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OBSERVATIONS ON SOME TASMANIAN FISHES: PART XXVII

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(with six tables, one text-figure and one plate)

ABSTRACT

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One new species is added to the Tasmanian list: *Ammotretis elongatus* McCulloch, 1914, from Goose Island, Furneaux Group, Bass Strait.

A detailed account, with table of dimensions, is given for two examples of *Trygonorrhina fasciata* Müller & Henle, 1841 (Rhinobatidae). It has hitherto been assumed the Tasmanian fiddler ray is the typical subspecies; however, the present paterial is determined as *T. f. guanerius* Whitley, 1932.

Other species noted are: *Dinolestes lewini* (Griffith, 1834) (Apogonidae), general specifications of a sample of eight specimens, with extensions of published meristic and morphometric ranges, *Beryx decadactylus* Cuvier, 1829, *B. decadactylus* (Günther, 1859) (Berycidae), *Paratrachichthys trailli* (Hutton, 1875) (Trachichthydae), the treatment of the last three species including detailed morphometry and various aspects of body form, with some comparison between them.

INTRODUCTION

This paper follows the general plan of others in the series. Linear measurements are given throughout unless otherwise specified in millimetres, the name of the unit commonly being omitted. The symbols *Ls*, *Lt*, *TLs*, *TLt* denote standard length, total length, thousandths (permillages) of standard length, thousandths of total length, respectively. Registration numbers denoted by Q.V.M. are those of the Queen Victoria Museum and Art Gallery, Launceston. Certain other conventions are noted in earlier contributions.

Family RHINOBATIDAE

The Handbook (Munro 1956) recognized three genera with Australian representatives, *Rhinabatos* Linck, 1790 (2 species, the Check-List (McCulloch 1929) recording 5), *Aptychotrema* Norman, 1926 (3 species) and *Trygonnorrhina* Müller & Henle, 1838 (rendered *Trygonorhina*) with 2 subspecies, the typical subspecies (type locality New Holland) in Queensland, New South Wales, Victoria, Tasmania and *Trygonorrhina fasciata guanerius* Whitley, 1932 from South Australia (type locality) and southern Western Australia (the Check-List includes a fourth genus, *Rhynchobatus* Muller & Henle, 1837, with 1 species). Of these only *Trygonorrhina fasciata* was listed for Tasmania. While no investigation appears to have been made as to the subspecific nature of the local fiddler ray — which is included in the earliest State list (the MS catalogue of Morton Allport) — it has been assumed since the recognition by Whitley of the existence of 2 subspecies that it is the eastern form categorized by him, and this is the position adopted in the Handbook, in Scott (1962), and in Scott *et al.* (1974). However, material from the estuary of the Tamar, northern Tasmania, observations on which are presented below, proves to be assignable to *T. f. guanerius*.

Observations on some Tasmanian Fishes: Part XXVII

Genus *TRYGONORRHINA* Müller & Henle, 1838

Trygonorrhina Müller & Henle, 1838 *Mag. Nat. Hist.* (Charlesw.), n.s., 2, p.90. Type-species, *Trygonorrhina fasciata* Müller & Henle. (Spelt *Trygonorhina* in PLAGIOST., 1841 on p.124 but *Trygonorrhina* on p143).

Trygonorrhina fasciata guanerius Whitley, 1932

Trygonorrhinus fasciata guanerius Whitley, 1932, p.317; cites figure 39 in Waite, 1921. Type locality: Kangaroo Island.
Trygonorrhina fasciata guanerius Whitley, 1940, p.174, fig.200 and 1964, p.34: Scott, 1954, p.106 and 1962, p.53, unnumbered fig.: Scott, Glover & Southcott, 1974, unnumbered fig.
Trygonorhina fasciata guanerius: Munro, 1956, p.15, fig.105.
Trygonorrhina guanerius Whitley, 1948, p.9.
Trygonorhina fasciata: Zietz, 1908, p.292: Waite, 1921, p.27, fig.9 and 1923, p.47, unnumbered fig.: Lord, 1923, (1922) p.62 and 1927, p.12: Lord & Scott, 1924, pp.6,26: McCulloch, 1929, p.23 (Tasmanian reference only): Stead, 1963, pp.138,201.
Trygonorhina fasciata: Johnston, 1883, p.40 and 1891, p.39.

Accounts Without Subspecific Differentiation

In the course of an excellent description, with figure, of a young specimen of *Trygonorrhina fasciata* from Sandon Bluff, New South Wales, McCulloch (1921b, p.460, pl.38, figs 1,2) noted, in addition to sources cited above in synonymy as dealing with material from South Australia, Western Australia or Tasmania (and thus presumably relating to *T. f. guanerius*), some treatments of *T. fasciata* without subspecific differentiation but in view of the localities involved presumably relating to the typical subspecies. The more important Australian texts cited include Castelnau (1872), Macleay (1881), Haswell (1884), Ogilby (1886), Lucas (1890), Hill (1895), Waite (1899, 1904): to these the following other texts may usefully be added McCulloch (1921a), Tindale (1926), Griffith (1936). Among basic extralimital references those of Müller & Henle (1838, 1841), Duméril (1865), Günther (1870) and Garman (1913) may be mentioned. Of these accounts some adopt *Trygonorrhina*, others, including McCulloch's own, *Trygonorhina*.

Subspecific Differentiation

The brief passage in which Whitley (1932) proposed his subspecies comprises only three sentences and may profitably be quoted verbatim. "The South Australian Fiddler Ray, which has been figured by Waite differs markedly from the New South Wales form in the disposition and nature of its colour-markings. The difference may be better appreciated by comparing Waite's figure with that of McCulloch than conveyed by written description." The only other available account of *T. f. guanerius* is that of Scott (1954). As noted above, the Tasmanian form has hitherto been assumed to be *T. f. fasciata*, but on the basis of the figures by Waite and McCulloch, subsequently reproduced side by side by Whitley (1940), our specimens are identifiable as *T. f. guanerius*. After preservation of the rays in formalin for several months the pattern, originally well defined, became indistinct. On available information no morphometric distinction between subspecies can be drawn.

Other Species

For upwards of a hundred years *Trygonorrhina* had been cited as a monotypic genus; however, a second species, *T. melaleuca* Scott, 1954, also from South Australia, has now been described. It differs at sight from *T. fasciata* in coloration, having a diffuse bluish-black pattern covering back and upper part of tail to caudal fin and 4 grey bars on the hinder part of the disc.

Material

Two examples collected in the Tamar estuary in the vicinity of Ilfraville, 3 March 1980: (a) female, total length 1046 mm standard length (to origin of caudal) 893 maximum disc width 474, I. Sutcliffe (Q.V.M. Reg.No. 1980/5/26), (b) female, total length 1139 mm standard length 994 maximum disc width 490, R. Hunt (Q.V.M., Reg.No. 1980/5/57).

Dimensions; Methods of Determination

Hubbs and Ishiyama (1968), extending the recommendations of the methods for the study of bony fishes by Hubbs and Lagler (1958, 1964) and in part those previously proposed and followed by Ishiyama (1958) for rays, set out a series of measurements and defined the conventions in accordance with which it is recommended they be made. A basic proposition is the following: "Each determination is taken point-to-point, as this procedure is far more objective and precise than measuring projections onto an imaginary line supposedly parallel with some axis." This procedure represents a radical departure from the general practice long observed in Australian and in the majority of overseas texts in respect of those measurements that can appropriately be made between parallels, e.g. directly between normals to the general anteroposterior axis of the fish — see, for instance, the "set of standard measurements for comparative and biometric studies of Australian sharks" devised by Whitley (1943 p.114) and extensively employed in his papers. In offering their recommendations Hubbs and Laglar observe "We hope that these methods will meet with the acceptance afforded the methods proposed by Hubbs and Lagler (1958, 1964) for the systematic study of bony fishes"; and this hope has found general fulfilment. It is here suggested such acceptance of the proposals (in particular the general point-to-point specification) may perhaps have been a somewhat uncritical one; some considerations regarding the appropriateness of the two methods of measuring and reporting the magnitude of some morphological features are here noted. The relative merits of measurements made point-to-point and those made between parallels may conveniently be examined in respect of two criteria, (a) the ease of operation and the precision, objectivity and reliability of specification, (b) the general biological significance of the magnitudes recorded.

Consider first ease, precision and objectivity. It is evidence that for the majority of measurements the point-to-point technique is indeed simpler and easier to perform and is calculated to yield an objective and precise result. It may be questioned whether in the case of the dozen or so measurements listed by Hubbs and Ishiyama that include the specification "from snout tip" point-to-point measurements made with dividers are likely to be as truly objective as those taken between parallels with the aid of a measuring board (the tip of the snout being objectively determined in the latter method by direct contact with the anterior board, the former involving some subjective decision as to the precise point to be treated as the tip of a part of the body commonly rounded in two planes). In respect, however, of reliability in the sense of uniformity of magnitude (i.e., as with reported measurements in general, relative magnitude; reported values conventionally being given as proportions, usually as percentages or millesimals of a standard magnitude such as maximum disc width - adopted by Hubbs and Ishiyama - or standard length) among members of a sample, hence as a systematic index, the point-to-point method is open to theoretical objection. Consider the listed measurement No.33, "*Prenarial length*: from tip of snout to nearest point on outer rim of nostril". If taken between parallels this involves only one axis that is the subject of variation, namely, the general anteroposterior axis of the ray. If taken point-to-point two axes subject to variation are involved, namely, the general anteroposterior axis and the transverse axis. With a large series of specimens at hand it would be instructive to compare the coefficients of variation of prenarial length yielded by point-to-point and between-parallels measurements. (Experience indicates that in species with a markedly sinuous outline in the anterior half of the disc individual variation in disc width here may be not inconsiderable; with this internarial distance may be correlated.) Further, in a measurement such as No.31, preocular length, there is introduced, at least as a formal component, a third plane of variation, that of depth.

The significance of certain dimensions and their mode of determination may next be considered. In the course of these contributions it has repeatedly been found for a variety of species among teleosts, selachians and (less extensively investigated) batoids that with measurements taken between parallels normal to the general anteroposterior axis dimensions such as length of head, length to vent, lengths to origins and terminations of vertical fins, calculated as relative to standard length, exhibit the exponential relation $L = b\ N^k$, where L = length to point, N = a natural number. It is difficult to believe that such formulations do not point to the existence of certain basic nodes of growth disposed linearly along the primary anteroposterior axis of the fish (*s.l.*). The location of such nodes so disposed would clearly be less precisely specified by point-to-point measurements involving the additional component of depth. Among rays, sharks and bony fishes the first, in view of their depressed form, would in general be least subject to such extra variation, while in deep-bodies forms the differences between the two types of measurement may be considerable. In a specimen of the moderately deep *Centroberyx affinis* (Günther, 1859) at hand the point-to-point measurements of length to dorsal origin, length to anal origin are 1.27 and 1.07 those taken between parallels. A more pertinent example is provided by a ray with an elevated dorsal profile such as *Myliobatis australis* Macleay, 1881, in a specimen of which with a total length of 1225 mm and a disc width of 990 mm the preocular length measured between parallels was found to be 65 mm, measured point-to-point 128, or virtually twice as much. The considerable difference between the figures just noted directs attention to a further significant point of difference between the two methods of measurement when the results are considered as applicable to a series of dimensions, namely, the relative divergence between the two data will not be constant for all items but will be subject to variation determined by the body form.

Where it has seemed expedient dimensions of the present specimens are recorded by both methods of measurement, thus making them directly comparable with those noted in accounts already published of this (and in general other Australian) species and with those specified in accordance with the more recent system.

Dimensions; Present Material

Published accounts of the typical subspecies provide no good series of measurements, but more than a dozen dimensions of a female *Trygonorrhina f. guanerius* from St Vincents Gulf, South Australia have been recorded by Scott (1954). Two sets of measurements are here presented. Apart from a couple of omissions the first represents the schedule of measurements of external features proposed by Hubbs and Ishiyama, absolute dimensions (mm) being recorded only for the first two entries, total length disc width, the remainder being given as millesimals of maximum disc width. The second set covers some additional morphological features not noticed in the Hubbs-Ishiyama schedule, in particular those here investigated in the section Aspects of form. In order to permit direct comparison of proportional relations here specified with comparable formulations for other species previously reported in these contributions, dimensions continue here to be expressed as millesimals of standard length, i.e., length to origin of more anterior caudal lobe ((a) 893 mm (b) 994 mm), rather than as millesimals of maximum disc width ((a) 474 mm (b) 490 mm) as in the preceding set. In the case of exponential relations of the form $Y = b\ N^k$, with N the serial number of a metameric or otherwise repetitive structure, here regularly rectified as $\log Y = k \log N + \log b$, conversion from a standard length to a disc width metric is obtained thus: the slope (k) is constant, the intercept ($\log b$) is transformed by multiplying its antilogarithm by absolute standard length, dividing by absolute disc width and taking the antilogarithm. The statistical significance as measured by t of course remains unaltered.

Hubbs-Ishiyama schedule, dimensions from No.3 onward as millesimals of maximum disc width.

1 Total length 1046 mm, 1139 mm

Disc measurements

2 Disc width 474 mm, 490 mm; 3 disc length 1014, 1020; 4 anterior projection 608, 571; 5 trunk length 647, 646; 6 mouth to tail 1215, 1238; 7 precaudal length 992, 1087.

Tail measurements

8 Tail length 1018, 1097; 9 tail width, end P_2 179, 179; 10 tail depth, end P_2 116, 122; 11 tail width, origin D_1 174, 173; 12 tail depth, origin D_1 105, 107; 13 predorsal length 100, 168; 14 D_1 origin to tail tip 918, 929.

Fin measurements

15 D_1 basal length 124, 120; 16 between D bases 211, 241; 17 D_2 basal length 122, 118; 18 postdorsal length 939, 989; 19 D_1 vertical height 173, 180; 20 D_2 vertical height 178 176; 21 C vertical height 86, 84; 22 lateral fold length 960, 929; 23 lateral fold width 19, 15; 24 behind lateral fold 127, 122; 25 between front tips, P_1, 970, 980; 26 P_2 width 222, 235; 27 P_2 length 396, 367 (mean of left and right); 28 anterior P lobe 141, 125 (mean of left and right); 29 clasper lengths (not here applicable) —.

Head measurements

30 Head length 543, 582; 31 preocular length 264, 253; 32 preoral length 253, 245; 33 prenarial length 190, 194; 34 internarial distance 179, 184; 35 nasal curtain length 92, 86; 36 nasal curtain width 194, 196; 37 between nasal fimbriae 179, 178; 38 between rostral pores —, —; 39 mouth width 148, 139; 40 eyeball length 36, 35; 41 between orbits 110, 112; 42 between spiracles 156, 155; 43 spiracle length 82, 86; 44 over 1st gill slits 418, 451; 45 prefontanelle length 385, 374; 46 anterior concavity 44, 39; 47 anterior convexity 143, 86; 48 posterior concavity 127, 78; 49 posterior convexity 137, 61.

Between disc spines

50 Left-right scapulars 158, 168; 51 spines, one side 316, 337; 52 over prescapulars 59, 61; 53 pre- to mediscapular 76, 87; 54 behind last scapular 46, 47; 55 over lumbar spines 348, 408.

Some additional dimensions, all measured between parallels and recorded as millesimals of standard length, smaller specimen cited first. Lengths to gill slits 1-5 (mean length on right and left sides as measured, the two values agreeing within 1.4% or less) 183 198 214 229 242, 191 209 226 243 258. Intervals between gill slits (inner ends) 181 172 159 145 138, 171 159 148 134 128. Lengths of gill slits (direct from tip to tip) 19.6 22.0 23.0 24.6 18.2, 23.1 24.8 25.7 26.1 17.8. Length to vent (middle) 489 512, length of vent 26 28. Length to origin of first dorsal 660 674, of second dorsal 839 849. Width of disc at 12 equal intervals along anteroposterior axis from tip of snout to and including posterior border 172 291 370 436 490 520 531 521 496 461 396 274, 160 258 337 400 456 486 493 479 458 425 372 241 (in view of the general lability of the disc in the region the last measurement of each set cannot be regarded as having a high degree of reliability). Preocular length 112 106 (*cf.* point-to-point 130 123).

South Australian Female Specimen

A description of a female of this subspecies of total length 864 mm, disc width 374, disc length 357, from St Vincent's Gulf, South Australia (Scott 1954, p.108) contains a dozen other dimensions (recorded in mm, here rendered as thousandths of disc width): tail 502, its width at posterior insertion of ventrals 86, eye 28, interorbital 71, preocular length 108, preoral length 116, width of mouth 91, width of internarial valve 96, length of ventral 86, first dorsal height 102, its distance from origin of tail 76, second dorsal height 89, its distance from origin of tail 211. The method of measurement is not specified but it may be presumed distances are measured between parallels.

General Features

The following account is based primarily on the larger individual, *Ls* 994 mm, entries relating to the smaller, *Ls* 893 mm, being in parentheses; all dimensions are here recorded as thousandths of standard length (*TLs*). As far as is relevant and expedient it follows, with some extensions, the description (with figures of dorsal aspect and oral region) by McCulloch (1921b) of a young specimen of *T. fasciata fasciata* 380 mm long from off Sandon Bluff, New South Wales.

Skin of upper surface of disc and tail more or less velvety, that of lower surface in general hard, smooth, glossy. On most of lower surface minute subcircular denticles occur in regularly arranged rows, some 50-60 cm^{-1}, their interspaces modally less than their diameters; on most of upper surface they are of two or more sizes, less regular in form, less evenly disposed. On dorsal surface of disc from immediately behind scapular arch at 1.8 (1.8) of disc length to origin of second dorsal (first dorsal, McCulloch) a band of small but clearly visible tubercles, set rather thickly, 15-20 cm^{-2}, width at origin 125 *TLs* (100) at insertion of first dorsal 50 (56) of second dorsal 25 (20).

An irregular patch of minute tubercles, seen with difficulty, below and behind eye (not mentioned by McCulloch or Scott). A row of tubercles along median line of back, first few poorly developed, largest, 11-12 long 3-4 high, before first dorsal, base modally elliptical (major axis anteroposterior) in some cases becoming more or less rounded, surmounted by a short straight keel or ending in a knob or blunt point, the whole structure enveloped in skin; first at 60 (67) behind eye, 2 others before pectoral arch, 1 on arch, 14 before first dorsal origin, 3 (0) in anterior two-thirds of interdorsal, total 21 (18) (18 before first dorsal, McCulloch; 17 + 2 between dorsals, Scott). A rather massive but only obscurely differentiated tubercle or knob at each end of the elevated supraorbital ridge, distance between front and back rather more than half that between right and left, which is the same for the anterior and posterior pairs. On either side of the median line of tubercles 2 scapular spines, the anterior one slightly in advance of the median tubercle situated on the transverse ridge of the arch, the posterior between the levels of this and the next median tubercle, direct distance between right and left anterior subequal to that between four successive median tubercles here, that between posterior a trifle less. Externad of these spines three on each side (in (a) tending to form a subcontinuous ridge) the anterior about four times as far in advance of ridge of arch as the front one of the inner series, the middle about level with the second inner, the posterior between the levels of the first two postscapular median series; mean distance apart of these outer spines about twice that between inner spines, this distance, however, increasing slightly from first spines to last. (A double row arranged in pairs, McCulloch; two rows of four on each side, Scott.)

Disc well rounded, anterior half rather less pointed than in figures by McCulloch and Waite; differing markedly in the snout region in our two specimens — in (b) outline here sloping evenly forward and very obtusely pointed (much as in illustrations cited), in (a) at round about one-third of the preocular length the width of the outline decreasing abruptly with formation of a well-marked median lobe, its length almost one-third its width, its anterior margin close to one-third of a circle (see below, Aspects of Form). Width of disc just less than, 0.996 its length (just greater than, 1.03) ("a very little narrower than long", McCulloch; 1.05 length, Scott). Width-length equations of both discs are given below. Ventrals wholly separate, subquadrangular, anterior segment of outer border approaching linear, its length about 110 (120), angle broadly rounded, posterior segment slightly convex subequal in length to anterior, tip acute, inner border gently bisinuous, its length 100 (70); greatest width a little more than twice in the length (length less than combined width, McCulloch); distance between anterior insertions of fins subequal to that between insertion and tip (length greater, McCulloch) or about 5 times that between insertion and vent, distance between posterior insertions 3.6 (2.9) in that between anterior; tip of pelvic extending behind hind border of pectoral by about 150 (135).

Preocular length from snout tip to eyeball between parallels 9.57 (9.70) or point-to-point 8.17 (9.08) in length of disc, and, parallels 2.95 (3.70), point-to-point 2.52 (3.08) width of disc at level of eyes. Eyes fairly well elevated above level of snout tip, with strong supraorbital ridges, the space between them flat but sloping somewhat down and forward longitudinally, very concave transversely. Eyeball 2.5 (3.0) (McCulloch, 3½; 2.5, Scott) in interorbital, 4.5 (4.3) in preocular length, here measured between parallels (McCulloch, 5; 3.9, Scott). Spiracle large, about one-sixth longer than eye, extending forward to just in advance of middle of eye, pointed in front sinuously rounded behind; from its posteroexternal border there projects a stout fleshy structure; viewed from above it constitutes an upwardly convex subtriangular process, its basal width one-fifth length of spiracle, its length half as great again; viewed laterally it is seen to be subtended lengthwise along the middle by a subtriangular fold, the basal (posterior, attached) border of which is subequal to the width of the external base of the structure.

Mouth cleft almost straight at most slightly proconvex, its width, here measured across tooth band of upper jaw, 0.55 (0.60) preoral length ("almost three-fifths of", McCulloch; 0.84, Scott), or 4.47 (5.06) in disc width here. In the larger individual a simple groove, its length about one-seventh width of mouth, curves back from either end of hind lip; in the smaller individual the groove on the left side, but not that on the right, continues round and back to trace out a blunt recurved process, which, however, achieves no independent existence as a three-dimensional structure, remaining merely outlined on the general plane here by the continuous groove. This dermoglyph is evidently one of the prominent and decidedly larger paired features shown in McCulloch's figure, of which that on the right of the illustration could perhaps be mistakenly interpreted as a process of the nasal curtain. External to the mouth cleft and, except very briefly below the dermoglyph, to these grooves a continuous or subcontinuous groove curves back from about the level of the rictus on either side, then turning inward and running subparallel to the mouth, but being slightly proconcave, thus forming a large transversely elongate loop; width of groove 1.1 that of mouth, greatest distance behind lower lip 0.3 its own length. Within this loop, subparallel to its hind border, from which it is distant about half as far as from mouth, a more or less straight groove, its length approximately equal to half mouth width.

