

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 Psittichadini 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 anthopeplus* (Polytelini). Only female incubates but both sexes involved with feeding of young, except in Kakapo, in which female raises young alone, and possibly Ground Parrot, in which male appears responsible for feeding of young. In most species, young generally leave natal area by 3–6 months old. Aust. lorikeets, *Polytelis*, *Eclectus*, and some *Neophema* often nest in loose colonies; others strictly solitary nesters. Generally defend only nest-hole. Most gregarious species roost communally, at least when not breeding.

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

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

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

trees (Rand 1942; Beehler 1982). Breeding generally seasonal but some species will breed at any time of year if conditions suitable, and some species can raise two or more broods in a season. Most species nest in hollows in trees, though some nest on ground, under rocks, vegetation or in burrows; some species excavate tunnels in termite mounds. Extralimitally, Red-flanked Lorikeet *Charmosyna placentis* (Loriinae), Orange-breasted Fig-Parrot *Cyclopsitta 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 eximius **Eastern Rosella**

COLOUR PLATE FACING PAGE 352

Psittacus eximius Shaw, 1792, *Nat. Misc.* 3: Pl. 93 — New Holland = New South Wales.

The specific name is an allusion to the brightly coloured plumage (Latin *eximius*, select, distinguished [from *eximere*, to take away]). Latham (1802, *Gen. Synop. Birds*, Suppl. II) named this bird the 'Nonpareil Parrot'.

OTHER ENGLISH NAMES Rosella; Common, Red, Red-headed, Golden-mantled, Rose Hill or White-cheeked Rosella; Nonpareil or Rosella Parrot; Golden-mantled, Rosehill or Rosella Parakeet; Joey; Pretty Joey.

POLYTYPIC Nominate *eximius*, se. Aust. from central NSW, through Vic., and se. SA, N to round Bordertown; *elecica*, Schodde, 1988, s. Qld from round Toowoomba, S to Hunter R. district of ne. NSW; *diemenensis*, North, 1911, Tas.

FIELD IDENTIFICATION Length 28–33 cm; wingspan 38–47 cm; weight 100–110 g. Medium-sized broad-tailed parrot, slightly smaller than Crimson Rosella *Platycercus elegans* but similar in size to Pale-headed Rosella *P. adsitus*. Unmistakable, colourful parrot with red head, neck and breast and white cheek-patches; scaly yellowish or greenish upperparts and yellow-green to bluish-green rump; bright blue shoulders; and

mostly yellow underbody with light-green vent and red undertail-coverts. Among rosellas, combination of red head with white cheek-patches, diagnostic. Sexes differ slightly. No seasonal variation. Slight geographical variation. Juveniles separable. **Adult male** Head, neck and breast, red, with prominent white cheek-patches. Lower hindneck and saddle, black, broadly streaked or scaled yellow-green or golden-yellow. Rump and

uppertail-coverts, light yellow-green to pale bluish-green, prominent in flight and contrasting strongly with uppertail which is mostly dark blue (dark green in centre) with broad pale-blue subterminal band and narrow white tip to outer feathers. At rest, folded wing shows narrow black shoulder-patch bordered below by broader light-blue band along leading edge of coverts; remiges edged dark blue, and inner few greater coverts, secondaries and all tertials edged yellow-green; in flight, upperwing shows small black patch on leading edge of innerwing, bordered by light-blue band in centre of wing, which contrasts with dark-blue rest of wing grading to blackish on wing-tip. Belly and fore-flanks, yellow grading into light green on vent and rear flanks; undertail-coverts, red. Undertail, light blue with narrow whitish tip. Underwing: most coverts, blue; greater coverts and remiges, grey-black. Bill, off-white. Cere, grey to grey-black. Iris, dark brown. Orbital ring, narrow periphthalmic ring, and legs and feet, dark grey. **Adult female** Similar to adult male but with varying white bar across underside of remiges, usually obvious in flight: well-marked birds have long white bar through middle of all remiges except outer few primaries; others have shorter white bar. Some bright-plumaged females very similar to adult male, differing only by white underwing-bar; others noticeably duller and washed out with patchy pattern of breast. Many also differ in having patch of yellow-green on upper mantle and nape (cf. juvenile). **Juvenile** Very similar to dull adult females but even duller; all have prominent pale-yellow or white double underwing-bars. Most can be aged by colour of bill and cere: pale yellow or orange at fledging, changing to off-white (as adult) within first few months. Further differ by: (1) always have prominent patch of green on nape, like some adult females, but usually larger, continuing onto crown in many; most or all also have some green mottling on upper ear-coverts; cheek-patch duller, off-white, often with bluish tinge; (2) streaking and scaling of saddle and inner secondaries and greater coverts distinctly duller green, and rump and uppertail-coverts duller green; (3) folded uppertail greener, central rectrices lacking obvious blue tone; (4) blue on wing distinctly duller; (5) belly to vent duller and greener; (6) in fresh plumage, tips of rectrices narrower and more pointed. **Immatures** Very similar to adult female, separable by retained juvenile wing and tail if plumage not too worn. Hybridizes with Pale-headed Rosella in se. Qld and ne. NSW; see Plumages: Hybrids.

Similar species None.

Gregarious; usually seen singly, in pairs or small flocks of up to 50 birds. Associate with Crimson and Pale-headed Rosellas and Red-rumped Parrots *Psephotus haematonotus*. Inhabit open forests and woodlands and adjacent grasslands; also urban parks and gardens. Familiar and common parrot; often seen along roadsides or perched on fences or overhead wires. Somewhat wary, not usually allowing close approach except when feeding in safety of trees. Arboreal and terrestrial; feed much on ground, retreating noisily into nearby trees when disturbed. Flight swift and strongly undulating, with alternating bursts of rapid shallow wing-beats and gliding dips; birds travelling long distances, particularly over open country, fly at considerable heights and with less undulation. Usual contact call, sharp repeated *chut-chit* or *chut-chit-chut*, uttered often in flight; perched birds give trisyllabic ascending whistle or metallic piping *kwink-kwink*, repeated; also conversational chattering while feeding. All calls similar to Crimson Rosella but noticeably higher-pitched.

HABITAT Open woodland and lightly wooded grassland, including partly cleared farmland and remnant patches of woodland in paddocks, along creeks, or roads (Hindwood &

McGill 1951; Brereton & Sourry 1959; McEvey 1965; Lendon 1973; Emison & Porter 1978; Loyn 1985c; Chan 1995; Hall; Forshaw; Vic. Atlas). In drier areas, may be restricted to wooded habitats along watercourses and round wetlands (Vic. Atlas). In e. Vic., often inhabit coastal *Banksia* woodland and thickets (Cooper 1974, 1975; Forshaw). Also occur in cultivated crops and orchards (Bridgewater 1934; Ryan 1953; Passmore 1982; Forshaw; NSW Bird Rep. 1976). Often in suburban habitats, particularly parks, gardens and on golf courses (Payne 1931; Paton 1976; Price 1977; Lenz 1990; Vic. Atlas; Qld Bird Rep. 1984) where grasses form the main vegetative cover and there is adequate open ground (ACT Atlas). Not recorded from treeless grassland and open paddocks with no cover (ACT Atlas); may occur in and near trees planted as wind-breaks and which are surrounded by open paddocks (J.M. Peter). Rare or absent in rainforest and wet sclerophyll forests (Brereton & Sourry 1959; Thomas 1965; Cooper 1974; Gibson 1977); occur in forests only at edges or in recently logged areas, including regrowth (Chisholm 1940; Heron 1973; Loyn 1980, 1985a). Sometimes in young pine plantations (Stevens 1975; Friend 1982). Rarely in heathland, mallee shrubland, paperbark *Melaleuca* swamps or estuarine mangroves (Hindwood & Sharland 1964; Pyke 1985; Vic. Bird Rep. 1984; NRS). At Sheffield, Tas., only recorded at local rubbish tip (Tas. Bird Rep. 23). In NZ, occur in lightly timbered or open areas: often at edges or near remnant patches of native forest in otherwise open farmland; also round shelterbelts and plantations of pines or larch; in orchards; and in urban areas, especially in parks, gardens and golf courses (Fleming 1944; Hamel 1970; McKenzie 1979; Baker 1980; Gill 1989; Pierce *et al.* 1993; Oliver; CSN; NZRD); sometimes in mangroves (CSN 31, Suppl. 19); at Hamilton, NI, once recorded in compost bin (CSN 33).

Nest in hollows in trees, in open forest and woodland; also in trees in other open areas, such as parks, gardens and golf courses, partly cleared farmland, or remnant patches of woodland left as shelterbelts, in paddocks or along roadsides; in Sugar Gums *Eucalyptus cladocalyx* planted as wind-breaks on farms (Hirth 1976; Price 1977; Loyn 1985c; NRS). Often in trees along rivers, round lakes, billabongs or swamps (NRS). Rarely in other habitats, such as mature Mountain Ash *E. regnans* forest, mallee shrubland and heathland (Loyn 1985a; NRS). Once in estuarine mangrove (NRS). Usually in native trees, often *Eucalyptus*, but in settled areas may also use hollows in exotic species in plantations and gardens, including pines, planes and even fruit trees (Hyem 1936; Vic. Bird Rep. 1987; NRS). Rarely nest in holes in sandbanks, or termitaria; also artificial structures that are like tree-hollows (see Breeding). In NZ, sometimes fall down chimneys in search of breeding sites (CSN 5).

Feed on ground and in trees and shrubs. Of 1864 observations of foraging at Warwick, Qld, 69% of feeding on ground (Wyndham & Cannon 1985); often feed among grass or weeds in grassland, clearings, pasture, and on lawns; also roadsides. In farmland, feed on spilt grain round haystacks, feed-boxes and fowl-runs (Fletcher 1921; Bridgewater 1934; Chisholm 1934; Hyem 1936; Stokes 1967; Cannon 1981; Loyn 1985c; NRS); also feed on seeds within cattle dung deposited in paddocks (Cannon 1981). Sometimes on fallen acorns beneath oak trees (Kloot & McCulloch 1993). Also feed in canopy of flowering, seeding or budding shrubs and trees, often in gardens (Fletcher 1921; Geary 1932; Chisholm 1966; Frith 1969; Cannon 1981; Smith *et al.* 1984; Ashton 1985; Browne 1990); also in orchards and some crops (Ryan 1953; NSW Bird Rep. 1976; Tas. Bird Rep. 16). Often among foliage infested with psyllids and coccids

in trees (Green & Swift 1965; Cannon 1981; Loyn 1985b; Wyndham & Cannon 1985); in pendulous mistletoe (Ashton 1985). Feed at seed-trays in gardens (Mitchell 1976). Sometimes feed in logged Mountain Ash forest, on flowering *Senecio* (Loyn 1985a). Rarely, feed on *Xanthorrhoea* flower-spikes in low heathland (Hindwood & Sharland 1964; Vic. Bird Rep. 1984). Once seen nibbling at soot from an open flue (Baldwin 1975). In NZ, feed on ground and in trees and shrubs: in paddocks, crops and newly sown pasture; on roadsides; orchards; hawthorn hedges; in native trees and shrubs, including Manuka *Leptospermum scoparium*, and introduced species, such as wattle, pine and willow; tender shoots of mangroves (Turbutt 1950; Hamel 1970; CSN).

Roost among foliage of trees, often in remnant patches of woodland; also at ends of branches in pine trees. Loaf in outermost branches of trees; may also perch on fences and powerlines (Fletcher 1934; Loyn 1985c; Wyndham & Cannon 1985; Forshaw). Bask on exposed branches in sunshine in early morning and evening (Wyndham & Cannon 1985). In NZ, recorded roosting in Totara *Podocarpus totara* forest (CSN 22).

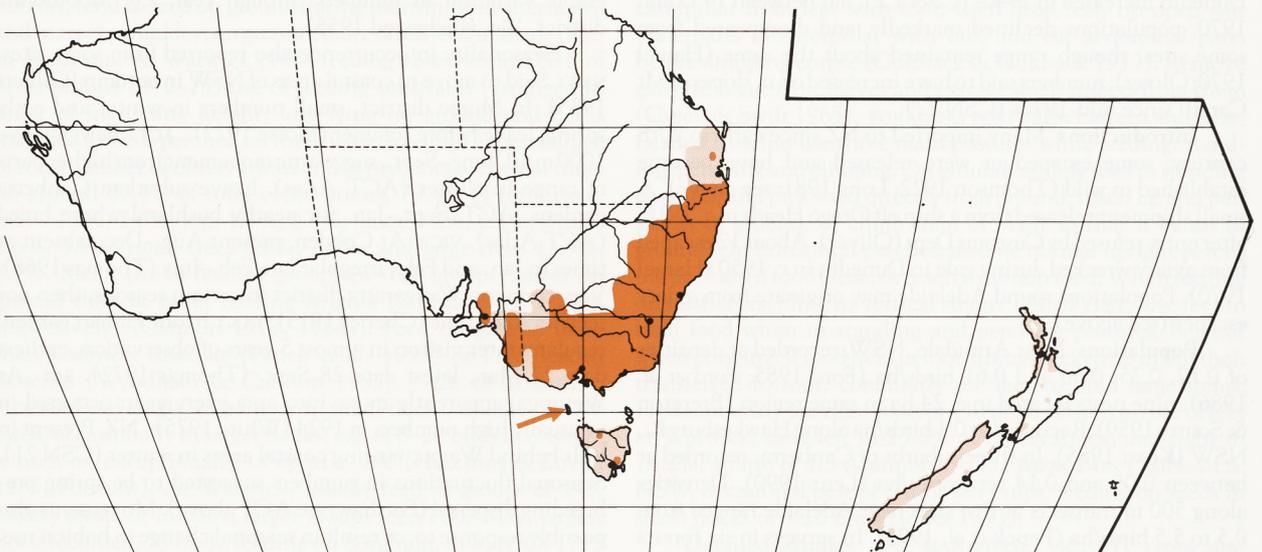
Has benefited from clearance of forests for conversion to open farmland (agricultural savanna); also benefited from planting of trees in predominantly grassy areas, such as suburban parks and gardens (Chisholm 1934; Parker 1988; Forshaw).

