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Order **CHARADRIIFORMES**

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

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

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

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

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

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

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

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Order CHARADRIIFORMES
Family SCOLOPACIDAE sandpipers and allies

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

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

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

When breeding, most scolopacids (except some snipes and woodcocks) are birds of open habitats, including tundra. At other times, use a variety of habitats, including forests (woodcocks) and open sea (phalaropes), though most prefer shallow, fresh, brackish or intertidal wetlands. Greatest concentrations occur on intertidal mudflats, especially estuaries. Feed mainly by touch, and the mandibular skeleton has distinctive features associated with tactile methods of foraging. When feeding, most probe into soft, moist substrata to catch invertebrates; some (e.g. Arenariinae) forage on rocky shores; surface-tension mechanism for feeding on plankton, recently described for Red-necked Phalaropes *Phalaropus lobatus* (Rubega & Obst 1993), may prove to be widespread among scolopacids with fine bills. Mixed-species foraging flocks common.

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

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

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

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

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

In CALIDRIDINAE, mating systems remarkably varied, including monogamy, polygyny, polyandry; most species monogamous (e.g. Pitelka *et al.* 1974). Role of sexes in parental care as diverse as mating systems. Apparently solely by female in the four polygynous species; roughly equally shared in some (e.g. Dunlin *C. alpina*), though female tends to leave chicks earlier; in others, male undertakes more of work and females leave before chick-rearing (or even incubation) complete. Behaviour more complex in successive polyandrous species, with males raising first brood while females may lay and raise another clutch. In GALLINAGONINAE, mating systems poorly known but several species monogamous; Great Snipe *Gallinago media* promiscuous, mating at leks, and apparently unique among snipe in performing courtship display on ground; others have crepuscular or nocturnal display-flights accompanied by distinctive calls and non-vocal sounds (see Gallinagoninae). Mass flights of displaying snipes have been said to be aerial leks in several species, but confirmation needed (could be result of unsettled territorial boundaries early in breeding season) (Byrkjedal 1990). In TRINGINAE, most species monogamous but successive polyandry can occur in Spotted Redshank *Tringa erythropus* and Spotted Sandpiper *Actitis macularia*. Parental care shared about equally or females leave breeding grounds early while males undertake or finish rearing chicks. ARENARIINAE are monogamous; Ruddy Turnstone territorial and aggressive. LIMNODROMINAE, poorly known; apparently monogamous; territorial but *L. semipalmatus* nests in small colonies. Both sexes incubate; males undertake most of chick-rearing. In PHALAROPODINAE, many sex roles reversed when breeding; females almost unique among Scolopacidae in undertaking courtship behaviour, contesting access to mates in 'scramble displays' (Reynolds 1987; Colwell & Oring 1988a). Phalaropes usually monogamous, though polyandry recorded in all three species; incidence of polyandry may vary between populations but reasons not yet clear (e.g. Colwell & Oring 1988b). Males undertake virtually all incubation and raise chicks alone (see Colwell 1986; Colwell & Oring 1988a,b).

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

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

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

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Subfamily **CALIDRIDINAE** arctic sandpipers and allies

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

Table 1

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

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

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

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

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

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Limicola falcinellus Broad-billed Sandpiper

COLOUR PLATE FACING PAGE 288 & 289

Scolopax falcinellus Pontoppidan, 1763, *Danske Atlas* 1: 623, Pl. XIII — Denmark.

Limicola is Latin for mud-dweller, from *limus*, mud or mire and *-cola*, dweller. *Falcinella* is Latin (diminutive of *falx*, *falcis*, a sickle) for a small sickle and refers to the long broad bill, decurved at the tip.

OTHER ENGLISH NAMES Murky Sandpiper.

POLYTYPIC Nominate *falcinellus* breeds northern Europe and western Siberia. Subspecies *sibirica* Dresser, 1876, eastern Siberia.

FIELD IDENTIFICATION Length 16–18 cm; wingspan 34–37 cm; weight *c.* 40 g. Small, short-necked, stint-like wader with short legs and diagnostic long straight black bill, which is flattened and kinked downwards at tip; from above, bill, broad with parallel sides, tapering sharply to pointed tip. Between Red-necked Stint *Calidris ruficollis* and Curlew Sandpiper *C. ferruginea* in size, though closer to former. Wing-tips project a short distance beyond tip of tail at rest. Breeding and juvenile plumages somewhat like those of snipes; non-breeding plumages more like those of stints. Flight-pattern like that of stints, with narrow white wing-bar and dark central line through rump and tail, but with black leading-edge to upperwing (like that of Sanderling, *C. alba*), conspicuous in non-breeding plumages. Sexes alike. Marked seasonal variation. Juvenile distinctive. Immatures separable in close view.

