

Order CHARADRIIFORMES

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

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

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

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

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

Because the Order comprises so many species and adaptations are so diverse, few characters shared by all species; those that are shared are mostly anatomical features of the skull, e.g. most or all have schizorhinal nostrils, schizognathous palates, well-developed vomer, lachrymals fused with ectethemoid and pre-frontal bones, well-developed supra-orbital grooves; see Olson & Steadman (1981) for more information on osteological characters. Wings usually have 11 primaries, with p10 longest and p11 minute; 15–24 secondaries; diastataxic except in *Scolopax minor*, as far as is known. Usually 12 tail-feathers. Necks usually rather long with 15–16 cervical vertebrae. Oil-gland bilobed and tufted. Syrinx, tracheo-bronchial; two carotids (type A-1 of Glenny 1955); caeca present. Legs usually rather long; hind toe small or lacking in most but all toes greatly elongated in Jacaniidae. Feathers with small thin afterfeathers. Normally two moults annually: complete post-

breeding and partial pre-breeding; some jacanas and alcids have flightless periods when moulting remiges. Young, downy, usually with intricate cryptic patterns on upperparts of three chief types: pebbly, spotted and striped, matching characters of habitat (Fjeldså 1976, 1977): precocial, nidifugous usually, self-feeding or not depending greatly on parents.

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

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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, rynchokinesis of skull highly developed, enabling flexible upper mandible to be opened or retracted at tip only (to grasp prey while probing). Tarsi and tibiae, short to long, with transverse scales (except in *Numenius*). Four toes in all species except Sanderling *Calidris alba*; toes fairly long with lateral membrane (webbed in some); hindtoe, small and raised (except in Arenariinae). No crop. Caeca present. Apparently no other waders have spiral sperm cells (similar to those of Passeriformes).

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

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

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

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

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

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

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

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

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

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

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

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

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

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28 Gallinagoninae

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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 Surf-bird *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 Surf-birds (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
<i>Aphriza</i>	1 (Surfbird)	0
<i>Calidris</i>	18	8 NB, 6A, 1D
<i>Eurynorhynchus</i>	1 (Spoon-billed Sandpiper)	0
<i>Micropalama</i>	1 (Stilt Sandpiper)	1 NA
<i>Tryngites</i>	1 (Buff-breasted Sandpiper)	1 NA
<i>Limicola</i>	1 (Broad-billed Sandpiper)	1 NB
<i>Philomachus</i>	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. melanotos*, 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 rhyndokinetic 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; Fjelds  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 ferruginea Curlew Sandpiper

COLOUR PLATE FACING PAGE 352 & 353

Tringa ferruginea Pontoppidan, 1763, *Danske Atlas* 1: 624 — Christianø Islands, off Bornholm, Denmark.

The specific epithet is Latin (*ferrugineus*) for rust-coloured (from *ferrugo*, iron rust), and refers to the rich chestnut-red of the breeding plumage.

The English name refers to the decurved, curlew-like bill.

OTHER ENGLISH NAMES Pygmy Curlew, Curlew Stint, Redcrop.

MONOTYPIC

FIELD IDENTIFICATION Length 18–23 cm; wingspan 38–41 cm; weight 57 g. Small, slim, long-necked sandpiper with longish legs and long, decurved bill with fine tip; these, with small rounded head, slender neck, and projection of wing-tips beyond tip of tail at rest, give distinctive shape and elegant jizz. Similar in size to Sharp-tailed Sandpiper *Calidris acuminata* but with smaller more rounded head; longer slimmer neck; slimmer body; longer wings extending beyond tip of tail at rest; longer legs; and much longer, decurved bill. Also very similar in size and shape to vagrant Stilt Sandpiper *Micropalama himantopus* and Dunlin *Calidris alpina*. In flight, all plumages have strong white wing-bar; distinctive squarish white patch across lower rump and uppertail-coverts (partly obscured by dark barring in breeding plumage) and tips of toes projecting beyond tip of tail. Sexes similar; females slightly larger and longer-billed; in breeding plumage, tend to have slightly paler chestnut underbody with more white feathers and dark barring, but sexes separable only within known pairs on breeding grounds. Marked seasonal variation. Juvenile distinctive. Immatures separable.

Description Adult breeding Head, neck and underbody to rear belly, rich chestnut-red, with some narrow black bars on belly and flanks, black streaks on crown, varying dusky loreal stripe, and white round base of bill and, sometimes, round eye; white tips to feathers produce pale-streaked and dusted appearance to head, neck and underbody. Vent and undertail-coverts, white with black bars, arrowheads and spots and varying chestnut suffusion. Mantle and scapulars, black with large chestnut lateral spots and greyish-white tips; often also have a few grey scapulars retained from non-breeding. Tertiaries typically a mixture of new black feathers with narrow chestnut fringes and white tips, and retained, worn, paler brownish-grey feathers. Innerwing-coverts, pale brownish-grey with narrow white fringes (retained from non-breeding) and a few fresh inner median and greater coverts, like new tertiaries. In flight, show: mostly brownish-grey innerwing-coverts and darker, black primary coverts and remiges, with prominent white wing-bar (broad white tips of greater coverts and diffuse white area across bases of inner primaries); dark-brown back and upper rump; prominent, squarish white patch across lower rump and uppertail-coverts, often slightly obscured by narrow dark barring; grey-brown tail with slightly darker central feathers; white underwing, with indistinct narrow dark leading-edge at carpal. With wear, white fringes and pale tips lost; chestnut-red of head, neck and underbody becomes more orange-chestnut, and chestnut of upperparts more yellow-orange. Bill, black, sometimes with brown or green tinge at base. Iris, dark brown. Legs and feet, black or black-grey, rarely

tinged brown or green. **Adult non-breeding** Like breeding, but differing by: cap, ear-coverts, hindneck and sides of neck, pale brownish-grey with fine dark streaks, grading to off-white with fine grey streaks on lower face, and white on chin and throat; also have narrow dark loreal stripe and prominent white supercilium from bill to above rear ear-coverts (often less distinct behind eye); some show faint white lateral crown-stripes in fresh plumage. Mantle, back, scapulars, tertiaries and innerwing-coverts, pale brownish-grey with fine dark streaks and narrow white fringes. Underbody, white, with varying brownish-grey wash and fine dark streaks on sides of foreneck and breast, extending across whole breast on some. Flight-pattern as breeding except lower rump and uppertail-coverts, white or with just a few small dark streaks and spots on lateral coverts. With wear, upperparts become browner as fine white fringes lost. **Juvenile** Like adult non-breeding, differing by: centre of forehead, crown and nape streaked black and buff, contrasting with pale-grey hindneck and sides of neck and giving slightly capped appearance; some have narrow buff or white lateral crown-stripes, which often join supercilium in front of eye to form split supercilium. Mantle, scapulars and tertiaries, dull grey-brown with thin black streaks and submarginal lines, and narrow, pale-buff scaling; pale edges to feathers sometimes form indistinct white lines along sides of mantle. Innerwing-coverts as scapulars but slightly paler. Foreneck and breast have pale-buff wash and less heavy and more diffuse dark streaks (heaviest on sides of neck and breast); rest of underbody, white, though have faint buff wash on belly in fresh plumage. With wear, buff wash on foreneck and breast and buff fringes to feathers of upperparts fade quickly, pale fringes persisting longest on innerwing-coverts. Scaly appearance of upperparts usually distinct in field until Nov. **First immature non-breeding** Distinguished from adult non-breeding by retained, somewhat worn juvenile innerwing-coverts and some tertiaries, contrasting with fresh non-breeding plumage; also, retained juvenile remiges fresh in spring–summer (worn or moulting in adult). In summer–autumn, most show contrast between old, worn brownish inner and new, fresh blackish outer primaries (primaries uniform and fresh in adults). In a few, primaries not replaced and appear uniformly worn, or all feathers replaced and then indistinguishable from adult. **First immature breeding** Attain varying amount of breeding plumage; all, except those that retain all juvenile remiges, separable from adult by contrast in moult of primaries till mid-Sept. of second spring.

