

Order PASSERIFORMES

The largest and most diverse order of birds, commonly called passerines or perching birds, and comprising some 5712 species in 45 families (based on Sibley & Monroe 1990; Sibley & Ahlquist 1990), and well over half the world's known bird species. In the HANZAB region, Passeriformes represented by some 382 species in 39 families. Tiny to large: smallest passerine is Pygmy Tit *Psaltria exilis* of Java, with a total length c. 8 cm; largest is Greenland Raven *Corvus corax principalis*, with a total length c. 64 cm and weighing up to 1.7 kg. Superb Lyrebird *Menura novaehollandiae* of e. Aust. probably second largest in Order, with a total length (in adult male) of c. 103 cm, including tail of c. 70 cm, and weight up to c. 1.1 kg. Cosmopolitan except Antarctica and some oceanic islands; and occupying all terrestrial habitats.

Overall, Passeriformes are characterized by (based on Raikow 1982; Sibley & Ahlquist 1990; and DAB [=Schodde & Mason 1999]): Palate aegithongnathous (except Conopophagidae [gnateaters]). Intestinal caeca rudimentary. Single left carotid artery (except paired in *Pseudocalyptomena* and possibly other broadbills [Eurylaimidae]). Aftershaft reduced or absent. Neck short, with 14 cervical vertebrae in most, but 15 in Eurylaimidae (broadbills); atlas perforated; metasternum usually two-notched (rarely four-notched). Bicep slip absent. Expansor secundariorum often present (Berger 1956; Raikow 1982; *contra* Beddard 1898; Ridgeway 1901). Pelvic muscles AXY (AX in *Dicrurus* [drongos]). Ambiens absent. Iliofemoralis externus usually absent, but present in some groups as 'developmental anomaly' (Raikow 1982). Tensor propatagialis brevis tendon present. Hypocleideum present (except Menuridae [lyrebirds]). Wings eutaxic. Usually ten primaries, but p10 often reduced or absent; 11 primaries in Menuridae (lyrebirds), most Eurylaimidae (broadbills), most Furnariidae (ovenbirds), and some Passeri (oscines [see below]). Usually nine secondaries (ten in Menuridae [lyrebirds]). Usually 12 rectrices, but from six (*Stipiturus* [Maluridae]) to 16 (Menuridae). Lesser primary and secondary coverts usually reduced or absent (Zeidler 1966; Morlion 1985; Winkler & Jenni 1996), but a few well-developed lesser primary coverts are present in Superb Lyrebird (Morlion 1985). Uropygial preen glands naked. No basipterygoid process. Nasal glands minute. Foot anisodactyl. Hallux incumbent, large and directed backwards; toes 2, 3 and 4 directed forward; digital formula 2-3-4-5. Deep plantar tendons usually of type VII (lacking vinculum), but often type I in Eurylaimidae (broadbills). Spermatozoa bundled with coiled head and large acrosome.

The DNA-DNA hybridization studies of Sibley & Ahlquist (1985a, 1990) revealed much about the relationships within the Passeriformes and resulted in fundamental changes to the higher level taxonomy of passerines, not least to the taxonomy of the Australo-Papuan oscine passerines. Importantly, these studies showed that many elements of the Australo-Papuan avifauna (e.g. the A'asian wrens [Maluridae], robins [Petroicidae], babblers [Pomatostomidae], and so on), represent an endemic radiation of forms that bear an external resemblance to Eurasian families. Many of the findings of DNA-DNA hybridization studies regarding the Australo-Papuan oscines have since been broadly corroborated by studies using protein allozymes (e.g. Christidis 1991; Christidis & Schodde 1991) and microcomplement fixation (e.g. Baverstock *et al.* 1991, 1992), though there are also many points that remain uncertain and many familial relationships within the Passeriformes are unresolved (Christidis & Boles 1994). (For discussion of historical taxonomic arrangements preceding results of DNA-DNA hybridization studies, see BWP, and Sibley & Ahlquist [1985a,b, 1990]).

The Passeriformes divide into two main groups:

SUBORDER TYRANNI (SUBOSCINES): The distribution of the suboscines is centred in the American and Afro-asian Tropics, with a massive radiation in South America (Sibley & Ahlquist 1990; DAB). Suboscines characterized by mesomyodian syrinx, with or without a single pair of intrinsic syringeal muscles (van Tyne & Berger 1976; Campbell & Lack 1985; DAB). Suborder sometimes named Oligomyodi (e.g. Sibley & Ahlquist 1985a,b), Deutero-Oscines (e.g. Morony *et al.* 1975; Voous 1977), or Clamatores (Campbell & Lack 1985). Poorly represented in the HANZAB region: only TYRANNIDAE (tyrant-flycatchers), with two species, both accidental to South Georgia; ACANTHISITTIDAE (NZ wrens), with four species (one extinct) in three genera, endemic to NZ; and PITTIDAE (pittas), with four species in one genus in HANZAB region (three breeding, one accidental). Tyranni formerly included the Menuridae and Atrichornithidae (e.g. Wetmore 1960; Storer 1971), though subsequently shown that these two families should be included in Passeri (e.g. Sibley 1974; Sibley & Ahlquist 1985, 1990).

SUBORDER PASSERI (OSCINES OR SONGBIRDS): Cosmopolitan in distribution. Within the HANZAB region there are 36 families of Passeri. The Australo-Papuan Passeri can be subdivided into several supra-familial groups, but those recognized differ between authors (for further information, see Sibley & Ahlquist 1985, 1990; DAB). Oscines are

characterized by acromyodian syrinx, with three or four pairs of intrinsic syringeal muscles (van Tyne & Berger 1976; Campbell & Lack 1985; Sibley & Ahlquist 1990; DAB).

Suborder Passeri comprises the major element of the Aust. and NZ passerine avifauna. The families recorded in the HANZAB region, and the representatives in the region, are (following Christidis & Boles [1994] for Aust., with additional species for wider region added as appropriate):

-
- MENURIDAE (lyrebirds): two species in one genus; endemic to Aust.;
- ATRICHORNITHIDAE (scrub-birds): two species in one genus; endemic to Aust.;
- CLIMACTERIDAE (A'asian treecreepers): six species in two genera breeding in Aust.;
- MALURIDAE (Australopapuan fairy-wrens, emu-wrens and grasswrens): 22 breeding species in three genera in Aust.;
- MELIPHAGIDAE (honeyeaters and Aust. chats): 76 species in 26 genera in Aust. and NZ, all breeding;
- PARDALOTIDAE (pardalotes, scrubwrens, thornbills and allies): 51 species (one extinct) in 15 genera in HANZAB region, all breeding;
- PETROICIDAE (A'asian robins): 23 species in eight genera in HANZAB region, all breeding;
- ORTHONYCHIDAE (logrunners): two breeding species in one genus in Aust.;
- POMATOSTOMIDAE (A'asian babblers): four breeding species in single genus in Aust.;
- CINCLOSOMATIDAE (whipbirds, wedgebills, quail-thrushes and jewel-babblers): eight breeding species in two genera in Aust.;
- NEOSITTIDAE (sitellas): single species breeding in Aust.;
- PACHYCEPHALIDAE (whistlers, shrike-thrushes and allies): 17 species in seven genera in HANZAB region, all breeding;
- DICRURIDAE (monarchs, flycatchers, fantails and drongos): 19 species in seven genera in HANZAB region, all breeding;
- CAMPEPHAGIDAE (cuckoo-shrikes, trillers and minivets): eight species (one extinct) in two genera in HANZAB region, all breeding;
- ORIOLIDAE (Old World orioles and figbirds): three species in two genera in Aust., all breeding;
- ARTAMIDAE (woodswallows, butcherbirds and currawongs): 14 species in four genera in HANZAB region, all breeding;
- PARADISAEIDAE (birds of paradise): five breeding species in two genera in Aust.;
- CORVIDAE (crows and jays): six breeding species in single genus in Aust. and NZ, including one introduced to NZ;
- CORCORACIDAE (Aust. mudnesters): two species in two monospecific genera, endemic to Aust.;
- CALLAEIDAE (NZ wattlebirds): three species (one extinct) in three monospecific genera, endemic to NZ;
- LANIIDAE (shrikes): two species in HANZAB region, one accidental to Prince Edward Is, the other accidental to Christmas I.;
- PTILONORHYNCHIDAE (bowerbirds): ten species in seven genera in Aust. (nine species) and NZ (one species), all breeding; Piopio of NZ probably extinct (Heather & Robertson 1997);
- ALAUDIDAE (larks): two breeding species in HANZAB region (including one successfully introduced to Aust. and NZ);
- MOTACILLIDAE (wagtails and pipits): eight species in two genera in HANZAB region, only two breeding (one on South Georgia), the rest non-breeding visitors or accidentals;
- PRUNELLIDAE (accentors): one species successfully introduced to NZ;
- PASSERIDAE (Old World sparrows and A'asian finches): 22 species in nine genera (including four successful introductions) in HANZAB region, all breeding;
- FRINGILLIDAE (Old World finches): seven species in four genera in HANZAB region, all introduced except one naturally occurring vagrant to South Georgia;
- EMBERIZIDAE (buntings, cardinals, tanagers and allies): two successfully introduced species, occurring NZ and Lord Howe I.;
- NECTARINIIDAE (sunbirds and spiderhunters): single breeding species in Aust.;
- DICAEDIDAE (flowerpeckers): single breeding species in Aust.;
- HIRUNDINIDAE (swallows and martins): eight species in four genera in HANZAB region, including four breeding species in Aust. and NZ, one non-breeding visitor and three accidentals;
- PYCNONOTIDAE (bulbuls): one successfully introduced species in Aust.;
- SYLVIIDAE (Old World warblers): 13 species in eight genera in HANZAB region, including ten breeding species (one extinct) in Aust. and NZ, and three accidental to region;
- ZOSTEROPIDAE (white-eyes): seven species (one extinct) in single genus in HANZAB region, all breeding;
- MUSCICAPIDAE (Old World flycatchers, thrushes and chats): eight species in six genera in HANZAB region, including five breeding species (two introduced), and four accidentals (including one on Prince Edward Is);
- STURNIDAE (starlings and mynas): five species in four genera, four breeding in HANZAB region (including two species successfully introduced, and one species now extinct), and one accidental.
-

