

Order **APODIFORMES**

A superficially heterogeneous order of three families of rather small to tiny land birds: (1) **APODIDAE**: cosmopolitan, almost wholly aerial and insectivorous swifts; (2) **HEMIPROCNIDAE**: e. Palaeotropic tree-swifts; and (3) **TROCHILIDAE**: nectarivorous New World hummingbirds. Apodiformes stand apart from other non-passerine land birds in sharing, in combination: Holorhinal and impervious nares. No basipterygoid processes; un-notched, posteriorly broadened sternum, with fused spina 'communis'; stout U-shaped furcula, with well-developed but short hypocleidium. Tiny feet, with simple single-furrowed hypotarsus yet well-developed claws for clinging and grasping; type 5 flexor tendons. Pelvic muscle formula of A. Single left carotid artery (except Cypseloidinae, which have two). Usually no caeca. Aftershafts usually present in contour plumage; very short and thick humerus and ulna, with 6–11 short secondaries, but prolonged carpus, with ten primaries (outermost longest), adapted for rapid flight; ten rectrices. Plain white eggs; young, altricial, nidicolous.

Historically, swifts and hummingbirds often thought unrelated, the swifts having supposed affinity with passerine swallows (e.g. Shufeldt 1885). Both morphological (Garrod 1874; Stejneger 1885; Beddard 1898; Burton 1971; Cracraft 1981, 1988; Olson 1985) and molecular (Sibley & Ahlquist 1990) evidence now indicate that they are one another's closest relatives, with further links to Caprimulgiformes still in dispute. Recent convention includes the swifts and hummingbirds in one order, usually as suborders (e.g. Stresemann 1934; Wetmore 1960; Peters; BWP). Wolters (1976), Sibley & Ahlquist (1990) and Sibley & Monroe (1990) separated them as orders, the latter within the superorder Apodimorphae, leaving the issue of status open. Hummingbirds differ from swifts and tree-swifts, *inter alia*, in: long slender bills and extendable tongues adapted to nectarivory; metallic plumage; much shorter wings, adapted for hovering; schizognathous palate; only 6–7 secondaries; vestigial aftershafts; no gall bladder; distinctly bilobed uropygial gland; and syrinx with two pairs of special extrinsic syringeal muscles and no sterno-tracheal muscles. Tree-swifts differ from other swifts in: tree-perching habit; heads ornamented with plumes; patch of downy or silky feathers on the flanks; lack of a claw on the carpus; anisodactylous feet, with hind-claw directed irreversibly backwards for tree-perching; tiny saucer-like arboreal nest; and mottled plumage of nestlings and fledgelings.

Wholly extralimital Hemiprocnidae and Trochilidae not considered further here. The comparative features of swifts (Apodidae) are discussed below.

REFERENCES

- Beddard, F.E. 1898. *The Structure and Classification of Birds*. Longmans Green, Lond.
- Benton, M.J. (Ed.) 1988. *The Phylogeny and Classification of the Tetrapods*. 1. OUP, Oxford.
- Burton, P.J.K. 1971. *Ibis* 113: 19–28.
- Cassino, S.E. (Ed.) 1885. *J. S. Kingsley, The Standard Natural History*. 4. Boston.
- Cracraft, J. 1981. *Auk* 98: 681–714.
- 1988. Pp 339–61 In: Benton 1988.
- Farner, D.S., et al. (Eds) 1985. *Avian Biology*. 8. Academic Press, New York.
- Garrod, A.H. 1874. *Proc. Zool. Soc. Lond.* 1874: 111–24.
- Kükenthal, W., & T. Krumbach (Eds) 1934. *Handbuch der Zoologie*. 7(2). W. de Gruyter, Berlin.
- Olson, S.L. 1985. Pp 79–238 In: Farner et al. 1985.
- Shufeldt, R.W. 1885. *Proc. Zool. Soc. Lond.* 1885: 886–915.
- Sibley, C.G., & J.E. Ahlquist. 1990. *Phylogeny and Classification of Birds*. Yale Univ. Press, New Haven.
- , & B.L. Monroe Jr. 1990. *Distribution and Taxonomy of Birds of the World*. Yale Univ. Press, New Haven.
- Stejneger, L. 1885. *Birds* In: Cassino 1885.
- Stresemann, E. 1934. *Aves* In: Kükenthal & Krumbach 1934.
- Wetmore, A. 1960. *Smithson. Misc. Coll.* 139(11): 1–37.
- Wolters, H.E. 1976. *Die Vogelarten der Erde*. 2. Paul Parey, Hamburg.