Similar species At rest, combination of: small size, slim build, long decurved black bill, and long black legs, distinctive; in flight, also distinguished by prominent white wing-bar,

distinctive squarish white patch across lower rump and uppertail-coverts, projection of toes beyond tip of tail, and rippling *chirrup* call. Adult in breeding plumage like breeding **Red Knot** *Calidris canutus*, which is easily distinguished by larger size; shorter, straight bill; and shorter and paler legs. Only other similar-sized sandpipers sharing white patch on rump or uppertail-coverts or both are vagrant **Stilt** and **White-rumped** *Calidris fuscicollis* Sandpipers. **Stilt Sandpiper**: in ALL PLUMAGES, differs by: *at rest*: (1) flatter, more sloping forehead, longer-necked appearance and slightly deeper belly; (2) slightly longer, thicker, straighter, blunter and more tubular bill; (3) longer, paler, green or yellow legs; stands noticeably taller and appears larger despite similar length and bulk; *in flight*: (4) no wing-bar, and much longer projection of legs (feet and part of tarsi) beyond tip of tail, which, with long wings and bill give characteristic cruciform shape; (5) slightly more emphatic and vertical sewing-machine probing when feeding. In ADULT BREEDING PLUMAGE, Stilt Sandpiper distinguished by heavily barred underbody. In non-breeding and juvenile plumages, Stilt and Curlew Sandpipers very similar; in addition to above differences, in NON-BREEDING PLUMAGE Stilt has: (1) much dark streaking on flanks, vent and undertail-coverts, sometimes forming long wavy lines down flanks; (2) white patch across rump and uppertail-coverts broader, usually with heavy dark streaks and spots; always have at least a few dark streaks and spots on lateral and distal feathers; (3) slightly darker forehead and crown giving slightly darker-capped appearance; and slightly darker brownish-grey upperparts. In JUVENILE PLUMAGE, Stilt Sandpiper differs by: (1) often brighter, rufous tinge to forehead, crown, ear-coverts, mantle and upper scapulars when fresh; often also have clearer and more prominent white lines on mantle; (2) lower scapulars have wider dark subterminal areas (cf. thin dark submarginal lines of Curlew Sandpiper), are more pointed and white fringes almost divided at tips by dark centres; appear to be striped white (cf. scaly aspect of Curlew Sandpiper); (4) streaking and spotting on foreneck, breast, flanks, vent and undertail-coverts usually heavier (these areas usually white in Curlew Sandpiper); (5) as in non-breeding, white patch on rump tends to be more marked. In non-breeding and juvenile plumages, Curlew Sandpiper can also be confused with non-breeding and juvenile **White-rumped Sandpiper**. Easily distinguished by shorter, less decurved and often slightly blunter bill (though a few Curlew Sandpipers have very short or broken bills, and have been confused with White-rumped Sandpiper). In ALL PLUMAGES, White-rumped distinguished by: *in flight*: (1) narrower, less prominent wing-bar; (2) white band across uppertail-coverts only, forming narrower white rump-patch; (3) feet do not project beyond tip of tail; (4) larger and more prominent dark leading-edge to underwing; *at rest*: (1) much smaller, slimmer and with shorter neck, with proportionately slightly larger head and much shorter legs; overall size like that of stint; (2) projection of primaries and wing-tips longer: four primary tips project beyond longest tertial and, three primary-tips beyond tail; wing-points longer, somewhat finer, and more crossed; (3) more horizontal, flat-backed stance and longer, more attenuated shape; (4) usual flight call, high, thin, squeaky, mouse-like *jeet* or *eeet*, quite different from call of Curlew Sandpiper. In NON-BREEDING PLUMAGES, White-rumped (1) darker brownish-grey above, with more prominent and darker black shafts, shaft-streaks and diffuse dark centres to feathers giving more patterned appearance above; (2) much overlap in pattern of head and marking of gorget, but usually show at least some dark streaks on flanks, and often a grey wash on fore-flanks; (3) usually

have small pale, orange-brown, green or yellow patch at base of lower mandible; and blackish legs can have slight green tinge. In FRESH JUVENILE PLUMAGE, White-rumped distinguished from same of Curlew Sandpiper by: (1) rufous tones on crown, ear-coverts, mantle, upper scapulars and tertials; (2) clear white mantle and scapular lines; (3) much darker blackish centres to feathers of mantle, upper scapulars and tertials and larger subterminal dark areas on lower scapulars; (4) paler buffish-grey foreneck and breast; when very fresh, weaker fly wash and more even dark streaking on foreneck and breast; and usually have fine dark streaking on fore-flanks; (5) bare parts as non-breeding. In non-breeding plumages can be confused with non-breeding **Dunlin** which differs by: *in flight*: dark central stripe through rump and uppertail-coverts, feet do not trail, and different flight call; *at rest*: (1) characteristic dumpy shape: slightly smaller, with larger head, shorter neck and fuller body giving hunched stance; shorter wings, with tips of primaries projecting only a little beyond tertials, reaching level with tip of tail; shorter legs; and slightly heavier, less decurved bill with slightly drooped tip; (2) plumage very similar, but supercilium always less distinct; foreneck and breast tend to be darker brownish-grey and more heavily streaked (though there is much variation and overlap) and some, at least, have fine dark streaking on fore-flanks.

Gregarious, often in large flocks; mix freely with other small waders when feeding and roosting. In non-breeding season, favour estuarine mudflats and muddy edges of fresh-water and brackish wetlands, both coastal and inland. Gait like that of other small calidrids. Feed on wet mud by pecking and probing; or wade in water; large groups often seen wading up to belly with heads submerged while probing; swim well, floating buoyantly with tail cocked; take off easily from water. Primary projection beyond tertials and tip of tail moderate to long in adults, typically with three primary-tips beyond tip of longest tertial and two beyond tail; long in juveniles, involving four beyond tertials and three beyond tail. Flight typical of genus: swift and agile, similar to small congeners. Usual flight call gentle rippling trill *chirrup* or *krillee*.

HABITAT In A'asia, mainly intertidal mudflats in sheltered coastal areas, such as estuaries, bays, inlets and lagoons; also round non-tidal swamps, lakes and lagoons near coast, and ponds in saltworks and sewage farms. Less often recorded inland: round ephemeral and permanent lakes, dams, waterholes and bore drains usually with bare edges of mud or sand (Badman & May 1983). Occasionally round floodwaters (Loyn 1978). In both fresh and brackish waters.

Forage on mudflats and nearby shallow water. In non-tidal wetlands, usually wade, mostly in water 15–30 mm, but up to 60 mm, deep; also forage farther out or on mud or sand covered by film of water (Thomas & Dartnall 1971a). At Port Hedland Saltworks, WA, observed feeding while swimming on large hypersaline ponds 1–2 m deep (C.D.T. Minton). Feed at edges of shallow pools and drains of intertidal mudflats and sandy shores (Boehm 1960). At high tide, feed among low sparse emergent vegetation, such as saltmarsh (Hindwood & Hoskin 1954; Loyn 1975; Vic. Atlas); sometimes in flooded paddocks (Loyn 1975, 1978) or inundated saltflats (Garnett 1989); rarely on pasture (Smith 1967). Occasionally forage on wet mats of algae or waterweed (Dann 1983), or on banks of beachcast seagrass or seaweed (Bransbury 1985; Wood 1985). Rarely forage on exposed reefs (Bransbury 1985).

Generally roost on bare dry shingle, shell or sand beaches, sandspits and islets in or round coastal or near-coastal lagoons

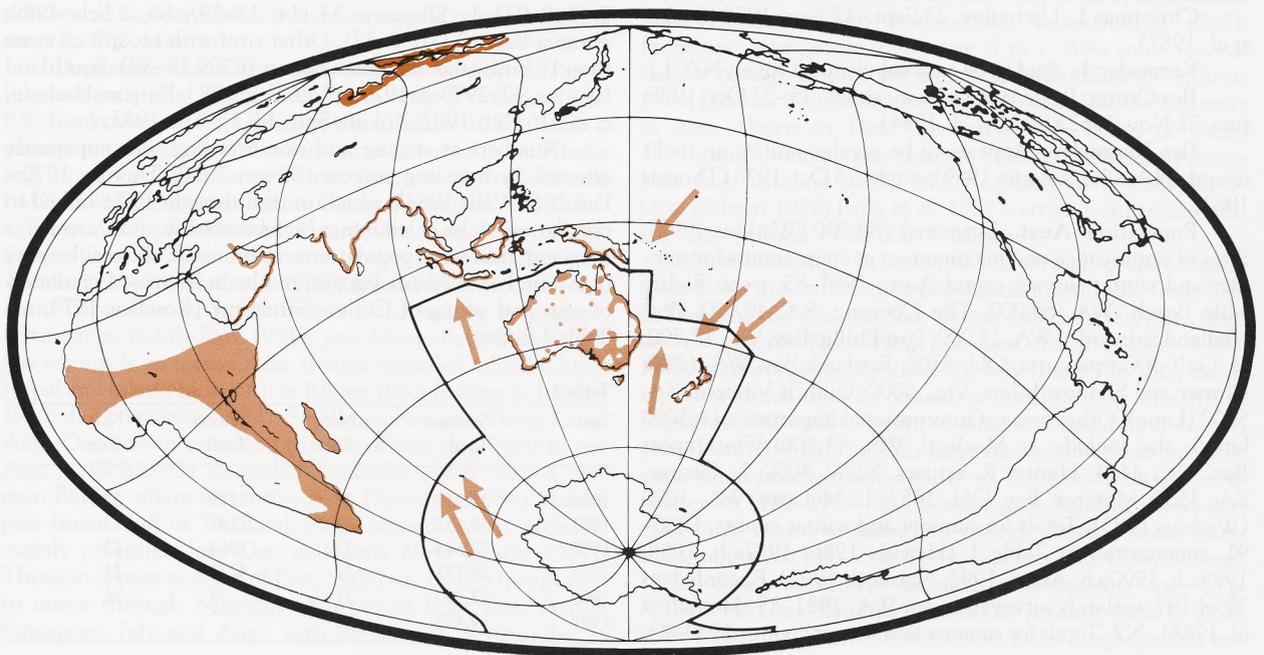
and other wetlands (Pegler 1983; Jones 1985; Lane; C.D.T. Minton); occasionally in dunes during very high tides and sometimes in saltmarsh (Hindwood & Hoskin 1954; Jones 1985; Garnett 1989). Infrequently, rest among beachcast seaweed (Bransbury 1985), on rocky shores (Morris *et al.* 1990) or on reefs (Schulz 1990).

