

Order CUCULIFORMES

A diverse and heterogeneous group, thought on the basis of DNA–DNA hybridization studies (Sibley & Ahlquist 1990) to comprise six families: (1) CUCULIDAE: True cuckoos and koels of Old World; all parasitic; roughly 46–54 species in 13–17 genera; *Cuculus* and *Chrysococcyx* largest genera (both in HANZAB region); (2) CENTROPODIDAE: Coucals, ground-cuckoos and couas of Palaeotropics; non-parasitic; about 39–42 species in three genera; (3) COCCYZIDAE: New World cuckoos, with about 18 species; (4) OPISTHOCOMIDAE: Monotypic Hoatzin *Opisthocomus hoatzin* of Amazonia; systematic position disputed and sometimes thought to be closer to Galliformes (e.g. Brush 1979; Campbell & Lack 1985); Sibley & Ahlquist (1973) suggested most closely related to Guira Cuckoo *Guira guira* (Crotophagidae); (5) CROTOPHAGIDAE: Anis of Neotropics; four species in two genera; gregarious, non-parasitic, communally breeding species; (6) NEOMORPHIDAE: New World ground-cuckoos and road-runners; 13 species, three of which parasitic, in six genera. About 143 species in total; on all continents except Antarctica, with species diversity greatest in the Tropics; generally absent from higher latitudes of North America and Eurasia, and s. South America (s. Chile and Argentina). Cuculiformes appear to be an ancient lineage with no close living relatives (Sibley & Ahlquist 1990). Turacos, or louries (Musophagidae), endemic to Africa, have traditionally been placed in this order (e.g. Sibley & Ahlquist 1972), but studies of DNA–DNA hybridization (Sibley & Ahlquist 1990), osteology, myology and pterylography (Lowe 1943), structure and pigmentation of feathers (Brom 1991; Dyck 1992), and development of young, diet and feather lice (Rowan 1983) suggest there are no close affinities between the turacos and Cuculiformes; they are best kept separate ordinarily (Rowan 1983; Fry *et al.* 1988; *contra* Campbell & Lack 1985).

Range from small (c. 15 cm) to large (c. 70 cm). Most have rather short, slender bills; straight or decurved; in some, bills large to massive (e.g. *Scythrops*). Holorhinal; nares more or less impervious. No basipterygoid processes; no cere; and rostrum immovable. Palate desmognathous, with small vomer. Fourteen cervical vertebrae (13 in *Clamator*), 17–18 presacral vertebrae, four dorsal vertebrae; atlas perforated; furcula present, no bony canal formed by coracoid, four ribs each sternum. Foot zygodactyl, with fourth toe permanently reversed; flexor tendons type 1; podotheca scutellate. Oil-gland, bilobed; naked in most families; has small tuft in some Opisthocomidae. Afterfeathers absent or small, eyelashes present. Ten primaries; 9–13 secondaries, eutaxic; usually ten rectrices (eight in Crotophagidae).

One species at least, the Common Cuckoo *Cuculus canorus*, has been known since antiquity because the calls of males during the breeding season attract attention and because its parasitic habits are mysterious and intriguing. For centuries, its two-note call has been incorporated in madrigals and in the works of such composers as Beethoven, Delius and Saint-Saens. The vernacular name of the bird in many languages is based onomatopoeically on its call. Parasitic habits were first recorded in ancient Vedic literature about 2000 BC for Common Koel *Eudynamis scolopacea* (Friedmann 1964) and Aristotle (384–322 BC) was aware of the matter. Yet the breeding habits of many species are still unknown or incompletely known. Many species were first described scientifically in the last half of the 18th century by such workers as Linnaeus and Latham; nearly all had been described by the middle of the 19th century, though there has been much re-arrangement since then into genera and subspecies. All species that occur in Aust. and NZ had been described by 1867, by Latham, Gould, Horsfield, Gmelin and others.

The mobility of members of the Order is as diverse as its other characters. All species are capable of flight, which varies from the swift and direct flight of long-distance migrants with their comparatively long, narrow and pointed wings (e.g. Oriental Cuckoo *Cuculus saturatus*), to the gliding flight of short-winged tropical forest-dwelling malkohas, and the awkward slow flight of short-winged tropical coucals (Centropodidae). Within Cuculidae, the flight of larger species is generally swift, noticeably direct, undulating and rather hurried, with deep rapid wing-beats not rising above the horizontal and often surprisingly like the flight of small species of *Accipiter*; indeed the general appearance, flight-silhouette and actions of these cuckoos bears some resemblance to these small birds of prey so that several species bear the name hawk-cuckoo. Species of *Cacomantis*, however, fly from perch to perch directly with undulating flight or bursts of rapid wing-beats interspersed with short glides. *Scythrops* often flies in pairs and quite high, with strong powerful wing-beats. Most adult cuckoos have a long tail which is used both as a rudder in slow flight and, in the case of cursorial ground-living cuckoos, as a steering device. Typical cuckoos awkward on ground, with shuffling walk (body and tail swivelling) and hopping. When on ground, coucals are generally slow and clumsy in their movements, but move rapidly in pursuit of prey. When capturing ground-prey, move forward with slow stalking walk, changing to hop and run when close to prey, and either ambush or chase down prey using 'flush and rush' method.

Only Cuculidae and Centropodidae occur in HANZAB region, and other families not considered further here. Occur in most habitats, from open shrublands in arid and semi-arid zones to tropical rainforest. Some species largely arboreal; others at least partly arboreal; and others largely terrestrial (especially Centropodidae). Migratory and resident (Payne 1997). Most detailed migration studies of Black-billed *Coccyzus erythrophthalmus* and Yellow-

billed Cuckoos *C. americanus* (Coccyzidae); these species migrate at night, orientate by stars and make direct flights of up to 4000 km (Payne 1997). Worldwide, species of Cuculidae resident, migratory and partly migratory. Tropical species tend to be resident, and temperate species tend to be migratory. Where species have widespread latitudinal distributions, same pattern of tropical residents and temperate migrants often apparent at populational level (Payne 1997). Worldwide, all Centropodidae considered resident except for populations of two species inhabiting dry areas, which are apparently migratory (Payne 1997). Nearly always solitary or, in monogamous species, in pairs. Most coucals and some cuckoos monogamous; others promiscuous. Monogamous species generally territorial. Vocal, advertising territories and for mates. Displays, both agonistic and sexual, well developed. Courtship feeding probably universal. For full details of social organization, social behaviour and breeding, see Family discussions.

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Family CUCULIDAE true cuckoos and koels

About 46–54 species of obligate brood-parasites in about 13–17 genera; 13 species in five genera in HANZAB region. The limits of Cuculidae not firmly established, and whether or not allied, non-parasitic forms (i.e. the 15 or so species of Old World malkohas [Phaenicophainae]) should be regarded as Cuculidae is not clear; status of extralimital *Clamator* is complex (unusual in possessing large crests, and in details of sequence of moult, structure of sternum and pelvis, and pelvic musculature) and warrants investigation (Schodde & Mason 1997). Following Schodde & Mason (1997) we only discuss true cuckoos and koels (including *Clamator*) in the following summary.

Small to large, rather slender birds. Following diagnosis based on Witherby et al. (1938) and Schodde & Mason (1997). Bills slightly decurved, and usually small, though bill stout in some, and massive in *Scythrops*; nostrils swollen and rounded, often with distinctive ‘crater-shaped’ raised rim; and rictal bristles vestigial. Nasal septum imperforate. Palate desmognathous, with vestigial and incomplete vomer; maxillary processes swollen and straight; lachrymals moderately enlarged to vestigial, sometimes almost reaching jugal bar, free from thin, varying enlarged ectethmoids; basipterygoid processes vestigial. Atlas notched or perforated; 14 cervical vertebrae (13 in *Clamator*). Sternum double-notched to almost entire on either side, both spina interna and externa present (fused in *Clamator*) or only spina externa (*Eudynamys*, *Scythrops*). Muscle formula ABXY or AXY (ABEXY in *Clamator*). Feet rather weak, adapted for perching; zygodactyl, with outer toe permanently reversed; tarsi, scutellate; toes have short claws; hypotarsus has two closed canals. Carotids paired. Syrinx tracheo-bronchial. Tongue small, cartilaginous. No crop; caeca present, rather long. Uropygial gland well-developed, naked. Plumage of body, soft and sleek; no down or afterfeathers; contour feathers close in varied tracts but without apterium between dorsal-cervical and interscapular tracts. Wings usually pointed, rounded in some; ten primaries; 9–12 secondaries, eutaxic; four feathers in alula. Tail ranges from short to long and graduated; ten rectrices.

Adults often intricately patterned; not usually brightly coloured, but some species brilliantly glossed green (e.g. *Chrysococcyx*) or blue-black (e.g. koels). Most have barred tails; some have brightly coloured bare parts. Sexual dimorphism in plumage striking in many species, slight to negligible in many others; *Cuculus* often polymorphic, with barred (so-called hepatic) morph only occurring in some or all females. Males often slightly larger than females. Young altricial and nidicolous; hatch naked or with sparse, stiff, hair-like down; in first week of life, species that evict eggs from host-nest (e.g. *Cuculus*, *Chrysococcyx*; see species accounts) have hollow in back in which balance host’s egg while it is pushed from nest. Colouring of nestlings mimics that of host-nestlings in some species (see below for more details). Juveniles usually differ markedly from adults; adult plumage usually attained in complete first or second pre-basic moult when no more than 1 year old. Primaries replaced in complex ‘transilient’ sequence that varies markedly between species; see Stresemann & Stresemann (1961, 1966) for reviews.

Occur throughout Eurasia, Africa and Madagascar, to islands of sw. Pacific Ocean and A’asia; distribution centred in Palaeotropics (Schodde & Mason 1997). In Aust., one species or another spread throughout continent; Pallid Cuckoo *Cuculus pallidus* and Horsfield’s Bronze-Cuckoo *Chrysococcyx basalis* are the most widespread, occurring in all States; most others are confined to, or more common, in e., n. and sw. Aust. (Aust. Atlas; see species accounts). In NZ, Shining Bronze-Cuckoo *C. lucidus* widespread in most regions, and the Long-tailed Cuckoo *Eudynamys*

taitensis, though more restricted in range, is also quite widespread (NZ Atlas; see species accounts). Worldwide, inhabit a wide variety of habitats, ranging from open shrublands in arid and semi-arid zones (e.g. Black-eared Cuckoo *Chrysococcyx osculans*) to tropical rainforest (e.g. Chestnut-breasted Cuckoo *Cuculus castaneiventris*). For parasitic species, breeding habitat is as that of host-species (and no details are given in the texts).

