

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 *Micrositta* 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 (Homerger 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) lorries 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 lorries 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 lorries. 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; Homerger 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 racket-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). Molt of tail usually starts after molt 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) molt 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 stretch 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 extraliminally. 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 *Apis 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 extraliminally: Psittrichadini (Pesquet's Parrot *Psittrichas 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 *Prosopieia* (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.: *Eclactus* 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 Psittichadina 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 *Purpurecephalus 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 lifelong 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 anthoepus* (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 gulelimitertii* (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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Platycercus elegans **Crimson Rosella**

COLOUR PLATE FACING PAGES 320, 321

Psittacus elegans Gmelin, 1788, *Syst. Nat.* 1: 318 — no locality = New South Wales.

The specific epithet reflects Latham's name (1781, *Gen. Synop. Birds*, 1[1]), 'Beautiful Lory', for this richly coloured parrot; from the Latin *elegans*, fine, choice.

OTHER ENGLISH NAMES Adelaide, Blue-cheeked, Murray, Murrumbidgee or Yellow Rosella; Crimson, Mountain, Pheasant, Red or Yellow Parrot; Adelaide, Campbell, Pennant's or Yellow Parakeet; Beautiful, Red or Swamp Lory; Mountain, Murrumbidgee or Red Lowry; Lory; Lowry; Murray Smoker.

POLYTYPIC Subspecies *nigrescens*, Ramsay, 1888, n. Qld, from Cairns to S of Bowen, and W to Ravenshoe; nominate *elegans*, e. and s. Aust., from Blackall Ras, s. Qld, through NSW, ACT, e. and s. Vic., W to round Kingston SE, se. SA; subspecies *melanoptera*, North, 1906, Kangaroo I.; subspecies *flaveolus*, Gould, 1837, riverine inland s. NSW, E to Yass and Gundagai, along Murray R. in n. Vic., and S to Mannum in SA; subspecies *fleurieuensis*, Ashby, 1917, Fleurieu Pen., SA; subspecies *adelaidae*, Gould, 1840, Mt Lofty Ras, SA, from just S of Adelaide N to about Clare; and subspecies *subadelaidae*, Mathews, 1912, s. Flinders Ras, S to near Gladstone.

Subspecies of Crimson Rosella fall into three separate groups, which have at various times been considered separate species, and are often identified as such in the literature. They are: **CRIMSON TYPES** (Crimson Rosella: nominate *elegans*, and subspecies *nigrescens* and *melanoptera*) of e. and se. Aust. and Kangaroo I.; **YELLOW TYPES** (Yellow Rosella: subspecies *flaveolus*) of inland se. Aust.; and **ADELAIDE TYPES** (Adelaide Rosella: subspecies *fleurieuensis*, *adelaidae* and *subadelaidae*) from Fleurieu Pen. round Adelaide, Mt Lofty and and s. Flinders Ras.

FIELD IDENTIFICATION Length 35–38 cm; wingspan 44–53 cm; weight c. 120–150 g. Medium-sized broad-tailed parrot, similar in size and shape to Eastern Rosella *Platycercus eximius*. Familiar and common parrot of e. and se. Aust. Marked geographical variation in colour of plumage, falling into three main types, described separately below; all ages of all subspecies have blue cheek-patch: **CRIMSON TYPE**, in which adults characterized by mostly crimson plumage with blue shoulder-patches and mostly blue tail; juveniles in se. Aust. have mostly olive-green plumage with crimson forehead, foreneck, vent and undertail-coverts, with juveniles in ne. Qld much more similar to adult. **YELLOW TYPE**, in which adults like adult Crimson Type but with crimson replaced by yellow, and with red frontal band; juveniles duller, mostly olive-green above and paler yellow below. **ADELAIDE TYPE**, intermediate between Crimson and Yellow Types, with paler red to orange-red in place of crimson in adults and juveniles but with much clinal variation in amount of red in plumage. Sexes differ slightly. No seasonal variation. Juvenile separable.

CRIMSON TYPE: Adult male Head, neck and most of body crimson, with prominent blue cheek-patches, and lower hindneck, mantle, scapulars, tertials and inner greater coverts, black boldly scaled crimson. Uppertail, dark blue, darkest and

appearing greenish basally, and with diffuse white tip to all but central rectrices. Upperwing: at rest, show broad light-blue shoulder-patch, narrow black band on innerwing, and black remiges, edged dark blue; in flight, upperwing appears mostly dark blue, grading to black at tip, with triangular black patch on innerwing, bordered by prominent light blue of rest of secondary coverts. Undertail, light blue, narrowly tipped white. Underwing: most coverts, dark blue; greater coverts and remiges, grey-black. Bill, pearl-grey. Cere, grey-black. Iris, dark brown. Orbital ring, grey-black. Legs and feet, light grey. **Adult female** Very similar to adult male but somewhat duller; best distinguished by: (1) short narrow white underwing-bar across centre of outer primaries (never in male); bar varies: some have longer bar extending onto inner primaries and secondaries; others have short broken bar or faint spots on outer primaries; (2) much stronger green tinge to central rectrices; and (3) feathers of mantle, scapulars and tertials have narrow dark-green subterminal bands. **Juvenile** In **SE. AUST.**, very different from adult. Most of head, neck and body, bright olive-green, with crimson forehead and forecrown, narrow crimson moustachial stripe encircling dark-blue cheek-patch and joining crimson foreneck, varying amounts of crimson on underbody, and diffuse dusky streaking on mantle and scapulars and, occasionally, broad crimson tips to longest uppertail-coverts. Uppertail: central rectrices, bright olive-green; rest as adult. Folded wing mostly bright olive-green with dusty streaking, and with narrower and dull-blue leading edge; folded remiges as adult. In flight inner upperwing mostly olive-green with diffuse narrow blue band; outerwing, dark blue grading to black at tips. Underwing: most coverts, dark blue; greater coverts and remiges, dark grey, with prominent broad cream bar across outer secondaries and all but outermost primaries. Bill and cere, yellow-brown at first, changing to adult coloration before or soon after fledging. In **NE. QLD**, juveniles more similar to adults. Differences from adult: slightly duller; feathers of mantle, scapulars

Plate 16

Crimson Rosella *Platycercus elegans* (page 321)

SUBSPECIES NIGRESCENS: 1 Adult male; 2 Juvenile; 3 Adult male; 4 Juvenile

SUBSPECIES FLAVEOLUS: 5 Adult male; 6 Juvenile; 7 Adult male; 8 Adult female

SUBSPECIES FLEURIEUENSIS: 9, 10 Adult; 11 Adult female

SUBSPECIES ADELAIDAE: 12, 13 Adult; 14 Adult female

SUBSPECIES SUBADELAIDAE: 15, 16 Adult; 17 Adult male

and tertials have narrow olive-green subterminal bands, most prominent on larger scapulars and on tertials; uppertail much duller, with green tinge to central rectrices. Bare parts and underwing-pattern as juveniles for se. Aust.

YELLOW TYPE: Adult male Pattern of plumage similar to adult male Crimson Type, except: crimson replaced with pale yellow; narrow red frontal band extends across forehead, grading to indistinct red wash on lores and under eye; and some have faint orange-red wash on foreneck, breast and belly. **Adult female** As adult male but differing in pattern of underwing as described for adult Crimson Type. **Juvenile** Similar to adult female but duller; also differs by: hindneck, sides of neck, mantle, scapulars, tertials and most secondary coverts of upperwing much more uniform and darker, olive-green; back to uppertail-coverts, duller, olive-yellow, and central rectrices on uppertail distinctly duller and greener; underbody uniformly pale yellow, with orange-red wash lacking or reduced to diffuse spots on foreneck and upper breast. Also differ from adult in bare parts and differences in underwing-pattern described for Crimson Type juveniles.

ADELAIDE TYPE: Subspecies intergrade in cline of decreasing red in plumage from S to N; red increasingly replaced by yellow on hindneck, sides of neck and breast, along flanks and on back to uppertail-coverts, and feathers of upperparts increasingly fringed with pale yellow. Predominantly yellow individuals can occur within red populations and vice versa. **Adult male** In S, typically similar to Crimson Type in general appearance, differing by: head, neck and, especially, underbody, paler red to orange-red, with feathers of upperparts generally fringed paler orange, and lower hindneck and sides of neck often washed yellow. In N, typically similar to Yellow Type, differing by varying orange-red suffusion on foreneck, breast, vent and undertail-coverts; scattered orange-red smudging over belly; varying orange-red wash over crown and orange-red smudging on uppertail-coverts. In middle of range, typically intermediate between these: forehead, crown and underbody, orange-red, grading to paler yellow on hindneck, sides of neck and underbody (latter with varying paler-yellow fringes to feathers); feathers of saddle fringed orange-yellow to pale yellow and back to uppertail-coverts orange-yellow with varying orange-red suffusion. **Adult female** Similar to respective males but differs by: blue subterminal bands to feathers of mantle, scapulars and tertials; also, underwing differs as in Crimson Type. **Juvenile** Similar to juvenile Crimson Type, but crimson areas of plumage replaced with paler red to orange-yellow; and lower breast and belly duller greenish-grey (not olive-green) faintly tinged blue in some.

Similar species None; blue cheek-patch in all plumages unique among rosellas of mainland Aust.

Gregarious except when breeding. Usually in pairs, family parties or small flocks; also occur in larger flocks at times, mainly of juveniles. Crimson Type occurs in humid coastal and montane habitats (preferring more forested habitats than Eastern Rosella); Yellow Type strongly associated with drier riverine habitats; Adelaide Type inhabits variety of timbered habitats. Active, noisy and conspicuous. Arboreal and terrestrial; feed in trees and shrubs and on ground. Often tame and confiding; will take handouts at some picnic and camping grounds; retreat noisily into nearby cover when disturbed. Flight swift, direct and undulating, with bursts of rapid shallow wing-beats interspersed with brief glides; at other times, fly with deep exaggerated wing-beats, dashing swiftly between trees; flight of Yellow Type said to be less undulating than other rosellas (Forshaw). Usual contact call, uttered often in flight, harsh

brassy disyllabic *cussik-cussik* or *cuzzuk-cuzzuk*. When perched, often give series of mellow piping notes resembling *kwik-kweek-kwik* or *kwik-kweek*, with upward inflection on second note. Also series of shrill shrieks in alarm. All calls noticeably deeper in tone than those of Eastern Rosella.

HABITAT Three subspecies groups, occupying different habitats. **CRIMSON TYPE:** Mainly forests and woodlands, with general tendency to be most common in older and wetter forests (R.H. Loyn); from sea level to subalpine areas (Cooper 1974; Marsland 1977; Aslin 1978; Forshaw; Vic. Atlas). Tropical, subtropical and temperate rainforest; in wet and dry sclerophyll forests, including those with dense understorey or in remnant patches in gullies or on ridges (Neilson 1964; Kikkawa *et al.* 1965; Bravery 1970; Loyn 1980, 1985a,b; Magrath 1981; Smith 1984; Wyndham & Cannon 1985; Boles & Longmore 1989); and in logged areas and in regrowth forest (Norris 1964; Griffin 1974, 1995; Loyn 1980, 1985a,b; Kavanagh *et al.* 1985; Smith 1985; Laurance *et al.* 1996). Also inhabit low Snow Gum *Eucalyptus pauciflora* woodlands at high altitudes up to tree-line (Marsland 1977; Emison & Porter 1978; Gall & Longmore 1978; Schulz 1991; Osborne & Green 1992); also inhabit forest and woodland with dense, open or grassy understorey; or riparian forests and woodland (Clarke 1967; Bravery 1970; Cooper 1974; Gepp & Fife 1975; McFarland 1982; Smith 1984; Leishman 1994; Chan 1995). In detailed surveys in forests throughout Vic., common in coastal *Eucalyptus* forests, but most often recorded in rainforest (3.8% of total population in community), Alpine Ash *E. delegatensis* forest (2.4%) and Mountain Ash *E. regnans* forest (2.4%); also in Manna Gum *E. viminalis*-Narrow-leaved Peppermint *E. radiata* forests in gullies in foothills (1.9%); mature stringybark forests on ridges in foothills (1.8%); Mugga Ironbark *E. sideroxylon* forests (1.8%); Mountain Grey Gum *E. cypellocarpa*-Messmate *E. obliqua*-Narrow-leaved Peppermint forests in gullies in foothills (0.8%); Snow Gum woodland (0.7%); and regrowth stringybark forest on ridges in foothills (0.2%) (Loyn 1985b). In detailed study in Mt Boss SE NSW, generally recorded at similar frequencies in 11 forest habitats which were unlogged, recently logged or logged c. 20 years before: mostly in cool temperate rainforest (recorded in 68–75% of surveys); also in dry open forest (41–66%), tall open forest (35–53%) and warm temperate or subtropical rainforest (21–35%) (Shields *et al.* 1985). In detailed study near Bombala, NSW, mostly recorded in Narrow-leaved Peppermint-Manna Gum-Mountain Gum *E. dalrympleana* forest (mean of 0.36 birds/ha/h); less often in dry open Narrow-leaved Peppermint and Mountain Gum forest (0.21 birds/ha/h); least often in mosaic of well-drained Narrow-leaved Peppermint-Manna Gum forest, Swamp Gum *E. ovata*, open Snow Gum-Black Sally *E. stellulata* woodland and pasture (0.14 birds/ha/h) (Recher & Holmes 1985). Occur in pine plantations (Pawsey 1966; Gepp & Fife 1975; Stevens 1975; Disney & Stokes 1976; Friend 1982; Traill 1985; see breeding habitat below); less often in plantations of Sugar Gums *E. cladocalyx* (Watson 1955). Visit orchards (Bridgewater 1934; Lendon 1973; Aslin 1978; Passmore 1982; Forshaw), causing damage to fruit crops. Occur in disturbed areas at edges of forest (Wigan *et al.* 1938; Aslin 1978) and in remnant patches of forest in farmland, especially when larger than c. 10 ha (Loyn 1987), and formerly occurred in areas infested by Prickly Pear *Opuntia vulgaris* (Hyem 1936). Also in open areas, including farmland, semi-cleared pasture, firebreaks and other clearings; such areas used more frequently if next to forests or strips of vegetation along roadsides, fencelines or watercourses (Pawsey 1966; Aslin

1978; Emison & Porter 1978; Forshaw; Vic. Atlas; J.M. Peter). In urban areas, often in parks, reserves, gardens and golf courses (Watson 1955; Lenz 1988, 1990; Forshaw; ACT Atlas); rarely in treeless city areas (Bryant 1938). Sometimes in dense coastal scrub and heathland; recorded in low coastal dune vegetation and saltmarsh at Wilsons Prom., Vic. (Hindwood & Sharland 1964; Cooper 1974, 1975; Gibson 1977; Smith 1984; Pyke 1985; Forshaw; Vic. Atlas; R.H. Loyn). Rarely on nearshore islands, e.g. Stradbroke I., Qld (Vernon & Martin 1975). Introduced populations (Crimson Type) in NZ mostly inhabit reserves, parks and gardens in leafy suburban areas (CSN; NZRD). At Brooklyn, NI, inhabit parks during winter, but move to suburban gardens in spring (CSN 31). Once recorded in back garden of a farmhouse close to bush (Hamel 1970). Introduced populations on **Norfolk I.** occur in almost all habitats except most open country: all forested areas, including hardwood rainforests with emergent Norfolk Island Pines *Araucaria heterophylla*; regenerating forests; built-up areas; open parkland; farmland, including pasture and cultivation; along roadsides; open streamside flats; and nearshore islets (Wakelin 1968; Smithers & Disney 1969; Schodde *et al.* 1983; Hermes 1985; Forshaw).

YELLOW TYPE: Mostly restricted to riparian or littoral River Red Gum *Eucalyptus camaldulensis* forests and woodlands (Boehm 1954; Hobbs 1961; McEvey 1965; Bedggood 1973; Roberts 1975; Ford 1977, 1987a; Schrader 1979; Loyn 1985b; Henle 1989); sometimes in dry woodlands or wooded farmlands near red gum forests (Vic. Atlas), e.g. near Wagga Wagga, NSW, occasionally in tall semi-arid Grey Box *Eucalyptus microcarpa* woodland (Degabriele *et al.* 1979). At Waldraira, NSW, small colony inhabits Belah *Casuarina cristata* growing among mallee shrubland; population probably displaced from riverine woodland by death of nearby River Red Gums (Hobbs 1961). Very occasionally among thickets of boxthorn *Lycium* or Peppercorn Trees *Schinus molle* in open areas (Hobbs 1961). Rosellas (possibly this type) have been recorded in tall dry mallee scrub near Mt Mary, SA (Boehm 1954, 1959).

ADELAIDE TYPE: In Mt Lofty Ras, inhabit variety of timbered habitats including: open forest and woodland; trees growing beside roads, watercourses or other wetlands; farmland and orchards; and tall dry mallee shrubland. In Flinders Ras, restricted to stands of River Red Gums along watercourses. Also inhabit urban parkland and pine plantations (Fuller 1949; Boehm 1952, 1959; Schodde 1956; Cox 1973; Gepp & Fife 1975; Stevens 1975; Paton 1976; Rix 1976; Fisher 1993; Penck *et al.* 1995; Forshaw).

Nest in hollows in trees, usually *Eucalyptus*, in forests or woodlands (Hyem 1936; Lendon 1973; Aslin 1978; Vic. Atlas; NRS). Often in mature forests, but also in regrowth forest and remnant patches of old forest in gullies (Loyn 1980). Near Bathurst, NSW, of 13 nests, 12 in wet sclerophyll forest, one in dry sclerophyll forest (Disney & Stokes 1976). Not recorded nesting in pine plantations (Disney & Stokes 1976), though will do so if nest-boxes provided (E.A. Krebs). Tend not to breed in open habitats, and where nest-boxes available in forested and open habitats close together, use only boxes in forest (Vogels 1996). Often use artificial nest-boxes near settlements (NRS), and lack of natural hollows in some urban areas may have forced some to nest in cavities in city buildings (Bryant 1938; Lenz 1988; ACT Atlas); will also use nest-boxes in natural habitats, e.g. in dry and wet sclerophyll forests, 81% of nest-boxes supplied were occupied (Vogels 1996; Krebs 1997). On Norfolk I., breed in holes in rotten trunks of dead exposed Norfolk Island Pines and other trees in forest (Schodde

et al. 1983; Hermes 1985; Forshaw); also recorded breeding in chimney (Wakelin 1968). Yellow Types breed in hollow *Eucalyptus* trees near waterways or wetlands (Hindwood 1940a; Lendon 1973; NRS); once recorded nesting in hollow in native pine *Callitris* (NRS). Adelaide Types also breed in hollows in *Eucalyptus* trees, living or dead; in open forest or woodland, farmland, along rivers and sometimes in mallee shrubland (Boehm 1959; Penck *et al.* 1995; Forshaw; NRS).

