

## A new species of extinct imperial pigeon (*Ducula*: Columbidae) from Henderson Island, Pitcairn Group

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### Abstract

A new species of extinct *Ducula* pigeon is described from abundant fossil material excavated from late Quaternary deposits on Henderson Island, Pitcairn Group, South Pacific Ocean. Tarsometatarsi that are longer than any extant *Ducula* and relatively reduced wing elements separate this species from all other extinct and extant *Ducula*. The description of this species adds another large endemic columbid to the suite that has become extinct since the arrival of man on one of the more isolated islands and island groups in the Pacific.

**Keywords:** *Columbidae*, *Ducula* new species, bird extinctions, Henderson Island, Pitcairn Group

### Introduction

Henderson Island of the Pitcairn Group is one of the most remote islands in Oceania (Figure 1). Located at 24°22'S, 128°18'W, it is about 177 km east–northeast of the high volcanic island of Pitcairn, and 220 km east of Oeno and 360 km west of Ducie, the two low atolls of the group. Henderson Island, with an area of about 37 km<sup>2</sup> and a maximum height above sea level of 33 m is a raised atoll whose outer rim is the ancient reef, and the lower inner region, the elevated floor of the lagoon.

Henderson Island was discovered by the Spaniard Pedro Fernandes de Quiros in 1606 and it was then uninhabited and has not been settled since that time (Benton and Spencer 1995; Wragg 1995a). The island has attracted many scientific investigations, beginning as early as 1825 with *HMS Blossom*, but the most significant in terms of duration of investigation and scope of studies was the Sir Peter Scott Commemorative Expedition to the Pitcairn Islands 1991–1992 (Spencer and Benton 1995). As part of this multidisciplinary expedition, extensive archaeological and some palaeontological investigations were made (Weisler 1994, 1995; Wragg 1995a b; Wragg and Weisler 1994).

Sinoto discovered there had been a prehistoric human presence on Henderson Island in 1971 (Fosberg *et al.* 1983; Sinoto 1983). Until then the island had been assumed to have a pristine biota that was unmodified by human influence, though the presence of the Pacific rat *Rattus exulans* should have suggested otherwise. Steadman and Olson (1985) studied 303 bird bones recovered from Sinoto's excavations and reported a fauna dominated by seabirds. Of the few landbirds, they reported two species of pigeon: one inseparable from *Ducula aurorae* or *Ducula pacifica* based on nine incomplete wing elements, and one similar to *Ducula galeata* based on two partial tibiotarsi and a mandibular fragment. The only species of pigeon now on Henderson Island is a small fruit dove *Ptilinopus insularis*, and thus Steadman and Olson documented apparent human-caused extinctions on this "uninhabited" island. Bourne and David (1986) considered it likely that these bones represented just one species with reduced wings. Schubel and Steadman (1989) reported another 2795 bird bones from Henderson, including a tarsometatarsus of the *Gallicolumba* species, but no bones of *Ducula*. Steadman (1997) continued to list *D. aurorae*

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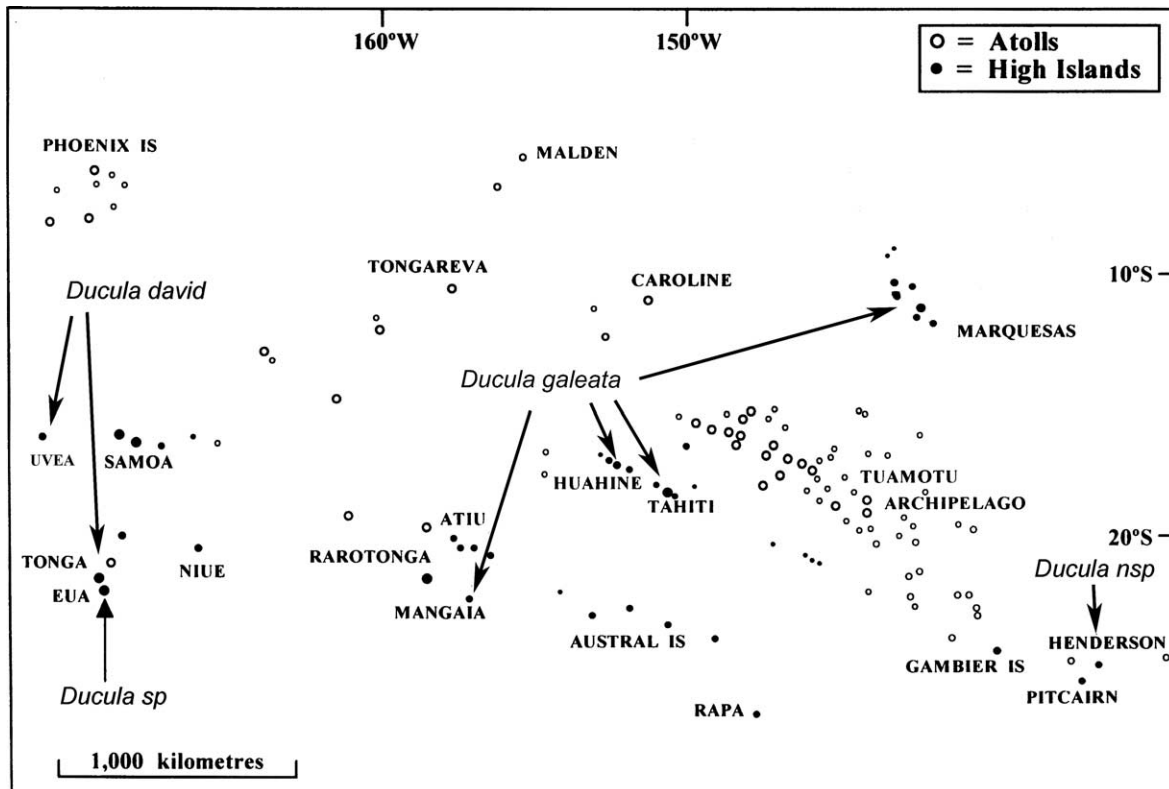


Figure 1. Location of Henderson Island in the eastern Pacific and the distribution of large extinct *Ducula* species including the new species described here. The undescribed species from 'Eua and Lifuka in the Ha'apai Group, Tonga was first listed by Steadman (1989a,b, 1993). The small extant *D. pacifica* has a range extending as far east as Samoa and Niue and *D. aurorae* is known from Tahiti. Fossils referable to either *D. pacifica* or *D. aurorae* are known from Mangaia and Atui (Steadman 1997).

and *D. galeata* from Henderson Island, while admitting that the taxonomy of the extinct columbids was unresolved.

