

Order PASSERIFORMES

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

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

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

The Passeriformes divide into two main groups:

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

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

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

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

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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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Family TURNAGRIDAE Piopio

Monotypic passerine family, endemic to NZ. The single species, the medium-sized Piopio *Turnagra capensis*, is extinct. The taxonomic affinities of *Turnagra* have been the subject of considerable debate (Olson *et al.* 1983). Buller (1869) originally placed the NI population in the family Turdidae (thrushes) with no justification. Based on Hans Gadow's examination of digestive tract, skeleton, pterolysis and external morphology, Buller (1887) later placed the genus *Turnagra* in a new family Turnagridae. Finsch (1872) originally placed it in the family Corvidae, but later suggested that the species was allied to the bowerbirds (Ptilonorhynchidae) based on external morphology (Finsch 1874). Mayr & Amadon (1951) suggest it is allied to the Australo-Papuan whistlers and shrike-thrushes (tribe Pachycephalini in the family Pachycephalidae), but without supporting evidence. Oliver rejected an association with the whistlers and placed *Turnagra* with the bowerbirds. Olson *et al.* (1983) examined external morphology, pterylosis, myology and osteology of the Piopio, and concluded that the taxon shows affinities with both the bowerbirds and the subfamily Cnemophilinae of the birds of paradise (Paradisaeidae). DNA-sequence analysis of the mitochondrial cytochrome-*b* gene indicates *Turnagra* closely related to the bowerbirds (Christidis *et al.* 1996), but the authors acknowledge that further molecular work is required to confirm this. Nonetheless, the latter authors retain the Piopio in the monotypic family Turnagridae. Olson *et al.* (1983) and NZCL place *Turnagra* in a separate subfamily Turnagrinae, at the base of the bowerbird and bird of paradise assemblage (which they combine as an extended family Paradisaeidae). However, several morphological and osteological characteristics (see diagnosis below) suggest *Turnagra* is not allied to the bowerbirds or birds of paradise, but is closer to the Pachycephalidae (Worthy & Holdaway 1993, 2002; FF; DAB). Sibley & Monroe (1990) and Monroe & Sibley (1993) place *Turnagra* in the tribe Pachycephalini within their expanded family Corvidae, but acknowledge (Sibley & Monroe 1990) that its affinities are uncertain. Given the wide range of opinions and conflicting data, it is perhaps prudent to consider the Turnagridae of uncertain affinities and taxonomic position (family *incertae sedis*). There are also conflicting views concerning species limits within *Turnagra*, some authors separating NI and SI piopios as different species (Olson *et al.* 1983; Holdaway *et al.* 2001; Worthy & Holdaway 2002; Medway 2004; Oliver; see Piopio: Geographical Variation).

The Piopio is of medium size (length c. 26 cm; Heather & Robertson 2000). The following morphological and osteological characteristics define *Turnagra* (Ames 1975; Olson *et al.* 1983; Oliver; DAB; FF; R. Schodde & I.J. Mason): Wings fairly long and broad with rather rounded tip. Ten primaries; p10 over half length of p9. Nine secondaries (J.S. Matthew; W.E. Boles), including three tertials (*contra* FF, who state eight secondaries). Tail fairly long, rather square at tip; 12 rectrices. Bill stout with notch near tip of upper tomium. Tarsus fairly long; scaling laminiplantar. Well-developed nasal, interramal and rictal bristles. Single pneumatic fossa at head of humerus (typically corvine). Distinct foramen on posterior face of proximal end of femur. Lack apterium in dorsal feather-tract; 15 rows of feathers in *pars dorsalis* tract. Appendicular myology rather similar to bowerbirds, particularly structure of *M. obturatorius lateralis pars dorsalis*, *M. flexor hallucis brevis* and presence of *M. iliofemoralis externus* (Borecky 1977; Olson *et al.* 1983). Cranial anatomy rather similar to catbirds *Ailuroedus*; temporal fossae rather small; zygomatic processes well developed and closely positioned to post-orbital processes; jugal bars fine and rather straight; ectethmoid large and extensively fused with frontal bone; lachrymal absent; palatine shelf narrow; tips of maxillopalatines merge in front of vomer; and internasal septum partially ossified.

For details of plumages, moults, structure and geographical variation, and the little that is known of habitat, food, movements, behaviour, voice and breeding, see the following account.

