

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. Moult-strategies of subadults complex and vary considerably with species, route of migration and age of first breeding. Adult plumage attained when 3–21 months old; most scolopacids of our region (except snipes) first attain adult plumage through partial first pre-alternate moult when c. 8–11 months old, or through complete second pre-basic moult when c. 12–16 months old (see discussion of Moults in General Introduction). Swift runners; wade expertly and some species swim habitually (Phalaropodinae). Stance often upright. Flight, fast and direct, often in tight flocks.

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

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

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

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

In non-breeding areas, most species undertake regular local movements between feeding and roosting sites or between different feeding sites. Most local movements are in response to tides, which affect exposure of feeding grounds (e.g. Hindwood & Hoskin 1954; Carter *et al.* 1976; Saunders & de Rebeira 1985; Smith 1985; Lane). Some roosting and feeding sites are close together, birds gradually dispersing from or returning to roosting sites as tides fall and rise (e.g. Robertson & Dennison 1979). At other sites, roosting and feeding sites farther apart, with birds even flying between islands or between islands and mainland (Saunders & de Rebeira 1985); in Capricorn Grp, Qld, Ruddy Turnstones and Grey-tailed Tattlers *Heteroscelus brevipes* fly at least 4 km from Tyron I., where roost at high tide, to North West Reef, where thought to feed (Prendergast *et al.* 1985); at Cairns, Qld, Whimbrels *Numenius phaeopus* move to mouth of Barron R. every evening (Amiet 1957) and can travel up to c. 20 km between roosting and feeding sites (McKenzie 1967; Garnett 1989). In poor weather, such as days of high winds or in storms, may move to sheltered areas other than normal roosting sites, such as near-coastal wetlands or pools in dunes (e.g. Crawford 1972; Forest 1982; Aust. Atlas). Some species dispersive, either locally or over longer distances (see accounts), sometimes in response to availability of food or availability of suitable wetland habitat. In NZ, Common Greenshanks *Tringa nebularia* tend to move round within harbours rather than returning to roosting site each day (Sibson 1965) and, in Tas., Common Greenshanks appear to move between coastal sites (Wall 1953); Curlew Sandpipers apparently move from 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; Fjeldså 1977; BWP).

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

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Calidris acuminata **Sharp-tailed Sandpiper**

COLOUR PLATE FACING PAGE 321

Totanus acuminatus Horsfield, 1821, *Trans. Linn. Soc. Lond.* 13: 192 — Java.

The specific epithet is Latin (*acuminatus*) for pointed (from *acuere*, to sharpen), referring to the pointed tail-feathers.

OTHER ENGLISH NAMES Asiatic Pectoral, Siberian Pectoral, Brown-eared Sandpiper; Sharp-tailed Stint, Little Greenshank and Snipe; in error, Marsh Sandpiper or Marsh Tringa.

MONOTYPIC

FIELD IDENTIFICATION Length 17–22 cm; wingspan 36–43 cm; weight c. 65 g. Small to medium-small portly sandpiper with flat back, pot-belly and somewhat drawn-out rear end; small, flat head on short neck; short, slightly decurved bill; and medium-length legs. At rest, primaries level with or slightly short of tip of tail; primary projection short in adults, moderate to long in juveniles. Very similar in size, shape,

general appearance and plumage to Pectoral Sandpiper *Calidris melanotos*; unlike Pectoral, marked differences in pattern of underbody with season and age. In flight, show indistinct narrow white wing-bar and prominent white sides to dark-centred rump and tail. Sexes similar. Marked seasonal variation. Juvenile distinctive. Immatures separable.

Description Adult breeding Forehead and crown, rufous,

streaked black, bordered by prominent off-white supercilium (which is narrowly streaked black throughout); supercilium narrowest over eye and broader above lores and ear-coverts. Broad clean white eye-ring contrasts with supercilium, narrow dark-brown loreal stripe, and dark patch on ear-coverts (which, in some, forms broad dark eye-stripe tapering to bill). Rest of head and neck, brown, grading to off-white on cheeks, chin and throat and with fine black streaks grading to fine spotting on cheeks and sides of chin and throat; chin usually unmarked, white. Mantle, back, scapulars and tertials, black densely streaked by broad rufous edges and with dull greyish-brown or white tips to scapulars; white tips of upper row of lower scapulars may align to form thin scapular lines; often retain a few dull non-breeding scapulars and tertials. Innerwing-coverts mostly dark grey-brown with narrow off-white fringes; varying number of inner median and greater coverts often more brightly coloured and patterned as rest of upperparts. Foreneck, centre of upper breast, sides of breast and fore-flanks, rufous-brown grading to buff on mid-flanks, overlain with heavy black spots and short streaks; rest of underbody, white, with bold black chevrons on lower breast and rear flanks, prominent dark spear-shaped markings and finer streaks on vent and undertail-coverts, and some fine markings sometimes extending onto sides of belly. In fresh plumage or early stages of moult to breeding plumage, appear more finely spotted below. In flight, show: broad dark line through centre of rump and narrower line through central uppertail-coverts, with white at sides of rump and uppertail-coverts (latter with dark streaks and V-shaped marks; often also visible at rest). Centre of tail, blackish brown, with rest paler grey-brown; upperwing, blackish brown, somewhat paler on bases of remiges and with off-white primary-shafts and clear narrow white wing-bar along tips of greater coverts; underwing, white, with contrasting grey remiges and greater primary coverts, and dark mottling along leading-edge. Bill, black, with paler grey, yellow-brown or pink tinge at base, particularly of lower mandible. Iris, dark brown. Legs and feet, olive or greyish olive to olive-yellow. **Adult non-breeding** Duller than adult breeding; greyer above with more contrasting head-pattern, and less heavily marked below. Head and neck, paler grey-brown, with fine dark streaks (not spots), though still with distinct rufous cap; supercilium more distinct, though eye-ring contrasts less; patch on ear-coverts better defined and darker, and chin and throat, unmarked white. Upperparts strongly patterned, appearing mottled: feathers of mantle and back, and scapulars, grey-brown, with ill-defined blackish centres or streaks and, when fresh, narrow white fringes; on some, scapulars (especially upper rows), tertials and inner few greater coverts have warmer rufous-brown edges grading to white at tips of feathers; if not too worn, pale fringes may align to form fairly distinct lines along edges of mantle and upper row of lower scapulars. Innerwing-coverts as rest of upperparts, but plainer, grey-brown with fainter dark shaft-streaks. Foreneck and breast, pale grey-brown, breaking into grey-brown smudges along fore-flanks, and finely streaked black, heaviest on foreneck and sides of breast; in some, whole chest heavily streaked darker, forming gorget fairly sharply cut off from white upper belly in straight line across lower breast. Rest of underbody, white, with fine dark streaks on rear flanks grading to thicker and bolder streaks on vent and undertail-coverts. **Juvenile** Distinctive; differs from adult breeding by: More contrasting head-pattern; supercilium cleaner white and more prominent, broadening behind eye to end above ear-coverts, and contrasting with rufous cap, which appears to sit forward on head; chin and throat, unmarked, white; and cheeks,

whiter and more finely streaked, making dark eye-stripe appear more prominent. Hindneck and sides of neck, warmer orange-buff and more finely streaked darker. Upperparts appear black, with bold chestnut or orange-buff stripes and white spots; mantle, back, scapulars, tertials and inner greater secondary coverts, black, with chestnut or orange-buff fringes; fringes grade to white at tips of feathers of outer mantle and scapulars, and, in fresh plumage, white tips align to form prominent mantle V and line along lower row of upper scapulars, and, sometimes, weaker second line along upper row of lower scapulars; rest of innerwing-coverts similar to rest of upperparts, but with paler and duller buff or white tips. Foreneck, breast and fore-flanks, orange-buff, with gorget of fine dark streaks across foreneck (sometimes broken in centre) grading to slightly thicker and sparser streaking on sides of upper breast and on fore-flanks. Rest of underbody, white, with some fine dark streaks on rear flanks and vent and heavy dark streaks on undertail-coverts. With wear, mantle and scapulars appear darker and more uniform; orange-buff tones elsewhere on upperparts and on chest become paler, and pale edges of innerwing-coverts fade to white. Plumage distinct till at least late Nov. Bare parts, as adult except legs and feet slightly paler, more yellow. **First immature non-breeding** During austral spring to early summer, distinguished from adult non-breeding by many retained, worn juvenile innerwing-coverts and, occasionally, some tertials, contrasting with fresh non-breeding plumage; perhaps also by warmer rufous cap and more uniform grey-brown centre of upper breast (see Plumages). Those that replace all juvenile plumage during spring-summer inseparable from adult non-breeding once moult complete. Those that retain juvenile remiges throughout first year separable from adult during summer by worn primaries (cf. moulting or fresh in adults); most that moult outer primaries (Dec.–Mar.) separable during Feb. to Sept. or Oct. by contrast between fresh outer and very worn inner primaries. **First immature breeding** Poorly known (see Plumages). Similar to or inseparable from adult breeding, though plumage may be slightly duller, tending to have small spots rather than chevrons on flanks and sides of breast (though adults moulting to or in very fresh breeding plumage may also show similar fine spotting in these areas). Differences in moult of remiges, as in first immature non-breeding, may also separate from adult breeding: during Feb.–Sept., those with worn primaries, or fresh primaries but worn secondaries, or marked contrast between fresh outer and worn inner primaries are readily aged as first immature breeding.