Migratory, partly migratory or resident. Species breeding in temperate regions usually but not always strongly migratory; for example, reasonably well-known European breeding population of Common Cuckoo *Cuculus canorus* breeds Apr.–July, and moves to sub-Saharan Africa in n. hemisphere autumn and winter, thus crossing the Equator; most cuckoos or populations of cuckoos breeding in s. Africa are migratory (Payne 1997; BWP). In HANZAB region, only Chestnut-breasted Cuckoo thought to be non-migratory, though some species poorly known (e.g. Black-eared Cuckoo); Oriental Cuckoo *Cuculus saturatus* spends non-breeding period in n. Aust., moving from breeding grounds in Asia (BWP). Most species breeding in HANZAB region move to non-breeding areas in lower latitudes, in n. Aust., Asia or Pacific islands (e.g. Long-tailed Cuckoo). In many cases relationship between breeding and non-breeding areas poorly known (e.g. Brush *Cacomantis variolosus* and Pallid Cuckoos) and complicated by overlap of populations during migration (e.g. in e. Aust. for the Shining Bronze-Cuckoo) or on non-breeding grounds (e.g. in Moluccas for Channel-billed Cuckoo *Scythrops novaehollandiae*). In some species, populations in n. Aust. appear to be resident (e.g. Shining Bronze-Cuckoo, Goulds Bronze-Cuckoo *Chrysococcyx russatus*) and in a number of species extralimital forms are non-migratory (e.g. populations of Little Bronze-Cuckoo *Chrysococcyx minutillus*). Some species make long trans-oceanic flights (e.g. Long-tailed Cuckoo). Commonly strike windows and lighthouses during migration. Young of many species thought to remain for first year in breeding range, or in non-breeding range; thus often thought to account for out-of-season records. Some evidence that young leave breeding areas after adults; in at least some extralimital members of family that are migratory (e.g. Common Cuckoo), adults leave breeding grounds before young (BWP). Similar pattern is apparent in at least some species breeding in HANZAB area, e.g. Fan-tailed Cuckoo *Cacomantis flabelliformis* and Pallid Cuckoo (see accounts). Some migratory species appear to lay down pre-migratory fat (Payne 1997); a little evidence suggests this may occur in at least some species in HANZAB region (e.g. Oriental Cuckoo, Bigg & Bigg 1988); further research needed. At least some migrate at night (e.g. Pallid Cuckoo and Long-tailed Cuckoo). Appears to be little strong evidence for any strictly diurnal migrants in HANZAB area (see accounts); claim that Channel-billed Cuckoo migrates during daytime (Payne 1997) neither differentiates migratory from local movements nor accounts for evidence of nocturnal movements (see account).

Understanding of movements hampered by lack of knowledge of relations between detectability and calling. For example, arrival dates based on first calling assume birds call as soon as they arrive; additionally, earliest arrivals might not be indicative of main arrival. Consequently, first arrivals based on calls warrant cautious interpretation. Further, problems relate to difficulty with assigning birds as breeders or non-breeders; e.g. breeding populations of Channel-billed Cuckoo on Bismarck Arch. only recently discovered (Mason & Forrester 1996). Further studies of geographical variation (e.g. Gill 1983) needed.

Mainly insectivorous; many specialize on hairy, sometimes toxic, caterpillars usually avoided by other birds. Stomachs often found to be lined profusely with hairs from caterpillars. Not all insectivorous: in HANZAB region, Common Koel *Eudynamis scolopacea* and Channel-billed Cuckoo eat fruits as well as insects, and Long-tailed Cuckoo rather carnivorous, eating small vertebrates. Mostly diurnal feeders, though, in HANZAB region, Long-tailed Cuckoo at least partly nocturnal. Forage solitarily, less often in pairs; may occasionally form small feeding groups. Feed mostly on or near ground, though able to obtain food at any level, from tops of trees to ground. Usually hunt through foliage and glean prey as they hop or creep about, or sit on lower perches, watching for prey on ground or in low vegetation, which captured by sally-pounce. Prey normally bashed against branches till gut and toxic contents removed before it is swallowed. Bills of most species show no special adaptations, though frugivorous species show some, e.g. large laterally compressed bill of *Scythrops* and unusually decurved and hooked bill of *Eudynamis*. Proventriculus large and well developed, and walls are twice as thick as those of stomach. Excrete indigestible matter by regurgitation; can periodically shed the weak lining of stomach (Wyllie 1981).

Social organization and behaviour complex and vary greatly but generally poorly known; best known from some African and European species (Wyllie 1981; Rowan 1983; Fry *et al.* 1988; BWP). Most species obligate brood-parasites. Common Koel, Channel-billed Cuckoo and *Clamator* monogamous, forming bonds lasting at least for a season; otherwise promiscuous or perhaps polygynous; Long-tailed Cuckoo may form leks (McLean 1988). Apart from migration when small flocks can occur, monogamous species usually seen in pairs and other species mostly solitary; larger gatherings occur occasionally at sources of food. Some species territorial, including monogamous ones; others not territorial (Wyllie 1981). Males highly vocal; call to advertise territory or for mates; females of monogamous species also vocal in contrast to other species. Display behaviour, both sexual and agonistic, well developed and varying; often includes display flights and chases and usually noisy. Communal gatherings of several birds calling, chasing and displaying common in non-monogamous species. Courtship feeding probably universal (Smithers 1977; Rowan 1983); in many species occurs before, during or after copulation; in non-frugivorous species, male usually feeds female caterpillars. Feeding of fledgelings by adults commonly reported (e.g. Moreau & Moreau 1939; see species

accounts, such as Shining Bronze-Cuckoo) but many probably misidentified cases of courtship feeding (Rowan 1983). However, other cases are unequivocal (e.g. Ambrose 1987), though even these may be misdirected courtship feeding by adult cuckoos. Only in monogamous species is it usual for males to assist females with laying by distracting the hosts; these species are also only ones in which females often lay repeatedly in the same nest and the nestlings do not eject eggs or young of hosts (e.g. see species accounts). Nestlings produce foul-smelling liquid faeces when disturbed. Fledgelings beg persistently and attract others besides foster-parents to feed them.

Obligate brood-parasite. Breeding reasonably known for most species in HANZAB region; Brooker & Brooker (1989a) undertook a detailed review of the breeding biology of all Aust. cuckoos, summarizing records of cuckoo eggs and nestlings, feeding of cuckoo chicks, and general statements of parasitism, based on published literature, museum and private egg-collections, records in NRS and ABBBS, and unpublished data. The breeding of parasitic cuckoos has long attracted human attention and, as it is not easily observed, somewhat mysterious, and rouses strong feelings in some people, it has given rise to many myths. Typically lay single egg in nest of passerine smaller than itself and at the same time remove an egg of the host; usually all incubation and care of nestlings and fledgelings by host. Breeding generally seasonal, with timing of laying coinciding with laying by host-species. Female cuckoo finds nest of host by watching nest-building birds inconspicuously from a concealed perch, and by searching through habitat of host-species. Cuckoo often visits nest when owner is away feeding, though in some species, mate distracts hosts while female lays in nest (Linton 1930; Payne 1997). Chance (1922, 1940) found that in fairly open country, female Common Cuckoos spent many hours at a vantage point, sitting quietly and watching the activities of potential hosts, no doubt trying to find nests. However, in woodland and forest in se. Aust., Fan-tailed Cuckoos and Shining Bronze-Cuckoos have been seen searching furtively through low understorey and not feeding; it may be a different strategy used in denser vegetation (S. Marchant). Females may also be able to carry a mature egg in the oviduct for a day or so in emergencies because developing embryos have been reported in newly laid eggs (Liversidge 1961; Perrins 1967; Payne 1973). It has also been suggested that females may be able to store sperm (Marchant 1989).

There has been much argument and controversy about how cuckoos deposit eggs in nests of hosts, particularly enclosed nests or nests that seem inaccessible. Many claims of cuckoos carrying its egg in its bill, or even its foot, from ground to host-nest (see species accounts). However, detailed studies have shown that cuckoos lay directly in nest of host-species and all claims of carrying eggs to nests must be considered doubtful. Chance (1922, 1940) proved conclusively that the Common Cuckoo lays its eggs directly in open cup-shaped nests of hosts (taking only a few seconds) and this has been confirmed since (Wyllie 1981). In HANZAB region, some cuckoos habitually parasitize hosts with domed nests with very small entrances, such as thornbills *Acanthiza* and scrubwrens *Sericornis*; Brooker *et al.* (1988) and Brooker & Brooker (1989b) have shown that Horsfield's and Shining Bronze-Cuckoos lay in the normal way in the nests of fairy-wrens *Malurus* and thornbills *Acanthiza*. The entrances of nests of Brown Thornbills *A. pusilla* parasitized by Fan-tailed Cuckoos are characteristically enlarged, damaged or distorted compared with those of unparasitized nests (S. Marchant). In HANZAB region, all species except Channel-billed Cuckoo lay single egg per host-nest, and most species usually remove egg of host after laying; the whole process takes only a few seconds. Channel-billed Cuckoos (and, extralimitally, *Clamator*) usually lay two or three eggs per host-nest but can lay up to five; they also do not necessarily remove an egg of host. Extralimitally, Common Koels lay more than one egg per nest (Baker 1934). Clutch-size of an individual female cuckoo has rarely been established but may be about ten in Common Cuckoo (Chance 1922, 1940); probably fewer in Aust. species. Some nests can contain eggs of more than one species of cuckoo, and cuckoos will remove eggs of other cuckoos. Laying usually occurs during or shortly after laying of host-clutch; eggs laid before those of host usually deserted or buried in nest. Eggs have hard and thick shell that resists cracking when female lays from above nest (Payne 1997).

In some species, the eggs closely match those of the host. Such mimicry is well known in Common Cuckoo and several Indian species (e.g. Baker 1942). In HANZAB region, mimicry is known for eggs of Horsfield's Bronze-Cuckoo, Pallid and Channel-billed Cuckoos; sometimes the match is so close that it is almost impossible to distinguish between cuckoo's eggs and those of the host. Other cuckoos, such as Shining Bronze-Cuckoo and Fan-tailed Cuckoo, make no attempt to mimic host-eggs; both these cuckoos use as hosts species that build covered and domed nests, where light inside nest is probably very poor and mimicry rather pointless (Marchant 1972b; S. Marchant). Although long lists of host-species are known for many parasitic cuckoos, most use the nests of only a few species regularly, and female cuckoos of the same species may lay eggs that closely mimic those of different hosts; non-mimetic eggs are possibly laid in nests of other hosts when suitable nests of preferred host are not available (Baker 1942; Rowan 1983). However brood parasitism by cuckoos arose, the evolution of egg-mimicry can most reasonably be assumed to be an effort to mislead the host-species and to lessen the chance of it removing a strange egg from its nest or deserting it altogether, thus ensuring the breeding success of the cuckoo; no doubt the more closely the parasite's eggs resemble those of host, the less chance of the host rejecting them or deserting its nest. A full discussion of the evolution of mimicry of host-eggs is beyond this summary; see Marchant (1972b), Brooker & Brooker (1989a,b), Baker (1942), Rowan (1983) and Payne (1997) for further discussion.

Mean size of eggs varies from 17.9 × 12.1 for Horsfield's Bronze-Cuckoo to 43.7 × 30.5 for Channel-billed Cuckoo

(Campbell; North); extraliminally, smallest eggs 16.9×12.3 , of Asian Emerald Cuckoo *Chrysococcyx maculatus* (Baker 1934). Cuckoos sometimes destroy contents of nests, probably to induce hosts to nest again and provide a suitable nest for parasitizing (Fien 1970; Marchant 1972a). Incubation period ranges from 12 to 25 days and is generally shorter than that of host-species. Young altricial, nidicolous. Generally do not develop down, but young of some species can hatch with a few trichoptiles or wisps of short down (Brooker & Brooker 1989a). Young of most species (and all species in HANZAB region except Channel-billed Cuckoo) eject eggs or young of host, usually within 48 h; Channel-billed Cuckoos generally do not evict eggs or young of host and will share nest with both conspecifics and young of host. Extraliminally, in India, Common Koel do not eject eggs or young of host, and young of Common Koel and host often found together in nest, though, like Channel-billed Cuckoo, young of cuckoo usually out-compete young of host, which often disappear from nest (Baker 1934; Ali & Ripley 1969; Goddard & Marchant 1983). Cuckoo young specially adapted, with broad flattened back to evict eggs or young of host by manoeuvring them onto its back tipping them out of nest (see above). Method of evicting young of host well-described for Brush (Hindwood 1930), Fan-tailed and Pallid Cuckoos (Cole 1908; Campbell 1915), Horsfield's Bronze-Cuckoo (Campbell), and Common Koel (Gosper 1964): chick works to gain a position under eggs or young of host till they are lodged on Cuckoo's back and against wall of nest; Cuckoo stiffens neck and rests head against bottom of nest for extra support; then reaches behind with wings to gain purchase on rim of nest for extra leverage and by pushing and pulling up and backward with legs, wings and shoulders, ejects eggs or young of host from nest. Little data for other species but method of eviction probably similar. Develop rapidly; most cuckoos fledge at 16–20 days, depending on host-species; up to c. 4 weeks for Channel-billed Cuckoo, Common Koel and Long-tailed Cuckoo. Fledgelings dependent on foster parents for up to 6 weeks; may be fed by birds other than hosts, and by more than one species. Adult Pallid Cuckoos known to feed fledgeling Cuckoos; extraliminally, Common Koel females will feed fledgelings (Ali & Ripley 1969).

