New Zealand Journal of Marine and Freshwater Research

ISSN: 0028-8330 (Print) 1175-8805 (Online) Journal homepage: http://www.tandfonline.com/loi/tnzm20

Review of New Zealand bullseyes (Perciformes: Pempheridae)

Randall D. Mooi

To cite this article: Randall D. Mooi (2000) Review of New Zealand bullseyes (Perciformes: Pempheridae), New Zealand Journal of Marine and Freshwater Research, 34:1, 87-102, DOI: 10.1080/00288330.2000.9516917

To link to this article: http://dx.doi.org/10.1080/00288330.2000.9516917

New Zealand Journal of Marine and Freshwater Research, 2000, Vol. 34: 87–102
0028–8330/00/3401–0087 $7.00

Review of New Zealand bullseyes (Perciformes: Pempheridae)

RANDALL D. MOOI
Milwaukee Public Museum
800 West Wells St
Milwaukee, WI 53233
United States
email: mooi@mpm.edu

Abstract The known pempherid fauna of New Zealand comprises two species: *Pempheris adspersa* Griffin, endemic to the north-eastern shores of North Island; and *P. analis* Waite, found in the Kermadec Islands as well as Norfolk Island, Lord Howe Island, and the east and west coasts of Australia. *Pempheris adspersa* differs from *P. analis* in having: some interorbital scales cycloid (versus all interorbital scales ctenoid), usually 3 or more predorsal scales cycloid which often form a mesial line of cycloid scales (versus rarely 4 or fewer predorsal scales cycloid), lateral-line scales 56–68 but rarely more than 66 (versus 63–77, rarely fewer than 65), and scales below lateral line 18–24 but rarely more than 22 (versus 22–27). A principal components analysis differentiates the two species with only slight overlap. Reports of *P. compressa* from New Zealand are erroneous; descriptions of *P. compressa* and *P. adspersa* have been confused in the literature. *Pempheris compressa* differs from *P. adspersa* in having: anal fin dusky along entire length (versus tips of first 4–5 anal-fin rays black), gular region scaled (versus unscaled), segmented anal-fin rays 35–40 (versus 29–35), head depth 36–41% of standard length (SL) (versus 31–38%), and body depth 44–52% of SL (versus 38–46%). A principal components analysis clearly differentiates the two species.

M99014
Received 23 March 1999; accepted 27 September 1999

Keywords *Pempheris*; bullseyes; taxonomy; distribution; morphometrics; principal component analysis

INTRODUCTION

Fishes of the family Pempheridae, commonly known as bullseyes or sweepers, are found on rock and coral reefs of the tropical and temperate Indo-Pacific and western Atlantic Oceans to depths of 100 m. Tominaga (1965) restricted the family to two genera of small to medium-sized fishes (usually <200 mm standard length (SL)) characterised by strongly compressed bodies, a single short dorsal fin, large eyes, and the lateral line extending well on to the caudal fin. Of the more than 30 nominal species in the genus *Pempheris* Cuvier, 1829 fewer than 20 are valid, whereas only half of the eight nominal species in *Parapriacanthus* Steindachner, 1870 are valid.

Early references to the family Pempheridae in New Zealand waters are sparse. The first is the original description of *Pempheris analis* by Waite (1910) from the Kermadec Islands. Griffin (1927) described *P. adspersa* from the Bay of Islands on the basis of a comparison of two specimens with a description of *P. affinis* McCulloch, 1911, a distinctive species endemic to Australia. *Pempheris adspersa* is actually most similar to *P. analis*—so similar that initial work on a worldwide review of the Pempheridae cast doubt on its validity. Griffin (1928) reported *Pempheris compressa* (White 1790) from Hauraki Gulf and provided a key to New Zealand *Pempheris*, distinguishing it only from *P. adspersa*, apparently unaware of Waite's (1910) report of *P. analis*.

A recent list of fishes of New Zealand teleost species held at the National Museum of New Zealand included *P. adspersa*, *P. analis*, and *P. compressa* (Paulin & Stewart 1985). Paulin et al. (1989: 192) provided an illustrated key to these three species, and Paulin & Roberts (1992) noted that three species were recorded for New Zealand. A biogeographic study of rockpool fishes listed *P. adspersa*, but excluded the other two species without

comment (Paulin & Roberts 1993). Francis (1996a) recorded *P. analis* from the Kermadec Islands, and *P. adspersa* from his Three Kings Islands and north-east North Island Zones, apparently dismissing reports of *P. compressa*. The inclusion of *P. compressa* as a member of the New Zealand fauna was considered unlikely by Mooi & Jubb (1996), who suggested that the species was endemic to the south-eastern coasts of Australia. However, popular texts (e.g., Paul & Heath 1997) continue to refer to three species in New Zealand waters. Thompson (1981), Doak (1981), and Francis (1996b) provided life history information on *P. adspersa*.

This review explores the validity of *Pempheris adspersa* Griffin 1927 and the New Zealand occurrence of *P. compressa* (White 1790) and *P. analis* Waite, 1910. It also provides full descriptions and a key for the species known to occur in New Zealand's Exclusive Economic Zone.

MATERIALS AND METHODS

The majority of measurements were acquired by photographing preserved specimens placed between glass in an aquarium and viewing the negatives with a computer image-analysis system. Some measurements that were difficult to make consistently (e.g., preanal length, pelvic-fin origin to anal-fin origin because of squamation on anal-fin base) were taken from radiographs. Observations on the holotype of *Pempheris adspersa* were based on a radiograph. Specimen sizes are reported as SL in mm. Head depth was measured at the vertical through the posterior margin of the eye. Predorsal, prepelvic, and preanal lengths were measured from the tip of the snout to the origin of the relevant fin (base of first spine). Body depth was defined as the distance from the dorsal-fin origin to the pelvic-fin origin. Peduncle depth was the vertical distance measured from the anal-fin insertion (base of last segmented ray). All other measurements follow Hubbs & Lagler (1949) or are self-explanatory.

Counts are presented with the holotype or lectotype and paratype or paralectotype value(s) first, separated by a slash (/) if different, and marked either H (L) or P if only a single value was available. These are followed, in parentheses, by the mode, range, and frequency comments for the remaining specimens. Calculation of mode and determination of range for number of lateral-line scales and gill rakers can include counts of both sides. Lateral-line counts are of all pored scales from the supracleithrum to the posterior extent of the hypural plates. Predorsal scales are counted along a mesial line to a vertical at anterior of pupil. Gill-raker counts are provided as upper + lower limb counts of outer elements (including rudiments) of the first arch with the raker at the angle included in the lower limb. Caudal-fin ray counts are provided as number of principal caudal rays (branched rays + 1 unbranched ray above and below). All other counts follow Hubbs & Lagler (1949). Cheek scale row number was often difficult to determine because scales are crowded and do not form obvious rows. Radiographs were used to make median-fin ray counts. Counts and measurements are based on all specimens listed as material examined, except in instances where damage (particularly for fin-ray measurements) precluded their use. Scales are described as ctenoid, here meaning those scales with transforming cteni, or as cycloid, meaning those without obvious cteni.

Statistical comparisons were performed using SAS Version 6 (SAS Institute Inc., SAS Campus Dr., Cary, NC 27513, United States). Morphometric and meristic characters used for principal components analysis (PCA) were limited to those with correlations of <75% as calculated for the PCA correlation matrices. Matrices were based on the residuals calculated from linear regressions of character measures plotted against SL after transformation to logarithms.

Materials for species represented in New Zealand are listed in the descriptions; dates of collections are provided as day/month/year or month/year. Institutional abbreviations follow Leviton et al. (1985). Comparative material included the following:

Pempheris compressa (White, 1790), 50 specimens, 56.0–135.6 mm SL: AMS I.16861–026, 20:79.0–135.6, NSW Aust.; AMS I.19901–049, 7:56.0–129.2, NSW Aust.; AMS I.27323–002, 12:65.4–93.0, NSW Aust.; MPM 31023, 4:59.0–119.5, NSW Aust.; NMV A.7579, 115.3, VIC Aust.; WAM P.23217–001, 6:83.2–110.2, NSW Aust.

P. japonica Döderlein, 1883, 18 specimens, 89.1–135.0 mm SL, all from Japan: BMNH 1891.5.26:7–8, 2:107.1–130.2, syntypes; FMNH 90820, 3:110.8–127.7; NMW 75308, 2:132.0–135.0, syntypes; NMW 89639, 4:109.5–122.1; NSMT 19237, 5:89.1–97.4; USNM 68229, 129.6, holotype of *Catalufa umbra* Snyder, 1911; ZMH 4250, 127.4, syntype.

Pempheris klunzingeri McCulloch, 1911, 61 specimens, 26.4–137.1 mm SL, all from WA, Australia: AMNH 37884, 6:54.3–72.9; AMS

I.19629–014, 5:51.1–102.8; AMS I.20247–008, 5:26.4–44.1; CSIRO A1725, 41.3; CSIRO A1726, 44.1; MPM 31030, 4:54.2–92.2; WAM P.20859–009, 2:124.8–137.1; WAM P.25178–001, 2:123.8–132.0; WAM 25773–13, 2:71.8–120.4; WAM P.26071–001, 35.6; WAM P.26608–19, 3:115.5–128.3; WAM P.27950–16, 4:77.8–112.8; WAM P.27959–010, 9:39.9–99.8; WAM P.28300–030, 27.6; WAM P.28284–09, 3:65.5–127.4; WAM P.28290–006, 8:27.7–38.4; WAM P.28293–024, 4:68.1–105.1.

