

## Order COLUMBIFORMES

Large homogeneous group of arboreal and terrestrial birds. The names pigeon and dove synonymous, though dove usually used for smaller species and pigeon for larger species, but distinction not consistently followed, and both sometimes used as alternative names for same bird. One extant family; dodos (Raphidae) and solitaires (Raphidae or Pezophapidae) extinct. Order monophyletic and easily distinguished, but affinities unclear. Columbiformes share a number of characters with Charadriiformes (shorebirds) including: schizognathous palate and schizorhinal nostrils; presence of small basipterygoid processes, tracheo-bronchial syrinx and usually diastataxic wings. However, differ in rigid vertebral column, large hindtoe, general biology, behaviour and type of young (see below). Also have anatomical similarities with Pteroclidiformes (sandgrouse), including structure of feathers, skull, shape of humeral head, sternum, pelvis and pectoral musculature. However, sandgrouse differ in several important ways: do not produce crop-milk, have large functional caecum and different syrinx. Sandgrouse often placed in Columbiformes (e.g. Bock 1994); or pigeons, sandgrouse and shorebirds combined in single order (e.g. Fjeldså 1977). However, studies of egg-white proteins (Sibley & Ahlquist 1972), composition of lipid oil-gland secretion (Jacob 1978) and DNA-DNA hybridization (Sibley & Ahlquist 1990) show no close affinities between pigeons and doves and other living birds; similarities to sandgrouse and shorebirds assumed to be convergence or retention of primitive characters. Best treated as discrete order Columbiformes (Sibley & Ahlquist 1990; BWP).

General features, moult, breeding and biology discussed below.

## Family COLUMBIDAE pigeons and doves

Small to very large; from *Geopelia cuneata* (19–21.5 cm, 23–37 kg) to *Goura victoria* (70–80 cm, 1.7–2.9 kg). About 310 species in c. 40 genera (including 15 monotypic genera, and 14 genera with fewer than five species) (Campbell & Lack 1985; Sibley & Monroe 1990; Goodwin; BWP). Major genera include: (1) *Columba* (typical pigeons) with 54 species; (2) *Ptilinopus* (fruit-doves), 51 species; (3) *Ducula* (imperial-pigeons), 36 species; (4) *Treron* (green pigeons), 22 species; (5) *Gallinula* (Old World quail-doves), 19 species; (6) *Geotrygon* (American quail-doves), 15 species; (7) *Streptopelia* (turtle-doves and collared-doves), 15 species; (8) *Leptopila* (doves), 11 species; (9) *Macropygia* (cuckoo-doves), ten species. Family homogeneous, and attempts to group the 40–43 genera unsatisfactory. Bock (1994) recognized five subfamilies; none was recognized by BWP; most useful arrangement perhaps informal one of Goodwin (1967; Sibley & Ahlquist 1990; Goodwin).

Cosmopolitan, except Arctic and Antarctic. In HANZAB region, 32 species in 15 genera (28 breeding, two vagrant, two extinct): *Columba* (3 species: endemic *C. leucomela*; introduced *C. livia*; *C. vitiensis*, extinct HANZAB region); *Streptopelia* (3; introduced); *Macropygia* (1); *Chalcophaps* (1); *Phaps* (3; genus endemic); *Ocyphaps* (monotypic; endemic); *Geophaps* (3; genus endemic); *Petrophassa* (2; genus endemic); *Geopelia* (3); *Leucosarcia* (monotypic; endemic); *Gallinula* (1; extinct); *Ptilinopus* (4); *Ducula* (4); *Lopholaimus* (monotypic; endemic); *Hemiphaga* (monotypic; endemic).

Relationships within genera of HANZAB region complex; many have affinities with species in Indonesia, New Guinea and surrounding islands; others endemic (see Christides & Boles 1994; Frith). Many taxonomic problems involving pigeons and doves of HANZAB region unresolved, e.g. (1) whether or not Aust. species of *Geopelia*, *Macropygia* and *Ducula* should be combined with similar allopatric congeners of New Guinea and Indonesia; (2) which genera to recognize in the *Petrophassa*–*Geophaps*–*Ocyphaps* assemblage; (3) whether Chatham Island Pigeon *Hemiphaga (novaeseelandiae) chathamensis* merits species status. Taxonomic treatment here follows Christides & Boles (1994) and NZCL.

Bodies generally plump and compact, with small heads and short necks. In most species, males larger than females. Have 37–39 vertebrae (including fused pelvis and pygostyle). Wings usually broad, with rounded tips. Eleven primaries; p1 reduced. Ten to 15 secondaries, including tertials; most species diastataxic, some eutaxic. Remiges rigid, causing loud and characteristic clapping sound when bird flies away (also in display). Flight strong and direct; cannot soar, but most will glide, especially in display. Tail of most long and broad, with square or slightly rounded tip; very long and pointed in some species; 12–14, sometimes 16, rectrices (up to 18 in crowned pigeons *Goura* and pheasant pigeon *Otidiphaps*). In many species, juvenile rectrices (and, less so, remiges) narrower than in adults; in *Ptilinopus*, wing of juveniles shorter and more pointed than in adults, giving different wing-formula. Bill, short, weak and superficially plover-like (except in some tropical fruit-eating genera), usually with an expanded tip; tip hard and sometimes hooked, base soft. Nostrils obliquely placed under a thin operculum in cere at base of bill.

Tarsi usually short, with small hexagonal or rounded scales at sides and rear. Feet of perching type, with three front toes and large functional hindtoe. Oil gland absent or rudimentary, unfeathered; powder-down used for plumage maintenance. Caeca, absent or rudimentary; crop, large and bilobed, resulting in asymmetric extrinsic muscles on tracheo-bronchial syrinx; two carotids. During breeding, glandular lining of crop of both sexes produces nutritious secretion, crop-milk, for feeding small young. Gizzard, heavily muscled; intestines, long and narrow in most species, but not in some frugivorous species, in which stomach only rubs pulp or pericarp off fruits (rather than grinding seeds), and seeds pass intact through short, wide gut. No gall bladder or supra-orbital salt-glands.

Feathers unique, with dense plumulaceous bases and strong and broad shafts that taper abruptly to thin point. Inserted loosely in skin and readily lost. No aftershafts, though remiges, rectrices and their coverts might have small aftertufts. Primaries variously emarginated, particularly on one or more of p8–p10; emarginations possibly involved in sound production (see Crested Pigeon *Ocyphaps lophotes*). Have little down, restricted to lateral apteria of body and pelvic apterium. Feathers of body have downy barbs at base and basal edges. Growing feathers (down, semi-plumes and downy portions of most contour feathers) shed fine white powder, which is used when preening and maintenance of feathers. Molt powder-producing feathers more often than other contour feathers and powder supplied nearly continuously. Most powder produced on flanks, especially in front of thigh and in front of and behind tail (Lucas & Stettenheim 1972).

Plumage usually shades of brown, grey and cream, but brilliantly coloured in many species (e.g. some fruit-pigeons) with bright greens, reds, oranges, yellows, pinks, golds, blues and purples; iridescence often present in feathers of wings, tail, head, neck and upperparts. Several species crested (e.g. in Aust., *Ocyphaps lophotes*, *Geophaps plumifera*), have coloured facial skin or orbital rings (e.g. *Geophaps scripta*) or enlarged ceres, which may form caruncles (e.g. *Lopholaimus antarcticus*). In most, sexes differ only slightly in appearance, with males somewhat brighter or more patterned; in others, sexes alike or differ markedly. Bare parts often coloured. Bill, black, brown, yellow, white, grey, green, or blue; tip and base often of different colours. Iris, red, orange, yellow, green or brown. Legs and feet, red, pink or purple. Undergo a complete post-breeding (pre-basic) moult each cycle, with no pre-breeding (pre-alternate) moult and so lack an alternate plumage. Primaries moult outwards; often very slowly, replacing only one feather at a time, though some can have more than one active wave of moult in wing. Arrested and suspended moult of primaries occurs in most, possibly all, Aust. species. Young altricial, nidicolous and wholly dependent on parents for food. Blind at hatching; sparsely covered in yellow, brown or grey down, usually thickest on upperparts. Young develop rapidly, and in some (e.g. *Ptilinopus superbus*) leave nest when remiges only half grown. Juvenile plumage distinct; usually duller, with dark subterminal bands and pale edges to contour feathers; usually held only briefly. Adult plumage attained in complete post-juvenile (first pre-basic) moult, which starts 1–3 months after hatching; post-juvenile moult of head, body and wing-coverts takes 3–6 months, of remiges and rectrices, 4–14 months.

Occur in most habitats; from arid and semi-arid zones to tropical rainforest. Found singly, in pairs or small flocks; some species in large flocks (e.g. Flock Bronzewing *Phaps histrionica* of Aust.). Some species sedentary, many are nomadic; a few undertake regular migration. Many species arboreal (fruit-doves of HANZAB region); others at least partly arboreal (e.g. *Phaps*, *Geopelia*, *Streptopelia*, *Macropygia*, *Columba*); but few strictly terrestrial (e.g. *Geophaps*, *Pterophassa*).

Diet mainly fruit or seeds or both; some also eat flowers, shoots, young leaves and invertebrates (e.g. *Hemiphaga novaeseelandiae*). Feed in trees, on ground, or both. Arboreal species usually cling, hang, and clamber among slender branches, and have large distensible gapes for swallowing large fruit. Terrestrial species do not scratch for food; glean while slowly moving, with sideway flicking movements of bill. Swallow food whole; cannot bite, chew or dehusk food. Grasp items in bill and tug. All species must drink and do so characteristically by inserting bill and sucking up continuous draught of liquid (Goodwin).

Movements vary. In Aust., migratory (e.g. Pied Imperial-Pigeon *Ducula bicolor*) to irruptive and dispersive (e.g. Flock Bronzewing *Phaps histrionica*), resident (Banded Fruit-Dove *Ptilinopus cinctus*) and even sedentary (e.g. Bar-shouldered Dove *Geopelia humeralis* and New Zealand Pigeon *Hemiphaga novaeseelandiae*). Movements of many species poorly known (e.g. Squatter Pigeon *Geophaps scripta*). Some species move to temporarily suitable habitat (e.g. Flock Bronzewing), while many rainforest pigeons move to temporarily available supplies of food (e.g. Brown Cuckoo-Dove *Macropygia amboinensis*). Introduced species non-migratory (e.g. Spotted Turtle-Dove *Streptopelia chinensis*), even mostly sedentary (e.g. Laughing Turtle-Dove *Streptopelia senegalensis*). One species, Rock Dove (Feral Pigeon) *Columba livia*, has been focus of much research on biological basis of homing and navigation; also widely kept and raced for sport.

All except green pigeons (*Tetron*) of Africa and Asia, which whistle, give a variety of soft cooing calls. *Lopholaimus* unique in being nearly silent, giving only low grunts and squeaks. Commonest call generally Advertising Call. For general discussion of calls, see Goodwin.