The narial region differs considerably in general appearance from that in the figure by McCulloch, the differences, however, being in part only a question of proportion. Thus: distance from level of outer border of upper rim of narial opening to level of hind border of nasal curtain (nasoral valve, internarial valve) much shorter relative to width of curtain, about 2.5 in latter, in our material 2.1 (2.1); length of opening together with its associated fringing fold much greater, about 0.7 (cf. about 0.4) curtain length, its greater length being largely accounted for by the great width of the fringing fold, about two-thirds (*cf.* about one-third) its width; anterior border of naris, broadly rounded in the Tasmanian specimens, figured as bluntly pointed; hind border of curtain, virtually coextensive with mouth, shown slightly and evenly proconvex, is slightly sinuous in (a) with approximately the same degree of overall curvature but almost linear in (b). Some distance below the general surface a fold crosses the upper half of the opening (wall bordering it externally undercut), its lower border continuing inward behind the curtain to constitute the forwardly convex anterior wall of the olfactory sac, the outer half of the posterior wall being formed by an elongate curved process representing a continuation of the external fold flanking the opening behind, the inner half by a separate proconcave fold; distance between hidden pointed inner ends of the right and left sacs about one-fourth greatest width of curtain, which at this level is broadly attached by a transverse base; within the sac, the large fusiform olfactory organ with the usual system of complex folds extends outwards beyond the external outer margin of the nasal opening.

Tooth complement in upper jaw a whitish band about one-tenth as wide as long, surface moderately convex fore and aft curving down most rapidly behind; extending across virtually whole extent of mouth cleft, anterior border rather strongly posterior slightly proconvex; teeth very small, lozenge-shaped, contiguous forming a smooth pavement with round about 70 rows from left to right, up to about 16 from back to front. In lower jaw extending on to external surface in a band, anterior border slightly proconvex posterior more decidedly proconcave, about one-tenth as wide as long, visible length 0.7 that of band of upper jaw; up to about 10 teeth in an oblique anteroposterior row.

Gill slits of moderate size, modally presenting a simple curve or briefly recurved at inner end, 5th sigmoid; length to 1st 0.39 (0.40) to 5th 0.52 (0.53) length of disc ("well behind middle of pectoral disc", McCulloch; slightly behind, Scott); anteroposterior extension of series subequal to direct (oblique) distance of 1st from angle of mouth; widths between 1st pair 2.88 (2.73) between last pair 3.82 (3.72) in disc widths at respective levels. (For further specifications of gill slits see section, Aspects of Form.)

Tail as measured between parallels from middle of vent to origin of caudal fin slightly shorter than body, 488 *TLs* (a little longer than, 502 *TLs*) ("a little longer", McCulloch; 1.01, Scott: tail in Scott includes, and in McCulloch probably includes, caudal fin); stout, its greatest depth two-thirds its greatest width or somewhat greater than (McCulloch, equal to) interocular width or 1.3 (1.1) width of mouth, lower surface flat, lateral strongly dorsal moderately convex, trenchantly divided in respect both of character of surface and colour into upper and lower elements by the well-developed lateral fold, originating nat far behind commencement of free tail at 55 (45) in front of first dorsal origin, traceable back, gradually lapsing to extinction on caudal fin, right to level of end of vertebral column, located in advance of tip of fin by 55 (62) ("lost at the base of the caudal", McCulloch).

Dorsal fins located in middle one-third of the total free tail with caudal fin, set rather close together, the interval between them 1.2 (1.1) height of the taller; fins much similar in size and form, first a trifle taller; in the first dorsal the slightly convex anterior border is 1.4 (1.4) the almost straight distal border and 4.6 (4.6) the slightly concave posterior, in second dorsal 1.4 (1.5) and 5.1 (5.4); bases subequal; in first dorsal height 1.8 (1.5) base, in second 1.1 (1.2). Caudal well developed, its length between parallels being 12.7 (14.6) in total length, or 1.3 (1.6) vertical height of first (taller) dorsal, paddle-shaped, upper border only very slightly convex, distal and ventral borders not sharply differentiated, together presented more or less a single sweep, 2.3 (2.1) as long as wide, lower lobe inserted shortly in advance of upper.

A feature not noted by McCulloch, Whitley or Scott and not observed in any other Tasmanian rajids at hand is a pair of grooves on the ventral surface, one on either side of the median longitudinal line, lying behind the gill slits by about one-tenth of the interval between the last pair of these. Each groove comprises a sinuous transverse segment, its length about five-sevenths of mouth width, and an outwardly convex segment the oblique arc of which slopes backward and outward, its length about half as great again as that of the transverse segment; at their anterior ends the grooves approach each other to within 3-4 mm, while the distance between their posterior extremities is 170 (190) *TLs* or 0.6 of disc width here. Each groove is divided into cells, longer than wide, about 5 in 20 mm, the partitions between which do not in general extend quite up to the level of the general external surface. From its structure this feature would seem probably to be of a sensory or secretory nature.

Aspects of Form

1. Shape of disc. In both individuals the disc overall is broadly rounded attaining its greatest width at seven-twelfths of its length from the tip, the front half being in the larger noticeably, in the smaller somewhat, less convex than the hind half. In the larger disc the tip is quite evently and rather bluntly rounded, the whole outline presenting a flowing curve, closely approximating those found in the figures of this subspecies by Waite (1921 unnumbered on p.27) of *Trygonorrhina fasciata* Müller & Henle, 1841, by McCulloch (1921, pl.38 fig.1) and of the South Australian *T. melaleuca* Scott, 1954 by its author (1954, fig.1); this may well be the modal configuration. In the smaller disc the outline in the anterior one-twelfth is more complex: at the hind boundary of this segment, 39 mm (44 *TLs*) behind the tip, the width is 172 *TLs* units; after continuing forward in the same general sense as the curve behind it for a distance of some 15 mm, representing a direct advance of some 10 mm, the disc rim on either side abruptly approaches a direction normal to the general anteroposterior axis, the least width now being only about 105 *TLs*; arising from the short right and left platforms thus established the remainder of the anterior outline takes the form of a clearly differentiated evenly rounded arc, its chord about three and a half times its length. It may be observed that in rays in general variability of outline tends to be more pronounced, at both the specific level (where it may be diagnostic) and the individual level, in the anterior than in the posterior moiety of the disc, the latter commonly being or approximating a simple conic curve.

With eleven measurements of width taken at equal intervals between the tip and the level of the hindmost point on the posterior border the disc outline is very satisfactorily specified in each case by a second degree polynomial. The data below are for widths as thousandths of "standard length" (to base of caudal fin), the larger individual noted first. Initially twelve measurements were made. However, that representing the distance between the most posterior points of the disc on either side was in the event rejected — an accurate determination being found to present some difficulty in view of the general lability of the disc in this region; further, calculation with twelve variates demonstrated the inability of a second degree or even a third degree polynomial to cope satisfactorily with the sharp decrease in magnitude of the width here (thus for the smaller specimen predicted *TLs* values for the eleventh and twelfth widths were 379, 387, measured 396, 274; a striking contrast to the accurate predictions of equations for eleven variates). The grid of measurements at twelve equal intervals between anterior and posterior boundaries of the disc here adopted misses the pronounced local variation in outline just behind the tip in the smaller ray.

$W = 44.73 + 124.11N - 8.6154N^2$. Calculated (measured) widths 160(160) 258(258) 340 (337) 403(400) 450(456) 479(486) 491(493) 486(479) 464(458) 424(425) 367(372). R 0.9978.
$W = 54.15 + 133.12N - 9.2822N^2$. 178(172) 283(291) 370(370) 438(436) 488(490) 519(520) 531(531) 525(521) 500(496) 457(461) 395(396). R 0.9994.
The addition of a term in N^3 yields only a marginally better fit (F 0.496 0.992).

In addition to some obvious difference of form already noted some other features distinguish the discs. With dimensions made directly comparable by being expressed as millesimals of standard length it is found that of the smaller example is longer relative to general length (524 *v.* 495) and also is relatively wider (172-531 mean 424.9, 160-493 mean 392.9). Without examination of further material it cannot be determined whether these variations are size-determined or are merely individual.

Not only do the specimens differ in overall relative length and relative width, they exhibit also variation in the proportional widths of their anterior and posterior sections, as is apparent from the subjoined equations for, first the outline from the tip to the maximum width, secondly, that from (and including) the maximum width to the posterior border (dimensions as *TLs*, larger individual first).

Front half:
$W = 43.14 + 124.71N - 8.50N^2$. R 0.9997. (Percentage variation of predicted from measured widths 0.0-1.4 mean 0.46).
$W = 49.43 + 136.16N - 9.631N^2$. R 0.9996. (Percentage variation 0.0-2.7 mean 0.92).

Hind half:
$W = 489.28 + 8.71N - 6.4286N^2$. R 0.9999. (Percentage variation 0.0-0.7 mean 0.16).
$W = 520.00 + 18.43N - 8.5714N^2$. R 0.9987. (Percentage variation 0.2-0.9 mean 0.47).

Hence while the sample widths both in the anterior halves of the two discs and in their posterior halves are strongly correlated, specimen with specimen (r 0.9991 0.9986, z 3.835 3.645) the parameters of the regression of one individual on the other differ noticeably when front and hind sections are compared. With the data for specimen (b) of *Ls* 994 mm plotted against those for (a) of *Ls* 893 mm the best straight lines are as below:
$Wa = 0.95Wb - 10.62$; t 51.712***.
$Wa = 0.88Wb + 20.35$; t 33.122***.

2. Head, length to vent, standard length (head is here taken as length to 5th gill slit, standard length as length to origin of anterior (lower) caudal lobe). In a loglog plot these three dimensions are significantly linear on integral 1 2 4. With lengths as *TLs* the best straight lines are as below (here, as customarily in these studies, minimization of the sum of the squares of deviations is performed for the logarithmic, not the arithmetic, deviations — in general it is found the two solutions do not lead to a significant difference in the formulation).
Log L = 0.9429 log N + 2.4237; t 23.206*; calculated lengths, *TLs*, 269 510 980.
Log L = 0.9722 log N + 2.4153; t 218.143**; 260 511 1 015

3. Origins of first dorsal, second dorsal, caudal fins. These dimensions are linear on a loglog plot on 8 9 10.
Log L = 1.8685 log N + 1.1347; t 17.416*; calculated lengths, *TLs*, 664 827 1 007.
Log L = 1.7715 log N + 1.2320; t 15.067*; 679 836 1 008.

4. Transverse distance between gill slits. It has been found in some unpublished investigations on sharks and rays that, in a loglog context, certain measurements involving gill slits, comprising length to length of and transverse distance between slits, are specifiable in terms of the sequential numbers of the slits. However, it would appear that in general one or other of the terminal slits (1st or 5th) stands outside the pattern presented by the remainder. In the case of the present material, when the transverse intervals (I) between slit pairs 1 2 3 4 5 are plotted on loglog paper on their reverse serial numbers (N') 5 4 3 2 1, variates 4 3 2 1 are effectively collinear while slit 1 on 5 lies outside the series. For the relevant variates the best straight lines are:

Log I = 0.2393 log N' + 2.0905; t 33.754***; calculated intervals, *TLs*, 145 160 172 181.
Log I = 0.2618 log N' + 2.0473; t 20.478**; 134 149 160 170.

5. Lengths to gill slits. With lengths (between parallels) from tip of snout as measured on right and left sides averaged (lengths for the two sides differing by a maximum of 1.4%, mean < 1%) it is found that in a loglog plot the lengths to slits 2-5 on their serial numbers are linear; with length to slit 1 outside the line.

Log L = 0.2151 log N + 2.2798; t 3.994 (just short of significance at P 0.05; 4.303); calculated lengths, *TLs*, 221 242 257 269.
Log L = 0.2358 log N + 2.2484; t 15.181**; 209 230 246 259.

6. Lengths of gill slits. In a loglog plot the lengths of slits 1-4 are linear on their serial numbers; with length of slit 5 well outside (below) the line of positive slope.

Log L = 0.1579 log N + 1.2921; t 9.908*; calculated lengths, *TLs*, 19.6 21.9 23.3 24.4.
Log L = 0.08808 log N + 1.3661; t 12.822**; 23.2 24.7 25.6 26.2.

7. Overall curves for gill slit variates. In formulations above it has been shown that the transverse interval between, the lengths to and the lengths of the gill slits are functions in a loglog plot of the serial numbers of the slits, with one of the terminal members of the series (1st or 5th slit) lying outside the specification. In view of their very wide occurrence such simple magnitude-number relations are clearly worthy of record even in a curtailed series. However, the question of the overall curves for the complete populations is itself a matter of separate interest, and polynomials of the third degree are found to provide very precise specifications of the data for all 5 slits, the relevant arithmetic (logarithmic) magnitude, expressed as millesimals of standard length, here being associated with their ordinal numbers. The relevant equations, together with values predicted by them and an indication of goodness of fit, are presented in table 1.

Coloration

The ground color of the upper surface is reported as varying "from sandy to light brown, yellowish, dark brown, even greyish at times, according to the immediate environment" (Stead 1963).

In both our specimens as preserved the ground color of the upper surface of the disc and tail is almost uniform dark somewhat greenish brown approaching black; pelvics a little lighter distally; dorsals dark elephant, a trifle lighter along distal margin, caudal concolorous with dorsals except area occupied by vertebral column which is concolorous with general dorsal surface. When first examined both individuals presented an elaborate pattern of bands of a light color approximating lilac, bordered along each margin by a narrower band of very dark brown, disposed along and symmetrically on either side of the median line — somewhat suggestive of the scroll-like holes and purflings in the belly of a violin, whence the vernacular name "fiddler ray" — the general arrangement being in close agreement with that shown in the figure (Waite 1921) of *T. fasciata guanerius*, departing clearly from that in the standard figure (McCulloch 1921a) of the typical subspecies. The markings have almost disappeared in (b) but most are still traceable in (a), main band greyish, modally some 10 mm wide, bordering lines usually of even width throughout (modally about 4 mm) dark brown.

TABLE 1

Trygonorrhina fasciata guanerius WHITLEY, 1932

Measurements involving gill slits defined by $Y = A + BN + CN^2 + DN^3$, where N = serial number of slit; dimensions as millesimals of standard length. Two specimens from the estuary of the Tamar River, northern Tasmania, (a) standard length 893 mm (b) 994 mm.

Feature	Transverse interval		Length to slit		Length of slit	
Specimen	(a)	(b)	(a)	(b)	(a)	(b)
A	179.00	176.00	170.20	173.50	22.28	27.10
B	9.05	–1.19	11.15	17.41	5.71	–7.68
C	–8.037	–4.607	1.892	0.322	3.735	4.461
D	0.91677	0.58333	0.24990	0.08333	0.55000	0.65832
R	0.9999	0.9987	1.0000	1.0000	0.9694	0.9887
Calculated (measured) values	181(181) 172(172) 159(159) 145(145) 138(138)	170(171) 160(159) 147(148) 135(134) 128(128)	183(183) 198(198) 214(214) 229(229) 242(242)	191(191) 209(209) 226(226) 243(243) 258(258)	19.7(19.6) 21.4(22.0) 23.9(23.0) 24.0(24.6) 18.6(18.2)	23.2(23.1) 24.3(24.8) 26.4(25.7) 25.6(26.1) 17.9(17.8)

The overall color of the ventral surface is ivory. In both individuals the disc is bordered in its hind half by a dark brown strip, regularly widening backward, up to about 60 in (a); the color in each case lightening inward; in (a) more or less continuously to end in a scalloped line of light grey, in (b) in two more or less distinct bands: in (b) this lateral darkening becomes apparent behind level of mouth, in (a) it is traceable forward virtually to tip of snout, here only 2-3 mm wide. Both examples present some dusky smudging, in (b) in scattered and quite irregular lines and patches on hind half of disc and front half of tail, in (b) chiefly as a large roundish smoky area surrounding vent and a smaller oval area at base of tail. In the larger specimen about five score of conspicuous black spots or splashes, mostly 3.5 mm in diameter a few much smaller, are scattered over the whole prenarial area, with half a dozen extending back to just behind level of mouth: in the smaller there are no more than ten, decidedly lighter, just behind left half of mouth.

FAMILY BERYCIDAE

Of the five Australian fishes referred to this family in the majority of texts from the Check-List (McCulloch 1929) onward one only appears in any Tasmanian list, *Centroberyx affinis* (Günther, 1859) – by Johnston (1883, 1891) listed as of the genus *Beryx* Cuvier, 1829, by Lord (1923, 1927) and Lord & Scott (1924) as of the genus *Trachichthodes* Gilchrist, 1903 and referred to the family Trachichyidae (the members of which as it is currently recognized have II-III (modally III) anal spines whereas the berycids characteristically have IV, occasionally III-IV). This deepwater species, recorded from all Australian States (and New Zealand) was noted by Johnston as rare in Tasmania. The distribution of the second local species, *Beryx decadactylus* Cuvier, 1829, is given in the Check-List as Victoria and Bass Strait but Tasmania is expressly cited along with Victoria in the Handbook (Munro 1958); it has a wide distribution, being also met with in both the Pacific and Atlantic oceans.

Observations on some Tasmanian Fishes: Part XXVII

KEY TO BERYCIDAE RECORDED FROM TASMANIA

Dorsal with 7 spines, 11-12 rays. Anal with 12 rays, base (sloping) subequal to base of second dorsal. Red above cream below, with longitudinal red streaks .... *Centroberyx affinis*

Dorsal with 4 spines, 16-19 rays. Anal with 28-29 rays, base (sloping) about 1½ base of second dorsal. Uniform carmine .... *Beryx decadactylus*

Genus *BERYX* Cuvier, 1829

Beryx Cuvier, 1829, REGN. ANIM., ed.2, p.151. Type-species, *Beryx decadactylus* Cuvier.

Beryx decadactylus Cuvier, 1829
(Fig. 1)

Beryx decadactylus Cuvier, 1829, HIST.NAT.POISS., 3, p.222. Type locality: unknown.
Beryx decadactylus: Günther, 1887, p.33, pl.6 (skeleton): McCulloch, 1929, p.130: Whitley, 1964, p.40: Matsuda, Araga & Yoshino, 1975, p.192, pl.29, colored fig.B.
Beryx decdactylus [*sic*]: Munro, 1958a, p.78, fig.542.

Remarks

The vernacular name in the Handbook (Munro 1958) (in which the first "a" of the second binomen is inadvertently omitted) is the widely adopted "imperador", the other Australian species of the genus, *B. splendens* Lowe, 1834 being designated the "alfonsin". This reaches English dictionaries as a general name for several berycoid fishes found at Madeira and in the West Indies, and Gunther (1887, p.32) quotes Lowe (1843) as reporting that Madeiran fisherman, engaged in an important fishery involving this family, call the present species the "Alfonsin a casta larga" and *B. splendens* as the "alfonsin a casta cumprida", its body being noticeably the shallower of the two. Australian records note the occurrence of *B. decadactylus* at 330-435 m, while the *Challenger* collected examples off Inoshima in 535 m. Remains attributed to *Beryx* and allied genera have been found abundantly in the Cretaceous.

Tasmanian Record

A specimen, *Ls* 385 *Lt* 511, taken by Mr Shane Down 23 km east of Binnalong Bay, east coast, in 330 m in March 1980 (Q.V.M. Reg. No. 1980/5/34).

Meristic Characters

Counts in parentheses given first are those of the Handbook (Munro 1958, p.78) followed where appropriate by those in Matsuda, Araga & Yoshino (1975). D. IV, 20 (IV, 18-19; IV, 16-20). A. IV, 30 (III-IV, 28-29; III-IV, 27-30). V. I, 10 (I, 10; I, 9-10). P. left 16, right 20 (15-16; 16-18). C. main rays 24. L. lat. 73 (63-71). L. tr. 10/23 (9-10/17-18). Gill rakers on lower anterior arch 19, slender, somewhat flattened, bluntly pointed, decreasing in length ventrally, longest half snout. The higher count in the right pectoral of the present specimen is accounted for by the occurrence of additional small and very small rays at the beginning of the lower border of the fin; clearly an individual peculiarity. The caudal fin is preceded above from the dorsal termination back by a series of spines developed as prolongations of the scales of the superior profile; approaching the fin base these increase notably in length (last four 4, 13, 25, 46 *TLs*), the hindmost virtually becoming an integral element in the overall structure of the fin. On the ventral surface a series of some eight scales without spines is followed by two spines 17, 23 long. Some observations on these pseudospines are made below in the account of *Centroberyx affinis*.

Dimensions as *TLs*

Length to end of upper caudal lone 1296 to end of lower caudal lobe 1372 to end of middle caudal rays 1169. Length to origin termination of dorsal 475 714 of anal 631 909.

Length to origin of pectoral 309 total length of fin 314 length of longest (5th) ray 270. Length to origin of ventral 405 total length of fin 556 length of longest ray (2nd from spine) 250. Length to vent (middle) 517. Head 351. Snout 83. Eye 132. Interorbital 73. Lengths of dorsal spines 14, 19, 109, 110 of first longest (2nd) last rays 244, 260, 87. Lengths of anal spines 10 20 89 99 of first longest (2nd) last rays 184 190 60. Length of ventral spine 149 of adjoining ray 239; for other rays see Aspects of Form, below. Depth (width) at front of eye 213(127) back of eye 379(145) opercular border 447(151) dorsal origin 478(138) vent 468(135) anal origin 431(119); maximum 481(156), caudal peduncle 123(90).

Proportions

The main diagnostic proportions are in good agreement with those given in the Handbook (Munro 1958, p.78) – depth in standard length 2.08 (Handbook 2-2.3) head in standard length 2.85(3) eye in head 2.65(2.5) eye in interorbital 1.86(1.66).

Aspects of Form

Length of head, length to vent, standard length. In a loglog plot these three primary dimensions yield a significantly straight line (t 53.201*) on {1 2 6}:

Log L = 0.5863 log N + 2.5418; calculated (measured) lengths, *TLs*, 348(351) 523(517) 996(1 000).

Location of vertical fin origins and terminations. In a loglog plot {length to dorsal origin anal original dorsal termination anal termination caudal origin} fall collinear with statistical significance (t 45.332***) on {3 5 6 9 10}, the equation of the best straight line being:

Log L = 0.6116 log N + 2.3798; calculated (measured) lengths, *TLs*, 470(475) 641(631), 717(714), 919(909), 981(1 000).

A comparison of the location pattern of vertical fin origins and terminations in this species with those for *Centroberyx affinis* (Günther, 1859) (in which the integral abcissal coordinates are 3 5 7 8 10) and *Paratrachichthys traill*i (Hutton, 1876) (in which they are 2 5 6 7 10) is exhibited in fig. 1.

Anal spines. In a number of diverse species possessing three anal spines a common pattern that has often been noted in these studies has their logarithmic lengths a function of the logarithms of their serial numbers. While in the four other berycids found in Australian waters the spines are regularly IV (regularly so also in the allied polymixids and the still more closely allied holocentrids), the count in the "imperador" may be either III or as in our example IV. In the present fish these constitute two pairs with their lengths falling in a loglog graph on the first two and the last two of the natural-number series 1-10:

Log L = 0.9539 log N + 1.0490; t 19.901**; calculated (measured) lengths, *TLs*, 11(10) 22(24) 91(89) 101(99).