DISTRIBUTION AND POPULATION Breeding mainly restricted to high Arctic of n. Siberia: Yamal Pen. E to Kolyuchiskaya Gulf, Chukotka Pen.; also New Siberian Is, and irregularly round Barrow, n. Alaska, in 1960s and 1970s. Passage migrant through Europe and n. Africa, Kazakhstan, w. and s.-central Siberia, Ussuriland, China, Taiwan, Japan, Philippines, w. Melanesia, Wallacea and New Guinea. During non-breeding period, occur throughout Africa, S of line from s. Mauritania to Ethiopia, along valley of Nile R. and in Madagascar; in Asia, from coastal Arabian Pen. to Pakistan and India, through Indomalaya, se. Asia and Indochina to s. China; A'asia. Frequent straggler to North America, and vagrant or accidental to Spitsbergen, Iceland, islands in Atlantic Ocean, Caribbean islands, Argentina, Peru, Hawaii, Syria and Jordan (Dement'ev & Gladkov 1951; Ali & Ripley 1980; AOU 1983; de Schauensee 1984; Coates 1985; Urban *et al.* 1986; White & Bruce 1986; Pratt *et al.* 1987; BWP; P.S. Tomkovich).

Aust. Qld Scattered records in Gulf of Carpentaria, between Massacre Inlet and Torres Str. Between Torres Str. and Cairns, recorded only from Quintell Beach, Iron Ra.; widespread along coast S of Cairns. Inland, sparsely scattered records, including regular sightings round Mt Isa (Carruthers 1966; Horton 1975; Schrader 1981; Qld Bird Reps; Aust. Atlas). **NSW** Widespread E of Great Divide, especially in coastal regions; occasionally recorded in Tablelands; widespread in Riverina and SW; scattered records elsewhere (NSW Bird Reps; Aust. Atlas). **Vic.** Widespread and common in coastal bays and inlets, e.g. w. Port Phillip Bay, Westernport Bay, Corner Inlet (E to McLaughlins Beach), Anderson's Inlet (Inverloch) and Shallow Inlet. Numbers on ocean beaches low; widespread in near-coastal wetlands (e.g. L. Reeve), and

inland in suitable habitats, e.g. Kerang area, Mildura, and w. districts (C.D.T. Minton). **Tas.** Recorded King I. and Furneaux Grp. Mostly in e. Tas., E of line between George Town, L. Augusta and Shannon Lagoon; also at several sites in NW. Occasionally on w. coast, round Strahan, Macquarie Harbour and Henty R. (Thomas 1979; Tas. Bird Reps; Aust. Atlas). **SA** Widespread coastal and subcoastal areas E of Streaky Bay. Important sites include ICI and Price Saltfields, and The Coorong (C.D.T. Minton). Occasionally in inland areas S of Murray R., and, elsewhere, including n. Eyre Pen., L. Eyre Drainage Basin, and Maralinga district (Badman 1979, 1989; Badman & May 1983; Bellchambers & Carpenter 1990; SA Bird Reps; Aust. Atlas). **WA** Regular, Eyre Bird Observatory (Congreve & Congreve 1985), Port Hedland Saltworks, 80 Mile Beach, Roebuck Bay and L. Macleod (C.D.T. Minton). Widespread round coastal and subcoastal plains from C. Arid to sw. Kimberley Div., but more sparsely distributed between Carnarvon and Dampier Arch. Rarely recorded nw. Kimberley, round Wyndham and L. Argyle. Occasionally inland, including L. Daly, Sturt Ck HS, and L. Gregory in the N; L. Gidgi, L. Brown, Kanandah, Hannan L. (near Kalgoorlie), L. Violet, Twelve Mile Bore, L. Wooleen, Meekatharra and L. Annean, all S of 26°S (Brooker *et al.* 1979; Johnstone 1983; Storr 1986; Jaensch & Vervest 1990; Aust. Atlas). **NT** Mostly round Darwin, N to Melville I. and Cobourg Pen., and E and SE to Gove Pen., Groote Eylandt and Sir Edward Pellew Is. Recorded inland from Victoria R. Downs and round Alice Springs (Crawford 1972; Schodde 1976; Boekel 1980; Roberts 1981; Aust. Atlas; H.A.F. Thompson & D.K. Goodfellow).

NZ Regular visitor in small numbers, few records before 1950s (NZCL). First recorded 1902 or 1903 (Sibson 1970; Oliver; NZCL) at L. Ellesmere or L. Te Anau, SI. Not recorded NI till Oct. 1941, in Firth of Thames (Sibson 1943). **NI** At n. harbours, including Parengarenga, Whangarei, Kaipara and Manukau and Firth of Thames; also Bay of Plenty, near Tauranga and Maketu. On e. coast, records clustered in region between Muriwai and Tutaekuri R. Occasionally recorded elsewhere, including L. Wairarapa and mouths of Manawatu and Turakina Rs. **SI** Recorded at several sites in N, from Farewell Spit to L.





Grassmere; many records from L. Ellesmere and adjacent lagoons; occasionally reported from other localities along e. coast. In Southland, recorded from Waituna Lagoon to Oreti R. estuary (Sibson 1970; CSN).

Norfolk I. Five, spring 1970; 1–2, 23 Sept. to 12 Oct. 1984 (Hermes *et al.* 1986).

Lord Howe I. Single, specimen, Dec. 1902 (Hindwood 1940); two, 19–20 Sept. 1963 (McKean & Hindwood 1965); single, 2 Dec. 1971 (NSW Bird Rep. 1971); single, 21 Feb. 1983 (NSW Bird Rep. 1983).

Christmas I. Up to five, 23 Sept.–12 Nov. 1978 (Stokes *et al.* 1987).

Kermadec Is Said to be a casual visitor (Oliver; NZCL).

Iles Crozet Ile de la Possession: single, 15–23 Oct. 1978; two, 22 Nov. 1982 (Stahl *et al.* 1984).

Iles Kerguelen Appears to be regular visitor; up to 11 recorded (Ausilio & Zotier 1989); single, 25 Oct. 1978 (Thomas 1983).

Population Aust. Estimated 188,000 (Watkins 1993). Sites of significance and maximum or average counts for summer and winter surveys round Aust., 1981–85, were: Eighty Mile Beach, WA, 60,000; The Coorong, SA, 40,000; Port Hedland Saltworks, WA, 25,000; Port Phillip Bay, Vic., 17,700; se. Gulf of Carpentaria, Qld, 8500; Roebuck Bay, WA, 6000; Corner and Shallow Inlets, Vic., 6000; Gulf St Vincent, SA, 5900 (Lane). Other areas of international importance (≥ 3000 birds), also include: L. Macleod, WA, 41,606; Westernport Bay, Vic., 4424; Hunter R. estuary, NSW, 4000; L. George, SA, 3582; Moreton Bay, Qld, 3057; L. McLarty, WA, 3000 (Watkins 1993). Totals for summer and winter counts, 1986–91, summarized in Table 1 (Hewish 1986, 1987a,b, 1988, 1989a,b, 1990a,b; Anon. 1992; Naismith 1992). Recorded on 30 of 197 wetlands surveyed in sw. WA, 1981–85 (Jaensch *et al.* 1988). **NZ** Totals for summer and winter counts, 1983–93,

summarized in Table 2; mean total summer count ($n=10$ summers): NI, 31 (25; 4–79); SI, 49 (16; 22–71) (OSNZ Nat. Wader Count; P.M. Sagar). Sites of importance, with mean summer counts given below; maximum counts that exceeded maxima from OSNZ Nat. Wader Counts are also given. **NI** Parengarenga Harbour, 14 (15; 0–39), also c. 40, 1 Nov. 1977; Manukau Harbour, 2 (3; 0–9), also 20, summer 1987–88; Firth of Thames: 15 (10; 0–36), also 53, 7 Jan. 1978, and, at Miranda, c. 50, 25 Mar. 1984; Kaituna Cut–Maketu Estuary, 1 (1; 0–4), also 13, Nov. 1976. **SI** Farewell Spit, 3 (3; 0–11); L. Grassmere, 2 (7; 0–22); L. Ellesmere 33 (14; 13–59), 86, 2 Feb. 1989; Awarua Bay, 10 (10; 0–37). Other sites with records of more than 10 birds, and maximum counts (CSN 19–39): Southland lagoons, 42, 29 Dec. 1979; 37, 26 Feb. 1983; Kaipara Harbour, c. 20, 16 Oct. 1982; Kokota Spit, 13, 17 Apr. 1983.

