

## 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 AXI (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):

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- 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.
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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).

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*Meliphaga cincta* Du Bus, 1839, *Bull. Acad. Roy. Sci. Bruxelles* 6(1): 295 — Nouvelle Zélande = North Island, New Zealand.

The genus is from the Greek νοτιος, southern, and μύστις, a mystic, a mystery, with reference to the Stitchbird's distribution and uncertain affinities. Replaced *Pogonornis* (Greek πρόγων, a beard, and ὄρνις, a bird), given with reference to the long rictal bristles. 'Ce philédon est remarquable par la longueur des poils qui garnissent la commissure du bec et le front, à la naissance des fosses nasales' (Du Bus de Ghisignies 1839, *Bull. Acad. Roy. Sci. Bruxelles*, 6 [1], 296). Specifically named for the yellow band separating the black head from the plainer underparts (Latin *cinctus*, banded). The bird was named 'Stitch Bird' by early European settlers because its common call bore a fancied resemblance to the word 'stitch'.

OTHER ENGLISH NAMES *Pogonornis*.

MONOTYPIC

**FIELD IDENTIFICATION** Length c. 18 cm; no available data on wingspan; weight: male 36.5 g, female 30 g. Medium-sized, rather plump NZ honeyeater with short, slender, gently decurved bill; and rather short tail, often held cocked. Much smaller than Tui *Prosthemadera novaeseelandiae*; slightly larger, plumper and finer billed than Bellbird *Anthornis melanura*. Sexes differ markedly in adult and immature plumages but alike in juvenile; males slightly larger than females. No seasonal variation. Adult male has short white tuft on sides of nape, and velvety black head, neck, mantle and breast, bordered by golden-yellow band across lower breast and shoulders; mostly pale brownish-grey underbody, diffusely streaked darker; and prominent white patch on folded wing. Adult female much duller and plainer: dark brownish olive above and on sides of head and neck; and paler brownish grey and diffusely streaked darker below, with prominent white patch on folded wing. Juvenile similar to adult female but slightly duller and browner, with more uniform underbody, duller buffish patch on folded wing, and prominent yellowish or orange gape. Immatures very similar to adults of same sex; only males separable in close view. **Adult male** Head, neck, upper mantle and most of breast, velvety black, with prominent short white tuft of erectile feathers at sides of nape. Black of upper mantle merges through grey-black lower mantle, back and scapulars into dark brownish-olive rump and uppertail-coverts; a few outermost anterior scapulars narrowly edged golden-yellow. Uppertail, blackish brown, with all rectrices edged olive-yellow. A striking golden-yellow band extends across lower breast (not meeting in mid-line) and upward across shoulders, bordering and separating black foreparts from off-white lower underbody, which is washed brownish grey and diffusely streaked dark brownish grey, most

strongly along sides. Undertail, dark brownish grey. Pattern of folded wing complex and distinctive: black, with: (1) conspicuous white patch at base of tertials (formed by mostly white inner tertials and inner greater secondary coverts); (2) golden-yellow shoulder-patch (marginal secondary coverts; forms part of golden-yellow border to black foreparts); (3) narrow yellow fringes to outer greater secondary coverts and tips of corresponding median coverts; (4) obvious yellow panel on secondaries (formed by yellow edges to secondaries and outer two tertials); and (5) thin yellow-white edges to distal halves and bases of primaries, where they form small and diffuse whitish patch abutting black primary coverts. In flight, note blackish upperwing with conspicuous white patch at base of wing, immediately behind striking golden-yellow shoulder-patch on leading edge of innerwing. Underwing: coverts, buff-white; rest, dark grey. Bill, black. Iris, blackish brown. Orbital ring narrow, grey-black. Legs and feet, dark red-brown to grey-black with paler cream soles. **Adult female** Much duller and plainer than male. Differs by: Top and sides of head and neck, and rest of upperbody, uniform dark brownish olive, with tiny white tuft on side of nape, rarely visible in field. Underbody (including chin and throat), off-white, washed brownish grey and diffusely streaked dark brownish grey, most strongly along sides. Folded wing patterned (including prominent white wing-patch) as male except ground-colour slightly duller, black-brown; yellow of shoulder-patch and edges of remiges, tertials and rest of secondary coverts, duller yellow or olive-yellow; and greater primary coverts and alula have narrow olive-yellow edges. **Juvenile** Sexes alike. Very similar to adult female; best distinguished by: upperparts slightly browner and underbody uniform, dark grey-brown to dull buff; on folded wing, white patch

replaced by smaller and duller buffish patch; pale fringes to secondary coverts duller, yellow-brown; and pale edges to remiges duller, grey-brown (though diffuse whitish patch abutting primary coverts just as prominent as on adult female). Bill duller, grey-black, merging to dirty yellow or brownish orange on basal two-thirds or so of lower mandible. Gape, yellow to orange-yellow and puffy. **Immature male** As adult male except retain juvenile remiges, primary coverts and alula. Best distinguished from adult male by colour and pattern of greater primary coverts and alula: duller and browner (cf. deep black in adult) with clear narrow olive-yellow edges (lacking in adult); these differences visible in close view, though both tracts are often partly or entirely concealed by overlapping feathers of breast. **Immature female** Very similar to adult female, but retained juvenile remiges, primary coverts and alula slightly duller and browner, with duller olive-yellow edges; doubtfully separable from adult female in field.

**Similar species** Adult and immature males unlikely to be mistaken. Females and juveniles sometimes confused with female and juvenile **Bellbird**, but range overlaps only on a few small islands; see Bellbird account for distinctions.

Usually in pairs or small groups of up to ten birds; often found among topmost branches of tall trees. Sometimes associate with Tui and Bellbirds and, during non-breeding season, often form mixed feeding flocks with Whitehead *Mohoua albicilla*, Saddleback *Philesturnus carunculatus* and other passerines. Tame and approachable. Agile and acrobatic when foraging, often hanging upside-down to reach flowers and fruit or pausing on vertical limb with head facing downward and tail kinked at right angle to body. Typically alight on branch with tail strongly cocked, sometimes to vertical or a little beyond.

**HABITAT** Account based on contribution by I. Castro. Inhabit various types of forest, at all altitudes in temperate zone; mainly occur in dense native forest, mostly in valleys, but sometimes on slopes and ridges when nectar is abundant there; rarely recorded in light open bush (Falla *et al.* 1975; Angehr 1985; Gill & Veitch 1990).

Originally inhabited broadleaf evergreen forests of the temperate rainforests on the main NI (Oliver). Now restricted to warm-temperate rainforest on Little Barrier I. (Gravatt 1971) with several translocated populations on other islands (Perrott & Armstrong 2000; see Distribution). Although found in all types of forest, favour mature moist forests (Angehr 1985). Mainly inhabit moist hardwood forest dominated by Tawa *Beilschmiedia tawa*, Taraire *B. tarairi*, Kohekohe *Dysoxylum spectabile*, Northern Rata *Metrosideros robusta* and Puriri *Vitex lucens* in valleys and on ridges up to 300 m asl; and often occur in mixed Tawa–Towai *Weinmannia silvicola* forest on steep slopes >500 m asl (Angehr 1985). Also recorded in tall, regenerating Kanuka *Leptospermum ericoides* forest in valleys; mixed Kauri *Agathis australis*–Hard Beech *Nothofagus truncata* forest on ridges at middle elevations; wet forest dominated by Tawa, Towai, Tawari *Ixerba brexioides* and Miro *Prumnopitys ferruginea* on ridges above 400 m; stunted forest on highest peaks; and coastal Pohutukawa *Metrosideros excelsa* forest (Sibson 1947; Gravatt 1970, 1971; Angehr 1985; Rasch 1989). Rarely recorded in second-growth Manuka *Leptospermum scoparium* (Falla *et al.* 1975). Sometimes move between different types of forest in response to local flowering and fruiting. Rarely recorded in gardens (Gravatt 1970).

In detailed study on Little Barrier I. (Angehr 1984a), mainly found in Tawa–rata and Tawa–Towai forests; less often recorded in Kauri forest and *Leptospermum* forest in valleys;

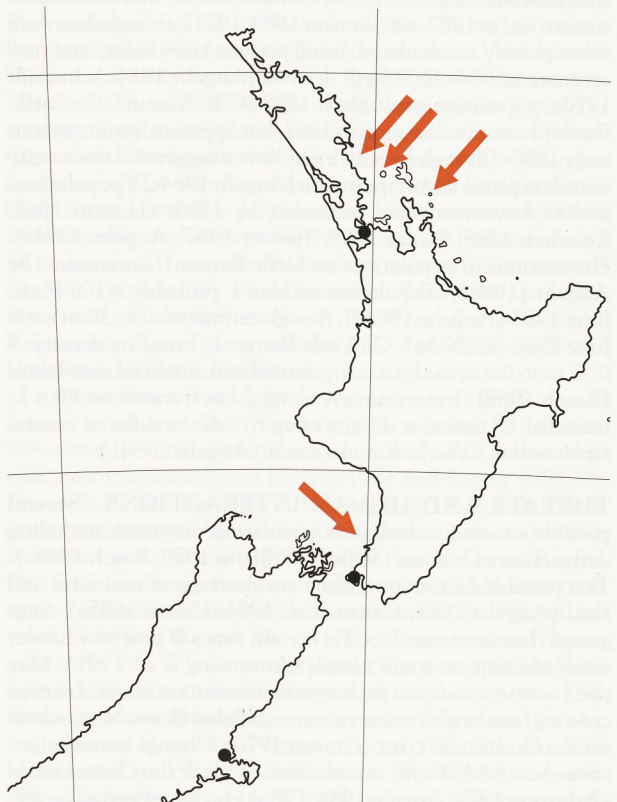
least common in *Leptospermum* forests on ridges and among *Quintinia*, *Ixerba* and Southern Rata *Metrosideros umbellata* on peaks. In study on Little Barrier I. by Kikkawa (1964), only recorded in sub-climax and climax forest dominated by Puriri and Pohutukawa with diverse, dense understorey, and not in regenerating Kanuka forest with more open understorey. On Hen I., released into coastal forest on steeper parts, and regenerating Kanuka forest on central plateau; these habitats similar in composition and structure to parts of Little Barrier I. On Hen I. recorded at densities of 0.65 birds/ha in coastal forest and 0.30/ha in Kanuka forest (Angehr 1984b). The forests on Kapiti I. are young and many plant species preferred by Stitchbird are rare; the island also supports a large number of bird species compared to other islands used or proposed for translocations of Stitchbird; therefore suggested that Kapiti I. might be at or near its carrying capacity for nectar–fruit eaters, and consequently the Stitchbird may never reach large numbers there (Castro 1995a).

**DISTRIBUTION AND POPULATION** Endemic to NZ.

**NI** Confined to a few small islands, mostly in Hauraki Gulf. Only natural population occurs on Little Barrier I.; introduced to Hen I. in Hen and Chickens Grp, Cuvier I., Kapiti I., Mokoia I. and Tiritiri Matangi I. (see Introductions) (Williams 1962; Angehr 1984b, 1985; CSN).

**Breeding** Breed throughout current range: on Little Barrier I., and on all islands where introduced (Angehr 1985; CSN).