Description Adult breeding Plumage varies much with wear. Crown and centre of forehead, black, with faint rusty streaking and thin white lateral crown-stripes that usually join prominent white supercilium in front of eye, forming distinctive split supercilium; supercilium extends from bill to above rear ear-coverts; prominent blackish eye-stripe extends across lores to upper ear-coverts; hindneck and sides of neck, grey, streaked black, grading to paler off-white and more finely streaked on lower face; chin and centre of throat, white. Upperparts appear dark, with broad greyish-white feather-tips obscuring underlying rufous fringing and giving upperparts a frosty appearance: mantle, scapulars and tertials, black, fringed rufous and off-white and broadly tipped greyish white; whitish fringes of outer mantle feathers and outermost row of upper scapulars align to form conspicuous snipe-like pale lines on upperparts; most innerwing-coverts, black, narrowly fringed off-white except on lesser coverts; often some inner lesser, median and greater coverts like scapulars, and some worn coverts retained from non-breeding. Underbody, white, with heavy black streaking, formed by lines of arrowheads, on foreneck and breast and along flanks; lateral vent and undertail-coverts have a few scattered arrowheads or streaks; dark of chest rather sharply demarcated from white belly. In flight: blackish remiges with narrow white wing-bar (tips of primary and greater coverts); black back; sides of rump and uppertail-coverts, white contrasting with black central line joining blackish central rectrices; outer retrices, pale grey; underwing, white, with pale grey remiges and some dark mottling round angle of wing. With wear, pale tips lost and upperparts appear more colourful and rufous; then become very dark with increasing wear, but retain pale lines on mantle, scapulars and crown; below, streaking becomes much darker, more obvious and extensive, breast appearing very dark, and with lines of coarse dark markings extending well down flanks. Bill, black, sometimes tinged green or brown, and often with small pale (usually yellow) area at base of lower mandible. Iris, dark brown. Legs and feet, blackish grey, often tinged green, yellow or brown. **Adult non-breeding** Centre of forehead, crown, nape, hindneck and sides of neck, pale grey-brown, finely streaked black; supercilium well marked, white (though finely dark-streaked behind eye in some); usually show obvious split supercilium, though thin white lateral crown-stripes vary and do not always join supercilium; usually obvious dark eye-stripe; rest of lower face, white, finely streaked dark; chin and throat, white. Mantle, back, scapulars, tertials and most innerwing-coverts, pale grey-brown with blackish streaks or diffuse dark centres, and narrow white fringes; blackish lesser innerwing-coverts form distinctive contrasting dark shoulder-patch, which may be obvious or concealed by overlying feathers. Underbody, mostly white; foreneck and breast, pale grey-brown with fine dark streaking, and fairly sharply demarcated from white belly; sometimes have a few thin dark streaks on flanks. Flight-pattern as adult breeding, except dark line through centre of rump and uppertail-coverts, paler and greyer; conspicuous blackish dark leading-edge to innerwing (like that of Sanderling) contrasts with paler grey-brown central coverts. Bare parts as adult breeding. **Juvenile** Very similar to adult breeding, differing by: in fresh plumage, upperparts paler, more colourful and more neatly and regularly patterned than adult in worn breeding plumage, appearing striped: mantle, scapulars and tertials have paler buff-chestnut and off-white fringes, and innerwing-coverts (excepting blackish leading-coverts) broadly fringed buff or white; lower scapulars and innerwing-coverts, narrower and more pointed than on adult, with pale fringes broken at tip by dark centres. Foreneck and breast neatly streaked and dotted black (not with coarse black arrowheads of adult), continuing on fore-flanks as fainter and much paler buff-brown spotting, though flanks less heavily marked than in adult breeding. With wear, lose all chestnut and buff tones; fringes fade to off-white; and appear rather uniformly dark on mantle, back, scapulars and tertials, with characteristically pointed innerwing-coverts appearing fresher, with broader white fringes. **First immature non-breeding** Like adult non-breeding but distinguished by retained worn juvenile tertials and innerwing-coverts, which contrast with fresh non-breeding upperparts (all equally fresh in adult); retained juvenile primaries slightly worn in spring–summer (fresh or still moulting in adult). In autumn, most replace juvenile outer few primaries and show contrast between old, worn brownish inner and fresh, darker blackish outer primaries (uniform and fresh in adults). **First immature breeding** Plumage varies: most that return to breeding grounds acquire much colourful breeding plumage similar to that of adult breeding; some remain in HANZAB area and acquire less breeding plumage; both separable from adult breeding by contrast in primaries (as in first immature non-breeding).

Similar species Combination of small size, stint-like shape and proportions, diagnostic long broad blackish bill characteristically kinked downwards near tip, short legs, split supercilium in all plumages, flight-pattern, and call, diagnostic. In juvenile and non-breeding plumages, may be confused with juvenile and non-breeding **Sanderling**, **Dunlin** *Calidris alpina* and **Western Sandpiper** *C. mauri*; see those accounts for details.

Usually seen singly or in small, loose flocks among Red-necked Stints and Curlew Sandpipers; occasionally in larger groups of a few hundred at favoured sites. Associate freely with other waders, and may join mixed-species roosts. Coastal in our area, favouring estuarine mudflats but also occasionally on saltmarshes, shallow freshwater lagoons and, sewage farms. Often tame; sometimes crouch, snipe-like, when disturbed. Gait, flight and general actions like that of stints, though differ by slower feeding actions and persistent vertical probing; feed by gentle vertical probing in mud or shallow water. Usual flight call an unmusical buzzing trill *chrrreet*; also shorter *tzit* and *trr*.

