

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	seed-snipes; 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.
Ibidorhynchidae	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, Procellariiformes, 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 charadriids and allies (Chionididae, Burhinidae, Haematopodidae, Recurvirostridae, Ibidorhynchidae, Charadriidae, Pluvianellidae, Dromadidae, Glareolidae, Stercorariidae, 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 charadriids (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, Stercorariidae, Laridae and Sternidae will be dealt with in Volume 3 of HANZAB.

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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, holorrhinal, 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 (Fjelds  1977).

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

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Sub-family CHARADRIINAE plovers

Generally small birds, usually smaller than lapwings (Vanellinae). Apparently a monophyletic assemblage. About 40 species in five (Voous 1973; Strauch 1978; BWP) to 10 genera (Sibley & Ahlquist 1990; Sibley & Monroe 1990; Christian *et al.* 1992), with most species in two genera, *Pluvialis* and *Charadrius*, and varying number of genera composed of only one or a few species (e.g. *Anarhynchus*, *Phegornis*, *Thinornis*, *Elseyornis*). The affinities of *Phegornis* (Diademed Sandpiper-plover of South America) have not been resolved (Sibley & Monroe 1990). Recent studies of allozymes of Aust. plovers and lapwings (Christian *et al.* 1992) indicate that Red-kneed Dotterel *Erythrogonys cinctus* is a lapwing (Vanellinae; q.v.).

We recognize the following genera within the Charadriinae in HANZAB region:

Pluvialis. Two regular non-breeding migrants (*fulva*, *squatarola*), two doubtfully recorded (*dominica*, *apricaria*). We follow Connors *et al.* (1983, 1993) and treat *fulva* and *dominica* as full species.

Charadrius. Four breeding species (*obscurus*, *ruficapillus*, *bicinctus*, *australis*), six non-breeding migrants (*hiaticula*, *dubius*, *mongolus*, *leschenaultii*, *asiaticus*, *veredus*), one accidental (*tricoloris*); one doubtfully recorded (*alexandrinus*). Inland Dotterel *C. australis* is a typical *Charadrius* plover (Maclean 1976; Christian *et al.* 1992 *contra* Jehl 1968); we follow NZCL in placing New Zealand Dotterel in *Charadrius*.

Thinornis. Two endemic species: *novaeseelandiae* and *rubricollis*.

Allozymes of *rubricollis* form a cluster (with *Elseyornis melanops*) well separated from those of typical *Charadrius*; placed in *Thinornis* on basis of similarities in morphology (Christian *et al.* 1992) and behaviour (Phillips 1980).

Elseyornis. Single species *melanops*, endemic to Aust. Allozymes, with those of *Thinornis rubricollis*, well separated from *Charadrius* (Christian *et al.* 1992).

Anarhynchus. Single species *frontalis*, endemic to NZ.

Thus, in HANZAB region, eight breeding species, eight non-breeding migrants, and four accidental or not acceptably recorded.

General features of the sub-family are outlined under Charadriidae. The plumages of *Pluvialis* are spangled in white or gold and black above, black below when breeding, and never with white band across nape; plumages of *Charadrius* and other genera in general plain brownish above and white below, boldly marked with black on face and head, at least when breeding;

usually with one or two black or chestnut bands across breast and often with white band across nape. Two moults per cycle: complete post-breeding moult, primaries outwards; and partial pre-breeding moult, which often brings in much brighter breeding plumage; supplemental plumage occurs in at least one species (Eurasian Golden Plover *Pluvialis apricaria*). Down of pebbled pattern (Jehl 1968; Fjeldså 1977, 1988; BWP). Juvenile plumage duller than adults in most species, with pale dorsal scalloping. Adult plumage attained at 1–2 years. Most probably first breed at 1–2 years, maturity perhaps delayed further in some migratory species (e.g. Gréy Plover *Pluvialis squatarola*).

Inhabit open places; when not breeding, many are typically birds of ocean beaches, coastal mudflats and estuaries; others use rivers and freshwater wetlands, often ephemeral; still others characteristic of dry habitats, including gibber plains, grasslands and steppes. Breeding may occur in any of these habitats, or in tundra or high-altitude moorlands. Most species probably migrate to some extent; about 15 species are long-distance transequatorial migrants. Diet consists of terrestrial and coastal invertebrates. When foraging, tend to spread out and feed separately over wide area, rather than feeding in flocks as do many scolopacids. In general, gregarious but less so than many scolopacids. Roost communally. Usually territorial when breeding; some species may defend feeding territories in wintering areas. Various mating systems recorded in different species: monogamy, polyandry (associated with sexual reversals), polygyny and polygamy. While breeding, generally rather aggressive, defending and advertising territories with displays on the ground and in the air, often with butterfly-like flights and song (long melodious trills). Courtship and mating behaviour often complex or stereotyped. Anti-predator strategies, injury-feigning and distraction displays generally elaborate and well developed. Most vocal during breeding season with variety of peeps, trills and mellow or liquid whistles.

Breed seasonally. Nest, a simple scrape on the ground, sparsely lined with plant stems, grasses and other objects; in open, often unvegetated places. Several scrapes may be prepared by male and one then selected by female. Eggs, oval, short oval or even somewhat pyriform; smooth, not glossy; ground-colour, buff, brown or grey, heavily blotched and spotted dark, well camouflaged. Clutch-size, 2–4, often consistently of one size in a species (e.g. two in *C. ruficapillus*). Laying at intervals of 24–60 h. Replacement laying, up to several times. Incubation by both sexes in monogamous species but share varies and is by male alone in Eurasian Dotterel *Eudromias morinellus*, the only plover in which female more brightly coloured than male. Incubation period, 24–31 days. Young hatched in natal down; precocial, nidifugous. Usually tended by both parents but feed themselves from hatching. Fledged in 3 (smaller species) to 5 (larger species) weeks.

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Charadrius bicinctus Double-banded Plover

COLOUR PLATE FACING PAGE 801

Charadrius bicinctus Jardine & Selby, 1827, *Ill. Orn.* 1: Pl. 28 and text — New Holland = New South Wales, *apud* Mathews 1912, *Nov. Zool.* 18:216.

The Latin *bicinctus* means 'two- (*bi*) girdled or encircled (*cinctus*)', referring to the black and chestnut bands of breeding plumage.

OTHER ENGLISH NAMES Double-banded Dotterel, Chestnut-breasted Plover.

NZ Banded Dotterel.

Double-banded is needed to avoid any confusion with the traditional usage of Banded Plover for *Vanellus tricolor* in Australia.

POLYTYPIC Nominate *bicinctus*, NZ and islands, migrating to Aust., Tas., Norfolk and Lord Howe Is; *exilis* Falla, 1978, Auckland Is.

FIELD IDENTIFICATION Nominate subspecies. Length: 18–21 cm; wingspan: 37–42 cm; weight: 60–80 g. Small plump plover with rather slender black bill and more upright stance than other small plovers; only plover in HANZAB region with two breast-bands. Slightly smaller than Mongolian Plover *Charadrius mongolus*, with shorter legs and finer bill; much smaller and with finer bill than New Zealand Dotterel *C. obscurus*. In breeding plumage, sexes separable especially when together; usually not separable in non-breeding plumage. Marked seasonal variation. Juvenile, distinct; first immature, separable.

Description Nominate *bicinctus*. **Adult male breeding** Crown, nape, hindneck, sides of neck and ear-coverts, dark grey-brown, with black frontal band between crown and white forehead; off-white supercilium to just behind eye; some have diffuse whitish arc beneath eye, which with whitish supercilium gives impression of broad pale eye-ring. Lorale stripe, black, joining narrowly over bill and merging below eye with blackish-brown line along lower border of ear-coverts, down sides of neck and into narrow black band across upper breast, separated from broad dark-chestnut band across lower breast by area of white; rest of underbody, white. Rest of upperparts and inner wing-coverts, uniform dark grey-brown with narrow rufous fringes when fresh;

wear also creates slightly paler, diffuse grey-brown wing-covert panel below scapulars. In flight, from above, blackish-brown remiges and primary coverts (slightly darker than rest of upperparts), with narrow white wing-bar formed by white bases to inner primaries and narrow white tips of greater secondary coverts; narrow white sides to rump; and rather dark, blackish-brown tail, with outermost feather white. Under wing-coverts, mostly white; undersides of remiges, pale grey. Bill, black. Iris, dark brown. Legs and feet, pale grey-green to yellowish green. **Adult female breeding** As male except: frontal bar, narrower and less clear-cut; black on head and upper breast-band duller, blackish-brown; and lower breast-band, duller chestnut. A few breed in plumage similar to non-breeding, without any trace of dark head markings, and both breast-bands, grey-brown. **Adult non-breeding** Similar to breeding but without any black and chestnut; differ in pattern of head and breast: crown and nape, dark grey-brown, without dark frontal bar; pale buff collar merging into white of throat; supercilium more prominent and longer, broadening over and behind eye to squarish end above rear ear-coverts; supercilium, lores, cheeks and collar, buff, fading to cream with wear. Underbody, white, with throat, foreneck and breast, buff, fading to cream with wear; upper breast-band reduced to narrow

dark grey-brown lateral patch or half-collar, and lower band to broader, often diffuse, lateral patch, which together form diagnostic double breast-tab. **Juvenile** Similar to adult non-breeding, differing by: crown, upperparts and inner wing-coverts, slightly darker grey-brown, finely streaked darker and scaled whitish buff (scaling rather quickly reduced or lost with wear); underbody, off-white, with varying grey area across breast (covering area of both breast-bands of adult), within which varying complete darker upper breast-band and indication of lower band; some have greyish smudging on centre of lower throat. Legs and feet tend to have stronger yellowish tinge. **Immature** Like adult non-breeding but at first retain worn juvenile inner wing-coverts, which show as paler panel of scaly feathers that contrast with fresh feathers with rufous fringes of upperparts (like adult). All birds acquire breeding plumage by Aug.–Sept. and then usually inseparable from adult breeding.

Similar species Breeding adult unmistakable; only plover in HANZAB area with two breast-bands. Non-breeding adults and juveniles can be confused with corresponding plumages of **Montgolian Plover** and **Large Sand Plover** (q.v. for fuller distinctions) but distinguished by smaller size, finer bill, shorter legs, darker upperparts, and characteristic double breast-tabs.

In pairs during breeding season; gregarious in non-breeding season; often feed in small loose groups, form large communal roosts; seldom join flocks of other waders. Breed in NZ, mostly inland and mainly on dry, open, well-consolidated parts of sandy or stony river beds; when not breeding, found on coastal and freshwater wetlands, sometimes well inland. Feed in typical stop-start plover fashion. Normal stance rather more upright than other plovers. Usual flight and anxiety call a clear incisive chip, often repeated three or four times.

