Order **PSITTACIFORMES**

Distinctive, familiar, and often strikingly coloured birds, with characteristic shape and structure. Often highly conspicuous. Small to large, ranging in size from tiny pygmy-parrots *Micropsitta* of New Guinea, the Moluccas and the Solomon Is (*c.* 9 cm in length and weighing 10–18 g) to large macaws of South America (up to *c.* 1 m in total length including tail, and weighing up to 1.7 kg), large cockatoos (e.g. Red-tailed Black-Cockatoo *Calyptorhynchus banksii*; up to 60 cm in total length including tail, and weighing up to 870 g), and flightless Kakapo *Strigops habroptilus* of NZ (up to 64 cm in total length, including tail, and weighing up to 2 kg). Third largest non-passerine order. Roughly 329–356 species in 76–93 genera, distributed on all continents except Antarctica; most are tropical; distributed widely in s. hemisphere, including some subantarctic islands of HANZAB region; in n. hemisphere occur as far N as Safed Koh Mts in e. Afghanistan (Slaty-headed Parakeet *Psittacula himalayana*). Greatest morphological and ecological diversity in A'asia and probably originated in A'asian sector of Gondwana, radiating from subtropical rainforests (Homberger 1991; see also Forshaw & Cooper 1989). In HANZAB region, 60 species in 27 genera. Appear to lack close living relatives, and nearest allies difficult to determine. Suggested that nearest allies are Columbiformes (pigeons) (Burton 1974; Forshaw & Cooper 1989), but this rejected by others (Sibley & Ahlquist 1990). Recent DNA–DNA hybridization studies suggest they should be placed between cuckoos and swifts (see Collar 1997; Rowley 1997). Other groups suggested as close allies include hawks, owls and piciforms (see Sibley & Ahlquist 1990). Recent works (e.g. Forshaw & Cooper 1989; Collar 1997; Rowley 1997) recognize three main groups: (1) cockatoos; (2) lories and lorikeets; and (3) parrots. However, taxonomic level of each varies: some (e.g. Forshaw & Cooper 1989) classify each at same level, but others (e.g. Collar 1997) group parrots with lories and lorikeets. On basis of biochemical (Christidis *et al.* 1991a) and chromosomal (Christidis *et al.* 1991b) studies, cockatoos were found to form a monophyletic lineage separate from all other Australo-Papuan parrots and lories. As such, Christides & Boles (1994) recognized two distinct families within Aust.: Cacatuidae (cockatoos) and Psittacidae, including the Loriinae (thus, parrots and lorikeets); an arrangement also supported by morphological and behavioural studies (Brereton & Immelmann 1962; Smith 1975; Homberger 1991). This arrangement followed here; both families represented in HANZAB region. Relationships between extralimital groups have not been examined closely and are in need of review. In recent works, extralimital subfamilies or tribes have been grouped with Aust. Psittacidae (Forshaw 1989; Collar 1997); that treatment has been followed here. The most widespread alternative taxonomy places all cockatoos and parrots in a single family, Psittacidae (e.g. Sibley *et al.* 1988; Forshaw & Cooper 1989; Sibley & Ahlquist 1990; Sibley & Monroe 1990; Peters). Many alternative taxonomies have been proposed; for reviews see Smith (1975), Sibley & Ahlquist (1990), and Schodde & Mason (1997); for discussion of Aust. taxa, also see alternative treatment of Wells & Wellington (1992).

Structure rather homogeneous. Bill distinctive: upper mandible downcurved, usually extending well beyond tip of lower mandible; lower mandible upcurved, and usually broad with rather square tip that fits neatly into inside of upper mandible. Usually have prominent cere. Rostrum movable, with hinge-like articulation at skull. Palate, desmognathous. Nares, holorhinal, impervious, always in cere. Basipterygoid process absent. Head usually large in proportion to body, and neck rather short; 13–15, usually 14, cervical vertebrae. Pelvic muscle formula, AXY. Sternum fenestrated or indented. Tongue, thick and muscular, tactile, grooved; moved by hyoid apparatus with large median foramen in entoglossum; tongue brush-tipped in some species (notably lorikeets in HANZAB region; see below). Feet, zygodactylous, with Type 1 flexor tendons (cf. Piciformes and Cuculiformes, which zygodactylous but with Type 6 flexor tendons). Crop present; no caeca. Oil-gland tufted or absent. Furcula weak or absent in some. Syrinx with three pairs of intrinsic muscles. Wings vary in shape from broad with rounded tip to narrow with pointed tip. Ten primaries; 10–14 secondaries; diastataxic. Tail short to very long; *Prioniturus* have ornate, projecting raquet-shaped central rectrices. Usually 12 rectrices. Aftershafts, short and downy. Legs, short and strong; tarsus short, with small granulate scales or papillae; middle toe longer than tarsus. Orbital ring usually complete. Whole body covered in down. Powder downs present; especially in uropygial region. Young ptilopaedic.

Adult plumage often brightly coloured (especially in Psittacidae), though also white, grey and black (especially in Cacatuidae); coarse in texture; and arranged in diffuse tracts. Bare parts mostly dull colours, but some species have brightly coloured bills, irides, lores and facial skin. Sexes alike (e.g. Rainbow Lorikeet *Trichoglossus haematodus*) or highly dimorphic (e.g. Eclectus Parrot *Eclectus roratus*).

Adults undergo a post-breeding (pre-basic) moult each cycle; usually complete, but some species can arrest moult before it is finished. Adult pre-breeding moults not reported (Forshaw & Cooper 1989). Usually moult once a year, but some possibly take longer than a year to finish; in HANZAB region, timing varies (see Family introductions). Moult of primaries of adults usually centrifugal, from mid-primaries, but starting position varies. Moult of secondaries of adults often starts from s10 at about time moult of primaries starts, and replaced outward to finish with s1, but

sequence also often irregular (see Forshaw & Cooper 1989). Moult of tail usually starts after moult of primaries well advanced, but usually finishes before last primary shed; sequence irregular (see Forshaw & Cooper 1989). Young altricial; blind at hatching, covered by sparse pale down. Juvenile plumage often similar to, or slightly duller than, adult plumage, but remiges and rectrices usually more pointed than adults. Rate of maturation and attainment of adult plumage and bare parts varies greatly; slow in some species. Sequence of plumages to adult and timing of moults varies greatly. Post-juvenile (first pre-basic) moult typically partial, but some possibly compete (e.g. Nestorinae). Some species have one or more immature plumages.

Worldwide, occur in wide variety of habitats, from dense rainforest to open, treeless grassed plains, though predominantly, and with greatest diversity, in tropical rainforests (Forshaw & Cooper 1981). In HANZAB region, widespread throughout alpine, tropical, temperate, semi-arid and arid zones; occur in most habitats, from coasts to high altitudes, including above treeline in alpine zones.

No species of Cacatuidae can be regarded as completely migratory (Rowley 1997), though some populations of some species undertake regular movements and considered partly migratory. Other Cacatuidae are resident, sedentary, or dispersive. Worldwide, Psittacidae considered resident, dispersive, nomadic or irruptive (Collar 1997); only two species considered migratory; at least one other species is partly migratory (Collar 1997; see Psittacidae below). Few species of Psittacidae are considered sedentary, usually island forms, and some of these occur in HANZAB region.

Herbivorous. Most feed on seeds and fruits, supplemented by a wide range of other food, such as flowers, nectar, pollen and leaves. Many species include small quantities of invertebrates, mostly insects and insect larvae, in their diet; almost all eat some seed, which always husked before swallowing (Forshaw & Cooper 1981; Campbell & Lack 1985). Specialization evident in some groups (see Family accounts below). Feed arboreally and terrestrially; in HANZAB region, *c.* 35% of species feed mainly arboreally, *c.* 35% feed mainly on ground, and the rest feed both arboreally and terrestrially. Of those considered primarily arboreal or terrestrial, about a third of species within those categories occasionally feed on other substrates. When feeding in trees or shrubs, agile and acrobatic, and clamber actively through outer branches and foliage, stretching to reach food, and often hanging upside down; use both bill and feet; while climbing among foliage of trees, often use bill to grasp branches and then clamber up or across from previous position. On ground, equally active, picking up fallen seeds or fruits from ground, or taking them directly from flowering or seeding heads; when food beyond reach, will stetch up to reach, or stand on stalks of plants, felling them to ground; many also use bill to dig up underground roots, corms or bulbs, or scratch soil with feet (Forshaw & Cooper 1981; also see species accounts). Many use bill to tear away or crush hard seed capsules, such as those of *Eucalyptus* and casuarina, and extract seeds from them; bill also used by some to tear open trunks of trees and branches for wood-boring insect larvae. Many use feet to manipulate food and to bring food to bill (Smith 1971; Forshaw & Cooper 1981); some show preference for use of particular foot, usually left (Forshaw & Cooper 1981; Joseph 1989; Magrath 1994). In HANZAB region, Glossy Black-Cockatoos *Calyptorhynchus lathami* exclusively or predominantly left footed (Joseph 1989; Magrath 1994; Pepper 1996), Yellow-tailed *Calyptorhynchus funereus* and Red-tailed Black-Cockatoos, Gang-gang *Callocephalon fimbriatum* and Palm *Probosciger aterrimus* Cockatoos predominantly left footed; while Eastern *Platycercus eximius* and Pale-headed *P. adscitus* Rosellas predominantly right footed (Cannon 1977; Prendergast 1985; Joseph 1989). Drink water at least once during day; most come to drink early in morning, some in morning and late afternoon, and some throughout day depending on heat of day; most drink by scooping water in lower mandible, then tilting head back (Campbell & Lack 1985); also drink water by lapping, ladling or suck-pumping (Schodde & Mason 1997).

Usually very vocal. Calls described as squawks, screeches, squeals, shrieks, whistles, cackles, chatters, buzzes or twitters. Many calls harsh, guttural and described as strident, but other calls can be musical rolling screeches and melodic whistles or warbles, often piping in quality. Many calls loud and distinctive; sometimes raucous. In HANZAB region, exceptional calls are those produced by mechanical means by Palm Cockatoos, and remarkable Booming made by male Kakapo during displays (see those texts for details). In HANZAB region, voice not well studied, though several notable exceptions (see below and family introductions). Repertoire of calls of Budgerigar *Melopsittacus undulatus* well known from studies in captivity and in wild; otherwise, repertoires poorly known. Size of repertoire appears to vary greatly between species, though this may be more a reflection of lack of knowledge of many species. Some species have as many as 20 or more described calls. Brereton (1963a,b, 1971a,b) and Pidgeon (1981) compared repertoires of a number of Aust. species. Brereton (1971b) suggested that the information content of vocalizations low in species occurring mainly in habitats with abundant resources, and most complex when resources at intermediate levels, but again simpler with increasing scarcity of resources. Suggested that some calls of Budgerigar functionally equivalent to song of passerine birds (see account for Budgerigar); this may also be true of calls of some other parrots. Within species, variation in calls sometimes complex, with some described as grading from one to another across a wide range of intermediates; these variations generally not well understood. Individual variation often used for individual recognition within pairs, and used to recognize members within family or other groupings (e.g. *Calyptorhynchus*, Galah *Eolophus roseicapillus* and Budgerigar). Some calls sexually distinctive in many species of both families. In HANZAB region, little or no information on seasonal variation for most species. Regional

variations in repertoire and variations in call characteristics little studied in HANZAB region but rarely apparent. However, known from at least three species in HANZAB region (Australian Ringneck *Barnardius zonarius*, Red-crowned Parakeet *Cyanoramphus novaezelandiae* and Kaka *Nestor meridionalis*). Calls of young often show similarity in structure between related species. Courtney (1974, 1986, 1993, 1996, 1997a,b,c) studied development of calls in young of many species of Aust. parrots. Food-begging Calls of many young parrots change with age. Brereton & Pidgeon (1966) speculate on ontogeny of calls in Eastern Rosella and provide illustrative sonagrams. They suggest adult calls develop from simple squawk given by nestlings. In exceptional instance of Galah being reared in wild with brood of Major Mitchell's Cockatoo *Cacatua leadbeateri*, Galah adopted calls of foster parents (Rowley & Chapman 1986). Mimicry almost absent in wild (but see Palm Cockatoo), but common in many species in captivity, especially cockatoos and Budgerigar, but also Rainbow Lorikeet, *Polytelis*, Swift Parrot *Lathamus discolor*, Red-crowned Parakeet and Turquoise Parrot *Neophema pulchella*.

For discussion of Social Organization and Social Behaviour, see family accounts below.

Breeding well known for most species in HANZAB region, poorly known extralimitally. Breeding generally seasonal, though some species can breed at any time if conditions suitable. Nest mainly in hollows in trees; some species nest on ground, under rocks or vegetation, or in tunnels excavated in arboreal or terrestrial termitaria. Eggs white. Clutch-size varies; in HANZAB region, largest clutches laid by Psittacinae and most species of Platycercinae in temperate areas and tropical semi-arid areas. Incubation by female only in Psittacidae and some Cacatuidae, by both sexes in *Cacatua*, *Callocephalon*, *Eolophus* and *Nymphicus*. Young altricial, nidicolous. Naked at hatching; generally develop down within first week. Young usually fed by female at first, then by both sexes. Fledgelings usually remain with parents for some time (Forshaw & Cooper 1981).