Pempheris rapa Mooi, 1998, 40 specimens, 14.7–134.7 mm SL, all from Rapa Iti, French Polynesia: AMS I. 37829–001, 130.5, paratype; BPBM 12889, 126.2, holotype; BPBM 12967, 21:15.0–26.3; BPBM 17289, 9:14.7–124.6; BPBM 37408, 4:125.0–131.7, paratypes; MNHN 1997–57, 128.7 mm, paratype; MPM 31325, 126.9 mm, paratype; ROM 70538, 127.3 mm, paratype; USNM 344109, 134.7 mm, paratype.

Pempheris adspersa Griffin, 1927

(Fig. 1–5; Tables 1–5)

Pempheris adspersus Griffin, 1927: 139–140, fig. 3 (original description)—Griffin 1928: 380 (key); Whitley in Graham 1956: 407 (list); Paulin & Stewart 1985: 43 (collection list); Roberts et al. 1986: 102, tab. 1 (list); Hardy et al. 1987: 245 (list, voucher for Three Kings Islands); Paulin et al. 1989: 192–93 (key); Paulin & Roberts 1992: 102–103, pl. 21a,b (description, distribution, colour photo); Paulin & Roberts 1993: 199 (distribution list); Francis 1996a: 45, 51 (distribution, list); Francis 1996b: 34, pl. 22 (description, colour photographs); Paul & Heath 1997: 41 (description, fig.).

Pempheris adspersa—Whitley, 1968: 61 (list); Grace, 1975: 97 (list); Russell 1971: 86 (annotated list); Willan et al. 1979: 451, tab. 3 (list, density); Doak 1981: 45–46, pl. 18 (life history); Thompson 1981: 149–50, tab. 2, (life history); Ayling & Cox 1982: p. 227–228, pl. 21 (description); Mooi 1998: 158 (comparison); Taylor & Willis 1998: tabs. 1–2, figs. 1–2 (growth and weight relationships).

Pempheris analis Waite, 1910 (in part)—Mooi & Jubb 1996: 129 (key, North Island distribution record).

Pempheris compressa (non White, 1790)—Griffin 1928:380 (key, description); Paulin et al. 1989:192 (key).

MATERIAL EXAMINED

Holotype AIM AK 74995, 118.8 mm, Bay of Islands, Northland, (approx. 35°13′S 174°12′E), taken by hand-line, L. T. Griffin, 03/26 (radiograph only).

Paratype AIM AK 74994, 98.3 mm, collected with the holotype.

Other material examined 145 specimens, 30.5–158.0 mm. AIM AK 272, 2:115.9–158.0 mm, Kawau Is., Auckland (36°25′S 174°51′E), 02/28; AIM AK 80886, 93.1 mm, Great Barrier Is., Auckland (36°10′S 175°25′E), 1930; AMS I.18282–001, 73.5 mm, Goat Is., Auckland (approx. 36°S 175°E), 20–21 m, 31/3/75. ANSP 122860, 2:71.9–91.7 mm, Urupukapuka Is., Bay of Islands, Northland (35°13′S 174°14′E), 0–3 m, 24/2/60. BMNH 1984.9.24:8, 139.0 mm, Aldermen Is., Bay of Plenty, (36°58′S 176°05′E), 14–17 m, 26/4/84. NMNZ P.3145, 9:63.5–97.3 mm, Urupukapuka Is., Bay of Islands, Northland (35°13′S 174°14′E), 2/61; NMNZ P.3156, 10:73.1–107.6 mm, Urupukapuka Is., Bay of Islands, Northland (35°13′S 174°14′E), 2/61 (3 gravid females); NMNZ P.3430, 9:40.9–117.3 mm, Te Taipa, Doubtless Bay, Northland (34°56′S 173°23′E), 18/11/63 (3 gravid females); NMNZ P.3437, 9:31.4–55.3 mm, Whatuwhiwhi, Doubtless Bay (34°56′S 173°23′E), 18/11/63; NMNZ P.15036, 19:52.8–121.7 mm, Oke Bay, Bay of Islands, Northland (35°14′S 174°16′E), 29/11/71 (4 gravid females); NMNZ P.18482, 144.3 mm, Southeast Bay, Great Is., Three Kings Is., Northland (34°9.5′S 172°8.9′E), 15 m, 13/02/86; NMNZ P.21675, 46:30.5–117.9 mm, between Fantail and Jackson Bay, Coromandel Peninsula (36°32′S 175°20′E), 0–3 m, 8/12/87 (13 gravid females); NMNZ P.21829, 8:73.8–115.6, Aldermen Is., Bay of Plenty (36°58′S 176°05′E), 4 m, 30/11/87 (2 gravid females); NMNZ P.28350, 16:87.3–142.1 mm, SE of Cape Runaway, East Cape (37°32.9′S 178°0.3′E), 24/4/92; NMNZ P.30104, 9:96.0–118.8 mm, eastern Whanarua Bay, Bay of Plenty (37°40.5′S 177°47.4′E), 8 m, 28/01/93 (3 gravid females).

Diagnosis

Pempheris adspersa is distinguished from other Pempheridae by the following combination of characters: some interorbital scales cycloid; usually 3 or more predorsal scales cycloid, often forming a mesial line of cycloid scales; no axillary scale; lateral-line scales 56–68, rarely more than 66; scales

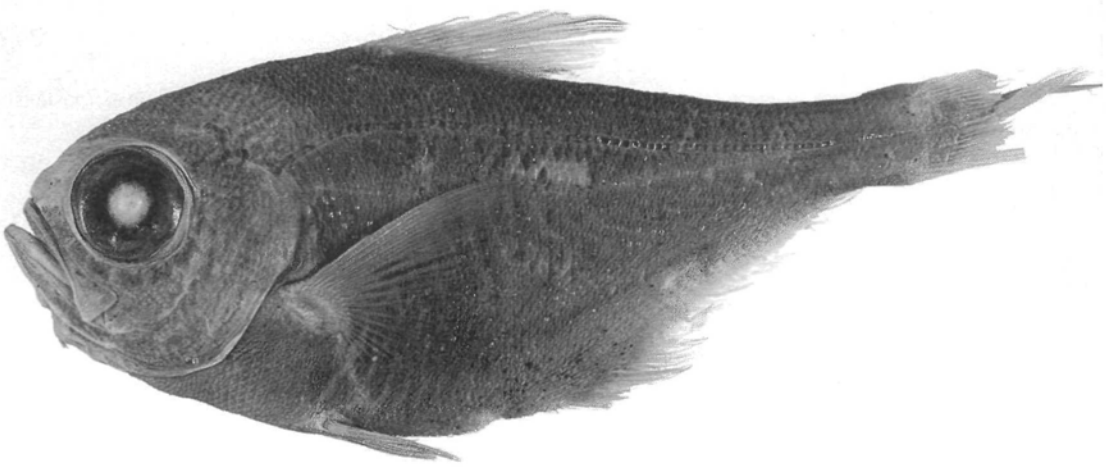

Fig. 1 Paratype of *Pempheris adspersa*, AIM AK 74994, 98.3 mm, Bay of Islands, Auckland Provincial District, (c. 35°13′S 174°12′E), taken by hand-line, L. T. Griffin, March 1926.

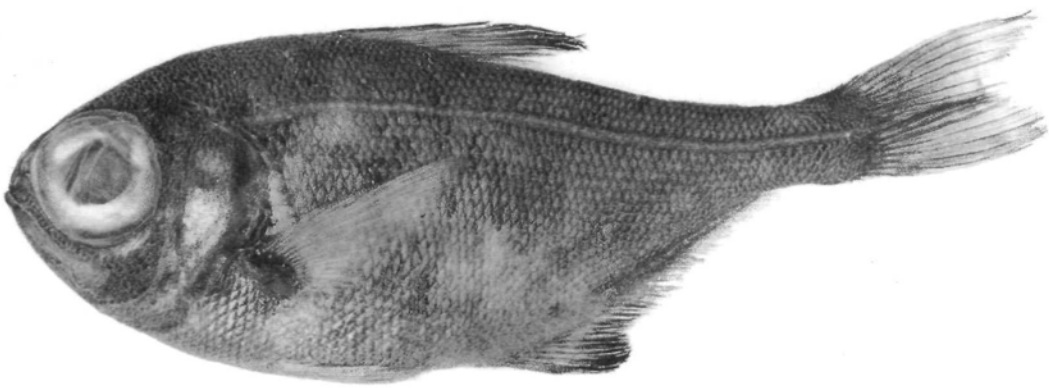

Fig. 2 More recent specimen of *Pempheris adspersa*, NMNZ 30104, 124 mm, eastern Whanarua Bay, Bay of Plenty (37°40.5′S 177°47.4′E), 8 m, 28 January 1993.

below lateral line 18–24, rarely more than 22; anal-fin rays 29–35; ratio of preanal length to anal-fin base length 1.19–1.55; ratio of pelvic-fin origin to anal-fin origin to anal-fin base length 0.38–0.59; no anterior light organ associated with pyloric caeca.

Description

Dorsal-fin rays VI,10/11 (VI,11; V-VI,10–12, V in 3 of 147, and 12 in 2 of 147); anal-fin rays III,31/30 (III,31; III,29–35, 35 in 1 of 145); pectoral-fin rays 17 (17; 15–18, 15 in 1 of 147); pelvic-fin rays I,5; principal caudal-fin rays 9+8; lateral-line scales 65 left/65 left and 64 right (61; 56–68, 56 in 2 of 147 and more than 66 in 3 of 147); scale rows above lateral line 9/10 (10; 8–12, only once 12); scale rows below lateral line 20/23 (20; 18–24); cheek scale rows 9P (8; 7–10); predorsal scales 36P (40; 36–45); circumpeduncular scales 26P (24; 21–26, only once

21); gill rakers 9+25P (10+23; 8–12 + 22–25, only once 8 and 12); total gill rakers 34P (33; 30–36, once 30, twice 36). Morphometric data are provided in Table 4, based on 112 specimens.