Crimson Types feed in trees and shrubs, and on ground (Breton & Sourry 1959; Aslin 1978; Forshaw; Vic. Atlas). Near Bombala, NSW, of 1309 observations of foraging, 46% in canopy (>10 m); 44% in subcanopy (4.1–10 m); 9% in shrub layer (0.2–4 m); and 1% on ground (Recher & Holmes 1985; Recher *et al.* 1985). In Mountain Ash forest near Toolangi, Vic., most foraging in shrub layer (Loyn 1985a). Near Armidale, NSW, recorded feeding in canopy of trees more often in winter, and on ground more during summer (Aslin 1978). Forage in canopy of forests and woodlands, in trees, including *Eucalyptus*, *casuarina*, *Banksia*, *Grevillea* and *Ficus* (Irby 1930; Marshall 1935; Stringfellow 1957; Cooper 1975; Marsland 1977; Magrath 1981; McFarland 1984; Ford *et al.* 1986; Schulz 1991; Osborne & Green 1992; Hall); may be highly effective in controlling infestation of psyllids (Loyn *et al.* 1983). In pine plantations, feed on new pine cones (Disney & Stokes 1976; Bedggood 1970). Often feed in fruit trees in orchards (Bridgewater 1934; Lendon 1973). Also forage in pendulous clumps of mistletoe (Aslin 1978). Forage in shrubs: in understorey of forest and woodlands (Griffin 1974; Magrath 1981); beside tracks in forest; at edges of forests, including regrowth; and especially in invasive weeds in disturbed areas at edges of or in forest and woodland, such as blackberry, brambles, wild tobacco and wild raspberry bushes in clearings (Marshall 1935; McNamara 1937; Wigan *et al.* 1938; Griffin 1974; Aslin 1978), and native colonizing plants, such as fireweed *Senecio* (Loyn 1985a). Sometimes feed on flowering *Xanthorrhoea* in heathland (Hindwood & Sharland 1964); and sometimes also on hedges (Forshaw). Rarely feed on ground in forests, but do so often in more open areas: feed on fallen pine seeds below trees in pine plantations; fallen acorns below oak trees *Quercus*; and other fallen fruit (Binns 1953; Pawsey 1966; Paton *et al.* 1988); in rural areas, feed on roadsides and in farmland, among grass or on low weeds, such as thistles, dock and onion grass growing in pasture and also on spilt grain; in more built-up areas, feed on lawns, nature-strips and sports ovals (Bridgewater 1934; Binns 1953; Bedggood 1958, 1970; Pawsey 1966; Stokes 1967; Gill 1970; Aslin 1978; Conole 1981; Hall). At Wilsons Prom., Vic., forage among succulent plants growing on beach and in saltmarsh (Cooper 1975; R.H. Loyn). Often feed at artificial sites, such as seed-trays in gardens, and at sanctuaries (Lendon 1973; Mitchell 1976; Popple 1981; Lenz 1988). In gardens, feed in trees, shrubs and on ground (Lenz 1988; Wood 1992). Once recorded taking insect from air (Stokes 1967). In NZ, introduced Crimson Types reported to feed on weeds, fallen acorns and other seeds on ground; and in trees and shrubs in suburban reserves, parks and gardens (CSN). Introduced Crimson Types on Norfolk I. feed in trees and on ground: in outer branches of Norfolk Island Pines; in fruiting Lantana; on cultivated land, feed in orchards, wheatfields and strawberry gardens (Bassett Hull 1909; Anon. 1963; Wakelin 1968; Smithers & Disney 1969). Yellow Types mainly forage in canopy of seeding or flowering River Red Gums; occasionally forage in River Red Gum saplings or in shrubs; also on or near ground, among grass or patches of weeds, often clinging to stems, such as thistles or paddymelons. Sometimes feed in mallee shrubland or farmland near

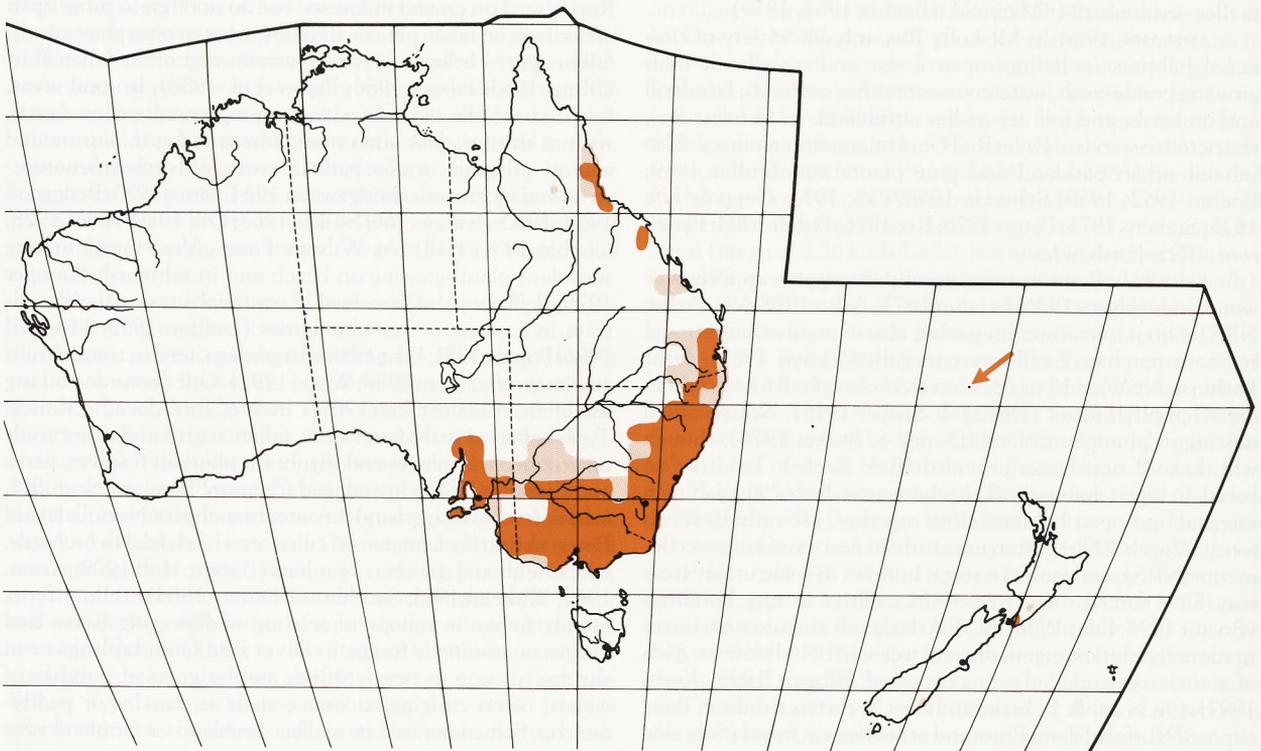
River Red Gum forests (Lendon 1973; Sonter 1984; Forshaw). Adelaide Types mainly feed in trees, such as *Eucalyptus* and *Callitris*; usually in higher branches. Also in fruit trees, especially cherry trees (either in bud, flower or fruit) in orchards, but also wild olive trees and oaks. Sometimes on ground, on grass, on playing fields or in gardens, including vegetable patches. May feed on spilt grain round haystacks and farmhouses (Boehm 1959; Rix 1976; Fisher 1993; Penck *et al.* 1995; Forshaw).

Roost in tall trees, often *Eucalyptus*; among leafy ends of horizontal branches in canopy (Marchant 1979, 1992); sometimes in thickets of *Melaleuca* (Marchant 1992). During heat of day, all types loaf in shade, either among inner foliage or on branches below canopy (Aslin 1978; Forshaw); Yellow Types usually roost in canopy of River Red Gums (Forshaw). May bask in sun on dead trees near edge of forests in early morning and near sunset (Aslin 1978). Only perch sideways on trunks of trees when inspecting nesting hollows (Aslin 1978). Near Torquay, Vic., often loaf on ledges and in cavities in coastal cliffs (J.M. Peter).

DISTRIBUTION AND POPULATION Endemic to Aust.; in e., se. and s. Aust. **Qld** Isolated population in Atherton Region, in NE; extending from Thornton Peak S to Paluma Ra. Said to have been recorded farther inland at Georgetown (Roff 1967). Another isolated population occurs in Eungella area. Also recorded on Blackdown Tableland and at Yeppoon (Cody 1991; Qld Bird Rep. 1985). In se. Qld, widespread S of 26°S, inland to Condamine and Kinson (Wheeler 1967; Bravery 1970; Ford 1977; Storr 19; Aust. Atlas). **NSW** Widespread from coast, W to at least North-west, Central-west and South-west Slopes Regions, and sometimes farther W, to Moree and S of Coonamble in North-west Plains Region; also widespread in Riverina and Lower Western Regions, particularly along Murray R. and its tributaries, including Murrumbidgee, Lachlan and

Darling Rs, upstream to Tumut, Hillston and Kinchega NP, respectively (Morris *et al.* 1981; Cooper & McAllan 1995; Aust. Atlas; NSW Bird Reps). **Vic.** Widespread in most regions, S of line from Yarrowonga to n. Little Desert, though sparse in central and s. Northern District; also widespread along Murray R. Valley, NW to Neds Corner. Generally absent from n. plains W to Big Desert and NW to Sunset Country (Vic. Atlas). Vagrant to Great Glennie I., off Wilsons Prom., Mar. 1979 (Wainer & Dann 1979). **Tas.** Escapes occasionally recorded near Hobart (Tas. Bird Reps 16, 18); and at E. Devonport (Tas. Bird Rep. 15); possibly elsewhere near settled areas. Two doubtful records on King I. before 1975; single juvenile at The Nook, Apr. 1975, may have been aberrant Green Rosella *Platycercus caledonicus* (Aust. CL; Tas. Bird Rep. 5); no aviary stocks of Crimson Rosellas are kept on King I. (Tas. Bird Rep. 5). **SA** Extreme SE, sometimes W to near s. Coorong; also from Fleurieu Pen. N through Mt Lofty Ras and Adelaide Plains to ne. Eyre Pen. at Port Augusta, and s. Flinders Ras near Mt Remarkable NP and Melrose. Also in n. Murray-Mallee Region, mainly along course of Murray R. and its tributaries (Condon 1969; Mack 1970; Cox 1973; Ford 1977; Paton *et al.* 1994; Stove 1994; Aust. Atlas; SA Bird Reps). Isolated population on Kangaroo I. (Abbott 1974; Ford & Paton 1975; Ford 1977; Baxter 1989; Aust. Atlas). **WA** Escapes recorded at least 7–8 times in Perth between 1960 and 1987 (Barrett 1987; Jaensch & Vervest 1987; Vervest *et al.* 1987, Long 1988).

NZ NI Established, from aviary escapes, in suburbs of Wellington since 1963; now mostly in w. and nw. suburbs (Falla *et al.* 1981; NZCL; CSN). Two recorded in Tararua Forest Park near Eketahuna in Sept. 1971 (CSN 19). **SI** A few, with some Eastern Rosellas, released off Otago Heads in c. 1910 after import not allowed; said to have interbred with Eastern Rosellas round Dunedin, so that few pure Crimson Rosellas remained by



1920s. Few records; said to have persisted till 1950s (Oliver; NZRD; NZCL). Several thought to have escaped from an aviary wrecked during a gale in Dunedin in c. 1950, but not subsequently recorded (Hamel 1970).

Lord Howe I. Several released in June 1918 from the beached SS *Makambo*, but no population established (Hindwood 1940b).

Norfolk I. Introduced as cagebird in first penal settlement, and established in wild from escapes; first recorded before 1838 (Schodde *et al.* 1983; Hermes 1985). Recorded in large numbers by early 1900s (Basset Hull 1909). Now widespread; recorded in c. 62% of land area of island (Schodde *et al.* 1983).

Breeding Widespread throughout most of range; in Atherton Region, from Crater NP S to Paluma; data lacking from Eungella; elsewhere, recorded from Blackall Ras, S to Wilsons Prom., and W to Kangaroo I. and near Quorn (Aust. Atlas; NRS). In NZ, breed round Wellington (CSN), and, formerly, near Dunedin (Oliver). Also breed Norfolk I. (Wakelin 1968; Hermes 1985; Hermes *et al.* 1986).

Change in range Slight expansions of range have been detected in Bendigo area, Vic., during 1970s (BFNC 1976) and in South-East and Adelaide Plains Regions of SA (Paton *et al.* 1994). Numbers round Naracoorte, SA, were thought to be increasing in 1960s (Attiwill 1972). However, numbers round Comboyne, NSW, declined in the 1930s after large numbers were shot (Chisholm 1934). On Norfolk I., numbers said to have declined between 1974 and 1976 with outbreak of disease, but numbers have now increased, though disease is still prevalent (Schodde *et al.* 1983; Hermes *et al.* 1986).

Populations On Blackdown Tableland, Qld, density of 0.29 birds/ha (Cody 1991). Near Armidale, NSW, 0.6 birds/ha (Ford & Bell 1981); 2.07–3.08 birds/ha in breeding season, and 1.52 birds/ha in non-breeding season (Vogels 1996); on 113 km road-trip between Tamworth and Armidale, NSW, 0.03 birds/km (Brereton 1977). Near Bathurst, NSW, densities of 1.75 and 0.375 pairs/ha recorded in wet and dry sclerophyll forests respectively (Disney & Stokes 1976). At three sites in n. Canberra, three territories recorded in 74.5 ha, three in 197.2 ha and five in 35.7 ha (Lenz 1990). In unlogged forests near Eden, NSW, densities of 0.1–0.6 birds/ha/h of obs. (Kavanagh *et al.* 1985); near Bombala, NSW, average densities of 0.14–0.36 birds/ha/h of obs. (Recher & Holmes 1985). At Jamieson, Vic., densities of 0.5–1.0 birds/ha (Aust. Atlas); and at Boola Boola, Vic., 0.07–0.29 territories/ha recorded (Loyn 1980). Near Adelaide, SA, densities of 2.7 birds/ha at Shephards Hill Reserve; 6.4 birds/ha at Belair NP; 4.8±0.4 birds/ha at Mt Lofty; and 0.4±0.3 birds/ha at Craighburn (Penck *et al.* 1995). On a 340 km road-trip between Port Augusta and Barmera, recorded at 0.01 birds/km (Brereton 1977).

Damage orchard crops and, possibly, young wheat crops (Basset Hull 1909; Norton 1922; Leach 1928; Halse 1986; Fisher 1993) and have as a result been shot in large numbers in past (Bridgewater 1934; Chisholm 1934; Anon. 1963). Colonization of Lord Howe I. may have been prevented by shooting (Disney & Smithers 1972). In some areas, many trapped for aviculture (Attiwill 1972). Sometimes killed by vehicles (Cox 1973; Vestjens 1973; Lepschi 1992). Possibly eaten by foxes (Cameron 1934), cats or dogs (Rose 1975; Dowling *et al.* 1994). Formerly, young taken for aviculture (North).

MOVEMENTS Throughout range (all subspecies), sedentary (Cooper 1975; Morris 1975; Gibson 1977; Forshaw; see Banding) or resident (e.g. Bravery 1970; Roberts 1975; Ford & Paton 1976; Baxter 1980; Morris *et al.* 1981; Schodde *et al.*

1983; Ashton 1985; Morris 1986; Griffin 1995) even at high altitudes (e.g. Gall & Longmore 1978). However, some movements observed: some populations considered nomadic (Cheney 1915; McEvey 1965) and presence or changes in numbers at some areas appear seasonal, though movements may only be local. No evidence for claim of migration (NSW Bird Rep. 1986).

No regular long-distance movements in Vic. (Vic. Atlas). Recorded with consistent frequency all year in ACT (ACT Atlas). At Jingellic, NSW, 1976–79, seasonal frequency of observation varied from 87% in summer to 100% in spring (Winterbottom 1981). Recorded New England NP, NSW, all months (McFarland 1984). Always present Boree, NSW (Norton 1922); recorded in all seasons in Bega–Bermagui forests, NSW (Smith 1984); recorded all year in Sandringham area, Melbourne (Norris *et al.* 1995). At Stonyfell, SA, formerly always a few present (Crompton 1915); observations in 1944 and 1945 indicate that occur at Old Rectory Farm, Willunga, throughout year (Symon 1946).

At least some remain at high altitudes all year (ACT Atlas); present throughout year in subalpine areas of Snowy Mts (Osborne & Green 1992); regarded as common in winter in Snow Gum Woodland in se. Aust. (Marsland 1977; Schulz 1991). Some altitudinal movement suggested, with claims of movement to lower altitudes in winter (Hobbs 1958; Lamm & Wilson 1966; Warringal Cons. Soc. 1981; Slack 1993), and some seasonal influxes attributed to movement from mountains, e.g. at Tomaree Pen., NSW (Slack 1993), but little evidence to distinguish real movements.

In some areas, regarded as occasional or irregular visitor, e.g. Melbourne Zoo (Dunn 1989); Mooroopna district, Vic. (Bedggood 1958); Sydney Botanical Gardens (Gannon 1932); Reedy Ck, SA (Cox 1973); occurred Mellor Park in 1927 even though had not been in area for a long time (Mellor 1927). Casual occurrence on Monaro Plains, NSW, attributed to movement in search of food, in years of plentiful seeding of grasses and thistles (Edwards 1925). Numbers sometimes vary between years, e.g. at Trialla, sw. Vic., rare in 1973 but common for most of 1974 (Hirth 1976). Some movement said to be nomadic (Forshaw): e.g. irregular at Cobden and Heywood, Vic., in winter (Thomas 1968); and rare visitor to Wagga Wagga, NSW, in winter (Sharrock 1981). Present Sandy Ck Conservation Park, SA, on most visits but appear to move away for short periods in some seasons: plentiful from late Jan. to mid- or late Sept., with numbers varying between years; general exodus takes place after mid-Sept., with remaining birds almost always subadults, though some subadults leave with adults; in some years a few adults return in Dec., but main influx Jan., when adults and juveniles seen (Rix 1976). At Blackwood, Mt Lofty Ras, usually visited in autumn; arrived early May in 1920 (Ashby 1920). In some areas influxes may occur in non-breeding season, though present at other times, e.g. Tomaree Pen., NSW (Slack 1993); e. Gippsland, Vic. (Bedggood 1970); Caniambo district, Vic. (Bedggood 1973). Influxes during non-breeding season sometimes mostly involve immatures (Bedggood 1980; Vic. Bird Rep. 1986–87).

Considered seasonal visitor in some areas, e.g. Turkeith Stn, w. Vic., Apr.–Sept. (Brown 1950); autumn visitor, Inverell, NSW (Baldwin 1975); winter visitor to lower Clarence R. Valley, NSW (NSW Bird Rep. 1986). In some areas, appear in autumn and winter only and appear not to be present at other times, e.g. Tocumwal and Finley area, near Murray R. (Hobbs 1958); S of Beechworth and Chiltern area, ne. Vic. (Campbell 1902); in 1986, arrived s. Wangaratta region 2 May, left 9 Sept.

(Vic. Bird Rep. 1986–87). Seasonal pattern possibly results from seasonal use of different habitats: in Ballarat region, Vic., visit more open areas in winter (Thomas & Wheeler 1983); in winter, flocks of subadults move to open forests (Frith 1969). At least some local movement in ACT, with flocks of young dispersing widely, and lower numbers in Canberra gardens, Sept.–Jan. when move to bushland to breed (ACT Atlas). At Strathbogrie Ras, Vic., said to spread to red gum country to N in winter (Bedggood 1972). Subspecies *flaveolus* inhabits *Eucalyptus* woodlands but moves to surrounding lands when not breeding (Aust. Atlas). In NZ, pair spent each winter at Central Park, Brooklyn, moving in spring to Kelburn–Highbury suburbs (CSN 31).