Worldwide, at least 90 species of parrots (c. 25% of all species) considered threatened (King 1981; Collar & Andrew 1988; Collar *et al.* 1994). In the HANZAB region, the only extinct taxa are: the Paradise Parrot *Psephotus pulcherrimus* (the only species extinct on mainland Aust.), probably through combined effects of overgrazing and drought; the Norfolk Island Kaka *Nestor productus*, which was killed for food and whose habitat was largely cleared; Lord Howe I. subspecies of Red-crowned Parakeet *Cyanoramphus novaezelandiae subflavescens*, possibly killed off by hunting and trapping; and the Macquarie I. subspecies of the Red-crowned Parakeet *C.n. erythrotis*, which was extirpated by cats (Garnett 1993). However, many more species are threatened: Garnett (1993) lists another 22 taxa in Aust. that are nationally threatened; of these, seven species are endangered, five vulnerable, five rare, and five insufficiently known. In addition, of the eight species of parrots native to NZ, the Kakapo is endangered; Orange-fronted Parakeet *Cyanoramphus malherbi* is rare; Kaka, Forbes' Parakeet *C. forbesi* and Antipodes Island Parakeet vulnerable; and Yellow-crowned Parakeet *C. auriceps* and Kea *Nestor notabilis* near threatened (Taylor 1985; Collar *et al.* 1994). In temperate woodlands and grassy woodlands of s. Aust., one species of woodland-dependent parrot, the Paradise Parrot, is extinct, and six others threatened; another three species of woodland-associated parrots are also threatened (Robinson & Traill 1996).

Overall, major threatening process is extensive clearance and fragmentation of habitat, particularly in S. America (King 1981; Collar & Andrew 1988; Collar *et al.* 1994). In HANZAB region, degradation, clearance and subsequent fragmentation of natural habitats for agriculture and forestry, including collection of firewood, have adversely affected many species (e.g. Glossy Black-Cockatoo, e. population of Regent Parrot *Polytelis anthopeplus*); small and isolated remnants are often too small to support viable populations of birds. Overgrazing and altered fire-regimes also change structure of vegetation, and have reduced populations and range of several species (e.g. Golden-shouldered Parrot *Psephotus chrysopterygius*, Scarlet-chested Parrot *Neophema splendida*, Ground Parrot *Pezoporus wallicus*). In Tas., preferred feeding habitat of Swift Parrot threatened by clearfelling and woodchipping of forests of Tasmanian Blue Gum *Eucalyptus globulus*. Orange-bellied Parrots *Neophema chrysogaster* threatened by destruction of coastal saltmarsh, the main feeding habitat on mainland Aust. In some areas, removal of hollow-bearing trees causes local shortages of nesting hollows, which, in turn, then reduces opportunities to breed. In s. Aust., harvesting of forests for firewood usually removes old dead trees, which often contain hollows; as a result, the reduction in the number of hollows available for nesting has caused declines of populations of many parrots throughout range (Robinson & Traill 1996). There is little replacement of suitable hollow-bearing trees, e.g. in sw. WA, the lowest average age of nest-trees used by parrots was estimated at 275 years and 446 years for cockatoos (Mawson & Long 1994, 1997; *contra* Stoneman *et al.* 1997). Further, introduced hollow-nesting species, such as Common Starlings *Sturnus vulgaris* and Common Mynas *Acridotheres tristis*, and some introduced parrots (such as Sulphur-crested Cockatoos *Cacatua galerita* in WA and Crimson Rosellas *Platycercus elegans* in NZ and on Norfolk I.), as well as Common Brushtailed Possums *Trichosurus vulpecula* and feral honeybees *Apus mellifera*, appear to compete with some species for use of hollows; this problem exacerbated in areas where hollows in short supply as a result of changes to habitats (Smithers & Disney 1969; Dawe 1979; Saunders *et al.* 1985; Garnett 1993).

Conversely, populations of some species (e.g. Elegant Parrot *Neophema elegans*) have increased, and ranges expanded after native vegetation cleared and converted to farmland, which has created habitat of similar structure to preferred natural habitats. Other species (e.g. Rainbow Lorikeet) have experienced increases in populations and

expansion of range since the 1970s, probably resulting from greater availability of food after the establishment and maturation of native trees in parks and gardens in urban areas (Veerman 1991). In some areas, changes to habitats through establishment of agricultural production, particularly grain production, and provision of water for stock, has allowed some species, notably Galahs, Sulphur-crested Cockatoos and Little *Cacatua sanguinea* and Long-billed *C. tenuirostris* Corellas, to undergo dramatic increases in population and expansion of range, to the extent that they are considered pests in some rural areas (Saunders *et al.* 1985; Rowley 1990; Serventy & Whittell). Worldwide, some species are threatened by persecution in agricultural areas, where seen as pests to crops (e.g. Blue-winged Macaw *Ara maracana*, Hispaniolan Parakeet *Aratinga chloroptera*); the Carolina Parakeet *Conuropsis carolina* of N. America was hunted to extinction in late 19th and early 20th centuries because it was considered a pest of agriculture (Halliday 1978; Collar *et al.* 1994). In agricultural areas of sw. Vic., one of the most common causes of death of Long-billed Corellas is shooting by farmers (Emison *et al.* 1994); in WA, an open season declared on feral Sulphur-crested Cockatoos (Saunders *et al.* 1985), and several other species of parrots are also legally shot (Robinson & Brouwer 1989). In NZ, large numbers of Red-crowned Parakeets were formerly shot as pests around crops (Turbott 1967; Taylor 1985; Oliver).

Popular cage-birds. Throughout world, illegal taking of eggs or young from nests, or adults from wild populations for avicultural trade a major threat to continued survival of some species, e.g. Red-and-Blue Lory *Eos histrio*, Spix's Macaw *Cyanopsitta spixii*, Hyacinth Macaw *Anodorhynchus hyacinthinus*, Thick-billed Parrot *Rhynchopsitta pachyrhyncha*, Green-cheeked Amazon *Amazona viridigenalis* (King 1981; Collar & Andrew 1988; Ridgely 1989; Snyder *et al.* 1989; Juniper 1991; Collar *et al.* 1994). However, the effect of illegal collecting is exacerbated by threats posed by loss of habitat as described above (Collar *et al.* 1994; Forshaw). In HANZAB region, several species of cockatoos and parrots with small populations are threatened by illegal collecting for aviculture, for both local and overseas markets, e.g. Eclectus Parrot and subspecies *narethae* of Blue Bonnet *Northiella haematogaster* (Garnett 1993). In Aust., many hollows destroyed by collectors hacking holes in trees to get access to nest-hollows and eggs or young. Hollows that are not destroyed often repeatedly robbed, either in subsequent seasons or after birds re-lay in same season after theft of clutch (Forshaw). In NT, trial programme introduced to legally exploit wild populations of Red-tailed Black-Cockatoos, involving collection of eggs, nestlings and adults (Anon. 1995). Similar schemes have been proposed in other areas of Aust., involving other abundant or pest species, but have not been accepted. Extralimitally, extinction or declines in populations have also been blamed on human persecution, especially if thought to be pest of agricultural production, and including hunting (e.g. Snyder *et al.* 1989).

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Family **PSITTACIDAE** parrots and lories

Usually brilliantly coloured, and vary greatly in size. About 310–335 species in 70–87 genera (Schodde & Mason 1997); 46 species in 21 genera in HANZAB region. Distributed on all continents except Antarctica; most diverse in A'asia, but other centres of diversity in Old World (Africa and Indian subcontinent) and New World (S. America and s. N. America) (Smith 1975; Forshaw & Cooper 1989; Schodde & Mason 1997).

Taxonomy at subfamily level not clear at present time. Different authors have recognized 5–11 different groups within Psittacidae (see Smith 1975; Forshaw & Cooper 1989; Sibley & Ahlquist 1990; Collar 1997). Eleven infrafamilial groups have been recognized here, following Schodde & Mason (1997) for those with representatives in HANZAB region, and Collar (1997) for those wholly extralimital. The following four groups occur extralimitally: Psittrichadini (Pesquet's Parrot *Psittrachas fulgidus*, monotypic); Micropsittini (pygmy parrots, six species); Psittacini (Afrotropical parrots, 12 species); and Arini (Neotropical parrots, 148 species); these not considered further below.

Schodde & Mason (1997) recognized six infrafamilial groups in Aust. and its territories. However, since relationship between species in some of these groups is still not clear, they treated only the three more clearly defined groups as subfamilies (Nestorinae, Loriinae and Platycercinae) and considered the other three groups as unplaced tribes (Psittaculini, Cyclopsittacini and Polytelini). Another subfamily, Strigopinae, is endemic to NZ (NZCL). Collar (1997) differs slightly in which groups he treats as subfamilies and which he treats as tribes; also does not recognize Polytelini, which he includes within Psittaculini. The seven groups occurring in the HANZAB region (based on Schodde & Mason [1997] unless stated and which see for further references):

SUBFAMILY STRIGOPINAE: Monotypic Kakapo *Strigops habroptilus*; endemic to NZ. Large, flightless. Furcula cartilaginous; keel vestigial (Holyoak 1973; Smith 1975). Barred remiges and rectrices (Smith 1975). Scratch head over wing (Smith 1975).

SUBFAMILY NESTORINAE: Kakas. One genus, *Nestor*, with two species endemic to NZ, and a third isolated and extinct species on Norfolk I. Large and short-tailed, with spines extending from tips of rectrices. Remiges barred (Smith 1975). Parahyoid process joined; styohyoideus muscle reduced; left carotid superficial; tongue thick and muscular with fringe of hair-like papillae on outer edge; pigments fluorescent (Holyoak 1973).

SUBFAMILY LORIINAE: Lorikeets and lories. Small, brightly coloured, and arboreal parrots. Eleven to 13 genera, distributed across e. Indonesia, New Guinea, islands of sw. Pacific and Aust. with greatest diversity in New Guinea, where 8–10 genera occur; three genera in HANZAB region: *Glossopsitta*, *Psitteuteles*, *Trichoglossus* (Schodde & Mason 1997). Most have permanent underwing-stripes (Smith 1975; Forshaw & Cooper 1989; Courtney 1997b); present only in some juveniles of extralimital *Charmosyna* (Courtney 1997b). Parahyoid process joined; styohyoideus muscle reduced or absent; tongue has brush of papillae at tip (Holyoak 1973; Smith 1975; Forshaw & Cooper 1989). Also characterized by pointed wings and tails, dashing flight, and short intestinal tract with inelaborate crop and gizzard.

SUBFAMILY PLATYCERCINAE: Broad-tailed parrots. Diverse group of small to medium-sized parrots. About 14 genera containing 35–38 species distributed across Aust., NZ and New Caledonia and on some associated islands; 11 genera and 28 species in HANZAB region: *Barnardius*, *Cyanoramphus*, *Lathamus*, *Melopsittacus*, *Neophema*, *Neopsephotus*, *Northiella*, *Pezoporus*, *Platycercus*, *Psephotus*, *Purpureicephalus*. Underwing-stripe present in juveniles and most adult females, but usually 'deciduous' in adult males (Holyoak 1973; Courtney 1997c); permanent in *Melopsittacus* and *Pezoporus* (Courtney 1997b,c); absent in extralimital *Prosopeia* (Courtney 1997c). Characterized by crescentic auditory maetus; foss at base of zygomatic process; orbit open below (except *Melopsittacus*); parahyoid process more or less converging; tongue has shallow grooves; furcula cartilaginous (except *Lathamus*); stylohyoideus muscle often wide; left carotid often superficial; fluorescent yellow pigment in plumage; scratch head over wing (Holyoak 1973). Except for *Geopsittacus* and *Pezoporus*, all have small patch of feathers on nape with white or pale yellow bases, instead of the usual grey, and which forms a nape-spot (Smith 1975), though spot hidden unless feathers of the region are erected or worn.

Unplaced tribes: PSITTACULINI: Palaeotropic parrots. Medium-sized arboreal parrots with heavy bills. Composition uncertain; about 11 genera, distributed from India to A'asia. Two genera in Aust.: *Eclectus* and *Geoffroyus*. Both tongue and dental pad ridged or grooved. No stripe on underwing.

CYCLOPSITTICINI: Fig-parrots. Small, green, arboreal fruit-eating parrots. Five species in 1–3 genera, with distribution centred in New Guinea; single species in genus *Cyclopsitta* in HANZAB region. Have stout ridged bills; wedge-shaped tails; marked sexual dimorphism; permanent double stripes on underwing; and completely ossified orbital ring free from well-developed zygomatic processes (Smith 1975; Courtney 1997b).

POLYTELINI: Long-tailed parrots. Slender medium-sized parrots. Eight species in three genera, with distribution centred in Aust. Five species from all three genera in HANZAB region: *Alisterus*, *Aprosmictus* and *Polytelis*.

