OBSERVATIONS ON SOME TASMANIAN FISHES: PART VIII

By

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ABSTRACT

A description is given of the inadequately-known stingray, *Dasyatis brevicaudatus* (Hutton, 1875) [Dasyatidae: Tasmanian representatives keyed], the large female dealt with apparently providing the first formal record of this species from Tasmania. A sample of six specimens of *Muraenichthys breviceps* Günther, 1876 [Echelidae], with a good approximation to a normal distribution of standard length, affords evidence of linear regression of some smaller anatomical features on major body regions. Observations are made on occurrence, nuptial coloration, standard length-total length ratio, and postmortem mouth posture in *Atherina microstoma* Günther, 1861 [Atherinidae]. Ontogenetic features of pigmentation and fin-membrane formation shown by a juvenile *Bovichtus variegatus* Richardson, 1846 [Bovichtidae] are noted. Form and size in the spines of the javelin fish, *Allomycterus pilatus* Whitley, 1931 [Diodontidae: Tasmanian representatives keyed], are briefly analysed.

In this as in some earlier contributions the word *Fishes* is interpreted *sensu lato* to include Elasmobranchs: the series of keys to the Tasmanian members of the families represented by species discussed is continued. Tables of synonymy are set out in general accordance with the well-considered suggestions of Schenk & McMasters (1948); while the selection of data for record in the quantitative specification of populations follows the recommendations of Simpson & Roe (1939). All linear dimensions are recorded in millimetres; except where its absence might lead to confusion, the name of the unit is omitted. Standard length and total length are regularly denoted by the symbols LS, LT, respectively.

Family DASYATIDAE

Australian genera and species enumerated in the Check List (McCulloch, 1929) total 7 and 17: Whitley (1940) recognizes the same number of species (two dropped, two described since 1929) but places them in 9 genera. Both authorities list three species for Tasmania: *Urolophus cruciatus* (Lacépède, 1804)—the synonymic *U. ephippiatus* Richardson, 1845, has Storm Bay, Tasmania as type locality—, *U. bucculentus* Macleay, 1884, *U. viridis* McCulloch, 1916. Earlier McCulloch (1921 b : 465) stated he had seen both *Dasyatis brevicaudatus* (Hutton, 1875) and *D. thetidis* Waite, 1899 trawled off the eastern coast of Tasmania; but he apparently either overlooked this record or was not satisfied with his determinations when he came to compile the Check List, in which localities for the former species are restricted to Bass Strait, New South Wales, South Australia, New Zealand, and for the latter to New South Wales: Whitley (1940) gives the same distributions. A specimen of *Dasyatis brevicaudatus* described below appears to furnish the first satisfactory record of the species from this State. (*See* Addendum, p. 156.)

D. thetidis has recently been recognized (partly on a record dating back to 1881) in New Zealand (Richardson and Garrick, 1953); and I have added it, for reference should occasion arise, to the subjoined key to the local members of the family.

KEY TO DASYATIDAE RECORDED FROM TASMANIA [plus *Dasyatis thetidis* Waite]

A. Caudal fin present. Dorsal fin present or absent. No ventral caudal keel. Disc-width < 2 ft. (modally 15-20 in.).

    B. Length of tail < its distance from mouth. Dark cross-like markings on back .... *Urolophus cruciatus*

    BB. Length of tail > its distance from mouth. No dark cross-like markings on back.

        C. Disc characteristically wider than long (without pelvics). Buccal papillae behind lower jaw more numerous (about 10, or more), their interspaces decidedly < their length. Pale brownish above and below, with numerous small white spots and vermiculations .... *Urolophus bucculentus*

        CC. Disc characteristically longer (without pelvics) than wide. Buccal papillae behind lower jaw less numerous (about 7, or fewer), their interspaces ≧ their length. Mainly light greenish above, whitish marginally; mainly white below, somewhat purplish marginally .... *Urolophus viridis*

AA. Caudal fin absent. Dorsal fin absent. A ventral caudal keel present. Disc-width > 2 ft. (to at least 5 ft.).

    D. Length of tail ≦ length of disc. Spear extending over part of posterior half of tail. Ventral caudal keel not extending to tip of tail; its length < 2 (usually subequal to) length of spear. Upper disc smooth, or with several spine-bearing tubercles .... *Dasyatis brevicaudatus*

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DD. Length of tail $>$ (about 1·3-1·4) length of disc. Tip of spear not reaching nearly to mid-point of tail. Ventral caudal keel extending to tip of tail; its length $>$ 2 (usually 4-5) length of spear. Upper disc largely smooth, but with spine-bearing tubercles tending to form one or more clearly defined longitudinal rows at, or near, middle of disc behind eyes .... *Dasyatis thetidis*

Genus **DASYATIS** Rafinesque, 1810

DASYATIS BREVICAUDATUS (Hutton, 1875)

Trygon brevicaudata Hutton, 1875, *Ann. Mag. Nat. Hist.*, (4), XVI : 317. Type locality : Dunedin, New Zealand.

[?] *Dasyatis brevicaudatus* (Hutton). Waite, 1909, *Rec. Cant. Mus.*, 1 : 151, pl. XXII.

Dasyatis brevicaudatus (Hutton). McCulloch, 1915, Biol. Results Endeavour, III, I : 102, pl. XV, fig. 1, pl. XVII, fig. 1. McCulloch, 1921, *Proc. Linn. Soc. N.S.W.*, XLVI, (4) : 426, text fig. 2. Waite, 1923, Fishes S. Aust.: 51, fig. Garrick, 1954, *Trans. Roy. Soc. N.Z.*, 82, 1 : 189, text figs. 1, 2. McCulloch, *Mem. Aust. Mus. Sydney*, V, 1 : 26.

[*non*] *Dasyatis brevicaudatus* (Hutton). Waite, 1921, *Rec. S. Aust. Mus.* II, I : 31, fig. 44.

[? *part.*] *Dasyatis brevicaudatus* (Hutton). Smith, 1950, Sea Fishes Southern Afr.: 70, fig. 81 (whole fish?; not jaws).

[?] *Trygon schreineri* Gilchrist, 1913, *Trans. Roy. Soc. S. Afr.*, III : 33. Type locality : False Bay, Agulhas Bank, South Africa.

[?] *Dasybatis schreineri* Gilchrist. Barnard, 1925, *Ann. S. Afr. Mus.*, 1 : 76.

Bathytoshia brevicaudata (Hutton). Whitley, 1933, *Rec. Aust. Mus. Sydney*, XIX, 1 : 61. Whitley, 1940, Fishes Aust., 1 : 201, figs. 223, 227, 228, 230, 231.