Dorsal spines and rays. In this specimen the four dorsal spines exhibit the same length-number pattern as the four anal spines, being two pairs of markedly different size with their logarithmic lengths collinear when plotted on logs 1 and 2 and logs 9 and 10.

Log L = 0.8810 log N + 1.1752; t 31.888***; calculated (measured) lengths, *TLs*, 15(16) 28(26) 104(106) 114(113).

The dorsal rays show some irregularity in length, increasing to 2nd then decreasing to 11th; 12th ray marginally longer than 11th but lengths then decreasing to 17th, with 17th < 18th < 19th > 20th. The logarithmic lengths of the set of seven rays 5th-11th is significantly linear, t 23.089***, on (as is usual in a descendant series) the logarithms of their reverse serial numbers, *i.e.*, on logs 10-16.

Log L = 1.1923 log N' + 0.8071; calculated (measured) lengths, *TLs*, 100(96) 112(114) 124(125) 137(140) 149(153) 162(161) 175(169).

Ventral. The presence in this family (and in some other Beryciformes) of a number of ventral rays in excess of the very widely found complement of 5 has long been interpreted

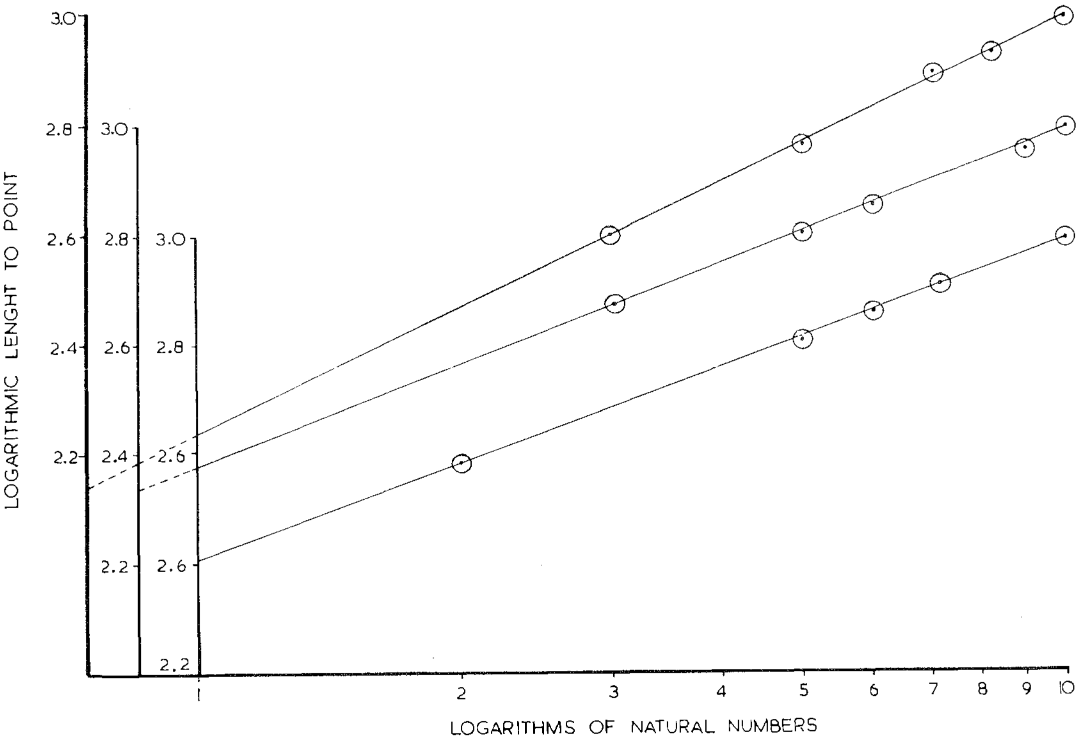

FIG.1 - Location of dorsal origin, anal origin, dorsal termination, anal termination and caudal origin according to the relation $L = b\ N^k$, where L = length to origin or termination (measured as thousandths of standard length) N = a natural number (2-10); illustrating the permutations exhibited by the related species, *Centroberyx affinis* (Günther, 1859), top graph, *Beryx decadactylus* Valenciennes, 1829 and *Paratrachichthys trailli* (Hutton, 1875), bottom graph.

(Boulenger 1910) as the retention of an archaic character. Among Australian Berycidae three species have 7 rays while in *Beryx splendens* Lowe, 1834 the count ranges fron 10 to 13 (such variability in this normally constant fin presumably being indicative of evolutionary instability). In the 10 in the present species the lengths (as found in our example) increase from first ray (defined as that farthest from spine) to ninth, with (as is usual also in 5-rayed fins) the last ray a little shorter than the penultimate, subequal to the antepenultimate. As is modally the case with the set of four successively longer rays, the logarithmic lengths of the nine here are a function of the logarithms of their serial numbers:

Log L = 0.54 log N + 1.8875; t 27.591***; calculated (measured) lengths, *TLs*, 77(82) 112(106), 140(134), 163(158), 184(184), 204(210), 221(226), 237(242), 253(250).

Precaudal pseudospines. The lengths (4 13 25 46 *TLs*) of the four spine-like processes developed on the dorsal profile immediately in advance of the caudal are related to their serial numbers thus $L = b\ N^k$, the slope of the rectified equation (k) being 1.7369, the intercept (log b) 0.5949: t 75.737***; calculated values of L 4 13 27 44.

General Features

Maxilla to below 0.5 eye, its greatest width 0.42 its length (165 *TLs*). Isthmus to below 0.1 eye. Pectoral to level of 13th dorsal ray, ventral to base of 3rd anal spine. Lower jaw slightly projecting, a median knob fitting into edentulous segment of upper jaw. Oval posterior nostril about one-sixth eye, its distance fron orbit twice its length, one and a half times its distance from posterior nostril, which is about half as large, more rounded. Teeth in upper jaw in right and left narrow bands tapering anteriorly to a point, in oblique rows of up to a dozen, minute pointed, not or barely erect directed inward and backward, a symphysial diastema with arc about one-fifth eye diameter; in lower jaw much as in upper, anterior ends of bands less than half as far apart; on vomer somewhat larger, in a transverse strip with anterior border convex posterior slightly sinuous, 5-6 rows at its middle; on palatine a single row of upwards of two score, larger than in jaws strongly recurved, acute.

Scales extending forward on to occiput in a conspicuous sharply delimited broad pennon reaching nearly to level of front of orbit, its width at back of eyes subequal to sum of widths of flanking scaleless strips there. Naked area of dorsum and whole of preorbital with numerous scattered minute pits with low subcircular rims. Operculum with some irregular scales much less clearly defined than those of flank. A scaly sheath along whose base of anal of virtually even height throughout, 2-3 rows of scales proximally, smaller than adjacent scales, external to these a single row of decidedly larger, less pigmented scales forming a distinct frill-like somewhat crenulated free border; a rather less developed sheath along dorsal base; on caudal a conspicuous median lingulate squamous extension backward from general caudal peduncle to end of median caudal rays.

Coloration

The "imperador" is a handsome species, being bright uniform carmine on the whole of the nead and body and all the fins. The inside of the mouth is mostly whitish with some traces of pale pink (contrast the "alfonsin", *Beryx splendens* Lowe, 1834, with inside of mouth bright red).

Genus *CENTROBERYX* Gill, 1862

Beryx Cuvier, 1829, REGN. ANIM., ed.2, p.151. Type-species, *Beryx decadactylus* Cuvier.
Hoplopteryx Agassiz, 1839, POISS. FOSS., 4, p.4. Type-species, *Hoplopteryx denticulatus* Westward. (Spelt Hoplopterix, p.131.)
Centroberyx Gill, 1862, *Proc. Acad. nat. sci. Philad.*, 14, p.238. Type-species, *Beryx lineatus* Cuvier.
Trachichthodes Gilchrist, 1903, *Mar. invest. S. Afr.*, 2, p.203. Type-species, *Trachichthodes spinosus* Gilchrist.
Austroberyx McCulloch, 1911, p.39. Type-species, *Beryx affinis* Günther.

Centroberyx affinis (Günther, 1859)
Fig. 1

Beryx affinis Günther, 1859, p.13. Type locality: Australia (Warwick)[=Sydney?, *fide* McCulloch (1929, p.131)].
Beryx affinis: Castelnau, 1878, p.225: Macleay, 1881, p.525: Johnston, 1883, p.109 and 1891, p.31 *in* Whitley (1929), p.49: Ogilby, 1893, ED. FISH. N.S.W., p.69, pl.21: Stead, 1908, ED. FISH. N.S.W., p.48, pl.17.
Hoplopteryx affinis: Regan, 1911, *Ann. Mag. Nat. Hist.*, 8(7), p.5.
Austroberyx affinis: McCulloch, 1911, p.43, fig.11.
Trachichthodes affinis: Waite & McCulloch, 1915, *Trans. R. Soc. S. Aust.*, p.463: Roughley, 1916, FISH. AUST. AND THEIR TECHN., p.49, color pl.11 and 1951, p.26, color pl.7: Waite, 1921, p.69, fig.105 and 1923, p.94, unnumbered fig.: McCulloch, 1921(a), p.43, pl.27, fig.117a and 1922, FISH. AND FISH-LIKE ANIM. N.S.W., p.33, pl.12, fig.117a and 1929, p.131: Lord, 1923, p.65 and 1927, p.13: Lord & Scott, 1924, pp.9 44, unnumbered outline fig.: Whitley, 1929, p.49: McCulloch & Whitley, 1925, *Mem. Qld Mus.*, 8(2), p.129: Marshall, 1964, p.128, pl.29, fig. 139 and 1966, TROP. FISH GREAT BARR. REEF, p.178, pl.29, fig.139.

Centroberyx affinis: Whitley, 1948, p.16 and 1962, p.71, unnumbered fig. and 1964, p.40 and 1968, p.47: Scott, 1962, p.103, unnumbered fig.: Selickaya, 1971, p.157: Scott, Glover & Southcott, 1974, p.116, unnumbered fig.: Pulley, 1974, MAR. FISH. AUST. WAT., p.65, unnumbered fig. opposite p.89: Thomson, 1974, p.117 and 1977, p.86: Pollard, 1978, p.102 (incidental reference).

Note on Vernacular Name

There has been some continued confusion regarding the vernacular name of this species, early on concerned only with differences in orthography, more recently involving quite different appelations. Oliver (1871) described it as *moora Nennigae*; Macleay (1881) headed his description "the *Nannygai* of Sydney fishermen"; Tenison-Woods (1882) gave reasons why the aboriginal name *mura ngin a gai* had been corrupted to *nan a dai*, this last rendered "Mother *Nan a di*" by Whitley (1962). From the first Australian catalogue of Macleay (1881) onward to the revised South Australian catalogue of Scott, Glover & Southcott (1974) systematic authors in Australia have almost invariably used *nannygai nannagai nannegai nanegai* (Castelnau, 1978) or *nannygy* the first being the preferred form. The Handbook (Munro 1958) provides an exception, giving redfish as an alternative name.

However, a different position has obtained more or less consistently for some two decades in the literature of commercial fisheries. While the first list of uniform names agreed upon at the annual conference of Australian Fisheries officers in February 1947, published as a large single-sheet supplement to the Commonwealth Government's *Fisheries Newsletter* (June 1947) compiled by G.P. Whitley and covering some 40 species does not include the present species, a second list (containing 57 names, some of which were changes in the names agreed upon in 1947) formulated by a similar conference in September 1960 and published shortly afterwards (*Fisheries Newsletter* November 1960, p.71) gave the official vernacular name as redfish. Regarding this change of name Thomson (1974, p.117) observed this fish "is one of the best sellers under the name of redfish which the public accepted as they never did the exotic [*sic*] name of nannygai". *Centroberyx affinis* has since appeared in the Fisheries Division's periodical as redfish in monthly and yearly tables of weights of catches and market prices: special illustrations include a colored cover picture (*Australian Fisheries* February 1971), with text "Redfish or nannygai", and No.37 in a series of 60 paintings by Robert Ingpen (*Australian Fisheries* February 1975, unnumbered centrefold between p.40 and p.41).

Several tangential elements of confusion remain to be noted. The closely allied, morphologically similar *Trachichthodes gerrardi* (Günther, 1887) – figured in color in *Australian Fisheries* (June 1978) – formerly known as red snapper or Bight snapper [Snapper = *Chrysophrys guttulatus* Valenciennes, 1830] is now officially designated Bight redfish, the change being made "in the hope of better selling" (Thomson 1974, p.121). In a comparison of 5 species of Berycidae Thomson (1977, p.86) heads his key, comprehensively, "Redfish". Pollard (1978, p.102) applies the name nannygai to *Trachichthodes lineatus* (Cuvier, 1829), previously widely known as the swallowtail, remarking "not to be confused with *Centroberyx affinis* or redfish". As further, it may be hoped final, complications Marshall (1964, p.128) reports that nannygai is used at the Brisbane Fish Market for *Glaucosoma scapulare* Macleay, 1881 (Glaucosomidae), elsewhere commonly known as pearl fish, pearl perch or epaulette (or epaulette fish), and Roughley (1951, p.27) states nannygai has appeared with this connotation in the official annual reports of the Queensland Fish Board. Again, Grant (1978) dealing also with Queensland usage, lists nannygai, large-mouthed nannygai, small-mouthed nannygai as alternative names for *Lethrinus chrysostomus* Richardson, 1848, *Lutjanus malabraicus* (Bloch & Schneider, 1801), *Lutjanus sanguineus* (Cuvier, 1828), for which the preferred vernaculars are sweetlip or sweetlip-emperor, scarlet sea-perch, saddle-tailed sea perch, respectively.

Commercial Importance

In New South Wales *Centroberyx affinis* is one of the State's most abundant food fishes. Examination of the tables of fish market returns published monthly in the Australian Government *Australian Fisheries*, in which it is listed under redfish, shows that in 1979, it occupied first place by weight in 6 months second in 5 third in 1, the recorded catches ranging from 68 699 kg to 330 980 kg, mean 154 687 ± 23 465. It is, however, decidedly the cheapest of the fish listed, the price being 29-64 (mean 42.4) cents per kg. It does not appear in either of the lists for Victoria or Queensland, the only other States for which returns are published. Roughley (1951) stated the catch of approximately 45 000 kg of this fish in 1944-5 increased in 1948-9 to 2 500 000 kg or 38% of the total catch of the trawlers and Danish seiners.

It is of interest to note in passing that five other fish found in Tasmanian waters are represented among the three at the top of the tables, namely, gemfish, *Rexea solandri* (Cuvier, 1832) (in Tasmania traditionally kingfish or Tasmanian kingfish, also king barracouta, hake; appearing in local lists also in the genera *Thyrsites* Cuvier, 1832, *Jordanidia* Snyder, 1911): the name hake, inviting confusion with the unrelated European *Merluccius vulgaris* remained in general use till the decision in 1974 of the Standing Committee on Fisheres (*Australian Fisheries* May 1975, p.18) that the fish should henceforth be marketed in New South Wales as gemfish (a name suggested (*Australian Fisheries* September 1974, p.12) by that of the family to which it belongs, Gempylidae) occupying first, second and third position in 3, 3, and 2 months; "flathead, trawled" (unspecified Platycephalidae) in 2, 1 and 3; morwong, *Nemadactylus macropterus* Bloch & Schneider, 1801 0, 2 and 5; sea (bully) mullet, *Mugil cephalus* Linne, 1758 2, 0 and 0; snapper, *Chrysophrys guttulatus* Valenciennes, 1830 (appears in the Check-List (McCulloch 1929) as a synonym of *Labrus auratus* Bloch & Schneider, 1801 referred by McCulloch to *Pagrosomus* Gill, 1893) 0, 0 and 1. Mean prices, cents per kg, quoted in New South Wales in 1979 for these five items were in sequence as above, 43-116 (mean 80.7), 88-143 (109.7), 91-181 (120.9), 42-118 (76.0), 210-400 (307.5). Of these species the deep-water *Centroberys affinis* is, as noted earlier, seldom taken currently in Tasmania; *Chrysophrys guttulatus* also is uncommon; *Mugil cephalus* is abundant particularly on the eastern and northern coasts and is a familiar sight in fish shops; of *Rexea solandri* Johnston (1881, p.25) wrote "Season, December to June. Come and go in vast numbers, but disappear in some years altogether", while Lord & Scott (1924, p.81) observed "At one time these fish were abundant in Tasmanian waters, and constituted one of the chief food fishes, but they are now seldom caught", currently they make an occasional appearance in the market; several species of platycephalids are among the best known commercial fishes and are also taken in very great numbers by amateur anglers, often by spearing at night.

An important paper on the distribution and general biology of the nannygai is that of Selickaya (1971), based on material from the TNIRO expeditions that carried out research in the Great Australian Bight in 1965-1967. Conclusions arrived at include: *Centroberyx affinis* is found in the Bight regularly between 124°40'E and 134°35'E in waters at 13°-19°, the largest catches in the central part being in 150-175 m, in the western part in 170-200 m; though a large number of trawlings were carried out, no fish were obtained outside the range 64-225 m; a substantial upward migration occurs in March-April, the latter month being the climax of the breeding season (February-March); the sex ratio is close to 1:1; the chief food is euphausians, with supplementation from prawns, crabs, fish.

Regarding the occurrence of this species in Tasmania, Johnston (1883) noted "Rare" and Lord & Scott (1924) observed "not often taken in Tasmania. Trawling operations would doubtless secure many of this species, for they are occasionally taken off the coast. Mr. W. Beddome secured a number a few years ago when fishing from his yacht near the entrance to D'Entracasteaux Channel". Two entries in Johnston's memoranda, redacted by Whitley (1929) show the interest with which local occurrences were regarded by the doyen of Tasmanian ichthyology. "A fine specimen" caught in the Derwent in 1895 — "Examined by me and found to be in all characters identical with those caught more abundantly near Sydney". The second may be quoted verbatim from Whitley. "[Note added much later, in shaky handwriting:-] 4 specimens in Fish Shop, Elizabeth [Street, Hobart]. Caught in Derwent Estuary, 14th March, 1918. One of the specimens about 15 inches [38 cm] long. Evidently this is the season when the "Nannegai" *Beryx affinis* enters the estuary of the Derwent. R.M.J."

Material

The primary data here reported has been provided by an example, (a), *Ls* 231 *Lt* 313, taken by Miss P. Bennell at St Helens (Q.V.M. Reg. No. 1958/5/26). Observations on this Tasmanian fish have been supplemented by an examination of six smaller Victorian specimens (b)-(g) made available through the courtesy of Dr Martin F. Gomon, Curator of Fishes, National Museum of Victoria, Melbourne - (b) (c), *Ls* 117,111 *Lt* 161,155, Victoria, 16 km south of Lakes Entrance, taken with Danish seine by the *Tambo Bay*, November 1973, Acc. No. 79.1; (d) (e) (f) (g), *Ls* 101.5,101,90,89.5 *Lt* 144,139,125,123.5, Victoria, off Phillip Island, 38°32'S 145°15'E, collected by W. Mitchell and T. Montague, 7 August 1979, Reg. No. A630.

Meristic Characters

Figures in parentheses denote number of instances. D. VII, 11(1) 12(5) 13(1). A. IV, 12(5) 13(2). V. 7. P. 1, 12(13) 13(1, left fin). C. 19(6) 18(1) (modally, upper and lower moieties each with 9 rays and an azygous median ray), preceded above and below by 5 pseudospines (see below). L. lat. 41(1), 43(3), 44(2), 45(1). L. tr. 6/11-13. Gill rakers on anterior arch 9-11 + 19-21, slender elongate more or less rodlike but slightly compressed, delicately spinulose along two edges, increasing from above and from below to angle of arch where they are subequal in length to longest gill filaments.

Dimensions

Dimensions of the seven specimens are set out in table 2, all entries being millesimals of standard length, except those of the first line which record standard length in millimetres.

Proportions

The principal diagnostic proportions of the adult example are followed by the range and the mean with standard error of the six juveniles; values in parentheses are those of the Handbook (Munro 1958a, p.78). Depth in standard length 2.22; 2.02-2.29; 2.11 ± 0.47, in total length 2.84; 2.81-3.19; 2.93 ± 0.07 (2.6-3.3). Depth of caudal peduncle in head 3.11; 2.09-3.07; 2.90 ± 0.07. Head in standard length 2.75; 2.59-2.73; 2.65 ± 0.02, in total length 3.51; 3.63-3.76; 3.69 ± 0.02 (3.4-3.5). Snout in head 3.50; 3.70-4.67; 4.01 ± 0.15, in eye 1.13; 1.19-1.70; 1.35 ± 0.09 (1.20). Eye in head 3.11; 2.73-3.22; 2.99 ± 0.09 (3). Interorbital in eye 1.21; 0.98-1.18; 1.06 ± 0.002. Pectoral in head 1.23; 1.05-1.21; 1.13 ± 0.03, in standard length 3.39; 2.78-3.19; 3.01 ± 0.08. Ventral in head 1.67; 1.40-1.51; 1.47 ± 0.03, in standard length 1.72; 1.71-1.78; 1.73 ± 0.01. Dorsal base in standard length 2.64; 2.69-2.96; 2.79 ± 0.05. Anal base in standard length 3.91; 3.64-4.14; 3.96 ± 0.09. Within the (narrow) length range of the juvenile set (though not with the inclusion of the adult) relative depth exhibits significant positive correlation with standard length (r 0.972 z 1.770 t 11.158***) or with total length (r 0.916 z 1.564 t 4.571**). No other clear correlations are apparent in the small sample.

General Features

The following account is based in the first instance on the adult Tasmanian specimen, variations exhibited by the Victorian juveniles receiving separate notice. Maxilla to just beyond hind margin of eye (in (b) (c) to hind margin, (d) (f) to 0.9 eye, (e) (g) to 0.8 eye); Handbook "to below hind half of eye": its greatest width 0.43 (0.40-0.45 $\bar{x}$ 0.427 ± 0.007) its length, which is 203 *TLs* (188-207 $\bar{x}$ 197.5 ± 2.59). It is largely overlapped by a rugose supplemental bone covering half or more of the width of most of the shaft and occupying the upper one-third or so of the expanded distal end, its linear (in young delicately denticulate) border here surmounting a broad subtriangular smooth maxillary component of the jaw. Isthmus to below anterior margin of orbit, its squamous part about to level of middle of eye. Dorsal originating over pectoral base, ending above 7th (7th-9th) anal ray, anal originating below 3rd (1st-3rd modally 1st) dorsal ray, pectoral extending to level of 5th (2nd-5th) dorsal ray, ventral extending to base of 1st (1st-3rd) anal spine. Upper lobe of caudal noticeably the longer (in (f) lobes subequal); emargination marked, the difference between length to tip of upper caudal lobe and length to end of middle caudal rays 229 (159-263 $\bar{x}$ 197.3 ± 17.33) *TLs*, the excess in the juvenile sample showing negative correlation with standard length (r −0.854 z −1.274 t 3.289*).

