

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	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, Jacanidae) 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 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, Stercorariidae, Laridae and Sternidae will be dealt with in Volume 3 of HANZAB.

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Order CHARADRIIFORMES

Family SCOLOPACIDAE sandpipers and allies

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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28 Gallinagoninae

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Subfamily PHALAROPODINAE phalaropes

Small (18–24 cm) swimming scolopacids, with distinctive breeding behaviour and migratory habits. Three species in two genera: (1) *Phalaropus*, with two species (Red-necked Phalarope *P. lobatus*, Grey Phalarope *P. fulicaria*) that breed in Arctic and Subarctic and migrate to pelagic non-breeding areas in Tropics and farther S; and (2) *Steganopus*, with single migratory species (Wilson's Phalarope *S. tricolor*) in New World. All recorded HANZAB region; Red-necked Phalarope a rare summer visitor, the other two accidental. Studies of osteology (Campbell 1979), allozymes (Dittman *et al.* 1989) and mitochondrial DNA (Dittman & Zink 1991) have shown *Steganopus* to be generically distinct. Structure, behaviour, appearance, reversed sexual dimorphism, moults and aquatic adaptations are unusual and rather uniform, so they have long been regarded as a 'natural' unit (BWP) and often treated as a full family. However, some analyses of allozymes and mitochondrial DNA suggest *Steganopus* is no more closely related to *Phalaropus* than to some Calidridinae or Tringinae, and monophyly of group remains unproven (Dittman *et al.* 1989; Dittman & Zink 1991; Rubega & Obst 1993). Despite uncertainties about affinities, studies of osteology and jaw musculature (Lowe 1931; Strauch 1978; Burton 1974), allozymes and mitochondrial DNA (Dittman *et al.* 1989; Dittman & Zink 1991; Sibley & Ahlquist 1990) show phalaropes are clearly scolopacids, as do patterns of downy young, which are very similar to those of sandpipers in tribe Tringini (Jehl 1968; Fjeldså 1977).

Neck, slender; head, small, with narrow forehead; musculature of jaw, weak but that of tongue well developed, especially in Grey Phalarope. Bill, straight and needle-like in Wilson's and Red-necked Phalaropes; in at least latter species, fine bill structure associated with feeding mechanism in which zooplankton transported rapidly from bill-tip to mouth by forces resulting from surface tension of water surrounding prey (Rubega & Obst 1993). Grey Phalarope may have different filter-feeding mechanism; bill is broader and a few well-developed papillae at inside tip of lower mandible probably act as strainers (Olson & Feduccia 1980). Bodies, slim and sandpiper-like; underparts more densely feathered than other scolopacids, presumably for improved waterproofing and buoyancy while swimming. Wings, narrow, pointed; flight low, fast, and direct. Swim readily and well (but do not dive), with structure of short legs and feet modified accordingly: tarsi are strongly laterally compressed and front toes are lobate, each broadly fringed by independent, scutellate webs (arrangement of scales and webs differs in each species). Anterior toes also have small basal webs; hindtoe relatively long, raised.

Sexual dimorphism reversed: females larger with more brightly coloured breeding plumage than males. Breeding plumage attained in partial pre-alternate moult and is highly decorative, with various combinations of rufous or maroon and white, black, grey, and buff, making females among the most colourful waders. Attain non-breeding plumage in complete pre-basic moult; plumage pale grey above, white below. Juvenile plumage distinct, with dark upperparts scaled buff, and white underparts often washed grey to orange-buff on foreneck and breast. Pre-basic moults (post-breeding and post-juvenile) occur earlier than in most scolopacids, often beginning near breeding grounds and well advanced by early stages of s. migration. Adult post-breeding moult usually starts earlier in females than males; genuine moult-migration reported in Wilson's Phalarope (q.v.; Jehl 1987). Down of precocial young, soft and silky; mainly rich buff above, grading to white on centre of underparts. Dorsal pattern similar to striped type of Tringinae, with three bold black bands on upperparts; most down-feathers have fine, deep purplish-grey terminal filaments (Fjeldså 1977).

Breed in open habitats, usually with some pools, lakes or other standing water nearby, from Arctic tundra (most Grey Phalaropes) and Subarctic (most Red-necked Phalaropes) to temperate prairies and taiga (Wilson's Phalarope). Wilson's Phalarope spends non-breeding season in inland wetlands of South America; non-breeding *Phalaropus*, tend to be strictly pelagic, spending non-breeding season at sea in tropical or subtropical waters where upwellings occur (though can occasionally occur on inland wetlands, especially during migration).

Characteristically feed while swimming, picking invertebrate prey from surface of water or just below it; when doing so in still water, often spin rapidly in tight circles, presumably to bring food into view or within reach (e.g. Höhn 1971). Wilson's Phalarope spins less often than *Phalaropus*, and feeds more while swimming directly or wading. When breeding, all three species have more diverse feeding behaviours and may also feed on land (e.g. Kistchinski & Chernov 1973; Höhn & Barron 1963; BWP).

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MALES

FEMALES

Phalaropus lobatus **Red-necked Phalarope**

COLOUR PLATE FACING PAGE 369

Tringa tobata (sic) Linnaeus, 1758, *Syst. Nat.*, ed. 10(1): 148, emended to *lobata* on page 824, based on Edwards, 1750, *Nat. Hist. Birds* 3: text for Pl. 143 — Hudson Bay.

The generic name is compounded from the Greek φάλαγγις, a coot, and πούς, foot, and refers to the coot-like lobes on the toes. *Lobatus* is derived from the Modern Latin (*lobus*) for lobe (from the Greek λόβός, lobe), and also refers to the lobes on the toes.

OTHER ENGLISH NAMES Northern Phalarope, Round-nosed Phalarope.

MONOTYPIC

FIELD IDENTIFICATION Length 18–19 cm; wingspan 31–34 cm; weight 34 g. Smallest phalarope. Distinctive marine wader with small head; slender neck; short straight needle-like bill; short legs; and feet with lobed toes. Between Broad-billed *Limicola falcinellus* and Curlew *C. ferruginea* Sandpipers in size. Smaller and slimmer than Grey Phalarope *Phalaropus fulicarius*, with smaller head, shorter narrower wings, and slightly longer and much finer bill; much smaller than Wilson's Phalarope *P. tricolor*, with much shorter bill and legs. In flight, all plumages show bold white wing-bar, white sides to dark-centred rump and uppertail-coverts, and white underwing with contrasting dark trailing-edge and markings on coverts. Red-necked and Grey Phalaropes the only waders occurring regularly at sea. Mainly winter at sea in Tropics, but occasionally seen on coastal and inland wetlands. Sexes separable in breeding plumage; similar in non-breeding and juvenile plumages. Marked seasonal variation. Juvenile distinct. Immatures separable.