It is worth noting that correct identification of the eggs of parasitic cuckoos can be difficult. In preparing these accounts, we have been made aware of one probable example of misidentification. We have been informed that cards in the NRS for the Fan-tailed Cuckoo from the se. coast of NSW in the 1970s and 1980s ought to be disregarded because identification of the cuckoo was not positively confirmed: the eggs and young could just as likely have been those of the Brush Cuckoo (S. Marchant). Rowan (1983), when dealing with S. African cuckoos, found herself faced with similar problems and rejected every record that was not supported by clearly identified fledgeling cuckoos. This has not been done in this summary, and caution needs to be exercised in interpreting the data presented.

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Scythrops novaehollandiae Channel-billed Cuckoo

Scythrops novae Hollandiae Latham, 1790, *Index. Orn.* 1: 141 — New Holland = region of Port Jackson, New South Wales.

The generic name refers to the huge curved bill and grim expression of this cuckoo (Greek *σχυθρωπός*, of angry countenance, sullen). Specifically named after the type-locality.

OTHER ENGLISH NAMES Channelbill, Flood Bird, Storm Bird, Big Storm Bird and Fig Hawk.

POLYTYPIC Nominate *novaehollandiae*, n. and e. subcoastal Aust., wintering in New Guinea and nearby islands, and Moluccas. Extralimitally, subspecies *fordi*, Mason, 1996, Sulawesi, including Banggai and Tukangbesi Is, dispersing to n. Sulawesi and the Moluccas, including Sula Is; subspecies *schoddei*, Mason, 1996, New Britain and Duke of York I., and possibly elsewhere in Bismarck Arch.

FIELD IDENTIFICATION Length 56–70 cm; wingspan 88–107 cm; weight 560–935 g. Very large distinctive cuckoo, with long pointed wings, very long slender tail (rounded at tip), and heavy decurved bill. Adult mostly grey with bold dark scalloping to upperbody and upperwing-coverts, fine dark barring over lower underbody, black trailing edge to wing, and black subterminal tail-band. Sexes differ slightly. No seasonal variation in plumage, but colour of bill may vary in adult male (see Bare Parts). Juvenile readily distinguished by smaller bill, buffy head and neck, and bold buff spotting on upperbody and upperwing-coverts. Flight-silhouette and loud raucous call distinctive. **Adult male** Head, neck and breast, light grey, grading to paler grey rest of underbody; thighs, vent and undertail-coverts finely barred blackish brown; and flanks and, sometimes, belly faintly barred grey. Upperbody, grey, contrastingly darker than head and neck, and boldly scalloped black. Uppertail, grey with broad black subterminal band and narrow white tip. Upperwing, grey with broad black tips to coverts (much as upperparts), which form series of bands across folded wing; in flight show prominent narrow black trailing edge, broadening slightly across wing-tip. Undertail, silvery grey with narrow black barring, broad black subterminal band, and narrow white tip. Underwing, greyish white with fine grey barring on greater coverts and prominent black trailing edge. Bill massive, grey-black with cream tip covering distal 20–30%; in spring, at least some have contrasting bright-pink tip. Iris, red. Orbital ring, loral skin and narrow strip of bare skin at base of upper mandible, pink-red to dark red. Legs and feet varying grey. **Adult female** Most obviously differ from male by much smaller bill, which has longer cream tip, covering distal 30–50% of bill. Also, underbody paler, grading from light grey on foreneck and upper breast to off-white on lower breast and rest of underbody, with more extensive barring: dark barring of vent and thighs encroaches onto flanks and belly, and narrow grey barring extends over entire flanks and often also belly and lower breast. **Juvenile** Most obvious differences from adult are: head, neck and upper breast, pale buff; rest of underbody paler, cream, with narrow dark barring on flanks and thighs; upperbody and innerwing-coverts boldly spotted buff; and, in flight, have fine pale trailing edge to wing. Bill at first much smaller and weaker; mostly dirty pink, with varying dusky wash basally, and cream tip of upper mandible, basal cutting edge, and gape; orbital ring much narrower and darker, greyish; and loral skin duller, grey or grey-pink; iris, brown to reddish brown when older.

Similar species None.

Seen singly, in pairs or small flocks; in open eucalypt forests, woodlands and scrublands, favouring tree-lined watercourses; occasionally also in rainforest. Shy but noisy and conspicuous; most active morning and evening; generally keep to tops of large trees, where they feed on figs and other fruits. Often first noticed by loud raucous call. Much harassed by crows and other birds, and often seen in flight pursued by antagonist. Flight strong, direct and hawk-like, often high; wings held stiffly and wing-beats appear rigid. Distinctive cruciform flight-silhouette: long slender body with prominent head, neck and heavy decurved bill, very long narrow tail, and long pointed wings; jizz not unlike that of hornbill. Usual call a loud raucous repeated *oik, awk, wark* or *kork-ork-ork-ork*, uttered in flight or when perched; often call at night. However, calls not dissimilar to calls of Brolog *Grus rubicunda*, Sarus Crane *Grus antigone* or Blue-winged Kookaburra *Dacelo leachii*.

HABITAT Canopy of variety of forests and woodlands that usually support figs *Ficus* trees; often near watercourses (MacDonald & Coulston 1966; Seton 1972; Brooker & Brooker 1989; Hall; Storr 11; Aust. Atlas); tropical and subtropical rainforest (Campbell & Barnard 1917; Woinarski 1993; Mason & Forrester 1996; Aust. Atlas); gallery forests, including *Melaleuca* forest lining creeks and rivers (Horton 1975; Schodde 1976; Mason & Forrester 1996; Storr 19); wet sclerophyll forest (Bravery 1970); dry sclerophyll, especially open *Eucalyptus*, forest (Hindwood & McGill 1951; Roberts & Ingram 1976; Leach & Hines 1987; Leach 1988; Slater 1995); woodlands, including wooded farmland (Bravery 1970; Schodde 1976; Ford 1978; Garnett & Bredl 1985; Leach 1988; Slater 1995); wooded swamps (Bravery 1970). Sometimes occur in scrubs dominated by *Acacia* (Barnard 1914; Hindwood & McGill 1951; Leach 1988). Also in gardens, especially those with tall fig trees (Gilbert 1939; Lord 1956; Pearson-Smith 1995) or in areas near larger tracts of woodland or forest, e.g. at Pearl Beach, central coast NSW (P.J. Higgins). Formerly occurred in arid interior along major ephemeral rivers, such as Diamantina R., when in flood (Reese 1924, 1927, 1929, 1932, 1936). Sometimes at edge of grasslands (Longmore 1978; Qld Bird Rep. 1991). In s. Gulf of Carpentaria, occasionally at edges of mangroves (Church 1925; Schodde 1976).

Mainly feed among outer branches and foliage in canopy of tall fruiting fig trees in rainforest, sclerophyll forests or woodlands (Campbell & Barnard 1917; Hindwood & McGill 1951; Lord 1956; McKean 1985). Sometimes also feed among

fruiting clumps of pendulous mistletoe (Hindwood & McGill 1951) or among foliage of insect-infested trees (Hyem 1936).

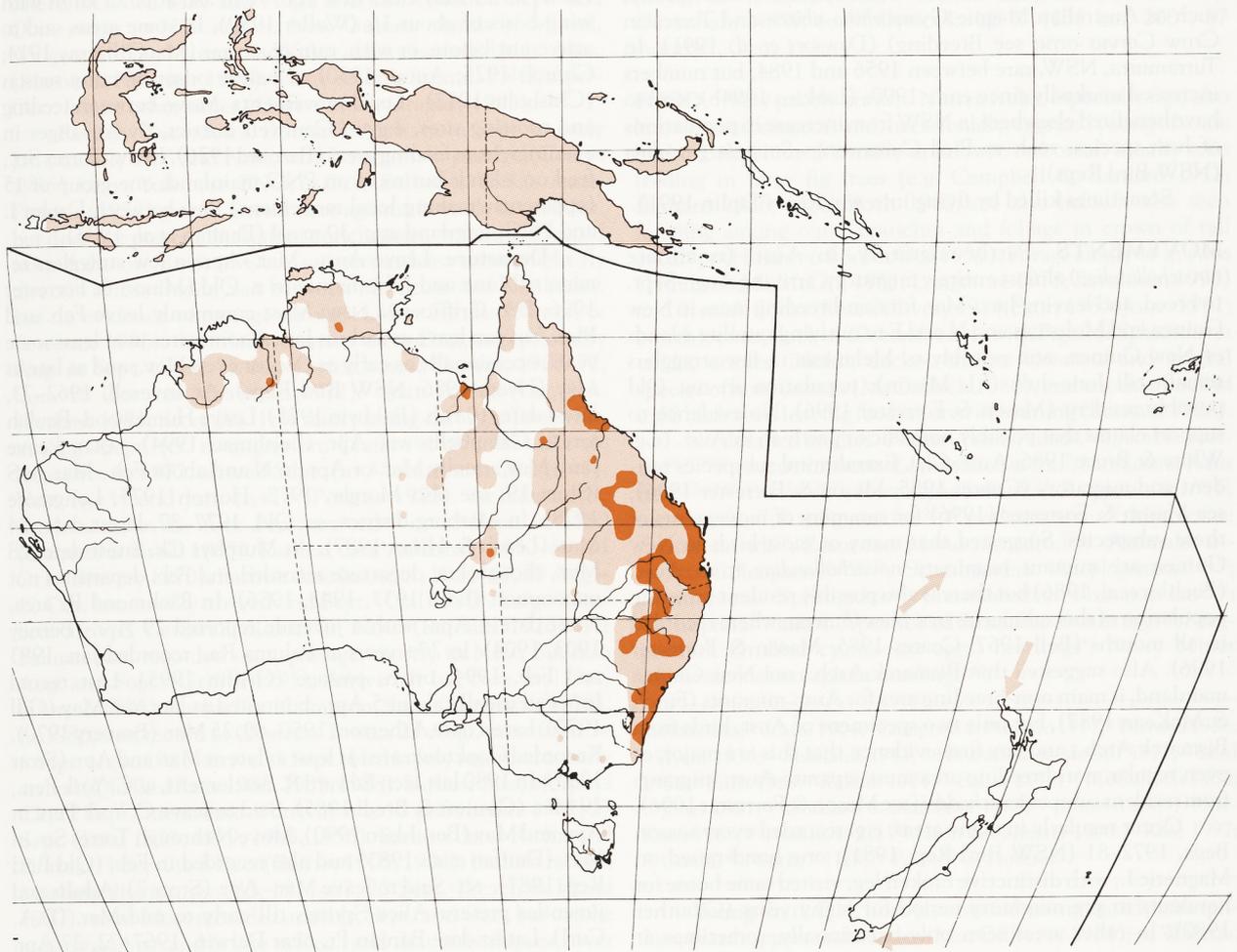
Roost away from feeding areas (Barnard 1926); vagrant at Bendigo roosted in tree c. 40 m from fig tree in which it had been feeding (Kellam 1974); also see Movements. Usually perch high in trees (Pearson-Smith 1995; Hall). At Alice Springs, once seen perching on patio railing (D.A. Curl).

