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Order CHARADRIIFORMES

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

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

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

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

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

Because the Order comprises so many species and adaptations are so diverse, few characters shared by all species; those that are shared are mostly anatomical features of the skull, e.g. most or all have schizorhinal nostrils, schizognathous palates, well-developed vomer, lachrymals fused with ectethemoid and pre-frontal bones, well-developed supra-orbital grooves; see Olson & Steadman (1981) for more information on osteological characters. Wings usually have 11 primaries, with p10 longest and p11 minute; 15–24 secondaries; diastataxic except in *Scolopax minor*, as far as is known. Usually 12 tail-feathers. Necks usually rather long with 15–16 cervical vertebrae. Oil-gland bilobed and tufted. Syrinx, tracheo-bronchial; two carotids (type A-1 of Glenny 1955); caeca present. Legs usually rather long; hind toe small or lacking in most but all toes greatly elongated in Jacanidae. Feathers with small thin afterfeathers. Normally two moults annually: complete post-breeding and partial pre-breeding; some jacanas and alcids have flightless periods when moulting remiges. Young, downy, usually with intricate cryptic patterns on upperparts of three chief types: pebbly, spotted and striped, matching characters of habitat (Fjeldså 1976, 1977): precocial, nidifugous usually, self-feeding or not depending greatly on parents.

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

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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, rhynchokinesis 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. Moult-strategies 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 Westernport 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.

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Subfamily **CALIDRIDINAE** arctic sandpipers and allies

Small to medium-sized (15–29 cm) migratory shorebirds. Twenty-four species in seven genera (see Table 1); six genera monotypic; *Calidris* comprises remaining 18 species (though these were once placed in several different genera). In HANZAB region, 19 species recorded: ten regular non-breeding migrants, eight accidental, one doubtfully recorded (and one problematic hybrid). *Calidris* may contain 2–3 species-groups (BWP): (1) knots (two species), which have much in common with Surfbird *Aphriza virgata*, especially Great Knot *C. tenuirostris* (Jehl 1968a); (2) sandpipers with partially webbed feet ('*Ereunetes*' group: *C. pusilla* and *C. semipalmatus*); and (3) other sandpipers ('*Erolia*' group). Groups (2) and (3) do not differ greatly, and may be more closely related to *Micropalama, Limicola, Eurynorhynchus, Tryngites* and *Philomachus* than they are to knots and Surfbirds (Jehl 1968a; BWP). Patterns of downy young suggest possible affinities of Calidridinae to Gallinagoninae, Limnodrominae and, possibly, Arenariinae (Jehl 1968a,b; Fjeldså 1977) but precise relationships not clear; allozyme and DNA research so far (e.g. Dittman *et al.* 1989; Dittman & Zink 1991; Christian *et al.* 1992) have not included comparison with all other subfamilies of Scolopacidae.

Table 1

GENUS	NUMBER OF SPECIES	NUMBER OF SPECIES IN HANZAB REGION[1]
Aphriza	1 (Surfbird)	0
Calidris	18	8 NB, 6A, 1D
Eurynorhynchus	1 (Spoon-billed Sandpiper)	0
Micropalama	1 (Stilt Sandpiper)	1 NA
Tryngites	1 (Buff-breasted Sandpiper)	1 NA
Limicola	1 (Broad-billed Sandpiper)	1 NB
Philomachus	1 (Ruff)	1 NB

[1] NB = regular non-breeding migrant; A = accidental; D = unacceptably claimed.

Females generally slightly larger than males, but male is larger in polygynous species: Pectoral *C. melanotus*, Sharp-tailed *C. acuminata*, and Buff-breasted *T. subruficollis* Sandpipers, and Ruff *P. pugnax* (Jehl & Murray 1986). Bill, short and finely pointed in most species, but superficially plover-like in *Tryngites* and broad and flattened in *Eurynorhynchus*. Nostrils in a depression extending anteriorly as a groove that nearly reaches tip of upper mandible. Highly rhynchokinetic except in *Aphriza*; upper jaw typically lightly built and tip of bill sensitive, with many Herbst's corpuscles (associated with tactile foraging). Muscles of jaw and tongue hypertrophied in *Limicola* and *Tryngites*; latter also has hypertrophied salivary glands, in these respects resembling plovers. Internal feeding apparatus of *Calidris* and *Micropalama* very similar (Burton 1974) and further research needed on whether *Micropalama* merits generic recognition. Legs, moderately long and tarsus scutellate. Hindtoe small and raised in most; uniquely among Scolopacidae, it is absent in Sanderling *C. alba*. Anterior toes usually unwebbed but *Calidris* of '*Ereunetes*' group have small basal web between front toes.

Adult breeding plumage finely patterned in rufous, black, grey and buff; white or rufous below, usually with dark spotting, streaking or suffusion on breast. Sexes alike or nearly so, except for strong sexual dimorphism in Ruff, which is also unusual in attaining breeding plumage in pre-supplemental (rather than pre-alternate) moult. Adult non-breeding usually much plainer, grey to brown above and mostly white below; in *Tryngites*, little seasonal change in appearance. Juvenile plumage distinctive, usually with upperparts superficially like that of adult breeding and underparts more like adult non-breeding. All species replace most of juvenile body-plumage early in first pre-basic moult (attaining plumage like non-breeding), typically when in late stages of s. migration or after arrival in non-breeding areas. Thereafter, moult-strategies of subadults complex, but can be separated into three broad categories: (1) Undergo complete moult of all juvenile feathers in first pre-basic when c. 6–8 months old, developing adult breeding plumage in first pre-alternate moult just before first n. migration when c. 9–10 months old (e.g. most Little Stints *C. minuta*, Least *C. minutilla* and Sharp-tailed *C. acuminata* Sandpipers). (2) Retain juvenile remiges, and often much of tail and wing-coverts, through first pre-basic; may replace some outer primaries in partial first pre-supplemental moult; attain plumage very similar to that of adult breeding in first pre-alternate moult before undertaking first n. migration when c. 9–10 months old (e.g. Dunlin *C. alpina* and Purple Sandpiper *C. maritima*). (3) Like second strategy, but first pre-alternate moult produces dull plumage, mostly like non-breeding but often with varying number of feathers like breeding plumage (colours of these feathers often duller than adult breeding); such birds typically delay first n. migration until at least 2 years old, first attaining adult non-breeding plumage in complete second pre-basic moult when c. 12–15 months old (e.g. Red-necked Stint C. *ruficollis*, Curlew Sandpiper C. *ferruginea* and Great Knot C. *tenuirostris*). Down of precocial young, long and loose, especially on nape. Mainly ochraceous to rich brown above, with complex patterns of black blotches and bands, including characteristic marking shaped like hour-glass on centre of back; white below, often with brown wash on foreneck and breast. As in Gallinagoninae and Limnodrominae, spotted dorsal pattern formed by white powder-puffs attached to tips of black down. In most species, white barbules at each feather-tip densely packed and interlock with those of other feathers as large closely knit puffs (resembling scattering of large snow-flakes). In knots and *Aphriza*, powder-puffs have looser microstructure and do not entangle much, so some areas (especially in older chicks) may appear to have diffuse white mottling rather than distinct spots. Some other variation in colour and pattern of downy young attributed to breeding habitat rather than taxonomy (see Jehl 1968b; Fjeldså 1977; BWP).