Family **APODIDAE** swifts

Small to medium-sized, ranging in size from Indo-Papuasian swiftlets of *Collocalia sensu stricto* (9–10 cm, 5–7 g) to the se. Asian *Hirundapus giganteus* group (22–25 cm, c. 180 g). Nearly 100 species in 14–20, and probably 17–20, genera (Wolters 1976; Campbell & Lack 1985; Sibley & Monroe 1990; Chantler & Driessens 1995; Peters). Most diverse in warmer parts of world, with centres in S. America, Africa, se. Asia and adjacent archipelagos. Principal genera include: *Aerodramus* (roughly 22–27 species of dull-plumaged, e. Palaeotropic swiftlets); *Apus* (roughly 14–17 species of Afro-Eurasian fork-tailed swifts); *Chaetura* (about nine species of New World needle-tailed swifts); and *Cypseloides* (about 9–10 species of dusky, diastataxic New World swifts, which build nests without binding saliva). Often broken up into three subfamilies (Lack & Campbell 1985; BWP): New World Cypseloidinae, cosmopolitan Chaeturinae, and prevalingly Old World Apodinae (the latter with toes 1 and 2 opposed to 2 and 4 for grasping laterally inward and

seemingly pamprodactyl at rest). DNA–DNA hybridization and mtDNA sequences (Sibley & Monroe 1990; Lee *et al.* 1996) nevertheless support Brooke's (1970) morphological case for two: CYPSELOIDINAE: About 12 species, occurring from S. to N. America; wing diastataxic; carotid arteries paired; trans-palatine processes vestigial; *Musculus splenius capitis* simple; feet anisodactylous; some sexual dimorphism in plumage; nestlings covered in down-like semi-plumes; and no cementing saliva used in nests. APODINAE: About 85 species; cosmopolitan; wing eutaxic; carotid arteries single; trans-palatine processes usually well developed; *Musculus splenius capitis* complex; feet anisodactylous or pseudo-pamprodactylous; no sexual dimorphism in plumage; nestlings naked (except *Cypsiurus*); cementing saliva used in nearly all nests (except *Hirundapus* and some others).

Circumscription of tribes in Apodinae unsettled. Usually three recognized: swiftlets (Collocaliini), needle-tailed swifts (Chaeturini), and pseudo-pamprodactyl Apodini (e.g. Brooke 1970; Chantler & Driessens 1995; Schodde & Mason 1997). MtDNA sequences (Lee *et al.* 1996), however, indicate that Collocaliini are polyphyletic, split by members of both Chaeturini and Apodini. Representation of family in HANZAB region poor, with only two species of swiftlets (Collocaliini) resident breeders, and one of Chaeturini (*Hirundapus*) and one of Apodini (*Apus*) regularly non-breeding migrants.

Skull broad and flat. Palate aegithognathous, with truncated vomer bifid at level of departure of palatine processes from maxillary; premaxilla unossified; maxillary processes unexpanded; palatine shelf unexpanded, with narrow posterior processes; lachrymals vestigial; and nasals and maxillary fused in a bar anteriorly to inarticulate naso-frontal hinge. Nasal septum extensively perforate. Thirteen to 14 cervical vertebrae; 6–7 ribs per side. Syrinx tracheo-bronchial, with single pairs of extrinsic and intrinsic muscles. *Musculus tensor patagium brevis* strong and extensively fleshed, but *M. expansor secundariorum*, *M. sternocoracoideus* and biceps slip absent; no *M. ambiens*; and deep plantar tendons Type V, usually fully fused. No crop in adults or nestling; right lobe of liver larger than left and gall bladder present; no caeca. Naked oil gland indistinctly bilobed. Diploid karyotype of 64–76 chromosomes, with five pairs of macrochromosomes (Christidis 1990).

