

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]):

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

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

Elsayornis. 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. Grey 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. Fledge in 3 (smaller species) to 5 (larger species) weeks.

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Charadrius novaeseelandiae Gmelin, 1789, *Syst. Nat.*, ed. 13, 1(2): 684 — New Zealand = Queen Charlotte Sound, South Island, ex Latham.

OTHER ENGLISH NAMES New Zealand Shore Plover; Masked, Sand or New Zealand Plover; Stone Plover (in error).

MONOTYPIC

FIELD IDENTIFICATION Length: 20 cm; weight: 60 g. Small, rather thickset plover with turnstone-like proportions and short, rather fine and slightly drooping bill; tip of longish tail projects beyond wing-tips at rest. Adult unmistakable: black mask contrasting with white underbody and bold white band round crown. Sexes separable. No seasonal variation. Juvenile and immatures, separable.

Description **Adult male** Crown, grey-brown, encircled by white band. Forehead, face, chin, throat, foreneck and sides of head and neck, black, forming mask joining narrowly on hindneck. Rest of upperparts, grey-brown, finely streaked darker and with pale fringes; in worn plumage, dark streaking more prominent, fringes reduced or lost, and develop paler grey-brown panel below scapulars. In flight: prominent white sides to rump and tail and white tips to all but central pair of rectrices; fine white trailing-edge to secondaries; white wing-bar extends from all-white inner few secondaries, across tips of greater secondary coverts, and broadly through primaries. Upper breast to under tail-coverts, white except for some grey-brown smudging on sides of breast and foreflanks. Underwing, whitish. Bill, bright red on basal two-thirds, with black tip. Orbital ring, bright red or deep orange. Iris, dark brown. Legs and feet, dull orange or pinkish orange. **Adult female** As male except: mask, dark brown, especially on lores, cheeks and ear-coverts, with darker blackish forehead and band round neck; less orange at base of bill, covering less than half of bill, merging to blackish tip. **Juvenile** Differ from adults in pattern of head and upperparts. Head and neck, vary: mostly brown with fine pale fringing on crown and nape, varying white forehead and lores, white supercilium ending above ear-coverts, and

white chin and throat; on some, mostly white, with brown crown (broadly fringed whitish), brown smudge before eye and brown patch on ear-coverts. Also differ by: brown lateral breast-patches, which, on darkest birds, continue across foreneck as narrow collar; more scaly appearance to upperparts and inner wing-coverts when fresh; and scapulars, tertials and inner wing-coverts have varying dark bars. Bill, black, with small orange or yellow area at base of lower mandible; orbital ring much duller than adult; legs and feet duller, pale orange. **Immature** Like adult except: head-pattern like dark-headed juveniles, though forehead and hindneck brown, and white supercilium restricted to in front of eye; prominent dark-brown lateral breast-patch as juvenile but without narrow collar across foreneck. Bare parts as juvenile, except bill has small, bright-red base and legs slightly brighter.

Similar species None; juvenile could be confused with superficially similar juvenile **Ruddy Turnstone** *Arenaria interpres*, which is noticeably larger, with darker head lacking bold white supercilium; broad blackish-brown breast-band; and, in flight, by striking white back, upper tail-coverts and base of tail and bold black tail-band.

Now restricted to rocky shore platforms and barren salt-swept turf of South East I., Chatham Grp. Usually in pairs or small groups while breeding; during the non-breeding season, flocks of up to 15 birds can be seen, congregating in favoured areas; often roost and feed in small groups. Swift plover-like gait, also likened to that of Ruddy Turnstone. Feed among rock pools and beds of barnacles and mussels, on marine invertebrates. Flight, strong, usually low with rather stiff, shallow wing-beats; a display-flight using butterfly-like slow wing-beats used on territories during

breeding. Highly vocal with loud ringing calls; also kleet or pip; calls of juveniles and females noticeably higher-pitched than those of adults and males.

HABITAT Confined to single small oceanic island. Most commonly round rocky shores with wave-cut platforms; also salt-meadows. Formerly occupied estuarine mudflats and sand-spits on mainland NZ, but none such within present distribution (Fleming 1939; Flack 1976; Phillips 1977) and authenticity of some records questioned (Davis 1987).

Mainly occupy rocky coasts, with bays bounded by steep headlands and adjacent boulder-strewn beaches and extensive wave-cut platforms. Wave-cut platforms usually large, up to 100 m out to sea, with shallow tidal pools; may be bare or covered with barnacles, limpets or patches of algae. Associated boulder-strewn beaches generally wave-washed at high tide, and piled high with boulders, or have boulders on floor of small pebbles and grit. Less often, in inland and subcoastal meadows, up to 60 m from coast and at least 30 m asl, composed of large mats and carpets of moist herbaceous turf-like plants, and halophytic vegetation (e.g. *Sarcocornia*) with scattered boulders, grass tussocks and patches of bare soil. Merge into boulder and pebble beaches above high-water mark or form strips above precipitous cliffs. Habitat farther inland generally unsuitable because overgrown with dense tangle of vegetation; however, clearings, such as areas where sheep formerly grazed, may have been used (Fleming 1939; Flack 1976; Phillips 1977; Davis 1987). On South East I., 69% of population on n. and e. coasts, which are sheltered from prevailing w. winds, facing sun, with feeding areas near nesting sites (Fleming 1939). Fly over sea to foraging areas and during displays (Phillips 1977).

Forage at low tide on large flat wave-cut platforms: on damp rocks, bare or covered in algae or barnacles; among short (2–3 cm) sea-lettuce; at edges of shallow tidal pools (saline or brackish), usually in very shallow water but occasionally up to belly in water (Fleming 1939; Flack 1976; Phillips 1977; Davis 1987).

Roost on large wave-cut platforms (Flack 1976), rocky beaches or on bare patches of black and brown soil among herbaceous plants (Flack 1976; Phillips 1977; Davis 1987). In former range, roosted with godwits on high sandbanks or mudbanks (Fleming 1939).

Usually breed on beaches with boulders piled high to provide suitable nesting cavities. Storm-surges may cause mass failure of nests. Inland salt-meadows with mats of herbaceous plants or clumps of lignum, up to 60 m from the shore provide secondary breeding habitat, where many more nests placed under logs, tree-roots, etc., than on beaches because boulders rather scarce. Historical record (Potts 1878) of nests in tussocks of wiry-grass or saw-edged *carex* on Rangitutahi, perhaps confused with those of Richard's Pipit *Anthus novaeseelandiae* (Fleming 1939; Flack 1976; Davis 1987).