Similar species Most likely to be confused with very similar **Pectoral Sandpiper**, which overlaps in size with Sharp-tailed: females similar to or slightly smaller than Sharp-tailed; males often bigger than largest Sharp-tailed; differences useful only in direct comparison. In shape and proportions, Pectoral looks slightly slimmer (less pot-bellied) with shorter legs, longer neck and smaller head, with more rounded crown and slightly more sloping forehead. Bill slightly longer and more decurved, (often markedly so in some males, though in some bill may be short and straight or only faintly decurved). Stance more upright than Sharp-tailed. While both species stand erect with head high on upstretched neck when alarmed, Pectoral has a very different, somewhat snipe-like appearance. In non-breeding plumage, Pectoral best distinguished by differences in size and structure (above) with following characters (in rough order of importance): (1) **GORGET**: foreneck, breast and fore-flanks, off-white to buff and more uniformly and coarsely streaked black, forming somewhat darker and always more pronounced gorget, which is much more sharply

demarcated from clean white belly; line of demarcation is slightly lower on underbody, is drawn into characteristic downwards point in centre, and has a distinctive spiked edge (in Sharp-tailed, gorget paler greyish-brown, more finely and sparsely streaked across foreneck, central upper breast and on sides of lower breast; lower border is more diffuse and merges into white of upper belly; and white of upper belly tends to intrude upwards onto centre of lower breast, so lower border of gorget appears gently rounded, straight or slightly concave, never with central point of Pectoral). (2) REST OF UNDERBODY: white except for some messy dark streaking along flanks and, at most, a few fine dark streaks on lateral undertail-coverts (cf. vent and undertail-coverts always heavily streaked darker on Sharp-tailed). (3) HEAD AND NECK: slightly darker, browner and more coarsely streaked, with less contrasting pattern, and no rufous on forehead and crown (though some very worn Sharp-tailed may have rufous reduced or absent); supercilium, broader, more bulging and prominent in front of eye than behind, with usually obvious pale lateral crown-stripes often joining fore-supercilia to create split supercilium; also, supercilia and lateral crown-stripes typically leave only narrow dark central ridge on forehead, giving rather snipe-like head-pattern; dark loreal stripe slightly narrower, darker and better defined; dark patch on ear-coverts less distinct; and eye-ring narrower, less prominent and contrasting. (4) UPPERPARTS: darker and browner. (5) BILL: appears bi-coloured on most, with larger paler area on basal third to half of both mandibles (on Sharp-tailed, pale base is duller grey, yellow-brown or pink, and smaller, usually confined to lower mandible). (6) LEGS AND FEET: yellower and brighter, brownish yellow to orange-yellow. (7) FLIGHT-PATTERN: wing-bar slightly narrower and less distinct; in close views, whitish shaft of outermost primary contrasts with duller brownish shafts of rest (on Sharp-tailed, all primary-shafts uniformly pale). (8) FLIGHT CALL: when flushed, readily distinguished by characteristic loud, harsh, reedy *trrit*, *kirrp*, *tiyrrp* or *kreep* call, often repeated and resembling harsher, lower-pitched version of call of Curlew Sandpiper or even some trilling notes of Budgerigar *Melopsittacus undulatus*. In breeding plumage, Pectoral easily separated by above differences (except upperparts) and well-streaked and sharply demarcated gorget and mainly clean white rest of underbody (some Sharp-tailed, moulting out of breeding plumage, may appear similar, though they never have sharply cut-off gorget with characteristic central point and spikey edge, and always have heavily streaked vent and undertail-coverts and markings elsewhere on underbody). Juveniles similar but easily distinguished by well-streaked gorget sharply demarcated from mainly clean white underbody; also separable by same differences in pattern of head and neck, bare parts and wing-bar as non-breeding (though many juvenile Pectorals have superficially similar rusty cap, it is not obviously tipped forwards and is duller, with rufous tones always paler than fringes of tertials, the reverse of pattern of Sharp-tailed). Can be confused with **Ruff** *Philomachus pugnax*, especially juveniles of each. Ruff is larger, with proportionately much longer neck and legs, and smaller, more rounded head with more sloping forehead. Non-breeding and juvenile Ruff have plainer, more open-faced expression; cap is never so rufous; supercilium less distinct; narrow tapering dark stripe behind eye is always more distinct than dark smudge in front of eye, and anterior lores are always pale (or paler than) rest of feathering round base of bill, and so lack clear dark loreal stripe. In non-breeding and juvenile plumages, Ruff does not have streaked foreneck and breast; and vent and undertail-coverts

are unmarked, without coarse dark streaking; upperparts of juvenile more uniformly scaled buff, sometimes with distinct off-white mantle V; in flight, easily separated by size, longer wings and slower, more measured wing-beats; and distinctive pattern of much larger white ovals almost reaching tip of tail on either side of thinner and sometimes incomplete dark central stripe; unlike Sharp-tailed, feet clearly project beyond tip of tail. Ought not to be confused with superficially similar but much smaller and more finely proportioned Long-toed Stint *Calidris subminuta* (q.v.).

Gregarious in non-breeding season; in small parties to large dense flocks (100s to 1000s). Freely associate with other small waders; in HANZAB area, typically feed and roost with Curlew Sandpipers and Red-necked Stints. Found on wide variety of coastal and inland wetlands and commonly on intertidal mudflats and coastal lagoons. Occasionally forage or roost on rocky and sandy beaches, mainly during migration. Forage on both wet and dry mud at edges of wetlands, often also feeding and roosting among flooded vegetation such as tussock grass or samphire. Often tame. Gait and feeding actions leisurely, similar to Pectoral Sandpiper; move slowly and steadily over substrate with head down and legs slightly flexed, combining picking with rapid shallow probing. When relaxed, stance more horizontal than that of Pectoral Sandpiper, emphasizing full chest and flat- or pot-bellied jizz; when alarmed, adopt upright stance with tail down and head held high on upstretched neck, identical to that of Pectoral; when in vegetation, may also crouch in alarm. Flight-action similar to that of Pectoral Sandpiper, lacking flutter of smaller congeners; leisurely, with loose measured wing-beats recalling those of female Ruff, only slightly faster; flushed birds quickly gather into small flocks, generally keeping low rather than towering. Occasionally seen in display during non-breeding months, with two birds chasing each other: in main display, adopt semi-erect posture with feathers of back and throat raised, wings stiffly dropped, and tail sometimes held vertically, fanned and vibrated sideways; second display involves same actions but with wings raised and arched, and wings, head and tail jerked up and down. Typical flight call distinctive; softer and less reedy than calls of Pectoral Sandpiper; typically utter *wheep*, *pleep* or *trrt* notes, often repeated or in short twittering sequence recalling call of Welcome Swallow *Hirundo neoxena*, e.g. *teet-teet-trrt-trrt* or *prtt-wheet-wheet*.

HABITAT In A'asia, prefer muddy edges of shallow fresh or brackish wetlands, with inundated or emergent sedges, grass, saltmarsh or other low vegetation; including lagoons, swamps, lakes and pools near coast; and dams, waterholes, soaks, bore drains and bore swamps, salt pans and hypersaline salt lakes inland (Favaloro 1943; Badman 1979; Badman & May 1983; Storr 1984a, 1987). Also saltworks and sewage farms (Smith 1964; Roberts 1981; Lane 1986). Use flooded paddocks, sedgelands and other ephemeral wetlands, but leave when they dry (Thomas 1968; Lane 1986). In NZ, prefer shallow open swampland, especially coastal saltmarsh and brackish lagoons where *Salicornia* and *Cotula* provide cover; less often use similar inland habitat, in wet fields of short grass, on open tidal mudflats and river estuaries (B.D. Heather). Occasionally, use intertidal mudflats in sheltered bays, inlets, estuaries or seashores (Thomas 1968; Loyn 1975; Dann 1981; Pegler 1981; Wakefield 1984); also swamps and creeks lined with mangroves (Storr 1984a,b; Garnett 1986). Thought to occupy coastal mudflats mainly after ephemeral terrestrial wetlands have dried out (Lane). In se. Gulf of Carpentaria, Qld,

frequent coastal mudflats during dry season, and move to ephemeral freshwater swamps in wet season (Garnett 1989). May be attracted to mats of algae and water weed either floating or washed up round terrestrial wetlands (Sibson 1970; Dann 1983), and coastal areas with much beachcast seaweed (Bransbury 1985; Storr 1987). Sometimes on rocky shores (Sibson 1970; Loyn 1975; Morris *et al.* 1990). Rarely on exposed reefs (Bransbury 1985). Also recorded on newly mown grass near runways of airport (Smith 1966).

