

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 proptagialis brevis tendon present. Hypocleideum present (except Menuridae [lyrebirds]). Wings eutaxic. Usually ten primaries, but p10 often reduced or absent; 11 primaries in Menuridae (lyrebirds), most Eurylaimidae (broadbills), most Furnariidae (ovenbirds), and some Passeri (oscines [see below]). Usually nine secondaries (ten in Menuridae [lyrebirds]). Usually 12 rectrices, but from six (*Stipiturus* [Maluridae]) to 16 (Menuridae). Lesser primary and secondary coverts usually reduced or absent (Zeidler 1966; Morlion 1985; Winkler & Jenni 1996), but a few well-developed lesser primary coverts are present in Superb Lyrebird (Morlion 1985). Uropygial preen glands naked. No basipterygoid process. Nasal glands minute. Foot anisodactyl. Hallux incumbent, large and directed backwards; toes 2, 3 and 4 directed forward; digital formula 2-3-4-5. Deep plantar tendons usually of type VII (lacking vinculum), but often type I in Eurylaimidae (broadbills). Spermatozoa bundled with coiled head and large acrosome.

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

The Passeriformes divide into two main groups:

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

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

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

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

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

The Aust. oscines fall into two distinct clusters, each with at least three major supra-familial lineages (DAB): One cluster is the Passerida, comprising the Muscicapoidea (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 Dicruridae and Corvidae (cf. Dicruridae–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 *Prothemadera 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 (Kroodma 1996).

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

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

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

REFERENCES

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

Family MELIPHAGIDAE honeyeaters and Australian chats

Mostly green through olive to brown in colour, though some are black, black-and-white, or red-and-black. Range in size from tiny to medium-large (total length 9–48 cm). In total, c. 182 species in c. 42 genera (Sibley & Ahlquist 1990; Sibley & Monroe 1990). Endemic to the sw. Pacific: primarily an A'asian family, with centre of diversity in Aust. and New Guinea, but spreading as far E as Hawaii, and W through Wallacea, with a single species occurring in Bali. Largest passerine family in Aust., with 73 species in 23 genera, including elevation of Western Wattlebird *Anthochaera lunulata* to species status (Christidis & Boles 1994; DAB); three species occur in NZ, all in monospecific genera (NZCL).

Sibley & Ahlquist (1985) showed unequivocally that the Meliphagidae belong to the corvoid adaptive radiation in Aust. The family is closely related to the Pardalotidae, Maluridae and Petroicidae. Other nectar-feeding passerines, such as the sunbirds and flowerpeckers (Nectariniidae) and Hawaiian honeycreepers (Drepanidini) are not closely related to honeyeaters.

Evidence from studies of egg-white proteins (Sibley 1976) and molecular and biochemical studies (Sibley & Ahlquist 1985, 1990; Christidis & Schodde 1991; Christidis *et al.* 1993) confirmed that the Aust. chats (*Epthianura* and *Ashbyia*, formerly Epthianuridae) are honeyeaters, as suggested by Parker (1973) on the basis of morphology, noticeably their brush-tongues. *Cleptornis* (Bonin Island 'Honeyeater') is a white-eye (Zosteropidae) (Sibley & Ahlquist 1990) and *Promerops* (Cape Sugar Bird) is not a honeyeater. Furthermore, Christidis *et al.* (1993) established that *Oedistoma* and *Toxorhamphus* of New Guinea are flowerpeckers, whereas *Timeliopsis* is a honeyeater. A few genera whose DNA has not been examined are perhaps questionably honeyeaters, such as *Notiomystis* (Stitchbird *N. cincta*) in NZ and the Hawaiian genera (*Moho* and *Chaetoptila*).

Most remarkably, Macgregor's 'Bird of Paradise' *Macgregoria pulchra* was found to be a honeyeater on the ground of base sequence of mitochondrial DNA (Cracraft & Feinstein 2000). It is close to the New Guinea genus *Melipotés*, with which it shares a number of morphological characters, including a large yellow facial patch or wattle.

The relationships of genera within the Meliphagidae are poorly understood, though some are closely related, e.g. *Lichenostomus* and *Meliphaga* (DAB, which see for further suggested relationships). A few genera are rich in species: *Lichenostomus* has 20 species, mostly in Aust.; and the similar *Meliphaga*, whose centre is New Guinea, has 13 species. *Myzomela* contains many sibling species or several superspecies and is geographically the most widespread genus, occurring from Sulawesi in the W to Micronesia in the N and Fiji in the E. *Melidectes* is a species-rich genus in New Guinea, with strong differentiation of some subspecies on isolated mountain ranges and hybridization between other taxa (Mayr & Gilliard 1952). *Philemon* and *Lichmera* have radiated in Wallacea (Coates *et al.* 1997), though both occur in Aust. and New Caledonia.

There are also several monospecific genera. In some cases their relationships appear obvious and the species have at times been placed in other genera, e.g. *Acanthagenys* in *Anthochaera*. In other cases their relationships are unclear, e.g. *Stresemannia*, *Guadalcanaria*, *Plectrorhyncha* and *Prosthemadera*.

Most honeyeaters are slim-bodied, though a few are solid-looking (e.g. *Meliphaga*) or even dumpy (*Notiomystis*). Almost all species have slightly to markedly decurved bills, short in some genera (*Pycnopygia*, *Melipotés*, *Conopophila*), longer in others (*Myzomela*, *Phylidonyris*) and long in *Acanthorhynchus* and *Melilestes*. *Plectrorhyncha* has a straight dagger-shaped bill. One key characteristic of honeyeaters is the brush-tongue. Salomonsen (1964) describes it as 'prolonged and protrusible; the basal part is curled on either side, forming two long grooves; the distal part is deeply cleft into four parts, which on their edges are delicately frayed and together form the "brush" which licks up nectar.' The length of the brush and number of bristles vary among species. When feeding, the tongue is rapidly extruded and withdrawn, and nectar and other liquids are drawn into the brush by capillary action (Paton & Ford 1977). As the bill closes with the tongue withdrawn, a process inside the upper mandible apparently compresses the brush, forcing any liquid into the groove down the throat. Honeyeaters are also characterized by: Temporal fossa usually small and flanked by zygomatic process that is often slenderly prolonged and longer than postorbital. Nares fully perforate. Palate slender and attenuately streamlined with characteristic structure (see DAB). Nasal bars thickened with one or two distinctive foramina. Ectethmoid plate broadly winged and thickened. Wing with ten primaries and ten secondaries; p10 often reduced, and outermost secondary vestigial. Tail with 12 rectrices. Head of humerus with basically single deep trabeculated fossa; sometimes (e.g. *Conopophila*) develop depression in same position as second fossa of other bird families. Feet strong with scutellate, bilaminipantar tarsi. The Aust. chats (Epthianurinae) differ from the honeyeaters

(Meliphaginae) by: smaller ectethmoid foramen; slender stems to palatines; nasal bars narrow and imperforate; ectethmoids rather thin; and maxillo-palatine processes flimsy and terete.

Many honeyeaters are greenish, olive or brown, often with some yellow, frequently as plumes or patches on sides of face (particularly on ear-coverts) or sides of neck (e.g. *Lichenostomus*, *Meliphaga*, *Lichmera*). In *Melithreptus*, the head is black or dark brown with a characteristic transverse white stripe across the nape in most species. Many species have an olive or yellow wash or edges to varying number of primaries or secondaries or both, and similar wash or edges to tail-feathers, and which form conspicuous olive to yellow panels on folded wings and tails and which are a strong feature in some *Phylidonyris* and *Grantiella*. Members of a few genera are heavily streaked (*Anthochaera*) or scaly (some *Xanthotis* and *Melidectes*). The large *Gymnomyza* of the Pacific Islands are sooty or greenish black. *Moho* is also black, but with brilliant yellow plumes, which were made into headdresses for Hawaiian royalty (Lepson 1998). Feathers are sometimes long and filamentous, giving a bearded effect (New Holland Honeyeater *Phylidonyris novaehollandiae*, some *Melidectes*). Modification of feathers has been taken to extremes in the Tui *Prosthemadera novaeseelandiae*, which has glossy black plumage with curled white feathers on either side of the breast.

The sexes tend to be monochromatic, though some are strikingly dichromatic. Males of many of the *Myzomela* (and occasionally females) show some brilliant red, whereas females are dull. Spinebills *Acanthorhynchus* and chats *Epthianura* are also sexually dimorphic. Probably males of all species are larger than females, though differences are often slight, with a few exceptions (e.g. Crescent Honeyeater *Phylidonyris pyrrhoptera*, Oahu Oo *Moho apicalis*).

Almost all honeyeaters display coloured bare skin. This may be modest, as in the swollen or extended gape-stripes or lines, eye-rings or eye-patches (e.g. in *Melithreptus*, *Lichenostomus* and *Lichmera*). Large colourful bare facial patches are shown in *Manorina* (yellow), *Melipotés* (yellow to red), *Melidectes* (blue to green) and *Entomyzon* (blue). The friarbirds *Philemon* have mostly bare black heads, often with a prominent knob or casque at the base of the bill. Two species of *Anthochaera* have red or yellow wattles hanging from the sides of their necks. The most adorned species are found in *Melidectes*, which may have bare facial skin and up to three wattles, of contrasting colours. Bills (*Manorina*, *Acanthagenys*) and legs may also be colourful. In a few species the iris is coloured or contrasts with the pupil. The function of most of these characters has not been studied, but they are presumably involved in communication, as the colour or its intensity may change with age (e.g. from green to blue in *Entomyzon*), breeding condition or even with level of excitement (e.g. *Melipotés*).

Adults of most species undergo a single complete post-breeding (pre-basic) moult annually, usually after completion of breeding, and typically from about Oct. to Mar. Some species have two moults annually: e.g. adult Banded Honeyeaters *Certhionyx pectoralis* known to have partial pre-breeding (pre-alternate) and complete post-breeding (pre-basic) moults each cycle, producing alternating breeding and non-breeding plumages. Primaries moult outward (ascendantly, from p1 to p10). Rectrices are moulted centrifugally (from the centre outward).

Nestling honeyeaters hatch blind and naked or almost so, but soon develop light down, with quills appearing after a few days and feathers erupting by about Day 7. Young fledge in complete or almost complete juvenile plumage. In most species the juvenile plumage is like that of the adult, though it is softer (particularly on upperbody and underbody) or duller or both. A few species (e.g. Tawny-crowned Honeyeater *Phylidonyris melanops*) have distinctive juvenile plumages, whereas in the sexually dimorphic species (e.g. Pied Honeyeater *Certhionyx variegatus*), juveniles resemble adult females. Sequence of moults and plumages before attaining adult plumage poorly known in many species. Most species typically undergo a partial post-juvenile (first pre-basic) moult soon after fledging, resulting in a first immature plumage that is often little different from adult plumage, and frequently distinguished only by retained juvenile remiges, rectrices or some wing-coverts; first immatures often not distinguishable in the field. Adult plumage then usually attained in complete first immature (second pre-basic) moult when c. 1 year old and that occurs slightly later than adult pre-basic moult.

Bare parts may also differ between juveniles, immatures and adults, with conspicuous yellow or cream, and swollen and fleshy, gapes being common in young birds.

Honeyeaters occupy virtually every habitat in the A'asian region. Several species are characteristic of mangroves (e.g. Mangrove *Lichenostomus fasciularis* and Red-headed *Myzomela erythrocephala* Honeyeaters). Coconut trees lining beaches may be occupied by White-tufted Honeyeater *Lichmera squamata* in Wallacea (Coates *et al.* 1997). Rainforests in New Guinea and sclerophyll forests, woodlands and heaths in Aust. may have ten or more resident species or regular visitors. In New Guinea, *Melidectes* ventures above the tree-line into subalpine shrubs as far as 4500 m asl (Beehler *et al.* 1986), though no honeyeaters appear to be found regularly in the alpine zones of Aust. or NZ, and altitudinal migration from high country of se. Aust. reported for a number of species (e.g. White-eared Honeyeater *Lichenostomus leucotis*). Semi-arid woodland and shrubland may also be rich in species, with parts of central Aust. regionally abundant as many different habitats are juxtaposed. The chats are particularly prevalent in shrub-steppe, with *Ashbyia* found in desolate gibber plains. No honeyeaters are found regularly in grasslands.

Honeyeaters have been especially successful in colonizing artificial habitats, such as parks and gardens in towns and cities. The White-plumed Honeyeater *Lichenostomus penicillatus* has become a common urban bird in se. Aust., and the larger honeyeaters (wattlebirds *Anthochaera*, Blue-faced Honeyeater *Entomyzon cyanotis*) also do well in

streets planted with native trees and shrubs. Noisy Miner *Manorina melanocephala* have spread through degraded woodland in agricultural regions.

Although most honeyeaters are arboreal, the chats forage and nest on or near the ground. A variety of honeyeaters occupy shrubs, such as Singing Honeyeater *Lichenostomus virescens*, *Acanthagenys* in inland Aust. and *Phylidonyris* in heathland. The genus *Lichenostomus* is especially associated with *Eucalyptus*, as trees or in mallee form.

Almost all honeyeaters are to some degree mobile (Keast 1968). Although many are basically sedentary or resident (many *Meliphaga*, *Lichenostomus*, *Manorina*) they still show local movement, as well as displaying fluctuations in abundance, which indicate movement on some scale. There is probably a tendency for movements to be greater and more erratic in arid than wetter habitats. To some degree this may reflect the fact that most Australians live near the coast. They see irruptions of species such as Crimson Chats *Epthianura tricolor* and Black Honeyeaters *Certhionyx niger* coastward from the inland, whereas incursions of coastal species towards the centre would be overlooked. For instance, the forest-dwelling Scarlet Honeyeater *Myzomela sanguinolenta* may move just as much as Black Honeyeaters. A few species are regular migrants, the best known being Yellow-faced *Lichenostomus chrysops* and White-naped *Melithreptus lunatus* Honeyeaters, which migrate from se. to central-e. Aust. However, even these species may be seen year-round at many localities and resident and migratory sub-populations probably intermingle.

Much movement is associated with flowering patterns of major food plants, such as eucalypts, coastal banksias or arid-zone emu-bush *Eremophila*. In some areas or regions, flowering is a regular event and movements to exploit these events result in regular seasonal movements, for instance the movement in winter to the N of the Great Divide in Vic. to feed on nectar of ironbarks (McGoldrick & Mac Nally 1998). In other cases flowering is irregular, which may lead to erratic influxes of honeyeaters. More curious are cases of intensive flowering that are virtually ignored by honeyeaters. We have barely begun to understand the complex movements of species such as Regent Honeyeaters *Xanthomyza phrygia*. Yellow-faced Honeyeaters show the fixed orientation tendency, NE in early autumn and NW in late autumn and southerly in spring, that is found in true migrants (Munro *et al.* 1993). Curiously, Regent Honeyeaters also show some innate directional tendency to orientate. Many honeyeaters migrate at level of tree-tops during the day, when they may be very conspicuous. Perhaps this behaviour involves an element of searching for resources, as well as a programmed migratory tendency.

Probably all honeyeaters consume some nectar: some depend on it as their main source of energy, others take it when it is abundant locally. Likewise, probably all take some arthropods, often small flying insects captured in the air by sallying, but also insects and spiders gleaned from foliage. A few species, notably Strong-billed Honeyeater *Melithreptus validirostris* and White-eared Honeyeater, probe into and beneath bark for insects and other foods. The former has evolved a strong bill to forage in this way in Tas., a region without treecreepers *Climacteris*. Whereas many species occasionally take fruit, this is a major food source in rainforests (especially for *Meliphaga* in New Guinea), and for a few species (Singing Honeyeater *Lichenostomus virescens* and Spiny-cheeked Honeyeater *Acanthagenys rufogularis*) in arid shrublands. The NZ species also consume fruit (Craig *et al.* 1981; see species accounts). Painted Honeyeater *Grantiella picta* is highly specialized to feed on mistletoe berries. A food source neglected by many observers until quite recently consists of other carbohydrate foods, including: manna, an exudate from eucalypt foliage; lerp, the sugary coating over the nymphs of some psyllids; and honeydew, excretions produced by psyllid and coccid hemipterans (Paton 1980). Sometimes sap from injuries caused by gliders (Petauridae) is eaten.

Unusual foods include crustaceans (Mangrove Honeyeater) and lizards (Wattled Honeyeater *Foulehaio carunculata*). A few honeyeaters also depredate birds' eggs and, occasionally, nestlings (e.g. Noisy Friarbird *Philemon corniculatus*, Red Wattlebird *Anthochaera carunculata*).

Honeyeaters are active and agile while foraging, often stretching or hanging upside-down to reach flowers or insects. They have strong legs and sharp claws. The smaller honeyeaters (*Acanthorhynchus*, *Myzomela*) occasionally hover at flowers, though this is energetically more demanding than perching and probably only used where flowers are inaccessible from a perch. There is a tendency for bills to be longer and more decurved in the more nectarivorous genera, though correspondence of shape of bills and flowers is loose and generalized. The brush-tongue is the most obvious adaptation for nectar feeding, though honeyeaters have rather simple digestive systems compared with more strictly insectivorous passerines. Honeyeaters sometimes defend foraging and breeding territories from conspecifics and other honeyeaters. Such territories may consist of a few flowering trees or shrubs or even part of a flowering tree. Intruders may be driven considerable distances from the territory.

Honeyeaters are very important pollinators of native plants in Aust. and NZ, and probably elsewhere (Armstrong 1979; Godley 1979; Ford & Paton 1986). Many species of the plant families Myrtaceae, Proteaceae and Epacridaceae are pollinated by birds. Bird flowers are usually red, yellow or white, though some are cryptically coloured. They are open and cup-shaped, tubular or gullet-shaped, with inflorescences often being presented as a large brush; for details of shapes of flowers used by different species of honeyeater in Wet-Dry Tropics of NT, see Franklin & Noske (In press). Honeyeaters too may be seed dispersers, and are both pollinators and seed dispersers of some of the mistletoes (Loranthaceae).

Honeyeaters may be solitary, especially when holding feeding territories. Mostly they breed as pairs, though these may be loosely associated in dispersed colonies. Several species are facultatively co-operative in the breeding season (e.g. *Melithreptus*, some *Lichenostomus*), whereas a few are obligate co-operative breeders. The miners *Manorina* live in large, dense colonies, from which other honeyeaters and other insectivorous birds are aggressively excluded; females defend the nesting sites, whereas males roam more widely and contribute to feeding young at many different nests. There have, however, been few studies of territoriality in the Meliphagidae; see Pyke *et al.* (1996) for review of territoriality in honeyeaters.

It is likely that most species are socially monogamous, though Noisy Miners appears to be promiscuous (McFarland & Ford 1991). Females of Crescent Honeyeaters may wander into neighbouring territories, and males make only a modest contribution to parental behaviour, suggesting that some extra-pair copulations may occur (Clarke & Clarke 1999). The few species whose breeding system has been examined genetically (including Noisy Miner) are monogamous. The Stitchbird of NZ may be polygynous, polyandrous or polygynandrous (Castro *et al.* 1996); males have exceptionally large testes and cloacal protuberances, and the species indulges in face-to-face copulation (the latter probably forced extra-pair copulation).

Outside the breeding season, many honeyeaters are social, joining loose, wandering flocks. The migratory species, e.g. Yellow-faced Honeyeater, may gather into large flocks. Whereas large numbers of honeyeaters may gather at rich nectar sources, these tend to be loose congregations rather than structured groups. Sometimes occur in mixed-species feeding flocks (e.g. Sage 1994). Allopreening observed in a few species, notably *Melithreptus* (Noske 1983) *contra* claim of Immelmann (1961) that mutual preening does not occur. Little is known about roosting, but Regent Honeyeaters and *Melithreptus* sometimes roost communally (*contra* Immelmann's [1961] general claim that honeyeaters do not tolerate physical contact after fledging).

Almost all observers of honeyeaters have commented on their aggressive and pugnacious nature. Two types of aggression commonly noted: CHASES, in which attacking bird pursues fleeing bird beyond the latter's point of takeoff; and DISPLACEMENTS, in which attacking bird lands on or near the perch vacated by the attacked bird (e.g. McFarland 1986). Flocks at feeding sites are often noisy, with frequent displacements and chases. Occasionally these result in fights where two or more birds fall to the ground with claws locked together. Pursued birds may be pecked, leading to feathers flying and, exceptionally, may be killed (Dow 1978). Conversely, honeyeaters that have been studied closely have been found to be quiet, even shy, especially during the breeding season.

One of the most complex behaviours, shown best in the miners *Manorina* but also in some *Lichenostomus* and *Phylidonyris*, is the CORROBOREE (Dow 1975; see species accounts). A dozen or more birds gather into a tight group with much calling and wing-fluttering. Sometimes one bird, or even a predator, appears to be the focus of the display. Possible functions include defence against predators and conspecific intruders, or even a show of togetherness by members of a group. With a few exceptions (Noisy Miner, New Holland Honeyeater), the displays of honeyeaters have not been methodically studied and described. The frequency of white or coloured feather-tufts and colourful bare skin suggests that honeyeaters use a wide variety of displays for intraspecific communication.

Most honeyeaters have strong and clear calls, and several species have attractive songs (Pizzey 1980). The simplest songs consist of a few whistles (New Holland Honeyeater), whereas more complex twittering phrases are quite common (some *Lichenostomus*). Black-chinned Honeyeater *Melithreptus gularis*, Singing Honeyeater and Spiny-cheeked Honeyeater have rich and varied songs (Immelmann 1961). However, the NZ honeyeaters, Tui *Prosthemadera novaeseelandiae* and Bellbird *Anthornis melanura*, are classed among the world's best songsters (Hartshorne 1973), on the basis of their pureness of tone and complexity. In contrast, some honeyeaters have harsh (wattlebirds *Anthochaera*) or even rather comical (friarbirds *Philemon*) calls. Song-flights are quite common (some *Lichenostomus*, Tawny-crowned Honeyeater). Mimicry has been recorded in the songs of a few honeyeaters (e.g. Regent Honeyeater, Stitchbird), though its function is not clear.

Many species have characteristic flight calls, especially those that migrate (e.g. White-naped Honeyeater). Probably all give alarm calls, with at least New Holland Honeyeater apparently having separate alarm calls for aerial and terrestrial predators. Such alarm calls often draw other honeyeaters towards the caller, which may lead to mobbing of the predator or corroborees or both. Whereas nestlings and juveniles tend to give distress calls when handled, adult honeyeaters are usually silent when captured. Nestlings and recently fledged juveniles also beg, typically using a simple whistling or piping call.

Most Aust. honeyeaters have long breeding seasons, with different species having peaks of breeding activity in late winter, spring or early summer. The NZ honeyeaters, and a few Aust. species (e.g. Noisy Friarbird) are more seasonal. In most cases honeyeaters make many attempts at breeding in a season, even after successfully raising young. Nests are cup-shaped, occasionally oval with a side entrance, and placed in a fork of branches or suspended from foliage or twigs. *Notiomystis* and at least one species of *Moho* are exceptional among honeyeaters in nesting in tree-cavities. Blue-faced Honeyeaters usually choose nests of other species, especially Grey-crowned Babblers *Pomatostomus temporalis*. Nests are made of twigs, grass, creepers, bark, fern, vines, often bound with spider web, and lined with plant down and animal hair, including wool. Hair is sometimes plucked from live animals, including Koalas *Phascolarctos cinereus* and people.

Honeyeater eggs range from white, through cream, buff, salmon to pink, and may be finely spotted to heavily blotched with light to dark lilac, red, purple, chestnut or black, typically more heavily at the blunt end. The most frequent clutch-size is two eggs in most species, though clutches of three or four are common in *Philemon* and *Manorina*. Two females are suspected of laying in the larger clutches of Blue-faced Honeyeater. Laying intervals are 24 h in a few well-studied species. Incubation periods range from 12 to 17 days, and fledging period from 11 to 20 days, occasionally longer (Ford & Trémont 2000). In most species, nest-building, incubation and brooding of nestlings is carried out primarily or exclusively by the female, though occasionally the male and even auxiliaries may participate. Both parents, and in a number of species, helpers, feed the young and guard the young from predators. Evidence from a few species indicate that young birds become independent from 26 to 42 days after fledging. However, this is a progressive process, with young starting to feed themselves in about half of this time. Breeding success, in well-studied species in Aust., ranges from 5.6% to 69.6% of nests. The highest value is for Rufous-banded Honeyeater *Conopophila albogularis* in a tropical urban environment, the lowest value is for Noisy Miner. Nest predators include Cats, snakes, currawongs *Strepera*, butcherbirds *Cracticus* and other birds. Nestlings may be attacked by green tree-ants *Oecophylla*, and by larval bot-flies *Passeromyia*. Honeyeater nests may be parasitized by a range of cuckoos (see species accounts, and HANZAB 4). Infanticide and egg-destruction of other species has been occasionally recorded (Dow 1975).