Numbers at staging and non-breeding sites apparently affected by breeding success (Sibson 1970; Thomas 1970a; Parish & Wells 1984), which in turn thought to be linked to population cycles of lemmings *Lemmus sibiricus* and *Dicrostonyx torquatus*: decreased populations of lemmings, the regular prey of Arctic Foxes *Alopex lagopus*, results in increased predation of eggs and young of Curlew Sandpiper (Roselaar 1979; see Table 1 below).

Table 1

Year	Summer Total	No. Sites	Winter Total	No. Sites
1986	35,929	23	3235	23
1987	31,432	22	2191	23
1988	22,644	23	1964	23
1989	25,733	22	4221	21
1990	23,390	21	8	21
1991	13,495	21		

Table 2

Year		Winter		Summer	
		Total	No. Sites	Total	No. Sites
1983	NI	–	–	24	31
	SI	–	–	54	43
1984	NI	0	42	17	44
	SI	1	68	45	73
1985	NI	1	60	6	79
	SI	5	83	70	65
1986	NI	2	91	47	75
	SI	1	77	55	73
1987	NI	0	66	45	54
	SI	1	53	71	63
1988	NI	1	58	19	65
	SI	10	66	39	54
1989	NI	7	56	4	30
	SI	4	65	25	56
1990	NI	0	34	7	31
	SI	0	49	22	40
1991	NI	0	33	64	37
	SI	3	47	52	35
1992	NI	70	45	79	34
	SI	18	52	57	44
1993	NI	2	43	–	–
	SI	0	42	–	–

MOVEMENTS Migratory; move from Siberia to non-breeding areas generally S of 35°N. Breeding widespread: populations breeding at least as far E as 128°E migrate S across Russia to w. half of Eurasia (AOU 1983; BWP); populations that breed as far W as c. 98°E, move to Aust. At least some Aust. birds make loop migration. Most migrate S via w. route, probably overland across Siberia and China, then through India, Burma, Malaysia, Singapore, Thailand, and w. Indonesia, with fewer moving along e. coast China, Hong Kong and Taiwan. N. migration much farther E, mainly along se. and e. coasts of China (where staging occurs), then continue overland to breeding areas; also recorded Gulf of Thailand and s. Vietnam (Lane; C.D.T. Minton; see Banding). In years where breeding success high, birds can occur more widely and in high numbers at locations other than main staging or non-breeding areas (C.D.T. Minton).

Departure Males leave early July, followed by females in July and early Aug., then juveniles in Aug. (Portenko 1959; P.S. Tomkovich; *contra* Dement'ev & Gladkov 1951). Main s. passage overland: small numbers occur Aleutian Is, w. Alaska and along Pacific coast of North America, S to California (AOU 1983); few occur Pacific Ocean (Pratt *et al.* 1987), far-e. Siberia (P.S. Tomkovich), Japan (Orn. Soc. Japan 1974), Korea (Gore & Won 1971) or e. and s. coasts of China (la Touche 1931–34; Chalmers 1986); few move down coast of e. Asia. Cross Russia, July till end Oct., mainly Aug.–Sept. (Dement'ev & Gladkov 1951); pass Mongolia (AWB 1993); few records from inland Asia, though recorded inland China, Nepal and inland India (Ali & Ripley 1980; Inskipp & Inskipp 1985; de Schauensee 1984). Small numbers pass Hong Kong, Aug.–Oct. (when estimated capable of non-stop flight to nw. Aust.) (AWB 1993). Recorded Cambodia (AWB 1993). Common Burma, where first arrive Aug. (Smythies 1986). Adults pass Inner Gulf of Thailand, Aug.; second influx, probably mainly juveniles, late Oct. and early Nov. (Starks 1987). Thousands pass w. coast of Pen. Malaysia; in 1983, appeared to move through Selangor, Aug. to at least Oct. Arrive Singapore, July and Aug., with percentage of juveniles in

population increasing late Aug. to mid-Sept. (adults estimated capable of flying non-stop to nw. Aust.) (Parish & Wells 1984; Hails & Jarvis 1987; AWB 1993). Pass Borneo, Aug. to early Nov. (AWB 1993). Regularly recorded w. coast s. Sulawesi from mid-Sept. (Escott & Holmes 1980). Locally common Sumatra (van Marle & Voous 1988). Many adults on passage n. coast of Java, Aug.–Sept. 1984 (Bowler *et al.* 1985); many Bali, Aug. and Sept. (Ash 1984). In Philippines in 1989, passage Olango I., Aug. to at least Nov. with peak (400 birds) in Oct. (Magsalay *et al.* 1990); pass Manila Bay, Aug. (AWB 1993). Uncommon migrant in w. Micronesia (Pratt *et al.* 1987). Regular, uncommon passage migrant s. New Guinea; in Port Moresby district, arrive as early as late Aug., mainly Oct. and Nov. (Beehler *et al.* 1987; Hicks 1990).

Aust. First arrive in NW from mid-Aug.; in SE during last week Aug. Most adults have arrived by end Sept. (C.D.T. Minton *cf.* Lane); first-year birds arrive 4–6 weeks after adults (Barter 1987): in NW, by mid-Sept., and in SE before end Sept.; most juveniles arrive Oct., with few late arrivals Nov.–Dec. Some also probably make prolonged stops at inland wetlands, only drifting to coast in summer (Jan.–Feb.) as these dry (C.D.T. Minton). Large numbers arrive nw. Aust. then move overland to se. and s. Aust. (e.g. birds colour-marked nw. Aust., seen SA and Vic. about 5 weeks later; Lane). No direct evidence of movement through Gulf of Carpentaria (Garnett 1986) to e. and se. Aust., though single seen flying S across Arafura Sea, early Dec. (Carter 1983), regular movements through Mt Isa district, Aug.–Oct. (Horton 1975), and several records from coastal Qld and NSW (VWSG; C.D.T. Minton) suggest at least some use this route. Uncommon passage migrant Torres Str. (Draffan *et al.* 1983). Some, occasionally hundreds, pass through ne. SA, late Aug. to early Dec. (Badman & May 1983); small numbers regularly, sw. NSW, from early Aug. (Hobbs 1961). Influx recorded at one site inland se. Aust., early Aug. and Sept. Flocks mainly arrive s. and e. coasts, Sept.–Oct. or Nov. (Alcorn 1988; Aust. Atlas; Lane). First arrive Vic. and Gulf St Vincent, SA, Aug. (Close & McCrie 1986; Vic. Atlas). In Vic., males apparently arrive before females (Barter 1986b), and juveniles later still (Paton *et al.* 1982). In Tas., adults arrive late Aug. and Sept., juveniles Nov. (Henderson 1981; Barter 1984; Newman *et al.* 1985). From nw. Aust., some also move S to s. WA; some records suggest passage along coast and inland (Bamford 1983; Storr 1986; Jaensch 1988); sometimes arrive coastal sw. WA, as early as Aug., always by Dec. (Serventy 1938; Bailey & Creed 1993); small numbers pass through Eyre, se. WA, mainly Aug.–Nov. (e.g. Dymond 1988). **NZ** Regularly arrive early Sept.–Oct. (Sibson 1970; Falla *et al.* 1981); arrive L. Ellesmere, SI, late Oct. (Sibson 1970; C.D.T. Minton).

Non-breeding In se. Asia and A'asia, proportionally more males in non-breeding population towards SE: from 56% in Thailand to 77% in se. Tas. (Barter 1987). In se. Aust., most move to coast by Dec. where, like most sites on e. coast N of c. 34°S, numbers generally stable till Feb. (Lane). In Vic., banding shows birds tend to remain in non-breeding sites till n. migration, and tend to return to same non-breeding sites each year (Dann 1981b); in Tas., large flocks sometimes occur at some embayments then appear to disperse to other areas (Patterson 1982, 1989). In Hobart region, banding shows that most birds return to same bay, though there is some interchange between bays within estuarine complex (Fletcher *et al.* 1982). Some movement between non-breeding sites (e.g. ABBBS 1992; see Banding), mainly by juvenile birds (VWSG *Bull.*; C.D.T. Minton). Tend to form large congregations be-

fore migration (Close & McCrie 1986). 'Courtship display' said to have occurred in early Mar. (Hindwood & Hoskin 1954).

