Hosts of the long-tailed cuckoo (*Eudynamys taitensis*) and museum specimens of the cuckoo's egg

B.J. GILL Auckland War Memorial Museum (retired), Auckland, New Zealand

Abstract: The description of the long-tailed cuckoo's (*Eudynamys taitensis*) egg was uncertain until the 1930s. Edgar Stead published evidence in 1936 that it was white with darker (red-brown or purplish) speckles, and therefore mimetic in colour and pattern (as well as size) to the eggs of many small song-birds in New Zealand. In reviewing eggs in museum collections, I find that only one (Auckland Museum LB8968) is certainly long-tailed cuckoo, and only eight other eggs are "probable" (with another eight "possible"). Average dimensions of the nine most likely eggs are 24.1 x 17.4 mm. Field observations of long-tailed cuckoo nestlings, or dependent fledglings receiving food, mostly involve whiteheads, yellowheads, and brown creepers (all in the genus *Mohoua*, Mohouidae), the principal biological hosts. There are single credible reports of a long-tailed cuckoo nestling being raised in a nest of South Island robin (*Petroica*; 1880s), silvereye (*Zosterops*; 1946, plus a vague record from the 1980s), and fantail (*Rhipidura*; 1963). The scarcity of secondary hosts is extremely rare. Seven other New Zealand song-birds have been cited as hosts of the long-tailed cuckoo, nestling being raised by the species concerned.

Gill, B.J. 2022. Hosts of the long-tailed cuckoo (*Eudynamys taitensis*) and museum specimens of the cuckoo's egg. Notornis 69(2): 89–98.

Keywords: brood-parasitism, passerine hosts, egg morphology, museum collections, historical records, New Zealand

INTRODUCTION

The migratory long-tailed cuckoo (koekoea, *Eudynamys taitensis* Cuculidae: Cuculinae) occurs seasonally on tropical and temperate islands of the south-west Pacific in a fan-shaped range extending some 11,000 km from west to east (Gill & Hauber 2012) and about 7,000 km from north to south. However, it breeds only in the far south of the range (New Zealand) where it parasitises principally the three species of *Mohoua* (Family Mohouidae), i.e. whitehead (*M. albicilla*) in the North Island, and in

Received 7 December 2021; accepted 15 January 2022 Correspondence: *adiantum@outlook.co.nz* the South Island, yellowhead (*M. ochrocephala*), and brown creeper (*M. novaeseelandiae*) (Higgins 1999).

The breeding of the long-tailed cuckoo remains poorly known. The events attending laying, hatching, nestling development, and eviction of eggs or nest-mates, are either unknown or have been seen and described at very few nests. This is mainly because the mohouid hosts nest in dense forest and scrub. In these habitats, systematic study of nesting is difficult and passing birdwatchers seldom find nests casually. The best information on the cuckoo's breeding comes from Elliott (1990), who collected important incidental notes on parasitism during a study of yellowheads. However, only six of 95 yellowhead nests were parasitised, and observations were restricted by the nests being in cavities and often in tall trees. An enquiry to the Nest Record Scheme in November 2021 revealed that there were no records for longtailed cuckoo.

Bad luck has perpetuated our ignorance of longtailed cuckoos, because two studies that might have shone light on parasitism did not. In the most detailed study of brown creepers (Cunningham 1985), 52 nests were observed near Kaikoura during 1979–1982, but long-tailed cuckoos were absent or rare in the area (Hunt & Gill 1979; Powlesland 1979) and so no parasitism was reported. In a study of whiteheads on Little Barrier Island during 1984-1989 (McLean & Gill 1988; Gill & McLean 1992), 72 nests were found in low-elevation areas in the southwest of the island. Unfortunately, none of these nests was parasitised despite whiteheads being seen feeding long-tailed cuckoo fledglings at higher elevations in the same summers (McLean 1988).

Long-tailed cuckoo eggs are rare in museum collections. Egg collections in New Zealand museums are fairly small, comprising c. 11,000 eggs or clutches of local and foreign species as against 30,000 study-skins (Gill 2006). Egg collections are low-quality for New Zealand native birds, containing many isolated eggs or partial clutches salvaged from nests that failed. The best New Zealand egg material was assembled by a handful of private collectors whose collections have now, thankfully, passed into public ownership. The Edgar Stead collection (Canterbury Museum) contains seven probable or possible long-tailed cuckoo eggs. At Auckland Museum, two small collections, those of J.C. McLean (Gill & Taylor 2010) and G.A. Buddle (Gill & Taylor 2012) contain no long-tailed cuckoo eggs. Even in the Stead collection there is no instance of an entire host clutch, with an interposed long-tailed cuckoo egg, having been collected. We do not yet have an image of a host clutch containing the parasite's egg (unless we photograph Egg 21 and the two eggs found with it – see Results).

There are literature records, reviewed by Cunningham (1949) and McLean (1988), suggesting that the long-tailed cuckoo has hosts in passerine families other than the Mohouidae. Brooker & Brooker (1989) used the term "biological host" for a successful host species for which there are multiple, independent records of parasitism involving more than one observer, more than one location, and more than one year. Records of parasitism may be egg records, nestling records (including those followed through to fledging) and records of fledglings being fed.

One aim of this study was to again re-assess the evidence for the long-tailed cuckoo's hosts. The cuckoo is believed to have a mimetic egg, i.e. whitish with dark (usually reddish-brown) speckling (Stead 1936), which is a good match for the eggs of many New Zealand native song-birds. Another aim of the study was to re-examine the evidence for what the cuckoo's egg looks like, and in doing that make an inventory of museum specimens.