The Aust. oscines fall into two distinct clusters, each with at least three major supra-familial lineages (DAB): One cluster is the Passerida, comprising the Muscicapoida (including true thrushes and allies), Sylvioidea (true warblers and babblers, and swallows, and others), and Passeroidea (including larks, pipits, sunbirds, flowerpeckers and all finches and their allies). The other cluster is the Corvida, which is centred on the Australo-Papuan region (though its origins are not certain) and which also comprises three main lineages: Menuroidea (lyrebirds, scrub-birds, treecreepers and bowerbirds), Meliphagoidea (A'asian wrens, pardalotes, acanthizid warblers, and honeyeaters), and Corvoidea (A'asian robins, logrunners, A'asian babblers, whipbirds and quail-thrushes, sitellas, whistlers, fantails and monarchs, birds of paradise, butcherbirds and woodswallows, cuckoo-shrikes, Old World orioles, crows and mudnesters).

Throughout this volume, arrangement of families follows that of Christidis & Boles (1994) except that the Meliphagidae precedes the Pardalotidae. This change was made to ensure the Meliphagidae were dealt with in a single volume, rather than split between volumes, and because the switch meant no change to the positioning of Meliphagidae relative to the Pardalotidae (including Acanthizidae), one another's closest relatives, and because there is little overriding evidence of the exact taxonomic positioning of all families within the Meliphagoidea; Sibley & Monroe (1990) also placed the Meliphagidae between the Maluridae and Pardalotidae. However, DAB points out that based on structure of humeral fossa, positioning of Meliphagidae between the Maluridae and Pardalotidae is not correct.

DAB, however, varies from the familial arrangement of Christidis & Boles (1994) in several ways. The main differences are: (1) recognition of Pardalotidae and Acanthizidae as separate families (combined in Pardalotidae in Christidis & Boles); (2) minor rearrangement of the sequence of the families Paradisaeidae–Artamidae–Campephagidae–Oriolidae between the Dicuridae and Corvidae (cf. Dicuridae–Campephagidae–Oriolidae–Artamidae–Paradisaeidae–Corvidae in Christidis & Boles); (3) and use of the more traditional muscicapoid (flycatcher) – sylvioid (warbler) – passeroid (finch) sequence of Sibley *et al.* (1988), Sibley & Ahlquist (1990) and Sibley & Monroe (1990) and much contemporary literature of n. hemisphere, with families in the sequence Muscicapidae–Sturnidae–Hirundinidae–Pycnonotidae–Zosteropidae–Sylviidae–Alaudidae–Dicaeidae–Nectariniidae–Passeridae–Motacillidae–Estrildidae–Fringillidae and noting recognition of the Estrildidae as a separate family (cf. the reversed sequence of Christidis & Boles, as given above, and which submerges the Estrildidae within the Passeridae). For discussion of the reasons for these changes, see DAB (and discussion under these families in future volumes of HANZAB).

Arrangement of genera and species within families also follows Christidis & Boles (1994), which was in turn largely based on Schodde (1975) unless there were specific reasons for change. Lastly, with few exceptions, which are discussed in individual species accounts, taxonomy of subspecies follows DAB.

Passerines are extremely diverse in body form and plumage, and vary greatly in rates of maturation. Some attain adult plumage within months or weeks of fledging; others can take up to 9 years to attain adult plumage (e.g. Superb Lyrebird). Degree of sexual dimorphism also varies greatly: some monomorphic, others vary in either size, plumage or both. Common pattern of annual moult is a single complete post-breeding (pre-basic) moult, but some groups (e.g. Maluridae) or species (e.g. Banded Honeyeater *Certhionyx pectoralis*) also undergo a partial pre-breeding (pre-alternate) moult annually. Moult of primaries usually outward. Secondaries moult from innermost and outermost toward s5. Moult of tail usually centrifugal (outward from centre). Young altricial, nidicolous and dependent on adults for food; usually hatch with sparse to very sparse covering of down, mainly on dorsum; Menuridae (lyrebirds) have heavy natal down. Juvenile plumage usually duller than adult, and in many sexually dimorphic species, often similar to that of adult female.

There are few common features of food, feeding behaviour, social organization and behaviour, voice or breeding in such a large and diverse group of birds.

Volant; extinct Stephens Island Wren *Traversia lyalli* probably the only flightless passerine (Millener 1988). Movements vary greatly: some species long-distance migrants (e.g. Barn Swallow *Hirundo rustica*, Nightingale *Luscinia megarhynchos* and many Old World warblers, such as *Acrocephalus* and *Locustella*, breed in temperate Palaearctic and migrate to Africa or Indian subcontinent [BWP]; Acadian Flycatcher *Empidonax virescens* breeds North America and migrates to South America [Ridgely & Tudor 1994]), others sedentary in small territories (e.g. Cactus Wren *Campylorhynchus brunneicapillus* of sw. USA and Mexico [Ricklefs 1975; Ehrlich *et al.* 1988]). In HANZAB region, movements also vary widely: e.g. Yellow-faced Honeyeater *Lichenostomus chrysops* regular annual migrant in parts of e. Aust.; Rifleman *Acanthisitta chloris* of NZ sedentary in small territories. In Aust., movements often poorly known and unstudied; many species often said to be nomadic, with such claims often based on no or very poor knowledge of actual movements and based only on apparently irregular occurrence in an area (see General Introduction [Movements] for fuller discussion of this point).

Arboreal or terrestrial or both; some strictly arboreal (e.g. Hirundinidae), others strictly terrestrial (e.g. Menuridae, Pittidae); most combine both arboreal and terrestrial foraging to varying degrees, but usually with one predominating. Feed on almost all known food, from plant material to vertebrate animals, but most show some specialization for certain food, such as feeding on nectar (Nectariniidae), seeds (Passeridae), fruit (Zosteropidae), small vertebrates (Artamidae) and, commonly, insects (e.g. Maluridae, Pardalotidae, Petroicidae and others). Mostly feed by gleaning

and probing, including probing flowers for nectar; and other substrates for invertebrates; also feed by sallying, including various sallying techniques (sally-hovering, sally-striking and sally-pouncing), each suited for one group of prey, particularly moving animals.

In passerines, parental care in both sexes is well developed. However, a few species are parasitic, e.g. cowbirds *Molothrus* (Campbell & Lack 1985). Young are dependent on parents for food. Young beg by gaping, typically exposing brightly coloured inside of mouth, often with contrasting pale or dark spots; in non-passerines, bright gape present only in hoopoes (Upupidae), mousebirds (Coliiformes) and cuckoos (Cuculiformes) (BWP). See Boles & Longmore (1985) for descriptions of colours and markings inside the mouths of some Aust. passerines.