Up till 1958, sheep grazed on South East I. and maintained close-cropped pastures, which provided some suitable habitat; after sheep removed, these areas became overgrown, causing a decline in populations (Flack 1976).

DISTRIBUTION AND POPULATION Endemic to NZ; restricted to Chatham Is. Formerly on NI and SI and adjacent islands of mainland NZ.

Chatham Is Confined to South East I., though vagrants occasionally recorded Pitt and Mangere Is after storms. Wrongly attributed to 'The Sisters' (Rangitutahi) by Potts (1885) (Fleming 1939). Unconfirmed records of flock at Star Keys (Fleming 1939).

Extinct on mainland; previously recorded from many regions of both islands (Fleming 1939). Former distribution and

movements on NI not known because extinction occurred early (Fleming 1939; NZCL). Few records; said to have occurred from near Wellington, N to Manukau Harbour, Firth of Thames, Coromandel Pen., and Great Barrier I., and E to Tauranga and L. Rotorua (Potts 1878, 1885; Buller 1888; Stidolph 1926; Fleming 1939; Bell & Brathwaite 1964; Oliver). Claim that birds migrated to NI after breeding on SI (Potts 1878, 1885) cannot be established (Fleming 1939). On SI, first recorded from Dusky and Charlotte Sounds during Cook's second voyage (Fleming 1939); later recorded from e. and se. coasts (Buller 1888). Buller (1888) said Shore Plover was 'very rare', but may have been extinct on the mainland by then; no subsequent mainland records (Fleming 1939). Probably occurred on all islands in Chatham Grp but earliest ornithological studies found it confined to outlying islands; extirpated on Pitt and Mangere Is by predators from earlier landings (Fleming 1939). Declines in population recorded or suspected after heavy collection of specimens, 1890–1910, and vigorous regeneration of vegetation after removal of sheep in 1950s, but populations have subsequently recovered or stabilized (Fleming 1939; King 1978–79). Specimen of *T. rossi* from Auckland Is generally considered juvenile Shore Plover that strayed or was incorrectly labelled (Fleming 1939; NZCL).

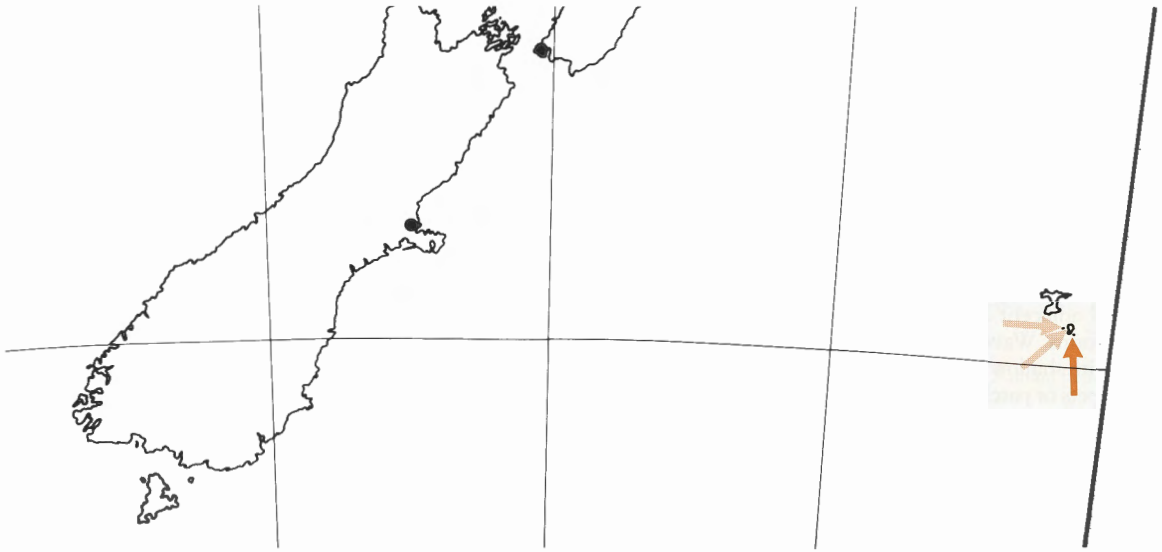
Introductions Reintroduced to Mangere I. in 1970 and 1971 but unsuccessful because birds quickly returned to South East I. (Bell 1974); also see Movements.

Endangered (King 1978–79). Population currently stable (CSN 36). Probably never abundant (Fleming 1939) though once said to be comparatively plentiful on NI and SI (Buller 1888). On South East I.: 1986–87, 118 birds (Davis 1987); earlier records: 1937, c. 70 pairs (Fleming 1939); summer 1968, c. 100 birds (CSN 19 Suppl.); Jan. 1971, 145 birds including 28 juveniles (CSN 29); 1972, 82 birds (Phillips 1977); Nov.–Dec. 1981, 101 birds excluding young (CSN 29); 1981–82, 105 birds (including 40 breeding pairs) (CSN 30). Nearly exterminated by introduced predators including rats, stoats, weasels and feral cats (Fleming 1939). After being exterminated elsewhere, hundreds were collected on South East I. between 1890 and 1910 for sale as scientific specimens (Fleming 1939). Easily disturbed while breeding, though desertions caused by human disturbance not recorded (Fleming 1939). Illegal landings and subsequent introduction of predators is constant threat on South East I. (Phillips 1977; Collar & Andrew 1988).

MOVEMENTS Based mainly on Davis (1987). Sedentary; local movements round South East in non-breeding season. Also feed on Seal Rock, 300–400 m offshore. Juveniles very mobile when first independent, moving throughout suitable habitat on s. and n. shores, but often settle on natal shore.

During breeding season (Sept.–Apr.), sedentary, pairs occupying breeding territories; unpaired birds in compact home-ranges, can be close to natal area; no movement between n. and s. shores during breeding season. In non-breeding season, many pairs join small flocks of juveniles, unpaired birds and other pairs; a few remain in breeding ranges; some movement along shores and between n. and s. shores. Many pairs or individuals (usually females) return to territories May–July. Historically, said to have migrated between NI and SI, forming flocks at river mouths and on mudflats after breeding (Buller 1888) though these statements now questioned (Davis 1987; NZCL).

