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Apterygon okarito, a new species of chewing louse (Insecta: Phthiraptera: Menoponidae) from the Okarito brown kiwi (Aves: Apterygiformes: Apterygidae)

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Abstract The new species *Apterygon okarito* is described and illustrated from four samples of lice collected from the Okarito brown kiwi (*Apteryx rowi* Tennyson et al., 2003) in Okarito, South Island, New Zealand. The morphological relationships of the new species are discussed, especially in connection with the taxonomic position of its host.

Keywords Phthiraptera; Menoponidae; *Apterygon*; lice; new species; Apterygidae; kiwi; Okarito; New Zealand

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INTRODUCTION

Apterygon Clay, 1961 is the only louse genus endemic to New Zealand. Currently, it comprises three species (Tandan 1972) parasitic on several species of kiwi belonging to the genus *Apteryx* Shaw & Nodder, 1813, itself a genus endemic to New Zealand.

Two *Apterygon* species have been recorded from three different brown kiwi hosts: *Apterygon mirum* Clay, 1961 from the North Island brown kiwi (*Apteryx mantelli* Bartlett, 1852) and *Apterygon dumosum* Tandan, 1972 from the Stewart Island brown kiwi (*Apteryx australis lawryi* Rothschild, 1893) and the South Island brown kiwi (*Apteryx australis australis* Shaw & Nodder, 1813) (Pilgrim & Palma 1982, p. 3). Another louse taxon was listed by Pilgrim & Palma (1982, p. 3) as "*Apterygon* sp." from the South Island brown kiwi, referring to an undescribed species from birds living in Okarito, Westland, South Island. At that time, all the brown kiwi populations in the South Island were regarded as belonging to one subspecies: *Apteryx australis australis* Shaw & Nodder, 1813 (Ornithological Society of New Zealand 1990, p. 8). However, the brown kiwi population from Okarito has subsequently been identified as a sister taxon of the North Island brown kiwi (see Baker et al. 1995; Burbidge et al. 2003), and described as a separate species: *Apteryx rowi* Tennyson et al., 2003.

The formal description, naming and publication of the new *Apterygon* species from the Okarito brown kiwi have been deferred in the hope that additional material would become available. The lack of a scientific name for the type host further delayed this publication. Considering (1) that an additional louse sample has been recently obtained, (2) that the Okarito brown kiwi has now been properly described and named, (3) that the present conservation status of this kiwi is regarded as critically endangered (BirdLife International 2000, p. 33; Hitchmough 2002), and (4) that there are

previously unsuspected affinities between the Okarito brown kiwi and the North Island brown kiwi, we now feel that publishing the description of this fourth species of *Apterygon* is well justified.

SYSTEMATICS

Order Phthiraptera

Suborder Amblycera

Family Menoponidae Mjöberg, 1910

Apterygon Clay, 1961

Apterygon okarito new species (Fig. 1–4)

Apterygon sp.; Pilgrim & Palma 1982: 3. Listed only.

Apterygon new species; Baker et al. 1995: 8256.

Apterygon new species; Burbidge et al. 2003: 172, 174.

TYPE HOST: *Apteryx rowi* Tennyson, Palma, Robertson, Worthy & Gill, 2003; the Okarito brown kiwi or rowi.

TYPE LOCALITY: Okarito, Westland, South Island, New Zealand.

HOLOTYPE: ♂ in the Museum of New Zealand Te Papa Tongarewa (MONZ).

