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## A review of the Australasian genus *Pseudophycis* (Gadiformes: Moridae), redescribing its four species and resurrecting the name *Physiculus palmatus* Klunzinger, 1872, for the Australian Red Cod

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### Abstract

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The commercially fished Red Cod *Pseudophycis bachus* Forster in Bloch and Schneider, 1801, is shown on the basis of both morphological and genetic evidence to be confined to New Zealand waters. The separation of the closely related but distinct Australian cognate brings the number of species in the Australasian genus *Pseudophycis* to four. The name *Physiculus palmatus* Klunzinger, 1872, which was long thought to be a junior synonym of *Pseudophycis barbata* Günther, 1862, is demonstrated to have been originally proposed for the Australian endemic *Pseudophycis palmata* (new combination) differs from *P. bachus* in having a prominent black blotch or spot basally on the pectoral fin that does not extend dorsally onto the body, in contrast to distinctly extending onto body, the second dorsal fin with 47–56 rather than 40–45 rays, the anal fin with 50–57 rather than 42–48 rays and the vertebral column with 47–50 rather than 44–46 total vertebrae. Diagnoses, colour descriptions, images and distributions for all four species and a key to members of the genus are provided.

### Keywords

Teleostei, Actinopterygii, morphology, re-description, comparison, distribution, COI

### Introduction

In an annotated catalogue of gadiform fishes of the world, Cohen et al. (1990) treated the morid genus *Pseudophycis* as comprising three species: *Pseudophycis bachus* Forster in Bloch and Schneider, 1801, *P. barbata* Günther, 1863, and *P. breviscula* Richardson, 1846, all confined to the temperate waters of New Zealand and Australia. The taxonomy followed Paulin's (1983) review of New Zealand species of Moridae that concluded that only three are present in New Zealand and Australian waters, despite the historical confusion over which names apply to the various *Pseudophycis* species. Paulin did, however, observe meristic variations in fin ray and scale counts between New Zealand specimens and the limited number of Australian specimens of *P. bachus* at his disposal, saying "examination of a larger sample of Australian specimens might show some differences but, in view of the variability within species of Moridae, there would probably be little justification for separating the populations at the species level" (Paulin, 1983, p. 92). Subsequent authors (e.g. Gomon in Gomon et al., 1994; Kuitert, 1993; Last et al., 1983; Paxton and Hanley in Paxton et al., 1989; Paxton et al., 2006;

Yearsley et al., 1999) dealing with temperate Australian fish biodiversity followed Paulin (1983) and Cohen et al. (1990) in treating the Australian Red Cod as conspecific with the New Zealand species.

Smith et al. (2008) detected genetic differences between Australasian samples of *Pseudophycis* using the COI locus. Their work included eight samples of *P. bachus*, four each from Australia and New Zealand, six samples of *P. barbata* from Australia, but no samples of the third species, *P. breviscula*. They found differences between the *P. bachus* samples from the two countries that were equivalent to differences between *P. barbata* and each of the two *P. bachus* morphs, suggesting species-level differences between all three. These genetic discrepancies were supported by work of Kemp (2010), who observed that there are a number of differences between individuals from Australian and New Zealand waters and that morphometric and meristic characteristics of *Pseudophycis* species in Australian waters have been poorly documented. She compared 50 Australian specimens with 160 from New Zealand, both series identified as *P. bachus*, and found

significant differences in mean values for the second dorsal (50.2 vs. 42.8, respectively) and anal (52.1 vs. 45.0) fin ray counts, as well as pyloric caeca (9.6 vs. 6.0). These observations provided the incentive to further compare the Australian and New Zealand populations with each other and with the other two long-recognised members of the genus, *P. barbata* and *P. brevisuscula*. The outcome was a recognition of four easily distinguished species in the genus and the initiation of research on the scientific name for the Australian Red Cod.

The Australian Red Cod is a relatively common demersal species, distributed in the shelf waters of south-eastern Australia (Gomon in Gomon et al., 2008). It is an important prey species for some high trophic level predators, including little penguins, *Eudyptula minor* (Chiaradia et al., 2003; Cullen et al., 1992; Montague and Cullen, 1988), Australian fur seals, *Arctocephalus pusillus doriferus* (Gales and Pemberton, 1994; Hume et al., 2004; Kirkwood et al., 2008; Littnan et al., 2007), and New Zealand fur seals, *Arctocephalus forsteri* (Page et al., 2005). The trophic role of Australian Red Cod as prey, coupled with its relatively common occurrence, suggests that this species is particularly important in Australian waters. Humans include these fishes as part of the non-targeted bycatch consumed annually, although the species is more frequently discarded than retained (pers. comm. M. Tudman, Bycatch Reduction Program Manager, Australian Fisheries Management Authority, 2008).

This contribution provides a name for the endemic Australian Red Cod, a detailed description that distinguishes it from the New Zealand *P. bachus*, descriptions for the four species in the genus and a dichotomous key to the species.

## Methods

Morphometric methodology mostly followed Paulin (1983), Trunov (1990), and Markle and Melendez (1988); measurements were taken directly (point-to-point) except that measurements between fins were horizontal distances between vertical projections at the origins of each fin, caudal peduncle length was taken from the posterior end of the anal fin base to the hypural joint, caudal-fin length was from the hypural joint to the fin tip, and lengths of gill rakers and filaments were taken at or adjacent to the angle of the gill arch. In lists of specimens examined, numbers of specimens and their standard lengths in mm are placed in parentheses after registration numbers, except for lots containing only a single specimen where only the length is presented. Meristic methods are those of Hubbs and Lagler (1947) where counts of unpaired fins and vertebrae were taken from radiographs, the number of trunk centra was counted from the cranium to the last centrum with pleural ribs and counts of tail centra exclude the urostyle. Selected meristic and relative morphometric ranges for the four congeners are presented in Tables 2–4. Other materials examined are in the ichthyological collections of the Australian Museum (AMS), Natural History Museum (formerly British Museum [Natural History]; BMNH),

Australian National Fish Collection (CSIRO), Museums Victoria (NMV), Museum of New Zealand Te Papa Tongarewa (NMNZ), South Australian Museum (SAMA), Staatliches Museum für Naturkunde, Stuttgart (SMNS) and Western Australian Museum (WAM).

*Genetic material and sequences.* A genetic analysis of mitochondrial cytochrome oxidase subunit I (COI) gene was carried out on 72 sequences from muscle tissues, representing 5 terminal taxa of the family Moridae.

The dataset included 61 sequences from the BOLD database ([www.boldsystems.org](http://www.boldsystems.org)) and 11 sequences newly generated for this study (see Appendix 1 for list of material and BOLD and GenBank accession numbers; vouchers for tissues yielding sequences in the material examined lists are indicated by a dagger †), including 18 specimens of *Pseudophycis bachus* from New Zealand, 23 *P. barbata* from Australia and New Zealand, 12 *P. brevisuscula* from Australia and New Zealand, 12 *P. palmata* from Australia, and 7 *Auchenoceros punctatus* from New Zealand as a morid outgroup.

Genomic DNA was extracted from the 11 (7 *P. bachus* [including neotype], 2 *P. brevisuscula* and 2 *P. barbata*) additional ethanol-preserved muscle tissues (Appendix 1) using DNeasy blood and tissue kit (Qiagen). A fragment of the COI gene was PCR amplified and sequenced using thermocycling conditions and primers (FishF2 and FishR1) from Ward et al., 2005). PCR products were purified by digestion with the ExoProStar (Illustra) or with the Zymo DNA Clean and Concentrator (Zymo Research, USA), following the manufacturer's instructions. PCR products were sequenced in both directions on an ABI-3730 (Massey University Genome Service, Palmerston North, New Zealand or Macrogen, Seoul, South Korea). Newly generated sequences were deposited in GenBank (see Appendix 1 for a list of voucher specimens and their accession numbers).

*Phylogenetic analyses.* All 72 sequences were individually aligned in ClustalW using the software Geneious Prime v10.0.5. The COI alignment contained no insertions or deletions. Maximum likelihood, neighbour joining and maximum parsimony trees were used to visualise distance relationships within and between species; node support was assessed with 1,000 bootstrap replications of each tree. For the maximum likelihood analyses, the most appropriate model of sequence evolution for each dataset was determined using the Akaike information criterion in ModelTest; the HKY + G model was selected (Hasegawa et al., 1985) because it was the best performing of 24 different nucleotide substitution models tested in the model selection option of MEGA version X (Kumar et al., 2018). A discrete gamma distribution was used to model evolutionary rate differences between sites (5 categories, +G, parameter = 0.3772). In addition, a neighbour joining tree was estimated using p-distances (uncorrected distances). The p-distance is the proportion of nucleotide sites at which two sequences being compared are different. It is obtained by dividing the number of nucleotide differences by the number of nucleotides

compared. It does not make any correction for multiple substitutions at the same site, substitution rate biases (e.g. differences in the transitional and transversional rates), or differences in evolutionary rates between sites. For the maximum parsimony analyses, a heuristic search algorithm with 1000 random addition sequence replicates and tree bisection and reconnection branch swapping methodology was used. Nodal support was tested with 500 bootstrap pseudo-replicates, with ten random addition replicates for each pseudo-replicate.

### Multivariate analysis of morphological data

To investigate the *a priori* grouping by species, a canonical analysis of principal coordinates (CAP) was performed using normalised Euclidean distances between specimens (Anderson and Willis, 2003). CAP is equivalent to a classical discriminant analysis. Leave-one-out mis-classification error (Lachenbruch and Mickey, 1967) was used to obtain a direct measure of the ability of the CAP discriminant model to identify species on the basis of the 20 characters. This cross-validation provided a rigorous assessment of the distinctiveness of the four species of *Pseudophycis*. The following 20 characters, measured in 124 *Pseudophycis* specimens of the four species (see material examined), were used in the analysis: anal fin base length, barbel length, caudal peduncle depth, caudal peduncle length, caudal fin length, first dorsal fin base length, first dorsal fin longest ray length, head length, orbit diameter, pectoral fin base width, pectoral fin length, pelvic fin length, postorbital length, pre-dorsal fin length, pre-anal fin length, pre-pectoral fin length, pre-pelvic fin length, pelvic fin origin to anal fin origin length, second dorsal fin base length, and snout length.

### Genus *Pseudophycis* Günther, 1862

*Pseudophycis* Günther, 1862: 350, type species: *Lota breviscula* Richardson, 1846, by monotypy.

*Austrophycis* Ogilby, 1897: 90, type species: *Austrophycis megalops* Ogilby, 1897 (= *P. breviscula*) by monotypy.

*Physiculus* (*Pseudophycis*) Whitley, 1956: 403, taxonomic decision.

**Diagnosis.** Morid fishes with an elongate body. Luminescent organs absent. Snout broadly rounded in dorsal view, not projecting greatly beyond mouth, length about equal to interorbital width. Eye diameter much less than postorbital length. Each jaw with broad band of small, depressible, caniniform teeth of uniform size. Vomerine teeth absent. Chin with well-developed, often small, barbel. Branchiostegal rays seven. Gill rakers of outer branchial arch short or of moderate length. Otolith with ostium approximately equal to the cauda (1:1 to 1:1.4), the crista superior as long as or longer than the crista inferior; otolith thickness 20–22% of its length (Paulin, 1983). Scales small, covering body and head; extending onto loose membranes enveloping the bases of dorsal and anal fins; lateral line pores at ends of short tubes from naked strip not associated with individual scales. Two dorsal fins and one anal fin, first dorsal slightly taller than, immediately adjacent to and joined to second by low membrane, with 8–14 rays, first ray not

prolonged; second dorsal and anal fins with elongate bases, of nearly uniform height; caudal fin separate, rounded or truncate. Ventral fins composed of five or six rays, the two outermost longest and projecting beyond fin membrane but not greatly prolonged.

**Etymology.** The feminine name *Pseudophycis* is an amalgamation of the Greek words *pseudos*, meaning “lie” or “false”, and *phykis*, “a fish living among seaweeds” (Brown, 1954) and the source word of the scientific name for the North Atlantic gadid genus *Phycis* Walbaum, 1792, in reference to the overall resemblance of species of the two genera to one another.

**Distribution.** Species of the genus are endemic to coastal waters of temperate Australia and New Zealand.

**Remarks.** Species referable to the genus *Pseudophycis* were described or treated as members of seven morid genera based on the superficial resemblances of species in the genera to one another. These include: *Gadus* Linnaeus, 1758, type species *Gadus morhua* Linnaeus, 1758, by subsequent designation of Jordan and Gilbert (1883: 802); *Enchelyopus* Bloch and Schneider, 1801, type species *Gadus cimbricus* Bloch and Schneider, 1801, by subsequent designation of Jordan and Evermann (1898: 2560); *Lota* Oken, 1817, type species *Gadus lota* Linnaeus, 1758, by subsequent tautonymy (Fricke et al., 2019); *Lotella* Kaup, 1858, type species *Lota phycis* Temminck and Schlegel, 1846, by monotypy and *Physiculus* Kaup, 1858, type species *Physiculus dalwigki* Kaup, 1858, by monotypy (see species treatments for details). *Austrophycis* Ogilby, 1897, caused particular confusion until Sazanov (2001: 343) identified the type specimen of *A. megalops* as *P. breviscula* (Richardson, 1846). The genus *Pseudophycis* comprises four species.

**Genetic analysis.** Concerted efforts to document genetic sequences for the CO1 gene across Australasian fish species as part of the Fish Barcode of Life project provided an additional means of testing suspect species concepts. A preliminary comparison of sequences of New Zealand and Australian specimens identified as *P. bachus* and *P. barbata* in BOLD had already revealed potentially cryptic sister species on either side of the Tasman Sea. Sequences for specimens identified as *P. bachus* had low divergence among specimens within Australia (0.002) and within New Zealand (0.000) but high sequence divergence in the pooled data (0.086) typical of species pairs (Smith et al., 2008: 8, fig. 5).

A comparison of a larger set of sequences for Australian and New Zealand specimens identified as species of *Pseudophycis*, plus sequences of specimens of *Auchenoceros punctatus* as an outgroup, generated a tree with five inferred species branches, four having a common basal node for vouchers identifiable as *P. barbata*, *P. breviscula*, *P. bachus* and *P. palmata* (Ward pers. comm.; fig. 1). Importantly, the branches of *P. bachus* and *P. palmata*, previously thought to be conspecific, are of about the same lengths as those of *P. barbata* and *P. breviscula*, despite the morphological differences distinguishing the latter two (Table 1).

### Key to species of *Pseudophycis*

1. Caudal margin truncate with angular corners in specimens larger than about 150 mm SL, central caudal fin rays distinctly shorter than those extending to the corners; basal portion of pectoral fin with distinct dark blotch or spot ..... 2
  - Caudal margin rounded with rounded corners, central caudal fin rays equal in length or longer than those extending to the corners; no distinct dark blotch or spot basally on pectoral fin ..... 3
2. Dark blotch or spot basally on pectoral fin extending dorsally onto body; second dorsal fin with 40–45 rays; anal fin with 42–48 rays; total vertebrae 44–46 ..... *Pseudophycis bachus*
  - Dark blotch or spot basally on pectoral fin not extending dorsally onto body; second dorsal fin with 47–56 rays; anal fin with 50–57 rays; total vertebrae 47–50 ..... *Pseudophycis palmata*
3. Scales above lateral line 16–22; second dorsal fin with 54–59 rays; anal fin with 54–63 rays; pyloric caeca 14–20; total vertebrae 48–51 ..... *Pseudophycis barbata*
  - Scales above lateral line 7–9; second dorsal fin with 44–52 rays; anal fin with 49–56 rays; pyloric caeca 6–9; total vertebrae 42–45 ..... *Pseudophycis breviuscula*

### *Pseudophycis palmata* (Klunzinger, 1872)

Proposed name: Australian Red Cod (Australian Standard)

Figures 1, 2, 3A, 4, 5; Tables 1–4

*Physiculus palmatus* Klunzinger, 1872: 38. Type locality: Hobsons Bay, Victoria, Australia. Types: SMNS 1589.

*Pseudophycis barbatus* (nec Günther, 1862). McCoy, 1878: 29, pl. 20 (in part; description).

*Pseudophycis bacchus* (nec Forster in Bloch and Schneider, 1801). Günther, 1880a: 28 (Twofold Bay, NSW); Waite, 1899: 119 (distribution).

*Pseudophycis bachus* (nec Forster in Bloch and Schneider, 1801). Ogilby, 1886: 48 (list, in part); Edgar et al., 1982: 32, fig. 17 (description, in part); Last et al., 1983: 234, fig. 21.7 (description, in part); Paulin, 1983: 93 (distribution, in part); Hutchins and Swainston, 1986: 34, 124, fig. 113 (description); May and Maxwell, 1986: 194 (description); Paxton and Hanley in Paxton et al., 1989: 302 (list, in part); Grant, 1991: 75, fig. 164 (list, in part); Gomon in Gomon et al., 1994: 333, fig.

297 (description, in part); Yearsley et al., 1999: 87, fig. (description); Paxton et al., 2006: 616 (taxonomy, in part); Gomon in Gomon et al., 2008: 313, fig. (description, in part).

*Physiculus bachus* (nec Forster in Bloch and Schneider, 1801). Waite, 1904: 24; Stead, 1906: 86 (description, in part); Waite, 1907: 18, fig. (South Australia); Stead, 1908: 48, pl. 16; Waite, 1921: 67; McCulloch, 1921: 42; McCulloch, 1922: XVII, 32; Waite, 1923: 92, fig. (description, in part); Lord and Scott, 1924: 8, 43 (description, in part); Lord, 1927: 13; McCulloch, 1927: 32, pl xi, fig. 112a (list); Waite, 1928: 6 (listed); McCulloch, 1929: 129; McCulloch, 1930: 129 (in part, listed); Norman, 1935: 3; Norman, 1937: 54, 55 (in part, listed); Munro, 1961: 62, fig. 441, (description; in part); Scott, 1962: 84, fig. (description, in part); Whitley, 1962: 58; Whitley, 1964: 40 (list, in part); Walker, 1972: 2; Suda, 1973: 2150–2152 (distribution); Scott et al., 1974: 95, 96, fig. (description, in part).

*Pseudophycis barbata* (nec Günther, 1862). Kuitert, 1993: 59, fig. (description, in part).

**Diagnosis.** First dorsal fin with 10–12 rays, second dorsal fin with 47–56 rays; anal fin with 50–57 rays; total vertebrae 47–50; nostrils located about two-thirds to three-quarters of the way from snout tip to eye; gill rakers of outer arch of moderate length, almost as long near angle as opposing gill filaments; chin barbel short, 6–17% HL; scales above lateral line in oblique series from base of first dorsal fin ray 11–15; oblique rows of scales intersecting with lateral line 96–116; pyloric caeca 8–10; caudal fin truncate with angular corners in specimens larger than about 150 mm SL, middle rays shorter than rays extending to corners; dark blotch basally on pectoral fin not extending onto side above fleshy pectoral fin base. A large species reaching at least 598 mm TL or approximately 532 mm SL (Kemp, 2010: 26).

**Description.** (Values for non-type specimens when different from type in parentheses; see Tables 2–4 for summary of selected meristic and comparative morphometric values.) First dorsal fin 11 (10–12, rarely 10, first ray usually minute); second dorsal fin 56 (47–56, rarely 47 or 54–55); anal fin 55 (50–57, rarely less than 51); pectoral fin 22 (22–27); pelvic fin 5 (5 or 6, rarely 6); caudal fin 37 (35–41) rays; gill rakers 4 + 10 (3–4 + 9–11 = 12–15); lateral line pores not associated with individual scales; oblique scale rows intersecting with lateral line unknown (96–116), scales in oblique series above lateral line 15 (11–15), scales in oblique series below lateral line unknown (28–40); vertebrae 16 + 34 (15–18 + 31–34) = 50 (47–50); pyloric caeca 10 (8–10).

Table 1. Estimates of evolutionary divergence over sequence pairs within (left) and between (right) species. Kimura-2-parameter genetic distances as averages over all sequence pairs within species are in the left column, with standard error estimates on the right (left table). Genetic distances as averages over all sequence pairs between species are below the diagonal with standard error estimates above it (right table).

Species	Within species			Between species				
	N	Distance	Standard Error	Distance below and Standard Error above diagonal				
				<i>A. punctatus</i>	<i>P. bachus</i>	<i>P. breviuscula</i>	<i>P. palmata</i>	<i>P. barbata</i>
<i>A. punctatus</i>	7	0.002	0.001		0.017	0.017	0.017	0.017
<i>P. bachus</i>	18	0.005	0.001	0.160		0.015	0.013	0.015
<i>P. breviuscula</i>	12	0.001	0.001	0.170	0.143		0.016	0.011
<i>P. palmata</i>	12	0.005	0.002	0.158	0.092	0.139		0.014
<i>P. barbata</i>	23	0.003	0.001	0.171	0.127	0.085	0.128	

Table 2. Selected counts for types and representative specimens of the four species of *Pseudophycis*.

Meristic character	<i>P. palmata</i>			<i>P. bachus</i>			<i>P. barbata</i>			<i>P. breviscula</i>		
	type	range	mean $\pm$ std dev	N	type	range	mean $\pm$ std dev	N	type	range	mean $\pm$ std dev	N
First dorsal fin rays	11	10 - 12	11.3 $\pm$ 0.5	47	11	11 - 13	11.5 $\pm$ 0.6	33	10	10 - 11	10.2 $\pm$ 0.4	36
Second dorsal fin rays	56	47 - 56	50.7 $\pm$ 2.3	47	42	40 - 45	42.5 $\pm$ 1.1	33	59	54 - 59	56.0 $\pm$ 1.6	36
Anal fin rays	55	50 - 57	54.0 $\pm$ 1.9	48	45	42 - 48	45.2 $\pm$ 1.5	33	59	54 - 63	57.4 $\pm$ 2.1	36
Pectoral fin rays	22	22 - 27	24.3 $\pm$ 1.1	28	24	22 - 25	23.8 $\pm$ 0.8	38	25	24 - 27	25.7 $\pm$ 0.7	31
Precaudal vertebrae	16	15 - 18	16.1 $\pm$ 0.5	46	16	16 - 17	16.2 $\pm$ 0.4	33		14 - 16	15.1 $\pm$ 0.6	35
Caudal vertebrae	34	31 - 34	32.8 $\pm$ 0.7	46	29	27 - 30	28.8 $\pm$ 0.7	33		33 - 37	34.7 $\pm$ 1.0	35
Total vertebrae	49	47 - 50	48.8 $\pm$ 0.7	47	45	44 - 46	45.0 $\pm$ 0.6	33		48 - 51	49.8 $\pm$ 0.8	35
Lower gill rakers	10	9 - 11	9.7 $\pm$ 0.6	30	10	10 - 12	10.5 $\pm$ 0.6	38		8 - 11	9.5 $\pm$ 0.6	34
Upper gill rakers	4	3 - 4	3.6 $\pm$ 0.5	30	4	4 - 5	4.4 $\pm$ 0.5	38		3 - 4	3.5 $\pm$ 0.5	34
Total gill rakers	14	11 - 15	13.3 $\pm$ 0.8	30	14	14 - 16	14.9 $\pm$ 0.8	38		12 - 14	13.0 $\pm$ 0.7	34
Upper procurent caudal fin rays	5	5 - 8	7.3 $\pm$ 0.9	27	8	6 - 9	7.2 $\pm$ 1.0	23	6	5 - 7	5.8 $\pm$ 0.8	21
Principal (branched) caudal fin rays	25	21 - 26	22.8 $\pm$ 1.2	26	20	19 - 24	21.3 $\pm$ 1.4	23	20	20 - 22	21.0 $\pm$ 0.9	21
Lower procurent caudal fin rays	7	6 - 8	7.1 $\pm$ 0.4	26	8	6 - 10	7.9 $\pm$ 1.0	23	7	5 - 7	6.1 $\pm$ 0.8	21
Total caudal fin rays	37	35 - 41	37.3 $\pm$ 1.3	42	36	33 - 39	36.4 $\pm$ 1.4	23	33	32 - 35	33.0 $\pm$ 1.0	18
Transverse scale rows		96 - 116	109 $\pm$ 7.2	14	112	102 - 136	118 $\pm$ 8.7	35		123 - 162	141 $\pm$ 10.5	27
Scales above lateral line	15	11 - 15	12.9 $\pm$ 1.4	27	11	10 - 12	11.3 $\pm$ 0.8	34		16 - 22	18.1 $\pm$ 1.6	30
Scales below lateral line		28 - 40	34.5 $\pm$ 3.8	14	30	26 - 34	29.5 $\pm$ 2.4	26	38	38 - 56	49.2 $\pm$ 5.0	27
Pyloric caeca	10	8 - 10	9.5 $\pm$ 0.8	8	6	6	6.0 $\pm$ 0.0	29		14 - 20	16.0 $\pm$ 1.5	20
										7 - 8	7.5 $\pm$ 0.5	8



Table 4. Selected proportional measurements for types and representative specimens of the four species of *Pseudophycis*.

