# Order **PASSERIFORMES**

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

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

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

The Passeriformes divide into two main groups:

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

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

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

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

MENURIDAE (lyrebirds): two species in one genus; endemic to Aust.;

ATRICHORNITHIDAE (scrub-birds): two species in one genus; endemic to Aust.;

CLIMACTERIDAE (A'asian treecreepers): six species in two genera breeding in Aust.;

MALURIDAE (Australopapuan fairy-wrens, emu-wrens and grasswrens): 22 breeding species in three genera in Aust.;

MELIPHAGIDAE (honeyeaters and Aust. chats): 76 species in 26 genera in Aust. and NZ, all breeding;

PARDALOTIDAE (pardalotes, scrubwrens, thornbills and allies): 51 species (one extinct) in 15 genera in HANZAB region, all breeding;

PETROICIDAE (A'asian robins): 23 species in eight genera in HANZAB region, all breeding;

ORTHONYCHIDAE (logrunners): two breeding species in one genus in Aust.;

POMATOSTOMIDAE (A'asian babblers): four breeding species in single genus in Aust.;

CINCLOSOMATIDAE (whipbirds, wedgebills, quail-thrushes and jewel-babblers): eight breeding species in two genera in Aust.;

NEOSITTIDAE (sitellas): single species breeding in Aust.;

PACHYCEPHALIDAE (whistlers, shrike-thrushes and allies): 17 species in seven genera in HANZAB region, all breeding;

DICRURIDAE (monarchs, flycatchers, fantails and drongos): 19 species in seven genera in HANZAB region, all breeding;

CAMPEPHAGIDAE (cuckoo-shrikes, trillers and minivets): eight species (one extinct) in two genera in HANZAB region, all breeding;

ORIOLIDAE (Old World orioles and figbirds): three species in two genera in Aust., all breeding;

ARTAMIDAE (woodswallows, butcherbirds and currawongs): 14 species in four genera in HANZAB region, all breeding;

PARADISAEIDAE (birds of paradise): five breeding species in two genera in Aust.;

CORVIDAE (crows and jays): six breeding species in single genus in Aust. and NZ, including one introduced to NZ;

CORCORACIDAE (Aust. mudnesters): two species in two monospecific genera, endemic to Aust.;

CALLAEIDAE (NZ wattlebirds): three species (one extinct) in three monospecific genera, endemic to NZ;

LANIIDAE (shrikes): two species in HANZAB region, one accidental to Prince Edward Is, the other accidental to Christmas I.;

PTILONORHYNCHIDAE (bowerbirds): ten species in seven genera in Aust. (nine species) and NZ (one species), all breeding; Piopio of NZ probably extinct (Heather & Robertson 1997);

ALAUDIDAE (larks): two breeding species in HANZAB region (including one successfully introduced to Aust. and NZ);

MOTACILLIDAE (wagtails and pipits): eight species in two genera in HANZAB region, only two breeding (one on South Georgia), the rest non-breeding visitors or accidentals;

PRUNELLIDAE (accentors): one species successfully introduced to NZ;

PASSERIDAE (Old World sparrows and A'asian finches): 22 species in nine genera (including four successful introductions) in HANZAB region, all breeding;

FRINGILLIDAE (Old World finches): seven species in four genera in HANZAB region, all introduced except one naturally occurring vagrant to South Georgia;

EMBERIZIDAE (buntings, cardinals, tanagers and allies): two successfully introduced species, occurring NZ and Lord Howe I.;

NECTARINIIDAE (sunbirds and spiderhunters): single breeding species in Aust.;

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, taxomony 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 widepread, and of two distinct types: (1) lateral posture, in which sunning bird squats or sits down, usually on ground, and leans to one side exposing the flank or the 'sun-wing', which has been lowered and partly unfolded, and the fanned tail, which has been brought round to the same side; and (2) spread-eagle posture, in which bird squats or lies flat with both wings open and tail fanned (details in Campbell & Lack 1985; Simmons 1986).

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

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

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

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

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

## REFERENCES

Ames, P.L. 1971. *Bull. Yale Peabody Mus. Nat. Hist.* 37: 1–194.
—— 1987. *Emu* 87: 192–5.
Baverstock, P.R., *et al.* 1991. *Aust. J. Zool.* 39: 417–25.
——, *et al.* 1992. *Aust. J. Zool.* 40: 173–9.
Beddard, F.E. 1898. *The Structure and Classification of Birds*. Longmans, Green & Co., London.
Berger, A.J. 1956. *Am. Midl. and Nat.* 55: 326–33.
Boles, W.E., & N.W. Longmore. 1985. *S. Aust. Orn.* 29: 213–19.
Brown, J.L. 1987. *Helping and Communal Breeding in Birds*. Princeton Univ. Press, Princeton, New Jersey.
Campbell, B., & E. Lack. (Eds) 1985. *A Dictionary of Birds*. T. & A.D. Poyser, Calton, England.
Christidis, L. 1991. *Chromosomes Today* 10 (1990): 279–94.
——, & W.E. Boles. 1994. *RAOU Monogr.* 2. Melbourne.
——, & R. Schodde. 1991. *Ibis* 133: 277–85.
Clench, M.H. 1978. *Condor* 80: 423–30.
Dow, D.D. 1978. *Int. Orn. Cong. Proc.* 17: 875–81.
—— 1980. *Emu* 80: 121–40.
Ehrlich, P.R., *et al.* 1986. *Auk* 103: 835.
——, *et al.* 1988. *The Birder's Handbook: A Field Guide to the Natural History of North American Birds*. Simon & Schuster, New York.
Farner, D.S., *et al.* (Eds) 1971. *Avian Biology. 1*. Academic Press, New York.
Ford, H.A. 1989. *Ecology of Birds*. Surrey Beatty, Sydney.
Frith, C.B. 1994. *Condor* 96: 552–5.
Hartshorne, C. 1973. *Born to Sing*. Indiana Univ. Press, Bloomington, Indiana.
Heather, B.D., & H.A. Robertson. 1997. *The Field Guide to the Birds of New Zealand*. OUP, Auckland.
Kroodsma, D.E. 1996. Pp 3–19 In: Kroodsma & 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.
Ridgeway, 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 ARTAMIDAE   woodswallows, butcherbirds, currawongs and Australian Magpie

A small but morphologically rather diverse family of medium-small to large passerines. The family comprises 24–25 species in six genera, distributed through s. and se. Asia to Wallacea, Aust., New Guinea and islands of sw. Pacific Ocean (Sibley & Monroe 1990; Monroe & Sibley 1993; Christidis & Boles 1994; DAB): (1) BUTCHERBIRDS *Cracticus*: six (seven in DAB) species, four (or five) in HANZAB region, confined to Aust. and New Guinea; (2) monotypic AUSTRALIAN MAGPIE *Gymnorhina tibicen*, in Aust. and Trans-Fly region of New Guinea, and introduced to NZ and Fiji; (3) CURRAWONGS *Strepera*: three species, endemic to Aust. (with outlying subspecies on Lord Howe I.); (4) WOODSWALLOWS *Artamus*: 11 species, six in HANZAB region, distributed from India to se. Asia, Wallacea, New Guinea, Aust. and sw. Pacific Ocean (with one species, White-breasted Woodswallow A. *leucorynchus*, widespread from Andaman Is E to Philippines and Palau, and SE through Wallacea, New Guinea, Aust. and Vanuatu, New Caledonia and Fiji); (5) monotypic BORNEAN BRISTLEHEAD *Pityriasis gymnocephala* from Borneo; and (6) PELTOPS *Peltops*: two species, endemic to New Guinea. In HANZAB region, total of 14 (or 15 [DAB]) species in four genera. Most early authors place the butcherbirds, Australian Magpie and currawongs in the family Cracticidae, separate from the woodswallows, in the family Artamidae (Amadon 1951; Peters). However, most recent works (Sibley & Monroe 1990; Monroe & Sibley 1993; DAB) combine these genera on the basis of shared cranial features (Pycraft 1907; Leach 1914; McEvey 1976; see details below), DNA–DNA hybridization studies (Sibley & Ahlquist 1985, 1990) and protein electrophoresis (Christidis & Schodde 1991). Sibley & Monroe (1990) and Monroe & Sibley (1993) place all species in the tribe Artamini, within the subfamily Corvinae in the extended family Corvidae. The woodswallows are genetically similar to butcherbirds, Australian Magpie and currawongs, as shown by DNA–DNA hybridization ($\Delta T_{50}H$ = 4.9; Sibley & Ahlquist 1985), and accordingly we follow DAB in combining all species in the family Artamidae, part of the corvoid lineage of passerines.

Size varies greatly, from medium-small (woodswallows) to medium-sized (butcherbirds, Bornean Bristlehead, peltops) and large (currawongs, Australian Magpie). In HANZAB region, Little Woodswallow *Artamus minor* smallest (length *c.* 14 cm, weight *c.* 17 g) and Grey Currawong *Strepera versicolor* largest (length *c.* 50 cm, weight *c.* 400 g). Wings fairly long and pointed in most species, but more rounded and shorter in butcherbirds, and rather long, broad and triangular in woodswallows; ten primaries, with p10 short in most species and vestigial in wood-swallows. Most species have ten secondaries, but 11 in Australian Magpie. Tail varies from fairly short (*Gymnorhina*, *Artamus*, Bornean Bristlehead) to long (*Strepera*), medium length in rest; usually rather square or gently rounded at tips, though *Peltops* have fairly long, forked tail. Base of maxilla rounded and raised. Bill fairly long in most species, but rather short and rather conical in woodswallows. Bill, bluish white to pale grey basally with dark tip in adults of most species except *Strepera*, *Peltops* and Bornean Bristlehead, in which bills entirely black. Nares amphirhinal, fully exposed as bare slits. Tarsus varies from fairly short in most species to fairly long in *Gymnorhina*. Tarsal scaling laminiplantar; acrotarsium tends to be more weakly scaled in *Strepera*. Orbital and palate region of skull distinct. Shared osteological characteristics include (DAB): single pneumatic fossa in humerus; narrow palate with elongated palatines, constricted medial shelf and long pointed transpalatine processes; pterygoids fused to palatine shelf; orbital processes on quadrates thin and long; zygomatic processes distinctly bifurcate; palate heavily ossified with nasal floor and palatal aperture covered by fusion of maxillo-palatine processes and bony maxillary shelf; ectethmoids thin and narrowly winged; and lack cranial foramina above optical foramen. In addition, genera have the following diagnostic features: *Cracticus* has robust and sharply hooked bill for killing prey; *Gymnorhina* has straighter bill lacking distinct hook or maxillary notch and also has shallower temporal fossae and shorter post-orbital processes than butcherbirds; *Gymnorhina* and *Strepera* have bluntly bifurcate zygomatic process compared with *Cracticus* and *Artamus*, which are more acutely bifurcate; and *Artamus* rather short-toed, with flared jugal bars and, uniquely among passerines, diagnostic pectoral and lumbar powder-downs.

Adult plumages vary, from entirely black (in Black Butcherbird *Cracticus quoyi* [though see Plumages of that account for details]) to diagnostically pied (most butcherbirds, Australian Magpie, Pied *Strepera graculina* and Black S. *fuliginosa* Currawongs) or with more varying combinations of greys, browns, white and black (e.g. Grey Currawong *Strepera versicolor*, and woodswallows). Powder-down of woodswallows imparts distinctive bloom to plumage. Juveniles tend to be more mottled or barred than adults and, in woodswallows, juveniles have narrow whitish streaking to head and body. Sexes identical or very similar in most species, but Masked *Artamus personatus* and White-browed A. *superciliosus* Woodswallows show distinct dimorphism in plumage. Nestlings of at least some species hatch with sparse down. Post-juvenile (first pre-basic) moult partial, resulting in first immature (first basic) plumage, which in some species (such as woodswallows) is similar to adults, but in others (e.g. Grey Butcherbird *Cracticus torquatus*) differs considerably from adults. Most species acquire adult plumage in complete first immature post-breeding (second pre-basic) moult when *c.* 1 year old. However, some species do not acquire adult plumage till

>1 year old (e.g. Australian Magpie). Primaries moult outward, starting at p1. Moult of tail centrifugal. Moult of tail and body usually starts about same time as primaries.

In Aust., representatives of the family occupy a wide range of habitats, from coasts (including beaches) to alpine highlands, and in all climatic zones: arid, semi-arid, temperate, subtropical and tropical; Australian Magpie one of the most widespread species in Aust. Most butcherbirds, woodswallows and Australian Magpie commonly in open habitats, including open sclerophyll woodlands and forests, including savanna, typically dominated by eucalypts but also dominated by acacias, paperbarks, casuarinas or cypress-pines *Callitris*, or shrublands of acacias or chenopods, and in lightly timbered farming land; woodswallows also often in grasslands (e.g. with scattered shrubs or trees) shrublands, and over open water such as wetlands and floodplains. Currawongs typically in more heavily forested habitats, such as wet and dry sclerophyll forests dominated by eucalypts, and rainforests, but also occur in open woodlands and forests and timbered farming land (as above). Some Aust. species, such as Australian Magpie, Pied Currawong and Grey Butcherbird, common and familiar urban birds, occurring in cities, suburbs and rural and regional towns, in parks, gardens and schoolgrounds; also use a range of other modified habitats, such as airfields, ski facilities in alpine areas, and exotic pine plantations. Other species, such as Black Butcherbird, more commonly in denser habitats, such as rainforests, gallery forests and mangroves, as well as some sclerophyll forests and woodlands. Other habitats used include coastal heaths, alpine herblands and heathlands, and mangrove associations. Extralimitally, habitat of butcherbirds, woodswallows and Australian Magpie much as above, though additionally reported from swamp forest, monsoon forest, secondary forest growth, clearings in and edges of forests, grasslands, ricefields, teak plantations and coconut groves, mangroves, swamps and lakes; Ivory-backed Woodswallow moderately common in selectively logged lowland forest on Taliabu. On Sulawesi, White-breasted Woodswallow often forages round herds of cattle or buffalo grazing in open valleys. New Guinean *Peltops* occupy rainforest and swamp forest, commonly at forest edges, and in secondary growth of forest clearings; Bornean Bristlehead occupies lowland forest, including peat swamp forest, of Borneo (King *et al.* 1978; Smythies 1981; Watling 1983; van Marle & Voous 1988; Coates 1990; Sibley & Monroe 1990; Coates *et al.* 1997; Coates & Peckover 2001; Robson 2002).

Patterns of movements in HANZAB region highly diverse, with Aust. species ranging from sedentary to highly mobile and dispersive (e.g. White-browed Woodswallow). All Aust. butcherbirds, currawongs and Australian Magpie sedentary or resident, e.g. Australian Magpie sedentary and territorial throughout year, with territories often stable from year to year. However, currawongs appear to be partial altitudinal migrants from highlands of Tas. and se. mainland Aust. in winter. Woodswallows all show varyingly complex and often unpredictable patterns of movement: Black-faced Woodswallow *Artamus cinereus* considered predominantly sedentary, with dispersive characteristics; other Aust. *Artamus* tend to be migratory or undertake long-distance movements, including: general N–S movement, largely vacating n. coast of Aust. during the wet season (e.g. Little Woodswallow A. *minor*); inland movements on a SE–NW axis (White-breasted and Masked Woodswallows); inland big-circle pattern of movement, apparently moving S by a more inland route than on northward passage (White-browed Woodswallow); and migration out of Tas. in winter, in Y pattern of n. movement, along the e. coast of Aust. and through w. Vic. into SA (Dusky Woodswallow A. *cyanopterus*). Movements of some woodswallows, however, appear highly erratic, and birds may be absent from an area for several years, before abruptly arriving in large numbers, sometimes to breed, then leaving just as suddenly; such movements or occurrence may be influenced by drought or availability food or both (e.g. White-browed Woodswallow, Masked Woodswallow). Some species show geographical variation in patterns of movements, e.g. White-breasted Woodswallows generally considered resident or present throughout year in n. and ne. Aust., but migratory in much of e. Aust., though with broad overlap between breeding and non-breeding ranges, and with erratic or unclear patterns of occurrence in inland regions (Griffioen & Clarke 2002; see species accounts). Extralimital taxa largely not well known; Australian Magpie resident in s. Trans-Fly region of New Guinea (Coates 1990); and White-breasted and other woodswallows described as resident in se. Asia, with Ashy Woodswallow, and no doubt others, locally dispersive or otherwise moving locally (White & Bruce 1986; van Marle & Voous 1988; Dickinson *et al.* 1991; Robson 2000).

All predominantly insectivorous, taking wide range of invertebrates, mainly insects; most species also take fruit and seeds occasionally and woodswallows have brush-tongue and often take nectar. Larger species (butcherbirds, currawongs and Australian Magpie) also take small vertebrates and some, such as Pied and Black Currawongs, and Australian Magpie, eat carrion. Woodswallows and *Peltops* predominantly aerial foragers, catching prey mostly by screening in continuous flight, but also by sally-striking; also glean prey from ground and vegetation (e.g. trunks, branches, foliage) and probe flowers for nectar. Butcherbirds and currawongs largely terrestrial and arboreal, foraging mainly on ground and in vegetation; butcherbirds usually solitary predators, foraging mainly by sallying, mostly sally-pouncing or sally-striking; currawongs glean and probe from ground, fallen logs and from standing vegetation. Australian Magpie gregarious, foraging mostly on ground, often round human habitation or activities, mainly by gleaning and probing, using bill to dig in or manipulate substrates. Bornean Bristlehead arboreal, gleaning prey from leaves, twigs and tree trunks, and occasionally foraging by sally-pouncing or sally-gleaning. Large prey items often manipulated before being eaten, though handling of prey less common in *Peltops*. Kleptoparasitism recorded for some species, such as White-browed and Dusky Woodswallows, Pied Currawong and Australian Magpie. Caching

recorded in butcherbirds (e.g. Grey Butcherbird), currawongs (e.g. Black Currawong) and Australian Magpie. Some, especially woodswallows and Australian Magpie, sometimes forage in large flocks, both of conspecifics and other Artamidae; currawongs can occur in large flocks in autumn–winter; butcherbirds generally forage singly or in twos; Bornean Bristlehead appear to forage in small flocks; and *Peltops* probably forage singly, in twos or small groups. All Artamidae regurgitate oblong pellets of hard, indigestible parts of food. In butcherbirds, currawongs and Australian Magpie, males have larger bills than females, suggesting possible sexual partitioning in foraging (Coates 1990; Coates *et al.* 1997; Colenutt 2002; DAB).

Social organization within the family quite diverse, with some species having quite complex social systems. However, many species, especially outside Aust., poorly known. Most species appear to breed in simple monogamous pairs, but Australian Magpie often lives in groups throughout year, sometimes leading to polygamous bonds, with both polygyny and polyandry recorded. Plural breeding occasionally recorded in Pied Butcherbird *Cracticus nigrogularis*. Gregariousness varies greatly. Butcherbirds and Lowland Peltops *Peltops blainvillii* usually seen in pairs or singly throughout the year; currawongs usually seen in pairs during breeding season, but often form flocks during non-breeding season; woodswallows often seen in flocks at any time of year, and several species breed in loose colonies. Bornean Bristlehead usually seen in small groups of 6–10 birds. Australian Magpies occur in groups throughout year, size of which varies greatly, with some complex geographical trends in group-size. Co-operative breeding widespread in several species, e.g. in Aust., recorded in White-breasted, Black-faced, Dusky and Little Woodswallows, Grey and Pied Butcherbirds, Australian Magpie, and possibly in Black Butcherbird. Division of parental care varies between species: often shared between sexes, and with helpers, in co-operatively breeding species (e.g. Dusky Woodswallow), but in some species, almost all parental care by female only (e.g. Australian Magpie); also see discussion of breeding below. Most species defend a territory, at least during breeding season. However, semi-colonial species such as White-browed Woodswallow defend only immediate area round nest. At least one species, Australian Magpie, defends a large all-purpose territory throughout the year, as apparently do Pied and Grey Butcherbirds. All woodswallows roost communally, often huddling together side by side on branches, or clustering together on a surface such as a tree-trunk. Social behaviour well known for some species, but poorly known for most. Some species show play behaviour, e.g. Black Currawong and Australian Magpie. Most species are vigilant in defence of nest and many attempt to drive off potential predators by swooping at them. Sexual behaviour generally poorly known, though aspects of courtship known in a few species (Coates 1990; Coates *et al.* 1997; Colenutt 2002; see species accounts).

Vocalizations of family quite varied. The butcherbirds, currawongs and Australian Magpie tend to have loud piping or ringing songs. Most woodswallow vocalizations tend to have a twittering or chattering quality (see species accounts). The most commonly uttered vocalizations from the two peltops are a series of rapidly repeated short, sharp notes, with that of the Lowland Peltops being likened to the sound made when winding a clock. The calls of the Bornean Bristlehead have been described as having a nasal and whining quality. Mimicry has been recorded in several woodswallows, butcherbirds, and the Australian Magpie, and possibly also in Pied Currawongs. Several species, such as Grey and Pied Butcherbirds, known to perform complex duets (Coates 1990; Colenutt 2002; see species accounts).

Breeding varies within family. Most species appear to nest in solitary pairs. However, several species, including some woodswallows and butcherbirds and Australian Magpie, also breed co-operatively (see discussion above); and Masked and White-browed Woodswallows sometimes nest in loose colonies, sometimes mixed with other species of woodswallow. Plural breeding recorded occasionally in Pied Butcherbirds; and Magpies occasionally polygamous (see above). Most species build nests in vertical or horizontal forks in branches or sometimes trunks of trees, though woodswallows use a wider variety of sites, including hollows; artificial sites are sometimes used by woodswallows (e.g. White-breasted, White-browed and Black-faced Woodswallows) and Australian Magpie. Butcherbirds, currawongs and peltops usually nest quite high, but woodswallow nests tend to be lower. Build rather insubstantial, untidy, and often shallow, open, cup- or bowl-shaped nests of sticks, twigs, rootlets, sometimes with other plant material such as strips of bark, casuarina needles or vine tendrils, and usually lined with finer and softer material, such as fine grass, rootlets, shredded bark, casuarina needles, wool, hair or fur, though in some species (e.g. White-breasted, White-browed and Dusky Woodswallows, and Black Butcherbird) nests are sometimes unlined; some species, such as Magpie and butcherbirds, occasionally include artificial materials, such as wire and string. In most species, nests built by both sexes; in some species, nests built only (e.g. Australian Magpie) or usually (e.g. Pied Currawong) by female. Eggs mostly varyingly oval, though some can be pyriform; usually smooth; usually glossy but varying. Ground-colour of eggs varies, but prominent tones are white (particularly in woodswallows), green, brown and grey, sometimes with shades of olive, blue, purple or red. Eggs usually marked with spots and blotches of varying shades of brown, grey, red or purple, and some also have underlying markings, usually of shades of grey. Most species lay eggs that, at least sometimes, have markings concentrated or forming zone at large end. Eggs occasionally unmarked. Clutch-size one to six, but usually 2–4; larger clutches recorded occasionally, but these probably laid by two or more females. Laying interval probably 24 h in most species, possibly longer (48 h) in Pied Butcherbird. Incubation by both sexes (e.g. in woodswallows and possibly Black Butcherbird), or by female only

(e.g. in Australian Magpie and probably most currawongs and butcherbirds); in co-operatively breeding species (e.g. Black-faced Woodswallow and Grey Butcherbird), helpers also assist with incubation. Incubation period, 11–17 days for woodswallows; roughly 19–23 days for butcherbirds, currawongs and Magpie. Young fed by both sexes; brooding by both sexes in woodswallows, by female only in butcherbirds (e.g. Grey Butcherbird) and currawongs (e.g. Pied Currawong), and usually by female only in Australian Magpie; in co-operatively breeding species, young can be brooded and fed by helpers. Fledging period 12–20 days in woodswallows, 21–33 days in butcherbirds, estimated 28–37 days in currawongs, and 30–34 days in Magpie. In Aust., parasitized by Pallid Cuckoo *Cuculus pallidus*, bronze-cuckoos *Chrysococcyx*, Common Koel *Eudynamys scolopacea* and Channel-billed Cuckoo *Scythrops novaehollandiae* (Coates 1990; Colenutt 2002; DAB; see species accounts).

No species currently listed as globally threatened by Stattersfield & Capper (2000); the Bornean Bristlehead is considered near threatened (Colenutt 2002). In Aust., C. York Pen. subspecies *normani* of Black-faced Woodswallow considered near threatened, with declines in population attributed to changes in fire regimes associated with pastoralism, resulting in loss of grasslands and increasing density of woodlands. The Torres Str subspecies of the Black Butcherbird *C.q. alecto* is considered near threatened; and the Black Currawong of King I. *S.f. colei* is vulnerable. Two subspecies of the Pied Currawong, *S.g. crissalis* of Lord Howe I. and *S.g. ashbyi* of w. Vic. are considered endangered and critically endangered respectively (Garnett & Crowley 2000).

## REFERENCES

Amadon, D. 1951. *Am. Mus. Novit.* 1504: 1–33.
Christidis, L., & R. Schodde. 1991. *Ibis* 133: 277–85.
——, & W.E. Boles. 1994. *RAOU Monogr.* 2.
Coates, B.J. 1990. *The Birds of Papua New Guinea. 2.* Dove Publs, Alderley, Qld.
——, & W.S. Peckover. 2001. *Birds of New Guinea and the Bismarck Archipelago.* Dove Publs, Alderley, Qld.
——, *et al.* 1997. *A Guide to the Birds of Wallacea.* Dove Publs, Alderley, Qld.
Colenutt, S. 2002. *Oriental Bird Club Bull.* 35: 75–7.
Dickinson, E.C., *et al.* 1991. *BOU Checklist* 12.
Garnett, S.T., & G.M. Crowley. 2000. *The Action Plan for Australian Birds 2000.* Env. Aust., Canberra.
Griffioen, P.A., & M.F. Clarke. 2002. *Emu* 102: 99–125.
King, B., *et al.* 1978. *Birds of South-East Asia.* Collins, London.
Leach, J.A. 1914. *Emu* 14: 2–38.
McEvey, A. 1976. *Int. Orn. Congr. Proc.* 16: 150–60.

Monroe, B.L. Jr., & C.G. Sibley. 1993. *A World Checklist of Birds.* Yale Univ. Press, New Haven, CT.
Pycraft, W.P. 1907. *Proc. Zool. Soc. Lond.* 1907: 352–79.
Robson, C. 2000. *A Field Guide to the Birds of South-East Asia.* New Holland, London.
—— 2002. *Birds of Thailand.* New Holland, London.
Sibley, C.G., & J.E. Ahlquist. 1985. *Emu* 85: 1–14.
——, & J.E. Ahlquist. 1990. *Phylogeny and Classification of Birds.* Yale Univ. Press, New Haven, CT.
——, & B.L. Monroe, Jr. 1990. *Distribution and Taxonomy of Birds of the World.* Yale Univ. Press, New Haven, CT.
Smythies, B.E. 1981. *The Birds of Borneo.* The Sabah Society, Sabah & The Malayan Nature Society, Kuala Lumpur.
Stattersfield, A.J., & D.R. Capper. (Eds) 2000. *Threatened Birds of the World.* Lynx Edicions, Barcelona, and Birdlife International, Cambridge, UK.
van Marle, J.G., & K.H. Voous. 1988. *BOU Checklist* 10.
Watling, D. 1983. *Emu* 83: 247–61.
White, C.M.N. & M.D. Bruce. 1986. *BOU Checklist* 7.

## *Gymnorhina tibicen* **Australian Magpie**

*Coracias tibicen* Latham, 1802 (1801), *Index Orn.*, *Suppl.*: 27 — Nova Wallia Australi = region of Port Jackson, New South Wales.

The generic name refers to the exposed nostrils of the Australian Magpie (Greek γυμνός, naked, and ρίς, ρῑνός, the nostril); the specific name, based on Latham's (1787; *Gen. Synop. Birds*, *Suppl.* I, p. 122) 'Piping Roller', alludes to the metallic, piping, duetting calls (Latin *tibicen*, a piper or flute-player).

OTHER ENGLISH NAMES Australasian, Tasmanian, Western, White-backed, Island White-backed, Black-backed, Little Black-backed, Varied, Varied-backed, Lesser or Long-billed Magpie; Piping Crow-shrike, Roller or Shrike; Flute-bird, Organ-bird, Piper or Maggie.

POLYTYPIC Subspeciation complex, with broad but poorly understood zones of intergradation between most forms on mainland Aust. (see Geographical Variation). Nominate *tibicen*, coastal and subcoastal se. Aust., from Moreton Bay, se. Qld, to Batemans Bay–Moruya, se. NSW, extending inland to Great Divide; introduced to NI and SI, NZ; *terraereginae* (Mathews, 1912), ne. and central-e. Aust., S from central C. York. Pen. and se. Gulf of Carpentaria Drainage Basin E of Norman R. to coastal Qld between Mary R. and Halifax Bay, thence throughout

Murray–Darling and e. L. Eyre Drainage Basins; *tyrannica* Schodde & Mason, 1999, from Twofold Bay, se. NSW, W through s. Vic., from s. slopes of Great Divide, through se. SA to Ninety-Mile Desert and The Coorong, SA; introduced on King I., Bass Str., and to NI and SI of NZ; possibly this subspecies introduced to Fiji; *hypoleuca* (Gould, 1837), Furneaux Grp in Bass Str., and e. Tas.; *telonocua* Schodde & Mason, 1999, Yorke and Eyre Pens, SA, N to Cowell, sw. Gawler Ras, and W to head of Great Aust. Bight; *dorsalis* A.J. Campbell, 1895, sw. Aust., W from mid-Great Aust. Bight, and N to Gantheaume Bay and mulga–eucalypt line; *longirostris* Milligan, 1903, Pilbara Region, WA, from Shark Bay, N along coast to Dampier Land, and inland to Gregory, Robertson and Carnarvon Ras and L. Carnegie; *eylandtensis* H.L. White, 1922, s. and central Kimberley Div., n. WA, E to s. Arnhem Land, Groote Eylandt and s. Gulf of Carpentaria Drainage Basin in ne. NT and nw. Qld, and S to upper reaches of Victoria R. and n. Barkly Tableland. Extralimitally, subspecies *papuana* Bangs & Peters, 1926, Trans-Fly Region of s. New Guinea. In Aust., subspecies intergrade broadly where they abut (see Geographical Variation).

**FIELD IDENTIFICATION**   Length 41 cm (37–43); wing-span 76 cm (65–85); weight varies significantly with subspecies, with means ranging from 220 g to 350 g. Large, familiar and handsome pied passerine of most of Aust., with fairly long and heavy wedge-shaped bill with pointed and slightly hooked tip; fairly short, square-tipped tail; and long, strong legs, with feathered thighs giving trousered appearance. In flight, wings appear long and triangular, with broad base and pointed tips. Song beautiful and distinctive part of Aust. soundscape. No seasonal variation in plumage, but considerable geographical variation, with eight subspecies that fall into three groups: (1) Black-backed Group (subspecies *longirostris*, *terraereginae*, *eylandtensis* and nominate *tibicen*) of Pilbara Region of WA and n. and e. Aust., and introduced to NZ; (2) White-backed Group (subspecies *tyrannica*, *hypoleuca* and *telonocua*) of se. Aust. and Tas., and also introduced into NZ; and (3) Western Group (*dorsalis*) of sw. Aust. Subspecies hybridize broadly where they abut. In all, ADULT MALE strongly pied: mostly glossy black with white on nape and hindneck, rump and uppertail-coverts, lower underbody, at base of tail (which broadly tipped black) and on leading edge of wing, and, in all, bill whitish with black tip; groups differ mainly in extent of white on upperbody: in Black-backed Group, mantle, scapulars and back (saddle), black; in White-backed and Western Group, upper-body wholly white; hybrids show an admixture of black and white on upperbody. **Adult female and second and some third immatures** inseparable in field; like adult male but with grey tinge to hindneck in Black-backed Group; grey hindneck and saddle in White-backed Group; and black upperbody with white scaling on saddle in Western Group. **Juvenile** much browner than adults with buff supercilium and shorter, dark bill and pinkish gape; upperparts vary with subspecies group: in Black-backed, lower hindneck barred black and buff and black of upperbody finely scaled buff; in White-backed, upper-body mostly grey with strong buff and black barring; and in Western, upperbody black with distinct and broad buff scaling. **First immatures** vary, some very like juveniles of respective subspecies groups, others closer to adult females, but all retain some juvenile plumage of wing and tail, showing moult-contrast with new immature plumage; and bill at first like juvenile, gradually attaining adult coloration by time 1 year old. **Second and third immatures**: Females probably attain adult plumage after moult from first immature, and then as adult female; males apparently indistinguishable from adult female in field, though in Western Group some third imma-ture males either as adult male or distinguishable as third immature (see Plumages, Bare Parts, Ageing).
   BLACK-BACKED GROUP:   **Adult male**   Predominantly glossy black with large white patch on nape and hindneck; rump, uppertail-coverts and most of uppertail, white with broad black tip to tail; lower underbody (belly, vent and undertail-coverts) and base to undertail, white, tipped black as

above; and, on folded wing, large white shoulder-patch (wholly white secondary coverts) and smaller white patch on lower edge of wing (mostly white primary coverts). At times, when perched and especially when on ground, white shoulder- and primary patches can be partly covered by overlying scapulars and feathers of flanks. In flight, upperwing appears largely black, with broad white triangular patch on leading edge covering most coverts; and upperparts appear boldly pied (see above). Underwing similar to upperwing but white triangular patch smaller. Bill, pale bluish-white with distinct black tip. Iris, dull red. Legs and feet, black. **Adult female and second (and possibly some older) immatures** Like adult male but white of nape merges to grey on hindneck; and rump, grey with black streaks and, in fresh plumage, white scalloping. (Also see Second immature below.) **Juvenile** Held for only short time. Plumage of body softer and more loosely textured than in adult. Head, neck and body mostly blackish brown (replacing black of adult) with fine buff to greyish-brown mot-tling or barring to saddle, chin, throat and anterior underbody, and with: narrow buff-brown supercilium; white nape grading to buff-white on upper hindneck, and dark brown, with light-grey mottling, on lower hindneck; off-white rump and upper-tail-coverts and white base to uppertail, which broadly tipped brownish black; and buff-white centre of belly and lower underbody, barred grey-brown on centre of belly, and with white base to undertail. Tail narrowly fringed light grey at tip when fresh. Folded wing similar to adult but white patches smaller and barred black and buff; alula neatly fringed buff; and remiges tinged brown. In flight, triangular patch on lead-ing edge of upperwing messily barred darker and less well defined than in adult; and, from below, wing-patch, whitish barred dark brown, and smaller than in adult. Rectrices nar-rower and more pointed than in adult. Bill shorter and stub-bier than in adult, black to grey-black with pinkish gape. Iris, dark brown. Legs and feet, grey-black or black. **First immature** Varies; upperbody like adult female in some, but paler and less glossy, while in others it is more like juvenile; all retain some juvenile plumage of wing and tail but lack loosely textured body-plumage of juvenile. Head and neck rather similar to juvenile, largely blackish brown, with: pale patch on nape and hindneck varying from like juvenile to like adult female; dif-fuse buff mottling or streaking on lores, ear-coverts, malar area and sides of throat; and chin and centre of throat, light brown to blackish brown, with buff mottling; some also have indis-tinct buff fore-supercilium. Upperbody varies from like juvenile to like adult female. Breast, flanks, belly and thighs, blackish brown, with narrow buff to light brownish-grey scalloping, which reduced or lost with wear; some birds have patchy mix-ture of dark-brown and blackish feathering; lower underbody, white. Retain all or most of juvenile rectrices, which narrower and with more pointed tips than in adults; any new feathers have black tips and show distinct moult-contrast with old

worn juvenile feathers, which have browner tips. Upperwing much as adult but retain all or most juvenile greater primary coverts, alula and remiges and, usually, juvenile outer greater secondary coverts; if replaced, new glossy black tertials show marked moult-contrast with old retained juvenile remiges. Pale triangular leading edge to underwing dirtier white than in adult, with grey mottling. With wear, some birds can appear much paler brownish-grey on head, upperbody and anterior underbody, usually with strong cream or buff scalloping and streaking on lower throat and breast; and tail and remiges appear much paler brown. Bill: at first, black, like juvenile; gradually attain adult coloration, first developing pale patches on base of bill, but while some have adult coloration by *c.* 1 year old, others do not (see Second immature). Pinkish gape of juvenile quickly lost. Iris, dark brown (not red). Legs and feet, black, as adult. **Second immature** While some or most indistinguishable from adult female, an unknown proportion do not attain adult coloration of bill in first year and iris said to stay dark brown (not red) till *c.* 2 years old; such birds, with immature colour of bill and iris and plumage like adult-female, probably second immatures. All have adult-like bare parts by time *c.* 2 years old (see Bare Parts, Ageing).

WHITE-BACKED GROUP: **Adult male** Like adult male Black-backed but whole upperbody, white. **Adult female and second (and possibly some older) immatures** Like adult male White-backed but hindneck, mantle, back, scapulars and rump, grey with black streaks and white scalloping when fresh; and greater secondary coverts, white with black tips and streaks. (Also see Second immature below.) **Juvenile** Like Black-backed juvenile but lower hindneck, mantle, back, scapulars and rump, light brownish-grey, heavily barred or scalloped black, and mottled or tinged buff to cream. **First immature** Like first immature Black-backed, but some birds have lower hindneck, mantle, back, scapulars and rump, grey with black bars and buff scalloping (rather like juvenile White-backed), while others more closely resemble adult female White-backed in dorsal pattern and colour. **Second immature** Some probably distinguished from adult female as in Black-backed Group.

WESTERN GROUP: **Adult male** As adult male White-backed. **Adult female and second immatures** Like adult female White-backed but lower hindneck, mantle, scapulars and back, black with neat white scalloping when fresh; with wear, scalloping lost, leaving these tracts wholly black. **Juvenile** Like juvenile Black-backed but lower hindneck, mantle, scapulars and back, black with broad cream or pale-buff fringing to feathers giving scaly appearance. **First immature** Differs from adult female and juvenile in much the same way as in other groups; upperbody varies from similar to adult female Western to like juvenile Western. **Third immature male** Vary. Some as adult male, with entirely white upperbody; others mostly white with diagnostic faint blackish mottling on mantle, distinguishing from adult male and female.

**Hybrids** Hybrids common in areas where ranges of above groups (and subspecies) overlap. Hybrids of various subspecies of Black-backed × White-backed Groups vary greatly: from mostly black on saddle, but with a few white markings; to patchy black and white (in roughly equal proportion); or with narrow black band across otherwise white upperbody; to mostly white on upperbody with a few black markings (see Plumages, Geographical Variation for further details).

**Similar species** Familiar and highly distinctive, and should not be confused with other species. However, occasionally mistaken for other black-and-white birds by inexperienced observers. Readily distinguished from **Pied Butcherbird** *Cracticus nigrogularis* by, in adult plumages: bold white to greyish-white patch on nape and hindneck, sharply demarcated from black rest of head and neck and black of anterior underbody (Butcherbird has broad white hindneck-collar bordering black

hood and bib, and which is continuous with white of rest of underbody); white tail with broad black tip (Butcherbird has black tail with white tip); and, in flight, black upperwing with large white triangular patch across coverts, with broad and wholly black trailing edge (Butcherbird has more complex pattern of black and white on spread wing, which appears black with conspicuous white stripe on leading edge and extending across innermost secondary coverts and secondaries to reach trailing edge of innerwing, and with isolated white bar near leading edge of outerwing across tips of greater primary coverts and bases of primaries; Magpie also much larger and more thickset with larger, dumpier body. Juvenile and immatures of the two species both broadly patterned much as adults, and distinguished in much the same ways, though dark areas of plumage much browner and white areas tinged grey or buff. In all plumages, readily distinguished from **currawongs** *Strepera* by much more white on head, neck and upperbody, with all having prominent white to greyish-white patch on nape and hindneck (all species of currawongs have entirely black head, neck and upperbody); in flight, wings rather broad, pointed and triangular (in currawongs, wings more rounded with well-fingered tips), and appear largely white (in large triangular patches on leading edge, covering most of coverts) with broad black trailing edge and tip (all currawongs have largely black wings [with no white on leading edge or innerwing], with at most, broad white patch across bases of primaries on outerwing; Grey *Strepera versicolor* and Black *S. fuliginosa* Currawongs also have white trailing edge to outer-wing, which never seen in Magpie); more pointed and, in profile, straight-edged bill (in Pied *S. graculina* and Black Currawongs, bill shows strongly decurved upper mandible in profile; Grey Currawong shares straight-edged profile but bill longer), which, in adults, is pale grey with black tip (all ages of currawong have wholly black bill); dull-red (in adults) or dark-brown (juveniles and immatures) iris (all adult and immature currawongs have conspicuous bright-yellow iris, though iris dark brown in juveniles); somewhat more thickset appearance, with fuller chest (currawongs appear more sleek and slender) and much shorter and broader tail; different and more direct flight, often characterized by rather even and rapid wingbeats (flight of currawongs much more jerky and undulating, often alternating wingbeats with descending glides with wings held against body); and very different calls (see below, and curra-wong accounts). Should not be confused with **Magpie-lark** *Grallina cyanoleuca*; Magpie much larger (roughly twice as big) with largely black head and neck with prominent white patch on nape and hindneck (Magpie-lark has very different and complex facial pattern of black and white); largely black underparts, with white confined to lower underbody (under-body mostly white on Magpie-lark, with contrasting black bib); much larger, heavier bill (Magpie-lark has small and slender bill); dull-red (adult) or dark-brown (juvenile and immature) iris (pale yellow in adult and immature Magpie-lark; dark brown in juveniles); more upright stance; and, in flight, pointed and triangular wings (wings rounded in Magpie-lark), and more direct flight with stronger, deeper wing-beats (flight of Magpie-lark more buoyant); main vocaliza-tions also very different (q.v.).

Usually seen singly, in twos or small groups of up to *c.* 20; less often in larger flocks of up to 100, including when forag-ing and roosting, and very occasionally in flocks of >100. Conspicuous, and usually rather bold and confiding, and often quite tame in and round human habitation and activities, but in areas where people seldom encountered, often shy and unapproachable. Pairs and groups of birds territorial through-out year, but often more aggressive during breeding period; well known for habit of some birds of aggressively swooping people and Dogs in breeding area, sometimes making contact; and often harass larger birds such as raptors. Largely terrestrial,

foraging mostly on ground in open habitats such as grasslands, paddocks and pastures, lawns and gardens, golf courses, sporting fields and parklands, occasionally on beaches; often forage near edges of forested habitats. However, often perch, in upright posture, in trees or on posts, powerlines or fences. Flight swift and direct, with rapid, powerful flapping interspersed with shallower wing-beats. On ground, walk and search rather slowly and deliberately, often pausing, and sometimes breaking into short, rapid run with rather jerky gait. Song familiar, rich, melodious yodelling described as flute- or organ-like carolling, by one or more birds, often while perched with bill pointing skyward; also give quieter Warble, which sometimes includes mimicry, and various other calls given in threat and other circumstances. Sometimes call at night.

**HABITAT** In Aust. and NZ, mainly in open habitats with low and open ground-cover (typically of grasses) or sometimes bare ground, or mosaic of both, and usually with sparse to moderate density of trees for shelter, roosting and nesting, either scattered, in windbreaks or shelterbelts, in patches (including remnants, and riparian or roadside strips of forest or woodland), or in adjacent extensive forests and woodlands. Mainly inhabit grasslands, both native and modified, with some trees (as above); and forests and woodlands bordering or associated with grassland or farmland, or in clearings in such habitats; often in ecotone between forests and woodlands and open habitats. Commonly in settled areas and modified habitats, including open farmland, partly cleared land (for grazing, forestry or other farming activities), and residential areas (from cities to rural towns) usually with trees (Morgan 1918; Ross 1926; Elliott 1934; Hindwood 1940; Crockett 1954; Westerskov 1954; Robinson 1956; McKenzie 1979; Bell 1980; Floyd & Woodland 1981; Innes 1982; Hickson 1984; Jones 1986; I.M. Taylor 1987; Luck et al. 1999; Hughes et al. 2002; Kennedy 2003; Kaplan 2004; Storr 16, 19, 27, 28; Aust. Atlas 1; Vic. Atlas; ACT Atlas; see below). Rare in dense native forests or pine plantations, occurring mostly at edges or in clearings (Carter 1924; Serventy 1948; Child 1975; Stevens 1975; Loyn 1980; Debus 1983b; Vic. Atlas; ACT Atlas; see below). Appear to have benefited from clearing and development in at least some areas (see Threats and Human Interactions). Occur in all bioclimatic zones in Aust. (Moriarty 1972; Baxter & Paton 1998; Aust. Atlas 1, 2; DAB; see Distribution); and range from coasts to alpine areas, where occasionally recorded at elevations of >1850 m asl on Mt Kosciuszko, s. NSW (Chapman 1969; Child 1975; Gall & Longmore 1978; Osborne & Green 1992; ACT Atlas), and at c. 1700 m asl on Mt Ruapehu, NI, NZ (Westerskov 1954). In NZ, forage on ground in open pasture, in paddocks, in grass and cultivated fields (McCaskill 1945; Rankin 1970; Hickson 1984; Veltman 1989a; Veltman & Hickson 1989).

Throughout range in Aust. and NZ, in such disparate areas as semi-arid zone of Aust. and alpine and subalpine zones of Aust. and NZ, mainly in GRASSLANDS, both natural and modified by grazing, either with scattered trees (Campbell 1902; Whitlock 1909, 1910; Westerskov 1954; Warham 1960; Cooper 1974, 1975a; Vestjens & Carrick 1974; Emison & Porter 1978; Pierce 1980; Ford & Bell 1981; McKean 1985; Jones 1986; Brereton et al. 1996; Bourne 2002; Davey 2002; CSN 9), remnant patches or riparian or roadside strips of forest or woodland, or windbreaks and shelterbelts (Fletcher 1918; Russell 1921; Ross 1926; Lamm & Calaby 1950; Westerskov 1954; Robinson 1956; Lord 1957; Napier 1969; Emison & Porter 1978; Ford & Bell 1981; Sedgwick 1986a,b; Er et al. 1995, 1998; Fisher & Goldney 1997; Heather & Robertson 2000; Bourne 2002; Kingston et al. 2002) or in grasslands bordered by extensive forests, woodlands or other wooded habitats (see below), also using grassy clearings in such habitats (e.g. Lamm & Calaby 1950; Kellam 1974; see below). Commonly

in open FARMLAND, especially in NZ, where it is the most commonly used habitat, usually with trees in landscape (as described for grasslands, above), and including pasture, cropland (including crops of Wheat, Corn, Oats and seasonal fodder such as Canola), newly harvested or ploughed paddocks, and partly cleared grazing land (e.g. Orchardist 1901; Webb 1902; Zietz 1914; Campbell 1927, 1929; Irby 1929; Ashby 1930; Thorogood 1941a; Cleland 1942; Westerskov 1954; Robinson 1956; Boehm 1957; Nielsen 1962; Ridpath & Moreau 1966; Green & McGarvie 1971; Gill 1977; Emison & Porter 1978; Ford & Bell 1981; Taylor 1982; Baxter 1989; Veltman 1989a; Loyn 1993; Davis & Recher 1996; Holdsworth 1997; Heather & Robertson 2000; Hughes et al. 2002); often occur round homesteads in farming land and other rural areas (Littler 1903a; Fletcher 1918; Russell 1921; Carter 1924; Mellor 1925; Lord 1957; Napier 1969). Prefer pasture on improved soils where invertebrates abundant (Taylor 1982). Also often inhabit (though less so in NZ), RESIDENTIAL AREAS, including cities, suburbs, regional centres and rural towns, where commonly occur in parks and reserves (including bushland remnants), gardens (including on lawns) and footpaths and streets (Mellor 1926b, 1927; Souter 1930; McGilp & Parsons 1937; Roberts 1963; Crawford 1972; Morris 1975, 1986; Gibson 1977; Price 1977; Fielding 1979; Jones 1981; Mason 1985; Green 1986; Guest & Guest 1987, 1993; McKilligan & McKilligan 1987; Gill 1989; Davey 1995; Griffin 1995; Brereton et al. 1996; Brooker & Brooker 1998; Gibb 2000; Fulton 2002; O'Leary & Jones 2002; White et al. 2005; ACT Atlas; ACT Bird Reps), and other open spaces, such as golf courses and playing fields (Hopkins 1948; Binns 1953; Sibson 1958; Middleton 1969; Price 1977; Baker 1980; Bell 1983; Ratkowsky 1993b; Day 1995; Griffin 1995; Paton 1996; McKinlay 2001; O'Leary & Jones 2002), school and university grounds (Fletcher 1934; Middleton 1969; Shurcliff & Shurcliff 1973; Preston 1983; Hickson 1984), or airstrips (Tindale 1930; Moeed 1976; Sonter 1980; Gynther et al. 1995; Steele 1997; Woodall 1999; Storr 35). In Canberra, while common in all suburban areas, all territories that produced young were in areas that contained well-established gardens and many large trees (Davey 1995). Also recorded in clearings for roads and powerlines (Bell 1980; ACT Atlas). In Aust., also often associated with DRY OPEN WOODLANDS AND FORESTS, typically dominated by eucalypts, including mallee, and usually with sparse to moderate density of trees, and patchy, little or no shrub layer and patchy or sparse ground-cover (often of grasses, including spinifex *Triodia*, or herbs or both); such woodland and forest habitats often closely associated with grassland or farmland (see above), including remnant patches in otherwise cleared landscapes or natural patches or strips in grassy or open landscapes, clearings within woodlands and forest, and burnt or grazed areas (e.g. Morgan 1917, 1918; Howe 1928; Tindale 1930; Condon 1951, 1962; Jones 1952; Tarr 1964; McEvey 1965; Ridpath & Moreau 1966; Clarke 1967; Pianka & Pianka 1970; Ford 1971; Moriarty 1972; Longmore 1973; Kellam 1974; Cooper 1975a; Gepp & Fife 1975; Matheson 1976; Hatch 1977; Gall & Longmore 1978; Bell 1980; Paton & Paton 1980; Ratkowsky & Ratkowsky 1980; Conole 1981; Ford & Bell 1981; Porter & Henderson 1983; Nichols & Nichols 1984; Ford et al. 1985, 1986; Loyn 1985a,b; Recher & Holmes 1985; Traill 1985; Jones 1986; Leach & Hines 1987; Schokman 1991; Gosper 1992; Ratkowsky 1993a,b; Er et al. 1995, 1998; Leach 1995; Er & Tidemann 1996, 2001; Traill et. al. 1996; Er 1997; Fisher & Goldney 1997; Luck et al. 1999; McDonald 2001; Davey 2002; Davis & Recher 2002; Kingston et al. 2002; Watson 2002; Kennedy 2003; see Grasslands, Farmlands above); and said to be seldom in forests and woodlands where no clearings (Ratkowsky & Ratkowsky 1980). However, also said to show some preference for rather undisturbed woodland with established understorey and

ground-cover (Recher & Holmes 1985; Fisher 2001). Also commonly in other woodlands and forests, such as those dominated by various combinations of cypress-pines *Callitris*, casuarinas, paperbarks, banksias or acacias, often also with eucalypts, and at least sometimes associated with more open habitats, as identified above for eucalypt woodlands and forests (Serventy 1926; Bryant 1937; Lamm & Calaby 1950; Paton & Paton 1980; Garnett & Bredl 1985; Halse *et al.* 1985; Carpenter & Matthew 1997; Fisher & Goldney 1997); includes remnants of closed Brigalow softwood scrub, or tall Brigalow scrub along roads, fence-lines, creeks and bordering farmland (Leach & Hines 1987; Leach & Recher 1993; Leach & Watson 1994; Leach 1995; Kingston *et al.* 2002). Less often in open forests and woodlands with well-developed shrubby understorey (Clarke 1967; Gepp & Fife 1975; Traill 1985; Fisher & Goldney 1997). In NZ, said to occupy forest patches (Heather & Robertson 2000), but no further details. Only occasionally in or associated with MOIST OR WET FORESTS with dense or closed canopy, often along roads bisecting forest, in clearings or recently logged, heavily grazed or burnt areas: including wet sclerophyll forest dominated by eucalypts and with dense understorey in Aust. (Cooper 1975a; Porter & Henderson 1983; Loyn 1985a; Gosper 1992). In NZ, recorded in tall forests of podocarps or hardwoods, including regrowth and in gaps (Freeman 1999; CSN 47); on Noises Is, in closed mixed forest of Pohutukawa *Metrosideros excelsa*–Karo *Pittosporum crassifolium* (Cunningham & Moors 1985). In NZ, as Aust., often at ecotones between naturally forested areas (such as national parks and other reserves) and cleared land, such as farmland, roads or areas cleared for forestry (Innes 1982). Also inhabit PLANTATIONS OF EXOTIC PINES of various ages, but mostly in mature stands, in Aust. (Gepp & Fife 1975; Stevens 1975; Dunkley 1976; Friend 1982; Debus 1983b; Traill 1985; Gepp 1986) and NZ (Rankin 1970; Heather & Robertson 2000). Regularly in low SHRUBLANDS AND HEATH-LANDS (Jones 1986); low heathland in coastal, subcoastal,

subalpine or alpine areas, at least sometimes in mosaic with patches of more open ground, including grassland (Sedgwick 1964; Cooper 1975a; Preston 1983; McFarland 1988; Baxter 1989; Schulz 1991; Osborne & Green 1992; Saffer 2001; Davey 2002) and in alpine and subalpine herbfields and adjacent frost-hollows (Longmore 1973; Gall & Longmore 1978; ACT Atlas); and low open chenopod shrubland, often with a few emergent (though sometimes stunted) trees or taller shrubs (Wilson 1946; Baxter & Paton 1998; Brandle 1998). Very rarely in RAINFORESTS, e.g. in ne. NSW, in dry (monsoon) rainforest and tall closed subtropical rainforest (Gosper 1992). Occasionally observed on beaches (Cooper 1975a; Gosper 1983; Fitzsimons 2003; J.M. Peter), and very occasionally among mangroves (Matheson 1976).

In study of use of edges in Murray–Mallee of SA, considered an open-country species, with greater mean abundance at edges than interior of mallee vegetation (though usually with greatest numbers outside mallee vegetation altogether); showed increased abundance at induced edges, where there was an abrupt transition between eucalypt vegetation and long-term human construct (such as road or open field), and rarely recorded >200 m into interior of patches or at inherent edges, where there was a gradual transition between eucalypt vegetation and open shrubland (Luck *et al.* 1999). In study of eucalypt woodland varyingly affected by dieback near Armidale, n. NSW, found in all four sites surveyed, from most affected through to least affected (Ford & Bell 1981).

**DISTRIBUTION AND POPULATION** Widespread throughout Aust. (see below); and occur in Trans-Fly Region of s. New Guinea, between Oriomo R. and Princess Mariane Str. (Black 1986; Coates 1990). Introduced to NZ, where widespread (see below); and also successfully introduced to Fiji and, unsuccessfully, to Solomon Is and Sri Lanka (Long 1981).