Description Adult female breeding Head and neck, slate-grey, except for small white spot over and in front of eye, white chin and throat (often narrowly bordered grey), and

prominent chestnut-red band starting behind ear-coverts (behind eye in some) and broadening down sides of neck to join broadly across foreneck. Breast-band and fore-flanks, slate-grey, grading to mottled grey and white in centre of breast; in some, grey of breast extends to throat, dividing chestnut band

Plate 19

Stilt Sandpiper *Micropalama himantopus* (page 326)

1 Adult non-breeding; 2 Juvenile; 3 First immature non-breeding

Cox's Sandpiper (page 307)

4 Adult non-breeding; 5 Juvenile, fresh plumage;
6 Juvenile, worn plumage

Curlew Sandpiper *Calidris ferruginea* (page 315)

7 Adult non-breeding; 8 Juvenile;
9 First immature non-breeding

Dunlin *Calidris alpina* (page 308)

10 Adult non-breeding; 11 Juvenile;
12 First immature non-breeding

on foreneck; rest of underbody, white, with messy but heavy grey streaks on rear flanks and sides of belly. Upperbody, and innerwing-coverts, mostly slate-grey, with broad buff lines along sides of mantle and through central scapulars; scapulars have blackish shaft-streaks and narrow white fringes (buff on central scapulars); tertials and smaller wing-coverts, like central scapulars. Sides of rump and lateral uppertail-coverts, white (with dark centres to some distal coverts) with narrow black line through central uppertail-coverts (narrowly scaled paler). In flight from above: slate-grey innerwing-coverts and otherwise blackish upperwing, with white shafts to primaries and white tips to greater coverts forming bold wing-bar across innerwing, tapering outwards; slate-grey tail and prominent white sides to dark-centred rump and uppertail-coverts. Underwing, white, with broad dark-grey trailing-edge and narrow dark-grey leading-edge, greater primary coverts and narrow bar across innerwing-coverts. With wear, buff stripes on upperparts fade and white fringing on upperparts and breast reduced or lost. Bill, black. Iris, dark brown. Legs and feet, dark grey to black. **Adult male breeding** Like female breeding but duller. Dark areas of head, neck, upperparts, breast and flanks, darker, brownish grey, with upperparts darker, almost black in some, and always with more buff edging, particularly on mantle and scapulars (including between mantle and scapular lines, whereas this area clean grey in female). White above eye more diffuse, normally joining with pale area on upper lores to form pale fore-supercilium. Patches on neck pale rusty-brown, and extend farther forwards to rear of eye, but vary from almost as large and rich chestnut as on typical female to virtually absent and replaced by grey; best distinguished by joining of rufous patch on neck with whitish fore-supercilium in combination with more extensive buff edging on upperparts. **Adult non-breeding** Differ from breeding by: head and neck, white, with oval-shaped black patch from in front of eye to rear ear-coverts, bending down over rear ear-coverts in some; and grey patch on nape, continuing in narrow dark line down hindneck to mantle. Mantle, scapulars and tertials, grey, with fine dark streaks; white edgings to larger feathers form ill-defined lines along sides of mantle and through central scapulars, these becoming less obvious with wear. Underbody, white, except for grey patch at sides of breast and smudgy grey streaking along flanks. Flight-pattern as breeding, except: grey saddle contrasts with blackish upperwing-coverts, back, rump and line through central uppertail-coverts; and lateral uppertail-coverts wholly white. **Juvenile** Head and neck much as adult non-breeding but with larger and darker blackish-brown cap and narrow line down centre of hindneck. Upperparts and innerwing-coverts also much darker, black, with bright-buff

edges (paler and narrower when worn), broadest and forming bold stripes along sides of mantle and through central scapulars; narrow subscapulars with crisp white edges often visible at base of tertials. Underbody as adult non-breeding, but with grey-buff to pinkish-grey wash on sides of neck, foreneck, upper breast and flanks that quickly fades to white. Flight-pattern as non-breeding but with dark cap; buff-striped, blackish saddle, not contrasting with wing-coverts, back, rump and central uppertail-coverts; dark centres to some distal lateral uppertail-coverts. Birds in full juvenile plumage unlikely to be seen in HANZAB area. Bare parts as adult, except: legs and feet yellow at first, soon changing to dark grey or black. **First immature non-breeding** Like adult non-breeding, but separable till austral summer by varying amounts of retained worn juvenile plumage (some innerwing-coverts, and on cap, scapulars and tertials); also, retained or as yet unmoulted juvenile primaries rather fresh in austral spring–summer (worn or moulting in adults). Most undergo complete moult in wintering area during austral summer–autumn and inseparable from adult non-breeding when moult finished. **First immature breeding** Most attain full breeding plumage (like adult breeding) in austral autumn and return to n. hemisphere; those few with partial post-juvenile moult (body only) thought to remain in non-breeding areas through first austral autumn and second austral spring, developing little or no breeding plumage and retaining very worn juvenile remiges (adults in breeding plumage, with fresh remiges).

Similar species Adults in breeding plumage, distinctive (small size; short fine black bill; dark-grey upperparts with bold buff stripes, contrasting white throat and chestnut patch on neck). Can be confused with **Grey Phalarope**, particularly in non-breeding and juvenile plumages. At all times, size and structure are the best distinctions: Grey is larger and bulkier, with slightly bigger head, and slightly shorter thicker and blunter bill (showing lateral expansion at tip). In **NON-BREEDING PLUMAGES**, Grey differs by: (1) upperparts, paler grey and plainer (darker Red-necked has broader white edgings to feathers forming conspicuous pale mantle and scapular lines); (2) yellow or yellowish-brown tinge at base of black bill (though may be indistinct on some); (3) tends to have square or roughly oval dark eye-patch extending horizontally from eye to ear-coverts (on Red-necked, patch tends to turn down behind eye and end in more of a point, though there is much overlap). In **JUVENILE PLUMAGE** very similar to juvenile Red-necked; differs by: dark blackish-brown upperparts with buff edges to feathers, but with only poorly defined buff lines along sides on mantle; also by differences in eye-patch and colour of bill as non-breeding, though pale base to bill more often indistinct, and some have all-black bill. By Sept.–Oct. have attained partial first-immature non-breeding plumage, with mainly grey mantle and scapulars, and often retain pinkish-buff or brown wash on foreneck and upper breast (in Red-necked, buff colour of neck and breast already faded to white, and upperparts still mostly juvenile). In flight, in all plumages, Grey: (1) larger and bulkier, with longer and slightly broader wings; fuller tail; and thicker, slightly shorter bill; (2) mostly whitish underwing without contrasting dark markings; (3) slower wing-beats and often less erratic flight; (4) at sea, tend to fly in loose flocks, scattered or in lines (Red-necked tend to fly in bunches, sometimes tightly packed, recalling *Calidris*); (5) in non-breeding plumages, paler and plainer grey saddle and innerwing-coverts (darker and contrasting with paler grey saddle in Red-necked). In non-breeding and juveniles plumages, may be confused with **Wilson's Phalarope** *P. tricolor*, which

Plate 20

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

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

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

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

differs at all times by: (1) longer, thinner bill; (2) larger size, with very different shape: smaller head with more sloping forehead; longer neck; wider body and more pot-bellied appearance; longer legs and longer, less distinctly lobed toes; (3) in flight: square white patch across uppertail-coverts; no wing-bar; mostly white underwing without contrasting dark markings, and feet clearly projecting beyond tip of tail. Adult non-breeding and first-immature Wilson's further distinguished from same of Red-necked by: (1) more uniform and paler-grey upperparts without white lines on mantle and scapular; (2) forehead, crown, nape, hindneck and narrow stripe behind eye to ear-coverts, uniform, pale grey and concolorous with rest of upperparts (on Red-necked, smaller and darker grey patch on rear-crown and nape and broader and darker blackish eye-patch, both contrasting with white forehead and paler grey upperparts); (3) paler, yellow or green legs and feet; (4) different, low grunting call (see Voice). Wilson's rarely at sea and found on land much more than other phalaropes.

