Order CHARADRIIFORMES

A large, diverse assemblage of small to medium-large (12–75 cm long) limicoline, pratincoline, aquatic or terrestrial birds. Cosmopolitan from Arctic to Antarctic regions; in all sorts of maritime, freshwater and open terrestrial habitats (including deserts) with a few (woodcocks and snipes) even using dense forests. Once known as Limicolae or Laro-limicolae (e.g. Mayr & Amadon 1951); colloquially, the assemblage (excluding alcids, skuas, gulls, terns and skimmers) is often referred to as waders (especially in Britain) or shorebirds (especially in North America).

About 350 species in 19 families, though taxonomic treatments vary. Following families recognized (mostly based on recent reviews of Order [Sibley *et al.* 1988; Sibley & Ahlquist 1990; Sibley & Monroe 1990]):

Thinocoridae	seedsnipes; four species, S. America.
Pedionomidae	Plains-wanderer; monotypic, Aust.
Scolopacidae	sandpipers, snipes and allies; *c.* 85 species, cosmopolitan.
Rostratulidae	painted snipes; two species, s. America and Old World.
Jacanidae	jacanas; seven species, pantropical.
Chionididae	sheathbills; two species, Antarctica and subantarctic islands.
Burhinidae	thick-knees, stone-curlews; nine species, widespread in Old World and two in Neotropics.
Haematopodidae	oystercatchers; *c.* 11 species, worldwide in tropics and temperate regions.
Recurvirostridae	avocets and stilts; about seven species, worldwide in tropical and temperate regions.
Ibidiorhynchidae	Ibisbill; monotypic, central Asia.
Charadriidae	plovers and lapwings; *c.* 60 species, cosmopolitan.
Pluvianellidae	Magellanic Plover; monotypic, S. America.
Dromadidae	Crab Plover; monotypic, Arabian region.
Glareolidae	pratincoles, coursers, and Egyptian Plover; *c.* 15 species, widespread in Old World.
Stercorariidae	skuas and jaegers; about seven species, mostly in Arctic and Antarctic regions.
Rhynchopidae	skimmers; three species, pantropical.
Laridae	gulls; *c.* 47 species, cosmopolitan.
Sternidae	terns; *c.* 42 species, cosmopolitan.
Alcidae	auks; *c.* 20 species, Arctic and temperate regions of n. hemisphere.

Apparently monophyletic. Pteroclididae (sandgrouse) probably sister-group of Charadriiformes (e.g. Fjeldså 1976, 1977; Sibley & Ahlquist 1990; BWP), though whether best placed within Charadriiformes or in separate order is debated. Flamingoes (Phoenicopteridae) and divers (Gaviidae) have also been treated as Charadriiformes (Olson & Feduccia 1981; Fjeldså 1976, 1977) but DNA–DNA hybridization studies (Sibley & Ahlquist 1990) inconsistent with these theories. Affinities to other orders still controversial; DNA–DNA hybridization has suggested closest links are to large waterbirds, such as storks, herons and allies, Pelicaniformes, Procellariformes, penguins, grebes, divers (Gaviidae) and also Falconiformes. All these were combined in huge order Ciconiiformes by Sibley & Ahlquist (1990).

Taxonomy and relationships reviewed in Sibley & Ahlquist (1990), Christian *et al.* (1992) and BWP (and references therein). Recent reviews have included: patterning of downy young (Jehl 1968; Fjeldså 1976, 1977), osteology (Strauch 1978; Mickevitch & Parenti 1980; Olson & Steadman 1981), DNA–DNA hybridization (Sibley *et al.* 1988, Sibley & Ahlquist 1990) and electrophoresis of tissue proteins (Christian *et al.* 1992). The studies of allozymes, DNA–DNA hybridization and the most recent osteological study of the entire order (Strauch 1978) have agreed in finding two or three well-knit, monophyletic assemblages within the Charadriiformes: scolopacids and allies (Thinocoridae, Pedionomidae, Scolopacidae, Rostratulidae, Jacanidae) and charadrids and allies (Chionididae, Burhinidae, Haematopodidae, Recurvirostridae, Ibidorhyncidae, Charadriidae, Pluvianellidae, Dromadidae, Glareolidae, Stercorcariidae, Rhynchopidae, Laridae, Sternidae, Alcidae); Strauch (1978) treated Alcidae as separate lineage, but skeletons may be so highly modified for foot-propelled diving that they do not reflect relations well (Sibley & Ahlquist 1990); gulls and allies have also been regarded as a separate lineage (Christian *et al.* 1992) or as allied to charadrids (e.g. Sibley & Ahlquist 1990). Further relationships within the Order discussed in introductions to families.

Because the Order comprises so many species and adaptations are so diverse, few characters shared by all species; those that are shared are mostly anatomical features of the skull, e.g. most or all have schizorhinal nostrils, schizognathous palates, well-developed vomer, lachrymals fused with ectethemoid and pre-frontal bones, well-developed supra-orbital grooves; see Olson & Steadman (1981) for more information on osteological characters. Wings usually have 11 primaries, with p10 longest and p11 minute; 15–24 secondaries; diastataxic except in *Scolopax minor*, as far as is known. Usually 12 tail-feathers. Necks usually rather long with 15–16 cervical vertebrae. Oil-gland bilobed and tufted. Syrinx, tracheo-bronchial; two carotids (type A-1 of Glenny 1955); caeca present. Legs usually rather long; hind toe small or lacking in most but all toes greatly elongated in Jacanidae. Feathers with small thin afterfeathers. Normally two moults annually: complete post-

breeding and partial pre-breeding; some jacanas and alcids have flightless periods when moulting remiges. Young, downy, usually with intricate cryptic patterns on upperparts of three chief types: pebbly, spotted and striped, matching characters of habitat (Fjeldså 1976, 1977): precocial, nidifugous usually, self-feeding or not depending greatly on parents.

Thirteen families recorded in HANZAB region, with 54 species breeding, 41 occurring as regular non-breeding migrants and c. 38 as accidentals or probable accidentals. Scolopacidae, Stercorcariidae, Laridae and Sternidae will be dealt with in Volume 3 of HANZAB.

REFERENCES

Christian, P.D., *et al.* 1992. *Aust. J. Zool.* 40: 291–302.

Fjeldså, J. 1976. *Vidensk. Medd. dansk. Natur. Foren.* 139: 179–243.

— 1977. *Guide to the Young of European Precocial Birds.* Scarv Nature Productions, Tisvildeleje.

Glenny, F.H. 1955. *Proc. US natn. Mus.* 103 (3346): 525–621.

Jehl, J.L., Jr. 1968. *Mem. San Diego Soc. nat. Hist.* 3.

Mayr, E., & D. Amadon. 1951. *Am. Mus. Novit.* 1496.

Mickevich, M.F., & L.R. Parenti. 1980. *Syst. Zool.* 29: 108–113.

Olson, S.L., & A. Feduccia. 1981. *Smithson. Contrib. Zool.* 323: 1–24.

—, & D.W. Steadman. 1981. *Smithson. Contrib. Zool.* 337: 1–25.

Sibley, C.G., & J.E. Ahlquist. 1990. *Phylogeny and Classification of Birds of the World.* Yale Univ. Press, New Haven.

—, & B.L. Monroe. 1990. *Distribution and Taxonomy of the Birds of the World.* Yale Univ. Press; New Haven.

—, *et al.* 1988. *Auk* 105: 409–423.

Strauch, J.G., Jr. 1978. *Trans. zool. Soc. Lond.* 34: 263–345.

Family **CHARADRIIDAE** plovers and lapwings

Small to medium-sized, mostly terrestrial, waders of open habitats. About 65 species, placed in varying number of genera. Evidently monophyletic by behaviour and structural characters. Distributed worldwide and separable into two distinct sub-families: Charadriinae (plovers) and Vanellinae (lapwings), both of which are represented in HANZAB region and are discussed in more detail below. Most closely related to Recurvirostridae, Haematopodidae and possibly Burhinidae (Sibley & Ahlquist 1990; Christian *et al.* 1992).

Bodies, compact. Size differences between sexes negligible; sometimes males and sometimes females slightly larger. Necks, short and thick; 15 cervical vertebrae. Wings, long and usually pointed but rounded in some lapwings; 11 primaries, p11 minute; 14–19 secondaries. Tails, short to medium-long, square or rounded; 12 feathers. Bill, short, somewhat swollen at tip and narrower centrally; no sensitive nerve-endings at tip and prey located by sight rather than touch. Nostrils, holorhinal, impervious, slit-like. Head, rounded; forehead steep and broad. Legs, fairly short or medium in length; bare part of tibia short; tarsi, reticulated, rarely with some transverse scutes. Usually three, rather short toes, slightly webbed at base in some plovers; no hind toe in most plovers and in some lapwings; hallux, short and vestigial if retained. No crop. Caeca present. Eyes large. Supraorbital salt-glands, often large; size related to salinity of habitat and influences structure of skull and appearance of head. Plane of *foramen magnum* of occiput nearly horizontal.

Plumages generally boldly patterned in brown, olive-grey, black and white; markings often have cryptic disruptive effect. Bill, bicoloured in some species, especially plovers. Stance erect with head held high. Fast runners for good distances but often proceed in short bursts with halts, especially when feeding. Post-breeding moult complete; primaries outwards; pre-breeding moult varies considerably. Young, precocial, nidifugous and always feed themselves; down of pebbly-pattern type (Fjeldså 1977).

See accounts of sub-families (below) for additional details.

REFERENCES

Christian, P.D., *et al.* 1992. *Aust. J. Zool.* 40: 291–302.

Fjeldså, J. 1977. *Guide to the Young of European Precocial Birds.* Skarv Nature Publs, Strandgården, Tisvildeleje.

Sibley, C.G, & J.E. Ahlquist. 1990. *Phylogeny and Classification of Birds.* Yale Univ. Press, New Haven.

Sub-family **VANELLINAE lapwings**

Mostly medium-sized terrestrial waders, generally larger than Charadriinae. Widespread in Old World and South America; centre of diversity in Africa. Three breeding species in HANZAB region; one accidental. Classifications have used carpal spurs, facial wattles, orbital skin, presence or absence of hind toe, and tarsal scutellation to divide the group into many genera. Peters recognized 24 species in 19 genera, 14 being monotypic; at the other extreme, Bock (1958) placed all in single genus *Vanellus*. Neither arrangement is satisfactory but until further studies are done, *miles* and *tricolor* should be treated as *Vanellus*. Red-kneed Dotterel *Erythrogonys cinctus* differs considerably from plovers (Charadriinae) and is placed in Vanellinae on basis of allozymes, patterning of wings, and retention of hind toe (Christian *et al.* 1992).

Plumage varies greatly but in many species tends to be dull brown above and with black, white or grey markings on head and breast; all have black primaries, often with broad diagonal white stripe across wing; all except *Chettusia leucurus* have black band on white tail. In flight, patterns of plumage striking. Most species characterized by horny lump or spur at carpal joint; also by red, yellow, greenish, pink or white facial wattles or orbital skin; a few species crested. Wings, broad and rather rounded at tip; flight more buoyant than that of plovers. Gait on land much the same as in Charadriinae. Adult post-breeding moult, complete; primaries outward. Pre-breeding moult restricted or absent. Young hatch in down of pebbled pattern. Juveniles duller than adult. Adult plumage attained in first year. Those few species studied first breed at 1–2 years old.

Breed in open habitats such as marshes, grassy steppes, agricultural lands and the like; after breeding most move away and congregate on estuaries and more coastal areas. May be migratory or partially so but many seem to have only local movements. Food usually and mostly invertebrates, caught by run-stop-grab method; when feeding, birds tend to be scattered rather than in flocks, unlike scolopacids.

Often breed in solitary pairs or at best in loose groups; outside breeding season, gregarious or with a tendency to form flocks. Territorial when breeding; may also hold winter territories. Pair-bond, monogamous. Aggressive displays in defence of territories. Courtship displays on ground or in air, with special song-flights. Voice rather hoarse and grating, far-carrying and conspicuous; song associated with swooping flights, though rasping, has melodious quality. Strongly aggressive towards predators and intruders when breeding; adjacent pairs apparently co-operate in such defence.

Breed seasonally. Nests on open ground; simple scrapes, sparsely lined with material available near nest. Eggs, oval to pyriform; smooth, not glossy; buff, yellowish or green ground-colour, heavily marked and blotched dark. Clutch-size, usually 3–4; replacements after loss. Incubation by both sexes. In hot weather adults may dampen eggs with water brought in belly-feathers. Incubation period, 24–26 days. Young hatched in down, precocial, nidifugous, self-feeding as soon as leaving the nest. Fledging period, 35–50 days.

REFERENCES

Bock, W.J. 1958. *Bull. Mus. Comp. Zool., Harv.* 118: 27–97.
Christian, P.D., *et al.* 1992. *Aust. J. Zool.* 40: 225–33.

Vanellus miles **Masked Lapwing**

COLOUR PLATE FACING PAGE 873

Tringa miles Boddaert, 1783, *Table Pl. enlum.*: 51, based on *Vanellus Ludovicianus armatus* Brisson, *Ornithologia*: 115 — Louisiana in error; Australia, Hartert, 1905, *Nov. Zool.* 12: 200.

Miles is Latin for a soldier, and refers to the carpal spurs which give an armed appearance.

OTHER ENGLISH NAMES Spur-wing, Spur-winged, Australian Spur-winged, Wattled and Masked Plover, Wattled Sandpiper, Alarmbird.

For this species, **Masked** is traditional for the nominate subspecies and is the evident choice; **spur-winged** has been long and widely used for an extralimital species, *V. (Hoplopterus) spinosus*; Australian Spur-winged is unnecessarily cumbersome.

POLYTYPIC Nominate *miles*, Moluccas, s. New Guinea and tropical n. Aust.; *novaehollandiae* (Stephens, 1819), e. and s. Aust., Tas.

FIELD IDENTIFICATION Length: 30–37 cm; wingspan: 75–85 cm; weight: 230–400 g. Large conspicuous and familiar lapwing with loud penetrating calls; noticeably larger than Banded Lapwing *Vanellus tricolor*, with broader, more rounded wings, shorter tail and longer legs. Sexes alike. No seasonal differences. Juvenile and immatures separable. Subspecies linked by broad zone of intermediates.

Description Adult Crown and nape, black, separated from mantle by white collar (subspecies *miles*), or continuing through centre of hindneck to join narrow black collar extending round lower hindneck and onto sides of breast (subspecies *novaehollandiae*); rest of feathered parts of head and neck, white. Mantle, back, scapulars, tertials, inner wing-coverts and alula, uniform pale grey-brown, with pale silvery-grey wing-bar along greater secondary coverts; outerwing and secondaries, black. Rump, longest upper tail-coverts and base of tail, white; rest of tail, mostly black with thin white tip. Underparts, mostly white, with black remiges and tail-band. Bill, yellow, paler at tip (sometimes greenish), with ridge of upper nail dusky. Wattles, bright yellow; in subspecies *miles*, large, covering whole forehead and sides of forecrown and reaching well behind eye, with long triangular lappets hanging down beside chin; in *novaehollandiae*, smaller, covering only forehead and reaching only to eye; lappets distinctly shorter. Iris, yellow. Orbital ring, bright yellow. Legs and feet, dull red, grey on front of tarsi in some; feet extend beyond tip of tail in flight. Wing-spur, long and sharp; yellow, with blackish tip in *novaehollandiae*; often concealed by feathers of breast. **Juvenile** As adult except: crown and nape, blackish brown, with buffish tips when fresh; mantle, scapulars, tertials and wing-coverts have dark-brown subterminal bands and are narrowly tipped buff; rectrices tipped buff; bill, duller yellow with dusky tip; wattles duller and initially small, but grow rapidly; wing-spur usually shorter and blunt; legs and feet, dark grey. **Immature** After post-juvenile moult, very similar to adult except some retain a few juvenile inner wing-coverts.

Similar species None, though sometimes confused with **Banded Lapwing**, which readily distinguished by clear white rear eye-stripe and blackish U-shaped breast-band; in flight, by bold diagonal white wing-bar on upperwing and often faster, more clipped wing-beats; Alarm Call similar in character but faster and slightly less raucous.

