Harbor, Western Australia, H.M.S. HERALD. PARALECTOTYPES. BMNH 1858.12.27.53–56 (2, ca. 83–112-mm SL, dried), data as for lectotype. OTHER MATERIAL. Western Australia: AMS I. 1379, 13283, 18177–001, AMS IB. 342, 346; Loc. unknown: BMNH 1858.12.27.73.

Festucalex erythraeus (Gilbert)
Figure 11

Ichthyocampus erythraeus Gilbert, 1905:613, fig. 238 (off Molokai, Hawaii).
Ichthyocampus townsendi Duncker, 1915:96 (Mekran Coast; Maldive Is.).
Ichthyocampus philippinus Fowler, 1938:43 (Tinakta Is., Sulu Archipelago).
Hippichthys amakusensis Tomiyama, 1972:6, fig. 3 (Aitsu, Japan).

Diagnosis.—Trunk rings 15–17, modally 16; total rings 48–53; pectoral-fin rays 11–12; pectoral-fin base without ridges in subadults or adults; head length more than 7 in SL; snout length 2 or more in HL; ridges of last 1–2 tail rings not modified.

Description.—Dorsal-fin rays 18–21; rings 15–17 + 32–37 = 48–53; subdorsal rings 0.5–1.0 + 3.5–5.0 = 4.25–5.75; pectoral-fin rays 11–12; see Tables 2–8, 11 and 13 for additional counts and proportional data.

Median dorsal snout ridge (Fig. 12) vestigial or obsolete anteriad, arches upward from near middle of snout; orbital ridges somewhat elevated, interorbital broadly concave between; prenuchal, nuchal, frontal, postorbital and lateral snout ridges very low, vestigial or obsolete; no supraorbital ridge; opercular ridge low and indistinct; small specimens with indication of single ridge dorsad on pectoral-fin base,

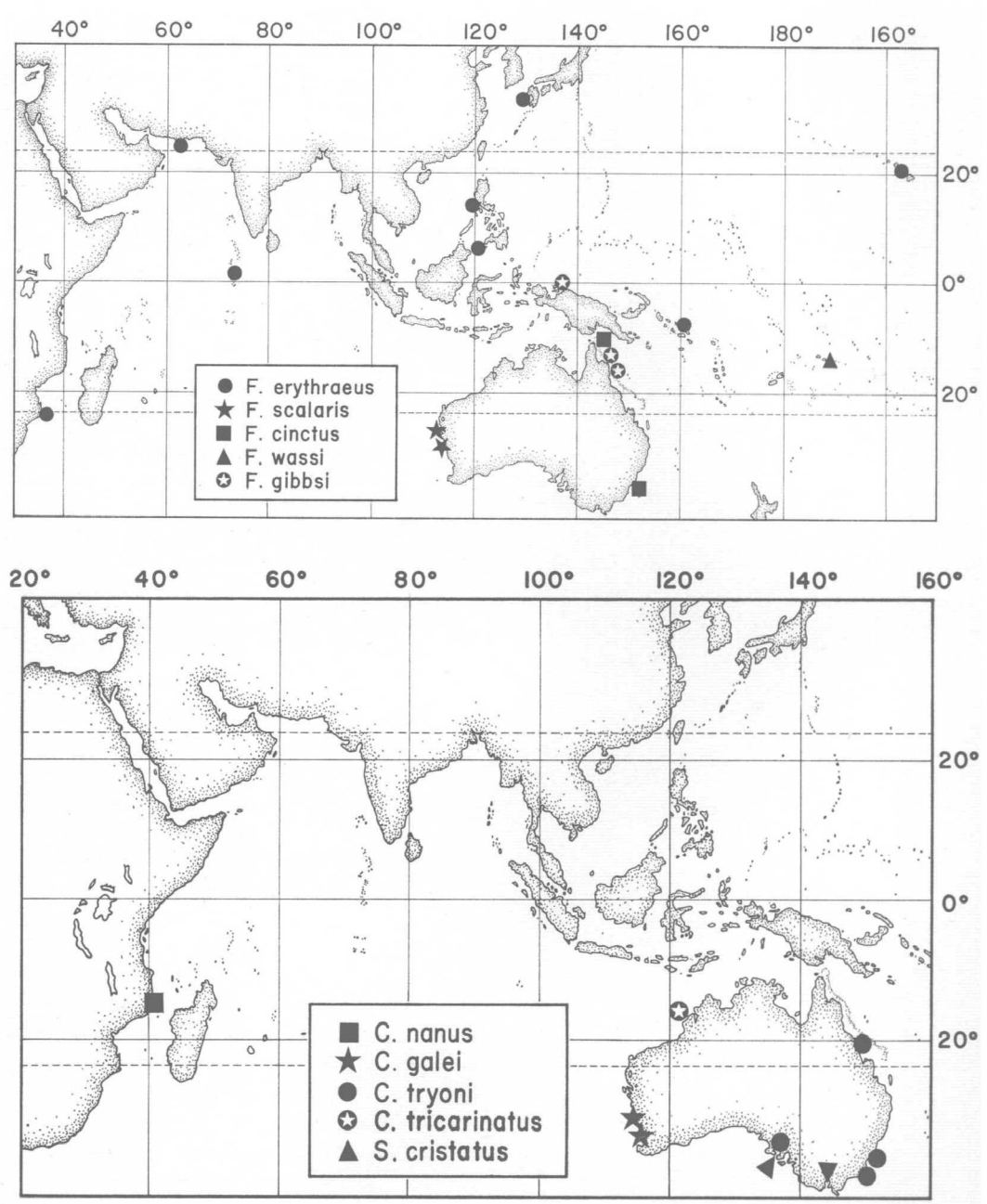

Figure 10. Distribution of species of *Festucalex*, *Campichthys* and *Stipecampus* based on examined material.

adults with fin base pocked or minutely sculptured but without ridges. Dorsum of trunk and tail flat or but slightly depressed between superior ridges; posterior tail rings without modified ridges; superior body ridges little indented between rings, essentially straight between indentations.

A 31-mm SL specimen (BPBM 15670),

Figure 11. Top.—*Festucalex erythraeus* (Gilbert), BMNH 1897.10.6.7 48-mm SL female, syntype of *Ichthyocampus townsendi*, Makran Coast Middle.—*Festucalex gibbsi* n. sp., BMNH 1975.10.9.7 (60-mm SL male, holotype), Queensland. Bottom.—*Festucalex wassi* n. sp., BPBM 18716 (70-mm SL male, holotype), Samoa.

described as "light red in life" by J. E. Randall, is now largely covered on sides and dorsum by fine reticulations formed by irregular lines of brown microchromatophores. Other study material is faded and no trace of color pattern remains. The holotype was described as brick-red in life, with 13 greenish bars on dorsum and with a pearly spot on alternate rings along inferior body ridges. Similar dorsal bars were reported for a specimen from Japan (Tomiyama, 1972) and a specimen from Mozambique (Smith, 1963) was brownish with very faint dusky lines on tail.

Comparisons.—The combination of modally 16 trunk rings, low counts of pectoral-fin rays (11–12) and low frequency of dorsal-fin rays (18–21) separates *F. erythraeus* from congeners (Tables 2, 4, 5). This species exhibits the poorest development of head ridges (other than snout ridge) and the lateral trunk ridge usually (79%) ends at the last trunk ring (ends on 1st–4th tail ring in all examined congeners.

Remarks.—Two immature males, 40- and 55-mm SL, have brood-pouch folds below 7 and 14 tail rings, respectively; a 67 mm male has pouch folds developed below 17 tail rings, there are no pouch protective plates, membranous egg-compartments are in maximum of four transverse rows with 20 compartments in outer right row; pouch closure is uncertain but margins of folds are rolled back suggesting the everted type closure.