DESCRIPTION: *Male* as in Fig. 1. Genitalia as in Fig. 3; sclerite **e** (*sensu* Clay 1966, p. 293) as in Fig. 4. *Chaetotaxy* (ranges, modal frequencies in parentheses): Metanotum with 8–11 (10) long thin marginal setae, 5–8 (5) short spiniform marginal setae and 6 short anterior setae. Mesosternum with 7–11 (10) long posterior setae and 2 minute anterior setae. Metasternum with 9–15 (11) long thin setae. Abdominal tergites I–II with 1 short antero-lateral seta on each side. Tergites I–VII with postero-marginal row formed by short, medium and long *thin marginal setae* (*t.m.s.*, including post-spiracular setae) plus *short spiniform* marginal *setae* (*s.s.s.*): tergite I with 9–14 (11) *t.m.s.* and 7–13 (10) *s.s.s.*; II with 17–24 (20) *t.m.s.* and 8–17 (12) *s.s.s.*; III with 22–28 (24) *t.m.s.* and 4–13 (8) *s.s.s.*; IV with 26–35 (28) *t.m.s.* and 2–9 (4) *s.s.s.*; V with 26–37 (30) *t.m.s.* and 3–7 (5) *s.s.s.*; VI with 26–34 (30) *t.m.s.* and 3–7 (5) *s.s.s.*; VII with 25–30 (28) *t.m.s.* and 5–9 (7) *s.s.s.* Tergite VIII with 24–35 (26, 32) *t.m.s.* Tergite IX with 40–52 (48, 50) *t.m.s.* divided into two rows, one anterior and one posterior. Abdominal sternites I–VIII with *anterior setae* (*a.s.*) and row of *posterior marginal setae* (*p.m.s.*): sternite I with 4–7 (6) *a.s.* and 5–8 (7) *p.m.s.*; II with 16–26 (21) *a.s.* and 20–23 (21, 23) *p.m.s.*; III with 17–28 (22) *a.s.* and 24–30 (29) *p.m.s.*; IV with 19–27 (25, 27) *a.s.* and 26–34 (27, 29) *p.m.s.*; V with 18–31 (18, 20) *a.s.* and 22–32 (28) *p.m.s.*; VI with 12–21 (14, 18) *a.s.* and 22–27 (25) *p.m.s.*; VII with 10–20 (15) *a.s.* and 17–22 (17) *p.m.s.*; VIII with 10–18 (13) *a.s.* and 9–12 (9) *p.m.s.* Sternite IX with 25–32 (25) short and long setae. Femora III each with 18–26 (21) ventral setae. *Measurements* as in Table 1.

Female mesothorax + metathorax and abdomen as in Fig. 2. Head and prothorax as in male. *Chaetotaxy* (ranges, modal frequencies in parentheses): Metanotum with 9–10 (10) long, thin marginal setae, 6–10 (9) short, spiniform marginal setae, and 6 short anterior setae. Mesosternum with 8–12 (9) long posterior setae and 2 minute anterior setae. Metasternum with 12–18 (14) long thin setae. Abdominal tergite I with 11–13 (12) short and medium, *thin marginal setae* (*t.m.s.*), 11–18 (14) *short spiniform* marginal *setae* (*s.s.s.*) and 2 *short anterior setae* (*s.a.s.*). Tergites II–VII with short, medium and long *t.m.s.* [numbers of *t.m.s.* include post-spiracular setae], *s.s.s.*, and *s.a.s.* [*s.a.s.* are divided into two lateral irregular rows]: tergite II with 20–24 (22) *t.m.s.*, 10–16 (14) *s.s.s.* and 10–17 (15) *s.a.s.*; III with 26–30 (28) *t.m.s.*, 5–12 (7, 10) *s.s.s.* and 16–22 (19) *s.a.s.*; IV with 31–36 (34) *t.m.s.*, 2–3 (2) *s.s.s.* and 10–15 (13) *s.a.s.*; V with 31–37 (35) *t.m.s.*, 1–4 (2) *s.s.s.* and 7–16 (8, 11) *s.a.s.*; VI with 31–36 (33) *t.m.s.*, 1–4 (2) *s.s.s.* and 8–14 (10) *s.a.s.*; VII with 24–32 (28) *t.m.s.*, 2–3 (2) *s.s.s.* and 6–12 (8) *s.a.s.* Tergite VIII with 23–29 (26) *t.m.s.* and 5–9 (7) *s.a.s.* Tergite IX with 41–54 (53) post-marginal and lateral setae, and 19–25 (21) short thin setae forming the dorsal anal fringe. Abdominal sternites I–VII with *anterior setae* (*a.s.*) and row of *posterior marginal setae* (*p.m.s.*): sternite I with 5–9 (7) *a.s.* and 5–9 (7) *p.m.s.*; II with 25–32 (29) *a.s.* and 20–25 (22) *p.m.s.*; III with 31–39 (33) *a.s.* and 27–31 (28) *p.m.s.*; IV with 41–52 (48) *a.s.* and 28–34 (29) *p.m.s.*; V with 42–50 (46) *a.s.* and 27–33 (28) *p.m.s.*; VI with 33–39 (33, 35) *a.s.* and 24–29 (28) *p.m.s.*; VII with 20–29 (27) *a.s.* and 13–18 (16) *p.m.s.* Sternite VIII with 11–16 (14) *a.s.* and 9–12 (11) submarginal setae in irregular row. Sternite IX with 21–26 (22) subgenital (vulval) marginal setae arranged in irregular rows around the mid-line of subgenital plate (vulva), 7–12 (9) lateral setae on each side, and ventral anal fringe formed by 33–38 (36) short thin setae. Femora III each with 21–25 (24) ventral setae. *Measurements* as in Table 1.