Most species breed in tundra, a few in other open habitats S to Temperate regions of n. hemisphere. Highly migratory; those breeding high Arctic breed faster and migrate farther than most other species of waders. In non-breeding season, inhabit wide range of shallow wetlands. Some species almost exclusively coastal (e.g. Red C. *canutus* and Great C. *tenuirostris* Knots and Sanderling C. *alba*); some typically occur on inland wetlands (e.g. Long-toed Stint C. *subminuta*); others rather catholic in choice of habitat. Feeding behaviour varies; include probing and stitching (a rapid series of shallow probes made close to one another). Usually forage by touch and several species known to detect prey by chemoreception or detection of vibrations (e.g. van Heezik *et al.* 1983; Gerritsen 1988).

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Calidris alba Sanderling

COLOUR PLATE FACING PAGE 288

Tringa alba Pallas, 1764, *Vroeg's Cat. Oiseaux Adumbr.*: 7 — coast of North Sea.

The specific epithet is Latin (*albus*) for white.

Origin of the English name is obscure, although it does suggest a little bird of sandy shores.

MONOTYPIC

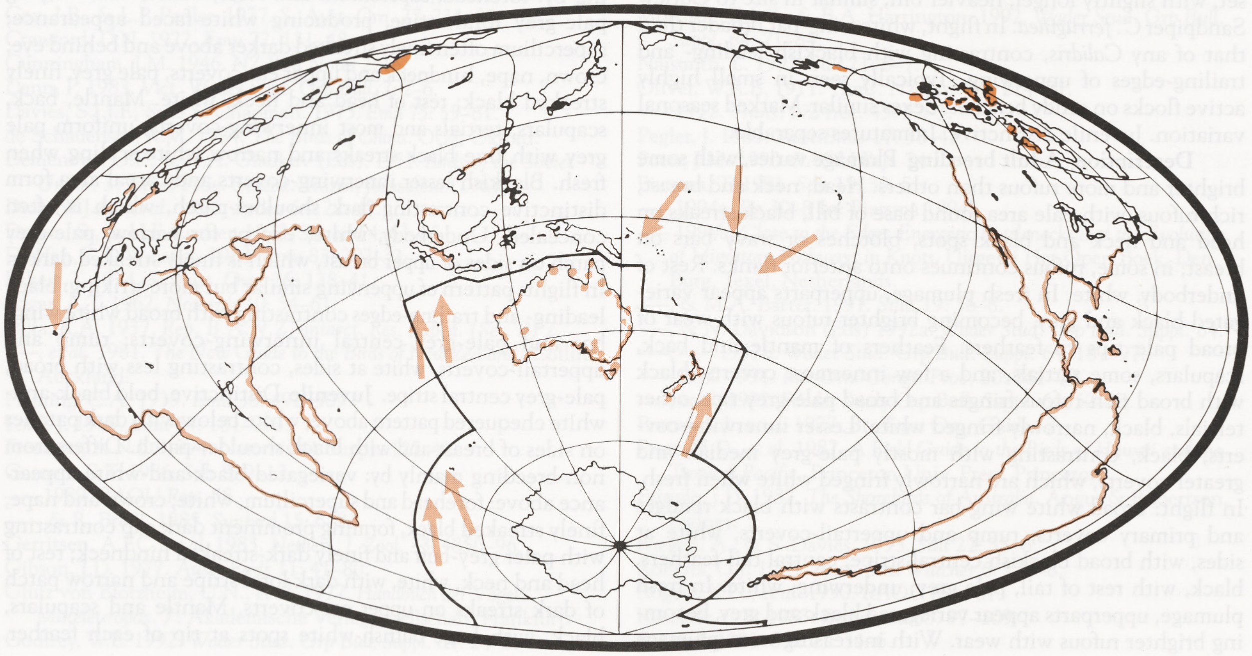
FIELD IDENTIFICATION Length 20–21 cm; wingspan 35–39 cm; weight *c.* 60 g. Small, rather thickset wader with short straight fairly heavy black bill, short black legs and much white in plumage. General shape and proportions similar to Red-necked Stint *Calidris ruficollis* but larger and more thickset, with slightly longer, heavier bill; similar in size to Curlew Sandpiper *C. ferruginea*. In flight, white wing-bar broader than that of any *Calidris*, contrasting with blackish leading- and trailing-edges of upperwing. Typically seen in small highly active flocks on sandy beaches. Sexes similar. Marked seasonal variation. Juvenile distinctive. Immatures separable.

Description **Adult breeding** Plumage varies, with some brighter and more rufous than others. Head, neck and breast, rich rufous, with pale area round base of bill, black streaks on head and neck and black spots, blotches or wavy bars on breast; in some, rufous continues onto anterior flanks. Rest of underbody, white. In fresh plumage, upperparts appear variegated black and grey, becoming brighter rufous with wear of broad pale tips to feathers. Feathers of mantle and back, scapulars, some tertials, and a few innermost coverts, black with broad rich-rufous fringes and broad pale-grey tips; other tertials, black, narrowly fringed white. Lesser innerwing-coverts, black, contrasting with mostly pale-grey median and greater coverts, which are narrowly fringed white when fresh. In flight: broad white wing-bar contrasts with black remiges and primary coverts; rump and uppertail-coverts, white at sides, with broad blackish central stripe; central tail-feathers, black, with rest of tail, pale grey; underwing, white. In fresh plumage, upperparts appear variegated black and grey, becoming brighter rufous with wear. With increasing wear, plumage much duller, variegated black and pale orange. A few birds lack nearly all rufous and appear much duller. Bill, black. Iris, dark brown. Legs and feet, black or blackish. **Adult non-breeding** Generally pale grey above, white below, and with characteristic black shoulder-patch. Differs from adult breeding by: forehead, supercilium and lores, white, with varying pale-grey loral stripe, producing white-faced appearance; supercilium often finely streaked darker above and behind eye; crown, nape, hindneck and upper ear-coverts, pale grey, finely streaked black; rest of head and neck, white. Mantle, back, scapulars, tertials and most innerwing-coverts, uniform pale grey with fine black streaks and narrow white scaling when fresh. Blackish lesser innerwing-coverts and carpal area form distinctive contrasting dark shoulder-patch, which is often concealed. Underbody, white, except for narrow, pale-grey patch on sides of upper breast, which is finely streaked darker. In flight: pattern of upperwing similar but more striking: black leading- and trailing-edges contrasting with broad white wing-bar and pale-grey central innerwing-coverts; rump and uppertail-coverts, white at sides, contrasting less with broad, pale-grey central stripe. **Juvenile** Distinctive, bold black-and-white chequered pattern above, white below with dark patches on sides of breast and with black shoulder-patch. Differs from non-breeding mainly by: variegated black-and-white appearance above: forehead and supercilium, white; crown and nape, finely streaked black, forming prominent dark cap contrasting with paler grey-buff and finely dark-streaked hindneck; rest of head and neck, white, with dark loral stripe and narrow patch of dark streaks on upper ear-coverts. Mantle and scapulars, black, with large buffish-white spots at tip of each feather, forming chequered pattern above. Tertials, pale grey grading to blackish at tip and broadly fringed buffish white; black shoulder-patch extends round carpal and often prominent, though sometimes concealed; rest of innerwing-coverts, pale grey with thin blackish streaks, white fringes and, usually, thin dusky submarginal lines. Underbody, white, with buff wash across upper breast (which soon fades) and narrow patches of short blackish streaks on sides of upper breast and fainter dusky streaking on sides of lower breast. In flight: similar to non-breeding, but with dark cap, darker black-and-white mantle and scapulars, and darker central line through uppertail-coverts. Soon lose all buff tones, and white spotting and fringing much reduced with wear and fading. **First immature non-breeding** As adult non-breeding, but distinguished by retained worn juvenile tertials, innerwing-coverts and a few feathers of mantle and scapulars, contrasting with fresh non-breeding plumage (all tracts fresh in adult). In first austral spring–summer retained juvenile remiges reasonably fresh (worn and moulting in adults); in summer–autumn, most replace outer primaries, which contrast with old, worn brownish inner primaries (primaries uniform and fresh in adults). A very few undergo complete post-juvenile moult and are inseparable from adult non-breeding once moult finished. **First immature breeding** Much variation. Most birds that return to breeding grounds acquire much breeding plumage and appear similar to adult breeding, though many separable by contrast in moult of primaries. Most remain over winter, many in first immature non-breeding; others develop a little breeding plumage, with new feathers usually intermediate in character between those of breeding and non-breeding. During first austral winter, differ from adult by contrast in moult of primaries or are in active primary-moult.