Social organization of Aust. pigeons little studied in wild. During non-breeding season, many species loosely gregarious, moving in small groups, though some (e.g. Flock Bronzewing) can congregate in thousands. Larger numbers often associated with water or abundant food. Some species, such as Wonga Pigeon, solitary. Usually

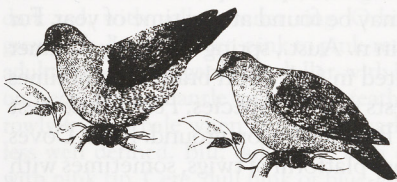


**Figure 1** Bowing Displays; high and low points shown unless stated: (a) Rock Dove *Columba livia*, sexual form; (b) Rock Dove, assertive form (low point); (c) White-headed Pigeon *Columba leucomela* (figure on extreme right shows bird mandibulating at end of display); (d) Brown Cuckoo-Dove *Macropygia amboinensis*; (e) Emerald Dove *Chalcophaps indica*, Bobbing Display, a type of Bowing Display; (f) Common Bronzewing *Phaps chalcoptera* (low point); (g) Crested Pigeon *Ocyphaps lophotes*; (h) Spinifex Pigeon *Geophaps plumifera* (male, at low point); (i) Chestnut-quilled Rock-Pigeon *Petrophassa rufipennis*; (j) Diamond Dove *Geopelia cuneata*; (k) Wonga Pigeon *Leucosarcia melanoleuca* (low point); (l) Banded Fruit-Dove *Ptilinopus cinctus*; (m) Pied Imperial-Pigeon *Ducula bicolor*; (n) Topknot Pigeon *Lopholaimus antarcticus*.

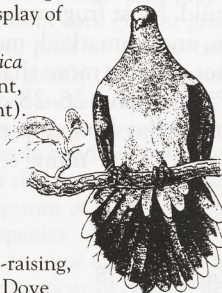
monogamous, pairing at least for duration of nesting cycle; mostly breed as single pairs but some form colonies (e.g. Pied Imperial-Pigeon, Flock Pigeon).

Postures and displays of all Aust. pigeons have been studied and described by Frith (1977; Frith). Not all displays illustrated in Frith have been reproduced here but many of the common displays and postures are shown in Figures 1 to 10. In these, illustrations are usually presented for only one species in each genus. Some other displays, usually particular to a species, are illustrated within the species accounts. The term bronze-winged pigeons (in the texts and in Frith), refers to all species of Aust. pigeons with iridescent panels in the wing (i.e. *Phaps*, *Ocyphaps*, *Geophaps* and *Petrophassa*).

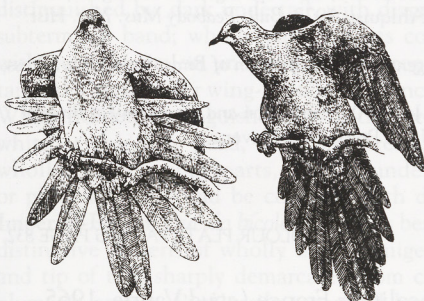
Displays used in threat and courtship often similar. Bowing Display and Display Flight two most common displays. Bowing Display (= Bow Coo) (see Fig. 1): Bird usually faces bird to which it is displaying, lowers head and calls, then raises head; in many species, tail is spread. Usually seen in sexual or aggressive circumstances. Most, possibly all, have postures that are homologous in appearance to a bow and often quite uniform within genera (see Frith). Display Flight (Fig. 10): Bird ascends in flight, often audibly beating wings then, at apex of ascent, spreads wings and tail and glides down. May be performed during normal flight or may start from, and return to, perch. In Aust., not recorded in *Ptilinopus*, *Geophaps*, *Petrophassa*, *Leucosarcia*, *Chalcophaps*, and Common and Flock Bronzewings and Bar-shouldered Dove. In species accounts, Display Flight placed under heading 'Aerial activity' because the function of display not studied in Aust. forms; assumed to advertise presence of sexually active male.



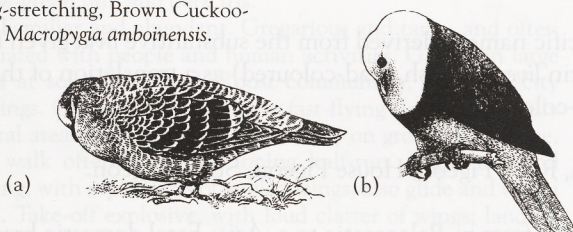
**Figure 2** Tail-raising Advertising Display of Emerald Dove *Chalcophaps indica* (left – high point, right – low point).



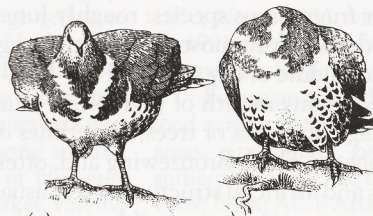
**Figure 4** Wing-raising, Bar-shouldered Dove *Geopelia humeralis*.



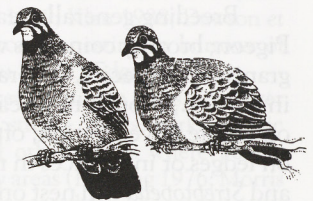
**Figure 7** Mantling and Wing-stretching, Brown Cuckoo-Dove *Macropygia amboinensis*.



**Figure 9** Advertising Call Posture: (a) Common Bronzewing *Phaps chalcoptera*; (b) Banded Fruit-Dove *Ptilinopus cinctus*.

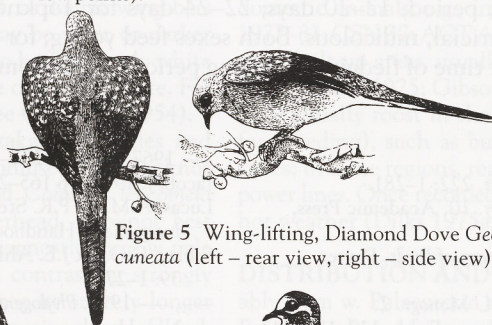


(a)



(b)

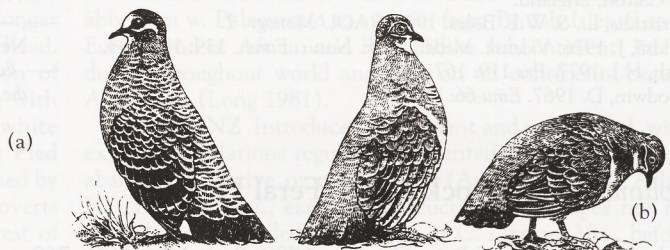
**Figure 3** Advertising Display: (a) Wonga Pigeon *Leucosarcia melanoleuca* (left – high point, centre – low point, right – rear view); (b) Squatter Pigeon *Geophaps scripta* (high and low points).



**Figure 5** Wing-lifting, Diamond Dove *Geopelia cuneata* (left – rear view, right – side view).



**Figure 6** Mantling, Wompoo Pigeon *Ptilinopus magnificus*.



**Figure 8** Post-copulatory Parade: (a) Common Bronzewing *Phaps chalcoptera*; (b) Partridge Pigeon *Geophaps smithii* (high and low points).



**Figure 10** Display Flight, Rock Dove *Columba livia*.

Other displays include: other Advertising Displays (Figs 2, 3) and Advertising Call Posture (special posture when giving Advertising Call; see Fig. 9). Parade (Fig. 8), usually seen at times of sexual excitement, and often given as a post-copulatory display. Jump, seen in sexually excited or aggressive birds and often associated with Parade. Driving (an avicultural term), where male moves mate away from other males. Preening-Behind-the-Wing, assumed to be sexual. Nest Calling is a posture adopted by male seeking suitable nesting site, as he calls to female. Nodding, function unknown. Wing-stretching (sometimes called Mantling; see Figs 6, 7), a comfort behaviour but possibly also used in sexual circumstances. Wing-lifting (Fig. 5) seen in aggression and alarm but function not known. Wing-raising (Fig. 4), a defensive-threat display also seen in sexual and alarm behaviour. (For latter three, involving raising of wings, terminology, as suggested by Frith, has not been strictly used in literature, which sometimes leads to confusion as to which displays are being described.) Allopreening occurs throughout sexual cycle, at nest and elsewhere. Courtship feeding (sometimes called Billing), commonly associated with copulation.

When roosting, pigeons do not tuck head behind wing, but draw it into body; sometimes one leg drawn up into feathers of belly. When loafing, may also squat or lie down. Bathe by wading into shallow water and immersing themselves; Flock Bronzewings will alight directly on water to drink, and possibly to bathe. Most also bathe in rain, often crouching, leaning to one side, and raising and fully extending wing, exposing underwing to rain; plumage often ruffled. Sunning posture similar to that when bathing in rain; may only partly open one or both wings and partly or fully spread tail. For more details on behaviour, particularly relationship between behavioural characters and taxonomy of family, see Frith, Frith (1977), Goodwin and Goodwin (1967).

Breeding generally seasonal. For frugivorous species: roughly June–Feb. in Aust., Sept.–Apr. for New Zealand Pigeon; broadly coincides with period when fruit most abundant, though nests may be found at any time of year. For granivorous species, generally early to middle of dry season (Feb.–Mar. to July) in n. Aust., spring and early summer in s. Aust., though nests can be found in any month of year. Nests usually situated in fork or on branch, sometimes on tangle of vegetation; often in foliage of shrubs or trees, sometimes on old nests of other species; *Petrophassa* nest on ledges or in crevices in rocks; *Geophaps*, Flock Bronzewing and, often, Brush Bronzewing on ground. Rock Doves and *Streptopelia* will nest on buildings and artificial structures. Nest usually a flimsy platform of twigs, sometimes with tendrils of vines, rootlets or grass; some species may build more substantial nests. Ground-nesting species make scrape, usually lined with vegetation. Males usually collect material and females build. Most frugivorous species lay one egg per clutch; granivorous species, two. Eggs usually white, sometimes cream, and unmarked; may have pink tinge when fresh. Eggs laid on successive days, sometimes 2 days apart. Some species may lay more than one clutch per season. Both sexes incubate; period, 12–20 days; 22–24 days for Topknot Pigeons and 26–28 days for Pied Imperial-Pigeons. Young semi-altricial, nidicolous. Both sexes feed young; for first few days, on crop-milk. Parents learn to recognize young at about time of fledging. Fledging period ranges from 11 to 35 days. Young sometimes fed after fledging.

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*Columba novæ Seelandiæ* Gmelin, 1789, *Syst. Nat.* 1 (2): 773 — New Zealand = Dusky Sound, South Island.

The generic name is a compound from the Greek ἡμί, half, and the final syllables of *Carpophaga*, fruit pigeon; Bonaparte considered the New Zealand Pigeon to be intermediate between the genera *Megaloprepia* (now *Ptilinopus*) and *Carpophaga* (now *Ducula*). Specifically named after the type-locality (Modern Latin *Nova Zeelandia*).

**OTHER ENGLISH NAMES** Keruru, Kukupu, Kuku, Chatham Island Pigeon, Native Pigeon, Wood Pigeon.

**POLYTYPIC** Nominate *novaeseelandiae*, NZ, including larger offshore islands; subspecies *chathamensis* (Rothschild, 1891) Chatham Is; subspecies *spadicea* (Latham, 1801) Norfolk I. (extinct).

**FIELD IDENTIFICATION** Length 50 cm; wingspan c. 75 cm; weight 600–700 g. Large brightly coloured fruit-pigeon. Distinctive: mostly iridescent dark green, purple and bronze on head, neck, upperparts and breast, sharply demarcated from white underbody. Noisy swishing and clapping of wings when moving about in foliage also distinctive. On Chatham Is, larger, with greyer upperparts, bronze-green undertail-coverts, and different bare parts. Sexes alike. No seasonal variation. Juvenile separable.