The excavations by Weisler and Wragg during the Pitcairn Islands Scientific Expedition of 1991–1992 resulted in a collection of some 42,213 bird bones (Wragg 1995a). About 421 m<sup>2</sup> test pits were excavated in 11 sites of the 28 identified archaeological sites and one natural site. Locations of the sites are shown in Weisler (1995, Figure 2) and Wragg (1995b, Figure 2.1) and site nomenclature used in those publications is followed here and on specimen labels. All sediment was screened with 6.4 mm mesh sieves and selected samples fine-screened with 1.5 or 3.2 mm meshes (Wragg and Weisler 1994). The bird bones were sorted from the recovered materials by Weisler, and initial identification of these made by Wragg and Weisler (1994). Wragg and Weisler (1994) listed four extinct landbirds, including a Columbidae n. gen. *et* n. sp., *Ducula* n. sp., and *Gallicolumba* n. sp., which latter taxon was described as *Gallicolumba leonpascoi* by Worthy and Wragg (2003). Excavations in many of the archaeological sites penetrated through the cultural horizons and many bones of the extinct taxa including the *Ducula* n. sp. were found in cultural and precultural contexts. Polynesians occupied Henderson for some

600 years commencing sometime in the period 1300–1000 <sup>14</sup>C years BP, but certainly by about AD 1050 (Weisler 1995). Precultural horizons dated up to 13,420 <sup>14</sup>C years BP (OxA-5910), with this oldest date being on bones of *G. leonpascoi*. (Wragg 1995b; Hedges *et al.* 1997).

An extensive fossil record of birds has now been described from many islands in the Pacific, and often up to half are extinct, for example, in the Marquesas (Steadman 1989a; Steadman and Rolett 1996), Hawaii (James and Olson 1991; Olson and James 1991), Easter Island (Steadman 1995), Society Islands (Steadman 1989a), Samoa (Steadman 1994), Niue (Steadman *et al.* 2000), the Tongan and Cook Island groups (Steadman 1989a, 1993, 1995), New Caledonia (Balouet and Olson 1989), and in Fiji (Worthy 2000, 2001). Amongst the extinct taxa are many species of columbids (Balouet and Olson 1987, 1989; Steadman 1989a, b, 1992, 1997; Worthy 2001). The purpose of the present contribution is to describe the extinct *Ducula* from Henderson Island.

## Methods

The following abbreviations are used throughout the text.



Figure 2. Tarsometatarsi of *D. harrisoni* and *D. latrans* in anterior view. A, MNZ S41715; B, MNZ S41609 (Holotype); C, FM28. Scale bar is 2 cm.

*Institutions:* AIM, Auckland Institute and Museum, Auckland, New Zealand (NZ); AMNH, American Museum of Natural History, New York, USA; BMNH, Natural History Museum, London, UK (formerly British Museum (Natural History)); OM, Otago Museum, Dunedin, NZ; CM, Canterbury Museum, Christchurch, NZ; FM, Fiji Museum, Suva, Fiji; MNZ, Museum of New Zealand Te Papa Tongarewa, Wellington (formerly National Museum of New Zealand, Dominion Museum, and Colonial Museum), NZ; MVZ, Museum of Vertebrate Zoology, University of California, Berkeley, California, USA; USNM, United States National Museum, Smithsonian Institution, Washington DC, USA; UWBM, Burke Museum, University of Washington, Seattle, Washington, USA.

*Skeletal elements and descriptive terms used:* The following abbreviations apply to single and plural usage of the elements. Acet, acetabular part of pelvis; cmc, carpometacarpus; cor, coracoids; cran, crania; fem, femora; fib, fibulae; frags, fragments; hum, humeri; imm, immature; juv, juvenile; mand, mandibles; max, maximum; min, minimum; pel, pelvis; phal, phalanges; pmx, premaxillae; pt, part; quad, quadrates; rad, radii; sac, synsacra; scap, scapulae; skel, skeleton; stern, sterna; tmt, tarsometatarsi; tt, tibiotarsi; and vert, vertebrae. When listing material, bones are sometimes identified as left (L) or right (R) elements. L or R prefixed by “p”, “s”, or “d” indicates “proximal”, “shaft”, or “distal” part of the element respectively, e.g. pR fem means the proximal part of a right femur. For coracoids, the humeral end is taken as proximal and the sternal end as distal.

Anatomical nomenclature for specific bone landmarks follows Baumel and Witmer (1993). Some common terms are abbreviated as follows: proc., processus; artic., articularis; TP, testpit.

### Measurements

Measurements were made with Tesa dial callipers and rounded to 0.1 mm, or if > 150 mm, with a steel tape to 1 mm. TL: greatest length, except for the coracoid, which was measured down the medial side. PW: proximal width in the lateromedial plane; femora were measured from the ball through the mid-depth point of the neck to the lateral side. SW: shaft width at mid-length (unless otherwise stated) in a lateromedial plane. SD: shaft width in a dorsoventral plane. DW: distal width. Tibiotarsi. PW: measured across the articular surface. Tibiotarsi. PD: proximal depth from between the cnemial crests to the posterior side of the articular surface. Tarsometatarsi. PD: proximal depth was measured as greatest proximal depth with one side of the callipers on the hypotarsus and the other across the anterior side of the cotylae. Tarsometatarsus DW is measured between the anterior part of the trochlea TII and TIV, rather than from the caudal process of TII to the side of TIV, which would be greater.

### Comparative material

Sex, male (M) or female (F), is indicated after the catalogue number were known. All material is from modern skeletons unless stated otherwise. Extinct taxa are indicated †.

- Goura cristata* Pallas 1764 western crowned-pigeon, CM Av7110, skel., northwest New Guinea;  
*Microgoura meeki* Rothschild 1904 Choiseul pigeon †, AMNH 24959, cast R tmt, cast dR tt from skin AMNH 616460, Choiseul Island, Solomon Islands;  
*Didunculus strigirostris* (Jardine 1845) tooth-billed pigeon, CM Av7160, Samoa;  
*Caloenas nicobarica* Linnaeus 1758 Nicobar pigeon, MNZ 22475, trunk skel, Wellington Zoo, New Zealand; USNM 292221, M, skel, Siam, Koh Tao; USNM 557085, F, skel, Halmahera Island, Moluccas; UWBM 38797, F, skel, zoo spec.;  
*Otidiphaps nobilis* Gould 1870 Pheasant pigeon, USNM 614236, F, loc. ?, captive bird;  
*Gallicolumba stairii* (G. R. Gray 1856) friendly ground dove, BMNH S/1975.3.3, F, Fiji. Fossil bones: MNZ S38223, 54 bones 6 individuals, Vatulele Island, Fiji;  
*Columba vitiensis* (Quoy and Gaimard 1830) metallic pigeon. *C. v. vitiensis* FM26, F, skel., Mali Island, Vanua Levu, Fiji; *Columba v. griseogularis* USNM 560654, ?M, Batan Island, Philippines; *Columba v. castaneiceps* CM Av10293, M, Samoa;