Similar species Dashing gait, normal sandy ocean-beach habitat, much white in all plumages, broad white wing-bar, and lack of hindtoe, distinctive. However, especially when seen in atypical habitats, often confused with **Red-necked Stint** (q.v.), which has superficially similar breeding and non-breeding plumages. Non-breeding **Broad-billed Sandpiper** *Limicola falcinellus* also has blackish shoulder-patch, but differs from non-breeding Sanderling by: smaller size; longer bill, with downwards kink near tip; bill often paler greenish or brownish at base; loral stripe and ear-coverts, darker, and centres of feathers of upperparts contrast more; clearer white supercilium, often with conspicuous pale lateral crown-stripes; narrower wing-bar; rather paler blackish-grey legs, often tinged green, yellow or brown; and buzzing *chrrreeit* call in flight. In flight, could be confused with non-breeding **Grey Phalarope** *Phalaropus fulicarius*, which has narrower, less extensive wing-bar, broader tail with narrower, less contrasting pale sides, and bold blackish eye-patch. Also, in flight, may be confused with non-breeding **Red-necked Phalarope** *P. lobatus*, which also differs by less extensive wing-bar and bold black eye-patch.

Gregarious; typically in small to large flocks, in hundreds at favoured localities; associate freely with other waders and may join mixed roosts, but often roost high on beach in tight monospecific flocks. Prefer open sandy beaches. Gait and foraging behaviour distinctive: birds dash across sand or along tideline, pause briefly to pick or probe, then run nimbly after retreating waves, like clockwork toys; normally feed by rapid probing or pecking, though sometimes behaviour more hesitant and plover-like. Often tame; rarely fly far when disturbed. Flight, rapid, with fast flickering wing-beats exaggerated by striking wing-pattern; rarely perform mass aerial manoeuvres. Voice distinctive: usual flight call quiet *twick* or *kip*, sometimes repeated; occasionally utter short trill.

HABITAT During non-breeding period, almost always on coast, mostly open sandy beaches exposed to open sea-swell; also on exposed sandbars and spits, and shingle banks; beaches may contain wave-washed rocky outcrops (Hindwood & Hoskin 1954; Carter *et al.* 1976; Bransbury 1985); on Rottnest I., beaches have only thin layer of sand over limestone (Storr 1965). Less often on more sheltered sandy shorelines of estuaries, inlets and harbours. In sw. Gulf of Carpentaria, Qld, a few recorded on hardened margins of exposed tidal mudflats (Garnett & Taplin 1990). Rarely, recorded in near-coastal wetlands, such as lagoons, hypersaline lakes, saltponds and samphire flats (Gibson 1977; Storr 1984; Jaensch *et al.* 1988;



Storr & Johnstone 1988). Rare inland records from sandy shores of ephemeral brackish lake (Curry 1979) and brackish river-pools (Storr 1985). One record on shingle river bed, NZ (Parrish 1988).

Forage along sandy beaches and exposed sandbars at edge of water in wave-washed zone (Hindwood & Hoskin 1954; Carter *et al.* 1976; Bransbury 1985; Garnett 1989); sometimes among heaps of rotting kelp (Carter *et al.* 1976). Also along edges of shallow pools on sandspits and nearby mudflats (Sutton 1967). Roost on bare sand, behind clumps of beachcast kelp, or in coastal dunes; also on rocky reefs and ledges (Carter *et al.* 1976; Bransbury 1985; Garnett 1989). In se. SA, roost on sheltered shores of The Coorong (Lane). In se. Qld, occasionally shelter on tidal flats during storms (Roberts 1979).

DISTRIBUTION AND POPULATION Breed at scattered localities from n. North America to n. Russia and islands in Arctic Ocean: round Barrow in n. Alaska, and on Canadian Arctic Is (Prince Patrick, Lougheed and n. Ellesmere Is), S to n. Mackenzie, w. Victoria I. and n. Keewatin (round Melville Pen.), and W to nw. Hudson Bay (round C. Fullerton), Southampton I. and n. Baffin I. (AOU 1983); Greenland; Spitsbergen; Russia, on Taymyr Pen., s. and central Severnaya Zemlya and on Novosibirskiye Is; single record, Lena R. in nineteenth century (Dement'ev & Gladkov 1951; Flint *et al.* 1984; BWP). During non-breeding period, almost cosmopolitan. Recorded along Pacific, Atlantic and Caribbean coasts of North and South America, from s. Alaska and British Columbia (and W to Aleutian Is), S to Magellanes, s. Chile, and from Gulf of St Lawrence, S through West Indies to Tierra del Fuego. In Europe, round coasts from Denmark to France and British Isles, with scattered records on Iberian Pen. and coasts of Mediterranean, Aegean, Black and Caspian Seas. In Africa, occur along entire coastline, but less often on coasts of Mediterranean and Red Sea; occasionally inland (usually on passage) round Niger R. in Mali, from Ghana to Nigeria and from Ethiopia and s. Sudan, through Zambia to South Africa. From Arabian Pen. and Persian Gulf, E to Pakistan and w. India; rare on sw. coast of India, but more common in E. Vagrant to Burma, but fairly common from Thailand and Malaysia, E through Indochina and se. China to Philippines, N to Japan and Korean Pen., and S to Indonesia. In A'asia, scarce round coasts of New Guinea, widespread round coastal Aust. and regular visitor to NZ in small numbers. In sw. Pacific, recorded from w. Polynesia, E to Kiribati and Samoa (Blake 1977; Ali & Ripley 1980; AOU 1983; de Schauensee 1984; Pratt *et al.* 1987; Urban *et al.* 1987; AWB 1993; BWP).