Extinct. Range contracted and population declined after c. 1870s, with suggested causes of decline: destruction of habitat (though much clearing began after decline of species started, and much suitable habitat remains), introduced predators, and disease (Stattersfield & Capper 2000; see following account for details).

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Turnagra capensis **Piopio**

Tanagra capensis Sparrman, 1787, *Mus. Carlson.* fasc. 2: no. 45, pl. 4 — Dusky Sound, South Island, New Zealand.

Combination of genus *Turdus* Linnaeus, 1785, thrush, and synonymized genus *Tanagra* Linnaeus, 1764, tanager. Quoy & Gaimard (in Lesson 1837; *Compl. Oeuvres Buffon*, VIII), wrote 'C'est des tangaras que nous rapprochons cet oiseau nouveau, bien qu'il ait des caractères qui l'en éloignent, comme par exemple d'avoir une dentelure bien plus prononcée à la mandibule supérieure. Il est de la grosseur des grives'. The Piopio was originally described as a species of tanager from the Cape of Good Hope, South Africa, the Swedish botanist Anders Sparrman having become confused over the provenance of many specimens obtained during Cook's *Resolution* voyage round the world 1772–75.

OTHER ENGLISH NAMES New Zealand, New Zealand Native, Native, North Island or South Island Thrush; North Island Piopio, South Island Piopio.

POLYTYPIC Nominate *capensis*, SI and Stephens I., NZ; *tanagra* (Schlegel, 1865), NI, NZ.

EXTINCT Very poorly known.

HABITAT At time of European settlement, thought to be widespread in forest, from coast to alpine zone; said to prefer undergrowth but also observed in higher strata in forest (Buller 1873; Smith 1888; Heather & Robertson 2000; Medway 2004; Oliver; NZCL). Said to prefer forest and mixed scrub, not far from water, and that also abundant on bluff faces and river flats, using sand spits and low vegetation (Potts 1872). Fossil record suggests that, on SI, Piopio more widespread in drier e. forests and shrublands than in the dense and wet w. forests; and, also based on fossil records, NI found up to 900 m asl in Matai *Prumnopitys taxifolia*-broadleaf forest near Hawkes Bay on NI (R.N. Holdaway). Reported foraging round human habitation and activities (see Threats).

DISTRIBUTION AND POPULATION Extinct. Formerly endemic to NZ. Confusion with widespread introduced Song Thrush *Turdus philomelos* possibly accounts for some reports in 20th century (Williams 1962).

NI Formerly widespread, though probably less so N of Waikato (Buller 1888; Turbott 1967) or Auckland (Oliver); occurred S to Wairarapa, and from Taranaki E to East Coast (Buller 1888; McLean 1912; Stidolph 1925, 1939; Sopp 1957; Turbott 1967). Last confirmed record was a specimen collected at Ohura in 1902 (Heather & Robertson 2000). Several unconfirmed reports since then: in Parakahi district, 1909 (Oliver), though this apparently refers to a record in 1890s (Medway 1968); e. side of Wanganui R., near Koroniti, 1917 (Mead 1950; CSN 3); inland from Patea, 1923 (CSN 3); inland from Te Araroa, c. 1927 (Oliver; NZCL); Whangamomona district, 1930 (Mead 1950); Ruahine Ras, c. 1933 (Olsen 1993); Wanganui R., 1937 or 1938 (Mead 1950); Hopuruahine, L. Waikaremoana, 1938 (Sopp 1957); two, L. Waikare-iti, May 1946 (Sopp 1957); between Gisborne and Wairoa, 7 May 1947 (CSN 3); at four sites along c. 25 km of Wanganui R., Mar. 1950 (Mead 1950); good population, N of L. Waikaremoana, 11 Nov. 1952 (Sopp 1957); near L. Waikare-iti, 9 Apr. 1953, and at least two birds, possibly in same area, 9 Apr. 1955 (Sopp 1957); and adult and two young, Hauhungaroa Ras, about Mar. 1970 (Bell & Singleton 1974). **SI** Formerly widespread, from Stephens I., S to Stewart I. (Worthy 1998; Heather & Robertson 2000; NZCL). Last reliably recorded in mid-1890s: present on Resolution I. after Richard Henry stationed there in 1894 (Hall-Jones 1966). A few unconfirmed reports in 20th century: two, near L. Hauroko, Southland, 17 Dec. 1947 (not 1949 as reported in Oliver) (Dunckley & Todd 1949; CSN 3); five, near Mt Zetland, Nelson, Jan. 1948 (Moore 1949; CSN 3); two, Caswell Sound,

Southland, 1949 (Oliver), though also specifically stated that the species was not seen there at that time (Oliver 1950); one, L. Waiuna, Southland, Aug. 1962 (NZCL); one, L. Wilmot, w. Otago, 24 May 1963 (Child 1965); and claim at Big Bay in 1960s (R.N. Holdaway).