TYPE MATERIAL: Ex *Apteryx rowi*. **Holotype** ♂, Forks, Okarito, South Island, New Zealand (43°15′S, 173°13′E), 20 Aug 2002, New Zealand Department

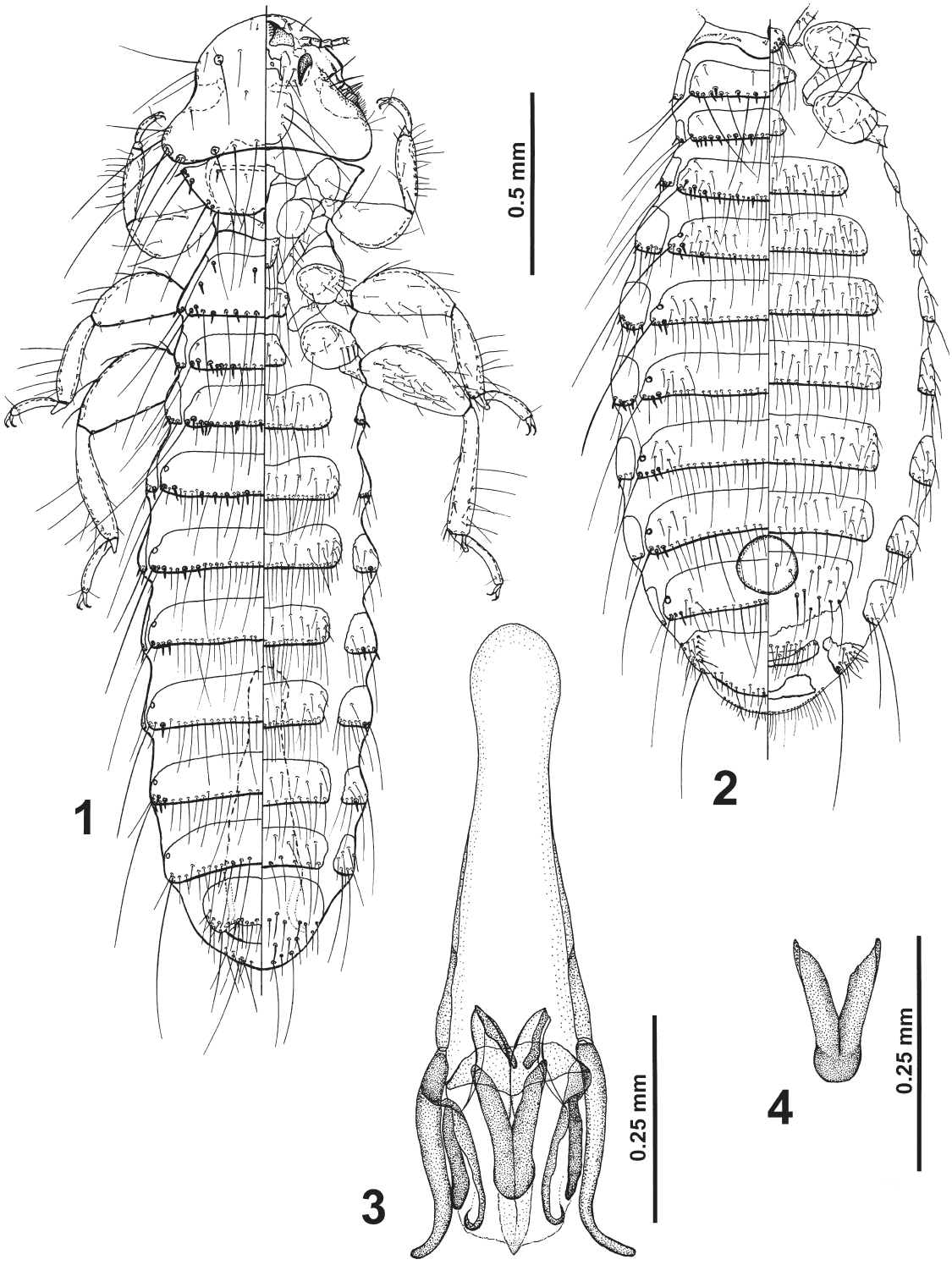

Fig. 1–4 *Apterygon okarito* n. sp. **1**, dorsal and ventral views of male; **2**, dorsal and ventral views of female meso- + metathorax + abdomen; **3**, ventral view of male genitalia (denticulations of the aedeagal sac are omitted); **4**, ventral view of male sclerite **e**.

Table 1 Measurements (in mm) of *Apterygon okarito* (means; ranges in parentheses).

	16 males	14 females
Head width (pre-antennal)	0.450 (0.44–0.46)	0.453 (0.44–0.47)
Head width (temporal)	0.639 (0.62–0.66)	0.651 (0.63–0.67)
Head length (mid-line)	0.374 (0.36–0.38)	0.381 (0.37–0.40)
Prothorax width	0.504 (0.48–0.52)	0.531 (0.51–0.55)
Prosternum length	0.113 (0.10–0.13)	0.118 (0.11–0.13)
Metathorax width	0.524 (0.50–0.54)	0.578 (0.56–0.60)
Abdominal segment IV width	0.673 (0.64–0.70)	0.917 (0.87–0.96)
Total length	2.644 (2.49–2.81)	2.613 (2.54–2.69)
Genitalia width[1]	0.194 (0.18–0.21)	–
Genitalia length	0.758 (0.73–0.80)	–
Sclerite **e** length	0.155 (0.15–0.17)	–

[1]Taken at the base of the parameres.