DISTRIBUTION AND POPULATION Endemic to se. Aust.; introduced to NZ.

Aust. Qld Restricted to SE, E of line from Maryborough to Goondiwindi (Aust. Atlas); said to occur more often on w. slopes of Great Divide than farther E (Roberts 1979; Storr 19). Some records from n. part of range, such as Maryborough and Toowoomba, suggested to be possible aviary escapes (Nielsen 1969; Jones 1981). Said to have been observed at Bundaberg (Forshaw). Records from Mitchell and Maranoa R. not accepted (Aust. Atlas). **NSW** Widespread. Mainly E of line from 150°E on NSW–Qld border SW to Barham; occasional records farther W, including 40 km S of Nymagee, near L. Cargelligo, near Mossiel, and at Dareton (Hobbs 1961; Morris *et al.* 1981; Cooper & McAllan 1995; Aust. Atlas; NSW Bird Reps). **Vic.** Widespread except in parts of Gippsland, North-East and Mallee Districts. In Gippsland and North-East Districts, mainly occur S and N of Great Divide respectively, with few or no records on Great Divide. In Mallee, virtually absent except in

far S and E: occur near Rainbow in S; and N to sites W of Tooleybuc (Vic. Atlas); rarely recorded Hattah-Kulkyne NP (Jones 1952; Vic. Atlas). **Tas.** One record for islands of Bass Str.: pair arrived King I., 1979, after strong winds, and bred; first clutch died, and second clutch raised, though female died before they left nest; assumed no longer extant (Tas. Bird Rep. 9). On Tas. mainland mainly in e. half but generally absent from NE. In N, recorded at Burnie, but most records E of Devonport, with a few isolated records farther S at Sheffield, Mole Creek and Caveside; from Devonport, range extends SE through Launceston to middle reaches of Esk R. and upper Macquarie R.; also on e. coast, from Scamander S to s. Tasman Pen. and Kingston, with single record farther S at Recherche Bay; inland to Ouse, and also The Steppes (Fletcher 1921; Thomas 1979; Green 1983; White 1985; Aust. Atlas; Tas. Bird Reps). **SA** Mostly in SE, N to Mt Rescue CP (near Tintinara) and W to S of Taillem Bend (Attwood 1977; Stove 1994; Aust. Atlas). Isolated population near Adelaide, mainly s. Mt Lofty Ras and s. Adelaide Plains, extending S to Aldinga–Sellicks Beach and n. Fleurieu Pen. near Myponga (Ashton 1985; Paton *et al.* 1994; Stove 1994; SA Bird Rep. 1977–81); origin not known: either a feral population (Lendon 1968; Mathews) or natural arrival from se. SA or w. Vic. (Parker 1988).

NZ NI Throughout Auckland Isthmus: in FAR NORTH, rarely N of Rangaunu Harbour and Doubtless Bay (e.g. at Motuopao I., Mt Camel and Ngataki); widespread S of Rangaunu, through NORTHLAND and AUCKLAND S to Manukau Harbour including some offshore islands such as Little Barrier and Waiheke Is; more sparsely distributed between Manukau Harbour and s. Kaipara Harbour. In SOUTH AUCKLAND, occasional records Awhitu Pen.; mostly recorded from S of Papakura, N to shores of Tamaki Str., and E to Hunua Ras and Wharekawa; also widespread sw. Coromandel Pen. In BAY OF PLENTY, sparsely distributed from near Pauanui S to Tauranga, and E to Waihi. Isolated records EAST COAST and HAWKES BAY, at Gisborne, Puketitiri, and Kaweka State Forest. Scattered records VOLCANIC PLATEAU, at Kaharoa, Rotorua and Putaruru; also near Waihaha, nw. L. Taupo. Farther S, widespread in w. WAIRARAPA, along e. slopes of Tararua Ra., SW to Wellington. In WELLINGTON and MANAWATU, scattered records W of Tararua Ra., including Paraparaumu, Levin and Foxton. In TARANAKI, scattered records, from Oakura and Kaitake Ras, to Uruti. Widespread in WAIKATO, from Kawhia Harbour and near Otorohanga, N to area W of L.



Waikare, and E to Te Kuiti and Hamilton; also recorded farther W at Matamata and farther S at Benneydale (Edgar 1971; McKenzie 1979; CSN; Oliver; NZCL; NZRD). **SI** Mostly in Otago, near Dunedin and Otago Pen., N to Puketeraki, and possibly Palmerston, and W to Maungatua, Berwick and Waipori Falls. Also in central Otago, near Arrowtown and Mt Allen (Hamel 1970; Oliver; NZ Atlas; CSN). Sometimes also seen at isolated sites elsewhere, including near Lyttelton Harbour, Invercargill and on Stewart I. (NZCL; CSN).

Breeding Throughout most of range in mainland Aust. In Tas., once bred on King I.; only four breeding records in Aust. Atlas, near Launceston and at Mt Nelson, SW of Hobart (NRS; Aust. Atlas). In NZ, few breeding records, but probably breed throughout main areas of range.

Change in range **Aust.** Range has expanded in several areas in 20th century, probably in response to changes to available habitat. In NSW, expanded into Comboyne area before 1934, with numbers subsequently increasing (Chisholm 1934). In Beacon Hill area, NSW, numbers were increasing as recently as 1986 (NSW Bird Rep. 1986). Near Winchelsea, Vic., first appeared Sept. 1928; another arrived in 1932, with first breeding recorded in 1934; by 1940, permanent residents (Brown 1950). At Naracoorte, se. SA, populations increased between 1941 and 1971 (Attiwill 1972). May have expanded from se. SA to near Adelaide (see above); first recorded Mt Lofty Ras in Aug. 1912, with range rapidly expanding during 1920s (Parker 1988). Conversely, declines recorded in Tas. since 1940s, especially in Midlands, but also in e. areas, such as Break O'Day Valley, St Marys and Fingal (Sharland 1959; Napier 1969; Green 1983). **NZ** Present in Auckland since at least late 1920s (Gill 1989) and range began to expand by early 1940s. First recorded Hunua Ra. in July 1943, and now plentiful (McKenzie 1979). Expansion of range mainly N from Auckland: n. limit, Tahekeroa and Silverdale in early 1940s; had reached Wellford and Leigh by 1944 (Fleming 1944); Mangawhai and Maungaturoto by 1949 (Turbott 1950); reached Whangaruru in 1960 (CSN 9); widespread N to 35°S by mid-1970s (NZ Atlas). Range now expanding S from Auckland (Falla *et al.* 1981): range and numbers have steadily increased in South Auckland and Waikato Regions and on Coromandel Pen. since at least 1970s (CSN). Established in Wellington since 1960s and said to be increasing; first recorded W of Tararua Ras in early 1974 at Reikorangi (CSN 21). On SI, populations in Dunedin increased in 1940s (CSN 1,2), but between 1955 and 1970, populations declined markedly, and disappeared from some sites, though range remained about the same (Hamel 1970; Oliver); numbers said to have increased on n. slopes of Mt Cargill since mid-1970s (CSN 22).

Introductions Many imported to NZ since early in 20th century; some escaped or were released and have become established in wild (Thomson 1922; Long 1981; see above). A small shipment released from a ship off Otago Heads in c. 1910, after entry refused by Customs Dept (Oliver). About 12 escaped from aviary wrecked during gale in Dunedin in c. 1950 (Hamel 1970). Populations round Adelaide may originate from aviary escapes (see above).

Populations Near Armidale, NSW, recorded at densities of 0.17, 0.25, 0.56 and 0.61 birds/ha (Ford 1985; Ford *et al.* 1986); nine nests located in c. 24 ha in same region (Brereton & Sourry 1959). Recorded at 0.1 birds/ha along Hawkesbury R., NSW (Keast 1985). In three suburbs of Canberra, recorded at between 0.05 and 0.14 territories/ha (Lenz 1990). Densities along 500 m transects at five sites near Adelaide ranged from 0.5 to 5.5 birds/ha (Penck *et al.* 1995). In surveys in six forests

in Far North Region of NZ, 1993, mean numbers counted ranged from 0.12 to 0.55 birds/5 min count (Pierce *et al.* 1993). On road-trip in NSW, between Hay and Forbes (375 km), recorded at 0.01 birds/km; between Forbes and Tamworth (515 km), 0.02/km; and between Tamworth and Armidale (113 km), 0.46/km (Brereton 1977).

Said to damage fruit, cereal and legume crops (CSN 3), and shot or poisoned (Littler 1910; Chisholm 1934; McColl 1957; Sharland 1959; Jack 1966; Hamel 1970; Falla *et al.* 1981). In 1940, over 200 shot in single orchard near Antill Ponds, Tas. (Green 1983). Population decline round Dunedin probably caused by eating poisoned grain intended for eradication of rabbits (Hamel 1970). Sometimes trapped in large numbers, and young taken from nests, for aviculture, causing local declines (Sharland 1936; Hamel 1970; Attiwill 1972; CSN 4). When feeding on roadsides, often struck by vehicles (Vestjens 1973; Conole 1981; Lepshi 1992; Forshaw). Claimed that competition for nesting sites with Common Starlings *Sturnus vulgaris* has forced Rosellas to nest in sub-optimal sites (Arnold 1928), and probably caused populations in Tas. to decline (Green 1983). Sometimes injured by cats or dogs (Fletcher 1934; Rose 1975; Dowling *et al.* 1994).

MOVEMENTS Sedentary (Brereton & Pidgeon 1966; Morris 1975; Gibson 1977; Green 1983; Wyndham *et al.* 1983; see Banding). Also considered resident (e.g. Cooper 1974; Baldwin 1975; Roberts 1975; Baxter 1980; Morris 1986, 1989; Hardy & Farrell 1990; Leishman 1994; CSN 35) and possibly locally or partly nomadic (Thomas & Wheeler 1983; Crome & Shields). No large-scale seasonal movements (Aust. Atlas); no regular long-distance movements in Vic. (Vic. Atlas). Some small-scale movements in ACT (ACT Atlas). In SA, pronounced post-breeding movement (Aust. Atlas). Young birds may be more mobile than adults. In 1979 a pair arrived King I., Bass Str., after strong winds, but might have been aviary escapes (Aust. Atlas; Tas. Bird Rep. 1979).

In many areas throughout range recorded throughout year (e.g. Austin 1907; Norton 1922; Mellor 1927; Olsen *et al.* 1991; Lane 1994; Leishman 1994; NSW Bird Rep. 1988; Tas. Bird Rep. 1991; CSN 39). Round Armidale, NSW, adults sedentary; subadults might be more mobile (Brereton 1963a). In some areas, numbers vary little throughout year, e.g. at Rotamah I., Gippsland, Vic. (Aust. Atlas). However, at some sites considerable variation in numbers through year, e.g. Mooroopna district, Vic. (Bedggood 1958).

Seasonality in occurrence also reported from some sites: **nsw:** Said to move to coastal areas of NSW in autumn (Gilbert 1935). In Moree district, small numbers in winter and early spring, leave before summer (Morse 1922). **ACT:** Fewer above 1000 m asl, June–Sept., suggesting movement from higher parts of range in winter (ACT Atlas). Leave suburban Canberra gardens, ACT, Sept.–Jan. for nearby bushland where breed (ACT Atlas). **vic.:** At Cobden, present Aug.–Dec., absent at times in Jan. and Feb., irregular late Feb.–July (Thomas 1968). Very common Wangaratta district in certain seasons, then not seen for some time (Cheney 1915). **TAS.:** In one Hobart garden, regular winter visitor; in almost 5 years of observation, earliest date 22 Mar., latest date 28 Sept. (Thomas 1972). **SA:** At Wetunga, apparently move into area every year; occurred in unusually high numbers in 1924 (White 1925). **NZ** Present in hills behind Waipu, visiting coastal areas in winter (CSN 21). Seasonal fluctuations in numbers suggested to be spring pre-breeding dispersal (Forshaw; see ACT above). Movements also possibly response to, or result in seasonal change in habitat use,

e.g. though resident in Ballarat Region, Vic., move to more open country in winter (Thomas & Wheeler 1983).

Occasional visitor (Russell 1921; Chisholm 1938; Terrill & Rix 1950; Napier 1969; Ashton 1985; McKilligan & McKilligan 1987; Dunn 1989) or irregular visitor (Marchant 1992) to some areas. At Yarra Valley, Vic., occasional visitor at any time of year (Fleming 1976). In some parts of NZ, reappear after absence of a few years (CSN 5).

Banding Of 3228 banded in Aust., 1953–96, 667 recoveries (20.7%): 664 (99.6%) <10 km from banding site; 2 (0.3%), 10–49 km; 1 (0.1%) ≥100 km. Long-distance recovery: Arcadia, Sydney, NSW, to Goulburn Grid Block, NSW (175 km, 223°, 2 months, Dec., 1).

Major study near Armidale (Brereton 1963a). In three separate populations c. 8 km apart, no interchange detected; many marked adults recaptured repeatedly over 12 months or longer, longest record was adult female recaptured 34 times over 9 years and 3 months (Brereton 1963a; Wyndham & Cannon 1985). Of 766 birds captured in 1965, no fewer than 706 were recaptured at banding site (Brereton & Pidgeon 1966). Of 116 tagged as nestlings, all disappeared from trapped population within a few months of fledging and only three reappeared at trapping site; either young disperse from natal area within a few months of fledging or patagial tags cause high mortality in young birds (Wyndham & Cannon 1985). Colour leg-bands lost at greater rate than wing-tags (Brereton & Pidgeon 1968). For details of banding of hybrid Crimson × Eastern Rosella see Crimson Rosella (Movements).