*Streptopelia chinensis* (Scopoli 1786) spotted dove, AIM B5632, Auckland, New Zealand (introduced sp.);  
*Phaps chalcoptera* (Latham 1790) common bronzewing, CM Av7129, skel., Australia;  
*Ptilinopus perousii* Peale 1848 many-colored fruit-dove, FM 31, M, skel., Vitilevu, Fiji; FM23, M, skel., Vitilevu, Fiji;  
*Ptilinopus victor* (Gould 1871) orange dove, FM unreg., M, skel., Vanua Levu, Fiji; BMNH S/1975.3.1, M, Fiji;  
*Ptilinopus porphyraceus* (Temminck 1821) crimson-colored fruit-dove, MNZ 16391, M, skel., Niue Island; THW colln skel., Niue Island;  
*Ducula goliath* (G. R. Gray 1859) New Caledonian imperial pigeon, MNZ 22839, three mixed individuals, New Caledonia;  
*Ducula pacifica* (Gmelin 1789) Pacific pigeon, MNZ 16389A, F, trunk skel, Niue Island; THW colln (NHS19) skel., Niue Island; MNZ 25350 skel., Niue Island; MNZ 25351 skel., Niue Island; MNZ 25352 skel., Niue Island; MNZ 25353 skel., Niue Island; AIM 7233, skel., Niue Island; AIM 7262, skel., Niue Island;  
*Ducula latrans* (Peale 1848) Peale's imperial pigeon, FM 28, F, skel., Vanua Levu, Fiji; BMNH S/1975.3.4, M, skel., Fiji; BMNH S/1975.3.2, F, skel., Fiji; MVZ 51372;  
*Ducula galeata* (Bonaparte 1855) Marquesan imperial pigeon, BMNH S/1975.9.5, F, skel.; MNZ 26971, cast of selected elements BMNH S/1975.9.5;  
*Ducula melanochroa* (Sclater 1878) Bismarck imperial pigeon, USNM 615013, M, skel., New Ireland, PNG;  
*Ducula pistrinaria* Bonaparte 1854 island imperial pigeon. *D. pistrinaria pistrinaria*, UWBM 60203, M, skel., Solomon Islands;  
*Ducula rubricera* (Bonaparte 1854) red-knobbed imperial pigeon. *D. rubricera rufigula*, UWBM 63088, F, skel., Solomon Islands;  
*Hemiphaga novaeseelandiae* (Gmelin 1789) New Zealand pigeon, OM Av1851, Dunedin, New Zealand.

## Systematic palaeontology

Aves  
 Columbiformes  
 Columbidae

The fossil species described herein is referred to the Columbidae (including *Raphus* and *Pezophaps*, see Kitchener (1993)) because the tarsometatarsi has the following combination of characters: *fossa metatarsi I* large and deep, extending beyond the medial edge of the *facies dorsalis*; large *fossa parahypotarsalis medialis* bound by thin shaft anteriorly; shallow, narrow *fossa parahypotarsalis lateralis*; *crista medialis hypotarsi* largest and joined to *crista lateralis hypotarsi* posteriorly to

enclose a single *canalis hypotarsi*; *trochleae metatarsi II* (TII) with marked medial inflection; *trochlea metatarsi III* width greater than anterior–posterior depth.

### *Ducula Hodgson, 1836*

The holotypical and paratypical tarsometatarsi described below are referred to *Ducula*, as they share with this genus the following combination of characters: 1, the tarsometatarsus has similar proportions to other members of the genus; 2, the *foramen vasculare distale* has a single plantar opening with a groove to the *incisura intertrochlear lateralis*; 3, the *foramina vascularia proximalia* are large (the medial being largest and elongate) and are widely separated, in a sulcus bound by prominent ridges with a lower inter-foraminal ridge; 4, the lateral profile of shaft to trochlea IV is slightly concave; 5, the *cotyla medialis* is hooked anteriorly; and 6, the *tuberositas m. tibialis cranialis* lies distal to the *foramina vascularia proximalia medialis* in the *sulcus extensorius* and partly on the ridge bounding the foramen medially.

The tarsometatarsus of *Goura*, *Didunculus*, *Gallicolumba*, *Otidiphaps* and *Caloenas* are relatively longer, and those of *Columba* relatively shorter; the lateral profile of the shaft is straighter in *Columba* than in *Ducula*. The *foramen vasculare distale* has separate openings distally in the *incisura intertrochlear lateralis* and on the plantar surface in *Caloenas*, *Otidiphaps*, *Columba* and *Didunculus*. The *foramen vascularia proximalia lateralis* is relatively more reduced, being nearly closed in *Columba*, *Didunculus*, *Caloenas*, and is equal in size to the *foramen vascularia proximalia medialis* in *Otidiphaps*. The *foramen vascularia proximalia medialis* is relatively smaller and is more circular in *Caloenas*, *Otidiphaps* and *Didunculus*, than it is in *Ducula*. *Ptilinopus* tarsometatarsi are smaller than those of *Ducula* and the *foramina vascularia proximalia* are of equal size and separated by a prominent ridge. The bone on the medial side of the *sulcus extensorius* is not raised into an elevated ridge in *Didunculus* and *Caloenas*, and is low in *Goura* and *Columba*. The *foramen vascularia proximalia medialis* lies close (less than the foramen width) to the medial edge in *Ducula*, whereas the bounding bone is much wider in *Columba* and even more so in *Caloenas* and *Didunculus*. The *cotyla medialis* is not hooked anteriorly in *Didunculus*, *Caloenas*, *Columba*, *Phaps*, *Hemiphaga*, *Gallicolumba*, *Goura*, *Microgoura*, *Caloenas*, but is in *Ptilinopus*.

### *Ducula harrisoni*, new species

*Etymology*: The species is named after Colin J. O. Harrison who has contributed hugely to the knowledge of fossil birds.

*Diagnosis*: A species with tarsometatarsus longer than that of the largest extant *Ducula* species *D. goliath* and *D. galeata* and similar in size to the extinct *D. david* and *D. lakeba*, but which differs from all *Ducula* species by

having relatively reduced wing elements. The tarsometatarsus has a more elongate shaft than that of *D. david* (Balouet and Olson 1987), with the *fossa parahypotarsalis medialis* well separated from the *fossa metatarsal I* (they abut in *D. david*), and is slightly shorter and more slender than that of *D. lakeba* (Table I).

*Holotype*: MNZ S41609, a right tarsometatarsus complete from the proximal end to the area immediately distad of *fossa metatarsi I*. It is pale brown with reddish mottling and black soil stains. The bone is broken and is missing the area distal to the *fossa metatarsi I* and the *eminentia intercotylaris* and medial edge to the *coryla medialis* are worn (Figures 2 and 3).

*Measurements of the holotype*: See Table I.

*Type locality*: Henderson Island, site 5, testpits 2, spit 7; collected by M. Weisler and G. Wragg during the Pitcairn Islands Scientific Expedition 1991–1992.

*Paratypes*: All from Henderson Island and collected by M. Weisler and G. Wragg during the Pitcairn Islands Scientific Expedition 1991–1992. MNZ S41715, 1dR tmt, Site 5, TP15, spit 3; MNZ S41653, 1dL tmt, Site 5, TP5, spit 5; MNZ S41735, 1L fem, Site 5, TP16, spit 3; MNZ S41717, 1sL2dR tt, Site 5, TP15, spit 3; MNZ S41641, 2pL hum, Site 5, TP5, spit 3; MNZ S41649, 1dR hum, Site 5, TP5, spit 4; MNZ S41722, 1dL hum, Site 5, TP16, spit 1; MNZ S41657, 1R ulna, Site 5, TP6, spit 1; MNZ S41617, 1L cmc, Site 5, TP3, spit 5; MNZ S41684, 1R cmc, Site 5, TP8, spit 3; MNZ S41618, 1R cor, Site 5, TP3, spit 5; MNZ S41639, 1L cor, Site 5, TP5, spit 3; MNZ S41640, 1R cor, Site 5, TP5, spit 3; MNZ S41728, 1R cor, Site 5, TP16, spit 2; MNZ S41758, 1L cor, Site 6, TP3, spit 3; MNZ S41760, stern, Site 6, TP3, spit 4.