TABLE 2

Centroberyx affinis (Gunther, 1859)

Dimensions of (a) an adult Tasmanian example, (b)-(g) six Victorian juveniles. Entries in the first line, standard length, in millimetres, all other entries as millesimals of standard length.

Dimensions	(a)	(b)	(c)	(d)	(e)	(f)	(g)
Standard length	231	117	111	101.5	101	90	89.5
Length to end of upper, lower caudal lobe	1355,1277	1385,1359	1396,1369	1419,1404	1378,1356	1389,1390	1380,1335
Length to end of middle caudal rays	1126	1226	1252	1222	1163	1183	1117
Length to origin, termination of first dorsal	411,597	444,582	424,532	426,544	446,603	449,607	426,547
Length to origin, termination of second dorsal	602,790	591,787	554,793	555,798	605,810	622,794	547,663
Length to origin, termination of anal	584,840	600,862	604,847	608,858	620,861	598,839	573,821
Length to pectoral, total length of fin	346,295	308,342	347,368	338,320	347,342	361,319	358,314
Length to longest pectoral ray	273	282	363	307	266(5th)	311(6th)	286(6th)
Length to ventral, total length of fin	411,217	376,249	396,260	394,271	416,262	389,261	374,246
Head	364	396	378	384	366	380	380
Snout	104	94	81	99	99	94	101
Eye, interorbital	117,97	138,120	138,117	119,122	118,115	124,134	123,123
Length to vent	580	583	586	578	575	581	561
Lengths of dorsal spines	45,78,100,128, 144,168,178	60,92,111,145, 158,179,192	47,80,109,135, 161,171,199	48,84,117,138, 163,177,206	49,80,113,139, 163,189,-	66,99,126,154, 178,201,224	56,89,123,147, 175,189,212
Lengths of anal spines	19,51,91,139	38,77,117,154	27,64,116,171	41,86,123,176	37,78,113,145	44,87,122,146	34,73,121,156
Lengths of superior pseudo-spines	19,39,61,87,113	16,41,64,94,120	18,44,72,99,122	29,49,70,89,117	30,50,69,94,107	28,54,72,100,123	17,39,64,89,118
Lengths of inferior pseudo-spines	16,35,52,78,103	17,38,61,92,114	18,41,62,91,105	30,48,79,97,118	18,41,64,89,107	22,44,73,103,128	21,45,65,89,112
Lengths of first, last, longest dorsal rays	130,95,215	295,113,295	241,135,241	259,128,259	231,117,231	259,102,259	235,108,235
Lengths of first, last longest anal rays	113,78,173	164,90,164	167,109,180	182,111,182	178,119,187	156,79,187	179,95,190
Lengths of ventral rays; spine	108,139,156,177, 195,203,199;169	144,166,178,188, 196,205,190;159	135,171,196,216, 221,234,207;163	139,167,192,216, 231,244,224;177	131,156,171,188, 197,203,198;168	122,159,180,200, 222,233,221;178	147,169,171,191, 200,203,201;162
Depth before eye, behind eye	260,398	265,393	234,396	271,394	307,406	294,411	268,391
Depth at opercular border, at vent	450,424	430,410	464,459	473,468	490,485	489,478	480,464
Maximum depth	450	436	464	478	490	494	492
Depth at caudal peduncle	126	124	135	125	137	133	128

Lower jaw projecting, with a broad medial process, its frontal aspect in the form of a truncated triangle (less conspicuous, more rounded in juveniles), each side with a row of 6-7 teeth, the innermost largest (in some juveniles subequal); a cluster of obscure odontoid processes on external surface at the base on either side (barely or not developed in juveniles); the whole fitting into an edentulous notch in upper jaw. Posterior nostril elliptical, its major (vertical) axis about one-sixth eye, its distance from orbit subequal to its length and to distance between its anterior border and anterior border of the posterior nostril, the latter somewhat smaller, more nearly round; both with a raised rim, that of the posterior wider, somewhat more elevated: internarial about two-thirds eye. Teeth in the upper jaw in a narrow transversely rounded band, minute, tuberculate, except for a small space anteriorly, rather less than an eye diameter, where there are a few (left side 5, right 10) larger blunt peglike teeth (rather less clearly differentiated in juveniles); behind the medial process in the lower jaw teeth larger than in upper jaw, though still small, mostly biserial in parts triserial; on vomer small, blunt in a small patch, subtriangular, apex anterior (or with the sides of the triangle produced briefly back behind the base); on each palatine in a band similar to that in one side of the upper jaw.

Scales strongly ctenoid, modally with about three dozen long slender spines projecting beyond exposed margin, usually near middle, extending forwards as conspicuous parallel ridges. Covering trunk and tail, extending as a weak sheath of one or two rows on to dorsal and anal bases, forming two contiguous patches on caudal base, small and obsolescent on pectoral base: on head ceasing abruptly on dorsum above anterior one-third (middle or posterior one-third) of eye and on side above four smoothish minutely papillate areas (in juveniles three, the soft uppermost not clearly recognizable) surmounting the opercular system; covering most of operculum; on preoperculum narrowly and imperfectly fringing vertical limb, broadening to a subtriangular patch at the angle; remainder of head scaleless. Several specialized areas on head, smooth, usually minutely papillate, sharply delimited, usually by ridges, which may be denticulate. The principal such areas are: a median lanceolate region on the interorbital dorsum extending from level of anterior nostril to that of pupil; flanking this on either side a strip of slightly greater maximum width curving back beyond the eye to bound the preoperculum, the paired strips terminating anteriorly, virtually in contact, along the hind margin of a subrectangular patch of skin, the latter bordered laterally and except for a small median hiatus also in front by an anterior extension of the preorbital, the short curved anterior margin of which carries an arc of 8-10 spines; a largely smooth minutely papillate broad arc below eye, reaching back almost to vertical limb of preoperculum, the first one-third of its inferior border with a score of small spines, the middle one-third entire, the hind one-third with some two dozen somewhat larger spines directed down and back; above the large supraorbital arc a lanceolate strip starting at level of front of pupil and reaching to level of posterior orbital border; some distance behind this at about the same horizontal level a smaller curved pennon; the space between these two filled with a smooth patch that expands above them to be in contact with the hind half of the first. Chin back to level of middle of eye with irregular striae, some feebly spinigerous; in (a) numerous small circular or ovoid openings between them. Hind half of orbit with three largish two-winged ridged and spined processes; a fourth above these usually developed in juveniles. Preoperculum with two subvertical borders, both denticulate, both with larger spines forming a conspicuous group at the angle; operculum with throughout most of its length parallel ridges ending in spines, two prominent spines about at level of middle of eye, the upper the larger, subequal to pupil; interoperculum minutely ridged and crenulate. All fin rays stout, more or less flattened distally, divided to or virtually to base, secondary fission occurring near middle of length, ray terminating in up to 8, exceptionally more, rami.

The Handbook (Munro 1958a, p.78) states "No keeled abdominal scutes": apart from recording the l. lat. count (43) and l. tr. (6/12), the account of this species by Castelnau (1878) makes no reference to scales. Here 11 median scales between the ventral base (where the foremost is partly overlapped by two or three normal scales) and shortly in advance of the vent differ trenchantly from other scales along the lower edge of the fish (and elsewhere), taking the form of two large plates (triangular at either and of the series elsewhere more or less clearly pentagonal) sloping towards each other to meet in the midventral line where they develop a low but distinct carina. In the adult this ridge does not bear prominent spines; however, a small prone pointed process, readily detectable by touch, occurs on it at the hind border of each scute, being quasi-continuous on each side with the uppermost of a series of low subparallel longitudinal striae that (except in the first two scutes where they are absent and in the next two or three where they are little developed) cover most of the modified scale. In specimens (b)-(g), juveniles, in which the specialized scales range in number from 9 to 12, distinct strong spines are developed, most notably in the anterior part of the series, where they may be little inferior in size to the first anal spine. There would appear to be no essential difference between these structures and those in *Paratrachichthys trailli* recognized in the Handbook as abdominal scutes.

Rays obviously identifiable as normal caudal rays are preceded on both the dorsal and ventral profiles by 5 interesting structures recorded in the meristic specifications above as pseudospines. In so far as their location is concerned, these of course correspond to the procurrent rays found in a wide range of species of many families: their nature and mode of development would appear to be such as to place them in a special class. They exhibit characters of both body scales and fin rays, being suggestive of the development of the latter from the former. The most anterior one, inserted somewhat in advance of the hypural joint, is foliate, compressed fore and aft, subtriangular in frontal view, its base wide about one-third its length, the anterior surface strongly transversely convex, the posterior surface attached by integument to the next pseudospine for about the proximal five-sixths of its height, the acute free end slightly concave: this structure is clearly a modified scale, being immediately preceded by normal scales differing notably from it only in having the free posterior margin in the form of a broad spinigerous arc instead of a wide pennon with a single acute point. Succeeding pseudospines progressively lengthen not only absolutely but also relatively, the length of the last exceeding its basal width by a factor of about 10, the general form closely approximating that of a normal ray. The structure is decidedly spine-like in respect of its shape (in other than the first one or two members of the series), its largely (particularly distally) translucent vitreous appearance (in marked contrast to the opaque true rays, pale gold in the preserved specimen) and its very considerable rigidity. Its ray-like nature is evidenced by the progressive development, readily visible under a lens, of septa: in the first element the beginning of this process is indicated only by the presence of a basal core of undifferentiated opaque yellow; increasing differentiation leads to the formation in the last element throughout the greater part of its length of septa comparable with those of the true caudal rays. The segmentation is more extensive longitudinally in the last ventral than in the last dorsal ray, reaching virtually to the tip; however, the process is more advanced in the dorsal element in respect of the transverse extent of the septa which here extend across the full width, whereas in the anal element a narrow longitudinal strip remains uncolonized. Similar caudal pseudospines occur in *Paratrachichthys trailli* and *Beryx decadactylus*.

Aspects of Form

Head, length to vent, standard length. In a loglog plot of the adult specimen (a) these three dimensions are significantly linear (t 28.054*) on 1 2 5 (*cf.* 1 2 6 for *Beryx decadactylus* and the quite exceptional 10 9 1 for *Paratrachichthys trailli*).

Log L = 0.6268 log N + 2.5659; calculated (measured) lengths, *TLs*, 368(364) 578(580) 1 009(1 000).

Parameters for juveniles (b)-(g): slope 0.5757, 0.7010, 0.5944, 0.6229, 0.6007, 0.6029, intercept 2.5960, 2.5708, 2.5841, 2.5670, 2.5881, 2.5752, t 62.587*, 17.100*, 269.088**, 48.771*, 104.021*, 98.134*.

Location of vertical fin origins and terminations. In a loglog plot {length of dorsal origin, to anal origin, to (second) dorsal termination, to anal termination, to caudal origin} fall collinear with statistical significance (t 138.885***) on {3 5 7 8 10}, the best straight line being:

Log L = 0.7459 log N + 2.2554; calculated (measured) lengths, *TLs*, 408(411) 598(584) 768(790) 848(840) 1 000(1 000).
Parameters for juveniles: slope 0.6845, 1.7121, 0.7121, 0.7169, 0.6791, 0.6700 0.7136, intercept 2.3135, 2.2895, 2.2871, 2.3240, 2.3246, 2.2801, t 29.571***, 54.823***, 45.948***, 37.115***, 21.556***, 18.2358***.
Some discussion of vertical fin location will be found in the observations on *Paratrachichthys trailli* below. The graph for (a) is shown in fig.1.

Dorsal anal and pectoral rays. The length-sequence pattern of the rays in these three fins exhibits one pronounced difference and several remarkable similarities. The pectoral differs from the two vertical fins in having two distal borders conveniently recognizable as distinct, a short leading (upper) edge of 3 rays (smallest inconspicuous) increasing in length from the uppermost — by the convention here adopted, 1st; see Part XIV (1974a, p.248) — followed by a long trailing edge of 11 rays, whereas in the dorsal and anal the border takes for form of a single edge, the rays decreasing in length from 1st, most anterior. The combination of an ascendant and a (usually longer) descendant segment is all but universal in the pectoral, and is more usual in the soft dorsal and in the rayed (main) section of the anal than the single descendant border found here. Secondly, while the slopes of corresponding subsets differ in the three fins, inspection of what may be interpreted as in some way a measure of the energy involved in ray formation, the area under the graph, shows the area per panel (*i.e.*, the interval between successive rays) is significantly the same in each of the fins for each of the subsets. So far as the writer is aware, such a relationship between the three fins has not previously been reported; and while effective equality in the dorsal and anal might not be wholly unexpected, the inclusion of the pectoral, in respect of its trailing (main) edge is certainly interesting and curious.

Data for the rays of the dorsal anal and pectoral are set out in the first 10 lines of table 3, the information provided comprising for each subset the serial numbers of the rays with an indication of whether they are counted directly (N) or inversely (N'), the relevant abscissal integers, parameters and significance of the best straight line for the rectified equation log $L = k$ log N' + log b together with calculated and measured ray lengths, as *TLs* (member common to intersecting subsets included in both for calculation of the subset equations), total area under graph (using measured, not calculated lengths), area per panel. For lines 11-14 of table 3 see below.

Ventral rays. In earlier observations in this series it has in general been found that in fish with the modal ventral formula, I, 5, the lengths of rays 1-4 — first specified as postaxial, see Part XIX (1974b) — are linear in a loglog context on their serial numbers, with spine and ray adjacent to it, 5th, outside the series, this ray shorter than 4th (commonly subequal to 3rd). Here with V. I, 7 the overall pattern is maintained in as much as the spine and its adjoining ray are again outside the exponential length-number set, which in this case comprises 6 instead of the usual 4 rays. The relevant data for specimen (a) are set out in full in table 2.
Parameters for juveniles (b)-(g): slope 0.2505, 0.3077, 0.3212, 0.2506, 0.3641, 0.1835, intercept 2.1175, 2.1377, 2.1362, 2.1175, 2.0854, 2.1695, t 36.065***, 21.922***, 30.493***, 37.695***, 49.887***, 31.443***.

Precaudal Pseudospines

While in some individuals the 5th (hindmost) process is more or less obviously classifiable as a spine, in others it is distincly septate and on the whole more ray-like than spine-like. However, in respect of magnitude it clearly remains a member of the set, being specified by the $L = b\ N^k$ relation exhibited by the others; equally clearly the next element, extending to the distal border of the fin is foreign (in a typical specimen the ratios of the length of each item to the length of the following item are for the set of 5 successively 2.3,1.6,1.4,1.3, whereas for the 5th element and the obvious ray the ratio becones 3.1). All 5 items are here regularly included in the calculation of the rectified equation, data relevant to which in the case of (a) are exhibited in table 2. Parameters for superior series in juveniles (b)-(g): slope 1.2404,1.1976,0.8593,0.8133,0.9120,1.2114,

TABLE 3

Centroberyx affinis (Günther, 1859)

Lengths of spines, rays and pseudospines as a function of their serial numbers, the relation being $L = b\,N^k$ rectified as $\log L = k \log N + \log b$; for reverse serial numbers (counted cephalad) N' is substituted for N; all dimensions as millesimals of standard length. Data for specimen (a), 231 mm in standard length, from St Helens, east coast, Tasmania.

Radial element	Counting sense	Serial numbers	Abcissal integers	k (slope)	log N (intercept)	t	Calculated (measured) lengths, millesimals of standard length	Area under graph Total	Per panel
Dorsal rays	N'	{12-10}	{1-3}	0.1174	1.9795	14.923*	95(95) 101(104) 109(108)	0.9573	0.4786
	N'	{10-7}	{3-6}	0.2523	1.9123	9.519**	108(108) 116(116) 123(121) 128(130)	0.6243	0.2081
	N'	{7-1}	{6-12}	0.7450	1.5340	49.987***	130(130) 146(147) 161(168) 176(174) 190(190) 204(207) 216(215)	0.6692	0.1115
Anal rays	N'	{12-10}	{1-3}	0.2124	1.8924	26.636*	78(78) 90(91) 99(98)	0.9266	0.4633
	N'	{10-7}	{3-6}	0.2060	1.8919	13.907**	98(98) 104(103) 109(108) 113(113)	0.6126	0.3041
	N'	{7-1}	{6-12}	0.6047	1.5912	22.929***	115(113) 127(128) 137(139) 147(145) 157(159) 166(167) 175(173)	0.6463	0.1077
Pectoral rays	N'	{14-12}	{1-3}	0.2793	1.9816	36.553*	98(96) 116(117) 130(130)	0.9767	0.4888
	N'	{12-9}	{3-6}	0.4794	1.8845	36.644***	130(130) 149(149) 165(165) 181(182)	0.6582	0.2194
	N'	{9-4}	{6-11}	0.6421	1.7616	21.781***	183(182) 201(199) 220(222) 237(238) 253(255) 269(265)	0.6164	0.1213
	N	{1-3}	{1-3}	1.9253	1.4743	35.569*	247(248) 113(113) 30(30)	0.9232	0.4516
Dorsal spines	N	{1-7}	{1-7}	0.7019	1.6679	44.684***	45(45) 76(78) 101(100) 123(128) 144(144) 164(168) 182(178)	1.6592	0.2765
Anal spines	N	{1-4}	{1-4}	1.4131	1.2859	98.277***	19(19) 51(51) 91(91) 139(139)	1.0329	0.3444
Ventral rays 1-6	N	{1-6}	{1-6}	0.3536	2.0322	40.820**	108(108) 138(139) 159(156) 176(177) 190(199) 203(203)	1.6886	0.3377
Ventral spine, ray 7	N	{7-8}	{1-2}	0.2381	2.2274	—	—(169) —(199)	0.6814	0.6814
Superior pseudospines	N	{1-5}	{1-5}	1.1356	0.2839	20.062***	17(17) 37(32) 58(53) 82(81) 105(113)	1.1356	0.2839
Inferior pseudospines	N	{1-5}	{1-5}	1.1285	0.2821	29.549***	16(16) 35(35) 56(52) 77(78) 99(103)	1.1285	0.2821

intercept 1.2205,1.2699,1.4446,1.4639,1.4474,1.2253, t 47.521***,33.162***,79.301***, 27.381***,32.348***,257.059***; inferior series: slope 1.1902,1.1182,0.8725,1.1277, 1.0967,1.0274, intercept 1.2294,1.2628,1.4624,1.2605,2.3443,1.3304, t 45.642***,32.068***, 26.754***,39.134***,84.549***,87.575***. The mean interspinous area under the graph (per panel) for the superior series is 0.27-0.31 $\bar{x}$ 0.29 ± 0.018 for the inferior series 0.29-0.31 $\bar{x}$ 0.29 ± 0.01 - significantly the same as for the much larger Tasmanian example (table 2).

Coloration

The appearance in life is concisely described by Castelnau (1878, p.225): "The general colour is of a most beautiful pink, with silver stripes on the body, the edges of the opercules of the last colour". Our adult example, after preservation in formalin, is almost wholly of a uniform dark straw, with some yellow on the head and on some fin rays, otherwise more or less whitish. The Victorian juveniles, in alcohol, in general have the body fawn above the silver lateral line, silvery below it; a narrow stripe of somewhat reddish brown along dorsal profile from just in advance of to just beyond dorsal base, widest near its middle, sharply defined below; whole of hind half or so of caudal peduncle fawn; narrow yellowish strip along anal base; head mostly fawn, more or less silvery below and behind eye and on preoperculum, operculum silvery or golden or partly both; fins pale yellowish to whitish.

Family TRACHICHTHYDAE

Of the seven species listed in the Handbook (Munro 1958a) only two are found in Tasmania, the "sandpaper fish" (occasionally referred to as "roughy"), *Paratrachicthys trailli* (Hutton, 1875), known from all Australian States other than Queensland (and with New Zealand as type locality) and the "roughy" *Trachichthys australis* (Shaw & Nodder, 1799), reported from all Australian States. Only the former occurs in the catalogues of Johnston (1883, 1891) where it appears as the synonymic *Trachichthys macleayi* Johnston 1881 (type locality: Derwent River, Tasmania), being referred to the Berycidae. The latter species was first included in a local list by Lord (1923), where, as in his later list (1927) and in Lord & Scott (1924), it is associated in the Trachichthydae with the former species and with *Centroberyx affinis*, cited in the genus *Trachichthodes* Gilchrist, 1903, this species now being customarily relegated to the Berycidae.

The two species occurring in our waters seldom come under notice locally. In the course of a good account of the only (Victorian) specimen of *Trachichthys australis* that had come under his notice McCoy (1886) gave a table of measurements. No such morphometric data on an Australian specimen of *Paratrachichthys trailli* appear to be available: metrical and other observations on two Tasmanian examples in the collections of the Queen Victoria Museum Launceston are made below.

KEY TO TRACHICHTHYDAE RECORDED FROM TASMANIA

Vent located normally, shortly in advance of anal base.
Head and trunk together subcircular, maximum depth ⩽ 2 in standard length. D. III-IV, 11-12. L. lat. < 80 (*ca* 65).
Reddish brown; a dark bar on operculum ....*Trachichthys australis*

Vent located exceptionally, far forward between ventrals.
Head and trunk together ovate, maximum depth ⩾ 2 in standard length. D. V, 13. L. lat. > 80 (*ca* 118).
Reddish purple; no dark bar on operculum ....*Paratrachichthys trailli*

Genus *PARATRACHICHTHYS* Waite, 1899

Paratrachichthys Waite, 1899, p.64. Type-species, *Trachichthys trailli* Hutton.

Paratrachichthys trailli (Hutton, 1875)
(Fig. 1)

Trachichthys trailli Hutton, 1875, *Ann. Mag. Nat. Hist.*, 4(16), p.315 and 1876, *Trans. N.Z. Inst.*, (1875), 8, p.212. Type locality: Stewart Island.
Trachichthys trailli: Arthur, 1885, p.162, pl.14, fig.2: Günther, 1887, p.23, pl.55, fig.A.
Trachichthys macleayi Johnston, 1881, pp.11,56. Type locality: mouth of the estuary of the Derwent.
Trachichthys macleayi Johnston, 1883, p.109 and 1891, p.31.
Paratrachichthys trailli: Waite, 1899, p.65: McCulloch, 1911, p.44 and 1921a, p.43, pl.27, fig.120a and 1929, p.132: Lord, 1923, p.65 and 1927, p.13: Lord & Scott, 1924, pp.9,45: Phillipps, 1927, p.24: Munro, 1958a, p.80, fig.552: Whitley, 1968, p.73.
Paratrachichthys trailii Whitley, 1964, p.40.

Date and Name of Species

The species is commonly taken to have been established in Hutton's paper in the *Transactions* of the New Zealand Institute for the session of 1875, published in May 1876, (McCulloch 1929, Munro 1958a, Lord & Scott 1924, McCulloch 1921a, Scott *et al*. 1974). However, Whitley (1964) gave 1875, and in his New Zealand catalogue (1968) cited the earlier account by Hutton in the *Annals and Magazine of Natural History* issued in September of that year (Günther 1887). Whitley (1964) gave the second binomen as *traillii*, but in 1968 accepted *trailli*.