Longest-lived 106 months: Adult male banded near Armidale, NSW, July 1961 retrapped at banding place 11 times, last occasion over 8 years 10 months after banding (ABBBS 1971).

FOOD Seeds of grasses, shrubs and trees; also fruits, buds, flowers, nectar, and insects and their larvae. **Behaviour** Detailed studies: at Warwick, Qld (data collected at 2-monthly intervals, 1972–74; Cannon 1977, 1981, 1984a; Wyndham & Cannon 1985); near Adelaide (Penck *et al.* 1995); and at Shepherds Hill Reserve and Belair NP, SA (Torcello 1990). **FORAGING HEIGHT:** Feed on ground and in shrubs and trees. At Warwick, feed mainly on ground in all months, but average height of feeding varies throughout year: Jan., 1.9 m; Mar., 3.7 m; May, 0.8 m; July, 3.8 m; Sept., 1.9 m; Nov., 0.6 m. Throughout day, tend to feed on ground during morning and afternoon, and in trees at midday; on ground, more often feed in shade than in direct sun. At Warwick (1864 feeding observations; 80 h of observations 1972–73) use of feeding substrates (arranged in order of increasing height; logs lying on ground and herbs included as birds perched on these when feeding) as percentage of total number of observations and as percentage of total time: on ground 69.4% of total observations, 79.4% of total time; herbs 4.0%, 5.6%; logs 1.3%, 0.6%; fence 0.2%, 0.1%; shrubs 2.6%, 3.9%; small trees 8.6%, 2.3%; and large trees 13.9%, 8.1%. Mean size of feeding groups (n=708 groups) larger on ground than at other feeding heights (5 birds cf. 1–2 birds respectively) (Cannon 1977, 1984a). Feed on ground more than Crimson Rosellas (Penck *et al.* 1995) or Pale-headed Rosellas (Wyndham & Cannon 1985). **SIZE OF FORAGING FLOCKS:** Feed singly, in pairs or in small flocks, usually of <10 birds; occasionally in larger flocks, e.g. of 8–20 birds at onset of winter, or, exceptionally, of up to c. 100 (Hutchins & Lovell 1985; Forshaw). At Warwick, usually feed in groups of 1–5, mostly alone or in pairs; larger groups seen Feb.–May; largest flock recorded, 55 birds, feeding on Sorghum, in May. Of 1713

feeding groups, 1972–74, 13% of groups >5 birds, and only 3.5% >10 birds; mean size of feeding groups <5 birds in all months; groups largest in late summer to early winter (at least partly a result of recruitment of juveniles); smallest in winter and spring (lowest 1.7 birds, in Nov.). Size of feeding groups also varies with time of day: largest in early morning (mean flock-size, 7 birds), smallest at midday (1–2 birds) and intermediate in late afternoon (3–4 birds) (n=1110 groups; Cannon 1984a). At Armidale, NSW, mean size of feeding flocks 5 birds (n=340 feeding groups; Brereton 1971a). **TIMES OF FORAGING:** At Warwick, May 1972 to Mar. 1973, feeding activity peaked in mid-morning and in afternoon in most months; in Sept., most feeding activity in afternoon; in May and July, forage more at midday than in other months (Cannon 1977). Over year, 49.7% of total annual time budget spent foraging (n=17,881 observations of behaviour); spend greater proportion of daily time foraging in 'cooler months' (50–60%) than in summer (30%) (Wyndham & Cannon 1985). At Shepherds Hill Reserve and Belair NP, SA, behaviour similar to that reported at Warwick; between Feb. and Sept., average 56% of daily time budget spent foraging (38% at Shepherds Hill from 7.4 h observations, 64% at Belair from 20.6 h observations). Time spent feeding varied throughout day and between months. Most feeding during first hours of day and at end of day, and lowest during mid-afternoon; seasonally, spent more time feeding during June–Aug. (winter) than in other months (Torcello 1990). **SEASONAL CHANGES IN DIET:** At Warwick, recorded feeding on a total of 82 species of plants over year, with 20 different species of plants, plus seeds obtained from cattle dung, forming bulk of diet over year; in any month, mean of 5.5 food plants form 70% of diet. Grasses main component of diet throughout year, providing 42.7% of total food eaten (ranging from 2.8% of observations in Sept. to 68.9% in May); also take food from herbs 26.8% (11.8% in July to 71.9% in Sept.), from shrubs 2.7% (0.8% in Sept. to 9.6% in Nov.) and trees 25.5% (10.9% in May to 52.8% in July). Mostly eat fruits and seeds (ranging from 48.5% of observations in July to 96.0% in May); also forage on or at flowers (maximum 20.1% in Jan.); and insects, mainly lerps (Psyllidae) and scale insects (Coccidae) eaten in most months of year (maximum nearly 50% of diet in July) (Cannon 1977, 1981). **HANDLING OF FOOD:** When feeding on caterpillars of cup moth *Doratifera*, grasp leaf in foot, cut through petiole with bill, then transfer leaf to bill and remove caterpillar from leaf with foot; then drop leaf, rip open soft underparts of caterpillar with bill, and eat abdominal parts before dropping corpse (Goldsack & Goldsack 1977). Remove galls from eucalypt leaves and extract small insects from them (Green & Swift 1965). **FORAGING POSTURES:** Eastern and Pale-headed Rosellas use three main postures while feeding: standing, perching and clinging. On ground, usually feed in standing position, and pick food directly from ground, reach up and pull plants to ground, or climb stem of plant so that it bends to ground. On horizontal perches, assume normal upright perching position if food close, or reach to obtain food. When feeding on mistletoes, cling to vertical stems. **USE OF FEET:** Use feet to hold food when in standing and perching postures, but not when clinging. If food held in foot, always picked up in bill then transferred to foot; commonly use feet to hold large items. Predominantly use right foot; of 430 observations on use of feet at Warwick, used left in 25.8% of observations, and right in 74.2%, a ratio of 1:3 (Cannon 1977). **IMPACT ON CROPS:** In n. NSW, occasional pest of Sunflower crops, feeding on seeds in small flocks of <10 birds (Jones 1983).

Detailed studies At MANSFIELD, VIC. (41 crops and

stomachs; Bridgewater 1934): **Plants** (Seeds unless stated.) Unident. 58.5% freq. MONOCOTYLEDONS: Cyperaceae: *Carex* 14.6; *C. inversa* 7.3; *Gahnia* 2.4; Iridaceae: *Romulea* 4.8; Juncaceae: *Luzula campestris* 4.8; Poaceae: *Avena* 14.6; *Panicum* 4.8; *Setaria* 2.4. DICOTYLEDONS: Asteraceae: *Carduus marianus* 12.2; *Cirsium arvense* 24.4; *Hypochaeris radicata* 21.9; *Onopordium acanthium* 12.2; Brassicaceae: *Diplotaxis* 7.3; *D. muralis* 4.8; Caryophyllaceae: *Silene* 4.8; *S. gallica* 7.3; *Stellaria media* 12.2; Chenopodiaceae: *Chenopodium* 2.4; Euphorbiaceae: *Euphorbia drummondii* 2.4; Fabaceae: *Medicago* 2.4; *Trifolium* 17.0; *T. glomeratum* 4.8; *T. subterraneum* 63.4; *Trigonella* 2.4; Geraneaceae: *Erodium* 19.5; Malvaceae: *Hibiscus trionum* 4.8; Polygonaceae: *Rumex* 9.7; *R. acetosella* 4.8; Ranunculaceae: *Ranunculus muricatus* 2.4; Rosaceae: *Malus sylvestris* 31.7; *Prunus avium* 4.8; *Pyrus communis* 2.4. **Animals** INSECTS: Unident. 9.7, eggs 7.3; Diptera: unident. larv. 9.7; Drosophilidae: *Drosophila* 2.4; Stratiomyida 2.4; Coleoptera: Curculionidae 2.4; Staphylinidae larv. 2.4; Hemiptera: Cercopidae 2.4; Cicadellidae 7.3; Isoptera: Rhinotermitidae: *Coptotermes* 4.8; Lepidoptera: Hepialidae eggs 2.4; Noctuidae larv. 2.4. Grit 7.3.

At WARWICK, QLD (1891 obs. of feeding, 1972–73; Cannon 1981). Fruits and seeds comprised 81.2% of total observations, flowers, 7%, and animal matter, mainly insect larvae, comprised 11.8%. Foods recorded with frequency of >1.0% of total observations; other items listed in Other records below): **Plants** (All fruits and seeds.) MONOCOTYLEDONS: Poaceae: *Avena sativa* 1.5% freq.; *Bothriochloa decipiens* 2.6; *Cymbopogon refractus* 3.2; *Eleusine indica* 1.1; *Sorghum bicolor* 22.4; *Urochloa panicoides* 1.7. DICOTYLEDONS: Asteraceae: *Cotula australis* 1.7; *Erigeron* 2.2; *Hypochaeris microcephala* 1.7; Boraginaceae: *Heliotropium amplexicaule* 2.8; Brassicaceae: *Capsella bursapastoris* 1.3; Caryophyllaceae: *Paronychia brasiliensis* 4.0; Casuarinaceae: *Allocauarina luehamannii* 1.1; Lorantheae: *Amyema miquelii* 2.3; Mimosaceae: *Acacia deanei* 4.0; Myrtaceae: *Eucalyptus* 9.5; *E. crebra* 1.2; *E. dealbata* 2.0; *E. moluccana* 4.7; Solanaceae: *Lycium ferocissimum* 1.3. Dung, from which extracting seeds 2.8.

Other records Aust. Plants (Records from Cannon [1981] not identified to type of item.) Seeds^{24,32,42}, fruits^{7,13,24}. GYMNOSPERMS: Pinaceae: *Pinus* sds, apical shoots¹⁵. MONOCOTYLEDONS: Cyperaceae: *Cyperus* sds⁴³; *Lepidosperma laterale* sds³⁸; Juncaceae: *Juncus usitatus*¹⁹; Poaceae: *Aristida*¹⁹; *A. calycina*¹⁹; *A. vagans*¹⁹; *Avena* sds^{5,24,34}; *A. sativa* sds³⁸; *Bromus* sds⁴³; *B. catharticus*¹⁹; *Chloris truncata*¹⁹; *C. ventricosa*¹⁹; *C. virgata*¹⁹; *Chrysopogon*¹⁹; *Cynodon dactylon*¹⁹; *Danthonia penicillata* sds⁴³; *Digitaria brownii*¹⁹; *D. ischaemum* sds³⁸; *D. sanguinalis* sds^{34,38}; *Echinochloa colona*¹⁹; *Enneapogon*¹⁹; *Eragrostis*¹⁹; *E. parviflora*¹⁹; *E. pilosa*¹⁹; *E. sororia*¹⁹; *Eriochloa pseudoacrotricha*¹⁹; *Hordeum hystrix* sds³⁸; *H. vulgare*¹⁹; *Panicum* sds⁴³; *P. simile*¹⁹; *Paspalum distichum*¹⁹; *P. urvillei* sds³⁸; *Pennisetum clandestinum* sds³⁸; *Phalaris aquatica* sds³⁴; *Poa annua* sds^{34,38}; *Rhynchelytrum repens*¹⁹; *Setaria*¹⁹; *Sporobolus creber*¹⁹; *S. diander*¹⁹; *S. elongatus*¹⁹; *Tragus australianus*¹⁹; *Triticum aestivum* sds^{2,24,40,43}; *Zeamays* sds^{24,39}; unident. grass sds^{13,24,31,39,42}; Xanthorrhoeaceae: *Xanthorrhoea* fl.¹⁰. DICOTYLEDONS: Amaranthaceae: *Alternanthera pungens*¹⁹; *Amaranthus* sds³⁹; *Gomphrena celosioides*¹⁹; Anacardiaceae: *Schinus molle*¹⁹; Apiaceae: *Actinotus helianthi* sds⁴²; Asteraceae: *Arctotheca calendula* sds³⁴; *Cassinia laevis* sds⁸; *Cirsium arvense* sds⁸; *Erigeron canadensis* sds³⁸; *Gazania* lvs^{16,21}; *Glossogyne bidens*¹⁹; *Helianthus annuus* sds^{20,24}; *Helichrysum romosissimum*¹⁹; *H. scorpiodes* sds⁴³; *Hypochaeris radicata* fl.^{19,34}; *Inula graveolens* sds³⁸; *Onopordium acanthium* sds^{7,42}; *Senecio lautus* fl.³⁴; *Taraxacum* sds³⁴; *Vittadinia*¹⁹; *V. australasica*¹⁹; *V. pustulata*¹⁹; *V. tenuissima*¹⁹; *Xanthium strumarium*¹⁹; *Zinnia peruviana*¹⁹; Betulaceae: *Betula pendula* sds³⁴; Bignoniaceae: *Jacaranda mimosifolia* fl.²¹;

