

## 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.
Jacaniidae	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, Jacaniidae) 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 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 Jacaniidae. 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.

## REFERENCES

- Christian, P.D., *et al.* 1992. *Aust. J. Zool.* 40: 291–302.
- Fjeldså, J. 1976. *Vidensk. Medd. dansk. Natur. Foren.* 139: 179–243.
- 1977. *Guide to the Young of European Precocial Birds*. Scarv Nature Productions, Tisvildeleje.
- Glenny, F.H. 1955. *Proc. US natn. Mus.* 103 (3346): 525–621.
- Jehl, J.L., Jr. 1968. *Mem. San Diego Soc. nat. Hist.* 3.
- Mayr, E., & D. Amadon. 1951. *Am. Mus. Novit.* 1496.
- Mickevich, M.F., & L.R. Parenti. 1980. *Syst. Zool.* 29: 108–113.
- Olson, S.L., & A. Feduccia. 1981. *Smithson. Contrib. Zool.* 323: 1–24.
- , & D.W. Steadman. 1981. *Smithson. Contrib. Zool.* 337: 1–25.
- Sibley, C.G., & J.E. Ahlquist. 1990. *Phylogeny and Classification of Birds of the World*. Yale Univ. Press, New Haven.
- , & B.L. Monroe. 1990. *Distribution and Taxonomy of the Birds of the World*. Yale Univ. Press; New Haven.
- , *et al.* 1988. *Auk* 105: 409–423.
- Strauch, J.G., Jr. 1978. *Trans. zool. Soc. Lond.* 34: 263–345.

## Order CHARADRIIFORMES

### Family SCOLOPACIDAE sandpipers and allies

Small to large shorebirds (12–66 cm) with long bills and legs. Largest family of suborder Charadrii, with some 88 species in c. 24 genera; most species only breed in higher latitudes of Holarctic, but migrate long distances and occur almost worldwide in non-breeding period. In HANZAB area, 51 species in 18 genera: two breeding species, 27 regular non-breeding migrants, 19 accidentals and three doubtfully recorded. All are transequatorial migrants except for the two species of *Coenocorypha* that breed NZ, which are sedentary. The family is usually split into six subfamilies (e.g. Jehl 1968; BWP): Scolopacinae, Gallinagoninae, Tringinae, Arenariinae, Calidridinae and Phalaropodinae; we place the dowitchers *Limnodromus* in a separate subfamily, Limnodrominae (q.v. for details). All except Scolopacinae (woodcocks) represented in HANZAB region. Though they are convenient groupings, these subfamilies may not be wholly monophyletic (e.g. Strauch 1978; Dittman *et al.* 1989; Sibley & Ahlquist 1990; BWP); until phylogeny within the Family is understood, sequence of genera and species followed by different authors is likely to remain unsettled. Sequence and taxonomy used here follows Christidis & Boles (1994). Studies of allozymes (Christian *et al.* 1992), DNA hybridization (Sibley *et al.* 1988; Sibley & Ahlquist 1990), osteology (Strauch 1978) and patterns of downy young (Jehl 1968) generally agree in treating Scolopacidae as monophyletic, with distant links to Jacanidae, Rostratulidae, Thinocoridae and Pedionomidae.

Body-form diverse, from slender to stocky. Females slightly to considerably larger than males, though in a few species males are larger (Jehl & Murray 1986). Wings, long and pointed; p10 longest; 15–22 secondaries, including elongate tertials, which, with scapulars, cover back and rump when at rest. Tail, short; 12 feathers except in *Gallinago*, which have 14–28, and *Coenocorypha*, which have 14. Neck, long. Shape of bill varies considerably, though generally long and slender; usually straight to decurved, but recurved in a few Tringinae; tip of bill, fine or only slightly swollen (cf. Charadriidae) with sensory pits. Compared to Charadriidae, eyes small and head narrow. Unlike Charadriidae, have numerous fine pores in premaxillary bone to accommodate Herbst's corpuscles, which are assumed to be associated with more tactile, less visual, methods of foraging; some species have been shown to be capable of sensing buried prey, either through chemoreception (van Heezik *et al.* 1983) or mechanical detection of vibrations or self-induced pressure signals (Gerritsen *et al.* 1983; Gerritsen 1988; Piersma *et al.* 1994). Skeleton and musculature of jaw distinctive (Burton 1974). In most species, rynchokinesis of skull highly developed, enabling flexible upper mandible to be opened or retracted at tip only (to grasp prey while probing). Tarsi and tibiae, short to long, with transverse scales (except in *Numenius*). Four toes in all species except Sanderling *Calidris alba*; toes fairly long with lateral membrane (webbed in some); hindtoe, small and raised (except in Arenariinae). No crop. Caeca present. Apparently no other waders have spiral sperm cells (similar to those of Passeriformes).

Non-breeding plumage mostly dull and cryptic: mottled greys and browns above, and paler or white below, with or without streaks and spots. Breeding plumage generally much brighter (except in curlews, snipes and woodcocks), with more rufous or black. In HANZAB region, adults seen mainly during austral summer in non-breeding plumage, though breeding plumage can be seen on birds just before n. migration or on arrival after s. migration. Sexes usually similar. Bills, legs and feet variously, sometimes brightly, coloured. Adults generally have two moults per cycle: (1) a partial pre-breeding (pre-alternate) moult of most feathers of body, and, often, some tertials and upperwing-coverts; and (2) a complete post-breeding (pre-basic) moult; both usually performed in non-breeding areas or while staging on migration. Primaries moult outwards, usually after s. migration; some subspecies of Dunlin *Calidris alpina* (q.v.), Purple Sandpiper *C. maritima* and Rock Sandpiper *C. ptilocnemis* moult all primaries on or near breeding grounds before s. migration, a strategy rare in *Calidris*; Bristle-thighed Curlew *Numenius tahitiensis* moult remiges rapidly, inducing flightlessness in 50–70% of birds, apparently uniquely among Charadriiformes. Precocial young nidifugous; most feed themselves. Down varies greatly in structure and pattern; pattern mainly of spotted or striped type (Fjeldså 1977). Juvenile plumage usually distinctive; most like that of non-breeding adults, but often a little brighter, especially in Calidridinae. Moults of subadults complex and vary considerably with species, route of migration and age of first breeding. Adult plumage attained when 3–21 months old; most scolopacids of our region (except snipes) first attain adult plumage through partial first pre-alternate moult when c. 8–11 months old, or through complete second pre-basic moult when c. 12–16 months old (see discussion of Moults in General Introduction). Swift runners; wade expertly and some species swim habitually (Phalaropodinae). Stance often upright. Flight, fast and direct, often in tight flocks.

When breeding, most scolopacids (except some snipes and woodcocks) are birds of open habitats, including tundra. At other times, use a variety of habitats, including forests (woodcocks) and open sea (phalaropes), though most prefer shallow, fresh, brackish or intertidal wetlands. Greatest concentrations occur on intertidal mudflats,

especially estuaries. Feed mainly by touch, and the mandibular skeleton has distinctive features associated with tactile methods of foraging. When feeding, most probe into soft, moist substrata to catch invertebrates; some (e.g. Arenariinae) forage on rocky shores; surface-tension mechanism for feeding on plankton, recently described for Red-necked Phalaropes *Phalaropus lobatus* (Rubega & Obst 1993), may prove to be widespread among scolopacids with fine bills. Mixed-species foraging flocks common.

Migration the most striking feature of scolopacids. All but some Gallinagoninae, Scolopacinae and two aberrant Tringinae migrate (though some Tringinae partly resident in Europe), usually from breeding grounds in higher latitudes of n. hemisphere to lower latitudes of n. or s. hemispheres; many undertake extremely long migration steps, with non-stop flights of several thousand kilometres preceded by dramatic increase in weight. Scolopacids of HANZAB region breed mainly in e. Russia, Mongolia, n. China and Alaska; Latham's Snipe *Gallinago hardwickii* breeds Japan and in small numbers in e. Russia.

Migratory routes vary dramatically depending on the relationship between breeding and non-breeding ranges, and the ability to undertake long-distance non-stop flights. Some species migrate overland, some via coastal routes and others cross oceans; many species use a combination of these routes. Some species return to breeding grounds by the same route used in s. migration while others return by different routes, and make a loop migration (e.g. Curlew Sandpiper *Calidris ferruginea*). Timing of departure from breeding grounds often varies between sexes (e.g. Bar-tailed Godwit *Limosa lapponica*) and between ages; juveniles often leave at slightly different time (e.g. Bar-tailed Godwit *Limosa lapponica*) or migrate via a different route (e.g. Sharp-tailed Sandpiper *Calidris acuminata*). Most regular non-breeding migrants to Aust. migrate via East-Asian–Australasian Flyway; others to Aust. and, especially NZ, cross Pacific Ocean. Generally, in Aust. and NZ, s. migration Aug.–Nov. and n. migration, Feb.–May. Individuals of most species display a high degree of site-fidelity at breeding, non-breeding and even staging areas; others have little fidelity to breeding site and populations mix much (e.g. Curlew Sandpipers; P.S. Tomkovich). In HANZAB region, displays sometimes seen before migration, e.g. Red Knots in tight single-species flocks in nw. Aust. before migration (Lane & Jessop 1985). Pre-migratory flighting observed during Mar. in NZ (McKenzie 1967).

In non-breeding areas, most species undertake regular local movements between feeding and roosting sites or between different feeding sites. Most local movements are in response to tides, which affect exposure of feeding grounds (e.g. Hindwood & Hoskin 1954; Carter *et al.* 1976; Saunders & de Rebeira 1985; Smith 1985; Lane). Some roosting and feeding sites are close together, birds gradually dispersing from or returning to roosting sites as tides fall and rise (e.g. Robertson & Dennison 1979). At other sites, roosting and feeding sites farther apart, with birds even flying between islands or between islands and mainland (Saunders & de Rebeira 1985); in Capricorn Grp, Qld, Ruddy Turnstones and Grey-tailed Tattlers *Heteroscelus brevipes* fly at least 4 km from Tyron I., where roost at high tide, to North West Reef, where thought to feed (Prendergast *et al.* 1985); at Cairns, Qld, Whimbrels *Numenius phaeopus* move to mouth of Barron R. every evening (Amiet 1957) and can travel up to c. 20 km between roosting and feeding sites (McKenzie 1967; Garnett 1989). In poor weather, such as days of high winds or in storms, may move to sheltered areas other than normal roosting sites, such as near-coastal wetlands or pools in dunes (e.g. Crawford 1972; Forest 1982; Aust. Atlas). Some species dispersive, either locally or over longer distances (see accounts), sometimes in response to availability of food or availability of suitable wetland habitat. In NZ, Common Greenshanks *Tringa nebularia* tend to move round within harbours rather than returning to roosting site each day (Sibson 1965) and, in Tas., Common Greenshanks appear to move between coastal sites (Wall 1953); Curlew Sandpipers apparently move from Westport Bay, Vic., in Aug. when daily exposure of intertidal feeding grounds reduced (Loyn 1978; see also Hindwood & Hoskin 1954; Alcorn 1988).

Mainly feed and roost in single-species flocks. All species are strong fliers and those that form flocks often perform spectacular and complex aerial movements, which are performed with remarkable precision. Many species territorial during breeding season, but others lack specific territorial boundaries and are semi-colonial. Courtship displays, elaborate, including spectacular song-flights, often associated with formation of pairs. Distraction displays include repetitive display-flights, rodent-runs, and feigning injury.

Mating systems extraordinarily diverse, including monogamy (some species pair for life), polygyny (in some species, males display on leks, mating with females that visit their territories; in others, males maintain simultaneous pair-bonds with more than one female but provide no parental care) and polyandry (including double-clutching monogamy, where female lays two successive clutches, each of which is incubated by single adult; and classical polyandry, where female maintains pair-bonds with more than one male). Reasons for diversity of mating systems not clear but short breeding seasons and ability of single parent to incubate clutch and brood and raise chicks probably involved; possibly also related to phylogenetic history. For reviews of mating systems, see Ligon (1993) and Pitelka *et al.* (1974).

In CALIDRIDINAE, mating systems remarkably varied, including monogamy, polygyny, polyandry; most species monogamous (e.g. Pitelka *et al.* 1974). Role of sexes in parental care as diverse as mating systems. Apparently solely by female in the four polygynous species; roughly equally shared in some (e.g. Dunlin *C. alpina*), though female tends to leave chicks earlier; in others, male undertakes more of work and females leave before chick-rearing (or even

incubation) complete. Behaviour more complex in successive polyandrous species, with males raising first brood while females may lay and raise another clutch. In GALLINAGONINAE, mating systems poorly known but several species monogamous; Great Snipe *Gallinago media* promiscuous, mating at leks, and apparently unique among snipe in performing courtship display on ground; others have crepuscular or nocturnal display-flights accompanied by distinctive calls and non-vocal sounds (see Gallinagoninae). Mass flights of displaying snipes have been said to be aerial leks in several species, but confirmation needed (could be result of unsettled territorial boundaries early in breeding season) (Byrkjedal 1990). In TRINGINAE, most species monogamous but successive polyandry can occur in Spotted Redshank *Tringa erythropus* and Spotted Sandpiper *Actitis macularia*. Parental care shared about equally or females leave breeding grounds early while males undertake or finish rearing chicks. ARENARIINAE are monogamous; Ruddy Turnstone territorial and aggressive. LIMNODROMINAE, poorly known; apparently monogamous; territorial but *L. semipalmatus* nests in small colonies. Both sexes incubate; males undertake most of chick-rearing. In PHALAROPODINAE, many sex roles reversed when breeding; females almost unique among Scolopacidae in undertaking courtship behaviour, contesting access to mates in 'scramble displays' (Reynolds 1987; Colwell & Oring 1988a). Phalaropes usually monogamous, though polyandry recorded in all three species; incidence of polyandry may vary between populations but reasons not yet clear (e.g. Colwell & Oring 1988b). Males undertake virtually all incubation and raise chicks alone (see Colwell 1986; Colwell & Oring 1988a,b).

