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, Procellariiformes, penguins, grebes, divers (Gaviidae) and also Falconiformes. All these were combined in huge order Ciconiiformes by Sibley & Ahlquist (1990).

Taxonomy and relationships reviewed in Sibley & Ahlquist (1990), Christian *et al.* (1992) and BWP (and references therein). Recent reviews have included: patterning of downy young (Jehl 1968; Fjeldså 1976, 1977), osteology (Strauch 1978; Mickevitch & Parenti 1980; Olson & Steadman 1981), DNA–DNA hybridization (Sibley *et al.* 1988, Sibley & Ahlquist 1990) and electrophoresis of tissue proteins (Christian *et al.* 1992). The studies of allozymes, DNA–DNA hybridization and the most recent osteological study of the entire order (Strauch 1978) have agreed in finding two or three well-knit, monophyletic assemblages within the Charadriiformes: scolopacids and allies (Thinocoridae, Pedionomidae, Scolopacidae, Rostratulidae, Jacanidae) and 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 alpina   **Dunlin**

Tringa alpina Linnaeus, 1758, *Syst. Nat.*, ed. 10(1): 149 — Lapland.

The specific epithet is directly from the Latin *alpinus* and refers to its alpine breeding habitat.

The English name refers to the colour dun (greyish-brown) and its small size (the suffix *-ling*).

OTHER ENGLISH NAMES   Red-backed Sandpiper; Blackcrop.

POLYTYPIC   Nominate *alpina* breeds n. Scandinavia and nw. Russia; subspecies *schinzii* (Brehm, 1822), Iceland, British Isles, E to Baltic, and N to s. Scandinavian coasts; subspecies *arctica* (Schiøler, 1922), ne. Greenland; subspecies *sakhalina* (Vieillot, 1816), ne. Siberia; subspecies *kistchinski* Nechaev & Tomkovich 1988, Kamchatka, nw. coast of Sea of Okhotsk and n. Kurile Is; subspecies *actites* Nechaev & Tomkovich 1988, n. Sakhalin I.; subspecies *pacifica* (Coues, 1861), s. Alaska; subspecies *arcticola* (Todd, 1953), n. Alaska; subspecies *hudsonia* (Todd, 1953), North West Territories, Canada. Subspecies occuring HANZAB region not known; *sakhalina* and *pacifica* most likely.

FIELD IDENTIFICATION Length 16–22 cm; wingspan 33–40 cm; weight *c*. 60 g. Small wader, with short neck, wings and legs and characteristically hunched jizz; short to medium-length bill, which droops near tip; and short legs. At rest, folded primaries level with tip of tail; primary projection moderate to long in adults and juveniles. Much variation in size and length of legs and bill; smallest often have short legs and short almost straight bill; largest have long legs and long decurved bills. Slightly smaller than Curlew Sandpiper *Calidris ferruginea* but with bigger head and shorter neck, wings and legs, which combine with hunched stance to give distinctive, dumpy jizz, quite different from slim, elegant appearance of Curlew Sandpiper; also, bill averages shorter and is heavier and straighter; always bigger than stints. Much variation in plumage (especially breeding plumage); this text describes subspecies *sakhalina* and *pacifica*, the two most likely to occur in HANZAB area. Adult in breeding plumage, distinctive, with chestnut cap and variegated chestnut and black upperparts; white neck and breast, boldly streaked with black; and rest of underparts, white, except for unique black patch on belly. Juveniles have diagnostic lines of dark spotting on sides of belly and flanks. In flight, all plumages show prominent white wing-bar and white sides to dark-centred rump and uppertail-coverts. Sexes differ in size and sometimes in breeding plumage, though sexing difficult unless race known: female larger and longer-billed. Marked seasonal variation. Juvenile distinctive. Immatures separable.

Description Adult breeding Centre of forehead, and crown, bright chestnut, boldly streaked black. Sides of head and neck, white and streaked black except for white supercilium (which is not prominent against pale head), diffuse dusky loral stripe, often broadening into smudge in front of eye, and diffuse brownish patch on ear-coverts (indistinct or absent on some), separated from eye by pale area. Chin and throat, white. Nape and hindneck vary: in male, typically white, finely streaked darker, as rest of head and neck; ground-colour darker brown in female. Mantle, scapulars and often some inner tertials, bright chestnut with irregular black markings producing distinctive red-backed appearance at distance; in some, lower scapulars unmarked, chestnut; also, when fresh, many scapulars and new inner tertials have paler buff or white tips, giving spangled appearance above. Outer tertials and all innerwing-coverts, retained from non-breeding, worn, grey-brown, contrasting with rest of upperparts. Foreneck and breast, white, with fine black streaks that become broader and bolder on breast. Rest of underbody, white, with diagnostic solid black patch on belly; in some, black streaking on breast meets patch on belly. In flight: show striking contrast between bright-chestnut saddle and brownish-grey innerwing-coverts; slightly darker rest of upperwing, except for prominent white wing-bar; broad blackish line through centre of rump and narrower line through central uppertail-coverts, contrasting with white sides of rump and coverts and black central tail-feathers, with paler brownish-grey rest of tail. Underwing, white except for narrow band of dark mottling along leading-edge of lining, greyish primary coverts, and diffuse narrow greyish trailing-edge. Bill, black. Iris, dark brown. Legs and feet, black or blackish grey. **Adult non-breeding** Differ from adult breeding by: Head, hindneck and sides of neck, plain brownish-grey and finely streaked darker, except for clean white chin and throat; slightly darker, diffuse dusky loral stripe, typically broadening into smudge in front of eye; and varying but usually fairly clear off-white supercilium, which is clearest in front of and above eye but often suffused grey and finely streaked darker behind