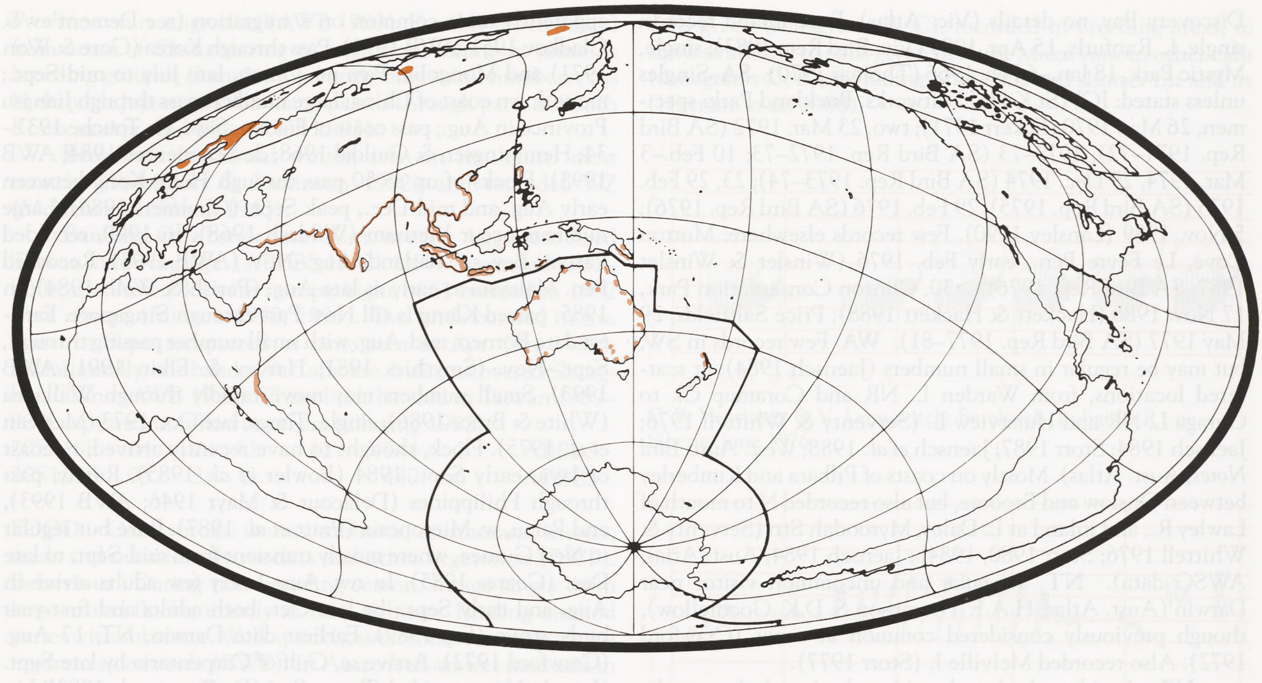
HABITAT

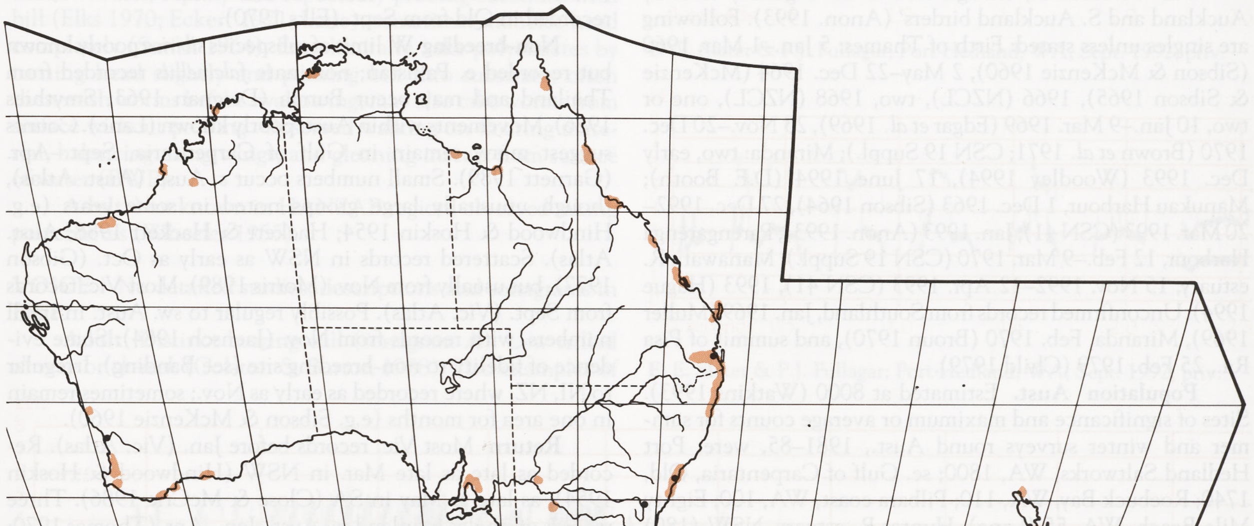
In A'asia, sheltered parts of coast, such as estuaries, harbours, embayments and lagoons, with large soft intertidal mudflats, which may have shell or sandbanks nearby. Occasionally on reefs or rocky platforms (Jaensch 1984; Morris 1989). Often on near-coastal sewage ponds and saltworks (Smith 1964; Eckert 1971; Jaensch 1984; H.A.F. Thompson & D.K. Goodfellow; Vic. Atlas); also lagoons, creeks, swamps and lakes near coast, particularly those with bare mudflats or sand exposed by receding water (Crawford 1972; Jaensch 1984; Storr & Johnstone 1988; Vic. Bird Reps). Often prefer mud among, or fringed by, mangroves, particularly on seaward side (Crawford 1972; Garnett 1989); sometimes in estuaries edged by saltmarsh (Jaensch *et al.* 1988). At Port Hedland Saltworks, WA, mostly occur round intake channels, avoiding ponds of higher salinity (Lane); recorded at Warden L., WA, where salinity 166 ppt (Jaensch 1984). Rarely recorded inland, e.g. edge of saline drainage basin at L. Ranfurly, Vic. (Vic. Atlas). In NZ, at Firth of Thames, seen in cultivated, sprouting turnip crop (Sibson & McKenzie 1960).

Feed on exposed flats of soft mud or wet sand at edges of coastal and near-coastal wetlands, often round channels on mudflats (Amiet 1957) or in accumulated mud in swales between shell banks (McKenzie & Sibson 1965). In n. Aust., feed in soft mud near mangroves, but may remain on same muddy section, even though fresher substrate exposed by falling tide (Garnett 1989). Also feed in shallow water on muddy edges of ponds (Smith 1964; Eckert 1971). Roost on banks on sheltered sand, shell or shingle beaches (Sibson 1964; McKenzie & Sibson 1965; Lane); in se. Gulf of Carpentaria, Qld, roost on beaches with shingle banks and nearby mangroves (Garnett 1989), but not on saltflat behind mangroves (cf. Lane); also in cultivated paddock in NZ (Sibson & McKenzie 1960).

DISTRIBUTION AND POPULATION

Breeding range poorly known; Scandinavia and scattered locations in Russia: in se. Norway from Hallingdal R., NE to e. Sor-Trondelag region; in sw. Sweden between headwaters of Ljungan and Indalsälven Rs; from junction of Angermanälven and Ströins Vattuadal Rs (central Sweden), NE through n. Norway to coast of Barents Sea round Varangerfjord, and E to e. Murinansk Pen. and e. White Sea, and S to Oulujärvi (central Finland) and L. Ladozhskoye; Kanin Pen.; s. Taymyr Pen.; region W of Indigirka R.; and round mouth of Kolyma R. (Dement'ev & Gladkov 1951; Flint *et al.* 1984; BWP). During non-breeding season, regularly in small numbers in ne. Ethiopia, se. Kenya, e. South Africa and w. Namibia; rare W to Mali, E to n. Somalia and S to Mozambique; in Asia, winter in coastal regions from Persian Gulf, E through Indian subcontinent and Indomalaya, E to Indochina, se. China, Taiwan and Philippines, and S to w. and s. Indonesia. Rare but regular visitor to New Guinea. Vagrant, Aleutian Is, Palau, w. and central Europe and Mediterranean coasts (Ali & Ripley 1980; AOU





1983; de Schauensee 1984; Coates 1985; Pratt *et al.* 1987; Urban *et al.* 1987; AWB 1993; BWP).