In pairs or family groups or, in non-breeding season, small parties or larger flocks occasionally numbering hundreds; in wide range of open habitats with low vegetation, from moist grasslands, pasture, and playing fields to margins of wetlands; a common and familiar bird on almost any grassy habitat in urban areas, even feeding on grassy areas close to busy traffic. Gait a slow stalking walk with shoulders hunched and head forward, followed by sudden dip to catch prey; often use foot-tapping when feeding on grass. Wary and alert, with upright stance when alarmed, accompanied by loud calling; aggressive in defence of chicks, repeatedly dive-bombing and screaming loudly at intruder. Normal flight slow, with quick clipped wing-beats below horizontal on broad, rounded, strongly bowed wings. Very noisy, often calling at night; main contact and alarm call loud grating staccato cry; also single piercing kek or more slurred repeated creak, often on descending scale.

HABITAT Wide range of natural and modified open habitats, usually near water. Prefer short-grassed areas; often at margins of shallow, fresh or saline terrestrial wetlands, including permanent or temporary swamps, marshes, billabongs, lakes, reservoirs, farm dams, receding floodwaters, saltmarshes with unvegetated ponds, waterholes, lagoons, waterlogged paddocks, bore drains, river-flats and occasionally river beds (Favaloro 1944; Hobbs 1961; van Tets *et al.* 1967; Storr 1980). Occur widely in modified and artificial habitats such as farmland, pasture, grasslands, playing fields, lawns, golf courses, roadside nature-strips and median strips, and parks, airfields, crops, stubble, fallow and freshly ploughed paddocks, sewage farms and saltworks; often in built-up urban areas (Smith 1966; Davies 1967; Thomas 1969; Barlow 1972; Barlow *et al.* 1972; Longmore 1978; Pierce 1980; Storr 1984). Also in sheltered coastal areas, such as intertidal mudflats, estuaries, river deltas, coastal lagoons, sheltered embayments and muddy, sandy or rocky beaches; occasionally on exposed wave-cut rock platforms (Thomas 1968, 1969; Barlow 1972; Patterson 1982; Park 1983; Pegler 1983; Schulz & Menkhorst 1984; Bransbury 1985; Powlesland & Robertson 1987; Morris *et al.* 1990; Schulz 1990). Round glacial lakes and streams, fens, bogs, short tussock grassland, river beds and swampy river-flats in high altitudes between *c.* 600 m and 1160 m asl (Longmore 1973; Child 1975; Lavers 1980). Inhabit arid plains so long as water available nearby (Hobbs 1961; Gibson 1986). May inhabit disturbed areas such as gravel pits and mine tailings, or beside roads or railway lines, round wharves and docks (Davies 1967; Harris 1980; Hoskin 1991; Favaloro 1944; Quinn 1962; McEvey 1965; Barlow 1972;

Barlow *et al.* 1972). Generally avoid uncleared timbered areas and mallee scrubs (Morris 1975; Vic. Atlas), but may occur in open forest in high country (Emison & Porter 1978), in heathland (McFarland 1988), woodlands, especially swampy or savanna (McEvey 1965; Thomas 1969; Bravery 1970; Gell 1977; Longmore 1978), or orchards (Fielding 1979).

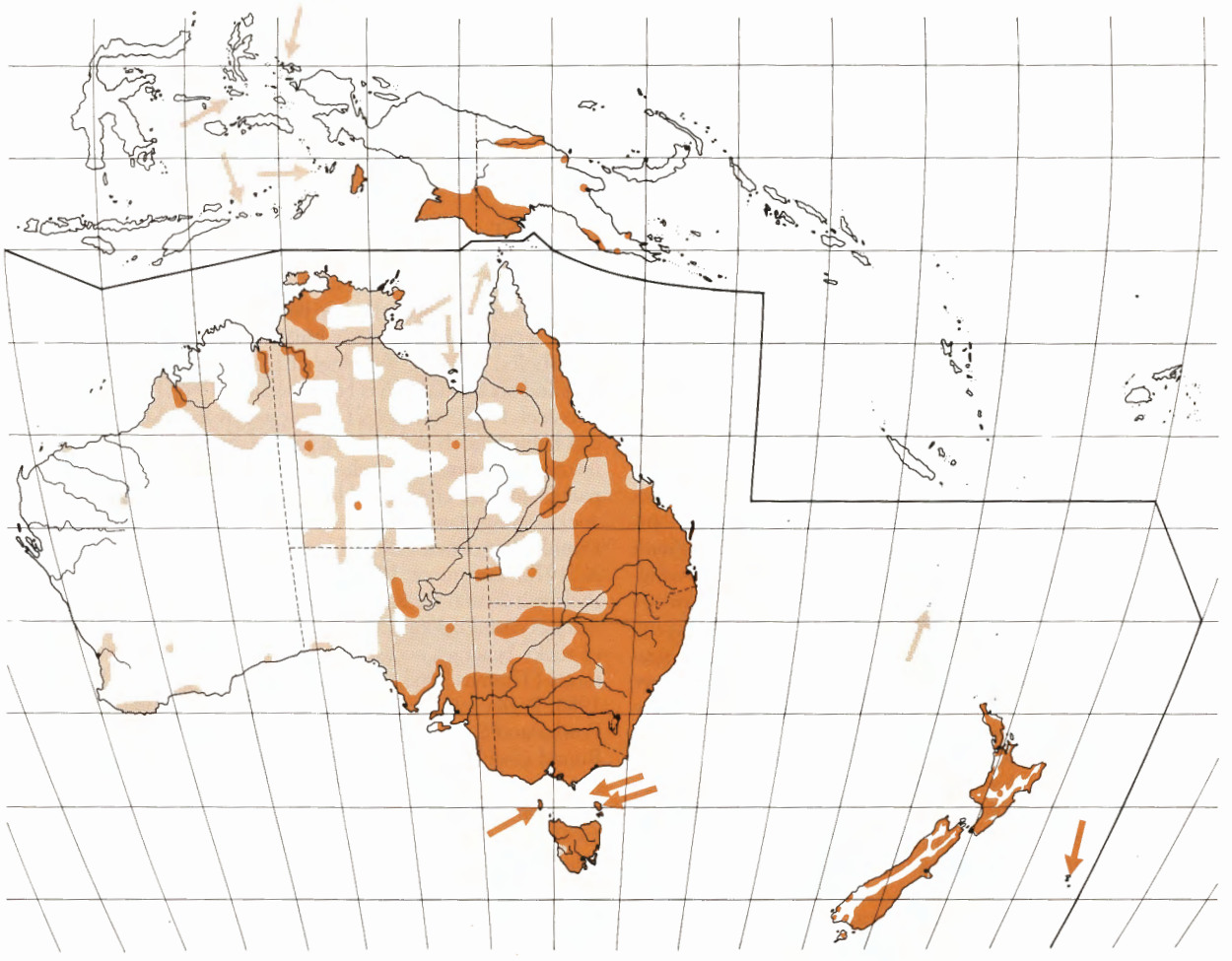
Nest on ground in short (<12 cm) grass or bare, stony or sealed ground, often near water; in NZ, >66% of all nests within 45 m of water (Barlow *et al.* 1972). Of 255 nests in Tas., 57% in improved grazed pasture, 14% in ploughed land and tillage; 11% on margins of lagoons, swamps and samphire flats; 7% on regularly mown airfields; 3% in ungrazed improved pasture ≥10 cm tall; 2% in native pasture; 2% in savanna woodland with short grass understorey; 1% in stubble; 0.4% in ploughed orchards; 0.4% on road verges with short grass; 0.4% on beaches (Thomas 1969). In Southland, NZ, of 308 nests, 42% were in rough pasture; 25% in good pasture, 14% in old crops; 10% in rough cultivated land; 4% in old grain stubble; 2% in young grain crops; 1.6% in gravel pits; 0.65% on reclaimed land (Barlow *et al.* 1972). Although nest in short grass, may be near scattered rushes, sedges, dead thistles or tufts of pasture (Barlow 1972; Barlow *et al.* 1972).

Forage and roost on ground, in short grass, bare areas of gravel or mud, or sparsely grassed areas (Loyn 1978; Park 1983; Pegler 1983; Wood 1985).

Has benefited from clearing of woodlands, conversion to pasture, irrigation schemes and construction of farm dams and reservoirs (van Tets *et al.* 1967; Thomas 1969). Make much use of artificially grassed areas (as above).

DISTRIBUTION AND POPULATION Probably regular visitor to Molluccas and Lesser Sunda Is; widespread in s. New Guinea from Frederik Hendrik I., Merauke and Trans-Fly region, E to Port Moresby; also in a few areas in the N; vagrant to Solomon Is; widespread through n. and e. Aust.; recently colonized Lord Howe I.; vagrant to Norfolk and Christmas (Ind.) Is; scattered in NI of NZ, and widespread in SI (Coates 1985; Beehler *et al.* 1986; White & Bruce 1986; Blaber 1990).

Aust. Qld Widespread. Mostly in E, E of line from near Mungindi, NSW, to about Karumba; W of this line, still widespread, but more scattered and sporadic (Aust. Atlas). **NSW, Vic., Tas.** Widespread in all regions. **SA** Widespread E of line from about Streaky Bay to Carpamoonganna Waterhole. Rarely recorded in W: near Ernabella; NW Reserve: just E of Eucla; near Nullarbor HS (Reilly *et al.* 1975; Serventy & Whittell 1976; Close & Jaensch 1984; Aust. Atlas). **WA** Vagrant S of 30°S; recorded round Eyre, Apr. 1986; several scattered records in SW, from Esperance, W to Bunbury, and N to Moora; also recorded at Boulder (Serventy & Butler 1956; Lindgren 1958; Ford 1960; Gray 1967; Serventy & Whittell 1976; Anon. 1983, 1986; White 1983; Jaensch 1986; Storr 1987; Vervest & Jaensch 1987; Storr & Johnstone 1988; Vervest 1988; Aust. Atlas). A few scattered records in Pilbara Div. Widespread in Kimberley Division, N of



20°S, from about Anna Plains to NT border, and S to L. Gregory (Storr 1980; Johnstone *et al.* 1981; Johnstone 1983; Jaensch & Vervest 1990; Aumann 1991; Aust. Atlas). **NT** Widespread throughout Top End, to Gulf Country; farther S, scattered records on Barkly Tableland, Tanami Desert, S to Alice Springs and to ranges SW of there. Few transient birds occasionally recorded in Simpson Desert (Carruthers 1966; Parker 1969; Crawford 1972; Roberts 1981; Gibson 1986; Gibson & Cole 1988; Thompson & Goodfellow in prep.; Aust. Atlas).

NZ NI Widely and often recorded throughout (M.L. Barlow); abundant N to Taranaki and Hawke's Bay, and recorded as far N as North Cape (NZCL). **SI** Abundant, especially SE of Southern Alps, from Southland, through Otago to s. and central Canterbury; also W of Southern Alps in West Coast. More scattered in N of SI, including n. Westland, Nelson and Marlborough. Few records from Fiordland (NZ Atlas; M.L. Barlow).

Norfolk I. Vagrant. Singles: Feb. 1980, Nov. 1980 (Moore 1981; Hermes *et al.* 1986).

Lord Howe I. Recent colonist. First recorded 1938 (Hutton 1990). Subsequently five, before 1941 (Hindwood & Cunningham 1950); 2–3, Aug.–Sept. 1985 (NSW Bird Rep. 1985); single, Nov. 1986 (NSW Bird Rep. 1986); five, Dec. 1988 to Oct. 1990; breeding recorded Dec. 1990 (Hutton 1990).

Christmas I. (Ind.) Vagrant. Single, before 1966 (Pearson 1966); two, Sept.–Oct. 1982 (Stokes 1988).

Chatham Is Rapid expansion since Jan. 1981 when pair with juvenile recorded; by July 1986, 19 birds. Recorded on associated islands since 1987, and common on main island by 1988 (CSN 30, 37).

Campbell I. Two (specimens), 5 June 1945 (Bailey & Sorensen 1962).

Breeding Widespread in e. Qld., e. and s. NSW, throughout Vic. and Tas., and S of 33°S in SA; more sparsely in n., central and w. NSW, n. and ne. SA, Kimberley Division, and Top End. Few records in w. and central Qld (Aust. NRS; Aust. Atlas). In NZ, breed throughout range (M.L. Barlow). Recorded on Lord Howe I. (Hutton 1990).

Range has gradually expanded. **Aust.** In Tas., rare till 1880s, gradually increasing after drought on mainland in 1888 (Legge 1901; Littler 1910); now very common (Thomas 1969). In central Aust., regarded as scarce visitor round Alice Springs before 1970s; recorded throughout district 1977–81 (Aust. Atlas). First recorded in s. WA in 1956 (Serventy & Butler 1956); at least seven records 1986–88 (Anon. 1986; Jaensch 1986; Storr 1987; Vervest 1988). **NZ** Self-introduced. Accidental between 1886 and 1932; breeding since 1932 when colonization began in Southland, and extended N with irregular supplementation by immigrants from Aust. Expansion still in progress. Colonization assisted by modification of habitat after *c.* 1860. Recorded twice in nineteenth century: single (specimen), Kai-iwi, 1886; single, Hokitika, 1892 (Oliver). Colonization began in *c.* 1932 on SI in coastal Southland when breeding pair recorded at Invercargill (Barlow 1972). By 1934, five birds present; by 1946, 30–50 birds within 10 km radius; by 1951, *c.* 100 birds, with breeding range expanded to 16 km radius; *c.* 1240 breeding birds in 1971 within same area, excluding Invercargill city and estuary segment (Barlow 1972). Breeding distribution expanded inland to n. Southland and near L. Wanaka, Otago, by 1955, but still rare outside Southland by 1966 (Falla *et al.* 1966). First recorded Stewart I. in 1967 (Barlow 1972); established by 1975, after which associated islands also colonized (CSN). Colonization of SI proceeded rapidly, following waterways and wetlands, but also in drier areas of central Otago, e.g. L. Wanaka: 1964, 60 birds; 1965, 96 birds; 1976, 538+ birds; 1982, 721 (Barlow 1972; CSN 23, 31), and Canterbury, e.g. L. Wainono: 1968, six birds; 1969, four; 1970, 2–8, with breeding suspected; 1977, flocks of over 100 regularly recorded; Aug. 1977, 153; Sept. 1988, 169 (Barlow 1972; Pierce 1980; CSN). Increase in number and range in Nelson, Marlborough and Westland mainly between 1977 and 1987 (CSN 31, 34, 35, 38; M.L. Barlow). First colonized NI in 1967 (though accidentals recorded earlier), when 2–3 birds recorded at L. Horowhenua and Hokio Beach, Manawatu (Barlow 1972). First NI breeding recorded from Tapuwaeroa R. near Gisborne in 1970 (CSN 29). Reported from Waiapu R., Gisborne, inland near Dannevirke and, in 1974, from six sites on coast W of Wellington (CSN 20, 22). By 1978, recorded at widely separated sites in most regions (CSN 25, 26); numbers increased by 1980, becoming common in Manawatu and spreading inland (CSN 28). Firmly established throughout by 1985, and by 1991, widespread throughout NI, with rapid increases recorded in S. Auckland, Waikato, Bay of Plenty, n. Taranaki and Hawke's Bay (CSN 35, 37; M.L. Barlow).

Anomalies In mid- to late 1950s, first records of subspecies *novaehollandiae* in sw. WA coincided with influx of the subspecies into n. Qld (Cooper 1966); both subspecies *miles* and *novaehollandiae* appeared in sw. WA almost simultaneously, from n. WA and se. Aust. respectively, after very wet seasons (Ford 1960).

Population Because often occurs away from wetlands, not possible to estimate populations from twice-yearly counts in Aust. and NZ, therefore data from these surveys omitted. Total population estimated 287,000 of which Aust. population *c.* 258,000 (D. Watkins). However, counts obtained in Aust. totalled tens of thousands of birds (Lane 1987). On Lord Howe I., recently colonized, the population was ≥7 birds in Dec. 1990 (Hutton 1990). Populations have increased in size and range because habitats modified (van Tets *et al.* 1967; Napier 1969; Thomas 1969; Dann 1981).