Gregarious except when breeding. Non-breeding season spent mainly in tropical seas, in small and sometimes large flocks (hundreds), particularly along convergence lines and edges of kelp beds. In our area, usually seen singly in variety of coastal wetlands. At sea, freely associate with other aquatic birds; on land, with other waders such as stilts, avocets and small calidrids. At all times, tame and approachable. Very active, normally seen swimming; swim rapidly and jerkily on erratic course, with behaviour like that of Dusky Moorhen *Gallinula tenebrosa*: show markedly buoyant carriage, with constant bobbing of head, which is held high on upstretched straight neck, adding to impression of wandering progression; line of back slopes down from high shoulders, and wings and tail angled slightly upwards; head hunched well into body when resting quietly on water. When swimming, folded primaries fall level with or slightly short of tip of tail; primary-projection short in adult breeding, moderate in juveniles. Feed mainly by picking with tip of bill from water or from emergent vegetation or rocks. Distinctive feeding actions include spinning and dabbing in one spot, sometimes stretching neck along surface of water to snatch at insects; spinning common in shallow waters but not on open ocean; rarely up-end, but can dive. Only rarely leave water to run about erratically along muddy shore or to preen or roost for short periods; will clamber over small objects but do not perch. Flight, rapid and erratic; over long distances often more erratic than Grey Phalarope, with faster wing-beats and rapid twists and turns, appearing more like small calidrid; over short distances, flight more flitting and nervous, with bird suddenly jumping off water, fluttering over surface, then suddenly landing again; body looks rather boat-shaped, feet do not trail beyond tip of tail. Usual flight call a short sharp single *twick*, *clip*, *kitt* or *chip*, similar to but lower pitched than equivalent call of Grey Phalarope; when alarmed, utter series of same notes, both in flight and when settled.

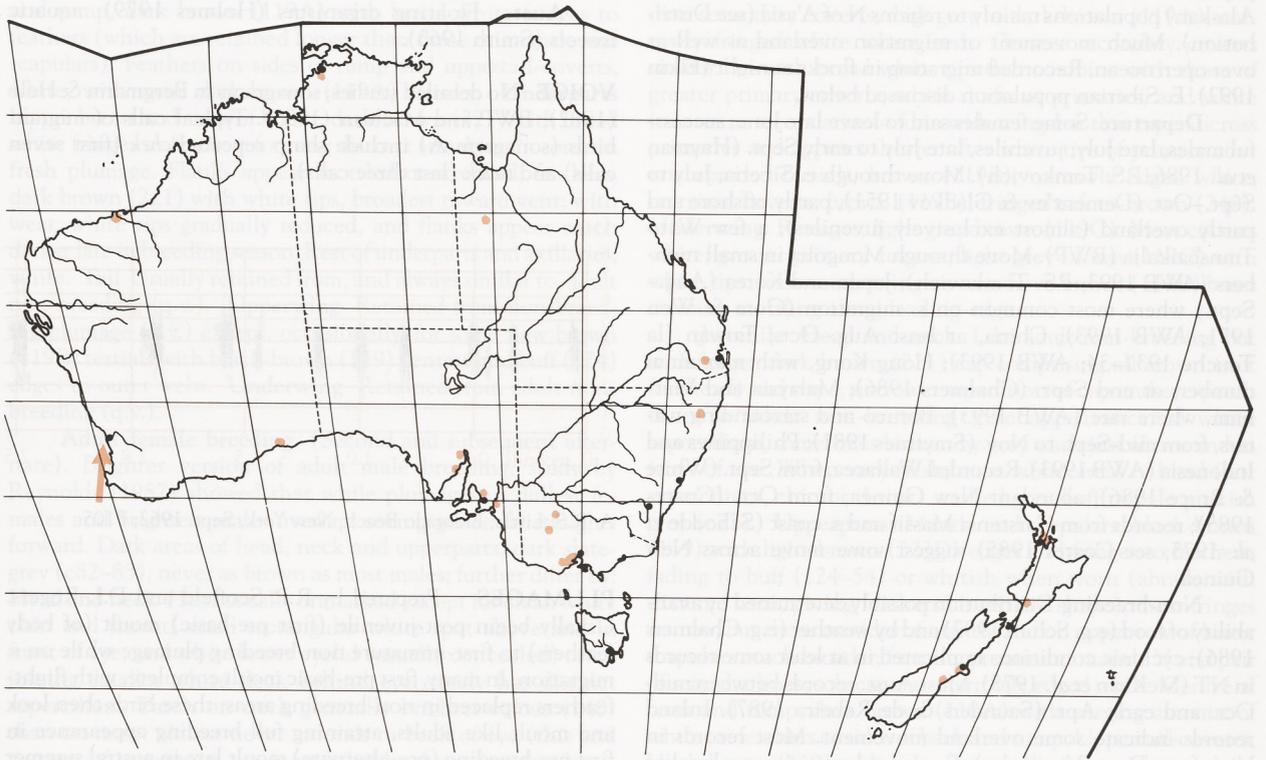
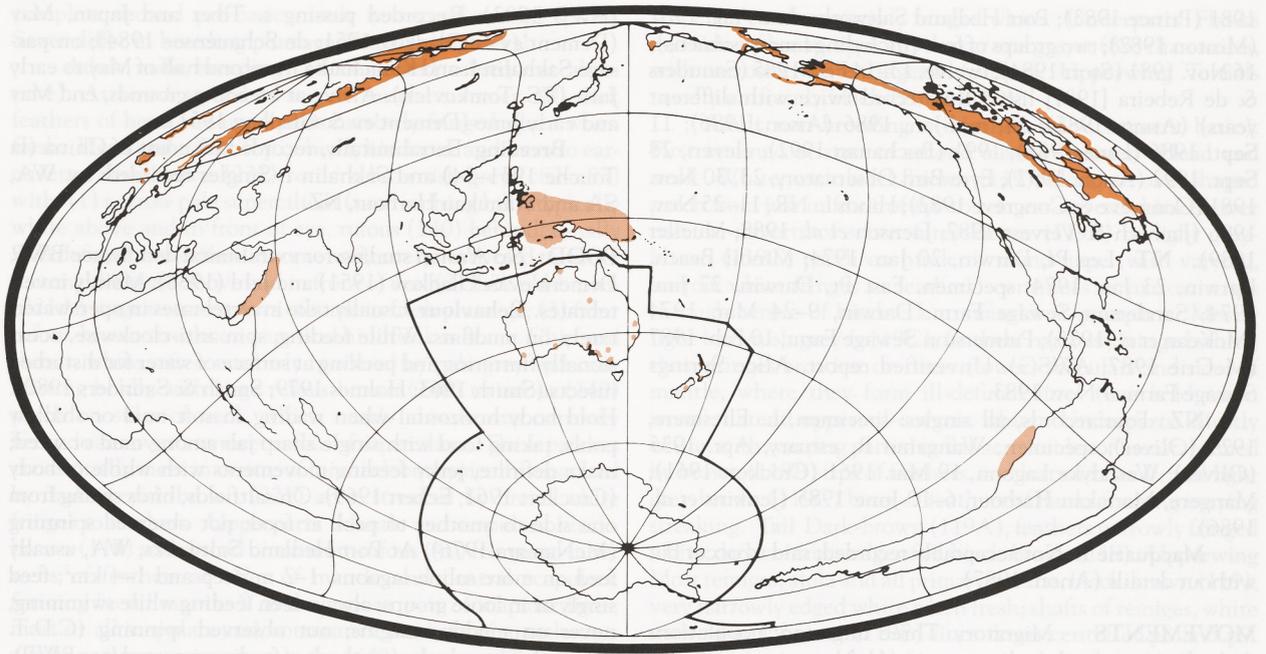
HABITAT During non-breeding period, usually pelagic, occasionally congregating round ocean slicks (Schulz 1987; Murphy). Infrequently recorded on coasts and shallow near-coastal wetlands, particularly on migration, with occasional records inland. Occasionally at high altitudes in New Guinea (Coates 1985). In A'sia, mainly shallow, fresh, brackish or saline near-coastal wetlands, usually with muddy edges, including lakes, lagoons, swamps, estuaries, pools and ponds, and sewage farms and saltworks. Usually observed swimming or wading in water, both near and far from shore (Smith 1969,