[*non*] *Bathytoshia brevicaudata* (Hutton). Waite in Whitley, 1940, Fishes Aust., 1, fig. 232.

Material; general remarks.—The present observations were made, on 15th January, 1952, on a large female at East Beach, Ulverstone. One male and three female examples of the eagle ray, *Mylobatis australis* Macleay, 1881, were lying on the sand nearby. These five rays are probably the subject of the following note in *The Advocate* of 17th January. "A party netting" on the eastern side of Button's Creek, "several nights ago caught four stingrays in one haul, the largest measuring six feet long and five feet across. The spear of the largest was 15 inches long. Efforts to kill the ray resulted in a broken oar, and finally an axe was used. Others netted were smaller but nevertheless dangerous. The party netted another ray the same evening".

The recent survey made by Garrick (1954), in the course of his study of this species, of the published data makes very apparent the meagre and inconclusive nature of our present knowledge concerning it. It is evident we are—at any rate in respect of rays from Australian waters—still at the primitive stage of inquiry that calls less for the analysis and comparison of extant information than for the routine accumulation of raw systematic material in the shape of mere observational data. The following fairly detailed notes on the Ulverstone example should make some contribution to the immediate need.

Dimensions.—All measurements made are set out in Table I, grouped, for convenience of reference, under 12 sectional headings.

TABLE I

Dasyatis brevicaudatus (Hutton, 1875). Dimensions of a female from Ulverstone, 15th January, 1952. "Length to" = "length from tip of snout to"; b.p. = between parallels; f.c. = following curve of surface or boundary; d.m. = direct measurement, as with dividers; if no specification, measurement is to be understood to be b.p., if applicable, otherwise d.m. (The larger dimensions were originally recorded to nearest sixteenth of an inch, here converted to millimetres; smaller dimensions taken directly in millimetres.)

Dimension	mm
A. Disc:	
Length to level of posterior border, without pelvics	1156
Length to hindmost point on posterior border of disc: d.m.	1162
Tip of snout to angle (*i.e.*, length of anterior border): d.m.; f.c.	787; 819
Angle to hindmost point on posterior border of disc (*i.e.*, posterior border of pectoral): d.m.; f.c.	781: 797
Length to level of maximum width (*i.e.*, to level of angle)	495
Width at spine t_4 (*i.e.*, at 806 mm behind tip of snout)	1029
Width at dorsal origin of tail (*i.e.*, at 1070 behind tip of snout)	610
Maximum height; length to level of this measurement	260; 580

Dimension	mm
B. Pelvics:	
Length to level of posterior border	1264
Length to middle of interpelvic notch	1171
Spread of pelvics: as they lie; fins pulled taut	457; 500
Anterior outer insertion of pelvic to outermost point on its margin, d.m.; on dorsal surface; on ventral surface	165; 240
Anterior outer dorsal insertion of pelvic to inner end of posterior border: f.c.	419
Anterior outer ventral insertion of pelvic to most anterior point on vent: d.m.	75
Length of hind margin	210
C. Tail, vent, ventral cutaneous keel:	
Length to dorsal origin of tail	1070
Intact proximal tail segment A: length from its dorsal origin; from end of postanal gutter; from middle of vent proper	514, 590, 655
Partly severed tail segment B: length	238
Total length of tail as extant from middle of vent proper	893
Estimated length of complete tail	1010
Total length to: tip of tail as extant; tip of complete tail (estimated)	1822; 1939
Length to anterior margin of vent	894
Length of vent: without; with postanal gutter	70; 100
Maximum width of vent	25
Tail: width; depth; girth:	
Near dorsal origin	124; 77; —
At level of angle of pelvics	101; —; 270
At level of spine t_5 (i.e., at 1298 behind snout-tip)	90; 57; 245
At level of spine t_9 (i.e., at 1481 behind snout-tip)	60; 43; 176
At level of origin of spear (i.e., at 1530 behind snout-tip)	43; 40; 135
At level of termination of spear-groove (i.e., at 1770 behind snout-tip; keel disregarded)	15; 21; —
Length to present origin of ventral cutaneous keel (imperfect anteriorly)	1584
Length of keel (imperfect anteriorly and posteriorly)	237
Height of keel: at present origin; present middle; present termination	10; 19; 12
D. Snout, eyes, spiracles:	
Subtriangular snout-tip (contour laterally lapses freely into fin-border, and limits of the projecting region must be determined more or less arbitrarily): base of triangle; height (anterolateral extent) of triangle	*ca* 30; *ca* 10
Interorbital distance	279
Interspiracular distance (minimum)	241
Length to level of front of spiracles	321
Length of spiracle: b.p.; d.m.	73; 79
Height of spiracular eminence	12
E. Mouth region:	
Length to middle of anterior border of: upper lip; lower lip	205; 231
Width of mouth	140
Length to level of front of internasal flap	145
Anterolateral tip of internasal flap to angle of mouth, d.m.	75
Internarial distance (to outer border of nostrils)	192
Visible dentigerous width of: upper jaw; lower jaw	110; 67
Nasal sac, d.m.: major axis; minor axis	75; 20
Teeth: length (anteroposterior); width	2·5-3; 4-4·5
F. Gill slits, G_1-G_5 :	
Length to most advanced point of: G_1; G_2; G_3; G_4; G_5	360; 405; 450; 497; 538
Distance between successive slits of one side: at outer extremities of slits; at inner extremities:	
G_1-G_2	45; 45
G_2-G_3	45; 40
G_3-G_4	47; 40
G_4-G_5	41; 45

Dimension	mm
Oblique lengths of slits; distances, b.p., between inner extremities of right and left slits:	
G_1	45; 305
G_2	50; 293
G_3	55; 271
G_4	43; 246
G_5	31; 217
G. Large spinous tubercles or bucklers, t_1-t_{10}, on disc (t_1-t_4) and on dorsal surface of segment A of tail (t_5-t_{10}):	
Length to level of spinous tubercle; length of buckler; width of buckler; vertical height of whole structure; sloping height of boss or spine; direct length from tip of snout (t_3 only) or maximum width of spine (t_9 only):	
t_1	11; 3; 3·5; 1·8; —
t_2	21; 3·5; 5; 1·8; —
t_3	234; 3; 4; 1·5; —; 234
t_4	806; 16·5; 9·5; 8; 5;
t_5	1298; 16; 14; 8; 3
t_6	1355; 18; 11·5; 9; 3
t_7	1379; 15·5; 12; 5·5; 1·8
t_8	1419; 17·5; 10; 5; 10·8
t_9 (spine serrated)	1481; 27; 12; 14; 27; 4·5
t_{10}	1503; 16·5; 7; 7; 3
H. Spear and " spear groove ":	
Length to origin of spear	(?) 1530
Spear: length, measured (imperfect), estimated; maximum width (near base)	62, 300+; 14
" Spear groove ": Length to origin; approximate length	1530; 240
I. Selected spinous tubercles on ventral surface of tail: Length to spine:	
Sv_1—first ventral on right side	1424
Sv_2—first ventral on left side	1427
Sv_3—first mesial ventral	1479
J. Selected spinous tubercles on lateral surface of tail: Length to spine:	
Sl_1; Sl_2—first lateral right; second	1325; 1363
Sl_3; Sl_4—first lateral left; second	1348; 1365
K. Spines on ventral cutaneous keel:	
Length to series of spines on external margin; length of series	1744; 78
Maximum width of midlateral band of spines	18
Approximate maximum length of midlateral spine	1
L. Spots on lateral surface of disc:	
Approximate length to origin of: x, the prescapular segment of the line of spots; y, anterior postscapular segment; z, posterior postscapular segment	300; 600; 806
Transverse interval between paired rows at: origin of x; junction of x and y; junction of y and z	655; 345; 370
Minimum distance (right row) of segment x from spiracle, d.m.; distance (right row), d.m., of junction of segments x and y from spiracle	118; 180
Modal diameter of spots	12

