Cyanoramphus novaezelandiae Red-crowned Parakeet

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Psittacus Novae Zelandiae Sparrman, 1787, *Mus. Carls. Fasc.* 2: xxviii and pl. — Dusky Sound, New Zealand.

Specifically named after the type-locality (Modern Latin *Nova Zeelanda*).

OTHER ENGLISH NAMES Cook's, Green, Kermadec, Macquarie Island, New Zealand, Norfolk Island, Reischek's or Red-fronted Parakeet; Antipodes, Chatham Island or New Zealand Red-crowned Parakeet; Green, Norfolk Island or Red-fronted Parrot; Norfolk Island Green Parrot; Red-fronted Kakariki. MAORI NAMES include Kakariki, Porete, Kaka-wariki, Powhaitere, Kawariki.

POLYTYPIC Eight subspecies, two of which extinct. Nominate *novaezelandiae*, NI and SI and many offshore islands, Stewart I. and Auckland Is; *cyanurus*, Salvadori, 1891, Kermadec Is; *chathamensis*, Oliver, 1930, Chatham Is; *hochstetteri* (Reischek, 1889), Antipodes I.; *erythrotis* (Wagler, 1832), Macquarie I. (extinct); *cookii* (G.R. Gray, 1859), Norfolk I.; *subflavescens*, Salvadori, 1891, Lord Howe I. (extinct); *saisseti*, Verreaux & Des Murs, 1860, New Caledonia.

FIELD IDENTIFICATION Length: male 25–27 cm, female 21–26 cm; wingspan 32–38 cm; weight: male 80 g, female 70 g. Medium-sized parrot, very similar in size and shape to Yellow-crowned Parakeet *Cyanoramphus auriceps*. Unmistakable: generally bright green or yellow-green with dark-blue outer upperwing and diagnostic crimson forecap and eye-stripe and small patch on sides of rump. Sexes alike in plumage but female slightly smaller, with smaller narrower bill; these differences noticeable when pair seen. No seasonal variation. Juvenile separable. Hybridize with Yellow-crowned Parakeet; see Plumages. Slight geographical variation, with five extant and allopatric subspecies in HANZAB region, differing slightly in size and coloration. Widespread nominate *novaezelandiae* described below; for others, see Plumages. **Adult** Bright green above and yellow-green below, with small crimson patch on either side of upper rump, which is normally concealed by wings at rest. Pattern of head diagnostic: forehead and forecrown, crimson, forming neat forecap that extends back to slightly behind level with rear edge of eye; crimson of sides of forehead continues in narrow stripe across lores and through eye to rear ear-coverts, forming prominent eye-stripe. Folded wing mostly bright green as upperparts, sometimes with dark blue of outerwing partly exposed as narrow blue leading edge; folded primaries, blackish, edged basally with dark blue and distally with dark green. In flight, upperwing appears mostly bright green with outer five primaries and their coverts contrastingly dark blue, grading to blackish on tip. Underwing: leading coverts, green-blue; greater coverts and remiges, dark grey, usually with obvious narrow pale-yellow bar across middle of inner primaries and most secondaries; bar sometimes very faint, occasionally absent. Undertail, dark grey. Bill, white to pale blue-grey with black cutting edge and tip. Cere, dark grey to black. Iris, red or bright orange. Orbital ring, grey-black to black. Legs and feet, grey to dark grey or pale brown. **Juvenile** Very similar to adult, differing by: crimson forecap slightly smaller, not extending behind level with rear edge of eye; crimson patch on sides of upper rump much smaller; pale underwing-bar always present, very prominent and slightly longer, covering all remiges except outer few primaries. Young juvenile best distinguished by colour of bare parts; in recently fledged birds: bill wholly pink or pink at base grading to grey at tip and along cutting edge of upper mandible, but quickly changes to adult coloration; cere, grey-pink; iris, black-brown, changing to pale red-brown; orbital ring, dark grey. Legs and feet paler, pink-grey.

Similar species All subspecies and ages readily identified by diagnostic crimson forecap and eye-stripe extending behind eye. **Yellow-crowned Parakeet** differs in having a yellow or orange-yellow crown-patch and narrow red or orange frontal band that extends to, but not behind, eye. Calls also differ slightly (see below). Beware confusion with hybrid Red-crowned × Yellow-crowned Parakeets; see Plumages for differences. Also see **Antipodes Island Parakeet** *C. unicolor*.

Gregarious; usually in pairs, family parties or small groups. Now very rare on main islands of NZ, where inhabit lowland native forests; more abundant on offshore and subantarctic islands, where occur in variety of habitats including forest, scrubland and open grassy areas. Sometimes associate with Yellow-crowned Parakeet. Mainly arboreal on main islands of NZ, but on predator-free offshore and subantarctic islands often also forage on ground. Generally quiet, unobtrusive and tame, usually allowing close approach. Flight swift and direct, noticeably less undulating than flight of rosellas *Platycercus*; fly with rapid shallow wing-beats interspersed with glides on gently bowed wings; markedly agile in flight, twisting and turning with ease through trees. Usual call, uttered in flight or when alarmed, prolonged repetitive chatter *ki-ki-ki-ki-ki* or *kek-kek-kek-kek*; also similar but quieter, more broken chatter when perched; when feeding, utter occasional subdued *kek-kik kek-kik kek-kik* or *kek-kik-kek kek-kik-kek*. Other calls include soft *tu-tu-tu-tu*; and, when perched, phrases sounding like *pretty dick, twenty-eight* or *tee-pee-wee*. All calls similar to those of Yellow-crowned Parakeet but tend to be lower-pitched and stronger.

HABITAT Account prepared by T.C. Greene. Occur in wide variety of habitats; range from Tropics to Subantarctic. **NZ** NI, SI: Now rare or absent on main islands but present on many offshore islands and Stewart I., in broad variety of habitats, including dense temperate rainforests, coastal forest, scrubland, forest edges and open areas. Occur in some habitats much modified by clearance or browsers or both; rare visitor to plantation forests on main islands (T.C. Greene). KERMADEC IS: On Meyer Is (Herald Grp), abundant in coastal scrub, stunted forest and steep rocky slopes vegetated by low shrubs, herbs, sedges and variety of salt-tolerant species (Cheeseman 1890;

Merton 1970; Taylor 1985). On Macauley I. abundant throughout in dense highly modified vegetation of sedges (*Cyperus* and *Scirpus*), fern (*Hypolepis* and *Pteris*) and scattered areas of ngaio trees (*Myoporum kermadecensis*) (Williams & Rudge 1969; Taylor 1985; Forshaw & Cooper 1989; Tennyson & Taylor 1989; Forshaw). NORFOLK I.: Occur in tall dense remnant *Araucaria* rainforest and other native vegetation; also recorded in *Eucalyptus* plantations near native forest and from orchards and gardens (Wakelin 1968; King 1981; Moore 1981, 1985; Schodde *et al.* 1983; Hay 1985; Taylor 1985; Forshaw & Cooper 1989; Garnett 1992). LORD HOWE I.: Extinct; formerly in forested habitats and areas of cultivation. CHATHAM IS: Prefer forested areas, edges of forests, shrublands and open grassland; often numerous on coast, on salt-meadows and at edges of forests. May be less numerous inside dense regenerating forest at certain times (Taylor 1975, 1985; Nixon 1982; O'Donnell & Dilks 1986). Mostly inhabit grassland in winter, and move to forest during summer (Nixon 1982). **Subantarctic islands** AUCKLAND IS: Recorded in habitats similar to those of NI and SI (Taylor 1985; Oliver). ANTIPODES IS: Abundant throughout but most common in low open vegetation, such as sedges, tussocks, shield fern *Polystichum* and low *Coprosma* scrub (Taylor 1975, 1985; Miskelly *et al.* 1990; Greene 1996). MACQUARIE I.: Extinct; formerly inhabited areas of tussock grasses and sedges, particularly along seaboard (Taylor 1979; Forshaw & Cooper 1989; Forshaw). Also occurs **New Caledonia**, where occupies indigenous mountain forests of the NW; recent records mainly from S, at La Coulee Rio and in Riviere-Bleue Forest Reserve (Hannecart & Letocart 1980; Taylor 1985; Forshaw & Cooper 1989).

Usually only breed in native vegetation, and prefer larger trees, particularly *Metrosideros*, *Vitex*, *Nothofagus*, *Olearia*, *Plagianthus*. Usually nest in hollow limb, hole, or stump of trees (alive or dead). Also nest in holes in cliffs, rocky crevices and holes or burrows in ground; use holes in matted bases of sedges and tussocks, and tunnels in tops of dense tussocks, particularly where there are no trees or trees small (Taylor 1985; Greene 1988, 1996; Forshaw & Cooper 1989; R.H. Taylor).

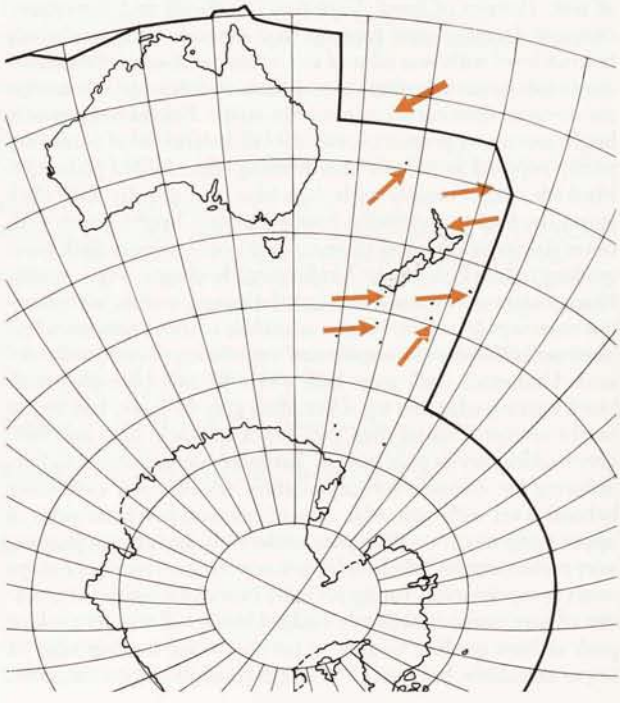
Forage from ground-level to canopy, depending on location of seasonally available food within habitat (Greene 1988). Prefer to feed in canopy of forested areas; feed on ground in open habitats, such as pasture and salt-meadow. On South East I., Chatham Grp, in autumn: feed mainly in unshaded canopy (34.5% of observations) and shaded canopy (29.9%); forage less on ground (23.9%) and least in lower understorey (5.4%), upper understorey (4.8%) and emergent trees (1.1%) (n=351 observations; O'Donnell & Dilks 1993). Also forage in highly modified or disturbed areas, on exotic plants, particularly grasses and invasive herbaceous weeds, particularly where original vegetation has been removed (Taylor 1985; Greene 1988). Rarely seen in pine and *Eucalyptus* plantations (Black 1963; Forshaw).

Roosting sites must have dense cover (T.C. Greene; T.G. Lovegrove). Roost in holes in trees, rock crevices, burrows, under overhanging rocks and vegetation, and in thick vegetation such as epiphytes, tussocks, sedges or ferns (Taylor 1985; Sagar 1988; Greene 1996; T.C. Greene; T.G. Lovegrove). Roosting sites often also nesting sites (T.C. Greene; T.G. Lovegrove). Loaf in trees or on ground in areas sheltered from wind, either in direct sunlight or available shade (Taylor 1985; Forshaw & Cooper 1989; T.C. Greene). When loafing in trees, usually in outer foliage (Nixon 1982). On Mangere I., Chatham Is, mostly perch on ground in grassland during winter, but more often in trees during summer when in forest (Nixon 1982).

Adversely affected by forestry operations: clear-felling and burning have drastically reduced available habitat; selective logging may reduce number of trees with suitable nesting holes and foraging opportunities (O'Donnell & Dilks 1986). Irruptions in 19th century (see Distribution) may have been caused by increased cultivation of crops by European settlers (Oliver).

DISTRIBUTION AND POPULATION Much of account prepared by T.C. Greene. Endemic to sw. Pacific Ocean and adjacent parts of Southern Ocean; distribution centred on NZ, and extends N to New Caledonia, S to Macquarie I., W to Lord Howe I. and E to Kermadec and Chatham Is (Taylor 1975, 1985; Forshaw & Cooper 1989; Triggs & Daugherty 1996; Oliver).

NZ Formerly widespread; range now much reduced, but still recorded on many nearshore and offshore islands. **NI** Few scattered records in FAR NORTH, from Raetea, Omahuta and Mangamuka, S to Waipua Forest, and rarely E to Bay of Islands and Opuawhanga. Scattered records in NORTHLAND, AUCKLAND and SOUTH AUCKLAND, from Parua Bay S to Hunua and Tapu on s. Coromandel Pen.; numerous on many islands in these regions, from Poor Knights and Hen & Chickens Grp, S to Mercury Grp. Rarely in BAY OF PLENTY, including isolated records near Whangamata and in Kaimai Ra.; also on Alderman Is. Several records in w. EAST COAST, from Ikawhenua Ra., S to L. Waikaremoana. Sparsely scattered records in n. HAWKES BAY and VOLCANIC PLAINS, from Kaweka Forest Park W to Kaimanawa State Forest and near Turangi. Isolated records around Te Kuti in e. WAIKATO. Farther S, isolated record in e. HAWKES BAY, at Maraetotawa; and several records in WAIRARAPA, MANAWATU and WELLINGTON from Aorangi and Ruahine Ra., S to L. Ponui; also on Kapiti I. (Skegg 1964; Challies 1966; Hicks *et al.* 1975; Taylor 1975, 1985; Falla *et al.* 1981; Bellingham 1987; MacMillan 1990; CSN; NZ Atlas; Oliver; R.J. Pierce). **SI** Scattered records, mostly on or W of Southern Alps and associated ranges. Scattered in e. NELSON and w. MARLBOROUGH, from se. Tasman Bay S to Nelson Ls. Several isolated records





WEST COAST, at Karamea, L. Hochstetter, Pukekura, near mouth of Cook R. and L. Ellery; also in Arthurs Pass NP in w. CANTERBURY. In SOUTHLAND, scattered records, mostly in Fiordland; elsewhere, isolated record at Fortrose on shores of Toestoes Bay. Widespread on Stewart I. and numerous other nearby islets. Single record OTAGO of two at Ross Ck, Dunedin, 2 Sept. 1961 (Blackburn 1965; Falla *et al.* 1981; Read & McClelland 1984; Taylor 1985; CSN; NZ Atlas; Oliver).

Lord Howe I. Extinct; formerly abundant (Hindwood 1940; Hutton 1991).

Norfolk I. Mostly in NW, centred on Mt Pitt and adjacent areas. Not recorded Philip and Nepean Is (Smithers & Disney 1969; Moore 1981, 1985; Schodde *et al.* 1983; Hicks & Greenwood 1989).

Macquarie I. Extinct; formerly abundant (Taylor 1975, 1979, 1985; Oliver; Forshaw).

Kermadec Is Recorded on Napier, N. Meyer, S. Meyer, Dayrell, N. Chanter, S. Chanter and Macauley Is; straggler to Curtis I. Formerly abundant on Raoul I., but extirpated in mid-19th century; now rare visitor from nearby islands (Edgar *et al.* 1965; Merton 1970; Taylor 1985; Tennyson & Taylor 1989; CSN; Oliver).