Tail ring counts are 32–33 in three specimens examined from the Indian Ocean and Philippine Is., whereas these counts are 35–37 in four fish from Japan and Hawaii; this variation is not considered atypical. No

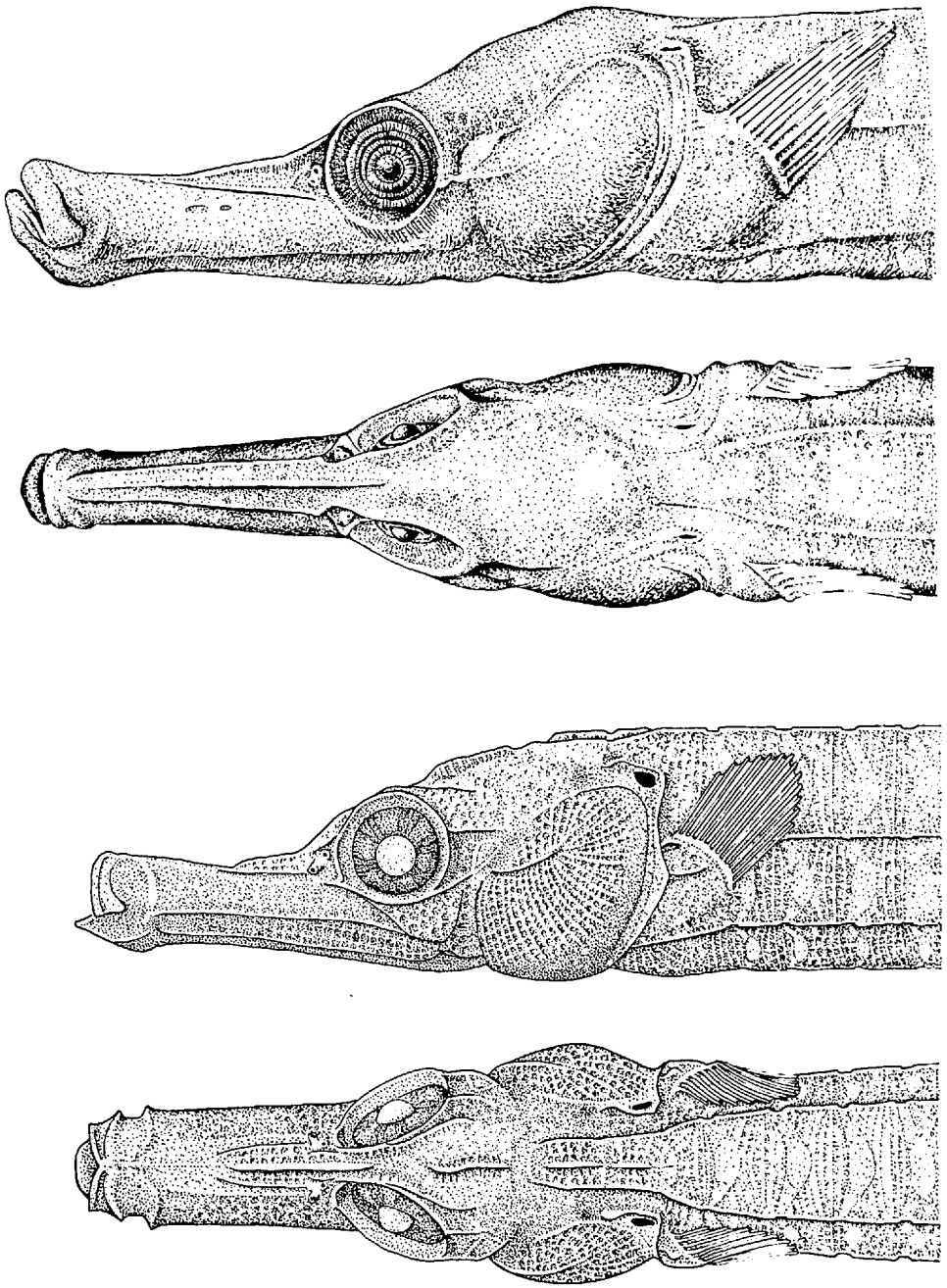

Figure 12. Lateral and dorsal aspects of head and anterior trunk rings. Top.—*Festucalex erythraeus* (79-mm SL female; UMMZ 197596). Bottom.—*Festucalex gibbsi* (60-mm SL male, holotype; BMNH 1975.10.9.7).

other geographic trends are indicated by the few specimens available for study.

Gilbert's (1905) description of the holotype does not agree with the accompanying figure. Twenty-two dorsal, 5 anal and 6 caudal-fin rays are described, whereas 20 dorsal, 3 anal and 9 caudal rays are figured. Furthermore, the described and figured count of 14 pectoral-fin rays is two more than that of other specimens referred to *F. erythraeus*. The holotype (USNM 51548) is now in very poor condition; the head and pectoral ring are lost, the remainder is in two pieces and the caudal fin is damaged. I count 20 dorsal-fin rays and 4 anal rays in this specimen but the original complement of pectoral and caudal rays remains questionable. Counts of 6 or 9 caudal-fin rays indicate inaccurate enumeration or that the specimen was anomalous, since caudal rays are 10 in all undamaged members of the genus. Despite these discrepancies, compared materials agree with the description and figure of *Ichthyocampus erythraeus* in general morphology as well as with my counts from the holotype (Tables 2, 3, 6). Should future collections indicate validity for Gilbert's count of 14 pectoral-fin rays, the 11–12 ray population may best be referred to *F. townsendi* as a separate species or as a subspecies of *F. erythraeus*.

The holotype of *Ichthyocampus philippinus* has 17 trunk rings (one more than other material) and the caudal fin has 7 rays (evidently regenerated). Coloration, originally described as more or less uniform brown, has now faded. Trunk ring count is within expected intraspecific variation (a 15 ring fish with regenerated tail (BPBM 15670) is also omitted from Tables) and the specimen otherwise agrees with *F. erythraeus*. Syntypes of *Ichthyocampus townsendi* consist of two specimens, one with a regenerated, 7 ray, caudal fin. Duncker (1915) reported 16–18 dorsal-fin rays, 10–11 pectoral rays and 2 anal rays, but I count 18–19 dorsal, 11 pectoral and 4 anal-fin rays in these specimens. Duncker erred in listing the type-locality as "Persischer Golf, Mekranküste." The Makran Coast is part of the northern boundary of the Arabian Sea, well to the east of either the Persian Gulf or Gulf of Oman. I have been unable to obtain the holotype of *Hippichthys amakusensis* for examination but Tomiyama's (1972) description and figure leave no doubt that the specimen is conspecific with *Festucalex erythraeus*. The Aitsu type-locality is close to Nagasaki, the reported locality for Japanese material examined here.

Festucalex erythraeus is known from Mozambique to Hawaii (Fig. 10). The Maldive Is. syntype of *Ichthyocampus townsendi* was reportedly dredged in 80.5 m (Regan, 1902; as *I. belcheri*) and three specimens (BPBM 15670, USNM 51548, 94080) are recorded from 18–44 m. Data are incomplete for other collections but the Mozambique specimen was probably collected in less than 5 m.

Material examined.—Ten specimens, ca. 31–79-mm SL, including holotype. HOLOTYPE. USNM 51548 (damaged female), S coast of Molokai Is., Hawaii, 42.1–43.9 m, 8 April 1902, ALBATROSS Sta. 3847. OTHER MATERIAL. Mozambique: RUSI 4650; Makran Coast: BMNH 1897.10.6.7 (syntype of *Ichthyocampus townsendi*); Maldive Is.: BMNH 1901.12.31.145 (syntype of *I. townsendi*); Sulu Archipelago: USNM 94080 (holotype of *I. philippinus*); Philippine Is.: USNM 137299; Japan: CAS 20409, UMMZ 197546; Solomon Is.: BPBM 15670.

Festucalex gibbsi new species
Figure 11

Diagnosis.—Trunk rings 18; total rings 50–51; pectoral-fin rays 13–14; pectoral-fin base with superior and inferior ridges; head length more than 7 in SL; snout length more than 2.0 in HL; ridges of last 1–2 tail rings not modified.

Description.—Dorsal-fin rays 21–24; rings 18 + 32–33 = 50–51; subdorsal rings 1.5–2.0 + 3.5–4.25 = 5.5–6.25; pectoral-fin rays 13–14; equivalent paired pectoral-fin ray counts 13 (in two); see Tables 2–8, 11 and

13 for additional counts and proportional data. Measurements (mm) of holotype and paratype (in parentheses) follow: SL 59.5 (50.5); HL 7.7 (6.4); snout length 3.5 (2.7); snout depth 1.1 (0.8); length of dorsal-fin base 6.0 (5.0); anal ring depth 2.7 (2.1); pectoral-fin length 1.6 (1.3); length of pectoral-fin base 1.1 (0.8).

Median dorsal snout ridge (Fig. 12) entire, vestigial or obsolete in front, originates near middle of snout, mainly low but arches upward just anteriad of nares; lateral snout ridge obsolete; postorbital ridge low; short supraopercular ridge present in holotype, vestigial or absent in other material; opercular ridge low, not protruding distinctly laterad; pectoral-fin base with distinct superior and inferior ridges; prenuchal and nuchal ridges low or vestigial, frontal ridge somewhat higher. Dermal flaps absent from body; frontal ridge margined by a low flap; paratype with slender simple flap dorsolaterad above middle of opercle. Dorsum of holotype somewhat depressed between superior trunk ridges and with shallow angular notches between rings, paratype nearly flat with slight indentations between rings; superior and inferior tail ridges somewhat elevated with sides and dorsum depressed between, ridges little indented between rings; posterior angles of tail rings produced to a minute point last 2–3 tail rings without modified ridges; venter of trunk distinctly V-shaped, median ridge prominent.