Banding Of 3964 banded in Aust., 1953–96, 454 recoveries (11.5%): 448 (98.5%) <10 km from banding site; 4 (1%), 10–49 km; 2 (0.5%), 50–99 km. Longest lived 135 months (ABBBS). Of 1741 banded, 146 recoveries of which only six were away from banding place (Wyndham & Cannon 1985). See also Jordan & Jordan (1984), Tidemann *et al.* (1988).

In study in ACT, of 168 colour-banded nestlings, 18 resighted in same study area; males more likely to be resighted in area than females (24.6% of males resighted, 3.7% of females) (Krebs 1997). In one study near Armidale, NSW, tagged birds (n=56) not sighted more than 750 m away from banding site (Aslin 1978). Hybrid Crimson × Eastern Rosella banded and tagged near Armidale, NSW, July 1970 recaptured ten times and resighted 15 times in area up to 26 Oct. 1971; found dead Nov. 1972 (Wyndham 1979).

FOOD A wide range of plant material: mainly seeds of grasses, weeds, shrubs and trees; also fruits, nuts, buds, flowers, nectar, treefern sori; also take insects and their larvae, especially psyllids and gall insects. **Behaviour** Forage in pairs or small flocks; on ground or in shrubs and trees (Forshaw); more often in shrubs and trees (Penck *et al.* 1995). In Snowy Mts, NSW, of 370 observations of foraging substrate during snow-free months, 47% on tree branches, 3% on foliage, 11% on shrubs, and 36% on ground; of 20 observations when snow cover extensive, 70% on foliage, 30% on shrubs and none on ground (Osborne & Green 1992). At Bondi State Forest, NSW, forage mainly in canopy (>10 m; 46% of 1309 observations of feeding) and subcanopy (4.1–10 m; 44%), less often in shrubs (0.2–4.0 m; 9%) and on ground (0.0–0.2 m; 1%); mean foraging height 13.1±5.3 m (Recher & Holmes 1985). When feeding in fruiting trees in subtropical rainforests of ne. NSW and se. Qld, 80% of visits <5 min duration, 12% between 5 and 10 min, and 8% between 10 and 15 min (n=50 visits); when feeding on *Acronychia oblongifolia*, seven birds made an average of 0.4 visit/h during 4 h observation, spending a mean of 3±1 min/visit (Green 1993). At Sherbrooke, Vic., fed for 46% of daylight hours in autumn and 38% in winter; in winter, fed just after sunrise and in afternoon; but no pattern obvious during autumn when birds fed at equal rates for most of day (Magrath & Lill 1983). At Shepherds Hill Reserve and Belair NP, SA, spent mean of 37% of day foraging over year; daily pattern of feeding varied significantly between months: time spent feeding decreased to minimum during hottest months, and maximum time spent feeding during Aug. Daily time spent feeding in morning, mid-morning, afternoon and late afternoon relatively constant, with slight increase in late afternoon period before sunset (Torcello 1990). Will feed in mixed flocks with Eastern Rosella (Penck *et al.* 1995; Forshaw), and with Superb Parrot *Polytelis swainsonii* and Australian Ringneck *Barnardius zonarius* (Forshaw). When feeding on christmas beetles *Anoplognathus*,

pick beetles from leaves by grasping underside of insect with bill, hold beetle in right foot and remove beetle's front end with one bite and drop it to ground, then eat soft abdominal parts (Davey 1989). When feeding on psyllids, often hold leaf or small branch in foot, and remove all psyllids and covering lerp from leaf by drawing it through bill (Loyn *et al.* 1983). Damage crops of apples, cherries, stone fruits, almonds and grapes (Halse 1986).

Detailed studies At DUEREN, MANSFIELD, VIC. (41 crops and stomachs; Bridgewater 1934): **Plants** (Seeds unless stated.) Unident. 36.5% freq.; bark pieces 9.7. **MONOCOTYLEDONS:** Cyperaceae: *Carex* 4.8; Poaceae: *Avena* 14.6; *Panicum* 2.4; *Triticum aestivum* 2.4; unident. 4.8. **DICOTYLEDONS:** Asteraceae: *Carduus marianus* 7.3; *Centaurea* 2.4; *Cirsium arvense* 17.0; *Hypochoeris radicata* 7.3; Brassicaceae: *Diplotaxis muralis* 2.4; *Sisymbrium officinale* 4.8; Caryophyllaceae: *Cerastium* 2.4; *Spergularia arvensis* 7.3; *Stellaria media* 4.8; Euphorbiaceae: *Euphorbia drummondii* 7.3; Fabaceae: *Medicago denticulata* 2.4; *M. maculata* 2.4; *Trifolium* 19.5; *T. subterraneum* 51.2; *Trigonella* 4.8; Geraniaceae: *Erodium* 9.7; Mimosaceae: *Acacia dealbata* 4.8; Myrtaceae: *Eucalyptus* 12.2; Plantaginaceae: *Plantago lanceolata* 2.4; Polygonaceae: *Rumex acetosella* 7.3; Rosaceae: *Crataegus* fru. 2.4; *Malus sylvestris* fru., sds 39.0; *Prunus* fru. 7.3; Solanaceae: *Solanum* 2.4. **Animals** **INSECTS** (larvae unless stated): unident. 7.4, eggs 9.7; Diptera 4.8; Coleoptera: Unident. 7.3; Curculionidae 4.8; Carabidae 4.8; Hemiptera: Aphididae 2.4; Coccidae 2.4; Corixidae 2.4; Isoptera: *Coptotermes* 7.3; Lepidoptera: Unident. 4.8; Hepialidae 2.4; Noctuidae 2.4. **Other matter** Grit 7.3.

At NEWHOLME, ARMIDALE, NSW (13 crops; Aslin 1978): **Plants** (Seeds unless stated.) Unident. 54% freq. **MONOCOTYLEDONS:** Cyperaceae: *Carex* 23.1. **DICOTYLEDONS:** Caryophyllaceae: *Lychnis* 7.5; Fabaceae: *Trifolium* 15.4; Myrtaceae: *Angophora floribunda* 54.0; *Eucalyptus* 7.5; Plantaginaceae: *Plantago* 38.4; Polygonaceae: *Rumex* 7.5; unident. bark fragments 30.7. **Animals** **INSECTS:** eggs 7.5; Coleoptera 15.4; Diptera 23.1; Hemiptera: Cicadidae 7.5; Coccidae 23.1; Psyllidae 30.7; Lepidoptera pupae 30.7. At same site (330 direct observations of feeding): **Plants** Seeds unless stated. Unident. 22.7% of total feeding observations. **MONOCOTYLEDONS:** Unident. grass sds 0.9. **DICOTYLEDONS:** Asteraceae: *Cirsium arvense* 2.7; *Taraxacum officinale* 0.9, fl. 0.9; Fabaceae: *Glycine* 1.8; Loranthaceae: *Amyema pendula* 8.5; Myrtaceae: *Eucalyptus* unident. (probably galls on leaves) 29.4, sds 19.4, shoots 2.7; Pittosporaceae: *Bursaria spinosa* lvs 1.8; Rosaceae: *Acaena anserifolia* 1.8; *Rubus fruticosus* fru. 2.7. **Animals** **INSECTS:** Coleoptera: Scarabidae ads 3.6.

At SHERBROOKE FOREST PARK, VIC. (262 feeding observations of adults in autumn; 229 in winter; Magrath & Lill 1983): **Plants** (Seeds unless stated.) Unident. 8.3% of observations in autumn, 6.5% winter. **FERNS:** Dicksoniaceae: *Dicksonia antarctica* sori 30.5, 21.4; Cyatheaceae: *Cyathea australis* spores 3.8, 0.9, frond pith –, 0.4. **MONOCOTYLEDONS:** Poaceae: *Dactylis glomerata* 0.4, –. **DICOTYLEDONS:** Asteraceae: *Bedfordia salicina* 3.1, –, petioles 1.9, –; *Hypochoeris radicata* 0.4, –; Boraginaceae: *Cyanoglossum latifolium* 0.4, –; Lamiaceae: *Prostanthera lasianthos* 0.8, –; Loranthaceae: *Amyema pendula* fru. 0.8, 1.3, bark 0.4, –; Mimosaceae: *Acacia dealbata* fl. –, 1.3; *A. melanoxylon* 6.1, 9.2; Myrtaceae: *Eucalyptus obliqua* 2.3, 0.4; *E. regnans* fl. buds 18.3, 45.9; *E. viminalis* 0.8, –; *Leptospermum lanigerum* 1.9, 0.9; Rhamnaceae: *Pomaderris aspera* shoot 5.4, 3.5, fl. buds –, 2.6; Rosaceae: *Acaena anserifolia* 1.9, 1.7. **Animals** **INSECTS:** Coleoptera: Chrysomelidae: 5.7, –; Diptera larv. 0.8, 0.4; Hemiptera: Psyllidae nymphs 6.1, 1.7; *Ctenarytaina* nymphs –, 1.7. At same site, obs. of food eaten by subadults during autumn

(90 feeding obs.; Magrath & Lill 1985): *Dicksonia antarctica* sori 1.1% of observations; *Acacia melanoxylon* sds 4.4; *Eucalyptus regnans* fl. buds 23.3; *Acaena anserinifolia* sds 12.2. **Animals**
INSECTS: Chrysomelidae: 44.4; Psyllidae nymphs 4.4.

Other records Plants (Seeds, unless stated.) Seeds^{12,60,61}, Fruits^{8,22,47,60}, vegetable matter⁶¹. **FERNS:** Dicksoniaceae: *Dicksonia antarctica* fru.²⁵. **GYMNOSPERMS:** Cupressaceae: *Callitris columellaris*⁴²; *C. endlicheri*^{62,65}, fru.⁶⁵; *Cupressus arizonica*⁵⁶; *C. macrocarpa*⁵⁶; *C. sempervirens*^{56,57}; *Thuja orientalis*⁵⁶; Pinaceae: *Pinus*^{21,28}, apical shoots³⁵, needles³⁰; *P. radiata*²⁹. **MONOCOTYLEDONS:** Areaceae: *Archontophoenix cunninghamiana* fru.⁶⁴; Cyperaceae: *Lepidosperma laterale*⁵⁶; Iridaceae: *Romulea rosea* bulbs¹⁸; Poaceae: unident.^{5,20,28,31,34,42,61}, *Avena*^{42,56,63}; *Danthonia*⁶²; *Digitaria sanguinalis*⁵⁹; *Poa annua*⁵⁶; *Paspalum*⁶³; *Secale cereale*⁴²; *Triodia*⁴²; *Triticum aestivum*^{30,42,61,63}; *Zea mays*^{5,9}; Xanthorrhoeaceae: *Xanthorrhoea* fl.^{27,61}; *X. semiplana* fl.²⁶; Zingiberaceae: *Alpinia caerulea*⁴⁵. **DICOTYLEDONS:** Amaranthaceae: *Alternanthera*⁶³; Anacardiaceae: *Euroschinus falcata* fru.⁶⁴; Apiaceae: *Foeniculum vulgare*⁵⁷; Asteraceae: unident.^{4,10,28,61,63}; *Arctotheca calendula* sds, fl.^{1,42,56}; *Bidens pilosa* fru.⁶⁴; *Carduus tenuiflorus* fru.²²; *Carthamus*⁶³; *C. lanatus* sds, fl.⁵⁶; *Coryza bonariensis*⁵⁶; *C. sumatrensis* fl.⁵⁶; *Crassocephalum crepidioides* fru.⁶⁴; *Cynara cardunculus*⁴²; *Gnaphalium purpureum* lvs, sds, sh.⁵⁶; *Helianthus annuus*³⁸; *Helichrysum scorpioides*⁶²; *Hypochaeris radicata* fl.⁵⁶; *Lactuca serriola*⁵⁶; *Onopordium acanthum*^{2,7,8,31,62}; *Sonchus oleraceus*⁴²; *Taraxacum officinale*⁴²; *Tragopogon porrifolius*⁵⁷; Betulaceae: *Betula pendula*⁵⁶; Bignoniaceae: *Catalpa bignonioides* fru.⁵⁷; Boraginaceae: *Echium lycopsis*⁴²; *Ehretia acuminata* fru.⁶⁴; Brassicaceae: *Brassica* lvs²²; *Hirschfeldia incana*⁵⁶; Cactaceae: *Opuntia vulgaris*¹⁴; Caesalpiniaceae: *Gleditsia*¹⁷; Caprifoliaceae: *Abelia grandifolia* fl.⁵⁷; Caryophyllaceae: *Cerastium glomeratum* fl.⁵⁶; *Paronychia brasiliana*⁵⁶; *Stellaria*⁶³; *S. media*^{59,61,62}; Casuarinaceae: unident.³⁴; *Allocasuarina littoralis*⁶⁵; *A. torulosa*⁵⁷; *A. verticillata*⁵⁶; *Casuarina cunninghamiana*⁵⁶; Chenopodiaceae: *Chenopodium album*⁵⁶; Clusiaceae: *Hypericum perforatum*⁵⁶; Cucurbitaceae: *Citrullus*⁴²; *Cucumis myriocarpus*⁶²; Elaeocarpaceae: *Elaeocarpus angustifolia* fru.^{11,62}; *E. reticulatus* fru.⁶⁵; Epacridaceae: *Astroloma conostephioides* fl.²⁶; *Brachyloma ericoides* fl.²⁶; *Epacris impressa* fl.²⁶; *Leucopogon*³⁴; *L. juniperinus*⁵⁶; *L. muticus* fru.⁶⁵; *Melichrus urceolatus* fl.⁵⁶; *Styphelia tubiflora* fru.⁶⁵; Euphorbiaceae: *Baloghia lucida*⁶²; *Glochidion ferdinandi* fru.⁶⁴; Fabaceae: unident.⁶¹; *Erythrina*^{40,53}; *Medicago*¹²; *Podolobium ilicifolium*⁵⁷; *Pultenaea cunninghamii* fl.⁵⁷; *Trifolium campestre*⁶³; *T. dubium*^{62,63}; *T. glomeratum*⁶¹; *T. subterraneum*^{42,63}; *T. pratense*^{31,42,47}; *Wisteria sinensis* fl.⁵⁷; Fagaceae: *Nothofagus moorei* fru.⁶⁴; *Quercus* acorns¹⁸; *Q. palustris*⁵⁶; Geraniaceae: *Erodium*¹²; *Geranium*⁶³; *G. retrorsum*⁵⁶; Grossulariaceae: *Ribes uvacrispa* fru.⁵⁷; Hamamelidaceae: *Liquidambar styraciflua*^{53,56}; Lamiaceae: *Lavandula stoechas*⁵⁶; *Salvia*⁶³; *S. verbenaca*⁵⁶; *Westringia fruticosa* fru.⁶⁵; Lauraceae: *Cinnamomum camphora*⁵⁹; Loranthaceae: unident. fru.⁴²; *Amyema miquelii* fru.^{26,56}; *A. pendulum*⁴³; *Muellerina eucalyptoides* fru.⁵⁶; *Lythrum salicaria*⁵⁶; Malvaceae: *Lavatera plebeia*⁴²; Meliaceae: *Melia azedarach*⁵⁶; Mimosaceae: *Acacia*^{32,33,34,42,61}; *A. aneurata*⁴²; *A. baileyana* sds, fl. buds^{56,58}; *A. dealbata* sds, fl. buds^{56,58}; *A. decurrens*⁵⁰; *A. fimbriata*⁵⁸; *A. flavescens*⁵⁸; *A. mearnsii* sds, lvs^{56,58}; *A. melanoxylon*^{49,56,58}; *A. orites* fru.⁶⁴; *A. oxycedrus*⁵⁸; *A. parramattensis*^{58,65}; *A. penninervis*⁶⁵; *A. retinodes*⁵⁸; *A. salicina*⁵⁸; *A. simsii*⁵⁸; *A. suaveolens*^{58,59}; *A. terminalis*^{58,65}; *Albizia julibrissin* fl. buds³⁷; Moraceae: *Ficus microphylla* fru., sds^{45,55,65}; *F. obliqua*⁴⁵; *F. watkinsiana* fru.^{55,64}; *Morus nigra* fru.⁵⁶; Myoporaceae: *Eremophila longifolia*⁴²; Myrtaceae: *Acmena igens* fru.^{44,55}; *Angophora costata*^{56,64}; *A. hispida*⁵⁶; *Baekea virgata*⁵⁶; *Callistemon* fl.⁵⁹; *C. citrinus*⁵⁶; *C. rugulosus*⁵⁷; *C. sieberi*⁵⁶; *Decaspermum*⁴⁵; *D. humile* fru.⁶⁴; *Eucalyptus*^{3,9,31,32,42,50,60}; *E.*

*amplifolia*⁵⁶; *E. blakelyi*⁵⁶; *E. bridgesiana*^{56,65}; *E. caesia* fl.⁴⁰; *E. camaldulensis*^{41,42,62}; *E. capitellata*⁶¹; *E. cinerea*⁵⁶; *E. crebra* fl.⁶⁵; *E. crenulata*⁵⁷; *E. dives*⁵⁶; *E. elata*⁵⁶; *E. fastigata*⁵⁶; *E. globoidea* fl.⁶⁵; *E. globulus*⁵⁶; *E. gummifera* fru.⁶⁵; *E. largiflorens*⁴²; *E. mannifera*⁵⁶; *E. melliodora*^{56,65}; *E. ovata*⁶²; *E. pauciflora*^{36,51,52}; *E. perriniana*⁵⁷; *E. polyanthemus*⁶⁵; *E. pulverulenta*⁵⁶; *E. punctata*⁶⁵; *E. radiata*⁵⁶; *E. rossii*⁵⁶, fru.⁶⁵; *E. rubida*⁵⁶; *E. saligna*⁵⁶; *E. sclerophylla*⁵⁶; *E. sieberi*⁶⁵; *E. viminalis* fl. buds⁵⁷; *E. watsoniana*⁵⁶; *Kunzea*³⁴; *K. ambigua*⁵⁹; *K. ericoides* fl.⁵⁶; *Leptospermum*³⁴; *L. polygalifolium*⁵⁶; *Lophostemon confertus* fru.⁶⁴; *Melaleuca*³⁴; *M. decussata*⁵⁷; *M. ericifolia*⁵⁶; *M. parvistaminea*⁵⁷; *Psidium guajava* fru.⁶²; *Rhodomyrtus psidioides* fru.⁶⁴; *Syzygium* fru.⁵⁹; Oleaceae: *Olea europaea*^{46,60}; Onagraceae: *Oenothera stricta*⁵⁶; Pittosporaceae: *Bursaria lasiophylla*⁵⁶; Polygonoaceae: *Persicaria hydropiper*^{5,62}; *Persicaria lapathifolia*⁶³; *Polygonum aviculare*⁵⁶; *Rumex*²¹; *R. acetosella*^{62,63}; *R. crispus*⁵⁷; *R. obtusifolius*⁵⁹; Proteaceae: *Banksia*³⁴; *Grevillea arenaria* fl.⁵⁶; *G. biternata* fru.⁵⁷; *G. buxifolia*⁵⁷; *G. robusta*¹³; *G. rosmarinifolia* fl.⁵⁶; *G. striata*⁴²; *Hakea multilineata* fl.⁵⁷; *Persoonia*^{43,60}; *Rhamnaceae:* *Alphitonia excelsa* fru.⁶⁴; *A. petriei* fru.⁶⁴; *Pomaderris*³⁴; *Spyridium*³⁴; Rosaceae: *Cotoneaster* fru.^{23,62}; *C. glaucophyllus*⁵³; *C. microphyllus*⁵⁶; *C. pannosus*⁵⁶; *Crataegus* fru.^{31,42,62}; *Cydonia oblonga* fru.^{65,57}; *Malus sylvestris* fru.^{5,6,23,31,42,43}; *Photinia serrulata* fru.⁵⁷; *Prunus armeniaca* fl.^{6,56}; *P. avium* buds⁵⁴; *P. cerasifera* sds, fl.⁵⁶; *P. domestica* fru., sds^{6,24}; *P. dulcis*⁴²; *P. persica* fru.⁶; *Pyracantha* fru.^{31,62}; *P. angustifolia*⁵⁶; *P. fortuneana*⁵⁶; *Pyrus aldhenhamensis*⁵⁷; *P. communis* fru.^{5,6,16,31,42,43}; *Rosa rubiginosa* fru.⁶²; *Rubus fruticosus*¹⁵; *R. hillii*¹³; *Sanguisorba minor* fru.⁵⁷; Rutaceae: *Acronychia oblongifolia* fru.^{55,64}; *Correa* fl.⁵⁶; *C. glabra* fl.²⁶; *Crowea exalata* fru.⁵⁷; *Euodia micrococca*⁴⁴; *Melicope micrococca* fru.⁶⁴; Santalaceae: *Exocarpos*⁴⁷; *E. cupressiformis*⁵⁶; Sapindaceae: *Diploglottis cunninghamii* fru., sds⁵⁵; *Dodonaea*⁴²; *D. triquetra* fru.⁶⁵; *Guioa semiglaucifera* fru.⁶⁴; Solanaceae: *Duboisia*⁵⁵; *Lycium ferocissimum*⁵⁷; *Nicotiana glauca*⁴²; *Solanum*^{61,63}; *S. mauritanium*^{44,62}; *S. nigrum*^{56,61}; Ulmaceae: *Aphananthe philippinensis* fru.⁶⁴; *Ulmus parvifolia*⁵⁶; *Zelkova serrata* lvs⁵⁶; Urticaceae: *Dendrocnida excelsa*⁴⁵; Verbenaceae: *Lantana* fru.^{30,65}; *L. camara* fru.⁶⁴; *Premna lignumvitae* fru.⁵⁵. **Animals** INSECTS: Coleoptera: larv.⁶⁰; Chrysomelidae: *Paropsis*⁶³; Scarabaeidae: *Anoplognathus*⁴⁸; Hemiptera: Coccidae: larv.^{59,61}; *Gascardia destructor*⁵⁹; Psyllidae: lerp^{19,39,61}; Lepidoptera larv.⁶¹; Limacodidae: *Limacodes longersans*⁵. Grit^{12,61}.