Forage at edge of water of wetlands or intertidal mudflats; either on bare wet mud or sand, or in shallow water (Sibson 1966; Ewart 1973; Dann 1981, 1983; Vic. Atlas); also among inundated vegetation of saltmarsh, grass or sedges (Boehm 1960; Thomas 1968; Pegler 1983; Wakefield 1984; Garnett 1986). In se. Gulf of Carpentaria, Qld, forage on flats of soft mud next to mangroves (Garnett 1986). Feed in paddocks of short grass, well away from water but damp from recent rain (Smith 1964). In County of Northumberland, NSW, forage on coastal mudflats at low tide, and move to freshwater wetlands near coast to feed at high tide (Morris 1975). Occasionally on wet or dry mats of algae, and among rotting beachcast seagrass or seaweed (Dann 1983; Congreve & Congreve 1985; Wood 1985). Sometimes recorded foraging round edges of stony wetland (Sibson 1970), or among rocks in water (Smith 1964); rarely on exposed reef (Bransbury 1985).

Roost at edges of wetlands, on wet open mud or sand, in shallow water, or in short sparse vegetation, such as grass or saltmarsh. Occasionally on stony shores (Loyn 1975) or on rocks in water (Smith 1964). Recorded loafing on mat of floating waterweed during hot weather (Sibson 1970); also on branches of a dead gum tree lying on mudflat (Wakefield 1984).

DISTRIBUTION AND POPULATION Breed ne. Siberia, from delta of Lena R., E to Chaun Gulf, E of Kolyma R. delta; may have bred in Norway in 1970. Passage migrant through e. Mongolia, China, Korea, Japan, Micronesia, Philippines and se. Asia; rare in Philippines, Burma and Malay Pen.; uncommon Borneo; scarce Melanesia. Small numbers occur North America, mainly w. Alaska and Aleutian Is, and occasionally farther S along Pacific coast; casual visitor elsewhere in North America; rare on passage in Hawaii. Vagrant to Scandinavia, w. Europe, India, Sri Lanka, Fiji and Tristan da Cunha (Hachisuka 1931; Delacour & Mayr 1946; Kozłowa 1967; Bauer & Persson 1971; Smart 1971; Medway & Wells 1976; Ali & Ripley 1980; Smythies 1981, 1986; Myers *et al.* 1982; AOU 1983; de Schauensee 1984; White & Bruce 1986; Pratt *et al.* 1987; BWP).

Aust. Most of population migrates to Aust.; mostly in SE (Lane). Many inland records of birds on passage. **Qld** Recorded most regions; widespread along much of coastline (Aust. Atlas); very sparsely scattered inland, particularly in central (between Toomba L. and Tambo) and sw. regions (between SW of Boulia and Nappa Merry Stn, Cooper Ck). **NSW, Vic.** Widespread in most regions, especially coastal, but sparse in s. central-Western Plain and e. Lower Western Regions of NSW, and ne. and n.-central Vic. (NSW Bird Reps; Vic. Bird Reps; Vic. Atlas; Aust. Atlas). **Tas.** Mostly in coastal areas E of line from George Town to Hobart; scattered records on nw. coast, and w. coast from Henty R. and Port Davey; also islands in Bass Str. Occasionally inland (Thomas 1979; Tas. Bird Reps; Aust. Atlas). **SA** Widespread in e. half, E of line from Streaky Bay NE to Pandiburra Bore and Conchera Waterhole; also found N of L. Eyre, NW to Oolgawa Waterhole (c. 100 km

NNE of Oodnadatta), SW to Mintabie and SE to Nunn's Bore. Farther W, recorded at Twin Rocks and Cook, e. Nullarbor Plain (Badman 1979; Badman & May 1983; Klau 1988; Cox 1991; Aust. Atlas). **WA** Scattered records Nullarbor Plain and s. Great Victoria Desert. Widespread from C. Arid to Carnarvon; round coastal and subcoastal plains of Pilbara Region to sw. and e. Kimberley Division. Widespread but scattered inland records occur from Newman, E to L. Cohen, S to Boulder and W to Meekatharra; also Kimberley. Other inland sites include L. Gregory and Sturt Ck HS (Storr 1985a,b, 1986; Jaensch *et al.* 1988; Jaensch & Vervest 1990; Aust. Atlas). **NT** Mostly n. coastal regions, generally E to Groote Eylandt and Gove Pen., but also round McArthur R. and E of Borroloola. Widely but sparsely scattered inland S to n. Tanami Desert (Crawford 1972; Boekel 1976; Gibson 1986; H.A.F. Thompson & D.K. Goodfellow; Aust. Atlas); in S, recorded from Alice Springs, N to n. Napabie Ls and S to Uluru NP; isolated record in Simpson Desert at L. Caroline (Thomas 1970; Roberts 1981; Gibson & Cole 1988; Aust. Atlas).

NZ Regular visitor in small numbers. Information from CSN, NZCL and B.D. Heather. **NI** Widespread on coast. In Northland and Auckland, many records between Parengarenga and Manukau Harbours; in Firth of Thames; in Bay of Plenty, from Maketu estuary to Ohiwa Harbour. Scattered records on coasts of Gisborne and Hawke's Bay, between estuaries of Karakatuwhero and Porangahau R. Regularly recorded L. Wairarapa. In SW, mainly at estuaries of Waikanae and Manawatu Rs, and Wanganui R. estuary. Inland records from Awaiti and L. Rerewhakaaiti. **SI** In N, scattered records from Farewell Spit to L. Grassmere, including Nelson Haven and Wairau estuary. On e. coast, mostly between mouth of Ashley R. and Wainono Lagoon, including many at L. Ellesmere. Few records from Otago; often recorded in Southland lagoons from Awarua Bay to mouth of Waimatuku R., including Invercargill estuary. On w. coast, recorded at L. Ryan and Westport.

Norfolk I. Visitor in small numbers (McKean *et al.* 1976; Schodde *et al.* 1983). Up to 12, 1–13 Nov. 1971 (Moore 1985); up to 20, early 1970s (Hermes *et al.* 1986); single, Nov. 1975 (McKean *et al.* 1976); single, 19, 22 Nov. 1979 (Moore 1981); two, 5–20 Nov. 1980 (Moore 1981); 1–13, 31 Oct.–15 Nov. 1981 (Moore 1985); eight, Feb.–Mar. 1983 (Hermes *et al.* 1986); two, 12 Oct. 1984 (Hermes *et al.* 1986).

Lord Howe I. Four, specimens, 3 Oct. 1903 (Hindwood 1940); three, 19 Oct. 1974 (NSW Bird Rep. 1974); single, 16–17 Nov. 1986 (NSW Bird Rep. 1986).

Christmas I. Up to five, 15 Oct.–26 Nov. 1978 (Stokes *et al.* 1987).

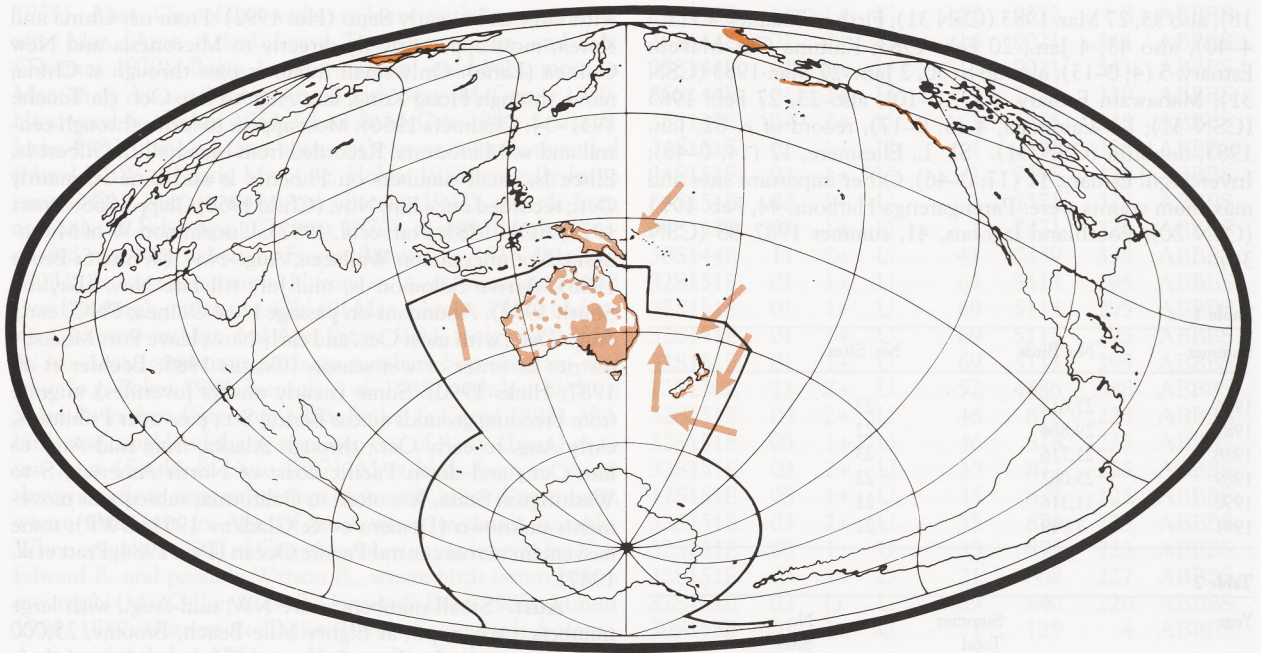
Cocos-Keeling Is Single, 4 Nov. 1993 (Carter 1994).