**Change in range, populations** Formerly widespread on NI, S from at least Waikato R. (though single early record farther N at Bay of Islands, and subfossil remains found at North Cape, King Country and Hawkes Bay [NZCL]), S to round Wellington; also on several offshore islands, e.g. Little Barrier,



Great Barrier and Kapiti Is. Populations declined rapidly during 1870s. Before 1870, common in s. NI, round Wellington and Hutt R. Valley, but rare N of lower reaches of Waikato R. in 1873, and absent by 1878; by mid-1880s, had disappeared from mainland and Great Barrier and Kapiti Is, leaving only relict population on Little Barrier I. (Buller 1888, 1897; Stidolph 1922; Turbott 1967; Angehr 1984c, 1985; Oliver). Last record on mainland was in Tararua Ra., near Wairarapa Valley, in Feb. 1883 (Buller 1888; Turbott 1967). However, it was rumoured to have also remained in Kawhanga Ra. into 1880s (Buller 1888; Turbott 1967), and there have been a few unconfirmed reports in Ruahine Ras, and a report from Ngunguru, near Whangarei, in 1936, which may have been a bird blown in from Little Barrier I. (Williams 1962).

**Introductions** Several releases of birds, captured on Little Barrier I., to establish the species on other small islands: on Hen I., 30 birds released in Mar. 1980 and 16 in Apr. 1981 (Angehr 1984b); on Cuvier I., 29 birds released in June 1982 (Angehr 1984b), and 27 in Apr. 1985 (CSN 34); on Kapiti I., 30 birds released in Aug. 1983 (Angehr 1984b; CSN 32). Despite records of breeding, none of these populations is regarded as well established (Rasch 1985a); in Aug. 1991, only four individuals could be found on Kapiti I. (Castro *et al.* 1994); probably now extinct on Hen and Cuvier Is (Armstrong *et al.* 1999). Between Aug. 1991 and Aug. 1992, 95 Stitchbirds (48 males and 47 females) transferred from Little Barrier I. to Kapiti I. (Castro *et al.* 1994). In Aug.–Sept. 1994, 40 were translocated from Little Barrier I. to Mokoia (Armstrong *et al.* 1999). Also transferred to Tiritiri Matangi I. in 1995 (40 birds) and 1996 (13 birds) (Rasch *et al.* 1996).

**Status** Vulnerable (Collar *et al.* 1994). **Populations** Total population estimated at 4000–5000 birds (Angehr 1985) or c. 6000 birds (Angehr 1984c). In 1959, population conservatively estimated at 200 pairs (Kikkawa 1964); similar estimate was arrived at 1967–68 (Gravatt 1969, 1971), though data were subsequently recalculated, using present knowledge, and new estimate of 800–1200 birds derived (Angehr 1984c). In mid-1970s, population probably c. 1000 (C.R. Veitch). On Little Barrier I., not uncommon in 1867, but apparently quite rare in early 1880s (though Reischek may have exaggerated their rarity to inflate prices for his specimens [Angehr 1984c]); populations said to have recovered somewhat by 1890s (Hutton 1868; Reischek 1885; Buller 1888; Turbott 1967; Angehr 1984c). Fluctuations in populations on Little Barrier I. summarized by Angehr (1984c). Population on Hen I. probably  $\geq 100$  birds, June 1983 (Angehr 1984b), though estimated at c. 20 in early June 1986 (CSN 34). On Little Barrier I., breeding density of 0.52 nests/ha in study sites augmented with artificial nest-boxes (Rasch 1989). In ten surveys along 2 km transect on Hen I., recorded 19 times, at density of up to 0.65 birds/ha in coastal forest and 0.30/ha in Kanuka forest (Angehr 1984b).

**THREATS AND HUMAN INTERACTIONS** Several possible causes for decline of population proposed, including destruction of habitat (Mills & Williams 1979; Rasch 1985a). Two possible factors in decline are shortage of nest-sites and food (Angehr 1985; Castro *et al.* 1994; Castro 1995a). Suggested that shortage of food at certain times of year may hinder establishment on some islands (Armstrong *et al.* 1999). May need continuous forest for longer movements as never observed crossing farmland to utilize nectar-rich Pohutukawa *Metrosideros excelsa* forests near coast (Gravatt 1970). Change in range (see above) coincided with introduction of Black Rats *Rattus rattus* (Atkinson 1973; Angehr 1984c). May also have been adversely

affected by diseases transmitted by exotic birds introduced round same time (Angehr 1984c, 1985; Oliver). On Little Barrier I., coexisted with feral Cats for over a century (Angehr 1984c) though, during early 1880s, Cats were said to 'commit great havoc' among Stitchbirds (Reischek 1886; Miskelly 1988); after 1980, when Cats eradicated, populations of Stitchbirds increased by c. 600% (Veitch 1980, 1983). Formerly 'ruthlessly sought by collectors' (Oliver); up to 130 of the 181 specimens collected in the 19th century were taken by Andreas Reischek (Angehr 1984c) and doubtless he shot more; for example, the first pair he shot were 'knocked ... to pieces with heavy shot' (Buller 1888; Turbott 1967; Angehr 1984c); whole families of Stitchbirds 'fell an easy prey to this insatiable collector' (Sibson 1947). Formerly caught for food by Maori with snares; at certain times of the year, up to 100 could be caught in a day (Buller 1888; Turbott 1967). Feathers incorporated into *kahu-hihi* (Maori ornamental cloaks made of Stitchbird feathers), which required an enormous number of feathers to make (Buller 1888; Turbott 1967; Angehr 1985; Oliver).

**MOVEMENTS** Sedentary. Apparently move less than other NZ honeyeaters (Gravatt 1970; Armstrong *et al.* Undated). Generally remain in small home-ranges or territories centred in valleys, though sometimes move into different types of forest in response to local flowering or fruiting of plants (Gravatt 1970; Angehr 1984c, 1985); may travel several kilometres in a day between good feeding sites (Heather & Robertson 1997).

**FOOD** Account based on contribution by I. Castro. Eat fruit, nectar and arthropods, mainly insects. **Behaviour** Mainly arboreal; mostly forage in trees and shrubs. **DETAILED STUDIES:** On Little Barrier I. (Gravatt 1969, 1971; Rasch 1985a), Kapiti I. (Castro *et al.* 1994; Castro 1995a), and Mokoia I. (Armstrong *et al.* 1999, Undated; Perrott & Armstrong 2000). **SIZE OF FEEDING FLOCKS:** Usually forage in pairs when breeding, and in small groups of 2–6 birds outside breeding season (Mar.–Sept.); sometimes associate with Tuis and Bellbirds, and often comprise part of mixed feeding flocks with Whiteheads and Saddlebacks (McLean *et al.* 1987; I. Castro). **FEEDING HEIGHTS, SITES:** On Little Barrier I. (n=79 feeding obs.), fed mostly in middle and lower understorey, among fine twigs, leaves and terminal shoots of trees and small shrubs: 26.5% of observations were of feeding in lower understorey; 29.1% in middle understorey; 8.9% in upper understorey; 17.8% in subcanopy; and 17.8% in canopy. Heights above ground of these feeding observations were: 1.0% on ground; 18.4% at 0.1–1.5 m; 11.7% at 1.6–3.0 m; 14.6% at 3.1–4.5 m; 6.8% at 4.6–6.0 m; 14.6% at 6.1–7.5 m; 8.7% at 7.6–9 m; 11.7% at 9.1–10.5 m; 8.7% at 10.6–12.0 m; and 3.9% at 12.1–13.5 m (Gravatt 1969, 1971). On Little Barrier I. (n=28 obs. of feeding on insects): 42.9% gleaned from leaves; 3.6% from twigs; 17.8% from terminal shoots; and 35.7% taken from air (Gravatt 1969, 1971). **FEEDING SOURCES AND SEASON:** On Little Barrier I., of 37 feeding observations in spring, 18 in summer, 14 in autumn, and 17 in winter: feeding on nectar accounted for 89.2% of observations in spring, 83.3% in summer, 21.4% in autumn, and 47.4% in winter; insects, 8.1%, 11.1%, 28.6%, 29.4%; and fruit 2.7%, 5.6%, 50.0%, and 23.5% (Gravatt 1969, 1971). In a later study on Little Barrier I. (Dec. 1983–Nov. 1984), of 18 feeding observations in spring, 79 in summer, 18 in autumn, and 43 in winter: nectar feeding comprised 56% of feeding observations in spring, 18% in summer, 6% in autumn, and 51% in winter; fruit, 33%, 13%, 89% and 40%; and insects, 11%, 70%, 4% and 7% (Rasch 1985a). On Kapiti I. (1991–94), fed on same three categories of



food in differing proportions throughout year; on average, 37.2% of feeding observations were of nectar, 22.7% of fruits, and 39.6% of invertebrates (Castro 1995a). Also on Kapiti I. (Sept. 1991–Sept. 1992; 15–120 feeding obs./month): in spring, 71% of feeding observations were of insects and 29% fruit or nectar; in summer, 46% of observations were of feeding on fruit and 45% of insects; in autumn, birds fed in equal proportions on nectar, insects and fruit (33.3% each); in winter, 73% of observations were of nectar. Birds transferred to Kapiti I. differed from those on Little Barrier I. in seasonal feeding patterns, feeding mainly on insects in spring, when birds on Little Barrier I. took mainly nectar; differences in feeding mainly due to different floristic composition and phenology between islands (Castro *et al.* 1994). Birds observed for first two weeks following translocation to Mokoia I. in 1994 (6.1 h of obs. of 32 individuals), spent 34% of time foraging for natural carbohydrates (nectar and fruit), 36% foraging for invertebrates, 29% perching, and 1% on other actions; carbohydrate foraging was at flowers of *Pseudopanax arboreus* (63%), *Fuchsia excorticata* (22%), and *Albizia lophanta* (3%), and on fruit of *P. arboreus* (7%) and *Schefflera digitata* (5%) (Armstrong *et al.* 1999). At Mokoia I., Sept. 1994–Sept. 1995, proportion of time spent foraging for three food-types (nectar, fruit and invertebrates) varied throughout year; proportion of foraging time spent at nectar sources highest during spring (75%) and winter (54%), and lowest during summer (15%) and autumn (21%). Proportion of time spent feeding on invertebrates highest in summer (73%) and autumn (51%), and lowest during winter (19%) and spring (20%). Proportion of foraging time spent feeding on fruit highest in autumn (28%) and winter (27%), and lowest in spring (3%) and summer (12%). Fed mostly on nectar and fruit in winter and spring, and mostly on invertebrates in summer and autumn. Plant species used most for nectar were generally those contributing most to nectar standing crop at the time; birds tended to avoid flowers comparatively low in nectar. In contrast, proportion of time spent feeding on different species of fruit bore little relation to available store of carbohydrates in fruit (Armstrong *et al.* Undated). FEEDING METHODS: Collect nectar by directly probing flowers; insects mostly collected by gleaning or by sallying into air (Gravatt 1969; Castro 1995a). Very acrobatic when foraging, hanging upside-down to reach flowers and fruit; move between inflorescences in same tree by walking, gliding or jumping along branches. Females seen feeding on beetles on forest floor, or following Kaka *Nestor meridionalis* to catch insects disturbed by the parrot while carving bark (I. Castro). Average number of flowers visited by individual Stitchbird while foraging for 1 min at various plant species: *Geniostoma rupestre* 70.4 fl./min (8.35; 17.3 min); male *Pseudopanax arboreus* 48.5 (9.13; 1.4 min); *Pittosporum crassifolium* 25.9 (5.3; 2.9 min) (Castro & Robertson 1997).