REFERENCES: ¹ Anon. 1906; White ² 1912a, ³ 1912b; ⁴ Cheney 1915; ⁵ Cole 1919; ⁶ White 1919; Chisholm ⁷ 1924, ⁸ 1934, ⁹ 1944; ¹⁰ Cayley 1928; ¹¹ Irby 1930; ¹² McKeown 1934; ¹³ Marshall 1935; ¹⁴ Hyem 1936; ¹⁵ McNamara 1937; ¹⁶ Pearse 1938; ¹⁷ Shanks 1949; ¹⁸ Binns 1953; ¹⁹ Stringfellow 1957; ²⁰ Bedgood 1958, ²¹ 1970; ²² Boehm 1959; ²³ Thomas 1959, ²⁴ 1963; ²⁵ Aston 1960; ²⁶ Paton & Ford 1977; ²⁷ Hindwood & Sharland 1964; ²⁸ Pawsey 1966; ²⁹ d'Andria 1968; ³⁰ Wakelin 1968; ³¹ Frith 1969; ³² Lendon 1973; ³³ Griffin 1974; ³⁴ Cooper 1975; ³⁵ Gepp & Fife 1975; ³⁶ Marsland 1977; ³⁷ Marchant 1979; ³⁸ Jones 1983; ³⁹ Loyn et al. 1983; ⁴⁰ Smith et al. 1984; ⁴¹ Sonter 1984; ⁴² Hutchins & Lovell 1985; ⁴³ Forde 1986; ⁴⁴ Holmes 1987, ⁴⁵ 1990; ⁴⁶ Paton et al. 1988; ⁴⁷ Baxter 1989; ⁴⁸ Davey 1989; ⁴⁹ Floyd 1990; ⁵⁰ Hoskin 1991; ⁵¹ Schulz 1991; ⁵² Osborne & Green 1992; ⁵³ Wood 1992; ⁵⁴ Fisher 1993; ⁵⁵ Green 1993; ⁵⁶ Lepschi 1993, ⁵⁷ 1997; ⁵⁸ McCulloch 1997; ⁵⁹ Rose 1997; ⁶⁰ Cleland; ⁶¹ Lea & Gray; ⁶² Forshaw; ⁶³ FAB; ⁶⁴ G. Holmes; ⁶⁵ T. Saunders.

Young Fed by both parents; food likely to be similar to that of adults. Parents regurgitate food directly to young; deliver an average of 10 g of food per feeding visit (1–32; 164 feeds at 18 nests). Males deliver larger loads to nest than females; size of loads increased slightly over fledging period. Feeding rates peaked at 15 days and did not differ between males and females

(Krebs 1997). No detailed analysis of crops of nestlings, but those examined appeared to contain small seeds, buds and small insect larvae (E.A. Krebs).

Intake At Lamington NP, Qld, six birds observed 380 min, took 4 fruits/min when feeding on *Acronychia oblongifolia* (Green 1993). At Torquay, Vic., ate 75 ripe *Cotoneaster* berries in 5 min 47 s (J.M. Peter). Near Olinda, Vic., took 48 psyllids and lerp/min (Loyn *et al.* 1983).

SOCIAL ORGANIZATION Based on study by Aslin (1978) at Armidale, NSW, unless stated; other major studies near Armidale, NSW (Vogels 1996), at Black Mt, ACT (Krebs 1997), in Dandenong Ras, Vic. (Magrath 1981) and Adelaide, SA (Torcello 1990; Penck 1992; Penck *et al.* 1995); Vogels (1996) not available for summary here but some information included. Adults nearly always found singly or as mated pairs, which sometimes gather in small groups. Mean number of birds in adult groups in whole year, 2.5 (Aslin 1978); in autumn–winter, 2.44 (Magrath 1981). Juveniles and immatures (collectively subadults) typically form larger flocks; during autumn–winter, mean flock-size of 5.71 (Magrath 1981) but flocks up to c. 100 recorded (Hutchins & Lovell 1985). Mean size of all groups throughout year: in se. Qld–NSW border region, 1.8 (0.7; 1–9; 24) (Cannon 1984); at Belair NP, Adelaide, 3.4 (n=58) (Penck *et al.* 1995) with similar findings in Torcello (1990). Flocks containing adults and subadults said to be rare, with mean size of such flocks between size of adult flocks and subadult flocks (Cooper 1975; Aslin 1978; Magrath 1981), but flocks of banded, unrelated juveniles and adults regularly seen foraging together in ACT (E.A. Krebs). Flocks consisting only of juveniles never observed by Vogels (1996). Three main age-classes recognized by Cooper (1975): juveniles; second-year subadults (probably first immatures; see Plumages) and adults. For all ages, groups tend to be largest when feeding on ground. Flocks of subadults move locally; disperse at start of breeding season. Mated pairs spend most of day alone, tending to join other pairs only in morning and late afternoon; during breeding season spend even more time alone. Groups of subadults tend to stay together throughout day.

Bonds Monogamous; bonds last at least several years (Vogels 1996; Krebs 1997); possibly for life. At Black Mt, ACT, divorce between banded pairs recorded twice (E.A. Krebs). Bond maintained year-round and pair rarely apart; closely coordinated when flying and feeding. Pair-bond assumed to first form in flocks of subadults (Aslin 1978) in first year (Vogels 1996). Can breed in first year while in subadult plumage (Lendon 1949; Calder *et al.* 1979; North; Forshaw) but pairs of adult and subadult almost always adult males and subadult females, so subadult males probably rarely breed (Vogels 1996; Krebs 1997; also see Forshaw). Suggested that most subadults prevented from breeding by established adult pairs (Smith & Brereton 1976; Aslin 1978). **Parental care** Female incubates and broods; both male and female feed young (Aslin 1978; Krebs 1997; Forshaw); female feeds small nestlings and male does not feed chicks till some days after hatching, when female stops continuous brooding (Aslin 1978; Schmidt 1984; Krebs 1997). Male feeds female throughout laying, incubation and early fledging stage (Krebs 1997). Observation of three birds (two adults, one subadult) attending young in nest (NRS). Parents accompany and feed young for several weeks after fledging; fledgelings then spend time away from parents (Penck 1992); at Black Mt, ACT, siblings did not associate after independence (Krebs 1997), but from few weeks after fledging, juveniles join flocks with other juveniles and subadults (Penck

1992); probably leave parents by 4 weeks after fledging (Aslin 1978) and generally not seen with parents more than 8–10 weeks after fledging (Penck 1992), though Forshaw (1962) claimed young from second brood sometimes spend winter with parents.

Breeding dispersion Solitary. At two sites in Adelaide, nests spaced 34 m (15; 7 nests) and 37 m (25; 10) apart (Penck *et al.* 1995); at Armidale, NSW, nests 60–100 m (n=3) (Aslin 1978); near Sunny Corner, NSW, 12–14 nests in 8 ha (Stokes 1974b). Spacing may be enforced as hollows near occupied nests often unused (Aslin 1978; Penck 1992; Penck *et al.* 1995), and pairs observed defending more than one hollow (Krebs 1997). **Territories, Home-ranges** Pairs defend small territories round hollow during breeding season, and try to prevent other pairs prospecting in territory and often fight with neighbours; in non-breeding season, wander more widely but still visit nest-site (Krebs 1997). Brereton (1971a) suggested individuals, pairs and groups have loosely defined, permanent, all-purpose home-ranges that overlap with others and that agonistic behaviour only occurs if birds meet at preferred sites. Use of areas within home-range can alter through year (Brereton 1971a; Aslin 1978; Krebs 1997). Movements increasingly restricted to area round nest as breeding season approaches, and conflicts become both more frequent and more intense. Pairs display aggressively in area close to nest-hole, particularly if other Rosellas come near (Brereton 1971a; Aslin 1978); others driven off from area around nest-hole (Cohn 1928; Stokes 1974b; Penck 1992). Nest-holes re-used (Barrett 1949; Forshaw 1962; Aslin 1978; Lenz 1988; Torcello 1990; Forshaw), by same or different pairs in consecutive seasons (Krebs 1997). Area of home-range not determined, but most sightings of tagged birds close to banding site (Lenz 1988; Vogels 1996; see Movements: Banding). Adults with young said to stay mostly near nest for c. 2 weeks after fledging (Lenz 1988).

Roosting Nocturnal. Birds go to roost just before last light (Aslin 1978); by sunset in autumn and winter (earlier, relative to time of sunset, in winter than in autumn) (Magrath & Lill 1983). Leave roost about sunrise (Magrath & Lill 1983; Torcello 1990); first sign of activity 15 min before sunrise (Magrath & Lill 1983); once, when with young, left roost before dawn (Aslin 1978). Mated pairs roost together except when nesting, when female spends night in nest-hole and male in nearby tree. During autumn and winter use horizontal perches in dense foliage (Magrath & Lill 1983). In morning and evening, bask on exposed perches, often dead trees and at tip of nearly vertical branches (Aslin 1978; Torcello 1990). During hottest part of day, loaf in shade of inner foliage of trees or shrubs (Forshaw); do not loaf in canopy on cold mornings (Magrath & Lill 1983). Main rest period round midday in summer, early morning in winter (Torcello 1990); overall increase in resting in winter compared with autumn, particularly in early morning (Magrath & Lill 1983). When loafing, bird settles body onto perch, ruffles feathers, pulls neck in, tucks one foot into feathers and partly closes eyes or slowly opens and closes them; if basking, face into sun. Roosting posture similar, except head turned back over shoulder and bill tucked into scapulars.

SOCIAL BEHAVIOUR Account based mainly on studies in wild at Armidale, NSW, and in captivity (Aslin 1978); other major studies at Armidale, NSW (Vogels 1996), Black Mt, ACT (Krebs 1997), and Adelaide, SA (Penck 1992; Penck *et al.* 1995); Vogels (1996) not available for summary here but some information included. Much behaviour similar to that of Eastern Rosella (Aslin 1978; Penck 1992; Vogels 1996). At

Armidale, in early morning, adults tend to gather in groups of 6–8 in one tree and perform Congregation Display, chase one another, and call for short time before moving on to other activities together, mostly feeding on ground. Individual pairs then separate and spend most of day alone before joining other birds in afternoon for more feeding on ground; Congregation Displays become more frequent in late afternoon. During breeding, pairs spend even more time away from other pairs. Groups of subadults tend to remain together throughout day and interact often, particularly brief chases, display flights and aggressive calls. Bathe in shallow standing water, beating wings to splash water onto back (Aslin 1978); may bathe in parties of 6–9, with at least one bird staying in tree; spend more than 1 min in water before moving to trees to preen (Vellenga 1965). When excited, males said to fly with stiff-winged, slow, erratic wing-beats accompanied by harsh, alarm-like calling (Aust. RD). Unusual in that most individuals of subspecies *elegans* use right foot to hold food (77%; n=90). Individuals of *flaveolus*, however, use left foot (100%; n=6) (Rogers 1980).

Agonistic behaviour In wild, aggression appears largely ritualized (Aslin 1978), though fights observed early in breeding season (Krebs 1997); agonistic interactions 9–11% of activity in breeding season (Aslin 1978; Penck *et al.* 1995; see also Schmidt 1984; Hutchins & Lovell 1985; Forshaw). Aggressive contact reported or observed much more commonly in captive birds. Individual distance varies between individuals, their environment and activity. **THREAT DISPLAY:** Partially spread feathers of tail, lift wings slightly, raise head with slight arching of neck and wag tail from side to side; accompanied by loud twittering and clattering of beak. Given in several contexts; most often in breeding season, by mated pair near nest-tree, particularly in response to other Rosellas coming near (Aslin 1978). In conflicts that escalate, birds become increasingly aggressive and calls can be given often (Penck 1992). **CONGREGATION DISPLAY:** Similar in form to Threat Display; several birds gather, perform display and call in same or adjacent trees. Congregation Display often accompanied by **DISPLAY FLIGHTS:** Make short fluttering flights, with tail splayed, from branch to branch; may displace other birds and may also lead to short chases. Other individuals attracted to Congregation Displays. **Attack, Fighting** In wild, birds will fly at each other while displaying and calling (Penck 1992), and have been observed in early breeding season to fight with bills and claws interlocked (Krebs 1997). In captivity: aggressor lunges, bites at and chases others; attack stops if victim flees; fighting can occur between members of opposite sex (Aslin 1978). Fighting can also occur in very confined areas (e.g. traps): aggressor pins other bird to ground on its back and bites at it; victim flails with wings (Aslin 1978). Defend nest-holes simply by displacing intruders (Cohn 1928; Stokes 1974b). **Hierarchies** Based mainly on studies of captive birds. Adult males tend to be dominant and aggressive (Aslin 1978; Johnston 1993); mated pairs more dominant than unmated birds; female rank enhanced by pairing with dominant male. Status of subadult and smaller birds lower than larger, older and more brightly coloured birds (Aslin 1978; Magrath & Lill 1985). In captivity, dominant birds move round with more freedom, subordinate birds giving way at their approach; birds in middle of hierarchy often avoid each other. Dominant bird may chase subordinate if it does not move off when approached. One subordinate bird continually tried to move close to a dominant pair, which caused pair to be aggressive to it. Lowest bird in hierarchy sometimes chased by all others and spent much time on least preferred perch. Hierarchy maintained without frequent overt aggression. Extremes of

rank appear well defined, but status of intermediates not so clear and conflicts tend to be two-sided. In captive study of dominance interactions during breeding, dominant females attempted to prevent subordinate females from breeding by destroying their eggs (Vogels 1996). On Black Mt, ACT, during 2-year study of wild birds (Krebs 1997), 31 cases of destruction of eggs in nest-boxes. **Alarm ALERT POSTURE:** Bird perches with legs slightly flexed, body upright, plumage sleeked, and looks round constantly; may tilt head to one side if listening to calls from others. Warning calls and, possibly, flashing of blue patches in wing probably alert groups to predators. Alarm calls given when bird flushed; others taking flight usually give same call. Groups of three or more usually took flight if one gave alarm call, but pairs perched in trees do not necessarily react to others flying past in alarm. If groups attacked by goshawks *Accipiter*, scatter in all directions calling loudly, but do not react to goshawks flying over (Aslin 1978). Birds whose mates trapped, wheel and call close by. One group of c. 30 observed mobbing a Southern Boobook *Ninox novaeseelandiae* (E.A. Krebs). Agonistic interactions, usually over nest-holes, occur with other rosellas and Rainbow Lorikeets *Trichoglossus haematodus*; also with Red-rumped Parrots *Psephotus haematotus* when feeding (Penck *et al.* 1995). Often chased by Red Wattlebirds *Anthochaera carunculata* and Noisy Miners *Manorina melanocephala* and chased by and chase Australian Magpies *Gymnorhina tibicen* but always retreat from attacking Pied Currawongs *Strepera graculina* (Aslin 1978; Penck 1992). Can be driven from nest-holes by Common Starlings *Sturnus vulgaris* (Lenz 1988), Common Mynas *Acridotheres tristis* (Pell & Tidemann 1997), more usually only in urban areas or edge habitats (E.A. Krebs). Once Sugar Glider *Petaurus breviceps* and once Common Ringtail Possum *Pseudocheirus peregrinus* destroyed eggs and took over hollow; and feral bees *Apis* can take over hollows (E.A. Krebs).