Aust. **Qld** Occasional in Gulf of Carpentaria and Torres Str.: Burketown (historical), Karumba, Edward R., and Booby and Warraber Is (Church 1925; Drake 1979; Stokes 1983; Garnett & Bredl 1985; Garnett 1989); recorded at Cairns and Michaelmas Cay (Qld Bird Rep. 1988; Aust. Atlas). Scattered records in mid-e. and se. Qld, including offshore islands, from Townsville and Alva Beach, S to Fraser I. (Barry & Vernon 1976; Sutton 1990; Qld Bird Reps; Aust. Atlas); round Moreton Bay (Qld Bird Reps; Aust. Atlas) and Pt Danger (Fien 1971). **NSW** From Hastings Pt, Tweed area (with many regularly round Ballina), S to Shoalhaven Heads and Comerong I. (Pegler 1983; NSW Bird Reps; Aust. Atlas); rarely farther S: Jervis Bay, Moruya, Tuross Head and Brou L. (Whiter 1991, 1992; Aust. Atlas). Inland record of single bird, L. Cawndilla, 29 Mar. 1987 (Henle 1989). **Vic.** Regular in large numbers round Corner Inlet–Shallow Inlet–Wilson's Promontory, and on sw. coast between Killarney and Nelson. In E, recorded at Mallacoota, Ls Entrance and Kalimna. Widespread records between Venus Bay and s. Bellarine Pen., W to Breamlea, with isolated records farther W at Anglesea and Apollo Bay (Carter *et al.* 1976; Vic. Bird Reps; Vic. Atlas). Inland record of four at

Cullen's L., 31 Oct.–10 Nov. 1982 (Vic. Bird Rep. 1982) and of one, Mildura, 1954 (Thomas 1970). **Tas.** First record, 28 Feb. 1965 at Anson's Bay (Wall 1965); now regular, scarce visitor. On all coasts except n. coast between Marrawah and C. Naturaliste; regularly recorded C. Naturaliste, Anson's Bay and mouth of Henty R. On King I. and Furneaux Grp (Wall 1965; Newman *et al.* 1984; Tas. Bird Reps). **SA** Widespread between Vic. border and Kingston SE; also The Coorong, mouth of Murray R., then W and NW to Kangaroo I., Yorke and Eyre Pens to Streaky Bay (Bransbury 1985; SA Bird Reps; Aust. Atlas). **WA** Most of coast from Eyre to Derby; also round Wyndham. More often recorded s. and sw. coasts, N to round s. Shark Bay; more sparsely scattered records farther N in Gascoyne and Pilbara Regions and Kimberley Division (Aust. Atlas). Inland record of single, L. Violet, 31 Dec. 1977 (Curry 1979). **NT** Round Darwin, and possibly elsewhere on nw. coast; also Melville I., shores of Van Diemen Gulf and Groote Eylandt (Crawford 1972; Storr 1977; Aust. Atlas; H.A.F. Thompson & D.K. Goodfellow).

NZ Scarce but probably regular visitor. **NI** Scattered records from Parengarenga Harbour, S to Kowaka, Miranda and Opoutere; multiple records at Kaituna Cut–Maketu; also recorded estuaries of Tukituki, Waikarae (old record), Manawatu and Turakina Rs (Wodzicki 1946; Jackson 1968; Brown 1971; Edgar 1971; CSN). **SI** Scattered localities, each with multiple records: Farewell Spit, usually singles but six, Jan. 1983; estuary Waimakariri R.–New Brighton; L. Ellesmere; L. Wainono; Waituna Lagoon; Awarua Bay (Turbott 1951; Sutton 1967; Muller 1969; Edgar 1974; Dennison & Robertson 1979; J. Hawkins; CSN).

Cocos-Keeling Is Up to 65 recorded between Oct. 1982 and Jan. 1983 (Stokes *et al.* 1984).

Christmas I. Probably regular visitor in small numbers (Stokes 1988).

Chatham Is Accidental Chatham I.: single, 1977 (NZCL); three, Te Whanga Lagoon, 6–7 Dec. 1985 (Freeman 1994).

Iles Crozet Recorded, but without details (Ausilio & Zotier 1989).

Iles Kerguelen Single, 24 Jan. 1987 (Ausilio & Zotier 1989).

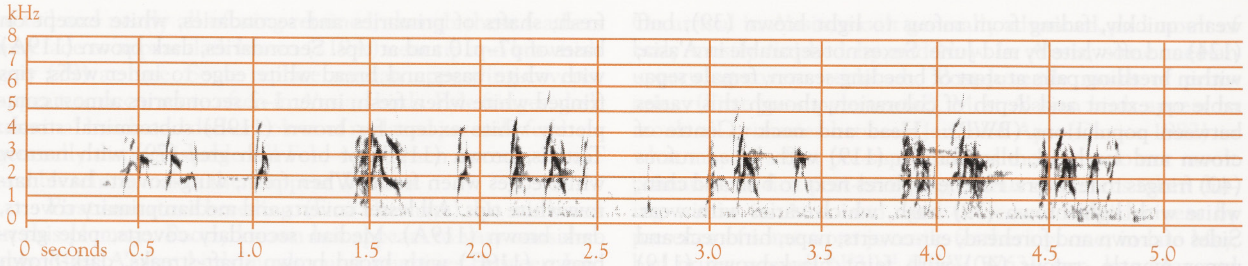
Populations Aust. Estimated at 8000 (Watkins 1993). Sites of significance and maximum or average counts for summer and winter surveys round Aust., 1981–85, were: Roebuck Bay, WA, 1510; The Coorong, SA, 930; se. coastal SA, 780; w. Eyre Pen., SA, 510; sw. coastal Vic., 430; Strahan, Tas., 330; Corner and Shallow Inlets, Vic., 180; se. Gulf of Carpentaria, Qld, 180; Furneaux Grp, Tas., 160 (Lane). Other sites of international importance (Watkins 1993) include: Garden I., WA, 485; Canundra NP, SA, 360; Gunya Beach, SA, 350; Sleaford Bay, SA, 200; Nuytsland NR, WA, 142; Darwin area, NT, 137; Sceale Bay, SA, 135. Totals for summer counts, 1986–91, in Aust. summarized in Hewish (1986, 1987, 1989, 1990), Anon. (1992) and Naismith (1992).