eye; some also show diffuse pale area round bottom of eye, paler than rest of cheeks and joining with supercilium to produce effect of broad diffuse pale eye-ring. Mantle, scapulars, tertials and innerwing-coverts, plain brownish-grey with fine dark shafts; tertials and some larger scapulars have faintly darker grey centres but these do not give patterned appearance to upperparts; typically, when fresh, all feathers finely fringed white, though a very few have narrow buff fringes to innerwing-coverts and tertials. Foreneck and breast strongly suffused brownish grey with fine dark streaking (boldest on sides of breast), giving distinctly dark-chested appearance against clean white rest of underbody; in some, centre of breast paler, while in others, wash and streaking extend onto anterior flanks. With wear, upperparts become browner and fine white fringes lost. **Juvenile** Resembles duller version of adult breeding, differing by: Cap, reddish brown, coarsely streaked black; rest of head and neck, paler, buffish brown and finely streaked darker, grading to white on chin and throat; otherwise like non-breeding, with dusky loral stripe, warmer reddish-brown patch on rear ear-coverts, and indistinct paler buff or off-white supercilium; some also have suggestion of broad diffuse pale eye-ring. Mantle and scapulars, black, with chestnut fringes grading to white on tips of feathers of outer mantle and outer scapulars; pale tips form usually clear white mantle V and, often, weaker second line on lower scapulars. Tertials paler than rest of upperparts, dark brownish-grey with clear whitish-buff fringes and black shafts merging to small blackish subterminal mark. Innerwing-coverts as tertials but paler, brownish grey with black subterminal markings only on inner few median and greater coverts. Foreneck and upper breast, buffish brown with coarse black streaking, broadest on sides. Rest of underbody, white, with black streaks of breast merging to diagnostic lines of blackish-brown spots on sides of upper belly and flanks. Juvenile plumage distinct in field to at least late Oct. With wear, chestnut and buff fringes of upperparts and innerwing-coverts fade to paler buff and are much reduced. **First immature non-breeding** Distinguished from very similar adult non-breeding by retained pale-fringed juvenile innerwing-coverts and tertials contrasting with fresh brownish-grey rest of upperparts; a few adults have narrow buff fringes to innerwing-coverts but lack more prominent black shafts and small black subterminal marks of juveniles which are normally obvious on tertials and often present on inner-most median and greater coverts, even on well-worn feathers. **First immature breeding** Varies greatly. Many attain full breeding plumage similar to adult breeding; others retain plain grey first non-breeding plumage except for scattered feathers on crown, mantle, scapulars and belly, which may be breeding feathers or have pattern intermediate between breeding and non-breeding; these have mainly grey upperparts (with black feather centres but little or no chestnut) and well-streaked foreneck and breast and large black patch on belly as adult breeding.

Similar species Black patch on belly of adult breeding, unique; also, lines of black spotting along sides of belly and flanks of juvenile distinctive among small sandpipers. Most likely to be confused in non-breeding plumage, when plain grey upperparts, size, general shape and long decurved bill like non-breeding **Curlew Sandpiper** (see that text for differences). In non-breeding and juvenile plumages, **Broad-billed Sandpiper** *Limicola falcinellus* superficially similar but is much smaller (closer to stints than to Curlew Sandpiper); has distinctive straight bill abruptly kinked down near tip; bill and legs are not black: black bill often tinged paler, green or brown and

sometimes has small pale area at base of lower mandible; legs are paler, blackish grey, often tinged green, brown or yellow. In non-breeding plumages, further distinguished by more prominent white split supercilium; paler grey upperparts which, unlike Dunlin, are often patterned by dark feather centres; and blackish shoulder patch. Juvenile darker above, with more contrasting head-pattern, including well-marked split supercilium; has well-streaked chest and indistinct brownish spotting extending onto anterior flanks but lacks bold blackish-brown lines of spotting on sides of belly and flanks. In non-breeding plumages, might also be confused with much smaller **Western Sandpiper** *Calidris mauri* (q.v.).

Gregarious in normal range, often in large flocks; mix freely with other waders when feeding and roosting; only solitary vagrants known from HANZAB area. In non-breeding season, favour estuarine mudflats but also occur on wide variety of freshwater and brackish wetlands, both coastal and inland, including sewage farms and commercial saltworks. Gait similar to other small congeners. When feeding on muddy shore, move slowly with characteristic head down, round-shouldered carriage and with legs flexed, pecking and probing vigorously in rapid series, often interspersed with short runs; feed at edge of water on wet mud, and wade into shallows. Combination of long gently decurved bill; large well-rounded head hunched into dumpy body; short wings level with tip of tail; and short legs; give characteristic hunched jizz. Rarely adopt upright posture on ground, except when alarmed. Flight typical of genus, rapid and agile, similar to that of Curlew Sandpiper and other small *Calidris*, though wing-beats slower than those of stints; feet do not project beyond tip of tail in flight (cf. Curlew Sandpiper). In normal range, large flocks perform coordinated aerial manoeuvres with rapid changes of direction. Usual flight call a distinctive, slurred, reedy, *kreee*, *treeep* or *cheeezp* with somewhat insect-like buzzing quality.