Adaptation to aerial life and insectivory reflected in aerodynamic form and internal structure. Body bullet-shaped, with short neck, and long-tapered and bow-shaped wings. Bill very short, wide and without bristles, with broadened gape extending back below eyes to increase sweep; bills dusky, or lower mandible flesh-toned; nostrils inoperculate oblique holes opening vertically at base of maxilla. Tongue short, triangular, bifid at tip and not extendable. Wide-gaped mouth able to accumulate insects in a saliva-cemented wad or bolus, which is carried in a pouch under the tongue when feeding young. Large salivary glands present, which swell during reproductive period to produce saliva for cementing nest. Eyes, large, with dark irises. Feet have feeble, often feathered, tarsi, and four strong and well-clawed heterodactyl (Apodini; Collins 1963) or anisodactyl (all other swifts) toes, the hallux reversible, used for clinging to vertical surfaces when at rest or nest. Swifts can barely more than shuffle at a perch and launch themselves into flight directly from resting place. Feathering sleek, in well-defined tracts: throat wholly feathered, so that paired ventral tracts begin on neck and widen without branching over breast; dorsal tract has narrow central apterium; and femoral tracts well marked; aftershafts long and downy, and apteria have dense under-down. Colouring usually dull, blackish greys and browns; infrequently glossy, with little patterning except for contrastingly pale throats and rumps. Sexual dimorphism none or slight (Cypseloidinae). Wings narrow, back-swept and down-swept, with shallow camber; adapted for high-speed, rather than manoeuvrable, flight, the long primaries and short secondaries producing a strong downward force and forward propulsion; swifts sweep through the air, with flickering wing-beats and protracted scything glides. Wing-shape varies between genera, from slender and arced (many Apodini) to broader and rounded (many Chaeturini), conferring different flight-characteristics. Carpus clawed, with 2–3 alula feathers; primaries moult outwards, and the 8–11 secondaries inward, but timing varies between taxa with season and age, and moult sometimes interrupted or much protracted (swiftlets); wave-moult occurs in some species of *Apus*. Tail from short and square-tipped to rather long and deeply forked; shafts of rectrices in many squarish tailed genera (Chaeturini, *Streptoprocne* in Cypseloidinae) projecting as short spines beyond tips of vanes, for bracing at perch; moult centripetal. Young fledge in adult-like, but duller, plumage; full adult plumage attained in a post-juvenile (first pre-basic) moult several months after hatching, commonly on arrival at wintering quarters in migratory species; this moult is usually complete except for remiges and, sometimes, wing-coverts.

Swifts are the most aerial of all birds, feeding, drinking, bathing, resting and even sleeping and copulating on the wing as well as in nest. Habitat is mainly the sky, from sea-level to 4000 m asl, sometimes more; mostly feed within 200 m of ground because abundance of prey declines significantly above this height. Occur over most types of habitat. When not nesting, swifts remain on the wing throughout day, but at night many (Cypseloidinae, Chaeturini, all swiftlets) congregate to roost at regularly used sites, such as crevices in cliffs, caves, buildings and dense crowns of trees, where cling and sleep in vertical position; Apodini, and possibly other swifts, thought to sleep on wing, particularly on migration. Migratory species in HANZAB region (i.e. Fork-tailed Swift, White-throated Needletail) sometimes incorrectly said to remain exclusively in air while in region, and, indeed, for Fork-tailed Swifts, most roosting probably aerial, but Needletails recorded roosting among foliage and in hollow branches, though number of references in literature probably overemphasize such occurrences.

Worldwide, eight species are threatened: some adversely affected by loss of habitat, others by disturbance by tourists or the introduction of potential predators, such as the Common Myna *Acridotheres tristis*; colonies of one species, the Volcano Swiftlet *Collocalia vulcanorum* of Indonesia, are susceptible to periodic extirpation by volcanic activity (Collar *et al.* 1994).

Sedentary, resident and migratory. Tropical species, including all swiftlets, rather sedentary or resident; species breeding in temperate latitudes migratory to varying extent. Those breeding in n. hemisphere commonly winter from tropical to temperate latitudes in s. hemisphere, including Aust., e.g. White-throated Needletail and Fork-tailed Swift abundant trans-equatorial migrants to HANZAB region from breeding grounds in n. hemisphere. Many larger species are highly mobile, foraging over vast distances in non-breeding periods, e.g. White-throated Needletail and Fork-tailed Swift in Aust. Several species recorded as vagrants have main distributions that abut HANZAB region.