Status of Johnston's Species

In establishing his *Trachichthys macleayi*, based on a specimen 240 mm in total length and having "length of body" (presumably standard length) 190 mm obtained in the Derwent estuary in 1880, Johnston was clearly unaware of the description by Hutton some five years earlier of the New Zealand *T. trailli*. In the first direct comparison of the two accounts Waite (1899), while reporting 13 abdominal scutes as in Johnston as against 11 noted by Hutton (1875) and Arthur (1885) and repeated by Günther (1887), nevertheless accepted *T. trailli*, formally placing *T. macleayi* in synonymy: the question of scute number was later clearly resolved by the finding by McCulloch (1911) in the 17 *Endeavour* examples from Bass Strait and Oyster Bay, Tasmania, of a range of 12-16. In the same paper Waite proposed his genus *Paratrachithys* on a feature Günther (1887) had been inclined to regard as a mere individual abnormality, namely, the location of the vent in front of, instead of behind, the abdominal scutes. The synonymization of Johnston's species has been generally accepted and is probably valid – it may be observed, however, that our material shows no evidence of the lateral line scales being enlarged and "armed with one or two visibly prominent transparent spines", and, as noted below in the section on Proportions, ratios derived from the recorded dimensions of the early fish include several curious values.

Material

Two Tasmanian examples, (a) *Ls* 135 *Lt* 168.5, 6.4 km north of Eddystone Point, taken in 26 m by Mr S. Down (Q.V.M. Reg. No. 1980/5/44), (b) *Ls* 168 *Lt* 211, Tinderbox, collected by Mr P.R. Last (Q.V.M. Reg. No. 1975/5/147).

Meristic Features

D. V, 13. A. III, 10. P. 13/13 13(left)/12 (Handbook (Munro 1958a) 12). V. I, 6. L. lat. *ca* 110 120 (Handbook 118, Waite (1899) 118); pierced scales *ca* 50 (Waite 55, Johnston (1881) "about fifty"). Abdominal scutes, 13,15 (Handbook 11-16). Caudal with 19 main rays; 7,8 precaudal pseudospines on dorsal border and 7,8 on anal border (see below, Aspects of Form). Gill rakers on anterior arch 14 + 12, increasing in length from either end to near the middle of the lower limb where they are elongate, flattened, very slowly tapering, minutely denticulate along either border, subequal to gill filaments. Br. 8, the first 2 small and poorly developed, the rest stout, flattened, strongly recurved, the anterior half or so of the inferior border minutely spined, most conspicuously in the 3rd-5th rays.

Dimensions as *TLs*

The dimensions below are given as millesimals of standard length, smaller individual (a) cited first: where measurements of Johnston's type of his *Trachichthys macleayi* (some reported in inches, to the nearest one-eight, some in millimetres) are available values calculated from them are here shown in parentheses. Length to end of upper caudal lobe 1256,1244(1267), to end of lower caudal lobe 1238,1233, to end of middle caudal rays 1125,1111. Length to origin of first dorsal 384,400 to termination 497,522, to origin of second dorsal 506,533 to termination 719,741, to origin of anal 649,649 to termination 804,800. Length to origin of pectoral 321,314 total length of fin 202,204 length of longest (7th 6th) ray 179,178. Length to origin of ventral 351,363 total length of fin, 173,196; for spine and rays see below, Aspects of Form. Length of first dorsal spine – 49(79) of last – 95(89); for other spines see below. Length of first dorsal ray 107,167 (157) of longest (4th 4th) 190,178 of last 95,107(79). Length of first anal spine 16,17 (10) of second 45,47 (31) of third 105,108 (100). Length of first anal ray 168,141(79) of longest (1st 2nd) 168,150 of last 107,81(115): Length of longest precaudal pseudospine 81,85(58). Head 345,333(467). Snout with rostral spines 65,59 without spines 54,52. Eye 101,96(110). Interorbital 110,115. Length of mouth (oblique) 193,202. Length of series of abdominal scutes 237,235(157). Breadth of largest scute 64,54(37) depth 44,42 (37). Depth at front of eye 196,259, back of eye 315,356, opercular border 381,393, vent 390(396), dorsal termination 230,259, anal termination 167,174; maximum depth 390,415 (550), depth of caudal peduncle 117,126(117).

Proportions

Depth in standard length 2.56,2.41 (Munro 2.25-2.5; Johnston 1.82, but depth in total length 2.25; Günther "twice and one-third"). Head in standard length 2.90,3.0 (M. 3-3.2; J. 2.1). Depth of caudal peduncle in head 2.6,2.9 (J. 4.0). Eye in head 3.5, 2.9 (M. 3; J. 4.2; G. three). Eye in interorbital 1.19,1.09. Pectoral in head 1.6,1.7. Ventral in head 1.8,1.7. Longest dorsal spine in head 3.7,3.6 (J. 3.5). Length to vent in standard length 2.80,2.81.

General Features

Where two entries occur the first relates to the smaller specimen (a). Maxilla to below hind border of pupil, to behind orbit by about one-eighth eye, its greatest diameter subequal to direct distance from its posterosuperior angle to orbit. A supplemental bone, widening in its hind half to constitute the greater part of the free end of the jaw surmounting the premaxilla, here very slender. Isthmus to below front half of eye. Dorsal originating over first one-fourth of ventral just behind posteroinferior angle of pectoral base, terminating above 4th anal ray; anal originating below 9th dorsal ray; pectoral to below 2nd dorsal ray, slightly beyond ventral tip, which is just more than halfway to anal. Jaws equal, lower projecting slightly, its tip enlarged, turned up, fitting into a shallow notch in upper jaw, its mesial anterior aspect occupied by a subvertical cutaneous strip bordered below by several small tuberosities. The whole external lower border of the upper jaw constituted by the premaxilla in the form of a narrow band continuing to narrow markedly and (save for a brief notch on the upper border about as wide as its distance from the anterior end) evenly backward; the entire surface closely beset with minute pointed elevations that appear along the inferior as downwardly pointed teeth; a short edentulous interval at symphysis. Lower jaw much the same but band in general decidedly narrower though expanding near symphysis to a width slightly exceeding maximum in upper jaw. A very small triangular patch of about a score of minute teeth on the middle of the vomer. A slender minutely dentigerous band on each palatine, similar to, but narrower than, and about half the length of, that of the upper jaw. Tongue absent in (a), in (b) stout, its tip in anterior view presenting an ovoid flattened platform above, with a mesial knob between this and the chin-like lower margin projecting above the soft tissue connecting organ to floor of mouth. Posterior nostril elliptical, with low rim, in part denticulate, its length twice or more its distance from orbit. Anterior nostril half as large or less, more or less circular, with elevated rim minutely crenulate.

Head without normal scales, much of it smooth usually with cutaneous pores, rugose or irregularly faveolate; with complex systems of plates, ridges, elevations and spines, only the most prominent noted here. Plates: two elongate lozenge-shaped, above front half or more of eyes, extending forward in advance of nostrils; inserted between the hind half of these the apex of a triangular plate extending back to level of hind border of orbit and continuing forward in a short double row then a single bead-like row of small contiguous subspherical nodules terminating anteriorly in a fanlike group extending to upper lip; a somewhat concave plate bordering eye from posterior nostril to about the same horizontal level behind, subcontinuous along its hunder half with a curved plate beginning above pupil and ending acutely at base of prominent spine adjoining lateral line. Ridges: from a small group of spines flanking on either side the fanlike group of nodules near upper lip one short arc to below anterior nostril, one backward to delimit externally the lozenge-shaped interorbital plate; one forming posterior border of hindmost plate, terminating in a spine immediately behind opercular border at origin of lateral line; one constituting the subvertical upper limb of preopercular border, connected at junction with lower limb with a short ridge ending in a prominent spine (largest on head) directed back and a little down; one delimiting much of free opercular border, the operculum itself with a low ridge running back and down across its upper one-third and projecting beyond margin as a strong spine (distant from spine near lateral line origin by rather more than half an eye diameter, from preopercular spine by about two diameters), the area above this ridge and the area below it each wholly covered with a fan of strong minutely spinate striae; interoperculum wholly ridged, margin denticulate; preorbital fluted, margin minutely spined. Spines, additional to those noted above: several irregular spines or groups of spines on orbit, particularly on its posterior half; several small bony shelves, their free margin more or less spinuliferous, a constant one immediately above and in front of upper end of opercular border — some differences between two sides of fish.

Scales with free border irregularly scalloped, with up to a score of variably sized spines, rest of exposed surface with stout spines, modally about a dozen, all large or mostly large with some smaller subequal to largest marginal spines. Scales extending on to bases of caudal rays in two small contiguous patches, very briefly on to pectoral and ventral. A narrow band of heavily spined specialized scute-like scales along dorsal base (best developed below rays) and anal base (about a score, mainly uniserial). Abdominal scutes 13,15, extending from shortly behind the small urinogenital papilla (behind and virtually contiguous with the external anal sphincter) to short of first anal spine by an interval equal to 2-3 scute bases; each scute with a strong pungent mesial spine flanked on either side by a moiety of the strongly ridged and denticulate hind border of the scute; greatest height above base of scute about equal to pupil diameter.

Waite in reporting on the *Thetis* individual, taken off Newcastle in 77-88 m "which adds a new species to the Australian fauna" observed, "It may be noted that the first scute is provided with two spines, which lie one on either side of the first median series, a character not shown in the figure quoted [Günther (1887 pl.25 fig.A)], nor mentioned in Johnston's description". With 17 *Endeavour* specimens from Bass Strait and Oyster Bay, Tasmania, at hand McCulloch (1911) remarked "I find from twelve to sixteen scutes and the first either divided or single, and with one median or two lateral spines". Examination of our material suggests the lateral spines are nothing other than the uppermost spine of the extensive marginal series sufficiently enlarged above its neighbours to invite separate recognition. Such specially developed spinules are barely recognizable in (a) but are apparent in the anterior half dozen scutes of (b): their prominent presence is evidently adventitious.

Aspects of Form

Head, length to vent, standard length. The quite exceptional location of the vent, between the ventrals just behind the head, far in advance of anal origin (in these specimens by 0.29 of standard length), negates the possible existence of any of the patterns commonly encountered in which in a logarithmic metric the lengths of these three regions fall collinear when graphed on early natural numbers (modally 1 2 3) – a configuration that, its mathematical simplicity would suggest, is presumably to be interpreted as an expression of some profound morphological Gestalt. With the present material it is found the logarithmic lengths are satisfactorily specified (*t* 31.793* 36.947*) with as abscissal values the logarithms of 10 9 1, respectively, the slopes of the best straight lines being −0.4741, −0.4649, the intercepts 3.0002,2.9998, predicted (in parentheses measured) lengths, *TLs*, being 336(333), 353(356, 1 003(1 000) and 343(345), 360(358), 996 (1 000). Whether this relation, differing so markedly from the customary "obvious" early-number relation with positive slope, represents the outcome of some comparatively simple and basic elan of growth, or is an arbitrary specification, formally efficiency, remains unresolved.

Location of vertical fin origins and terminations. In a loglog plot {length to dorsal origin, to anal origin, to (second) dorsal termination, to anal termination, to caudal origin} fall collinear with statistical significance (*t* 99.899*** 72.055**) on {2 5 6 7 10}, the relevant equations being:

Log L = 0.5665 log N + 2.4263; calculated (measured) lengths, *TLs*, 395(400) 664(644) 736(741) 804(800) 984(1 000).

Log L = 0.5934 log N + 2.4029; 381(384) 657(649) 732(719) 802(804) 991(1 000).

It may be noted that the case of the second trachichthyid reported from Tasmanian waters, *Trachichthys australis* Shaw & Nodder, 1799 occurring in local catalogues from that of Lord (1923) onward would appear probably to present a comparable length-number fin pattern to that specified above. In an account, with figure, of the single Victorian example of Shaw & Nodder's species that had come under his notice M'Coy (1886, p.57, pl. 114) gave among other dimensions lengths to origins of dorsal, anal and caudal (last as *Ls*), and in a loglog plot these three dimensions are significantly collinear (*t* 13.595*) on {2 5 10}, as found above. At the same time the markedly less elongate form of *Trachichthys australis* results in much higher relative lengths to vertical fin origins (D. 639 *TLs cf.* 400 384, A. 837 *cf.* 664 649), while with the subcircular outline of the fish in advance of the caudal peduncle diminishing the difference between D. and A. origins (198 *TLs cf.* 264 265), the slope of the loglog length-number graph becomes less (0.28 *cf.* 0.57 0.59) with concomitant increase in magnitude of the intercept (2.72 *cf.* 2.43 2.40).

A comparison of the patterns of location of vertical fin origins and terminations noted above for *Beryx decadactylus* and *Centroberyx affinis* with that for *Paratrachichthys trailli* leads to the recognition of a striking relation between them, it becoming evident their diversity can be neatly accounted for as resultant upon simple permutations of the integral numbers in the length-number pattern. In the subjoined formulation the addition, in lower case, or *o* or *t* to the upper case letter conventionally employed to designate the fin (*e.g.*, *D* for dorsal, here with refinement D_1 first dorsal D_2 second dorsal) denotes length to origin or length to termination of that fin. With lengths and serial numbers both in logarithms the situation, as represented by the present material, is as follows:

	1	2	3	4	5	6	7	8	9	10
Beryx decadactylus			D_1o		*Ao*	D_2t			*At*	*Co*
Centroberyx affinis			D_1o		*Ao*		D_2t	*At*		*Co*
Paratrachichthys trailli		D_1o			*Ao*	D_2t	*At*			*Co*

Thus in all three species the relative positions of anal and caudal origins are constant. With the first species taken as standard, first dorsal origin is displaced one unit forward in the third species, second dorsal termination (*i.e.*, termination of the continuous fin) is displaced one unit backward in the second, while anal termination is displaced in the second species one unit in the third species two units forward. These simple whole-number translations adequately specify the variation in fin disposition encountered in the three species as samples. See fig.1.

It may be remarked that in the above equations specifying the location of the vertical fins the parameters of those for the two examples of *Paratrachichthys trailli*, 0.5665,2.4263 and 0.5934,2.4029, are quire similar to those reported earlier for *Beryx decadactylus*, 0.5863,2.3798. Thus when the variates for the two species (being for *P trailli* the geometric mean) are plotted together the entries for the two species for *Ao D t* and *CO* on 5 6 10 are virtually coincident (on 10 necessarily coincident), while the single-species values for *D o* and *Ao* on 2 3 7 9 are very close to being collinear with them, the graph for the pooled 10 variates being linear at t 33.225***, with the percentage differences of predicted from given measurements (*TLs*) extremely small, being for *P. trailli* 0.5-3.1 (mean 1.4) for *B. decadactylus* 1.3-3.3 (mean 2.0). However, the parameters for these two species differ markedly from those for *Centroberyx affinis*, for which the geometric means are 0.7033 ± 0.0100, 2.2963 ± 0.00974.

Dorsal spines. These are damaged in the smaller individual, while in the larger all save the second are intact, their lengths increasing backward, the length-number relation being an exponential one $L = bN^k$, common for ascendant sets of radial elements; k 0.3930 log b 4.805; t 9.322**; calculated (measured) lengths, *TLs*, 48(49) -(-) 74(71) 83(80) 90(95).
Anal spines. The logarithmic lengths of the 3 anal spines are a linear function of logarithms 1 2 4.

Log L = 1.3451 log N 1.2249; t 18.490*; calculated (measured) lengths, *TLs*, 17(16) 43(45), 108(105).

Log L = 1.3249 log N + 1.2492; t 18.984*; 18(17) 44(47) 111(108).

With dimensions given by Johnston (1881, p.56) for the type of his synonymic *Trachichthys macleayi* we find Log L = 0.62 log N + 1.02; t 73.366***; 10(10), 32(31), 99(100).

Ventral rays. In ventral fins with the most frequently encountered formula I, 5 it is usually found the lengths of the rays increase from the 1st – here defined as in Part XIX (1974a) as the postaxial – to the 4th, with the 5th somewhat shorter than the 4th (often subequal to the 3rd) and the spine shorter still; the lengths of the rays being related to their serial numbers as defined as $L = b\ N^k$. It is of interest to note that in this fish with V.I, 6 a comparable pattern is maintained, the 5th ray becoming associated with 1st-4th in the exponential relation with in the larger specimen the preaxial ray (imperfect in the smaller) and in both the spine shorter as usual (spines, *TLs*, 124 133).

Log L = 0.2552 log N + 2.0754; t 7.200**; calculated (measured) lengths, *TLs*; 119(115) 142(148) 157(163) 169(170) 179(172)

Log L = 0.1363 log N + 2.0940; t = 21.253***; 124(124) 136(136) 144(143) 150(151) 155(155).

A difference in slope of the magnitude found here is unusual in two conspecific specimens not differing greatly in overall size.

Precaudal pseudospines. In his account of his synonymic *Trachichthys macleayi* Johnston (1881) observed "Upper and lower margins of the caudal peduncle armed repsectively with 8 and 7 strong adpressed translucent spines." These are the structures discussed above in an account of *Centroberyx affinis*. In our smaller individual there are 7 on each border, while the larger has 8 on each border, 4 of the dorsal series, however, being damaged and not measurable. They are similar to those already described, with the last of either series fully septate, bound throughout its length to the adjacent regular ray, similarly pigmented (dull yellowish with numerous minute red-brown chromatophores), and distinguishable from it only by its lesser length (about one-third) and its spine-like rigidity. The earlier members are more obviously vitreous, though possessing a basal whitish or yellowish partly segmented core, and bearing some (in the dorsal series numerous) chromatophores. As in the other species, the logarithmic lengths are a function of the logarithms of the serial numbers counted caudad. The following are the parameters of the rectified equations for the dorsal and ventral series of the smaller specimen followed by that for the central series for the larger example, all lengths being millesimals of standard length. Slope 0.8757,1.3548,1.2836, intercept 1.0478, 0.7773,0.7971; t 72.394*** 75.006*** 146.837***: predicted (measured) lengths 11(11), 20 (21),29(30),38(37),46(44),53(53),61(63); 15(16),27(27),39(38),53(56),68(68),84(81); 6(6),15(16),26(27),37(37),49(47),63(65),76(78),91(85).

Inspection of the parameters of the smaller fish (in which alone both dorsal and ventral sets are measurable) shows that while the dorsal slope is much less than (0.65) the ventral, the dorsal intercept is much greater (1.35). The net effect of these two contrasting ratios is to bring the areas under the graphs into approximate equality, the mean areas per panel (*i.e.*, between adjoining spines), with lengths measured as millesimals of standard length and serial extensions in common logarithms, being 0.20 and 0.19; for the dorsal set for the second specimen 0.17. Otherwise expressed, though the size of the set may differ (N = 7 7 8) and though the length of both the first members (1.5,0.8,1.0 mm or 11.1,5.9,6.0 *TLs*) and of the last (8.5,11.0,14.2 mm or 63.0, 81.5,84.5 *TLs*) exhibit considerable variation, the mean logarithmic length of the spine relative to length of fish remains significantly constant, namely 1.51,1.49,1.54.

Coloration

The color of the fish in life is noted in the Handbook as being "reddish purple with yellow fins". The smaller of our specimens, preserved in alcohol, is faintly purplish brown with on the left side some four-fifths of trunk and tail and on the right side some small patches silvery; head except for operculum off-white. Except for dark brown on the operculum and some yellowish in the mouth region, the larger is an indefinite greyish fawn, somewhat more brownish above the lateral line. In both the fins are more or less evenly yellowish; some duskness on caudal.

Family APOGONIDAE

The Cardinal Fishes are represented in Tasmania by 5 species: (1) *Dinolestes lewini* (Griffith, 1834) (2) *Siphamia cephalotes* (Castelnau, 1875) (3) *Lovamia fasciata* (Shaw, 1790) (4) *Vincentia novaehollandiae* (Valenciennes, 1832) (5) *Gronovichthys lemprieri* (Johnston, 1883) (type locality Dunkleys Point, Tasmania). A further species, *Apogon guntheri* Castelnau 1872, that appears in the second list by Johnston (1891) is treated in the Check-List (McCulloch 1929) as a queried synonym of (4) (referred to the genus *Apogon* Lacépède, 1802) and in the Handbook (Munro 1960) is formally accepted as identical with that species (along with *Apogon conspersus* Klunzinger, 1872, *Vincentia waterhousii* Castelnau, 1872, *Mionorus ramsayi* Fowler, 1908 – referred in the Check-List to *Apogonichthys* Bleeker, 1854 – and (5), see below.)

In some recent texts – *e.g.*, Scott (1962) Whitley (1962) Marshall (1964) Scott, Glover & Southcott (1974) – (1) is referred to the monotypic family Dinolestidae, which, however, is not recognized as distinct by Greenwood *et al.* (1966) in their provisional classification of living teleosts. In the Handbook (5), described in *Apogon*, is accommodated in *Vincentia* Castelnau, 1872, and identified with (4). However, there are good grounds for regarding Johnston's Tasmanian species as valid – see Part XII (1964), which carries a full description with figure, Part XVII (1969), Part XX (1974b), which reports a local example of (4), and Part XXIV (1978), which advances reasons for transferring it from *Apogon* through *Vincentia* to *Gronovichthys* Whitley, 1929. The Tasmanian species were keyed in Part XII, but as pointed out in Part XX the specification of the spines of the second dorsal involves an error, while the receipt of additional material has shown the distinction there drawn between (4) and (5) in respect of size of interorbital relative to eye cannot in all cases be relied on, the primary point of distinction between these two forms being that the dorsals are united in the former separate in the latter.

Genus *DINOLESTES* Klunzinger, 1872

Dinolestes Klunzinger, 1872, p.29. Type-species, *Dinolestes mulleri* Klunzinger.
Neosphyraena Castelnau, 1872, p.96. Type-species, *Neosphyraena multiradiata* Castelnau.
Lanioperca Günther, 1872, *Ann. Mag. Nat. Hist.*, 4(10), p.183. Type-species, *Lanioperca mordax* Günther.

Dinolestes lewini (Griffith, 1834)

Esox lewini Griffith, 1834 *in* ANIM. KINGD. (Cuvier), 10, p.465, pl.60. Type locality: New Holland (Lewin).
Dinolestes mulleri Klunzinger, 1872, p.30, pl.3. Type locality: Hobsons Bay, Victoria.
Neosphyraena multiradiata Castelnau, 1872, p.97. Type locality: Melbourne Market.
Lanioperca mordax Günther, 1872, *Ann. Mag. Nat. Hist.*,4(10), p.183. Type locality: Tasmania (Allport).