At least some interorbital scales cycloid. Some predorsal scales cycloid (2–25; usually 3 or more) sometimes forming mesial series; all other scales ctenoid. Gular unscaled. Snout anterior to eye and dorsal to nares unscaled. Pelvic axillary scale absent. Prepelvic area (breast) unkeeled, flat and broad. No anterior light organ associated with pyloric caeca. Caudal fin forked.

Coloration In life (from colour transparencies of several specimens photographed at Poor Knights Islands by M. Francis): head and body of adults coppery-red with purplish highlights dorsally, especially along dorsal edge of lateral line; median fins hyaline to dusky, rays dusky with darker bases; anterior edge of dorsal fin and tips of first 3–4 segmented dorsal-fin rays black; anal fin with black tips on spines and first 4–5 segmented rays; caudal fin with black tips on upper and lower lobes, lateral-line scales along median rays sometimes forming a dark median stripe; pectoral fin reddish with dark base varying from distinct spot to diffuse smudge; pelvic fin pale yellow with a paler edge along spine and first ray. Smaller individuals generally paler, often yellowish-brown and without black tips to fins, the smallest individuals transparent posteriorly; pelvic fin bright yellow or orange. Colour photographs available in Doak (1981: pl. 18), Paulin & Roberts (1992: pl. 21a,b), and Francis (1996b: pl. 22).

In 70% ethanol: holotype as described by Griffin (1927:139–140): "Uniform silvery purple brown on body, covered with minute brown dots which require a lens to view them properly. A few much larger brown dots are found scattered about on the sides of the fish. The ground-colour is somewhat darker on the nape and posterior border of operculum. Dorsal, anal, and caudal, dark purple brown tipped with black, and covered with minute dark brown dots. Pectoral white, a dark brown band at lateral base. Ventrals white on margins, the middle membrane being light purple and minutely dotted."

Paratype quite uniformly brownish; fins paler than body, only dorsal with slightly darker tips (Fig. 1).

Other specimens (Fig. 2) with dorsal part of head and nape dark brown; operculum dark brown dorsally, paler ventrally, chromatophores becoming more widely separated and evident as individual dots, background colour sometimes silvery; branchiostegals pale but edged with brown

Table 1 Number of lateral-line scales (left side) of specimens of three species of *Pempheris*. Holotype, lectotype, paratype, and paralectotype values indicated by superscripts ($^{h, l, p}$). Griffin's (1928) specimen of *P. adspersa* (AIM AK 272, 115.9 mm standard length (SL)) and second specimen with this catalogue number (158.0 mm SL), misidentified as *P. compressa*, indicated by superscripts ^{G} and ^{g}.

No. lateral-line scales	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77
Pempheris adspersa	2	3	3	10	16	31	28^{g}	17	10^{G}	7^{hp}	7	2	1									
Pempheris analis																						
Kermadec Islands											1	1	1^{l}				1^{p}		2			
Australia + Lord Howe										7	4	1	8	12	10	6	10	6	3	3	2	1
Norfolk Island								1						1								
Pempheris compressa				1	3	6	16	8	8	3	1	1	3									

chromatophores; gular area straw yellow; premaxilla, maxilla and dentary dark brown; eye usually dark, occasionally silvery ventrally; body generally uniform brown with scale pockets edged with darker pigment, slightly paler ventrally, occasionally fading to straw yellow; lateral line pale and edged in brown; ventral area anterior to pelvic fins paler, sometimes silvery, speckled with chromatophores; rays of all fins darker than fin membranes; dorsal fin darker than body colour, with a black anterior edge involving spines and distal tips to first three or four segmented rays; anal fin dark with black distal tips on first four segmented rays; caudal dark with black tips to dorsal-most and ventral-most three or four branched rays, occasionally all rays tipped in black and/or outermost rays black along entire length; pectoral fin pale, usually with conspicuously darker base; pelvic fin pale. Smaller specimens paler; adult colour obtained by 40–50 mm SL.

Comparisons

The genus *Pempheris* can be divided into two phenetic groupings: a species complex with a prepelvic keel and cycloid scales and a species complex without a prepelvic keel and ctenoid scales. The pempherids known from New Zealand fall into the latter grouping. This complex includes *Pempheris adspersa*, *P. analis* Waite, 1910 (mainland Australia and the Lord Howe, Norfolk and Kermadec Islands), *P. compressa* (White, 1790) (eastern Australia), *P. japonica* Döderlein, 1883 (Japan), *P. klunzingeri* McCulloch, 1911 (Australia), *P. rapa* Mooi, 1998 (Rapa Iti, French Polynesia), and *P. ypsilychnus* Mooi and Jubb, 1996 (Australia).

Among these seven ctenoid-scaled *Pempheris* species, only *P. ypsilychnus* bears a pelvic axillary scale, a Y-shaped posterior light organ that is visible through the body wall, and a Y-shaped anterior light organ. Total gill-raker counts for *P. ypsilychnus* are considerably lower than for other ctenoid-scaled members of the genus, including that of *P. adspersa* (25–31, rarely more than 29 versus 29–35, rarely 29). *P. klunzingeri* differs from *P. adspersa* in having five dorsal spines (versus usually six), an anterior light organ (versus no light organ), more segmented anal-fin rays (35–41 versus 29–35), more lateral-line scales (69–80, rarely 69 versus 56–68), more scale rows below the lateral line (23–29 versus 18–24), and a scaled gular region (versus unscaled). It also has a distinctive coloration, with an orange-yellow

Table 2 Number of segmented anal-fin rays of specimens of three species of *Pempheris*. Holotype, lectotype, paratype, and paralectotype values indicated by superscripts (^{h}, ^{l}, ^{p}). Griffin's (1928) specimen of *P. adspersa* (AIM AK 272, 115.9 mm standard length (SL)) and second specimen with this catalogue number (158.0 mm SL), misidentified as *P. compressa*, indicated by superscripts ^{G} and ^{g}.

No. of anal-fin rays	29	30	31	32	33	34	35	36	37	38	39	40
Pempheris adspersa	7	20^{p}	49^{h,G}	37^{g}	25	6	1					
Pempheris analis												
Kermadec Islands			1	4^{l,p}	1			1				
Australia + Lord Howe		2	6	17	12	16	9	8	4	1		
Norfolk Island			1		1							
Pempheris compressa							7	15	17	5	4	2

Table 3 Number of scale rows below lateral line in specimens of three species of *Pempheris*. Holotype, lectotype, paratype, and paralectotype values indicated by superscripts (^{h}, ^{l}, ^{p}). Griffin's (1928) specimen of *P. adspersa* (AIM AK 272, 115.9 mm standard length (SL)) and second specimen with this catalogue number (158.0 mm SL), misidentified as *P. compressa*, indicated by superscripts ^{G} and ^{g}.

No. of scales below lateral line	18	19	20	21	22	23	24	25	26	27	28
Pempheris adspersa	4	18^{G}	41^{h}	38^{g}	33	5^{p}	1				
Pempheris analis											
Kermadec Islands					3^{l}	1	2^{p}				
Australia + Lord Howe					6	15	23	17	10	2	
Norfolk Island						1	1				
Pempheris compressa					1	3	6	10	12	11	1

bar above the pectoral-fin axis and a dark anal-fin margin. In comparison with *P. adspersa*, *P. japonica* and *P. rapa* have more lateral-line scales (70–77 and 72–84 versus 56–68) and more scale rows below the lateral line (23–29 and 22–27 versus 18–24). In addition, *P. japonica* usually has more segmented anal-fin rays (34–38 versus 29–35) and *P. rapa* has more gill rakers on the first arch in adults (37–42 versus 30–36).

Pempheris compressa differs substantially from *P. adspersa* in having a scaled gular region (versus unscaled), more segmented anal-fin rays (35–40 versus 29–35) (Table 2), and more scale rows below the lateral line (22–28 versus 18–24) (Table 3). *Pempheris compressa* has a deeper head and deeper body than *P. adspersa*, but a shorter pelvic-fin origin to anal-fin origin distance and a shorter preanal length (Table 4). The higher anal-fin ray count in *P. compressa* is reflected in an anal-fin base that is longer than in *P. adspersa* (Table 4). The ratio of pelvic-fin origin to anal-fin origin length with anal-fin base length is relatively lower in *P. compressa* (0.20– 0.34 versus 0.38–0.59) (Table 4). A PCA that included meristic data separated the two species without overlap (Fig. 3). Eigenvectors are provided in Table 5 (proportion of the variance accounted for by the first and second principal components were 38.3 and 14.1% respectively). Results of a PCA using only morphometric features were essentially identical.

Characters distinguishing *Pempheris adspersa* and *P. analis* are less conspicuous than those noted for the comparisons above. *Pempheris adspersa* always has at least some cycloid scales in the interorbital region and some cycloid predorsal scales (usually 3 or more), whereas *P. analis* has no cycloid

Table 4 Selected morphometrics as percentages of standard length for specimens of three species of *Pempheris*. Type values separated by a slash, with holotype and lectotype values (H, L) followed by paratype and paralectotype values (P, L). For non-type values, means followed by ranges in parentheses.