Most scolopacids breed first at 2 years old, though some species can breed in their first year and maturity may be delayed for more than 2 years in some large long-distance migrants. Usually nest on ground, often concealed in herbage. The scrape, often made during a scraping ceremony by the male in the presence of female, is often lined, usually after laying the first egg and more lining is added during incubation. Unusually, Solitary *Tringa solitaria*, Green *Tringa ochropus* and some Wood *Tringa glareola* Sandpipers recorded nesting in trees, usually in nests of other birds (see BWP). Usually four eggs per clutch, in some cases two or three. Eggs usually pyriform, with dark-brown and black markings, over paler ground-colour; all are cryptically coloured. Incubation normally starts with laying of last egg and chicks hatch almost simultaneously. Both sexes usually share incubation, though one bird often takes greater share. Downy young leave nest within 1 day of hatching and generally accompanied by brooding adult till able to fly. Social organization, social behaviour and breeding not discussed further in subfamily accounts.

In East-Asian–Australasian Flyway, hunting and destruction of wetland habitats major threats to shorebirds; this Flyway said to be probably the most threatened migration system in world (Lane & Parish 1991). Outside Aust. and NZ, hunting widespread, mainly for food, but little information available on impact on populations (Lane & Parish 1991). For example, in Thailand and n. Vietnam, both Great Knot and Red-necked Stint on passage or overwintering are eaten, and captive birds are kept to act as decoys to catch other waders; band-recoveries of Red-necked Stints in n. Vietnam have come from birds taken for food (Starks 1987; J.R. Starks). Many wetlands destroyed by reclamation for agriculture, aquaculture, salt-production, and urban or industrial development, including wetland habitats in Aust. and NZ (Lane & Parish 1991). Aust. is signatory to the Ramsar Convention and to bilateral treaties with Japan (JAMBA) and China (CAMBA) to protect migratory birds.

In many n. hemisphere breeding areas, breeding success cyclical and thought to be linked to population cycles of lemmings, which in turn influence levels of predation of breeding birds (Underhill *et al.* 1993). For example, in breeding areas of Curlew Sandpipers, decreased populations of lemmings *Lemmus sibiricus* and *Dicrostonyx torquatus*, the regular prey of Arctic Foxes *Alopex lagopus*, results in increased predation of eggs and young of Curlew Sandpipers (Roselaar 1979). Reproductive success in n. hemisphere in preceding breeding season reflected in numbers and proportion of juveniles and immatures in populations in non-breeding areas, such as Aust. and NZ.

## REFERENCES

- Alcorn, R. 1988. *Stilt* 12: 7–23.  
 Amiet, L. 1957. *Emu* 57: 236–54.  
 Burton, P.J.K. 1974. *Feeding and the Feeding Apparatus in Waders*. Br. Mus. Nat. Hist., Lond.  
 Byrkjedal, I. 1990. *Ornis scand.* 21: 239–47.  
 Carter, M.J., *et al.* 1976. *Aust. Bird Watcher* 6: 173–7.  
 Christian, P.D., *et al.* 1992. *Aust. J. Zool.* 40: 291–302.  
 Christidis, L., & W.E. Boles. 1994. *RAOU Monogr.* 2.  
 Colwell, M.A. 1986. *Auk* 103: 611–12.  
 —, & L.W. Oring. 1988a. *Behav. Ecol. Sociobiol.* 22: 165–73.  
 —, — 1988b. *Wilson Bull.* 100: 567–82.  
 Crawford, D.N. 1972. *Emu* 72: 131–48.  
 Dittman, D.L., *et al.* 1989. *Auk* 106: 324–6.  
 Fjeldså, J. 1977. *Guide to the Young of European Precocial Birds*. Skarv Nature Publs, Strandgården, Tisvildileje.  
 Forest, B.S. 1982. *Aust. Bird Watcher* 9: 159.  
 Garnett, S.T. 1989. *RAOU Rep.* 58.  
 Gerritsen, A.F.C. 1988. Unpubl. PhD thesis, Univ. Liedon.  
 —, *et al.* 1983. *Neth. J. Zool.* 33: 485–96.  
 Hindwood, K.A., & E.S. Hoskin. 1954. *Emu* 54: 217–55.  
 Jehl Jr, J.R. 1968. *Mem. San Diego Soc. Nat. Hist.* 3.  
 —, & B.G. Murray. 1986. *Current Orn.* 3: 1–86.  
 Johnsgard, P.A. 1981. *The Plovers, Sandpipers and Snipes of the World*. Univ. Nebraska Press, Lincoln.  
 Lane, B.A., & A. Jessop. 1985. *Stilt* 6: 2–16.  
 —, & D. Parish. 1991. *ICBP Tech. Publ.* 12: 291–312.  
 Ligon, J.D. 1993. *Current Orn.* 10: 1–46.  
 Loyn, R.H. 1978. *Emu* 78: 11–19.  
 McKenzie, H.R. 1967. *Notornis* 14: 154–7.  
 Piersma, T. 1994. *Close to the Edge: Energetic Bottlenecks and the Evolution of Migratory Pathways in Knots*. Uitgeverij Het Open Boek, Den Burg, Texel, Netherlands.  
 —, *et al.* 1994. Paper 3 In: Piersma 1994.  
 Pitelka, F.A., *et al.* 1974. *Am. Zool.* 14: 185–204.  
 Prendergast, H.D.V., *et al.* 1985. *Sunbird* 15: 80–3.  
 Reynolds, J.D. 1987. *Ibis* 129: 225–42.  
 Robertson, H.A., & M.D. Dennison. 1979. *Notornis* 26: 73–88.

Roselaar, C.S. 1979. *Watervogels* 4: 202–10.  
 Rubega, M.A., & B.S. Obst. 1993. *Auk* 110: 169–78.  
 Saunders, D., & P. de Rebeira. 1985. *The Birdlife of Rottnest Island*.  
 Authors, Perth.  
 Sibley, C.G., & J.E. Ahlquist. 1990. *Phylogeny and Classification of Birds*. Yale Univ. Press, New Haven.  
 —, et al. 1988. *Auk* 105: 409–23.  
 Sibson, R.B. 1965. *Notornis* 12: 44–6.

Smith, F.T.H. 1985. *Bird Obs.* 643: 81–2.  
 Starks, J. 1987. *Report on Shorebird Surveys in Thailand*. Interwader Publ. 25.  
 Strauch Jr, J.G. 1978. *Trans. zool. Soc. Lond.* 34: 263–345.  
 Underhill, L.G., et al. 1993. *Ibis* 135: 277–92.  
 van Heezik, Y.M., et al. 1983. *Neth. J. Sea Res.* 17: 47–56.  
 Wall, L.E. 1953. *Emu* 53: 80–6.

## Subfamily GALLINAGONINAE snipes

Small to medium-sized (17–33 cm) skulking, marsh-dwelling waders, with very long bills. About 18 species in three genera: (1) *Coenocorypha*, comprising two sedentary species of subantarctic NZ islands (NZCL), though specific recognition of some forms probably warranted (see those accounts); (2) *Limnocyptes*, single migratory species of Palaearctic; and (3) *Gallinago*, comprising c. 15 species, including three in HANZAB region (one regular non-breeding migrant and two accidentals); mostly migratory, breeding in Palaearctic, but with more sedentary species in Africa and South America. Genus *Gallinago* referred to as *Capella* in much early literature, and three South American species sometimes placed in separate genus *Chubbia*. Dowitchers often included in Gallinagoninae but treated in separate subfamily here (*Limnodrominae*, q.v.). Snipes sometimes combined with woodcocks in *Scolopacinae*, but kept separate here based on differences in downy young and dorsal vertebrae (Jehl 1968; BWP). Anatomy, downy young, internal feeding apparatus and studies of DNA hybridization suggest closest living relatives are *Scolopacinae* or *Calidridinae* (e.g. Jehl 1968; Burton 1974; Fjeldså 1977; Strauch 1978; Sibley & Ahlquist 1990) but conclusive biochemical and DNA studies needed.

Bill, long, usually straight but slightly decurved in some (especially *Coenocorypha*); tip, sensitive, with many Herbst's corpuscles; highly rhyndokinetic. Like woodcocks, have suborbital bar in skull, giving head rigid appearance, with eyes set higher and farther back than in most *Scolopacidae*; thus have very broad field of vision. Differ from woodcocks in having six unfused dorsal vertebrae (woodcocks have five unfused vertebrae and two fixed vertebrae in rigid *os notarium*) and larger pre-acetabular part of pelvis, giving horizontal crouching stance. Wings somewhat shorter and broader than in most *Scolopacidae*; fly strongly and most have explosive take-off and characteristic zigzagging flight when flushed. Tail, rather short; usually 14–28 rectrices in *Gallinago*, 12 in *Limnocyptes*, 14 in *Coenocorypha*. Outer rectrices usually stiff and strong; often also narrow. In most species they are splayed almost at right angles during display flights and their vibrations thought responsible for loud and species-specific drumming, whinnying or even fizzing noises that characterize such displays. However, mechanisms for production of such non-vocal sounds only known in a few species (Tuck 1972; Reddig 1978; Byrkjedal 1990; see account for Latham's Snipe *Gallinago hardwickii*). Non-vocal sounds of *Gallinago* snipe appear to differ structurally from those of Chatham Island Snipe *Coenocorypha pusilla* (q.v.). Legs and toes, moderately long; toes, unwebbed; hallux, short and raised.

Sexes similar, though females slightly larger and longer-billed (not *Limnocyptes* and *Coenocorypha*). Adult plumages, cryptic, intricately patterned in various shades of buff, brown and black; many species (especially *Gallinago*) have bold buff or rufous lines on scapulars and mantle, dark axillaries and underwing-coverts barred white, and large rufous patches on central rectrices. At least some species have partial pre-breeding moult, but none has seasonal changes in appearance of plumage. Juveniles very similar to adults, sometimes indistinguishable; moults of subadults poorly known and immatures not usually separable from adults after post-juvenile (first pre-basic) moult finished (e.g. Tuck 1972; Sæther et al. 1994; BWP; this volume). Downy young of most species, mainly dark chestnut-brown above and below; upperparts have black stripes overlain by small white powder-puffs, which are densely packed, short white barbules at tips of feathers. Unlike *Calidridinae*, powder-puffs do not tangle together, and are aligned in straight lines along back, rather than forming hour-glass pattern; number and density of powder-puffs varies much between species (Jehl 1968; Fjeldså 1977).

Typically birds of marshy habitats, with soft muddy soil and dense low vegetation, such as sedges and herbs; some species use dry moorlands and heathlands (including tundra) and several species use more forested habitats than any other waders other than woodcocks. Feed mostly on invertebrate prey, which is located by touch when probing; also pick invertebrates, seeds and other food from surface. Range from highly migratory (e.g. the three *Gallinago* species reaching Aust.) to sedentary (e.g. *Coenocorypha*).

### REFERENCES

Burton, P.J.K. 1974. *Feeding and the Feeding Apparatus of Waders*. Br. Mus. Nat. Hist., Lond.  
 Byrkjedal, I. 1990. *Ornis scand.* 21: 239–47.  
 Fjeldså, J. 1977. *Guide to the Young of European Precocial Birds*. Skarv Nature Pubs, Strandgården, Tisvildileje.

Jehl Jr, J.R. 1968. *Mem. San Diego Soc. nat. Hist.* 3.  
 Reddig, E. 1978. *J. Orn.*, Lpz. 119: 357–87.  
 Sæther, S.A., et al. 1994. *Condor* 96: 959–72.  
 Sibley, C.G., & J.E. Ahlquist. 1990. *Phylogeny and Classification of Birds*. Yale Univ. Press, New Haven.  
 Tuck, L.M. 1972. *Can. Wildl. Serv. Monogr. Ser.* 5.

*Coenocorypha aucklandica* New Zealand Snipe

COLOUR PLATE FACING PAGE 65

*Gallinago aucklandica* G.R. Gray, 1845, *Voyage Erebus and Terror, Birds*: 13 Gray — Auckland Islands.

The specific epithet refers to the type-locality, the Auckland Islands, which were named after William Eden, first Baron Auckland.

**OTHER ENGLISH NAMES** Snipe; Island, Southern Islands, Subantarctic or Sub-antarctic Snipe; Auckland, Auckland Island(s), Antipodes Island, Stewart Island and Snares Island Snipe; Bush or Native Snipe; Semi-woodcock, New Zealand Semi-woodcock.

**POLYTYPIC** Nominate *aucklandica*, Auckland Is; *barrierensis* Oliver, 1955, Little Barrier I. (extinct); *iredalei* Rothschild, 1921, islands off Stewart I. (apparently extinct); *huegeli* (Tristram, 1893), Snares Is; *meinertzhagenae* Rothschild, 1927, Antipodes Is.

**FIELD IDENTIFICATION** Length 21–24 cm; wingspan 30–35 cm; weight 90–120 g. Small chunky cryptically patterned snipe with long bill and short neck, wings, tail and legs. Larger than Chatham Island Snipe *C. pusilla*, with longer bill. Stockier and smaller than *Gallinago* snipes, with shorter bill, neck, wings, tail and legs. Confiding and difficult to flush. Sexes not separable in field. No seasonal variation. Juveniles similar to adults but with slightly duller plumage and greyer bill and legs. Subspecies vary mainly in markings on underparts, colour of bare parts and size.