Return Aust. Migrate N on a broad front, with fewer in nw. Aust. than on s. migration (C.D.T. Minton). Return begins Mar. (Lane); in 1981–87, departure finished by late Apr. (Alcorn 1988); in 1985, by late Mar. (Starks & Lane 1987). In SE, begin leaving second week Mar., with most gone by end of first week Apr. In NW, begin leaving late Mar., with most early Apr., a few staying until mid- to late Apr. Leave Tas., Mar.–May; most first-year birds leave Tas. in most years; at George Town, all age-groups apparently leave at same time (Thomas 1970a,b; Henderson 1982). Near Hobart, departure apparently protracted, with colour-marked first-year birds, but not adults, recorded moving through e. Bass Str. and Vic., and bird of unknown age also seen ne. NSW (Newman *et al.* 1985). Leave Vic. by late Apr. or early May (Alcorn 1988; Vic. Atlas) with males apparently leaving before females (Barter 1986b). Birds from Vic. and Tas. estimated to be able to fly non-stop to nw. Aust., and often farther (Barter 1984; Thomas 1987; Lane). In SA, influx before departure occurs at some sites, e.g. Gulf St Vincent; remain at some sites till late Apr. (Close & McCrie 1986; Alcorn 1988). Sightings of colour-marked birds, and influx at inland site in se. Aust. in Apr., suggest some passage through inland; band-recovery suggests at least some birds from se. Aust. move to nw. Aust. before leaving Aust. (Alcorn 1988; Minton 1993a; see Banding). Influxes occur on e. coast, N to c. 30°S, Mar. and Apr. (Lane). Leave coastal sites in e. Qld between mid-Jan. and mid-Apr., but no influxes occur (Alcorn 1988). Unusually large flock at Ayr, n. Qld, in poor weather in early Apr. 1987, suggests possible passage along ne. coast (Johnson 1987). Influx of birds in breeding plumage through Edward R., Gulf of Carpentaria, in mid-Apr. may represent passage, possibly from e. Aust. (Garnett & Bredl 1985; Garnett 1989). Locally common in NT (e.g. Melville I.) during n. passage in Apr. (Storr 1977). Large influx in nw. Aust. in late Mar. and Apr., when birds have estimated non-stop flight range of c. 3700 km (Lane & Jessop 1985). In sw. Aust., leave some sites by late Mar. (Alcorn 1988), early Apr. (Serventy 1938); Rottneest I., mid-Apr. to late May (Storr 1965). **NZ** Usually remain till Mar. or Apr. (Falla *et al.* 1981); as late as mid-May (Sibson 1970).

Extralimitally, small numbers occur New Guinea, early Apr. to mid-May (Coates 1985; Beehler *et al.* 1987; Hicks 1990). Many Bali, Mar. (Ash 1984), and Sumatra, Mar.–Apr. (van Marle & Voous 1988); not recorded w. coast of s. Sulawesi after mid-Mar. (Escott & Holmes 1980); small numbers pass through Brunei, Borneo, mid-Feb. to May (Harvey & Elkin 1991). Up to 400 recorded Olango I., Philippines, Mar.–Apr. 1989; up to 500, Jan.–Mar. 1991 (Magsalay *et al.* 1990; Magsalay 1991) and over 1000 counted at Manila Bay in early Apr. 1987. Leave Singapore, early Mar.; pass through Malaysia, Mar.–Apr. (AWB 1993). Move through Inner Gulf of Thailand, late Mar.–May (Starks 1987). Common n. Vietnam, late Mar. and early Apr. 1991 (Lane 1991; AWB 1993). Leave Burma, May (Smythies 1986). Occur along coast of China (cf. s. migration), mainly mid-Apr. to mid-May, with very few birds after third week of May (C.D.T. Minton *contra la Touche* 1931–34); all recoveries on e. coast of China of birds banded in Aust. between late Mar. and mid-June (see Banding); large flocks occur Hong Kong, between early Apr. and mid-May (Chalmers 1986). Few through Korea (Apr.–May), Japan (Gore & Won 1971; AWB 1993) and Sakhalin (P.S. Tomkovich). First arrive Chukotka region, Russia, late May or early June

(Kondratiev 1982). Males said to arrive at breeding grounds before females (Portenko 1959); most females arrive paired (Tomkovich 1988).

Breeding Many, mostly young, stay in non-breeding areas during breeding season (e.g. Coates 1985; Smythies 1986). No evidence of adults not migrating, nor of first-year birds undertaking migration, though some first-year birds move some distance N, and may move locally Apr.–Aug. (C.D.T. Minton). Generally remain at normal non-breeding sites but in lower numbers. In Aust., reporting rates 0.8% in winter and 3.1% in summer (Aust. Atlas); at most sites, wintering population only small proportion of maximum counts (Alcorn 1988). Strong correlation between wintering numbers and breeding success of previous year (C.D.T. Minton). In Aust., first-year birds tend to move N during breeding season (Garnett 1986; Barter 1987). Occur n. Aust.; small numbers on coast of Qld (Anon. 1992), Torres Str. (Draffan *et al.* 1983), Gulf of Carpentaria (Garnett 1986), Darwin region, NT (Crawford 1972), and 200 recorded on wetland in Kimberley region, WA (Campbell 1990). Also occur s. Aust., sometimes in large numbers (Morris 1975; Park 1983; Patterson 1984; Close & McCrie 1986; Hewish 1988, 1990b; Vic. Atlas). In se. Aust., much dispersal to inland wetlands (C.D.T. Minton). Some movements apparently dispersive; in 1984 low numbers wintered in Tas. and Vic. and high numbers recorded at L. Eyre, which provided suitable habitat at that time (Newman *et al.* 1985). In NZ, some occasionally winter, tending to join flocks of Wrybills *Anarhynchus frontalis* (Falla *et al.* 1981; Sagar 1992).

Banding, Colour-marking Birds banded Aust. recovered during s. migration from upper Yenisey R., Russia (n=1), s. India (n=1) and Java (n=2). Of birds banded extralimitally then recovered in Aust.: two were banded during n. migration in Taiwan; single banded on s. migration, and single banded on n. migration in Hong Kong; single banded Singapore during s. migration (ABBBS 1992, 1993). Single colour-marked in Singapore sighted in nw. Aust. (Parish & Wells 1984). Birds banded and colour-marked in nw. Aust. recorded se. Aust. within non-breeding season (Lowe 1988b; Minton 1993b; Lane). Fidelity to non-breeding site suggested by numerous recoveries (e.g. Harris 1982), and by thousands of retraps (C.D.T. Minton), though some local movement (Harris 1984; Lowe 1988a) and also some considerable movements apparent between and within States (e.g. Anon. 1982; Harris 1982; Harris 1986; Minton 1993a). Birds banded in Aust. recovered s. Vietnam (n=1) and Gulf of Thailand (n=2) on n. migration. Numerous recoveries and sightings of colour-marked birds on coast of e. China during period of n. migration (ABBBS 1992,

Plate 17

Red-necked Stint *Calidris ruficollis* (page 258)

- 1 Adult breeding, pale bird; 2 Adult breeding, bright bird;
- 3 Adult breeding, worn plumage; 4 Adult non-breeding;
- 5 Juvenile, typical; 6 Juvenile, bright plumage;
- 7 First immature non-breeding

Little Stint *Calidris minuta* (page 250)

- 8 Adult breeding, fresh plumage; 9 Adult breeding, worn plumage;
- 10 Adult non-breeding; 11 Juvenile;
- 12 First immature non-breeding

Long-toed Stint *Calidris subminuta* (page 270)

- 13 Adult breeding, bright plumage; 14 Adult breeding, typical plumage;
- 15 Adult non-breeding; 16 Juvenile;
- 17 First immature non-breeding

1993; Minton 1993a). One Aust. band, originally on Curlew Sandpiper, subsequently placed on Black-tailed Godwit *Limosa limosa* in Thailand (Starks 1985). Of 19 banded in NZ to mid-1994 (all at Miranda, Firth of Thames), two re-sighted Karaka in Manukau Harbour (one was banded 21 Apr. 1992, resighted 10 Apr. 1994) (NZWSG; A. Riegen; S. Davies).

Long-distance recoveries (ABBBS): 73 recoveries >5000 km (63 banded Aust., 10 banded extraliminally and recovered Aust.); 30 recoveries 1000–4999 km; 43 recoveries 100–999 km.