Aust. Most common on n. and nw. coasts; regularly at scattered localities in S. **Qld** Scattered coastal records, including Massacre Inlet and Karumba region, s. and se. Gulf of Carpentaria; Coen R., Eagle I., Cairns, Innisfail, Townsville and Jerona in n. Qld; Mackay, Emu Park and Gladstone in mid-E; and from North Stradbroke I., S to Moreton Bay and W to Clontarf and Seven-Mile Lagoon, Lowood, in SE (Gill 1970; Longmore 1978; Roberts 1979; Storr 1984a; Smith 1987; Garnett 1989; Sutton 1990; Qld Bird Reps; Aust. Atlas). **NSW** Regular visitor in small numbers, though up to 180, Kooragang I., 26 Feb. 1972 (NSW Bird Rep. 1972). Coastal, from Ballina, S to Shoalhaven Heads (NSW Bird Reps; Aust. Atlas). Recorded inland at Fletcher's L., Dareton, Jan.–Mar. 1963 (Thomas 1970). **Vic.** Annual visitor in small numbers (Vic. Atlas). Occasionally recorded elsewhere in coastal regions: single, L. Reeve, 9 Jan. 1986 (Vic. Bird Rep. 1986);

Discovery Bay, no details (Vic. Atlas). Rare inland records: single, L. Ranfurly, 15 Apr. 1983 (Vic. Bird Rep. 1983); single, Mystic Park, 18 Jan.–6 Feb. 1966 (Thomas 1970). **SA** Singles unless stated: ICI (St Kilda) Saltworks, Buckland Park: specimen, 26 Mar. 1970 (Eckert 1971); two, 23 Mar. 1972 (SA Bird Rep. 1971–72); 1972–73 (SA Bird Rep. 1972–73; 10 Feb.–3 Mar. 1974, 29 Dec. 1974 (SA Bird Rep. 1973–74); 23, 29 Feb. 1975 (SA Bird Rep. 1975); 29 Feb. 1976 (SA Bird Rep. 1976); 5 Nov. 1989 (Lansley 1990). Few records elsewhere: Mutton Cove, Le Fevre Pen., early Feb. 1976 (Winslet & Winslet 1987; SA Bird Rep. 1976); ≥30, Clinton Conservation Park, 17 Nov. 1986 (Hackett & Hackett 1988); Price Saltfields, 29 May 1977 (SA Bird Rep. 1977–81). **WA** Few records in SW, but may be regular in small numbers (Jaensch 1984): at scattered locations, from Warden L. NR and Coramup Ck to Guraga L. NR and Hurstview L. (Serventy & Whittell 1976; Jaensch 1984; Storr 1987; Jaensch *et al.* 1988; *West. Aust. Bird Notes*; Aust. Atlas). Mostly on coasts of Pilbara and Kimberley between Onslow and Broome, but also recorded N to mouth of Lawley R., and inland at L. Daley, Myroodah Stn (Serventy & Whittell 1976; Storr 1980, 1984b; Jaensch 1984; Aust. Atlas; AWSG data). **NT** Irregular and uncommon visitor near Darwin (Aust. Atlas; H.A.F. Thompson & D.K. Goodfellow), though previously considered common at times (Crawford 1972). Also recorded Melville I. (Storr 1977).

NZ Accidental, though said to be 'regularly seen by Auckland and S. Auckland birders' (Anon. 1993). Following are singles unless stated: Firth of Thames: 5 Jan.–1 Mar. 1960 (Sibson & McKenzie 1960), 2 May–22 Dec. 1964 (McKenzie & Sibson 1965), 1966 (NZCL), two, 1968 (NZCL), one or two, 10 Jan.–9 Mar. 1969 (Edgar *et al.* 1969), 23 Nov.–20 Dec. 1970 (Brown *et al.* 1971; CSN 19 Suppl.); Miranda: two, early Dec. 1993 (Woodley 1994), 17 June 1994 (D.F. Booth); Manukau Harbour, 1 Dec. 1963 (Sibson 1964), 27 Dec. 1992–20 Mar. 1993 (CSN 41), Jan. 1993 (Anon. 1993); Parengarenga Harbour, 12 Feb.–9 Mar. 1970 (CSN 19 Suppl.); Manawatu R. estuary, 15 Nov. 1992–12 Apr. 1993 (CSN 41), 1993 (Hague 1994). Unconfirmed records from Southland, Jan. 1969 (Muller 1969), Miranda, Feb. 1970 (Broun 1970), and summit of Pisa Ra., 25 Feb. 1979 (Child 1979).

Population Aust. Estimated at 8000 (Watkins 1993). Sites of significance and maximum or average counts for summer and winter surveys round Aust., 1981–85, were: Port Hedland Saltworks, WA, 1800; se. Gulf of Carpentaria, Qld, 1740; Roebuck Bay, WA, 110; Pilbara coast, WA, 100; Eighty Mile Beach, WA, 55 (Lane). Hunter R. estuary, NSW (180) also of international importance (Watkins 1993).

MOVEMENTS Two migratory populations with partial overlap of non-breeding ranges: (1) nominate *falcinellus* breeds ne. Europe and w. Siberia; moves mainly through e. Europe, and round Caspian Sea to non-breeding areas in n., e., and possibly s. Africa and coasts of Arabian Sea as far E as w. India; (2) subspecies *sibirica* breeds Siberia; moves to non-breeding areas from Bay of Bengal, SE to Aust. and occasionally NZ (Ali & Ripley 1980; BWP). Parties of up to several hundred can occur on migration (Hayman *et al.* 1986). Only subspecies *sibirica* discussed below.

Departure Timing not known, though adults and young possibly leave at different times, as in nominate *falcinellus* (BWP). Infrequent to Aleutian Is on s. migration (AOU 1983). Pass L. Baikal and s. coasts of Sea of Okhotsk, Russia, as early as end July; juveniles recorded at mouth of Amur R., Sept. Recorded from Kurile Is; some pass through Japan where apparently more common on s. migration (see Dement'ev & Gladkov 1951; AWB 1993). Pass through Korea (Gore & Won 1971) and Mongolia. Pass ne. China, late July to mid-Sept.; move down coast of China; large numbers pass through Jiangsu Province in Aug.; pass coast of Fukien, Sept. (la Touche 1931–34; Hemmingsen & Guildal 1968; de Schauensee 1984; AWB 1993). Flocks of up to 50 pass through Hong Kong between early Aug. and mid-Dec., peak Sept. (Chalmers 1986). Large numbers occur Vietnam (Wildash 1968). In 1990, recorded Pattani Bay, s. Thailand, Aug.–Nov. (AWB 1993). Recorded Pen. Malaysia as early as late Aug. (Parish & Wells 1984); in 1985, passed Klang Is till Nov. Pass through Singapore. Earliest date Borneo, mid-Aug. with small number passing through, Sept.–Nov. (Smythies 1981; Harvey & Elkin 1991; AWB 1993). Small numbers may move rapidly through Wallacea (White & Bruce 1986); single, Timor, late Oct. 1973 (McKean *et al.* 1975). Flock, thought to have recently arrived, n. coast of Java, early Sept. 1984 (Bowler *et al.* 1985). Rarely, pass through Philippines (Delacour & Mayr 1946; AWB 1993), and Palau, w. Micronesia (Pratt *et al.* 1987). Rare but regular to New Guinea, where mostly transient from mid-Sept. to late Dec. (Coates 1985). In nw. Aust., very few adults arrive in Aug. and early Sept.; by late Oct. both adults and first-year birds arrive (Fry 1989). Earliest date Darwin, NT, 17 Aug. (Crawford 1972). Arrive se. Gulf of Carpentaria by late Sept. (Lane). Not recorded Torres Str. (Draffan *et al.* 1983) but recorded in Qld from Sept. (Elks 1970).