Some honeyeaters have coped well with the impact of European settlement in Aust. Several species (White-plumed, Rufous-banded, and Brown *Lichmera indistincta* Honeyeaters) are among the commonest native suburban birds. Noisy Miners have become common in fragmented and degraded woodlands in agricultural regions in se. Aust. Perhaps most species in Aust., though, have declined in abundance as their forest, woodland or heathland habitat has been cleared. There have been local extinctions or substantial declines of remnant populations (e.g. Yellow-plumed Honeyeater *Lichenostomus ornatus* in the WA Wheatbelt, Black-chinned Honeyeater in the Mt Lofty Ras of SA). A major effort has been made to save the last population of the distinctive subspecies *cassidix* of Yellow-tufted Honeyeater *Lichenostomus melanops* in Vic., which declined as most of its habitat was lost; it also suffers from competition with Bell Miner *Manorina melanophrys*. In mallee of se. Aust. the Black-eared Miner *Manorina melanotis* has almost disappeared as a species through hybridization with Yellow-throated Miner *M. flavigularis*, which has been favoured by clearing, fragmentation and opening up of the mallee. One of the most difficult species to conserve is the Regent Honeyeater, which is now classed as endangered. It is highly mobile, visiting a wide range of nectar and other food sources over a large area. The details of its movements, and the habitats it may depend on, are poorly known. Several other wide-ranging species of arid and semi-arid regions are considered rare or even threatened, though this may be partly a result of our lack of knowledge.

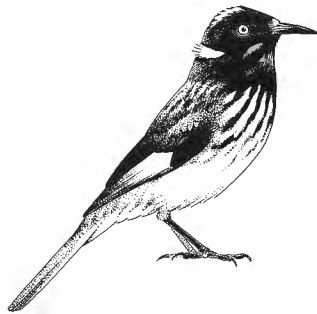
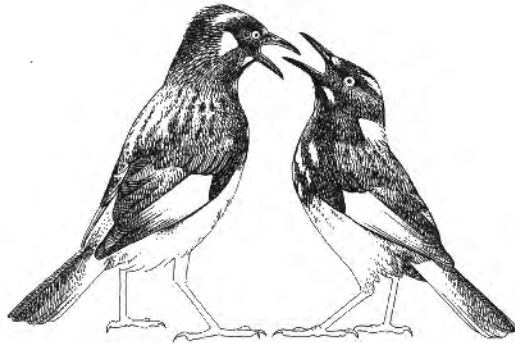
Island species of honeyeaters are often restricted to small ranges and are uncommon. In NZ, the Stitchbird was reduced to a single population on Little Barrier I., as a result of nest-predation by introduced mammals. It has since been translocated to several other islands (Castro *et al.* 1994), although its long-term future there may depend on ongoing management, such as provision of nest-boxes and feeders. Many of the honeyeaters in Wallacea are endemic to only one island (e.g. on Buru, Seram, Wetar). Their status is poorly known, despite a number of recent expeditions, and they are vulnerable to the clearing of forest, which is happening throughout Indonesia (Collar *et al.* 1994). The large forest-dwelling *Gymnomyza* honeyeaters appear to be declining in New Caledonia and Samoa, if not on Fiji (Collar *et al.* 1994). The most disastrous situation, however, exists on the Hawaiian Is. Three species (*Chaetoptila*, two species of *Moho*) are extinct, the survival of Kauai Oo *M. braccatus* on Kauai seems doubtful, and the exact status of Bishop's Oo *M. bishopi* on Maui is not known, though it apparently still exists. They probably declined from forest clearance, introduced mammalian predators and, finally, avian malaria, which has decimated the honeycreepers of Hawaii (van Riper *et al.* 1986).

H.A. FORD

REFERENCES

- Armstrong, J.A. 1979. *NZ J. Bot.* 17: 467–508.
 Castro, I., *et al.* 1994. Pp 113–20 In: Serena 1994.
 —, *et al.* 1996. *Ibis* 138: 765–71.
 Christidis, L., & W.E. Boles. 1994. *RAOU Monogr.* 2.
 —, *et al.* 1993. *Aust. J. Zool.* 41: 423–32.
 Clarke, R.H., & M.F. Clarke. 1999. *Aust. J. Ecol.* 24: 644–54.
 Coates, B.J., *et al.* 1997. *A Guide to the Birds of Wallacea*. Dove Pubs, Alderley, Qld.
 Collar, N.J., *et al.* 1994. *Birds to Watch 2: The World List of Threatened Birds*. BirdLife Int., Cambridge.
 Cracraft, J., & J. Feinstein. 2000. *Proc. R. Soc. Lond.* 267: 233–41.
 Craig, J.L., *et al.* 1981. *NZ J. Zool.* 8: 87–91.
 Dow, D.D. 1975. *Z. Tierpsychol.* 38: 70–96.
 — 1977. *Emu* 77: 115–21.
 Ford, H.A., & D.C. Paton. 1986. *The Dynamic Partnership: Birds and Plants in Southern Australia*. D.J. Woolman, Adelaide.
 —, & S. Trémont. 2000. *Aust. J. Zool.* 48: 21–32.
 Franklin, D.C., & R.A. Noske. In press. *Aust. J. Bot.*
 Godley, E.J. 1979. *NZ J. Bot.* 17: 441–66.
 Hartshorne, C. 1973. *Born to Sing*. Indiana Univ. Press, Bloomington, Indiana.
 Immelmann, K. 1961. *J. für Orn.* 102: 164–207.
 Keast, J.A. 1968. *Emu* 67: 159–209.
 Lepson, J.K. 1998. *Pacific Sci.* 52: 210–19.
 McFarland, D.C. 1986. *Aust J. Ecol.* 11: 107–20.
 —, & H.A. Ford. 1991. *Int. Orn. Congr. Proc.* 20: 1141–55.
 McGoldrick, J.M., & R. Mac Nally. 1998. *Ecol. Res.* 13: 125–39.
 Munro, U., *et al.* 1993. *Emu* 93: 59–62.
 Noske, R.A. 1985. *Emu* 85: 188–94.

- Parker, S.A. 1973. *Emu* 73: 19–20.
Paton, D.C. 1980. *Emu* 80: 213–26.
——— 1981. *Aust. J. Zool.* 29: 217–24.
———, & H.A. Ford. 1977. *Emu* 77: 73–85.
Pizzey, G. 1980. *A Field Guide to the Birds of Australia*. Collins, Sydney.
Pyke, G.H. 1980. *Aust. J. Ecol.* 5: 343–69.
——— 1981. *Anim. Behav.* 29: 861–7.
———, et al. 1996. *Aust. J. Zool.* 44: 297–317.
Sage, B. 1994. *Aust. Bird Watcher* 15: 260–4.
Salomonsen, F. 1964. P. 374 In: Thomson 1964.
Serena, M. 1994. *Reintroduction Biology of Australian and New Zealand Fauna*. Surrey Beatty, Sydney.
Sibley, C.G. 1976. *Int. Orn. Congr. Proc.* 16: 557–70.
———, & J.E. Ahlquist. 1985. *Emu* 85: 1–14.
———, ——— 1990. *Phylogeny and Classification of Birds: A Study in Molecular Evolution*. Yale Univ. Press, Newhaven.
———, & B.L. Monroe. 1990. *The Distribution and Taxonomy of Birds of the World*. Yale Univ. Press, New Haven.
Thomson, A.L. (Ed.) 1964. *A New Dictionary of Birds*. Nelson, London.
Van Riper, C., et al. 1986. *Ecol.* 56: 327–44.



Anthochaera carunculata Red Wattlebird

COLOUR PLATE FACING PAGE 449

Merops carunculata Shaw, 1790, In J. White, *J. Voy. New South Wales*: 240 — New South Wales = region of Port Jackson, New South Wales.

The generic name refers to the nectar-loving habits of these honeyeaters (Greek ἄνθος, a flower, and χάρω, to enjoy). The specific name refers to the fleshy red neck wattles, from the Latin *carunculatus*, wattled (from *caruncula*, a small piece of flesh).

OTHER ENGLISH NAMES Wattled Honeyeater; Wattlebird; Barkingbird; Butcherbird; Gillbird; Gilly Wattler; Muttonbird; What's o'clock; Check.

POLYTPIC Nominate *carunculata*, coastal and subcoastal e. mainland Aust., from far se. Qld, on w. Great Divide, W to central Vic.; vagrant to NZ; *woodwardi* Mathews, 1912, s. and sw. Aust., E to Mt Lofty Ras, SA; *clelandi* (Mathews, 1923), Kangaroo I., SA. Ranges of nominate and *woodwardi* linked by broad zone of intergradation across w. Vic. and se. SA.

FIELD IDENTIFICATION Length: male 35 cm (33–37), female 35 cm (34–37); wingspan: male 44 cm (40–47), female 45 cm (42–49); weight: male 120 g, female 101 g. Large slim honeyeater, with long, strongly graduated tail and sturdy, gently decurved bill. Much larger than Little Wattlebird *Anthochaera chrysoptera*, Western Wattlebird *A. lunulata* and Spiny-cheeked Honeyeater *Acanthagenys rufogularis*, with flatter forehead in profile than first two and proportionately longer and more rounded tail than latter. Adult, black-brown above with conspicuous white streaking, and coarsely streaked dark brown and white below, with yellow patch on belly, prominent whitish facial patch and diagnostic red wattles on sides of neck. Loud raucous calls distinctive. Sexes separable only when breeding pair directly compared: female usually slightly smaller. No seasonal variation. Juvenile duller and browner than adult, with very small wattles and distinctive call. Immature doubtfully separable from adult female in field. Only slight geographical variation (see that section for full details); three subspecies, of which only *clelandi* of Kangaroo I., SA, perhaps discernibly different in field; said to be consistently darker overall than nominate *carunculata*, but some variation and overlap. **Adult** Pattern of head and neck distinctive. Cap (forehead and crown), black-brown, extending to level with eye. Nape and hindneck, black-brown, densely streaked white. Silvery-white lores and ear-coverts form prominent triangular patch below eye, framed by prominent black-brown submoustachial stripe that turns up behind ear-coverts to meet sides of nape; a narrow strip of pink skin sometimes exposed in front of black border to rear ear-coverts. Obvious and diagnostic pink-red wattle hangs from lower rear corner of ear-coverts. Obvious diffuse whitish line runs down sides of neck from behind ear-coverts, separating white-streaked hindneck from more coarsely streaked dark-brown and white chin, throat and foreneck. Saddle and rump, dark brown with indistinct narrow grey fringing and bolder narrow white streaking; uppertail-coverts similar, but streaking more subdued and feathers have clearer and broader white fringes, making uppertail-coverts appear slightly paler than saddle or tail. Uppertail, dark brown grading to paler greyish towards base, with rectrices narrowly edged and boldly tipped white. Upperwing, black-brown, with clear white fringes to secondary coverts, tertials and secondaries, those of latter showing as prominent whitish panel in folded wing; all pri-

maries tipped white, broadly so on outer primaries. Foreneck and breast, dark brown with bold narrow white streaking, merging to coarse dark-brown and white streaking along flanks, and with large yellow patch on belly and vent; undertail-coverts, dark brown with broad white fringes and narrow white shaft-streaks. Undertail, brownish grey, with all feathers boldly tipped white, as uppertail. Underwing, brownish grey, merging to pink-buff on bases of primaries, which are tipped white (as upperwing); coverts have white fringes. In fresh plumage, have distinctly grey tone and, in flight, note prominent white tips to outer primaries and tail and suggestion of pale rump; with wear, upperparts become noticeably darker and less grey, and effect of pale rump is lost as pale feather-margins and grey wash reduced. Bill, black; gape, grey-black. Iris, red. Legs and feet, pink-brown or pink. **Juvenile** Similar to adult but slightly duller and browner, differing by: forehead and crown duller, dark brown and finely streaked whitish (cf. uniformly blackish); submoustachial stripe as adult, or silvery white as ear-coverts and bordered by thin dark moustachial and malar stripes; white streaking on rest of body finer; yellow belly-patch often smaller and paler; secondary coverts, tertials and remiges have pink-buff fringes and edges, though these soon fade to whitish, as in adult; iris, dark brown; wattle paler, pink-red and very small, visible only in close view; strip of bare skin at rear of ear-coverts duller pink; and legs and feet much brighter pink. Newly fledged and still dependent juveniles further distinguished by: looser and fluffier plumage; still-growing and often much shorter tail; noticeably shorter and duller grey-black bill with tiny pale tip and puffy yellow-orange gape; and incessant buzzing call.

Similar species Unmistakable if seen well, but in poor view or in flight can be confused with **Little** and **Western Wattlebirds** and **Spiny-cheeked Honeyeater**; see those texts for details.

Gregarious; during breeding season seen singly, in pairs, family groups or small parties; in autumn and winter, often in larger flocks, sometimes numbering in hundreds or, exceptionally, thousands. Active, noisy and conspicuous, and sometimes markedly pugnacious towards other birds. Strongly arboreal; forage mainly in upper and outer canopy though often down to ground level in low or prostrate shrubs; sometimes forage on ground and often sally for insects. When on ground, hop with tail held slightly cocked. Travelling flight swift, direct and

gently undulating, generally level with or just above canopy, with bursts of rapid shallow wing-beats between undulating glides; note slender body, rounded wings, slightly fingered at tips and held straight out from body, and long tail held tightly furled but clearly rounded at tip; travelling autumn–winter flocks often settle briefly on high bare branches of emergent trees before continuing on.

HABITAT Mostly inhabit temperate zone, but extend into subtropical, semi-arid and alpine zones. Occur at all altitudes from sea level up to c. 1900 m asl (Longmore 1973; Gall & Longmore 1978; Osborne & Green 1992; Cooper & McAllan 1995). Mostly occur in eucalypt woodlands and forests, but also in variety of other woodlands, heathlands and shrublands.

Mostly occur in or at edges of wide variety of forests and woodlands, usually dominated by eucalypts, including regrowth, with grassy, sclerophyllous or heathy understorey, in variety of landforms, including on ridges and in gullies (Clarke 1967; Masters & Milhinch 1974; Gall & Longmore 1978; Marchant 1979; Loyn 1980, 1985b; Paton 1980; Smith 1984; Ford *et al.* 1985; McFarland 1985a; Milledge & Recher 1985; Henle 1989; Osborne & Green 1992; Saunders 1993; Possingham & Possingham 1997; Ford 1999; Storr 27, 28). Recorded in healthy forests and woodlands more often than in those affected by dieback (Ford & Bell 1981). Occur in mallee associations, including woodlands, shrublands and heathlands, sometimes with spinifex *Triodia* in understorey; also recorded in banksia heathlands or thickets of Broombush *Melaleuca uncinata* associated with mallee scrub, especially floristically diverse stands (Anon. 1926; Rix 1943, 1945; Storr 1947; Glover 1955; Schodde & Glover 1955; Mack 1961; Mack 1970; Eckert 1974; Gell 1977; Ford 1979; D.C. Paton & P.A. Paton 1980; Carpenter & Matthew 1986, 1997; Sedgwick 1986; Baxter 1989; Woinarski 1989; Saunders 1993; Possingham & Possingham 1997). Sometimes recorded in wet sclerophyll forest, such as mature stands or regrowth of Mountain Ash and Alpine Ash *Eucalyptus delegatensis*, with rainforest or sclerophyllous understorey, on wet slopes or in gullies of mountains and foothills (Morris 1975; Recher 1975; Gibson 1977; Emison & Porter 1978; Gall & Longmore 1978; Loyn 1980, 1985a,b; Friend 1982; Smith 1984; Milledge & Recher 1985; Saunders 1993). Occur in coastal shrublands and heathlands, especially those with banksias, paperbarks or *Correa*, sometimes with scattered emergent eucalypts or *Angophora*, or acacias and native pines *Callitris* (Condon & Rix 1936; Serventy 1938; Bell 1964; Storr 1965; Liddy 1966; McEvey & Middleton 1968; Recher & Abbott 1970; Morris 1975; Gibson 1977; Bedggood 1980; Preston 1983; Smith 1984; Pyke & Recher 1988; Baxter 1989; Reilly 1991a; Horrocks & Brown 1993). Also occur in remnants of forest or woodland on farmland (Hirth 1976; Emison & Porter 1978; Sedgwick 1984; Loyn 1985c; Traill *et al.* 1996; Vic. Atlas); and in thickets of paperbarks, sometimes with *Callistemon* and emergent eucalypts, near wetlands (Sutton 1927, 1931a,b, 1932; Hood 1934; Storr 1947; Sedgwick 1964; Clarke 1967; Dell 1972; Sedgwick 1973b; Baxter 1989); once in gallery forest of River Oak with much mistletoe (Lamm & Calaby 1950); and once reported in gully–riparian forest dominated by tree-ferns (Reilly 1991a). Rarely recorded in rainforest, including cool and warm temperate rainforest (Kikkawa *et al.* 1965; Smith 1984; Loyn 1985b). Very occasionally recorded in pine *Pinus* plantations, especially older (>12 year) stands (Gepp & Fife 1975; Friend 1982; Traill 1985); in woodland or scrub dominated by acacias, including Myall *Acacia papyrocarpa* and Mulga (Arnold 1927; Glover 1957; McEvey & Middleton

1968; Matthew & Carpenter 1993), or native pines *Callitris* (Parsons & McGilp 1934; Turner 1992); or in high altitude herbfields or alpine heathland during snow-free months (Longmore 1973; Osborne & Green 1992). Common in parks, gardens, golf courses, and other reserves in urban and rural areas; also in vineyards and orchards (Mellor 1924; Sutton 1928b; Storr 1947; Sedgwick 1973a, 1984; Price 1977; Hopper & Burbidge 1978; Whatmough 1978; Paton *et al.* 1983, 1988; Saunders 1983; Green 1984, 1986; Backhouse 1985; Browne 1990; Lenz 1990; Storr 28).

DISTRIBUTION AND POPULATION Widespread in s. Aust.; vagrant to NZ.

Aust. Qld Confined to South-Eastern Region. Mostly recorded S of Brisbane and Toowoomba, though sometimes farther N to Noosa and Cooloolo, and single Aust. Atlas record near Chinchilla (Jack 1966; Robertson & Woodall 1983; McKilligan & McKilligan 1987; Storr 19; Aust. Atlas). **NSW** Widespread on and E of Great Divide, extending W into s. North-West Plain, Central-West Slope and e. Riverina Regions. Farther W, few scattered records from Moama N to near Wanganella, along Murray R. Valley from Euston downstream to Wentworth, and a few other isolated records between there and Fowlers Gap (Morris *et al.* 1981; Henle 1989; Cooper & McAllan 1995; Aust. Atlas). **Vic.** Widespread in all areas, though sparsely scattered in parts of Western District and from ne. Wimmera, N into e. Mallee and E through much of Northern Country (Vic. Atlas). **SA** In Lower North, recorded N to Devonborough Downs Stn and Manunda, but elsewhere widespread S of 31°S, from Wilpena Pound in s. Flinders Ras W to Nullarbor Stn (Mack 1970; Paton *et al.* 1994; Stove 1994; Aust. Atlas; SA Bird Reps). **WA** Recorded at scattered sites on s. Nullarbor Plain, from Wanteen and Eucla Pass to Caiguna. Farther W, more widespread in area W of 125°E and S of 29°S (Reilly *et al.* 1975; Saunders & Ingram 1995; Aust. Atlas; Storr 26, 27, 28). Elsewhere, few scattered records N to near Murchison R., around Nerren Nerren and Paynes Find (Sedgwick 1949a; Aust. Atlas; Storr 21).

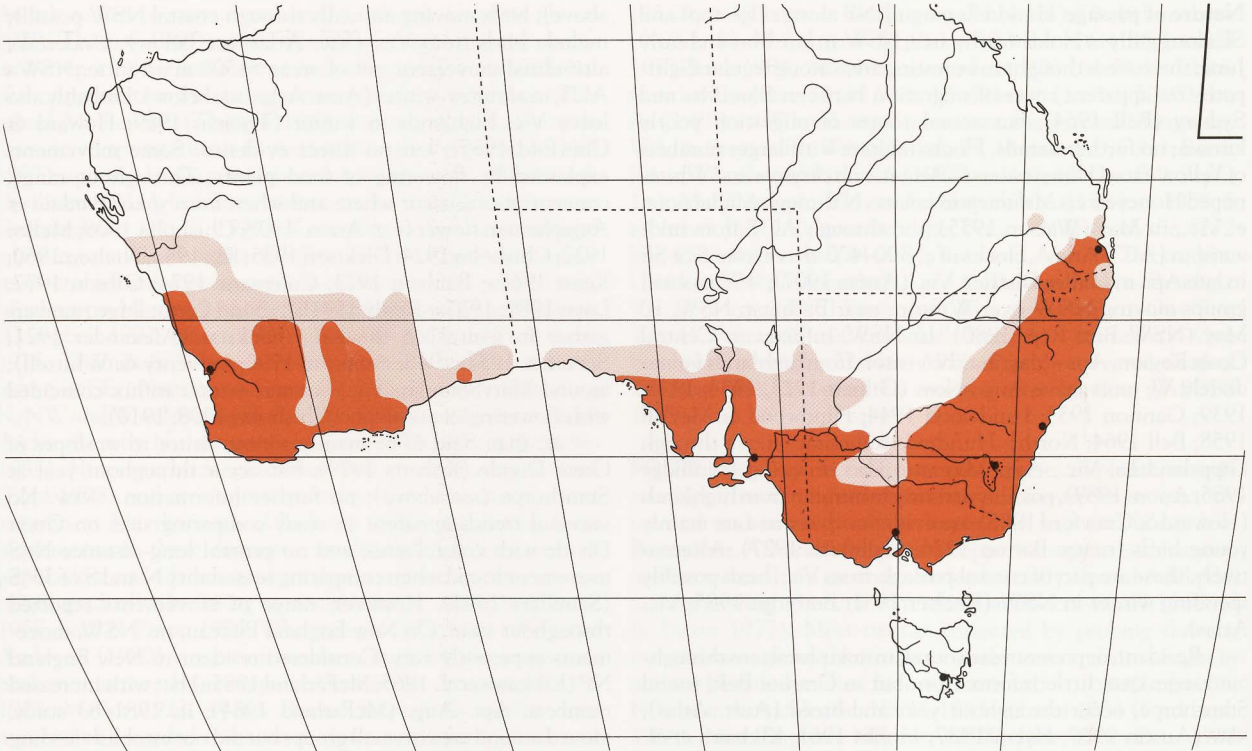
NZ Vagrant. **NI** Two historical records: single specimen, Matakana, c. 1865 (Stidolph 1927; Sibson 1987; Oliver); single, Rohutu, Taranaki, c. 1885 (Stidolph 1927; Oliver). **SI** Unconfirmed report of single, Motupiko, ≤1938 (Moncreiff 1938).

Breeding Throughout range in Aust. (Aust. Atlas; NRS); not in NZ.

Change in range At Nambucca Heads, NSW, rarely recorded before 1984; visited area in 1985–86 and present throughout year since 1987, and widespread in 1992–93; breeding first recorded in 1991 (NSW Bird Rep. 1993); and said to have become resident on Lefevre Pen., SA, after 1982, where it had only been an occasional visitor previously (Winslet & Winslet 1987).

Anomalies Noticeable influx recorded in Sunraysia Region of nw. Vic., 1968 (Hobbs 1969).