HABITAT   During non-breeding period, sheltered coasts with large mudflats; estuaries, coastal lagoons, swamps and saltpans; occasionally farther inland at edges of lakes and dams, in flooded fields and sewage ponds (AOU 1983; Urban

et al. 1986; BWP). In Aust., single record of bird roosting and feeding on large intertidal mudflats (Roberts 1983). In NZ, recorded in sheltered harbours and embayments, round intertidal mudflats and sandy shell banks at edges of tidal pools; seen roosting on dry sand among scattered clumps of sedges (Brown 1975; Habraken 1980).

DISTRIBUTION   Breed Eurasia and North America: British Isles, n. Germany, Scandinavia, Baltic countries, and in Russia from Kola and Kanin Pens and s. Novaya Zemlya, E through Gyda and Taymyr Pens, mainly N of 69°N, to Chukotskiy Pen. and Wrangel I., S along coast of Bering Sea and Sea of Okhotsk, round Kamchatka to n. Kurile Is and Magadan region; also n. Sakhalin I.; w. and n. Alaska, rarely, S to s.-coastal regions; ne. Mackenzie; from s. Somerset I., S through ne. Keewatin, Southampton I. and ne. Manitoba to n. Ontario, round C. Henrietta Maria; also e. Greenland and Iceland. Spend non-breeding period in n. hemisphere; straggler S of Equator. Occur Europe and Africa, British Isles, countries in North Sea, coasts of Mediterranean, and along Nile R.; along Atlantic coast S to Guinea; vagrant to rare in Nigeria, Somalia and Ethiopia, rarely S to Burundi, Uganda, Kenya, and accidental to South Africa; along coast of Red Sea, coastal Arabia and s. Iran, E to w. Indian subcontinent; also coasts from Sea of Japan, S through e. China and n. Vietnam to South China Sea; infrequently W to Bay of Bengal; occasionally in se. Asia; unconfirmed record from Timor. In North America, winter along Pacific coast from se. Alaska to Baja California and Sonora, Mexico; on Atlantic—Gulf of Mexico—Caribbean coast, between Massachusetts and Yucatan Pen., Mexico; uncommonly in Hawaii; vagrant to w. Nicaragua and posibly Panama. Accidental to A'asia (Dement'ev & Gladkov 1951; McKean *et al.* 1975; Blake 1977; AOU 1983; Urban *et al.* 1986; White & Bruce 1986; BWP; P.S. Tomkovich).

Aust.   Single accepted record: Cairns, Qld, 4 Jan. 1983 (Roberts 1983; RAC). About 20 other records, either unacceptable or retracted: **Qld** 'Three or four [specimens]', which cannot be found, Claremont Is, 12–13 Apr. 1885 (Hindwood 1944); three records from Cairns: 'several', 10 Dec. 1971 (Fien
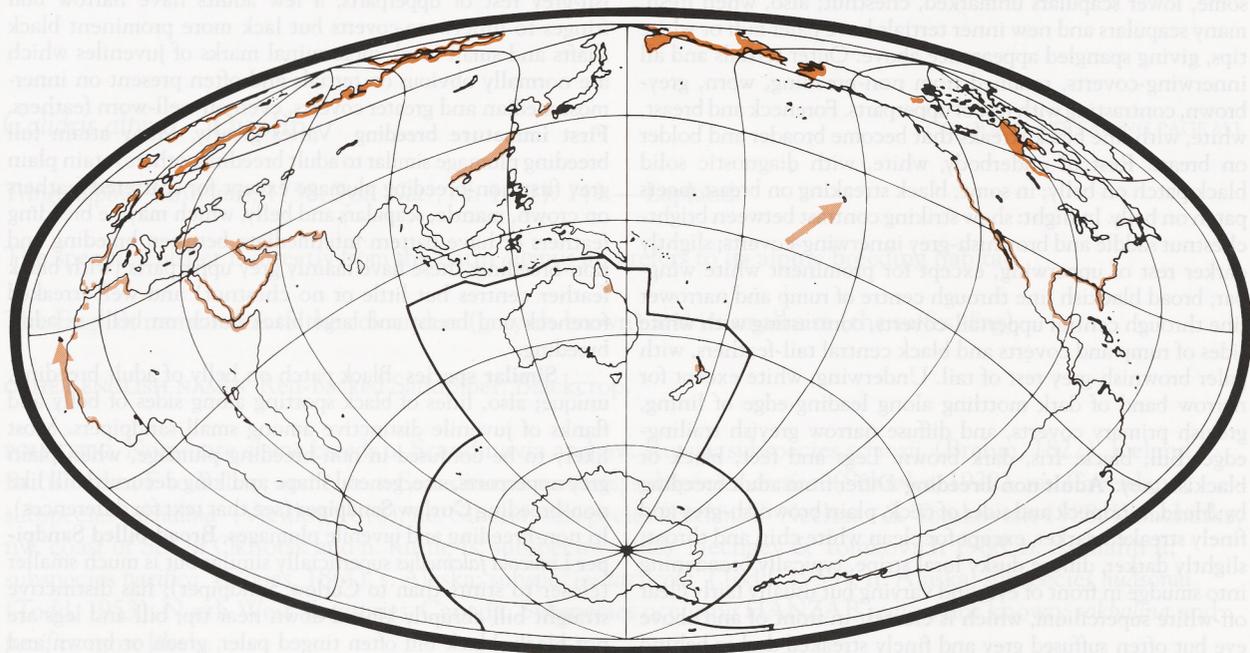
1972); single, 3 and 18 Dec. 1977 (Lindsey & Lindsey 1978; RAC). **Vic.** All retracted (Smith 1981; Sympson 1985; see hybrid *Calidris* sandpipers); all round Port Phillip Bay (singles unless stated): Carrum, 14 Nov. 1970 (Smith 1972a,b); Altona: 27 Jan. 1955 (Wheeler 1957; Smith 1969); 10 Apr. 1955, 10 Sept. 1967, 25 Nov. 1967, 3 Mar. 1968 (Smith 1969); 28 Mar. 1971 (Smith 1972a,b); Laverton, 24 Dec. 1967 (Sympson 1968); Werribee, 5 Oct. 1969 (Smith 1970, 1972a,b); Geelong Saltworks, 20 Dec. 1970 (Smith 1972a,b); Melbourne–Geelong district, 1 Dec. 1974 (Wheeler 1975). **Tas.** Three, Barilla Bay–Orielton Lagoon–Lauderdale, Sept.–Oct. 1966 (Thomas 1969). **SA** Single, ICI Saltworks, St Kilda, 23 Aug. 1970 (Lendon 1971); two, near Ardrossan, 11 Oct. 1975 (McKean 1976; RAC). **WA** Single, Stokes Inlet, Esperance, 23 Apr. 1985 (Anon. 1985).