	Pempheris adspersa		*Pempheris analis*		*Pempheris compressa*
	H/P	non-type $n = 110$	L/P	non-type $n = 82$	non-type $n = 50$
Head length	31.3/30.4	31.3(27.6–34.9)	33.0/31.1	30.5(27.7–33.3)	31.4(27.0–35.5)
Head depth	33.2/34.6	34.7(31.4–38.4)	33.4/32.9	35.1(31.9–39.5)	38.4(36.1–41.4)
Snout length	4.4/4.4	4.3(2.4–5.8)	4.4/4.6	3.8(2.1–7.3)	4.1(2.5–6.0)
Eye diameter	13.7/13.7	14.0(11.3–16.8)	13.5/14.1	13.9(12.1–18.6)	13.8(11.2–15.7)
Upper jaw length	14.1/15.3	15.7(12.9–19.4)	16.4/14.5	16.8(13.2–20.3)	16.1(13.0–19.9)
Predorsal length	38.0/40.9	42.9(39.6–47.0)	40.7/41.8	42.3(38.3–45.5)	42.7(38.2–46.9)
Prepelvic length	38.2/40.8	40.2(35.3–50.0)	38.7/37.5	38.6(35.9–43.8)	40.4(38.0–44.5)
Preanal length	57.8/58.0	56.4(51.2–60.3)	52.2/54.5	52.6(47.6–55.2)	51.7(46.9–55.4)
Pelvic-fin origin to anal-fin origin	22.4/21.6	19.6(16.4–23.9)	16.1/18.2	16.7(13.3–20.0)	14.1(10.0–18.1)
Body depth	43.1/43.4	42.7(38.8–46.9)	41.3/41.7	43.5(38.7–47.2)	48.1(44.5–52.5)
Pectoral-fin length	26.6/28.2	27.2(23.8–31.2)	25.5/26.4	27.5(21.2–33.8)	28.4(21.8–34.1)
Pelvic-fin length	16.6/18.7	16.8(12.1–20.6)	16.1/16.4	16.9(11.2–22.1)	17.3(13.2–19.4)
Dorsal-fin base	20.7/20.6	20.5(18.1–24.7)	20.9/21.5	20.1(18.0–22.3)	20.1(17.8–22.1)
Longest dorsal ray	18.9/21.3	23.6(18.9–28.0)	22.9/23.1	23.9(19.4–27.5)	24.9(18.2–29.0)
Anal-fin base	41.8/39.7	42.3(37.8–45.8)	42.7/42.9	45.7(42.7–49.0)	51.6(47.1–56.2)
Longest anal ray	13.5/13.2	12.8(10.8–17.8)	16.6/13.3	13.7(10.2–16.7)	10.6(9.7–13.7)
Peduncle length	11.0/11.6	12.6(10.7–15.2)	12.6/12.2	12.6(10.5–15.6)	11.6(10.1–13.6)
Peduncle depth	10.1/11.2	10.8(9.0–12.2)	11.1/10.4	10.2(9.2–11.5)	11.5(10.0–12.9)
Dorsal-fin origin to anal-fin insertion	56.0/52.8	55.5(49.1–64.4)	56.6/56.3	56.9(51.4–60.1)	59.3(56.6–61.8)
Dorsal-fin insertion to pelvic-fin origin	48.4/47.0	45.1(41.3–49.8)	44.0/44.9	45.0(41.6–50.2)	49.5(46.3–54.3)
Dorsal-fin insertion to anal-fin insertion	35.8/32.4	35.8(31.3–43.8)	36.8/36.4	37.4(33.2–41.6)	40.1(36.7–44.7)
Preanal:anal-fin base	1.38/1.46	1.34(1.19–1.55)	1.22/1.27	1.15(1.04–1.27)	1.00(0.88–1.18)
Pelvic origin to anal origin:anal-fin base	0.54/0.54	0.47(0.38–0.59)	0.38/0.42	0.36(0.28–0.44)	0.27(0.20–0.34)

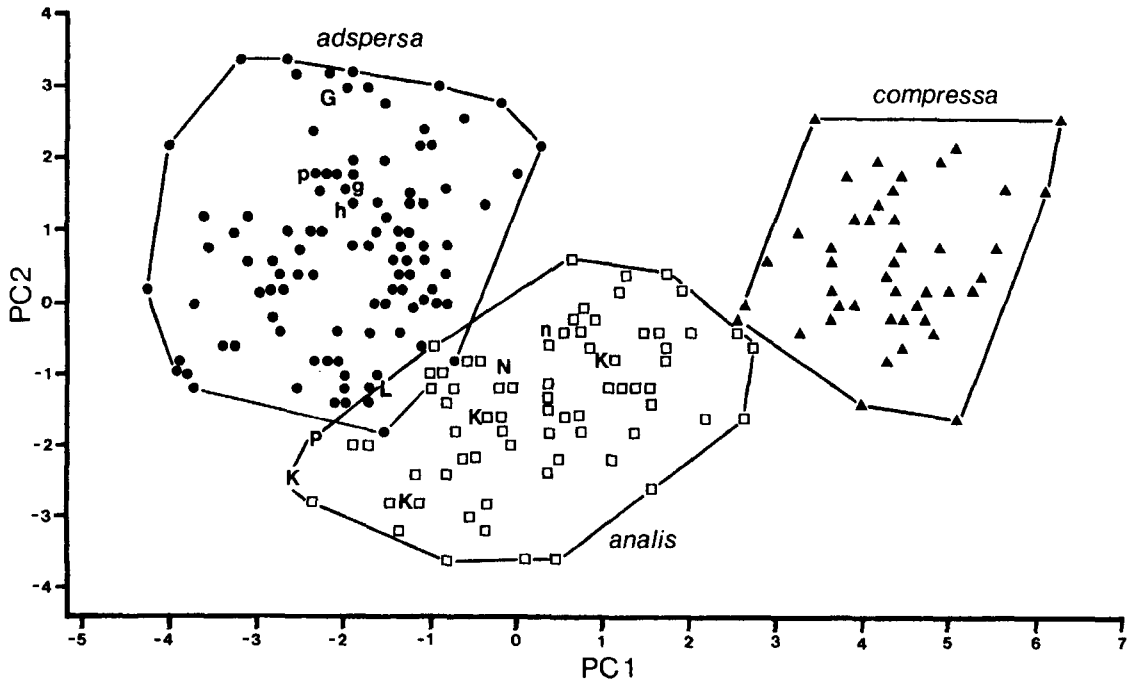

Fig. 3 Plot of first and second principal components scores (PC1 and PC2) of specimens of *Pempheris adspersa* (h, holotype; p, paratype; G, Griffin's (1928) misidentified "*compressa*"; g, larger misidentified "*compressa*" in AIM AK 272; ●, other nontype material); *P. analis* (L, lectotype; P, paralectotype; K, Kermadec Is. material; N, Norfolk Is. specimen; n, Norfolk Is. specimen with low numbers of lateral-line scales and some cycloid scales in predorsal and interorbital areas; □, Australian and Lord Howe Is. material); and *P. compressa* (▲). Proportional eigenvalues of PC1 and PC2 are 0.383 and 0.141, respectively. Eigenvectors are presented in Table 5.

Table 5 Eigenvectors for logarithmically transformed variables on first and second principal components (PC1, PC2) for a principal components analysis involving specimens of *Pempheris adspersa*, *P. analis*, and *P. compressa* (see Fig. 3).

Variable	PC1	PC2
Head depth	0.296	0.273
Eye diameter	0.013	0.056
Body depth	0.335	0.216
Prepelvic length	0.004	0.478
Preanal length	–0.278	0.369
Dorsal base	–0.042	0.186
Anal base	0.355	–0.070
Dorsal insertion to pelvic origin	0.287	0.254
Dorsal insertion to anal insertion	0.317	–0.033
Pelvic origin to anal origin	–0.314	0.146
Pelvic origin to upper caudal base	0.220	0.065
Peduncle length	–0.156	–0.196
Peduncle depth	0.080	0.078
Caudal base depth	0.184	0.243
No. of lateral-line scales	0.065	–0.453
No. of scales below lateral line	0.300	–0.251
No. of segmented anal-fin rays	0.327	–0.087

interorbital scales and very rarely cycloid predorsal scales (4 or fewer, not forming a series). The difference in number of lateral-line scales is highly significant, with *P. adspersa* having fewer than *P. analis* ($\bar{x}$ = 61.8 versus 70.0; *t*-test, $t = 22.9$, d.f. = 217, $P < 0.0001$) (Table 1). Overlap between the ranges of the counts is mostly attributable to a single specimen from Norfolk Island (AMS I.20254–015; Table 1) as discussed in Remarks of *P. analis*. Although there are similar differences between the two species in other meristic characters, overlap is greater; *P. adspersa* generally has fewer anal-fin rays (Table 2) and fewer scale rows below the lateral line (Table 3). *P. adspersa* has a relatively longer preanal length and greater pelvic-fin origin to anal-fin origin distance than *P. analis* at similar body sizes (Table 4). The anal-fin base of *P. adspersa* is usually shorter than that of *P. analis* of similar size (Table 4). Ratios of these measurements illustrate these differences and can be used to differentiate the species (Table 4; Fig. 4). A PCA that includes some meristic data separates the two species with only