Measurement	<i>P. palmata</i>			<i>P. bachus</i>			<i>P. barbata</i>			<i>P. breviscula</i>		
	type	range	mean $\pm$ std dev N	type	range	mean $\pm$ std dev N	type	range	mean $\pm$ std dev N	type	range	mean $\pm$ std dev N
Standard Length (mm) % SL	172	73.5 - 380		351	110 - 539		394	82.0 - 531		152	59.4 - 179	
Body depth (anal fin origin)	23.6	18.7 - 26.5	22.0 $\pm$ 1.8 31	19.5	18.4 - 23.7	20.9 $\pm$ 1.4 36	19.7	19.7 - 29.3	24.1 $\pm$ 2.0 34	22.8	20.6 - 23.3	21.8 $\pm$ 0.8 28
Caudal peduncle depth	5.5	4.1 - 5.9	5.0 $\pm$ 0.4 32	3.8	3.8 - 5.9	4.5 $\pm$ 0.4 38	3.8	3.3 - 5.2	4.5 $\pm$ 1.0 35	4.0	3.9 - 4.8	4.3 $\pm$ 0.3 29
Caudal peduncle length	8.9	6.7 - 10.8	9.1 $\pm$ 0.9 31	8.5	7.7 - 10.5	9.1 $\pm$ 0.7 38	5.4	5.2 - 9.2	6.9 $\pm$ 1.0 35	4.8	5.7 - 8.5	7.2 $\pm$ 0.8 29
Head length	26.1	25.9 - 30.0	27.8 $\pm$ 0.9 33	26.5	25.9 - 29.6	27.1 $\pm$ 0.8 38	23.3	23.3 - 31.6	28.8 $\pm$ 1.6 35	25.8	23.4 - 26.0	24.8 $\pm$ 0.6 29
Head depth (eye)	12.8	10.2 - 18.4	13.9 $\pm$ 2.0 30	11.7	10.2 - 15.6	11.8 $\pm$ 1.1 37	11.0	11.0 - 17.9	13.6 $\pm$ 1.4 33	12.1	10.8 - 15.2	12.8 $\pm$ 1.1 27
Orbital diameter	7.3	5.3 - 9.7	7.4 $\pm$ 0.9 33	5.6	4.6 - 8.1	6.2 $\pm$ 0.9 38	4.9	4.9 - 8.3	6.9 $\pm$ 0.9 35	7.1	6.2 - 8.7	7.2 $\pm$ 0.8 29
Postorbital length	13.1	12.2 - 16.0	14.0 $\pm$ 0.9 33	14.1	12.4 - 16.4	14.2 $\pm$ 0.8 38	12.2	7.5 - 17.7	14.9 $\pm$ 1.9 35	14.7	11.4 - 14.3	13.3 $\pm$ 0.8 29
Interorbital width	8.7	7.9 - 10.0	9.0 $\pm$ 0.6 32	8.8	7.2 - 9.9	8.6 $\pm$ 0.6 38	6.5	6.5 - 8.8	8.0 $\pm$ 0.5 34	6.4	5.5 - 7.4	6.3 $\pm$ 0.4 29
Suborbital depth	2.7	1.4 - 3.2	2.2 $\pm$ 0.4 32	2.5	1.5 - 3.3	2.5 $\pm$ 0.3 38	1.7	1.7 - 3.7	2.6 $\pm$ 0.6 34	2.1	1.3 - 2.4	2.0 $\pm$ 0.3 29
Snout length	7.6	6.7 - 9.1	7.8 $\pm$ 0.6 33	7.5	7.1 - 9.0	8.0 $\pm$ 0.5 38	7.5	6.5 - 9.6	8.1 $\pm$ 0.7 35	5.9	5.1 - 7.0	6.2 $\pm$ 0.5 29
Upper jaw length	15.0	13.6 - 16.2	15.2 $\pm$ 0.6 33	13.9	12.8 - 14.8	13.9 $\pm$ 0.4 38	12.3	12.3 - 17.5	15.6 $\pm$ 1.1 35	13.4	11.0 - 13.2	12.5 $\pm$ 0.5 29
Barbel length	3.0	1.7 - 4.9	3.5 $\pm$ 0.8 32	3.2	2.4 - 4.8	3.4 $\pm$ 0.6 36	4.9	4.7 - 9.6	6.6 $\pm$ 1.1 34	5.4	4.9 - 7.5	6.3 $\pm$ 0.7 28
Pre-dorsal fin length	31.2	28.1 - 32.7	30.6 $\pm$ 1.1 32	28.2	27.5 - 31.8	29.5 $\pm$ 1.1 38	34.4	29.2 - 37.4	32.8 $\pm$ 1.7 35	31.0	27.8 - 31.6	30.0 $\pm$ 1.0 29
Pre-anal fin length	41.5	37.9 - 48.0	43.6 $\pm$ 2.5 31	42.4	39.6 - 47.3	43.9 $\pm$ 1.7 37	45	38.6 - 51.0	44.8 $\pm$ 3.5 35	44.1	35.0 - 41.4	38.0 $\pm$ 1.9 27
Pre-pectoral fin length	27.5	26.3 - 32.6	28.7 $\pm$ 1.3 32	26.8	25.8 - 30.2	27.9 $\pm$ 1.0 38	25.7	25.7 - 32.7	29.5 $\pm$ 1.5 35	27.1	24.5 - 28.5	26.0 $\pm$ 1.0 29
Pre-pelvic fin length	18.2	18.2 - 26.0	20.5 $\pm$ 2.0 31	19.6	17.0 - 22.2	19.8 $\pm$ 1.2 38	18.1	16.4 - 23.6	19.3 $\pm$ 1.9 35	15.1	13.9 - 21.1	17.2 $\pm$ 1.9 27
Pelvic fin origin to anal fin origin	24.4	18.5 - 30.5	24.6 $\pm$ 2.4 30	24.2	22.8 - 28.7	25.4 $\pm$ 1.6 37	27.9	20.2 - 33.5	26.8 $\pm$ 3.3 35	30.4	18.0 - 25.5	22.1 $\pm$ 2.1 27
First dorsal fin base length	10.2	6.8 - 12.1	10.4 $\pm$ 1.2 32	10.4	9.2 - 13.1	11.0 $\pm$ 0.9 37	8.3	6.8 - 13.6	9.2 $\pm$ 1.2 35	9.9	7.9 - 19.1	10.6 $\pm$ 2.7 29
First dorsal fin longest ray	17.3	8.5 - 17.3	12.6 $\pm$ 1.9 31	10.7	9.8 - 15.0	11.9 $\pm$ 1.2 35	7.6	7.6 - 15.0	10.0 $\pm$ 1.4 35	9.0	8.6 - 12.8	11.2 $\pm$ 1.0 18
Second dorsal fin base length	54.5	47.9 - 56.7	52.9 $\pm$ 2.0 33	53.7	48.6 - 56.2	53.1 $\pm$ 1.7 38	53.2	50.4 - 62.3	54.8 $\pm$ 2.7 35	55.9	53.0 - 60.2	56.7 $\pm$ 1.8 29
Anal fin base length	50.9	45.0 - 57.4	51.1 $\pm$ 2.6 33	50.2	45.4 - 53.8	50.1 $\pm$ 1.7 37	51.9	46.3 - 58.4	53.0 $\pm$ 2.5 35	56.5	53.8 - 66.0	58.3 $\pm$ 2.8 29
Pectoral fin length	16.6	13.5 - 17.7	15.8 $\pm$ 1.0 33	17.2	14.6 - 19.4	17.1 $\pm$ 1.3 38	11.2	11.2 - 17.5	15.8 $\pm$ 1.3 35	16.7	13.6 - 17.5	15.7 $\pm$ 1.0 29
Pelvic fin length	15.1	11.7 - 17.3	14.3 $\pm$ 1.5 31	16.0	11.5 - 21.1	16.7 $\pm$ 2.0 36	13.3	13.3 - 24.9	20.2 $\pm$ 2.5 35	17.6	16.6 - 21.6	19.1 $\pm$ 1.2 27
Caudal fin length	10.3	9.9 - 15.3	12.2 $\pm$ 1.4 32	13.3	11.2 - 15.6	13.7 $\pm$ 1.2 37	8.6	8.6 - 15.3	12.7 $\pm$ 1.5 35	12.7	11.4 - 18.1	13.6 $\pm$ 2.0 28

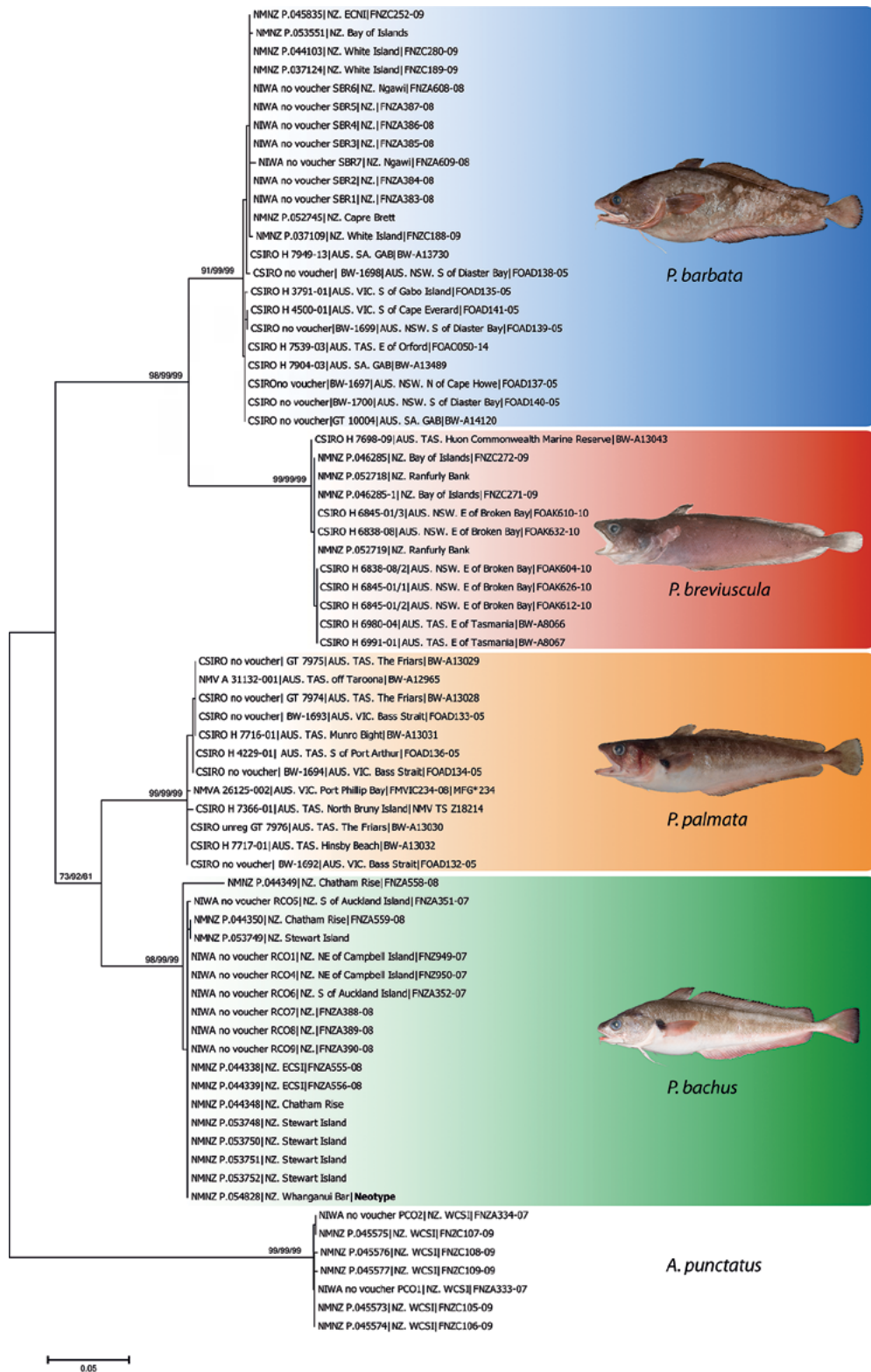


Figure 1. Hasegawa-Kishino-Yano maximum likelihood tree of 65 COI sequences from four purported species of *Pseudophycis*, along with seven sequences for an outgroup species, *Auchenoceros punctatus*. Percentage bootstrap values followed by bootstrap values in p-distance neighbour joining and maximum parsimony trees are given for all well supported nodes (2 of 3 exceeding 80%). Specimen numbers are those of registered museum vouchers or sequence numbers in the Barcode of Life Database (BOLD, <http://www.barcodinglife.org/>).



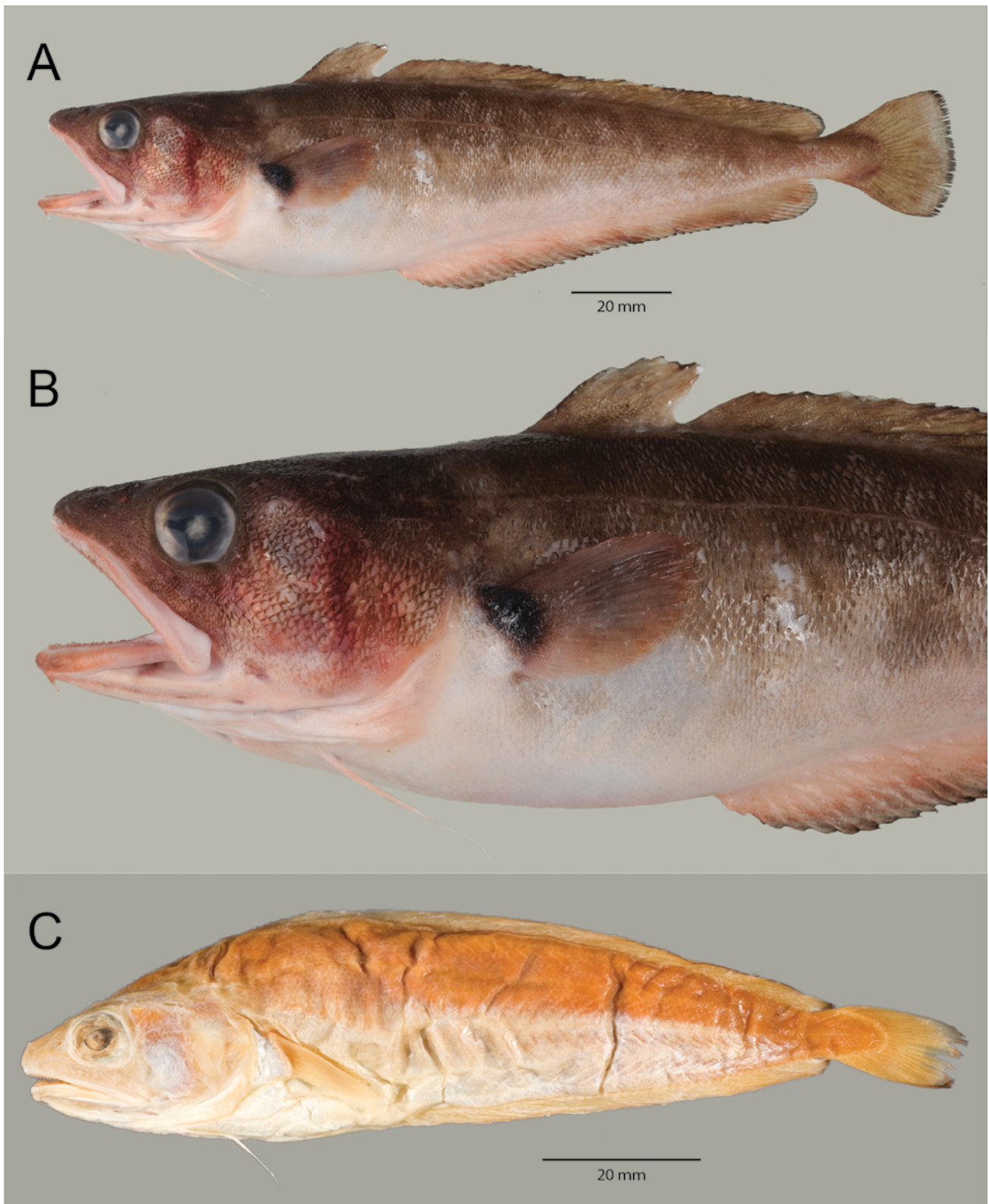


Figure 2. *Pseudophycis palmata*. A, B, CSIRO H 7366-01, 265 mm SL, Storm Bay, east of Variety Bay on North Bruny Island, Tasmania, Australia, fresh specimen, lateral view of body and lateral view of head and anterior body with black pectoral blotch, respectively, (photographs C. Devine, CSIRO); C, SMNS 1589, holotype, 172 mm SL, Port Phillip, Hobsons Bay, Victoria, Australia (photograph C. Struthers, NMNZ).

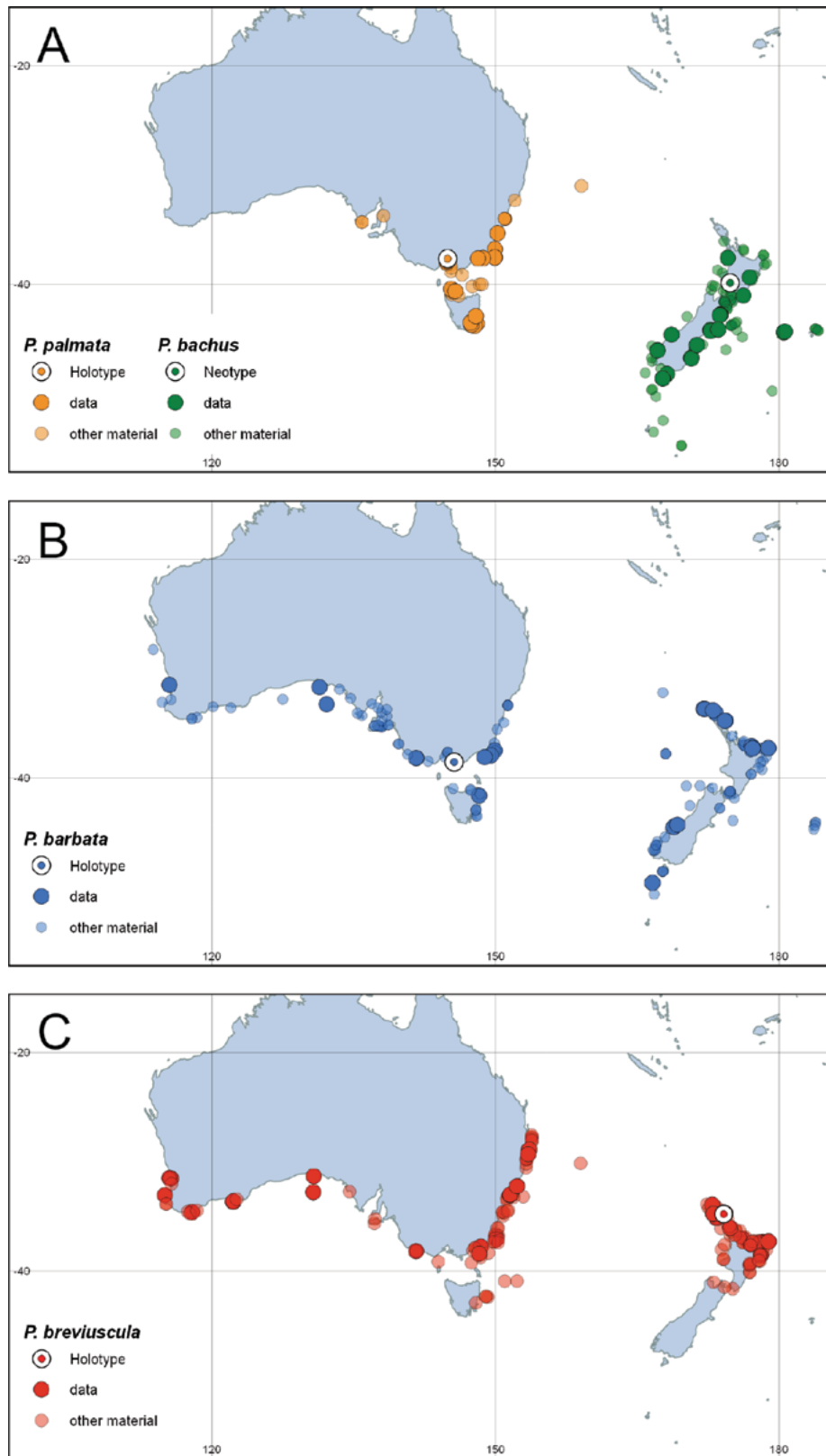


Figure 3. Collection localities for specimens of *Pseudophycis* spp. in museums. A, *P. bachus*, green and *P. palmata*, orange; B, *P. barbata*, blue; C, *P. breviuscula*, red.

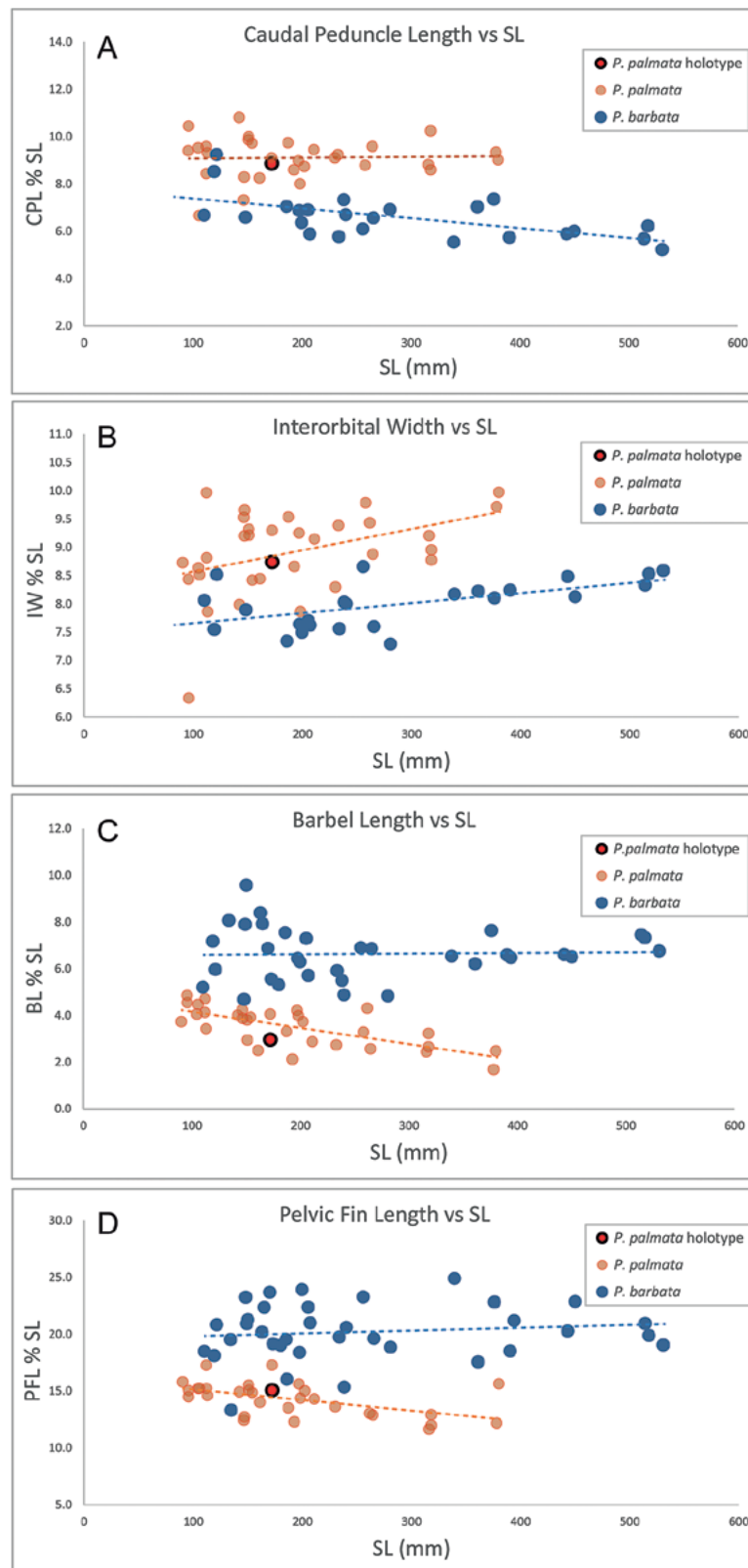


Figure 4. Plots of proportional measurements (% SL) against standard lengths for non-type specimens of *Pseudophycis palmata*, *P. barbata* and holotype of *P. palmata*. A, caudal peduncle length; B, interorbital width; C, barbel length; D, pelvic fin length.

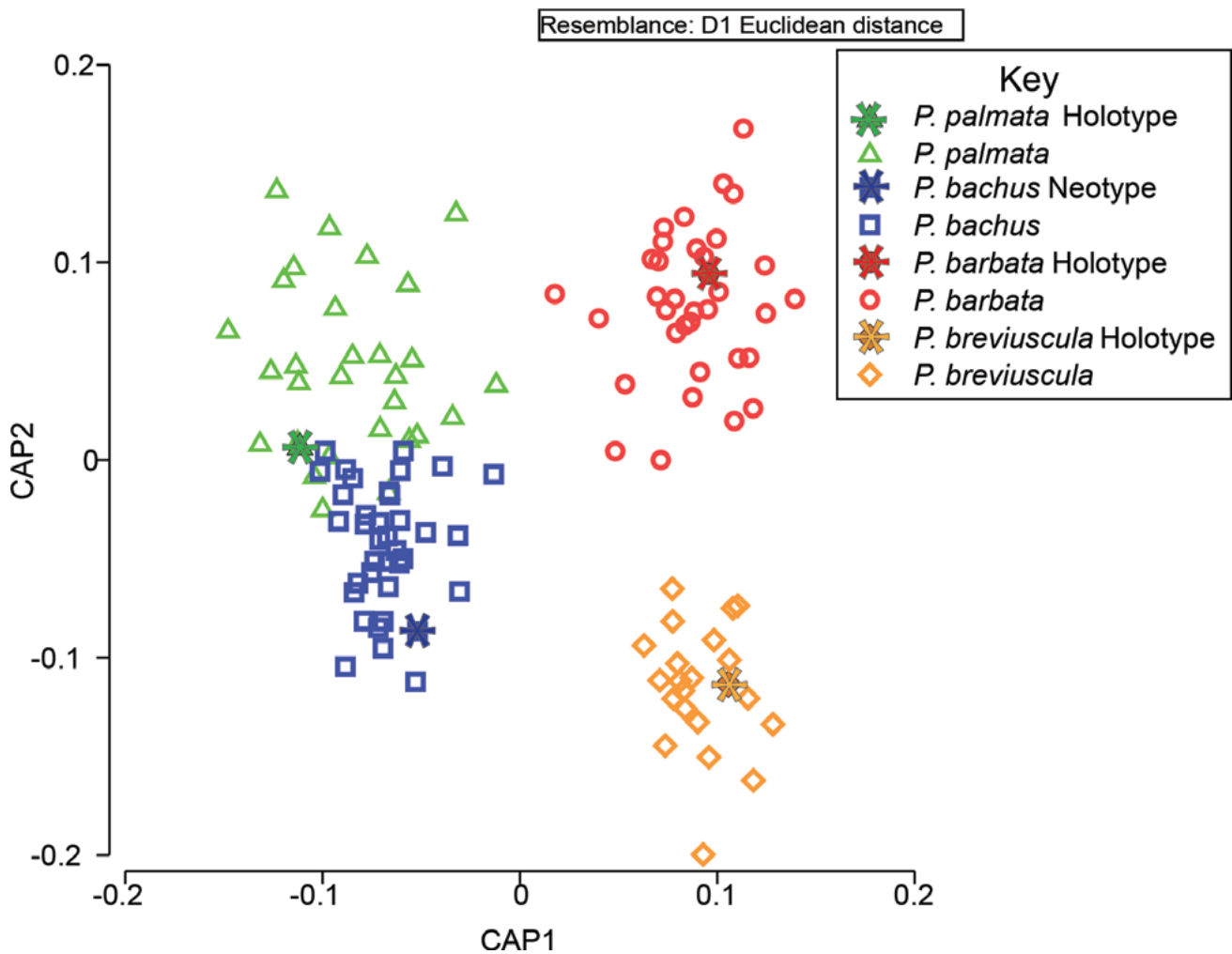


Figure 5. Scatter plot of canonical analysis of principal coordinates scores on the first and second canonical axes for 124 specimens of *Pseudophycis*, including types.

Body moderately slender, compressed laterally (fig. 2), greatest depth at anal fin origin 23.6 (18.7–26.5)% SL, tapering uniformly from second dorsal fin origin to shallow caudal peduncle; caudal peduncle moderately short, 8.9 (6.7–10.8)% SL, strongly compressed, depth subequal to orbital diameter. Distance between middle of anus and base of anal fin slightly less than half suborbital depth. Body cavity extending to above origin of anal fin.