of Conservation [host kept in Canterbury Museum collection, catalogue no. Av38269]. **Paratypes**: 6 ♂, 10 ♀, same data as holotype; 3 ♂, 1 ♀, Tidal Creek, Okarito, Westland, South Island, New Zealand, 10 Oct 1979, Colin Roderick; 3 ♂, Deep Creek, Okarito, Westland, South Island, New Zealand, 12 Oct 1979, Colin Roderick; 3 ♂, 3 ♀, Okarito, Westland, South Island, New Zealand, Oct 1979, Colin Roderick. The holotype and 29 paratypes are deposited in the MONZ collection.

ETYMOLOGY: The specific name *okarito* is a noun in apposition derived from the type locality of the new species.

DISCUSSION

Apterygon okarito males can be separated from males of all the other species by the shape and size of the genital sclerite **e** (compare Fig. 4 with Clay 1966, p. 293, fig. 2 and Tandan 1972, p. 59, fig. 14, 19), by the shape of the parameres, and by differences in the chaetotaxy of the metanotum and the abdomen. The genital sclerite **e** is probably the endomeral plate *sensu* Clay (1970, p. 177). Males of *A. okarito* have greater numbers of metanotal marginal setae of both types: long thin and short spiniform (peg-like in Tandan 1972), as well as greater numbers of all abdominal tergal setae (*t.m.s.* and *s.s.s.*) and sternal setae (*a.s.* and *p.m.s.*). Males of *A. okarito* are larger than males of *A. hintoni* and *A. dumosum* in all measurements (compare Table 1 with data in Tandan 1972, pp. 58, 63), but of approximately equal size to *A. mirum*.