Holotype mainly brownish; snout pale, shaded posteriad with microchromatophores, remainder of head blotched with tan and brown; dorsum and upper half of trunk barred indistinctly with brown between rings and with irregular scattering of small tan spots; venter and lower half of trunk brownish, with diffuse pale bars (about one ring wide) on 2nd, 6th, 11th and 15th rings; dorsum and sides of tail brownish with indications of bars between rings, scutella often ringed with minute pale spots; pouch folds minutely flecked with pale, venter of tail elsewhere mainly brown; dorsal and pectoral-fin rays lined proximad with brown chromatophores, mainly hyaline toward margin; caudal fin brownish with pale margin. Paratype light tan or creamy; head with subtriangular irridescent white bar below opercular ridge, venter and snout immaculate, dorsum with scattered microchromatophores; dorsum and sides of body irregularly shaded with minute chromatophores, most abundant dorsad; venter and pouch folds immaculate; fins hyaline.

Comparisons.—The paired ridges on pectoral-fin base separate *F. gibbsi* from all congeners except *F. wassi*. These species differ in counts of trunk rings (18 against 14–15 in *wassi*), pectoral-fin rays (13–14 against 16–17 in *wassi*) and a number of other characters (Tables 2–8 and 13). The trunk ring count of 18 is shared with *F. cinctus* and *F. scalaris* but these species lack ridges on the pectoral base in adults, they have higher total ring counts (53–59 against 50–51 in *gibbsi*) and differ in details of coloration and other features (see descriptions). The prominent tail ridges of *F. gibbsi* are grossly similar to those of some juvenile *Phoxocampus belcheri*, but they are not produced distinctly laterad nor are posterior angles of rings produced to the free hook-like points characteristic of *Phoxocampus*.

Etymology.—Named *gibbsi* in recognition of P. E. Gibbs, collector of the type-material.

Remarks.—The holotype has pouch folds under 15 tail rings, there are about 76 eggs in single layer (up to 5 transverse rows) below the anterior 14 rings; eggs embedded in gelatinous matrix similar to that found in *Corythoichthys* (Dawson, 1977a); brood-pouch plates present; pouch folds fall well short of midline of egg-filled pouch and closure appears to be the semi-BPC type. Brood pouch empty in paratype; pouch folds extend below 13 tail rings and there is little development of protective plates.

A somewhat faded 58-mm SL female from

New Guinea has a slightly longer snout than holotype or paratype (7.5 in HL against 7.7–7.9), three more dorsal-fin rays (24 against 21) and dorsum of trunk and tail is crossed by 12 diffuse brownish bars. This fish agrees well in other characters and is considered conspecific with the Australian type-material. This species is known only from Queensland, Australia and New Guinea (Fig. 10).

Material examined.—Three specimens, 50.5–59.5-mm SL, including holotype and paratype. HOLOTYPE. BMNH 1975.10.9.7 (59.5-mm SL, male), Australia, Queensland, 14°36′48″S, 145°27′42″E, 22 m, 21 Oct. 1973, Great Barrier Reef Expdn., P. E. Gibbs. PARATYPE. BMNH 1975.10.9.8 (50.5-mm SL, male), Australia, Queensland, 16° 38′06″S, 145°57′48″E, 27 m, 18 Aug. 1973, Great Barrier Reef Expdn., P. E. Gibbs. OTHER MATERIAL. ANSP 134699 (58-mm SL, female), New Guinea, Padeaido Is., Wamsoi Lagoon, 1.8 km E of Dauwi, 55–91 m, dredge on coralline bottom with much algae and sponge.

Festucalex wassi new species
Figure 11

Diagnosis.—Trunk rings 14–15; total rings 46–47; pectoral-fin rays 16–17; pectoral-fin base with prominent superior and inferior ridges; head length less than 7-in SL; snout length less than 1.9-in HL; ridges of last 1–2 tail rings not modified.

Description.—Dorsal-fin rays 22–23; rings 14–15 + 32 = 46–47; subdorsal rings 0.25–1.0 + 4.25–5.0 = 5.0–5.5; pectoral-fin rays 16–17; equivalent paired pectoral-fin ray counts 16 (in three); see Tables 2–8, 11 and 13 for additional counts and proportional data. Measurements (mm) of holotype follow: SL 69.5, HL 10.7, snout length 6.1, snout depth 1.2, length of dorsal-fin base 6.6, anal ring depth 2.9, pectoral-fin length 2.2, length of pectoral-fin base 1.7.

Median dorsal snout ridge (Fig. 13) begins on anterior third of snout, ridge low, straight or with shallow emarginations anteriad, but arches dorsad just before nares; lateral snout ridge short, prominent; interorbital broadly concave between elevated orbital ridges; postorbital and supraopercular ridges well developed; frontal ridge somewhat elevated, nuchal and prenuchal ridges lower; opercular ridge prominent, elevated well above opercular surface; pectoral-fin base not strongly protruding laterad, with prominent superior and inferior ridges. Superior trunk ridges somewhat elevated above dorsum, notched between rings, ring margins essentially straight between; sides and dorsum of tail somewhat depressed between superior and inferior ridges; posterior angles of tail rings produced to minute sharp points; last 1–2 tail rings without modified ridges; venter of trunk distinctly V-shaped. Body without dermal flaps; vestiges of flaps persist on supraopercular and frontal ridges in two paratypes, flaps lacking in other material.

Snout of holotype hyaline in front, posterior half shaded with brown on sides and dorsum; head elsewhere brownish with pale or tan blotches; dorsum and sides of trunk and tail crossed by 10 diffuse pale bars, three crossing brood-pouch folds; bars, less than ring width, spaced on 4–5 ring intervals; interspaces brownish, irregularly blotched or flecked with tan or pale; venter of trunk mainly brownish with faint indications of tan bars near middle of each ring; pouch folds with three narrow pale bars between principal (wider) pale markings, remainder of folds and venter of tail mainly brown; dorsal and pectoral fins hyaline; caudal fin brownish with pale margin. Paratypes pale with indistinct tan or light brown markings, all with indications of dark bars crossing sides and dorsum. Life color notes on holotype and associated female, provided by R. C. Wass, follow: "Male—brown body with pale rings; reddish on side of snout. Female—pale cream body with white rings bordered by dusky rings; reddish on side of body behind pectorals."

Comparisons.—The elongate snout (1.7–1.8 in HL) and counts of pectoral-fin rays (16–17) immediately separate *F. wassi* from all congeners. The paired ridges on pectoral-

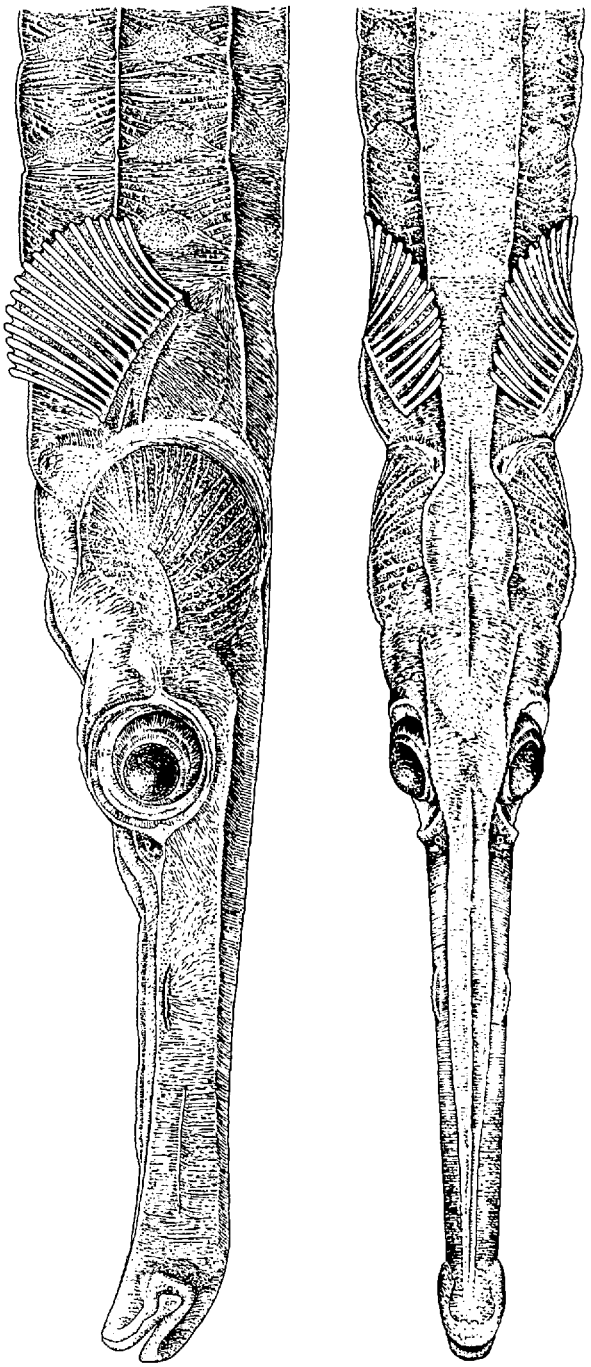

Figure 13. *Festucalex wassi.* Lateral and dorsal aspects of head and anterior trunk rings (from 74-mm SL female, paratype; BPM 18716).

fin base are shared only with *F. gibbsi* but that species has a shorter snout (2.1–2.4 in HL), fewer pectoral-fin rays (13–14) and more trunk rings (18 against 14–15 in *wassi*). This species has a distinctly protruding opercular ridge and prominent lateral snout ridge, whereas the opercular ridge is very low in all congeners and lateral snout ridge is usually vestigial or obsolete.