Adults transferred to Mangere I., 10 km from South East, quickly returned to South East. A second release that included immatures stayed for few weeks but later returned. A third release, where birds had wings clipped was unsuccessful (Flack 1976). Few records of vagrants on Pitt I., although only 2 km from South East



I.: a few occurrences after heavy gales (Fleming 1939); single, summer 1938–39 (Fleming 1939); occasional juveniles recently (Davis 1987).

FOOD Study by Davis (1987). Crustaceans, arachnids, molluscs and terrestrial insects of rocky shores. **Behaviour** Diurnal and nocturnal, especially on moonlit nights. Usually glean and peck among tide-wrack, and on wet rocky shore platforms covered by algae and barnacles; on South East I., feed at freshwater seeps and pools (Fleming 1939; Davis 1987); though formerly on mainland fed on mudflats (Buller 1888). Use step-peck-peck-peck behaviour with rapid short steps. Foot-trembling common on wet algae-covered rock platforms and salt-meadow turf; may feed with head and bill tipped to one side (Davis 1987) or belly-deep in water, with head submerged (Phillips 1977). Search rates vary between 76.6 and 80.8 pecks/min; peck rates 40.2–49.6 pecks/min, and success rates, i.e. where food was swallowed, 18.7–31.2 pecks/min, with significantly more success in freshwater seeps and fewer pecks on wet algae-covered platform. Similar food on both n. and s. shores, but more insect larvae taken on n. shore, and more copepods on s. shore. Take hemipterans, caterpillars and larvae on *Senecio* bushes and on salt-meadow turf (Davis 1987). Carry fish to dry land and swallow them head first (Phillips 1977).

Adult No detailed studies. Animals: Nemertean. Platyhelminthes. Annelids: polychaetes. Molluscs: gastropods: *Zeacamantus*; *Littorina* (7 mm); bivalves: *Mytilus*. Crustaceans: copepods (0.5 mm); ostracods; (Davis 1987); amphipods (Fleming 1939; 1–7 mm, Davis 1987); isopods (Davis 1987): *Idotea*; *Sphaeroma?*; *Isocladus* (Fleming 1939); decapods; chilopods. Arachnids: spiders; Acarina. Insects: larv. (3 mm); Hemiptera: Aphididae; Coleoptera: ads.; larv.; Lepidoptera: larv.; Diptera (Davis 1987). Fish (2–3 cm) (Phillips 1977). **Young, Intake** No data.

SOCIAL ORGANIZATION Well known, account based on detailed study of remaining population on South East I. by Davis (1987); also observations by Phillips (1977), Flack (1976), and Fleming (1939). Usually in pairs or small groups. During breeding season, in territorial pairs but occasional groups of three and unpaired birds (Flack 1976); Fleming (1939) recorded seeing larger numbers of birds of both sexes in which males predominated. After breeding, on n. shore, some pairs remain within breeding home-ranges (see below), and others join groups of

juveniles and unpaired birds in nearby areas; on s. shore, nearly all pairs abandon breeding home-ranges to join flocks, of up to 34 birds, with other pairs, unpaired birds and juveniles (Davis 1987); pairs and their broods seen to mingle peaceably (Fleming 1939); Phillips (1977) found that most pairs that had gathered to feed stayed well apart. For rest of non-breeding season, some pairs stay within, and some return to, breeding home-ranges while others remain mobile; small flocks of 3–5 common, usually unpaired birds and juveniles with pairs; often roosting and feeding flocks consist of same unpaired birds keeping company (Davis 1987). In past, flocks on mainland NZ in spring and autumn; associated freely with flocks of godwit *Limosa* when feeding and roosting at high tide (Buller 1888).

Bonds Monogamous; high mate-fidelity: of 40 pairs over 5 years, 30% stayed together, 25% lost partners (died), and only 5% changed mates; between seasons, mate-retention very high, from 80% (n=88) to 94% (n=80) (Davis 1987). Most birds first breed at 3 years old; some pairs of breeding age defend areas but do not breed (Davis 1987). By Sept., most birds have formed pairs (NZRD). **Parental care** Both members of pair select site and build nest; both incubate, female more than male; both sexes brood and guard young about equally though female does so more actively as she remains closer to chicks than does male; brooded until chicks fledge (Fleming 1939; Davis 1987). Brood together in first week; as young become more mobile, move farther apart (Davis 1987). In Mar., many juveniles still accompany pairs and approach them despite frequent chases by adults (Phillips 1977). Birds usually establish nest-sites near natal area; imprinting on habitat type or location may occur before chicks independent (Davis 1987).

Breeding dispersion Territorial breeding pairs concentrate in suitable habitat (Fleming 1939; Flack 1976; Davis 1987). Nest-density: two nests only c. 3 m apart, and in one short stretch of beach no fewer than 12 pairs nesting (Fleming 1939); suitable chick-raising areas may limit spacing of breeding pairs (Davis 1987). **Territories, Home-ranges** During breeding season, pairs occupy separate home-ranges, defending at least nest-site and chick-rearing areas; size of remaining area of home-range defended varies between pairs (e.g. some also defend associated feeding and roosting sites) (Fleming 1939; Flack 1976; Davis 1987). Most birds establish breeding home-ranges close to natal breeding range and, once established, normally stable for at least 5 years. Boundaries may change during breeding season and from

year to year and may overlap, particularly during chick-rearing period. Some pairs occupy breeding home-ranges all year; others abandon them after breeding, re-occupying them May–July (usually female, sometimes pairs), but most re-occupied or established by end of Sept.; outside breeding season, little intraspecific aggression by paired birds on home-ranges or among birds in flocks. Breeding home-ranges contain up to three discrete areas, classified according to dominant activities within them: nesting, chick-rearing, feeding, and combinations of these. On n. shore, each home-range consists of single area in which pair carries out all activities and which is entirely defended; on s. shore, consists of separate areas for nesting, chick-rearing, and feeding, and whereas those of nesting and chick-rearing always defended, some feeding areas are not. Within home-ranges, breeding pairs spend most time in core area, which changes during season; core areas rarely overlap. Chicks stay well within parental home-range, occupying larger areas as they become more mobile; ranges of different broods do not overlap. Pairs maintain exclusive zones beyond ranges of broods. During breeding season, home-ranges of unpaired adults and juveniles have less definite boundaries than breeding birds, overlapping with each other, and to small extent with breeding pairs (Davis 1987). **Feeding territories** During breeding season, feeding areas defended to varying extent: usually defended if within or next to nesting territories, but only defended sometimes if feeding areas disjunct (Davis 1987); non-incubating members of pairs usually fed near nest in association with other conspecifics (Fleming 1939). After breeding, Phillips (1977) noted that despite frequent interactions, neighbouring pairs used overlapping feeding areas.