Head acute, of moderate size, length 26.1 (25.9–30.0)% SL, width 14.5 (15.3–21.6)% SL and depth 12.8 (10.2–18.4)% SL; snout of moderate length 7.6 (6.7–9.1)% SL, not projecting in advance of upper jaw, rounded in dorsal view. Nostrils small, located about two-thirds to three-quarters of the way from snout tip to eye, distance from nostril to orbital margin less than (equal to or less than) diameter of combined nostrils; nostrils positioned above horizontal through centre of eye; posterior opening larger than (about half size to larger than) anterior opening, separated from it by raised skin flap; most of

margin (most or just posterior opening) encircled by tubular flap. Interorbital broad, slightly convex. Eye of moderate size, orbital diameter 28.0 (18.9–31.5)% HL, 1.33 (0.66–1.87) times in interorbital space, 2.41 (1.65–7.06) times suborbital distance, circular, upper edge of eye adjacent to dorsal margin of head in lateral view, transparent skin covering eye faintly pigmented near orbital dorsal margin. Postorbital moderately long, 0.91 (0.85–1.01) times length of upper jaw. Mouth large, terminal, upper jaw terminating posterior to (at or posterior to) vertical through posterior margin of eye. Jaw teeth caniniform, slightly curved, depressible, band of up to four or five irregular rows in upper jaw with distinct hiatus at symphysis; teeth in outer row more regularly arranged than in inner rows; band tapering near rear of jaw. Teeth of lower jaw similar in form to those of upper jaw; band of two or three rows with broader patch on either side of symphysis, tapering to single, widely spaced row posteriorly; rows almost contiguous across symphysis. Vomerine teeth absent.

Opercular bones strong; upper extremity of gill opening at horizontal through middle of eye; gill membranes continuous across isthmus. Gill rakers on outer arch slender, of moderate length, about 0.8 to 1.3 times length of opposing gill filaments, 8.4–12.2 times in head, their inner margin denticulate. Chin barbel short, subconical 11.3 (6.0–17.4)% HL.

Small cycloid scales covering all of head, including gular region and isthmus, and body except for branchiostegal membranes, surface of maxilla and premaxilla, lower lip and distal parts of fins; thick mucus covering obscuring scales and pores in freshly preserved material. Most head pores tiny, following main cephalic sensory canals; row of slightly raised pores from nostrils to tip of snout and then posteriorly just above lower edge of suborbital; row of enlarged mandibular pores on underside of lower jaw. Lateral line comprising widely spaced pores on short tubes arising from narrow scaleless gap, anterior end curved upwards slightly, then gradually descending to lateral midline below posterior 25% of second dorsal fin, remaining on lateral midline posteriorly.

Membranes of first and second dorsal fins continuous at base; first dorsal originating distinctly behind vertical through pectoral fin base; anterior two-thirds of second dorsal of uniform height, 10th to 12th ray from posterior end of fin longest, its height about 1.4 times length of 2nd ray at anterior end of fin, last ten or so rays progressively shorter; rays of both dorsal fins mostly unbranched, only last 13 to 16 rays, apart from last one to three, branched. Fleishy, fine scale-covered basal sheath on third or more of first dorsal and anterior portion of second dorsal fins; fin rays interconnected by membranes to tips, sheath gradually decreasing slightly in coverage and thickness posteriorly, encompassing about half of second dorsal fin near its insertion; sheath extending onto body for anterior third of combined dorsal fin base, broadest anteriorly, narrower posteriorly. Profile of anal fin like second dorsal fin with comparable unbranched and branched rays. Anal fin enclosed in broad fleshy sheath like dorsal fins; sheath also extending onto body for anterior third or less of fin. Caudal fin truncate with distinct dorsoposterior and ventroposterior corners in adults, posterior margin with slight convex curve; longest rays to corners, middle rays about 85–90% length of longest rays; fin more rounded in juveniles; base of fin covered by indistinct sheath sharply demarcated from scales of caudal peduncle. Pectoral fin tip reaching (not quite to or to) vertical through anal fin origin, sixth or seventh ray longest. Pelvic fin inserted anterior to vertical through posterior edge of preopercle (more posteriorly in some specimens); outer two rays longer than inner rays; second ray longest, 15.1 (11.7–17.3)% SL, nearly twice length of subsequent ray, reaching vertical through first dorsal fin origin.

*Fresh colour.* (Based on images of non-type material; fig. 2A, B.) Medium brown above extending ventrally to about ventral portion of pectoral fin base, white below, suffused with pinkish hue, especially above anal fin base; lateral line slightly paler at least anteriorly. Underside of head, jaws and barbel white, sometimes tinged with pink. Dorsal, caudal and distal half of anal fins medium brown; proximal half of anal fin white, especially anteriorly, with pink hue; dorsal and anal fins with

fine black edge; posterior edge of caudal fin with broad black margin. Pectoral fin medium brown with semi-circular black basal spot covering dorsal 80% of proximal edge of fin, extending little if at all onto side dorsal to fin base. Pelvic fin rays white with pink hue.

*Preserved colour.* Mostly pale (upper half of head and body pale dusky to dusky, lower half very pale, frequently pearly white. Dorsal, caudal and distal half of anal fins pale dusky; distal edges of dorsal and anal fins with fine dark margin; posterior edge of caudal fin broadly dark; pelvic fin, pectoral fin and basal half of anal fin very pale; pectoral fin with prominent dark spot (faded in type) covering dorsal half or more of basal edge, not extending onto side of body dorsally.

*Etymology.* The specific epithet *palmata* appears to be Latin for “embroidered with palm branches”, although the reason for the name is unknown.

*Distribution.* Endemic to coastal temperate waters of south-east Australia at least from Port Lincoln, Spencer Gulf, South Australia (34° 44' S, 135° 52' E, SAMA F2766), to Port Stephens, New South Wales (32° 49' S, 152° 05' E, AMS I.25865-003), including all of Tasmania (fig. 3a). An unverified record at Coles Point, South Australia, 34° 22' 06" S, 135° 21' 09" E (SAMA F11864), may extend the distribution slightly farther to the west (fig. 3A). Occurs on soft bottom habitat at 2–115 m.

*Remarks.* *Pseudophycis palmata* is closely related to the New Zealand *P. bachus*, with which it was confused (Günther, 1880a: 28; McCulloch, 1921: 42; Ogilby, 1886: 48; Waite, 1904: 24). Both differ from the remaining two congeners by the possession of a black spot or blotch at the base of the pectoral fin and a truncated caudal fin margin in adults. The two also differ from the others in having the lower half of the body and the basal half or more of the anal fin mostly white, rather than tan to brown, although these areas are occasionally suffused with orange to pink in specimens of all four species. Morphometrically, the pair appear to have a deeper caudal peduncle (3.8–5.9, mean 4.7% SL vs. 3.3–5.2, mean 4.4% SL), shorter barbel (1.7–4.9, mean 3.5% SL vs. 4.7–9.6, mean 6.5% SL) and shorter or longer head (25.9–30.0, mean 27.4% SL vs. 23.3–31.6, mean 28.8 in *P. barbata* and 23.4–26.0, mean 24.8% SL in *P. brevisuscula*), as well as other relative lengths of features that correspond with the general body form. All four species in the genus are separable by vertical fin ray, scale and vertebral counts, as identified in the above key and in Table 2. Both *P. palmata* and *P. bachus* attain a large size, as does *Pseudophycis barbata* (well over 600 mm SL), while *P. brevisuscula* is the smallest species, reaching only about 150 mm SL.

The two *P. bachus*-like species are very similar to each other proportionally, although the eye of the Australian species is slightly larger than that of *P. bachus*, the orbital diameter 5.3–9.7, mean 7.4% SL vs. 4.6–8.1, mean 6.2% SL, the paired fins proportionally shorter, pectoral fin 13.5–17.7, mean 15.8% SL vs. 14.6–19.4, mean 17.1% SL and pelvic fin 11.7–17.3, mean 14.3% SL vs. 11.5–21.1, mean 16.7% SL, and caudal fin similarly shorter 9.9–15.3, mean 12.2% SL vs. 11.2–15.6, 13.7% SL. *Pseudophycis palmata* is readily

separable from *P. bachus* by the smaller pectoral fin blotch that fails to extend onto the body above the pectoral fin base. It also differs subtly from *P. bachus* in having the distal half of the anal fin brownish with a fine black margin rather than whitish, like the basal half, and the black margin confined to the posterior lobe of the fin, if it is present at all. The Australian cognate has fewer transverse scale rows (96–116 vs. 102–136 in *P. bachus*) but more pyloric caeca (8–10 vs. 6), anal fin rays (50–57 vs. 42–48) and second dorsal fin rays (47–56 vs. 40–45).

In the course of exploring the taxonomic identity of the Australian Red Cod, the species to which the name *Physiculus palmata* Klunzinger, 1872, is referable became less and less clear. The name was regarded as a junior synonym of *P. barbata* for more than 80 years (McCulloch, 1929: 129). Klunzinger's (1872) original description is inadequate for separating the three species of *Pseudophycis* occurring at or in the vicinity of the type locality. A specimen (SMNS 1589) in the Stuttgart Museum, the repository of Klunzinger's type material, registered the year the name was published, apparently collected at the type locality and clearly identified by Klunzinger as that species, was regarded as a syntype by Fricke (1992: 13; 2005: 48). It is much smaller (173 mm SL) than the 50 cm length given in the description, implying Klunzinger was aware of or had other material. The dark spot on the base of the pectoral fin that is diagnostic for the species, as well as dark pigment on the distal edge of the caudal fin, has completely faded. The only other specimen of *Pseudophycis* (SMNS 2242) dating from that approximate time currently in the Stuttgart collection was identified by Klunzinger in 1877 and is unlikely to have been available when the description was published. We therefore follow Fricke in regarding SMNS 1589 as the only known type.

Although the three species occurring near the type locality are clearly separable by morphological characters, the colours and markings on the type specimen that would have been diagnostic have faded. Meristic characters including vertebral numbers, fin ray and scale counts have ranges that overlap slightly in the two most likely candidate species, *P. barbata* and the Australian *P. bachus* cognate. Unfortunately, the type specimen of *P. palmata* has meristic values that fall in the overlap zone for all but three characters, the number of scales above the lateral line 15 (11–15 in *P. bachus*-like vs. 16–22 in *P. barbata*), total caudal fin rays 37 (35–41 in *P. bachus*-like vs. 32–35 in *P. barbata*) and pyloric caeca 10 (8–10 in *P. bachus*-like vs. 14–20 in *P. barbata*) that favour its identity as the *P. bachus* cognate (Table 1). A comparison of relative morphometric values for the type with those of these two species, however, revealed clear support for the identity of the type as the *P. bachus*-like species with eight of the type's relative measurements (head length, caudal peduncle length, caudal peduncle depth, post-orbital length, interorbital width, barbel length, pelvic fin length and caudal fin length) positioned closer to the *P. bachus*-like species proportional curves relative to standard length (e.g. fig. 4) and curves for the same measurements (not head length) equally close to the proportional curve relative to its head length. Only predorsal fin length has clearly different proportional curves for the *P.*

*bachus*-like species and *P. barbata*, with the predorsal value for the type of *P. palmata* falling equidistant between the curves of the two species for that measurement.

The diagnostics of a CAP analysis revealed that 96.8% of 124 specimens of *Pseudophycis* were correctly classified as their respective species based on the 20 characters examined. By species, the percentage of individuals correctly classified by the CAP discriminant model was 96.6% for *P. palmata* (with one misclassified as *P. bachus*), 97.3% for *P. bachus* (with one misclassified as *P. palmata*), 94.3% for *P. barbata* (with one misclassified as *P. palmata*) and 100% for *P. breviuscula*. Separation of the four species of *Pseudophycis* is shown in fig. 5, with some overlap of *P. palmata* and *P. bachus*. SMNS 1589 (holotype of *P. palmata*) is grouped within the other specimens of *P. palmata* and is well separated from *P. barbata*. Consequently, the CAP analysis and fig. 5 support the taxonomic decision to resurrect *Pseudophycis palmata* as the appropriate name for the Australian endemic previously thought to be conspecific with *P. bachus*. Overlap of *P. palmata* and *P. bachus* is consistent with the historical confusion involving the two species.

Despite its close relationship with *P. bachus*, the first known detailed description of this species appears to be that of McCoy (1878) who based his description of *P. "barbatus"* almost entirely on specimens of the Australian *P. bachus*-like species. That species was probably the common representative of the genus in the Melbourne markets at the time. Meristic and morphometric data presented by McCoy appear to be entirely attributable to specimens of *P. palmata*, with only the illustration (McCoy, 1878: pl. 20) based on a specimen of *P. barbata*. Although several of McCoy's specimens were either lost or obscured by early collection practices, NMV A23366-001 is likely to be the specimen featured in the illustration, while counts and measurements were probably taken from NMV 43104, 43105, A841 and A23366-002. Other old NMV collection specimens of the new species that lack documented provenance probably comprised the remaining three. Considering the frequent occurrence of this species at the type locality of *P. palmata*, together with the strong morphological support discussed above, we consider the name to be applicable to the Australian *P. bachus*-like cognate. Paulin (1983) failed to deal with the name in the synonymies of the three species he recognised.

This species has the most restricted range of Australian *Pseudophycis* species, with no records of it west of Spencer Gulf, South Australia. Its latitudinal limits approach those of *P. bachus* in New Zealand, as do those of the two species occurring in both Australia and New Zealand where bathymetrically feasible.

*Material examined.* Type. *Physiculus palmatus* SMNS 1589 (172, holotype) Port Phillip, Hobsons Bay (northernmost section of Port Phillip Bay immediately south of Melbourne), Victoria.

*Other material.* (51 non-type specimens examined for meristic or morphometric values, 90.1–380 mm SL; see Appendix 2 for additional material in Australasian collections.) **Australia, New South Wales:** AMS I.34462-004 (2, 230–233) north-east of Lookout Point, Twofold Bay, 37° 4.2' S, 149° 56.1' E, 100 m, J.K. Lowry and S.J. Keable, 26–27 November 1988; AMS I.34567-001 (146) middle of Long Beach,

Batemans Bay, 35° 42' S, 150° 13' E, 50 m, J.K. Lowry and S.J. Keable, 23–24 November 1988; AMS I.34569-003 (112) east of Lookout Point, Twofold Bay, 37° 46' S, 149° 56' E, 50 m, J.K. Lowry and S.J. Keable, 26–27 November 1988; AMS I.34570-001 (3, 117–190) east of Lookout Point, Twofold Bay, 37° 46' S, 149° 55' E, 50 m, 26–27 November 1988. **Victoria:** NMV A840-001 (2, 95.5–211) old collection, no data; NMV A840-002 (2, 198–202) old collection, no data; NMV A3859 (187) eastern Bass Strait, 6 km west-south-west of Cape Conran, 37° 49.8' S, 148° 40' E, 26 m, BSS 208 T, M.F. Gomon and R.S. Wilson, 30 July 1983; NMV A8870-001 (4, 95.7–113) and NMV A8870-002 (121) Bass Strait, 1 km off Lake Tyers, 37° 51.1' S, 148° 9' E, 15 m, Marine Science Laboratories, 5 June 1984. **Tasmania:** AMS I.23880-004 (192) north of George Town, 40 57.90' S, 146 46.20' E, 50 m, K. Graham and FRV Kapala, 13 July 1980; AMS I.34952-003 (258) mouth of Fortescue Bay, 43° 7.77' S, 147° 59.47' E, 50 m, J.K. Lowry and K. Dempsey, trawl, 9–10 April 1994; CSIRO H 4229-01† (380) south of Port Arthur, 43° 17.3' S, 147° 47.1' E–43° 16.5' S, 147° 49.6' E, 115–119 m, B. Evans, 27 May 1996; CSIRO H 6205-02 (136) Battery Point, CSIRO wharf, 42° 53' S, 147° 20' E, H. Motomura, 20 February 2005; CSIRO H 7366-01† (265) Storm Bay, east of Variety Bay on North Bruny Island, 43° 12.17' S, 147° 27.46' E, 40–45 m, hook and line, A. Pender, 6 May 2012; CSIRO H 7716-01† (350) Munro Bight, 43° 11' S, 147° 59' E, 22 m, A. Pender, January 2012; CSIRO H 7717-01† (362) Hinsby Beach, Tarooma, 42° 57.22' S, 147° 20.82' E, 2 m, A. Pender, February 2012; CSIRO T 1186-02† (8, 110–262) Nutgrove Beach, Sandy Bay, Derwent River, P.R. Last, 19 May 1980; CSIRO T 1417 (113 mm SL) Derwent Estuary, 7 m, P.R. Last; NMNZ P.024340 (4: 142–197) Nakyrare Beach, Derwent Estuary, 43° 3.000' S, 147° 22.000' E, FV Ophelia, 29 March 1988; NMV A 1218-001 (316), NMV A 1218-002 (318) central Bass Strait, 20 km north-north-east of North Point, 40° 31.8' S, 145° 22.8' E, 44 m, BSS 116 T, M.F. Gomon, G.C.B. Poore and P. Forsyth, 4 November 1980; NMV A1275 (378) central Bass Strait, 23 km east of Cape Rochon, Three Hummock Island, 40° 22.8' S, 145° 16.998' E, 40 m, BSS 112 T, M.F. Gomon, G.C.B. Poore and P. Forsyth, 3 November 1980; NMV A1528-001 (6, 73.5–161) and NMV A1528-002 (3, 93.6–151) central Bass Strait, 30 km north of Wynyard, 40° 33.07' S, 145° 44.69' E, 67.7 m, 4 February 1981; NMV A 31132-001† (318) off Tarooma between Tarooma and Alum Cliffs, 42° 57.470' S, 147° 20.797' E, 6 m, hook and line, B. Barlow, 10 May 2014.

***Pseudophycis bachus* (Forster in Bloch and Schneider, 1801)**

Common name: New Zealand Red Cod (new Australian name); red cod, hoka (New Zealand)

Figures 1, 3A, 5, 6; Tables 1–4

*Enchelyopus bachus* Forster in Bloch and Schneider, 1801: 53. Type locality: Queen Charlotte Sound, New Zealand. No types known. Based on manuscript description of *Gadus bacchus* by Forster.

*Gadus bacchus* Cuvier, 1817: 486; Forster in Lichtenstein, 1844: 120, 420; Whitehead, 1978: 40; Hoare, 1982: 269.

*Lota bacchus* Cuvier, 1829: 334; Richardson, 1846: 61.

*Brosmius venustus* Richardson and Gray, 1843: 222 (generic referral of Parkinson's unpublished manuscript name *Blennius venustus*, written on the painting used by Forster for his description of *Gadus bacchus*). Richardson, 1843: 27; Taylor, 1855: 413.

*Enchelyopus bacchus*. Lichtenstein, 1844: 419 (index only).

*Lotella bacchus*. Günther, 1862: 347; Hutton and Hector, 1872: 46, 115; Hector, 1875: 239; Hector, 1884: 55; Hector, 1886: 28; Hutton, 1875: 134; Thomson, 1877: 485; Thomson, 1878: 326; Thomson, 1879: 382; Dambeck, 1879: 536, 547, 555; Parker, 1882: 263; Parker, 1883:

234, 235, pl. 33; Sherrin, 1886: 16, 17, 93, 304; Thomson, 1890: 370, pl. 28; Beattie, 1891: 71, 81, 82, pl. 12, pl. 13, pl. 14, pl. 15; Thomson, 1892: 212; Ayson, 1900: 14; Mair, 1903: 319; Ayson, 1907: 22; Johnson, 1921: 473; Carter and Malcolm, 1926: 647; Malcolm, 1926: 658; Svetovidov, 1937: 1285; Svetovidov, 1948: 17, 60 (anatomy).

*Pseudophycis bacchus*. Günther, 1880a: 26 (Port Hardy, D'Urville Island); Murray, 1895: 599 Gill, 1893: 94, 95, 100, 120 (list); Karrer, 1971: 153, 179, 180, 185, 195; Habib, 1975: 1; Ayling and Cox, 1982: 142, pl. 9. (description).

*Pseudophycis bachus*. Günther, 1880b: 542–543, fig. 248; Ogilby, 1886: 48 (list, in part); Hutton, 1890: 282; Fitch, 1972: 570, 573; Marshall and Cohen, 1973: 490; Edgar et al., 1982: 32, fig. 17 (description, in part); Paulin, 1983: 91 (description, taxonomy, in part); Paulin and Stewart, 1985: 22; Paul, 1986: 57, fig. (in part); Francis 1988: 21, pl. 18; Paulin, 1988: 450, 451, 453; Paxton and Hanley in Paxton et al., 1989: 302 (list, in part); Paulin et al., 1989: 119 (keyed), 255 (list); Cohen in Cohen et al., 1990: 373 (taxonomy, in part); Paulin in Amaoka et al., 1990: 155, fig. 103 (description, in part); Paulin and Roberts, 1992: 130, fig. 62a (description, in part); Kuitert, 1993: 59 (description, in part); Gomon in Gomon et al., 1994: 333 (description, in part); Francis, 1996: 20, pl. 18; Horn, 1996: 151, 158; Kuitert, 1997: 50 (description, in part); Paulin, 1998: 52, fig. (description); Paul, 2000: 57 (description); Francis, 2001: 25, pl. 19; Beentjes and Renwick, 2001: 315, 316; Paxton et al., 2006: 616 (taxonomy, in part); Hirt-Chabbert, 2006: 39; Gomon in Gomon et al., 2008: 313 (description, in part); Roberts et al., in Gordon et al., 2009: 532 (listed); McMillan et al., 2011a: 161, 162; McMillan et al., 2011b: 94; Francis, 2012: 5; Horn et al., 2012: 624, 625, 627–629, 631–633; Roberts et al., 2014: 18 (listed); Struthers et al., in Roberts et al., 2015: 864, fig. 107.20 (description); Roberts et al., 2015: S164 (listed); Roberts et al., 2017: 81 (listed), Roberts et al., 2019: 90 (listed).

*Physiculus bacchus*. Günther, 1887: 87; Goode and Bean, 1895: 365, 549; Hutton, 1896: 316; Hutton, 1904: 48 (listed); Thomson, 1906: 551; Thomson and Anderton, 1921: 74; Thomson and Thomson, 1923: 111; Frost, 1924: 609; Frost, 1926: 488, 490; Young, 1925: 370; Archey in Speight, Wall and Laing, 1927: 203; Anonymous, 1931: 32; Frost, 1933: 140; Benham, 1934: 31; Benham, 1935: 22; Benham, 1938: 56; Graham, 1938: 405; Graham, 1939: 364; Doogue and Moreland, 1960: 197, 288; Doogue and Moreland, 1961: 208, 316; Moreland, 1963: 20; Webb, 1966: 52, fig. 2.8, 70, 128, table 3.4, 164, 209, 230, 231, 234, 238–240, 257, 263, 266, 280, 294b, 294c; Webb, 1972b: 43; Webb, 1973: 307–309; Heath and Moreland, 1967: 37, 56; Whitehead, 1969: pl. 11; Anonymous, 1971: 17; Anonymous, 1972c: 47; Watkinson and Smith, 1972: 31; Knox and Kilner, 1973: 354; Vooren, 1974: 43, 44.

*Physiculus bachus*. Stead, 1906: 86 (in part); Waite, 1907: 18 (listed); Zietz, 1909: 266; Waite, 1909: 51, 52, 57, 134; Waite, 1911: 162, 183, 259, 265, 270, pl. 31; Thomson, 1913: 233; Phillipps, 1918: 271; Phillipps, 1921: 121, 125; Phillipps and Hodgkinson, 1922: 95; Waite, 1923: 92 (in part); Ayson, 1924: 7; Lord and Scott, 1924: 8, 43; Phillipps, 1926: 528; Lord, 1927: 13; Phillipps, 1927a: 128; Phillipps, 1927b: 23, 60; Phillipps, 1927c: 12; Waite, 1928: 6 (listed); McCulloch, 1929: 129 (in part); Young, 1929: 141; Anonymous, 1930: 28; Finlay, 1930: 47; Anonymous, 1934: 43; Anonymous, 1935: 34; Norman, 1935: 3; Benham, 1936: 26; Hefford, 1936: 71, 74; Cunningham, 1937: 898; Norman, 1937: 54, 55 (in part, listed); Shorland, 1937: 223; Wilson, 1937: 31; Johnston, 1938: 47; Munro, 1938: 62; Graham, 1939b: 364; Fowler, 1940: 758; Rapson, 1940: 35; Phillipps, 1947: 42; Phillipps, 1948: 129; Shorland, 1948: 109; Laird, 1949: 14, 19, 36, 37, 39, 53, 56, 60, 61, 137, 145, 146; Phillipps, 1949: 24, 59; Shorland, 1950: 35; Laird, 1951: 287, 298, 306, 308; Laird, 1952: 589, 590, 595, 596, 600; Graham, 1953: 166, 173, 399; Manter, 1954: 498, 545, 547, 549, 559; Robinson, 1955: 10, 71, 105, pls 9 and 14; Anonymous, 1957: 69; Kaberry, 1957: 90; Moreland, 1957: 34, 36; Parrott, 1957: 47, 175; Anonymous, 1958: 73; Parrott, 1958: 117; Anonymous, 1959: 70;

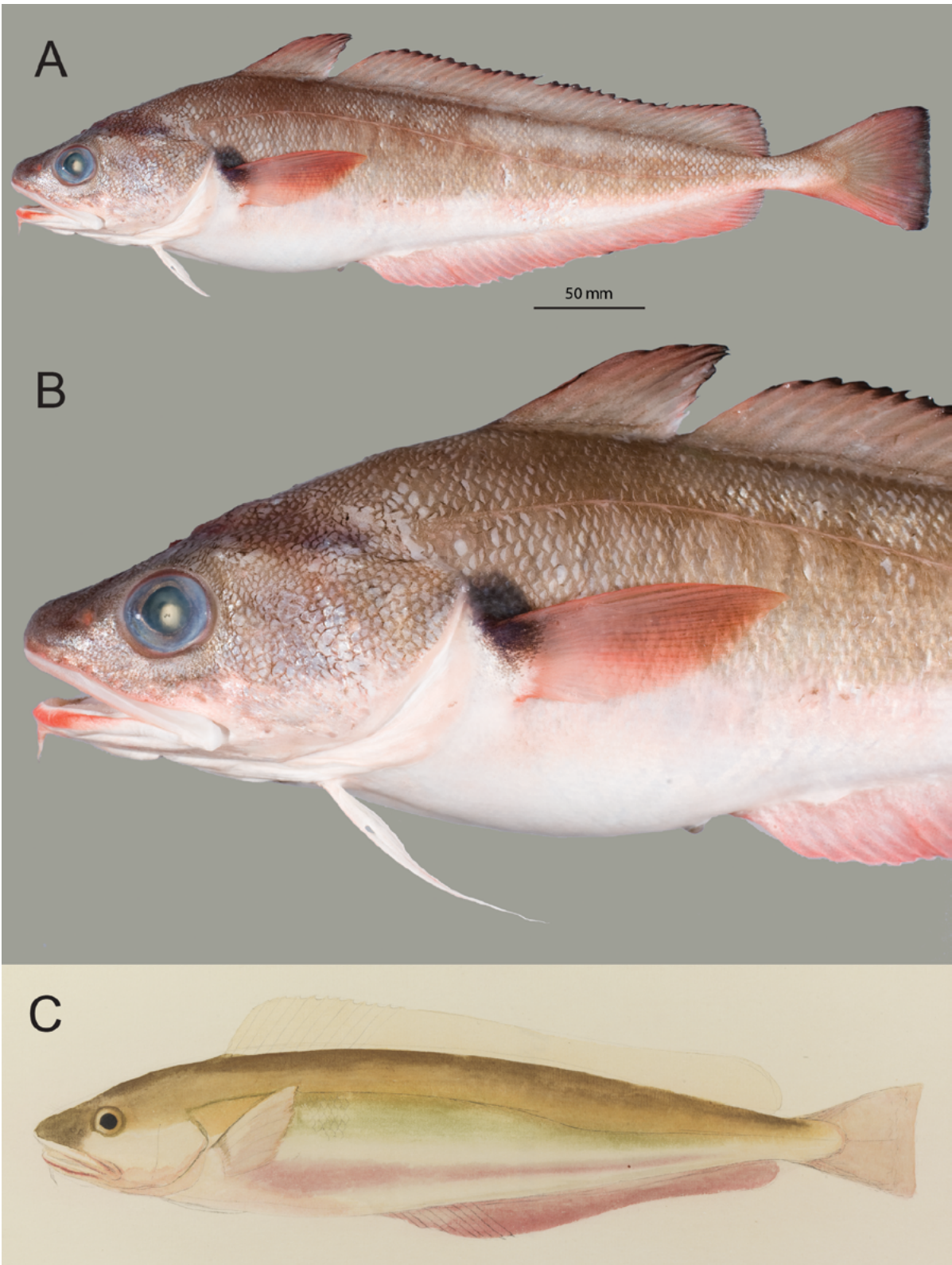


Figure 6. *Pseudophycis bachus*. A, B, NMNZ P.054828, neotype, 351 mm SL, 2.5 km off coast from Whanganui River bar, Whanganui, New Zealand, fresh specimen, lateral view of body and anterior body showing black pectoral blotch respectively (photographs C. Struthers, NMNZ); C, unpublished line drawing by S. Parkinson of *Enchelyopus bachus* Forster in Bloch and Schneider, 1801 (reproduced from Whitehead, 1969: pl. 31).