FOOD Omnivorous. Mainly invertebrates: worms, molluscs, crustaceans, and insects; also seeds. Extraliminally, shrimp, crabs and small fish also recorded. **Behaviour** Diurnal and nocturnal. Usually forage in water, near shore (Thomas & Dartnall 1971a; Dann 1981a) or on bare wet mud at edge of wetlands (Dann 1983); also probe in shallow water; jab at edge of water where film of water remains on sand; glean from mud, from surface of water, or in drier areas above edge of water. Jab less than half length of bill into substrate or probe with slightly open bill to its full length (c. 40 mm) (Thomas & Dartnall 1971a). Recorded gleaning and probing at rate of 0.65 feeding movements/s (Dann 1983). May wade up to belly (Hindwood & Hoskin 1954). At Port Hedland Saltworks, nw. WA, up to hundreds regularly feed by swimming and picking food from surface of water in manner similar to that of phalaropes *Phalaropus* and Banded Stilts *Cladorhynchus leucocephalus* (C.D.T. Minton). Size of prey: hard molluscs 3–5 x 1–3 mm; annelids up to 80 mm long apparently eaten whole (Thomas & Dartnall 1971a). In A'asia, often feed with Red-necked Stints *Calidris ruficollis* (Lane). In s. South Africa, type of prey taken varies between seasons; females forage faster, achieve higher success rates, and feed in segregated feeding flocks (Puttick 1978, 1981).

Adult In se. Tas. (58 stomachs; Thomas & Dartnall 1971a): Plants: vegetable matter and sds 39.6% freq. Animals: Annelids: polychaetes: Nereidae 12; Molluscs: bivalves 25.9; gastropods: Hydrobiidae (*Assiminea brazieri*, *A. tasmanica*) 67.2; Crustaceans: unident. 13.8; amphipods: *Paracorophium* 17.2; crabs 6.9; Insects: Diptera (Stratiomyidae, Chironomidae): ads 1.7; larv. and pupae 58.6. Unident. debris 32.7.

Other records Plants: Ruppiaceae: *Ruppia* sds (Paton 1982). Animals Annelids: worms: polychaetes: Nereidae: *Ceratonereis eurythraensis* (Dann 1981a); Molluscs (van Tets *et al.* 1977; Gould): gastropods; Crustaceans (Lea & Gray); Insects (Gould): Coleoptera: larv. (Paton 1982); Dytiscidae: larv.; Scarabaeidae: larv. (FAB); Diptera: larv. (Lea & Gray); Lepidoptera (Smith 1967). Grit (van Tets *et al.* 1977; Lea & Gray).

Intake For maximum numbers of different taxa in stomach in se. Tas., see Thomas & Dartnall (1971a).

Plate 18

Pectoral Sandpiper *Calidris melanotos* (page 287)

1 Adult male breeding; 2 Adult female non-breeding;
3 Juvenile; 4, 5 Adult

Sharp-tailed Sandpiper *Calidris acuminata* (page 295)

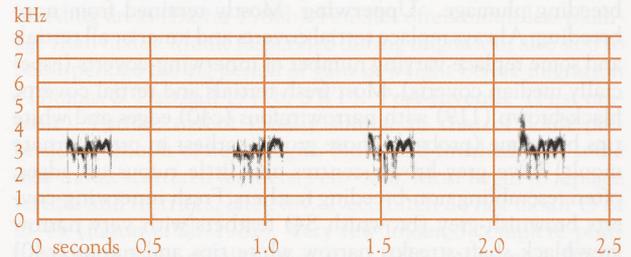
6 Adult male breeding; 7 Adult female non-breeding;
8 Juvenile; 9 First immature non-breeding; 10 First immature male breeding; 11, 12 Adult

Buff-breasted Sandpiper *Tryngites subruficollis* (page 329)

13 Adult male; 14 Juvenile; 15, 16 Adult

VOICE No detailed studies; published sonagrams in Bergmann & Helb (1982), McLean (1985), and BWP.

Adult CONTACT CALL: gentle rippling *chirrup* (Hayman *et al.* 1986), or trill (sonagram A); without grating quality of similar call of Dunlin (BWP). Given in flight; sound of flock is a pleasant twitter.



A R. Swaby; Price, SA, Nov. 1979; P36

PLUMAGES Prepared by A.M. Dunn and D.I. Rogers. First migrate S in distinctive juvenile plumage. Undergo partial first pre-basic moult into immature non-breeding plumage shortly after arrival in non-breeding areas. Usually replace some outer primaries in first pre-supplemental moult, Jan.–Mar. Most stay in non-breeding areas during first austral winter, undergoing partial pre-breeding moult to immature breeding plumage during winter (though some may skip this moult). Adult non-breeding plumage first attained in second pre-basic moult. Thereafter, partial pre-alternate moult to breeding plumage occurs just before n. migration, and complete pre-basic moult to non-breeding plumage occurs mostly just after s. migration. Sexes differ slightly in breeding plumage; similar in non-breeding plumage. Probably first breed late in second year.

Adult male breeding (Second and subsequent alternate). **Head and neck** Crown and most of forehead, black-brown (119) with rufous (40) edges to feathers giving streaked appearance. Feathers round base of bill (including chin), off-white, lightly speckled black-brown (119) and rufous-brown (c240). Rest of head, neck and throat, rufous-brown (c240); lores, cheeks, ear-coverts, supercilium and hindneck, faintly streaked or spotted dark brown (121) (forming varying dusky loreal stripe in some) with a few white feathers on cheeks. All feathers finely tipped white when fresh. **Upperparts** Mantle and scapulars, black-brown, boldly spotted or mottled rufous and white; feathers mostly black-brown (119) with pairs of rounded rufous (c40) notches along margins and white spots near sides of tip; some smaller feathers, black-brown (119) with rufous (c40) edges and white tips. Some have a few, usually grey, longer (outer) scapulars, either retained from non-breeding or fresh and intermediate in appearance between breeding and non-breeding. Back and rump, mostly dark brown (121) with narrow off-white fringes and black-brown (119) shaft-streaks to feathers. Uppertail-coverts, white with faint black-brown (119) barring. **Underparts** Feathers of breast, belly and flanks, mostly rufous-brown (c240) with thin dark-brown (121) subterminal band, narrow white fringe and concealed grey-black (82) bases; with wear, white fringes and most subterminal bands disappear, leaving underparts almost uniform rufous-brown (c240); some scattered feathers like non-breeding plumage, but with very faint rufous-brown (c240) subterminal bar. Lower belly, rufous-brown (c240) in some; in others, white with rufous (40) wash and dark-brown (121)

subterminal band to feathers. Vent, white with rufous wash (c240) in some; feathers have concealed grey-black (82) bases. Undertail-coverts, white with dark-brown (121) subterminal bar, chevron or spot; some smaller feathers washed rufous (c40) across middle. **Tail** T1, uniform dark brownish-grey (brownish 83) with narrow white fringes and narrow black-brown (119) subterminal fringe; t2–t6 retained from non-breeding plumage. **Upperwing** Mostly retained from non-breeding. Always replace tertial coverts and inner or all tertials and some replace varying number of innerwing-coverts (especially median coverts). Most fresh tertials and tertial coverts, black-brown (119) with narrow rufous (c40) edges and white tips but some (probably those grown earliest in pre-alternate moult) have grey-brown centres and little rufous on edges, often resembling non-breeding feathers. Fresh innerwing-coverts brownish-grey (brownish 84) feathers with very narrow grey-black shaft-streaks, narrow white tips and rufous (c40) edges. **Underwing** Retained from non-breeding plumage.

Adult female breeding (Second and subsequent alternate). Varies greatly, possibly becoming brighter when worn (BWP). Differs from adult breeding male by: wider white tips to fresh feathers of head and body; and feathers of underparts often have pronounced black-brown (c119) subterminal bars, and broader white tips when fresh. Some females are much paler: supercilium, white, meeting white chin and base of bill; crown, hindneck and scapulars, greyer, with black-brown (119) restricted to centre of feathers and rufous (c40) mainly restricted to sides of bases of feathers; often have mostly grey-brown feathers, like non-breeding, among outer scapulars and tertials; underparts, mainly white, narrowly barred black-brown (119) from breast to belly and flanks, and with rufous (c40) bases to feathers of throat, breast and upper belly. Intermediates occur, differing most obviously from males by duller hindneck, heavier black-brown barring on underparts, and more white on vent and lower belly.

Adult non-breeding (Second and subsequent basic).