General description.—For convenience of comparison, the subjoined account follows, as closely as practicable, the detailed description by Garrick (1954) of his New Zealand specimen, a female of *LT* 64 inches; but it is considerably compressed by omission of all statements involving ratios calculable by reference to Table I: it should be worked through with the table at hand for constant consultation.

Body depressed, thick, subrhomboidal; snout with distinct, bluntly pointed tip. Head wide, not markedly differentiated from disc. Dorsal profile in front of eyes moderately concave. Tail stout, tapered (imperfect distally), tuberculate and spinous (details below); with large serrated spear. Disc with four spines: t_1 mesial, near base of snout-tip; t_2 behind, to right of, sharper than, t_1; t_3 in advance of, nearly as far from main antero-posterior axis as, right eye; t_4 in mesial line. Eyes small, lateral. Spiracles large, ovoidal, postero-lateral to eyes. Gill slits smallish, sigmoid. Nostrils ovoidal, somewhat obliquely transverse. Broad subrectangular internasal flap, slightly wider posteriorly than anteriorly; lateral border markedly sinuate; posterolateral corner fairly acute; posterior edge slightly concave; a stout mesial frenulum. Mouth moderately proconvex. Upper lip with some indeterminate coarse pleats laterally: lower lip with conspicuous forwardly directed lobular projections, a single row of large and some scattered small ones mesially, two rows of small laterally. Both lips laterally bounded by incurving nasoral grooves. When the posterolateral corner of the internasal flap is lifted, three-quarters, or less, of the nasal sac is disclosed, its posteroexternal half being obscured by a second, smaller, forwardly directed flap: of the parallel cartilaginous slats articulated, at right angles, to the transversely oblique cartilaginous stringer, 10 were counted in about 13 mm. Teeth arranged in pavement, quincuncially, not in contact; occlusal surface slightly convex, finely rugose; no cusps noted: only those readily visible were observed, namely, 90-100 in three " rows " in upper jaw, 37 in lower jaw. A good approximation to the modal tooth shape in plan may be obtained thus: in circle draw two radii, meeting at 90°-100°, to represent posterolateral borders; as anterior border, draw flattish curve about midway between arc and chord, giving a lateral-anteroposterior ratio of about 1·6.

Pectorals wide, the anterior margin of each distinctly sinuous—in sequence backwards from base of snout-tip, slightly concave, convex, broadly concave, convex just before angle. Posterior margin evenly rounded; posterior angle bluntly convex. Pelvics with outer lateral margin slightly concave; posterior margin convex; inner lateral margins together forming a wide inverted U; external insertion making deep notch with pectoral.

General plan of vent slenderly ovate-acuminate, but this figure with its posterior border broadly notched mesially; a postanal gutter, deepest anteriorly, its hinder superficial boundary rounded, nicked mesially.

Tail depressed anteriorly, compressed posteriorly. When examined it comprised an intact proximal segment, *A*, followed by an almost severed segment, *B*, imperfect at tip, attached to *A* only by ligament, with the epithelium missing in places for a distance of several centimetres. Serrated spear imperfect proximally (indications of its origin near end of *A*) and distally: portion present adherent to tail. A mesial groove at presumed site of missing anterior part of spear, and behind attached portion. Ventral cutaneous caudal keel along whole of *B*, both its origin and termination missing: its maximum height near middle as preserved. Anterior to spear, in mid-dorsal row on tail six well-separated spinous tubercles or bucklers, t_5-t_{10}. Like t_1-t_4 on disc, each consists of a longitudinally ovoidal shield, from which rises a blunt boss, or, usually, a tolerably sharp spine (in t_9 serrated), from whose base ridges run radially to the (usually crenulate) external border. Besides larger tubercles t_1-t_{10}, others, varying considerably in size, occur on tail, as follows. Ventral surface: extensive anterior surface wholly bare and smooth: to present origin of ventral keel about 54 spines, set irregularly, more densely posteriorly; beside keel bare. Ventral cutaneous keel: posterior one-third carries very small spines along external margin, 32 on right, 28 on left; mostly in single irregular peripheral row, but a few set in a little from margin. Lateral surface: to end of *A*, on right side 69 spines, on left 40; on *B*, at first somewhat irregularly disposed, with some indications of 1, 2, or 3 rows, the larger chiefly anterior and superior; shortly becoming confined to a mid-lateral band; in 215 mm 85 spines. Dorsal surface: except for t_5-t_{10} essentially bare; anteriorly, however, some upper members of lateral series encroach marginally on dorsal surface.

Rays in pectoral about 23 (to angle) + 77; in pelvic about 22.

Dorsal surface of disc slate-grey, evenly gradated, darkest mesially. Two rows of whitish spots, subcircular, or somewhat elliptical, with major axis in most anteroposterior, but in some distinctly transverse. Each series comprises three contiguous segments: segment *x*, with 10-12 spots, begins about midway between spiracle and lateral margin of disc, or rather nearer latter, and runs backwards and inwards, roughly parallel to disc-margin, to scapular region; *y*, with 7-9 spots, a little sinuous, general direction anteroposterior, the two series somewhat convergent caudad, terminating about at beginning of last one-third of disc: *z*, with, on left, one well-defined rounded spot (largest on disc) followed by large anteriorly elongate patch, on right one similar patch only. Ventral surface of disc white, with, from level of mouth caudad, a narrow marginal band of purplish-black, its outer margin complete, its inner in general tolerably sharply defined, but in parts, particularly anteriorly, broken by, and bordered with, scattered islands of dark or darkish spots and splashes; narrowest at beginning, widest (about half mouth-width) at middle of disc or on pelvics. Upper surface of pelvics about concolorous with pectoral margins; lower surface white, with external dark band continued from pectorals sharply delimited internally. Segment *A* of tail: dorsally, dark-brown, darkest mesially; laterally, dark-brown; ventrally, wholly whitish to level of end of pelvics, thereafter whitish laterally (some

purplish mottling continued from sides), otherwise purplish, with some lighter mottling. Segment *B*: dorsally, dark-brown, fairly sharply delimited from sides; laterally, ranging from whitish to pale brownish; ventrally, chiefly whitish. Inferior caudal keel: anteriorly dark-brown in external one-third, rest whitish; a brown band gradually increasing in width posteriorly, finally involving whole keel.