Non-breeding W. limit of subspecies *sibirica* poorly known but recorded e. Pakistan; nominate *falcinellus* recorded from Thailand and may occur Burma (Deignan 1963; Smythies 1986). Movements within Aust. poorly known (Lane). Counts suggest many remain in Gulf of Carpentaria, Sept.–Apr. (Garnett 1989). Small numbers occur s. Aust. (Aust. Atlas), though unusually large groups noted in some years (e.g. Hindwood & Hoskin 1954; Hackett & Hackett 1988; Aust. Atlas). Scattered records in NSW as early as Oct. (Gibson 1977), but usually from Nov. (Morris 1989). Most Vic. records from Sept. (Vic. Atlas). Possibly regular to sw. Aust. in small numbers, with records from Nov. (Jaensch 1984). Some evidence of fidelity to non-breeding site (see Banding). Irregular to NI, NZ, where recorded as early as Nov.; sometimes remain in one area for months (e.g. Sibson & McKenzie 1960).

Return Most Vic. records before Jan. (Vic. Atlas). Recorded as late as late Mar. in NSW (Hindwood & Hoskin 1954), as late as May in SA (Close & McCrie 1986). Three records of singles in inland se. Aust., Jan.–Apr. (Thomas 1970; Vic. Atlas), suggest some overland passage. Latest date Darwin, 2 May (Crawford 1972). Large numbers in nw. Aust., Mar.–Apr. (Lane & Jessop 1985; Minton 1987; Aust. Atlas) with birds leaving about mid-Apr., when estimated flight-range (without stopping), 3500 km, i.e. to Gulf of Thailand or Malay Pen. (see Fry 1989).

Rare but regular in New Guinea, where mainly transient Apr. and May (Coates 1985). Pass through Borneo where, in Sarawak, usually <100 recorded, Apr.–May, but over 1000 recorded Apr. 1986. In 1986 passage through Pen. Malaysia noted in Mar. and Apr. In 1991 numbers decreased at Pattani Bay, s. Thailand, Jan.–Apr. Over 100 sometimes recorded in Mar. at Red R. Delta, Vietnam (AWB 1993). Flocks of up to 50 pass through Hong Kong between mid-Mar. and early June, peaking late Apr. (Chalmers 1986). At least some Aust. birds pass through Taiwan, Apr. and May (Blackshaw 1978; see Banding). Pass along coast of China where common in Fukien, Apr. and May (la Touche 1931–34); very few recorded Jiangsu

Province on n. migration (AWB 1993). Possibly move inland from coast of China during n. migration, taking w. route to breeding grounds (Lane). Apparently only small numbers pass N through Japan; in 1988 many passed through parts of South Korea in Apr. and May (AWB 1993).

Breeding In austral winter, seen in nw. Aust. most months (Pattinson & Pattinson 1992) and recorded NZ (McKenzie & Sibson 1965).

Banding One banded nw. Aust. in early Aug., recovered Taiwan following Apr. (ABBBS 1992). Of 767 captured 1981–90 in nw. Aust., 35 were retraps; eight of 61 banded in 1992 were retraps (Minton 1992, 1993). Two birds banded in nw. Aust. in Sept. recaptured in same area in Apr. (Fry 1989). Extralimitally, one banded Pt Calimere, India, recovered Shanghai, China (AWB 1993). Three birds banded in Taiwan 1989–90 recaptured in following years (Chuang 1992).

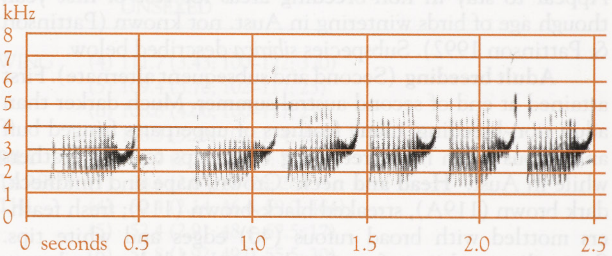
20S118E	04	2+	U	12	4944	2	ABBBS
20S118E	03	2+	U		440	56	ABBBS

FOOD Omnivorous: worms, molluscs, crustaceans, insects, seeds and occasionally rootlets and other vegetation (BWP). **Behaviour** During non-breeding season, forage singly or in large mixed flocks, mainly in tidal habitats. Feeding method varies with substrate. Walk quickly, sometimes running, gleaning from side to side (BWP). In Aust., feed on wet mud and in shallow water, rapidly and repeatedly probing substrate with bill (Elks 1970; Eckert 1971; Lane); sometimes immerse head completely (Smith 1964). Extralimitally, take polychaetes by turning head slightly and pushing bill into substrate; often then wash worms before swallowing; may also take worms from surface without probing. Observed walking on floating material, balancing using wings, and gleaning insects from surface of water (BWP).

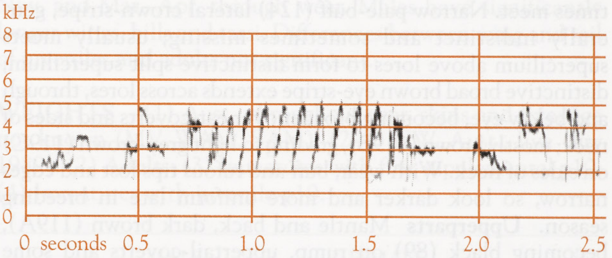
Adult Not known in HANZAB region; observed taking polychaetes (Wheeler 1955).

VOICE No detailed studies; descriptions and sonagrams in BWP.

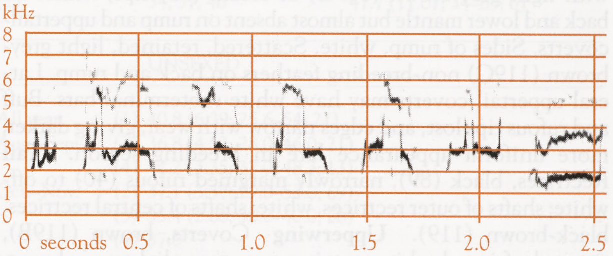
Adult Distinct buzzing call (sonagram A). Low trilled *chrreep* or *ch-reek* (Colston & Burton 1988). Two examples of calls given (sonagrams B, C), recorded in breeding areas, to show similarity to calls given in Aust. Make various other calls (sonagrams D, E), including brief trills and shorter *tzit* and *trr* (Hayman *et al.* 1986).