Populations Near Armidale, NSW, reported densities of: 0.05–0.92 birds/ha (Ford & Bell 1981); 0.02–0.20 birds/ha (Ford *et al.* 1985); and 0.10/ha (Ford *et al.* 1986); in Bundarra-Barraba area, 0.18 birds/ha (Oliver *et al.* 1999). In New England NP, NSW, recorded at 3.48 birds/km (3.79; 0–11.92; n=12 monthly means of 48 counts along 1.2 km transect) (McFarland 1984). At Back Yamma SF, near Forbes, NSW, maximum density of 3 birds/ha (Saunders 1993). At Beverley Hills, NSW, four Wattlebirds inhabited 1.6-ha woodland (McFarland 1983). Near Canberra, density of 0.07 birds/ha (Bell 1980). Near Bombala, NSW, mean densities of two 10-ha plots, 0.4 and 0.43



birds/ha (Recher & Holmes 1985). Near Orbost, Vic., mean number recorded along 200 m transects through unthinned and old regrowth forest was 0.4 and 0.6 respectively (Kutt 1996). Near Morwell, Vic., density of 2.17 birds/km (along 600 m transect) (Traill 1985). At Olinda SE, Vic., maximum density was 1.07 birds/ha (median = 0.09 birds/ha) (MacNally 1997). Along Gardiners Ck, Bennettswood, e. suburban Melbourne, Vic., mean density of 0.66 birds/ha (0.57; 0–4.79; n=513 weekly surveys, 1989–98) (J.M. Peter). At Torquay, Vic., mean density of 1.72 birds/ha (0.999; 0.24–3.57; n=24 quarterly surveys, 1989–95) (J.M. Peter). At Eyre Bird Observatory, WA, densities of 0.18–2.45 birds/ha (Davies 1982). At Margaret R., WA, density of 0.2 birds/ha (Keast 1985). Claimed that breeding populations have increased around Sydney (Hoskin 1991; Disney 1992); and populations said to have increased around Adelaide (Paton *et al.* 1994; Ashton 1996).

THREATS AND HUMAN INTERACTIONS Adversely affected by removal of undergrowth of banksias in Rockingham District, WA (Sedgwick 1940a). In detailed study examining effects of logging and burning in Karri forests near Pemberton, sw. WA, was most abundant in mature forest, including forest that had not been burnt for at least 3 years (Tingay & Tingay 1983). Said to have benefited from establishment of gardens near Aldinga Scrub CP, SA (Ashton 1996). In Wheatbelt of WA, populations have declined in areas that have been extensively cleared, and disappeared from several areas where the species was once common (Saunders & Ingram 1995). Often killed by Cats, and occasionally injured by Dogs (Rose 1975; Dowling *et al.* 1994). Sometimes killed on roads (Vestjens 1973; Brown *et al.* 1986); occasionally collide with windows (Buchanan 1992). Said to be a pest of orchards and vineyards, and formerly shot, sometimes in large numbers (Dickison 1935; McEvey 1965; Hobbs 1969; Passmore 1982); at Araluen, NSW, not considered pest in orchards of nectarines and peaches, as they

only eat overripe fruit left on trees (A.S.J. Saunders). Formerly, also shot for sport or food (Gilbert 1923; Bell 1964), as they were renowned as ‘the best eating bird in the bush’ (Leach 1928); ‘Gill-bird pie sounds ever so much better than grilled chicken’ (Gilbert 1923). Birds fed on refined sugar in gardens sometimes die from thiamine deficiency (Bonnin 1989).

MOVEMENTS Apparently complex, and incompletely known; no major studies, though one study (Saunders 1993) looked at seasonal variation in occurrence in e. NSW. Various considered resident, nomadic and at least partly migratory in some areas (e.g. Carnaby 1933; Wheeler 1967; BFNC 1976; Morris *et al.* 1981; Storr 28). Resident or present throughout year (though abundance may vary) throughout much of range. However, a variety of movements also reported throughout range. Such movements poorly understood, and few clear patterns emerge; many local or regional movements may be driven by flowering of food plants (see below). At several locations, resident populations supplemented at times by non-breeding visitors or passage migrants, e.g. around Perth and Canberra (Serventy 1948; ACT Atlas). Various movements or patterns of abundance considered migration or partial migration, especially in WA and s. and n. coastal NSW; altitudinal migration reported in se. NSW–ACT (see below). Also often described as nomadic or partly nomadic (e.g. Chisholm 1924; Wheeler 1967, 1972; Attiwill 1972; Sonter 1980; Turner 1992; Traill *et al.* 1996; Storr 28), usually with no evidence of actual movements or numbers, and based on perceived patterns of presence/absence or numbers locally. Much study needed to determine true range of movements. Some evidence of autumn–winter movement inland (Keast 1968a; Paton *et al.* 1983; see below). Records outside normal range usually in winter (e.g. Mack 1970; McKilligan & McKilligan 1987; Robertson & Woodall 1983; Durrant & MacRae 1994; Qld Bird Rep. 1986); vagrant to NZ, but records not dated (see Distribution).

Nature of passage Hundreds moving NE along ridge-tops and SE along gully in Holdsworth area, NSW, in late May and early June; these areas thought to be resting areas along regular flight-paths on apparent route of migration between Blue Mts and Sydney (Bell 1964), but actual routes of migration poorly known; no further details. Flocks migrate with larger numbers of Yellow-faced Honeyeaters *Lichenostomus chrysops* and White-naped Honeyeaters *Meliphreptus lunatus* N through Mallacoota, e. Vic., in May (Watson 1955) and through ACT from mid-autumn (ACT Atlas). Flocks of c. 300–400 arrive from S or SE in late Apr. in Mallee District, Vic. (Anon. 1907); ≥ 70 in small groups moving NNW over Winton, near Bathurst, NSW, 10 May (NSW Bird Rep. 1980). In NSW, influxes to Central Coast Region, Apr.–May, may be visitors from highlands immediately W; most leave Aug.–Nov. (Gilbert 1923, 1934, 1935, 1939; Gannon 1933; Hindwood 1944; Hindwood & McGill 1958; Bell 1964; North). Hundreds sometimes move through Gippsland Ls, Vic., Apr.–May and also in spring (Burbidge 1985; Anon. 1989), possibly arriving in autumn from highlands (Howard & Crawford 1985); no evidence that these are mainly young birds (*contra* Barton 1926; Galbraith 1927). Alternatively, these are part of coastal passage from Vic., birds possibly spending winter in NSW (Recher 1981; Burbidge 1985; Vic. Atlas).

Resident, or present year-round, in many locations throughout range: QLD, little information, but in Granite Belt, round Stanthorpe, occur throughout year and breed (Aust. Atlas); NSW (Austin 1907; Hyem 1937; Hobbs 1961; Kikkawa *et al.* 1965; Morris 1975, 1986, 1989; Smith 1984; Ford & Debus 1994; NSW Bird Rep. 1993); ACT, where some present round Canberra throughout year (Balfour 1980; Ford *et al.* 1985); VIC (Ford 1918; Barton 1926; Galbraith 1927; Payne 1931; Shanks 1949; Hore-Lacy 1964; Anon. 1966; Bedgood 1973; Price 1977; Loyn 1980; Collins & Collins 1981; Burbidge 1985; Humphreys 1986; Norris 1995) including around Melbourne, where no significant seasonal variation in occurrence (Aston & Balmford 1978; *contra* Fleming 1976; see also Ambrose 1990); SA (Crompton 1915; Souter 1942; Leiblich 1971; Cox 1973; Rix 1976; Baxter 1980; D.C. Paton & J.B. Paton 1980; Ashton 1985; Winslet & Winslet 1987); and WA, in lower SW, round Perth to Northam (Alexander 1921; Jenkins 1931; Serventy 1937, 1948; Heron 1970; Sedgwick 1973a, 1988; Masters & Milhinch 1974; Ambrose 1990; Hunt 1992; Saunders & Ingram 1995; Serventy & Whittell), and most of Wheatbelt (Orton & Sandland 1913; Sedgwick 1937; Serventy 1937; Ford & Stone 1957; Keast 1968a; Saunders & Ingram 1995; Serventy & Whittell; Storr 21).

However, variety of movements (or changes in abundance) also reported throughout range: migration (including altitudinal migration), nomadism and changes in abundance linked to flowering of trees and shrubs. Such movements poorly understood, and few clear patterns emerge. Descriptions of movements usually largely based on incomplete information and different classifications (e.g. migration versus nomadism) based on the preconceptions and opinions of authors. Below, movements discussed state by state. Said to be nomadic, or partly so, in many areas (Chisholm 1924; Wheeler 1967, 1972; Attiwill 1972; Sonter 1980; Turner 1992; Traill *et al.* 1996), but this may be local movement between patchy food sources (Belcher 1914; also see Thomas 1968; Bedgood 1980; Vic. Bird Rep. 1986). Partial N–S migration occurs in WA (Serventy 1937; Saunders & Ingram 1995; Aust. Atlas) and probably in S. NSW (e.g. Keast 1968a; Marchant 1979). Routes of migration not well established (*contra* Aust. RD; see Nature of passage,

above); birds moving annually through coastal NSW possibly include birds from Vic. (Vic. Atlas; see below). Undertake altitudinal movement out of areas >1500 m asl in se. NSW–ACT, in autumn–winter (Aust. Atlas; see below). Probably also leave Vic. highlands in winter (Thomas 1969; Howard & Crawford 1985), but no direct evidence. Some movements explained by flowering of food plants. Throughout range, concentrations occur where and when *Eucalyptus*, *Banksia* or *Angophora* in flower (e.g. Anon. 1908; Chisholm 1908; Mellor 1922; Chisholm 1924; Dickison 1935; Rix 1943; Nielsen 1960; Keast 1968a; Baldwin 1973; Coleman 1974; Gibson 1977; Loyn 1980, 1985a; Reilly 1991b); round Perth, large numbers gather in winter on flowering banksias (Alexander 1921; Serventy 1937, 1948; Ambrose 1990; Serventy & Whittell); around Maryborough, Vic., autumn–winter influx coincided with flowering of eucalypts (Chisholm 1908, 1910).

SE. QLD: Said to be mainly winter visitor to w. slopes of Great Divide (Roberts 1979), but occur throughout year at Stanthorpe (see above); no further information. NSW: No seasonal trends apparent in study comparing sites on Great Divide with coastal sites; and no general long-distance N–S movement found when comparing seasonality N and S of 33°S (Saunders 1993). However, range of movements reported throughout state. On New England Plateau, ne. NSW, movements apparently vary. Considered resident in New England NP (Kikkawa *et al.* 1965; McFarland 1985a) but with increased numbers, Apr.–Aug. (McFarland 1984); in 1981–83 study, moved around area in small groups but did not establish feeding territories (McFarland 1986a). Around Armidale, more common spring–summer, and least common in winter (Ford *et al.* 1985; H.A. Ford), but in one study of four sites near Armidale, over 7 months, July–Jan., recorded fewer than three times, only in Aug. (Chan 1995). At Boree, 80 km S of Armidale, very common spring–summer breeding visitor, leaving to E, about Apr. (Norton 1922). Some birds may move N on mid-n.coast after breeding (Liddy 1966; Morris 1970); occur Northern Rivers Region in non-breeding season (Morris *et al.* 1981). Numbers increase in winter round Inverell (Baldwin 1973). Also suggested that migrate between Blue Mts and Sydney area, in late May and early June (Bell 1964; also see above). Partial migration reported along s. coast, moving N from Mallacoota, Vic., to at least Moruya in Apr.–May, sometimes as late as June, and S in Aug.–Sept., sometimes as late as Nov. (Watson 1955; Keast 1968a; Marchant 1979; NSW Bird Reps 1992, 1994, 1995). Around Bombala, said to migrate N for winter and to move S in Sept. (Recher & Holmes 1985); mainly winter visitor around Moruya and at Barren Grounds NR (Marchant 1979; Jordan 1984, 1987; Jordan & Jordan 1984; Baker 1991), and in this area birds may be altitudinal migrants or latitudinal migrants or both; needs further study. In 1976, many birds remained over winter on s. coast when eucalypts flowered heavily; said that normally migrate to n. NSW (Recher 1981). In Kosciusko NP and Thredbo Valley, numbers decline in autumn and increase in spring; absent above 1530 m asl when covered by snow (Gall & Longmore 1978; Osborne & Green 1992). Some may move inland in winter, e.g. recorded Wellington area, July–Aug. (Althofer 1934); ≥ 70 moved NNW near Bathurst, 10 May (NSW Bird Rep. 1980). However, a few seen SW of Dubbo in Nov. (H.A. Ford). ACT: Partly migratory. Birds leave Brindabella Ra. in autumn, and return Aug. (Lamm & Wilson 1966; Tidemann *et al.* 1988; ACT Atlas); in winter, occupy area round Canberra <700 m asl (Bell 1980; Clayton 1981; ACT Atlas; ACT Bird Rep. 1979–80), and some leave ACT entirely, as early as Mar. (Er & Tidemann 1996; ACT

Atlas); return to some sites round Canberra in spring (Jones 1929; Thomas 1969). vic.: Spring–summer seasonal occurrence reported for some areas, including inland: claimed that part of population are spring–summer visitors to lowland sites round Melbourne (Thomas 1969; but see above); formerly considered spring visitor to Ararat area, arriving from S (Hill 1907); appeared in large numbers in spring round L. Hindmarsh (Sullivan 1911); summer visitor to L. Coradgil area, near Camperdown (Hirth 1976). Common in late summer and autumn round Rutherglen (McEvey 1965). Numbers increase in several inland areas in autumn–winter, e.g. round Chiltern, Mooropna, Marong (near Bendigo), Maryborough and Ballarat (Campbell 1902; Anon. 1907; Chisholm 1908, 1910; Roberts 1975; Thomas & Wheeler 1983); arrived in Mallee District from S or SE, in late Apr. (Anon. 1907; see above), and moving N, NW and W at Marong in Apr. (Ford 1908); at Ballarat, small flocks often fly N, late summer–winter (Thomas & Wheeler 1983). However, birds sometimes move S at Marong in May (Ford 1908) and arrive in response to flowering eucalypts in autumn at Maryborough (Chisholm 1908), suggesting local movements in these districts. sa: Round Adelaide, part of population considered resident, but numbers increase in autumn, gradually declining to a minimum in summer (Clarke 1967; Ford & Paton 1976; Whatmough 1978; Ford 1983), but Ambrose (1990) suggested numbers in Adelaide sometimes peak in summer; this is supported by historical reports (Anon. 1908; Mellor 1922, 1926). Round Stoneyfell, regular daily movement recorded in autumn, down to plains to feed, and return to hills to roost (Crompton 1915). Possibly part of population moves N and inland in winter and spring: mainly winter visitor to some parts of Murray–Mallee, Adelaide Plain and Flinders Ras: Wilpena Pound, Aug.–Sept. (SA Bird Rep. 1965), Mt Mary–Sutherlands (Boehm 1957); N of Murray R. (Mack 1970); round Mannum (Cox 1973); occur mainly winter–spring at Sandy Ck CP (Rix 1976) and Port Wakefield (P.W. Taylor 1987); in surveys round Monarto, Dec. 1974–Aug. 1976, mainly occurred July–Dec., which coincided with maximum production of nectar (Ford 1979). On Kangaroo I. (subspecies *clelandi*), after breeding, form autumn–winter flocks of up to 200 birds (Baxter & Berris 1995). wa: Partly migratory round Perth, with some birds moving N in Apr.–June and S in Aug.–Nov. (Alexander 1921; Cohn 1926; Serventy 1937, 1948; Heron 1970; Serventy & Whittell); also considered nomadic, in roving flocks from late summer till early winter (Storr 28); formerly, round Guildford, very plentiful at times but scarce May–Aug. (Hill 1904). In Avon R. Valley, round Northam, different timing of passage reported: most obvious in winter and early spring, when birds usually pass from SE to NW (Jenkins 1931; Masters & Milhinch 1974). More commonly recorded in South-East Interior and parts of n. Wheatbelt, e.g. round Moora, Apr.–Oct. or Nov. than rest of year (Orton & Sandland 1913; Saunders & Ingram 1995; Aust. Atlas; Storr 26); possibly also at n. extremity of range on Lower Murchison R. (Sedgwick 1949a). Near Kellerberrin, in Wheatbelt, recorded ‘travelling over 12 km to suitable food sources and returning the same day’ (Saunders & Ingram 1995). At L. Grace, partly migratory (Carnaby 1933); no details on seasonality. Sometimes congregate along sw. coast in summer (Carter 1924; Serventy & Whittell), though sometimes briefly absent from some sites (e.g. Campbell 1938; Sedgwick 1940a,b). Many pass E though Eyre in summer and return W in autumn (Dymond 1985, 1988; Watkins & Watkins 1994; Aust. Atlas). Vagrant to Rottnest I., Jan. 1931 (Storr 1964).

Banding Of 8028 banded in Aust., 1953–97, 1178 recoveries (14.7%). Of 541 recoveries, July 1984–Mar. 1999: 514

(95.0%) < 10 km from banding site; 22 (4.1%), 10–49 km; three (0.6%), 50–99 km; two (0.4%) ≥ 100 km. Of 4135 banded 1953–June 1984, 248 public recoveries: 202 (81.5%) < 10 km from banding site; 32 (12.9%), 10–49 km; 8 (3.2%), 50–99 km; six (2.4%) ≥ 100 km. Long-distance recoveries: near Manjimup, WA, to Stoneville, WA (271 km, 7°, 34 months^D, Feb.); Berri, SA, to Hazelwood Park, SA (197 km, 248°, 10 months^D, Sept.; 1+); Maryborough, Vic., to Frankston, Vic. (176 km, 135°, 5 months^D, July; 1+); near Bendigo, Vic., to Ringwood, Vic. (172 km, 153°, 9 months^D, Mar.; J); Burwood, Vic., to Talbot, Vic. (144 km, 301°, 16 months^D, Apr.; 1); Balwyn, Vic., to Bendigo, Vic. (140 km, 330°, 13 months^D, Apr.; 1+); Perth to Gin Gin, WA (126 km, 49°, 60 months^D, Dec.; 1). **LONGEVITY:** One banded as juvenile, 22 Nov. 1980, Perth, recovered dead at Toodyay, WA, 12 years 11 months after banding (ABBBS 1998).

FOOD Feed on nectar from many species of plants, mainly eucalypts; less often feed on manna and invertebrates (mainly insects) and insect products, especially lerp and honeydew.

Behaviour Arboreal; forage from upper canopy to understorey, and occasionally on ground; also feed aerially. Round Adelaide, ratio of feeding on nectar to feeding on insects was 67:33 (Ford & Paton 1977). Most nectar collected by probing flowers; invertebrates gleaned from various substrates and also caught in air (see Detailed studies, below). **DETAILED STUDIES:** In Imbota NR, near Armidale, ne. NSW, 1981–82 and 1984 (Ford *et al.* 1986); New England NP, ne. NSW, June 1981–Dec. 1983 (McFarland 1986a,b); Menai, sw. Sydney, Apr. 1989–Oct. 1993 (Egan 1997); Bondi SE, near Bombala, se. NSW, Dec. 1976–Jan. 1981 (Recher & Holmes 1985; Recher *et al.* 1985); Golton Vale, w. Vic., Oct. 1976–Sept. 1978 (Paton 1980); 16 sites round Adelaide, including Mt Lofty Ras, 1973–76 (Ford & Paton 1977; Ford 1979); and Kendenup and Gingin, s. WA (Hopper & Burbidge 1986). **SIZE OF FEEDING FLOCKS:** Forage singly, in pairs or small groups. On Kangaroo I., SA, occasionally congregate in large flocks, sometimes of >100 birds, where food abundant (Baxter 1989). Interact with many species at sources of food, especially other honeyeaters (see Social Behaviour: Agonistic behaviour). Often recorded feeding with New Holland Honeyeaters *Phylidonyris novaehollandiae* (Keast & Condon 1968; McFarland 1996), Noisy Friarbirds *Philemon corniculatus* (Saunders 1993), Little Friarbirds *P. citreogularis* (Favaloro 1931), Western Wattlebirds (Carter 1924), Little Wattlebirds (Belcher 1914), Rainbow Lorikeets *Trichoglossus haematodus* (Keast & Condon 1968), Purple-crowned Lorikeets *Glossopsitta porphyrocephala* (Hopper 1980), Satin Bowerbirds *Ptilonorhynchus violaceus*, Pied Currawongs *Strepera graculina* and Crimson Rosellas *Platycercus elegans* (McFarland 1984). **FEEDING TERRITORIES:** Often defend individual feeding territories; other nectivorous birds usually chased away, sometimes >100 m from territory. In one territory with Yellow Gums at unknown site in se. Aust., Wattlebird defended c. 3000 flowers; owner left territory about once per hour to feed for a few minutes at a time in adjoining territories or farther away (Paton 1986). On Kangaroo I., SA, single bird defended all or part of Cup Gum *Eucalyptus cosmophylla* over 7 days, May–June 1978; size of feeding territory decreased as density of flowers in territory increased; at first, bird defended whole tree, but later defended single branch with c. 760 flowers. Six other species attempted to feed on the flowers, and all but Rainbow Lorikeets were chased away; both number of intruders and chases were highest on first day territory defended (Ford 1981). On Northern Tablelands of NSW, bird observed defending group of

Apple Box *E. bridgesiana* trees; intruders, such as thornbills which were nesting nearby, were chased away (Davis & Recher 1993). In National Botanic Gardens, Canberra, territorial Wattlebirds spent significantly more time feeding at *Banksia ericifolia* inflorescences than non-territorial birds; mean time spent by territorial birds at each inflorescence, 41.8 s (24.4; 100), and non-territorial birds 24.3 s (19.1; 39) (Prendergast 1984). In New England NP, sometimes foraged in feeding territories of New Holland Honeyeaters; owner of territory either fed with intruding Wattlebird or reacted by fluttering conspicuously round intruder; Wattlebirds foraged for significantly longer in territories with tolerant owners (110 s [11; 11 territories]) than in those with fluttering owners (35 s [12; 15 territories]) (McFarland 1996). FEEDING SITES: Mostly forage at flowers of trees and shrubs, especially eucalypts, banksias and epacrids; sometimes feed at flowers and fruit of mistletoe, and eat fruit of trees and shrubs (Terrill & Rix 1944; Jenkins 1968; Keast 1968a; Ford 1977, 1979; Hopper & Burbidge 1978, 1986; Hawkeswood 1981; Ford & Paton 1982; Paton & Ford 1983; Loyn 1985c; Forde 1986; Reid 1986; Franklin & Robinson 1989; Woinarski 1989; Matthew & Carpenter 1993; McFarland 1996; Wheal 1996; Vic. Atlas). Forage less often among foliage and from bark of trunks and branches of trees and shrubs; often feed aerially, and sometimes on ground (Mellor 1924; Dickison 1935; Cleland 1952; Baldwin 1972; Loyn 1985b,c; Woinarski 1989; Osborne & Green 1992; Vic. Atlas). At Imbota NR, only recorded feeding in trees, mainly among flowers and foliage; of 155 feeding observations: 43.9% were on flowers, mainly in eucalypts, but also mistletoe; 37.4% among foliage; 3.2% on twigs; 12.3% on branches; 1.3% on trunks of trees; and 1.9% in air. At Bondi SF (n=254 feeding obs.), foraged mainly among flowers (65%), in foliage (24%), bark of branches (7%), on ground (2%) and in air (2%). In Snowy Mts, NSW, foraged mainly in shrub layer at higher altitudes during snow-free months; of 24 observations on foraging substrate, 63% were on shrubs, 29% on branches of trees and 8% among foliage of trees (Osborne & Green 1992). In detailed study in suburban Melbourne, mostly fed in eucalypts and other native plants, and less often in exotic species, in air, on ground, and on other substrates, including buildings (Green 1984, 1986). Obtain nectar from many species of plants; thought to prefer plants that produce much nectar, such as eucalypts, banksias, *Eremophila* and *Xanthorrhoea*, and tend to ignore those that provide little nectar; also thought to experience difficulty in feeding on tubular flowers in low dense shrubs such as *Epacris*, *Astroloma* and *Adenanthos* (Paton 1986). In New England NP, fed almost exclusively on nectar from *Banksia integrifolia* and *B. spinulosa*; numbers of birds at two study sites increased significantly with increasing density (no./m²) of productive inflorescences. At Imbota NR, food obtained from variety of plants, including *Eucalyptus melliodora* (34.6%), *E. blakelyi* (18.6%), *E. caliginosa* (14.7%), *E. viminalis* (12.8%), *Amyema* (12.8%), *Acacia* (1.9%) and other species (2.6%); only 1.9% obtained from air, ground or among litter. At Menai, fed on nectar and pollen from four species of Proteaceae; in pollen samples taken from foreheads and bills of 45 birds, Apr.–Aug., 87% of birds had pollen from *Banksia marginata*, 49% from *B. ericifolia*, 13% from *B. oblongifolia*, and 2% from *Grevillea*. At Golton Vale, mostly fed on honeydew and nectar, proportions of which varied seasonally: in winter, fed mostly on honeydew from beneath loose bark of Manna Gum, and less often on honeydew from Messmate, and on nectar; in spring, fed entirely on honeydew from Manna Gum; in summer, fed on both honeydew from beneath bark of Messmate and nectar; in autumn, when Yellow Gum flowering,