Etymology.—Named *wassi* in recognition of Richard C. Wass, collector of the type-material.

Remarks.—Brood-pouch folds extend below 14 tail rings in holotype and below 15 in the male paratype; the holotype contained about 100 eggs in pouch, arranged in single layer of 1–5 transverse rows; eggs embedded in gelatinous matrix; pouch protective plates well developed in holotype, less so in male paratypes; pouch closure the semi-BPC type.

This species is known only from Samoa (Fig. 10); detailed collection data are not available.

Material examined.—HOLOTYPE. BPBM 18716 (69.5-mm SL, male), Tutuila Is., Samoa, 1974, R. C. Wass. PARATYPES. BPBM 20325 (74-mm SL, female), collected with holotype, GCRL 14899 (72-mm SL, male), USNM 216311 (70.5-mm SL, female); data as for holotype.

Campichthys Whitley

Campichthys Whitley, 1931:313 (subgenus of *Festucalex*; type-species: *Ichthyocampus tryoni* Ogilby, 1890, by original designation).

Diagnosis.—Superior and inferior ridges of trunk continuous with corresponding ridges of tail; lateral trunk ridge not deflected ventrad near anal ring, terminates midlaterally between last trunk ring and 4th tail ring; venter of trunk distinctly V-shaped, ridged but without longitudinal keel; dorsum essentially flat, little depressed between superior ridges; sides of tail usually flat between superior and inferior tail ridges; superior ridges notched or indented between rings, ring margins usually straight; principal tail ridges not angled progressively laterad toward caudal fin; posterior angles of tail rings not produced as free hooklike projections; principal ridges of last 1–2 tail rings entire; scutella without longitudinal ridge or keel. Median dorsal snout ridge an elevated platelike crest or a series of 2–3 distinct crests or knoblike elevations (except some *nanus*), terminates on or just anteriad of interorbital, margined behind by anterior supraorbital ridges, ridge usually rather thick and substantial. Lateral snout ridge and supraopercular ridge present or obsolete; orbital ridge somewhat elevated dorsad; median dorsal head ridges low, vestigial or obsolete; opercular ridge angled dorsad, usually crosses entire opercle; remainder of opercle with ridgelike striae below, striate or sculptured above; pectoral-fin base with single ridge (except *nanus*). Dermal flaps absent from trunk and tail; usually with minute flaps on eye and a few small flaps elsewhere on head; margins of head and body ridges granular to finely denticulate, not serrate. Total rings 39–52; dorsal-fin origin on trunk, fin base not elevated, membrane closely bound to fin rays; dorsal-fin rays 16–19; pectoral-fin rays 7–11; anal-fin rays 3–4 (unknown in *nanus*); caudal-fin rays 10 (except 8 in *galei*). Brood pouch under tail (unknown in *tricarinatus*); pouch plates present or absent; pouch closure unknown. Without odontoid processes in jaws; nares somewhat enlarged in *C. tryoni*, distinct in congeners, 2-pored bilaterally; neuromasts not usually distinct under low magnification. Maximum size at least 72-mm SL. Indo-Pacific; marine.

Comparisons.—See under *Phoxocampus* and *Festucalex* for comparisons.

Remarks.—Among the four included species there are but 29 known specimens and males are unknown in *tricarinatus*. These forms generally share several common features (see diagnoses) but the 8-ray caudal fin in *C. galei* is unusual among pipefishes and *C. nanus*, with well developed pouch

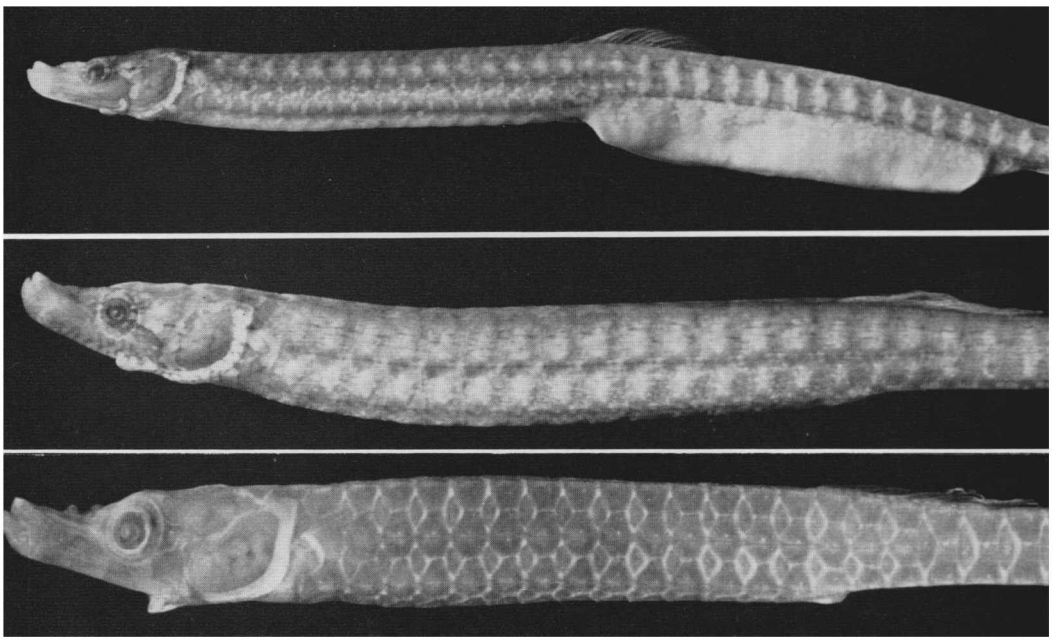

Figure 14. Top and middle.—*Campichthys tryoni* (Ogilby), AMS IA. 7362–3, Queensland, (66-mm SL male and 65-mm SL female). Bottom.—*Campichthys tricarinatus* n. sp., BMNH 1892.1.14.45 (32-mm SL female, holotype), Northwest Australia.

plates, differs markedly from *C. tryoni* wherein plates are lacking. Pending collection of adequate material, *Campichthys* must be considered a catch-all genus for species with the following combination of characters: lateral ridge ending without deflection ventrad, without laterally produced tail ridges, snout ridge wholly or in part elevated, snout short (depth 1.4–2.3 in length), length of dorsal-fin base 1.2–1.7 in HL, trunk rings 13–17.

Campichthys tryoni (Ogilby)
Figure 14

Ichthyocampus tryoni Ogilby, 1890:56 (Moreton Bay, Queensland).
Festucalex (*Campichthys*) *tryoni*, Whitley, 1931:313 (type-species of subgenus *Campichthys* Whitley, 1931).
Campichthys tryoni, Whitley and Allan, 1958:60 (new combination).

Diagnosis.—Trunk rings 16–17; total rings 49–52; pectoral-fin rays 7–9; caudal-fin rays 10; median dorsal snout ridge broadly elevated, subcontinuous and platelike; single ridge on pectoral-fin base.

Description.—Dorsal-fin rays 17–19; rings 16–17 + 33–35 = 49–52; subdorsal rings 0.25–1.25 + 3.0–4.0 = 4.0–4.75; pectoral-fin rays 7–9; equivalent paired pectoral-fin ray counts modally 8; see Tables 2–8, 11 and 14 for additional counts and proportional data.

Median dorsal snout ridge (Fig. 15) elevated, may extend above level of dorsal margin of orbit in mature males, usually with shallow emarginations but without separate knoblike projections or crests. Lateral snout ridge obsolete; interorbital somewhat concave between orbital ridges; postorbital ridge little developed, supraopercular ridge vestigial or obsolete; opercular ridge often complete, restricted to anterior third or half of opercle in some; pectoral-fin base crossed