Change in range, populations Range contracted and population declined after c. 1870s. Suggested causes of decline are: destruction of habitat (though much clearing began after decline of species started, and much suitable habitat remains), introduced predators (but see Threats below), and disease (Stidolph 1922; Williams 1962; Heather & Robertson 2000; NZRD). **NI** Formerly widespread and common, at least S of Waikato. Said not to have been recorded in Bay of Plenty since c. 1820; and straggler collected near Kaipara in 1852 was recognized only by an old Maori, having become extinct in area decades before (Buller 1888; Turbott 1967). Considered common in s. NI in 1870s, though populations declined rapidly soon after. Recorded at Rangataua L., near base of Mt Ruapehu, in 1880; and recorded near L. Rotokare, s. Taranaki, in Apr. 1881, but not seen often by then; and probably largely absent from inland Taranaki and Wanganui, where previously very common, by mid-1880s (Buller 1888, 1892; Turbott 1967; Medway 1968); two specimens collected along Turakina R. between 1879 and 1882, but certainly uncommon by then; and a few remained in isolated pockets in Mangawhero, Mangamahu, Turakina and Porewa Valleys by 1884, where previously plentiful (Medway 1968). Ten specimens collected in upper reaches of Waitotara R., s. Taranaki, in 1884–85 (apparently not in 1887 as mentioned in Annabell [1949]) (Medway 1968) but also claimed to have been present there in c. 1896 (Mead 1950). Last record from near Wellington was in Horokiwi Valley, near Porirua Harbour, in 1884 (Stidolph 1926). By 1888, considered 'one of our rarest species ... doomed to extinction within a very few years' (Buller 1888; Turbott 1967). Buller (1892) received a specimen from Makuri Ra. in 1892, the first he had seen in >20 years. Persisted till 1902, when last specimen collected at Ohura, s. Waikato (Heather & Robertson 2000). No valid records thereafter, though even into the 1930s, considered only as almost extinct (Stidolph 1933). Doubtfully claimed that area along Wanganui R. colonized in 1930s, and that numbers there subsequently increased (Mead 1950). **SI** Formerly widespread and abundant (Buller 1888; Turbott 1967); on mainland, recorded from Nelson S to Southland (Moncrieff 1938; Hall-Jones 1966; Worthy 2001), and also found on Stephens I. (Heather & Robertson 2000; Oliver; NZCL); subfossils recovered at Mason Bay on Stewart I. said to have been of this species (Worthy 1998), but may have been those of Common Blackbird *Turdus merula* (R.N. Holdaway). Previously

common in many areas, but populations declined soon after settlement (Buller 1888; Turbott 1967), by early 1870s in some areas, e.g. population at Banks Pen., Malvern Hills, Alford Forest and Thirteen-Mile Bush largely gone by 1872 (Potts 1872), and though once common round Dunedin, extinct by 1880s (Buller 1888). Persisted, and remained common, in various areas of West Coast well into 1880s, e.g. common round Reefton, 1881–85 (Phillipps 1948), present in Inangahua Valley till 1880s (Bell 1948), and common at L. Brunner in 1888, though gone from other nearby areas (Arnold R., Stillwater) by then (Smith 1888; Oliver); still present on Resolution I. in 1894 (Hall-Jones 1966). Persisted at Milford Sound, and possibly at sites in West Coast, till at least 1895 (Fulton 1907). Numerous on Stephens I. in 1895, though almost extirpated from latter site by 1898 (Medway 2004). No valid records thereafter, though even into the 1930s considered only as almost extinct (Stidolph 1933).

Status Extinct.

THREATS AND HUMAN INTERACTIONS Suggested that decline in some areas hastened by predation by Cats, Black Rats and Stoats (Oliver 1927; Turbott 1967; Atkinson 1973; Heather & Robertson 2000; Oliver), though the last said unlikely to have been involved, at least in initial decline, as by the time decline started it had not spread to all areas where *Ptarmigan* were declining (Williams 1962). Sudden decline on Stephens I. probably caused by predation by Cats (Medway 2004). Easily killed round camps by Dogs (Buller 1888; Turbott 1967). Formerly occasionally eaten: 'it makes a savoury broil for those who bring the proper sauce—hunger' (Hutton & Drummond 1904). Often considered tame, especially round camps, where birds foraged in and between tents on goldfields, and occasionally entered settlers' huts in search of food (Buller 1888; Hutton & Drummond 1904; Turbott 1967; Oliver; see Food, Social Behaviour).