**Description** Nominate *novaeseelandiae*. **Adult** Most of head and neck, iridescent dark green, with golden or bronze sheen. Nape, hindneck, most of saddle and smaller secondary coverts, iridescent dark purple, with coppery sheen. Lower back, rump, uppertail-coverts and rest of upperwing, paler iridescent grey-green, with silvery-grey wash on rump, uppertail-coverts and bases of primaries. Depending on angle of light, can appear mainly grey above. Pale grey-green lower back to uppertail-coverts and silvery-grey bases of primaries promi-

nent in flight. Tail, black-brown, with green sheen and diffuse narrow pale terminal fringe. Upper breast, iridescent dark green, with golden or bronze sheen, forming dark rounded bib, sharply demarcated from white rest of underbody, and with narrow white band between dark breast and dark folded wings. Undertail, silvery grey, with broad dark-brown subterminal band. Underwing-coverts, pale grey; underside of remiges, dark brown. Bill, crimson, slightly paler near tip. Iris, red. Orbital ring, red to pink. Feet, dark red. Subspecies *chathamensis*. Similar but dark plumage duller and upperparts more strongly suffused grey. Head, neck and breast, iridescent dark purple, with bronze and green sheen; lower back to uppertail-coverts, paler, silvery grey, only faintly tinged green; greater upperwing-coverts, paler green-grey and grey bases to primaries on upperwing larger; undertail-coverts, bronze-green. **Juvenile** Like adult, but differ by: (1) head, neck and upper breast, duller grey-green; (2) colour of bare parts in nominate *novaeseelandiae*: bill, dull brown or purple-brown; iris, dark

brown; orbital ring, dull purple; and legs and feet, dull pink; and (3) in subspecies *chathamensis*: pale-buff undertail-coverts; and duller bill and feet.

**Similar species** None. Much larger than other NZ pigeons.

Usually seen singly or in pairs; occasionally in loose flocks where food abundant. Tame, often allowing close approach. Feed in trees and shrubs; occasionally on floor of forest and in paddocks. Flight undulating over distances >200 m; fly with slow wing-beats, making swishing sound with wings. Loud wing-claps during display. Usual call a single soft but sometimes quite penetrating *ku* or *oooo* when feeding or resting; note sometimes ends on higher pitch, sometimes trails off.

**HABITAT** Prefer dense mixed podocarp-broadleaf forests, usually with complex structure, including dense canopy with tall emergent trees and well-developed shrub layer; occur in large tracts and remnant patches of forest (Challies 1966; Hilton 1969; Edgar 1971; Onley 1980; Dunn 1981; Clout *et al.* 1988, 1991; Gill 1989; Pearson & Climo 1993; Oliver; CSN). Visit higher altitudes in spring. Said to occur only rarely in pure *Nothofagus* forest (Sibson 1958; St Paul 1977; Clout *et al.* 1986; CSN; M.N. Clout). Visit modified habitats, such as plantations of *Pinus* and *Pseudotsuga*, and secondary regrowth or weed-infested areas (Dunn 1981; CSN). Also in shelterbelts or other plantings, especially in areas beside lowland forest and, in spring, preferring exotic deciduous trees, such as *Populus*, *Ulmus*, *Salix* and *Prunus* (Jenkins & Sibson 1975; Dunn 1981; Clout *et al.* 1986, 1988; CSN). Numbers in logged forests significantly lower than in unlogged forests (Onley 1980, 1983), and decline in populations in part attributed to loss of habitat (McKenzie 1979; Oliver). Remaining forests also adversely modified by feeding activities of introduced herbivores (Williams 1962; Pearson & Climo 1993; Oliver). Also occur in urban areas, particularly parks and gardens with fruiting trees (Dunn 1981; CSN; M.N. Clout); occasionally in paddocks, grassy clearings and lawns, usually only if trees nearby (Dawson 1950; Morris 1979; CSN); round Kiripaka, many deaths thought to have been caused by use of weedkiller on pasture (CSN 19). Rarely above treeline; recorded up to c. 1300 m asl (Challies 1966; Child 1975; Dawson *et al.* 1978; CSN 23). Once seen landing briefly on calm pond (Jenkins & Sibson 1975).

Nest mainly in native forests, usually at low altitudes, but sometimes >1100 m asl; occasionally in pine plantations and gardens. Nest in dense foliage in canopy or subcanopy of native or exotic trees, such as *Podocarpus*, *Nothofagus*, *Pinus* and *Ulma* (Clout *et al.* 1986, 1988, 1991; CSN); also in dense shrubs or hedges or among clumps of vines (Guthrie-Smith 1910; Morrison 1959; Genet & Guest 1976; Bell 1980; Oliver). Most breed in lowland forests, though some move to *Nothofagus* forest at higher altitudes (Clout *et al.* 1986).

Prefer to feed in mixed podocarp-broadleaf forests, with high plant diversity and complex structure; forage from ground level to canopy (Dunn 1981; Clout *et al.* 1991). Feed mostly in upper understorey (59% of time spent foraging); less in canopy (19%) and lower understorey (17%); least on ground (6%); most foraging within 5 m of ground, in small trees (56%) and shrubs (35%) (117 hours observation; Dunn 1981). On Chatham Is, mostly recorded foraging in canopy of mixed broadleaf forest (Pearson & Climo 1993). Also forage in modified or disturbed areas, on exotic plants, particularly deciduous trees; in plantations or trees planted in open country or along streams; also in secondary regrowth or among invasive weeds in cleared areas (St Paul 1977; Dunn 1981; Clout *et al.* 1988, 1991; CSN). Often feed in urban parks and gardens (Gibb

1970; Dunn 1981; Flux 1990; Clout *et al.* 1991; CSN), usually at higher level in vegetation than in forested areas (Dunn 1981). Occasionally recorded feeding on grass or clover in clearings, pasture, suburban lawns and roadsides (Dawson 1950; Hamilton 1961; Morris 1979; Pearson & Climo 1993; CSN).

Often loaf in tall trees of forest; sometimes in plantations. Often on branches in sunlight but on shaded branches during hot weather (Roberts 1953; St Paul 1977; Morris 1979; Dunn 1981). Occasionally on telephone poles (CSN 19 Suppl., 39). Usually roost in dense trees and shrubs (Dunn 1981; Clout *et al.* 1991; CSN 30, 35); once recorded asleep on road (CSN 37).

**DISTRIBUTION AND POPULATION** Endemic to NZ and Chatham Is. Formerly occurred Norfolk I. and, possibly, Raoul I. (Kermadec Grp). Only native pigeon in NZ.

**NZ NI** Widespread throughout, though sparsely scattered N of Kaitaia, in parts of central and nw. Waikato, s. Volcanic Plateau, s. Hawke's Bay, Wairarapa and s. Manawatu. **SI** Widespread n. Marlborough and E of Kaikoura and Amuri Ras; also widespread n. Canterbury, S to Hurunui R., and on Banks Pen.; scattered inland W of Canterbury Plains, S to Waitaki; also scattered in Otago, though often recorded SW of Dunedin; widespread Southland and Stewart I. and many islands in Foveaux Str., W to Fiordland and throughout West Coast (E to Southern Alps) and Nelson (Blackburn 1968; Muller 1969; Cooper 1984, 1991; Cooper *et al.* 1986; CSN; NZ Atlas).

**Chatham Is** Mainly on Chatham I.; reintroduced to South East I. (Fleming 1939; Lindsay *et al.* 1959; M.N. Clout). Not reintroduced to Pitt I. (M.N. Clout cf. NZCL). Once abundant on Chatham, Pitt and Mangere Is. Decline noticed in 1930s, possibly as a result of hunting, degradation of habitat and predation by introduced mammals. Numbers have increased after predator controls introduced (M.N. Clout).

**Kermadec Is** Extinct. A large fruit-pigeon was found by early settlers on Raoul I., but populations quickly declined through hunting by settlers and predation by feral cats (Sorensen 1964; Clout 1990; but see Geographical Variation).

**Norfolk I.** Extinct. First recorded in 1774 and abundant in 1830s. Populations declined as a result of hunting by settlers and, possibly, predation by feral cats; no records since 1900 (Schodde *et al.* 1983; Hermes 1985; Clout 1990; see Geographical Variation).



**Breeding** Throughout much of range.

**Populations** In many lowland forests, densities 0.1–2 bird/ha (M.N. Clout). At Tapanui, SI, 15–20 birds in c. 3 ha (Stenhouse 1957). On Chatham I., total population about 1990, c. 30 birds (Clout 1990); more recent counts, >100 birds (M.N. Clout); 10 birds recorded in c. 20 ha round Cascade Gorge in Mar. 1977 (Morris 1979); during summer 1988–89, seven birds recorded in 12,500 ha on s. Chatham I. (Freeman 1994).

Formerly abundant in mainland NZ. Numbers decreased soon after European settlement, as a result of clearance and modification of habitat, and hunting. Decline stopped with protection from hunting in 1921. Populations may have increased in some areas (Falla *et al.* 1981; CSN; NZCL) but have declined in Northland (Pierce *et al.* 1993).

Hunted for food since first human settlement. Maori formerly killed thousands at single sites (Clout 1990; Oliver). Early settlers found Pigeons 'most delicious eating' (Oliver) and Pigeons were 'shot by the sackful' (St Paul & McKenzie 1974). Pigeons on Norfolk and Raoul Is, extirpated in nineteenth century, probably through hunting (Schodde *et al.* 1983; Hermes 1985; Clout 1990). On Norfolk I., between 1838 and 1840, 17 hunting expeditions killed at least 72 Pigeons, with largest daily bag of 25 taken in Sept. 1838 (Moore 1985). Still occasionally shot illegally in NZ (Westerskov 1972, 1977; Macmillan & McClure 1990), which may cause local populations to decline (McKenzie 1979; Clout 1990; Clout *et al.* 1991; Pierce *et al.* 1993; CSN 6). Introduced predators, including cats and Stoats *Mustela erminea*, kill adults, sometimes taking several at a feeding or drinking site (Clout 1990; CSN 8). Stoats, rats and Common Mynas *Acridotheres tristis* eat eggs (St Paul & McKenzie 1974; McKenzie 1979; Clout 1990). Introduced Brush-tailed Possums *Trichosurus vulpecula* may compete for food (Bettesworth 1981; Clout 1990) and eat eggs and young in nests (Brown *et al.* 1993; Pierce *et al.* 1993). Often harassed by introduced Australian Magpies *Gymnorhina tibicen* (CSN) and, round Maungatautari, decline in Pigeon numbers coincided with increased population of Magpies (CSN 28). Pigeons occasionally collide with power lines or windows (Devonshire 1980; Flux 1990).

**MOVEMENTS** Sedentary, but with considerable local movements (Clout 1990); maximum movement of radio-tagged bird, 25 km, between spring feeding site and summer range near Nelson (Clout *et al.* 1991). Numbers counted in native forests change seasonally (usually lowest in late winter and spring) and influxes to farms, suburban gardens and river banks (to feed) occur in spring (St Paul 1977; Dawson *et al.* 1978; Clout & Gaze 1984; Wilson *et al.* 1988; Clout *et al.* 1991). Will cross sea; fly between islands, e.g. from Little Barrier I. to Great Barrier I. (Bell & Brathwaite 1963) and 21 observed flying over Centre I. towards Stewart I. (Wright 1975). About 1930, great flight from Hen I. to Waipu Range; birds so thin and weak many fell and died (CSN 2). Said to fly high on regular n. movement at Maunga-Haumia, NI (M'Lean 1911); and to keep low in bad weather (St Paul 1977).

Movements studied at Pelorus Bridge Scenic Reserve, Marlborough (n=54 radio-tagged birds; Clout *et al.* 1991). In spring, birds fed in areas next to reserve on deciduous foliage. From early summer, about half the birds moved 2–18 km to other areas of native forest, with most departures in Dec. Probably moved in response to availability of food; peak of departure corresponded with start of fruiting season and change of diet to fruit. Most stayed away for 2–9 months, though some made up to three return movements to and from Pelorus

Bridge within 1 year, visiting different sites at different times of year. At least some bred at summer sites. Peak return to Pelorus Bridge, June. Seasonal ranges appear traditional, though timing of movements varied between years and depended on fruiting phenology and breeding success.