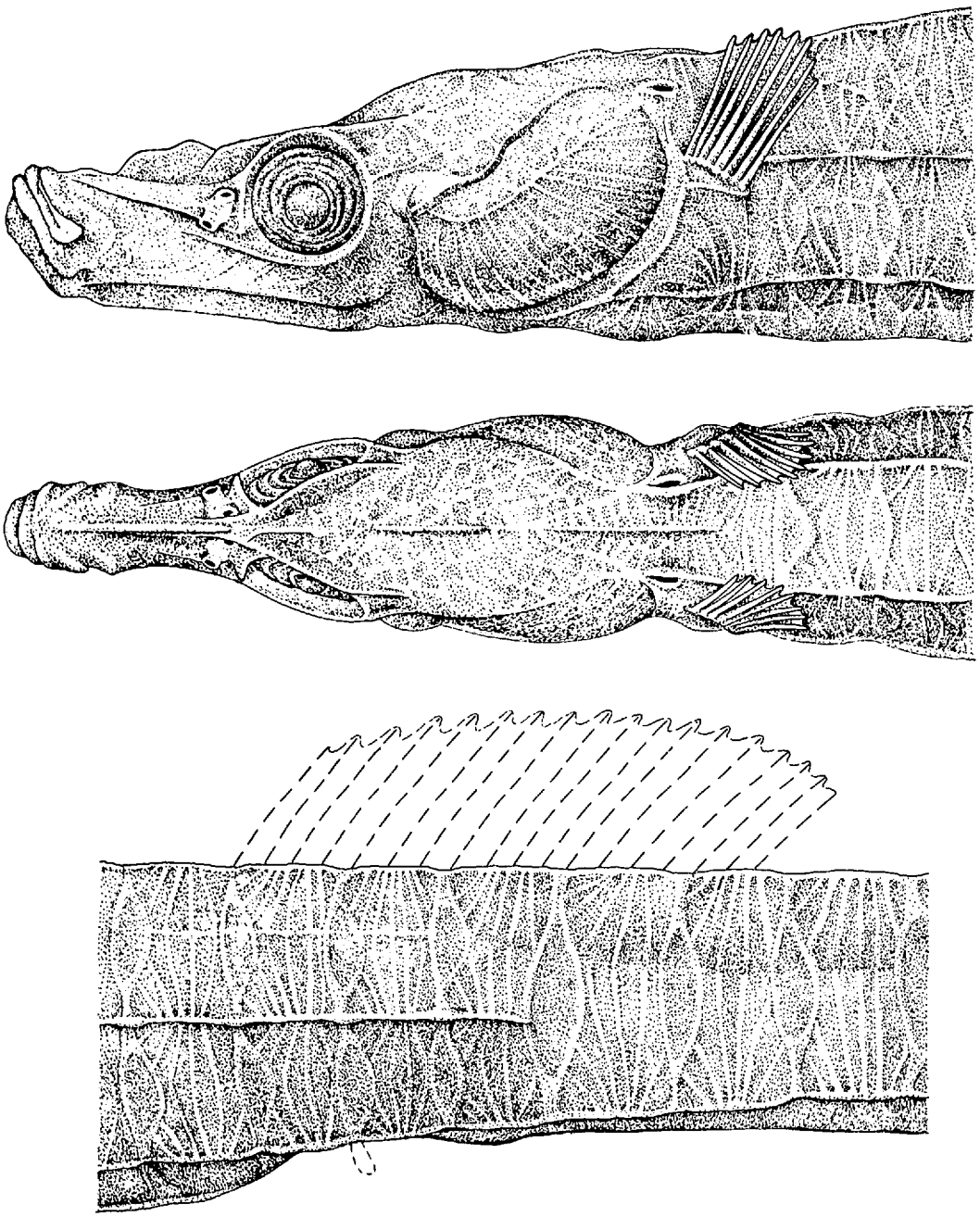

Figure 15. *Campichthys tryoni*. Top to bottom.—Lateral and dorsal aspects of head and anterior trunk rings. Posterior trunk and anterior tail rings, illustrating ridge pattern and position of dorsal and anal fins (from 68-mm SL male, holotype; AMS I. 494).

by single low ridge. Dorsum little depressed between superior body ridges; ridges little indented between rings, essentially straight between indentations; minute dermal flaps on eye; inconspicuous flaps often present on opercular and supraopercular ridges and along posterior margin of opercle; nares prominent, the pores large.

Ground color light tan, markings brownish. Upper half of snout pale or light tan; lower half of snout brown, mottled or with irregular series of pale and light brown bars; eye with circlet of alternating pale and brownish bars; dorsum of head plain or mottled. Side of head behind eye usually with large irregular pale blotch anteriad above opercle, males usually with pale bar continued ventrad on upper half of anterior third of opercle; dorsal and posterior margin of opercle with irregular series of small pale blotches; trunk and tail largely plain, mottled or finely streaked with brown. Males often with indications of irregular tan bars between trunk rings on venter and lower half of side, the subequal brownish interspaces with irregular tan blotches; brood-pouch folds plain or mottled, shading to plain tan near margins; venter of tail elsewhere with indications of narrow brown bars and broad pale interspaces. Dorsal and pectoral fins hyaline or with faint brownish spots; caudal fin brown with pale margin.

Comparisons.—The combination of continuous elevated snout ridge, 16–17 trunk rings, 10 caudal rays and modally 8 pectoral rays clearly distinguishes *C. tryoni* from congeners. The elevated snout ridge is similar to that of *Stipecampus cristatus* but that species differs in lateral trunk ridge configuration, higher trunk ring count (19–20) and other features (see description).

Remarks.—Brood pouch under 14–17 (usually 15–16) tail rings in 14 males 61–72-mm SL, none of study material with completely filled pouch but eggs are deposited in single layer and in maximum of three transverse rows; 37 membranous egg-compartments were present in pouch of 66-mm male; without pouch protective plates; pouch closure unknown, but slightly rolled back margins of some pouch folds suggest the everted type of closure. Anal-fin rays indeterminate in holotype, 3 in three fish and 4 in four others examined.

The high snout ridge of the holotype (Fig. 15) is typical of mature males; ridge is lower in females and young, and seldom exceeds level of dorsal rim of orbit. Ogilby (1890) stated that the snout ridge was bifurcate posteriorly in the holotype. I find this ridge terminating on anterior portion of interorbital, it is not branched behind although margined bilaterally by anterior supraorbital ridges. Several of the larger males have asymmetrical snout ridges in that they are more or less confluent with either right or left orbital ridge; ridges terminate on midline of interorbital in other material. The holotype (AMS I. 494) is now completely faded; dorsal fin is damaged but there appear to be about 18 rays; the opercular ridge is rather distinct anteriad but reduced to a very low rounded striation over posterior half of opercle; brood pouch extends below 15 tail rings. Measurements (mm) follow: SL 68.0, head length 6.5, snout length 2.2, snout depth 1.2, length of dorsal-fin base 5.1, anal ring depth 2.6, pectoral-fin length 1.6, length of pectoral-fin base 0.6; see Tables 2–8 and 11 for counts.

With the exception of a small damaged specimen from St. Vincent Gulf, S. Australia, all examined material is from Queensland (Fig. 10); there are apparently no literature records from other areas. Ogilby (1890) stated that the holotype was dredged; collection data lacking for other samples studied.

Material examined.—Nineteen specimens 46–72-mm SL, including holotype. HOLOTYPE. AMS I. 494 (68-mm SL male), Moreton Bay, Queensland, May 1886, J. Ogilby. OTHER MATERIAL. Australia, S. Australia: SAM F.4153; Queensland: AMS IA. 7362, AMS IB. 1910 (2 "paratypes" of *C. tryoni lindemanensis*).

Campichthys tricarinatus new species
Figure 14

Diagnosis.—Trunk rings 15; total rings 45; pectoral-fin rays 10–11; caudal-fin rays 10; median dorsal snout ridge tripartite, not a continuous elevated projection; single ridge on pectoral-fin base.

Description.—Dorsal-fin rays 17; rings 15 + 30 = 45; subdorsal rings 1.0 + 3.5 = 4.5; pectoral-fin rays 10–11. Measurements (mm) of holotype follow: SL 32.0, HL 4.5, snout length 1.6, snout depth 0.7, length of dorsal-fin base 2.7, anal ring depth 1.6, pectoral-fin length 1.0, length of pectoral-fin base 0.5; see Table 14 for proportional data.

Median dorsal snout ridge essentially tripartite, a low ridge immediately behind upper jaw followed by two well separated knoblike projections; lateral snout ridge short; orbital ridges little elevated dorsad, interorbital concave between; postorbital ridge short and low; supraopercular ridge obsolete; frontal ridge low, nuchal and prenuchal ridges obsolete; opercular ridge complete, angled dorsad, distinct and, in part, elevated above opercular surface; remainder of opercle crossed by 18–20 prominent ridgelike striae below principal ridge, the area above with wafflelike sculpturing; pectoral-fin base with single, well developed, ridge. Principal trunk and tail ridges distinct; dorsum little depressed; superior ridges notched between anterior trunk rings, elsewhere indented between rings; ring margins essentially straight. Eye with circlet of 5–6 rather large flaps; opercular ridge with small rounded flap anteriad, a larger flap laterad above posterior third of opercle and a few minute flaps along rear margin of opercle; nares distinct but not conspicuously enlarged.

Comparisons.—This species is separated from congeners by low counts of trunk and total rings (15 and 45 against 16–17 and 48–52). Snout ridge is a continuous elevated platelike process in *C. tryoni*, whereas it is in three more or less separate parts and not strongly elevated in *C. tricarinatus*. Snout ridge configuration is somewhat similar to that of *C. galei*, but complete separation is shown by counts of caudal-fin rays (10 against 8 in *galei*) and other meristic and proportional features (Tables 2–8 and 14). Among pipefishes treated here, the 10–11 pectoral-fin ray count of *C. tricarinatus* overlaps only those of *Phoxocampus belcheri* and *Festucalex erythraeus* (Table 4). The present species lacks hooklike points on tail rings (present in *belcheri*), head ridges clearly differ from those of *F. erythraeus* (see description) and there are a number of differences in counts and proportions.