NZ Singles: Tapora, Kaipara Harbour, 24 Feb. 1974 (Brown 1975); Taramaire, Firth of Thames, 12 Mar. 1977 (Brown 1979); Miranda, Firth of Thames, 29 Mar. 1977 (Brown 1979); Karaka Shellbanks, Manukau Harbour, 23–28 June 1979 (Habraken 1980). Two unacceptable records of single birds in Manukau Harbour, at Puketutu, 19 Nov. 1969 and Karaka, summer 1969–70 (McKenzie et al. 1971).

MOVEMENTS Migratory, though less so than most *Calidris* (Hayman et al. 1986). Breed n. temperate and arctic Europe, arctic and subarctic Siberia, Alaska, Canada, Greenland and Iceland. Move to non-breeding areas on most ice-free coasts of n. hemisphere; few S of c. 15°N; straggler S of Equator (BWP). At least three subspecies breed and migrate along e. Asian coast. Origins of Aust. and NZ birds unknown, probably from populations breeding ne. Siberia (Smith 1969; Falla et al. 1981) and which discussed below. For details of other migratory populations, see BWP.

Departure Late June (Kamchatka) or mid-July (more n.

populations) to end Sept.; females leave first, then males (P.S. Tomkovich), then juveniles. In Ussuriland, main passage begins Aug. and usually continues till mid-Sept., occasionally as late as Oct. Common in Japan, with main passage early to mid-Sept. (Dement'ev & Gladkov 1951; Orn. Soc. Japan 1974); and in Korea, particularly numerous Sept.–Oct. (Gore & Won 1971). Pass Beidaihe, China, mainly between late Sept. and late Oct.; common in se. China, passing Lower Yangtse in Oct.–Nov. (la Touche 1931–34; de Schauensee 1987; AWB 1993) and recorded from late Oct. in Hong Kong (Chalmers 1986). Recorded from s. Vietnam and Malay Pen. (King et al. 1975). Unconfirmed reports, probably subspecies *sakhalina*, from Borneo (Smythies 1981), Sulawesi (Escott & Holmes 1980), Sumatra (van Marle & Voous 1988), Java (Bowler et al. 1985) and Timor (McKean et al. 1975). Also scattered records from w. Micronesia (Pratt et al. 1987). Not recorded New Guinea (Beehler et al. 1987).

Non-breeding Extralimitally, from Sea of Japan to South China Sea, infrequently in Bay of Bengal (BWP). Vagrant to NZ and Aust.

Return Extralimitally, not recorded in Hong Kong after early Mar. (Chalmers 1986); pass through Lower Yangste, China, Apr. and May (la Touche 1931–34), through Korea in Apr. (Gore & Won 1971). N. migration route in Russia apparently mainly E of Ussuriland, probably through Japan, where large flocks in May. Arrive in parts of ne. Siberia in late May (Dement'ev & Gladkov 1951; Kondratiev 1982; AWB 1993).

Breeding Extralimitally, most 1-year-old birds return to breeding grounds, though some remain in non-breeding areas throughout boreal summer (BWP). One winter record for HANZAB region: NZ, late June to Sept. (Habraken 1980).