*Referred material*: All from Henderson Island and collected by M. Weisler and G. Wragg during the Pitcairn Islands Scientific Expedition 1991–1992. MNZ S41605, pL cmc, Site 1, TP1, spit 10; MNZ S41607, R M2.1, Site 1, TP1, spit 10; MNZ S41608, dR ulna, Site 1, TP1, spit 10; MNZ S41610, pL tmt, Site 5, TP2, spit 12; MNZ S41611, pL cor, Site 5, TP3, spit 1; MNZ S41612, prox frag stern, Site 5, TP3, spit 1; MNZ S41613, pL tmt, Site 5, TP3, spit 1; MNZ S41614, pL cor, Site 5, TP3, spit 3; MNZ S41615, 1R scap, Site 5, TP3, spit 4; MNZ S41616, 1dR cor, Site 5, TP3, spit 4; MNZ S41619, 1dR cor, Site 5, TP3, spit 5; MNZ S41620, 1pL fem, Site 5, TP3, spit 5; MNZ S41621, 1dL hum, Site 5, TP3, spit 5; MNZ S41622, 1dR rad, Site 5, TP3, spit 5; MNZ S41623, 1R scap, Site 5, TP3, spit 5; MNZ S41624, 1pR cor, Site 5, TP3, spit 6; MNZ S41625, pedal phal I.1, Site 5, TP3, spit 6; MNZ S41627, L side mand, Site 5, TP3, spit 7; MNZ S41628, R M2.1, Site 5, TP3, spit 7; MNZ S41629, R M2.1, Site 5, TP3, spit 8; MNZ S41630, pR cor, Site 5, TP5, spit 1; MNZ S41631, 1sL1pL cor, Site 5, TP5, spit 2; MNZ S41632, 1pR fem, Site 5, TP5, spit 2; MNZ S41633, L side mand, Site 5, TP5, spit 2; MNZ S41635, 1dR ulna, Site 5, TP5, spit 2; MNZ S41638, 2dL cor, Site

5, TP5, spit 3; MNZ S41642, pt L scap, Site 5, TP5, spit 3; MNZ S41643, pt L side stern, Site 5, TP5, spit 3; MNZ S41644, 1sR tt, Site 5, TP5, spit 3; MNZ S41645, 1dL ulna, Site 5, TP5, spit 3; MNZ S41648, 2dL cor, Site 5, TP5, spit 4; MNZ S41650, L M2.1, Site 5, TP5, spit 4; MNZ S41651, 1R scap, Site 5, TP5, spit 4; MNZ S41652, 1R scap, Site 5, TP5, spit 4; MNZ S41654, 1pL cor, Site 5, TP6, spit 1; MNZ S41655, 1L scap, Site 5, TP6, spit 1; MNZ S41656, pt dR tmt, Site 5, TP6, spit 1; MNZ S41658, 1dL cor, Site 5, TP6, spit 2; MNZ S41658, 1pL hum, Site 5, TP6, spit 2; MNZ S41659, 1dL cor, Site 5, TP6, spit 3; MNZ S41660, pt R side stern, Site 5, TP6, spit 3; MNZ S41661, sL tmt, Site 5, TP6, spit 3; MNZ S41662, 1L1pL fem, Site 5, TP6, spit 4; MNZ S41663, 1pR1dL cor, Site 5, TP7, spit 1; MNZ S41664, 1R scap, Site 5, TP7, spit 1; MNZ S41665, ant stern, Site 5, TP7, spit 1; MNZ S41666, pL tt, Site 5, TP7, spit 1; MNZ S41667, pL cor, Site 5, TP7, spit 3; MNZ S41668, R M2.1, Site 5, TP7, spit 3; MNZ S41669, pR M2.1, Site 5, TP7, spit 4; MNZ S41670, ped phal LI.1, Site 5, TP7, spit 4; MNZ S41671, 2L sides mand, Site 5, TP8, spit 1; MNZ S41673, 2L2R scap, Site 5, TP8, spit 1; MNZ S41674, pt dL tmt, Site 5, TP8, spit 1; MNZ S41675, 4dL cmc, Site 5, TP8, spit 2; MNZ S41677, 1dR1pR4pL cor, Site 5, TP8, spit 2; MNZ S41678, 1sL hum, Site 5, TP8, spit 2; MNZ S41679, 1L1R M2.1, Site 5, TP8, spit 2; MNZ S41680, 1L M2.2, Site 5, TP8, spit 2; MNZ S41681, 1R quad, Site 5, TP8, spit 2; MNZ S41682, 1sL tmt, Site 5, TP8, spit 2; MNZ S41683, 1dR2dL1pR1pL cmc, Site 5, TP8, spit 3; MNZ S41686, 1pR hum, Site 5, TP8, spit 3; MNZ S41687, R side mand, Site 5, TP8, spit 3; MNZ S41688, pmx, Site 5, TP8, spit 3; MNZ S41689, 3L1R M2.1, Site 5, TP8, spit 3; MNZ S41690, ped phal LI.1, Site 5, TP8, spit 3; MNZ S41691, 1L scap, Site 5, TP8, spit 3; MNZ S41692, 1pL1dR tmt, Site 5, TP8, spit 3; MNZ S41693, 1dL tt, Site 5, TP8, spit 3; MNZ S41694, 1sR tt, Site 5, TP8, spit 3; MNZ S41695, 1pR1dR1sR ulna, Site 5, TP8, spit 3; MNZ S41696, 1dL cmc, Site 5, TP8, spit 4; MNZ S41697, 1dR ulna, Site 5, TP8, spit 4; MNZ S41698, ped phal RI.1, Site 5, TP13, spit 5; MNZ S41699, 1pR cmc, Site 5, TP15, spit 1; MNZ S41702, pt ant stern, Site 5, TP15, spit 1; MNZ S41703, 1sR tmt, Site 5, TP15, spit 1; MNZ S41704, 1dR cmc, Site 5, TP15, spit 2; MNZ S41705, 2pL cor, Site 5, TP15, spit 2; MNZ S41706, 1sL hum, Site 5, TP15, spit 2; MNZ S41707, 1L metatarsal, Site 5, TP15, spit 2; MNZ S41708, 2R M2.1, Site 5, TP15, spit 2; MNZ S41709, ped phal 1dR I.1, Site 5, TP15, spit 2; MNZ S41710, 1L scap, Site 5, TP15, spit 2; MNZ S41711, 1sL1dL tt, Site 5, TP15, spit 2; MNZ S41712, 1pL cor, Site 5, TP15, spit 3; MNZ S41713, 1pR hum, Site 5, TP15, spit 3; MNZ S41714, ped phal 3R1L I.1, Site 5, TP15, spit 3; MNZ S41716, 1sL tmt, Site 5, TP15, spit 3; MNZ S41719, 1dR ulna, Site 5, TP15, spit 4; MNZ S41721, 1dR cor,

Table I. Measurements (mm) of tarsometatarsi of *D. harrisoni* compared with *D. lakeba*, *D. galeata*, and *D. david*. *CM*, *cond. medialis*; *FM1*, *fossa metatarsi I*; Length 2 - Length from post edge *CM* to prox end of *FM1*; Length 3 - Length from post edge *CM* to distal end of medial prom of *FM1*.