Characterized by long, attenuated pink-tipped tails (Schodde & Mason 1997); inner webs of lateral rectrices have rose-pink edging, a character not possessed by any other parrot (Courtney 1997a). Other characters include: marked sexual dimorphism; no stripe on underwing; tongue ridged or grooved; soft palate; extrinsic syringeal muscles evidently attached to lung membrane.

Generally slim bodied, with short necks and short bills. Plumage coloured by carotenoid pigments and back-scattering of light through hollow cortical cylinders in feather barbs (Dyke-texture or Tyndall-texture). All feathers of body (except nape of some groups) have grey bases. None has erectile crests, though Horned Parakeet *Eunymphicus cornutus* of New Caledonia has elongated feathers on crown forming an immovable crest (Forshaw & Cooper 1989). Maxillae attached to skull by a flexible joint. Carotid arteries paired, fused, or left carotid superficial. Syrinx bronchial, the first rings upcurved, ossified and fused (except in Nestorinae). Zonary proventriculus present. No gall bladder. See introduction to order for characters shared with Cacatuidae.

Adult plumage often bright and colourful; ground-colour commonly green, with blue, red or yellow markings. In most, sexes similar or differ only slightly in plumage; in *Eclectus*, *Psephotus* and some *Neophema*, sexual dimorphism in plumage marked. In those groups that have stripe on underwing, presence often related to age or sex. Adult bare parts vary greatly: dull greys, browns and creams in many, but can be bright red or orange in many others. In most species, males slightly larger than females. Adult post-breeding (pre-basic) moult usually complete. Moult of primaries centrifugal; usually begins from p6, but in some can begin with any primary between p5 and p8. Nestlings usually hatch with sparse covering of down; a few hatch naked or nearly naked. A second, mesoptile, down develops in many species. In most, juvenile plumage duller than that of adults (and often resembles dull version of adult females in species where sexes differ). Post-juvenile (first pre-basic) moult partial in most species. Time to attain adult plumage varies greatly between species; in some, young birds not separable from adults after a few months, in others, adult appearance not attained until *c.* 4 years old. Similarly, time of first breeding can vary between species, from within first year to 4 years or older.

Occur in most habitats, from arid and semi-arid zones to tropical rainforest. Some species wholly arboreal, e.g. Loriinae, Cyclopsittacini, Eclectus Parrot *Eclectus roratus*; most others at least partly arboreal; a few strictly terrestrial, e.g. Night Parrot *Pezoporus occidentalis*, Ground Parrot *P. wallicus*. Though recorded in most habitats, some are specialists: e.g. fig-parrots *Cyclopsitta* mostly restricted to tropical and subtropical rainforests; Kaka *Nestor meridionalis* mostly inhabits temperate beech, broadleaf or podocarp rainforests; and Ground Parrot mainly confined to heathland in s. and e. Aust. In contrast, rosellas *Platycercus* may occur in a wide variety of treed habitats. Most require hollows, and therefore old trees, in which to nest, and are adversely affected by the removal of hollow-bearing trees (see Introduction to Order).

Patterns of movements vary greatly: from sedentary (e.g. Ground Parrot, Kakapo *Strigops habroptilus*), resident (e.g. Australian Ringneck *Barnardius zonarius*), to highly nomadic or dispersive (e.g. Budgerigar *Melopsittacus undulatus*). Several species migratory: Swift Parrot *Lathamus discolor* and Orange-bellied Parrot *Neophema chrysogaster* breed in Tas. and most or all of population moves to mainland Aust. for non-breeding season; further, Tas. breeding population of Blue-winged Parrot *Neophema chrysostoma* also apparently mostly migratory, moving to mainland Aust. Kakapo of NZ flightless. As with Cacatuidae, movements of many species poorly known, and many types of patterns have been attributed to them (e.g. Superb Parrot *Polytelis swainsonii*), probably in ignorance of actual movements, but possibly because movements vary between years or areas. Movements of lorikeets in Aust. (Loriinae) often considered to be related to flowering of food-trees. Many other species in HANZAB region appear to move in response to rainfall; in Budgerigar, both rainfall and temperature act indirectly on control of movements and breeding by affecting production of food (Wyndham 1980, 1983). Some species might make altitudinal movements (e.g. Eastern Rosella *Platycercus eximius*). Even suggested that movements of Golden-shouldered Parrots *Psephotus chrysopterygius* possibly linked to those of Black-faced Woodswallows *Artamus cinereus* (Garnett & Crowley 1995). Major studies of movements have been carried out on some species in HANZAB region (e.g. Crimson Rosella *Platycercus elegans*), using standard leg-banding, radio-tracking, and, in case of Ground Parrot, even cotton and spool method (Jordan 1987, 1988).

Almost all are herbivorous, feeding mainly on seeds, though many also take insects and their larvae. Most gregarious. Feed on ground, in trees, or both. Drink water by lapping, ladling or suck-pumping. All (except monotypic Psittrichichadini of New Guinea) husk seeds in same way: seed held between tip of lower mandible and notch on horny palate of upper mandible (which also corrugated to improve grip); the tip of the lower mandible driven into husk, between seed and husk, which is thus removed. The seed is then split and eaten; very hard nuts are held in part of bill nearest gape, where pressure between mandibles greatest (Collar 1997). Handling of other items similar. In HANZAB region, groups show variety of adaptations and behaviour; the following based on Forshaw & Cooper (1981), Schodde & Mason (1997), Forshaw, and species accounts, unless stated. LORIINAE: Almost exclusively arboreal, feeding mainly on nectar and some pollen and fruit. Specialized for harvesting pollen and nectar, with: narrow and protruding bills, brush-tipped tongues (see Churchill & Christensen 1970; Hooper & Burbidge 1979), non-muscular gizzard, and compound glands arranged linearly along wall of proventriculus (Steinbacher 1934). Gizzards of lorikeets much

smaller than those of seed-eating parrots of similar body weight, and intestine substantially shorter (Richardson & Wooller 1990). Gregarious, feeding in noisy flocks that continually move from one stand of flowering trees to another. When feeding, very active, clinging to and climbing all over flowering branches. PSITTACULINI: Arboreal, mainly in canopy of rainforest trees. Feed on fruits, seeds, flowers and nectar; said to prefer rainforest fruits. Usually feed in pairs or small flocks. CYCLOPSITTICINI: Wholly arboreal, but may descend to *c.* 1 m from ground to feed on low branches and trunks of fig-trees. Frugivorous, eating mainly figs, though tend to extract seeds from fruit and discard pulp rather than eat fruit. Bills broad, stout and ridged. Feed in pairs or small parties. POLYTELINI: Arboreal and terrestrial, granivorous. *Alisterus* and *Aprosmictus* arboreal, feeding mainly on seeds of native trees, such as *Eucalyptus*; *Polytelis* spend more time on ground feeding on seeds of grasses and herbaceous plants. Feed in pairs or small flocks, though *Polytelis* usually feed in flocks. PLATYCERCINAE: Terrestrial and arboreal. Diet: (1) mainly seeds of grasses, herbs and trees, procured from ground or from shrubs and trees (*Barnardius*, *Neopsephotus*, *Northiella*, *Platycercus*, *Polytelis*); (2) mainly seeds of grasses and herbs obtained almost exclusively from ground (*Melopsittacus*, *Neophema*, *Pezoporus*, and *Psephotus* [except Mulga Parrot *P. varius*, which feeds both on ground and in trees]); (3) nectar (*Lathamus*); (4) leaves of grasses and sedges (*Cyanoramphus*). Some highly specialized, e.g. Red-capped Parrots *Pururecephalus spurius* have narrow projecting bill and feed on seeds extracted from capsules of Marri *Eucalyptus callophylla*. Many also supplement main diet with flowers, nectar, or fruits, and almost all take some invertebrates. One, Antipodes Island Parakeet *Cyanoramphus unicolor*, known to take dead and nesting seabirds. Most feed in small flocks; some feed in large flocks (e.g. Budgerigar); others often feed singly or in pairs (e.g. *Platycercus*). Feeding behaviour varies widely depending on nature of food and where obtained; for details see individual species accounts. NESTORINAE: Mainly herbivorous but omnivorous, taking wide range of plant foods and invertebrates. Arboreal and terrestrial, forage at all levels from ground to canopy of trees. Use wide range of foraging methods, including gleaning, probing, digging, stripping and chiselling bark, excavating wood, and licking nectar from flowers; unlike other parrots, feed on sap by stripping bark and exposing cambium, and then lick sap from damaged surface. Feed singly, in pairs or small flocks, though Kaka more often singly. STRIGOPINAE: Mainly herbivorous, partly granivorous. Forage at all levels, including canopy of tall forest, but most foraging on or near ground. Sense of smell thought to be well developed and of importance in foraging, and at least some birds can locate foods by smell alone. Short, powerful and compressed bill, and short, broad and thick tongue adapted for browsing, crushing, grinding and extracting juices from fibrous plant tissues. Solitary.

In HANZAB region, all species gregarious to some extent with notable exception of Kakapo. In most species, flocks typically of up to *c.* 30 birds. However, some species in flocks of 100s and, in Budgerigars, 1000s. Most species more gregarious in non-breeding season, though even in breeding season, many species often form flocks when feeding. All monogamous, with exception of Kakapo, in which the sexes come together only at leks. Pair bonds life-long and mates remain together year round. Co-operative breeding does not occur, with probable exception of Eclectus and Red-cheeked *Geoffroyus geoffroyi* Parrots (Psittaculini) and possibly, but rarely, Regent Parrot *Polytelis anthopeplus* (Polytelini). Only female incubates but both sexes involved with feeding of young, except in Kakapo, in which female raises young alone, and possibly Ground Parrot, in which male appears responsible for feeding of young. In most species, young generally leave natal area by 3–6 months old. Aust. lorikeets, *Polytelis*, *Eclectus*, and some *Neophema* often nest in loose colonies; others strictly solitary nesters. Generally defend only nest-hole. Most gregarious species roost communally, at least when not breeding.

Often conspicuous, vocal and active but may be hard to observe when feeding in tree-tops or on ground. All species courtship feed, except Kakapo; in some, occurs year round e.g. *Trichoglossus*. Many known to, or likely to, allopreen, except rosellas *Platycercus*, Australian Ringneck, *Cyanoramphus*, *Neosephotus*, *Neophema*, Red-winged Parrot *Aprosmictus erythropterus*, Australian King-Parrot *Alisterus scapularis*, possibly Red-cheeked Parrot, and assumed not to in Kakapo. Sexual and aggressive displays generally fairly simple, consisting of actions such as bobbing, eye-blazing, arching of wings, fanning and wagging of tail and calls. However, in *Trichoglossus* and Varied Lorikeet *Psitteuteles versicolor* (Loriinae), displays complex and performed in many social contexts; in *Trichoglossus*, displays often performed either reciprocally or in unison by both members of a pair. Other notable displays are aerial circling performed by Eclectus and Red-cheeked Parrots, and distinctive calling behaviour of Kakapo and Ground Parrot.

Calls usually described as whistles, chatterings or pipings, though some are shrieks. Calls often melodic and some are extraordinarily complex, such as Warble song of Budgerigar, and highly varying yodelling calls of Kaka *Nestor meridionalis*. Booming of Kakapo at lek unique form of vocalization in parrots. Sexually differentiated calls known in many species in most genera. Food-begging Call of all Aust. lorikeets a repeated sharp high-intensity hissing note that begins with a structureless hiss, which gives way abruptly to a brief high-energy blip preceding a structured hiss (see Courtney 1997b). For details of Food-begging and other calls of platycerine parrots see Courtney (1997c, which was not available for summary in species accounts).

Breeding well known in HANZAB region. Extralimitally, breeding of most species of Loriinae, Platycercinae and Cyclopsittacini virtually unknown; some species of Psittaculini moderately well known. Plum-headed Parrot *Psittacula cyanocephala* and some lovebirds *Agapornis* (Psittaculini) breed colonially (Forshaw & Cooper 1981), and Large Fig-Parrot *Psittaculirostris desmarestii* (Cyclopsittacini) thought to breed colonially within hollow trunks of large

trees (Rand 1942; Beehler 1982). Breeding generally seasonal but some species will breed at any time of year if conditions suitable, and some species can raise two or more broods in a season. Most species nest in hollows in trees, though some nest on ground, under rocks, vegetation or in burrows; some species excavate tunnels in termite mounds. Extralimitally, Red-flanked Lorikeet *Charmosyna placentis* (Loriinae), Orange-breasted Fig-Parrot *Cyclopsitta gulielmitertii* (Cyclopsittacini) and some *Agapornis* (Psittaculini) nest in holes excavated in arboreal termitaria (Rand 1942; Bell & Coates 1979; Forshaw & Cooper 1981; Coates 1985). Hollows generally unlined, or lined with wood dust chewed from sides of hollow; extralimitally, *Agapornis* and hanging parrots *Loriculus* (Psittaculini) line hollow with pieces of leaves or bark or both; female carries material in bill or tucked among feathers of rump, flanks or lower back (Abdulali 1964; Ali & Ripley 1969; Forshaw & Cooper 1981). Eggs invariably white but can become stained in nest. Mean size of eggs varies from 19.5 × 16.4 for Little Lorikeet to 50.5 × 37.2 for Kakapo. Extralimitally, smallest egg (16.8 × 13.5) laid by Pygmy Lorikeet *Charmosyna wilhelminae* (Forshaw & Cooper 1981). Loriinae, Nestorinae, Strigopinae, Cyclopsittacini, Ground Parrot and most Psittaculini generally lay small clutches (2–4); a few species of Psittaculini and most Platycercinae generally lay 4–7 eggs, but can lay up to nine. Incubation lasts 18–23 days for most species; up to 25 days for Rainbow Lorikeet *Trichoglossus haematodus*, 26 days for Eclectus Parrot, between 3 and 4 weeks for Kea *Nestor notabilis* and 25–30 days for Kakapo. In all species, female incubates; male usually feeds female at nest or nearby. Young altricial, nidicolous. Most hatch naked and develop whitish to grey down in first few days. Generally, young fed by regurgitation, by female only, or by female for first few days then assisted by male; only male Ground Parrots feed young; male Kakapos play no part in nesting. Young of most species fledge at 5–7 weeks, 7–10 weeks for Rainbow Lorikeet, Kaka and Kakapo, 11–12 weeks for Eclectus Parrot, and 13 weeks for Kea; Ground Parrot has the shortest fledging period, *c.* 24 days. Fledgelings usually remain with parents for some time (Forshaw & Cooper 1981).