Said to have benefited from clearing and development because this has increased populations of breeding host-species (Dawson *et al.* 1991).

DISTRIBUTION AND POPULATION Widespread in n. and e. Aust. Extraliminally, occur e. Indonesia (breeding Sulawesi and Sula Is in Moluccas) and New Guinea, including satellite islands, E to Bismarck Arch. (breed on New Britain and Duke of York I.); may breed New Guinea (Watling 1983; Bell 1984; Coates 1985; White & Bruce 1986; Mason & Forrester 1996). Vagrant to NZ (see below) and New Caledonia (Hindwood 1953).

Aust. Mainly in e. Aust.; more scattered in n. areas. **WA** Sparsely scattered, mainly in Kimberley Div., in S and E, from Cockatoo I., S to Fitzroy R., and E to Osmond Ck and Kununurra (Ford 1987; Aumann 1991; Storr 11; Aust. Atlas); Aust. Atlas also shows records at Sturt Creek Stn and Mt Frederick, NE of Great Sandy Desert. Sight record Ashmore Reef, Oct. 1969 (Mason & Forrester 1996). **NT** Scattered records in Top End, S to Victoria R. Downs and Wave Hill in W, and from Katherine

and middle reaches of Roper R. in E. In Gulf of Carpentaria, recorded on Groote Eylandt, Sir Edward Pellew Is and at Borroloola (Sedgwick 1947; Haselgrove 1975; Schodde 1976; Boekel 1980; Thompson 1982; McKean 1985; Hall; Storr 7; Aust. Atlas; H.A.F. Thompson & D.K. Goodfellow). Few records S of this range: once recorded at Frewina Road Stn; scattered records at Tobermorey, Jinka and Numery Stns, and Yuendumu (Gibson & Cole 1988; Aust. Atlas); also recently recorded round Alice Springs (D.A. Curl). **Qld** Scattered records North-western and Central-western Regions, from Boulia, N to se. Gulf of Carpentaria, at Burketown, Normanton and Mornington I. Widespread C. York Pen. and Torres Str. and all e. regions, W to middle reaches of Gilbert R., Georgetown, Richmond, Winton, Quilpie and Cunnamulla. Historical record in South-western Region, on Georgina R. near Urandangie (Church 1925; Cameron 1932; Ford & Parker 1974; Draffan *et al.* 1983; Larkins 1994a; Storr 19; Aust. Atlas; Qld Bird Reps). **NSW** Widespread along e. coast, S to Bega, though once farther S to near Eden; inland to locations W of Moree, in Warrumbungle NP, near Dubbo, Wombeyan Caves near Crookwell, Canberra and Bombala (Lamm *et al.* 1963; Cooper & McAllan 1995; Aust. Atlas; NSW Bird Reps). Single record farther W, c. 10 km N of Bourke, 29 Oct. 1981 (Cooper & McAllan 1995; NSW Bird Rep. 1981). **Vic.** Vagrant. Four records since 1970: single, near Bendigo, 22 Mar. to 2 Apr. 1974 (Kellam 1974); single, near Genoa, Apr. 1976 (Vic. Atlas); single, Ringwood, 22 Oct. 1983 (Vic. Bird Rep. 1983); two,



Rotamah I., 6 Apr. 1985 (Anon. 1989). A few unconfirmed historical reports (Campbell 1902; Wheeler 1967; Kellam 1974). **Tas.** Vagrant. Single, specimen, Clarence Plains, Nov. 1867 (Littler 1910); single, specimen, East Tamar, near Launceston, 13 Feb. 1943 (Sharland 1943). **SA** No recent records (Badman 1989). Historical records restricted to NE: first recorded in 1874–75 near L. Eyre (Sutton 1923, 1927); many records at Minnie Downs Stn, nearby Cordillo Downs and lower reaches of Diamantina R. between Mar. 1924 and May 1936 (Reese 1924, 1925, 1926, 1927, 1929, 1931, 1932, 1935, 1936; Cleland 1925); also recorded at Tinga Tingana Stn between L. Blanche and Innamincka (Cleland 1925). Unconfirmed report on Diamantina R., 40 km downstream from Pandie Pandie HS, 17 Apr. 1984 (Badman 1989).

NZ Vagrant. Single, Invercargill, Dec. 1924 (Oliver); single, Ngataki and Kauri Flat, Oct. 1986 to mid-Jan. 1987 (CSN 35).

Norfolk I. Two, 25 Oct. to early Nov. 1996 (Anon. 1997; M. Christian).

Breeding In Aust., sparsely scattered records in N, from Kimberley Div., E to Burketown in Gulf Country; in e. Aust., from near Ingham, inland to Richmond and S to South Coast of NSW (Storr 19; Aust. Atlas; NRS). Inland, said to breed regularly in Alice Springs, with confirmed nesting in 1998 (D.A. Curl). Historical record at Minnie Downs in ne. SA (Reese 1932).

Populations At Logan Reserve, se. Qld, numbers have increased (coinciding with increased numbers of host-species, such as Australian Magpie *Gymnorhina tibicen* and Torresian Crow *Corvus orru*; see Breeding) (Dawson *et al.* 1991). In Turrumurra, NSW, rare between 1956 and 1984, but numbers increased markedly since early 1990s (Larkins 1994b); said to have benefited elsewhere in NSW from increase in populations of host-species, such as Pied Currawongs *Strepera graculina* (NSW Bird Reps).

Sometimes killed by flying into windows (Taplin 1991).

MOVEMENTS Partly migratory. In Aust. (nominate *novaeollandiae*) almost entirely migratory, arriving Aug.–Sept. to breed, and leaving Jan.–Mar. for non-breeding areas in New Guinea and Moluccas and N and E to outlying satellite islands of New Guinea, and possibly n. Melanesia; a few stragglers remain till June–July (I.J. Mason); population in nw. Qld possibly resident (Mason & Forrester 1996). No evidence to support claims that possibly nomadic or partly so in Aust. (e.g. White & Bruce 1986; Aust. CL). Extralimital subspecies resident and migratory (Coates 1985; Mason & Forrester 1996); see Mason & Forrester (1996) for summary of movements of these subspecies. Suggested that many or most birds in New Guinea are migrant nominate *novaeollandiae* from Aust. (Beehler *et al.* 1986) but there is also possibly resident breeding population of this subspecies in s. New Guinea, where recorded in all months (Bell 1967; Coates 1985; Mason & Forrester 1996). Also suggested that Bismarck Arch., not New Guinea mainland, is main non-breeding area for Aust. migrants (Finch & McKean 1987), but only two specimens of Aust. birds from Bismarck Arch., and any firm evidence that this is a major, or even regular, non-breeding area must separate Aust. migrants from resident subspecies *schoddei* (see Mason & Forrester 1996).

Occur regularly in many areas, e.g. recorded every season Bega, 1972–81 (NSW Bird Rep. 1981); one hand-raised on Magnetic I., with distinctive broken leg, visited same house for handouts in pre-migratory period for many years (Crouther 1980). In other areas seen only occasionally, sometimes at

intervals of years, e.g. Moree, NSW (Morse 1922). Numbers can also vary from year to year; unusually plentiful in some years (e.g. White 1904). Timing of arrival and departure can also vary, e.g. arrived Gilgai on 21 Sept. 1972, 4 Oct. 1974, 6 Oct. 1979 (Perkins 1973; NSW Bird Reps 1974, 1979); Murwillumbah, 11 Oct. 1971, 18 Sept. 1972, 24 Sept. 1976, 18 Sept. 1978, 18 Sept. 1979 (Pratt 1972; Perkins 1973; NSW Bird Reps); in 1991, arrived at some NSW locations much earlier than usual (NSW Bird Rep. 1991). Movements of birds that occur outside normal range or in areas where rare are variously attributed to prevailing winds, drought conditions and bushfires (D'Ombra 1952; Waller & Le Gay Breerton 1959) but without substantial evidence. Also suggested that timing of movements affected by drought (Hopson 1919).

Nature of passage Migrate through Torres Str. singly or in groups of less than 15 (Draffan *et al.* 1983); in Qld, flocks recorded during migration (Bravery 1970; Wieneke 1992). One flock (not known if migratory or local movement) flew in line (Hindwood & McGill 1951). Some records of loose flocks probably represent pre-migratory congregations (Broadbent 1910; Coates 1985; I.J. Mason). Some records of juveniles leaving after adults (e.g. NSW Bird Rep. 1986). Fly at night and possibly migrate at night: one heard flying over Noosa, Qld, at 04:00 in Oct. 1958 (Wheeler 1959); at Eccleston, NSW, almost invariably arrive at night (Hopson 1919). Observations on C. York Pen. during evenings in Apr. 1989 indicated that some birds left then (Beruldsen 1990). One flying NE near Armidale, NSW, on 19 May 1959 flew at c. 90 m asl, at c. 75 km/h with wing-beats of about 1/s (Waller 1959). In some areas said to arrive just before, or with, rain or storms (MacGillivray 1914; Church 1925; Anon. 1930) or before onset of rainy season (Chisholm 1917). **Local movements** Move between feeding and roosting sites, e.g. in Cardwell district, fly to ranges in evenings, from feeding areas (Barnard 1926). In nw. Torres Str., feed on islands but roost on PNG mainland; one group of 15 (apparently making local movement) flew between Dauan I. and PNG mainland at c. 30 m asl (Draffan *et al.* 1983).

Departure Leave Aust., Mar.–Apr.; a few stragglers remain till June and July, mainly in n. Qld (Mason & Forrester 1996; P.A. Griffioen). **nsw:** Most commonly leave Feb. and Mar., but can leave as early as Jan. at some sites in at least some years, occasionally as early as Dec. or even Nov.; and as late as May (Hyem 1936; NSW Bird Reps). At Inverell, 1962–73, latest date, 10 Feb. (Baldwin 1975). Leave Humewood–Beulah forest, Campbelltown, Apr. (Leishman 1994). **QLD:** Leave Jan.–May, usually Mar. or Apr. in N and about Feb.–Mar. in S (Storr 19; see also Morgan 1972; Horton 1975; Longmore 1978). In Marburg district, se. Qld, 1977–87, latest date, 24 Mar. (Leach & Hines 1987). At Murphys Ck, latest date, 28 Mar., though Jan. departure recorded and Feb. departures not uncommon (Lord 1933, 1943, 1956). In Richmond R. area, latest date 4 Apr., with a juvenile reported 29 Apr. (Berney 1903, 1904). In 20+ years at Paluma Ra., recorded Jan. 1983 and Feb. 1994, on n. passage (Griffin 1995). Last record Innisfail usually about 5 Apr., but noted as late as 6 May (Gill 1970). Latest date Atherton, 1950–69, 25 Mar. (Bravery 1970). Recorded Cooktown area at least as late as Mar. and Apr. (Storr 1953). In 1980 last seen Edward R. Settlement, w. C. York Pen., 29 Mar. (Garnett & Bredl 1985). Said to leave C. York Pen. in Apr. and May (Beruldsen 1990). Move N through Torres Str. in Mar. (Draffan *et al.* 1983) and also recorded in Feb. (Qld Bird Rep. 1987). **NT:** Said to leave Mar.–Apr. (Storr 7). Adults and juveniles present Alice Springs till early to mid-Mar. (D.A. Curl). Latest date Banjan Pt, near Darwin, 1967–72, 27 Apr.