**Detailed studies** ON LITTLE BARRIER I. (68 birds observed feeding on nectar over 12 months; Gravatt 1969, 1970): **PLANTS** DICOTYLEDONS: Araliaceae: *Pseudopanax arboreus* 1 bird seen feeding on this species (Sept.); *Schefflera digitata* 2 (Feb.); Caprifoliaceae: *Alseuosmia macrophylla* 9 (Aug.–Oct.); Meliaceae: *Dysoxylum spectabile* 2 (Aug.); Myrtaceae: *Metrosideros excelsa* 29 (Dec.); *M. fulgens* 2 (Apr., June); *M. perforata* 2 (Jan.); *M. robusta* 17 (Dec.–Jan.); Oleaceae: *Nestegis* 1 (Sept.); Pittosporaceae: *Pittosporum umbellatum* 12 (Aug.–Sept.); Proteaceae: *Knightia excelsa* 5 (Sept.–Oct.); Scrophulariaceae: *Hebe* 3 (Sept.); Verbenaceae: *Vitex lucens* 10 (May, July, Sept., Nov.).

Also on LITTLE BARRIER I. (92 obs. of feeding on nectar and

fruit; Rasch 1985a): **PLANTS** DICOTYLEDONS: Araliaceae: *Pseudopanax arboreus* fru. 1.0% no. of obs.; Caprifoliaceae: *Alseuosmia macrophylla* nectar 12.0; Epacridaceae: *Cyathodes fasciculata* fru. 1.0; Gesneriaceae: *Rhabdothamnus solandri* nectar 9.0; Loganaceae: *Geniostoma ligustrifolium* fru. 4.3; Meliaceae: *Dysoxylum spectabile* nectar 4.3; Myrsinaceae: *Myrsine australis* fru. 1.0; Myrtaceae: *Metrosideros excelsa* nectar 5.5; Piperaceae: *Macropiper excelsum* fru. 1.0; Pittosporaceae: *Pittosporum umbellatum* nectar 13.0, fru. 1.0; Rubiaceae: *Coprosma* fru. 40.0; Verbenaceae: *Vitex lucens* nectar 5.5.

Another study on LITTLE BARRIER I. (seeds recovered from faeces from 14 birds; Gaze & Fitzgerald 1982): **PLANTS** DICOTYLEDONS: Loganaceae: *Geniostoma ligustrifolium* 14% freq.; Myrsinaceae: *Myrsine australis* 86; Piperaceae: *Macropiper excelsum* 7; Rubiaceae: *Coprosma* 7; Violaceae: *Melicactus* 29. INSECTS 14.

ON KAPITI I. (obs. of plants visited for nectar and fruit; Aug. 1991–Aug. 1994; <sup>3</sup>= frequent visits [every time flower available, visited by Stitchbird], <sup>2</sup>= occasional visits, <sup>1</sup>= rare visits; Castro 1995a; Castro & Robertson 1997): **NECTAR** MONOCOTYLEDONS: Agavaceae: *Phormium tenax*<sup>3</sup>; Arecaceae: *Rhopalostylis sapida*<sup>3</sup>; Liliaceae: *Astelia*<sup>1</sup>; Orchidaceae: *Earina autumnalis*<sup>1</sup>; Smilacaceae: *Ripogonum scandens*<sup>3</sup>. DICOTYLEDONS: Araliaceae: *Pseudopanax arboreus*<sup>3</sup>; *P. crassifolium*<sup>2</sup>; *Schefflera digitata*<sup>2</sup>; Cornaceae: *Griselinea littoralis*<sup>2</sup>; Cunoniaceae: *Weinmannia racemosa*<sup>3</sup>; Elaeocarpaceae: *Aristotelia serrata*<sup>3</sup>; *Elaeocarpus dentatus*<sup>3</sup>; Lauraceae: *Beilschmiedia tawa*<sup>2</sup>; Loganaceae: *Geniostoma rupestre*<sup>3</sup>; Malvaceae: *Hoheria populnea*<sup>1</sup>; Meliaceae: *Dysoxylum spectabile*<sup>3</sup>; Myoporaceae: *Myoporum laetum*<sup>3</sup>; Myrsinaceae: *Myrsine australis*<sup>1</sup>; *M. salicina*<sup>2</sup>; Myrtaceae: *Metrosideros excelsa*<sup>3</sup>; *M. fulgens*<sup>3</sup>; *M. perforata*<sup>3</sup>; *M. robusta*<sup>3</sup>; *Syzygium maire*<sup>3</sup>; Onagraceae: *Fuchsia excorticata*<sup>3</sup>; Passifloraceae: *Passiflora tetrandra*<sup>2</sup>; Pittosporaceae: *Pittosporum cornifolium*<sup>3</sup>; *P. crassifolium*<sup>3</sup>; *P. eugenioides*<sup>3</sup>; *P. tenuifolium*<sup>3</sup>; *P. umbellatum*<sup>3</sup>; Proteaceae: *Knightia excelsa*<sup>3</sup>; Rosaceae: *Rubus cissoides*<sup>3</sup>; Rununculaceae: *Clematis vitalba*<sup>1</sup>; Verbenaceae: *Vitex lucens*<sup>3</sup>; Violaceae: *Melicactus ramiflorus*<sup>2</sup>. **FRUITS** MONOCOTYLEDONS: Liliaceae: *Astelia*<sup>1</sup>; Smilacaceae: *Ripogonum scandens*<sup>3</sup>. DICOTYLEDONS: Araliaceae: *Pseudopanax arboreus*<sup>3</sup>; *P. crassifolium*<sup>2</sup>; Cornaceae: *Griselinea littoralis*<sup>3</sup>; Corynocarpaceae: *Corynocarpus laevigatus*<sup>3</sup>; Elaeocarpaceae: *Aristotelia serrata*<sup>3</sup>; Escalonaceae: *Carpodetus serratus*<sup>3</sup>; Loganaceae: *Geniostoma rupestre*<sup>3</sup>; Meliaceae: *Dysoxylum spectabile*<sup>3</sup>; Myrsinaceae: *Myrsine australis*<sup>1</sup>; *M. salicina*<sup>2</sup>; Myrtaceae: *Metrosideros robusta*<sup>3</sup>; Onagraceae: *Fuchsia excorticata*<sup>3</sup>; Passifloraceae: *Passiflora tetrandra*<sup>3</sup>; Piperaceae: *Macropiper excelsum*<sup>2</sup>; Rosaceae: *Rubus cissoides*<sup>3</sup>; Rubiaceae: *Coprosma grandifolia*<sup>3</sup>; *C. lucida*<sup>3</sup>; *C. robusta*<sup>2</sup>; Violaceae: *Melicactus ramiflorus*<sup>3</sup>.

ON MOKOIA I. (list of plants visited for nectar and fruit, and seasons in which eaten [Sp=spring; S=summer; A=autumn; W=winter; R=rare, seasonal use not given]; data collected in year after translocation of birds in 1994 and during 1994–95; Perrott & Armstrong 2000; Armstrong *et al.* Undated). **PLANTS** MONOCOTYLEDONS: Agavaceae: *Cordyline australis* nectar (S); *Phormium tenax* nectar (R); Liliaceae: *Astelia* nectar (R), fru. (R); Orchidaceae: *Earina autumnalis* nectar (S, A). DICOTYLEDONS: Araliaceae: *Pseudopanax arboreus* nectar (Sp, W), fru. (all year); *Schefflera digitata* fru. (A, W); Coriariaceae: *Coriaria arborea* fru. (A, W); Corynocarpaceae: *Corynocarpus laevigatus* nectar (S); Cunoniaceae: *Weinmannia racemosa* nectar (R); Elaeocarpaceae: *Aristotelia serrata* nectar (Sp), fru. (S, A); Loganaceae: *Geniostoma rupestre* nectar (W, Sp), fru. (S); Meliaceae: *Dysoxylum spectabile* nectar (A, W); Mimosaceae: *Albizia lophantha* nectar (A, W); Myrsinaceae: *Myrsine australis*

nectar (R), fru. (S, A); Myrtaceae: *Leptospermum ericoides* nectar (R); *Metrosideros excelsa* nectar (S); *M. robusta* nectar (R); Onagraceae: *Fuchsia excorticata* nectar (W, Sp), fru. (S); Piperaceae: *Macropiper excelsum* fru. (A); Pittosporaceae: *Pittosporum tenuifolium* nectar (Sp, S); Polygonaceae: *Muehlenbeckia australis* fru. (A, W); Proteaceae: *Knightia excelsa* nectar (S); Rosaceae: *Rubus cissoides* nectar (R), fru. (R); *R. fruticosus* fru. (R); Rubiaceae: *Coprosma* fru. (A, W); Sapindaceae: *Dodonaea viscosa* nectar (R); Violaceae: *Meliccytus ramiflorus* fru. (S, A).

**Other records** **Plants** Fruit<sup>5</sup>. **MONOCOTYLEDONS:** Agavaceae: *Phormium colensoi*<sup>2</sup>; *P. tenax* nectar<sup>5</sup>. **DICOTYLEDONS:** Araliaceae: *Pseudopanax lessonii* fru.<sup>3</sup>; Caprifoliaceae: *Alseuosmia macrophylla* nectar<sup>4,5,10</sup>; Coriariaceae: *Coriaria sarmentosa* fru.<sup>1</sup>; Elaeocarpaceae: *Aristotelia serrata* fru.<sup>4</sup>; Epacridaceae: *Cyathodes* nectar<sup>4</sup>; *C. fasciculata* fru.<sup>4</sup>; Escalloniaceae: *Ixerba brexioides*<sup>2</sup>; Meliaceae: *Dysoxylum spectabile* nectar<sup>5,9</sup>; Moraceae: *Ficus* fru.<sup>3</sup>; Myrsinaceae: *Myrsine australis* fru.<sup>4,8,9</sup>; Myrtaceae: *Metrosideros excelsa* nectar<sup>4,5</sup>; *M. fulgens* nectar<sup>6</sup>; *M. robusta* nectar<sup>4</sup>; *M. umbellata*<sup>2</sup>; Pittosporaceae: *Pittosporum crassifolium* nectar<sup>4</sup>; Proteaceae: *Knightia excelsa* nectar<sup>4</sup>; Rutaceae: *Citrus* nectar<sup>3</sup>; Scrophulariaceae: *Hebe* nectar<sup>4</sup>; Verbenaceae: *Vitex lucens* nectar<sup>5,6</sup>; Violaceae: *Meliccytus ramiflorus* fru.<sup>3,4</sup>; Winteraceae: *Pseudowintera axillaris* fru.<sup>7</sup>. **Animals** **SPIDERS**<sup>11</sup>. **INSECTS**<sup>5</sup>: Coleoptera<sup>11</sup>.

**REFERENCES:** <sup>1</sup> Turbott 1967; Gravatt <sup>2</sup> 1969, <sup>3</sup> 1970, <sup>4</sup> 1971; <sup>5</sup> Falla *et al.* 1978; <sup>6</sup> Gaze & Fitzgerald 1982; <sup>7</sup> Norton 1982; CSN <sup>8</sup> 28, <sup>9</sup> 37, <sup>10</sup> 44; <sup>11</sup> I. Castro.