**Aust. Qld** Widespread in all areas except C. York Pen., where generally absent N of 13°S, and only occasionally
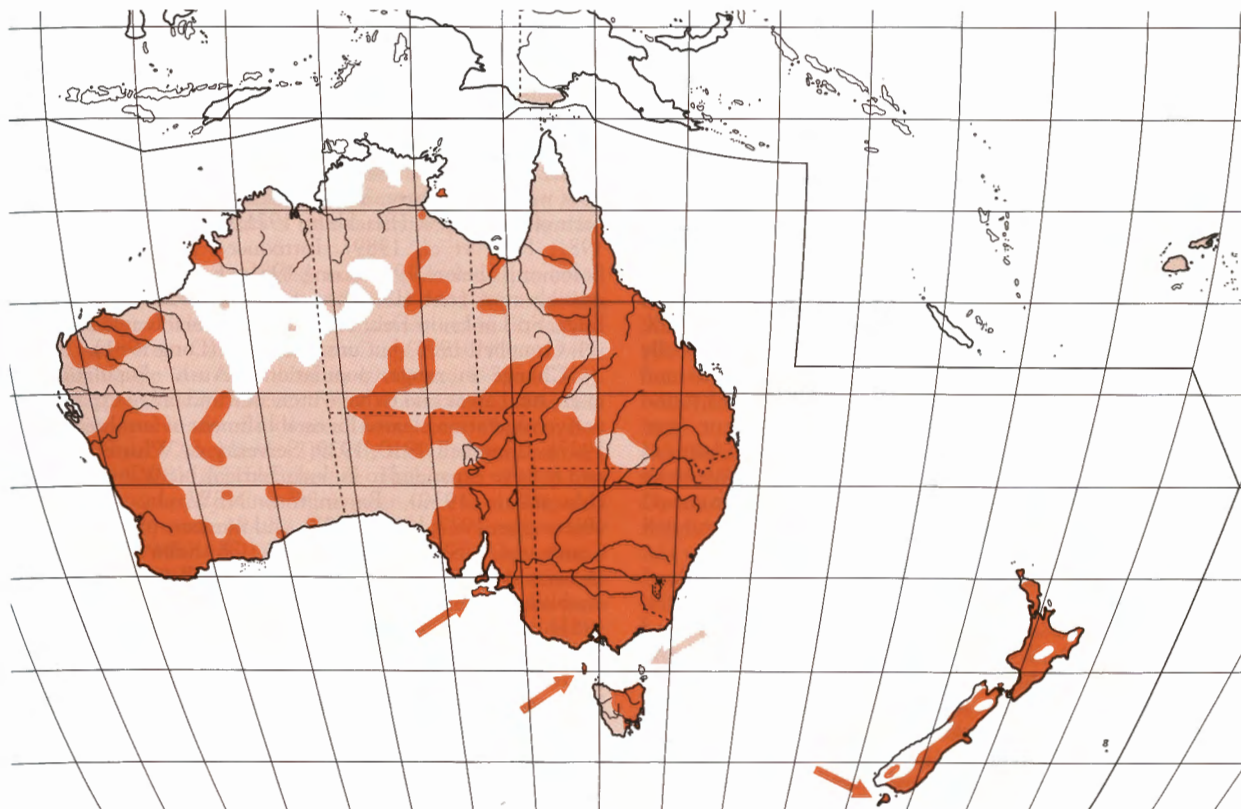
recorded in coastal Atherton Region (Wet Tropics) between Cooktown and Ingham (Hopkins 1972; Nielsen 1996; Aust. Atlas 1, 2; Storr 19). However, single Aust. Atlas record farther N, at Weipa, 2 June 1978 (Aust. Atlas 1). **NSW, Vic.** Widespread (Morris *et al.* 1981; Cooper & McAllan 1995; Aust. Atlas 1, 2; Vic. Atlas). **Tas.** Widespread in e. half, E of line roughly from Port Sorell, through Hamilton, to Kettering and Bruny I., though more sparsely scattered in ne. corner than elsewhere. On n. coast, also extend farther W, to Redpa and Hunter I. Absent from W and SW (Green & Mollison 1961; Thomas 1979; White 1985; Bryant & Holdsworth 1992; Aust. Atlas 1, 2; Tas. Bird Reps). Also occur on King I. and Furneaux Grp in Bass Str. (see Introductions, below). **SA** Widespread (Condon 1969; Stove 1994; Aust. Atlas 1, 2). **WA** Generally widespread in all areas except parts of Great Sandy and Gibson Deserts, where either absent or very sparsely scattered; also apparently absent from Peron Pen. and Dirk Hartog I. (Ford 1969; Davies & Chapman 1975; Johnstone *et al.* 1979, 2000; Storr 1981; Saunders & Ingram 1995; Storr 11, 16, 21, 22, 26, 27; Aust. Atlas 1, 2). **NT** Widespread in most areas except Top End, where only records N of 15°S are in e. Kakadu NP and Arnhem Land, occurring N to Waterfall Ck and Goyder Ck Crossing (on Gove Rd), as well as on Groote Eylandt; also only sparsely scattered in parts of Tanami Desert (Gibson 1986; Noske & Brennan 2002; Storr 7; Aust. Atlas 1, 2; H.A.F. Thompson & D.K. Goodfellow).

**NZ** Introduced. **NI:** Widespread, though in Far North largely absent N of line from Tauroa Pt, through Awanui, to Taupo Bay, with only a few records in area from Te Werahi and Tapotupotu Bay E to Parengarenga Harbour, and sparsely scattered from Taupo Bay S to line joining Sandy Bay and Hokianga Harbour; and also sparsely scattered in area bounded by line joining se. Firth of Thames, round mouth of Waihou R. (S. Auckland), S to Taihape (n. Manawatu), and then NE to n. Raukumara Ra. (NZ Atlas; CSN). Also recorded on several offshore islands, e.g. Whale, Great Barrier, Little Barrier and Noises Is (Sibson 1947; Dawson 1950; Bell 1976; Cunningham & Moors 1985; CSN 9, 24, 38). **SI:** Mostly absent from Nelson, with isolated record at Pakawau, and a few records on Waimea Plain, Richmond, SW through Tapawera and Hope Saddle, to Murchison. In Marlborough, isolated records on D'Urville I., near Port Gore and Pelorus Bridge, and scattered along Wairau R. to sw. Richmond Ra.; widespread from near C. Campbell, SW through Inland and Seaward Kairoura Ras; farther SW, generally widespread in Canterbury and Otago, W to e. foothills of S. Alps and S to Fortrose in Southland; scattered in Southland, where generally not recorded S of line from e. Toestoes Bay NW to round Lumsden, though recorded at Woodlands, on Ruapuke and Stewart Is, and between Invercargill and Winton, and small, isolated population at Pahia (see Introductions), and generally absent from Umbrella, Garvie, Eyre and Thomson Mts and most of Fiordland, though very occasionally recorded round e. L. Te Anau and Eglinton Valley. Mostly absent from Westland, except isolated record at Okuru R. and at widespread sites in area from Whataroa R., near Harihari, N to Westport on coast, and farther inland at Boatmans Ck, near Reefton, and Springs Junction, and inland to Milltown, Inchbonnie and Bell Hill, and isolated records at Karamea (NZ Atlas; CSN).

**Breeding** Probably breed throughout range. In mainland Aust., widespread S and E of line joining Mt Carbine, ne. Qld, and Yalata Roadhouse, SA; also widespread in n. SA and s. NT; and in WA, W of line joining C. Le Grand NP and Meekatharra, and N to 26°S. Recorded at scattered sites in all other regions; in Tas., most records in e. half, especially in SE (Aust. Atlas 1, 2; NRS). Little data for NZ but probably breed throughout most of range.

**Introductions** In Aust., released illegally in nw. mainland Tas. some time before 1974 (Tas. Bird Reps 4, 8), and suggested

that some introduced to w. coast, probably in 19th century (Littler 1903b). Released on islands in Bass Str. (Cooper 1975b; Thomas 1979; Long 1981; Tas. Bird Rep. 8): birds from Vic. released on King I. in *c.* 1901 (Green & McGarvie 1971) and in 1903 'a number of young' were collected by Mr McGowan round Launceston, Tas., destined for release on King I. (Le Souëf 1904) (though in late 1920s, said that there were no records from the island [Campbell 1929]); and birds of unknown origin released at Emita on Flinders I. in *c.* 1940, and subsequently at Memana, possibly in 1960s (Green 1969). Released on Kangaroo I., SA, in *c.* 1860 (Morgan 1929); and possibly on Rottnest I., WA, 'from time to time' (Storr 1965). Early settlers in parts of sw. and mid-WA said to have released Magpies in newly settled areas 'to give them a more "homely" appearance' (Carter 1924; Serventy & Whittell). Doubtfully released round Gawler Ras, SA (White 1913). Also claimed to have been released on Madura Pass Stn, on Nullarbor Plain, in either late 19th or early 20th century (McColl 1929). Pinioned birds released in Melbourne Zoo 'on several occasions', presumably in early 20th century, but were promptly attacked by wild birds (Le Souëf 1916). **NZ** Introduced in large numbers at various sites between 1864 and 1874; sites mentioned where known (summarized from Thomson 1922). **NI:** In Auckland, unknown number released at Kawau before 1867; ten at unknown site in 1867; and one in 1870. Unknown number released in Hawkes Bay in 1870s (McCaskill 1945). In Wellington, 260 released in 1874. 'Two young ones' unsuccessfully released round Hamilton in *c.* 1940s (CSN 6). **SI:** In Canterbury, eight released in 1864, four in 1866 and 32 in 1867 (all from Vic.); 18 from Tas. also released, though timing not known; large number of Tas. birds released at Glenmark, N of Waipara, in 1870; and 24 birds of unknown origin released in 1871. In Otago, three released in 1865, 20 in 1866, 32 in 1867, 20 in 1868 and six in 1869 (Thomson 1922). Small breeding colony round Pahia, W of Invercargill, said to have originated from a pair brought in from Canterbury in 1970 (CSN 21). Six birds captured at Waikari in Canterbury were released, apparently unsuccessfully, at Arahura Valley in West Coast in 1941 (McCaskill 1945); some isolated records in 1960s in West Coast thought to have possibly been escapes (CSN 19 Suppl.). **EXTRALIMITALLY:** Introduced to Tavenui in Fiji in *c.* 1883, and more imported in *c.* 1902, though also claimed that first introduced in *c.* 1915, with additional release in 1930s. Established on Tavenui by early 1940s, and now widespread there, and occasionally recorded on nearby parts of Vanua Levu (Blackburn 1971; Clunie *et al.* 1978; Long 1981; Pratt *et al.* 1989). Introduced to Guadalcanal in Solomon Is before 1945 (Long 1981), but did not thrive and possibly now gone (Doughty *et al.* 1999). Taken to Nuwara Eliya, Sri Lanka, in Dec. 1905, and presumably released there (H. Campbell 1906) but unsuccessfully (Long 1981).

**Change in range, populations Aust.** Populations in many rural areas said to have increased and range expanded as native vegetation cleared for establishment of farmland (Batey 1907a; Campbell 1910, 1929; Serventy & Whittell). Range said to have expanded to include Terrigal, NSW, by late 1920s (Macarthur 1930), Barrington, NSW, by late 1920s (Bettington 1927; Hyem 1937), and numbers increased round Comboyne, NSW, by early 1930s (Chisholm 1934). While said not to be recorded round Maroubra till 1983, where now established, claim of expanded range in suburban Sydney (Bell 1983) doubtful. Populations increased round Drouin, Vic., in early 1900s (A.J. Campbell 1906), round Red Cliffs, nw. Vic., in *c.* 1930s (Chandler 1944), round Turkeith, w. Vic., in *c.* 1940s (Brown 1950) and possibly increased round Caniambo, n. Vic., and Break O'Day Valley, Tas. in 1960s (Napier 1969; Bedggood 1973). Range has expanded in Tas.: not recorded in NE, E of line from Bridport, through Scottsdale, to St Marys, before 1980 (Thomas 1979), but range has expanded into NE since

1990s, with scattered records, e.g. Waterhouse in 1996 and Rushy Lagoon in 1999 (Tas. Bird Reps 25, 26, 28). Record at Kettering in 1995 most s. record on Tas. mainland (Tas. Bird Rep. 24). Range also appears to have expanded W along n. coast since late 1970s (Tas. Bird Reps). Earlier, range said to have expanded to include w. coast of Tas. in early 1900s (Littler 1910) but possibly released there (see Introductions) and no recent records. After introduction on King I. in 1901 (see above), now widespread and common (Green & McGarvie 1971); on Flinders I., though range expanded and numbers increased slightly after release in 1940, still fairly localized by late 1960s (Green 1969), and most Aust. Atlas records are from round areas of initial release (Aust. Atlas 2). In SA, numbers said to have increased round Naracoorte (Attiwill 1972), Mt Mary Plains (Boehm 1957) and L. Frome (McGilp 1923). In nw. SA, said to have been recorded only after European settlement of the area and was 'very rare' there in 1930s (McGilp 1935a), but widespread and common by early 1980s (Close & Jaensch 1984). Range expanded rapidly in sw. WA, including Wheatbelt, after conversion of forest to farmland (Ford & Stone 1957; Saunders & Ingram 1995; Storr 35): known to have expanded range to include Leeuwin–Naturaliste Ridge between 1887 and 1901, as not recorded either S or W of Carbadup R. in 1887, and first recorded in area between Cowaramup and Margaret R. in 1900, and had still not reached Augusta by 1919; occurred S to Cranbrook in 1889, but not recorded in Porongurup Ra. till 1910, and not present at Albany till after 1921 (Milligan 1902; Carter 1924; Serventy & Whittell; Storr 35). First recorded at Gibb Rock, WA, in Mar. 1967 (Sedgwick 1986b). Some historical references mention expansion of range of one subspecies or subspecies group into range of another, e.g. black-backed birds expanding range into that of white-backed birds round Mt Mary, SA (Boehm 1956, 1957) but these not dealt with further here.

There have also been declines recorded. In 1930s, numbers had declined in Tas., variously attributed to extensive rabbit-baiting (Dove 1938), the removal of pine trees (Dove 1941) or an increase in populations of Masked Lapwings *Vanellus miles* (Sharland 1942); record at Devonport in 1940 first since 1918 (Dove 1938) or 1931 (Dove 1932), having previously occurred regularly (Dove 1932, 1938, 1941). Similarly, numbers round Northam, WA, declined dramatically between 1940 and 1955, but population subsequently recovered (Masters & Milhinch 1974). Severe drought in 1902 caused populations in parts of Qld to decline greatly (Barnard & Barnard 1925).

**NZ** Range has expanded and populations increased dramatically since initial introductions. In NI, range has expanded to include virtually entire island, and in SI, expansion of range from Canterbury into Otago noted since 1940s, and from Otago into Southland in 1960s and 1970s (CSN). By 1945, spread away from centres of release was so slow that distribution was confined to three discrete areas: (1) from Bay of Islands S to S. Auckland; (2) s. NI; and (3) from Kaikoura S to near Dunedin (Heather & Robertson 2000). In Northland, occurred round Whangarei since *c.* 1890s, and between then and 1940s, population remained stable (McCaskill 1945). In Auckland, first recorded round Waimauku in 1908 and Maungatawhiri in 1940 (McCaskill 1945). Population round Mangere still increasing in early 1980s (CSN 30). In S. Auckland, first recorded at Mangatarata in 1963 (CSN 19 Suppl.), and population was increasing throughout in late 1970s, especially in W (CSN 26, 28). In Bay of Plenty, recorded upstream from Opotiki in 1945 or 1946, at Whakatane in 1946 and Waimana in *c.* 1948 (Westerskov 1954) and first recorded at Tauranga in 1960 (CSN 9), and said to have been spreading in the area, including Omokoroa and Tauriko, later in 1960s (CSN 19 Suppl.),

and though still generally scarce by late 1970s, population said to have been 'entrenched' by then, and still increasing in size (CSN 26, 28). Round Ohauiti, near Tauranga, population increased in early to mid-1970s (CSN 23). Range expanded rapidly in Volcanic Plateau in late 1940s: recorded round Rotorua at L. Okataina in 1940 (Westerskov 1954); first recorded in SW at Kaimanawa Mts in 1946 (Johnson 1946), and recorded at various sites, including along Taharua R. and Rotorua by 1949 (Westerskov 1954); well established by early 1950s (Westerskov 1954). Established at Putaruru from across Mamaku Ra. in 1964, though had not colonized Rotorua by then (CSN 19 Suppl.), despite occasional records (e.g. CSN 31). Farther S, first recorded at Taupo in 1946 (Phillipps & Lindsay 1948), and present still farther S at Waiouru and Tarawera in 1964 (CSN 19 Suppl.). In East Coast, n. limit in early 1940s was Ruatoria, where first recorded in *c.* 1938, and widespread from there S to Gisborne (McCaskill 1945; CSN 4); numbers increased dramatically in 1940s and 1950s (Westerskov 1954): at Ruatoria, numerous by 1951 (CSN 4); at Tuai, L. Waikaremoana, two recorded in 1940 and *c.* 200 in 1956 (CSN 7); and population at Tolaga Bay said to have been increasing in early 1940s (McCaskill 1945). After release in Hawkes Bay in 1870s, small colony established at Tangoio before 1882, and two appeared farther N at Tutira Stn in 1885 (McCaskill 1945). First recorded at Norsewood in late 1930s, and population subsequently increased (Rep. & Bull. OSNZ 2), and widespread and numerous in Region by 1947–48 (CSN 3). Unclear when first occurred in Wairarapa: first recorded at Masterton in *c.* 1910 (McCaskill 1945). In some parts of Masterton, distinct increase in population noticed between 1920s and 1940s (McCaskill 1945), and elsewhere in the town, population increased dramatically between early 1940s and early 1970s, e.g. recorded nine times May 1942–Apr. 1943, and in same area, 127 times May 1971–Apr. 1972 (Stidolph 1977); also increased round Martinborough in early 1940s (McCaskill 1945). Numerous round L. Wairarapa in 1920s (McCaskill 1945). Numerous and well established in Wellington by early 1940s, with increase recorded at Wainuiomata in early 1940s (McCaskill 1945). In mid-1930s, only odd pairs recorded in Manawatu, but occurred in large flocks by 1949 (CSN 3). Round Levin, populations increased noticeably in late 1930s and early 1940s, especially round Foxton, Palmerston North and Bulls (McCaskill 1945; Rep. & Bull. OSNZ 3). In Wanganui, common in inland parts before 1920 (Thomson 1922), and said to have been numerous round Turakina Valley since at least early 1920s (McCaskill 1945), and widespread and numerous by early 1940s (McCaskill 1945); great increase noted round Okoia and Fordell in late 1930s or early 1940s (McCaskill 1945); first recorded at Whakahoro in 1948, and present in 'fair numbers' by 1950 (CSN 4). In Taranaki, said to have been less abundant in 1916 than some years previously (Thomson 1922). Said to have been first recorded at New Plymouth in 1938, and occurred in large numbers at various sites, mainly in w. and s. Taranaki (McCaskill 1945), and range said to have expanded slowly in mid- to late 1950s (CSN 7) with population increasing round Opunake, Okato and New Plymouth in mid-1960s (CSN 19 Suppl.). In Waikato, generally scarce in 1937 (CSN 20), when first recorded round Te Pahu (McCaskill 1945), though range thought to have expanded slowly, as first recorded at Marakopa in 1954 (Fordham 1955); population said to have been increasing in early 1960s (CSN 19 Suppl.), and quite common by 1972 (CSN 20). In Nelson, where range restricted and population small, population round Murchison had not increased and range had not expanded by 1963 (CSN 19 Suppl.). N. limit of distribution in Marlborough was round Kaikoura in early 1940s, though population there said to have been increasing at the time (McCaskill 1945). In Canterbury, first recorded at Cheviot in early 1900s, and by 1920 there

were ≥100 pairs (McCaskill 1945). First noticed round Cass in 1931 (McCaskill 1945) or *c*. 1932 (Rep. & Bull. OSNZ 1), and numbers round Christchurch increased, and range expanded in early 1940s (McCaskill 1945; Rep. & Bull. OSNZ 3), e.g. at Mt White Stn, on West Coast Line, first recorded in 1924, and hundreds present in early 1940s; and at Springfield, population was 30 in 1942 and 45 in 1943 (McCaskill 1945). First recorded between Harper and Wilberforce Rs in 1930, and common by 1940s (McCaskill 1945). First recorded at Waimate in 1900, and common by 1940s (McCaskill 1945). At Okains Bay, Banks Pen., first recorded in 1939, and 20 birds present within a few years (McCaskill 1945). Immediately after introductions to Otago, began to breed round Dunedin and Inchclutha, and thought to have been doing well, but died out soon after, though range of birds from Canterbury began to expand S into Otago (Thomson 1922; McCaskill 1945). In 1940s, s. limit usually said to have been near Oamaru, but exact limits unclear: variously described as being round Maheno in 1941–42 (Rep. & Bull. OSNZ 3), Oamaru in 1949 (CSN 4) and Waitaki R. (CSN 3), though as early as 1920s, said to have expanded range S of Waitaki R., S at least to Horse Ra. (Thomson 1922). In 1940s, populations said to be increasing round Herbert (where first recorded in 1930s), Waianakarua and Palmerston (McCaskill 1945); and spread upstream along Waitaki R. to Omarama, and thence through Lindis to L. Wanaka; from there spread slowly S along Clutha R., where present in Cromwell in 1964 (CSN 19 Suppl.), and first recorded round Alexandra in mid-1960s (CSN 31) with numbers gradually increasing there till at least early 1980s (Child 1983), and common in Balclutha in 1967 (CSN 19 Suppl.). Also in 1960s, recorded in upper reaches of Manuherikia R. and Lauder, probably having spread from Omarama over n. end of Hawkdun Ra. (CSN 19 Suppl.). Also spread S from Oamaru in late 1940s (CSN 3): reached Merton in 1938 (McCaskill 1945) and Taieri, S of Dunedin, in 1940 or 1941 (Rep. & Bull. OSNZ 2), but not recorded at Waipori, W of Dunedin, till 1956 (CSN 7). Numbers built up round Dunedin by mid-1960s (CSN 19 Suppl.). Range generally expanded farther S in 1960s, with records at Tapanui in 1966 and at Owaka and Chaslands in 1967 (CSN 19 Suppl.). In Southland, recorded at Gore in 1948, when generally not known S of Oamaru (CSN 3); a few stragglers recorded in Southland in 1960s (CSN 19 Suppl.), but range then expanded rapidly in 1970s (CSN 23) and continued to expand in early 1980s (CSN 31); recorded on Ruapuke I. in 1986 (CSN 36). In West Coast, where recorded at isolated sites in 1960s (CSN 19 Suppl., 28), range had expanded by 1970s and populations still increasing in 1990s (CSN): e.g. present round Taramakau since early 1960s, but population increased only slowly by late 1970s (CSN 28); and increases in population round Greymouth recorded in early 1990s (CSN 41); and round Westport, where first recorded in Dec. 1987 (CSN 36), population had begun to increase by mid-1990s (CSN 45).

**Anomalies** Large numbers sometimes congregate at plagues of grasshoppers, caterpillars or House Mice (Lord 1956b, 2001; Boehm 1957; Hobbs 1971a).

**Populations** Total population of subspecies *dorsalis* in WA estimated at 450,000–900,000 birds (Serventy & Whittell). RECORDED DENSITIES: **Aust.** In Townsville, ne. Qld, mean 0.07 birds/ha in dry season 1980 (Jones 1983) and mean 0.04 birds/ha in dry season 1997 (Jones & Wieneke 2000); 0.18 and 0.11 birds/ha, near Tallegalla, Qld (Leach & Watson 1994); up to 1.19 birds/ha, Corinda, Qld (Walters 1985); 0.1–1.6 birds/ha (read from graph), Brisbane (Hughes *et al*. 1983); 0.03–0.05 birds/ha, Cooloola NP, Qld (McFarland 1988); 0.03–0.97 birds/ha and 0.17–0.35 birds/ha, near Armidale, NSW (Ford & Bell 1981; Ford *et al*. 1985); 0.2 birds/ha, Hawkesbury R., NSW (Keast 1985); 0.18 birds/ha, near

Canberra (Carrick 1972); 0.02–0.8 birds/ha, near Canberra (Bell 1980); 0.3 birds/ha, near Eden, NSW (Kavanagh *et al*. 1985); 0.03–0.2 birds/ha, near Bombala, NSW (Recher & Holmes 1985); 0.1 birds/ha, Olinda SF, Vic. (Mac Nally 1997); 0.31 birds/ha (0.17; 0–1.42; 720 weekly surveys), Gardiners Ck, Bennettswood, e. suburban Melbourne (J.M. Peter); 1.7–3.1 birds/ha, near Moyston, Vic. (Kennedy 2003); 0.3 birds/ha, Margaret R., WA (Keast 1985); 0.1 birds/ha, Swan Coastal Plain, WA (Serventy & Whittell); 0.035 birds/ha, between Northampton and Katanning, WA (Serventy & Whittell); 0.79 birds/ha, Wellard, WA (Plumb 1948). Along 800-m transect, Kellerberrin district, WA, 0.02–0.05 birds/100 m (Arnold & Weeldenburg 1990); on trip of *c*. 330 km between Pemberton and Armadale, sw. WA, 0.16 birds/km (Glover 1951).     **NZ** 0.75 birds/ha, Linton, Manawatu (Veltman 1989a); 1.65 birds/ha, Totara Valley, Canterbury (McCaskill 1945). On 56 trips between Foxton and Palmerston, NI (32.5 km), 0.8 birds/km (9.05; 0.28–1.35; 56) (Gill 1977); round Springs Junction, SI, on trip of 40 km, 0.25 birds/km (CSN 35); in Wanganui, NI, on trip of *c*. 48 km, 1.7 birds/km (CSN 2); round Levin, NI, on trip of 14.5 km, 0.69 birds/km (Rep. & Bull. OSNZ 3).

**Survival and Mortality** Near Canberra, between 1966 and 1966, rates of survival of 994 territorial adults were 84% for males and 86% for females (Carrick 1972). In same study, of 74 colour-banded birds found dead 1956–62: 17 (23%) were killed on roads, eight (11%) poisoned or shot, six (8%) taken by Foxes or Feral Cats, and three (4%) electrocuted; another six (8%) died of disease and the rest had been dead for too long to determine cause (Carrick 1972; see Threats and Human Interactions). In survey of road-killed birds between Canberra, ACT, and L. Cowal, NSW, 1970–72, Magpies recorded at rate of 6.9 dead birds/km (n=409; ages combined) with dead birds recorded in all months; most (59%) were first-year birds, and most were found Oct.–Dec. (95% of all records of first-year birds) with a few recorded Jan.–May (Vestjens 1973, which see for monthly breakdown of ages).

**THREATS AND HUMAN INTERACTIONS** Have benefited from clearing of forests for conversion to farmland or residential development, and often among first native species to occupy newly developed suburbs (e.g. Campbell 1929; Macarthur 1930; Chisholm 1934; Terrill & Rix 1950; Westerskov 1954; Robinson 1956; Jones 1981; Mason 1985; Baxter 1989; Dawson *et al*. 1991; Evans *et al*. 1997), sometimes appearing as soon as vegetation cleared (Wilson 1922; Saunders & Ingram 1995). Widely reported swooping at or attacking people, usually near nests, and, while seldom making contact, sometimes cause serious injuries (see Social Behaviour: Agonistic behaviour [Attacks on people]; for reviews, see Jones *et al*. [1980], and Jones [1996, 2002]). Also said to peck at eyes of sheep and, once, of a horse, to occasionally kill lambs, and sometimes to attack sheepdogs and poultry (McCaskill 1945; CSN); and in NZ, attacks by Magpies on native species said to have contributed to declines in populations of those species (Barrington 1995, 1996); once attacked a teddy bear (Sedgwick 1940). Sometimes shot, often because of attacks, and occasionally for 'sport' (Batey 1907b,c; Chisholm 1910; Cole 1921; Condon 1940; McCaskill 1945; Robinson 1956; Nielsen 1962; Carrick 1963, 1972; ABBBS 1977; Jones & Finn 1999; Lord 2001; Jones 2002; CSN 9); in 1939–40, 19 permits to kill Magpies were issued in SA (Condon 1942); and in Oct. 1954, 32 Magpies were shot by The Authorities in WA after attacks on people (Robinson 1956). Magpies considered troublesome sometimes caught and translocated (Jones & Finn 1999; Jones 2002; Jones & Nealson 2003; see Movements) or, in NZ, trapped and killed (Barrington 1995, 1996). At Ethelton, Canterbury, NZ, after Magpies damaged fixtures and harassed poultry and people,

150 shot in winter 1939, and another 250 shot in winter 1940, but lack of ammunition during World War II allowed population to increase (McCaskill 1945). Often killed on roads, especially young birds (Sullivan 1929; Binns 1953; Carrick 1963; Learmonth 1967; Bull & Dawson 1969; Carrick 1972; Vestjens 1973; Disney & Fullagar 1978; Brown *et al.* 1986; Debus 1990; Lepschi 1992; Wood 1998; Jones 2002; Rollinson & Jones 2002; see Mortality, above). Very occasionally collide with aircraft (Hutchinson 1999; Jones 2002). Often electrocuted by power-lines (McCaskill 1945; Carrick 1972; Oliver), and round Mayfield, Canterbury, when power-poles first erected, many were electrocuted by perching on metal cross-beams (CSN 3). Electrocuted Magpies have been blamed for starting fires, after falling to ground with flaming feathers (NZRD), but confirmation needed. Often attracted to artificial sources of food such as feeding tables in gardens, or picnic areas or other places where scraps available (see Food), and sometimes quite tame at these sites (see Social Behaviour); sometimes also attracted to farming activities, to feed on insects disturbed by machinery or stock (see Food). Sometimes considered a minor pest of crops, eating Grapes, figs and Peaches, digging up newly planted or sprouting grain and dancing on branches of trees in orchards and shaking off fruit. However, pest status outweighed by appetite for insect pests (Orchardist 1901; Littler 1903b, 1910; Barnard 1905; Campbell 1905; Batey 1907b,c; Hill 1907; Dove 1908; Chisholm 1910; McKeown 1923; Carter 1924). Occasionally poisoned, usually accidentally, by baits targeting House Sparrows *Passer domesticus*, Rabbits, Mice or rats (Anon. 1903; Littler 1903b, 1910; Batey 1907b; Hill 1907; Russell 1921; Chisholm 1938; Lord 1957; Carrick 1972; Du Guesclin *et al.* 1983; Phillipps 1993; Jones 2002). In NZ, brodifacoum residue detected in tissues of Magpies (Robertson *et al.* 1993); and said to have been adversely affected by pesticides round Stanthorpe, Qld (Passmore 1982). Formerly kept as pets (Littler 1903b, 1910; Batey 1907b,c; Carter 1924; Leach 1928; Campbell 1929; Dove 1930; McCaskill 1945, 1946; La Roche 1950; Carrick 1963; Campbell), with large numbers of nestlings illegally sold in towns (Littler 1903b, 1910). Often killed or injured by Cats or occasionally by Dogs (Lord 1956a, 1957; Carrick 1963; Dowling *et al.* 1994), and, in NZ, Stoats *Mustela erminia* (CSN 37). Formerly used occasionally as bait in fox-traps (Stephen 1909), and occasionally caught in rabbit-traps, resulting in amputation of legs or bills (Madden 1906; Edwards 1920; Bonnin 1930; Carrick 1963). In NZ, Magpies have died after becoming entangled in hip-chain cotton used to measure distances (Brown & Miller 1997).

**MOVEMENTS** Sedentary and territorial throughout year, with territories often maintained with stable boundaries from year to year (Campbell 1902; Robinson 1945, 1956; Veltman 1989a; Carrick 1972; see Social Organization; see below). Broad-scale analysis of bird atlas and count data from e. Aust. found strong evidence of no movement (Griffioen 2001; Griffioen & Clarke 2002). Most recorded movements appear highly local, with territorial birds (Territorial Groups) seldom moving beyond territorial boundaries and Non-territorial Flocks moving greater distances (Robinson 1945; Wilson 1946; Carrick 1963, 1970, 1972; Veltman 1989a; see below; see Social Organization). Few long-distance movements recorded, with longest distance between banding and recovery 360 km (see Banding). However, analysis of genetic differentiation and size of groups between populations indicated that dispersal of immatures affected genetic differentiation and size of groups in Magpies, with lowest levels of immature dispersal (high immature philopatry) and gene-flow in sw. WA (Baker *et al.* 2001; see Geographical Variation).

Detailed studies of social organization (q.v.) indicate that Territorial Groups (of two or more birds) sedentary, remaining

together and defending territories throughout year and from year to year, often with little change in territorial boundaries (Robinson 1945, 1956; Wilson 1946; Carrick 1963, 1972; see Social Organization). In ACT, all movements of Territorial Groups and Non-territorial Flocks apparently local; four types of Territorial Group identified, based on quality of territory, which in turn affected movements of group: Permanent Groups and Marginal Groups defended territories in which nesting and nearly all foraging occurs, with birds largely remaining within territorial boundaries; Mobile Groups spent much time commuting between separate breeding and foraging territories, flying 460–1600 m between foraging and breeding areas; and Open Groups (of which there were few), which defended treeless foraging areas and roosted communally (and did not attempt to breed), usually within 1.6 km of foraging area. Mobile and Open Groups may roost up to several kilometres from feeding grounds (Carrick 1963, 1972). In ACT, and at Linton, NI, NZ, Non-territorial Flocks (usually mostly immature birds) were locally nomadic, though movements poorly known; tended to forage in pasture not defended by Territorial Groups (Carrick 1963, 1970, 1972; Vestjens & Carrick 1974; Veltman 1989a). In ACT, daily feeding movements of Non-territorial Flock birds normally limited, often to within a few hundred metres, and flocks typically return to same foraging area each day for weeks or even months; flocks travelled daily between foraging areas from roosting sites in woodlands up to 8 km away (Carrick 1963, 1972; Vestjens & Carrick 1974). At Linton, Non-territorial Flocks roosted in large congregations, either near foraging sites or at more distant, but unknown, sites (Veltman 1989a). See Social Organization: Gregariousness, Breeding dispersion (Territories) for further details of gregariousness and territoriality.

Also widely described as sedentary, resident, or present throughout year in anecdotal reports in Aust. literature: in Qld, on and E of Great Divide, in NE (Bravery 1970; Gill 1970) and SE (Longmore 1978; Bielewicz & Bielewicz 1996; Hughes *et al.* 1996), and inland (Berney 1905; Sharp & Sewell 1995); in NSW, in coastal and subcoastal areas (Morris 1975; Gibson 1977; Marchant 1979; Gregory-Smith 1991; Egan *et al.* 1997; Andrew 1999), on Great Divide, including in ACT (Carrick 1970, 1972; Gall & Longmore 1978; Taylor 1984; Hardy & Farrell 1990; Osborne & Green 1992; Er & Tidemann 1996; see above), and W of Great Divide (Hobbs 1961; Schmidt 1978); in Vic., in NE and Gippsland (Rowley 1961; Bedggood 1970, 1972; Thomas & Gilmore 1976; Peters 1989), Northern Country (Roberts 1975; Hughes *et al.* 1996) and Central Districts (Fleming 1976; Humphreys 1986); in lowland areas of Tas. (Green 1989); in SA, on Adelaide Plains (Symon 1946; Clarke 1967; Baxter 1980; Ashton 1985), Mt Lofty Ras (Rix 1976; Paton & Paton 1980), Kangaroo I. (Baxter 1989), Eyre Pen. (Leiblich 1971) and inland (Gee *et al.* 1996; Read *et al.* 2000); in s. WA (Robinson 1945; Wilson 1946; Sedgwick 1973b; Masters & Milhinch 1974; Dymond 1988; Stranger 1993; Ashton *et al.* 1996); and in Keep R. NP in NT (McKean 1985). Little information for NZ; considered resident in s. NI (Moncrieff 1929) and n. SI (CSN 35).

Some movements reported, but few details; banding data indicate few long-distance movements, with longest known 360 km; translocated birds also found to return to territories, with greatest distance 112 km (see Banding). Occurrence in some areas shows seasonal trends: in Snowy Mts, only present >1800 m asl during snow-free months (Osborne & Green 1992). In sw. NSW, black-backed birds resident but population of white-backed birds increases in winter (Hobbs 1961). Similarly, in ne. Vic., black-backed resident throughout with small numbers of white-backed breeding in ranges, augmented by influx to area in winter (Bedggood 1972); and in E. Gippsland, Vic., small proportion of population of white-backed birds leaves in late autumn and returns in early spring

(Bedggood 1970). Extent of these movements not known. Seen to congregate at Wilsons Prom., s. Vic., in spring and to fly S, suggesting possible movement across Bass Str. (Sutton 1998). However, no records of mainland subspecies in Tas. or Flinders Grp but, as at least some mainland birds introduced to King I. (see Introductions), presence of mainland birds there would be difficult to ascertain. In sw. WA, non-territorial birds (individuals or small groups up to five) usually seen moving Feb.–Oct. (Robinson 1956) but extent of such movements not known. Also recorded irregularly at some sites. Occasional visitor to Herbert R., coastal ne. Qld, arriving during severe inland drought (Webb 1902). Irregular influxes at Brindana Gorge, n. Flinders Ras, SA, in winter (Hornsby 1997). Occasionally visit islands where not resident, e.g. Peel I., Qld (Agnew 1921), Garden I., WA (Abbott 1980) and Rottnest I., WA (Saunders & De Rebeira 1985).

DISPERSAL OF JUVENILES–FIRST IMMATURES: Most appear to leave natal territory by time 1 year old, by start of following breeding season of their parents, though some remain longer. Distance moved rarely known, but most remain in local area, and often settle in nearby flocks. For details of dispersal of young, see Social Organization (Bonds).

**Banding**  Of 16,022 banded in Aust., 1953 – June 2003, 1095 recoveries (6.8%), of 770 birds: 997 (91.1%) <10 km from banding site; 81 (7.4%) 10–49 km; nine (0.8%) 50–99 km; and eight (0.7%) >100 km (ABBBS). LONG-DISTANCE RECOVERIES: Narrabeen to Armidale, NSW: 358 km, 213°, 5 months, Dec., 1; near Borallon, Qld, to Tweed Heads, NSW: 176 km, 161°, 13 months[D], July, +1, M; near Borallon to near Gympie, Qld: 173 km, 3°, 21 months, Aug., +1, M; N of Oxenford to Worongary, Qld: 157 km, 166°, 1 month, Sept., +1, M; Seymour to Glenrowan, Vic.: 114 km, 57°, 21 months[D], Nov., J; Samford to Imbil, Qld: 104 km, 347°, 1 month, July, +1, M; near Nambour to Goodna, Qld: 104 km, 185°, 20 months[D], Oct., +1, M; near Nambour to near Borallon, Qld: 102 km, 196°, 2 months, Sept., +1, M (ABBBS). LONGEVITY: Adult female banded at Gunghalin, ACT, 13 Sept. 1953, recaptured at banding place 23 years 9 months after banding (ABBBS). Nestling banded at Gunghalin, ACT, 16 Oct. 1953, remained round banding site for at least 17 years (to 1970, at last report) with greatest recorded distance from banding site c. 1250 m; held territory c. 400 m from natal territory from 1958 to 1970 (Carrick 1970). Of 178 nestlings banded round Canberra, 147 (83%) bred within 1.6 km of natal territory (Carrick 1972). At Gooseberry Hill, WA, of >60 records over 7 years of a pair banded Jan. 1986, all were within c. 800 m of banding site (Brooker 2001).

TRANSLOCATION: In se. Qld, 146 birds trapped, colour-banded and translocated 1–150 km from territories in 1994–2000, and 21 birds (14.4%) subsequently recovered (reported or retrapped), 13 in original territories; five released within 25 km all returned to territories, typically within the same day; of four released 26–30 km away, 2 (50%) returned to territories; of 137 released >30 km away, 6 (4%) returned. Longest return distances were 97 km taking 3 days, and 112 km taking c. 2 months. When released, birds usually flew away from release site within a few minutes, flying directly and rapidly in a straight line. The direction of this flight was noted for all released birds, and the proportion of birds heading towards home territories did not differ from that expected by random flight, implying that birds not capable of long-distance navigation. Thus, high proportion of returns from within 25 km indicates 'familiar area' of c. 1950 km², suggesting that mobile immatures range over wide area or that adults travel outside territories more often than previously thought (Jones 2002; Jones & Nealson 2003). Of 20 aggressive males captured and translocated from Brisbane area, three returned to original territories, from 17, 26 and 60 km away; return from 60 km was only one of 18 birds released >30 km away (Jones & Finn 1999).

**FOOD**  Mainly invertebrates, mostly terrestrial insects, and vertebrates, including frogs, lizards, small birds and mammals, and carrion; also seeds, fruit, scraps of food and refuse. **Behaviour**  Well known. Forage on open ground (e.g. Orchardist 1901; Littler 1903a; Anon. 1914; Robinson 1956; Gepp & Fyfe 1925; Recher & Holmes 1985; Recher et al. 1985; Ford et al. 1986; Osborne & Green 1992; Fitzsimons 2003; Kaplan 2004; Hall), gleaning from and probing ground, and turning over stones, bark or dung looking for prey (e.g. Robinson 1956; Recher et al. 1985; Ford et al. 1986; O'Leary & Jones 2002).  DETAILED STUDIES: AUST.: In suburban Brisbane (O'Leary & Jones 2002); Imbota NR, near Armidale, n. NSW, 1981–82 and 1984 (Ford et al. 1986); e. NSW (Rose 1973, 1999); in ACT, mostly in and round Canberra (Vestjens & Carrick 1974); Snowy Mts, NSW (Osborne & Green 1992); near Bombala, in se. NSW and ne. Vic., Oct. 1980–Jan. 1981 (Recher & Holmes 1985; Recher et al. 1985); at Melbourne Airport (Steele 1997); in suburban Melbourne and at Serendip, near Melbourne, breeding seasons of 1975–79 (Pellis 1981a); and at Coolup, s. WA (Robinson 1956). NZ: At Massey University, Palmerston N, NI (Hickson 1984); and at Linton and Palmerston N (Veltman 1989a,b; Veltman & Hickson 1989); Christchurch Airport, SI, 1968–69 (Moeed 1976); and at Port Hills, near Christchurch, SI, 1970 (Rankin 1970).  FORAGING ASSOCIATIONS: In Aust. and NZ, forage singly, in twos or in small parties of 10–20 birds (e.g. Campbell 1902; Webb 1902; Littler 1903a; Tindale 1925; Randell 1930; McCaskill 1945; Gepp & Fife 1975; Hickson 1984; G.D. Price), in larger flocks of 20–100 (e.g. Orchardist 1901; McCaskill 1945; Bedggood 1970; Moeed 1976; Veltman & Hickson 1989), or, less often, one to several hundred birds (e.g. McCaskill 1945; Vestjens & Carrick 1974; Hewish 2002a,b; J.M. Peter). At Port Hills, mean size of foraging flocks 2.8 birds (1.51; 1–7; 35). Size of foraging flocks linked to social organization, specifically size of Territorial Groups and Non-territorial Flocks (see Social Organization for details). Non-territorial Flocks consist of a few birds to several hundred birds that forage together, but with individuals usually spaced c. 9 m apart when on ground (Robinson 1956; Carrick 1963, 1972; Veltman 1989a; Veltman & Hickson 1989). At Massey University, NZ, however, birds not observed foraging in closely spaced and cohesive groups: individuals appeared to move independently of each other in feeding flocks of up to ten, sometimes more, birds, as well as foraging singly (Hickson 1984). Within Territorial Groups, dominant females have first choice of feeding areas ahead of subordinate females (Carrick 1972).  FORAGING TERRITORIES: Defend permanent and well-defined territories, within which most food obtained; different Territorial Groups defend differently structured territories. Non-territorial Flocks do not defend territories (see Social Organization [Gregariousness, Breeding dispersion, Territories] for further details of use, size and structure of territories; see Movements for range of movements of groups and Non-territorial Flocks). In ACT, territorial adults rarely forage beyond territorial borders; noted once when food was scarce in a winter with prolonged frosts and at same time, Non-territorial Flock invaded some territories in search of food, which resulted in flock and territorial birds foraging in same area. Birds can also come together to feed on swarms of insects (Carrick 1972).  ASSOCIATIONS WITH OTHER SPECIES: Show dominance hierarchy when foraging with other species on ground, with Magpies usually having priority (Kaplan 2004), though Magpies sometimes excluded, e.g. at Seymour, Vic., crows displace Magpies unless single crow opposed by large number of Magpies (J.M. Hughes). In NZ, other species said to avoid landing within 50 m of Magpies foraging on pasture (Innes et al. 2004). In Aust., often forage with currawongs (including Pied Currawong), butcherbirds *Cracticus*, crows or ravens *Corvus* (including Forest Raven C. *tasmanicus*) and woodswallows

*Artamus*, and occasionally with White-winged Choughs *Corcorax melanorhamphos*, Noisy Miners *Manorina melanocephala* and Magpie-lark (Pearse 1929; Griffin 1995; Fitzsimons 2003; Kaplan 2004). During infestation of caterpillars at Murphys Creek, se. Qld, seen foraging with White-faced Herons *Ardea novaehollandiae*, Masked Lapwings, Laughing Kookaburras *Dacelo novaeguineae*, Noisy Miners, Jacky Winters *Microeca fascinans*, Magpie-larks, Willie Wagtails *Rhipidura leucophrys*, Black-faced *Coracina novaehollandiae* and Ground *C. maxima* Cuckoo-shrikes, Grey *Cracticus torquatus* and Pied Butcherbirds, Pied Currawongs, Torresian Crows *Corvus orru* and Common Starlings *Sturnus vulgaris* (Lord 1956b). Also seen foraging on roadside clearing with ten Long-billed Corellas *Cacatua tenuirostris* and eight Sulphur-crested Cockatoos *C. galerita* (G.D. Price). In NZ, small flock once observed foraging with single Rook *Corvus frugilegus* (Criglington 1969). FORAGING HEIGHTS: Mostly forage on ground (e.g. Orchardist 1901; Littler 1903a; Anon. 1914; Mellor 1925; Robinson 1956; Rankin 1970; Gepp & Fyfe 1975; Rowley 1975; Taylor 1982; Hickson 1984; Ford *et al.* 1986; Veltman 1989a; Veltman & Hickson 1989; Osborne & Green 1992; O'Leary & Jones 2002; Fitzsimons 2003; Kaplan 2004; Hall; see Habitat; also see Foraging sites). Sometimes forage above ground, in trees and other vegetation and, seldom, in air (see Foraging sites below); observed foraging at heights of 5 m (Hewish 1997), *c.* 10 m (Wilson 1950) and *c.* 15 m above ground (Boehm 1957). In Imbota NR, all of 102 observations of foraging were on ground (Ford *et al.* 1986). In open grassland in ACT, mainly foraged from just below ground level to *c.* 45 cm above ground (Vestjens & Carrick 1974). Near Bombala, of 622 observations of foraging, 98% on ground and 2% 0.2–4.0 m above ground (Recher & Holmes 1985; Recher *et al.* 1985). FORAGING SITES: Mostly forage on ground, in wide range of open habitats, but especially grasslands and farmland (Kaplan 2004; see Foraging heights above; also see Habitat), taking prey from surface, below ground or above ground, from grass and other vegetation (Rankin 1970; Carrick 1972; Vestjens & Carrick 1974; Pellis 1981a; Heather & Robertson 2000; Kaplan 2004). Sometimes forage above ground: occasionally forage in trees and other vegetation (Rankin 1970; Recher & Holmes 1985; Recher *et al.* 1985), though some arboreal prey taken only after it has blown to ground or been otherwise dislodged (Carrick 1972; Vestjens & Carrick 1974); and sometimes take prey from air (Wilson 1950; Robinson 1956; Boehm 1957; Pellis 1981a; Recher *et al.* 1985; Hewish 1997; C.J. Veltman). Often attracted to artificial sources of food, such as feed-tables in gardens, picnic areas or other places where scraps available (e.g. White 1923; Mellor 1925; Fletcher 1934; Elliott 1952; Roberts 1963; Baldwin 1976; Nevill 1976; Walters 1980; Passmore 1982; Buchanan 1983; Hickson 1984; Morris 1986; McKilligan & McKilligan 1987; How & Dell 1990; Wood 1998; Lord 2001; Jones 2002). Most common bird fed by suburban residents in Brisbane (Rollinson *et al.* 2003), and also elsewhere in Aust. (Jones 2002). In suburban Brisbane (n=990 min obs. foraging), spent most time foraging on lawns (72.5% of time spent foraging by males, 90.3% by females) and green pasture (12.7%, 4.5%); with rest in tall dry grass, garden beds, leaf-litter and footpaths (14.8%, 5.2%) (O'Leary & Jones 2002). In Imbota NR (n=102 obs. foraging), all foraging on ground: 86.3% of observations in grass, 10.8% in leaf-litter and 2.9% on bare ground. Near Bombala, of 622 observations of foraging, 98% on ground, 1% among foliage and 1% in air. In Snowy Mts, foraged on ground, including in areas of snow and meltback; of 61 observations of foraging, during months with patchy snow, all were on ground, including 27% on snow-covered surfaces and 6% on snow meltback areas; of seven observations during periods of extensive snow cover, foraged only in areas of snow meltback. At Serendip, for one

family group (observed roughly Sept.–Feb. over 2 years): *c.* 73% of foraging attempts on soil surface and *c.* 7.5% beneath ground, *c.* 17% arboreal (from blades of grass, shrubs), and *c.* 2.5% from air (items flying near ground); adults tended to forage more on items on or below surface than juveniles (84% of foraging attempts by adults, 76% by juveniles), while juveniles took more items from air and blades of grass than adults (23% by juveniles, 16% by adults), though differences declined as juveniles grew. Preferred foraging site changed from spring (Sept.–Nov.) to summer (Dec.–Feb.): 73% of foraging attempts in spring and 72% in summer from soil surface; 14% and 0.5% beneath ground; 12.5% and 22% arboreal; and 0.5% and 5.5% from air. Change in substrates appeared to be associated with increased heat and desiccation of ground, as comparison of data from 1975 and 1977 (a hotter, drier year) showed similar shift towards arboreal and aerial foraging during warmer weather. Similar data obtained for a second family at Serendip (Pellis 1979). In Murray–Mallee of SA, often foraged in cleared areas and perched in adjacent vegetation, such as at edge of roadside mallee vegetation, where microhabitat associated with roads (such as increased warmth or run-off) may attract prey such as invertebrates and basking reptiles, which also have increased likelihood of being killed by vehicles, with road-kill providing an easily obtained source of food (Luck *et al.* 1999). Also forage in areas recently burnt by bushfires, along roads and among debris of receding floods (Robinson 1956). In ACT, some invaded stock enclosures for food during drought; during prolonged frosts in one winter, birds abandoned open pasture (which failed to thaw, and ground invertebrates inactive) to forage for insects and seed on softer ground round haystacks (Carrick 1972). At Palmerston N, small numbers sometimes foraged among mud and stones on river bed adjacent to pasture where birds normally foraged (Hickson 1984). Two seen feeding on goose barnacles on driftwood (CSN 49). FORAGING METHODS: Attack mainly by gleaning from or probing into ground (see below). SEARCH: When searching for prey, often turn stones, sticks, bark or dung, or scatter drifts of leaves (e.g. Anon. 1914; Robinson 1956; Carrick 1972; Recher *et al.* 1985; Ford *et al.* 1986; O'Leary & Jones 2002; J.M. Peter); when foraging on beaches, toss aside clumps of seaweed or dig up partly buried seaweed or seagrass, to expose invertebrates; at one site, before pecking at prey, bird would take one or two steps forward (Fitzsimons 2003; J.M. Peter). On ground, walk slowly and deliberately (Floyd & Woodland 1981), moving systematically across foraging area (Kaplan 2004). Use both auditory and visual cues to detect prey: listening for prey just beneath surface of soil, and looking for prey moving on surface (Anon. 1914; Robinson 1956; Floyd & Woodland 1981 [which see for details of experimental manipulations]; Pellis 1981a; O'Leary & Jones 2002). When prey detected, cock head to one side, then sometimes to the other, before thrusting bill into ground and exposing prey by levering earth with bill or by tearing out plug of grass and soil with bill (Floyd & Woodland 1981). In suburban Brisbane used visual cues more often (3.1±0.8 visual cues/min) than auditory cues (0.2±0.4 auditory cues/min) (O'Leary & Jones 2002). In Melbourne and at Serendip, movement of prey appeared to incite capture attempts, though adults appeared less stimulated by movement than juveniles. Though juveniles became more selective as they aged, observations suggest movement remains an important cue, at least in some situations (Pellis 1981a); see Young for further information on development of foraging methods. Sometimes stir grass with foot, to disturb prey (Gardner & Gardner 1975). Often follow farm machinery or horses, taking prey thus disturbed or exposed (Le Souëf 1904; Thorogood 1941a; McCaskill 1945; Nielsen 1962; Burnett 1996). ATTACK: Mainly by gleaning from, or probing into, ground. Glean invertebrates and other prey exposed by turning or moving

leaf-litter and other debris on ground and beaches (Anon. 1914; Robinson 1956; Carrick 1972; Recher et al. 1985; Ford et al. 1986; O'Leary & Jones 2002; Fitzsimons 2003; J.M. Peter). After detecting subterranean invertebrates, such as beetles and their larvae and worms, expose prey by digging into or probing ground with bill (Orchardist 1901; Anon. 1914; Lord 1956b; Robinson 1956; Carrick 1972; Floyd & Woodland 1981; Recher et al. 1985; Ford et al. 1986; O'Leary & Jones 2002), or levering earth with bill or by tearing out plug of grass and soil with bill (Floyd & Woodland 1981); usually pull prey out whole (Floyd & Woodland 1981). Dung pulled apart or probed for grain or invertebrates (Robinson 1956). Sometimes lunge at invertebrate prey (Pellis 1981a). Also sally from ground or perches in trees to catch flying insects in air (Wilson 1950; Robinson 1956; Boehm 1957; Carrick 1972; Kaplan 2004; C.J. Veltman). Seen to attack small passerines in flight (screening) or swooping down onto them (sally-strike or sally-pounce), and kill them by pecking at head (Sexton 1922; Sharland 1922; Porter 1993; Hewish 2002a; Tas. Bird Rep. 19); once seen to attack flock of rosellas Platycercus foraging on ground, catch one and eat it (Bedggood 1976). Juveniles seen to jump from ground and sally-strike prey from foliage or spider webs, turn over debris on ground, and examine crevices between stones (Roberts 1963). Sometimes forage on carcasses and other dead meat on ground (Kaplan 2004). Once seen jumping up and down beside nest of European Wasp Vespula germanica on ground, provoking wasps, which were then caught in air and swallowed (Bray & Davey 2002). In Imbota NR, of 102 observations of foraging: 83.3% by gleaning and 16.7% by probing (Ford et al. 1986). Near Bombala, of 622 observations of foraging: 56% by gleaning, 43% by probing and 1% by sallying (Recher & Holmes 1985; Recher et al. 1985). At Port Hills, most food gleaned from surface of pasture, with rest probed from below surface (Rankin 1970). In one family group at Serendip, 8-week-old juveniles had similar prey-capture rates to their parents during the day (78% and 75% respectively). However, at twilight, juveniles attempted to snare beetles that flew in swarms over foraging grounds by pursuing one, which they would lose, and then target another, which resulted in reduced capture success (54%); in contrast, adults only attacked beetles that landed near them, and so maintained a high rate of success (78%) (Pellis 1981a). Scarab larvae are a favoured prey, but only large, late second or third instar larvae eaten; in one territory, where density of these larvae was only 0.2 larvae/m$^2$, Magpies retrieved larvae from 96% of holes excavated (Floyd & Woodland 1981). KLEPTOPARASITISM: Once, a pair stole food from Australian Raven Corvus coronoides (Lepschi 1990). HANDLING OF FOOD: Rarely need to manipulate food items, which usually grabbed and eaten with one powerful jab of bill (Kaplan 2004), though large prey usually torn apart and eaten in pieces (Robinson 1956). Small prey usually swallowed whole, by flicking or tossing head back (Pellis 1981a; Hickson 1984). Bees or wasps wiped against ground to remove sting before being swallowed (Griffiths & Holyoak 1993); after catching European Wasps, appeared to swallow them whole, two or three at a time, after rubbing bill on ground (Bray & Davey 2002; see Foraging methods above). Large prey, such as large insects, frogs, birds and mice, held in bill and usually bashed, hammered or rubbed on ground, branch or stone to kill, dismember or soften prey before it is eaten piece by piece or swallowed (Anon. 1914; Robinson 1956; Pellis 1979, 1983), e.g. a Skylark Alauda arventris held in bill and bashed on ground till it was dead (Porter 1993). One mouse was repeatedly pecked and shaken in bill before being eaten (Alexander 2002). Large prey often held down with feet while it is torn apart and eaten in pieces (Sexton 1922; Alexander 2002; Maddeford 2002), e.g. a frog beaten on ground, then held with one foot and torn apart with bill and

eaten piece by piece (Robinson 1956) and, in NZ, Double-banded Plovers Charidrius bicinctus chicks held against ground with feet and killed and eaten by pecking at them (Keedwell & Sanders 1999). While holding prey beneath feet, birds may also shake their heads while grasping prey in bill and sometimes shake head and pull at prey (Pellis 1979, 1983), e.g. Bag Moth pupae held with foot and torn apart with bill (C.J. Veltman). Tear strips of meat off carcasses with bill (Kaplan 2004). Sometimes spend much time extracting marrow from bones of dead animals found on ground using two methods: (1) grasp bone with foot and hold it up so that open end of bone faces upward, and extract marrow with bill; or (2) hold bone down with left foot while bending down and inserting bill into open end of bone (Kaplan 2004), though said that sometimes hold bones down with both feet (Roberts 1963). CACHING: Only males seen to cache food (Rollinson 2002). Cache food on ground, by burying it, sometimes covered with loose layer of leaf-litter, or placing it under leaf-litter, stones or logs; or cache food in grass or other plants, by pushing it between leaves or stems, or wedging it behind peeling bark of tree (Robinson 1956; Roberts 1963; Hewish 1998; Oliver 1998; Maddeford 2002; Rollinson 2002; Kaplan 2004); one young bird attempted to store piece of meat between crack in brickwork and in small tin, before leaving it among some pot-plants (Elliott 1952). Food often retrieved within 1 h of caching (Kaplan 2004); a piece of meat stored at 09:00 was retrieved at c. 17:00 the same day (Elliott 1952). Food sometimes relocated if original caching seen by another Magpie, and birds often raid cache sites of others (Kaplan 2004). Fledgelings often cache excess food without retrieving it (Roberts 1963). SEASONAL VARIATION AND TIMES OF FORAGING: In ACT, forage in morning, afternoon and evening (Carrick 1972), though anecdotal reports say forage mostly in morning or late afternoon (Orchardist 1901; Wilson 1946). Sometimes search for insects till dark (Anon. 1914; Carrick 1972; C.J. Veltman), particularly during breeding season (Kaplan 2004), and observed foraging at night (Smith 1995; Scambler 1996), sometimes under street-lights (Hewish 1998) or other illuminated areas (J.M. & K.F. Peter). At Linton, most birds in Non-territorial Flocks foraged little in early morning, with foraging activity intensifying as day progressed; proportion of birds in Non-territorial Flocks observed foraging greatest in Feb.–Mar., indicating potential shortages of prey during those months (Veltman & Hickson 1989, which see for details of seasonal time-budgets). In ACT, invertebrates common in diet throughout year, and seed and other vegetable matter eaten mostly in winter; other items showed little or no variation throughout year (Vestjens & Carrick 1974, which see for details of seasonal variation, and effect of climatic extremes on intake of major food items). At Christchurch Airport, adult and larval Coleoptera (mainly weevils and other beetles) formed main component of diet for most of year but Lepidoptera larvae formed major component in Jan. (up to 55% freq. of diet) (Moeed 1976, which see for seasonal breakdown; for species eaten, see below). FEEDING RATES: When feeding on lawns in suburban Brisbane, birds (sexes combined) made mean of 1.5±0.2 pecks/min and 2.4±0.4 probes/min, and ingested mean total 2.4±0.4 items/min, including 0.2±0.1 worms/min. At Massey University, during May (n=60 × 1-min. foraging), birds in Non-territorial Flocks made mean of 3.97±1.5 pecks/min, and had mean intake of 2.05±0.8 items/min (including 0.70±0.8 worms/min) with mean success of 51.6%; for territorial birds (n=60 × 1-min obs.), figures were 3.85±3.1 pecks/min, 2.02±1.5 items/min (0.55±0.8 worms/min) and 52.5%; no significant difference between flocks or territorial birds in rates of pecking or food intake (Hickson 1984; Veltman & Hickson 1989). At Port Hills, mean duration of foraging 10.8 min (10.01; 1–55; 35) with all bouts ≥22 min except for single

bout of 55 min, though suggested latter may be truer indication since many bouts observed (and included in mean) had already begun when bird sighted (Rankin 1970). On Wilsons Prom., Vic., bird gleaning from sand on beach made 41 pecks/min, with 1.3 s between pecks (Fitzsimons 2003). PEST STATUS: Sometimes (at least formerly) considered a minor pest of grain and fruit crops (including Grapes, figs and Peaches), digging up newly planted or sprouting grain and dancing on branches of trees in orchards and shaking off fruit. However, pest status outweighed by appetite for insect pests (Orchardist 1901; Littler 1903b, 1910; Barnard 1905; Campbell 1905; Batey 1907b,c; Hill 1907; Dove 1908; Chisholm 1910; McKeown 1923; Carter 1924; Boehm 1929, 1937). PELLETS: Sometimes regurgitate cylindrical pellets, those of adults roughly 19–32 mm long × *c.* 13 mm wide, and those of juveniles *c.* 19 mm × *c.* 10 mm. Pellets are sticky when fresh and typically consist of indigestible remains of beetles and other insects, packed together with other matter such as seeds or seed-husks (Robinson 1956; Roberts 1963). When ejecting pellet, bird stands erect with neck arched and mouth wide open (Roberts 1963), and sometimes shakes pellets from bill (Robinson 1956). DRINKING: Do not appear to need free water for drinking (Carrick 1972). However, seen drinking from water-tray at house during extreme heat (Mellor 1923b), and from well, by flying down shaft (Mules 1932). Young do not begin drinking till several weeks after fledging (Kaplan 2004). ADAPTATIONS: Use sharp bill to probe soft ground or explore cracks, and to turn over debris on ground (Rowley 1975). Hook on end of bill useful for holding prey (Kaplan 2004). Suggested that long, thin bill of birds in WA adapted for digging in hard soil (Milligan 1904).