Chatham Is All forested islands, including s. Chatham, Pitt, Rabbit, Mangere, Little Mangere and South East I. (Fleming 1939; Lindsay *et al.* 1959; Freeman 1994; Nilsson *et al.* 1994; CSN).

Auckland Is Restricted to Enderby, Rose, Ewing, Ocean and Adams Is; probably formerly on all forested islands (Taylor 1985; Bartle & Paulin 1986; Triggs & Daugherty 1996; Oliver; G.P. Elliott; R.H. Taylor).

Antipodes Is Recorded on Bollons and Antipodes Is, and Leeward, Archway and Windward Is (Warham & Bell 1979; Taylor 1985; Miskelly *et al.* 1990; Greene 1996; Oliver; G.P. Elliott).

Breeding Not recently recorded on mainland NZ; widespread elsewhere throughout range.

Introductions Many undocumented, small liberations throughout NZ from privately held stock. Recent successful releases include: Tiritiri Matangi I. (35 birds in Jan. 1974; 22, Oct. 1975; 27, Sept. 1976); Cuvier I. (30, 22 Mar. 1974) and Whale I. (1985; 24,1986); all have become established. Unsuccessfully released at Huia (17, May 1977; 14, Oct. 1977), Wairarapa, Waikanae and Waitakere Ras. (Taylor 1985; Atkinson 1990; MacMillan 1990; CSN; K. Owen).

Irruptions In 19th century, occasional irruptions recorded, some said to be of tens of thousands of birds: Hutt Valley, *c.* 1840s; Canterbury in 1871 and twice in 1880s, including spring–summer 1884; Otago and Nelson, 1870s and 1880s; Marlborough, 1888 (Buller 1888; Oliver). Many killed during these irruptions.

Change in range NI, SI: Formerly widespread throughout, with abundant subfossil evidence (NZCL). In 19th century, occurred in large numbers; now rarely recorded on mainland; dramatic population decline and contraction of range caused by destruction of habitat, persecution, and introduction of predators and competitors (Taylor 1985; Oliver). For example, formerly occurred in area from Hunua Ras W to Papakura, Pukehoke and Waiuku until 1880s, but disappeared after native forests were cleared and replaced with *Pinus* plantations in early 20th century (St Paul & McKenzie 1974; McKenzie 1979); last recorded around Makara in 1887, and died out round nearby Karori by 1914 (Secker 1956); large numbers occasionally visited Nelson and Marlborough in 19th century, but numbers then reduced and did not recover (Oliver); large flocks formerly common on Canterbury Plain and Banks Pen., but disappeared entirely by late 19th century (Dawson & Cresswell 1949; Oliver); formerly occurred in Paparoa Ra. in 19th century, but now locally extinct (Onley 1980). Mostly restricted to refuges on nearby islands (Taylor 1985). On Solander I., appears to have completely replaced Yellow-crowned Parakeet between 1948 and 1973 (Cooper *et al.* 1986; McLean & Russ 1994). LORD HOWE I.: Formerly abundant; persecuted by early settlers after large numbers of Parakeets damaged crops and gardens; last recorded in 1869 (Hindwood 1940; Hutton 1991). NORFOLK I.: Once abundant, but by 1908 population had declined and was restricted to area around Mt Pitt; a special protection order prevented killing of Parakeets unless they were caught '*in flagrante delicto*, damaging fruit crops' (Basset Hull 1909; Hicks & Greenwood 1989). Adversely affected by loss of habitat, competition and predation by introduced species, avian diseases and, formerly, persecution (Wakelin 1968; Schodde *et al.* 1983; Hicks & Greenwood 1989; Forshaw). Populations now increasing following captive-breeding program (see Populations below). MACQUARIE I.: Formerly abundant in 19th century. Despite being killed in large numbers by sealers for food and small population of feral cats present for *c.* 70 years, Parakeet populations probably remained fairly stable till late 19th century. Populations said to have declined rapidly after *c.* 1880: Wekas *Gallirallis australis*, which take eggs, were introduced in 1872; rabbits became established by 1878, and, through providing an alternative year-round food supply, allowed population of feral cats to increase. Last recorded in 1880 (Taylor 1979; Oliver; Forshaw). KERMADEC IS: Plentiful on Raoul I. in 1836, but extirpated by cats by mid-19th century (Sorensen 1964; Merton 1968, 1970). Population on Macauley I. increased after removal of goats from island, which allowed vegetation to

regenerate (Taylor 1985). CHATHAM GRP: Populations on Chatham and Pitt Is have declined after destruction of habitat and predation by cats and rats (Nilsson *et al.* 1994). Although abundant on South East I., populations declined when forest and scrub vegetation regenerated after sheep were removed in 1961. Said to have disappeared from Mangere I. in *c.* 1940, but later recolonized island (Nixon 1994; Tennyson & Millener 1994). Numbers on Mangere I. increased in early 1970s (Taylor 1975; Flack 1976); till recently, populations on Mangere and Little Mangere Is were artificially manipulated in attempt to prevent hybridization with Chatham Is subspecies of Yellow-crowned Parakeet (Taylor 1975, 1985; Butler & Merton 1992; Nixon 1994; Triggs & Daugherty 1996; Oliver). AUCKLAND IS: Populations and range decreased after cats, mice and pigs introduced. ANTIPODES IS: Populations stable, despite introduction of mice (Taylor 1979, 1985; Triggs & Daugherty 1996; G.P. Elliott).

Status Extinct on Lord Howe and Macquarie Is; endangered on NI and SI, NZ, and Norfolk I. (Taylor 1985; Forshaw & Cooper 1989; Garnett 1993). **Populations** In s. Chatham I., 161 birds recorded in 12,500 ha (Freeman 1994; CSN 37). In Kermadec Grp: on Meyer Is, *c.* 100 birds (Taylor 1985); populations on Macauley I. increased from >1000 birds in 1966 to 17,000–20,000 in Sept. 1988, after removal of goats from island between 1966 and 1970, which allowed vegetation to regenerate; numbers declined by 5–10% by late 1988 (Merton 1970; Taylor 1985; Tennyson & Taylor 1989; Tennyson *et al.* 1989). On Antipodes Is, estimated 4000–5000 birds (Taylor 1985; Greene 1996). On Norfolk I.: in 1977–78 estimated total population, 17–30 birds, and population had declined further by 1983 (Hermes *et al.* 1986); in 1983, captive-breeding program established; by Mar. 1989, at least 28 wild and ten captive birds; by July 1991, wild population increased to ≥40 birds, with 13 in captivity (Hermes *et al.* 1986; Hicks & Greenwood 1989; Greenwood 1991; Forshaw).

Hunted for food by Maori (Best 1977). Formerly persecuted because birds damaged crops and gardens: shot and trapped on Lord Howe I. (Hindwood 1940); shot as pests of crops or for food by early settlers or sealers on main islands of NZ and on Norfolk and Macquarie Is (Buller 1888; Wakelin 1968; Falla *et al.* 1981; Taylor 1985; Oliver); on Norfolk I., convicts said to have used sticks to drive them from ripening corn (Hicks & Greenwood 1989). Formerly shot for sport in NZ; feathers were used to stuff mattresses (Potts 1869; King 1984; Taylor 1985; O'Donnell & Dilks 1986). Sometimes caught in hats on Kermadec Is (Cheeseman 1887, 1890). Said to be adversely affected by competition for food or breeding sites with introduced species, such as Common Mynas *Acridotheres tristis*, Common Starlings *Sturnus vulgaris*, Eastern Rosellas *Platycercus eximius*, Crimson Rosellas *P. elegans*, Common Brushtail Possums *Trichosurus vulpecula* and honey bees *Apis mellifera* (Smithers & Disney 1969; Dawe 1979; Hicks & Greenwood 1989; Brockie 1992; Murphy & Dowding 1995; Oliver; NZ Atlas; T.C. Greene). May be killed and eaten by other introduced species, including cats, rats and stoats (Taylor 1985; Hicks & Greenwood 1989; Garnett 1993; CSN). Formerly kept as pets (Buller 1888; Oliver). Captive-breeding program established on Norfolk I. Hybridization with Yellow-crowned Parakeets recorded, especially where habitats much modified and densities of one, or both, species low (Taylor 1975, 1985; Butler & Merton 1992; Triggs & Daugherty 1996; cf. Veitch 1979).

MOVEMENTS Account prepared by T.C. Greene. Sedentary. Also considered resident (Schodde *et al.* 1983; NZCL). Occur throughout year in most habitats. Adults exhibit little movement before or after breeding (T.C. Greene). Regularly move between islets in island groups and can cross wide expanses of sea: observed commuting between main islands in Poor Knights Grp (average distance of 150 m), Hen & Chicken Is (200 m), Mokohinau Grp (50 m) and Mercury Grp (1 km). On Chatham Is, recorded flying 2.5 km from Mangere I. to Pitt I. (Fleming 1939); and in Kermadec Grp, between Herald Is and Raoul I. (3 km); occasionally travel 40 km from Macauley I. to Curtis I. (Taylor 1985; Forshaw & Cooper 1989). Appear to have colonized Solander I. from either Stewart I. (60 km) or adjacent mainland (40 km) between 1948 and 1973 (Cooper *et al.* 1986). Two records of birds flying away from Macquarie I. (Falla 1937) suggest either movement to rocky islets or that birds blown away from mainland (Forshaw). Windy weather does not deter inter-island movements, but delays arrival and makes flight more erratic (Richdale 1958); often fly between islands in pairs (Sladden & Falla 1928). Also seen flying high over ridges, and crossing directly between ridges (Dawe 1979).

Possibly some altitudinal movement, most likely as response to availability of food. On Little Barrier I., move from *Leptospermum* and *Agathis–Nothofagus* forest to low coastal vegetation in Apr. (Greene 1988); on Mangere I., shift from open grass habitats in winter to taller forest in summer (Nixon 1994); on Norfolk I., visit gardens at times of year when trees fruiting (Smithers & Disney 1969; Schodde *et al.* 1983). Formerly erupted from forest to settled areas in NZ when cold, wet weather or severe frosts reduced supply of food in forests (Oliver). Home-ranges for breeding birds on Little Barrier I. shown in Greene (1990).

Young Post-fledging dispersal of juveniles poorly understood, but from a few observations of colour-banded fledgelings, most seem to have left area of nest, or died, within 1 month of fledging (T.C. Greene).

Banding Few detailed studies. Of 329 banded in Puweto Valley, Aorangi I., Poor Knights Is, 26 recaptured at same site; marked predominance of males among captured and recaptured birds suggests males have higher survival rate than females, although also suggested that differences could be result of males moving about more than females so capture more likely (Sagar 1988). Of 27 adults and 11 juveniles colour-banded on Little Barrier I., 20 seen within 500 m of capture site and five of seven identifiable pairs bred in same area in consecutive years (T.C. Greene). Adult colour-banded on Antipodes I. in Nov.–Dec. 1978 resighted on 12 Oct. 1990 (Miskelly *et al.* 1990). Adult female banded Feb. 1969 recaptured at same site, Nov. 1978; adult male banded Nov. 1978 recaptured same area Dec. 1989 (R.H. Taylor).

Of 113 banded on Norfolk I., Aust., 1953–96, 5 recoveries (4.4%): all <10 km from banding site.

FOOD Account prepared by T.C. Greene. Omnivorous; mainly seeds, berries, fruits, buds, flowers and shoots of plants; also small numbers of invertebrates and marine molluscs; occasionally scavenge animal carrion, including birds. **Behaviour** Forage singly, in pairs or in loose flocks of up to 30 birds (T.C. Greene). Feed at all levels, from ground to outermost canopy; feeding height above ground varies depending on structure of habitats (Dawe 1979; Greene 1988; O'Donnell & Dilks 1993; Nixon 1994; see Habitat). Most feeding in morning and afternoon (Taylor 1985). On Little Barrier I. over 60% of day spent foraging (Greene 1988). On Macauley I., Kermadec Grp, feeding on limpets determined by tides (Taylor 1985; R.H. Taylor). Tend not to feed in heavy rain (T.C. Greene). Move quickly

over substrate (walk, jump, climb, flutter) with frequent short pauses to feed. When feeding on ground, use feet to scratch at surface, with characteristic fowl-like sideways movements of legs, to expose seeds or invertebrates or both (Forshaw & Cooper 1989). Will often hold food in one foot when feeding (Dawe 1979; Greene 1988). Mainly feed by biting items from substrate, then chewing, crushing, mashing, peeling and husking. Also glean food items, particularly invertebrates, from surfaces by manipulating substrate of food in bill and either scraping item from surface using lower mandible or prising it from surface using upper mandible. Will pierce flower nectaries to get to nectar; also use tongue to drink nectar (Greene 1988). Destructive feeder and seed predator and often create large amounts of debris (Wilkinson & Wilkinson 1952). Presence often betrayed by continual clicking of mandibles, steady stream of discarded fragments and occasional calls (Forshaw & Cooper 1989). On Mangere I., seeds usually ingested whole, with exception of large *Dactylis glomeratus*, which are first bitten into pieces; seeds of *Embergeria grandifolia* and *Geranium traversii* usually husked; leaves cut into 3–4 mm-long fragments, but clover leaves eaten whole and rolled into boli about 3 mm in diameter; leaves of grasses cut into 4 mm lengths and edges rolled inward; invertebrates eaten usually small, up to 8 mm long, and eaten whole (Nixon 1994). Need water, and drink throughout day (Taylor 1985; T.C. Greene).

Detailed studies For all detailed studies, items that comprised <1% no. of total observations listed in Other records. On TIRITIRI-MATANGI I., NI (343 feeding observations throughout year; Dawe 1979): **Plants** Fruits, seeds 10.5% no. of total obs.; lichens, bark, dead wood 2.3. GYMNOSPERMS: Podocarpaceae: *Podocarpus totara* fru. 1.2. MONOCOTYLEDONS: Agavaceae: *Cordyline australis* fru., lvs, sh. 8.7; *Phormium tenax* sds, fl. 9.9; Liliaceae: *Astelia banksii* fru. 1.7; Poaceae: Unident. 1.7. DICOTYLEDONS: Apocynaceae: *Parsonsia heterophylla* sds, fl. 4.7; Asteraceae: *Brachyglottis* sds 2.6; *Sonchus oleraceus* sds, fl., lvs, sh. 3.9; Elaeocarpaceae: *Elaeocarpus dentatus* fl. 1.4; Meliaceae: *Dysoxylum spectabile* fl., fru., lvs, sh. 2.7; Myoporaceae: *Myoporum laetum* fru. 2.3; Myrsinaceae: *Myrsine australis* fru. 2.0; Myrtaceae: *Kunzea ericoides* sds, fl. 2.6; *Leptospermum scoparium* sds, fl. 6.1; *Metrosideros excelsa* sds, fl., lvs, sh. 10.9; Phytolaccaceae: *Phytolacca octandra* fru. 2.0; Polygonaceae: *Muehlenbeckia complexa* sds, fl., lvs, sh. 7.0; Proteaceae: *Knightia excelsa* sds 1.2; Rubiaceae: *Coprosma* fl., fru. 3.4; *C. rhamnoides* fru. 3.8; Violaceae: *Melicytus ramiflorus* fl., fru., lvs, sh 2.1.