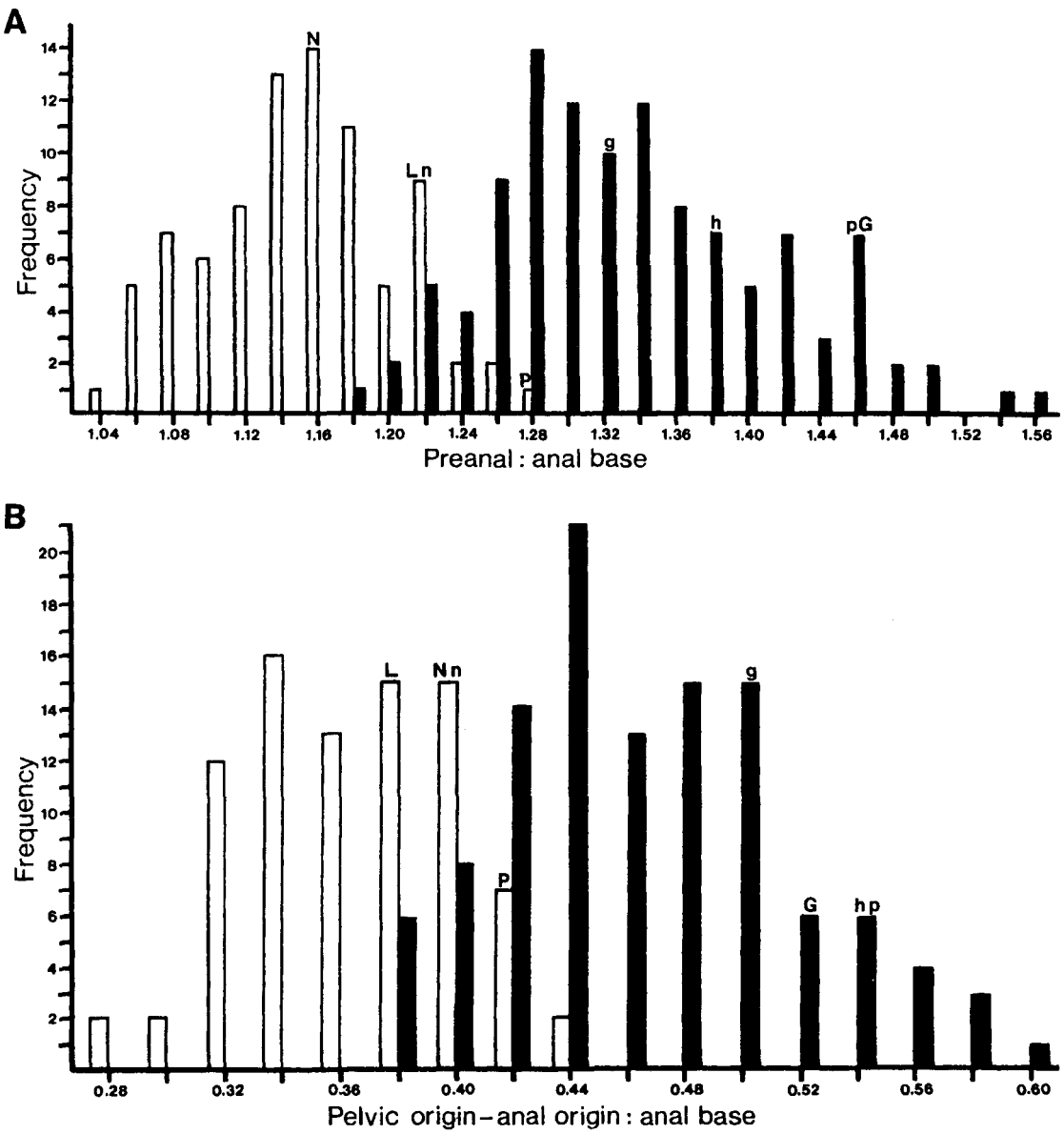

Fig. 4 Frequency distributions of morphometric ratios for *Pempheris adspersa* (black bars) and *P. analis* (open bars). Frequencies are pooled as classes centred at intervals of 0.02. Letters indicate the class where particular specimens fall: *P. adspersa*; h, holotype; p, paratype; G, Griffin's (1928) misidentified "*compressa*"; g, larger misidentified "*compressa*" in AIM AK 272; *P. analis*; L, lectotype; P, paralectotype; N, Norfolk Is. specimen; n, tentatively identified Norfolk Is. specimen. **A**, Preanal:anal base ratios. **B**, Pelvic-fin origin to anal-fin origin:anal base ratios.

slight overlap (Fig. 3). Results of a PCA using only morphometric features were essentially identical.

Distribution

This species is endemic to north-eastern New Zealand. Specimens of *P. adspersa* are known from the Three Kings Islands to Hick's Bay of East Cape (not examined: NMNZ P.28310, west of Matakaoa Pt., Hicks Bay, 37°34′S 178°20′E) (Fig. 5). This distribution corresponds to "regional group 3" of Francis (1996a), which includes Three Kings Islands and north-east North Island faunas, and reinforces

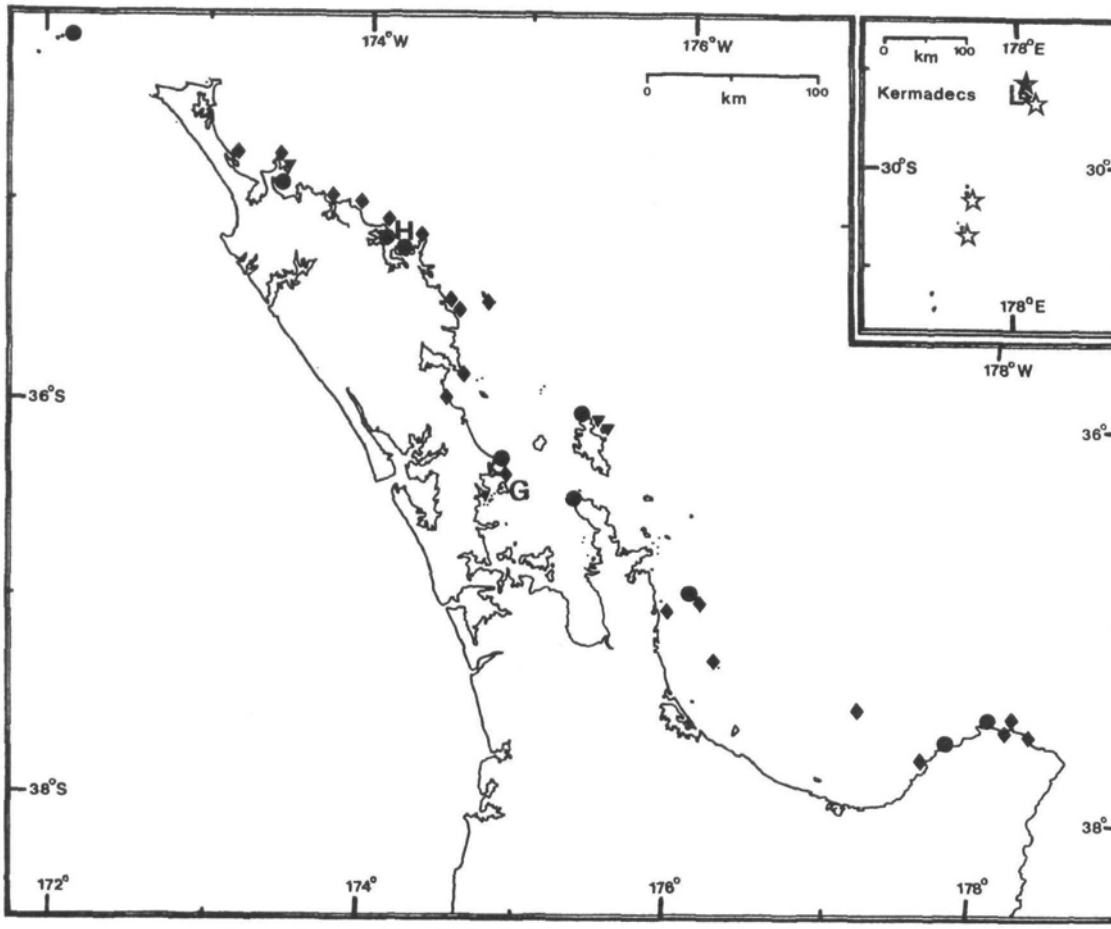

Fig. 5 Distribution of *Pempheris* in New Zealand. *P. adspersa* Griffin, 1927: H, holotype, AIM AK 74995; G, Griffin's (1928) specimen misidentified as *P. compressa*, AIM AK 272; ●, voucher specimens examined; ◆, additional voucher specimens in NMNZ; ▼, literature records not otherwise supported by vouchers. *P. analis* Waite, 1910: L, lectotype, CMC F701; ★, other vouchers; ☆, records from Francis et al. 1987 (table 1).

the observation of Paulin & Roberts (1993) that endemic species often exhibit the same general distributions as other New Zealand marine fauna. The north-eastern fauna is influenced by the warm East Auckland Current, part of which flows southward as the East Cape Current (Heath 1975; Denham et al. 1984), making the existence of the East Cape boundary difficult to explain. Francis (1996a) suggested that some north-east coast species might yet be found as far south as Hawke Bay, where higher sea surface temperatures first begin to be influenced by the cooler waters of the Southland current. The absence of records of *P. adspersa* (and other apparent northeast coast species) from the west coast of North Island might be, in part, an artifact of collecting effort. Although there are extensive areas of sandy surf beach and little sheltered reef habitat that potentially explains the absence of reef fauna, this portion of the coast is also exposed to prevailing westerlies and open ocean swell hampers collecting and observation (Francis 1996a). Pempherids could be expected to occur in suitable reef habitat on the west coast at least as far south as Hokianga or Kaipara Harbours (C. Roberts, NMNZ pers. comm.).

Biology

Pempheris adspersa is reported to occur as deep as 70 m (Thompson 1981), although the deepest recorded voucher specimen is 20 m. Adults hide in caves or under ledges and large boulders in schools during the day, emerging at night to feed on large nocturnal plankton. They return to shelter each

morning, sometimes at the same sites (Thompson 1981). During the day, juveniles up to a length of 40 mm form groups of up to 150 individuals hovering over *Ecklonia*-covered rocks or kelp forest, never far from shelter (Doak 1981). Thompson (1981: 150) reported that adult diet consists of amphipods (45%), mysids (20%), polychaetes (20%), isopods (7%), and crab larvae and ostracods (8%) which are taken out of the water column c. 4–5 m from the bottom. Juveniles (<40 mm) are diurnal feeders, mostly of small copepods. Doak (1981) reported that some groups enter rivers by night in summer and swim well upstream into mangrove forests to feed on crab larvae, shrimps, amphipods, and other zooplankton.

The species can be a very common and conspicuous component of rocky reef fauna. In the Cape Rodney area, Thompson (1981) found densities as high as 3200 individuals/ha on shallow broken rock habitat (complex rocky topography to 10 m) and about half this density on deeper reef (rocky slopes of tumbled boulders at more than 18 m), but the species was rare or non-existent on rock flats, turf flats, *Ecklonia* forest, and sponge gardens. Somewhat further north at Cape Karikari, Willan et al. (1979) reported c. 250 individuals/ha, but this estimate was averaged over all habitats surveyed.