mostly fed on nectar, but also on honeydew and sometimes from foliage or in air. In mallee shrubland with Broombush *Melaleuca uncinata* in nw. Vic., fed among leaves and flowers of eucalypts, and not seen feeding in Broombush; of 34 feeding observations, 47% were among flowers, 41% in foliage, 3% in branches, and 9% in air (Woinarski 1989). In Mt Lofty Ras (n=498 feeding obs.), fed mainly on nectar (60%), but also on insects (40%); nectar obtained mainly from eucalypts (35%), and less often from banksias and grass-trees *Xanthorrhoea*; occasionally from tubular flowers (27%); insects were obtained mainly in air (20%), and less often gleaned from foliage (8.6%) and bark (9.3%). On Kangaroo I. (20 min of foraging obs. of 25 birds on 11 occasions), 85% of time spent feeding on insects and 15% on nectar (Keast & Condon 1968). Also on Kangaroo I., from 7200 min of observations, single bird spent 48% of time feeding; rest of time spent sitting and flying (Ford 1981). At Kendenup and Gingin, WA, select feeding plants on basis of nectar production and ease of access to nectar; when offered a choice of *Anigozanthos humilis* and *A. bicolor* and their hybrids, all of which have similar floral characteristics, birds fed at all plants without discrimination (Hopper & Burbidge 1978). Often feed on nectar in gardens, and eat soft fruits, such as peaches, figs, and plums, in orchards (Anon. 1908; White 1914; Ryan 1953; Smith *et al.* 1984; North). Recorded feeding on sap exuding from scars on Apple Box *Eucalyptus bridgesiana* trees that had been gouged by Sugar Gliders *Petaurus breviceps* (H.A. Ford). Once foraged round beehive (Mueller 1991). Sometimes feed at artificial feeding stations (e.g. Armstrong 1992). FEEDING HEIGHTS: At Imbota NR, of 155 feeding observations: 2.6% were at heights of 1–2 m; 5.2% at 3–5 m; 16.2% at 6–9 m; 48.1% at 10–14 m; and 27.9% >15 m. At Bondi SF (unknown no. of feeding obs.), fed mainly in shrub layer (0.2–4 m; 65%) but also in subcanopy (4.1–10 m; 16%), in canopy (>10 m; 17%) and occasionally on ground (0–0.2 m; 2%); mean foraging height 5.9±5.8 m. In box-ironbark forest in Rushworth SF, n. Vic., feed mostly in canopy, but sometimes in shrubs in understorey, and rarely, on ground (K.Y. Al-Dabbagh). FEEDING METHODS: Obtain nectar by probing flowers; and mostly take insects by probing bark and sallying, or less often by gleaning from bark and foliage of trees or other substrates (Mellor 1924; Ford & Paton 1977; Ford 1979; Ford *et al.* 1986). Sometimes clamber among branches, often stretching and hanging down to flowers, holding on with strong legs and claws (H.A. Ford). Sometimes sally for long distances to catch small insects (Recher & Abbott 1970). At Torquay, Vic., often forage on ground: pounce from low shrubs onto insects in sparse grass; or stand on ground searching for invertebrate prey, and when insect sighted, hop over to it and pick it from grass (J.M. Peter). When feeding on *Anigozanthos humilis*, which had flowers on short stalks, always stood on ground to feed, and moved between plants by hopping; flowers of *A. manglesii* could not be reached from ground, and bird perched on stems to feed (Hopper & Burbidge 1978). Recorded perching on back of pendent flowers of exotic *Abutilon* while feeding (McCulloch 1977). At Imbota NR, of 155 feeding observations, mainly fed by probing (47.1%) and gleaning (40.7%), and less often by sallying (12.3%), which included sally-striking (11.6%) and sally-hovering (0.7%). At Bondi SF (n=254 feeding obs.), foraged by probing flowers for nectar (65%), gleaning (or hang-gleaning) manna, lerp or insects from foliage (18%) and branches (7%), and sally-striking for insects (10%). In New England NP, mainly foraged by probing flowers for nectar and by taking insects by gleaning and sally-striking in air. Rates of feeding on both nectar and insects varied with availability of nectar. Concentrations of nectar were

categorized into three levels: low = 0.05 kJ/m², moderate = 0.5 kJ/m² and high = 3.0 kJ/m². Mean foraging rates were lowest on days when availability of nectar was high. When feeding on nectar at low concentration (n=14 birds observed), birds made 9.4 probes/inflorescence, spent 25.9 s/inflorescence, and probed inflorescences 0.36 times/s; at moderate concentration (n=15 birds) rates were 6.7, 21.3, 0.32; and at high concentration (n=19 birds) 5.4, 15.2, 0.36. Rate of feeding on insects also varied with availability of nectar: did not feed on insects when nectar at low concentration; at moderate concentration, sallied 0.06 times/min and gleaned at rate of 0.35 picks/min; and at high concentration, 0.35 and 0.25; lack of insect feeding when nectar availability low probably a result of low ambient temperature, which reduces insect activity and hence availability (McFarland 1986a). At unknown site in se. Aust., spent 62.9% of time feeding, and made 46,601 visits/day to flowers at rate of 88 visits/min, and visited individual flower 15.5 times/day (Paton 1986). **TIME-BUDGETS:** In New England NP, time budgets determined at various levels of nectar availability (low = 0.05 kJ/m², moderate = 0.5 kJ/m², high = 3.0 kJ/m²); time spent foraging decreased with increasing availability of nectar: proportion of time spent feeding when nectar levels were low was 34.3% (14.9; 3778 s of obs.; 14 birds); moderate, 21.7% (9.4; 4308 s; 15); and high 6.3% (9.7; 7125 s; 19). Based on these time-budgets, energy expenditure (kJ/bird/day) was greater in winter than in autumn, and increased as availability of nectar declined; in winter, energy expenditure 218.6 kJ/bird/day at low levels of nectar, 210.5 at moderate levels and 190.4 at high levels; in autumn, 209.5, 202.5 and 182.2 (McFarland 1986a). **FEEDING TIMES:** In Rushworth SF, Vic., begin feeding early in morning, with much activity and calling; rest and become mostly silent during middle of day, then resume foraging in late afternoon (K.Y. Al-Dabbagh). Also in Rushworth SF, diurnal foraging activity appears to have two phases: an early morning phase, characterized by high levels of nectar feeding and little insect feeding; and a second phase occupying rest of day, characterized by reduced nectar feeding and increased insectivory; switch between two phases usually occurred mid-morning (Timewell 1997). **ADAPTATIONS FOR FEEDING:** Tongue can extend beyond tip of bill far enough to probe and feed on nectar of many tubular flowers; mean length of bill 23.5 mm (measured from tip to junction of bill and skin); mean length of bill and extended tongue 44.0 mm (Paton & Ford 1977). Mean width of gape 10.1 mm (0.13; 7.5–12.5; 56) (Saunders *et al.* 1995). Strong legs, feet and claws adapted to holding on when stretching or hanging down to reach flowers (H.A. Ford). Tongue brush-tipped, which enables birds to cover greater surface area and collect nectar efficiently; one tongue measured contained 132 bristles which were, on average, 16.3 mm long and 2.7 mm wide (Paton & Collins 1989). When feeding on inflorescences of *Banksia ilicifolia*, which undergo change in colour from green to yellow to pink to red during life of flowers, birds strongly preferred foraging on yellow flowers: 98% of 84 feeding observations were on yellow flowers, though plants had 2.5 times more red flowers than yellow flowers, and 2.5 times more yellow than pink flowers (Lamont & Collins 1988). Feed from sugar-water feeders (Armstrong 1992). At Beverly Hills, NSW, when offered selection of different-coloured sugar-water in feeders, birds showed no preference for colour; but when different concentrations of sugar offered, birds selected higher concentrations (McFarland 1985b).

Detailed studies In MT LOFTY RAS and adjacent parts of MURRAY R. VALLEY (observations of plants visited for nectar at nine sites, Sept. 1973–Dec. 1975; 1 = persistent visitor, ≥10

records; 2 = persistent visitor, <10 records, with birds purposefully moving from one flower to another; 3 = casual visitor, <10 records, with bird feeding for very short time; 4 = never seen to visit, but pollen collected from birds; Paton & Ford 1977): **Plants MONOCOTYLEDONS:** Xanthorrhoeaceae: *Xanthorrhoea semiplana*¹. **DICOTYLEDONS:** Epacridaceae: *Astroloma conostephioides*³; *Brachyloma ericoides*⁴; Lorantheae: *Amyema miquelii*³; *Lysiana exocarpi*⁴; Myrtaceae: *Callistemon macropunctatus*²; *Eucalyptus cosmophylla*²; *E. diversifolia*²; *E. fasciculosa*³; *E. leucoxylon*¹; Proteaceae: *Banksia marginata*¹; *B. ornata*¹; *Grevillea ilicifolia*⁴; *G. lavandulacea*²; Rutaceae: *Correa reflexa*⁴; *C. schlechtendalii*⁴.

In s. WA (99 feeding obs. at eight most frequently visited flowers of native plants [from total of 52 species visited]; Hopper & Burbidge 1986): **Plants MONOCOTYLEDONS:** Haemodoraceae: *Anigozanthos* 16% of obs. **DICOTYLEDONS:** Myrtaceae: *Calothamnus* 1; *Eucalyptus* 34; *Melaleuca* 2; Proteaceae: *Banksia* 27; *Dryandra* 5; *Grevillea* 5; *Hakea* 5.

Other records Plants (Nectar unless stated.) Nectar^{32,94,96}; fruit^{5,6,22,32,94,96}; vegetable matter⁹⁷. **MONOCOTYLEDONS:** Agavaceae: *Agave americana*⁶⁹; *Cordylina australis* fru.⁶⁸; *Phormium tenax*⁶⁸; Haemodoraceae: *Anigozanthos bicolor*⁴⁶; *A. flavus*^{18,60,69}; *A. humilis*^{45,46}; *A. manglesi*^{8,18,27,45,46}; *A. viridis*⁸⁹; *Blancaea canescens*⁴⁹; *Macropidia fuliginosa*⁸⁹; Xanthorrhoeaceae: *Xanthorrhoea*^{11,44}; *X. drummondii*⁸; *X. preissii*^{8,89}. **DICOTYLEDONS:** Aizoaceae: *Tetragonia implexicoma* fru.⁶⁶; *T. tetragonioides* fru.⁶⁶; Araliaceae: *Schefflera actinophylla*⁶⁰; Asteraceae: *Chrysanthemoides* fru.⁹¹; Bignoniaceae: *Jacaranda mimosaeifolia*⁶⁰; *Tecomaria capensis*³¹; Chenopodiaceae: *Enchylaena tomentosa* fru.⁶⁶; Rhagodia fru.⁶⁶; Epacridaceae: *Astroloma conostephioides*^{12,88} fru.⁶⁶; *A. humifusum* fru.⁶⁶; *Leucopogon parviflorus* fru.^{66,91,104}; *Styphelia tubiflora*¹⁰⁴; Fabaceae: *Brachysema praemorsum*⁹⁰; *Clianthus dampieri*⁸; *Crotalaria laburnifolia*⁴³; *Erythrina*^{8,16,26,28,44,60,91,104}; *E. cristagalli*⁷⁷; *Memcia leakeana*⁸⁹; *Swainsona formosa*⁸; *Templetonia retusa*⁸; Lorantheae: *Amyema* fru.⁹⁷; *A. congener*¹⁰⁴; *A. miquelii* fru., nectar^{66,71}; *A. pendulum* fru.⁷¹, nectar^{71,104}; *A. quandam* fru., nectar^{71,84,104}; *Lysiana exocarpi* fru., nectar^{1,66,71}; *Nuytsia floribunda*⁵⁵; Malvaceae: *Abutilon darwinii*⁴³; *Hibiscus*¹⁰⁴; *Lagunaria patersonii*⁶⁰; Meliaceae: *Melia azedarach*⁶⁰; Mimosaceae: *Acacia ligulata* fru.⁶⁶; *A. implexa* sds¹⁰⁴; *A. melanoxydon* fru.⁶⁶; *A. sophorae* fru.⁶⁶, sds⁹¹, though possibly refers to arils attaching seeds to pod¹⁰⁰; *Paraserianthes lophantha*⁶⁰; Moraceae: *Ficus* fru.³; *F. carica* fru.⁶⁶; *F. platypoda* fru.⁶⁹; Myoporaceae: *Myoporum insulare* fru.¹⁰⁴; Myrtaceae: *Callistemon*⁶⁹; *C. citrinus*^{60,69}; *C. linearis*⁶⁹; *C. phoeniceus*⁸⁹; *C. pinifolius*⁶⁹; *C. salignus*⁶⁰; *C. subulatus*⁶⁹; *C. viminalis*^{60,104}; *Calothamnus*⁹⁰; *C. blepharospemus*⁸⁹; *C. gracilis*⁸⁹; *C. homalophyllus*⁸⁹; *C. quadrifidus*⁶⁹; *C. rupestris*⁸⁹; *Eucalyptus*^{9,11,28,95}; *E. annulata*⁸⁹; *E. blakelyi*¹⁰⁰; *E. brachyphylla*⁶⁹; *E. bridgesiana* sap¹⁰⁰; *E. caesia*^{52,60,69}; *E. caliginosa*¹⁰⁰; *E. calophylla*²²; *E. camaldulensis*^{29,47}; *E. cinerea*^{68,83}; *E. citriodora*⁶⁰; *E. cladocalyx*⁶⁰; *E. clivicola*⁸⁹; *E. cornuta*⁴⁸; *E. cosmophylla*^{28,41,74}; *E. crebra*¹⁰⁴; *E. curtisii*⁶⁹; *E. decipiens*⁸⁹; *E. densa*⁸⁹; *E. diversicolor*⁸⁹; *E. diversifolia*¹⁰; *E. eremophila*⁸⁹; *E. erythrocorys*⁸⁹; *E. eugenioides*¹⁰⁴; *E. falcata*⁸⁹; *E. ficifolia*¹⁰³; *E. flocktoniae*⁸⁹; *E. forrestiana*¹⁰³; *E. goniantha*⁸⁹; *E. gracilis*⁵⁷; *E. gratiae*⁸⁹; *E. gummifera*¹⁰⁴; *E. kruseana*⁸⁹; *E. lehmannii*^{69,90}; *E. lesouefii*⁶⁹; *E. leucoxylon*^{40,53,60,90}; *E. longicornis*⁶⁹; *E. loxophleba*⁸⁹; *E. macrandra*⁶⁹; *E. macrocarpa*⁶⁹; *E. macrocera*⁴⁸; *E. macrorhyncha*¹⁰⁴; *E. maculata*⁶⁹; *E. mannifera*⁸⁶; *E. megacarpa*⁸⁹; *E. megacornuta*⁸⁹; *E. melliodora*^{100,104} sap¹⁰⁴; *E. microcarpa*⁹³; *E. occidentalis*⁵¹; *E. orbifolia*⁸⁹; *E. perriniana*¹⁰³; *E. pileata*³⁰; *E. platycorys*⁸⁹; *E. platypus*⁸⁹; *E. polyanthemus*⁸³; *E. pulverulenta*⁶⁸; *E. punctata* sap¹⁰⁴; *E. pyriformis*⁸⁹; *E. rhodantha*⁸⁹; *E. robusta*⁹¹; *E. rudis*⁸⁹; *E. sargentii*³⁷; *E. sideroxydon*^{60,75,87,104}; *E. sporadica*⁸⁹; *E.*

stoeati^{56,89}; *E. torquata*⁸⁹; *E. transcontinentalis*⁸⁹; *E. tricarpa*^{14,21}; *E. uncinata*⁴⁸; *E. viminalis*^{69,104}; manna⁵³; *Feijoa sellowiana* lvs⁸⁰; *Kunzea pomifera* fru.⁶⁶; *Melaleuca acuminata*⁸⁹; *M. elliptica*⁶⁹; *M. halmaturorum*⁷⁴; *M. huegelii*⁸⁹; *M. hypericifolia*^{29,60}; *M. neglecta*⁷⁴; *M. radula*⁶⁹; *Syncarpia glomulifera*^{60,104}; Oleaceae: *Olea europea* fru.⁶⁴; Pittosporaceae: *Billardiera* fru.⁶⁶; *Pittosporum philliraeoides* fru.⁶⁶; Polygonaceae: *Muehlenbeckia gunnii* fru.⁶⁶; Proteaceae: *Adenanthos*³⁹; *Banksia*^{9,11,16,28,39,60,95}; *B. ashbyi*⁸⁹; *B. aspleniifolia*⁶⁰; *B. attenuata*^{54,89}; *B. baxteri*⁹⁰; *B. benthamiana*³⁸; *B. brownii*⁴⁸; *B. ericifolia*^{59,60,63,68,104}; *B. grandis*^{8,15,54,90}; *B. hookeriana*⁸⁹; *B. ilicifolia*^{73,89}; *B. integrifolia*^{60,70,91,104}; *B. littoralis*⁸⁹; *B. marginata*^{60,74}; *B. media*⁸⁹; *B. menziesii*^{8,42,54}; *B. prionotes*⁸; *B. robusta*^{60,68}; *B. serrata*^{60,91}; *B. spinulosa*^{70,79}; *Dryandra floribunda*⁸; *D. sessilis*⁶⁹; *Grevillea*^{8,17,39,60,68}; *G. banksii*⁶⁰; *G. eriostachya*^{17,69}; *G. excelsior*⁸⁹; *G. floribunda*¹⁰⁴; *G. hookeriana*⁶⁰; *G. juniperina*⁶⁰; *G. lavandulacea*⁶⁰; *G. leucopteris*⁶⁹; *G. macrostylis*⁸⁹; *G. oncogyne*⁸⁹; *G. pritzelii*⁸; *G. punicea*⁶⁰; *G. robusta*^{60,68,101}; *G. rosmarinifolia*^{60,68}; *G. tripartita*⁸⁹; *G. victoriae*⁶⁰; *Hakea bucculenta*⁶⁹; *H. francisiana*⁸⁹; *H. laurina*⁸⁹; *H. multilineata*¹⁷; *H. obtusa*⁸⁹; *H. orthorrhyncha*⁸⁹; *H. petiolaris*⁵²; *H. verrucosa*⁸⁹; *H. victoriae*⁸⁹; *Lambertia formosa*¹⁰⁴; *L. inermis*⁸⁹; *Stenocarpus sinuatus*⁶⁰; Rosaceae: *Eriobotrya japonica* fru.⁶⁶; *Malus sylvestris* fru.^{66,68}; *Prunus* fru.⁶⁶; *P. armeniaca*^{58,68,95,104}; *P. avium* fru.¹⁹; *P. domestica* fru.^{3,95}; *P. persica* fru.^{3,4,19,68}; *Pyrus communis* fru.^{60,66}; *Rubus parvifolius* fru.⁶⁸; Rubiaceae: *Coprosma lucida* fru.⁶⁶; *C. quadrifida* fru.^{78,82}; Rutaceae: *Correa*^{39,68}; *Diplolaena grandiflora*⁸⁹; Santalaceae: *Exocarpos* fru.^{66,104}; Sapindaceae: *Alectryon oleifolius* fru.⁶⁶; Solanaceae: *Lycium ferocissimum* fru.⁶⁶; *Solanum laciniatum* fru.⁵⁰; Theaceae: *Camellia*⁶⁰; Vitaceae: *Vitis vinifera* fru.^{23,66}. **Animals** SPIDERS^{15,97}. INSECTS^{9,11,32,94,95,96}. Coleoptera^{7,34,36,97,98}: Cantharidae³⁶; *Chauliognathus lugubris*⁶⁹; Carabidae⁹⁹; Chrysomelidae^{36,99}; *Paropsis*⁹⁹; Coccinellidae³⁶; Curculionidae^{97,99}; Elateridae⁹⁹; Scarabaeidae⁹⁹; *Anoplognathus*⁹⁹; *Diphucephala*²; *Liparetrus*⁹⁷; Tenebrionidae⁹⁹; Diptera¹⁰⁴: Cecidomyiidae⁹⁷; Stratiomyidae⁶⁷; Hemiptera^{36,97}: Cicadidae^{92,99}; *Psaltodea moerens*⁶⁹; Cercopidae⁹⁷; Eriococcidae: honeydew⁵³; Psyllidae: lerp, honeydew^{33,99,104}; *Glycaspis fuscovena* lerp⁷⁶; Hymenoptera: wasps^{97,104}; Apidae: *Apis mellifera*⁸⁰; Formicidae^{36,97,99}; *Camponotus*^{35,99}; *Iridomyrmex*^{35,97}; *I. purpureus*⁹⁷; *Pheidole*⁶⁸; Ichneumonidae⁹⁹; Pergidae: *Perga* larv.²⁴; Sphecidae: *Sphex*⁹⁷; Vespidae¹⁰; Isoptera³⁵; Lepidoptera: ads⁹⁹, larv.^{36,43}; Hesperidae: *Cephrenes augiades*⁷²; Noctuidae: *Agrotis infusa*⁶⁸; Pieridae: *Pieris rapae*⁶⁹; Mantodea: Mantidae⁹⁹; Orthoptera³⁴; Acrididae⁹⁹; Tettigoniidae⁹⁹; Phasmatodea⁶²; Phasmatidae: *Didymuria violescens*²⁵. REPTILES: Scincidae⁵⁰. BIRDS: Yellow-rumped Thornbill *Acanthiza chrysorrhoa* eggs, nestlings⁶⁵. **Other matter** Sugar water, including soft drink^{70,81,102}; pieces of meat⁶¹; minced beef¹⁰⁵; kangaroo mince¹⁰⁶; bread¹⁰¹.

REFERENCES: Cleland¹ 1906; ² 1911; ³ Anon 1908; ⁴ White 1914; ⁵ Morgan 1919; ⁶ Norton 1922; ⁷ Morgan *et al.* 1926; ⁸ Sargent 1928; ⁹ Dickison 1935; ¹⁰ McKeown 1936; ¹¹ Hindwood 1944; ¹² Terrill & Rix 1944; ¹³ Rix 1945; ¹⁴ Ipsen 1947; ¹⁵ Elliot 1948; ¹⁶ Serventy 1948; ¹⁷ Sedgwick¹⁷ 1949b; ¹⁸ 1969; ¹⁹ Ryan 1953; ²⁰ Wakefield 1956; ²¹ 1958; ²² Robinson 1960; ²³ McEvey 1965; ²⁴ Quinn 1965; ²⁵ Readshaw 1965; ²⁶ McGill 1967; ²⁷ Jenkins 1968; ²⁸ Keast²⁸ 1968a; ²⁹ 1968b; ³⁰ Keast & Condon 1968; ³¹ Arthur & Arthur 1971; ³² Officer 1971; ³³ Baldwin 1972; ³⁴ Matthiessen 1973; ³⁵ Rose³⁵ 1974; ³⁶ 1999; ³⁷ Dell³⁷ 1976; ³⁸ 1979; ³⁹ Ford³⁹ 1976; ⁴⁰ 1979; ⁴¹ 1981; ⁴² Dell & Johnstone 1977; ⁴³ McCulloch 1977; ⁴⁴ Parker 1977; ⁴⁵ Hopper & Burbidge⁴⁵ 1978; ⁴⁶ 1986; ⁴⁷ Reid 1978; ⁴⁸ Keighery⁴⁸ 1979; ⁴⁹ 1980; ⁵⁰ 1984; ⁵¹ Hopper⁵¹ 1980; ⁵² 1981; ⁵³ Paton 1980; ⁵⁴ Whelan & Burbidge 1980; ⁵⁵ Hawkeswood 1981; ⁵⁶ Hopper & Moran 1981; ⁵⁷ Hopper & Burbidge 1982; ⁵⁸ Paton & Reid 1983; ⁵⁹ Prendergast 1984; ⁶⁰ Smith *et al.* 1984; ⁶¹ Kroger 1985; ⁶² Loyn 1985a; ⁶³ Paton *et al.* 1985; ⁶⁴ 1988; ⁶⁵ Brown & Brown 1986; ⁶⁶ Forde 1986; ⁶⁷ Lepschi⁶⁷ 1986; ⁶⁸ 1993; ⁶⁹ 1997; ⁷⁰ McFarland 1986b; ⁷¹ Reid 1986; ⁷² Hutchison 1988; ⁷³ Lamont & Collins 1988; ⁷⁴ Baxter 1989; ⁷⁵ Franklin & Robinson 1989; ⁷⁶ Woinarski *et al.* 1989; ⁷⁷ Browne 1990; ⁷⁸ French 1990; ⁷⁹ Vaughton

1990; ⁸⁰ Mueller 1991; ⁸¹ Armstrong 1992; ⁸² French *et al.* 1992; ⁸³ Lindenmayer 1993; ⁸⁴ Matthew & Carpenter 1993; ⁸⁵ Saunders 1993; ⁸⁶ Leonard 1995; ⁸⁷ Bounds *et al.* 1996; ⁸⁸ Wheal 1996; ⁸⁹ Brown *et al.* 1997; ⁹⁰ Comer 1997; ⁹¹ Gosper⁹¹ 1999a; ⁹² 1999b; ⁹³ Peter & Weston 1999; ⁹⁴ Gould; ⁹⁵ North; ⁹⁶ Hall; ⁹⁷ Lea & Gray; ⁹⁸ Hall; ⁹⁹ FAB; ¹⁰⁰ H.A. Ford; ¹⁰¹ R.K. Hicks; ¹⁰² D.C. McFarland; ¹⁰³ J.M. Peter; ¹⁰⁴ A.S.J. Saunders; ¹⁰⁵ R. Wilson; ¹⁰⁶ J. Zimmerman & A. Clough.