On LITTLE BARRIER I., NI (200 feeding observations over spring, summer, autumn; Dawe 1979): **Plants** MONOCOTYLEDONS: Liliaceae: *Astelia* fru. 1.5% no. of total obs.; Juglandaceae *Juglans regia* fl. 11.0; Poaceae: Unident. grass sds 17.0. DICOTYLEDONS: Asteraceae: Unident. fl. 2.0; Fabaceae: *Trifolium* sds 2.5; Fagaceae: *Nothofagus truncata* fl., lvs, sh. 1.5; Myrtaceae: *Kunzea ericoides* sds, fl. 7.0; *Leptospermum scoparium* sds 2.5; *Metrosideros excelsa* sds, lvs, sh. 5.0; Onagraceae: *Fuchsia* fl. 1.0; Polygonaceae: *Muehlenbeckia complexa* sds, fl. 14.5; Rubiaceae: *Coprosma* fru. 4.0; *C. arborea* fl. 2.5; Salicaceae lvs 1.0; Verbenaceae: *Vitex lucens* fl., fru., lvs, sh. 14.5; Violaceae: *Melicytus ramiflorus* fl., lvs, sh 4.5. On LITTLE BARRIER I. (1745 feeding observations over 11 months; Greene 1988): **Plants** GYMNOSPERMS: Araucariaceae: *Agathis australis* sds, fl., lvs, sh. 2.5% no. of total. obs. MONOCOTYLEDONS: Poaceae: *Poa annua* sds 2.4. DICOTYLEDONS: Araliaceae: *Pseudopanax edgerleyi* fl., fru. 1.2; Fagaceae: *Nothofagus truncata* sds, fl., lvs, sh. 31.1; Myrtaceae: *Kunzea ericoides* sds, fl., lvs, sh. 4.9; *Metrosideros excelsa* sds, fl., lvs, sh. 3.1; Phytolaccaceae: *Phytolacca octandra* fru. 3.7; Pittosporiaceae: *Pittosporum umbellatum* sds, fl., lvs, sh. 1.9; Polygonaceae: *Muehlenbeckia complexa* sds, fl., 17.7; Solanaceae: *Solanum americanum* fl., fru. 2.3; Verbenaceae: *Vitex lucens* fl., fru 4.3. **Animals** INVERTEBRATES: *Ctenochiton viridis* 2.2; *Sensorioaphis nothofagi* 6.3.

At BURGESS I., MOKOHINAU GRP, NI (264 feeding observations, Dec. 1983 – Jan. 1984; Bellingham 1987): **Plants** LICHEN: Ramalinaceae: *Ramalina celastri* fru. 3.0% no. of total obs. MONOCOTYLEDONS: Unident. grass 4.9; Agavaceae: *Phormium tenax* sds 12.1; Cyperaceae: *Cyperus ustulatus* sds 4.5; Poaceae: *Anthoxanthum odoratum* sds 3.4; *Chionochloa bromoides* sds 4.2; *Holcus lanatus* sds 1.8. DICOTYLEDONS: Aizoaceae: *Disphyma australe* fru. 1.1; Asteraceae: *Hypochoeris radicata* sds 4.5; Convolvulaceae: *Dichondra repens* fru. 1.1; Myoporaceae: *Myoporum laetum* lvs 20.9; Myrtaceae: *Metrosideros excelsa* fl. 21.2; Polygonaceae: *Muehlenbeckia complexa* fru. 2.7; Rubiaceae: *Coprosma macrocarpa* fru. 1.9; *C. repens* fru. 11.0.

On MANGERE I., CHATHAM GRP (32 crops and oesophagi, Feb. 1980; Nixon 1994): **Plants** Seeds 18.8% freq., flowers 2.9, leaves 49.8, wood 5.9. MONOCOTYLEDONS: Cyperaceae: *Carex* sds 5.9; Poaceae: Unident. grass lvs 2.9; *Dactylis glomeratus* sds 9.1. DICOTYLEDONS: Aizoaceae: *Disphyma papillatum* sds 2.9, fl. 24.8; Asteraceae sds 5.9; *Embergeria grandifolia* sds 2.8; Caryophyllaceae sds 9.1; *Cerastium* sds, fru. 18.8; Fabaceae: *Trifolium* lvs 22.0. **Other matter** Grit 21.9. On MANGERE I. (34 feeding observations at same site as previous data, May–June 1979; Nixon 1994): **Plants** LICHEN: Unident. lvs, sh. 8.8% no. of total obs. MONOCOTYLEDONS: Poaceae: Unident. grass 17.6. DICOTYLEDONS: Aisoaceae: *Disphyma papillatum* lvs, sh. 8.8; Asteraceae: *Olearia chathamica* lvs, sh. 5.8; *Olearia traversii* lvs, sh. 20.6; Malvaceae: *Plagianthus chathamica* lvs, sh. 5.8; Polygonaceae: *Muehlenbeckia australis* sds 2.9; Rosaceae: *Acaena* sds 8.8; Scrophulariaceae: *Hebe chathamica* lvs, sh. 8.8. **Animals** INSECTS: Hemiptera: Pseudococcidae 11.7. On MANGERE I. (59 feeding observations, Nov. 1970, 1973, 1976; R.H. Taylor): **Plants** MONOCOTYLEDONS: Agavaceae: *Phormium* fl. 1.7% no. of total obs. DICOTYLEDONS: Aizoaceae: *Disphyma papillatum* fl., lvs, sh. 6.8; Asteraceae: *Brachyglottis huntii* fl. 8.5; *Carduus* fl. 1.7; *Leptinella* lvs, sh. 3.4; *Olearia traversii* sds, fl., lvs, sh. 54.3; *Sonchus* sds 1.7; Caryophyllaceae: *Stellaria media* fl. 5.1; Crassulaceae: *Crassula moschata* lvs, sh. 3.4; Polygonaceae: *Muehlenbeckia* lvs, sh. 1.7; Malvaceae: *Plagianthus cathamicus* fl. 10.2. **Animals** INSECTS: Hemiptera: Coccoidea 1.7.

On ANTIPODES I. (205 feeding observations, Oct.–Nov. 1995; Greene 1996): **Plants** MONOCOTYLEDONS: Cyperaceae: *Carex appressa* sds, fl., lvs, sh. 28.8% no. of total obs.; Poaceae: *Poa foliosa* fl., lvs, sh. 6.2; *P. litorosa* fl., lvs, sh. 32.2. DICOTYLEDONS: Apiaceae: *Anisotome antipoda* fl., lvs, sh. 5.7; Caryophyllaceae: *Colobanthus apetalus* fl., lvs, sh. 2.8; Rosaceae: *Acaena minor* lvs, sh. 1.4; Rubiaceae: *Coprosma ciliata* fru. 5.8; *C. rugosa* fru., lvs, sh. 9.7.

On SOUTH EAST I., CHATHAM GRP (279 feeding observations, Nov. 1970, 1973, 1976; R.H. Taylor): **Plants** MONOCOTYLEDONS: Cyperaceae: *Scirpus* sds, fl. 1.1% no. (of total obs.); Poaceae: Unident. grass sds, lvs, sh. 5.7; *Hordeum* sds 1.1. DICOTYLEDONS: Aizoaceae: *Disphyma papillatum* fl., lvs, sh. 12.1; Asteraceae: *Brachyglottis huntii* fl., lvs, sh. 5.3; *Carduus* sds, fl. 5.3; *Olearia traversii* sds, fl., lvs, sh., bark 5.8; *Sonchus* sds, fl. 1.5; Caryophyllaceae: *Stellaria media* fl., lvs, sh. 1.8; Chenopodiaceae: *Einadia trigonus* lvs, sh. 1.5; Fabaceae: *Vicia* lvs, sh. 2.1; Malvaceae: *Malva* fl., lvs, sh. 3.9; *Plagianthus chathamicus* fl., fru., lvs, sh., bark 1.9; Myrsinaceae: *Myrsine chathamica* fru., lvs, sh. 1.1; Polygonaceae: *Muehlenbeckia* lvs, sh. 26.5; Rosaceae: *Acaena* sds, fl. 4.6. **Animals** Unident. 2.1; INSECTS: Hemiptera: Coccoidea 2.8.

On MACAULEY I., KERMADEC GRP (691 observations, Nov. 1980; R.H. Taylor): **Plants** ALGAE: Unident. seaweeds 4.0. MONOCOTYLEDONS: Cyperaceae: *Cyperus ustulatus* sds, lvs 63.96; *Isolepis nodosa* sds, lvs, sh. 1.29; Poaceae: *Lacnagrostis filiformis* sds 1.15; *Microlaena stipoides* fl., lvs, sh. 1.87; *Poa anceps* sds 1.44; *Rhytidosperma racemosum* sds, lvs 1.29. DICOTYLEDONS: Aizoaceae: *Disphyma australe* lvs, sh. 3.9; Asteraceae: *Pseudognaphalium luteoalbum* fl., lvs 2.31; Solanaceae: *Solanum nodiflorum* sds, fru. 12.15. **Animals** MOLLUSCS: Acmaeidae: *Scutellastra kermadecensis* 3.33. **Other matter** Grit 58.

Other records MAIN ISLANDS OF NZ AND NEARBY ISLANDS: **Plants** BRYOPHYTES: Unident. moss spores[31]. FERNS: Polypodiaceae: *Pyrrosia elaegnifolia* lvs, sh.[18]. GYMNOSPERMS: Araucariaceae: *Agathis australis* sds[12]; Cupressaceae: *Cupressus funebris* cones[20]; *C. macrocarpa* lvs[15], fl.[18]; Phyllocladaceae: *Phyllocladus trichomanoides* lvs[18]; Pinaceae: *Pinus pinca* cones[20]; *P. radiata* sds[8], buds, sh.[15]; Podocarpaceae: *Dacrycarpus dacrydiodes* fru., lvs, shoots, bark[15]. MONOCOTYLEDONS: Agavaceae: *Phormium tenax* sds[4,5,6,7,16,18,30,32], fl. buds[9]; Cyperaceae: sds[21]; *Carex virgata* sds[18]; *Cyperus ustulatus* sds[20]; *Gahnia* sds[12]; *Isolepis nodosa* fru.[17]; *Leptocarpus* sds[19]; *Uncinia uncinata* sds[20]; Juncaceae: *Juncus australis* sds[18]; Liliaceae: *Astelia* fru.[26]; *Dianella intermedia* fru.[18]; Poaceae: unident. grass sds, lvs[15]; *Bromis hordaceous* sds[18]; *Cortaderia richardii* sds[4,6,7,19]; *Dactylis glomerata* sds[2,3,6,23]; *Holcus lanatus* sds[18]; *Sporobolus africanus* sds[18]; *Stenotaphrum secundatum* sds[17]. DICOTYLEDONS: Aizoaceae: *Aptenia cordifolia* sds[17]; *Disphyma australe* sh.[16], fl.[7,16]; Alseuosmiaceae: *Alseuosmia macrophylla* fl., fru.[18]; Araliaceae: *Meryta sinclairii* fru.[13]; *Pseudopanax* lvs[15]; *P. arboreus* fl., fru.[18]; *P. crassifolius* sds[4], lvs[18]; *P. lessoni* fru.[15,32]; *Schefflera digitata* fru.[18]; Asteraceae: *Brachyglottis repanda* sds[15]; *Cassinia leptophylla* sds, buds[20]; *Conyza albida* sds, fl.[18]; *Hypochoeris radicata* fl.[18]; *Olearia* sds[18]; *O. arborescens* fl.[10]; *O. furfuracea* sds[15]; *Pseudognaphalium luteoalbum* sds[18]; *Senecio bipinnatisectus* sds[18]; *Sonchus* sds[6,20,21]; *S. olearaceus* fl.[18]; *Taraxacum officinale* sds[6]; Caryophyllaceae: *Stellaria media* sds[6,18]; Chenopodiaceae: *Chenopodium urbicum* sds[1]; Convolvulaceae: *Calystegia* sds[14]; Coriariaceae: *Coriaria arborea* fru.[20]; Epacridaceae: *Cyathodes juniperina* fl., fru.[18]; *Dracophyllum latifolium* sds[18]; *Leucopogon fasciculatus* fru.[15,18]; Euphorbiaceae: *Euphorbia peplus* sds[18]; Fabaceaea: *Pisium sativum* fru.[20]; Fagaceae: *Nothofagus solandri* var. *cliffortioides*[25]; *N. truncata* leaf buds[12]; *Quercus* fru.[20]; Fumariaceae: *Fumaria muralis* fl.[18], sds[15]; Geraniaceae: *Geranium molle* fl.[18]; Crossulaceae: *Ribes* fru.[20]; Icacinaceae: *Pennantia corymbosa* fru.[6]; *P. baylisiana* fl. buds[33]; Lauraceae: *Beilschmiedia tarairi* lvs[15]; *Laurelia novae-zelandiae* fru.[18]; Lamiaceae: *Mentha pulegium* fl.[18]; Loganiaceae: *Geniostoma lingustrifolia* fru.[32]; Loranthaceae: *Peraxilla tetrapetala* fl.[29]; Mimosaceae: *Acacia* sds[20]; Moraceae: *Streblus banksii* apical sh.[9,10]; Myoporaceae: *Myoporum laetum* fru.[6]; Myrsinaceae: *Myrsine australis* fru.[4,15]; Myrtaceae: *Guava* lvs[18], fru.[15]; *Kunzea ericoides* sds[15,16,24,32]; *Leptospermum scoparium* sds[4,6,15,16], fl.[9], fru., lvs[18]; *Metrosideros* lvs[15]; *M. excelsa* fl.[18]; *M. fulgens* sds, fl.[18]; *M. perforata* lvs[15]; *M. umbellata* fl.[18]; Oleaceae: *Nestegis lanceolata* fl., fru., lvs[12,18]; Onagraceae: *Fuchsia excorticata* fru.[20]; Passifloriaceae: *Passiflora tetandra* fru.[4]; Phytolaccaceae: *Phytolacca octandra* fru.[12,23]; Piperaceae: *Macropiper excelsum* fl., sds[19,32]; Pitto-sporaceae: *Pittosporum crassifolium* sds[19], lvs[9]; *P. umbellatum* sds[12,28]; Polygonaceae: *Muehlenbeckia complexa* fl.[2,16]; Proteaceae: *Knightia excelsa* sds, fl.[15,18]; Rosaceae: *Acaena* sds[16]; *Cotoneaster* fru.[15]; *Fragaria vesca* fru.[20]; *Malus sylvestris* fru.[20]; *Prunus* fl., lvs[15]; *P. domestica* fru.[20]; *P. persica* fru.[15,18]; Rubiaceae: *Coprosma* fru.[22,24]; *C. arborea* fl., fru.[18]; *C. macrocarpa* fru.[19,32], fl.[11,18]; *C. rhamnoides* fl.[18]; *C. repens* lvs[9], fru.[15]; Ranunculaceae: *Ranunculus* lvs[15]; Rutaceae: *Melicope ternata* lvs[9]; *Phebalium nudum* fl.[18]; Salicaceae: *Salix* lvs, sh.[15]; Santalaceae: *Mida salicifolia* fl.[18]; Sapotaceae: *Pouteria costata* sds[15,29], apical shoots[11], lvs[9]; *M. ternata* sds[18]; Scrophulariaceae: *Hebe* sds, buds[20]; Solanaceae: *Solanum americanum* fru.[18]; *S. aviculare* fru.[20]; Verbenaceae: *Vitex lucens* fl.[15,18], fru.[27], lvs[15]; Violaceae: *Melicytus novae-zelandiae* lvs[9]; *M. ramiflorus* fl., fru., lvs[4, 12 18, 32].