Anting is a highly specialized behaviour: ants are held in the bill and applied to the plumage, usually to the underside of the wing-tip (direct or active anting, or ant-application), or ants are allowed access to the plumage (indirect or passive anting, or ant-exposure), or both, e.g. anting recorded in Regent Honeyeaters *Xanthomyza phrygia* in HANZAB region, with bird then seen eating ant. Thought to be unique to Passeriformes (e.g. Simmons 1966; Campbell & Lack 1985; BWP). Suggested this may be comfort behaviour related to maintenance of feathers, by perhaps reducing ectoparasite load, removing stale or excess lipids, or adding supplementary essential oils (Campbell & Lack 1985); some secretions of ants are antibiotic, inhibiting growth of both fungi and bacteria, and the secondary acquisition of these antibiotic secretions would be an important advantage of anting (Ehrlick et al. 1986).

Other behavioural characters include head-scratching indirectly (or over the wing) in most families, with the foot brought up above the lowered wing. Head oiled indirectly, as seen in most taxa, but passerines also oil head by head-scratching, in which bird oils the bill directly, then transfers the oil first to one foot by scratching the bill, and then to the head by scratching the head with foot. To oil the undersurface of the wings, use bill or bill and head together, extending one wing at a time sideways and forward, carpus uppermost, and often alternating rapidly from one wing to the other. The stretching of one wing as a comfort movement seems common to all birds, but in passerines it is often accompanied by sideways fanning of tail. After both wings are stretched, passerines often give a two-leg stretch as they straighten the tarsal joints and lift the body. Heat is dissipated by gaping and panting (not by gular-fluttering, so far as known) (Campbell & Lack 1985; BWP). Bathing widespread, mainly by standing in shallow water, but some groups jump into and out of water repeatedly, or flight- or plunge-bathe, while others bathe only or mainly in rain or among wet foliage; for further details of bathing, see Campbell & Lack (1985). Passerines do not flap wings in the manner of non-passerines to dry, but perform various shaking movements, as well as preening (Campbell & Lack 1985). Dusting confined to only a few groups, but sunning, both for gaining heat (sun-basking) and other purposes (sun-exposure), is widespread, and of two distinct types: (1) lateral posture, in which sunning bird squats or sits down, usually on ground, and leans to one side exposing the flank or the 'sun-wing', which has been lowered and partly unfolded, and the fanned tail, which has been brought round to the same side; and (2) spread-eagle posture, in which bird squats or lies flat with both wings open and tail fanned (details in Campbell & Lack 1985; Simmons 1986).

There is a high incidence of co-operative breeding in Aust. and NZ, and it is especially common and well-studied in the Maluridae but is more widely recorded, including within the Acanthisittidae, Meliphagidae, Petroicidae, Pomatostomidae and Corcoracidae (see Dow 1978, 1980; Brown 1987; Ford 1989; Rowley & Russell 1997).

In vocal abilities, species of Passeriformes are more accomplished than those of any other order, but songs may be simple or highly complex, and repertoires small or large. Mimicry of calls of other species is practised by many species; c. 15% of Australian passerine species have been reported to mimic (Marshall 1950). The Superb Lyrebird and the Tui *Prosthemadera novaeseelandiae* have been classed among the best seven of the world's songsters (Hartshorne 1973). Oscines, or songbirds, have specialized forebrain song nuclei, and, through auditory feedback, learn their songs from those of adults, in much the same way as human young learn their spoken language from adults. In contrast, the songs of suboscines are relatively simple (like the non-learned call-notes of songbirds), repertoires are small, geographical variation is minimal, and development of song appears to take place without any imitative or feedback process. Some oscine species use vocal learning to generate large song repertoires and may vary them geographically, even locally. Other oscine species forgo these possibilities and have song repertoires more like those of suboscines; how the learning process maintains stereotypy of song over the range of such species is a mystery (Kroodsma 1996).

Apart from the five families discussed hereunder, syringeal structure of passeriform species of our area is similar, there being four pairs of intrinsic muscles. Pittidae have no intrinsic muscles (Ames 1971); calls are mostly loud strong whistles (Pizzey 1980). Acanthisittidae also have no intrinsic muscles, but the presence of a well-developed drum (fusion of posterior tracheal elements) suggests they may have once been present; vocal repertoire is not great (Ames 1971). Menuridae and Atrichornithidae have similar syringeal structures, with three pairs of intrinsic muscles; songs are highly developed, and there can be much mimicry (Ames 1971). Climacteridae, with four pairs of intrinsic muscles, exhibit gross asymmetry of the extrinsic muscles, unusual directions of muscle fibre in the intrinsic muscles, and an exceptionally robust sternotracheal muscle (Ames 1987); calls are brisk, sharp and piping (Pizzey 1980).

Extended tracheae are found in the genus *Manucodia* (Paradisaeidae), the calls of which are deep, loud or far-carrying (Frith 1994). In the only species occurring in our area, the Trumpet Manucode *M. keraudrenii*, the trachea forms a flat coil between the skin and the pectoral muscles, sometimes extending over the abdominal muscles as well,

and may be up to 828 mm in length, compared with body-length, from bill to pygostyle, of c. 150 mm (Ames 1971; Clench 1978).

REFERENCES

- Ames, P.L. 1971. *Bull. Yale Peabody Mus. Nat. Hist.* 37: 1–194.
 ——— 1987. *Emu* 87: 192–5.
 Baverstock, P.R., et al. 1991. *Aust. J. Zool.* 39: 417–25.
 ———, et al. 1992. *Aust. J. Zool.* 40: 173–9.
 Beddard, F.E. 1898. *The Structure and Classification of Birds*. Longmans, Green & Co., London.
 Berger, A.J. 1956. *Am. Midl. and Nat.* 55: 326–33.
 Boles, W.E., & N.W. Longmore. 1985. *S. Aust. Orn.* 29: 213–19.
 Brown, J.L. 1987. *Helping and Communal Breeding in Birds*. Princeton Univ. Press, Princeton, New Jersey.
 Campbell, B., & E. Lack. (Eds) 1985. *A Dictionary of Birds*. T. & A.D. Poyser, Calton, England.
 Christidis, L. 1991. *Chromosomes Today* 10 (1990): 279–94.
 ———, & W.E. Boles. 1994. *RAOU Monogr.* 2. Melbourne.
 ———, & R. Schodde. 1991. *Ibis* 133: 277–85.
 Clench, M.H. 1978. *Condor* 80: 423–30.
 Dow, D.D. 1978. *Int. Orn. Cong. Proc.* 17: 875–81.
 ——— 1980. *Emu* 80: 121–40.
 Ehrlich, P.R., et al. 1986. *Auk* 103: 835.
 ———, et al. 1988. *The Birder's Handbook: A Field Guide to the Natural History of North American Birds*. Simon & Schuster, New York.
 Farner, D.S., et al. (Eds) 1971. *Avian Biology*. 1. Academic Press, New York.
 Ford, H.A. 1989. *Ecology of Birds*. Surrey Beatty, Sydney.
 Frith, C.B. 1994. *Condor* 96: 552–5.
 Hartshorne, C. 1973. *Born to Sing*. Indiana Univ. Press, Bloomington, Indiana.
 Heather, B.D., & H.A. Robertson. 1997. *The Field Guide to the Birds of New Zealand*. OUP, Auckland.
 Kroodsmma, D.E. 1996. Pp 3–19 In: Kroodsmma & Miller 1996.
 ———, & E.H. Miller. (Eds) 1996. *Ecology and Evolution of Acoustic Communication in Birds*. Comstock, Ithaca, New York.
 Marshall, A.J. 1950. *Emu* 50: 5–16.
 Millener, P.R. 1988. *J. R. Soc. NZ.* 18: 383–406.
 Morlion, M.L. 1985. *Rec. Aust. Mus.* 37: 143–56.
 Morony, J.J., et al. 1975. *Reference List of the Birds of the World*. Am. Mus. Nat. Hist., New York.
 Pizzey, G. 1980. *A Field Guide to the Birds of Australia*. Collins, Sydney.
 Raikow, R.J. 1982. *Auk* 99: 431–45.
 Ricklefs, R.E. 1975. *Condor* 77: 34–45.
 Ridgely, R.S., & G. Tudor. 1994. *The Birds of South America*. 2. *The Suboscine Passerines*. OUP, Oxford.
 Ridgway, R. 1901. *Bull. US Natn. Mus.* 50(1): 1–715.
 Rowley, I., & E. Russell. 1997. *Fairy-wrens and Grasswrens*. OUP, Oxford.
 Schodde, R. 1975. *Interim List of Australian Songbirds: Passerines*. RAOU, Melbourne.
 ———, & I.J. Mason. 1999. *The Directory of Australian Birds: Passerines*. CSIRO Publ., Melbourne.
 Sibley, C.G. 1974. *Emu* 74: 65–79.
 ———, & J.E. Ahlquist. 1985a. *Emu* 85: 1–14.
 ———, ——— 1985b. *Int. Orn. Congr. Proc.* 18: 83–121.
 ———, ——— 1990. *Phylogeny and Classification of Birds: A Study in Molecular Evolution*. Yale Univ. Press, New Haven.
 ———, & B.L. Monroe. 1990. *The Distribution and Taxonomy of Birds of the World*. Yale Univ. Press, New Haven.
 ———, et al. 1988. *Auk* 105: 409–23.
 Simmons, K.E.L. 1966. *J. Zool., Lond.* 149: 145–63.
 ——— 1986. *The Sunning Behaviour of Birds*. Bristol Orn. Club, Bristol.
 Storer, R.W. 1971. Pp 1–18 In: Farner et al. 1971.
 van Tyne, J., & A.J. Berger. 1976. *Fundamentals of Ornithology*. John Wiley & Sons, New York.
 Voous, K.H. 1977. *Ibis* 119: 223–250, 376–406.
 Wetmore, A. 1960. *Smithson. Misc. Collection* 139.
 Winkler, R., & L. Jenni. 1996. *Auk* 113: 968–9.
 Zeidler, K. 1966. *J. für Orn.* 107: 113–53.