Discussion.—It is not proposed to institute a detailed comparison with descriptions given by Garrick and others; but attention may profitably be called to a few major features: it is unfortunate that critical data are not available on dorsal keel, point of termination of ventral keel, maxillary velum, oral papillae, fimbriation of internasal flap. Generally speaking, the specimen agrees well with Garrick's *Maimai* female, with McCulloch's (1915) male from off Babel Island, and perhaps with *D. schreineri* (Gilchrist) as described by Barnard (1925 : 76). All (except possibly Whitley's example; point indeterminable from photo) have front pectoral margin slightly longer than hind. Noteworthy points in which the Tasmanian differs from the New Zealand example include: (*a*) more prominent snout-tip (Garrick states, however, a small projecting snout characterizes the type; it appears to be conspicuous in Whitley's (1940) fig. 227, and is evident in both McCulloch's (1915) plates); (*b*) shape of teeth (quite different also from Waite's photograph in Whitley; and lacking the cusps noted by McCulloch); (*c*) presence of tubercles on disc (*cf. D. agulhensis* Barnard, 1925; it seems possible, however, that while in Barnard's species the spines may be characteristic, they may here represent nothing more significant than three small additions to the spine in the middle of the back of the type: size and shape of tail differ notably from *D. aghulensis*); (*d*) presence of whitish spots (a similar pattern seems to be recognizable in Whitley's figs. 227, 228); (*e*) internasal valve widest posteriorly (as in McCulloch, pl. XVII); (*f*) various differences in proportion.

The very provisional conclusions derivable from this discussion are formulated in the table of synonymy. I have followed Fowler (1941), Smith (1950), Richardson and Garrick (1953), and Garrick (1954) in non-recognition of *Bathytoshia* Whitley, 1933. (Richardson & Garrick speak of difficulty arising from some measure of obscurity in the diagnosis. The palmary point, however, is procedural: *Bathytoshia* is established essentially by the differentiation of its orthotype, *Dasyatis thetidis* Waite, 1899, from *Dasyatis fluviorum* Ogilby, 1908, orthotype of *Toshia* Whitley, 1933, and not, as the case requires, by the differentiation of *D. thetidis* from *Dasyatis* Rafinesque, 1810, as specified primarily by its genotype, *D. ujo* Rafinesque.)

Family ECHELIDAE

In an earlier contribution in this series (1953) a key to the three Tasmanian echelids—*Muraenichthys breviceps* Günther, 1876, *M. tasmaniensis* McCulloch, 1911, *M. australis* Macleay, 1881—was provided, and some observations were made on an example of the first-named species.

I have since been fortunate in securing five additional specimens of *M. breviceps;* a metrical examination of which yields the interesting result set out below.

Genus **MURAENICHTHYS** Bleeker, 1865

MURAENICHTHYS BREVICEPS Günther, 1876

Muraenichthys breviceps Günther, 1876, *Ann. Mag. Nat. Hist.* (4), XVII : 401.
Muraenichthys breviceps Günther. McCulloch, 1929, *Mem. Aust. Mus. Sydney,* V, 1 : 67. Scott, 1953, *Pap. Proc. Roy. Soc. Tasm.,* 87 : 146 (synonymy).

Material.—Six specimens: (*a*) *LT* 583, Tamar River at Blackwall, 5th July, 1935, Mr. Lyall; (*b*) *LT* 491, Stanley, received 28th February, 1938, Mr. B. Mollison; (*c*)-(*f*) *LT* 393·3, 370·5, 313·5, 234·8, respectively, from stomachs of ling, *Genypterus blacodes* (Bloch and Schneider, 1801), taken on long line in 250-300 fm, off Maatsuyker Island, " a few weeks " before date of receipt, 11th December, 1953, Mr. J. R. Cowper. The sample, it is seen, exhibits a considerable *LT* range: it is significantly symmetrical ($t = 0.41$), and on a range/σ test falls well within the P = 0·05 value for a random sample drawn from a normal population.

Linear regressions.—Analysis of this satisfactorily distributed sample reveals the existence of linear regressions of most of the important anatomical regions and of some diagnostic ratios on *LT*, head length, and so on. These results (Table II) are not only noteworthy in themselves, but would seem to be of special interest in view of the fact that precision measurements of numerically smaller samples, with narrower *LT* ranges, in several echelid genera recently studied by Schultz (1953) in general yield no clear evidence of comparably regular correlation.

For the taxonomist the interest of a regression equation commonly resides not only in the mere establishment of its formal validity, by means of a test of significance, but also in its degree of usefulness as an instrument of prediction in diagnosis: and while the essential information on the second point is of course inherent in a summary, formal guise in a *t*-value, it has seemed worthwhile to study in the table the convenience of the practising systematist by the inclusion, first, of each value of the dependent variable as calculated from the regression equation, and, secondly, in each equation, of the mean divergence, absolute and percentage (sign disregarded), of predicted from observed magnitude. It will be noticed that on several occasions a dimension appears in one equation as a unit (e.g., length to vent) and again in other equations as its components (head, trunk): this course has been followed to permit of direct comparison with data elsewhere in the literature.

Two points of interest emerge regarding what I have elsewhere (1953 : 142) designated Schmidt's index: first, it is here subject to systematic variation (I am not aware of any establishment of this circumstance in Anguillidae, the family for which it was devised); secondly, with a variation of less

TABLE II

Muraenichthys breviceps Günther, 1876. Linear regressions of lengths of certain body regions (and values of some ratios) on lengths of certain important body regions conventionally treated in diagnosis as independent variables. Six specimens: No. 1 Tamar River; No. 2 Stanley; Nos. 3-6 from stomachs of ling, *Genypterus blacodes* (Bloch & Schneider, 1801), off Maatsuyker Island. Observed measurements and directly calculated magnitudes are followed by predicted values in parentheses.