One seen flying out to sea at East Pt, Darwin, 27 Mar. 1971 (Crawford 1972). WA: Records from Darwin and Arnhem Land suggest that Kimberley birds might move through Arnhem Land, across Arafura Sea to New Guinea and Moluccas (see Mason & Forrester 1996).

Exhausted birds arrive Port Moresby, PNG, from direction of sea, suggesting some cross Coral Sea (Aust. Atlas). Arrive Yule I., se. PNG, Mar. (Salvadori 1880). Vagrant Ok Tedi, Western Province, Feb., Mar. and May, possibly on passage from Aust. (Murray 1988; Gregory 1995). Recorded s. Bismarck Arch., from mid-Feb. to early May, mainly Mar. and Apr., possibly on n. passage; records from Bismarck Arch. thought to represent migrants from Aust. (Coates 1985); resident subspecies in n. Melanesia, but two specimens, apparently of migrant subspecies *novaehollandiae*, collected n. Melanesia (Mason & Forrester 1996).

Non-breeding Some remain in breeding range. **Aust.** In N, dry-season, including winter, records from: rivers of Kimberley Div., WA (Aumann 1991); Darwin area (Thompson 1982); Torres Str. (Ingram 1976); and elsewhere in n. Qld, e.g. Townsville (Lavery & Hopkins 1963), Lawn Hill and Burketown (Mason & Forrester 1996; Qld Bird Reps 1987, 1988, 1991). Also, some winter records from s. Qld (e.g. one pair arrived Peel I., Moreton Bay, 23 Feb. 1916 and left in July; Agnew 1921), and NSW (e.g. NSW Bird Rep. 1987). **Extraliminally** Most specimens from Moluccas collected Apr.–Sept. Disperse throughout New Guinea, especially N to Sepik R. Drainage, where recorded May and Aug., and also common Sept. and Oct.; range to NW and n. New Guinea islands of Misool, Waigeo, Kofiau, Manam and Kakar, where recorded Mar.–Nov. (Mason & Forrester 1996). Many records from n. PNG, Apr.–Oct., few at other times (Coates 1985; Gregory 1996).

Return Recorded s. Bismarck Arch. from Sept. to early Jan., mainly Oct. and Nov., which suggests s. passage (Coates 1985). Leave Yule I., se. PNG, in Oct. (Salvadori 1880). **Aust.** Perkins (1973) graphs arrival date against latitude for e. Aust. but does not present analysis or conclusions. WA: Single record from Ashmore Reef, in Oct., suggests at least some might fly directly across Banda Sea between Moluccas and Kimberley, but no evidence of passage through Lesser Sundas (Mason & Forrester 1996). NT: Said to arrive Oct.–Dec., exceptionally Aug. or Sept. (Storr 7). Most records near Darwin, 1967–72, from 18 Oct. on (Crawford 1972). QLD: Arrive Aug.–Jan. (Perkins 1973; Storr 19). Few seen passing through Torres Str. in Aug.–Sept. (cf. n. migration; Draffan *et al.* 1983). At six locations, in 1972, arrived Sept. (n=3 locations), Oct. (n=1), Nov. (n=1) and Jan. (n=1) (Perkins 1973). At Edward R. Settlement, w. C. York Pen., arrived 9 or 13 Sept. in 1980 (Garnett & Bredl 1985). Earliest date Atherton, 1950–69, 24 Oct. (Bravery 1970). Earliest date Innisfail, 1954–69, 29 Aug.–12 Oct. but usually arrived end Sept. (Gill 1970). Large numbers arrived Cardwell district in Nov. (Barnard 1926). At Paluma Ra., recorded on s. passage, mostly in Nov., but also Aug. and Sept. (Griffin 1995). Arrive Mt Isa, Nov. and Dec. (Horton 1975). Arrive Rockhampton, Sept. (Longmore 1978). In 1986, first record at Charters Towers 25 Aug., most from 5–6 Sept. on; in 1987, arrived 5 Sept.; bird in July regarded as early arrival (Qld Bird Reps 1986, 1987, 1988). Earliest date, Murphys Ck, 12 Sept.; mean date of arrival over 10 years before 1942, 27 Sept. (Lord 1933, 1939, 1943, 1956). Earliest dates Richmond R. area, 11 Sept. to 3 Dec. (Berney 1903, 1904). Earliest record, Marburg district, se. Qld, 1977–87, 23 Sept. (Leach & Hines 1987). NSW: Most recorded arrivals, Sept. and Oct., but can be as early as Aug. and as late as Dec.; said that arrival spread over

period of 1 month (NSW Bird Reps); at various locations across state (source NSW Bird Rep. for given year); arrivals 13 Sept. to 20 Oct. in 1994 (n=8 locations); 11 Sept. to 12 Oct. in 1993 (n=7); 15 Sept. to 20 Oct. in 1992 (n=9); 12 Sept. and 31 Oct. in 1991 (n=6); 20 Sept. to 17 Dec. in 1990 (n=8); 28 Aug. to 13 Nov. in 1988 (n=13); 16 Sept. to 8 Oct. in 1987 (n=3); 1 Sept. to 23 Sept. in 1986 (n=3). At Inverell, 1962–73, earliest date, 8 Sept. (Baldwin 1975). Arrive Sydney area as early as first week Sept., but most records Oct.–Dec. (Larkins 1994b); arrive Humewood–Beulah forest, Campbelltown, Sept. (Leishman 1994).

Breeding Throughout Aust. range; in n. Aust., recorded wet season (Haselgrove 1975; Schodde 1976; Barnett 1980; Boekel 1980; Garnett & Bredl 1985; McKean 1985, Undated; Ford 1987; Collins 1995; Bielewicz & Bielewicz 1996; Storr 11); in se. Aust., occur from spring till summer or autumn (e.g. Morris 1975; Jones 1981; Garnett & Cox 1983; Wieneke 1988; Hardy & Farrell 1990; Sutton 1990; Templeton 1992; NSW Bird Rep.). In some areas only remain for a few months, e.g. Coultts Crossing in 1985, recorded between 1 Oct. and 9 Dec. (NSW Bird Rep. 1985); or less than a month, e.g. 23 Oct. till 19 Nov. at Moruya (NSW Bird Rep. 1982); even only a few days (Marchant 1979). **Extraliminally** Possibly breeds s. New Guinea (Bell 1967) and recorded New Guinea in all months (Coates 1985; Mason & Forrester 1996).

Banding Of 18 banded in Aust. and New Guinea, 1953–96, 4 recoveries (22%): 2 (50%) <10 km from banding site; 1 (25%), 10–49 km; 1 (25%) ≥100 km. Long-distance recovery: Ourimbah, NSW, to Mollymook, NSW (235 km, 200°, 37 months^p, Oct., 1+).

FOOD Very poorly known. Native fruits, especially figs; also known to take insects and, occasionally, eggs and young of some birds. **Behaviour** Virtually unknown. Arboreal; usually seen feeding in large fig trees (e.g. Campbell & Barnard 1917; Barnard 1926; McCulloch 1980; see also below); also seen foraging among outer branches and foliage in crown of tall eucalypt (Hindwood & McGill 1951). Forage singly or in twos (Hindwood & McGill 1951; Longmore 1978; Beruldsen 1990) and in small flocks (MacGillivray 1914; Storr 1953; Jones 1981; North); once, flock of 20 seen feeding with Figbirds *Sphecotheres viridis*, orioles *Oriolus*, cuckoo-shrikes *Coracina* and several species of honeyeaters (McCulloch 1980), and another flock of c. 60 birds seen leaving feeding area in evening (Barnard 1926).

No detailed studies. **Plants** Fruits, seeds, vegetable matter^{18,19,20,22}. **DICOTYLEDONS:** Loranthaceae fru.⁷; Moraceae: *Ficus* fru.^{1,2,3,4,7,8,9,10,11,15,16,20,21}; *F. microphylla* fru.^{11,22}; *F. opposita* fru.²²; *F. racemosa* fru.²²; *F. rubiginosa* fru.²²; *F. watkinsiana* fru.²²; Myrtaceae: *Eucalyptus* sds¹⁸; Rosaceae: *Morus nigra* fru.^{5,20}. **Animals** **INSECTS:** Coleoptera^{18,19,20,21}; Scarabaeidae: *Anoplognathus*^{4,20,22}; Lepidoptera: Sphingidae¹⁶; Phasmatodea: Phasmatidae^{14,17}; Orthoptera²⁰. **BIRDS:** Apostlebird *Struthidea cinerea* eggs¹³; Magpie-lark *Grallina cyanoleuca* eggs, nestlings⁴; Noisy Miner *Manorina melanocephala* nestlings^{6,10}.

REFERENCES: ¹ White 1904; ² Campbell & Barnard 1917; ³ Barnard 1926; ⁴ Hyem 1936; ⁵ Sharland 1943; ⁶ Hindwood & McGill 1951; ⁷ Lord 1956; ⁸ Frith 1969; ⁹ Kellam 1974; ¹⁰ Salter 1978; ¹¹ McCulloch 1980; ¹² Jones 1981; ¹³ Goddard & Marchant 1983; ¹⁴ Johnson 1983; ¹⁵ McKean 1985; ¹⁶ Hoskin 1991; ¹⁷ Mason & Forrester 1996; ¹⁸ Rose 1997; ¹⁹ Gould; ²⁰ North; ²¹ Hall; ²² FAB; ²³ G. Holmes.

Young In n. Qld, host-parents fed young mostly caterpillars, grasshoppers and beetles (MacGillivray 1914); at Walcha,

NSW, one young fed pieces of meat from carrion by a raven (North). In Alice Springs, fed regurgitated food by Little Crows *Corvus bennetti*, which had been observed feeding on household scraps; at fledging, Crows visited nest with grasshoppers, and other items, held in bill, and seen to insert these into bill of begging young, but then remove them; also observed inserting bill into that of young without fully regurgitating (D.A. Curl). Just before fledging, feeding rate reached 4 feeds/h in 2 h after dawn, but typically lower in hotter parts of day (D.A. Curl).

SOCIAL ORGANIZATION Poorly known. During breeding season in Aust., commonly seen in groups up to about ten birds (MacGillivray 1914; Hindwood & McGill 1951; Storr 1953; Jones 1981; North; NSW Bird Reps 1975, 1983); often also occur in twos, which often said to be pairs (Hyem 1936; Longmore 1978; Beruldsen 1990); probable pair observed together near nest of Little Crows in Alice Springs (D.A. Curl). Larger flocks also occur: up to 50 birds (North); up to 20 feeding in one tree (McCulloch 1980); up to 60 observed in evening, flying from feeding sites, probably to a roost (Barnard 1926). At end of breeding season, large numbers can gather, apparently for migration (Broadbent 1910), forming groups of 6–7 (North), or up to 30+ (Gill 1970). Said that always leave C. York on n. migration in twos (Beruldsen 1990). During non-breeding season, in PNG, occur singly and in groups up to about 12 (Coates 1985); flocks of up to 15 seen flying from mainland, where roosting occurs, to feeding sites on islands, though migration appears to occur singly or in smaller groups (Draffan *et al.* 1983); concentration of >60 birds in Nov. suggested to have been pre-migratory gathering (Coates 1985).