1983; Prince 1983). Rarely, on intertidal mudflats (Smith 1969), reservoirs (Qld Bird Reps 1986, 1991) and sandy ocean beach (Congreve & Congreve 1982); once recorded on lagoon in New England Tablelands, 1300 m asl (Holmes 1979).

Mainly forage from surface of water (Mueller 1989): either open and unvegetated, or among floating or emergent aquatic vegetation, such as algae and water-weed (Crockett 1961; Smith 1963; Jenkins *et al.* 1986). Mostly in shallows; occasionally in small shallow pools; rarely along muddy edges or on soft mud-spits (Smith 1963; Eckert 1969). Roost or loaf in shallow pools or on clay, mud or sand at edges of wetlands or on small islets (Crockett 1961; Smith 1963, 1969; Eckert 1969).

DISTRIBUTION Breed in Arctic and subarctic North America, Europe and Russia: in w. and n. Alaska and n. Canada, on Aleutians, and N from Hooper Bay, and E through n. Mackenzie and Southampton I. to Peninsula d'Ungava in nw. Quebec, and N to Melville, Bathurst, Devon and s. Baffin Is. SW. Greenland, with scattered records round e. coast, throughout Iceland; scattered records in n. and w. British Isles; in Scandinavia, in e. and n. Norway, w. and n. Sweden and n. Finland; through Kola Pen, E through n. Russia, including Yamal Pen. and s. and central Taymyr Pen., to Bering Str.; in e. Russia, S through Koryak Highlands, Kamchatka Pen., n. Kurile Is and n. Sakhalin I.; also n. Sea of Okhotsk, W to Magadan region. Spend non-breeding period at sea in three distinct areas: (1) outer edges of Humboldt Current off coasts of Ecuador and Peru, between Equator and c. 20°S, straggling to Chilean coast, S to Patagonia; (2) s. Arabian Pen., mostly from Gulf of Aden, E to Gulf of Oman; occasionally in small numbers in e. Africa, from Somalia and Ethiopia, S to Zimbabwe and South Africa; also occasionally off Pakistan and nw. India, and infrequently elsewhere in India and Bangladesh; (3) from s. Philippines, SW to Makassar Str., and S to seas S of Lombok, Sumbawa and Timor; E from Makassar Str., through Sulawesi and Moluccas to Banda and Arafura Seas, rarely SE to s. Frederik Hendrik I. and Merauke; off w. and n. coast of New Guinea, from w. Papuan Is and Vogelkop, E to w. Huon Pen. and Bismarck Arch. (E to New Ireland) and N to Mussau I. and Admiralty Grp; not recorded E of Bismarck Arch., PNG (Dement'ev & Gladkov 1951; Johnson 1965; Blake 1977; Ali & Ripley 1980; AOU 1983; de Schauensee 1984; Coates 1985; Urban *et al.* 1986; White & Bruce 1986; AWB 1993; Murphy; BWP). Said to winter 'off tropical west Africa' (NZCL), but no supporting data or further information.

Aust. Regular at Port Hedland Saltworks and Rottneest I., WA, and ICI Saltworks, SA. Records before 1987 summarized by Saunders and de Rebeira (1987) (singles unless stated). **Qld** L. Moondarra, Mt Isa, 3 Dec. 1986 (Qld Bird Rep. 1986); Hood's Lagoon, Helidon, 8–22 Oct. 1988 (Qld Bird Rep. 1988); L. Moondarra, 25 Dec. 1991 (Qld Bird Rep. 1991). **NSW** Near Guyra, 29 Jan.–3 Feb. 1979 (Holmes 1979). **Vic.** Werribee Sewage Farm, 22 Dec. 1962 (Smith 1963); 27 Dec. 1966 (Smith 1969); 5 Jan.–23 Feb. 1986; 21 Aug.–16 Nov. 1986 (Vic. Bird Rep. 1986); Altona, 15 Jan.–19 Feb. 1967; Seaholme, 28 Feb. 1967 (Smith 1969); L. Connewarre, 15 Feb.–1 Mar. 1981; L. Tutchewop, 10–11 Apr. 1981 (Vic. Bird Rep. 1981); 3–5 Dec. 1983 (Vic. Bird Rep. 1983); L. Victoria, Pt Lonsdale, 31 Dec. 1982–Feb. 1983 (Smith 1983; Vic. Bird Rep. 1983); L. Murdeduke, 19–26 Jan. 1986 (Vic. Bird Rep. 1986); 15 Feb. 1987 (Vic. Bird Rep. 1987); L. Buloke, 5 Apr. 1986 (Vic. Bird Rep. 1986). Unverified reports: L. Tutchewop, 1–2 birds, 13 Jan.–16 Mar. 1989; two, Laverton Saltworks, 29