Robinson, 1959: 152; Anonymous, 1960: 70; Parrott, 1960: 67, 164; Meglitsch, 1960: 321–323; Scott, 1962: 84 (in part); Gorman, 1963: 29; Graham, 1963: 167; Doogue and Moreland, 1964: 205, 311; Street, 1964: 18; Anonymous, 1965: 15, 22; Churchman, 1965: 56; Doogue and Moreland, 1966: 205, 311; Elder, 1966: 96, 97; Howell, 1966: 33; Paul, 1966: 372, 373; Svetovidov, 1967: 1685, 1686, 1689, 1690; Sorensen, 1968: 148; Tong and Elder, 1968: 64; Doogue and Moreland, 1969: 205, 311; Russell, 1969: 108; Cowper, 1970: 45; Godfriaux, 1970: 257; Iwai et al., 1970: 21; Shuntov, 1970: 373, 374, 376; Sorensen, 1970: 4, 17; Coakley, 1971: 24; Russell, 1971a: 9, 19, 21, fig. 3, 38, 41, 94, 173, table 10, fig. 13, 191, 197; Russell, 1971b: 83; Anonymous, 1972a: 229; Anonymous, 1972b: 187–189, 278; Doak, 1972: 19, 101, 131; Hewitt and Hine, 1972: 92; Iwai et al., 1972: 29, 36; Shuntov, 1972: 339; Walker, 1972: 2; Webb, 1972a: 16; Suda, 1973: 2150–2152; Waugh in Williams, 1973: 257, 274; Williams, 1973: 427; Godfriaux, 1974: 502; Ryan, 1974: 133, 135; Scott et al., 1974: 95, 96 (in part).

*Lotella bachus*. Ayson, 1908: 28; Rendahl, 1926: 2.

*Physiculus backus*. Fowler, 1940: 758 (near Loba, New Zealand).

*Physiculus (Pseudophysicis) bachus*. Graham, 1956: 166; Whitley, 1956: 403; Whitley, 1968: 40 (list).

*Pseudophysicis bachus*. Doogue and Moreland, 1982: 218, fig. (misspelling).

**Diagnosis.** First dorsal fin 11–13 rays, second dorsal fin 40–45 rays; anal fin 42–48 rays; total vertebrae 44–46; scales above lateral line in oblique series from base of first dorsal fin ray 10–12; oblique rows of scales intersecting with lateral line 102–136; pyloric caeca 6; caudal peduncle moderately short 28.0–38.9% HL; barbel short, 8.6–16.9% HL; caudal fin truncate with angular corners in specimens larger than about 150 mm SL, middle rays shorter than rays extending to corners; dark blotch basally on pectoral fin extending well onto side above fleshy pectoral fin base; underside of head and body whitish; anal fin mostly whitish with faint narrow black distal margin only posteriorly, if at all. A large species reaching at least 650 mm SL.

**Description.** (Values for neotype with those for non-type specimens when different in parentheses; see Tables 2–4 for summary of selected meristic and comparative morphometric values.) First dorsal fin 11 (11–13, rarely 13, first ray usually minute); second dorsal fin 42 (40–45, usually 42 or 43); anal fin 45 (42–48, usually 45–47); pectoral fin 24 (22–25, rarely 22); pelvic fin 5; caudal fin 36 (33–39); gill rakers 4 + 10 (4–5 + 10–12 = 14–16); lateral line pores not associated with individual scales; oblique scale rows intersecting with lateral line 112 (102–136); scales in oblique series above lateral line 11 (10–12), scales in oblique series below lateral line 30 (26–34, rarely 33 or 34); vertebrae 16 + 29 (16–17 + 27–30 = 44–46); pyloric caeca 6.

Body moderately slender, compressed laterally (fig. 6), greatest depth at anal fin origin 19.5 (18.4–23.7)% SL, tapering uniformly from second dorsal fin origin to shallow caudal peduncle; caudal peduncle short, 8.5 (7.7–10.5)% SL, strongly compressed, depth less than orbital diameter. Distance between middle of anus and base of anal fin less than suborbital depth. Body cavity extending posteriorly to above origin of anal fin.

Head acute, of moderate size, length 26.5 (25.9–29.6)% SL, its width 14.4 (13.4–17.7)% SL and depth 11.7 (10.2–15.6)% SL; snout of moderate length 7.5 (7.1–9.0)% SL, not

projecting in advance of upper jaw, rounded in dorsal view. Nostrils small, located about two-thirds to three-quarters of the way from snout tip to eye, distance from nostril to orbital margin equal to or greater than diameter of combined nostrils; nostrils positioned above horizontal through centre of eye; posterior opening larger than anterior, separated from it by raised skin flap; posterior opening with tubular flap encircling margin. Interorbital of moderate width, very slightly convex. Eye of moderate size, orbital diameter 21.1 (17.0–30.4)% HL, 1.58 (0.98–2.00) times in interorbital space, 2.20 (1.50–4.25) times suborbital distance, circular, upper edge of eye adjacent to dorsal margin of head in lateral view, transparent skin covering eye faintly pigmented near orbital dorsal margin. Postorbital moderately long, 1.01 (0.89–1.22) times length of upper jaw. Mouth large, terminal, upper jaw terminating at vertical through posterior margin of eye. Jaw teeth caniniform, slightly curved, depressible, band of up to four or five irregular rows in upper jaw with distinct hiatus at symphysis; teeth in outer row more regularly arranged than in inner rows; band tapering near rear of jaw. Teeth of lower jaw similar in form to those of upper jaw; band of two or three rows with broader patch on either side of symphysis, tapering to single, widely spaced row posteriorly; rows almost contiguous across symphysis. Vomerine teeth absent. Opercular bones strong; upper extremity of gill opening at horizontal through middle of eye; gill membranes continuous across isthmus. Gill rakers on outer arch slender, of moderate length, almost as long near angle as opposing gill filaments, 12.8 (9.5–12.8) times in head, their inner margin denticulate. Chin barbel short, subconical 12.0 (8.6–16.9)% HL.

Small cycloid scales covering all of head, including isthmus and gular region, and body except for branchiostegal membranes, surface of maxilla and premaxilla, lower lip and distal parts of fins; thick mucus covering obscuring scales and pores in freshly preserved material. Most head pores tiny, following main cephalic sensory canals; row of slightly raised pores from nostrils to tip of snout and then posteriorly just above lower edge of suborbital; row of enlarged mandibular pores on underside of lower jaw. Lateral line comprising widely spaced pores on short tubes arising from narrow scaleless gap, anterior end curved upwards slightly, then gradually descending to lateral midline below posterior 25% of second dorsal fin, remaining on lateral midline posteriorly.

Membranes of first and second dorsal fins continuous at base; first dorsal originating vertically above pectoral fin base; anterior two-thirds of second dorsal of uniform height, 7th to 9th ray from posterior end of fin longest, its height about 1.4 times length of 2nd ray at anterior end of fin, subsequent rays progressively shorter; rays of both dorsal fins mostly unbranched, only last 13 to 16 rays of second dorsal, apart from last one to three, branched. Fleshy, fine scale-covered basal sheath on third or more of first dorsal and anterior portion of second dorsal fins; fin rays interconnected by membranes to tips, sheath gradually decreasing in coverage and thickness posteriorly, encompassing about half of second dorsal fin near its insertion; sheath extending onto body for anterior third of combined dorsal fin base, broadest anteriorly, narrowing posteriorly. Profile of anal fin like that of second

dorsal fin, although shallower posteriorly, with comparable unbranched and branched rays. Likewise, anal fin enclosed in broad fleshy sheath that is like that of dorsal fins; sheath also extending onto body for anterior third or less of fin. Caudal fin truncate with distinct dorsoposterior and ventroposterior corners in adults, posterior margin with little if any convex curve; longest rays to corners, middle rays about 85–90% length of longest rays; fin more rounded in juveniles; base of fin covered by indistinct sheath sharply demarcated from scales of caudal peduncle. Pectoral fin tip variably reaching almost to, to or past vertical through anal fin origin, sixth or seventh ray longest. Pelvic fin inserted anterior to vertical through posterior edge of preopercle (more posteriorly in some specimens); outer two rays longer than inner rays; second ray longest, 16.0 (11.5–21.1)% SL, nearly twice length of subsequent ray, reaching past a vertical through first dorsal fin origin.

*Fresh colour.* (Based on images of neotype; fig. 6A, B.) Medium brown above extending ventrally to level of ventral edge of pectoral fin base, white below, suffused with pinkish hue, especially above anal fin base; lateral line slightly paler at least anteriorly. Underside of head, jaws and barbel white, tinged with pink. Dorsal and caudal fins medium brown, caudal paler with reddish tinge ventrally; anal fin white with pink hue; dorsal fins with fine black distal margin; caudal fin margin with broader, more diffuse black margin; anal fin with faint black distal margin, darkest posteriorly. Pectoral fin medium brown with semi-circular black basal spot covering dorsal half of fin edge proximally, extending well onto side of body above fin base; ventroposterior margin of fin pale to translucent. Pelvic fin rays white with pink hue.

*Preserved colour.* Upper half of head and body pale dusky to dusky, lower half very pale, frequently pearly white. Dorsal and caudal fins pale dusky; distal edge of dorsal fin with fine dark margin; posterior edge of caudal fin broadly dark; anal fin very pale, distal edge of fin posteriorly with fine dark margin in some; pelvic fin, pectoral fin and basal half of anal fin very pale; pectoral fin with prominent dark spot covering dorsal half or more of basal edge that extends onto side above pectoral fin base.

*Etymology.* The name *bachus* is an altered spelling of *bacchus*, the Greek god of wine, adopted for the wine-red colouration assumed shortly after capture but lost soon after death.

*Distribution.* Endemic to New Zealand, occurring around both the North and South Islands, and reaching the Chatham Islands in the east (fig. 3A). A demersal species on soft bottom at 2–570 m depth.

*Remarks.* *Pseudophycis bachus* was originally described as *Enchelyopus bachus* Forster in Bloch and Schneider, 1801, based on Forster's manuscript description of "Gadus bachus", subsequently published by Lichtenstein (1844: 120). Forster's drawing No. 180, on the back of which is pencilled "ex Queen Charlotte Sound", is evidently an illustration of the fish on which the description was based. Although both Bloch and Schneider (1801: 53) and Lichtenstein gave the origin of the

specimen simply as "in the seas around New Zealand", Whitehead (1969: pl. 11), Paulin (1983: 91) and Fricke et al. (2019) regarded Queen Charlotte Sound, the presumed collection locality of the specimen implied in the note on Forster's illustration, as the type locality. However, Hoare's (1982: 269) reproduction of *Forster's Resolution Journal* has a footnote stating "Gadus bacchus of Descr. Anim., p. 120 and Forster drawing 180 (undated). The description is from a specimen of 22 inches (559 mm), dated 13 April 1773". That date puts the type locality as Dusky Sound from a larger fish. Paulin (1983: 92) provided a detailed discussion of the origin and various iterations of Bloch and Schneider's name.

An unfinished drawing by Parkinson (vol. 2, no. 5, ex Totarra 'nue, 404 mm tot. l.) reproduced by Whitehead (1969: pl. 11; here as fig. 6C), has "*18, Blennius venustus*" pencilled on the reverse side and is the basis for Richardson and Gray's (1843: 222) *Brosmius venustus*. The fish figured is clearly an example of *P. bachus*, despite the incomplete nature of the illustration. Totaranui is the Maori name for Queen Charlotte Sound. The scientific name is regarded as unavailable because no distinguishing features were provided by the authors (Fricke et al., 2019). The illustrated characters agree with those of specimens from New Zealand identified as *P. bachus*.

Because no type specimen of *P. bachus* is known (Fricke et al., 2019), the designation of a neotype for *P. bachus* is considered justified. A specimen (NMNZ P.054828, 351 mm SL; fig. 6a) collected from 2.5 km off the coast from Whanganui River bar, Whanganui, New Zealand, is proposed as the neotype for *P. bachus*. Accordingly, Whanganui, New Zealand, becomes the type locality of *P. bachus* under Article 76.3 (ICZN, 1999), replacing the original type locality Queen Charlotte Sound, New Zealand.

*Material examined.* Neotype. NMNZ P.054828<sup>†</sup> (351) 2.5 km off the coast from Whanganui River bar, Whanganui, New Zealand, 39° 53' S, 174° 49' E, 18 m, C. Papple, 10 October 2012.

*Other material.* (38 non-type specimens examined for meristic or morphometric values, 110–539 mm SL; see Appendix 2 for additional material in Australasian collections.) **New Zealand, North Island:** NMNZ P.001718 (539) off Castlepoint, Wairarapa, 40° 54' S, 176° 13' E, 73–110 m, F. Abernethy, 8 July 1955; NMNZ P.033899 (5, 121–202) off Raglan, Waikato, 37° 48.33' S, 174° 34.00' E, RV Kaharoa, 61–63 m, 26 October 1996. **South Island:** NMNZ P.025037 (2, 479–512) Blueskin Bay, Otago Peninsula, Otago, 45° 43.28' S, 170° 40.33' E, 20–22 m, C.D. Roberts and C.D. Paulin, 9 May 1990; NMNZ P.025129 (4, 137–192) Entrance mole, Otago Harbour, Otago, 45° 46.45' S, 170° 43.23' E, 6–9 m, C.D. Roberts, 9 May 1990; NMNZ P.027580 (239) Harrold's Bay, Halfmoon Bay, Stewart Island, 46° 53.75' S, 168° 9.25' E, 2–5 m, NMNZ Stewart Island field team, 4 March 1992; NMNZ P.032385 (2, 328–395) Mooring, head of Gold Arm, Charles Sound, Fiordland, 45° 8.55' S, 167° 8.78' E, 5–10 m, NMNZ Fiordland 1995 field team, 24 March 1995; NMNZ P.032393 (3, 292–309) Mooring at Toe Cove, head of Nancy Sound, Fiordland, 45° 10.55' S, 167° 8.85' E, 25 m, NMNZ Fiordland 1995 field team, 26 March 1995; NMNZ P.035991 (388) Flowerpot Rock, Jackson's Bay, West Coast, 43° 58.03' S, 168° 37.30' E, 5–8 m, NMNZ Jackson-Haast 1999 field team, 7 February 1999; NMNZ P.044338<sup>†</sup> (136) south of Timaru, Canterbury, 44° 45.04' S, 171° 18.40' E, 26–31 m, RV Kaharoa, 3 June 2007; NMNZ P.044339<sup>†</sup> (176) south off Timaru, Canterbury, 44° 45.04' S, 171° 18.40' E, 26–31 m, RV Kaharoa, 3 June 2007; NMNZ P.047709 (229) Lyttelton Port, Canterbury, 43° 36.33' S, 172° 43.10' E, NIWA

Port Survey, 4 November 2004; NMNZ P.049392 (343) c. 7 km east-north-east of Kaikoura Peninsula, 42° 24.77' S, 173° 48.22' E, 93 m, C.D. Struthers, 16 November 2010; NMNZ P.049401 (370) c. 6 km north-east of Kaikoura Peninsula, 42° 23.60' S, 173° 47.59' E, 49 m, C.D. Struthers, 16 November 2010; NMNZ P.049402 (545) c. 5 km east-south-east of Kaikoura Peninsula, 42° 26.77' S, 173° 46.39' E, 94 m, C.D. Struthers, 17 November 2010; NMNZ P.049403 (519) c. 5 km south off Kaikoura Peninsula, 42 28.09' S, 173 43.02' E, 91 m, C.D. Struthers, 19 November 2010; NMNZ P.049406 (485) and NMNZ P.049407 (467) c. 3 km south off Kaikoura Peninsula, 42° 24.72' S, 173° 45.22' E, 47 m, C.D. Struthers, 17 November 2010; NMNZ P.049678 (358) Bay View, end of Franklin Road, Hawke's Bay, 10–15 m, C.D. Struthers and D.H. Struthers, 27 December 2010; NMNZ P.052508 (297) and NMNZ P.052509 (290) south of Pegasus Canyon mouth, Canterbury Bight, 43° 33.99' S, 173° 33.44' E, 86 m, RV Tangaroa, 13 May 2011; NMNZ P.053748<sup>†</sup> (383), NMNZ P.053749<sup>†</sup> (405), NMNZ P.053750<sup>†</sup> (368), NMNZ P.053751<sup>†</sup> (373) and NMNZ P.053752<sup>†</sup> (337) Port Pegasus; Stewart Island, 47° 13.20' S, 167° 41.38' E, 64 m, C.D. Struthers, 20 February 2012. **Chatham Rise:** NMNZ P.044348<sup>†</sup> (273) central Chatham Rise, 43° 47.42' S, 179° 30.01' W, 327–328 m, RV Tangaroa, 31 December 2007; NMNZ P.044349<sup>†</sup> (382) central Chatham Rise, 43° 47.42' S, 179° 30.01' W, 327–328 m, RV Tangaroa, 31 December 2007; NMNZ P.044350<sup>†</sup> (297) central Chatham Rise, 43° 43.78' S, 179° 24.00' W, 367–375 m, RV Tangaroa, 31 December 2007.

### *Pseudophycis barbata* Günther 1862

Common name: Bearded Rock Cod (Australian Standard); southern bastard cod (New Zealand)

Figures 1, 3B, 4, 5, 7; Tables 1–4

*Pseudophycis barbatus* Günther, 1863: 116. Type locality: Victoria, South Australia. Holotype: BMNH 1863.1.15.38 (skin in alcohol).

*Pseudophycis barbatus*. McCoy, 1878: 29, pl. 20 (in part, description); Johnston, 1883: 126 (description); Ayling and Cox, 1982: 144, fig. (description).

*Lotella grandis* Ramsay, 1881: 462. Type locality: Wollongong, New South Wales. Holotype: AMS I.696 (decision by Paulin, 1983: 94).

*Lotella grandis*. Steindachner, 1901: 509 (description).

*Physiculus barbatus*. Zietz 1909: 266; Waite, 1923: 91, fig. (description); Lord and Scott, 1924: 8, 43 (description); McCulloch, 1927: 32 (listed); Waite, 1928: 6 (listed); McCulloch, 1929: 128 (list); Norman, 1937: 55 (listed); Munro, 1938: 62, fig. 440 (description); Whitley, 1955: 119 (taxonomy); Scott, 1962: 84, fig. (description); Whitley, 1964: 40 (list); Svetovidov, 1967: 1686; Scott et al., 1974: 95, fig. (description).

?*Pseudophycis brevisculus* (nec Richardson, 1846) Graham, 1939: 405 (after Paulin, 1983: 93).

*Pseudophycis brevisculus* (nec Richardson 1846). Habib, 1975: 32–57.

*Physiculus (Pseudophycis) breviculus* (nec Richardson, 1846). Graham, 1956: 173 (in part, locality implies multiple species; misspelling).

*Physiculus (Pseudophycis) brevisculus* (nec Richardson, 1846) Whitley, 1956: 403 (in part?).

*Pseudophycis barbata*. Paulin, 1983: 94, fig. 10 (description, new record for NZ); Paulin and Stewart, 1985: 22; Hutchins and Swainston, 1986: 34 124, fig. 114 (description); May and Maxwell, 1986: 195 (description); Paul, 1986: 58, fig; Francis, 1988: 21, pl. 19; Paulin, 1988: 453; Paxton and Hanley in Paxton et al., 1989: 302 (list); Paulin et al., 1989: 119 (key), 255 (listed); Cohen in Cohen et al., 1990: 374

(taxonomy); Paulin in Amaoka et al., 1990: 156 (description); Kuitert, 1993: 59 (description); Gomon in Gomon et al., 1994: 334 (description); Francis, 1996: 21, pl. 19; Horn, 1996: 157; Kuitert, 1997: 50 (description); Paulin, 1998: 67, fig. (description); Paul, 2000: 58; Francis, 2001: 25, pl. 18; Hutchins, 2001: 23 (description); Paxton et al., 2006: 616 (list); Hirt-Chabbert, 2006: 40; Gomon in Gomon et al., 2008: 314 (description); Roberts et al. in Gordon et al., 2009: 532 (listed); McMillan et al., 2011a: 161, 162; McMillan et al., 2011b: 94; Francis, 2012: 52; Roberts et al., 2014: 18 (list); Struthers et al. in Roberts et al., 2015: 863, fig. 107.21 (description); Roberts et al., 2015: S164; Roberts et al., 2017: 81 (list), Roberts et al., 2019: 90 (listed).

**Diagnosis.** First dorsal fin with 10–11 rays, second dorsal fin with 54–59 rays; anal fin with 54–63 rays; total vertebrae 48–51; scales above lateral line in oblique series from base of first dorsal fin ray 16–22; oblique rows of scales intersecting with lateral line 123–162; pyloric caeca 14–20; caudal peduncle short 13.5–18.6% HL; chin barbel of moderate length, 16.5–35.1% HL; caudal fin rounded without angular corners, the middle rays equal to or longer than rays above and below; no distinct, dark blotch basally on pectoral fin although fin base sometimes overall dark; underside of head and body tan to brown; anal fin tan to brown with distinct black distal margin. A large species reaching at least 620 mm SL.

**Description.** (Values for non-type specimens when different from type in parentheses; see Tables 2–4 for summary of selected meristic and comparative morphometric values.) First dorsal fin 10 (10–11), first ray small to minute; second dorsal fin 59 (54–59, rarely 59); anal fin 59 (54–63); pectoral fin 25 (24–27, rarely 24); pelvic fin 5; caudal fin 33 (32–35 rays); gill rakers unknown (3–4 + 8–11 = 12–14); lateral line pores not associated with individual scales; oblique scale rows intersecting with lateral line unknown (123–162); scales in oblique series above lateral line unknown (16–22), scales in oblique series below lateral line unknown (38–56, rarely less than 45); vertebrae unknown (14–16 + 33–37, rarely 37 = 48–51); pyloric caeca unknown (14–20).

Body of moderate depth, moderately compressed laterally (fig. 7b), greatest depth at anal fin origin unknown (19.7–29.3)% SL, tapering uniformly from second dorsal fin origin to shallow caudal peduncle; caudal peduncle short, 5.4 (5.2–9.2)% SL, strongly compressed, depth subequal to orbital diameter. Distance between middle of anus and base of anal fin slightly less than suborbital depth. Body cavity extending to above origin of anal fin.

Head acute, of moderate size, length 23.3 (23.3–31.6)% SL, width unknown (14.9–19.8)% SL and depth unknown (11.0–17.9)% SL; snout of moderate length 7.5 (6.5–9.6)% SL, not projecting in advance of upper jaw, rounded in dorsal view. Nostrils small, located about two-thirds to three-quarters of the way from snout tip to eye, distance from nostril to orbital margin about equal to or greater than diameter of combined nostrils; nostrils positioned above horizontal through centre of eye, both with low tubular rim; posterior opening about half size of anterior, separated from it by raised skin flap. Interorbital of moderate width, very slightly convex. Eye of moderate size, orbital diameter 20.8 (16.8–28.5)% HL, unknown (0.91–1.68) times in interorbital space, unknown (1.46–4.71) times suborbital distance, circular, upper edge of eye adjacent to



Figure 7. *Pseudophycis barbata*. A, NMNZ P.037124, 450 mm SL, Bay of Plenty, east of north-east point, North Island, New Zealand (photograph C. Struthers, NMNZ); B, BMNH 1863.1.15.38, holotype of *Pseudophycis barbata*, 394 mm SL, Victoria, South Australia (photograph © The Trustees of the Natural History Museum, London).

dorsal margin of head in lateral view. Postorbital moderately long, 1.00 (0.52–1.21) times length of upper jaw. Mouth large, terminal, upper jaw terminating at vertical through posterior margin of eye. Jaw teeth caniniform, slightly curved, depressible, band of up to four or five irregular rows in upper jaw with distinct hiatus at symphysis; teeth in outer row more regularly arranged than in inner rows; band tapering near rear of jaw. Teeth of lower jaw similar in form to those of upper jaw; band of two or three rows with broader patch on either side of symphysis, tapering to single, widely spaced row posteriorly; rows almost contiguous across symphysis. Vomerine teeth absent. Opercular bones strong; upper extremity of gill opening at horizontal through middle of eye; gill membranes continuous across isthmus. Gill rakers on outer arch slender, moderately

short, unknown (about 0.6–0.8) times length of opposing gill filaments near angle, unknown (19–22) times in head length, slightly denticulate. Chin barbel of moderate length, subconical 21.1 (16.5–25.3)% HL.

Very small cycloid scales covering all of head and body except for branchiostegal membranes, surface of maxilla and premaxilla, lower lip and distal parts of fins; thick mucus covering obscuring scales and pores in freshly preserved material. Most head pores tiny, following main cephalic sensory canals; row of slightly raised pores from nostrils to tip of snout and then posteriorly just above lower edge of suborbital; row of enlarged mandibular pores on underside of lower jaw. Lateral line comprising widely spaced pores on short tubes arising from narrow scale-less gap, anterior end

curved upwards slightly, then gradually descending to lateral midline below posterior 25% of second dorsal fin, remaining on lateral midline posteriorly.