**Description Adult** Forehead, buff, with dark-brown central stripe; crown, brown-black, with indistinct buff median stripe from forecrown to nape. Narrow brownish-black stripe extends from bill through eye to nape, and contrasts with pale-buff supercilium extending from sides of forehead to well behind eye, and narrow buff crescents above and below eye. Sides of face, buff, grading to buffy white on chin and throat, and marked with a few spots and streaks of dark brown; indistinct dark-brown moustachial stripe extends from bill to below ear. Nape and hindneck, like crown. Mantle and scapulars, dark grey-brown, boldly blotched blackish and streaked buff to rufous-brown; buff edges most prominent on lower scapulars and tend to align as scapular V or stripes (recalling pattern of *Gallinago* snipes but not so obvious). Back, uniform brown; rump and uppertail-coverts, like back but with varying fine dark blackish-brown barring. Tail, mostly concealed by uppertail-coverts; outer feathers, greyish brown with narrow cream fringes and shaft; rest of tail, dark brown, with narrow buff fringes. Upperwing: primaries, secondaries and greater primary coverts, plain brown, with varying cream fringes and tips; rest of coverts, buff-brown to rufous-brown, with dark-brown blotching and buffish streaking, and with broad buff tips and irregular dark-brown barring to secondary coverts. Breast, buff, variously streaked and barred blackish brown, forming varying gorget, and grading to unmarked buff, yellowish-brown or whitish belly and undertail-coverts; flanks marked with varying blackish-brown chevrons; on Snares Is, underparts generally wholly barred. Underwing, pale brown, with pale-buff barring or mottling on lesser and median coverts. Bill, pale brown or grey-brown, with blackish distal half. Iris, dark brown. Legs and feet, olive-yellow, olive, grey or flesh. **Juvenile** Like adult, but with drab grey-brown plumage; mostly without buff streaking to feathers of back and wing; and flight-feathers have larger pale markings. Basal half of bill, lead grey to dark grey. Legs and feet, grey.

**Similar species** **Chatham Island Snipe** is much smaller with much shorter bill and paler underparts; ranges do not overlap. On Auckland Is, occurs with **Lewin's Rail** *Rallus pectoralis*, which is smaller, slimmer, and with shorter bill and longer legs and more furtive behaviour. Vagrant *Gallinago* snipe (a single Latham's Snipe *G. hardwickii* has occurred on Snares Is) are larger, more slender, with longer bill, neck, wings, tail and legs; *Gallinago* snipes tend to flush more readily when disturbed and call on taking flight.

Sedentary and solitary; pairs consort only during courtship and after failed breeding attempts, and parents each care for a single chick; on Snares Is, territorial males do not chase non-calling males, so occasionally up to six snipe feeding together within c. 10 m<sup>2</sup>. Widespread and numerous in areas with dense ground cover. Confiding, but easily overlooked because plumage is cryptic and habitat dense. Active throughout day and night, often feeding in more open areas at night. Feed by probing soil, to full length of bill; probe continually while walking, except when disturbed or during interactions with other Snipe. Run quickly, keeping to dense ground cover; shuffle with crouched gait or freeze if forced into open during day. Rarely fly; apart from nocturnal aerial displays, will fly only if disturbed at close range; rise with whirring wings, usually <2 m above ground and flying <20 m; sometimes fly farther if flushed from tussock grasslands. Do not call when flushed (cf. *Gallinago* snipe in HANZAB region). Most common call is a strident repeated *trerk trerk trerk* or *queeyoo queeyoo queeyoo* or both given by territorial males; on Snares Is, heard often during day but rarely at night; on Antipodes and Auckland Is, call much less, mainly at night. Territorial males respond strongly to playback of taped calls.

**HABITAT** Based on text by C.M. Miskelly. Occur in NZ on cool temperate and subantarctic islands, in all vegetation types that provide sufficient cover.

On **SNARES I.**, most abundant in moist areas beneath *Olearia* and *Brachyglottis* forest, with mosaic of ground cover, including mat-forming herbs, grass tussocks, sedges and shield ferns *Polystichum*; also in tussock grasslands on cliff-tops; rarely seen in *Olearia* forest with no ground cover. Nest mainly under shield ferns; also among clumps of sedges, ferns *Blechnum* or spleenworts *Asplenium*; rarely in tussocks of grass (Miskelly 1989b; P.M. Sagar). On **ANTIPODES I.**, in tussock grasslands, under sedges and shield ferns and in herbfields; most often observed among low vegetation away from coast. Nests found



under tussocks and shield ferns (B.D. Bell; R.H. Taylor). **AUCKLAND IS:** On Adams I., most common in tussock grassland; also in forests, shrubland or herfields (G.P. Elliott); on Disappointment I., observed beneath tussock and *Anisotome* herbs (Taylor 1988); on Ewing I., occur in dense *Olearia* forest (Taylor 1988; Moore & McClelland 1990). Nesting recorded at coastal edge of forest, among tall grass and *Leptinella* buttonplants (R.G. Ordish); on Rose I., seen among grass and *Histiopteris* ferns (Moore & McClelland 1990); on Ocean I., seen among tussocks and under *Dracophyllum* scrub (Taylor 1988); on Enderby I., seen among scrub and fern (Moore & McClelland 1990).

Formerly reported from Big South Cape I. in wooded areas (Guthrie-Smith 1936), among dense thickets of prostrate manuka *Leptospermum*, and *Dracophyllum* and in burnt-out areas (Guthrie-Smith 1936), in tussocks above bushline (Wilson 1959) and beneath manuka 2 m tall, on peaks and 'in the bush' (Richdale [undated]). Breeding recorded beneath stunted manuka and tussocks (Guthrie-Smith 1936; Wilson 1959).

On Snares Is, forage during the day among tussocks and clumps of grass, sedges, ferns and bryophytes; also along sides of rotting logs. At night forage in open swards of *Callitriche antarctica* and *Crassula moschata*. On sunny afternoons may roost in dense cover where a gap in the canopy allows sunlight to reach the ground. May shelter from heavy rain beneath dense clumps of ferns *Polystrichum* (C.M. Miskelly).

**DISTRIBUTION AND POPULATION** Endemic to NZ. Now restricted to Snares, Antipodes and Auckland Is; formerly on Little Barrier and Motukorea Is in Hauraki Gulf, and on islands off Stewart I. Subfossil remains from NZ mainland.

**Snares Is** Breed on Main (North East) and Broughton Is; recorded on Alert Stack (C.M. Miskelly).

**Antipodes Is** Recorded on Antipodes, Bollons, Archway and Inner Windward Is; breeding recorded only on Antipodes I., but probably throughout. May also be present on Leeward and Outer Windward Is (both inaccessible) (C.M. Miskelly).

**Auckland Is** Mainly on Adams, Disappointment and Ewing Is, where breeding recorded; also reported on Enderby,

Rose, Ocean, Dundas and Figure of Eight Is (Dept Lands Surv. 1987; Taylor 1988; Moore & McClelland 1990). Formerly on Auckland I.

**Hauraki Gulf** Recorded on Little Barrier I. (specimen 1870) and Motukorea (Brown's) I. (1820); now extinct (Miskelly 1987, 1988).

**Stewart I.** Formerly on at least nine islands off Stewart I. Assumed to have bred throughout, but confirmed only on Big South Cape and Jacky Lee Is. Extinct on Ruapuke, Green and Breaksea Is by late 1800s; extinct on Jacky Lee and Herekopare Is by 1920s; extinct on Poutama and Solomon Is by 1930s; extinct on Big South Cape and Pukeweka Is by 1960s (Miskelly 1987; Galbreath & Miskelly 1988). May survive on Big South Cape, Little Moggy or other islands (C.M. Miskelly). Unsubstantiated records from Big Moggy, Little Moggy, Kundy and Little Solander Is between 1920s and 1950s may have been stragglers from nearby islands (Miskelly 1987).

**Status** Extant populations considered stable, but vulnerable to introductions of terrestrial predators (C.M. Miskelly).

**Population** Total probably c. 30,000 birds. On Snares Is, 1100 birds (95% C.L.: 870–1410 birds) with breeding population of 410 pairs (95% C.L.: 310–500 pairs) at densities of up to 11.5 birds/ha or 3.8 pairs/ha (Miskelly 1990c), but densities vary in different habitats (see Habitat). On Antipodes Is, c. 8000 birds, at c. 4 birds/ha (Miskelly *et al.* 1900). On Auckland Is, probably  $\geq 20,000$  birds (C.M. Miskelly). **SURVIVAL:** Adult survival 83% per year and did not vary with sex or breeding status ( $n=203$  bird-years) (Miskelly 1989b). **LONGEVITY:** Probably  $>20$  years; oldest banded bird more than 14 years old (though most banding done in last 10 years) (Miskelly 1989b).

Local extinctions on many islands probably caused by introductions of terrestrial predators such as Kiore *Rattus exulans*, feral cats, pigs and Weka *Gallirallus australis* (Miskelly 1987, 1988; Galbreath & Miskelly 1988). On Antipodes, Snipe coexist with introduced House Mice *Mus musculus* (C.M. Miskelly).

**MOVEMENTS** Sedentary. No reported movements or conclusive evidence for movements between island groups or within or between small islands where present; no extralimital sightings. On Snares Is, not recorded more than 350 m from



site of banding (n=233 birds banded over 6 consecutive years; Miskelly 1989b). Occasional sightings on Enderby, Rose, Ocean and Dundas Is may represent dispersal from Ewing I., 1.7–5.0 km away, though these islands may all have undiscovered resident populations (C.M. Miskelly).

**FOOD** Information supplied by C.M. Miskelly. Most data from Snares Is. Carnivorous; soil-dwelling invertebrates especially earthworms, amphipods, adult beetles, and larvae and pupae of beetles and flies. **Behaviour** Diurnal and nocturnal; most active early morning and at night. Feed almost entirely by probing soil and compacted vegetation. Once observed picking prey directly from surface of ground (C.M. Miskelly). Probe continuously during feeding bouts, often partially inserting bill then pausing to detect prey. Will probe soft soil to full length of bill; up to 18 holes/100cm<sup>2</sup> in soft mud. Swallow while probing. Swallow most prey without taking bill from soil; remove large items (e.g. adult and larval Scarabaeidae, large earthworms) from soil and manipulate them before swallowing. Large leeches are mandibulated for several minutes before swallowing. Very large earthworms are eased from burrows by gradually pulling part of the worm out, then quickly releasing it and plunging bill into burrow to grab worm again; this process is repeated until the worm is removed or escapes. Mandibles and tongue long and slender; tip of upper mandible overlaps lower. Pliable mandibles can manipulate prey within soil. Distal end of upper mandible thought to contain Herbst's corpuscles, which are used to detect movements of prey within soil.

**Adult Snares Is** (16 faeces; Dec. 1982–Feb. 1983; Miskelly 1984): Annelids: oligochaetes 100% freq., 23 min. no. Crustaceans: amphipods 94, 32 (incl. *Parorchestia*; *Makawae parva*; *Talorchestia patersoni*). Arachnids: Spiders: Agelenidae: *Myro* 19, 3; Opiliones: Laniatores: *Hendea* 6, 1; mites 31, 6. Insects: Orthoptera: Stenopelmatidae: *Zealandosandrus subantarcticus* 6, 1; Coleoptera ads 100, 47 (incl. Carabidae: *Diglymma castigatum* 56, 10; *Synteratus ovalis* 6, 1; Leioididae: *Paracatops* 31, 5; Staphylinidae 25, 4; Scarabaeidae: *Prodontria longitarsus* 50, 9; Byrrhidae: *Synorthus insularis* 13, 2; *Epichorius tumidellus* 6, 1; Anthribidae: *Cacephatus aucklandicus* 13, 2; Curculionidae: *Gromilus laqueorum* 56, 10; *Nestrius laqueorum* 25, 4; *Notacalles planidorsus* 6, 1; *Phrynixus laqueorum* 6, 1); larv. and pupae 38, 14 (incl. Carabidae: *Mecodema alternans* 6, 1; Byrrhidae: *Synorthus insularis* 31, 7; Scarabaeidae: *Prodontria longitarsus* 6, 6); Diptera: Tipulidae: *Leptotarsus* larv. 6, 3. Also three faeces contained amphipods (75, 75 and 90% vol.). Arachnids: spiders 1 no.; mites 11. Insects: Dermaptera: earwigs 1; Coleoptera ads: Carabidae 1; Scarabaeidae 2; Curculionidae 2; Lepidoptera: larv. 3 (Anderson 1968). **Other records** Annelids: worms (Stead 1948); Leeches: Gnathobdelliformes: *Ornithobdella edentula*. Insects: Coleoptera: Curculionidae larv.; Diptera: Tipulidae pupae; Syrphidae larv. (C.M. Miskelly).

**Antipodes Is** (2 faeces, Oct. 1990; C.M. Miskelly): Annelids: oligochaetes: Haplotaxida (two faeces); Crustaceans: amphipods: Talitridae: *Kanikania* cf. *parva* (2); isopods: Oniscoidae: *Phallomiscus chiltoni* (2); Arachnids: mites (1); Insects: Coleoptera: Curculionidae: *Gromilus insularis* ads (2); larva: Staphylinidae (1).

**Big South Cape I.** Seen to feed on minute red worms and small chrysalis-like objects (Guthrie-Smith 1936).

**Young** As adult (Miskelly 1990c). On Snares Is (4 faeces, Feb. 1983; Miskelly 1984): Annelids: Oligochaeta 100% freq., – no.; Amphipoda 100, 5 (incl. *Transorchestia bollonsi*);

Arachnids: Spiders: Agelenidae: *Myro* 25, 1; Insects: Coleoptera: ads 25, 3 (incl. Staphylinidae 25, 2; Curculionidae: *Notacalles planidorsus* 25, 1); larv. 25, 2 (incl. Scarabaeidae: *Prodontria longitarsus* 25, 1; Byrrhidae: *Synorthus insularis* 25, 1). **Other records** One ad. Scarabaeidae and 50% vol. amphipods (Anderson 1968).