Roosting Activity related to tide, and must feed much at night (Phillips 1977). Outside breeding season, adults often roost in small groups (Flack 1976). During breeding season, unpaired birds spend much time roosting; in breeding pairs, proportion of time spent feeding and roosting changes during a season; pairs roost for longest time in post-breeding period; in pre-nesting period, pair usually roosts in central area of home-range; during chick-rearing, female rests close to chicks and watches them (Davis 1987).

SOCIAL BEHAVIOUR Some information from observations by Fleming (1939), Davis (1987) and behavioural study by Phillips (1977) after breeding season; few displays described. Tame and allow close approach by people, even during daylight; easily caught on nests at night (Phillips 1977). Fleming (1939) considered courtship habits similar to typical behaviour of waders.

Agonistic behaviour Most aggressive interactions occur between paired and unpaired birds (71%; n=880); mostly before nesting (32%; n=444) and in chick-rearing period (43%), and with males more involved than females (61% breeding males; n=617). Dominance of some birds over others and tendency for birds to use areas at different times reduces conflict (Flack 1976). Pairs usually chase unpaired birds from home-range, and tolerate them only on periphery (Davis 1987); juveniles seen to chase females but in turn chased by males and clearly dominated by adult pairs (Phillips 1977). Conflict between neighbouring pairs often involves up to three pairs (Phillips 1977); most interactions occur on boundaries or zones of overlap of home-ranges. Many aggressive interactions begin with paired bird chasing unpaired bird, then neighbouring pair becomes involved; once unpaired bird driven off, paired birds interact aggressively, on ground or in air (Davis 1987); Mobbing behaviour, used in defence of nest (see Parental anti-predator strategies), often results in aerial chases between rival males (Fleming 1939). Aggressive behaviour (mostly

undescribed) always accompanied by loud Threat Call; includes Horizontal Runs, Upright Threat Postures, Lunges, short Up-flights and aerial chases; Parallel Walking, Parallel Running and Piping displays. Phillips (1977) and Davis (1987) describe some of these behaviours; prolonged running sessions interspersed with flights and pauses can last for over 1 h and involve both members of pair. Pair advertises presence in home-range by **FLIGHT DISPLAY**: birds fly in circle above home-range giving Advertising Call; common at beginning of breeding season (Davis 1987). **PIPING DISPLAYS**: males of pairs involved, sometimes accompanied by partners, walked slowly up and down within a metre of each other, bills pointed to ground and body hunched; utter loud continuous Threat Call; occurs for up to 5 min at a time before pairs move off quietly (Davis 1987). Occurs when aggression high, usually after other aggressive behaviours have taken place, and often between pairs, and between unpaired birds and pairs. **CHASING**: bird runs at opponent with head thrust forward, tail half-spread and depressed (but not to ground), and feathers of back sleeked to ruffled; crown-feathers depressed so that white feathers over eyes stand out sharply; humeri often raised but manus kept folded. Fleeing bird runs with crown fluffed and tail in normal posture. **UP-FLIGHTS**: when encounter fierce, often fly or leap 15–30 cm above ground. Once, male tilted dorsum and upper surface of spread tail towards opponent, then pulled out beakful of opponent's feathers. **V-WINGED FLIGHT**: during aggressive encounters, often last few metres of approach flight made with wings held in V over back, vibrating slightly; in response to passing bird, one female flew up, giving Threat Call and V-winged Flight as she neared it. Often, one or more birds from a group-encounter fly far out to sea, high in air in characteristic strong 'buzzy' flight, flying till almost out of sight before circling back to shore. **Fights** Contact fights observed occasionally (Davis 1987). **Alarm** When approached, often reluctant to fly, instead running only 2–10 m in front; may give Alarm Call (Buller 1888; Phillips 1977). If surprised, may face away, squat with tail up and slightly spread, and flick wings slightly over back. Bobbing common during mild alarm. Become alert at appearance of skuas *Catharacta* and Swamp Harriers *C. approximans*; will chase skuas (Fleming 1939); in presence of Harriers, may fly; sometimes fly large circles round Harrier, and give Alarm Calls (Phillips 1977).

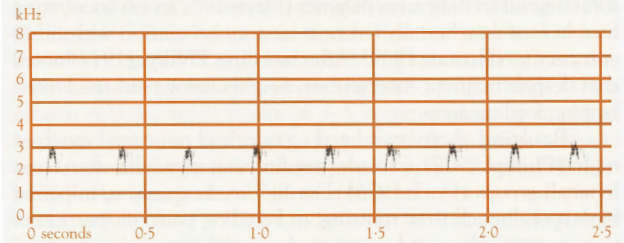
Sexual behaviour **Courtship** At start of courtship, male repeatedly lunges at female and she moves away rapidly; male sometimes chases for short distance. Two courtship displays observed, **CROUCH DISPLAY** and **FLUTTER DISPLAY**; latter usually performed by male of pair but also unpaired female to paired male and occasionally paired female to mate; Advertising Call given by displaying bird (Davis 1987). In Dec., Fleming (1939) saw mated pairs often performing **PURSUIT FLIGHTS**, where pair flew perfectly co-ordinated zigzag course; Mobbing Behaviour sometimes initiated Pursuit Flights between pairs. Possibly related to territorial advertising (see above). **Greeting** May have specific call when pair meet after period of separation (Fleming 1939). Members of pair give Contact Calls to each other when feeding or otherwise active (Phillips 1977). **Copulation** Sometimes follows courtship displays; often male repeatedly lunges at and chases female until she remains still and copulation occurs. Male approaches female with body nearly horizontal and begins rapid high-stepping walk while giving rapid Contact Call; when female remains still, male mounts and coition occurs; mounting lasts 58 s (6; 24–100; 18) and coition lasts 9.5 s (0.9; 5–16) (Davis 1987). After coition, male slides off female and performs Post-copulatory display (not described) up to eight times, accompanied by Contact Call. Female shakes feathers and preens for several seconds, occasionally Head-bobbing several times (Davis 1987).