Membranes of first and second dorsal fins continuous at base; first dorsal originating distinctly behind vertical through pectoral fin base; anterior two-thirds of second dorsal of uniform height, 7th to 9th ray from posterior end of fin longest, its height about 1.4 times length of 2nd ray at anterior end of fin, last ten or so rays progressively shorter; rays of both dorsal fins mostly unbranched, only last 13 to 16 rays, apart from last one to three, branched. Fleshy, fine scale-covered basal sheath on third or more of first dorsal and anterior portion of second dorsal fins; fin rays interconnected by membranes to tips, sheath gradually decreasing slightly in coverage and thickness posteriorly, encompassing about half of second dorsal fin near its insertion; sheath extending onto body for anterior third of combined dorsal fin base, broadest anteriorly, narrowing posteriorly. Profile of anal fin like that of second dorsal fin, although less deep posteriorly, with comparable unbranched and branched rays. Likewise, anal fin enclosed in broad fleshy sheath that is like that of dorsal fins; sheath also extending onto body for anterior third or less of fin. Caudal fin distinctly rounded without obvious dorsoposterior and ventroposterior corners in adults; all but anterior-most rays of similar length; base of fin covered by indistinct sheath with much smaller scales (sheath sharply demarcated from scales of caudal peduncle). Pectoral fin tip variably reaching not quite to, or past vertical through anal fin origin, sixth or seventh ray longest. Pelvic fin inserted anterior to vertical through posterior edge of preopercle; outer two rays longer than inner rays; second ray longest, 13.3 (13.3–24.9)% SL, nearly twice length of subsequent ray, reaching vertical through first dorsal fin origin.

**Fresh colour.** (Based on images of non-type material; fig. 7A.) Medium to dark reddish brown above, extending ventrally to level of ventral portion of pectoral fin base, white below in smaller individuals, large individuals becoming brown ventrally and often much darker; lateral line not distinctively coloured. Underside of head, jaws and barbel white, tinged with pink to orange, becoming more orange to brown in larger individuals; ventral margin of suborbital dusky to dark. Dorsal and caudal fins of similar colour to brown of sides, anal fin pink or orange in smaller individuals, becoming brown like other median fins in large individuals, dorsal, caudal and anal fins with distinct broad to narrow black margin distally, margin on caudal fin broadest. Pectoral fin orange to brown with faintly darker semi-circular brown blotch basally, covering dorsal 80% of edge of fin proximally. Pelvic fin rays white with pink to orange hue, becoming brownish in large individuals.

**Preserved colour.** Head and body dusky to dark dusky; underside of head, belly and side adjacent to anal fin pale, especially in small specimens, extent of pale underside less in large individuals. Dorsal, caudal and anal fins dusky to dark dusky, anal fin often less dark than dorsal and caudal; distal edges of dorsal, caudal and anal fins with distinctly dark margins, dark margin on caudal fin broad; pectoral fin broadly dusky basally, becoming pale toward outer margin. Pelvic fin pale dusky.

**Etymology.** The specific epithet *barbatus* is Latin for “bearded” in reference to the chin barbel, which is characteristic of this species, its congeners and many other members of the family.

**Distribution.** Endemic to coastal waters of Australia and New Zealand from Rottneest Island, Western Australia (32° 01' S, 115° 30' E), to Port Stephens, New South Wales (32° 30' S, 152° 35' E), including all of Tasmania and around both the North and South Islands of New Zealand, reaching the Chatham Islands in the east (fig. 3B). A demersal species on rocky bottom at 1 to at least 520 m. Although found at considerable depths in New Zealand waters, this is a shallow reef-dwelling species in southern Australia, where it shelters in caves and beneath overhangs during daylight hours, venturing out at night to feed.

**Remarks.** *Pseudophycis barbata* has an overall darker colouration than its congeners, often with a reddish hue in fresh material, and distinct black margins to the dorsal, caudal and anal fins. In particularly dark individuals, the basal portion of the pectoral fin is similarly dark but lacks the distinct black spot present in *P. bachus* and *P. palmata*. *Pseudophycis barbata* is easily separable from *P. breviuscula* by the more numerous scales (16–22 vs. 7–9) in a transverse row between the dorsal fin origin and lateral line.

As mentioned above under Remarks for *P. palmata*, McCoy's (1878: 29) treatment of *P. barbata*, the first published after Günther's original description, was largely based on specimens of *P. palmata*, but the accompanying illustration is of a large specimen of *P. barbata*. Although Ramsay's (1881) description of *Lotella grandis* is inadequate for a conclusive identification of the species, the lone type specimen (AMS I.696) is clearly *P. barbata*. Early taxonomic confusion resulted in Steindachner (1901: 509) reporting *P. barbata* from New Zealand as *L. grandis*, Norman (1937: 55) speculating that *P. barbata* (as *Physiculus barbatus*) may be identical with *P. bachus*, and Graham (1938: 399) and Habib (1975) treating it in New Zealand as *P. breviusculus*. The last stems from our assumption that *P. breviusculus* does not occur in the waters of the South Island based on specimens examined and reliable identification records.

**Material examined.** *Types.* *Pseudophycis barbatus* BMNH 1863.1.15.38 (394, holotype) Victoria, South Australia (fig. 7a); *Lotella grandis* AMS I.696 (503, holotype) Wollongong, New South Wales.

**Other material.** (38 specimens examined for meristic or morphometric values, 111–531 mm SL; see Appendix 2 for additional material in Australasian collections.) **Australia, Victoria:** CSIRO H 3791-01<sup>†</sup> (340) south of Gabo Island, 37° 43.30' S, 149° 55.20' E–37° 41.10' S, 149° 57.10' E, 116–107 m, A. Graham, 17 September 1994; CSIRO H 4500-01<sup>†</sup> (410) south of Cape Everard, 38° 07.81' S, 149° 30.87' E, 156 m, A. Williams and M. Lewis, 13 January 1997; NMV A2248 (5, 134–185) Portland Harbour, halfway along lee breakwater, adjacent to oil wharf, 38° 20.916' S, 141° 37.398' E, 7–12 m, R. Kuiter, R. Wilson and I. Head, 22 October 1981; NMV A2261-001 (4, 149–180) Portland Harbour, end of lee breakwater, 38° 21' S, 141° 36' E, 12 m, R. Kuiter, R. Wilson and I. Head, 21 October 1981; NMV A13046 (203) eastern Bass Strait, 110 km E of Paradise Beach, 38° 18.7' S, 148° 50.7' E, 201–208 m, M. Gomon, 7 August 1993. **Tasmania:** AMS I.20079-009 (90.1) south side of Rocky Cape, in National Park, 40° 51' S, 145° 31' E, 2–8 m, B.C. Russell, 8 December 1977; CSIRO H 7539-03<sup>†</sup> (185) south-east of Orford, rock point W of Triabunna woodchip mill, 42°

32.92° S, 147° 54.80' E, 3 m, P.L. Last, W. White and J. Pogonoski, 01 April 2014. **South Australia:** CSIRO CA 3526 (410 mm SL) Great Australian Bight, 32° 11.8' S, 131° 22.4' E–32° 13.4' S, 131° 22.2' E, 60 m, 7 December 1981; CSIRO H 7949-13<sup>3</sup> (2, 47–70) Great Australian Bight, 33° 20.20' S, 130° 15.42' E–33° 20.20' S, 130° 16.26' E, 191–188 m, A. Graham, J. Pogonoski, M.F. Gomon and D.J. Bray, 15 December 2015. **Western Australia:** WAM P.26621.003 (135) Porpoise Bay, 32°00' S, 115°30' E, 1 m. **New Zealand, North Island:** NMNZ P.01930 (514) Wellington, Ohau Point, Makara Coast, 41 14.00' S, 174 39.00' E, 18 m, J. Moreland, 10 June 1956; NMNZ P.014921 (2, 207–240) Three Kings Islands, west end of Great Island, 34° 8.5' S, 172° 9.1' E, 5–7 m, G.S. Hardy and A.L. Stewart, 28 November 1983; NMNZ P.037109<sup>3</sup> (518) Mahina Knoll, NW of White Island, Bay of Plenty, 37° 20.46' S, 177° 5.43' E, 303 m, NMNZ/MARS White Island field team, 22 March 2009; NMNZ P.037124<sup>3</sup> (450) east of north-east point; White Island, Bay of Plenty, 37° 30.96' S, 177° 13.54' E, 296 m, NMNZ/MARS White Island field team, 19 March 2009; NMNZ P.044103<sup>3</sup> (250) southeast of Club Rock; White Island, Bay of Plenty, 37° 32.35' S, 177° 11.92' E, 99 m, NMNZ/MARS White Island field team, 16 March 2009; NMNZ P.044272 (376) and NMNZ P.044273 (361) Three Kings Islands, northern edge of Three Kings Shelf; north off Princess Islands, 114 m, NMNZ/MARS Three Kings field team, 10 March 2010; NMNZ P.045835<sup>3</sup> (197) east off Parengarenga Harbour entrance, 34° 30.93' S, 173° 18.05' E, 176 m, RV Kaharoa, 4 August 2009; NMNZ P.046563 (339) Three Kings Islands, at anchor, Northwest Bay; Three Kings Island, 34 9.16' S, 172 8.06' E, 27 m, C.D. Struthers, 6 March 2010; NMNZ P.052585 (339) Northland, off North Cape, 34° 16.47' S, 173° 0.80' E, 130–132 m, RV Tangaroa, 25 March 2011; NMNZ P.052745<sup>3</sup> (443) eastern side of Motkokoko Island, Cape Brett, 35° 9.90' S, 174° 20.27' E, S. Tindale, 7 September 2011; NMNZ P.053551<sup>3</sup> (531) Kingfish Reef, Bay of Islands, 35° 11.20' S, 174° 15.40' E, 35 m, S. Tindale, 8 April 2012. **South Island:** NMNZ P.035978 (2, 234–266) West Coast, Open Bay Island, south end Popotai Islet, 43° 51.82' S, 168° 52.48' E, 14–19 m, NMNZ Jackson-Haast field team, 14 February 1999; NMNZ P.036535 (3, 186–256) West Coast, Open Bay Island, south end Popotai Islet, 43° 51.82' S, 168° 52.48' E, 14–19 m, NMNZ Jackson-Haast field team, 14 February 1999; NMNZ P.037525 (4, 111–148) West Coast, North of Murphy Beach, Whakapohai Rocks, 43° 42.27' S, 169° 14.33' E, 12–14 m, NMNZ Haast-Buller field team, 18 February 2000. NMNZ P.053753 (281) off Snares Islands, 47° 59.99' S, 166° 36.25' E, 160 m, NMNZ/MARS Auckland Island field team, 21 February 2012; NMNZ P.053754 (390) Stewart Island, North Arm, Port Pegasus, 47° 10.73' S, 167° 40.95' E, 38 m, NMNZ/MARS Auckland Island field team, 20 February 2012.

### *Pseudophycis breviuscula* (Richardson 1846)

Common name: Bastard Red Cod (Australian Standard); northern bastard cod (New Zealand)

Figures 1, 3C, 5, 8; Tables 1–4

*Lota breviuscula* Richardson, 1846: 61, Pl. 38 (figs 1–2). Type locality: Bay of Islands, New Zealand. Holotype: BMNH 1855.9.19.1182.

*Pseudophycis breviusculus*. Günther, 1862: 350; Günther, 1863: 116; Hector in Hutton and Hector, 1872: 116, pl. 8; Hutton in Hutton and Hector, 1872: 47; Dambeck, 1879: 536, 547, 555; Hector, 1884: 55; Hector, 1886: 28; Sherrin, 1886: 304; Gill, 1893: 120 (list); Hutton, 1904: 48; Thomson, 1906: 551; Young, 1925: 370; Graham, 1938: 405; Graham, 1939b: 365; Ayling and Cox, 1982: 143, fig. (description).

*Austrophycis megalops* Ogilby, 1897: 91. Type locality: Maroubra Bay, New South Wales, Australia. Holotype: AMS I.3655.

*Austrophycis megalops*. McCulloch, 1927: 32 (list); McCulloch,

1929: 129 (list); Munro, 1938: 62, fig. 443 (description); Whitley, 1964: 40 (list); Paxton and Hanley in Paxton et al., 1989: 302 (list).

?*Pseudophycis breviusculus*. Graham, 1939: 399.

*Physiculus* (*Pseudophycis*) *breviusculus*. Graham 1956: 173, 174 fig.; Whitley, 1956: 403 (list); Svetovidov, 1967: 1686, 1689; Whitley, 1968: 40 (list).

*Pseudophycis breviuscula*. Paulin, 1983: 93 (description, taxonomy); Francis, 1988: 21; Paxton and Hanley in Paxton et al., 1989: 302 (list); Paul, 1986: 58; Paulin, 1988: 450, 451, 453; Paulin et al., 1989: 119 (key), 255 (list); Cohen in Cohen et al., 1990: 375 (taxonomy); Paulin and Roberts, 1992: 128, fig. 68a (description); Kuitert, 1993: 60 (description); Gomon in Gomon et al., 1994: 335 (description); Francis, 1996: 21; Paul, 2000: 58; Francis, 2001: 25; Hutchins, 2001: 23 (distribution); Sazonov, 2001: 293 (taxonomy of *A. megalops*); Paxton et al., 2006: 616 (list); Gomon in Gomon et al., 2008: 314 (description); Roberts et al. in Gordon et al., 2009: 532 (list); McMillan et al., 2011a: 161, 162; McMillan et al., 2011b: 94; Francis, 2012: 52; Struthers et al., in Roberts et al., 2016: 864, fig. 107.22 (description); Roberts et al., 2015: S164; Roberts et al., 2017: 81; Roberts et al., 2019: 90 (listed).

?*Austrophycis marginata* (nec Günther, 1878). Cohen in Cohen et al., 1990: 356 (taxonomy of *A. megalops*).

**Diagnosis.** First dorsal fin with 8–10 rays, second dorsal fin with 44–52 rays; anal fin with 49–56 rays; total vertebrae 42–45; nostrils adjacent to anterior margin of orbit, interval between nostril and orbital margin less than diameter of combined nostrils; posterior nostril with raised anterior border but without tubular flap posteriorly; gill rakers of outer arch moderately short, those near angle much shorter than opposing gill filaments; caudal peduncle short 28.8–33.4% HL; chin barbel of moderate length, 23.4–30.5% HL; scales above lateral line in oblique series from base of first dorsal fin ray 7–9; oblique rows of scales intersecting with lateral line 77–93; pyloric caeca 7–8; caudal fin rounded without angular corners, the middle rays equal to or longer than the rays above and below; no distinct dark blotch at base of pectoral fin; underside of head, body and anal fin tan to brown, anal fin with fine black distal margin. A small species reaching at least 151 mm SL.

**Description.** (Values for non-type specimens when different from type in parentheses; see Tables 2–4 for summary of selected meristic and comparative morphometric values.) First dorsal fin 9 (8–10, rarely 8), first ray often minute; second dorsal fin 46 (44–52, rarely less than 46); anal fin 50 (49–56); pectoral fin 21 (20–23); pelvic fin 4 (4–5); caudal fin 26 (26–32, rarely 26); gill rakers 3 (2–3) + 8 (7–8) = 9–12; lateral line pores not associated with individual scales; oblique scale rows intersecting with lateral line 93 (77–93); scales in oblique series above lateral line 7 (7–9), scales in oblique series below lateral line 23 (22–28, rarely 28); vertebrae 13 (11–14, rarely 11) + 31 (30–33) = 42–45, rarely 42; pyloric caeca 7–8.

Body of moderate depth, moderately compressed laterally (fig. 8), greatest depth at or just in advance of anal fin origin 22.8 (20.6–23.3)% SL, tapering gradually from second dorsal fin origin to posterior portion of fin and then more steeply to shallow caudal peduncle; caudal peduncle short, 4.8 (5.7–8.5)% SL, strongly compressed, depth subequal to orbital diameter. Distance between middle of anus and base of anal fin less than diameter of posterior nostril. Body cavity extending to above origin of anal fin.



Figure 8. *Pseudophycis breviuscula*. A, CSIRO H 4384-01, 110 mm SL, Albany, Western Australia (photograph compliments CSIRO Marine Research); B, BMNH 1855.9.19.1182, holotype of *Lota breviuscula*, 152 mm SL, Bay of Islands, New Zealand (photograph © The Trustees of the Natural History Museum, London).

Head acute, moderately short, length 25.8 (23.4–26.0)% SL, its width 16.6 (12.4–17.9)% SL and depth 12.1 (10.8–15.2)% SL; snout moderately short 5.9 (5.1–7.0)% SL, not projecting in advance of upper jaw, rounded in dorsal view. Nostrils small, located on posterior half of snout just in front of eye, distance from nostrils to orbital margin less than diameter of combined nostrils; nostrils positioned above horizontal through centre of eye; diameter of posterior opening about 1.5 diameter of anterior, separated from it by raised skin flap; posterior opening without tubular flap encircling posterior margin. Interorbital of moderate width, slightly convex. Eye of moderate size, orbital diameter 27.4 (24.7–35.7)% HL, 0.91 (0.53–1.10) times in interorbital space, 3.72 (2.20–5.78) times suborbital distance, circular, upper edge of eye just below dorsal margin of head in lateral view, skin covering eye unpigmented. Postorbital moderately long, 1.09 (0.97–1.50) times length of upper jaw. Mouth large, terminal, upper jaw terminating just posterior to vertical through posterior margin of eye. Jaw teeth small, caniniform, slightly curved, depressible, band of up to four or five irregular rows in upper jaw with narrow hiatus at symphysis; band tapering near rear

of jaw. Teeth of lower jaw similar in form to those of upper jaw; band of several rows with broader patch on either side of symphysis, tapering posteriorly; rows almost contiguous across symphysis. Vomerine teeth absent. Opercular bones strong; upper extremity of gill opening at horizontal through middle of eye; gill membranes continuous across isthmus. Gill rakers on outer arch club-shaped, moderately short, about 0.3–0.8 times length of opposing gill filaments at angle, 15–23 times in head, slightly denticulate. Chin barbel of moderate length, subconical 21.0 (19.6–30.5)% HL.

Moderately small cycloid scales covering all of head and body except for branchiostegal membranes, surface of maxilla and premaxilla, lower lip and distal parts of fins; very thick mucus covering obscuring scales and pores in freshly preserved material. Most head pores tiny, following main cephalic sensory canals; row of slightly raised pores extending from tip of snout posteriorly just above lower edge of suborbital; row of enlarged mandibular pores on underside of lower jaw. Lateral line comprising pores on tubes arising above upper end of gill opening, anterior end curved upwards slightly, then gradually descending to lateral midline below

posterior third of second dorsal fin, remaining on lateral midline posteriorly.

Membranes of first and second dorsal fins continuous at base; first dorsal originating distinctly behind vertical through pectoral fin base; anterior two-thirds of second dorsal of uniform height, 7th to 9th ray from posterior end of fin longest, its height about 1.2 times length of 2nd ray at anterior end of fin, last eight or so rays progressively shorter; rays of both dorsal fins mostly unbranched, only about last 14 or 15 rays, except last few, branched. Fleshy basal sheath on base of first dorsal and anterior portion of second dorsal fins not especially prominent with scales apparently confined to basal margin of fin; fin rays interconnected by membranes to tips; sheath more obvious on body below much of combined dorsal fin base, broadest anteriorly, narrowing posteriorly. Profile of anal fin similar to that of second dorsal fin, with comparable unbranched and branched rays. Fleshy sheath on and below anal fin similar to that of dorsal fins. Caudal fin rounded without distinct dorsoposterior and ventroposterior corners, posterior margin distinctly convex; all but anteriormost rays of similar length; base of fin covered by indistinct sheath (sheath demarcated from scales of caudal peduncle). Pectoral fin tip reaching past vertical through anal fin origin, seventh or eighth ray longest. Pelvic fin inserted anterior to vertical through posterior edge of preopercle; outer two rays longer than inner rays; second ray longest, 17.6 (16.6–21.6)% SL, two to four times length of subsequent ray, reaching vertical through first dorsal fin origin.

**Fresh colour.** (Based on images of non-type material; fig. 8B.) Medium brown to pale brown above, paler below with white chest and belly in smaller individuals, bronze in larger individuals; lateral line not distinctive. Underside of head and jaws brownish; ventral edge of suborbital darker brown; barbel white. Dorsal, anal and caudal fins very pale brown in smaller individuals, darker in large individuals; fins with distinct broad to narrow black margin distally, more diffuse in large individuals. Pectoral fin orange with very faint semi-circular brown blotch basally. Pelvic fin rays white with pink to orange hue.

**Preserved colour.** Head, body and fins pale dusky to dusky, chest and belly very pale, ventral edge of suborbital darker; distal edges of dorsal, caudal and anal fin with diffuse darker margins.

**Etymology.** The name *breviuscula* is Latin for “rather short”, probably in reference to the relatively small maximum size of the species compared with others of the genus, although Richardson separated it from other New Zealand morids simply by fin counts.

**Distribution.** Endemic to coastal waters of Australia and New Zealand, from Perth, Western Australia (32° 01' S, 115° 30' E), to Tweed Heads, New South Wales (28° 14' S, 153° 50' E), including all of Tasmania and around the North Island of New Zealand (fig. 3C). A demersal reef-dwelling species at 0–273 m, although most often encountered at less than 100 m on rocky and boulder reefs (Struthers et al. in Roberts et al., 2016: 864).

**Remarks.** *P. breviscula* is the smallest of the four species in the genus, reaching less than half the maximum length of its

congeners. It also occurs in slightly warmer waters compared with the other three members of the genus, reaching well onto the northern New South Wales coast in eastern Australia and around New Zealand's North Island.

Paulin (1983: 94) provided a thorough synonymy of *P. breviscula* from a New Zealand perspective but failed to mention *Austrophycis megalops* Ogilby, 1897, which was based on a specimen from New South Wales, Australia. This omission was possibly due to the widespread uncertainty about the identity of Waite's shrivelled 65 mm type specimen. Some authors regarded Ogilby's species as congeneric with Günther's (1878: 19) *A. marginatus* based on material from the south-eastern Pacific and others thought the two were likely to be conspecific (Cohen in Cohen et al., 1990: 356). Sazonov (2001: 343) reported that he had examined the type specimen and found it to be *P. breviscula* relegating the name *A. megalops* to synonymy with that species.

**Material examined. Types.** *Lota breviscula* BMNH 1855.9.19.1182 (152, holotype) Bay of Islands, New Zealand (fig. 8a); *Austrophycis megalops* AMS I.3655 (65, holotype) Maroubra Bay, New South Wales, Australia, 33° 57' S, 151° 16' E, T. Whitelegge, 1897 (after Sazonov, 2001: 343, holotype, not re-examined for this study).

**Other material.** (47 specimens examined for meristic or morphometric values, 70.2–139 mm SL; see Appendix 2 for additional material in Australasian collections.) **Australia, Victoria:** NMV A2261-002 (2, 106–111) Portland Harbour, end of lee breakwater, 38° 21' S, 141° 36' E, 12 m, R. Kuitert, R. Wilson and I. Head, 21 October 1981; NMV A8882 (2, 84.0–127) Bass Strait, 80 km south-east of Loch Sport, 38° 34.3' S, 148° 18.2' E, 86 m, Victorian Marine Sciences Laboratory, 6 June 1984. **Tasmania:** CSIRO H 7698-09<sup>†</sup> (66) Huon Commonwealth Marine Reserve, 43° 42.72' S, 147° 11.32' E–43° 42.97' S, 147° 10.35' E, 122 m, A. Graham and J. Pogonoski, 8 April 2015. **Western Australia:** WAM P.25342.004 (112) Cape Naturaliste, 33°32' S, 115°01' E, J. Scott, 16 February 1964; WAM P.25343.017 (2, 108–119) Fremantle, 32°02' S, 115°40' E, L.M. Marsh et al., 24 June 1975; WAM P.26616.005 (125) Point Clune, 32°00' S, 115°30' E, 8 m, J.B. Hutchins et al., 29 March 1979; WAM P.28297.006 (5, 59.4–139) Lucky Bay, 34°08' S, 122°15' E, 8–10 m, J.B. Hutchins, 13 April 1984; WAM P.28300.005 (5, 63.8–131) Lucky Bay, 34°05' S, 122°15' E, 11–12 m, J.B. Hutchins et al., 16 April 1984. **New Zealand, North Island:** NMNZ P.028044 (9, 82–127) Matatuahu Point, Tawharanui Peninsula, Hauraki Gulf, 36° 23' S, 174° 49' E, 0–5 m, A.L. Stewart and C.D. Paulin, 8 April 1992; NMNZ P.028118 (7, 62–119) Onepoto Bay, Hicks Bay, East Cape, 37° 35.25' S, 178° 18.00' E, 0–3 m, NMNZ East Cape 1992 field team, 4 May 1992; NMNZ P.029805 (3, 55–135) Waihou Bay, Bay of Plenty, 37° 36.8' S, 177° 54.6' E, 4–6 m, NMNZ East Cape 1993 field team, 27 January 1993; NMNZ P.030036 (4, 103–135) inside of Tuamotu Island, Gisborne Harbour, 38° 42.2' S, 178° 2.4' E, 4–7 m, NMNZ East Cape 1993 field team, 21 January 1993; NMNZ P.046263 (103) north of Tom Bowling Bay; North Cape, 34° 22.56' S, 172° 55.28' E, 61–72 m, RV Tangaroa, 14 July 2009; NMNZ P.046285<sup>†</sup> (2, 72.2–81.4) east of Purerua Peninsula, Bay of Islands, 35° 6.36' S, 174° 17.10' E, 119–121 m, RV Tangaroa, 7 July 2009; NMNZ P.048310 (70.4) western end of Omapere wharf, 35° 32.05' S, 173° 23.14' E, 4 m, NMNZ & AIM Northland 2011 field team, 13 February 2011; NMNZ P.048311 (70.5) western end of Omapere wharf, 35° 32.05' S, 173° 23.14' E, 4 m, NMNZ & AIM Northland 2011 field team, 13 February 2011; NMNZ P.048312 (82.6) western end of Omapere wharf, 35° 32.05' S, 173° 23.14' E, 4 m, NMNZ & AIM Northland 2011 field team, 13 February 2011; NMNZ P.048380 (124), NMNZ P.048381 (96.8) and NMNZ P.048382 (3, 59.9–101) reef inside southern



headland of Hokianga Harbour, 35° 32.01' S, 173° 22.10' E, 5–8 m, WCN 11/09, NMNZ & AIM Northland 2011 field team, 15 February 2011; NMNZ P.049600 (84.8) and NMNZ P.049703 (93) Tauroa Point, Ahipara, 35° 10.48' S, 173° 2.73' E, 21 m, WCN 11/35, NMNZ & AIM Northland 2011 field team, 22 February 2011; NMNZ P.049708 (100) Tauroa Point, Ahipara, 35° 9.96' S, 173° 3.12' E, 14 m, NMNZ & AIM Northland 2011 field team, 22 February 2011; NMNZ P.051786 (119) Tauroa Point, Ahipara, 35° 10.48' S, 173° 2.73' E, 21 m, NMNZ & AIM Northland 2011 field team, 22 February 2011; NMNZ P.057218† (78.5) and NMNZ P.052719† (82.3) Ranfurly Bank, 37° 32.78' S, 178° 53.42' E, 68–70 m, RV Tangaroa, 30 May 2011.