Head and neck Feathers of forehead, crown and nape, brownish grey (c79) with slightly darker shaft-streaks. Broad white supercilium extends from base of upper mandible to above ear-coverts; slightly streaked brownish-grey (c79) behind eye. Lores, brownish grey (c79), lightly speckled white. Ear-coverts, sides of neck and hindneck, brownish-grey (brownish 79) with white edges to feathers, giving streaked appearance. Lower face, off-white, finely streaked grey, grading to white chin and throat. Ear-coverts and area just below eye can be darker than rest of face, and join loreal stripe to form varying dark eye-stripe. **Upperparts** Mantle and scapulars, brownish grey (brownish 79) with off-white tips to feathers and very narrow grey-black shaft-streaks; larger scapulars more distinctly tipped white. Back and rump, dark brown (c121) with very narrow black-brown (119) shaft-streaks and white fringes. Uppertail-coverts, mostly white; some feathers have dark-brown (121) central wedge and some have grey-black (c82) base and dark-brown (121) subterminal blotches. **Underparts** Mostly white. Sides of breast and foreneck have varying pale brownish-grey wash overlain by fine dark streaking; in some, greyish wash and dark streaking extend across whole upper breast to form varying gorget. Feathers of foreneck and upper breast, light grey-brown (c119C) to brownish grey (c79) with broad white fringes and very narrow dark-brown (121) shaft-streaks; feathers at sides of breast often have narrower white fringes. **Tail** T1, uniform dark brownish-grey (brownish 83) with narrow white fringes; t2–t6, lighter, with white shafts and concealed white bases. **Upperwing** Marginal and lesser secondary cov-

erts, dark brown (121) with very narrow off-white fringes. Median secondary coverts, brownish grey (brownish 84) with very narrow grey-black shaft-streaks and narrow white fringes, which disappear with wear. Greater secondary coverts, brownish grey (brownish 84), broadly tipped white. Lesser, median and greater primary coverts, dark greyish-brown (greyish 121), narrowly tipped white; tips much broader on inner greater primary coverts. White tips of greater primary and secondary coverts form narrow white wing-bar. Alula, dark greyish-brown (greyish 121). Primaries, black-brown (119), grading to light grey-brown (c119C) basally, with white base to inner webs; shaft of primaries, white, with narrow brown (119A–119B) tips and broad brown (119A–119B) bases. Secondaries, brownish grey (brownish 79) with large patch of white along edge of inner web; inner secondaries narrowly fringed white. Tertials, brownish grey (brownish 79), narrowly fringed white and with black-brown (119) shafts. **Underwing** Marginal and lesser coverts, brown (28) with white tips. Outermost greater primary coverts, brownish grey (79), tipped white. Rest of coverts, white. Primaries grade from pale grey (86) at base to dark grey (83) at tip. Secondaries, light grey (85) with white basal half of inner web; innermost secondaries fringed white.

Juvenile Differences from adult non-breeding: **Head and neck** Forehead and crown, black-brown (119), mottled or streaked when fresh by buff (c123D) fringes to feathers; appear darker than hindneck. Some have buff or off-white lateral crown-stripes, often joining supercilium to give effect of split supercilium. White of ear-coverts, sides of neck and lower throat, washed light brown (c39) to pink-buff (c121D), which fades to buff (c123D) or off-white with wear. **Upperparts** Feathers of mantle and scapulars, greyish-brown (c79), grading to black-brown (c20) distally, with black-brown (119) shafts and pale buff-brown (pale 39) fringes that quickly fade to off-white. Pale fringes give boldly scaled appearance. Greyish-brown bases of feathers more exposed on longer (outer) scapulars, which contrast more with blacker mantle. Feathers of back and rump have pink-buff (121D), not white, fringes. Uppertail-coverts, white; when fresh, some feathers have pale-buff (c123D) wash at tip or black fringes but do not have black markings of most adults. **Underparts** Breast has buff (c123D–121D) wash when fresh, which can form distinct gorget (buff extends onto belly in a few). Dark streaks of sides of breast, finer and less conspicuous than in adult non-breeding. **Tail** Feathers have fine buff (c123D) edges and broad buff (c123D) tips when fresh; t1 may have black-brown (c119) subterminal marks and some feathers occasionally mottled buff or off-white in centre. **Upperwing** Median and lesser coverts, grey-brown (c91) with dark-brown (c219) shafts, dark-brown (c219) to black-brown (119) subterminal fringe or bar, and contrasting broad buff (c123D) fringes that fade to off-white when worn. Tertials, greyish brown at base grading to black-brown (c20) distally, with contrasting pale buff-brown (pale 39) fringes; sometimes have faint buff (c123D) submarginal marks.

First immature non-breeding (First basic). Like adult non-breeding but retain worn juvenile feathers from back to uppertail-coverts and juvenile rectrices, outer tertials and all wing-coverts and remiges. Most easily aged on condition of primaries (see Ageing), as buff fringes of retained juvenile plumage mostly worn away, but often some fringes remain on innermost median secondary coverts and tertials. Retained juvenile plumage on back, rump and wing-coverts, browner and contrasts more with fresh non-breeding plumage than do old feathers in adults undergoing post-breeding moult.

First immature breeding (First alternate). Vary greatly

and most easily aged on moult of primaries (see Ageing). Many appear like first immature non-breeding; either attain alternate plumage in which feathers are like those of non-breeding plumage, or do not undergo pre-alternate moult. Some have many scattered breeding feathers on throat, breast, belly and mantle, which resemble those of adult breeding. Many others have feathers intermediate between adult breeding and adult non-breeding. Amount of rufous-brown (c240) on feathers of breast can vary greatly between individuals; some mostly rufous-brown (c240) as in adult breeding, some white with a faint rufous-brown (c240) wash, some white with small rufous-brown (c240) subterminal marks, some all white. Half of the skins (MV) of birds collected in Aug. of their second year contained at least some rufous alternate plumage.

BARE PARTS Based on photos (Farrand 1983; Pringle 1987; Chandler 1989), descriptions (BWP; AWSG) and labels of museum skins (HLW, MV). **Adult, Juvenile** Bill, grey-black (82) to black (89); on some, base slightly paler. Iris, dark brown (c121). Legs and feet, grey-black (82); brown or olive tinge reported occasionally (BWP) but no such records from HANZAB region.

MOULTS Based on published material from Aust. (Thomas & Dartnall 1971b; Paton *et al.* 1982; Barter 1986a,b,c; Rogers *et al.* 1990) and overseas (Elliott *et al.* 1976; Pienkowski *et al.* 1976; BWP), and 31 Aust. skins (HLW, MV). **Adult post-breeding** (Third and subsequent pre-basic). Complete, primaries outwards. Moult of body begins about July, before leaving breeding areas, or in staging areas during migration; suspended during migration. Starts with scattered feathers of head, neck, mantle, scapulars and underparts; non-breeding appearance attained Sept.–Oct. In HANZAB region, moult of primaries occurs in non-breeding areas; in Europe and n. Africa, some moult all primaries rapidly (40–70 days) at staging areas or begin moult of primaries while staging and then suspend moult till arrival in non-breeding areas (BWP). Timing of moult of primaries dependent on arrival date in non-breeding areas: in Vic., primary-moult of males begins early Oct., 1–2 weeks before females (Barter 1986b); in Tas., timing similar, but differences between sexes not examined; mostly begins Sept.–Oct., but some begin early Nov. (Barter 1986a); records of birds starting Aug. (Thomas & Dartnall 1971b) were probably of birds in second pre-basic; in nw. Aust., males start late Aug. (2–3 weeks before males in Vic.) and females 2 weeks later (2–4 weeks before females in Vic.) (Barter 1986c). Most birds of both sexes complete moult of primaries, late Jan.–early Feb. in Vic. and Tas. (Thomas & Dartnall 1971b; Barter 1986a,b); completion dates in nw. Aust., not known. Sexual differences in timing of moult of primaries also observed in Morocco and Mauritania (Pienkowski *et al.* 1976; Wilson *et al.* 1980). Published estimates of duration of moult of primaries include 120 days in Vic. (Starks 1983) and 125–133 days in Tas. (Thomas & Dartnall 1971b; Barter 1986a); like extralimital estimates (Elliott *et al.* 1976; Dean 1977), these may be affected by inadvertent inclusion in the analyses of birds in second pre-basic moult. Secondaries moult inwards, starting after p4 or p5 has been shed and finishing before moult of primaries complete (Thomas & Dartnall 1971b). Moult of tail begins shortly after start of moult of secondaries and finishes at about the same time as moult of primaries; sequence centrifugal in some, irregular in others (Thomas & Dartnall 1971b). See BWP for more information on timing of moult in Africa. **Adult pre-breeding** (Second and subsequent pre-alternate). Partial; head,