Family CALLAEIDAE¹ New Zealand wattlebirds

A small but morphologically rather diverse family of three species of small-medium to medium-large passerines, endemic to NZ. Two species, Saddleback *Philesturnus carunculatus* and Kokako *Callaeas cinerea*, extant but threatened; the third, Huia *Heteralocha acutirostris*, is extinct (Oliver; Peters; NZCL). Taxonomic affinities of the family have been subject to some debate. Garrod (1872) suggested that the Huia was related to the families Icteridae (New World orioles, grackles and allies) and Sturnidae (starlings), but this was later rejected by Mayr & Amadon (1951), who placed the New Zealand wattlebirds between the Grallinidae (*Grallina*, *Corcorax* and *Struthidea*) and the Cracticidae (butcherbirds and allies). Sharpe (1877) placed them in the Corvidae between *Picathartes* (rockfowls and rock-jumpers) and *Falcula* (vangas). Based largely on pterylography and osteology (summarized below), Stonor (1942) concluded that all three species of New Zealand wattlebirds are from the same stock that gave rise to the Sturnidae and their immediate allies. Again, Mayr & Amadon (1951) rejected the hypothesis that Callaeidae and Sturnidae are allied. Oliver combined Saddleback and Huia in the family Philesturnidae, and placed Kokako in a separate but closely allied family Callaeidae. Williams (1976) did not give an opinion concerning the affinities of the group. Sibley & Ahlquist (1985, 1990) lacked DNA samples of the three species and were thus unable to conduct DNA–DNA hybridization analysis with other passerines; consequently these authors combined them as the family Callaeidae and placed them between the Corvidae and Picathartidae.

Species range in size from medium-small (Saddleback: length c. 20 cm, weight c. 80 g) to large (Huia: length c. 53 cm, c. 400 g). Morphological and osteological characteristics shared by the three species are (Stonor 1942; Williams 1976; Oliver): Wings rather short and rounded at tips. Ten primaries; p10 rather long. Nine secondaries, including three tertials. Tail long and rounded at tip; 12 rectrices. Bill varies between species: rather short and robust with decurved upper mandible in Kokako; long and straight with compressed ridge along culmen in Saddleback; and, in Huia, very long and sickle-shaped in adult female, shorter and only slightly decurved in adult male. Tongue morphology varies: lanceolate and shallowly bifid at tip in Saddleback, oblong and truncated at tip in Kokako (McCann 1964). Tarsus rather long; scaling laminiplantar. Feet rather large and strong. Hindclaw fairly long. All species have distinct and brightly coloured fleshy wattle on each side of gape. All species have weak keel to sternum and large nasal depressions. Kokako has following cranial features: distinct ‘bridge’ on upper edge of nasal; large lachrymals with thickened basal portion abutting jugal bar; large post-orbital processes; deep temporal fossae; two small unfused sesamoid bones, larger of which separates articulation of lower mandible from quadrate; maxillo-palatines expanded below vomer into pointed head; and palatines thickened and trans-palatine processes extend posteriorly to acute tip. Huia has similar palate structure and post-orbital processes to Kokako, but also has: articulation of lower mandible extends greatly backward; smaller lachrymals; distinct occipital crest; lacks deep temporal fossae; and lacks sesamoid bones. See Buller (1888) for more details on osteology of the Huia. Little known about osteological characters of Saddleback, but said to be similar to Huia, particularly in having distinct extension of articulation of lower mandible.

Plumage varies: mostly bluish grey in Kokako; blackish with distinct rufous band across upperparts in Saddleback; black with white tip to tail in Huia. Juvenile Kokako and Saddlebacks superficially resemble adults, but have softer and more loosely textured feathers of head and body. Kokako hatch with well-developed natal down (Gill 1993). Undergo a partial post-juvenile (first pre-basic) moult to adult-like first immature (first basic) plumage. Acquire adult plumage in complete first immature post-breeding (second pre-basic) moult, probably when c. 1 year old. After acquiring adult plumage, a complete post-breeding (pre-basic) moult each cycle produces successive adult (basic) plumages with no change in appearance. Sexes alike in plumage. Primaries moult outward, starting at p1; in Kokako, up to three primaries grow at once. Moult of tail and body not well known; timing probably much as moult of primaries.

Inhabit native forests, from lowlands to higher altitudes of mountain ranges. In NI, Kokako found mainly in structurally complex lowland forests, preferring tall mature hardwood forest dominated by *Tawa Beilschmiedia tawa* with emergent podocarps; in SI, occur in higher-altitude forests dominated by beech *Nothofagus*. Only survive in habitat free of most exotic predatory mammals. Saddleback occupies evergreen coastal and mixed lowland broadleaf forests, especially seral forests and secondary growth with high turnover of dead wood and numerous fruiting shrubs; also in coastal and montane shrublands. Translocated populations of Saddleback also occur in range of other habitats, such as lowland beech forest, mixed evergreen podocarp–hardwood forest and in exotic pines and wattles. Huia mainly inhabited montane and lowland hardwood–podocarp forests with dense understorey, occasionally beech forest (I. Flux; J.G. Innes; T.G. Lovegrove; see species accounts).

¹ For discussion of correct spelling of family name, see Peters.

In Saddleback and Kokako, breeding adults sedentary and territorial throughout year and from year to year, though, in Saddleback, adults known to traverse neighbouring territories to forage and drink. In Kokako, young disperse, sometimes >20 km, before settling into territories close to natal territories (see species accounts).

Omnivorous, but main components of diet vary with species: Kokako eats mainly fruit and leaves and, less often, flowers, moss, buds, nectar and invertebrates; Saddleback eats mainly insects and berries, as well as other invertebrates and nectar and occasionally buds; Huia considered a specialist predator of Huhu beetle *Prionophus reticularis* larvae, but also ate other invertebrates and fruit. Forage at all levels in forests: on soil, in leaf-litter and decaying timber on ground; and among branches and live and dead foliage of trees and shrubs from near ground to canopy. Forage mostly by probing, tearing and gleaning; probe bark of trees, dead and decaying wood of branches, trunks, stumps and logs, and often tear off chunks of bark or wood from trees, exposing insects beneath. Sometimes lift fronds, leaves, lichens or moss, and sometimes toss leaves like a Common Blackbird *Turdus merula*. Bills long and strong, and forage with them either open or closed; upper mandible sometimes used as skewer; also use bill to zirkeln. Male and female Huia had markedly different bills: males had strong, slightly decurved, moderately long bills and well-developed cranial musculature, allowing them to break up rotten wood by chiselling and gaping; while females had longer, slender and more decurved bills, suited to probing holes and crevices. Use feet to manipulate and hold food. Kokako and Saddleback forage throughout day; and usually forage singly or in pairs, very occasionally in larger groups. Saddlebacks often seen foraging with Grey Fantails *Rhipidura fuliginosa* (see species accounts).