**Detailed studies** In SUBURBAN BRISBANE (99 × 10-min obs. of 20 birds, taking 740 food items; O'Leary & Jones 2002); 12 food-types taken: small unidentified items (65.1% of items detected); potato chips (9.4%); worms (8.9%); bread (7.4%); clover *Trifolium* seeds (5.8%); beetle larvae, moths, ants and skinks (1.8%); and apple, sausage and meat (1.3%).

In E. NSW (contents of 21 stomachs; Rose 1999, including data from Rose 1973): **Plants** Seeds 14% freq., fruit 5, leaves 19. **Animals** MOLLUSCS: Gastropods 14. SPIDERS 52. DIPLOPODS 14. INSECTS: Blattodea 14; Coleoptera 95; Hemiptera 19; Hymenoptera: Formicidae 38; Lepidoptera: larv. 10, ads 14; Orthoptera 67. AMPHIBIANS: Frogs 10. BIRDS: Eggshells 5. **Other matter** Food scraps 10.

In ACT (contents of 1319 stomachs; little difference in type and proportion of food eaten between adults and immatures; Vestjens & Carrick 1974): **Plants** MONOCOTYLEDONS: Unident. remains 7.7% freq.; seeds (including *Avena sativa, Setaria, Triticum aestivum*) 12.7. DICOTYLEDONS: Unident. 6.4; seeds (including *Crataegus, Rosa rubiginosa, Rumex, Solanum, Trifolium*) 4.7. **Animals** ANNELIDS: Oligochaetes 37.7. MOLLUSCS: Gastropods 0.1. CRUSTACEANS: Decapods: Parastacidae: *Cherax albidus* 0.3. SCORPIONS 0.3. SPIDERS 38.1, eggs 4.0. DIPLOPODS 0.7. CHILOPODS 1.8. INSECTS: Blattodea cockroach ads 4.5, eggs 0.8; Coleoptera: unident. 5.0; Carabidae 27.9; Chrysomelidae (including *Paropsis*) 14.9; Curculionidae 73.1; Elateridae ads 22.8, larv. 10.5; Lucanidae 0.8; Scarabaeidae: Scarabaeidae ads 42.4, Retulinae (including *Anoplognathus*) 12.7, other scarabaeid ads 25.3, larv. 33.9; Tenebrionidae 5.9; Dermaptera 2.3; Diptera ads 3.6, larv. 4.4; Hemiptera: Cicadidae 1.0; Pentatomidae 29.9; Hymenoptera: unident. 13.9; Apidae 0.2; Formicidae (including *Camponotus, Iridomyrmex, Myrmecia, Pheidole, Rhytidoponera*) 70.3; Tenthredinidae 1.0; Lepidoptera: ads 2.4, larv. 2.0; Mantodea ads 2.3, eggs 2.8; Neuroptera larv. 0.2; Odonata 0.1; Orthoptera: Acrididae 39.6; Gryllacrididae 0.8; Gryllidae 20.8; Gryllotalpidae 9.8; Tettigoniidae 5.4. AMPHIBIANS: Frogs 0.3. REPTILES: Lizards 0.1. BIRDS: Eggshell 0.5, flesh 1.1, bone 3.3. MAMMALS: Eutherians: Muridae: *Mus musculus* 0.1. **Other**

matter Grit 6.4. (For variation in frequency of occurrence of most important food categories between seasons and during climatic extremes, see Vestjens & Carrick [1974].)

At MELBOURNE AIRPORT, VIC. (213 items from stomachs of 10 birds; Steele 1997): **Plants** Seeds 8.0% no., 10% freq. **Animals** ANNELIDS: Oligochaetes 0.9, 20. MOLLUSCS: Gastropoda 0.5, 10. CRUSTACEANS: Isopoda 8.0, 10. DIPLOPODS: 1.9, 30. INSECTS: Coleoptera 0.9, 20: Curculionidae 26.7, 50; Dermaptera 3.8, 40; Hemiptera 0.5, 10; Hymenoptera: wasps 0.9, 20; Formicidae 30, 30; Lepidoptera 0.5, 10; Orthoptera: Gryllidae 17.4, 50.

At COOLUP, S. WA (contents of stomachs of 17 adults; Robinson 1956): **Plants** MONOCOTYLEDONS: Grass lvs 12% freq., roots 18; Poaceae: *Avena sativa* sds 12; *Triticum aestivum* 12. DICOTYLEDONS: Dioscoreaceae: *Dioscorea transversa* tubers 18; Fabaceae: *Pisum sativum* 6. **Animals** SPIDERS 12. INSECTS: Coleoptera: Carabidae 29; Chrysomelidae: *Paropsis* 6; Curculionidae 6: *Listroderes* 6; *Orthorhinus* 6; Tenebrionidae 70; Dermaptera 29; Diptera 6; Hemiptera: Pentatomidae 65; Hymenoptera: Formicidae 6; Lepidoptera larv. 53: Noctuidae larv. 76; Orthoptera: grasshoppers 12. REPTILES: Lizards 12. MAMMALS: Muridae: *Mus musculus* 6. **Other matter** Grit, charcoal 18.

At MASSEY UNIVERSITY, PALMERSTON N, NZ (169 items from faecal samples of birds from Non-territorial Flocks, and 178 items from faecal samples of birds from Territorial Groups; samples collected Mar.–May; Hickson 1984; Veltman & Hickson 1989): **Plants** Seeds 2.4% no. for birds in Non-territorial Flocks, 20.4% no. for territorial birds. **Animals** CRUSTACEANS: Amphipods 0.5, –. SPIDERS: Araneida 7.0, 24.3. CHILOPODS: Centipedes –, 1.7. INSECTS: Unident. 1.2, 0.5; Coleoptera: Carabidae 3.4, 2.8; Curculionidae: *Graphognathus* 1.8, 1.7; *Irenimus* 2.4, 8.4; *Listronotus bonariensis* 2.4, 3.5; Scarabaeidae: *Costelytra zealandica* 14.0, 5.1; Staphylinidae 2.4, –; Diptera: Sarcophagidae 8.1, 9.6; Hemiptera: Nabidae 1.8, 1.7; Hymenoptera: Formicidae: unident. 14.4, –; *Chelaner antarcticum* 16.4, 1.7; Ichneumonidae 12.4, 5.0; Vespidae 1.2, 1.2; Lepidoptera: larv. 3.5, 1.7: Hepialidae: *Wiseana* 2.4, 4.0; Orthoptera: Acrididae –, 0.5; Gryllidae 1.8, 6.2. REPTILES: Lizard –, 0.5.

**Other records—Aust. Plants** Seeds[1,6,61,67,110]; fruit[1,72]. GYMNOSPERMS: Pinacea: *Pinus* sds[96]. MONOCOTYLEDONS: Cactaceae: *Opuntia stricta* fru.[55]; Iridaceae: *Romulea rosea* corms[54]; Liliaceae: *Dichopogon preisii* tubers[54]; Poaceae: sds[108,111], lvs[70]; *Avena sativa* sds[4,28,72,109,111]; *Hordeum vulgare* sds[72]; *Triticum aestivum* sds[19,34,72,108,109,111]; *Zea mays* sds[22]. DICOTYLEDONS: Fabaceae: *Trifolium repens* fru.[90], leaves[72]; Juglandaceae: *Juglans regia* fru.[54]; Loranthaceae: fru.[57]; Mimosaceae: *Acacia* sds[102]; *A. sophorae* sds[102]; Moraceae: *Ficus* fru.[1,2,54,108]; *F. carica* fru.[86]; Oleaceae: *Olea europea* fru.[49,54,86]; Rosaceae: *Fragaria vesca* fru.[72]; *Prunus armeniaca*[54]; *P. persica* fru.[1]; Santalaceae: *Exocarpos* fru.[86]; Solanaceae: *Lycopersicon esculentum* fru.[53]; *Physalis* fru.[53]; Verbenaceae: *Lantana camara* sds[23]; Vitaceae: *Ampelocissus brevipeduncula* fru.[91]; *Vitis vinifera*[54]. **Animals** ANNELIDS: Oligochaetes: earthworms[6,34,54,67,72,111,113]. MOLLUSCS: Gastropods[70,72]; Helicidae[72]; Limacidae[72]. CRUSTACEANS: Isopods: Porcellionidae[113]. SCORPIONS[54]. SPIDERS[6,23,69,70,72,75,108,109,111]; Pisauridae[75]; Salticidae[75]. DIPLOPODS[72,111]. CHILOPODS[54]: Scolopendridae: *Ethmostigma rubripes*[70]. INSECTS[1,15,38,42,64,95,108,109,110]: Blattodea: ads[70,72], eggs[70,111]; Blattidae: *Periplanata americana*[72]; Coleoptera: ads[18,19,23,34,61,64,67,108,109,110,113], larv.[33,67,70,113]; Carabidae[23,64,72,108,109,111]: *Catadromus australis*[75]; *Clivina*[75]; *Hypharpax australis*[75]; *Notagonum submetallicum*[75]; *Trigonothops*[109]; Chrysomelidae[111]: *Haltica ignea*[75]; *Paropsis*[108]; Curculionidae[63,64,72,75,108,109,111]: *Desiantha*[33]; *Polyphrades*[109]; Elateridae[75,111]; Lycidae: *Chauliognathus lubugris*[90]; Scarabaeidae[4,23,43,70,72,75,108,111]; *Anoplognathus*[67,108]; *Aphodius howitti*[56];

*Heteronychus arator*[72]; *Onthophagus*[108,109]; Staphylinidae[111]; Tenebrionidae[64]: *Saragus lanicollis*[109]; Dermaptera[109]: Labiduridae: *Labidura truncata*[111]; Diptera[63]: ads[113], larv.[108]; Calliphoridae: *Lucilia cuprina*[90]; Hemiptera[61,64,72]: Cicadidae[23,97]; Cicadellidae[111]; Pentatomidae[64,75,111]; Hymenoptera: wasps[64,75,109]; *Vespula germanica*[105]; Apidae[41]: *Apis mellifera*[90,92]; Formicidae[21,53,67,72,108,109,111]: *Camponotus*[71,103,111]; *Iridomyrmex*[64,71,75]; *I. purpureus*[75]; *Myrmecia*[7,71,72,108,111]; *M. tarsata*[72]; *Pheidole*[71,72,75,109]; *Polyrhachis*[109]; *Rhytidoponera*[71,75,111]: *R. metallica*[108,109,111]; *R. mayri*[109]; Ichneumonidae[23]; Tenthredinidae[64]; Vespidae: *Polistes*[75]; Isoptera[72,79]: Rhinotermitidae: *Coptotermes*[90]; Termitidae: *Amitermes*[75]; Lepidoptera: larv.[19,33,52,53,64,75,109,111], ads[72]; Arctiidae: *Spilosoma curvata* larv.[72]; Geometridae: *Oenochroma vinaria* larv.[72]; Hepialidae: *Oncopera fasciculata* larv.[56]; Limacodidae: *Doratifera vulnerans*[109]; Noctuidae larv.[4,36,72,108,111]: *Agrostis infusa*[12,72]; Psychidae[111]: *Oiketicus elongatus*[72]; Sphingidae[108]; Zygaenidae: *Lactura caminaea*[72]; Mantodea: Mantidae[62]: *Tenodera australasiae*[90]; Orthoptera: grasshoppers[1,3,21,23,35,38,42,53,54,67,72,108,109,113]; Acrididae[1,72,111]: *Austroicetes*[90]; *Chortoicetes terminifera*[44]; *Phaulacridium vittatum*[90]; *Praxibulus*[90]; Eumastacidae[72]; Gryllidae[5,23,111,113]: *Teleogryllus commodus*[75]; Gryllotalpidae: *Gryllotalpa*[72];Phasmatodea[23,111]. **AMPHIBIANS**: Frogs[6,54,60,67,72,104,111]. **REPTILES**: Snakes: Elapidae: *Hemiaspis signata*[72]. Lizards[6,60,67,104]: Agamidae: *Amphibolurus barbatus*[75]; Scincidae[22,54]: *Lampropholis quichenoti*[72]. **BIRDS**[67,104] (Ads unless stated): quail *Coturnix*[10]; Domestic Fowl *Gallus gallus* egg, chicks[46]; Purple Swamphen *Porphyrio porphyrio* carrion[51]; Spotted Turtle-dove *Streptopelia chinensis* nestlings[72]; Eastern Rosella *Platycercus eximius*[73]; Rainbow Bee-eater *Merops ornatus* fledgelings[82,83]; small passerines[6,24,54,60]; pardalote *Pardalotus*[27]; Southern Whiteface *Aphelocephala leucopsis*[94]; Yellow-rumped Thornbill *Acanthiza chrysorrhoa* nestlings[85]; Flame Robin *Petroica phoenicea*[29]; Western Yellow Robin *Eopsaltria griseogularis*[93]; Willie Wagtail *Rhipidura leucophrys*[72]; Richard's Pipit *Anthus novaeseelandiae*[13,31,32]; sparrow *Passer*[11]; House Sparrow *P. domesticus*[11,13,37,40,48,99]; Common Starling *Sturnus vulgaris*[30,48,87]. **MAMMALS**: Dasyuridae: Antechinus[104]; Muridae: *Mus musculus*[6,16,20,65,66,78,80,81,95,104,106,111]; Leporidae: *Oryctolagus cuniculus* carrion[42,45]; *Lepus capensis* carrion[72]; Bovidae: sheep *Ovis* carrion[24,54,75]. **Unidentified carrion**[67,89]. **Other matter** Grit, soil, sand and charcoal[54,107]; bread; meat, and meat scraps and pieces, including offal and pieces of fat[6,8,9,14,17,24,25,26,47,50,54,58,59,64,68,74,77,84,88,98,100]; tinned dog food[112]; cheese, milk and butter[6,9,53,76].

REFERENCES: [1] Orchardist 1901; Barnard [2] 1905, [3] 1914; [4] Campbell 1905; [5] Stephen 1907; Anon. [6] 1914, [7] 1962; Fletcher [8] 1915, [9] 1921; [10] Burnell 1918; [11] Sexton 1922; [12] Slaney 1922; [13] Sharland 1922; [14] White 1923; [15] Mellor 1925; [16] Cohn 1926; [17] Souter 1926; [18] Tilley 1926; Boehm [19] 1929, [20] 1937, [21] 1957; [22] Irby 1929; [23] Jarvis 1929; Pearse [24] 1929, [25] 1938a, [26] 1938b; [27] Hanks 1930; [28] Randell 1930; [29] Bridgewater 1932; [30] Cameron 1933; [31] Gannon 1933; [32] Hordern 1933; Sutton [33] 1933, [34] 1937; [35] McGilp 1935b; [36] Roberts 1936; [37] Morell 1937; [38] Chisholm 1938; [39] Thorogood 1941b; [40] Chandler 1944; [41] Terrill 1944; Wilson [42] 1946, [43] 1950; [44] Basse 1948; [45] Favaloro 1948; [46] Brown 1950; [47] Morrison 1950; [48] Brandon 1951; [49] Cleland 1952; [50] Elliott 1952; [51] Binns 1953; Lord [52] 1956b, [53] 1957; [54] Robinson 1956; [55] Quinn 1959; [56] Wheeler 1959; [57] Sedgwick 1962; [58] Roberts 1963; [59] Oatley 1966; [60] Frith 1969; [61] Lavery 1969; [62] Pearce 1969; van Tets *et al.* [63] 1969, [64] 1977; [65] Hayward & Macfarlane 1971; [66] Hobbs 1971a; [67] Carrick 1972; [68] Lawrence & Lawrence 1972; [69] Hooper 1973; Rose [70] 1973, [71] 1974, [72] 1999; [73] Beddgood 1976; [74] Nevill 1976; [75] Vestjens 1977; [76] Alley 1979; [77] Walters 1980; [78] Saunders & Cooper 1982; [79] Moffatt 1983; [80] Hahne 1984; [81] Schlager 1984; Ashton [82] 1985, [83] 1986; [84] Donohoe 1985; [85] Brown & Brown 1986; [86] Forde 1986; Butterfield [87] 1988, [88] 1992; Lepschi [89] 1990, [90] 1993, [91] 1997; [92] Griffiths & Holyoak 1993; [93] Hassan 1994; [94] Trémont 1995; [95] Burnett 1996; [96] Paton 1996; Hewish [97] 1997, [98] 1999, [99] 2002a; [100] Jorm 1998; [101] Oliver 1998; [102] Gosper 1999; [103] Simpson 2000; [104] Alexander 2002; [105] Bray & Davey 2002; [106] Maddeford 2002; [107] Mawson 2002; [108] Cleland; [109] Lea & Gray; [110] Hall; [111] FAB; [112] A.M. Dunn; [113] S. Pellis.

**Other records—NZ Plants** DICOTYLEDONS: Lauraceae: *Beilschmiedia tawa* fru.[1]. **Animals** CRUSTACEANS: Goose barnacles[15]. INSECTS[1]: Coleoptera: *Aphodius howittii*[3]; *Costelytra zealandica*[3]; *Desiantha maculata*[3]; *D. variabilis*[3]; *Hyperodes bonariensis*[3]; *Hypharpax antarcticus*[3]; *Irenimus aequalis*[3]; *Lacon variabilis*[3]; *Listroderes delaiguei*[3]; *Metaglymma monilifera*[3]; *Megadromus antarcticus*[3]; *Pyronota setosa*[3]; Hymenoptera: Apidae: *Apis mellifera*[1]; Lepidoptera: larv.[1], ads[1,17]; Coleophoridae: *Coleophora*[3]; Hepialidae: *Wiseana cervinata* larv.[3]; Nymphalidae: *Danaus plexippus*[14]; Psychidae: pupae[17]. REPTILES: Lizards[1]. BIRDS (Adults unless stated): Doublebanded Plover *Charadrius bicinctus* eggs, chicks[6,7,9]; Blackfronted Tern *Sterna albostriata* chick[4]; White-faced Heron *Ardea novaehollandiae* eggs, nestlings[11]; small passerines[1]; Skylark *Alauda arvensis* eggs, nestlings[5]; House Sparrow *Passer domesticus*[1]; Common Blackbird *Turdus merula*[1,2,13]; Song Thrush *Turdus philomelos* eggs[16]. MAMMALS: Muridae: *Mus musculus*[1,10,13]; Leporidae: *Oryctolagus cuniculus* carrion[1]; Bovidae: sheep *Ovis* carrion[1], and possibly also sick or dying sheep and lambs[1,8]; cattle *Bos taurus* carrion[1]. **Other matter** Grit[1]; meat scraps[11]; cooked eggs[12].

REFERENCES: [1] McCaskill 1945; [2] Moon 1968; [3] Moeed 1976; [4] Lalas 1977; [5] McKenzie 1979; [6] Phillips 1980; [7] Keedwell & Sanders 1999; [8] Heather & Robertson 2000; [9] Sanders & Maloney 2002; CSN [10] 1, [11] 19, [12] 22, [13] 44, [14] 47, [15] 49; [16] C.J. Veltman.

**Young** Contribution of male to feeding of nestlings and fledgelings varies; young may be fed mostly, or solely, by female, or by both sexes; young also fed by other members of group, if present (see Breeding: [Young, Fledging to independence]; also see Social Organization: [Co-operative breeding]). Nestlings usually fed equally and in turn, with usually only one fed per visit by a parent or helper; food placed into throat of nestlings. Claimed that nestlings usually fed at intervals of 20 min (Kaplan 2004). In and near Melbourne, for four family groups, each with two or three nestlings, adults provided 30.9±11.6 food deliveries/young/adult foraging h in week before fledging (Pellis 1981a); for data after fledging, see Development of foraging skills, below. Adults selective in food brought to young, sometimes eating some types of food themselves and delivering other types to young (Alley 1979; Larkin 1980); in and near Melbourne, adults selectively fed fledgelings soft-bodied prey (see Development of foraging skills below). A female given some bacon ate all but three pieces, which she took and fed to her three nestlings (Morrison 1950); and another female also provided with meat took three pieces at a time to her three nestlings (Souter 1926). For some information on feeding of captive nestlings, see La Roche (1950). A female provided with meat varied the number of food items she carried depending on location of her three fledgelings, e.g. took three pieces at same time if all three fledgelings together, or two pieces and one piece if two fledgelings were in one tree and one in another (Souter 1926). Fledgelings sit in trees waiting for parents to bring them food, until able to fly strongly (Wilson 1946; Robinson 1956), then join flock to forage on ground (Wilson 1946). Fledgelings spend much time learning foraging methods from parents, walking close to adult while they forage (Kaplan 2004). Juveniles said to take more ants and spiders than adults (Carrick 1972). Young can be fed by parents for up to 6 months, sometimes even 12 (Wilson 1946; Robinson 1956; also see

Social Organization: Parental care). One female fed a brood of three fledgelings until after they could feed themselves (Souter 1926). DEVELOPMENT OF FORAGING SKILLS: (All from Pellis 1981a.) For four family groups, each with two or three nestlings, adults provided 30.9±9.0 feeds/young/adult foraging h during first 2 weeks after fledging. Adults provided food less frequently as juveniles grew older; mean number of successful feeds of juveniles per adult foraging hour (figures estimated from graph): c. 32 (c. 31 initiated by parent, c. 1 initiated by juvenile) at fledging, c. 47 (c. 31, c. 16) at 2 weeks after fledging, c. 42 (c. 14, c. 28) at 4 weeks, c. 18 (c. 5, c. 13) at 6 weeks, c. 7 (c. 1, c. 6) at 8 weeks, c. 3 (c. 0, c. 3) at 10 weeks, c. 1 (0, c. 1) at 12 weeks. Juveniles received mean five items (3–8) per feed when parent initiated feeding, as adults collected a billful of items before feeding young; juveniles received less food when they solicited food, as they begged after adults had captured a single item. Though feeds initiated by juveniles were more frequent from 4 weeks on, voluntary feeding by adults still provided most food items owing to differences in food loads between feeds initiated by adults and those by juveniles. When foraging for juveniles, adults stored soft-bodied invertebrates in bills, and ate hard-bodied prey. However, juveniles begged irrespective of prey-type captured by adult; thus, as the number of parent-initiated feeding exchanges decreased (as above), proportion of soft-bodied prey provided by adults decreased also. From 6 weeks on, adults often attacked juveniles when they begged. Proportion of daylight hours spent foraging by two or three juveniles in one family group (at fortnightly intervals after fledging, which defined as when young no longer returned to nest; figures estimated from graph): c. 9% at 2 weeks after fledging, c. 22% at 4 weeks, c. 50% at 6 weeks, c. 39% at 8 weeks, c. 36% at 10 weeks, c. 31% at 12 weeks, c. 38% at 14 weeks, and c. 32% at 16 weeks. During first 2 weeks after fledging, juveniles followed foraging adults on ground, begging for food and making first attempts to capture prey. However, foraging comprised only a small component of juveniles' time (as above), and unlike adults and older juveniles, did not involve consistent search for prey. Proportion of food of juveniles provided by adults decreases in weeks after fledging; for two or three juveniles in three family groups, mean proportion of food items provided by adults (figures estimated from graph): 100% at fledging, c. 81% at 2 weeks after fledging, c. 47% at 4 weeks, c. 11% at 6 weeks, c. 3% at 8 weeks, c. 1% at 10 weeks, c. 0% at 12 weeks. Juveniles foraged more efficiently as they got older; for two or three juveniles in three family groups, mean capture rate when feeding from surface (figures estimated from graph; figures for adults given in brackets for comparison): c. 1% (c. 76%) at fledging, c. 15% (c. 68%) at 2 weeks after fledging, c. 32% (c. 77%) at 4 weeks, c. 54% (c. 74%) at 6 weeks, c. 68% (c. 78%) at 8 weeks, c. 76% (c. 81%) at 10 weeks, c. 74% (c. 85%) at 12 weeks, c. 79% (c. 84%) at 14 weeks, c. 75% (c. 79%) at 16 weeks. In first 4 weeks after fledging, juveniles walked short distances between capture attempts, but because they had little success at this time (see above), the distance travelled per item caught was greater than for adults. As juveniles grew, they became more selective when foraging (see below) and, from 8 weeks, mean distance walked between capture attempts much as adults; this, combined with improved foraging efficiency (as above), resulted in juveniles and adults travelling similar distances between successful prey captures at 8–10 weeks after fledging (for further details, see Pellis 1981a). The proportion of large prey (size relative to bill) captured by juveniles increased as they approached independence; in one family group, 2 weeks after fledging, juveniles attempted to capture small prey on grass in 29% of 109 observed capture attempts (adults attempted to capture small prey on grass in only 8% of 194 capture attempts); in another family group, proportion of large prey items taken from surface

by juveniles (corresponding data for adults given in brackets: 29% (of 63 items) at 6 weeks after fledging (for adults, 44% [n=39 items]), 25% (112) at 8 weeks (38% [82]), 36% (76) at 10 weeks (35% [32]), 37% (63) at 12 weeks (42% [66]), 31% (92) at 16 weeks (34% [50]).

No detailed studies of diet of young. **Aust. Plants** MONO-COTYLEDONS: Poaceae: *Triticum aestivum* sds[6]. DICOTYLEDONS: Mimosaceae: *Acacia* fl.[14]; Solanaceae: *Lycium ferocissimum* fru.[6]. **Animals** ANNELIDS: Oligochaetes: earthworms[11,13]. CRUSTACEANS: Isopods[11]. DIPLOPODS[7]. SPIDERS: Lycosidae[7]; Sparassidae[7]. INSECTS[9,10]: Coleoptera: ads, larv.[11]; Scarabaeidae[7]; Lepidoptera larv.[1]: Geometridae: *Oenochroma vinaria* larv.[8]; Noctuidae larv.[6]; Orthoptera: grasshoppers[4]; Acrididae: *Gastrimargus musicus*[7]; Gryllotalpidae: *Gryllotalpa*[7]. REPTILES: Scincidae: *Ctenotus robustus*[8]. BIRDS: House Sparrow nestlings[3]. **Other matter** Sausages[12]; bacon[5]; meat[2].

REFERENCES: [1] Hall 1909; [2] Souter 1926; [3] Chandler 1944; [4] Wilson 1946; [5] Morrison 1950; [6] Robinson 1956; Rose [7] 1973, [8] 1999; [9] Alley 1979; [10] Larkin 1980; [11] Pellis 1981a; [12] Jorm 1998; [13] Kaplan 2004; [14] S. Pellis.

**NZ** (All from McCaskill 1945.) **Animals** INSECTS: Hymen-optera: Apidae: *Apis mellifera*. BIRDS: Domestic Fowl chicks; House Sparrow nestlings.

**Intake** Mean weight of food in stomachs estimated to be 25% full was 3.9 g; stomachs 50% full, 5.1 g; 75% full, 7.2 g; and in full stomach 10.7 g; maximum weight of food in stomach was 14.0 g (n=65 stomachs). Mean rate of intake in captive birds 6 g/h (4.2–13.2; 62.25 h obs.). Passage time of food through gut shorter in birds kept in large cages than those kept in small cages; e.g. setae of earthworms found in droppings of birds in large cages after 8 min, and 17 min for those in small cages (Vestjens & Carrick 1974). Near Perth, adult male seen to regurgitate three small stones, measuring 14.4 × 11.2, 14.1 × 8.5 and 9.4 × 5.1 mm; and weighing 1.4, 0.7 and 0.2 g (Mawson 2002).

**SOCIAL ORGANIZATION** Well known, with many detailed studies. Major studies undertaken in the ACT, round Canberra, using colour-banded birds, from 1955 to 1966, with additional observations from as early as 1953 and continuing till 1970 (Carrick 1963, 1972; Veltman & Carrick 1990); and at Coolup, sw. WA, 1943–55, where, though birds not banded, some individuals distinguished by plumage characters (Robinson 1945, 1956). Other studies include: of colour-banded birds in suburban Brisbane, 1992–93 (Hughes *et al.* 1996); of unbanded birds in suburban Sydney, 1959–63 (Roberts 1963); of colour-banded birds at Seymour, Vic., 1992–93 (Hughes *et al.* 1996), and Sept. and Nov. 1994 (Finn & Hughes 2001); near Lara, Vic., and round Melbourne, 1975–78, using some colour-banded birds and others distinguishable by plumage (Pellis 1979); in Kings Park, Perth, Apr.–Nov. 1938, also with unbanded birds, some of which distinguishable by plumage (Wilson 1946); and, in NZ, of colour-banded birds at Linton, NI, June 1978–Nov. 1982 (Brown & Veltman 1987; Veltman 1989a,b), and at Massey University, Palmerston N, NI, Feb. 1985–Feb. 1986 (Brown & Veltman 1987). Account supplemented by contribution by G. Kaplan.

**Gregariousness** Varies. Well known from detailed studies, but also many anecdotal reports of gregariousness in literature. In Aust. and NZ, throughout year, usually seen singly, in twos or in small groups, usually of c. 12–20 birds (e.g. Milligan 1902; Sedgwick 1946; Westerskov 1954; Boehm 1962; Ford 1971; Moriarty 1972; Schulz 1991; Veltman 1989a; CSN 48; see below); less often in larger flocks of 20–100 birds, including while foraging and roosting (Orchardist 1901; Batey 1907c; Chandler 1920; Buller 1947; Westerskov 1954; Boehm 1957; Bedggood 1970; McGarvie & Templeton 1974; CSN;

see below; also see Food, Roosting). Occasionally in flocks of >100, e.g. in NZ, flock of 300 in Jan. at Motunau R., Canterbury (Crockett 1954), including at communal roosts (see Roosting). Large flocks also sometimes form during droughts, e.g. up to 250 in foraging flock on Mt Mary Plains Stn, SA (Boehm 1957). TERRITORIAL GROUPS: Territories defended by groups of two or more birds that remain together throughout year (Wilson 1946; Robinson 1956; Carrick 1972; Dow 1980; Hughes et al. 1996). Four types of Territorial Groups identified in ACT, based on quality of territory held: (1) PERMANENT GROUPS: Occupy long-term territories that contained sufficient resources for both survival and successful breeding; most groups of this type. (2) MARGINAL GROUPS: Occupy territories with either few potential breeding sites or little foraging area, and have few successful breeding attempts. (3) MOBILE GROUPS: Spend much time defending and commuting between separate small breeding territories with trees and a larger foraging area some distance away; these groups did not breed successfully, and few groups of this type. (4) OPEN GROUPS: Defend treeless foraging areas, but roosted communally; did not attempt to breed, and varied in success at defending foraging areas against Non-territorial Flocks; few groups of this type (Carrick 1963, 1972). SIZE AND COMPOSITION OF GROUPS: Size of groups varies geographically. While variously claimed that groups in sw. Aust. generally larger than those in e. Aust. (Carrick 1963; Rowley 1975; Baker et al. 2000), data on group-size collected from throughout Aust. range indicate that groups in Tas., central Vic. and sw. WA of similar size to each other (means of 6.7, 6.7–9.3, 5.2–7.6 birds/group respectively; see below) but larger than groups elsewhere in e. mainland Aust. (means 2.3–4.8 birds/group) and NZ (3.7 birds/group) (Veltman 1989a; Hughes & Mather 1991; Hughes et al. 1996; Finn & Hughes 2001). Groups in e. Aust. often comprise simple pairs (Carrick 1963; Burbidge 1982; Hughes et al. 1996; see below). Territorial Groups (excluding juveniles) in general smallest in NT and Qld; slightly larger on Great Divide between Armidale and Coffs Harbour, in regions round Canberra and Melbourne, and in NZ; slightly larger again in Adelaide region; and much larger in central Vic., Tas. and sw. WA (Hughes & Mather 1991; Hughes et al. 1996; G. Kaplan; as follows); mean size of Territorial Groups (number of birds per group and from Hughes & Mather [1991] unless stated): NT: Brunette Downs, 2.9 (0.70; 2–4; 11); QLD: Townsville, 3.2 (0.45; 3–4; 5); Rockhampton, 2.8 (0.84; 2–4; 5); Nambour, 3.2 (1.10; 2–5; 5); Brisbane, 3.4 (2.09; 2–5; 27) (Hughes & Mather 1991), 2.3 (0.61; 2–3; 29) (Hughes et al. 1996); ACT: Canberra, 3.7 (1.53; 2–10; 418) (Hughes & Mather 1991), 2.8 adults/group (max. 10; n=37) (Carrick 1972); VIC.: Seymour, 7.2 (2.88; 3–15; 62) (Hughes et al. 1996), 9.3 (2.53; 5–13; 12) (Finn & Hughes 2001); Melbourne, 3.5 (2.64; 2–10; 7); TAS.: Launceston, 6.7 (2.75; 3–15; 34); SA: Adelaide 4.8 (1.68; 2–8; 25) (Hughes & Mather 1991) or 3.6 adults/group (2–8; 25) (Shurcliff & Shurcliff 1973); Nullarbor Plain, 3.1 (0.90; 2–5; 7); WA: Perth, 7.6 (2.90; 4–13; 25); Kings Park, 9.3 birds/group (n=9) (Wilson 1946); Busselton, 5.2 (1.79; 2–8; 9); LINTON, NZ, mean 3.7 birds/group (n=41 over 3 years) (Veltman 1989a); for other estimates, and further details of composition of groups, see following. In ACT, composition of groups changed constantly. Permanent Groups comprised mean 2.8 adults/ group (n=37) with total size of 3–5 birds per group when young included; largest Permanent Group contained ten birds: three adult males, three adult females and four first-year birds. In Permanent Groups, males seldom outnumbered females, with mean 1.2 males (1–4; 37) and 1.6 females (1–3; 37) per group. Open and Mobile Groups contained more adults, especially males, than Permanent Groups; proportion of adult males in Permanent and Marginal Groups was 43%, and 49% in Mobile and Open Groups (Carrick 1972). At Linton, mean

3.7 birds/group (n=41, over 3 years); of 30 territories, 9–12 (30–40%) were defended by monogamous pairs, and rest defended by larger groups of various sizes; occupancy of territories changed from pairs to larger groups or vice versa on six occasions, depending on whether juveniles dispersed after first year (Veltman 1989a). At Massey University, groups contained 4–5 birds (Hickson 1984), and near Porangahau, NI, up to six (Cunningham & Wodzicki 1948). Over 2 years in suburban Brisbane, in 14 territories, 12 contained single pairs and remaining two each had a juvenile remaining from previous season (Hughes et al. 1996); also in Brisbane, 2–5 birds/group (n=19) (Hughes et al. 1983). At Seymour, Vic., 12 territories (in 1 year) contained mean of 2.5 adult males (1.17; 1–5; 12), 3.7 adult females (1.61; 1–7; 12), 0.8 immatures (1.19; 0–3; 12) and 2.3 juveniles (1.66; 0–5; 12) (Finn & Hughes 2001). At Coolup, groups usually contained 6–12 birds, with up to 20 in favourable years; groups said mainly to comprise related birds, but sometimes include outsiders, and include breeding adults and non-breeding immatures. Number of breeding adults and sex-ratio within groups varies, e.g. one group of 12 contained two adult males and six incubating females; another of ten contained one adult male and three breeding females; and one group of eight birds contained five adult males and one adult female (Robinson 1945, 1956). At Broome Hill, WA, group of 11 round house in Aug. (Carter 1911); and at unknown location in sw. WA, one group contained eight birds, from which two pairs bred (Wilson 1946). In Kings Park, WA, at start of breeding season, mean 9.3 birds/group (n=9): 69% adults (26 males; 32 females), 8% third-year immatures (4 males; 3 females), 10% second-year immatures (n=8), and 13% first-year immatures (n=11) (Wilson 1946). In Perth, six groups each comprised 9–15 birds (Buller 1947; Heron 1970). Groups increase in size as a result of breeding, then usually decline before next breeding season (G. Kaplan). FORMATION OF GROUPS AND CHANGE OF GROUP STATUS: Groups apparently form in several different ways, though often form from birds dispersing from Non-territorial Flocks (Robinson 1956; Carrick 1972; Veltman 1989a; see below). In ACT, groups tended to form from alliances forged in Non-territorial Flocks. However, loyalty to group apparently less important than individual advancement, as both males and females often left non-permanent groups to replace birds of same sex in adjacent Permanent Groups. Open Groups formed when 2–6 adults from Non-territorial Flock (see below) united to defend a feeding area during the day. Some Mobile Groups and Marginal Groups later became Permanent Groups by acquiring territory from neighbouring Permanent Groups. Permanent Group status was attained by ten of 27 known Open Groups, 11 of 26 Mobile Groups, and ten of 38 Marginal Groups; many more Open Groups possibly present, but they are difficult to distinguish from Non-territorial Flocks (Carrick 1972). At Coolup, formation of new groups poorly understood; outcast birds sometimes congregated in refuge areas between established territories, possibly forming nucleus of new group; and females sometimes nested in seldom-used part of territory, well away from main nesting area, possibly sometimes leading to division of group (Robinson 1956). At Kings Park, birds occupying large area divided into two groups when nesting, but often reunited amicably at other times, possibly representing a large group splitting into two that may defend separate territories in the future (Wilson 1946). At Linton, Territorial Groups sometimes formed by birds from Non-territorial Flock (Veltman 1989a). LONGEVITY OF GROUPS: In ACT, Open Groups lasted mean 8 months (98% <2 years; max. 38 months; n=47); Mobile Groups, 8 months (97% <2 years; max. 28 months; n=36); Marginal Groups, 13 months (85% <2 years; max. 52 months; n=54); and Permanent Groups, where start and end date known, 30 months (n=51), but when all Permanent Groups included,

>47 months (14% <2 years; max. >133 months; n=108). Displacement and dissolution of groups often resulted from loss of dominant members (Carrick 1972; see Territorial succession). At Linton, birds from disbanded Territorial Group usually moved back to Non-territorial Flock, but some joined neighbouring Territorial Groups (Veltman 1989a). NON-TERRITORIAL FLOCKS: Individuals that do not own territories often congregate in loose Non-territorial Flocks of varying size; such flocks usually mainly of immature birds but sometimes also non-breeding adults (Carrick 1972; Veltman 1989a; see below). In ACT, Non-territorial Flocks consisted of a few to >500 birds in loose association, with individual distances between birds in flock when on ground varying but usually *c.* 9 m; flocks moved locally, and tended to forage in areas of poorer pasture with fewer trees than areas claimed by Territorial Groups (Carrick 1972; also see Breeding dispersion). When compared with birds from Permanent Groups, birds from Non-territorial Flocks tended to weigh less, were more prone to disease and had higher rates of mortality (Carrick 1972; Vestjens & Carrick 1974). In sw. WA, do not appear to form large Non-territorial Flocks, but dispersing individuals sometimes congregate in small numbers in poorly defended areas between territories (Robinson 1956). At Linton, Non-territorial Flocks, of 10–77 birds, formed Aug.–Sept. (n=3), though size of flock varied between days and months; one newly formed flock of 77 birds in Aug. had declined to 26 birds by following Aug. Number of birds in Non-territorial Flock ≤20% of birds in territories. Of 33 captured from one Non-territorial Flock, 26 (78%) were *c.* 1 year old, three (9%) were immatures (2–3 years old), and four (13%) were adults. Non-territorial Flocks foraged in undefended, treeless pasture, and roosted in large congregations in nearby trees or other unknown locations (Veltman 1989a). However, there were no large quantitative differences in availability of food for Non-territorial Flocks compared with Territorial Groups (Veltman & Hickson 1989). Near Palmerston N, NI, Non-territorial Flock contained 20–30 birds (Hickson 1984).

**Bonds** Complex. Socially monogamous and polygynous (Tilley 1926; Wilson 1946; Robinson 1956; Carrick 1972; Hughes *et al.* 1996). Possibly very occasionally polyandrous (Robinson 1956); in one Territorial Group with two males and one female at Rowsley, Vic., genetic analysis revealed both males contributed to paternity of one brood (Durrant 2004). At Rowsley, Vic., using genetic methods, found that 38% of fledgelings were sired by males outside Territorial Group of mother (Durrant 2004); and near Perth, 82% of fledgelings were sired by males outside Territorial Group (Hughes *et al.* 2003). Also near Perth, nearly 10% of juveniles were not genetic offspring of any female within their Territorial Group, suggesting some intraspecific brood parasitism (Hughes *et al.* 2003). Monogamous pairs stay together throughout year (Carrick 1972; Veltman 1989a; Kaplan 2004); and at least some bonds long-lasting (e.g. up to 13 years), often till death of partner (Hall 1909; Cole 1921; Lord 1956a, 1957; Carrick 1972). In ACT, one pair together for ≥11 years (Carrick 1972). At Murphys Ck, se. Qld, history of bonds of several unbanded birds tracked over at least 35 years (individuals identified by plumage characters): after partner died, one male formed new pair that lasted till his death *c.* 13 years later; widowed female then paired with another male in following year, bond lasting for *c.* 10 years; male then divorced female and moved to territory *c.* 1.6 km away and paired with another female. The divorced female then paired with another male within a few days, but later died, and widowed male then paired with a third female (Lord 1956a, 1957; also see Examples of life histories of two individuals, below). Once, a male deserted mate and two recently fledged offspring, then returned 1 month later with two females and chased off former

partner and offspring (G. Kaplan). At Canberra, 35% of Permanent Groups comprised one adult male and two adult females, and sometimes both females nested (Carrick 1972). At Mooroolbark, Vic., two females once nested in territory that contained only one male (Lawrence & Lawrence 1972). At Coolup, adult males often polygamous, both within own Territorial Group, and between Groups, with males often surreptitiously visiting other Territorial Groups to try and copulate with other females, usually in Feb.–Oct. (Robinson 1956; see Sexual behaviour). Seldom live solitarily unless orphaned as nestlings or fledgelings, injured, or evicted from territory (Kaplan 2004). SEX-RATIOS: Within Territorial Groups, sex-ratio often not even, and differs between groups (Robinson 1945, 1956; Wilson 1946); at Seymour, males comprised *c.* 47% of population (n=45) (Finn & Hughes 2001); in ACT, proportion of males in Territorial Groups was 43–49%, and in Non-territorial Flocks, 61% (Carrick 1972; also see Gregariousness, above). AGE OF FIRST BREEDING: Females probably reach sexual maturity after 1 year, but some do not first breed till 5 years old (G. Kaplan). In ACT, males first bred at 2–7 years old (n=18), of which 61% first bred at 3 years old (Veltman & Carrick 1990). At Coolup, do not usually breed till >21 months old, and many males probably do not breed till 3.5–4.5 years old (Robinson 1956). **Co-operative breeding** Sometimes breed co-operatively, though degree of help varies greatly between Territorial Groups and individuals, and possibly also geographically (e.g. Dow 1980; Hughes *et al.* 1996; see below). In Territorial Groups of all sizes, most if not all individuals assist to defend territory (see Breeding dispersion) but contribution to breeding by birds other than parents varies greatly. In three different years at Seymour, Vic., birds other than putative parents fed nestlings or fledgelings in 47% (n=36), 65% (n=26) and 78% (n=9) of territories (Hughes *et al.* 1996; Finn & Hughes 2001). In one territory, female flew between two nests to feed nestlings at both; she had incubated eggs in one nest but a different female had incubated in the other; in another territory, one female fed four fledgelings that came from two different nests; and in another territory, two females each fed each of three fledgelings (Hughes *et al.* 1996). In same area, of five nests with helpers, nestlings were fed by more than one male in four nests, by two females in two nests, and by one juvenile at two nests. Of eight territories where fledgelings were fed by helpers, fledgelings were fed by more than one male in five, by more than one female in six, by more than two females in four, by an immature in two, and by a juvenile in two. In some territories, some helpers that fed nestlings did not feed fledgelings. In one territory, all five individuals in group fed young. Also at Seymour, non-adult birds were seen feeding young in five of seven territories. Two adult males feeding young at same nest were not necessarily helping, as each was a potential sire. In four territories where nestlings and fledgelings were watched, 54% of birds (n=28, both helpers and parents) attended young (Finn & Hughes 2001). At one nest in Canberra, a male and two females each fed nestlings (Balfour & Balfour 1986); and at Coolup, immatures sometimes helped raise young, but extent of help varied greatly, and sometimes care of fledgelings almost entirely by immatures (Robinson 1956). In suburban Brisbane, only assumed parents seen to visit nest or feed fledgelings (Hughes *et al.* 1996). Similarly, at Linton, NZ, though some Territorial Groups contained more than one male, usually only one fed nestlings (though other members of group defended territories). However, in one territory with two nesting females, dominant male fed nestlings in one nest, and a subordinate male fed nestlings at the other, but no male seen to feed more than one brood of young. Other members of group assisted with terri-torial defence (Veltman 1989a). Once round Armidale, brooding female took food from bill of female helper and fed it to nestlings; the female helper, in second

year, was not allowed to land within 25 cm of edge of nest, and if helper attempted to perch on nest, breeding female pecked sharply on the back of its neck (G. Kaplan). ABERRANT HELP-ING: Once in Melbourne, a female attended nest of Common Blackbird *Turdus merula* for 6 days, till young fledged, bringing food at intervals of 30–60 min throughout day, staying at nest for 1–5 min; on the few times when checked closely, nestlings not seen to accept food (Nevill 1976). **Plural breeding** Within some Territorial Groups, several nests active simulta-neously, e.g. at Coolup, one group had six active nests, and at one stage, all had nestlings (Robinson 1956). At Seymour, most groups had more than one nest partway through breeding season, usually built sequentially by different females, so that nestlings were at different stages of development at any given time (Hughes *et al.* 1996). At Mooroolbark, two females in a Territorial Group each built a nest (Lawrence & Lawrence 1972). At Linton, of five times when two females of group both built nests, one female destroyed nest of other on three occasions (Veltman 1989a). **Parental care** Mostly by female, at all stages of breeding cycle; contribution by male varies greatly, and some appear not to provide any assistance (see Breeding: Young, Fledging to independence). When more than one nest in territory, females at second or third nests not usually assisted by male (Carrick 1972; Lawrence & Lawrence 1972; Veltman 1989a; Hughes *et al.* 1996). Helpers within Territorial Groups may also assist with feeding of nestlings and fledgelings (Hughes *et al.* 1996; see Co-operative breeding above). Brood partitioning sometimes occurs after fledging (Hall 1909; Robinson 1956), though young thought not to be separated because they are fighting over food (Robinson 1956; *contra* Hall 1909). Fledgelings sometimes fed by parents until 6 or even 12 months old (Robinson 1956). INDEPENDENCE AND DISPERSAL OF YOUNG: Timing of independence varies; once, fledgelings began to search for own food 20 days after fledging, though some birds do not do so for 2–3 months; young can still beg and receive some food from parents till 6 months old, though usually forage independently, or largely so, by this age; some continue to beg for food till 8–9 months old, though usually not fed (Hall 1909; Wilson 1946; Robinson 1956; Carrick 1972; Kaplan 2004; Campbell; G. Kaplan). Immatures sometimes first venture outside natal territory accidentally, e.g. while chasing prey or play-chasing siblings (Pellis 1979). Juveniles and immatures often forced out of territory by adults, but timing of eviction differs between sexes and groups (Carrick 1972; Veltman 1989a); possibly also varies geographically, with those in e. Aust. leaving earlier than those in sw. WA (see below). In ACT, all young fed independently of parents by Jan., and began to leave territories in Mar.; by Nov., c. 75% of young (mostly males) had left natal territories, and most of rest left in following year. Departure from natal territory depends on aggressiveness of adults of same sex as offspring (Carrick 1972). However, in later analysis in ACT, young usually left natal territory to join Non-territorial Flock when 8–10 months old; 40% of all offspring (n=58) had dispersed by end of first year, 12% did not disperse at all, and rest left at 2, 3 or 4 years old (Veltman & Carrick 1990). Males (n=33) dispersed when significantly younger than females (n=25) (Veltman & Carrick 1990) with young females usual-ly remaining in natal territory c. 1 year longer than males, and spending less time in Non-territorial Flock (Carrick 1972). Of 18 pairs of siblings of same age, 17 separated at time of dispersal, but two sibling females stayed together in Non-territorial Flock, and later in a Territorial Group. There were no significant differences in patterns of dispersal between ter-ritories defended by pairs and those defended by groups (Veltman & Carrick 1990). In ACT, time spent in Non-territorial Flock varied, from 6 months to 4 years, with median of 15 months (Veltman & Carrick 1990). Young males stayed in Non-territorial Flock for mean 28 months before attaining

territory, with mean 31 months for those that left natal territory in first year, and 8 months for those that left in second year. Young females stayed in Non-territorial Flock for mean of 21 months before attaining territory, with mean of 29 months for those that left natal territory in first year, and 7 months for those that left in second year. No birds in first-year plumage obtained territories (Carrick 1972). At Linton, of 58 young, 51 (88%) dispersed from natal territories when c. 1 year old, just before first breeding attempt of adults in following breed-ing season; of rest, three (5%) delayed dispersal for one more year, and four (7%) stayed in natal territories beyond second year; sex of dispersing juveniles not known. After dispersal, juveniles congregated in Non-territorial Flocks that formed in Aug.–Sept. (see above). Experimental manipulation of avail-ability of food did not appear to affect timing of dispersal from territories, but young did not disperse from two of five territo-ries with supplemental food, and two from which young did disperse attracted new unbanded females (Veltman 1989a,b). At Coolup, as young become independent, they often foraged apart from rest of Territorial Group, sometimes mixing with young from other groups. In Feb.–July, some second- and third-year birds regularly moved back and forth between dif-ferent Territorial Groups as they were harassed by adults, and often sought refuge in areas that are poorly defended (includ-ing temporary refuge in buildings), where they probably associated with other such birds. In Feb.–Oct., up to five birds, often lone males, sometimes seen flying rather hesitantly at great heights, and suggested these either outcasts moving to refuge areas, or birds seeking a new territory (though no evidence for claim that they had travelled some distance). Also, sometimes in July–Oct., immatures or subordinate adults left territory in morning and flew till out of sight, to return later in day; these were not usually harassed by groups as they passed (Robinson 1956). In Gippsland, Vic., and in Adelaide, SA, usually disperse from territories at c. 1 year old (Shurcliff & Shurcliff 1973; Burbidge 1982). In SA, young driven from territories by adults in late May, and form flocks (Anon. 1914). Distance of dispersal of immatures rarely quantified, though most appear to disperse to adjacent flocks (Carrick 1970). Of 178 nestlings banded in ACT, 147 (82.6%) eventu-ally bred within 1.6 km of natal territory (nest-site from which hatched); of 84 female nestlings, 45 (53.6%) bred within 400 m of natal territory. While immatures usually disperse from natal territories (often evicted by parents), on rare occasions offspring allowed to remain and breed in natal territories (Carrick 1972), e.g. one fledgeling apparently remained in ter-ritory with male and two females, and nested successfully there in second year (Lawrence & Lawrence 1972). Immatures usually disperse <20 km from natal territory (Jones 2002) but suggested that some may disperse much farther (Baker *et al.* 2001). Study of gene-flow across Aust. suggests that popula-tions in sw. Aust., where Territorial Groups are large and there is no evidence of dispersal to flocks, had lowest levels of female dispersal (Baker *et al.* 2000). EXAMPLES OF LIFE HISTORIES OF TWO INDIVIDUALS IN ACT: (1) One female first attempted to breed when 5 years old. She remained in natal territory till c. 22 months old, then joined Non-territorial Flock for c. 2 years, and probably paired during this time; when c. 4 years old, formed Open Group with mate, and group attained Permanent Group status the next year by displacing another Permanent Group; when c. 8 years old, group annexed an adjacent territory; when c. 12 years old, mate assumed to have died, and she paired with subordinate male from neighbouring territory; observations stopped when female c. 16.5 years old, still occupying same territory. (2) One male remained in natal territory till c. 8 months old; seen in Non-territorial Flock in following year, then back in natal territory when c. 2.5 years old, but later in same year returned to Non-territorial Flock; when c. 4 years old, he evicted male

from Marginal Group, but this group was displaced by a Permanent Group within 2 months; from roughly 5–10 years old, alternated between Non-territorial Flock and part of various Mobile or Open Groups, and sometimes attempted to join Permanent Group; when *c.* 10 years old, he formed Permanent Group by taking over a long-term territory, but died next year, when *c.* 11 years old (Carrick 1972).