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Nestor meridionalis **Kaka**

COLOUR PLATE FACING PAGE 640

Psittacus meridionalis Gmelin, 1788, *Syst. Nat.* 1(1): 333 — Dusky Sound, New Zealand.

Specifically named after the type-locality (Latin *meridionalis*, southern).

OTHER ENGLISH NAMES North Island and South Island Kaka; Brown or Bush Parrot.

POLYTYPIC Nominate *meridionalis*, SI and associated nearshore and offshore islands, including Stewart I., NZ; subspecies *septentrionalis*, Lorenz, 1896, NI and associated nearshore and offshore islands, NZ.

FIELD IDENTIFICATION Length 38–44 cm; wingspan 72–86 cm; weight: male 400 g, female 340 g. Large stocky broad-winged and short-tailed parrot. Similar in shape and proportions to Kea *Nestor notabilis* but smaller, with shorter and much heavier upper mandible with conspicuous notch (not in Kea). Unmistakable: mostly olive-brown with scaly appearance, and with distinctive grey or grey-white forecap and orange-yellow patch on ear-coverts, crimson belly to undertail-coverts, rump-patch and narrow collar, bold red underwing-coverts, and broken pink barring on undersides of remiges and rectrices. Sexes alike but males larger, with longer bills. No seasonal variation. Juvenile separable. Slight geographical variation.

Adult Head and neck mostly light grey-brown, scaled darker, with: prominent pale-grey cap that extends from forehead and lores and grades across nape into dark of hindneck; dull-red malar area and cheeks; prominent yellow-orange patch on ear-coverts; and narrow crimson collar round lower hindneck. Saddle, olive-brown with faint iridescent green sheen and narrow dark scaling. Back to uppertail-coverts, crimson, prominent in flight. Uppertail, grey-brown with diffuse dusky subterminal band. Upperwing: olive-brown, slightly darker on remiges, with dark scaling to coverts and diffuse pale patch at base of primaries. Foreneck and breast, brownish grey with dark scaling; some SI adults have scattered orange-yellow or crimson markings on breast (both in some), but this not recorded on NI adults. Rest of underbody, crimson, with indistinct dark scaling. Undertail, olive-brown with narrow broken pink barring and diffuse dusky subterminal band. Underwing: coverts mostly crimson with narrow dark leading edge; remiges, dark grey with prominent broken pink barring across bases. Bill, dark grey, with fleshy texture. Cere, grey to dark grey. Iris, dark brown. Orbital and periophthalmic rings, dark grey. Legs and feet, grey

or blue-grey. **Juvenile** Very similar or identical to adult. On SI, pale cap tends to be slightly duller and there is more crimson or orange-yellow on breast; on NI, plumage identical to adult. Best distinguished from adult by colour of bare parts: gape, cere, orbital ring and periophthalmic ring, pale yellow at fledging till *c.* 4 months old; periophthalmic ring loses yellowish colour by 6 months of age but remains slightly paler than adult till 1 year old; orbital ring remains pale yellow till at least 1 year old, gradually attaining adult colour over next 1–2 years. Bill usually smooth (not flaky as in adult). See Ageing for discussion.

Similar species Unmistakable if seen well, but beware confusion with **Kea** (q.v.) on SI.

Usually seen singly or in small flocks of up to ten birds. Inhabit native forests. Quieter and more unobtrusive than Kea. Allow close approach in some areas, such as offshore islands or where fed. Usually seen sitting or foraging quietly in tree-tops or flying over canopy of forest, calling loudly. Most active in early morning and late afternoon; often heard calling at night. Walk with rolling gait; climb using bill. Flight similar to that of Kea, with rapid shallow wing-beats; note broad rounded wings, short tail and rather big-headed appearance. Commonest call a loud harsh *ka-aa* uttered often in flight; also utter variety of loud to soft whistles and warbles and yodelling notes.

HABITAT Based on contribution by R.J. Moorhouse. Mostly confined to canopy of unmodified, indigenous, temperate rainforests: in low broadleaf forests supporting trees such as Tawa *Beilshmiedia tawa*, Hinau *Elaeocarpus dentatus*, Kohekohe *Dysoxylum spectabile*, Pohutukawa *Metrosideros excelsa* and Kamahi *Weinmannia racemosa*, usually with much epiphytic growth and diverse undergrowth including ferns; and in tall podocarp forest dominated by Totara *Podocarpus totara*, Rimu *Dacrydium cupressinum*, rata *Metrosideros*, Miro *Prumnopitys ferruginea* and Matai *Prumnopitys taxifolia*; also in beech *Nothofagus* forests with sparse understorey, or mixed podocarp–broadleaf–beech forests (Penniket 1955; Creswell 1958; Jackson 1971; Guest 1975; St Paul 1977; Wilkinson & Guest 1977; Onley 1980, 1983; Innes *et al.* 1982; O'Donnell & Dilks 1989; Beaven 1996; Oliver; CSN). Rarely in tea-tree *Leptospermum* scrub (CSN 41). Usually in large areas of unlogged forest, and sometimes near edges; usually absent from logged areas, including areas of dense regrowth (Phillipps & Lindsay 1948; Dawson *et al.* 1978; Onley 1980, 1983; Innes *et al.* 1982; Wilson *et al.* 1988; CSN; *contra* Dunkley *et al.* 1949). Usually do not readily adapt to altered environments (Onley 1980), but small numbers sometimes remain in remnant patches of forest (CSN). Very occasionally in modified habitats, including: farmland, especially orchards (Turbott 1952; CSN); open, settled areas, such as parks and gardens in towns and suburbs, grounds of schools or hospitals, cemeteries and camping grounds (Turbott 1947; Imber 1967; CSN) and spread rapidly into settled areas on Stewart I. in 1940s (Dawson 1951); sometimes in plantations of *Eucalyptus* or pines *Pinus* (Muller 1969; Beaven 1996; CSN), but rarely where these plantations replace forests (Onley 1983). Rarely, in clumps of bamboo or gorse (CSN 24). Recorded from sea-level, where inhabit coastal forests (CSN 8, 36), as well as sometimes beachfront, sand-dunes and, rarely, intertidal areas (CSN 5, 19, 31), to subalpine and alpine zones, among stunted scrub (Challies 1962; Oliver), up to 1200 m asl (Creswell 1958); may prefer low to mid-altitudes (Guest 1975; Dawson *et al.* 1978). Often on islands; sometimes fly over sea, especially from islands (Sibson 1947).

Breed in hollows in dead or living trees within dense forest; sometimes at ecotone between different forest types, or beside roads (Jackson 1963, 1971; Merton & Atkinson 1968; St Paul 1977; Moorhouse 1991; Oliver; CSN).

Forage arboreally and terrestrially. Feed in flowering, fruiting or seeding trees and shrubs within forests, usually in canopy or in crowns of emergent trees (Sibson 1947; St Paul 1977; O'Donnell & Dilks 1994; Beaven 1996; Moorhouse 1996; Oliver; CSN). Also in flowering ornamental plants, such as *Camellia* and *Banksia*, in gardens and parks well away from forests; or in plantations of introduced species, such as *Eucalyptus* (Imber 1967; Oliver; CSN). Sometimes feed in trees in orchards, on emerging buds or ripening fruit; also in nut trees (Oliver; CSN). Once seen nipping fruits from tree-tomato, dropping them and then eating them on ground (CSN 7). Sometimes forage on ground, on fallen seeds (Moorhouse 1996) or dig among humus or rotten logs (Dunkley *et al.* 1949; Imber 1967; Oliver; CSN). Also excavate grubs from standing, overmature trees; sometimes in prostrate shrubs or among bare branches of deciduous trees (Oliver; CSN). Sometimes feed on sap from beneath bark of trunk or branches of trees, both native and introduced, from ground-level to outer canopy (Tily 1951; O'Donnell & Dilks 1989; O'Donnell 1993; CSN). Sometimes also feed in epiphytes (CSN 21). Occasionally fossick inside huts for food. Once fed on sheep's pluck hung on tree and once seen feeding on fat attached to skin of recently skinned sheep (Hutton & Drummond 1904; Oliver; T.C. Greene).

Roost and loaf in canopy or subcanopy of native forest (Dawson 1950; Jackson 1963; Forshaw & Cooper 1989; CSN; R.J. Moorhouse), and rarely in remnant patches (CSN 5). Sometimes in isolated street trees or introduced pines (CSN 31, 39). Formerly, perched on fences, haystacks and roofs in e. Otago; sometimes entered houses to perch on beams during bad weather (Hutton & Drummond 1904; Oliver).

Adversely affected by clearance of forests for timber production or agriculture, and said not to adapt to modified habitats; generally absent from clear-felled and selectively logged areas (St Paul 1977; Onley 1980, 1983; Wilson *et al.* 1988; Oliver; CSN; T.C. Greene), but small numbers sometimes occur in cleared areas away from forest. Feeding activities can damage pine trees, by ringbarking them (Beaven 1996; CSN 20), and fruit and almond trees, by removing buds (Hutton & Drummond 1904; Oliver).

DISTRIBUTION AND POPULATION Endemic to NZ and offshore islands.

NI Scattered records in most regions; often on nearshore and offshore islands. Scattered records in NORTHLAND, from between s. Rangaunu Harbour and Maungataniwha Ra., S to near Dargaville, and, rarely, near Kaipara Harbour, including once on Tinopai Pen.; many records round Whangarei; widespread Hen & Chickens Is. In AUCKLAND and SOUTH AUCKLAND, widespread on Great Barrier and Little Barrier Is; few, scattered records on mainland on Auckland Isthmus and on mainland adjacent to Barrier Is on Tawharanui Pen. and Snells Beach, and from Manukau Heads E through suburban Auckland to Hunua Ras; also on several islands in s. Hauraki Gulf, and on Coromandel Pen. In BAY OF PLENTY, recorded on Mayor I., and widespread but scattered records from near Pauanui, S to Kaimai Ra. and Tauranga Harbour (and nw. Volcanic Plain, S to near Rotorua), and E to Opotiki. Rarely in EAST COAST, with isolated records in Raukumara Ra., and farther S, at Gisborne, Whakaki and Wairoa. Widespread from w. VOLCANIC PLATEAU and n. HAWKES BAY, E to w. and s. WAIKATO, w. TARANAKI and n. WANGANUI and MANAWATU: in area centred on L. Taupo, and enclosed by line joining Matawai, L.

Waikaremoana, Ahimamawa Ra., Kaweka Ra., near Pipikiri and Herangi Ra.; absent on plateau from n. and w. L. Taupo, NW to lakes E of Rotorua; also rare, isolated records round Hamilton, New Plymouth and Hawera; farther S, sparsely scattered records from near Hunterville E to Waipukurau. Also sparsely scattered in s. MANAWATU, w. WAIRARAPA and WELLINGTON, from Palmerston North, S to s. Rimutaka Ra., including Kapiti I. (Edwards 1955; Imber 1967; Merton & Atkinson 1968; Lovegrove 1975; Bell 1976; McKenzie 1979; Falla *et al.* 1978; Pierce *et al.* 1993; NZ Atlas; CSN; R.J. Moorhouse). **SI** Widespread W of Southern Alps. Scattered records in MARLBOROUGH, on Chetwode Is, and from Marlborough Sounds S to Blenheim and Richmond Ra.; more widespread W of Waihopei R., extending into w. CANTERBURY, occasionally E to Hanmer Ra. and middle reaches of Waimakariri R.; recent records at Kowhai and Christchurch. Formerly widespread throughout OTAGO, but now mainly confined to near Ls Hawea, Wanaka and Wakatipu in Southern Alps; rare, isolated records at Taieri Bay, and in S around Papatowai and Tautuku Pen. In SOUTHLAND, widespread in and E of Waitutu Forest, near e. Te Waewae Bay, throughout Fiordland. Widespread on Stewart I. and other islets in Foveaux Str. Widespread throughout WEST COAST and most of NELSON, N to Abel Tasman NP, Takaka and s. Wakamarama Ra. (O'Donnell & Dilks 1986; NZ Atlas; CSN; P.R. Wilson).