Banding Extralimital recoveries confirm movement of subspecies *sakhalina* along e. Asia coast (Norton 1971; McClure 1974; Chuang 1992).
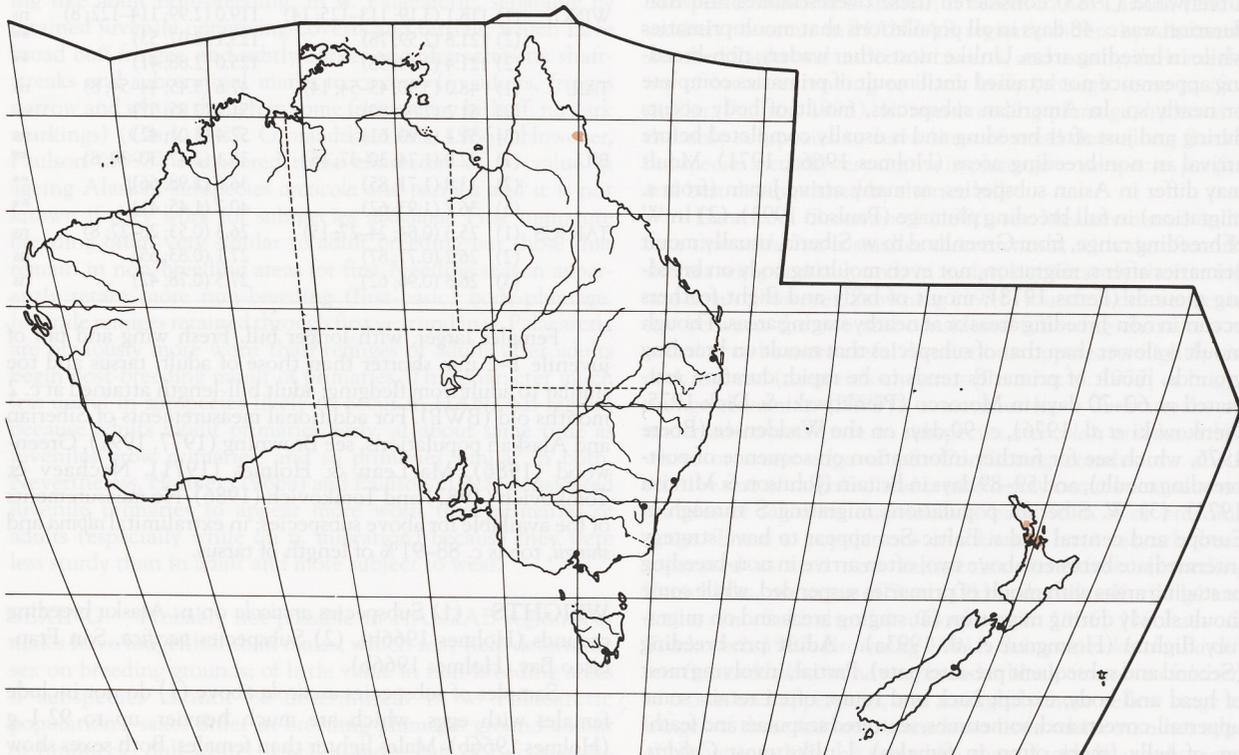
PLUMAGES   Prepared by D.I. Rogers. Insufficient material in Aust. or NZ museums to prepare full texts on plumages and related matters; see BWP for full details. Not know which subspecies occur HANZAB region; most likely *sakhalina*, *arcticola* or *pacifica*, which breed from e. Siberia to Alaska. In these subspecies, much partial post-juvenile (first pre-basic) moult to first immature non-breeding can occur before leaving breeding grounds. Most attain full breeding plumage in partial first pre-alternate moult just before n. migration and breed in first year; others appear to develop less breeding plumage, remain in non-breeding areas, and do not breed in first breeding season. Adult non-breeding plumage first attained in complete second pre-basic moult when *c.* 12 months old. Thereafter, moult twice annually: a partial pre-alternate moult to breeding plumage before n. migration; and a complete pre-basic moult to non-breeding appearance mostly on or near breeding areas (few other *Calidris* moult all primaries on breeding grounds). Moult-strategy differs in some other subspecies.

MOULTS   Based on BWP, Greenwood (1983), Holmes (1966a, 1971) and Holmgren (1993a).

Adult post-breeding (Second and subsequent pre-basic). Complete; primaries outwards. Timing in relation to s. migration varies with breeding locality; three general strategies exist: (1) In Siberia (e. of Yenisei valley), Alaska and ne. Canada, subspecies *sakhalina*, *arcticola*, *pacifica* and *hudsonia* moult all primaries on or near breeding grounds before s. migration. This moult-strategy rare in *Calidris* (see Scolopacidae introduction). In most of these populations, moult of primaries overlaps with breeding, beginning during laying in mid- to late June and finished by late Aug.; in w. Alaska, begins end of June, after laying, and finished on coast near breeding grounds after young have fledged. Moult of primaries rapid; Holmes (1966a, 1971) gave duration for subspecies *arcticola* as 60–70 days and for w. Alaskan subspecies *pacifica* as *c.* 97 days; Greenwood (1983) considered these overestimates and that duration was *c.* 48 days in all populations that moult primaries while in breeding areas. Unlike most other waders, non-breeding appearance not attained until moult of primaries complete or nearly so. In American subspecies, moult of body occurs during and just after breeding and is usually completed before arrival in non-breeding areas (Holmes 1966a, 1971). Moult may differ in Asian subspecies, as many arrive Japan (from s. migration) in full breeding plumage (Paulson 1993). (2) In W of breeding range, from Greenland to w. Siberia, usually moult primaries after s. migration, not even moulting body on breeding grounds (Ferns 1978); moult of body and flight-feathers occurs in non-breeding areas or at nearby staging areas. Though moult is slower than that of subspecies that moult on breeding grounds, moult of primaries tends to be rapid; duration estimated at 60–70 days in Morocco (Pienkowski & Dick 1975; Pienkowski *et al.* 1976), *c.* 90 days on the Waddensee (Boere 1976, which see for further information on sequence of post-breeding moult), and 59–89 days in Britain (Johnson & Minton 1973). (3) W. Siberian populations migrating S through e. Europe and central and s. Baltic Sea appear to have strategy intermediate between above two; often arrive in non-breeding or staging areas with moult of primaries suspended, while some moult slowly during migration (at staging areas and on migratory flights) (Holmgren *et al.* 1993a). **Adult pre-breeding** (Second and subsequent pre-alternate). Partial, involving most of head and body, except back and rump; often retain some uppertail-coverts and, sometimes, scattered scapulars and feathers of belly (more often in females). Unlike most *Calidris*,