At L. Rotoroa, most abundant June–Sept.; numbers drop Oct.–Nov., when leaves of food tree fall. Two radio-tagged birds left in Oct.–Nov. 1984, moved 2.8 and 11 km, and returned to Lake in July and Sept. 1985 (Clout *et al.* 1986).

Other records of movements: At Hinewai Reserve, absent June–July (when feeding on lucerne at lower altitudes), numbers increase in Oct., and common in summer (CSN 39). Come down from bush at Maraetotara each winter (CSN 38). Rarely seen near Reefton, SI, in late winter and spring when numerous in coastal forests (Dawson *et al.* 1978; Onley 1980). In Fiordland, move from higher-altitude forests in winter (CSN 19); and many round Te Anau from late May to Nov. (CSN 19). Said to move from place to place following food supply (M'Lean 1911). At Wanganui, regular visitor throughout year (CSN 41). At Minginui, numbers vary seasonally: numbers high Feb.–May, apparently because fruit abundant; disperse when fruiting finished; numbers fluctuate between years, probably in response to fluctuations in food supply (St Paul 1977). Common on Whangaparaoa Pen., winter 1971, after years of absence (CSN 19). Unusual record of pair present over winter 1986, Green I., Dunedin (CSN 35).

**FOOD** Mainly fruit, especially of native trees; also take leaves, young shoots, flowers and buds. **Behaviour** Feed in trees, mainly alone or in pairs; occasionally feed on ground on fallen fruits (Porter 1933; Gibb 1970; M.N. Clout). Will congregate in small loose flocks where ripe fruit abundant (e.g. CSN 37; Oliver), or when feeding on deciduous foliage in spring (M.N. Clout). During winter, single birds or pairs defend feeding territories, sometimes for long periods, but these territories break down over summer (Clout 1990). Feed throughout day, with foraging activity peaking mid- to late afternoon. On average, spend 25% of daylight hours feeding (Dunn 1981). May feed on one species of plant for entire day or for weeks, or may change plant species several times in a day or even an hour. Obtain most food from trees and shrubs (see Habitat); usually forage on small light branches (0.5–2 cm in diameter). Feeding height above ground and proportion of major food types (fruit, leaves, twigs or flowers) varies depending on structure of forest (Dunn 1981). When feeding, pick only ripe fruits that can be pulled off easily (Gibb 1970). Prefer purple-black fruit (ripe) to green (unripe) fruit. For quantitative estimates of feeding behaviour and general feeding ecology, see Dunn (1981) and Habitat. At Pelorus Bridge, SI, annual cycle well defined: in spring, leave forest and congregate to feed on spring-foliage of willows along river valley; return to forest late Dec. when fruiting begins and remain in forest from Jan. to Mar., eating a variety of native fruits (and also breed); in autumn and early winter, feed on fruits of Miro *Promnopytis ferruginea*; when Miro has finished fruiting, feed mainly on foliage of native plants before again moving to river valley in spring (Clout 1990; also see Movements).

**Adults** Central NI (177 crops and gizzards; McEwen 1978) (Fruit unless stated): GYMNOSPERMS: Cupressaceae: *Libocedrus plumosa* 0.6; Podocarpaceae: *Dacrycarpus dacrydioides* 0.6% freq.; *Pruynopitys ferruginea* 65.5, lvs 0.6; *Phyllocladus trichomanoides* lvs 0.6. DICOTYLEDONS: Elaeocarpaceae: *Elaeocarpus dentatus* 0.6; Escalloniaceae: *Carpodetus serratus* lvs 0.6; *Ixerba brexioides* 1.1; Fabaceae: *Lupinus* lvs, fl. 1.1; *Sophora tetraptera* lvs 0.6; *Trifolium* lvs 0.6; unident. fru., lvs



1.1; Fagaceae: *Nothofagus menziesii* lvs 0.6; *N. truncata* lvs 0.6; Grossulariaceae: *Griselinia* 2.5; *G. lucida* 3.5; *G. littoralis* 2.5; Lauraceae: *Beilschmiedia tarairi* 3.5; Malvaceae: *Hoheria* lvs 2.5; Meliaceae: *Dysoxylon spectabile* 3.5; Monimiaceae: *Hedycarya arborea* 1.1; Myrsinaceae: *Myrsine australis* 0.6; Myrtaceae: *Metrosideros* lvs 0.6; *M. diffusa* lvs 0.6; *M. umbellata* lvs 0.6; Oleaceae: *Nestegis montana* lvs 0.6; Onagenaceae: *Fuchsia excorticata* 0.6; lvs 0.6; Proteaceae: *Knightia excelsa* lvs 0.6; Rubiaceae: *Coprosma* 5.6, lvs 1.1; Verbenaceae: *Clerodendron bungei* lvs. 0.6; Violaceae: *Melicytus ramiflorus* lvs. 1.1.

At **Catlins State Forest Park, SI** (7044 min obs. of feeding; Dunn 1981): FERNs: Plants: Aspleniaceae: *Asplenium flaccidum* lvs 0.6% of total obs., fru. -% of total obs.; Polypodiaceae: *Phymatodes diversifolium* 2.1, -. GYMNASPERMS: Podocarpaceae: *Dacrydium cupressinum* -, 8.8; *Podocarpus ferrugineus* -, 21.6; *P. spicatum* -, 4.0; *P. totara* -, 0.2. MONOCOTYLEDONS: Smilacaceae: *Rhipogonum scandens* -, 0.2. DICOTYLEDONS: Araliaceae: *Pseudopanax edgerleyi* 0.5, -; *P. simplex* 1.5, -; Apocynaceae: *Parsonia* 8.4, -; Elaeocarpaceae: *Aristolelia serrata* -, 2.2; Escalloniaceae: *Carpodetus serratus* -, 0.1; Moraceae: *Paratrophis microphylla* 0.2, -; Myrsinaceae: *Myrsine australis* -, 2.6; Onagraceae: *Fuchsia excorticata* -, 5.9; Polygonaceae: *Muehlenbeckia complexa* 5.0, -; Ranunculaceae: *Clematis paniculata* 0.2, -; Rubiaceae: *Coprosma areolata* 4.8, -; *C. foetidissima* 0.3, 0.4; *C. polymorpha* 4.3, -; *C. propinqua* 0.1, -; *C. rotundifolia* 19.8, 0.2; Winteraceae: *Pseudowintera colorata* -, 6.0.

At **Whare Flat, SI** (10,285 min obs. of feeding; Dunn 1981): Plants: MONOCOTYLEDONS: Agavaceae: *Cordyline australis* lvs -% of total obs., fl. -% of total obs., fru. 0.1% of total obs. DICOTYLEDONS: Caprifoliaceae: *Sambucus nigra* 0.1, -, 16.6; Elaeocarpaceae: *Aristolelia serrata* -, -, 4.7; Fabaceae: *Sarothamnus scoparius* 18.4, 16.4, -; *Sophora microphylla* 33.9, 0.6, -; Oleaceae: *Fraxinus* 0.1, -, -; Polygonaceae: *Muehlenbeckia australis* 1.9, -, 1.0; Salicaceae: *Populus* 5.6, -, -; Solanaceae: *Solanum laciniatum* -, -, 0.5; Violaceae: *Melicytus ramiflorus* 0.1, -, -.

In **urban Dunedin, SI** (6626 min obs. of feeding; Dunn 1981): Plants: MONOCOTYLEDONS: Agavaceae: *Cordyline australis* lvs -% of total obs., fl. -% of total obs., fru. 2.3% of total obs. DICOTYLEDONS: Araliaceae: *Pseudopanax crassifolium* -, -, 0.7; Apocynaceae: *Parsonia* 0.1, -, -; Aquifoliaceae: *Ilex aquifolium* -, -, 0.2; Caprifoliaceae: *Sambucus nigra* -, -, 0.3; Convolvulaceae: *Calystegia tuginorum* 0.2, -, -; Cornaceae: *Griselinia littoralis* -, -, 0.1; Elaeocarpaceae: *Aristolelia serrata* -, -, 4.0; *Elaeocarpus hookerianus* -, -, 0.3; Escalloniaceae: *Carpodetus serratus* -, -, 0.1; Fabaceae: *Cystisus proliferus* 1.1, -, -; *Laburnum abagyroides* 9.8, 1.5, -; *Sarothamnus scoparius* 0.1, 0.5, -; *Robinia pseudacacia* 1.1, 0.3, -; *Sophora microphylla* 25.5, 2.5, -; Malvaceae: *Plagianthus betulinus* 1.0, -, - (incl. twigs 5.1%); *Hoheria angustifolia* 1.3, -, -; Moraceae: *Paratrophis microphylla* 0.1, -, -; Myrtaceae: *Myrtus obcordata* -, -, 0.1; Onagraceae: *Fuchsia excorticata* -, -, 2.4; Rosaceae: *Prunus* 11.8, 2.5, 0.3; *Crataegus* 0.3, -, -; *Sorbus* 2.1, -, 0.4; *Malus* -, -, 1.7; Rubiaceae: *Coprosma areolata* 0.1, -, -; *C. propinqua* -, -, 0.7; *C. robusta* -, -, 3.4; Salicaceae: *Populus* 5.9, -, -; *Salix* 0.9, 0.8, -; Taxaceae: *Taxus baccata* -, -, 5.5; Ulmaceae: *Ulmus* -, 0.5, 2.1; Violaceae: *Melicytus ramiflorus* 0.3, -, -.

At **L. Rotoroa, NI** (146 obs.; Clout et al. 1986); diet exclusively fruit from Feb. to May (23 obs.) and mostly leaves from June to Jan. (123 obs.). Plants (fruits unless stated): Podocarpaceae: *Prumnopitys taxifolia* 2.0% of total obs.; *P. ferruginea* 0.7; Cornaceae: *Griselinia* 0.7; Elaeocarpaceae: *Aristolelia serrata* 0.7; Escalloniaceae: *Carpodetus serratus* 1.3; Onagraceae: *Fuchsia excorticata* 5.5; Fabaceae: *Sophora* lvs 65.7, buds 3.4, fl. 2.0; Rubiaceae: *Coprosma rotundifolia* 2.7, lvs 8.9;

Rununculaceae: *Clematis* lvs 0.7; Winteraceae: *Pseudowintera colorata* 2.0.