Etymology.—Named *tricarinatus* in allusion to the tripartite snout ridge.

Remarks.—The holotype and only known specimen is apparently an adult or subadult and no trace of original coloration remains; anal-fin rays appear to be 3.

Material examined.—HOLOTYPE. BMNH 1892.1.14.45 (32-mm SL female), Australia, Baleine Bank, NW Australia, J. J. Walker; no other data available.

Campichthys nanus new species
Figure 16

Diagnosis.—Trunk rings 13; total rings 39–40; pectoral-fin rays 8–9; caudal-fin rays 10; median dorsal snout ridge with or without knoblike emarginations, not a continuous elevated process; pectoral-fin base without ridge.

Description.—Dorsal-fin rays 18–19; rings 13 + 26–27 = 39–40; subdorsal rings 0.5–1.0 + 4.0–4.25 = 4.75–5.0; pectoral-fin rays 8–9; see Tables 2–8 and 11. Measurements (mm) of holotype follow: SL 25.0, HL 3.0, snout length 1.0, snout depth 0.7, length of dorsal-fin base 2.4, anal ring depth 1.2, pectoral-fin length 0.8, length of pectoral-fin base 0.3; see Table 14 for proportional data.

Figure 16. Upper pair.—*Campichthys nanus* n. sp., RUSI 4663 (25-mm male, holotype), Mozambique. Lower pair.—*Campichthys galei* (Duncker), USNM 216313 (52-mm SL female, neotype), Western Australia.

Median dorsal snout ridge of holotype vestigial or obsolete anteriad, with a broadly pointed crest near middle of snout followed by a shallow concavity and a higher broadly rounded crest behind, the latter united bilaterally with anterior supraorbital ridges; lateral snout ridge obsolete; orbital ridges little elevated dorsad; interorbital somewhat concave, narrowing in front but rather broad behind; postorbital ridge low; supraopercular ridge distinct; median dorsal head ridges very low; opercular ridge vestigial, crosses anterior third of opercle, remainder of opercle waffled with intersecting striae; pectoral-fin base sculptured, without a distinct ridge. Superior trunk and tail ridges little elevated; ridges distinctly notched between rings, margins straight between notches; posterior angles of rings truncate to slightly rounded; most body surfaces sculptured; apparently without dermal flaps. Brood-pouch protective plates enlarged, angled distinctly outward (Fig. 16); pouch folds wide, extend below 9 anterior tail rings, overlap completely throughout much of the empty brood pouch. I am unable to locate anal fin,

Table 14. Number of specimens measured and standard length range, together with range and mean ($\bar{x}$) for selected proportional characters in species of *Campichthys* and *Stipecampus*

Character	*Campichthys tryoni*		*Campichthys tricarinatus* Holotype	*Campichthys nanus* Holotype	*Campichthys galei*		*Stipecampus cristatus*	
	Range	$\bar{x}$			Range	$\bar{x}$	Range	$\bar{x}$
No. of specimens	18				4		5	
Standard length (mm)	48.0–72.0	62.7	32.0	25.0	44.5–52.0	48.0	140.5–206.0	178.5
Head length in SL	8.4–10.5	9.8	7.1	8.3	8.9– 9.8	9.3	12.8– 14.2	13.6
Snout length in HL	2.6– 3.2	2.9	2.8	3.0	2.7– 3.3	3.0	3.3– 3.6	3.4
Snout depth in snout length	1.5– 2.0	1.8	2.3	1.4	1.5– 2.1	1.8	1.3– 1.6	1.5
Length of dorsal-fin base in HL	1.2– 1.6	1.3	1.7	1.2	1.5– 1.7	1.6	0.8– 0.9	0.9
Anal ring depth in HL	2.2– 3.0	2.6	2.8	2.5	3.0– 3.3	3.1	2.7– 3.4	3.0
Pectoral-fin length in HL	3.7– 5.0	4.1	4.5	3.8	3.6– 3.9	3.7	3.6– 4.2	4.0

presumably concealed within pouch folds anteriad, without damage to specimen.

Snout ridge apparently entire and without elevated projections in 2nd specimen; anterior supraorbital ridges seem to unite with median ridge in advance of orbits; without opercular ridge, surface of opercle waffled throughout; minute anal fin present but I am unable to count rays under ×90 magnification.

Holotype brownish, without prominent persistent markings; traces of 5 narrow pale bars crossing dorsum of trunk. The second specimen is light tan throughout.

Comparisons.—The trunk ring count of 13 and low total ring count (39–40) distinguish *C. nanus* from all pipefishes treated here (Tables 2–3). Among congeners, the snout ridge configuration of the holotype is similar to that of *C. tricarinatus* and *C. galei*, but these species have well developed ridges on opercle and pectoral-fin base (ridges vestigial or obsolete in *nanus*). This species further differs from *C. galei* in number of caudal-fin rays (10 against 8 in *galei*) and it has fewer pectoral-fin rays than *C. tricarinatus* (8–9 against 10–11). Confluent snout and supraorbital ridges also occur in *Mannarichthys* and *Stipecampus* but included species differ from *Campichthys nanus* in a number of features (see descriptions and diagnoses).

Etymology.—Named *nanus* in reference to the diminutive size of the male holotype.

Remarks.—Duncker (1915) and Herald (1953) report that males of some species of *Doryrhamphus* are sexually mature at 23–27 mm. The holotype of *Campichthys nanus* appears to be the smallest known mature syngnathine (tail pouch) pipefish.

Reduction or loss of ridges on opercle and pectoral-fin base, an entire snout ridge in the 2nd specimen, well developed pouch plates in the holotype and indeterminate number of anal-fin rays, pose questions regarding the generic placement of this species.

Among materials studied here, it most closely agrees with *C. tryoni* and *C. carinatus* and is provisionally referred to *Campichthys*.

Material examined.—HOLOTYPE. RUSI 4663 (25-mm SL, male), Pinda, Mozambique, ca. 1950, J. L. B. Smith. OTHER MATERIAL. RUSI 861 (24.5-mm SL), Pinda Reef, Mozambique, 1950, J. L. B. Smith.

Campichthys galei (Duncker)
Figure 16

Ichthyocampus galei Duncker, 1909:240 (W. Australia, Sharks Bay, Freycinet Estuary).

Diagnosis.—Trunk rings 16; total rings 48–51; pectoral-fin rays 7–8, modally 8; caudal-fin rays 8; median dorsal snout ridge not a continuous elevated process, usually with two knoblike projections posteriad.

Description.—Dorsal-fin rays 16–17; rings 16 + 32–35 = 48–51; subdorsal rings 0.5–1.0 + 3.0–3.75 = 3.75–4.5; pectoral-fin rays 7–8; equivalent paired pectoral-fin ray counts modally 8; see Tables 2–8, 11 and 14 for additional counts and proportional data.

Median dorsal snout ridge (Fig. 17) vestigial or obsolete anteriad, with a bluntly pointed knoblike elevation near middle of snout followed by a rather deeply concave emargination and a higher crest between nares; lateral snout ridge distinct in smallest specimen examined, vestigial or obsolete in other material; orbital ridges little elevated dorsad; interorbital broadly concave, interrupted in front by rear portion of snout ridge; postorbital ridge short, little elevated; supraopercular and median dorsal head ridges vestigial or obsolete; opercular ridge prominent, margined below by ridgelike striae and striate or sculptured above; single ridge on pectoral-fin base; principal body ridges little elevated, indented between rings, straight or slightly arched between indentations. A few minute dermal flaps on eye; 1–3 vestigial flaps dorsolaterad above opercle and on its posterior margin; nares not conspicuous; anal-fin rays 4 (5 specimens).

Snout mainly pale with faint brown shading on venter and lower part of side, underside of lower jaw brownish; a large irregular pale blotch on postorbital and anterior half of opercle; broad pale bar crosses nape between upper margins of opercles; remainder of head behind eyes and posterior half of opercle brown. Dorsum and upper part of side crossed by 12 diffuse pale bars between head and caudal-fin base; pale areas equal or shorter than ring width, brown interspaces 3–5 rings wide and marked with irregular dark streaks; side of trunk and anterior third of tail streaked with brown above, mainly pale ventrad; venter pale with irregular shading of brown microchromatophores; dorsal and pectoral-fin rays spotted with brown; caudal fin brownish with pale margin; foregoing description from neotype. Coloration of other material variably tan to dark brown; venter of some with indication of narrow pale bars between trunk rings.