HABITAT Littoral, estuarine and fresh or saline terrestrial wetlands; also saltmarsh, grasslands and pasture. Stable banks of graded shingle, gravel or sand, of wide braided rivers, bare of vegetation or with low coarse sparse vegetation of tussocks, moss and lichen (Soper 1959; Pierce 1980a, 1983, 1989; Bomford 1986, 1988); muddy, sandy, shingled or sometimes rocky beaches, bays and inlets, harbours and margins of fresh or saline terrestrial wetlands: lakes, lagoons and swamps, shallow estuaries and lacustrine river mouths (Stidolph & Fleming 1939–40; Smith 1966; Child 1967; Morris 1975; Pierce 1980a,b, 1983, 1987; Bransbury 1985; Bomford 1988; Oliver). Short open saltmarsh, interspersed with bare shelly or sandy patches and shallow channels (Thomas 1968; Robertson & Dennison 1979); sometimes associated with coastal lagoons (Park 1983), inland saltlakes (Lane 1987) and saltworks (J.M. Peter). Seagrass beds, especially *Zostera*, which, when exposed at low tide, remain heavily saturated or have numerous water-filled depressions (Pierce 1987); sometimes on kelp beds (Pierce 1980b, 1987). Open grassy areas including short pasture, ploughed or newly cropped paddocks, swards, airstrips, and sports grounds such as golf courses or race-tracks; may be near the coast or well inland (Sibson 1946, 1958, 1978; Armstrong 1962; Child 1967; Phillips 1980; Pierce 1980a,b, 1987; Owen & Sell 1985; Schulz 1990). In winter, use pasture more readily in NZ than in Aust. (Lane 1987). Exposed reefs and rock platforms with shallow rock pools (Morris 1975, 1989; Falla 1978; Pierce 1980b). Coastal sand-dunes (Hodgkins 1949; Robertson & Dennison 1979; Pierce 1987). Floodwaters (Wakelin 1968; Pierce 1989); drowned river valleys (Marples 1954); occasionally areas of bare pumice or scoria (Winstone *et al.* 1958; Armstrong 1962). At high altitudes in NZ, dry montane habitats with short vegetation, including subalpine meltwater basins and streams, cirques, tarns and swamps, tundra, fellfields, herbfields

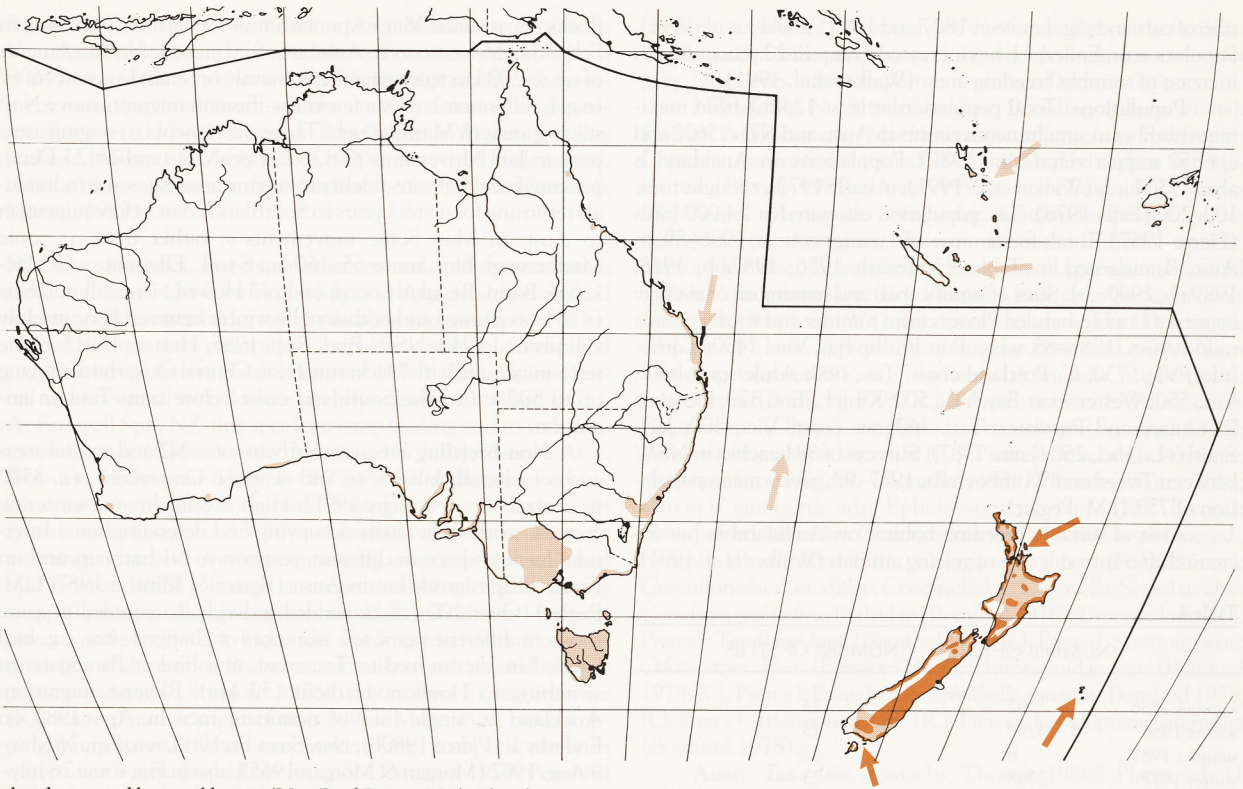
and tussock grasslands; also wet, mossy and shingly depressions below snow-banks (Child 1969, 1975, 1979). On Chatham I., inhabit boggy moorlands with sparse stunted bracken and heath (Fleming 1939).

Usually breed in dry open stable areas of shingle, sand or stones (Bomford 1986). Mainly on old river terraces in valleys, deltas or alluvial fans; prefer stable, flat or gently sloping shingle banks of braided streams with substrate often graded, ranging from large stones to shingle, gravel and fine sand; prefer gravel; avoid boulders and areas cluttered with drift, vegetation or trees. Banks often stabilized by low plant cover, such as short coarse grass, but nests usually in adjacent bare areas (Soper 1959; Pierce 1980a, 1983; Owen & Sell 1985; Bomford 1988). In coastal regions, breed on sandy, shelly or shingly beaches, spits and backing dunes, especially round estuaries (Stidolph & Fleming 1939–40; Hodgkins 1949; Potter 1949; Sibson 1978; Owen & Sell 1985; Oliver; CSN Suppl. 19). Shingle and sandy beaches of lakes (Stidolph & Fleming 1939–40; Pierce 1980a); high altitudes, including on Auckland Is, (up to 1646 m asl) in montane habitats, where breeding may also occur on bare rock (Sibson 1958; Falla 1978; Bomford 1986; CSN Suppl. 19). Also pasture and ploughed or stony paddocks (Anon. 1939–40; Armstrong 1962; Munro 1971; Oliver; CSN Suppl. 19); areas of bare pumice (Stidolph & Fleming 1939–40; Armstrong 1962); gravel pits, quarries, gravel tracks and roads with wide gravel edges (R.J. Pierce). Regenerating herbfields near rivers (Pierce 1989); in coastal areas, often breed when there is no prostrate vegetation, but sometimes in association with stunted shrubs and debris; in inland areas, prefer herbfields and dwarf shrublands, with scattered to dense vegetation; isolated tall shrubs (>50 cm) or trees are tolerated, but areas with tall plants forming more than c. 10% ground cover avoided (R.J. Pierce). Not necessarily close to water. Also use racecourses and airstrips (CSN Suppl. 19). On Chatham Is, breed on sparsely covered, boggy, peaty moorlands with stunted bracken and heath (Fleming 1939).

After breeding and before migration, remain close to inland and coastal breeding areas, on wide river deltas and river beds, drying ponds, lagoons, tidal flats, beaches, herbfields, pasture and saltmarsh. In inland areas, depend less on herbfields than during breeding, and often on expanses of bare shingle, sand and pumice (R.J. Pierce). Usually winter on estuaries and other coastal habitats such as lagoons, saltmarsh, beaches and pasture. In inland NZ, some winter on gravel river deltas, lake shores and pasture (R.J. Pierce). Often forage in river beds during cold weather (usually adults after breeding); often use wet paddocks during mild weather (usually juveniles) (Pierce 1989). Occasionally wade into belly-deep water (Pierce 1980b).

Roost on bare open areas or among vegetation; also offshore islets. Roosting sites may be near feeding areas or hundreds of metres away (Sibson 1946; Marples 1954; Smith 1966; Thomas 1968; Robertson & Dennison 1979; Pierce 1980b, 1987; Park 1983; Owen & Sell 1985; Minton 1987; Chafer 1989). During strong winds, may shelter behind rocks, small clods of earth, clumps of vegetation or seaweed (Smith 1966; Robertson & Dennison 1979; Schulz 1990; M. Weston), or in depressions in ground (J.R. Starks).

In Aust. and NZ, favoured by clearing of wooded lands and conversion to pasture (Armstrong 1962; Sibson 1978), where regularly feed, roost, and occasionally breed (Child 1967; Sibson 1978). Use other artificially short-grassed areas (see above), though conversion of bare pumice nesting ground to golf course thought to have caused local extinction (Armstrong 1962). Round sewage farms and saltworks (Smith 1966; Anon. 1974; Vic. Bird Reps); gravel roads and quarries (R.J. Pierce); occasionally artificial



islands created by spoil heaps (Vic. Bird Rep. 1982). Flood mitigation and planting of willows and other trees have decreased amount of available nesting habitat (Owen & Sell 1985 R.J. Pierce).

DISTRIBUTION AND POPULATION Widespread throughout NZ; occurs in e. and s. Aust., mainly between Tropic of Capricorn and w. Eyre Pen., with occasional records in n. Qld and WA. Regular, visitor to Norfolk and Lord Howe Is; vagrant to Fiji, Vanuatu and New Caledonia.

NZ NI Widespread on coast and in harbours of Northland; widely distributed along n. and e. coasts from Whangarei Harbour, S to Cook Str.; widespread in floodplain of Ruamahanga R., round coast from Wellington to about Wanganui, including inland river systems of Manawatu; sparse records in Taranaki; round harbours in Waikato and Auckland, including Kawhia, Raglan, Manakau and Kaipara Harbours. Other inland occurrences include near Rotorua Ls and S of L. Taupo, in s. Volcanic Plateau and ne. Wanganui (NZ Atlas). **SI** Widely distributed round coasts of Golden and Tasman Bays and S to Nelson Ls; scattered records in Marlborough; more widely distributed in n. Canterbury, S to Banks Pen.; most abundant and widespread from central Canterbury, from near Arthur's Pass, S through s. Canterbury and throughout Otago; scattered in Southland; absent from Fiordland; widespread along West Coast, from near Awarua Bay, NE to about C. Foulwind; also inland along Grey R.; occasionally in Karamea Bight (NZ Atlas).

Aust. Qld Record from Warraber I., Torres Str., before 1875 (Masters 1875) uncertain; occasional records from Cairns, Townsville and Ayr (Liddy 1960; Lane 1987; Qld Bird Reps 1986, 1987, 1988; Aust. Atlas). Most records in SE, S of Rockhampton (Aust. Atlas). **NSW** Widespread in coastal regions. Occasional inland records; recorded in sw. NSW after 1956 floods (Hobbs 1956, 1958, 1961; Morris *et al.* 1981; Lane 1987; Aust. Atlas). **Vic.** Widespread along coastline; scattered inland records in w. half (Vic. Atlas). One record of c. 3500 in central Vic. (Appleby

1991). **Tas.** Widespread in E and N, with occasional records inland and in W (Thomas 1979; Aust. Atlas). Also islands of Bass Str. **SA** Widespread in coastal regions from SE to w. Eyre Pen. (Eckert 1971; SA Bird Rep. 1977–81; Aust. Atlas). Occasional records inland along Murray R.; recorded at Morgan, SA, after 1956 floods (Boehm 1960). **WA** Generally rare, but common in SE between Eyre and Pt Malcolm. W of Pt Malcolm, recorded at: Stokes Inlet, single, Apr. 1984 (Anon. 1984); Oyster Harbour, Albany, four specimens, 1906–7 (Ford 1967); Wilson's Inlet, two specimens, Mar. 1910 (Ford 1967); Penguin I., two, Aug. 1940 (Serventy & White 1943; Sedgwick 1946); Pelican Pt, Swan R., doubtfully recorded, Apr., Sept.–Nov. 1936 (Serventy 1948); Guraga L., single, July 1987 (Vervest & Jaensch 1987); Leeman Salt L., single, Mar. 1964 (Ford 1967); W. Wallabi, Houtman Abrolhos, details unknown, not listed in Storr (1986) (Serventy & Whittell 1976). Records from Condon, Port Hedland and NW Cape (Carter 1904; Whitlock 1909) misidentified (Ford 1967). **NT** No records.