METHODS

I searched the literature to trace back to their earliest sources all records of host species and eggs of the long-tailed cuckoo. To locate long-tailed cuckoo eggs in museum collections I searched on-line catalogues or made enquiries to museum curators. I visited collections to examine all such eggs in New Zealand museums. I listed in chronological order the more detailed published descriptions of eggs reported to belong to long-tailed cuckoos (including obvious mis-identifications). They are given consecutive numbers to form a catalogue. I have incorporated into this list the long-tailed cuckoo eggs preserved in museum collections at Auckland War Memorial Museum (AIM), Museum of New Zealand Te Papa Tongarewa (NMNZ, Wellington), Canterbury Museum (CMC, Christchurch) and The Natural History Museum (BMNH, Tring, United Kingdom). Many of the likely long-tailed cuckoo eggs that Stead (1936) examined and described, were collected or obtained by him, and several of his descriptions of individual eggs now cross-reference to CMC specimens. Where a museum egg did not have a published description or measurement, I have given these here from my own examination (measurements with vernier callipers).

As far as I can tell, there are no long-tailed cuckoo eggs at Otago Museum (Dunedin), or at the principal natural history museums in Sydney (Australian Museum), Melbourne (Museum Victoria), New York (American Museum of Natural History), Washington D.C. (National Museum of Natural History) or Paris (Muséum National d'Histoire Naturelle). It seems unlikely that any genuine long-tailed cuckoo eggs are held overseas.

The early writers on New Zealand ornithology often reported second-hand accounts of bird observations from correspondents. Some of these early reports were imprecise, inaccurate, or unlikely to be true. Bogert (1937) credited Stead (1936) with the first credible descriptions of the eggs of the long-tailed cuckoo and considered previous accounts erroneous. I have annotated each egg in the following list as "rejected", "possible", "probable" or "certain" in terms of its likelihood of belonging to a long-tailed cuckoo. "Rejected" eggs seem obviously wrong for long-tailed cuckoo. "Possible" is for eggs without good information to support such an attribution (e.g. evidence for the identity of the nest-maker and details of laying). "Probable" is where the visual appearance of the egg seems right for long-tailed cuckoo and the nesting observations or circumstances add plausibility. The only "certain" egg was recovered from the oviduct of a dead cuckoo.

RESULTS

Catalogue of putative long-tailed cuckoo eggs

The following list shows that of eggs ascribed to long-tailed cuckoo, eight are possible (Eggs 12–14, 16–20), eight are probable (Eggs 7–11, 15, 21, 22) and only one is certain (Egg 23).

Eggs 1 & 2. Ramsay (1865) gave one description common to two eggs he had, one from a bellbird (*Anthornis melanura*) nest and one from a New Zealand fantail (*Rhipidura fuliginosa*) nest. They were "of a pale yellowish salmon-colour, freckled indistinctly with marks of a deeper hue" and "10 lines long by $7\frac{1}{2}$ lines broad" (21.2 x 15.9 mm). Accuracy must have suffered if one description and set of measurements could apply to two eggs. The dimensions seem too small for the cuckoo. REJECTED.

Egg 3. Buller (1873: 76; 1888, 1:131) received an egg "some years ago" from Rev. R. Taylor (Wanganui; no host species stated) who had obtained it from someone else. It was "almost spherical in shape, with a slightly rough or granulate surface" and "of a pale buff or yellowish-brown colour". It measured 1:25 inches long by 1:15 inches broad (31.8 x 29.2 mm), and was "now in the Colonial Museum", Wellington (NMNZ; currently missing). Buller (1873: 76) admitted that the "authenticity cannot be considered quite certain". Potts (1885) referred to the same egg. It seems too big to be a long-tailed cuckoo's and is the wrong colour; Stead (1936) thought it was probably a pullet's egg. REJECTED.

Egg 4. Buller (1888, 1:131) referred to an egg in Canterbury Museum (currently missing) from a grey warbler (*Gerygone igata*) nest (Oamaru, Mr Smith, Nov. 1885) that "corresponds exactly with mine", i.e. Egg 3, "except that it is slightly narrower". REJECTED.

Egg 5. Nehrkorn (1879) reported an egg in the Godeffroy Museum (Hamburg, Germany) from Mr. Kleinschmidt (no locality). It measured 35×21 mm, and was very shiny, olive-brown, with a wreath of black-smeared spots at the blunt end, and pear-shaped. Finsch (1901) clarified that this

egg was from Fiji, which makes it unlikely to be a long-tailed cuckoo's. Timmermann (1931) corrected the size to 32.9 x 20.5 mm and the location to Viti Levu. REJECTED.

Egg 6. Oates & Reid (1903) listed an egg in BMNH (1902.10.25.502) from the collection of W. Radcliffe Saunders. They described it as "spherical in shape, rough in texture, and pale buff in colour". Oates & Reid gave the size as 1.1×0.85 inches (27.9 x 21.6 mm). Schönwetter (1964) considered this to be a dwarf egg of the domestic chicken and gave the dimensions as 25.3×21.4 mm. I examined the egg at Tring (2011) and confirmed Schönwetter's measurements. The egg is marked "From Potts colln. 91" indicating its New Zealand origin from T.H. Potts. REJECTED.

Egg 7. Fulton (1904) received a nest of the tomtit (*Petroica macrocephala*), containing four fresh eggs, collected in the Milford–Te Anau area by the Ross brothers. Three eggs were small (0.75×0.55 inches = 19.1 x 14.0 mm), and tomtit eggs are about 18 x 15 mm (Heather & Robertson 1996). The fourth, which Fulton surmised to be a long-tailed cuckoo's, was larger (0.94×0.7 inches = 23.9×17.8 mm). It was "white with purplish-brown speckles, becoming thicker and darker at the larger end" and "ovoido-elliptical" in shape. Stead (1936) accepted this record. PROBABLE.