Remarks

This species has the distinction of having had three genera established for it in the one year (in Germany, Australia, England): in Tasmania, which provided the type locality for Günther's genus, the type material being forwarded to England by Morton Allport, it is not uncommon. Listed under Günther's name and placed in Sphyraenidae by Johnston in both his catalogues (1883, 1891) it was entered under *Dinolestes lewini* (genus Klunzinger, species Griffith) in the later lists of Lord (1923, 1927) and Lord & Scott (1924) being there transferred to Apogonidae. It has been reported from all Australian States other than Queensland. It differs clearly from all other Australian apogonids in having more numerous dorsal rays (18-19, *cf.* maximum 11, mode 8 or 9), anal rays (25-26 *cf.* maximum 15 mode 8 or 9), lateral line scales (64-67 *cf.* maximum 50 mode 20-30) and in reaching a greater length (500 mm *cf.* maximum 250 mode about 50-80): by some recent Australian authors – *e.g.*, Whitley (1962) Scott (1962) Scott *et al.* (1974) – it is referred to a monotypic family, but is retained in Apogonidae in the Check-List (McCulloch 1929) and the Handbook (Munro 1960). The close superficial resemblance of this fish to the widely distributed sea pikes or barracudas led early writers – *e.g.*, Castelnau (1872) Macleay (1881) Johnston (1891) – to associate it with them in the family Sphyraenidae, a taxon of different subordinal (or, according to authors who place it in the Mugiliformes, ordinal) rank from the Apogonidae. Vernacular names: long-finned pike, long-finned sea pike, skipjack – more commonly applied to *Pomatomus saltator* (Linné, 1766) – Tasmanian jack.

Material

Eight specimens, *Ls* 192-317 *Lt* 227-380, collected by scuba divers at an interstate competition at Croppies Point near Bridport, 28 December 1973 (Q.V.M. Reg. No. 1974/5/158). The coefficient of variation of standard length (16.5) appears somewhat high for a wholly homogeneous size group for which values of ≥10 are usual: however, no obvious mode of dissection of the sample presents itself.

Meristic Characters

D. V; I, 17(2)-18(6): in 1 example with 17 rays and 2 with 18 the last ray is divided to base. A. II, 25(1) 26(2) 27(3) 28(2): in 2 examples with 27 rays and 2 with 28 the last ray is divided to base (one specimen with anal imperfect). P. 16(3) 17(4) 18(1: both right and left fins). V. I, 5. L. lat. 63(1) 64(1) 65(3) 66(1) 67(1) 70(1).

In several cases these counts involve more or less marked emendation of local published accounts, of which the more significant are that of Castelnau (1872) of his *Neosphyraena multiradiata* (measured specimen cited 0.39 m) that of M'Coy (1886) with figure (pl.115) and dimensions of a Victorian example of total length 0.495 m and the synoptic notice of the Handbook (Munro 1960). Spines of the first dorsal are constant at 5, though, as pointed out by M'Coy, the figure by Klunzinger (1872) has only 4, while the photograph in Tenison-Woods (1882) does not show the first dorsal at all, "the error in both cases probably arising from the ease with which the spines are completely concealed when depressed into a deep slit or groove at the base of the fin" (p.62). Spines of the second dorsal are noted at 2 by M'Coy, the Handbook admits 1-2, while Castelnau gives a total of 17-21 elements, observing in a footnote "It would be more exact to say that the two first rays of the second dorsal are not branched, and could be called spines if they were not soft; the following (third) ray is much longer". The lower second dorsal ray count of 17 falls outside the Handbook's range, 18-19. Anal ray counts in 5 individuals here exceed by 1-2 the maximum of 26 found in the Handbook and in M'Coy (Castelnau notes "twenty-eight rays" but his convention in this context appears to take account both of spines and soft rays). Pectoral counts in 5 specimens exceed by 1-2 the 16 given by all three authors cited above; while the lateral line range 63-70 transgresses at both limits the Handbook's synoptic 64-67 (Castelnau's "about seventy-five scales" appears clearly to be no more than a rough approximation).

Dimensions

Morphometric data on this species are few and local accounts do not provide measurements of more than a single fish. A series of dimensions of each of the present 8 individuals is set out in table 4, measurements other than that of standard length being recorded as millesimals of standard length.

TABLE 4

Dinolestes lewini (Griffith, 1834)

Dimensions of eight specimens, Croppies Point, near Bridport, Tasmania (Q.V.M. Reg. No. 1979/5/158). First entry standard length, *Ls*, in mm, all other entries as millesimals of standard length.

Feature	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
Standard length (lth), mm	192	219	260	266	280	289	317	317
Lth to end of upper caudal lobe	1 172	1 142	1 158	1 135	1 182	1 166	1 186	1 192
Lth to end of lower caudal lobe	1 182	1 171	1 165	1 139	1 200	1 180	1 196	1 199
Lth to end of middle caudal rays	1 104	1 089	1 123	1 086	1 125	1 131	1 132	1 114
Lth to first dorsal origin	406	-	415	398	421	394	420	391
Lth to forst dorsal termination	432	-	438	444	464	429	426	426
Lth to second dorsal origin	589	584	608	575	625	557	584	587
Lth to second dorsal termination	750	753	773	763	790	772	803	779
Lth to anal origin	531	575	585	539	607	588	599	577
Lth to anal termination	849	815	850	818	854	834	864	852
Lth to vent (middle)	505	553	550	498	561	545	563	533
Lth to ventral origin	323	338	362	331	350	315	341	328
Lth (total) of ventral	128	128	127	124	132	114	123	120
Lth to pectoral origin	281	292	304	289	307	308	325	290
Lth (total) of pectoral	156	151	158	164	171	152	162	158
Head	292	292	308	299	314	322	338	306
Snout	130	128	135	124	136	125	142	136
Eye	52	53	50	53	46	45	50	47
Orbit	60	64	56	60	57	62	60	54
Interorbital	47	46	50	-	47	49	54	54
Depth at front of eye	109	100	112	-	107	118	111	139
Depth at back of eye	125	132	131	-	132	149	139	167
Depth at opercular border	161	160	185	177	175	166	189	174
Depth at vent	188	183	188	188	196	173	186	200
Maximum depth	198	187	196	192	204	176	196	202
Depth of caudal peduncle	96	100	89	91	93	92	95	98
Lth of longest dorsal spine	42	-	46	43	44	38	-	38
Lth of longest dorsal ray	146	162	140	120	139	114	122	132
Lth of longest anal ray	161	148	131	110	121	104	110	103
Lth of longest ventral ray	120	118	100	102	106	93	95	99
Lth of longest pectoral ray	135	179	137	133	108	142	156	145

Proportions

Each of the proportions noted below gives in succession range, mean with standard error, coefficient of variation with standard error, with the addition in parentheses of values derivable from M'Coy's single specimen, Castelnau's account, and Munro's synoptic data where these items are available.

Head in standard length 3.0-3.4 3.26 ± 0.05 4.3 ± 1.1 (3.3, three and two-thirds in total length, 3.4-3.5). Maximum depth in standard length 4.9-5.7 5.16 ± 0.09 4.7 ± 1.2 (5.1, about six and a half in total length, 4-6.5). Eye (horizontal) in head 5.6-7.2 6.27 ± 2.08 9.4 ± 2.4 (orbit 5.2 6.2 5.5). Eye (vertical) in head 4.6-5.7 5.43 ± 0.19 7.5 ± 1.9. Eye in snout 2.4-2.9 2.67 ± 0.08 7.9 ± 2.0 (— — 2.5). Eye in interorbital 0.9-1.1 1.00 ± 0.03 7.9 ± 2.0 (— — "equal"). Pectoral in head 1.8-2.4 1.99 ± 0.07 10.0 ± 2.5 (2.2 2.5 —). Ventral in head 2.3-3.2 2.55 ± 0.12 12.7 ± 3.3 (3.3 3.4 —). Depth of caudal peduncle in head 3.0-3.5 3.3 ± 0.08 6.8 ± 1.7. Longest dorsal spine (6 entries only) 6.7-8.5 7.39 ± 0.29 9.6 ± 2.4, longest dorsal ray 1.8-2.8 2.34 ± 0.12 15.0 ± 3.9, longest anal ray 1.8-3.1 2.57 ± 0.17 18.8 ± 5.1, all in head.

The second and third of the last three ratios each exhibit significant positive correlation with standard length, r 0.793 (z 1.075) t 3.187*, r 0.942 (z 1.760) t 6.907***: this systematic variation of ray length in dorsal and anal with head length (and hence with standard length, with which head length is correlated at r + 0.984) has not previously been noted. The six entries of the longest spine ratios also show positive correlation with head length but not at a formally significant level (r 0.645 z 0.767).

Aspects of Form

(1) Length of head, length to vent, standard length. In this species, as in many others of considerable taxonomic diversity, the anteroposterior extensions of the basic regions head, head + trunk, head + trunk + tail exhibit the relation $L = b\ N^k$ where L = regional length, N = an early natural number, the present set being {1 2 4}: the relation is conveniently rectified as log L = k log N + log b. For the mean lengths for the sample the best straight line is:

Log L = 2.4852 log N + 0.8475; t 32.154*; calculated (measured) lengths, *TLs*, 309(309),550(539) 990(1 000).

Parameters of equations for the eight individual fish together with indications of statistical significance and with calculated and measured values are set out in table 5.

TABLE 5

Dinolestes lewini (Griffith, 1834)

Parameters of the equation log L = k log N + log b where L = {length of head length to vent standard length} N = {1 2 4} together with significance and with calculated (measured) lengths as millesimals of standard length, *TLs*: eight specimens from Croppies Point near Bridport, Tasmania.

Specimen	Standard length, mm	k	log b	t	Calculated (measured) lengths, *TLs*		
(a)	192	0.8880	2.4556	15.661*	285(292)	528(505	978(1 000)
(b)	219	0.8880	2.4687	145.936***	294(292)	545(553)	1 008(1 000)
(c)	260	0.8495	2.4872	354.524***	308(308)	553(550)	997(1 000)
(d)	266	0.8709	2.4621	11.183	290(299)	530(498)	965(1 000)
(e)	280	0.8356	2.4971	1124.598***	314(314)	560(561)	1 006(1 000)
(f)	289	0.8174	2.5020	24.311*	317(322)	560(545)	987(1 000)
(g)	317	0.7824	2.5243	29.249*	334(338)	575(563)	989(1 000)
(h)	317	0.8542	2.4803	23.803*	302(306)	546(533)	988(1 000)

(2) Origins and terminations of vertical fin systems. Lengths to dorsal origin, anal origin, (second) dorsal termination, anal termination, and standard length fall significantly collinear on a loglog grid with as abcissae five integers {3 5 7 8 10}. For mean lengths for the sample (seven entries only for lengths to dorsal origin and anal termination) the best straight line (sum of logarithmic, not arithmetical, deviations from mean minimized) is:

Log L = 0.7554 log N + 2.2435; t 37.543***; calculated (measured) lengths, *TLs*, 401.7 (406.4),605.0(575.1),761.9(772.6),842.8(842.0),997.5(1 000).

Data for individual specimens are recorded in table 6.

TABLE 6

Dinolestes lewini (Griffith, 1834)

Parameters of the equation log L = k log N + log b where L = {length to dorsal origin, to anal origin, to (second) dorsal termination, to anal termination, to caudal origin (Ls)} N = {3 5 7 8 10}, together with significance and with calculated (measured) lengths as millesimals of standard length, TLs: seven specimens from Croppies Point, near Bridport, Tasmania.

Specimen	Standard length, mm	k	log b	t	Calculated (measured) lengths, TLs
(a)	192	0.7721	2.2215	12.891**	389(406) 570(531) 748(750) 829(849) 985(1 000)
(c)	260	0.7377	2.2616	133.217***	411(415) 599(585) 767(773) 847(850) 998(1 000)
(d)	266	0.7758	2.2164	16.571***	386(398) 574(539) 745(762) 826(818) 981(1 000)
(e)	280	0.7192	2.2808	1030.985***	421(421) 607(607) 774(790) 852(854) 1 000(1 000)
(f)	289	0.7724	2.2285	210.242***	395(394) 587(588) 761(772) 843(834) 1 002(1 000)
(g)	317	0.7339	2.2724	103.268***	399(420) 610(599) 781(803) 861(864) 1 015(1 000)
(h)	3.7	0.7908	2.2144	128.122***	391(391) 585(577) 763(779) 848(852) 1 012(1 000)

(3) Ventral rays 1-4. The ray lengths are regularly 1<2<3<4>5, ray 1 being defined as in Part XIX (1974a, p.248) as that farthest from the spine (nearest to medioventral line of fish; postaxial). As is usually the case with this very common pattern the lengths of rays {1-4} are collinear in a loglog plot with their serial numbers. The relevant best straight line has been calculated for the largest specimen (h):

Log L = 0.0832 log N + 1.4487; t 10.549**; calculated (measured) lengths, mm, 28.1(28.0) 28.8(29.9) 30.8(31.0) 31.5(31.3)

Family SCOMBRIDAE

Greenwood *et al.* (1966) in their provisional classification of living teleosts assemble in the wide taxon Scombridae six or eight groups treated by most Australian authors as separate families. The species here dealt with, the butterfly mackerel, *Gasterochisma melampus* Richardson, 1845, was placed first by McCulloch (1922) in Scombridae later (1929) in Scomberomoridae, in which it was accommodated also by Whitley (1962); however, in the Handbook (Munro 1958) it is referred to Gasterochismatidae (rendered Gasterochismidae by Greenwood *et al.* in their synonymy). In all Tasmanian lists it appears in Scombridae.

Genus *GASTEROCHISMA* Richardson, 1845

Gasterochisma Richardson, 1845, p.346. Type-species, *Gasterochisma melampus* Richardson.
Lepidothynnus Günther, 1889, p.15. Type-species, *Lepidothynnus huttonii* Günther.

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Gasterochisma melampus Richardson, 1845
(pl.1)

Gasterochisma melampus Richardson, 1845, p.346. Type locality: Port Nicolson, New Zealand.
Gasterochisma melampus Richardson, 1846, p.60, pl.37.
Lepidothynnus huttonii Günther, 1889, p.15, pl.6, figs A,A'. Type locality: Lyttleton, New Zealand.
Lepidothynnus huttoni [*sic*]: McCulloch, 1929, p.265.
Gasterochisma melampus: Johnston, 1883, p.118 and 1891, p.11 and Whitley, 1929, p.60: Waite, 1912, p.220, pl.8: McCulloch, 1922, p.104, pl.48, fig.287a, 1929, p.265: Lord, 1923, p.70, 1927, p.15: Lord & Scott, 1924, pp.12,79, unnumbered fig.: Munro, 1958b, p.110, fig.740: Whitley, 1962, p.184, unnumbered fig.: Scott, 1979, p.119.

Tasmanian Occurrence

In including *Gasterochisma melampus* in his first catalogue Johnston (1883, p.118) noted the recent capture [by the schooner *Malcolm*] of an example at the mouth of the estuary of the Derwent and reported its meristic characters together with a dozen dimensions. Johnston's fin counts were included in his memoranda made available by Whitley (1929), being there accompanied by a newspaper cutting that repeated the catalogue measurements, adding "width of widely forked tail at tips 12 inches" (305 mm) and rendering total length and 'length of body' (*i.e.*, length without caudal) as 1022 mm and 889 mm as against 991 mm and 838 mm in the memoranda and in the catalogue. This record appears to have provided the sole basis for the presence in the local lists of Lord (1923, 1927) and Lord & Scott (1924) of this "very rare oceanic species" (McCulloch 1922, p.104) that occasionally comes ashore. Though having a wide range it has not hitherto been listed from Western Australia (Whitley 1948) or South Australia (Scott *et al.* 1974). An example, *Ls* 372 *Lt* 459, stranded at Falmouth on 14 November 1978 was reported in Part XXV (1979). Two other Tasmanian specimens are here noted — *Ls* 460 *Lt* 578, collected by Mr Shane Down 3.2 km east of Binnalong Bay in March 1980 (Q.V.M. Reg. No. 1980/5/35), *Ls* 342 *Lt* 417, trolled in 70-90 m about 8 km off the south of the Mersey River by Mr K.W. Spilstead in mid June 1980 (Q.V.M. Reg. No. 1980/5/59). These individuals are denoted (a) (b) (c) in order of ascending standard length.

In quantitative statements below entries for the Queen Victoria Museum's three examples are cited, where appropriate, in order of ascending magnitude of *Ls*, with variates for the specimen reported by Johnston, the largest individual, shown where available in parentheses.

Meristic Characters

D. XVII XVI XVI; 1, 9 9 10; 6 8 7 finlets. A. I II I, 9 10 10; 6 8 6 finlets. P 23 22 22. L. lat. 65, not traceable beyond level of second dorsal finlet 74 —. L. tr. 8/20 7/21 7/20. Caudal about 18 + 18 rays + 4/5 strong spine-like procurrent rays — —.

Gill Rakers

The Handbook (Munro 1958b, p.110) states "G.R. absent", Whitley (1962, p.185) has "no gill-rakers"; however, in a more qualified statement, Waite (1912, p.222) wrote "no distinct rakers are developed, their place being taken by curved spines, irregularly disposed". Of the Falmouth specimen it was noted "While there are no elongate rodlike structures, the anterior arch bears 11 small spinulose mounds, placed about their own diameter, 2 mm, apart at the middle of the series, closer together at the ends". In the present material the arrangement is essentially similar. In the Binnalong Bay individual several mounds at the inferior end of the series are in contact, their distal borders effectively continuous and a precise determination of their number becomes somewhat arbitrary; if 3 are counted in this region the total number on the lower limb of the anterior arch is 13: in the northwest coast individual, 14. Each mound bears from half a dozen to a dozen curved spines, in some only on the free upper surface in others extending on to the proximal part, being here usually smaller. There is some difference in size of the major spines in the present two specimens, those of the larger fish being relatively larger. Thus the spines are borne on discrete structures, not "irregularly disposed" as assessed by Waite, and these mammilliform structures would clearly appear, by their location number and character, to represent rudimentary or vestigial rakers.

Dimensions

The principal dimensions are recorded below as millesimals of standard length; of the two versions of standard length reported for the early Derwent estuary specimen (see above) the smaller, 991 mm, given by Johnston himself (1883, p.118) has been accepted. Length to tip of upper caudal lobe 1219 1931 1257 ("total length" 1182), to tip of lower caudal lobe 1211 1204 1226, to end of middle caudal rays 1053 1054 1087. Length to origin termination of first dorsal 275 253 287 605 556 570, of second dorsal 635 594 628 (579) 725 719 715, of anal 646 632 663 (657) 731 723 740. Length to vent (middle) 620 613 653. Length to origin of pectoral 254 250 272, of ventral 251 250 257. Total length of pectoral 127 123 133 (150), of ventral 264 284 270 (304 — , ventral correctly noted in memoranda (Whitley 1929, p.60) but rendered "anal" in catalogue). Length to origin of upper caudal lobe 961 949 980, of lower caudal lobe 959 962 985.

Head 250 242 254 (250). Snout 99.4 92.7 104 (114). Eye, horizontal diameter 31.9 29.8 30.4 ("eye" 25.0), vertical diameter 33.6 32.5 32.6. Interorbital 76.0 67.2 73.9. Depth at front of eye 155 153 154, at back of eye 187 188 187, at opercular border 243 263 333, at vent 243 245 228; maximum 275 277 261 (257 — in newspaper cutting "at shoulder"), depth of caudal peduncle 37 38 35 (29 — in catalogue "least depth"). Width at same points 73 83 76, 79 91 96, 99 108 107, 79 99 80; 110 118 113, 26 47 21. In first dorsal length of first spine 38 43 39, of longest intact spine 108(9th) 123(8th) 96(11th), of last spine 20 32 37; in second dorsal length of spine 37 57 57, of first ray 67 — 79, of longest ray 76(2nd) 64(3rd longest intact) 79(1st), of last (shortest)ray 19 21 17, longest (last) finlet 47 54 43. Anal spine 52 30(first) 39, first ray — (second 44) 47(longest) 85(longest), longest (last) finlet 53 54 -.

Proportions

Greatest depth 3.6 3.6 3.8 3.9 (Handbook, Munro 1958b, 3.9-4.1), head 4.0 4.1 3.9 (4.0) (Handbook 4-4.1) in standard length. Depth of caudal peduncle in head 6.8 6.4 6.4. Eye, horizontal, in head 7.8 8.1 8.4 ("eye" 10) (Handbook "eye in head" 5.5-7.4). Eye, horizontal, in snout 3.1 3.1 3.0 ("eye" 4.6), in interorbital 2.4 3.3 2.4. Pectoral in standard length 6.5 6.6 6.0 (6.7), in head 1.6 1.6 1.5 (1.17). Ventral in standard length 3.1 2.9 3.1 (6.1), in head 1.3 1.4 1.3 (1.5). First dorsal base (to last spine) in standard length 3.0 3.3 3.4. Second dorsal base (to last ray) in standard length 11.0 8.0 10.3. Anal base (to last ray) in standard length 10.7 10.9 13.0.

General Features

Maxilla to below 0.5 0.4 0.3 eye ("front margin of eye", Waite), its greatest oblique width 17 15 21 *TLs*, its exposed length short 0.28 0.33 0.33 mouth cleft, shortest distance from eye 14 17 21 *TLs*. Upper jaw projecting very slightly, mouth cleft at an angle of about 25°-30° (contrast Waite, "horizontal"). Teeth in jaws minute subconical relatively stout, somewhat variable in size, uniserial, on palate similar rather more slender directed somewhat backward, on vomer in a kite-shaped patch. Posterior nostril a short downwardly and backwardly oblique slit, its length subequal to its distance from orbit. Anterior nostril small round aperture about on horizontal level with superior orbital border and inferior border of upper lip, direct distance from lip 1.3 1.1 1.0 that from orbit ("midway", Waite). Border of ventral fin somewhat irregular, grossly slightly concave (shown strongly convex by Richardson, strongly concave by Waite almost straight by Günther), ray lengths 1>2<3<4=5 1>2<3>4<5 1>2>3>4<5 (ray 1 farthest from spine), preaxial ray 1.3 1.1 1.2 postaxial ray or 2.0 2.3 2.4 spine, rays in general with three strong rami widely diverging distally remaining separate almost to base. Greatest depth of groove for reception of fin 30 32 37 *TLs*, inner surface fleshy smooth white.

Dorsal originating behind head being by 0.5 eye behind pectoral origin is specimens (a) (c), above hinder part of operculum being 0.5 eye in advance of pectoral margin in (b).

This variation in location of the fin is of interest not only in itself but also as throwing some light on a vexed question. Of Günther's figure of his specimen (1889, pl.6 fig.A), noted as being only a sketch, Waite (1912, p.220) stated "it is evident the dorsal fin is incorrectly shown", possibly, he suggested, to conform to the "wrongly articulated" skeleton (pl.6 fig.A'), which makes "it appear that the fin arises over the opercle instead of at some distance behind it" (the assumption that the latter position is an absolute specification now being shown by our specimens to be invalid): in fact, Günther's text has "above the gill-slit" and his illustration of the fish shows dorsal origin distinctly behind opercular border, about midway between it and pectoral origin, much as in the figure by Richardson (1846, pl.37). For the large Kaikoura example Waite notes dorsal origin "behind the root of the pectoral", his illustration depicting it at level of hind margin of the fin base. With the specifications here reported being exhibited by examples of much the same size it would appear the positioning of the fin origin is subject to mere individual variation, with no evidence to suggest the existence of heterogonic growth such as, for instance, that determining location of dorsal origin in some centrolophids (Haedrich 1967).