Feb. 1992. SA Specimen, Langhorne Ck, 19 Nov. 1966 (Eckert 1969); near Whyalla, 17 Feb.–1 Mar. 1973 (Cox 1973); Price Saltfields, 1 Feb. 1976 (McNamara 1976); ICI Saltfields, St Kilda: 30 Mar. 1976 (McNamara 1976), 28 Jan. 1981 (SA Bird Rep. 1977–81), 3 Dec. 1985 (Stove 1994); three, near Magrath Flat, central Coorong, 7–8 Feb. 1986 (Jaensch & Barter 1988); near Port Gawler, 1984–85, Dec. 1985 (Stove

1994). Unverified reports: ICI Saltfields: 3 Dec. 1986–28 Mar. 1987; 1–2 birds, 11 Nov. 1987–15 Feb. 1988; 10 Mar. 1991; July 1992. WA Rottneest I., two, 4–8 Feb. 1980 (Smith & Saunders 1980); 10–23 Oct. 1983 (Saunders & de Rebeira 1986); 21 June–8 July 1986 (Saunders & de Rebeira 1987); Oct. 1986 (Jaensch 1986); 20–23 Aug. 1992 (Bailey & Creed 1992); 1992 (Buchanan 1992); Pelican Pt, Swan R., 7–8 Apr.

1981 (Prince 1983); Port Hedland Saltworks, late Aug. 1981 (Minton 1982); two groups of four (including four specimens), 16 Nov. 1981 (Storr 1984); twelve, 13–14 Feb. 1985 (Saunders & de Rebeira [1987] listed this record twice with different years) (Anon. 1985); 24, mid-Jan. 1986 (Anon. 1986); 11 Sept. 1986 (Lane 1988); 1991 (Buchanan 1992); eleven, 28 Sept. 1992 (Anon. 1992); Eyre Bird Observatory, 23, 30 Nov. 1981 (Congreve & Congreve 1982); Hinds L. NR, 11–25 Nov. 1986 (Jaensch & Vervest 1987; Jaensch *et al.* 1988; Mueller 1989). **NT** Lee Pt, Darwin, 20 Jan. 1974; Mindil Beach, Darwin, 23 Jan. 1974; specimen, East Pt, Darwin, 27 Jan. 1974; Sanderson Sewage Farm, Darwin, 9–24 Mar. 1974 (McKean *et al.* 1975); Palmerston Sewage Farm, 10 Feb. 1987 (McCrie 1987; AWSG). Unverified report, Alice Springs Sewage Farm, 9 Nov. 1983.

NZ Four records, all singles: specimen, L. Ellesmere, 1929 (Oliver); specimen, Wanganui R. estuary, Apr. 1935 (Oliver); Washdyke Lagoon, 19 Mar. 1961 (Crockett 1961); Mangere, Manukau Harbour, 6–10 June 1985 (Jenkins *et al.* 1986).

Macquarie I. Not acceptably recorded; said to occur but without details (Anon. 1987).

MOVEMENTS Migratory. Three migratory populations with distinct non-breeding areas: (1) Nearctic population mostly to Humboldt Current; (2) European and w. Siberian populations to Arabian Sea; (3) e. Siberian (and probably Alaskan) populations mainly to regions N of A'asia (see Distribution). Much movement or migration overland as well as over open ocean. Recorded migrating in flocks at night (Elkin 1992). E. Siberian population discussed below.

Departure Some females said to leave late June; successful males, late July; juveniles, late July to early Sept. (Hayman *et al.* 1986; P.S. Tomkovich). Move through e. Siberia, July to Sept.–Oct. (Dement'ev & Gladkov 1951), partly offshore and partly overland (almost exclusively juveniles), a few W to Transbaikalia (BWP). Move through Mongolia in small numbers (AWB 1993; P.S. Tomkovich); Japan and Korea (Aug.–Sept.) where most common on s. migration (Gore & Won 1971; AWB 1993); China, at least Aug.–Oct.; Taiwan (la Touche 1931–34; AWB 1993); Hong Kong, with maximum numbers at end Sept. (Chalmers 1986); Malaysia and Vietnam, where rare (AWB 1993); Borneo and surrounding waters, from mid-Sept. to Nov. (Smythies 1981); Philippines and Indonesia (AWB 1993). Recorded Wallacea, from Sept. (White & Bruce 1986); abundant New Guinea, from Oct. (Coates 1985); records from Carstensz Massif and s. coast (Schodde *et al.* 1975; see Coates 1985) suggest some move across New Guinea.

Non-breeding Distribution possibly determined by availability of food (e.g. Schulz 1987) and by weather (e.g. Chalmers 1986); cyclonic conditions implicated in at least some records in NT (McKean *et al.* 1975). Most Aust. records between mid-Oct. and early Apr. (Saunders & de Rebeira 1987). Inland records indicate some overland movement. Most records in Vic., from Dec. (Vic. Atlas). Some birds remain at a locality for months (e.g. Vic. Bird Rep. 1986). NZ records, Mar.–Apr. and June.

Return Extraliminally, migration mid-Mar. to end May (BWP). Abundant New Guinea till third week Apr. (Coates 1985). Main passage probably E of Borneo, through Sulawesi and Philippines (Smythies 1981). Highest numbers at Hong Kong during n. migration, with peak passage, Apr. (Chalmers 1986). Most common at Kuantu, Taiwan, Mar. till at least May

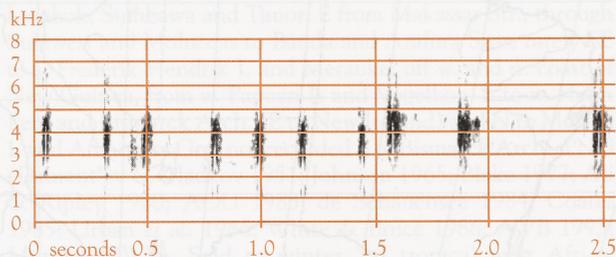
(AWB 1993). Recorded passing s. Tibet and Japan, May (Dement'ev & Gladkov 1951; de Schauensee 1984); on passage Sakhalin I. and Kamchatka in second half of May to early June (P.S. Tomkovich). Arrive at breeding grounds, end May and early June (Dement'ev & Gladkov 1951).

Breeding Extraliminally, recorded off coast of China (la Touche 1931–34) and Sakhalin I. Singles recorded: sw. WA, SA and Manukau Harbour, NZ.

FOOD No A'asian studies; for extralimital details, see BWP, Dement'ev & Gladkov (1951) and Jehl (1986). Mainly invertebrates. **Behaviour** Usually take invertebrates in open water; rarely, on mudflats. While feeding, spin anti-clockwise, occasionally fluttering and pecking at surface of water for disturbed insects (Smith 1963; Holmes 1979; Smith & Saunders 1980). Hold body horizontal when wading in soft mud or shallow pools, taking food with single sharp jab among mud or weed; make definite, jerky feeding movements with whole of body (Crockett 1961; Eckert 1969). On saltfields, birds swung from one side to another to peck at food; not observed spinning (McNamara 1976). At Port Hedland Saltworks, WA, usually feed on more saline lagoons, 1–2 m deep and 1–4 km²; feed singly or in loose groups; always seen feeding while swimming, never on muddy margins; not observed spinning (C.D.T. Minton). Several other methods of feeding reported (see BWP). Recent work shows that surface tension is key aid to feeding (C.D.T. Minton).