**Breeding dispersion** Nest within strongly defended all-purpose territories (see below) but dispersion varies, from solitary nesting (e.g. when Territorial Group consists of single breeding pair) to two or three active nests within territory when plural breeding or polygamous males in Territorial Group (Robinson 1956; Carrick 1972; Veltman 1989a; also see Bonds, Plural breeding, above). Probably mostly nest solitarily (e.g. Carrick 1972; Hughes & Mather 1991; Hughes *et al.* 1996). Even when more than one breeding female within Territorial Group, dominant females have first choice of nest-site over subordinate females; and interference or direct attack by dominant females usually leads to subordinate females nesting at some distance (e.g. up to 380 m), or screened from, dominant female (Robinson 1956; Carrick 1972; see Breeding: Site). However, nests occasionally placed close together (e.g. 6–27 m apart) (e.g. Souter 1926; Tilley 1926; Fletcher 1934; Robinson 1956; see Breeding: Site) and, twice in ACT and at least once in Coolup, tolerant or evenly matched females within Territorial Group nested in same tree (Robinson 1956; Carrick 1972). **Territories** Throughout range, Territorial Groups defend all-purpose territories throughout year (Campbell 1902; Robinson 1945, 1956; Wilson 1946; Carrick 1972; Veltman 1989a; see Gregariousness above). However, in ACT, while territory defended throughout year, most territorial disputes recorded July–Oct. (Carrick 1972). Most Territorial Groups conduct all daily activities within territory (Robinson 1956; Carrick 1972) and seldom move beyond borders (Veltman 1989a). In ACT, defended territories vary with type of group: Permanent Groups (most groups) occupied long-term territories with sufficient resources for survival and successful breeding; Marginal Groups occupied territories with either few potential breeding sites or foraging areas, and made few successful breeding attempts; Mobile Groups spent much time commuting between and defending separate small breeding territories with trees and larger foraging areas (and no successful breeding recorded); and Open Groups attempted to defend treeless foraging areas (with varying success against Non-territorial Flocks), roosted communally, and did not attempt to breed (Carrick 1972; see Gregariousness above). While territories fairly stable over time, boundaries may change considerably through expansion, contraction, split and gain (Shurcliff & Shurcliff 1973; see Territorial succession, below), but current boundaries always well defined, and when group driven towards boundary, always double back when it is reached (Robinson 1956; Shurcliff & Shurcliff 1973). At Coolup, when territory became vacant, neighbouring groups would not immediately cross territorial boundary, even though it was no longer defended (Robinson 1956). Territories defended against all other Magpies; by most members of Territorial Group (ranging from simple pair up to 20 birds), though dominant male has leading role (Robinson 1956; Carrick 1963, 1972; Veltman 1989a; Cilento & Jones 1999; Kaplan 2004; Aust. Atlas 1; see Hierarchies, below) and first-year birds do little (Carrick 1972). In both Qld and NZ, adult males and females defended territories significantly more often when with other Magpies than when alone (Farabaugh *et al.* 1992). As group size increases, time spent by each bird defending territory decreases (Farabaugh *et al.* 1992). Ability of dominant male to defend territory possibly independent of state of gonads: in ACT, castrated males retained territories for years (Carrick 1972), though doubt cast on result as not known whether birds

actually neutered (C.J. Veltman). Adults initially repel only Magpies of their own sex, but will repel other sex when defending as part of group. Defending birds usually win territorial disputes, but poor habitat defended less vigorously (Carrick 1972). Long-term territories require suitable nesting trees and areas of grassland (Robinson 1956; Carrick 1972) but can cover wide range of habitats (Hughes *et al.* 1983); minimum size of a territory is set by amount of feeding pasture needed to sustain a group (Vestjens & Carrick 1974). Suggested that access to permanent surface water also an advantage (Robinson 1956), though also suggested that birds do not require free water for drinking (see Food). At Linton, territories centred on clumps or lines of trees (Veltman 1989a); and within a territory, area used for nesting usually encompasses a clump of trees or edge of forest (Robinson 1956). At Coolup, adjacent territories often had strip of land between them that was not rigidly defended, and immatures from neighbouring groups sometimes mingled when adjacent groups foraged near these areas. Large forested areas on edge of some territories seldom entered and often not defended (Robinson 1956). In urban habitats, territories include gardens of many houses (Pizzey 1988). Some breeding birds concentrate defence round nest-site, sometimes neglecting defence of margins of territory (Brown *et al.* 1993). TERRITORY SIZE: Size of territory varies greatly, both geographically and between groups. In suburban Brisbane, territories 8.1 ha (2.31; 29 [over 2 years]) (Hughes *et al.* 1996), and 9.3 ha (1.40; 2–26; 19) (Hughes *et al.* 1983); no correlation between size of territory and size of Territorial Group (cf. Adelaide, below), but there was a negative relationship between area of grass/ha within a territory and size of territory, i.e. small territories had proportionately more grass than larger ones (Hughes *et al.* 1983). In ACT, mean area of territories of Permanent Groups 8 ha (2–24; 89): 16% 2.0–4.9 ha, 67% 5.3–12.1 ha and 16% 12.5–24.3 ha; smallest territory where nesting attempted was *c.* 2.4 ha but smallest territory that produced fledgelings was *c.* 3.2 ha. Of 67 Marginal Groups: 49% had feeding territories of 0.8–4.9 ha, 33% 5.3–12.1 ha, and 18% 12.5–16.2 ha. Size of foraging areas of Mobile and Open Groups were indeterminate (Carrick 1972). At Seymour, Vic., territories 4.2 ha (1.26; 36) (Hughes *et al.* 1996). In Adelaide, territories 6.6 ha (2.9–12.5; 25); unlike Brisbane, size of territory increased with size of Territorial Group for groups of up to five birds, with mean area of 1.3 ha/Magpie (0.8–1.8; 25) (Shurcliff & Shurcliff 1973). At Linton, mean area of territories 5 ha (n=12) (Veltman 1989a). At Port Hills, two groups, each of seven birds, inhabited (and foraged within) adjoining territories of *c.* 4 ha (Rankin 1970). In Perth, two territories each *c.* 60 ha (Robinson 1956); and at Coolup, territories all *c.* 40 ha in 1944 (n=7), but in subsequent years, six new territories were established, with smallest *c.* 12 ha, and some older territories contracted (Robinson 1945, 1956). TERRITORY DENSITY: In ACT, *c.* 6–9 territories/km², in area of *c.* 6 km² (Carrick 1972); in three suburbs of Canberra, *c.* 13, 17 and 17 territories/km² in areas of *c.* 1.9, 0.7 and 0.4 km² respectively (Lenz 1990); at Bennettswood, e. suburban Melbourne, *c.* 16 territories/km² in 0.19 km² (J.M. Peter); in Adelaide, *c.* 8–11 territories/km² in area of *c.* 1 km² (Shurcliff & Shurcliff 1973); and in Perth, *c.* 2 territories/km² in area of *c.* 2.4 km² (Heron 1970). TERRITORIAL SUCCESSION: Some territories remain essentially unchanged for many years, whereas boundaries of others change constantly from year to year (Carrick 1972; Shurcliff & Shurcliff 1973). Territories may be held for between one year and a lifetime; recorded up to 18 years (Kaplan 2004). In ACT, of 37 territories occupied by Permanent Groups at start of study, 21 remained essentially unchanged 11 years later, eight of which were occupied by same group (Carrick 1972). At Coolup, territorial boundaries changed little as long as habitat stable, and territories often occupied by same group

through successive generations (Robinson 1956); at Harvey, WA, most changes to territorial boundaries probably resulted from removal of mature trees (Sedgwick 1988). In Adelaide, position of territorial boundaries changed much between years, often expanding or contracting; one territory was displaced in one direction without size changing significantly, one split into two smaller territories, and a new territory was set up by a new group (Shurcliff & Shurcliff 1973). In ACT, loss of territory by a Permanent Group often resulted from death of adult members of group, especially dominant male, with road casualties causing several changes in territorial boundaries or ownership. After territories of Permanent Groups vacated (n=108), 67 (62%) were usurped immediately by new Permanent Groups, 32 (30%) annexed immediately by neighbours (25 permanently and seven temporarily), and nine (8%) stayed vacant for ≥3 months. After territories of Marginal Groups vacated (n=41), 19 (46%) were usurped immediately by new groups, two (5%) were annexed, and 20 (49%) stayed vacant for up to 3 years. Of nine groups that lost part of long-term territory, three later recovered it, and in all but one of the rest, the loss had little effect on the group. In ACT, of adults that returned to Non-territorial Flock after losing territory, c. 50% regained territorial status after 9–10 months, and the rest disappeared after 8–9 months (Carrick 1972). At Linton, of 30 territories, 27 lasted ≥22 months, with some lasting ≥48 months (Veltman 1989a). **Hierarchies** Within each Territorial Group, individuals often ranked in social hierarchy; groups with more than one adult male or more that one adult female have clearly established hierarchy within adults of each sex, and with young birds subordinate to all adults (Robinson 1956; Carrick 1972) so that social hierarchy in small groups is age-related (G. Kaplan). One adult male usually dominant in Territorial Group (Robinson 1956; Roberts 1963); dominance not recorded in monogamous pairs (G. Kaplan). In ACT, on attaining Permanent Group status, some aggressive individuals evicted birds of their own sex from Territorial Group; and in Permanent and Marginal Groups, most males and c. 50% of females were intolerant of another adult of same sex. Dominant females nest earlier than subordinate females and have preferential choice of nest-site and feeding sites. Very subordinate males usually leave group, but very subordinate females often remain in group despite interference in their breeding attempts by dominant females (such as prevention of nest-building, or destruction of eggs); some harassed subordinate females have retarded ovaries and do not attempt to breed. Less subordinate females often nest after dominant female has started incubation. In Permanent Groups in ACT, 15% (149 of 970) of adult females laid eggs; in Marginal Groups, 32% (35 of 109) laid; and in Mobile Groups, 19% (208 of 1117). In Permanent Groups, failure to lay mostly resulted from aggression from other females within group; and in non-permanent groups, mostly resulted from either poor quality of territory, or interference from other groups (Carrick 1972). At Coolup, dominant male sometimes drove subordinate males from territory. Number of males in group thought to be determined by aggressiveness of dominant male rather than by number of females. Dominant male often intolerant of pair-formation by other males within Territorial Group, and often attacks other males that made overtures to females of group. When females nesting, one male, probably dominant, often appeared to guard nesting area; other males of group usually foraged together at some distance from nesting area. In one Territorial Group, dominant male often chased an immature male when it sang. In a group with two adult males and five breeding adult females, dominant male appeared interested in four of the females, while the second male appeared interested in the other female, but furtively. In one group, dominant male died, leaving one adult male, an immature male and several females; immature male

appeared to assume dominance after the surviving adult male was attacked by others in group, who all sang at it (see Agonistic behaviour: Advertising); c. 10 days later, adult male appeared to temporarily assume dominance, but later on same day, immature male regained dominant position. Sometimes dominant adult female drives other females from territory (Robinson 1956). Sometimes a subordinate not allowed to feed or roost with group but allowed to defend territory (Kaplan 2004).

**Roosting** At Coolup, Territorial Group usually roosted together in same tree (Robinson 1956). Near Booligal, NSW, territorial birds roosted in pairs, but birds from Non-territorial Flocks roosted in loose flock of up to 20 birds, either alone or with up to seven birds in same tree (Stokes 1979). At Linton, birds from Non-territorial Flocks roosted in large aggregations (Veltman 1989a). Sometimes roost in very large numbers; e.g. hundreds near Wingeel, Vic. (Russell 1921), 3000 at Sunbury, Vic. (Batey 1907b), and flock of c. 300 near Motunau Beach, SI (Crockett 1954). SITE: In outer foliage of trees, especially in thickets of trees (White 1912; Russell 1921; Robinson 1956; Stokes 1979; Schulz 1991), including eucalypts, pines, willow *Salix* and poplar *Populus* (Batey 1907b; McGilp 1925; Crockett 1954; Hough 1969; Hickson 1984). At Sunbury, Vic., said to roost in low trees on bright moonlit nights, and in tall trees on dark nights (Batey 1907b). In ACT, Permanent and Marginal Groups roosted within territory; Mobile and Open Groups usually roosted up to several kilometres from foraging areas; those in Mobile Groups sometimes roosted in trees on territory, especially in breeding season (Carrick 1972). At Coolup, Territorial Groups had preferred roosting sites, and often roosted in same tree for several nights, then changed to another (Robinson 1956); and at Lower Plenty, Vic., one group used same roost intermittently over 2 years (Hough 1969). In NZ, birds in Non-territorial Flocks often roosted in trees near foraging area (Hickson 1984; Veltman 1989a), but at Linton, sometimes flew away to unknown roosts (Veltman 1989a). Fledgelings return to nest to roost for c. 2–3 weeks after fledging (Anon. 1914). MOVEMENTS TO AND FROM SITE: Near Booligal, NSW, seen flying to and entering roost at 17:52–17:59 on 3 days in early May. Birds from Non-territorial Flocks entered roosting area c. 20 min before dark, arriving in groups of 2–4, and flying higher than territorial birds, and silently. At dawn, birds from Non-territorial Flock left in loose flock, flying high (Stokes 1979). In sw. WA, just before dusk, all birds of Territorial Group flew to trees to roost together (Wilson 1946).

**SOCIAL BEHAVIOUR** Well known, with many detailed studies (as Social Organization). Account supplemented by contribution by G. Kaplan. Usually conspicuous and readily observable (G. Kaplan). Often rather bold and confiding, and readily become tame in and round residential areas, settlements and homesteads, or round human activities, especially where food readily available, such as in gardens and picnic areas (e.g. White 1922c; Geary 1932; McCaskill 1945; Lord 1957; Roberts 1963; Lawrence & Lawrence 1972; see Habitat, Threats and Human Interactions, Food). However, in areas where people seldom encountered, often shy and unapproachable (Jones 2002). Well known for habit of swooping at and attacking people (Jones 2002; see below; also see Threats and Human Interactions). Once, when one male foraged on ground, he sometimes took a few steps, then paused with one foot forward but not quite touching ground; then rocked from one foot to the other, raising each foot c. 2 cm from ground; this tapping continued for 2–3 s, then he moved forward another 30 cm or so before resuming foraging. Thought to have possibly been conflict behaviour rather than feeding method (Baldwin 1976), though Magpies have been recorded foraging by stirring grass with feet (see Food). **Furtive behaviour** When intruding into territory of other groups, males usually move

silently and alone, and hide in dense foliage away from group; sometimes approach more closely when group distracted. When a female close, intruder leaves secluded perch and attempts forced extra-pair copulation (Robinson 1956; see Sexual behaviour). Intruding males often roost in territory of another group, flying in just before dark, and often singing at dusk (Robinson 1956). **Play** Sibling young often play with each other or an adult (e.g. Batey 1907c; Anon. 1914; Pellis 1979; Fleming 1999; Talmage 1999). From *c.* 4 weeks after fledging, start to use feet to manipulate items in bill, at first making mistakes, such as overbalancing while attempting to grasp object in bill with both feet. When older (e.g. 8 weeks after fledging), these actions sometimes repeated in play, birds rolling onto backs and manipulating items in bill with feet. In one group, social play reached peak at *c.* 10 weeks after fledging, and in another group at *c.* 14 weeks (Pellis 1979); also see Lone play (below). Playful encounters more often initiated by adults than juveniles or immatures, and when initiated by young, usually initiated by largest juvenile–immature. Most play is between two birds, very occasionally more (Pellis 1979, 1981b). Play mostly manipulation of objects, play-chasing, mock fighting or a combination of these (Robinson 1956; Mollison 1962; Pellis 1979; Talmage 1999). Once play starts, offensive and defensive roles alternate between players (Pellis 1979; Talmage 1999). Solicit play by crouching in front of another bird with bill open, by squatting behind another and tweaking its tail-feathers with bill, or by pursuing another in flight (Brown & Veltman 1987). Bouts of play sometimes last for several minutes (Pellis 1981a), but sometimes up to 10 min, often followed by a second and third bout (Kaplan 2004; G. Kaplan). MANIPULATION OF OBJECTS: Lone juveniles or immatures often pick up or pull at objects and play with them (see Lone play below). Often when one young bird is manipulating an object, it will be approached by a sibling who attempts to take object for itself, often leading to chases or mock fights (Pellis 1979, 1981b). PLAY-CHASING: Often play game in which one bird chased in air by others who attempt to catch its tail-feathers and bring it to ground (Batey 1907c; Wilson 1946; Robinson 1956). Sometimes, one picks leaf from ground or shrub, and is then chased by others (Roberts 1963). Of 142 play encounters, 32% involved play-chasing (Pellis 1981b). Sometimes play tug-of-war with piece of paper, bark or food; if one bird lets go, other runs away with it, chased by others in half-run, half-flight (Roberts 1963; Fleming 1999). Once, game of tug-of-war with piece of bark lasted *c.* 10 min; during game, if several pulled in one direction, bird on other side was dragged along, sometimes on belly with legs trailing behind, or sometimes dragged on back (Fleming 1999). Once, four immatures pulled a banksia cone to pieces and then chased each other (Wilson 1946). MOCK FIGHTING: Occurs often, particularly between adult male and offspring, or between siblings (Robinson 1956; Talmage 1999). Of 142 play encounters, 62% involved mock fighting (Pellis 1981b). During mock fights, birds often lie on sides on ground, wrestling with claws (Anon. 1914; Robinson 1956; Roberts 1963), sometimes two tumbling together (Talmage 1999), and sometimes one hovers above back of the other (Pellis 1979); sometimes birds feign injury (Robinson 1956). Once, two young alternately lay on ground while the other walked over it (Pellis 1979). At Coolup, during one game among six young, one picked up ring of wire and ran with it in bill while the others attacked it; intermittently, attacked bird rolled onto its back and the others dragged it round by its wings or feet. Later, during same game, dominant male arrived and attacked each of the young birds in similar manner; they rolled onto their backs and stayed where they were. At one stage, male had four young lying on their backs, and two stayed there for some time, as though pretending to be dead, while the others examined them, at times pecking at them or pulling

their wings. Young also took turns to lie on their backs while others examined them (Robinson 1956). In Sydney, sometimes two playfully pecked at each other through a trellis (Roberts 1963). Once, one rolled onto its back with feet in air, calling softly while another attacked it (Talmage 1999); and once, one bird of group rolled on ground and stayed on its side while others walked round it and pecked or pulled at its feathers (Mollison 1962). Occasionally, mock fighting escalates into real fight (Anon. 1914; Roberts 1963). Play behaviour often preceded by BOUNCE-WALK: as one bird approaches another, it makes a series of small hops or jumps while walking forward, often ending with a jump onto back of other bird and off other side (Pellis 1979; Talmage 1999). Occasionally also use begging postures, or roll onto back as prelude to play (Talmage 1999). OTHER PLAY BEHAVIOUR: In strong wind, twice seen playing game where young birds circled tall tree and landed into wind, then allowed wind to lift them and whirl them away; resembled Topping-the-tree game of Pied Currawong (q.v.). Once while playing this game, one hung upside down by one foot from branch, allowing itself to be spun around by wind (Roberts 1963). In Melbourne, also seen to perform mock copulations, with one mounting another, and mock-begging, with one crouching before other, assuming begging posture, with roles reversed several times (Talmage 1999). **Lone play** While most play occurs between siblings, or between siblings and parents, sometimes play with inanimate objects, and occasionally with other species (see below). Often pick up sticks, bark, leaves or pieces of wire from ground and play with them (Cheney 1915; Robinson 1956; Roberts 1963). Sometimes use bill to tug at one end of an object that is fixed at other, such as earthworms, blades of grass, reeds, leaves attached to overhanging branches of trees or shrubs, rope, or clothes tied to posts. Sometimes swing around item while pulling on it (Wilson 1946; Robinson 1956; Roberts 1963; Pellis 1979); and once seen swinging from a young dead bird that was hanging from bottom of a nest (Robinson 1956). Sometimes hang upside down, dangling and swinging by one or both feet (Kaplan 2004). When manipulating large leaf or piece of bark, sometimes stand on it, pull at it and fall over, often repeatedly (Roberts 1963). Sometimes, after being fed by observer, picked up piece of food in bill and threw it sideways several times (Cheney 1915; Roberts 1963). Once, an immature had mock fight with leafy, broken branch on ground: pulled off leaves and held them in bill, and wriggled under branch on back, pushing at it with legs; also appeared to fight branch with feet. Sometimes grabbed branch with feet and fell over; after falling, flopped wings out to either side of body and appeared to feign injury. Play lasted for *c.* 6 min (Drake-Brockman 1999). **Play behaviour with other species** Once an immature appeared to play with Blue-faced Honeyeater *Entomyzon cyanotis*: Honeyeater landed *c.* 3 m from Magpie and hung upside-down from perch; Magpie then moved to within a few centimetres and Honeyeater dropped from perch and flew off, with Magpie in pursuit. The two flew together for some distance, alternating being pursuer and pursued before landing *c.* 2 m apart. The whole game was then repeated before the two flew away, alternately chasing one another (Brown 1986). Sometimes males chase Australasian Pipits *Anthus novaeseelandiae* or woodswallows *Artamus* during breeding season; these said to be playful, and sometimes whole group joined in (Robinson 1956). **Maintenance behaviour** In ACT, daily activity typically begins with dawn chorus, followed by foraging; after foraging in morning, usually rest and preen at midday or during heat of day, sometimes moving to timbered area to do so; then forage again in afternoon and evening (Orchardist 1901; Carrick 1972; G. Kaplan; see below). In non-breeding season, rest at any time of day after foraging, usually on branches in less exposed areas of tree, not in tree-tops (G. Kaplan). PREENING: Preen much each day,

often interspersed with singing, followed by short bouts of sleep, usually lasting <1 min; usually preen while perched in tree (as above) but sometimes preen on ground. Preen most of body using bill, but scratch head and neck with claws, and rub head over preening gland (G. Kaplan); scratch head indirectly, leg passing over wing (Pellis 1979, 1983; Brown & Veltman 1987). One tame bird often perched in steam above boiler-house, preening with wings outstretched; thought to have had similar effect to anting (Chisholm 1959). ANTING: In WA, seen to press ants to plumage with bill (Chisholm 1959). SUNNING: Often sun on warm days; usually lie on ground with back exposed to sun and wings spread to side or curved forward so that tips meet in front of head, and feathers of head, neck and body ruffled; sometimes bird lies on belly or on side with wings folded (Robinson 1956; Roberts 1963; Talmage 1997; Hewish 2000); sometimes rest head on ground, with neck tilted sideways so that skin exposed (G. Kaplan). Sunning often recorded after cold nights, or in early weeks of spring (G. Kaplan), though also noted on summer mornings (J.M. Peter). Sunning posture adopted in open or shade, on stones, bare soil or among short grass (Robinson 1956; Roberts 1963; J.M. Peter). Once, female and two juveniles were sunning simultaneously (Roberts 1963). While sunning, nictitating membrane usually drawn across eyes (Roberts 1963). Though remaining alert, sunning birds often do not move till approached closely, and are sometimes mistakenly assumed to be dead (Robinson 1956; Roberts 1963; Talmage 1997). THERMOREGULATION: In cold weather, fluff up feathers of body, and sometimes perch on one leg, drawing the other into feathers of belly, later exchanging feet to minimize exposure to cold. In hot weather, rest in shade, pant with mouth open, and raise wings slightly at carpal joints to allow air to circulate under wing (Carrick 1972; Kaplan 2004; G. Kaplan). Sometimes gather in shade of artificial structures, such as sheds, to avoid high temperatures; once, when air temperature was c. 45 °C, 25 seen emerging from cellar (Boehm 1957); and once, when temperature was c. 42 °C, eight gathered in shade of concrete culverts under road (Favaloro 1947). BATHING: In summer, often bathe in shallow water by fluttering and submerging, wetting entire body (G. Kaplan); in Adelaide, one bathed beneath sprinkler on lawn (Mellor 1926a). After bathing, usually perch on low branch and preen entire body (G. Kaplan). At Gisborne, Vic., one seen dust-bathing (Batey 1907c) but this seldom recorded (G. Kaplan). ROOSTING: When settling to sleep, squat low on branch, fluff feathers of head and body, and either point bill forward or tuck it into feathers above wing. Sometimes rest on one leg, tucking other up into feathers of belly (Brown & Veltman 1987). Some or all birds of group sometimes sing or give particular call while gathering at roost (Batey 1907c; Wilson 1946; see Voice) and birds can sing from roost at any time of night (see Voice). At Lower Plenty, Vic., group huddled together on branch in canopy of tree at last light, and usually took ≥30 min to settle at roost; once, while five birds settling to roost, one landed and pecked another, which then swung beneath branch and hung there with legs contracted and wings closed; it gradually extended its legs, then let go with one foot and hung motionless for c. 30 s before somersaulting onto lower branch (Hough 1969).

**Agonistic behaviour   Advertising** CAROLLING: Both males and females advertise and defend territory with Carol (Robinson 1945, 1956; Roberts 1963; Carrick 1972; see Voice), which often given with bill pointed skyward and chest expanded, with sound produced as head thrown back (Brown & Veltman 1987; Kaplan 2004). Carol usually delivered by several, if not all, members of Territorial Group, but also sometimes by solitary birds. A chain-reaction of singing often triggered by one singer, or by territorial dispute (Robinson 1945, 1956; Carrick 1972). Carol given at any time of day, and often

late at night (see Voice). Territorial Groups often sing at each other without fighting, and Carol thought to act as distance threat (Robinson 1945, 1956), though also given before or after chases and fights (see below). Carol also given during disputes within groups, and towards intruders into territory (Robinson 1956; Lord 1957). In one group, dominant pair usually initiated bouts of Carolling (G. Kaplan). When flying along boundary or just inside neighbouring territory, male performs TILTING FLIGHT-DISPLAY, tilting from side to side, with 5–7 wing-beats to each tilt; flight usually quite noisy (thought to be made by wings), at about level of tree-tops and direct, but sometimes fly in semicircle. Performed only by males, and in Feb.–Nov.; also given by most intruding males when returning to own territory (Robinson 1956; Brown & Veltman 1987). Sometimes perform SWOOP-UP: bird flies swiftly and directly, 3–6 m above ground, then suddenly swoops up almost vertically for c. 5 m, sometimes defecating at zenith; then return to ground by free-fall fluttering or by turning in mid-air and returning to perch. Given when advertising at territorial boundary, and also during disputes at territorial borders (Brown & Veltman 1987). Also sometimes perform BORDER PATROL, in which territorial bird, usually male, flies to boundary and then along it for at least 50 m before returning farther inside territory; flight usually swift, direct and relatively low, sometimes 2–3 m above ground (Brown & Veltman 1987). When violating air-space of territory of rival Territorial Group, sometimes perform DIHEDRAL SOARING, holding wings in V while soaring high in a straight line, alternating with short periods of rapid flapping. Sometimes when landing, especially in exposed position, hold wings in high V for a few seconds before folding them (Brown & Veltman 1987). **Threat** When confronted by intruder, dominant male gives THREAT CALL (see Voice), usually delivered with back arched, wings outspread and head lowered (G. Kaplan). Also said to give low croak (which possibly refers to Threat Call) during disputes between members of Territorial Group, e.g. over food, crowding at roost-site, or when a male too close to female on nest (Robinson 1956). Threat Call sometimes also given by male during border disputes (Buller 1947; Robinson 1956). **Border disputes and territorial intrusions** At Coolup, most territorial interactions between groups fall into three categories: (1) Local border interactions on shared territorial boundaries; Territorial Groups often encounter each other at territory boundaries, with encounters sometimes developing into disputes (see below); occasionally confrontations by several groups at junction of three or four territories result in large, noisy gatherings. (2) Mass invasion of territory by another group occurred occasionally, with several birds of group combining to invade neighbouring territory, resulting in fighting and much singing. Larger groups apparently bolder, and made more mass intrusions into neighbouring territories than smaller groups. (3) Territorial intrusions by lone males to attempt to copulate with neighbouring females; lone males sometimes surreptitiously entered territory of another group and attempted to copulate with females; if discovered, intruding male attacked by group. During breeding season, Territorial Groups often spend more time defending females against intruding males than defending territories; some intruding males persist, with one driven from five territories in one morning. Such intruding males usually adults, but probably never dominant (Robinson 1956; see below for further details). Escalation of defence often leads to close approach and swooping flights at opponents (Carrick 1972; see below). Trespassing by immatures thought to result from poor understanding of importance of territories (Robinson 1956). There may be regional differences in type of displays used in border disputes: in Seymour, Vic., close-range displays common, but in suburban Brisbane, aerobatics were the norm (Kallioinen et al. 1995). In response to RALLY CALL, all birds in Territorial Group except young

juveniles assemble at site of territorial dispute, and all, other than young juveniles, help to defend territory; level of participation often varies with status, with dominant male initiating attack, followed by other adult males, then females and immatures (Robinson 1945, 1956; Wilson 1946; Brown & Veltman 1987; Veltman 1989a; see Voice). If dominant male absent, defence and attack usually less vigorous (Robinson 1956). During border disputes, a variety of displays can be given, though exact circumstances of one display or posture over another not certainly known. Sometimes perform NEGOTIATING DISPLAY, in which dominant members of group gather on ground at territorial boundary and Carol while walking back and forth (Kaplan 2004). Sometimes give GROUP STRENGTH DISPLAY, in which whole group lines up along territorial boundary; apparently used only when group is almost matched by number of invaders (Robinson 1956; Kaplan 2004). Similarly, defenders sometimes gather in front of intruders during group intrusions (Buller 1947). Dominant male sometimes gives LEADERSHIP DISPLAY, in which he initially makes swooping flights, then focuses swooping at opponent, probably to demonstrate his strength and agility. Sometimes also perform AERIAL BLUFF DISPLAY, in which entire group fly in wide circles or swoop up and down (Kaplan 2004). During border disputes, adult males perform DEFIANT DISPLAY, walking or running towards opponent in crouched attitude with wings held slightly away from body, and with head lowered and neck retracted into body, giving overall hunched appearance (Buller 1947; Robinson 1956). Sometimes also adopt ERECT POSTURE when threatening (Pellis 1979). Readiness to attack signalled by PUFFED POSTURE, in which feathers of belly, flanks and back raised so that body appears like rounded ball of feathers, but feathers of head and neck sleeked, eyes appear to bulge, bill held straight or tilted slightly downward, and wings lowered slightly to display white markings on first few primaries. Degree to which wings lowered at carpal joint correlates directly with readiness to attack. In most extreme form, which usually immediately precedes fight, bill pointed straight down, body held horizontally, and feathers of body fully raised, carpal joints lowered and primaries fanned; sometimes Carol in this posture. Upon close approach by another, sometimes give BILL-SNAP, lunging head forward and snapping mandibles once or twice; often given while in Puffed Posture. Sometimes give FORWARD THREAT POSTURE in which neck stretched forward and bill sometimes opened. Sometimes perform MOCK FORAGING during boundary disputes, when protagonists turn side-on to one another and walk slowly with bill pointing downward and feathers of body partly raised, sometimes pecking hard at ground, appearing as exaggerated foraging (Brown & Veltman 1987). Sometimes threaten by SWOOPING, particularly at people, often sleeking feathers of body before attacking (Kaplan 2004; G. Kaplan; see Threats and Human Interactions); whooshing sound produced by wing-beats possibly also functions as warning or threat (Kaplan 2004). Twice, when dominant male from one territory intruded into neighbouring territory, defending dominant male flew at intruder, calling loudly; intruder fled both times, as dominant male was joined by three or four others from group, and all sang loudly (Rankin 1970). Occasionally, OTHER DISPLAYS performed during disputes: intermittently, each group gives bursts of Carolling, and submissive displays, including Lyre-wing Display (Wilson 1946; Buller 1947; Robinson 1956; see below). During border disputes, sometimes one bird flies or walks towards rival group and then returns, possibly feigning attack (flight possibly Aerial Bluff Display). Sometimes dominant male attempts to get his group to retreat from border during such attacks (Buller 1947; Robinson 1956). **Chasing** When a group intrudes into territory, dominant male of local group usually dives repeatedly at an adult male from intruding group, then chases it when it takes to air (Buller 1947). When large groups invade territory of smaller groups, defending male often left exhausted (Robinson 1945, 1956). When an intruder takes flight, it is often chased for considerable distance by defenders giving harsh cries (Buller 1947). Once, one chased another several times over c. 5 min, and both birds sang (probably Carol) after each chase (Rankin 1970). **Fighting** Territorial disputes sometimes escalate into fighting, though blood seldom spilt (Carrick 1972). Once, when whole group invaded territory of another group, strong Carolling was followed by a fight involving most members of both groups (Robinson 1956). Physical contact includes PECK, by jabbing sharply at opponent with closed bill; BITING, by pinching with mandibles; JUMPING ON, where aggressor rushes at opponent and leaps onto its back; WRESTLING, in which opponents tightly grip each other's feet and peck at each other; DIVE-BOMBING, in which aggressor flies at perched opponent, hitting it with full force; and, very occasionally, TAKING DOWN, where flying bird forces another onto ground (Brown & Veltman 1987). Once, in July at Laverton, Vic., seven seen in aerial combat (Watson 1955), but in Kings Park, groups not seen fighting (Wilson 1946). Once, when an immature was lured across boundary, opposing group held it down and all appeared to peck it, while dominant male of immature's group swooped at attackers; immature immediately returned to own territory when released (Robinson 1956). **Appeasement and Submissive displays** Often CROUCH to appease or signify submission; when crouching, often fluff out feathers at sides of body, and extend head forward slightly with bill raised just above horizontal, and sometimes give soft Begging Calls (Robinson 1956; Pellis 1979; Brown & Veltman 1987). Sometimes juveniles crouch when approached by adult, even without overt threat by adult (Pellis 1979); once at Coolup, when dominant male walked within 1–2 m, immature male crouched submissively and rapidly wagged tail up and down several times; immature was ignored by dominant male (Robinson 1956). Similarly, immatures and subordinate adult males often adopt submissive posture in presence of dominant male (Robinson 1956). Sometimes crouch in response to sleeking of plumage by another (G. Kaplan). Sometimes show submission, especially to parent, by CRINGEING, in which bird leans away from aggressor with legs bent, wings held above back and bill usually opened and pointed slightly upward (Brown & Veltman 1987). During border disputes, immatures sometime give LYRE-WING DISPLAY, running with wings raised almost vertically but wing-tips angled outward, and sometimes accompanied by Carolling (Robinson 1956; Brown & Veltman 1987); immatures displayed similarly in presence of stuffed or captive adult male (Robinson 1956). Often a juvenile turns its head to look away when an adult faces it, which thought to be submissive behaviour (Pellis 1979). Sometimes subordinate male stands motionless while dominant male forages nearby, with posture often held till dominant male ≥6 m away (Kaplan 2004; G. Kaplan). During breeding season, when attacked by dominant birds, immatures often give display that resembles begging behaviour of young (Robinson 1956). When fighting, sometimes signal submission by rolling onto back with feet in air (Brown & Veltman 1987). If intruding male caught and brought to ground, it often cries like a young bird (probably Begging Calls) and rolls onto its back to defend itself with its beak and claws (Robinson 1956). Often open bill slightly when defending against attack (Pellis 1979). See also Relations within family group. **Escape behaviour** When chased, usually flee by flying erratically from side to side and in up-and-down swoops; if escape route blocked, sometimes hide under shrubs or rocks, or squeeze into crevices, sometimes not emerging for hours (G. Kaplan). **Triumph ceremony** After border dispute or after chasing intruder from territory, most, if not all, birds of Territorial Group gather and Carol together (Robinson 1945, 1956; Buller 1947;

Rankin 1970; Kaplan 2004). Most often occurs just before breeding season (Buller 1947). In NZ, once given after chasing Swamp Harrier *Circus approximans* from territory (Rankin 1970). Usually performed from elevated perch (G. Kaplan). **Social dominance** Dominant male said to stalk about with wings and head lowered (Robinson 1956). Juveniles often attacked if they fly in front of a perched or flying adult, especially a male; adult flies above juvenile, pecking at its head and forcing it onto ground; sometimes adult females also attacked if they fly in front of a flying adult male (Pellis 1979, 1981b). Very occasionally male threatened female if she approached too closely while he was feeding, female then immediately walking away (Roberts 1963). Sometimes adult seen to run up to juvenile and jump over it; juvenile usually responds by crouching (Pellis 1979). Sometimes adult Carols after attacking an immature, victim sometimes joining in (Robinson 1956). At Coolup, dominant male often settled disputes between others in Territorial Group (Robinson 1956); in one group near Christchurch, two juveniles that were fighting stopped when dominant male arrived (Rankin 1970). Often members of Territorial Group forage within a few metres of each other, but sometimes subordinates prohibited from feeding with resident pair or near dominant male or female; attempts to move closer provoke pursuit and, if caught, pecking. In one group, dominant males always fed first, and it has been suggested that subordinates called to alert dominant male to food source (G. Kaplan). See also Relations within Family Group. **Redirected aggression** Sometimes pull at vegetation or strike at substrate during aggressive encounters, and sometimes chase or peck at other species of birds or mammals immediately after border dispute or territorial intrusion (Brown & Veltman 1987). **Alarm** Give loud Alarm Calls upon detecting danger, such as raptor, and sometimes crouch while calling (Anon. 1914; Robinson 1956; Roberts 1963). Given by members of flock upon approach of person, often when person approaches nest-tree or fledgelings, and while attacking intruders near nests (Robinson 1956; see Parental anti-predator strategies below). When alarmed, first sleek feathers, stretch neck and scan surroundings, then call and prepare to fly. When raptor detected, often point bill and whole body towards raptor, flatten tail to ground, and remain still (e.g. for *c.* 20 s or till raptor well out of territory) while continuing to watch raptor; often give loud Alarm Calls. Juveniles seen to respond by walking to and keeping still in tussock of tall grass, or crouching flat and still on ground but following flight-path of raptor by moving head (Vincent 1975; Pellis 1979; Hewish 2002b; G. Kaplan). Two Magpies gave trumpeting squawk in alarm when Little Eagle *Hieraaetus morphnoides* flew overhead (Hewish 2002b); and one group scattered in alarm when Little Eagle made diving attack into crown of eucalypt (Debus 1983a). In response to sudden noises made by person (e.g. shutting door or dropping object), birds often glanced up or lifted wings and leapt sideways (Roberts 1963). In NZ (where snakes absent), upon seeing confectionery snake *c.* 1 m long, tame bird flew 2–3 m away, puffed out plumage, spread and lowered wings and tail, arched neck and lowered head and gave quick, loud Alarm Calls while constantly watching snake; same response elicited by three different toy snakes. Did not produce same response when confronted by other novel objects (Brockie & Sorensen 1998). Claimed that SENTINELS guard territory, with usually lone bird perched in highest conspicuous position in territory, e.g. top of tree, power pole or similarly tall structures (G. Kaplan). However, sentinel behaviour considered doubtful (C.J. Veltman) and confirmation needed. **Mobbing** Sometimes join with other species, especially Noisy Miners, to attack threats such as raptors, and other species often react to Alarm Calls of Magpies (G. Kaplan): together with butcherbirds and a kookaburra, once mobbed a Masked Owl *Tyto novaehollandiae*

(Debus 1993); a nesting pair, with assistance from other birds, drove Red Goshawk *Erythrotriorchis radiatus* to ground (Favaloro 1981); two, together with a Pied Currawong, mobbed an Osprey *Pandion haliaetus* (Rose 2000); three, together with five Noisy Miners, three Blue-faced Honeyeaters and four Magpie-larks, mobbed a Common Brushtail Possum *Trichosurus vulpecula* (Woodall 1994); and once, in NZ, one, together with Tuis *Prosthemadera novaeseelandiae*, chased juvenile New Zealand Falcon *Falco novaeseelandiae* (CSN 35). **Interspecific agonistic interactions** Attack and chase many species, including birds (see below), people (see below) and other animals, including Common Brushtail Possums (Woodall 1994; CSN 3), Rabbits (D.I. Stone), Stoats *Mustela erminea* (CSN 32), Foxes (Taylor 1986), Dogs (McCaskill 1945) and, once, a Swamp Tortoise *Chelodina oblonga* (McMillan 1963). Reported pecking eyes of disabled Sheep (McCaskill 1945), and once seen giving Alarm Calls and swooping teddy bear (Sedgwick 1940). ATTACKS ON BIRDS: Detection of a predatory bird stimulates Alarm, and sometimes Rally, Calls, with entire group (except juveniles) responding by gathering to attack and mob threat; birds from Non-territorial Flocks sometimes also gather to attack avian predators (Robinson 1956; Brown & Veltman 1987; G. Kaplan). Attack birds of all sizes, from large raptors to small passerines. In NZ, chased *c.* 8% of birds (excluding Harriers, see below) that ventured within 50 m of a territorial bird (D. Morgan). RAPTORS: Often one, two or several birds from a group attack, harass or chase raptors, sometimes assisted by birds from neighbouring groups (J.M. Hughes; G. Kaplan). One after another, attackers fly above raptor, trying to injure its back or head (G. Kaplan). In Aust., reported to attack: Black-shouldered Kite *Elanus axillaris* (Ragless 1958), Square-tailed Kite *Lophoictinia isura* (Brown et al. 2000), Black Kite *Milvus migrans* (McGill 1955), Whistling Kite *Haliastur sphenurus* (Anon. 1914; Watson 1955), White-bellied Sea-eagle *Haliaeetus leucogaster* (D'Ombrain 1952), Grey Goshawk *Accipiter novaehollandiae* (J.M. Peter); Red Goshawk (Lord 1952; Favaloro 1981), Wedge-tailed Eagles *Aquila audax* (Anon. 1914; Carter 1924; J.M. Peter), Little Eagle (Austin 1953), Brown Falcon *Falco berigora* (Watson 1955), Australian Hobby *F. longipennis* (Metcalf 1989), Peregrine Falcon *F. peregrinus* (D'Andria 1969), Nankeen Kestrel *Falco cenchroides* (Genelly 1978), Masked Owl (Debus 1993) and Barn Owl *Tyto alba* (Ashton 1996). In NZ, attacked: New Zealand Falcon (McCaskill 1945; Lawrence & Gay 1991; CSN 31, 45), Swamp Harrier (McCaskill 1945; Rankin 1970; CSN 24), Southern Boobook *Ninox novaeseelandiae* (Morgan et al. 2005) and Little Owl *Athene noctua* (CSN 48). Often dive at perched or flying raptor from above and behind (Rankin 1970; Lawrence & Gay 1991), occasionally making contact (Genelly 1978). In NZ, Swamp Harriers attacked on *c.* 39% of occasions they came near a territory, and attacked on *c.* 17% of occasions they ventured near a Non-territorial Flock (D. Morgan). Near Christchurch, attacked and chased Swamp Harrier four times, with dominant male attacking first, quickly joined by others from group; called loudly while attacking (Rankin 1970); once, four attacked and killed a male Swamp Harrier (CSN 3). CHOUGHS: Groups often have fierce battles with groups of White-winged Choughs when respective territories close together (Baldwin 1971, 1972; Rowley 1978; Mackness & O'Brien 1997). Most attacks occur outside breeding season of Chough, when they wander over large areas, often entering other territories, inadvertently provoking almost daily attacks (Rowley 1975, 1978). Groups usually succeed in driving Choughs from territory outside breeding season, but less successful during breeding season when Choughs more territorial and tend to stand their ground (Baldwin 1971). Sometimes a Magpie stands on each side of a

group of Choughs and harasses them till they begin to run; the Magpies then go to rear of group and fly back and forth, driving Choughs away in one direction for up to 800 m or so (Baldwin 1971). Once in Sept., two Magpies took turns to repeatedly dive and snap bills at circle of seven Choughs; each attack lasted *c*. 15 s, and when one Magpie returned to tree, other maintained attack. Choughs stayed in tight circle during attack, but dispersed when Magpies stopped attacking after several minutes (Mackness & O'Brien 1997). Repeatedly attack single Choughs till they leave territory. Attacks usually stop or decrease if group of Choughs gives Plum-pudding Display (Rowley 1975, 1978). OTHER BIRDS: Often chase small birds, in Aust. and NZ, especially: Australasian Pipit (Batey 1907c; Sedgwick 1936, 1940; McCaskill 1945; J.B. Paton 1977), Skylark (McCaskill 1945; Porter 1993), House Sparrow (McCaskill 1945; Barr 1986) and Common Blackbird (McCaskill 1945; D.C. Paton 1977; CSN 44). Sometimes kill small birds (McCaskill 1945; Porter 1993), and very occasionally eat them (see Food). When chasing Blackbirds, sometimes peck tail, head or back, and once, when diving at Blackbird, hit it on back of head, killing it, but then ignored corpse (D.C. Paton 1977). Once, one attacked a currawong that had been swooping at it, first catching currawong by wing, and then, when currawong was on its back, Magpie jabbed its breast with bill (Comrie-Smith 1938). Once, when one confronted a Little Raven *Corvus mellori* while standing on ground, both extended necks while facing each other; it seemed as though each was trying to appear taller than the other. The two then lunged at one another with feet and briefly grappled; Raven was forced onto its back and Magpie stood over it. Raven then stood up and the two repeated neck-stretching (J.M. Peter). Once, one struck back of incubating Satin Bowerbird *Ptilonorhynchus violaceus* (Donaghey 1981). In Aust., other birds attacked, chased or harassed include: Domestic Fowl *Gallus gallus*, Buff-banded Rail *Gallirallus philippensis*, Purple Swamphen *Porphyrio porphyrio*, Bush Stone-curlew *Burhinus grallarius*, Spotted Turtle-dove *Streptopelia chinensis*, Crested Pigeon *Ocyphaps lophotes*, Galah *Eolophus roseicapillus*, Sulphur-crested Cockatoo, Pale-headed Rosella *Platycercus adscitus*, Australian Ringneck *Barnardius zonarius*, Red-rumped Parrot *Psephotus haematonotus*, Channel-billed Cuckoo *Scythrops novaehollandiae*, Laughing Kookaburra, Yellow-rumped Thornbill *Acanthiza chrysorrhoa*, Southern Whiteface *Aphelocephala leucopsis*, Noisy Friarbird *Philemon corniculatus*, Grey-Shrike-thrush *Colluricincla harmonica*, Black-faced Cuckoo-shrike, Grey Butcherbird, Pied Butcher-bird, Grey Currawong, ravens and crows, European Goldfinch *Carduelis carduelis* and Common Starling (Hill 1903; Cameron 1933; Bright 1935; Sedgwick 1936; Brandon 1938; Quinn 1961; Roberts 1963; Daley 1966; Pratt 1972; Kellam 1974; D.C. Paton 1977; Phillips 1977; Morris 1978; Baldwin 1989; Trémont 1995; Cilento & Jones 1999). In NZ, birds attacked, chased or harassed, other than those above, include Domestic Fowl, Common Pheasant *Phasianus colchicus*, California Quail *Callipepla californica*, Paradise Shelduck *Tadorna variegata*, Mallard *Anas platyrhynchos*, Great Cormorant *Phalacrocorax carbo*, White-faced Heron, Cattle Egret *Ardea ibis*, Purple Swamphen, New Zealand Dotterel *Charadrius obscurus*, Double-banded Plover, Masked Lapwing, Kelp Gull *Larus dominicanus*, Silver Gull *Larus novaehollandiae*, Black-fronted Tern *Sterna albostriata*, Rock Dove *Columba livia*, Spotted Turtle-Dove, New Zealand Pigeon *Hemiphaga novaeseelandiae*, Eastern Rosella *Platycercus eximius*, Kaka *Nestor meridionalis*, Kea *N. notabilis*, Long-tailed Cuckoo *Eudynamys taitensis*, Sacred Kingfisher *Todiramphus sanctus*, Grey Warbler *Gerygone igata*, Bellbird *Anthornis melanura*, Tui, New Zealand Tomtit *Petroica macrocephala*, Grey Fantail *Rhipidura fuliginosa*, Kokako *Callaeas cinerea*, Yellowhammer *Emberiza citrinella*, Common Chaffinch *Fringilla coelebs*, Common Canary *Serinus canaria*, European Goldfinch, Silvereye *Zosterops lateralis*, Common Blackbird, Song Thrush *Turdus philomelos*, Common Starling, and Common Myna *Acridotheres tristis* (McCaskill 1945; Porter 1993; Morgan *et al.* 2005; CSN 7, 24, 31, 36, 41, 44, 48, 49). ATTACKS ON PEOPLE: Widely reported in literature (Whitlock 1909; Batey 1910; Tilley 1926; Wigan 1931; Hyem 1937; McCaskill 1945; Wilson 1946; Sedgwick 1948; Carrick 1963; Hobbs 1972; Oliver; and references below); for reviews, see Jones *et al.* (1980), Jones (1996, 2002), and the species most often reported to injure people (Bourke 1958). Usually attack from behind (Hill 1903; Jones *et al.* 1980). Always attack head, but seldom make contact; if contact made, inflict wounds with either claws or bill, or strike with weight of body at great speed (Elliott 1934; Kilpatrick 1935; Robinson 1956; Jones *et al.* 1980), and can cause nasty wounds, particularly to eyes (Robinson 1956; Rowley 1975; Horsburgh *et al.* 1992; Jones 2002). Two deaths have been attributed to attacks by Magpie; one boy apparently died from tetanus contracted from severe peck on head, and unsubstantiated claim of spinal cord of man being penetrated at back of neck (Jones 2002). Some individuals more aggressive than others (Bourke 1958; Cilento & Jones 1999); of 118 suburban Magpies round Brisbane, found that 9% were aggressive towards people (Jones 2002). Object of aggression often specific and varies greatly, e.g. some attack only adults, others only children, strangers, boys, or cyclists (Sedgwick 1936; McCaskill 1945; Robinson 1956; Warne & Jones 2003). Suggested that aggression towards people possibly stems from experience of rock-throwing or nest-robbing by people (Bourke 1958). Often attack people in urban areas (Jones *et al.* 1980; Jones 1996), only very occasionally do so in rural areas (Cilento & Jones 1999). Male parent usually most aggressive when nestlings present (Cole 1921; Elliott 1934; Cilento & Jones 1999). Attacks often stop a few days after young fledge (Elliott 1934) but birds sometimes more aggressive once young have fledged (Pellis 1979; J.M. Peter). In Brisbane, males made *c*. 97% of all attacks, and attacked people far more than females did; females tended to attack potential predators rather than people, other Magpies or non-predatory birds (Cilento & Jones 1999). At Coolup, usually only one male (probably dominant male) of group attacked, but after nestlings hatched, female (probably dominant female) sometimes also attacked (Robinson 1956). At Nedlands, WA, male usually attacked first, often backed up by female; while attacking, pair gave Rally Call and others flew in and gave Alarm Calls (Kilpatrick 1935). ATTACKS BY OTHER SPECIES: Once, one pecked two large pieces from side of partly built Magpie-lark nest, and was then chased by Magpie-larks upon return to nest (Anon. 1914).