MOVEMENTS Migratory. Holarctic breeding range mostly N of *c.* 70°N, N of 73°N in Siberia; move S to non-breeding areas S of *c.* 45°N. Link between breeding and non-breeding grounds not known; birds breeding Canada and Alaska apparently move S to Americas; birds breeding Greenland and Siberia migrate to w. Palaearctic, some to Africa; other Siberian populations move to coasts of Indian Ocean and probably sw. Pacific (Hayman *et al.* 1986; BWP). Birds reaching se. Asia and Aust. probably breed New Siberian Is, n. Siberia (Smythies 1981; P.S. Tomkovich) though biometrics of Vic. birds similar to birds breeding near Spitsbergen, Norway (Jessop 1992). Tend to migrate in long flights, overflying large areas (BWP); typically in large flocks (Hayman *et al.* 1986). For extralimital information on optimal fat loads and estimated flight-ranges, see Gudmundsson *et al.* (1991).

Departure Adults, mid-July to mid-Aug.; juveniles, early Aug. to early Sept. (Hayman *et al.* 1986; P.S. Tomkovich). Most appear to move W and SW from Taymyr and down e. coast of Russia from New Siberian Is, though some move across inland, apparently in broad front (e.g. common L. Baikal, Sept.; recorded passing Caspian Sea in large numbers from Aug. to Oct.; on Russian coast, pass Shantar I. in first half Sept.; pass Kurile Is; appear Ussuriland as early as end July, but mainly second half Aug. to end Sept. (Dement'ev & Gladkov 1951; P.S. Tomkovich); on Taymyr Pen., no differences in timing of departure between sexes (P.S. Tomkovich), *contra* Dement'ev & Gladkov (1951), who state that in Ussuriland females move through before males. Pass through Mongolia, where rare. In coastal China, peak migration at Beidaihe, late Aug.–Sept.; pass through ne. Chihli and Shantung, Jiangsu and Fohkien Provinces between Aug. and Oct. (la Touche 1931–34; Hui 1992; AWB 1993). Most common Japan during s. migration (AWB 1993; Minton 1993). Common passage migrant through Korea, where particularly common on e. coast, Aug.–Sept. (Gore & Won 1971). Scarce passage migrant Hong Kong, Aug.–Nov. (Chalmers 1986). Pass through Vietnam and Cambodia; rare in Burma (Smythies 1986; AWB 1993). Mainly non-breeding visitor on Malay Pen.; apparently only small numbers pass through Thailand, Aug.–Nov., and small numbers recorded on e. coast of Pen. Malaysia and Singapore. Small numbers apparently pass through Borneo, Aug.–Dec. (AWB 1993). Possibly move through Wallacea rapidly; recorded Sulawesi, from Sept., with large numbers in Oct. (Escott & Holmes 1980; White & Bruce 1986). Few records in Sumatra, mostly Aug.–Dec. (van Marle & Voous 1988). Apparently common in Indonesia (AWB 1993), but rare in Java (Hoogerwerf 1969); common in Bali, with maximum numbers late July (Ash 1984). Small numbers pass through Philippines (AWB 1993). Some passage across Pacific Ocean. Probably common throughout tropical Pacific; common Hawaiian and Marshall Is; recorded Phoenix and Line Is, mainly Nov.; rare Gilbert and Ellice Is, from Nov.; uncommon central and w. Micronesia, from Sept. Uncommon from Kiribati, S to Fiji and Samoa (Child 1956; Jenkins 1981; Pratt *et al.* 1987). Small numbers Cook Is during s. migration (Holyoak 1976). Rare and irregular visitor to Port Moresby district, PNG, where usually first arrive Oct. (Hicks 1990).

Arrive Aust., Sept. (Lane). Mostly in NW: move through Roebuck Bay, nw. Aust., Darwin, NT, and Eyre, s. WA, Sept.–Nov.; seem to cross continent to s. Aust. coast (Lane) though few inland records; do not pass in large numbers through Gulf of Carpentaria (Garnett 1989) or Torres Str. (Draffan *et al.* 1983). Small numbers regularly arrive late Aug. and early Sept. at Rottnest I., sw. WA (Saunders & de Rebeira 1985). Arrive near Sydney, NSW, from mid-Sept. (McGill 1951; Hindwood & Hoskin 1954); in County of Camden, recorded from Aug. (Gibson 1977). Large numbers from Oct. in se. SA in 1982 (Bransbury 1985).

Non-breeding At least some remain at non-breeding sites for months, possibly even for most of non-breeding period (Wheeler 1955; Davies 1982), though numbers in one flock, regularly counted in Vic., varied markedly between days (Carter *et al.* 1976). Some dispersive movements, e.g. single recorded



A C. Chappuis; Bay of the Somme, w. France, May; *Sounds of Migrant and Wintering Birds — Western Europe*. Cassette 2: #72

at Wiluna, central WA, in Dec. 1977 after thunderstorm (Curry 1979).

Return Leave Rottnest I., Apr. and May (Saunders & de Rebeira 1985). Leave Sydney area, NSW, by early Apr. (McGill 1951; Hindwood & Hoskin 1954). Apparently move W along s. coast before moving N; at least some stop on n. coast. Pass through Eyre and Darwin in Mar. and Apr. Few pass through nw. Aust. (Lane & Jessop 1985; Lane).

Extralimitally, usually leave Port Moresby district, Mar. (Hicks 1990). Apparently pass through Fiji, where small peak in numbers, mid-Mar. 1970 (Smart 1973), and through Phoenix and Line Is, where a few records Mar. and Apr. (Clapp & Sibley 1967; Clapp 1968). Small numbers move through Olango I., Philippines (Magsalay *et al.* 1990; Magsalay 1991). Few recorded Brunei, Feb.–Apr. 1988 (Harvey & Elkin 1991). Not recorded after Apr. in s. Sulawesi (Escott & Holmes 1980). Very few recorded during n. migration in s. Thailand and Red R. Delta, Vietnam (AWB 1993). Small passage through Hong Kong, late Mar. to late May, with peak end Apr. (Chalmers 1986). Very small passage through Kuantu, Taiwan, in Apr. and May 1984, though large numbers sometimes recorded in non-breeding season (AWB 1993). Pass along coast of China, Apr. and May (la Touche 1931–34; AWB 1993). Fewer pass through Japan and very small numbers recorded in South Korea, Apr. and May (AWB 1993). Move through Ussuriland and Sakhalin I., second half of May and early June (P.S. Tomkovich). Arrive Taymyr Pen. and New Siberian Is, June, with some birds already in pairs (P.S. Tomkovich).

Breeding Extralimitally, many 1-year-olds return to breeding range but some remain in non-breeding quarters (BWP). Some winter in Aust.; reporting rates in summer, 0.76%, and in winter, 0.17% (Aust. Atlas). Flocks regularly reported from se. and sw. Aust. (Aust. Atlas) with over 100 counted in Corner Inlet, Vic., in winter (Vic. Atlas). Recorded in n. Aust. and as far S as Tas. (e.g. Crawford 1972; Tas. Bird Rep. 1984). One record during winter in NZ (Sagar 1992).

Banding, Colour-marking Birds colour-marked Vic. seen Japan in Aug. and Sept. as well as farther E along Vic. coast and as far W as SA (Minton 1993). Extralimitally, high recapture rate of passage and non-breeding birds (see BWP). Juvenile banded Chany L., w. Siberia, Sept. 1984, recovered Thailand, Nov. 1984 (Starks 1987).