Nests and eggs trampled by stock (Thomas 1969; Dann 1981); sometimes run over by mowers (Wheeler 1967). Birds often struck by motor vehicles (Thomas 1969; Vestjens 1973; M. Rice) or aircraft (van Tets *et al.* 1977; Hermes *et al.* 1986). Nesting birds taken or disturbed by rats, feral cats and foxes (Quinn 1962; Thomas 1969). Road-works can cause desertion of nest (Thomas 1969). In nw. Qld, shot for food in absence of waterfowl (Liddy 1960). In NZ, proposals to make species a gamebird in 1980 and 1981 rejected through lack of national support and because it is not a characteristic game-bird (M. Rodway; R.R. Sutton). In NZ, the most serious avian hazard to aircraft, especially jets. Number of incidents (strikes or near misses) increasing as colonization proceeds: 1988, 81 incidents; 1991, 182 incidents. Accidents involving Lapwings, as percentage of total number of accidents: 1988, 8%; 1989, 11%; 1990, 14%; 1991, 22%. About 45% of incidents involving Lapwings are strikes: birds congregate on runways and are less manoeuvrable in flight than gulls. Controls include destruction of nests on airfields; shooting birds on airfields; vehicular bird-scanning patrols on runways before aircraft movement; maintaining unsuitable habitat (long grass) round airfields. Invertebrate controls effective (T. Caithness). Early nesters, presaging new life, raise spirits of some people, especially in the long dark winters of s. NZ (M.L. Barlow).

MOVEMENTS Resident. Banding studies suggest adults remain in general area from year to year (Allen 1967; Thomas 1969; Barlow 1972); no large-scale seasonal trends in reporting rates apparent in Aust. (Aust. Atlas; Vic. Atlas) *contra* unsupported claims that species migratory (e.g. Legge 1901). Apparently move in response to availability of wetlands, using temporary and

recently constructed artificial wetlands, then leaving when wetlands dry or supply of food diminished; also recorded using flooded regions and leaving drought-stricken areas (Favaloro 1944; Hindwood & Cunningham 1950; Wheeler 1955; Liddy 1960; Johnstone 1983), e.g. in n. Aust., birds gather round available wetlands in dry season, dispersing after rain when other wetlands form (Thomson 1935; Crawford 1972; van Tets & Vestjens 1973; Campbell). Fluctuations in availability of wetlands may explain seasonal trends in numbers, e.g. regular counts in Aust. suggest birds may retreat to coastal areas in autumn after drying of inland wetlands in summer, with extent of movement depending on rainfall (Alcorn 1990). May move far, e.g. to Christmas I., Norfolk I., Lord Howe I., Solomon Is, from Aust. to NZ (Hindwood & Cunningham 1950; Barlow 1983; Hermes *et al.* 1986; Stokes 1988; Blaber 1990; Aust. Atlas). Possibly move across Torres Str., as intermediates and pure *novaehollandiae* recorded in PNG, and present on many islands of Torres Str. but not recorded breeding, and two seen to move from N to land on Booby I. (Warham 1962; Bell 1966; Draffan *et al.* 1983; Coates 1985).

In second or subsequent years, fledged young in NZ: (1) remained and bred near natal area (14 of 70 banded); (2) moved to nearby area and bred (4/70 found 3.2–4.8 km from natal area); or (3) left area (44/70) (Barlow 1972). During daylight, sometimes seen flying high and in direct line; singly, in twos, threes or fours; fly at night, as calls heard overhead; nocturnal movement also occurs in poor weather (Littler 1910; Favaloro 1944; Liddy 1960; Barlow 1972). River valleys apparently provide route for dispersal in NZ (Barlow 1972).

In Aust. and NZ, flocks form mainly autumn and winter (Favaloro 1944; Amiet 1957; Napier 1969; Barlow 1972), but in some areas flock at other times (e.g. McGarvie & Templeton 1974). Origin of birds in flocks unknown; in Tas. numbers in flock varied daily, which suggests that flocks may be mobile and with varying composition (Allen 1967; Thomas 1969). Flocks move but no evidence that movements are anything but local (Thomas 1968), e.g. one flock fed on intertidal mud at Barilla Bay, Tas., and returned each high tide (Thomas 1969). In NZ, non-breeding adults remained within 5 km of territories; moved from territory and often returned for short periods (Barlow 1972; M.L. Barlow).

Regular counts in Aust. indicate dispersal to breed late winter and early spring (Lane 1987). In Tas., most pairs take up territories, May–July (Thomas 1969). In Vic.: in Geelong district birds pair off, early July (Belcher 1914). In NZ: in May, some birds disperse to breed; in June some pairs visit previous year's breeding territory and newly formed pairs move to unoccupied habitat; by mid-Aug. most established pairs on territories (Barlow 1983). Birds moving to unoccupied habitat either bred on perimeter of established breeding area or in previously unpopulated area (Barlow 1972).

Breeding In NZ, adults found in breeding territory 9–10 months of year (Barlow 1972). Movements during nesting very local (Favaloro 1944). Flocks during breeding season (assumed to be non-breeders) are nomadic (Thomas 1969).

Banding Substantial (selected recoveries only). Adult movements limited; Qld: adult banded 15 Nov. 1979 recovered 29 July 1981, 10 km ENE at Indooroopilly (Anon. 1982); NSW: adult banded, L. Cowal 21 Jan. 1964 recovered dead on railway 14 Nov. 1968, *c.* 150 km SSW, but possibly transported by train (Purchase 1970); Vic.: none of 140 adults banded on Phillip I. recovered beyond island (Allen 1967). Some young remain near natal area, but some longer movements recorded: in Vic.: of birds banded as runners on Phillip I. and recovered more than 9 months later, one was retrapped at nest on island 4 and 6 years later, another 2 years later; one was recovered at Bacchus Marsh *c.* 110 km NW and one recovered 22 months after banding at Eildon Weir *c.* 150 km NNE (longest recorded Aust. movement); one banded as runner was recovered *c.* 35 km E when 3 months old (Anon. 1962 gives wrong banding site for longest movement; Hitchcock 1964; Allen 1967); Tas.: of 14 banded as pulli and recovered after fledging, only 2 moved more than 10 km; one was recovered *c.* 55 km S from place of banding 46 months later and one *c.* 125 km S 28 months later (Thomas 1969); of 4 banded runners recovered as free-flying birds, three were recaptured within 8 km; fourth moved *c.* 125 km S in about 28 months (Liddy 1960). NZ: of 81 birds banded as pulli and surviving to 6 months old: 23 (28%) were last seen at banding site at 7.8 months (6–9) and not resighted elsewhere; 51 (63%) remained at banding site after attaining independence at *c.* 9 months; 6 (7%) were recovered 11–40 km from banding site at 10 months to 5 years old (mean 2 years); one moved 248 km (longest NZ movement) from banding site in 19.5 months (M.L. Barlow). In Southland, of 94 birds banded as adults: 79 (74%) were recovered at or near banding site 1–11 years after banding (M.L. Barlow).

FOOD Molluscs, worms, millepedes, centipedes, insects, crustaceans, and occasionally seeds, leaves and frogs. **Behaviour** Diurnal, though often heard flying at night. Usually forage in wet pasture and grassland but will feed on mudflats, on beaches (CSN 37) and in shallow water. Stalk, run and peck at prey; glean and probe. Walk, or run, lunge and stab at prey (Barlow 1983). Foraging rate higher in adults than young, adults taking 4.3–12.5 s foraging time per item swallowed (n=27), whereas young take 12.4–28.2 s per item (n=71) (Burger & Gochfeld 1985). Juvenile birds rely on earthworms that are brought to surface by rainfall (Dann 1981). Seeds and leaves said to be eaten when insects are scarce in dry or cold weather (Aust. RD).

Adult Aust. (134 stomachs from airport kills; van Tets *et al.* 1977). **Plants** Monocotyledons: lvs 4.5% freq.; Poaceae: lvs 0.7; Panicoideae: sds 4.8; *Echinochloa colonum* 0.7; *Panicum* 1.5; *Paspalum* sds 0.7; *Setaria italica* sds 2.2; *Bromus* sds 2.2; *B. mollis* sds 1.5; *Eleusine* sds 0.7; *Poa pratensis* sds 0.7; *Triticum aestivum* sds 1.5; *Vulpia bromoides*: lvs 0.7; sds 0.7; Cyperaceae sds 1.5; *Juncus* sds 0.7; *Atriplex semibaccata* sds 0.7; *Amaranthus* sds 1.5; *Portulaca oleracea* sds 0.7; *Stellaria* sds 0.7; *Polygonum aviculare* sds 3.7; *Rumex acetosella* sds 0.7; *Rosa* sds 0.7; *Medicago polymorpha* sds 0.7; *M. sativa* sds 2.2; *Stylosanthes humilis* sds 0.7; *Trifolium*: lvs 1.5; sds 8.2; *T. glomeratum* sds 0.7; *T. subterraneum*: lvs 0.7; sds 4.5; *Oxalis corniculata* sds 0.7; Epacridaceae sds 0.7. **Animals** Annelids: oligochaetes 24.6: Lumbricidae 0.7. Molluscs: gastropods 5.2: *Bankivia fasciata* 1.5; *Littorina unifasciata* 1.5; bivalves: Plecypoda 0.7. Crustaceans: isopods: *Armadillidium vulgare* 1.5. Arachnids: spiders 15.7. Myriapods: millipedes 0.7. Insects: Blattodea: Blattidae 2.2; Orthoptera: Gryllidae 17.9; *Teleogryllus commodus* 18.7; Gryllotalpidae 6.0; Acrididae 14.2: *Acrida conica* 0.7; Dermaptera 12.7: Forficulidae: *Forficula auricularia* 6.7; Labiduridae: *Labidura riparia* 15.7; Thysanoptera: Thripidae: *Heliothrips* 0.7; Hemiptera 17.9: Cicadidae 0.7; Reduviidae 0.7; Cydnidae 0.7: *Adrisa* 0.7; Pentatomidae 13.4; Coleoptera: Carabidae: larv. 1.5; ad. 20.9; *Clivina* ad. 1.5; Staphylinidae 3.7; Scarabaeidae: larv. 7.5; ad. 44.0; Aphodiinae 1.5; Scarabaeinae 8.2: *Onthophagus* 0.7; Melolonthinae 0.7; Dynastinae 6.7: *Heteronychus* 3.0; *H. arator* 2.2; Buprestidae 0.7; Elateridae: larv. 6.7; adults 14.2; Tenebrionidae: ad. 14.2; Chrysomelidae 4.5; Curculionidae 68.7: Amycterinae 1.5; Diptera: ad. 3.0; Culicidae 0.7; Syrphidae 0.7; Lepidoptera: larv. 31.3; ad. 9.0; Noctuidae: larv. 11.2; ad. 2.2; Hymenoptera: Ichneumonidae 1.5; Formicidae: wingless ants 30.6; *Camponotus* wingless 2.2; *Rhytidoponeura* wingless 4.5; *R.*

metallica 0.7 winged; 3.0 wingless; *Iridomyrmex* 0.7 winged; 9.0 wingless. Bread 0.7; charcoal 0.7; glass 0.7; grit 11.9.

At **Aust. airports** (58 stomachs, recalculated; van Tets *et al.* 1969). **Animals** Arachnids: spiders 17.2% freq. Insects: Gryllidae 19.0; Gryllotalpidae 6.9; Acrididae 12.1; Blattodea 5.2; Dermaptera 44.8; Hemiptera: Reduviidae 1.7; Pentatomidae 12.1; Coleoptera 3.5: Carabidae 19.0; Staphylinidae 3.5; Scarabaeidae 34.5: Scarabaeinae 8.6; Elateridae 17.2; Tenebrionidae 10.3; Chrysomelidae 8.6; Curculionidae 63.8; Lepidoptera: moths 6.9; Hymenoptera: wasps 5.2; Formicidae 39.7.

At **Mackay Airport, Qld** (29 stomachs, recalculated; van Tets & Vestjens 1973). **Plants** Poaceae: lvs 6.9% freq, 0.1 no.; sds 10.3, 0.9: *Sporobolus africanus* sds 3.4, 0.1; *Brachiaria* sds 24.1, 5.6; *Cenchrus echinatus* sds 3.4, 0.1; *Digitaria* sds 3.4, 0.1; *Echinochloa colonum* sds 6.9, 0.3; *Panicum* sds 6.9, 28.8; *Paspalum* sds 3.4, 0.1; *Setaria italica* sds 10.3, 5.4; Paniceae sds 20.7, 3.3; Panicoideae sds 3.4, 0.2; Cyperaceae sds 6.9, 0.6; *Fimbristylis dichotoma* sds 6.9, 0.1; Fabaceae sds 3.4, 0.2; *Stylosanthes humilis* sds 3.4, 0.1; *Trifolium* sds 3.4, 0.6. **Animals** Molluscs: gastropods 3.4, 0.1. Arachnids: spiders 17.2, 0.4. Insects: Thysanura 3.4, 0.1; Blattodea 13.8, 1.2; Dermaptera 34.5, 1.9; Tettigoniidae 10.3, 0.5; Gryllidae 24.1,0.6; Gryllotalpidae 13.8, 0.9; Acrididae 24.1, 0.9; Hemiptera: Cicadellidae 3.4, 0.1; Lygaeidae 3.4, 0.2; Cydinidae: *Adrisa* 6.9, 0.6; Pentatomidae 37.9, 2.1; Coleoptera: Carabidae 51.7, 2.3; Scarabaeidae 20.7, 0.9: Scarabaeinae 6.9, 0.4; Dynastinae 20.7, 1.2; Elateridae: ad. 24.1, 1.4; larv. 6.9, 0.1; Tenebrionidae 37.9, 2.4; Chrysomelidae 3.4, 0.1; Curculionidae 58.6, 8.2; Diptera: larv. 10.3, 1.5; Lepidoptera: larv. 41.4, 9.1; Hymenoptera: wasps 17.2, 0.7; 55.2, 15.6. Frogs: Hylidae tree-frog 6.9, 0.2.

Other records **Plants** Vegetable matter (Hall 1974); aquatic plants (Favaloro 1944; North); Poaceae: sds (Hall 1974), lvs (Rose 1973); *Echinochloa colonum* sds (Lavery 1969); wheat *Triticum aestivum* sds (Barker & Vestjens; Lea & Gray); barley *Hordeum* sds (Lea & Gray); *Medicago* sds (Vestjens 1977); *M. sativa* sds; *Trifolium subterraneum* sds; *Acacia* sds (Barker & Vestjens). **Animals** Annelids: oligochaetes (Barker & Vestjens; Gould): earthworms (Pierce 1980; Burger & Gochfeld 1985; M.L. Barlow). Molluscs: freshwater molluscs (Barker & Vestjens); gastropods: small snails (Favaloro 1944; Hall 1974). Crustaceans (Hall 1974; North). Arachnids: spiders (Rose 1973). Myriapods: centipedes (Vestjens 1977). Insects (Thomson 1935; Favaloro 1944; Hall 1974; Gould; Mathews; Lea & Gray): ads, larv. (Burger & Gochfeld 1985; North); Orthoptera (Green 1966): Gryllidae: *Teleogryllus commodus* (Stephen 1907); Acrididae: *Austroicetes vulgaris* (Green 1966); grasshoppers (Favaloro 1944; Lavery 1969); Gryllotalpidae (Vestjens 1977): *Gryllotalpa* (Rose 1973; Barker & Vestjens); Dermaptera: *Forficula auricularia* (Barker & Vestjens); Hemiptera (Vestjens 1977): Cydnidae; Pentomidae (Barker & Vestjens); Coleoptera (Green 1966; Hall 1974; Cleland): larv. (Vestjens 1977; Cleland); aquatic beetles (Vestjens 1977; North); Carabidae (Vestjens 1977; Barker & Vestjens); Hydrophilidae; Geotrupidae (Barker & Vestjens); Scarabaeidae (Vestjens 1977; Barker & Vestjens): grass-grub larv. (Fletcher 1908; Mathews); *Costyletra zealandica* grass-grub larva (Pierce 1980); *Aphodius tasmaniae*; *A. pseudotasmaniae* (Green 1966); *Onthophagus australis* (Green 1966; Barker & Vestjens); Dynastinae: *Heteronychus arator* (Barker & Vestjens); Elateridae: ad. (Barker & Vestjens); larv. (Green 1966; Rose 1973); Tenebrionidae (Vestjens 1977): *Adelium neophytum* (Lea & Gray); Curculionidae (Vestjens 1977; Barker & Vestjens; Cleland): *Desiantha* (Green 1966; Lea & Gray); *D. vittata* (Green 1966); Amycterinae (Barker & Vestjens): *Amorphorrhinus* (Cleland); Diptera: larv. (Vestjens 1977); Stratiomyidae: larv. (Rose 1973); Lepidoptera (Green 1966): larv. (Lord 1956b; Vestjens 1977; Barlow 1983; Barker & Vestjens; Lea & Gray); Hepialidae: *Porina* larv. (Barlow 1983); Noctuidae: cutworm larv. (Cleland); *Spodoptera* army worm larv. (Roberts 1936); Hymenoptera: wasps; Tentherinidae (Barker & Vestjens); Formicidae (Vestjens 1977): *Iridomyrmex*; *Myrmecia* (Barker & Vestjens); *Rhytidoponera* (Rose 1973; Barker & Vestjens); *R. metallica* (Barker & Vestjens); *Phiodole* (Green 1966; Rose 1974; Lea & Gray). Small stones (Hall 1974); gravel (North); mud and pebbles (McKeown 1934); grit (Vestjens 1977); pebbles (7–8 in five adults, 5–10 mm; M.L. Barlow).