Young Fed on following items: Manna. INSECTS: Coleoptera; Diptera; Hemiptera: Cicadidae; Odonata; Phasmatodea (H.A. Ford).

Intake In Mt Lofty Ras, estimated feeding rate on flowers of Cup Gum *E. cosmophylla* was 35 flowers/min (n=850 flowers visited) with each flower estimated to contain 48.5 J (19.6–163.2); and on Yellow Gum, 49 flowers/min (n=320), each containing 34.3 J (19.2–44.8); based on these data, birds would require 585.7 J/min to satisfy daily energy requirements (Ford 1979). On Kangaroo I., total daily energy requirements estimated at 176 kJ/day, of which 74 kJ/day expended in feeding; visited mean of 35 flowers/min (n=857 flowers), and, in one feeding territory containing 760 flowers of Cup Gum, one bird made 16 visits to each flower, and is estimated to have collected 195 kJ/day (Ford 1981). At Healesville, Vic., mean of 91±36 seeds of *Coprosma quadrifida* collected from faeces of three adult birds (French 1990); seeds originated from fleshy fruit consumed (H.A. Ford).

SOCIAL ORGANIZATION Nothing known of most aspects; some information on feeding territories (e.g. Ford & Paton 1982; Ford & Debus 1994), including that of single bird in May–June on Kangaroo I., SA (Ford 1981). No detailed studies of banded birds while breeding. Gregarious; seen singly, in pairs, small flocks or larger concentrations (e.g. Bedgood 1973; Marchant 1979; McFarland 1986b; Baxter 1989; Carter 1996; Storr 26, 27, 28). Usually in pairs or small parties (Browne 1990; Gould; Mathews), at least some of which are family parties (Talmage 1993; NRS). In New England NP, n.e. NSW, c. 65% of 449 observations over 2.5 years were of flocks of 2–5; rest occurred, nearly equally, singly or in groups of 6–10 (McFarland 1986b). At Ararat, Vic., arrived in flocks of 12–20, bred, again formed flocks and then left (Hill 1907). On Kangaroo I., SA, birds flock after breeding, and over autumn–winter occur in large loose flocks of up to 100–200 on coast and in smaller flocks inland (Baxter 1989); in coastal NSW, usually appear in large flocks in Apr.–May (North); in ACT, seen in flocks of 10–20+ in Feb.–May (COG 1997); in Vic., at Geelong, Feb.–Mar., in groups of 10–20 (Belcher 1914), round Torquay, Apr.–May, in flocks of up to 60 (J.M. Peter) and at Wilsons Prom., in small flocks in winter (Cooper 1975); in WA, from summer to early winter, sometimes in flocks of up to 100 (Storr 27, 28, 35). Largest flocks occur in areas with abundant food, particularly nectar, e.g. in sw. WA, flocks of up to thousands reported (Carter 1924) and large numbers gather at flowering banksias in winter (Mathews). Usually travel in small to large flocks (e.g. Officer 1971; Vic. Bird Rep. 1986), e.g. of up to 15–30 in WA (Heron 1970; Serventy & Whittell) once with c. 100 passing overhead in a few minutes (Heron 1970); of 5–150 in NSW (Marchant 1979; NSW Bird Reps 1992, 1994). Once, in late May–early June round Sydney, mobile flocks of c. 20 birds gathered for short periods in Smooth-barked Angophora *Angophora costata* forest, at one time reaching 300+ before birds moved on (Bell 1964). Migrating flocks occasionally associated with other migrating honeyeaters, such as Noisy Friarbirds (Vic. Bird Rep. 1986) and White-naped and Yellow-faced Honeyeaters (Watson 1955). Birds defend resources singly or in

pairs (Browne 1990; Ford 1981; Davis & Recher 1993; Ford & Debus 1994) but not as group (Browne 1990), though once 4–5 birds appeared to act in concert against intruding Regent Honeyeater *Xanthomyza phrygia* (Leonard 1995). Sometimes attack predators as group (Jurisevic & Sanderson 1994b). Recorded feeding alongside or associating with many other species of birds, e.g. Satin Bowerbirds, Pied Currawongs, Crimson Rosellas (McFarland 1984), Noisy and Little Friarbirds (Favaloro 1931) and Little (Belcher 1914; O'Grady & Lindsey 1979) and Western Wattlebirds (Carter 1924) (also see Agonistic behaviour).

Bonds No information. Generally nest as solitary pairs (Ley & Williams 1994; NRS; see Breeding). In Geelong, Vic., often paired by end of July, and nesting mid-Aug. (Belcher 1914); near Armidale, NSW, copulation seen mid-Aug. and once round time when nest being built, in mid-Sept. (NRS). Apparent co-operative breeding occasionally recorded, with immatures, possibly young of previous clutch, as well as adults feeding begging fledgelings; these immatures often said to have small or no wattles (Talmage 1993; NRS). **Parental care** Both sexes build nest but sometimes male stands by while female builds; probably only female incubates and broods; both sexes defend nest and feed nestlings (NRS) and fledgelings (Talmage 1993; NRS). After fledging, young of one brood fed themselves, at least sometimes, after c. 2–3 weeks; after c. 27 days, young fed themselves in company of adults in nest area (NRS); after 38 days, young of another brood still fed some food, though parents nesting again (Talmage 1993). Elsewhere noted that parents, which were re-nesting, continued to feed young of previous brood (NRS). When independent, young sometimes still beg when near parents, and either tolerated or repelled by parents (NRS); after 63 days, one young was tolerated in parents' territory even though it was developing wattles (Talmage 1993); birds with small or no wattles seen beside adults, helping to feed juveniles (Talmage 1993; NRS). Young of first brood still foraged together even after second brood had fledged (NRS). Once, two adults seen feeding two begging young of different ages perched side by side (Talmage 1993).

Breeding dispersion Nest as simple solitary pairs (Ley & Williams 1994; NRS). Near Armidale, c. 20 pairs bred in 240 ha (Ford & Debus 1994). At three sites in Canberra: 18 breeding territories in 197.2 ha, seven in 74.5 ha, and eight in 35.7 ha (Lenz 1990). In Boola Boola SF, Vic., 22 territories/km² (Loyn 1980). At Kamarooka State Park, Vic., seven nests near each other, some being roughly 25–100 m apart, and all within c. 800 m (NRS). Sometimes nest within 50 m ($n \geq 11$) (NRS). Claim of six nests in one large tree, but not known if all were occupied (North); old nests sometimes survive for some time. Same nesting sites sometimes used in consecutive years, and new nests occasionally built a few metres from unsuccessful nests (NRS), but not known if by same birds. Claimed that studies of nesting sites show that smaller species tend not to nest nearby (Longmore), but confirmation needed. **Territories** Chase many species of birds away from nests or food sources. Nesting territories 50–200 m in diameter at Inverell, n. NSW (Baldwin 1973). Not all nesting territories have nectar source; Wattlebirds do most, if not all, feeding within territory (H.A. Ford). **FEEDING TERRITORIES:** Strongly defend sources of nectar in feeding territories (e.g. flowers in trees and shrubs) from other nectar-feeding birds, including conspecifics without territories (e.g. Bruce 1973; Ford 1981; Prendergast 1984; Woinarski 1984; Mathews); also defended bark of Messmate (which probably contained honeydew) for part of each day on several consecutive days (Paton 1980); and artificial feeders (Armstrong

1992). Size of territories and number of territorial encounters vary with number of flowers on plant: on Kangaroo I., SA, over 9 days, one feeding territory decreased in size by two-thirds and had fewer intruders, as more flowers bloomed on Cup Gum *Eucalyptus cosmophylla*; at first, bird tried to defend entire tree and chased many intruders, successfully removing only about one-third of those chased; and later spent much time in smaller territory, with fewer trespassers and fewer chases (all successful), and with several honeyeaters feeding outside territory in same tree but without harassment. Daily energy requirements of this bird closely approximated daily production from nectar in smaller territory (Ford 1981). Near Cranbourne, Vic., some defended territories that supplied more energy than they needed (Paton 1979). In open parkland at Macquarie University, NSW, pairs or small loose groups moved round within distinct, established territories, each consisting of a clump of eucalypts; birds flew up to 400 m from territories to feed at a Coral Tree *Erythrina crista-galli* which seemed to be a shared feeding area (Browne 1990). It was, however, not made clear if territories were breeding or feeding territories. In New England NP, NSW, considered not to hold feeding territories, probably because considerable daily variation in production of nectar in area made it energetically uneconomical (McFarland 1996). For species of birds chased or excluded at feeding areas, and for rates of aggressive interactions at feeding sites, see Agonistic behaviour.

Roosting In Armidale SF, NSW, numbers roosted in trees along a stream (Debus 1983). On Kangaroo I., SA, May–June, birds seen feeding 25 min before sunrise (Ford 1981). During breeding season, call from dawn till dark (Mathews). Fledgelings seen roosting near nest-tree (NRS). Spend some time perching during daylight (see McFarland 1986a). In SA, when returning to roost in evening, always follow one another from tree to tree and take same route (Crompton 1915).

SOCIAL BEHAVIOUR Little published other than some information on aggressive behaviour, e.g. at artificial feeding sites (McFarland 1983, 1985b); aggressive behaviour quantified in woodland near Armidale, NSW, 1990–93 (Ford & Debus 1994). Large, noisy and active; one of the most conspicuous honeyeaters (e.g. Baxter 1989). Considered by some to be shy and wary (e.g. Chandler 1913; Gould; Campbell; Mathews); said to be quiet and secretive during post-breeding moult (Clarke 1967) and in breeding season (H.A. Ford). Claimed that flocks usually silent while migrating or moving (Longmore). Flocks feeding together call much (Officer 1971). At communal gatherings or while foraging in pairs or alone, birds use a variety of calls (Jurisevic & Sanderson 1994b); when calling, bird throws head up and back and moves body with violent jerk (Mathews); Cackles heard most often in spring (Jurisevic & Sanderson 1994b). Said to have display-flight (Boles & Longmore 1985). **FOLIAGE BATHING:** For some minutes, bird flies and flops back and forth in wet foliage of trees, shaking body, fluffing feathers and ducking head as though bathing; then flies to branch and preens or flies away (Morris 1976; Hubregtse 1987; Beasley 1992). Once, bird seen to behave similarly in dry foliage of flowering Sweet Pittosporum *Pittosporum undulatum*, doing so with feet tucked up and bill clacking (Sherlock 1990). Also seen bathing under garden sprinkler (NRS). For time budgets of birds at feeding sites, see Food.

Agonistic behaviour Aggressive (Jurisevic & Sanderson 1994b). Birds give special Agonistic Call during interactions with conspecifics or other honeyeaters. Cackles sometimes

given by males during territorial encounters (Jurisevic & Sanderson 1994b). Other aggressive behaviours directed at conspecifics and other species include: aggressor flies towards another bird which then departs. **DISPLACEMENT** may then occur where aggressor lands on vacated perch of departed bird. More often, **CHASING AND FIGHTING** occurs, with aggressor chasing other bird for some distance, often out of sight, occasionally snapping at victim's tail or back with its bill, or even grasping victim with its claws. Occasionally birds interlock and tumble to ground with feathers flying; this typically involves conspecifics or other large species of honeyeaters (McFarland 1985a,b; Ford & Debus 1994). At artificial feeding stations, in presence of larger conspecifics, smaller birds appear to obtain access to food by adopting **APPEASEMENT POSTURE** (Fig. 1):

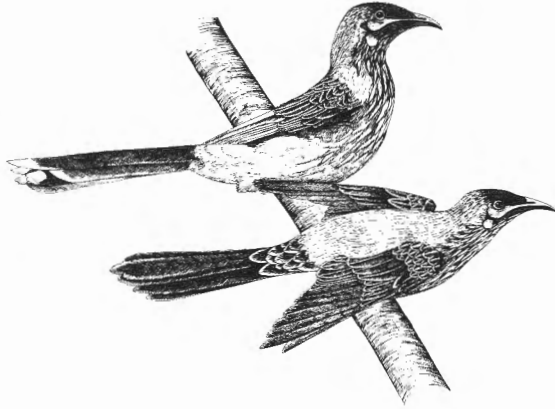


Figure 1 Appeasement Posture (Source: McFarland 1983)

standing side-on to large bird, small bird lowers head and squats low with body-plumage appearing sleek, and with bill held horizontally; in this pose, flutters wings, holding wings away from body and moving tips of wings up and down by twisting and rotating innerwing; then sidles along branch towards larger bird; display lasts 20–40 s and sometimes results in larger bird flying away. At artificial feeding stations, after fighting, loser left feeding area, but loser of displacements and Appeasement Displays sometimes moved to poorer nearby feeding site (McFarland 1983, 1985b). Wattlebirds sometimes also chase other species from preferred feeding sites, but not out of area (Bruce 1973). **RATES OF AGGRESSION:** Near Armidale, NSW, birds spent only 1.8% of time in aggressive activities; away from nests, chased 7.7 birds/h; at one flowering Silky Oak *Grevillea robusta*, often filled with many Wattlebirds and Noisy Friarbirds, chased 6.1 birds/h (Ford & Debus 1994). In forest with banksia understorey, spent 0.4–2.1% of time in aggression (McFarland 1986b); one Wattlebird, holding territory in flowering tree, chased 37 birds/h (Ford 1981). Attack many species of birds. In New England NP, NSW, aggression often directed at conspecifics rather than at other species of honeyeaters (McFarland 1986b). In one study near Armidale, Wattlebirds attacked 20 species of birds away from nest (see Ford & Debus [1994] for complete list): 29% of 199 attacks were against conspecifics, 34% on other large honeyeaters (20% Noisy Miners *Manorina melanocephala*, 13% Noisy Friarbirds, 1% other), 19% on potential predators, and 18% on other species. Near nests, attacked 20 species of birds: 19% of 252 attacks were against conspecifics, 30% on other large honeyeaters (15% Noisy Friarbirds, 15% Noisy Miners) and 41% on other species (e.g. 11% rosellas *Platycercus*), often smaller species (e.g. 17% Fuscous Honeyeater *Lichenostomus fuscus*); the rest were against potential predators

(see below). Both near and away from nest, only five species showed aggression towards Wattlebird; small insectivorous birds were only occasionally chased (Ford & Debus 1994). When feeding with Noisy Friarbirds at sources of abundant food, interspecific aggression observed only when density of flowers was low and supply of nectar restricted (Saunders 1993); but frequent aggression between the species observed at prolifically flowering Silky Oak (Ford & Debus 1994). In other areas, Wattlebirds sometimes have greater impact on small birds (Woinarski 1984; Davis & Recher 1993). In New England NP, Wattlebirds were the largest and most dominant of all honeyeaters present (McFarland 1986b); usually the aggressor in interactions with other large honeyeaters, though sometimes chased by Noisy Friarbirds and Noisy Miners and, at one flowering tree, Friarbirds chased Wattlebirds twice as often as Wattlebirds chased Friarbirds; when Friarbirds and Wattlebirds bred near each other, Wattlebirds appeared dominant, e.g. one male Wattlebird chased a breeding female Friarbird, and then landed near the male Friarbird, faced him and called; then pair of Wattlebirds inspected the Friarbird nest, with little response from male Friarbird; eventually Friarbirds moved, building new nest c. 60 m farther away from Wattlebird territory (Ford & Debus 1994). At other places, Friarbirds seem dominant over Wattlebirds. However, at some sites where nectar abundant, aggression between the two species is reduced and they feed amicably as close as 0.5 m apart, though remain aggressive to conspecifics and other species (Saunders 1993). Other notes on dominance of Red Wattlebirds relative to other species of birds include: on Kangaroo I., SA, dominant over Silvereyes *Zosterops lateralis*, Eastern Spinebills *Acanthorhynchus tenuirostris*, and New Holland, Purple-gaped *Lichenostomus cratitius*, Crescent *P. pyrroptera* and Brown-headed *Melithreptus brevirostris* Honeyeaters (Ford 1981; Ford & Paton 1982). In New England NP, intruded on feeding territories of New Holland Honeyeaters but not expelled; owner sometimes used a flitting behaviour to interfere with Wattlebird's feeding, which sometimes resulted in Wattlebird chasing the owner from territory and not returning (McFarland 1996). Red Wattlebirds occasionally chase single or small groups of Little Wattlebirds (Browne 1990; Officer 1991), but avoid areas defended by larger numbers of Little Wattlebirds (Browne 1990; see Little Wattlebird account). Although chase Regent Honeyeaters (Leonard 1995), once Wattlebird left food source when faced with Regent which mimicked Wattlebird-type call (Veerman 1994). At an artificial feeding station, Rainbow Lorikeets dominant over Red Wattlebirds (Carter 1996); elsewhere, Wattlebirds chase Rainbow Lorikeets and Scaly-breasted Lorikeets *Trichoglossus chlorolepidotus* from preferred sites, but not from area, as each species seems to use different parts of flowering trees (Bruce 1973); on Kangaroo I., did not chase Rainbow Lorikeets (Ford 1981). Others have recorded Red Wattlebirds being aggressive in feeding areas, e.g. chasing or excluding conspecifics, New Holland Honeyeaters, Lewin's Honeyeaters *Meliphaga lewinii*, Eastern Spinebills (McFarland 1985a), Striated Thornbills *Acanthiza lineata* (Woinarski 1984; Davis & Recher 1993), Spotted Pardalotes *Pardalotus punctatus* (Bruce 1973; Woinarski 1984), Striated Pardalotes *P. striatus* (Woinarski 1984) and Purple-crowned Lorikeets (Hopper 1980). Once Wattlebirds seen chasing and attacking Gang-Gang Cockatoos *Callocephalon fimbriatum*, and Gang-gangs knocked Wattlebirds from perches (Collins & Collins 1981). **Alarm** Sometimes mob predators, giving Alarm Calls as they do so; some Alarm Calls attract conspecifics as well as other species, e.g. Australian Magpies *Gymnorhina tibicen* (Whittell 1933; Jurisevic & Sanderson

1994b). At Armidale, away from nest-site, seen to chase potential predators: Collared Sparrowhawk *Accipiter cirrocephalus*, Black-faced Cuckoo-shrike *Coracina novaehollandiae*, Olive-backed Oriole *Oriolus sagittatus*, Australian Magpie, Pied Currawong and raven *Corvus*; probably only Collared Sparrowhawk presented any threat to adults, and birds were probably chasing potential nest-predators, even when they were not near their nests, or potential competitors for food (Ford & Debus 1994). Elsewhere seen attacking Laughing Kookaburras *Dacelo novaeguineae*, Australian Magpies, currawongs *Strepera*, butcherbirds *Cracticus*, Common Mynas *Acridotheres tristis* and ravens (Collins & Collins 1981; Buchanan 1987; D.C. McFarland); Dogs (Buchanan 1987); and a Cat (Whitell 1933); also see Buchanan (1987) for examples of aggression towards other species which are neither potential predators nor competitors. One bird gave Cackle after chasing Grey Currawong *Strepera versicolor* (Jurisevic & Sanderson 1994b). Seen attacking a Common Ringtail Possum *Pseudocheirus peregrinus* with no indication of nest nearby (Appleby 1992). When adults handled, give Distress Call and flap or peck (Jurisevic & Sanderson 1994b); and insert sharp claws into fingers (H.A. Ford; J.R. Starks). Often fly as person approaches the tree they are in (North). Also see Parental anti-predator strategies.

Sexual behaviour Some chasing in breeding season involves courtship. Larger male chases smaller female, often snapping at her tail; females often have quite ragged tails by end of breeding season (Ford & Debus 1994). At one nest, both birds were chattering, then chased each other in synchronized flight (NRS). Whistle Call often given by female in reply to Cackle calls of male; this calling usually occurs when one bird joins another at a foraging site (Jurisevic & Sanderson 1994b). During breeding season, antiphonal calling between birds reported with larger, probably male, bird giving raucous call and smaller, probably female, bird replying with clucking (NRS). Claimed, without evidence, that pair-bond maintained by duetting between male and female (Aust. RD). One male Wattlebird, which had been chasing nesting Noisy Friarbirds, called and was joined by female that had lost nearby nest; pair duetted, then inspected Friarbird nest (Ford & Debus 1994). **Copulation** Once, when Appeasement Display was given by small bird, larger bird tried unsuccessfully to copulate, then flew away (McFarland 1983). Copulation once took place high in tree c. 20 m from nest (NRS).

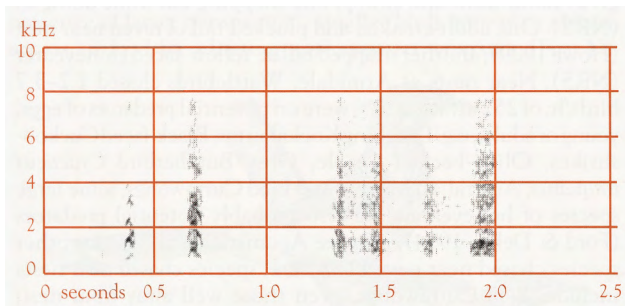
Relations within family groups Some adults heard to give quiet clucking call while approaching nest with food or when about to feed young. Nestlings make small squeaky Begging Calls (NRS). Fledgelings beg for food; sit beside each other waiting to be fed, usually in cover (Talmage 1993; NRS), or flutter through trees following adults. Family seen bathing together near nest. Young of first brood sometimes still forage together when second brood fledged, but may show aggression to each other or young of second brood (NRS). **Anti-predator responses of young** If disturbed, older nestlings may fly from nest (NRS), sometimes to ground (Dove 1911). Occasionally fledgelings are hidden in vegetation; one found perched c. 6 m from nest, c. 1 m above ground; and gave croaking Alarm Calls if approached too closely (NRS). **Parental anti-predator strategies** (Most behaviours below recorded in response to people near nest.) Aggressive, with vocal defence, usually Alarm Call (see Voice) by both adults. Bird on nest (i.e. female) may flush, but sometimes stays on nest (may flatten in nest) while other (i.e. male) defends nest; one sitting bird was swooped by currawongs but did not leave nest. After distur-

bance, adult sometimes slips unobtrusively back to nest (NRS). At one nest, adult male very aggressive on day young hatched. Sometimes nestlings left unattended (NRS). **DISTRACTION DISPLAYS** given on ground: bird runs with open wings or races at intruder giving Alarm Calls (North); flutters (NRS); feigns injury for short periods, occasionally moving back to branches and calling (Dove 1911; Mathews). Will dive and swoop while calling (NRS) and peck at people that are banding nestlings and fledgelings (Ford & Debus 1994). Some birds with young just perch near nest (NRS). Adults still attack after young fledged; in response to Alarm Calls of fledgelings, adults may give Alarm Calls and swoop, one snapping bill while doing so (NRS). One adult croaked and plucked tail of raven near nest (Howe 1909); another snapped bill at Yellow-faced Honeyeater (NRS). Near nests at Armidale, Wattlebirds chased 1.2–3.7 birds/h; of 252 attacks, 10% were on potential predators of eggs, young or adults, e.g. Laughing Kookaburras, Black-faced Cuckoo-shrikes, Olive-backed Oriole, Grey Butcherbird *Cracticus torquatus*, Australian Magpie and Pied Currawongs; some large species of honeyeaters are also probably potential predators (Ford & Debus 1994); also see Agonistic behaviour for other species chased near nest. Elsewhere, species chased near nests include: Pied Currawongs, even those well away from nest; Australian Magpies, Laughing Kookaburras, other honeyeaters (such as White-plumed *Lichenostomus penicillatus* or Yellow-faced Honeyeaters), Swift Parrots *Lathamus discolor* feeding in nest-tree; and a Cat (NRS).