Chatham Is Subfossil remains, possibly of this species, recorded; thought to have become extinct before 1871 (Dawson 1952, 1959; Cassels 1984; Tennyson & Millener 1994).

Breeding Probably throughout range, but few published records. Recorded from Waipoua Forest in Far North, S to Stewart I. Most records from Hen & Chickens Is, Kapiti I. and Little and Great Barrier Is (Bell & Brathwaite 1963; Blackburn 1966; Merton & Atkinson 1968; Moorhouse 1991; CSN).

Change in range Populations have declined and range contracted over much of mainland, mostly following clearance of habitat. In 1860s, considerable numbers in parts of e. Otago, but almost completely gone by 1880s (Oliver). Formerly occurred Banks Pen., but gone by *c.* 1912 (Oliver). Common Tutumore Ra., 1916–23 (Olsen 1987); now rare (NZ Atlas). Decline in population around Clevedon, near Auckland, first noticed by early 1940s and continued through 1950s, though some still occur there (CSN). At Mt Herbert, near Governors Bay, numbers declined by late 1940s (Dawson 1949). Numbers in East Coast began decreasing in late 1950s (CSN 19 Suppl.) and were noticeably lower than in 1920s (Creswell 1958). Once plentiful and breeding in Hunua Ras; now casual visitor (McKenzie 1979). More recently, surveys in six forests in Far North in 1979 revealed several Kakas in each of four of the forests; surveys in same forests in 1993 found single bird (Pierce *et al.* 1993). However, in some areas, populations have increased, including: West Coast, since 1940s (CSN 1) and Waikaremoana, since mid-1950s (CSN 7). Increases in population have been most notable on islands: rarely on Mayor I. in 1926, but common by 1952 (Edwards 1955); population of six birds on Taranga (Hen) I. in 1956 (Heather 1957) increased to *c.* 30 by early 1960s (Skegg 1964); numbers on Great Barrier I. increased since the 1950s (Bell & Brathwaite 1963); scarce on Kapiti I. in 1940s (Stidolph 1948) but now common (O'Donnell & Rasch 1991; R.J. Moorhouse); on Stewart I., spread rapidly into settled areas in 1940s (Dawson 1951), then numbers appeared to decline, but began to increase again by early 1970s (CSN 19 Suppl.).

Irruptions In Otago in 1856, so many perched on fences that 'if a person shot along the line of a fence, he could knock over half-a-dozen at one shot' (Hutton & Drummond 1904). Apparent irruption recorded on West Coast in 1943–44, when numbers observed were greatest for 15–20 years (CSN 1).

Status Threatened (Bell 1986); vulnerable (Collar *et al.* 1994). **Populations** On Codfish I., 34 recorded along *c.* 550 m of track (Blackburn 1968); in Hunua Ras, average of three recorded along 4 km track (Lovegrove 1975).

Adversely affected by competition with introduced species, especially Common Brushtailed Possums *Trichosurus vulpecula*, wasps *Vespula* and bees (Beggs & Wilson 1991; O'Donnell & Rasch 1991; Oliver); local population decline at Mt Herbert, near Governors Bay, in 1940s blamed on increase in number of Possums (Dawson 1949). Also eaten by introduced mammals, such as Stoats *Mustela erminea* and rats *Rattus* (Moorhouse 1991; O'Donnell & Rasch 1991; Wilson *et al.* in press; Oliver). Formerly much trapped by Maori, who used decoys, snares, spears and thwacking-sticks (Hutton & Drummond 1904; Oliver). Sometimes shot (Hutton & Drummond 1904; CSN 2, 6, 36). Occasionally killed by collisions with windows (CSN 39). Once caught in possum trap (CSN 5). Formerly damaged thatched buildings and haystacks (Hutton & Drummond 1904; Oliver). Once seen swooping down on car to devour its tyres (cf. Kea) (CSN 30). Sometimes caused nuisance by cutting buttons off hanging clothes (Hutton & Drummond 1904).

MOVEMENTS Based on contribution by R.J. Moorhouse. Resident (Beaven 1996; CSN 8, 34, 35; R.J. Moorhouse). Do not migrate (R.J. Moorhouse) *contra* unsupported claims that migrate in some areas (Roberts 1953; Elliott & Rasch 1995; see Oliver). In early literature term 'migration' misapplied to cases of apparently infrequent, irregular or unusual movements (Hutton & Drummond 1904; Moncrieff Undated), or to movements that could not be differentiated from non-migratory or even local movements (Hutton & Drummond 1904). No strong evidence for altitudinal movements described by Guthrie-

Smith (1914). Evidence of long-distance dispersal of juveniles from one island population (DOC Banding Scheme). Said that when moving long distances, fly very high, often at *c.* 1200 m asl; travel in groups up to about seven, not in large flocks (Hutton & Drummond 1904; St Paul 1977). At least sometimes fly on moonless nights (Heather 1957). Some movements suggested to occur along traditional flight-paths, e.g. between forests N of Manukau Harbour and forests S of Waikato R., with traditional sites where birds landed; such areas were exploited by Maori hunters (see Oliver).

Generally resident throughout range; seen throughout year at many sites (e.g. St Paul 1977; Wilson *et al.* 1988; CSN). For details of home-ranges, see Social Organization.

Sometimes move between offshore islands to exploit localized sources of food (Roberts 1953; see also Wilson 1959). Suggestion of regular movement through Mokohinau Grp: said to move to Burgess I. from N at certain time of year, remain for a day and disappear to S the next night (Roberts 1953); flew over Moko Hinau I. in Apr. 1951, 1952 and 1953 (Emmens 1954); speculated that birds seen Mokohinau Grp, Cuvier I., Leigh and Whangarei Heads originate from Hen & Chicken Is, Little Barrier I. and Great Barrier I. (MacCallum *et al.* 1984). Also move between islands and mainland, e.g. one flew into Opoutere from Mayor I. (CSN 31). Suggested, with little evidence, that sometimes cross Cook Str., in both directions (Moncrieff Undated; Oliver).

Seasonal variation in numbers apparent at some sites (e.g. Williams 1960; CSN 1); significant seasonal difference in counts near Reefton, SI; most often recorded Oct.–Feb., but not known if this result of movement or changes in conspicuousness (Dawson *et al.* 1978); at Minginui, few seen in winter, with seasonal trend attributed to dispersal to open habitats (St Paul 1977). Even where occasional, some seasonality noted, e.g. Gillespies Beach, SI (CSN 23), Warkworth (CSN 28). In at least some areas numbers vary between years (e.g. Williams 1960; St Paul 1977).

Regarded as occasional visitor to some areas (e.g. McKenzie 1979; CSN 19; CSN 28). Rare vagrant to Noises Is (Cunningham & Moors 1985). However, validity of records of singles in unusual places complicated by possibility of aviary escapes (e.g. CSN 22). Many records of birds arriving in an area and remaining for weeks or months then moving on (e.g. CSN 20).

Said to make mass movements in search of food when it becomes scarce in any locality (Williams 1973); in 1856, apparent irruption into Otago (Hutton & Drummond 1904).

Dispersal of young On Little Barrier I. post-fledging dispersal of juveniles to NI mainland and adjacent Great Barrier I. confirmed by observations of live banded birds and recoveries of dead banded birds (DOC Banding Scheme). Juvenile dispersal possibly density-dependent since such dispersal not recorded on Kapiti I. (R.J. Moorhouse).

Banding, Radio-tracking Longest movement recorded was juvenile banded Little Barrier I. and recovered *c.* 400 km away in Gisborne (Moorhouse & Greene 1995). Five radio-tagged birds moved between Chickens I., Little Barrier I. and Whangarei between Sept. 1993 and June 1994 (CSN 42).

FOOD Omnivorous. Seeds, fruits, flowers, leaves, nectar, sap, and insects and their larvae. **Behaviour** Based on contribution by R.J. Moorhouse. Arboreal and terrestrial. Forage actively (Moorhouse 1992). In trees, forage on trunks, branches and among both live and dead twigs on ground, observed scratching through leaf-litter with feet; foraging on exposed roots of trees (Imber 1967; Turbott 1967; Beggs & Wilson 1991; O'Donnell & Dilks 1994; Moorhouse 1996; Oliver; T.C. Greene). Most active and conspicuous early in morning and late evening (Beaven 1996; T.C. Greene; R.J. Moorhouse); can also remain active after dark (Moorhouse 1992). Forage singly, though sometimes congregate in small groups of 20 or so at sources of food (Moorhouse 1992, 1996); 40+ recorded at concentrated sources of artificial food on Little Barrier I. (T.C. Greene). FEEDING METHODS: Vary with food. (1) Search for wood-boring beetles and larvae of moths by drumming on surface of branches with tongue to find hollow cavities; then excavate item by gripping branch with upper mandible and driving lower mandible forward like a chisel (Tily 1951; Moorhouse 1992). Only males observed to extract large grubs from live wood; females forage mainly on dead wood, do not excavate to same depth as males and tend to eat smaller items (Beggs & Wilson 1987, 1991; T.C. Greene; R.J. Moorhouse). (2) Find other bark-dwelling invertebrates by systematically stripping bark or moss from trees (Moorhouse 1992), or splitting twigs (Tily 1951). (3) Glean scale insects from underside of live foliage (Moorhouse 1996). (4) Locate fruiting or seeding trees by sight, when flying through or over canopy or by following calls of other foraging birds (R.J. Moorhouse). (5) Obtain sap by chiselling away bark to expose vascular cambium, from which sap licked (O'Donnell & Dilks 1989; O'Donnell 1993). In s. Westland, two birds spent an average of 6.6 min (1–12; seven feeding bouts in 57 min of obs.) prising away bark and, between bouts, visited older scars and ate sap leaking from them, spending average 1.8 min lapping sap (1–3; six bouts in 57 min obs.) (O'Donnell & Dilks 1989). (6) Seeds extracted from large fruits by holding fruit in one foot and stripping away skin and flesh till kernel exposed (R.J. Moorhouse). (7) Fallen seeds taken from ground (Moorhouse 1996) and upper surfaces of large horizontal branches (T.C. Greene). (8) Pluck and eat small fruits whole; larger fruits held in one foot and pieces bitten off and eaten (R.J. Moorhouse). (9) Usually lick nectar directly from flowers but may grasp flowers with foot and pull them closer to bill (R.J. Moorhouse). Also pull flowers off tree with bill, split nectaries with lower mandible, lick nectar with tongue and discard flower (T.C. Greene). Spend much time foraging for insects (Beggs & Wilson 1991; O'Donnell & Dilks 1994; Moorhouse 1996); take wide variety of fruits and nectar when available (O'Donnell & Dilks 1994; Moorhouse 1996). At WHIRINAKI, CENTRAL NI (25.35 min obs. of feeding; Beaven 1996), spent 24.3% of time feeding on fruits, 16.5% on seeds from cones of introduced and native pines, 13.4% on other seeds, 24.0% stripping bark to obtain sap and feeding on sap, and 22% searching for and eating insects (fossicking, prising open live and dead wood and stripping mosses). In S. WESTLAND (3180 min obs. of feeding; O'Donnell & Dilks 1989), fed on nectar (12.1% of time spent feeding) and sap (2.8%) throughout year, with peak in nectar-feeding Dec. (22.4%), while sap-feeding increased to 10.3% in Aug. when no flower or sources of nectar available. Fed on sap from 37 trees of five species: Southern Rata *Metrosideros umbellata* (26 trees); Vine Rata *M. fulgens* (2), Kamahi *Weinmannia racemosa* (1), Rimu *Dacrydium cupressinum* (4) and Mountain Totara *Podocarpus cunninghamii* (4). Tongue tipped with fine hairs, which assumed to assist ingestion of nectar and sap (Kirk *et al.* 1993). Males have significantly longer and deeper bills than females (Holdaway & Worthy 1993; Moorhouse *et al.* in press; Wilson *et al.* in press; see Measurements).

Detailed studies At WHIRINAKI, CENTRAL NI (1521 s obs. of feeding; Beaven 1996). **Plants** GYMNOSPERMS: Pinaceae: *Pinus radiata* sds 12.3% obs. time, sap 0.1; *Pseudostuga manzieii*

sap 9.1%; Podocarpaceae: *Dacrydium cupressinum* sds 1.6; *Podocarpus dacrydioides* fru. 7.5, sds 6.7; *P. ferrugineus* fru. 9.2; *P. hallii* sap; *P. spicatus* fru.7.2, sds 4.2, sap 1.6; *P. totara* sds 0.3. DICOTYLEDONS: Fagaceae: *Nothofagus* sds 5.0, sap 2.5; Lauraceae: *Beilschmiedia tawa* sap 9.4%; Proteaceae: *Knightia excelsa* sds 0.1. **Animals** INSECTS: 22.0 (includes time spent searching as well as time spent feeding on insects).