MOVEMENTS Nothing known (but see Social Behaviour).

FOOD Medway (2004) provided a detailed summary of early observations of this species; while original sources used here as far as possible, information cited as Medway (2004) below based on Reischek (1885) and Reischek (1892), mainly the latter, which was not available for summary. Mostly ate insects and other invertebrates, also fruit, seeds and foliage (Medway 2004; see below). Foraged mostly on ground, scratching with feet and using bill to search among and turn over dry leaves, rotten wood and moss on forest floor (Buller 1905; Turbott 1967; Medway 1968, 2004); one foraged for worms and grubs by hopping about on ground under shelter of roadside vegetation (Buller 1905); one pair searched for invertebrates on turned soil (Medway 2004). Said to snip fruiting stalks from moss, to search among *Acaena* and to pick seed from trailing *Veronica*; several were seen sallying for insects from tree-tops, like flycatchers (Potts 1872); and claimed to have foraged among higher branches of trees during dull or wet weather (Smith 1888; Hutton & Drummond 1904). Said to have obtained much food from glades in river beds during summer (Potts 1872). More recent, but unconfirmed, reports describe birds foraging in trees and shrubs, one apparently foraging among moss on limbs of a Tawa *Beilschmiedia tawa* tree (Mead 1950); and another foraging for several minutes on leaf-roller grubs on the outer face of a shrub while hovering (Sopp 1957). Commonly foraged in and round human habitation: in camps, such as on goldfields, and settlements, foraging between tents and round huts, and occasionally entering tents or huts to feed on crumbs (including from a table) and food scraps and to gather spiders (Potts 1872; Buller 1888; Smith 1888; Phillipps 1949; Turbott 1967; Medway 2004; Oliver). One observer reported that sometimes 12 or so would come to his tent, eating

off his plate and taking food from his hand (Pascoe 1969). Said to shell oats like a sparrow (Oliver).

No detailed studies. **Plants** Fruit^{1,7,8,9}, seeds^{1,9}, leaves⁸, moss capsules¹, grasses¹, plants⁸. **MONOCOTYLEDONS:** Poaceae: *Avena sativa* sds⁹. **DICOTYLEDONS:** Onagraceae: *Fuchsia* fru.⁹; Scrophulariaceae: *Veronica* sds¹. **Animals** **WORMS**^{3,7}. **SPIDERS**⁹. **INSECTS**^{1,7,9}: larv.^{3,8}. **Other matter** Food scraps^{7,9}; crumbs, including bread and fish crumbs^{2,4,8,9}; unconfirmed reports also list grubs⁵, and lepidopteran larvae (Tortricidae)⁶. One captive bird ate insects, earthworms, fruit, green herbs, dry pulses, grain, cooked potato and raw meat; it also ate several bird's eggs⁷.

REFERENCES: ¹ Potts 1872; ² Smith 1888; ³ Buller 1905; ⁴ Phillipps 1949; ⁵ Mead 1950; ⁶ Sopp 1957; ⁷ Turbott 1967; ⁸ Medway 2004; ⁹ Oliver.

SOCIAL ORGANIZATION Very poorly known. Usually seen in twos, which probably pairs, but also seen foraging singly (Reischek 1885, 1892; Buller 1892, 1905; Medway 1968, 2004; see Food); claimed that 12 or so sometimes foraged at one camp (Pascoe 1969); and one observer once counted 40 near a camp (Heather & Robertson 2000). Breed in pairs (Buller 1888; Turbott 1967); and thought to be territorial (Hutton & Drummond 1904; Oliver).