Boraginaceae: *Myosotis* sds⁴³; Brassicaceae: *Capsella bursapastoris* sds³⁹; *Lepidium bonariense*¹⁹; *Sisymbrium erysimoides* sds³⁴; Caryophyllaceae: *Cerastium* sds⁴⁰; *C. glomeratum* fl., lvs, sds³⁴; *Stellaria* sds¹⁸; *S. media* sds^{38,40}; Casuarinaceae: *Casuarina* sds²¹; Chenopodiaceae: *Chenopodium* sds⁴³; *C. album* sds³⁴; *Einadia polygonoides*¹⁹; *Maireana microphylla* sds^{19,34}; *Melilotis alba* sds⁴²; Convolvulaceae: *Evolvulus alsinoides*¹⁹; Crassulaceae: *Crassula sieberiana*¹⁹; Dilleniaceae: *Hibbertia scandens* fru.⁴⁴; Elaeocarpaceae: *Sloanea woollsii* sds²⁷; Euphorbiaceae: *Baloghia lucida* sds²⁷; *Cleistanthus cunninghamii* fru.²⁸; Fabaceae: *Erythrina* sds²¹; *Medicago minima*¹⁹; *M. polymorpha*¹⁹; *M. sativa*¹⁹; *Robinia pseudoacacia* fl.³⁵; *Trifolium dubium* sds⁴³; *T. subterraneum* sds^{24,43}; Fagaceae: *Quercus palustris* sds³⁴; *Q. robur* fru.³³; Lorantheae: unident. fl.^{22,46}; *Dendrophthoe glabrescens*¹⁹; Meliaceae: *Melia azedarach* sds³⁵; Mimosaceae: *Acacia* sds^{24,31}; *A. baileyana* sds³⁴; *A. dealbata* sds^{34,37}; *A. falcata*¹⁹; *A. genistifolia* sds³⁷; *A. implexa* sds³⁴; *A. mearnsii* sds³⁷; *A. melanoxylon* sds²⁷; *A. podalyrifolia*¹⁹; *Calliandra haematocephala* sds³⁸; *Paraserianthes lophantha* sds²¹; Moraceae: *Ficus virens* fru.⁴⁴; Myrtaceae: *Acmena ingens* fru.⁴⁴; *Angophora floribunda* sds⁴⁶; *Callistemon* fl.³⁸; *Eucalyptus* sds, fl.^{1,42}; *E. albens* fl.⁴⁶; *E. camaldulensis* sds²⁴; *E. cinerea* fl.²¹; *E. drepanophylla*¹⁹; *E. melliodora* sds²⁴, fl.^{35,46}; *E. sideroxylon* sds⁴⁶; Oleaceae: *Olea europaea* fru.²⁹; Oxalidaceae: *Oxalis* sds^{40,43}; Plantaginaceae: *Plantago varia* sds¹⁹; Platanaceae: *Platanus orientalis* sds³⁰; Polygonaceae: *Persicaria hydropiper*¹⁹; *Rumex acetosella* sds⁴³; *R. crispus* sds³⁵; Portulacaceae: *Portulaca*¹⁹; Proteaceae: *Banksia integrifolia* sds^{14,38}; *B. serrata* sds¹⁴; *Grevillea* sds³¹, nectar³⁸; Rosaceae: *Crataegus* sds, fru.^{21,24,42}; *Cotoneaster pannosus* sds³⁴; *Cydonia oblonga* fru.^{4,35}; *Malus sylvestris* fru.^{4,6,12,25,38,39}; *Prunus armeniaca* fru.⁴; *P. avium* fru.²⁵; *P. domestica* fru.³⁵; *P. dulcis* sds²⁴; *P. persica* fru.^{4,9,21,38}; *Pyracantha* sds^{21,42}; *P. angustifolia* sds³⁴; *P. fortuneana* sds³⁴; *Pyrus communis* fru., buds^{2,4,6,21,25}; *Rosa rubiginosa* sds²⁴; Rubiaceae: *Rondeletia amoena* sds²¹; Rutaceae: *Coleonema pulchrum* fl., buds, lvs, sds³⁴; Salicaceae: *Populus* lvs, buds⁴²; *Salix* buds⁵; *S. babylonica*¹⁹; Sapindaceae: *Guioa semiglaucula* sds²⁷; *Jagera pseudorhus* sds³²; Solanaceae: *Cestrum* fl.²¹; *Lycium ferocissimum* sds^{3,22}; Sterculiaceae: *Brachychiton acerifolius* sds²¹; Ulmaceae: *Ulmus* sds⁴⁵; *Zelkova serrata* lvs³⁴; Urticaceae: *Urtica urens*¹⁹; Verbenaceae: *Lantana camara* sds^{27,38}. **Animals** INSECTS: Unident. larv.^{24,31}; Coleoptera: Chrysomelidae: *Cadmus*⁴³; *Paropsis*⁴²; Curculionidae: larv.⁴³; Diptera larv.^{39,43}; Hemiptera: Coccidae^{19,38}; *Gascardia destructor*³⁸; Lygaeidae⁴³; Psyllidae^{23,36,46}; Trioziidae: *Schedotrioza* galls¹¹; Isoptera²⁴; Lepidoptera: Limacodidae: *Doratifera* larv.¹⁷. Meat scraps²⁶; refuse¹⁸. Grit^{18,41}.

REFERENCES: ¹ Littler 1904; ² Batey 1907; ³ Austin 1912; ⁴ White 1919; ⁵ Fletcher 1921; ⁶ Mellor 1921; ⁷ Chisholm 1934; ⁸ Hyem 1936; ⁹ Ryan 1953; ¹⁰ Hindwood & Sharland 1964; ¹¹ Green & Swift 1965; ¹² Noonan 1965; ¹³ Lendon 1973; ¹⁴ Cooper 1975; ¹⁵ Gepp & Fife 1975; ¹⁶ Baldwin 1976; ¹⁷ Goldsack & Goldsack 1977; ¹⁸ van Tets *et al.* 1977; ¹⁹ Cannon 1981; ²⁰ Jones 1983; ²¹ Smith *et al.* 1984; ²² Ashton 1985; ²³ Wyndham & Cannon 1985; ²⁴ Hutchins & Lovell 1985; ²⁵ Halse 1986; ²⁶ Buckingham 1987; Holmes²⁷ 1987, ²⁸ 1990; ²⁹ Paton *et al.* 1988; ³⁰ Browne 1990; ³¹ Hoskin 1991; ³² Green 1993; ³³ Kloot & McCulloch 1993; Lepski³⁴ 1993, ³⁵ 1997; ³⁶ Green 1995; ³⁷ McCulloch 1997; ³⁸ Rose 1997; ³⁹ Cleland; ⁴⁰ Lea & Gray; ⁴¹ Hall; ⁴² Forshaw; ⁴³ FAB; ⁴⁴ G. Holmes; ⁴⁵ J.M. Peter; ⁴⁶ T. Saunders.

NZ **Plants** (Seeds unless stated.) GYMNOSPERMS: Araucariaceae: *Agathis australis*³; Pinaceae: *Pinus pinaster*⁹; Podocarpaceae: *Dacrydium cupressinum*¹; *Podocarpus dacrydiodes*⁵; *P. totara*⁵. MONOCOTYLEDONS: Agavaceae: *Cordyline*¹⁰; *Phormium tenax*^{5,12}; Poaceae⁵: *Triticum aestivum*³. DICOTYLEDONS:

Asteraceae^{3,5}: *Senecio jacobaea* fl.⁸; Mimosaceae: *Acacia*^{5,11}; Myrtaceae: *Acmena* fru.⁷; *Eucalyptus*⁵; Plantaginaceae: *Plantago*⁷; Polygonaceae: *Rumex*³; Rosaceae: *Crataegus*^{4,5}; *Malus sylvestris*^{2,5}; *Pyrus communis*⁶; *Rosa canina*³; *Rubus idaeus*³; Salicaceae: *Salix lvs*^{3,9}; Verbenaceae: *Vitex lucens* fl.^{9,12}. **Animals** INSECTS: Lepidoptera: ads, eggs of moths^{5,13}. (REFERENCES: ¹ McKenzie 1979; ² Baker 1980; ³ Oliver; CSN ⁴ 3, ⁵ 19, ⁶ 20, ⁷ 24, ⁸ 28, ⁹ 29, ¹⁰ 32, ¹¹ 36, ¹² 38, ¹³ 39).

Intake Based on Cannon (1977). Mean time taken to eat items of food varies with item and where obtained (e.g. ground, trees). On ground, mean time to eat: grass seeds, 2.0–6.0 s/seed, mostly <4 s; flowers of herbs, 2.5–5.6 s; fruits, 2.4–7.4 s, with fruits of most herbs taking <4 s to consume. Generally, take longer to eat mature fruits than immature fruits (e.g. *Lycium ferocissimum*: immature fruit 6.2 s, mature 10.8 s; *Lantana camara*: immature 3.8 s, mature 4.6 s). Mean time taken to eat items in trees also varied depending on nature of item (e.g. fruit, flower, insect); generally, more time taken (15.3–33.3 s) to eat fruits from non-eucalypt species than fruit from eucalypt species (9.2–11.8 s); maximum mean time to eat an item, 33.3 s for cones of *Casuarina cunninghamiana*, minimum mean time 9.2 s for fruits of *Eucalyptus*. When feeding on insects, time taken to search a leaf, consume insect, and drop leaf ranged from 5.3 to 10.3 s; time taken to eat individual insects other than insect galls, 1.1–2.7 s/insect.

SOCIAL ORGANIZATION Reasonably well known; detailed study of foraging behaviour near Warwick, Qld (Cannon 1977, 1984a) and long-term studies of social organization at Armidale, NSW, by Brereton (1963a,b, 1971a,b) and Vogels (1996), but latter not available for study here. Adults mostly found in solitary mated pairs throughout year. After breeding season, juveniles disperse from natal area 10–12 weeks after fledging and, with subadults, form unstable flocks of 4–6 birds; such small flocks often amalgamate to form large flocks, usually of 25–30 birds but occasionally up to several hundred. As spring approaches, larger flocks usually disintegrate into smaller flocks again; newly formed pairs then enter the breeding population, while non-breeders continue to roam in flocks of 4–6, only occasionally amalgamating into larger flocks (Brereton 1963a,b, 1971a,b; Hutchins & Lovell 1985; Wyndham & Cannon 1985; Penck 1992; Tzaros 1993). Small parties originally suggested, wrongly, to be family groups (Brereton 1963a,b). In e. Qld–NSW border region mean size of all groups 1.9 (0.9; 1–6; 59 groups) (Cannon 1984b); in Belair NP, Adelaide, 2.9 (n=67 groups) (Penck *et al.* 1995). Groups largest when feeding; for details of feeding flocks, see Food section.

Bonds Monogamous; pairs remain together throughout year and from year to year (Brereton 1963a, 1971b). Generally first breed when c. 3 years old (Cannon 1977); can breed in first year but most probably do not; subordinates perhaps inhibited from breeding by dominant adult pairs (Smith & Brereton 1976; Wyndham & Cannon 1985). Pair-bonds probably form in flocks in non-breeding season; pairings evident during non-breeding season but not necessarily permanent till after winter and pairs stabilize and separate from flock (Brereton 1971a).

Parental care Female incubates and broods (Brereton 1963b, 1971a; Cannon 1977; Schmidt 1984; Forshaw; cf. Fairlie 1991). Both parents feed nestlings but male not until 10–21 days after hatching (Brereton 1963b, 1971a; Forshaw 1962; Tzaros 1993; Forshaw; cf. Fairlie 1991). If young fledge asynchronously, female cares for remaining nestlings and male tends fledgelings (Brereton 1971a). Both parents feed young for 2–3 weeks (Brereton 1971a; Penck 1992) or 5–14 days (Tzaros 1993) after

fledging, after which care by female decreases (Brereton 1971a); male may continue feeding young for up to another 4 weeks (Brereton 1971a). Juveniles remain in natal area for up to 10–12 weeks before dispersing (Brereton 1971a; Penck 1992; Tzaros 1993; Wyndham & Cannon 1985). One bird seen to feed nestling Crimson Rosellas (Jorm 1993).

Breeding dispersion Solitary. At two sites in Adelaide mean distance between nests 45 m (37; 11) and 44 m (14; 9); inter-nest distance possibly enforced (Penck 1992; Penck *et al.* 1995); two nests 110 m apart (Tzaros 1993). **Home-ranges, Territories** During breeding season, pairs defend small territory round nesting hollow (Aston 1959; Brereton 1963b; Tzaros 1993; Lane 1994; Forshaw), and chase away intruders from c. 30 m round nest (Cannon 1977). Other pairs searching for nest-sites within 45–90 m of occupied nest-hole driven off (Brereton 1971b; Smith & Brereton 1976), but this does not prevent low-status birds feeding near occupied nest-holes (Brereton 1971b). Pair observed to defend nest-box during non-breeding season (Tzaros 1993). 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 meet at preferred sites. Use of areas within home-range can alter through year (Brereton 1971a). Nest-sites often re-used, but not known if by same pairs (Brereton 1963b; Lane 1994).

Roosting Nocturnal. Roost on fine twigs among dense outer foliage (Brereton 1963a,b, 1971a; Forshaw). Members of pairs usually roost alone, often in different trees, though some pairs roost together, with birds almost touching. Flocks of non-breeding birds roost together, with up to four birds in one tree; groups of 12–25 roosting together in autumn are non-breeding flocks (Brereton 1971b *contra* Brereton 1963a); in captivity, female starts roosting in nest-hole in early spring (Brereton 1963b). Bask high, on ends of exposed branches near roosting site (Brereton 1971a; Torcello 1990). During day loaf, hidden in foliage of eucalypts (Brereton 1971a; *contra* Forshaw). During day, groups of 10–20 birds loaf in trees, spread out over up to 1.2 ha with 2–4 birds in a tree (Brereton 1971a,b). Daily pattern of activity, especially of feeding, perching, resting and maintenance behaviour, does not vary greatly. Leave roost about sunrise or earlier, and then bask; bask or loaf again just before sunset; main rest period at midday in summer, early morning in winter (Brereton 1971a; Wyndham & Cannon 1985; Torcello 1990). At Armidale, move into foliage as light fades (Wyndham & Cannon 1985). Time spent resting and in maintenance activities greatest during middle of day in most months, but variation in time spent in these behaviours not statistically significant on either daily or yearly basis (Cannon 1977). In Adelaide region, go to roost later than Crimson Rosella *P. e. adalaidae* (Torcello 1990). Resting and roosting postures almost identical to those of Crimson Rosella (Aslin 1978).