Norfolk, Lord Howe Is Regular visitor (Hindwood 1940; Schodde *et al.* 1983; Hermes 1985; Hutton 1991).

Chatham Is Breed Te Whanga Lagoon and South East I. (R.J. Pierce).

Auckland Is Breed Enderby and Adams Is.; formerly Auckland I. (R.J. Pierce).

Breeding Throughout NZ; major breeding concentrations occur in s. NI and SI, particularly inland Hawke's Bay: including Nuhaka, Whakaki Lagoon, mouth Wairoa R. and Mohaka, Tutaekuri, Ngaruroo and Tukituku Rs and their tributaries; Marlborough, including: Wairau, Awatere, Flaxbourne, Waimea, Clarence, Hapuka, and Kowhai Rs, L. Grassmere, and Kaikoura Pen.; throughout Canterbury, central and w. Otago; rarely on e. coast: where sites include Kakanui, Otago Pen., and mouth Clutha R.; and Southland: including Oreti and Aparima Rs, Waituna-Tiwai and Mataura R.; also Ruapuke and Stewart Is (R.J. Pierce).

Numbers on Auckland Is declined in 1800s after introduc-

tion of cats and pigs between 1807 and 1840 (Walker *et al.* 1991). Population on Enderby I. has increased over past 20 years, after an increase of suitable breeding areas (Walker *et al.* 1991).

Populations Total population at least 12,450, from maximum number in simultaneous counts in Aust. and NZ: c. 5600 and c. 6850 respectively (Lane 1987). Populations on Auckland Is about 730 birds (Walker *et al.* 1991); in early 1970s, thought to be 100–200 (Falla 1978). Tas. population estimated at $\geq 4,000$ birds (Pierce 1987). Totals for summer and winter counts, 1986–89, in Aust. summarized in Table 1 (Hewish 1986, 1987a,b, 1988, 1989a,b, 1990a,b). Sites of significance and maximum or average counts of Double-banded Plovers from summer and winter counts round Aust., 1981–85, were: Port Phillip Bay, Vic., 1400; Corner Inlet, Vic., 730; C. Portland coast, Tas., 680; Anderson's Inlet, Vic., 550; Westernport Bay, Vic., 500; King I., Tas., 370; Derwent R. estuary and Pittwater, Tas., 360; sw. coast, Vic., 300; Jack Smith's L., Vic., 250 (Lane 1987). Surveys of 89 beaches in NSW between Tweed and Womboy R., 1987–92, gave a mean population of 753 (J.M. Pegler).

Area of suitable breeding habitat on Auckland Is has increased after introduction of grazing animals (Walker *et al.* 1991).

Table 1

	NUMBER OF BIRDS	NUMBER OF SITES
summer 1986	92	23
winter 1986	3290	23
summer 1987	6	22
winter 1987	2748	23
summer 1988	44	23
winter 1988	4432	23
summer 1989	85	22
winter 1989	4275	21

MOVEMENTS Nominate *bicinctus*. Recent unpublished study by OSNZ and VWWSG. Partly migratory and dispersive. Most birds undertake long-distance migrations to n. NZ or se. and sw. Aust., but others sedentary. Marked regional patterns in movements; birds that breed inland or at high altitude regions almost entirely migratory; movements related to availability of food: breeding grounds over 600 m asl often covered in snow in winter and rivers are unreliable sources of food (R.J. Pierce), except in areas with muddy or silty lakeshores where aquatic food more reliably available (e.g. Ls Tekapo and Wanaka) or in farmland (e.g. Valetta, mid-Canterbury). Destination varies regionally. Birds breeding in inland s. SI migrate to Aust.; birds breeding in inland areas N of Christchurch mostly move within NZ; birds breeding at coastal lagoons, ocean beaches and estuaries throughout NZ, mostly sedentary including those breeding on Southland coast, L. Wainono, Washdyke Lagoon, L. Ellesmere, Ashley, Kaikoura, Chatham Is and beaches of NI. Few s. SI birds move to NI; SI birds that do so, mostly winter in Far North, whereas NI breeders winter mostly in Bay of Plenty and Auckland areas; Westland birds move mostly to Farewell Spit.

Subspecies *exilis* (Auckland Is). Not well studied; probably partly dispersive. Part of population winters on tidal shoreline of Enderby I. Possibly some remain in territories or over-winter in Carnley Harbour. While breeding, birds move nightly from fellfields to beaches to feed. Some roost on smaller islands at night, such as Rose and Ewing Is (Walker *et al.* 1991).

Departure Depending on region, birds begin to leave territories, Oct.–Nov., peaking in Dec., and join local flocks. Local flocking peaks Dec.–Jan. In inland areas of s. SI, these

flocks persist until Mar.–Apr. with most departures occurring in Feb.–Mar. Movements to Aust. are often preceded by movements of up to 200 km to staging areas, mainly on e. and s. coasts of SI (e.g. L. Ellesmere); only a few trans-Tasman migrants move N to staging areas in Marlborough. These movements to staging areas peak in Jan. Movements to n. NZ, Dec.–Mar. (earliest 23 Dec.), peaking Feb. High site-fidelity to staging areas, e.g. some individuals returning for up to 3 years to Southland coast before migration to Aust. in Mar. Some movements s. rather than n.: some Marlborough birds move 65–160 km S to L. Ellesmere and Mackenzie Basin. Regularly occur on Lord Howe I., in small numbers (<10), on passage and occasionally winter between Feb. and July (Hindwood 1940; NSW Bird. Rep. 1985; Hutton 1991). Some retro-migration, with Mackenzie Basin Central Otago birds moving up to 300 km to the Southland coast before trans-Tasman migration.

Non-breeding Frequent harbours of n. NZ and coastal areas and occasionally lakes of se. and sw. Aust. One record of c. 3500 in central Vic. (Appleby 1991). High site-fidelity on wintering grounds, with individuals occupying and defending same intertidal feeding space in different years on n. NI harbours and on Farewell Spit, as well as in Aust. (Barter & Minton 1987; L.M. Pegler). Over 100 colour-banded individuals recorded at same roosts in different years, few instances of changed sites, e.g. bird banded in Vic. moved to Tas. coast, and bird at Parengarenga switching to Houhora Harbour (30 km). Reverse migration: Auckland Is, single bird of nominate race in Apr. 1980 on Enderby I. (Pierce 1980b); two, Suva Pt, Viti Levu, Fiji, 26 May–9 Aug. 1962 (Morgan & Morgan 1965); also in Fiji, some 26 July–20 Aug. 1969 and 10 Mar.–29 Aug 1970 and at least two in winter 1971 till 15 Aug. (Smart 1971); single from 15 Mar.–14 May 1982 (Skinner 1983); single at Vatuaqa, Suva in June 1980 (Miles 1982); up to seven, 21 Mar.–7 Aug. 1982 (Skinner 1983); single on Ono-i-Lau I., Fiji Grp in July 1971 (Smart 1971). Unconfirmed reports for Vanuatu (Oliver; NZCL) and two reported from Campbell I. in Apr. 1944 (Bailey & Sorensen 1962).

Return Birds return direct to breeding grounds mostly in Aug. and early Sept. from non-breeding grounds in NZ and Aust. Earliest return dates 7 July for bird from C. Palliser that wintered in Auckland, and 21 July for bird from Mackenzie Basin that wintered in Aust. Trans-Tasman migrants appear to return on broad front. One-year-old birds in Mackenzie Basin return later in season than older birds (Pierce 1989). Also recorded Noumea, New Caledonia, six on 24 Aug. 1974 (Garrett & Garrett 1975); Raoul I., Kermadec Is, single, Sept. 1913 (Oliver); Norfolk I., four birds, Aug. 1963, and ten birds, Aug. 1967 (Wakelin 1968), 17 Feb. 1968 (Schodde *et al.* 1983), 18 on 12 July 1976 (Moore 1981) and 60 in June 1983 (Hermes *et al.* 1986).

Breeding Highly faithful to nesting site (Pierce 1989). Few movements during breeding season. During incubation, off-duty bird within 2 km of nest. Failed nesters sometimes join flocks of Plovers in pasture up to 2 km from territories as do birds whose territories are flooded. During snowfalls and subsequent loss of nests move up to 10 km, possibly more, to find feeding areas at lakes or rivers.

Banding Typical banding recovery: adult female colour-banded delta of Cass R. 25 Nov. 1977, returned 1978, sighted 17 June 1979 Port Wilson, s. Vic., a distance of 2000 km; had returned by 21 July 1978 to Cass R. (Dann & Pierce 1979). Percentages of Aust. winter band recoveries from different breeding regions: inland Southland 74%, Central Otago 95%, Mackenzie Basin 65%, Canterbury 27%, Westland 15%, Marlborough-Nelson 3%, NI 1%. Percentages of SI birds from different breeding regions moving to NI: Southland and Otago 0%, Mackenzie

Basin 5%, Canterbury 8%, Westland 15%, Marlborough 62%. In Vic., Aust., only six birds (four adults and two first-year birds) out of 241 retraps found to have moved from original site, all movement occurring in different seasons and none during single season; five moved 12–49 km within Port Phillip or Westernport Bay and one 155 km; also, only five of 1900 colour-dyed birds moved, three within one season, the farthest being 55 km (Barter & Minton 1987).