Egg 8. Stead (1936) found an egg in a deserted whitehead nest (Silverstream; 19 Sep. 1909) that he suspected was a long-tailed cuckoo's. The "ground-colour was creamy white with purplish brown markings more thickly distributed at the larger end". It was measured by Stead: 23.5 x 17.0 mm. CMC AV4991 (Stead no. 234d). PROBABLE.

Egg 9. CMC AV4988 (Stead no. 234h); white with reddish-brown blotches concentrated at the blunter end; Kapiti Island; coll. A.S. Wilkinson 1936 from a whitehead nest. Part of the shell is missing but the egg is still measurable at about 25 x 17 mm. PROBABLE.

Egg 10. Stead (1936) observed a brown creeper nest with two eggs (Jacky Lee Island, off Stewart Island); "last year" = Dec. 1932. One egg (19.5×15.0 mm; CMC AV4496, Stead no. 284c) was assumed to be a creeper's. Brown creeper eggs are about $18.5 \times$ 14 mm (Heather & Robertson 1996). The other egg (22.8 x 17.5 mm; coll. 16 Dec. 1932) was assumed to be a long-tailed cuckoo's; this is CMC AV4993 (Stead no. 234a). The latter was "creamy white in groundcolour with purplish brown markings – more numerous at the larger end and with underlying markings of grey". PROBABLE.

Egg 11. Stead (1936) found a deserted brown creeper nest with one egg when in February (= Feb. 1933) he re-visited Jacky Lee Island. The egg (23.5 x 17.0 mm) was assumed to be a long-tailed cuckoo's. It was similar in colouring to Egg 10, but the "creamy tint of its ground colour was slightly more pronounced". CMC AV4994 (Stead no. 234e). PROBABLE.

Egg 12. CMC AV4990 (Stead no. 234g); white with reddish-brown and grey blotches concentrated at the blunter end; "Dunedin Museum"; 24.1 x 17.8 mm. Identity of source nest not recorded. Little observational information to support its identity. POSSIBLE.

Egg 13. CMC AV4989 (Stead no. 234f); similar colour to Egg 12; Dunedin; coll. A. Portman; 22.5 x 18.0 mm. From a European greenfinch (*Carduelis chloris*) nest. Stead (1936) reported three cuckoo eggs that Mr Portman obtained in a Dunedin gully, two from song thrush (*Turdus philomelos*) nests and one from a greenfinch nest. Greenfinch eggs are about 22 x 14.5 mm (Heather & Robertson 1996). Little observational information to support its identity. POSSIBLE.

Egg 14. CMC AV4992 (Stead no. 234b); cream with red-brown speckles; no data; 26.3 x 16.9 mm. No observational information to support its identity. POSSIBLE.

Egg 15. Cunningham (1949) described an egg from a deserted silvereye (*Zosterops lateralis*) nest (Wairarapa) as "very pale pink in ground colour, slightly darker at the larger end, thickly blotched at that end and more sparingly at the smaller end, with purplish brown; size, 24 x 17.8 mm". Silvereye eggs are immaculate pale blue and about 17.5 x 13 mm (Heather & Robertson 1996), so a larger, spotted egg in a silvereye's nest could well be a long-tailed cuckoo's. PROBABLE.

Egg 16. Stidolph (1949) gave measurements of an egg from a deserted silvereye nest (Wairarapa) as $23.7 \times 18.0 \text{ mm}$ (no description of colour and pattern). Although Stidolph was a trusted observer, he provided little observational information on the nest or egg to support their identities. This was a different egg from Egg 15 (further details given under 'Secondary hosts' below). POSSIBLE.

Egg 17. CMC AV17568; shape rounded, background colour pinkish with red-brown speckles and blotches concentrated at the blunter end; Kokiri, Westland; coll. J.G. Penniket Jan. 1958; 20.8 x 16.9 mm (reported as Jan. 1957 in Anon. 1958: 199). Found addled in abandoned tomtit nest with fragments of tomtit eggshell "thinner, glossier white, spots greyer and browner" (CMC label). Tomtit eggs are 18 x 15 mm (Heather & Robertson 1996), so this egg is not much bigger. POSSIBLE.

Egg 18. NMNZ OR7258; white with reddish-brown speckles; no data; 23.2 x 17.6 mm. No observational information to support its identity. POSSIBLE.

Egg 19. NMNZ OR11260; white with reddish-brown speckles; York Bay, Wellington; coll. PJ.H. Purvis 26 Nov. 1964; 22.4 x 17.3 mm. No observational information to support its identity. POSSIBLE.

Egg 20. CMC AV25598; white with a slight bluegreen tinge, grey and red-brown blotches and speckles concentrated at the blunter end; no data; Robin Francis-Smith colln., pres. 1971; 23.1 x 15.7 mm. No observational information to support its identity. POSSIBLE.

Egg 21. NMNZ OR17353; pale, speckled with red-brown, particularly towards the blunter end; Orongorongo Valley, Wellington; coll. P.C. Bull 16 Feb. 1973; 25.0 x 17.5 mm. From an abandoned whitehead nest containing three eggs. The other two eggs, presumed to be whitehead's, were also collected. One is pale beige-pink without spots; 19.4 x 14.8 mm. The other is pale without evident markings; damaged, but *c*. 21 mm long. Whitehead eggs are about 20 x 15 mm (Heather & Robertson 1996). PROBABLE.

Egg 22. AIM LB864; white with brown and grey speckles spread over most of the egg; Urewera; coll. 2 Feb. 1978; 24.2 x 18.0 mm (Fig. 1). From a whitehead nest; identified by S.M. Reed. PROBABLE.