usually retain all feathers of upperwing, though a few moult inner tertials or a few median upperwing-coverts. In most subspecies, moult occurs immediately before or during n. migration; about Apr. in w. North America (Holmes 1966a; Paulson 1993); no detailed information on timing for subspecies *sakhalina*. Schedules can differ between subspecies, e.g. on staging area at Severn Estuary, Britain, subspecies *alpina* undergoes whole pre-breeding moult but *arctica* and *schinzii* arrive in full breeding plumage (Ginn & Melville 1983). **Post-juvenile** (First pre-basic). Partial; similar in extent to adult pre-breeding. Mainly from late Aug. to Oct. (BWP); in Alaska, usually starts on breeding grounds and many have attained immature non-breeding appearance on arrival in non-breeding areas by late Sept.–early Oct. (Holmes 1966a, 1971; Paulson 1993). **First immature pre-breeding** (First pre-alternate). Usually similar to adult pre-breeding, at least in those that return to breeding grounds in first year. The few that remain in non-breeding areas during breeding season (assumed to be immatures in first alternate) often retain much non-breeding body plumage (Paulson 1993). **Immature post-breeding** (Second pre-basic). In w. Palaearctic, occurs slightly earlier than adult post-breeding (Boere 1977; Holmgren *et al.* 1993); not known if this applies to subspecies that moult all primaries before leaving breeding grounds.

MEASUREMENTS   (1–3) Skins, ages combined (Greenwood 1986; BWP): (1) Subspecies *sakhalina*, e. Siberia W to Yenisei Valley (said not to include individuals from e. Siberian populations sometimes treated as subspecies *kistchinkski* and *actites* [Browning 1991]); (2) Subspecies *arcticola*, n. Alaska, S to Brooks Ra.; (3) Subspecies *pacifica*, s. Alaska, N to C. Prince of Wales.

		MALES	FEMALES	
WING	(1)	118.1 (3.19; 113–125; 14)	119.0 (2.99; 114–122; 8)	ns
	(2)	121.8 (2.59; 78)	125.1 (2.07; 53)	**
	(2)	121.4 (2.44; 58)	125.0 (2.88; 41)	**
TAIL	(1)	48.0 (3.90; 43–54; 14)	47.6 (3.45; 44–54; 8)	ns
	(2)	51.2 (2.88; 80)	51.7 (2.85; 57)	ns
	(3)	51.4 (2.90; 61)	52.4 (3.01; 42)	ns
BILL	(1)	32.0 (1.74; 30–37; 15)	35.1 (2.47; 30–39; 8)	**
	(2)	33.8 (1.71; 85)	36.6 (1.98; 66)	**
	(3)	36.7 (1.93; 62)	40.2 (1.45; 41)	**
TARSUS	(1)	25.6 (0.84; 24–27; 15)	26.3 (0.53; 26–27; 8)	ns
	(2)	26.2 (0.77; 87)	27.1 (0.83; 65)	ns
	(3)	26.6 (0.96; 62)	27.5 (0.78; 42)	ns

Females larger, with longer bill. Fresh wing and tail of juvenile 1–2 mm shorter than those of adult; tarsus and toe similar to adult from fledging; adult bill-length attained at *c.* 2 months old (BWP). For additional measurements of Siberian and Alaskan populations, see Browning (1977, 1991), Greenwood (1986), MacLean & Holmes (1971), Nechaev & Tomkovich (1987) and Tomkovich (1986). No measurements of toe available for above subspecies; in extralimital *alpina* and *shinzii*, toe is *c.* 88–91% of length of tarsus.

WEIGHTS   (1) Subspecies *arcticola* on n. Alaska breeding grounds (Holmes 1966b). (2) Subspecies *pacifica*, San Francisco Bay (Holmes 1966b).