Species	Catalogue number	Length	Length 2	Length 3	PW	Depth <i>CM</i> across artic sulcus	Prox depth hypotarsal ridge to anterior face above main ridge	Width between prox foramina	SW greatest, at <i>FM1</i>	SW least (A)	SD at "A"	DW
<i>D. harrisoni</i>	Holotype MNZ S41609	–	24.0 (= 2.08*PW)	26.8	10.9 <sup>+</sup> (est 11.5)	6.1	11.5	2.3	5.0	–	–	–
<i>D. harrisoni</i>	MNZ S41715	–	–	–	–	–	–	–	5.05	6.6	3.4	11.4
<i>D. harrisoni</i>	MNZ S41613	–	–	–	11.4	6.3	–	–	–	–	–	–
<i>D. harrisoni</i>	MNZ S41692	–	–	–	10.9	6.2	–	–	–	–	–	–
<i>D. galeata</i>	MNZ 26971	41.3	22.5 (= 2.08*PW)	25.3	10.8	6.0	10.6	2.3	4.7	4.2	–	10.4
<i>D. david</i>	Holotype	NA	20.5 (= 1.72 *PW)	?	11.9	?	?	?	6.2	NA	3.9	–
<i>D. lakeba</i>	197-3-w-1-6, 6	47.0	25.25 (= 2.05*PW)	28.7	12.3	6.3	?	2.8	5.7	4.9	3.9	12.8
<i>D. lakeba</i>	Worthy 2001 (mean ± SD, range, count)	–	–	–	–	–	–	–	5.75 ± 0.169 5.5–6.1, 11	5.37 ± 0.257 4.7–5.6, 11	3.88 ± 0.271 3.4–4.2, 11	–

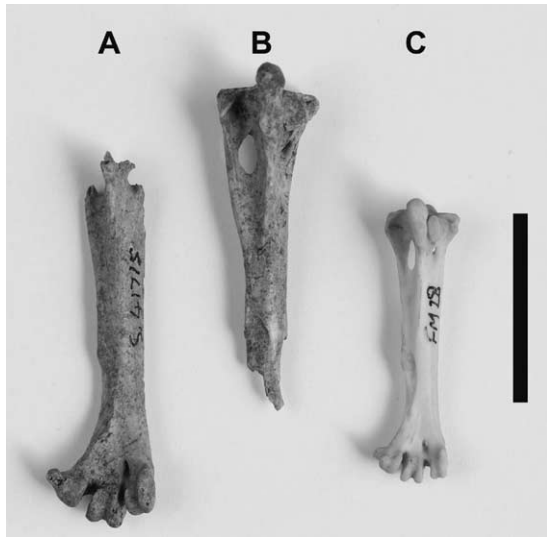


Figure 3. Tarsometatarsi of *D. harrisoni* and *D. latrans* in plantar view. A, MNZ S41715; B, MNZ S41609 (Holotype); C, FM28. Scale bar is 2 cm.

Site 5, TP16, spit 1; MNZ S41723, 1R scap, Site 5, TP16, spit 1; MNZ S41724, 1dR tt, Site 5, TP16, spit 1; MNZ S41725, 1sL ulna, Site 5, TP16, spit 1; MNZ S41726, 1pR cmc, Site 5, TP16, spit 2; MNZ S41729, 1dL hum, Site 5, TP16, spit 2; MNZ S41731, 2L scap, Site 5, TP16, spit 2; MNZ S41732, 1pR cmc, Site 5, TP16, spit 3; MNZ S41734, 1dR1pL1pR cor, Site 5, TP16, spit 3; MNZ S41736, 1pR hum, Site 5, TP16, spit 3; MNZ S41738, pmx, Site 5, TP16, spit 3; MNZ S41739, ped phal LI.1, Site 5, TP16, spit 3; MNZ S41740, 1L scap, Site 5, TP16, spit 3; MNZ S41741, pt L side stern, Site 5, TP16, spit 3; MNZ S41742, 1dL tmt, Site 5, TP16, spit 3; MNZ S41743, 1pR cmc, Site 5, TP16, spit 4; MNZ S41744, 1dL fem, Site 5, TP16, spit 4; MNZ S41745, 1sR1pR hum, Site 5, TP16, spit 4; MNZ S41746, pmx, Site 5, TP16, spit 4; MNZ S41747, 3L M2.1, Site 5, TP16, spit 4; MNZ S41748, 1dL rad, Site 5, TP16, spit 4; MNZ S41749, 1L scap, 5, TP16, spit 4; MNZ S41750, 1pR cor, 5, TP16, spit 5; MNZ S41751, 1sR tmt, Site 5, TP16, spit 6; MNZ S41752, 1pL hum, Site 5, TP16, burrow (50); MNZ S41754, M1.1, Site 5, TP16, burrow (50); MNZ S41756, L M2.1, Site 5, TP97; MNZ S41756, ped phal RI.1, Site 5, TP97; MNZ S41757, 1R metatarsal, Site 6, TP1, spit 16; MNZ S41759, 1sR ulna, Site 6, TP3, spit 3; MNZ S41761, 1dL1R cmc, Site 6, TP3, spit 4; MNZ S41762, 1dL rad, Site 6, TP4, spit 5; MNZ S41763, 1L scap, Site 10, TP2, spit 6; MNZ S41764, 1sL hum, Site 12, TP2, spit 10; MNZ S41765, 1R M2.1, Site 12, TP2, spit 10.

*Description:* The fossa metatarsi I is relatively smaller than it is in *D. david* (Figure 3). The *foramina vascularia proximalis* are proportioned as in *D. latrans* and *D. pacifica* with the medial one very much larger than the lateral one, which latter is relatively larger

than that of *D. david*. In the sulcus *extensorius*, there is a ridge extending distad from the area between the *foramina vascularia proximalis*, which is bound by grooves on each side as it does in *D. latrans*, but in *D. david* and *D. pacifica* the sulcus *extensorius* is nearly flat below the medial foramen. Trochlea II and IV are rotated plantarly of trochlea III such that a line joining the distal medial condyles of trochlea II and IV passes distad of the condyles of trochlea III. In strictly arboreal taxa such as *D. pacifica*, *D. latrans* and *D. galeata* the three trochlea are on the same plane. The rotated condition seen in *D. harrisoni* is seen in *D. lakeba*.