VOICE Reasonably well known. Studies of repertoire near Adelaide (Jurisevic & Sanderson 1994b), and of alarm calls (Jurisevic & Sanderson 1994a), including sonagrams of many calls. Account based on Jurisevic & Sanderson (1994b) unless otherwise stated. Noisy; calls loud, harsh and varied; utter single guttural croaks and other loud harsh calls (Hall), described as raucous rattling notes and persistent raucous squawks (Gilbert 1923; Barry 1928). In breeding season in nw. Vic., their harsh and raucous calls said to dominate all others (Favaloro 1966). The chorus of voices of a large flock is audible for a considerable distance (Mathews), and much noise is made by feeding flocks (Officer 1971). There was continuous noisy squabbling at a flowering tree where there were up to five Wattlebirds and up to 20 Noisy Friarbirds (Ford & Debus 1994), though most of noise was made by Friarbirds (H.A. Ford). Calls heard during all seasons but most often in spring, and especially when feeding (Frith 1969). During breeding season, call from dawn till dark (Mathews), but may be rather quiet (1–2 calls/h) when incubating or feeding young (H.A. Ford). Cackle uttered throughout year, mostly in spring. Often call when flying from tree to tree (North), and sometimes call when swooping aggressively (NRS). Said that usually silent when travelling in flocks, giving soft calls when pausing on the limbs of tall trees (Longmore) but confirmation needed. Cackles are made by the male. When members of pair meet at foraging site where there are other birds, female often gives Whistle Call in reply to Cackle of male. Male and female may duet, female giving Whistle Call while male gives Cackle (Ford & Debus 1994). Another observer reports antiphonal calling, with raucous calls given by larger bird and clucking by smaller bird (NRS). **NON-VOCAL SOUNDS:** Bill-snapping sometimes accompanies swooping of person approaching young, and may be employed against other species (Prendergast 1987; NRS); also while bathing (Sherlock 1990); claimed that often precedes a duet (Aust. RD).

Adult CACKLE: Loud raucous notes of a wide frequency range (sonagram A) with energy concentrated between 1 and

3 kHz, and which carry well. In most, the final note is emphasized (as in sonagram A). A fairly long note, followed by two shorter ones is common (Frith 1969). Described as loud hiccupping, gurgling notes, and as guttural sounds (Carter 1924; North), hacking cough (Pizzey & Knight 1997) or coughing squawk (H.A. Ford). Phonetic renderings include *yak*, *yaak*, *yakyak* and *yakayak* (Pizzey & Knight 1997). When uttered Cackle, head is thrown up and far back, and body moved by a violent jerk (Mathews). Given by birds foraging alone, during communal gatherings or territorial encounters. Once given after chasing Grey Currawong from tree. Often heard (Mathews).



A D.A. Stewart; Pilliga NR, NSW, Aug. 1991; M13–17

WHISTLE CALL: Varying series of single whistled notes *pleu*, *pleu*, *pleu...* or *tew-tew-tew-tew*, repeated in quick succession, 3–4 times/s. A common call. Usually given by female (H.A. Ford). Pleasant melodious call of ‘five short quick round notes ascending about three notes on the scale’ (Smedley 1979), though notes may not ascend (H.A. Ford), given when stretched almost upright, with bill open and throat throbbing with each note (Smedley 1979), probably this call. **SINGLE NOTE:** A varying, emphatic single note, which carries well. Some sound like *cook*, *chock* or *quok*, and have 4–5 harmonics, while others are harsh and raucous with little harmonic structure. Deep guttural single note (Mathews), probably describes the latter type. Thought to be a contact call. Also common call (Mathews). **ALARM CALLS:** Narrow and broad-band alarm calls are used alternately when mobbing (Jurisevic & Sanderson 1994a). The narrow-band calls are a rapid succession of low-pitched pulses, with a narrow frequency range (1.1–2.2 kHz) and intervals between pulses of 75–100 ms. The broad-band calls are loud, harsh and rasping, lasting 140–330 ms, with a wide frequency range (1.3–5.9 kHz), and most energy concentrated in the low frequencies. When given while mobbing a predator, it attracts both conspecifics and other species, e.g. Australian Magpie. Both harsh croaks uttered when chasing a corvid (Howe 1909). Single *quok* calls given when perched after each of a number of dives at a domestic Cat (Whittell 1933; see Single Note, above), possibly refer to this call. **DISTRESS CALL:** Harsh calls are given when handled, and are usually accompanied by wing-flapping or pecking or both, which continue for as long as the bird is handled. Harsh grating calls during Distraction Display near nest (North), and when photographer approached nestlings (Dove 1911), may be this call or Alarm Call (see above). **AGONISTIC CALL:** A harsh call lasting 150–400 ms, with most energy between 1.5 and 7.0 kHz. Similar to the broad-band Alarm Call. Given during encounters with birds of own and other species. **Other calls** When flying from tree to tree a short *kwok*, *kwok*, *kwok* is often uttered (North). At one nest, both members of pair chattered before chasing each other in synchronized flight (NRS). Soft clucking call sometimes given

when approaching nest with food, or when about to feed young (NRS; H.A. Ford).

Young Nestlings and fledgelings make squeaking Begging Calls, sometimes loudly (NRS; H.A. Ford); sound very similar to fledgelings of Regent Honeyeater (A.S.J. Saunders); fledgelings give croaky Alarm Calls if approached (NRS). Dependent juvenile gives buzzing *zeep*. No other information.

BREEDING Reasonably well known; detailed study of 97 nests over eight seasons (1990–98) in Imbota NR, near Armidale, ne. NSW (Ford 1999; Ford & Trémont 2000); construction and materials of one nest recorded in detail by Baldwin (1973); 746 records available for analysis in NRS to Dec. 1996. Usually nest solitary (NRS), though occasionally breed communally (Talmage 1993); twice, group nesting has been observed (North; NRS). Nests of other species sometimes nearby (NRS).

Season Breed late May to late Mar.; eggs, late May–Jan., most (66%, n=199), early Sept. to early Nov. QLD: Breed Sept.–Nov. (Storr 19; Aust. Atlas); single Aust. Atlas record of breeding Dec.–Feb. (Aust. Atlas). NSW: Eggs, July–Dec., most (68%, n=22) mid-Sept. to early Nov. (Morris *et al.* 1981; NRS); fledgelings Aug.–Feb. (NRS); at Imbota NR, first eggs, Aug.; last fledgelings, Feb.; 90% (n=105) of nests, Sept.–Nov. (H.A. Ford); in Cobbora district, eggs 22 Aug.–19 Oct. (Austin 1918). ACT: Breed mid-Aug. to mid-Mar.; eggs, mid-Aug. to mid-Dec., mostly (71%, n=21) late Oct. to mid-Dec. (I. Taylor 1987; NRS); fledgelings, Sept.–Feb. VIC: Eggs, mid-July to mid-Jan., most (87%, n=93) mid-Aug. to early Nov.; fledgelings, June–Mar. (NRS). SA: Breed May–Jan. (Ford 1980; NRS). Eggs, May, July–Dec., most (69%, n=32) late Aug. to late Oct. (NRS). Near Adelaide, in Mt Lofty Ras and Murray–Mallee, breeding recorded May–Jan. (11 records in May, 3 in June, 6 in July, 11 in Aug., 19 in Sept., 8 in Oct., 1 in Nov., 3 in Dec. and 2 in Jan.; Ford 1980). WA: Eggs, July–Nov., most (73%, n=30) early Aug. to early Oct.; young, June–Jan. (NRS).

Site Mostly nest in tall shrubs or trees, such as eucalypts (including saplings and older trees), casuarinas, native pines, banksias, paperbarks and acacias (Hill 1907; Dove 1911; Sutton 1927, 1928a; Ashby 1930; Lashmar 1937; Rix 1943, 1976; Serventy 1958; Bell 1964; Gannon 1966; Heron 1973; Ford 1999; Vic. Atlas; NRS). Usually in live plant, though sometimes in dead section of live plant; often near plants in flower (NRS); sometimes well hidden in prickly shrubs, bushy trees, saplings (Campbell; NRS). Of 210 records in NRS, c. 60% in eucalypts, 10% in acacias, 6% in banksias, 4% in Turpentine *Syncarpia glomulifera*, 3% in casuarinas, 3% in paperbarks and 3% in pines *Pinus*. Sometimes nest in mistletoe (Cleland 1906; Dove 1911; Baldwin 1973; Bedgood 1973; Rix 1976; Campbell, e.g. in Imbota NR, NSW, 29% of nests were in mistletoe (Ford 1999). In Imbota NR, nests considered to be of intermediate conspicuousness: visible from two or three directions; usually placed closer to centre of nest-plant and less conspicuous than nearby nests of Noisy Friarbirds (Ford 1999). Usually supported by horizontal or sloping branch, vertical fork, or branchlets, sometimes at end of leafy branch, well concealed by foliage (Dove 1911; Dickison 1935; Favalaro 1942; Baldwin 1973; NRS). Position in nest-tree varies: either near top, centrally placed, or at extremity of branch; sometimes in leafy or twiggy growth, including growths caused by ‘witch’s broom’ pathogen (NRS; H.A. Ford). Recorded nesting close to nest of previous year (NRS). In Imbota NR (n=117 nests), 40% were in *Eucalyptus caliginosa*, 22% in *E. viminalis*, 21% in *E. blakelyi*, 10% in *E. melliodora*, 3% in *E. bridgesiana* and 3% in other species; showed significant preference for *E. viminalis* and

E. bridgesiana relative to proportion of number of trees available (Ford 1999; H.A. Ford). MEASUREMENTS (m): Height of nest 6.4 (4.58; 0.33–30.0; 626); height of nest-plant, 10.5 (6.96; 1.0–50.0; 484) (NRS). In Imbota NR, height of nest, 10.22 (4.73; 2–22; 97); height of nest-plant, 14.38 (5.09; 3–23; 96); horizontal distance from base of tree, 2.75 (2.06; 0–8; 96); diameter of trunk 28.27 cm (16.70; 4–80; 89) (Ford 1999; H.A. Ford). Sometimes nest within 50 m of conspecifics ($n \geq 11$ nests); once, seven nests within c. 800 m (closest distance between nests 25 m) (NRS); once, claimed that six nests in same tree, but almost certainly not all active (North). Two colour-banded females moved c. 1 km between consecutive nests (H.A. Ford). Sometimes nest in same tree as: Magpie-lark *Grallina cyanoleuca* ($n=4$); Willie Wagtail *Rhipidura leucophrys* ($n=3$); Fuscous Honeyeater ($n=1$); and Brown Falcon *Falco berigora* ($n=1$); and near (usually within 50 m; single reports unless stated): Noisy Friarbird ($n=4$), Black-faced Cuckoo-Shrike ($n=3$), Australian Magpie ($n=3$), Superb Fairy-wren *Malurus cyaneus*, Olive-backed Oriole, Grey Butcherbird, Figbird *Sphecotheres viridis*, Laughing Kookaburra, Tawny Frogmouth *Podargus strigoides*, Southern Boobook *Ninox novaeseelandiae*, Little Raven *Corvus mellori*, Australian Hobby *Falco longipennis*, Regent Honeyeater, and Topknot Pigeon *Lopholaimus antarcticus* (NRS).

Nest, Materials Open (Campbell). Shape of nest varies: from flat (Campbell) or saucer-shaped (Serventy & Whittell) to a deep cup (NRS). Also described as large shallow cup; said to begin as large cup-shaped structure which is gradually flattened into compact saucer (Longmore). Composed of three distinct parts: a concave substructure of sticks or grass; a cup, in hollow of substructure, made of smaller sticks, bark or grass; and a soft inner lining, of wool or fur (Baldwin 1973; NRS). Nest usually made from long thin sticks and sometimes grass, and occasionally leaves, plant stems, string, wool, rootlets or feathers; lined with bark, or less often wool, fine grass, plant down, feathers, hair, fur, and rarely rootlets, small twigs or spider web (NRS); in WA, usually unlined (Campbell). Often built by both birds, but sometimes by female only. Collect sticks and strips of bark from live or dead trees (up to 300 m away), grass stems from ground, and twine and fibre round human habitation (NRS); once, pliant *Kunzea* branchlets brought from 400 m away (Baldwin 1973); especially fond of dead *Cassinia* twigs (H.A. Ford). Building sometimes takes >2 weeks; once, 6 days were spent collecting twigs, 1 day collecting bark, 1 day collecting cow hair, and 1 day collecting both cow hair and wool, totalling 9 days (NRS). Twigs of specific shape and size are used for different elements in nest; twigs worked together and locked into place around branches of nest-tree, and bound with hair, plastic, fine bark and thread; inner cup made of naturally curved twigs, interlocking with a few vertical pieces; once, lining added during incubation and was removed from nest when it became wet (Baldwin 1973). Interval between end of building and incubation once ≥ 1 day (NRS) and may be a few weeks (H.A. Ford). Sometimes re-use nesting material from disused nests of own or other species, e.g. Australian Magpie (Favaloro 1930; NRS). Often build nests, then relocate to final site (NRS). Twice recorded building in Magpie-lark nest (Masters & Milhinch 1974; NRS). MEASUREMENTS (cm): Diameter, 21.7 (8.36; 12–36; 17), excludes two nests of 80 cm diameter; in WA, typically 18–20 (Serventy & Whittell). One nest had slightly incurving sides a few centimetres high (NRS). One nest had overall diameter 23, inside cup 10; width of stick rim 5, bark lining 1.2; external depth 12.5, internal depth 6.2, depth of lining 2 (Baldwin 1973). External diameter 15.2–17.8, internal diameter 8.9, internal depth 5.1 (Campbell); external diameter

19.1, external height 9.5, internal diameter 10.2, internal height 5.7 (North).

Eggs Oval or short oval (Campbell); long oval (North). Close-grained, smooth, and slightly glossy (Campbell; North); rich flesh or pale reddish buff to pale salmon-red, freckled and spotted with shades of chestnut or purplish red, with faint underlying markings of dull violet-grey; markings are often irregular, sometimes in streaks or lines, sometimes rounded; once, eggs had yellowish brown markings (North); pinkish buff or salmon, blotched or spotted, especially around apex, with rich reddish brown and dull purplish grey (Campbell); reddish, with chestnut and brown spots usually in broken ring at larger end (Belcher 1914); pinkish buff, spotted with reddish brown and purplish grey (Serventy & Whittell); off-white to buff, with zone of brown-red spots at larger end and a few scattered spots on rest of egg (NRS). Said that eggs from WA smaller, rounder, and lighter in colour than those from e. Aust. (Campbell) but further measurements needed. MEASUREMENTS: 32.2 (2.1; 29.2–36.1; 9) \times 21.9 (1.15; 20.1–23.4) (Campbell; North); in WA, 30.7 (28.0–33.8; 33) \times 21.8 (19.5–23.3) (Serventy & Whittell). WEIGHT: One egg, 7.7 (Lill & Fell 1990).

Clutch-size Usually two; occasionally one or three (Austin 1918; Campbell; North; Serventy & Whittell; NRS). Throughout range, 1.97 (0.374; 1–3; 72): C/1 \times 6, C/2 \times 62, C/3 \times 4 (NRS); in Vic., 2.0 ($n=27$) (Lill & Fell 1990); in WA, 1.98 (0.39; 1–3; 47): C/1 \times 4, C/2 \times 40, C/3 \times 3 (Storr 26, 27, 28).

Laying Begins 2–5 days after completion of nest (NRS). Two broods probably usual for season (Belcher 1914), though three sometimes occur; once, two clutches raised 7 Sept.–19 Dec. (NRS). Once, eggs replaced twice in one season (Belcher 1914); one pair raised two broods from three nesting attempts between Aug. and Jan. (D.C. McFarland); observed incubating again 7 days after loss of chicks; another observed incubating c. 3 weeks after previous clutch fledged (NRS). Also observed incubating while still feeding fledgelings of previous clutch (Talmage 1993).

Incubation Sometimes both sexes incubate, sometimes only female incubates. Young often differ in size, suggesting that incubation may start after first egg laid (NRS). Near Armidale, during 52 h observation of 12 nests, eggs were incubated for 58.5% observation time (H.A. Ford & K. Takue). INCUBATION PERIOD: 16 days (Dove 1911; Talmage 1993); once, 15 days (Dove 1911); sometimes more: NRS has 17–21, 14+, c. 21, c. 19 and c. 17 days. An unhatched egg remained in nest for at least 6 days after other egg hatched; egg exploded when observer touched it (NRS).

Young Mostly naked at first, then develop grey down; eyes open at c. 7 days (Dove 1911; NRS). Both parents brood young, though female does most; both sexes feed young approximately equally (NRS; H.A. Ford & K. Takue); near Armidale, during 19 h observation of 12 nests, female brooded for 23% of time during first week, rarely thereafter; during 54 h observation of 12 nests, young fed 7.1 feeds/h (H.A. Ford & K. Takue). Subadults (assumed to be from previous clutch) occasionally also feed young, but contribution small (Talmage 1993; NRS). At one nest, young fed at 1–3 min intervals; at another, 15 min intervals. Adults probably remove faecal sacs (NRS). Eggshells removed at one nest (NRS). Adults perform Distraction Displays if nestlings threatened (Dove 1911; North; NRS; see Social Behaviour).

Fledging to independence Both sexes feed fledgelings; usually for 2–3 weeks after fledging; after parents stop feeding, fledgelings continue to beg, and sometimes adults eventually

drive fledgelings from area. **FLEDGING PERIOD:** 14, 15 days (Dove 1911); 15, 16, 17 days (Talmage 1993); estimates from near Armidale and in NRS: 15–20 days (n=11); >20 days (n=4); 26 days (n=1); period may be extended by cold, wet weather (Ford & Trémont 2000).

Success In Imbota NR, over eight seasons, 33.3% of 90 nests fledged at least one young; no relationship between success of nest and its height or conspicuousness, height of nest-tree, diameter of trunk, starting date, nest-plant species or horizontal distance of nest from base of tree (Ford 1999). Throughout range, from 272 eggs in 143 nests, 165 (60%) hatched; in nests where number of eggs and outcome known, of 161 eggs in 83 nests, 61 (38%) hatched and 42 (26%) fledged, equivalent to 0.51 fledged young per nest; where outcome known, of 380 nests, 262 fledged at least one young and 118 failed (NRS). Loss of nests in extremely wet or windy weather is probably substantial; one nestling died after it became caught between sticks in nest. One fledgeling hit by car (NRS). Parasitized much by Pallid Cuckoo *Cuculus pallidus*, less often by Common Koel *Eudynamis scolopacea* (HANZAB 4). **Predators OF NESTLINGS:** Brown Goshawk *Accipiter fasciatus*, Pied Currawong, Australian Raven *Corvus coronoides*, domestic Cat (NRS); snake (Campbell). Other likely predators include Grey Butcherbird and Brush-tailed Possum *Trichosurus vulpecula* (Ford 1999). Contents of one nest taken by Black Falcon *Falco niger* (Aust. Atlas). Also see Social Behaviour for species attacked, possibly as potential predators.

PLUMAGES Prepared by S.A. McKenzie and A.M. Dunn. Fledge in juvenile plumage. Partial post-juvenile (first pre-basic) moult results in adult-like immature (first basic) plumage. Thereafter, complete post-breeding (pre-basic) moults each cycle produce successive adult plumages without change in appearance. Sexes differ slightly in adult plumage. Two subspecies; nominate *carunculata* described below; based on examination of skins of 60 adult males, 32 adult females, ten juveniles and seven first immatures.

Adult male (Second and subsequent basic). **HEAD AND NECK:** Forehead and upper lores (to about level with bottom of eye), black-brown (119). Crown, black-brown (119) with fine shaft-streaks that grade from light brown (239) on forehead to white on hindcrown. Nape and hindneck subtly paler than crown, with thicker shaft-streaks; feathers, black-brown (119) with light olive-grey (c45) edges and white shaft-streaks. Lower lores and anterior ear-coverts below eye, white or off-white (ne), forming boldly contrasting triangular facial patch; bordered below by broad (4–6 mm wide) black-brown (119) submoustachial stripe extending from base of lower mandible to beneath wattle; and bordered above and behind by black-brown (119) stripe that extends from rear of eye and curves down to join rear ear-coverts, which are longer than anterior coverts, and mostly black-brown (119) with white tips. Conspicuous wattle dangles from lower rear ear-coverts (see Bare Parts). Sides of neck, light grey-brown (119D) to white, forming varying but distinctive patch or, if neck extended, stripe that merges with pale tips of rearmost ear-coverts. Chin, black-brown (119), fading to brown (28) with wear. Throat, black-brown (119) with large white shaft-streaks, giving a heavily streaked appearance. There are scattered black-brown (119) bristles around base of bill, and on lores, cheeks and chin. **UPPERPARTS:** Mantle, scapulars, back and rump, dark brown (119A) with light olive-grey (45) fringes to feathers, and bold white shaft-streaks, which are broad basally, and taper to a point distally (shaft-streaks also slightly broader on back and rump).

Overall, appears strongly streaked. Uppertail-coverts, dark brown (121) with white fringes; shortest uppertail-coverts also have white shaft-streaks. **UNDERPARTS:** Ground-colour of breast, brown (28) when fresh, fading to light grey-brown (27) with wear; overlain with bold, narrow white shaft-streaks, giving a streaked to almost striped appearance. Breast merges with much more coarsely and diffusely streaked flanks; feathers of flanks mostly white, with broad grey-brown (91) submarginal lines. Centre of belly and lower belly, orange-yellow (18) when fresh, fading to yellow (55) with wear. Upper belly and sides of belly as flanks, but with yellow (55) wash to tips or edges of feathers. Vent, white with pale-yellow (c157) wash. Undertail-coverts, brown (119B) with broad white fringes and narrow white shaft-streaks. Thighs, brown (28) with white shaft-streaks. Axillaries, brownish grey (80) with white fringes. **UPPERTAIL:** T1, black-brown (119) near shaft, grading to dark brown (121) near margins, and with narrow white edges and narrow white tip, which are sometimes lost with wear. Rest of rectrices, dark brown (121) with broad white tips. **UNDERTAIL:** Brownish grey (80) with large white tips to all rectrices; tail strongly graduated, and pale tips form conspicuous rows. **UPPERWING:** Marginal secondary coverts, black-brown (119) with narrow white shaft-streaks and light-brown (223D) fringes to tips. Median secondary coverts, dark brown (c219) with light-brown (223D) shafts, and with white fringes to tips. Inner greater secondary coverts, dark brown (121), grading to brown (119B) towards outer edges and with off-white (ne) to light grey-brown (119D) fringe to outer webs; outer greater secondary coverts, dark brown (219), grading to brown (119B) near outer edge, with white tips and outer edges, and with light brown (223D) shafts. Alula, dark brown (121) with white tips to feathers. Marginal primary coverts, dark brown (121) with off-white (ne) to light grey-brown (119D) fringes. Median primary coverts, dark brown (219) with off-white (ne) tips. Greater primary coverts, dark brown (121) with off-white (ne) fringes to outer webs and tips, and concealed pink-buff (121D) edge to inner webs. Tertiaries, dark brown (121) with white fringes (slightly wider on outer web). Secondaries subtly darker than tertiaries, dark brown (121) with narrow white edges to outer webs, concealed pink-buff (121D) edge to basal half of inner webs, and narrow white fringes to tips; white fringes to tips vary between individuals, from sharply defined with broad tip at shaft in some, to diffuse and barely discernible in others. Primaries, dark brown (c121) with white tips and concealed pink-buff (121D) edges to basal part of inner webs; tips narrow on p1–p4 and broad on p5–p10; length of pink-buff edges decreases from about two-thirds of length of feather on inner primaries to one-quarter on outer primaries. **UNDERWING:** All secondary coverts, brownish grey (80) with white fringes. Marginal and median primary coverts, dark brown (121) with white fringes, which are narrower on median coverts. Greater primary coverts, reflective, brownish grey (80) with narrow white fringes. Remiges, brownish grey (80) with broad pink-buff (121D) edges to basal half of inner webs (as on upperwing) and white tips (as on upperwing).