Egg 23. AIM LB8968; white with small brown speckles mostly towards the blunter end; East Coast, North Island; no collector or date (but before May 1998); 25.0 x 16.6 mm. I removed this egg from the oviduct of an adult long-tailed cuckoo during dissection (spread wing of this female preserved as LB8981). The bird was received frozen and unlabelled in April 1998 from the East Coast Conservancy, Department of Conservation. The abdomen had been torn open during collision-trauma or predation. I checked the gonads for



Figure 1. A probable egg of the long-tailed cuckoo taken from a whitehead's nest. Egg 22 (AIM LB864); 24.2 x 18.0 mm. Photo: B. Gill.

sexing and discovered the egg in the oviduct, cracked on one side along the long axis. After cleaning and drying the egg I stabilised it by gluing the broken edges with a stiff solution of Paraloid B-72 dissolved in acetone. This egg seems pale and poorly spotted, likely because its time in the oviduct was insufficient for full pigmentation. One end is very pointed. It is currently the only long-tailed cuckoo's egg whose identity is beyond doubt (Fig. 2). CERTAIN.

General description and size of eggs

Stead (1936), who saw many long-tailed cuckoo eggs while they were fresh, summed up their appearance as "ground colour white, tinted with cream or creamy pink, freely spotted and streaked with purplish-brown and having underlying spots of grey, the markings being larger and more numerous at the larger end". He described the egg as having a thick, hard shell and a surface that is smooth and slightly lustrous.



Figure 2. An undoubted egg of the long-tailed cuckoo removed from the oviduct of an adult during dissection. Egg 23 (AIM LB8968); 25.0 x 16.6 mm. This egg probably had insufficient time in the oviduct to develop full spotting. Photo: B. Gill.

In his text, Stead (1936) gave measurements of *three* presumed long-tailed cuckoo eggs (Eggs 8, 10 and 11) in the course of describing them. Eggs 8 and 11 had the same dimensions. He summed up at the end by giving measurements of *four* eggs. Unfortunately, things do not match up. Egg 8 or 11 is given only once (why not twice, making *five* eggs?). Egg 10's length and width are listed, but measurements for two other eggs are unexplained and not previously mentioned. There may be errors in this final listing, so, to be conservative, I have attributed only three egg measurements to Stead (1936), as given in his text describing each egg.

The nine probable or certain long-tailed cuckoo eggs (Eggs 7–11, 15 and 21–23) have a mean length of 24.1 mm (sd = 0.78, range = 22.8-25.0), and a mean width of 17.4 mm (sd = 0.48, range = 16.6-18.0). Figure 3 plots the dimensions of these eggs alongside the approximate values for eggs of known and potential hosts. The cuckoo eggs cluster tightly with similar dimensions. Long-tailed cuckoo eggs are close in size to those of the yellowhead and South Island robin, but larger than those of the whitehead and brown creeper. They are much larger than silvereye or fantail eggs.

Principal hosts

There is good evidence for the three species of *Mohoua* being regular "biological hosts" (as used by Brooker & Brooker 1989) of the long-tailed cuckoo. This evidence includes the feeding of nestling cuckoos. Observations of the feeding of fledgling cuckoos do not prove parasitism (discussed further below). However, parasitism is the most likely explanation when fledgling feeding by the three mohouids is seen, and such records reinforce the conclusion that parasitism of these species is the norm throughout New Zealand.



Figure 3. Length and width (mm) of nine probable or certain eggs of long-tailed cuckoos (black diamonds; see text). Two eggs have the same dimensions so only eight symbols show. The approximate sizes (from Heather & Robertson 1996) of the eggs of known and potential hosts are shown: fantail (Fan), silvereye (Sil), brown creeper (BC), whitehead (WH), yellowhead (YH), and South Island robin (SIR).

Whitehead

Fulton (1904: 141) had a third-hand report of a cuckoo nestling in a whitehead's nest. Wilkinson (1927) stated that on Kapiti Island the whitehead was the "principal victim" of the long-tailed cuckoo and the only species seen feeding the parasite. In February 1925 he had climbed to a whitehead nest and found "a young Long-tailed Cuckoo the sole occupant, and even at this early stage nearly filling the nest" (Wilkinson 1927). Again on Kapiti, a whitehead nest with a long-tailed cuckoo nestling as the sole occupant was observed during 16 days in January 1936 until it fledged (Wilkinson & Stidolph 1947). Wilkinson & Wilkinson (1952) provided two photographs of a well-feathered cuckoo being fed in the nest by a whitehead on Kapiti (one of these images was also reproduced in Oliver 1955: 540). On Little Barrier Island in three summers (1984– 1987), McLean (1988) found one late-term cuckoo nestling and 16 cuckoo fledglings. All were fed by whiteheads, showing that this species is the principal host on the island. A fledgling cuckoo was being fed by whiteheads at Mt Climie, Upper Hutt, in April 1991 (Taylor & Parrish 1992), and at Boundary Stream, Hawkes Bay, in February 2003 (Parrish 2006).

Yellowhead

Fulton (1904: 141) had a report from R. Riddle of Orepuki (Southland) of a young long-tailed cuckoo in a yellowhead's nest. Elliott (1990) provided details of parasitism at six yellowhead nests at Knobs Flat, Eglinton Valley, Fiordland.

Brown creeper

R. Riddle of Orepuki sent a report to Fulton (1904: 141) of a brown creeper feeding a young long-tailed cuckoo. Edgar Stead and Robert Wilson visited Jacky Lee Island, off Stewart Island, in December 1932 (Wilson 1959), where brown creepers and long-tailed cuckoos were common. Wilson found a creeper nest containing a "half fledged" cuckoo being fed by creepers (Stead 1936; Wilson 1959). One of them found a brown creeper's nest with two eggs, one of which (Egg 10) they considered to be a long-tailed cuckoo's. The eggs were being incubated but were soon deserted with the clutch remaining at two. In February 1933, Stead (1936) was on the island again and found a deserted brown creeper's nest with one egg (Egg 11) that he considered to be a cuckoo's from the similarity in size and colouring to Egg 10.