**Sexual behaviour** Said to have few courtship behaviours (Robinson 1956). Process of mate selection not known and courtship behaviour appears difficult to observe; there are no known visual displays used to attract a partner (G. Kaplan). Male may PREEN incubating or brooding female (G. Kaplan). Pair occasionally perform TUMBLE: one bird, usually male, flies directly at perched partner, causing them both to tumble to ground, clasped together; they then separate and fly away from each other. Interaction brief and without any obvious prelude; performed only in winter and spring (Brown & Veltman 1987). In WA, Solo Song (possibly Warbling; see Voice) given only by male and thought to have sexual function, as not given in agonistic situations (Robinson 1956). **Courtship feeding** Male sometimes feeds female on nest, usually during incubation (Hall 1909; Anon. 1914; Tilley 1926; Elliott 1934; Lord 1956a; Robinson 1956; Carrick 1972; Veltman 1989a; Hughes *et al.* 1996; Campbell) but also before incubation (Kaplan 2004). Female usually fed by a single male (Hughes *et al.* 1996), probably mate. In one territory with two incubating females, male fed both on nest (Tilley 1926). **Pre-copulatory displays** Only

behaviour by male before copulation appears to be trembling of wings (Robinson 1956) and sometimes singing (Wilson 1946), though exact song not known. Male loses interest if female unresponsive after several attempts (Robinson 1956). Once squawked before attempting copulation (Wilson 1946). Males sometimes appear to attempt copulation without any preliminary display (Secker 1952; see also Forced Copulation, below). Female invites copulation with INVITATORY DISPLAY: crouches low on branch, cocks tail, lifts wings slightly, bends head back so that bill pointing skyward, puffs out feathers round vent and quivers tail rapidly (Wilson 1946; Robinson 1956; Brown & Veltman 1987; Kaplan 2004). At least once, Invitatory Display was preceded by low, short song by female (Robinson 1956), and sometimes both sexes sing after Invitatory Display but before copulation (Wilson 1946). Female sometimes also invites copulation by trembling wings. Sometimes males do not respond to Invitatory Display (Robinson 1956). **Copulation** Unceremonious, quick and seldom observed (Kaplan 2004). During copulation male flies to soliciting female and lands on her back, grasps her nape with bill and makes cloacal contact briefly before flying away (Brown & Veltman 1987). Once, after Invitatory Display by female, male briefly attempted copulation (not further described) and then flew away; female continued Invitatory Display and male returned, perched beside female and sang, with female joining in; male then landed on uppertail-coverts of female and manoeuvred his lower body beside her tail, keeping balance with spread wings and tail; copulation lasted c. 3 s and male flew away (Wilson 1946). **Forced copulation** Males that have intruded into another territory sometimes attempt to copulate with females by force. Sometimes attempt copulation by pouncing onto female from a secluded perch; female usually struggles while male holds her by feathers of crown and forces her to ground; rest of female's group usually arrives quickly and attack male, who then flees like a bat out of hell. Sometimes intruding male attempts to copulate with a female on a nest. Subordinate males from within group possibly also attempt to sneak forced copulations. Once a female gave call, similar to Rally Call, that attracted two male intruders; one was chased away by dominant male of female's group, but female was chased through trees by second intruder; when chased, female did not attempt to return to group or call to group; male eventually gave up and left (Robinson 1945, 1956).

**Relations within family group** When parents or helpers approaching nest with food, usually fly to perch near nest-tree and wait briefly before moving to nest (Gardner & Gardner 1975). Nestlings utter Begging Calls briefly when a parent arrives at edge of nest. When young being fed, distribution of food not dependent on begging or physical position of nestlings, but apparently determined by which nestlings had not been fed before; thus no competition between nestlings, and each receives similar amounts of food. Sometimes adult female spreads wings over nestlings to protect them from sun or inclement weather. Sometimes parent (usually female) preens or softly nudges nestlings with bill (Kaplan 2004; G. Kaplan). At 4 weeks old, nestlings actively preen, flap wings, move about nest, peck at twigs and feathers, and peck at parents (Pellis 1979, 1981a). Nestlings said to practise Song only when parents or other adults ≥20 m from nest, presumably just beyond audible range of adults. Fledgeling siblings usually stay together, play together and often explore surroundings together (Kaplan 2004; G. Kaplan; see Play above). During first 4–6 weeks after fledging, young often follow foraging parent on ground, often begging (Pellis 1979). During first 3 months after fledging, fledgelings spend much time near foraging adults, learning foraging methods, walking near parents and watching adults foraging; at this time, parents tolerate constant pestering and begging by young (Kaplan 2004; G. Kaplan). Fledgelings

often show much interest in novel, inedible objects while following parents, especially in late morning and early afternoon when probably not hungry. While following parent, fledgelings sometimes distracted while examining an object and parent continues on; fledgeling then runs to catch up (Pellis 1979). If a fledgeling attempts to fly farther than c. 30 m, a parent will fly above it, settle on its back and force it to ground (Kilpatrick 1935; Wilson 1946), possibly to prevent it from straying across territorial boundary (Robinson 1956). Similar behaviour also thought to be used as parental anti-predator strategy (see below). Nestlings or juveniles that have been removed from their parents for a week are always accepted back immediately but not after absence of 4 weeks (Kaplan 2004; G. Kaplan). BEGGING: When begging for food, nestlings extend neck, gape bill and give faint Begging Calls. Before eyes open, begging triggered by movement of nest when parent lands; after eyes open, triggered by arrival of parent at nest or nearby branch. By third week, nestlings can see farther afield, and adopt begging posture before parent or helper arrives at nest (Kaplan 2004). When begging, fledgelings give distinctive loud and persistent Begging Call with bill wide open, often accompanied by fluttering of wings (Wilson 1946; Robinson 1956; Roberts 1963; Pellis 1979); these actions become more intense as parents approach with food (Roberts 1963). In first 6 weeks out of nest, fledgelings beg while standing, but if pecked or otherwise attacked by adult from which it was begging, young stop briefly before continuing to beg. From 6 weeks out of nest begging fledgeling will crouch and lie inert after being attacked and then resume begging in crouched stance, though some stand up again after several successful begs (Pellis 1979, 1981a). At c. 6 months old, ability to forage independently varies individually; some continue to beg for food till 8–9 months old, but begging usually ignored or young attacked by parents, encouraging them not to approach (G. Kaplan). When food thrown on ground by person, fledgelings often pointed to food with open mouth and begged (Roberts 1963). SIBLING RIVALRY OVER FOOD: Sometimes when two fledgelings attempt to take food from same adult, one charges at other, which adopts an erect posture that terminates the attack (Pellis 1979). During hostile encounters over food, fledgelings often gave Scolding Call, pointed at food with bill, ruffled feathers, and sometimes sang. When two fledgelings approached same piece of food, both uttered Scolding Calls, and once one gave mixture of Begging and Scolding Calls when defending food from other fledgelings (Roberts 1963; see Voice). Once when two fledgelings squabbled over food, one took food from the other and then sang loudly. Fledgelings often cache excess food but not seen to retrieve it (see Food). **Play** For details of play between members of family group or Territorial Group, see above. **Dominance and submissive behaviour** Parents maintain dominance over juveniles by pecking them or threatening to peck, and adults often threatened or pecked juveniles if they approached food claimed by adult; juveniles usually adopted a submissive posture to avoid aggression (Roberts 1963). In Sydney, juveniles use three types of SUBMISSIVE POSTURES in response to threat (in order of increasing submissiveness): (1) raise wings, vibrate tail, ruffle feathers and utter Appeasement Call; this posture often immediately effective; (2) squat low on ground with bill pointed downward and feathers ruffled, uttering continuous Appeasement Calls; given if threat imminent; (3) roll onto side or back with feathers ruffled, uttering Appeasement Calls more loudly as threat increases; most abject submission (Roberts 1963). Some also give APPEASEMENT DISPLAY, rapidly fluttering wings in a manner similar to begging, accompanied by Begging or Distress Calls (Kaplan 2004; G. Kaplan). When juveniles quiet and submissive, plumage often fluffed up (G. Kaplan). In Sydney, juveniles pecked or attacked only three times after assuming submissive posture: once, male pecked

juvenile gently; once female briefly dragged it along ground while juvenile protested loudly but made no attempt at defence; and once, female rushed at juvenile, which abandoned submissive posture and was then chased in flight. Sometimes juvenile in Submissive Posture was imitated by other juveniles that were not directly threatened. No fighting seen within family group (Roberts 1963). In one brood of four fledgelings that often fought among themselves, two dominated and often prevented the other two from being fed by parents; the two submissive birds began feeding independently much earlier than the dominant two, and tended to feed in same area as, but apart from, parents (Hall 1909). **Anti-predator responses of young** When adults give Alarm Calls, nestlings huddle and crouch in nest, lowering their heads below rim of nest; fledged juveniles take cover in dense vegetation (G. Kaplan). In first few days after fledging, very attentive to all kinds of stimuli, and explore much, venturing short distances from nest then returning (Pellis 1979). However, once young move farther from nest, become more wary and less active, and when confronted with threatening stimulus (e.g. approach of person), often adopt a bill-up, frozen posture, sometimes crouching (Robinson 1956; Pellis 1979); or sometimes fly short distance, but seldom make second attempt at flight; give Distress Calls when picked up (Robinson 1956). Fledgelings defecate when frightened, including when being handled (Batey 1907b). When Alarm Call given by parent, juveniles stop foraging and remain alert, turning head to locate danger. Once when juveniles out of sight of adult, they flew closer when adult gave Alarm Call (Roberts 1963). When raptor nearby, juveniles usually seek cover (G. Kaplan). However in NZ, occasionally join adults in chasing Swamp Harriers, though they never initiate chase (D. Morgan). When approached by cars, juveniles crouch and lift wings or assume fluffed-up submissive posture (see above) but do not attempt to flee, often resulting in fatality (Sullivan 1929; J.M. Peter). **Parental anti-predator strategies** Parents often attack raptors and people that come near nest-tree (see Interspecific agonistic interactions above), and often give Alarm Calls when people approach nest-tree or fledgelings (Elliott 1934; Wilson 1946; Hobbs 1987). When potential threat approaches nest, usually first give warning signals such as Carolling, Bill-snapping or swooping at a distance (Kaplan 2004). Incubating or brooding female not usually involved in attacks; males usually swoop people (Jones & Finn 1999; Kaplan 2004). When with nestlings, some parents attack potential aerial threats but ignore ground-based threats (Pellis 1979), whereas others very aggressive towards people (see Interspecific agonistic interactions); male parent and any helpers present directly confront threat and attempt to chase it away (Jones 2002; G. Kaplan). At Coolup, fledgelings guarded zealously by some females, but others took little interest when fledgeling picked up by person (Robinson 1956). Once at Gol Gol, NSW, person was attacked near empty nest, while fledgeling was perched *c.* 180 m away, but was not attacked when fledgeling was approached (Hobbs 1972). Once, when calling juvenile was approached by person, a male landed in front of juvenile, then walked behind it and took hold of feathers of crown and forced it into crouching position, whence it became almost invisible in grass, hiding juvenile from potential danger (Robinson 1956). Once in Sydney, when juvenile approached a Laughing Kookaburra too closely, female flew between the two, uttering Alarm Call (Roberts 1963). Once near Hamilton, Vic., adult said to have grasped bill of juvenile in its own bill and swung juvenile off its feet to move juvenile out of path of car (Sullivan 1929). On seeing snake or unfamiliar stimuli, adults fly away and young follow (G. Kaplan; A. Koperof). Once, observer found a young Magpie on ground and took it home, at least 1.6 km away; doubtfully claimed that parents later arrived and each grasped one wing of young bird, lifted young

into air, and carried it away (Reid 1971), but probably describes attack of juvenile by local group.

**VOICE** Very well known. Many detailed studies: of vocalizations, including Dawn Song and Dusk Song, near Coolup, sw. WA (Robinson 1956); of repertoire in SA (Sanderson & Crouch 1993); of repertoire, including Alarm Calls and song-sharing, near Palmerston N, NI, NZ, and near Brisbane (Brown & Veltman 1987; Brown *et al.* 1988; Farabaugh *et al.* 1988; Brown & Farabaugh 1991a,b); and of repertoire, including song structure, mimicry and Alarm Calls, mostly near Armidale, NSW (Kaplan 2000, 2003, 2004, 2005; G. Kaplan & L.G. Rogers). Sonagrams in Brown & Veltman (1987), Brown *et al.* (1988), Farabaugh *et al.* (1988), Brown & Farabaugh (1991a,b), Sanderson & Crouch (1993), Jurisevic & Sanderson (1994, 1998) and Kaplan (2003). Account based on contribution by G. Kaplan, and Kaplan (2005), on which unreferenced statements based. Among finest songbirds in Aust. (Wilson 1946). Vocalizations vary greatly in volume, duration and quality: from very soft to loud, brief to extended, and harsh to tuneful and melodious flute-like sounds with rich overtones (Sanderson & Crouch 1993; Kaplan 2003; see below). Songs are complex modulated sounds, some spanning more than four octaves; some include elegant crescendos or descend in a 'sweeping line reminiscent of Maria Callas in her best opera performances' (Kaplan 2003). Diversity of structure and function of most vocalizations possibly reflect highly developed system of communication, though Warbles appear to be produced by individuals away from group and possibly have no communicative function. Many vocalizations used to defend and advertise territory or to communicate over longer distances, and are of high amplitude, though often still melodious. ANNUAL AND DIURNAL PATTERN: Vocalize throughout year, though less often during breeding season than at other times of year. During breeding season, birds in breeding groups utter Warbles very occasionally; Carolling (Territorial Song) peaks Mar.–July, and decreases during breeding season, when it seems mainly confined to unemployed and immature birds (Robinson 1956). Vocalize at greatest levels and most diverse in period from late in breeding season to just before beginning of next. In SA, Dawn Song given July to early Oct., stopping at first light, after which loud Carols sung by both sexes (see below). Moonlight Song from birds in WA, start in Aug. and continue occasionally through breeding season (Robinson 1956). Warble given at any time of day, but often more frequent in middle of day, and may continue for ⩾45 min (Sanderson & Crouch 1993; Kaplan 2000). Sometimes vocalize (including Carol) at night (White 1912; Sutton 1919; Boehm 1950a; Sedgwick 1951; Robinson 1956; Hewish 1998; Mathews; J.M. Peter). DIFFERENCES BETWEEN SEXES: Few differences in vocalizations of sexes; adult male not reported to utter Begging Call or Pre-copulatory Call (see below). Males and females have same song-nuclei in forebrain and same cell-types in those nuclei. Development of some song-nuclei appears to be faster in females than in males: juvenile females showed a fully developed set of song-nuclei 2–3 months after fledging, whereas males of same age did not (Deng *et al.* 2001). INDIVIDUAL DIFFERENCES AND GEOGRAPHIC VARIATION: Much geographical variation. In study of Alarm Calls in populations in NZ and Qld, some calls confined to one population, and others given by both populations were given in different circumstances, suggesting that at least some learned (Brown & Farabaugh 1991a). There is also Geographical variation in Dawn Song: Songs from widely separated areas (e.g. Adelaide and n. Flinders Ras, or Adelaide and Perth) easily distinguished (Sanderson & Crouch 1993). In addition to geographic origin, vocalizations may contain information that indicates territory, kin or even individual identity; individuality in a call or duet may be expressed by

use of a particular terminal phrase or sequence of cadenzas (Falls 1969; Brown & Farabaugh 1991a,b; Kaplan 2003, 2004). Greatest individual variation occurs in Warbles and Carols; Dawn Song more stereotyped so that birds at a given locality sound similar (Sanderson & Crouch 1993). Analysis of Warbles from 23 individuals (from six Territorial Groups and a Non-territorial Flock, including a tame individual) showed that they comprised 893 syllable-types; none was shared by all 23 birds, few were shared by more than five birds (mostly syllables with simple structure), and 67% were peculiar to an individual (Brown et al. 1988). Birds with territories near forests or away from other groups less vocal than those in more open habitats. MIMICRY: Occurs only within sequences of Warble (Pollard 1930; Lord 1941; Robinson 1991; Sanderson & Crouch 1993; Kaplan 2000, 2003, 2004). Often given, by both sexes, throughout year and throughout range (Kaplan 1998, 2004). However, detailed analysis using sonagrams revealed that many claims of mimicry actually fall within normal range of Warble song (Kaplan 2005). Not given in fixed sequence, but snippets interspersed in own Warble song in all possible patterns (Kaplan 2000). Suggestion that mimicry confined to a particular season (Collins 1983) not confirmed (Kaplan 2004). Most mimicry spontaneous; and exposure to the mimicked sound or sequence sometimes brief, even just a few seconds (Kaplan 1996). Mimicry of human voice rare, only where there is some interaction with humans; while some birds whistle in almost human fashion, some or all may be imitations of whistles of Pied Currawongs (Chisholm 1937; Sanderson & Crouch 1993; G. Kaplan). Mimicry of >35 species of birds noted, including: Black Swan *Cygnus atratus*, Brown Falcon, Banded Lapwing *Vanellus tricolor*, Masked Lapwing, Crested Pigeon, Cockatiel *Nymphicus hollandicus*, owls, Forest Kingfisher *Todiramphus macleayii*, Variegated Fairy-wren *Malurus lamberti*, Red Wattlebird *Anthochaera carunculata*, Spiny-cheeked Honeyeater *Acanthagenys rufogularis*, Noisy Miner, Yellow-throated Miner *Manorina flavigula*, White-eared Honeyeater *Lichenostomus leucotis*, White-plumed Honeyeater *Lichenostomus penicillatus*, Grey Shrike-thrush, Magpie-lark, Willie Wagtail, Black-faced Cuckoo-Shrike, Olive-backed Oriole *Oriolus sagittatus*, Grey Butcherbird, Common Blackbird and Common Starling. Also often imitate mammals, especially Dogs or Horses (Pollard 1930; Conway 1940; Lord 1941; Thorogood 1941a; Chisholm 1946, 1947; Boehm 1948; Collins 1983; Sanderson & Crouch 1993; Hewish 2000, 2002a; Kaplan 2000; R.H. Loyn). Suggestion that mimicry learned mainly from parents, with few individuals directly mimicking other species (Robinson 1977) not confirmed (G. Kaplan), but mimicked sounds possibly passed between individuals (Waite 1903). Despite variety of mimicked sounds, mimicry occurs selectively, and claimed that only sounds of species permanently occurring in territory are mimicked (Kaplan 2004). NON-VOCAL SOUNDS: Bill-snapping produces loud, sharp crack; used as threat or warning. When swooping or in attack-flight, whooshing or whistling of wing-beats audible.

**Adult** WARBLE (= Subsong of Robinson 1975, Whisper-song of Chisholm 1946): Soft, undulating, tuneful and melodious, with rich tones and overtones, possibly from simultaneous activation of both membranes of syrinx; and includes snippets of mimicry (see above). Sequences of Warbles may last for up to 1 h without interruption; even after such long bouts, sometimes perform another bout of up to 1 h after interval of 2–5 min. Sonagram **A** shows an excerpt from a long sequence. Most common song; uttered by both sexes (Brown & Veltman 1987; Farabaugh et al. 1988; Kaplan 2005); usually performed by bird on its own, e.g. when roosting or after feeding. Function not known, but apparently not for communication (G. Kaplan). May or may not be followed by Carolling. Solo Song of Robinson (1956) possibly Warble, but Solo Song

said to be performed only by male; Solo Song not given in agonistic circumstances, and thought to have sexual function. CAROL (= Territorial Song of Robinson 1945, 1956, Heather & Robertson 2000): Loud series of slurred, melodious, flute-like yodelling calls (sonagram **B**); usually preceded by Warble. Fundamental frequencies similar to those of Dawn Song (see below), but usually also with prominent harmonic overtones (Sanderson & Crouch 1993). Famously rendered by poet Denis Glover as *quardle oodle ardle wardle doodle* (Heather & Robertson 2000). Typically, dominant bird (usually male, though sometimes female) starts to Carol and is then joined by one or more others (Robinson 1956; Kaplan 2004). Performed in any location, but often on ground. Functions: to advertise and defend territory, including during border disputes (both with and without fighting); as warning vocalization when potential threat approaches nest; during disputes within group (Robinson 1945, 1956; Buller 1947; Lord 1957; Roberts 1963; Rankin 1970; Carrick 1972; Kaplan 2004; see Social Behaviour); to reinforce group-bonds; and apparently used when important food-source located (Kaplan 2005). Carol a powerful warning signal in territorial defence; when a Territorial Group strong, Carolling usually sufficient to settle territorial disputes, e.g. in ACT, after removal of dominant male, playback of Carol sufficient to successfully defend and maintain territory (Carrick 1972). Song sometimes uttered by one or both sexes before copulation (Wilson 1946; Robinson 1956), possibly Carol. DUSK SONG: A short, stereotyped carolling song of even tone, repeated regularly at intervals of c. 7 s, in twilight between sundown and dark, when gathering to roost; sometimes given by all birds of group; in WA, heard from early Apr. to middle of breeding season (Batey 1907b,c; Wilson 1946; Robinson 1956; Mathews). DAWN SONG: Similar to Dusk Song but slightly louder and richer in tone. Always given before dawn, e.g. in WA, first heard in early Aug. at c. 05:00, while still dark, and then heard earlier as season progressed (Robinson 1956). Over 6 years at Belair NP, SA, heard regularly in early morning till first light from July to early Oct., stopping about time young fledged; e.g. on 11 Sept., one bird sang from 03:26 to 03:48, uttering 83 Songs, at rate 4–5 Songs/min, and from 04:33 to 05:40, uttering 431 Songs at rate of 6–10/min. Singing birds always perched in tree not
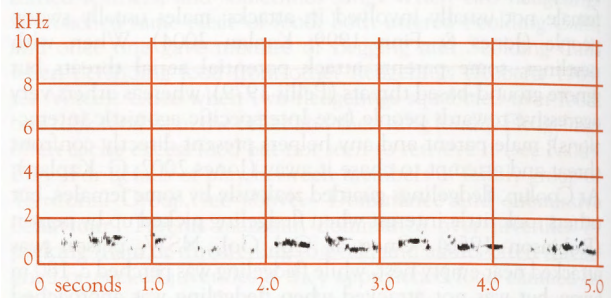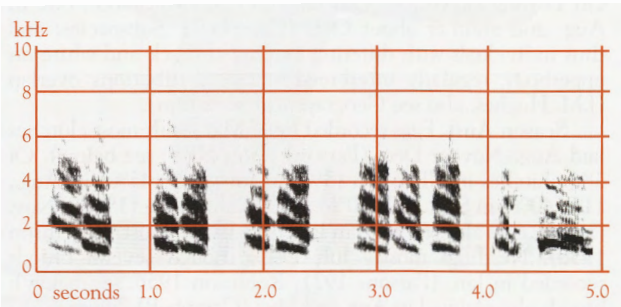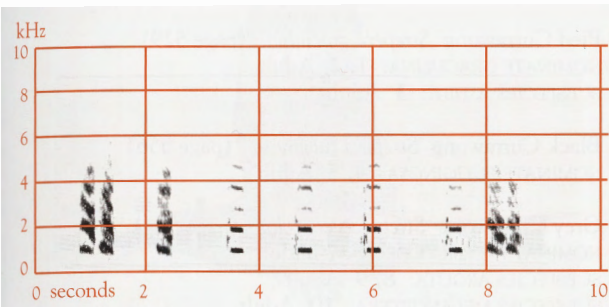


**A** G. Kaplan; priv.
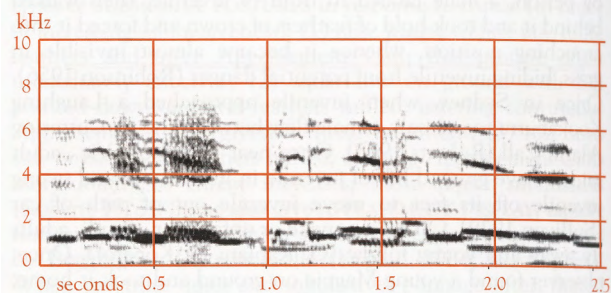


**B** G. Kaplan; priv.

on nest (Sanderson & Crouch 1993), and may have been helpers or adult male. MOONLIGHT SONG: Described only from WA. Similar to Dawn Song. Heard only occasionally, only when moon full, or nearly so, and during breeding season (starting in Aug.) (Robinson 1956). AUTUMN SONG: Described only from WA. Similar to Dusk Song but of irregular length, given at irregular intervals and heard at any time of day; given from late summer, and sometimes lasts for 2–3 h in middle of day in autumn or early winter (Robinson 1956). CONTACT CALLS: Brief calls with amplitude and harmonic structure depending on distance that sound is to travel; normally used over short distances, and comprise single sounds with little harmonic structure. Used to maintain contact with members of group. FOOD CALL: Brief call with similar structure to Contact Call but with many more harmonics. Given to attract members of group when rich source of food has been located. If dominant male or female (or both), present often followed by Carols. THREAT CALL: A broadband call usually uttered by dominant male on detecting or when confronting conspecific, and usually accompanied by a distinct posture; also given when dominant male flew at intruder, forcing it to flee (Rankin 1970; see Social Behaviour). Low croak uttered during disputes between members of Territorial Group (Robinson 1956) possibly also this call. ALARM CALLS: Utter a wide range of calls in alarm (G. Kaplan); some described as a loud or trumpeting squawk (Brockie & Sorensen 1998; Hewish 2002b) or harsh *ká* (Robinson 1956). Used to alert other members of group to impending danger, and often given when people approach nest-tree or fledgelings (G. Kaplan; see Social Behaviour: Alarm, Relations within family group). Type of calls given may indicate degree of danger (from low to high), or its nature, e.g. there are specific calls for raptors, and for terrestrial predators such as goannas *Varanus* (G. Kaplan & L.J. Rogers). Broad-band Alarm Calls uttered while mobbing potential threats (Jurisevic & Sanderson 1994). Sonagram **C** shows alarm calls, sonagram **D** two birds alarm-calling, and sonagram **E** high-alert alarm calls. RALLY CALL (= Two-Tone Call of Brown & Veltman 1987): Loud, high-pitched, two-tone call, audible over long distance and used to assemble members of group at site of territorial dispute or for defence against predatory bird (Robinson 1956; Brown & Veltman 1987). Also described as narrow-band descending call, uttered in response to live or stuffed owls (Jurisevic & Sanderson 1994). In Melbourne, described as descending, short and low whistle *pe-ew* (K. Bartram). When given, members of group gather, then call together and sometimes mob or chase intruder or predator from territory (see also Social Behaviour). Some-times uttered with Alarm Calls (e.g. Jurisevic & Sanderson 1994); while attacking people, one pair gave Rally Call and others flew in and gave Alarm Calls (Kilpatrick 1935). Once, a female gave call (said to be similar to Rally Call) that attracted two intruders into territory (Robinson 1956). DISTRESS CALL: A high-pitched, broadband call (sonagram in Jurisevic & Sanderson [1998]). Given by males caught intruding into another territory and brought

to ground by defending bird, to signify submission, together with rolling onto back (Robinson 1956). APPROVAL SOUNDS: Varying, low-amplitude, grunting sounds; uttered between members of pair, and between female and nestlings. Indicate approval, and accompanied by gentle allopreening and nudging. Tamed birds give cat-like purring sounds, accompanied either by allopreening or roosting near parent (Kaplan 2004). BEGGING CALL: Similar to those of young (see below). Uttered by breeding females when soliciting food from male (see Sexual behaviour); also by submissive bird to signify appeasement (see Agonistic behaviour). PRE-COPULATORY SQUAWK: Female sometimes squawks before copulation (Wilson 1946; also see Carol). **Other calls** In Vic., uttered low *hurrough* when going to roost (Batey 1907c).

**Young** Nestlings, juveniles and first immatures (first-year birds) utter a variety of calls (some of which may be uttered by adults in exceptional circumstances). Up to 6 months old, only calls uttered are Begging, Distress, Appeasement and Alarm Calls (Kaplan 1999). BEGGING CALLS: Well-defined calls of high amplitude, with harmonic structure. Uttered by nestlings and dependent juveniles and immatures; given by nestlings when parent arrives at edge of nest, though older nestlings may call on seeing parents returning. In first few weeks, Begging Calls usually brief and quiet, but gradually increase in length and volume. Sometimes also given when requesting an item for play (Kaplan 2004; G. Kaplan). DISTRESS CALLS: High-pitched broad-band sounds. Given mainly by juveniles and first immatures; nestlings may also give these calls in life-threatening situations. Apparently an involuntary signal of fear or pain; given in presence of conspecific or predator, when young attacked by adults, during play-fighting, and when picked up (Robinson 1956; G. Kaplan). APPEASEMENT CALL: Similar to Distress Calls in tonal quality, but quieter, shorter and of lower pitch; described as whimpering (Roberts 1963). Usually associated with submissive postures (see Social Behaviour). ALARM CALLS: Probably as those of adult. One uttered squawk when alarmed (Wilson 1946). SCOLDING CALL: Hostile churring notes given by fledgelings during hostile encounters over food; once, one gave mixture of Begging and Scolding Calls when defending food from other fledgelings (Roberts 1963; see Social Behaviour). SONG: Once



**D** G. Kaplan; priv.



**C** G. Kaplan; priv.
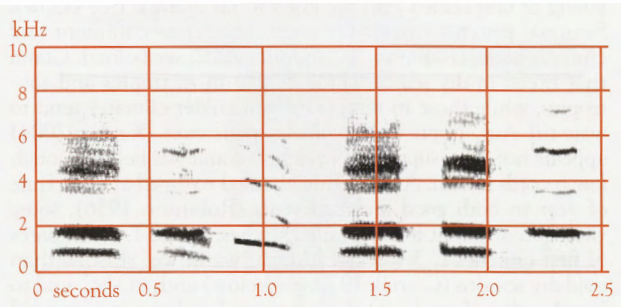


**E** G. Kaplan; priv.

when two fledgelings squabbled over food, one took food from the other and then sang loudly (Roberts 1963), though type of song not known. ACQUISITION OF SONG: Nestlings practise singing, but only when adults ≥20 m from nest. Song acquired by learning and apparently able to learn new sounds till at least 1 year old (Kaplan 1996, 2004; G. Kaplan). As most juveniles eventually leave natal territories and as there is song-sharing among neighbours (Farabaugh et al. 1988), life-long learning possible (G. Kaplan). MIMICRY: Capable of learning mimicry quickly; under controlled conditions, can render sounds accurately after an exposure of only 1 min (Kaplan 2000).

**BREEDING**   Well known. In Aust., detailed studies: in the ACT, round Canberra, using colour-banded birds, from 1955 to 1966, with additional observations from as early as 1953 and continuing till 1970 (Carrick 1963, 1972); of breeding ecology in suburban and rural habitats in Greater Brisbane region, in two breeding seasons, 2000–01 (Rollinson & Jones 2002); and at Coolup, sw. WA, 1943–55, where, though birds not banded, some individuals distinguished by plumage characters (Robinson 1945, 1956); and 1276 records in Aust. NRS to June 2003. Also >4200 records of breeding in Aust. Atlas 2. Robinson (1956) also collated data on breeding season from round Aust. Other Aust. studies include: of colour-banded birds in suburban Brisbane, 1992–93 (Hughes et al. 1996); of colour-banded birds at Seymour, Vic., 1992–93 (Hughes et al. 1996) and Sept. and Nov. 1994 (Finn & Hughes 2001); in Kings Park, Perth, Apr.–Nov. 1938, also with unbanded birds, some of which distinguishable by plumage (Wilson 1946). In NZ, detailed studies include McIlroy (1968) and Veltman (1984); these unavailable for full summary here. Socially monogamous and polygamous; sometimes breed co-operatively, though degree of help varies greatly between Territorial Groups and individuals, and possibly also geographically. Nest within all-purpose territories, which strongly defended by Territorial Group of two to c. 20 birds. Breeding dispersion varies, from solitary nesting (e.g. when Territorial Group consists of single breeding pair) to two or three active nests close together when plural breeding or polygamous males in Territorial Group (see Social Organization for all details). On Darling Downs, se. Qld, said to rear two broods, one in Aug. and another about Oct. (Campbell). Subspecies, and thus individuals with differing extents of black and white in upperbody, regularly interbreed where distributions overlap (J.M. Hughes; also see Geographical Variation).

   **Season Aust.** Eggs recorded June–Mar., with most clutches laid Aug.–Nov. or Dec. (Parsons 1921; NRS; see below). Of 286 clutches in NRS: ten (3%) in July, 129 (45%) in Aug., 115 (40%) in Sept., 29 (10%) in Oct. and three (1%) in Nov. (NRS); eggs also recorded in late June in nw. Aust. (Robinson 1956). Nestlings mostly July–Dec., though several broods recorded in Jan. (Parsons 1921; Robinson 1956; see below); broods also claimed in Apr. and May (Campbell). Unspecified breeding activity (almost certainly including nest-building and young of unspecified age) recorded in all months (see below). Seasonal patterns remarkably consistent across continent and climatic zones (Robinson 1956; Jones 2002; see below). Claim that breed in dry season (June–Sept.) in n. tropics and sub-tropics, while those in temperate and colder climates tend to wait till Aug.–Sept. when coldest spells over (Kaplan 2004) appears not to be supported by detailed analysis below, though few records from n. Aust. While claimed to breed at same time of year in both good and bad years (Robinson 1956), some variation apparent from detailed studies: in ACT, mean dates of first clutches c. 3 weeks earlier in warm wet seasons than cold dry seasons (Carrick 1972; see below) and, in Vic., said to breed earlier (from June) if winters mild and season extended if early autumn rains (Bedggood 1973; see below). Also said to

be more active nests in good years (Robinson 1956). In Greater Brisbane, suburban populations breed earlier than those in rural areas (Rollinson & Jones 2002; see below). Within a Territorial Group, individual females may begin breeding at different times; subordinate females may delay breeding till dominant females incubating, to avoid interference from them (Carrick 1972; Jones 2002; see Social Organization). Suggested that in areas inhabited by goannas Varanus (probably a major predator), may begin breeding in earlier and colder part of season when monitors and snakes are either still hibernating or emerging only for brief periods (Kaplan 2004). However, few areas in Aust. where these predators not present. Below, Robinson (1956) does not provide N for dated in clutches in MV. For discussion of gonadal cycles in ACT, see Carrick (1972). QLD: Eggs, July–Mar. (Robinson 1956; Lavery et al. 1968; Campbell; North; NRS [n=3 records]); dated clutches in MV, 16 Sept.–27 Nov. (Robinson 1956). Nestlings mid-Aug. to early Nov. (NRS); of 46 broods (only one of which from n. Qld): five (10.9%) in Aug., 26 (56.5%) in Sept., 14 (30.4%) in Oct. and one (2.2%) in Nov. Otherwise, fledgelings and unspecified breeding recorded in all months, in both N (N of 23°28') and S (Robinson 1956; Bravery 1970; Horton 1975; Storr 19; Aust. Atlas 2; NRS). In GREATER BRISBANE, suburban populations began laying significantly earlier than rural populations: where Day 1=1 June, in suburban populations, laying began at 67.2 days (9.8; 24) in 2000 and 66.2 days (10.0; 22) in 2001; in rural populations, laying began at 82.6 days (11.5; 12) in 2000 and 84.3 days (15.0; 15) in 2001. Variation in timing may be result of differences in supply of food and temperature between sites (see Rollinson & Jones 2002 for further details). NSW–ACT: Eggs, July–Dec. (Robinson 1956; Morris et al. 1981; North; NRS); of 40 clutches in NRS: one (2.5%) in July, 17 (42.5%) in Aug., 15 (37.5%) in Sept., six (15.0%) in Oct. and one (2.5%) in Nov. Dated clutches in MV, late Aug. to Dec., with most Sept.–Oct. (Robinson 1956). In ACT, mean dates of first clutches ranged from 22 Aug. in warm wet seasons to 15 Sept. in cold dry seasons (Carrick 1972). Nestlings early Aug. to late Dec. (Baldwin 1976; North; NRS [n=223]). Fledgelings and unspecified breeding recorded all months (Robinson 1956; Carrick 1972; Baldwin 1979; Costello 1981; Aust. Atlas 2; NRS). VIC.: Eggs late July to mid-Nov., mostly Aug.–Sept. (Favaloro 1930; Robinson 1956; North; NRS); of 100 clutches in NRS: two (2%) in July, 54 (54%) in Aug., 34 (34%) in Sept., eight (8%) in Oct. and two (2%) in Nov. Dated clutches in MV, 23 Aug.–Nov. (Robinson 1956). Nestlings, mid-Aug. to mid-Dec. (NRS [n=196]). Fledgelings and unspecified breeding recorded all months (Parsons & McGilp 1934; Bedggood 1973, 1980; Vic. Atlas [n=343 records]; Aust. Atlas 2; NRS). Round Caniambo, usually

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**Plate 17**                                            (N. Day)

Pied Currawong *Strepera graculina*   (page 529)
NOMINATE *GRACULINA*:  **1, 2**  Adult
SUBSPECIES *ASHBYI*:  **3**  Adult

Black Currawong *Strepera fuliginosa*   (page 556)
NOMINATE *FULIGINOSA*:  **4, 5**  Adult

Grey Currawong *Strepera versicolor*   (page 564)
NOMINATE *VERSICOLOR*:  **6, 7**  Adult
SUBSPECIES *ARGUTA*:  **8, 9**  Adult
SUBSPECIES *MELANOPTERA*:  **10**  Adult
SUBSPECIES *INTERMEDIA*:  **11**  Adult

breed Sept.–Dec., but said to be as early as June in mild seasons, and as late as Feb.–Mar. if early autumn rains fall (Bedggood 1973). TAS.: Eggs, Aug. to mid-Dec. but few data: two clutches in Aug. (NRS); eggs, 6 Sept.–6 Oct. (North); and dated clutches in MV, 2 Oct. to 17 Dec. (Robinson 1956). Nestlings, late Aug. to early Dec. (NRS [n=11]). Fledgelings and unspecified breeding recorded Sept. to mid-Jan. (Aust. Atlas 2; Tas. Bird Rep. 19; NRS). SA: Eggs, early July to late Oct., mostly Aug.–Sept. (Sutton 1924, 1926, 1929; Souter 1925b, 1928; Kuss 1934; Lashmar 1942; Robinson 1956; North; NRS); of 111 clutches in NRS: six (5.4%) in July, 44 (39.6%) in Aug., 49 (44.1%) in Sept. and 12 (10.8%) in Oct. Round Naracoorte, earliest eggs 27 July, and latest 9 Sept. (Attiwill 1972). Nestlings, mid-July to late Nov. and late Jan. (Mellor 1921d; Souter 1925b, 1927; Anon. 1926; Sutton 1927a; Hood 1935; Robinson 1956; Cox & Pedler 1977; North; NRS [n=171]). Fledgelings and unspecified breeding recorded mid-June to mid-Apr. (Morgan 1914, 1919, 1925, 1932; Anon. 1917; Mellor 1921b,c, 1922a,b, 1923a,c, 1927, 1932; Sutton 1923, 1927b, 1928, 1929, 1930, 1932; Harvey 1928; Brandon 1937; Brown 1937; Lashmar 1937; Clarke 1967; Attiwill 1972; P.W. Taylor 1987; Aust. Atlas 2; SA Bird Rep. 1977–81; NRS). Of 31 nests in Aldinga Scrub CP, earliest 'brooding' 31 July, and latest fledgeling 13 Oct. (Ashton 1987). WA: In ALL AREAS EXCEPT KIMBERLEY DIV.: Eggs, late June to late Oct. (Carnaby 1954; Robinson 1956; Slater 1962; NRS); of 30 clutches in NRS: one (3.3%) in July, 11 (36.7%) in Aug., 15 (50.0%) in Sept., and three (10.0%) in Oct. Nestlings, mostly late Aug. to mid-Nov., but one brood mid-Dec. (Robinson 1955; Sedgwick 1962; Slater 1962; NRS [n=62]). Fledgelings and unspecified breeding recorded all months except Mar. (Sedgwick 1953, 1955, 1962, 1973a; Robinson 1955; Serventy 1968; Whitley 1971; Brooker & Estbergs 1976; Brooker 2001; Storr 16, 21, 22, 26, 27, 28, 35; Aust. Atlas 2; NRS). In KIMBERLEY DIV.: one clutch from Derby, 3 Dec. (Le Souëf 1908); nestlings recorded 14 Nov. (Coate *et al.* 2001); fledgelings recorded 2 Oct. (Aumann 1991); and unspecified breeding Oct.–Jan. (Storr 11; Aust. Atlas 2). THROUGHOUT: Dated clutches in MV, 11 Aug.–18 Oct. (Robinson 1956). NT: Few data. Dated clutches in MV, 20 Oct.–2 Dec. (Robinson 1956). Single records of nestlings in mid-July and late Aug. (NRS). Unspecified breeding recorded May, July and Sept.–Nov. (Jarman 1944, 1945; Storr 7; Aust. Atlas 2).

NZ Eggs recorded July–Nov. (McCaskill 1945; Veltman 1984; Heather & Robertson 2000; CSN 1, 7; C.J. Veltman). Nestlings, Aug.–Nov. (McCaskill 1945; Veltman 1984; CSN 1, 4, 7; C.J. Veltman), though one nestling found in second week of June (CSN 1), indicating laying in May or earlier. Indeterminate young, Sept.–Oct. and Dec.–Feb. (McCaskill 1945; Westerkov 1954; Bull & Dawson 1969; Brockie & Sorensen 1998; CSN 1, 37). Fledgelings and unspecified breeding recorded Aug.–Jan. (McCaskill 1945; Crockett 1954; Bull & Dawson 1969; CSN 1, 5, 33, 34), mostly Sept.–Oct. (McCaskill 1945).

**Site** Usually in vertical forks, in outer canopy of tall live tree; occasionally nest in dead plants, or nest low, in shrubs or on ground (usually where trees unavailable); also use variety of artificial structures (Carrick 1972; NRS; and references below). Of 1129 records in NRS, 97.4% were in live plants, 1.3% in dead plants and 1.2% on artificial structures. NEST-PLANT: In AUST., most nests in tall live eucalypts (e.g. Littler 1903a; McClymont 1903; Le Souëf 1908; Anon. 1926; Mellor 1926c, 1931; Sutton 1928, 1929; Lashmar 1942; Wilson 1946; Ford 1971; Carrick 1972; Cooper 1972; Lawrence & Lawrence 1972; Baldwin 1976; North; NRS). Other nest-plants include *Acacia*, *Araucaria*, *Banksia*, *Bursaria*, *Callitris*, casuarinas, conifers, *Crataegus*, *Leptospermum*, *Lycium*, *Nicotiana*, *Pinus*, *Prunus*, *Solanum*, *Syncarpia* and *Ulmus* (Anon. 1914, 1926; Smith 1920; Mellor 1921a, 1922c, 1927; Souter 1925a, 1926, 1930; Morgan 1927; Newell 1927; Sutton 1927a, 1929, 1932; Elliott 1934; Morton 1954; McNamara 1958; Carrick 1972; Gardner & Gardner 1975; Close & Jaensch 1984; North). Of a sample of 258 records in NRS, 186 (72%) were in eucalypts, 18 (7%) in *Acacia*, 16 (6%) in pines *Pinus*, seven (3%) in *Leptospermum*, five (2%) in *Melaleuca*, seven (3%) on artificial structures (see below), and remaining 19 (7%) in other trees and shrubs (NRS). In Kings Park, Perth, of 43 nests, 41 (95.3%) were in Jarrah, with one (2.3%) in each of Tuart and Western Sheoak (Wilson 1946). On Kangaroo I., SA, of 21 nests, 20 were in Kangaroo Island Narrow-leaved Mallee *Eucalyptus cneorifolia*, and one in an unidentified gum (Lashmar 1937). In Barlee Ra., WA, most nests in Snakewood *Acacia xiphophylla*, which was tallest tree away from creeks (Robinson 1956). In Greater Brisbane, all nests in rural areas were in native trees (the only trees available), mainly eucalypts; at suburban sites comprising native and introduced vegetation, most nests in eucalypts but four in Norfolk Island Pines, and one each in African Tulip *Spathodea campanulata* and coconut palm *Cocos*; no nests were on artificial structures in rural or suburban areas (Rollinson & Jones 2002). Very occasionally nest on tussock of grass or among Capeweed *Arctotheca calendula* (Hood 1904; Hood 1935) or on bare ground (Sharland 1932; Ey 1944; Carrick 1972); in ACT, a subordinate female that was not allowed near shrub with nest of primary female tried to nest on ground (Carrick 1972). Other sites include single records on top of a tree-fern (Dickison 1930), in orchids beneath veranda, and in a vine over a doorway (Campbell). In NZ, mostly nest in tall trees, especially pines *Pinus*, but also Monterey Cypress *Cupressus macrocarpa*, eucalypts, Tawa *Beilschmiedia tawa*, willow *Salix*, beech *Nothofagus*, cabbage trees *Cordyline*, and hedges of gorse *Ulex* or hawthorn *Crataegus* (McCaskill 1945; Westerkov 1954; McIlroy 1968; Heather & Robertson 2000; CSN 1, 2, 7). In NI, nest in tall forest trees, living or dead (McCaskill 1945). ARTIFICIAL STRUCTURES: Sometimes nest on artificial structures in Aust. and NZ, including: on top of telephone, lighting or power poles (including among wires), electrical transformers, windmills, machinery, roofs of buildings and outbuildings (including top of airport tower), and top wires of a fence (Anon. 1926; Souter 1928; Sutton 1928; Dickison 1930; Hood 1935; Ey 1944; McCaskill 1945; McIlroy 1968; Carrick 1972; Heather & Robertson 2000; Campbell; NRS); single records on garden seat (Anon. 1914), stone wall (Sharland 1932) and in kerosene tin on a stand (Dove 1930). Of a sample of 258 records in NRS, seven (3%) were on artificial structures, including six on telephone or light poles, and one on a crane. SITE: Nests often exposed to sunlight and weather, and poorly concealed, though some protected by dense foliage (Wilson 1946; Carrick 1972; Baldwin 1979; Kaplan 2004); tend to be built on sheltered side of trees, away from prevailing winds (Hall 1909; Kaplan 2004). Usually select a firm support, often a stiff vertical fork, but other sites include clumps of mistletoe with rigid branches. Younger birds tend to select inferior sites, such as horizontal forks on thin, flexible branches, indicating that selection of site improves with age

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**Plate 18** (K. Franklin)

Australian Magpie *Gymnorhina tibicen* (page 579)
SUBSPECIES *TERRAEREGINAE*: **1** Adult male; **2** Adult female;
**3** Juvenile; **4** First immature; **5, 6** Adult male
SUBSPECIES *TYRANNICA*: **7** Adult male; **8** Adult female;
**9** Juvenile; **10** First immature; **11** Adult male
HYBRID *TERRAEREGINAE* × *TYRANNICA*: **12** Adult male
SUBSPECIES *DORSALIS*: **13** Adult female

or experience or both (Baldwin 1976). Fork of branch usually incorporated into nest-structure, anchoring nest to branch (Favaloro 1930; Baldwin 1979; see Nest, Materials). In an area of overlap, nests of black-backed birds said to be built near trunks of medium-sized saplings, while those of white-backed birds built near ends of branches high in tall trees (Hall 1909). Position of nest-tree can affect breeding success (see Success). SELECTION OF, AND FIDELITY TO, SITE: Site selected by female (Carrick 1972). Pairs and territories tend to be stable and can be maintained for many years, even for life; thus established pairs breed annually in same territories (see Social Organization). Some evidence of fidelity to nest-sites, with same trees or nests used annually for several years, though not always certainly by same birds (French 1900; McGilp 1925; Wigan 1942; Greaves 1965; North). However, suggested that c. 50% chance of females nesting in same tree in following season (J.M. Hughes). A tame bird known to have nested with a wild one in one tree for 8 years (North). Some nests also built on top of old nests or in same tree as old nest (NRS), but not known if by same birds. One nest used for two successive clutches (Ashton 1987). BREEDING DISPERSION: Varies (see Social Organization: Breeding dispersion). Probably mostly nest solitarily (e.g. Hughes et al. 1996) but sometimes more than one breeding female, and thus more than one active nest, within Territorial Groups; while such nests often some distance apart (e.g. up to 380 m), they are sometimes close together (though may be screened from each other) (Carrick 1972), e.g. once three pairs, probably all from same Territorial Group, nested in separate trees within c. 6 m of each other (Fletcher 1934), once two females from same territorial group nested c. 27 m apart and, once, two pairs (probably all from same Territorial Group) nested within 10 m of each other (Souter 1926); twice in ACT, tolerant or evenly matched females within Territorial Group nested in same tree (Carrick 1972). ASSOCIATIONS WITH OTHER SPECIES: Often nest in same trees as Willie Wagtails, Yellow-rumped Thornbills and Southern Whitefaces often nest in same tree, sometimes as close as 1.5 m; and both Wagtails and Thornbills together noted nesting close below Magpie nests (Anon. 1926; Hobbs 1972; North; NRS); Noisy Miners sometimes also nest in same tree (Littler 1904; North). One tree contained six nests of Little Pied Cormorant Phalacrocorax melanoleucos, two nests each of White-necked Heron Ardea pacifica and Yellow-billed Spoonbill Platalea flavipes, and one Magpie nest (Hood 1935). Some Magpie nests used by Striated Pardalotes Pardalotus striatus at same time as Magpie; Pardalotes dig small tunnel into lower part of Magpie nest and line inside it; Magpies make no attempts to remove or disrupt the intruders (Kaplan 2004). Once, thousands of ravens and Magpies bred together, with Nankeen Kestrels, in belts of Black Oak (McNamara 1958). MEASUREMENTS (m): Height of nest, for all sites, 10.3 (7.33; 1.0–80.0; 1055) (NRS); on Kangaroo I., SA, 2.1–12.2 (n=21) (Lashmar 1937). Other reports from literature (including approximations), 6.8 (4.30; 0.8–21.3; 43) with all but one apparently in trees or shrubs (exception on telephone pole at c. 4.9) (McClymont 1903; Littler 1904; Anon. 1914, 1926; Smith 1920; Mellor 1922c; Morgan 1927; Sutton 1927a, 1928, 1929; Favaloro 1930; Elliott 1934; Kuss 1934; Lashmar 1942; Ford 1971; Cooper 1972; Hobbs 1972; Gardner & Gardner 1975; Kitchener et al. 1975; Baldwin 1979; Coate et al. 2001; Campbell; North). In NZ, one 9.1 (CSN 1). Otherwise, said usually to be >12 (Rollinson & Jones 2002), 12–18.5 (Anon. 1914), up to 18 (Watson 1955; North), and, in Kings Park, Perth, 8–10 (Wilson 1946). Height of nest-tree, 15.6 (9.86; 1.3–84.0; 712), and height of tree above nest, 3.9 (4.38; 0–60.0; 704); height of artificial structures, 6.2 (3.58; 1.8–10.0; 4) (NRS). One nest in a Yellow Box was built across 15 cm wide horizontal fork on limb 2.5 cm in diameter, 2.5 m from trunk and 1.5 m from end of limb (Baldwin 1979).

Height of nests in part determined by height of available vegetation; in more arid regions, this often includes fairly low branches of shrubs and low trees, sometimes almost without leaves, and often less than a few metres above ground (Kaplan 2004; G. Kaplan). In Little Desert NP, w. Vic., one nest <1 m above ground, despite availability of taller trees (Gardner & Gardner 1975). Height of nest tends to be lower in pine trees than in eucalypts, reflecting structure of tree, as eucalypts produce useable branches only higher up (Kaplan 2004).