Kermadec Is Single, specimen, Oct. 1908 (Oliver); single, specimen, 29 Oct. 1910 (Sorensen 1964).

Chatham Is Chatham I.: unknown number, 1977; three, 26 Nov. 1981; unknown number, 1983; Te Whanga Lagoon: 2, 7 Dec. 1985; 5, 3 Dec. 1987; 20, 22 Nov. 1988 (Freeman 1994; CSN 30, 37; NZCL). The Forty Fours: single, 2 Dec. 1983 (Freeman 1994).

Snares I. Singles: Nov. 1968 (Warham & Keeley 1969); Nov. 1976–Mar. 1977 (Sagar 1977); Nov.–Dec. 1987 (P.M. Sagar).

Population Aust. Estimated at 166,000 (Watkins 1993). Totals for summer counts in Aust., 1986–91, summarized in Table 1 (Hewish 1986, 1987, 1989, 1990a; Anon. 1992; Naismith 1992). Sites of significance and maximum or average counts for summer and winter surveys round Aust., 1981–85, were: The Coorong, SA, 55,700; Eighty Mile Beach, WA,



25,000; Port Hedland Saltworks, WA, 20,000; Gulf St Vincent, SA, 17,000; Port Phillip Bay, Vic., 8800; far nw. lakes of NSW, 7400; se. Gulf of Carpentaria, Qld, 7300 (Lane). Other areas of international importance (≥ 4000 birds) (Watkins 1993) include: L. Buloke, 12,000; L. Gregory, WA, 10,000; Tullakool Saltworks, NSW, 10,000; L. Gol Gol, NSW, 6000; L. Tutchewop, Vic., 4562; L. Murdeduke, Vic., 4500; Reedy L., Vic., 4170; L. Eyre, SA, 4000. At L. Gregory, WA, estimated c. 14,000 in Mar. 1988 (Jaensch & Vervest 1990). Recorded on

40 of 197 wetlands surveyed in sw. WA, 1981–85 (Jaensch *et al.* 1988). NZ Estimated 100–200 annually (B.D. Heather). Totals for summer counts, 1983–92, summarized in Table 2; mean total summer count ($n=10$ summers): NI, 45 (26; 18–102); SI, 30 (30; 7–112) (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 Karikari Pen., 7 (5; 0–15); Kaipara Harbour, 4 (3; 0–8); Manukau Harbour, 9 (6; 2–

18), also 33, 27 Mar. 1983 (CSN 31); Firth of Thames, 13 (12; 4–40), also 43, 4 Jan., 20 Feb. 1983; Kaituna Cut–Maketu Estuary, 5 (4; 0–13), also up to 30, 2 Jan.–27 Mar. 1983 (CSN 31); Manawatu Estuary, 2 (3; 0–10), also 23, 27 Feb. 1983 (CSN 31); L. Wairarapa, 4 (5; 0–17), record of c. 82, Jan. 1983, doubtful (CSN 31). **SI** L. Ellesmere, 12 (14; 0–48); Invercargill Estuary, 11 (17; 0–46). Other important sites and maximum counts were: Parengarenga Harbour, 44, Feb. 1973 (CSN 20); Southland lagoons, 41, summer 1987–88 (CSN 36).

Table 1

Summer	No. Birds	No. Sites
1986	27,612	23
1987	29,864	22
1988	21,716	23
1989	25,062	22
1990	11,316	21
1991	7,849	21

Table 2

Year		Summer Total	No. Sites
1983	NI	31	31
	SI	51	43
1984	NI	27	44
	SI	7	73
1985	NI	102	79
	SI	30	65
1986	NI	79	75
	SI	14	73
1987	NI	61	54
	SI	112	63
1988	NI	27	65
	SI	20	54
1989	NI	36	30
	SI	17	56
1990	NI	18	31
	SI	19	40
1991	NI	29	37
	SI	20	35
1992	NI	40	34
	SI	8	44

MOVEMENTS Migratory; breed ne. Siberia, and move to non-breeding areas S of Equator (BWP). On passage, observed in large flocks (Coates 1985) and landing on ships (Le Souéf 1913).

Departure Begins late June, with most leaving Aug.; adult males leave early July, females in second half July, and juveniles in Aug. (Flint & Kistchinski 1973; BWP; P.S. Tomkovich). Main migration of adults directly S across Transbaikalia, with small numbers on broad front from e. Kazakhstan E to Sea of Okhotsk; juveniles migrate from breeding grounds to Pacific coasts (no inland records) (Tomkovich 1982; P.S. Tomkovich). In Russia, pass through Anadyr Territory and Kamchatka Pen., Sept.; Commander Is, Sept. and Oct.; Kurile Is, present till late Oct. (Dement'ev & Gladkov 1951). Move overland through Mongolia, China and Manchuria to coastal Asia; large numbers Korea, Aug.–Oct. (Gore & Won 1971); regular passage migrant in Japan (Orn. Soc. Japan 1974). Abundant ne. China, late July–Sept. (la Touche 1931–34); in 1991, small numbers Jiangsu Province, Aug.,

with large influx early Sept. (Hui 1992). From ne. China and Korea, most apparently fly directly to Micronesia and New Guinea (Lane). Only small numbers pass through s. China; move through Hong Kong, late Aug. to late Oct. (la Touche 1931–34; Chalmers 1986). Most appear to move through central and w. Micronesia. Recorded from Marshall I., Gilbert Is, Ellice Is, small numbers on Phoenix Is and Line Is, mainly Oct.; recorded once Fiji, Nov. (Child 1956; Clapp 1968; Smart 1971; AOU 1983; Pratt *et al.* 1987). Uncommon W of Micronesia. Not uncommon Wallacea, Aug.–Nov. (White & Bruce 1986). Arrive Solomon Is, mid-July till late Nov. (Bayliss-Smith 1972). Abundant on passage New Guinea; PNG, early Aug.–Dec., with most Oct. and early Nov.; leave Port Moresby district at onset of wet season (Coates 1985; Beehler *et al.* 1987; Hicks 1990). Some (nearly always juveniles) migrate from breeding grounds across Bering Str.; pass over Pribilof Is, early Aug. to early Oct.; through Alaska, from mid-Aug. to late Oct.; and down Pacific coast of North America, S to Washington State, less often to California; subsequent movements unknown (Dement'ev & Gladkov 1951; BWP); some movement across central Pacific Ocean (Pyle 1984; Pratt *et al.* 1987).

Aust. Small numbers arrive NW, mid-Aug., with large numbers, early Sept.; at Eighty Mile Beach, Broome, 25,000 arrived in one night (Lane & Jessop 1985; Lane; Aust. Atlas). Small numbers occur coast of Gulf of Carpentaria, Sept. and Dec. (Lane), and pass through Torres Str. (Druffan *et al.* 1983); occur coast of ne. Qld as early as late Aug. (Alexander 1926). Most move to s. Aust., arriving from mid-Aug.; slowly move S across continent; temporary influxes Darwin, nw. Qld, and inland wetlands of arid and e. Aust. between Aug. and Dec. (Thomas 1970; Lane). In Sydney district, first arrive early Aug., with main influx in Sept. (Hindwood & Hoskin 1954). In SA and Vic., numbers generally greatest, Jan. and early Feb. (Lane). In Gulf St Vincent, SA, some arrive very early, with evidence of passage, Sept.–Oct.; numbers greatest, Dec. (Close & McCrie 1986). In Tas., arrive between Sept. and Nov., though on islands of Bass Str., as early as mid-Aug. (Thomas 1970; McGarvie & Templeton 1974). In sw. WA, may arrive during Aug. but mainly from Nov. (Serventy 1938; Storr 1965; Bailey & Creed 1993); pass Eyre, s. WA, Aug.–Dec. (Dymond 1988). Most records Norfolk I. and Lord Howe I., Oct. and Nov. **NZ** Arrive late Sept. to Oct., mostly Oct. (Hadden 1990; B.D. Heather; CSN; NZCL); at Manawatu R., from Oct. in 1976 (Dennison 1979); occur at L. Ellesmere as early as late Aug. (CSN 39).

Non-breeding Most of world population in Aust. Move from many n. Qld sites after Jan., when first rains of wet season occur (Amiet 1957; Liddy 1960; Horton 1975; Bravery 1970). Numbers generally not stable in s. Aust. (Lane). Movements appear to be dispersive, with birds moving to temporary or flooded wetlands and leaving them when they dry (Alcorn 1986; Lane), which may result in some seasonal patterns in occurrence, e.g. in Gulf of Carpentaria mainly along coast in dry season and mainly on freshwater swamps in wet season (Garnett 1989) and in s. Aust. found on intertidal mudflats, Dec.–Mar. possibly because inland wetlands have dried (Lane). In NZ, numbers increase from Oct. to Dec. at most sites and remain stable till about Mar. However, individuals and flocks appear to move locally (B.D. Heather; CSN; OSNZ).