FOOD Molluscs, insects, crustaceans and spiders; sometimes seeds and fruits. On Cass R., in July and Aug. feed on tubificid worms and chironomid larvae in mudflats and sandflats of delta, on earthworms and caterpillars in pasture and on mayfly and caddisfly larvae in river beds (Bomford 1978). **Behaviour** Diurnal and nocturnal with decline in early evening (Bomford 1978). At Farewell Spit, NZ, first species to stop feeding and roost before incoming tide (Robertson & Dennison 1979; R.J. Pierce). At L. Wainono, birds spent 63–96% (8.75–9.1 h) of daylight foraging between Feb. to July; nocturnal foraging was not recorded. On Auckland Is, forage for 15–20% of daylight in three peaks, early morning, noon and evening continuing into night, regardless of tide (Pierce 1980b). Forage on vegetated shingle beds, closely cropped pasture, tilled ground and mudflat. In harbours forage on pasture and sandflats at high tide. Feeding method varies with time, tide and weather. Probe occasionally in soft ground, on wet pasture and mud (Bomford 1978), more often in bad weather (R.J. Pierce) and at night (Dann 1991). Make short runs, stopping intermittently, when may make a step, and peck; rarely in water over 5 mm deep (Robertson & Dennison 1979; Bomford 1978). Uses run-stop-look-step-peck rhythm on dry sandflat where movement of bird disturbs prey, and run-stop-peck rhythm on wet sand where prey more mobile. On open wet sand and saltmarsh, birds do same or occasionally probe. At L. Wainono, NZ, on cold mornings birds fed on shore flies at edge of water until after sunrise when flies became active, then changed to feeding on saltmarsh (Bomford 1978). Use foot-trembling in damp habitats including saturated sand, silt, mud and on slightly damp grass, to disturb prey (Pierce 1980b). Will pursue insects a few metres into air, especially subimago mayflies (Bomford 1978; Robertson & Dennison 1979). Grapsid crabs in Tas. located visually and pounced upon. Crabs up to c. 2 cm across dismembered and swallowed piecemeal (Thomas 1986). On Auckland Is, probing *Corellina* turf provided most food despite birds only spending 12% of time there. Rate of search varied with habitat ($n=51$): 79 steps/30 s in grass sward and 78 steps/30 s on shingle; 44 steps/30 s on mid-littoral shelf and 41 steps/30 s on mid-littoral stones; differences in rate may reflect density of prey (Pierce 1980b). Length of run inversely proportional to density of prey, e.g. at L. Wainono average length of run, 0.1 m at edge of water (10,000 prey items/m²); 0.5 m on mudflats (4200); 1.0 m on saltmarsh (67); and 5 m on pasture (14). Peck-rate declined from 35 to 4 pecks/min and from 1.5 to 0.4 pecks per run respectively (Bomford 1978). In n. Hawke's Bay while breeding (22 timed bouts of total time 37.3 min): 0.38 ± 0.26 runs/s and 0.26 ± 0.31 pecks/s with average 0.59 ± 0.37 pecks per run (Phillips 1980). Peck-rate of 8.6–11.6/min recorded from Auckland Is; lower rate possibly reflects larger size of prey, though, when probing, peck-rate 30 pecks/min (Pierce 1980b). Outside breeding season, sometimes feed in loose flocks. On wintering grounds, feeding associations of both subspecies vary, from loose feeding flocks to small to large individual territories. Birds on n. NZ harbours defend feeding territories at low tide, individuals using same general area in different years (R.J. Pierce). On Auckland Is, in autumn, defend feeding territories of up to 2000 m² but size decreases as more birds arrive. Feed on mayflies

in Sept. and Oct. (Bomford 1978). Generalist with straight, medium-sized bill enabling pecking and probing for variety of prey. Large eyes reflect importance of visual location of prey.

NZ Adult No detailed studies. **Breeding** (observations): Plants: Polygonaceae: *Muehlenbeckia axillaris* fru.; Rubiaceae: *Coprosma petriei* fruits (Stead 1932). Animals: surface invertebrates (Pierce 1989; Dann 1991); annelids; oligochaetes (R.J. Pierce). Myriapods: centipedes. Arachnids: spiders: *Lycosa*; *Lithyphantes*; *Arangina*; *Taieria*. Insects: Ephemeroptera: Leptophlebiidae: *Deleatidium*; Hemiptera: Lygaeidae (Bomford 1978); Coleoptera: larv. (R.J. Pierce); Carabidae; Coccinellidae: *Coccinella* (Bomford 1978); Tricoptera: ads, larv.; Lepidoptera: ads (R.J. Pierce); larv.; Diptera: Stratiomyidae (Bomford 1978). **Non-breeding** (observations): Animals: Annelids: oligochaetes: earthworms (Bomford 1978; R.J. Pierce); tubificids (R.J. Pierce). Crustaceans (Oliver): amphipods: *Paracallioppe* (Bomford 1978); *Paracorophium*; Mysidae; crabs (R.J. Pierce). Arachnids: Araneae: *Araneus*; *Lycosa hilaris*; (Bomford 1978). Insects (Potts 1882; Oliver): emerging ads; Ephemeroptera: larv. (R.J. Pierce); Hemiptera: Cydiniidae: *Chaerocydnus nigrosignatus*; Lygaeidae: ad., nymph (Bomford 1978); Coleoptera: larv. (R.J. Pierce); Curculionidae; Leiodidae; Coccinellidae: *Coccinella*; Scarabaeidae: *Costelytra zealandica*; Pythidae (Bomford 1978); Diptera: larv. (R.J. Pierce); Tipulidae: larv. (Bomford 1978; R.J. Pierce); Stratiomyidae: *Odontomyia chloris* (Bomford 1978); Chironomidae: larv. (Bomford 1978; R.J. Pierce); Ephydriidae: *Ephydrella aquaria*; (Bomford 1978; R.J. Pierce); Trichoptera: larv. (R.J. Pierce); Lepidoptera: caterpillar (Bomford 1978).

Aust. Tas. (six stomachs; Thomas 1986): Plants: sds 11 stomach. Animals: Molluscs: gastropods 2. Crustaceans: isopods 1; crabs: Grapsidae (2 cm) 4. Insects: ads 2, larv. 3.

Other records Plants: roots. Animals: Molluscs: gastropods (Barker & Vestjens): *Polinices* shells (Lea & Gray). Arachnids: spiders. Crustaceans (Barker & Vestjens). Insects (Lea & Gray): Dermaptera: earwigs; Hemiptera; Coleoptera: Carabidae; Dytiscidae (Barker & Vestjens); Staphylinidae: *Trogophlaeus* (Lea & Gray); Curculionidae (Barker & Vestjens): *Aphela helopoides* (Lea & Gray); Diptera: larv.; Hymenoptera: Formicidae: ants. Small grit and stones (Lea & Gray).

Auckland Is Plants: sds (Pierce 1980b). Animals: Annelids: polychaetes; oligochaetes. Crustaceans: isopods: *Exosphaeroma*; amphipods: *Talorchestia* (>20 mm); Gammaridae (>20 mm); Oedicerotidae (2–5 mm); decapods: Hymenosomatidae: *Halicarcinus*. Arachnids: spiders: Araneidae. Insects: Coleoptera: Coelopidae; Diptera: kelpflies. Highest energy contribution from polychaetes, earthworms, amphipods and crabs (Pierce 1980b).

Young Precocial. Peck at ground on first trip away from nest after 3–4 h and soon feed (Bomford 1988). **NZ** Plants: sds, fruits (Dann 1991); *Pimelia* berries; *Muehlenbeckia* berries (Pierce 1989); *M. axillaris* sds, fruits (stomach, Bomford 1978; Dann 1991); *Coprosma pumila* berries (Pierce 1989). Animals: surface invertebrates (Pierce 1989; Dann 1991). insects: Coleoptera: Carabidae; Hymenoptera: Formicidae: small ant (stomach, Bomford 1978).

Intake No data.

SOCIAL ORGANIZATION Well known; based on studies at Cass R., SI (Bomford 1978; Pierce 1989) and contribution by R.J. Pierce. Gregarious. Outside breeding season, may roost in tight flocks (Thomas 1968; R.J. Pierce); most often feed singly but sometimes in loose flocks; within feeding flock, birds defend small individual distances, though on coast at low tide commonly defend larger feeding territories. After breeding, leave breeding territory to join local flocks, of up to 150 birds; local flocks peak Dec.–Jan. but in some areas may persist until Mar.–Apr.; juveniles

tend to form small concentrations in wetter habitats, whereas adults tend to form larger concentrations in drier habitats (Pierce 1989). After this, birds gather at wintering areas, sometimes also assembling at staging areas on way (see Movements) (R.J. Pierce). At start of breeding, flocks still apparent, e.g. flocks of 100, early July (Phillips 1980); birds leave social feeding flocks late winter and early spring to establish breeding territories (Bomford 1986). During breeding season, seen as territorial pairs, which usually feed alone; occasionally loose feeding associations seen, which include birds from territories up to 2 km away whose nests have failed, birds whose territories have flooded, and some off-duty breeding birds (Pierce 1989). Other notes on size of concentrations or flocks outside breeding season: at roosts typically 50–200, but ≤ 1000 (Pierce 1987; R.J. Pierce); at high tide on coast, concentrations of ≤ 100 over many hectares of pasture; in NZ, report of 3000, but no date given (Veitch 1974), and winter concentrations of up to c. 2500 (R.J. Pierce). In NZ, recorded associating with other species, e.g. Ruddy Turnstone *Arenaria interpres* (Howell & Harrison 1982), but associations rare, though often feed in same areas as some calidrid waders. In Aust., occasionally with other species, e.g. Red-capped Plovers *C. ruficapillus*, Red-necked Stints *Calidris ruficollis* (Thomas 1968), and Hooded Plovers *Thinornis rubricollis* (Wheeler 1960).

Bonds Monogamous; rarely, additional males or females may share incubation (Pierce 1989). Pair-bond seasonal: of 18 pairs, eight persisted in second year, while ten changed mates. Within same season, of ten pairs that re-nested after failure of first nest, eight did so with original partner, and two changed mates (Pierce 1989). Sex-ratio about even (R.J. Pierce). Most 1-year-old birds return to breeding grounds and nest or try to nest; a few do not return until second year (Pierce 1989). Pair-formation begins when male returns to territory in late winter or early spring; earliest in lowland areas (July); latest in high altitude areas where may not form until Sept.–Oct., e.g. Volcanic Plateau and mountains of Central Otago. Pair-bond breaks down about time chicks fledge or shortly after, about late Oct. to Feb. (R.J. Pierce). **Parental care** Both sexes build nest, but mostly male (Phillips 1980). Both sexes incubate (Falla *et al.* 1970; Stidolph 1931; Soper 1972; Bomford 1986); female does so for 82% of daylight (Bomford 1978), which probably accounts for suggestion that male only incubates if female disturbed from nest (Phillips 1980); male may take greater role at night (Bomford 1988; R.J. Pierce). Both sexes brood and guard chicks; contributions of sexes unknown, but generally much variation between pairs (Bomford 1978). Young deserted soon after fledging or, less often, before fledging (Bomford 1978; Pierce 1989).

Breeding dispersion Nest as solitary territorial pairs; territory may be isolated or part of a cluster (Dann 1991). Typically 100–150 m between nests, averaging 113 m (61.7; 25–250; 20) at L. Ellesmere and 123 m (43.6; 70–220; 11) at Cass R. (Dann 1991), but often as little as 20–25 m (R.J. Pierce); other estimations: c. 40 m ($n=32$) between active nest, closest being 4–5 m apart (Phillips 1980); averaged c. 50 m apart (Soper 1972). Whereas experienced adults nest near previous years' sites, first-time breeders nest farther way from natal sites and then adopt this chosen site for later years, particularly females, which choose sites on average 5.15 km away but up to 31 km (Pierce 1989). **Territories** Defend breeding and sometimes feeding territories. Breeding territory established by male, often without female, at start of season; begin to leave territories Oct.–Nov. (peak Dec.) to join local flocks (R.J. Pierce). Average diameter of breeding territory c. 50–70 m though not circular (Phillips 1980). Male remains in territory much of time; after courting, female gradually spends more time in territory and begins to join male in boundary

disputes (Phillips 1980). Off-duty bird feeds mainly within 200 m of nest and keeps mainly within territory (Pierce 1989). Feeding territories sometimes established by off-duty breeding birds; linear areas < 50 m in length, along edges of ponds or lakeshores, and up to 2 km from nesting territory (R.J. Pierce). In non-breeding season, feeding territories often established and held for up to several hours; in NZ, some individuals seen defending same intertidal feeding territories in different years; in autumn, defend area of up to 2000 m² but if more birds arrive, territories contract (Pierce 1980b; R.J. Pierce).