In March 1978, Paddy Latham saw a juvenile long-tailed cuckoo being fed by a pair of brown creepers at Franz Josef (Sibson 1978). In January 1988, Ralph Powlesland watched two long-tailed cuckoo fledglings, each at a separate location on Codfish Island, being fed by brown creepers (McLean 1988; R.G. Powlesland, *pers. comm.* to BJG Nov. 2021). In February 1991, Colin O'Donnell saw three separate cuckoo fledglings being fed by brown creepers (and another by yellowheads) at Knobs Flat (O'Donnell & West 1992).

Secondary hosts

For three other species there is credible evidence that nestling long-tailed cuckoos were once or twice seen in nests, but no case gave evidence of the species raising the cuckoo to fledging and independence. These species cannot be considered biological hosts. The records are from the 1880s, 1946 and 1963, with an additional vague report from before 1988.

New Zealand fantail

Ramsay (1865) reported that a Mr Huntley in December 1862 forwarded him a fantail nest, probably from Wellington, containing four fantail eggs and an egg said to belong to a long-tailed cuckoo. We might discount this dubious record had not Roberts (1963) published a stunning monochrome photograph that he took at Pye's Pa Bush, near Tauranga, showing a fantail feeding a long-tailed cuckoo nestling in what is clearly a typical fantail nest. The fantail, presumably with food in its bill, is advancing towards the open gape of the chick. The cuckoo nestling is well-feathered, at least two-thirds of the way through its nestling period, and shows the pale dorsal spots typical of an immature long-tailed cuckoo. The gape is much larger than a fantail chick's would be. The cuckoo fills the nest and appears to be the sole occupant. Unfortunately, Roberts, who perhaps visited the nest only once, provided no details beyond the photo caption.

South Island robin

Buller (1888, 1:131) reported observations by W.W. Smith of an "undoubted case" of an egg of the longtailed cuckoo being hatched out by a South Island robin Petroica australis. On 29 October (no year or locality given) the nest had two eggs, and four eggs on 31 October. On 3 November, Smith found an "egg of Eudynamis taitensis placed among the rest" making five eggs. By 24 November, all eggs had hatched, the young cuckoo was "of enormous" size compared to its mates" and one robin chick was dead. Smith's observation on 2 December was that the cuckoo "will soon be too large for the nest, and already has to lie on top of the young Robins". On 9 December, Smith removed two robin chicks leaving one, which the next day was nearly ready to fly. On 11 December, Smith placed mesh over the nest through which the chicks could be fed. On 15 December, he released the robin chick and brought the cuckoo home ("now in fine plumages, spotted with white or greyish white on a brown ground"), where he fed it but it was dead by 22 December. This nest was under close observation, and we have to accept that Smith, a well-known naturalist, correctly identified the cuckoo chick. However, it is suspicious that the cuckoo did not evict the robins to be raised alone.

Stead (1936) and Wilson (1959) reported finding what they considered to be a long-tailed cuckoo's egg in a robin nest on Jacky Lee Island, Stewart Island, in December 1932. It was the only egg in the nest, and disappeared next day, so the evidence is weak.

Silvereye

On 5 January 1946, Cunningham (1949) found a speckled egg (Egg 15) that he believed to be a long-tailed cuckoo's in a deserted silvereye nest at Kiriwhakapapa, in the Tararua foothills north of Masterton. On 27 February 1949, at the same location, Mrs Stidolph found an old silvereye nest from a previous season containing a supposed long-tailed cuckoo's egg (Egg 16; Stidolph 1949). Neither account described the nest, or stated whether any pale blue silvereye eggs were also present, information that could have corroborated the identification.

Stidolph (1949) had visited the same locality on 20 January 1946, when his wife found a silvereye's nest containing "a large chick, with the eyes just opening, of a long-tailed cuckoo". It had "a yellow gape, dark feathers were appearing on the back and yellowish ones on the sides of the underparts". Stidolph removed the chick for examination but made no comment on the beak, legs or tail. He noted that "the adult" silvereyes were "in attendance" (i.e. in the vicinity?) and uttered the alarm note, but he did not stand back to confirm that silvereyes were bringing food to the nestling. At the next inspection, seven days later, before the chick would have been old enough to fledge, the nest was empty. (This did not surprise Stidolph because he felt it impossible that a silvereye's delicate cradlelike nest, suspended at the rim, could ever take the weight of a fully grown long-tailed cuckoo nestling.) If it really was a long-tailed cuckoo chick, then it is possible that it merely occupied an atypical whitehead nest, the species being present at the location though "somewhat scarce". Whiteheads can build atypical nests "suspended from light twigs, after the habit of the Silvereye" (see Plate 2 of Buddle 1951). However, Stidolph was a trusted observer and we must accept his record as credible.

P. Harper reported to McLean (1988) an observation of a long-tailed cuckoo nestling being raised by silvereyes in the Waikato, but no corroborating details were given.

Unlikely hosts

Records of the following species as successful hosts are dubious. They involve putative cuckoo eggs laid or thought to have been laid in nests, but they give no firm evidence of a cuckoo egg hatching, or a cuckoo nestling being raised, in the nests concerned.

Grey warbler

The long-tailed cuckoo plate in the second edition of Buller's *A History of the Birds of New Zealand* (1888) shows a grey warbler feeding the cuckoo fledgling. At this time the warbler was thought to be host to long-tailed cuckoos ("as many witnesses can testify"), as well as to shining cuckoos, but Buller gave no strong evidence for parasitism by the former. Potts (1885) cited observations of fledglings being fed by grey warblers in Canterbury. Mr W.W. Smith, at Oamaru in November 1885, took an egg (Egg 4) thought to be a long-tailed cuckoo's from a grey warbler's nest (Buller 1888, 1:131), but this egg was plain and spherical, so not likely to be a longtailed cuckoo's.