Adult female (Second and subsequent basic). Very similar to adult male and almost inseparable on plumage. Hindneck, sides of neck and foreneck tend to be less boldly streaked than adult male, but much overlap. Wattle also appears to be slightly shorter, but could not be measured on skins.

Downy young Hatch mostly naked with some dark-grey down on head and body (Dove 1911). From photos (Pizzey 1988; Longmore), nestlings with primaries still in pin had covering of dark greyish-brown (c121) natal down on crown and back.

Juvenile Sexes similar. Superficially similar to adult. **HEAD AND NECK:** Top of head paler than adult, and feathers have looser texture and bolder white shaft-streaks. Ground-colour of forehead and crown, brown (119A), grading to light brown (239) on nape and hindneck; all overlain with bold shaft-streaks that grade from light brown (223D) on forehead to white on crown, nape and hindneck. Upper lores, dark brown (121); only slightly lighter than in adult, and contrast with pale forehead. Triangular facial patch on lores and anterior ear-coverts, as adult. Submoustachial stripe varies between individuals; sometimes as adult, but usually narrower and slightly paler, dark brown (121). Rear ear-coverts, sides of neck, and dark stripe extending from rear of eye to rear ear-coverts, as adult. Chin and throat, white with light-brown (239) fringes to feathers, giving diffusely streaked appearance. **UPPERPARTS:** Much paler than adult, with broader white shaft-streaks to feathers. Mantle, back, scapulars and rump, brown (28) with broad but diffuse white shaft-streaks to feathers; some feathers have an additional very narrow light-brown (39) subterminal fringe, making the feathers appear almost barred. In very fresh plumage, scapulars may have traces of pink-buff (121D) on fringes. Uppertail-coverts mostly brown (119B) with off-white (ne) edges and white shafts. **UNDERPARTS:** Paler than adult with washed-out appearance to belly. Breast, flanks and sides of belly, light brown (239) with broad white shaft-streaks and grey (84) bases to feathers; grey bases concealed on breast, but partly exposed on flanks and sides of belly. Feathers of upper belly as breast but with pale-yellow (c157) wash to tips. Lower belly and vent, white with very weak pale yellow (c157) wash to feathers. Undertail-coverts mostly white with light grey-brown (119D) submarginal lines. Thighs, light grey-brown (119D). **TAIL:** Mostly as adult, but with pink-buff (121D) suffusion to tip of t1. **UPPERWING:** Coverts as adult but with pink-buff (121D) suffusion to fringes. Remiges much as in adults but with cream (54) outer edges to secondaries and pink-buff (121D) tinge to basal two-thirds of outer edges of primaries. **UNDERWING:** As adult.

First immature (First basic). Best distinguished by heavily worn retained juvenile remiges and characteristic bare parts (q.v.). Plumage mostly as adult female, but yellow feathers of belly on average slightly paler (yellow [c157]) and retained juvenile feathers in wing worn and contrast with newer feathers; worn feathers usually grey-brown (c91), with substantially reduced white tips to primaries.

BARE PARTS Based on photos (Pizzey 1988; unpubl.: C. Morris; A.F. Hurst; D. Plant; M.J. Carter; and standard sources) and notes from live birds caught at Rushworth, Vic. (S.A. McKenzie). **Adult** Sexes alike. Bill, black-brown (119) or black (89). Gape, grey-black (82). Inside of mouth, yellow-orange (18). Iris, orange-red (15), red (12), crimson (108) or red-brown (132A). Orbital ring, dark grey (83). Wattle, red (13) or peach-red (94); hangs down as rounded flap of skin from lower rear ear-coverts. Legs and feet, pink-brown (219D or 219C), pink (c3) or dull pink (5). Soles, light grey-brown (44). Claws, dark brown (219 or 219A). **Nestling** Upper mandible, pink-brown (221C); lower mandible not known. Gape, yellow (55) with orange-rufous (132D) creases. Sparsely feathered skin round eyes, dark blue-grey (78) or dark grey (83). Sparsely feathered skin round ear-coverts, white to dull pink (5). Skin on throat, yellow-orange (18) to orange-rufous (132D). **Juvenile** Bill, grey-black (82) with dirty pink (4) tinge and yellow-brown (24) tip; has swollen area around nostrils. Gape, puffy, yellow-orange (18). Inside of mouth, yellow-orange (18). Bare skin along edges of lower mandible and around ears, dull

pink (5) to pink (3). Iris, dark brown (129); or brown or grey-brown (Hall). Orbital ring, blue-grey (ne). Wattle paler than adult, and significantly smaller (though ranges overlap) (<4 mm); pink-red (10); or whitish (Hall). Legs and feet, flesh-grey (Hall). **First immature** Gape, pinkish grey (84 or 83). Outer ring of iris, light brown (129); and inner ring, orange-red (15).

MOULTS Based on examination of skins of 77 adults and 38 juveniles and immatures (HLW, MV, SAM, WAM) and published information as cited. **Adult post-breeding** (Pre-basic). Complete; primaries outward. From skins, moult of primaries begins in Nov. or Dec. and finishes between Mar. and May: in Nov. (2 of 6 moulting, with PMS of 5, 9); Dec. (2 of 6, PMS 10, 14); Jan. (0 of 2); Feb. (0 of 2); Mar. (4 of 5, PMS 45.5 [1.73; 44–47; 4]); Apr. (0 of 1); May (1 of 4, PMS 42). None was moulting primaries June–Oct. (n=51). Active moult of tail recorded in Dec. and Mar. Active moult of body recorded in Dec., Mar. and May. Moult of back, breast, median and lesser coverts occurs before replacement of feathers of crown, remiges and rectrices. Near Adelaide, two started moult of primaries in Oct., with PMS of 2 and 11 (Ford 1980). On Kangaroo I., SA, one began moult of primaries in Nov., with PMS of 2 (Ford 1980). In Vic., moult begins in late Dec. and is finished by end of Apr. (Rogers *et al.* 1986). In WA, adults were moulting in Feb. and Mar. (Hall). **Post-juvenile** (First pre-basic). Few data. Partial; involves most plumage except remiges, rectrices and often some upperwing-coverts. None examined was actively moulting. **First immature post-breeding** (Second pre-basic). Complete. Timing appears similar to that of adult post-breeding. Moult of primaries starts about Nov. of second year and finishes by May: two in Nov. had PMS of 4 and 5; one in Feb. had PMS 39; one in Mar. had PMS 44; one in Apr. had PMS 27. No other information.

MEASUREMENTS NOMINATE CARUNCULATA: (1) E. Aust., W to w. side of Port Phillip Bay, Vic., adults, skins (HLW, MV).

| | | MALES | FEMALES | |
|--------|-----|----------------------------|----------------------------|----|
| WING | (1) | 157.8 (7.48; 142–171; 19) | 149.5 (6.72; 140–161; 10) | ** |
| TAIL | (1) | 163.0 (9.98; 150–182; 17) | 151.9 (7.43; 136–160; 8) | ** |
| BILL S | (1) | 33.2 (1.66; 29.1–36.8; 21) | 32.3 (1.29; 30.8–34.3; 9) | ns |
| TARSUS | (1) | 35.2 (1.66; 32.4–38.8; 22) | 35.0 (0.94; 33.4–36.2; 10) | ns |

(2–4) Unsexed birds; Gape W = width of gape measured between commissural points; Wattle L = length of wattle; Wattle W = width of wattle. (2) Vic., live (BATH project). (3) Rushworth SF, Vic., live (C.H. Sandbrink & J.L. Sandbrink). (4) NSW, skins (Saunders *et al.* 1995).

| | | ADULTS | JUVENILES AND IMMATURES | |
|----------|-----|----------------------------|----------------------------|----|
| WING | (2) | 152.9 (7.83; 139–166; 32) | 146.7 (4.39; 141–152; 7) | * |
| | (3) | 153.5 (9.22; 130–174; 24) | 147.0 (6.49; 135–159; 16) | ** |
| TAIL | (2) | 160.0 (9.07; 142–177; 31) | 155.8 (8.45; 148–171; 6) | ns |
| | (3) | 162.4 (16.03; 117–191; 23) | 153.7 (11.76; 133–175; 16) | * |
| THL | (2) | 61.2 (2.72; 57.5–65.8; 30) | 59.5 (2.50; 55.3–61.8; 7) | ns |
| | (3) | 62.4 (2.66; 58.7–67.3; 24) | 59.5 (2.81; 55.8–67.1; 16) | ** |
| WATTLE L | (2) | 8.9 (2.24; 4–14; 83) | 4.4 (1.72; 2–7; 7) | ** |
| | (3) | 8.7 (2.11; 5–12; 22) | 5.4 (2.30; 2.0–8.0; 5) | ** |
| WATTLE W | (2) | 7.7 (1.49; 6–11; 10) | – | |
| GAPE W | (4) | 10.1 (0.97; 56) | – | |

SUBSPECIES WOODWARDI: (5) S. WA. and s. SA., W of Mt Lofty Ras, SA (HLW, MV, WAM).

| | | MALES | FEMALES | |
|--------|-----|----------------------------|--------------------------|----|
| WING | (5) | 152.0 (4.88; 143–160; 19) | 145.4 (4.56; 139–152; 8) | ** |
| TAIL | (5) | 156.9 (11.05; 132–171; 16) | 150.6 (7.83; 140–162; 7) | ns |
| BILL S | (5) | 33.9 (1.30; 32.1–35.5; 8) | 29.5, 32.1 | |
| TARSUS | (5) | 34.5 (1.41; 32.1–36.8; 8) | 33.5, 34.1 | |

(6) Unsexed birds; Kings Park and Mt Claremont, WA, live (B.J. Wykes).

| | | ADULTS |
|----------|-----|----------------------------|
| WING | (6) | 148.8 (9.20; 136–156; 5) |
| THL | (6) | 62.1 (2.77; 56.8–66.6; 21) |
| WATTLE L | (6) | 10.4 (2.79; 6–14; 10) |

SUBSPECIES CLELANDI: (7) Kangaroo I., SA, adults, skins (ANWC, HLW, SAM).

| | | MALES | FEMALES |
|--------|-----|----------------------------|------------------|
| WING | (7) | 154.1 (4.88; 147–161; 9) | 135, 137, 141 |
| TAIL | (7) | 162.1 (5.74; 153–171; 10) | 150, 151 |
| BILL S | (7) | 35.2 (1.44; 33.2–37.8; 10) | 30.2, 30.9, 31.7 |
| TARSUS | (7) | 33.9 (0.94; 32.4–35.3; 11) | 31.9, 32.8, 33.1 |

SUBSPECIES NOT IDENTIFIED: (8) Adults and immatures, live, location and method of sexing not known (Baker *et al.* 1997).

| | | MALES | FEMALES | |
|------|-----|---------------------------|---------------------------|----|
| WING | (8) | 154.2 (7.2; 130–167; 46) | 143.4 (6.3 (121–160; 73) | ** |
| TAIL | (8) | 161.8 (10.7; 140–184; 18) | 156.5 (14.3; 138–200; 22) | ns |
| THL | (8) | 64.1 (1.9; 55–68; 64) | 58.2 (3.4; 35–68; 91) | ** |

(9) Adults and immatures, live, location not known (Baker *et al.* 1997).

| | | UNSEXED |
|------|-----|----------------------------|
| WING | (9) | 147.4 (8.5; 104–169; 398) |
| TAIL | (9) | 157.2 (13.7; 122–190; 134) |
| THL | (9) | 60.3 (3.5; 35–69; 534) |

Paton & Collins (1989) give length of brush of tongue as 16.3 mm and tongue width as 2.7 mm; subspecies, age and sex not specified.

WEIGHTS (1–3) Adults, from museum labels (ANWC, MV, SAM, WAM): NOMINATE CARUNCULATA: (1) E. Aust., W to w. Port Phillip Bay, Vic. SUBSPECIES WOODWARDI: (2) S. WA and s. SA, W of Mt Lofty Ras, SA. SUBSPECIES CLELANDI: (3) Kangaroo I. SUBSPECIES NOT IDENTIFIED: (4) Adults and immatures, live, location and method of sexing not known (Baker *et al.* 1997).

| | | MALES | FEMALES |
|-----|--|--------------------------|--------------------------|
| (1) | | 122, 135, 136 | – |
| (2) | | 114.1 (9.69; 99–131; 12) | 98.7 (8.33; 84–106; 6) |
| (3) | | 113.5 (4.59; 110–121; 6) | 95, 99, 106 |
| (4) | | 120.2 (13.3; 90–140; 33) | 101.1 (10.7; 82–133; 45) |

NOMINATE CARUNCULATA: (5–6) Vic., live (BATH data): (5) Adults; (6) Juveniles and immatures. (7–8) Rushworth SF, Vic., live (unpubl.: C.H. Sandbrink & J.L. Sandbrink): (7)

Adults; (8) Juveniles and immatures. SUBSPECIES WOODWARDI: (9) Kings Park and Mt Claremont, WA, adults (B.J. Wykes). SUBSPECIES NOT IDENTIFIED: (10) Adults and immatures, live, location not known (Baker *et al.* 1997).

| | | UNSEXED |
|------|--|------------------------------|
| (5) | | 114.2 (12.50; 93–134; 31) |
| (6) | | 99.1 (15.31; 81–119; 5) |
| (7) | | 120.3 (15.06; 98–150; 23) |
| (8) | | 99.6 (16.35; 76.5–129.8; 16) |
| (9) | | 100.2 (13.42; 73–125; 24) |
| (10) | | 108.6 (14.9; 44–163; 432) |

STRUCTURE Wing of moderate length, broad with rounded tip. Ten primaries: p5–p6 longest; p10 65–75 mm shorter, p9 18–29, p8 2–9, p7 2–3, p4 6–9, p3 19–28, p2 27–35, p1 34–40. P4–p8 emarginated on outer web. Nine secondaries, including three tertials. Tail long and strongly graduated; 12 rectrices: t1 longest, t2 2–14 mm shorter (t1 and t2 sometimes considerably reduced with wear), t3 8–19, t4 16–30, t5 22–38, t6 39–52. Bill tapered and slightly decurved (depth 7.3–8.1 mm; width 6.8–7.5 mm); about same length as head. Fleshy wattle hangs from below ear-coverts as rounded flap of skin; usually very small in juveniles (cf. adults; see Measurements). Tarsus moderately long; scaling, scutellate on front, fused on sides and back. Middle toe 22–25 mm. Outer toe, 72–83% of middle, inner toe 68–82%, hindtoe 64–77%.

AGEING JUVENILES: Plumage probably only retained for a few months after fledging. Readily distinguished from adult by differences in plumage and bare parts (as described above). Most conspicuous differences are: Lighter crown and upperparts; smaller and paler yellow patch on belly; wattles very much smaller (see Measurements); and iris, brown (orange-red in adult). **FIRST IMMATURES:** Best distinguished from adult by shorter wattles; bi-coloured iris, with thin light-brown outer ring; and grey-pink gape. Plumage very like that of adult, especially adult female, but differs by heavily worn retained juvenile upperwing and tail.

SEXING Rogers *et al.* (1986) used THL to determine sex of adults. They sexed adults as female if THL <59.9 mm and as male if THL >62.9 mm; this correctly sexed 68.4%, incorrectly sexed 0.6% and left 31.0% unsexed. Rogers *et al.* (1986) also suggested that length of wattle could be useful for sexing, but recent analysis of banding data suggests wattle length is much less reliable than THL for separating the sexes (K.G. Rogers; this study).

GEOGRAPHICAL VARIATION Three subspecies recognized (DAB): *carunculata* in Vic., e. NSW and se. Qld; *woodwardi* in s. WA and s. SA, E to Mt Lofty Ras; and *clelandi* on Kangaroo I., SA. Nomininate and *woodwardi* separated by broad zone of intergradation across w. Vic. and e. SA, spanning the 'Bassian Volcanic Barrier' (volcanic plains of w. Vic., N to Wimmera and Little and Big Deserts); the zone extends from Mt Lofty Ras in W, E to w. Port Phillip Bay (DAB).

SUBSPECIES WOODWARDI: Occurs in s. WA and s. SA, W of Mt Lofty Ras. Average slightly smaller than nominate; males had significantly shorter Wing ($P < 0.01$). Plumage mostly as nominate, but have slightly richer yellow coloration in belly (DAB; this study).

SUBSPECIES CLELANDI: Confined to Kangaroo I., SA. Similar in size to nominate, but males had significantly longer Bill

S ($P < 0.01$) and shorter Tarsus ($P < 0.05$). Said to appear consistently more melanistic than nominate, with dusky feathering pervading even the silvery facial patch (DAB). However, adult skins ($n=14$) could not be separated from some individuals (c. 5 of 50) of nominate.

REFERENCES

- ABBBS. 1998. *Corella* 22: 126–8.
- Alexander, W.B. 1921. *Emu* 21: 149–68.
- Althofer, G.W. 1934. *Emu* 34: 105–12.
- Ambrose, S. 1990. *RAOU Newsl.* 85: 6.
- Anon. 1907. *Emu* 7: 52–3.
- 1908. *Emu* 8: 41–2.
- 1926. *S. Aust. Orn.* 8: 171–219.
- 1966. *Victorian Nat.* 83: 46.
- 1989. *RAOU Rep.* 63: 10–28.
- Appleby, C. 1992. *Bird Obs.* 717: 18.
- Armstrong, D.P. 1992. *Emu* 92: 170–9.
- Arnold, M.A.R. 1927. *Emu* 26: 207–11.
- Arthur, J., & E. Arthur. 1971. *S. Aust. Orn.* 26: 6.
- Ashby, E. 1930. *Emu* 29: 183–92.
- Ashton, C.B. 1985. *S. Aust. Orn.* 29: 169–79.
- 1996. *S. Aust. Orn.* 32: 93–8.
- Aston, H.L., & R.A. Balmford. 1978. *A Bird Atlas of the Melbourne Region*. Vict. Orn. Res. Grp, Melbourne.
- Attwill, A.R. 1972. *S. Aust. Orn.* 26: 59–64.
- Austin, T.P. 1907. *Emu* 7: 28–32.
- 1918. *Aust. Zool.* 1: 109–37.
- Backhouse, J. 1985. *Aust. Birds* 19: 56–61.
- Baker, G.B., et al. 1997. *Report on the Australian Bird and Bat Banding Scheme, 1995–96*. Environment Australia, Canberra.
- Baker, J. 1991. *Wingspan* 1(3): 22.
- Baldwin, M. 1972. *Aust. Birds* 6: 70–1.
- 1973. *Sunbird* 4: 10–12.
- Balfour, D. 1980. *Canberra Bird Notes* 5(4): 11–15.
- Barry, H.C. 1928. *Emu* 28: 152–3.
- Barton, F. 1926. *Victorian Nat.* 43: 241–2.
- Baxter, C.I. 1980. *S. Aust. Orn.* 28: 90–8.
- 1989. *An Annotated List of the Birds of Kangaroo Island*. S. Aust. Natn. Parks Wildl. Serv., Kingscote, Kangaroo I., SA.
- , & M. Berris 1995. *Birds of Kangaroo Island*. Rev. edn. S. Aust. Natn. Parks Wildl. Serv., Adelaide.
- Beasley, L. 1992. *Bird Obs.* 722: 12.
- Bedggood, G.W. 1973. *Aust. Bird Watcher* 5: 12–22.
- 1980. *Aust. Bird Watcher* 8: 147–62.
- Belcher, C.F. 1914. *Birds of the District of Geelong, Australia*. Griffiths, Geelong, Vic.
- Bell, H.L. 1964. *Emu* 64: 65–6.
- 1980. *Corella* 4: 8–19.
- BFNC (Bendigo Field Nat. Club). 1976. *Aust. Bird Watcher* 6: 186–208.
- Boehm, E.F. 1957. *Emu* 57: 311–24.
- Boles, W.E., & N.W. Longmore. 1985. *S. Aust. Orn.* 29: 221–3.
- Bonnin, J.M. 1989. *S. Aust. Orn.* 30: 190–2.
- Bounds, J., et al. 1996. *Canberra Bird Notes* 21(3): 41–55.
- Brown, E.M., et al. 1997. *Pollination in Western Australia: A Database of Animals Visiting Flowers*. Handbook 15. West. Aust. Nat. Club, Perth.
- Brown, R.J., & R.M.B. Brown. 1986. *Aust. Bird Watcher* 11: 218–23.
- , et al. 1986. *Corella* 10: 118–22.
- Browne, R. 1990. *Aust. Birds* 24: 23–4.
- Bruce, M.D. 1973. *Emu* 73: 186–7.
- Buchanan, B. 1987. *West. Aust. Bird Notes* 43: 6–7.
- 1992. *West. Aust. Bird Notes* 63: 5.
- Burbidge, A.H. 1985. *RAOU Rep.* 16: 23–55.
- Campbell, A.G. 1902. *Emu* 2: 9–18.
- 1938. *Emu* 38: 317–22.
- Carnaby, J.C. 1933. *Emu* 33: 103–9.
- Carpenter, G.A., & J.S. Matthew. 1986. *S. Aust. Orn.* 30: 29–37.
- , — 1997. *S. Aust. Orn.* 32: 134–40.
- Carter, M.J. 1996. *Aust. Bird Watcher* 16: 344–8.
- Carter, T. 1924. *Emu* 23: 306–18.
- Chan, K. 1995. *Aust. Bird Watcher* 16: 11–20.
- Chandler, L.G. 1913. *Emu* 13: 33–45.
- Chisholm, A.H. 1908. *Emu* 8: 37.
- 1910. *Emu* 9: 166–7.
- Chisholm, E.C. 1924. *Emu* 24: 102–6.
- Clarke, G. 1967. *S. Aust. Orn.* 24: 119–34.
- Clayton, M. 1981. *Canberra Bird Notes* 6(3): 82–3.
- Cleland, J.B. 1906. *Emu* 5: 223–4.
- 1911. *Emu* 11: 79–95.
- 1952. *S. Aust. Orn.* 20: 72–7.
- COG (Canberra Orn. Grp). 1997. *Canberra Bird Notes* 22 (Suppl.): 1–55.
- Cohn, M. 1926. *Emu* 25: 282–6.
- Colemane, A. 1974. *Aust. Birds* 8: 79–80.
- Collins, J., & A. Collins. 1981. *Geelong Naturalist* 18(2): 50.
- Comer, S. 1997. *RGC Wetland Centre Tech. Rep.* 39. RGC Minerals Sands, Capel, WA.
- Condon, H.T., & C.E. Rix. 1936. *S. Aust. Orn.* 13: 203–19.
- Cooper, R.B. 1975. *Aust. Bird Watcher* 6: 103–16.
- Cooper, R.M., & I.A.W. McAllan. 1995. *The Birds of Western New South Wales: A Preliminary Atlas*. NSW Bird Atlassers, Albury, NSW.
- Cox, J.B. 1973. *S. Aust. Orn.* 26: 103–14.
- Crompton, R. 1915. *S. Aust. Orn.* 2: 36–43.
- Davies, S.J.J.F. 1982. *RAOU Rep.* 3: 43–9.
- Davis, W.E. Jr, & H.E. Recher. 1993. *Corella* 17: 25–7.
- Debus, S.J.S. 1983. *Corella* 7: 14–16.
- Dell, J. 1972. *West. Aust. Mus. Nat.* 12: 71–2.
- 1976. *Rec. West. Aust. Mus. Suppl.* 4: 117–32.
- 1979. *Rec. West. Aust. Mus. Suppl.* 9: 95–116.
- , & R.E. Johnstone. 1977. *Rec. West. Aust. Mus. Suppl.* 4: 37–72.
- Dickison, D.J. 1935. *Emu* 35: 33.
- Disney, H.J. de S. 1992. *Corella* 16: 97–103.
- Dove, H.S. 1911. *Emu* 11: 43–4.
- Dowling, B., et al. 1994. *Tech. Rep. Arthur Rylah Inst. Environ. Res.* 134.
- Durrant, B.M., & I.C. MacRae. 1994. *Birds of Bribie Island, Pumicestone Passage and Environs*. Bribie I. Env. Prot. Assoc., Bribie I., Qld.
- Dymond, N. 1985. *West. Aust. Bird Notes* 35: 4–5.
- 1988. *RAOU Rep.* 38: 13–47.
- Eckert, J. 1974. *S. Aust. Orn.* 26: 138–41.
- Egan, K.H. 1997. *Corella* 21: 83–7.
- Elliot, S. 1948. *West. Aust. Nat.* 1: 171.
- Emison, W.B., & J.W. Porter. 1978. *Emu* 78: 126–36.
- Er, K.B.H., & C.R. Tidemann. 1996. *Corella* 20: 117–25.
- Favaloro, N.J. 1930. *Emu* 30: 105–9.
- 1931. *Emu* 31: 48–59.
- 1942. *Emu* 41: 268–76.
- 1966. *Proc. R. Soc. Vict.* 79: 621–6.
- Fleming, A.M. 1976. *Aust. Bird Watcher* 6: 151–60.
- Ford, H.A. 1976. *S. Aust. Orn.* 27: 134–8.
- 1977. *S. Aust. Orn.* 27: 199–203.
- 1979. *Aust. J. Ecol.* 4: 145–64.
- 1980. *Aust. Wildl. Res.* 7: 453–63.
- 1981. *Aust. J. Ecol.* 6: 131–4.
- 1983. *Corella* 7: 25–31.
- 1999. *Emu* 99: 91–9.
- , & H.L. Bell. 1981. *Emu* 81: 202–8.
- , & S. Debus. 1994. *Corella* 18: 141–7.
- , & D.C. Paton. 1976. *S. Aust. Orn.* 27: 88–95.
- , — 1977. *Aust. J. Ecol.* 2: 399–407.
- , — 1982. *Aust. J. Ecol.* 7: 149–59.
- , — (Eds) 1986. *The Dynamic Partnership: Birds and Plants in Southern Australia*. D.J. Woolman, Adelaide.
- , & S. Trémont 2000. *Aust. J. Zool.* 48: 21–32.
- , et al. 1985. *Corella* 9: 78–107.
- , et al. 1986. *Emu* 86: 168–79.
- Ford, H.W. 1908. *Emu* 8: 26–31.
- 1918. *Emu* 17: 221–3.
- Ford, J.R., & P.S. Stone. 1957. *Emu* 57: 9–21.
- Forde, N. 1986. Pp 42–58 In: Ford & Paton 1986.
- Franklin, D.C., & J.L. Robinson. 1989. *Aust. Bird Watcher* 13: 129–32.
- French, K. 1990. *Emu* 90: 185–89.
- , et al. 1992. *Aust. J. Ecol.* 17: 35–42.
- Friend, G.R. 1982. *Emu* 82: 80–91.
- Frith, H.J. (Ed.) 1969. *Birds of the Australian High Country*. Reed, Sydney.
- Galbraith, J. 1927. *Victorian Nat.* 43: 308.
- Gall, B.C., & N.W. Longmore. 1978. *Emu* 78: 189–96.
- Gannon, G.R. 1933. *Emu* 33: 24–6.
- 1966. *Emu* 65: 241–53.