**Nest, Materials** Nest an open bowl; usually of sticks and twigs, and lined with softer materials, such as wool, hair or fur, rootlets, shredded bark and fine grass; nests occasionally include artificial materials, especially wire (Littler 1903b; Anon. 1914; Sutton 1929; Favaloro 1930; Kuss 1934; McCaskill 1945; Wilson 1946; Gardner & Gardner 1975; McGill & Goddard 1979; Heather & Robertson 2000; Kaplan 2004; Campbell; North; see below). Some nests consist of three distinct layers, e.g. an external layer or bowl of sticks and twigs, an inner layer of bark and grass, and a lining of wool (Littler 1904; McCaskill 1945; Gardner & Gardner 1975; Baldwin 1979; see Detailed composition below). From a sample of 50 records in NRS, materials include: sticks or twigs (recorded in 49 nests), grass (15), wire (4), plant stalks or fibres (4), plastic (1) and bark (1); materials used in lining included grass (10), hair (7), wool (2), fur (2), hessian (1) and string (1). Occasionally build nests that include wire (even barbed wire) or wire netting, with some built largely or entirely of wire (Littler 1903b; Anon. 1914, 1924; Mellor 1926c; Favaloro 1930; McCaskill 1945; Hamilton 1949–50; Serventy 1949; Sedgwick 1956; Stranger 1963; Campbell; North; CSN 1; NRS; see Detailed composition below); and nests occasionally also include, in structure or lining, other scraps, debris and bits of junk, such as iron clippings, old spoons, glass, pieces of china, tape, sacking, cloth (including a handkerchief), cotton wool, string, twine or rope, paper or cardboard, plastic or rubber, potato tops or rotten wood (Anon. 1914; Fletcher 1918; Dove 1930; Kuss 1934; McCaskill 1945; Kaplan 2004; NRS). Other materials include straw, feathers, leaves and rhizomes (McCaskill 1945); inner structural layer of one included horse dung and mustard stalks (Kuss 1934); in one area, several nests made of fragments of African Boxthorn (Hill 1903); external structure of one nest made of Cassytha tendrils (Sutton 1929); one made entirely of twine ends from threshing (Fletcher 1918). Other materials used in lining include green moss, horse dung, strips of cloth, twine and feathers (e.g. Emu Dromaius novaehollandiae) (Dove 1930; Favaloro 1930; Cooper 1972; Lawrence & Lawrence 1972; Campbell); a nest from Coen, ne. Qld, was neatly lined with roots of grasses and a few thin vines, and fur and hair not used to line nests in this area (White 1922b). DETAILED COMPOSITION: Though site selection appears to improve with experience (see Site), nests of young birds and adults appear similar in terms of construction (Baldwin 1979). One nest blown from tree at Gilgai, NSW, had three layers: (1) an outer cup, made mainly of blackberry runners (109 runners, 9–119 cm long, 1–5 mm thick) and twigs (49, 9–55, 2–5), most of which from Angophora (30, 19–44, –); (2) an inner cup, within but extending above outer cup, mainly of blackberry runners (30, 14–120, 2–5), Angophora twigs (16, 16–55, 2–5) and thistle stalks (n=17); and (3) lining mostly of herbaceous plant material (60 pieces, 11–32 cm long), bark fibre (10, 12–28) and dry grass (–, 20–57 cm). Most material taken from trees or vines, 50–150 m from nest, and mainly from Blackberry and Angophora despite other trees and shrubs nearby (Baldwin 1979, which see for further details; also see Construction below). One from Claremont, WA, built of 73 pieces of wire (12.7–218.4 cm long, ≤3 mm thick and mostly <2 mm), 24 twigs (24 twigs, 15.2–38.1 cm long) and 134 buffalo grass runners (12.7–188.0 cm long), and with lining of fine rootlets (c. 100 pieces) and a single piece of bark; the grass

was woven into a circular cup and entwined with thin twigs (Stranger 1963, which see for further details). A nest near Brookton, WA, made of 321 pieces of wire (7.6–213.4 cm long, 1.0–4.0 mm wide, total weight 4.14 kg) and two twigs (15.2 cm long, 6.4 mm thick); and lined with dried grass, a short length of frayed rope, a few eucalypt leaves, and two feathers (Stranger 1963, which see for further details). A nest from Caron, WA, built from 286 pieces of wire 7.6–147.3 cm long (mostly 17.8–50.8 cm, with mean length 35.6 cm; total length of wire 103 m), and a single piece of twine that was wrapped round wire (Serventy 1949). A nest from L. Grace, WA, made of 238 pieces of wire (11.4–127 cm long, and total length of 74 m) (Hamilton 1949–50). One in Kings Park had cup composed of stems up to 76 cm long (Wilson 1946). In NZ, one nest comprised three pieces of wire, 12 sticks, 12 small pieces of sacking, several pieces of twine and wool, 18 pieces of binder twine and string (≥60 cm long), bark from eucalypts and 150 pieces of dried sorrel *Rumex* (≥68 cm long) (McCaskill 1945). CONSTRUCTION AND RE-USE OF NESTS: Both male and female may collect nest-material (Baldwin 1979; Kaplan 2004) but only female builds (Carrick 1972; Veltman 1989a; Kaplan 2004). Nests usually incorporate the fork of branch on which it rests in order to anchor it; inexperienced birds may not anchor nests solidly and thus lose nests (Baldwin 1979; Kaplan 2004; G. Kaplan). At Gilgai, NSW, when collecting material, bird scanned branches from ground or limbs before selecting a twig; most twigs were removed by chewing, twisting and tugging but if this failed, birds would swing on twig to remove it. Once removed, twigs examined with bill and some discarded; suitable twigs carried to nest in bill. Twigs were added by grasping large end of twig in bill and placing it among branches round fork, then curving round and anchoring tip and lateral branches; other materials were pushed through foundation of nest to fill gaps, and the flexible laterals woven to form a shallow cup, which also appeared to be reinforced with a few vertical twigs. Materials were woven together so that interior of nest was level and of even thickness, but untidy outside with sticks protruding up to 30 cm; shallow inner cup was similarly constructed, with woven laterals and protruding proximal ends, but used finer twigs and whole inner structure bound together with some *Kunzea*; nest then lined with dry grass, fibrous bark and pieces of herbs (Baldwin 1979). Materials also collected from nearby tip (Favaloro 1930), from near a doorway to house (Mellor 1920) and string taken from bags of chaff (Mellor 1921e); wool sometimes pulled from live or dead sheep (Favaloro 1930; Pringle 1906; Gardner & Gardner 1975). One pair used almost all (not lining) of a fallen nest (of same pair) that had been placed on a table (Lipscombe 2003). One old nest, used in previous season, was cleaned out and relined before being re-used (Greaves 1965). One pair rebuilt nest from previous season; later, after female of this pair was found dead, lining of renovated nest removed by another pair (Souter 1930). One bird thought to have removed twigs from nearby Tawny Frogmouth *Podargus strigoides* nest, but not certainly known to have been used in Magpie's nest (Ashby 1927). Nests sometimes built and abandoned (Wilson 1946). TIME OF CONSTRUCTION: One nest took at least 2 months to build, but after loss of eggs, new nests built in 14–17 days (Favaloro 1930); one tame bird took *c.* 3 weeks to build nest (Campbell). In NZ, after initial failure, pair began building second nest on 4 Oct. and first egg of second clutch laid 13 days later (McCaskill 1945). MEASUREMENTS (cm): In Aust., external diameter 30.8 (7.13; 17.8–45.0; 11); external depth 22.6 (10.36; 12.7–47.5; 11); internal diameter 16.6 (3.11; 12.7–20.3; 9); internal depth 10.0 (2.14; 6.4–13; 9) (White 1922b; Favaloro 1930; Kuss 1934; Wilson 1946; Baldwin 1979; NRS). For unknown number or, most likely, average nests, 29.2–45.7, 16.5–20.3, 12.7–20.3, 6.4–10.2 (Campbell

1894; Campbell; North). Single nest in NZ, external diameter 30.5 and external depth 19.1 cm, internal diameter 17.8 and internal depth 7.6 (McCaskill 1945). WEIGHT: In Aust., one nest weighed 2 kg (Baldwin 1979); and two built largely or wholly from wire weighed 6.24 and 2.27 kg respectively (Hamilton 1949–50; Serventy 1949). In NZ, three nests weighed 225–775 g (McIlroy 1968); and another weighed 510 g (McCaskill 1945). One observer claimed that a bird's first nest was smaller than subsequent nests (McCaskill 1945).

**Eggs** Oval or elongate oval; close-grained, smooth and lustrous (Campbell; North). Vary in colour and size, sometimes even in same nest (Anon. 1914; Tilley 1926; Robinson 1939; McCaskill 1945; Campbell; North), though also said that colours and markings of eggs of individual birds do not vary between seasons (Anon. 1914). AUST.: Ground-colour typically shades of blue or green (such as pale or dull bluish-white, pale blue, faint bluish-grey, greenish blue or bluish green, greyish blue, dull or light greenish-grey or greyish green), less often shades of red or brown (such as reddish grey, reddish buff, greyish red, dull brown, light brown, bluish brown, dingy ashy-brown, greenish brown, olive-green or pale olive-brown), or very occasionally grey (such as pale stone-grey). While some eggs unmarked, often marked with spots, blotches, freckles, short or irregular streaks, hair-lines, scratches, wavy or smudgy markings and smears of dark brown, reddish or chestnut-brown, wood-brown, sepia-brown, umber, umber-brown, greyish brown, blackish brown, black, rich reddish-brown, purplish brown, purplish red, pinkish red, faint greenish or dull slate; markings sparse or irregular and pale on some, and almost obscure ground-colour on others, or occur over entire shell or form indistinct 'clouds'. Some also have underlying markings of dark brown, dull ashy-grey, inky black and burnt umber, smears of faint violet-grey or nearly obsolete spots of a deeper hue (Littler 1903b; Le Souëf 1908; Campbell 1909; Anon. 1914; Tilley 1926; Kuss 1934; Beruldsen 1980; Campbell; North; NRS). Near Sutherlands, SA, unusual clutches of beautifully marked, bright reddish-brown eggs resembling those of falcons *Falco* in colour and markings, noted annually for *c.* 10 years (Boehm 1950b). NZ: Usually bluish green with olive blotches (McCaskill 1945; Heather & Robertson 2000); three clutches (from different nests) from Rokeby, SI: light green with olive streaks and blotches; greenish blue with sparse dark blood-coloured blots and diffused purple tinges; and light greenish-blue with a dozen brown spots (McCaskill 1945). SUBSPECIFIC DIFFERENCES: Said to be no distinguishable difference, in colour, size or shape, between subspecies (Beruldsen 1980). However, also suggested that eggs of *dorsalis* of s. WA and several clutches of *longirostris* of mid-central WA differ, mainly in form of markings: with streaks or smears in *dorsalis*, and spots in *longirostris* (Serventy & Whittell). However, other clutches of *longirostris* from slightly further N at Coongan R. and Derby, WA, have been described as having blotches and smudgy lines (Le Souëf 1908; Campbell 1909). MEASUREMENTS: 38.5 (2.36; 32.3–43.2; 64) × 27.1 (0.9; 24.9–29.5) (Le Souëf 1908; Campbell 1909; Campbell; North); 40.7 (37.0–43.5; 26) × 29.0 (27.0–30.5) (Anon. 1914). In NZ, 40.4 (2.15; 37.5–43.0; 5) × 28.1 (1.58; 26.0–29.6) (Oliver); 39 × 28 mm (Heather & Robertson 2000). WEIGHT: 18.63 g (n=6) (Lill & Fell 1990).

**Clutch-size** In Aust., from one to, rarely, six, usually 3–5 (Anon. 1914; Newell 1927; Watson 1955; Beruldsen 1980; Campbell; Storr 19). Throughout Aust.: 3.3 (0.85; 126): C/1 × 6, C/2 × 12, C/3 × 51, C/4 × 55, C/5 × 2 (NRS); 3.5 (0.66; 46): C/2 × 3, C/3 × 20, C/4 × 22, C/5 × 1 (Wilson 1946). In ACT, 3.5 (1–6; no N) (Carrick 1972); in WA, 3.4 (0.92; 1–6; 157): C/1 × 6, C/2 × 15, C/3 × 64, C/4 × 59, C/5 × 12, C/6 × 1 (Storr 11, 16, 21, 22, 26, 27, 35); from various sources and sites, mostly Vic., 3.6 (n=30) (Lill & Fell 1990). Once, six young in single nest (White 1922a). Round Millicent, se. SA,

where C/4 and C/5 formerly common, of 55 nests in c. 1939–1944: C/2 × 15, C/3 × 38, and C/4 × 2 and suggested that clutch-size was decreasing (Ey 1944). In NZ, from two to five, usually 3–4 (McCaskill 1945; Heather & Robertson 2000). From sample of 54 clutches in NZ NRS: on NI, 3.5 (1.5; 2–5; 31); on SI, 3.5 (1.5; 2–5; 23) (Veltman 1984). In ACT, clutch-size varied little between years, even in dry territories during drought, and was not affected by size or quality of territory (Carrick 1972). One observer claimed that clutch-size smaller in first year of breeding than in subsequent years (McCaskill 1945).

**Laying** Interval between eggs not properly known; probably 24 h. Three eggs laid between 12:00 and 13:00 on successive days (Hall 1909); and three eggs laid over 4 days (Anon. 1914; Campbell); hatching interval (see Young) also indicates that eggs probably laid at intervals of 24 h. However, in NZ, claimed that one clutch of three laid at intervals of 2 days, and another clutch of three laid at intervals of 3 days (McCaskill 1945). While usually single-brooded, very occasionally raise second brood following success (Anon. 1914; McCaskill 1945; Robinson 1956; Carrick 1972; Baldwin 1976; Kaplan 2004; North), though long period of fledgeling care usually precludes raising two successful broods (Carrick 1972). However, in good years in urban areas can produce two or three clutches (Jones 2002); and, on Darling Downs, se. Qld, said to usually rear two broods (in Aug. and Oct.) (Campbell). Often re-nest or re-lay in same nest after failure (Anon. 1914; McGilp 1925; McCaskill 1945; Robinson 1956; Carrick 1972; Hobbs 1972; Baldwin 1979; Heather & Robertson 2000; Campbell; North; see Site); one female laid three clutches (C/4, C/4, C/3) after first two clutches removed (McCaskill 1945). In Greater Brisbane, nine of 50 pairs in suburban territories produced a second clutch: one pair successfully raised two broods in a season, and eight pairs laid replacement clutches; attempted re-nesting after failure if loss occurred early in breeding cycle (five failed during incubation, three with small nestlings). Conversely, no pairs in rural populations re-nested after failure or success during 2 years of study (Rollinson & Jones 2002). One pair, whose nestlings depredated on successive nights, 2–3 Oct., began building second nest on 4 Oct. and first egg of second clutch laid on 17 Oct. (McCaskill 1945). Claimed that two females once laid in same nest (Smith 1920).

**Incubation** By female only (Elliott 1934; Robinson 1945, 1956; Wilson 1946; Carrick 1972; Veltman 1989a; Hughes et al. 1996; Heather & Robertson 2000; Kaplan 2004), contra claims that males sit occasionally (Anon. 1914; Tilley 1926; Kilpatrick 1935), which at least sometimes appear to be describing brooding (see below). Once, known to begin from laying of first egg (Anon. 1914). Incubating bird fed on nest by male (see Social Behaviour: Sexual behaviour). When female leaves nest, male or another member of Territorial Group, including helpers, guards eggs (Kaplan 2004). Round L. Frome, SA, eggs often covered with fur when bird leaves nest, but not known if this deliberate (McGill & Goddard 1979). Claimed that two females, having each laid three eggs

in same nest, then tossed all but two of their eggs out of nest; observer then placed bantam eggs in nest, prompting females to remove their remaining two eggs and to incubate bantam clutch. Twice, observer placed bantam eggs in nest of these females, and twice young bantams were hatched. During incubation, females fed each other on nest, and would often sit on nest together (Smith 1920). INCUBATION PERIOD: No data in Aust. NRS. In Greater Brisbane (data for two season combined), 22.8 days (2.30; 66) with no significant differences between suburban (22.5 days [2.7; 46]) and rural (23 days [1.9; 20]) populations (Rollinson & Jones 2002). Elsewhere in Aust.: 20.7 days (1.51; 19–22; 6 eggs) (Hall 1909; Anon. 1914); 21 days (n=1 record) (Hobbs 1971b); 18–21 days (Robinson 1956); 20 days (Carrick 1972); usually 20 days (Kaplan 2004). In NZ, 21 days (n=1 egg), 22 days (n=1 egg) (McCaskill 1945); 20–21 days (Heather & Robertson 2000). Rollinson & Jones (2002) suggested that as period varied little, and was similar to that recorded by Robinson (1956), it is not influenced significantly by external factors.

**Young** Hatch asynchronously, usually at intervals of ≤24 h (Hall 1909; Anon. 1914; McCaskill 1945; Robinson 1956; Hobbs 1972; contra Kaplan 2004). Altricial (Kaplan 2004), nidicolous (Pellis 1981). Hatch blind and naked (Kaplan 2004); eyes usually open at c. 10 days (Hall 1909; Kaplan 2004), though <7 days in some (NRS). Develop sparse covering of fine downy feathers on head, wings and back in first week. In second week: feathers in pin on wings, tail and along ridge of back; pin- and down-feathers on rump; and head well covered with black feathers (Hall 1909; Kaplan 2004; NRS). A brood of two, in NZ, had feathers on head at 3 and 5 days old, though necks still bare; older nestling had black and white feathers at 9 days; and at 12 and 14 days old, both had black feathering on head and black-and-white feathers on wings, though underparts still bare (McCaskill 1945). **Growth** For measurements and weights of nestlings in inland NSW, see Table 1. **Parental care** BROODING: Usually by female only, though male sometimes broods while female forages (e.g. Hall 1909; Wilson 1946; Robinson 1956). During cold, wet weather, females sit motionless with wings spread to protect nestlings from rain or hail, and in warm weather, females return to nest intermittently, shading nestlings by spreading wings over them; males not known to do so. Males protect nest and nestlings; female will also leave nest to mob avian predators though, when helpers present, they engage in mobbing and female stays on nest (Kaplan 2004). FEEDING: Nestlings can be fed by both parents and sometimes other members of group (see Social Organization: Co-operative breeding, Parental care; see below), though contribution of male parent to feeding nestlings varies greatly. At some nests, nestlings fed mostly (Carrick 1972; Rowley 1975) or solely (Robinson 1945, 1956; Wilson 1946; Carrick 1972; Rowley 1975) by female; at others, fed by both parents (Anon. 1914; Kilpatrick 1935; McCaskill 1945; Robinson 1956; Carrick 1972; Lawrence & Lawrence 1972; Heather & Robertson 2000; Kaplan 2004; see below). In secure territories, monogamous males can contribute much to feeding of nestlings and

**Table 1.** Development of young in inland NSW (Kaplan 2004). Figures are means, except where a range provided (n=36). Bill-width G = width of bill measured at gape. Claw-length = length of claw on middle toe.

| AGE | WEIGHT (g) | BILL (mm) | BILL-WIDTH G (mm) | BODY-LENGTH (mm) | TARSUS (mm) | CLAW-LENGTH (mm) |
|---|---|---|---|---|---|---|
| Week 1 | 50–73 | 22 | 24 | 51 | 43 | 21 |
| Week 2 | 100–208 | 26 | 27 | 76 | 56 | 32 |
| Week 3 | 220–250 | 31–38 | 25 | 89 | 65 | 35 |
| Week 4 | 380 | 52 | 19 | 104 | 67 | 35 |
| 3 months | 340–400 | 50–55 | 17–24 | 104 | 71 | 35–37 |

fledgelings, or they may do little; in bigamous and trigamous systems male feeds only young of first brood (Carrick 1972). Elsewhere, during first 2 weeks of nestling period, male or helpers may provide more food than female, who concentrates on brooding (Kaplan 2004). For further details of feeding, see Food (Young). FAECAL SACS: Removed as soon as they are deposited (Kaplan 2004). Contribution by male varies; removed by both parents at some nests (Anon. 1914; Robinson 1956; Lawrence & Lawrence 1972), by female only at others (Kaplan 2004); not known if ever removed by other members of group. Before eyes open, nestlings do not defecate till they feel vibration of nest on arrival of parent; parent sometimes prompts defecation of older nestlings by tapping anus of nestling with bill (Kaplan 2004). At one nest, female carried faecal sacs away in bill and dropped them at one place in a paddock (McCaskill 1945). Female also rearranges material and vigorously pulls and throws debris from nest each day, moving nestlings to one side of nest to do so (Kaplan 2004). Two infertile eggs were removed by parents when nestlings were 5 days old (Gardner & Gardner 1975). Once, youngest bird of brood fell behind in growth and disappeared from nest (Hall 1909).

**Fledging to independence** FLEDGING PERIOD: Few accurate determinations (e.g. only one precise record in sample of 500 records from Aust. NRS). In AUST.: In Greater Brisbane, in suburban populations, 38.2 days (3; 19) in 2000 and 34.5 days (4; 21) in 2001; in rural populations, 37.3 days (2.5; 6) in 2000, and 37.8 days (4.6; 10) in 2001. Fledging periods of suburban and rural birds significantly different in 2001 but not 2000 (Rollinson & Jones 2002). Other estimates for Aust. include: three determinations of 30, 31 and 33 days (Hobbs 1971b); one apparently fledged at 35 days (NRS); and maximum 32–34 days for two nestlings in one nest (Hall 1909); claims of 4 weeks (Carrick 1972), usually *c.* 4 weeks (Kaplan 2004) or *c.* 3 weeks (Anon. 1914) seem short compared with data above. NZ: Once, 33 or 34 days (McCaskill 1945); also said to be *c.* 28 days (Heather & Robertson 2000) but see Aust. above. **Parental care** All members of a brood tend to fledge together (Kaplan 2004). Fledgelings can be fed by both parents, and often by other members of Territorial Group also (Hughes *et al.* 1996; see Co-operative breeding). However, as with nestlings, role of male varies; in ACT, in secure territories, monogamous males can contribute much or little to feeding fledgelings, while in bigamous and trigamous systems male only provides food for first brood (Carrick 1972). Broods sometimes partitioned between parents (Robinson 1956; Hall 1909; see Social Organization: Parental care). Fledgeling Magpie once fed by Blue-faced Honeyeater (Longmore). May roost in nest in first week after fledging, where brooded overnight by female; may then roost on sides of nest for another 1–2 weeks (Anon. 1914). Alternatively, spend first few days on logs, low shrubs or branches near nest-tree (Mellor 1921b; Robinson 1956; Hobbs 1972). Newly fledged young fly only weakly, capable only of fluttering (Mellor 1921b, 1921d, 1927; Carrick 1972). Flight-skills develop during first 2 weeks after fledging, with distances flown slowly increasing; initial attempts at flight clumsy, with young often crashing through branches or overshooting target perches when landing (Kaplan 2004). Timing of independence varies; once, began to search for own food 20 days after fledging, though some birds do not do so for 2–3 months; young can still beg and receive some food from parents for up to 6 months, though usually forage independently, or largely so, by this age; some continue to beg for food till 8–9 months old, though usually not fed (for details of independence and dispersal of young, see Social Organization). Young almost fully grown at fledging, and attain adult size by end of first year (Carrick 1972).

**Success** AUST.: Throughout range, where number of eggs and outcome known, of 365 eggs, in 121 nests, 173 (47.4%) hatched and 97 (26.6%) young fledged, equal to 0.80 fledged young per nest. Of 596 eggs, in 198 nests, 337 (56.5%) hatched; where outcome known, of 641 nests, 458 fledged at least one young and 183 failed (NRS). In GREATER BRISBANE: Of 86 breeding attempts, 2000–01: at least one egg hatched in 66 (76.7%); young fledged from 58 (67.4%); and young survived till late Feb. in 50 (58.1%). Success varied little between rural and suburban populations: of 27 breeding attempts in rural populations and 59 in suburban populations (data for 2000 and 2001 combined): eggs hatched in 74.1% (20 attempts) and 78.0% (46); young fledged from 66.7% (18) and 67.8% (40); and young survived till late Feb. in 66.7% (18) and 54.2% (32). In rural populations, mean number of young/pair at fledging 1.0 (0.8; 12) in 2000 and 1.3 (1.0; 15) in 2001; and mean number of young/pair surviving till late Feb. 0.7 (0.6; 12) in 2000 and 0.8 (0.8; 15) in 2001. In suburban populations, respective figures were 1.2 (0.8; 25) and 1.6 (1.2; 25); and 0.7 (0.8; 25) and 1.0 (0.7; 25). Reduced success for both populations during 2000 possibly result of drought (Rollinson & Jones 2002). At MOGILL, QLD: In 1992, 14 groups produced mean 1.43±0.27 fledgelings/territory (= 0.75 fledgelings/Magpie in group); and in 1993 15 groups produced 1.67±0.97 fledgelings/territory (= 0.66 fledgelings/Magpie in group) (Hughes *et al.* 1996). In ACT: Mean annual production (number of young that survived to reach independence in Feb.) of Permanent Groups 33 young/year (13–50; 37 groups [total of 45 adult males and 59 adult females]), giving annual productivity of 0.32 young/breeding adult, or 0.56 young/adult female. For Marginal Groups, annual productivity was 0.09 young/adult female. All breeding attempts by Mobile Groups failed, with few eggs hatching and no young surviving. Open Groups never attempted to breed (see Social Organization for details of groups). Maximum number of young fledged from a single territory was four. Fledging success (young per season, and per female) greater on larger or higher-quality territories (i.e. those with more cover, moist places, variety of food); in small territories, two females never reared young to Feb. Breeding success of females related to social and territorial status: as number of females in group increased from one to three, probability of a female breeding decreased from 97% to 64%; when number of females laying increased from one to three, probability of successfully rearing young decreased from 53% to 46%. Of territories with one nest, 62% fledged young; of those with two nests, 87% produced young, but only 37% fledged young from both nests; no more than two broods were reared from five territories with three nests, and two territories with four nests. Maximum number of females that bred in a single territory was four. Of mean 33 young/year that survived to independence in Feb., mean 9 young/year (1–17; no N) survived to Nov. of first year, and mean 5 young/year (1–9) survive to Nov. of second year (Carrick 1972). In ACT, 208 of 1117 territorial females (18.6%) failed to lay (see Social Organization for further details), mainly owing to intraspecific aggression and inadequate resources (see Carrick 1972 for further details). Subordinate females harassed by dominant females sometimes have retarded ovaries and make no attempt to breed (Carrick 1972). At SEYMOUR, VIC.: In 1992, 26 territorial groups produced mean 1.89±0.27 fledgelings/territory (0.25 fledgelings/Magpie in group); in 1993, 36 groups produced 2.89±0.45 fledgelings/territory (0.43 fledgelings/Magpie in group) (Hughes *et al.* 1996). In 1994, 14 young fledged from nine of 12 nests in seven territories (Finn & Hughes 2001). At Seymour, position of nest-tree affected breeding success: nest-trees with understorey produced more fledgelings (4.52±0.51 fledgelings) than those in open sites (2.26±0.48 fledgelings), but proportion of banded fledgelings surviving till Mar. was highest in territories with no cover (92.9%) and lowest in those with much cover (80.5%) (Hughes *et al.* 2002). From 1992 to 2000, mean number of fledgelings recruited into

24–63 Territorial Groups ranged from 0.88 to 3.88 fledgelings/ group, representing annual survival of fledgelings of 65–95% (Hughes *et al.* 2002). At LINTON, VIC.: In 1989 12 groups produced 1.2 fledgelings/territory (0.5 fledgelings/Magpie in group) (Hughes *et al.* 1996). In ALDINGA SCRUB CP, SA: Of 11 nests where outcome known, ten were successful and one failed (Ashton 1987). At LINTON, NZ, 1978–82: 99 juveniles were raised in 77 nesting attempts, = 1.3 juveniles per breeding female; co-operative breeding was not observed, and success did not differ between territories defended by pairs and those defended by groups (Veltman 1989a). At ROKEBY AND BLUECLIFFS, SI, of ten eggs, in three attempts, eight (80%) hatched and three (30%) young fledged (McCaskill 1945). At PAHIA, one small group reared three, five and four young in consecutive seasons (CSN 21). CAUSES OF FAILURE: In ACT, high proportion of eggs and nestlings lost through predation (mainly by Australian Raven) and poor weather (high wind, heavy rain); dominant females also sometimes destroyed eggs of subordinate females. Fledgelings killed by cars, Cats and Foxes. Eggs and nestlings vulnerable to predation, and eggs to addling, when females absent from nest, i.e. when foraging or engaged in boundary disputes; and aggressive females can neglect nest to such an extent that half-incubated embryos die. Losses greatest in Mobile, Marginal and Permanent Groups with small territories, where boundary disputes common; smallest territory from which young successfully reared was 3.2 ha (Carrick 1963, 1972). Elsewhere, nests often abandoned in hot, dry weather when food scarce (Baldwin 1979; Kaplan 2004). Nests also fail as a result of poor site selection, probably largely by inexperienced birds (e.g. Dickison 1930; Baldwin 1979; see Social Organization and Behaviour). Nests can be blown down by strong wind (e.g. Souter 1926; Brandon 1937; NRS) and nestlings sometimes fall, or are blown, from nests (McCaskill 1945); nestlings sometimes die if left unattended during rain (Robinson 1956). Use of twine, nylon thread or fishing line in inner cup of some nests can cause serious injury to young (Kaplan 2004). Many juveniles and immatures killed on roads (see Threats and Human Interactions). Most of 50 Magpies killed during unseasonable (Nov.) snowstorm in South Canterbury, SI, 1967, were young of the year (Bull & Dawson 1969). Eggs sometimes taken by children (Ross 1924). Claim that smallest nestling in broods of three often starves (Hall 1909) not confirmed. PREDATORS: Nestlings taken by Brown Falcons (Littler 1903b; Tilley 1926; Cameron 1986), Red Goshawks (Lord 1952) and Australian Raven (Carrick 1972; Kaplan 2004); nestlings and fledgelings taken by Pied Currawongs (Cooper & Cooper 1981; Bayly & Blumstein 2001); and fledgelings by Cats and Foxes (Carrick 1972). Young taken by Barking Owl *Ninox connivens* (Kaplan 2004); and one young bird found in castings of Swamp Harrier (Douglas 1970). One brood taken by vermin (McCaskill 1945). CUCKOOS: Parasitized by Channel-billed Cuckoo (Brooker & Brooker 1989; Pearson-Smith 1995; Kaplan 2004; HANZAB 4; NSW Bird Rep. 1999); and Common Koel *Eudynamys scolopacea* (Dawson & Dawson 1991).

**PLUMAGES** Prepared by J.S. Matthew. Naked at hatching. Down develops within first week after hatching. Fledge in juvenile plumage. Undergo a partial post-juvenile (first prebasic) moult to first immature (first basic) plumage, starting within *c.* 3 months after fledging. Complete first immature post-breeding (second pre-basic) moult when *c.* 1 year old results in adult plumage in females, and in adult female-like second immature (second basic) plumage in males. Some males probably acquire adult plumage in second immature post-breeding (third pre-basic) moult, when *c.* 2 years old; other males possibly do not acquire adult plumage till fourth pre-basic moult, when *c.* 3 years old. Once adult plumage attained, a complete post-breeding (pre-basic) moult each

cycle produces successive non-breeding (basic) plumages with no change in appearance. Sexes differ. Eight subspecies recognized here (after DAB) with both *tyrannica* and nominate *tibicen* described below; subspecies *tyrannica* described from examination of skins of 22 adult males, 26 adult females, four probable second immature males, seven first immatures and five juveniles (ANWC, HLW, MV); and nominate *tibicen* from examination of skins of seven adult males, six adult females and one juvenile (ANWC, HLW, MV). See Geographical Variation for discussion of hybridization between taxa.

**Adult male** (Definitive basic). SUBSPECIES TYRANNICA (WHITE-BACKED, BLACK-THIGHED): HEAD AND NECK: Mostly glossy black (ne) with faint bluish tinge in good light, appearing duller black (89) in poor light. Hindneck and upper sides of neck, white, sharply demarcated from black rest of head; in some birds, white extends to lower nape. Several fairly short black (89) bristles protrude from lower lores and interramal area. All feathers have concealed grey (84) bases. UPPERPARTS: Mostly white; outer one or more rows of scapulars, black-brown (119) with glossy black (ne) fringes, combining to form fairly broad black stripes down sides of upperbody, sharply demarcated from white rest of upperbody and merging anteriorly with black underparts. All feathers have concealed dark-grey (83) bases. UNDERPARTS: Breast, flanks, axillaries and most of belly, glossy black (ne) with faint bluish (ne) tinge, appearing duller in poor light; feathers, black-brown (119) with glossy black (ne) fringes. Thighs, black-brown (119) or blackish (c89); some birds have narrow off-white (ne) tips to a few feathers. Centre of lower belly, vent and undertail coverts, white. UPPERTAIL: T1, white on basal two-thirds to three-quarters, black (89) on remaining distal portion (black tip 40–65 mm long on inner web). White bases terminate progressively closer to base from t1 to t6: on t6, white usually restricted to basal half of inner web and, in some birds, confined to band or patch at base of inner web, or t6 entirely black (89); some birds also have narrow white outer edge at extreme base of t6. Mean length of black at tip of inner web of t6, 70.9 mm (11.27; 48–95; 22); also given as from 55 mm to entire length of inner web (DAB). With age, black tip to tail said to become narrower, and shafts to rectrices paler; shafts become white in old males (see Ageing). Shafts to rectrices, black-brown (19). UNDERTAIL: Patterned as uppertail but dark areas blackish (c89) and white bases to rectrices only just, or do not, extend beyond tips of undertail-coverts when tail folded (DAB; this study). UPPERWING: All marginal and median secondary coverts, white. Greater secondary coverts, white, with black (89) inner edges near tips of outer 4–5 coverts, concealed when wing folded. Secondary coverts combine to form broad white shoulder-patch. Marginal primary coverts, white with narrow black (89) tips or fringes to most; and median primary coverts, white; these combine to form narrow white strip on leading edge of wing next to alula. Greater primary coverts, black (89) with white basal two-thirds to three-quarters of outer webs of all but outer three (which entirely black). Alula, black (89); in most birds, all except longest feather have white on basal half of, or entire, outer web; a few birds have less white on second longest feather. Remiges, black (89), contrasting sharply with white shoulder-patch; remiges fade to blackish brown (c119) with wear, or dark brown (121) when very worn. UNDERWING: All secondary coverts and marginal primary coverts, white. Median primary coverts, black (89). Greater primary coverts, blackish brown (c119). Remiges, blackish (c89), slightly paler than on upperwing.

NOMINATE TIBICEN (BLACK-BLACKED, BLACK-THIGHED): Except for upperparts, very similar to adult male *tyrannica* from which differs by: UPPERPARTS: Extreme upper mantle, white, combining with white hindneck and upper sides of

neck to form distinct white patch, sharply demarcated from black rest of upperparts. Rest of mantle, back and most scapulars, glossy black (ne) with very faint bluish tinge, appearing duller black (89) in poor light, and forming broad black band across mid-upperbody; a few outermost scapulars, white, usually concealed by black rest of scapulars. Rump and uppertail-coverts, white, combining to form broad white patch, sharply demarcated from black rest of upperparts. TAIL: Black tip significantly shorter (P<0.01) than in *tyrannica*: mean length of black at tip of inner web of t6, 47.8 mm (8.47; 40–61; 7); also given as 40–60 mm (DAB). White at base of rectrices extends slightly to moderately beyond tips of undertail-coverts (DAB; this study).

**Adult female** (Definitive basic). SUBSPECIES TYRANNICA: Very similar to adult male *tyrannica*, from which differ by: HEAD AND NECK: Lower hindneck, greyish white (ne) or white with light-grey (pale 84) tinge (pure white in adult male), grading to whiter on upper hindneck and upper sides of neck; forms broad, diffuse whitish patch on hindneck, contrasting with light-grey upperparts. UPPERPARTS: Mantle, most scapulars, back and rump, light grey (pale 84) with fine white scalloping and fine dark-brown (c121) streaking when fresh; feathers, light grey (pale 84) with narrow white fringe at tips and dark-brown (121) or blackish-brown (119) shafts; fringes reduced or lost, and shafts become paler (light brown [239]) with wear. Uppertail-coverts, white. Outer two or more rows of scapulars, black-brown (119) with glossy black (ne) fringes, as in adult male. Suggested that older females may have whiter back (Rowley 1975). TAIL: Black tip said to be longer than in adult male (DAB) but not statistically significant for this subspecies (this study); mean length of black at tip of inner web of t6, 74.6 (15.31; 54–101; 16). UPPERWING: Some birds have blackish (c89) or blackish-brown (c119) inner edges to median secondary coverts, sharply demarcated on outer coverts, and more diffuse towards inners; on some birds, outer few coverts largely blackish brown (119) with greyish-white (ne) tips. Greater secondary coverts usually more extensively blackish; most birds have broad blackish (c89) tips and inner edges to outer few coverts, blackish markings less extensive towards inner coverts and confined to narrower blackish (c89) inner edges of inner coverts. Shoulder-patch slightly narrower and less pure white than in adult male. Alula entirely black-brown (119), though some birds have white base to outer web of shortest 2–3 feathers; older birds possibly have more white on alula, approaching that of adult male (see Ageing below). Rest of upperwing as adult male but greater primary coverts and remiges slightly paler, blackish (c89) or black-brown (119) (when compared with adult male in similar state of wear).

NOMINATE *TIBICEN*: Very similar to adult male *tibicen*, from which differs by: HEAD AND NECK: Lower hindneck, greyish white (ne), grading to white or off-white (ne) on upper hindneck and upper sides of neck. UPPERPARTS: Extreme upper mantle, light grey (pale 84) with white scalloping when fresh; combines with hindneck and upper sides of neck to form greyish-white (ne) patch, sharply demarcated from black rest of upperparts. Rest of mantle, back and scapulars, black as adult male. Rump, light grey (pale 84) with white scalloping and narrow dark-brown (121) streaking when fresh, forming fairly broad light-greyish band, sharply demarcated from black back and white uppertail-coverts. TAIL: Much as adult male, though black tip longer (DAB); mean length of black tip to inner web of t6, 59.3 (8.81; 52–71; 4). UPPERWING: As adult female *tyrannica*.

**Nestling** Soon after hatching, nestlings had sparse covering of long, tawny down on head and back (Hall 1909). Said that fine down appears on head, wings and back within 1 week of hatching (Kaplan 2004).

**Juvenile** Sexes similar. Feathers of upperparts and underparts softer and more loosely textured than in adult. SUBSPECIES TYRANNICA: Differs from adult female *tyrannica* by: HEAD AND NECK: Forehead, crown, nape, upper sides of neck, eye-ring, lores and feathers extending narrowly below eye, blackish brown (19, 119). Lower sides of neck, lower ear-coverts, malar area and lower throat, dark brown (c119A) with buff (124) tinge, grading to buff (124) with faint dark-brown (c119A) mottling on chin and upper throat. Hindneck and upper sides of neck, off-white (ne) with yellow-brown (123C) tinge and diffuse greyish (c84) mottling; sharply demarcated from blackish-brown top of head. Very narrow and indistinct brown (121C) supercilium formed by narrow line of feathers extending to just above ear-coverts. UPPERPARTS: Mantle, most scapulars, back and rump, light greyish (c85) or light brownish-grey (ne) with fine white streaks on mantle, boldly scalloped or barred blackish brown (c119) and usually faintly mottled or tinged yellow-brown (123C) on back, scapulars and rump; in some birds, scalloping extends over entire mantle; feathers, light greyish (c85) or light brownish-grey (ne) with diffuse blackish-brown (119) subterminal band and narrow yellow-brown (123C) tips to most feathers, and with white shafts to tips of feathers of mantle. Outer two or more rows of scapulars, dark brown (c21). Uppertail-coverts, white with diffuse buff (124) or yellow-brown (123C) tips; in some birds, longest coverts have small greyish-black (c82) subterminal patch. UNDERPARTS: Breast, most of belly, flanks, axillaries and thighs, dark brown (c119A, c21) with buff (124) flecking or mottling, faint on breast, bolder on belly and thighs where producing more barred appearance; feathers, dark brown (c119A) with narrow buff (124) tips. Centre of lower belly, vent and undertail-coverts, off-white (ne) with buff (124) tinge to tip of undertail-coverts. TAIL: Rectrices more acute at tip and tend to be narrower than in adult. Distal part of rectrices slightly paler, black-brown (c119) than in adult; but white bases as adult. All rectrices have narrow light grey-brown (119D) or light-greyish (ne) fringes when fresh. UPPERWING: Marginal and median secondary coverts, white with diffuse buff (124) or yellow-brown (123C) fringe at tips, and narrow dark-brown (121) subterminal band to all, or some, coverts. Marginal and median primary coverts, dark brown (119A) or off-white (ne) with dark-brown (119A) subterminal band, and diffuse yellow-brown (123C) tips to all coverts. Greater secondary coverts: inner 4–5, white with narrow yellow-brown (123C) fringes at tips, and usually with diffuse dark-brown (121) inner edges and, often, subterminal band; outer 6–7, black-brown (119) with concealed or partly exposed white bases and narrow yellow-brown (123C) fringe at tips. Greater primary coverts and alula similar to adult female but usually with narrow buff (124) fringes at tips when fresh (lost with wear). Remiges similar to adult female but with narrow light-brown (239) or light grey-brown (119D) fringes when fresh, usually more prominent on tertials and secondaries; some birds have richer cinnamon-brown (39) fringes at tips of tertials; fringes lost with wear. UNDERWING: All marginal coverts, off-white (ne) with diffuse yellow-brown (123C) tips, and, on most coverts, diffuse dark-brown (119A) subterminal band. Median and greater secondary coverts, dark brownish (ne). Median and greater primary coverts, dark brown (119A) with narrow yellow-brown (123C) tips. Remiges, as upperwing but ground-colour paler, dark brownish (ne).

NOMINATE *TIBICEN*: Similar to juvenile *tyrannica*, from which differs by: HEAD AND NECK, UPPERPARTS: Lower hindneck, mantle, scapulars and back, blackish brown (c119) with diffuse and narrow brown (119B) or light greyish-brown (ne) tips to feathers, forming pale scalloping or flecking; area contrasts with upper hindneck and upper sides of neck, which off-white (ne) with yellow-brown (123C) tinge and greyish (c84) mottling. Rump and uppertail-coverts, off-white (ne) with faint pale-buff (123D) suffusion at tips of feathers.

**First immature** (First basic). Sexes similar. Vary individually in appearance. Some birds superficially similar to adult females of respective subspecies, but paler and less glossy on head and underparts; other birds more closely resemble juveniles. Texture of feathers as adult (cf. soft and loosely textured in juvenile). SUBSPECIES *TYRANNICA*: Differences from adult female: HEAD AND NECK: Rather similar to juvenile. Forehead, crown, nape, lores, eye-ring, ear-coverts, malar area, lower sides of neck and sides of throat, blackish brown (c119), slightly glossy on top of head, with indistinct fine light-brown (223D) or buffy (c124) flecking or streaking on lores, ear-coverts, malar area and sides of throat. Some birds have narrow buffy (c124) fore-supercilium. Chin and centre of throat, dull buff (c124) with fine blackish-brown (c119) mottling formed by subterminal patches to feathers. Hindneck and upper sides of neck as adult female in some birds, others similar to juvenile. UPPERPARTS: As adult female in some birds, others rather similar to juvenile. UNDERPARTS: Breast, flanks, most of belly and thighs, dark brown (121) or blackish brown (c19), or patchy mixture of both, with light brownish-grey (c80), buff (c124) or off-white (ne) scalloping formed by fringes at tips of feathers, boldest on breast and belly, much finer and less distinct on flanks; scalloping reduced or lost with wear; feathers of thighs have diffuse light-brown (239) tips. Centre of lower belly, vent and undertail-coverts, white as adult. TAIL: Retain all, or most, juvenile rectrices; some birds replace one or more rectrices in post-juvenile moult; those replaced are adult-like and contrast with more worn retained juvenile rectrices, which have dark-brown (not black) tips. UPPERWING: Similar to adult female; retain all, or most, juvenile remiges, greater primary coverts and alula; some replace one or more tertials in post-juvenile moult. Replaced feathers adult-like and contrastingly blacker than retained juvenile feathers. Some birds retain one or more juvenile outer greater secondary coverts, which show obvious moult-contrast with replaced adult-like coverts, but this difficult, or not possible, to see in field.

NOMINATE *TIBICEN*: No information; probably similar to first immature *terraereginae* (see Geographical Variation).

**Second immature male** (Second basic). Three skins of *tyrannica* (ANWC, MV) reliably sexed as males (gonads described) have plumage as adult female with upperparts (except outer rows of scapulars) and lower hindneck washed light greyish (c84) (cf. pure white in adult male); these birds have no retained juvenile feathering and are probably in second or later immature plumage. Skin (QVM) from King I., presumed to be *tyrannica*, reliably sexed as male (testes described) and has plumage identical to adult female with no retained juvenile feathering; this bird most likely to be second or later immature male.

**Third immature male** (Third basic). No information. For evidence of such plumage see descriptions of subspecies *dorsalis* (in Geographical Variation below).

**Aberrant plumage** Several skins (MV) entirely white; some of these had iris described as pinkish or white, and as such must be considered albino.

**BARE PARTS** Based on photos (Watts 1999; Collier *et al.* 2000; Kaplan 2004; unpubl.: M.J. Carter; R. Drummond;

J.S. Matthew; and standard sources), information from museum labels (ANWC, MV, QVM) and other sources as cited. All subspecies similar and combined below. **Adult** Sexes alike. Bill, pale bluish (c168D) or bluish white (ne) with black (89) distal third; in Vic., described as white tipped black (Rogers *et al.* 1990); also described as blue-grey or greyish white with black tip (Hall). Gape, black (89). Palate described as black, grey or flesh-coloured (Hall). Iris usually red-brown (132B, c32); also described as tan (Rogers *et al.* 1990), bright orange-brown (Mees 1961) or red (Hall). Orbital ring, black (89). Legs and feet, black (89), grey-black (82) or dark grey (c83). **Nestlings** Bill, light greyish (c85) with cream-white (ne) tomia and gape; gape swollen. Iris, blackish (c89). Orbital ring, dark greyish (c83). Naked at hatching; bare skin, pink at hatching (Kaplan 2004); becoming black within 1–2 weeks (Hall 1909). **Juvenile** Differences from adult: Bill, dark grey (c83) with pinkish (c3) tomia; also described as blackish (Rogers *et al.* 1990). Said that bill loses pinkish tinge during post-juvenile moult (Robinson 1956); and birds partway through post-juvenile moult develop greyish-white (ne) patches at base of bill (Rogers *et al.* 1990). Gape, pinkish (c3); or pinkish grey (Rogers *et al.* 1990). Palate, peach-red (c94). Iris, dark brown (121) or brown (121C); also described as mid-umber (ANWC). Legs and feet, as adult or slightly paler grey (c84). **First immature** Differences from adult: Bill blackish (c89) or dark greyish (c83) at first; similar to adult by *c.* 1 year old. Robinson (1956) states that some birds have bill similar to adult by time of second pre-basic moult (when *c.* 1 year old), and all birds have adult bill-colour by time of third pre-basic moult, when *c.* 2 years old, the black tip becoming narrower with age. Iris, rich brown (121C); Wilson (1946) states that iris dark brown till *c.* 2 years old. **Second and subsequent immatures** As adult, but see First Immature above for changes in colour of bill. Colour of iris said to intensify with age (Robinson 1956).

**MOULTS** Based on examination of skins: ten adult nominate; 44 adult, three first immature and six juvenile *terraereginae*; 47 adult, six first immature and four juvenile *tyrannica*; 25 adult, four first immature and three probable second immature *hypoleuca*; 13 adult *telonocua*; 23 adult and six first immature *dorsalis*; nine adult *longirostris*; and 13 adult and three first immature *eylandtensis* (AM, ANWC, HLW, MV, QVM, SAM); and other information as cited. **Adult post-breeding** (Third, or later in some birds, and subsequent pre-basic). Complete. Primaries outward, starting at p1. Usually two or three primaries grow at once, but occasionally up to five. Available data suggest timing of moult of primaries similar across range, and probably affected by seasonal conditions (see below). Table 2 summarizes moult of primaries in adults (subspecies combined). In Vic., one halfway through conventional moult of primaries in Nov. 1982 (during drought); conventional moult of primaries from Dec. to Mar. in non-drought years; and four birds with all primaries new and one with all primaries old in Feb. 1987 (non-drought year) (Rogers *et al.* 1990). Insufficient data for comparison of timing of moult from n. and s. Aust., but one from Borroloola, n. NT, had PMS 25 in mid-Feb. (cf. PMS 35–43 from four birds in Vic. and Tas.). Moult (tracts not given) recorded sw. WA in Feb.; and

**Table 2.** Summary of moult of primaries in adults, subspecies combined (from skins). Mean PMS calculated using only those with active moult.

| | JULY | AUG. | SEPT. | OCT. | NOV. | DEC. | JAN. | FEB. | MAR. | APR. | MAY | JUNE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number examined | 15 | 17 | 19 | 25 | 21 | 9 | 5 | 5 | 5 | 16 | 18 | 12 |
| Number with PMS of 50 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 10 | 16 | 9 |
| Number with active moult | 2 | 0 | 1 | 9 | 11 | 6 | 5 | 5 | 4 | 4 | 0 | 0 |
| Mean PMS | 22.0 | – | 3 | 16.1 | 18.5 | 20.8 | 28.6 | 37.2 | 46.8 | 48.0 | – | – |

one from Kimberley Div., WA, in fairly fresh plumage in July (Hall). Combined results indicate some variation in timing of moult of primaries, but generally starts about Oct. and finishes about Mar. or early Apr., though sometimes not finished till July. Moult of secondaries starts when moult of primaries about halfway through. Moult of tail centrifugal, starting at t1. Starts during early stage of moult of primaries, e.g. two birds, one in Oct. with PMS 13 and one in Nov. with PMS 19, with t1 just emerging from sheaths, and rest of rectrices worn; and three with PMS 3, 4 and 8 not yet started moult of tail. Moult of body probably starts before start of moult of primaries, and not finished till after finish of moult of primaries. **Post-juvenile** (First pre-basic). Partial. Occurs within *c.* 3 months of fledging (Robinson 1956; Rowley 2002). Involves all or most feathers of body, all or most marginal and median coverts, and, usually, a few inner greater secondary coverts; some birds replace one or more rectrices or tertials, or both. Rogers *et al.* (1990) recorded one bird from Vic. undergoing unconventional moult of primaries in Oct., but no further details given. Active post-juvenile moult recorded from five skins collected Oct.–Apr. **First immature post-breeding** (Second pre-basic). Complete. Active moult of primaries recorded from: one bird from se. SA, had PMS 13 in early Sept.; one from Groote Eylandt, NT, had PMS 18 in Jan.; one from n. NT had PMS 30 in Feb.; one from Qld had PMS 45 in Apr.; and one from sw. WA had PMS 44 in July. Rogers *et al.* (1990) recorded one bird in Vic. halfway through conventional moult of primaries in Feb. Rowley (2002) states that in *dorsalis* this moult occurs Jan.–Feb. and results in highly varying plumage, with sexes difficult to separate. This limited data suggests that timing of moult of primaries much as in adult post-breeding. Some, possibly all, birds attain adult female-like plumage in this moult. Mees (1982) collected an immature (possibly first immature) from s. PNG in Aug. with no active moult. **Second immature post-breeding** (Third pre-basic). Poorly known. One probable second immature male from se. SA (skin with adult female-like plumage; gonads described) in early stage of moult of primaries (PMS 8) in early Sept. Some, possibly most, birds acquire adult plumage in this moult, but more data needed. Rowley (2002) indicates that in *dorsalis* this moult occurs when *c.* 2 years old and some third immature males have greyish tinge or blackish mottling to mantle and back; these birds probably do not acquire adult plumage till fourth pre-basic moult. Robinson (1956) notes that some male *dorsalis* acquire fully white back in this moult, but others resemble adult females or have a few black-tipped feathers on back (see Geographical Variation for descriptions of *dorsalis*). **Third immature post-breeding** (Fourth pre-basic). Little information. Robinson (1956) states that most *dorsalis* acquire adult plumage in this moult, when *c.* 3.5 years old, but some males have a few black streaks on otherwise white back, and do not acquire adult plumage till a later moult (probably fifth pre-basic).

**MEASUREMENTS**  (All skins from WAM measured by I.J. Mason and R. Schodde.) NOMINATE TIBICEN: (1) NSW (E of Great Divide), adults and second immatures, skins (ANWC, HLW, MV). (2) ACT, adults, skins, including some hybrids (Black 1986).

|  |  | MALES | FEMALES |  |
|---|---|---|---|---|
| WING | (1) | 270.7 (16.74; 249–295; 7) | 259.7 (7.47; 250–271; 6) | ns |
|  | (2) | 269 (252–282; 34) | 263 (250–282; 24) |  |
| TAIL | (1) | 142.1 (10.70; 124–153; 7) | 144.1 (6.42; 135–152; 6) | ns |
|  | (2) | 153 (144–168; 34) | 149 (138–163; 24) |  |
| BILL S | (1) | 54.8 (2.25; 51.0–56.7; 7) | 51.4 (2.49; 48.2–53.5; 6) | * |
|  | (2) | 53 (47–57; 34) | 49 (43–57; 24) |  |
| TARSUS | (1) | 57.0 (3.05; 52.5–61.7; 7) | 57.9 (3.90; 52.0–62.4; 6) | ns |

SUBSPECIES TERRAEREGINAE: (3–5) Qld, NSW W of Great Divide, nw. Vic. and ne. SA, skins (ANWC, HLW,

MV): (3) Adults and second immatures; (4) First immatures; (5) Juveniles. (6) Qld, adults, skins (Black 1986).

|  |  | MALES | FEMALES |  |
|---|---|---|---|---|
| WING | (3) | 250.0 (10.07; 232–277; 29) | 241.5 (6.97; 221–255; 27) | ** |
|  | (4) | 242.8 (14.84; 229–258; 4) | 216, 220 |  |
|  | (5) | 231.3 (2.12; 216–245; 4) | 222, 231 |  |
|  | (6) | 249 (228–262; 17) | 245 (230–264; 14) |  |
| TAIL | (3) | 135.0 (9.35; 111–148; 29) | 131.5 (6.34; 116–145; 27) | ns |
|  | (4) | 132.3 (11.32; 122–146; 4) | 122, 134, 138 |  |
|  | (5) | 128.6 (3.68; 125–134; 4) | 126, 132 |  |
|  | (6) | 135 (128–141; 17) | 136 (125–155; 14) |  |
| BILL S | (3) | 55.2 (3.14; 49.4–61.5; 29) | 51.6 (2.41; 43.9–55.9; 27) | ** |
|  | (4) | 54.6 (3.15; 51.0–57.3; 4) | 45.1, 50.8, 53.2 |  |
|  | (5) | 51.7 (1.97; 49.2–54.0; 4) | 45.6, 51.1 |  |
|  | (6) | 52 (49–54; 17) | 48 (42–53; 14) |  |
| TARSUS | (3) | 52.2 (2.69; 46.5–58.6; 29) | 52.3 (3.11; 46.1–57.7; 27) | ns |
|  | (4) | 50.2 (2.59; 47.8–53.8; 4) | 48.6, 48.8, 49.8 |  |
|  | (5) | 49.7 (3.93; 46.1–54.1; 4) | 46.3, 52.2 |  |

SUBSPECIES *TIBICEN* AND *TERRAEREGINAE* COMBINED: (7) NSW and Vic., adults, skins (including some from samples 1–3 above) (Burton & Martin 1976).

|  |  | MALES | FEMALES |
|---|---|---|---|
| WING | (7) | 265.4 (233–292; 62) | 256.0 (233–272; 41) |
| TAIL | (7) | 143.5 (124–159; 62) | 140.6 (129–157; 41) |
| BILL F | (7) | 52.0 (43.8–58.7; 62) | 47.6 (43.9–53.2; 41) |
| TARSUS | (7) | 57.1 (51.0–63.5; 62) | 56.1 (51.3–60.3; 41) |

SUBSPECIES TYRANNICA: (8–9) S. Vic. and se. SA, skins (ANWC, HLW, MV): (8) Adults and second immatures; (9) First immatures. (10) NSW and Vic., adults, skins, including some from sample (8) (Burton & Martin 1976).

|  |  | MALES | FEMALES |  |
|---|---|---|---|---|
| WING | (8) | 277.1 (8.92; 251–290; 27) | 265.9 (9.27; 250–282; 28) | ** |
|  | (9) | 256.5 (4.80; 250–261; 4) | 246, 260 |  |
|  | (10) | 275.8 (252–300; 50) | 262.1 (233–282; 43) |  |
| TAIL | (8) | 144.8 (5.91; 136–157; 27) | 143.3 (8.26; 124–161; 28) | ns |
|  | (9) | 135, 144, 156 | 129, 141 |  |
|  | (10) | 148.1 (137–164; 50) | 145.4 (135–164; 43) |  |
| BILL S | (8) | 56.4 (2.52; 50.7–60.8; 26) | 52.9 (2.35; 48.9–58.9; 28) | ** |
|  | (9) | 56.0 (1.07; 54.5–56.9; 4) | 43.9, 54.9 |  |
| BILL F | (10) | 53.7 (44.8–59.3; 50) | 49.6 (43.9–61.2; 43) |  |
| TARSUS | (8) | 57.4 (2.29; 54.2–63.6; 27) | 57.5 (2.81; 51.4–63.6; 28) | ns |
|  | (9) | 57.6 (4.06; 51.6–60.6; 4) | 56.1, 60.2 |  |
|  | (10) | 59.3 (53.4–66.3; 50) | 57.2 (50.0–63.2; 43) |  |

Vic. (probably subspecies *terraereginae*, *tyrannica* and hybrids between these), unsexed, ages combined, live: Wing 259.7 (9.95; 244–279; 27); Tail 137.7 (6.47; 128–152; 18); THL 86.1 (2.89; 80.3–92.5; 28) (Rogers *et al.* 1990).