Andersen (1926) reported that a Mr Overton of Otago saw a long-tailed cuckoo lay an egg on the ground and carry it in its beak to place it in a grey warbler's nest. This is not credible since where the act of egg deposition has been seen in other parasitic cuckoos the female typically sits on the nest to lay (e.g. Wyllie 1981: 124). St Paul (1976) claimed to have seen two grey warblers "by the Wanganui River" bringing food to a big long-tailed cuckoo nestling. He did not confirm that it was in a grey warbler's nest – it could have been a case of passing warblers feeding a chick in another species' nest.

Moncrieff (1949), defending her inclusion (in Moncrieff 1948) of grey warbler as a long-tailed cuckoo host, wanted to keep an open mind on the subject. Fulton (1904), Stidolph (1949), and Oliver (1955) thought that records of grey warblers hosting long-tailed cuckoos were mistaken.

Bellbird

Ramsay (1865) was given a batch of birds' nests and eggs by Mr R. Huntley of Wellington. These included an egg said to be a long-tailed cuckoo's taken from the nest of a bellbird, a species that Ramsay believed was "frequently the foster-parent of the Long-tailed Cuckoo". Fulton (1904) thought it "probable" that the bellbird is parasitised because it chases and harries the long-tailed cuckoo.

Tui

Higgins (1999) cited a cuckoo's egg being found in a tui's nest (*Prosthemadera novaeseelandiae*) but I cannot trace the original report.

Tomtit

Fulton (1904) had a letter from Mr J.C. Buckland (November 1903) stating that a Mr Westenra of Akaroa found a nearly fledged long-tailed cuckoo in a tomtit's nest, but this third-hand observation lacks corroborating detail on how the nest was identified (McLean 1988). Fulton received a tomtit nest from Fiordland with four fresh eggs, one of which was larger and thought by Fulton to be a long-tailed cuckoo's (Egg 7). J. Penniket also found a supposed cuckoo's egg (Egg 17) in an abandoned tomtit nest at Kokiri, Westland, in January 1957 (Anon. 1958: 199). These last two egg records are possible or probable but not firmly established.

Song thrush

Smith (1931) stated that eggs of the long-tailed cuckoo have "occurred in the nest of the English Thrush" but gave no details. Stead (1936) saw two eggs collected from two song thrush nests by A. Portman, of Ravensbourne, Dunedin. Stead considered them to be long-tailed cuckoo eggs based on their size, colour, and pattern being similar to that of long-tailed cuckoo eggs Stead had seen. These eggs have not been found in any museum collection.

House sparrow

Kinsky (1957) saw a long-tailed cuckoo visit a house sparrow (Passer domesticus) nest on Kapiti Island in January 1957, pushing its head and half its body into the nest for "a short while". The nest was checked and contained four eggs, "three of them normal sparrow's eggs and the fourth somewhat smaller and lighter in colour". Next day the nest contained five eggs, "four normal sparrow eggs and the mysterious egg of the day before". Kinsky believed the latter to be a cuckoo's egg from its size and colour and because atypical lighter sparrow eggs are usually the last egg laid, not the penultimate. This record seems unlikely, not least because sparrow eggs are about 22 x 16 mm (Heather & Robertson 1996) and the cuckoo's egg would be bigger than this, not smaller. McLean (1988) credited P. Jenkins with an account of a long-tailed cuckoo laying in a house sparrow's nest on Kapiti Island. This may be the same Kinsky observation, whose paper McLean did not cite, rather than a second such record on the same island.

European greenfinch

Stead (1936) saw an egg (Egg 13) collected from a greenfinch nest by A. Portman, of Ravensbourne, Dunedin, that Stead considered was a long-tailed cuckoo egg. The identity was based on its size, colour, and pattern being similar to that of other presumed long-tailed cuckoo eggs seen by Stead.

Unparasitised species feeding cuckoo fledglings

Nestlings and fledglings of parasitic cuckoos in general, with their large size (relative to hosts), large gape and noisy begging, can represent a super-stimulus to passing birds of any species (e.g. Davies 2000: 80–81). The mobility of dependent fledgling cuckoos within the host territory puts them in the path of many other birds. It seems that unconnected birds, even of species that are never parasitised, may get diverted to feeding the begging cuckoo fledgling if they pass by while carrying food intended for their own offspring.

On Little Barrier Island in 1982, McLean (1982) saw a group of three whiteheads feeding two longtailed cuckoo fledglings. The assumption here is that two adjacent whitehead groups, each with a cuckoo fledgling as a result of parasitism, merged briefly and one group accidentally "adopted" the second cuckoo ending up with two to feed. It shows the effect of the super-stimulus operating within a parasitised species. McLean (1988), while following long-tailed cuckoo fledglings on Little Barrier Island, saw them begging to passing stitchbirds (*Notiomystis cincta*), tui, bellbirds and red-crowned parakeets (*Cyanoramphus novaezelandiae*), species that are unlikely to be parasitised.

It is unsurprising that there are many records of long-tailed cuckoo fledglings being fed by a diversity of species. These observations of course are not proof that the species concerned was parasitised. New Zealand pigeon. R. Riddle Southland) saw this species (Hemiphaga (of novaeseelandiae) feeding a fledgling cuckoo (Fulton 1904: 141), an improbable record (Oliver 1955) given that the cuckoo is an insectivore and the pigeon a herbivore. **Grey warbler.** Cases of grey warblers feeding long-tailed cuckoos were reported by Potts (1874: 148, 1885: 477) and Buller (1888). Oliver (1955: 540) mentions grey warblers feeding a long-tailed cuckoo on the ground. Tui. Alfred Reynolds of Riverton reported to Fulton (1904: 141) a tui feeding a "young cuckoo". This was considered improbable by Oliver (1955). Tomtit. J.C. Buckland (of Akaroa) reported to Fulton (1904) a fledgling long-tailed cuckoo being fed by a tomtit. North Island robin. On Little Barrier Island a fledgling cuckoo "was fed by a female Robin [Petroica longipes] at least twice" (McLean 1986, 1988). South Island robin. R. Riddle

(of Southland) reported a fledgling long-tailed cuckoo being fed by this species (Fulton 1904: 141).