Sexual behaviour Courtship **COURTSHIP DISPLAY:** Sitting on branch near female, male thrusts shoulders forward, drops wings slightly to expose raised feathers of rump, puffs out feathers of breast, and holds head high and tilted back or slightly bowed; male fans tail and wags it sideways in quick, agitated manner; display accompanied by almost incessant chattering (Forshaw); female said to respond with similar but less intense display (Aust. RD). In captivity, some males coming into breeding condition will chase mates (Schmidt 1991). **Courtship feeding** Usually members of pair approach each other; otherwise male approaches female, while both perched on branch. Male feeds female by bill-to-bill regurgitation, male pumping neck with each regurgitation; two or three separate regurgitations in each feed. When female incubating and brooding, male approaches nest furtively and perches nearby and calls softly (Aslin 1978; Forshaw); female emerges from nest-hole and pair fly to nearby tree where male feeds female 8–12 separate regurgitations before both birds move off to feed elsewhere (Aslin 1978); in captivity, female can also be fed at entrance to nest (Johnston 1993). Female observed to beg from male during laying, and when feeding young chicks (E.A. Krebs) *contra* female does not give food-begging call (Aslin 1978; Forshaw). **Allopreening** Does not occur (Aslin 1978). **Maintenance of pair-bond** Defence of nest probably serves to reinforce bond. **NEST-HOLE INSPECTION:** Appears ritualized and involves calling and displaying. Both birds fly to perches near hole and sit twittering quietly; give loud aggressive twittering and Tail-wagging Display (undescribed) if other birds approach or call nearby, or if loud noises heard. While male continues twittering, female flies to entrance, perches on trunk of tree and

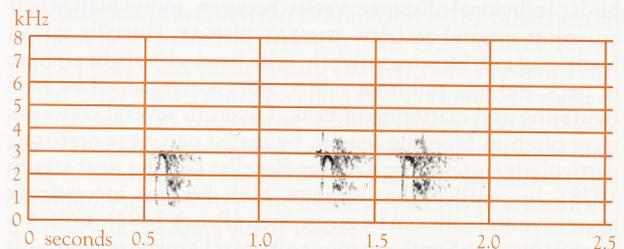
looks inside; peers in and out of hole for <10 s before going inside for 1 min or more, occasionally reappearing at entrance. She then exits and flies to perch nearby; male then similarly inspects hole but may not peer in and out of hole. After male emerges, female may revisit hollow, and this pattern of alternating inspections may be repeated several times. Occasionally female may tap bill against trunk, usually moving it in an arc above entrance of hole. Both repetitive peering and tapping of trunk appear to be stereotypic (Aslin 1978). In ACT, inspections occur all year, but especially from Aug. to Nov., and pair often inspects several different adjacent holes repeatedly (E.A. Krebs). **Copulation** Once, female flew to another perch and was followed by male; pair moved close together and male fed female with four regurgitations, then both wiped their bills on branch. Male waved neck back and forth and sidled back and forth on branch. Moving closer, he nudged side of female and then mounted. During copulation, male flapped wings and wagged tail and gave soft calls which become louder as he almost fell off; after 25 s, male dismounted and moved off along branch. Initial approach to dismounting took 2–3 min.

Relations within family group **BROOD REDUCTION:** Chicks hatch asynchronously within broods, so that chicks differ in size and age. Last-hatched chicks more likely to die than first-hatched chicks; 42% (22/52) of all observed chick mortality occurred within 1–2 days of hatching, and all were last-hatched chicks; these chicks were never fed. However, at other nests, adults often observed to seek out and feed small chicks, which suggests that females deliberately reduced size of brood under some circumstances (E.A. Krebs). By time male assists with feeding, nestlings are left alone during day except for feeding visits, but female returns just before last light to spend night on nest. Fledgelings follow parents and beg (Penck 1992). **BEGGING:** Newly hatched young give weak cheeps and do not beg consistently till eyes are open (at c. 4 days old); female typically initiates feeding by nuzzling chicks with her bill. Once chicks mobile and eyes open, they begin to beg when parent initiates feeding, with intensity of begging increasing during feed. Intensity of begging increases with age: by about 3 weeks old, beg before parent enters hollow, probably in response to soft contact call of parent; but never observed to beg constantly (Krebs 1997; cf. Aslin 1978). Chicks give piercing Begging Call, and bend head back and under that of parent; often flap wings. Begging does not always lead to feeding (Aslin 1978). In captivity, male will attempt to drive young away once independent, especially young males (Schmidt 1984; Johnston 1993; Forshaw). **Anti-predator behaviour of young** Gave continuous buzzing alarm call in nest when disturbed by treecreepers near entrance. **Parental anti-predator behaviour** Adults cautious round nest (Stokes 1974a). Male will sit near nest-hole and give alarm calls to mate on nest (Forshaw 1962; Stokes 1974a) and both may then fly off together; if they do fly off, return to nest slowly, pausing often for up to 5 min (Stokes 1974a; see also Lenz 1988).

VOICE Detailed short-term studies at Armidale, NSW (Aslin 1978) and Adelaide, SA (Penck 1992). Latter compared calls with Eastern Rosella. Early studies gave repertoire of 20 calls (Brereton 1971a) or 21 calls (Brereton 1971b), but none were fully described. Aslin (1978) lists 21 adult calls (and many variants), provides sonagrams for ten, and describes one nestling call. Penck (1992) recognized only ten different calls, and included sonagrams of each. Noisy; calls variously described as mellow, ringing, brassy, piping and shrill (e.g. Pizzey 1980; Forshaw). Calls generally similar to those of other rosellas. All

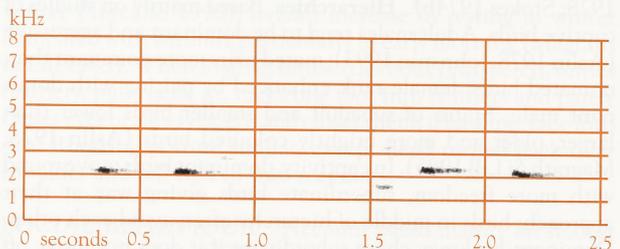
calls said to be deeper in tone than those of Eastern Rosella (Forshaw); lower pitched and less 'tinny' in quality than similar calls of Eastern Rosella (Aslin 1978). However, in SA, said that no such difference audible in calls of Adelaide Type and Eastern Rosellas (K.J. Sanderson). Piping described as intermediate in quality between piping calls of Eastern Rosella and rounded bell-like notes of Australian King-Parrot *Alisterus scapularis* (Aslin 1978). Calling described as often contagious; alarm or flight calls usually repeated by others after taking flight; aggressive twittering calls (see below) usually taken up by others hearing them, and piping calls often answered with same or similar piping calls producing duets, sometimes lasting several minutes (Aslin 1978). Calls of young often distinctly squeaky, imperfect, and often given *sotto voce* (Aslin 1978). Some information on diurnal variation in rate of calling given by Aslin (1978). Mimicry not reported in wild. **NON-VOCAL SOUNDS:** Make loud clattering of bill during Threat Display. Female taps tree-trunk with bill during inspections of nest-holes. Ruffling of feathers audible in some displays.

Adult Calls described by Aslin (1978) and Penck (1992) not easily reconciled, and summaries of each given separately, those of Aslin first. Function not known unless stated. (1) **CHALK CALL** (=Screech of Penck 1992) (sonagram **A**): Harsh usually loud screech with guttural, rather than metallic, quality; often given as couplet but can be given singly or repeated.



A W.M. Flentje; Mt Alexander, Vic., July 1988; P40

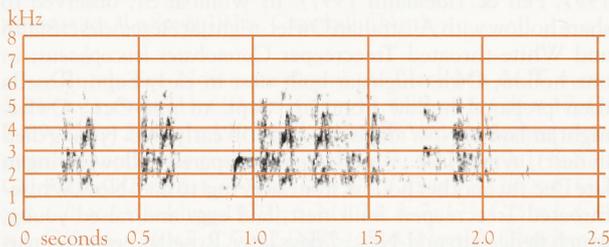
An alarm call. Usually given just before taking flight or during flight and invariably when flushed. When perched often given as a single softer call, even as a plaintive *cheep*. (2) **CHALK-PRETTY:** Typical Chalk Call followed by whistling note that ascends in pitch. Similar variants include *chalk-chalk-pretty-pretty* and *ch'pretty* when first part of call is abbreviated. (3) **PRETTY:** Single note call; variant *pretty-pretty*. (4) **PIPING CALLS:** Aslin describes ten calls that include piping notes that probably serve to locate the individual; piping calls shown in sonagram **B**. (4a) Piping *who-he-who*. Usually first and third notes of same pitch and second note higher in pitch, though third sometimes a little higher than first. Pitch, tempo and quality vary greatly.



B W.M. Flentje; Warburton, Vic., June 1982; P40

Usually melodious but may have squeaky-gate quality when second note higher than usual. Several variants also recognized: *cl' who-he-who*, in which call prefixed by a brief resonant

note; *whoee-oo*, with first and second notes run together; *who-he*, consists of only first and second notes, second higher pitched than usual. Most common and familiar of this large category of calls. Suggested to function in individual location and identity. (4b) *Pee-pee*; two piping notes of same pitch; also similar *pee-ee* with the two notes not so sharply distinct; probably used to indicate location of individual. (4c) *Pee-pee-pee*; three piping notes of same pitch; tempo varies, with first two or last two syllables almost run together and a variant *pee-pee-hee-pee* with brief penultimate piping note. Probably used to indicate location of individual. (4d) *Cl'-pee-pee*; has same prefix as one variant of *who-he-who* call (4a) followed by two piping notes of same or slightly lower pitch; also *cl'-pee-ee* with two piping notes not so sharply distinct. (4e) *Cl'-pee-pee-pee* with three piping notes; also *cl'-pee* when prefix is followed by single, often very loud and penetrating pipe, usually pitched slightly or occasionally much higher than prefix. (4f) A single piping note *pee*. (4g) *Hee-pee-pee* of three piping notes of approximately equal duration, first note higher pitched; also have variant *hee-pee* with only first two notes. (4h) Penetrating *cl'-cl'* call of two brief resonant notes with variants, *cl'-cl'-cl'* (uncommon) and *cl'*. (4i) A descending piping *pee-oo* with several variants; *peoo-oo* when last part is repeated, *peoo-peeoo*, *cl'-peeoo* and *cl'-cl'-peeoo*. (4j) A call with prefix and piping note separated by a guttural sound *cl'-uck-pee* and variant *cl'-uck-pee-ee* where piping note is drawn out, or *cl'-uck-peeoo* with piping note slightly descending in pitch. (5) AGGRESSIVE TWITTER (sonagram C): Loud, scolding, continuous twitter; often includes a loud and penetrating *p'quink-p'quink*. Often given by several birds at once. (6) CHATTER: Loud chattering sound;



C R. Buckingham; (*P.e. adelaidae*) Mt Remarkable NP, SA, Oct. 1987; P40

given during agonistic behaviour (q.v.). (7) QUIET TWITTER (named as Clatter by Aslin): Variety of soft clucking and warbling sounds: *whit-whit*, *tew-tew*, *whit-tew-whit* and *w-cheeawhit*. Given intermittently by perched birds. With increasing intensity may grade into Aggressive Twitter (see above). Suggested to function in close-range location or co-ordination of activities. **Other calls** Aslin (1978) lists five calls given by adults but of unknown purpose. (8) A repetitive and metallic sounding *twing-twing*, heard once from a perched bird late in breeding season. (9) A metallic screech, heard three times from birds in flight or perched. (10) A repetitive, plaintive, squeaky *quee-quee*, given by birds soliciting food. (11) A raucous squawk, given by frightened birds or those held in the hand. (12) A sharp single *lek*, given by birds when pursued at close quarters.

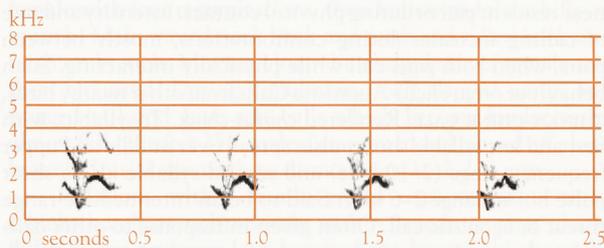
Following account based on Penck (1992). SCREECH (=Chalk Call of Aslin 1978): No phonetic rendition. Short call, with sound spread across wide frequency range. Variations include calls of different pitch, double calls and longer series of screeches. Alarm or threat call; given when frightened, in threatening situations, while flying, and during various situa-

tions of social contact. AGONISTIC CHATTER (see Chatter call of Aslin): No phonetic rendition. Call structured as continuous, alternating ascending and descending sound of low frequencies (1–5 kHz). Another threat call. Increasing intensity of Agonistic Chatter grades into full Agonistic Call (see below). Given in response to presence or calls of same or other species, and other calls often given interspersed with this call. Often given just before or after an intense agonistic encounter when again perched, and may be accompanied by tail-wagging and tail-shaking. AGONISTIC CALL: No phonetic rendition. Call uses wide frequency range and becomes more structured with increasing intensity, when individual syllables with harmonics recognizable. Intense threat call; mostly given when another bird is near resident pair or during physical contact. Intensity and rate of calling increases during confrontations, mostly between pairs, when both pairs call while physically interacting. Such behaviour often elicits Agonistic Calls from other nearby birds. CHINKA-CHINK CALL: Rendered *chinka-chink*. Trisyllabic, with first and last syllable short pulses spread over middle and upper frequency range (2–10 kHz) and second syllable also a short pulse but in range 2–6 kHz. Said to be an intermediate range threat or agonistic call. Often given in response to other calls rather than in direct agonistic contact. CONTACT CALLS: Penck (1992) lists five calls functioning as intermediate or long-range contact calls: (1) A call rendered as *du-du-du...* Call varies in length, with three or five repeated syllables most common; pitch varies, but most energy at 1.8–2.5 kHz with an upper harmonic at 7.5 kHz. Often given just after alighting in a tree, and often followed by Agonistic Chatter. As well as Contact Call, possibly serves also to signal mild threat to other birds. (2) A call rendered as *ka-di-di-di*. Call varies slightly in pitch and number of repeated syllables but has a short harsh sound preceding it. Main energy at about 2.5 kHz, with harmonics at 5, 7.5 and 9.5 kHz. Possibly derived from previous call and often given just before Agonistic Chatter. Probably indicates presence of another bird to which it is signalling a threat. (3) A call rendered as very soft *whut-whut-whut*; of low frequency; structure similar to *ka-di-di-di* call except much lower in pitch and lacking harsh syllable at start. Often given by adult in response to calling young. (4) A local variant *ka-tii ka-tii* of previous call used in one area (Mt Lofty). A repeated disyllabic call structured as short-duration low-frequency note of 1.8 kHz followed by a long-duration note at c. 3 kHz, occasionally with harmonic at c. 8.5 kHz. (5) Very rapidly repeated notes of short duration *f-r-r-r-r-r-r-r-r-r-r*. Main energy concentrated at c. 2.5 kHz with another energy band at c. 7 kHz. Considered to be an intermediate-range contact call. SOFT CHATTER: No phonetic rendition. Structured as continuous succession of ascending and descending notes, which often take form of inverted V on sonagrams. No solid or repetitive structure found, but frequency range from 1–5 kHz. Said to be used as close contact call between members of breeding pair. Given by male when female inspecting nest-hollows (see Social Behaviour).

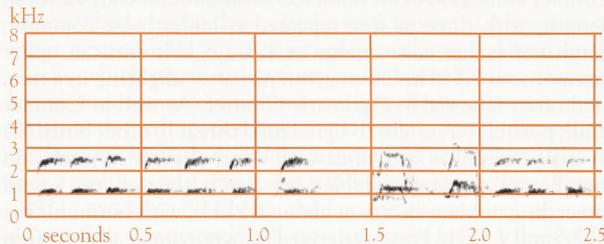
Other calls Forshaw reports a number of calls: Disyllabic *cussick-cussick*; considered a contact call and often given in flight; not known to which of Aslin's or Penck's calls this equates. Harsh shrieks in alarm; no doubt the same as Chalk Call of Aslin and Screech of Penck. Mellow piping notes resembling *kwik-kweek-kwik* or *kwik-kweek*, with an upward inflection on second note; frequently given when perched; equivalent to Piping Calls of Aslin. Pizzey (1980) also describes a mellow ringing *trip-kee* or slow bell-like *kee-kee-kee*, which he considered a contact call and which probably equivalent to Piping Calls of Aslin. Raucous brassy clanging *kee kee kee*

given in flight (Pizzey 1980) probably same as Chalk Call of Aslin and Screech of Penck.

Young FOOD-BEGGING CALL: Described as soft to loud cheeps (E.A. Krebs) or a continuously rising and falling *buzz* (Aslin 1978). Nestlings <c. 4 days old beg infrequently, with weak cheeps; after c. 4 days, beg when parent starts feeding and calls louder and stronger; by 3 weeks, beg strongly before adult enters hollow. Call changes with age (J. Courtney; E.A. Krebs). Call of downy young, with some feathers in pin, shown in sonagram D; young fledgelings shown in sonagram E. Fledgelings commonly utter repetitive plaintive squeak (R.H. Loyn; see Other calls of Aslin, number 3).



D J. Courtney; captive, Dec. 1964; priv.



E J. Courtney; captive, Jan. 1965; priv.

BREEDING Studies of nominate *elegans* (i.e. Crimson Type) at Armidale, NSW (Aslin 1978; Vogels 1996), at Black Mt, ACT (Krebs 1997), at two sites over three seasons in Wombat SF, Vic. (Golding 1979); and of *adelaidae* round Adelaide (Penck 1992); 126 records in NRS to Dec. 1995. Vogels (1996) not available for summary here, but some information included. Most information for nominate *elegans*. Hybridize with Eastern Rosella; at least one example of a pair comprising female Eastern and male Crimson (Rogan 1966; NRS); *adelaidae* reported to hybridize with mallee form of Australian Ringneck (Hutchins & Lovell 1985).

Season CRIMSON TYPE: E. Aust.: Sept.–Jan. (Forshaw); Oct. to late Jan. or mid-Feb. (North); in Wombat State Forest, Vic.: laying, late Oct. to early Jan.; mean, late Nov.; mean timing of hatching, mid-Dec.; fledging, mid-Jan. (Golding 1979); SA: eggs, early Sept. to mid-Nov. (Attiwill 1972); Norfolk I.: feathered young, early Dec. (Forshaw). In ACT, date of laying of first egg varied by 3 weeks in 4-year study; began earliest in wettest year and latest in a drought year (Krebs 1997). Subspecies *nigrescens*: eggs, late Nov. (Le Souëf 1908); young, late Sept. (Gill 1970). ADELAIDE TYPE: Sept.–Dec. (North); July–Nov. (Shephard 1989). YELLOW TYPE: late Aug. to Dec. or early Jan. (Forshaw); July–Nov. (Shephard 1989).

Site All subspecies nest in natural hollows. Nominate *elegans*: In hollow in trunk, limb, spout or stump of large tree, usually a eucalypt, but also in lilly pilly *Acmena smithii*; also in

nest-boxes, fence posts, hollow in brick wall, under roof and in chimney of buildings (Le Souëf 1908; Jackson 1920; Hyem 1936; Bryant 1938; Wakelin 1968; Beruldsen 1980; Lenz 1988; Vogels 1996; Krebs 1997; NRS). Also said to nest in holes in sides of river banks (Hutchins & Lovell 1985). From 66 records of Crimson Type in NRS: 34 (51.5%) in trunk, 8 (12.1%) in limb or spout, 6 (9.1%) in stump and 18 (27.3%) in nest-boxes. On Norfolk I.: in hollows in trees; two nests found in hollow trunks of dead Norfolk Island Pines *Araucaria heterophylla*; also in chimneys (Wakelin 1968; Forshaw). Subspecies *adelaidae*: In hollow limb or trunk of eucalypt, preferring sites surrounded by dense scrub and trees (Penck 1992); in hollow trunk of mallee (Boehm 1959). Of 17 sites round Adelaide: 8 (47%) were in dead parts of tree and 9 (53%) in living part; 5 (29%) in branch and 12 (71%) in trunk of tree (Penck 1992). Subspecies *flaveolus*: Hollow in tall eucalypt, living or dead, in or near water (Barrett 1916; North; Forshaw).