Return NZ Early to late Apr. but varying from year to year (Pierce 1980; B.D. Heather; OSNZ). Left Manawatu R., after Feb., 1977 (Dennison 1979), though single recorded as late as mid-May in Invercargill, s. SI (Sibson & Urquhart

1955). **Aust.** One of first waders to leave, with few remaining after Mar. (Aust. Atlas). Leave Tas. between Jan. and Feb. (Thomas 1970). Begin leaving s. Aust., mid-Feb., most in Mar.; in se. Aust. a few remain till early May (McGarvie 1950; Hindwood & Hoskin 1954; Close & McCrie 1986; Starks & Lane 1987; Lane). Many apparently cross inland; recorded inland NSW till early May (e.g. Hobbs 1958); usually leave central Qld, Mar. to early Apr. (Berney 1907); records from arid inland, Feb.–Apr. (Thomas 1970), though hundreds recorded mid-May when L. Frome flooded in 1918 (McGilp 1923). At least some move N from se. Aust. via coast of Qld (see Banding); present se. Qld till Mar. (Amiet 1957) and on ne. Qld coast in Mar. and Apr. (Storr 1953; Sedgwick 1955). In sw. Aust., sometimes in large numbers between Jan. and Mar. (e.g. Baker 1988; Jaensch *et al.* 1988) with last birds in Swan R. in Apr. (Serventy 1938; Bailey & Creed 1993). Vic. birds not capable of flying non-stop out of Aust. (Lane) or to nw. Aust (Starks & Lane 1987). Most birds from se. Aust. thought to fly to seasonal swamps of coastal Gulf of Carpentaria, where abundant in Apr. of years when wetlands suitable. When staging in Gulf of Carpentaria, occur at least as far N as Edward R. and possibly Watson R., where birds fatten before moving N (MacGillivray 1917; Garnett & Bredl 1985; Garnett 1986, 1989; Garnett & Taplin 1990). Some birds from se. Aust. evidently head W from Aust. and move through se. Asia (Starks & Lane 1987; see Banding), others apparently overfly New Guinea and Micronesia to s. and e. China (Lane).

Extraterritorially, small passage through PNG; in Port Moresby district and islands to N, possibly as early as late Feb., but generally Mar. to early May (Coates 1985; Hicks 1990). Rare W from Philippines (e.g. Borneo, Smythies 1981), though locally common Bali, mid-Mar. to early Apr. (Ash 1984). Move through Hong Kong, late Mar. to early June (Chalmers 1986); along Chinese coast, Apr. and May (la Touche 1931–34); some through Taiwan between Mar. and May (AWB 1993); large numbers Korea, Apr.–May (Gore & Won 1971). More common in Japan during n. migration (Orn. Soc. Japan 1974; AWB 1993). Present Ussuriland, May and early June; arrive breeding grounds in early June (Dement'ev & Gladkov 1951; P.S. Tomkovich). Do not move N along Pacific coast of North America; small numbers recorded Hawaiian Is, Phoenix I. and Line I. during n. migration (Clapp & Sibley 1967; Pratt *et al.* 1987; BWP).

Breeding Very few said to winter in S (Hayman *et al.* 1986). Few remain Tas., Vic., SA, Qld, or NZ during winter (Falla *et al.* 1981; Close & McCrie 1986; Anon. 1988; Hewish 1988, 1990b, 1992; Ashby 1991; Vic. Atlas). In Darwin, recorded all months except June (Crawford 1972); not observed Gulf of Carpentaria in winter (Garnett 1989), 200 recorded in mid-July in Kimberley, WA (Campbell 1990). Some records from PNG (Hadden 1981; Coates 1985).

Banding, Colour-marking Birds banded sw. WA, recovered e. Siberia (n=1). Birds banded Vic., recovered e. Siberia (n=1), e. China (n=1) and Taiwan (n=1). Birds banded NSW, recovered e. China (n=2) and Java (n=1). Bird banded SA, and bird banded NT, recovered e. China (ABBBS 1992). Birds colour-marked Vic. sighted on n. and s. migrations on se. Qld coast (n=2) and in near-coastal se. Qld on s. migration (n=2); and one sighted in e. Java, Apr. (Minton 1993).

38S144E	01	2+	U	52	11830		ABBBS
31S115E	01	2+	M	4	11198	7	ABBBS
31S115E	01	1+	M	4	11198	7	ABBBS
31S115E	01	2+	M	4	11188	7	ABBBS
31S115E	01	1+	M	4	11188	7	ABBBS

12S130E	11	1+	F	102	9332	8	ABBBS
38S144E	01	2+	U	16	9021	343	ABBBS
38S144E	01	1+	U	16	9021	343	ABBBS
35S144E	01	2+	U	27	7730	339	ABBBS
35S137E	02	2+	U	1	7655	345	ABBBS
34S151E	02	1+	U	1	7395	328	ABBBS
34S151E	02	1+	U	1	7395	328	ABBBS
34S151E	02	1+	U	1	7371	328	ABBBS
34S151E	02	1+	U	1	7371	328	ABBBS
38S144E	11	2+	U	41	7339	335	ABBBS
32S151E	01	1+	U	69	5113	295	ABBBS
32S151E	01	1+	U	69	5113	295	ABBBS
32S151E	01	1+	U	69	5113	295	ABBBS
32S151E	01	1+	U	69	5113	295	ABBBS
12S130E	11	2+	U	52	4886	348	ABBBS
32S151E	03	2+	U	46	878	225	ABBBS
32S151E	03	1+	U	46	878	225	ABBBS
32S151E	03	2+	U	35	877	225	ABBBS
32S151E	03	1+	U	35	877	225	ABBBS
32S151E	03	2+	U	35	874	225	ABBBS
32S151E	03	1+	U	35	874	225	ABBBS
32S151E	03	1+	U	21	868	227	ABBBS
32S151E	03	U	U	69	840	226	ABBBS
30S153E	01	1+	U	1	125	4	ABBBS

FOOD Omnivorous. Seeds, worms, molluscs, crustaceans and insects. **Behaviour** Feed mostly at edge of water on mudflats, wetlands and sewage ponds. After rain, may feed on short pasture (Smith 1964). Often in hypersaline environments (Lane). At L. Reeve, Vic., foraged in wet areas of algal mat and on bare mud, mainly pecking (49%) and jabbing (33%) at average feeding rate of 0.36 movements/s (Dann 1983). In Westernport Bay, Vic., probe 0–1.3 cm below surface (Dann 1981). Can swim; observed flying into tops of small shrubs, clinging there briefly before dropping down (Smith 1964). In PNG, sometimes take flying insects, or floating dead fish; also glean for insects (Bell 1985).

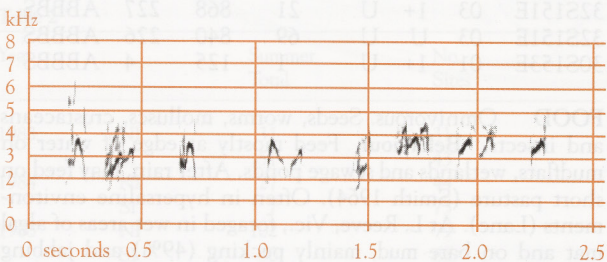
Adult At **Aust. airports** (13 stomachs; van Tets *et al.* 1977): Plants: Poaceae: *Paspalum* sds 100% freq. Animals: Molluscs 31. Grit 100. At **L. Cowal, NSW** (21 stomachs; Vestjens 1977): Plants: Fabaceae (*Medicago*; *M. sativa*) 19.0% freq. Animals: Molluscs: gastropods 14.3; bivalves: Hyriidae 4.8; Insects: Odonata 4.8; Orthoptera: Acrididae 4.8; Dermaptera 9.5; Hemiptera 14.3; Coleoptera 38.1; Carabidae 42.9; water beetles: 71.4; larv. 47.6; Chrysomelidae 9.5; Curculionidae 9.5; Diptera: larv. 42.9; Lepidoptera: larv. 23.9. Grit 52.4. At **L. Reeve, Vic.** (9 stomachs; Poore *et al.* 1979): Plants: Ruppiaceae: *Ruppia* sds 4% freq. Animals: Molluscs: gastropods: *Coxiella striatula* 6; Crustaceans: ostracods: *Australocypris hypersalina* 2; amphipods: *Parhyalella* 5; Insects: Diptera; Tipulidae: larv. 4; Chironomidae: pupae 4. Mainly seeds in Oct. and Dec.; insects in Mar. In **Barilla Bay, se. Tas.** (8 stomachs; Thomas 1986): Plants: sds 1% freq. Animals: Molluscs: gastropods 7; bivalves 2; Crustaceans: ostracods 2; insect larv. 5; unident. debris 2.

Other records Plants: sds (McLennan 1917; McKeown 1944; Cleland); Ruppiaceae: *Ruppia* sds; Chenopodiaceae: *Chenopodium* sds; Fabaceae: *Trifolium* sds (FAB); *Medicago* sds (Cleland); Polygonaceae: *Polygonum* sds. Animals: Annelids (Bryant 1905): polychaetes: Nereidae: *Ceratonereis eurythraeensis* (Dann 1981); Molluscs (Mathews 1909, 1910; McLennan 1917; Hindwood & Hoskin 1954; Lea & Gray); gastropods (Dann 1983); *Smargadella* (McKeown 1944); Insects (Bryant 1905; McLennan 1917; Hindwood & Hoskin

1954; Gould; Cleland; Lea & Gray): larv. and pupae (Dann 1983); Odonata: ads and larv. (Lea & Gray); Dermoptera: earwigs (FAB); Coleoptera: ?Rhysodidae; Dytiscidae ads; Hydrophilidae (Cleland; FAB); Tenebrionidae; Curculionidae (Lea & Gray); Diptera: Cyclorrhapha; Anisopodidae larv. (FAB); Lepidoptera: larv. (Cleland; FAB); Hymenoptera: Symphyta; Formicidae (Cleland): *Iridomyrmex* (FAB). Grit (Mathews 1909; Lea & Gray); sand (McLennan 1917; McKeown 1944; Hindwood & Hoskin 1954); charcoal (Hindwood & Hoskin 1954). Extraliminally, also reported to take crustaceans; arachnids; Hemiptera and dead fish (Preble & McAtee 1923; Dement'ev & Gladkov 1951; Kistchinski 1973; Bell 1985).