DISCUSSION

Good evidence establishes the whitehead, vellowhead, and brown creeper as principal biological hosts of the long-tailed cuckoo. It makes evolutionary sense for this cuckoo to be a specialist brood-parasite of mohouid passerines. The mohouids form an endemic family (Aidala et al. 2013) and their association with a broodparasite endemic to New Zealand (in terms of breeding) at the specific, or perhaps even generic level (as Urodynamis; Payne 2005), suggests a long co-evolutionary relationship (Fleming 1982). This brood-parasitic interaction is likely to be older than that between the shining cuckoo (Chrysococcyx *lucidus*), which is only subspecifically endemic to New Zealand, and its hosts the grey warbler and Chatham Island warbler (Gerygone albofrontata), which are New Zealand endemics at just the species level.

There is evidence from a very few nests that long-tailed cuckoo nestlings can be reared by South Island robins (1880s), silvereyes (1946), and fantails (1963), but the use of secondary hosts is extremely rare. In the past 60 years there has been a big upsurge in professional field-work on songbirds throughout New Zealand, and an increase in amateur bird-watching. Yet there are no reports during this time of long-tailed cuckoos parasitising species other than mohouids, except for a poorly documented silvereye record (*c.* 1980s; McLean 1988).

The Roberts photograph (1963) seems to give evidence that fantails can raise a long-tailed cuckoo nestling to an advanced stage of development. Assuming that fantails can also raise the cuckoo fledgling to independence one wonders why the cuckoo does not parasitise fantails regularly across the country. That they do not implies that the association is suboptimal in some way. It might be, for example, that the cuckoo's egg, so much bigger than the fantail's (Fig. 3), is frequently rejected.

The survey of eggs in museum collections revealed one certain long-tailed cuckoo egg and 16 that are probable or possible. None has been collected in the field since 1978 (Egg 22, Fig. 1). A useful next step would be to settle the identities of the uncertain eggs from DNA extracted by a minimally destructive method. Stead's (1936) general description of the colour and pattern of the long-tailed cuckoo's egg is still accurate.

ACKNOWLEDGEMENTS

For access to eggs in museum collections I thank Alan Tennyson and Gillian Stone (NMNZ, 2009), Douglas Russell (BMNH, 2011) and Paul Scofield (CMC, 2020). I am grateful to Colin Miskelly (NMNZ) and Paul for checking my list of eggs and providing important corrections and background information. Julie Senior and Susan Tolich (AIM Library) helped me to obtain old journal articles and Roger Sharp checked the Nest Record Scheme for long-tailed cuckoo records.

LITERATURE CITED

- Aidala, Z.; Chong, N.; Anderson, M.G.; Ortiz-Catedral, L.; Jamieson, I.G.; Briskie, J.V.; Cassey, P.; Gill, B.J.; Hauber, M.E. 2013. Phylogenetic relationships of the genus *Mohoua*, endemic hosts of New Zealand's obligate brood parasitic long-tailed cuckoo (*Eudynamys taitensis*). *Journal* of Ornithology 154: 1127–1133.
- Andersen, J.C. 1926. Bird-song and New Zealand song birds. New Zealand, Whitcombe & Tombs.
- Anonymous 1958. Classified Summarised Notes. Notornis 7: 191–200.
- Bogert, C. 1937. Birds collected during the Whitney South Sea Expedition. 34. The distribution and the migration of the long-tailed cuckoo (*Urodynamis taitensis* Sparrman). American Museum Novitates 933: 1–12.
- Brooker, M.G.; Brooker, L.C. 1989. Cuckoo hosts in Australia. *Australian Zoological Reviews* 2: 1–67.
- Buddle, G.A. 1951. *Bird secrets of New Zealand*. London, Allen & Unwin.
- Buller, W.L. 1873. *A history of the birds of New Zealand*. 1st edition. London, John van Voorst.
- Buller, W.L. 1888. *A history of the birds of New Zealand*. 2nd edition. London, The author.
- Cunningham, J.B. 1985. Breeding ecology, social organisation and communicatory behaviour of the brown creeper (*Finschia novaeseelandiae*). Ph.D. thesis. University of Canterbury, Christchurch.
- Cunningham, J.M. 1949. Rearing of long-tailed cuckoo. *New Zealand Bird Notes* 3: 176–178.
- Davies, N.B. 2000. *Cuckoos, cowbirds and other cheats*. London, Poyser.
- Elliott, G.P. 1990. The breeding biology and habitat relationships of the yellowhead. Ph.D. thesis. Victoria University, Wellington.
- Finsch, O. 1901. Zur Catalogisirung der ornithologischen Abtheilung. I. Cuculi [Catalogue of the ornithological division]. Notes from the Leyden Museum 22: 75–125.
- Fleming, C.A. 1982. George Edward Lodge. The unpublished New Zealand bird paintings. Wellington, Nova Pacifica.
- Fulton, R. 1904. The kohoperoa or koekoea, longtailed cuckoo (*Urodynamis taitensis*): an account of its habits, description of a nest containing its (supposed) egg, and a suggestion as to how the

parasitic habit in birds has become established. *Transactions of the New Zealand Institute* 36: 113–148.