SOCIAL BEHAVIOUR Reasonably well known; account based mainly on long-term studies at Armidale, NSW (Brereton 1963a,b, 1971a,b) with some information from Adelaide, SA (Torcello 1990; Penck 1992; Penck *et al.* 1995); recent detailed study at Armidale by Vogels (1996) not available for summary here. Some information from captive birds (e.g. Schmidt 1984; Fairlie 1991; Vroegop 1993). Vocal and active when breeding and in flocks; pairs in non-breeding season quiet and less conspicuous. Generally conspicuous but can be somewhat wary and unobtrusive when feeding. Agonistic and sexual display: noisy, conspicuous and often communal; almost identical to those of other rosellas; large vocal repertoire compared to many parrots; most frequently performed during breeding season

(Brereton 1971a,b; Aslin 1978). Calling, aggression and supplanting common in groups going to roost. Juveniles often give adult calls in inappropriate context until c. 10 weeks after fledging (Penck 1992). Juveniles occasionally seen to touch as if performing incipient allopreening (which does not occur in adults, see below) or allofeeding, but this behaviour sometimes appears aggressive (Brereton 1971a). At nest-box where two pairs apparently resident in vicinity, one Rosella emerged from nest-box and flew off holding an egg in its foot, followed by another Rosella; two eggs were also found on ground near nest-box in previous few days (E.L. Cadwallader). **Flock behaviour** Flocks not cohesive but composed of smaller parties, pairs and individuals that move independently; within flocks, birds widely spaced, but pairs stay closer and move together. Observed coming to bathe in parties of 6–9; at least one bird remains in trees while others bathe; wade out to water 15–20 cm deep, splash and shake; stay in for >1 min then fly to trees to preen (Vellenga 1965). Mainly use right foot to hold food (see Food).

Agonistic behaviour Agonistic encounters infrequent during non-breeding season; as breeding progresses, agonistic behaviour becomes more frequent and more intense, both within and between non-breeding groups and between pairs and other birds; at first, agonistic encounters mostly at feeding and roosting sites but later solely over nesting areas and holes (Brereton 1971a,b; Penck 1992). At two sites in SA, agonistic behaviour 8% and 17% of activity during breeding season (Penck *et al.* 1995). At Warwick, Qld, no statistically significant changes in time spent in agonistic behaviour between seasons or through day (Cannon 1977). When feeding, spacing of individuals varies with season and feeding station but mean generally ranges from <1 to c. 3 m; mated pairs generally feed closer together than non-paired birds (Brereton 1971a; Cannon 1977, 1984a). **Threat, Attack** THREAT DISPLAY: Similar to that of Crimson Rosella. If others approach while birds inspecting nest-hole, male gives aggressive chatter; if intruders persist, male may fly at them wagging tail, calling and spreading tail; may involve several birds and be noisy (Brereton 1963b). **Fighting** Males seen aggressively attacking one another close to nest-sites, often locking feet and tumbling to ground from perches; utter constant loud chattering and squawking, with feathers often being lost from one or both birds; eventually one retreats (C. Tzaros). **Hierarchies** Occur at all social levels (between groups and between individuals within groups); pairs dominant to non-breeding groups; lower status groups usually give way without fighting; subordinate will not come to feeding station if dominant present (Brereton 1971a,b); principles governing hierarchy appear similar to those in Crimson Rosella (q.v.; Aslin 1978). **Alarm** Flocks take flight at sudden danger, with one or several birds giving flight alarm call (Brereton 1971a); disturbed flocks tend to fly only short distance and land close together; sometimes fly farther and disperse (Brereton 1971a). Large flocks break into groups of c. 20 when disturbed (Brereton 1963b). General alarm call may attract up to 20–30 birds to caller (Brereton 1963a). During Nest-hole Inspection, male gives alarm call if predator appears while female in hole (Brereton 1963a). Pairs scared from nest-hole during inspection land nearby, call and wag tails (Torcello 1990). Aggression toward other species common; at Adelaide, most often toward Crimson Rosellas, Rainbow Lorikeets *Trichoglossus haematodus* and Red-rumped Parrots; also chased by Noisy Miners *Manorina melanocephala* (Forshaw 1962; Penck 1992; Penck *et al.* 1995); observations of Common Starlings being chased from nest-holes and competition for nest-hole with Scaly-breasted Lorikeets *Trichoglossus chlorolepidotus* (NRS).

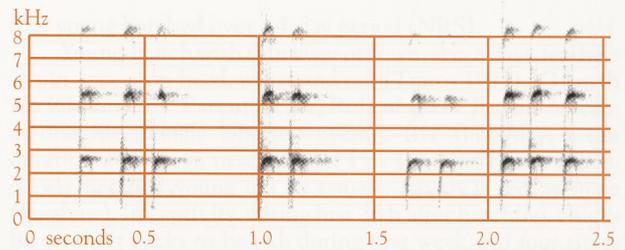
Sexual behaviour Male initiates most behaviour of pair (Brereton 1971b). **Courtship** COURTSHIP DISPLAY: Similar to that of other rosellas (Forshaw 1962; Forshaw); drop wings and wag tail while chattering quietly (Lucas 1975; Fairlie 1991). Often performed on ground in manner similar to ground-dwelling pigeons; before breeding season, several males will often display simultaneously to female, but fights quickly erupt (Forshaw 1962). **Courtship feeding** Male feeds female from shortly before laying, through incubation and after chicks hatch, till male begins to feed chicks; if birds re-nest, courtship feeding resumes as soon as first brood fledges (Brereton 1963b). In captivity, male sometimes feeds female all year (Fairlie 1991). During incubation, female briefly leaves nest 2–4 times/day to be fed by and to feed with male (Brereton 1963b; Tzaros 1993; Forshaw). When female on nest, male calls to her and follows when she emerges; usually fly to feeding ground or nearby tree where he may feed her (Brereton 1971a). **Allopreening** Does not occur among adults (Brereton 1963a,b; Cannon 1979), but behaviour which is perhaps incipient allopreening occasionally seen among juveniles (Brereton 1971a), and full allopreening observed in one group of captive juveniles (see below). **NEST-HOLE INSPECTION:** Male flies to tree while wagging tail, looks into hole and moves off short distance; female then peers into hole and later enters for short periods; male gives distinctive call as female enters hollow; female may press bill against wood near hole (Brereton 1963b) as in Crimson Rosella; this behaviour considered to be stereotypic (Aslin 1978). **Copulation** In captivity, normally preceded by Courtship Display and courtship feeding (Fairlie 1991). Observed near nest-hole and once on ground, after which female visited nest-hole (NRS).

Relations within family group Nestlings give grating call when parents visit (Forshaw 1962). Both parents call and make short flights to encourage young to leave nest (Brereton 1963b, 1971a; De Graaff 1989); as young fly from nest, escorted by one parent on each side (Brereton 1971a). In wild, siblings seen to fence with bills (Cannon 1979). In one captive group of juveniles, some engaged in allopreening, begging and allofeeding with each other from 20–33 days old. Fledgelings will chase parents while begging (NRS). Female becomes aggressive to young 2–4 weeks after fledging; male may tolerate and perhaps feed them for up to another 4 weeks but also shows some aggression (Brereton 1971a,b). Young remain together near nest-site and dependent on parents for food for 2–4 weeks after fledging; range of one brood 18 days after fledging c. 300 m² (Tzaros 1993); thereafter spend time away from parents and increase range, often forming small flocks with other juveniles (Brereton 1971a,b; Penck 1992; Tzaros 1993). At Adelaide, formed groups with juvenile Crimson Rosellas (Penck 1992). Detailed studies above do not support claim that young stay with parents for many months unless adults re-nest (Forshaw). **Anti-predator behaviour of young** Can be approached more closely than young of Crimson Rosellas (Forshaw 1962). Observation of family group flying in different directions when flushed, one fledgeling with each parent (NRS). **Parental anti-predator behaviour** Male may perch <30 m from nest when female sitting (Brereton 1971a). In wild, may sit tight on nest (NRS). In captivity, female sits tight on nest; if nest inspected, female settles over eggs or young, spreads wings and opens bill aggressively (Fairlie 1991).

VOICE Detailed studies near Armidale, NSW (Brereton 1963a,b, 1971a,b; Brereton & Pidgeon 1966) and near Adelaide, SA (Penck 1992). Brereton (1963a) claims a repertoire

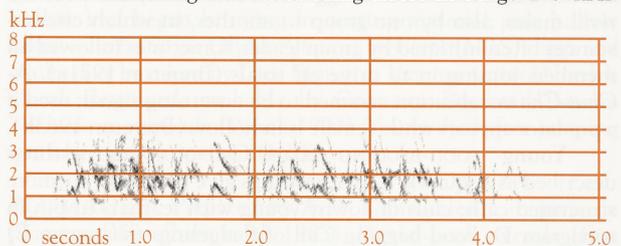
of 19 calls, including one generalized alarm, one flight alarm, eight post-flight contact calls, five calls used in agonistic display, three very quiet or murmuring calls and one food-begging call, but gives no details. Brereton (1963b) mentions a predator alarm (A-Chut-Cha Call, see below), but again without details. Brereton & Pidgeon (1966) refer to 24 calls, of which only 13 said to have any function and with most of rest appearing to be corrupted versions of functional calls; functional calls were grouped as warning and distress calls, aggression calls and location and intention calls, but no complete description of repertoire given; sonagrams given to illustrate structure of calls and possible derivation of adult calls from calls of young. Later, Brereton (1971a) mentions 25 calls, six exclusive to non-reproductive behaviour and seven exclusive to reproductive behaviour, with 12 common to both; again no details given. Only 14 calls can be identified from these accounts. Penck (1992) lists seven calls and provides sonagrams, giving descriptive information for each. Noisy; calls variously described as sharp, brisk, metallic, piping, shrill and chattering (e.g. Pizzey 1980; Forshaw). All calls said to be like those of other rosellas, but calls noticeably higher pitched than those of Crimson Rosella (Forshaw). Also, Penck (1992) compared calls of Eastern Rosella and Crimson Rosella: calls of Eastern sound more melodic, generally have more restricted frequency range and have more strongly defined harmonics. Structural comparisons show calls of Eastern and Crimson Rosella to be very similar, though some may sound very different (Penck 1992; Brereton 1971a). In year-long study at Moggill, Qld, vocal activity shown to vary seasonally; in Jan., vocal activity peaked in morning and afternoon; in Mar. and May, most calling occurred in afternoon and evening; in July, Sept. and Nov. most calling occurred in morning and middle of day (Cannon 1977). Near Armidale (Brereton & Pidgeon 1966; Brereton 1971a): Piping uttered more or less constantly throughout year, but most commonly heard from birds in flocks in summer and autumn; in Feb. and Mar., Choying of young most noticeable call; gradually Choying replaced by Pinging and Piping as most obvious calls; these most common during autumn, in flocks, and in part because juveniles develop these calls at this time. Agonistic calls more common in flocks in autumn and in spring. Roosting accompanied by frequent noisy disturbances (Brereton 1963b). Little information on individual or regional variation; in Vic., differences in the flight and alarm calls between central and nw. Vic.; in nw.Vic., calls harsher and not so sharp, more closely resembling the pitch and tone of subspecies *flaveolus* of Crimson Rosella (C. Tzaros). Mimicry not reported in wild; said to be rare in captivity (Tavistock 1929). NON-VOCAL SOUNDS: Audible ruffling of feathers in some displays.

Adult Account mostly based on Brereton (1971a), Brereton & Pidgeon (1966) and Penck (1992). **PINGING CALL:** Loud pure-toned disyllabic pinging sound (Brereton 1971a; Brereton & Pidgeon 1966); metallic piping *kwink-kwink ... kwink-kwink* (Forshaw) or *pink-pink* (Pizzey 1980). Call considered to be a warning and group co-ordination signal in response to danger (Brereton & Pidgeon 1966). Equivalent to Geck or Pik calls of Penck (1992) (sonagrams A): a short-duration call spanning range 1–10 kHz. Number of repetitions of this *pik* sound vary, reflecting intensity of calling (Penck 1992); often given as single or double call; given in alarm or threat; sometimes accompanied by agonistic vocalizations (Penck 1992). **PIPING CALLS** (= p call of Brereton 1971a; Brereton & Pidgeon 1966): Piping note repeated from two to many times; probably *chut-chit ... chut-chit ... chut-chit* or *chut-chit-chut ... chut-chit*



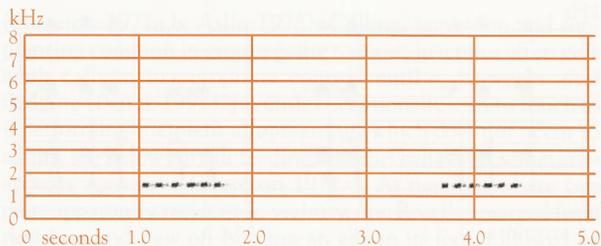
A D.A. Stewart; Mullumbimby, NSW, Mar. 1993; priv.

chut of Forshaw, or slow ringing *pee-p-pee* of Pizzey (1980) (sonagram B); in sample of 1165 Piping Calls from 140 h observations over 15 months, distribution of variants was: two note (2p), 22%; three (3p), 56%; four (4p), 12%; five (5p), 2% and six or more (6p), 8% (Brereton & Pidgeon 1966). Said to function as perch location call (Brereton 1971a) but not known what this may be; three-note piping (p of Brereton) often heard after birds land. Penck (1992) describes four piping calls, which were thought to function as contact calls and used at different ranges: (1) High-pitched *pii-pi-dee*, with first and last syllables longer than middle; all notes centred at c. 2.5 kHz. Medium to long-range contact call; rarely heard and then with Agonistic Calls. (2) Repeated *du-du ...*, varying in length and pitch; three or five repeated syllables most common and most energy at c. 2 kHz with an upper harmonic at c. 7.3 kHz; syllables long, c. 170 ms. Medium-range contact call; possibly signals mild threat to other birds; often given just after alighting in tree (cf. three-note piping of Brereton), and often followed by Chatter. (3) Soft, low-frequency *whut-whut-whut*. Intermediate range contact call; often given by adult in response to calling young but may also serve as mild threat. (4) Soft Chatter: continuous series of ascending and descending notes in range 1–5 kHz.