Most aerial of all birds; feeding solely on aerial insects and some drifting spiders. Usually gather food well above ground, from one to several hundred metres. Feeding flight characterized by much circling, particularly through prey-rich sites; most species in Aust. search for prey along edges of low-pressure systems. Forage in small to very large groups above forests and open agricultural land; some (e.g. Glossy Swiftlet *Collocalia esculenta*) forage at low elevations in cultivated areas, over open water, or over fig trees at times when fig-wasps swarming (Hymenoptera: Agaonidae). Mostly diurnal, but some subspecies of White-rumped Swiftlets in Indonesia feed at twilight. Bill short and broad with wide gape that usually occupies full width of broad skull. No crop; no caeca; salivary gland large, and enlarged further in breeding season, when used in construction of nests. Food collected for young is formed into bolus in mouth.

Commonly gregarious. Swifts pair monogamously to nest, usually in loosely to densely packed colonies; in migratory species, re-pairing takes place at nesting site of previous season, which is commonly re-used. Nesting sites, especially holes, defended by threat display (screaming, attacking flight with raised wings), followed by aerial fighting if pressed; will also grapple with feet, and, to lesser extent, bills. Aerial copulation, often at high altitude, preceded by display flight initiated by female: female flies in front of male, dipping down with wings held vertically above back, the male in pursuit; she then flattens out on quivering wings, the signal for the male to mount, his wings held high over his back while hers are horizontal. Flight-path then becomes a shallow descending glide, as both partners manipulate their tails frantically to effect coitus while one or other flaps its wings. This sequence the norm for Common Swift *Apus apus* (Lack 1956), but is similar in other swifts (Chantler & Driessens 1995). Many species also copulate in nest, swiftlets apparently exclusively so.

Calls range from insect-like to parrot-like chattering, twitters, wheezes and buzzes, rapid chippings, and drawn-out buzzy screams or screeches. *Aerodramus* swiftlets utter unique metallic clicks which function as sonar and allow them to echolocate and find their nests in the darkness of deep roosting and nesting caves (Medway & Pye 1977; see White-rumped Swiftlet); the glossy swiftlets and waterfall swiftlet (*Collocalia*, *Hydrochous*) do not echolocate. Noisy at breeding sites, and when arriving at and leaving roosts (which are often same as breeding sites).

Timing of breeding correlated with seasonal conditions that increase populations of prey, e.g. wet monsoon in Tropics. Nests small and usually shallow; bowl- or bracket-shaped; of finely interwoven plant material (commonly bryophytes) and feathers, usually gathered on wing, and bound with cementing saliva produced by enlarged salivary glands in mouth (except Cypseloidinae); proportions of material and saliva vary, particularly in swiftlets, where composition species-specific (Medway 1966); nests of se. Asian species building nests prevailing of saliva are harvested commercially for culinary purposes, especially bird's-nest soup. Some species (e.g. *Panyptila*) build hanging sleeve-like nests with nest-chamber at top, and others semi-suspended hemispherical bags (*Tachornis*, Little Swift *Apus affinis*); still others (e.g. *Hirundapus*) nest on a scrape in tree-hollows. Nest built by both sexes; most nests are placed on rock ledges, where supported at base (Cypseloidinae, some Apodini), or on vertical or overhanging walls in rock and tree holes, caves, rock crevices and chimneys, where glued on at side by saliva (many Chaeturini, swiftlets); side-glued nests may also be fastened to underside of large leaves (e.g. palm fronds), and the eggs glued to the nest-lining as well, to prevent their rolling out (Afro-Asian palm swifts, *Cypsiurus*). Eggs elliptical, white and lustreless. Clutches usually 2–3, occasionally 1 or 4. Eggs laid normally at intervals of 2 days, and incubated by both sexes in turn at intervals of roughly 1–3 h by day (Fry *et al.* 1988; BWP). Incubation and nestling periods long for size of birds: incubation period mostly 20–30 days; fledging period 35–60 days. Nestlings hatch naked or, in Cypseloidinae and apodinine *Cypsiurus*, covered with dense dark-grey protoptile down (Collins 1963, 1965). Both parents brood and feed nestlings; brooding continuous for c. 1 week, then mainly at night. Feeding by bill-to-bill deposition of whole food bolus into large gapes of nestlings. Nestlings beg with sibilant screaming and waving of upthrust open bill; initiated by appearance of arriving parent and accompanying sounds. Susceptible to snakes, rats and other predators at nests, and to adverse weather conditions, which can cause starvation (Chantler & Driessens 1995). Mortality rates low, commonly <20% per year across species.