Variate and ratio	Specimen No. (and LT, mm)						Regression equation	$t^{(1)}$	Error of predicted value on observed value	
	1 (583)	2 (491)	3 (393.3)	4 (370.5)	5 (313.5)	6 (234.8)			Mean error (mm or pure number)	Percentage error
Head on LT	44.0 (45.2)	40.0 (39.1)	34.5 (32.7)	30.4 (31.2)	27.5 (27.4)	21.3 (22.2)	$y = 0.06618x + 6.3$	12.96	0.9	3.5
Length to vent on LT	221.8 (222.1)	187.0 (185.5)	146.5 (146.6)	137.0 (137.5)	112.0 (114.8)	85.5 (83.4)	$y = 0.3982x - 10.06$	57.29	1.2	1.0
Trunk on LT	177.8 (176.9)	147.0 (146.3)	112.0 (113.9)	106.6 (106.3)	84.5 (87.4)	64.2 (61.3)	$y = 0.3320x - 16.69$	40.00	1.3	1.8
Tail on LT	361.2 (360.9)	304.0 (305.5)	246.8 (246.7)	233.5 (233.0)	201.5 (198.7)	149.3 (151.4)	$y = 0.6018x + 10.07$	81.80	1.2	0.6
Length to dorsal origin on LT	94.0 (95.5)	83.0 (80.8)	65.6 (65.2)	61.5 (61.5)	52.0 (52.4)	39.3 (39.8)	$y = 0.1605x + 2.07$	23.06	0.8	1.1
Length to anal origin on LT	225.0 (228.7)	191.0 (186.8)	148.2 (148.0)	140.2 (138.9)	115.5 (116.3)	89.5 (85.0)	$y = 0.3973x - 8.27$	63.57	2.5	1.8
Dorsal-anal interval on LT	131.0 (129.5)	108.0 (107.8)	82.6 (84.6)	78.7 (79.2)	63.5 (65.7)	50.2 (47.1)	$y = 0.2368x - 8.49$	28.63	1.6	2.4
Schmidt's index (^{2})	21.92 (21.85)	21.18 (21.17)	20.57 (20.45)	20.38 (20.28)	19.14 (19.85)	19.68 (19.23)	$y = 0.007424x + 17.53$	4.73	0.3	1.3
Snout on head	8.8 (9.1)	8.2 (8.4)	8.2 (7.3)	6.6 (6.5)	5.5 (5.9)	4.5 (4.7)	$y = 0.1963x + 0.48$	6.48	0.4	5.0
Postorbital head on LT	32.8 (32.0)	28.9 (28.7)	22.7 (24.3)	20.7 (20.9)	18.8 (18.6)	14.2 (13.6)	$y = 0.8109x - 3.71$	15.73	0.6	2.8
Postorbital head on head	32.8 (33.2)	28.9 (28.1)	22.7 (22.8)	20.7 (21.6)	18.8 (18.5)	14.2 (14.2)	$y = 0.05449x + 1.39$	25.70	0.4	1.7
Eye-in-interorbital on LT	2.08 (2.09)	1.72 (1.73)	1.36 (1.37)	1.29 (1.28)	1.13 (1.07)	0.73 (0.77)	$y = 0.003777x + 0.12$	27.58	0.02	2.1
Eye-in-interorbital on head	2.08 (2.00)	1.72 (1.78)	1.36 (1.47)	1.29 (1.24)	1.13 (1.08)	0.73 (0.73)	$y = 0.5594x - 0.46$	12.89	0.1	3.7
Eye on head	2.4 (2.9)	2.9 (2.9)	3.6 (3.0)	3.1 (3.0)	3.2 (3.0)	3.6 (3.1)	$y = -0.009563x + 3.28$	0.38	0.3	14.1
Eye on snout	2.4 (2.7)	2.9 (2.8)	3.6 (2.8)	3.1 (3.0)	3.2 (3.1)	3.6 (3.3)	$y = -0.1238x + 3.83$	1.13	0.3	11.5
Eye on interorbital	2.4 (3.0)	2.9 (3.0)	3.6 (3.0)	3.1 (3.0)	3.2 (2.9)	3.6 (2.8)	$y = 0.08341x + 2.63$	0.48	0.3	11.3
Maximum depth on LT	14.0 (15.7)	14.6 (12.7)	10.5 (10.0)	8.4 (9.3)	8.0 (7.8)	5.2 (5.6)	$y = 0.02792x - 1.00$	6.06	0.9	8.5

(1) With D.F. = 4, at $P = 0.1$, $t = 2.13$; $P = 0.05$, $t = 2.78$; $P = 0.01$, $t = 4.60$

(2) Schmidt's index, $S = \dfrac{L_v - L_d}{LT}$, where L_v = length to vent, L_d = length to dorsal origin; LT = total length.

than three units over an LT range of 348·2 mm, or 3·07 σ, it is relatively stable ($V = 4·9$, $V^1 = 5·5$) —in this context it thus appears to be a useful discriminant.

In the material examined, diameter of eye may be absolutely greater in smaller than in larger individuals: the same feature appears in precision measurements by Schultz (1953) of some other Echelidae, and is encountered also in the allied families Ophichthidae and Moringuidae. Several equations in Table II not specifying statistically significant linear relations have been included to illustrate the problem presented by this curious irregularity in eye-size.

Family ATHERINIDAE

In the Check List (McCulloch, 1929), seven atherines are accredited to Tasmania. Some of the early diagnoses are brief and inconclusive, and the data requisite for the satisfactory keying of our fauna are probably not at present available.

Genus ATHERINA Linné, 1758
ATHERINA MICROSTOMA Günther, 1861

Atherina microstoma Günther, 1861, *Cat. Fish. Brit. Mus.*, III : 91. Type locality: Tasmania.
Atherina microstoma Günther. Waite, 1923, *Fish S. Aust.*: 104, fig. on p. 105. McCulloch, 1929, *Mem. Aust. Mus. Sydney*, V, 1 : 108.

Occurrence.—About December-January this species is encountered in countless thousands round our eastern and western (and probably other) coasts. Very young individuals, in which the dull orange yolk sac may still be visible, are very pale greenish, almost transparent; the eye has a broad conspicuous silver annulus. They move slowly, almost at the surface, among weeds or over open sand in shallow water, commonly in schools of from a couple of score to a hundred or more. Specification of LS of a sample netted in The Arm, a long narrow inlet, with a river-like facies, in George's Bay, St. Helens, on 20th January, 1953: n 17; range 12·5-19·1; $\bar{x}$ 15·30 $\pm$ 0·49; σ 2·03 $\pm$ 0·35; V 13·3 $\pm$ 2·4. Larger individuals usually travel in smaller schools, and at a greater depth.