- Gill, B.J. 2006. Birds in Australian and New Zealand museums—a major resource for ornithology. *New Zealand Journal of Zoology* 33: 299–315.
- Gill, B.J.; Hauber, M.E. 2012. Piecing together the epic transoceanic migration of the long-tailed cuckoo (*Eudynamys taitensis*): an analysis of museum and sighting records. *Emu 112*: 326–332.
- Gill, B.J.; McLean, I.G. 1992. Population dynamics of the New Zealand whitehead (Pachycephalidae)—a communal breeder. *Condor* 94: 628–635.
- Gill, B.J.; Taylor, M.J. 2010. J.C. McLean's collection of New Zealand and foreign birds' eggs. *Records* of the Auckland Museum 47: 75–88.
- Gill, B.J.; Taylor, M.J. 2012. G.A. Buddle's collection of New Zealand and Canton Island birds' eggs. *Records of the Auckland Museum* 48: 29–44.
- Heather, B.D.; Robertson, H.A. 1996. *The field guide* to the birds of New Zealand. Auckland, Viking.
- Higgins, P.J. (Ed.) 1999. Handbook of Australian, New Zealand and Antarctic birds. 4. Parrots to dollarbird. Melbourne, Oxford University Press.
- Hunt, D.H.; Gill, B.J. (*Eds.*) 1979. *Ecology of Kowhai Bush, Kaikoura*. Christchurch, Biological Society, University of Canterbury.
- Kinsky, F.C. 1957. Long-tailed cuckoo and house sparrow. *Notornis* 7: 112–113.
- McLean, I.G. 1982. Whitehead breeding, and parasitism by long-tailed cuckoos. *Notornis* 29: 156–158.
- McLean, I.G. 1986. [Long-tailed cuckoo record in Classified Summarised Notes]. *Notornis* 33: 115.
- McLean, I.G. 1988. Breeding behaviour of the longtailed cuckoo on Little Barrier Island. *Notornis* 35: 89–98.
- McLean, I.G.; Gill, B.J. 1988. Breeding of an islandendemic bird: the New Zealand Whitehead *Mohoua albicilla*; Pachycephalinae. *Emu 88*: 177–182.
- Moncrieff, P. 1948. New Zealand birds and how to identify them. 3rd edition. New Zealand, Whitcombe & Tombs Ltd.
- Moncrieff, P. 1949. Grey warbler and cuckoos. *New Zealand Bird Notes* 3: 111–112.
- Nehrkorn, A. 1879. Mittheilungen über nester und eier des Museums Godeffroy zu Hamburg [Reports on nests and eggs from the Godeffroy Museum in Hamburg]. *Journal für Ornithologie* 27: 393–410.
- Oates, E.W.; Reid, S.G. 1903. Catalogue of the collection of birds' eggs in the British Museum (Natural History). Volume III. Carinatae (Psittaciformes– Passeriformes). London, British Museum (Natural History).

- O'Donnell, C.F.J.; West, J.A. 1992. Classified Summarised Notes, South and Chatham Islands 1 July 1990 to 30 June 1991. *Notornis 39*: 211–232.
- Oliver, W.R.B. 1955. New Zealand birds. 2nd edition. Wellington, Reed.
- Parrish, G.R. 2006. Classified Summarised Notes, North Island, 1 July 2002 to 30 June 2003. *Notornis* 53: 240–247.
- Payne, R.B. 2005. *The cuckoos*. Oxford, Oxford University Press.
- Penniket, J.G. 1958. [Long-tailed cuckoo record in Classified Summarised Notes]. Notornis 7: 199.
- Potts, T.H. 1874. On the birds of New Zealand [Part 4]. *Transactions of the New Zealand Institute* 6: 139–153.
- Potts, T.H. 1885. Oology of New Zealand [Part 4]. New Zealand Journal of Science 2: 475–484.
- Powlesland, R.G. 1979. [Long-tailed cuckoo record in Classified Summarised Notes]. Notornis 26: 416.
- Ramsay, E.P. 1865. On the nests and eggs of some New Zealand birds. *Ibis 7*: 154–157.
- Roberts, P.M. 1963. Plate XV [Nestling long-tailed cuckoo in fantail nest; photograph only]. *Notornis* 10: 173.
- St. Paul, R. 1976. A bushman's seventeen years of noting birds. Part D. Shining cuckoo and longtailed cuckoo. *Notornis* 23: 289–298.
- Schönwetter, M. 1964. *Handbuch der Oologie*. Vol. 1. Part 9. Berlin, Akademie Verlag.
- Sibson, R.B. 1978. Classified Summarised Notes. Notornis 25: 332–349.
- Smith, W.W. 1931. Feeding habits of the shining bronze-cuckoo. *Emu* 30: 217–218.
- Stead, E.F. 1936. The egg of the long-tailed cuckoo (Eurodynamis taitensis). Transactions of the Royal Society of New Zealand 66: 182–184.
- Stidolph, R.H.D. 1949. Long-tailed cuckoo victimising silver-eye. *New Zealand Bird Notes* 3: 175.
- Taylor, G.A.; Parrish, G.R. 1992. Classified Summarised Notes, North Island 1 July 1990 to 30 June 1991. *Notornis* 39: 161–210.
- Timmermann, G. 1931. Mittheilungen ueber einige vogeleier aus Zentralpolynesien [Reports about some bird eggs from central Polynesia]. Beiträge Fortpflanzungsbiologie der Vögel mit Berücksichtigund der Oologie 7: 104–109, 139–141.
- Wilkinson, A.S. 1927. Birds of Kapiti Island. *Emu* 26: 237–258.
- Wilkinson, A.S.; Stidolph, R.H.D. 1947. A cuckoo in the nest. *New Zealand Bird Notes* 2: 77–79.
- Wilkinson, A.S.; Wilkinson, A. 1952. Kapiti bird sanctuary. A natural history of the island. Masterton, Masterton Printing Co.
- Wilson, R.A. 1959. *Bird islands of New Zealand*. Christchurch, Whitcombe & Tombs Ltd.
- Wyllie, I. 1981. The cuckoo. London, B.T. Batsford Ltd.