Bonds Appear to form pairs, at least for part of breeding season (e.g. Hyem 1936; Beruldsen 1990); North reports flocks of 6–50 during Sept.–Oct. in which no pairing evident. **Parental care** No evidence for claim that adult Cuckoos feed young at night while host-parents do so during day (Broadbent 1910). May fly near host-nest more than once after laying in it and later when young fledging; two adults observed with fledgeling raised by Pied Currawongs in Sydney, before all three birds left (D.A. Curl).

Breeding dispersion Four birds that arrived in same area in spring spent a couple of days in confrontation, in trees and in flight, before one pair drove off others (Pearson-Smith 1995). Same breeding area can be used for several successive years and nest of same individual host laid in; only evidence that use is by same pair is claim that, based on recognition of eggs, same two female Cuckoos laid in nest of same Magpie-lark pair for 3 successive years (Lord 1933; Goddard & Marchant 1983; Pearson-Smith 1995).

Roosting One bird, probably on n. migration, stayed in area for 11 days and roosted alone in same position on at least two occasions 4 days apart (Kellam 1974). In PNG, roost communally (Coates 1985).

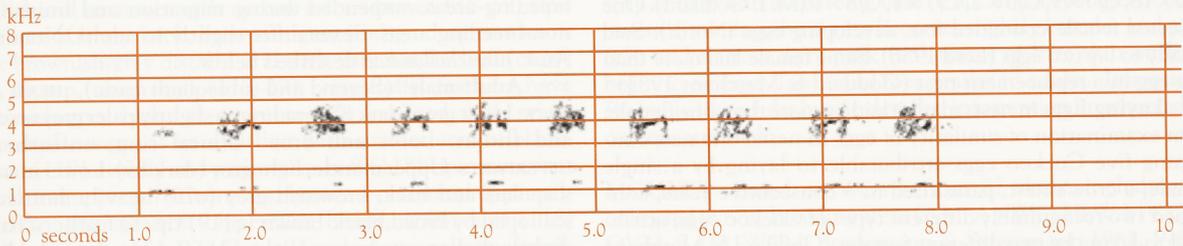
SOCIAL BEHAVIOUR Poorly known. Conspicuous and noisy, at least while in Aust. (Storr 1953; Jones 1981; McKean 1985). Active and vocal during day and night (Berney 1906; Broadbent 1910; MacGillivray 1914; Hyem 1936; Boehm 1951; Lord 1956; North). At one tree where up to 20 feeding, very noisy in flight and while feeding; were easily disturbed but returned if observers remained still (McCulloch 1980). Kloot (1993) found them difficult to observe, moving and feeding quietly and generally keeping high in trees. **Flock behaviour** Appear to feed early in day then just sit, preening or motionless, for long periods, or fly about; appear to stay at a feeding site all

day (Kloot 1993). One pair in garden during spring usually spent time quietly but sometimes called loudly while jumping around in trees and occasionally swooping around area (Pearson-Smith 1995). On probable departure from C. York on n. migration, left in twos, birds calling occasionally in flight (Beruldsen 1990). **Alarm** Presence of Carpet Python *Morelia spilota* thought to be stimulus for group of 5–6 birds flying from branch to branch and calling excitedly (North).

Sexual behaviour **Courtship feeding** Observed in spring and early summer. One pair perched in tree with female uttering quiet reedy trumpeting sounds and male carrying stick-insect in bill; male gradually approached calling female, who squatted low on branch and spread wings; male immediately mounted but fell off 4 s later when female reached up and took, and ate, insect from bill of male. Pair then moved c. 50 m apart; female continued calling and watched male, who remained silent apart from low guttural calls made by both birds when they moved; 30 min later, male caught another stick-insect and female quickly moved over to him and the same performance was repeated; same occurred again after another 30 min but this time male held onto insect when female tried to take it; female then spent 30 s perched beside male trying to snatch insect before male ate it himself. Both moved out of sight c. 5 min later, female still calling as had been almost entire time (Johnson 1983). Large insect was also the food fed by one bird to another (Goddard & Marchant 1983), but another apparent male approached apparent female with whom had foraged earlier, and presented her with spray of leaves that he had softened by chewing; female took leaves, after much effort pulling them from male, and swallowed them. At this stage, female was lying flat on branch with wings dropped while male stood beside and over her with tail raised; copulation imminent but pair disturbed and moved away (Hindwood & McGill 1951).

Relations within family group Male of pair said to drive hosts from nest and to distract them while female lays in nest (Larkins 1994a,b). However, at one nest, both of pair attacked nesting hosts till sitting bird moved off and female Cuckoo gained access to nest (Crouther 1980); at another, two adults flew around nest of Little Crow, calling for c. 10 min, with one Cuckoo chased off by Crow (D.A. Curl). Fledgelings beg constantly and will chase host-parents about (Berney 1904; Wood & Wood 1991). In Alice Springs, single chick, while in nest and immediately after fledging, only begged when adult flew in or approached to within 1 m, otherwise Begging Calls notably absent; 6 days after leaving nest-tree, fledgeling began begging more often without close approach of adult host, and began to move or fly toward adults, adopting horizontal posture with wings quivering and held out while begging (D.A. Curl). In area where Pied Currawongs usually parasitized, young said to have identical calls to young of host (Lord 1956). One fledgeling observed calling loudly for food and being fed by pair of Australian Magpies, with pair of adult Cuckoos calling in same tree; seen several times until all three Cuckoos disappeared at end of summer (Pearson-Smith 1995). One adult Cuckoo remained for several weeks near nest in which it had laid (North); at nest in which young apparently present, pair said to visit nest at dusk then spend night in area calling before becoming silent at dawn. Adults also said to gather young together before leaving on n. migration (Campbell; D.A. Curl).

VOICE Poorly known. Can be very noisy, especially in flight. Utter loud, harsh and discordant notes and screeches, audible perhaps to 500 m, at any hour of day or night, and often in flight (Berney 1906; MacGillivray 1914; Sedgwick 1951; Bell 1970;



A R. Buckingham; Lawn Hill Gorge, Qld, Aug. 1983; P40

McCulloch 1980; Beruldsen 1990; North; Mathews). In breeding season, can fly about and screech all night, becoming silent at dawn (Campbell; Broadbent 1910); also said to be most usually heard early in morning (Mathews). Very vocal in flight (MacGillivray 1918; Storr 1953). When feeding may be silent for hours (North), but can also be noisy (Jones 1981). One pair uttered screaming calls for over 1 h while wheeling in flight and skirmishing with Torresian Crows over access to nest (Crouther 1980). Chorus of cries, or cries in flight, before rain, hence vernacular Stormbird (Berney 1904; North).

Adult SCREECHING CALL: Wide variety of sounds. Harsh and loud rasping scream *cree-cree-cree...* (Wolstenholme 1925; Gilbert 1939). Raucous *ee-awk, ee-awk, ee-awk, ca-ca-ca-ca-ca* (Storr 1953), or *crerk-crerck-crerck-...tawark-tawark-tawark-...ko-ko-ko...*, the *ko-ko-ko...* uttered while settling in tree (Lord 1956). Sonagram A shows *ee-awk, ee-awk, ee-awk...* or *tawark-tawark-tawark...*, uttered in flight. Loud raucous *quorrk* given in flight; 4–12 notes given, rising in pitch and volume (Hindwood & McGill 1951). **CROAK:** Harsh croak given once when attacked by another species, but usually silent in this situation (Kellam 1974). **Other calls** Quiet reedy trumpeting sounds from female when male approaching with food during courtship feeding; also low guttural calls from both birds (Hindwood & McGill 1951; Johnson 1983).

Young Fledgelings have distinctive Contact and Begging Calls, louder, more raucous and clamorous than, but still similar to, those of fledgeling Pied Currawongs, Australian Magpies, and corvids (Lord 1956; Goddard & Marchant 1983). Calls described as shrieking and screaming (Crouther 1980; Pearson-Smith 1995), and made incessantly (Wood & Wood 1991). One nestling gave Begging Calls only on close approach by host-adult Little Crows; otherwise silent till near fledging, when occasional croak given in absence of food or host-parent (D.A. Curl; see Social Behaviour). Full adult-like call given by captive-reared bird within 1 month of fledging (D.A. Curl).

BREEDING Not well known and no major studies; 23 records in NRS to July 1997 available for analysis. Goddard & Marchant (1983) summarized information from literature, museums, NRS and personal observations up to 1983; Brooker & Brooker (1989) conducted a detailed review of 138 records, to 1987, of Cuckoo eggs and nestlings, feeding of Cuckoo chicks, and general statements of parasitism from literature, museum and private egg-collections, NRS, ABBBS and unpublished information. S. extent of breeding distribution in e. Aust. may be limited by timing of laying of host-species (Goddard & Marchant 1983). Usually do not eject young of host, and more than one Cuckoo chick may be raised by host. Nest parasite.

Season In n. Aust.: laying, Nov.–Jan. (Lavery *et al.* 1968); egg, Mar. (MacGillivray 1914); young, Feb., Mar. and Apr. (Hall 1903; MacGillivray 1914; Aust. Atlas). For single egg at

Alice Springs, central Aust.: laid Jan.; hatched late Jan. or early Feb.; young fledged late Feb. (D.A. Curl). In s. and e. Aust.: eggs, Oct.–Dec. (Salter 1978; Campbell); fledgelings, Oct. and Jan. (NRS). Juveniles collected, Dec.–May (Mason & Forrester 1996).

Site In large open nests, mainly Australian Raven *Corvus coronoides*, Little Crow and Torresian Crow, Pied Currawong and Australian Magpie; occasionally parasitize nests of Magpie-lark, White-winged Chough *Corcorax melanorhamphos*, Pied Butcherbird *Cracticus nigrogularis*, Forest Raven *Corvus tasmanicus*, Collared Sparrowhawk *Accipiter cirrhocephalus* and Brown Falcon *Falco berigora* (MacGillivray 1914; White 1915; Barnard 1926; Cameron 1932; Lord 1933, 1939; Goddard & Marchant 1983; Brooker & Brooker 1989; North; NRS). Of 90 records of nests with eggs or nestlings, 46 (51.1%) were Pied Currawong, 30 (33.3%) ravens or crows, 12 (13.3%) Australian Magpie (Brooker & Brooker 1989). At Tenterfield, ne. NSW, of 50 nests containing Cuckoo eggs, 26 (52%) were in nests of Pied Currawong, 16 (32%) in nests of Torresian Crow, 6 (12%) in nests of Australian Raven, 1 (2%) in nest of Australian Magpie, and 1 (2%) in nest of Magpie-lark (M.T. Goddard). Claimed that same female Cuckoos will parasitize replacement clutches (Goddard & Marchant 1983). Claimed that same pair of Cuckoos may parasitize nests in same area each year (Lord 1933); a Pied Currawong's nest was parasitized for 5 successive years; a crow's nest for 3 successive years (Goddard & Marchant 1983). **MEASUREMENTS:** Estimated height of nest of host, 16.9 m (7.49; 8–30; 8) (NRS; D.A. Curl).