Anal originating shortly behind, under middle of second dorsal. Pectoral reaching to below 7th 9th 11th dorsal spine. The later rays of the dorsal and anal increasingly assume the tufted character of the finlets, the last two or three being formally distinguished from these only by being more closely set and by the presence of but feebly developed membrane. Outer rays of the furcate caudal inserted well in advance of hypural joint, reaching forward for an eye diameter or more at least to the front of the penultimate vertebra. Behind the level of their insertion the tail continues back as a scaled tumid fleshy lobe covering the hypural plate (formed by fusion of several hypurals) and reaching nearly to the tips of the short median rays. Scales rounded, a little deeper than long, cycloid; diameter of scale from midflank to about two-thirds that of eye; ceasing on dorsum of head at level of front of orbit, posterior nostril, anterior nostril; preoperculum squamous save for narrow gelatinous arc constituting hind border; operculum without scales but a small subcircular patch of about half a dozen scales just above and in front of it immediately in advance of origin of lateral line; isthmus scales to, or almost to, tip at least to level of front of orbit; rest of head smooth. In his description of the large Kaikoura example (*Ls* 1 473 mm) Waite reported the head as being naked "with the exception of about 4 rows of scales on the cheeks"; a progressive decrease in cephalic scalation would appear probable. Lateral line rising about to level of middle of spinous dorsal, initially abruptly in a short arc subequal to eye diameter then gradually and evenly about to its termination below or just behind rayed dorsal base where its distance from profile is rather less than two eye diameters. A noticeable feature of the compressed head, to which attention has been drawn by Günther and Waite, is the presence of a median dorsal ridge clearly defined from in advance of posterior nostril to above hinder part of preoperculum, lapsing (variably in individuals) forward towards tip of snout backwards towards dorsal origin: this marks the site of the supraoccipital crest of the neurocranium, originating in general in scombrids at the pineal foramen and extending to or beyond the exoccipitals.

Radiograph

By courtesy of the Radiography Department Launceston General Hospital several radiographs were taken of specimen (c) (Plate 1).

Examination of the radiographs and comparison of these by Günther's reproduction of a photograph (1889, pl.5 fig.A') with an articulated skeleton in the Canterbury Museum, Christchurch, New Zealand suggest the following comments. Our fish appears to have about seven more vertebrae (44 *v.* 37) and those in the posterior one-fifth of the series are here somewhat larger relative to the rest. As pointed out by Waite (1912) the articulation has been incorrectly carried out, the origin of the dorsal fin being made to appear too far forward: in our specimen the insertion of the fin at the dorsal profile is vertically over the 6th (*cf.* about 2nd) vertebra and well behind the cranium; the first anal ray is below the 21st (about 19th). The mouth cleft in the Tasmanian example slopes distinctly down and back (extends virtually horizontally).

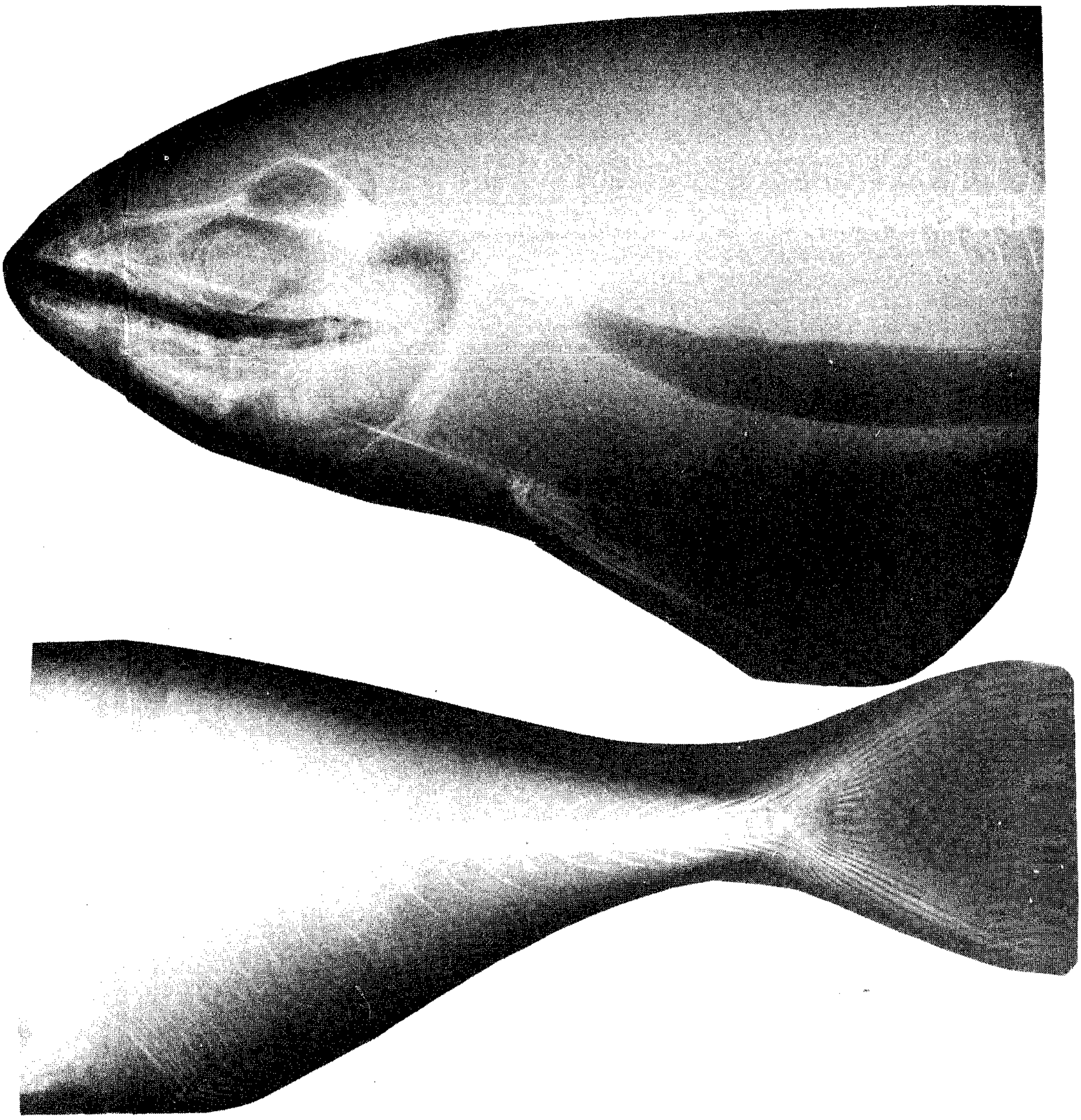

PLATE 1.- *Gasterochisma melampus* Richardson, 1845. Radiographs of anterior and posterior portion of a specimen 342 mm in standard length, 417 mm in total length, collected off the mouth of the Mersey River, Tasmania; (K.W. Spilstead) Q.V.M. Reg. No. 1980/5/59. Radiograph, Launceston General Hospital; print, D.R. Barratt.

While the complete pattern of the caudal complex cannot be determined with certainty, the following features appear to be recognizable: a large subtriangular plate formed probably by the fusion of the hypurals 1-4 (together with 5?); a preural followed by parhypural (? fused with hypural plate; region obscured by intrusion of proximal parts of caudal rays) with moderate parhypurophysis; 4-5 of the upper and 5-6 of the lower caudal rays extend forward over the hypural plate, the origins of the outermost virtually in contact near the front of the plate, the interval between those of the others rapidly decreasing backward, while the bases of the central rays, 7 of which are the thickest of the total series, stop short of the hind margin of the plate, leaving here in the radiograph a distinct featureless bar (Collette & Chao 1975, p.578, state "One of the diagnostic characters of the Scombridae [*Sarda* Cuvier, 1829 *Gymnosarda*, Gill, 1862 *Orcynopsis* Gill, 1862 *Cybiosarda* Whitley, 1935 *Allothunnus* Serventy, 1948] is that the bases of the caudal rays cover the hypural plate (Figure 57), instead of only extending part way over the plate as is true of Gempylidae and Trichiuridae"); 2 preural centra support, or are level with the bases of, small early caudal rays both above and below.

Variation with Growth

Several notable changes in both quantitative and qualitative characters take place during growth. The chief age-determined morphometric features are (a) a striking decrease in relative length of ventral (b) a less pronounced increase in relative length of pectoral (c) a decrease in height of first dorsal relative to that of second dorsal.

(a) Ventral. This fin is of extraordinary size in the young (its wide membrane expanse suggesting the epithet in the vernacular name, butterfly mackerel); as figured by Richardson (1846) in a small example being almost twice length of head and extending back for a distance equal to the length of the median ventral cleft to reach virtually to the vent, whereas in an adult figured by Waite (1912) it is barely half length of head and reaches less than one-third of distance to vent. Examination of the data for Richardson's type of *Gasterochisma melampus* followed in sequence of increasing size by those for the four Tasmanian examples, the Kaikoura fish (Waite 1912) and the synonymic *Lepidothynnus huttonii* (as measured by Richardson) shows that in six of the seven cases (specimen from near the Mersey estuary the exception) an increase in total length is accompanied by a decrease in relative length of the ventral fin, the total lengths, mm, being 203 417 459 578 991 1 637 1 664, the relative fin lengths, millesimals of standard length, 331 264 284 270 147 97 71, giving r −0.978 (z −2.256), with t 10.234***. While the fin thus undergoes reduction in length the midventral cleft into which it can be withdrawn continues to extend from its origin at the fin base to its termination just anterior to anal origin. With the three fish here reported in ascending order of overall size the length of the ventral is 0.87 0.97 0.85 that of the groove.

(b) Pectoral. - While the relative length of the ventral decreases with age that of the pectoral increases, the degree of change, however, being very much less. With fish in ascending order of Lt as above, TLs lengths of pectoral are 110 127 123 133 135 149 168 (the northwest coast example again out of sequence): r = 0.932 (z 1.669), t 5.768**. The relevant linear equation for regression of relative fin length on total length (L = 0.029 Lt + 110.0) yields predicted lengths differing from measured lengths by 0.8-6.0 mean 4.15 per cent.

(c) Relative heights of dorsals. In the young the height of the spinous dorsal is decidedly greater than, in the adult noticeably less than, the height of the soft-rayed dorsal, approximate ratios with increasing length of fish being for the sample here considered 2.6 2.0 1.5 1.2 <1 (Johnston) 0.7 0.5, the height of the anterior fin being contained about 1.9 2.0 2.1 2.7 – 4.7 6.7 times in length of head. In contrasting the relative heights of the fins in his specimen with the condition as figured by Günther (1880a, p.455) – *i.e.*, after Richardson (1846) – Johnston spoke of his specimen as "mature"; as pointed out by Waite it is of intermediate size and exhibits intermediate values of the size-related features here discussed.

The positions of the dorsals relative to one another appears to be the subject of some confusion. Munro (1958, p.110) states they are "united basally in young, widely separated in adults", and this specification was accepted in Part XXV (1979, p.120). This would appear to be substantiated by the following facts. In Richardson's 200 mm specimen the fins are virtually contiguous, while in the Queen Victoria Museum's three examples and Günther's type of *Lepidothynnus huttonii* as figured (relative total lengths of these fish, with Richardson's as unity, 2.1 2.3 2.8 8.2) they are separated by 0.11 0.13 0.21 *ca*.0.8 of first dorsal base, or 30 38 78 *ca* 100 *TLs* units: the termination of the first dorsal and the origin of the second dorsal are here taken to be specified by the location of the last spine and the first ray – in the northwest coast fish (after Richardson's the smallest) a low continuous strip of membrane extends the full length between spine and ray. On the other hand it should be observed, first, that Günther's figure is noted as being simply a sketch; secondly, Waite's own figure of the Kaikoura specimen (subequal in length to Günther's fish) depicts the fins as quite closely approximated, the interval being only about 0.1 first dorsal base or some 30 *TLs* units.

Four qualitative features have been reported as exhibiting variation with growth. In older fish there would appear to be some reduction in the scales on the head. In the material at hand they extend forward on the dorsum to level of middle of anterior border of orbit (in Waite's large individual commencing behind the occiput); preoperculum partly or fully scaled, operculum naked. On the ventral surface scales are found on the whole length of the narrow isthmus, which runs forward to a little in advance of level of anterior nostril. The lateral line suffers diminution with age. Figured in the young as terminating in advance of the hinder finlets though described as reaching the caudal, it is here traceable to level of first dorsal finlet in (a) (b) last one-fourth of second dorsal base in (c), while in Waite's individual, about three times as long, it is reported as ceasing below middle of first dorsal. There is some disagreement regarding the presence of absence of lateral keels on the caudal peduncle in this species, and on evidence provided by the present material it would appear the feature is an inconstant one, perhaps without regard to overall size. In his paper on the generic characters of the new species Richardson (1845, p.346) notes "cauda gracilis sine carinis" – a reference to caudal keels doubtless being suggested by the presence of these structures in most of the Scombridae (*sensu lato*, as recognized in the provisional teleost classification of Greenwood *et al.* (1966), including Thunnidae, Katsuwonidae, Scomberomoridae and other groups treated in many Australian texts as separate families; similarly the Handbook (Munro 1958b, p.110) states "Tail penducle without keels"; Whitley (1962, p.185) has "no caudal keels"; while earlier McCulloch (1922, p.104), recognizing eight Australian genera in the Scombridae, keyed off two of them, *Scomber* and *Gastrochisma* with the entry in the primary couplet "Caudal peduncle without a median keel on each side". On the other hand Günther's diagnosis of *Lepidothynnus* includes "tail with two keels at the base of the dorsal" and Waite states "There are two low ridges on each side of the tail". No keel was found in the Falmouth specimen, *Ls* 372, reported in Part XXV (1979, p.120). In the smaller of the two other specimens, *Ls* 342, there occurs on the left side of the fish a rather deep straight groove, extending for 33 mm from the level of the middle of the 4th dorsal finlet to beyond the base of the 7th finlet by a distance subequal to the base of that finlet (failing to reach level of insertion of upper caudal lobe by some 10 mm): on either side the groove is flanked throughout by an elongate bolster-like elevation, the combined transverse extent of the two bolsters and intervening groove being 10 mm near the middle 7 mm shortly before the rounded ends. No similar structure is apparent on the right side. In the example of *Ls* 460 a short distance below the upper profile a low rounded linear elevation, a ridge rather than a keel, originates below base of last dorsal finlet and runs along the convex extension of the caudal peduncle back beyond the forwardly inserted uppermost and lowermost caudal rays (the forked bases of the rays, as in other scombrids, completely embracing the hypurals the early part of the caudal thus becoming part of the dorsal and anal profiles to about midway between the origin of the uppermost ray and the hind border of the peduncle); a similar ridge occurs below, in this case forming the actual profile of the fish: these ridges, between which is a shallow trough, are traceable for a distance subequal to half postorbital length of head, diverging somewhat posteriorly. Collette & Chao (1975, p.576) state "The Gasterochismatimae and the primitive members of the Scombrinae (Scombrini - mackerels and Scomberomorini - Spanish mackerels) lack supporting bony keels and have only external keels on the caudal peduncle"; and recognize a general evolutionary trend in the relative development of keels leading through low segmented keels to a wide flattened plate extending over several vertebrae. The small pits above and below at base of caudal reported by Waite are present here, but assume the form of short transverse notches rather than of pits.

In discussing variation with growth Waite remarked "The presence of a small corselet is not al all foreshadowed in Richardson's figure"; no distinct corselet is apparent in his own figure nor does a corselet receive express mention in his description, though he notes scales "clothe the whole of the body excepting a naked callous area in which lies the pectoral fin". No distinct naked area is found near the pectoral in any specimens. However, there is found in this region a specialized condition of the scales that may possibly represent an adumbration of a corselet. Above and behind the operculum 6-7 rows of scales extend from the dorsal profile to about the first one-fifth of the upper pectoral rays, their general sense being tangential to opercular border at about 30° to anteroposterior exis of fish, their direction marking them off rather sharply from the more steeply inclined rows adjoining them. This condition is most marked in specimen (b), least in (a). In (a) and (b) several scales below the pectoral are larger than immediately adjacent scales.

Aspects of Form

Head, length to vent, standard length. In a loglog plot these three dimensions are significantly collinear on 1 2 3. With lengths expressed as millesimals of standard length the best straight lines for the Museum's specimens of the rectified relation $L = b\ N^k$ are as follows:

Log L = 1.2970 log N + 2.3873; t 36.793*; calculated (measured) lengths 244(242) 599(612) 1 014(1 000).

Log L = 0.2583 log N + 2.4136; t 15.726*; 259(254) 620(652) 1 036(1 000).

Log L = 1.2671 log N + 2.4014; t 36.895*; 252(250) 621(620) 1 014(1 000).

Dorsal Spines

The spines are slender, highly attenuate and flexible distally, and are readily damaged. In the 1979 fish they increase in length to at least 6th = 7th, in the east coast specimen to at least 4th. In the northwest coast fish, in which all spines other than 10th and 12th are measurable, a clear pattern is evident, involving an anterior set A of 9 spines ascendant caudad, with subsets A_1 = {1st - 3rd} and A_2 = {3rd - 9th} and a posterior set of 8 descendant caudad, with subset B_1 = {13th - 17th} and a possible subset B_2 = {10th - 13th; ? 9th - 13th}. In a loglog plot A_1 is linear on {1-3} and A_2 is linear, with a lesser slope, on {3-9}; while with the elements of B taken in reverse order (*i.e.*, numbered cephalad) and thus yielding as for A a positive slope B_1 is linear on {1-5}, with a suggestion from the graphing that B_2 may well be linear on {5-8; ? 5-9} with a slope markedly less than that of B_1 (and of A_1) but subequal to that of A_2. It will be noted A_1 and A_2 exhibit intersection (common element 3rd spine) as also do B_1 and B_2 (13th common); further if the full series of measurements for B_2 were available it might be found 9th is a member of both A and B.

A_1. Log L = 0.7021 log N + 1.5824; t 27.995***; calculated (measured) lengths, *TLs*, 38(38) 62(63) 83(82).

A_2. Log L = 0.2477 log N + 1.7931; t 7.179***; 82(82) 88(86) 93(92) 97(96) 101(99) 104(105) 107(108).

B_1. Log L = 0.9349 log N' + 1.3180; t 32.761***; 21(20) 40(41) 58(57) 76(79) 94(91). With spine lengths in *TLs* units and serial numbers in common logarithms the total area under the graph of A with spines ascendant caudad is 1.7750; if it is assumed the graph for B_2 from 13th spine to 9th is linear, the total area under the graph of B with spines ascendant cephalad is 1.7517, representing with 8 interspine panels in each set 0.222 0.219 per panel, respectively. The panel figure presumably represents in some way an energy output with two measurable factors (length of spine, vector length along anteroposterior axis of fish): in the present case (accepting linearity for B_2) it is seen to be significantly the same in the enantiomorphic expressions of spine development.

General Form

The broadly fusiform beautifully streamlined form of the Scombridae (*sensu latissimo*, as recognized by Greenwood *et al.* (1966), comprising fishes commonly distributed in Australian texts among half a dozen families) has long been recognized as a remarkable adaptation to fast swimming. That the overall configuration evolved is an efficient one is clear from its constancy — an inspection of the figures in the Handbook

(Munro 1958b) makes it evident that for a score of species there referred to Thunnidae, Scomberidae, Scomberomoridae, Sardidae the general outline of any one species, with allowance made in some instances for some difference in depth, could serve tolerably well for all. In passing mention may be made of the interesting physiological adaptation for rapid and sustained locomotion by the development of homoeothermal mechanisms.

The ontogeny of *Gasterochisma melampus* proceeds from the juvenile with high spinous dorsal, low soft dorsal, short pectoral and exceptionally large ventral fin (this last clearly a specialized adaptation to a specific lifemode) to the more typically scombrid adult through the fin changes considered, and in large part quantified, above. Features in this species (and in general in other scombrids) conducive to speedy movement through water include: dorsal and ventral verticals (Gregory 1928) in or nearly in line and subequal, tending to promote equivalence of stream flow above and below the fish; curvature in the vicinity of highest and lowest points on profiles (apex and gasterion) slight, rendering transition from entrance to run gradual, minimizing turbulence; smooth mainly scaleless head compressed, with dorsal surface forming a lancet arch surmounted by a fine median ridge for ready entrance, the ventral surface is similarly rather acutely rounded each mandible bounded by a ridge comparable with that of the dorsum, these ridges diverging posteriorly, being for the greater part of the length subparallel to the general plane of the lateral surface of the head; short caudal peduncle specially modified to facilitate even flow by the presence of a stout scaled fleshy pad into which the bases of the rays fit, covering the hypural plate – a condition well illustrated by the radiograph of the caudal complex in a bonito, *Orcynopsis unicolor* (St Hilaire, 1817) by Collette & Chao (1975, fig.57); large furcate caudal fin; reduced falciform or subtriangular ventrals, leading edge evenly convex (large size in young nullified by total reception as occasion arises into the abdominal groove): similarly formed anal and second dorsal; first dorsal here (in adult) low, depressible into a groove (where more highly developed with leading edge highest, sloping markedly backward); caudal keels (inconstant) that may mediate slipstream; dorsal and anal finlets (found also in the allied Gempylidae, and either present as discrete structures or adumbrated by a tuft-like extension of one or two posterior rays of the vertical fins in some carangids; both speedy types); finlets are further considered below.

Dorsal and ventral profiles. - In view of the interest attached to the outline in lateral aspect, 10 equidistant measurements of the height of the dorsal profile above and 10 of the depth of the ventral profile below a horizontal axis between mouth cleft and middle of caudal peduncle have been made for specimen (a) and a polynomial calculated for each of these and for total height of fish represented by their sum. As pointed out by Snedecor (1950, p.392) at the stage of the third degree the polynomial begins to exhibit "certain snakelike curves", appropriate in a context such as the present, and while a formulation at this or even an earlier stage may yield a value of R of 0.9 or better, continued calculation not only results in a general refinement in accuracy but in particular leads to improvement in the estimates of the first and last members of the series of measurements. The relevant data for specimen (a) with 4° equations, N being the serial number of the measurement (counted caudad) and dimensions being millesimals of standard length, are subjoined.

Dorsal profile. $H = 35.72 + 25.154\ N + 1.8481\ N^2 - 0.95286\ N^3 + 0.0493585\ N^4$; R 0.9946; calculated (measured) heights 61.8(61.4) 86.6(87.7) 106.1(108.2) 117.6(115.5) 119.4(114.0) 111.3(111.1) 94.1(102.3) 69.5(70.2) 41.0(35.1) 12.8(14.6).