- Gell, P. 1977. *Aust. Bird Watcher* 7: 52–5.
- Gepp, B.C., & A.J. Fife. 1975. *S. Aust. Orn.* 27: 12–9.
- Gibson, J.D. 1977. *Aust. Birds* 11: 41–74.
- Gilbert, P.A. 1923. *Emu* 23: 109–18.
- 1934. *Emu* 34: 101–5.
- 1935. *Emu* 34: 200–9.
- 1939. *Emu* 39: 107–10.
- Glover, B. 1955. *S. Aust. Orn.* 21: 90–100.
- 1957. *S. Aust. Orn.* 22: 30–6.
- Gosper, C.R. 1999a. *Corella* 23: 53–62.
- 1999b. *Aust. Birds* 31: 142–4.
- Green, R.J. 1984. *Aust. Wildl. Res.* 11: 181–90.
- 1986. Pp 130–9 *In*: Ford & Paton 1986.
- Hawkeswood, T.J. 1981. *West. Aust. Nat.* 15: 17–21.
- Henle, K. 1989. *Aust. Birds* 22: 53–68.
- Heron, S.J. 1970. *Emu* 70: 155–8.
- 1973. *Emu* 73: 119–23.
- Hill, G.F. 1907. *Emu* 7: 18–23.
- Hill, H.E. 1904. *Emu* 3: 226–9.
- Hindwood, K.A. 1944. *Aust. Zool.* 10: 231–51.
- , & A.R. McGill. 1958. *The Birds of Sydney*. Royal Zool. Soc. of NSW, Sydney.
- Hirth, G.J. 1976. *Aust. Bird Watcher* 6: 310–17.
- Hobbs, J.N. 1961. *Emu* 61: 21–55.
- 1969. *Rep. Sunraysia Naturalists' Res. Trust* 6: 55–6.
- Hood, J.B. 1934. *S. Aust. Orn.* 13: 207–11.
- Hopper, S.D. 1980. *Emu* 80: 239–40.
- 1981. *Aust. Wildl. Res.* 8: 187–97.
- , & A.H. Burbidge. 1978. *Aust. J. Bot.* 26: 335–50.
- , — 1982. *West. Aust. Nat.* 15: 74–5.
- , — 1986. Pp 20–31 *In*: Ford & Paton 1986.
- , & G.F. Moran. 1981. *Aust. J. Bot.* 29: 625–38.
- Hore-Lacy, I. 1964. *Emu* 64: 29–32.
- Horrocks, G.F.B., & G.W. Brown. 1993. *Aust. Bird Watcher* 15: 24–34.
- Hoskin, E.S. 1991. *The Birds of Sydney*. Surrey Beatty, Sydney.
- Howard, T., & I. Crawford. 1985. *RAOU Newsl.* 64: 11.
- Howe, F.E. 1909. *Emu* 8: 130–8.
- Hubregtse, V. 1987. *Bird Obs.* 665: 71.
- Humphreys, J.S. 1986. *Aust. Bird Watcher* 11: 153–66.
- Hunt, J. 1992. *West. Aust. Bird Notes* 61: 4.
- Hutchison, M.J. 1988. *West. Aust. Nat.* 17: 73–86.
- Hyem, E.L. 1937. *Emu* 36: 262–72.
- Ipsen, J.C. 1947. *Bird Obs. Dec.*: 2.
- Jack, 1966. *Emu* 66: 151–2.
- Jenkins, C.F.H. 1931. *Emu* 31: 30–5.
- 1968. *West. Aust. Nat.* 11: 19–20.
- Jones, C.E., & R.J. Little. (Eds) 1983. *Handbook of Experimental Pollination Biology*. Van Nostrand Reinhold, New York.
- Jones, D.P. 1929. *Emu* 28: 252–4.
- Jordan, R. 1984. *RAOU Rep.* 11: 13–25.
- 1987. *RAOU Rep.* 27: 25–37.
- , & P. Jordan. 1984. *RAOU Newsl.* 59: 11.
- Jurisevic, M.A., & K.J. Sanderson. 1994a. *Emu* 94: 69–77.
- , — 1994b. *Emu* 94: 141–8.
- Keast, A. 1968a. *Emu* 67: 159–209.
- 1968b. *S. Aust. Orn.* 25: 52.
- (Ed.) 1981. *Ecological Biogeography of Australia*. Junk, The Hague.
- 1985. Pp 97–116 *In*: Keast et al. 1985.
- , & H.T. Condon. 1968. *Rec. S. Aust. Mus.* 15: 699–703.
- , et al. (Eds) 1985. *Birds of Eucalypt Forests and Woodlands*. Surrey Beatty, Sydney.
- Keighery, G.J. 1979. *West. Aust. Nat.* 14: 150–1.
- 1980. *Flora* 171: 521–4.
- 1984. *West. Aust. Nat.* 15: 23.
- Kikkawa, J., et al. 1965. *Emu* 65: 139–43.
- Kroger, H. 1985. *Geelong Nat.* 21: 84.
- Kutt, A.S. 1996. *Emu* 96: 280–4.
- Lamm, D.W., & J.H. Calaby. 1950. *Emu* 50: 114–22.
- , & S.J. Wilson. 1966. *Emu* 65: 183–207.
- Lamont, B.B., & B.G. Collins. 1988. *Aust. J. Ecol.* 13: 129–35.
- Lashmar, A.F.C. 1937. *S. Aust. Orn.* 14: 59–64.
- Leach, H.A.C. 1928. *Emu* 28: 83–99.
- Leiblich, G. 1971. *S. Aust. Orn.* 25: 234–5.
- Lenz, M. 1990. *Emu* 90: 145–53.
- Leonard, J. 1995. *Canberra Bird Notes* 20(4): 81–3.
- Lepschi, B.J. 1986. *Canberra Bird Notes* 11(3): 109–10.
- 1993. *Emu* 93: 195–9.
- 1997. *Emu* 97: 84–7.
- Ley, A.J., & M.B. Williams. 1994. *Aust. Bird Watcher* 15: 366–76.
- Liddy, J. 1966. *Emu* 66: 87–103.
- Lill, A., & P.J. Fell. 1990. *Emu* 90: 33–9.
- Lindenmayer, B. 1993. *Canberra Bird Notes* 18(3): 46.
- Longmore, W. 1973. *Aust. Birds* 8: 33–5.
- Loyn, R.H. 1980. *Emu* 80: 145–56.
- 1985a. *Emu* 85: 213–30.
- 1985b. Pp 33–46 *In*: Keast et al. 1985.
- 1985c. Pp 323–31 *In*: Keast et al. 1985.
- Mack, D.B. 1961. *S. Aust. Orn.* 23: 69–79.
- Mack, K.J. 1970. *S. Aust. Orn.* 25: 126–41.
- MacNally, R. 1997. *Emu* 97: 253–8.
- Marchant, S. 1979. *Aust. Birds* 13: 59–68.
- Masters, J.R., & A.L. Milhinch. 1974. *Emu* 74: 228–44.
- Matthew, J., & G. Carpenter. 1993. *S. Aust. Orn.* 31: 127–31.
- Matthiessen, J.N. 1973. *Emu* 73: 191–3.
- McCulloch, E.M. 1977. *Aust. Bird Watcher* 7: 113–23.
- McEvey, A.E. 1965. *Emu* 65: 1–56.
- , & W.G. Middleton. 1968. *Emu* 68: 161–212.
- McFarland, D.C. 1983. *Aust. Birds* 17: 76–7.
- 1984. *Aust. Bird Watcher* 10: 255–63.
- 1985a. *Corella* 9: 22–5.
- 1985b. *Corella* 9: 45–8.
- 1986a. *Aust. J. Ecol.* 11: 107–20.
- 1986b. *Aust. J. Ecol.* 11: 331–40.
- 1996. *Emu* 96: 181–8.
- McGill, A.R. 1967. *Aust. Birds* 4: 30–2.
- McKeown, K.C. 1936. *Emu* 36: 21–30.
- McKilligan, H.J., & N.G. McKilligan. 1987. *Sunbird* 17: 17–27.
- Mellor, J.W. 1922. *S. Aust. Orn.* 6: 141.
- 1924. *S. Aust. Orn.* 7: 197–8.
- 1926. *S. Aust. Orn.* 8: 219–23.
- Milledge, D.R., & H.F. Recher. 1985. Pp 47–52 *In*: Keast et al. 1985.
- Moncreiff, P. 1938. *Emu* 37: 207–34.
- Morgan, A.M. 1919. *S. Aust. Orn.* 4: 7–20.
- , et al. 1926. *S. Aust. Orn.* 8: 171–219.
- Morris, A.K. 1970. *Aust. Birds* 5: 14–15.
- 1975. *Aust. Birds* 9: 37–76.
- 1986. *Aust. Birds* 20: 65–81.
- 1989. *Aust. Birds* 23: 7–21.
- , et al. 1981. *Handlist of Birds in New South Wales*. NSW Field Orn. Club, Sydney.
- Morris, F.T. 1976. *Aust. Bird Watcher* 6: 183.
- Mueller, O. 1991. *West. Aust. Nat.* 18: 234.
- Nielsen, L. 1960. *Aust. Bird Watcher* 1: 109–12.
- Norris, M. 1995. *Local Birds of Bayside*. Bayside City Council, Melbourne.
- Norton, S.P.W. 1922. *Emu* 22: 39–44.
- O'Grady, G.Y., & T. Lindsey. 1979. *Australian Birds and their Young*. Cassell, Sydney.
- Officer, C. 1991. *Bird Obs.* 713: 106.
- Officer, H.R. 1971. *Australian Honeyeaters*. Third impr. Bird Obs. Club, Melbourne.
- Oliver, D.L., et al. 1999. *Pacific Cons. Biol.* 5: 224–239.
- Orton, C.L.E., & P.T. Sandland. 1913. *Emu* 13: 75–80.
- Osborne, W.S., & K. Green. 1992. *Emu* 92: 93–105.
- Parker, S.A. 1977. *Aust. Bird Watcher* 7: 124–33.
- Parsons, F.E., & J.N. McGillp. 1934. *S. Aust. Orn.* 13: 192–8.

Plate 19

(M.J. Bamford)

Little Wattlebird *Anthochaera chrysoptera* (page 489)
 NOMINATE CHRYSOPTERA: 1 Adult; 2 Juvenile; 3, 4 Adult

Western Wattlebird *Anthochaera lunulata* (page 503)
 5 Adult; 6 Juvenile; 7 Adult

Spiny-cheeked Honeyeater *Acanthagenys rufogularis* (page 508)
 8 Adult; 9 Juvenile; 10 Immature; 11, 12 Adult

- Passmore, M.D. 1982. *Aust. Bird Watcher* 9: 227–37.
- Paton, D.C. 1979. Unpubl. PhD thesis, Monash Univ., Melbourne.
- 1980. *Emu* 80: 213–26.
- 1986. Pp 9–19 In: Ford & Paton 1986.
- , & B.G. Collins. 1977. *Emu* 77: 73–85.
- , — 1983. Pp 235–48 In: Jones & Little 1983.
- , — 1989. *Aust. J. Ecol.* 14: 473–506.
- , & J.B. Paton. 1980. *S. Aust. Orn.* 28: 120–6.
- , & P.A. Paton. 1980. *S. Aust. Orn.* 28: 137–8.
- , & N.C.H. Reid. 1983. *Agricult. Rec.* 10: 8–11.
- , et al. 1983. *Aust. J. Zool.* 31: 147–54.
- , et al. 1985. *Aust. J. Bot.* 33: 271–6.
- , et al. 1988. *S. Aust. Orn.* 30: 158–9.
- , et al. 1994. *S. Aust. Orn.* 31: 151–93.
- Payne, H.W. 1931. *Emu* 30: 228–32.
- Peter, J.M., & M.A. Weston. 1999. *Swift Parrot Monitoring at Melbourne Airport*. Unpubl. Rep. to Melbourne Airport, Melbourne.
- Pizzey, G. 1988. *A Garden of Birds*. Viking O'Neil, Melbourne.
- , & F. Knight. 1997. *The Field Guide to the Birds of Australia*. Angus & Robertson, Sydney.
- Possingham, M.L., & H.P. Possingham. 1997. *S. Aust. Orn.* 32: 145–60.
- Prendergast, H.D.V. 1984. *Corella* 8: 83–8.
- 1987. *Canberra Bird Notes* 12(2): 86–9.
- Preston, I. 1983. *Aust. Bird Watcher* 10: 132–5.
- Price, G. 1977. *Aust. Bird Watcher* 7: 134–6.
- Pyke, G.H., & H.F. Recher. 1988. *Emu* 88: 33–42.
- Quinn, W.L. 1965. *Bird Obs.* 398: 3.
- Readshaw, J.L. 1965. *Aust. J. Zool.* 13: 275–90.
- Recher, H.F. 1975. *Emu* 75: 213–25.
- 1981. Pp 1639–48 In: Keast 1981.
- , & I.J. Abbott. 1970. *Emu* 70: 90.
- , & R.T. Holmes. 1985. Pp 79–96 In: Keast et al. 1985.
- , et al. 1985. *Aust. J. Ecol.* 10: 399–419.
- Reid, N. 1978. *S. Aust. Orn.* 28: 24–5.
- 1986. Pp 64–84 In: Ford & Paton 1986.
- Reilly, P.N. 1991a. *Corella* 15: 134–42.
- 1991b. *Emu* 91: 100–6.
- , et al. 1975. *Emu* 75: 73–6.
- Rix, C.E. 1943. *S. Aust. Orn.* 16: 57–78.
- 1945. *S. Aust. Orn.* 17: 56–72.
- 1976. *Aust. Bird Watcher* 6: 330–54.
- Roberts, G.J. 1979. *The Birds of South-east Queensland*. Queensland Conservation Council, Brisbane.
- Roberts, R.G. 1975. *Aust. Bird Watcher* 6: 61–8.
- Robertson, J.S., & P.F. Woodall. 1983. *Sunbird* 13: 1–14.
- Robinson, A. 1960. *West. Aust. Nat.* 7: 109–15.
- Rogers, K.G., et al. 1986. *Banders Aid*. A. Rogers, St Andrews.
- Rose, A.B. 1974. *Aust. Birds* 9: 26–30.
- 1975. *Aust. Birds* 10: 12–13.
- 1999. *Aust. Bird Watcher* 18: 26–34.
- Ryan, J.V. 1953. *Emu* 53: 331.
- Sargent, O.H. 1928. *Emu* 27: 185–92.
- Saunders, A.S.J. 1993. *Aust. Bird Watcher* 15: 49–59.
- , et al. 1995. *Emu* 95: 297–300.
- Saunders, D.A., & J.A. Ingram. 1995. *Birds of Southwestern Australia*. Surrey Beatty, Sydney.
- Saunders, J. 1983. *S. Aust. Orn.* 29: 40–1.
- Schodde, R., & B. Glover. 1955. *S. Aust. Orn.* 21: 65–72.
- Sedgwick, E.H. 1937. *Emu* 36: 291–3.
- 1940a. *Emu* 40: 129–52.
- 1940b. *Emu* 40: 237–45.
- 1949a. *Emu* 48: 212–42.
- 1949b. *West. Aust. Nat.* 2: 25–33.
- 1969. *West. Aust. Nat.* 11: 65–6.
- 1973a. *West. Aust. Nat.* 12: 131–9.
- 1973b. *West. Aust. Nat.* 12: 147–55.
- 1984. *Aust. Bird Watcher* 10: 157–60.
- 1986. *Aust. Bird Watcher* 11: 171–80.
- 1988. *Aust. Bird Watcher* 12: 222–32.
- Sedgwick, L.E. 1964. *Emu* 64: 7–20.
- Serventy, D.L. 1937. *Emu* 37: 90–4.
- 1938. *Emu* 37: 269–73.
- 1948. *Emu* 47: 241–86.
- Serventy, V. 1958. *Emu* 58: 5–20.
- Shanks, D. 1949. *Emu* 49: 132–41.
- Sherlock, P. 1990. *Bird Obs.* 702: 107.
- Sibson, R.B. 1987. *Notornis* 34: 81–3.
- Smedley, D.I. 1979. *Aust. Birds* 13: 56.
- Smith, L., et al. 1984. *Aust. Birds* 18: 17–32.
- Smith, P. 1984. *Emu* 84: 200–10.
- Sonter, C. 1980. *Canberra Bird Notes* 5(3): 3–23.
- Souter, T.G. 1942. *S. Aust. Orn.* 16: 27–30.
- Stidolph, R.H.D. 1927. *Emu* 26: 212–19.
- Storr, G.M. 1947. *S. Aust. Orn.* 18: 31–6.
- 1964. *Emu* 64: 172–80.
- 1965. *West. Aust. Nat.* 9: 187–96.
- Stove, K. (Ed.) 1994. *S. Aust. Orn.* 31: 195–265.
- Sullivan, A.M. 1911. *Emu* 11: 114–19.
- Sutton, J. 1927. *S. Aust. Orn.* 9: 5–29.
- 1928a. *S. Aust. Orn.* 9: 173–83.
- 1928b. *S. Aust. Orn.* 9: 215–18.
- 1931a. *S. Aust. Orn.* 11: 74–92.
- 1931b. *S. Aust. Orn.* 11: 112–19.
- 1932. *S. Aust. Orn.* 11: 174–84.
- Talmage M.E. 1993. *VORG Notes* 28: 19–25.
- Taylor, I. 1987. *Canberra Bird Notes* 12(1): 8–13.
- Taylor, P.W. 1987. *S. Aust. Orn.* 30: 62–73.
- Terrill, S.E., & C.E. Rix. 1944. *S. Aust. Orn.* 17: 17–18.
- Thomas, D.G. 1968. *Emu* 68: 42–84.
- 1969. *Emu* 68: 249–71.
- Thomas, R., & J. Wheeler. 1983. *Birds of the Ballarat Region*. Authors, Linton, Vic.
- Tidemann, S.C., et al. 1988. *Corella* 12: 1–6.
- Timewell, C.A.R. 1997. Unpubl. BSc(Hons) thesis, Monash Univ., Melbourne.
- Tingay, A., & S.R. Tingay. 1983. *Bird Communities in the Karri Forest of Western Australia*. Unpubl. rep. to Aust. Conserv. Found.
- Trill, B.J. 1985. *Aust. Bird Watcher* 11: 74–9.
- , et al. 1996. *Aust. Bird Watcher* 16: 309–26.
- Turner, R.J. 1992. *Corella* 16: 65–74.
- Vaughton, G. 1990. *Aust. J. Ecol.* 15: 109–16.
- Veerman, P.A. 1994. *Aust. Bird Watcher*: 15: 250–9.
- Vestjens, W.J.M. 1973. *Emu* 73: 107–12.
- Wakefield, N.A. 1956. *Victorian Nat.* 73: 46.
- 1958. *Emu* 58: 163–94.
- Watkins, R., & G. Watkins. 1994. *Wingspan* 4(2): 28–9.
- Watson, I.M. 1955. *Emu* 55: 312–13.
- Whatmough, R.J. 1978. *S. Aust. Orn.* 28: 1–15.
- Wheal, M. 1996. *Emu* 96: 55–61.
- Wheeler, W.R. 1967. *A Handlist to the Birds of Victoria*. Vict. Orn. Res. Grp, Melbourne.
- 1972. *Birds of the Dandenongs*. Vic. Field Nat. Club, Melbourne.
- Whelan, R.J., & A.H. Burbidge. 1980. *Aust. J. Ecol.* 5: 1–7.
- White, S.A. 1914. *S. Aust. Orn.* 1(2): 13–15.
- Whittell, H.M. 1933. *Emu* 32: 182–9.
- Winslet, J., & B. Winslet. 1987. *S. Aust. Orn.* 30: 103–10.
- Woinarski, J.C.Z. 1984. *Emu* 84: 137–41.
- 1989. *Aust. Wildl. Res.* 16: 217–38.
- , et al. 1989. *Aust. J. Ecol.* 14: 227–34.

Plate 20

(P. Slater)

Helmeted Friarbird *Philemon buceroides* (page 529)
 SUBSPECIES YORKI: 1 Adult; 2 Juvenile; 3 Immature;
 4, 5 Adult
 SUBSPECIES GORDONI: 6 Adult
 SUBSPECIES AMMITOPHILA: 7 Adult

Silver-crowned Friarbird *Philemon argenteiceps* (page 538)
 NOMINATE ARGENTICEPS: 8, 9, 10 Adult
 SUBSPECIES KEMPI: 11 Juvenile; 12 Immature

Noisy Friarbird *Philemon corniculatus* (page 546)
 SUBSPECIES MONACHUS: 13 Adult; 14 Juvenile; 15 Immature;
 16, 17 Adult

Sponsor: JT Appleton



MICHAEL J. BAMFORD, 2000

Volume 5, Plate 18 [caption errors corrected from original]

Red Wattlebird *Anthochaera carunculata* (page 463)

NOMINATE CARUNCULATA: 1 Adult with large wattles; 2 Adult with small wattles; 3 Juvenile; 4 Adult

Yellow Wattlebird *Anthochaera paradoxa* (page 482)

NOMINATE PARADOXA: 5 Adult with breeding wattles; 6 Adult with non-breeding wattles; 7 Juvenile; 8, 9 Adult

© [Mike Bamford](http://www.mikebamford.com)