Eggs Oval; coarse-grained; slightly lustrous; ground-colour, warm buff; markings vary but are generally spots and blotches of chestnut, brown or umber, with underlying spots and blotches of pale purplish-brown or violet-grey or both; markings larger on thicker end (Campbell; North); other eggs described as elongate-oval, somewhat pointed at smaller end; rather close-grained, smooth; slightly lustrous; pale yellowish-brown, spotted and blotched all over with brown and inky grey, particularly at larger end, where form large or small clouded patches (North). Closely resemble those of Pied Currawong (Goddard & Marchant 1983); like those of Australian Magpie (North); not like those of *Corvus* (Goddard & Marchant 1983). **MEASUREMENTS:** 43.7 (2.64; 40.6–47.0; 6) × 30.5 (1.24; 28.7–32.0) (Campbell; North; excludes one egg in North removed from a dissected female). **WEIGHT:** c. 19.4, 3.2% adult body-weight (Brooker & Brooker 1989).

Clutch-size Female can lay more than one egg per nest; mean number of eggs in nest probably laid by same female: in nests of crows *Corvus*, 2.55 (1.29; 1–5; 11): C/1 × 3, C/2 × 2, C/3 × 4, C/4 × 1, C/5 × 1; Pied Currawong, 1.67 (0.82; 1–3; 15): C/1 × 8, C/2 × 4, C/3 × 3 (Goddard & Marchant 1983). For 61 records of parasitism of nests, mean number of Cuckoo eggs per nest, 1.9 (1.50; 1–8): E/1 × 32, E/2 × 18, E/3 × 5, E/4 × 1, E/5 × 2, E/6 × 1, E/7 × 1, E/8 × 1 (Brooker & Brooker 1989); probably includes following data: mean, 2.1 (1.45; 1–8; 53): C/1 × 22,

C/2 × 18, C/3 × 9, C/5 × 2, C/7 × 1, C/8 × 1 (M.T. Goddard). One dissected female contained four developing eggs (North). Said usually to lay two eggs (Lord 1956). Same female laid more than one egg in a replacement nest (Goddard & Marchant 1983).

Laying Eggs in nests may be laid by more than one female; from examination of similarity of eggs in nests: one nest containing five Cuckoo eggs attributable to laying by a single female; a crow's nest, parasitized in 3 consecutive years, contained two recognizably different types of Cuckoo eggs, attributed to laying by two different females (Goddard & Marchant 1983). Three eggs in nest of Pied Currawong laid 4–5 days apart (Goddard & Marchant 1983). For five young in nest of Little Crow, each appeared to be c. 2 days apart in age (MacGillivray 1914). Three cuckoos fledged from a nest of *Corvus*, 3 weeks apart (Salter 1978). Usually one or more eggs of host are damaged; fragments of shells of host's eggs often found on ground below parasitized nests (Goddard & Marchant 1983); a Cuckoo was seen to leave a nest of Pied Currawong with an egg in its bill (Goddard & Marchant 1983).

Incubation Host provides all incubation duties (NRS). INCUBATION PERIOD: Not known.

Young Altricial, nidicolous. Naked at hatching (Goddard & Marchant 1983). Young fully feathered at 4 weeks (with short bill and tail), spending much of day on branches near nest, increasingly jumping to and from nest and stretching wings (D.A. Curl). Usually do not eject young of host, but young of host usually disappear within 7 days, probably because Cuckoos monopolize food from host-parents (Goddard & Marchant 1983); one record of a host-chick fledging with two Cuckoo chicks (Berney 1907), another of two host-chicks fledging several weeks before Cuckoo (Salter 1978). Conspecifics not ejected (MacGillivray 1914; Goddard & Marchant 1983); mean number of Cuckoos per nest, 1.95 (1.28; 1–8; 102); one Cuckoo young × 44, two × 38, three × 13, four × 1, five × 3, six × 1, seven × 1, eight × 1 (Brooker & Brooker 1989). **Host-care, Role of sexes** At one nest in Alice Springs, pair of Little Crows shared feeding of young and regularly sat in nest, even when young ready to fledge, especially after feeding or during heat of day. Sometimes both host-parents sat in neighbouring nests, or one perched, usually silently, in neighbouring tree. Crows lowered rate of feeding at time of fledging by visiting nest without feeding young, or by not delivering food though pretending to feed (see Food: Young), possibly to encourage Cuckoo to leave nest (D.A. Curl). Grey Currawong *Strepera versicolor* seen feeding fledgelings, but not known if Currawongs raised them (NRS).

Fledging to independence FLEDGING PERIOD: Probably 17–24 days (Goddard & Marchant 1983); one nest, c. 4 weeks, with further 4 days before young first flew from nest-tree (D.A. Curl). Fledgelings remain with *Corvus* foster parents for several weeks; two fledgelings stayed with flock of crows *Corvus* and were fed by host-parents (Berney 1907; North).

Success Of two eggs usually laid by Cuckoo, chicks usually raise only one chick (Lord 1956); up to three chicks fledged successfully (Berney 1907; Lord 1939; Salter 1978; North).

PLUMAGES Prepared by D.I. Rogers. Fledge in juvenile plumage. Complete post-juvenile (first pre-basic) moult begins on body soon after fledging, but some or all remiges retained till migration to non-breeding areas, where remaining juvenile wing-feathers are moulted. Resultant first basic plumage often identical to adult, perhaps sometimes separable by a small number of retained juvenile remiges. No seasonal variation in plumage of adults; post-breeding (pre-basic) moult begins in

breeding areas, suspended during migration and finished in non-breeding areas. Sexes differ slightly in adults. Nominatae Aust. *novaeollandiae* described below.

Adult male (Second and subsequent basic). **HEAD AND NECK:** Light grey (dark 85) grading to slightly paler grey on chin and throat. Lores and broad orbital ring, unfeathered. **UPPERPARTS:** Upper mantle, light grey (dark 85). Lower mantle, scapulars and back, brownish grey (c79) heavily mottled or scalloped by broad black-brown (c119) tips to feathers. Rump slightly darker grey-brown (light 121) than back, with black-brown (c119) tips to feathers that are less sharply demarcated and often narrower; accordingly rump usually looks slightly darker and less patterned than rest of upperparts. Most uppertail-coverts, brownish grey (ne) with broad black-brown (119) spot at tip of each feather; on lateral uppertail-coverts, black-brown (119) spots become much smaller and one or two outermost pairs of feathers have white outer edges that bulge into small white half-bars on outer webs of feathers of some birds. **UNDERPARTS:** Mostly pale grey (c86); feathers grade to grey-white bases that can be partly exposed to give paler appearance, especially on belly. Thighs and undertail-coverts barred dark grey-brown (121) to light brownish-grey (c80); bars are 2–3 mm wide and spaced at intervals of c. 8 mm. Diffuse and narrow grey (c79) barring extends from thighs onto flanks, axillaries and sometimes belly; these markings are faint and often difficult to see. Axillaries barred like flanks but narrowly tipped white. **TAIL:** Brownish grey (c79), slightly browner (119B) when worn, with broad black-brown (119) subterminal bar (c. 70 mm wide on t1 to c. 30 mm on t6) and white tips, which are broad (20–30 mm wide) on most feathers, narrow on t1 from which they are often lost with wear. On t2–t6 there is a series of small white half-bars along inner edge, each with broad black-brown (119) lower margin; these markings only visible from below. **UPPERWING:** Remiges, alula, all greater and median coverts and longest lesser secondary coverts, brownish grey (c79) with broad black-brown (119) tips; on remiges these line up as broad bold trailing edge that peters out at p8–p9. Blackish tips of coverts become narrower toward leading edge of wing and are absent from shortest lesser coverts and marginal coverts of some birds. **UNDERWING:** Coverts, light grey (85–86) grading to whitish at partly concealed bases; light grey areas break into diffuse grey (85–86) and white bars on greater secondary coverts. Remiges, light grey (85) with black-brown (119) tips patterned like upperwing; inner edges of inner primaries often have diffuse white speckling.

Adult female (Second and subsequent basic). Similar to adult male but ground-colour of underparts paler: grades from pale grey (c86) on uppermost breast to off-white on most of breast, belly and flanks. Dark grey-brown (121) barring of thighs encroaches onto flanks and belly; barring is more extensive and slightly more conspicuous than in males, and diffuse light brownish-grey (c85) barring extends over all of flanks and often merges to lighter brownish-grey (85–86) barring up to centre of breast.

Nestling Naked at hatching (Goddard & Marchant 1983).

Juvenile Sexes similar. **HEAD AND NECK:** Face, top of head, hindneck and sides of neck, light rufous-brown (39); feathers are smaller and fluffier than in adult, with concealed pale-grey (86) bases, and narrow, slightly darker grey (85) subterminal areas; light-grey (85–86) bases to feathers partly exposed on ear-coverts. Chin and throat, pale rufous-brown (pale 39) with pale-grey (86) to white bases which can be partly exposed. **UPPERPARTS:** Mantle, back and scapulars as in adult, but feathers

smaller and narrower with narrow rufous-brown (38–39) tips. Feathers of lower back, brownish grey (ne) grading to narrow dark brownish-grey distally, and with very narrow buff (c124) tips. Rump, warm buff (118–39), very fluffy; feathers have brownish-grey bases that are readily exposed with wear. Uppertail-coverts as in adult but with smaller area of black-brown (119) distally and with warm-buff (118) tips, narrowest on central uppertail-coverts and broadest on lateral uppertail-coverts. **UNDERPARTS:** Uppermost breast, warm buff (118) grading to cream (54–92) on rest of underparts, palest near tail. Flanks and thighs clearly barred dark brown (121); bars are c. 3 mm wide and spaced at interval of c. 9 mm; they grade to grey-brown (79) barring on belly. **TAIL:** As adult except feathers narrower and slightly shorter. **UPPERWING:** As adult but with rufous-brown (38) or pale rufous-brown (39) tips to all feathers. On remiges, pale rufous tips are only 3–5 mm wide (on secondaries, hardly broad enough to form pale trailing edge) and fade to white (especially on p9–p10) when worn; on coverts, rufous tips are broader (especially near shafts) and can fade to buff (124) when worn. **UNDERWING:** Most coverts buff (124) or cream (92) with narrow dark-brown (c119A) or grey-brown (c79) barring; greater secondary coverts, cream (92) to off-white with light grey-brown (c80) barring. Remiges similar to adult but with buff (39–124) tips, 3–5 mm wide, forming narrow pale trailing-edge that tapers out on p8–p9; pale speckling on inner webs of inner primaries and outer secondaries is cream (c54) when plumage very fresh but rapidly fades to white.

Immature (First basic). Similar to adult in both sexes and probably often indistinguishable; one specimen (see Moults) suggests that at least some differ from adult in retaining small number of juvenile remiges into second austral summer.