The femora MNZ S41662, 41735 (Figure 4) are typical of *Ducula*, but are slightly shorter and more slender than the smallest *D. lakeba* femur (Table II). They have relatively broader distal and proximal ends than the BMNH specimen of *D. galeata*, and are bigger than any other extant species of *Ducula* (Appendix 1).

The tibiotarsi fragments MNZ S41693, 41711, 41717, 41724 (Figure 4) of *D. harrisoni* have the typical features of *Ducula* (Worthy 2001). The distal tibiotarsus of *D. harrisoni* is broader than that of the largest extant species, *D. galeata* (Table III, Appendix 1), and smaller than the largest known fossil species *D. lakeba*, and the tibiotarsus of *D. david* is not known.

Humeri are best represented by distal (MNZ S41649, 41722) and proximal (MNZ S41641) fragments that are typical of *Ducula* and present no distinguishing features (Figure 4). They are slightly

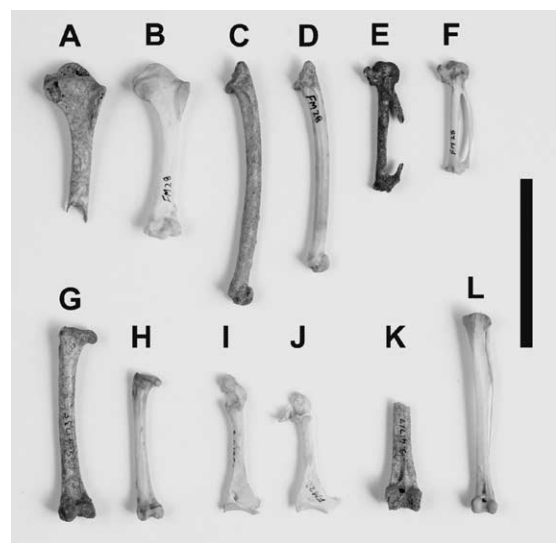


Figure 4. Long bones of *D. harrisoni* (A, MNZ S41641; C, MNZ S41657; E, MNZ S41684; G, MNZ 41735; I, MNZ S41758; K, MNZ S41717) compared to those of *D. latrans* (FM28) B, D, F, H, J, L. A, B left humeri in cranial view; C, D right ulnae in ventral aspect; E, F right carpometacarpi in ventral aspect; G, H left femora in caudal aspect; I, J right coracoids in dorsal aspect; K, L left tibiotarsi in anterior aspect. Scale bar is 5 cm.

Table II. Measurements (mm) for femora of selected species of *Ducula*. Data for *D. lakeba* (mean  $\pm$  SD, range, count) from data in Worthy (2001). Abbreviations as in methods: and SD, shaft depth; PD, proximal depth; DD, distal depth.

Species	Catalogue no.	Length	PW	PD	SW midpoint	SD midpoint	DW	DD
<i>D. lakeba</i>		57.9, 61.4	12.41 $\pm$ 0.217 12.1–12.6, 4	9.4, 9.5	5.53 $\pm$ 0.225 5.3–5.9, 6	5.10 $\pm$ 0.071 5.0–5.2, 5	12.40 $\pm$ 0.356 12.1–12.8, 4	9.83 $\pm$ 0.33 9.5–10.2, 4
<i>D. harrisoni</i>	MNZ S41735	57.1	11.4	8.3	4.6	4.4	11.2	8.5
<i>D. harrisoni</i>	MNZ S41744						10.9	8.4
<i>D. harrisoni</i>	MNZ S41662	60.0	11.7	8.5	4.6		11.8	8.8
<i>D. harrisoni</i>	MNZ S41662		11.3					
<i>D. harrisoni</i>	MNZ S41632		11.1 +	8.4				
<i>D. galeata</i>	BMNH S/1975.9.5	58.6	10.8		4.6		10.9	

Table III. Measurements (mm) for tibiotarsi of selected species of *Ducula*. Data for *D. lakeba* from Worthy (2001). Abbreviations as in methods: and lc, *cond. lateralis*; mc, *cond. medialis*.

Species	Catalogue number	DW	Depth lc	Depth mc
<i>D. lakeba</i>	197-3-w-2, 2	11.4	9.2	10.2
<i>D. lakeba</i>	197-3-w-2, 13	11.3	9.0	10.1
<i>D. harrisoni</i>	MNZ S41724	10.6	8.8	–
<i>D. harrisoni</i>	MNZ S41693	10.6	9.0	–
<i>D. harrisoni</i>	MNZ S41717	10.6	–	–
<i>D. harrisoni</i>	MNZ S41717	10.6	9.3	9.4
<i>D. harrisoni</i>	MNZ S41711	10.8	8.5	9.5
<i>D. galeata</i>	MNZ 26791	10.2	8.3	9.0

bigger than those of *D. latrans* but much smaller than those of *D. galeata* or *D. goliath* (Table IV, Appendix 2). The ulna (MNZ S41657) is similar in form to those of other *Ducula* species (Figure 4), but it and other fragments are smaller than those of *D. goliath* and *D. galeata* (Table V, Appendix 2). It differs from extant taxa such as *D. latrans* and *D. pacifica* in that the olecranon is less produced anteriorly of the cotylae. The preserved carpometacarpi have the typical form of *Ducula* but are smaller than those of *D. galeata* and *D. goliath* and slightly bigger than those of *D. latrans* (Table VI, Appendix 2).

The coracoids (Table VII, Figure 4) have typical features of *Ducula* (Worthy 2001). They are much smaller than those of *D. lakeba* and smaller than those of *D. galeata* and *D. goliath*, and are slightly bigger than *D. latrans* (Appendix 2). The sternum (Figure 5) has a lower angled *pila carinae* and a shallower *carina sterni* than a similar length sternum of *D. latrans*.

### Discussion

Historically, and at present, large imperial fruit pigeons have a disjunct distribution in the Pacific (Figure 1), with the largest species, *D. goliath*, in New Caledonia, and *D. galeata* in the Marquesas, and none of similar size known from the intervening area (Goodwin 1967). The first indication that there had been a prehistoric presence of such large imperial fruit pigeons in the intervening area was when *D. david* was described from an archaeological site on Wallis or Uvea Island (Balouet and Olson 1987). Large *Ducula* bones were then recorded from archaeological sites on Mangaia in the Cook Islands, and Huahine in the Society Islands, and referred to *D. galeata* (Steadman 1989a b, 1995, 1997). And in the same period other large *Ducula* bones from Lifuka, Ha'apai Group, and from caves on 'Eua, in Tonga were referred to *D. david* (Steadman 1989b, 1993, 1995, 1997). Bones of a pigeon nearly as large as *Goura*, referred to as *Ducula* nsp, were also reported from Lifuka and 'Eua (Steadman 1989b, 1993, 1997). The extinction of these large species has allowed the spread

Table IV. Measurements (mm) of *Ducula* humeri. Those for *D. lakeba* from Worthy (2001). Abbreviations as in methods: and SD, shaft depth; DD, distal depth through *condylus dorsalis*.