Roosting Feed by day and sometimes at night in both inland and coastal locations (R.J. Pierce). During breeding season, typically roost alone on elevated site, e.g. bank. Outside breeding season, roost in compact flocks at traditional sites. Post-breeding and wintering sites are in many artificial and natural habitats (see Habitat); different sites may be used in different weather. Compared with diurnal roosts, nocturnal sites often much more inaccessible, on islands, headlands, or protected beaches (R.J. Pierce). Outside breeding season, arrival at roosts each day usually determined by tidal cycle, birds arriving in protracted manner from 3 h before high tide; as soon as sandflats exposed, generally leave (R.J. Pierce); much variation; possibly alters if high-tide feeding habitat available (R.J. Pierce).

SOCIAL BEHAVIOUR Very well known; detailed studies mainly during breeding season by Phillips (1980) and Bomford (1978, 1986, 1988). Easily studied because widespread, common, and not easily disturbed; nesting female said to be more shy than nesting male (Phillips 1980). Behaviour typical of *Charadrius* plovers, see Phillips (1980) for comparisons. **Flock behaviour** In winter, utter quiet churring calls when feeding or roosting in flocks; some social cohesion between birds defending feeding territories, and birds may flock when disturbed or changing feeding areas (Lane 1987). **NORMAL POSTURE:** either sex normally stands with back and tail in line 30°–60° from horizontal; line of head and neck making angle of c. 120° with back and tail; bill $< 15^\circ$ below horizontal; plumage relaxed so that back only slightly rounded; seen when birds resting and during pauses between feeding (Phillips 1980). **PICK-AND-TOSS:** pick up small pebble or debris and flick over shoulder with sideways jerk of head; often incomplete and takes form of slight nodding of head; seen early in incubation, when sitting male restless (Phillips 1980) and when male walks away after Nest-Scrape display (Bomford 1986).

Agonistic behaviour Uncommon within flocks at roosts; birds defend breeding territories and, when feeding, often individual distances or feeding territories. When breeding, no evidence that males interact selectively with males or females with females (Phillips 1980). In July, aggression within flock increases (Phillips 1980; Bomford 1986). At first, male defends territory, but after courting, gradually joined by female (Phillips 1980), though male more aggressive and does more to defend territory (Bomford 1986). Behaviour almost always consists of threats; bodily contact rare; involves following postures and displays, based mainly on Phillips (1980), unless otherwise stated (for further details on Calls, see Voice). **ADVERTISING:** holds head higher than line of back but feathers of breast, throat and back fluffed, giving rounded appearance, specially noticeable on back. **HORIZONTAL, BULGED BREAST (HBB)** (Fig. 1): back and tail nearly in line but axis of body lowered almost to horizontal, back rounded, head thrust forward with bill nearly horizontal, throat and breast bulged so that chestnut colour shows from behind as well as from front; usually adopted only while bird walks or runs; seen only in male and characteristic of lone males early in breeding season. **BUTTERFLY FLIGHT (BF):** circling flight with wings beating

more slowly than normal and appearing to be fully extended rather than alternately extended and flexed as in normal flight; usually not more than 3–7 m from ground, though may go much higher; curves round in circles and figures of eight over area 30–60 m in diameter; typically call *pit* with each wing-beat but sometimes also Threat Call or *peet*; apparently occurs in males only. **ERECT, PUFFED BREAST (EPB)** (Fig. 2): body and tail held in line 60–75° above horizontal with neck retracted and bill horizontal or

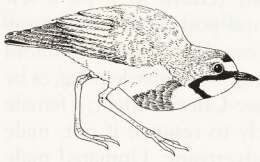
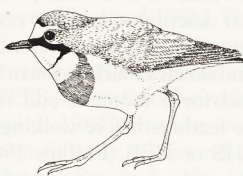


Figure 1 Horizontal, Bulged Breast (HBB)



Figure 2 Erect, Puffed Breast (EPB)

depressed as much as 15°; breast raised and puffed so that chestnut band almost square and outlined in white when viewed from front; feathers of flanks often spread laterally to cover carpals and edges of wings, and white easily seen from behind; characteristic male posture (much less so of females) during pauses in intense territorial and other agonistic encounters. In one rare version of EPB, seen during stationary close aggressive encounters between two males, legs and neck extended, bill horizontal, and plumage of body fluffed. **HORIZONTAL SPREAD (HS)** (Fig. 3a,b): bill, head, back and tail held horizontally; feathers of breast and flanks spread laterally, beyond folded wings, so that, from behind, white outlines body; neck withdrawn so that black collar hidden. Mainly



3a



3b

Figure 3 Horizontal Spread (HS)

occurs when one bird runs toward another, with EPB characteristically adopted during stops. Both sexes use these two postures in aggressive approaches, but male does so more often. **Advertising, Threat** Occasionally, lone male will stand apart, often on rise, and adopts Advertising posture; periodically utters bouts of Wow Call or runs smoothly in HBB for 3–30 m and resumes Wow Call; periodically turns one eye skyward, apparently looking for conspecifics; possibly responds to passing males with Threat Call and BF, and to females with *peet*, Wow Calls and Scraping. When advertising or giving Wow Call sometimes suddenly performs BF for no apparent reason, though often seems to be stimulated by sight or sound of another male in BF Bomford (1986) described **TERRITORIAL FLIGHT DISPLAYS** of males, which are probably similar to BF, but loud click heard with each wing-beat, audible for more than 100 m; often accompanied by Threat Call and 80% are after territorial encounters; upon landing after flight, male momentarily assumes upright threat posture, runs in horizontal posture (see below), then often stands on rise and views territory; vigorously chases and threatens intruders if present. Territorial Flight displays reach average maximum height of 7 m (2–15), and range over average 1530 m² (180–3320; 56); often occur in first 2–4 days of

occupation of territory (Bomford 1986). In another flight behaviour described by Phillips (1980), male occasionally chases males that fly over or land nearby; flight low, fast, and curving; usually gives Threat Call and rarely rises over 2 m; chases often involve two males and a duller individual, assumed to be female. If group of chasing birds approaches a male, he joins in while another bird usually drops out, gliding back to near original position. Upon landing, almost always assumes EPB. Such males clearly defend territory and often attack (in HS runs with EPB stops, low pursuit flights), even intruding females. In boundary disputes on ground, neighbouring males approach one another in HS runs with EPB pauses; often preceded with low flights (with throat and breast bulged downward) if distance between birds >50 m. Bomford (1986) also describes threat, which involves running at intruder in horizontal posture, black collar conspicuously displayed (which contrasts to HS, where black collar hidden); horizontal posture punctuated by upright threat where chest lifted and thrust forward, which appears similar to EPB; display always accompanied by Threat Call. If intruder runs away, owner follows in horizontal posture and gives repeated Threat Calls; if intruder flies away, owner usually flies after it, again giving Threat Call, and if intruder lands within territory, Threat displays resume (Bomford 1986). If threatened bird does not retreat, displaying bird continues to approach in horizontal running and upright posture; when within 1 m of each other, face each other in upright threat (Bomford 1986), though sometimes may turn to one side, so standing parallel rather than face to face (Phillips 1980). Birds may then approach and retreat from each other in series of horizontal runs; or both may perform horizontal run roughly parallel to each other, <1 m apart. Parallel running may continue for up to 30 min, and disputing birds often joined by mates, who occasionally give support with Threat displays and calls; may help define territory boundaries (Bomford 1986). **Fighting** Phillips (1980) found attacks common: male rushed another in HS, then both jumped up, apparently trying to kick one another; or one flew low, silent or with Threat Call, at other causing it to duck, which often led birds to jump upward and try to kick each other. Bomford (1986) described attacks where one bird jumped up and tried to land on other's back, but attacked bird dodged or fluttered away; usually disputing birds jumped at each other alternately, but sometimes one repeatedly jumped at other, or both jumped simultaneously, chest to chest, then landed and faced each other in upright threat postures; altercations usually ended with parallel running, or when one bird retreated or was chased away; rarely increased in intensity to fast-moving fights, where birds sprang at each other beating wings and striking with feet and bills, sometimes plucking feathers; such intense fights lasted for up to 1 min and involved both males and females. Territorial birds often chase other species, e.g. Sky Larks *Alauda arvensis* most often, but also Kelp Gulls *Larus dominicanus*, Black-winged Stilts *Himantopus himantopus*, South Island Pied Oystercatchers *Haematopus finschi*, Black-fronted Plovers *Elseyornis melanops* and Wrybills (Phillips 1980; Bomford 1986). Non-breeding birds may posture with head down and tail in air at nearby Kelp Gulls, Silver Gulls *L. novaehollandiae*, and Antarctic Terns *Sterna vittata* (Pierce 1980b). **Alarm BOB**: raise and lower head without changing position of bill and while body remains stationary; no differences between sexes; uncommon, occurring most often during mild disturbance and after alighting; also often by female tending newly hatched chicks (Phillips 1980). One immature seen to swim when disturbed (Stidolph 1931). In non-breeding season, if approached, usually run when person c. 25 m away, and when followed, fly and land 50–100 m away (Bomford 1986). See also Parental anti-predator strategies.

Sexual behaviour Males temporarily visit breeding grounds first at start of breeding season (R.J. Pierce). Involves some displays as described in Agonistic Behaviour as well as the following additional displays (Phillips 1980): **SCRAPE**: kick legs alternately out and behind (c. 1 kick/s), with breast lowered to ground, neck retracted, and bill horizontal; rear end raised, so that back and tail make angle of c. 60° from horizontal; usually wing-tips folded on back but occasionally dropped slightly; tail folded and not moved. After a few seconds, likely to stand, turn in new direction and repeat; male Scrapes more than female. **CHOKE** (Fig. 4): squat, often in scrape-site, with back slightly fluffed and neck withdrawn; head, throat and breast fluffed, and bill horizontal; thrusts head forward c. 1 cm and withdraws in series of quick movements, reminiscent of swallowing; no vertical movement; mean rate 1.3/s (0.54; 11); usually performed by male, less often by female. **BOW** (Fig. 5): in horizontal posture with plumage held as in Choking, bird suddenly tips bill down, balloons throat, and spreads tail in about half the Bows; gives Courtship Calls; male does this much more often than female. **LEADING**: when female walks past Scraping male and does not return, male often leaves scrape and glides by her with very short rapid steps in HBB (see Agonistic behaviour), then begins to Scrape, Bow, or Choke some metres in front of her. **TILT-AND-WING-RAISE (TWR)** (Fig. 6):