The largest examined specimen was 158 mm SL from Kawau Island. Thompson (1981) implied that the largest individuals occur on offshore islands, although a 142 mm specimen was taken from coastal waters of the East Cape. The smallest identified gravid female was 85.6 mm SL and the largest 123 mm SL. Gravid females were found among collections made in mid November into February. The smallest specimens, 12–20 mm SL, had been collected in February. These observations agree with those of Thompson (1981) and Francis (1996b) who reported that spawning occurs from November through February and that juveniles settle in January through April.

Etymology

The specific epithet comes from the Latin *sparsus*, meaning sprinkled or strewn, in reference to the small pigment spots observed on preserved specimens. Originally spelt *adspersus*, but emended here to the feminine spelling *adspersa* to agree with the gender of *Pempheris*.

Remarks

The "larger brown dots" on the flanks of the holotype described by Griffin (1927: 139) appear to be abnormal for this species.

Griffin (1928:381) reported *P. compressa* from New Zealand based on a single specimen, "120 mm long from the symphysis of the lower jaw to caudal peduncle" collected from Kawau Island in February, 1928 stored in the "Auckland Museum". Later records of this species were likely influenced by this initial one. Although two specimens are associated with data that match this locality and date (AIM AK 272), the smaller of these (115.9 mm SL and with lower left first gill arch removed for gill raker count) is clearly Griffin's fish. Both are *P. adspersa* (Tables 1–3, Fig. 3–4). All specimens examined in the Auckland Museum and Museum of New Zealand that have been identified as *P. compressa* are similarly *P. adspersa* (Fig. 3). It is highly likely that *P. compressa* does not occur in New Zealand, but is endemic to the south-eastern coasts of Australia, as suggested by Mooi & Jubb (1996).

Pempheris analis Waite, 1910

(Fig. 3–7; Tables 1–5)

Pempheris analis Waite, 1910: 375–6, pl. 36 (original description)—Whitley in Graham 1956: 407 (list); Whitley 1968: 61 (list); Allen et al. 1976: 405 (annotated faunal list); Paulin & Stewart 1985: 43 (collection list); Hutchins & Swainston 1986: 331 (brief description, colour illustration); Francis et al. 1987: 4, tab. 1 (abundance in Kermadecs); Allen & Swainston 1988: 92 (brief description, colour illustration); Paulin et al. 1989: 192–93 (key); Randall et al. 1990: 213 (description, colour photograph); Francis, 1993: 162 (list, distribution); Hutchins 1994: 48 (list, distribution); Francis 1996a: 51, appendix (distribution, list); Mooi & Jubb 1996: 129 (key, in part, minus North Island distribution); Freeman & Tunnicliffe 1997: 8 (type information); Mooi 1998: 158 (comparison).

Material examined

Lectotype CMC F701, 145.6 mm, Kermadec Islands, Raoul Is., Denham Bay (29°16′S 177°56′W), washed up on beach, W.R.B. Oliver, between May and September, 1908.

Paralectotype CMC F1615, 155.4 mm, collected with lectotype.

Other material 82 specimens, 30.3–153.1 mm. AMS IA.1983, IA.1984, 2:123.8–124.5 mm, Hayman Is. of Whitsunday Group (21°58′S 148°53′E); AMS I.4005–7, 3:81.3–120.6 mm, Heron Is., Qld. (23°26′S 151°55′E) (1 gravid female); AMS I.15647–047, 123.5 mm, One Tree Is., Qld. (23°30′S

152°05′E), 13 m, 9/10/68 (1 gravid female, but not ripe); AMS I.17366–003, 6:114.2– 141.7 mm, Lord Howe Is. (31°32′S 159°04′E), 25 m, 9/2/73 (2 gravid females); AMS I.17368– 006, 4:134.4–149.4 mm, Middle Beach, Lord Howe Is., 3 m, 02/73 (2 gravid females); AMS I.17373–004, 35:50.7–153.1 mm, off Rabbit Is., Lord Howe Is. (31°32′S 159°04′E), 10–13 m, 19/2/73; AMS I.17445–152, 6:60.0–75.8 mm, One Tree Is., Qld. (23°30′S 152°05′E), 3–4 m, 19/9/68; AMS I.20254–015, 93.3 mm, Duncombe Bay, Norfolk Is. (29°00′S 167°56′E), 20 m, 7/9/75; AMS I.20269–009, 103.7 mm, Sydney Bay, Norfolk Is. (29°04′S 167°57′E), 19/9/75; AMS I.26983–001, 139.2 mm, Lord Howe Is. (31°33′S 159°05′E), 6/2/73; BPBM 14772, 3:110.6–141.2 mm, Lord Howe Is., 18–26 m (colour and black-and-white photo of smallest, a gravid female); BPBM 14888, 141.7 mm, Rabbit Is., Lord Howe Is., 10 m, 19/2/73 (colour photo); MPM 31025, 4:98.2–139.9 mm, Lord Howe Is., same data as AMS I.17373–004; NMNZ P.13456, 137.3 mm, Raoul Is., Kermadec Is. (29°13′S 178°10′W), 25/05/11; NMNZ P.15665, 146.7 mm, Boat Cove, Raoul Is., Kermadec Is. (29°10′S 177°50′W), 20/3/84; NMNZ P.28558, 2:30.3–31.8, Meyer Is., Kermadec Is. (29°14.9′S 177°52.2′W), 0–3 m, 3/6/92; NMNZ P.28582, 150.7 mm, Denham Bay, Kermadec Is. (29°16′S 177°50′W), 12 m, 4/6/92; WAM P.25113–009, 131.7 mm, Kendrew Is., WA (20°28′S 116°34′E), 6/11/74; WAM 26043–002, 108.5, Shark Bay, WA; WAM 26071–001, 3:53.3–68.8 mm, Beacon Is., Houtman-Abrolhos, WA (28°29′S 113°47′E), 3–10 m, 9/4/78; WAM 27950–17, 3:103.1–132.7 mm, Jurien Bay, WA (30°18′S 115°00′E, 4–6 m, 9/4/83; WAM 29887–016, 121.7 mm, Abrolhos, WA (28°53′S 114°00′E), 0.5–2.5 m, 7/3/88 (gravid female).

Diagnosis

Pempheris analis is distinguished from other Pempheridae by the following combination of characters: all scales strongly ctenoid (rarely 4 or fewer predorsal scales cycloid); no axillary scale; lateral-line scales 63–77, usually 65 or more; scales below lateral line 22–27; anal-fin rays 30–38; ratio of preanal length to anal-fin base length 1.04–1.27; ratio of pelvic-fin origin to anal-fin origin to anal-fin base length 0.28–0.44; no anterior light organ associated with pyloric caeca.

Description

Dorsal-fin rays VI,11 (VI,11; VI, 9–12, 9 in 1 of 84); anal-fin rays III,32 (III,32; III,30–38, 38 in 1 of 84); pectoral-fin rays 17 (17; 16–18); pelvic-fin rays I,5; principal caudal-fin rays 9+8; lateral-line scales 69/72 (69; 63–77, 63, 77 each in 1 of 81); scale rows above lateral line 11/12 (11; 10–13); scale rows below lateral line 22/24 (24; 22–27); cheek scale rows 9/10 (8; 7–10); predorsal scales 44 (42; 37–46); circumpeduncular scales 27/26 (25; 23–28, only once 23, 28); gill rakers 9+23P (10+24; 9–11 + 22–25, only once 22); total gill rakers 32P (34; 31–36, once 31). Morphometric data are provided in Table 4, based on 84 specimens.

All scales ctenoid (4 or fewer cycloid predorsal scales in 3 of 84 specimens, none in lectotype or paralectotype). Gular almost always unscaled, always unscaled anteriorly (lectotype and paralectotype unscaled). Snout anterior to eye and dorsal to nares unscaled. Pelvic axillary scale absent. Prepelvic area (breast) unkeeled, flat and broad. No anterior light organ associated with pyloric caeca. Caudal fin forked.

Coloration In life (from colour transparencies of several specimens photographed at Lord Howe Island by M. Francis, J. E. Randall, and Raoul Island of the Kermadecs by M. Francis): head and body of adults coppery-red with purplish highlights dorsally, especially along dorsal edge of lateral line; cheek, opercle, and flank sometimes with silvery highlights; median fins hyaline to dusky, rays dusky with darker bases; anterior edge of dorsal fin and tips of first 3–4 segmented dorsal-fin rays black; spines and first 4–5 segmented rays of anal fin with black tips; upper and lower lobes of caudal fin with black tips, lateral-line scales along median rays sometimes forming a dark median stripe; pectoral fin yellowish or reddish with dark base varying from distinct to diffuse; pelvic fin pale yellowish with a paler edge along spine and first ray. Individuals from the Kermadecs appear generally paler than those from Lord Howe, with very distinct spots on the pectoral-fin base and all fins with a yellowish cast.

Colour of type series as described by Waite (1910: 376): "Purplish-brown, not darker above than below, lower parts of head lighter, a golden spot behind the eye; dorsal, caudal, and paired fins yellow; anal grey; spines and tip of dorsal and axis and base of pectoral black; first few rays of anal also black."