**Other records** Plants (Fruit unless stated.) Berries, stone fruits, leaves, buds, flowers and shoots<sup>18</sup>. FUNGI: *Cyttaria*<sup>25</sup>; *C. gunnii*<sup>21</sup>. FERNs: *Asplenium* buds, lvs<sup>24</sup>; *Polypodium* buds, lvs<sup>24</sup>. GYMNASPERMS: Podocarpaceae: *Dacrydium cupressinum*<sup>1,12,16,19,22,23,24,25</sup>; *Dacrydium cupressinum*<sup>25</sup>; *Prumnopitys ferruginea*<sup>1,2,4,12,16,19,20,22,23,24,25</sup>; *P. taxifolia*<sup>12,16,19,24,25</sup>; *Podocarpus nivalis*<sup>25</sup>; *P. totara*<sup>25</sup>. MONOCOTYLEDONS: Agavaceae: *Cordyline australis*<sup>1,16,19,24,25</sup>; Araceae: *Rhopalostylis sapida* fru.<sup>12,14,22,23,24</sup>, sds<sup>25</sup>; Cyperaceae: *Chamaecyparis lawsoniana* lvs<sup>18</sup>; Liliaceae: *Astelia banksii*<sup>18</sup>; Poaceae lvs<sup>7</sup>; Smilacaceae: *Rhipogonum scandens*<sup>1,12,23,24</sup>. DICOTYLEDONS: Apocynaceae: *Parsonia capsularis* lvs<sup>1</sup>; *P. heterophylla*<sup>16</sup>; Aquifoliaceae: *Ilex aquifolium*<sup>16,19,24,25</sup>; Araliaceae: *Pseudopanax arboreus*<sup>1</sup>; *P. lessonii*<sup>19</sup>; *P. crassifolium*<sup>12,19,25</sup>; *P. edgerleyi* lvs<sup>19</sup>; *Schefflera digitata*<sup>12,16</sup>; Aspidiaceae: *Polystichum richardii*<sup>19</sup>; Asteraceae: *Senecio* lvs<sup>19</sup>; Brassicaceae: *Brassica* lvs<sup>19</sup>; *B. napus* lvs<sup>19</sup>; Caprifoliaceae: *Sambucus nigra*<sup>25</sup>; Convolvulaceae: *Calystegia* lvs, fl.<sup>22</sup>; Coriariaceae: *Coriaria arborea*<sup>19</sup>; Corynocarpaceae: *Corynocarpus laevigatus*<sup>12,16,22,23,24</sup>; Elaeocarpaceae: *Aristolelia serrata* fru.<sup>1,10,12,19,20,24,25</sup>, lvs<sup>12,19,24</sup>; *Elaeocarpus dentatus*<sup>1,12,16,19,24</sup>; *E. hookerianus*<sup>19</sup>; Escalloniaceae: *Carpodetus serratus*<sup>25</sup>; Fabaceae: *Carmichaelia* lvs<sup>19</sup>; *Cytisus proliferus* lvs<sup>12,16,19,22,24,25</sup>, fl.<sup>12</sup>, buds<sup>19</sup>; *C. scoparius* lvs, buds, fl., buds<sup>6,19</sup>; *Trifolium repens* lvs<sup>16,19,24,25</sup>; *Vicia*<sup>19</sup>; *Lotus* lvs<sup>19</sup>; *Lupinus* lvs<sup>19</sup>; *Laburnum* lvs<sup>16,24</sup>; *Sophora* lvs, fl.<sup>18,23</sup>; *S. macrophylla* lvs, fl., buds<sup>19,24,25</sup>; *S. tetraaptera* lvs<sup>16</sup>, fl.<sup>12</sup>, young shoots<sup>1</sup>; *Trifolium repens*<sup>1</sup>; Fagaceae: *Nothofagus menziesii* lvs<sup>25</sup>; Grammitaceae: *Grammitis billardieri* lvs<sup>19</sup>; Grossulariaceae: *Griselinia*<sup>12</sup>; Icacinaceae: *Pennantia corymbosa*<sup>12</sup>; Lauraceae: *Beilschmiedia tarairi*<sup>14,16,19,22,23,24,25</sup>; *B. tawa*<sup>1,12,16,19,20,22,24,25</sup>; *Hedycarya arborea*<sup>20</sup>; *Litsea calicaris*<sup>16</sup>; Loganiaceae: *Geniostoma ligustrifolium*<sup>12</sup>; Loranaceae: *Tupeia antarctica*<sup>12,19</sup>; Malvaceae: *Abutilon*<sup>25</sup>; *Hibiscus* lvs<sup>19</sup>; *Hoheria populnea* lvs<sup>19,23,24,25</sup>, buds<sup>24</sup>, young shoots<sup>25</sup>; *H. glabrata* lvs, buds<sup>24</sup>; *Plagianthus betulinus*<sup>19</sup>; Meliaceae: *Dysoxylon spectabile*<sup>12,25</sup>; Mimosaceae: *Acacia* fl., buds<sup>25</sup>; Monimiaceae: *Hedycarya arborea*<sup>1,12,24,25</sup>; Myoporaceae: *Myoporum laetum*<sup>12,19</sup>; Myrsinaceae: *Myrsine australis*<sup>12,16,19</sup>; *M. salicina*<sup>19</sup>; Myrtaceae: *Acmena*<sup>25</sup>; *Eucalyptus* lvs, young shoots<sup>25</sup>; *Eugenia mairii*<sup>12,16,24,25</sup>; *Leptospermum scoparium*<sup>19</sup>; *Myrtus bullata*<sup>16</sup>; *Psidium cattelium*<sup>5,25</sup>; Nyctaginaceae: *Heimerliodendron brunonianum*<sup>19</sup>; Oleaceae: *Gymnelaea*<sup>12</sup>; *Ligustrum*<sup>25</sup>; *Nestegis*<sup>16,24,25</sup>; Onagraceae: *Fuchsia* fru.<sup>16,19,24,25</sup>, lvs<sup>19</sup>, buds<sup>19</sup>; *F. excorticata*<sup>1,3,8,12,20</sup>; Passifloriaceae: *Tetrapathaea tetrandra*<sup>12</sup>; Piperaceae: *Macropiper excelsum*<sup>12</sup>; Polygonaceae: *Muehlenbeckia australis* lvs<sup>4,12,19</sup>; *M. complexa* lvs, buds<sup>24</sup>; Proteaceae: *Persoonia toru*<sup>12</sup>; Rosaceae: *Cotoneaster*<sup>25</sup>; *Crataegus monogyna*<sup>25</sup>; *Malus* lvs<sup>9,16,24</sup>, buds<sup>19</sup>; *Prunus*<sup>3,17</sup>; *Cherry*<sup>16,19,22,24,25</sup>, Plum<sup>19,22,25</sup>, lvs, fl., buds, young shoots<sup>25</sup>; *Pyrus* lvs<sup>19</sup>; *Rosa eglanteria*<sup>19</sup>; *R. rubiginosa*<sup>16,24</sup>; *Rubus australis*<sup>12</sup>; *Sorbus aucuparia*<sup>16,24</sup>; Rubiaceae: *Coprosma*<sup>10,12,25</sup>; *C. australis*<sup>16</sup>; *C. grandifolia* lvs<sup>25</sup>; *C. lucida* fru.<sup>1,24,25</sup>, lvs<sup>24</sup>; *C. parviflora*<sup>20</sup>; *C. rotundifolia*<sup>25</sup>; *C. rubusta*<sup>19</sup>; Rutaceae: *Citrus* buds<sup>25</sup>; Salicaceae: *Populus* lvs<sup>16,22</sup>; *Salix* lvs<sup>11,13,16,22,24,25</sup>, fl.<sup>25</sup>, buds<sup>25</sup>; Santalaceae: *Media salicifolia*<sup>19</sup>; Sapindaceae: *Alectryon exelsus*<sup>12,16,24</sup>; Sapotaceae: *Planchonella novozealandica*<sup>15,19,23</sup>; Solanaceae: *Solanum aviculare*<sup>16</sup>; *S. nigrum*<sup>19</sup>; *S. tuberosum*<sup>19</sup>; Tiliaceae: *Entelea arborescens*<sup>16</sup>; Ulmaceae: *Ulmus* lvs; buds<sup>19,22,25</sup>; Verbenaceae: *Vitex lucens* fru.<sup>5,16,19,22,23,24,25</sup>, fl.<sup>25</sup>; Violaceae: *Melicystis lanceolatus* lvs, buds<sup>19</sup>; *M. ramiflorus* fru., lvs<sup>16,25</sup>; Winteraceae: *Pseudowintera axillaris*<sup>12,25</sup>; *P. colorata*<sup>10,16</sup>.

REFERENCES: <sup>1</sup> McLean 1911; <sup>2</sup> Wilkinson 1924; <sup>3</sup> Dunedin Field Nat. Club 1948; <sup>4</sup> McKenzie 1948; <sup>5</sup> Hodgkins 1949; <sup>6</sup> Taylor 1949; <sup>7</sup> Dawson 1950; <sup>8</sup> Martin 1950; <sup>9</sup> Taylor 1950; <sup>10</sup> Bull & Falla 1951; <sup>11</sup> Knight 1951; <sup>12</sup> Wilkinson & Wilkinson 1952; <sup>13</sup> Stenhouse 1957; <sup>14</sup> Bell & Brathwaite 1963; <sup>15</sup> Merton 1966; <sup>16</sup> Turbott 1967; <sup>17</sup> Gibb 1970; <sup>18</sup> St Paul 1977;

<sup>19</sup> McEwen 1978; <sup>20</sup> Clout & Gaze 1984; <sup>21</sup> Clout *et al.* 1986; <sup>22</sup> Clout 1990; <sup>23</sup> Pierce 1993; <sup>24</sup> Oliver; <sup>25</sup> CSN 1–41.

**Young** Little known. Fed by regurgitation; on crop-milk at first; fed fruit within 1 week (Clout 1990; Pierce 1993). Fed once (Clout 1990), or 2–3 times (Pierce 1993) a day. Parent reaches down and holds bill of chick at side of its own and regurgitates with convulsive movements of throat and crop, forcing food into chick (Morrison 1959).

**Intake** Swallow fruit whole; defecate intact seeds (McEwen 1978; Dunn 1981; Clout 1990). Maximum diameter of fruit ingested, 26 mm (Gibb 1970). Average of five *P. ferruginea* fruits in crop; one bird had 52 fruits weighing c. 50 g (34 in crop, 5 in gizzard, 13 in intestine); another had 14.2 g dry weight of leaves in crop. Estimated that Pigeons ate 8500 fruits of *P. ferruginea* in 3 months (McEwen 1978). Feeding rates varied with time of year, air temperature, size of items, species of plant, type of food, and time of day (see Dunn 1981).

**SOCIAL ORGANIZATION** No detailed studies. Account based on studies near Auckland, in Hawke's Bay and in Marlborough (Clout 1990; Clout *et al.* 1986, 1988, 1991, 1995) unless stated. Usually solitary or in pairs. Remain in well defined home-range or territory while breeding. Many disperse or migrate during autumn and winter; others remain within breeding range throughout year (M'Lean 1911; Turbott 1967). Loose flocks of several to 100+ may gather where food abundant, usually in spring (on new foliage) and winter (at fruit crops) (M'Lean 1911; Anon. 1950; Taylor 1950; Bell & Brathwaite 1963; Turbott 1967; Clout *et al.* 1991; Oliver). Individuals or pairs may defend trees in fruit at non-breeding sites, often for long periods. Dispersion closely related to availability of food and thus varies between areas and years. Most birds probably have a series of feeding sites and individuals vary as to how far apart these sites are. Use of sites by individuals can be traditional but also use other sites opportunistically. Those that move return to breeding sites when fruiting begins.

**Bonds** Monogamous. Pair-bond probably lasts more than one season; pairs associate in non-breeding season (M'lean 1911; Turbott 1967; Clout *et al.* 1991; Pearson & Climo 1993). Sex-ratio nearly even (11 males:10 females) (Clout *et al.* 1995). **Parental care** Both parents build nest, incubate, care for and feed young. Male may contribute more material to nest, though Bell (1980) noted only female appeared to carry material. Eggs rarely left uncovered (Wilkinson & Wilkinson 1952; Morrison 1959; Clout *et al.* 1988); female incubates from late afternoon and through night; usually relieved by male in mid-morning (Clout *et al.* 1988; Clout 1991; Hadden 1993). Chicks brooded constantly for first few days, with pattern of brooding similar to that of incubation (Wilkinson & Wilkinson 1952; Clout *et al.* 1988). After fledging, fed for at least 1 week by parents. At one nest, one week after young fledged, male was no longer seen with young; young regularly moving outside parental range within 2 weeks of fledging (Clout *et al.* 1988). Independent when c. 6 weeks old, c. 1 week after fledging. On Chatham I., juveniles said to be accompanied by adults (Morris 1979).