Social organization of the family appears to be rather uniform. None appear to be particularly gregarious, with birds usually seen singly or in pairs, but sometimes form small family groups after breeding (see species accounts). All species monogamous and form long-term pair-bonds, possibly remaining paired for life. Where known, both parents feed nestlings and fledgelings, but only female incubates or broods. All species thought to nest solitarily and defend an all-purpose territory throughout the year. Territories maintained mostly by vocalizations, but threat displays, chasing and even physical fighting have been recorded during territorial disputes. Both extant species perform Archangel Displays (see species accounts) and courtship feeding as part of pair-formation and pair-bond maintenance. Vocalizations also play a major role in all sexual activities and all other aspects of social behaviour.

Vocalizations are varied, but all produce melodious piping or flute-like vocalizations. Other vocalizations include organ-like notes, and harsher chattering or churring vocalizations. Much variation between different locations in the vocalizations heard, and components of song can often be categorized to local dialects. All respond strongly to imitation or playback of their vocalizations. Both extant species often perform duets, and both also sometimes counter-sing with neighbours.

Solitary nesters. Typically, female alone constructs nest, incubates and broods, while being fed by the male. However, young usually fed by both parents. A variety of nesting sites used, but Kokakos nest mostly among branches of trees and shrubs, 2–32 m above ground, mostly ≤10 m, while Saddlebacks usually nest in hollows in trees or epiphytes at low levels, including on ground. Huia's nested on ground to high in canopy. Build large, cup-shaped nests, consisting of loosely constructed base mostly of sticks and twigs, with inner layer and lining of finer material. Eggs oval, though also elliptical-ovate in Kokako. Ground-colour pale, usually shades of pale to darker pinkish or purplish grey, but also white and very pale browns; marked with spots and blotches, sometimes streaks or lines, of shades of brown and purple, usually concentrated at large end. Clutch-size usually two or three, occasionally one or four; Huia's said to have often laid clutches of four, but clutch-size variously claimed to be from one to five. Normally raise one or two broods per season. Incubation period from 16 to 28 days; fledging period, from 25 to 37 days. Breeding failures largely result of predation, mostly by small introduced mammals, such as rats *Rattus* and Common Brushtail Possums *Trichosurus vulpecula*, which are able to attack the low and easily accessible nests, but also by predatory birds such as Swamp Harriers *Circus approximans*, Southern Boobooks *Ninox novaeseelandiae* and Wekas *Gallirallus australis* (see species accounts).

All members of family globally threatened: Kokako is endangered; Saddleback near threatened; and Huia extinct (Stattersfield & Capper 2000; Fuller 2002; NZCL; for details see species accounts). Ranges of Saddleback and Kokako much reduced, but both increasing with translocations to offshore islands and protected mainland sites (particularly Saddleback). Main threat is predation by introduced mammalian predators; Kokako also probably adversely affected by competition from introduced omnivores and herbivores, which eat foods also eaten by Kokako and have altered pattern of regeneration of forests. Historically, all three species adversely affected by loss or fragmentation of habitat, through logging (both clear-felling and selective logging, and subsequent degradation) and large-scale clearing and burning of native vegetation, and to some extent, hunting. Predation by introduced mammals may also have contributed to extinction of Huia.

REFERENCES

- Buller, W.L. 1888. *A History of the Birds of New Zealand*. Second edn. Author, London.
- del Hoyo, J., et al. 2002. *Handbook of the Birds of the World*. 7. Lynx Edicions, Barcelona.
- Fuller, E. 2002. *Extinct Birds*. In: del Hoyo et al. 2002.
- Garrod, A.H. 1872. *Proc. R. Soc. Lond.* 1872: 643–7.
- Gill, B.J. 1993. *Rec. Auckland Inst. Mus.* 30: 87–91.
- Mayr, E., & D. Amadon. 1951. *Am. Mus. Novit.* 1496: 1–42.
- McCann, C. 1964. *Catalogus* 11: 36–45.
- Sharpe, R.B. 1877. *Catalogue of the Birds in the British Museum*. 3. *Coliiformes*. Br. Mus. Nat. Hist., London.

- Sibley, C.G., & J.E. Ahlquist. 1985. *Emu* 85: 1–14.
- , —— 1990. *Phylogeny and Classification of Birds*. Yale Univ. Press, New Haven, CT.
- Stattersfield, A.J., & D.R. Capper. (Eds) 2000. *Threatened Birds of the*

- World*. Lynx Edicions, Barcelona, and BirdLife International, Cambridge, UK.
- Stonor, C.R. 1942. *Ibis* (14)6: 1–18.
- Williams, G.R. 1976. *Int. Orn. Congr. Proc.* 16: 161–70.

Heteralocha acutirostris **Huia**

Neomorpha acutirostris Gould, 1837, *Synops. Birds Aust.* 1: pl. 11, fig. 1 and text — New Zealand.

The striking differences between the bills of male and female Huia led to the coining of the generic name (Greek *ἕτερος*, different, and *ἄλοχος*, a wife). The specific name refers to the bill of the female, from the Latin *acutus*, sharp-pointed, and *-rostris*, billed (from *rostrum*, the bill), the male having been described at the same time as a different species with the epithet *crassirostris* (from the Latin *crassus*, thick, heavy).

OTHER ENGLISH NAMES None.

MONOTYPIC

EXTINCT

HABITAT Mainly montane and lowland hardwood-podocarp forests with dense understorey; occasionally in *Nothofagus* forest (Buller 1868, 1870; Drummond 1910; Phillips 1963; Turbott 1967; Medway 1968; Oliver). Observed by J.R. Annabell, in 1882–83 (Medway 1968), in indigenous vegetation of Matai *Prumnopitys taxifolia*, Rimu *Dacrydium cupressinum*, Kahikatea *Dacrycarpus dacrydioides*, Northern Rata *Metrosideros robusta*, maire *Nestegis*, Hinau *Elaeocarpus dentatus*, Totara *Podocarpus totara*, Rewarewa *Knightia excelsa*, Mahoe *Meliclytus ramiflorus* and Tarairi *Beilschmiedia tarairi* with understorey of Kareao Supplejack *Ripogonum scandens*. Recorded at sea-level, in a patch of Karaka *Corynocarpus laevigatus* at C. Turakirae (Colenso 1886). Possibly undertook seasonal altitudinal movements (see Movements). Not observed in burnt forest or land cleared for farming (Buller 1892).

DISTRIBUTION AND POPULATION Extinct. Formerly endemic to NI, NZ, and last confirmed record, of three birds, on 28 Dec. 1907 (Oliver).

NI Formerly widespread but scattered, mainly in s. half. Mostly in Ruahine, Tararua and Rimutaka Ras, from round Mataroa and Taihape S to ranges on either side of Wellington Harbour and hills round Palliser Bay and L. Wairarapa, though also recorded in adjacent lowlands, e.g. from Hutt R. Valley N to near Shannon in W, and from site inland from Riversdale Beach, N through Puketoi Ra. and Dannevirke, to Patanga in E; also in forested areas along upper and middle reaches of major rivers, e.g. Rangitikei R. and its tributaries. Recorded at scattered sites farther N, from middle reaches of Wanganui R., N through Tongariro NP to s. L. Taupo, and thence E to Huiarau Ra. (which literally means 'a hundred Huias'). Isolated records from still farther N, near Mahoenui in W and s. Raukumara Ra. in E (Phillips 1963; Turbott 1967; Medway 1968; Williams 1976). **SI** No confirmed records. Doubtfully claimed to have occurred in Nelson and Marlborough, round Golden Bay, between Nelson and Picton, and in Ure R. Valley (Phillips 1963). No subfossil records on SI (NZCL).

Introductions None. Several attempts made to capture Huias for translocation into sanctuaries at L. Waikeremoana and on Little Barrier I., Kapiti I. and Resolution I., in Fiordland, between early 1890s and 1924 (Phillips 1963). Buller procured a pair in late 1892 (after they were protected), apparently for translocation to England, where they were sent to Lord Rothschild (Galbreath 1989). No others were obtained (Phillips 1963).