In 55% isopropanol: lectotype (Fig. 6) with head and body uniformly brownish; dorsal fin dusky with dark tips to first 4 segmented rays; anal fin hyaline except for black tips on first 5 segmented rays; caudal dusky with slightly darker tips to upper and lower lobes; pectoral fin hyaline with slightly darker basal spot; pelvic fin dusky. Paralectotype uniformly

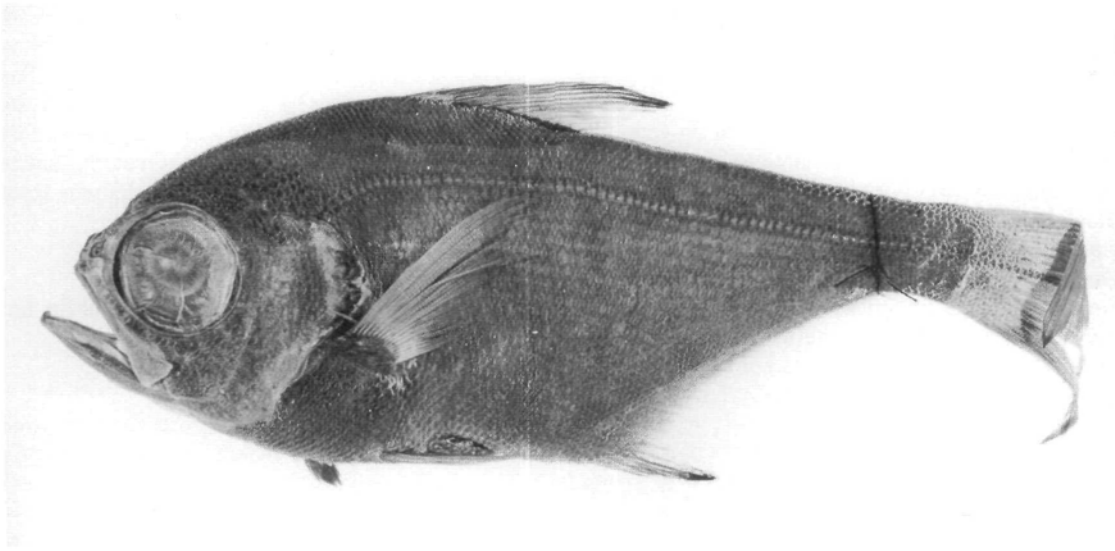

Fig. 6 Lectotype of *Pempheris analis*, CMC F701, 145.6 mm, Kermadec Islands, Raoul Is., Denham Bay (29°16′S 177°56′W), washed up on beach, W. R. B. Oliver, between May and September 1908.

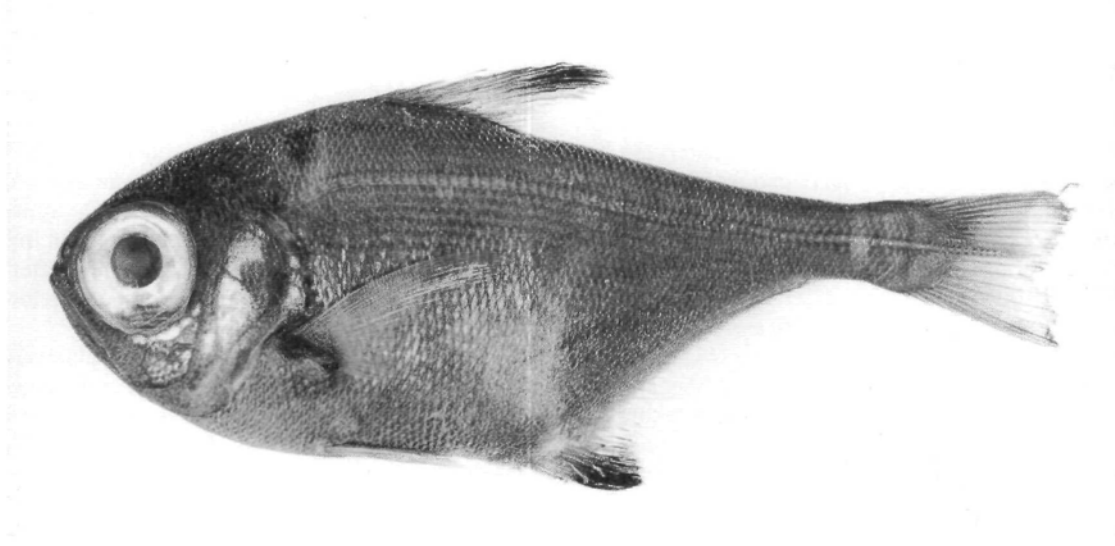

Fig. 7 More recent specimen of *Pempheris analis*, AMS I.17368–006, 138 mm, Middle Beach, Lord Howe Is., 3 m, February 1973.

brownish; dorsal fin pale with dark anterior edge and dark tips to first three segmented rays; anal fin hyaline with dark tips to first six segmented rays; caudal hyaline with slightly dusky posterior edge; paired fins hyaline.

In 70% ethanol: other specimens (Fig. 7) with dorsal part of head and nape dark brown; operculum dark brown dorsally, often becoming gradually paler as chromatophores become more widely separated, appearing as individual dots, background colour sometimes silvery; branchiostegals pale but edged with brown chromatophores; gular area straw yellow to dark brown; premaxilla, maxilla and dentary dark brown; eye usually dark, occasionally silvery ventrally; body generally uniform brown or reddish-brown, sometimes with copper or silver iridescence,

scale pockets edged with darker pigment, slightly paler ventrally, occasionally fading to straw yellow; lateral line pale and edged in brown; ventral area anterior to pelvic fins paler, sometimes silvery, speckled with chromatophores; dorsal fin generally pale, with black tips to first three to six segmented rays; anal fin usually pale, sometimes dusky, with black tips on the first four to eight segmented rays; caudal fin dusky with black tips to the dorsal-most and ventral-most three or four branched rays, occasionally all rays tipped in black and/or outermost rays black along entire length; pectoral fin pale, usually with a conspicuously darker base; pelvic fin usually pale, sometimes with dusky edges.

Comparisons

As noted in Comparisons for *Pempheris adspersa*, *P. analis* belongs to the phenetic group of *Pempheris* whose members lack prepelvic keels, but have ctenoid scales. Differences between members of this group and *P. analis* are essentially the same as those described above for *P. adspersa* with the following noted differences: the number of scales in the lateral line and below the lateral line in *P. klunzingeri* overlap with *P. analis*; the number of lateral-line scales in *P. japonica* and *P. rapa* overlap more broadly with *P. analis* (70–77 and 72–84 versus 63–77, usually fewer than 74); and, *P. compressa* has fewer lateral-line scales than *P. analis* (59–68, rarely more than 65 versus 63–77, rarely fewer than 65) (see also Tables 1–4).

Distribution

Within New Zealand waters, *Pempheris analis* is found only on the Kermadec Islands (Fig. 5, inset). Francis et al. (1987) reported that the species increased in abundance from south to north through the Kermadec Islands, with none seen at L'Esperance and Havre Rocks, but schools seen at least occasionally at Cheeseman, Curtis, Macauley, Haszard, Raoul, and Meyer Islands. Outside New Zealand, the species is recorded from Norfolk and Lord Howe Islands, and has a disjunct distribution on the eastern and western coasts of Australia.

Biology

Little has been reported on the biology of *Pempheris analis*. It is a schooling species that has been collected to depths of 25 m. The largest specimen examined was 155.4 mm SL (paratype from the Kermadecs). The smallest identified gravid female was 86.1 mm SL and the largest 149.4 mm SL. Gravid females were found among collections made in October through March, although specimens from the early dates carried immature eggs; no New Zealand specimens were found to be gravid. The smallest specimens, 30.3–31.8 mm SL from the Kermadecs, were collected in June, suggesting that juveniles settle early in the year. Over the entire range of the species, collections are known from September to June.

Etymology

The specific name "analis" refers to the anal fin, but the exact reference is unknown.

Remarks

Waite (1910: 376) described *P. analis* from nine specimens, but the fate of only two are presently known. Both are housed in the Canterbury Museum collection and have been mislabelled holotype and paratype through a clerical error (Freeman & Tunnicliffe 1997; Mark Walker pers. comm.). These specimens are designated as lectotype (CMC F701, 145.6 mm SL) and paralectotype (CMC F1615, 155.4 mm SL). Both are in poor condition, having been collected as beach wash and having deteriorated before preservation.

The original description (Waite 1910) and recent colour photographs of *P. analis* from the Kermadecs indicate that this population has yellow fins in life. This contrasts with colour photographs of Lord Howe Island specimens whose fins are hyaline, dusky or with a coppery sheen. Whether or not this colour difference is indicative of taxonomic differentiation of non-Kermadec populations requires further investigation.

Only a single specimen could not be conclusively identified using the characters provided in the diagnoses for *P. adspersa* and *P. analis*. This Norfolk Island specimen (AMS I.20254-015) is provisionally identified as *P. analis* despite having an unexpectedly low number of lateral-line scales for this species and numerous cycloid scales in both the interorbital and predorsal areas. A second Norfolk Island specimen examined is clearly *P. analis* (Tables 1–4; Fig. 3–4) and actually falls closer to the edge of the *analis* cluster in the PCA (Fig. 3) than does the specimen in question. Until further Norfolk Island material becomes available, the specimen will be considered aberrant, and *P. adspersa* will continue to be regarded as an endemic New Zealand species.

Descriptions of the anatomy of *P. analis* and discussions of its taxonomy and relationships in Tominaga (1963, 1968) are not of this species, but

refer to the recently described *P. ypsilychnus* (Mooi & Jubb 1996).