38E142S	03	2+	U	32	205	293	ABBBS
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38E142S	03	2+	U	32	205	293	ABBBS

FOOD

Omnivorous. Plants, seeds, worms, crustaceans, spiders, insects; occasionally medusae, fish and larger molluscs and crustaceans taken as carrion. **Behaviour** Diurnal and nocturnal; extralimital study found birds form larger, tighter foraging flocks at dusk; those that continued foraging through dusk into night increased the amount of time spent actively foraging (Burger & Gochfeld 1991). Run–pause–probe foraging, with short fast runs, and probes 5–25 mm apart. Hold bill slightly open while probing; robust bill allows probing in hard ground and dry sand (Glutz von Blotzheim *et al.* 1977). Sometimes repeat probing a number of times in small area (cf. sewing machine action; Cooper 1970); sometimes said to have more hesitant, plover-like feeding action (Hayman *et al.* 1986). On flat beaches, very active in tightly synchronised flocks, darting onto moist sand between breaking waves (Hindwood 1949). May probe among rotting kelp (Carter *et al.* 1976). Also glean, lunging quickly from side to side, and may skim food from surface of shallow water while running (BWP) or capture flying and rapidly moving prey on ground (Glutz von Blotzheim *et al.* 1977). Use all senses to locate prey, but visual location and sensitivity of bill most important (Glutz von Blotzheim *et al.* 1977; Gerritsen & Meiboom 1986). Observed on crest of beach in NZ, running in one place, presumably to disturb prey (Brown 1971). Foraging effort increases with abundance of prey and size of flock (BWP). May defend feeding territory in non-breeding period (Myers *et al.* 1979).

Adult No detailed studies. Annelids; Arachnids: spider; Insects: Coleoptera: Scarabaeidae: *Aphodius*; Lepidoptera: larv.; Hymenoptera: Formicidae: *Camponotus* (Lea & Gray).

VOICE

No detailed studies; sonagrams in Bergmann & Helb (1982), BWP and Miller *et al.* (1988). Not particularly vocal; soft twittering conversational calls given in flocks outside breeding season, and liquid *twick-twick* in flight (BWP).

Adult TWICK-CALL: (see BWP) sharp twitter; very varying (sonagram A). Most common call outside breeding season.

PLUMAGES

Prepared by R.P. Scofield. Begin partial post-juvenile moult to first immature non-breeding (first basic) plumage on s. migration, generally finishing moult in non-breeding areas by mid-Nov. Late in first austral summer, most begin partial (possibly sometimes complete) pre-supplemental moult of remiges. Most do not migrate N in first year; undergo partial first pre-breeding (first pre-alternate) moult, attaining varying amount of breeding plumage, though usually little. First attain adult non-breeding plumage in complete second post-breeding (pre-basic) moult at beginning of second austral summer. Thereafter, moult twice annually: a partial pre-breeding (pre-alternate) moult to breeding plumage beginning before n. migration; and a complete post-breeding (pre-basic) moult to non-breeding plumage, which can begin during incubation, birds generally attaining non-breeding appearance before arriving A'asia. No subspecies; slight clinal variation in colour of breeding plumage. Following description based on skins from Aust. and e. Siberia.

Adult breeding (Second and subsequent alternate). Extent of pre-breeding moult of body varies and some retain much basic plumage. Rufous (40) feathering bleaches and wears quickly, fading from rufous to light brown (39), buff (124) and off-white by mid-June. Sexes not separable in A'asia; within breeding pairs at start of breeding season, female separable on extent and depth of coloration, though this varies between populations (BWP). **Head and neck** Centre of crown and forehead, black-brown (119) with broad rufous (40) fringes to feathers. Forehead, lores next to bill, and chin, white with light-brown (39) wash, which varies with wear. Sides of crown and forehead, ear-coverts, nape, hindneck and upper mantle, rufous (40) with faint black-brown (119) speckling on sides of head and black-brown (119) streaking on hindneck and upper mantle. Throat, rufous (40) with small black-brown (119) specks and streaks. **Upperparts** Lower mantle and most scapulars, black-brown (119) with broad rufous (40) fringes. Often, longest scapulars, and sometimes other scapulars, have broad rufous (40) subterminal band, interrupted by black-brown (119) shaft-streak that reaches tip. Fresh scapulars have narrow unfrayed white tips. Extent of moult of rest of upperparts varies greatly. When fresh, back, rump and central uppertail-coverts, black-brown (119) with narrow light-brown (39) fringes and subterminal streaks and spots; lateral uppertail-coverts, white. With wear, rufous and pale fringes much reduced, upperparts then appearing mostly black-brown (119) by July and early Aug. **Underparts** Upper breast and fore-flanks like throat, rufous (40) with small black-brown (119) specks and streaks that grade to broad chevrons on sides of breast and flanks. Demarcation between rufous of upper breast and white of lower breast indistinct and varies between populations, sexes and seasons. Lower breast mostly white, usually with some light-brown (39) feathers and sometimes with black-brown (119) chevrons or streaks. Rest of underparts, white. **Tail** Mostly retained from non-breeding but in some cases t1 replaced: black-brown (119) with rufous (40) outer edge and tip. **Wing** Extent of moult of wing appears related to sex and age. Like adult non-breeding but with varying number of fresh coverts; often replace longest tertials, some tertial coverts, inner greater and median coverts, and innermost or longer lesser coverts: black-brown (119) with narrow rufous (40) fringes and submarginal marks. New feathers have narrow white tips.

Adult non-breeding (Second and subsequent basic). **Head and neck** Forehead, chin, throat, supercilium and narrow eye-ring, white. Narrow line from bill to eye through lores, off-white, speckled light grey-brown (119C). Crown, nape, ear-coverts, sides of neck, small spots in front of and behind eye and narrow line below eye, light grey-brown (119C) with dark-brown (119A) shaft-streaks to feathers. **Upperparts** Mantle, scapulars, back and rump, light grey-brown (119C) with off-white fringes and dark-brown (119A) shafts to feathers. Sides of rump, white. Lateral uppertail-coverts, white. Central uppertail-coverts, brown (119B) with uniform white fringes round entire distal two thirds. Longest tail-coverts, black-brown (119). **Underparts** White with varying, incomplete brownish band on upper breast, formed by light grey-brown (119C) feathers, some of which have dark-brown (119A) shaft-streaks. Undertail-coverts, white. **Tail** Central rectrices, dark brown (119) merging to light grey-brown (119C) on t6; width and extent of white fringes on tips and inner web also increases outwards. **Upperwing** Mostly brown, with broad white wing-bar formed by white tips of inner greater coverts and white bases of inner primaries and secondaries. P1–p6, dark brown (119A) with white bases on outer webs; p7–p10, black-brown (119) on outer webs and tips with white bases on edge of inner web; basal edge of outer web of p7, white when fresh; shafts of primaries and secondaries, white except on bases of p7–p10 and at tips. Secondaries, dark brown (119A) with white bases and broad white edge to inner webs; tips fringed white when fresh; inner 1–2 secondaries almost completely white except for brown (119B) subterminal streak. Tertials, brown (119B) or brownish grey (79) with narrow white edges when fresh. When fresh, wing-coverts have narrow white tips. All lesser coverts and median primary coverts, dark brown (119A). Median secondary coverts, pale grey-brown (119C) with broad brown shaft-streaks, dark-brown (119A) shafts and broad semi-pennaceous white fringes. Alula and outer greater primary coverts, black-brown (119); inner greater primary coverts and greater secondary coverts, brown (119B) with white tips broadening toward body. **Underwing** Coverts, white, with faint brown freckling on leading-edge, formed by brown (119A) bases to some lesser and outer marginal coverts, and pale grey-brown (119D) bases to outer greater coverts. Remiges, silvery grey (85).