Aust. Floating organisms (Holmes 1979); aquatic insects (Smith 1963).

VOICE No detailed studies; sonagrams in Bergmann & Helb (1982); BWP and Maclean (1985). Typical calls of migrant birds (sonagram A) include sharp repeated *chek* (first seven calls) and *twick* (last three calls).



A R.S. Little; Eldorado Beach, New York, Sept. 1962; P105

PLUMAGES Prepared by R.P. Scofield and D.I. Rogers. Usually begin post-juvenile (first pre-basic) moult (of body feathers) to first-immature non-breeding plumage while on s. migration. In many, first pre-basic moult complete, with flight-feathers replaced in non-breeding areas; these birds then look and moult like adults, attaining full breeding appearance in first pre-breeding (pre-alternate) moult late in austral summer just before migrating N to breed; then first attain adult non-breeding plumage in complete second post-breeding (pre-basic) moult, beginning on s. migration soon after breeding. Other birds perform only partial first pre-basic moult, retaining remiges and apparently delaying maturity for 1 year; these stay in non-breeding areas through first austral winter and develop no or little breeding plumage in first pre-alternate moult, eventually attaining adult (non-breeding) plumage in

complete second pre-basic moult in second austral spring. Sexes differ in breeding plumage (females brighter).

Adult male breeding (Second and subsequent alternate). Attained at end of second austral summer. All dark feathers of head and upperparts narrowly fringed white when fresh. **Head and neck** Top of head, hindneck and lores to ear-coverts, dark brown (221) to dark brownish-grey (c82–c83) with: (1) narrow pale supercilium (not reaching bill), typically white above and in front of eye, rufous (140) behind; usually well defined, but diffuse in some and, rarely, restricted to white rectangular mark above and in front of eye; (2) dark red-brown (221A) tinge to ear-coverts of some in fresh plumage; (3) faint rufous-brown streaks on nape and hindneck in some. Chin and throat, white, often narrowly bordered by pale grey and contrasting boldly with large rufous-brown (240) to rufous (140) patch on sides of neck, which nearly always runs narrowly behind ear-coverts to meet rufous of supercilium. These patches occasionally meet in centre of foreneck but typically separated by dark greyish-brown (221) area, streaked by broad white fringes to feathers. **Upperparts** Mantle and scapulars, black-brown (119) with broad cinnamon-rufous (40) fringes to outer webs of feathers at sides of mantle and central scapulars, forming broad mantle V and narrower pair of scapular lines; most or all scapulars and, sometimes, feathers of mantle usually have narrow cinnamon-rufous (40) edges, making mantle V and scapular lines less obvious; with wear, fringes and edges quickly fade to buff-yellow (53) or buff (124). Most of back and rump, dark brown (119A) with broad white fringes to feathers (which are retained longer than those on mantle and scapulars). Feathers on sides of rump and uppertail-coverts, white, with some dark-brown (119A) streaks. **Underparts** Upper breast and sides of breast, dark-brown (221) with broad white fringes to feathers forming distinct streaking in some in fresh plumage. Flanks appear mottled or streaked; feathers, dark brown (221) with white tips, broadest toward vent; with wear, white tips gradually reduced, and flanks appear much darker late in breeding season. Rest of underparts and axillaries, white. **Tail** Usually retained from, and always similar to, adult non-breeding (q.v.). **Upperwing** Retained from non-breeding plumage (q.v.) except, occasionally, for some new brown (119B) tertials with black-brown (119) centres and buff (124) edges to outer webs. **Underwing** Retained from adult non-breeding (q.v.).

Adult female breeding (Second and subsequent alternate). Brighter version of adult male breeding; study by Reynolds (1987) showed that while plumages of dullest females and brightest males overlap, sexing generally straightforward. Dark areas of head, neck and upperparts, dark slate-grey (c82–83), never as brown as most males; further differ by: **Head and neck** Head usually unmarked except for clean white chin and throat, small rectangular white spot above and in front of eye, and white lower eyelid (usually concealed) often joining smaller white fleck behind eye; rarely has distinct supercilium. Patch on neck generally brighter rufous (140) than on male; almost never extends to back of eye (this and pattern of upperparts are most reliable characters for determining sex) but usually extends through centre of foreneck as distinct half-collar (which can be spotted dark grey [83] in centre of foreneck and is occasionally broken, like that of male). **Upperparts** Mantle V and single pair of scapular lines along upper row of lower scapulars contrast boldly with rest of mantle and scapulars, which are otherwise unmarked, or have only faint traces of the other rufous-cinnamon or buff edges to feathers characteristic of males. Lower two rows of lower

scapulars can be narrowly fringed white. **Underparts** Flanks and sides of breast, typically darker and greyer (83) than males, with narrower white fringes to feathers. **Upperwing** Tertials usually uniformly black-brown (119).

Adult non-breeding (Second and subsequent basic). First attained at start of second austral summer. **Head and neck** White, with black-brown (119), elongate oval-shaped patch from just in front of eye to rear ear-coverts, kinked over rear ear-coverts of some. Grey-brown (119B) to light grey-brown (119C) patch on hindcrown and nape (with varying, narrow white fringes to feathers) continues as narrow stripe through centre of hindneck to mantle. **Upperparts** Mostly light brownish grey (c119C), feathers narrowly fringed white; these fringes broadest on outer (lower) scapulars and sides of mantle, where they form ill-defined lines (less bold when worn). Lateral uppertail-coverts, white. **Underparts** Mostly white, with: varying partial collar across sides of breast, formed by brown (119B) tips of feathers, and lost with wear; and light grey-brown (119C) bases of feathers of flanks forming varying streaking. **Tail** Dark-brown (119A), feathers narrowly fringed white; dark central wedge of t1, black-brown (119). **Upperwing** Most remiges, alula and all primary coverts, black-brown (119), very narrowly edged white when fresh; shafts of remiges, white with narrow brown (119B) lines down centre of p8 and p9. Broad white outer edges of inner secondaries broaden towards bases of feathers; innermost secondaries, white, with broad, pale grey-brown (119C) submarginal streak. Lesser and median secondary coverts, dark grey to dark-brown (119A), narrowly fringed white when fresh. Greater secondary coverts similar but with broad white tips that combine with those of greater primary coverts, white shafts at primaries, and white innermost secondaries to form wide wing-bar that tapers across primaries and appears shorter after white tips of primary coverts abrade. Tertials, brown (119B), narrowly edged white; marginal coverts, brown (119B), fringed rufous-brown (240). **Underwing** Remiges, light grey-brown (119C). Most coverts white; greater primary coverts, light grey-brown (119C) with white tips; lesser underwing-coverts have brown (119B) bases creating mottling along leading-edge.