Young Nidifugous. Not fed by adults (Burger & Gochfeld 1985). Annelids: Oligochaetes: earthworms 17% vol., 100% freq.; molluscs 8, 16.6; insects 6, 50.0: Coleoptera: ad. 41, 83.3; larv. 28, 83.3 (n= 6 stomachs; Dann 1981). Pebbles in two recently fledged young (M.L. Barlow).

Intake No data.

SOCIAL ORGANIZATION In NZ, well known; account based on contribution by M.L. Barlow and studies by Barlow (1972) and Barlow *et al.* (1972) in Southland, and Moffat (1981) in Manawatu. In Aust., less well known; studies of breeding biology in Tas. (Thomas 1969) and breeding behaviour in se. Qld (Giese 1990). Gregarious but nest as single pairs. In NZ, social organization differs between established and stable population in Southland, and low-density population in process of colonization in Manawatu. In Southland, breeding occupies 9–11 months of year, and most of this time is spent as pairs or families on territories. In non-breeding season, some adults remain in pairs on or near territory; others join loose flocks, occasionally moving from flock to visit territory (M.L. Barlow). During breeding season, small flocks of non-breeders and failed breeders that have left territories occur near breeding areas; some breeding adults, including failed breeders who continue to hold territories, leave territories briefly and join flocks. Flocks most common in autumn; about this time young start to mingle, usually accompanied by one or both parents, with neighbouring families, and form loose flocks for short periods in day; May–June, many families still on territories, though members come and go from flocks; within flocks juveniles less than 8–10 months old and parents feed as family; in early July, parties of restless juveniles occur (Barlow *et al.* 1972; M.L. Barlow). Larger flocks (≥100) believed to contain many non-breeding birds (Barlow 1972). Some old or deformed adults, known past-breeders, spend much time in loose flocks (Barlow 1988), alone, or in non-breeding pairs (M.L. Barlow). At Manawatu, from Aug. to Dec., when many birds breeding, flocks of 5–42 recorded; flocks swell in Nov. as families and territorial pairs join; by end of Jan., all birds in flocks. Outside breeding season (Jan.–May) in flocks of 20–30 with daily interchange of individuals between flocks; flocks disperse over feeding areas, and pairs and families feed in distinct groups. In May, pairs leave flocks to establish territories, possibly in response to rise in water-table; remaining small groups become increasingly mobile (Moffat 1981). In Tas., most flock after young fledge, though a few pairs remain on territories all year. Outside breeding, most remain in flocks usually near water, e.g. margins of swamps and rivers, and tidal flats; observations about this time suggest flocks mobile and composition varies. From May to July, birds become territorial and flocks decline. During breeding season, small flocks, assumed to be non-breeding birds, persist; somewhat nomadic (Thomas 1969). Other observations in Aust.: s. Vic., larger flocks occur after breeding (Smith 1966); numbers in area seem to peak summer and Mar.–Apr. (Wheeler 1955); at Phillip I., during breeding season most birds on territories, and few non-breeding birds (Allen 1967). Inland Vic. and NSW, larger flocks more common autumn–winter; possibly not all birds in flocks breed

each season (Favaloro 1944). Armidale, NSW, non-breeding flock present all year (Heron 1970). Often described as being in small flocks or flocks of up to 100 or so (e.g. Favaloro 1944; Hindwood & Hoskin 1954; Lord 1956a; Smith 1966; Napier 1969; Burger & Gochfield 1985); larger groups not unusual, e.g. 200–300 or more (Hindwood & Hoskin 1954; Wheeler 1955; Smith 1966; Hobbs 1968), up to *c.* 500 (Thomas 1969), and *c.* 750 (Sharland 1943a).

Bonds Monogamous; sustained or long-term. Change in pairing rare; one case where male took new mate on territory and female paired with neighbour. Pair again on death of partner; occurrences of male dying, leaving female with young chicks; chicks disappeared, presumably died, and female took new mate onto territory in 14–15 days and bred (Barlow *et al.* 1972). One nest containing six eggs, probably laid by two females, attended by three adults (Barlow *et al.* 1972). Members of pre-breeding pair feed together; during breeding, off-duty bird feeds alone, distant from nest or brood, or in flock (M.L. Barlow), though during incubation Sharland (1930) noted off-duty bird remained close, sometimes for hours without movement, and was occasionally joined by mate to feed. Giese (1990) recorded members of pair closest just before incubation (19.5±9.16 m), farther apart during incubation (53.8±26.2 m), closer after chicks hatch (34.4±22.2 m) with distances increasing only slightly after fledging (41.3±21.4 m). Pairing said to occur mid-winter (Thomas 1969) or before territories established (Favaloro 1944). Breed in second year, but probably pair in first autumn–winter; copulation and nest-building by one male at 10 months; one female bred at 11 months (Barlow *et al.* 1972; M.L. Barlow). **Parental care** Successful breeding occupies both parents for 9–11 months of year (Barlow *et al.* 1972). Both sexes build nest, incubate, brood and tend young, and defend territory against intruders of own and other species (e.g. Favaloro 1944; Bourke 1953; Frith 1969; Thomas 1969; Giese 1990; M.L. Barlow), though in some pairs one member appears to do so for longer periods (Giese 1990); role of sexes in incubation varies between pairs and daily within pair (M.L. Barlow); possibly male undertakes most nocturnal incubation (Barlow *et al.* 1972); for further details of parental investment, see Giese (1990). In NZ, young less than 6 months old guarded by one or both parents; after this, one and for much of day, both, parents remain near; as fledged juveniles grow older, off-duty parent may spend more time away from brood but seldom moves farther than *c.* 1.4 km away (Barlow *et al.* 1972; M.L. Barlow); in se. Qld., often one or both parents with or near (≤20 m) young even after fledging (Giese 1990). In Southland, most young independent when *c.* 8–10 months old, av. 40 weeks (32–48; 15); young of early breeders independent Feb.–Mar.; by May–July most juveniles feed independently within flock, though in early July, when some adults copulating, some families still spend some time together (Barlow *et al.* 1972; M.L. Barlow). At Manawatu, dependent up to 6 months after fledging; families apparently together within flocks until late Apr. (Moffat 1981). In Aust., many families stay together after young can fly (Thomas 1969); report of pair defending nest in association with three juveniles, which also circled above, calling weakly (Bourke 1953). In ACT, juveniles may assist to defend territory until first egg laid (G.F. van Tets). Many birds seem to leave natal areas, though some found to breed or stay nearby (Allen 1967; Anon. 1969); young become established in vacant territories or disperse (Barlow 1972).

Breeding dispersion Solitary, though nests may be close together in favourable habitat; two unusually close nests 20 m apart (e.g. Smith 1966; Barlow *et al.* 1972). **Territories** Defended when breeding. Characteristics of territories differ between areas. In Southland, all-purpose traditional breeding territories defended 8–10 months of year, and visited but not defended for remaining months. Breeding pairs establish new, or return to old, territories Apr.–July; used for feeding by pair before laying, and by on-duty parent with chicks less than 6 months old; after this, family continues to feed on territory so long as habitat, especially height of vegetation, allows; off-duty bird feeds in or out of territory. Pattern may be disrupted if habitat alters, e.g. vegetation grows >15 cm, area floods, or farming practices change (Barlow *et al.* 1972). At Manawatu, maintained for 4–37 weeks; length of occupation not related to number of fledged young, but if young fledged, maintained significantly longer than if less successful breeding occurred; all birds leave territories by end of Jan. Some pairs maintained stable territories; others, not restrained by neighbouring territories, moved unfledged young, defending large mobile territories round chicks rather than round nest. Pairs may move because: vegetation >15 cm, disturbance by stock or humans, lack of longer cover, or flooding (Moffat 1981). Similar mobile territories recorded in Tas. (Thomas 1969); Frith (1969) also mentions families leaving territories to wander freely round ACT. In Tas., a few pairs probably maintain territories all year, but most from May onwards; only 35% (n=35) of territories used in 2 consecutive years, just under half of unused ones probably being unsuitable because vegetation too tall. Off-duty bird remains in territory or moves outside it to feed (Thomas 1969). Unfledged young do not move far (Liddy 1969); some broods remain close to nest-site, even after young fledged (Thomas 1969). Nest-fidelity: of 71 nesting territories identified in Tas. in 1965 and checked in 1966 only 35% were used in both years, with slightly less than 50% of unused territories apparently unsuitable (Thomas 1969); on Phillip I., nests found at same location year after year; banded bird nested on identical site for 3 years running and nested only *c.* 23 m away when heavy rain precluded use of former site (Allen 1967). A few maintain territories all year but usually start to occupy territories mid-May, and breed from mid-July onward (Dann 1981). In se. Qld., Giese (1990) found pairs began to occupy territories May–June, and defended even after young fledged. Size in Southland, 14.5 ha (8.4–19.4; 9) in 375-ha area; five pairs shared at least one boundary, and there was slight overlap on some boundaries; gaps of 40+ ha between these and remaining four territories (Barlow *et al.* 1972). At Manawatu, size 1.5–15.6 ha (n=28); those where chicks fledged significantly larger than unsuccessful territories; size not related to number of fledged young (Moffat 1981). In Aust., few details of size; one at least 50 x 75 m with intruders being chased to *c.* 200 m outside territory (Prestedge 1983). In NZ, territories on flat land with vegetation <15 cm high (Barlow *et al.* 1972; Moffat 1981) had discrete clumps or small (<5 m^2) areas of taller growth such as *Carex* or rushes, rank grasses, thistles, tussocks, or docks as cover for the birds (M.L. Barlow); 88% (n=308) had soft mud where young fed (Barlow *et al.* 1972). For details of relation between territory and environmental factors, e.g. water-table, length of day, temperature, and rainfall, see Moffat (1981). Some pairs defend territories against Banded Lapwings (Wheeler 1955), even driving out nesting birds; others nest apparently amicably among them (Thomas 1969); van Tets *et al.* (1967) recorded no territorial or other social interactions between these species.

Roosting Little known of nocturnal roosting; when territorial, probably remain on territory overnight (M.L. Barlow); may travel at night when can be heard calling (e.g. Favaloro 1944; McKean 1963; Barlow 1972). Roost on ground, with or without cover (M.L. Barlow). In Southland, outside breeding season, roost and loaf in pairs, members <1 m to several metres apart, or in small (<12) to large (100+) flocks; autumn flocks spend much of day loafing. Pre-breeding pairs roost and loaf on territories. In

breeding season, off-duty adult roosts and loafs on edge of territory or off territory; up to 5 weeks after hatching, parents usually have little time for diurnal roosting, though this varies. Chicks <7 days old always brooded at dawn and dusk; until 2 weeks old, sometimes roost in close group; distances between chicks increase as chicks grow but some juveniles up to 10 months old still roost within a few centimetres of sibling or parent (M.L. Barlow). As fledged juveniles grow older, off-duty parent may spend more time roosting and loafing away from brood (Barlow 1972). At Manawatu, flocks rest in middle of day, especially in spring and summer, sitting or standing for considerable periods; some even roost for a few minutes. Distances between individuals usually *c.* 1 m; some, possibly mated pairs, sit or stand within a few centimetres. Loafing peaks Oct., gradually declining to Feb.; very little diurnal resting Mar.–Aug. (Moffat 1981). In Aust., birds move about locally both day and night (Thomas 1969); appear to loaf in grass for hours (Dove 1937). Healthy adults roost standing with neck retracted, head turned, and bill tucked into neck plumage or under wing; rarely sit on ground but occasionally do in strong wind; immatures, very old birds (Barlow 1988), and those with damaged feet or legs (Barlow 1978) sometimes roost sitting on ground. Two resting positions described by Giese (1990): SITTING AT REST: sits with head sunken. STANDING AT REST: head sunken, body inclined at 45° to ground, on both legs or on one.

SOCIAL BEHAVIOUR Well known in some respects; behavioural study during two breeding seasons, se. Qld. by Giese (1990) and D.N. Jones. Some individuals more tolerant of disturbance than others (M.L. Barlow). Throughout year all birds usually preen beside or in water (M.L. Barlow). Comfort behaviour includes BACK-SHOULDER PREEN, FRONT-CHEST PREEN, SIDE-SHOULDER PREEN, UNDERWING PREEN, TAIL PREEN, and HEAD-SCRATCH (indirect). At end of preening or in presence of conspecific give FLUFF: beginning with tail, all feathers progressively shaken and head sunken. DOUBLE WING-LIFT (Fig. 1): lifts both wings slowly above head and holds for 2–3 s with neck extended and inclined slightly forward and body upright. HEAD-BOBBING: short sharp vertical movement of head, occurs with body upright and neck extended (Giese 1990).

Agonistic behaviour Observed between neighbouring territory owners (van Tets *et al.* 1967 *contra* Barlow *et al.* 1972) including offspring of previous year (G.F. van Tets). Defence includes following behavioural postures (Giese 1990): HUNCH (Fig. 2): body held 30° downward, breast close to ground, tail in air, and head sunken; may transfer weight from one foot to another while keeping eyes on intruder. BODY ERECT DEFENDING (BED) (Fig. 3): body as in exaggerated form of Standing Alert (see below); expands chest so that spurs protrude, and extends neck vertically. These postures incorporated in following displays: GROUND CHASE: resident runs towards intruder holding body in exaggerated form of Hunch, then, when close to intruder, flies up to 50 cm into air. AERIAL DISPLACEMENT: resident flies quickly and directly at intruder; may repeatedly dive at intruder after circling it. AERIAL CHASE: resident and intruder fly close together (<1 m) in approximate synchrony; flight-pattern erratic with many elaborate and varied manoeuvres. PAIR SYNCHRONY: in most encounters, pair synchronized; members of pair, <30 cm apart, adopt BED posture then walk quickly toward intruder calling loudly (Fig. 4); if intruder does not retreat when 30–50 cm away, members of pair Hunch and lift bodies again and repeat; if still not displaced, pair remains near intruder and holds BED posture until intruder relaxes, or member of pair flies at intruder, as in Ground Chase; occasionally intruder also adopts BED posture, though only seen before start of incubation. Sequence similar if performed by only one member of pair. May lead to Aerial Displacement. In captivity, pairs recorded screaming at conspecifics flying overhead and mobbing those landing in territories (van Tets *et al.* 1967).