Other records Plants (Seeds or fruit unless stated.) Fruit[1,2], buds[5,9], shoots[5]. GYMNOSPERMS: Araucariaceae: *Agathis australis*[5,9]; Cupressaceae: *Cupressus macrocarpa* sap[8]; Podocarpaceae: *Podocarpus dacrydioides*[9]; *Dacrydium cupressinum* sap[8]; *Podocarpus cunninghamii* sap[7,8]; *P. totara*[16,17]; *Prumnopitys ferruginea*[9]; *P. taxifolia*[9]. MONOCOTYLEDONS: Agavaceae: *Phormium tenax* nectar[2,9]; Arecaceae: *Phoenix dactylifera*[3,5]; Iridaceae: *Iris*[17]; Pandanaceae: *Freycinetia banksii* nectar[2]. DICOTYLEDONS: Actinidiaceae: *Actinidia chinensis*[16]; Araliaceae: *Pseudopanax colensoi* sap[2]; Asteraceae: *Olearia angustifolia* sap[8]; *O. colensoi* sap[8]; Cornaceae: *Griselinia littoralis* sap[7]; Cunoniaceae: *Weinmannia racemosa*[7]; Ebenaceae: *Diospyros*[18]; Escalloniaceae: *Ixerba brexioides*[9]; Fagaceae: *Nothofagus* nectar[9]; *N. solandri* sap[6]; Juglandaceae: *Juglans*[19]; Lauraceae: *Beilschmiedia tarairi*[5,11]; *B. tawa*[9], sap[8]; Meliaceae: *Dysoxylum spectabile*[10,13]; Myrtaceae: *Eucalyptus* nectar[9,12]; *Metrosideros* nectar[3,14]; *M. excelsa* nectar[8,9,10,16], sap[21]; *M. fulgens*[7]; *M. robusta* nectar[9]; *M. umbellata*[7,8]; Proteaceae: *Banksia* fl.[12]; *Knightia excelsa* nectar[2,3,9]; Rosaceae: *Prunus*[19]; *Sophora* nectar[2]; *S. microphylla* nectar[9,15]; Rubiaceae: *Coprosoma*[9]; Rutaceae: *Citrus*[19,20]; *Melicope ternata*[3]; Solanaceae: *Datura* sap[10]; *Solanum aviculare*[3,9]; Theaceae: *Camellia* nectar[4]; Verbenaceae: *Vitex lucens*[9,16,17,19,21]. **Animals** INSECTS: Unident.[5,11]; Coccoidea: unident. scale insects[22]; Coleoptera: larv.[3]; Cerambycidae ads, larv.[2]; Lepidoptera: ads, larv.[3,9,19]

REFERENCES: Turbott [1] 1952; [2] 1967; [3] Wilkinson & Wilkinson 1952; [4] Imber 1967; [5] St Paul 1977; [6] Beggs 1988; [7] O'Donnell & Dilks 1989; [8] O'Donnell 1993; [9] Oliver; CSN [10] 19, [11] 24, [12] 25, [13] 28, [14] 29, [15] 36, [16] 37, [17] 38, [18] 39, [19] 41, [20] 42, [21] 43; [22] R.J. Moorhouse.

Young Diet as adults, except perhaps differing in relative proportions of food consumed. Examination of faeces of one nestling on Kapiti I. showed that fruits of *Pseudopanax arboreus* (Araliaceae) common component of diet (Moorhouse 1996).

SOCIAL ORGANIZATION Account prepared by R.J. Moorhouse. Most information from studies by Moorhouse (1991, 1992, 1996; Moorhouse & Greene 1995; Moorhouse *et al.* in press). Often seen flying above canopy in groups of 3–5 birds, occasionally in flocks of >10 (Sibson 1947). Usually forage alone but can congregate at food, in groups of >20 birds (Moorhouse 1992, 1996) and, exceptionally, 40+ at artificial source of food on Little Barrier I. (T.C. Greene). Early in breeding season, before incubation begins, often seen in pairs. After fledging, form family groups till young independent.

Bonds Monogamous but can change mates between seasons. Sex-ratio difficult to determine as sexes only reliably distinguished by measurement (Greene & Fraser in press; Moorhouse *et al.* in press); sex-ratio for various sites summarized in Table 1. Increased male bias on SI consistent with high incidence of predation of incubating females by Stoats. Determination of age of sexual maturity complicated because wild birds do not breed every year (Moorhouse 1991; Wilson *et al.* in press); in captivity, where breed every year, reach sexual maturity at 4 years old (M.J. Sibley). On Kapiti I., mates spend progressively more time together from late winter to early spring; return to separate foraging once young independent. **Parental care** Female incubates and broods; during incubation, female receives most of her food from male (Jackson 1963). Nestlings fed mostly by females but males will also feed nestlings if female away from nest (Wilson *et al.* in press). Both parents feed fledgelings and male continues to feed female; female usually stays close to fledgelings. On Kapiti I., young continue to beg until *c.* 6 months old, after which family group separates and members forage independently (Moorhouse & Greene 1995; T.C. Greene; R.J. Moorhouse). **Co-operative breeding** Unpaired males reported to feed incubating females (P.R. Wilson) but probably consequence of female shortage in population (Wilson *et al.* in press) rather than widespread behaviour. Preening and feeding of fledgelings by birds other than parents (once by sibling from previous year) also seen.

Breeding dispersion Nests can be as close as 30 m apart (R.J. Moorhouse). Nest-cavities defended from other birds before incubation, but otherwise not territorial. **Home-range** On NI, core home-range estimated as 15.5 ha (n=6 birds; Beaven 1996); sometimes move outside core area to feed on localized sources of food, such as nectar or fruit (R.J. Moorhouse), supposedly up to at least *c.* 13 km (Guthrie-Smith 1914).

Roosting Roost within home-range wherever vegetation provides cover. During breeding season, male and female of pair often roost together before incubation; pair and fledgelings also roost close together. Rest for up to 2 h during day, and assumed to roost for longer periods at night, though often remain active long after dark. Time of going to roost varies and irregular; increased vocal activity at dawn suggests most become active then. Often rest and preen during day, particularly in middle of day, usually before sleeping. When resting, simply squat on perch; when sleeping, stand on one foot and tuck head over wing, burying bill in scapulars.

SOCIAL BEHAVIOUR Account prepared by R.J. Moorhouse. Most information from studies by Moorhouse (1991,

Table 1. Sex-ratio for Kaka populations (T.C. Greene).

Location	Period	Estimation Method	Sex-ratio (Female : Male)	N	Reference
Kapiti I.	1988–91	Mist-net	1:1.27	25	1
Little Barrier I.	1989–93	Cage-trap	1:1.3	70	2
S. Westland	1992	Observation	1:3.2	46[A]	3
Nelson Ls	1984–89	Mist-net	1:2	30	4
	1989–91	Mist-net	1:2.8	23	4
Waihaha Ecological	1994	Mist-net	1:6	21	5
Area	1995	Observation	1:3	14[B]	5

[A] Number of confirmed-sex sightings from a total of 325 observations; [B] Number of confirmed-sex sightings from a total of 161 observations.
REFERENCES: [1] R.J. Moorhouse; [2] DOC; [3] C.F.J. O'Donnell; [4] P.R. Wilson; [5] T.C. Greene.

1992, 1996; Moorhouse & Greene 1995; Moorhouse *et al.* in press). No detailed studies. Arboreal habits make behaviour somewhat difficult to observe, but displays rather conspicuous. Some displays resemble those of Kea. **Flock behaviour** Flocks of >10 birds will circle in flight above canopy, calling incessantly, breaking up and re-forming till flock eventually breaks up (Sibson 1947). No record of bathing in wild. Mock fights seen, usually only between juveniles; occasionally mock-fight or play with inanimate objects, such as branches.

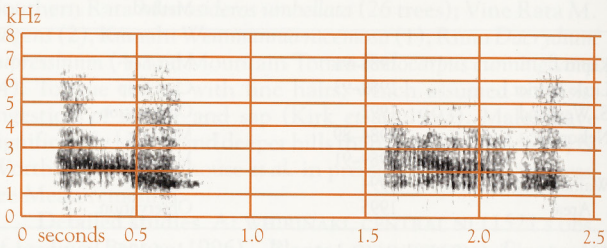
Agonistic behaviour Do not usually tolerate approach of others within one body-length unless mated or part of large congregation feeding at artificial source of food. Males protective of mates before completion of clutch and will drive away, even kill, rivals (Wilson *et al.* in press). Juveniles sometimes severely injured or killed in fights over food provided by people (A.J. Dobbins). Will defend nest-site but do not react to others approaching offspring. Dominance hierarchy, not related to sex, evident at feeding congregations. **Threat** Displays often subtle, such as turning to face another bird, but can also be accompanied by harsh grating calls or by spreading wings to reveal bright-red underwing-coverts. When perched side by side, sometimes attempt to displace one another by pushing with foot. **Appeasement display** Adult males occasionally seen sitting upright, with head drawn in, feathers of crown and body raised and tail spread; in this posture, periodically bob head and utter muted staccato call. This display very similar to Begging Display of fledgelings and breeding females, and usually occurs in feeding congregations; thought to be used in appeasement. Females and fledgelings perform Begging Display when attempting to get to feeding sites being used by others; thought to inhibit aggression. **Fighting** Most fights involve grappling with bills and attempts to bite feet of opponent, accompanied by loud harsh calls. Defeat indicated by retreat. **Alarm** Easily alarmed, particularly when in large feeding congregations. When raptor nearby, will circle above canopy giving loud Alarm Calls, which usually elicit strong mobbing response: birds approach threat closely and give Alarm Call continuously. Once when New Zealand Falcon *Falco novaeseelandiae* landed on perch near a perched Kaka, Kaka slowly lowered itself till it was lying almost fully stretched out on horizontal perch, where it remained, silent, till Falcon left several minutes later (D. Wills).

Sexual behaviour Since males feed female and young for long period, suggested possible that frequency and quality of food provided acts as indicator of desirability as mates. **Courtship feeding** Males begin providing food to females weeks, or even months, before incubation and continue to feed them throughout incubation and fledging periods (Moorhouse 1992). Females solicit feeding from males by performing Begging Display identical to that of fledgelings (see below; Moorhouse & Greene 1995). When male returns to female after foraging, usually begins feeding her immediately; if female incubating, male calls her from nest to be fed. **Allopreening** Functional rather than ritualized. Reciprocal, and usually confined to head and face, which birds cannot preen themselves. Occurs often during breeding season but rarely at other times. **Copulation** Usually preceded by courtship feeding and allopreening. PRE-COPULATORY DISPLAY: Male sidles up to female and raises near-side wing to expose red underwing-coverts; also raises feathers of crown, shakes head and gives high-pitched, squeaking call. If receptive, female crouches on perch, with head and tail raised and wings slightly flexed. Male mounts and moves tail of female to one side to achieve cloacal contact; then thrusts rhythmically, maintaining balance with wings partly spread. Participants touch bills often and males occasionally grasp upper mandible of female with own bill. After copulation, pair freeze on perch for several minutes. Copulation prolonged and frequent, requiring 8–15 min to complete and often occurring several times in 1 h; most frequent in week before and during laying but often occurs earlier, and sometimes after, completion of clutch (Moorhouse 1992).

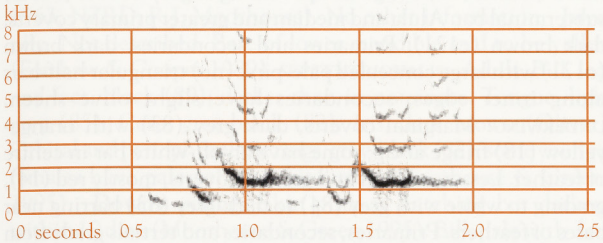
Relations within family group Young often fledge before able to fly and spend first few days out of nest on ground or perched in low trees or shrubs. At this time, very cryptic, often hiding under cover, and beg for food with subdued twittering. Once able to fly, beg loudly, conspicuously and often. BEGGING DISPLAY: Perch in hunched posture, with plumage of head and body raised, tail spread, wings partly spread with primaries held below body and fluttered; bob head and utter harsh staccato Begging Call. Parents and fledgelings use variety of calls to maintain contact; recognition of family members probably by voice. Parents preen entire body of fledgelings till young *c.* 5 months old. **Anti-predator strategies** If alarmed, young fledgelings attempt to run or climb away while giving Alarm Call, which usually elicits Alarm Calls and immediate approach from parents. Females usually stay close to fledgelings, particularly while they are unable to fly; observed driving off predatory Weka *Gallirallus australis* (Moorhouse & Greene 1995).