neck, mantle, underparts, most scapulars, some inner median secondary coverts, inner or all tertials, central rectrices and, sometimes, central uppertail-coverts. Rarely, begins before pre-basic moult of primaries is complete. In Vic., males start late Jan.; some have completed moult before leaving HANZAB region and all probably finished well before arrival in breeding areas; females start mid-Feb., probably finishing after arrival in breeding areas (Barter 1986b). Females often moult less plumage than males. Moult suspended during migration; also said to be suspended during period of gain in weight before migration (Thomas & Dartnall 1971b; BWP). **Post-juvenile** (First pre-basic). Partial; extent usually similar to that of adult pre-breeding. Moult of body begins Nov., and finished Jan.; some may moult scattered feathers, Feb.–Mar. Most begin to replace tertials and rectrices, late Nov.–Dec.; often do not moult t5 or t3–t5 (Paton *et al.* 1982). Very few undergo complete post-juvenile primary-moult (Elliott *et al.* 1976; Paton *et al.* 1982). **Post-juvenile moult of primaries** (First pre-supplemental). Partial, involving varying numbers of remiges; undertaken by 88% of birds in Vic. and 90% in n. WA (Barter 1986c). In Vic., most moult some primaries, late Jan. to early May (usually mid-Feb. to end Apr.), replacing outer 4.3 (1.35; 1–8; 115) feathers; also moult some secondaries, Feb.–Mar., beginning midway along tract and proceeding inwards (often skipping some feathers). A few arrest moult of remiges (Paton *et al.* 1982). In n. WA, moult similar but 4% moult all primaries (none do so in Vic.); apparently begin slightly earlier in n. WA, where moult completed by early Apr. (Barter 1986c). Similar moult-strategies reported from South Africa, Zimbabwe and Indonesia (Elliott *et al.* 1976; BWP), but in inland Kenya, only 20–30% of immatures moult outer primaries (Pearson *et al.* 1974). **First immature pre-breeding** (First pre-alternate). Varies greatly. Some seem to moult directly from first immature non-breeding to second non-breeding plumage, but many undergo a first pre-breeding moult, beginning about June. Extent varies considerably between individuals, but often involves breast, throat, belly, scapulars, and tertials. **First immature post-breeding** (Second pre-basic). Similar in extent to adult post-breeding. Begins earlier than in adults, in first half of Sept. or even in Aug. in Vic. where all in active moult by late Oct.; in n. WA, begins about 4 weeks earlier than in Vic. and Tas. (Barter 1986a). Finish at about same time as adults.

MEASUREMENTS (1) Indonesia and Aust., adults (including immatures with first supplemental p10); combined data from BWP and Aust. museums (HLW, MV). (2) Aust., adults (including juveniles with first supplemental p10), skins (HLW, MV). (3) Tas., ages combined, skins (Thomas & Dartnall 1970). (4) Aust., adults, live (Rogers *et al.* 1990); sexing based on HUMPS methods of Rogers (1995).

	MALES	FEMALES	
WING	(1) 130.1 (2.19; 125–134; 23)	132.0 (2.66; 126–136; 18)	*
	(3) 126.5 (4.0; 118–135; 33)	129.8 (3.4; 124–135; 19)	**
TAIL	(2) 47.0 (2.12; 43–50; 9)	47.8 (2.67; 43–51; 11)	ns
BILL	(1) 36.5 (1.76; 32.0–39.6; 26)	39.9 (2.06; 35.7–43; 21)	**
	(3) 35.6 (2.35; 31.5–40.0; 34)	39.5 (2.5; 35.5–43.5; 23)	**
	(4) 37.0 (1.55; 550)	41.0 (1.49; 265)	**
TARSUS	(1) 29.6 (1.14; 27–32.3; 29)	30.6 (1.20; 28.5–33; 21)	**
	(3) 28.4 (1.7; 26–30; 33)	29.8 (1.2; 27.5–33; 23)	**
TOE C	(2) 23.4 (0.58; 22.5–23.9; 5)	23.2 (0.71; 22.3–24.1; 6)	ns

Wings with juvenile p10 (juvenile and immature) slightly (c. 2 mm) but significantly shorter than wing of adult; wing-length similar to that of adult after p10 replaced in first pre-supplemental moult. In Europe, tail of juvenile c. 2 mm shorter than that of adult; bill, tarsus and toe similar to adult after mid-Aug. (BWP). Extralimital measurements, mostly of bill, in BWP (w. and central Europe), Elliott *et al.* (1976) (South Africa), Prater *et al.* (1977) and Minton & Stanley (1972). Review of data on bill-length shows tendency for males to migrate farther S than females (Barter 1985, 1987).

WEIGHTS (1) Vic., adults, live (Barter 1986b); sexing based on length of bill, using PCF methods of Griffiths (1968).

	MALES	FEMALES	
Aug.	(1) 53.6 (3.8; 16)	56.7 (3.8; 4)	ns
Sept.	(1) 55.2 (3.5; 41)	57.3 (4.6; 11)	ns
Oct.	(1) 58.2 (4.4; 72)	59.5 (4.1; 35)	ns
Nov.	(1) 54.5 (3.4; 110)	55.9 (3.4; 50)	**
Dec.	(1) 56.6 (4.6; 205)	59.6 (4.1; 74)	**
Jan.	(1) 55.5 (3.6; 116)	57.6 (3.2; 46)	**
Feb.	(1) 64.0 (7.7; 180)	65.5 (8.5; 103)	ns
Mar.	(1) 72.5 (8.3; 120)	74.9 (8.6; 99)	*
Apr.	(1) 85.3 (1.5; 4)	89.0 (4.6; 11)	ns

(2–3) Sexes combined, live: (2) Tas. (Barter 1984); (3) Aust. (Rogers *et al.* 1990).

	ADULTS	JUVENILES-IMMATURES	
Sept.	(2) 57.2 (3.3; 15)	–	
Oct.	(2) 55.4 (2.8; 67)	–	
Nov.	(2) 56.3 (2.4; 25)	53.9 (2.8; 12)	**
Jan.	(2) 55.2 (2.9; 88)	55.2 (3.6; 189)	ns
Feb.	(2) 58.4 (3.8; 251)	58.6 (3.3; 28)	ns
Mar.	(2) 68.7 (6.5; 62)	55.5 (3.2; 11)	**
early Apr.	(3) 92.9 (4.6; 7)	–	

Mean weight of adults varies little Sept.–Jan., but increases markedly from early Feb. in Vic. (Barter 1986b), and from Mar. in Tas. (Thomas & Dartnall 1971b), as adults gain weight before migration. During Mar. in Tas., weight of males increased from an average of 57.8 g (n=4) to 66.8 g (n=4); females from 59.8 g (n=6) to 69.5 g (n=6). First-year birds also gain weight during Jan.–Feb. in Tas., but weight declines in Mar. (Barter 1984). Most first-year birds leave Tas., moving N at least as far as Vic. during winter, and may be reason first-year birds gain weight (Barter 1984). Similar changes in weights occur in Africa (see Elliott *et al.* 1976).

STRUCTURE Wing, long, narrow and pointed. Eleven primaries; p10 longest; p9 1–4 mm shorter, p8 7–12, p7 17–22, p6 26–33, p5 36–42, p4 44–47, p3 51–54, p2 56–61, p1 63–72; p11 minute. Fourteen secondaries, including four tertials; tips of longest tertials fall between p5 and p8 on folded wing. Tail, short and almost square; 12 rectrices; t1 and t6 often projecting slightly. Bill, long and slender, with decurved distal half; c. 1.5 times length of head; upper mandible slightly longer than lower. Nostril, long, slit-like and set in shallow nasal groove that extends about two-thirds length of bill. Rarely, birds observed with very short bills (same length as head), which can cause confusion with White-rumped Sandpiper (D.W. Eades). Tarsus, long and slender; scutellate. Lower 12–20 mm

of tibia exposed. Outer toe c. 87% of middle, inner c. 83%, hind c. 31%.

AGEING After arrival in Aust., Aug.–Dec., three age-classes distinguishable: (1) juveniles and first-immature non-breeding; (2) adults and (3) birds undergoing second pre-basic moult. Juveniles arrive in full juvenile plumage, with fresh primaries, which are retained until at least Feb.; first-basic plumage attained by about early Dec. Adults arrive with all primaries worn; moult of primaries begins soon after arrival and remains active until Jan.–Feb. Most birds undergoing second pre-basic moult can be distinguished before about late Nov. by very worn inner primaries, which contrast with newer outer primaries; by late Nov.–Jan., new inner primaries contrast only slightly with slightly worn outer primaries. Some birds in second pre-basic (those that did not undergo first pre-supplemental moult and retained all juvenile primaries), recognizable till about Jan. by extremely worn outer primaries. All birds with fresh wings aged as adults from about Jan., but first-immature non-breeding separable at this time by heavy abrasion of primaries or active moult in outer primaries leaving worn inner primaries.

GEOGRAPHICAL VARIATION Slight; no subspecies. W. populations, which move through Europe to non-breeding areas in Africa, differ from populations of e. flyway by: in females, underparts have more dark barring and, in worn breeding plumage, seldom uniformly rufous (BWP); wing apparently slightly longer: adult males 132 mm (2.06; 12), adult females 133 mm (2.66; 18). Bill of adult females from Indonesia said to be longer than those from Europe (BWP) but based on few data; other measurements of bill-length from e. flyway (see Barter 1985) show no such difference.

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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 Juvenile; 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

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