REFERENCES: [1] Smith 1888; [2] Sibson 1949; [3] Dawson 1950; [4] Wilkinson & Wilkinson 1952; [5] Chambers *et al.* 1955; [6] Wilkinson 1957; [7] Kinsky & Sibson 1959; [8] Black 1963; [9] Skegg 1963; Blackburn [10] 1968, [11] 1970; [12] Gravatt 1969; [13] Ramsay & Watt 1971; [14] Stidolph 1971; [15] Dawe 1979; [16] Taylor 1985; [17] Bellingham 1987; [18] Greene 1988; [19] Sagar 1988; [20] Oliver; CSN [21] 2, [22] 7, [23] 9, [24] 21, [25] 23, [26] 30, [27] 31, [28] 32, [29] 33, [30] 39, [31] 42; [32] T.C. Greene; [33] P.J. de Lange.

ANTIPODES, CHATHAM, KERMADEC, LORD HOWE, MACQUARIE, NORFOLK IS. **Plants** LICHEN: sds[21]. BRYOPHYTES: Unident. moss[19,25]; Hepaticae: Liverwort[21]. FERNS: Blechnaceae: *Blechnum durum* lvs, sh., roots[25]; Dennstaedtiaceae: *Histiopteris incisa* lvs[21]; *Hypolepis dicksonioides* lvs[25]; Dryopteridaceae: *Polystichum vestitum* lvs, sh., stems, leaf bases[25]; Lycopidaceae: *Lycopodium*[22]; Pteridaceae: *Pteridium esculentum* lvs[25]. GYMNOSPERMS: Araucariaceae: *Araucaria heterophylla* cones[11,13,15,16]. MONOCOTYLEDONS: Cyperaceae: *Carex appressa* sds[10,25], lvs, sh., roots[25]; *C. ternaria* sds[25]; *C. trifida* sds[21,25]; *Cyperus* sds[9]; *C. ustulatus* sds[18]; *Isolepis aucklandicus* sds[25]; Juncaceae: *Luzula crinita* sds[25]; Poaceae: unident. grass lvs[22]; *Bromus willdenowii* lvs[25]; *Holcus lanatus* lvs, sh.[25]; *Poa foliosa* sds[25]; *P. litorosa* sds, fl., lvs, sh.[25]; *Puccinellia walkeri* sds, stems, leaf bases[25]. DICOTYLEDONS: Aizoaceae: *Disphyma* sds[4]; Apiaceae: *Anisotome antipoda* sds, fl., stems, leaf bases[25]; *Apium prostratum* lvs, sh.[25]; Araliaceae: *Stilbocarpa polaris* lvs[19], bracts, fl.[25]; Asteraceae: *Brachyglottis huntii* fl.[4]; *Cirsium vulgare* sds[25]; *Conyza* sds[1,2]; *Gnaphalium* sds[1,2]; *G. gymnocephalum* lvs[25]; *Leptinella plumosa* sds, fl.[21,25]; *Olearia* fl.[4]; *O. semidentata*[5]; *Senecio radiolatus* fl.[25]; *Sonchus asper* sds[25]; *S. kirkii* lvs[25]; *Taraxacum officinale* sds, fl.[25]; Brassicaceae: *Coronopus didymus* sds, lvs, sh.[25]; *Nasturtium* lvs, sh.[25]; Callitrichaceae: *Callitriche antarctica* lvs, sh.[25]; Caryophyllaceae: *Cerastium glomeratum* fl.[25]; *Colobanthus apetalus* fl.[25]; *C. muscoides* fl.[25]; *Polycarpon tetraphyllum* sds[9,25]; *Stellaria decipiens* lvs[22,25]; Chenopodiaceae: *Einadia trigonos* sds[9]; Crassulaceae: *Crassula moschata* sds, fl., lvs, sh.[25]; Epacridaceae: *Dracophyllum* sh.[23]; Euphorbiaceae: *Baloghia lucida* sds, fl.[17]; Gentianaceae: *Gentiana antipoda* fl.[25]; Malvaceae: *Lagunaria patersonia* fl.[17]; Myoporaceae: *Myoporum kermadecensis* fl.[25]; *M. laetum* lvs, sh.[25]; Myrtaceae: *Metrosideros kermadecensis* leaf sh.[9]; *Psidium guajava* fru.[12,13,17]; *Rhodomyrtus psidioides* fru.[12,13,17]; Oleaceae: *Olea africana* sds, fru.[11,14,17]; Oxalidaceae: *Oxalis thompsonii* lvs[25]; Polygonaceae: *Muehlenbeckia* sh.[24]; *Rumex* fl.[25]; *R. obtuifolius* sds[25]; Primulaceae: *Anagallis* fl.[25]; Rosaceae: *Acaena* burrs[4,5]; *A. minor* sds, fl.[25]; *Prunus persica* fru.[6,7,13,17]; Rubiaceae: *Coprosma* lvs, sh., fru.[9,22]; *C. chathamica* fru., lvs[25]; *C. ciliata* fru., fl.[25]; *C. perpusilla* fru., lvs, sh., sds, fl.[25]; *C. pumila* fru.[21]; *C. rugosa* fru., lvs, sh.[25]; Scrophulariaceae: *Hebe dieffenbachii* lvs, sh.[25]; Solanaceae: *Solanum mauritianum* fru.[17]; *S. nodiflorum* sds[9]; *S. tuberosum*[22]; Urticaceae: *Urtica australis* sds[25]. **Animals** CRUSTACEANS[3]. INSECTS: larv.[20]; Diptera: pupae, larv.[4,21,25]; Coelopidae[22]; Hemiptera[20]; Aphididae[22]. BIRDS: Penguin eggshells[22]; petrel corpses[21,25]; White-headed Petrel *Pterodroma lessoni* corpses[21]. MAMMALS: Goat carcasses[8].

REFERENCES: Cheeseman [1] 1887, [2] 1890; [3] Hamilton 1894; [4] Fleming 1939; [5] Bell 1955; [6] Wakelin 1968; [7] Smithers & Disney 1969; [8] Williams & Rudge 1969; [9] Merton 1970; [10] Warham & Bell 1979; [11] Forshaw 1980; [12] Moore 1981; [13] Schodde *et al.* 1983; [14] Low 1984; [15] Hay 1985; [16] Taylor

1985; [17] Forshaw & Cooper 1989; [18] Tennyson & Taylor 1989; [19] Miskelly *et al.* 1990; [20] Nixon 1994; [21] Greene 1996; [22] Oliver; CSN [23] 26, [24] 28; [25] R.H. Taylor.

Young Information from Little Barrier I. (T.C. Greene), unless stated. Nestlings fed by regurgitation. Food appears to be transparent liquid at first; becomes thicker and coarser after 4–5 days; after 10–12 days, chicks fed large pieces and whole seeds. For first 2 weeks chicks fed by female *c.* 12 times/day, during daylight hours; increases to *c.* 20 times/day after adult male starts to feed chicks directly. Diet of young depends on habitat and availability of food. Seeds appear to be an important and preferred component of nestling diet; comprise 50–80% of adult diet during nestling period. Observations of adults with nests showed seeds of *Poa annua*, *Kunzea ericoides*, *Leptospermum scoparium* and *Muehlenbeckia complexa* to be particularly important. Fruits of *Melicytus ramiflorus*, *Coprosma rhamnoides* became important just before and after chicks fledge.

Intake On Mangere I., maximum amount of material recorded in crop 9.8 ml of plant and invertebrate material; largest invertebrate 8 mm long (Nixon 1994). On Little Barrier I., most faeces comprise finely crushed vegetable matter with few visible seeds. Feeding rate varies with season, type of food and size of food items (Greene 1988).

SOCIAL ORGANIZATION Much of account prepared by T.C. Greene. Fairly well known, especially from studies on Little Barrier I. (Greene 1988, 1989, 1990, 1996). Dispersion closely related to abundance of food and so varies between seasons and years. Usually solitary or in pairs. Flocks can form at abundant food in any season, but such flocks usually short-lived; most flocks small, with only 9.3% more than five birds. On islands with little fresh water, will congregate at water to drink and bathe (Merton 1970; Dawe 1979; Taylor 1985; Greene 1988, 1996; O'Donnell & Dilks 1993; Nixon 1994; Forshaw; T.C. Greene). Once independent, juveniles often forage with adults, forming small groups; generally close to nest at first, then dispersing over wider area (Greene 1990).

Bonds Apparently monogamous. On Little Barrier I., eight pairs retained partners and bred in two consecutive seasons; mates associate in non-breeding season (T.C. Greene). Occurrence of polygyny unconfirmed, but entry into nest by more than single pair occasionally observed. Incubating females also seen soliciting and receiving food from males other than mate (Dawe 1979; T.C. Greene). Population sex-ratio on Little Barrier I. probably approximately equal (T.C. Greene); possibly male-biased in populations where introduced predators present (Hicks & Greenwood 1989; Garnett 1992). Age at first pairing and breeding in wild unknown, but one juvenile female, only 1 week after reaching independence, seen repeatedly with adult male and behaving as mated pair (Greene 1990). In captivity, said to first breed when <1 year old (C.D. Roderick). Courtship and pair-formation can occur through much of year, but commonly seen Sept. and Oct. in most populations (Sibson 1947; Wilkinson & Wilkinson 1952; Dawe 1979; Taylor 1985; Forshaw & Cooper 1989; Oliver; T.C. Greene). **Parental care** After nest-cavity chosen, female prepares nest, incubates eggs, broods young, and feeds nestlings for first 2–3 weeks; during this period, female prevents access to nest by male, who provides food to female and chases other Parakeets from near nest; both sexes feed nestlings and fledglings thereafter (Moon 1957; Wilkinson 1957; Dawe 1979; Taylor 1985; Greene 1990; T.C. Greene; R.H. Taylor). Adult of one pair fed nestling of another pair (Dawe 1979). Fledgelings begin to feed themselves 2 weeks after fledging but still pursue adults, begging for food. Adults begin lunging at and chasing young away 3–4 weeks after fledging; young become independent 4–5 weeks after fledging (Dawe 1979; Taylor 1985; Hicks & Greenwood 1989; T.C. Greene).

Breeding dispersion Nest solitarily. Many nests apparently used over many years (Greene 1990). **Territories** Most pairs remain within fairly distinct areas before and during breeding season; apparently centred on regularly occupied roost- and nest-sites. Males aggressive to other Parakeets near nest; female at one nest also chased off female intruders during incubation period (Greene 1990; T.C. Greene; see below).

Roosting Solitary; sites usually traditional and invariably well concealed; often same roost used throughout year (Taylor 1985; Greene 1990; T.C. Greene; T.G. Lovegrove; see Habitat). Members of pair roost 10–200+ m apart. Once, before breeding season, male and female of different pairs roosted in same tree without aggression. At night, outside breeding season, often roost in nest-holes, usually, but not always, subsequently nesting there. During breeding season, male of pair consistently roosts close to, and possibly within, nest. Arrive at nocturnal roost at, or soon after, sunset; leave just before sunrise. Loafing generally occurs most often in middle of day (8% of total time-budget; Greene 1988), usually in sheltered and often shaded areas; on Antipodes Is, actively seek out sheltered and sunny areas in which to loaf. Often preen while loafing. When resting, usually sit low, with feathers fluffed; will sleep in this position but usually turn head over one shoulder; keep both feet on perch when roosting (Dawe 1979; Taylor 1985; Greene 1988, 1990; T.C. Greene).

SOCIAL BEHAVIOUR Account largely prepared by T.C. Greene. Fairly well known, especially from studies on Little Barrier I. (Greene 1988, 1989, 1990, 1996) and in captivity (Dawe 1979). Tame wherever there is little human impact and disturbance, such as on Kermadec Is (Cheeseman 1887; Taylor 1985), Antipodes Is (Taylor 1985; Greene 1996) and formerly Norfolk, Lord Howe and Macquarie Is (Oliver; Forshaw). More often seen than heard, particularly in forest habitats, where well camouflaged (Williams 1976; Calder & Deuss 1985; T.C. Greene). Most displays and behaviours inconspicuous. Usually quiet while feeding, giving only occasional soft Contact Calls; vocalizations during copulation, begging and agonistic behaviour (see Voice) obvious and indicative of behaviour (Dawe 1979; Greene 1988, 1996; T.C. Greene). **Flock behaviour** Form loose flocks with little cohesion, usually congregating at locally abundant food (Greene 1988). Usually respond to disturbance more quickly while in flocks than when solitary (T.C. Greene). **Comfort behaviour** Based on observations by Dawe (1979) unless stated; similar to other small parrots. Preening usually thorough and often prolonged; use bill to preen all parts of body except head; fan tail and wing and raise remaining plumage; after preening, shake and settle feathers (T.C. Greene). In captivity and wild, observed preening feathers, particularly of wing and tail, with mixture of chewed aromatic leaves and preen-oil, and this has some effect against parasites; this material also often ingested and suggested to have some effect on internal parasites (Greene 1989). Often scratch head vigorously with foot. Remove flaking skin and foreign matter from feet by vigorous shaking or with bill; bill cleaned by rubbing it on vegetation. Usually stretch after period of inactivity, and stretching usually interspersed with periods of feather-shaking; stretching commonly includes backward and downward extension of one wing and foot on same

side; tail sometimes turned and spread toward outstretched wing. Stretching often followed by raising carpal joints over back and spreading wings; sometimes also yawn. **Bathing** Bathe vigorously, using only fresh clean water, though on Macauley I., Kermadec Grp, where no permanent freshwater, bathe in shallow intertidal pools. Prefer to bathe every day; stand in shallow water, dip head and splash water over back with wings while shaking body; dry plumage by shaking body and wings, preening, and sitting in sun with feathers ruffled (Dawe 1979; Taylor 1985; T.C. Greene).