Females appear to select site (Aslin 1978). Sites used for two or more seasons by same or different pairs (Krebs 1997; NRS); but pairs tend to use different hollow in same area in successive years; in Wombat SF, some artificial hollows used in three successive seasons (Golding 1979); one site in wall-cavity said to have been used for c. 5 years (Lenz 1988). One pair nested 60 cm below hollow of Laughing Kookaburra *Dacelo novaeguineae*, in same tree (NRS). May compete for hollows with Eastern Rosellas, Galahs *Eolophus roseicapillus*, Laughing Kookaburras, Common Starlings, Common Mynas, Common Brushtail Possums *Trichosurus vulpecula*, Common Ringtail Possums *Pseudocheirus peregrinus* and Sugar Gliders *Petaurus breviceps*; and feral bees *Apis* (Hutchins & Lovell 1985; Krebs 1997; Pell & Tidemann 1997). In Wombat SF, observed to share hollow with Australian Owlet-nightjar *Aegotheles cristatus* and White-throated Treecreeper *Cormobates leucophaeus*; in one hollow, Owlet-nightjar built nest in early Sept., Rosella then prepared hollow from late Sept. to mid-Oct., Owlet-nightjar laid in Nov. and had young till early Dec. (young died in nest); in mid-Dec., Rosellas again prepared hollow, laying in late Dec.; at another hollow, from late Aug. to mid-Nov., White-throated Treecreepers built nest, laid eggs and raised young, which fledged in mid-Nov.; 7 days later, Rosellas began preparing hollow and went on to lay eggs and fledge young (Golding 1979).

Nest, Materials Eggs laid on wood debris at bottom of hollow (Boehm 1959; NRS). May occupy sites used and lined previously by other species: one hollow contained lining of sticks and feathers; another, strips of bark and wood-chips; a pair using a nest-box laid eggs on finely shredded bark from old nest of possum (NRS). Do not bring material to hollows; leaves, twigs or pieces of bark in hollows before occupation by Rosellas are broken into smaller pieces (Golding 1979; Krebs 1997). Add to debris in nest by scratching and chewing wood, rotten wood, or sometimes charcoal, from wall of hollow and from round entrance; nest-boxes chewed in 1 cm annulus round entrance; bark near opening of artificial hollow torn back up to 7 cm from edge of hole (Golding 1979; NRS). Preparation of hollow usually involves rearrangement of all loose material in nest, including shredding of previous nests, eggs or carcasses; many small feathers added to material, and material may be lost through cracks in base or side of hollow (Golding 1979). At Black Mt, ACT, only females observed preparing nest-hollow (Krebs 1997). Of 50 nest-boxes monitored in ACT, no directional preferences found, though nest-boxes with cover or branches close to entrance may be avoided (Krebs 1997; cf. Jorm 1993). **MEASUREMENTS:** Height of hollow (m): *elegans*:

10.7 (7.87; 2.4–23.0; 32); in limb or spout, 11.7 (6.10; 3.2–20.0; 7); in trunk, 7.8 (3.74; 2.4–15.0; 33); in stump, 2.1 (0.17; 2.0–2.4; 5); in nest-box, 3.9 (0.84; 3.0–5.3; 17) (NRS); *adelaidae*: at Belair, 7.4 (2.72; 4–12; 7); at Mt Lofty, 7.6 (4.6; 0–15.5; 10) (Penck 1992). Hollows may be as low as 1.5 m (Hyem 1936). Depth of hollow (cm): *elegans*: 93.4 (90.7; 30–270; 8) (Jackson 1920; NRS); in stumps, 30, 200 and 2700 (Jackson 1920; NRS); in trunk, 40, 61 and 76 (NRS); *adelaidae*: one hollow in stump, 120 (NRS). Dimensions of entrance: *elegans*: two hollows, 5 × 5 cm and 30 × 10 cm (NRS); of three hollows in NSW: two round, c. 12 and c. 15 cm in diameter; other slit-like, 25 cm deep and 8–10 cm wide (Aslin 1978).

Eggs Rounded oval to elliptical; close-grained, smooth; slightly lustrous to glossy; white, sometimes stained yellowish from wood-dust (Campbell; North). **MEASUREMENTS:** Summarized in Table 1.

Table 1

	LENGTH	BREADTH	REF
CRIMSON TYPE			
ELEGANS	29.1 (0.66; 27.9–30.0; 16)	23.5 (0.83; 22.4–24.6)	2,3
NIGRESCENS	28.0 (27.9–28.2; 3)	22.5 (21.8–23.1)	1
MELANOPTERA	27.6 (0.45; 27.2–28.2; 5)	23.6 (0.29; 23.4–24.1)	3
YELLOW TYPE			
FLAVEOLUS	27.4 (0.20; 27.2–27.7; 5)	23.1 (0.34; 22.6–23.4)	3
ADELAIDE TYPE			
ADELAIDAE	29.5 (0.70; 28.7–30.5; 7)	24.1 (0.31; 23.6–24.6)	3
SUBADELAIDAE	28.2 (0.64; 27.2–29.5; 20)	22.9 (0.46; 22.1–23.6)	2,3
FLEURIEUENSIS	–	–	–

REFERENCES: ¹ Le Souëf 1908; ² Campbell; ³ North.

Clutch-size Nominat *elegans*: At Black Mt, ACT, mean 5.23 (1.21; 3–8; 71): C/3 × 6, C/4 × 12, C/5 × 25, C/6 × 17, C/7 × 9, C/8 × 2 (Krebs 1997); Wombat SF, Vic. (including some estimated and some possibly incomplete): 3.51 (2.10; 1–8; 87): C/1 × 20, C/2 × 16, C/3 × 11, C/4 × 7, C/5 × 17, C/6 × 6, C/7 × 8, C/8 × 2 (Golding 1979); 5.2 (1.24; 3–7; 17): C/3 × 1, C/4 × 1, C/5 × 6, C/6 × 7, C/7 × 2 (NRS); 5–8 (North). Clutches in nest-boxes in 4-year-old forest averaged 1.9 eggs; those in 20-year-old forest averaged 4.0; clutch-size increased at both sites during subsequent seasons (Aslin 1978). Clutch-size significantly larger in hollows used in three successive seasons than in hollows used in one or two seasons; clutch-size smaller in hollows first occupied later in season (Golding 1979; Krebs 1997). In 4-year study in ACT, clutch-sizes varied significantly between years; largest during wettest year (1995) (Krebs 1997). Subspecies *adelaidae*: C/2 × 1, C/5 × 1, C/6 × 1 (NRS).

Laying At Black Mt, ACT, eggs laid at mean interval of 2.1 days (0.1; 1–4; 37) (Krebs 1997); at Wombat State Forest, Vic., 1 or 2 days (Golding 1979). In captivity, eggs appear to be laid every second day; hatching asynchronous (Terrill 1931); will double-brood (Shephard 1989).

Incubation By female only (Aslin 1978; Forshaw). Male feeds female, who leaves hollow to be fed (Aslin 1978); female leaves nest in morning and in late afternoon to feed with and be fed by male (Forshaw). Unhatched egg still in nest after young fledged (Rogan 1966). At Black Mt, ACT, onset of incubation varies, but often starts with third egg (Krebs 1997). In captivity, incubation may begin when clutch half to two-thirds complete (Terrill 1931). Clutches hatch asynchronously over 3.6 days (0.2; 0.5–7; 46); not strongly correlated with size of clutches or broods, but asynchrony increased over breeding

season (Krebs 1997). **INCUBATION PERIOD:** At Black Mt, for birds breeding in nest-box, last laid to last hatched averaged 19.7 days (0.4; 16–28; 28) (Krebs 1997); 19 days (Forshaw); estimated 23.3 ± 2.4 days (Golding 1979). In captivity, c. 21 days (n=2) (Terrill 1931). At Black Mt, mean laying interval decreased over breeding season (Krebs 1997).

Young Altricial, nidicolous. At hatching, chicks covered in white down and eyes closed; eyes open at c. 4 days; primaries emerge at c. 8 days (Golding 1979; Krebs 1997). **Growth** Rate of growth varies greatly between broods, but last-hatched chicks do not grow more slowly than first hatched, despite 500% difference in weight at hatching. Mean weight at hatching, 7.0 g (0.1; 109); maximum weight attained, 163 g. Mean weight at fledging (≥28 days): males, 138.5 g (2.9; 30); females, 123.4 g (2.3; 40). Mean wing-length: at 1 day old, 10.0 mm (0.1; 101); at fledging, 133.5 mm (1.7; 71); no significant differences in wing-length between sexes at or near fledging (Krebs 1997).

Parental care, Role of sexes Female broods and feeds chicks for about first 6 or so days after hatching; thereafter, both parents feed young; chicks fed by direct bill-to-bill regurgitation from crop. Feeding rates increase up to about Day 15 and then decrease. Mean number of feeds by either parent over 12 h period of observation: 9.3 visits/12 h (0.6; 26) (Krebs 1997). At Armidale, NSW, during a 14 h period, one pair visited hollow seven times; intervals between feeds (min): 127.5 (87–210; 6), shortest in morning, longest in early afternoon; time spent in hollow (min): female, 4.5 (3–7; 6); male, 3.5 (2–5; 6); female roosted in hollow at night (Aslin 1978). Once, two adults and bird in immature plumage observed attending a nest (NRS). Young of one pair fed occasionally by an Eastern Rosella (Jorm 1993). Adults perform no nest sanitation (E.A. Krebs).

Fledging to independence **FLEDGING PERIOD:** 32–34.2 days (Aslin 1978); c. 5 weeks (Forshaw); estimated interval between hatching and fledging, 33.1 ± 3.4 days (Golding 1979). In captivity, c. 30 days (Terrill 1931). After fledging, young actively and noisily solicit food from parents and continue to be fed for unspecified period, but probably no more than 4 weeks (Aslin 1978); young dependent on parents for food for several weeks after fledging (Penck 1992). Remain with parents for a few weeks, then, with other subadults, form post-breeding flocks (Forshaw).

Success In **WOMBAT SF:** at Korweinguboorra site, from 142 eggs in 50 clutches, 39 (27.5%) hatched, 21 (14.8%) fledged, which equals 0.42 fledged per clutch; at Specimen Hill site, from 178 eggs in 38 clutches, 69 (38.8%) hatched, 55 (30.9%) fledged, which equals 1.45 fledged per clutch; of 212 eggs that failed, 73.6% were destroyed and 26.4% were abandoned; clutches of 1–3 often destroyed soon after laying; reasons for destruction of eggs not known. In Wombat SF, hatching success higher in clutches of 5–8 than in clutches of 1–3; 86% of all fledgelings originated in hollows used in three successive seasons (Golding 1979). At **BLACK MT, ACT:** of 375 eggs in 71 nests, 66.3% hatched and 50% fledged, which equals 3.6 ± 0.2 young hatched and 2.4 ± 0.2 young fledged per breeding attempt, or 4.1 ± 0.2 young fledged per successful breeding attempt (Krebs 1997). The most common source of breeding failure was destruction of eggs by other Crimson Rosellas: for 52 nests that failed during egg-stage, 31 (59.6%) were destroyed by other Crimson Rosellas, 6 (11.5%) were eaten by mammals, 2 (3.8%) were abandoned, and 13 (25%) failed for unknown reasons. Hatching success varied over 4 years, and was highest in wettest year and lowest in driest year. Proportion of eggs hatched did not vary with differences in clutch-sizes. Hatching failure common in nest-boxes (34% of eggs in completed clutches)

(Krebs 1997). **THROUGHOUT RANGE:** from 31 eggs in six nests, 14 (45.2%) hatched, 13 (41.9%) fledged, which equals 2.3 young hatched and 2.2 fledged per nest (NRS); fate of eggs for 11 nests that failed at egg-stage: 7 (63.6%) deserted, 3 (27.3%) damaged and one (9.1%) gone (NRS). At Armidale, only eggs from clutches of two or more ever hatched; only nestlings from clutches of four or more fledged; hatching success highest for clutches of six; percentage fledged increases with number of chicks hatched (Aslin 1978). At one nest, young died in nest after adult taken by predator (NRS). Nests abandoned when bees take over hollow (Krebs 1997; NRS); once, Laughing Kookaburras removed eggs of Rosellas and took over hollow (Hutchins & Lovell 1985).

PLUMAGES Prepared by A.M. Dunn. Fledge in distinctive juvenile plumage. Undergo partial post-juvenile (first pre-basic) moult to immature plumage at 6–12 months of age. Then undergo first immature post-breeding (second pre-basic) to adult plumage. Thereafter, undergo a complete post-breeding (pre-basic) moult each cycle, producing successive adult plumages without change in appearance. Sexes differ slightly in some subspecies. Seven subspecies; *elegans* and *flaveolus* most divergent forms and each age of these described below; other subspecies discussed in Geographical Variation.

Adult male (Second and subsequent basic). **NOMINATE ELEGANS:** **HEAD AND NECK:** Most of head and neck, crimson (108) with concealed dark-grey (83) to grey-black (82) bases to feathers. Large patch of feathers on nape with concealed white bases. Cheeks, sides of throat and foreneck, violet (71) with concealed dark-grey (83) bases to feathers, forming large prominent cheek-patch. Scattered feathers on upper throat, dark grey (83). **UPPERPARTS:** Feathers of mantle and scapulars, grey-black (82) to black (89) with red (12) to crimson (108) fringes about 2 mm wide; sometimes have bluish (c170) subterminal fringes or edges. Feathers of back, rump and uppertail-coverts, red (12) to crimson (108) with concealed dark-grey (83) bases, separated from crimson of feathers by narrow pale-blue (168D) band. **UNDERPARTS:** Wholly red (12); concealed bases to feathers, grey (84) to light grey (85). **UPPERTAIL:** T1, mostly dark violet (c72) but appears much darker from some angles; dark wash near base of inner webs appears greenish from some angles. T2, dark violet (c72) on outer web, black-brown (119) on inner web. T3–t6, light violet (c170D) with diffuse white tip and mostly concealed dark base, which is black-brown (119) with dark-violet (c72) outer edge. **UNDERTAIL:** T1 and t2, dark grey (83), sometimes with pale bluish-grey (c86) edges on tips of t2. T3–t6, mostly light violet (c170D) with white tips and concealed dark-grey (83) bases. **UPPERWING:** Marginal coverts, anterior row of lesser secondary coverts (bordering marginal coverts) and rest of outer lesser secondary coverts near carpal joint, violet (71). Rest of lesser secondary coverts, black (89). Inner median secondary coverts, inner greater secondary coverts and innermost secondaries (tertials), black (89) with red (12) edges; some have narrow grey-olive (c43) subterminal edging. Outer median secondary coverts, grey-mauve (c77); outermost greater secondary coverts, grey-mauve (c77) with concealed grey-black (82) inner web; central greater secondary coverts, violet (c71) with grey-black (82) inner edge and narrow grey-mauve (c77) outer edge. Lesser and median primary coverts, violet (c71) with dark-grey (83) bases. Alula and greater primary coverts, dark violet-blue (72–74) with grey-black (82) inner web and tip. Primaries and outer secondaries, mostly grey-black (82) with mostly dark violet-blue (72–74) outer web except for tips of feathers; outer five primaries have very fine off-white edge to

middle of outer web. **UNDERWING:** Lesser and median coverts, violet (71) with mostly concealed grey (84) bases to feathers. Greater coverts and remiges, dark grey (83).

SUBSPECIES FLAVEOLUS: **HEAD AND NECK:** Band across lower forehead, red (12). Large cheek-patch, violet (71) with concealed grey (84) bases to feathers, as in *elegans*. Rest of head and neck, pale yellow (c157) with concealed dark-grey (85) bases to feathers; all feathers, except on crown and upper forehead, have very fine grey-black (c82) fringe at tip. Feathers of foreneck, lores and feathers below eye, often faintly washed orange-red (c15). **UPPERPARTS:** Pattern similar to *elegans* but crimson or red of feathers of mantle, scapulars and back replaced with very pale yellow (pale 157), and crimson or red of rump and uppertail-coverts replaced with pale yellow (c157). **UNDERPARTS:** Wholly pale yellow (c157), often with very fine black (89) fringes at tips of feathers that are only evident in the hand and probably disappear with wear. Feathers of breast and belly sometimes faintly washed orange-red (c15) or burnt orange (c116). **TAIL:** Similar to *elegans* but with a strong straw-yellow (c57) suffusion to base and inner web of upper side of central rectrices (t1). **UPPERWING:** Similar to *elegans* but red edges to secondary coverts and tertials replaced with very pale yellow (pale 157). **UNDERWING:** Similar to *elegans*.

Adult female (Second and subsequent basic). **NOMINATE ELEGANS:** **HEAD AND NECK:** As adult male. **UPPERPARTS:** Much individual variation. Typically similar to adult male but most differ slightly; at least some probably not separable by coloration of upperparts. Typically, most feathers of mantle and scapulars have greenish subterminal edges and most feathers of back, rump and uppertail-coverts have concealed greenish or bluish subterminal fringe; colour of green areas varies individually, usually grey-olive (43), pale green (c162D) or lime-green (c59). **UNDERPARTS:** As adult male. **UPPERTAIL:** Similar to adult male but with large greenish area to base of central rectrices (t1): basal half to two-thirds, dark olive (46–49) grading to dark violet (c72) toward tip. **UNDERTAIL:** As adult male. **UPPERWING:** Much individual variation, as with upperparts. Typically similar to adult male but differ slightly; at least some probably not separable on coloration of upperwing. Typically, tend to have broader greenish subterminal edging to inner greater secondary coverts and innermost secondaries (tertials). **UNDERWING:** Similar to adult male but usually have indistinct off-white underwing-bar on central primaries, formed by narrow indistinct off-white spot or partial bar in middle of outer web of p5–p8; spots often present only on 1–3 primaries between p5 and p8. Occasionally secondaries and inner primaries have small narrow spot or partial bar; some birds have no underwing-bar.

SUBSPECIES FLAVEOLUS: Similar to adult male *flaveolus*, but many probably identifiable as female by presence of underwing-bar: at least some adult females have indistinct off-white underwing-bar on central primaries (p5–p8), similar to that of adult female *elegans*.

Downy young **NOMINATE ELEGANS, SUBSPECIES FLAVEOLUS:** Covered in white down at hatching (Krebs 1997); in white down by c. 7 days old (Golding 1979).