**Breeding dispersion** Nest as single pairs. **Territories, Home-ranges** In breeding season, have well-defined home-ranges of up to 10 ha. Same home-ranges used each year or established close to previous sites. Area near nest-tree defended (Bell 1980; Hadden 1993). Some birds stay within breeding range all year, making only irregular short-term movements away to feed; others have series of traditional feeding areas they visit for most of non-breeding season before return-

ing to breed again (M'Lean 1911; Turbott 1967; Clout *et al.* 1988, 1991; Clout 1990). During winter, single birds or pairs defend feeding territories.

**Roosting** Active during day but spend hours loafing near feeding trees, especially when foliage is main food. Sometimes roost or loaf in plants that are not used for feeding. Often loaf in sunny positions, especially on cold mornings; or in dense foliage, usually high in canopy. Loaf alone or in pairs (Wilkinson & Wilkinson 1952; Turbott 1967; Morris 1979; Clout 1990; Pearson & Climo 1993). Some sites traditional (Clout 1990; Clout *et al.* 1991). Loaf with head drawn in, tail drooping and half spread, and wings closely folded (Morris 1979; Turbott 1967).

**SOCIAL BEHAVIOUR** No detailed studies. Bathing in rain recorded occasionally (e.g. Gibb & Flux 1994): lean to one side, often partly lying on one wing, and raise other wing so that rain can fall on underwing and flanks; six birds seen bathing together. Often sun in tall trees but only once seen raising wing while doing so (Gibb & Flux 1994). **Aerial activity** **DISPLAY FLIGHTS:** Conspicuous during breeding season, particularly at beginning. Often performed above nest-site. Male flies steeply upwards from tree, then stalls, spreading wings and tail, and glides back to perch (Porter 1933; Turbott 1967; Clout 1990; Clout *et al.* 1995; M.N. Clout). Groups of birds also seen swooping, diving and chasing one another (Wilkinson & Wilkinson 1952; CSN 30). On Chatham I., pair observed soaring repeatedly in wide arcs from cliffs, each member taking turns (Morris 1979).

**Agonistic behaviour** Two males often seen fighting for female and also said to be aggressive when feeding, one bird driving others away (Porter 1933). Display Flights (see above) probably advertise ownership of territories; often performed in response to approach of another bird (Clout 1990). Breeding males also flick wings at intruders and will chase them (Bell 1980; Hadden 1993). On Chatham I., an adult, assumed to be male parent, observed flying at a fledgeling that was feeding on ground near another adult, assumed to be female parent. Attacker then faced other adult and walked towards it, bobbing head and with feathers slightly fluffed and tail and wing-tips dragging along ground; then flew at it. Both birds rose about 1 m into air and tumbled together before landing and repeating the tumbling again; likened to posturing and head-bobbing of Rock Doves *Columba livia* (Morris 1979). Once, one bird killed another sick bird (Parkin 1947). **Alarm** When alarmed, *coo* quietly and repeatedly (Turbott 1967) or utter single loud *ku* (Guthrie-Smith 1910); clap wings when taking off and fly directly (Turbott 1967). When Swamp Harrier *Circus approximans* flies over, nearby birds fly from perches and circle (Wilkinson & Wilkinson 1952).

**Sexual behaviour** Display Flights (see above) said to be used in courtship (NZRD). **Greeting** Change-over at nest usually rapid, with little interaction (Clout 1990). **Allopreening** Observed 4–5 days before laying, on site where nest later built (Hadden 1993). **Copulation** Preceded by **BOWING DISPLAY:** male moves beside female, places bill under his wing, and shakes bill vigorously; then faces front again. Bowing Display performed up to four times. Male then usually places bill on breast and bobs entire body up and down. If female receptive, she crouches and male mounts, maintaining balance by flapping wings. After male dismounts, both birds preen. Mounting and dismounting takes c. 3 s. In one pair copulation seen twice 4 days before laying: once in a Kanuka *Leptospermum ericoides* tree where nest later built and once on nearby power lines (Hadden 1993; NZRD).

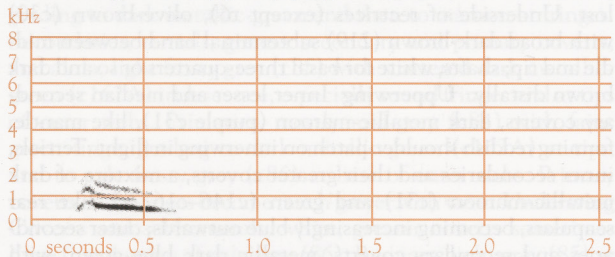
**Relations within family group** A few days after hatch-

ing, chick left unattended most of time. As parent approaches, chick makes piping call and holds wings out and quivers them. Adult takes chick's bill in its own and, with swaying and undulatory movements, regurgitates contents of crop (Guthrie-Smith 1910; Morrison 1959). Length of association between parents and offspring not known. **Anti-predator responses of young** Chick sits quietly and still in nest but flaps and strikes with wings if threatened (Guthrie-Smith 1910; Wilkinson & Wilkinson 1952). **Parental anti-predator strategies** Incubating bird sits tightly but will move to far side of nest, dragging egg without exposing it. Growl, peck and strike with wings at intruder. Once reported to fly from nest, feigning injury and performing Broken-wing Display (Guthrie-Smith 1910; Porter 1933; Wilkinson & Wilkinson 1952; Morrison 1959).

**VOICE** Usually silent; most common call, single soft but sometimes penetrating *coo* (Falla *et al.* 1981; Oliver); utter soft *coos* when resting (M'Lean 1911). **NON-VOCAL SOUNDS:** Take off with loud flapping of wings; wings beat loudly or swish in flight (Buller 1888; St Paul 1977). When feeding, wings hum as birds flutter from branch to branch (M'Lean 1911).

**Adult** **ADVERTISING CALL:** Soft but sometimes penetrating *oooo* or *ku* (sonagram A) when feeding or resting, sometimes ending on higher pitch, sometimes trailing off (Falla *et al.* 1981; NZRD). **ALARM CALLS:** Scarcely audible *coo*, slowly repeated while swaying head to and fro (Buller 1888); a variant of Advertising Call (Oliver). Also single loud *ku* (Guthrie-Smith 1910). **CALLS AT NEST:** Female growled 'in extreme anger'; bird watching nest moaned; slightly sibilant whistle given in greeting; bird gave grunt and whistle (Guthrie-Smith 1910).

**Young** Nestling gave piping calls (Guthrie-Smith 1910).



A L.B. McPherson; in captivity, Mt Bruce, NZ; P105

**BREEDING** Detailed study, over 7 years, of breeding and survival at three sites: Pelorus Bridge, SI, and Mohi Bush and Wenderholm, NI (Clout *et al.* 1995). Breeding activity appears related to abundance of fruit, with little or no breeding in poor fruiting years; young fledge at time of maximum abundance of fruit (Clout *et al.* 1995). Breed as single pairs.

**Season** Eggs in all months of year but mostly Nov.–Mar. (Clout *et al.* 1988). At Pelorus Bridge (n=45): Nov.–Mar., once in June; peak laying, mid-Dec. to mid-Feb., with re-nesting extending laying season to mid-Mar. or later. At Mohi Bush and Wenderholm (n=28): Sept.–Apr., with most Oct.–Jan. (Clout *et al.* 1995). Eggs, Sept.–Apr. (Genet & Guest 1976); as late as June, July (Genet & Guest 1976; Oliver). On Chatham I.: nest found, 29 Nov. (Oliver). At Pelorus Bridge, not all adults nested in a season; proportion of adults breeding ranged from 100% (n=5) to 0% (n=6); no breeding apparent during poorest fruiting year (Clout *et al.* 1995).

**Site** In trees (e.g. Silver Beech *Nothofagus menziesii*, Totara *Podocarpus totara*, Tawa *Beilschmiedia tawa*) low and dense shrubs, hedges (e.g. of Taupata *Coprosma repens* and Mahoe *Meliclytus ramiflorus*); on steep E-facing slope, sometimes in small tree overhanging cliff; in well-shaded position

in canopy; on lateral forked branches, stout branch or dense cluster of twigs, vines or branches that do not sway in breeze (Guthrie-Smith 1910; Annabell 1949; Wilkinson & Wilkinson 1952; Morrison 1959; Bell 1980; Clout *et al.* 1986, 1988; Oliver). **MEASUREMENTS:** Height of nest (m): 5.0 (4.0; 2.5–12; 5) (Morrison 1959; Genet & Guest 1976; Bell 1980; Clout *et al.* 1986, 1988); usually 4.6–9.1 m (Oliver), from 1.8 m (Wilkinson & Wilkinson 1952). One pair built second nest c. 100 m from first, and third nest 30 m from first (Clout *et al.* 1988).

**Nest, Materials** Frail platform of twigs (typically Kanuka *Kunzea ericoides*) with shallow cavity; unlined; egg visible through nest. Twigs intertwined (Guthrie-Smith 1910; Genet & Guest 1976; Oliver; M.N. Clout). Material for one nest collected from nearby Rata *Metrosideros umbellata* (Annabell 1949). One of pair plucked small dry twigs from bush and carried small load in bill to nest-site (Wilkinson & Wilkinson 1952); female seen picking up sticks from ground (Bell 1980). **MEASUREMENTS:** Diameter, c. 30 cm; depth of cavity, 2.5 cm (Wilkinson & Wilkinson 1952). Nest probably completed in 2 days (Wilkinson & Wilkinson 1952; Bell 1980); egg laid 2 days after completion (Bell 1980). Nest began to tilt as chick grew (Genet & Guest 1976). For one pair: on day of loss of egg, adult added a few sticks to nest, then appeared to desert nest for 2 days; returned and continued adding a few sticks for 12 days; laid egg 2 days later (Bell 1980). Replacement nest built at least 8 days after loss (Clout *et al.* 1988). One pair building second nest when chick in first c. 29 days old (Clout *et al.* 1988).

**Eggs** Ovoid; smooth; white (Oliver). **MEASUREMENTS:** 49 x 34 (Wilkinson & Wilkinson 1952).

**Clutch-size** One (Oliver).

**Laying** Nesting attempts can overlap: one pair laid egg in new nest when first chick c. 35 days old and still on nest (Clout *et al.* 1988). At a nest where egg lost on morning of laying, replacement egg laid in same nest 14 days later (Bell 1980). At Pelorus Bridge, about 50% breeding pairs make more than one nesting attempt each season; three pairs known to make at least three attempts each. In captivity, often raise two or three chicks a year (Clout *et al.* 1995).

**Incubation** By both sexes (Clout *et al.* 1986, 1988). An adult continually on nest between 09:00 and 13:00 (7 days of daily observation; Morrison 1959). Same adult incubated from at least 09:15 to 18:30 each day, then relieved by mate (12 days observations; Clout *et al.* 1988). An egg on edge of nest on day of laying later found back in centre of nest (Bell 1980). One egg left exposed for >4 h (Guthrie-Smith 1910). **INCUBATION PERIOD:** 29 days (Wilkinson & Wilkinson 1952; Oliver); 28–30 days (Clout *et al.* 1988). Incubating bird sits tight and will not leave nest even when observer tries to push bird off nest (Guthrie-Smith 1910).