**Antipodes Is** (one faeces, Oct. 1990; C.M. Miskelly): Annelids: Oligochaeta: Haplotaxida; Crustaceans: amphipods: Talitridae: *Kanikania* cf. *parva*; Coleoptera: Carabidae: *Oopterus clivinooides* ad.

**SOCIAL ORGANIZATION** Details known only for population on Snares Is (Miskelly 1989a,b, 1990c; C.M. Miskelly); little known about other populations. Information supplied by C.M. Miskelly. During breeding season, usually seen singly or in twos; members of breeding pair consort during courtship; each member independently cares for single chick; occasional congregations of up to six birds at preferred feeding sites but do not behave as flock. No observations outside breeding season.

**Bonds** Monogamous (95% pairs), but instances of polygamy (Miskelly 1989a; 1990c). One territory was held for two consecutive breeding seasons by one male, then for two more by second male; both males showed same behaviour on territory; each male had two or three mates simultaneously at different nests, but did not provide parental care at all nests; both males had been monogamous for two seasons before being polygamous (Miskelly 1989a, 1990c). Parent that has lost dependent chick and whose original mate still rearing other chick from brood, sometimes mates with another partner (i.e. sequential polygamy): one of seven males, having finished first breeding attempt, was recorded breeding with a subsequent mate, as were three of 12 females; these birds returned to original mates at start of next breeding season (Miskelly 1990c). Where both members of pair alive at start of next breeding season, 92% (n=47) of pairs remained together (Miskelly 1989b); fidelity not affected by breeding success of previous season. Not known if pairs stay together during autumn and winter. Some pairs consort for 3.5 months before laying; pairs consort almost continuously during courtship. Pair-bond ends at hatching but re-forms if both chicks die (n=14) (Miskelly 1990c). Ratio of males to females over six breeding seasons, 1.4:1 but varied from 1:1 to 2:1. At start of each breeding season up to 47% of males and 30% of females not able to obtain territory or mate. One male (11%) bred as 1-year-old, as did four females (57%); all birds 3 years old or older were members of breeding population (Miskelly 1989b). Auxiliaries have never been observed assisting with incubation or brood-rearing. **Parental care** Both members of pair select nest-site but only female seen to build. Both sexes share incubation equally; male incubates at night, female from dawn till early afternoon, then alternate until dusk (Miskelly 1989b); at two nests where male simultaneously polygamous, incubation only by females (Miskelly 1989a). Each parent raises one chick; chick and attendant parent do not interact with other parent and sibling. Chick can fly at c. 30 days but stays with parent until 65 days old (57–79; 15) (Miskelly 1990c). Other populations apparently monogamous with shared incubation; single adult with one chick observed on Auckland and Antipodes Is; pairs of adult attending single chicks reported on Big South Cape I. (Guthrie-Smith 1936).

**Breeding dispersion** Solitary nesting in territories. Nests can be as close as 8 m if near territorial boundaries. Mean spacing of nests for monogamous pairs with contiguous territories, 31 m (13; 8–48; 17) (C.M. Miskelly). **Territories** All

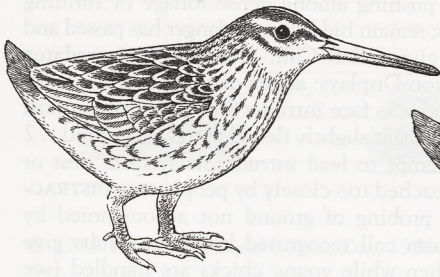


Figure 1 Partially Raised Tail



Figure 2 Low Walk

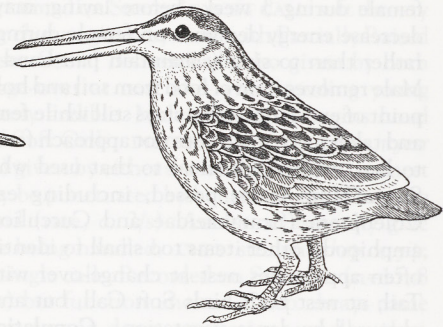


Figure 3 Loud Call

available habitat in 7.5 ha study area on Snares I. divided into contiguous non-overlapping territories of 0.27 ha (0.12; 0.08–0.63; 82) (Miskelly 1989b). Ownership of territory essential to obtain mate. Male chases other calling males from territory but females and males that do not call are tolerated unless approach within 2 m of resident female. Main function of territory is defence of mate by male. During day, foraging by both sexes confined to territory; at night, if territory has poor feeding habitat, both sexes will forage up to 250 m beyond boundaries. Defence of territory stops when chicks hatch; adults with dependent young often forage beyond boundaries of previously held territory. Some territories used sequentially by two pairs in season: when defence by earlier breeding male ceases, territory usurped by previously non-territorial male. First male always reclaims original territory, apparently before start of next breeding season ( $n=76$ ; Miskelly 1989b), though not known whether territories defended when not breeding.

**Roosting** Active day and night, especially early morning and at night. Generally solitary; pairs roost together during courtship. Preferred roosting sites on ground in patches of sunlight among dense vegetation; generally in mid-afternoon. During heavy rain, roost under very dense vegetation.

**SOCIAL BEHAVIOUR** No detailed studies; account based on observations on Snares Is (Miskelly 1984, 1987, 1989b, 1990b,c). Information supplied by C.M. Miskelly. Displays rarely seen because behaviour and coloration cryptic, habitat is dense, and display only infrequently; some displays performed only at night. Non-vocal displays inconspicuous, mostly raising closed or fanned tail. Females rarely perform recognizable postural displays. Most displays similar to those of Common Snipe *Gallinago gallinago* (see BWP) but repertoire more restricted.

**Agonistic behaviour** Territorial male defends c. 2 m round themselves and their mate using silent displays, and rest of territory using vocal displays; evicts other calling males from territory, but tolerates females and non-calling males unless approach within 2 m of resident female. **Threat PARTIALLY RAISED TAIL** (Fig. 1): bird holds body rigid and slowly raises closed tail to angle of c. 45°; most common postural aggressive display but also used in sexual behaviour (see below). Often leads to Low Walk or Chase or both. Rarely female gives Partially Raised Tail if another adult approaches very young chick. **LOW WALK** (Fig. 2): male lowers head and bill in line with body, keeping closed tail raised, and walks towards opponent with slow, deliberate placement of feet. **CHASE**: if intruder persists, male maintains Low Walk posture and rushes at and after intruder; usually stops within 3 m unless intruder Loud Calls. **LOUD CALL** (Fig. 3): most common vocalization

(see Voice); delivered with head raised and bill just below horizontal and slightly open; with each call body rises and falls, throat pulsates, and bill opens farther then closes; given only by males in agonistic and sexual circumstances (see below); territorial males use Loud Call to advertise ownership of territory, often in reply to neighbouring or rival males. If intruding rival Loud Calls, owner Loud Calls in reply with Partially Raised Tail before running towards intruder; if intruder persists with Loud Calling, fighting ensues. Neighbouring males at territorial boundaries often Loud Call and perform parallel walk, two males both Low Walking in same direction while c. 1 m apart; may continue for over 10 m. **HAKAWAI**: Aerial display with non-vocal acoustic component homologous to drumming-flights of *Gallinago snipes*, performed only at night (see Voice); assumed to be used to advertise territories (not reported for population on Snares Is). **Fighting** Birds leap at each other, flapping wings, sparring with bills and kicking; if one bird gets on top of other it pecks opponent's breast or back. Fight in brief bouts of c. 30 s, often interspersed with Chasing and Loud Calling by both birds. During Chases, birds often hold feathers pulled from opponent in tip of bill and chasing bird runs with wings drooped to ground or extended, and flapping at a rate of c. 2 beats/s. Sequences of fighting, Chasing and Loud Calling sometimes last more than 1 h. Always involve territorial male and previously non-territorial male, rather than neighbouring territory-holders. **Appeasement, Escape** No displays noted. Bird flees from aggressor and becomes silent. **Alarm** Usually run to dense cover. If disturbed in open, will crouch close to ground and freeze, or shuffle slowly towards cover. Difficult to flush; if startled at close range will rise suddenly with whirring wings and without calling, and fly low to ground for 3–20 m, occasionally farther.

**Sexual behaviour** **Advertising** Main display is Loud Call (see above) given by territorial male; female sometimes replies with Chur (see Voice). Male ceases Loud Calling at or soon after chicks hatch. Territorial males without mates Loud Call frequently. No recognized difference in Loud Call given as advertisement or threat. Most pairs stable from year to year and presumably stay in contact throughout non-breeding season. During courtship pair stay close; male Loud Calls if he loses sight of female, and female moves towards male or, if female replies with Chur, both may move towards each other. When male within 0.5 m of female he gives Partially Raised Tail (see above) accompanied by Soft Call (see Voice); may develop into **FAN TAIL**, where tail fully spread and raised perpendicular to body. Female not seen to display. Pair may inspect potential nest-sites, disappearing under thick fronds of dead Shield Fern *Polystichum* for up to 15 min, where both (apparently) give Soft Calls. **Courtship feeding** Male feeds

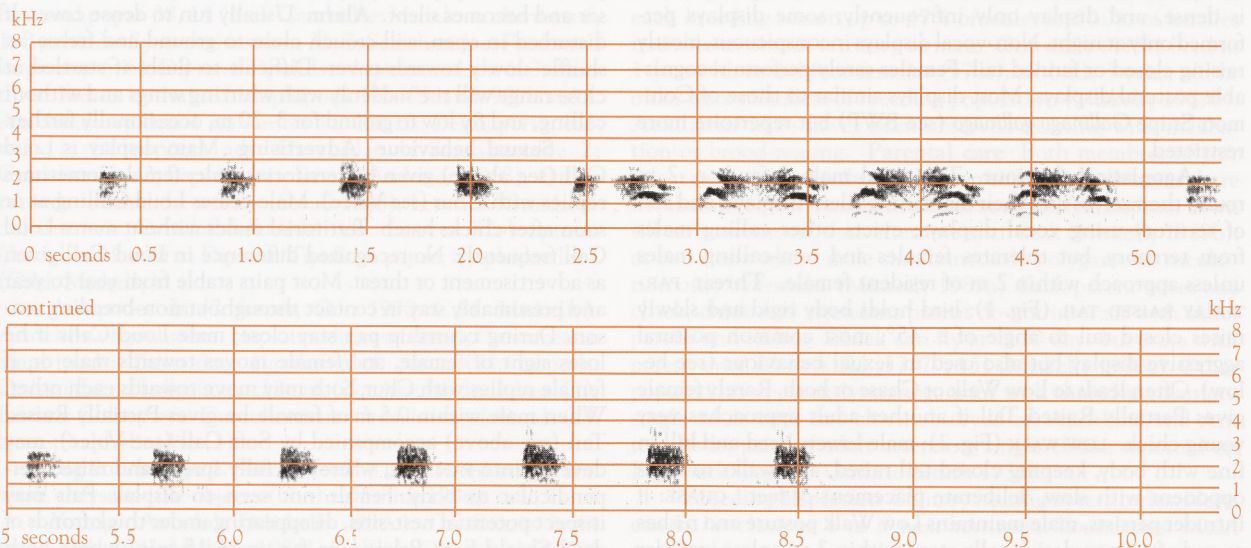
female during 3 weeks before laying; may have evolved to decrease energy demands on female during formation of egg, rather than to simply maintain pair-bond (Miskelly 1990c). Male removes item of food from soil and holds it 2–3 cm above point of extraction then stays still while female moves forward and takes food; male does not approach female or present food to her; method identical to that used when feeding young. Some large items passed, including earthworms, larval Coleoptera (Scarabaeidae and Curculionidae), and large amphipods; other items too small to identify. **Greeting** Bird often approaches nest at change-over with Partially Raised Tail; at nest both birds Soft Call, but any postural displays obscured by dense vegetation. **Copulation** Recorded 14.4 days (6.3; 4–21; 9) before laying (Miskelly 1990c). Courtship feeding only once observed immediately before copulation. Copulation usually preceded or followed by Loud Calling by male. Male approaches female with Partially Raised Tail while giving Soft Calls; as he nears, male performs HIGH STRUT: tilting body back, fluttering wings, and lifting legs above horizontal at each step. If receptive, female lowers breast to ground, partially lifts closed wings, and raises closed tail. Male mounts from behind, gripping female's nape with bill and fluttering his wings to maintain balance; remains mounted for 20–60 s. After copulation, both preen. Allopreening not recorded.

**Relations within family group** Each parent cares for one chick independently of mate and other chick: male takes first chick to leave nest; female cares for second chick (n=10) (Miskelly 1990c); pair may swap chicks on day of hatching (recorded in 2 of 12 pairs); no swaps recorded after first day. If either chick dies or only one egg hatches, adult without chick does not assist mate (see Social Organization). Brooding observed only on day of hatching. At first chick fed entirely by attendant parent; first probing by chick seen at 13 days; chicks partially fed by parents until at least 41 days (Miskelly 1990c). Chick stays close to parent; adult removes prey from soil and holds it 2–3 cm above point of extraction, then chick moves forward and takes food item from tip of parent's bill; adult does not carry food to chick or turn towards it. Chick and parent stay close together unless disturbed, maintaining contact with Soft Calls by parent and quiet twittering by chick; young chicks call loudly if separated from parent (see Voice). Siblings

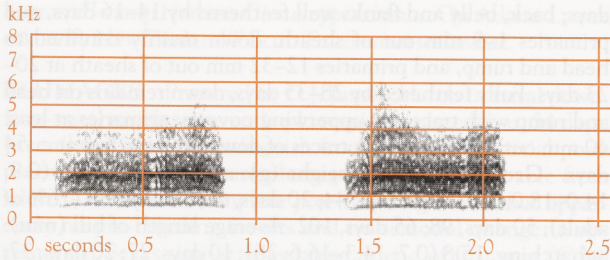
do not interact. **Anti-predator responses of young** Hide well from an early age, pushing among dense foliage or running down petrel burrows; remain hidden until danger has passed and parent approaches giving Soft Call. **Parental anti-predator strategies** Distraction Displays: adults disturbed suddenly on nest or with young chicks face intruder and give Distress Call (see Voice); may also beat slightly flexed wings on ground c. 2 beats/s. Do not attempt to lead intruder away from nest or chick. Adults approached too closely by people may DISTRACT PROBE: rapid probing of ground not accompanied by swallowing. No alarm call recognized but some adults give Distress Call or Chep while young chicks are handled (see Voice). After chicks c. 5 days old, adult keeps quiet and skulks near by until danger has passed, then calls chick out of hiding with Soft Call. Chick stays with adult for c. 9 weeks.