Change in range, populations Deposits of subfossils indicate that formerly occurred over much of NI, from North C. to s. tip of NI (NZCL) but range assumed to have contracted greatly after arrival of Maori (Heather & Robertson 2000). At beginning of European occupation, only recorded in range described above; and populations declined sharply in 1860s (Buller 1868; Phillips 1963; Turbott 1967; Williams 1976). Conversely, in 1880s, Buller considered the species to be 'far

more plentiful than formerly' (Buller 1888). Survived in Puketoi Ra. till 1880s but dwindled thereafter; single Huia seen on expedition to ranges behind Waikanae and Hutt R. Valley in 1892, though the species had been plentiful in same area in mid-1880s; in Pahiatua–Dannevirke area, many specimens collected in 1883, and extinct there by 1890s; in 1889–93, becoming rare in Tararua Ra.; plentiful round Utiku in 1898 and round Akatarawa R. till 1900; plentiful round Akitio in 1895, but practically disappeared by c. 1901. Still considered plentiful in some areas in early 20th century, especially between Hawkes Bay and Wairarapa, e.g. in 1905, flock of 100–150 recorded at summit of Akatarawa–Waikanae Track, and in 1906, fairly plentiful in upper reaches of Rangitikei R, yet last accepted record was in 1907 (Phillips 1963; Oliver). Small numbers, however, claimed to have survived into 1920s, as many reports till then, some of which quite credible; with a few reports till 1940s, and several recent reports, near Mt Urutawa (1952), Urewera Country (1952) and near L. Waikare Iri (1961) (Phillips 1963).

Status Extinct (Stattersfield & Capper 2000; NZCL).

THREATS AND HUMAN INTERACTIONS Decline throughout NI probably a combination of large-scale clearance and burning of native vegetation as settlement spread, hunting (see below) and possibly predation by introduced mustelids (introductions of which peaked in 1880s [Thomson 1922], which coincided with sudden decline of Huia), rats and feral Cats (Phillips 1963; Medway 1968; Lovegrove 1996; Heather & Robertson 2000; Oliver). Also suggested that exotic parasites and diseases, possibly introduced from Asia with Common Myna *Acridotheres tristis*, a potential cause of decline (I. Flux). Said to have possibly been poisoned by baits laid round cereal crops to kill Rabbits (Phillips 1963). **MAORI:** Considered sacred, and their rectrices were highly valued and traded widely, including into SI; so prized were they that they were kept in special carved boxes or containers known as *waka huia*. Only allowed to be worn by chiefs, who usually wore them in their hair as a 12-feather headdress (*marereko*) (Hutton & Drummond 1904; Phillips 1963; Best 1977; Oliver); though also claimed they were worn as a badge of mourning (Turbott 1967). In addition, skins of Huias, with wings and legs removed, were worn as pendants (*pahoe*) from the ears, and dried Huia heads were also worn as pendants (*ngutu huia*). Rectrices were also placed round vessels (*patua*) that held preserved pigeons to indicate that this was food fit for chiefs (Phillips 1963; Oliver). Birds were trapped by a noose of flax and a long rod (*tari*), sometimes baited with insect larvae, with birds attracted by whistled imitation of call. Mainly hunted in July, when plumage said to be at its most attractive (Hutton & Drummond 1904; Phillips 1963; Turbott 1967; Oliver). In 1874, >600 Huias were killed by Maori in Wellington Province alone, and a year later, hunting by Maori was so extensive that concerns were expressed for the species if the country was opened up. Preserved by being skinned, leaving the bill and wattles but removing the wings and legs; skin then stretched and placed in front of fire to dry,

then packed in bark (Phillipps 1963). **EUROPEANS (PAKEHA):** Widespread clearance and burning of native forest was a major factor in decline of the species as settlement spread. Formerly shot often by early settlers, with shooting being a major concern by late 1880s. Many were taken as specimens for European museums; in 1888, 646 skins were obtained in 1 month (Phillipps 1963; Turbott 1967; Medway 1968). When, in 1902, a Maori guide placed a Huia feather in the hat-band of the Duke of York while visiting Rotorua, a fashion began, and there was much demand for feathers thereafter. Though officially protected from 1892, regular hunting parties were organized as the price of feathers increased to £1 each (thus each bird was worth £12), and by 1915 single feathers were being sold for £5 each. Easily attracted to within shooting range by Maori assistants, and some 'followed the decoy almost on to the barrels of their [the hunters'] guns'; hundreds were shot round road or rail construction camps. Occasionally eaten, e.g. in pies and curried stew, though gastronomic opinion varied greatly: considered by some to be 'delicious' and 'good eating', though 'a tough morsel' and 'not fit to eat' by others. The long, curved bills of females were sometimes turned into grotesque brooches. Occasionally kept as pets (Colenso 1886; Hutton & Drummond 1904; Phillipps 1963).

MOVEMENTS Very poorly known but probably sedentary. One old male known to have stayed in same area in Ruahine Ra. for several years. A pair were once chased for c. 5 km, members of pair keeping close to each other (Turbott 1967). However, also suggested that may have frequented ranges in summer and moved to lower altitudes in winter (Drummond 1910; Phillipps 1963; Oliver). Seldom flew above tree-height, and usually moved by hopping and bounding along branches and ground (Turbott 1967).

FOOD Considered a specialist predator of Huhu beetle *Prioponops reticularis* larvae (Buller 1870, 1888; Colenso 1886); also ate other insects, spiders and fruit. **Behaviour** Insects taken from decaying wood, from under bark, lichens and mosses, and from ground (Buller 1888; Oliver). Foraged alone, in pairs, or in small flocks of up to four or five, which probably family groups (Buller 1870, 1888; Potts 1885; Colenso 1886; Oliver). **SEXUAL DIMORPHISM AND FEEDING ADAPTATIONS:** Males and females had markedly different bills: males had strong, slightly decurved, moderately long bills and well-developed cranial musculature, permitting rotten wood to be chiselled and broken apart by gaping; females had longer, slender and more decurved bills, suited to probing holes and crevices (Buller 1870; Selander 1966; Burton 1974; Oliver). A lack of competitors in these foraging niches may explain development of such divergence, with differences in structure of bill, and associated foraging methods, probably reducing foraging competition between monogamous pairs, and may have led to different diets (Selander 1966; Jamieson & Spencer 1996; Moorhouse 1996). **FORAGING METHODS:** Foraged mainly on decaying wood. Males chiselled at rotten timber, somewhat like woodpecker, to excavate insect larvae (Buller 1870; Oliver); tore large pieces of bark from trees to get at invertebrates; and a solitary male observed foraging among moss on ground (Buller 1888; Oliver). Females probed holes and crevices and the softer parts of decaying timber (Buller 1870). At Manuwatu R., groups of four or five observed tearing moss and ferns from branches of trees in pursuit of insects (Potts 1885). One pair observed hunting wetas (wingless cricket: Orthoptera) co-operatively on a green sapling: male tore off outer part of sapling, while female then attempted to retrieve weta with her bill; if unsuccessful, male attempted to enlarge hole. Pair flew off together once weta obtained (Oliver). In captivity, birds foraged independently: male pecked away rotten wood but was unable to reach grub;

female then probed hole and procured larvae, which she then ate (Buller 1870). When given Huhu grubs in captivity, birds carried grub to perch and held larvae against branch with foot, tore head off and discarded it, and then swallowed body whole (Buller 1870). One female taken off nest with young and then hand-fed by observer (Buller 1892). **INTERSPECIFIC COMPARISONS:** Method of breaking up rotten timber by male similar to that of Saddleback *Philesturnus carunculatus*, though associated skeletal and muscular features better developed in Huia (Burton 1974; Jamieson & Spencer 1996). **DRINKING:** Captive birds drank regularly from a water dish (Buller 1870).

No detailed studies. **Plants** Fruit⁹, vegetable matter⁴. **GYMNOSPERMS:** Podocarpaceae: *Dacrycarpus dacrydioides* fru.³. **DICOTYLEDONS:** Cunoniaceae: *Weinmannia silvicola* sds⁴; Elaeocarpaceae: *Elaeocarpus dentatus* fru.^{3,9}, sds (probably from fru.)¹; *E. hookerianus* fru.^{3,9}; Icacinaceae: *Pennantia corymbosa* sds (probably from fru.)⁴; Monimiaceae: *Hedycarya arborea* fru.^{3,4,9}; Rubiaceae: *Coprosma lucida* fru.^{3,9}. **Animals** **SPIDERS**^{3,4,9}. **INSECTS**^{3,4,5,9}: larv.^{1,9}; Coleoptera¹: Cerambycidae: *Prioponops reticularis* larv.^{1,3,7,8}; Diptera¹; Lepidoptera: larv.^{1,3}; Mantodea: Mantidae: *Mantis*³; Orthoptera³: Stenopelmaticidae^{3,4,9}: *Hemideina thoracica*³. **Other matter** In captivity: cooked potato, boiled rice, raw minced meat^{1,2,6}; another captive bird was given mixed food comprising mostly boiled eggs, fresh meat and earthworms².