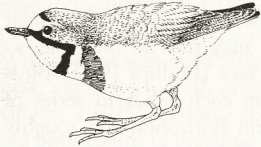


Figure 4 Choke

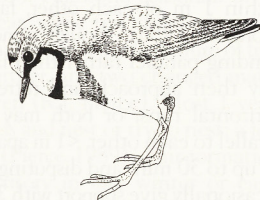


Figure 5 Bow

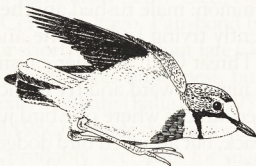


Figure 6 Tilt-and-wing-raise (TWR)

crouched with head back and tail horizontal, and neck withdrawn, bird tilts dorsum toward approaching bird and, with carpal flexed, raises wing on side away from approaching bird; tail sometimes spread. Occurs most often at scrape when Scraping bird exposes dorsum as much as possible to approaching bird. Occurs less often than Bow, and often accompanied by Bowing and Courtship Calls. Advertising and display-flights by male possibly have both territorial and courtship roles (Bomford 1978, 1986). **Courtship** Female often flies c. 20 m above shingle with low *pit* or *peet* calls, landing near, then approaching advertising male; then either flies away or stays for 1 h or more, courting or idling. Male may respond to female with Leading; then Scrapes, Chokes, Bows, gives Courtship Calls, or gives combination of all, increasing in tempo if female approaches. Bomford (1986) observed similar displays soon after female (or pairs together) arrived on breeding territory: male attracts female with **NEST-SCRAPE DISPLAY**, by standing, crouching, or sitting in hunched posture in scrape giving Courtship Call; when female approaches, male stops calling and starts rapid-jerking bowing, which becomes faster as female approaches. Female slowly approaches displaying male; often circling scrape, male turning to keep facing her; she eventually runs to scrape, holding body horizontal. Male quickly backs

out of scrape with body hunched, and rapidly fans and closes tail once. Occasionally female may touch male's flank with her bill or pair may bow heads together for a few seconds (Bomford 1986). Female replaces male in scrape, and sometimes just stands for a few seconds before running off, but usually crouches and shuffles for up to 10 s while male stands nearby facing her (Bomford 1986), sometimes performing Tilting and Wing-raising, and Bowing with Courtship Calls on side of scrape (Phillips 1980). When female runs from scrape, male usually returns to it for a few seconds, then he runs off in horizontal posture or walks away picking up objects and throwing them over his shoulder (Bomford 1986). Sequences interrupted at any stage by female leaving, or by male launching into BF or joining Whee-Cheedle flight; if female present on his return, courtship likely to resume; if not, male likely to resume HBB, Wow, and Advertising. Unmated male establishes several scrapes and Leads from one to another so long as female follows. Occasionally female Scrapes and Bows, Chokes and gives Courtship and Wow Calls, and males approach; in >5% of observed occurrences, led to exchanges at scrape as described above but with roles of sexes reversed (Phillips 1980). **Greeting** Pairs give calls as they walk about, especially early in season during pair-formation and nesting; probably keeps birds in contact and possibly reinforces individual recognition (Phillips 1980). During change-over, incubating bird leaves or flies from nest when mate approaches; occasionally gives Nest-scrape display and bows until mate comes (Bomford 1986). **Copulation** Seen early July, several weeks before first laying. After courtship at scrape-site, if female walks slowly away from scrape in fluffed, slightly hunched posture and stops c. 1 m away, male approaches and **PARADE-MARCHES**: holding body nearly upright, walks or marks time, raising feet very high. He then mounts and treads for c. 1 min and, when cloacal contact made, grabs her nape with bill and pulls her over backwards so that both land on their backs, wings flailing. Bomford (1986) gives similar description but also notes that before mounting occurs, receptive female stands in front of male with tail conspicuously raised and slowly crouches down. No post-copulatory displays; birds stand for a moment and fluff plumage, then often preen or settle feathers before walking or flying away; male may run off in HS or HBB (Phillips 1980; Bomford 1986).

Relations within family group To attract chicks to brood them, parent crouches, fluffs feathers, and gives repeated soft calls; alternatively head-bows sometimes also accompanied with calls. When chick arrives, parent rises and fluffs out feathers (Bomford 1986). One female Choked and pecked at her young chicks (Phillips 1980). Brooding reduced as chicks' feathers grow (Bomford 1978); once fledgeling brooded (Barlow 1988). When hatching complete, nest deserted. In early stages, young forage close to nest, gradually moving farther afield, but throughout fledgeling period rarely move 200 m from natal site (Bomford 1988; R.J. Pierce). **Anti-predator behaviour of young** When parents give Alarm Call, chicks in nest stay still, while older chicks generally run small distances on open ground before folding legs beneath body and crouching. When handled, chicks give alarm call (Bomford 1986). **Parental anti-predator strategies** Distraction Displays consist of crouch-runs, injury-feigning, and false brooding. At low intensity: false-brood; or crouch-run away with legs bent, neck retracted, and body horizontal; or, when close to intruder, run away with body leaning to one side, and wings and tail slightly lowered, then crouch, often by large stone or small shrub (Bomford 1986). In more conspicuous displays, adopt sideways leaning posture, described above, and run from intruder, sometimes giving alarm call; then crouch and spread wings (Fig. 7); often give drawn-out alarm call and may flap wings



Figure 7 Distraction Display

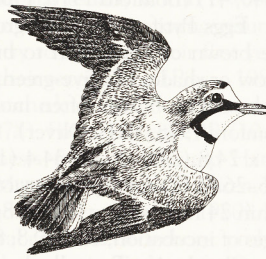
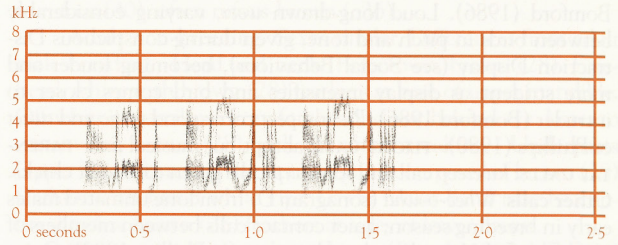


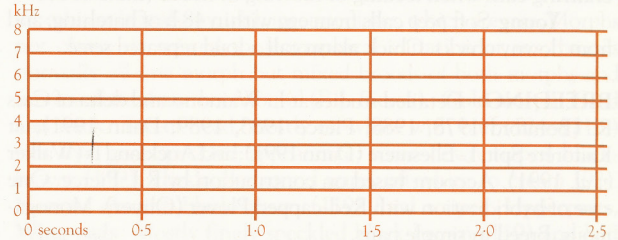
Figure 8 Intense Distraction Display

noisily on ground; usually given in one place but may move towards intruder. At highest intensity (Fig. 8), come close to intruder giving louder strident alarm calls; circle intruder, repeatedly raising one wing and fanning and lowering tail (Bomford 1986). Distraction Displays can attract conspecifics (Bomford 1986). Aspects of some Distraction Displays probably similar to TWR display (Phillips 1980). Sitting bird alert during day (Bomford 1986). During incubation, if intruder approaches to 50–100 m (Bomford 1986) or 200–300 m (Phillips 1980), bird leaves nest in crouch-run and gives alarm calls. Remains away from eggs, giving alarm calls and Bobbing; in first week of incubation, false brooding common and always silent; in later stages, other low-intensity Distraction Displays frequent. If intruder approaches closer, bird flies or runs back in stops and starts; partner or neighbours, alerted by Alarm Call, may bob and fly round observer (Bomford 1986). Phillips (1980) found females tended to disappear until danger passed; suggested that male more likely to incubate if female disturbed from nest, and that male probably uses EPB posture for ordering female back to nest during disturbance (Phillips 1980). In presence of bird of prey, groups of nesting Plovers fly and circle round, giving Alarm Calls; no swooping of predators (Bomford 1986; Stead 1932). After hatching, Soper (1972) and Stidolph (1931) report that adults lead chicks to cover. One or both parents give more conspicuous Distraction Displays if approached or if chick gives alarm call (Bomford 1986). When chicks handled parent crouches and squats with tail half-spread (Phillips 1980); when released, one parent often gives conspicuous Distraction Display while other parent flies above chick giving Alarm Calls (Bomford 1986); one male approached and led chick away, then brooded within 20 m of observer (Phillips 1980). Parental care decreases as chick nears its first flight; young deserted soon after fledging or, sometimes, before (Bomford 1978; Pierce 1989).

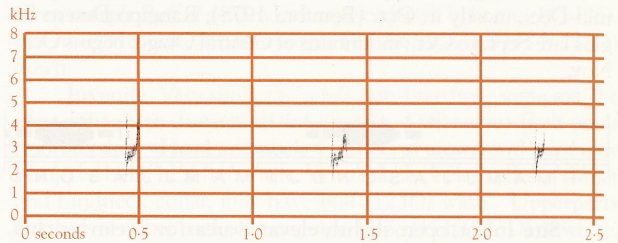
VOICE Well known. Based on studies by Cunningham (1973) and Bomford (1978, 1986) and contribution by R.J. Pierce. Sonagrams in Phillips (1980). Vocal when defending territories on both breeding and winter feeding areas; generally silent. Most common year-round advertising and alarm calls are a loud *pit*, while flying flocks often maintain a musical chattering comprising many individual *tink* calls. **Non-vocal sounds** During Territorial Flight display (see Social Behaviour) male performs wing-clicking flight with loud click, audible to 100 m, with each wing-beat; clicking lasted average 40 s (5–120); heard from dawn to dusk but not at night. During conspicuous Distraction Displays wings sometimes beaten noisily against ground.



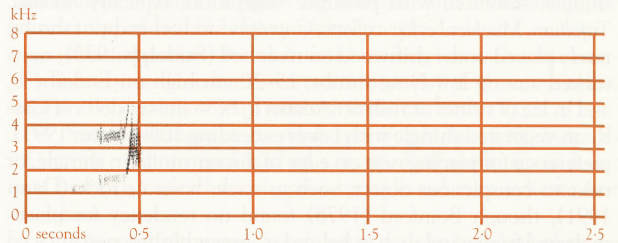
A K. & J. Bigwood; P102



B R. Buckingham; Adams I., Auckland Is, NZ, Nov. 1989; P107



C L. McPherson; Ashley R., SI, NZ, Oct. 1978; P36, P104



D L. McPherson; Ashley R., SI, NZ, Oct. 1978; P36, P104

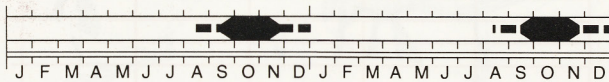
Adult ADVERTISING CALLS: loud, high-pitched, far-carrying *pit*, but pitch varies and often given as low abrupt double-note *chip-chip*, sometimes slurred together. **COURTSHIP CALL:** soft low crooning *kwereep*, sliding up scale in second syllable; delivered every few seconds. Given by male during Scrape Ceremony and during 7% of display-flights. In 46 change-overs, three incubating birds (one male, two females) initially called mates with *kwereep*. Corresponds to *mo* of Phillips (1980). **THREAT CALL:** fast rolling scratchy *chee-ree-a-ree* (three calls shown in sonagram A), accent on second syllable (Cunningham 1973; Bomford 1986), given in defence of breeding territory, nest-site, etc., before or during 79% of flight displays, and during defence of feeding territory or individual distance on winter feeding grounds. Corresponds to *whee-cheedle* of Phillips (1980). **ALARM CALLS:** usually loud high-pitched *pit* (sonagram B), varying in pitch and tone, ranging down to lower *chip*. Repeated every 1–2 s; carries well. Urgent alarm calls louder and more drawn-out *peet* (sonagram C), calls of male deeper and clanging, those of female thinner and more highly pitched (Cunningham 1973); sexual difference not discernible to

Bomford (1986). Loud long-drawn *wee*, varying considerably between birds in pitch and tone, given during conspicuous Distraction Display (see Social Behaviour), becoming louder and more strident as display intensifies and bird comes closer to intruder (Bomford 1986). *Pit* and *peet* correspond to *tic* and *tweet* of Phillips (1980). **FLIGHT CALL:** abrupt but musical *tink*. **PARENTAL CALLS:** *kuereep* call and soft *chirp* calls given to attract chicks. **Other calls** *Whee-o-whit* (sonagram D) from lone unmated males early in breeding season; quiet contact calls between members of pairs, particularly early in breeding season (Phillips 1980). Quiet churring calls when feeding or roosting in flocks (Lane 1987).

Young Soft *peep* calls from egg within 48 h of hatching, and from downy chicks. Chick alarm call a loud repeated *scree*.