Relations within family group Parents stay close to nest when eggs begin to pip (Davis 1987); brood young in nest continuously for 1–2 days after hatching; young leave nest when parents call them off with Contact Call, and, though both parents present, male does most calling; lead young to closest suitable rearing area, up to 200 m away, but within parental home-range; brood usually kept together in first week but move up to 10 m apart as become more mobile; brooding continues till young fledge, and after this parents stay close to them at night (Fleming 1939; Davis 1987). No interactions between siblings observed (Davis 1987). **Anti-predator behaviour of young** When approached, run to cover or flatten and freeze; occasionally cheep (Fleming 1939); if avian predators overhead, run under cover in response to Alarm Call of adults and stay hidden till parents stop calling (Davis 1987). **Parental anti-predator strategies** If disturbed during nest-building, pair walks quietly round with heads hunched against bodies, and bills low and parallel to ground. During laying, female usually flushes from near or on nest; does not sit closely and not anxious to return (Fleming 1939). Distraction displays occur during incubation and when with young. During incubation, sitting birds usually remain on nest when avian predators nearby; flush when observer approaches within 20 m then usually runs for c. 10 m and stand in alert posture Head-bobbing (Davis 1987), or run silently off to distance of c. 3 m, and then gives piping Alarm Call, attracting mate and conspecifics nearby; **MOBBING BEHAVIOUR** may follow, where all attracted birds fly round and call in chorus; where nest away from feeding area, mate may not return; some birds perform Broken-wing display (most likely to be seen in females); one female ran back and forth between nest and observer, sometimes False-feeding (Fleming 1939). When intruder walks away from nest, some birds run in front, pausing every few metres to Head-bob or False-brood; return to nest shortly after intruder out of sight of nest; after disturbance, male keeps watch on prominent rock (Fleming 1939; Davis 1987). If disturbed at night, incubating bird stays sitting for c. 1 min before running and standing in Alert Posture nearby (Davis 1987). As incubation proceeds, sit more closely (Fleming 1939). Adult brooding young on nest usually shows no reaction when avian predators overhead, though guarding bird occasionally gives soft Alarm Call; when people approach within 20 m, guarding bird warns brooding bird with loud and rapid anti-predator Alarm Call, then brooding bird runs rapidly off nest and both birds either begin distraction displays (Crouched Run and Broken-wing display), or move about intruder in agitated manner giving anti-predator Alarm Call, occasionally stopping in Alert Posture and Head-bobbing (Davis 1987); conspecifics may be attracted (Fleming 1939). If brooding bird disturbed at night, moves off rapidly, leaving chicks sitting alone (Davis 1987). When chicks off nest, one or both parents give anti-predator Alarm Call when gulls, harriers, or skuas fly overhead (Davis 1987). When pairs lose chicks, pairs sometimes disappeared but seen in home-range a week later, became conspicuous by frequent home-range advertisement displays, or became very quiet, occasionally performing Crouched Run when approached (Davis 1987).

VOICE Well known from study of Phillips (1977), which includes sonagrams, and on which all unreferenced statements based. Study took place after breeding season, but calls recorded during breeding season sound no different; additional information in Davis (1987). Calls are soft and loud pipings, the latter becoming a ringing rattle during attack. Highly vocal, many calls loud and ringing, in striking contrast to Double-banded Plover *Charadrius bicinctus*, New Zealand Dotterel *C. obscurus* and Wrybill *Anarhynchus frontalis*; loud and frequent calls accompany aggres-

sive encounters with neighbouring pairs. Heard to call at night. Contact call of female higher-pitched. Call by one of pair often followed by rapid response from mate.

Adult CONTACT CALL: low *kleet* or *pip*, often given by undisturbed pairs, call of female higher-pitched. Male reported giving rapid high-pitched *chip-chip-chip* just before copulation; post-copulatory display accompanied by soft crooning *kwee-kwee*; parents give soft *chip-chip-chip* call to keep chicks near or call them off nest (Davis 1987). **ALARM CALL:** plaintive persistent piping *peep* (sonagram A); given in response to mild disturbance, e.g. approach of intruder, summoning all Shore Plovers within audible range, which then fly round piping in agitated chorus (Fleming 1939). Also described as loud *kleet* or *splew* given singly or at deliberate intervals (c. 1 s), intervals becoming shorter when about to flush. Loud rapid *kleet* or *ti-ti-ti* uttered while flying round Swamp Harrier. **THREAT CALL:** loud repeated calls, similar to Alarm Call, accelerating to prolonged ringing rattle during attacks on intruding conspecifics. Rattle given by males more often than females; never given by fleeing birds. Rattle accompanies piping displays (see Social Behaviour) (Davis 1987). Rattle may be given in flight. Davis (1987) adds that aggressive behaviour always accompanied by loud rolling call. **ADVERTISING CALL:** ringing call, or long drawn-out *beep-beep* call given by pairs advertising their presence in home-range. Given during flight display (Davis 1987).



A. R. Nilsson; South East I., Chatham Is, NZ, Oct. 1987; P104

Young Juveniles normally subordinate, not giving loud calls; however, one heard to rattle when chasing lone adult female. Pitch of calls apparently higher than in adults.

BREEDING Not well known. Detailed study by Davis (1987), on which account based; information also in Fleming (1939) and Flack (1976). Breed in simple pairs, solitary.

Season Broadly, Sept.–Apr.; laying from mid-Oct., hatching from late Nov., replacements laid from mid-Nov. (Davis 1987); laying, Sept. to late Dec. or early Jan. (Flack 1976). Breeding synchronized between pairs in same area but not between n. and s. shores. Pairs probably nest earlier in sites above reach of spring storms and tides and where risk of predation is lower (Fleming 1939).

Site Well hidden, in crevices under boulders near shoreline and under large rocks on grassy ground above beach and inland meadows up to 60 m asl; almost always sheltered from above by vegetation or rock; also in deserted burrows of petrels or shearwaters, in open-ended hollow log, under log, roots of shrub, in tussock-grass, small tunnel in thick *Acaena* (Fleming 1939; Flack 1976). Most common nest-cover is *Poa*, *Carex* and live *Muehlenbeckia* (Davis 1987). Height of entrance varies from a crevice less than 5 cm wide to hollow log c. 22 cm wide (Fleming 1939). High site-fidelity; over six seasons, 45% of females and 50% of males bred in same area; 17% pairs nest in same site from season to season and 52% within 6 m of former site (Flack 1976; Davis 1987). Re-nest after failure; some pairs (11%) re-nest in same site, most (56%) within 6 m (Davis 1987). Nests found

within 23 m of skuas' nest (Fleming 1939). Both sexes select site (Davis 1987).