Juvenile Head and neck Like adult non-breeding but with larger, dark-brown (221) cap comprising all crown (not forehead) and nape; narrower separation of cap and eye-patch than in adult non-breeding give appearance of white supercilium, sometimes broken by grey wash just above and in front of eye. When very fresh, most white areas of head (not supercilium, chin or throat) washed grey-buff to pale pinkish grey (c77). **Upperparts** Mantle and scapulars, black-brown (119) with light-brown (223D) edges and fringes to feathers, fading to buff (124–54) or whitish when worn (abrade with extreme wear, giving feathers lanceolate shape); most fringes narrow, but those on sides of mantle and on upper row of lower scapulars much broader, forming prominent mantle V and pair of scapular lines; subscapulars narrowly edged white. Centre of back and rump, dark brown (119A) with varying amount of white on feathers of sides of back and rump. Uppertail-coverts, black-brown (119) with pale edges grading from white at base to light brown (223D) at tip. **Underparts** Mostly white with: grey-buff to pale pinkish-grey (77) wash on breast and fore-flanks, which is quickly lost with wear. Small brown (119B) tips to feathers on sides of breast form fine mottling; paler brown (119C) and reduced when worn; brown shaft-streaks and bases to feathers form diffuse streaking on flanks, which becomes bolder when worn. **Tail** As uppertail-coverts; feathers, grey at base. **Upperwing** As adult non-breeding but tips

of greater secondary coverts washed buff (124) when fresh; median secondary coverts have buff (124) fringes, which are often divided at tip by black-brown shaft-streaks; tertials, black-brown, with narrow light-brown (223D) fringes that fade to off-white when worn.

First immature non-breeding (First basic). By late in austral summer, as adult non-breeding; some retain some worn juvenile innerwing-coverts and all remiges when adults are in active primary-moult; others (perhaps most) replace all juvenile remiges and may only be separable from adults by slighter wear of those outer primaries which have still to be moulted.

First immature breeding (First alternate). Some do not breed in this plumage. Indistinguishable from adult breeding in those that moult juvenile remiges and breed in second calendar year (Schamel & Tracy 1988). Others, probably those remaining in non-breeding areas till third calendar year, retain very worn juvenile remiges and develop little or no breeding plumage (BWP; Prater *et al.* 1977), presumably retaining other plumage from first immature non-breeding; perhaps more extensive breeding plumage develops in some individuals that do not attempt to breed in second calendar year (see Moults).

BARE PARTS Based on museum labels (WAM, SAM) and photos, none apparently from HANZAB region (Pringle 1987; Chandler 1989; Trounson & Trounson 1989; Aust. RD; NZRD). **Adults** Bill, black (89). Iris, dark brown (21, 22). Legs, dark grey (83) to grey-black (82). **Juveniles** Bill and iris, as adult. Foot, at first buff-yellow (53) with grey (84) tinge spreading from joints, outer toe and outer sides of tarsus; like adult from Oct.–Nov. of first year (BWP).

MOULTS Poorly known, especially for immatures. Based on BWP, Paulson (1993) and skins (MV, SAM, WAM).

Adult post-breeding (Second and subsequent pre-basic). Complete; primaries outwards. Little overlap of moult and breeding (though males start moult on sides of neck from mid-June). Much body-moult occurs at staging areas near breeding grounds: females arrive at staging areas and begin moult, late June–early July; males, about mid-July. Usually attain non-breeding appearance by start of s. migration, late July to early Sept., though usually retain wing-coverts, remiges, outer rectrices, some feathers of back and rump; some retain much more breeding plumage, e.g. one in s. WA, late Oct. in breeding plumage (Saunders & de Rebeira 1987). Most moult all flight-feathers in non-breeding areas, starting late Sept. to late Nov., finishing Feb. to early Apr.; timing perhaps does not vary as much as above data imply, as immatures moulting all primaries difficult to age (especially in second pre-basic) and some may have been treated as adults. A few adults said to begin moult of primaries from July, suspend moult during migration, and possibly complete moult as early as Dec. (BWP); early moult of primaries also recorded during migration at Mono L., California, beginning in Aug. (Paulson 1993). **Adult pre-breeding** (Second and subsequent pre-alternate). Partial; involves head, neck, mantle, scapulars, underparts and sometimes central uppertail-coverts and some tertials; retain other wing-feathers, tail, rump and back. Two birds in Vic. in breeding plumage in Dec. (Smith 1963; RAOU *Newsletter* 59: 3) probably had reversed moult-cycles. **Post-juvenile** (First pre-basic). Usually complete. Moult of body begins early on s. migration; on w. coast of North America, many begin moult by mid-Aug. and most moulting by Sept. Possibly moult later on Palaearctic flyways, where mostly in worn juvenile plumage, Oct.–Nov., even in non-breeding areas; in both Old and New

World, many or most migrating juveniles show fresh first-basic plumage on scapulars and often, mantle, head and neck. Moult of body completed in non-breeding areas; timing poorly known but a few worn juvenile feathers retained on cap, mantle, scapulars, tertials and wing-coverts into first austral summer. Some, probably most, moult all flight-feathers in non-breeding areas starting from about Jan. (Stresemann & Stresemann 1966); others retain them until second pre-basic. **First immature pre-breeding** (First pre-alternate). Varies. In those that undergo complete post-juvenile moult, like adult pre-breeding; resultant plumage indistinguishable from adult breeding during first breeding attempt in second calendar year (Schamel & Tracy 1988). Those that retain juvenile primaries apparently delay maturity for another year, remaining in non-breeding areas and develop little or no breeding plumage; this strategy has been described only briefly (BWP; Prater *et al.* 1977) and confirmation is needed. Further, two unaged females in NZ and s. WA with much breeding plumage in June and July (Jenkins *et al.* 1986; Moon 1988; Saunders & de Rebeira 1987) do not fit moult- and migration-strategies described above.

MEASUREMENTS (1–3) Greenland, Iceland and Scandinavia, skins (BWP): (1) Adults; (2) Juveniles; (3) Ages combined. (4) Hudson Bay, Canada, adults, live (Reynolds 1987).

	MALE	FEMALE	
WING	(1) 108 (3.44, 104–114; 11)	114 (3.06; 109–117; 12)	**
	(2) 109 (3.53; 104–115; 10)	109 (3.19; 102–113; 14)	ns
	(4) 107.5 (2.6; 189)	112.8 (2.5; 101)	**
TAIL	(3) 47.9 (2.14, 45–53; 13)	50.4 (1.76; 48–53; 21)	**
BILL	(3) 21.1 (1.29; 19–23; 22)	21.4 (0.80; 20–23; 25)	ns
	(4) 21.5 (1.3; 190)	22.5 (1.0; 100)	**
TARSUS	(3) 20.4 (0.74; 19–22; 13)	20.3 (1.24; 19–22; 24)	ns
	(4) 20.4 (0.7; 189)	20.6 (0.8; 100)	**
TOE C	(3) 19.5 (0.56; 19–20; 10)	20.2 (0.89; 19–21; 10)	ns

Females larger than males. Wing of juvenile females significantly shorter than wing of adults ($P < 0.01$). Additional measurements in Schamel & Tracy (1988) and Murphy.