**Young** Fed by both parents; females attend nests more often than males, and in some nests females alone raise young (I. Castro). Mostly, if not entirely, fed on insects <3 mm in length during first 8–10 days *contra* Falla *et al.* (1978) who state that only nectar given to chicks. After this, usually fed on nectar, fruit and large insects. Parents bring food to chick in gular pouch and regurgitate food whole into chick's mouth (I. Castro).

**Intake** On Kapiti I., energy intake when feeding on nectar from three species of plants estimated at 0.2–1.0 kJ/min, which usually meets estimated energetic requirements of 0.25 kJ/min. When feeding on *Geniostoma rupestre*, birds need to choose carefully at which flowers to feed in order to satisfy energy requirements, because flowers contain very little nectar. On Mokoia I., birds spent 0.9–2.46 s per flower to obtain at least 2 J/s from flowers of all species they fed on, except *Cordyline australis*, *Corynocarpus laevigatus* and *Schefflera digitata* (where J/flower <2). Birds estimated to obtain 2.9 J/s from *Fuchsia* flowers, 3.5 J/s from *Albizia*, 15–24 J/s from *Metrosideros excelsa*, and 6–10 J/s from *Knightia excelsa* (Armstrong *et al.* Undated).

**SOCIAL ORGANIZATION** Account based on contribution by I. Castro. Quite well known. Detailed study on Little Barrier I., where many birds unbanded, of behavioural ecology of wild population (Rasch 1985a,b, 1989) with some additional information from other studies (Gravatt 1970; Angehr 1984a). On Kapiti I., most of population banded and detailed study of behaviour undertaken 1991–94 (Castro *et al.* 1994, 1996; Castro 1995a); some observations conducted at artificial feeding station (Castro *et al.* 1996). Translocated population at Mokoia I. studied from 1994, especially aspects of mating system (I. Castro & K.M. Mason). Breeding behaviour differs between population on Little Barrier I. and translocated population on Kapiti I. (Castro *et al.* 1994). Outside breeding season,

i.e. Mar.–Sept., forage and move round in small groups of 2–6 birds (I. Castro). These foraging groups often associate with other passerines, such as Whiteheads and Saddlebacks, in mixed flocks (Gravatt 1969; Oliver; I. Castro); on Little Barrier I., in July, just as likely as not to be found in a mixed-species flock (McLean *et al.* 1987). During summer, form groups of up to ten birds (mostly males) at nest-sites.

**Bonds** Males have large testes (c. 4.2% of body-mass), very large numbers (1460 × 10<sup>6</sup>) of sperm in their seminal glomera and an unusually enlarged cloacal protuberance; all features found in other species with highly varying mating systems where males are under intense sperm competition (Castro *et al.* 1996). On Little Barrier I., considered monogamous (Falla *et al.* 1978; Rasch 1985a); in one study, each of ten nests found appeared to be attended by single male and single female (Castro *et al.* 1996). However, some irregularities occur: males possibly seek extra-pair matings round time of laying, with an influx of males observed at some nests, and up to four males present at one nest; polygynous matings suspected (Castro *et al.* 1996); one male appeared to be involved in two nests (Rasch 1985a). Suspected that, on Little Barrier I., if suitable nest-sites available nearby, they may allow male to be polygynous, but experiments with artificial nest-sites found that proximity of nest-site did not influence mating system, and birds continued to behave monogamously (Rasch 1989). Possible polygyny also noted on Cuvier I. (Castro *et al.* 1994). Males also observed visiting several different nests on Kapiti (Castro *et al.* 1996), Mokoia (I. Castro & K.M. Mason) and Tiritiri Matangi Is (Ewen *et al.* 1999). On Kapiti I., mating system in translocated population varies much. Male considered associated with nest if recorded within 50 m of nest; male considered owner of nest if he often called near nest and entered nest-hole, though often identity of male partner not apparent until he started to feed young; of 34 nests: 65% considered monogamous, where single male and female attended nest; 12% polygynous, where two females shared single nest-cavity, or where male attended nests of two females; 9% polyandrous, where one female and more than one male fed young; and 3% polygynandrous. Males often force copulation on females (Castro *et al.* 1994, 1996) (see Social Behaviour). Some individuals bred in more than one mating situation, usually with different partners. Some males with nests of their own visited other nest-sites where clutches were not yet laid. Some fertile females were visited at their nest-sites by several males, and females seemed to copulate with these males as well as their mates; at one nest-site, six copulations between female and three males observed in 25 h, but only one male, considered her partner, helped rear young; all three males were often seen at nest, calling and chasing each other, but male partner and another of the males also had mates and nests elsewhere. When laying completed, male stops visiting nest (Castro *et al.* 1996). Some males closely guarded mates during their fertile period, following their every move and thus limiting opportunities for extra-pair copulations by the female, but other males did not spend much time with one female during period from pre-laying to end of incubation. At artificial feeding site, copulation apparently involving unpaired females often seen (Castro *et al.* 1996). Length of pair-bond varies; some pairs stay together for years, while others change partners between clutches in same season (I. Castro & K.M. Mason). **SEX-RATIO:** On Kapiti I., where 48 males and 47 females translocated in 1991–92, ratio remained at 1:1 between 1991 and 1994 (Castro *et al.* 1996); in 1997, 2 females:1 male (R.A. Empson). On Mokoia I., after translocation of 20 males and 20 females, sex ratio 1:1 for 2 years, but since 1995, about 2 males:1

female (I. Castro). On Tiritiri Matangi I., 3 males:1 female (J.G. Ewen). Sex-ratio on Little Barrier I. not known; possibly more males than females, as large numbers of unmated males observed during breeding season (Rasch 1989). However, males gather at females' nest-sites during this time of year (a fact not known in 1989), and this may have given a false perception of sex ratio. Reasons for changes in sex-ratios not known. First form pairs in season after fledging, at minimum age of 6 months (I. Castro). **Parental care** Usually only female builds nest (but see Breeding). Sometimes 2–4 females at one nest-site at start of season; all help to build nest-platform, but normally only dominant female builds nest-cup and only one stays in area and remains associated with nest (Castro *et al.* 1994). Only female incubates (Rasch 1985a; Castro *et al.* 1996); once, two females were associated with nest and both incubated (Castro *et al.* 1994; Taylor 2000). Both sexes feed chicks, but contribution of male often less than that of female; in monogamous pairs, contribution of male (visits/h) about one-third that of female; male's help in feeding young possibly not essential, as females sometimes noted raising young alone (Rasch 1985a; Castro *et al.* 1996). Male spends much time either defending partner at own nest-site or competing for copulations at other nest-sites (I. Castro & K.M. Mason). Contribution of each parent to feeding of fledgelings, rate at which fledgelings are fed, and length of time spent feeding fledgelings vary depending on whether female lays second clutch soon after first brood fledges. Usually, if female does not lay second clutch, fledgelings fed by both parents (but mostly by female) for up to 2 weeks. If female lays second clutch, she will feed fledgelings while male guards her up to start of incubation; if female starts incubating while first brood still <1 week after fledging, male may resume feeding fledgelings (I. Castro & K.M. Mason). About 1 week after fledging, young join crèches, where they are not fed by parents. Adult males accompany crèches. Crèches recorded Dec.–Mar. vary in size and are probably important for social development (Castro 1995b). Members of crèche often visit different crèche for c. 1 day before returning to their own. Crèches disband towards autumn (I. Castro & K.M. Mason). For behaviour in crèches, see Social Behaviour.

**Breeding dispersion** On Little Barrier I., eight nests found in c. 20 ha; shortest distance between any two active nests, 100 m, though possibly sometimes closer; availability of suitable nest-holes did not limit breeding density (Rasch 1985a,b, 1989). On Kapiti I., nests  $\geq$ 110 m apart (Castro *et al.* 1996). Where possible, female builds in several suitable cavities before choosing one for nesting. On Kapiti I., where shortage of suitable nesting sites, up to three females seen building in same cavity; once, two females shared same natural cavity and, though visual inspection not possible, assumed to have shared nest (Castro *et al.* 1994). On Mokoia I. during 1994 and on Tiritiri Matangi I., occasionally two females observed sharing nest-boxes, both laying 4–5 eggs and both incubating, but all such observed attempts failed (Taylor 1999, 2000; I. Castro & K.M. Mason). Breeding asynchronous (Castro *et al.* 1996).

**Territories** Territorial only during breeding season. Male defends c. 30 m round nest-site, chasing away other males; female aggressive to conspecifics and other birds that land near nest-site (Rasch 1985b; Castro *et al.* 1996). Male does not defend resources for mate (Rasch 1985b), unlike other honeyeaters in NZ, e.g. Tui (Stewart 1980) and Bellbird (Rasch 1985b). **DOMINANCE AND HIERARCHIES:** Use same food resources as Tui and Bellbird, and dominance hierarchies sometimes form in which Tuis and Bellbirds dominant over Stitchbirds. Typically, older Stitchbirds displace younger ones,

especially of same sex, and males dominant over females, though this will vary with mating and residential status (Stewart 1980; Craig *et al.* 1981b; Angehr 1984a; Craig 1984; Rasch 1985a). At nest-sites on Little Barrier I., females dominant over males when young nestlings present (Castro *et al.* 1996), but at other times of year males can be dominant (Angehr 1984a; Craig 1984; Rasch 1985a). On Kapiti I., females subordinate to males, though female sometimes aggressive to mates (Castro *et al.* 1996). Males and females in polygynous and polyandrous groups aggressive towards each other (I. Castro), and hierarchies of dominance usually formed, with a dominant male or dominant female, or both, that are aggressive to other birds of same sex (Castro *et al.* 1996); early in nesting, dominant female at each site tried to discourage subordinate females from remaining in area; when young present, dominant male harassed subordinate males found approaching nest or in nesting area, making it difficult for subordinate males to feed young (I. Castro & K.M. Mason). On Little Barrier I., nested near nesting Rifleman *Acanthisitta chloris* and Red-crowned Parakeet *Cyanoramphus novaezelandiae*, which also nest in tree-cavities, without aggression (Rasch 1985a); on Kapiti I., much aggression between Stitchbirds and Red-crowned Parakeets noted round nest-sites (Castro *et al.* 1994; Castro 1995a). **Home-range** Using marked birds, home-range found to be small: on Kapiti I., small groups ranged along c. 3 km of streams within areas 500 m wide (Castro 1996); on Mokoia I., individuals range all over the 135-ha island (I. Castro). On Kapiti I., single stream catchment was shared by group with overlapping home-ranges (Castro *et al.* 1996); home-ranges similar in breeding and non-breeding seasons, but breeding birds spend more time within 50 m of nest-sites (Castro 1995a). On Little Barrier I., restricted to 'territories', which provided for all needs, and did not range far from breeding areas (Gravatt 1970); male and female of pair apparently used separate foraging areas, but overlapped near nest and sometimes at particularly good sources of food; female used areas close to nest, while male did not appear to favour any particular area (Rasch 1985a), possibly because males roam in search of fertile females and copulation opportunities (I. Castro); one female fed 170 m from nest (Rasch 1985b).

**Roosting** Roost in cavities in groups (Castro *et al.* 1994); groups of several birds seen roosting in clumps of *Collospermum* and in tree-cavities (Lovegrove 1986); also roost in rock outcrops, thickets of leaves and lianas in trees (I. Castro).