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Appendix 1. COI sequences and source information for *Pseudophycis* spp featuring in Figure 1.

Species	Source Institution	Voucher Reg No./ Sample ID No.	Country	Collection Locality	BOLD Sequence ID	GenBank accession
<i>A. punctatus</i>	NMNZ	P.045573	New Zealand	South Island, west coast	FNZC105-09	MN200065
<i>A. punctatus</i>	NMNZ	P.045574	New Zealand	South Island, west coast	FNZC106-09	MN200089
<i>A. punctatus</i>	NMNZ	P.045575	New Zealand	South Island, west coast	FNZC107-09	MN200090
<i>A. punctatus</i>	NMNZ	P.045576	New Zealand	South Island, west coast	FNZC108-09	MN200094
<i>A. punctatus</i>	NMNZ	P.045577	New Zealand	South Island, west coast	FNZC109-09	MN200092
<i>A. punctatus</i>	NIWA	no voucher PCO1	New Zealand	South Island, west coast	FNZA333-07	MN200088
<i>A. punctatus</i>	NIWA	no voucher PCO2	New Zealand	South Island, west coast	FNZA334-07	MN200093
<i>P. bachus</i>	NIWA	no voucher RCO1	New Zealand	Campbell Island	FNZ949-07	MN200031
<i>P. bachus</i>	NIWA	no voucher RCO4	New Zealand	Campbell Island	FNZ950-07	MN200023
<i>P. bachus</i>	NIWA	no voucher RCO5	New Zealand	Auckland Islands	FNZA351-07	MN200039
<i>P. bachus</i>	NIWA	no voucher RCO6	New Zealand	Auckland Islands	FNZA352-07	MN200027
<i>P. bachus</i>	NIWA	no voucher RCO7	New Zealand	no data	FNZA388-08	MN200026
<i>P. bachus</i>	NIWA	no voucher RCO8	New Zealand	no data	FNZA389-08	MN200030
<i>P. bachus</i>	NIWA	no voucher RCO9	New Zealand	no data	FNZA390-08	MN200028
<i>P. bachus</i>	NMNZ	P.044338	New Zealand	South Island, south of Timaru	FNZA555-08	MN200037
<i>P. bachus</i>	NMNZ	P.044339	New Zealand	South Island, south of Timaru	FNZA556-08	MN200029
<i>P. bachus</i>	NMNZ	P.044348	New Zealand	Chatham Rise	FNZA557-08	MN200062
<i>P. bachus</i>	NMNZ	P.044349	New Zealand	Chatham Rise	FNZA558-08	MN200024
<i>P. bachus</i>	NMNZ	P.044350	New Zealand	Chatham Rise	FNZA559-08	MN200040
<i>P. bachus</i>	NMNZ	P.053748	New Zealand	Stewart Island, Port Pegasus		MN200063
<i>P. bachus</i>	NMNZ	P.053749	New Zealand	Stewart Island, Port Pegasus		MN200069
<i>P. bachus</i>	NMNZ	P.053750	New Zealand	Stewart Island, Port Pegasus		MN200076
<i>P. bachus</i>	NMNZ	P.053751	New Zealand	Stewart Island, Port Pegasus		MN200075
<i>P. bachus</i>	NMNZ	P.053752	New Zealand	Stewart Island, Port Pegasus		MN200035
<i>P. bachus</i>	NMNZ	P.054828 (Neotype)	New Zealand	North Island, Whanganui Bar		MN200038
<i>P. barbata</i>	CSIRO	H 3791-01	Australia	VIC, Gabo Island	FOAD135-05	MN200087
<i>P. barbata</i>	CSIRO	H 4500-01	Australia	VIC, Cape Everard	FOAD141-05	MN200080
<i>P. barbata</i>	CSIRO	H 7539-03	Australia	TAS, Orford	FOAO050-14	MN200085
<i>P. barbata</i>	CSIRO	H 7904-03	Australia	SA, Great Bight	FOAP009-16	MN200086
<i>P. barbata</i>	CSIRO	H 7949-13	Australia	SA, Great Bight	FOAP215-16	MN200079
<i>P. barbata</i>	CSIRO	no voucher	Australia	NSW, Cape Howe	FOAD137-05	MN200083
<i>P. barbata</i>	CSIRO	no voucher	Australia	NSW, Diaster Bay	FOAD138-05	MN200078
<i>P. barbata</i>	CSIRO	no voucher	Australia	NSW, Diaster Bay	FOAD139-05	MN200081
<i>P. barbata</i>	CSIRO	no voucher	Australia	NSW, Diaster Bay	FOAD140-05	MN200082
<i>P. barbata</i>	CSIRO	no voucher GT 10004	Australia	SA, Great Bight	FOAP335-17	MN200084
<i>P. barbata</i>	NIWA	no voucher SBR1	New Zealand	no data	FNZA383-08	MN200073
<i>P. barbata</i>	NIWA	no voucher SBR2	New Zealand	no data	FNZA384-08	MN200072
<i>P. barbata</i>	NIWA	no voucher SBR3	New Zealand	no data	FNZA385-08	MN200074
<i>P. barbata</i>	NIWA	no voucher SBR4	New Zealand	no data	FNZA386-08	MN200070
<i>P. barbata</i>	NIWA	no voucher SBR5	New Zealand	no data	FNZA387-08	MN200066
<i>P. barbata</i>	NIWA	no voucher SBR6	New Zealand	North Island, Ngawi	FNZA608-08	MN200036
<i>P. barbata</i>	NIWA	no voucher SBR7	New Zealand	North Island, Ngawi	FNZA609-08	MN200068
<i>P. barbata</i>	NMNZ	P.037109	New Zealand	North Island, White Island	FNZC188-09	MN200091
<i>P. barbata</i>	NMNZ	P.037124	New Zealand	North Island, White Island	FNZC189-09	MN200077
<i>P. barbata</i>	NMNZ	P.044103	New Zealand	North Island, White Island	FNZC280-09	MN200071
<i>P. barbata</i>	NMNZ	P.045835	New Zealand	North Island, East coast	FNZC252-09	MN200067
<i>P. barbata</i>	NMNZ	P.052745	New Zealand	North Island, Cape Brett		MN200025
<i>P. barbata</i>	NMNZ	P.053551	New Zealand	North Island, Bay of Islands		MN200033
<i>P. breviscula</i>	CSIRO	H 6838-08	Australia	NSW, Broken Bay	FOAK632-10	MN200059



Species	Source Institution	Voucher Reg No./ Sample ID No.	Country	Collection Locality	BOLD Sequence ID	GenBank accession
<i>P. breviscula</i>	CSIRO	H 6838-08/2	Australia	NSW, Broken Bay	FOAK604-10	MN200053
<i>P. breviscula</i>	CSIRO	H 6845-01/1	Australia	NSW, Broken Bay	FOAK626-10	MN200054
<i>P. breviscula</i>	CSIRO	H 6845-01/2	Australia	NSW, Broken Bay	FOAK612-10	MN200055
<i>P. breviscula</i>	CSIRO	H 6845-01/3	Australia	NSW, Broken Bay	FOAK610-10	MN200060
<i>P. breviscula</i>	CSIRO	H 6980-04	Australia	TAS, east coast	FOAK246-10	MN200057
<i>P. breviscula</i>	CSIRO	H 6991-01	Australia	TAS, east coast	FOAK247-10	MN200056
<i>P. breviscula</i>	CSIRO	H 7698-09	Australia	TAS, northeast	FOAO611-15	MN200064
<i>P. breviscula</i>	NMNZ	P.046285	New Zealand	North Island, Bay of Islands	FNZC272-09	MN200058
<i>P. breviscula</i>	NMNZ	P.046285-1	New Zealand	North Island, Bay of Islands	FNZC271-09	MN200061
<i>P. breviscula</i>	NMNZ	P.052718	New Zealand	North Island, Ranfurly Bank		MN200032
<i>P. breviscula</i>	NMNZ	P.052719	New Zealand	North Island, Ranfurly Bank		MN200034
<i>P. palmata</i>	NMV	A 26125-002	Australia	VIC, Port Phillip Bay	FMVIC234-08	MN200052
<i>P. palmata</i>	NMV	A 31132-001	Australia	TAS, east coast	FOAO533-15	MN200043
<i>P. palmata</i>	CSIRO	H 4229-01	Australia	TAS, southeast	FOAD136-05	MN200041
<i>P. palmata</i>	CSIRO	H 7366-01	Australia	TAS, North Bruny Island		MN200048
<i>P. palmata</i>	CSIRO	H 7716-01	Australia	TAS, Munro Bight	FOAO599-15	MN200047
<i>P. palmata</i>	CSIRO	H 7717-01	Australia	TAS, Hinsby Beach	FOAO600-15	MN200051
<i>P. palmata</i>	CSIRO	no voucher BW-1692	Australia	VIC, Bass Strait	FOAD132-05	MN200050
<i>P. palmata</i>	CSIRO	no voucher BW-1693	Australia	VIC, Bass Strait	FOAD133-05	MN200044
<i>P. palmata</i>	CSIRO	no voucher BW-1694	Australia	VIC, Bass Strait	FOAD134-05	MN200042
<i>P. palmata</i>	CSIRO	no voucher GT 7974	Australia	TAS, east coast	FOAO596-15	MN200045
<i>P. palmata</i>	CSIRO	no voucher GT 7975	Australia	TAS, east coast	FOAO597-15	MN200046
<i>P. palmata</i>	CSIRO	no voucher GT 7976	Australia	TAS, southeast	FOAO598-15	MN200049

Appendix 2. Specimens registered in Australasian collections not used for compiling morphological data. Not all specimens listed were examined in the course of the study.

### *Physiculus palmata*

(78 specimens, 30–410 mm SL.) **Australia:** AMS I.7534 (310) no locality, 1905. **New South Wales:** AMS I.15024 (420) Merimbula, 36°53' S, 149°56' E, 1908; AMS I.34458-001 (87) one third of way to Tollgate Island from Three Islet Reef Batemans Bay, 35°44' S, 150°15.5' E, 100 m, 23–24 November 1988; AMS I.34461-001 (190) Lookout Point, Twofold Bay, 37°4.5' S, 149°55' E, 50 m, 26–27 November 1988; AMS I.34566-001 (225) Batemans Bay west end of Long Beach, 35°42' S, 150°13' E, 50 m, 23–24 November 1988; AMS I.34568-001 (128) North Head Beach, Batemans Bay, 35°43' S, 150°16' E, 50 m, 23–24 November 1988; CSIRO H3537-01 (5, 54–97) south of Disaster Bay, 37°24.2' S, 149°58.4' E–37°22.9' S, 149°58.7' E, 42–44 m, 13 August 1993. **Victoria:** NMV A639 (221) off Phillip Island, 38°39' S, 145°19.8' E, 07 August 1979; NMV A836 (2, 104–138) Port Phillip Bay, 38°06' S, 144°52.8' E, 1970; NMV A837 (2, 129–133) Port Phillip Bay, 38°06' S, 144°52.8' E, 1971; NMV A838 (2, 134–146) Port Phillip Bay, 3.2 km (2 miles) Port Phillip Bay, west of Sandringham, 37°57' S, 144°57' E, 30 March 1971; NMV A839 (250) Port Phillip Bay, 38°06' S, 144°52.8' E, 25 July 1972; NMV A841 (2, 245–250) Port Phillip Bay, Hobsons Bay, 37°52.2' S, 144°55.8' E, September 1867; NMV A846 (2, 190–207) Port Phillip Bay, Hobsons Bay, 37°52.2' S, 144°55.8' E, September 1867; NMV A848 (315) no data, old collection; NMV A2285 (51.4) central Bass Strait, 38 km southwest of Cape Paterson, 38°55.5' S, 145°17' E, 70 m, 12 November 1981; NMV A2667 (51.8) Eastern Bass Strait, 8 km south of South East Point, Wilsons Promontory, 39°12.9' S, 146°27.3' E, 65 m, 18 November 1981; NMV A10580 (242) Western Port, 5 km north of Cowes, 38°26.1' S, 145°15.3' E, 20 m, 22 October 1986; NMV A20816 (2, 201–210) no data, old collection, August 1864; NMV A26125-002 (61.0) Port Phillip Bay, central part of bay, east of St Leonards, 38°12.8' S, 144°50' E, 24 m, 12 December 1996; NMV A23366-002 (401) no data, old collection; NMV A31156-001 (237) Port Phillip Bay, Hobsons Bay, 37.87°S, 144.93°E; NMV A31157-001 (223) same collection data as NMV A31156-001. **Tasmania:** AMS IB.1192 (142) d'Entecasteaux Channel, Simpsons Bay, 43°17' S, 147°18' E, 7 July 1942; AMS I.10287 (140), Oyster Bay, 42°40' S, 148°03' E, 1909; AMS I.14182 (300) Port Arthur, 43°09' S, 147°51' E, 13 April 1917; AMS I.14183 (248) Port Arthur, 43°09' S, 147°51' E, 13 April 1917; AMS I.6243 (62) NW coast: Ulverston, 41°10' S, 146°11' E, 1903; AMS I.6275 (340) Tamar River Heads, 41°20' S, 147°02' E, 1903; AMS I.6276 (245) Tasmania, Tamar River Heads, 41°20' S, 147°02' E, 1903; AMS I.9259 (252) Port Arthur, 43°09' S, 147°51' E, 1908; AMS I.9989 (177) Bass Strait, east of Flinders Island, 40°01' S, 148°42' E, 1909; AMS I.9990 (195) Bass Strait, east of Flinders Island, 40°01' S, 148°42' E, 1909; NMV A1218-003 (2, 297–299) Central Bass Strait, 20 km north-northeast of North Point, 40°31.8' S, 145°22.8' E, 44 m, BSS 116 T, M.F. Gomon, G.C.B. Poore, and P. Forsyth, 4 November 1980; NMV A1289 (294) central Bass Strait, 23 km east of Cape Rochon, Three Hummock Island, 40°22.2' S,

145°17' E, 40 m, 3 November 1980; NMV A1381 (38.5) central Bass Strait, 6 km northeast of Stanley, 40°48.8' S, 145°22' E, 22 m, 4 November 1980; NMV A1479 (67.2) central Bass Strait, 32 km west-southwest of Settlement Point, Flinders Island, 40°9.95' S, 147°31.8' E, 51–52 m, 6 February 1981; NMV A1535 (8, 163–220) central Bass Strait, 32 km northwest of Devonport, 40°56' S, 146°5.4' E, 68–64 m, 4 February 1981; NMV A9776 (272) near Marlo Reef, 37°48' S, 148°31.8' E, 1991; NMV A9777 (276) Marlo Reef, 37°48' S, 148°31.8' E, 1991; NMV A20556 (202) Bass Strait, east coast of Flinders Island, 40° S, 148°20' E, 73 m, 16 June 1909; NMV A21590 (4, 150–182) Bass Strait, east of Flinders Island, 40°S, 148°33' E, 1909; WAM P.27554.001 (186) Spring Bay, 42°32' S, 147°55' E, 1–8 m; **South Australia:** SAMA F 2777 (1) Gulf St Vincent, 34°11' S, 138°9' E, 14 July 1953; SAMA F4624 (8) Robe, 37°10' S, 139°45' E, 9 September 1979; SAMA F7172 (1) Spencer Gulf, Port Lincoln, 34°44' S, 135°52' E, 1992; SAMA F10581 (1), Robe, bay near river mouth, 16 March 2003; SAMA F10855 (1) Investigator Strait, 35°24'28" S, 137°54'40" E, 16 December 2006; SAMA F10900 (1) Investigator Strait, 35°19' 09" S, 137°46' 05" E, 15 December 2006; SAMA F11864 (1) Great Australian Bight, Coles Point, 34°22'06" S, 135°21'09" E, 21 March 2003; SAMA F12755 (1) Victor Harbour, 35°33' S, 138°37' E, 14 September 2003.

### *Pseudophyscis bachus*

(416 specimens, 21–573 mm SL.) **New Zealand, North Island:** NMNZ P.001129 (373) Wellington, Ngauranga, Wellington Harbour, 41°15' S, 174°50' E, 3 August 1952; NMNZ P.001809 (174) North Auckland, off Kaipara Bar, 36°24' S, 174°9.5' E, 183 m, August 1955; NMNZ P.002271 (227) Wellington, Wellington Harbour, off Petone, 41°14.0' S, 174°52.5' E, 13–18 m, 22 August 1957; NMNZ P.002372 (neurocranium) Wellington, York Bay, Wellington Harbour, 41°15.9' S, 174°54.2' E, 10–11 m, 31 May 1953; NMNZ P.002440 (2, otoliths) Wellington, Wellington Harbour, 41°16.5' S, 174°51.0' E, 1953; NMNZ P.003011 (otoliths and skeleton) Wellington, Paraparaumu Beach, 40°53' S, 174°56' E, 8 January 1961; NMNZ P.004788 (11, 71–128) Wellington, Palliser Bay, 41°26.3' S, 175°3.0' E, 64–82 m, 15 February 1968; NMNZ P.006562 (10, 73–99) north of Kapiti Island, off Foxton, 40°30.5' S, 174°53.0' E, 101 m, 1 March 1976; NMNZ P.006802 (2, 212–243) Bay of Plenty, 8 km north of Mayor Island, 37°12' S, 176°15' E, 366 m, 28 September 1962; NMNZ P.007357 (otoliths) Wellington, Te Mimi, south end of Kapiti Island, 40°52.35' S, 174°54.60' E, 3 m, 22 August 1977; NMNZ P.007441 (otoliths) Wellington, 11 January 1978; NMNZ P.008363 (3, 90–94) South Auckland, east-northeast of Tolaga Bay, 38°15.2' S, 178°38.6' E, 139 m, 16 January 1979; NMNZ P.009415 (84) Gisborne, Matakaoa, East Cape, 37°34' S, 178°20' E, 15 m, 26 June 1988; NMNZ P.009823 (3, 79–112) Taranaki, west-northwest of Cape Egmont, 38°48.8' S, 173°29.6' E, 146 m, 9 January 1981; NMNZ P.010543 (315) Bay of Plenty, north of Mayor Island/east of Slipper Island,

37°4.95' S, 176°12.70' E, 315–352 m, 18 April 1981; NMNZ P.014082 (2, 107–109) Wellington, off Castle Point, 40°56.25' S, 176°22.80' E, 115–140 m, 17 April 1978; NMNZ P.016708 (10, 32–68) Wellington, east of Cape Campbell, 41°44.15' S, 174°27.65' E, 47 m, 15 December 1978; NMNZ P.017108 (293) Taranaki, Seal Rocks, Sugar Loaf Islands, New Plymouth, 39°3.25' S, 174°0.20' E, 30 m, 24 March 1985; NMNZ P.017508 (2, 96–100) Wellington, Hikurangi Trench, 40°54.8' S, 176°25.4' E, 140 m, 17 April 1976; NMNZ P.017509 (102) Wellington, Hikurangi Trench, 40°57.7' S, 176°20.2' E, 115 m, 17 April 1976; NMNZ P.018714 (2, 52–57) Manawatu, southwest of Whanganui, 40°22.65' S, 174°22.80' E, 62–80 m, 17 July 1985; NMNZ P.019115 (57) Gisborne, east of Tolaga Bay, 38°23.05' S, 178°26.65' E, 30 m, 11 January 1980; NMNZ P.019331 (50) Hawke's Bay, Cape Kidnappers, 39°39' S, 177°10' E, 36 m, 19 October 1969; NMNZ P.023430 (230) Gisborne, Matakaoa, East Cape, 37°34' S, 178°20' E, 15 m, 26 June 1988; NMNZ P.029685 (5, 310–360) off Mohaka, 39°15' S, 177°20' E, 17 November 1992. **South Island:** AMS I.14733 (440) Portobello, Otago Harbour, 45°51' S, 170°39' E, 13 December 1918; AMS I.14734 (550) Otago, Blueskin Bay, 45°44' S, 170°35' E, 29 November 1918; NMNZ P.001753 (148) Otago, edge of Karitane Canyon, northeast of Tairua Head, 45°38.5' S, 171°2.0' E, 220 m, 14 August 1955; NMNZ P.006548 (2, 90–109) Marlborough, Western Cook Strait; ca 14 km northeast of Stephens Island, 40°33' S, 174°7' E, 130–132 m, 4 March 1976; NMNZ P.006704 (278) Canterbury, northeast Mernoo Bank, Chatham Rise, 43°10.5' S, 174°58.5' E, 298–422 m, 23 June 1975; NMNZ P.007180 (305) Snares Islands, west side of western chain, Snares Island, 48°3' S, 166°30' E, 120 m, 4 December 1976; NMNZ P.007349 (200) Marlborough, Kaikoura area, 41°20' S, 174°9' E; NMNZ P.007442 (otoliths) Marlborough, 'Run Under Point'; Cook Strait between Port Underwood and Tory Channel, 41°18.25' S, 174°14.55' E, 19 January 1978; NMNZ P.007457 (505) Canterbury, Western Chatham Rise, off Mernoo Bank, 43°16.45' S, 174°55.50' E, 220 m, 11 December 1977; NMNZ P.007730 (12, 31–123) Marlborough, Cloudy Bay, 41°26.1' S, 174°15.9' E, 59–64 m, 28 January 1979; NMNZ P.008107 (79) Nelson, 6.4 km northwest of Farewell Spit, 40°27.0' S, 172°48.5' E, 70 m, 10 March 1976; NMNZ P.008355 (185) Southland, Crooked Arm, Fiordland, 45°25' S, 166°58' E, 16 m, 7 January 1977; NMNZ P.008356 (14, 67–105) Marlborough, Cloudy Bay, 41°26.35' S, 174°9.70' E, 27–28 m, 28 January 1979; NMNZ P.008365 (18, 60–118) Marlborough, Cloudy Bay, 41°26.35' S, 174°9.70' E, 27–28 m, 28 January 1979; NMNZ P.009282 (5, 228–360) Canterbury, Western Chatham Rise, off Mernoo Bank, 43°16.45' S, 174°55.50' E, 220 m, 11 December 1977; NMNZ P.009283 (7, 170–213) Canterbury, Western Chatham Rise, off Mernoo Bank, 43°16.45' S, 174°55.50' E, 220 m, 11 December 1977; NMNZ P.010598 (2, 168–170) Otago, off Oamaru, 45°5' S, 170°59' E, 46 m, July 1962; NMNZ P.010647 (115) Otago, Cape Wanbrow, off Oamaru, 45°7' S, 171°3' E, 100–101 m, June 1963; NMNZ P.010703 (65) Otago, Oamaru, 45°7' S, 174°22' E, 73 m, March 1973; NMNZ P.012069 (14, 57–75) Marlborough, Mernoo Bank, 43°6.1' S, 175°20.5' E, 153 m, 12 January 1979; NMNZ P.012088 (2, 65–80) Marlborough, Cloudy Bay, 41°26.35' S, 174°9.70' E, 27–28 m, 28 January 1979; NMNZ P.013119 (490) Snares Islands, Puysegur Trench, 46°49.15' S, 165°50.50' E, 459–515 m, October 1982; NMNZ P.016344 (272), Snares Islands, off North Promontory, 48°0' S, 166°36' E, 110 m, 5 December 1984; NMNZ P.017527 (2, 34–35) Stewart Island, Foveaux Strait, 46°30' S, 167°30' E, May 1976; NMNZ P.017876 (12, 58–80) Nelson, north of Cape Farewell, 40°4.65' S, 172°57.09' E, 102 m, 14 December 1978; NMNZ P.017879 (2, 36–60) Canterbury, northern Canterbury Bight, off Waiau River mouth, 42°36.8' S, 173°40.4' E, 81 m, 16 December 1978; NMNZ P.017884 (80) Nelson, north of Cape Farewell, 40°8.75' S, 173°11.15' E, 90 m, 14 December 1978; NMNZ P.017885 (5, 38–46) Canterbury, northern Canterbury Bight, off Kaikoura Peninsula, 42°39.30' S, 173°35.95' E, 130 m, 16 December 1978; NMNZ P.017891 (12, 28–40) Marlborough, off Cape Campbell, 41°42.1' S, 174°25.5' E, 60 m, 15 December 1978; NMNZ P.017892 (15, 33–64) Canterbury, northern Canterbury Bight, off Kaikoura Peninsula, 42°38.15' S, 173°39.75' E, 91 m, 16 December 1978; NMNZ P.017893 (15, 21–46) Marlborough, Cook Strait, east of Cape Campbell, 41°46.8' S, 174°28.6' E, 18 m, 15 December 1978; NMNZ P.018854 (48) Marlborough, east of Flaxbourne Depression, 41°59.9' S, 174°26.9' E, 100 m, 19 January 1982; NMNZ P.018865 (45) Marlborough, east of Flaxbourne Depression, 41°59.50' S, 174°30.55' E, 100 m, 19 January 1982; NMNZ P.018878 (69, 26–75) Canterbury, Canterbury Bight/southeast of Timaru, 44°43.4' S, 171°54.7' E, 95 m, 16 January 1982; NMNZ P.019322 (2, 45) Westland, northwest of Hokitika, 42°34.18' S, 170°15.19' E, 204 m, 10 December 1978; NMNZ P.019509 (99, 29–55) Canterbury, northeast of Clarence River mouth/central Campbell Bank, 42°6.00' S, 174°6.95' E, 84–86 m, 24 November 1982; NMNZ P.019831 (500) Southland, North Port, Fiordland, 45°59' S, 166°34' E, 27 m, 8 May 1986; NMNZ P.019949 (205) Southland, 30 Fathom Point, Fiordland, 45°43.3' S, 166°30.3' E, 36–37 m, 13 May 1986; NMNZ P.020802 (110) East coast South Island, 1982; NMNZ P.020806 (2, 72–76) East coast South Island, 1982; NMNZ P.025063 (3, 88–137) Otago, off Tairua Head, Otago Peninsula, 45°45' S, 170°45' E, 1990; NMNZ P.025077 (3, 96–135) Otago, off Otago Peninsula, 45°36.55' S, 170°51.88' E, 41–59 m, 10 May 1990; NMNZ P.025093 (8, 76–116) Otago, off Otago Peninsula, 45°41.85' S, 170°58.72' E, 97–100 m, 10 May 1990; NMNZ P.025186 (90) Otago, Blueskin Bay, Otago Peninsula, 45°43.28' S, 170°40.33' E, 20–22 m, 9 May 1990; NMNZ P.025782 (2, 443–480) Canterbury, Pegasus Canyon, 43°23.78' S, 173°40.50' E, 113–109 m, 1 June 1990; NMNZ P.030708 (7, 87–120) Snares Islands, Southern Snares Shelf, 48°30.75' S, 166°58.50' E, 134–136 m, 1 April 1993; NMNZ P.032382 (420) Southland, Waterfall mooring, head of Bligh Sound, Fiordland, 44°50' S, 166°32' E, 8–10 m, 21 March 1995; NMNZ P.032398 (3, 395–410) Southland, mooring at Precipice Cove, Bradshaw Sound, Fiordland, 45°15' S, 167°10' E, 20 m, 28 March 1995; NMNZ P.036007 (2, 266–300) Westland, outer Frog Rock, 43°58.52' S, 168°33.48' E, 14–20 m, 11 February 1999; NMNZ P.036769 (2, 120–130) Canterbury, southwest of Timaru, 44°35.71' S, 171°12.55' E, 18–19 m, 20 December 1998; NMNZ P.045793 (104, C&S)

Marlborough, Cloudy Bay, 41°26.1' S, 174°15.9' E, 59–64 m, 28 January 1979. **Bounty Islands:** NMNZ P.006643 (573) Bounty Platform, southeast of Islands, 48°7.25' S, 179°16.25' E, 230–238 m, 18 November 1975. **Auckland Islands:** NMNZ P.007136 (264) northwest Auckland Islands/ Campbell Plateau, 50°10.35' S, 167°43.10' E, 120 m, 21 January 1977. **Chatham Rise:** NMNZ P.008357 (2, 78–79), Chatham Rise, Mernoo Bank, 43°36' S, 175°31' E, 375 m, 12 February 1954; NMNZ P.008358 (66) Mernoo Bank, Chatham Rise, 42°59.4' S, 175°30.5' E, 112 m, 23 January 1954; NMNZ P.009414 (2, 94–188) east of Chatham Islands, 43°30.95' S, 176°9.25' W, 176–205 m, 22 May 1987; NMNZ P.020910 (4, 100–125) Subantarctic Slope, 43°39.95' S, 175°51.40' W, 220–246 m, 28 May 1987; NMNZ P.020922 (270) northeast of Chatham Islands, 43°33.6' S, 176°0.5' W, 228–234 m, 26 May 1987; NMNZ P.020952 (273) east of Chatham Islands, 43°30.95' S, 176°9.25' W, 176–205 m, 22 May 1987; NMNZ P.020989 (2, 127–129) east of Chatham Islands, 43°39.15' S, 175°52.10' W, 216–244 m, 24 May 1987; NMNZ P.035283 (142) Urry Bank, Chatham Rise, 44°9.0' S, 176°6.5' E, 126 m, October 1979. **Campbell Island:** NMNZ P.009284 (390) Campbell Island Rise, northeast of Island, 51°51' S, 169°40' E, 250–271 m, 10 April 1982; NMNZ P.012110 (530), Campbell Island Rise, northeast of Island, 51°51' S, 169°40' E, 250–271 m, 10 April 1982.