Agonistic behaviour Generally rare in wild and usually only involves displacement of conspecifics when in flocks at locally abundant food or near active nests. Resident male often repeatedly attacks pairs or individuals investigating nest-hole of resident; usually, approach of resident male causes intruders to leave but sometimes results in aerial fights, and once two males fought on ground. Nest of one pair in study investigated often throughout breeding season by others; while incubating, resident female ignored intruding males, but would fly from nest and chase intruding females from vicinity (Greene 1988; T.C. Greene). Usually respond by turning toward and lunging or rushing at opponent while churring or chattering; bill-gaping may also occur (Greene 1988). Even if interference persistent, aggression usually remains at low intensity while foraging, usually halting if intruder moves 2–3 m away (Greene 1988). Near nests, intensity of agonistic interactions much greater and usually results in active pursuit of intruders from area, often for >100 m, accompanied by loud chattering (Greene 1988). Sometimes attack individuals showing signs of illness (Dawe 1979). Following descriptions of agonistic behaviours from study of captive group of males by Dawe (1979), but nearly all behaviours also seen in wild. Considerable use of feet in aggression unusual for small parrots. Many behaviours, especially positions of body, vary greatly and do not form distinct displays; ritualization poorly developed. During aggression, feathers can be sleeked, relaxed or fluffed and feathers of crown can be raised; raising feathers of crown and fluffing appear in both aggressive and escape contexts, but fluffing usually associated with submissive postures and escape. **Threat** FORWARD POSTURES: Vary continuously in position of body, angle of tarsus and angle between tarsus and tibia; Low Forward and High Forward merely represent typical postures (Fig. 1); given with bill closed or gaped or while calling; usually given in response to other aggressive behaviours and usually after initial aggressive approach toward opponent. Opponent usually retreats or

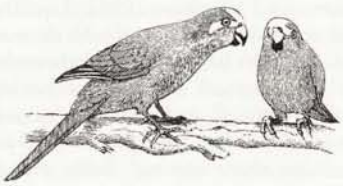


Figure 1 Forward posture

assumes submissive posture but can also respond aggressively; if opponent does not retreat or submit, further aggression often follows. LOW FORWARD (Fig.2): Typically hold tarsus angled slightly back from vertical with tibia vertical to slightly forward and with body horizontal; head can be pulled in close to body or head and neck can be extended fully toward opponent. Can merge into more defensive Crouch posture by lowering body and drawing in head; or, with slight backward stepping, can



Figure 2
Low Forward posture



Figure 3
High Forward posture

merge into Back Away (see Submission). HIGH FORWARD (Fig. 3): Typically hold legs only slightly back from vertical, and body, neck and head extended upward and forward at angle of 50–60°, exposing more of upper leg than normally visible in Low Forward. Can merge into more defensive upright posture by leaning backward; body often then turned slightly away and with further turning can merge into Lean-away, held as far back as possible. LEAN TOWARD: Occasionally when several birds gathered round food, one leans toward another in high, upright posture and faces it (cf. Lean-away); functions as low-intensity threat in crowded situations. TURN TOWARD: Turns toward opponent with aggressive intent, as indicated by alert and quick nature of movement; usually given in response to aggression, often as first in sequence of aggressive acts unless, as often happens, opponent retreats. SIDLE TOWARD: Used to approach opponent when motivation not so great as that eliciting frontal approach; usually holds head in line with body or turned slightly in direction of movement; usually results in opponent retreating; rarely used against aggressive individual, which then requires higher level of aggression. Often followed by further aggression; sometimes turns head toward opponent and gapes bill or calls, which almost always causes opponent to fly away. MOVE TOWARD: Holds body in one of Forward positions while moving toward opponent; usually keeps bill closed, and sometimes gapes or calls; usually given in response to low-level aggression but also to submissive and retreat behaviours; opponent almost always retreats or shows submission, usually flying away, especially if performer gapes or calls; usually preceded by less aggressive act, especially Turn Toward and stationary postures; usually followed by further aggression if opponent does not submit or retreat. WAVE FOOT TOWARD: Foot held toward opponent and moved in slow clawing action; in extreme cases, foot held almost still and pointed at opponent, with toes spread. Most often given as response to mild aggression, functioning as threat; opponent usually backs off in response but rarely flies away. BILL-GAPING: Opens bill wide and toward opponent; most often followed with other aggressive acts using bill, as not to do so invites attack from opponent; opponent must respond with intense aggression, such as Pecking or Lunging, to have chance of winning encounter. Gaping while moving toward opponent increases likelihood of opponent flying away; such aggressors more likely to continue with further aggression than if attacking with bill closed. Gaping can also be used in stationary forward positions. FEEDING: Can be considered as low-intensity threat when feeding individual ignores threat of others and continues to feed or produces signs of submission in nearby bird; Face-away, Lean-away and Stand Still Side-on are usual responses by individuals perceiving feeding as threat, with other submissive postures and retreat rarely given as response. **Attack** RUSH: Runs at opponent, which almost always flees immediately. FLIGHT APPROACH: Flying to land on or near opponent commonly used to direct aggression at opponent

initially some distance away. Opponent usually flies away before attacker lands, and always does so if landed on; otherwise usually retreats along perch or assumes submissive postures; if opponent does not flee, attacker normally continues with further aggression but sometimes instead continues flight or itself shows submission. Common for bird flying off to circle round to land and re-start encounter. FLYING CHASE: Occasionally when defeated bird flies away, aggressor flies after it and lands close beside it whenever it lands, often lunging at it. STANDING CLAW: Foot raised and claw swung at body or head of opponent; usually results in opponent retreating, turning away or assuming submissive posture; usually given in response to roughly equally aggressive acts but also to submissive postures and feeding individuals. Usually precedes further aggressive acts and performers seldom retreat. FLYING CLAW: If flying to perch and perched opponent does not move off, attacker can hover above opponent and rake it with claws; when two birds facing one another in aggressive encounter, one sometimes flies above other to claw at it; Flying Claw usually causes opponent to fly off. FOOT PUSH (Fig. 4): Foot raised and pushed against body of opponent; often results in opponent losing balance, in which case attacker directs force downward to push opponent off perch, causing it to fly away; can be given from forward or side-on position. Can be given to fend off opponent in close,

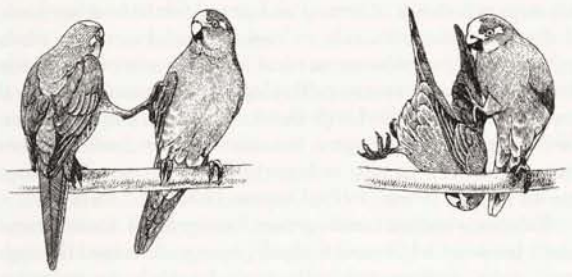


Figure 4 Foot Push

upright, front-on confrontation; Foot Push can be followed by further aggression if opponent does not retreat, but submission or retreat of attacker equally likely. STANDING ON BODY OR TAIL: When several birds crowd round food, aggressor sometimes stands on tail or body of another in order to reach food; standing on tail does not usually cause recipient to retreat but rather to turn toward aggressor; standing on body usually causes recipient to move away or assume submissive posture, allowing aggressor to walk over it to food; aggressor standing on back likely to peck opponent if it does not immediately retreat or submit. LUNGE: Without moving feet, rapidly and forcefully thrusts head and neck, and often entire body, toward opponent; often gapes bill and sometimes utters short squawk; Lunge does not connect with opponent, either because it is out of reach or rapidly moves to be so. FLYING LUNGE: On rare occasions when two opponents facing each other, one will fly at other in extremely forceful lunge involving movement of entire body in flight; holds gaped bill toward opponent with neck extended. PECK: Lunge which connects with opponent; usually involves head and neck being thrust at other; most often directed at head of opponent, rarely at tail and legs. BITE: Reaches out and bites opponent without forcefully striking it; usually directed to sides of body, neck or wings of opponent; usually given when facing opponent but not front on; birds held in bite usually released after showing submission. BILL-SPARRING: Opponents extend heads upward and bite and peck each other round bill and attempt to grasp bill of other; if bills grasped, will push and twist each other. Most often occurs when opponents already in sparring position and Bill-gaping; usually ends with one retreating; occasionally escalates to Fighting. Lunge, Flying Lunge, Peck and Bite usually cause opponent to fly, sidle or walk away; recipient rarely responds with aggression. Lunges, Pecks and Bites usually given in response to less aggressive acts but sometimes to equally or more aggressive behaviour; sometimes given to birds showing submission; usually precede further aggression but rarely follow submissive postures or retreat. **Fighting** Rare in both wild and captivity. Can occur in flight, where combatants claw at each other for several seconds before one flies away or one or both land; if both land, fight can resume after short pause. Fighting also occurs on perch using one or more of Standing Claw, Flying Claw, Foot Push, Standing On Body Or Tail, Peck, Lunge, Flying Lunge, Bill-gaping and Move Toward; feet used in fighting much more than in many species of small parrot. **Submission** Have many submissive postures compared with other small parrots. Postures described are part of continuum and grade into one another with changes in position of body, orientation and so on; tend to cause opponent to stop attacking, and retreat often follows submissive postures. FACE-AWAY: If opponents facing each other, with bodies oriented along perch, one can turn head away *c.* 90° rather than turn whole body away; given in response to low-intensity aggression but less often than Lean-away or Stand Still Side-on; performer likely to retreat farther afterwards. BACK-AWAY: Takes several short steps backward, with body held low and well back on legs while remaining oriented toward opponent; if fewer steps taken, grades into Low Forward as body held farther forward; given in response to less extreme threats and often followed by further retreat; usually takes submissive bird away from opponent and thus usually stops attack. CROUCH (Fig. 5): Uncommon; body held low back on legs with head withdrawn; often feathers slightly fluffed and tail held low, giving hunched appearance; body can be held in any orientation to other birds; given in response to variety of aggressive behaviour; birds in Crouch usually ignored by dominants; usually follows and precedes other submissive or retreat behaviour. LOW LEAN-AWAY (Fig. 6): Holds body horizontally, with one leg stretched out to side, other folded back across perch and head held close to body; resembles Crouch with one leg extended to tilt body. HIGH LEAN-AWAY (Fig. 7): Holds body upright and leans back to hold head away from and tail toward opponent, with near-side leg extended toward opponent and weight carried largely on folded



Figure 5
Crouch



Figure 6
Low Lean-away



Figure 7
High Lean-away

far-side leg; head and neck can be held close to body or extended upward in line with body or upward and sideways even farther from opponent. Moves more of body away from opponent than Low Lean-away; given much more often. In both Lean-away postures, head almost always faced across perch or away from opponent, rarely toward it. Lean-away

while facing toward opponent and gaping acts as low-intensity defensive threat and is rarely given. Lean-away given equally in response to aggressive behaviour and to feeding birds; usually precedes further retreat or submission; usually ignored by opponent. STAND STILL SIDE-ON: Remains stationary, facing across perch in various postures from normal to upright to horizontal; if given in response to feeding bird, head can be moved round slightly, but if given in response to aggression, performer remains completely still. Most often given in response to feeding bird but also to aggression (e.g. see submissive bird in Fig. 1). **Escape** TURN AWAY: Turning away from opponent indicates submissiveness; given in response to aggression, usually of low intensity; usually aggressor ignores performer but occasionally responds aggressively; can be given after various behaviours but usually signals end of any aggressive activity of performer and usually followed by retreat or submissive postures. SIDLE AWAY: Turns head slightly in direction of movement and thus away from opponent; given in response to aggression, often after Turning Away or assuming submissive postures; commonly followed by further retreat or submission; by far most common means of retreating from threatening dominant without flying off; opponent occasionally directs aggression at performer. DIRECT RETREAT: Walks rapidly forward away from aggressor, which then does not continue with aggression; usually only used when facing along perch when threatened from behind. FLY AWAY: Most common reaction to all types of aggression; usually ends aggression from dominants, but sometimes aggressor continues by flying after retreating bird; occasionally performer circles round to land again and continue aggression. **Hierarchy** Unstable and non-linear in captive group of six males; addition of pairs greatly increases complexity of hierarchy (Dawe 1979). **Alarm** When alarmed or disturbed, usually take flight, chattering loudly, and move to nearest cover; often fly erratic course and weave at speed through dense vegetation (T.C. Greene). Interactions with Yellow-crowned Parakeets extremely rare and Yellow-crowned are usually tolerated, even when very close (Greene 1988).

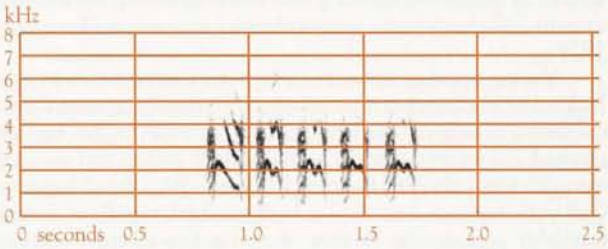
Sexual behaviour Male of one pair displayed much interest in female and nest of another pair nesting nearby; mate of female continually chased intruding male but with little effect; intruding male often preened with female, and escorted her back to nest, before returning to own nest and calling to and feeding own mate; eventually intruding male began calling female off nest and feeding her, despite attempts by her mate to prevent this; intruding male stopped visiting female once laying was finished (Greene 1990). **Courtship** Main components appear to be mutual tolerance followed by mutual attentiveness, co-ordination of activities and pre-copulatory behaviour. Few pre-copulatory displays, most important being SWITCH-SIDLING: only observed before breeding; male repeatedly moves toward and away from stationary female, while turning from side to side; turning movements particularly pronounced at points closest to and farthest from female; often walks back and forth over back of female or jumps from branch to branch. Male often accompanies display with head-bobbing, drooping wings, soft chattering and rapid repeated dilation of pupils; female stays stationary and somewhat hunched, sometimes uttering high-pitched whine while Bill-gaping. Courtship feeding usually follows if female accepts advances (Dawe 1979; T.C. Greene). **Courtship feeding** Rare until *c.* 2 months before laying starts, then increasingly frequent and longer, particularly as selection and occupation of nests begins. Continues through incubation, with male coming to nest at regular intervals, either approaching entrance immediately or first spending several minutes nearby feeding, preening or perching. Usually makes final approach to entrance on foot and, once at entrance, calls softly till female emerges. Sometimes male perches some distance from nest and calls, or approaches entrance without calling. Female usually leaves nest rapidly, flying directly to sheltered perch, usually nearby, which is used often throughout breeding season. Male follows female to perch, where female then crouches with head slightly back, tail at 70° to body, bill open and giving prolonged whining call while facing male. Male jerks head up and down several times before taking bill of female crossways in own and regurgitating, 6–21 times, till crop empty. Male then turns away from female and ignores any further begging; female then performs maintenance activities before returning to nest (Greene 1990; T.C. Greene). **Greeting** Appears restricted to soft contact calls, which are important cue for female to leave nest to be fed by mate (T.C. Greene). **Copulation** Inconspicuous, with only soft calls. Usually on stable perches in trees but can also take place on ground if trees scarce. Females usually solicit copulation, but males often do not respond; females usually signal willingness to copulate by uttering high-pitched *her-her-her* calls, which continue throughout copulation. Male usually becomes highly agitated and moves rapidly round female, jumping from perch to perch while calling softly; female then crouches low, in hunched horizontal position, with carpal joints and head and tail slightly raised. Male steps onto back of female and grasps feathers of her back, and lowers and twists tail to make cloacal contact while flapping wings for balance; several attempts sometimes made before male mounts successfully. Copulation lasts from several seconds to >1 min. On Little Barrier I., first copulations seen *c.* 30 days before laying begins, but most occur in 2 weeks before laying; frequency largely unknown, but one pair copulated twice in 45 min (Dawe 1979; Greene 1990; T.C. Greene).