Alarm The following observations by Giese (1990) also relate to Parental anti-predator strategies. Vigilant postures: SITTING ALERT: same as Sitting at Rest, but neck extended and head mobile; STANDING ALERT: body upright, neck extended vertically, head moving; gazes to locate enemies or mate. When vigilant, may make little movement or may combine vigilance with other behaviour, e.g. preening. Often in response to disturbance gives TAIL-FLICK: short, rapid flick of tail sideways; body as for Standing Alert or Hunch. Aggressive towards harmless intruders (e.g. Australian Magpie-lark *Grallina cyanoleuca*, Red-capped Plover *Charadrius ruficapillus*) and threatening species (e.g. Brown Goshawk *Accipiter fasciatus*) (Giese 1990); in se. Qld, frequently 'dive-bombed' by Sulphur-crested Cockatoos *Cacatua galerita*, and Lapwings often fly aggressively at passing cockatoos, with or without provocation (D.N. Jones); may use Ground Chase, par-

Figure 1 Double Wing-lift

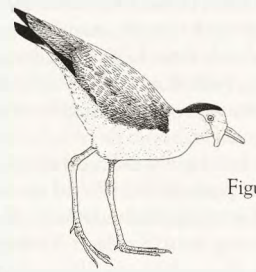
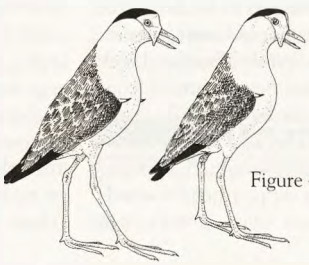


Figure 2 Hunch

Figure 3 Body Erect Defending (BED)



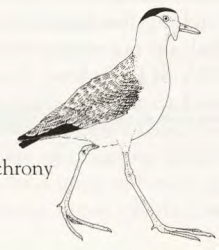


Figure 4 Pair Synchrony

ticularly against former group, or Aerial Displacement involving one or both members of pair, and occasionally including Lapwing from neighbouring pair. Sometimes Hunches facing away from intruder, often Head-bobbing and Tail-flicking, and occasionally Sitting Alert for 1–2 s before Hunching again; seems to be associated with extreme nervousness (Giese 1990). Other recorded responses to alarm: fly off giving Alarm Call (Favaloro 1944); small flock hid in grass, one standing as immobile sentry until Peregrine Falcon *Falco peregrinus* passed (Legge 1910); one adult, attacked by Brown Falcon *F. berigora*, landed on deep water (Wheeler 1962). **Mobbing** Seems to occur at any time of year: about 200 in three large flocks took to air giving Alarm Call in response to Black Falcon *Falco subniger* (Wheeler 1955); groups recorded mobbing Swamp Harriers *Circus approximans* (Smith 1965), once possibly while Lapwings were nesting (Dove 1936); appeared attracted by conspecific Alarm Calls (Bedggood 1973); Alarm Calls of breeding birds can attract other Lapwings within hearing to assist (Favaloro 1944).

Sexual behaviour Pairs probably form in loose flocks and in PIPING PARTIES of up to 6–7 birds, which face each other, forming a loose circle, usually on elevated ground; actions include Upright Stance (see below); all or some birds may step sideways on stiff legs and individuals may retreat as others advance inwards; bursts of loud rattling calls alternate with silence. Parties may continue at high intensity for 20 min; concludes when one, or more, bird turns away, head low, and walks or flies away. Two birds may break from circle and march 2–5 m together with stiff legs and semi-upright stance, calling loudly; no physical attack observed. Occasionally, 1–2 birds chase on ground, for a few to up to 20 m. Eventually two birds left in area, where they may stay for only a few seconds before flying off. Mated pairs in Piping Parties act together and usually, but not always, dominate. Piping Parties not always related to territories and may relate to dominance, especially of pairs. In Southland, independent juveniles and 1-year-old birds outnumbered adults in Piping Parties (M.L. Barlow). UPRIGHT STANCE: with legs straight, breast pushed out with feathers puffed, abdomen concave, wings folded and held slightly away from body, with spurs exposed. **Greeting** Change-over without ceremony; normally sitting bird calls softly and mate approaches, 'mock-feeding'; while approaching bird is *c.* 10 m away, sitting bird rises and walks quietly away, often in opposite direction; change-over often occurs after pair have been defending eggs (Bourke 1953). **Copulation** Seen before (Giese 1990) and during incubation (Bourke 1953). Begin with female standing in horizontal posture; male approaches slowly from behind, making a purring sound. After male dismounts, both stand side by side in upright posture, spurs showing and carousel round each other for several turns (G.F. van Tets).

Relations within family group Incubate and brood in Sitting at Rest or, less often, Sitting Alert postures; can brood up to four chicks (Giese 1990) but each parent may brood some offspring separately (M.L. Barlow); young seen to circle sitting parent, then go back in under raised wings of parent (Prestedge 1983). Once, after start of rain squall, 1 day-old chicks climbed up into ventral plumage of standing parent (G.F. van Tets). Chicks leave nest soon after hatching and led by parents to feeding area; during hatching, first hatched young sometimes led away by non-sitting bird; do not return to nest (Frith 1969; Thomas 1969; Giese 1990; M.L. Barlow). Young recorded being carried from nest on roof to ground: parent grasped chick by leg while chick hung on to facial wattle of adult with bill (Davies 1967). Parents and unfledged young of one family noted returning each evening to nesting island in dam; adult constantly dipped head towards water until chicks swam across; young can swim at early age (Thomas 1969; Tratt & Tratt 1988). In Southland, parent guarding young less than *c.* 6 months old seldom feeds while young feed; off-duty parent feeds elsewhere (M.L. Barlow); at Manawatu, young feed close to parents for up to 14 days, after which adults feed up to 200 m apart with chicks between them (Moffat 1981); as young develop or if they scatter, parents split brood (Favaloro 1944; Thomas 1969). Family often moves from nesting or brooding area when young *c.* 2 weeks old, then move again when *c.* 5–6 weeks old; move probably influenced by many factors, e.g. disturbances, land-use, amount of protective cover, food supply, flooding, or drying of wet areas (Barlow *et al.* 1972); broods known to cross roads, ditches, gravel pits, heavily stocked paddocks, watercourses, even a river (Barlow *et al.* 1972). In Tas., broods generally mobile within radius of *c.* 1 km until fully fledged (Thomas 1969), e.g. family moved *c.* 400 m from nest in 2 weeks (Fletcher 1933). In NZ, single chick travelled *c.* 800 m from nest within 3 days of hatching (Barlow *et al.* 1972). Exceptional Tas. record of banded runner moving 9.6 km in 2 days, but there is doubt regarding location of banding and recovery (Liddy 1969). **Anti-predator responses of young** Lie flat and still on ground with head down, eyes open, white breast concealed, and presenting camouflaged dorsum. Reaction usually stimulated by Alarm Calls of parents, and young emerge when adults cease Alarm-calling and give Re-grouping or All-clear Call; as young develop, react without adult Alarm Calls (e.g. Favaloro 1944; Thomas 1969; Barlow *et al.* 1972; Moffat 1981; M.L. Barlow); chicks 1–2 days old may not respond to predator or Alarm Call or may respond by lying still but soon start to move again; when 4+ weeks old, run for cover and crouch there; close to fledging, some continue to run and hide, or run for considerable distances (50+ m) before crouching. Young in shallow water seen to submerge, leaving only bills above water (Quinn 1962). **Parental anti-predator behaviour** Breeding adults aggressive to intruders, specially when with young; attack many other species, e.g. Silver Gulls *Larus novaehollandiae*, Swamp Harriers, Brown Falcons, Australian Kestrel *F. cenchroides*, Pallid Cuckoos *Cuculus pallidus*, Forest Ravens *Corvus tasmanicus*, and Australian Magpies *Gymnorhina tibicen*, as well as people and dogs (Thomas 1969). As distraction displays, occasionally feign injury (Thomas 1969); uncommonly bird may approach to within *c.* 1 m of intruder and stand upright with wings fully extended and tips touching ground; at maximum intensity, bobs body up and down with tail fanned, and quivers wings while making rattling sound in throat (Fig. 5) (Thomas 1969); Sharland (1943a) described birds using similar attitude to defend eggs or young. One adult with young alighted *c.* 10 m from

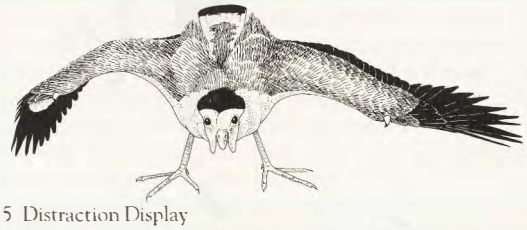


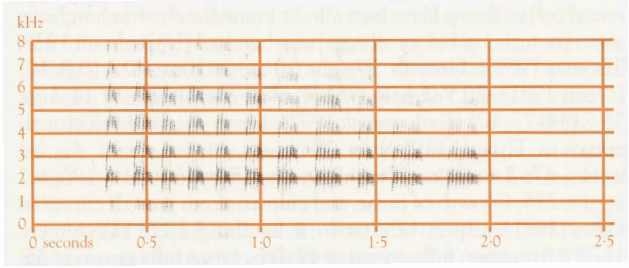
Figure 5 Distraction Display

observer, spread wings, chattered, and performed jumps that carried it a few centimetres off ground (Bourke 1953). Before laying, pairs loud and aggressive, and chase potential predators of eggs from nesting area (Frith 1969). During incubation, sitting bird remains silent and unobtrusive (Frith 1969); when danger at distance, sitting bird usually slips quietly from nest and moves furtively to cover where remains silently concealed. When surprised on nest, normally runs or flies a short distance away, often giving Alarm Call either on ground or flying over nest-territory; if off-

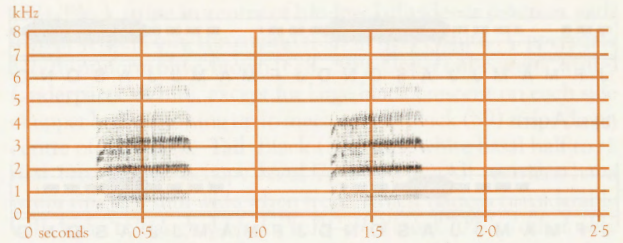
duty bird in or near territory, it joins mate; dive-bombing uncommon at this stage (Thomas 1969). As sheep passed by, on-duty bird seen straddling eggs in half-sitting posture, calling loudly and striking with wings, while other stood by, making great demonstration (Favaloro 1944); often fly in face of sheep and cows to prevent them treading on eggs (Sharland 1943a); will stand and peck nose of sheep (G.F. van Tets) sitting bird will leave nest to pursue crows and ravens (Bourke 1953). Return to nest by series of short runs with body horizontal, pausing to peck at ground (false feeding) (Thomas 1969). Become more aggressive as hatching approaches (Thomas 1969). After hatching, more vigilant and more aggressive to other species than during incubation (Giese 1990); most aggressive when young <2 weeks old (M.L. Barlow). One or both adults chase, dive, and call at aerial predators, people and other animals that come too near offspring (e.g. Fletcher 1924; Frith 1969; Thomas 1969; M.L. Barlow). Often repeat Alarm Call for young to freeze until danger passes (Thomas 1969). Off-duty parent sometimes out of sight of brood, but probably often nearby because will join and sometimes precede on-duty adult in protective behaviour (M.L. Barlow). Adults occasionally round up and move chicks away from danger (Giese 1990). If farm animals get too near, adults stand over or beside young with wings extended and head down (M.L. Barlow). As chicks grow older, adults become more secretive (Barlow *et al.* 1972). Parents sometimes joined by conspecifics when attacking predators (see Agonistic Behaviour). After disturbance, adults quickly return to brood chicks <2 weeks old (Moffat 1981); one parent seen false-feeding as it led young to other adult (Fletcher 1924). In families that include apparently independent young, adults more vigilant than young (Burger & Gochfeld 1985). If juvenile remains in territory for longer than 8–10 months, as next breeding season approaches, parents become increasingly hostile towards it (M.L. Barlow); one juvenile left 4 weeks after territory set up for next breeding season (Moffat 1981). Surviving juveniles may stay and help parents defend nesting territory; juveniles leave area as soon as first egg is laid (G.F. van Tets).

VOICE Quite well known; no detailed studies. Loud penetrating stutter, the Alarm Call, draws attention of conspecifics and other species to presence of intruder (Boehm 1960; North). Often heard at night and often given in flight (Kersey 1919; Condon & McGill 1952; Campbell; North). Also give rattling, chattering, trills, purring and soft calls. Individuals and pairs in unison utter loud rattling calls in Piping Parties (see Sexual Behaviour) during autumn and winter (M.L. Barlow). Little, if any, difference between calls of subspecies (Condon & McGill 1952; Amiet 1957; Frith 1969).

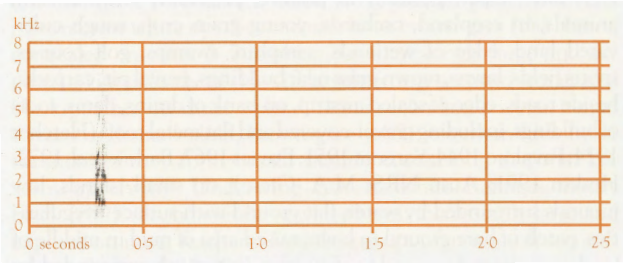
Adult ALARM CALL: loud penetrating stuttering *keer-kick-ki-ki-ki* (sonagram A; harmonics extend to 10 kHz). Sometimes a single *keer* (two shown in sonagram B) or *click* (sonagram C). Given on ground and in flight; whenever disturbed (Frith 1969); Alarm Calls of a pair bring others within hearing to assist (Favaloro



A F.N. Robinson; Stanthorpe, Qld, Nov. 1964; P36



B F.N. Robinson; in captivity, Canberra, ACT, Oct. 1964; B514



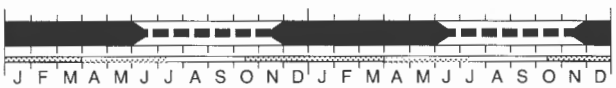
C F.N. Robinson; in captivity, Canberra, ACT, Oct. 1964; B514

1944). Rattling sound in throat in Extended-wing Display in defence of nest (Thomas 1969) and chattering after attacks on intruder failed (Bourke 1953) may be this call. PURRING: soft purring sound from male just before copulation (Frith 1969); running trills in display (Pizzey 1980) may be this call. SOFT CALLS: soft clucking calls by adult when it returns to chicks after chasing off intruder; appears to act as all-clear signal, upon which chicks emerge from hiding or crouching; often followed by brooding of chicks; not always effective with older chicks (M.L. Barlow). Soft call during change-over at nest (Bourke 1953). Soft clucking note from one of pair, soon after starting to brood chick, brought mate (Bourke 1953). Murmuring notes to chick (Fletcher 1924).

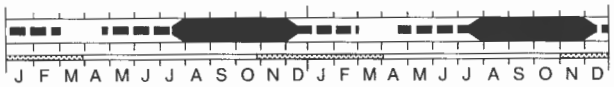
Young Loud calling from chipping egg (Bourke 1953). Flying juveniles call rather weakly when attacking (Bourke 1953).

BREEDING Well known. Detailed study over three seasons in Tas. (Thomas 1969), for one season in Vic. (Dann 1981), and for 5 years in NZ (Barlow *et al.* 1972); 1602 records in Aust. NRS up to Sept. 1992. Information from NZ based on contribution by M.L. Barlow. Breed in simple pairs.

Season Almost any time of year in n. Aust.; June–Dec. in s. Aust.; June to late Nov. in NZ. **NT** Laying, Jan.–May (Frith & Davies 1961); eggs, Nov.–Apr. (Aust. NRS). **N. WA** Breed Aug.–Nov. (Slater 1959); eggs, Mar. (Aust. Atlas). **NE. Qld** Laying recorded in all months (Lavery 1986). **S. Qld** Breeding begins in July (Lord 1956a); eggs, mid-Aug. to early Dec., also early Mar. (Aust. NRS). **NSW** Eggs, mid-June, late July to late Nov. (Aust. NRS). **Vic.** Early July to Nov., rarely in early June (Favaloro 1944; Wheeler 1955; Dann 1981; Aust. NRS). **SA** Eggs, mid-Apr. to mid-Oct. (Attiwell 1972), late Aug. to early Nov. (Aust. NRS). **Tas.** Laying, late June to late Oct., with peak in mid-Aug. (Thomas 1969; Aust. NRS). **NZ** Laying, early June to late Nov., with peak in Aug.; unseasonal nests in Apr. and May (M.L. Barlow). Hatching, early July to late Dec.; clutches recorded later often attributed to replacement clutches (Barlow *et al.* 1972).



(a) n. Aust.