**HYBRIDS (INTERMEDIATES) BETWEEN TYRANNICA AND TERRAEREGINAE:** (11) Central and n. Vic., and se. NSW, adults, skins (Burton & Martin 1976). Populations from se. NSW probably intergradient between *tyrannica*, *terraereginae* and nominate *tibicen* (DAB; see Geographical Variation).

|  |  | MALES | FEMALES |
|---|---|---|---|
| WING | (11) | 272.1 (253–286; 30) | 261.7 (243–286; 17) |
| TAIL | (11) | 151.3 (130–163; 30) | 148.2 (130–162; 17) |
| BILL F | (11) | 51.2 (48.2–55.0; 30) | 46.4 (42.3–49.4; 17) |
| TARSUS | (11) | 58.6 (53.3–64.4; 30) | 56.5 (51.3–62.3; 17) |

SUBSPECIES HYPOLEUCA: (12–13) Tas., including Flinders I., skins (ANWC, HLW, MV, QVM): (12) Adults; (13) First immatures.

|  |  | MALES | FEMALES |  |
|---|---|---|---|---|
| WING | (12) | 251.2 (6.81; 239–259; 13) | 238.7 (7.12; 224–252; 16) | ** |
|  | (13) | 223, 234 | 230.0 (2.94; 226–233; 4) |  |

| | | MALES | FEMALES | |
|---|---|---|---|---|
| TAIL | (12) | 138.0 (6.55; 125–149; 14) | 133.5 (8.45; 121–154; 16) | ns |
| | (13) | 118, 130 | 130.3 (9.98; 123–145; 4) | |
| BILL S | (12) | 49.1 (1.75; 45.7–52.2; 14) | 46.8 (2.61; 42.2–50.7; 16) | ** |
| | (13) | 44.2, 46.6 | 43.8 (3.09; 40.4–47.6; 4) | |
| TARSUS | (12) | 53.0 (2.84; 46.7–56.8; 14) | 51.6 (2.90; 47.3–56.2; 16) | ns |
| | (13) | 47.0, 50.1 | 53.1 (2.88; 49.0–55.2; 4) | |

SUBSPECIES TELONOCUA: (14) Eyre and Yorke Pens (except far N), SA, adults, skins (ANWC, MV).

| | | MALES | FEMALES | |
|---|---|---|---|---|
| WING | (14) | 253.8 (4.62; 246–261; 8) | 249.2 (5.27; 240–255; 6) | ns |
| TAIL | (14) | 135.9 (4.97; 130–146; 8) | 139.3 (7.47; 130–148; 6) | ns |
| BILL S | (14) | 56.5 (3.00; 51.7–61.6; 8) | 52.1 (2.62; 48.8–55.5; 6) | * |
| TARSUS | (14) | 54.3 (2.33; 50.0–56.7; 8) | 55.0 (2.95; 50.6–59.7; 6) | ns |

INTERGRADES BETWEEN TELONOCUA AND TYRANNICA: (15) Mt Lofty Ras, Adelaide Plains, SA, adult males, skins (SAM).

| | | MALES |
|---|---|---|
| WING | (15) | 266.6 (7.41; 255–279; 16) |
| TAIL | (15) | 140.9 (6.78; 130–156; 16) |
| BILL S | (15) | 58.1 (3.13; 53.2–65.1; 16) |
| TARSUS | (15) | 57.6 (2.26; 54.1–62.1; 16) |

SUBSPECIES DORSALIS: (16–17) SW. WA, N to c. 30°S, skins (AM, ANWC, HLW, MV, SAM, WAM): (16) Adults; (17) First immatures. (18) SW. WA, adults, skins (Black 1986).

| | | MALES | FEMALES | |
|---|---|---|---|---|
| WING | (16) | 259.6 (10.18; 231–275; 19) | 251.7 (7.42; 239–266; 19) | ** |
| | (17) | 245.3 (2.22; 243–248; 4) | 226, 235, 248 | |
| | (18) | 260 (251–275; 23) | 251 (234–265; 15) | |
| TAIL | (16) | 136.5 (6.09; 128–147; 11) | 135.2 (6.82; 122–152; 13) | ns |
| | (17) | 133.6 (3.90; 131–139; 4) | 125, 127, 132 | |
| | (18) | 135 (126–146; 23) | 135 (131–143; 15) | |
| BILL S | (16) | 59.9 (2.14; 56.2–64.7; 19) | 54.9 (3.90; 48.5–63.4; 19) | ** |
| | (17) | 59.5 (2.02; 57.0–61.9; 4) | 53.2, 53.3, 56.5 | |
| | (18) | 58 (54–62; 23) | 55 (50–63; 15) | |
| TARSUS | (16) | 56.2 (1.99; 51.7–59.3; 10) | 54.5 (3.84; 45.4–60.1; 14) | ns |
| | (17) | 57.6 (2.90; 53.7–60.6; 4) | 50.6, 52.7, 54.4 | |

SUBSPECIES LONGIROSTRIS: (19) Pilbara Region, WA, adults, skins (ANWC, HLW, WAM).

| | | MALES | FEMALES | |
|---|---|---|---|---|
| WING | (19) | 244.6 (11.59; 225–255; 6) | 240.7 (40.76; 234–247; 5) | ns |
| TAIL | (19) | 124, 126, 137 | 131, 139, 139 | |
| BILL S | (19) | 64.4 (4.39; 59.5–70.9; 6) | 57.0 (1.34; 55.0–58.0; 4) | * |
| TARSUS | (19) | 54.3, 54.7, 54.7 | 49.3, 50.8, 50.8 | |

SUBSPECIES EYLANDTENSIS: (20) N. NT, S to c. 20°S, adults, skins (ANWC, HLW, MV, WAM). (21) N. WA and NT, adults, skins (Black 1986).

| | | MALES | FEMALES | |
|---|---|---|---|---|
| WING | (20) | 246.7 (8.79; 234–257; 9) | 240.3 (5.81; 234–247; 5) | ns |
| | (21) | 249 (235–258; 9) | 238 (232–245; 11) | |
| TAIL | (20) | 136.1 (5.05; 128–143; 8) | 126, 132, 140 | |
| | (21) | 135 (130–144; 9) | 130 (123–137; 11) | |
| BILL S | (20) | 60.9 (3.29; 56.0–64.8; 9) | 53.9 (2.57; 50.5–56.2; 4) | ** |
| | (21) | 61 (57–63; 9) | 54 (48–58; 11) | |
| TARSUS | (20) | 51.6 (1.82; 49.9–54.8; 8) | 47.1, 50.0, 52.4 | |

SUBSPECIES PAPUANA, s. New Guinea, skins: Wing: males 230–255, female 228; Tail, males 121–130, females 121–134; Bill F, males 63–68, females 61–62 (Black & Ford 1982). For a few other measures, see Black (1986) and Mees (1982).

**WEIGHTS** All from museum labels (ANWC, MV, QVM). (1) NOMINATE TIBICEN, NSW E of Great Divide, adults. (2) SUBSPECIES TERRAEREGINAE, Qld, NSW W of Great Divide, nw. Vic. and ne. SA, adults. (3–4) SUBSPECIES TYRANNICA, S. Vic. and far-se. SA: (3) Adults; (4) Juveniles. (5) SUBSPECIES HYPOLEUCA, Tas., including Flinders I., adults. (6) SUBSPECIES TELONOCUA, Eyre and Yorke Pens (except far N), SA, adults. (7) SUBSPECIES DORSALIS, sw. WA N to c. 30°S, adults. (8) SUBSPECIES LONGIROSTRIS, Pilbara Region, WA, adults (includes data from Mees 1961). (9) SUBSPECIES EYLANDTENSIS, n. NT S to c. 20°S, adults.

| | MALES | FEMALES | |
|---|---|---|---|
| (1) | 284, 305 | 305, 335, 350 | |
| (2) | 260.4 (29.18; 212–325; 21) | 250.7 (20.97; 219–300; 21) | ns |
| (3) | 345.2 (50.97; 250–410; 13) | 327.1 (40.24; 237–372; 18) | ns |
| (4) | 210, 235, 341 | – | |
| (5) | 260.6 (12.59; 236–273; 8) | 244.8 (20.97; 190–279; 10) | ns |
| (6) | 284.1 (26.93; 242–315; 8) | 275.7 (23.99; 244–295; 6) | ns |
| (7) | 327.5 (33.04; 290–360; 4) | 309.2 (28.96; 265–350; 6) | ns |
| (8) | 260, 274, 317 | 230, 259 | |
| (9) | 223 (7.50; 215–230; 4) | 212, 215 | |

Weight of immature male *papuana*, from Koerik, s. New Guinea, 328 (Mees 1982). Weight of live birds, ages combined, from Vic. (probably subspecies *terraereginae, tyrannica* and their hybrids): 305.8 (31.64; 238–385; 24) (Rogers *et al.* 1990). In ACT, mean monthly weights of adults and first immatures greatest in Apr.–May, decreases in winter, then shows slight increase in Sept.–Oct. before summer minimum; first-year birds (probably juveniles and first immatures) weigh less than adults; and birds from Non-territorial Flocks, particularly females in breeding season (Aug.–Nov.), weigh less on average than birds from Territorial Groups (Carrick 1972).

**STRUCTURE** Wing long, broad and rather pointed at tip; tip of longest primary falls to about three-quarters length of tail when wing folded. Ten primaries: p7 usually longest, p8 sometimes equal longest or occasionally longest; p10 89–107 mm shorter, p9 24–36, p8 0–5, though sometimes 1–4 mm longer than p7; p6 2–15, p5 19–47, p4 43–70, p3 61–85, p2 68–99, p1 78–113. Slight emargination to outer webs of p6–p8 and inner webs of p6–p10. Eleven secondaries, including three tertials; tips of longest tertials fall short of secondaries on folded wing. Tail moderately long; rather square at tip when folded; 12 rectrices; longest is one of t1–t4, t5 c. 5 mm shorter than longest, t6 c. 7 mm. Rectrices of juvenile more acute at tip and slightly narrower than in adult. Bill long and rather robust; upper mandible decurved at extreme tip and overhangs tip of lower mandible to form small hook; slight notch near tip of tomia. Nares amphirhinal. Tarsus fairly long, compressed laterally; scaling laminiplantar but scutes on acrotarsium rather weakly defined. Tibia fully feathered. Feet rather powerful. Middle toe with claw, 44.1 mm (3.35; 39.7–48.1; 6); outer toe 79–86% of middle, inner 71–84%, hindtoe 77–85%. Hindclaw, c. 15 mm long.

**AGEING** JUVENILES and FIRST IMMATURES distinguished from later immatures and adults by plumage and bare parts (q.v.). SECOND AND SUBSEQUENT IMMATURES: Second and later immature females probably not separable from adult females by plumage. Second and possibly third immature males very similar to, or not distinguishable from, adult females. Some birds apparently do not acquire adult-like bill and iris colour till c. 2 years old (when in second immature plumage); birds with adult female-like plumage but with brown iris and non-adult bill-colour are therefore probably second immatures. Little known about individual variation in plumage of third and subsequent immature males in subspecies other than *dorsalis* (see below). More detailed examination of bill-colour, upperparts, rectrices, alula and upperwing-coverts

needed, from birds of various ages and across range in Aust., to elucidate ageing in this species. SUBSPECIES *DORSALIS*: Photos in Rowley (2002) show individual and age-related variation in plumage of colour-banded male *dorsalis*, e.g. a second immature in Mar. 1999, *c*. 1.5 years old, closely resembles adult female, having blackish mottling and white scalloping to mantle and back contrasting with white hindneck; same male, photographed in May 2000, when just over 2.5 years old (in third immature plumage after finish of third pre-basic moult), had back and mantle mostly white but with scattered blackish-brown mottling; same bird was in adult plumage, with pure-white back, by June 2001 when nearly 4 years old (Rowley 2002). Shafts of rectrices said to become whiter, and black tip to tail narrower, with age (Campbell 1929; Robinson 1956; Black & Ford 1982; DAB). Milligan (1903) found that oldest adult males examined (age not specified) had white shafts to rectrices except at tip (along terminal black band) where shafts became black; in younger adult males shafts to rectrices varyingly black and white along white areas of feather-venation; and females and immature males have wholly black shafts. Campbell (1929) indicates that old males differ from younger adult males by: entirely white greater secondary upperwing-coverts; more extensive white on feathers of alula; narrower black tip to tail; and white shafts to rectrices except at tip. Robinson (1956) found a correlation between extent of skull ossification and colour of shafts of rectrices: old birds with heavily ossified skull have white shafts to rectrices, and younger birds with less ossified skull have shafts more extensively black. Rowley (2002) indicates bill in *dorsalis* has fully mature coloration by *c*. 2 years old. Robinson (1956) suggests age when bill-colour fully mature varies individually, but all birds have adult bill-colour by finish of third pre-basic moult when *c*. 2.5 years old; also suggests black tip to bill becomes narrower with age.

**SEXING**   Adults differ in plumage; at least some second and later immature males difficult, or impossible, to distinguish from adult females by plumage; male and female juvenile and first immatures indistinguishable (see Plumages, Ageing and Geographical Variation). ADULTS: In most subspecies, adult males have longer mean Wing (P<0.01) than adult females, and in all subspecies adult males have longer mean Bill S (P<0.05), but measurements overlap to some extent (see Measurements). Females said to have broader black tip to tail than adult males (DAB); this holds for subspecies *terraereginae* (P<0.01) but not statistically significant for subspecies *tyrannica* (this study); see Geographical Variation. SECOND AND SUBSEQUENT IMMATURES: Second and subsequent immature plumages in subspecies other than *dorsalis* poorly known; more data needed to determine if these ages can be readily sexed by plumage or measurements. In SUBSPECIES *DORSALIS*: Second immatures difficult to sex: some males have all grey bill and mostly black back, which lacks or has only very narrow white tips to feathers. Sexes can usually be distinguished once third immature plumage acquired when *c*. 2.5 years old: most males have largely white back, sometimes with a few black-tipped feathers; some adult females have very broad white tips to feathers of back and these closely resemble third immature males; by finish of fourth pre-basic moult, when *c*. 3.5 years old, most males are in adult plumage and readily distinguished from females, but a few males have some black streaks on otherwise white back (Robinson 1956).

Examination of skins (this study) suggests extent of white on feathers of alula may be useful for sexing. In all subspecies except *eylandtensis*, and possibly *longirostris*, adult females (n=32) have entirely black feathers of alula, or at most have small area of white at, or near, base of outer webs of shortest 2–3 feathers; all adult males and some second immature males (n=36) have broad white outer edges or extensively white outer webs to all except longest feather. In *eylandtensis* (see Geographical Variation), adult males (n=9) have entirely white or mostly white outer webs to all except longest feather of alula; adult females (n=6) have white basal half to second longest feather and extensively white outer web to shortest two feathers (not unlike adult males of other subspecies). Some adult female *longirostris* (3 of 4 skins examined) have alula markings similar to adult female *eylandtensis*. For all age-classes other than juveniles and first immatures, absence of white or white confined to base of feathers of alula indicates female or immature male; birds with largely or wholly white outer web to second longest feather are adult or second and subsequent immature males. More data required to assess importance of alula markings as sexing criterion. Observations of Campbell (1929) largely support these findings on alula markings.

**GEOGRAPHICAL VARIATION**   Very complex, and views concerning species and subspecies vary considerably. Amadon (1951) recognized two species: Black-backed G. *tibicen* and White-backed G. *hypoleuca* Magpies, but suggested that these may be conspecific, with intergradation between taxa. Other authors (Serventy 1953; Burton & Martin 1976) recognized three species: Black-backed, White-backed and Western (or Varied) G. *dorsalis* Magpies. Carrick (1963) recognized two species, Black-backed Magpie G. *tibicen* (including White-backed and Black-backed) and Western Magpie G. *dorsalis*. Ford (1969) recognized only one species—Australian Magpie G. *tibicen*—which now generally accepted (Sibley & Monroe 1990; Christidis & Boles 1994; Peters; DAB) and followed here.

Subspecific limits more controversial. Most recent comprehensive study (DAB), and which followed here, recognizes eight subspecies in Aust., with broad (but poorly understood) zones of intergradation between most forms on mainland Aust. where they abut: nominate *tibicen* from se. Qld and e. NSW E of Great Divide; *terraereginae* over much of e. Aust., from s. Cape York Pen., Qld, S through rest of Qld and NSW W of Great Divide, nw. Vic. and e. SA (excluding SE); *tyrannica* (recently described) from extreme se. NSW, s. Vic S of Great Divide, and se. SA; *hypoleuca* from Tas. and Furneaux Grp, Bass Str.; *telonocua* (recently described) from Yorke and Eyre Pens, SA, W to e. edge of Nullarbor Plain; *dorsalis* from s. WA, N to *c*. 30°S; *longirostris* from Pilbara Region, WA; *eylandtensis* from Kimberley Div., WA, E across humid savanna of n. NT to Gulf of Carpentaria Drainage Basin in nw. Qld (see Masthead for further details). Separation of *telonocua* and *tyrannica* (previously combined as subspecies *leuconota* by Amadon [1951]) requires confirmation (see below). Extralimitally, the outlying population from s. Trans-Fly region of New Guinea is considered subspecies *papuana* (Amadon 1951; Mees 1982; Black 1986; Coates 1990; Peters). Introduced populations on King I., Bass Str., mostly *tyrannica*, but some black-backed and intermediate birds probably partly originated from white-backed × black-backed 'hybrid zone' in se. Aust., possibly from Vic. (DAB). Introduced populations in NZ and Fiji mostly white-backed birds (probably *tyrannica*) with some black-backed birds (probably *tibicen*). Examination of 44 skins (AIM, NMNZ; this study) collected in NZ (35 from NI, nine from SI) indicates that 70% of birds are white-backed, 14% black-backed and 16% hybrids. One adult female skin (AIM 5474) from Kawakawa Bay, NI, closely resembles subspecies *dorsalis* from sw. WA, having black mantle and back, with distinct white scalloping formed by white fringes to tips of feathers. It is possible that birds introduced to NZ have broader geographical origins than just se. Aust. White-backed, Black-backed and hybrids are present in Fiji (Watling 1982; Clunie 1984).

Geographical variation in this species mainly involves: (1) extent and pattern of black on upperparts, with populations

usually described as black-backed (nominate *tibicen*, *terraeregi-nae*, *eylandtensis*, *longirostris*), white-backed (*tyrannica*, *hypoleuca*, *telonocua*), varied (*dorsalis*), or intermediate between white-backed and black-backed (hybrids); (2) length of black tips to rectrices; (3) extent of white on thighs; and (4) size, especially length of wing and bill (see Measurements, Plumages, and descriptions of subspecies below). Subspecies, and thus birds with backs of different colours, regularly interbreed where distributions overlap (J.M. Hughes; see below).

Two major studies (Hughes *et al.* 2001; Toon *et al.* 2003) provide an insight into the genetic basis for geographical variation in plumage patterns. Hughes *et al.* (2001) investigated sequence variation in mitochondrial DNA (mtDNA) control-region of e.-Aust. populations, including Tas. Their results show: (1) little genetic divergence within e. Aust., with no obvious concordance between population genetic structure and dorsal pattern; (2) Tas. white-backed populations are no more closely related to mainland white-backed than to mainland black-backed populations; (3) significant N–S gene-flow across contact zone between black-backed and white-backed populations (see Hybrid zones below); (4) geographical variation in dorsal pattern probably maintained by differential selection pressures, with genes for black-backs favoured in open vegetation in N, and genes for white-backs favoured in denser vegetation in S; and (5) patterns of plumage variation have evolved by primary intergradation and not through historical isolation of white-backed and black-backed populations.

Toon *et al.* (2003) compared a 590 base-pair sequence from the mtDNA control-region, sampling 439 individuals from 13 populations across se. and w. mainland Aust. They found little concordance between plumage coloration and genetic structure in sampled Aust. populations; and results showed: (1) a high level of genetic divergence on opposite sides of Nullarbor Plain; (2) no sequences (haplotypes) shared between w. and e. populations; (3) little genetic divergence within w. populations (from Albany W through coastal and subcoastal WA, and N to n. Pilbara Region) with more genetic variation within populations than between plumage forms; (4) within e. populations (four sites in Vic.), most haplotypes are shared between populations, regardless of coloration of plumage; and (5) population at Ceduna, w. SA, has unique haplotypes, which more closely resemble e.-Aust. haplotypes than those in WA. As in e. Aust. (see summary above of Hughes *et al.* [2001]), differential selective pressure on loci controlling plumage colour thought to maintain geographical variation in plumage patterns in w. Aust.: genes for black-backs favoured in N and genes for white-backs favoured in S.

Baker *et al.* (2000) analysed variation in allozymes and mtDNA sequences to investigate relationship between population genetic structure and size of groups in four regions, se. Aust (Vic.), central-e. Aust. (e. NSW), ne. Aust. (ne. NSW, se. Qld) and sw. WA. They found substantial gene-flow within each region but estimated it was lowest in sw. WA where group sizes largest. They concluded that juvenile dispersal affects group-size and genetic differentiation in Magpies: the lowest levels of juvenile dispersal (high juvenile philopatry), and thus gene-flow, were in sw. WA, where group-sizes and levels of population genetic differentiation were higher compared with e. Aust. Baker *et al.* (2001) analysed variation in allozymes and mtDNA in se. Aust., and found evidence of gene flow, through juvenile dispersal, over distances of up to 1600 km; genetic and geographical distance are highly correlated, supporting the hypothesis of isolation by distance.

The studies of Hughes *et al.* (2001) and Toon *et al.* (2003) also indicate the Nullarbor Plain forms an ecological barrier to gene-flow across s. Aust. Baker (1999) suggested that e. populations have been separated from populations in sw. Aust. (*dorsalis*) for *c.* 90,000 years; gene-flow between e. and

w. populations has been restricted by the Nullarbor Plain since before last period of aridity, 15,000–25,000 years ago. Unpublished genetic data (T. Chesser & J. Ten Have) indicate that: (1) DNA sequence-analysis from mitochondrial ND2 gene reveals 1.7% sequence divergence between populations in e. Aust. (E of Eyre and Yorke Pens) and w. Aust. (W of Nullarbor Plain); (2) overlap between e. and w. genotypes apparently occurs round Eyre and Yorke Pens (cf. Nullarbor Plain); and (3) zone of overlap between e. and w. genotypes may extend N into Central Aust., as birds from s. NT have either e. or w. haplotypes.

There are some general geographical trends in size on mainland Aust. Present study reveals N–S clinal increase in body-size in e. populations: on mainland e. Aust. (E of *c.* 140°E), simple linear regression indicates N–S increase in Wing (P<0.01; $r^2$=0.53; n=86 adult males), Tail (P<0.01; $r^2$=0.25) and Tarsus (P<0.01; $r^2$=0.33); importantly, ratio Bill S:Wing shows decrease from N to S (P<0.01; $r^2$=0.54). In WA, simple linear regression indicates N–S increase in Wing (P<0.01; $r^2$=0.30; n=25 adult males) and decrease in Bill S:Wing (P<0.01; $r^2$=0.50), but sample size small and clinal trends, if any, require confirmation. Through Central Aust. (130°–140°E), from NT, S to Kangaroo I. and s. Fleurieu Pen., SA, N–S increase in Wing (P<0.01; $r^2$=0.33; n=41 adult males) and Tarsus (P<0.01; $r^2$=0.31; n=39 adult males), slight decrease in Bill S (P<0.01; $r^2$=0.18) and decrease in ratio Bill S:Wing (P<0.01; $r^2$=0.45). There is also slight N–S trend in length of black tip to rectrices: in e. Aust. (E of *c.* 140°E) length of black tip to inner web of t6 increases from N to S (P<0.01; $r^2$=0.25; n=56 adult males); through Central Aust. (130°–140°E), length of black tip also increases N–S (P<0.01; $r^2$=0.27; n=34 adult males); and no N–S trend in length of black tip to t6 in WA, but sample size small. Birds on Tas. and Flinders I. are disparately small (DAB; this study), reversing general N–S cline of increasing body-size on mainland Aust.

The molecular studies of Hughes *et al.* (2001) and Toon *et al.* (2003) indicate that variation is largely clinal, and this has implications for the taxonomy of the species, particularly concerning recognition of subspecies. The following descriptions of subspecies, in combination with those of nominate and *tyrannica* (in Plumages, above), summarize plumage variation in the species. While full discussion of the validity of subspecies is outside the scope of this work, the extensive zones of intergradation indicated in DAB bring into question the taxonomic treatment of that study (Horton 2000).

NOMINATE TIBICEN AND SUBSPECIES TYRANNICA: Described above. Little variation within nominate or *tyrannica*, apart from N–S clinal variation in size (as above; DAB). Details of hybridization between nominate and *tyrannica* and *terraereginae* given below (after description of *terraereginae*).

SUBSPECIES TERRAEREGINAE (BLACK-BACKED, BLACK-THIGHED): Identical, or nearly so, to nominate *tibicen* in plumage. Adult male *terraereginae* have shorter Wing and Tarsus (P<0.01) than adult male nominate. Adult *terraereginae* have shorter Wing, Tail and Tarsus (P<0.01, both sexes, separately) than adult *tyrannica*, but do not differ in size from *telonocua*. Bill of moderate length (ratio exposed culmen: Wing, 0.20–0.23 for males, 0.19–0.22 for females [DAB]), proportionally longer than nominate and *tyrannica* (0.18–0.21 for males, 0.17–0.20 for females). Plumage description based on examination of skins of 29 adult males, one probable second immature male, 27 adult females, seven first immatures and four juveniles (ANWC, HLW, MV).

Very similar, or identical to, nominate, differing by: **Adult male** Black tip to rectrices tends to be slightly shorter, and white at base of rectrices extends well beyond tips of undertail-coverts (DAB; this study). Mean length of black tip to inner web of t6, 40.6 mm (6.76; 27–53; 19); also given as 30–55 mm (sexes combined; DAB). Populations from N of

range tend to have shorter black tip to rectrices than s. populations, e.g. adult males from n. Qld (14–18°S) have mean length of black tip to t6, 36.0 (5.26; 27–41; 7). Also, some birds, especially in Qld, have white tips to a few, or most, feathers of thighs (DAB; this study); for example, two skins (ANWC) from s. C. York Pen. have broad white tips to most feathers of thighs, possibly reflecting intergradation with subspecies *eylandtensis* (see below). **Adult female** As adult female nominate but black tip to tail shorter (P<0.01); black tip tends slightly longer (P<0.05) than in adult male *terraereginae*. Mean length of black tip to inner web of t6, 46.2 mm (7.23; 36–64; 19). **Juvenile** As juvenile nominate. On skins examined: mantle, scapulars and back, blackish brown (c119) with indistinct buff (124) scalloping, formed by narrow and diffuse fringes at tips of feathers; scalloping on upper mantle tends to be coarser and paler, buff-white (ne) or off-white (ne); rump and uppertail-coverts, off-white (ne) or white. **First immature** Similar to first immature *tyrannica* (see Plumages) except hindneck and upperparts similar to adult female nominate and *terraereginae*; some birds have lower hindneck and upperparts similar in colour and pattern to juvenile nominate (see Plumages above). **Second immature male** One skin (ANWC) reliably sexed as male (gonads described) but with adult female-like upperparts.

**HYBRIDS BETWEEN WHITE-BACKED AND BLACK-BACKED BIRDS IN E. AUST.:** Hybridization between white-backed and black-backed birds has generated considerable discussion. Subspecies *tyrannica* (often referred to as *hypoleuca* or *leuconota* in earlier works) and *terraereginae* (often referred to as *tibicen* in earlier works) interbreed across a fairly narrow (see below) zone of se. NSW and n. and central Vic. (Burton & Martin 1976; Hughes 1982). DAB stated that white-backed *tyrannica* intergrades with black-backed *terraereginae* from n. and central Vic. (except NW) W to The Grampians; and that farther E, in Snowy Mts–Monaro region and on coast between Batemans Bay and Bega, there is a complex zone of intergradation between *tyrannica*, *terraereginae* and *tibicen* (see below). Burton & Martin (1976) analysed plumage and morphometric variation across 'hybrid zone' between white-backed (*tyrannica*) and black-backed (*terraereginae* and *tibicen*) populations in Vic. and se. NSW (with most sampling in central and w. Vic.). Using quantitative analysis of variation in patterns of dorsal plumage (using a hybrid index and plotting index values along several N–S transects), they found: (1) white-backed birds (*tyrannica*) averaged larger than black-backed, but with much overlap in measurements (see Measurements); (2) in w. and central Vic., transects traversed a 'hybrid zone' grading from *terraereginae* (pure black-backed) in far N to *tyrannica* (pure white-backed) in far S, with varying proportions of parental

and intermediate phenotypes in between (see Fig 1.); (3) at localities where intermediates present, one or both parental phenotypes also common; (4) zone of overlap of parental phenotypes varied on different transects, with mean of 52.5 km (n=5 transects); (5) the 'hybrid zone' in Vic. is asymmetrical, with zone of white-backed and intermediates much narrower than zone of black-backed and intermediates; and (6) on one transect through central-e. Vic., plumage changed abruptly between two sites 13 km apart, separated by forested section of Great Divide; n. site had mostly black-backed and hybrid birds, and s. site had mostly white-backed.

Burton & Martin (1976) indicate hybrids between white-backed and black-backed birds have a varying black band on upperparts. Some birds, especially in central-n. and central-w. Vic. (e.g. St Arnaud–Avoca, Nagambie–Broadford, Colbinabbin–Heathcote, Horsham) have a continuous or broken, narrow to broad black band across mantle, often extending onto the back. Some birds, especially in nw. and n. Vic. (e.g. Ouyen–Beulah, Quambatook, Peechelba–Wangaratta), extensively black-backed but with white extending a little farther anteriorly than in phenotypically 'pure' *terraereginae*. A detailed list of frequencies of white-backed, black-backed and intermediate birds at many locations in Vic. is given by Burton & Martin (1976: Table 1). In ne. Vic. and se. NSW (including ACT, Monaro and Snowy Mts regions), populations also comprise a mix of phenotypes, e.g. of 49 adult male skins (ANWC) from ACT, 39 are pure black-backed, four are pure white-backed and six are intermediate (with black band across mantle, 30–55 mm down midline of body). DAB suggested that these populations are part of a complex zone of intergradation between three subspecies: nominate, *terraereginae* and *tyrannica*, but this needs confirmation.

Suggested the asymmetry of the 'hybrid zone' between white-backed and black-backed populations can be explained by simple genetic model, with dorsal coloration being determined by a small number of genes, with those coding for black backs dominant to those coding for white backs (Hughes & Mather 1980; Hughes 1982). Some evidence for this provided by studies of families of Magpies: two black-backed parents very occasionally produce white-backed (or nearly so) progeny, but black-backed progeny of two white-backed parents have not been recorded (Hughes 1982). Further, there were no morphological (apart from dorsal colour), behavioural or biochemical differences between white-backed and black-backed birds (Hughes 1980). Dorsal coloration thought to be determined by two loci on different chromosomes, each locus with two genes (alleles); genes for black-backs ($b1$ and $b2$) are dominant to genes for white backs ($w1$ and $w2$), and the effects are cumulative; therefore, a fully black-backed bird must have one
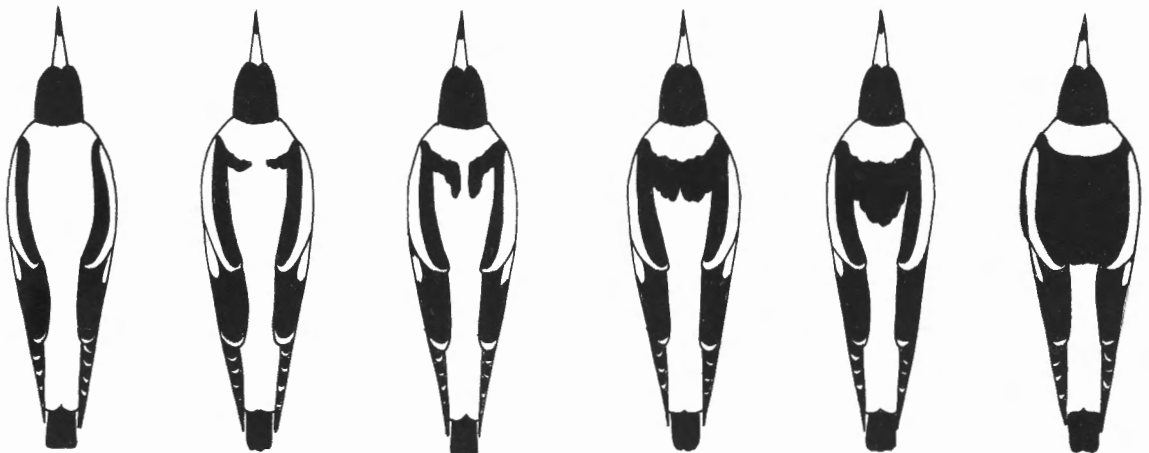


Figure 1   Clinal variation in upperparts of adult males in Vic., from pure white-backed in S to pure black-backed in N

(heterozygous) or two (homozygous) *b* genes at both loci, and a fully white-backed bird must be homozygous for *w* genes at both loci; intermediates have at least one *b* gene at one locus (Hughes 1982). Hughes & Mather (1980) suggested that genes for white-backs are present at low frequency in black-backed populations, and differences in selection pressure between n. and s. Aust. (such that white-backed birds are favoured in s. Aust. and black-backed in n. Aust.) could account for different geographical distribution of the two pheno-types (or morphs). The observed asymmetric 'hybrid zone' in se. Aust. can be explained by such a genetic model; and the predicted and observed frequencies of black-backed, white-backed and intermediate birds at each site on transects (see Burton & Martin 1976 for details of transects) agree fairly closely (see Hughes 1982 for detailed discussion). Hughes (1982) acknowledged that there may be other models that explain the observed asymmetric 'hybrid zone', such as three or more loci controlling dorsal colour, differing effects of each locus, and environmental influences affecting width of black dorsal band. However, the genetic model discussed above is the simplest. Such a model may also apply to 'hybrid zones' between white-backed and black-backed populations in central SA and s. central WA (see below).

SUBSPECIES HYPOLEUCA (WHITE-BACKED, BLACK-THIGHED): Very similar to *tyrannica* but adult *hypoleuca* have shorter Wing, Tail, Bill S and Tarsus (P<0.01, both sexes, separately) and weigh less (P<0.01, both sexes) than adult *tyrannica*. Bill pro-portionally short (exposed culmen:wing, 0.17–0.18 males, 0.16–0.18 females [DAB]). The smaller size of birds in Tas. inconsistent with general N–S cline of increasing size found on mainland Aust. Plumage description based on examination of skins of 16 adult males, 14 adult females, six first immatures and two probable second immature males (ANWC, HLW, MV, QVM, SAM).

Differences from *tyrannica*: **Adult male** As adult male *tyrannica* but black tip to tail significantly shorter (P<0.01): mean length of tip to inner web of t6, 58.7 mm (6.73; 46–70; 14); also given as 45–60 mm (DAB; sexes combined). White at base of rectrices extends slightly to moderately beyond tips of undertail-coverts (DAB; this study). **Adult female** As adult female *tyrannica* but black tip to tail significantly shorter (P<0.01). Mean length of black tip to inner web of t6, 61.2 mm (8.98; 47–75; 12). Said that whitish patch on hindneck narrower than in *tyrannica* (DAB); comparison of skins from mainland Tas. (n=11) with *tyrannica* (from Vic. and King I.) supports DAB, but much overlap between the two subspecies in this character. **Juvenile** No information. **First immature** As first immature *tyrannica* but blackish-brown (c119) tips to rectrices similar in length to adult *hypoleuca*. **Second imma-ture males** Two reliably sexed males (ANWC, QVM; gonads described) resemble adult female.

Skins (ANWC, QVM) from King I., Bass Str., examined in present study are *tyrannica*. Adult Wing (271, 271, 272 for males; 259.0 [7.45; 250–270; 5] for females) and length of black tip to inner web of t6 (48 and 94 for males; 75, 81 and 94 for females) consistent with *tyrannica* and not *hypoleuca*. DAB stated that some birds on King I. wholly or partly black-backed, and suggested that birds introduced there originated from white backed–black-backed 'hybrid zone' in se. Aust. One adult male skin (QVM) from Swansea, Tas., has broad black band across rump and lower back (this study), indicat-ing some individual variation in plumage in Tas.

SUBSPECIES TELONOCUA (WHITE-BACKED, BLACK-THIGHED): Recently described (DAB). Previously referred to as sub-species *leuconota* (which ranged in s. Vic. and SA) (Amadon 1951; Peters). Very similar to *tyrannica*, but adult *telonocua* have shorter Wing, Tarsus (P<0.01, both sexes, separately) and Tail (P<0.01, males only), and weigh less (P<0.01, both sexes, separately) than adult *tyrannica*. Adult female *telonocua*

have longer Wing and Tail and weigh more (P<0.05) than adult female *terraereginae*; adult male *telonocua* do not differ significantly in size but weigh more (P<0.05) than adult male *terraereginae*. Bill proportionally short (exposed culmen:wing, 0.18–0.22 males, 0.17–0.20 females [DAB]). Plumage descrip-tion based on examination of skins of eight adult males and six adult females, collected on Yorke and Eyre Pens, W to Ceduna (ANWC).

Differences from nominate *tyrannica*: **Adult male** As *tyrannica* but black tip to tail significantly shorter (P<0.01); mean length of black tip to inner web of t6, 57.0 mm (7.21; 49–62; 8); also given as 45–60 mm (sexes combined; DAB). White at base of rectrices extends slightly beyond tips of undertail-coverts (DAB; this study). **Adult female** As adult female *tyrannica* but black tip to tail shorter (P<0.01). Mean length of tip to inner web of t6, 53.2 mm (8.30; 44–63; 6). Said that whitish patch on hindneck narrower than *tyrannica* (DAB); present study supports DAB, but indicates some over-lap between the two subspecies in this character.

Subspecies *telonocua* said to intergrade with *tyrannica* in Mt Lofty Ras and on Kangaroo I. (DAB). Subspecies *telonocua* and *tyrannica* have virtually identical plumage, making inter-pretation of intergrade zone difficult. It is possible *telonocua* is not a valid subspecies, but part of a general N–S cline of increasing size and length of black tip to tail (see above). However, DNA-sequence data (T. Chesser & J. Ten Have; see above) indicates a zone of overlap between e. and w. geno-types in Gulf St Vincent–Spencer Gulf–Eyre Pen. region of SA. Examination of skins (ANWC, SAM; this study) of 16 adult males and 20 adult females from Adelaide Plains–Mt Lofty Ras–s. Flinders Ras–Kangaroo I. indicates that all are white-backed, but with longer (P<0.01) black tip to rectrices than those on Eyre and Yorke Pens; mean length of black tip to inner web of t6, 67.0 (9.71; 58–89; 8). Adult males from Mt Lofty Ras–Adelaide Plains (n=16) have longer Wing and Tarsus (P<0.01) than adult male *telonocua* (from Yorke and Eyre Pens), but shorter Wing (P<0.01) than adult male *tyran-nica* from se. SA and Vic. DAB also found that Mt Lofty Ras–Kangaroo I.–s. Flinders Ras populations (n=57) are white-backed and have longer wing and black tip to tail than those on Eyre and Yorke Pens (n=16). These observations sup-port the notion that populations from s. Flinders Ras, S through Mt Lofty Ras to Kangaroo I. are intergradient between *telonocua* and *tyrannica*. The data is, however, also consistent with a general N–S cline in size and length of black tip to tail (see discussion above).

Skins from w. Murray–Mallee, central and n. Flinders Ras, and Gawler Ras of SA are black-backed or intermediate, suggesting intergradation with *terraereginae* (DAB). This sup-ported by examination of adult skins from n. Flinders Ras (n=9) and w. Murray–Mallee (n=9) which are black-backed or intermediate. In Gawler Ras, black-backed, white-backed and hybrids occur, from Nonning Stn to farther W between Tarcoola–Kingoonya and Barton Sandhills (Black 1975; Paton 1975; J.S. Matthew). Baxter & Paton (1998) state that white-backed birds more common than black-backed in Gawler Ras. There are also records of pure white-backed birds from far inland, such as 150 km N of Laverton, in South-east-ern Interior Region of WA (Ford 1971; Black 1975; Black & Ford 1982). Populations in central Aust., and possible intergradation with *dorsalis* and *longirostris* across central-s. WA discussed below (under *longirostris*). These findings, in combination, suggest that populations in Murray–Mallee, N to Flinders Ras and L. Torrens are intergradient between three subspecies: *telonocua*, *tyrannica* and *terraereginae* (DAB).

SUBSPECIES DORSALIS (VARIED OR WESTERN, BLACK-THIGHED): Adult male similar to adult male white-backed populations from se. Aust., and closest to *telonocua* (white-backed from w. SA). Dorsal pattern of females and immature

males differs considerably from all other subspecies (see below). Adult male *dorsalis* have longer Bill S (P<0.01) and weigh more (P<0.05) than adult male *telonocua*; adult females do not differ in measurements or weight. Adult *dorsalis* have longer Wing, Bill S (P<0.01, both sexes, separately), Tarsus (P<0.01, males only) and weigh more (P<0.01, both sexes, separately) than adult *terraereginae*. Bill medium length and slender (exposed culmen:wing, 0.21–0.23 males, 0.20–0.22 females [DAB]). Plumage descriptions based on examination of skins of ten adult males, nine adult females, four first immature males, two first immature females and four juveniles (AM, ANWC, HLW, MV, SAM), and other information as cited.

**Adult male** Very similar to adult male *tyrannica* and *telonocua* except for size. Black tip to tail significantly shorter than in *telonocua* (P<0.01); mean length of black tip to inner web of t6, 35.5 mm (6.06; 28–47; 17); also given as 30–45 mm (sexes combined; DAB). White bases to rectrices extend well beyond undertail-coverts (DAB). **Adult female** Differences from adult female *telonocua* (also see discussion below): HEAD AND NECK: Upper hindneck, white or off-white (ne), forming fairly broad white patch; lower hindneck, black (89) or black-brown (c119) with fine white scalloping formed by narrow fringes to tips of feathers. UPPERPARTS: Mantle, scapulars and back, black (89) or black-brown (c119), grading to light grey (c85) on rump, and usually with white or greyish-white (ne) scalloping when fresh, boldest on upper mantle and rump; some birds have bold white scalloping on upper mantle and rump, and only fine whitish (ne) flecking on lower mantle, scapulars and back. Uppertail-coverts, white as in *telonocua*. Scalloping to upperparts formed by white or greyish-white (ne) tips or fringes to tips of feathers, which are reduced or lost with wear, so upperparts from mantle to rump can appear rather uniform blackish (c89) in worn birds. Rowley (2002) states that amount of white on upperparts does not change once adult plumage acquired. TAIL: Black tip to tail longer (P<0.05) than in adult male *dorsalis*. Mean length of black tip to inner web of t6, 43.7 mm (7.70; 37–59; 7). **Juvenile** Broadly similar to juvenile nominate (q.v.). Full description as follows: HEAD AND NECK: Black-brown (119), slightly paler, dark brown (121), on sides of neck, malar area, chin and throat. Hindneck, white. UPPERPARTS: Mantle, scapulars and back, black-brown (119) with fine cream-buff (123D) scalloping formed by narrow fringes to tips of feathers; upper mantle has coarser off-white (ne) scalloping or mottling formed by broad tips to feathers. Rump, greyish white (ne) with scattered dark-brown (121) mottling. Uppertail-coverts, white. UNDERPARTS: Black-brown (20), slightly paler than upperparts, grading to dark brown (121) on belly. Thighs, dark brown (121) with fine cream-buff (c123D) barring. Vent and undertail-coverts, white. TAIL: Rectrices, black-brown (20) with white basal half to inner webs of t1–t6. UPPERWING: Mostly blackish brown (119) with: (1) all marginal and median coverts, white with diffuse dark-brown (121) subterminal band, which often broken by white in centre; (2) greater secondary coverts: inner 4–5, white with broad dark-brown (121) inner edges, narrow cream-buff (123D) tips and uneven dark-brown (121) patch on centre of outer webs; rest (outers), black-brown (119) or dark brown (121) with narrow cream-buff (123D) tips and mostly concealed white bases; (3) greater primary coverts and alula, dark brown (121) or black-brown (119) with narrow off-white (ne) or cream-buff (123D) tips to inner coverts and shortest two feathers of alula, and partly exposed white bases to outer webs of coverts (except outer three, which lack white at bases). Remiges as juvenile nominate. UNDERWING: As juvenile nominate. **First immature** Both sexes very similar to adult female but retain juvenile feathering of wing and tail as in first immature *tyrannica* (q.v.). Colour of underparts rather varying, as in *tyrannica* (q.v.).

Upperparts also vary individually: some rather similar to adult female, others (e.g. SAM 22841, HLW 5167) have mantle and back, light greyish (c85) with bold blackish (c89) mottling, and with fine blackish (c89) shaft-streaks and white fringes to tips of feathers of rump. **Second and third immature males** At least some second immature males very similar to adult females; most third immatures apparently similar to adult male but some birds have scattered blackish (c89) mottling on mantle and back. See Ageing for details.

Some variation in female *dorsalis* (Black 1975): some skins (WAM) have a few grey feathers on upperparts, especially on rump and lower back; these feathers have grey distal one-third to half, paler towards edges, with varying amount of white at tips, and dark or black shaft-streaks; one skin (WAM 11723) from Jerramungup, sw. WA, has dark-grey back, with some feathers with blackish patch in centre. White fringes or edges to feathers of upperparts of adult females vary in width (R. Schodde & I.J. Mason), but much variation related to wear (Amadon 1951; this study). Wilson (1946) also briefly described variation within *dorsalis*. Intergradation with *longirostris*, and possibly also *telonocua*, across central-s. WA discussed below (under *longirostris*).

SUBSPECIES LONGIROSTRIS (BLACK-BACKED, WHITE-THIGHED): Very similar to *terraereginae* but adult *longirostris* have longer Bill S (P<0.01, both sexes, separately) than adult *terraereginae*. Adult *longirostris* have shorter Wing (P<0.01, both sexes, separately), longer Bill S (P<0.01, males only), and weigh less (P<0.05, females only) than adult *dorsalis*. Bill proportionately long and slender (exposed culmen:wing, 0.23–0.25 both sexes [DAB]). Plumage descriptions based on examination of skins of six adult males and five adult females (ANWC, HLW, WAM); WAM skins not available for present study, and information on these obtained from R. Schodde & I.J. Mason.

Differences from *terraereginae*: **Adult male** UNDERPARTS: Feathers of thighs, white, some birds have a few blackish-brown (c119) patches on thighs. TAIL: Black tip to rectrices similar to *terraereginae* and *dorsalis*; mean length of tip to inner web of t6, 38.2 mm (4.07; 31–43; 6); also given as 30–45 mm (sexes combined; DAB). White bases to rectrices extend well past tips of undertail-coverts (DAB). **Adult female** Feathers of thighs, white (as adult male). Upperparts similar to adult female *terraereginae*. While few data, black tip to tail probably similar to adult female *terraereginae* and *dorsalis*; also probably longer than in adult male *longirostris*; for three skins, length of black tip to inner web of t6, 40, 43 and 57 mm. In some birds, extent of white on feathers of alula similar to that of adult female *eylandtensis*, but others similar to adult female of other Aust. subspecies.

Subspecies *longirostris* and *dorsalis* intergrade across a broad zone of s.-central WA, from Shark Bay and lower reaches of Murchison R., E to sw. edge of Great Victoria Desert, where there may also be intergradation with *telonocua* (DAB). In this region, adults vary greatly in appearance, suggesting complex intergradation between at least two subspecies. Examples of skins from Wiluna, central WA, are described by Black & Ford (1982) and also briefly here: (1) one immature female (WAM 13999) has pale-grey upperparts with narrow black shaft-streaks to feathers, and blackish thighs; (2) an adult female (ANWC 19651), mated to a black-backed male, has pale-grey upper back, white lower back and hindneck, greyish rump, and black thighs with greyish tips to some feathers; (3) one adult male (ANWC 19646) has entirely white upperparts except for one black feather on upper back, and white thighs; (4) one adult female (ANWC 19703) has grey upperparts, with dark shaft-streaks, more extensive blackish streaks on lower back, and narrow broken black band across upper back. Skins 1–2 resemble adult female *telonocua*; skin 3 is possibly hybrid *dorsalis* × *longirostris*, or *telonocua* × *longirostris*; skin 4

has unusual markings and is possibly hybrid between *dorsalis* and *longirostris*, or *telonocua* and *longirostris* (Black & Ford 1982).

Near Carnegie, *c.* 200 km NE of Wiluna, skins typical *longirostris*: adult male (ANWC 32974) has mostly white upperparts with narrow black band (40 mm wide) across mantle, and white thighs; adult female (ANWC 32973) has light-grey (c85) upperparts with narrow blackish shaft-streaks and narrow white fringes at tips of feathers, fairly broad (55 mm) black band across mantle, and white thighs.

SUBSPECIES *EYLANDTENSIS* (BLACK-BACKED, WHITE OR BLACK-THIGHED): Similar to subspecies *terraereginae* but adult male *eylandtensis* have shorter Wing (P<0.05), longer Bill S (P<0.01) and weigh less (P<0.05) than adult male *terraereginae*; measurements not significantly different for adult females. Bill long and slender (exposed culmen:wing, 0.23–0.25 males, 0.21–0.23 females; DAB). Plumage descriptions based on examination of skins of 11 adult males, five adult females and two first immature males (ANWC, HLW, MV, WAM).

Differences from *terraereginae*: **Adult male** UPPERPARTS: White with fairly narrow (55–75 mm wide on midline of body) black (89) band across lower mantle and upper back. White of hindneck extends down over most of mantle. UNDERPARTS: Thighs vary from white to blackish (c89) with white tips to most feathers. TAIL: Black tip to tail shorter (P<0.01) than in *terraereginae*; mean length of black tip to inner web of t6, 32.0 mm (6.80; 25–49; 11); also given as 25–40 mm (sexes combined; DAB). White at base of rectrices extends well beyond undertail-coverts (DAB). UPPERWING: All skins examined have wholly or mostly white outer webs to all but longest feather of alula (other black-backed subspecies have less extensive white on outer web of second longest feather. Inner five or so greater primary coverts entirely white or white with black-brown (119) inner edges (cf. black in other subspecies). **Adult female** Very similar to adult male *eylandtensis* but differs by: (1) hindneck to upper mantle, pale greyish (c86), some birds having faint and narrow light grey-brown (27) or brown (28) shaft-streaks to feathers; and (2) outer web of second longest feather of alula usually white on basal half and black on distal half (cf. white on entire web in males), but one skin had alula identical to adult females of other subspecies (i.e. mostly black with small white bases to two shortest feathers). **Juvenile** No information. **First immature male** Very similar to first immature male *terraereginae*, but black-brown tip to tail tends shorter (31 and 44 mm on inner web of t6 on two skins). Hindneck and upper mantle as adult female. Lower mantle, scapulars and back, blackish (c89) or black-brown (119), grading to off-white (ne) with scattered black-brown (119) patches on rump and uppertail-coverts.

Little known about variation within populations in n. Aust., but birds on Groote Eylandt, NT (from which type of *eylandtensis* collected) possibly smaller than *eylandtensis* from mainland NT. Male skin from Groote Eylandt has Wing 230 and two female skins 224 and 226, though lengths probably underestimated as plumage of all birds heavily worn and all were in moult (DAB). Farther S, in central Aust. (round Alice Springs and Haast Bluff), plumage varies greatly and birds thought to be intergradient between *terraereginae* and one or more of *longirostris*, *eylandtensis* or *telonocua* (DAB). Wilson (1946) recorded mixed flocks of white-backed and black-backed birds in MacDonnell Ras, s. NT; DAB examined 27 skins from ranges of central Aust. (mostly MacDonnell Ras), and noted much variation in plumage, with some birds having long bill, similar to *longirostris*, or *eylandtensis* or both. Parker (1969) described two skins from round Alice Springs (skins in NTM), both females with grey backs, and sight record of white-backed male with grey-backed female from central-s. NT; he suggested that these were subspecies *leuconota* (now termed *telonocua*). All ten adult male skins examined in

this study (ANWC, SAM) from central Aust. (ne. SA, s. NT, and central-e. WA) are black-backed or intermediate with fairly broad black band across mantle and back; they are very similar to subspecies *terraereginae*, except for their longer black tip to tail (see below). However, one skin (ANWC 24573) from Haast Bluff, s. NT, is fully white-backed with a long bill (Bill S 66.2 mm), similar to adult male *dorsalis*. These skins also have rather long black tip to tail, with mean length of tip to inner web of t6, 49.5 mm (9.25; 36–62; 10) (this study); this similar to *telonocua* (see above). In summary, more data, including DNA sequence analysis, needed to determine affinities of populations in central Aust. An analysis of 'hybrid zones' through central SA and in WA, using morphological characters (Burton & Martin 1976), in combination with DNA sequencing, would help to clarify our understanding of variation in this distinctive subspecies.

Subspecies *eylandtensis* and *terraereginae* possibly intergrade around se. Gulf of Carpentaria drainage (DAB); birds from s. Cape York Pen. with broad white tips to feathers of thighs may reflect such intergradation.

SUBSPECIES *PAPUANA* (WHITE- OR BLACK-BACKED, WHITE-THIGHED): Poorly known. Black & Ford (1982) and Black (1986) indicate: (1) adult male has white back with narrow black band on mantle, mostly hidden by feathers of hindneck; (2) adult female has narrow white band on nape, black back with white tips to all feathers except those on middle of back, and white rump; (3) immature male similar to adult female but with grey or sooty-grey rump, or, in some birds, grey rump speckled with white; (4) juvenile male has brown tips to otherwise black feathers of back; (5) all birds have white feathers of thighs; (6) black tip to rectrices rather long, given as 45–80 mm on t1; and (7) all birds have long and deep bill with strongly decurved upper edge to culmen. Mees (1982) described an immature male as having broad black band across middle of back, bordered by grey posteriorly, and with white nape, rump and base of tail (see Measurements); photo of immature male skin (RMNH 33673 in Black [1986]) indicates upperparts mostly black with white uppertail-coverts and whitish tips to feathers of rump.

Black (1986) indicated that *papuana* has dorsal pattern similar to *dorsalis* but other characteristics closer to *longirostris* (populations termed *longirostris* in Black [1986] includes both *longirostris* and *eylandtensis* as defined in DAB and present study). Black (1986) suggested that populations in New Guinea and n. Aust. derived from same stock, but have diverged since sea-level rises have separated Aust. and New Guinea.

## REFERENCES

ABBBS. 1977. *Corella* 1: 39–41.
Abbott, I. 1980. *West Aust. Nat.* 14: 189–93.
Agnew, N.V.I. 1921. *Emu* 21: 131–7.
Alexander, J. 2002. *Bird Obs.* 819: 7.
Alley, T.H. 1979. *Corella* 3: 86.
Amadon, D. 1951. *Am. Mus. Novit.* 1504.
Andrew, E. (Ed.) 1999. *Nature in Eurobodalla* 13: 6–46.
Anon. 1903. *Emu* 3: 130–1.
—— 1914. *S. Aust. Orn.* 1(4): 7–11.
—— 1917. *S. Aust. Orn.* 3: 93–6.
—— 1924. *S. Aust. Orn.* 7: 169–72.
—— 1926. *S. Aust. Orn.* 8: 171–219.
—— 1962. *Victorian Nat.* 79: 22–4.
Arnold, G.W., & J.R. Weeldenburg. 1990. *Biol. Conserv.* 53: 295–315.
Ashby, E. 1927. *S. Aust. Orn.* 9: 33–4.
—— 1930. *S. Aust. Orn.* 10: 237–8.
Ashton, C.B. 1985. *S. Aust. Orn.* 29: 169–79.
—— 1986. *Bird Obs.* 656: 96.
—— 1987. *Aust. Bird Watcher* 12: 73–82.
—— 1996. *S. Aust. Orn.* 32: 93–8.
Ashton, I., *et al.* 1996. *RAOU Rep.* 97: 24–76.
Attiwill, A.R. 1972. *S. Aust. Orn.* 26: 59–64.