BREEDING Detailed studies at L. Wainono and delta of Cass R. (Bomford 1978, 1988; Pierce 1983, 1989; Dann 1991); at Kaitorete Spit, L. Ellesmere (Dann 1991); and Auckland Is (Walker *et al.* 1991). Account based on contribution by R.J. Pierce. One case of hybridization with Red-capped Plover (Oliver). Monogamous. Breed in simple pairs.

Season In lowland: laying, Aug. or early Sept. to early Dec. or later; in high country areas: Cass R.: mid-Aug., mid-Sept. to mid-Dec., mostly in Oct. (Bomford 1978); Rangipo Desert: begins late Sept. to Oct.; mountains of Central Otago: begins Oct.–Nov.



Site In flat, open, slightly elevated areas, on ocean beaches, in braided river beds; on Auckland Is: on central moors on Enderby I. and fellfields on Adams I.; on sand, shells, gravel or shingle, stabilized with prostrate vegetation, typically *Raoulia*, *Trifolium*, *Muehlenbeckia axillaris*, *Coprosma* and other dwarf shrubs; rarely placed under driftwood on river bed (Stidolph 1923); nests tucked among low-lying shrubs, 15–20 cm high on Enderby I., and in lee of stones or rush on Adams I.; 80% sites at delta of Cass R. on vegetated shingle with cover exceeding 10% (Dann 1991); preference for placing nest on edge of discontinuity in shingle, or next to conspicuous object, such as stick, bone or rock (Dann 1991), though Bomford (1978) found no tendency for places sheltered from wind such as behind stones or bushes; nests placed <10 m to sometimes over 1 km from water; occasionally under shelter of debris or small bush; avoid sites with tall shrubs; some birds nested on shingle among rows of seedlings in nursery; one nest found between two rows of oats c. 15 cm high, in paddock next to river (Stidolph 1931); some nests may be modified hoofprints of cattle or horses (R.J. Pierce). Experienced nesters have high fidelity to site: males nested an average 42 m (5–200; 13) from previous site; females 245 m (0–6200; 49) (Pierce 1989). Repeat clutches usually less than 110 m away; one pair re-nested in same site; a 1-year-old female re-nested 15 km away (Pierce 1989).

Nest, Materials Scrape in ground, lined with small stones c. 10 mm diameter, and small pieces of *Raouli*, *Muehlenbeckia*, lichen, moss, grass, twigs and other vegetable matter, and dung. Amount of lining varies from virtually none to eggs being almost buried. Male prepares a number of shallow scrapes before one is chosen, which is then further excavated. To deepen scrape, male sits, pivots on breast and kicks backwards; female sometimes shuffles in scrape but rarely does much excavation. Before laying, male collects material by throwing items over shoulder towards or into scrape; may do this for up to 10 min at a time, returning to sit

in scrape periodically, and picking up items in bill and placing them in scrape; lining material collected <2 m from nest. Both sexes add material after incubation begins (Bomford 1978; 1988). **MEASUREMENTS** (mm): diameter, 97 (7; 65–110; 47); depth, 32 (5; 25–40; 47) (Bomford 1978, 1988).

Eggs Pyriform, smooth; ground-colour varies from pale grey, pale brown or pale green to brown, blue-green, dark greenish yellow or shades of olive-green, spotted, blotched and streaked black or dark brown, often more heavily marked at larger end (Bomford 1978, 1988; Oliver). **MEASUREMENTS:** 34.1 (31.9–37.2; 63) x 24.8 (24.0–26.4); 34.4 (1.2; 31.4–37.4; 139) x 24.9 (0.6; 22.6–26.4) (Dann 1991). **WEIGHT:** before incubation started, or within 24 h of laying, 11.5 (0.8; 51) (Bomford 1988); at various stages of incubation, 10.5 (0.8; 8–12; 88) (Dann 1991).

Clutch-size Typically three, occasionally two or four; mean 2.93: C/2 x 3, C/3 x 38 (Bomford 1978). One record of five eggs in clutch laid by one female (R.J. Pierce); a clutch of six eggs appeared to be laid by two females (Phillips 1980).

Laying Intervals average 73 h (<60–120; 12), with tendency towards longer interval between first and second eggs (average 86 h; n=6) than between second and third eggs (average 67 h; n=12) (Bomford 1978). During laying, male actively adds lining to nest; many nests had eggs almost completely covered by material before incubation started (Bomford 1988). Re-lay after failure, up to three times, usually within 1 month (Pierce 1989); once within 1 week (Stead 1932). Double-brooding rare (Pierce 1989).

Incubation Both sexes incubate; often begins on day of completion of clutch, sometimes before or up to 5 days afterwards, with tendency for incubation to start earlier in laying period as season progresses (Bomford 1988). Eggs placed on top of lining once incubation starts. Eggs incubated for 93% daylight hours, and not left unattended for more than 10 min; pairs change-over at nest 2–15 times during day; female incubates an average 82 (67–99)% of time; average stints of incubation, 177 min (10–570; 8); male may incubate through most of night; male takes larger share as incubation advances (Bomford 1978, 1988). Incubating bird removes egg-shells within minutes of hatching, flying 5–25 m or more away with large pieces and dropping them, and concealing smaller pieces beneath lining of nest (Bomford 1978). **INCUBATION PERIOD:** 25 days (Soper 1972); 26–27±1 days from last egg laid to last hatched (n=4; Bomford 1988). Eggs hatch 2–50 h after pipping. Synchrony of hatching difficult to determine as many chicks hatch at night, interval usually 30–35 h but may vary from 20 to 45 h (n=8; Bomford 1978, 1988).

Young Precocial, nidifugous. Downy young show different colour-phases: most common phases show either golden or grey upperparts, usually with traces of black or white, and white underparts (Dann 1991). Leave nest 3–4 h after hatching, or up to over 24 h later if during bad weather or at night (Bomford 1988). **Parental care, Role of sexes** Young brooded regularly until feathering appears, then amount of time spent brooding rapidly decreases (Bomford 1988). Forage close to nest when small, gradually moving farther afield but rarely more than 200 m from nest during period before fledging (Pierce 1989; R.J. Pierce). Chicks crouch, motionless, when intruder approaches and rely on cryptic coloration to avoid detection; older chicks scatter in response to alarm call of adult (Bomford 1978). Adults feign injury, even death, if nest approached, but usually pretend to forage, always edging away from nest (Oliver); perform broken-wing display if approached (Walker *et al.* 1991). **Growth WEIGHT** (g): within 24 h of hatching, 8.0 (0.4; 32) (Bomford 1988); at hatching, 7; at first flight, 38–45, or 63–75% adult weight (R.J. Pierce).

Fledging to maturity May be abandoned by parents towards end of fledging period but this generally occurs after fledging. **FLEDGING PERIOD:** 5–6 weeks (Bomford 1988). Young remain in territory with parents until after fledging; leave territory as family group; young appear to part company usually within 2 weeks of fledging (Bomford 1978; Pierce 1989). Most young return to breeding grounds and breed or try to breed in their first year; a small proportion first return in their second year (Pierce 1989).

Success For 99 eggs: 44 hatched; five lost during laying, 50 during incubation (Bomford 1978). From 116 eggs, 12 (10.4%) hatched, one young fledged; nests taken by Swamp Harriers *Circus approximans*, Australian Magpies *Gymnorhina tibicen*, Kelp Gulls, cats, dogs, rats, stoats and children (Phillips 1980). Eggs and young taken by *Mustela*, feral cats and hedgehogs; probably pigs (Walker *et al.* 1991). Predation rates higher after sudden declines in rabbit numbers or where stoats present; lowest predation rates occurred on shingle fans and on islands in mid-river. Nests trampled by sheep and cattle (Pierce 1983).

PLUMAGES Prepared by A.M.Dunn. Hatch in natal down. Begin pre-juvenile moult at unknown age. Partial post-juvenile moult to first immature plumage followed by partial pre-breeding moult to second immature plumage, which very similar to non-breeding and breeding adults respectively. Thereafter, complete post-breeding and partial pre-breeding moults each cycle produce alternating non-breeding and breeding plumages with distinct seasonal change in appearance. Nominative *bicinctus* described below.

Adult male breeding Definitive alternate. **Head and neck** Forehead, white, with black (89) feathers above base of bill. Off-white supercilium extends from forehead to rear of eye. Forecrown, black (89). Crown, nape, ear-coverts and hindneck, brown (28), with very fine buff (124) to orange-buff (118) fringes to feathers. Loes, black (89). Black moustachial stripe runs from loes to upper breast-band. Chin and throat, white. **Upperparts** Mantle, upper back, scapulars and central lower back, rump and upper tail-coverts, brown (28), with orange-buff (118) to rufous (40) fringes to feathers. Side of lower back and rump and outer upper tail-coverts, white. **Underparts** Mostly white except for two prominent breast-bands, 1–1.5 cm apart. Upper breast-band, black (89), 1–1.5 cm deep; lower breast-band, red-brown (c32), 2.5–3 cm deep. Margins of breast-bands neat with sharp edges. **Tail** Central rectrices, t1–t3, dark brown (119A) with thin white fringe. T4–t6, light grey-brown (119C) with broader white fringes. **Upperwing** Lesser and median secondary and most marginal coverts, brown (28) with orange-buff (118) to rufous (40) fringes that disappear with wear. Marginal coverts near carpal joint, white. Alula, lesser and median primary coverts, dark brown (219). Greater secondary coverts, dark brown (119A), with white fringes. Greater primary coverts, black-brown, with thin white tips. Outer primaries, p6–p10, black-brown (19) with white streak on shaft. Inner primaries, p1–p5, dark brown (121) with visible white base to outer web, which forms part of narrow white wing-bar. Secondaries, brown (28) with thin white tips. Tertiaries, brown (28). **Underwing** Lesser and median primary and secondary coverts, white, with light grey-brown (119C) bases. Greater primary and secondary coverts, pale grey (c86) with broad white tips. Primaries and secondaries, grey (c84).

Adult female breeding Differences from adult male breeding. **Head and neck** Forecrown, black (89) to dark brown (119A). Loes and moustachial stripe, black-brown (19) to brown (28). **Underparts** Margins of breast-band never neat with sharp edges. Upper breast-band varies from black (89) to brown (28); often grey-black (c82). Lower breast-band varies from red-brown (c32)

to rufous (40); often rufous-brown (c36).

Adult non-breeding Sexes similar. Differences from adult male breeding. **Head and neck** Forecrown, brown (28). Forehead, white with brown (28) feathers at base of upper mandible. Off-white supercilium from forehead to just behind eye. Loes to ear-coverts, brown (28) with off-white streaking. **Underparts** Upper breast-band, diffuse centrally and composed of brown (28) feathers with broad white tips. Lower breast-band may be confined to few brown (28) feathers at sides of lower breast.

Downy young Based on photos (Pringle 1987; NZ DOC Slide Library) and skins (AWMM, CM, NMNZ). Two colour-morphs: gold and grey, with intermediates, which are rare. Morphs not obviously related to geographical variation or sex; broods normally all one morph but mixed broods of both morphs and intermediates have been found (R.J. Pierce). **Gold morph** **Head and neck** Top of head, mostly off-white with buff (124–121D) tips that give speckled appearance; some down tipped black-brown (119). Hindcollar round nape, off-white to cream (92). Narrow, obscure black-brown (119) loreal stripe. **Upperparts, Wing-pads** Mostly finely speckled black-brown (119) and buff (124–121D), with scattered larger black-brown (119) blotches. Black-brown (119) trailing-edge to wing. **Underparts** Off-white. **Grey morph** Buff of gold morph replaced with light grey (85–86). Intermediates have mixture of grey (85–86) and buff (124–121D) down.