Nest, Materials Bulky, cup-shaped nest; more substantial in wetter sites, scanty in well-drained sites where coarse grit forms floor of nest; lined with material from nearby vegetation, occasionally feathers, shells and pebbles; in damp site, nest had foundation of wet roots, built up with dead grass (Fleming 1939; Davis 1987). Both sexes make scrape; made by bird lowering breast to ground and kicking soil out from behind (Davis 1987). **MEASUREMENTS:** diameter, generally 6–8 cm; depth, 2–4 cm (Davis 1987).

Eggs Pyriform; pale buff, brownish buff, or olive-brown, with blotches, spots, streaks or minute speckles of black or dark brown, uniformly distributed or concentrated at larger end where markings confluent (Fleming 1939; Flack 1976). **MEASUREMENTS:** 36.5 (1.96; 34–38.5; 4) x 25.4 (0.85; 24.5–26.5) (Fleming 1939); 36.6 (0.08; 30–39.4; 252) x 25.7 (0.05; 21–29.4) (Davis 1987). **WEIGHT:** 12.6 (0.19; 10.5–14.5; 27) (freshly laid) (Davis 1987).

Clutch-size Usually three, sometimes two eggs per clutch (Flack 1976); average, 2.8: C/2 x 23, C/3 x 96; one clutch of six resulted from two females laying in same nest (Davis 1987).

Laying Eggs laid daily (Fleming 1939); average duration of laying of three-egg clutch, 4.1 days (0.62; 2–9; 20), significantly longer on s. shore (4.8 days) than on n. shore (3.3 days); average interval between first and second egg, 4.6 days (0.64; 10), between second and third egg 3.5 days (0.27; 10) (Davis 1987). Will re-nest after failure (Flack 1976); re-nesting interval ranges from 9 to 32 days early in season, 18 to 23 days later in season; more often after loss of eggs than after loss of young; do not raise successive broods (Davis 1987).

Incubation Female does most incubating; may sit before clutch complete but begins fully when clutch complete; females incubate for average 71% (51–90) of total incubation time, males for 29% (Fleming 1939; Davis 1987). Average duration of stints of incubation: females, 100.6±13.5 min; males, 50.6±6.5 (Davis 1987). **INCUBATION PERIOD:** from beginning of incubation to first chick hatched (which is not correct way to estimate period): average, 27.8 days (0.3; 26–31; 21). Infertile clutch incubated for 62 days before being abandoned (Davis 1987). Hatching normally synchronized within 6 to 12 h, sometimes delay of up to 24 h before last chick hatches. Parents remove all traces of egg-shells from nest immediately after hatching (Davis 1987).

Young Precocial, nidifugous. At hatching: upperparts, mottled with grey, buff, tawny-yellow, dark brown and blackish spots, usually lighter on head; underparts, tawny-white; feet and legs, flesh; bill, blackish with suggestion of flesh-coloured base (Fleming 1939). Young remain in nest or just outside it for 1–2 days after hatching (Davis 1987).

Growth See Davis (1987). **Parental care, Role of sexes** Both sexes brood newly hatched young, continuously for first 1–2 days; remain near young almost continuously during day for first week; male appears to do most brooding at night (Fleming 1939; Davis 1987). If intruder approaches, adult runs silently off nest to c. 3 m away then calls to attract other Shore Plovers; feign injury or crouch and run to distract intruder (Fleming 1939). At approach of intruder, chicks scatter for cover, hiding in cracks, under boulders or vegetation, or freeze and flatten to ground; adults feign injury and give alarm call (Fleming 1939). Occasionally, different broods and parents mingle (Fleming 1939). **FLEDGING PERIOD:** 29–63 days (Davis 1987).

Fledging to maturity Period till independent, 41–67 days; varies with habitat (Davis 1987). Age at first breeding, 3 years (Davis 1987).

Success From 287 eggs, 238 (83%) hatched, 72 (25%)

fledged, equalling 1.5 independent young/pair; of unhatched eggs, 53% infertile, 14% addled and 33% abandoned (n=49) (Davis 1987). Fledging success lower for replacement clutches (Davis 1987). Clutches abandoned when one of pair died and once when two females laid in same nest (Davis 1987). Mortality of chicks high during first week (Davis 1987); only 8–19 fledgelings and immatures alive by Feb. from more than 80 eggs (Flack 1976). Eggs washed away by storms; greatest losses occur during first few weeks after hatching (Flack 1976). Chicks eaten by Silver Gulls and skuas, washed away by breaking waves (Fleming 1939; Davis 1987). Over 50% birds die in their first year; highest survival rate in birds 2–6 years old; mean longevity, 6 years; some birds may live at least 17 years (Davis 1987). Most birds begin to breed when 3 years old (Davis 1987).

PLUMAGES Prepared by D.J. James. Hatch in natal down. Begin pre-juvenile moult at unknown age. Complete post-juvenile moult introduces immature plumage. Complete immature post-breeding moult at end of first year introduces adult plumage. Thereafter, complete post-breeding moult each cycle renews adult plumage without seasonal variation in appearance.

Adult male (Definitive basic). Feathers have large, concealed dark-grey (83) bases. **Head and neck** Forehead, lores, ear-coverts, chin and throat, black-brown (119), uniform. Crown, dull brown (119B). Narrow white band encircles crown, from forecrown, over eye and ear-coverts, joining across nape; slightly broader across forecrown than elsewhere and thin and partially obscure across nape; cut off neatly from dark face but less tidily from crown. Narrow black-brown (119) collar on upper hindneck, continuous with black-brown ear-coverts, sides of neck, and throat; merges with dull-brown (119B) lower hindneck. **Upperparts** Scapulars, mantle and back, dull brown (28–119B), fading very slightly with wear; feathers have thin light-brown (25) to light grey-brown (27) fringes that quickly fade with wear but may persist on subscapulars. Rump, dull brown (119B), very slightly paler than back. Central and longest upper tail-coverts, dark brown (119A), with white outer tail-coverts forming white sides to base of tail. **Underparts** White, except for dull-brown (28) wash at side of breast (extension from mantle) and light grey-brown (119c) patch on fore-flanks, at and below bend of wing. **Tail** Distally, generally dark brown, grading to paler base with white edges. T6, all white; t5, white with subterminal brown (c28) spot or bar on inner web, three-quarters along, sharply demarcated distally but grading to white basally; t4 grades from light grey-brown (119c) at base to dark brown (223) distally, with broad (5–7 mm) white tip; central rectrices similar but tip narrower (1–3 mm) on t3 and absent on rest. **Upperwing** Generally dull brown (119B) with broad irregular white wing-bar tapering from base of wing, outwards to outer primaries. P10, dull brown (119B) along outer edge and tip, grading to light grey-brown (119D) along inner edge; shaft, dark brown (219) at base, white over most of length (with white extending narrowly onto webs) and narrowly dull brown (119B) at tip; p9–p7, similar but with broad white outer edges extending along middle half of feather, and more white extending from shafts onto webs, this gradually increasing inwards; p6 to outer 3–4 secondaries, dull brown (119B) with broad exposed white bases extending up shafts and adjacent outer webs in broad asymmetrical shaft-streaks for about three-quarters of length; narrow white tips when fresh. Inwards, secondaries increasingly white with diminishing dull-brown (119B) patch subterminally (persisting only on outer web of about s7–s8); s9, completely white; s10, light grey-brown (119C) with broad white outer edge and tip; tertials, dull brown (28), very slightly darker than scapulars, fading slightly to narrow