Juvenile **NOMINATE ELEGANS:** Description based on skins from s. end of range. Juveniles from se. Qld possibly similar to juveniles of subspecies *nigrescens* and hence redder than those described below and possibly more similar to adult than juveniles in S of range. However, no material from se. Qld available to examine this possibility. **HEAD AND NECK:** Forehead and most of crown, crimson (108), often with very narrow pale-yellow (c157) or pale-green (c161) fringes to feathers of crown. Nape, hindneck, sides of neck and sides of crown above eye, bright

olive-green (ne). Lores, narrow supercilium, and feathers below and behind eye grade from olive-grey (c42) on lores to green (c63) behind eye. Cheek-patch, as in adult, violet (c71). Moustachial stripe, crimson (108) to red (12); extends round edge of cheek-patch to join red (12) lower foreneck. Chin, unfeathered or with scattered small grey (84) feathers. **UPPERPARTS:** Mantle, scapulars and back, bright olive-green (ne) with grey (84) bases to feathers. Rump and uppertail-coverts, yellow-olive (ne) with concealed grey (84) bases; occasionally, longest uppertail-coverts have broad crimson (108) subterminal fringes. **UNDERPARTS:** Upper edge of breast, red (12) with scattered red or red-tipped feathers sometimes extending to lower breast. Middle and lower breast and most of belly and flanks, pale green (c162D) with bright yellow-olive (ne) fringes to feathers; fringes very broad at sides of breast, belly and along flanks, narrower or none on central breast and belly. Lower edge of belly has scattered red (12) or red-tipped feathers. Feathers of thighs, vent and undertail-coverts, red (12) with narrow pale-yellow (c157) or pale yellow-green (ne) fringes. Amount of red on underparts varies greatly between individuals; in most it is confined to upper breast and lower belly, vent and undertail-coverts; occasionally it may cover most of underparts, leaving only a small area of green on upper belly. **UPPERTAIL:** Central rectrices (t1), dark olive (c46), often with dark red-brown (132) suffusion at edges. T2, mostly dark bluish-green (ne) with dark-blue (c74) outer edge near tip and black-brown (119) inner edge. Rest of rectrices, t3–t6, as adult male. **UNDERTAIL:** As adult male. **UPPERWING:** Most lesser, median and greater secondary coverts, bright olive-green (ne) with dark-grey (83) bases; marginal coverts, outer lesser secondary coverts near carpal joint and outer median secondary coverts, violet (c71) to light violet (c170C); outer greater secondary coverts have blue or violet tinge. Lesser and median primary coverts, violet (c170B) with grey (84) bases. Alula, greater primary coverts and primaries, similar to adult male. Secondaries, mostly dark grey (83) with bright yellowish olive-green (ne) outer edge. **UNDERWING:** Lesser coverts, brownish grey (79) with violet (c71) tips. Median coverts, violet (c170B) with brownish-grey (79) bases and very narrow yellowish-white (ne) tips. Greater coverts, brownish-grey (79). Primaries and secondaries, dark brownish-grey (dark 79) with broad yellowish-white (ne) underwing-bar across inner primaries and outer secondaries, formed by large, rather square and well-defined spot in middle of inner web of inner primaries (p1–p8) and outer secondaries (s1–s6); bar c. 1 cm thick.

SUBSPECIES FLAVEOLUS: **HEAD AND NECK:** Band across lower forehead, burnt orange (116) or orange-red (15). Cheek-patch slightly paler than in adult. Rest of head and neck, straw-yellow (57) to yellow-olive (52) with very fine grey-black (82) fringes to tips of feathers. **UPPERPARTS:** Mantle and scapulars vary individually: yellow-olive (c52) to olive-green (ne) with brownish-grey (79) bases to feathers. Back, rump and uppertail-coverts, olivaceous yellow (ne) to yellow-olive (c52) with concealed grey (84) bases to feathers. **UNDERPARTS:** Wholly very pale yellow (pale 157); on some, a few feathers of breast have blue tinge and some have a few scattered feathers on upper breast suffused with orange (16). **UPPERTAIL:** T1 and t2 much yellower than in adult (ne); outer rectrices appear duller or washed out when compared with adult. **UNDERTAIL:** Paler than in adult. **UPPERWING:** Similar to juvenile *elegans* but much paler, and olive-green areas of wing much yellower (ne). **UNDERWING:** Similar to that of juvenile *elegans*.

Immature (First basic). **NOMINATE ELEGANS:** Varies greatly; some close to adult, some very similar to juvenile, most

fall between these extremes and described below. Cannot be reliably sexed on plumage. Many immature females probably inseparable from adult female; some immature males separable from adult male by presence of underwing-bar. **HEAD AND NECK:** Similar to adult male, but feathers of crown, hindneck and sides of neck often have very narrow black (89) or pale-yellow (ne) fringe or have very narrow black (89) fringe and pale-yellow (ne) subterminal fringe. **UPPERPARTS:** Feathers of mantle and scapulars, grey-black (82) with very narrow pale-yellow (c157) fringe at tip bordered proximally by red (12) fringe which itself is bordered proximally by light-blue (168C) submarginal line that grades to bright olive-green (ne) basally and, in some, expands to basal edge. Back, rump and uppertail-coverts, red (12) or crimson (108) with narrow yellow (c55) fringes at tips of feathers. **UNDERPARTS:** Wholly red (12) with fine yellow (c55) or pale-yellow (c157) fringes at tips of feathers, which are probably lost with wear. **TAIL:** Retained from juvenile. **UPPERWING:** Contains mixture of retained juvenile and new first basic feathers; proportion of new to old feathers varies greatly between individuals. Most new coverts similar to adult male *elegans*, but inner lesser, median and greater secondary coverts of some individuals, grey-black (82) with dark-green (c260) fringes; on many of these feathers, green fringe bordered on inside by red (12) fringe or line, and some feathers have light-blue (c168) suffusion below red marking. Remiges retained from juvenile. **UNDERWING:** Remiges retained from juvenile and thus have underwing-bar on primaries.

SUBSPECIES FLAVEOLUS: Mostly similar to adult male, but retain juvenile remiges and rectrices and sometimes retain some juvenile upperwing-coverts, thus show pale underwing-bar found in juveniles.

Interspecific hybrids Can hybridize with Eastern Rosella in wild (see Eastern Rosella for description). Subspecies *adelaidae* reported to hybridize with mallee form of Australian Ringneck in wild (Hutchins & Lovell 1985). Hybrids with other species listed in Gray (1958), but probably from captive birds.

BARE PARTS Based on photos (Robinson 1970; Wade 1975; Lindsey 1992; Trounson & Trounson 1994; Flegg & Madge 1995; Aust. RD; Crome & Shields; unpubl.: J.N. Davies; R. Davies), museum labels (MV) and published information. No obvious differences between subspecies. **Adult** Bill, pearl-grey (81). Cere, grey-black (82). Iris, black-brown (119); also reported as dark brown (MV). Orbital ring, grey-black (82). Legs and feet, light grey (c85) or grey (84). **Downy young** Bill said to be buff (Aust. RD). No other information. **Juvenile** Bill, yellow-brown (c123C) at fledging, quickly darkening to adult coloration; or pale horn with pinkish tinge to lower part of upper mandible (Rogers *et al.* 1986). Cere, light grey-brown (c27); or yellow (Rogers *et al.* 1986). Gape, yellow palate, white (Rogers *et al.* 1986). Iris, dark brown (121) or black-brown (119); brown (MV). Orbital ring and periophthalmic ring, brownish grey (79) or grey-green (ne). Legs and feet, grey, probably lighter than adult when newly fledged. **Immature** As adult.

MOULTS Based on examination of 235 adult skins (16 *nigrescens*, 42 *elegans*, 15 *melanoptera*, 34 *flaveolus*, 39 *fleurieuensis*, 50 *adelaidae*, 39 *subadelaidae*) (AM, ANWC, HLW, MV, QM, SAM) and 70 juvenile or first immatures (8 *nigrescens*, 34 *elegans*, 5 *melanoptera*, 12 *flaveolus*, 3 *fleurieuensis*, 6 *adelaidae*, 2 *subadelaidae*) (AM, HLW, MV, QM, SAM). No differences in timing and sequence of moults between subspecies in se. Aust. Little information on n. subspecies since no specimens of

nigrescens were moulting (all collected between Apr. and Oct.). Data from different subspecies combined for analysis. **Adult post-breeding** (Third and subsequent pre-basic). Complete. Primaries, centrifugal, beginning from p6 (Holyoak 1973; this study); 46 adults were moulting primaries and all had started or appeared to start at p6. Usually two growing feathers in wing at any one time. Moulting of primaries starts between Nov. and Jan.; in Nov., PMS of those moulting 6.1 (2–15; 14); in Jan., 14.3 (5–20; 6). Moulting of primaries finishes Mar.–Apr.; in Mar., PMS of those moulting 45.0 (39–49; 5). None moulting primaries between May and Oct. (n=121). Moulting of body begins at same time as moulting of primaries. Active moulting of body: Nov.–Dec., 29.5% of skins (n=61); Jan.–Mar., 65% (n=20); Apr., 46.9% (n=32); May–Oct., only 4.1% (n=121). Moulting of body appears to begin on head, neck and mantle, followed by underparts and rest of upperparts; last upperwing-coverts replaced just before completion of moulting of primaries. Tail replaced during early stages of moulting of primaries. **Post-juvenile** (First pre-basic). Partial; involves most plumage except remiges, rectrices and some upperwing-coverts. Moulting prolonged; begins when c. 8 months old and finishes at about 14–16 months. Moulting appears to proceed slowly, and possibly suspended for short periods; only 16 were recorded with active moulting of body (i.e. with growing feathers), but moulting difficult to detect since only a few feathers grow at once. Moulting of body usually begins with some feathers of head, neck and mantle in about Oct. of first year; heaviest moulting occurs in Mar. when moulting nearly finished. In *elegans*, first replaced scattered feathers on hindneck and mantle, followed by feathers of underparts and round face, resulting in underparts appearing much redder; rest of upperparts slowly replaced till finally coverts and some scapulars replaced last. **First immature post-breeding** (Second pre-basic). Very little information. Probably complete. Active moulting of primaries recorded Oct. and Nov.; probably begins Sept.

MEASUREMENTS NOMINATE *ELEGANS*: (1–2) Skins (HLW, MV, SAM): (1) Vic., NSW, se. SA and se. Qld, adults; (2) Vic., NSW, juveniles and immatures with juvenile remiges and rectrices.

	MALES	FEMALES	
WING	(1) 178.6 (6.21; 167–188; 27)	172.2 (3.54; 166–178; 20)	**
	(2) 172.6 (6.87; 161–192; 21)	169.2 (5.22; 161–179; 16)	ns
TAIL	(1) 194.2 (7.47; 182–216; 27)	187.3 (8.16; 167–199; 19)	**
	(2) 178.1 (10.90; 165–212; 18)	176.2 (5.39; 166–185; 16)	ns
BILL	(1) 18.1 (0.75; 17.0–20.0; 27)	16.6 (0.69; 14.8–17.5; 20)	**
	(2) 17.6 (0.99; 15.8–19.0; 20)	16.7 (0.88; 15.3–18.6; 16)	**
BILL W	(1) 13.2 (0.61; 11.5–14.5; 27)	12.0 (0.51; 11.3–13.4; 20)	**
	(2) 12.9 (0.80; 11.3–14.2; 21)	12.1 (0.68; 11.2–13.9; 16)	**
TARSUS	(1) 21.7 (0.61; 20.5–23.1; 27)	21.2 (0.66; 20.0–22.4; 19)	**
	(2) 21.8 (0.87; 19.7–23.3; 21)	21.4 (0.75; 20.2–22.8; 16)	ns
TOE C	(1) 26.3 (2.18; 23.4–30.1; 15)	26.2 (1.10; 23.9–27.6; 11)	ns
	(2) 26.5 (1.71; 23.1–29.4; 12)	26.7 (1.60; 24.5–29.4; 7)	ns

Adult *elegans* had significantly longer Wing ($P < 0.01$ male, $P < 0.05$ female) and Tail ($P < 0.01$ both sexes) than juveniles.

(3) Vic., unsexed, live (K.G., A., & D.I. Rogers).

	ADULTS	FIRST IMMATURES	JUVENILES
WING	(3) 184.7 (5.20; 175–193; 11)	177.7 (6.82; 166–188; 12)	166.3 (18.75; 132–184; 6)
TAIL	(3) 204.6 (12.27; 187–228; 8)	201.0 (11.15; 183–213; 8)	163.7 (44.50; 79–197; 6)
BILL	(3) 19.3 (0.68; 18.8–20.3; 6)	18.2 (0.90; 16.7–19.2; 8)	17.6 (2.35; 15.1–19.9; 6)

SUBSPECIES MELANOPTERA: (4–5) Kangaroo I., skins (ANWC, SAM): (4) Adults; (5) Juveniles and first immatures with juvenile remiges and rectrices.

	MALES	FEMALES
WING	(4) 177.9 (3.79; 173–187; 14)	176
	(5) –	165.8 (3.92; 160–171; 5)
TAIL	(4) 196.9 (7.70; 181–211; 14)	200
	(5) –	174.2 (7.18; 167–183; 4)
BILL	(4) 19.0 (0.64; 18.1–20.6; 14)	17.8
	(5) –	16.8 (0.62; 16.1–17.7; 5)
BILL W	(4) 13.3 (0.45; 12.7–14.4; 14)	12.4
	(5) –	11.9 (0.37; 11.3–12.2; 5)
TARSUS	(4) 22.4 (0.84; 21.3–24.0; 13)	21.2
	(5) –	21.5 (0.53; 20.7–22.0; 5)
TOE C	(4) 27.5 (1.43; 26.2–29.4; 6)	–
	(5) –	26.6 (0.85; 25.8–27.8; 4)

SUBSPECIES NIGRESCENS: (5–6) N. Qld, skins (AM, ANWC, HLW, QM, SAM): (5) Adults; (6) Juveniles.

	MALES	FEMALES	
WING	(5) 164.5 (2.65; 158–169; 14)	157, 159	
	(6) 151.2 (2.50; 148–154; 4)	151.5 (4.93; 146–157; 4)	ns
TAIL	(5) 180.9 (7.58; 165–195; 13)	175, 176	
	(6) 153, 156, 165	162.0 (6.48; 155–170; 4)	
BILL	(5) 18.3 (0.71; 17.3–20.0; 14)	16.6	
	(6) 16.7 (0.77; 15.6–17.4; 4)	16.6 (0.72; 16.0–17.6; 4)	ns
BILL W	(5) 13.9 (0.51; 13.2–14.7; 14)	12.2	
	(6) 12.7 (0.84; 11.9–13.7; 4)	12.4 (0.67; 11.7–13.3; 4)	ns
TARSUS	(5) 19.9 (0.69; 18.8–21.4; 14)	16.7, 20.3	
	(6) 19.9 (0.62; 19.1–20.6; 4)	20.0 (0.36; 19.7–20.4; 4)	ns
TOE C	(5) 24.1 (0.40; 23.4–24.6; 6)	22.7, 24.3	
	(6) 23.3 (1.26; 22.2–24.9; 4)	22.6, 24.8, 25.2	

Adult male *nigrescens* had significantly longer ($P < 0.01$) and wider ($P < 0.01$) Bill than juvenile male *nigrescens*.

SUBSPECIES FLAVEOLUS: (7–8) N. Vic., mid-w. SA and inland NSW, skins (AM, ANWC, HLW, MV, SAM): (7) Adults; (8) Juveniles.

	MALES	FEMALES	
WING	(7) 169.0 (3.46; 163–177; 24)	161.5 (6.64; 151–174; 13)	**
	(8) 162.6 (1.52; 161–165; 5)	157.5 (4.13; 153–165; 6)	*
TAIL	(7) 183.1 (7.87; 170–196; 23)	174.7 (7.65; 158–186; 11)	**
	(8) 167.7 (5.91; 160–174; 4)	161.2 (4.97; 156–167; 5)	ns
BILL	(7) 17.1 (1.01; 15.3–19.1; 23)	15.9 (0.65; 14.8–16.9; 13)	**
	(8) 17.7 (0.88; 17.0–18.8; 5)	15.8 (1.09; 14.8–17.9; 7)	**
BILL W	(7) 12.8 (0.44; 11.7–13.5; 24)	11.5 (0.67; 10.6–13.2; 13)	**
	(8) 12.9 (0.15; 12.7–13.1; 5)	11.5 (0.77; 10.8–13.2; 7)	**
TARSUS	(7) 20.6 (0.80; 19.0–22.3; 24)	20.0 (0.65; 19.0–20.7; 12)	*
	(8) 20.7 (0.77; 20.0–21.7; 4)	20.3 (0.88; 18.7–21.2; 7)	ns
TOE C	(7) 26.7 (1.38; 24.6–29.4; 16)	25.6 (0.91; 24.5–27.0; 5)	ns
	(8) 25.5, 26.6	24.0, 25.1, 26.5	

Adult male *flaveolus* had significantly longer Wing ($P < 0.01$) than juvenile male *flaveolus*, and adults had significantly longer Tail ($P < 0.01$) than juveniles for both sexes.

SUBSPECIES *FLEURIEUENSIS*: (9) Fleurieu Pen., SA, N to Myponga, adults, skins (ANWC, MV, SAM).

	MALES	FEMALES	
WING	(9) 174.5 (4.67; 167–186; 23)	165.6 (3.51; 159–171; 20)	**
TAIL	(9) 190.9 (6.70; 180–200; 23)	184.7 (6.02; 169–193; 18)	**
BILL	(9) 17.9 (0.60; 16.8–18.9; 24)	16.0 (0.54; 14.9–16.9; 16)	**
BILL W	(9) 12.8 (0.34; 12.0–13.3; 24)	11.3 (0.36; 10.6–12.0; 20)	**
TARSUS	(9) 21.4 (0.55; 20.5–22.5; 24)	20.9 (0.60; 19.7–21.5; 19)	*
TOE C	(9) 26.6 (1.80; 24.3–30.4; 14)	25.3 (1.10; 23.8–27.0; 10)	ns

SUBSPECIES *SUBADELAIDAE*: (10) SA, Flinders Ras and S to Gladstone, adults, skins (ANWC, MV, SAM).

	MALES	FEMALES	
WING	(10) 173.8 (3.54; 166–182; 23)	166.8 (3.30; 161–175; 19)	**
TAIL	(10) 192.0 (7.91; 180–210; 18)	185.2 (6.92; 173–195; 16)	*
BILL	(10) 18.0 (0.72; 16.7–19.6; 20)	16.2 (0.86; 14.4–17.9; 19)	**
BILL W	(10) 13.0 (0.31; 12.4–13.6; 21)	11.7 (0.41; 11.0–12.6; 20)	**
TARSUS	(10) 21.0 (0.88; 19.6–23.7; 23)	20.6 (0.49; 19.7–21.4; 20)	*
TOE C	(10) 25.7 (0.90; 24.5–27.2; 10)	25.0 (1.75; 20.9–27.5; 13)	ns

SUBSPECIES *ADELAIDAE*: (11–12) SA, area bordered by Willunga and Strathalbyn in S to Clare and Florieton in N, skins (ANWC, HLW, MV, SAM): (11) Adults; (12) Juveniles.

	MALES	FEMALES	
WING	(11) 172.1 (3.30; 162–178; 31) (12) 161, 167	164.4 (4.93; 157–178; 23) 159.7 (2.87; 156–163; 4)	**
TAIL	(11) 190.1 (6.68; 181–209; 29) (12) 173, 193	181.4 (7.54; 167–195; 23) 170.2 (8.18; 160–180; 4)	**
BILL	(11) 17.7 (0.67; 16.1–18.8; 30) (12) 15.0, 15.6	16.2 (0.87; 14.9–19.4; 24) 15.6 (0.46; 15.2–16.2; 4)	**
BILL W	(11) 12.7 (0.38; 11.6–13.4; 31) (12) 11.4, 11.4	11.6 (0.55; 10.9–13.2; 24) 11.6 (0.10; 11.5–11.7; 4)	**
TARSUS	(11) 21.5 (0.59; 20.0–22.9; 31) (12) 21.0, 21.3	20.7 (0.80; 19.2–22.6; 23) 21.2 (0.73; 20.3–22.0; 4)	**
TOE C	(11) 25.7 (1.12; 24.0–28.0; 15) (12) 24.8	25.1 (1.79; 20.4–27.9; 15) 23.6, 25.4	ns

Adult female *adelaidae* had significantly longer Tail ($P < 0.05$) than juvenile female *adelaidae*.

Where sufficient data, adult females significantly smaller than adult males for most measurements (only exception length of T toe with claw). Juvenile females usually significantly smaller than juvenile males; see Measurement tables for details.

Additional measurements in Rogers *et al.* (1986), Forshaw.