Samples of subspecies *arcticola* above (1) do not include females with eggs, which are much heavier, up to 92.1 g (Holmes 1966b). Males lighter than females. Both sexes show

	MALES	FEMALES	
Early June	(1) 55.0 (29; 46.5–65; 55)	61.5 (1.15; 56.5–74; 15)	ns
Mid-June	(1) 53.5 (4.78; 42–60.5l 33)	59.5 (11.25; 55–66; 9)	*
Late June	(1) 56.0 (3.43; 47–61.5; 21)	60.5 (5.01; 55–65; 10)	**
Early July	(1) 55.5 (2.65; 50–60; 18)	60.5 (7.51; 58–73.5; 13)	*
Mid-July	(1) 53.5 (1.05; 50–60; 13)	58.5 (1.86; 48–66.5; 31)	**
Late July	(1) 53.0 (1.38; 48.5–58.5; 30)	57.0 (18.86; 49.5–64; 32)	ns
Early Aug.	(1) 55.0 (1.23; 48–64; 26)	58.5 (18.63; 54–64; 20)	ns
Mid-Aug.	(1) 57.0 (2.29; 50–65; 21)	63.0 (11.30; 56–74; 15)	*
Late Aug.	(1) 62.5 (8.82; 56–66; 7)	68.5 (14.2; 56.5–77; 6)	ns
Sept–early Oct.	(2) 53.6 (3.32; 48.7–58.7; 11)	63.5 (8.94; 50.3–73.6; 5)	**
Mid-Oct.	(2) 52.5 (3.98; 47.7–61.1; 11)	59.3 (5.96; 47.5–70.0; 21)	**
First half Nov.	(2) 53.1 (1.00; 44.7–59.1; 25)	57.7 (1.08; 51.7–64.0; 13)	**
Dec.–Jan.	(2) 56.5 (0.95; 50.9–58.3; 10)	58.1 (1.20; 51.7–63.7; 16)	**
First half Apr.	(2) 53.8 (0.95; 50.9–58.3; 10)	57.4 (0.99; 53.6–63.4; 11)	**
Last half Apr.	(2) 65.2 (4.16; 60.0–72.2; 6)	70.8 (9.95; 53.7–85.1; 11)	ns

slight decrease in weight about July, attributed to onset of intense post-breeding moult; weights increase significantly by late Aug. before s. migration. Average weights of breeding subspecies *pacifica*: males 53.4 (n=140), females 59.4 (n=67); of breeding subspecies *hudsonia*: males 53.5 (n=24), females 54.5 (n=13) (MacLean & Holmes 1971). Few data for Asian subspecies but may be lighter; breeding males: subspecies *sakhalina* 48.6 (42–55); subspecies *kistchinski* 45.8 (43.7–46.8); subspecies *actites* 35.5, 36.6, 40.2 (Browning 1991). Changes in weight in non-breeding subspecies *pacifica* appear similar to those of subspecies that moult in non-breeding areas; weights fairly stable after slight decline on arrival, with rapid increase before migration. Additional information in Goede & Nieboer (1983), Davidson *et al.* (1986), Goede *et al.* (1990), Holmgren *et al.* (1993b), BWP, and references therein.

AGEING Difficult to age after post-juvenile (first-basic) moult complete. From Oct. to Mar., first immature non-breeding like adult non-breeding. In w. Palaearctic, separable by retained juvenile upperwing-coverts and tertials, which have broad buff fringes, and subtly darker and characteristic shaft-streaks and subterminal marks to coverts (in adults, fringes narrow and white, though in some fringes may be buff; no dark markings) (Clark 1987; Gromadzka 1985, 1986). However, Paulson (1993) considered these characters of no value in ageing Alaskan subspecies *arcticola* and *pacifica* and it is not known if they work for subspecies *sakhalina*. First immature breeding often very similar to adult breeding but those that remain in non-breeding areas for first breeding season apparently retain more non-breeding (first-basic) body-plumage. Juvenile remiges retained through first year and in w. Palaearctic are obviously more worn than remiges of adults after adults begin post-breeding moult of primaries. This character much less useful in subspecies likely to occur in HANZAB region, because adults moult primaries early, at about same time as juveniles grow primaries, and so primaries similar in both. Nevertheless, Holmes (1966a) and Paulson (1993) considered juvenile primaries to appear more worn than primaries of adults (especially while on n. migration) because they were less sturdy than in adult and more subject to wear.

SEXING Probably not possible in HANZAB region. Females have longer bill than males, which may help determine sex on breeding grounds; of little value in non-breeding areas if subspecies cannot be determined. In w. Palaearctic populations, sexes differ in breeding plumage: ground-colour of hindneck, dull-white in males, more buff or rufous in fe-

males; females also tend to have broader grey tips to feathers of mantle and scapulars, and broader white tips to black feathers of belly. These distinctions apparently less clear in e. populations; determining sex on plumage was not reliable on breeding birds in Yakutia and on Wrangel I. (D.I. Rogers, N. Holmgren) and Paulson (1993) made no mention of plumage when discussing sexing in nw. USA.

GEOGRAPHICAL VARIATION Marked; as many as 11 subspecies have been recognized recently; nine are recognized here, following reviews in BWP, Greenwood (1986) and Browning (1991). Diagnosis of subspecies is based mainly on colour of breeding plumage and on measurements (especially length of bill). In general terms, vary from small subspecies with dull upperparts and small black patch on belly in far W of range (Greenland–s. Scandinavia), to large and brightly coloured subspecies in American Arctic. Role of Pleistocene glacial refuges in evolution of geographical variation discussed by Greenwood (1986), but variation in moult-schedules has not been explained. Except where stated, differences in plumages are for breeding plumage.