**Young** Eyes open when chick at least 7 days old (Morrison 1959). Feathered at 24 days. No other information on development. **Growth** One chick c. 28 days old weighed 400 g (Clout *et al.* 1988). No other information. **Parental care, Role of sexes** Both sexes brood (Clout *et al.* 1988), till chick at least 5 days old (Morrison 1959), or constantly for first 7 days (Wilkinson & Wilkinson 1952). One chick fed twice while being brooded during 3 h observation. Between c. 9 and 36 days old, chick fed on nest but otherwise left unattended; at c. 28 days old, fed at 12:30 by one parent and at 16:00 by other (Clout *et al.* 1988). Young first fed on milky secretion from crop; gradually replaced by less pre-digested food until last week in nest when fed on raw or near raw berries. Observations of feeding of one chick: in early morning (c. 09:00), chick became watchful, began to pipe faintly and vibrate wings; as adult approached, chick shuffled body round so that

it faced a bough leading to nest, while staring at adult; adult slowly reached bough and approached chick, bent neck down towards chick, which raised its head; bill of adult overlapped that of chick; contents of crop transferred with swaying motion. Transfer took c. 3 s; adult remained at nest for a few minutes then flew off. Chick fed again in same manner in late afternoon (c. 16:00). Fed at same times of day for much of nestling period. When being fed berries, transfer takes longer, and is repeated 2–3 times in 2 min (Guthrie-Smith 1910). For chick at least 5 days old: adult reached down and took chick's bill in side of its own and, with convulsive movements of throat and crop, appeared to force food into chick. Fed at intervals of c. 30 s during a 5 min period. Chick did not appear to demand food (Morrison 1959). Feathered young may not be fed for 12 h during day (Guthrie-Smith 1910). Adult of one pair alternated between feeding young from first nest and incubating egg in second nest (Clout *et al.* 1988). One instance of adults evidently having fed and tended young that had fallen from nest. After lengthy disturbance, including removal of egg and lowering of nest-plant with adult still on nest, adult flew off, feigned injury, performed Broken-wing Display and fluttered off through undergrowth. Young defecate over edge of nest (Guthrie-Smith 1910).

**Fledging to maturity** FLEDGING PERIOD: 36–45 days (Clout *et al.* 1988). Laying to fledging, 70 days (Oliver); subtracting incubation period of 29 days (Oliver) gives fledging period of 41 days; between 34 and 37 days (n=1) (Genet & Guest 1976). One chick left nest at 46 days old (Wilkinson & Wilkinson 1952); chick in nest-tree c. 36 days after hatching (Clout *et al.* 1988). One chick fed by parents c. 7 days after fledging (Clout *et al.* 1988).

**Success** One pair fledged one young from three successive clutches; first nest successful, second and third clutch failed at egg-stage (Clout *et al.* 1988). At Pelorus Bridge: from 45 nests over seven seasons, 15 (33%) young hatched, 10 (22%) fledged; annual success ranged from 0 to 0.67 young per nest. Success per pair, 0.24; annual success, 0 to 0.6. Thirty nests failed at egg-stage, mostly from predation (33%) or unknown causes (50%); five nests failed at chick-stage, mostly (80%) from predation. At Mohi Bush and Wenderholm: from 29 nests over seven seasons, 2 (7%) young hatched, none fledged. Most (>79%) eggs and both chicks lost through predation. For all sites, Black Rats *Rattus rattus* responsible for most predation of eggs and chicks; Stoats also take eggs; other causes of failures: desertion or disturbance, infertile eggs, fallen eggs and death of parent. Brush-tailed Possums eat eggs; Common Mynas probably take eggs and young chicks (Clout *et al.* 1995).

**PLUMAGES** Prepared by D.J. James. Large fruit-pigeon maturing in 1 year. Moults to juvenile plumage and fledge when 40–45 days old (see Breeding). Soon after fledging, undergo complete post-juvenile moult to adult plumage. Thereafter, have slow continuous moult without distinct moulting season nor seasonal change in appearance. Age of first breeding not known. Sexes similar. Three (possibly four) subspecies or species (one or two extinct), all in HANZAB region (see Geographical Variation). Descriptions based on skins (AIM, CM, NMNZ) and photos (Moon 1979, 1992; Moon & Lockley 1982; Clout 1990; NZRD; unpubl.: NZ DOC Slide Library).

**Nominate *novaezealandiae*** **Adult** (First and subsequent basic). Metallic-green and coppery-red pigeon, with white underparts and grey outerwing; metallic plumage has coppery iridescence that varies with intensity and angle of light. All contour feathers have large but concealed dark olive-brown (129) bases and dense white down at base. **Head**

**and neck** Face (forehead, lores, ear-coverts, chin and throat), dark metallic-green (c162A); tips of feathers, paler, sometimes appearing yellowish-green in bright light. Nape and neck a mixture of dark metallic-green (c162A) and dark metallic-maroon or coppery-red (purple c31); feathers green subterminally and grading to maroon basally; appear more maroon with wear. **Upperparts** Mantle and anterior scapulars, dark metallic-maroon (purple c31) with reflective green highlights near tips of feathers. Rear scapulars, greener, finely dusted dark metallic-maroon (c31) and dark metallic-green (c146–c162A); reflective properties of tips slightly different to rest, giving almost scaly look in some light. Back and rump, dark metallic blue-green; feathers less reflective at fringes and sometimes looking faintly scaled. Sides of rump, light grey-green, slightly iridescent, and with dark-green (162A) shafts to feathers. Uppertail-coverts like rear scapulars. **Underparts** Upper breast, dark metallic-green (c162A–c160) with maroon suffusion near sides and with faint golden iridescence at fringes (which is possibly stronger when fresh); with wear, dark olive-brown (129) bases can become slightly exposed, breast then appearing duller. Lower breast, belly, vent, central undertail-coverts, flanks and thighs, white. Demarcation between upper and lower breast, sharp, rounded, and higher at sides, leaving narrow white strap between dark bend of wing and side of upper breast (shoulder strap). Lateral undertail-coverts, mid-grey (84) with fine dark metallic-green (c162A) flecking (visible in hand). Axillaries, pale grey (86). **Tail** Upperside, black-brown (119) with weak dark metallic-green (c162A) tinge, especially along edges; grades to dark-brown (121) or grey-brown (28) without green tinge at tips, forming diffuse paler band across tip; fades slightly with wear and green tinge lost. Underside of rectrices (except t6), olive-brown (c30) with broad dark-brown (219) subterminal band between middle and tip; shafts, white for basal three-quarters or so and dark brown distally. **Upperwing** Inner lesser and median secondary coverts, dark metallic-maroon (purple c31), like mantle, forming reddish shoulder-patch on innerwing in flight. Tertiaries, inner secondaries and their greater coverts, a mixture of dark metallic-maroon (c31) and green (c146–c162A), like rear scapulars, becoming increasingly blue outwards; outer secondaries and secondary coverts, metallic dark blue-green, with varying purplish-green centres. Primaries and primary coverts, dark metallic-green (c162A), with strong silvery-blue sheen in some lights; basal half of inner webs of primaries, olive-brown (c30); primaries lose metallic iridescence with wear. Alula, like primary coverts, but with some dark metallic-maroon iridescence. **Underwing** Coverts and subhumeral, pale grey (86). Remiges, dull dark olive-brown (129) to dark grey-brown (grey 129).

**Downy young** Hatch in sparse, wispy light-yellow (c157) down; much skin visible on upperparts; underparts and skin round eye, naked. During post-natal moult, long tubular light-grey sheaths develop round growing feathers, with tufts of down protruding at tips.

**Juvenile** Similar to adult when fresh, but metallic fringes to feathers narrower. Lose metallic iridescence more rapidly than adults and plumage generally already uniformly worn and dull by time of fledging, though often retain conspicuous clinging down. Specific differences from adult include: **Head and neck** Throat, dull dark-olive (c49). Nape and crown, slightly browner. **Upperparts** Rear scapulars tend to be dull dark-olive (c49) with some metallic-maroon iridescence. Rest of upperparts, generally duller. **Underparts** Upper breast slightly browner, duller and blotchy, though still metallic. **Upperwing** Narrow yellow to orange-brown tips to primaries

and greater primary coverts conspicuous in hand.

**Aberrant plumages** Prone to albinism and partial leucism; also other colour aberrations (Oliver).

**Subspecies chathamensis Adult** (First and subsequent basic). **Head and neck** Throat, crown, forehead and ear-coverts, dark metallic green and blue, grading to dark metallic green and purple on neck and with slight golden iridescence in some lights; feathers have dark metallic-green (c160) bases and dark metallic-blue or -purple tips; when fresh, have narrow metallic-green (c160) tips, which enhance green iridescence. **Upperparts** Mantle and anterior scapulars, metallic maroon-black, usually with dark metallic-green (c162A) iridescence. Rear scapulars, dark metallic-green (c162A) with dark metallic-maroon (c31) iridescence, especially round fringes. Back and rump, light grey (between 86 and 85) with silvery sheen, but no iridescence. Sides of rump, pale grey (86). **Uppertail-coverts**, dark metallic-green (c162A–262). **Underparts** Upper breast, like throat, dark metallic green and purple. Most undertail-coverts, dark grey (83) with metallic-green-black (c162) iridescence; shorter lateral coverts, white, dusted with light grey (85). Rest of underparts, white, including bold white 'shoulder-strap' between breast and bend of wing. **Tail** Upperside, purplish black grading to green-black (c162) at edges of rectrices, and with distinct metallic gloss; bases of rectrices and much of outer web of t6, brownish grey (c80). With wear, tips, dull dark olive-brown (129) as metallic gloss lost. Underside, glossy black (89), becoming black-brown (119) with wear; shafts, white on basal fifth, rest black. **Upperwing** Inner lesser secondary coverts, metallic maroon-black, like mantle. Median and outer lesser secondary coverts and lesser primary coverts, light frosty grey (c85) at bases grading to dark metallic-green and then to maroon at fringes. Secondaries, tertials, greater secondary and primary coverts, and alula, light frosty grey (c85) with scattered dark metallic-green (c162A) iridescence, especially round fringes and at tips of outer webs. Primaries, mostly mid-grey (c84) with faint green tinge, grading to dark metallic-green (c162A) at tips, and to pale frosty grey (c86) at base of outer webs. Primary coverts and remiges become much greyer with wear. **Underwing** Coverts and subhumeral, white; greater coverts sometimes have fine dusting of pale grey (86). Remiges, light grey (85) at bases grading to black-brown (119) distally.

**Downy young** Not described. Presumably similar to nominate *novaeseelandiae*.

**Juvenile** No skins examined. Differs from adult in duller, darker upperparts and buff undertail-coverts (Fleming 1939; also see Bare Parts).

#### BARE PARTS Sources as Plumages.

**Nominate novaeseelandiae Adult** Bill, red (13–108), slightly paler towards tip, and often yellow (c57–157) or orange (dull 17) on nail. Mouth, red (c13). Tongue, light pink (c7). Iris, bright red (c14). Orbital ring, red (c108A) to pink (c108C), dull pink (c5) or mauve (c77); orange with red rim, and grey with red rim (two labels). Feet, bright red (11–108A); pale edges to scutes conspicuous. Soles, usually light grey (85) to grey-brown (28); bright yellow (one label). Claws, black. Photos in Clout (1990: 15, 19) show a bird with black tips to mandibles and red-brown (c132A) irides; this might be first basic or another 'subadult' plumage. **Downy young** Bill, dull pink (c5) at tip, dark red (c8) or purple-brown towards base. Iris, dark brown. Orbital ring, dull purplish-pink. Feet, 'leaden to flesh colour' (Oliver). Iris, brown. Bill and feet, said to be grey-brown (NZRD). **Juvenile** Bill, dark brown (c12) or purplish brown, grading to orange-brown along tomlia and at tip.