**VOICE** No detailed studies; described by Guthrie-Smith (1936), Warham (1967, 1970), Anderson (1968) and Miskelly (1984, 1987, 1989b). Two sonagrams in Warham & Bell (1979). Text based mostly on observations by C.M. Miskelly from Snares Is. Most conspicuous call is Loud Call of territorial males, which is a series of vibrant monosyllabic notes, often building up to repeated disyllabic whistles. Females and non-territorial males call less often. On Snares Is, Loud Calls heard throughout day in breeding season, more often at dusk and dawn; rarely at night. On Auckland and Antipodes Is, Loud Calls, heard mostly at night, rarely during day (G.P. Elliott, C.M. Miskelly). Small repertoire, with many calls shared by both sexes; Loud Call and probably Hakawai given only by male, Chur given only by female. Females sometimes call in reply to Loud Calls by mate. On Auckland and Antipodes Is (and, formerly, on islands off Stewart I.) thought to give a nocturnal acoustic aerial display (Hakawai) that includes non-vocal drumming, but no recordings exist (see Miskelly 1987, 1989b). Only recordings are Loud Calls from Auckland and Antipodes Is.

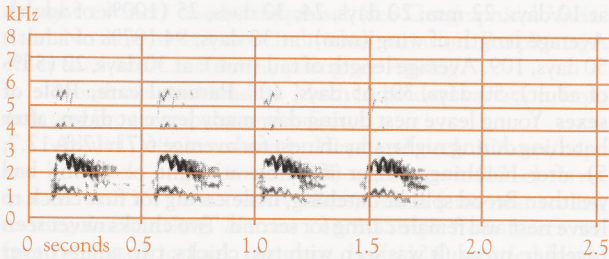
**Adult male LOUD CALL** (see Fig. 3): series of 5–19 monosyllabic notes, variously described as *keerk*, *kurk* or *tewk* (Warham 1967, 1970), low vibrant *chup* (Anderson 1968), strident *terk* (Miskelly 1984), *chip* (Warham & Bell 1979), or a low hoarse double croak (Guthrie-Smith 1936). Each call



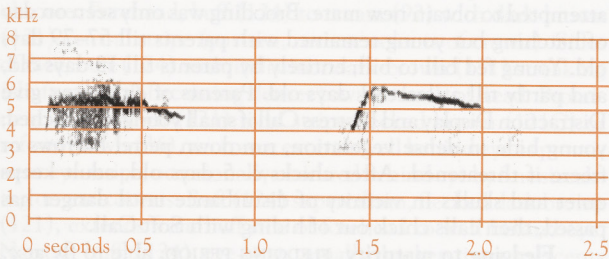
A C.M. Miskelly; Snares Is, NZ, Nov. 1986



B C.M. Miskelly; Snares Is, NZ, Dec. 1986



C C.M. Miskelly; Snares Is, NZ, Dec. 1986



D C.M. Miskelly; Snares Is, NZ, Dec. 1986

lasts c. 0.15 s; at rate of c. 1.8 calls/s. Main energy at 1.5–3.5 kHz. May be preceded by Soft Call (see below) that is audible only at close range. These monosyllabic notes often build up to a series of tuneful disyllabic whistles *queeyoo queeyoo* (Warham 1967), *quee-er* (Warham 1970) or *chew-a-wa* (Warham & Bell 1979), which are repeated 2–8 times at c. 1.5 calls/s, followed by c. 5 monosyllabic notes; each whistle lasts c. 0.6 s, at a frequency of 1.5–4 kHz; whole sequence could be rendered as: *trerk trerk trerk trerk trerk queeyoo queeyoo trerk trerk trerk trerk trerk trerk* (sonagram A). Sequence occasionally begins with 1–5 disyllabic whistles followed by a series of monosyllabic notes. Given during courtship and as threat (with Partially Raised Tail; see Fig. 1). **HAKAWAI:** nocturnal aerial display; starts with a series of 4–8 disyllabic whistles (as in Loud Call, but rendered as *hakawai, hakawai* in traditional Maori accounts for the extinct subspecies *iredalei*; see Miskelly 1987), followed by non-vocal roar thought to be produced by vibrating rectrices as bird dives at speed, and considered homologous with Drumming of *Gallinago* snipes (Miskelly 1987, 1989b; BWP). For population on islands of Stewart Is, the non-vocal component has been variously described as like 'a chain being lowered into a boat', 'a jet or shell passing overhead', or 'a blind rolling itself up' (see Miskelly 1987). On Antipodes Is, observed only once (D.S. Horning); on Auckland Is, only evidence for Hakawai is characteristically worn rectrices on museum skins (Miskelly 1987). No evidence for

Hakawai being performed on Snares Is. **SOFT CALL:** soft throaty *chur chur* or *churr churr* given by male with Partially Raised Tail or Fan Tail (see Social Behaviour). Also given by both sexes during change-over at nest and when tending young chicks; can be barely audible. Male sometimes begins Loud Call with series of Soft Calls. **DISTRESS CALL:** plaintive *nyerr nyerr* (sonagram B) given by either sex when disturbed on nest or with chick. May be punctuated by bouts of audible beating of wings on ground (rate, c. 2/s). Adults occasionally give Distress Call while being handled. **CHEP:** strident *chep* or *yip*; irregularly spaced single calls. Recorded on Snares Is (n=15, 8 by day, 7 by night) but function unclear. Chep always came from a bird hidden among dense vegetation, usually when observer within 10 m; also as young chick was being handled (n=5). Given much more often by Chatham Island Snipe (q.v., sonagram C of that species).

**Adult female CHUR:** (sonagram C); louder version of Soft Call, rendered as *chur chur*, repeated 3–5 times, usually in response to Loud Call by mate. Has distinctive wavering structure in a descending pattern with most energy between 2 and 3 kHz. Only call unique to female. Courtship and distress calls as in male.

**Young Chicks** with parents maintain very quiet incessant *sisisisi*. If separated from parent, this gradually develops into **CHICK CALL:** a piercing *peeyoo* (sonagram D); a note lasting c. 0.3 s, which rises rapidly to about 5 kHz, before slowly decreasing in pitch by about 1 kHz; audible up to 40 m. Slightly wavering, recalling structure of female Chur (sonagram C).

**BREEDING** Well known for Snares Is population; poorly known elsewhere. Field studies by Guthrie-Smith (1936), Stead (1948) and Miskelly (1984, 1989a,b, 1990a,c). Information supplied by C.M. Miskelly. Usually monogamous; two instances of simultaneous polygyny. Nest solitarily, among dense ground vegetation.

**Season** Varies between populations; Antipodes Is: laying begins, mid- to late Aug. (Miskelly *et al.* 1990); eggs found mid-Nov. (B.D. Bell; R.H. Taylor; P.J. Moors); female with unshelled egg in oviduct, 25 Feb. (Warham & Bell 1979). Snares Is: early Nov. to mid-May; laying, 4–28 Nov., extending 71–89 days; last clutches, 4–16 Feb.; one clutch probably in early Apr. (Horning & Horning 1974; Miskelly 1989b). Islands off Stewart Is: laying, late Oct. to at least late Nov. (Guthrie-Smith 1936; Wilson 1959). Auckland Is, clutch laid early Jan. (R.G. Ordish); on Adams I., chicks found Nov.–Dec. (G.P. Elliott) from clutches laid late Sept. to early Nov.

**Site** On ground or in base of tussock, sedge or fern. On Snares Is: under forest of *Olearia* and *Brachyglottis* and among tussock grasslands. On Big South Cape I.: under stunted manuka and among tussock (Guthrie-Smith 1936; Wilson 1959). On Antipodes I.: among tussock and shield fern *Polystichum* (B.D. Bell, R.H. Taylor). On Ewing I.: among *Poa foliosa* and *Leptinella* on edge of *Olearia* forest (R.G. Ordish). Of 45 nests found on Snares Is: 24 (53%) concealed under dead fronds of clumps of *Polystichum*, 9 (20%) in clumps of *Asplenium* or *Blechnum*, 9 (20%) in heart of sedges *Carex* and 3 (7%) at base of tussocks of *Poa tennantiana* (Miskelly 1989b); only other site reported was one in a tussock of *Poa astonii* (P.M. Sagar). All but one of these nests had solid wood, matted stipes or dense crown of sedge or tussock leaves 7–30 cm above cup. Nesting sites not traditional; no female laid twice in same site. Three nests used 2–3 times in same (n=1) or different (n=3) seasons were used by different pairs or by male with new mate (Miskelly 1989b).

Nests invariably close to petrel burrows, as islands in range support dense populations of petrels. Both sexes select site.

**Nest, Materials** Two types of nest built: natural depressions or bowls formed in plant detritus, fragments of fern, leaves, fragments of bark or *Dracophyllum* needles; sometimes piled 5 cm high with moss, soft lichen and frayed manuka accumulated under skirt of fronds; substantial, well-formed cups of *Carex* or *Poa* leaves among sedge or tussock (Guthrie-Smith 1936; Miskelly 1989b; B.D. Bell; R.H. Taylor). Only females seen to build nests, but few observations; both sexes rearrange nest material during incubation. Most nesting material collected within reach of nest, though two nests had *Poa* leaves that may have been carried from at least 1 m away (Miskelly 1989b). Nest formed by picking up material with tip of bill and placing it by flank, and rotating in nest-bowl while kicking backwards. Interval between finishing nest and laying not known (Miskelly 1989b). Empty nest-bowls often found, suggesting that more than one nest is constructed before laying. One female built two nests 2 m apart before laying in one (Miskelly 1989b). **MEASUREMENTS** (cm): Snares Is: nest under ferns: inside diameter, 10.0 (1.4; 8.5–13; 23); depth, 1.8 (1.8; 0–6; 23); nest among sedge or tussock: inside diameter, 11.1 (1.3; 9–13; 10); depth 4.0 (2.4; 1–10; 10) (Miskelly 1989b).

**Eggs** Oval to blunt pyriform, smooth and slightly glossy; light to very pale brown, fawn, olive or greeny brown with small spots and blotches of mid-grey, pale brown, red-brown and dark brown all over, often concentrated round broad end. **MEASUREMENTS**: Snares Is: 43.9 (1.1; 39.1–46.4; 81) x 31.9 (0.6; 30.4–33.1) (Miskelly 1989b); islands off Stewarts I.: 39.9 (1.4; 37.8–42.2; 8) x 30.1 (1.2; 28.7–32.1) (C.M. Miskelly; eggs collected by E.F. Stead); Antipodes Is: 40.5 (0.6; 39.8–41.2; 4) x 32.2 (1.3; 30.8–33.4) (B.D. Bell); 42.8 x 33.1 (Schönwetter 1963); Auckland Is: 42.4 x 30.8 (C.M. Miskelly; NMNZ); measurement of one egg given by Oliver (51 x 35) seems improbably large. **WEIGHT**: Snares Is: 23.7 (1.1; 21.1–26.7; 81) (Miskelly 1990c). Estimated mean fresh weight: islands off Stewarts I.: 19.1 g; Antipodes Is: 22.1; Auckland Is: 21.2 (using equation of Miskelly 1989a).

**Clutch-size** Typically two. Snares Is: C/2 x 55, C/3 x 1 (Miskelly 1990c); islands off Stewarts Is: C/2 x 6 (Guthrie-Smith 1936; Wilson 1959; C.M. Miskelly); Antipodes Is: C/2 x 3 (B.D. Bell; R.H. Taylor); Auckland Is: C/2 x 1 (R.G. Ordish).

**Laying** Details known only for Snares Is: laying interval, 3.0 days (n=5); eight of nine eggs laid during daylight hours. Seven females re-laid 36 days (13; 19–53) after failure of first clutch or brood less than 5 days old. No pairs re-laid after successfully rearing first brood.

**Incubation** Only known for Snares Is: equally by both sexes, beginning when clutch complete (n=5); solely by female at two nests where male was simultaneously polygynous. Incubation continuous; sitting bird does not leave nest until relieved by mate; male incubates at night, female from dawn till early afternoon; then alternate until dusk; longest stints of incubation, 12.8 h for male and 8.5 h for female. Two females incubating by themselves left eggs exposed for 17–40% of day while they foraged; longest stints of incubation, 10.5 h. **INCUBATION PERIOD**: 22.1 days (n=3) for pairs, 37–39 days (n=1) for female in polygynous mating. Addled eggs not incubated for more than 1 day after first egg hatched. Hatching synchronic, at any time of day or night; eggs in a clutch hatched 5.1 h apart (4.5; 0–12.7; 11). Egg-shells left in nest at hatching.