SOCIAL BEHAVIOUR Poorly known. Described as tame, bold and fearless, and readily approached people and foraged in and round settlers' camps and the like (Hutton & Drummond 1904; Medway 1968, 2004; Oliver; see Food, Social Organization). Birds reported approaching imitation of vocalizations and unusual loud noises (see Voice). When singing, spread tail and lower wings slightly (Potts 1872; Buller 1888; Turbott 1967); also see Sexual behaviour. On ground, hopped with both feet together, with slight fluttering of wings and flitting of tail with each movement (Potts 1872; Hutton & Drummond 1904). Flights usually short and rapid (Buller 1888; Turbott 1967), though also described as powerful flier (Smith 1888; Oliver); said to fly with swooping flight (Hutton & Drummond 1904). In captivity, one roosted on perch on one leg, with plumage puffed out to form of perfectly round ball (Buller 1888; Turbott 1967). **Agonistic behaviour** Drove conspecific rivals as well as other birds from near nest (Potts 1872; Hutton & Drummond 1904; Oliver). One uttered call while chasing another (Potts 1872). When approached too closely by person, said to always descend to ground (Hutton & Drummond 1904). Once, when attracted to unusual noise, approached with spread tail, moving sideways along branch, and turning body right and left, examining observer closely (Smith 1888; Hutton & Drummond 1904). **Sexual behaviour** Once, one uttered 'wild jubilant note' as it dropped from perch and repeatedly flew from tree to tree, which thought to be possible pairing behaviour (Smith 1888; Hutton & Drummond 1904). **Relations within family group** Adults strongly defend young (Potts 1872).

VOICE Not well known. Described as best of native songsters (Buller 1888; Fulton 1907; Turbott 1967) with a variety of song and calls (Heather & Robertson 2000); one captive bird described as having astonishing vocal power and variety of notes (Buller 1888; Turbott 1967). Not known whether singing was seasonal, but vocalizations heard May, June and Oct. (Medway 1968), and one unconfirmed report in Mar. (Mead 1950). Most vocal in early morning and evening (Smith 1888; Hutton & Drummond 1904; also see Mead 1950), and usually continued to sing in morning after other birds stop (Buller 1888; Turbott 1967). Said to sing or answer each other's calls a few hours after sunrise (Oliver) or a few hours after sunset (Hutton & Drummond 1904). Usually

silent during day in fine weather (Smith 1888; Hutton & Drummond 1904; Oliver). **RESPONSE TO IMITATION:** One pair approached observer when call imitated (Buller 1888; Turbott 1967); and readily attracted to unusual noise (Smith 1888; Hutton & Drummond 1904; also see Mead 1950). **MIMICRY:** Some notes of Song very similar to call of Yellowhead *Mohoua ochrocephala*, which may be mimicry (Buller 1888; Turbott 1967). One call similar to that of oystercatcher *Haematopus* also thought to be possible mimicry (Potts 1872; Hutton & Drummond 1904). One in captivity uttered loud rasping note as if mimicking Australian Magpie *Gymnorhina tibicen* from same cage (Buller 1888; Turbott 1967). **SIMILAR SPECIES:** Usual Song said to be similar to that of Australasian Pipit *Anthus novaeseelandiae* (Potts 1872; Oliver). Song described as similar to but lacking charm of song of Song Thrush (Potts 1872; Mead 1950). Also see mimicry above. **NON-VOCAL SOUNDS:** Unconfirmed report mentioned audible fluttering of wings while birds foraging (Sopp 1957).

Adult SONG: Musical with splendid notes (Buller 1888; Smith 1888; Hutton & Drummond 1904; Turbott 1967). Consists of five distinct phrases, each repeated 6–7 times in succession; singing often stopped to introduce a variety of other notes, including peculiar rattling sound (Buller 1888; Turbott 1967); and said to utter two notes before giving Song (Potts 1872). Unconfirmed report (Mead 1950; see Distribution) describes Song as clear and consisting of five, occasionally six, phrases of equal length: first and fifth phrases consisting of loud, sweet-toned notes repeated about six times; intermediate three phrases each consisted of a single note repeated about six times: a lower note, a very high note, and a chirping note. When added, the sixth phrase was shorter and consisted of two or four notes, or the double whistle (possibly contact call) sometimes repeated (Mead 1950). Other unconfirmed reports describe song as beautiful, loud and clear (Sopp 1957), and including clear, bell-like notes (Olsen 1993). **CONTACT CALL:** Usual call a short, sharp, whistling cry, quickly repeated; the name *Piopia* onomatopoeic, and based on this call (Buller 1888; Turbott 1967). Unconfirmed report of double whistles (Mead 1950) probably referring to this call. **ALARM CALL:** One in captivity uttered sharp repeated whistle when alarmed or startled (Buller 1888; Turbott 1967). Unconfirmed report described alarm call as even staccato notes like that of Bellbird *Anthornis melanura* but louder and slower, and usually given three times with very short pauses between; often given from dense cover (Sopp 1957). **THREAT CALL:** Both male and female utter low purring *chur-r-r* as a threat to intruders at nest (Potts 1872; Oliver). **Other calls** Once, one uttered 'wild jubilant note' as part of possible pairing display (Smith 1888; Hutton & Drummond 1904; see Social Behaviour). While chasing another, one uttered quick *chi-chi-chit chi-chi-chit* (Potts 1872). Utter long-drawn rather plaintive note in morning, but only at certain times (Potts 1872; Oliver). Sometimes utter piping note three times, similar to call of oystercatcher; said to be often uttered when near water (Oliver). One in captivity uttered short flute-like note at intervals during early morning (Buller 1888; Turbott 1967). Unconfirmed report mentioned chirping calls (Mead 1950).