B F. van Gessel; Patterson, NSW, Sept. 1987; P40

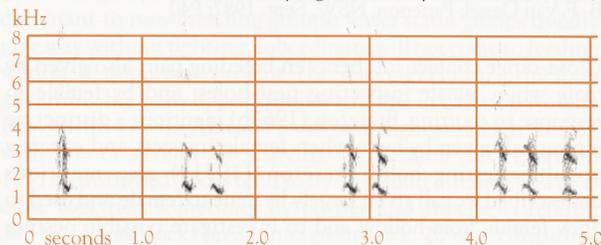
Close-range contact call between breeding pair; also given by male when female inspecting nest-holes; and by female in response to courting. Brereton (1963b) mentions a distinctive piping call given by male when female inspects and enters a possible nesting hole; Brereton (1971a) also mentions undescribed *wc* call given largely by male to female and used to draw female from hollow and to investigate possible nesting sites. Both possibly variants of soft chatter. **CHATTER CALL:** Probably ACH call of Brereton (1971a). Penck (1992) distinguishes two types of Chatter call: a Chatter and Beak Clatter (sonagram C; the sound of Beak Clatter follows some Chattering). The chatter is a continuous series of ascending and descending notes in range 1–5 kHz; Beak Clatter is structured in range 2–9 kHz, with much shorter notes. ACH Call of Brereton said to be strong call, given only when perched and generally when Pinging heard in distance; suggested to function to bring flying groups to perch near caller (Brereton 1971a). But Penck (1992) considered Chattering Call to be agonistic calls and suggested they function as mild threat at



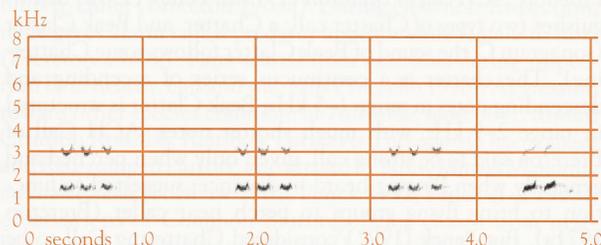
C D.A. Stewart; Mullumbimby, NSW, Aug. 1993; priv.

intermediate range in presence of other birds or in response to vocalizations from them; both types of Chatter given between stronger Agonistic Calls. Brereton (1963b) mentions a Beak Clatter used by male if another Rosella flies too close during nest-inspections by female. Chatter followed by a bell-like *peep-pip-pip* and twittering call followed by a chatter may be variants of Chatter Call. Clicking (bc) of Brereton & Pidgeon (1966) illustrated by sonagram but not described fully is possibly this call. **AGONISTIC CALL** (Penck 1992): No phonetic rendition. Structure better defined than that of Chatter; each syllable containing recognizable harmonics across full range from 1 to 10 kHz. Suggested to function as more intense threat than Chatter; said to be given by resident pair when another bird is near or during physical confrontations, when intensity of call increases with agitation. Can elicit similar calls from other birds nearby. Often given with tail-wagging, either in flight or when perched; also with tail-spreading and ruffling of feathers (Penck 1992). **Other calls** A Squawk, like Food-begging Call of nestlings (q.v.); heard when bird caught by predator (Brereton & Pidgeon 1966). **A3C** call: not described but similar to wc call (see Piping Calls: Soft Chatter). However, function very different to wc call; claimed to be aggressive call used by males toward rival males; also by one group to another, in which circumstances often initiated by group leader, sometimes followed all members joining in to drive off rivals (Brereton 1971a). **A-Chut-Cha** vocalization assumed to be a warning signal; used if a predator appears while female is in hollow (Brereton 1963b).

Young FOOD-BEGGING CALLS: Call of young nestlings described as a squawk. Older nestlings give progressively more structured calls; calls of downy young with feathers in pin in sonagram **D**. Food-begging Call of fledgelings (sonagram **E**) differs more and termed Choying (C call) by Brereton (1971a).



D J. Courtney; captive; Dec. 1967; priv.



E J. Courtney; captive; Jan. 1968; priv.

Brereton & Pidgeon (1966) speculate on ontogeny of calls, providing illustrative sonagrams; they suggest adult calls develop from simple squawk given by young nestlings and that signs of modification of Food-begging Call toward pinging, piping and aggression calls detectable from c. 2 weeks after young leave nest.

BREEDING Studied in SA (Penck 1992) and Vic. (Tzaros 1993); also in Armidale, NSW (Vogels 1996), but this study not available for summary here. Two hundred and fifty-seven records in NRS up to Dec. 1995. No information from NZ. Hybridizes with Crimson Rosellas (McKean 1959); all known hybrid pairs consist of male Crimson and female Eastern Rosellas (Rogan 1966).

Season Aug. to Jan. or Feb., occasionally later. From 151 records in NRS: eggs, late Aug. to early Jan.: Aug. 1%; Sept. 9%; Oct. 44%; Nov. 31%; Dec. 14%; Jan. 1%; most (62%) between mid-Oct. and mid-Nov.; one record of young in early Sept. Breed Sept.–Feb. (Bedgood 1973); at Mernot, NSW, usually breed from Sept. but on two occasions, eggs and young in Apr. and May (Hyem 1936).

Site Usually in hollow in limb, trunk, fallen log or stump of tree; in fence posts, nest-boxes; occasionally in other sites such as tunnel in sandbank of river or sand-mining area and in buildings, including open-topped brick pillar forming part of garage wall, and in concealed gutter of church roof; once in hole near top of cliff in quarry; in rabbit's burrow; old nest of Grey-crowned Babbler *Pomatostomus temporalis*; arboreal termitarium originally excavated by Laughing Kookaburra *Dacelo novaeguineae*; in elkhorn fern *Platyserium* mounted on wall of house (Quiney 1903; Arnold 1928; McEvey 1954; Bedgood 1962; Carter 1996; North; Forshaw; NRS). Most hollows in eucalypts, living or dead, including Blakely's Red Gum *Eucalyptus blakelyi*, Broad-leaved Stringybark *E. caliginosa*, River Red Gum *E. camaldulensis*, Spotted Gum *E. maculata*, Western Grey Box *E. microcarpa*, Messmate *E. obliqua*, Swamp Gum *E. ovata*, Scribbly Gum *E. rosii*, Forest Red Gum *E. tereticornis* and Manna Gum *E. viminalis*; also in Blackwood *Acacia melanoxylon*, Rough-barked Apple *Angophora floribunda*, White Mangrove *Avicennia marina*, Apple *Pyrus malus*, Moreton Bay Fig *Ficus macrophylla*, Monterey Pine *Pinus radiata*, *Casuarina*, *Melaleuca*, *Leptospermum* and willow *Salix* (Hyem 1936; Penck 1992; North; NRS). From 233 records in NRS: 113 nests (48%) in tree-hollows, including 38 (16%) in trunk and 24 (10%) in limb of tree; 61 (26%) in tree-stumps; 19 (8%) in fence posts; and 40 (17%) in nest-boxes. For 20 nests in SA: 10 in limb and 10 in trunk of tree; 9 in dead part and 11 in living part of tree (Penck 1992). **MEASUREMENTS:** Height of hollow (m): in trees, 4.5 (3.86; 1.0–30.0; 100); tree-stumps, 1.5 (0.65; 0.2–4.0; 46); fence posts, 1.4 (0.35; 0.3–1.8; 17); nest-boxes, 4.2 (1.95; 0.8–10.0; 26) (NRS). At Belair, SA, 5.0 (1.5; 3.0–7.5; 11); at Craighburn, SA, 4.5 (2.4; 2–10; 9) (Penck 1992). Said to use hollows in fence posts because available natural hollows occupied by Common Starlings (Arnold 1928); and said to breed in low hollows and stumps when taller timber removed (Sharland 1936). Will re-nest in same site (Carter 1996; NRS). May use same site year after year (Sharland 1936); one nest-log used for at least four consecutive years, probably by same pair (Lane 1994). One pair took possession of a hollow in which a pair of White-throated Treecreepers *Cormobates leucophaeus* was building a nest (Aston 1959). Hollows usurped by Scaly-breasted Lorikeets, Dollarbirds *Eurystomus orientalis*, Common Mynas *Acridotheres tristis* and Common Starlings (Lord 1942; Peters & Peters 1993; NRS). Nest in same tree as Red-rumped Parrots

(NRS); four nests of Rosellas and one nest of Tree Martin *Hirundo nigricans* in same tree (North). For distance between conspecifics, see Social Organization: Breeding dispersion. Distance to nests of other species: in SA, 49 m (23; 11) (Penck *et al.* 1995); 15 m from nest of Common Starling; 250 m from nest of Turquoise Parrot *Neophema pulchella* (NRS).

Nest, Materials Hollows unlined or lined with wood-chips or decayed wood; grass, plant fibre or feathers found in some hollows probably left from previous occupation; one pair laid on top of old nest of Common Starling (NRS); chamber at end of tunnel in sandbank sprinkled with wood-chips (McEvey 1954). Most hollows vertical; some hollows in inclined or horizontal limbs; one limb angled downward (NRS). A tunnel in sandbank probably enlarged tunnel of Rainbow Bee-eater *Merops ornatus* (Bedggood 1962). **MEASUREMENTS** (cm): Depth of hollow: in limb or trunk of tree, 68.3 (37.2; 18–130; 19); tree-stump, 73.4 (42.7; 30–244; 31); fence post, 94.6 (51.1; 23–160; 17) (NRS). Dimensions of entrance: hollows, 17.1 (8.6; 6–41; 13) × 17.4 (11.9; 8–43; 11) (NRS); two tunnels in sandbank, c. 18 × 10 and 8 × 13 (McEvey 1954; Bedggood 1962).

Eggs Round to round-oval or elliptical; close-grained, occasionally coarse, sometimes with many nodules; lustreless or with slight gloss; white (White 1916; Campbell; North). **MEASUREMENTS**: 26.4 (1.03; 24.4–29.2; 35) × 22.1 (0.96; 20.1–23.9) (White 1916; Campbell; North); ne. NSW, 26.4 (26.2–26.7; 6) × 23.2 (22.6–23.4); s. NSW, 26.9 (25.7–28.1; 7) × 21.7 (21.3–22.1); Tas., 28.1 (27.3–28.8; 8) × 22.5 (22.2–22.9) (Forshaw). Claimed, without evidence, that birds in Gippsland forests lay larger eggs than those of more open country of w. Vic. (Campbell).

Clutch-size Mean 5.6 (1.30; 3–9; 63): C/3 × 4, C/4 × 8, C/5 × 16, C/6 × 22, C/7 × 10, C/8 × 1, C/9 × 2 (NRS); 4–7 (White 1916); 5–9 (North).

Laying In wild, eggs laid at 2-day intervals (Tzaros 1993); 1–3 days (Lane 1994); a clutch of six completed in 11 days (NRS); one egg laid between 09:45 and 18:00 (NRS). In captivity: eggs laid 37–69 h apart (Shephard 1989). Most eggs laid between 08:00 and 14:00 (Shephard 1989). Will continue laying if first eggs of clutch taken (Campbell). One hollow with two entrances contained five young and six eggs, probably a result of laying by two females (Favaloro 1942). Will lay replacement clutches within a few days of loss of eggs or young (Wyndham & Cannon 1985). At Armidale, NSW, laid single brood (Wyndham & Cannon 1985). Lendon (1973) claims usually double-brooded. One pair began laying 1 day before last chick of first brood fledged (Tzaros 1993); another, almost certainly same pair, began laying within 15 days of first brood fledging (Carter 1996).

Incubation By female only (Tzaros 1993; NRS). In one nest, incubation began after laying of fourth egg of a clutch of six (Lane 1994); in captivity, begins with second egg (Shephard 1989). Female leaves nest for brief periods to feed with and to be fed by male (Forshaw); in captivity, male feeds female 8–9 times a day (Shephard 1989). One pair in Vic.: for first clutch, female left nest, accompanied by male, at c. 08:10 and 17:00, earlier on warmer days; mean time away from nest, 5 min 38 s; for second clutch, weather was warmer and female left on average four times/day, usually at c. 08:00, 11:10, 15:00 and 17:45 (Tzaros 1993). **INCUBATION PERIOD**: 19 days (n=11) (Tzaros 1993); 18–22 days (n=3) (NRS); 20–21 days (n=4) from start of incubation (Lane 1994). Eggs hatch at 2-day intervals (n=9) (Tzaros 1993); in captivity, first and second eggs hatch on same day, others 1.5–2 days apart (Shephard 1989); six young hatched over a 5-day period (Hyem 1936);

four young hatched over a 3-day period (NRS).

Young Hatch with thin layer of down; at c. 8 days, feathers in pin appear on head, wings and tail (Tzaros 1993). **Growth** No information. **Parental care, Role of sexes** Female broods; at one site, female left nest average five times/day; mean duration away from nest, 22 min 15 s (no N) (Tzaros 1993). Newly hatched young fed by female, which is fed by male (Forshaw). In captivity, during first 36 h after hatching, chicks lie on their backs to be fed; during first week, fed four times during night; once per night thereafter (Shephard 1989). At c. 10 days, both parents feed young (Forshaw); male entered hollow when young c. 19 days old (Tzaros 1993). At one nest, both adults brooded young on cold rainy day (NRS).

Fledging to independence A brood of five fledged over a 5-day period; after first two young left hollow, adults encouraged remaining young to leave (Ford 1918); a brood of four fledged over a 5-day period (Carter 1996). **FLEDGING PERIOD**: For brood of six and brood of four: first chicks fledged at 36 and 37 days old, second at 35 days, third at 33 days, fourth at 32 days; fifth and sixth young of first brood fledged at 31 days old (Tzaros 1993); 30–33 days (NRS); six young, 28–32 days old, left hollow when disturbed (Hyem 1936). Young of one brood fed for up to 14 days after fledging (Tzaros 1993).