VOICE Account prepared by R.J. Moorhouse and information from R.J. Moorhouse unless stated. No detailed studies. Calls range from harsh grating *kraa* to muted squeaks, musical whistles and warbles. Most noticeable calls are harsh *ka-aa* and variety of yodelling notes (Falla *et al.* 1978; Forshaw & Cooper 1989). Generally silent, particularly during non-breeding season, but often noisy in flight and in feeding congregations. More vocal in early morning and at dusk; also in early part of breeding season before incubation. Heard calling at night (CSN 36), particularly on moonlit nights (T.C. Greene). Calls do not closely resemble those of any other species; readily distinguished from calls of Kea. Members of family group probably recognize each other by voice. Only apparent sexual differences are Pre-copulatory Call give only by male and Begging Call given only by females (Moorhouse 1992). Marked geographical variation in calls apparent but not studied. On Little Barrier I., imitate human wolf-whistles for short periods; also imitate calls of Swamp Harrier *Circus approximans*, which can cause panic among New Zealand Pigeons *Hemiphaga novaeseelandiae* and other Kaka (T.C. Greene).

Adult FLIGHT CALL: Harsh loud *ka-aa* (sonagram **A**); given when flying above forest canopy; said that sometimes call incessantly in flight (Falla *et al.* 1978; Forshaw & Cooper 1989). ALARM CALL: Harsh loud *kraak*; given in alarm and when mobbing threats. CONTACT CALL: Varying, high-pitched, usually multisyllabic whistles and warbles that range in volume from loud to muted (see sonagram **B**). Given in response to



A K. & J. Bigwood; Kapiti Is, Nov.; P102



B L.B. McPherson; Kapiti Is, Oct. 1956; P105

similar call from other Kaka, or to Flight Call from overflying bird, or for no apparent reason (T.C. Greene; R.J. Moorhouse). These calls show marked geographical variation, but no details. Soft whistling when feeding (M'Lean 1911) no doubt Contact Call. AGGRESSIVE CALL: Harsh but muted *ngaak-ngnaak*; given in disputes when feeding. **Other calls** A muted staccato call given in appeasement, but no other details. Utter harsh screaming *karrunk*, which may be type of Alarm Call; when feeding, often utter low musical *karrunk* calls, which may be variant of Contact Call (R.J. Moorhouse).

Adult male PRE-COPULATORY and NEST-PROSPECTING CALL: High-pitched, muted squeaking *tsee-tsee-tsee*, given during Pre-copulatory Display and when indicating potential nest-sites to female. **Adult female** BEGGING CALL: Loud harsh whining *kree-kree* interspersed with guttural *aa-aa*, given by female when soliciting food from mate. Similar to Food-begging Call of young (Moorhouse & Greene 1995).

Young FOOD-BEGGING CALL: Chicks in nest give muted buzzing calls, which increase in volume as chicks get older (T.C. Greene). Fledgelings that cannot fly utter soft, muted twittering *twee-twee-twee*. Older fledgelings give call like Begging Call of adult female: high-pitched screeching or squealing interspersed with guttural coughing or choking sounds (Moorhouse & Greene 1995). ALARM CALL: Fledgelings give hoarser and more drawn-out call than that of adults.

BREEDING Not well known and no major studies; nestling development studied on Kapiti I., NI, by Moorhouse & Greene (1995); observations at one nest near Greymouth, SI, by Jackson (1963). Very occasionally, males can have two mates that nest side by side in same cavity (Oliver).

Season NI: Laying, Nov. and Dec. (Oliver); eggs and young, early Feb. (CSN 4); young, early Dec. (CSN 43); fledge from Dec., with most in Feb. (Moorhouse & Greene 1995). SI: Said to lay from Sept.–Mar. (Jackson 1963); eggs, Oct.–Feb., Dec.–Mar.; young, Feb. and Mar.; fledgelings, Dec. and Mar. (Guthrie-Smith 1914; Jackson 1963; CSN 20; Oliver).

Site In hollow in limb or trunk of tree (Forshaw & Cooper 1981; Oliver); in Red Beech *Nothofagus fusca*, Mountain Beech *N. solandri* var. *cliffortioides*, Cabbage Tree *Cordyline indivisa*, Kamahi *Weinmannia racemosa*, Matai *Podocarpus spicatus*, Puriri *Carpodetus serratus*, Rimu *Dacrydium cupressinum* and rata *Metrosideros* (Jackson 1963, 1971; Wilson 1986; CSN 4, 20, 43; T.C. Greene). MEASUREMENTS: Height of nest: at Pureora, central NI, 11.5 m (6.24; 5–23.5; 7) (T.C. Greene); 5.6 m (3.38; 1.8–9.1; 4) (Jackson 1963; CSN 4, 20); from near ground-level to >10 m (Moorhouse 1991; R.J. Moorhouse). Bottom of one hollow almost at ground-level (Guthrie-Smith 1914). Sites traditional, used for many years, but not always every year (Jackson 1963); one site used for at least three consecutive seasons (CSN 43).

Nest, Materials Entrance often enlarged by nesting pair (Forshaw & Cooper 1981); interior of one hollow enlarged by incubating female (Guthrie-Smith 1914). One hollow had four entrances (Guthrie-Smith 1914). Nest lined with decayed and powdered wood, small wood-chips and sometimes bark (Guthrie-Smith 1914; Jackson 1963). MEASUREMENTS: Depth of hollow, 91 and 152 cm (Jackson 1963; CSN 4); at Pureora, 126 cm (79.97; 62–282; 6) (T.C. Greene). Diameter at bottom of one hollow, *c.* 61 cm (Guthrie-Smith 1914); in two nests at Pureora, 33.8 and 23 cm (T.C. Greene).

Eggs Rounded to slightly oval; slightly rough, finely pitted; white (Oliver). MEASUREMENTS: NI: 42.1 mm (2.39; 39.5–44.2; 3) × 30.8 (0.53; 30.2–31.2) (Oliver). SI: 42.5 mm (1.40; 41.5–44.6; 4) × 31.2 (1.07; 30–32.2) (Oliver). Location not known, 41.2 mm (38.3–44.5; 18) × 31.0 (30.0–32.3) (Forshaw & Cooper 1981).

Clutch-size On NI, three or four; on SI, four sometimes five (Oliver); one clutch probably of two (CSN 20).

Laying Fifth egg laid between 14:00 and 06:15 next day (Jackson 1963).

Incubation By female only; probably begins with first egg as hatching asynchronous (Jackson 1963). Female mostly fed by male; one incubating female left nest three times between 18:00 and 19:30, and was off nest for 5 min each time; in following morning, left nest three times between 04:30 and 06:00 (Jackson 1963). INCUBATION PERIOD: About 3 weeks (Jackson 1963).

Young At 1–3 days, chicks covered in pale-grey down, and eyes closed; at 7–9 days, eyes open; at 11–15 days, feathers in pin appear on wings, crown and tail; at 15–17 days, pins fully emerged; at 17–22 days, feathers emerge on wings, crown and tail; at 34–55 days, fully feathered, except on flanks and shoulders (Moorhouse & Greene 1995; see also Jackson 1963). **Growth** WEIGHT: For one nestling on NI: at 11 days, 296; 15 days, 383; 17 days, 452; 22 days, 527; 26 days, 562; 34 days, 587; mean at 60 days, 540 (517–562; 10 nestlings) (Moorhouse & Greene 1995). **Parental care, Role of sexes** Female broods; fed by male (Jackson 1963). Young fed mostly by female, but male will feed young if female away from nest (Wilson *et al.* in press). At one nest, male fed female in tree next to nest; feeding bouts lasted 5–10 min (Jackson 1963); male also observed bringing food to nest (Guthrie-Smith 1914). At one nest, when female away, two downy young huddled belly to belly and with head resting on other's shoulder (Guthrie-Smith 1914).

Fledging to independence FLEDGING PERIOD: 73 days (68–81; 10) (Moorhouse & Greene 1995); 9 or 10 weeks (Jackson 1963). Often fledge before they can fly; most fledgelings spend first few days on ground or in low trees or shrubs, often hidden; lack co-ordination to climb till third day; usually begin flying at 3–8 days (Moorhouse & Greene 1995). Both parents feed fledgelings and male continues to feed female (R.J. Moorhouse); male said to take greater part of care of fledgelings and feeds them while female stays near nest (Jackson 1963). Fledgelings fed by regurgitation (Oliver). Dependent on parents for food for 1 month after fledging, after which they obtain an increasing proportion of their food themselves; self-sufficient at 3 or 4 months; largely independent after 5 months (Moorhouse & Greene 1995; see Social Organization).

Success Said seldom to rear more than two young per nest (Oliver). One pair fledged 11 young from three nesting attempts (Jackson 1963). For three nests where clutches probably complete but clutch-size not critically determined: from nine eggs, seven (78%) hatched (Guthrie-Smith 1914; Jackson 1963; CSN 20). In 1996–97 breeding season, eight chicks

fledged (3, 3 and 2) from three nests (T.C. Greene). Eggs failed and were eaten by rats (Wilson 1986); nest with eggs destroyed when tree felled; one tree containing nest with two young felled, one chick died, the other was raised by hand (CSN 4).

PLUMAGES Prepared by A.M. Dunn. Begin pre-juvenile moult to juvenile plumage at *c.* 11–15 days (Moorhouse & Greene 1995) and fledge in juvenile plumage. Undergo complete post-juvenile (first pre-basic) moult to adult (first basic) plumage at 10–12 months old. Thereafter, complete post-breeding (pre-basic) moults annually produce successive adult plumages without change in appearance. Sexes similar. Two subspecies; both described below.

Adult (First and subsequent basic). NOMINATE *MERIDIONALIS*: HEAD AND NECK: Forehead, crown, nape and lores, pale grey (c86), forming pale cap; feathers of nape have dark-grey (c83) to dark-brown (c121) fringes; feathers of crown occasionally have indistinct dark fringes and, occasionally, a yellowish wash. Ear-coverts, cheeks and sides of throat, long and pointed, and radiate from round eye. Ear-coverts below and behind eye, orange-yellow (18), often with brown (c28) fringes or tips giving slightly streaked appearance. Cheeks and sides of throat, peach-red (94) with dark-brown (c121) fringes; feathers often pale grey (c86) near base. Chin and upper throat bare. Feathers of sides of neck and foreneck, light grey-brown (119C) with dark-brown (121) fringes. Band of feathers across hindneck and down sides of neck, crimson (108–110) with orange-yellow (c18) subterminal fringe and narrow black (89) fringe, forming a collar; some feathers along upper and lower edges of collar, olive (c50) to dark olive (c46) with narrow black (89) fringes and grey (c84) bases. UPPERPARTS: Mantle and scapulars, olive-brown (c30) with black (89) fringes at tips of feathers and brown (28) bases; feathers have slight iridescent sheen. Feathers of back and rump, olive-brown (30) with broad crimson (c108) subterminal fringes and narrow black (89) fringes at tips. Uppertail-coverts, mostly crimson (c108) with narrow black (89) fringe at tip and concealed grey-brown (91) bases; occasionally have indistinct black (89) subterminal spot or indistinct partial black (89) barring on longer feathers. UNDERPARTS: Feathers of breast, brownish grey (c80) with broad dark-brown (121) to black-brown (119) fringes, giving scalloped appearance; some scattered feathers have indistinct orange-yellow (18) subterminal fringe and, sometimes, additional crimson (108) band or wash inside subterminal fringe. Feathers of belly, vent, undertail-coverts and flanks, crimson (c108) grading to brownish grey (79) at base, with narrow black (89) fringe at tip; in some birds, feathers have one or two indistinct dark-brown (c121) subterminal bars. In a few birds, undertail-coverts mostly grey-brown (c91) with crimson (c108) barring. Differences between individuals in patterns of feathers of underparts possibly related to age, but not enough information available. UPPERTAIL: Rectrices grade from olive-brown (c30) near base to dark brown (c121) near tip, with brown (119B) to grey-brown (91) tip; t2–t6 have rows of salmon (106) triangular spots or partial bars along concealed inner edge. UNDERTAIL: Rectrices, dark brown (121) in middle, with paler-brown (ne) tip and base, which can appear straw-yellow (c56), orange-yellow (18) or orange (17) depending on angle of view; t2–t6 have large salmon (106) triangular spots to half-bars along inner edges. UPPERWING: Most lesser secondary coverts, dark grey (83) with black (89) fringes at tips. Larger, innermost lesser secondary coverts, and median and greater coverts, olive-brown (c30) with iridescent sheen and black (89) rosethorn and fringe. Lesser primary coverts, brownish grey (79) with narrow black (89) fringe at tips and light grey-brown (119D) subterminal bar. Alula and median and greater primary coverts, dark brown (c121). Primaries and secondaries, dark brown (c121) with large concealed pale-pink (ne) triangular half-bars along inner edges; secondaries have slight olive sheen. UNDERWING: Marginal coverts, dark grey (83) with orange-yellow (18) fringe at tip; some have an off-white bar in centre of feather. Lesser, median and greater coverts, mostly red (14), grading to white with grey (84) to dark-grey (83) barring near bases of feathers. Primaries, secondaries and tertials grade from grey-black (82) on outer primaries to grey (84) on tertials; all except tertials have very pale pink (ne) barring on basal half of inner web.