Relations within family group Recognition, location and contact between adults and fledged young maintained through various calls. Various soft calls given by adults to maintain contact; loud and prolonged chattering calls given in flight and when alarmed (Moon 1957; Taylor 1985; Forshaw & Cooper 1989; Oliver; T.C. Greene). **Selection of nest** Male escorts mate to various sites, often repeatedly, while uttering continual quiet Contact Calls; both inspect each potential hole and, if female appears interested, male rushes back and forth near entrance, often Side-switching and dilating pupils. Female indicates selection by repeatedly entering and leaving hole over prolonged period; male sometimes continues introducing female to other sites, but generally without effect. Female then spends increasing amount of time in nest but regularly comes to entrance, especially if mate nearby. Time off nest is usually spent feeding with mate; throughout period in which female preparing nest, male remains nearby. Nestlings huddle together till able to thermoregulate at *c.* 3 weeks old (Greene 1990). **Feeding of young** Only interaction between young and adults after fledging. Begging of nestlings immediately after hatching involves maximum vertical extension of both neck and body, in attempt to contact bill of female, while uttering Food-begging Calls; young nestlings almost fed on backs, with heads either leaning on rim of nest or bodies of siblings; nestlings begin to beg loudly after detecting parents outside nest. Adults usually visit nest independently; as fledging approaches, begin visiting nest together more often, when usually only one approaches and feeds nestlings at a time, usually the female first. As nestlings mature, siblings actively seek food by repeatedly thrusting head toward regurgitating adult; before fledging, call much and will try to get access to entrance of nest where feeding

usually occurs. Food-begging Calls obvious, and continue till moment of regurgitation, when they become muffled as food transferred with open bills grasped at right angles; parent rapidly jerks head up and down several times before regurgitating; adult regurgitates up to 20 times during one feeding session. Parent brings food to fledgelings by coming to general area where fledgelings perched then calling to locate them. Begging fledgelings call loudly and often follow adults along branch, with wings slightly spread; usually only one fledgeling fed each visit despite all chicks begging. After 13 days, frequency of feeding decreases and fledgelings begin to range over larger area to feed themselves and, calling loudly, actively pursue adults; family groups often seen in flight at this time. Three to four weeks after fledging, adults feed young infrequently, ignoring most begging, and become aggressive toward young. While some young still in nest and others recently fledged, parents can divide feeding of young between them, each attending different individuals; once all young fledged and able to fly, parents feed all young. As nestlings approach fledging age, instead of flying off immediately after feeding nestlings, adults fly to perch nearby and call quietly and fly back and forth to nest. If nestlings do not respond after several minutes, adults fly off and repeat process on next visit. Fledging observed on one such visit: chick climbed out of hole and perched on adjacent branch for c. 3 min before fluttering to ground and moving rapidly along ground to thick cover followed by agitated parent flying overhead; on reaching cover, fledgeling climbed shrub to height of c. 2 m where parent fed it. In areas without cover nearby, or if young cannot fly well, fledgelings remained on ground below nest for up to several hours on first leaving nest, till parents escorted them to more distant cover. Flying ability of young upon fledging varies greatly; some able to fly high into trees within minutes, others remain on or close to ground for up to several days. Fledgelings tend to associate only with siblings; respond only to Begging Calls of one another, ignoring those of other broods nearby; little if any sibling rivalry occurs. Recent fledgelings usually stay within 100 m of nest for first 2 weeks, spending most of time perching quietly or sleeping. Thereafter, range over larger area but return to area round nest often during day and to roost at night (Sibson 1947, 1949; Dawson 1950; Wilkinson & Wilkinson 1952; Merton 1970; Dawe 1979; Hicks & Greenwood 1989; Greene 1990; T.C. Greene). **Anti-predator response of young** Nestlings and recently fledged young usually remain silent and still when disturbed; older young will attempt to fly away or seek dense cover. Inexperienced fledgelings often roost in exposed sites and are vulnerable to predation from Southern Boobooks *Ninox novaeseelandiae* (T.C. Greene). **Parental anti-predator strategies** Adults can call loudly if disturbed near nest. In response to potential aerial predators, usually fly rapidly toward dense cover while calling loudly, and calls can continue for some time after reaching cover (Dawe 1979; MacMillan 1990; T.C. Greene).

VOICE Account prepared by T.C. Greene. Reasonably well known. Detailed study of captive birds and some recordings from wild, with sonagrams, by Pickard (1990), on which account based unless stated. Pickard's samples small, especially for isolated subspecies. Pickard recognized repertoire of eight basic adult calls and three nestling or juvenile calls (for nominate *novaezelandiae*). Most calls can be described as chattering. Often heard in flight, particularly where numerous; otherwise unobtrusive and usually quiet while feeding, giving only occasional soft calls; begging of fledged young noisy. Variety of soft calls used by adults to maintain contact; loud and prolonged chattering calls given in flight and when alarmed. Vocalizations during copulation, begging and agonistic behaviour obvious and characteristic of behaviour (Dawe 1979; Greene 1988, 1996; T.C. Greene). Recognition, location and contact between adults and fledged young maintained using variety of calls (Moon 1957; Taylor 1985; Forshaw & Cooper 1989; Oliver; NZRD; T.C. Greene). Adults call loudly when disturbed at or near nest; will fly rapidly to cover, calling loudly, where continue to call (see Social Behaviour). Nestlings and fledgelings usually remain silent when disturbed (Dawe 1979; MacMillan 1990; NZRD; T.C. Greene). Period of calling not studied. No seasonal differences reported. Mimicry not reported in wild; can learn to talk in captivity (Tavistock 1929). GEOGRAPHICAL VARIATION: Calls of most populations similar, but some geographical variation. Within nominate *novaezelandiae*, calls of Auckland Is populations do not differ significantly from those of populations from NI and SI. Calls from Chatham Is population (*chathamensis*) differ from nominate in frequency and length of note, but notes are of similar shape and intervals between notes similar. Calls from Kermadec Is populations (*cyanurus*) significantly longer than those of nominate, particularly Vocal Loud Single-note Call. Calls from Antipodes Is populations (*hochstetteri*) differ markedly from those of nominate: structure of calls similar but with lower maximum frequency than in nominate; Vocal Chatter Display and Vocal Chatter Display Territory Calls similar to those of sympatric Antipodes Island Parakeet (q.v.), though notes longer; Vocal Two-note Chatter Call resembles that of Yellow-crowned Parakeet (q.v.); Vocal Chatter and Vocal Loud Single Note Calls are unique (Pickard 1990; T.C. Greene). Calls of Norfolk I. and New Caledonian subspecies not studied (but see Other calls, below).

Adult VOCAL CHATTER DISPLAY CALL: Long sequence of notes distinguished from Vocal Chatter Display Territory Call of adult male (q.v.) by shorter notes of lower pitch. Rendered *ki-ki-ki-ki* (Forshaw & Cooper 1989; NZRD) and rapid series of *chit chit chit chit* notes (sonagram **A**) with rattle-like quality (Chambers 1989). Vocal Chatter Display Call can be given by more than one bird at a time; in flight, delivered in short bursts of 6–8 notes, with change to slower harsher, lower-pitched calls after alighting (Dawe 1979). Functions as contact call in flight or when perched; may also function as low-intensity agonistic



A W.V. Ward; Kermadec Is, Nov. 1966; P106

call. Sometimes preceded by Vocal Loud Single-note Call (cf. Vocal Chatter Display Territory Call of adult male). VOCAL CHATTER CALL: Rather quiet call, uttered in sequences of 3–4 notes, which vary in length and structure but are of generally constant pitch. A contact and conversational call, often given during maintenance activities. Given by single birds. Distinctive variant given by females (q.v.) in defence of nest. Antipodes Is population give distinctive version of this call (T.C. Greene). VOCAL CONVERSATION CHATTER CALL: String of soft,

high-pitched chattering notes; length and structure vary but pitch constant. A conversational or contact call. Given by feeding, preening or resting birds; also given by groups of birds. VOCAL TWO-NOTE CHATTER CALL: Soft, inflected call of two notes that vary in pitch, duration and structure. Possibly functions as conversational or contact call. VOCAL SOFT SINGLE-NOTE CALL: Single high-pitched note uttered within sequences of Vocal Conversational Chatter. Functions as contact call between feeding birds. VOCAL LOUD SINGLE-NOTE CALL: Occurs in two forms, both of which can be given a few times before the described Chatter Display calls: (1) Short note that usually precedes Vocal Chatter Display Call; functions as alarm or alert call; (2) Loud short note (slightly longer than first version) preceding Vocal Chatter Display Territory Call of adult male (q.v.); functions in agonistic behaviour and to indicate aggressive intent. Antipodes Is population has distinctive version of this call (T.C. Greene).

Adult male VOCAL CHATTER DISPLAY TERRITORY CALL: Single loud notes delivered rapidly at constant pitch; number of notes in sequence varies but may be >30; often preceded by Vocal Loud Single-note Call. Functions as agonistic or alarm call. Loudness varies with circumstances of use. **Adult female** BEGGING CALL (= Vocal Female Begging of Pickard 1990): Described as single-note call, produced in varying sequences (Pickard 1990); or prolonged whining (Greene 1990; T.C. Greene). Given when begging for food from mate. Female also reported to sometimes utter high-pitched whine while Bill-gaping during Courtship Display (Dawe 1979; T.C. Greene). Also give call like Begging Call when soliciting copulation; said to utter series of high-pitched calls, described as *her-her-her...* to signal willingness to copulate. Calls associated with copulation soft and inconspicuous (Dawe 1979; Greene 1990; T.C. Greene). VOCAL CHATTER CALL: Distinctive version used by female in defence of nest (T.C. Greene), but no details.

Other calls Following descriptions no doubt correspond to one or more of above calls. While perched, utter a shrill trisyllabic call or a soft *tu-tu-tu-tu*; sometimes utter subdued chattering while feeding (Forshaw & Cooper 1989). Other calls rendered as: *tee-pee-wee* (Williams 1976); *pretty-dick* (Andersen 1926; Williams 1976; Falla *et al.* 1981); *twenty-eight* (Buller 1888; Williams 1976); *do-be-quick* (Falla *et al.* 1981); and *free-kick* (Andersen 1926). Calls of Norfolk I. birds described as melodious bleating and soft murmuring noises, one sounding like *heigh-ho* in a tone of cheerful resignation (Tavistock 1929).

Young FOOD-BEGGING CALL (= VOCAL NESTLING CHEEP of Pickard): Nestlings beg from parents with rapidly repeated low-frequency note given for long periods; becomes louder, higher pitched and repeated more rapidly as chick grows, and evolves into different calls after fledging (Pickard 1990). Food-begging Call of fledgelings described as high-pitched, rapidly repeated disyllabic call similar to that of Antipodes Island Parakeet (q.v.). Fledgelings can give slower, more querulous variant of this call when perched (NZRD; T.C. Greene). Begging Calls continue until moment of regurgitation then become muffled as food is swallowed (T.C. Greene). VOCAL NESTLING BUZZ: Sharp repeated buzzing; given by nestlings in alarm, distress and when disturbed by siblings.

BREEDING Account prepared by T.C. Greene. Detailed study of breeding over 2 years on Little Barrier I., NI (Greene 1988, 1990; T.C. Greene); also studied on Tiritiri Matangi I. (Dawe 1979) and Norfolk I. (Hicks & Greenwood 1989); some data from birds in captivity (Dawe 1979; Hicks & Greenwood 1989). Breeding appears related to climatic conditions and seasonal availability of food (Forshaw 1980; Taylor 1985; T.C. Greene). Hybridize with Yellow-crowned Parakeet (Taylor 1975).

Season Breeding recorded in all months of year, with main period of laying varying throughout range. ISLANDS ROUND NI AND SI: Generally breed Oct.–Feb.; laying mostly Oct.–Dec., with peak in Dec.; eggs also in Mar. and Apr.; young in Aug., probably from eggs laid in June (Oliver; T.C. Greene). NORFOLK I.: Laying recorded in all months (Hicks & Greenwood 1989); eggs, Oct., Dec., Feb. and Mar. (Basset Hull 1909; Hicks & Greenwood 1989); young, Mar. (Hicks & Greenwood 1989). KERMADEC IS: Laying, mainly Oct. and Nov. (Oliver); eggs and small young, Nov. (Taylor 1985); young in nest, late Nov. to early Jan.; fledging, late Dec. and early Jan. (Merton 1970). CHATHAM IS: Most eggs laid Oct.–Dec.; recently fledged young, early Nov. (Taylor 1985); eggs and feathered young, late Dec. (Fleming 1939). ANTIPODES IS: Nests found Nov.–Mar.; young in nests in Feb. (Taylor 1985; G.P. Elliott).

Site In hollow or cavity in limb, spout, trunk or stump of living or dead tree; in natural hollows modified or repaired by humans. In NZ, in Kanuka *Kunzea ericoides*, Puriri *Vitex lucens*, Kauri *Agathis australis*, Mahoe *Melicytus ramiflorus*, Ngaio *Myoporum laetum*, Pohutukawa *Metrosideros excelsa*, *Cordyline australis* and *Olearia*; one pair nested in old nest of New Zealand Saddleback *Philesturnus carunculatus* (Sibson 1947; Dawson 1950; Wilkinson 1957; Veitch 1979; Moon 1979; CSN 32; T.C. Greene). On Norfolk I., most nests in Bloodwood *Baloghia inophylla*, Ironwood *Nestegis apetala*, Ti Tree *Cordyline obtecta* and Norfolk Island Pine *Araucaria heterophylla* (Hicks & Greenwood 1989). On Kermadec Is, in *Metrosideros kermadecensis* (Merton 1970). In areas lacking suitable tree-hollows, will nest in holes in cliffs, banks, root-mass of fallen tree, in crevice in rock, tunnel in dense crown of fern *Polystichium*, leafy base of *Xeronema callistemon*, in burrow of White-necked Petrels *Pterodroma cervicalis* or Broad-billed Prions *Pachyptila vittata*; also recorded breeding under eaves of building (Reischek 1885; Wilkinson & Wilkinson 1952; Merton 1970; Taylor 1985; Bellingham 1987; Sagar 1988; Hicks & Greenwood 1989; Oliver; NZ NRS; T.C. Greene; R.H. Taylor). MEASUREMENTS (m): Height of entrance: on Norfolk I., usually <2 m (Hicks & Greenwood 1989); on Little Barrier I., 2.8 (1.5; 0–6.4; 25) (T.C. Greene). Height of nest-tree: on Little Barrier I., 12.9 (3.0; 8–20; 24) (T.C. Greene). Minimum distance between active nests *c.* 30 m but largely dependent on availability of suitable nesting sites. Sites traditional, often used by same birds for successive broods; nesting failure often results in use of alternative nest-sites in same or subsequent years (Dawe 1979; T.C. Greene); one site used for at least 14 years (Oliver). Often evicted from burrows of seabirds (R.H. Taylor; NZ NRS); Kiore *Rattus exulans* known to exclude Parakeets from traditional sites by caching food in holes (T.C. Greene). Both adults prospect for suitable site; female makes final choice (Moon 1957; Dawe 1979; T.C. Greene).