Iris, dark brown (c121). Orbital ring, dull purple. Feet, dull pink (c5) to pale pink (c7). **Subspecies chathamensis Adult** Poorly known. Bill, red (c13) with pale-yellow (between 55 and 157) tip, larger and better defined than in *novaeseelandiae*. Iris, red-brown (c32–35); possibly brighter red sometimes. Orbital ring, orange-pink. Feet, dull red. **Downy young** No information. **Juvenile** Similar to adult, but bill and feet duller (Fleming 1939).

**MOULTS** Based on examination of 115 skins (AIM, CM, NMNZ), including 19 of subspecies *chathamensis*. No differences detected between nominate *novaeseelandiae* and subspecies *chathamensis*. **Adult post-breeding** (Second and subsequent pre-basic). Complete. Slow continuous moult, with frequent pauses. Number of birds actively moulting and PMS correlate weakly with time of year (more activity and higher median PMS in summer), but no distinct moulting season (see Table 1). Primaries, sequentially outwards. Usually only one primary at a time, very rarely two. Perhaps sometimes have two concurrent waves (e.g. Nov.:  $3^1N6^3O^2$ ). Occasionally skip a primary. Uncommonly pause with all primaries replaced. When resuming after pauses, begin at or near where moult previously left off, but occasionally skip a feather. Tail, centrifugal (outwards), but often slightly out of sequence; symmetrical or asymmetrical. Head and body replaced more or less continuously so never uniformly fresh nor worn. **Post-juvenile** (First pre-basic). Complete. Sequence similar to that of adults. Body fully replaced by time only inner half or so of primaries finished. Timing unknown.

**Table 1.** Primary-moult from 84 adult skins (AIM, CM, NMNZ).

% moulting = percentage of birds with at least one primary active (scores of 2–4; missing primaries not taken as definite indication of active moult).

Month	Sample	Median PMS	Range of PMS	% Moulting
Jan.	4	32	17–41	75
Feb.	3	0	0–14	33
Mar.	3	20	15–30	0
Apr.	6	29	0–39	33
May	7	15	0–44	29
June	8	0	0–38	25
July	9	0	0–35	0
Aug.	10	15	0–45	10
Sept.	8	3	0–50	13
Oct.	12	15	0–50	8
Nov.	4	17	0–39	75

**MEASUREMENTS** (1–7) Skins; Tarsus and Toe difficult to measure accurately because feathering at top of tarsus dense and scutes at joint between tarsus and toe large (AIM, CM, NMNZ).

(1–2) Nominate *novaeseelandiae*: NI, SI, and Stewart I. and outlying islands: (1) Adults; (2) Juveniles.

	MALES	FEMALES	
WING	(1) 262.8 (6.01; 252–273; 38) (2) 250	260.0 (8.27; 247–277; 44) 252.3 (2.06; 250–255; 4)	**
TAIL	(1) 193.6 (8.33; 177–209; 38) (2) 168, 172	189.3 (9.14; 172–205; 42) 190.5 (13.3; 174–204; 4)	*
BILL	(1) 17.0 (1.10; 14.6–19.1; 37) (2) 14.5	16.7 (1.14; 14.7–18.9; 42) 15.0, 16.6	ns
BILL D	(1) 7.2 (0.24; 6.7–7.7; 15) (2) 7.0	7.1 (0.34; 6.5–7.7; 22) 6.3, 7.2	ns
TARSUS	(1) 34.8 (2.47; 30.0–39.9; 33) (2) 34.3	34.0 (1.95; 30.3–39.1; 36) 30.8, 36.5	ns
TOE	(1) 36.2 (2.50; 31.9–40.8; 19) (2) 36.9	36.0 (2.04; 32.6–40.7; 19)	ns

(3) Subspecies *chathamensis*: Chatham Is, adults.

	MALES	FEMALES	
WING	(3) 275.2 (3.49; 271–281; 6)	270.2 (3.63; 268–276; 5)	*
TAIL	(3) 200.6 (3.05; 197–204; 5)	198.8 (6.34; 190–205; 4)	ns
BILL	(3) 20.6 (1.37; 19.0–22.6; 7)	20.8 (0.80; 19.7–21.5; 5)	ns
BILL D	(3) 9.4 (0.64; 8.5–10.5; 6)	9.5 (0.66; 8.4–10.2; 5)	ns
TARSUS	(3) 36.7 (1.84; 34.3–40.0; 7)	34.2 (1.30; 32.3–35.5; 5)	*
TOE	(3) 39.0, 40.0	41.2, 42.5	

(4–7) Geographical breakdown, adults, sexes combined (includes data in samples 3 and 4 and unsexed skins). (4–6) Nominate *novaeseelandiae*: (1) NI (including Little Barrier and Kapiti Is); (5) SI; (6) Stewart I. and outlying islands. (7) Subspecies *chathamensis*: Chatham Is.

	UNSEXED
WING	(4) 260.4 (8.09; 243–277; 50) (5) 260.5 (7.02; 247–272; 19) (6) 255.8 (7.26; 245–263; 5) (7) 271.4 (4.81; 262–281; 17)
TAIL	(4) 191.8 (9.45; 172–209; 47) (5) 192.7 (8.56; 176–204; 19) (6) 186.6 (8.79; 177–199; 5) (7) 198.2 (4.98; 190–205; 14)
BILL	(4) 16.8 (1.03; 14.6–18.9; 48) (5) 16.7 (1.09; 15.3–19.1; 19) (6) 17.1 (0.88; 16.1–18.1; 4) (7) 20.8 (1.03; 19.0–22.6; 18)
BILL D	(4) 7.2 (0.31; 6.7–7.7; 25) (5) 7.1 (0.37; 6.5–7.5; 5) (6) 6.8, 7.0 (7) 9.5 (0.58; 8.4–10.5; 15)
TARSUS	(4) 34.5 (2.28; 30.0–39.9; 41) (5) 35.0 (2.26; 31.5–38.5; 15) (6) 32.7 (1.77; 30.5–34.8; 5) (7) 36.0 (1.97; 32.3–40.0; 15)
TOE	(4) 35.9 (1.82; 32.6–40.7; 20) (5) 36.1 (2.46; 32.3–40.8; 13) (6) 39.5 (7) 39.4 (3.07; 34.4–42.5; 7)

Differences between ages, locations and subspecies tested with sexes combined. Nominate *novaeseelandiae* juveniles have shorter Bill than adults ( $P < 0.01$ ). No significant differences between NI, SI and Stewart I. samples (4–6). Subspecies *chathamensis* significantly larger than nominate *novaeseelandiae* in all measurements ( $P < 0.01$ , except Tarsus  $P < 0.05$ ).

**WEIGHTS** From museum labels (NMNZ): (1–2) Nominate *novaeseelandiae*: (1) Adults; (2) Juveniles. (3) Subspecies *chathamensis*: Adults.

	MALES	FEMALES
(1)	510, 567, 795	651.8 (56.5; 567–680; 4)
(2)	680	–
(3)	720	680

Nominate *novaeseelandiae*: Clout (1990) reported adult range of 550–850, apparently for this subspecies; wild bird of unknown sex increased from 560 to 595 between 28 June and 26 Oct. (Clout *et al.* 1986); said to fledge at c. 400 g (Clout 1990). Subspecies *chathamensis*, adult, unsexed: 750 (NMNZ).

**STRUCTURE** Nominate *novaeseelandiae* Wing, very broad, with rounded tip, and bulging trailing-edge to innerwing. Eleven primaries: p8 longest, p10 25–36 mm shorter, p9 2–8, p7 2–5, p6 6–12, p5 22–31, p4 37–45, p3 48–57, p2 55–65, p1 61–78; p11 minute; p9–p5 have long but slight emargination on outer webs. Thirteen secondaries, including three tertials. Tail, long, shallowly forked; 12 rectrices; t6 longest, t1 9–23 mm shorter. Bill, short and stubby, with bulbous tip to both mandibles; strong hook at tip of upper mandible; prominent ridge along basal three-quarters of lower mandible just below tomiom. Nostril in deep groove at base of upper mandible, partly covered dorsally by elongated scaly operculum. Tarsus, mostly densely feathered, with three heavy scutes visible at bottom. All toes strong; heavy scutellate scales dorsally and small reticulate scales on soles. Outer toe 67–81% of middle, inner 64–74%, hind 48–61%. Claws, long, strong, laterally compressed, sharp, strongly curved. **Subspecies *chathamensis*** Differs by: (1) Slightly different wing-formula: p7 longest, p8 equal or up to 2 mm shorter, p1, 72–81; and (2) bill considerably heavier and stronger with more bulbous tip.

**GEOGRAPHICAL VARIATION** No previous reviews. Three isolated forms, two of which extant (*novaeseelandiae*, NZ; and *chathamensis*, Chatham Is) and one extinct (*spadicea*, Norfolk I.). (A pigeon, possibly of this genus, once inhabited Kermadec Is, but see below.) These probably all distinct, and do not and did not interbreed. Once treated as separate species (Rothschild 1891; Salvadori 1893; Mathews; Oliver) but more recently treated as subspecies (Turbott 1967; Falla *et al.* 1978; Peters; Goodwin; NZRD; NZCL). No detailed arguments have been presented for either treatment. All three, *novaeseelandiae*, *chathamensis* and *spadicea*, best treated as separate species (rather than subspecies). Combination of allopatric distributions, differences in ecology and many differences in morphology clearly indicate that *chathamensis* and *novaeseelandiae* are different species. Introductions of extant taxa to Norfolk I. (former range of *spadicea*) and Kermadec Is, as mooted by Clout (1990), thus problematical and should not proceed.

**NOMINATE NOVAESEELANDIAE:** No variation in size detected throughout range (see Measurements). One adult skin from s. Westland (CM) had blue-grey tinge to rump and slight greyish tinge to primaries and greater primary coverts; in these it recalled subspecies *chathamensis*. No other geographical variation known.

**SUBSPECIES CHATHAMENSIS:** No geographical variation within population. Differences from nominate *novaeseelandiae*: (1) Larger; most measurements 3–5% greater; bill much heavier than in *novaeseelandiae*, c. 23% longer (see Measurements); (2) Rump, grey (not blue-green); (3) Breast, darker with considerably more purple iridescence; (4) Undertail-coverts, dark; (5) Tail predominantly blue and purple (not green) and more iridescent; (6) Narrower brown tip to tail; (7) Primary coverts much greyer; (8) Bases to remiges, pale grey; (9) Wing-lining mostly white; (10) Wing-formula (see Structure). Other lesser differences also exist.

**SUBSPECIES SPADICEA:** Extinct. No specimens examined. Poorly known. Following based on Salvadori (1893) and Mathews. Said to resemble *chathamensis* more than *novaeseelandiae*. Shares with *chathamensis*: (1) Much grey on outerwing; (2) Greyish rump; and (3) Purplish-black tail. Differs from *chathamensis* and *novaeseelandiae* by: distinctive chestnut mantle, clearly demarcated from coppery-green hindneck; and unique combination of white undertail-coverts and underwing-coverts. Similar in size to *novaeseelandiae*. Considering biogeography, most parsimonious to treat as separate species.

KERMADEC IS: A pigeon, sometimes thought to be *Hemiphaga*, formerly existed on Raoul I. (Clout 1990; Oliver), but was extinct by about mid-nineteenth century. No specimens were collected and the only information on the bird are mentions in the journal of a whaling captain, and second-hand reporting by Cheeseman (1888). No data on taxonomy.

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New Zealand Pigeon *Hemiphaga novaeseelandiae* (page 1016)  
Nominate *novaeseelandiae* 1, 2 Adult; 3 Juvenile; 4, 5 Adult  
Subspecies *chathamensis* 6, 7 Adult