**SOCIAL BEHAVIOUR** Based on contribution by I. Castro. Social behaviour studied on Kapiti I. (Castro *et al.* 1996); account based on observations by I. Castro except where otherwise stated. Displays easy to observe, as birds tolerant of people, but as species is rare there are few observations; in some areas, continuous observation of individuals difficult because habitat dense and birds move much (Castro *et al.* 1996). Throughout year, give Contact Calls, which usually answered by nearby conspecifics (I. Castro, K.M. Mason & E.O. Minot). Male starts to sing at nest-site in Sept.; on Kapiti I., where shortage of suitable nesting cavities, males call year-round at nest-sites, but intensity of calling increases in Sept.

**Agonistic behaviour** Aggressive during breeding season (Rasch 1985a). **Territorial advertising** Male utters Song within 30 m of nest-site, or at rich feeding areas (Castro *et al.* 1996; I. Castro, K.M. Mason & E.O. Minot). Near nest-site, male calls consistently from Sept. to Oct.; intensity of calling greatest 2 days before laying and virtually stops after laying (Castro *et al.* 1996). Outside breeding season, call less often (I.

Castro, K.M. Mason & E.O. Minot). **Threat** Threat displays usually performed when birds near each other or in direct line of sight. First sign of threat is **AGGRESSIVE CHAT** (see Voice). **AGGRESSIVE DISPLAY** (Fig. 1): Bird leans forward with tail cocked at 90° to body, wings lifted at shoulders and tips of wings crossed over back, and ear-tufts raised. Display accentuates white in wings of both sexes, and golden yellow of male's shoulders.

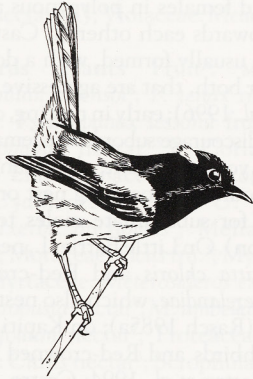


Figure 1 Aggressive Display (Source: photo by I. Castro)

Aggressive Display used by male towards conspecifics, e.g. by dominant male if subordinate male feeding nearby, or by breeding male if another male comes too near its nest-site, young or mate. Sometimes bird displays very briefly, then chases antagonist, but at other times displays for longer, with male moving body, in position described above, from side to side. Display stops at any time, in an intermediate state, if antagonist leaves or moves. Female also uses Aggressive Display in similar situations to males, but display mostly directed towards other females or juveniles; rarely directed at mate near nest. **FEMALE ULTIMATE AGGRESSIVE DISPLAY**: Female opens wings and moves decisively towards male, or any other bird, near nest, and gives Hiss. Sometimes leads to fighting or chasing if antagonist does not leave. Females often behave aggressively towards mates: perching at nest, shaking wings and hissing (Rasch 1985a). **MALE ULTIMATE AGGRESSIVE DISPLAY**: Male points bill skyward, with wings spread at shoulders and ear-tufts erect; vibrates wings slightly while giving low-volume *cooing*. Male antagonist sits quietly, with body sleeked, and looks away from displaying male. Display always followed by chase. Performed in very aggressive situations, e.g. when intruding male refuses to leave nesting area after owner repeatedly gives Aggressive Display and chases it many times. **CHASING**: Usually all aggressive encounters finish in a chase. Both males and females may give Chase Call when chased by conspecifics (I. Castro, K.M. Mason & E.O. Minot). Chasing also noted elsewhere when birds intrude near nest-holes; males chase males, females chase females and both sexes chase fledgelings other than their own (Rasch 1985a). **Fighting** Rarely seen. Birds hold each other's claws while pecking one another. Fights often start in mid-air, and birds drop to ground. Most fighting occurs during breeding season, e.g. between male of pair and intruding male that forcibly copulated with female of pair and then was slow in making his escape; or between adult males and young males acquiring adult plumage. Females also seen fighting with conspecifics and other bird species that approached nest-site too closely and then did not leave when threatened with display. Sometimes female attacks mate near nest with her bill, wings and claws. Sound of fighting sometimes heard within

nest-cavity (Rasch 1985a); now known to be when forced copulations occur inside nests (J.G. Ewen). **Submissive displays, Escape behaviour** Often submissive bird looks away from aggressive bird, and sleeks feathers to appear small and streamlined, with tail held low. When male or female intrudes into another nesting area, or when fertile female meets male (including its partner), it often 'freezes'; one female played dead, closing eyes while lying sideways on platform of nest. Often resident male seems not to notice 'frozen' intruder or female, and such 'frozen' birds sometimes eventually leave area without being attacked. If resident male notices intruder, he attacks, usually with fast chase; if a partner trying to avoid detection is noticed, he will also chase her. One male that noticed female, not his mate, playing dead, approached her carefully and jumped on her; as she started to leave, he grasped her and forcibly copulated with her. When chased by other birds or when entering nest other than their own, individuals may give Squeak (Castro *et al.* 1996). **Alarm** Emit various warning or alarm calls, depending on intensity of alarm (see Voice). When alarmed or excited, male raises tail and ear-tufts; when disturbed, female sometimes hides and remains quiet (Buller 1888). Often mob predators, especially Southern Boobooks *Ninox novaeseelandiae* and cuckoos. When roost of predator located, Stitchbird gives frequent and loud chipping while circling c. 2 m from predator; this often attracts conspecifics and other species; if predator flies away, many birds mob it, and the Stitchbirds may give Alarm Call, attracting more birds to area; mobbing stops only when predator has left area.

**Sexual behaviour Sexual advertising displays** Seen Oct.–Mar., at nest-sites. On Kapiti I., male often enters nest-cavity in presence of female; during early courtship, some males seen entering and leaving cavities with sticks or leaves in their bills (I. Castro, J. Taylor & J.G. Ewen). On Little Barrier I., males seem wary of entering nest (see Greeting, below). **MALE DISPLAY FLIGHT AND METALLIC CALL**: When leaving entrance to nest, male performs slow downward glide to perch near female; during glide, wings remain open, accentuating yellow and white in wings, ear-tufts kept erect, and gives Metallic Call. Male often lands on ground after flight or flies to higher branch to perch on completion of display. **DISPLAY WALK**: Male displays to female by walking on forest floor while Warbling, with wings crossed over back and ear-tufts erect; often leads to copulation. **Greeting** On Kapiti I., male uttered Identification Chat each time he met partner. After male gave Song on arrival at nest-site, female within nest-cavity gave Identification Call (I. Castro, K.M. Mason & E.O. Minot). On Little Barrier I., males generally wary about entering nests, calling repeatedly before entering; if both parents simultaneously arrived at nest, female entered first, and male waited till she left (Rasch 1985a); similar behaviour observed on Mokoia I. (I. Castro & K.M. Mason). **FEMALE REQUEST FOR COPULATION DISPLAY**: Female requests copulation by moving through vegetation with vibrating wings crossed over back and feathers of head raised; makes loud and repetitive *pew* call. When male nearby, female often Warbles instead of giving *pew* call, and increases vibration of wings. Sometimes leads to copulation (Ewen 1998; I. Castro). **Copulation** Occurs over period of c. 9 days, from when nest finished till laying completed; mainly in morning and late afternoon; usually on ground within 20 m of nest-site, and rarely on branches (Castro *et al.* 1996; I. Castro & K.M. Mason), though sometimes birds display on branches of trees, then fly to ground (Castro *et al.* 1996); sometimes inside nesting cavity (J.G. Ewen); sometimes copulate away from nest, in feeding areas; sometimes start up to 17 days before

laying. At one nest, six copulations in 25 h involved female and three males. Copulate in two positions: conventional mounting from behind, and face-to-face mounting. During conventional copulation (Fig. 2a), members of pair display to each other with feathers of head raised, and wings crossed then vibrated; also Warble. Once on ground, birds give a neck-rubbing display, which includes touching bills. Male climbs onto female's back; no calls given, though once male gave soft *pew* call. Male often mounts female several times. Before and after each mount, pair rub necks and touch bills. Copulation lasts 6–30 s. After copulation, male often Display Walks and utters Song as he moves away from female; female either returns to nest, preens, or flies away with male. One female performed conventional copulation with three different males at nest-site. Female may mount male during copulation (Castro *et al.* 1996).

**FORCED COPULATION** (Fig. 2b–d): Single male chases female to ground and then mounts her, holding her upside-down on her back, so birds are face to face; female's wings are spread and she tries to fly, or kicks male, as though trying to escape; during copulation, male spreads his wings, or points bill vertically and slightly extends wings. Afterwards, male and female fly away separately. Female often forced to ground several times before copulation. During chase, and sometimes during copulation, female gives Forced Copulation Call till end of chase, or till birds on ground, which attracts other males (Castro *et al.* 1996) or, if copulating male is an intruder, female's partner, who sometimes interrupts copulation (I. Castro, K.M. Mason & E.O. Minot). Generally, most Forced Copulations start with one male chasing female, then up to four other males join in, flying in line after female. On ground, only first male grasps female; other males watch from 0.1–1 m away, giving Alarm Call or Warning Call, but not interfering. Forced Copulation lasts from 6–8 s (Castro *et al.* 1996) to >1 min, usually lasting longer if there are no other males in vicinity. Forced Copulation often performed by male not paired with female, but occasionally male forces copulation on his female partner, especially when many other males in nesting area; female sometimes forced from nesting cavity to copulate. This face-to-face copulation is unique among birds (Castro *et al.* 1996). In captivity, all copulations seen were face to face (Anderson 1993). Not known whether sperm transferred from male to female during face-to-face copulations, but presence of enlarged cloacas in both sexes could aid transfer of sperm (Castro *et al.* 1996). Once, resident male observed Forced Copulating with another male after repeatedly chasing second male from Puriri *Vitex lucens* tree; this occurred shortly before female laid eggs. Males also sometimes observed Forced Copulating with fledgelings near nest-sites (I. Castro & K.M. Mason).

**Relations within family group** While in nest-cavity, to beg for food, nestlings stretch their necks towards adults, presenting open bills and giving Begging Call; older nestlings crouch down, vibrating wings and presenting their open bills to adult. Once fledged, fledgelings open bill and vibrate wings while leaning towards parent, but are silent. For 2 weeks after fledging, young give Fledgeling Contact Call, seemingly to parents. Fledgelings touching a parent, sibling or another fledgeling may move sideways, closer towards the other bird, while uttering Fledgeling Chuckle Call (I. Castro, K.M. Mason & E.O. Minot). Chicks also try to imitate sounds of other species of birds. Parents call to fledgelings when they wish to induce them to move (I. Castro, K.M. Mason & E.O. Minot). In crèches, fledgelings display play behaviour, performing follow the leader and pushing; in pushing, fledgeling lands on branch next to line of other fledgelings, and pushes them till