light grey-brown (119C) fringes. Primary coverts and alula, dark-brown (219), former with broad white tips and latter with thin white fringe at tip of outer webs. Secondary coverts, similar to upperparts but ground-colour slightly paler and fringes slightly broader on median and lesser coverts, so appear as slightly paler band; greater coverts have broad white tips, narrowing outwards, forming part of wing-bar. **Underwing** Outer primaries, mostly brown-grey (c80), grading slightly darker towards tip and with white inner edges. Inner primaries, similar though slightly darker brown-grey (dark 80). Secondaries appear mostly whitish from below. Greater primary coverts, reflective, pale grey (c86). Rest of coverts and submarginals, white.

Adult female Differs from male only in pattern of bill (see Bare Parts) and head. Lores, ear-coverts, chin and throat, dark brown (c121), and faintly streaked blackish, so appearing a little untidy and contrasting slightly with black-brown (119) forehead and ring round neck. Fleming (1939) remarked that appear heavier than males in life, but measurements do not support this.

Downy young Down, thick, soft, silky, moderately long. Upperparts and top of head, finely flecked off-white, buff (124), light brown (26) and black-brown (119) all over (skins); apparently considerable individual variation in colour (Fleming 1939); unlike typical *Charadrius* plovers, no white band on nape separating mantle from crown (Jehl 1968). Obscure, black-brown (119) median crown-stripe. Forehead, dark, mostly black-brown (119), flecked paler. Indistinct dark-brown dorso-lateral stripe. Underparts, cream (c54).

Juvenile Differs from adult mostly by paler facial pattern and broader fringes on upperparts. Exact description of plumage and variation of plumage not possible because insufficient data, some of which is conflicting. Photo of a fresh juvenile in Davis (1987) shows completely different head-pattern from seven old but consistent juvenile skins (CM, NMNZ). Following description from skins. **Head and neck** Centre of forehead, white with broad brown (c28) tips to feathers that are reduced, and probably lost, with wear; size of tips varies between individuals, so prominence of patch on forehead also varies; side of forehead, brown (28). White supercilium from side of forehead above lores to rear of ear-coverts; broad before, but narrowing slightly over, and flaring behind, eye; rather square-cut posteriorly; some have brown (c28) tips to feathers at side of forehead, giving faint mottled effect. Crown, nape and hindneck, dull-brown (28–119B) with thin whitish to light grey-brown (119D) fringes to feathers reduced rapidly by wear; posterior rows of feathers of hindneck have broad, exposed off-white to pale-brown (c223D) bases that form indistinct pale hind collar, not continuous with supercilium. Broad brown (28–119A) facial stripe broadens posteriorly from base of bill, through lores, through and below eye, and over ear-coverts to side of neck, joining broad brown (28–119A) collar on side of neck; collar continues narrowly across foreneck, sometimes becoming indistinct, broken; encloses white chin and throat. **Upperparts** Mantle, dull brown (28–119B) with thin indistinct light grey-brown (119D) fringes to feathers. Scapulars, dull brown (119B); feathers with faintly darker brown (28) submarginal bands inside thin but distinctly paler light grey-brown (119D) fringes. Rest apparently similar to adult. **Underparts** Mostly white except for untidy dull-brown patch on side of breast and foreflanks formed by large exposed dull-brown (28–119B) bases of feathers. **Tail** Similar to adult. White tip perhaps slightly broader and extending inward to t3. **Upperwing** Similar to adult. Primaries, narrower and slightly pointed but difference very slight. Tertiaries, like adults but paler and more like colour of scapulars, dull brown (119B) with broader, richer and distinct pale-brown (223D) fringes and faintly darker-brown (28) submarginal fringes

at tips. Greater primary coverts have only very thin white tips. Greater secondary coverts, dull brown (119B) with broad white tips, uniform in width from inners to outers. Median and lesser secondary coverts broadly fringed pale brown (223D). **Underwing** As adult.

The juvenile photographed in Davis (1987) resembles the illustration in Hayman *et al.* (1986), and differing from skins by: forehead, broad supercilium, chin, throat and possibly all of neck, white; squarish, isolated brown patch on ear-coverts; brown mottling on lores; crown and nape, brown, with broad white tips to feathers; scapulars have conspicuous light grey-brown fringes but darker submarginal markings not evident.

Immature (First basic). Bird photographed at Mangere I. (NZ DOC Slide Library) that had undergone some post-juvenile moult, very similar to juvenile described from skins (above). Head, mantle, scapulars, inner two tertials and underparts, fresh, but wing-coverts and outer two tertials, old. **Head and neck** Similar to juvenile except: forehead, uniformly brown (c28); supercilium, shorter anteriorly, extending only just in front of eye; no trace of brown collar across foreneck, so chin, throat and foreneck, all white; top of head may lack pale fringes. Rest of plumage, similar to adult; scapulars and tertials without dark submarginal bands of juvenile.