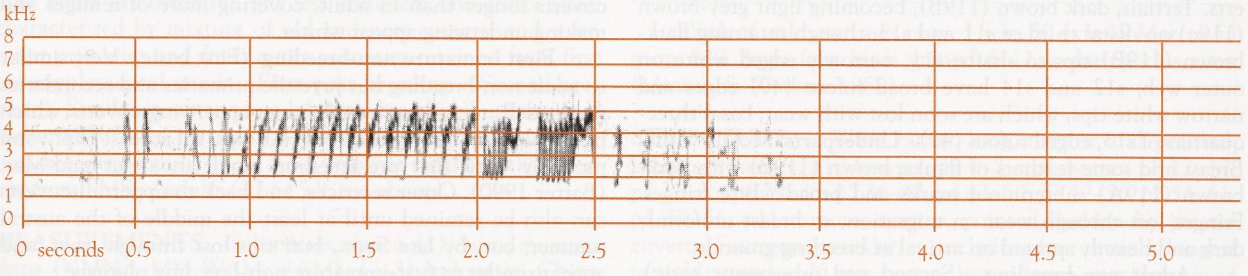
C B. Veprinsev & V. Leonovitch; Berelyakh, Indigirka R., ne. Siberia, June 1976



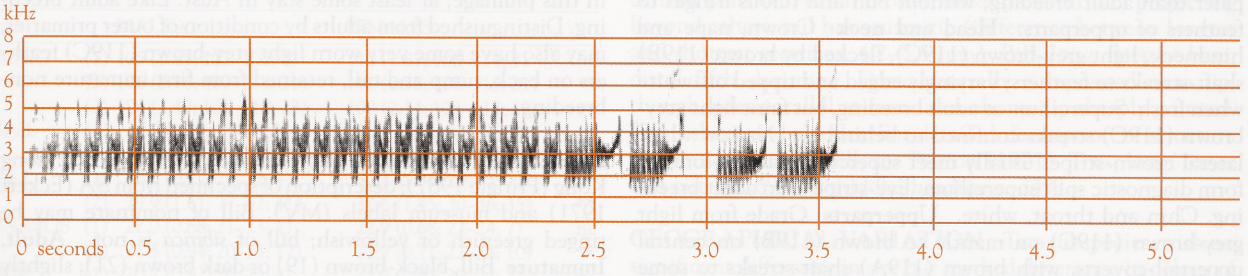
D E. Slater & P.J. Fullagar; Port Hedland, WA, Sept. 1992; priv.



E E. Slater & P.J. Fullagar; Port Hedland, WA, Sept. 1992; priv.



A E. Slater & P.J. Fullagar; Port Hedland, WA, Sept. 1992; priv.



B B. Veprinsev & V. Leonovitch; Berelyakh, Indigirka R., ne. Siberia, June 1976

PLUMAGES Prepared by R.P. Scofield. Begin partial moult to first immature non-breeding (first-basic) plumage, late Aug., during s. migration. Undergo partial first pre-supplementary moult of outer four primaries in nw. Aust. (Barter 1990). Appear to stay in non-breeding areas for rest of first year, though age of birds wintering in Aust. not known (Pattinson & Pattinson 1992). Subspecies *sibirica* described below.

Adult breeding (Second and subsequent alternate). First attained at end of second austral summer. Much darker than adult non-breeding, many feathers of upperparts fringed buff and rufous when fresh, retaining white tips to most feathers while in Aust. **Head and neck** Crown, nape and hindneck, dark brown (119A), streaked black-brown (119); fresh feathers mottled with broad rufous (40) edges and white tips. Supercilium, white, often faintly streaked light grey-brown (119C); supercilia broad in front of eyes and usually separated by brown (119B) strip continuous with crown; supercilia sometimes meet. Narrow pale-buff (124) lateral crown-stripe, generally indistinct and sometimes missing; usually meets supercilium above lores to form distinctive split supercilium; distinctive broad brown eye-stripe extends across lores, through and below eye, becoming broader over ear-coverts and sides of neck; mostly brown (119B), grading to light grey-brown (119C) on sides of neck. With wear, buff and rufous tips lost and edges narrow, so look darker and more uniform late in breeding season. **Upperparts** Mantle and back, dark brown (119A), becoming black (89) on rump, uppertail-coverts and some scapulars; all feathers fringed rufous (40) or rufous-brown (38) with light grey-brown (119C) or cream (92) tips, widest on back and lower mantle but almost absent on rump and uppertail-coverts. Sides of rump, white. Scattered, retained, light grey-brown (119C) non-breeding feathers on back and rump. Lateral uppertail-coverts may have white subterminal bars. Buff and rufous tips lost, and edges narrow with wear, giving darker, more uniform appearance late in breeding season. **Tail** Rectrices, black (89), narrowly margined rufous (40) to off-white; shafts of outer rectrices, white; shafts of central rectrices, black-brown (119). **Upperwing** Coverts, brown (119B), narrowly fringed white; retain some worn light grey-brown (119C) feathers from non-breeding, especially median coverts. Tertials, dark brown (119B), becoming light grey-brown (119c) on distal third of s11 and s13, though retaining dark-brown (119B) tips to shafts; s11, narrowly edged white on outer web; s12 and s14 have broad rufous (40) edges and narrow white tips, which are soon lost with wear; basal three-quarters of s13, edged rufous (40). **Underparts** Mostly white. Breast and some feathers of flanks, brown (119B) with dark-brown (119A) subterminal marks and broad white fringes. Fringes lost through wear on migration, so breast uniformly dark and heavily spotted on arrival at breeding grounds.