Nest, Materials Nest-chamber a roughly circular depression at end of hollow or burrow, or in darkest corner of cavity. Lined with material from surrounding substrate, including dry powdered wood, earth, powdered pumice, feathers, moss, grass stems, tree-fern scales or other dry plant material (Moon 1979; Taylor 1985; Oliver; T.C. Greene; R.H. Taylor). Female excavates depression using bill to loosen substrate and feet to rake material away; debris ejected from nest at entrance at regular intervals; material lining or protruding into nest-chamber often chewed and added to nest; less intensive preparation

continues during laying but declines with onset of incubation. Interval between occupation of site and onset of laying usually 4, occasionally 6, weeks; interval appears to be significantly reduced if re-nesting occurs (T.C. Greene). MEASUREMENTS: On Norfolk I., nest-chamber 20–40 cm diameter (Hicks & Greenwood 1989). Nesting depression up to 10 cm deep and 15 cm wide depending on size of nest-chamber and depth of substrate (T.C. Greene). On Little Barrier I., size of entrance to nest 99.6 cm^2 (86.6; 25–341; 25); depth to nest-chamber 77.1 cm (46.1; 16–144; 25) (T.C. Greene). Length of burrow, 10 and *c.* 100 cm (Sagar 1988; R.H. Taylor). On Norfolk I., said to compete for hollows with Crimson Rosellas *Platycercus elegans* and Common Starlings (Hicks & Greenwood 1989).

Eggs Broadly elliptical; smooth; lustreless; white (Forshaw). MEASUREMENTS: NI: 25.8 (0.44; 25.3–26.4; 6) × 20.7 (0.26; 20.2–20.9); 25.5 (0.82; 24.5–26.6; 5) × 21.2 (0.59; 20.5–22.0; 5) (Oliver); Kermadec Is, 27.1 (0.93; 25.5–28.5; 8) × 21.2 (0.82; 20.0–22.2) (Oliver; R.H. Taylor); Chatham Is, 26.5 × 21.5, 28.5 × 21.0, 23.5 × 20.5, 24.0 × 20.5 (Fleming 1939); Norfolk I., 26.7 (2.60; 22.4–29.2; 5) × 22.4 (1.73; 19.8–24.6) (Basset Hull 1909; Forshaw). In captivity, 25.8 (23.4–28.2; 12) × 21.3 (19.2–23.7) (Forshaw & Cooper 1989). WEIGHT: NI, 6.14 (0.21; 6.0–6.5; 10); in captivity: 6.11 (5.3–7.0; 19) and 5.17 (4.7–5.6; 17) (Dawe 1979).

Clutch-size Mean 7.0 (4–9; 20): C/4 × 1, C/6 × 5, C/7 × 7, C/8 × 6, C/9 × 1 (T.C. Greene); 3–10 (Oliver); up to 11 (Buller 1888). On Norfolk I., 6 (1–8) (Hicks & Greenwood 1989); on Kermadec Is, 2–5 (Taylor 1985; Oliver); on Chatham Is, 5–7 (Fleming 1939; Taylor 1985).

Laying Eggs laid at intervals of 2 days (Hicks & Greenwood 1989). On Little Barrier I., interval between first and second egg, 1.6 days (1.0; 1–4; 13); second and third, 1.5 days (0.5; 1–2; 12); third and fourth, 1.9 days (0.8; 2–3; 12); fourth and fifth, 1.9 days (0.3; 1–2; 11); fifth and sixth, 2.3 days (0.6; 1–3; 11); sixth and seventh, 3.5 days (1.6; 3–8; 9); seventh and eighth, 2.6 days (1.5; 1–4; 3) (T.C. Greene); third and fourth egg laid within 2 days (Sibson 1947). In wild, start of second clutch *c.* 2 weeks after failure of first nesting attempt; one replacement clutch laid within 14 days of death of nestlings (T.C. Greene). Usually only one successful breeding attempt in any given season (T.C. Greene). On Norfolk I., a wild-bred female, released from captivity, laid four clutches in 8 months; last clutch started before young from third nest had fledged (Hicks & Greenwood 1989).

Incubation By female only; begins with first or second egg (Wilkinson & Wilkinson 1952), or second or third egg (Hicks & Greenwood 1989). During incubation, female called from nest at *c.* 1 h intervals to be fed by male; feeding bouts last 4–6 min; both then fly off to feed; female returns after *c.* 10 min (Moon 1979). Mean length of stints during incubation, 68.9 min (27.0; 40). Eggs arranged within nest to facilitate incubation; large clutches may be arranged in a rectangular pattern with eggs in pairs; eggs moved regularly from periphery of clutch to centre; female often changes position on clutch (T.C. Greene). INCUBATION PERIOD: 18–21 days (Falla *et al.* 1981; Hicks & Greenwood 1989; Forshaw); for 17 clutches of marked eggs, 23–25 days (T.C. Greene). Females may eat part of shell of freshly hatched eggs; remnants often buried or trampled into floor of nest (T.C. Greene). Female generally defecates when out of nest, being fed or feeding (T.C. Greene).

Young Altricial; semi-nidicolous. At hatching, eyes closed and sparsely covered in fine light-grey down; over next 3–4 days, down thickens and darkens (Dawe 1979; T.C. Greene). At 5–6 days, feather-tracts visible under skin, and particularly prominent on wings, tail and scapulars; at 9 days, eyes begin to open and continue to open slowly over next 10 days; at 12 days, pins emerge on crown and wings; at 18–22 days, rectrices, remiges and first feathers of body burst from pins; at *c.* 30 days, nearly fully feathered, with some pins still present on flanks, rump and face. **Growth** Nominate *novaezelandiae*: Weight (g): at hatching, 4.6 (0.6; 3.65–5.75; 15); maximum, 87.8 (13; 71–100; 6); at fledging, 81.3 (16.6; 59–100; 6); usually reach adult body-weight at 26–28 days (T.C. Greene). **Parental care, Role of sexes** Brooded closely till all eggs hatch; length of brooding period for first 14 days, 60.1 min (40.9; 3–224; 43); after 14–20 days, length of brooding periods decreases, and female spends longer intervals away from nest (T.C. Greene). Young fed mostly by female; male may finish rearing young if female re-nests (Hicks & Greenwood 1989). In captivity, female feeds chicks, in nest (Hicks & Greenwood 1989). At first, young fed only by female, who is fed by male; bill usually seized at right angles and food regurgitated using a pumping action; food may be regurgitated up to six times per feeding visit; at 14–20 days, male assists in feeding young (Wilkinson & Wilkinson 1952; T.C. Greene; see Relations within family group). Young defecate in nest; faeces generally become buried in nesting material during movements of adults or young. On Norfolk I., two instances of chicks being placed in other nests and fostered successfully (Hicks & Greenwood 1989).

Fledging to independence FLEDGING PERIOD: On islands round NI and SI, 5–6 weeks (Taylor 1985); Little Barrier I., 40.9 days (4.7; 32–49; 45) (T.C. Greene); Norfolk I., *c.* 7 weeks (Hicks & Greenwood 1989); Kermadec Is, 32–40 days (Merton 1970; Dawe 1979). In captivity, 38–45 days (Dawe 1979); older of two chicks fledged at 44 days (Hicks & Greenwood 1989). Young fledge after considerable encouragement from adults; young usually leave nest within 2 or 3 days of each other, regardless of age; fledgelings 40 or more days old able to fly on leaving nest, younger fledgelings (<36 days) often inept or unable to fly and may spend up to 7 days on ground or low perches in dense cover (Wilkinson & Wilkinson 1952; T.C. Greene; also see Relations within family group). After fledging, young remain near nest and are dependent on parents for 2–3 weeks (Hicks & Greenwood 1989). Fledgelings stay within 100 m of nest for first 2 weeks; after 13 days, fledgelings begin to feed themselves; form family groups after fledging (Dawson 1950; Merton 1970; Dawe 1979; T.C. Greene). Young generally independent *c.* 30 days after fledging (T.C. Greene).

Success From 20 nests on Little Barrier I.: 140 eggs laid, 117 (84%) hatched, 46 (33%) fledged, equalling 2.3 young fledged per nest, and 3.1 young per successful nest; 16% of eggs laid infertile (T.C. Greene). Smallest chicks often die in nest. Reasons for failure of five nests: deserted after nest became infested by blood-sucking mites; deserted at nestling stage for reasons unknown; deserted because of disturbance from other birds; young starved as result of poor provisioning by male; Kiore ate chicks (T.C. Greene). On Norfolk I., 15 young fledged from eight nests; 21 from 14; rats take eggs and young (Hicks & Greenwood 1989); Black Rats *Rattus rattus* responsible for failure of five of 14 known breeding attempts (including death of two incubating females) in 1988–89 season (Hicks & Greenwood 1989). On Little Barrier I., Southern Boobooks take 30–40% of fledgelings (T.C. Greene).

Other known predators of adults and fledgelings include feral cats (Merton 1970; Dawe 1979; Taylor 1979, 1985; MacMillan 1990; Oliver), Stoats *Mustela erminea* (Taylor 1985; Murphy & Dowding 1995), Brown Rats *Rattus norvegicus* (Merton 1970, Taylor 1985), Swamp Harriers *Circus approximans*

(T.C. Greene) and Long-finned Eels *Anguilla dieffenbachii* (T.C. Greene).

PLUMAGES Prepared by A.M. Dunn. Fledge in juvenile plumage. Undergo complete post-juvenile (first pre-basic) moult to adult plumage probably toward end of first year. Thereafter, complete post-breeding moults each cycle produce successive adult plumages without change in appearance. Sexes similar. Probably first breed at 1 year old. Eight subspecies; nominate *novaezelandiae* described below.

Adult (First and subsequent basic). HEAD AND NECK: Forehead, lores, forecrown to level with rear of eye, and short stripe on ear-coverts behind eye, crimson (108); feathers of forehead and crown have concealed narrow yellow (c58) bar above greyish-brown (79) bases. Hindcrown, supercilium (from above front of eye), hindneck, sides of neck and most ear-coverts, green (between c60 and 260). Cheeks and sides of throat, slightly yellower, lime-green (c159). Feathers of chin and centre of throat, small, dark grey (83) with pale-green (162D) tips to some. All green feathers of head and neck have concealed brownish-grey (79) bases, except for small patch of feathers on centre of hindneck, which have concealed narrow pale-yellow (157) band above white bases. UPPERPARTS: Most feathers green (between c60 and 260) with concealed brownish-grey (79) bases. Small patch of feathers on each side of upper rump, crimson (108); patches usually concealed by folded wings when at rest. UNDERPARTS: Yellowish green (ne) with concealed grey (84) bases to feathers; flanks and sides of belly tend to be slightly darker than rest. Longer undertail-coverts have bluish streak near shafts. UPPERTAIL: Mostly dark green (c146) with black shafts and concealed grey-black (82) inner edges to t2–t6. UNDERTAIL: Dark yellowish-grey (yellowish 83). UPPERWING: Secondary coverts, green (between c60 and 260) with concealed brownish-grey (79) bases to lesser and median coverts and concealed dark-brown (c121) inner webs to greater coverts. Lesser and median primary coverts, blue-green (ne). Alula mostly dark blue (74) with black-brown inner edge to feathers. Outer webs of greater primary coverts grade from dark blue (74) on outermost to dark blue-green (ne) on innermost; also grade into inner webs, which are black-brown (119) with greenish tinge near tips. Secondaries and inner primaries have black-brown (119) to dark-brown (121) inner web and tip and dark-green (c146) outer web; most birds have concealed pale-yellow (157) spot in middle of inner edge. On p6–p9, outer web dark blue (74) on basal half, grading to dark green (c146) subterminally and with very fine pale-yellow (157) edge; whole tip and most of inner web, black-brown (119); some have concealed pale-yellow (157) spot in middle of inner edge. P10 mostly black-brown (119) with greenish tinge to outer edge. UNDERWING: Lesser and median coverts, green-blue (c164) with grey (84) bases to feathers. Greater coverts, grey (84), sometimes with very faint yellowish spot on inner web forming very faint bar across greater coverts. Primaries and secondaries, dark brown (c121); most birds have varying pale-yellow (157) spot or smudge on inner edge of inner primaries (p1 to about p6) and most secondaries (s1 to about s7); some birds unmarked; yellowish marks combine to form varyingly distinct underwing-bar; bar sometimes extremely faint; occasionally no bar.

Downy young See Breeding: Young. At hatching, covered in fine light-grey down (Dawe 1979).

Juvenile Green plumage slightly duller than in adult, but probably only evident in direct comparison in the hand. Differences from adult: HEAD AND NECK: Feathers of forecrown, green (c260) with crimson (108) tips; crimson not as extensive, extending only to front of eye. Green of head and neck slightly duller (c260). UPPERPARTS: Slightly duller green. Red patch on side of rump smaller, with only one or two red feathers. UNDERPARTS: Slightly duller green. UPPERWING: Slightly duller. UNDERWING: Lesser and median coverts slightly duller. Always have bold pale-yellow (157) spots on inner edge of most primaries and secondaries, forming much bolder underwing-bar than in adults; spots larger and usually extend to p10 on primaries.

Aberrant plumage Several colour variations have been recorded (Oliver), most being replacement of green plumage with some other colour. Yellow colour-morphs rare in wild but common in captivity; have all green plumage replaced by pale yellow, but red and blue markings unchanged.

Hybrids Hybridize with Yellow-crowned Parakeet on Mangere I., Chatham Grp (Taylor 1975, 1985; Flack 1976; Nixon 1982, 1994) and on Auckland Is (Taylor 1975). Hybrids vary considerably. Some very similar to Red-crowned Parakeet but with orange bordering red on crown. Some very similar to Yellow-crowned Parakeet but with faint yellowish-orange spots behind eyes. Most are intermediate between these plumages, with narrow red band on forehead, orange crown, and small reddish-orange patches behind eyes and on side of rump (Taylor 1975).

BARE PARTS Based on photos (Hicks & Greenwood 1989; Moon 1992; Temple 1996; Crome & Shields); published descriptions (Oliver; NZRD), and museum labels (MV, NMNZ).

NOMINATE *NOVAEZELANDIAE*: **Adult** Bill, white to pale bluish-grey (c86) with a black (89) cutting edge and tip. Cere, dark grey (83) to black (89). Iris, red (10 or 11) or bright orange (MV). Orbital ring, grey-black (82) to black (89). Legs and feet, grey (87), dark grey (83) or pale brown (Oliver). **Downy young** Bill, pinkish horn; iris, dark; legs and feet, pinkish grey (NZRD; R.H. Taylor). **Juvenile** Bill, pink (108D). Cere, greyish pink (greyish 108D). Tongue, pinkish grey (pinkish 84). Iris, black-brown (c119); said to change to pale reddish-brown (NZRD). Orbital ring and periophthalmic ring, dark grey (83). Legs and feet, as adult. *CYANURUS*: **Adult** Bill, light blue-grey or slate-grey with black tip (NMNZ), or bluish (Oliver). Iris, dark yellow, pale yellow (NMNZ) or red (Oliver). Feet, greyish brown (Oliver; NMNZ) or greyish black (NMNZ). **Downy young, Juvenile** No information. *CHATHAMENSIS*: **Adult** Bill, pearl-grey with black tip (NMNZ) or bluish (Oliver). Iris, yellow (Oliver) or orange (NMNZ). Feet, grey (Oliver) or greyish black (NMNZ). **Downy young, Juvenile** No information. *HOCHSTETTERI*: **Adult** Bill, pearl-grey with black tip (NMNZ). Iris, yellow-red (NZRD), bright orange or light buff (NMNZ). Legs and feet, dark grey (NMNZ). **Downy young, Juvenile** No information. *COOKII*: **Adult** Bill, white to pale bluish-grey (c86) with black (89) cutting edge and tip. Cere, black (89). Iris, red (210). Orbital ring, dark grey (83). Legs and feet, dark grey (83). **Downy young** Based on photos (Hicks & Greenwood 1989). Bill, dull pink (c5). Iris, very dark. Legs and feet, greyish pink (ne). **Juvenile** No information. *ERYTHROTIS*: **Adult** Bill, black with whitish-blue base to upper mandible. Iris, yellow or red. Feet, greenish brown (Oliver). **Downy young, Juvenile** No information.