Juvenile Very similar to adult non-breeding; some may be very difficult to distinguish from adults. Differences from adult non-breeding. **Head and neck** Feathers of crown and nape may be tipped buff (123D) to white. White areas of face, sides of throat and hindneck collar, may have buff (123D) wash. **Upperparts** Feathers of upper back and scapulars tipped buff (123D) to white, giving scalloped appearance. **Underparts** White, with no breast-bands, though may have pale-grey (86) to buff (123D) wash across upper breast. **Upperwing** Median and lesser secondary coverts tipped buff (123D) to white.

First immature As adult non-breeding but with some juvenile light-fringed median coverts retained. Buff wash across collar, face and upper breast may indicate first-year bird.

Second immature As adult breeding but may retain traces of juvenile pale-fringed median coverts. Buff wash across collar and buff tips to feathers of upper breast-band may indicate first year-bird.

Aberrant plumages Single adult male in breeding plumage (NMNZ 18125) from Auckland has three breast-bands; a narrow second black band borders the anterior margin of chestnut band.

BARE PARTS Based on photos (Pringle 1987; NZDOC Slide Library; unpubl.: M.A. Barter) **Adult** Bill and iris, black (89). Legs, feet and toes, pale green, ranging from dull grey-green (c43) to yellow-olive (c52). **Downy young** Bill, grey-black (82). Iris, black (89). Legs, feet and toes, pale grey-green (c42). **Juvenile, Immature** As adult.

MOULTS **Adult post-breeding** Second and subsequent pre-basic moult; complete. Primaries moult outward. Primary-moult occurs on or near breeding grounds Nov.–Feb. and probably completed before migration to wintering areas (Thomas 1972; R.J. Pierce). Most birds complete body-moult by Feb.–Mar., but a few may not finish until May (Thomas 1972). **Adult pre-breeding** Second and subsequent pre-alternate moult; partial. All feathers of body appear to be replaced; some wing-coverts may be replaced, others retained. Males appear to begin moult before females; males begin moult in May; females in June (Barter & Minton 1987). Both sexes appear to reach full breeding plumage

before migration to breeding grounds in July–Aug. (Barter & Minton 1987). **Pre-juvenile** Timing of appearance of first feathers unknown. Young birds fully feathered by c. 6 weeks (Stead 1932). **Post-juvenile** First pre-basic moult; partial. Most body-feathers replaced. Scapulars and feathers of mantle, upper back and crown, replaced first. Remiges, rectrices and some median secondary coverts, retained. **Immature pre-breeding** First pre-alternate moult; partial. All feathers of body appear to be replaced; some wing-coverts may be replaced, others, particularly inner coverts, retained. First-year birds do not begin moult until July but catch up to adults by Aug. (Barter & Minton 1987).

MEASUREMENTS Nominate *bicinctus*: (1) NZ, adults, skins (CM, NMNZ). (2) SE. Aust., adults, skins (HLW, MV). (3) SE. Aust., immatures, skins (HLW, MV). (4) Vic., adults, live (Barter & Minton 1987). (5) Vic., immatures, live (Barter & Minton 1987).

	MALES	FEMALES	
WING	(1) 127.1 (2.63; 123–134; 27) (2) 130.2 (2.86; 124–135; 11) (3) 128.2 (4.07; 124–135; 6) (4) 131.3 (3.2; 357) (5) 127.9 (3.4; 84)	127.7 (2.50; 124–131; 10) 127.2 (3.47; 118–134; 18) 127.1 (3.56; 122–132; 11) 130.1 (3.2; 382) 126.7 (3.2; 73)	ns * ns ** *
8TH P	(1) 78.1 (2.17; 75–81; 11) (2) 88.4 (2.63; 85–92; 10) (3) 87.3 (5.43; 80–94; 6)	81 85.4 (3.01; 78–89; 11) 83.6 (2.84; 80–87; 11)	ns * ns
TAIL	(1) 56.3 (2.79; 49–61; 26) (2) 55.5 (2.28; 52–61; 12) (3) 54.8 (3.35; 52–60; 5)	57.3 (2.23; 54–60; 9) 54.3 (2.61; 47–59; 18) 53.0 (2.57; 48–56; 11)	ns ns ns
BILL	(1) 17.0 (0.76; 15.5–18.5; 28) (2) 17.2 (1.15; 15.1–19.0; 11) (3) 17.4 (0.63; 16.8–18.4; 5) (4) 17.1 (0.7; 68)	17.2 (0.67; 16.0–18.0; 12) 17.0 (0.85; 16.0–19.0; 18) 17.1 (0.61; 16.5–18.1; 11) 17.1 (0.8; 61)	ns ns ns ns
BILL W	(1) 4.94 (0.32; 4.5–5.5; 9)		
BILL W	(6) 5.78 (0.16; 5.6–6.0; 5)	5.90 (0.29; 5.6–6.2; 4)	ns
TARSUS	(1) 29.9 (1.52; 26.5–32.8; 28) (2) 31.3 (1.68; 28.6–34.0; 11) (3) 30.5 (0.72; 29.3–31.3; 6)	30.0 (1.30; 27.7–31.9; 12) 30.1 (1.17; 27.4–32.0; 17) 30.8 (1.22; 28.7–32.7; 11)	ns * ns
TOE	(1) 17.0 (0.70; 14.6–18.2; 24)	16.9 (0.39; 16.0–17.6; 12)	ns
THL	(4) 46.9 (1.0; 134) (5) 46.6 (1.2; 27)	46.4 (1.0; 127) 46.7 (1.6; 18)	** ns

Subspecies *exilis*: (6) Auckland Is, adults, skins (CM). (7) Auckland Is, skins (NMNZ, CM) (Falla 1978).

	MALES	FEMALES	
WING	(6) 133.2 (2.28; 131–136; 5) (7) 132.0 (1.58; 130–134.5; 8)	133.0 (5.60; 125–138; 4) 129.5 (4.2; 124–133.5; 5)	ns ns
8TH P	(6) 85.6 (2.70; 81–88; 5)	84.2 (2.22; 82–87; 4)	ns
TAIL	(6) 65.0 (1.0; 64–66; 5) (7) 59.9 (1.65; 58–63; 8)	61.7 (4.6; 56–66; 4) 61.7 (59–65; 5)	ns ns
BILL	(6) 19.1 (0.71; 18.4–20.3; 5) (7) 18.3 (0.3; 17–19; 8)	18.0 (1.09; 16.6–19.2; 4) 17.2 (1.15; 16–18.5; 5)	ns ns
BILL W	(6) 5.78 (0.16; 5.6–6.0; 5)	5.90 (0.29; 5.6–6.2; 4)	ns
TARSUS	(6) 35.7 (0.94; 34.6–37.0; 5) (7) 34.8 (1.5; 33–37; 8)	34.3 (1.25; 32.5–35.5; 4) 34.0 (1.8; 32–36; 5)	ns ns
TOE	(6) 22.5 (0.81; 21.6–23.3; 4) (7) 27.6 (1.17; 27–28.5; 8)	22.6 (1.27; 21.1–24.2; 4) 27.4 (1.47; 26–29.5; 5)	ns ns

Wing-lengths of nominate *bicinctus* significantly different between adults and immatures for both sexes (Barter & Minton 1987). Subspecies *exilis* has significantly longer wing, tail, bill, tarsus and toe and wider bills than *bicinctus* for both sexes.

Nominate *bicinctus*: (7) Vic., adults, live (Barter & Minton 1987). (8) Vic., immatures, live (Barter & Minton 1987).

UNSEXED	
WING	(7) 130.7 (3.1; 1299) (8) 127.7 (3.2; 279)
BILL	(7) 17.3 (0.9; 324) (8) 17.4 (0.9; 73)
THL	(7) 46.5 (1.1; 455) (8) 46.5 (1.1; 92)

WEIGHTS Nominate *bicinctus*: (1) SE. Aust., adults, skins (HLW, MV).

	MALES	FEMALES	
(1)	58.8 (3.71; 55–65; 7)	58.4 (9.28; 47–76; 11)	ns

(2) NZ, adults (Pierce 1980b); (3–7) Vic., (Barter & Minton 1987): (3) adults, Mar.–Apr., immediately after arrival; (4) adults, May–July; (5) adults, Aug., before departure; (6) first-years, May–July; (7) Aug.

UNSEXED	
(2)	57.7 (53–67; 6)
(3)	55.0 (4.0; 87)
(4)	59.4 (3.9; 183)
(5)	73.7 (8.8; 70)
(6)	57.1 (s.d.=3.6)
(7)	63.0 (s.d.=7.6)

First-year birds from Vic. average lighter than adults and begin fattening later than adults.

Subspecies *exilis*, unsexed adults from Auckland Is., 81.8 (77.5–88.7; 4) (Pierce 1980b).

STRUCTURE Nominate *bicinctus*. Wing, long, narrow and pointed. Eleven primaries; p10 longest; p9 1–2 mm shorter, p8 7–10, p7 16–20, p6 26–29, p5 35–38, p4 43–48, p3 52–57, p2 58–62, p1 64–70, p11 minute. Sixteen secondaries including four tertials; tips of longest tertials fall between p7 and p9 on folded wing. Tail, slightly rounded; 12 rectrices; t1 longest, t6 5 mm shorter. Bill, short, thin and pointed; half length of head; nasal groove, shallow and half length of bill; nostril, small and slit-like. Tarsus, slightly laterally compressed; scales, reticulate. Outer toe 78–84% of middle, inner 70–75%, no hind toe.

GEOGRAPHICAL VARIATION Two subspecies. Nominate *bicinctus* breeds NI and SI, NZ, and most of population migrates to s. Aust. in winter. Subspecies *exilis*, uncommon and sedentary on Auckland Is (Falla 1978). Adult *exilis* generally more robust and differs from nominate in: larger size; slightly larger bill, heavier at base; heavier tarsus; longer heavier toes; and plumage (see Measurements). In adult breeding plumage, males have breast-pattern like typical adult breeding female of *bicinctus*, with chestnut band untidily defined and mottled by whitish fringes and grey smudges on feathers; no skins of either sex examined (n=15) had complete black breast-band, but always retained scattered grey-brown (grey 28) feathers of non-breeding plumage. White area separating the two breast-bands, slightly narrower than on *bicinctus* and always appearing untidy, not cleanly

defined. Top of head and upper parts, darker (c29–121). Females in breeding plumage tend to be untidy, with poorly defined breast-bands; lower band heavily mottled by broad but untidy white fringes; upper band rather brown (c28). Top of head and upper parts, also darker (c29–121). In adult non-breeding plumage, upperparts darker (c29–121) and with more extensive brown wash on breast, extending to lower breast (confined to upper breast in *bicinctus*). No juvenile or immature specimens examined. By Apr., immatures difficult to separate from adults in field (R.J. Pierce).

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Volume 2, Plate 64 [caption error corrected from original]

Double-banded Plover *Charadrius bicinctus* (page 847)

1 Adult breeding male; 2 Adult breeding female; 3 Adult non-breeding; 4, Downy young; 5 Juvenile; 6, 7 Adult non-breeding

Wrybill *Anarhynchus frontalis* (page 919)

8 Adult male breeding; 9 Adult female breeding; 10 Adult non-breeding; 11 Downy young; 12 Juvenile; 13, 14 Adult female breeding