#### *Pseudophycis barbata*

(211+ specimens, 26–620 mm SL.) **Australia:** AMS IB.7565 (465) no locality, 1966. **New South Wales:** AMS I.16970-014 (176) Boydtown, Nullica Bay, 37°6' S, 149°53' E, 13 March 1972; AMS I.19833-003 (5, 48–60) east of Ulladulla, 35°20' S, 150°51' E, 128 m, 14 May 1974; AMS I.25974-003 (91) Eden, eastern Bass Strait, 37°5' S, 149°55' E, 18–46 m, 26 November 1984; AMS I.27359-008 (270) Quarantine Beach inside North Head, 33°49' S, 151°18' E, 6 April 1967; AMS I.27359-009 (4, 105–180) Quarantine Beach inside North Head, 33°49' S, 151°18' E, 6 April 1967; AMS I.28908-001 (305) east of Shoalhaven Bight, 34°53' S, 151°06' E, 18 April 1985; AMS I.34570-002 (140) east of Lookout Point Twofold Bay, 37°46' S, 149°55' E, 26–27 November 1988; AMS I.34854-003 (115) off Newcastle, 33°2' S, 151°58' E, 117–121 m, 24 March 1993; AMS IB.8192 (514) Eden, 37°4' S, 149°55' E, 9 June 1968; CSIRO A 1117 (72 mm TL) between Cronulla and Eden, October 1948; CSIRO B 3455 (4, 59–96 mm TL) off Moruya at "The Pines Close", 35°55' S, 150°10' E, 90 m, 28 April 1939. **Victoria:** AMS I.16987-006 (5, 75–150) Petersborough, estuary, near boat ramp, 38°37' S, 142°52' E, 6 m, 21 March 1972; CSIRO H 3793-03 (83) south of Gabo Island, 37°44.0' S, 149°58.0' E–37°42.3' S, 149°59.5' E, 108–115 m, 17 September 1994; NMV 30055 (502) Western Port, 38°22.2' S, 145°22.2' E, October 1858; NMV 43104 (375) Port Phillip Bay, Hobsons Bay, 37°52.2' S, 144°55.8' E, October 1878; NMV 43105 (375) Port Phillip Bay, Hobsons Bay, 37°52.2' S, 144°55.8' E, October 1879; NMV A842 (252) No location data, 1 January 1971; NMV A2941 (102) Port Phillip Heads, 38°16.8' S, 144°37.8' E, 1864; NMV A10567 (225) Western Port, 5 km north of Cowes, 38°26.1' S, 145°15.3' E, 20 m, 22

October 1986; NMV A23366-001 (438) no data, old collection. **Tasmania:** AMS I.17545-016 (70) Eaglehawk Neck, 43°2' S, 147°56' E, 29 November 1972; AMS I.17555-011 (6, 62–95) The Gardens, north of Binalong Bay, 41°13' S, 148°13' E, 1 m, 6 December 1972; AMS I.20086-001 (75) Spring Beach, 42°35' S, 147°54' E, 2–4 m, 16 December 1977; AMS I.34952-003 (260) Mouth of Fortescue Bay, 43°07'46" S, 147°59'28" E, 9–10 April 1994; CSIRO B 1259 (6, 50–62 mm TL) NE coast, 43°03' S, 148°03' E, 17 December 1976; CSIRO C 1405 (165) St Helens, 28 February 1951; CSIRO H 1151-02 (90) 40°55.05' S, 147°21.35' E, 33 m, 17 June 1987; CSIRO T 1105 (26) east of Babel Island, 120 m, 12 April 1984; CSIRO T 1252 (1) St Helens, 41°25' S, 148°16' E, 30 m; CSIRO T 1523 (1) St Helens Point, east coast of Tasmania, 25 February 1982; CSIRO T 1625-01 (27) Flinders Island; WAM P.27553.002 (103) Mercury Passage, 42°33' S, 147°57' E, 7–8 m; WAM P.27554.002 (2, 136–206) Spring Bay, 42°32' S, 147°55' E, 1–8 m; WAM P.27559.002 (2, 74–94) Saint Helens Point, 41°16' S, 148°22' E, 3 m; WAM P.27560.002 (2, 111–296) Bridport, 41°00' S, 147°23' E, 8–9 m; **South Australia:** AMS I.18470-005 (191) Robe, southwest coast, 37°10' S, 139°45' E, 1 m, 3 October 1975; AMS I.20180-021 (5, 69–112) Kangaroo Island, Penneshaw, 35°44' S, 137°58' E, 0–5 m, 9 March 1978; CSIRO CA 3516 (281 mm TL) west of Investigator Group, Great Australian Bight, 33°43.8' S, 132°07.8' E–33°45.1' S, 132°08.9' E, 180–184 m, 8 December 1981; SAMA AMSTAC102 (1) Great Australian Bight, Anxious Bay, 33°20'03" S, 134°38'47" E, 25 February 1981; SAMA AMSTAC181 (1) 30 miles west of Robe, 37°09'47" S, 139°12'31" E, 7 April 1981; SAMA AMSTAC213 (1) 4.5 miles west of Beachport, 37°29' S, 139°55' E, 8 April 1981; SAMA AMSTAC288 (1) Cape Buffon, 1 April 1981; SAMA AMSTAC289 (1) Cape Buffon, 1 April 1981; SAMA AMSTAC292 (1) 2 miles west of Cape Buffon, 1 April 1981; SAMA AMSTAC711 (1) Great Australian Bight, South East Isles, 34°20' S, 123°42' E, 26 July 1981; SAMA AMSTAC1331 (1) Spencer Gulf, between Wardang Island and Tipara Reef, 34°12'06" S, 137°18'24" E; SAMA AMSTAC1490 (1) Kangaroo Island, 2–3 miles off West Bay, 36°03'40" S, 137°12'39" E, 16 January 1982; SAMA AMSTAC1602 (1) off Port MacDonnell, 38°03' S, 140°42' E, 1 January 1982; SAMA F505 (1) 1918; SAMA F1012 (1) Gulf St Vincent, 35°10' S, 137°55' E, 1928; SAMA F1144 (1) 1928; SAMA 1145 (1); SAMA 1146 SAMA 1736 (1) St Vincent Gulf, Port Wakefield, 34°11' S, 138°29' E, 8 July 1932; SAMA F2011 (1) Spencer Gulf, Moonta, 34°3' S, 137°34' E, 14 October 1937; SAMA F2031 (1) Eyre Peninsula, Venus Bay, 33°12' S, 134°40' E, 29 April 1938; SAMA F2766 (1) Spencer Gulf, Port Lincoln, 34°44' S, 135°52' E, 28 January 1953; SAMA F3045 (1) Adelaide, Outer Harbour, 34°47' S, 138°29' E, 26 January 1962; SAMA F3377 (1) Kangaroo Island, Stokes Bay, 35°37' S, 137°12' E, 15 August 1966; SAMA F3392 (1) Kangaroo Island, Stokes Bay, 35°37' S, 137°12' E, 15 August 1966; SAMA F3649 (1) Kangaroo Island, Osmanli Reef, D'Estrees Bay, 35°59' S, 137°38' E, 13 August 1966; SAMA F3972 (1) near Coffin Bay, Farm Beach, 34°31' S, 135°23' E, 31 August 1974; SAMA F3980 (1) Encounter Bay, Port Elliott, Bashams Beach, 35°32' S, 138°41' E, 13 October 1974; SAMA F4093 (1) Encounter Bay, 35°33' S, 138°38' E,

20 July 1975; SAMA F4281 (1) Kangaroo Island, Emu Bay, 35°35' S, 137°31' E, 21 January 1968; SAMA F5162 (1) Port MacDonnell, 38°3' S, 140°42' E, 1984; SAMA F5204 (1) Gulf St. Vincent, 34°26' S, 137°55' E, June 1984; SAMA F5529 (1) Kangaroo Island, Penneshaw, 35°43' S, 137°56' E, 29 October 1985; SAMA F6416 (1) Spencer Gulf, Cowell, 33°41' S, 136°55' E, 1988; SAMA F7174 (1) Spencer Gulf, 34°44' S, 135°52' E, 17 February 1993; SAMA F9097 (1) Kangaroo Island, north of Hog Bay, 35°43' S, 137°57' E, 20–22 m, 6 June 1954; SAMA F9576 (1) Investigator Strait, Althorpe Islands, 35°22'00" S, 136°52'00" E; SAMA F10526 (1) Investigator Strait, 17 km N of Point Marsden, 35°24'58" S, 137°38'15" E, 28 June 2001; SAMA F10723 (1) Great Australian Bight, 32°15'31" S, 132°39'15" E, 20 April 2002; SAMA F10749 (1) Great Australian Bight, 34°01'26" S, 134°28'34" E, 18 April 2002; SAMA F11194 (1) Gulf St Vincent, 35°16'54" S, 138°09'36" E, 17 May 2007; SAMA F11195 (1) Gulf St Vincent, 35°16'54" S, 138°09'36" E, 17 May 2007; SAMA F11196 (1) Gulf St Vincent, 35°16'54" S, 138°09'36" E, 17 May 2007; SAMA F14170 (1) Rivoli Bay, 37°31'44" S, 140°00'04" E, 6 April 2009. **Western Australia:** AMS I.12324 (225) Great Australian Bight, southwest of Eucla, 32°00' S, 128°00' E, September 1912; CSIRO H 4383-08 (72) Bunbury, inner harbour, general berth, 33°19.54' S, 115°39.57' E, 10.5 m, 6 March 1996; CSIRO H 4904-07 (108) Bunbury, outer harbour (disused jetty groyne), 3.5 m, 6 March 1996; NMV A9232 (350) Great Australian Bight, 120 km south of Middini Beach, 33°17.1' S, 127°29.7' E, 162–160 m, 14 February 1990; SAMA F73 (1) Abrolhos Islands, 28°45' S, 113°47' E, 22 April 1913; WAM P.1794.001 (365) Hopetoun, 33°57' S, 120°07' E; WAM P.7687.001 (350) Albany, 35°00' S, 117°52' E; WAM P.14596.001 (lost?) 31°54' S, 110°10' E; WAM P.26119.001 (149) Lookout Point, 34°53' S, 118°25' E; WAM P.29035.009 (270) 34°03' S, 122°00' E; WAM P.29339.001 (160) Mandurah. **Tasman Sea:** NMNZ P.009285 (280) southern Lord Howe Rise, 38° S, 168° E, 260 m, 7 December 1993; NMNZ P.030825 (460) southern Lord Howe Rise, 38° S, 168° E, 400–405 m, 31 August 1993; NMNZ P.031243 (540) southern Lord Howe Rise, 38° S, 168° E, 260 m, 7 December 1993. **New Zealand, North Island:** NMNZ P.000256 (135) Auckland, Hauraki Gulf, 36°30' S, 175°0' E, September 1920; NMNZ P.001236 (486) Wellington, Makara, 41°13.0' S, 174°42.5' E, 40 m, 28 February 1953; NMNZ P.001462 (528) Wellington, Cape Terawhiti, 41°17' S, 174°37' E, 9 m, 28 February 1954; NMNZ P.001970 (165) Bay of Plenty, northwest of Mayor Island, 37°15' S, 176°12' E, 146–219 m, 18 August 1956; NMNZ P.002233 (379) Wellington, North of Castle Point, 41°37' S, 175°16' E, 65 m, 25 September 1957; NMNZ P.002795 (500) Wellington, South of Titahi Bay, 41°6' S, 174°50' E, 3 m, 12 July 1959; NMNZ P.006783 (308) Wellington, Breaker Bay, Seatoun, 41°20' S, 174°50' E, 9 October 1973; NMNZ P.007789 (92) Hawke's Bay, 30 km east of Portland Island, 39°18.25' S, 178°12.00' E, 258–306 m, 27 January 1979; NMNZ P.008360 (116) Bay of Plenty, southeast of Mayor Island, 37°22.5' S, 176°22.0' E, 207–219 m, 27 February 1957; NMNZ P.008361 (8, 74–120) South Auckland, east-northeast of Tolaga Bay, 38°15.2' S, 178°38.6' E, 139 m, 16 January 1979; NMNZ P.009286 (2, 322–331) South

Auckland, Anchor Reef, southeast corner Whale Island, 37°51' S, 176°59' E, 1 July 1998; NMNZ P.010327 (3, 315–352) Bay of Plenty, north of Mayor Island/east of Slipper Island, 37°4.95' S, 176°12.70' E, 315–352 m, 18 April 1981; NMNZ P.013608 (550) Wellington, Mana Island, 41°5' S, 174°52' E, 74 m, 12 March 1983; NMNZ P.014893 (2, 360–410) Three Kings Islands, NW Bay, Great Island, 34°9.0' S, 172°8.5' E, 14 m, 25 November 1983; NMNZ P.017924 (3, 42–48), off Mayor Island, Bay of Plenty, 37°14.35' S, 176°21.15' E, 218–225 m, 13 December 1975; NMNZ P.018168 (422) Bay of Plenty, off east side of Mayor Island, 37°18' S, 176°18' E, 37–91 m, 17 February 1986; NMNZ P.023405 (385) Gisborne, Waiaka Bay near Lottin Point, East Cape, 37°33' S, 178°9' E, 6 m, 24 June 1988; NMNZ P.028461 (288) Gisborne, southeast of Cape Runaway, East Cape, 37°32.9' S, 178°0.3' E, 8–12 m, 24 April 1992; NMNZ P.030132 (570) Gisborne, Monowai Reef, 38°35.9' S, 178°16.7' E, 15–21 m, 20 January 1993; NMNZ P.030137 (286) Gisborne, inside of Tuamotu Island, Gisborne Harbour, 38°42.2' S, 178°2.4' E, 4–7 m, 21 January 1993; NMNZ P.031312 (279) Hawke's Bay, 'White Cliffs', ~3 km south of Cape Kidnappers, 39°42' S, 177°3' E, 40 m, 23 January 1994; NMNZ P.031697 (200) Bay of Plenty, southern Kermadec Ridge, 37°32.90' S, 177°6.12' E, 325–327 m, 14 January 1995; NMNZ P.031923 (114) Bay of Plenty, southern Colville Ridge, 36°57.12' S, 176°15.90' E, 336–339 m, 9 January 1995; NMNZ P.033156 (340) Wellington, north end of Mana Island, 41°4.63' S, 174°47.40' E, 10–15 m, 8 March 1996; NMNZ P.033318 (160) Wellington, north end of Mana Island, 41°4.63' S, 174°47.40' E, 10–15 m, 8 March 1996; NMNZ P.033569 (245) Bay of Plenty, Long Point, Mahia Peninsula, 39°10' S, 177°49' E, 8 m, 4 January 1995; NMNZ P.034786 (520) Hawke's Bay, White Cliffs, northern end of Ocean Beach, 39°41' S, 177°3' E, 20 m, 27 April 1997; NMNZ P.036897 (440) South Auckland, Anchor Reef, southeast corner Whale Island, 37°51' S, 176°59' E, 1 July 1998; NMNZ P.036907 (375) South Auckland, east side of White Island, 37°31' S, 177°12' E, 160 m, 4 July 1998; NMNZ P.041342 (380) Northland, 232 m, 25 January 2005. **South Island:** NMNZ P.005345 (2, 127) Nelson, Central Eastern Challenger Plateau, west of Farewell Spit, 40°37.5' S, 171°37.5' E, 247 m, 3 March 1971; NMNZ P.007707 (353) Canterbury, Mernoo Bank, 43°23.0' S, 175°6.8' E, 124–129 m, 12 January 1979; NMNZ P.008031 (489) Marlborough, Kaikoura region, 42°25' S, 173°43' E, 109–128 m; NMNZ P.009008 (2, 290–380) Westland, Hokitika Canyon, 42°13' S, 170°34' E, 305–380 m, 12 August 1979; NMNZ P.009465 (420) Marlborough, Kaikoura region, 42°25' S, 173°43' E; NMNZ P.016345 (300) Snares Islands, off North Promontory, 48°0' S, 166°36' E, 110 m, 5 December 1984; NMNZ P.016889 (422) Southland, west of Richards Point, Bradshaw Sound, Fiordland, 45°16.7' S, 167°0.7' E, 15–21 m, 27 February 1985; NMNZ P.016933 (2, 150–177) Southland, off Seymour Island, Doubtful Sound, Fiordland, 45°18' S, 167°0' E, 12 m, 28 February 1985; NMNZ P.016970 (460) Southland, off Seymour Island, Doubtful Sound, Fiordland, 45°18' S, 167°0' E, 12 m, 28 February 1985; NMNZ P.017874 (65) Westland, NW off Hokitika, 40°38.48' S, 170°11.42' E, 169 m, 11 December 1978; NMNZ P.021159 (620) Southland, mouth of Caswell Sound, Fiordland, 44°58.9'

S, 167°7.6' E, 48 m, 15 February 1987; NMNZ P.023949 (430) Stewart Island, off Hebe Island, Port Pegasus, 47°11.8' S, 167°38.5' E, 10–16 m, 28 January 1989; NMNZ P.027612 (2, 195–256) Stewart Island, SE Point Rosa Island, Port Pegasus, 47°9.9' S, 167°42.0' E, 0–9 m, 10 March 1992; NMNZ P.027622 (390) Stewart Island, 13 Fathom Point, Whale Passage, Port Pegasus, 47°11.00' S, 167°43.05' E, 20 m, 13 March 1992; NMNZ P.027870 (225) Stewart Island, SE Point Rosa Island, Port Pegasus, 47°9.9' S, 167°42.0' E, 0–9 m, March 1992; NMNZ P.030270 (133) Southland, 'Little Cove', Acheron Passage, Fiordland, 45°39.88' S, 166°44.78' E, 0–10 m, 21 March 1993; NMNZ P.030520 (320) Southland, "46 fathom point", Broughton Arm, Breaksea Sound, Fiordland, 45°33.35' S, 166°57.95' E, 2–18 m, 21 March 1993; NMNZ P.030554 (330) Southland, Peninsula opposite Oak Island, Wet Jacket Arm, Fiordland, 45°38.65' S, 166°51.90' E, 0–33 m, 28 March 1993; NMNZ P.030559 (310) Southland, Stephens Cove, Fiordland, 45°36' S, 166°40' E, 7 m, 18 March 1993; NMNZ P.030940 (3, 84–183) Tasman, Taupo Point, Abel Tasman National Park, 40°47.5' S, 172°57.0' E, 4–8 m, 19 November 1993; NMNZ P.032260 (157) Southland, 1 nautical mile south of Deas Cove, south side of Thompson Sound, Fiordland, 45°12.79' S, 166°57.31' E, 8–24 m, 28 March 1995; NMNZ P.033439 (475) Stewart Island, south of Stewart Island, Campbell Plateau, 48°47.78' S, 166°47.26' E, 158 m, 5 March 1996; NMNZ P.035083 (140) Westland, Bridget Point, Milford Sound; Fiordland, 44°38.61' S, 167°54.86' E, 6–14 m, 5 April 1998; NMNZ P.035981 (462) Westland, point south of Teer Creek, 44°0' S, 168°29' E, 15–18 m, 13 February 1999. **Chatham Rise:** NMNZ P.020957 (2, 265) east of Chatham Islands, 43°30.95' S, 176°9.25' W, 176–205 m, 22 May 1987; NMNZ P.021008 (378) east of Chatham Islands, 43°31' S, 176°7' W, 206–226 m, 24 May 1987; NMNZ P.026557 (5, 143–255) channel between Point Munning and Te Whakuru Island, Chatham Island, 43°44.3' S, 176°12.0' W, 0–3 m, 15 February 1991; NMNZ P.026670 (245) Cape Fournier, Owenga, Chatham Island, 44°2.0' S, 176°19.5' W, 15–17 m, 10 February 1991; NSMT 32967 (537) Wanganella Bank, 32°41.6' S, 167°42' E, 123–405 m, 12 December 1989.

### *Pseudophycis breviuscula*

(636 specimens, 15–196 mm SL). **Australia, New South Wales:** AMS I.3982 (152) off Newcastle, 32°56' S, 151°56' E, 4 March 1898; AMS I.3983 (170) off Newcastle, 32°58' S, 151°55' E, 4 March 1898; AMS A.10105 (138) Port Jackson, 33°50' S, 151°10' E, 1881; AMS I.16879-001 (105) Jervis Bay, off Darling Road, 35°3' S, 150°44' E, 22 September 1971; AMS I.17178-016 (65) Port Jackson, near Manly, 33°50' S, 151°16' E, 13 August 1972; AMS I.19893-024 (4, 67–128) south of Nadgee River mouth, north end of Blackpoint, 37°30' S, 149°58' E, 0–5 m, 26 August 1976; AMS I.20065-002 (27, 35–46) off Ulladulla, 35°21' S, 150°49' E, 0–250 m, 27 October 1977; AMS I.20472-002 (2, 40–43) east of Green Cape, 36°24' S, 150°18' E, 0–128 m, 1 November 1977; AMS I.20568-002 (2, 130–170) east of Tweed Heads, 28°14' S, 153°50' E, 132–137 m, 2 June 1978; AMS I.20653-008 (119) and AMS I.20653-013 (59) east of Hat Head, 31°5' S, 31°2' S,

153°13' E, 155 m, 24 August 1977; AMS I.21366-019 (5, 35–45) off Newcastle, 33°17' S, 153°5' E, 28 November 1979; AMS I.21797-003 (127) east of Tuggerah Lake, 33°8' S, 151°54' E, 115 m, 17 July 1978; AMS I.21798-002 (4, 100–120) east of Tweed Heads, 28°14' S, 153°50' E, 132–137 m, 2 June 1978; AMS I.22873-002 (115) southeast of Cape Byron, 28°43' S, 153°49' E, 131 m, 1 November 1978; AMS I.23379-006 (42) Coffs Harbour, boat harbour, 30°20' S, 153°20' E, 0–6 m, 3 May 1977; AMS I.23685-001 (132) Smoky Cape, Coffs Harbour, Scott Point, Nambucca Heads, 30°43' S, 153°16' E, 134–151 m, 10 October 1978; AMS I.23687-001 (82) Ballina - Tweed Heads, 28°4' S, 153°50' E, 137 m, 16 August 1978; AMS I.23688-001 (3, 117–165) Ballina - Tweed Heads, east of Brunswick Heads, 28°25' S, 153°48' E, 119 m, 3 June 1978; AMS I.23692-001 (2, 122–145) Ballina - Tweed Heads, 28°34' S, 153°50' E, 146–150 m, 18 August 1978; AMS I.23870-006 (106) Sydney-Newcastle, 33°40' S, 152°56' E, 720 m, 20 December 1976; AMS I.24367-003 (2, 37–48) off Sydney, 33°43' S, 151°54' E, 430–541 m, 27 October 1983; AMS I.24440-002 (4, 35–45) east of Twofold Bay, 37°03' S, 150°20' E, 149 m, 1 November 1977; AMS I.25865-003 (145) off Port Stephens, 32°49' S, 152°2' E, 40–46 m, 10 April 1985; AMS I.25893-001 (196) off Twofold Bay, 37°5' S, 149°55' E, 18–46, 25 November 1984; AMS I.26239-005 (118) east of Woolli, 29°49' S, 153°24' E, 36–54 m, 25 March 1985; AMS I.26444-002 (112) northeast of Broken Bay, 33°29' S, 151°49' E, 142–137 m, 13 March 1986; AMS I.26451-005 (4, 51–99) Sydney, off Broken Bay, 33°35' S, 151°41' E, 134–135 m, 10 February 1986; AMS I.26906-009 (93) Iluka, 29°24' S, 153°21' E, 1987; AMS I.26919-002 (42) northeast of Jervis Bay, off Point Perpendicular, 35°5' S, 150°55' E, 128 m, 13 December 1984; AMS I.27064-006 (91) 35°0' S, 150°45' E, 2–7 m, January 1987; AMS I.27179-010 (43) 30°40' S, 159°0' E, 0–229 m, 20 September 1987; AMS I.27322-005 (141) off Tuncurry, 32°08' S, 152°31' E, 1 October 1985; AMS I.27323-004 (104) east of Camden Head, 31°42' S, 152°49' E, 2 October 1985; AMS I.27670-001 (93) off Coffs Harbour, 30°26' S, 153°22' E, 25 July 1981; AMS I.31483-003 (135) off Evans Head, 29°00' S, 153°49' E, 6 May 1990; AMS I.32120-001 (109) off Clarence River, 29°24' S, 153°35' E, 1–2 May 1990; AMS I.34467-001 (2, 143–162) off Wollongong, 34°28' S, 151°2' E, 100 m, 6–7 May 1993; AMS I.34472-002 (3, 90–150) off Wollongong, 34°26' S, 150°58' E, 7–8 May 1993; AMS I.34474-001 (94) off Wollongong, 34°28' S, 151°2' E, 100 m, 7–8 May 1993; AMS I.34475-001 (128) off Wollongong, 34°28' S, 151°2' E, 100 m, 7–8 May 1993; AMS I.34557-003 (96) off Wollongong, 34°26' S, 150°57' E, 50 m, 6–7 May 1993; AMS I.34715-001 (2, 85–115) Botany Bay channel off revetment, 33°59' S, 151°12' E, 16 December 1978; AMS I.34894-001 (125) off Wollongong, 34°0' S, 151°0' E, 28–29 March 1994; AMS I.35422-001 (2, 95–120) northeast of Coffs Harbour, 30°15.75' S, 153°21.98' E, 98 m, 12–13 August 1993; AMS I.35424-001 (3, 120–135) east of Coffs Harbour, 30°17' S, 153°13' E, 50 m, 8–9 September 1994; AMS I.35427-001 (2, 86–93) east of Coffs Harbour, 30°17' S, 153°13' E, 50 m, 9 September 1994; AMS I.40321-006 (130) southeast of Yamba, 29°39' S, 153°41' E, 5 July 1999; AMS I.40491-001 (6, 84–125) off Wollongong, 32°26' S, 150°57' E, 50 m, 6–7 May 1993;