Young Unconfirmed report of fledgeling giving plain chirp, not a trilling chirp like that of Song Thrush (Bell & Singleton 1974).

BREEDING Very poorly known and no studies, though many nests examined by Potts (1872).

Season NI: A single, unconfirmed report, from 1970, of a dependent fledgeling sighted about Mar. (Bell & Singleton 1974); another observer encountered a pair in late Dec., which were thought to have been breeding though nest not located (Turbott 1967). SI: Two clutches late Dec. (Potts 1872).

Site In fork, usually in small upright branch of tree, usually Tutu *Coriaria* but sometimes Manuka *Leptospermum scoparium* or Karamu *Coprosma*; said to be usually in thick foliage (Potts 1872; Mathews 1930), though also said not to be well hidden (Potts 1872). **MEASUREMENTS (m):** Height of nest usually 2.1–2.4, but ranging from 1.2 to >3.7; single nests found at c. 3.7 and c. 4.6 (Potts 1872).

Nest, Materials Nest cup-shaped; loosely or compactly built of small dry twigs and shreds of bark and moss, and lined with fine dry grass, sometimes with tree-fern scales or other fibres (Potts 1872; Hutton & Drummond 1904; Turbott 1967). One nest, from Stephens I., was a shallow cup formed entirely of rootlets and lined with dry grass (Buller 1905). **MEASUREMENTS (cm):** One nest, said to have been of average size, had external diameter 17.8, internal diameter 7.6, and depth (probably internal) 5.1 cm (Potts 1872). One nest from Stephens I. measured 17.8 × 12.7 (Buller 1905). One nest had external depth c. 30 (Turbott 1967).

Eggs Ovoid, sometimes elongated; rather glossy. Pure white or pinkish white, spotted and blotched with light and dark brown, brownish grey, blackish brown or black, sometimes with additional purplish blotches at larger end; markings mostly scattered over surface but can form zone at larger end (Potts 1872; also see Hutton & Drummond 1904; Mathews 1930; Oliver). **MEASUREMENTS:** *NOMINATE CAPENSIS:* 32.8 × 24.4, 40.1 × c. 25.4 (Potts 1872); 32.5 × 25.5, 35 × 25 (Oliver); 40–41 × 24 (Mathews 1930); length 36.8 (Hutton & Drummond 1904). *SUBSPECIES TANAGRA:* Said to be smaller than eggs of nominate *capensis* (Mathews 1930). **Clutch-size** Potts (1872) never recorded >C/2 in a nest; though he found four eggs in ovary of one female. Also claimed up to five eggs were laid (Phillipps 1949). **Laying** Thought to have bred twice in season (Potts 1872). **Incubation** Single egg found in one nest was being incubated by female (Potts 1872).

Young Have covering of dark-brown down at hatching (Potts 1872). **Fledging to independence** No information.

Success Said to be host of Long-tailed Cuckoo *Eudynamis taitensis* (Bogert 1937), though this possibly referring to introduced Song Thrush (Dow 1972).

PLUMAGES Prepared by J.S. Matthew. Little known about plumage and moult cycles. Appeared to undergo a partial post-juvenile (first pre-basic) moult to adult-like first immature plumage; and probably acquired adult plumage in complete first immature post-breeding (second pre-basic) moult. Sexes apparently alike. Two subspecies; nominate *capensis* from SI described below based on examination of skins of one adult and two first immatures (MV).