**Young** Precocial, nidifugous, ptilopaedic. Feathers first appear on scapulars and belly, emerging from sheaths at 7–10

days; back, belly and flanks well feathered by 14–16 days, and primaries 1–9 mm out of sheath; down mainly confined to head and rump, and primaries 12–32 mm out of sheath at 20–23 days. Fully feathered by 28–35 days, down remains on head and rump with traces on upperwing-coverts; primaries at least 40 mm out of sheath. Last traces of down on nape lost at c. 54 days. **Growth** Average weight (g): at hatching, 15.5 (0.9; 14.0–18.0; 28); at 10 days, 44; 20 days, 68; 30 days, 83 (76% of adult); 50 days, 98; 65 days, 102. Average length of bill (mm): at hatching, 15.8 (0.7; 14.3–16.6; 28); 10 days, 27; 20 days, 37; 30 days, 44 (79% of adult); 50 days, 53; 65 days, 56. Average length of tarsus (mm): at hatching, 19.3 (0.7; 18.0–20.5; 28); at 10 days, 22 mm; 20 days, 24; 30 days, 25 (100% of adult). Average length of wing (mm): at 30 days, 94 (87% of adult); 50 days, 109. Average length of tail (mm): at 30 days, 22 (55% of adult); 50 days, 39; 65 days, 40. **Parental care, Role of sexes** Young leave nest during day; many leave at dawn, after hatching during night; stay in nest for average 6.7 h (2.8–12.7; 5) after hatching, longer if hatch at night or during bad weather. Brood split at hatching, male caring for first chick to leave nest and female caring for second. Two chicks never seen together; no adult was seen with two chicks; two adults never cared for same chick (26 two-chick broods, 6 one-chick broods). Adults without a chick to care for did not assist mate but attempted to obtain new mate. Brooding was only seen on day of hatching but young remained with parents till 57–79 days old. Young fed bill to bill; entirely by parents till 13 days old, and partly till at least 41 days old. Parents of either sex give Distraction Display and Distress Call if small young approached; young hide in dense vegetation, run down petrel burrows or freeze if threatened. After chicks c. 5 days old, adult keeps quiet and skulks in vicinity of disturbance until danger has passed, then calls chick out of hiding with Soft Call.

**Fledging to maturity** **FLEDGING PERIOD**: able to fly at c. 30 days but partially dependent on parent for another 27–49 days; become independent at 65 days (6; 57–79; 15). Young and parent stay close together unless disturbed, maintaining contact with Soft Calls. Behaviour after becoming independent poorly known. Birds of both sex capable of pairing and breeding at 1 year if they can obtain a territory or mate. Most start breeding at 2 or 3 years.

**Success** Snares Is: of 62 pairs over 4 years, 42 (68%) laid. Of 40 nests, 26 (65%) hatched both eggs, 6 (15%) hatched one egg and 8 (20%) failed. From 79 eggs laid, 58 (73%) hatched; average 1.5 eggs per nest, and 1.8 eggs per successful nest. Of 25 chicks banded in nest, 12 (48%) survived to fledging. Of 29 chicks banded in the nest, 3 (10%) survived to 1 year; 15 (46%) of 33 fledgelings survived to 1 year old. During two intensive study seasons, 32 (82%) of 39 pairs bred; from 63 eggs, 49 (78%) hatched; from 50 chicks, 24 (48%) fledged, 8 (16%) survived to 1 year old, representing 0.6 fledgelings/pair/year and 0.2 1-year-olds/pair/year. During El Niño Southern Oscillation of 1982–83, breeding delayed by 3.5 weeks, with lower success; adult mortality increased (Miskelly 1990a).

Of eight nests that failed over four breeding seasons, seven were deserted and one was destroyed by a Sooty Shearwater *Puffinus griseus* attempting to excavate nest burrow; of six eggs incubated full term that failed to hatch, one was infertile, three were slightly cracked and addled, and two chicks died at hatching. A Silver Gull *Larus novaehollandiae* was seen eating a young chick, but capture not observed. **PREDATORS**: On Snares Is, remains of two adults found in middens of Great Skua *Catharacta skua*; three were taken by

vagrant Swamp Harriers *Circus approximans*. On Adams I., one taken by New Zealand Falcon *Falco novaeseelandiae*.

**PLUMAGES** Prepared by D.J. James. Hatch in natal down. Post-natal moult to juvenile plumage completed by c. 54 days. Juvenile difficult to distinguish from adult; after partial post-juvenile moult, immature plumages not distinguishable from adult. Adults have complete post-breeding moult, but apparently no pre-breeding moults and no seasonal change in appearance. Sexes similar. May breed at end of first year (C.M. Miskelly). Considerable geographical variation; current treatment of single species with five allopatric subspecies (two thought extinct) needs reappraisal (see Geographical Variation). No morphs, but some individual variation. For plumages other than adult and downy young see Ageing.

**Nominate aucklandica** Much individual variation, from dark and brown to paler and rufous.

**Adult** (Definitive basic). **Head and neck** Crown, nape and hindneck, black-brown (119) with brown (121c) to rufous-brown (36) corners to feathers, which form neat scaling to irregular mottling. Narrow central stripe from forehead (not forehead) to back of crown, buff (124) mottled black; formed by two rows of buff (124–92) feathers with black-brown (119) shaft-streaks or outer webs; stripe sometimes obscure. Forehead, buff (124) to cream (92) with dark-brown (121) central stripe (pattern, reverse colours of crown). Sides of face, buff (124) with indistinct dark-brown (121) streaking (shaft-streaks) becoming denser towards back of head. Prominent dark-brown (121) loreal stripe flecked brown (121C) or rufous-brown (36), as crown; extends well behind eye as prominent eye-stripe; occasionally obscured behind eye by fine streaking on ear-coverts. Buff (124) supercilium, flecked dark brown (121), extends from buff side of forehead to well behind eye. Narrow buff (124) eye-ring, usually broken into crescents above and below eye, more prominent below. Dark-brown (121) crescentic mark on lower cheek under eye, extends anteriorly as broken ill-defined cheek-stripe, ending in line of fine dark-brown (121) spots beneath lores. Chin and throat, pale buff (pale 124) to cream (92) in brown birds, to pale pink-buff (pale 121D) in more rufous birds. Front and sides of neck, similar to throat, with brown (121A–34) centres to feathers (a third width of feathers) producing gorget of streaks; often, streaks flared at tips giving slightly spotted appearance. **Upperparts** Generally greyish brown, boldly blotched blackish and striped buff to rufous-brown. Mantle, dark brown (121), streaked buff to rufous-brown; feathers, greyish brown (c28) at base, becoming dark brown (121) at distal centre (central stripe about half width of feather) with buff (c24) or dull rufous-brown (37) distal edges; dark centre gives impression of spot at tip, this effect becoming enhanced rearwards as spots become blackish (c119), well defined and demarcated from central stripe. Scapulars similar: greyish brown (28) for basal two-thirds (partially exposed) with large black to black-brown (119) subterminal blotch, and sharply defined fringes of buff (124–24) to rufous-brown (37–136), forming conspicuous striping; sometimes vermiculated black bars cross greyish-brown bases; blotch at tip often triangular or rounded, sometimes broken by buff or rufous-brown bar across centre of blotch; margins on outer webs, paler, more buff and hence more conspicuous, the difference more evident on lower scapulars; tendency on lower scapulars for margins of outer web to align as scapular V or stripes, though these less pronounced than in *Gallinago*. Subscapulars usually irregularly barred or vermiculated buff (124, 24) to rufous-brown (37, 136) basally,

with black subterminal blotch leaving broad buff to rufous-brown fringe at tip. Back, uniform; feathers have concealed greyish-brown (28) bases, grading to light brown (123, 123A) (perhaps with faint buff [124] tips), or rufous-brown (136, 340, 139) distal third. Rump and uppertail-coverts, like back but usually with trace of fine blackish barring; barring can be profuse and quite evident (in hand but not field) or inconspicuous, straight or chevron-shaped; bars mostly narrower than interspaces. **Underparts** Narrow streaked gorget and small amount of barring on flanks border unmarked abdomen and undertail-coverts. Feathers of upper breast, brown, sometimes dull (c28) or with reddish tinge (c221B, 223B), edged buff (124) or pink-buff (121D) for one-quarter to one-third width of feather; form streaked gorget; brown centres narrower posteriorly, fading to merge with unmarked cream, (92), buff (124) or pink-buff (121D) lower breast, belly and undertail-coverts. Feathers of flanks and sides, rich brown (121C), irregularly marked with light to heavy black-brown (119) chevrons (not straight bars), and fringed buff (124) to pink-buff (121D); some of these feathers extend to base of thighs. **Tail** Mostly concealed by coverts. Outer four rectrices, greyish brown (c28) with narrow cream (92) edges or fringes, and shaft. Inner rectrices, dark brown (219) with narrow buff (24) to light rufous-brown (139) fringes and fine vermiculations or bars near tip. **Upperwing** Coverts, similar to scapulars but less clearly patterned. Lesser and median coverts, greyish brown (28) at base grading to buff-brown (24), rich brown (121C) or rufous-brown (37) distally, with dark-brown (219–119A) subterminal blotch, and buff (124) or pale-cinnamon fringe to outer web; subterminal blotches, ill defined and broken by vermiculations of ground-colour, which are sometimes quite obscure. Greater secondary coverts, buff-brown (24) to light rufous-brown (139) with broad buff (124) to pink-buff (121D) tips, and many irregular, vermiculate black-brown (119) bars, narrower than interspaces; inner greater secondary coverts, usually more uniform grey-brown, like remiges, vermiculations becoming less distinct inwards. Primaries, grey-brown (c119B) to dark brown (119A) with irregular cream (92) markings round fringes; on outer few, markings confined to narrow fringe at tip of outer web; shafts, pale buff (pale 124). Secondaries, as primaries, but markings round fringes less regular (sometimes vermiculated along outer edge), becoming more marked inwards, grading to more patterned tertials; inners typically have narrow band of vermiculations inside fringe. Tertials, like subscapulars: ground-colour buff (124) to rufous-brown (136) with large black spot at tip and many vermiculations basal to spot; a few birds have clean white or buff (124) fringes to outer webs. Alula and greater primary coverts have narrow to moderately broad off-white tips or fringes. **Underwing** Remiges and greater coverts, uniform grey-brown (91) to light grey-brown (119C). Lesser and median coverts, grey-brown (28–91), broadly fringed pale buff (pale 124), appearing finely barred or mottled. Subhumeral, off-white, with light grey-brown (119C) chevron-shaped bars.

**Downy young** No specimens examined. Down, sooty brown, tipped greyish buff; long down filaments, black; blackish median crown-stripe; greyish white central underparts (Meinertzhagen 1926).

**Subspecies meinertzhagenae**

**Adult** (Definitive basic). Very similar to nominate *aucklandica*, but darker and more boldly patterned above, and with yellowish hue to underparts. Less variation between individual skins than other subspecies, but sample small. Differs from nominate *aucklandica* by: **Head and neck** Crown slightly

darker, black-brown (119), lightly flecked buff (24) to rufous-brown (38); all specimens examined show clear crown-stripe. Sides of head, similar, but streaking less dense round eye and on ear-coverts, so both eye-stripe and cheek-stripe more prominent and clear behind eye. Throat like that of *aucklandica* but no specimens had pink-buff (121D) coloration. Streaks on neck, broader, darker (dark brown 21–22) and generally rounder, creating denser, more spotted gorget. **Upperparts** Slightly darker, with larger blackish blotches and narrower buff to rufous-brown fringes. On scapulars, blotches take up distal third of feathers, leaving only narrow fringes; fringes and ground-colour of feathers vary from buff (24) to dull rufous-brown (37), but not known to be bright rufous-brown (136, 340). Scapular stripes may be generally less distinct. Back similar but some have slight blackish barring on feathers, which would not be evident in field. Barring on uppertail-coverts as broad or broader than interspaces, and can appear mostly dark. **Underparts** Generally brighter buff. Seemingly always have heavier gorget; dark central streaks, brown (121A) to dark brown (119A), about half width of feather, with buff (124–24) edges; on lower breast, central stripes can become V-shaped, and fine terminal fringes of same dark brown can give slight scaled impression. Gorget extends slightly lower, to lower breast. Flanks similar but ground-colour usually browner buff (c24), contrasting less with belly, and chevrons usually broader and cleaner (usually narrow and vermiculated in *aucklandica*). Central belly, vent and undertail-coverts, usually unmarked, buff (124), tinged yellowish; little variation (though fade with wear); undertail-coverts sometimes have a few inconspicuous dark spots or bars. **Tail** Ground-colour slightly darker brown, with fewer vermiculations distally on central rectrices. **Upperwing** Like *aucklandica*; coverts slightly duller than scapulars, but black blotches larger, and better formed. Greater secondary coverts, buff (24), often boldly, sometimes irregularly, barred black-brown (119). Primaries and secondaries, similar, except inner secondaries have broad, neat buff (124) fringes; few or no vermiculations. Primary coverts and alula, more narrowly tipped white. Tertiaries usually boldly fringed buff (24) with large blackish diamond-shaped subterminal blotches and lots of black-brown (119) vermiculations at bases, though pattern varies. **Underwing** Remiges, dark brown (119A–29), darker than *aucklandica*. Coverts, dark brown (121), narrowly fringed buff (124). Subhumerals, like *aucklandica* or uniform greyish brown (28), tipped white.

**Downy young** No information.

**Subspecies *huegeli*** Most distinct form, characterized by complete barring on underparts and reduced blotching on upperparts.