Nuptial attire.—In individuals manifesting the so-called nuptial attire, of which some account, based on material from the mouth of the Glenelg River, near the Victorian-South Australian border, has been given by Waite (1923 : 104), a blood-red bar, expanded somewhat at the hypurals, extends along the midflank, wholly replacing the normal silvery stripe, while, almost always, the whole eye also is a glittering blood-red. While this brilliant display is, indeed, probably associated, as Waite's term would indicate, with sexual activity, an examination of 12 samples, comprising in all 289 specimens collected at The Arm, George's Bay, on 3rd-24th January, 1953, reveals some puzzling features. From data set out in the protocol (Table III) it will be seen, first, that presence or absence of the marking does not appear to be necessarily a matter of mere size; secondly, that of samples caught on successive days one may be wholly affected and one wholly unaffected; thirdly, that preservation in alcohol commonly, but not invariably, elicits either the whole pattern, or, at times,

only the lateral stripe (in, it may be added, varying degrees of intensity) from individuals devoid of it in life. It is not improbable the bright red pattern is, totally or sectionally, under hormonal control.

Postmortem mouth posture.—Attention was called earlier (1953 : 156) to specific differences in the relative postmortem positions of some of the mouth elements in the case of two common rock-pool fishes, *Bovichtus variegatus* Richardson, 1846, and *Pictiblennius tasmanianus* (Richardson, 1849) (derrised specimens). In one series of the present material intraspecific variation was observed. All specimens of a sample of 22 trapped on 22nd January, 1953, and left overnight in a bucket were dead next morning: 12 died with mouth wide open, fully protracted, incapable of being permanently closed; three with mouth open, but, after a little manipulation, capable of being restored temporarily to the normal retracted position; seven with mouth closed. As the accompanying protocol (Table IV) shows, postmortem mouth posture in this sample is significantly associated with size of fish. With the two subgroups of open-mouths pooled to give a twofold table for LS and mouth posture, adjusted χ^2 is 4·95.

Length of caudal.—While length of caudal is not a constant fraction of LS, and is hence not amenable to the familiar naïve formulation, "x is a in y" ($y = ax$), it is nevertheless, with very good statistical accuracy, a simple function of length of fish. However, whereas in another small locally-found fish, *Galaxis attenuatus* (Jenyns, 1842), the LT-LS relation has been shown (Scott, 1938 : 120) to be allometric ($LT = bLS^k$), it is here isogonic ($LT = mLS + k$), thus affording a further instance of the marked tendency towards form-constancy found, since the work of Hecht (1916), to be generally characteristic of fish. Data are exhibited in Table V, accompanied by the calculated magnitudes of LT given by the equation $LT = 1·1568LS + 1·03$, computed from actual means of LS classes (not class-marks) and unweighted LT means. As will be seen, the fit is extremely good ($t = 78·72$). It has been thought expedient to employ a rather small class-interval ($h = 3$); well-filled terminal classes being sacrificed to gain as wide a range as practicable.

The range of variation of LT associated with a given magnitude of LS may be directly illustrated: for seven specimens of LS 36, LT is 40·9, 42·2, 42·5 (2), 42·7, 43·1 (2); for 5 of LS 34·9, LT is 39·2, 40·8, 41·1, 41·2 (2); for 5 of LS 40·0, LT is 47·0, 47·4, 47·9, 48·1 (2)—giving V 1·7, 1·9, 0·9, respectively.

Family BOVICHTIDAE

A key to Tasmanian members of the family has been given in a previous contribution 1953 : 155).

Genus **BOVICHTUS** Cuvier & Valenciennes, 1831.
Bovicthys variegatus Richardson, 1846, *Zool. Voy. Erebus and Terror, Fish.*: 56, pl. xxxiv, figs. 1-4. Type locality: Port Jackson.
Bovichiths roseo-pictus Hutton, 1904, *Trans N.Z. Inst.*, xxxvi : 148.
Bovichtus variegatus Richardson. McCulloch, 1929, *Mem. Aust. Mus. Sydney*, V, III 336. Scott, 1953, *Pap. Proc. Roy. Soc. Tasm.*, **87** : 155.

TABLE III

Atherina microstoma Günther, 1861. Presence or absence of nuptial attire before, and after, preservation in alcohol; 12 samples (289 specimens) from The Arm, George's Bay, St. Helens. Asterisk = color pattern present; zero = color pattern absent; dash = no record: first mark of reference specifies state before, second state after, preservation.

Standard length class (mm)	I 3/1/53	II 10/1/53	III 11/1/53	IV 11/1/53	V 13/1/53	VI 13/1/53	VII 16/1/53	VIII 17/1/53	IX 19/1/53	X 20/1/53	XI 22/1/53	XII 24/1/53
29–34	—	2^{**}	2^{**}	8^{0*}	—	—	1^{0*}	5^{0-}	$2^{00},1^{**}$	—	1^{0*}	—
35–40	1^{**}	11^{**}	13^{**}	26^{0*}	$1^{0-},1^{*-}$	2^{00}	$5^{0*},2^{00}$	27^{0-}	$7^{00},2^{**}$	4^{0-}	6^{0*}	—
41–46	—	10^{**}	7^{**}	3^{0*}	$9^{0-},3^{*-}$	—	1^{00}	15^{0-}	6^{00}	—	7^{0*}	1^{0-}
47–52	—	9^{**}	1^{**}	4^{0*}	2^{0-}	—	3^{00}	12^{0-}	$3^{00},1^{**}$	3^{0-}	6^{0*}	—
53–58	—	11^{**}	1^{**}	1^{0*}	—	—	2^{00}	7^{0-}	2^{00}	1^{0-}	2^{0*}	1^{0-}
59–64	—	5^{**}	—	1^{0*}	—	—	1^{00}	5^{0-}	—	—	—	—
65–70	—	2^{**}	—	1^{0*}	1^{0-}	—	—	1^{0-}	1^{00}	—	—	—
71–76	—	2^{**}	—	1^{0*}	—	—	1^{00}	1^{0-}	—	—	—	—
77–82	—	1^{**}	—	—	—	—	—	—	—	—	—	—
83–88	—	1^{**}	—	—	—	—	—	—	—	—	—	—
Total	1	54	24	45	17	2	16	73	25	8[1]	22	2

[1] This sample included a ninth specimen of L_S 18.4 (no colour pattern).

TABLE IV

Atherina microstoma Günther, 1861. Postmortem mouth posture and size of fish (standard length); 22 specimens, trapped, The Arm, George's Bay, St. Helens, 22nd January, 1953. Double asterisk = mouth open and permanently protracted; single asterisk = mouth open and protracted, but retractable and closable; zero = mouth closed.