Adult non-breeding (Second and subsequent basic). First obtained at start of second austral summer. Considerably paler than adult breeding, without buff and rufous fringes to feathers of upperparts. **Head and neck** Crown, nape and hindneck, light grey-brown (119C), flecked by brown (119B) shaft-streaks to feathers; varyingly edged and tipped off-white when fresh. Supercilium as adult breeding, but faint light grey-brown (119C) streaks confined to behind eye. Narrow white lateral crown-stripes usually meet supercilium above lores to form diagnostic split supercilium. Eye-stripe as in adult breeding. Chin and throat, white. **Upperparts** Grade from light grey-brown (119C) on mantle to brown (119B) on central uppertail-coverts, with brown (119A) shaft-streaks to some scapulars and feathers of back. Feathers on mantle, back and scapulars edged and tipped buff (121D), cream (92) and off-white when fresh. Sides of rump and lateral uppertail-coverts, white. **Tail** Central rectrices, light grey-brown (119C); outer rectrices, brown (119B); all narrowly edged white and with white shafts. **Underparts** Mostly white. Breast, mottled white and buff (121D), becoming brown (119B) as shaft-streaks become exposed by wear of white tips. **Upperwing** Marginal coverts and alula, black-brown (119), mottled cream (92) along leading-edge; lesser coverts, dark brown (119A); median and greater secondary coverts, light grey-brown (119C); these coverts combine to form dark carpal patch on closed wing. All inner secondary coverts have black-brown (119) shaft-streaks, and are edged and tipped buff (121D), cream (92) and off-white when fresh. Outer three greater primary coverts, black-brown (119); rest, dark brown (119A), tipped white. Outer primaries, dark brown (119A) grading to brown (119B). Secondaries, dark brown (119A). Shafts of primaries and secondaries, cream (92). Tertials, light grey-brown (119C) with dark-brown (119A) shaft-streaks and broad cream (92) edges. **Underwing** Coverts have black-brown (119) outer edges giving scalloped appearance to wing. Primaries and tertials, light grey-brown (119c). Terminal third and outer web of secondaries, pale grey-brown (119D), becoming white on basal inner webs. Shafts of primaries and secondaries, white, with some brown (119B) encroaching onto central shafts of p7–p9.

Juvenile Differences from adult breeding: **Head and neck** Pattern as for adult, but dark areas mottled brown (119B) with dark-brown (119A) shaft-streaks and rufous-brown (38) and pink-buff (121D) fringes and tips to most feathers. Lateral crown-stripe sometimes appears cream (92) (photos in Pringle 1987). **Upperparts** Pattern, like adult, but feathers dark brown (119), broadly tipped rufous (39); on some feathers, tips fade to buff (121D). **Tail** Tipped white. **Underparts** Breast, mottled brown (119B) and white; feathers, white, with dark-brown (119A) shaft-streaks; some feathers edged buff (92). **Upperwing** Outer greater primary coverts tipped white; inner greater coverts have broad white terminal band; all secondaries have white tips, and inner secondaries mostly white. Tertials have rufous-brown edges. **Underwing** Median coverts longer than in adult, covering more of remiges and making underwing appear whiter.

First immature non-breeding (First basic). Very similar to adult non-breeding but juvenile primaries and secondaries retained. Retain some juvenile inner upperwing-coverts, which have pale buff (124) and rufous (40) tips, till at least Sept., and probably until first pre-breeding moult in about mid-Mar. (Barter 1990). Outer rectrices, and back to uppertail-coverts can also be retained until at least the middle of the austral summer, but, by late Sept., buff tips lost through wear, and appear similar to first-immature non-breeding plumage.

First immature breeding (First alternate). Do not breed in this plumage; at least some stay in Aust. Like adult breeding. Distinguished from adults by condition of outer primaries; may also have some very worn light grey-brown (119C) feathers on back, rump and tail, retained from first immature non-breeding.

BARE PARTS Based on photos from Aust., Japan and Hong Kong (Pringle 1987); description of specimen from SA (Eckert 1971) and museum labels (MV). Bill of nominate may be tinged greenish or yellowish; bill of *sibirica* is not. **Adult, Immature** Bill, black-brown (19) or dark brown (21); slightly paler, even olive-brown (30) or yellow (1 year old on 19 Feb.;

D.I. Rogers) at base, of lower mandible. Iris, dark brown (22). Legs and feet, deep grey-olive (43). **Juvenile** As adult, but legs of some paler, possibly even yellow-olive (52), especially on distal end of tarsus. Joints, dark.

MOULTS From BWP, Fry (1989), Barter (1990) and skins (NMNZ, MV, WAM). **Adult post-breeding** (Third and subsequent pre-basic). Complete; primaries outwards. Most moult of body occurs on stopovers during migration, birds arriving Aust. with advanced moult. Moult feathers of back and uppertail-coverts last; skin from nw. Aust., early Nov., retained only a few breeding feathers on rump (MV B13040). Moult of remiges and rectrices starts soon after arrival in non-breeding areas. Mean PMS of four adults, Aug.–Sept.: 20 (4.08; 15–25; 4); 164 birds, Oct.–Nov., had mean PMS: 27.6 (5.90; 3–39; 164). Some reach Aust. with moult suspended and new inner primaries, which suggests some moult of primaries occurs during stopovers on migration (MV B4615; AWSG); advanced PMS, Aug.–Sept., may also indicate moult of primaries begins on migration (Fry 1989). No primary-moult observed by Mar.–Apr. (Fry 1989). **Adult pre-breeding** (Second and subsequent pre-alternate). Partial; usually first occurs at end of second austral summer. Replace all feathers of head, neck, mantle, scapulars, tertials, underparts, all or most of back, rump and uppertail-coverts and some inner median upperwing-coverts. Often replace central, and sometimes all, rectrices. Percentage of breeding plumage on all birds captured in nw. Aust increases from 68% (20; 25–90; 25) in mid-Mar. to 81% (25; 5–100; 233) by early Apr. **Post-juvenile** (First pre-basic). Partial; starts during s. migration (late Aug.). Birds in full juvenile plumage recorded Japan without date (Pringle 1987); moult to first immature non-breeding mostly completed by late Sept. on arrival in Hong Kong (with one bird [NMNZ 24329] in advanced moult of head, neck, mantle, scapulars, underparts and tail). Continue moult of body during rest of first austral summer, replacing much of back, rump and uppertail-coverts, tertials, and upperwing-coverts (BWP). **Post-juvenile moult of primaries** (First pre-supplemental). Partial; in nw. Aust., Mar.–Apr., moult outer four primaries (Fry 1989; Barter 1990; QM). **First pre-breeding** (First pre-alternate). Like adult pre-breeding, but less complete and starts later; characterized by mixture of old and new coverts, and worn inner primaries and fresh outer primaries retained from first pre-supplemental moult. **First post-breeding** (Second pre-basic). Similar in extent to adult post-breeding but may start earlier (BWP). In nw. Aust., Oct.–Nov., PMS of birds in first post-breeding moult, 26.2 (5.40; 26); not significantly different from PMS of adults (27.6±5.9; see above).

MEASUREMENTS Subspecies *sibirica*. (1) Aust., museum skins (NMNZ, MV, WAM, SAM). (2–3) Indonesia, China and se. Asia, skins and live (BWP): (2) Adults; (3) Juveniles.