ACKNOWLEDGMENTS

This paper was written at the invitation of C. D. Roberts (NMNZ), and I thank him for the opportunity to participate in his New Zealand EEZ fishes project. Loans of specimens were kindly arranged by R. Prasad and J. Riley (AIM), N. Feinberg (AMNH), W. Saul (ANSP), M. McGrouther (AMS), P. Campbell and A. Gill (BMNH), J. Randall and A. Suzumoto (BPBM), G. Tunnicliffe (CMC), P. Last and A. Graham (CSIRO), M. Rogers (FMNH), G. Duhamel (MNHN), C. Roberts and A. Stewart (NMNZ), K. Matsuura (NSMT), M. Gomon and L. Jonker (NMV), E. Mikschi (NMW), M. Rouse and R. Winterbottom (ROM), S. Jewett, L. Palmer, and J. Williams (USNM), G. Allen, B. Hutchins, S. Morrison, and K. Smith (WAM), H. Wilkens (ZMH). Colour photographs were kindly provided by M. Francis and J. E. Randall. Special thanks to T. Ehlinger (University of Wisconsin-Milwaukee) for use of computer image-analysis equipment and associated software, M. Rogers and K. Swagel (FMNH) for use of the X-ray unit and dark room under their care, J. Riley (AIM) for provision of a radiograph of the type of *P. adspersa*, and to J. Peterson (MPM) for photographic development and printing. M. Francis (NIWA), M. Walker (CMC), R. McPhee (NMNZ), and A. C. Gill (BMNH) all tracked down references that were difficult to obtain. This project was completed with the laboratory assistance of B. Torreano. Drafts of the manuscript were improved by A. C. Gill , C. D. Roberts, and C. Paulin. The final version benefitted greatly from reviews by M. Gomon and M. Francis. This publication is based upon work supported by the National Science Foundation under Grant No. DEB-9317695.

REFERENCES

Allen, G. R.; Hoese, D. F.; Paxton, J. R.; Randall, J. E.; Russell, B. C.; Starck II, W. A.; Talbot, F. H.; Whitley, G. P. 1976: Annotated checklist of the fishes of Lord Howe Island. *Records of the Australian Museum 30*: 365–454.

Allen, G. R.; Swainston, R. 1988: The marine fishes of northwestern Australia. Perth, Western Australian Museum. 201 p.

Ayling, T.; Cox G. J. 1982: Collins guide to the sea fishes of New Zealand. Auckland, Collins. 343 p.

Cuvier, G. 1829: Le règne animal, distribué d'après son organisation, pour servir de base à l'histoire naturelle des animaux et d'introduction à l'anatomie comparée. Tome II. Les reptiles, les poissons, les mollusques et les annélides. Paris, Deterville. 532 p.

Denham, R. N.; Bannister, R. W.; Guthrie, K. M.; Crook, F. G. 1984: Surveys of the East Auckland and East Cape currents, New Zealand. *Australian Journal of Marine and Freshwater Research 35*: 491–504.

Doak, W. 1981: Fishes of the New Zealand region. Revised edition. Auckland, Hodder and Stoughton.

Döderlein, L. 1883: Beitrage zur Kenntniss der Fische Japan's (II.). *Anzeiger der Akademie der Wissenschaften in Wien 20(15)*: 123–125.

Francis, M. P. 1993: Checklist of the coastal fishes of Lord Howe, Norfolk, and Kermadec Islands, southwest Pacific Ocean. *Pacific Science 47(2)*: 136–170.

Francis, M. P. 1996a: Geographic distribution of marine reef fishes in the New Zealand region. *New Zealand Journal of Marine and Freshwater Research 30*: 35–55.

Francis, M. P. 1996b: Coastal fishes of New Zealand, a diver's identification guide. Revised edition. Auckland, Reed Books. 63 p.

Francis, M. P.; Grace, R. V.; Paulin, C. D. 1987: Coastal fishes of the Kermadec Islands. *New Zealand Journal of Marine and Freshwater Research 21*: 1–13.

Freeman, A. N. D.; Tunnicliffe G. A. 1997: Recent vertebrate types in the Canterbury Museum, Christchurch, New Zealand. *Records of the Canterbury Museum 11*: 1–16.

Gill, A. C.; Reader, S. 1992: Fishes. *In*: The Australian Museum. Reef biology: a survey of Elizabeth and Middleton Reefs, South Pacific. *Kowari 3*: I-xviii, 1–230.

Grace, R. V. 1975: White Island notes. *Tane 21*: 91–100.

Graham, D. H. 1956: A treasury of New Zealand fishes. 2nd edition. Auckland, Reed. 424 p.

Griffin, L. T. 1927: Additions to the fish fauna of New Zealand. *Transactions and Proceedings of the New Zealand Institute 58*: 136–150.

Griffin, L. T.1928: Studies in New Zealand fishes. *Transactions and Proceedings of the New Zealand Institute 59*: 274–388.

Hardy, G. S.; Grace, R. V.; Francis, M. P. 1987: Fishes observed at the Three Kings Islands, northern New Zealand. *Records of the Auckland Institute and Museum 24*: 243–250.

Heath, R. A. 1975: Oceanic circulation off the east coast of New Zealand. *New Zealand Oceanographic Institute memoir 55*. 80 p.

Hubbs, C. L.; Lagler, K. F. 1949: Fishes of the Great Lakes region. Bloomfield Hills, Cranbrook Press. 186 p.

Hutchins, B. 1994: A survey of the nearshore reef fish fauna of Western Australia's west and south coasts—the Leeuwin Province. *Records of the Western Australian Museum, Supplement No. 46*: 1–66.

Hutchins, B.; Swainston R. 1986: Sea fishes of Southern Australia. Daglish WA, Swainston Publishing. 180 p.

Leviton, A. E.; Gibbs, Jr., R. H.; Heal, E.; Dawson, C. E. 1985: Standards in herpetology and ichthyology: Part I. Standard symbolic codes for institutional resource collections in herpetology and ichthyology. *Copeia 1985(3)*: 802–832.

McCulloch, A. R. 1911: Zoological results of the fishing experiments carried out by the F.I.S. "Endeavour," 1909–10. Part I. Report on the fishes obtained by the F.I.S. "Endeavour," on the coasts of New South Wales, Victoria, South Australia, and Tasmania. Edward Lee & Co., Sydney. Pp. 1–87, pls. 1–16.

Mooi, R. D. 1998: A new species of the genus *Pempheris* (Teleostei: Pempheridídae) from Rapa Iti, French Polynesia. *Pacific Science 52(2)*: 154–160.

Mooi, R. D.; Jubb, R. N. 1996: Descriptions of two new species of the genus *Pempheris* (Pisces: Pempheridídae) from Australia, with a provisional key to Australian species. *Records of the Australian Museum 48*: 117–130.

Paul, L.; Heath, E. 1997: Marine fishes of New Zealand 1. Shoreline and shallow seas. Auckland, Reed Books. 93 p.

Paulin, C. D.; Roberts, C. D. 1992: The rockpool fishes of New Zealand. Wellington, Museum of New Zealand Te papa Tongarewa. 177 p.

Paulin, C. D.; Roberts, C. D. 1993: Biogeography of New Zealand rockpool fishes. *In*: Battershill, C. N. et al. *ed.* Proceedings of the Second International Temperate Reef Symposium, 7–10 January 1992, Auckland, NZ. Wellington, NIWA Marine. Pp. 191–199.

Paulin, C.; Stewart, A. 1985: A list of New Zealand teleost fishes held in the National Museum of New Zealand. *National Museum of New Zealand Miscellaneous Series No. 12*. 63 p.

Paulin, C.; Stewart, A.; Roberts, C.; McMillan, P. 1989: New Zealand fish, a complete guide. *National Museum of New Zealand Miscellaneous Series No. 19*: 1–279.

Randall, J. E.; Allen, G. R.; Steene, R. C. 1990: Fishes of the Great Barrier Reef and Coral Sea. Honolulu, University of Hawaii Press. 507 p.

Roberts, L. I. N.; Ward, C.; Francis M. P. 1986: Fishes of northeastern Great Barrier Island, New Zealand. *Journal of the Royal Society of New Zealand 16(4)*: 357–362.

Russell, B. C. 1971: A preliminary annotated checklist of fishes of the Poor Knights Islands. *Tane 17*: 81–90.

Snyder, J. O. 1911: Descriptions of new genera and species of fishes from Japan and the Riu Kiu Islands. *Proceedings of the U.S. National Museum 40 (No. 1836)*: 525–549.

Steindachner, F. 1870: Ichthyologische notizen (X.). *Sitzungberichte der Kaiserlichen Akademie der Wissenschaften in Wien, Mathematisch-Naturwissenschaftliche 61(1)*: 623–642.

Taylor, R. B.; Willis, T. J. 1998. Relationships amongst length, weight and growth of north-eastern New Zealand reef fishes. *Marine and Freshwater Research 49*: 255–260.

Thompson, S. 1981: The fish of the Cape Rodney to Okakari Point Marine Reserve: a guide to the identification and biology of common coastal fish of north-eastern New Zealand. University of Auckland, Leigh. 364 p.

Tominaga, Y. 1963: A revision of the fishes of the family Pempheridae of Japan. *Journal of the Faculty of Science, Section 4 10(1)*: 269–297.

Tominaga, Y. 1965: The internal morphology and systematic position of *Leptobrama müller*i, formerly included in the family Pempheridae. *Japanese Journal of Ichthyology 12(3/6)*: 33–56.

Tominaga, Y. 1968: Internal morphology, mutual relationships and systematic position of the fishes belonging to the family Pempheridae. *Japanese Journal of Ichthyology 15(2)*: 43–95.

Waite, E. R. 1910: A list of the known fishes of Kermadec and Norfolk Islands, and a comparison with those of Lord Howe Island. *Transactions of the New Zealand Institute 42*: 370–383.

White, J. 1790. Journal of a voyage to New South Wales with sixty-five plates of non descript animals, birds, lizards, serpents, curious cones of trees and other natural productions. I. London, Debrett. 267 p.

Whitley, G. P. 1968: A check-list of the fishes recorded from the New Zealand region. *The Australian Zoologist 15(1)*: 1–102.

Willan, R. C.; Dollimore, J. M.; Nicholson, J. 1979: A survey of fish populations at Karikari Peninsula, Northland, by scuba diving. *New Zealand Journal of Marine and Freshwater Research 13(3)*: 447–458.