Standard length (mm)	Post mortem mouth posture	Standard length (mm)	Post mortem mouth posture	Standard length (mm)	Post mortem mouth posture
31.4	0	41.7	0	47.8	* *
35.2	*	42.0	*	49.0	* *
35.6	0	42.7	0	49.0	* *
37.3	0	43.6	* *	50.7	* *
37.4	0	44.6	* *	51.9	* *
38.2	0	45.2	* *	53.0	* *
39.3	0	47.3	* *		
41.1	*	47.8	* *		

TABLE V

Atherina microstoma Günther, 1861. Linear regression of total length (LT) on standard length (LS): predicted values of LT calculated from the equation: $LT = 1.1568\ LS + 1.03$ mm. Material (272 specimens) trapped; The Arm, George's Bay, St. Helens, January, 1953.

LS class (class mean)	No. of speci- mens	LT Ob- served	LT Pre- dicted	LS class (class mean)	No. of speci- mens	LT Ob- served	LT Pre- dicted	LS class (class mean)	No. of speci- mens	LT Ob- served	LT Pre- dicted
17–19 (18.4)	1	21.6	23.31	47–49 (48.24)	26	56.80	56.83	68–70 (69.97)	3	82.30	81.97
29–31 (30.98)	4	36.40	36.86	50–52 (51.44)	18	60.46	60.53	71–73 (72.40)	2	85.50	84.78
32–34 (33.63)	25	40.27	39.93	53–55 (54.46)	14	64.62	64.02	74–76 (75.60)	3	89.97	88.48
35–37 (36.19)	52	42.91	42.89	56–58 (57.16)	9	67.29	67.15	77–79 (78.1)	1	91.4	91.38
38–40 (39.34)	54	46.65	46.54	59–61 (60.48)	9	71.12	70.99	80–82 (83.2)	1	95.3	97.27
41–43 (42.32)	29	50.27	49.99	62–64 (63.23)	3	74.67	74.18				
44–46 (45.27)	16	53.63	53.39	65–67 (66.50)	2	76.40	77.96				

Juvenile characters.—A specimen of LS 30·5, LT 37·1, *i.e.*, rather less than one-seventh full grown— the smallest individual I have examined—obtained by derrising a rock pool at East Beach, Low Head, Northern Tasmania, on 14th December, 1953, shows several interesting ontogenetic features.

In the pectoral, ray 1 (uppermost) is simple; 2-8 are cleft distally; 9, 10 are scarcely divided; while 11-15 are simple, thickened throughout, bluntly pointed; but the extensive incision of the last few (usually five) interspaces that forms so characteristic a feature of the adult is represented only by two barely discernible scallopings at rays 13-14 and 14-15. In the distal half of the anal, however, emargination is fairly pronounced.

Complex color patterns, consisting essentially of more or less clearly developed alternate dark and light rows of spots, or imperfect bands, subparallel to free margin, that characterize all fins, except anal, in the adult are here present in very diverse stages of manifestation. From first dorsal caudad the normally patterned unpaired fins exhibit a negative gradient of ornamentation development. In the first dorsal pigmentation is quite extensive, and three or four interrupted cross bars are well marked: in the anterior half of the second dorsal are rudiments (visible only with lens) of three or four blackish bars; in the third one-fourth of fin a few very small chromatophores indicate the position of one or two bars; while in last one-fourth membrane and rays alike are virtually colorless:

in the caudal only the submarginal dark bar is observable, being represented by two to eight (modally about six) minute melanophores along either border of each ray, the pigmentation being most advanced on the lateral rays (except outermost, which is either pigmented only along its external margin—superior ray; or wholly unpigmented—inferior ray), and being much less obvious on the central two or three. In the ventral there are small clusters of chromatophores at base of spine; also beyond, at, before middle of 1st, 2nd, 3rd rays, respectively. The beginnings of a dusky bar mark the pectoral base; and a few punctulations occur elsewhere, mainly near middle of fin.

The large size of the eye (3·0 in head) results in minimum distance of eye from preorbital being less than one-fourth, compared with adult ratio of about one-half, orbital diameter: and interorbital becomes disproportionately large, being 5·3 (in adult 8-10 in head).

Family DIODONTIDAE

The two Tasmanian representatives are a globe fish, *Atopomycterus nicthemerus* (Cuvier, 1818), and a javelin fish, *Allomycterus pilatus* Whitley, 1931: in all published local lists our javelin fish is identified, apparently incorrectly (Whitley, 1931 : 125), with *Diodon jaculiferus* Cuvier, 1818, which is a West Australian form. The eastern form has been described and figured by McCulloch (1921 *a*).

KEY TO DIODONTIDAE RECORDED FROM TASMANIA

A. Spines slender, subcylindrical, two-rooted, movable; their modal length on midflank $\geqq$ minimum depth of caudal peduncle; about 13 in longitudinal line from nostril to dorsal origin. D. *ca* 12. A. *ca* 12. Head > ⅓ total length. Dorsal base < twice minimum depth of caudal peduncle; $\leqq$ eye .... *Atopomycterus nicthemerus*

AA. Spines usually massive, a postpectoral pair somewhat depressed, the remainder compressed (often javelin-like); three-rooted, fixed (except two-rooted, movable postpectoral pair); their modal length on midflank < minimum depth of caudal peduncle; about 7 in longitudinal line from nostril to dorsal origin. D. *ca* 16. A. *ca* 16. Head $\leqq$ ⅓ total length. Dorsal base > twice minimum depth of caudal peduncle; > eye .... *Allomycterus pilatus*

Genus **ALLOMYCTERUS** McCulloch, 1921

ALLOMYCTERUS PILATUS Whitley, 1931

Allomycterus pilatus Whitley, 1931, *Rec. Aust. Mus. Sydney*, xviii, 3 : 125. Type locality: New South Wales.

[*non*] *Diodon jaculiferus* Cuvier, 1818, *Mem. Mus. d'Hist. Nat. Paris*, IV : 130, pl. VII, central fig.

Chilomycterus jaculiferus (Cuvier). Johnston, 1883, *Pap. Proc. Roy. Soc. Tasm.* (1882): 136. Johnston, 1891, *Pap. Proc. Roy. Soc. Tasm.* (1890) : 17.

Allomycteris jaculiferus (Cuvier). McCulloch, 1921, *Rec. Aust. Mus. Sydney*, xiii, 4 : 141, pl. xxxiii, fig. 2. Lord, 1923, *Pap. Proc. Roy. Soc. Tasm.* (1922): 72. Lord and Scott, 1924, *Synopsis Vert. Anim. Tasm.*: 95.

[*part.*] *Allomycterus jaculiferus* (Cuvier). McCulloch, 1929, *Mem. Aust. Mus. Sydney*, V, iii : 434—eastern Australian records (N.Z.?).