Because of aerial lifestyle and speed of flight, swifts have few predators except some falcons. Swifts carry an array of ectoparasites and endoparasites, including cestodes, cimicid bugs, hippoboscid flies, ticks, feather mites and feather

lice (Acarina, Mallophaga); some are represented by endemic families. Two particular genera of feather lice, *Eureum* and *Dennyus*, also endemic on swifts; the distribution of their species-groups carries information on phylogenetic affinities of their hosts (e.g. Ledger 1970).

REFERENCES

- Brooke, R.K. 1970. *Durban Mus. Novit.* 9: 13–24.
- Campbell, B., & E. Lack. 1985. *A Dictionary of Birds*. T. & A.D. Poyser, Calton, England.
- Chantler, P., & G. Driessens. 1995. *Swifts*. Pica, Robertsbridge, England.
- Collar, N.J., et al. 1994. *Birdlife Cons. Ser.* 4.
- Collins, C.T. 1963. *Condor* 65: 324–8.
- 1965. *Ostrich* 20: 201–2.
- Christidis, L. 1990. *Animal Cytogenetics*. 4. Borntraeger, Berlin.
- Fry, C.H., et al. 1988. *The Birds of Africa*. 3. Academic Press, Lond.
- Lack, D. 1956. *Swifts in a Tower*. Chapman & Hall, Lond.
- Ledger, J.A. 1970. *J. Ent. Soc. S. Africa* 33: 239–60.
- Lee, P.L.M., et al. 1996. *Proc. Natl. Acad. Sci. USA* 93: 7091–6.
- Medway, Lord, & J.D. Pye. 1977. Pp 225–38 *In*: Stonehouse & Perrins 1977.
- Schodde, R., & I.J. Mason. 1997. *Zoological Catalogue of Australia*. 37.2. *Aves*. CSIRO Publ., Melbourne.
- Sibley, C.G., & B.L. Monroe Jr. 1990. *Distribution and Taxonomy of Birds of the World*. Yale Univ. Press, New Haven.
- Stonehouse, B., & C. Perrins (Eds) 1977. *Evolutionary Ecology*. Macmillan, Lond.
- Wolters, H.E. 1976. *Die Vogelarten der Erde*. 2. Paul Parey, Hamburg.

Apus pacificus **Fork-tailed Swift**

COLOUR PLATE FACING PAGE 1057

Hirundo pacifica Latham, 1802 (1801), *Index. Orn. Suppl.*: 58 — Nova Hollandia = New South Wales, probably in region of Port Jackson (*apud* Schodde & Mason 1997. *Zool. Cat. Aust. Aves*).

The specific name alludes to the Pacific Ocean area, referring to the type-locality.

OTHER ENGLISH NAMES Australian, Migrant, Pacific, White-belted, Large White-rumped, Siberian White-rumped or White-rumped Swift; New Holland Swallow; Rainbird; Rain-brother.

POLYTYPIC Nominate *pacificus*, s. Siberia from Altai to Kamchatka, n. Mongolia, n. China and Japan; migrate through se. Asia to Aust. Extraliminally, subspecies *kanoi* (Yamashina, 1942), se. Tibet through s. China to Taiwan; *leuconyx* (Blyth, 1845), outer Himalayas and hills of Assam in ne. India; subspecies *cooki* (Harrington, 1913), se. Asia (S of Kanoi) from e. Burma to Malay Pen.