REFERENCES: Buller¹ 1870, ² 1873, ³ 1888, ⁴ 1892; ⁵ Reischek 1885; ⁶ Colenso 1886; ⁷ Drummond 1910; ⁸ Phillipps 1963; ⁹ Oliver.

Young Fed by both parents (Potts 1885; Buller 1892). Young successfully hand-raised on Huhu grubs (Potts 1885).

SOCIAL ORGANIZATION AND BEHAVIOUR Poorly known. Usually seen in pairs (Colenso 1886; Buller 1888; Drummond 1910; Phillipps 1963; Turbott 1967; Heather & Robertson 2000), sometimes singly or occasionally in parties of four or more (Buller 1888; Turbott 1967; Oliver; see Food). **Bonds** Probably paired for life (Colenso 1886; Blackburn 1964; Williams 1976). Members of pair often kept close together (Buller 1870; Colenso 1886; Phillipps 1963), one pair while being chased for c. 5 km (Buller 1888; Turbott 1967). In one captive pair, when one accidentally killed, mate appeared distressed and died 10 days later (Buller 1870, 1888; Turbott 1967). **Breeding dispersion** Probably nested solitarily; pairs said to be territorial and to remain on territory for life (Blackburn 1964). **Sexual behaviour** A pair in captivity seen to hop from branch to branch and occasionally fan tails, then meet to caress each other with bills while giving low twittering Contact Calls (Buller 1870, 1888; Turbott 1967); this possibly a sexual display. Males said to feed females in courtship and when incubating or brooding (Williams 1976). **Relations within family group** Birds sat tight on nest; one female allowed herself to be handled on nest (Buller 1892; Phillipps 1963). When a nestling taken from nest and placed in cage, adults followed to camp and continued to feed the young bird, entering a tent to do so (Buller 1892).

VOICE Not well known. Calls in musical notation in Phillipps (1963). Mostly a varied array of whistles, described as peculiar and strange, but also soft, melodious and flute-like (Buller 1870, 1888; Phillipps 1963; Turbott 1967). Maori name onomatopoeic, derived from distress call (Hutton & Drummond 1904; Phillipps 1963; Oliver). Often quiet, though audible for up to 400 m (Phillipps 1963). Calls said to differ between sexes, and that pairs also called antiphonally (Williams 1976) but no details. Calls given with head and neck stretched upward, and bill pointing at 30–45° from vertical (Phillipps 1963). **DIURNAL PATTERN:** Most references describe calls in morning: first bird to call 'in the early dawn'

(Buller 1888; Turbott 1967) and captive birds known to 'wake the household' in early morning (Phillipps 1963). On approach of wet weather said to be 'happy and in full song' (Phillipps 1963). **RESPONSE TO IMITATION:** Often attracted to whistled imitations of call, and sometimes to other whistles or croaks (Buller 1870, 1888; Enys 1875; Drummond 1910; Phillipps 1963; Turbott 1967; Medway 1968; Oliver); sometimes called in from >100 m away (Drummond 1910; Phillipps 1963). Occasionally merely answered imitations with low chirping note, low tremulous whistle or whimper; and young birds answered feebly (Buller 1888; Turbott 1967). **NON-VOCAL SOUNDS:** When foraging arboreally, presence sometimes betrayed by noisy dropping of pieces of bark torn from rotten trees onto floor of forest (Buller 1888; Turbott 1967).

Adults CONTACT CALL: Soft, quick, flute-like, twittering whistle; rich, deep and melodious, and mostly given in short, staccato phrases (Buller 1870; Williams 1976). Varied, comprising either four or five short notes followed by a long one, or a prolonged note followed by a short one, often repeated, with a trill similar to that of Shining Bronze-Cuckoo *Chrysococcyx lucidus* but deeper in tone. Given by both sexes, constantly in flight or, less often, when foraging (Buller 1870, 1888; Phillipps 1963; Turbott 1967; Oliver). Twittering calls also given during sexual display (see Social Organization and Behaviour). Plaintive whistle (Phillipps 1963) possibly also describes this call. **DISTRESS CALL:** Shrill, high-pitched whistle, repeated many times (Buller 1870, 1888; Turbott 1967; Oliver); rendered as *uia, uia, uia* or *where-are-you?* Said to be given when excited or hungry (Buller 1888; Phillipps 1963; Turbott 1967). **SCREAM:** Once, in morning, gave a long screech followed by two short ones (Phillipps 1963). **CRY:** Soft, musical, whimpering note, almost indistinguishable from whining of young puppies (Buller 1870, 1888; Phillipps 1963; Turbott 1967). **CHUCKLE:** Low chuckling note given (Buller 1870, 1888; Turbott 1967).

Young Little information. Nestling taken from nest and kept in tent was very noisy. Young birds said to utter a plaintive cry, pleasant to the ear (Phillipps 1963). Feebly answer imitations by people (Buller 1888; Turbott 1967).

BREEDING Few records: two eggs and no more than four nests described. Thought to have raised one brood per season (Potts 1885).

Season Eggs recorded Oct., and nestlings Nov., and said to breed Oct.–Nov. (Buller 1877, 1892; Potts 1884, 1885).

Site Some said to be on or near ground (Oliver), usually at base of large tree; others above ground, in dead tree, in tree-hollow, in depression formed at top of truncated tree, or on branch; sometimes covered by overhanging foliage or epiphytic growth or vines (Buller 1870, 1876, 1888, 1892; Potts 1885; Oliver). One nest in old Northern Rata *Metrosideros robusta* tree (Buller 1892); another in old Hinau *Elaeocarpus dentatus* (Potts 1884). **MEASUREMENTS:** One nest c. 5.5 m above ground (Potts 1885).

Nest, Materials Nest large and saucer-shaped, with thick walls; made of dry grass, leaves and withered stems of herbaceous plants, carefully woven together (Buller 1888); one made of dead sticks and sprays (Potts 1885); another made of large sticks and *Astelia* leaves, with base mainly of leaves and a few dead sticks, and walls formed by interwoven sticks and leaves (Phillipps 1963; Oliver). Internal cup lined with softer, fine material, usually grass, leaves, stems or twigs (Buller 1888; Phillipps 1963; Oliver), though one nest had inner lining of coarse grass (Potts 1885). Photo of nest in Hutton & Drummond (1904) and Phillipps (1963). **MEASUREMENTS** (including approximations): External diameter, c. 33.0 cm; internal diameter, 15.2 cm; internal depth, 7.6 cm (Potts 1885). One nest (Canterbury Museum) has external diameter c. 36 cm, internal diameter c. 18 cm, and internal depth 6.4 cm

(Oliver); same nest said to have external dimensions of 35 × 28 cm and internal depth of 5.5 cm, though nest said to have degraded since discovery, when estimated to have been at least 7 cm deep (Phillipps 1963).

Eggs Only three eggs described: (1) Ovoido-conical; pale stone-grey with small purplish-grey spots and speckles and staining of same colour, markings in some places running into dark wavy lines (Buller 1876); painting of this egg (Phillipps 1963) shows elongated blotches, mainly at large end, but with a few extending towards small end. (2) More elliptical; delicate stone-grey, inclining to greyish white, marked at larger end, mainly on one side, with scattered spots of dark purple-grey and brown, and some obsolete spots towards small end (Buller 1877). (3) 'Beautifully fine and delicate', pure white and unmarked (Kirk 1883). However, identity of eggs questioned, given differences in form, size and colour, and similarity to eggs of closely related Kokako *Callaeas cinerea* (Kirk 1883; Phillipps 1963). **MEASUREMENTS:** Single eggs (as above): 36.8 × 26.7 (Buller 1876); 45.7 × 27.9 (Buller 1877); 36.8 × 27.9 (Kirk 1883). **Clutch-size** Claimed to be: three to five, often four (Drummond 1910); two to four (Oliver); possibly one to four (Williams 1976); possibly four (Mathews 1930). **Laying** No information. **Incubation** Probably mostly by female, though thought that also occasionally by male; males captured in Nov. had developed brood-patches but to lesser extent than females (Buller 1892). Claim that incubating female possibly fed on nest by male (Buller 1888) lacks evidence. Eggshells apparently removed from nest by adults (Potts 1885). **INCUBATION PERIOD:** Not known.