Occurrence.—Though, unlike *Atopomycterus nicthemerus*, this species does not appear—*fide* Johnston (1883 : 136, 137)—in Allport's MS List, Johnston himself notes "common". It is, however, either much less abundant, or more local, than the slender-spined species. Along the North-West Coast I have encountered, over many years, scores of beach-dried examples of the latter, but I have secured only one javelin fish, a fairly freshly stranded specimen found on East Beach, Ulverstone, on 13th February, 1955.

Fin counts and dimensions.—D. 16. A. *ca* 15. P.? C. 9. *LS* 280. Length to origin of: pectoral *ca* 100, dorsal 215, anal 220. Fin base, between parallels, direct: dorsal 33, 36; anal 24, 25. Snout 24. Horizontal, vertical diameter of orbit 25, 28. Bony interorbital 51 anteriorly, 78 posteriorly. Internarial distance 34. Depth 125.

Caudal rays.—The caudal exhibits a peculiarity that appears to have been generally overlooked. The hard hyaline fin rays are either divided, or very readily fissile, throughout their whole length, in the sagittal plane. Attention has been called elsewhere in these studies (1953 : 161) to the existence of a similar condition in *Brachionichthys hirsutus* (Lacépède, 1804).

Spines.—As Waite (1923 : 229) justly observes, whereas the globe fish is defended directly by its long movable two-rooted spines, the javelin fish is protected mainly by the cuirass formed by the relatively large and massive roots by which all spines save two are held immovable. In the collapsed skin, from which there were recovered 218 perfect and 2 imperfect spines, the imbrication of the roots had led to the production of a lattice of remarkable complexity and strength.

Considering them simply in terms of mere location, and disregarding strains resultant upon muscular stresses, we may probably regard all the spines, without exception, as a series of three-dimensional solutions of the problem of the projection on to the complex surface of a bilaterally symmetrical subprolatum of an archetypal plane triradial root system, with the paired shorter limbs collinear, and the azygous (anatomically, cephalad)

root normal to them; to which radical complex the spine is added primitively as a fourth radial element collinear with, and in sense opposite to, the unpaired root (for its plane of development, see below).

A formal analysis of observed modifications of the basic plan has been made, and has been found to involve 40 categories, with the lowest infracategory at the fifth level of subordination. It will suffice here to call attention to a few of the chief features of interest. For convenience of description, let a typical item be oriented in the same relation to the observer as the inverted typographical mark of reference, the dagger (†), on the page: the azygous root (a) will be taken to be directed forwards, and the spine (s) backwards, while the paired roots will be right (r) and left (l). Then with a, r, l coplanar and the system symmetrical, r and l may become convergent backwards (at most to a slight degree; more pronouncedly when r and l are curved), or forwards (modally to about 160°; minimum angle 65°): asymmetry may be introduced by inequality of angles made by r with a and by l with a (maximally, one about thrice the other), by variations in relative shape and size of r and l, by curvature of r, l, or a, by combinations of these modifications, and so on. When we come to deal with three dimensions, the situation obviously becomes highly complex: in general, if a, the lower surface of which is rectilinear or very nearly so, is taken to be in the primitive plane, r and l are bent downwards, modally to about the same extent. Roots are frequently somewhat spatulate distally; if to varying degrees, least so in a.

When typically developed, s appears to be essentially a continuation forward of a; though it may, and commonly does, have a conspicuous hyaline rootlike substructure extending not only along a, but also, and at but little lower level of development, along each of r and l, the inferior junction of the three usually forming a small transverse slot or shallow cavity. Among the larger items, s is large (from basal slot to tip about one-third a), strongly compressed, straight, lanceolate, its tip about as high above slot as latter is above level of tips of r and l, so that it projects well beyond anterior borders of a and l. Among smaller items, it tends to be relatively shorter and less compressed, to have anterior border concave, and to be set at a greater (though variable) angle to a, so that its tip often fails to reach anterior root-contour. In four pairs of items, s has been subject to a torsion that results in its coming to lie virtually along r or l: in one of these pairs (from caudal peduncle) s is very large, its length from slot (17) being subequal to length of r or l.

The two anomalous movable postpectoral spines, which are commonly said to be two-rooted are, indeed, virtually so: each, however, has a rudiment, or (in the light of the interpretation of the pattern advanced above, perhaps more probably) a vestige, of a third root. In both, s is slenderly pointed, much depressed proximally, slightly depressed distally; in lateral view gently sigmoid.

It was suggested above that the archetypal triradiate root system was plane; the question of the plane of the fourth element, the spine, being left open. Now, a coplanar system of four elements, of which three are roots and one a spine, would clearly have no, or little, functional value if set, as the case requires, in the integument subparallel to its surface. Hence, for a radical constellation so disposed, the spine-tip must rise above the root-plane. However, it is of much interest to note that in the "two-rooted" spines r, l, and s and the minute a are effectively coplanar; the erection and depression of s being brought about by rotation of the $(r + l)$ spindle, a movement uninhibited by the degenerate a. Hence we may perhaps regard two-dimensional symmetry as formally prior to three-dimensional.

Length of unpaired root, measured from its junction with anterior border of paired roots: n 216; range 7·8–31·1; $\bar{x}$ 17·97 ± 0·33; σ 4·79 ± 0·023; V 26·6 ± 1·3. Span (direct from tip to tip) of paired roots: n 216; range 9·4–45·1; $\bar{x}$ 24·43 ± 0·58; σ 8·47 ± 0·041; V 34·7 ± 1·7.

In view of the relatively self-sufficient character of a, it might be expected that the distribution of its length would approximate the normal. Calculation gives g_1 0·087 ± 0·17, g_2 — 0·28 ± 0·33; the departures from normality (platykurtosis, positive asymmetry) being non-significant ($t = 0·52, 0·87$). On the other hand, variation in the span $(r + l)$ is clearly likely to be complex, being dependent on a number of variables, of which some have been noted above; and it is found the frequency distribution shows pretty clear indication of being multimodal, with a primary mode at 25, tolerably well-marked subsidiary modes at 16, 34, and perhaps another at 42.

ADDENDUM

It is noted above (p. 1) that *Dasyatis brevicaudatus* (Hutton) is not recorded for Tasmania by McCulloch (1929) or Whitley (1940), and it is suggested that the individual here described provides perhaps the first formal record for this State. While this paper has been in press, the section on the family *Dasyatidae* in Mr. I. S. R. Munro's *Handbook of Australian Fishes* (now appearing in parts in the *Fisheries Newsletter*) has been published: localities there given for this species are New South Wales, Victoria, South Australia, Tasmania, southern Western Australia.

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