AMS I.44627-019 (79) Tathra, Baronda Headland, south side, 36°41'11" S, 149°59'54" E, 8 April 2008; AMS I.44627-020 (81) Tathra, Baronda Headland, south side, 36°41'11" S, 149°59'54" E, 8 April 2008; AMS I.44632-006 (2, 100) Tathra, Kianniny boat ramp, 36°44'15" S, 149°58'60" E, 9 April 2008; AMS I.44823-022 (97) north side of Moon Island, 33°05'12" S, 151°40'16" E, 5 May 2009; AMS I.45025-004 (4, 96–115) Colliers Beach, inlet near Mollymook Golf Course, 35°20'46" S, 150°28'36" E, 10 March 2010; AMS I.45025-005 (2, 100–115) Colliers Beach, inlet near Mollymook Golf Course, 35°20'46" S, 150°28'36" E, 10 March 2010; AMS I.45027-018 (2, 65–75) Jones Beach, Mollymook, 35°19'19" S, 150°29' E, 11 March 2010; AMS I.45633-057 (6, 71–95) Washerwomans Beach, 35°14'39" S, 150°32'09" E, 16 March 2011; AMS IA.1955 (72) off Green Cape, 13–35 km northeast of cape, 37°4' S, 150°9' E, 71–84 m, June 1924; AMS IA.1956 (80) and AMS IA.1957 (60) 13–35 km northeast of Green Cape, 37°4' S, 150°9' E, 71–84 m, June 1924; AMS IA.2966 (125) 16–19 km northeast of Sydney Harbour, 33° S, 151°E, 110–146 m, 1926; AMS IA.6898 (75) 5 km off Broughton Island, 32°37' S, 152°22' E, 82–91 m, 29 May 1936; AMS IB.4359 (110) east of Tuggerah Lakes, 33°20' S, 151°35' E, 229–260 m, 19 June 1959; AMS IB.7005 (147) off Port Stephens, 32° S, 152° E, 1964; CSIRO A 1622 (84 mm TL) Pambula Bay, 11 m, 13 May 1950; CSIRO A 1639 (97 mm TL) Twofold Bay, off Eden, 10.8 m, 5 May 1950; CSIRO A 1640 (83 mm TL) Twofold Bay, off Eden, 10.8 m, 5 May 1950; CSIRO H 3575-01 (2, 60–70) east of Merimbula, 36°55.4' S, 149°56.8' E–36°54.6' S, 149°58.0' E, 33–40 m, 4 August 1993; CSIRO H 4258-04 (107) south of Green Cape, 37°21.23' S, 150°06.03' E–37°20.1' S, 150°06.52' E, 90–94 m, 7 May 1996; CSIRO H 4773-01 (148) east of Yamba, 29°24' S, 153°35' E–29°23' S, 153°35' E, 68–71 m, 17 April 1996; CSIRO H 4773-02 (4, 132–158) east of Yamba, 29°24' S, 153°35' E–29°23' S, 153°35' E, 68–71 m, 17 April 1996; CSIRO H 5962-01 (2, 105–142) northeast of Coffs Harbour, 29°50' S, 153°27' E–29°48' S, 153°27' E, 66–68 m, 15 April 1996; CSIRO H 6838-08 (4, 103–160) east of Broken Bay, 33°32.3' S, 151°30.9' E–33°28.3' S, 151°32.5' E, 60–62 m, 27 June 2006; CSIRO H 6845-01 (3, 117–181) east of Broken Bay, 33°29.4' S, 151°32.2' E–33°33.7' S, 151°29.8' E, 60–62 m, 29 June 2006; CSIRO T 1434 (1) off Port Stephens, 32°44' S, 152°16' E–32°43' S, 152°23' E, 83–104 m, 20 August 1979; NMV A6437 (31.0) 65 km east of Nowra, 34°52.9' S, 151°22.7' E, 23 October 1988; NMV A6438 (31.3) 52 km east-southeast of Nowra, 34°56.1' S, 151°14.7' E, 21 October 1988; NMV A13051 (2, 52.4–68.5) 12 km east-northeast of Bermagui, 36°23.3' S, 150°10.7' E, 72–69 m, 15 August 1993. **Victoria:** NMV A7531 (55.9) Batison Point, tide pool, 37°34.2' S, 149°46.2' E, 1 m, 6 April 1989; NMV A7560 (55.9) Gabo Island, harbour on southeast side, 37°34.2' S, 149°55.2' E, 4 m, 4 April 1989; NMV A13050 (68.8) Disaster Bay, 37°16.3' S, 149°57.9' E, 24–29 m, 11 August 1993; NMV A2682 (28.1) central Bass Strait, 26 km southeast of Aireys Inlet, 38°39.8' S, 144°18.2' E, 79 m, 19 November 1981; NMV A3776 (2, 72.2–77.2) eastern Bass Strait, 24 km southwest of Lakes Entrance, 38°03' S, 147°49.8' E, 45 m, 1 October 1983; NMV A3841 (4, 58.9–79.3) eastern Bass Strait, 28 km south-

southwest of Marlo, 37°58.8' S, 148°27' E, 51 m, 30 July 1983; NMV A5812 (3, 46.8–61.8) eastern Bass Strait, 40 km south-southwest of Lakes Entrance, 38°18' S, 147°37' E, 55 m, 31 July 1983; NMV A835 (108) Bass Strait, 24 km (16 miles) south-southwest of Lakes Entrance, 38°7' S, 147°51.8' E, 29–37 m, 27 April 1948; NMV A8775 (38.3) Bass Strait, 30 km east of Gabo Island, 37°37.2' S, 150°16.7' E, 432 m, 14 October 1984; NMV A20817 (74.5) southeast of Lakes Entrance, 38°10.2' S, 148°4.8' E, 1971; NMV A20818 (4, 48.3–80.0) no collection data; NMV A29091-001 (80.5) Portland, inner harbour, South Henty, 38°21' S, 141°36' E, 13 m, 1 May 1996. **Tasmania:** AMS I.43935-001 (78) East of Fortescue Bay, north of Hippolyte Rocks, 43°06'42" S, 148°03'27" E, 9–10 April 1994; CSIRO H 6980-04 (42) southern Tasman Sea, 40°48.97' S, 150°58.30' E–40°49.16' S, 150°56.54' E, 392–185 m, 21 June 2009; CSIRO H 6991-01 (36) southern Tasman Sea, 40°48.35' S, 152°16.42' E–40°48.53' S, 152°15.25' E, 174–91 m, 21 June 2009; CSIRO T 1952 (150) Frederick Henry Bay, 25 m, 19 September 1983; NMV A2626 (47.2) eastern Bass Strait, 100 km northeast of North Point, Flinders Island, 38°52.6' S, 148°25.2' E, 130 m, 15 November 1981; NMV A2676 (35.4) central Bass Strait, 35 km north of Cape Wickham, King Island, 39°13.6' S, 143°55.6' E, 85 m, 23 November 1981; NMV A3789 (40.7) eastern Bass Strait, 18 km north-northeast of Deal Island, 39°19.2' S, 147°27' E, 63 m, 1 October 1983; NMV A6435 (25.8) 68 km east of Cape Tourville, 42°3.9' S, 149°11.9' E, 27 October 1988; NMV A6439 (2, 24.3–34.0) 52 km east-northeast of Cape Tourville, 42°2.4' S, 148°58.3' E, 28 October 1988; NMV A6440 (3, 17.7–22.2) 54 km east-northeast of Cape Tourville, 42°02.1' S, 148°58.4' E, 28 October 1988; NMV A6909 (30.5) 78 km south of Point Hicks, 38°30.1' S, 149°15.5' E, 25 October 1988; NMVA26688-003 (2, 65.0–76.4) Port Phillip Bay, off Seaford, artificial reef, 38°05.25' S, 145°05.95' E; NMV A31158-001 (101) Port Phillip Bay, off Carrum, 7 April 2011; NMV A31159-001 (95.5) and NMV A31159-002 (87.9) Port Phillip Bay, 28 March 2011; WAM P.27554.021 (127) Spring Bay, 42°32' S, 147°55' E, 1–8 m. **South Australia:** AMS I.20167-021 (69) Kangaroo Island, Knob Point, 2 km east of Stokes Bay, 35°37' S, 137°15' E, 15 m, 5 March 1978; AMS I.20168-013 (77) Kangaroo Island, Hanson Bay, 36°01' S, 137°52' E, 6 March 1978; AMS I.20171-022 (41) Kangaroo Island, Vivonne Bay, 36°0' S, 137°11' E, 0–2 m, 6 March 1978; CSIRO H 5337-01 (2, 73–86) Great Australian Bight, 33°16.00' S, 130°43.15' E–33°16.60' S, 130°48.63' E, 137 m, 11 May 2000; CSIRO H 5338-01 (4, 69–125) Great Australian Bight, 31°50.05' S, 130°45.90' E–31°50.32' S, 130°45.10' E, 55 m, 14 May 2000; SAMA AMSTAC589 (4) Great Australian Bight, 8 nautical miles south of Point Weyland, 33°22'49" S, 134°37'53" E, 18 September 1981; SAMA AMSTAC1660 (1) Great Australian Bight, 6 miles off Venus Bay, 33°18'S, 134°35'E, 1 July 1982; SAMA F3948 (1) northern Great Australian Bight, 32°24' S, 133°30' E, 42 m, 5 May 1973; SAMA F9096 (1) Kangaroo Island, Nepean Bay, 35°38' S, 137°46' E, 54 m, 28 April 1981; SAMA F9098 (1) Great Australian Bight, Anxious Bay, 33°20'03" S, 134°38'47" E, 25 February 1981; SAMA F9099 (1) Great Australian Bight, Nuyts Archipelago, off Goat Island, 32°17'00" S, 133°30'00" E, 40 m, 28 February 1981;

- SAMA F10955 (1) Investigator Strait, 35°26'43" S, 137°56'42" E, 17 May 2007; SAMA F10990 (1) Investigator Strait, 35°24'28" S, 137°54'40" E, 17 May 2007; SAMA F14583 (1) 22 May 1905. **Western Australia:** AMS I.20229-021 (90) Cockburn Sound, 1 km south of Carnac Island, 32°10' S, 115°40' E, 6–8 m, 26 March 1978; AMS I.20247-010 (2, 58–63) Rottneest Is, Kingston Reefs, 31°59' S, 115°33' E, 12 April 1978; CSIRO H 4384-01 (110) Albany, Princess Royal Harbour, 35°02.02' S, 117°53.05' E, 7 m, 28 February 1996; WAM P.2999.001 (120) Mandurah, 32°32' S, 115°43' E; WAM P.7409.001 (174) Augusta, 34°19' S, 115°09' E; WAM P.21913.001 (135) Wilson Inlet, 34°59' S, 117°26' E; WAM P.25195.019 (3, 47–56) Cape Naturaliste, 33°32' S, 115°02' E, 1–5 m; WAM P.26006.003 (46) 34°07' S, 122°16' E, 13 m; WAM P.26009.006 (2, 65–70) Lucky Bay, 34°00' S, 122°14' E, 13 m; WAM P.26600.008 (4, 30–76) Albany, 35°08' S, 117°38' E; WAM P.26608.016 (2, 50–75) Cheyne Beach, 34°53' S, 118°25' E, 12–15 m; WAM P.26621.003 (117) Porpoise Bay, 32°00' S, 115°30' E, 1 m; WAM P.28292.008 (9, 45–121) Lucky Bay, 34°00' S, 122°14' E, 7–10 m; WAM P.28293.011 (67) Lucky Bay, 34°00' S, 122°14' E, 5–7 m; WAM P.28296.013 (5, 45–96) 34°08' S, 122°15' E, 5–6 m; WAM P.28298.004 (24, 42–118) Lucky Bay, 34°08' S, 122°15' E, 24 m; WAM P.28513.006 (92) Duke of Orleans Bay, 33°54' S, 122°37' E, 8 m; WAM P.28523.006 (3, 38–70) Augusta, 34°19' S, 115°10' E, 12–13 m. **New Zealand, North Island:** AMS I.18281-005 (6, 75–90) Auckland, Goat Island, 18 m, 1975; AMS I.18282-003 (8, 65–105) Auckland, Goat Island, 57°S, 168°E, 20 m, 31 March 1975; NMNZ P.002281 (4, 80–106) southeast of Mayor Island, 37°22.50' S, 176°22.00' E, 207–219 m, 27 February 1957; NMNZ P.002289 (69) south of Mayor Island, 37°19.5' S, 176°16.5' E, 102 m, 27 February 1957; NMNZ P.002299 (102) Manakau Harbour, above Weymouth, 37°2.45' S, 174°50.25' E, 0–5 m, 5 January 1957; NMNZ P.003151 (10, 78–117) Urupukapuka Island, Bay of Islands, 35°12.32' S, 174°14.40' E, 2–7 m, February 1961; NMNZ P.003616 (2, 73–79) 22.5 km east of White Island, 37°30' S, 177°26' E, 192 m, 3 April 1963; NMNZ P.003756 (130) Napier breakwater, 39°28.50' S, 176°55.25' E, 9 m, March 1964; NMNZ P.005275 (132) off Kaipara Harbour, 36°26.0' S, 173°50.5' E, 115 m, 9 January 1971; NMNZ P.005866 (2, 93–109) northeast of Motiti Island, 37°39' S, 176°33' E, 64 m, 14 April 1972; NMNZ P.005969 (2, 93–99) main channel off Kopumiti Point, Whangaroa Harbour, 35°2' S, 173°45' E, 9–15 m, 22 February 1974; NMNZ P.006801 (75) northern Taranaki Bight, Aotea Seamount, 38°13.5' S, 173°54.0' E, 135–137 m, 13 November 1971; NMNZ P.007794 (8, 51–72) 9 km north of Motuhara Island, 37°48.15' S, 177°1.10' E, 72–84 m, 20 January 1979; NMNZ P.007865 (10, 60–83) north of Mayor Island, 37°10.90' S, 176°10.75' E, 198–273 m, 22 January 1979; NMNZ P.007899 (3, 55–110) between Motuhara Island and Rurima Inlets, 37°51.75' S, 176°55.90' E, 34–39 m, 21 January 1979; NMNZ P.008349 (4, 68–121) north of Mayor Island, 37°10.90' S, 176°10.75' E, 198–273 m, 22 January 1979; NMNZ P.008362 (9, 54–79) east-northeast of Tolaga Bay, 38°15.2' S, 178°38.6' E, 139 m, 16 January 1979; NMNZ P.008364 (12, 15–86) off Mayor Island, 37°9.1' S, 176°24.4' E, 753–826 m; NMNZ P.008461 (108) off Kohinga point, Bay of Islands, 35°10' S, 174°10' E, 8 December 1973; NMNZ P.008463 (74) Goat Island, Leigh, 36°16' S, 174°48' E, 1970; NMNZ P.008472 (120) Whatawhiwhi, Doubtless Bay, 34°53.00' S, 173°24.25' E, 17 November 1963; NMNZ P.009003 (2, 73–76) Spirits Bay, Northland, 34°27' S, 172°50' E, 4 m, 14 November 1963; NMNZ P.009796 (56) southeast of Three Kings Islands, 34°20.2' S, 172°21.8' E, 121 m, 2 February 1981; NMNZ P.009802 (75) Ranfurly Bank, East Cape, 37°38.4' S, 178°51.7' E, 79–83 m, 22 January 1981; NMNZ P.009809 (3, 49–71) off Ninety Mile Beach, 34°41.9' S, 172°33.5' E, 103 m, 10 January 1981; NMNZ P.009813 (61) off Raglan Harbour, 37°48.0' S, 174°14.7' E, 103 m, 13 January 1981; NMNZ P.009817 (4, 68–90) off Parengarenga Harbour, 34°32' S, 173°6' E, 93–102 m, 27 January 1981; NMNZ P.009828 (6, 59–122) northwest Ahipara, 34°50.0' S, 172°46.1' E, 90 m, 10 January 1981; NMNZ P.010431 (63) off Mahia Peninsula, 39°10' S, 178°0' E, 15 m, 14 April 1981; NMNZ P.011874 (95) 2.4 km west of Cape Colville, Hauraki Gulf, 36°37' S, 175°28' E, 40–70 m, 17 February 1976; NMNZ P.012089 (58) northeast of Ninepin Rock, Bay of Islands, 35°8.8' S, 174°10.9' E, 66–79 m, 1 December 1971; NMNZ P.012091 (103) North Cape, 34°25' S, 173°3' E, 109–146 m, 8 October 1964; NMNZ P.012093 (108) north of the Noises, Hauraki Gulf, 36°42' S, 174°58' E, 46 m, 17 May 1965; NMNZ P.014301 (12, 72–120) Matai Bay, south side of middle headland, Othngahunga Bay, 34°50' S, 173°25' E, 7–13 m, 18 August 1983; NMNZ P.014349 (2, 90–97) Waikato Bay, south end of Matai Bay, Northland, 34°50' S, 173°25' E, 3–5 m, 19 August 1983; NMNZ P.014380 (2, 100–109) north end of Taupo Bay, 34°59.17' S, 173°43.00' E, 7–8 m, 20 August 1983; NMNZ P.014397 (3, 75–92) Oakura Bay, Northland, 35°23' S, 174°21' E, 4–6 m, 21 August 1983; NMNZ P.015199 (108) channel between Henry Island and Cape Home, Oakura Bay, 35°23.0' S, 174°22.2' E, 14–17 m, 23 February 1984; NMNZ P.015305 (110) south of Tutukaka Harbour entrance, Northland, 35°37.36' S, 174°32.55' E, 13 m, 19 February 1984; NMNZ P.016983 (34) seawater intake, New Plymouth Powerhouse, 39°3' S, 174°5' E, 1983; NMNZ P.018115 (110) off marine laboratory, Island Bay, 41°21' S, 174°45.89' E, 15 m, 22 January 1986; NMNZ P.018200 (3, 80–111) reef in northern Crater Bay; Mayor Island, 37°17.2' S, 176°16.4' E, 12 m, 19 February 1986; NMNZ P.018223 (96) Mount Manganui, Bay of Plenty, 37°37.5' S, 176°10.4' E, 0–3 m, 13 February 1986; NMNZ P.018258 (88) Tauranga Bay, Mayor Island, 37°18.4' S, 176°15.8' E, 12 m, 18 February 1986; NMNZ P.018290 (3, 62–100) off Rabbit [Motuotou] Island, Mount Manganui, 37°38.0' S, 176°11.6' E, 6–15 m, 14 February 1986; NMNZ P.021081 (7, 83–134) off Bell Block, New Plymouth, 39°1' S, 174°9' E, 9 m, 13 December 1986; NMNZ P.021541 (4, 52–83.2) rocks off Whangamata Beach, Coromandel, 37°12.88' S, 175°53.65' E, 17 m, 29 November 1987; NMNZ P.021645 (72.8) east side of Great Mercury Island, Coromandel, 36°37.05' S, 175°50.23' E, 15 m, 2 December 1987; NMNZ P.021767 (3, 59–89.3) pools between Jackson and Fantail Bays, Coromandel, 36°32' S, 175°20' E, 0–3 m, 8 December 1987; NMNZ P.021797 (10, 72.1–99.8) rocks off Whangamata Beach, Coromandel, 37°12.88' S, 175°53.65' E, 17 m, 29 November 1987; NMNZ P.021883 (95)



Firth of Thames, 37°0' S, 175°20' E, 30 January 1965; NMNZ P.023179 (93) Matakaoa, East Cape, 37°34' S, 178°20' E, 16 m, 25 June 1988; NMNZ P.023211 (6, 81–113) Waiaka Bay near Lottin Point, East Cape, 37°33' S, 178°9' E, 6 m, 24 June 1988; NMNZ P.024349 (72) Higgins Wharf, Napier, 39°30' S, 176°50' E, 22 March 1988; NMNZ P.026295 (110) Charity Reef, Pourerere, 40°6.2' S, 176°53.5' E, 12 m, 19 January 1991; NMNZ P.026356 (66) Pauanui Point Reef, East Coast, 40°4.4' S, 176°53.8' E, 7–10 m, 16 January 1991; NMNZ P.028100 (4, 59–120) Okakari Point, Northland, 36°15' S, 174°46' E, 2–3 m, 9 April 1992; NMNZ P.028204 (5, 86–151) Midway Point, south of Lottin Point, East Cape, 37°32.6' S, 178°12.9' E, 15–17 m, 2 May 1992; NMNZ P.028237 (5, 59–110) west side of Orete Point, Te Kaha, 37°35.25' S, 177°53.15' E, 11–12 m, 3 May 1992; NMNZ P.028271 (2, 95–131) bay west of Lottin Point, Waiaka Bay, East Cape, 37°32.9' S, 178°8.7' E, 15–20 m, 1 May 1992; NMNZ P.028389 (2, 62–68) south of Tohora Pirau, Lottin Point, 37°32.7' S, 178°10.0' E, 7–10 m, 2 May 1992; NMNZ P.028428 (4, 74–87) Kaipiro Reef, Maraetai Bay, Te Kaha, Bay of Plenty, 37°42.6' S, 177°41.7' E, 19–21 m, 30 April 1992; NMNZ P.028460 (98) Kaipiro Reef, Maraetai Bay, Te Kaha, Bay of Plenty, 37°42.6' S, 177°41.7' E, 19–21 m, 30 April 1992; NMNZ P.029790 (2, 105–130) off Horoera Point, East Cape, 37°37.8' S, 178°28.9' E, 8–10 m, 24 January 1993; NMNZ P.029846 (2, 57–64) between Moutahiauru Island and Koutunui Head, East Cape, 38°3.35' S, 178°22.20' E, 9 m, 25 January 1993; NMNZ P.029855 (3, 60–75) Whanarua Bay, Bay of Plenty, 37°40.0' S, 177°46.7' E, 15–21 m, 28 January 1993; NMNZ P.029875 (2, 62–75) between Te Araroa and Horoera, East Cape, 37°37.6' S, 178°25.0' E, 0–3 m, 24 January 1993; NMNZ P.029969 (8, 45–65) northeast Waipiro Bay, East Cape, 38°0.0' S, 178°23.1' E, 21 m, 25 January 1993; NMNZ P.030070 (3, 63–120) Tatapouri Beach, Gisbourne, 38°39.2' S, 178°9.9' E, 6–8 m, 22 January 1993; NMNZ P.030121 (5, 60–75) eastern Whanarua Bay, Bay of Plenty, 37°40.5' S, 177°47.4' E, 8 m, 28 January 1993; NMNZ P.030607 (2, 70–117) Port of Napier, 39°28' S, 176°55' E, 23 March 1993; NMNZ P.030609 (7, 70–92) Gisborne Wharf, Poverty Bay, 38°40.5' S, 178°1.5' E, 8 m, 4 December 1992; NMNZ P.030615 (3, 78–117) Gisborne Wharf, Poverty Bay, 38°41' S, 178°2' E, 18 May 1993; NMNZ P.030617 (2, 62–73) Gisborne Wharf, Poverty Bay, 38°40' S, 178°1' E, March 1993; NMNZ P.030631 (4, 71–104) Port of Napier, 39°29' S, 176°55' E, 25 June 1993; NMNZ P.030685 (2, 87–106) Port of Napier, 39°21.9' S, 176°54.1' E, 5 m, 22 September 1992; NMNZ P.030692 (19, 49–103) Gisborne Wharf, Poverty Bay, 38°40.8' S, 178°1.1' E, 23 June 1993; NMNZ P.033570 (119) Long Point, Mahia Peninsula, 39°10' S, 177°49' E, 8 m, 4 January 1995; NMNZ P.033644 (6, 50–110) Whangawehi, Mahia Peninsula, 39°7' S, 177°54' E, 14 m, 25 January 1995; NMNZ P.034527 (90) off Great Exhibition Bay, Northland, 34°40.4' S, 173°31.0' E, 182 m, November 1977; NMNZ P.035537 (10, 77–105) Archway, east end of Whale (Moutohora) Island, 37°51.44' S, 176°59.39' E, 12–17 m, 1 June 1998; NMNZ P.035560 (3, 90–140) Rurima Islets, 37°49.78' S, 176°52.63' E, 7–10 m, 2 June 1998; NMNZ P.035584 (8, 82–139) North Bay, Whale (Motuhora) Island, 37°51.05' S, 176°58.57' E, 13–15 m, 3 June 1998; NMNZ P.036587 (23, 66–112) south Whale (Motuhora) Island, 37°51.70' S, 176°58.43' E, 8–12 m, 22 April 1999; NMNZ P.036641 (8, 82–118) Nursery Cove, White Island, 37°31.42' S, 177°10.37' E, 5–16 m, 23 April 1999; NMNZ P.036667 (7, 77–94) off Homestead Point, White Island, 37°31.77' S, 177°10.68' E, 8–14 m, 23 April 1999; NMNZ P.036698 (5, 77–116) west end of White Island, 37°51.05' S, 176°57.63' E, 12–16 m, 24 April 1999; NMNZ P.036723 (22, 65–95) southeast MacEvans Bay; Whale (Motuhora) Island, 37°51.57' S, 176°59.12' E, 12–17 m, 26 April 1999; NMNZ P.048348 (2, 62.1–67.9) off Kaweura, midway between South Head, Omapere and Maunganui Bluff, 35°38.14' S, 173°26.09' E, 0–10 m, 14 February 2011; NMNZ P.048431 (65.8) first coast beach south of southern headland of Hokianga Harbour, 35°32.93' S, 173°22.01' E, 16 February 2011. **South Island:** NMNZ P.033548 (2, 110–133) Foul Point, Abel Tasman, 40°54' S, 173°4' E, 8 m, 3 December 1993.