Apterygon okarito females can be readily separated from females of *A. hintoni* Clay, 1966 and *A. dumosum* Tandan, 1972 by the chaetotaxy of abdominal segment IX, especially by the number and arrangement of the subgenital (vulval) marginal setae, as well as by the number and length of the lateral setae on sternite IX (compare Fig. 2 with Tandan 1972, p. 57, fig. 9, 11). Further, *A. okarito* females have a greater number of metanotal marginal setae of both types: long thin and short spiniform setae.

Apterygon okarito females are morphologically closest to those of *A. mirum*. In the key to the species of *Apterygon* published by Tandan (1972, p. 69) females of *A. okarito* would key out to *A. mirum*, if only the number and arrangement of the subgenital (vulval) marginal setae are considered. However, *A. okarito* females differ from *A. mirum* females by having a greater number of short, spiniform marginal setae on the metanotum: 6–10 (mode 9) in *A. okarito*, 2–6 (4) in *A. mirum* (50 specimens). Furthermore, *A. okarito* females have consistently greater numbers, about twice as many, of all abdominal tergal setae (*t.m.s.*, *s.s.s.*, and *s.a.s.*) than those of *A. mirum*, especially the short anterior setae (*s.a.s.*) on tergites II–VIII. *Apterygon okarito* females also have a greater number of sternal posterior marginal setae (*p.m.s.*) than those of *A. mirum* (see Tandan 1972, p. 62, table 1). Females of *A. okarito* are about 10% larger than those of *A. mirum* in all measurements, especially in features which are not greatly affected by the slide-mounting process, such as the widths of head, prothorax, and metathorax (compare Table 1 with data in Tandan 1972, p. 66). The posterior pointed process of the prosternal plate in both sexes is about 40% longer in *A. okarito* than in *A. mirum*.

Although there is no combination of characters which would place males of *A. okarito* morphologically closer to any *Apterygon* species

than the remainder, females of *A. okarito* have greater similarities to *A. mirum* than to any of the other two species (see above). These similarities were both unexpected and puzzling in 1979, when the first samples of *A. okarito* became available for study. We realised then that, not only does the Okarito brown kiwi population support a different *Apterygon* species from that living on the brown kiwi population in Fiordland, but also that it is an undescribed species unique to the Okarito brown kiwi, showing affinities with *A. mirum*, the *Apterygon* species parasitising the North Island brown kiwi. At that time, the Okarito brown kiwi population was taxonomically placed together with other South Island brown kiwi populations in a single subspecies, namely *Apteryx australis australis*. Although Brian Reid and the late Colin Roderick (both of the former New Zealand Wildlife Service, succeeded by the Department of Conservation) correctly claimed that the Okarito brown kiwi—known to them from the 1950s—was morphologically different from the brown kiwi living in Fiordland (see O'Donnell & Dilks 1986, p. 26), it took several years for other evidence to emerge which confirmed the unique status of the Okarito population (Peat 1990, pp. 91, 100). However, the phylogenetic relationships of the Okarito brown kiwi were not clarified until molecular studies of all brown kiwi were undertaken by Baker et al. (1995). Recently, the Okarito brown kiwi was formally described and named by Tennyson et al. (2003). The similarity between *Apterygon okarito* and *A. mirum*, if regarded as an indication of phylogenetic relationship, is further evidence that the Okarito brown kiwi and the North Island brown kiwi are closely related, as shown by Baker et al. (1995) and Burbidge et al. (2003).