VOICE No detailed studies; described in BWP, Colston & Burton (1988) and Hayman *et al.* (1986). Monosyllabic calls are higher pitched, more metallic, and less reedy and twittering than those of Pectoral Sandpiper.

Adult When flushed, a repeated short soft *pleep*, *pliep* or *trrt*, *whEEP*, *psiep* (sonagram A); in some variations, syllables run together to form a variety of twittering or trill-like calls.



A R. Buckingham; Altona, Vic., Feb. 1981; P36

PLUMAGES Prepared by D.I. Rogers. First migrate S in distinctive juvenile plumage. Undergo first pre-basic moult to (immature) non-breeding plumage after arrival in non-breeding areas; during first austral summer, most moult all or outer primaries in first pre-basic or first pre-supplemental moult. First pre-alternate moult to breeding plumage late in first austral summer; these immatures leave Aust., mid-Apr., but not known if they return to breeding grounds. Thereafter migrate annually, beginning complete pre-basic moult on arrival in non-breeding areas, and regaining breeding appearance in partial pre-alternate moult before return to breeding areas. Sexes similar. Age of first breeding unknown.

Adult breeding (Second and subsequent alternate). First attained late in second austral summer. **Head and neck** Feathers of crown and nape, rufous-brown (36) with black-brown (119) shaft-streaks that broaden at base of feather and are more exposed when worn; forms bold ginger cap, coarsely streaked darker. Supercilium, white, with narrow black-brown (119) shaft-streaks to feathers; supercilium narrowest above eye, and broader above lores and ear-coverts. Supercilia meet base of culmen but do not join; separated by narrow brown (119B) strip (streaked dark brown [121]) in centre of forehead. Broad clean white orbital ring, contrasts with supercilium, narrow brown (c25–121) loreal stripe, and light rufous-brown (39) marking on ear-coverts (which extends as narrow line below and in front of eye). Ear-coverts indistinctly marked by narrow black-brown (119) shaft-streaks, which adds to appearance of broad eye-stripe tapering near bill. Hindneck and sides of neck, light brown (c39–c223C), finely and densely streaked darker; feathers have black-brown (119) shaft-streaks that are

broadest at tips. Cheeks, chin and upper throat, white, streaked dark brown (121); streaks shorter and broader than on sides of neck; on chin, streaks reduced to small brown (121–119B) spots or absent. Foreneck and sides of lower neck, light rufous-brown (39) with black (89) spot near centre of tip of each feather and black shafts; appear speckled and faintly streaked black; in fresh plumage, markings partly obscured by white tips to feathers. **Upperparts** Feathers of mantle and back, and upper (inner) scapulars, black-brown (119) (grading to dark brown [121] at bases, which are generally concealed) with broad rufous-brown (36–136) edges that grade to grey-brown (c119B) distally, especially at tips of upper scapulars; lower scapulars, similar, but rufous-brown edges merge to pale grey-brown (119C–119D) or white at tip; often, some feathers retained from non-breeding plumage. Black-brown centres to feathers usually taper to a point, especially on scapulars; on lower scapulars, pale tips may align, forming irregular line along scapulars. Rump and uppertail-coverts usually retained from non-breeding plumage; in those few that moult, breeding plumage on rump and most uppertail-coverts, black-brown (119) with narrow rufous-brown (136) fringes, broadest at tips of feathers (especially on central uppertail-coverts). Lateral uppertail-coverts, white, with dark-brown (121) shaft-streaks tapering to point on shorter coverts; and with dark-brown V-shaped marks on longer coverts (broad dark-brown streak on inner web, narrower and closer to shaft than streak on outer web); in at least some, longest coverts have up to four bold dark-brown (121) rounded bars, and ground-colour tinged cinnamon (c39) near tip of inner webs. **Underparts** Sides of breast, fore-flanks and uppermost centre of breast, light rufous-brown (c39); upper breast speckled like foreneck; spots broaden on sides of breast to black-brown (119) subterminal bars across each feather. Ground-colour becomes buff (124) on mid-flanks, and white on belly, rear-flanks and centre of lower breast. Lower breast and flanks coarsely marked by broad dark-brown (121) chevron on each feather; smaller chevrons may extend onto sides of otherwise white belly; chevrons grade to dark-brown (121) spear-shaped streaks on undertail-coverts (most conspicuous on lateral feathers). In very fresh plumage, or during pre-alternate moult, breast and flanks appear finely spotted, as chevrons partly obscured. **Tail** Similar to, and often retained from, non-breeding plumage; some replace a few central rectrices, which have light rufous-brown (123A) fringes that grade to buff (c118) at tips. **Upperwing** Mostly retained from non-breeding plumage. Always replace some tertials (many retain non-breeding outer tertials); breeding tertials are black-brown (119) with broad rufous-brown (38–340) edges that become broader and uneven and grade to light grey-brown (119C) at tips of feathers, and with narrow white fringes at tip, which are lost with wear. Blackish centres to tertials narrow evenly to a point, or unevenly so that light grey-brown (119C) area at tip of feather appears narrowly divided by black-brown (119) shaft-streak. Most breeding tertial coverts have white tips as in non-breeding plumage, but longest can be tipped buff (124). Attain varying number of breeding lesser and median secondary coverts and innermost greater coverts, which are dark brown (121) with narrow black-brown (119) shaft-streaks that do not reach pale brown-grey (c45) to off-white tips, and rufous-brown (340) edges. **Underwing** Retained from non-breeding plumage.

Adult non-breeding (Second and subsequent basic). First attained in second austral spring. **Head and neck** Duller version of adult breeding. On crown and nape, black-brown (119) centres to feathers less sharply defined, and edges of

feathers, fawn-brown (c25) to cinnamon (c39); dark cap much less ginger than in breeding or juvenile, though distinctly warmer than rest of non-breeding plumage. Orbital ring does not contrast quite as strongly as in adult breeding. Hindneck, as mantle. Chin and upper throat, white, only rarely with fine dark-brown (119A) speckling extending onto sides. Ear-coverts, brown (119B), and sides of neck, light greyish-brown (greyish 119C), both finely streaked dark brown (121), but streaking much less striking than in adult breeding. Foreneck, as upper breast. **Upperparts** Mantle, back and scapulars without rufous edges to feathers of adult breeding, and acute blackish centres to feathers less sharply defined; general appearance mottled (cf. neatly streaked or fringed in adult breeding and juvenile plumages); feathers, dark brown (c121) grading to brown (c119B) at edges and with varying broad black-brown (119) subterminal shaft-streaks (edges sometimes dull rufous-brown [c121C] on longer scapulars); scapulars and longer feathers of mantle have narrow white fringes at tips when fresh. Dark tips of feathers taper gradually, feathers becoming lanceolate when worn. Feathers of rump and most uppertail-coverts, black-brown (119) with narrow rufous-brown (136) to brown (c119B) fringes, broadest at tips, especially on central uppertail-coverts. Lateral uppertail-coverts, white, with tapering black-brown (119–121) shaft-streaks on shorter feathers, and bold chevron (formed by dark brown (121) diagonal streak on outer web meeting dark streak along shaft of inner web) on longer feathers; form narrow white sides to rump in flight. **Underparts** Upper breast and fore-flanks, pale brown (c119C) to pale greyish-brown (c119D), finely streaked or speckled by dark-brown (121) shafts meeting small dark-brown (121) tear-shaped spots near tip of feathers. In very fresh plumage, narrow white tips obscure darker markings, especially towards belly, and can then superficially resemble juvenile (though with greyer ground-colour) with dark streaking confined to indistinct band across upper breast and foreneck. Above patterning most extensive on sides of breast, grading to white on centre of breast, and belly, rear-flanks and undertail-coverts. Rear-flanks have indistinct tapering dark-brown (121–119B) shaft-streaks to feathers (contrasting, in some feathers, with white shafts), grading posteriorly to thick bold black-brown (119) shaft-streaks on undertail-coverts. Streaks broadest on lateral undertail-coverts, where they surround white streak along outer edge of shafts. Axillaries, white. **Tail** Most feathers, dark greyish-brown (c121–c119B), grading to black-brown (119) towards tip and narrowly fringed white; area of black-brown largest on central feathers; on t1, at least distal third black-brown and pale fringes strongly tinged buff (c223D). **Upperwing** Primaries, secondaries, alula, carpal covert and all primary coverts, black-brown (c119), grading to mostly concealed dark grey-brown area on inner webs; fade to dark brown (c119A) when worn. Secondaries and p1 to p5–p6 have white shafts and narrow white outer edges; outer primaries have no white on outer edges and dark-brown (119A) bases to shafts, more extensive on outer feathers and occupying about basal half of shaft of p10. Alula and outer primary coverts have narrow white fringes at tip, contrastingly narrower than broad white tips (2–4 mm wide when fresh) of carpal covert and inner five primary coverts. Greater secondary coverts, dark grey-brown (c119A) becoming darker brown (121) on outer feathers, also with broad white tips contributing to long narrow central wing-bar; inner feathers have narrow white outer edges when fresh. Median and lesser coverts, grey-brown (c119A) with narrow off-white fringes, broadest at tips, and black-brown (119) shafts surrounded by varying, indistinctly