Comparisons.—The count of 8 caudal-fin rays readily distinguishes *C. galei* from congeners wherein this count is 10 in all undamaged specimens. Other counts overlap those of *C. tryoni* (Tables 2–8), but *C. galei* lacks the elevated platelike snout ridge characteristic of *C. tryoni*. Snout ridge configuration is similar to that of *C. tricarinatus* but these species differ in counts of total rings and pectoral-fin rays (48–51 and 7–8 against 45 and 10–11 in *tricarinatus*) and in some proportional features (Table 14). The 8-ray caudal fin is shared with *Stipecampus cristatus* but these species differ in general morphology (see descriptions) and a number of meristic and proportional characters (Tables 2–8, 14).

Remarks.—An apparently immature 48-mm male (GCRL 15553) lacks eggs in pouch, has but a slight indication of brood-pouch plates and pouch folds extend across 14 tail rings; pouch folds are rolled inward in scroll-like fashion. One specimen has a low short crest on snout behind upper jaw, others have only the two larger projections posteriad.

With the exception of a specimen with 6

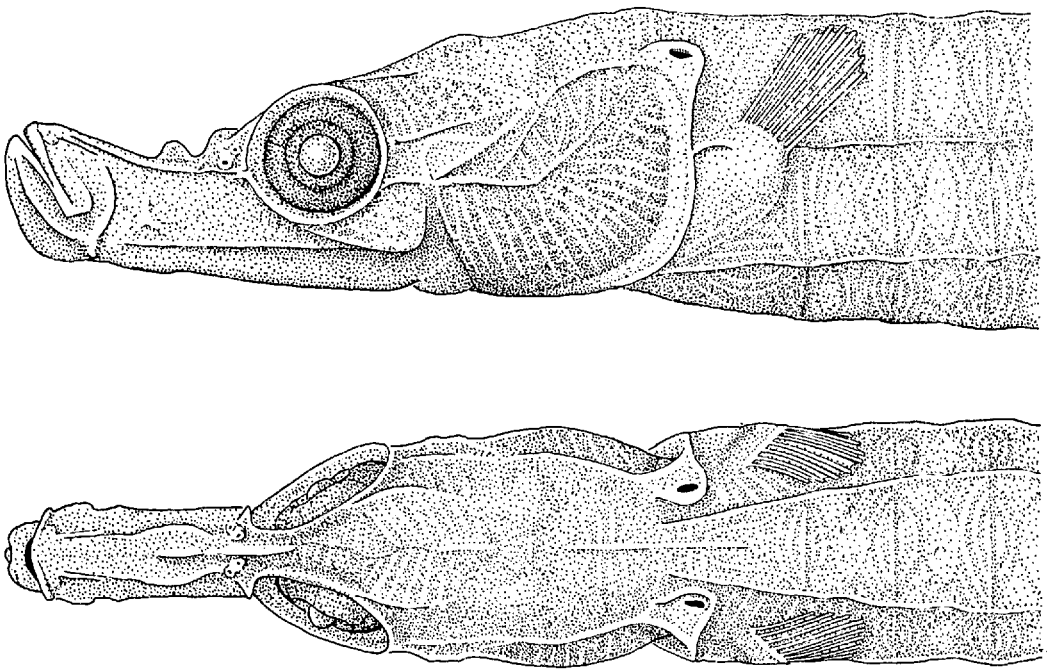

Figure 17. *Campichthys galei*. Lateral and dorsal aspects of head and anterior trunk rings (from 50-mm SL female; WAM P.1149).

regenerated rays, there are 8 caudal-fin rays in all examined material and 8 rays were reported in the original description (Duncker, 1909). This is unusual in pipefishes wherein the count is commonly 9 or 10 in undamaged material. Frequency of caudal-fin rays is a highly conservative character in other genera [*Syngnathus*, *Corythoichthys*, *Festucalex*, etc. (10 rays); *Oostethus*, etc. (9 rays)] and this count alone could support separate generic treatment or referral to *Stipecampus* (8 rays). In the absence of adequate study material (including mature males) and general agreement with *C. tryoni* and *C. tricarinatus* in other characters, I provisionally treat this form as an aberrant species of *Campichthys*.

Duncker's type-material was destroyed in World War II and I here select a female (USNM 216313) as the neotype of *Ichthyocampus galei*. Preserved coloration (Fig. 16) is described above; left pectoral fin is damaged or distorted but I count 8 rays in both fins; measurements (mm) follow: SL 52.0, HL 5.6, snout length 2.1, snout depth 0.9, length of dorsal-fin base 3.3, anal ring depth 1.7, pectoral-fin length 1.5, length of pectoral-fin base 0.6; see Tables 2–8 and 11 for counts.

Known only from Western Australia. Present material (Fig. 10) is all from the general vicinity of Perth (ca. 32°S), considerably south of the Sharks Bay type-locality (ca. 26°S). Two collections were by beam trawl and dredge, the latter on a "weed bank" in 14.6–18.3 m.

Material examined.—Nine specimens, 29–52-mm SL, including neotype. NEOTYPE. USNM 216313 (52-mm SL, female), Western Australia, Point Peron, ca. 55 km S of Perth, 0–7.6 m, 12 Feb. 1970, BBC 1446, B. Collette and party. OTHER MATERIAL. Western Australia: GCRL 14907, 15553, WAM P.1149, P.25346-014, and WAM uncat.

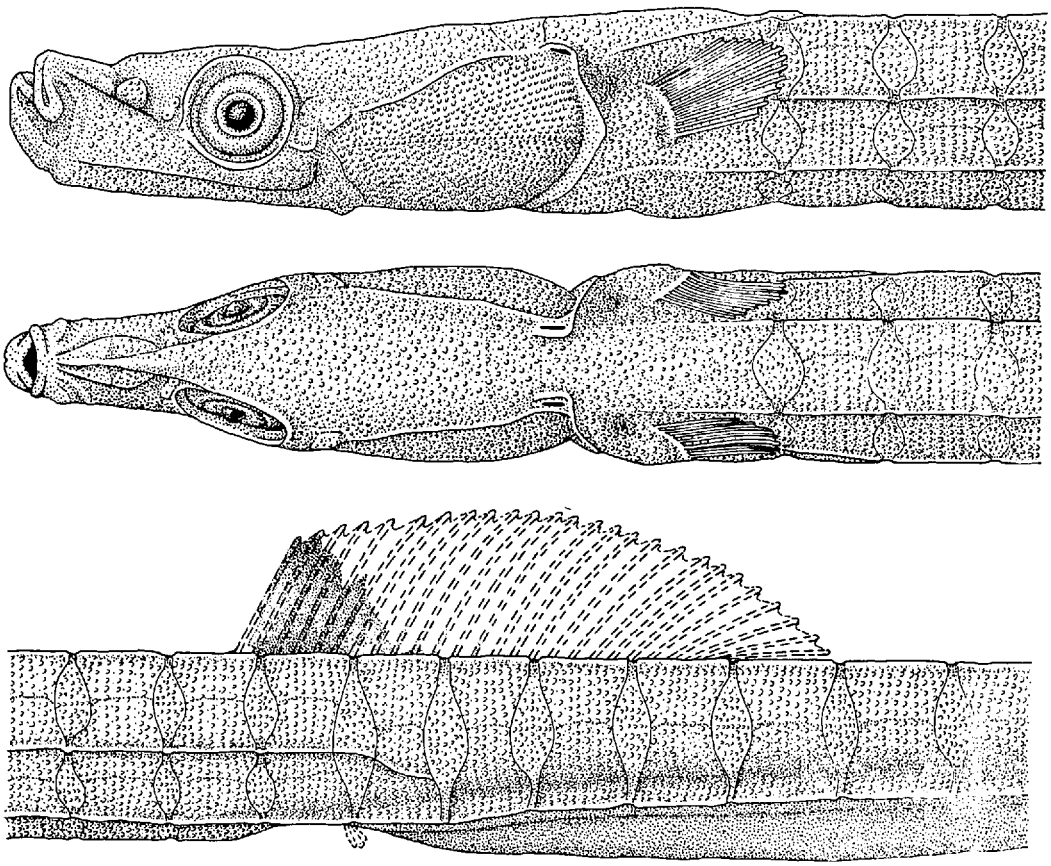

Figure 18. *Stipecampus cristatus.* Top to bottom.—Lateral and dorsal aspects of head and anterior trunk rings. Posterior trunk and anterior tail rings, illustrating ridge pattern and position of dorsal and anal fins; surface granulations accentuated (from damaged adult male) QM I.9826; dorsal-fin blotch from 220-mm SL male, AMS I. 19211–006.

Stipecampus Whitley

Stipecampus Whitley, 1948b:75 (type-species: *Ichthyocampus cristatus* McCulloch and Waite, 1918, by original designation).