Aberrant plumages Pure white bird allegedly collected at Chatham Is, 1880 (Oliver)

BARE PARTS Based on photos (Soper 1984; Davis 1987; NZRD; DOC Slide Library), museum labels (NMNZ) and literature. **Adult male** Bill, bright red (c13) to orange-red on about basal two-thirds (14–15 mm), sharply demarcated from black distal third (10–11 mm). Orbital ring, bright red (photos); deep orange (Fleming 1939). Iris, dark brown (photos), possibly with brown outer ring (NMNZ); olive-brown (Fleming 1939). Legs, dull orange or pinkish orange. Claws, black. **Adult female** Bill, dull red for about basal third (10–11 mm) untidily grading to black distal two-thirds (14–15 mm); difference in pattern can clearly be seen on skins, despite fading of colours. Rest, as male (Fleming 1939). **Downy young** Bill, all black (photos) or with indistinct flesh area at base (Fleming 1939). Legs, pale pink, pale orange-pink or pale greyish-pink. **Juvenile** Bill, black with small orange base to lower mandible; or yellow base also reported (Hutton & Drummond 1904). Orbital ring, not brightly coloured, possibly pale orange. Iris, dark brown. Legs, pale orange. Claws, black. **Immature** As juvenile, except bill has small bright-red base and legs faintly brighter.

MOULTS Based on examination of c. 85 skins (AWMM, CM, NMNZ), c. 20 with date. Not known if partial pre-breeding (pre-alternate) moults (and consequently alternate plumages) occur, mainly because specimens with dates not collected through year; no seasonal variation in appearance of plumage reported. **Adult post-breeding** (Pre-basic). Complete. Primaries, outwards; usually two or three active at a time (J.E. Dowding; E.S. Kennedy). Mostly moult during summer; males may moult slightly before females; primary moult-scores for males: 20 (Dec.), 41 (Jan.); for females: 21 (Feb.), 26, 46 (Mar.). One female more than 7 years old collected while breeding, Oct., had PMS of 49. **Pre-juvenile** Time of start, unknown. Rate of moult (as measured by rate of growth of wing, cf. Davis 1987) varies with quality of habitat. **Post-juvenile** (First pre-basic). Poorly known; probably partial moult of head and body only. **First immature post-breeding** (Second pre-basic). Complete. One skin (CM) had primary moult-formula N^2O^4 in Dec. and was getting dark feathers on throat.

MEASUREMENTS (1–2) Chatham Is, skins (AWMM, CM, NMNZ): (1) adults (sexed by patterns of head and bill); (2) juveniles and immatures (sexing based on labels).

| | MALES | FEMALES | |
|--------|---|---|----------|
| WING | (1) 121.2 (2.49; 115–127; 29) (2) 117.5 (2.38; 115–120; 4) | 121.1 (2.77; 17–126; 33) 117.4 (2.30; 115–120; 4) | ns ns |
| 8TH P | (1) 78.7 (4.56; 71–86; 30) (2) 75.3 (3.2; 73–80; 4) | 78.3 (3.78; 71–85; 33) 76.3 (4.35; 72–80; 4) | ns ns |
| TAIL | (1) 61.1 (2.23; 57–65; 26) (2) 58.0 (1.63; 56–60; 4) | 61.3 (2.35; 57–67; 29) 59.0 (2.58; 56–62; 4) | ns ns |
| BILL F | (1) 23.9 (0.87; 22.1–25.9; 30) (2) 22.7, 22.7, 24.9 | 22.7 (1.02; 21.1–25.5; 34) 22.5 (0.57; 22.1–23.3; 5) | ns ns |
| TARSUS | (1) 23.1 (0.91; 21.9–24.9; 26) (2) 23.1 (0.58; 22.4–23.8; 4) | 22.8 (0.82; 21.2–24.7; 32) 23.3 (0.50; 22.8–24.0; 4) | ns ns |
| TOE | (1) 16.9 (0.66; 15.6–18.2; 26) (2) 16.7 (1.07; 15.5–17.8; 4) | 16.9 (0.51; 15.7–17.7; 28) 16.5, 16.5, 17.0 | ns ns |

Wing and tail of juveniles apparently shorter than those of adult but sample of young small and differences not significant.

(3) South East I., live, sexes combined; wing, minimum chord (Davis 1987).

| | UNSEXED |
|--------|--------------------------------|
| WING | (3) 116 (5.0; 107–123; 24) |
| BILL F | (3) 23.9 (1.62; 21.9–28.4; 24) |
| TARSUS | (3) 26.4 (0.88; 24.8–28.1; 24) |

WEIGHTS South East I., live, sexes similar and combined, 61.0 (3.3; 52–69; 24) (Davis 1987). Adult female, Mar., 59 g with some fat (NMNZ).

Rate and timing of weight-gain in chicks varies considerably with quality of habitat (Davis 1987); gain generally low in first 5 days, then rapid to day 20 or slow and constant to day 30, then reaching plateau until fledging date (29–63 days); fledge at mean 37 g regardless of fledging date.

STRUCTURE Wing, quite long, narrow and pointed. Eleven primaries; p10 longest; p9 equal or 1 mm shorter, p8 4–7, p7 11–15, p6 18–21, p5 25–29, p4 31–37, p3 38–44, p2 45–51, p1 52–58, p11 minute. Fourteen secondaries including four tertials. Tail, short, square at tip; twelve rectrices. Bill, moderately long and

thin, tubular and tapering at tip; nostril, long, slit-like in long nasal groove. Tarsus, quite short, stout, slightly thicker than that of Double-banded Plover. No hind toe; toes have typical fleshy pads of family; small semipalmation between middle and outer toes. Scales, reticulate. Outer toe 84–89% of middle, inner 63–74%. Claws, very slightly twisted outwards.

AGEING Single skin (AWMM) and photo (NZ DOC Slide Library) of females that differ from typical adults in scattered white feathers on throat and large, exposed white bases to dark-brown (121) feathers of forehead, lores, ear-coverts, chin and throat, and black-brown (119) feathers of neck; these may be second immatures (second basic), but confirmation needed.

GEOGRAPHICAL VARIATION Extant population on Chatham Is shows no geographical variation. Population on mainland NZ extinct (see Distribution), with nothing in literature to suggest it differed from birds on Chatham Is; no skins examined. Single specimen allegedly taken at Auckland Is (described as separate species *T. rossi*), usually considered same species that strayed or with incorrect locality data, but issue unsettled (Fleming 1939, 1982; NZCL).

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Volume 2, Plate 61

New Zealand Dotterel *Charadrius obscurus* (page 818)

1 Adult breeding, s. population; 2 Adult breeding, n. population; 3 Adult non-breeding; 4 Downy young; 5 Juvenile; 6, 7 Adult non-breeding

Shore Plover *Thinornis novaeseelandiae* (page 912)

8 Adult male; 9 Adult female; 10 Downy young; 11 Juvenile; 12, 13 Adult male