defined areas of dark brown (121), most extensive on outer feathers and towards leading-edge. Marginal coverts, blackish brown (119–121), fringed off-white. Tertiaries, black-brown (119), grading to dark grey-brown (c119A–c119B) near edges, narrowly fringed off-white to buff (c119D); similar to outer scapulars. **Underwing** Remiges, glossy grey (c80), grading to black (c82) at tips of outer primaries, and pale grey (c86) at bases of feathers. Coverts, mostly white; greater primary coverts have varying grey (79) to dark grey (c83) centres and bases, darker and larger on outer feathers and, in some individuals, extending onto outermost greater and median secondary coverts. Marginal coverts and shortest lesser coverts have black-brown (119) basal halves, adding to effect of broad dark leading-edge.

Juvenile Retained till about Nov., later than in most other Aust. *Calidris*. Similar to adult breeding, distinguished by pattern of underparts, uniform wear of plumage, and season. Differ from adult breeding by: **Head and neck** Slightly darker rufous-brown (c36) ground-colour of crown and nape creates more obvious capped appearance. White supercilium, broader (especially behind eye) and slightly longer; dark streaking on rear-supercilium, fainter or missing. No dark spotting on white chin and upper throat. Light rufous-brown (c38 when fresh, c39 when worn) area on ear-coverts slightly darker and better defined, creating clearer eye-stripe, which is also accentuated by rufous-brown (c38) tinge to rear of lores when very fresh. Foreneck and sides of neck, orange-buff to cinnamon (39), grading to buff (124) or white on lower face. Dark-brown (121) shaft-streaks on lower face, ear-coverts and sides of neck similar to those of adult non-breeding but only extend across throat as thin band at border of foreneck and upper breast. **Upperparts** Fringes of feathers of mantle, back and scapulars, slightly darker rufous (c136–c36) when fresh; no dull-brown areas at tips of scapulars, which, with longest feathers of mantle, have white tips to rufous fringes of outer webs; when fresh, forms narrow but distinct mantle V, and scapular lines or scalloping. **Underparts** Foreneck, upper breast and fore-flanks, orange-buff or cinnamon (39), grading to pale brown (223D) and then to white on rear-flanks, lower breast and belly; dark-brown (121) subterminal shaft-streaks form indistinct gorget between foreneck and otherwise unmarked upper breast; gorget narrow (often broken in centre), but broadens at far sides of breast to extend onto fore-flanks. When worn, streaking becomes slightly more conspicuous and ground-colour becomes dull through partial exposure of pale-brown (223D) to pale-grey (86) bases of feathers, though diagnostic appearance of unmarked buff centre of lower breast retained until post-juvenile moult. Rest of underparts, white; rear-flanks faintly streaked dark brown (119A) in some (less so than in adult non-breeding) and undertail-coverts coarsely streaked like adult. **Tail** When fresh, fringes of t6–t4, white; of t3, buff (124); grading to light rufous-brown (c38) on t1; all fringes fade to off-white. **Upperwing** Mostly as adult breeding. Rufous-brown (37–340) fringes to tertiaries, more uniform in width (do not broaden irregularly on distal edges or grade to brown area at tip); black-brown (119) central wedges to feathers rounded at tips. Terial coverts fringed rufous-brown (340) at tips (cf. mostly white in adult breeding). Median and longer lesser secondary coverts, grey-brown (c119A–c119B), usually with narrower black-brown (119) shaft-streaks than in adult non-breeding; broad fringes to feathers, ill-defined, pinkish buff (c121D) to off-white. **Underwing** As adult.

First immature non-breeding (First basic). Like adult non-breeding but retain worn juvenile feathers on back and

rump; also retain some juvenile tertials and rectrices and, most obviously, some inner median and lesser secondary coverts with buff edges, and tertial coverts with buff fringes. Often retain varying number of juvenile primaries (see Moults, Ageing). First pre-basic moult occurs later than in most other *Calidris* in Aust., and from mid- to late austral summer, plumage of body fresher than in worn non-breeding plumage of adults; pale dorsal edges of feathers, especially on tertials, thus look more uniform at this time, and centre of upper breast tends to look more uniform pale-brown or pale grey-brown. Also thought to have warmer rufous-brown cap than in adult non-breeding (R.J. Swindley).

First immature breeding (First alternate). Probably do not breed in this plumage. Similar to or inseparable from adult breeding, though moult of primaries often a reliable guide to age (see Moults, Ageing). Some retain varying number of juvenile wing-coverts (becoming so worn that rufous-brown to buff fringes only recognizable on tertial coverts), outer rectrices and much of juvenile feathers on back and rump. Field observations and photographs of the few birds that remain in Vic. in austral winter (R.J. Swindley) show that the plumage is more subdued than that of adult breeding, with slightly less distinct orbital ring and with smaller dark-brown markings on flanks and sides of breast, which tend to appear as spots rather than chevrons; the age of these birds is not known but they may be in first-immature breeding (first alternate) plumage. Three skins collected in nw. NSW in July (MV) in first-alternate plumage did not differ from adult breeding.

BARE PARTS From photographs (Webb & Carey 1979; Pringle 1987; Kaufmann 1987; Moon 1988; Aust. RD; NZRD; unpubl.: J.N. Davies, D.W. Eades, H.M. Gibbs, R.J. Swindley).

Adults, Immatures Bill, dark grey-brown (c121, c19), dark grey (83) or darker, grading to grey-black (82) on distal third; also grades to small pale patch at base of lower mandible (occupying no more than basal 20–25%) and extreme base of upper tomion, which varies from grey-brown (91) or pinkish brown (221C, c121D) to buff (124, 123B, 6). Iris, black-brown (119). Legs, olive (46, 50, 51) or greyish olive (43–42) to olive-yellow (52, c57); claws, grey-black (82). Bright-orange legs recorded once (R.J. Swindley). **Juvenile** Similar to adult. Sometimes iris tinged grey-brown (BWP). Yellow tinge to legs probably more common than in adult, though no difference in range of variation of leg-colour. Aberrant 'flesh-coloured' legs reported but age of bird not stated (Oreel 1974).

MOULTS Based on skins, mostly from Aust., of 54 adults and 45 younger birds (HLW, MV, NTM, WAM) and data on moult of primaries for 322 immatures in first Vic. summer (M.A. Barter, AWSG). Additional information from photographs (unpubl., especially D.W. Eades, J.N. Davies, R.J. Swindley), BWP, Prater *et al.* (1977) and Rogers *et al.* (1990).

Adult post-breeding (Second and subsequent pre-basic). Complete. Some moult a few feathers of mantle, scapulars, crown, foreneck and upper breast and 1–4 innermost primaries, at staging points on s. migration, arriving HANZAB region with moult suspended. Most delay onset of moult till just after arrival in Aug. or Sept.; initial stages of body-moult rapid, generally attaining non-breeding appearance by early to mid-Oct.; some complete moult of body by late Oct., but others replace last few non-breeding feathers (on breast and especially back, rump and uppertail-coverts), Dec. and early Jan. Primaries moult outwards, beginning Sept. to Oct. or, rarely, early Nov.; usually completed by late Jan. Birds