Aumann, T. 1991. *Aust. Bird Watcher* 14: 51–67.
Austin, C.N. 1953. *Emu* 53: 77–80.
Baker, A.M. 1999. Unpubl. PhD thesis, Qld Univ. Tech., Brisbane.
——, *et al.* 2000. *Heredity* 85: 167–76.
——, *et al.* 2001. *Biol. J. Linn. Soc.* 72: 333–43.
Baker, R.T. 1980. *Notornis* 27: 331–4.
Baldwin, M. 1971. *Aust. Bird Watcher* 4: 69–77.
—— 1972. *Aust. Bird Watcher* 4: 182–200.
—— 1976. *Aust. Bird Watcher* 6: 166–8.
—— 1979. *Aust. Birds* 14: 40–2.
—— 1989. *Sunbird* 19: 21–3.
Balfour, B., & L. Balfour. 1986. *Canberra Bird Notes* 11(4): 134–5.
Barnard, C.A., & H.G. Barnard. 1925. *Emu* 24: 252–65.
Barnard, E.D. 1905. *Emu* 5: 36–7.
Barnard, H.G. 1914. *Emu* 14: 39–57.
Barr, J. 1986. *Canberra Bird Notes* 11(4): 133.
Barrington, J. 1995. *Forest & Bird* 275: 4.
—— 1996. *Forest & Bird* 281: 32–5.
Basse, F. 1948. *S. Aust. Orn.* 19: 8.
Batey, I. 1907a. *Emu* 6: 132–4.
—— 1907b. *Emu* 7: 1–17.
—— 1907c. *Emu* 7: 81–6.
—— 1910. *Emu* 10: 49.
Baxter, C.I. 1980. *S. Aust. Orn.* 28: 90–8.
—— 1989. *An Annotated List of the Birds of Kangaroo Island*. S. Aust. Natl Pks Wildl. Serv., Kingscote, Kangaroo I., SA.
——, & P.A. Paton. 1998. *S. Aust. Orn.* 33: 1–15.
Bayly, K.L., & D.T. Blumstein. 2001. *Emu* 101: 199–204.
Bedggood, G.W. 1970. *Aust. Bird Watcher* 3: 252–65.
—— 1972. *Aust. Bird Watcher* 4: 116–28.
—— 1973. *Aust. Bird Watcher* 5: 12–22.
—— 1976. *Bird Obs.* 539: 78.
—— 1980. *Aust. Bird Watcher* 8: 147–62.
Bell, B.D. 1976. *Notornis* 23: 310–19.
Bell, H.L. 1980. *Corella* 4: 8–15.
—— 1983. *Aust. Birds* 18: 1–6.
Berney, F.L. 1905. *Emu* 5: 72–8.
Beruldsen, G.R. 1980. *A Field Guide to Nests and Eggs of Australian Birds*. Rigby, Adelaide.
Bettington, B.C.J. 1927. *Emu* 26: 188–92.
Bielewicz, J., & F. Bielewicz. 1996. *Sunbird* 26: 81–120.
Binns, G. 1953. *Emu* 53: 211–21.
Black, A. 1975. *S. Aust. Orn.* 27: 8–10.
—— 1986. *Emu* 86: 65–70.
——, & J.R. Ford. 1982. *Corella* 6: 114–18.
Blackburn, A. 1971. *Notornis* 18: 147–74.
Boehm, E.F. 1929. *S. Aust. Orn.* 10: 18–19.
—— 1937. *S. Aust. Orn.* 14: 91–6.
—— 1948. *Emu* 47: 395–6.
—— 1950a. *Emu* 50: 62–3.
—— 1950b. *Emu* 50: 139.
—— 1956. *Emu* 56: 348.
—— 1957. *Emu* 57: 311–24.
—— 1962. *Emu* 62: 176.
Bonnin, J.M. 1930. *S. Aust. Orn.* 10: 274–5.
Bourke, P.A. 1958. *Emu* 58: 94–6.
Bourne, D. 2002. *Canberra Bird Notes* 27(2): 60–5.
Brandle, R. 1998. (Ed.) *A Biological Survey of the Stony Deserts, South Australia, 1994–1997*. Heritage & Biodiversity Section, Dept Env. Heritage & Aboriginal Affairs, Adelaide.
Brandon, T. 1937. *S. Aust. Orn.* 14: 49–51.
—— 1938. *S. Aust. Orn.* 14: 218–21.
—— 1951. *S. Aust. Orn.* 20: 20.
Bravery, J.A. 1970. *Emu* 70: 49–63.
Bray, J., & C. Davey. 2002. *Canberra Bird Notes* 27(2): 76.
Brereton, R.N., *et al.* 1996. *Tasm. Nat.* 118: 31–40.
Bridgewater, A.E. 1932. *Emu* 32: 116.
Bright, J. 1935. *Emu* 34: 159–63.
Brockie, R.E., & L. Sorensen. 1998. *Notornis* 45: 269–70.
Brooker, M.G. 2001. *West Aust. Nat.* 23: 62–106.
——, & B. Brooker. 1998. *Canberra Bird Notes* 23(1): 20–30.
——, & L.C. Brooker. 1989. *Aust. Zool. Rev.* 2: 1–67.
——, & A.J. Estbergs. 1976. *West. Aust. Nat.* 13: 160–70.
Brown, A.G. 1950. *Emu* 50: 105–13.
Brown, B., *et al.* 2000. *Aust. Bird Watcher* 18: 270–3.
Brown, E.D. 1986. *Sunbird* 16: 83–5.
——, & S.M. Farabaugh. 1991a. *Bird Behav.* 9: 64–8.

——, —— 1991b. *Behaviour* 118: 244–74.
——, & C.J. Veltman. 1987. *Ethology* 76: 309–33.
——, *et al.* 1988. *Behaviour* 104: 1–28.
——, *et al.* 1993. *Anim. Behav.* 45: 814–16.
Brown, K.P., & C. Miller. 1997. *Notornis* 44: 109–10.
Brown, R.F. 1937. *S. Aust. Orn.* 14: 24–7.
Brown, R.J., & M.N. Brown. 1986. *Aust. Bird Watcher* 11: 218–23.
——, *et al.* 1986. *Corella* 10: 118–22.
Bryant, C.E. 1937. *Emu* 36: 229–42.
Bryant, S.L., & M.C. Holdsworth. 1992. *Tas. Bird Rep.* 21: 31–2.
Buchanan, R.A. 1983. *Aust. Birds* 17: 49–55.
Bull, P.C., & D.G. Dawson. 1969. *Notornis* 16: 172–9.
Buller, K.G. 1947. *Emu* 46: 347–8.
Burbidge, A. 1982. *RAOU Rep.* 2: 8–36.
Burnell, T.C. 1918. *Aust. Zool.* 1: 179.
Burnett, S. 1996. *Sunbird* 26: 76–8.
Burton, T.C., & A.A. Martin. 1976. *Emu* 76: 30–6.
Butterfield, M.A. 1988. *Canberra Bird Notes* 13(2): 34.
—— 1992. *Canberra Bird Notes* 17(3): 82–3.
Cameron, A.C. 1933. *Emu* 32: 227.
—— 1986. *Sunbird* 16: 24.
Campbell, A.G. 1902. *Emu* 2: 9–19.
—— 1905. *Emu* 5: 68–72.
—— 1910. *Emu* 9: 169–70.
—— 1927. *Emu* 27: 176–8.
—— 1929. *Emu* 28: 165–76.
Campbell, A.J. 1894. *Proc. R. Soc. Vic.* 7: 202.
—— 1906. *Emu* 6: 60–5.
—— 1909. *Emu* 8: 142–8.
Campbell, H. 1906. *Emu* 5: 231–3.
Carnaby, I.C. 1954. *West. Aust. Nat.* 4: 149–56.
Carpenter, G.A., & J.S. Matthew. 1997. *S. Aust. Orn.* 32: 134–40.
Carrick, R. 1963. *Int. Orn. Congr. Proc.* 13: 740–53.
—— 1970. *Aust. Bird Bander* 8: 62–3.
—— 1972. *US Dept. Int. Wildl. Res. Rep.* 2: 41–99.
Carter, T. 1911. *Emu* 10: 294–9.
—— 1924. *Emu* 23: 306–18.
Chandler, L.G. 1920. *Emu* 20: 4–13.
—— 1944. *Emu* 44: 93–6.
Chapman, G.S. 1969. *Canberra Bird Notes* 1(4): 2–6.
Cheney, G.M. 1915. *Emu* 14: 199–213.
Child, P. 1975. *Notornis* 22: 143–50.
—— 1983. *Notornis* 30: 243–4.
Chisholm, A.H. 1910. *Emu* 9: 246.
—— 1937. *Ibis* (14)1: 703–21.
—— 1946. *Nature's Linguists*. Brown Prior Anderson, Melbourne.
—— 1947. *Victorian Nat.* 64: 25–6.
—— 1959. *Emu* 59: 101–30.
Chisholm, E.C. 1934. *Emu* 34: 8–23.
—— 1938. *Emu* 37: 301–13.
Christidis, L., & W.E. Boles. 1994. *RAOU Monogr.* 2.
Cilento, N.J., & D.N. Jones. 1999. *Emu* 99: 85–90.
Clarke, G. 1967. *S. Aust. Orn.* 24: 119–34.
Cleland, J.B. 1942. *S. Aust. Orn.* 16: 31–3.
—— 1952. *S. Aust. Orn.* 20: 72–7.
Close, D.H., & R.P. Jaensch. 1984. *S. Aust. Orn.* 29: 81–99.
Clunie, F. 1984. *Birds of the Fiji Bush*. Fiji Museum, Suva.
——, *et al.* 1978. *Notornis* 25: 118–27.
Coate, K.H., *et al.* 2001. *West. Aust. Nat.* 23: 9–38.
Coates, B.J. 1990. *The Birds of Papua New Guinea*. 2. Dove Publs, Alderley, Qld.
Cohn, M. 1926. *Emu* 25: 282–6.
Cole, C.F. 1921. *Emu* 21: 51–4.
Collier, J., *et al.* 2000. *Birds, Birders and Birdwatching: A Celebration of One Hundred Years of the South Australian Ornithological Association*. S. Aust. Orn. Assoc., Adelaide.
Collins, J. 1983. *Geelong Nat.* 20: 80.
Comrie-Smith, E. 1938. *Emu* 37: 319.
Condon, H.T. 1940. *Emu* 39: 191–3.
—— 1942. *Emu* 41: 208–11.
—— 1951. *S. Aust. Orn.* 20: 26–68.
—— 1962. *S. Aust. Orn.* 23: 86–148.
—— 1969. *A Handlist of the Birds of South Australia*. S. Aust. Orn. Assoc., Adelaide.
Conole, L. 1981. *Aust. Bird Watcher* 9: 14–23.
Conway, K. 1940. *Victorian Nat.* 56: 141.
Cooper, C.D., & R.M. Cooper. 1981. *Aust. Birds* 15: 50–2.

Cooper, R.M., & I.A.W. McAllan. 1995. *The Birds of Western New South Wales: A Preliminary Atlas*. NSW Bird Atlassers, Albury, NSW.
Cooper, R.P. 1972. *Aust. Bird Watcher* 4: 171–81.
—— 1974. *Aust. Bird Watcher* 5: 137–74.
—— 1975a. *Aust. Bird Watcher* 6: 47–60.
—— 1975b. *Aust. Bird Watcher* 6: 103–16.
Costello, J. 1981. *Aust. Bird Watcher* 9: 55–67.
Cox, J.B., & L.P. Pedler. 1977. *S. Aust. Orn.* 27: 231–50.
Crawford, F.M. 1972. *Birds (J. NSW FOC)* 6: 56–7.
Criglington, M.J. 1969. *Notornis* 16: 145.
Crockett, D.E. 1954. *Notornis* 6: 40–2.
Cunningham, D.M., & P.J. Moors. 1985. *Notornis* 32: 221–43.
Cunningham, J.M., & K.A. Wodzicki. 1948. *Emu* 47: 177–98.
D'Andria, A.H. 1969. *Canberra Bird Notes* 1(5): 10.
D'Ombrain, A.F. 1952. *Emu* 52: 214–15.
Daley, R. 1966. *S. Aust. Orn.* 24: 110.
Davey, C. 1995. *Canberra Bird Notes* 20(1): 25–31.
—— 2002. *Canberra Bird Notes* 27(3): 97–123.
Davies, S.J.J.F., & G.S. Chapman. 1975. *Emu* 75: 55–61.
Davis, W.E., Jr, & H.F. Recher. 1996. *Aust. Bird Watcher* 16: 303–4.
——, —— 2002. *Corella* 26: 70–3.
Dawson, E.W. 1950. *Notornis* 3: 27–31.
Dawson, P., & D. Dawson. 1991. *Sunbird* 21: 93–110.
——, *et al.* 1991. *Sunbird* 21: 93–111.
Day, T.D. 1995. *Notornis* 42: 175–86.
Debus, S.J.S. 1983a. *Aust. Bird Watcher* 10: 73–8.
—— 1983b. *Corella* 7: 14–16.
—— 1990. *Corella* 14: 169–71.
—— 1993. *Aust. Bird Watcher* 15: 168–91.
Deng, C. *et al.* 2001. *Behav. Brain Res.* 123: 89–102.
Dickison, D.J. 1930. *Emu* 30: 145–7.
Disney, H.J. de S., & P.J. Fullagar. 1978. *Corella* 2: 89.
Donaghey, R.H. 1981. Unpubl. PhD thesis, Monash Univ., Melbourne.
Donohoe, J. 1985. *West. Aust. Bird Notes* 33: 10.
Doughty, C., *et al.* 1999. *Birds of the Solomons, Vanuatu and New Caledonia*. Christopher Helm, London.
Douglas, M.J.W. 1970. *Notornis* 17: 92–5.
Dove, H.S. 1908. *Emu* 8: 66–71.
—— 1930. *Emu* 30: 96.
—— 1932. *Emu* 32: 50–1.
—— 1938. *Emu* 37: 319–20.
—— 1941. *Emu* 40: 318.
Dow, D.D. 1980. *Emu* 80: 121–40.
Dowling, B., *et al.* 1994. *Tech. Rep. Arthur Rylah Inst. Env. Res.* 134.
Drake-Brockman, P. 1999. *VORG Notes* 34(1): 13.
Du Guesclin, P.B., *et al.* 1983. *Corella* 7: 37–9.
Dunkley, A.H. 1976. *S. Aust. Orn.* 27: 159.
Durrant, K.L. 2004. Unpubl. PhD thesis, Griffith Univ., Brisbane.
Dymond, N. 1988. *RAOU Rep.* 38: 13–63.
Edwards, H.V. 1920. *Emu* 20: 36–7.
Egan, K.H., *et al.* 1997. *Corella* 21: 1–16.
Elliott, A.J. 1934. *Emu* 34: 28–30.
Elliott, S. 1952. *West. Aust. Nat.* 3: 116.
Emison, W.B., & J. W. Porter. 1978. *Emu* 78: 126–36.
Er, K.B.H. 1997. *Corella* 21: 101–11.
——, & C.R. Tidemann. 1996. *Corella* 20: 117–28.
——, —— 2001. *Canberra Bird Notes* 26(2): 33–42.
——, *et al.* 1995. *Corella* 19: 109–14.
——, *et al.* 1998. *Aust. Bird Watcher* 17: 370–82.
Evans, R., *et al.* 1997. *Sunbird* 27: 38–44.
Ey, A.E. 1944. *S. Aust. Orn.* 17: 32–7.
Falls, J.B. 1969. Pp 207–32 **In**: Hinde 1969.
Farabaugh, S.M., *et al.* 1988. *Behaviour* 104: 105–25.
——, *et al.* 1992. *Ethology* 92: 283–92.
Favaloro, N.J. 1930. *Emu* 30: 105–9.
—— 1947. *Emu* 47: 61–2.
—— 1948. *Emu* 47: 352–6.
—— 1981. *Aust. Bird Watcher* 9: 44–53.
Fielding, P. 1979. *Tasm. Nat.* 57: 2–12.
Finn, P.G., & J.M. Hughes. 2001. *Emu* 101: 57–63.
Fisher, A.M. 2001. *Emu* 101: 25–31.
——, & D.C. Goldney. 1997. *Pacific Conserv. Biol.* 3: 275–88.
Fitzsimons, J.A. 2003. *Aust. Field Orn.* 20: 24–7.
Fleming, A.M. 1976. *Aust. Bird Watcher* 6: 151–60.
—— 1999. *VORG Notes.* 34(1): 11.

Fletcher, J.A. 1915. *Emu* 14: 218–19.
—— 1918. *Emu* 18: 96–101.
—— 1921. *Emu* 21: 147–8.
—— 1934. *Emu* 34: 138–9.
Floyd, R.B., & D.J. Woodland. 1981. *Anim. Behav.* 29: 510–17.
Ford, H.A., & H. Bell. 1981. *Emu* 81: 202–8.
——, & D.C. Paton. (Eds) 1986. *The Dynamic Partnership: Birds and Plants in Southern Australia*. D.J. Woolman, Adelaide.
——, *et al.* 1985. *Corella* 9: 97–107.
——, *et al.* 1986. *Emu* 86: 168–79.
Ford, J.R. 1969. *Emu* 68: 278–9.
—— 1971. *Emu* 71: 27–36.
——, & P.S. Stone. 1957. *Emu* 57: 9–21.
Forde, N. 1986. Pp 42–58 **In**: Ford & Paton 1986.
Fordham, R.E.W. 1955. *Notornis* 6: 131.
Freeman, A.N.D. 1999. *Notornis* 46: 388–404.
French, C. 1900. *Victorian Nat.* 17: 126.
Friend, G.R. 1982. *Emu* 82: 80–91.
Frith, H.J. (Ed.) 1969. *Birds in the Australian High Country*. Reed, Sydney.
Fulton, G.R. 2002. *Corella* 26: 1–12.
Gall, B.C., & N.W. Longmore. 1978. *Emu* 78: 189–96.
Gannon, G.R. 1933. *Emu* 32: 196.
Gardner, T., & P. Gardner. 1975. *Aust. Bird Watcher* 6: 82–4.
Garnett, S.T., & R. Bredl. 1985. *Sunbird* 15: 25–40.
Geary, N. 1932. *Emu* 32: 108–9.
Gee, P., *et al.* 1996. *S. Aust. Orn.* 32: 76–81.
Genelly, R.E. 1978. *Emu* 78: 137–44.
Gepp, B.C. 1986. Pp 140–9 **In**: Ford & Paton 1986.
——, & A.J. Fife. 1975. *S. Aust. Orn.* 27: 12–17.
Gibb, J.A. 2000. *Notornis* 47: 13–35.
Gibson, D.F. 1986. *Tech. Rep. Cons. Comm. North. Terr.* 30.
Gibson, J.D. 1977. *Aust. Birds* 11: 41–80.
Gill, B.J. 1977. *Notornis* 24: 75–81.
—— 1989. *Notornis* 36: 81–7.
Gill, H.B. 1970. *Emu* 70: 105–16.
Glover, B. 1951. *West. Aust. Nat.* 3: 19–20.
Gosper, C.R. 1999. *Corella* 23: 53–62.
Gosper, D.G. 1983. *Corella* 7: 7–13.
—— 1992. *Corella* 16: 78–88.
Greaves, V. 1965. *Victorian Nat.* 81: 288.
Green, R.H. 1969. *Rec. Queen Vict. Mus.* 34: 1–32.
—— 1989. *Birds of Tasmania*. Potoroo Publs, Launceston, Tas.
——, & A.M. McGarvie. 1971. *Rec. Queen Vict. Mus.* 40: 1–42.
——, & B.C. Mollison. 1961. *Emu* 61: 223–36.
Green, R.J. 1986. Pp 130–9 **In**: Ford & Paton 1986.
Gregory-Smith, R. 1991. *Canberra Bird Notes* 16(4): 65–74.
Griffin, A.C.M. 1995. *Sunbird* 25: 73–92.
Griffioen, P. 2001. Unpubl. PhD thesis, LaTrobe Univ., Melbourne.
——, & M.F. Clarke. 2002. *Emu* 102: 99–125.
Griffiths, G.A., & D.T. Holyoak. 1993. *Aust. Bird Watcher* 15: 144.
Guest, R., & G. Guest. 1987. *Notornis* 34: 59–64.
——, —— 1993. *Notornis* 40: 137–41.
Gynther, I., *et al.* 1995. *Sunbird* 25: 93–5.
Hahne, K. 1984. *Canberra Bird Notes* 9(4): 158.
Hall, R. 1909. *Emu* 9: 16–21.
Halse, S.A., *et al.* 1985. *West. Aust. Nat.* 16: 57–69.
Hamilton, C.S. 1949–50. *Gould League Notes*: 25.
Hanks, E.S. 1930. *Emu* 29: 292–6.
Hardy, J.W., & J.R. Farrell. 1990. *Corella* 14: 1–15.
Harvey, W.J. 1928. *S. Aust. Orn.* 9: 267–9.
Hassan, L. 1994. *West. Aust. Bird Notes* 70: 1.
Hatch, J.H. 1977. *S. Aust. Orn.* 27: 163–72.
Hayward, J.L., & N. Macfarlane 1971. *Aust. Bird Watcher* 4: 62–6.
Heather, B.D., & H.A. Robertson. 2000. *The Field Guide to the Birds of New Zealand*. Viking, Auckland.
Heron, S.J. 1970. *Emu* 70: 153–8.
Hewish, M.J. (Ed.) 1997. *Geelong Bird Rep. 1996*: 3–29.
—— (Ed.) 1998. *Geelong Bird Rep. 1997*: 3–41.
—— (Ed.) 1999. *Geelong Bird Rep. 1998*: 3–51.
—— (Ed.) 2000. *Geelong Bird Rep. 1999*: 3–47.
—— (Ed.) 2002a. *Geelong Bird Rep. 2000*: 3–61.
—— (Ed.) 2002b. *Geelong Bird Rep. 2001*: 3–65.
Hickson, R. 1984. Unpubl. BSc(Hons) thesis, Massey Univ., Palmerston N, NZ.
Hill, G.F. 1907. *Emu* 6: 176–9.
Hill, H.E. 1903. *Emu* 2: 161–7.

Hinde, R.A. (Ed.) 1969. *Bird Vocalizations*. Cambridge Univ. Press, Cambridge.
Hindwood, K.A. 1940. *Emu* 39: 219–32.
Hobbs, J.N. 1961. *Emu* 61: 21–55.
—— 1971a. *Aust. Bird Watcher* 4: 43–6.
—— 1971b. *Aust. Bird Watcher* 4: 98–100.
—— 1972. *Aust. Bird Watcher* 4: 131–2.
—— 1987. *Aust. Bird Watcher* 12: 63–5.
Holdsworth, M.C. 1997. *Tas. Bird Rep.* 26: 29–37.
Hood, J.B. 1935. *S. Aust. Orn.* 13: 107–19.
Hood, R.A.D. 1904. *Emu* 3: 190.
Hooper, H.L.N. 1973. *Bird Obs.* 503: 7.
Hopkins, N. 1948. *Emu* 47: 331–47.
—— 1972. *Sunbird* 3: 1–5.
Hordern, D. 1933. *Emu* 33: 68–9.
Hornsby, P. 1997. *S. Aust. Orn.* 32: 118–27.
Horsburgh, B.J., *et al.* 1992. *Medic. J. Aust.* 157: 756–9.
Horton, P. 2000. *S. Aust. Orn.* 33: 88–90.
Horton, W. 1975. *Sunbird* 6: 49–69.
Hough, K. 1969. *Emu* 68: 282.
How, R.A., & J. Dell. 1990. *West. Aust. Nat.* 18: 122–31.
Howe, F.E. 1928. *Emu* 27: 252–65.
Hughes, J.M. 1980. Unpubl. PhD thesis, LaTrobe Univ., Melbourne.
—— 1982. *Emu* 82: 50–3.
——, & P.B. Mather. 1980. *Sunbird* 11: 42–3.
——, —— 1991. *Proc. R. Soc. Qld* 101: 13–19.
——, *et al.* 1983. *Emu* 83: 108–11.
——, *et al.* 1996. *Emu* 96: 65–70.
——, *et al.* 2001. *Biol. J. Linn. Soc.* 74: 25–34.
——, *et al.* 2002. *Emu* 102: 331–8.
——, *et al.* 2003. *Molecular Ecol.* 12: 3441–50.
Humphreys, J.S. 1986. *Aust. Bird Watcher* 11: 153–60.
Hutchinson, A. 1999. *Sydney Airport Bird Hazard Management Study. Ann. Rep. Oct. 1999*. Unpubl. Rep. by Birds Aust. for Sydney Airports Corp., Sydney.
Hyem, E.L. 1937. *Emu* 36: 262–72.
Innes, J.G. 1982. *Notornis* 29: 93–9.
——, *et al.* 2004. Magpie impacts on other birds. Unpubl. Rep. to Wellington, Waikato, Southland, Bay of Plenty, Northland, Hawkes Bay, Auckland, Canterbury and Marlborough Regional Councils. Hamilton, NZ.
Irby, F.M. 1929. *Emu* 29: 142.
Jarman, H.E.A. 1944. *S. Aust. Orn.* 17: 24–9.
—— 1945. *S. Aust. Orn.* 17: 74–8.
Jarvis, H. 1929. *Qld Agric. J.* 32: 8–12.
Johnson, M. 1946. *NZ Bird Notes* 2: 16.
Johnstone, R.E., *et al.* 1979. *Wildl. Res. Bull. West. Aust.* 8: 22–30.
——, *et al.* 2000. *Rec. West. Aust. Mus. Suppl.* 61: 371–448.
Jones, D.N. 1981. *Aust. Wildl. Res.* 8: 109–19.
—— 1983. *Emu* 83: 12–18.
—— 1986. *Sunbird* 16: 1–11.
—— 1996. *Wingspan* 6(3): 12–15.
—— 2002. *Magpie Alert*. Univ. NSW Press, Sydney.
——, & P.G. Finn. 1999. *Wildl. Res.* 26: 271–9.
——, & T. Nealson. 2003. *Wildl. Res.* 30: 167–77.
——, & J. Wieneke. 2000. *Corella* 24: 53–60.
Jones, J. 1952. *Emu* 52: 225–54.
Jones, L., *et al.* 1980. *Bird Behav.* 2: 113–17.
Jorm, P. 1998. *Canberra Bird Notes* 23(1): 3–4.
Jurisevic, M.A., & K.J. Sanderson. 1994. *Emu* 94: 69–77.
——, —— 1998. *J. Avian Biol.* 29: 61–71.
Kallioinen, R.U.O., *et al.* 1995. *Aust. J. Zool.* 43: 665–73.
Kaplan, G. 1996. *Int. J. Psych.* 31: 233.
—— 1998. *Ostrich* 69: 256.
—— 1999. *Australian Society for the Study of Animal Behaviour: 10.* Univ. New England, Armidale, NSW.
—— 2000. *Int. J. Comp. Psych.* 12: 219–41.
—— 2003. *Nature Aust.* 27(10): 60–7.
—— 2004. *Australian Magpie: Biology and Behaviour of an Unusual Songbird*. CSIRO Publs, Melbourne.
—— 2005. Vocal behaviour of Australian Magpies *Gymnorhina tibicen*. Unpubl. PhD thesis, Univ. Qld, Brisbane.
Kavanagh, R.P., *et al.* 1985. Pp 273–81 **In**: Keast *et al.* 1985.
Keast, A. 1985. Pp 97–116 **In**: Keast *et al.* 1985.
——, *et al.* (Eds) 1985. *Birds of Eucalypt Forests and Woodlands*. Surrey Beatty, Sydney.
Keedwell, R., & M.D. Sanders 1999. *Notornis* 46: 499–501.

Kellam, J.W. 1974. *Aust. Bird Watcher* 5: 201–4.
Kennedy, S.J. 2003. *Corella* 27: 33–44.
Kilpatrick, A.G. 1935. *Emu* 34: 240–1.
Kingston, M.B., *et al.* 2002. *Sunbird* 32: 1–14.
Kitchener, D.J., *et al.* 1975. *Rec. West Aust. Mus. Suppl.* 1.
Kuss, M.S. 1934. *S. Aust. Orn.* 12: 204–6.
La Roche, S.A. 1950. *Notornis* 4: 14.
Lalas, C. 1977. Unpubl. MSc thesis, Univ. Otago, Dunedin.
Lamm, D.W., & J.H. Calaby. 1950. *Emu* 50: 114–22.
Larkin, D. 1980. *Corella* 4: 46.
Lashmar, A.F.C. 1937. *S. Aust. Orn.* 14: 59–64.
—— 1942. *S. Aust. Orn.* 16: 37–40.
Lavery, H.J. 1969. *Qld. J. Agric. Anim. Sci.* 26: 447–55.
——, *et al.* 1968. *Emu* 68: 133–47.
Lawrence, C., & S. Lawrence. 1972. *Aust. Bird Watcher* 4: 135–6.
Lawrence, S.B., & C.G. Gay. 1991. *Notornis* 38: 173–82.
Le Souëf, D. 1904. *Emu* 3: 141–67.
—— 1908. *Emu* 8: 61–3.
—— 1916. *Emu* 16: 48–50.
Leach, G.J. 1995. *Corella* 19: 118–26.
——, & H.B. Hines. 1987. *Sunbird* 17: 65–95.
——, & H.F. Recher. 1993. *Wildl. Res.* 20: 233–49.
——, & D.J. Watson. 1994. *Corella* 18: 155–61.
Leach, H.A.C. 1928. *Emu* 28: 83–99.
Learmonth, N. 1967. *Bird Obs.* 426: 4.
Leiblich, G. 1971. *S. Aust. Orn.* 25: 234–5.
Lenz, M. 1990. *Emu* 90: 145–53.
Lepschi, B.J. 1990. *Canberra Bird Notes* 15(1): 21.
—— 1992. *Corella* 16: 75–7.
—— 1993. *Emu* 93: 195–9.
—— 1997. *Emu* 97: 84–7.
Lill, A., & P.J. Fell. 1990. *Emu* 90: 33–9.
Lipscombe, J. 2003. *Canberra Bird Notes* 28(3): 65.
Littler, F.M. 1903a. *Emu* 2: 171–2.
—— 1903b. *Emu* 3: 81–9.
—— 1904. *Emu* 3: 213–17.
—— 1910. *A Handbook of the Birds of Tasmania and its Dependencies.* Author, Launceston, Tas.
Long, J.L. 1981. *Introduced Birds of the World*. Reed, Sydney.
Longmore, N.W. 1973. *Birds (J. NSW FOC)* 8: 33–5.
—— 1978. *Sunbird* 9: 25–53.
Lord, E.A.R. 1941. *Emu* 41: 90–1.
—— 1952. *Emu* 52: 23–4.
—— 1956a. *Emu* 56: 100–28.
—— 1956b. *Emu* 56: 163–4.
—— 1957. *Emu* 57: 338–40.
—— 2001. *Sunbird* 31: 94–112.
Loyn, R.H. 1980. *Emu* 80: 145–56.
—— 1985a. *Emu* 85: 213–30.
—— 1985b. Pp 323–31 **In**: Keast *et al.* 1985.
—— 1993. *Effects of Previous Logging in Bird Populations in East Gippsland: VSP Retrospective Study*. Value-adding & Silvicultural Systems Prog. Tech. Rep. 18. Dept Conserv. Nat. Res., Melbourne.
Luck, G.W., *et al.* 1999. *Emu* 99: 157–69.
Mac Nally, R. 1997. *Emu* 97: 253–8.
Macarthur, A.J. 1930. *Emu* 30: 143.
Mackness, B., & R. O'Brien. 1997. *Sunbird* 27: 24–5.
Maddeford, W. 2002. *West. Aust. Bird Notes* 103: 25.
Madden, F. 1906. *Emu* 5: 205–6.
Marchant, S. 1979. *Aust. Birds* 13: 59–68.
Mason, P. 1985. *Corella* 9: 14–21.
Masters, J.R., & A.L. Milhinch. 1974. *Emu* 74: 228–43.
Matheson, W.E. 1976. *S. Aust. Orn.* 27: 125–30.
Mawson, P. 2002. *West. Aust. Bird Notes* 103: 23.
McCaskill, L.W. 1945. *NZ Bird Notes* 1: 86–104.
—— 1946. *NZ Bird Notes* 2: 11.
McClymont, J.R. 1903. *Emu* 3: 56–8.
McColl, H.S. 1929. *Emu* 29: 91–100.
McDonald, D. 2001. *Canberra Bird Notes* 26(3): 65–76.
McEvey, A. 1965. *Emu* 65: 1–56.
McFarland, D. 1988. *Emu* 88: 249–57.
McGarvie, A.M., & M.T. Templeton. 1974. *Emu* 74: 91–6.
McGill, A.R. 1955. *Emu* 55: 76–7.
——, & M.T. Goddard. 1979. *Aust. Birds* 14: 23–4.
McGilp, J.N. 1923. *Emu* 22: 274–87.
—— 1925. *Emu* 25: 17–19.
—— 1935a. *Emu* 34: 163–76.

—— 1935b. *Emu* 35: 127–9.
——, & F.E. Parsons. 1937. *S. Aust. Orn.* 14: 3–13.
McGilp, L.K. 1928. *S. Aust. Orn.* 9: 273–4.
McIlroy, J.C. 1968. Unpubl. M. Agricult. Sci., Lincoln Univ., NZ.
McKean, J.L. 1985. *Aust. Bird Watcher* 11: 114–30.
McKenzie, H.R. 1979. *Notornis* 26: 105–19.
McKeown, K. 1923. *Emu* 23: 42–8.
McKilligan, H., & N. McKilligan. 1987. *Sunbird* 17: 17–25.
McKinlay, B. 2001. *Notornis* 48: 47–53.
McMillan, P. 1963. *West. Aust. Nat.* 8: 147.
McNamara, T. 1958. *S. Aust. Orn.22*: 76.
Mees, G.F. 1961. *J. Proc. R. Soc. West. Aust.* 44: 97–143.
—— 1982. *Zool. Verh., Leiden.* 191: 1–188.
Mellor, J.W. 1920. *S. Aust. Orn.* 5: 107–8.
—— 1921a. *S. Aust. Orn.* 5: 23–4.
—— 1921b. *S. Aust. Orn.* 6: 25–6.
—— 1921c. *S. Aust. Orn.* 6: 27.
—— 1921d. *S. Aust. Orn.* 6: 45–8.
—— 1921e. *S. Aust. Orn.* 6: 91.
—— 1922a. *S. Aust. Orn.* 6: 118–20.
—— 1922b. *S. Aust. Orn.* 6: 138–9.
—— 1922c. *S. Aust. Orn.* 6: 178–80.
—— 1923a. *S. Aust. Orn.* 7: 24–5.
—— 1923b. *S. Aust. Orn.* 7: 28–30.
—— 1923c. *S. Aust. Orn.* 7: 108–9.
—— 1925. *S. Aust. Orn.* 8: 95–6.
—— 1926a. *S. Aust. Orn.* 8: 219–23.
—— 1926b. *S. Aust. Orn.* 8: 282.
—— 1926c. *S. Aust. Orn.* 8: 346–8.
—— 1927. *S. Aust. Orn.* 9: 45–7.
—— 1931. *S. Aust. Orn.* 11: 104–6.
—— 1932. *S. Aust. Orn.* 11: 139–40.
Metcalf, E.C. 1989. *Aust. Bird Watcher* 13: 20–9.
Middleton, A.L.A. 1969. *Emu* 69: 44–6.
Milligan, A.W. 1902. *Emu* 2: 68–77.
—— 1903. *Emu* 3: 96–102.
—— 1904. *Emu* 3: 177–9.
Moeed, A. 1976. *NZ J. Zool.* 3: 373–90.
Moffatt, J.D. 1983. *Emu* 83: 310–11.
Mollison, B.C. 1962. *Emu* 62: 112–14.
Moncrieff, P. 1929. *Emu* 28: 301–13.
Moon, G.J.H. 1968. *Notornis* 15: 267.
Morell, R. 1937. *Emu* 37: 18.
Morgan, A.M. 1914. *S. Aust. Orn.* 1(4): 11–21.
—— 1917. *S. Aust. Orn.* 3: 99–109.
—— 1918. *S. Aust. Orn.* 3: 132–6.
—— 1919. *S. Aust. Orn.* 4: 7–20.
—— 1925. *S. Aust. Orn.* 8: 128.
—— 1927. *S. Aust. Orn.* 9: 148–9.
—— 1929. *S. Aust. Orn.* 10: 132–3.
—— 1932. *S. Aust. Orn.* 11: 141–6.
Morgan, D., *et al.* 2005. *Notornis* 52: 61–74.
Moriarty, T.K. 1972. *Emu* 72: 1–7.
Morris, A.K. 1975. *Aust. Birds* 9: 37–76.
—— 1986. *Aust. Birds* 20: 65–81.
——, *et al.* 1981. *Handlist of Birds in New South Wales.* NSW Field Orn. Club, Sydney.
Morris, F.T. 1978. *Aust. Bird Watcher* 7: 165.
Morrison, R.J. 1950. *West. Aust. Nat.* 2: 89.
Morton, H.J. 1954. *S. Aust. Orn.* 21: 48–9.
Mules, M.W. 1932. *S. Aust. Orn.* 11: 212–21.
Napier, J.R. 1969. *Aust. Bird Watcher* 3: 179–92.
Nevill, J. 1976. *Aust. Bird Watcher* 6: 229.
Newell, H.H. 1927. *S. Aust. Orn.* 9: 29–33.
Nichols, O.G., & F.M. Nichols. 1984. *West. Aust. Nat.* 15: 179–89.
Nielsen, L. 1962. *Emu* 62: 143.
—— 1996. *Birds of Queensland's Wet Tropics and Great Barrier Reef.* Gerard Industries, Adelaide.
Noske, R.A., & G.P. Brennan. 2002. *The Birds of Groote Eylandt.* Univ. North. Terr., Darwin.
O'Leary, R.A., & D.N. Jones. 2002. *Corella* 26: 53–4.
Oatley, E. 1966. *Birds (J. NSW FOC)* 1: 26.
Oliver, D.L. 1998. *Aust. Bird Watcher* 17: 309–10.
Orchardist. 1901. *Emu* 1: 13–19.
Osborne, W.S., & K. Green. 1992. *Emu* 92: 93–105.
Parker, S. 1969. *S. Aust. Orn.* 25: 59–71.
Parsons, F.E. 1921. *S. Aust. Orn.* 6: 12–23.

——, & J.N. McGilp. 1934. *S. Aust. Orn.* 12: 192–8.
Passmore, M.D. 1982. *Aust. Bird Watcher* 9: 227–37.
Paton, D.C. 1977. *S. Aust. Orn.* 27: 185.
——, & J.B. Paton. 1980. *S. Aust. Orn.* 28: 120–6.
Paton, J.B. 1975. *S. Aust. Orn.* 26: 180–93.
—— 1977. *S. Aust. Orn.* 27: 185.
Paton, P. 1996. *S. Aust. Orn.* 32: 90.
Pearce, I.M. 1969. *Bird Obs.* 448: 8.
Pearse, N.H. 1929. *S. Aust. Orn.* 10: 135–8.
—— 1938a. *S. Aust. Orn.* 14: 163–5.
—— 1939b. *S. Aust. Orn.* 14: 225–6.
Pearson-Smith, K. 1995. *Aust. Birds* 29: 13.
Pellis, S.M. 1979. Unpubl. PhD thesis, Monash Univ., Melbourne.
—— 1981a. *Bird Behav.* 3: 37–49.
—— 1981b. *Bird Behav.* 3: 61–79.
—— 1983. *Bird Behav.* 4: 57–62.
Peters, D. 1989. *RAOU Rep.* 63: 9–33.
Phillipps, H. 1993. *Wingspan* 12: 10–12.
Phillipps, W.J., & C.J. Lindsay. 1948. *NZ Bird Notes* 3: 43–50.
Phillips, N.A. 1977. *Aust. Bird Watcher* 7: 4.
Phillips, R.E. 1980. *Emu* 80: 177–97.
Pianka, H.D., & E.R. Pianka. 1970. *Emu* 70: 17–22.
Pierce, R.J. 1980. *Notornis* 27: 21–44.
Pizzey, G. 1988. *A Garden of Birds.* Viking O'Neil, Melbourne.
Plumb, W. 1948. *Emu* 47: 291–303.
Pollard, J. 1930. *Emu* 30: 62–3.
Porter, D. 1993. *Notornis* 40: 246.
Porter, J.W., & R. Henderson. 1983. *Sunbird* 13: 61–8.
Pratt, E. 1972. *Sunbird* 3: 11–12.
Pratt, H.D., *et al.* 1989. *A Field Guide to the Birds of Hawaii and the Tropical Pacific.* Princeton Univ. Press, Princeton, NJ.
Preston, I. 1983. *Aust. Bird Watcher* 10: 132–5.
Price, G. 1977. *Aust. Bird Watcher* 7: 134–6.
Pringle, M. 1906. *Emu* 6: 66–7.
Quinn, W.J. 1959. *Bird Obs.* 335: 4.
—— 1961. *Aust. Bird Watcher* 1: 179.
Ragless, G.B. 1958. *S. Aust. Orn.* 22: 73–5.
Randell, A.S. 1930. *S. Aust. Orn.* 10: 236–8.
Rankin, N.A. 1970. Unpubl. BSc(Hons) thesis, Univ. Canterbury, Christchurch.
Ratkowsky, A.V. 1993a. *Tasm. Nat.* 113: 7–8.
—— 1993b. *Tas. Bird Rep.* 22: 15–22.
——, & D.A. Ratkowsky. 1980. *Emu* 80: 169–70.
Read, J.L., *et al.* 2000. *S. Aust. Orn.* 33: 71–83.
Recher, H.F., & R.T. Holmes. 1985. Pp 79–96 **In**: Keast *et al.* 1985.
——, *et al.* 1985. *Aust. J. Ecol.* 10: 399–419.
Reid, H. 1971. *Victorian Nat.* 88: 61.
Ridpath, M.G., & R.E. Moreau. 1966. *Ibis* 108: 348–93.
Rix, C.E. 1976. *Aust. Bird Watcher* 6: 330–54.
Roberts, N.L. 1936. *Emu* 36: 54–5.
—— 1963. *Emu* 63: 234–41.
Roberts, R.G. 1975. *Aust. Bird Watcher* 6: 61–8.
Robertson, H.A., *et al.* 1993. *Notornis* 40: 253–62.
Robinson, A.H. 1939. *Emu* 38: 461–6.
—— 1945. *Emu* 45: 100–9.
—— 1955. *West. Aust. Nat.* 4: 187–92.
—— 1956. *Emu* 56: 233–336.
—— 1975. *Emu* 75: 23–7.
Robinson, F.N. 1977. *Aust. Bird Watcher* 7: 1–4.
—— 1991. *Emu* 91: 61–3.
Rogers, K.G., *et al.* 1990. *RAOU Rep.* 67.
Rollinson, D.J. 2002. *Sunbird* 32: 19–21.
——, & D.N. Jones. 2002. *Urban Ecosystems* 6: 257–69.
——, *et al.* 2003. *Corella* 27: 52–8.
Rose, A.B. 1973. *Emu* 73: 177–83.
—— 1974. *Aust. Birds* 9: 26–30.
—— 1999. *Aust. Bird Watcher* 18: 106–20.
—— 2000. *Aust. Bird Watcher* 18: 274–9.
Ross, J.A. 1924. *S. Aust. Orn.* 7: 261–2.
—— 1926. *Emu* 25: 179–83.
Rowley, I.C.R. 1961. *Emu* 61: 7–17.
—— 1975. *Bird Life.* Collins, Sydney.
—— 2002. *Bird Obs.* 817: 6–7.
—— 1978. *Ibis* 120: 178–97.
Russell, J. 1921. *Emu* 21: 137–42.
Saffer, V.M. 2001. *Corella* 25: 15–17.
Sanders, M.D., & R.F. Maloney. 2002. *Biol. Conserv.* 106: 225–36.

Sanderson, K., & H. Crouch. 1993. *Aust. Bird Watcher* 15: 162–4.
Saunders, D.A., & C.P. de Rebeira. 1985. *Aust. Wildl. Res.* 12: 467–77.
——, & J.A. Ingram. 1995. *Birds of Southwestern Australia.* Surrey Beatty, Sydney.
Saunders, G.R., & K. Cooper. 1982. *Emu* 82: 227–9.
Scambler, E. 1996. *Aust. Bird Watcher* 16: 219.
Schlager, F. 1984. *Canberra Bird Notes* 9(4): 158.
Schmidt, B.L. 1978. *Aust. Birds* 12: 61–86.
Schokman, F.C.M. 1991. *Tas. Bird Rep.* 20: 4–17.
Schulz, M. 1991. *Aust. Bird Watcher* 14: 95–102.
Secker, H.L. 1952. *Notornis* 5: 24–5.
Sedgwick, E.H. 1936. *Emu* 36: 52–3.
—— 1940. *Emu* 40: 237–45.
—— 1946. *Emu* 46: 349–78.
—— 1948. *Emu* 48: 59–63.
—— 1951. *Emu* 50: 266.
—— 1953. *West. Aust. Nat.* 4: 12–20.
—— 1955. *West. Aust. Nat.* 5: 46–7.
—— 1956. *West. Aust. Nat.* 5: 63–70.
—— 1962. *West. Aust. Nat.* 8: 87–96.
—— 1973a. *West. Aust. Nat.* 12: 131–9.
—— 1973b. *West Aust. Nat.* 12: 147–55.
—— 1986a. *Aust. Bird Watcher* 11: 146–9.
—— 1986b. *Aust. Bird Watcher* 11: 171–80.
—— 1988. *Aust. Bird Watcher* 12: 222–32.
Sedgwick, L.E. 1964. *Emu* 64: 7–19.
Serventy, D.L. 1926. *Emu* 26: 64–9.
—— 1948. *Emu* 47: 241–86.
—— 1949. *West. Aust. Nat.* 2: 46–7.
—— 1953. *Emu* 53: 131–45.
—— 1968. *West. Aust. Nat.* 11: 14–18.
Sexton, J.M. 1922. *Emu* 21: 312.
Sharland, M.S.R. 1922. *Emu* 22: 151.
—— 1932. *Emu* 31: 270.
—— 1942. *Emu* 41: 205–7.
Sharp, A., & S. Sewell. 1995. *Sunbird* 25: 49–59.
Shurcliff, A., & K. Shurcliff. 1973. *S. Aust. Orn.* 26: 127–32.
Sibley, C.G., & B.L. Monroe, Jr. 1990. *Distribution and Taxonomy of Birds of the World.* Yale Univ. Press, New Haven, CT.
Sibson, R.B. 1947. *NZ Bird Notes* 2: 134–44.
—— 1958. *Notornis* 7: 213–19.
Simpson, K. 2000. *Bird Obs.* 805: 8.
Slaney, H.B. 1922. *Emu* 21: 238–9.
Slater, P. 1962. *West. Aust. Nat.* 8: 124–6.
Smith, A. 1920. *Emu* 19: 245.
Smith, L.F. 1995. *Aust. Bird Watcher* 16: 78.
Sonter, C. 1980. *Canberra Bird Notes* 5(3): 3–23.
Souter, T.G. 1925a. *S. Aust. Orn.* 8: 34.
—— 1925b. *S. Aust. Orn.* 8: 35.
—— 1926. *S. Aust. Orn.* 8: 344–5.
—— 1927. *S. Aust. Orn.* 9: 70–1.
—— 1928. *S. Aust. Orn.* 9: 231–5.
—— 1930. *S. Aust. Orn.* 10: 176–7.
Steele, W.K. 1997. *Bird Hazards and Their Management at Melbourne International Airport.* Unpubl. Rep. by Birds Aust. for Melbourne Airport.
Stephen, W.J. 1907. *Emu* 7: 88.
—— 1909. *Emu* 9: 93.
Stevens, J.H. 1975. *Aust. Bird Watcher* 6: 77–9.
Stidolph, R.H.D. 1977. *Notornis* 24: 196–7.
Stokes, T. 1979. *Corella* 3: 77–81.
Storr, G.M. 1965. *Emu* 64: 172–80.
—— 1981. *Rec. West. Aust. Mus.* 9: 65–99.
Stove, K. (Ed.) 1994. *S. Aust. Orn.* 31: 195–265.
Stranger, R.H. 1963. *West. Aust. Nat.* 8: 174–5.
—— 1993. *West Aust. Nat.* 19: 257–64.
Sullivan, C. 1929. *Emu* 29: 76.
Sutton, J. 1919. *S. Aust. Orn.* 4: 96–9.
—— 1923. *S. Aust. Orn.* 7: 24.
—— 1924. *S. Aust. Orn.* 7: 118–59.
—— 1926. *S. Aust. Orn.* 8: 334–9.
—— 1927a. *S. Aust. Orn.* 9: 5–29.
—— 1927b. *S. Aust. Orn.* 9: 72–5.
—— 1928. *S. Aust. Orn.* 9: 173–83.
—— 1929. *S. Aust. Orn.* 10: 22–45.
—— 1930. *S. Aust. Orn.* 10: 186–94.
—— 1932. *S. Aust. Orn.* 11: 174–84.
—— 1933. *S. Aust. Orn.* 12: 106–9.
—— 1937. *S. Aust. Orn.* 14: 74–8.
Sutton, P. 1998. *Tas. Bird Rep.* 26: 24–8.
Symon, O. 1946. *S. Aust. Orn.* 18: 24–5.
Talmage, M.E. 1997. *VORG Notes* 32(2): 39–49.
—— 1999. *VORG Notes* 34(1): 4–10.
Tarr, H.E. 1964. *Aust. Bird Watcher* 2: 85–8.
Taylor, I.M. 1982. *Canberra Bird Notes* 7(3): 63–5.
—— 1984. *Canberra Bird Notes* 9(3): 50–139.
—— 1986. *Canberra Bird Notes* 11(4): 131.
—— 1987. *Canberra Bird Notes* 12(4): 110–31.
Taylor, P.W. 1987. *S. Aust. Orn.* 30: 62–73.
Terrill, S.E. 1944. *S. Aust. Orn.* 17: 44.
——, & S.E. Rix. 1950. *S. Aust. Orn.* 19: 53–99.
Thomas, D.G. 1979. *Tasmanian Bird Atlas.* Univ. Tas., Hobart.
Thomas, D.J., & A.M. Gilmore. 1976. *Aust. Wildl. Res.* 3: 189–208.
Thomson, G.M. 1922. *The Naturalization of Animals and Plants in New Zealand.* Cambridge Univ. Press, Cambridge.
Thorogood, H. 1941a. *Emu* 40: 328.
—— 1941b. *Emu* 40: 418–19.
Tilley, D.M. 1926. *Emu* 25: 214–16.
Tindale, N.B. 1925. *S. Aust. Orn.* 8: 10–21.
—— 1930. *S. Aust. Orn.* 10: 209–12.
Toon, A., *et al.* 2003. *Emu* 103: 337–43.
Traill, B.J. 1985. *Aust. Bird Watcher* 11: 74–9.
——, *et al.* 1996. *Aust. Bird Watcher* 16: 309–26.
Trémont, S. 1995. *Aust. Bird Watcher* 16: 79.
van Tets, G.F., *et al.* 1969. *CSIRO Wildl. Res.* 14: 129–51.
——, *et al.* 1977. *Guide to the Recognition and Reduction of Aerodrome Bird Hazards.* Aust. Govt Publ. Serv., Canberra.
Veltman, C.J. 1984. Unpubl. PhD thesis, Massey Univ., Palmerston North, NZ.
—— 1989a. *Ibis* 131: 601–8.
—— 1989b. *Ardea* 77: 211–16.
——, & R. Carrick. 1990. *Anim. Behav.* 40: 190–2.
——, & R.E. Hickson. 1989. *Aust. J. Ecol.* 14: 319–26.
Vestjens, W.J.M. 1973. *Emu* 73: 107–12.
—— 1977. *Tech. Memo. Div. Wildl. Res. CSIRO, Aust.* 12.
——, & R. Carrick. 1974. *Aust. Wildl. Res.* 1: 71–83.
Vincent, D. 1975. *S. Aust. Orn.* 27: 21.
Waite, E.R. 1903. *Nature* 68: 322.
Walters, I.N. 1980. *Sunbird* 11: 47–8.
—— 1985. *Aust. Bird Watcher* 11: 17–27.
Warham, J. 1960. *Emu* 60: 1–7.
Warne, R.M., & D.N. Jones. 2003. *Wildl. Res.* 30: 265–7.
Watling, D. 1982. *Birds of Fiji, Tonga and Samoa.* Millwood Press, Wellington, New Zealand.
Watson, D.M. 2002. *Emu* 102: 275–81.
Watson, I.M. 1955. *Emu* 55: 224–48.
Watts, D. 1999. *Field Guide to Tasmanian Birds.* New Holland, Sydney.
Webb, E.H. 1902. *Emu* 2: 109–10.
Westerskov, K. 1954. *Notornis* 5: 243–8.
Wheeler, J.R. 1959. *Aust. Bird Watcher* 1: 6–7.
White, G. 1985. *Birds and Other Vertebrates of South West Tasmania.* Author, Sydney.
White, H.L. 1922a. *Emu* 21: 167–9.
—— 1922b. *Emu* 22: 99–116.
—— 1922c. *Emu* 22: 149.
—— 1923. *Emu* 23: 2–3.
White, J.G., *et. al.* 2005. *Landscape Urban Planning* 71 (2–4): 123–35.
White, S.A. 1912. *Emu* 12: 1–8.
—— 1913. *Emu* 13: 16–32.
Whitley, G.P. 1971. *West. Aust. Nat.* 12: 41–4.
Whitlock, F.L. 1909. *Emu* 8: 173–94.
—— 1910. *Emu* 9: 181–219.
Wigan, M.L. 1931. *Emu* 30: 303.
—— 1942. *Victorian Nat.* 58: 182.
Wilson, A.H. 1922. *Emu* 21: 202–5.
Wilson, H.M. 1946. *Emu* 45: 233–44, 271–86.
—— 1950. *Emu* 50: 122.
Wood, J. 1998. *Notornis* 45: 126–8.
Woodall, P.F. 1994. *Sunbird* 24: 22–4.
—— 1999. *Sunbird* 29: 29–40.
Zietz, F.R. 1914. *S. Aust. Orn.* 1(4): 28–9.

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Australian Magpie  *Gymnorhina tibicen*   (page 579)
SUBSPECIES *TERRAEREGINAE*:  **1** Adult male; **2** Adult female; **3** Juvenile; **4** First immature; **5, 6** Adult male
SUBSPECIES *TYRANNICA*:  **7** Adult male; **8** Adult female; **9** Juvenile; **10** First immature; **11** Adult male
HYBRID *TERRAEREGINAE* x *TYRANNICA*:  **12** Adult male
SUBSPECIES *DORSALIS*:  **13** Adult female