WEIGHTS All from museum labels; juveniles include immatures with juvenile remiges and rectrices (AM, ANWC, MV, QM, SAM). (1–2) SUBSPECIES *ELEGANS*, Vic. and e. SA: (1) Adults; (2) Juveniles. (3) SUBSPECIES *MELANOPTERA*, Kangaroo I., adults. (4–5) SUBSPECIES *NIGRESCENS*, n. Qld: (4) Adults; (5) Juveniles. (6–7) SUBSPECIES *FLAVEOLUS*, Vic. and NSW: (6) Adults; (7) Juveniles. (8) SUBSPECIES *FLEURIEUENSIS*, Fleurieu Pen., SA, adults. (9) SUBSPECIES *SUBADELAIDAE*, mid-SA, Flinders Ras and S to Gladstone, adults. (10) SUBSPECIES *ADELAIDAE*, SA, area bordered by Willunga and Strathalbyn in S to Clare and Florieton in N, adults.

	MALES	FEMALES	
(1)	140.0 (12.51; 115–170; 28)	125.3 (15.50; 99–170; 23)	**
(2)	133.2 (17.79; 107–160; 6)	129.5 (13.90; 115–152; 6)	ns
(3)	137.5 (12.32; 117–153; 6)	–	

(4)	115.0 (6.39; 105–121; 6)	100	
(5)	–	102	
(6)	127.2 (8.12; 112–140; 10)	101.7 (13.16; 75–113; 8)	**
(7)	110, 125	112	
(8)	135.1 (10.35; 120–157; 16)	118.0 (10.89; 102–135; 15)	**
(9)	139.5 (7.37; 132–155; 15)	123.2 (7.73; 108–135; 14)	**
(10)	130.0 (11.16; 117–142; 4)	128.4 (15.65; 107–160; 14)	

SUBSPECIES *ELEGANS*: Vic., unsexed, live (K.G., A., & D.I. Rogers): Adults, 148.5 (10.91; 137–170; 8); Immatures, 137.4 (12.59; 123–165; 10); Juveniles, 118.5 (9.91; 103–128; 6). A few extra data in Rogers *et al.* (1986).

STRUCTURE Based on subspecies *elegans*. Wing broad and rounded at tip, with slight inward curve to trailing edge near junction of primaries and secondaries. Ten primaries: p8 longest; p10 18–26 mm shorter, p9 0–3, p7 0–5, p6 8–16, p5 35–40, p4 47–52, p3 54–59, p2 60–65, p1 64–68. Outer web of p6–p9 emarginated; inner web of p7–p10 emarginated. About 12 secondaries, including about five tertials; tips of longest tertials fall between p2 and p3 on folded wing. Tail long and pointed; 12 rectrices; t1 longest, t6 95–116 mm shorter. Bill short and broad; Bill of male appears heavier and is broader at base than that of female (bill of males significantly wider than that of females [$P < 0.01$]; also significantly longer [$P < 0.01$]). Cutting edges of upper mandible, sharp; straight from base to small notch c. 7 mm from tip, then slightly concave to tip, which appears rounded from front but has sharp cutting edge; inside of tip flattened, with shallow transverse grooves. Lower mandible broad and shovel-like, with slightly raised cutting edge at tip. Narrow bare cere along base of upper mandible, in which small rounded nostrils situated close to top. Tarsus short and rounded; granulate. Tibia fully feathered. Outer toe directed backward. Outer hindtoe 81–90% of outer front, inner front 63–71%, inner hind 42–51%.

SEXING Adult male bills significantly longer ($P < 0.01$) and wider ($P < 0.01$) than those of adult females in all subspecies where sample sizes sufficient to test differences. Bills of males appear to be much broader than those of females for all age classes and could probably be used to sex juveniles and immatures. The head of males also appears larger (Condon 1941; Shephard 1989) and squarer (E. Krebs) than that of females.

GEOGRAPHICAL VARIATION Great, and classification varies. Have been separated into three different species: *elegans*, *flaveolus* and *adelaidae* (Condon 1954a; Forshaw) or combined in single species (Condon 1941; Cain 1955; Christidis & Boles 1994; Aust. CL). Aust. CL, which is followed here, recognized seven subspecies: nominate *elegans*, e. and se. Aust., N to Blackall Ras, s. Qld, and W to Kingston, SA; *flaveolus*, inland se. Aust.; *nigrescens*, ne. Qld; *melanoptera*, Kangaroo I.; *fleurieuensis*, Fleurieu Pen., SA; *adelaidae*, along Mt Lofty Ras, SA, from just S of Adelaide to about Clare; and *subadelaidae*, s. Flinders Ras, SA. McAllan & Bruce (1988) described a subspecies (*filewoodi*) from an isolated population in Clarke Ras, central e. Qld. They claim it is similar in plumage to *nigrescens* but with similar measurements to *elegans*. There are few specimens from this population and little other information available to determine the validity of this subspecies.

Relationships between accepted subspecies complex. Range of most subspecies overlaps those of adjacent subspecies, with hybrid individuals in zone of overlap (e.g. Ford 1987b). Within this species there are three clearly distinguishable groups of species: crimson group, which includes *elegans*, *melanoptera*,

and *nigrescens*; yellow group, which consists of *flaveolus* only; and Adelaide group, which includes *fleurieuensis*, *adelaidae*, and *subadelaidae*. Nominate *elegans* and subspecies *flaveolus* (so-called Yellow Rosella) appear to be the two most divergent forms. Within crimson group, *nigrescens* and *melanopectera* are darker than nominate *elegans* and are forms that have been isolated respectively from the extreme n. and sw. ends of range of *elegans*. Within crimson group there also appears to be a trend for smaller size to N. Subspecies *nigrescens* and *melanopectera* have always been considered subspecies of *elegans* (e.g. Forshaw). Subspecies *subadelaidae* close to *adelaidae* and was formerly classified as a subspecies of *adelaidae* when this was considered a separate species (e.g. Forshaw). Subspecies *fleurieuensis* considered subspecies of *adelaidae* by some (Ashby 1925) and a synonym by others (e.g. Forshaw). These three subspecies form Adelaide group and appear intermediate in coloration between *elegans* and *flaveolus*; has been suggested that they arose during a period of hybridization between *elegans* and *flaveolus* and were subsequently isolated (Condon 1954a; Ford 1977). This supported by: (1) aviary crosses between *elegans* and *flaveolus* that result in offspring similar in appearance to *adelaidae* (Forshaw); (2) appearance of *elegans* × *flaveolus* hybrids in region of headwaters of Murray R. (L. Joseph); (3) genetic study showing possible introgression of *flaveolus* genes into *adelaidae* (Joseph & Hope 1984). However, Ford (1977) suggested that *flaveolus* originated in area currently occupied by *adelaidae* and moved inland with a change in climate and vegetation to occupy its current range.

Within Adelaide group there is a trend toward yellower forms toward N. Range of *adelaidae* between that of *fleurieuensis* and *subadelaidae*, and *adelaidae* appears intermediate in plumage between these subspecies. It is debatable whether *adelaidae* is a distinct subspecies, but it is treated as such here. Birds within range of *adelaidae* exhibit great variation in plumage: most at s. end of range tend to be similar to *fleurieuensis* but slightly yellower; most at n. end of range tend to be similar to *subadelaidae* but slightly redder. However, at any location within range of *adelaidae* there can be much individual variation in plumage. There does not appear to be a break in distribution between *fleurieuensis* and *adelaidae*, and there appears to be a continuous cline in coloration. But birds on the Fleurieu Pen. N to about Myponga (35°23'S 138°28'E) appeared to show less variation than those farther N (this study); birds N of Myponga were allocated to subspecies *adelaidae*. Possibly a break in distribution between *adelaidae* and *subadelaidae* (Condon 1954b; Forshaw), but not evident in 10' maps of distribution (Aust. Atlas). On e. edge of range, *adelaidae* probably also intergrades with *flaveolus* (Ashby 1917; Joseph & Hope 1984).

SUBSPECIES FLAVEOLUS: Differs significantly from *elegans* in adult and juvenile plumage (described above) and in size. Adults of both sexes significantly smaller than *elegans* in length of wing ($P < 0.01$), tail ($P < 0.01$), bill ($P < 0.01$), tarsus ($P < 0.01$), and width of bill (male $P < 0.01$; female $P < 0.05$); adult females significantly lighter ($P < 0.05$).

SUBSPECIES NIGRESCENS: Similar to nominate *elegans* but differs substantially in size and slightly in plumage. Adult males significantly smaller than *elegans* in length of wing ($P < 0.01$), tail ($P < 0.01$), tarsus ($P < 0.01$) and toe ($P < 0.05$) and weighed less ($P < 0.05$), but significantly larger than nominate in width of bill ($P < 0.01$); sample sizes of adult females were too small to test. The tail is also much narrower than nominate. Sexes similar in plumage. There does not appear to be a separate immature (first basic) plumage, and juveniles appear to moult directly into adult-like plumage.

Adult (Definitive basic). Sexes similar (cf. *elegans*). Similar to adult male *elegans*; darker than most *elegans* but almost identical to some darker birds. Bases of feathers tend to be darker than *elegans* and tracts that sometimes appear red (c12) in nominate appear crimson (108) or slightly darker in *nigrescens*. Bases of all feathers of head and neck, grey-black (82) to black (89). Bases of all feathers of back, rump, uppertail-coverts and of all underparts, dark grey (83) to grey-black (82). Bases of feathers of mantle and scapulars, black (89). Feathers of upperwing with violet coloration appear a slightly darker shade than in *elegans*. **Juvenile** Based on only a few specimens (six skins). Much redder than juvenile *elegans* and much more similar to adult plumage than juvenile *elegans* is to adult *elegans*. **HEAD AND NECK:** Forehead, crown, nape and hindneck, mostly grey-black (c82) with narrow dull-red or brownish-red (ne) fringes to feathers. Feathers of cheek-patch similar to adult, but grey-black (82) bases visible, making patch look darker than adult. On some birds, some feathers of nape and hindneck have narrow pale-green (c162) subterminal fringes. **UPPERPARTS:** Appear to vary between individuals. Feathers of mantle, grey-black (82) with very narrow fringes, which are mostly crimson (108) or brownish red (ne) in some or mostly dark green (c160) with a few reddish (ne) fringes in others. Scapulars, dark grey (83) with dark-olive (c49) fringes; sometimes have narrow red (c12) edges. Back, rump and uppertail-coverts, grey-black (82) with very broad crimson (108) tips and narrow olive (c50) or yellowish-olive (c52) subterminal band. **UNDERPARTS:** Appear duller than on adult *nigrescens*. Mostly grey (84) to dark grey (c83) with red (c12) or very dull greenish (ne) fringes to feathers; most fringes brownish red (brownish 12) but often have narrow yellow-olive (c52) suffusion where red and grey meet on feathers. **TAIL:** Much duller than adult *nigrescens* and with greenish tinge to central rectrices (t1). Narrower than adult *nigrescens* and slightly more pointed. **UPPERWING:** Similar to adult *nigrescens* but duller, with an olive (50) suffusion to tips of some innerwing-coverts and edges of inner secondaries. **UNDERWING:** Similar to adult *nigrescens* but with narrow off-white wing-bar on inner primaries and outer secondaries.

SUBSPECIES MELANOPTERA: Very similar to *elegans*; appears to follow trend shown in Adelaide group toward redder individuals in S (see below), but *melanopectera* distinct from Adelaide group. Adults males significantly larger than *elegans* in bill ($P < 0.01$) and tarsus ($P < 0.01$). Adult males also significantly larger than *fleurieuensis* (closest neighbour) in wing ($P < 0.05$), tail ($P < 0.05$), length of bill ($P < 0.01$), width of bill ($P < 0.01$) and tarsus ($P < 0.01$). Sample sizes of adult females were too small to test. Adults and juveniles have similar plumage to same age of *elegans*, which prompted Cain (1955) to question validity of subspecies. Tend to be darker than most *elegans*, but some cannot be distinguished from *elegans* on plumage alone.

The three subspecies in Adelaide complex, *adelaidae*, *subadelaidae*, and *fleurieuensis*, appear to form cline in coloration from N to S; mostly yellow in N to orange-red in S. Do not differ significantly in size from each other, but all three slightly smaller than nominate *elegans*.

SUBSPECIES ADELAIDAE: Adults of both sexes significantly smaller than *elegans* in length of wing ($P < 0.01$), tail ($P < 0.05$), bill ($P < 0.05$) and width of bill (male $P < 0.01$; female $P < 0.05$); adult females significantly smaller in length of tarsus ($P < 0.05$) and toe. Plumage varies greatly; average plumage from area near Adelaide described below.

Adult male Differences from *elegans*. **HEAD AND NECK:** Forehead, crown and nape, grade from red (c12) on lower forehead to dull orange (c116) on nape. Hindneck and sides of

neck, straw-yellow (c56), often with a dull-orange (c116) wash. Lores and round edge of cheek-patch, red (c12). Cheek-patch slightly lighter. **UPPERPARTS:** Mantle and scapulars vary greatly, both within and between individuals. Feathers of mantle usually grey-black (82) with creamy-yellow (ne) fringes, often with peach-red (c94) suffusion to some fringes. In some birds, feathers of mantle very similar to those of *fleurieuensis*. Scapulars usually have strong peach-red (c94) suffusion to fringes, and fringes sometimes appear mostly peach-red (c94). **UNDERPARTS:** Much more orange than in *elegans*. Most are red (c14) to dull orange (c116) with narrow pale-yellow (c157) fringe and pale-yellow (c157) suffusion in middle of feathers; concealed bases, pale grey (86). Some very similar to *fleurieuensis* and others very similar to *subadelaidae*. **UPPERWING:** Similar to *elegans*, but red edges to coverts and tertials replaced with cream (54), peach-red (94) or cream (54) suffused with peach-red (94). **UNDERWING:** As *elegans*. **Adult female** Similar to adult male, but sex can probably be determined by presence of underwing-bar (see *elegans*). **Juvenile** Very similar to juvenile *elegans*, but duller and paler green with duller red on head and neck. Appears intermediate between juvenile *elegans* and juvenile *flaveolus*.

SUBSPECIES FLEURIEUENSIS: Differs slightly in size from *elegans*; very different in plumage. Adult males significantly smaller than *elegans* in length of wing ($P < 0.05$) and width of bill ($P < 0.01$); adult females significantly smaller than *elegans* in wing ($P < 0.01$), length of bill ($P < 0.01$), width of bill ($P < 0.01$) and length of toe ($P < 0.05$).

Adult male Differences from *elegans*: **HEAD AND NECK:** Similar to *elegans* but with lighter, more yellowish appearance. Cheek-patch slightly paler. Rest of head and neck varies individually, from crimson (c108) to red (c210). Often appear to have a slight yellow wash on lower hindneck and sides of neck. Most feathers of head and neck have very narrow area suffused with yellow near border between red and grey of feather. **UPPERPARTS:** Feathers of mantle and scapulars, black (89) centrally, usually with very narrow cream (54) fringe, bordered on inside by broad peach-red (c94) subterminal fringe, this in turn bordered by another very narrow cream (54) fringe, and with blue (c168B) subterminal line adjoining innermost cream fringe near base of feather. Some fringes appear almost entirely cream (54). On some birds, fringes much redder (c12) with little or no cream. **UNDERPARTS:** Much more orange than in *elegans*; red (c14) to orange-red (15) with yellowish suffusion to fringes of feathers and concealed grey (84) bases to feathers. **TAIL:** Similar to *elegans* but with slightly stronger greenish tinge. **UPPERWING:** Similar to *elegans* but red areas much paler and more orange. **Adult female** Similar to adult male *fleurieuensis* but tend to be slightly paler or yellower. Often have blue (c168B) subterminal fringes to feathers of upperparts. **Juvenile** Differences from juvenile *elegans*. Red on forehead, round cheek-patch and lower foreneck, duller and less extensive: peach-red (94) to dull orange (116). Green on underparts much duller and greyer: olive-grey (c42) with yellow-olive (c52) fringes. T1 greyer, grey-olive (c43). Rest of rectrices similar to juvenile *elegans* but slightly greyer and paler.

SUBSPECIES SUBADELAIDAE: Most similar to *flaveolus* in plumage. Adult males significantly smaller than adult male *elegans* in length of wing ($P < 0.01$) and tarsus ($P < 0.01$); significantly larger than *flaveolus* in length of wing ($P < 0.01$), tail ($P < 0.01$) and bill ($P < 0.01$) and significantly heavier ($P < 0.01$). Adult females significantly smaller than adult female *elegans* in length of wing ($P < 0.01$), bill ($P < 0.05$), tarsus ($P < 0.01$) and toe ($P < 0.05$); and significantly larger than *flaveolus* in length of wing ($P < 0.01$), tail ($P < 0.01$) and tarsus ($P < 0.05$) and

significantly heavier ($P < 0.01$). Subspecies *subadelaidae* appears to be isolated from both *adelaidae* and *flaveolus*, but little is known of the extent of its range (see Condon 1954b; Ford 1987b).

Adult male Similar to *flaveolus* but much paler yellow with orange-red wash on underparts and blue subterminal fringes to feathers of upperparts. **HEAD AND NECK:** Forehead, orange-red (c15). Crown and nape grades from orange-red (c15) to pale straw-yellow (c56). Hindneck and sides of neck, pale straw-yellow (c56). Lores and round edges of cheek-patch washed orange-red (c15). **UPPERPARTS:** Mantle and scapulars, dark grey (83) with cream (92) fringes and dark grey-blue (ne) subterminal fringe. Back, rump and uppertail-coverts, pale straw-yellow (pale 56) with concealed grey (84) bases. **UNDERPARTS:** All underparts, straw-yellow (c56) with pale burnt-orange (pale 116) wash to most or all feathers; wash darkest near centre of feather and paler near edges, so that edges of feathers appear straw-yellow. Concealed bases of feathers, grey (84). **TAIL:** Similar to adult male *elegans* but slightly bluer. **UPPERWING:** Similar to adult male *elegans* but red replaced with very pale yellow (pale 157). **UNDERWING:** Similar to adult male *elegans* but much paler. **Adult female** Most of plumage similar to adult male *subadelaidae*. Many can probably be sexed by presence of underwing-bar. **Juvenile** Only two specimens examined, but appear to be similar to juvenile *flaveolus*.

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Sponsors: Mrs A Bedford, Mr JS Guest, in memory of Mrs I Woolcroft, the Hon JH Wootten



Volume 4, Plate 15

Green Rosella *Platycercus caledonicus* (page 313)

1 Adult male; 2 Adult female; 3 Juvenile male; 4 Juvenile female; 5 Adult male; 6 Adult female; 7, 8 Juvenile

Crimson Rosella *Platycercus elegans* (page 321)

NOMINATE ELEGANS: 9 Adult male; 10 Adult female; 11 Juvenile; 12 Immature; 13 Adult male; 14 Adult female; 15, 16 Juvenile

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Crimson Rosella *Platycercus elegans* (page 321)
 SUBSPECIES NIGRISCENS: 1 Adult male; 2 Juvenile; 3 Adult male; 4 Juvenile
 SUBSPECIES FLAVEOLUS: 5 Adult male; 6 Juvenile; 7 Adult male; 8 Adult female
 SUBSPECIES FLEURIEUENSIS: 9, 10 Adult; 11 Adult female
 SUBSPECIES ADELAIDAE: 12, 13 Adult; 14 Adult female
 SUBSPECIES SUBADELAIDAE: 15, 16 Adult; 17 Adult male