Species	Catalogue number	PWmax	PW from dors tub	SW midpoint	SD midpoint	DW	DD
<i>D. lakeba</i>	197-v-2, 1	–	–	7.4	6.0	–	–
<i>D. lakeba</i>	197-3-w-1-4, 10	–	–	–	–	>16.8	–
<i>D. galeata</i>	MNZ 26791	21.1	17.6	6.1	–	14.6	–
<i>D. harrisoni</i>	MNZ S41649	–	–	5.1	4.3	12.8	–
<i>D. harrisoni</i>	MNZ S41722	–	–	–	–	12.4	7.2
<i>D. harrisoni</i>	MNZ S41641	20.1	16.5	5.7	5.0	–	–
<i>D. harrisoni</i>	MNZ S41641	–	16.6	–	–	–	–

Table V. Measurements (mm) of *Ducula* ulnae. Those for *D. lakeba* from Worthy (2001). Abbreviations as in methods: and SD, shaft depth; W cond dors uln is width across *condylus dorsalis ulnaris*.

Species	Catalogue number	Length	PW	SW midpoint	SD midpoint	DWmax	W cond dors uln
<i>D. lakeba</i>	197-3-w-1-4	–	–	5.7	6.4	–	8.7
<i>D. lakeba</i>	197-3-v-1, 5	–	–	5.3	5.8	–	–
<i>D. harrisoni</i>	MNZ S41657	71.5	8.1	4.2	4.7	7.9	7.7
<i>D. harrisoni</i>	MNZ S41719	–	–	–	–	8.0	8.0
<i>D. harrisoni</i>	MNZ S41645	–	–	4.1	5.0	8.0	7.4
<i>D. harrisoni</i>	MNZ S41695	–	8.4	–	–	–	–
<i>D. harrisoni</i>	MNZ S41695	–	–	4.1	4.5	–	–
<i>D. harrisoni</i>	MNZ S41695	–	–	–	–	7.6	7.6

of *D. pacifica* into some groups, e.g. Tonga (Steadman 1997).

More recently, Worthy (2001) has described the large *Ducula lakeba* from Lakeba, Lau Group, Fiji, and reported a similar sized species of *Ducula* from Vitilevu. The Lakeba bones had been previously reported as *D. david* (Steadman 1997), but *D. lakeba* has a more slender and elongate tarsometatarsus than that species. The description here of *D. harrisoni* from Henderson Island in the Pitcairn Group, reveals another similar sized *Ducula* species. It resolves the problem of having two *Ducula* species reported from the island, one *D. cf aurorae* on wing elements, and the other *D. cf galeata* on

leg elements and a part mandible (Steadman and Olson 1985), into a single species as predicted by Bourne and David (1986). The continued reporting of a former widespread distribution for *D. galeata*, e.g. on Marquesas, Pitcairn Group, Society Islands and Cook Islands (Steadman 1997) thus needs to be checked. It seems that the large species of *Ducula* reported from the Society Islands and Cook Islands are more likely to represent distinct species. The large species of *Ducula* in Tonga may be *D. david*, *D. lakeba*, or another undescribed form, which latter position might be predicted from the presence of other apparent endemics to the group (Steadman 1993).

Table VI. Measurements (mm) of extinct *Ducula* carpometacarp. Those for *D. lakeba* from Worthy (2001). Abbreviations as in methods. PW is taken parallel to shaft. DW is across the articular facets and excludes the *os metacarpale minus*.

Species	Catalogue number	Length	PW	SW max midpoint	DW
<i>D. lakeba</i>	197-3-w-1-8, 4	–	–	5.4	8.4
<i>D. lakeba</i>	197-1-w-2	–	–	4.7	8.4
<i>D. lakeba</i>	197-3-w-1-5, 2	–	13.5	4.08	–
<i>D. harrisoni</i>	MNZ S41605	–	11.0	–	–
<i>D. harrisoni</i>	MNZ S41726	–	10.8	–	–
<i>D. harrisoni</i>	MNZ S41743	–	11.4	–	–
<i>D. harrisoni</i>	MNZ S41699	–	11.0	–	–
<i>D. harrisoni</i>	MNZ S41617	39.6	11.0	3.9	6.7
<i>D. harrisoni</i>	MNZ S41684	39.1	10.6	4.0	6.5
<i>D. harrisoni</i>	MNZ S41675	–	–	4.1	7.0
<i>D. harrisoni</i>	MNZ S41675	–	–	3.9	6.6
<i>D. harrisoni</i>	MNZ S41675	–	–	4.1	7.0
<i>D. harrisoni</i>	MNZ S41675	–	–	4.1	6.9
<i>D. harrisoni</i>	MNZ S41683	–	11.1	–	–

Table VII. Measurements (mm) of extinct *Ducula* coracoids. Those for *D. lakeba* from Worthy (2001). Abbreviations as in methods: fas is *facies articularis sternalis*; Length cot scap to acrocor is length from the sternal side of the *cotyla scapularis* to the tip of the *proc. acrocoracoideus*.

Species	Catalogue number	Length medial	Length to cot. scap. from middle of fas	Length to middle of fas	SW least	Width sternal facet	Length cot scap to acrocor
<i>D. lakeba</i>	197-3-w.1.6, 17	-	-	-	-	-	14.7
<i>D. lakeba</i>	197-3-w-2, 9	-	-	-	-	-	15.6
<i>D. lakeba</i>	197-3-w-1-7, 48	-	36.7	-	4.2	13.7	-
<i>D. harrisoni</i>	MNZ S41758	40.3 +	30.0	39.8	3.2	-	12.0
<i>D. harrisoni</i>	MNZ S41728	-	30.2	41.5	3.6	-	13.3
<i>D. harrisoni</i>	MNZ S41639	-	31.4	41.8	3.7	-	12.5
<i>D. harrisoni</i>	MNZ S41640	42.2	31.0	40.8	3.3	11.8	12.2
<i>D. harrisoni</i>	MNZ S41618	41.6	30.7	40.9	3.5	-	12.2
<i>D. harrisoni</i>	MNZ S41750	-	-	-	-	-	12.8
<i>D. harrisoni</i>	MNZ S41705	-	-	-	-	-	12.9
<i>D. harrisoni</i>	MNZ S41624	-	-	-	-	-	12.8
<i>D. harrisoni</i>	MNZ S41677	-	-	-	-	-	12.8

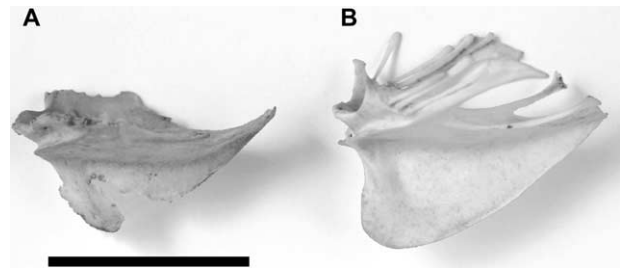


Figure 5. Sterni of *D. latrans* and *D. harrisoni* in left lateral view. Scale bar is 4 cm. Note the lower angled *pila carinae* in *D. harrisoni*.