Ventral profile. $D = 71.99 + 13.49\ N + 13.2377\ N^2 - 3.21399\ N^3 + 0.1702648\ N^4$; R 0.9869; 95.7(90.6) 129.9(140.4) 158.6(156.4) 175.3(171.7) 175.1(169.6) 155.9(155.0) 121.5(131.6) 87.0(85.0) 39.8(35.1) 19.3(14.6).

Total vertical extension. $H + D = 92.18 + 61.252\ N + 5.6933\ N^2 - 2.7343\ N^3 + 0.1483542\ N^4$; R 0.9947; 156.5(152.0) 218.0(228.1) 265.9(264.6) 291.3(286.6) 291.7(283.6) 266.3(266.1) 218.2(233.9) 152.2(155.2) 84.6(70.2) 23.2(29.4).

To illustrate the improvement of prediction in the caudal region gained by taking the calculation one degree further, the data for the 5° equation for the dorsal profile are here noted for comparison with the data for the 4° recorded above.

H = 11.05 + 102.25 N - 38.6226 N^2 + 8.09505 N^3 - 0.8499830 N^4 + 0.0327033 N^5; R 0.9982; calculated heights (measured, as above) 59.9 91.2 106.8 113.9 117.5 113.3 97.6 69.8 36.3 14.7.

Width. Measurements of the width of the same individual at 10 equal intervals between snout tip and hypural have been made and a 4° polynomial calculated.

W = 49.53 + 22.723 N - 0.9445 N^2 - 0.50725 N^3 + 0.035460 N^4; R 0.9938; calculated (measured) depths, *TLs*, 70.8(70.9) 87.7(88.2) 98.4(97.1) 101.9(101.5) 98.7(100.6) 88.3 (88.2) 73.5(70.6) 56.4(58.8) 40.3(39.7) 29.7(29.7).

Relation of width and depth. When these 10 measurements of width are plotted against the 10 measurements of total depth at the same points along the anteroposterior axis an interesting relation becomes apparent. For measurements 1-5 at the front and 9-10 at the posterior part of the fish the relationship is highly significantly linear R + 0.996 (z 3.057), the slope being 0.281 the intercept 22.53 (all dimensions *TLs*). The three measurements 6 7 8 in which the coordinates of depth lie below the line (in a downwardly concave arc) are those at the level of the second dorsal and anal — which, with the retractile first dorsal and anal withdrawn and the pectorals folded, present the only local interruptions to the general curve, a circumstance that may well account for the lapse in this region from the linear width-depth relation subsisting throughout the rest of the length.

Finlets

As suggested above the develoment of finlets in such fast and powerful swimmers as the scombrids is probably to be seen as a locomotory adaptation. These structures are found to present interesting relations in respect of (1) location relative to whole fish (2) location within the series (3) shape (4) size that may be presumed to have hydrodynamic significance, though in just what fashion at present remains undetermined. These aspects have been made the subject of general investigation, with quantitative data reported for specimen (c).

(1) Location relation to whole fish. The development of finlets along the profiles behind the soft dorsal and anal fins (placed about opposite) and in advance of the caudal would seem to relate to the mediation of the stream flow above the stream bed in the latter part of its emergent phase behind the point of maximum resistance (in the example here examined the greatest height of the dorsal profile the greatest depth of the ventral profile and the greatest width is in each case found at the 4th of the 10 measurements taken at equal intervals along the primary fish axis), presumably operating towards the maintenance, after the localized friction occasioned by the vertical fins, of an effective fair form (*i.e.*, one bounded by surfaces of continuous curvature), with the contour not too abruptly decreased by the pronounced peduncular decrement in body volume.

(2) Location within the series. At the next level downward in spatial arrangement, the location of the members of the series relative to one another, a systematic pattern is recognizable. With the anterior point of insertion of the hindmost finlet taken as origin and successive distances back to the insertions of the earlier finlets measured it is found the seven lengths are a function of their reverse (*i.e.*, cephalad) serial number, N', with $L = b\ N'^{(k)}$. For the dorsal finlets the rectified equation has slope 0.9943 intercept 1.0391 with calculated (measured) lengths, *TLs*, 32(32) 64(62) 95(98) 127(132) 159(161) 190(192) 221(211); the anal series has slope 0.9660 intercept 1.4883 lengths 31(30) 61(61) 89(92) 117(120) 146(148) 174(175) 202(193). For the first equation t is 50.578*** for the second 33.538***.

(3) Shape. The shape undergoes systematic change along the series, the anterior finlets being subquadrangular, with successive members backward developing a progressively lengthening pennon, the total length of the hindmost finlet being about thrice that of the first and about thrice that of its own base. These pennons (which find obvious analogues in the dorsal, particularly the second dorsal, and anal fins of some sharks) are mobile (the best developed highly so) and may be presumed to mediate filaments of flow.

As here developed the tip of the last finlet extends back to make contact with the base of the rigid anterior caudal ray, about which it plays freely. Hence during differential displacement of the caudal fin and the precaudal region the finlets' mobility can be assumed to promote continuity of flow between the two components of the current bed.

(4) Size. The systematic change in form is associated with a regular increase in length from first finlet to last; in a loglog plot the lengths being linear on reverse serial numbers,

Dorsal. Log L = —0.4722 log N' + 1.8413; t 48.353***; calculated (measured) lengths, *TLs*, 26.0(25.7) 27.8(28.7) 29.8(29.8) 32.5(32.5) 36.1(35.1) 41.3(40.9) 50.2(50.0) 69.4 (70.2).

Ventral. Log L = —0.4323 log N' + 1.8148; t 31.151***; 26.6(26.3) 28.2(28.7) 30.1(30.7) 32.6(32.5) 35.9(34.8) 40.6(39.5) 48.4(50.3) 65.3(64.9

The finlets increase in height to the 4th then decrease to the 8th. In both the dorsal and anal sets there is apparent some tendency for the heights in the ascendant set to be an exponential function of the serial numbers and the heights in the descendant set of the reverse serial numbers, but the relations in these small sets do not all reach statistical significance (dorsal t 7.178*3.015 anal 7.376*4.904). The height, however, calls for further consideration. The fact that as in both the height and the depth of the body above and below the primary horizontal axis the maximum here is attained also at about the middle of the length suggests the possible existence of a recognizable relation between the contours of the body and of the finlets; this possibility has been investigated as follows. The scale of distances between the bases of the finlets specified above has been proportionally transferred to the longitudinal extension considered for the body profile (*i.e.*, *Ls*) and the heights and depths at the relevant levels calculated from the polynomials for the dorsal and ventral profiles of the fish given above, and against these have been graphed finlet heights. A striking result emerges, the two types of contour being strongly correlated, dorsal body with dorsal finlets ventral body with anal finlets, each pair with markedly different anterior and posterior segments. With dorsal finlets 1-4 we find r 0.997 (z 3.299) with 4-8 (the segments intersecting) r 0.995 (z 3.230); with anal finlets r 0.991 (z 3.225) r 0.972 (z 2.124). With the relation expressed as a linear equation $y = mx + c$, for dorsal finlets 1-4 m = 0.064 c = 6.605 t = 23.673**, for 4-8 m = 0.029 c = 11.223 t = 17.658**: for anal finlets 1-4 0.043 6.916 10.245**, for 4-8 0.023 11.469 7.141*.

As with the superior and inferior profiles of the body, the total curves constituted by the external margins of the dorsal and anal finlets are adequately specified by polynomials of the third degree. Equations for specimen (a) below.

Dorsal finlets. $H = -0.118 + 8.23\,N - 1.444\,N^2 + 0.07475\,N^3$, R 0.9953; calculated heights, *TLs*, 6.7 11.2 13.6 14.5 14.3 13.4 12.4 11.6.

Anal finlets. $H = 0.501 + 8.161\,N - 1.3823\,N^2 + 0.06743\,N^3$; R 0.9898; 8.0 11.8 14.4 15.3 15.2 14.3 13.0 11.8.

The investigations here reported are clearly of an exploratory nature only; examination of more extensive sets of data is necessary before definitive conclusions can be reached. However, the high degree of precision of the relations encountered suggests these interesting and novel formulations may well specify morphometric patterns with significant biological and hydrodynamic implications not at present apparent.

Coloration

No mention of color occurs in the diagnosis by Richardson (1845) of the generic characters of *Gasterochisma melampus* ("nomen genericum fissuram ventris denotat"), while in his account of *Lepidothynnus huttonii* Günther (1889) observed merely, "Colour uniform steel-grey, lighter below; cuadal fin and inside of pectoral darker". Waite reported body nearly black above and silvery beneath, head steel-blue. "Midnight blue above lilac to gunmetal on sides and greyish silvery below" (Whitley 1962); Whitley gives "blueskin" as an alternative vernacular name to the customary butterfly mackerel.

Among our material specimens (a) and (c) are much alike, with trunk and tail very deep blue in parts approaching black down to near midlateral line, thereafter gunmetal lightening below to silvery and becoming close to white immediately above ventral profile; (b) differs noticeably, being overall much lighter and in general more bluish. Dorsum of head blackish, darkest anteriorly. Operculum in (a) (c) dark greyish narrowly bordered with off-white, in (b) much lighter and with wider more yellowish border, in all with indications of 2-3 oblique lighter stripes, obscurely yellowish or in (b) distinctly reddish. Preoperculum more or less like trunk but with some yellowish. Small yellowish arcs regularly present bordering eye in front and behind. Lower jaw in (a) partly yellowish partly whitish with some dusky marbling inferiorly, in (b) pale yellow virtually immaculate, in (c) blackish brown in front obscurely yellow behind with some black mottling. First dorsal hyaline, "like plastic" (Whitley 1962), spines sometimes whitish or straw (brown, Waite). Second dorsal and anal similar, dark brownish in parts close to black, tips of some rays ashen or pale yellowish. Pectoral with rays brownish or deep grey, almost black on inner surface (fin silvery, Waite). Ventral black (bluish black, Whitley) except for first ray which shows some brownish red and white mottling (front ray silvery, Whitley), in (b) short orange streaks on bases of 3 rays. Caudal with outer rays blackish others greyish or whitish, on lower lobe of (b) on both lobes of (c) heavily mottled dark and light (tail black, Waite).

Family PLEURONECTIDAE

Ten species of right-hand flounder have so far been reported at one time or another from Tasmanian waters, of which individual authors have recognized half a dozen or fewer: a further species is now added. These are listed below and the status accorded them in some selected texts noted. In the subjoined schedule the presence of a cross indicates Tasmanian occurrence, that of a number signifies the species concerned has been expressly treated by the author as synonymic with the species listed with that number in the left-hand column; doubtful entries are shown with a question mark, placed after the specifications (locality or taxonomic status) that is queried. Questions of synonymy are the subject of comment only by Norman (1926) McCulloch (1929) Last (1978).

		Johnston 1883,1891	Lord 1923,1927	Lord & Scott 1924	Norman 1926	McCulloch 1929	Munro 1957	Last 1978	Scott herein
1	*Ammotretis lituratus* (Richardson, 1843)	x?	-	-	-	x	-	x	x
2	*Ammotretis rostratus* Günther, 1862	x	x	x	x	x	x	x	x
3	*Ammotretis tudori* McCulloch, 1914	-	x	x	x1?	x	x	1	-
4	*Ammotretis macrolepis* McCulloch, 1914	-	x	x	x3?	x	x	x	x
5	*Ammotretis elongatus* McCulloch, 1914	-	-	-	-	-	-	-	x
6	*Rhombosolea plebeia* Richardson, 1843	-	-	-	x?	-	x?	-	-
7	*Rhombosolea monopus* Günther, 1862	x	-	-	6	6	-	8?	-
8	*Rhombosolea tapirina* Günther, 1863	x	x	x	x	x	-	x	x
9	*Rhombosolea flesoides* Günther, 1863	-	x	x	8	8	-	8?	-
10	*Azygopus pinnifasciatus* Norman, 1926	-	-	-	x	-	x	x	x
11	*Taratretis derwentensis* Last, 1978	-	-	-	-	-	-	x	x

With Tasmania interpreted as including Bass Strait, it is or is included among the type localities of seven species: 1 [no locality (collected by Thomas James Lempriere 1796-1852, public official, author, artist, Hobart) = Tasmania, *fide* McCulloch (1929, p.281)]; 2 ["Norfolk Is." = Tasmania (McCulloch)] 3, 4, 8, 10, 11. The generic name *Ammotretis* is regularly rendered *Amnotretis* in the early Tasmanian catalogues by Johnston.

Observations on Some Tasmanian Fishes: Part XXVII

The seven species of left-hand flounder validly included in the Tasmanian faunal list have been keyed in Part XXI (1975).

Genus *AMMOTRETIS* Günther, 1862

Ammotretis Günther, 1862, CAT. FISH. BRIT. MUS., 4, p.458. Type-species, *Ammotretis rostratus* Günther.

Ammotretis elongatus McCulloch, 1914

Ammotretis elongatus McCulloch, 1914, p.123, pl.27. Type locality: "Investigator Strait, South Australia, or the area south of Kangaroo Island".
Ammotretis elongatus: Waite, 1921, p.159, fig.260 and 1923, p.183, unnumbered fig.: Norman, 1926, p.271: McCulloch, 1929, p.281: Scott, 1962, p.90, unnumbered fig.: Scott, Glover & Southcott, 1974, p.103, unnumbered fig.: Whitley, 1964, p.49.

Identification

Ammotretis elongatus is readily distinguishable from the six remaining species accepted as Tasmanian by Last by the following combination of characteris: snout produced into a fleshy hook, two pelvic fins the right with 13 rays, joined to anal, no fleshy tubercle at tip of first ray of left pectoral, depth of body >2 (2.1-2.5) in length without caudal fin. In the key by Last (1978, p.22) it enters the last couplet, being distinguishable from the two species there included, *A. lituratus* and *A. macrolepis* by its greater number of right pelvic rays, 13 (*cf.* 10-12), higher pelvic ratio, >3 (*cf.* 1.5-2.4); further from the first species by lacking a fleshy tubercle on the left pectoral and from the second by having decidedly fewer rays along the lateral line, 66 (*cf.* 88-92).

Material

A specimen 65 mm in standard length 76 mm in total length, collected by Mr J. Shea at Goose Island, Bass Strait in May 1980 (Q.V.M. Reg. No. 1980/5/64).

Meristic Characters

D. 75. A. 55. P. dex. 11 P. sin. 8 V. dex. 13. V. sin. 5. C. 3/12/3. Scales in longitudinal series just above lateral line *ca* 90, between lateral line and highest point on dorsal profile *ca* 30.

Dimensions

The species was founded (McCulloch 1914) on a single individual 98 mm long and the account in the report on the Heterosomata collected by the *Endeavour* (Norman 1926) is based on three specimens 90-125 mm in total length. Neither author provided any absolute morphometric data, such dimensions as are noted being given in the form of proportions. All dimensions here recorded are thousandths of standard length 65 mm. Measurements are in general taken between parallels, those taken point-to-point being shown in parentheses.

Total length 1200. Head 285, length to preopercular border 200. Snout to lower eye 83, to upper eye 89. Lower eye diameter horizontal 65, vertical 34, diameter of eyeball horizontal 31, vertical 26, shortest direct distance to ventral profile 60; greatest external diameter of orbit 71. Upper eye diameter horizontal 62, vertical 37, diameter of eyeball horizontal 32, vertical 28; greatest external diameter of orbit 71. Interorbital 14. Length of maxillary (80), length of lower jaw of ocular side (83), of blind side (85). Snout to vent 285 (323). Left pectoral length to origin 286, total length of fin 91, length of longest (5th) ray 85, oblique length of base (28). Right pectoral length to origin 292, total length of fin 135, length of longest (6th) ray 123, oblique length of base (37). Left pelvic length to origin 197, length of base 63(64), length of longest (5th) ray 63. Right pelvic length to origin *ca* 70 (some displacement of body here), length of base 300(323), length of longest (11th = 12th) ray 77. Dorsal length to origin 0 to termination 977, length of longest ray (near middle of fin) 112 of last ray 29. Anal length to origin 315 to termination 980, length of longest ray (near middle of fin) 108 of last ray 29. Length of longest (inner) unbranched caudal ray 137, of longest (middle) branched 185. Depth at front of eye 262 back of eye 323 operculum 477, maximum depth (at about 0.4 of standard length) 492, depth of caudal peduncle 108.

General Features

Elongate, evenly ovate, its depth 2.03 in standard length, *Ls*, (McCulloch, $2\frac{1}{4}$ in *Ls* Norman, $2\frac{1}{3}$-$2\frac{1}{2}$ "in the length"), depth of caudal peduncle 2.7 in head. Head 3.51 in *Ls* (McC., $4\frac{3}{4}$ in *Ls*, N., 4-$4\frac{2}{3}$ "in the length"). Snout moderate, to anterior eye 3.4 in head; rostral hook stout, its inferior border strongly concave, its length subequal to width of hook, acute, barely extending down to level of maxillary on ocular side. Lower eye slightly in advance of upper, horizontal diameter of latter 1.7 its vertical diameter, 4.4 interorbital (N., about 4), 4.6 (McC., $4\frac{3}{4}$-5, N., $4\frac{1}{4}$-5) in head, 0.7 of relevant preocular length. Mouth small, the two sides not symmetrical; on blind side the dentigerous jaws much alike but upper upwardly convex, a trifle longer than lower, which is upwardly concave; maxillary failing to reach level of eye by about one-fifth eye length; length of lower jaw of ocular side 3.4 (N., $3\frac{1}{6}$-$3\frac{1}{4}$) in length of head. Several minute tubercles on lower lip on ocular side (N., "forming a fringe"). Teeth along whole length of both jaws on blind side, small closely set moderately acute, in a band of subequal width throughout, in 5-6 rows. Nostrils shortly in front of eyes small tubular with very slightly raised rims, anterior larger (McC., on "both sides with posterior lobes"). Upper angle of gill slit about level with inferior orbital border of upper eye, opercular lobe just above pectoral base. Gill rakers minute tubercular (N., about 10) on upper limb of anterior arch. Scales variable; on ocular side mostly cyloid, those behind and below the head either with 2-4 blunt or jagged processes or with 4-6 short tolerably acute processes inserted inside the scale border; those on blind side in general ctenoid with 8-10 slender acute processes with a bifid base and behind these a segment of blunt elevations; extending up dorsal rays, other than some anterior ones, anal and caudal rays for two-thirds of their length or more; not present on pectorals or pelvics. Lateral line almost straight from caudal peduncle to just behind level of pectoral tip where it turns a little upward in a very slightly upwardly convex segment to just above angle of gill slit, then continuing briefly (McC., continuation not shown in figure) in a nearly straight line halfway towards upper eye.

Dorsal 75 (McC., 74-75, N., 74-75) commencing at tip of rostral hook, about 30 (McC., figure, 20) anterior rays more or less free simple slender minutely serrated, forming a crest, the hindmost ray somewhat higher than the more massive ray immediately following it, these later rays briefly bifid, longest 2.5 in head; last ray inserted far back on caudal peduncle almost contiguous with uppermost caudal ray. Anal 55 (McC., 50-51 N., 50-51), in general similar to dorsal but a trifle lower than its postcephalic portion, commencing shortly behind (McC., figure, below) pectoral base, ending barely behind dorsal. Right pectoral 11 (N., 8-10), upper end of its base about level with middle of lower eye, 1.8 in head. Left pectoral 8 (N., no count; McC., overall pectoral range "P. 8-10"), length 0.7 that of (N., equal to) right. Right pelvic 13 (McC., N., 13), its anterior ray at the tip of the isthmus, inserted below jaws of blind side, its base a little longer than head, in line with and joined to anal, posterior rays scaly on ocular side. Left pelvic 5 (McC., N., 3-4), 3 rays close together, the first of these located about as noted by Norman, opposite space between eleventh and twelfth of right pelvic, the 2 others in advance of these separated from them and from each other by almost as great an interval as that between third and fifth rays, total base 4.6 in head. Caudal 3/12/3, rounded, 1.4 in head. Caudal peduncle very short, last dorsal and anal rays almost contiguous with first caudal rays, depth 2.7 in head length.

Where the scales have been lost the pterygiophores form a conspicuous closely set palisade the intervals between them much less than their width, the combined height of the dorsal and ventral series accounting for one-fourth of the depth at opercular border, for rather more near middle of length; the external termination shows a bulbous enlargement, with a suggestion the radial may be briefly bisegmented (or trisegmented), but this point cannot be satisfactorily determined.

Aspects of Form

It has been shown in these contributions that for a wide range of species in a loglog plot length of head length to vent and standard length are effectively collinear on three low natural numbers (modally 1 2 3). While this formulation is appropriate for the majority of forms in which the vent is normally located shortly in advance of a reasonable rearward anal fin, it is clearly not applicable to species with an exceptionally forwardly placed vent. In one such species, *Paratrachichthys traill* (Hutton, 1876), in which the vent lies between the bases of the ventral fins, it is found (see above) that, with logarithmic values as before, a significant straight line is obtained with a reverse pattern of graphing involving a negative slope with standard length on 1 and the other lengths on higher natural numbers in the vicinity of 10 (in this instance 9 10). However, it was questioned whether such a formulation was a biologically significant one or a mathematically neat but adventitious solution. It is thus of interest to note that in the present species as represented by our specimen such a solution with abscissal values of 1 9 10 is statistically significant.

Log L = -0.5410 log N + 3.0002; t 67.547**; calculated (measured) lengths, *TLs*, 288(285) 305(308) 1 000(1 000).

The above results have prompted the examination of another form with the vent close behind the head noted in these contributions, *Carpus rendahli* Whitley, 1941, measurements of a Tasmanian example of which recorded in Part XXIV (1978) yield the subjoined equation, the abscissae here being 1 8 10.

Log L = -0.9895 log N + 3.0013; t 44.049*; calculated (measured) lengths, *TLs*, 103(100) 128(132) 1 003(1 000).

An equation for the low, even curve of the dorsal profile with greatest rate of change of curvature one-tenth, that should not be without comparative taxonomic significance has been computed (displacement in the region forward of the operculum precluded a satisfactory evaluation of the ventral profile). Ten measurements of height of profile, H, above a line joining most advanced point on rostral hook and middle of end of caudal peduncle were made.

H = 138.93 + 22.877 N + 7.11001 N^2 – 2.25042 N^3 + 0.125175 N^4; R 0.9991; calculated (measured) heights, *TLs*, 167(162) 207(203) 221(226) 233(231) 228(222) 208(202) 176(180) 137(142) 101(103) 80(77).

Coloration

After preservation in alcohol both sides are in general more or less uniformly yellowish, blind side the lighter. McCulloch and Normal mention and the former figures minute black dots over the head, body and fins on ocular side: in our pecimen a sprinkling of obscure black dots occurs on the head but only a few are evident on body and fins, the latter overall white. The location of internal organs is indicated by a dark oval patch behind the head above the vent and a pennon-like area beginning immediately behind this and extending just above the ventral pterygiophores back to within about half a head length of caudal origin; also the course of the vertebral column can be traced.

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