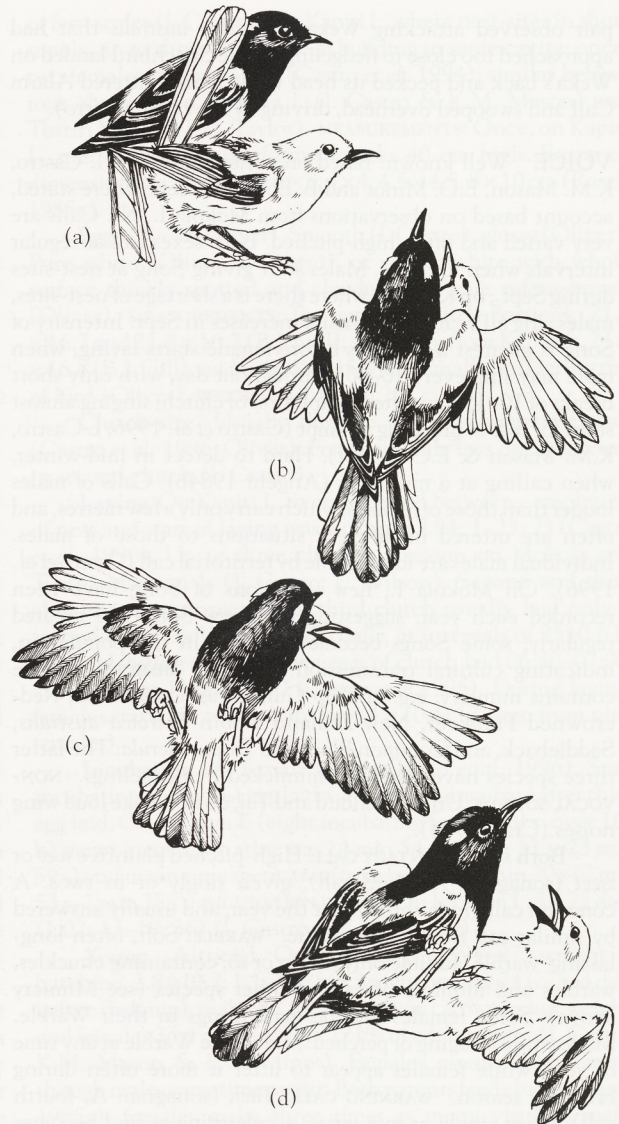


Figure 2 Copulation behaviour: (a) Conventional copulation posture; (b–d) Face-to-face copulation postures (Source: Fig. 4, Castro *et al.* 1996)

one of them hangs upside-down; and process then repeated (Castro 1995b). Fledgelings also allopreen, harass each other and perform MOCK COPULATIONS (I. Castro & K.M. Mason). Mock Copulations occur on branches and do not end in proper mountings; rather, fledgeling that is being mounted rolls on branch till it is upside-down, or flies away. Fledgelings also rub their necks on branches and other vegetation. Mock Copulation and rubbing of neck seen only in crèches located near where adults currently actively copulating.

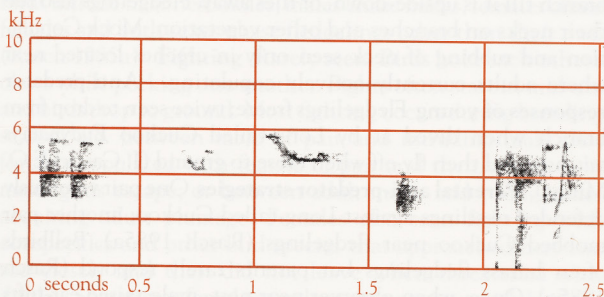
**Anti-predator responses of young** Fledgelings freeze; twice seen to drop from branch when dived at by Long-tailed Cuckoo *Eudynamis taitensis*, and then fly off when close to ground (I. Castro; E.O. Minot).

**Parental anti-predator strategies** One pair vigorously defended nestlings against Long-tailed Cuckoo; another pair mobbed Cuckoo near fledgelings (Rasch 1985a). Bellbirds often harass fledgelings but parents rarely respond (Rasch 1985a). Once, when observer near nest, male raised ear-tufts and excitedly hopped about (Buller 1888). Once, on Kapiti I.,

pair observed attacking Weka *Gallirallus australis* that had approached too close to fledgelings; male Stitchbird landed on Weka's back and pecked its head while female uttered Alarm Call and swooped overhead, driving Weka off (I. Castro).

**VOICE** Well known. Based on contributions by I. Castro, K.M. Mason, E.O. Minot and B. Ebbert. Except where stated, account based on observations from Mokoia I., NI. Calls are very varied and often high-pitched. Both sexes call at regular intervals when foraging. Males start giving Song at nest-sites during Sept.; on Kapiti I., where there is a shortage of nest-sites, males sing all year, but intensity increases in Sept. Intensity of Song is greatest a few days before female starts laying, when male may sing every 10–20 s throughout day, with only short breaks of 10–15 min; after completion of clutch, singing almost stops for rest of breeding attempt (Castro *et al.* 1996; I. Castro, K.M. Mason & E.O. Minot). Hard to detect in mid-winter, when calling at a minimum (Angehr 1984b). Calls of males louder than those of females, which carry only a few metres, and often are uttered in different situations to those of males. Individual males are identifiable by territorial call (Castro *et al.* 1996). On Mokoia I., new variations of Song have been recorded each year, suggesting that new Songs are created regularly; some Songs become common in the population, indicating cultural transmission of Song. **MIMICRY:** Warble contains mimicry, e.g. of Kelp Gull *Larus dominicanus*, Red-crowned Parakeet, New Zealand Robin *Petroica australis*, Saddleback, and Common Blackbird *Turdus merula*. The latter three species have also been mimicked by fledgelings. **NON-VOCAL SOUNDS:** Unlike Bellbird and Tui, do not make loud wing noises (Craig 1984).

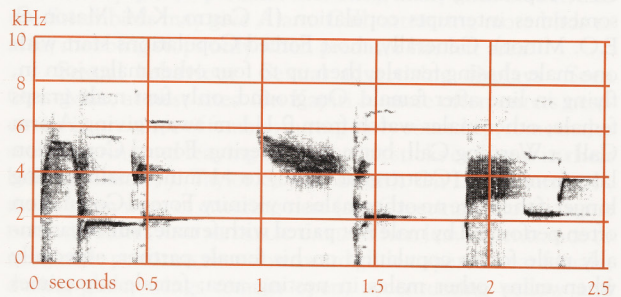
**Both sexes** **CONTACT CALL:** High-pitched plaintive *wee* or *tset* (sonagram A, third call), given singly or in twos. A common call given throughout the year, and usually answered by similar call from a conspecific. **WARBLE:** Soft, often long-lasting, warble, audible only to 4 m or so, containing chuckles, warbles and mimicry of calls of other species (see Mimicry above). Some females include male Songs in their Warble. Made while foraging or perched. Males give Warble at any time of year, while females appear to utter it more often during breeding season. **WARNING CALL:** *Titch* (sonagram A, fourth call), given singly or in a series, accelerating as bird becomes more agitated, and may be succeeded by Alarm Call. A common call, and origin of the vernacular name. **ALARM CALL:** Series of high-pitched *yeng* calls, given in alarm. May succeed Warning Call. **AGGRESSIVE CHAT:** Sounds somewhat like a chuckle or warble with emphasis on last part of call (sonagram A, fifth call). Given by males when meeting birds of either sex, but mainly other males. Given less often by females, but used by dominant female in response to another female or when chas-



A I. Castro, K.M. Mason, and E.O. Minot; Kapiti I., NI; priv.

ing fledgelings from nest-site. **CHASE CALL:** Rapid series of *pew* calls, given when chased by conspecifics (Castro *et al.* 1996; I. Castro, K.M. Mason & E.O. Minot). **PARENTAL CALL:** High-pitched short calls made by parents to induce fledgelings to move. **SQUEAK:** Series of soft short squeaky sounds, uttered when looking inside nest-hollow other than own; also given by male when chased by other males during breeding season (Castro *et al.* 1996).

**Adult male** **SONG:** Loud high-pitched whistle of 2–3 notes, *wee-ah-wee, wee-ah,* or *trr-ah-wee*. Described as melodious (Buller 1888). During a bout of calling each male combines several variations. Sonagram B shows a Song from each of three different individuals. A common call. As many as 120 Songs/h have been recorded (Castro *et al.* 1996). Given within 30 m of nest-site, and at feeding areas (Castro *et al.* 1996). May be given after copulation. **NEST CALL:** *Chi-ching* (sonagram A, first call), given only at the nest area. Usually interspersed with Song. **IDENTIFICATION CHAT:** Series of squeaky and warbling sounds, given at each meeting with mate. **COPULATION COOING:** Long series of plaintive coos *ooee-ooee-ooee...* given while copulating. **THREAT COOING:** Soft cooing given during Male Ultimate Aggressive Display. **METALLIC CALL:** Resembles sound of a metal sheet being flexed by wind; given during Male Display Flight. **QUIET PEW CALL:** Very quiet *pew* call, once given by male during normal copulation (Castro *et al.* 1996).



B I. Castro, K.M. Mason, and E.O. Minot; Kapiti I., NI; priv.

**Adult female** **IDENTIFICATION CALL:** Short, soft, high-pitched *sweet* (sonagram A, second call). Given from within nesting hollow in reply to Song that male gives upon his arrival. **COPULATION REQUEST CALL:** Loud repeated plaintive *pew*, uttered when seeking copulation. **COPULATION REQUEST WARBLE:** Loud high-pitched warble, also given when seeking copulation. Often follows Copulation Request Call, and accompanies Request for Copulation Display. **FORCED COPULATION CALL:** Loud rapidly repeated *pew*; same as the Chase Call of Castro *et al.* (1996). Uttered when chased by males attempting forced copulation and during forced copulation. **HISS:** Hiss given when behaving aggressively towards mate (Rasch 1985a; I. Castro).

**Young** **NESTLING BEGGING CALL:** Very loud *shh, shh, shh*, audible for several metres from nesting hollow. Given in response to visit from an adult, and may sometimes be induced by observer touching nest-tree or nest-box. **FLEDGELING CONTACT CALL:** Repetitive high-pitched *pee-ping*, uttered for about 2 weeks after fledging; possibly a location call. **FLEDGELING CHUCKLE CALL:** Chuckle given when physically touching a parent, sibling or other fledgeling, accompanied by sideways 'walk' closer towards the other bird. **JUVENILE CALL:** Persistent *sit, sit, sit...* or *stitt, stitt, stitt*; probably a feeding call (Guthrie-Smith 1925; Sibson 1947), or possibly a fledgeling contact call (I. Castro).

**BREEDING** Account based on contribution from I. Castro, including much unpublished data from I. Castro and K.M. Mason. Reasonably well known. Nine nests observed on Little Barrier I. 1982–84 (Rasch 1985a).

**Season** Breeding asynchronous; nests at different stages, Oct.–Mar. (Castro *et al.* 1996). Begin investigating cavities in Aug.; males start calling at nest-sites (or increase calling intensity) during Sept.; earliest pairing recorded Oct. (Rasch 1985a; Castro 1995a). Earliest nests usually complete by first week of Oct., and first eggs are laid by mid-Oct. (Castro *et al.* 1996). On Kapiti I., timing varied between years, e.g. in 1992, first clutches laid 16 Nov.–9 Dec., but in 1993, 5–19 Dec.