Diagnosis.—Superior and inferior trunk ridges continuous with corresponding ridges of tail; lateral trunk ridge (Fig. 18) terminates between last trunk ring and 3rd tail ring, distally straight or deflected ventrad but not confluent with inferior ridge; venter of trunk flat to somewhat V-shaped, without median longitudinal keel; dorsum and sides little depressed between principal ridges; superior ridges little indented between rings, straight between indentations; principal tail ridges not angled laterad; posterior angles of tail rings not pointed (except in postlarvae); ridges of last 2–3 tail rings not modified; scutella without longitudinal ridge or keel. Median dorsal snout ridge a large, continuous, platelike elevation, confluent posteriad with orbital ridges; snout ridge bilaterally with a thickened submarginal bony process near middle of snout length (most prominent in adults); gape subvertical, tip of upper jaw near or above level of dorsal rim of orbit; interorbital essentially flat with vestigial median ridge anteriad; orbital ridges

little elevated; postorbital, supraopercular and median dorsal ridges of head vestigial or obsolete; opercle with or without an indistinct ridge, crossed elsewhere by about 40 minutely granular striae; sides and dorsum of head granular, without minute ridges or sculpturing; pectoral-fin base somewhat protruding, rounded, without distinct ridges in subadults and adults; margins of principal body ridges granular; adults without dermal flaps. Dorsal-fin origin on trunk, fin base not elevated, membrane closely bound to fin rays; caudal rays 8; brood pouch under tail; pouch protective plates and folds present. Without odontoid processes in jaws; nares small, 2-pored bilaterally; neuromasts indistinct under low magnification. Maximum size at least 230 mm SL. Indian Ocean; marine.

Comparisons.—The continuous, strongly developed and elevated, snout ridge confluent with orbital ridges, the flat interorbital, absence of ridges on pectoral-fin base and presence of pouch plates constitute a combination of characters not found in other pipefishes examined here. Snout ridge configuration is somewhat similar to that of male *Campichthys tryoni* but the ridge is confluent with orbital ridges (not so in *tryoni*) and there is complete separation in a number of meristic features (Tables 2–8); the variably straight or deflected posterior portion of the lateral ridge is not found in related genera.

Remarks.—Eight caudal-fin rays were reported for *S. cristatus* by McCulloch and Waite (1918), Waite and Hale (1921), Scott (1970) and 8 caudal rays are present in five recently collected specimens (AMS I.19211–006). As noted under *Campichthys galei*, this count is unusual in pipefishes and it is here considered a distinctive generic character.

Retention of *Stipecampus* as a monotypic genus is open to question since *S. cristatus* could well be included in the catch-all genus *Campichthys*. Nevertheless, I retain separate status for *Stipecampus*, since it differs in physiognomy, morphological details (including granular surface ornamentation), meristic values and other features from species here included in *Campichthys*.

Stipecampus cristatus
(McCulloch and Waite)
Figure 19

Ichthyocampus cristatus McCulloch and Waite, 1918:40 (Spencer Gulf, South Australia).
Stipecampus cristatus, Whitley, 1948b:75 (type-species of *Stipecampus*).

Diagnosis.—Diagnostic features are those of the genus.

Description.—Dorsal-fin rays 26–29; rings 19–20 + 39–42 = 58–62; subdorsal rings 0.5–1.25 + 4.0–5.25 = 5.0–6.25; pectoral-fin rays 12–13; equivalent paired pectoral-fin ray counts modally 12; see Tables 2–8, 11 and 14 for additional counts and proportional data. Opercular ridge complete but very low in holotype, ridge obsolete or but faintly indicated in other material.

Ground color and markings of head and body variable (Fig. 19); pale areas cream to irridescent white, elsewhere various shades of brown or tan. Upper half or two thirds of opercles and dorsum of head faintly striped with narrow brown lines. Sides and dorsum of snout dark to light brown, plain or with irregular pale spots or blotches, in 4 of 6 examined fish; snout mainly pale in others, but with brownish shading on dorsum and with a narrow brown bar before eye and another on suborbital, both bars angled anteroventrad and (in one fish) continue across venter of snout. Dorsum of trunk and tail plain brown or crossed by 9–11 irregular brown bars (2–5 rings wide) separated by narrower tan interspaces. Sides of trunk mainly brown but marked above by continuations of pale bars crossing dorsum and along inferior ridge by a series of irridescent white spots or irregular tan blotches. Sides of tail with upper half mainly brown; lower

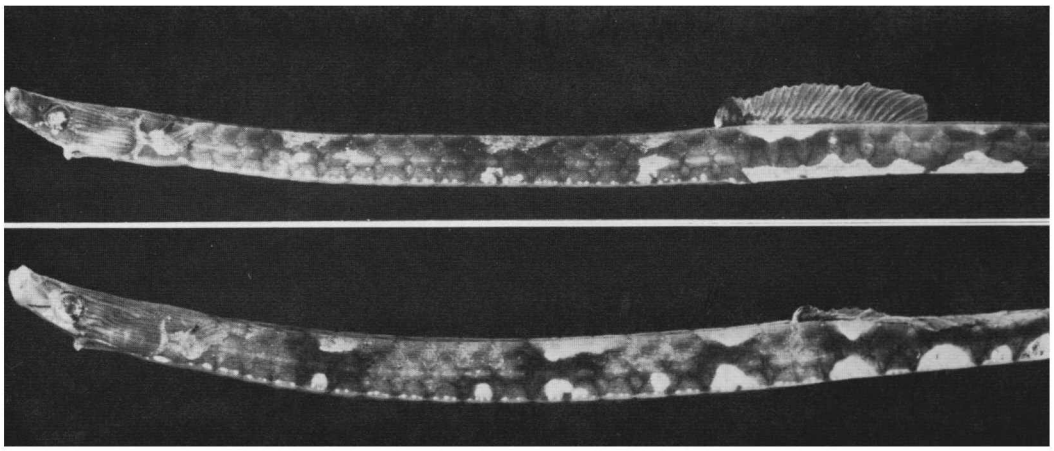

Figure 19. *Stipecampus cristatus* (McCulloch and Waite), AMS I. 19211–006, Victoria, Australia. Top. —Male, 220-mm SL. Bottom.—Female, 206-mm SL.

portion predominantly pale with irregularly distributed narrow intrusions of brown crossing scutella to inferior tail ridge. Venter of head irregularly blotched with brown or crossed by two narrow brown bars; venter elsewhere usually pale (brown in 140-mm SL specimen), often with small brown spots between rings on margin of inferior ridge. Dorsal fin with prominent dark blotch anteriad (Fig. 18), fin elsewhere mainly pale with rays narrowly edged with brown. Area about pectoral-fin base pale, often with iridescent white spots; pectoral fin irregularly blotched and shaded with brown; caudal fin brownish. Color description from 6 recently collected specimens 140–220-mm SL (AMS I. 19211–006). Extensive color notes were given for the only known Tasmanian specimen by Scott (1970); unfortunately this fish cannot now be located (pers. comm., E. O. G. Scott).

Remarks.—Brood pouch under 13 anterior tail rings in holotype and two other mature males, under 16 rings in an immature male (220-mm SL); pouch plates well developed and angled distinctly laterad; pouch folds damaged in mature specimens, closure unknown; eggs in 1–2 transverse rows, separate and not in gelatinous matrix; anal-fin rays 3 in three counted, possibly 4 in two others.

The holotype is dried, in two pieces, and I am unable to verify the described counts of 26 dorsal-fin rays, 12 pectoral- and 8 caudal-fin rays.

The posterior configuration of the lateral trunk ridge is variable in examined specimens. It is deflected ventrad on the 2nd tail ring of the holotype but fails to reach the inferior ridge. Another specimen has the right ridge deflected on the 1st tail ring, whereas the left ridge ends without deflection on the last trunk ring. The right ridge is similarly deflected in a 3rd specimen examined, but the left ridge ends without deflection on the 1st tail ring; ridges terminate without deflection in other material. Although other pipefishes treated here may vary in angle of ridge deflection (*Ichthyocampus*) or in relative length of right and left ridges, *Stipecampus cristatus* is the only species wherein the lateral trunk ridge is variably straight or deflected posteriad.

A postlarval specimen (ca. 17-mm SL) taken in a plankton tow at a depth of 10 m off South Australia (33°52′S, 137°10′E) on 20 February 1939 is provisionally identified as *S. cristatus*. This fish (CAS 37881) has

the posterior angles of trunk and tail rings produced as prominent recurved spines, and as with other planktonic pipefishes (e.g. *Corythoichthys* spp.) the lateral trunk ridge also bears spiny projections. Counts, not included in tables, follow: dorsal-fin rays 26; rings 20 + 40; subdorsal rings 1.5 + 5.5; caudal-fin rays 8; lateral trunk ridge ends bilaterally at rear of anal ring, anal fin present.

The holotype was taken by dredge, the Victoria specimens were taken with SCUBA in 3–5 m; collection data are lacking for other specimens examined. This species, apparently an Australian endemic, is known only from South Australia, Victoria and Tasmania.

Material examined.—Fifteen specimens, ca. 17–220-mm SL, including holotype. HOLOTYPE. SAM F.569 (ca. 200-mm SL, male), Spencer Gulf, South Australia, J. Verco. OTHER MATERIAL. South Australia: CAS 37881, MCZ 52102, QM I.9826–7, SAM F.631, 632; Victoria, Port Philip: AMS I. 19211–006, GCRL 15225.

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