**Adult** (Definitive basic). Differs from nominate *aucklandica* by: **Head and neck** Face, including ear-coverts, supercilium, sides of forehead and throat, extensively streaked dark brown (121), reducing prominence of facial pattern; supercilium nevertheless obvious. Cheek-stripe reduced to little more than spot or crescent below eye, though occasionally quite prominent. Eye-stripe, prominent behind eye, contrasting with pale-buff area immediately below. Throat more heavily spotted. **Upperparts** Least rufous and patterned subspecies. Ground-colour of scapulars varies from brown-buff (24) to, rarely, rufous-brown (37) (never bright rufous of *iredalei*). Margins of feathers generally indistinct, except for buff (124) outer edges to lower scapulars, which form typical 'tram-lines'; subterminal blotches rather small, sometimes just narrow bars; typically have two blackish chevrons basal to blotch. Back to uppertail-coverts, dull, like scapulars, brown-

buff (24), light brown (123A) or dull rufous-brown (37) with indistinct narrow tightly spaced black-brown (119) bars; most barred of all subspecies, but bars small, similar to those of *aucklandica*. **Underparts** Almost completely barred. Upper breast sometimes as *aucklandica*, but more often with dark-brown (121) chevrons on buff (124) feathers, appearing more scaly. Lower breast, belly, undertail-coverts and thighs, buff (124), finely and densely barred dark brown (119A); bars straight, about half width of interspaces, slightly broader on lower breast than belly; tips of feathers may be dark brown or buff. Usually only small unbarred area on vent between legs. Flanks, richer buff-brown (24–123A) with bold dark-brown (121) to black-brown (119) chevrons, but contrast little with belly. **Tail** Slightly more patterned than other subspecies. Outer rectrices edged buff (124), and some faint buff (124) barring. Central rectrices, dark brown (219) with buff-brown (24) margins and V-shaped bars, latter often as wide as interspaces. **Upperwing** Coverts mostly without dark blotches. Lesser and median coverts, brown-buff (24), irregularly mottled and vermiculated dark brown (121). Greater secondary coverts, dark brown (121) with brown-buff (24) bars about half as wide as interspaces. Primary coverts, like *aucklandica*. Alula, like *aucklandica* but sometimes with more extensive buff (124) mottling on fringes. Outer edge of primaries finely mottled buff (124); inner primaries have broad buff fringe, which may form mottled submargin on inner web (females and juveniles generally more marked than adult males). Secondaries, similar to *aucklandica* but inner secondaries may have many buff variegations (124) at tips. Tertiaries, black-brown (119), mottled and vermiculated rich brown (121C) with buff-brown (24) fringes. **Underwing** Much like *aucklandica*, but lesser and median coverts more neatly and regularly barred greyish brown (28) and grey-white. White bars on axillaries, narrower, and feathers appear darker.

**Downy young** Feathers, greyish brown (28), tipped pale cinnamon (pale 139), light brown (123A) and black-brown, so appear very speckled. Distinct dark-brown (121) loreal and crown-stripes. Very narrow buff (124) to cream (54) eye-ring.

**Subspecies *iredalei*** Much more rufous and cinnamon than other subspecies, but vary; few specimens available.

**Adult** (Definitive basic). **Head and neck** Facial pattern more reduced than that of subspecies *huegeli*. Eye-stripe indistinct behind eye; cheek-stripe obscure under eye and lores, little more than a spot under ear. Sides of forehead, buff (124) to cinnamon-buff but heavily flecked dark brown (121) to black-brown (119) by tips of feathers, so lack clear buff 'headlights' of subspecies *aucklandica* and *meinertzhagenae*. Supercilium, pink-buff (121D), partly obscured by dark-brown (121) tips of feathers. In some, crown has faint narrow buff (124) border above supercilium (more obvious in photos than skins). Feathers of crown tend to have broader bold rufous-brown (136–37) tips than in subspecies *aucklandica* and *meinertzhagenae*, and rufous tinge on crown obvious. Crown-stripe, narrower, often formed only by buff lateral half of inner web of two central rows of feathers. Ear-coverts, more heavily streaked than in other subspecies; lower cheeks in particular have long dark-brown (121) or sometimes dull rufous-brown (37) streaks. Throat, spotted dark brown (121) to brown (34). **Upperparts** Much more rufous than other subspecies; ground-colour often bright rufous-brown (136–340); brownest birds at least dull rufous-brown (37). Subterminal blotches on scapulars slightly smaller than on subspecies *aucklandica* and *meinertzhagenae*, but larger and clearer than on subspecies *huegeli*; black submarginal lines typically extend short distance

from back of blotches towards bases, highlighting margins. 'Tram-lines' often less prominent, as fringes on outer webs of scapulars washed pale rufous or cinnamon, contrasting less with ground-colour; in others, clearly white and conspicuous. Back and uppertail-coverts, same colour as scapulars (i.e. always rufous-brown, between 340 and 37); blackish barring faint and inconspicuous to bold and almost as wide as interspaces, thus pattern like that of subspecies *aucklandica*. **Underparts** Upper breast, streaked like that of subspecies *aucklandica* and *meinertzhagenae*, but with redder tinge, brown (121B–22) to dull rufous-brown (37) with poorly defined pale-rufous or pale-cinnamon fringes; on lower breast, streaks become chevrons or crescents and, with pale-cinnamon fringes, appear more scalloped than other subspecies. Flanks vary from off-white to rich brown (121C), heavily marked with dark-brown (121) chevrons or crescents, so barring or scalloping bolder and clearer than in subspecies *aucklandica* and *meinertzhagenae*, extending farther towards centre of belly. Narrow area of central belly and vent, off-white, cream (92) or pink-buff (121D). Thighs and undertail-coverts, coloured as belly, with varying dark brown (121–219) chevrons or crescents. **Tail** Central rectrices, more heavily patterned than subspecies *aucklandica* but less so than in subspecies *huegeli*; have broad rufous-brown (37–136) fringes and more or less distinct subterminal chevrons. **Upperwing** Primaries and secondaries, much like those of subspecies *aucklandica* but without vermiculated tips to inner secondaries. Secondary coverts less patterned, with small and irregular blotches, and pale-cinnamon or pale-rufous wash to fringes; slightly paler and duller than scapulars. Tertiaries usually bright rufous-brown (136), heavily vermiculated blackish; black-brown (119) subterminal spot can be prominent, but often broken by rufous barring. **Underwing** Similar to that of subspecies *aucklandica*, but coverts have faint cinnamon tinge.

**Subspecies *barrierensis*** From unique specimen (AIM AV.78.2) which is faded and in poor condition (see Miskelly 1988 for history); unsexed adult. Resembles subspecies *iredalei* most closely.

**Adult Head and neck** Facial pattern prominent, as in subspecies *aucklandica*. Throat, white (probably faded from buff) without prominent streaking or spots. Front and side of neck heavily blotched. **Upperparts** Generally rich dark-brown, like dullest specimens of subspecies *iredalei*. Blotches on scapulars smaller than in subspecies *aucklandica* but larger than in subspecies *huegeli*. Pale edges of scapulars inconspicuous; possibly because skin is in poor condition. **Underparts** Large dark blotches on breast form dense gorget, which extends farther towards belly than in subspecies *aucklandica*, but less so than in subspecies *iredalei*. Thighs, barred. Belly, vent and undertail-coverts, unmarked. Flanks not scalloped like those of subspecies *iredalei*.

**BARE PARTS** Based on information provided by C.M. Miskelly and photos (NZ DOC Library; unpubl.: G.P. Elliott; C.M. Miskelly; P.M. Johns). **Nominate *aucklandica* Adult** Bill, pink-brown (c219D), often grey or grey-brown distally. Cere, grey-brown. Narrow orbital ring, grey-black (82). Iris, blackish. Legs, brown-yellow to grey-yellow. **Subspecies *meinertzhagenae* Adult** Bill grey-black (82) with dark pinkish-brown (c219) base, which is larger on lower mandible. Cere, grey-brown (c91). Iris, blackish. Narrow orbital ring, grey-black (82). Legs, light grey (85); in two individuals tinged pinkish, or pale grey-yellow. **Subspecies *huegeli* Adult** Bill, grey-black (82); base, dark grey; lower mandible tinged pink-

ish or brownish; upper mandible and cere, brown-red. Mouth, dark red to purplish pink. Iris, black. Orbital ring, grey-black (82), narrow. Legs of male, pale yellowish (56) to cream (54); female, olive-grey (olive 44). Claws, black. **Downy young** Newly hatched: bill, cere and legs, grey-black (82); small white egg-tooth; iris, black; toes, dark grey with dark-purplish tinge. At 2 weeks, faint-purplish tinge to base of lower mandible. **Juvenile** Bill, dull grey, including base; legs, dull grey with black soles (C.M. Miskelly). **Subspecies *iredalei* Adult** Bill, grey-black (82) at tip grading to pink-brown (219D) at base. Iris, black. Legs, pink-brown (pale 219D), slightly paler than base of bill; pinker toward toes and greyer towards tibia.

**MOULTS** Seventy-one skins examined, 34 with date; 616 handlings of live subspecies *huegeli* (C.M. Miskelly). Poorly known; no evidence of pre-breeding (pre-alternate) moults, though there may be vestigial moult. **Adult post-breeding** (Pre-basic). Complete; primaries outwards (sometimes simultaneous in subspecies *huegeli*; C.M. Miskelly). Primaries begin Dec. (mostly failed and non-breeders) to Mar., finishing Apr.–Sept. Only 2% of 227 subspecies *huegeli* handled Jan.–Mar. were moulting primaries; another 2% were moulting body. Moults of body, apparently protracted; begins slightly earlier than primaries (as early as Nov.); many skins in body-moult, but no flight-feathers under way; little winter data. In failed and non-breeding subspecies *huegeli*, moult begins with brood-patch. **Post-natal** In subspecies *huegeli*, juvenile plumage complete after c. 54 days, but recorded flying at 30 days (Miskelly 1990c). **Post-juvenile** (First pre-basic). Partial moult of head and body. On Snares Is, moult ended before end of first year, before breeding season (C.M. Miskelly).

**MEASUREMENTS** Below, adult and first-year skins from AIM, CM, NMNZ; sexing based on labels; unsexed samples include all skins from sexed samples.

Nominate *aucklandica*. (1) Skins.

	MALES	FEMALES	
WING	(1) 106.2 (3.54; 100–110; 6)	109.2 (2.73; 104–112; 13)	ns
TAIL	(1) 37.0 (1.67; 35–40; 6)	37.1 (3.54; 32–42; 10)	ns
BILL F	(1) 57.5 (2.40; 55.5–60.2; 5)	60.9 (3.74; 52.6–66.0; 13)	ns
TARSUS	(1) 25.3 (0.54; 24.5–26.1; 6)	25.8 (0.72; 24.8–26.9; 11)	ns
TOE	(1) 26.4 (0.50; 25.8–26.8; 5)	26.3 (1.54; 23.5–28.1; 8)	ns
UNSEXED			
WING	(1) 107.9 (3.28; 100–113; 29)		
TAIL	(1) 37.3 (2.90; 32–42; 22)		
BILL F	(1) 59.8 (3.67; 52.6–67.0; 26)		
TARSUS	(1) 25.6 (0.67; 24.5–26.9; 22)		
TOE	(1) 26.5 (1.14; 23.5–28.2; 17)		

Subspecies *meinertzhagenae*. (2) Skins; (3) Live birds (C.M. Miskelly). Additional measurements in Warham & Bell (1979), including fresh measurements of same specimens as sample [2].

	MALES	FEMALES	
WING	(2) 107.5 (0.58; 107–108; 4) (3) 108.1 (2.9; 102–111; 7)	109.3 (2.63; 107–113; 4)	ns
TAIL	(2) 37.7 (1.26; 37–39; 4) (3) 39.4 (1.2; 37.0–40.8; 7)	36.3 (2.63; 34–39; 4)	ns



BILL F	(2)	59.9 (1.52; 57.6–60.8; 4)	63.8 (1.57; 61.5–65.0; 4)	ns
	(3)	62.9 (0.9; 61.8–64.3; 7)		
TARSUS	(2)	25.4 (1.20; 24.1–27.0; 4)	26.7, 26.9, 27.2	
	(3)	26.3 (0.5; 25.5–26.7; 7)		
TOE	(2)	25.7, 26.3	26.4, 26.5	
TOE C	(3)	35.4 (0.7; 34.3–36.6; 7)		

## UNSEXED

WING	(2)	108.4 (2.00; 107–113; 8)
TAIL	(2)	37.0 (2.07; 34–39; 8)
BILL F	(2)	61.8 (2.52; 57.6–65.0; 8)
TARSUS	(2)	26.0 (1.20; 24.1–27.2; 7)
TOE	(2)	26.2 (0.34; 25.7–26.5; 4)

Subspecies *huegeli*. (4) Skins; (5) Live birds (C.M. Miskelly). Measurements of holotype in Wagstaff (1978), and of small live series in Anderson (1968).

	MALES	FEMALES	
WING	(4) 102, 104, 104	104, 108	
	(5) 107.9 (1.7; 103–111; 93)	109.4 (1.6; 106–114; 63)	**
TAIL	(4) 36, 37, 38	40, 41	
	(5) 40.3 (1.9; 34.8–46.1; 91)	40.2 (1.8; 36.6–46.0; 62)	ns
BILL F	(4) 50.0, 53.9, 54.2	58.2, 58.5	
	(5) 54.7 (1.4; 51.0–57.7; 93)	57.0 (1.7; 51.4–60.8; 63)	**
TARSUS	(4) 23.5, 23.6, 24.0	24.0	
	(5) 24.2 (2.1; 23.3–25.4; 93)	25.1 (0.6; 23.9–26.1; 63)	**
TOE	(4) 25.0, 26.0, 26.5	24.1, 27.6	
TOE C	(5) 33.7 (0.6; 32.3–35.4; 93)	34.5 (0.8; 33.1–36.7; 63)	**

## UNSEXED

WING	(4)	104.7 (1.62; 102–108; 1)
TAIL	(4)	37.8 (2.30; 35–42; 12)
BILL F	(4)	55.0 (2.44; 50.0–58.5; 5)
TARSUS	(4)	24.0 (0.42; 23.5–25.0; 1)
TOE	(4)	25.9 (1.08; 24.0–27.6; 4)

Subspecies *iredalei*. (6) Skins.