Success From 280 eggs, 176 (62.9%) hatched (n=47 nests); for 42 nests where outcome known or young capable of leaving nest when last seen: from 234 eggs, 137 (58.5%) hatched, 127 (54.3%) fledged; 92.7% of eggs that hatched produced fledgelings; mean success per pair: 5.6 eggs laid, 3.3 hatched and 3.02 young fledged (NRS). For 27 clutches that failed: 9 (33%) deserted, including two where remains of adult found at hollow, 9 (33%) infertile, addled or broken in nest, 5 (19%) flooded after heavy rain, 3 (11%) gone, and 1 (4%) eaten (NRS). Two nests deserted after Common Starlings took over hollow and began bringing in nesting material; one hollow taken over by Sugar Glider *Petaurus breviceps* (NRS). Eggs and adults may be taken by Lace Monitors *Varanus varius* (North); clutch destroyed, probably by Common Brushtail Possum *Trichosurus vulpecula* (Penck 1992). Young died after jumping out when nest inspected (NRS).

PLUMAGES Prepared by A.M. Dunn. Fledge in juvenile plumage (Wyndham *et al.* 1983). Partial post-juvenile (first pre-basic) moult to immature plumage begins within 6 months of hatching. Attain adult plumage in complete first immature post-breeding (second pre-basic) moult early in second year. Thereafter, complete post-breeding (pre-basic) moults each cycle produce successive adult plumages without change in appearance. Sexes differ slightly. Age at first breeding not known. Three subspecies; nominate *eximius* described below.

Adult male (Second and subsequent basic). **HEAD AND NECK**: Most of head and neck (forehead, crown, nape, lores, ear-coverts, sides of neck and feathers under eye), dark red (c108D) with very fine black (89) tips and concealed dark-grey (83) bases to feathers. Cheek-patches, white. Chin and upper throat sparsely feathered with small white feathers. Hindneck varies individually: typically, upper hindneck as most of head and neck; feathers of lower hindneck, yellow (55) with narrow black (89) shaft-streaks or small black (89) central spot; in some, lower one or two rows of hindneck wholly yellow; in others five or six rows wholly yellow. **UPPERPARTS**: Feathers of mantle and scapulars, black (89) with yellowish-green (c58) or pale-green (161) edges; on larger scapulars, edges sometimes join at tip to form a fringe; edges of feathers of upper mantle and outer scapulars tend to be slightly yellower; edges of feathers of

lower mantle and inner scapulars tend to be greener. Feathers of back, black (89) with very broad light-green (c61) fringes, often with area of dark bluish-green (ne) along interface of black centre and green fringes and near tip of feather. Rump and uppertail-coverts, bright green (c58) with very fine black (89) fringe at tip of feathers. **UNDERPARTS:** Breast, red (12). Upper belly and upper flanks, yellow (c55) grading to light green (c61) on lower belly, lower flanks, thighs and vent. Undertail-coverts, red (12). Border between breast and belly well defined but occasionally demarcation messy, with scattered red feathers extending onto centre of upper belly. Some feathers of upper flanks, black (89) with yellow (c55) fringe. All feathers of underparts have very fine black (89) fringes at tips that are quickly lost with wear; most noticeable on yellow of belly. **UPPERTAIL:** Central rectrices (t1) mostly dark green (c146) with dark-blue (c74) suffusion near tips. T2, mostly dark bluish-green (ne), grading to dark violet-blue (72–74) toward tip and on outer web; tip and edge of inner web, black-brown (119). T3–t6, light violet (c170D) with white tip and mostly concealed dark base, which is dark violet-blue (72–74) at outer edge, dark bluish-green (ne) near rachis, and black-brown (119) at inner edge. **UNDERTAIL:** T1 and t2, dark grey (83), sometimes with pale bluish-grey (c86) edges on tips of t2. T3–t6, mostly light blue (c66) with white tips and concealed dark-grey (83) bases. **UPPERWING:** Marginal coverts, outer lesser secondary coverts near carpal joint, and anterior rows of smaller, inner lesser secondary coverts, violet (c71). Rest of lesser secondary coverts, black (89). Outer median secondary coverts, light violet (c170C) grading to violet (71) near tips. Outer greater secondary coverts, light violet (ne) with grey-black (82) base and inner edge and narrow dark violet-blue (72–74) band between violet and grey-black parts of feather. Inner median secondary coverts, inner greater secondary coverts and inner-most secondaries (tertials), black (89) with yellowish-green (c58) or pale-green (161) edges; often have dark bluish-green (ne) or dark-blue (c74) band between black and green of feathers. Lesser and median primary coverts, violet (c71) with dark-grey (83) bases. Alula, mostly dark violet-blue (72–74) with grey-mauve (77) outer web near tip and concealed grey-black (82) bases. Greater primary coverts, mostly dark violet-blue (72–74) with concealed grey-black (82) bases. Primaries and outer secondaries, mostly grey-black (82) with outer web mostly dark violet-blue (72–74) except for tips of feathers; outer four primaries have very fine off-white edge in middle of outer web. **UNDERWING:** Lesser and median coverts, violet (71) with concealed grey (84) bases. Greater coverts, primaries and secondaries, dark grey (c83). Occasionally small underwing-bar present as faint white smudge in middle of outer web of middle primaries (roughly p3–p8).

Adult female (Second and subsequent basic). Plumage varies much more than in adult male. Some very similar to adult male and differ only by underwing-bar (see below); others can appear much paler than adult male, with patchy breast and washed-out appearance. Differences from adult male: All have at least a partial underwing-bar on inner remiges, made up of a series of large yellowish-white (ne) or off-white (ne) spots in middle of inner web of remiges; usually seven and 14 spots on remiges between p8 and s6, with only one spot per remex (Wyndham & Brereton 1982). Occasionally have off-white spots on some underwing-coverts; up to seven spots (Wyndham & Brereton 1982). Some have underwing-bars on both remiges and greater coverts; others have underwing-bar confined to remiges. Centre of nape and hindneck often dark green (c260) with grey-black (82) shaft-streaks or spots and narrow black

(89) fringes at tips of feathers forming large dark patch. Rest of nape and hindneck, as adult male. Central rectrices (t1) slightly duller and more olive-green (c47), and often have broader white tip on outer rectrices (t3–t6). Some adult females possibly indistinguishable from immature males and females, particularly those with spots on greater underwing-coverts.

Downy young Hatch in sparse covering of down (Wyndham *et al.* 1983; Tzaros 1993); down white (Forshaw 1962).

Juvenile Generally much paler and duller than adult male; can be similar to dullest adult females. Plumage varies but not to the extent of adult females. Differences from adult male: **HEAD AND NECK:** Forehead, crown, sides of neck and ear-coverts, peach-red (c94) with very fine black (89) fringe at tips of feathers, bordered on inside by very fine yellow (55) subterminal fringe. Cheek-patch, off-white (ne) with bluish tinge near lower edge of patch. Nape and centre of hindneck dark green (c260) with black (89) shaft-streaks and very fine black (89) fringes at tips of feathers; form dark patch larger than on any adult females. **UPPERPARTS:** Much greener. Fringes of feathers of mantle and scapulars, green (c60) and usually complete rather than broken at tip. Back, rump and uppertail-coverts, lime-green (c159). **UNDERPARTS:** Breast, paler and more patchy; feathers mostly peach-red (c94) with very fine black (89) fringes at tips bordered on inside by very fine yellow (55) subterminal fringe; peach-red of distal centre grades to pale yellow (c157) in partly concealed mid-feather to pale grey (c86) at base, and partly exposed yellow of feathers gives breast patchy appearance. Lower belly, lower flanks, thighs and vent, slightly bluer than in adult. **TAIL:** Central rectrices tend to be duller and much more olive than adult male or female; mostly grey-olive (43) with bluish wash near tip. Rest of rectrices similar to adult male, possibly slightly duller. **UPPERWING:** Primaries and primary coverts appear greyer. Outer edge of inner secondaries and tertials, bright green (158), much greener than in adult male. **UNDERWING:** Like that of adult male but with: (1) broad pale-yellow (c157) to off-white (ne) underwing-bar formed by single large spots on inner webs of remiges; usually 11–17 remiges have spots (Wyndham & Brereton 1982), usually including most primaries, except outer two or three, and outer secondaries up to s4–s9; and (2) pale-yellow (c157) to off-white (ne) spots or patches on greater coverts, usually outer-most greater secondary coverts; usually have 3–12 spots on greater coverts (Wyndham & Brereton 1982).

Immature (First basic). Similar to adult females, differing only by retained juvenile primaries and wing-coverts; some probably inseparable from adult females, but others differ slightly in underwing (Wyndham & Brereton 1982; Wyndham *et al.*

Plate 17

Eastern Rosella *Platycercus eximius* (page 341)
NOMINATE EXIMIUS: 1 Adult male; 2 Adult female; 3 Juvenile;
 4, 5 Adult male; 6 Adult female; 7 Juvenile
SUBSPECIES ELECICA: 8 Adult male
SUBSPECIES DIEMENENSIS: 9 Adult male

Pale-headed Rosella *Platycercus adscitus* (page 356)
SUBSPECIES PALLICEPS: 10 Adult male; 11 Juvenile; 12, 13 Adult male; 14 Adult female; 15 Juvenile

Hybrid Eastern *P. e. eximius* × Pale-headed *P. a. palliceps* Rosella
 16–18 Adult male

1983); amount of spotting on underwing-coverts and remiges much bolder and more extensive than on adult female.

Aberrant plumages Three individuals of a red (erythristic) variant have been described in central Vic. (Tzaros 1992). The first was observed for a total of 7 hours on several different occasions between Nov. 1990 and July 1991; it had red head, neck, breast, belly, rump and undertail-coverts; flanks, paler red; back, red, intermingled with orange-green and yellow on lower back; central rectrices, orange-green; rest similar to adult female. The second was only seen once and had yellow-orange underparts and back. The third was observed on 13 different occasions; it had peach-red head, neck, chest, belly and undertail-coverts; rump, peach-red mottled with yellow; vent, yellow; cheek-patches, white; central rectrices, orange-green; back, mantle and wings had normal coloration of an adult female.

Hybrids A wild hybrid with Crimson Rosella has been described from near Armidale, NSW (Wyndham 1979). The plumage was intermediate between the two species: cheek-patch, blue and white; feathers of back and upperwing-coverts, black with yellow-green and red fringes; lower breast, mixture of yellow, green and red; upper rump, red; lower rump, yellow-green with red spots; tail, blue-green and blue with a white tip. Two hybrid juveniles from Bendigo observed perching near male Crimson Rosella and female Eastern Rosella (C.L. Tzaros); description similar to that given above. Several hybrids with Crimson Rosellas in museum collections (HLW, NMNZ, SAM).

Wild hybrids with Pale-headed Rosella often observed in ne. NSW and se. Qld, where the ranges of the two species overlap (Cannon 1984b; Ford 1987; Cooper & McAllan 1995; Aust. Atlas). Hybrids vary greatly and in general have a very patchy appearance. Some similar to Eastern Rosella but with large yellow areas on head and breast and a bluish belly. Others very similar to Pale-headed Rosella but with some red areas across upper breast and large red areas on head and neck.

BAREPARTS Based on photos (Aust. RD; Crome & Shields; unpubl.: J.N. Davies). No differences between subspecies. **Adult** Bill, pearl-grey (81). Cere, grey (84) to grey-black (82). Iris, dark brown (c121). Orbital ring and periophthalmic ring, dark grey (c83). Legs and feet, dark grey (c83). **Downy young** Bill, said to be buff (Aust. RD). No other information. **Juvenile** Bill, yellow-brown (c123C), orange or yellow (Wyndham & Brereton 1982); changes to adult coloration within a few months of fledging (Wyndham & Brereton 1982). Cere, yellow-brown (c123C) when fledging, quickly changing to brownish grey (brownish 84). Iris, as adult. Orbital ring, dark grey (c83). Periophthalmic ring, grey (84). Legs and feet, as adult. **Immature** As adult.

MOULTS Based on examination of 86 adult skins, 28 juvenile skins, ten immature skins (AM, HLW, MV, QVM, SAM)

Plate 18

Pale-headed Rosella *Platycercus adscitus* (page 356)

NOMINATE ADSCITUS: 1 Adult; 2 Juvenile; 3, 4 Adult male; 5 Adult female; 6 Juvenile HYBRID P.A. ADSCITUS × P.A. PALLICEPS: 7 Adult

Northern Rosella *Platycercus venustus* (page 364)

NOMINATE VENUSTUS: 8 Adult; 9 Juvenile; 10, 11 Adult male; 12 Adult female; 13 Juvenile SUBSPECIES HILLI: 14 Adult

and detailed study near Armidale, NSW (Wyndham *et al.* 1983). **Adult post-breeding** (Third and subsequent pre-basic). Complete. Primaries centrifugal; usually begins at p5 (Wyndham *et al.* 1983; skins); p10 usually replaced last. Molt of primaries proceeds rapidly; usually two or three growing feathers in each wing. At Armidale, p10, or p9 and p10, occasionally not moulted and retained till next moult-cycle; if outer primaries not moulted, in subsequent moult usually replaced after replacement of middle primaries but before replacement of p3–p7 and p2–p8. At Armidale, timing of start of moult appeared to depend on when young fledge; moult begins just before or just after chicks fledge. Mean starting date of moult of primaries at Armidale was 22 Jan. (3.8 days; 33) and the mean duration was 114 days (5.9; 35). From skins, active moult of primaries recorded between Dec. and Apr. (29% of skins); none were moulting primaries in other months; at Armidale, primary-moult of population began in early Jan. and finished in late May. At Armidale, moult of head and body recorded from early Dec. to mid-June, but most active between Jan. and Mar. when 90–100% in active moult. From skins, most moult of body recorded Feb.–Apr. when 55% (11 of 20) had active moult; 13 of 87 birds from other months were moulting feathers of body. At Armidale, rectrices mainly replaced between mid-Dec. and mid-Apr., but a few birds replaced rectrices at other times, possibly after accidental loss of feathers. In skins, moult of rectrices mostly recorded between Jan. and Mar. At Armidale, no differences in timing and duration of moult between males and females. **Post-juvenile** (First pre-basic). Partial; involves feathers of head and body (Wyndham *et al.* 1983). In Armidale, population began in early Jan. when c. 2 months old and finished by end of June when c. 6 months old; most were active in Mar. to May when c. 80% were in active moult. From skins, active moult of body recorded between Mar. and June. **First immature post-breeding** (Second pre-basic). Complete. In Armidale population, moult of remiges, rectrices and body began in early Dec. when c. 12 months old. Mean starting date of moult of primaries, 21 Dec. (6.6 days; 10), significantly different from that of adults ($P < 0.001$). Finished moult in mid-May when c. 18 months old; most finished moult of primaries by late Apr. From skins, only one from NSW with active moult of primaries, in Dec. ($3^{11}2^1N^43^1V^1$); and four had active body moult: one each in Dec. and Mar. and two in June.