**Site** Mainly in cavities in trunks and branches of living or dead trees. Mostly recorded nesting in hollows in Puriri *Vitex lucens* or Pohutukawa *Metrosideros excelsa*, but sometimes also in Tawa *Beilschmiedia tawa* and Tarairi *B. tarairi* (Sibson 1947, 1956; Angehr 1985; Rasch 1985a, 1989; Oliver). On Little Barrier I., recorded in Pohutukawa and Puriri trees in Kanuka *Leptospermum ericoides* forest (Rasch 1985b); also in other types of forest on Little Barrier I., but not studied. Occasionally nest in rock outcrops (I. Castro); once, female left transmitter in old abandoned rat-hole close to breeding season (I. Castro). On Kapiti I., nest in cavities in Pukatea *Laurelia novae-zelandiae*, rata *Metrosideros*, Hinau *Elaeocarpus dentatus* and Kamahi *Weinmannia racemosa*; mostly in Kamahi–Tawa and rata forests (Lovegrove 1986; I. Castro). Of nine nests observed on Little Barrier I. over 3 years, none was re-used for laying second clutch. One pair re-used nest in following season and one nest was re-used by a different pair. One pair nested in a different site each year (Rasch 1985a); on Kapiti I., same cavities used from year to year, for both first and second clutches (Castro *et al.* 1994), though sometimes nest well away from site used in previous year (Castro *et al.* 1994). Forests on Mokoia and Tiritiri Matangi Is not sufficiently mature to have natural hollows; instead, birds use artificial nesting boxes that simulate natural cavities and are cleaned after each nesting attempt (I. Castro & S. Taylor). On Little Barrier I., closest nests were c. 100 m apart (Rasch 1985a); and on Kapiti I.,  $\geq 110$  m apart (Castro *et al.* 1996). **MEASUREMENTS:** On Little Barrier I., in 1919, one 15.2 m above ground, three others 9.1–18.3 m above ground, and another much lower; in 1948, one in a kingfisher hole only 2.6 m above ground, and in 1955, one 7.2 m above ground (Sibson 1956; Oliver); in study from 1982 to 1984, 6.25 m (2.75, 1–10; 9) (Rasch 1985a).

**Nest, Materials** Complex. Includes platform, 15–20 cm high, made from sticks. Nest-cup made of fern rhizomes held together with spider web. When cup completed, lined with scales from ponga *Dicksonia* and tree-ferns *Cyathea* and feathers (Castro *et al.* 1996). Sometimes use rootlets as well as sticks (Oliver). Building nearly always by female; no males were seen building nests during 4-year study on Kapiti I., though single males seen building nests on Mokoia and Tiritiri Matangi Is (I. Castro; J.G. Ewen). However, males often take sticks inside cavities at beginning of breeding season, especially when female nearby (I. Castro, J. Taylor & J.G. Ewen). Female collects material within 10 m of nest, and builds at any time of day. Building females may spend much time near nest. Nests sometimes built in 3 days, but usually take up to 2 weeks (Castro *et al.* 1996; I. Castro). Most difficult part of construction probably building platform. Female drops many twigs outside cavity and twigs sometimes pile up below entrance of nest-cavity. Sometimes female starts building in several cavities before deciding on which one to nest in (I. Castro). Material sometimes added to nest after eggs laid; recently laid egg often hidden by feathers

or fern scales (I. Castro). On Kapiti I., where nest-sites in short supply, up to three females seen building in same cavity; once, two females shared cavity (Castro *et al.* 1994); similar behaviour observed on Mokoia I. (I. Castro & K.M. Mason) and Tiritiri Matangi I. (J. Taylor). **MEASUREMENTS:** Once, on Kapiti I., nest included a platform of sticks 40 cm high. Entrance dimensions for four nests: 4×8, 4×4, 4.5×4.5, 8×10 cm (Rasch 1985a).

**Eggs** Ovoid (Oliver). Smooth (I. Castro), glossy (Oliver). Pure white (Oliver; I. Castro), or yellow-white with whole surface thickly spotted and clouded with pale rufous-brown (Oliver). **MEASUREMENTS:** Two eggs from Little Barrier I., 21.8×16.7 and 21.8×16.7 (B.J. Gill); single egg from Kapiti I., 21.3×16.8 (B.J. Gill); said to be 19×15.4 mm, small considering size of bird (Oliver). **WEIGHT:** 3.1 (0.23; 26).

**Clutch-size** Usually three to five, but sometimes two (Castro *et al.* 1996; Oliver). Female usually lays one egg fewer in second clutch (I. Castro).

**Laying** On Kapiti I., average period between completion of nest and start of laying was 9.6 days (7.94; 1–23; 7) (Castro *et al.* 1996). Up to three clutches a season on Mokoia and Tiritiri Matangi Is (I. Castro; L. Wilson). Second and third clutches often unsuccessful; third clutch usually laid only if second clutch failed. Eggs laid daily, at intervals of 25±0.6 h; eggs laid during morning: first eggs of clutch laid 06:30–07:00, and last eggs 11:00–12:00 (Castro *et al.* 1996). During laying, females stayed in nest-cavity for 1.4 h (0.4; 12 eggs, from nine females).

**Incubation** By female alone (Castro *et al.* 1996). Start incubating on day last egg laid. Often mock-incubate after third egg laid. On Mokoia I. (eight incubating females obs. over 161 h) mean incubation stint was 14 min 54 s (9 min 13 s–23 min 59 s) and mean time spent away from nest was 4 min 20 s (2 min 53 s–7 min 38 s). **INCUBATION PERIOD:** On Mokoia I., 15.75 days (1.02; 13–19; 36) (I. Castro & K.M. Mason).

**Young** Altricial. On Mokoia I., 1994–97, weight at hatching, 2.8 g (0.7; 1.1–4.5; 56); weight on Day 24 (c. 3–4 days before fledging): males 43.8 g (2.9; 26) or 120% of adult weight, and females 36.4 g (2.8; 20) or 121% of adult weight (I. Castro, K.M. Mason & E.O. Minot). Females usually brood most, though males sometimes assist. Both parents feed chicks (Rasch 1985a); females make three times as many visits as males (Rasch 1985a; Castro *et al.* 1996; see Social Organization). Young join crèches from c. 1 week after fledging (see Social Organization and Social Behaviour). Both parents remove faecal sacs from nest, though nests soon become dirty and thick liquid often seeps from nest-cavities.

**Fledging to maturity** **FLEDGING PERIOD:** Remain in the nest for 26–32 days (Rasch 1985a; I. Castro & K.M. Mason). If female does not lay second clutch, fledgelings fed for up to 2 weeks by both parents (but mostly by female). If female lays second clutch, she will feed fledgelings up to start of incubation of second clutch while male guards her. If fledgelings still  $\leq 1$  week old, when female begins incubation of second clutch, then male resumes feeding fledgelings. Fledgelings join crèches from c. 1 week, and then not fed by parents.

**Success** On Kapiti I. during 1991–92, 1992–93, and 1993–94 breeding seasons, success for first clutches was 2.3, 1.1, and 1.0 fledgelings/nest respectively; second clutches were less successful, with nine of 11 second clutches failing (Castro *et al.* 1996). Once, interference from Red-crowned Parakeet may have led to abandonment of nesting attempt. Though usually lay second clutches, nesting cavities sometimes taken over by Parakeets a few days after young Stitchbirds fledged (Castro

*et al.* 1994). On Mokoia I., Saddlebacks have been seen taking sticks protruding from Stitchbird nest-boxes, though effect on success, if any, not known (I. Castro). Bellbirds have been seen harassing fledgeling Stitchbirds (Rasch 1985a).

**PLUMAGES** Prepared by A.M. Dunn. Fledge in juvenile plumage. Post-juvenile (first pre-basic) moult to immature plumage usually partial and begins a few weeks after fledging; occasionally post-juvenile appears complete, resulting in adult plumage, but this needs confirmation. After attaining adult plumage, complete post-breeding (pre-basic) moults each cycle produce successive adult plumages without change in appearance. Sexes differ in plumage. No subspecies. Description based on examination of skins of 21 adult males, nine adult females and four juveniles; other descriptions based on photos.

**Adult male** (Definitive basic). **HEAD AND NECK:** Forehead, crown, nape, hindneck, sides of neck, lores and ear-coverts, black (89), except for tuft of long white feathers at sides of nape. Chin and throat, black-brown (119) with white shafts to feathers. Four large black (89) rictal bristles emerge from base of gape and several black (89) bristles emerge from chin and lower forehead. Most feathers of head and neck have concealed grey (84) bases. **UPPERPARTS:** Mantle and scapulars, black (89) with narrow grey-olive (43) edges to feathers; edges 1–2 mm wide. Back, rump and uppertail-coverts, brownish grey (c79) with indistinct grey-olive (43) to light-brown (c223C) edges to feathers; edges 2–4 mm wide. All feathers of upperparts also have concealed grey (84) bases. **UNDERPARTS:** Upper breast, as chin and throat; black-brown (119) with white shafts to feathers. Sides of lower breast, yellow (55) to orange-yellow (18), forming broad band that does not meet in midline. Feathers of centre of lower breast and belly, brownish grey (c79) with diffuse off-white (ne) to cream (92) edges, giving faintly streaked appearance. Feathers of flanks, grey-olive (43) with diffuse cream (c54) to buff (c124) edges; more boldly streaked than belly. Vent, cream (54). Undertail-coverts, olive-grey (43) with buff (124) edges. Thighs, light grey-brown (c45). **UPPERTAIL:** T1–t5, dark brown (121) to black-brown (119) with straw-yellow (c56) to yellow (c55) edge to outer webs. T6, dark brown (c121) with light grey-brown (45) outer web. **UNDERTAIL:** Brownish grey (c79). **UPPERWING:** Marginal secondary coverts, yellow (55) to orange-yellow (18); larger marginal coverts have black (89) bases. Median secondary coverts, black (89) with straw-yellow (56) to yellow (55) fringe at tips. Outer six greater secondary coverts, black (89) with straw-yellow (56) to yellow (55) edge to outer webs; innermost greater secondary coverts, white. Marginal primary coverts along edge of wing, white with yellow (55) tips. Rest of marginal primary coverts and median primary coverts, white; sometimes median primary coverts have diffuse grey-black (82) shaft-streaks of varying thickness. Greater primary coverts, black (89) with white bases. Marginal and median primary coverts and bases of greater primary coverts form white patch, mostly hidden by alula; in those with dark shaft-streaks to median primary coverts, these form smudgy dark line through middle of white patch. Alula, black (89). P10, black-brown (119). P9, black-brown (119) with very fine white edge to outer web. P4–p8, black-brown (119) with fine white edge to distal half of outer web and fine straw-yellow (c54) edge to basal half of outer web; straw-yellow edge broadens near base of feather to cover most of outer web. P1–p3 and secondaries, black-brown (119) with narrow straw-yellow (c56) to yellow (c55) edge to outer web; edge <1 mm wide on p1–p3 and c. 1 mm wide on secondaries. Outermost tertial, black-brown (119) with white edges and white base; next tertial, white with black-

brown (119) shaft-streak; and innermost tertial completely white. White of tertials and innermost greater secondary coverts form prominent white wing-patch. Yellow parts of upperwing fade with wear. **UNDERWING:** Marginal coverts, off-white (ne) with yellow (55) tips. Rest of secondary coverts, white with buff (124) suffusion. Rest of primary coverts, brownish grey (c79). Remiges mostly dark grey (c83), but grade to pale grey (c86) towards base of inner webs.