Young Embryonic nestling recovered from egg was bare except for fine black down, 1.3–1.9 cm long, on crown, down spine, along outer edge of each wing and behind each thigh (Buller 1876). Nestling taken from nest and kept in cage in tent continued to be fed by both parents in the tent (Buller 1892). Brood-size said usually to be two, and on one occasion three (Buller 1892). Males said to feed females on nest (Williams 1976). **Fledging to independence** Young remain in family group, being fed by adults for 'a considerable time', probably till at least 3 months old, when almost indistinguishable from adults (Potts 1885).

PLUMAGES Prepared by J.S. Matthew. Little information on plumage and moult cycles. Following descriptions of adults based on examination of skins of one adult male and one adult female (MV). See Phillipps (1963) for general information on plumages and sexual dimorphism.

Adult Sexes alike in plumage. **HEAD AND NECK, UPPER-PARTS, UNDERPARTS, WING:** Entirely blackish (c89) with greenish-blue (ne) or dark-bluish (ne) gloss; feathers of back and rear-flanks rather long and silky in texture. Buller (1870) states that some birds have white tips to undertail-coverts; this possibly age-related (see Juvenile). All feathers have concealed light-grey (c85) bases. **TAIL:** Blackish (c89), probably becoming paler, dark brown (121) with wear; and with broad white tips (c. 25 mm long) to all rectrices, which about equal in length on each rectrix and about same length on each web. Buller (1870) states that some birds have rufous tinge to tail-tip.

Juvenile Little information. Buller (1888) gives the following description of 'young' birds, probably referring to juveniles. Entire plumage duller than adult, black or black with slight brownish suffusion, and with very little gloss; male has pale-rufous and white tips to feathers on lower part of abdomen; females have undertail-coverts tipped white (lacking in males); and in males and females, terminal bar on tail washed rufous-yellow.

Aberrant plumage An albino bird recorded at Wanganui; and a brownish-black bird with grey bands to plumage also recorded (Oliver).

BARE PARTS Based on information in Buller (1870) except where stated. **Adult** Bill described as ivory-white darkening to bluish grey at base. Large wattle at gape, roughly ovate in shape (c. 24 mm long, 16 mm wide; from skins in MV); described as orange; Buller (1888) stated that sick birds had lemon-yellow wattles. Palate described as yellow (Buller 1888). Legs described as bluish grey (Buller 1870) or black with tinge of blue on edges (Buller 1870). Feet described as bluish grey. Claws described as horn colour. **Juvenile, First immature** Wattles described as flesh-white (Buller 1870).

MOULTS Little known. Two undated skins (MV) examined indicate adults underwent complete post-breeding (pre-basic) moult: both skins had active moult of primaries (one with PMS 39, other with PMS 30) with up to four primaries growing at once. Both skins also had active moult of body, but had not yet started moult of tail. One male, killed in Sept., had not yet started moult and tail had a 'rusty' appearance (Potts 1873).

MEASUREMENTS (1) Adult skins (MV). (2) Adults (Oliver). (3) Adults, skins (Potts 1873).

	MALES		FEMALES	
WING	(1)	202		180
	(2)	(210–220)		(200–202)
TAIL	(1)	199		175
	(2)	200		(195–200)
BILL S	(1)	58.3		93.8
	(3)	54.8, 54.8		92.3
BILL F	(2)	(57–60)		(85–88)
TARSUS	(1)	80.2		77.4
	(2)	(84–86)		(77–78)

WEIGHTS Buller (1888) stated that recently killed bird weighed 406 g (14.5 oz).

STRUCTURE Wing fairly long, rather rounded at tip. Ten primaries; p5–p7 longest. Nine secondaries including three tertials. Tail long, slightly rounded at tip; 12 rectrices; t1 longest, t6 c. 25 mm shorter than t1. Bill differs greatly between sexes: very long, rather narrow and strongly decurved in adult female; much shorter, deeper at base and only slightly decurved in adult male (see Fig. 1). Large and distinct fleshy wattle (see Bare Parts for dimensions), roughly ovate and flattened, hangs down from base of lower mandible–gape in adults. Tarsus long, compressed laterally; scaling lamini-plantar. Middle front tow longest, 50–55 mm long including claw; inner and outer front toes c. 10 mm shorter than middle, hindtoe slightly shorter than middle. Hindtoe with claw c. 45 mm long.

SEXING No differences in plumage, but bill very different between sexes (see Measurements, Structure and Fig. 1; also see Burton 1974; Jamieson & Spencer 1996; Frith 1997).

GEOGRAPHICAL VARIATION None known.

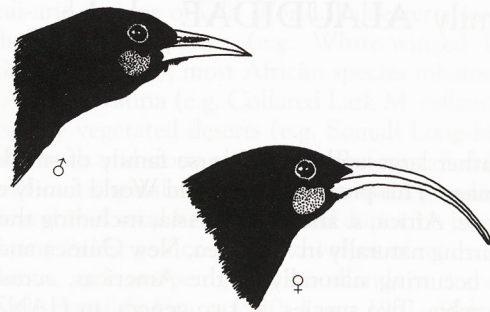


Figure 1 Sex-dimorphism in bill structure in adults

REFERENCES

- Best, E. 1977. *Forest Lore of the Maori*. Te Papa Press, Wellington.
- Blackburn, A. 1964. *Notornis* 11: 87–92.
- Buller, W.L. 1868. *Trans. Proc. NZ Inst.* 1: 213–31.
- 1870. *Trans. Proc. NZ Inst.* 3: 24–9.
- 1873. *A History of the Birds of New Zealand*. J. van Voorst, London.
- 1876. *Trans. Proc. NZ Inst.* 8: 192–3.
- 1877. *Trans. Proc. NZ Inst.* 10: 212.
- 1888. *A History of the Birds of New Zealand*. Second edn. Author, London.
- 1892. *Trans. Proc. NZ Inst.* 25: 63–8.
- Burton, P.J.K. 1974. *Bull. Br. Mus. Nat. Hist. (Zool.)* 27: 1–48.
- Colenso, W. 1886. *Trans. Proc. NZ Inst.* 19: 140–5.
- Drummond, J. 1910. *Emu* 10: 60–2.
- Enys, J.D. 1875. *Trans. Proc. NZ Inst.* 8: 204–5.
- Frith, C.B. 1997. *Notornis* 44: 177–84.
- Galbreath, R. 1989. *Walter Buller: The Reluctant Conservationist*. GP Books, Wellington.
- Heather, B.D., & H.A. Robertson. 2000. *The Field Guide to the Birds of New Zealand*. Viking, Auckland.
- Hutton, F.W., & J. Drummond. 1904. *Animals of New Zealand*. Whitcombe & Tombs, Christchurch.
- Jamieson, I.G., & H.G. Spencer. 1996. *Notornis* 43: 14–18.
- Kirk, T.W. 1883. *NZ J. Sci.* 1: 262–3.
- Lovegrove, T. 1996. *Notornis* 43: 91–112.
- Mathews, G.M. 1930. *Emu* 29: 278–87.
- Medway, D.G. 1968. *Notornis* 15: 177–92.
- Moorhouse, R.J. 1996. *Notornis* 43: 19–34.
- Phillips, W.J. 1963. *The Book of the Huia*. Whitcombe & Tombs, Christchurch.
- Potts, T.H. 1873. *Trans. Proc. NZ Inst.* 6: 139–53.
- 1884. *The Zoologist* (3)8: 387.
- 1885. *NZ J. Sci.* 2: 373–484.
- Reischek, A. 1885. *Trans. Proc. NZ Inst.* 18: 96–104.
- Selander, R.K. 1966. *Condor* 68: 113–51.
- Stattersfield, A.J., & D.R. Capper. (Eds) 2000. *Threatened Birds of the World*. Lynx Edicions, Barcelona.
- Thomson, G.M. 1922. *The Naturalisation of Animals and Plants in New Zealand*. Cambridge Univ. Press, Cambridge.
- Turbott, E.G. 1967. *Buller's Birds of New Zealand*. Whitcombe & Tombs, Christchurch.
- Williams, G.R. 1976. *Proc. Int. Orn. Congr.* 16: 161–70.