Adult (Definitive basic). **HEAD AND NECK:** Top of head, hindneck and sides of neck, olive-brown (dark 123) with buff (124) or yellow-brown (123C) streaking on lower sides of neck, forehead and just above eye; streaking diffuse on lower sides of neck, clearer and narrower on forehead and above eye. Ear-coverts, dark olive-brown (129) with fine buff (124) or yellow-brown (123C) shaft-streaks. Eye-ring and lores, rufous-brown (c38) or light brown (c39) with dark olive-brown (129) mottling on lores. Malar area, chin and throat diffusely streaked olive-brown (c29) and boldly mottled whitish (ne) or yellow-brown (123C); feathers, off-white (ne), usually grading to yellow-brown (123C) distally, and with broad olive-brown (c29) fringes. Several short black (89) bristles on lower forehead, nasal area and interramal area. **UPPERPARTS:** Mostly olive-brown (dark 123); longest uppertail-coverts have rufous-brown (240) tips or shafts-streaks. All feathers have concealed grey (87) bases. **UNDERPARTS:** Boldly mottled off-white (ne) or yellowish white (ne) with bold olive-brown (c29) streaking; feathers, off-white (ne), often tinged pale yellowish (c157) towards edges, with broad olive-brown (c29) fringes; feathers on sides of upper breast tend to be buffier (c124) or

cream-buff (123D) in centre. **UPPERTAIL:** T1, olive-brown (c29) with red-brown (221B) shaft. T2–t6, red-brown (dark 35, c221B) with bright-rufous (140) shafts; and with narrow olive-brown (c29) tips or fringes to tips of t2–t4. **UNDERTAIL:** All rectrices, russet-brown (c34); and shafts, light brown (223C). **UPPERWING:** Marginal and median secondary coverts, olive-brown (c29) with narrow light-brown (39) fringe at tips of median coverts. Alula and all greater coverts, olive-brown (c123) with concealed dark-brown (121) basal half to inner webs. Most marginal and median primary coverts, olive-brown (c123); row of coverts along leading edge of wing, orange-buff (118). Remiges, olive-brown (c123) on outer webs; dark brown (121) or black-brown (19) on inner webs, with concealed light-brown (223D) inner edges; shafts, red-brown (35). **UNDERWING:** Secondary coverts, yellow-brown (123B, 123C). Primary coverts, yellow-brown (123B) with grey (83) bases. Remiges, brownish grey (c79) with narrow light-brown (223D) inner edges.

Nestling Natal down, dark brown (Potts 1872).

Juvenile Little information. Oliver states that 'immature' has more rufous on forehead, sides of head, throat and upperwing-coverts than adult; this description may refer to juvenile. Retained juvenile rectrices and remiges in immature (below) much as adult.

First immature (First basic). Very similar to adult, from which differs by: **HEAD AND NECK:** Rufous-brown (36) streaking on forehead more prominent than in adult. **TAIL:** Rectrices retained from juvenile plumage; these as adult but outer rectrices narrower and more acute at tips (see also Olson *et al.* 1983). **UPPERWING:** All secondary coverts, olive-brown (c123) with rufous-brown (36) tips which are: very narrow or rosethorn-shaped on marginal coverts; broad on median coverts; and broad on outer webs of outer greater coverts (extending narrowly to inner webs), becoming progressively narrower on inner greater coverts. Alula and greater primary coverts, olive-brown (c123) with narrow rufous-brown (36) fringes at tips. Marginal and median primary coverts, olive-brown (c123) with narrow rufous-brown (36) rosethorn-shaped tips. Remiges retained from juvenile plumage; these as adult but with very narrow rufous-brown (c40) fringes to tips of tertials and secondaries.

BARE PARTS Subspecies combined. **Adult** Bill and feet, dark brown; iris, yellow (Buller 1869) or bright pale-yellow (Potts 1872). **Juvenile, First immature** No information.

MOULTS Little information. Adult post-breeding (pre-basic) moult probably complete, but no information on timing. Post-juvenile (first pre-basic) moult apparently partial (Medway 2004) as first immature have distinct rufous tips to most feathers of upperwing (see Plumages above); much of juvenile wing and juvenile rectrices retained.