BARE PARTS From photos (Flegg & Longmore 1994; Aust. RD; Strahan; unpubl.: J.N. Davies; R. Davies), museum labels (AM, ANWC, HLW, MV, QM, QVM, SAM, WAM) and Hall. **Adult male** Bill, grey-black (82) with cream (92) tip (c. 20–30% of bill), slightly more extensive on upper mandible than on lower; cutting edge of upper mandible often wholly cream (92). Some photographed in spring have shown strong orange-buff (c118) tinge to distal third of upper mandible; this possibly a flush associated with courtship but might have been caused by staining. Mouth, pinkish white. Iris, red (12, 14, c108). Broad orbital ring, narrower band of exposed skin on lores, strip of bare skin bordering base of upper mandible (except culmen), gape and base of cutting edge of lower mandible, pinkish red (13) to dark red (11, 12, 108A). Tarsus and toes, light grey (85) to grey (84) or dark grey (83) with narrow off-white boundaries to scutes, and grey-white sole; varying green tinges reported on some labels (e.g. Hall). Claws, grey-black (82). **Adult female** Similar to adult male but distal 30–50% of bill is cream (92) and black area at base of bill is correspondingly smaller. **Nestling** Gape, pinkish-red; skin, bronze (Goddard & Marchant 1983). **Juvenile** Bill: at first, dirty pink (3) grading to dark pink (4) at base of upper mandible; also described as dark blackish-brown (Goddard & Marchant 1983); gape, basal half of upper mandible and extreme tip of upper mandible, cream (c92). Begin to develop grey (84–85) smudges on basal half of bill, and cream smudges on distal half, during very early stages of post-juvenile moult of body; reddish-pink (c13) borders to nostril retained longer than other pink or red areas on bill. Iris, brown (c23), turning to brownish red (c132A) before post-juvenile moult finished. Orbital ring very narrow and greyish at first; lores are mainly feathered except for very narrow central band of dark-blackish skin (Goddard & Marchant 1983), and there is no

strip of bare skin at extreme base of bill. In early stages of post-juvenile moult, orbital ring becomes slightly broader and pink (c7) and narrow dirty-pink (c6) traces of bare skin on lores begin to emerge. Tarsus and toes similar to adults. **Immatures** Probably like adults but no detailed information on when adult colours attained.

MOULTS Based on records from 82 skins, including 25 collected in non-breeding areas (AM, ANWC, HLW, MV, QM, QVM, SAM, WAM; Stresemann & Stresemann 1961, 1966). **Adult post-breeding** (Second and subsequent pre-basic). Complete; wear of remiges, rectrices and body is uniform in Aust. birds during spring. Moult of tail and body occurs at about same time as moult of primaries, though body sometimes starts slightly earlier. Timing inadequately known as records only available from 42 adults of known collection date. Do not moult in Aust. during period when assumed most breeding occurs, Sept.–Nov. (n=12). Earliest records of active moult of primaries from Dec. (n=1), and many have begun moult by Feb. (five of nine examined); all have begun by Mar. (n=3) and Apr. (n=3). At least some suspend moult of primaries to migrate N (e.g. female at Shoalwater Bay had primary-moult N²O¹N¹O¹ N¹O⁴ on 4 Feb.; also see Hall); not known if some migrate N before beginning moult of primaries. Moult of primaries resumes in non-breeding areas and is typically finished May–June. Several exceptions to above model of moult-timing for Aust. birds from New Guinea (ANWC; Stresemann & Stresemann 1966): (1) Two males and two females in early stages of moult of primaries (PMS 8–16) in June; (2) male with PMS 20 in late Nov.; (3) male with active moult and PMS of 38, in June. Latter bird may simply have been an Aust. bird moulting rather late, but others appear to have completely different moult-schedule; possible that these not of Aust. breeding origin. Sequence of moult of primaries complex, irregular and poorly understood; considered to be random transilient by Stresemann & Stresemann (1961, 1966). Number of growing primaries per actively moulting wing, 2.3 (0.87; 1–5; 35); adjacent primaries seldom grow concurrently (only three exceptions in the 36 moulting wings examined). Sequence of moult of primaries often differs between left and right wing (five of thirteen skins). Sequence of moult of primaries also varies individually, e.g. first primary to be moulted included all primaries but p3 (n=23 moulting wings); last primary to be moulted included all primaries but p4 and p9 (n=16). In general, though, there is a trend for outer primaries to begin and finish moult before inner primaries; moult started between p6 and p10 in 17 wings, between p1 and p5 in only six wings; last primaries to moult were between p1 and p5 in 12 wings examined, between p6–p10 in only four wings. **Post-juvenile** (First pre-basic). Complete in at least some. Moult of body begins while in Aust. Begins soon after fledging in some birds, which show much first basic plumage of body in Jan. and Feb.; in others, onset delayed till Mar. and Apr. At least some migrate N before moulting any primaries. Earliest records of moult of primaries, Dec. and Jan. (New Guinea); in Apr., one specimen had PMS of 25. Record of male finishing post-juvenile moult of primaries in Oct. (Stresemann & Stresemann 1966) suggests that moult of primaries is rather gradual during first austral winter. Number of primaries that grow concurrently in each wing, 2.0 (1.50; 1–5; 18), and not very different from adult, so if immatures do perform a slower moult it must be because some suspend moult in non-breeding areas; this may explain New Guinea immature male with interrupted moult N⁴O²N¹O¹N¹O¹ in Nov. (Stresemann & Stresemann 1966) and Sepik district immature

female with interrupted moult O¹N¹O⁸ in May. Possibly some immatures have different moult-strategy, e.g. immature from Minnie Downs, SA, finishing primary-moult O¹N¹⁴N⁷ and 4¹N¹O¹N⁷ in Jan. retained juvenile p1 (left wing), p3 (right wing) and a juvenile secondary; it may have not have replaced any remiges in post-juvenile moult, and then undertaken an early second pre-basic moult in second austral summer. Immatures recorded by Stresemann & Stresemann (1966) with PMS of 42 (Ceram, May) and 49 (New Guinea, Apr.) are also confusing; they may have been Aust. birds that began very early first pre-basic moult of primaries, or they may not be Aust. breeding birds.

MEASUREMENTS (1–2) Aust., skins (AM, ANWC, HLW, MV, QM, QVM, SAM, WAM): (1) Adults; (2) Juveniles.

| | MALES | FEMALES | |
|--------|--------------------------------|----------------------------|----|
| WING | (1) 353.9 (7.77; 337–367; 21) | 346.8 (9.07; 336–368; 9) | * |
| | (2) 337.6 (8.05; 328–346; 5) | 337.8 (12.28; 327–352; 4) | ns |
| TAIL | (1) 266.5 (7.39; 253–278; 21) | 262.8 (7.19; 253–276; 12) | ns |
| | (2) 278.5 (12.48; 265–295; 4) | 281, 287, 288 | |
| BILL | (1) 86.4 (2.31; 83.7–93.5; 20) | 74.5 (2.99; 70.3–79.0; 13) | ** |
| | (2) 68.7 (5.39; 63.5–75.1; 5) | 67.3 (6.53; 61.1–76.2; 4) | ns |
| BILL N | (1) 69.7 (2.18; 66.7–75.0; 19) | 57.4 (4.08; 50.1–62.5; 10) | ** |
| | (2) 55.8, 60.1 | 48.8, 57.3 | |
| TARSUS | (1) 45.8 (2.27; 41.8–49.8; 21) | 44.0 (1.98; 38.7–46.3; 13) | * |
| | (2) 44.2 (2.68; 42.3–48.6; 5) | 43.5 (2.22; 40.9–46.8; 5) | ns |
| TOE C | (1) 55.8 (2.57; 52.5–59.8; 7) | 53.7 (3.01; 50.5–59.1; 7) | ns |
| | (2) 45.7, 50.4 | 51.6, 51.6, 54.5 | |

Males significantly larger than females for Wing, Tarsus and, especially, Bill and Bill N; Mason & Forrester (1996) also found significant differences between sexes, in Wing, Tail, Bill N and Tarsus. Wing and, especially, bill of juveniles, significantly shorter than in adult; tail of juveniles significantly longer than that of adults; tarsus and toes of juvenile do not differ significantly from adults. Few data on age at which adult size attained: immature female with first basic remiges had Wing 327, Tail 239, Bill S 71.3 and Bill N 57.6, suggesting wing and tail shorter than in most adults while bill close to, or at full size, before 1 year old. Additional measurements, of Aust. and extralimital birds, in Mason & Forrester (1996).

WEIGHTS Aust.; combined data from museum labels (ANWC, QM, WAM) and Hall.

| | MALES | FEMALES | |
|-----------|----------------------------|----------------------------|----|
| ADULTS | 708.2 (113.5; 560–935; 12) | 660.0 (83.68; 560–800; 12) | ns |
| JUVENILES | 554.7 (91.63; 448–670; 4) | – | |

Males probably heavier than females, but differences not significant in above samples. Juvenile males significantly lighter than adult males. Pre-migratory gain of weight of adults suggested by weights of males from NSW to central coast of Qld: Oct.–Nov., 665.8 (50.86; 5); Jan.–Feb., 746.7 (67.35; 6); Mar., 935.1. Weights of adults from non-breeding grounds in New Guinea, May–July (males 640, 720; females 700, 776.6), do not appear to differ greatly from those available from Aust.

STRUCTURE Wing long, broad, pointed at tip. Ten primaries: p8 longest; p10 110–123 mm shorter, p9 17–26, p7 2–10, p6 24–34, p5 55–63, p4 83–95, p3 105–124, p2 127–142, p1 148–170. Eleven or 12 secondaries, including three or four tertials (small tertial-like innermost feather may in fact be a

covert). Tail long, rounded at tip; ten rectrices; t5, 49–77 mm shorter than t1. Bill massive, longer than head; nostrils small and round, without raised rims, set at side of upper mandible. Upper mandible c. 28 mm wide and c. 24 mm deep at base in males; slightly decurved through most of length, with a small hook at tip; a small rounded groove (the so-called channel) runs from just above nostrils almost to tip of bill and is separated from distinct culmen ridge by a parallel rounded ridge and groove. Lower mandible mostly straight but drops slightly at tip; gonys runs from tip almost to base of bill, so no distinct gonydeal angle apparent. Bill of females noticeably less massive, with shallower channel and less distinct ridge on culmen. Bill of juveniles smaller still, and channels absent or barely noticeable at fledging. Tarsus sturdy, mainly scutellate, but top half feathered on front of tarsus. Toes strong, scutellate; outer front toe longest, outer hind c. 96%, inner front c. 75%, inner hind c. 47%. For further information on anatomy, see Beddard (1898).

GEOGRAPHICAL VARIATION Rather slight; three subspecies, differing mainly in size. Subspeciation was recognized only recently (Mason & Forrester 1996) and was previously overlooked through: (1) difficulty in distinguishing migrants from residents in areas N of Aust.; and (2) failure to recognize that sexes differ greatly in size. Nominate *novaehollandiae* (described above) occurs e. and n. Aust., migrating to New Guinea and Moluccas for non-breeding season; Mason & Forrester (1996) showed that variation in size within Aust. is negligible. Subspecies *fordi*, resident in Sulawesi, differs in larger size (e.g. in adult males, Wing 361.5 [4.3; 17]; in adult females, Wing 347.8 [5.0; 8]; Mason & Forrester 1996). Subspecies *schoddei* of Bismarck Arch. has heavier dorsal scalloping than other forms, is rather large (with disproportionately long tail and, especially, bill) and shows only slight sexual dimorphism in size (in adult males, Wing 352.5 [8.5; 4]; in adult females, Wing 346.5 [2.6; 3]; Mason & Forrester 1996). It is possible that there is a breeding population in s. New Guinea, which may differ from Aust. migrants in being slightly smaller (Mason & Forrester 1996); situation has not been resolved and further study needed, making use of moult-stage to distinguish resident birds from Aust. migrants. Subspeciation is also not resolved for the Sundan population (I.J. Mason).

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Volume 4, Plate 36 [caption errors corrected from original]

Channel-billed Cuckoo *Scythrops novaehollandiae* (page 782)
 1 Adult male; 2 Adult female; 3 Juvenile; 4, 5 Adult

Pheasant Coucal *Centropus phasianinus* (page 793)
 NOMINATE PHASIANINUS: 6 Adult male breeding; 7 Adult female breeding; 8, 9 Adult male breeding; 10 Adult female non-breeding;
 11 Downy young
 SUBSPECIES MELANURUS: 12 Adult female non-breeding; 13 Immature male; 14 Juvenile male just starting moult to immature

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