Juvenile Head and neck, Upperparts Feathers of crown, black-brown (119) with buff (124) fringes. Sides of crown, forehead, ear-coverts, nape, hindneck and upper mantle, pale grey-brown (119D) with faint dark-grey (119A) shaft-streaks to feathers, varying black-brown (119) patches in front of and just below eye, and dark line from lores through eye to ear-coverts. Chin and throat, white. Feathers of lower mantle and scapulars, black-brown (119) with brown (119B) central wedges and buff (124) tip divided by black-brown (119) shaft-streaks that reach edge of feather. Feathers of back and rump, light-brown (119C) with broad buff (124) or cream (54) tips, narrow black terminal bands and black-brown (119) shaft-streaks. Uppertail-coverts similar but with black-brown subterminal marks. **Underparts** Centre of upper breast, white or off-white; incomplete band of orange-buff (153) or cream (92) on upper breast and sides of upper breast; sides of lower breast, streaked with black-brown (119) or, occasionally, dark-brown (119A) terminal bands. Rest of underparts, white. **Tail** Like adult but t1 has light grey-brown (119C) outer web, large buff (124) spots forming wide pale fringes, and narrow black-brown (119) shaft-streak. **Upperwing** Differs from adult non-breeding by: tertials, black-brown (119) with light grey-brown (119C) centres and varying pale-buff (c124) spots at edges; tertial coverts and inner median coverts, light grey-brown (119C) with large buff (124) or cream (54) spots forming wide fringes, black-brown (119) shaft-streaks, and black-brown terminal bands or edges on one or both sides.

On arrival in A'asia (late Aug. and early Sept.), wear and fading have reduced markings on inner upperwing-coverts to paired off-white spots, which are diagnostic of juveniles; other pale fringes also reduced, crown appearing black (119), supercilium appears white, dark patches round eye resemble eye-stripe, and colour of breast faded to buff (124).

First immature non-breeding (First basic). Very similar to adult non-breeding; separable only by retained juvenile plumage (back, rump, tertials, some uppertail-coverts, wing-coverts and tail, and nearly all of wing), which is generally more worn and darker than non-breeding plumage of adults, and contrasts with fresh immature non-breeding plumage of rest of body. Retained worn juvenile plumage: tertials, dark brown (219) with off-white and pale-cream (54) spots, marginal and submarginal marks and spots; back and rump, light grey-brown (119D) with off-white or pale-cream (54) tips, narrow black terminal bands and dark-brown (219A) shaft-streaks; (3) some (usually inner) uppertail-coverts and wing-coverts also have black (89) terminal bands. Varying amount of tail and nearly all of wing retained, though these feathers may fade to appear dark brown (219A) near tip and brownish grey (79) at base. Some replace median upperwing-coverts; appears to occur more often in A'asian birds. Pale fringes, dark terminal bands and darker colour of replaced juvenile feathers generally distinguishable till Feb.–Mar. when excessive wear and bleaching makes them appear uniform.

First immature breeding (First alternate). Do not breed in this plumage. Poorly known but appears to vary considerably. Most A'asian birds moult outer primaries between Jan. and Apr. (Davies 1982) in first pre-supplemental moult. In Europe, and possibly some in n. Aust., may replace most of immature non-breeding plumage but retain juvenile tertials, back, rump and wing-coverts. Few A'asian birds have been reliably aged as second-year birds as these juvenile feathers are heavily worn and difficult to distinguish from retained adult non-breeding (see Moults). However, a specimen from nw. Aust. (HLW 5762) in late June had completed full moult of tail and wing and was only distinguishable from adult breeding by heavily worn wing-coverts. In Europe, individuals may be: in plumage similar to full breeding, in non-breeding, in mixture of breeding and non-breeding, or in plumage intermediate between breeding and non-breeding (e.g. upperparts light grey-brown [119C] with large black [89] subterminal spot on each feather).

BARE PARTS Based on photos (Farrand 1983; Pringle 1987; Chandler 1989) and museum labels (HLW, MV). **Adults, Immatures** Bill, black (89) or, sometimes, black-brown (119). Iris, dark brown (21, 22) to black-brown (119). Legs, black-brown (119) to grey-black (82). Inside mouth, dark grey (83). **Juvenile** Similar to adult except often have dark olive-brown (129) tinge to tarsus.

MOULTS Based on BWP, Davies (1982), Boere (1976), Underhill (1985), 380 live birds (VWSG) and examination of 30 skins (HLW, MV, SAM, WAM, QM).

Adult post-breeding (Third and subsequent pre-basic). Complete. May begin moult of body mid-July; one had begun moult 5 days before chicks hatched, which makes determination of sex based on coloration of chest difficult late in breeding season (Ferns 1978). Moult of primaries occurs rapidly when migration complete (Boere 1976). In s. Vic., few have begun moult in early Nov., with mean PMS 4.7 (11.43; 0–28; 6); in late Nov., moult advanced in most, with PMS 20.0 (10.3; 0–38; 134); on 2 Mar., most had finished, with PMS 49.2 (1.85; 38–50; 206); and nearly all had done so by 7 Mar., when PMS 49.8 (0.38; 49–50; 35) (AWSG). In South Africa, mean date of start of moult of primaries, 10 Nov. (20.7 days; 1758); mean duration of moult of primaries, 98 days (2.94; 1758); estimated date of completion of moult, 16 Feb. (Underhill 1985). **Adult pre-breeding** (Second and subsequent pre-alternate). Little data from A'asia; first adult pre-breeding moult apparently at end of second austral summer. Most have finished moult before migration from A'asia, though some may moult at stop-overs *en route*. Partial, involving head, neck, mantle, scapulars, chin, breast and, probably, all of underparts, inner tertials, and varying amount (generally sides and, occasionally, centre of back, rump and uppertail-coverts and t1 (especially in male); occasionally also some other tail-feathers). In Aust., often moult many tertial and median upperwing-coverts (some males may moult some lesser coverts; BWP). **Post-juvenile** (First pre-basic). Partial. Starts during s. migration, on mantle, scapulars and sides of breast. On arrival in A'asia, moult generally advanced, and moult of body mostly finished by mid-Nov. In A'asia, some median upperwing-coverts replaced. **Post-juvenile moult of primaries** (First pre-supplemental). Most A'asian birds appear to moult all primaries between Jan. and Apr. (Davies 1982) in what may be a first pre-supplemental moult, or do not moult primaries till first post-breeding; of four specimens taken during winter in Aust. and aged in second calendar year by presence of some worn juvenile feathering: one, in late May, had primary-moult N^{8}2^{1}V^1 (HLW 5763); two, late May and late June, had not started moult of primaries. **First pre-breeding** (First pre-alternate). Partial; mainly May–June. Those that return to breeding grounds undergo moult similar to adult pre-breeding, sometimes moulting more upperwing-coverts. Most birds spend austral winter in non-breeding areas, replacing only a little plumage, mainly on crown, sides of breast, mantle, scapulars, and uppertail-coverts, occasionally elsewhere; new feathers usually intermediate in appearance between adult breeding and adult non-breeding. **First immature post-breeding** (Second pre-basic). Complete; like adult post-breeding, but starts in July in those that remain in non-breeding areas for austral winter; also see Boere (1976).