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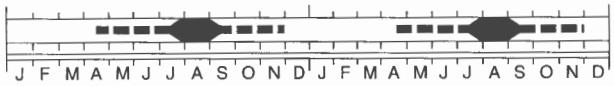

NZ

Site Open position in pasture, preferably without farm animals, in cropland, orchards, young grain crop, rough cultivated land, edge of wetlands, samphire swamps, golf courses, sports fields, lawns, mown grass near buildings, gravel pit, carparks, beside roads, edge of sealed airstrip, on bank of drains, dams, roofs of buildings, including gravel-covered and flat metal roofs (Fletcher 1924; Favaloro 1944; Sansom 1951; Davies 1967; Barlow *et al.* 1972; Hoskin 1991; Aust. NRS; M.A. Giese); on small islands, low mounds surrounded by water, flat ground with surface irregularities, patch of bare ground in lawn, raised area of mud in middle of road, wet ground near edge of swamp, in tussock surrounded by weed in water *c.* 30 m from shore, on floating reeds on edge of lake, semi-submerged log in lagoon, in patches of short vegetation surrounded by taller growth, scanty tussock growing in fissure of rock, often near clump of thistles, rank weeds, piece of wood or large stone (Fletcher 1924, 1933; Favaloro 1944; Bourke 1953; Thomas 1969; Barlow *et al.* 1972). In Tas., 56% nests placed on ridges, mounds and slopes, 43% on flat areas and 1% in hollows (Thomas 1969). Replacement clutches laid up to 728 m from previous site (Favaloro 1944; Barlow *et al.* 1972; M.L. Barlow).

Nest, Materials Usually depression in ground, unlined or lined with whatever material nearby; amount of material used varies depending on what is near nest, but may collect material up to 220 m away; lined with dry grass, small twigs, sticks, rootlets, thistle stems, leaves, small round pebbles, rabbit and sheep droppings, dry globules of mud, debris from beach; sometimes encircled with small stones; some nests in freshly ploughed land, unlined (Dove 1938; Favaloro 1944; Thomas 1969; Barlow *et al.* 1972); one nest on trodden grass (Innes 1930). Material for lining nest <1.3 cm long (Favaloro 1944). Both sexes build; do not carry material but usually toss it towards nest from *c.* 1.8 m from nest; material gathered and placed in nest while sitting or standing on site; nest shaped by sitting bird pressing breast into cup of nest and shuffling in circle (Barlow *et al.* 1972). Sitting bird may reach out to collect material and place it under itself (Favaloro 1944). On two occasions, pair placed a few pieces of straw and grass round eggs after they were moved (Lord 1956a). If site becomes waterlogged, may attempt to raise level of eggs by adding material (Thomas 1969). May prepare more than one nest before laying (Thomas 1969). Building may continue during first week of incubation (Barlow *et al.* 1972). MEASUREMENTS: diameter of depression, 15 cm (n=2; Aust. NRS).

Eggs Pyriform or oval, pointed at smaller end; close-grained, dull or lustrous; ground-colour varies from light yellowish-olive, brownish-olive, light or bright olive-green to dark stone, with numerous irregular freckles, spots and blotches of brownish black or purple, usually intermingled with a few barely visible spots and blotches of dull inky-grey. Markings may join to form large patches or smears (Thomas 1969; North). Colour may vary within clutches; two clutches of four eggs each composed of two light olive-green and two dark-stone eggs (Thomas 1969). Eggs become darker during incubation from staining (Thomas 1969). MEASUREMENTS: **Aust.** Vic.: 48.8 (2.25; 45.2–54.2; 82) x 35.9 (1.24; 32.5–37.3) (Dann 1981); Tas.: 51.3 (2.25; 42–59; 171) x 37.4 (1.24; 32–38); one very small egg, 32 x 21 (Thomas 1969). **NZ** SI: 49.4 (2.0; 45.7–54.8; 60) x 35.3 (1.0; 33.0–37.6) (Barlow *et al.* 1972); NI: 45.8 (1.58; 43.1–50.5; 46) x 33.3 (0.85; 31.8–35.2) (Moffat 1981). WEIGHT (g): in Vic., average during incubation (from graph; Dann 1981): 31 (3.4; 25–35; 51); average loss of weight during incubation, 3.9 (n=11); mean weight of eggs during incubation: at 3 weeks before hatching, 31.2 (30–32.2; 4); at 2 weeks, 30.5 (29–31.8; 6); at 1 week, 29.2 (27.5–30.8; 6) (M. Weston; J. Starks).

Clutch-size Aust. Vic.: 3.6: C/1 x 2, C/2 x 0, C/3 x 5, C/4 x 19 (Dann 1981); Tas.: usually 3–4, average 3.5: C/1 x 4, C/2 x 7, C/3 x 37, C/4 x 87 (Thomas 1969); clutches of five, six and seven recorded (Sharland 1943b). **NZ** Average 3.7: C/1 x 2, C/2 x 5, C/3 x 36, C/4 x 162, C/5 x 1 (Barlow *et al.* 1972). A clutch of six eggs arranged in two rows of three; a clutch of seven probably result of two females laying in same nest as two birds sitting on nest with third bird standing a few yards away (Sharland 1943a,b).

Laying Eggs laid at *c.* 24 h intervals, occasionally at least 48 h for last egg in clutch (Bourke 1953; Barlow *et al.* 1972); 48-h intervals in captivity (D'Ombrain 1928). Will re-lay after failure; recorded re-laying up to three times after predation of eggs in se. Qld (D.N. Jones); interval between loss of clutch and replacement, 2 weeks (Favaloro 1944), 6–28 days (n=16; Barlow *et al.* 1972); re-laying after loss of brood, 19–21 days (n=3; Barlow *et al.* 1972); second clutch laid when surviving chick of first clutch fledged at *c.* 7 weeks (M.L. Barlow). Re-nesting after excessively long incubation not observed (Barlow *et al.* 1972).

Incubation Both sexes incubate; begins after clutch complete (D'Ombrain 1928; Bourke 1953); adults may sit before completion but not certain if it is true incubation (Thomas 1969; M.L. Barlow). Length of stints of incubation ranged from 3 min to more than 6 h; eggs uncovered for 1–20 min (Bourke 1953; Thomas 1969; Barlow *et al.* 1972); male may incubate all night (Thomas 1969). One pair continued to incubate after eggs twice moved a short distance during ploughing and harrowing (Lord 1956a). Hatching usually synchronic; within 2 h (Innes 1930), 24 h (D'Ombrain 1928; Thomas 1969) but may extend over 2–3 days (Thomas 1969). Eggs may chip on consecutive days, first egg up to 4 days before hatching (Innes 1930; Bourke 1953; Thomas 1969). INCUBATION PERIOD: 28–30 days from start of incubation (D'Ombrain 1928; Bourke 1953); 30–34 days after laying (Barlow *et al.* 1972). One bird sat for 3 days on infertile eggs after fertile egg hatched (Hyem 1936); a pair sat on infertile eggs for over 5 weeks (Thomas 1969); addled eggs incubated for 55–62 days (n=5; Barlow *et al.* 1972). Egg-shells removed from nest and dropped in nearby waterbodies or reeds (Sharland 1943a); at one nest, when egg-shell placed in nest with newly hatched young, one bird flicked it away, second bird picked it up and dropped it in dam nearby (Bourke 1953). White feather removed from near nest with eggs (van Tets 1972).

Young Precocial, nidifugous. At hatching, down on crown and back mottled brown and black, white on underparts and round collar. Young leave nest almost immediately after hatching; some young leave before all eggs have hatched (D'Ombrain 1928; Thomas 1969). **Growth** Weight (g) at hatching, 20.3 (0.8; 10) (Dann 1981), 20.5 (14–26; 75) (Barlow *et al.* 1972); at 14 days, 58.7 (44–77; 10) (Barlow *et al.* 1972). Mean weight, from growth curves in Thomas (1969): at 0.1 weeks, 24; 1.2 weeks, 39; 2.3 weeks, 67; 3.4 weeks, 106; 4.5 weeks, 154; 5.6 weeks, 190; 6.7 weeks, 225. Growth of tarsus and culmen, from growth curves in Dann (1981), respectively: tarsus: at hatching, 28.2±1.0; culmen, 11.7±0.6; culmen fully grown at 42 days, tarsus fully grown at 35. Weight increase, and growth of tarsus and culmen at 0, 10, 20, 30

and 40 days, from growth curves in Moffat (1981), respectively: weight: 20.3, 33.4, 73.8, 140.5 and 226.7; tarsus: 21.1, 29.6, 37.7, 45.5 and 53.9; culmen: 9.0, 13.0, 17.2, 21.3 and 25.5. **Parental care, Role of sexes** Brooded by both adults for first 14 days, also at night and during rain (Thomas 1969; M.L. Barlow). Guarded by both adults when small; young may scatter over as much as 200 m, with each adult guarding chicks closest to it (Favaloro 1944; Thomas 1969). Young follow parents but find own food; newly hatched young led to feeding areas (M.L. Barlow). Defend young by dive-bombing intruder (Thomas 1969), stand beside or above chicks with wings extended and head lowered (M.L. Barlow). At approach of danger, young may first run towards cover, but on call from adults, lie flat on ground and freeze with head and neck stretched out and eyes open; may lie against objects such as rocks (Fletcher 1924; Thomas 1969). As chicks near fledging, tend to run rather than freeze (Thomas 1969). One incident of brood-capture; a brood of three, 2–3 weeks old, gained two more 2–3 week-old young, one week later (Thomas 1969).

Fledging to maturity Young usually fledge at 6–7 weeks, but may vary from 5 to 8 weeks (Thomas 1969), 7 to 8 weeks (n=18; M.L. Barlow). Dependent for up to 6 months after fledging (Moffat 1981). Begin to mingle with other birds when 7–8 months old but still usually found with one or both parents (Barlow *et al.* 1972). One female recorded breeding at end of its first year; male and females recorded breeding in their second year (Barlow *et al.* 1972).

Success For three nests: 12 eggs laid, ten young hatched and fledged (Bourke 1948). In se. Qld: of 28 nests, 22 failed before hatching by predation; of the six remaining clutches (42 eggs), 12 chicks were successfully fledged (M.A. Giese; D.N. Jones). Vic.: from 180 eggs laid, 81 (45%) hatched, 16 (8.9%) fledged; 44% of nests successful (Dann 1981). Tas.: for successful nests: mean number of young fledged, 1.52–1.78 (Thomas 1969). **NZ** SI: from 542 eggs laid, 401 (74%) hatched, 25% of these estimated to have fledged; of 141 eggs that failed to hatch: 11% eggs infertile, 50% addled, 11% dead in shell, 10% cracked, 18% missing; from 232 chicks with known outcome, 142 (61%) survived to 14 days; total nesting success, 50% (44.4–66.0) (Barlow *et al.* 1972; M.L. Barlow); NI: from 58 eggs, 43 (74%) hatched, 20 (47%) fledged (Moffat 1981). Nests deserted after stock introduced into nesting area; also during road-making operations; eggs destroyed during cultivation, trampled by cattle, sheep and horses, taken by crows and ravens or egg-collectors; newly hatched chicks drowned after heavy rain flooded nest-site (Wheeler 1955; Aust. NRS); some young killed on roads by cars (Thomas 1969). In se. Qld, Pied Butcherbirds *Cracticus nigrogularis* take eggs and chicks, especially after disturbance that left nest unprotected (D.N. Jones). Twice, birds disturbed during laying or early incubation seen to trample nest and use feet and bill to break eggs, which were then eaten (Barlow *et al.* 1972).

PLUMAGES Prepared by D.I.Rogers. Hatch in natal down; distinctive juvenile plumage starts to appear by 10 days. Partial post-juvenile moult when *c.* 3–4 months old, resulting in immature (first-basic) plumage very similar to adult but sometimes distinguishable on narrower remiges, shorter carpal spur and remnant juvenile coverts in upperwing. Adult plumage attained in complete second pre-basic moult when about 1 year old. Sexes, similar. Two subspecies that differ considerably with overlap in broad zone of intermediates. Subspecies *novaehollandiae* described below.

Adult Head and neck Forehead, feathered white but largely concealed by facial lappets described in Structure. Crown (as far as lower rim of eye), nape and centre of hindneck, black (89). Black stripe in centre of hindneck divides at junction with mantle. Face, chin, throat and sides of neck, white. **Upperparts** Mostly uniform olive-brown (c28–c91). Upper tail-coverts, white. **Underparts** White, except for large black crescent on each side of upper breast running up to meet narrow black (89) stripe down centre of hindneck. **Tail** Black (89), with white basal half to t1 that broadens to occupy basal 70% of t12. All rectrices have white tips, *c.* 5 mm wide when fresh, which narrow considerably with wear; t6 has grey-brown (c79–c91) basal 70% to outer web. **Upperwing** Tertials and marginal, lesser and median secondary coverts, uniform olive-brown (c28–c91). Primaries, primary coverts and most secondaries, black (89); median primary coverts have narrow white tips. Secondaries have brown-grey (c85) bases, concealed on outer 6–7 feathers but increasingly large and exposed on inner feathers; s11–s13 largely brown-grey with concealed black patches on inner webs. Greater secondary coverts, carpal coverts and small alula, brown-grey (c85); together with inner secondaries they form broad, slightly contrasting diagonal bar across upperwing. **Underwing** Coverts, white. Remiges, mostly black (c89); secondaries have white bases, increasingly large and exposed on inner feathers. Tertials and tips of innermost secondaries, pale grey (c85–c86).

Downy young Head and neck Forehead, buff (124). Crown and area directly behind eye, light brown (c39), sometimes speckled buff (c124), with much black (89) mottling, heaviest on centre of crown and directly above eye. Black (89) mottling least extensive on hindcrown but light-brown (39) areas of down here have black-brown (119) bases that are exposed in older individuals. Nape, black (89); sides of black nape-band extend almost to rear of eye. Lores covered by diagnostic strip of yellowish skin. Rest of head and neck, white; white hindneck forms conspicuous collar. **Upperparts, Wing-pads** Light-brown (c39) tips, speckled with buff (124), to light-brown (39) down-feathers, irregularly mottled black (89). Black (89) mottling heaviest on midline of upperparts and on extreme sides. All feathers have concealed black-brown (119) bases. **Underparts** Mostly white; rear-flanks washed buff (c124), with dark-brown (121) line running down outside of thighs. Dark-brown (121) line at sides of upper breast is shaped like black marking seen in adults.

Juvenile Fledge at *c.* 7 weeks. **Head and neck** Forehead, white; covered by facial lappets in older individuals. Crown to level with underside of eye, black (89), heavily mottled light-brown (39) when fresh; black (89) to black-brown (119) with less heavy buff (124) mottling when worn. Feathers, black (89) grading to black-brown (119) at base; sharply defined light-brown (39) tips become narrow and buff (124) when worn. Nape, black (89). Rest of feathers of head and neck, white except for narrow dark-brown (119A) stripe of rather downy feathers down centre of hindneck. Facial wattles, smaller than in adults, pendent loral wattles not hanging below level of mandibular rami at first. **Upperparts** Mostly olive-brown (c28–c91), at first, heavily scalloped by buff (124–c39) tips to feathers and broader black-brown (119) subterminal bands; latter narrow on mantle. Longest scapulars have buff (124–c39) distal ends with 1–2 black-brown (119) subterminal bands. When worn, most buff tips of upperparts lost; usually remain on longest scapulars while back and shorter scapulars remain speckled by remnants of dark subterminal bands. Upper tail-coverts, white with light-brown (c39) distal ends split by dark-brown (119A) subterminal bands; strands of down often remain attached to tips of upper tail-coverts. **Underparts** Mostly white; black-brown (119) sides of upper breast (similar in shape to those of adults) faintly mottled by buff (124) tips. **Tail** Similar to adult but tips of central feathers, cream (c92) and curve farther round edges of feathers; t1 also has light grey-brown (c45) spot

round distal end of shaft. **Upperwing** Tertials and median, lesser and marginal secondary coverts, as longest scapulars. Rest, similar to adults but greater secondary coverts, narrowly tipped white and median primary coverts, narrowly tipped buff (c124). Carpal spur, much shorter than in adults (see Structure, Measurements). **Underwing** Similar to adult.