MOULTS Based on examination of 112 adult skins (35 *novaezelandiae*; 20 *cyanurus*; 44 *chathamensis*; 7 *hochstetteri*; 6 *cookii*) (AIM, CM, NMNZ), eight juvenile skins (6 *novaezelandiae*; 2 *cookii*) (AIM, CM) and published information. **Adult post-breeding** (Second and subsequent pre-basic).

Complete. Primaries usually centrifugal, starting at p6 (Stresemann & Stresemann 1966; Holyoak 1973), but sometimes moult inner two or three primaries outward from p1; from skins, seven of eight began from p6, one from p5. Innermost 2–3 primaries sometimes appear to be of a different age to others and occasionally one or two primaries in middle of wing appear much older than others; possibly results from skipping primaries during moult or replacing primaries out of sequence and may be related to age, but not enough information. Primaries replaced rapidly, often with 2–4 feathers growing at once. Moult can differ between left and right wing. Timing of moult can differ slightly between subspecies; probably result of differences in timing of breeding. No information on moult of tail of any subspecies. In *NOVAEZELANDIAE* from mainland NZ, only three recorded with active moult of primaries; one just starting in Jan. (PMS=3), one in early stages in Sept. (PMS=18), and one nearing completion in Oct. (PMS=35). Moult of body recorded from most months between Oct. and Apr., but appeared heaviest in Dec. and Jan. No moult of body recorded from other months, but only two skins collected between May and Aug. In *CYANURUS* from Kermadec Is, three of five collected in Nov. were just beginning moult of primaries (PMS 3–6) and one had slight moult of body in Dec.; none of 11 collected between Jan. and Sept. were moulting. In *CHATHAMENSIS* from Chatham Is, moult of primaries appears to start between Dec. and Feb. (one in Dec., PMS=2; two from Jan., PMS=2 and 10; one from Feb., PMS=1; one from Mar., PMS=17). Moult of body was recorded in Mar., Sept. and Dec. (n=3); one in Mar. had heavy moult, the others only slight moult. No moult recorded in Oct. or Nov. (n=18). No information from Apr. to Aug. In *HOCHSTETTERI* from Antipodes Is, all collected between June and Nov. and none were moulting primaries. Two were moulting body; one in Sept. and one in Nov. In *COOKII* from Norfolk I., one was just starting moult of primaries in Feb. (PMS=13) and another was about half finished in Nov. (PMS=26); neither had active moult of body. Others collected from Oct. and Nov. were not moulting. **Post-juvenile** (First pre-basic). Very little information. Probably complete. Only specimens of nominate *novaezelandiae* were moulting. Of two birds actively moulting primaries, one in Feb. (PMS=6) had one new and one growing feather, the other in Apr. (PMS=19) had replaced three primaries and had two growing primaries. Three had active moult of body, one each in Apr., May and Sept. No information on moult of tail.

MEASUREMENTS NOMINATE novaezelandiae: (1–3) NZ main islands and offshore islands, skins (AIM, CM, MV, NMNZ): (1) Adults, wild birds; (2) Juveniles, wild birds; (3) Adults, aviary stock. (4) Poor Knights and Aorangi Is, live; sexed using plot of wing-length against bill-length that resulted in two distinct clusters (Sagar 1988).

		MALES	FEMALES	
WING	(1)	131.8 (5.37; 120–140; 26)	125.9 (4.11; 119–133; 18)	**
	(2)	121, 132, 135	123.0 (2.71; 119–125; 4)	
	(3)	131.0 (2.34; 126–135; 16)	124.0 (5.72; 113–133; 9)	**
	(4)	130.4 (5.01; 114–142; 143)	122.7 (5.27; 104–135; 54)	**
TAIL	(1)	136.2 (10.94; 116–162; 21)	127.2 (6.71; 116–143; 15)	**
	(2)	120, 131, 138	114, 118, 132	
	(3)	131.7 (6.37; 119–141; 11)	123.0 (12.2; 103–145; 10)	*
	(4)	133.9 (13.68; 99–164; 55)	125.9 (12.03; 103–147; 22)	**
BILL	(1)	16.3 (1.30; 13.2–18.5; 26)	14.3 (1.21; 12.9–17.0; 19)	**
	(2)	16.7, 17.0	12.6 (0.76; 12.0–13.7; 4)	
	(3)	16.7 (1.40; 12.5–19.2; 18)	13.3 (0.52; 12.6–14.3; 13)	**
	(4)	17.0 (0.79; 14.6–19.3; 180)	13.6 (0.63; 12.2–14.8; 62)	**
BILL W	(4)	10.4 (0.46; 9.1–11.8; 174)	8.9 (0.36; 7.7–9.6; 56)	**
TARSUS	(1)	21.2 (0.91; 19.4–23.0; 23)	20.6 (1.00; 19.0–22.5; 14)	ns
	(2)	19.4, 21.2	19.9 (0.80; 19.0–20.9;4)	
	(3)	20.9 (1.08; 18.7–22.2; 15)	20.0 (1.04; 18.6–21.8; 10)	*
	(4)	21.1 (0.84; 19.9–23.2; 14)	20.2 (0.85; 18.9–22.0; 11)	**
TOE C	(1)	24.4 (1.27; 21.3–27.0; 18)	22.5 (1.08; 20.1–24.1; 15)	**
	(2)	22.9, 23.6	21.9	
	(3)	23.1 (1.44; 20.9–25.2; 10)	21.4 (0.61; 20.7–22.2; 4)	*

CYANURUS: (5) Kermadec Is, adults, skins (AIM, CM, NMNZ).

		MALES	FEMALES	
WING	(5)	140.1 (4.35; 133–147; 11)	133.8 (5.11; 128–143; 6)	*
TAIL	(5)	157.6 (10.26; 142–170; 7)	137, 147, 147	
BILL	(5)	17.7 (1.10; 15.0–19.1; 12)	15.1 (1.63; 13.0–17.5; 6)	**
TARSUS	(5)	22.3 (1.23; 20.6–24.4; 12)	21.3 (0.88; 20.2–22.7; 6)	ns
TOE C	(5)	26.2 (1.47; 23.8–28.5; 10)	25.0 (1.02; 23.4–26.2; 5)	ns

CHATHAMENSIS: (6) Chatham Is, adults, skins (AIM, CM, NMNZ).

		MALES	FEMALES	
WING	(6)	136.5 (4.11; 128–145; 31)	131.4 (3.72; 125–137; 16)	**
TAIL	(6)	136.9 (13.68; 109–156; 28)	134.2 (7.91; 123–150; 15)	ns
BILL	(6)	17.0 (0.75; 15.5–18.7; 31)	14.1 (1.47; 12.4–17.4; 15)	**
TARSUS	(6)	21.2 (0.93; 19.3–23.4; 31)	19.9 (0.83; 18.5–21.5; 15)	**
TOE C	(6)	24.5 (1.05; 22.2–26.6; 23)	23.6 (1.02; 21.9–25.0; 8)	*

HOCHSTETTERI: Antipodes Is, skins: (7) Adults (AIM, AM, CM, NMNZ). (8) Adults (Forshaw & Cooper 1989).

		MALES	FEMALES	
WING	(7)	138.2 (3.70; 132–141; 5)	132.8 (1.72; 131–135; 6)	*
	(8)	143.4 (135–150; 11)	129	
TAIL	(7)	133, 134, 142	134.5 (1.29; 133–136; 4)	
	(8)	126.3 (116–131; 11)	117	
BILL	(7)	18.6 (0.72; 17.4–19.3; 5)	16.2 (1.76; 14.8–19.6; 6)	*
	(8)	18.7 (18–19; 11)	15	
TARSUS	(7)	24.5 (0.66; 23.7–25.2; 5)	23.1 (1.44; 21.1–25.5; 6)	ns
	(8)	24.6 (23–26; 11)	22	
TOE C	(7)	26.9, 27.1, 29.1	26.2 (1.07; 25.0–27.6; 4)	

COOKII: Norfolk I., skins: (9) Adults (AIM, AM, ANWC, NMNZ). (10) Juveniles (ANWC). (11) Adults (Forshaw & Cooper 1989).

		MALES	FEMALES
WING	(9)	144.8 (6.57; 134–151; 7)	134, 136, 151
	(10)	141, 143	–
	(11)	145.5 (138–150; 18)	134.1 (128–137; 15)
TAIL	(9)	156.0 (7.11; 149–166; 5)	140, 155
	(11)	154.5 (138–183; 18)	145.1 (136–169; 15)
BILL	(9)	20.6 (1.63; 17.6–22.8; 8)	17.5, 18.7, 21.5
	(10)	19.1, 19.3	–
	(11)	21.3 (20–23; 18)	17.4 (17–19; 15)
TARSUS	(9)	23.4 (1.11; 21.2–24.8; 8)	22.4, 22.8, 24.5
	(10)	24.0, 24.1	–
	(11)	23.4 (21–25; 18)	22.2 (21–23; 15)
TOE C	(9)	29.1 (2.40; 26.3–31.7; 7)	27.1
	(10)	29.6	–

SUBFLAVESCENS: (12) Lord Howe I., adults, skins (Forshaw & Cooper 1989).

		MALES	FEMALES
WING	(12)	147	149
TAIL	(12)	145	162
BILL	(12)	19	22
TARSUS	(12)	21	22

ERYTHROTIS: Macquarie I.: (13) Adult skin (CM). (14) Adult skins (Forshaw & Cooper 1989).

		UNSEXED
WING	(13)	138
	(14)	142, 145
TAIL	(13)	136
	(14)	128, 158
BILL	(13)	14.7
	(14)	15, 20
TARSUS	(13)	23.4
	(14)	21, 24

For additional measurements, see Forshaw & Cooper (1989).

WEIGHTS Nominate *novaezelandiae*: (1–2) Adults, museum labels (AIM, NMNZ): (1) NZ and offshore islands, wild birds; (2) Aviary stock. (3) Poor Knights and Aorangi Is, live; sexed using plot of wing-length against bill-length that resulted in two distinct clusters (Sagar 1988).

	MALES	FEMALES	
(1)	72, 87	46	
(2)	63, 65, 89	43	
(3)	82.1 (8.80; 63–113; 181)	67.9 (7.48; 50–90; 64)	**

Weight of live birds varied during year: highest in May; declined gradually from Aug. to Nov. Pattern of change in weight was similar for both sexes, but degree of change was greater in males (Sagar 1988). One unsexed adult weighed 70 g (AIM).

Other subspecies, all adults, from museum labels (ANWC, NMNZ). Subspecies *cyanurus*, Kermadec Is: males 87.7 (10.34; 75–98; 4); females 73, 73. Subspecies *chathamensis*, Chatham Is: males 82, 83. Subspecies *hochstetteri*, Antipodes Is: male 91. Subspecies *cookii*, Norfolk I.: male 100.

STRUCTURE Wing short broad and wedge-shaped, with rounded tip. Ten primaries: p8 longest; p10 8–16 mm shorter, p9 0–2, p7 0–3, p6 12–16, p5 24–29, p4 31–37, p3 32–34, p2 37–44, p1 40–46. P7–p9 have emargination on outer web and p9 or p10 or both have slight emargination of inner web. About 12 secondaries, including about four tertials; tips of longest tertials fall between p2 and p3 on folded wing. Tail long and pointed; 12 rectrices; t1 longest, t6 53–58 mm shorter. Bill short and broad. Cutting edges of upper mandible sharp and slightly convex from base to about 5 mm from tip, then concave to tip; tip rounded in front but with sharp cutting edge; lower mandible broad and scoop-like, with slightly raised cutting edge at tip. Narrow mostly bare cere along base of upper mandible, in which small rounded nostrils situated close to top. Tarsus medium length and slender; granulate. Tibia fully feathered. Outer toe directed backward. Outer hindtoe 83–92% of outer front, inner front 73–81%, inner hind 44–52%.

GEOGRAPHICAL VARIATION Eight subspecies, seven within HANZAB region; two subspecies extinct. Nominate *novaezelandiae* in main islands of NZ and surrounding islands, Stewart I. and Auckland Is; *cyanurus* on Kermadec Is; *chathamensis* on Chatham Is; *hochstetteri* on Antipodes Is; *erythrotis* on Macquarie I. (extinct); *cookii* on Norfolk I.; *subflavescens* on Lord Howe I. (extinct); and *saissetti* from New Caledonia. Subspecies differ in size and coloration. Plumages of nominate *novaezelandiae* described above.

SUBSPECIES CYANURUS: Significantly larger than nominate in all measurements for both sexes ($P<0.01$). Plumage differs slightly from nominate: green of much of plumage slighly bluer; outer web of primaries much bluer, with only a trace of green on outer web of inner primaries, which appear mostly greenish blue; lesser and median underwing-coverts noticeably bluer; tail has slightly bluer tinge, especially on outer rectrices; undertail-coverts noticeably bluer.

SUBSPECIES CHATHAMENSIS: Significantly larger than nominate in Wing (both sexes, $P<0.01$), Bill (male, $P<0.05$) and Tail and Toe C (female, $P<0.01$). Plumage differs only slightly from nominate: red markings on head and sides of rump brighter, red (c210); and facial area slightly bluer green.

SUBSPECIES HOCHSTETTERI: Significantly larger than nominate in Wing, Bill, Tarsus and Toe C ($P<0.01$ for both sexes). All plumages distinctly yellower than nominate: red of forehead, forecrown and spots at sides of rump slightly lighter, red (12–210); underparts much yellower, yellow-green (c58) with no blue in undertail-coverts; all remiges and rectrices have very fine yellow (c55) outer edges; feathers of alula and greater primary coverts of upperwing paler and more greenish; median and lesser underwing-coverts slightly more greenish.

SUBSPECIES ERYTHROTIS: Probably larger than nominate, but insufficient data to test significance. Only one skin examined. Differed only slightly in plumage from nominate: paler and more yellowish; blue on remiges paler and washed with green; doubtfully distinct from *hochstetteri* (Forshaw & Cooper 1989).

SUBSPECIES COOKII: Larger than nominate; all measurements of adult males significantly larger than nominate adult males ($P<0.01$); sample sizes too small to compare females. Forshaw & Cooper (1989) describe plumage as similar to nominate. But photos (in Hicks & Greenwood [1989]) show red on head possibly slightly darker than in nominate and red behind eye present as faint spot rather than stripe.

SUBSPECIES SUBFLAVESCENS: No skins examined. Probably larger than nominate (based on measurements from Forshaw & Cooper [1989]). Plumage more yellow than nominate, especially on cheeks and underparts; red markings on head not so extensive (Forshaw & Cooper 1989).

SUBSPECIES SAISSETTI: No skins examined. Based on measurements from Forshaw & Cooper (1989), probably similar in size to nominate. Plumage differs slightly from nominate: face and upperparts more yellow; red on crown, paler, brighter (Forshaw & Cooper 1989).

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