		MALES	FEMALES	
WING	(1)	105 (0.85; 103–107; 4)	110 (2.87; 106–114; 7)	*
	(2)	106 (2.96; 100–111; 21)	111 (2.32; 108–115; 21)	**
	(3)	106 (2.40; 101–110; 28)	109 (2.14; 105–114; 27)	**
TAIL	(1)	36.7 (1.31; 35–38.5; 4)	38.7 (1.36; 37–40; 7)	ns
	(2)	36.7 (1.49; 34–39; 13)	38.1 (1.32; 36–40; 6)	ns
BILL	(1)	30.5 (0.77; 29–31; 4)	32.7 (1.36; 29–35; 7)	*
	(2)	29.9 (1.61; 27–32; 41)	32.6 (1.45; 30–36; 35)	**
TARSUS	(1)	22.0 (0.68; 21–23; 4)	22.9 (0.68; 22–24; 7)	ns
	(2)	21.5 (0.94; 20–23; 17)	22.9 (0.71; 22–24; 10)	**
TOE	(1)	20.7 (0.82; 20–22; 4)	21.0 (0.62; 20–22; 7)	ns

(4–7) NW. Aust., live (Fry 1989; AWSG): (4) Adults; (5) Immatures with first supplemental p10; (6) Immatures with juvenile p10; (7) All ages (Minton & Watkins 1989).

		UNSEXED
WING	(4)	111.7 (3.43; 100–122; 370)
	(5)	109.4 (3.70; 102–117; 25)
	(6)	108.8 (4.06; 100–117; 21)
	(7)	108.3 (3.29; 102–114; 26)
BILL	(7)	31.0 (2.21; 27–36; 26)
TARSUS	(7)	24.6 (2.03; 22–28; 26)
THL	(4)	52.4 (2.14; 46.6–59.0; 464)
	(5)	52.4 (2.91; 48.4–57.5; 17)
	(6)	51.8 (1.92; 49.0–55.5; 20)

Significant differences in length of wing between Oct.–Nov. and Mar.–Apr. through wear. Males have significantly longer wings, bills and tarsi. Differences between wing and tail of juveniles and adults not significant.

WEIGHTS (1) Aust., throughout year, skins and live; age not known (MV, WAM, SAM). (2–4) NW. Aust., live (Fry 1989): (2) Adults; (3) Immatures with first supplemental p10; (4) Immatures with juvenile p10.

	MALE	FEMALE
(1)	34, 37, 46	47.7 (11.07; 34–65; 6)

		UNSEXED
All year	(1)	40.8 (6.39; 25.6–54; 21)
Aug.–Sept.	(2)	36.8 (4.52; 28.0–46.0; 21)
	(4)	42.2 (3.35; 37.0–48.3; 13)
Oct.–Nov.	(2)	37.1 (3.37; 29.0–52.0; 69)
	(3)	35.4 (2.66; 30.0–40.0; 26)
	(4)	37.0
Mar.–Apr.	(2)	54.5 (6.03; 33.0–74.0; 392)
	(4)	39.6 (9.41; 34.0–61.0; 11)

Birds of unknown age, ranged from 50 g on 19 Mar. to 55 g on 8–9 Apr.; four birds gained 6–11 g during this time (Minton & Watkins 1989).

STRUCTURE Wing rather long, narrow and pointed. Eleven primaries; p10 longest, p9 0–2 mm shorter, p8 12–17, p7 21–25, p6 29–35, p5 36–42, p4 43–50, p3 49–56, p2 54–61, p1 59–66; p11 minute, narrow, pointed, hidden by greater coverts. Fourteen secondaries, including four tertials; longest tertials extend *c.* 25 mm beyond secondaries, reaching tip of p7–p8 on closed wing. Tail, short; 12 rectrices, usually with central pairs (t5, t6) and often outer pairs (t1, t2) projecting beyond others; tail has square tip (difference between longest and shortest rectrices, 4.2–5.5 mm). Bill, long, deep at base; distal fifth decurved. Dorso-ventrally compressed near tip, though sides parallel as seen from above; tip sharply pointed. Tarsi, short and slender. For detailed description of structure and musculature of bill, see Burton (1971). Toes, long; inner and outer *c.* 89% of middle, hindtoe *c.* 34%.

GEOGRAPHICAL VARIATION Two subspecies, with no significant difference in size but marked difference in colour of breeding plumage: in nominate *falcinellus*, ground-colour of upperparts, black-brown (119) and black; in subspecies *sibirica*, ground-colour, dark brown (119A) with black (89), if present, restricted to shaft-streaks; *sibirica* also has broader and brighter tips to feathers of upperparts. Non-breeding plumages very similar; in fresh plumage, subspecies *sibirica* has wider, white fringes to feathers of upperparts, which are quickly lost with wear; in worn plumage, *sibirica*, greyer with few dark-brown shaft-streaks showing by Nov. In juvenile plumage, *sibirica* has broader buff fringes to feathers of upperparts, though these soon lost with wear.

Populations differ in number of primaries replaced by juveniles in first pre-supplemental moult; may be related to distance of migration or possibly a subspecific trait; Indonesian and Aust. *sibirica* lose 3–4 outer primaries; European *falcinellus* replace 2–3 (BWP); in India, which said to be nominate *falcinellus*, lose 3–4.

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Baird's Sandpiper *Calidris bairdii* (page 283)
1 Adult breeding; **2** Adult non-breeding; **3** Juvenile

White-rumped Sandpiper *Calidris fuscicollis* (page 279)
4 Adult breeding; **5** Adult non-breeding; **6** Juvenile

Broad-billed Sandpiper *Limicola falcinellus* (page 333)
7 Adult breeding; **8** Adult non-breeding; **9** Juvenile; **10** First immature non-breeding

Sanderling *Calidris alba* (page 237)
11 Adult breeding; **12** Adult non-breeding; **13** Juvenile; **14** First immature non-breeding

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Volume 3, Plate 16

Red-necked Stint *Calidris ruficollis* (page 258)
1, 2 Adult

Little Stint *Calidris minuta* (page 250)
3, 4 Adult

Long-toed Stint *Calidris subminuta* (page 270)
5, 6 Adult

Broad-billed Sandpiper *Limicola falcinellus* (page 333)
7, 8 Adult

Sanderling *Calidris alba* (page 237)
9, 10 Adult

White-rumped Sandpiper *Calidris fuscicollis* (page 279)
11, 12 Adult

Baird's Sandpiper *Calidris bairdii* (page 283)
13, 14 Adult

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