Immature First basic; attained at *c.* 4 months. Closely similar to adults; sometimes distinguishable on length of carpal spur (see Measurements) and on remnants of juvenile plumage. When present, remnant juvenile upper wing-coverts most conspicuous ageing characters; though buff tips of juvenile upper wing-coverts may be entirely lost, black-brown subterminal bars remain rather conspicuous on some lesser coverts (especially near carpal) and inner median coverts. In some, all upper wing-coverts replaced in first pre-basic moult; ageing sometimes possible based on remnant juvenile rectrices (cream tips to inner rectrices and light grey-brown patch near tip of t1) and remiges (all narrower than in adults, this trend being most obvious on tertials; juvenile tertials can lose all traces of buff and black-brown marking with wear but remain obviously narrow). Facial lappets at first smaller than in adults but no repeatable measurements can be taken from skins.

Aberrant plumages Thomas (1966) reported an apparent case of non-phaeomelanic schizochroism: upperparts and upperwing of a Tas. *novaehollandiae* were light grey. Three records of partial albinism available for *novaehollandiae*: (1) adult skin (MV R5272) in which most plumage was white but primaries, secondaries, alula, greater secondary coverts and a few marginal coverts were coloured normally; (2) one bird, entirely white but for yellow facial lappets, black cap and breast (Tas., Lord 1984); (3) one bird, probably adult, white with apparently normal remiges and rectrices, some brown mottling on upper wing-coverts, yellow facial mask and pale-pink feet and legs (unpubl. photographs, Tas., G.A. Denholm).

BARE PARTS From photos (Barlow 1983; Coates 1985; Pringle 1986; Moon 1988; Aust. RD; NZRD; unpubl.: J.N. Davies, N. Marr).

Adult Bill, pale yellow (157, occasionally c54, c55) grading to white distal third with small dark-grey (83) tip to culmen. Iris, cream (54) to yellow (157, 55). Orbital ring, lores and attached facial lappets, pale yellow (157, 55); see Structure for notes on shape of lappets. Carpal spurs of wing, cream (54) to buff-yellow (153, 118) with black (82–89) tips. Feet and legs, dark pink (c4, c3, 108B) with dark-grey (83) tops of toes and front and rear edges to tarsus. Joints 'suffused with fresh tomato-red' for short period early in breeding season (Barlow 1983). **Downy young** At first: bill, pale grey (c86) with large dark-grey (83) areas at base and tip of culmen, and white egg-tooth. Iris, black-brown (119). Orbital ring and narrow strip of skin across lores, yellowish brown (c123) to buff-yellow (53) or cream (54). Feet and legs, grey (84–83). In older individuals: bill becomes cream (54) with varying pink (c108D, pale 7) patch in centre of culmen; tip of culmen, grey-black (82). Orbital ring and lappets of lores broaden in older chicks; pale yellow (c53–c157), sometimes tinged pale green (c59) at front of orbital ring. Feet and legs become pale grey (c86). Chicks have no carpal spur at hatching. **Juvenile** Bill: at first, cream (c92) with dark-grey (83) tip to culmen; with age, pale yellow (c157), with pale-grey (c86) to white distal end, tip of culmen remaining dark grey; adult colours attained before first pre-basic moult complete. Iris, dark brown (c121) with straw-yellow (57) outer ring that broadens with age; older juveniles have straw-yellow (157) iris with greener (c59) tinge round pupil. Orbital ring and facial wattles, pale yellow (157); wattles grow rapidly in juveniles and are almost fully grown at time of post-juvenile moult. Carpal spur, short (only 3–8 mm long) and rounded at tip; cream (c92), lacking darker tip. Feet and legs, light grey (c85–84), with dark-pink (4) tinge on sides of tarsus and toes spreading with age. **Immature** Similar to adult. Carpal spur generally shorter (see Measurements). Barlow (1983) found legs a useful ageing character: rather smooth with faint silvery tinge in immatures; look somewhat more scaly in adults with more knobbly joints.

MOULTS Except where stated, based on skins of 94 adults (30 nominate *miles*, 28 intermediates and 36 *novaehollandiae*) and 14 juveniles and immatures (HLW, MV, SAM, WAM).

Adult post-breeding Second and subsequent pre-basic moults; complete. Primaries usually moult outwards; this applied to 31 skins collected in active moult (16 *miles*, nine *novaehollandiae* and six intermediates) and was also the case in *c.* 60 *novaehollandiae* banded in Vic. (Barter 1992; M. A. Barter). Usually one or two primaries grow concurrently; five records of three primaries growing concurrently during outwards primary-moult, all from nominate *miles*. Waves of primary-moult are interrupted in a few individuals but moult apparently always resumes shortly afterwards at point of interruption. Seven records available of birds with irregular sequence of primary replacement; two of these were *novaehollandiae*, the others intermediates from L. Eyre catchment area. Most of these irregular sequences caused by moult of one or two primaries being skipped, replacement of skipped feathers beginning before outward moult-wave completed. In two intermediates, outward moult-waves began at two points (p1 and p6–p7); sequence in another intermediate with primary-moult $N^4 4^1 O^1 4^1 O^1 4^1 O^1$ defies logical explanation. Individuals with irregular sequences usually have three primaries growing concurrently, occasionally two or four. Sequence of tail-moult also varies; in nominate *miles* some replace rectrices in centrifugal moult, others begin tail-moult at t2 or t3 and others begin moult at two points, e.g. t3 and t5. Sequences of moult of secondaries and body, unknown. All available records of active moult in *novaehollandiae* from Nov. to Mar. (Barlow 1983; Barter 1992; above series of skins). Probable that moult can begin earlier than Nov., e.g. 13 Vic. adults in late Nov. already had median primary moult-score of 24 (Barter 1992). Duration of moult of primaries in individual *novaehollandiae*, unknown. Moult follows breeding but timing of moult in individuals that have bred unusually early or late, unknown. Perhaps of interest that timing of moult in adults captured during severe 1982–83 drought (Barter 1992) was not strikingly different from that of *novaehollandiae* collected or studied in non-drought years, though there are too few data to rule out small but significant differences in timing. Most nominate *miles* moult during wet season but timing varies considerably; earliest record (moult score 13) from Oct., latest records from June (moult score 49) and early July (moult score 40). One nominate *miles* with very worn feathers was midway through primary-moult in late July. In L. Eyre catchment area, intermediates have been collected in primary-moult from Sept. to Feb. **Adult pre-breeding** Probably no pre-alternate moult but no systematic notes on body-moult have been taken in early breeding season. No seasonal change in appearance of plumage and, in general, feathers of body show similar amount of wear to remiges. **Post-juvenile** First pre-basic. Partial, not involving primaries or secondaries. Moult begins at 2–3 months old, and stops at *c.* 4 months old (Barlow 1983; skins). Some individuals retain a few juvenile feathers in upperwing (especially inner medians and outer lesser and marginal coverts), in tail and in tertials; less commonly a few juvenile feathers retained in mantle and scapulars. Barlow (1983) has also mentioned juvenile

plumage retained in crown of individuals that hatched late but it is not clear whether these birds had completed moult or not.

MEASUREMENTS (1) Subspecies *novaehollandiae*: Vic., coastal NSW and se. SA, adult, skins; SPUR = maximum length of carpal spur as measured from the side of the base closest to carpal joint (HLW, MV, SAM, WAM). (2) Nominate *miles*: Kimberley, WA, Top End, NT, and C. York Pen., Qld, adult, skins (HLW, MV, SAM, WAM). (3) Adult intermediates: L. Eyre catchment area, mostly ne. SA (SAM); for further information on this sample, see Geographical Variation. Barlow *et al.* (1972) present measurements of spur from Southland, NZ; their data also indicate that length of spur is of little use in sexing.

		MALES	FEMALES	
WING	(1)	252.6 (5.91; 244–268; 19)	247.6 (5.80; 238–258; 13)	*
	(2)	227.2 (4.93; 216–237; 14)	223.2 (6.19; 213–233; 15)	ns
	(3)	242.9 (7.94; 231–260; 12)	235.8 (6.45; 223–248; 15)	**
8TH P	(1)	178.3 (5.29; 171–189; 17)	174.9 (5.16; 170–185; 12)	ns
	(2)	164.0 (7.23; 157–178; 7)	158.7 (4.77; 152–167; 7)	ns
SPUR	(1)	14.9 (1.41; 12.1–16.9; 19)	13.6 (2.36; 10.3–18.9; 12)	ns
	(2)	13.7 (2.61; 10.4–17.8; 9)	11.3 (2.41; 7.0–14.3; 8)	ns
TAIL	(1)	107.0 (3.94; 101–114; 19)	104.0 (3.68; 96–110; 12)	*
	(2)	95.4 (2.27; 93–100; 9)	92.5 (2.12; 89–95; 8)	*
BILL	(1)	33.6 (1.61; 30.5–36.1; 18)	33.1 (1.39; 30.6–35.2; 13)	ns
	(2)	36.1 (2.01; 33.9–40.8; 13)	35.2 (1.89; 30.9–38.7; 12)	ns
	(3)	34.7 (1.30; 32.6–36.8; 12)	34.1 (1.61; 31.0–37.5; 15)	ns
TARSUS	(1)	78.3 (3.09; 72.0–83.3; 19)	74.7 (3.40; 69.1–81.0; 13)	**
	(2)	79.2 (3.26; 73.7–84.7; 14)	76.9 (3.43; 69.2–81.9; 15)	ns
	(3)	77.1 (2.60; 73.5–81.8; 13)	75.6 (3.50; 69.6–80.3; 15)	ns
TOE C	(1)	38 (1.2; 36–40; 9)	36.7 (1.02; 34.9–38.3; 8)	*
	(2)	38.0 (1.42; 35.7–39.6; 4)	36.8 (0.77; 35.6–37.9; 5)	ns

Subspecies *novaehollandiae*, Vic.: (1) Adult, live; THL = total head-length (Barter 1992); (2) First year, live; most captured Feb.–June and thus likely to be in first-basic plumage (Barter 1992). Immatures and adults similar in size but spurs significantly shorter in immatures. Difference is still more striking in some immature skins, in which spur can be as short as 5.5 mm. Further research may show length of spur to be useful guide to ageing.

		UNSEXED
WING	(1)	250.8 (6.82; 234–264; 86)
	(2)	251.1 (8.06; 232–265; 32)
SPUR	(1)	16.2 (2.41; 11.5–21.4; 23)
	(2)	13.4 (3.76; 8.5–19.8; 10)
BILL	(1)	33.5 (2.00; 30.0–37.0; 23)
	(2)	34.6 (1.18; 33.4–37.2; 11)
THL	(1)	73.1 (1.72; 69.2–75.7; 36)
	(2)	74.1 (1.54; 71.8–76.1; 7)

WEIGHTS (1) Subspecies *miles*: Kimberley, WA, to C. York Pen., n. Qld, adults; combined data from labels (SAM, WAM) and Hall (1974). (2) Intermediates: L. Eyre catchment area of ne. SA, adults (Hall 1974; SAM). (3) Subspecies *novaehollandiae*: se. Aust. and NZ, adults; combined data from labels (SAM, MV), Bailey & Sorensen (1962) and Barlow *et al.* (1972).

	MALES	FEMALES	
(1)	264.2 (20.3; 230–300; 14)	252.8 (23.3; 191–296; 15)	ns
(2)	313.3 (37.1; 252–279; 10)	312.1 (17.2; 290–344; 11)	ns
(3)	370.2 (31.9; 338–412; 11)	349.4 (31.6; 296–410; 9)	ns

Unsexed adult *novaehollandiae* from Vic., 387.0 (26.5; 333–440; 96); significantly heavier than first-year birds (mostly immatures) from Vic. weighing 372 (37.8; 317–465; 32) (Barter 1992). For information on rates of growth of chicks, see Breeding, Thomas (1969) and Barlow *et al.* (1972).

STRUCTURE Wing, broad and rather long. Eleven primaries; p8 and p9 longest, about equal; p10 0–5 shorter, p7 1–8, p6 8–21, p5 21–39, p4 32–54, p3 42–65, p2 53–76, p1 66–86; p11 minute. Slight emargination on outer webs of p6–p9 and on inner webs of p10 and sometimes p9. Eighteen secondaries, including 5–6 tertials. Large spur on leading-edge of wing, just outside carpal joint; it is slightly flattened in the same plane as wing and points forwards when wing folded; sharp and slightly upcurved when fully grown; blunt and knob-like in juveniles (Frith 1969). Spur grows slowly (only 3–8 mm long in juveniles) and is generally shorter in immatures than in adults; horny outer layer of spur shed periodically. Tail, square; 12 feathers. Bill, about length of head and moderately slender; mostly straight but culmen and tomia gently decurved at tip. Nostrils, slit-like, set in large nasal groove running along basal two-thirds of lower mandible. Both subspecies have large yellow facial wattles, anchored on lores and orbital ring; subspecies *novaehollandiae* has: (1) a pair of triangular flaps of skin from lores that drape across forehead and usually overlap slightly; they extend back to rear edge of eye; (2) a longer triangular flap of skin hanging from lores, dangling slightly less than one bill-depth below mandibular rami; rear edge of this lappet meets front lower edge of orbital ring. Legs, fairly long; distal half of tibia, unfeathered. Tarsus, scutellate in front with series of square scutes c. 3 mm wide; reticulate elsewhere with scales smallest on outside edge of tarsus. Toes, short with short straight claws; outer toe c. 81% length of middle, inner toe c. 74%, near-vestigial hind toe c. 18%.

RECOGNITION Downy young most readily distinguished from downy young of Banded Lapwing by: (1) strip of yellowish skin on lores; (2) pale buff, rather than orange-buff, forehead; (3) no dark markings below eye; lower ear-coverts of Banded Lapwing mottled dark brown and buff.

GEOGRAPHICAL VARIATION Considerable; a tropical and a temperate subspecies occur with broad zones of intermediates between. Subspecies *novaehollandiae* occurs in s. half of e. Aust. and in NZ; see Plumages and Bare Parts. Nominate *miles*, once considered separate species, occurs in tropical Aust. and s. New Guinea and differs in many characters (see Figs 6a,c, 7a,c): (1) facial lappets much larger; in adults, forehead lappet extends behind eye for about two eye-widths; pendent lappet from lores, longer, dangling about two bill-depths below mandibular rami; rear edge of this lappet meets bottom rear or rear of orbital ring; lappets are smaller in younger *miles* but even in chicks there are distinct lobes behind the eyes and below the lores; (2) in adults,

Figure 6a *novaehollandiae* Figure 6b intermediates Figure 6c *miles*

Figure 6

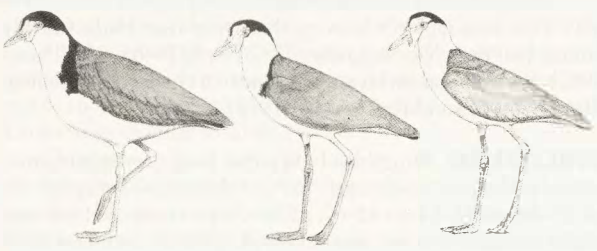

Figure 7a *novaehollandiae* Figure 7b intermediates Figure 7c *miles*

Figure 7

black cap smaller than in *novaehollandiae*, only extending to mid-level of eye; also, seldom has a black stripe in centre of white hindneck; dark cap similarly restricted in downy young and juveniles of *miles*; (3) upperparts and upper wing-coverts of adults and immatures, light grey-brown (c91–c27), paler and greyer than in *novaehollandiae*; (4) underparts, wholly white at all ages, lacking black marking at sides of breast; (5) pale diagonal bar of upperwing (juveniles, immatures, adults), paler grey (c85–c86) than in *novaehollandiae* and contrasts more boldly; (6) carpal spur lacks black tips; (7) culmen of adults often lacks dark tip invariably present in *novaehollandiae*; (8) feet and legs, dark pink (198B) to pink-red (c12); scutes on front of tarsus have dark-grey (83) centres, smaller and less striking than dark markings on legs of *novaehollandiae*; (9) smaller and lighter than *novaehollandiae*, with significantly shorter wing and tail; bill is significantly longer than that of *novaehollandiae*; tarsus about same length as in *novaehollandiae* but because it has a smaller body and more exposed skin on tibia, looks a longer-legged bird.