SUBSPECIES *SEPTENTRIONALIS*: Differences from nominate: HEAD AND NECK: Forehead, crown and nape, darker; vary individually, from brownish grey (c79) to greyish brown (greyish 28); usually have black-brown (119) fringes to feathers of nape and faint dark fringes to feathers of crown, so that these areas appear more scalloped than in nominate. Fringes of feathers of rest of head and neck, darker than in nominate, dark brown (c121) to black-brown (119). Collar of crimson and orange-yellow feathers across hindneck, narrower and slightly duller. UPPERPARTS: Slightly darker and browner. UNDERPARTS: Breast, darker and browner and do not have any feathers with orange-yellow or crimson fringes. Rest of underparts similar to nominate, but some birds tend to be darker. UPPERWING: Remiges tend to have a more olive-yellow sheen. UNDERWING: Barring pattern on remiges more orange, salmon (106).

Juvenile *MERIDIONALIS*: Very similar to adult; differs by: HEAD AND NECK: Similar to adult but forehead, crown and nape tend to be slightly darker. UNDERPARTS: Breast much redder. Most feathers of breast have orange-yellow (18) subterminal fringe and crimson (108) centres that grade into brownish grey (c79) at base with very fine black (89) fringe at tip. Belly, vent and undertail-coverts tend to be faintly barred, but otherwise similar to adult. TAIL: Underside slightly brighter near tip than in adult. Rectrices much more pointed at tip than adults (see Ageing) and usually have long spines that project *c.* 15 mm past tip of feather (Moorhouse & Greene 1995). UPPERPARTS, WING: Similar to adult. *SEPTENTRIONALIS*: Differs from juvenile nominate in same way that adults of each subspecies differ. Differences from adult much less marked than in nominate; juvenile *septentrionalis* very similar to adult, differing only in colour of bare parts and shape of rectrices (see Ageing).

Downy young *MERIDIONALIS*: No skins available. Hatch in grey down (Oliver); second down also described as grey (Jackson 1963). *SEPTENTRIONALIS*: Down paler than in nominate, white (Oliver) or pale grey (Moorhouse & Greene 1995).

Aberrant plumages Abnormalities in colour of plumage not uncommon. Oliver describes several, most involving replacement of brown plumage with white, yellow, red or combinations of these. Several brightly coloured specimens in NZ collections (CM, NMNZ). Some colour varieties had Maori names, e.g. kaka-kura, kaka-pipiwarauroa (Oliver).

BARE PARTS Based on photos (Moon 1992; NZRD; unpubl.: A.M. Dunn), published descriptions (Jackson 1963; Forshaw & Cooper 1989; Moorhouse & Greene 1995; Oliver) and museum labels (NMNZ).

MERIDIONALIS: **Adult** Bill, dark grey (c83). Cere, grey (84) to dark grey (c83). Iris, dark brown (219). Orbital and periophthalmic rings, dark grey (83). Legs and feet, grey (c84); also blue-grey (Oliver; NZRD). **Downy young** No photos. Said that: upper mandible and tip of lower mandible black;

base of lower mandible and cere, mostly lemon-yellow (Jackson 1963; NZRD; R.J. Moorhouse). No other information. **Juvenile** Not described. Base of lower mandible said to be yellow (Forshaw & Cooper 1989). *SEPTENTRIONALIS*: **Adult** Bill, legs and feet, black (89); darker than in nominate. Tongue, light grey (85). Cere, grey-black (82). Iris, dark brown (Oliver). Orbital and periophthalmic rings, grey-black (82); some younger females have pale-yellow orbital ring (Moorhouse & Greene 1995). **Downy young** Skin pink at hatching but darkens within 10 days (Moorhouse & Green 1995). Bill, pale with dark tip at hatching; changes to black within 3 days (Moorhouse & Greene 1995); also described as whitish grey at hatching (Oliver). Gape, yellow (Moorhouse & Greene 1995). Cere, pale yellow (Oliver). Feet, said to be dull pale-grey (NZRD). **Juvenile** When <4 months old, periophthalmic ring, cere and gape, pale yellow; and soles have yellow tinge. Periophthalmic ring loses yellowish colour by 6 months old but remains slightly paler than that of adult until *c.* 1 year old. Orbital ring remains pale yellow until at least 1 year old, fading over next 1–2 years before sexual maturity reached; possibly retained after reaching sexual maturity in some females, but fades with age (Moorhouse & Greene 1995).

MOULTS Based on examination of 66 adult (27 *meridionalis*; 39 *septentrionalis*) and 32 juvenile skins (5 *meridionalis*; 27 *septentrionalis*) (AIM, CM, MV, NMNZ) and published information. Few moulting birds in sample and so subspecies combined for analysis. **Adult post-breeding** (Second and subsequent pre-basic). Complete. Primaries centrifugal; can begin with any primary, but usually p5 to p8 (Holyoak 1973). Inner primaries (p1–p4) often moulted out of sequence; probably much later than other primaries, as inner three or four often appear much fresher than outer primaries. Most begin between Dec. and Apr., but some much later; probably starts after breeding. Of 66 adult skins, most (86%) were not moulting primaries; between Dec. and Apr., six had active moult of primaries with mean PMS of 6.5 (3.56; 3–12; 6); only three others recorded with active moult of primaries, one in July (PMS=13), one in Aug. (PMS=45) and one in Nov. (PMS=20). Of six adults captured on Kapiti I. between May and Aug., all had active moult of primaries (Moorhouse & Greene 1995). Primaries replaced rapidly, often with two or three feathers growing at once; of ten with active moult of primaries, five had two growing feathers and two had three growing feathers. Moult of body most active after two or three primaries have been replaced. Moult of body also appears to proceed rapidly and probably finished before moult of primaries finished. No information on moult of tail. **Post-juvenile** (First pre-basic). Probably complete, but little information. Only one of 31 skins had active moult of primaries and was replacing inner three primaries in Mar. Two had active moult of body in June and July. Indistinguishable from adults (on plumage) once rectrices replaced or worn. Of ten juveniles captured on Kapiti I. between May and Aug., none had active moult of primaries (Moorhouse & Greene 1995).

MEASUREMENTS Nominate *meridionalis*, SI and Stewart I., skins (AIM, CM, NMNZ): (1) Adults; (2) Juveniles.

		MALES	FEMALES	
WING	(1)	296.3 (8.22; 283–311; 14)	292.0 (7.21; 283–307; 12)	ns
	(2)	292.8 (11.93; 276–304; 4)	287	
TAIL	(1)	164.5 (7.19; 153–175; 14)	167.2 (5.73; 160–180; 13)	ns
	(2)	173.5 (10.91; 160–185; 4)	163	
BILL	(1)	51.9 (4.22; 44.0–56.7; 14)	47.8 (2.41; 43.3–51.7; 13)	**
	(2)	52.3 (2.72; 50–55; 4)	47.7	
TARSUS	(1)	39.2 (1.61; 36.0–41.5; 13)	37.4 (2.26; 33.4–40.9; 13)	*
	(2)	38.1 (1.87; 35–39; 4)	36.8	
TOE C	(1)	50.9 (2.49; 46.0–54.1; 13)	48.7 (2.87; 44.0–53.3; 11)	ns
	(2)	52.1 (0.57; 52–53; 4)	–	

Subspecies *septentrionalis*; NI: (3–4) Skins (AIM, CM, MV, NMNZ): (3) Adults; (4) Juveniles. (5) Live, adults (Moorhouse *et al.* in press).

		MALES	FEMALES	
WING	(3)	267.8 (6.76; 256–285; 25)	263.8 (5.88; 255–276; 17)	ns
	(4)	270.2 (7.01; 261–282; 12)	266.6 (6.41; 254–278; 11)	ns
TAIL	(3)	148.3 (8.10; 135–160; 25)	146.2 (7.13; 135–165; 17)	ns
	(4)	158.7 (7.57; 147–172; 12)	156.6 (7.98; 142–168; 11)	ns
BILL	(3)	48.9 (2.59; 42.9–52.0; 25)	42.4 (1.54; 40.4–46.5; 17)	**
	(4)	45.6 (2.47; 39.4–49.3; 12)	40.5 (1.43; 37.6–43.2; 11)	**
	(5)	49.1 (2.43; 44.6–55.0; 32)	42.4 (1.80; 37.8–46.7; 36)	**
TARSUS	(3)	36.0 (1.32; 33.2–38.4; 25)	35.4 (1.32; 32.8–37.5; 17)	ns
	(4)	34.9 (1.26; 33.2–37.7; 12)	34.8 (1.05; 33.6–37.1; 11)	ns
	(5)	35.4 (1.18; 33.3–37.9; 19)	34.7 (1.65; 32.0–38.6; 17)	*
TOE C	(3)	47.0 (2.45; 42.3–50.8; 18)	43.3 (2.63; 38.7–47.5; 10)	**
	(4)	43.4 (2.15; 40.9–47.4; 6)	43.4 (2.76; 39.1–46.8; 8)	ns

In *septentrionalis*, juveniles had significantly longer tails and shorter bills than adults (both sexes). Differences in length of tail probably associated with prominent rachides ('tail-spines') in juveniles.

Additional measurements in Forshaw & Cooper (1989).

WEIGHTS Nominate *meridionalis*, SI: adult males 383, 425, 560; adult females 494; juvenile male 400 (NMNZ).

Subspecies *septentrionalis*; NI: (1–2) From museum labels (AIM, NMNZ): (1) Adults; (2) Juveniles. (3) Live, adults (Moorhouse *et al.* in press).

	MALES	FEMALES	
(1)	396.8 (65.02; 320–550; 13)	340.6 (100.87; 210–455; 5)	
(2)	353.4 (98.15; 267–575; 8)	348.7 (71.22; 245–400; 4)	
(3)	458 (44.04; 402–555; 18)	400 (26.58; 358–450; 21)	**

Weight varied considerably between individuals. The small sample showed no evidence of seasonal changes in weight.

STRUCTURE Wing long and triangular, broad near body and rounded near tip. Ten primaries: p7 longest; p10 27–33 mm shorter, p9 3–10, p8 1–5, p6 6–12, p5 28–42, p4 60–63, p3 70–78, p2 80–91, p1 94–103. Twelve secondaries, including about four tertials; tips of longest tertials fall between p3 and p4 on folded wing. Tail long and slightly rounded at tip; 12 rectrices; t1 longest, t6 8–17 mm shorter. Bill long, slender, pointed and strongly downcurved. Cutting edges of upper mandible sharp, with indentation where upper and lower mandible meet and a notch 10–15 mm from tip; tip sharp, flattened inside, with small transverse grooves. Lower mandible narrow and chisel-like, with straight sharp cutting edge at tip. Tongue has brush tip (Oliver). Narrow bare cere along base of upper mandible contains small rounded nostrils. Tarsus short and thick; granulate. Tibia fully feathered. Outer toe directed backward. Outer hindtoe 90–100% of outer front, inner front 69–76%, inner hind 49–54%.

AGEING When newly fledged, juveniles easily recognized by pale cere, gape, orbital ring and periophthalmic ring. All but orbital ring darken to adult coloration by *c.* 6 months old.

Juveniles also usually have smoother bills than adults (R.J. Moorhouse) but not known when develop flaky texture of adults. Juveniles can also be recognized by differences in shape of tips of rectrices (see Fig. 1). Moorhouse & Greene (1995)

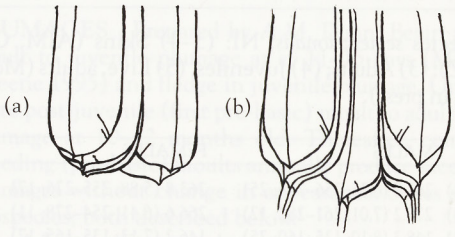


Figure 1 Rectrices (a) Juvenile (b) Adult

suggested using presence of protruding tail-spines on rectrices to distinguish juveniles from adults; these protrude *c.* 15 mm past tip of rectrices in juveniles. However, the shape of the rectrices appears to be a much better ageing character than the presence of tail-spines since spines can be present on some rectrices in adults, though they are always shorter. Furthermore, Moorhouse & Greene (1995) suggest these spines develop through wear and are not present on some juveniles <3 months old, but further study needed. Moult and wear of plumage can also be used to distinguish juveniles from adults. On Kapiti I.: between Mar. and May, juveniles have fresh plumage whereas adults have not yet moulted and have frayed tips to rectrices; between May and Aug., adults in active moult and juveniles not moulting; between Sept. and Dec., adults have fresh plumage and juveniles have noticeably worn and faded plumage (Moorhouse & Greene 1995).

SEXING Males much larger than females, particularly in size of bill. As in Kea, most can probably be sexed on length of bill.

GEOGRAPHICAL VARIATION Two subspecies, differing in size and plumage: *meridionalis* from SI, and *septentrionalis* from NI. Both described above. Subspecies *septentrionalis* significantly smaller than nominate in all measurements, and adult plumage generally darker and colours appear less bold; plumage of juveniles and downy young also differ.

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Kea *Nestor notabilis* (page 613)
1 Adult male; **2** Adult female; **3** Juvenile female; **4** Immature male; **5, 6** Adult

Kaka *Nestor meridionalis* (page 623)
NOMINATE *MERIDIONALIS:* **7–9** Adult
SUBSPECIES *SEPTENTRIONALIS:* **10** Adult male; **11** Juvenile; **12** Adult