Kiwi are parasitised by several species of another louse genus (*Rallicola* Johnston & Harrison, 1911), placed in the subgenus *Aptericola* Harrison, 1915 which—like *Apterygon*—is endemic to New Zealand (see Pilgrim & Palma 1982, p. 3; Palma 1991). The correct status of the species of *Aptericola* from three separate populations of brown kiwi living in the South Island (*Apteryx rowi* in Okarito, *A. australis australis* in Haast and Fiordland), as well as that from brown kiwi on Stewart Island (*A. australis lawryi*), has not yet been properly decided. At present we recognise only one morphological species, namely *Rallicola* (*Aptericola*) *gadowi* Harrison, 1915 *sensu lato*, but the many samples available in the MONZ collection show it to be extremely variable in several significant features, among and within host populations, and even within samples from individual birds. There is also a population of *Rallicola* (*A.*) *gadowi* parasitising the little spotted kiwi (*Apteryx owenii* Gould, 1847) living on Kapiti Island, off the North Island. The population of *R.* (*A.*) *gadowi* parasitising the Okarito brown kiwi is morphologically closest to, but not identical with, those living on brown kiwi from Haast and little spotted kiwi from Kapiti Island. These unexpected similarities need to be further investigated, preferably by molecular studies of all the louse populations of *R.* (*A.*) *gadowi*, before any decision is made about the identity of the *Rallicola* (*Aptericola*) lice from the Okarito brown kiwi.

The recognition of the Okarito brown kiwi as a unique taxonomic entity and its present conservation status as endangered mean that its host specific lice, in particular *Apterygon okarito*, should also be regarded as endangered species. The plight of host specific parasites living on endangered host species has been discussed by several authors (Rózsa 1992; Stork & Lyal 1993; Windsor 1995; Pérez & Palma 2001). In particular, Pérez & Palma (2001, p. 936) recommend avoiding treatment with insecticides when hosts are kept in captivity to ensure the survival of their ectoparasites.

In Baker et al. (1995, p. 8256, table 2) there are three errors which need to be corrected: (1) the species given as "*A. rodericki* on Little Barrier Island" under the North Island brown kiwi in the second column, should be "*R. rodericki* on Little Barrier Island" referring to *Rallicola* (*Aptericola*) *rodericki* Palma, 1991 (see also page 8257 where this species is correctly associated with the genus *Rallicola*); (2) the word "Absent?" under the North Island brown kiwi in the second column, needs to be deleted; (3) the asterisks and the dagger assigned to the three species of lice listed under "Spotted kiwis" in the last column, referring to two footnotes need to be exchanged, i.e., "*A. hintoni*" and "*R. gracilentus*" are the lice from the great spotted kiwi (*Apteryx haastii* Potts, 1872), while "*R. pilgrimi*" is a louse from the little spotted kiwi. Unfortunately, Burbidge et al. (2003, p. 174, table 4) have taken their kiwi louse distribution data from Baker et al. (1995, p. 8256, table 2), including the errors described above.

The localities given in Appendix 1 for all the species of *Apterygon* include records taken from Clay (1961, 1966) and Tandan (1972), as well as hitherto unreported samples held in the MONZ collection.

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Appendix 1 Host and geographical distribution of *Apterygon* species.

***Apteryx mantelli* Bartlett, 1852**	**North Island brown kiwi**
Apterygon mirum Clay, 1961	
North Island: Taranaki; Northland; Urewera Ranges; East Cape; Bay of Plenty; Rotorua; Little Barrier Island	
***Apteryx rowi* Tennyson et al., 2003**	**Okarito brown kiwi or rowi**
Apterygon okarito Palma & Price, 2004	
South Island: Okarito	
***Apteryx australis australis* Shaw & Nodder, 1813**	**South Island brown kiwi**
Apterygon dumosum Tandan, 1972	
South Island: Dusky Sound, Fiordland	
***Apteryx australis lawryi* Rothschild, 1893**	**Stewart Island brown kiwi**
Apterygon dumosum Tandan, 1972	
Stewart Island: Easy Harbour; Mason's Bay; Diprose Bay; Maori Bay	
***Apteryx owenii* Gould, 1847**	**Little spotted kiwi**
Apterygon dumosum Tandan, 1972	
North Island: Kapiti Island	
***Apteryx haastii* Potts, 1872**	**Great spotted kiwi**
Apterygon hintoni Clay, 1966	
South Island: Gouland Downs; Heaphy Track; Karamea; Buller	