**Adult female** (Definitive basic). **HEAD AND NECK:** Feathers of forehead, crown, nape, hindneck and sides of neck, dark brown (c221) with dark-olive (49) subterminal fringe, giving faintly scalloped appearance; feathers at sides of nape (same position as white tuft in male) have paired white subterminal spots, usually concealed but sometimes partly visible, giving impression of faint white spot. Lores and ear-coverts, olive-grey (c43). Chin and throat, brownish grey (c80) to light grey-brown (45). As in male, four large black (89) rictal bristles emerge from base of gape, and several black (89) bristles emerge from chin and lower forehead. **UPPERPARTS:** Feathers of mantle, back and scapulars, dark brown (c221) in centre, grading to dark olive (c48) at edges. Rump and uppertail-coverts, olive-brown (c29). All feathers of upperparts also have concealed grey (84) bases. **UNDERPARTS:** Breast, brownish grey (c80) to light grey-brown (45). Feathers of belly, brownish grey (c80) with diffuse off-white (ne) edges to feathers, giving faintly streaked appearance. Rest of underparts as adult male. **UPPERTAIL:** As adult male, or with slightly browner (ne) tinge to edge of outer webs of t1–t5. **UNDERTAIL:** As adult male. **UPPERWING:** Pattern similar to adult male, but slightly duller. Marginal secondary coverts, orange-buff (c153) to yellow (c55) or olive-yellow (ne) with dark-brown (221) bases. Median secondary coverts, dark brown (221) with straw-yellow (c56) to olive-yellow (ne) fringe at tips. Outer six greater secondary coverts, dark brown (221) with straw-yellow (c56) edge to outer webs; innermost greater secondary coverts, white with cream (54) suffusion near tips. Marginal primary coverts along edge of wing, as in male, white with yellow (c55) tips. Rest of marginal primary coverts and median primary coverts, white with dark-brown (221) centres. Greater primary coverts, dark brown (221) with indistinct narrow straw-yellow (c57) edge to outer web. Largest feather of alula, dark brown (c221); rest, dark brown (221) with narrow straw-yellow (c56) edges to outer webs. Primaries and secondaries similar to those of adult male, but edges to outer webs slightly duller: edge to outer web of p9 and edge to distal half of outer web of p4–p8, off-white (ne) (cf. clean white in male), and edge to outer web of secondaries, straw-yellow (c56) to yellow-brown (c24). Tertials similar to adult male, but with buff (124) suffusion near tips of feathers; white wing-patch slightly duller than in adult male. **UNDERWING:** As adult male.

**Nestling** No published information. Photo of 3-day-old nestling (unpubl: I. Castro) shows it sparsely covered with tufts of long light-grey (85) down on head, back and lower flanks; rest naked.

**Juvenile** Similar to adult female overall, but slightly browner with subtle differences in plumage pattern. **HEAD AND NECK:** Feathers of forehead, crown, nape, hindneck and sides of neck, grey-olive (c43), with slightly darker bases and fringe to tips, giving faintly mottled, not scalloped, appearance (cf. adult female). Lores and ear-coverts as in adult female. Chin and throat as in adult female or marginally browner (no colour number difference), but feathers have softer or looser texture. **UPPERPARTS:** More uniform and slightly browner than adult female; olive-brown (c29). **UNDERPARTS:** More uniform and



slightly browner than adult female, but differed slightly between individuals examined; varied from uniform grey-brown (c91) to uniform buff (c124). **TAIL:** Similar to adult male and female, but edge to outer webs of t1–t5 slightly browner, yellow-brown (c24). **UPPERWING:** Similar to adult female, but fringes slightly browner or more olive, and white wing-patch smaller and strongly tinged with buff. Marginal and median secondary coverts, dark brown (c221) with yellow-olive (ne) to olive (c51) tips. Innermost greater secondary coverts, white with dark-brown (c221) shaft-streaks and buff (124) suffusion; outer six greater secondary coverts, greater primary coverts and alula similar to adult female, but fringes olive (c51) to yellow-brown (c24) and slightly broader. Marginal primary coverts along edge of wing, off-white (ne) (lack yellow tips of adults). Rest of marginal primary coverts and median primary coverts, off-white (ne) with diffuse black-brown (119) centres to feathers. Primaries and secondaries similar to adult female, but yellow fringes to outer webs browner, yellow-brown (c24); and off-white edges of p4–p9 of adult female are light grey-brown (119D) in juvenile. Tertiaries similar to adult female but feathers smaller with more extensive buff (124) to yellow-brown (c123C) suffusion to distal half of feathers, resulting in little or no white visible when wing folded. **UNDERWING:** Similar to adult, but marginal coverts, buff (c124).

**First immature male** (First basic). Based on photos (unpubl.: I. Castro). **HEAD AND NECK, UPPERPARTS, UNDERPARTS:** As adult male. **TAIL:** No information. Probably retained from juvenile plumage. Probably appears browner than adult male, as it should show greater wear than that of an adult male at any particular time of year. **UPPERWING:** Similar to adult male, but retain juvenile alula, remiges and greater primary coverts. Alula browner than in adult male, with dull yellow-olive (ne) edges to outer webs of feathers. Area of white below alula appears smaller than in adult male; area is formed from marginal and median primary coverts and white bases of greater primary coverts. Median primary coverts have broad, diffuse black-brown (119) centres to feathers. White area probably appears smaller than in adult male because white bases of greater primary coverts smaller and centres to median primary coverts dark. **UNDERWING:** As adult male.

**First immature female** (First basic). Based on photos (unpubl.: I. Castro). **HEAD AND NECK, UPPERPARTS, UNDERPARTS:** As adult female. **TAIL:** No information. Probably retained from juvenile plumage. Probably appears browner than in adult female, as it should show greater wear than adult female at same time of year. **UPPERWING:** Similar to adult female, but retain juvenile remiges and alula. Alula slightly paler brown than in adult female, and feathers have broader and duller yellow edge to outer web. **UNDERWING:** As adult female.

**BARE PARTS** Based on photos (Williams 1963; Angehr 1985; Barnett 1985; Chambers 1989; Hadden 1990; Moon 1992; Castro 1995b; NZRD; unpubl.: I. Castro; K.M. Mason; J.J. Scott). **Adult male** Bill, black (89). Tongue, pink (c7). Iris, black-brown (c119). Orbital ring, grey-black (82), dark blue-grey (78) or dark brown (c219A). Legs and feet, dark brown (219), pink-brown (221C or 221D), maroon (31) or dark grey (83). Soles, pink-buff (121D). **Adult female** Bill, black (89), often with dark-brown (c121A) base to lower mandible. Rest as adult male. **Nestling** Based on photo of 3-day-old nestling (unpubl.: I. Castro). Bill, straw-yellow (56). Skin of body, legs, feet and wing-buds, pink-buff (121D). **Juvenile** Based on photo of two young at fledging age (Angehr 1985): bill grades from black-brown (119) near tip to dark brown (c121) at base

and salmon (c106) along tomtia; gape, orange-buff (c153); tongue, pink (c7) at base grading to greyish yellow (ne) at tip; iris very dark, probably black-brown (c119). Based on several photos of young at fledging age (unpubl.: P. & J. Morris): bill, black (89) with yellow (55) basal half to tomtia; gape, yellow (55) and puffy; iris, black-brown (119); legs and feet, pink-brown (221C) or dark brown (c119A). Based on single photo of older male beginning post-juvenile moult (unpubl.: I. Castro & K.M. Mason): bill, black (89); gape, cream (92); iris, black-brown (119); orbital ring, dark brownish grey (c83).

**MOULTS** Based on examination of skins of eight adults and one juvenile (CM, NMNZ). **Adult post-breeding** (Pre-basic). Few data. Complete, primaries outward. Only two skins had active moult of primaries; one in Dec. was starting moult of primaries (with PMS of 8), and one was finishing moult of primaries in Mar. (with PMS of 45). None of those examined was moulting tail, and only one collected in Mar. had active moult of body. **Post-juvenile** (First pre-basic). Few data. Usually partial, but occasionally appears complete. One bird in mostly juvenile plumage in Apr. had slight moult of upperparts. Starts c. 4 weeks after fledging (I. Castro). A small number of juveniles appear to moult directly into adult plumage (I. Castro), but this needs confirmation. **First immature post-breeding** (Second pre-basic). No information.

**MEASUREMENTS** (1–2) NZ, skins (CM, NMNZ): (1) Adults; (2) Juveniles. (3–4) Little Barrier I., live: (3) Adults (Craig *et al.* 1981a,b); (4) Adults and first-year birds (fledgelings excluded) (Gill & Veitch 1990); Wing U = Length of unstraightened chord of wing. (5) Mokoia I., NZ, adults, live (I. Castro); Nape Tuft = length of tuft of feathers on right side of nape.

	MALES	FEMALES	
WING	(1) 103.0 (4.68; 98–117; 18)	93.2 (2.17; 91–97; 9)	**
	(2) 93, 100	–	
	(3) 99.3 (1.75; 6)	87.6 (3.26; 6)	**
	(5) 100.2 (3.1; 31)	92.5 (3.46; 23)	**
	(4) 98.4 (2.66; 93–103; 54)	88.6 (2.53; 85–94; 45)	**
WING U TAIL	(1) 73.9 (3.49; 68–83; 18)	69.4 (2.74; 64–72; 9)	**
	(2) 63, 72	–	
	(3) 78.2 (0.75; 6)	68.5 (3.15; 7)	**
	(4) 75.9 (2.79; 66–80; 54)	69.1 (2.63; 64–75; 44)	**
BILL S	(1) 21.5 (0.85; 20.4–23.4; 20)	20.4 (1.00; 18.5–21.9; 9)	**
	(2) 19.7, 20.2	–	
	(3) 43.6 (0.90; 6)	41.4 (0.42; 7)	**
THL TARSUS	(1) 28.2 (0.57; 27.2–29.0; 15)	28.0 (0.61; 27.0–28.7; 6)	ns
	(2) 26.9, 28.5	–	
	(4) 29.0 (0.65; 26.7–30.2; 59)	27.7 (0.67; 26.4–29.3; 52)	**
	(5) 12.8 (1.26; 10–15; 14)	1.9 (0.73; 1–3; 7)	**

**WEIGHTS** (1–2) Little Barrier I., live: (1) Adults (Craig *et al.* 1981a,b); (2) Adults and first-year birds (fledgelings excluded) (Gill & Veitch 1990).

	MALES	FEMALES	
(1)	40.2 (2.16; 5)	30.3 (1.38; 7)	**
(2)	37.3 (2.70; 29–42; 59)	30.2 (1.72; 26–35; 50)	**

Few museum specimens had weight data; two adult males weighed 30.0 g and 30.4 g, and one adult female weighed 30.0 g (NMNZ).

**STRUCTURE** Wing broad and rounded. Ten primaries: p6 longest; p10 39–44 mm shorter, p9 12–17, p8 1–4, p7 0–1, p5 0–3, p4 7–10, p3 11–17, p2 17–21, p1 20–25. P5–p8 with slight emargination on outer web; none on inner web. Nine secondaries, including three tertials; tips of longest tertials fall short of secondaries on folded wing. Tail long and square; 12 rectrices. Bill moderately long and narrow with a slight downward curve to pointed tip; about half length of head. Tarsus moderately long and slender; scaling holothecal. Tibia fully feathered. Middle toe with claw, 20.3 (0.91; 19.3–21.4; 6). Outer toe 78–88% of middle, inner 67–82%, hindtoe 82–99%.

**GEOGRAPHICAL VARIATION** None.

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Tui *Prothemadera novaeseelandiae* (page 1191)  
 NOMINATE NOVAESEELANDIAE: 1 Adult; 2 Juvenile; 3 Adult

Bellbird *Anthornis melanura* (page 1173)  
 NOMINATE MELANURA: 4 Adult male; 5 Adult female; 6 Juvenile male; 7 Juvenile female; 8 Adult male

Stitchbird *Notiomystis cincta* (page 954)  
 9 Adult male; 10 Adult female; 11 Juvenile; 12 Adult male