WEIGHTS (1–2) Breeding adults: (1) Hudson Bay, Canada, including some females close to laying (Reynolds 1987); (2) Localities combined (BWP).

	MALE	FEMALE	
(1)	34.5 (2.6; 179)	39.0 (4.8; 97)	**
(2)	32.4 (28–40; 23)	37.4 (29–48; 17)	

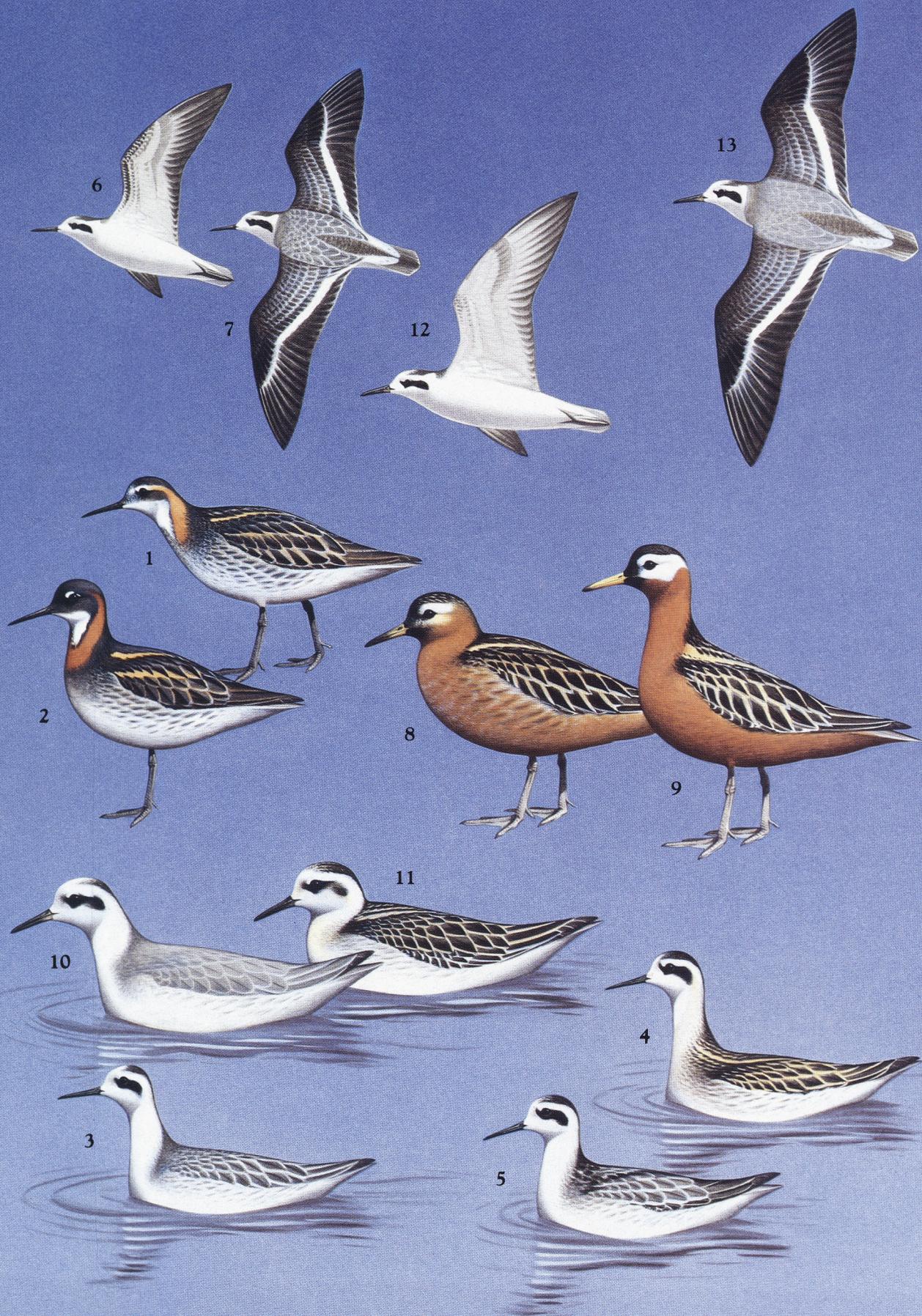
Females heavier. Variation related to age only studied on Alaskan breeding grounds, where (first alternate) males breeding in first year, 31.1 (2.2; 13); significantly lighter than older breeding males, which weighed 33.5 (2.1; 22) (Schamel & Tracy 1988). Seasonal fluctuation in weights poorly known and full extent of gain in weight before migration not known. Migrating adults in nw. Iran, 26.5 (2.8; 20–36; 93) (Glutz von Blotzheim *et al.* 1977), for further information see BWP. In non-breeding areas: adult females, nw. Aust., 16 Nov., 32.3 (2.38; 29–34; 4) (WAM); exhausted male, Darwin, late Jan., 15.6 (Saunders & de Rebeira 1987); adult females in wing-moult off Peru, Jan., 26.5, 31, 36 (BWP).

STRUCTURE Wing, long and pointed. Eleven primaries: p10 longest, p9 0–2 mm shorter, p8 3–11, p7 12–19, p6 18–28, p5 27–36, p4 34–42, p3 41–48, p2 46–55, p1 47–62; p11 minute, hidden by lesser primary coverts. Wing formula may differ between sexes, but insufficient data. Longest tertials reach p6–p7 on folded wing. Tail, short, 12 feathers; t1 longest, gradually decreasing to t5, shortest, giving slight wedge-shape when spread. Bill, needle-like and straight, circular or slightly oval (dorso-ventrally) in cross-section; 0.87–1.12 times length of head; tip of upper mandible, slightly decurved. Tarsus, short and slender; scutellate; slightly laterally compressed. Front toes with distinct serrated lobes; distinct web between outer and middle toe connecting two basal phalanges; smaller web between base of middle and inner toe. Hindtoe, elevated; lobe reduced. Outer toe, c. 91% of middle toe, inner c. 87%, hind c. 30%.

GEOGRAPHICAL VARIATION None.

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Volume 3, Plate 22

Red-necked Phalarope *Phalaropus lobatus* (page 352)

1 Adult male breeding; 2 Adult female breeding; 3 Adult non-breeding; 4 Juvenile; 5 First immature non-breeding; 6, 7 Adult

Grey Phalarope *Phalaropus fulicaria* (page 360)

8 Adult male breeding; 9 Adult female breeding; 10 Adult non-breeding; 11 Juvenile; 12, 13 Adult