MEASUREMENTS (1) Aust., ages combined, skins (AM, HLW, MV, QM, WAM). (2–3) Netherlands, skins (BWP): (2) Adults, boreal autumn and winter, breeding grounds not known; (3) Juveniles, Aug.–Mar.

		MALES	FEMALES	
WING	(1)	123.3 (3.20; 120–129; 12)	125.0 (2.41; 121–128; 20)	ns
	(2)	124 (1.99; 122–128; 17)	129 (1.89; 126–132; 28)	**
	(3)	123 (1.87; 119–126; 25)	126 (1.90; 123–130; 30)	**
TAIL	(1)	48.8 (2.12; 45–53; 33)	47.6 (2.25; 41–51; 33)	ns
	(3)	47.1 (1.31; 45–49; 16)	48.3 (1.17; 46–51; 17)	*
BILL	(1)	24.1 (1.62; 22.1–27.5; 18)	25.6 (1.17; 23.6–28.6; 11)	**
	(2)	24.4 (1.36; 21.7–27.3; 38)	25.7 (1.10; 24.2–27.8; 55)	**
TARSUS	(1)	24.6 (0.48; 23.6–25.1; 12)	25.3 (1.02; 23.8–27.8; 20)	*
	(2)	24.3 (0.84; 22.8–25.4; 25)	25.2 (0.93; 23.8–27.9; 38)	**
TOE C	(1)	18.5 (0.88; 17.5–20; 11)	19.0 (1.18; 17.2–21.8; 19)	ns

Females larger than males in all measurements. In Netherlands, wing and tail of juveniles significantly shorter ($P<0.05$) than those of adults; bill similar from mid-Sept.; tarsus and toe from Aug. (BWP).

(4–5) Aust., adults and immatures (latter mostly with worn primaries): (4) Live (AWSG); (5) Skins (AM, HLW, MV, QM, WAM).

		ADULTS	IMMATURES	
WING	(4)	128.0 (3.71; 116–137; 318)	124.6 (2.98; 117–130; 23)	**
	(5)	125.5 (2.74; 122–128; 6)	124.5 (3.45; 121–130; 6)	ns
TAIL	(5)	48.8 (1.47; 47–51; 6)	47.0 (2.10; 44.0–50.0; 6)	ns
BILL	(4)	24.9 (1.50; 21.3–29.7; 379)	25.0 (1.34; 23.5–28.0; 24)	ns
	(5)	24.8 (1.43; 23.3–27.0; 7)	25.9 (0.74; 25–26.9; 7)	ns
THL	(4)	50.4 (1.97; 39.8–60.5; 379)	50.4 (1.49; 47.0–53.5; 24)	ns
	(5)	49.2	51.2	**
TARSUS	(5)	24.7 (1.33; 23.4–26.6; 6)	25.1 (0.85; 24.0–26.3; 6)	ns
TOE C	(5)	19.0 (1.01; 17.5–20.0; 6)	19.5 (0.82; 18.3–20.5; 6)	ns

Wing and tail of juveniles significantly shorter than those of adults. In a small sample, tarsus and toe longer in juveniles than in adults. Length of wing apparently decreases with wear;

in Aust. samples above, on birds with worn primaries, wing 3–5 mm shorter than those with fresh primaries (though no birds were measured in which tips of primaries were broken). Additional Aust. data in Jessop (1992). For data from South Africa, see Summers *et al.* (1987). For additional measurements, see BWP.

WEIGHTS (1) Aust., all ages, skins collected austral summer (AM, HLW, MV, QM, WAM). (2) Netherlands, all ages, boreal winter (BWP).

	MALES	FEMALES	
(1)	49.0 (8.19; 36–56; 5)	60.0 (7.58; 53–76; 9)	*
(2)	60.7 (8.14; 49–70; 6)	60.5 (5.74; 55–70; 5)	ns

Unsexed: (3) S. Vic., live.

		UNSEXED	
		ADULTS	IMMATURES
First week Nov.	(3)	54.3 (4.93; 48–60; 6)	–
Fourth week Nov.	(3)	56.6 (4.28; 48–68; 134)	57.9 (3.52; 51–64; 23)
First week Mar.	(3)	60.7 (4.57; 50–74; 206)	–
Second week Mar.	(3)	61.0 (4.95; 52–72; 35)	–

Gradual increase in weights through austral summer, with greatest weight just before migration. Only significant change in weight between Nov. and second week of Mar. ($P<0.01$). In South Africa, weight differs significantly between months and ages (see Summers & Waltner 1979; Summers *et al.* 1987). Calculation of body fat and flight-ranges from weights discussed by Castro & Myers (1989, 1990).

STRUCTURE Wing, long, narrow and pointed. Eleven primaries: p10 longest, p9 1–4 mm shorter, p8 7–11, p7 16–21, p6 25–29, p5 36–39, p4 44–49, p3 52–55, p2 57–62, p1 64–68; p11 minute, concealed by lesser primary coverts. Longest tertials reach tip of p5–p8. Fourteen secondaries including four tertials. Tail short; 12 feathers, t1 projects 4–5 mm. Bill, straight; 0.88–1.1 times length of head; deep at base and laterally compressed; distal one-eighth slightly flattened abruptly, forming sharp tip. Leg, short, *c.* 9 mm of lower tibia generally exposed. Toes rather short and flattened on soles; scutellate. Unlike all other scolopacids, hindtoe usually absent, occasionally rudimentary (BWP); outer toe *c.* 87% of middle, inner 82%.

AGEING Wear and moult of primaries can be used, as in most other Aust. *Calidris* (e.g. Red-necked Stint, q.v.). See Field Identification.

GEOGRAPHICAL VARIATION Slight but poorly known; brightness of fresh breeding plumage and length of wing and bill varies. Populations breeding Greenland, smallest; populations breeding Canada and w. Siberia, largest; populations breeding e. Siberia (which assumed to migrate to A'asia) intermediate in size between those breeding Canada and Greenland, though with shorter wings; for further discussion, see BWP.

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Broad-billed Sandpiper *Limicola falcinellus* (page 333)
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Sanderling *Calidris alba* (page 237)
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