recorded moulting later, Feb. to late Mar., may have been wrongly aged and undertaking complete first pre-basic moult. Rectrices and last wing-coverts replaced in later stages of moult of primaries. **Adult pre-breeding** (Second and subsequent pre-alternate). Partial, involving head, neck, underparts, mantle, most or all scapulars and tertials (basic outer tertials often retained) and a few to many median coverts, longer lesser coverts and inner greater secondary coverts. Sometimes moult a few central rectrices; few moult rump and uppertail-coverts. Moult begins early to late Jan. (often starting before pre-basic moult of primaries completed), continuing till about late Mar.; at least some have completed pre-breeding moult before leaving se. and nw. Aust. on n. migration. **Post-juvenile** (First pre-basic). Extent varies, but always involves most or all feathers of body. Begins later than in most other Aust. *Calidris*; at earliest, moult of body starts late Oct. and some do not begin until early Dec. Usually retain many juvenile wing-coverts, much or all of tail, and at least some feathers of rump and uppertail-coverts; most retain primaries and secondaries (though much moult of these feathers occurs shortly afterwards in pre-supplemental). Some of both sexes also moult all primaries and secondaries, and more feathers of body and rectrices; some may moult all juvenile plumage, though some tertial coverts, inner lesser coverts and median coverts are retained in at least some. First pre-basic moult of primaries imperfectly known because it is difficult to age individuals in later stages; should perhaps be regarded as pre-supplemental moult but appears to begin earlier (most records from early Dec. to Jan., of birds with PMS ranging from c. 20–30) and seems always to coincide with moult of secondaries. **Post-juvenile moult of primaries** (First pre-supplemental). Partial; not undertaken by all birds; a few immatures (no more than 1%) retain juvenile primaries, secondaries and many rectrices through first austral winter, replacing them in second pre-basic moult; suppressed by those moulting primaries in first pre-basic moult. Nevertheless, large proportion of population moults varying number of outer primaries and associated primary coverts at some stage between Dec. and Apr. (noticeably later than adult pre-basic moults). This moult here treated as pre-supplemental moult rather than as part of first pre-basic, by analogy with other waders in this volume and because moult of primaries begins about 1 month after pre-basic moult of body (in other pre-basic moults, primaries of *C. acuminata* begin moulting at about the same time as body-feathers). Most data on timing and extent of moult of primaries from 236 immatures in this stage of moult captured in Vic. (M.A. Barter, AWSG). Usually, outwards moult of primaries begins at p4 (25% of individuals) or p5 (55%); fewer begin moult at p6 (11%) and 1–2% begin at each of p2, p3, p7 or p8. Some undertake more extensive moult, some moulting all primaries and secondaries, though inner secondaries (s4, s5 or s6–s10 in those examined) can be retained. Earliest records are from last half of Nov.; most active moult in Dec., though some (less than 1%) start as late as Jan. Generally completed in Mar. or later; duration not known, but almost all (87/89 examined) still active at end of Feb.; small samples from late Mar. (n=11) suggest moult likely to be complete at end of Apr. First-alternate bird from nw. NSW in mid-July with primary-moult N⁹⁴1 (MV) was probably aberrant. **First immature pre-breeding** (First pre-alternate). Similar to pre-breeding moults of adults in extent but perhaps starts slightly later. **First immature post-breeding** (Second pre-basic). Similar to adult post-breeding but may start slightly earlier. In Aug., first birds arriving Vic. usually have fresh non-breeding plumage, in

contrast to adults, which have much worn breeding plumage (R.J. Swindley); former birds perhaps in second basic (implying earlier moult) but also possible that they are adults that left breeding grounds early after failed breeding attempts.

MEASUREMENTS (1–3) Indonesia and Aust., skins; from Aust. museums (HLW, MV, WAM) and BWP; data on length of bill from BWP excluded as methods of measuring apparently differed: (1) Adults; (2) Subadults with juvenile p10 and t1; (3) Ages combined. (4–5) Aust., live (M.A. Barter; AWSG); sexed using HUMPS_UV (Rogers 1995): (4) Adults; (5) Juveniles and first immature non-breeding.

	MALES	FEMALES	
WING	(1) 137.6 (2.89; 131–142; 33)	129.7 (3.82; 120–131; 46)	**
	(2) 140.7 (3.25; 134–146; 32)	131.7 (2.72; 126–136; 23)	**
	(4) 138.8 (3.00; 579)	130.7 (2.83; 779)	**
	(5) 142.5 (2.76; 66)	132.8 (2.58; 91)	**
	TAIL	(1) 55.7 (2.48; 52–60; 29)	51.9 (2.81; 47–60; 44)
TAIL	(2) 56.4 (2.75; 51–62; 32)	53.6 (2.87; 48–59; 18)	**
	BILL	(3) 25.0 (1.00; 22.6–27.9; 44)	23.9 (1.05; 21.8–26.8; 49)
THL	(4) 52.8 (1.26; 596)	49.7 (1.19; 762)	**
	(5) 52.9 (1.29; 69)	49.8 (1.21; 88)	**
TARSUS	(3) 30.5 (1.16; 26.6–32.8; 71)	28.9 (0.97; 26.3–30.2; 70)	**
TOE	(3) 29.0 (1.05; 26.3–32; 42)	27.8 (1.24; 25.2–31; 45)	**

Differences in length of wing and tail between juveniles and adults significant in above samples, perhaps because few adults measured had fresh outer primaries and central rectrices; BWP reported no differences between juveniles and adults. Juveniles arrive in our region with bill, tarsus and toe as long as those of adult.

WEIGHTS (1–3) Vic.; in samples taken after Dec., some immatures may have been incorrectly aged as adult (AWSG). Sexing criteria of samples (2) and (3) based on CRIT-UV program (Rogers 1995) with 95% chosen as minimum probability of correct sexing; use of these criteria to calculate weights for each sex is not entirely satisfactory (estimates will be biased as large females and small males excluded from sample) but, in this case, weight estimates similar to those produced by HUMPS (e.g. see data for adults in Oct., Dec. and Feb.): (1) Adults; sexed using HUMPS (Rogers 1995); (2) Adults; considered male if THL ≥ 52.7; female if THL ≤ 49.7; (3) Immatures in first austral summer; considered male if THL ≥ 52.9, as female if THL ≤ 49.7.

	MALES	FEMALES	
Sept.	(1) 72.8 (5.07; 244)	56.4 (3.93; 171)	**
Oct.	(1) 72.1 (4.00; 143)	57.5 (3.18; 161)	**
	(2) 72.6 (5.37; 57–89; 35)	58.1; (3.65; 51–77; 79)	**
Nov.	(1) 72.3 (4.13; 105)	55.9 (3.19; 111)	**
Dec.	(1) 73.0 (5.09; 506)	57.3 (4.00; 498)	**
	(2) 74.4 (5.38; 54–92; 161)	58.7 (5.20; 49–88; 195)	**
	(3) 71.6 (4.62; 65–83; 20)	56.5 (4.03; 50–70; 21)	**
Jan.	(1) 76.4 (6.31; 507)	58.7 (4.85; 470)	**
Feb.	(1) 86.3 (7.66; 160)	63.2 (5.61; 303)	**
	(2) 86.7 (9.74; 60–111; 67)	62.1 (5.10; 52–77; 96)	**
	(3) 78.6 (5.97; 70–90; 14)	60.1 (3.59; 53–68; 27)	**
Mar.	(2) 91.0 (11.33; 76–105; 5)	66.0 (9.57; 56–105; 23)	**

Males significantly heavier than females. Weights of adults appear fairly stable through most of austral summer, and are

similar to the few data from austral winter (in July in NSW, male 75; females 55, 55, 52.5 [MV]). Above data suggest period of gain of weight before migration of adults begins earlier than most Aust. waders; in Jan. in males, in Feb. in females. Immatures slightly lighter than adults (differences significant in Feb., and in males in Dec.); immatures also undergo gain in weight before migration in about Feb. of first austral summer. Departure weights from Vic. not well known, but seldom >100–110 g in males, and 70–80 g in females (above data; C.D.T. Minton) and insufficient to fuel long migration step (probably stage in n. Aust.). Departure weights from other areas not known; only available data from s. New Guinea in mid-Apr., when adult males 63, 91, 98 and females 66.0 (12.31; 58–87; 5) (BWP).

STRUCTURE Wing, long, narrow, pointed. Eleven primaries; p10 longest, p9 0–4 mm shorter, p8 5–11, p7 14–22, p6 24–33, p5 33–47, p4 44–54, p3 51–62, p2 57–69, p1 63–75; p11 minute, narrow and generally hidden by primary coverts. Fifteen secondaries, including five tertials. Tips of longest tertials usually lie between tips of p6 and p7 on folded wing. Tail, short, wedge-shaped; 12 rectrices, all pointed (more sharply so on central feathers); t1 longest, t2 1–3 mm shorter, t3 2–6, t4 4–7, t5 6–9, t6 8–13. Bill, short (90–110% of length of skull and generally appearing slightly shorter than head), slender, laterally compressed and mostly straight, tapering to fine tip, which is very slightly decurved; slightly expanded tip of upper mandible extends just beyond tip of lower. Tarsus and tibia, slender, short; tarsus scutellate. Toes, long and slender with narrow claws; outer toe c. 90% of middle, inner c. 83%, hind c. 30%. In male, subcutaneous tissue of foreneck and upper breast swollen in early breeding period, similar to that of *C. melanotus* but not as strongly developed and with muscular subcutaneous layer (BWP).

AGEING Difficult to age after post-juvenile body-moult because many immatures undergo early and extensive moult of primaries. Few retain all juvenile primaries through first year (none in this study), and are assumed to be easy to age from Dec. to Feb. by lack of primary-moult, and from Mar. until about Oct. (near end of complete second pre-basic moult) on basis of more worn outer primaries than those of other age-groups. Many moult outer primaries (usually outer 4–6) in first austral summer; contrast between outer primaries and more worn inner primaries diagnostic from about Feb. to Sept. or Oct., by which stage all worn inner primaries can be replaced in complete second pre-basic. Those moulting all primaries in first austral summer pose considerable problems, except when some juvenile coverts (especially rufous-brown to buff-tipped tertial coverts) or secondaries retained. Some replace all juvenile plumage in first austral summer and thereafter not reliably separable from adults on present knowledge. In second austral summer, primaries of some such individuals slightly fresher than in adults; slightly earlier moult of primaries may also offer potential guide to age.

GEOGRAPHICAL VARIATION None.

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Volume 3, 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