Descriptions in Field Identification summarize general appearance of subspecies *pacifica* (s. Alaska), *sakhalina* (e. Siberia) and *arcticola* (n. Alaska). These are large subspecies, with rich chestnut fringes to feathers of crown, mantle and scapulars, large black patch on belly, and much white on outer web of outer primaries; adults moult primaries while on breeding grounds. Morphological differences between the three are slight; *pacifica* has significantly longer bill and tarsus than the others (see Measurements); fringes of feathers of mantle and scapulars, slightly darker chestnut (though this of little value in subspecific identification as upperparts of all subspecies fade and develop more yellow tinge when worn); some have faint dark streaking on undertail-coverts; usually dark streaking of upper breast is separated from black belly by white band. Subspecies *hudsonia* is similar; it breeds in ne. Canada (and is unlikely to occur in HANZAB region; differs by: distinctly streaked flanks and undertail-coverts, and usually, dark streaking of breast extending to black belly (though some *pacifica* similar; Paulson 1993). In non-breeding plumage, *hudsonia* is the only subspecies to have lines of small dots along flanks. Subspecies *arcticola* very similar in plumage to subspecies *pacifica* and best distinguished by shorter bill.

Data from Greenwood (1986, see Measurements) indicate that *sakhalina* is smaller than *arcticola*, with significantly shorter wing and tail, and, in males, significantly shorter bill and tarsus. However, Browning (1991) found no differences in size between the two and considered following characters of *sakhalina* to be more useful distinctions: upperparts slightly less dark and red (deep rich chestnut [Prater *et al.* 1977] or bright orange-cinnamon [BWP]); sometimes have dark streaks on undertail-coverts (rare in subspecies *arcticola*); and have less white on outer edge of p8. Conflicting conclusions about relative size of *sakhalina* and *arcticola* may occur because some samples of *sakhalina* may include birds from S of breeding range. These s. populations of *sakhalina* have recently been separated as two new subspecies: *kistchinski* (breeding Kamchatka, nw. coast of Sea of Okhotsk and n. Kurile Is) and *actites* (n. Sakhalin I.) (Tomkovich 1986; Nechaev & Tomkovich 1987; Browning 1991). Subspecies *kistchinski* differs from *sakhalina* in having broader black centres to feathers of crown and upperparts, and in slightly more yellow tinge to fringes of these feathers; some have little white on outer edge of p8 but in others, p8 resembles that of *sakhalina*. Subspecies

actites differs by even larger black centres and yellower fringes to feathers of upperparts; no white on outer edge of p8; and is distinctly smaller; wing is *c*. 8 mm shorter and bill 3–4 mm shorter than bill of *sakhalina* and *kistchinski* (Browning 1991). It has yet to be seen whether *kistchinski* and *actites* will be generally accepted; their non-breeding areas and moult schedules appear to be unknown.

Nominate *alpina* breeds from n. Scandinavia through w. Siberia to delta of Kolyma R. Differs from e. subspecies by: more cinnamon tinge to upperparts and broader black centres to feathers of upperparts; pale grey or off-white fringes to scapulars, *c*. 1–4 mm wide at tips when fresh; rather coarse, short black streaks on cheeks, and on throat to upper breast (much finer and fainter in e. races); only p1–p6 have white patch over base and middle portions of outer webs; ground-colour of hindneck, white to pale buff in males, rufous to buff in females. Smaller than *sakhalina*, e.g. average wing and bill of males 115 and 31.1, of females 117 and 32.9. Populations from Taymyr Pen. to delta of Kolyma R., show some characters intermediate between *sakhalina* and *alpina*; sometimes treated as a subspecies *centralis*, but more often combined with *alpina* (BWP; Greenwood 1986). W. subspecies *schinzii* (Britain–s. Scandinavia) and *arctica* (ne. Greenland) differ much from e. subspecies; they are small (e.g. average wing and bill of male *arctica* 112 and 26.1, of females 116 and 29.5); with paler, more cinnamon fringes to feathers of upperparts; little white on outer primaries; and rather small black patch on belly, often heavily blotched white (belly may even appear white with heavy black blotches at sides). For further differences, see BWP.

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Volume 3, Plate 19

Stilt Sandpiper *Micropalama himantopus*   (page 326)
1 Adult non-breeding; **2** Juvenile; **3** First immature non-breeding

Cox's Sandpiper   (page 307)
4 Adult non-breeding; **5** Juvenile, fresh plumage; **6** Juvenile, worn plumage

Curlew Sandpiper *Calidris ferruginea*   (page 315)
7 Adult non-breeding; **8** First immature non-breeding; **9** First immature non-breeding

Dunlin *Calidris alpina*   (page 308)
10 Adult non-breeding; **11** Juvenile; **12** First immature non-breeding

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Volume 3, Plate 20

Curlew Sandpiper *Calidris ferruginea*   (page 315)
1 Adult breeding, fresh plumage, bright bird; **2** Adult breeding, fresh plumage, dull bird; **3** Adult breeding, worn plumage; **4, 5** Adult

Cox's Sandpiper   (page 307)
6 Adult breeding; **7, 8** Adult

Dunlin *Calidris alpina*   (page 308)
9 Adult breeding; **10, 11** Adult

Stilt Sandpiper *Micropalama himantopus*   (page 326)
12 Adult breeding; **13, 14** Adult