MEASUREMENTS Nominate *eximius*: (1–2) Vic. and s. NSW, skins (AM, ANWC, HLW, MV, SAM): (1) Adults; (2) Juveniles and immatures with retained juvenile remiges and rectrices.

	MALES	FEMALES
WING	(1) 157.1 (3.17; 152–163; 25)	150.8 (4.20; 143–158; 22) **
	(2) 151.3 (6.53; 138–161; 15)	144.0 (4.69; 138–151; 6) *
TAIL	(1) 160.6 (4.31; 151–168; 23)	155.7 (5.35; 145–165; 21) **
	(2) 154.2 (9.19; 137–168; 12)	148.0 (9.15; 130–157; 7) ns
BILL	(1) 16.4 (1.06; 15.2–19.1; 25)	15.4 (0.73; 14.3–17.1; 22) **
	(2) 16.0 (1.14; 13.9–17.9; 11)	14.1 (0.40; 13.4–14.5; 6) **
BILL W	(1) 11.1 (0.45; 10.2–12.0; 25)	10.3 (0.56; 9.0–11.4; 23) **
	(2) 11.2 (0.43; 10.4–12.0; 11)	10.0 (0.50; 9.3–10.8; 7) **
TARSUS	(1) 20.5 (0.73; 19.0–22.0; 24)	20.2 (1.01; 18.6–22.0; 23) ns
	(2) 20.9 (1.16; 19.0–22.7; 11)	19.5 (1.10; 18.0–20.7; 7) *
TOE C	(1) 24.7 (1.57; 22.1–28.7; 17)	24.5 (1.02; 23.2–26.1; 15) ns
	(2) 24.6 (1.25; 22.7–26.7; 7)	23.5, 24.4

Juveniles significantly smaller than adults for both sexes in Wing ($P < 0.01$) and Tail ($P < 0.05$).

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

	ADULTS	JUVENILES AND IMMATURES	
WING	(3) 157.7 (4.94; 148–165; 11)	151.5 (5.17; 141–164; 21)	**
TAIL	(3) 163.4 (6.05; 157–172; 7)	157.6 (9.99; 137–179; 17)	ns
BILL	(3) 16.5 (0.97; 14.2–17.2; 10)	15.8 (1.38; 13.6–18.7; 15)	ns

Juveniles and immatures have significantly smaller wings ($P < 0.01$) than adults.

Subspecies *elecica*: (4–5) N. NSW and s. Qld, skins (AM, ANWC, HLW, MV, SAM): (4) Adults; (5) Juveniles. (6) Armidale area, NSW, adults, live (Wyndham & Breerton 1982).

	MALES	FEMALES	
WING	(4) 160.2 (5.27; 145–168; 22)	155.5 (4.41; 148–165; 16)	**
	(5) 155.8 (4.15; 148–161; 9)	156.0 (6.03; 148–165; 7)	ns
TAIL	(4) 167.1 (5.78; 156–176; 21)	161.2 (5.62; 152–171; 15)	**
	(5) 154.2 (10.50; 138–169; 9)	157.3 (7.09; 145–165; 7)	ns
	(6) 173 (n=25)	160 (n=25)	**
BILL	(4) 16.0 (0.76; 14.0–17.1; 17)	14.9 (0.56; 13.8–16.0; 16)	**
	(5) 15.4 (0.83; 14.3–16.8; 8)	15.0 (0.90; 13.9–16.6; 7)	ns
BILL W	(4) 11.4 (0.40; 10.8–12.3; 17)	10.8 (0.61; 9.9–11.8; 16)	**
	(5) 11.0 (0.54; 9.9–11.6; 9)	10.9 (0.54; 10.1–11.6; 7)	ns
	(6) 11.7 (n=68)	10.6 (n=27)	**
TARSUS	(4) 20.2 (0.69; 18.7–21.6; 17)	19.8 (0.69; 18.8–21.0; 16)	ns
	(5) 20.3 (0.62; 19.7–21.3; 9)	20.2 (0.78; 19.1–21.4; 7)	ns
TOE C	(4) 25.7 (1.37; 24.0–27.9; 9)	24.3 (1.23; 22.7–26.9; 11)	*
	(5) 25.8 (1.00; 24.9–27.3; 5)	26.0 (2.36; 23.9–29.4; 4)	ns

Subspecies *diemenensis*: (7–8) Tas., skins (AM, ANWC, HLW, MV, QVM, SAM): (7) Adults; (8) Juveniles and immatures with retained juvenile remiges and rectrices.

	MALES	FEMALES	
WING	(7) 157.5 (4.77; 149–166; 20)	155.2 (3.62; 150–162; 16)	ns
	(8) 153, 158	144, 155, 156	
TAIL	(7) 167.7 (7.75; 146–177; 19)	166.1 (6.06; 158–181; 16)	ns
	(8) 161, 178	143, 155, 161	
BILL	(7) 17.9 (1.78; 15.2–21.1; 21)	16.3 (1.76; 13.2–20.2; 16)	**
	(8) 15.2	15.2, 19.2, 20.4	
BILL W	(7) 11.7 (0.61; 10.6–13.2; 21)	10.8 (0.35; 10.2–11.7; 16)	**
	(8) 10.7, 11.3	9.2, 10.2, 12.4	
TARSUS	(7) 21.7 (0.94; 19.9–23.5; 21)	21.4 (1.24; 19.9–24.9; 16)	ns
	(8) 21.9, 22.4	19.8, 21.8, 24.6	
TOE C	(7) 26.1 (1.16; 23.9–28.9; 17)	25.8 (1.86; 24.0–29.9; 11)	ns
	(8) 25.3, 25.9	26.2, 26.9, 29.9	

(9) Hybrids between nominate *eximius* and subspecies *elecica*, Cobbora, NSW, adults, skins (HLW). (10) NZ, adults, skins; both *eximius* and *elecica* in population and some are hybrids (AIM, NMNZ).

	MALES	FEMALES	
WING	(9) 161.1 (3.43; 155–166; 13)	150, 155	
	(10) 151.7 (7.27; 142–162; 7)	146	
TAIL	(9) 164.2 (4.81; 157–172; 12)	148, 160	
	(10) 163.0 (10.13; 142–175; 7)	152	
BILL	(9) 15.7 (0.63; 14.8–16.8; 13)	14.4, 14.9	
	(10) 16.4 (0.69; 15.4–17.3; 6)	14.5	
BILL W	(9) 11.5 (0.39; 10.7–11.9; 13)	10.3, 10.7	
TARSUS	(9) 20.7 (0.46; 19.9–21.5; 13)	19.1, 21.0	
	(10) 20.8 (0.64; 20.1–21.6; 7)	–	
TOE C	(9) 25.2 (1.27; 23.7–26.7; 8)	–	
	(10) 25.7	–	

WEIGHTS From museum labels (AM, ANWC, MV, QVM) unless stated. N nominate *eximius*: (1) Vic. and s. NSW, adults. (2) Vic., juveniles.

	MALES	FEMALES	
(1)	108.6 (1.59; 101–112; 5)	103.2 (8.31; 89–122; 10)	ns
(2)	118, 118	91, 100, 110	

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

	ADULTS	JUVENILES AND IMMATURES	
(3)	104.4 (6.71; 95–116; 11)	100.9 (7.47; 87–116; 21)	ns

Subspecies *elecica*: (4) NSW, adults. (5) Armidale area, NSW, adults, live (Wyndham & Breerton 1982).

	MALES	FEMALES	
(4)	102.4 (11.21; 86–120; 10)	101.7 (5.32; 92–106; 6)	ns
(5)	116.7 (41)	102.2 (18)	**

Subspecies *diemenensis*: (6–7) Tas.: (6) Adults; (7) Juveniles.

	MALES	FEMALES	
(6)	103.8 (12.88; 75–125; 13)	104.1 (11.37; 87–123; 10)	ns
(7)	103	78, 78, 90	

STRUCTURE Wing broad with rounded tip. Ten primaries: p8 longest; p10 12–17 mm shorter, p9 0–2, p7 0–5, p6 8–18, p5 31–37, p4 41–50, p3 47–57, p2 51–62, p1 56–66. P6–p8 or p9 have emarginated outer web; p8–p10 have emargination on inner web. About 13 secondaries, including about five tertials; tips of longest tertials fall between p1 and p3 on folded wing. Tail long and pointed; 12 rectrices; t1 longest, t6 75–90 mm shorter. Bill short and broad. Cutting edges of upper mandible sharp and slightly concave with a shallow notch c. 5 mm from tip; tip rounded from front, inside flattened with small transverse grooves. Lower mandible broad and scoop-like; cutting edge sharp and mostly straight but with cutting edge raised at tip. Narrow bare cere along base of upper mandible, in which small rounded nostrils situated close to top. Tarsus short, moderately thick; granulate. Tibia fully feathered. Outer toe directed backward. Outer hindtoe 80–94% of outer front, inner front 66–70%, inner hind 44–56%.

GEOGRAPHICAL VARIATION Three subspecies: *elecica* in ne. NSW and se. Qld; *eximius* in se. Aust., from central NSW, through Vic., to se. SA; and *diemenensis* in Tas. Subspecies differ in size and coloration. Schodde (1988) used the name *elecica* to replace *ceciliae* of Mathews, 1911, and *splendidus* of Gould, 1846, which were based on unidentifiable hybrids between Eastern and Pale-headed Rosellas. There is no break in distribution between *eximius* and *elecica* and they intergrade along w. side of Great Divide in ne. NSW. Within this hybrid zone there are birds that resemble each of the two subspecies and some that show a mixture of plumage characters from each subspecies.

Eastern Rosella hybridizes with Pale-headed Rosella in broad hybrid zone at n. end of range (see Hybrids). Some consider Eastern and Pale-headed to be conspecific, with Pale-headed as subspecies *adscitus* (e.g. Schodde & Mason 1997).

SUBSPECIES DIEMENENSIS: Largest subspecies; significantly

larger than *eximius* (for both sexes) in length of tail ($P < 0.01$), bill (male $P < 0.01$, female $P < 0.05$), tarsus ($P < 0.01$) and toe (male $P < 0.01$, female $P < 0.05$) and width of bill ($P < 0.01$); females also have significantly longer wings ($P < 0.01$). Subspecies *diemenensis* also significantly larger than *elecica* in length of bill ($P < 0.01$) and tarsus ($P < 0.01$) for both sexes; females had significantly longer tail ($P < 0.05$) and toe ($P < 0.05$). Differ from nominate *eximius* by larger white cheek-patches; and red of head, neck and breast slightly darker, crimson (c108).

SUBSPECIES ELECICA: Differs from nominate in both pattern of plumage and size. Significantly larger than *eximius* (for both sexes) in length of wing (male $P < 0.05$, female $P < 0.01$), tail ($P < 0.01$) and width of bill (male $P < 0.5$, female $P < 0.01$); females had significantly shorter bills ($P < 0.05$). Upperparts, underparts and upperwing differ from nominate: **UPPERPARTS:** Feathers of mantle and scapulars, black (89) with broad golden-yellow (c55) fringes; fringe narrows, and occasionally broken, at tip of feather. Feathers of back, black (89) with broad pale-green (162D) fringes; fringes often washed with yellow (c55). Rump and uppertail-coverts, pale green (c162D) and can have blue or yellow tinge. **UNDERPARTS:** Mostly similar to *eximius*, but lower belly slightly paler and bluer, pale green (c162D). **UPPERWING:** Inner median and greater secondary coverts and tertials have slightly brighter edges than in *eximius*: yellow-green (c158) to yellow (c55).

Eastern Rosellas have also been introduced to NZ from aviary stocks of both *eximius* and *elecica*. Birds in NZ can resemble either of these two subspecies or hybrid individuals, showing a mixture of characters.

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Eastern Rosella *Platycercus eximius* (page 341)

NOMINATE EXIMIUS: 1 Adult male; 2 Adult female; 3 Juvenile; 4, 5 Adult male; 6 Adult female; 7 Juvenile

SUBSPECIES ELECICA: 8 Adult male

SUBSPECIES DIEMENENSIS: 9 Adult male

Pale-headed Rosella *Platycercus adscitus* (page 356)

SUBSPECIES PALLICEPS: 10 Adult male; 11 Juvenile; 12, 13 Adult male; 14 Adult female; 15 Juvenile

Hybrid Eastern *P.e. eximius* x Pale-headed *P.a. palliceps* Rosella
16-18 Adult male