MEASUREMENTS All unsexed. (1) Adults, skins (MV); (2) Adults (Oliver); (3) First immatures, skins (MV).

| | CAPENSIS, SI | TANAGRA, NI |
|--------|----------------|-------------|
| WING | (1) 126 | 128 |
| | (2) (128–132) | (128–133) |
| | (3) 121, 121 | – |
| TAIL | (1) 125 | 115 |
| | (2) (120–126) | (128–130) |
| | (3) 110, 120 | – |
| BILL S | (1) 26.8 | 27.0 |
| | (3) 24.6, 25.8 | – |
| | (2) (20–23) | (18–20) |
| BILL F | (1) 36.3 | 41.4 |
| | (2) (32–38) | (30–38) |
| | (3) 35.6, 36.8 | – |

WEIGHTS Potts (1873) gives average weight of either sex (subspecies not known) as 3.5 oz (99 g).

STRUCTURE Wing fairly long and broad with rather rounded tip. Ten primaries; p5 longest (p6 sometimes =); p10 44–49 mm shorter than p5; p9 18–22; p8 5–9; p7 1–3; p6 0–1; p4 3–5; p3 11–12; p2 15–19; p1 20–24. Slight emargination to outer webs of p5–p8 and inner webs of p7–p10. Nine secondaries, including three tertials (*contra* Frith & Frith [2004], who state they have eight); tip of longest tertial falls slightly short of tip of p1. Tail fairly long with rather square tip; 12 rectrices; t2 and t3 longest; t1 c. 2 mm shorter than t2; t6 9–16 mm shorter than t2. Outer rectrices of juvenile slightly narrower and more acute at tip than those of adults. Central rectrices sometimes asymmetrical in length (Olson *et al.* 1983). Bill robust, rather short and broad at base, about same length as head; upper mandible slightly decurved; lower mandible inclined slightly upward at gonys; culmen has rather prominent ridge; slight notch near tip of upper tomium. Tongue described as pointed with horn-like texture to underside (Potts 1872). Nasal groove largely feathered. Tarsus rather long, compressed laterally; scaling laminiplantar. Tibia fully feathered. Feet rather large and powerful. Middle front toe longest, mean length including claw 27.9 mm (1.25; 26.5–28.8; 4); inner and outer front toes 70–75% shorter than middle, hindtoe 75–85% shorter than middle. Hindclaw c. 9 mm long.

For further discussion of comparative structure, see Olson *et al.* (1983), Frith & Frith (2004: pp. 22–23), DAB and Family introduction.

GEOGRAPHICAL VARIATION Two subspecies generally recognized: *capensis* from SI, and *tanagra* from NI (Heather & Robertson 2000; Oliver; Peters; NZCL), both of which almost certainly extinct (see Distribution and Population). Several authors (Olson *et al.* 1983; Holdaway *et al.* 2001; Worthy & Holdaway 2002; Medway 2004) separate NI and SI populations as distinct species: North Island Piopio *Turnagra tanagra* and South Island Piopio *T. capensis*. Olson *et al.* (1983) suggest NI and SI birds differ in cranial osteology but this requires confirmation. Fleming (1915) and Medway (2004) consider populations from Stephens I. as subspecies *minor* of the South Island Piopio, based on their small size, more rufous coloration, particularly on head, more distinct streaking on crown, and richer reddish-buff underwing-coverts and bend of wing (Medway 2004).

SUBSPECIES TANAGRA: Described below based on examination of one adult skin (MV). Differences from nominate: **Adult HEAD AND NECK:** Top of head, from forehead to nape, sides of neck, eye-ring and ear-coverts, darker, greyish olive-brown (greyish 129), lacking rufous or buff streaking. Malar area, dark brownish-grey (c79). Chin and throat, white, sharply demarcated from malar area and ear-coverts. Lores, blackish brown (c119), darker than rest of face and forming narrow dark loreal stripe. **UNDERPARTS:** Lacks streaked or mottled appearance. Centre of upper breast, white, as throat. Rest of breast, brownish grey (c79). Flanks and thighs, olive-brown (c123). Belly, vent and shortest undertail-coverts, white or off-white (ne); rest of undertail-coverts, olive-brown (c123) with broad white fringes which often tinged pale yellow (c157).

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Kokako *Callaeas cinerea* (page 965)

NOMINATE CINEREA: 1 Adult

SUBSPECIES WILSONI: 2 Adult; 3 Immature; 4 Adult

Saddleback *Philesturnus carunculatus* (page 986)

NOMINATE CARUNCULATUS: 5 Adult; 6 Juvenile

SUBSPECIES RUFUSATER: 7 Adult; 8 Immature

Piopio *Turnagra capensis* (page 958)

NOMINATE CAPENSIS: 9 Immature

SUBSPECIES TANAGRA: 10 Adult