	MALES	FEMALES
WING	(6) 106, 109	106
TAIL	(6) 37, 40	38
BILL F	(6) 50.0, 52.5	50.2
TARSUS	(6) 24.1, 25.3	23.8
TOE	(6) 25.1, 25.9	25.2

## UNSEXED

WING	(6)	107.1 (1.96; 104–111; 14)
TAIL	(6)	38.6 (2.68; 34–43; 14)
BILL F	(6)	53.1 (2.45; 50.0–56.4; 12)
TARSUS	(6)	24.4 (0.56; 23.6–25.3; 14)
TOE	(6)	25.5 (0.87; 23.5–26.6; 13)

Subspecies *barrierensis*, unique type specimen (unsexed mount): wing, 107+ (worn); tail, 35; bill (f), 52.6; tarsus, 22.8; toe, 23.1; slightly different measurements of specimen in Miskelly (1988) and Oliver.

Sexual dimorphism weak, only evident in large, live sample of subspecies *huegeli*. Geographical variation marked,

best compared in unsexed samples of skins: *aucklandica* and *meinertzhagenae* similar in all measurements; significant differences (at 0.05) are: WING, *huegeli* smaller than other three; BILL, *huegeli* and *iredalei* similar, smaller than *aucklandica* and *meinertzhagenae*; TARSUS, *iredalei* smaller than both *aucklandica* and *meinertzhagenae*, and *huegeli* smaller still.

**WEIGHTS** Nominate *aucklandica*: (1) Adults, labels (NMMNZ).

	MALES	FEMALES
(1)	82, 83, 94	107

Live adults, unsexed, Nov.–Dec. (G.P. Elliott): 95.0 (11.6; 85–122; 8).

Subspecies *meinertzhagenae*, Antipodes I.: (2) Fresh specimens (Warham & Bell 1979; J. Warham); (3) Live, adults (C.M. Miskelly).

	MALES	FEMALES	
(2)	91.9 (9.3; 82–106; 6)	121.7 (7.0; 115–129; 3)	*
(3)	90.7 (5.5; 87–102; 7)		

Subspecies *huegeli*: (4) Live, adults, Sept.–Mar. (C.M. Miskelly); (5) Live, adults (P.E.N. Wright).

	MALES	FEMALES	
(4)	101.2 (4.8; 89–118; 92)	116.1 (6.6; 98–128; 62)	**
(5)	104.5 (5.9; 97–121; 16)	120.6 (5.1; 113–131; 10)	*

Subspecies *huegeli*: weight at hatching: 15.5 (0.9; 14–18; 28) (Miskelly 1990c); growth fairly slow; growth-curve for first 60 days in Miskelly (1990c) (see Breeding).

**STRUCTURE** Wing, short, rounded at tip. Eleven primaries; outer three slightly pointed at tip (inners squarer), approximately equal longest; p7 3–5 mm shorter, p6 6–10, p5 11–15, p4 16–20, p3 20–24, p2 23–28, p1 27–31; p11 minute. Fourteen secondaries including four tertials; tips of longest tertials fall between p6 and p7 on folded wing. Wing loading high (Warham & Bell 1979); less for males than females of subspecies *huegeli* (see Miskelly 1990c). Tail, short, mostly hidden by coverts; 14 rectrices; central rectrices, soft like coverts; rest narrow, stiff, becoming more so outwards; modi-

## Plate 1

Latham's Snipe *Gallinago hardwickii* (page 29)  
1 Adult; 2 Juvenile; 3 First immature non-breeding;  
4, 5 Adult; 6 Tail

Pin-tailed Snipe *Gallinago stenura* (page 38)  
7–10 Adult; 11 Tail

Swinhoe's Snipe *Gallinago megala* (page 42)  
12 Adult; 13 First immature non-breeding;  
14, 15 Adult; 16 Tail

fied for aerial display; outer rectrices characteristically break off near tip in V-shape on displaying birds, mostly males (Miskelly 1987). Bill, long, decurved, similar to bill of *Gallinago* snipe; culmen straight over basal quarter (concave in *Gallinago*); long nasal groove c. 75% length of culmen; nostril, small horizontal slit at very base of culmen. Narrow horny cere. Herbst's corpuscles on distal third of bill form rippling on ramphotheca. Bill differs slightly between subspecies: nominate *aucklandica* and subspecies *meinertzhagenae* similar; subspecies *huegeli*, *iredalei* and *barrierensis*, slightly shorter and straighter with decurve only toward tip. Tarsus, slightly laterally compressed; scales scutellate on front of tarsus, reticulate elsewhere. Toes, long and slender, unwebbed; hindtoe, raised; outer toe 87–92% of middle, inner 75–79%, hind 24–31%. Claws, sharp, laterally compressed, slightly twisted outwards, moderately decurved; mid-claw, pectinate.

**AGEING** Not properly known. Colours of bare parts may be useful for ageing. Juveniles of subspecies *huegeli* and *aucklandica* not well known; often said to be duller or greyer than adults, with smaller blotches above and finer spotting on throat and neck (e.g. Oliver; NZRD), though at least some juvenile *aucklandica* have upperparts within range of adults. Juvenile *aucklandica* tend to differ from adult by: spotted rather than streaked gorget; broader buff margins and mottling to greater primary coverts and alula; broader, bolder barring on greater secondary coverts, especially inner ones. However, probably overlap with adults (especially females) in all features. Primaries of both juvenile *huegeli* (C.M. Miskelly) and *aucklandica* (skins) more extensively mottled buff round margins than in adults, but some overlap with adult females. Juvenile subspecies *huegeli* drab above compared with adult, with less conspicuous buff margins of feathers, and bill, legs and feet more uniformly grey (C.M. Miskelly). Some old skins in poor condition, with unreliable data, are difficult to identify: probably juvenile *iredalei*, but possibly *huegeli*; recall *iredalei* in general rufous and cinnamon coloration, prominent dorsal blotches and scalloped flanks, but recall *huegeli* in near complete barring on belly; thus juvenile *iredalei* may have barred belly.

No information on young of subspecies *meinertzhagenae* or *barrierensis*. After post-juvenile moult, no reliable methods for identifying first-year birds. In first basic, contrast of fresh adult-like body-plumage and worn juvenile primaries may be useful (C.M. Miskelly).

**SEXING** No reliable methods known. Females (and juveniles) tend to have slightly more buff mottling on fringes of primaries than adult males, at least in subspecies *huegeli* (C.M. Miskelly), but feature not found reliable in skins of any subspe-

cies. Legs yellow in males and olive or greyish in females of subspecies *huegeli* (C.M. Miskelly), but no information for other subspecies. V-shaped breaks in rectrices found in c. 13% of mature males (but some live birds and skins sexed as females have these) (Miskelly 1987, 1990c). Both sexes have brood-patches.

**GEOGRAPHICAL VARIATION** No recent reviews of relationships within *Coenocorypha*. Formerly distributed widely; subfossils indicate past distribution over main islands of NZ (Miskelly 1987), Norfolk I. (Meredith 1991) and possibly New Caledonia (Balouet & Olson 1989). NZCL treats extant and recent populations of *Coenocorypha* under two species: monotypic *C. pusilla* of Chatham Is and *C. aucklandica*, with five subspecies: *aucklandica*, *meinertzhagenae*, *huegeli*, *iredalei* and *barrierensis*. Meinertzhagen (1926), Tuck (1972), Johnsgard (1981), NZRD, and others treated all above as one species. Another slightly larger species from Chatham Is (*C. chathamica*) is known only from subfossils (Lowe 1915; NZCL). All extant populations are isolated and sedentary, and there is no evidence of recent gene flow. Previous revisions have often been hindered by lack of material, erroneous locality data (Hartert 1927; D.J. James), misidentified specimens, and confused nomenclature.

*C. pusilla* is smaller, and plumage differs slightly from *C. aucklandica*: it is more like nominate *C. aucklandica* in plumage than is any other form of *Coenocorypha*.

Of the forms presently treated under *C. aucklandica*, nominate *aucklandica* and subspecies *meinertzhagenae* are most similar in measurements and plumage, though there are some consistent differences in plumages which make it possible to identify all specimens. They probably diverged comparatively recently. Subspecies *huegeli* is the smallest (though larger than *C. pusilla*) and most aberrant in plumage, particularly in its complete barring below and drab patterning above. Subspecies *iredalei* is, in measurements and some plumage characters, intermediate between *aucklandica* and *huegeli*, but in others (e.g. scalloped breast and flanks, rufous and cinnamon tinges) is unique and easily distinguished. Specimens of subspecies *iredalei* from Big South Cape and Jacky Lee Is show some plumage differences from each other, but insufficient skins examined to resolve this; no specimens of *iredalei* were examined from other localities. Status of *barrierensis* is unclear, because there is little material; while distinctive, it is tentatively considered closest to *iredalei*.

Trends in plumage characters and measurements seem parallel, and do not show geographical clines; *huegeli* is geographically placed between *aucklandica* and *iredalei*, suggesting that *huegeli* and *aucklandica* were independently derived from ancestral mainland stock. The difficulty in separating some old, probably juvenile, skins of *iredalei* or *huegeli* has led to suggestions that these two integrate, but in fact they do not. The differences in plumage and measurements in forms of *Coenocorypha* are greater than between some sympatric species of *Gallinago* (see Tuck 1972). Thus the best arrangement would be to recognize at least four recent species in the genus *Coenocorypha* (excluding subfossils): *C. pusilla*, monotypic; *C. aucklandica* with subspecies *aucklandica* and *meinertzhagenae* (which may warrant treatment as a separate species); *C. huegeli*, monotypic; and *C. iredalei* with subspecies *iredalei* and, provisionally, *barrierensis*. The relationship between *iredalei* and *barrierensis* cannot be resolved without study of subfossil material from main islands (Worthy 1987).

## Plate 2

New Zealand Snipe *Coenocorypha aucklandica* (page 54)

- 1 Adult, Antipodes Is, subspecies *meinertzhagenae*;
- 2 Adult, Auckland Is, subspecies *aucklandica*;
- 3 Adult male, Snares Is, subspecies *huegeli*;
- 4 Adult, islands off Stewart I., subspecies *iredalei*;
- 5 Downy young, Snares Is, subspecies *huegeli*;
- 6 Juvenile, Snares Is, subspecies *huegeli*;
- 7, 8 Adult, Snares Is, subspecies *huegeli*

Chatham Island Snipe *Coenocorypha pusilla* (page 47)

- 9 Adult; 10 Downy Young; 11 Juvenile; 12 Adult

## REFERENCES

- Anderson, R.A. 1968. *Notornis* 15: 223–7.
- Balouet, J.C., & S.L. Olson. 1989. *Smithson. Contrib. Zool.* 469.
- Dept. Lands Surv. 1987. *Management Plan for the Auckland Islands Nature Reserve*. Rep. Dept Lands Surv.
- Galbreath, R., & C.M. Miskelly. 1988. *Notornis* 35: 215–16.
- Guthrie-Smith, H. 1936. *Sorrows and Joys of a New Zealand Naturalist*. Whitcombe & Tombs, Lond.
- Hartert, E. 1927. *Novit. Zool.* 34.
- Horning, D.S., & C.J. Horning. 1974. *Notornis* 21: 13–24.
- Johnsgard, P.A. 1981. *The Plovers, Sandpipers and Snipes of the World*. Univ. Nebraska Press, Lincoln.
- Lowe, P.R. 1915. *Ibis* (10) 3: 690–716.
- Meinertzhagen, A.C. 1926. *Ibis* (12) 2: 477–521.
- Meredith, C. 1991. Pp 1345–82 **In:** Vickers-Rich *et al.* (1991).
- Miskelly, C.M. 1984. Unpubl. BSc thesis, Univ. Canterbury.
- 1987. *Notornis* 34: 95–116.
- 1988. *Notornis* 35: 273–81.
- 1989a. *Wilson Bull.* 101: 127–32.
- 1989b. Unpubl. PhD thesis, Univ. Canterbury.
- 1990a. *Emu* 90: 24–7.
- 1990b. *Emu* 90: 28–32.
- 1990c. *Ibis* 132: 366–79.
- , *et al.* 1990. *Antipodes Islands Expedition*. Unpubl. Rep. Univ. Canterbury.
- Moore, P.J., & P.J. McClelland. 1990. *NZ Dept. Cons. Sci. Res. Ser.* 93.
- Richdale, L.E. (Undated) *Vanishing New Zealand Birds*. Otago Daily Times & Witness Newspapers, Dunedin.
- Schönwetter, M. 1963. *Handbuch der Oologie* 7: 410.
- Stead, E.F. 1948. *NZ Bird Notes* 3: 70–80.
- Taylor, G.A. 1988. *Auckland Islands Expedition*. Unpubl. Rep. Dept. Cons.
- Tuck, L.M. 1972. *Canadian Wildl. Serv. Monogr.* 5.
- Vickers-Rich, P., *et al.* (Eds) 1991. *Vertebrate Paleontology of Australasia*. Pioneer Design Studio, Melbourne.
- Wagstaff, R. 1978. *Type Specimens of Birds in the Merryside County Museums*. Merryside County Museums, Liverpool.
- Warham, J. 1967. *Notornis* 14: 122–39.
- 1970. *Birds of the World* 3: 902–3.
- , & B.D. Bell. 1979. *Notornis* 26: 121–69.
- Wilson, R.A. 1959. *Bird Islands of New Zealand*. Whitcombe & Tombs, Christchurch.
- Worthy, T.H. 1987. *Notornis* 34: 343.



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New Zealand Snipe *Coenocorypha aucklandica* (page 54)

1 Adult, Antipodes Is, subspecies *meinertzhagenae*; 2 Adult, Auckland Is, subspecies *aucklandica*; 3 Adult male, Snares Is, subspecies *huegeli*;  
 4 Adult, islands off Stewart I., subspecies *iredalei*; 5 Downy young, Snares Is, subspecies *huegeli*; 6 Juvenile, Snares Is, subspecies *huegeli*;  
 7, 8 Adult, Snares Is, subspecies *huegeli*

Chatham Island Snipe *Coenocorypha pusilla* (page 47)

9 Adult; 10 Downy Young; 11 Juvenile; 12 Adult

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