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Appendix 1. Measurements for different leg elements of *Ducula* spp. Specimens are individuals except for the different elements of *D. goliath* MNZ 22839 which includes bones of three mixed individuals.

Species	Catalogue	FemL	FemP	FemS	FemD	TibL	TibP	TibS	TibD	TmtL	TmtP	TmtS	TmtD
<i>Ducula galeata</i>	NHM S/1975.9.5	58.6	10.8	4.6	10.9	82.1	10.4	4.3	10.2	41.3	10.8	4.2	10.4
<i>Ducula goliath</i>	MNZ 22839	53.7	11.01	4.5	10.8		8.6	4.0					
<i>Ducula goliath</i>	MNZ 22839	53.1	10.7	4.7	10.8		9.0	4.2					
<i>Ducula goliath</i>	MNZ 22839	55.0	11.1	4.7	10.7	71.3	8.7	4.2	9.8				
<i>Ducula latrans</i>	NHM S/1975.3.4	47.0	9.2	3.7	8.8	66.0	7.6	3.6	8.0	33.8	8.6	3.6	
<i>Ducula latrans</i>	MVZ 51372	45.2	9.6	4.1	9.2	62.7	7.4	3.7	8.2	31.4	8.8	3.6	8.8
<i>Ducula latrans</i>	FM 28	43.3	8.4	3.6	8.5	59.4	6.7	3.5	7.3	29.6	7.9	3.4	8.7
<i>Ducula latrans</i>	NHM S/1975.3.2	46.6	8.9	4.0	8.5	64.3	7.1	3.2	8.1	32.3	8.7	3.6	7.8
<i>Ducula melanochroa</i>	USNM 615013	53.4				69.3				34.0			8.7
<i>Ducula pacifica</i>	MNZ NHS19	46.0	8.8	3.8	9.0	62.4	6.9	3.5	7.9	30.6	8.6	3.6	
<i>Ducula pacifica</i>	MNZ 16389a	44.9											8.4
<i>Ducula pacifica</i>	AIM 7233	47.9	9.1	3.8	8.7	63.8	7.6	3.8	7.5	32.2	8.4	3.9	
<i>Ducula pacifica</i>	AIM 7262	47.6	8.6	3.7	8.7	65.0	7.1	3.3	7.7	31.8	8.0	3.4	8.2
<i>Ducula pacifica</i>	MNZ 25353	46.6	8.8	4.2	9.4	66.0	7.8	3.6	8.4				8.0
<i>Ducula pacifica</i>	MNZ 25352					62.4	6.8	3.8	7.7				
<i>Ducula pacifica</i>	MNZ 25351	45.6	8.6	4.0	9.3			3.6	8.0				
<i>Ducula pacifica</i>	MNZ 25350	48.6	9.0	3.8	8.7	66.9	7.0	3.5	8.6	33.0	9.1	3.8	
<i>Ducula pistrinaria pistrinaria</i>	UWBM 60203	48.7	10.8	4.2	9.8	61.6	8.4	4.1	8.8	31.9	9.3	3.8	8.4
<i>Ducula rubricera rufigula</i>	UWBM 63088	50.6	10.5	4.4	10.2	63.2	8.1	4.2	9.1	32.4	9.8	3.9	

Appendix 2. Measurements for different wing elements of *Ducula* sp. Specimens are individuals except for the different elements of *D. goliath* MNZ 22839 which includes bones of three mixed individuals.

Species	Catalogue	HumL	HumP	HumS	HumD	UlnaL	UlnaP	UlnaS	UlnaD	CmcL	CmcP	CorL
<i>Ducula galeata</i>	NHM S/1975.9.5		17.7	6.0	14.1		9.9	4.6	7.8		11.2	47.1
<i>Ducula goliath</i>	MNZ 22839		22.3		14.3	84.8	10.1	4.8	9.0			44.6
<i>Ducula goliath</i>	MNZ 22839	72.3	24.1	6.5	15.1	84.5	9.8	4.9	9.0			48.6
<i>Ducula goliath</i>	MNZ 22839	71.9	23.5	6.7	15.5	82.9	9.6	5.1	8.7		11.8	45.6
<i>Ducula goliath</i>	MNZ 22839	72.1	23.5	6.9	14.9	77.3	9.4	5.1	8.4	45.0	12.3	48.4
<i>Ducula latrans</i>	NHM S/1975.3.4	57.3	17.8	5.3	12.1	67.8	8.7	3.9	6.9	38.0	10.0	41.5
<i>Ducula latrans</i>	MVZ 51372	55.8	19.6	5.7	12.3	66.4	8.0	4.3	7.4	36.6	10.2	40.2
<i>Ducula latrans</i>	FM 28	52.2	17.9	5.2	11.2	62.0	7.2	3.8	6.7	34.2	9.6	36.1
<i>Ducula latrans</i>	NHM S/1975.3.2	56.9	17.8	5.6	11.8	67.4	8.0	4.0	6.7	36.2	9.6	38.6
<i>Ducula melanochroa</i>	USNM 615013	64.8				75.0				42.2		48.0
<i>Ducula pacifica</i>	MNZ NHS19	55.0	18.4	5.0	11.6	65.5	7.7	3.7	7.0	34.4	9.9	37.5
<i>Ducula pacifica</i>	AIM 7233	56.1	18.6	5.0	11.6	66.2	7.0	3.8	7.0		9.9	38.9
<i>Ducula pacifica</i>	AIM 7262	56.8	18.3	4.7	11.1	67.4	7.4	3.6	6.6	36.3	9.3	37.8
<i>Ducula pacifica</i>	MNZ 25353	58.2	18.1	5.4	11.9	68.4	7.6	4.1	7.0	37.8	10.1	39.9
<i>Ducula pacifica</i>	MNZ 25352	56.3	18.4	5.5	11.8	67.2	7.3	4.0	6.8	36.5	9.9	37.5
<i>Ducula pacifica</i>	MNZ 25351	54.4	17.6	5.0	11.3	64.8	7.1	3.7	6.7	36.1	9.9	36.6
<i>Ducula pacifica</i>	MNZ 25350	57.6	18.6	4.9	11.3	67.8	7.3	3.9	6.7	36.8	10.0	40.0
<i>Ducula pistrinaria pistrinaria</i>	UWBM 60203	60.1	22.5	6.3	14.0							41.6
<i>Ducula rubricera rufigula</i>	UWBM 63088	58.6	21.7	6.2	8.2		8.9	4.8	7.9	37.7	11.4	43.0
<i>Ducula zoeae</i>	AMNH	59.4				69.7				38.8		44.6

Appendix 3. Samples of *Ducula harrisoni* bones dated (Hedges et al.1997).

Element	Site	Testpit	Spit	Oxford Laboratory identifier	CRA (years BP)
1sL tt	5	8	3	OxA6016	755 ± 55
1sR tmt	5	8	4	OxA6017	900 ± 55
1R tmt	5	9	8	OxA5453	2065 ± 55
ant sternum	6	1	7	OxA5452	800 ± 50
dR fem	5	8	1	OxA6015	860 ± 55
ant sternum	5	1	6	OxA5454	1295 ± 50