Nominate *miles* and *novaehollandiae* interbreed in zone of intermediates (Figs 6b, 7b). Distributional limits of subspecies not fully understood; often assumed that there is a broad continuous zone of intermediates (e.g. Hayman *et al.* 1986) but only two areas adequately known and described: (1) breeding ranges of *miles* and *novaehollandiae* meet in Townsville, n. Qld, where intermediates also occur; only *miles* occurs at Cairns (c. 280 km farther N) and only *novaehollandiae* occurs at Mackay (c. 330 km farther S) (van Tets *et al.* 1967); (2) SAM holds large series of intermediates, including breeding individuals, collected throughout large L. Eyre catchment area under the direction of late S.A. Parker. One record is of nominate *miles*, 13 of *novaehollandiae* and 46 are intermediates. Interbreeding of subspecies obviously common in this area, though it is not clear how much (if any) bias towards collection of intermediates occurred. In both areas, occurrence of most characters of *miles* in intermediates is correlated, e.g. individuals with large facial lappets usually also have pale upperparts, restricted black on crown, sides of breast and tips of spurs. In some intermediates, dark areas on lateral breast are mostly light grey-brown (c91), sometimes with black patches towards centre of breast. In *novaehollandiae*-like intermediates, characters of *miles* most often expressed are slightly enlarged lappets, with lobe of forehead lappet extending slightly behind eye. Most persistent character of *novaehollandiae* in *miles*-like hybrids is usually slightly larger black cap, with black stripe running down hindneck.

It is not known if measurements are related to plumage characters in intermediates. In only sample of intermediates measured (Measurements for L. Eyre Catchment data), means for wing, bill and weight were intermediate between *miles* and *novaehollandiae*. However variances for these samples were surprisingly small, considering that intermediates measured showed almost complete range of plumage variation between *miles* and *novaehollandiae*. More data needed to find if mensural variation clinal rather than following subspecies limits.

Origin of NZ population unknown. Said to have been derived from birds from n. part of range of *novaehollandiae*, from se. coast Qld and n. coast NSW (Brathwaite & van Tets 1975; Dann 1977), based on claim that *novaehollandiae* from this area differed from *novaehollandiae* elsewhere (Brathwaite & van Tets 1975), though neither claim has been confirmed. Most, if not all, NZ birds are typical *novaehollandiae* with no intermediate characters and with much black on hindneck and sides of breast (e.g. photos in Barlow 1983; Moon 1988; NZRD; unpubl.: D.I. Rogers) and no other claims of intermediates in NZ have been published. Measurements from NZ and e. coast of Aust. would help clarify origins of NZ population. Eggs in NZ are significantly smaller than in Tas. and Vic. but similar in size to a small sample from NSW (Dann 1977); apparent difference between mainland Aust. and NZ birds needs further investigation.

Measurements from NZ and e. coast of Aust. would help clarify origins of NZ population.

REFERENCES

Alcorn, R. 1990. *Stilt* 16: 9–22.
Allen, P. 1967. *Aust. Bird Bander* 5: 30–32.
Amiet, L. 1957. *Emu* 57: 236–54.
Anon. 1962. *Aust. Bird Bander* 1: 39.
—— 1969. *Aust. Bird Bander* 7: 16.
—— 1982. *Corella* 6: 46–8.
—— 1983. *West. Aust. Bird Notes* 28: 9–10.
—— 1986. *West. Aust. Bird Notes* 38: 7–8.
Attiwell, A.R. 1972. *S. Aust. Orn.* 26: 59–64.
Aumann, T. 1991. *Aust. Bird Watcher* 14: 51–67.
Badman, F.J., & I.A. May. 1983. *S. Aust. Orn.* 29: 29–39.
Bailey, A.M., & J.H. Sorensen. 1962. *Proc. Denver Mus. Nat. Hist.* 10: 1–305.
Barlow, M.L. 1972. *Notornis* 19: 201–11.
—— 1978. *Notornis* 25: 150.
—— 1983. *The Year of the Spur-winged Plover*. Craig, Invercargill.
—— 1988. *Notornis* 35: 195–6.
——, *et al.* 1972. *Notornis* 19: 212–49.
Barter, M.A. 1992. *Stilt* 21: 24–5.
Bedggood, G.W. 1973. *Aust. Bird Watcher* 5: 12–22.
Beehler, B.M., *et al.* 1986 *Birds of New Guinea*. Princeton Univ. Press, Princeton, New Jersey.
Belcher, C.F. 1914. *Birds of the District of Geelong*. Griffiths, Geelong.
Bell, H.L. 1966. *Emu* 66: 32.
—— 1985. *Corella* 9: 108–13.
Blaber, S.J.M. 1990. *Emu* 90: 205–14.
Boehm, E.F. 1960. *Emu* 60: 211–18.
Boekel, C. 1980. *Aust. Bird Watcher* 8: 171–93.
Bourke, P.A. 1948. *Emu* 47: 321–30.
—— 1953. *Emu* 53: 105–8.
Bransbury, J. 1985. *S. Aust. Orn.* 29: 180–7.
Brathwaite, D.H., & G.F. van Tets. 1975. *Notornis* 22: 180–1.
Bravery, J.A. 1970. *Emu* 70: 49–63.
Burger, J., & M. Gochfeld. 1985. *Emu* 85: 47–8.
Campbell, J. 1985. *Stilt* 7: 21–2.
Carruthers, R.K. 1966. *Aust. Bird Watcher* 2: 211–14.
Child, P. 1975. *Notornis* 22: 143–50.
Close, D.H., & R.P. Jaensch. 1984. *S. Aust. Orn.* 24: 81–9.
Coates, B.J. 1985. *The Birds of Papua New Guinea. 1*. Dove Publs, Alderley, Qld.
Condon, H.T., & A.R. McGill. 1952. *Field Guide to the Waders*. Bird Obs. Club, Melbourne.
Cooper, R.P. 1966. *Aust. Bird Watcher* 2: 225–37.
Crawford, D. 1975. *S. Aust. Orn.* 26: 193–5.
Crawford, D.N. 1972. *Emu* 72: 131–48.
D'Ombrain, E.A. 1928. *Emu* 28: 110.
Dann, P. 1977. *Notornis* 24: 284–5.

— 1981. *Emu* 81: 121–7.
Davies, R. 1967. *Aust. Bird Watcher* 3: 30–1.
Dove, H.S. 1936. *Emu* 35: 218.
— 1937. *Emu* 37: 61–2.
— 1938. *Emu* 37: 184.
Draffan, R.D.W., *et al.* 1983. *Emu* 83: 207–34.
Emison, W.B., & J.W. Porter. 1978. *Emu* 78: 126–36.
Falla, R.A., *et al.* 1966. *A Field Guide to the Birds of New Zealand*. Collins, Lond.
Favaloro, N. 1944. *Emu* 43: 145–53.
Fielding, P. 1979. *Tasm. Nat.* 56: 7–8.
Fjeldså, J. 1985. *Emu* 85: 141–9.
Fletcher, J.A. 1908. *Emu* 8: 79–80.
— 1924. *Emu* 24: 107–17.
— 1933. *Emu* 33: 58–9.
Ford, J. 1960. *Emu* 60: 57–60.
Frith, H.J. (Ed.) 1969. *Birds in the Australian High Country*. Reed, Sydney.
—, & S.J.J.F. Davies. 1961. *Emu* 61: 97–111.
Gell, P. 1977. *Aust. Bird Watcher* 7: 52–5.
Gibson, D.B., & J.R. Cole. 1988. *Tech. Rep. Cons. Comm. North. Terr.* 40.
Gibson, D.F. 1986. *Tech. Rep. Cons. Comm. North. Terr.* 30.
Gibson, J.D. 1977. *Aust. Birds* 11: 41–74.
Giese, M.A. 1990. Unpubl. BSc(Hons) thesis, Griffith Univ.
Gray, N. 1967. *West. Aust. Nat.* 10: 138.
Green, R.H. 1966. *Emu* 66: 105–10.
Hall, B.P. (Ed.) 1974. *Birds of the Harold Hall Australian Expeditions, 1962–70*. Brit. Mus. (Nat. Hist.), Lond.
Harris, J.G.K. 1980. *Tasm. Nat.* 60: 1–6.
Hayman, P., *et al.* 1986. *Shorebirds*. Croom Helm, Sydney.
Hermes, N., *et al.* 1986. *Notornis* 33: 141–9.
Heron, S. 1970. *Aust. Bird Watcher* 3: 269–72.
Hindwood, K.A., & J.M. Cunningham. 1950. *Emu* 50: 23–35.
—, & E.S. Hoskin. 1954. *Emu* 54: 217–55.
Hitchcock, W.B. 1964. *Tech. Pap. Div. Wildl. Res. CSIRO, Aust.* 7.
Hobbs, J.N. 1961. *Emu* 61: 21–55.
— 1968. *Aust. Bird Watcher* 3: 128–30.
Hoskin, E.S. 1991. *The Birds of Sydney*. Surrey Beatty & Sons, Chipping Norton.
Hutton, I. 1990. *Birds of Lord Howe Island Past and Present*. Author, Coffs Harbour.
Hyem, E.L. 1936. *Emu* 36: 109–27.
Innes, H.H. 1930. *Emu* 30: 61.
Jaensch, R. 1986. *West. Aust. Bird Notes* 40: 2–3.
—, & R.M. Vervest. 1990. *RAOU Rep.* 32.
Johnstone, R.E. 1983. *Wildl. Res. Bull. West. Aust.* 11: 54–69.
—, *et al.* 1981. *Wildl. Res. Bull. West. Aust.* 10: 46–53.
Kersey, H.J. 1919. *Emu* 19: 50–3.
Lane, B. 1987. *Shorebirds in Australia*. Nelson, Melbourne.
Lavers, R. 1980. *OSNZ News* 16: 4.
Lavery, H.J. 1969. *Qld J. agric. Anim. Sci.* 26: 447–55.
— 1986. *Emu* 86: 111–13.
Legge, R.W. 1910. *Emu* 10: 51.
Legge, W.V. 1901. *Emu* 1: 82–6.
Liddy, J. 1960. *Emu* 60: 203–10.
— 1969. *Aust. Bird Bander* 7: 12–14.
Lindgren, E. 1958. *West. Aust. Nat.* 6: 124–30.
Littler, F.M. 1910. *A Handbook of the Birds of Tasmania and its Dependencies*. Author, Launceston.
Longmore, N.W. 1973. *Birds (J. NSW FOC)* 8: 33–5.
— 1978. *Sunbird* 9: 25–53.
Lord, E.A.R. 1956a. *Emu* 56: 100–28.
— 1956b. *Emu* 56: 163–4.
Lord, M.K. 1984. *Tasm. Nat.* 76: 5.
Loyn, R.H. 1978. *Emu* 78: 11–19.
McEvey, A. 1965. *Emu* 65: 1–56.
McFarland, D. 1988. *Emu* 88: 249–57.
McGarvie, A.M., & M.T. Templeton. 1974. *Emu* 74: 91–6.
McKean, J.L. 1963. *Aust. Bird Watcher* 2: 60.
McKeown, K.C. 1934. *Rec. Aust. Mus.* 19: 113–35.
Moffat, M. 1981. Unpubl. MSc thesis, Massey Univ.
Moon, G. 1988. *New Zealand Birds in Focus*. Weldon Auckland.
Moore, J.L. 1981. *Notornis* 28: 50–6.
Morris, A.K. 1975. *Aust. Birds* 9: 37–76.
—, *et al.* 1990. *Aust. Birds* 23: 44–65.
Napier, J.R. 1969. *Aust. Bird Watcher* 3: 179–92.
Park, P. 1983. *Occ. Stint* 2: 15–33.
Parker, S. 1969. *S. Aust. Orn.* 25: 59–71.
Patterson, R.M. 1982. *Occ. Stint* 1: 21–8.
Pearson, A.J. 1966. *Bull. Br. Orn. Club* 86: 66–71..
— 1981. *Emu* 81: 121–7.
Pegler, J.M. 1983. *Aust. Birds* 17: 38–42.
Pierce, R.J. 1980. *Notornis* 27: 21–44.
Pizzey, G. 1980. *A Field Guide to the Birds of Australia*. Collins, Sydney.
Powlesland, R.G., & H.A. Robertson. 1987. *Notornis* 34: 327–38.
Prestedge, C.K. 1983. *Bird Obs.* 621: 89.
Pringle, J.D. (Ed.) 1986. *Shorebirds of Australia*. Angus & Robertson, Sydney.
Purchase, D. 1970. *Tech. Pap. Div. Wildl. Res. CSIRO, Aust.* 21.
Quinn, W.L. 1962. *Aust. Bird Watcher* 1: 236–7.
Reilly, P.N., *et al.* 1975. *Emu* 75: 73–6.
Roberts, G.J. 1981. *S. Aust. Orn.* 28: 175–7.
Roberts, N.L. 1936. *Emu* 36: 54–5.
Rose, A.B. 1973. *Emu* 73: 177–83.
— 1974. *Aust. Birds*. 9: 26–30.
Sansom, O. 1951. *Notornis* 4: 138–9.
Schulz, M. 1990. *Stilt* 17: 40–3.
—, & K.A. Menkhorst. 1984. *Stilt* 5: 21–4.
Serventy, D.L., & H.M. Whittell. 1976. *Birds of Western Australia*. Univ. West. Aust. Press, Perth.
Serventy, V.N., & W.H. Butler. 1956. *West. Aust. Nat.* 5: 235.
Sharland, M.S.R. 1930. *Emu* 30: 43–7.
— 1943a. *Emu* 42: 164–6.
— 1943b. *Emu* 43: 95–6.
Slater, P. 1959. *West. Aust. Nat.* 7: 35–41.
Smith, F.T.H. 1965. *Aust. Bird Watcher* 2: 128–34.
— 1966. *Aust. Bird Watcher* 2: 246–66.
Stephen, W.J. 1907. *Emu* 7: 88.
Stokes, T. 1988. *ANPWS Occ. Pap.* 16.
Storr, G.M. 1980. *Spec. Publs West. Aust. Mus.* 11.
— 1984. *Rec. West. Aust. Mus. Suppl.* 19.
— 1987. *Rec. West. Aust. Mus.* 27.
—, & R.E. Johnstone. 1988. *Rec. West. Aust. Mus.* 28.
Thomas, D.G. 1966. *Emu* 65: 208.
— 1968. *Emu* 68: 95–125.
— 1969. *Emu* 69: 81–102.
Thompson, H.A.F., & D.K. Goodfellow. In prep. *Annotated List of the Birds of the Top End*.
Thomson, D.F. 1935. *Birds of Cape York Peninsula*. Green, Melbourne.
Tratt, T., & P. Tratt. 1988. *Bird Obs.* 681: 131.
van Tets, G.F. 1972. *Emu* 72: 115.
—, & W.J.M. Vestjens. 1973. *Tech. Memo. Div. Wildl. Res. CSIRO, Aust.* 8.
—, *et al.* 1967. *Emu* 67: 85–93.
—, *et al.* 1969. *CSIRO Wildl. Res.* 14: 129–51.
—, *et al.* 1977. *Guide to the Recognition and Reduction of Aerodrome Bird Hazards*. Aust. Govt. Publ. Serv., Canberra.
Vervest, R. 1988. *West. Aust. Bird Notes* 47: 2–3.
—, & R. Jaensch. 1987. *West. Aust. Bird Notes* 43: 2–3.
Vestjens, W.J.M. 1973. *Emu* 73: 107–12.
— 1977. *Tech. Memo. Div. Wildl. Res. CSIRO, Aust.* 12.
Warham, J. 1962. *Emu* 62: 99–111.
Wheeler, R. 1955. *Emu* 55: 279–95.
Wheeler, W.R. 1962. *Aust. Bird Watcher* 1: 220–2.
— 1967. *Aust. Bird Watcher* 3: 55–76.
White, C.M.N., & M.D. Bruce. 1986. *BOU Checklist* 7.
White, J.R. 1983. *West. Aust. Nat.* 15: 168.
Wood, K. 1985. *Aust. Birds* 19: 17–38.

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Volume 2, Plate 68

Masked Lapwing *Vanellus miles* (page 943)
1 Adult, subspecies *novaehollandiae*; **2** Adult, nominate *miles*; **3** Downy young, subspecies *novaehollandiae*; **4** Downy young, nominate *miles*; **5** Juvenile, subspecies *novaehollandiae*; **6, 7** Adult, subspecies *novaehollandiae*

Banded Lapwing *Vanellus tricolor* (page 935)
8 Adult; **9** Downy young; **10** Juvenile; **11, 12** Adult