FIELD IDENTIFICATION Length 18–21 cm; wingspan 40–42 cm; weight 30–40 g. Medium-large elegant swift with slim body, long scythe-shaped wings that taper to finely pointed tips, and rather long, deeply forked tail. Smaller and slimmer than White-throated Needletail *Hirundapus caudacutus*, with much narrower wings and forked, not square-ended, tail, giving altogether more rakish flight-silhouette. Much bigger than swiftlets (*Aerodramus* and *Collocalia*) with proportionately much longer wings and longer, more deeply forked tail. Mainly blackish with white band across rump, white patch on chin and throat, and, in close view, diagnostic scaly appearance to underbody. Sexes alike. No seasonal variation. Juvenile inseparable in field in HANZAB region (see Plumages, Ageing). **Adult** Head and neck, blackish brown with darker eye-patch

and broad triangular white patch on chin and throat. Body, tail and upperwings, black-brown (slightly paler brown below) with bold, narrow, slightly U-shaped white band across rump and rear-flanks; faint pale scaling to saddle; and white scalloping to underbody, visible in close view; in worn plumage, pale scaling to saddle is lost and upperwing can appear patchily paler dark-brown; and underbody can appear mottled paler. Underwing: lesser and median coverts, blackish, contrastingly darker than glossy dark-grey remiges and greater coverts (though greater coverts can appear darker at tips, darker than surrounding plumage); all coverts narrowly fringed white, but obvious only on larger coverts in close views. Bare parts appear blackish in flight views.

Similar species Distinctive and usually easily separated

from other swifts by combination of size, structure and plumage. For differences from **White-throated Needletail** and vagrant **House Swift** *Apus affinis*, see those accounts.

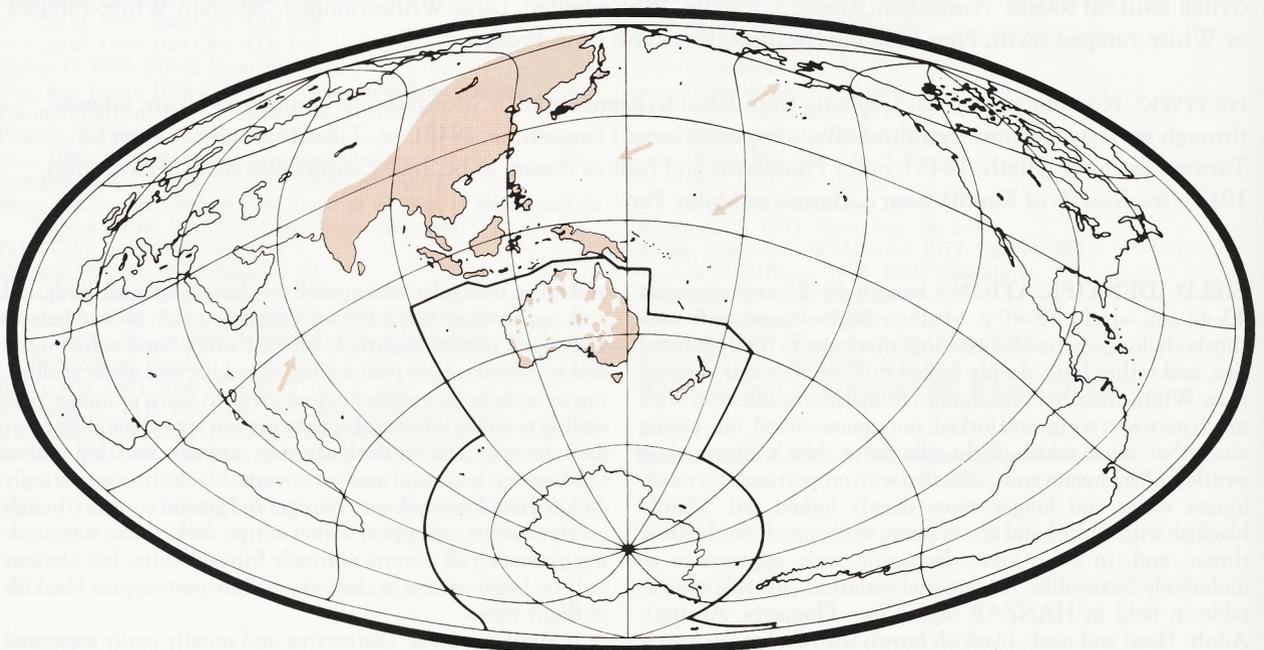
Aerial. Usually seen in flocks, sometimes of hundreds or thousands and, exceptionally, in tens of thousands (see **Distribution and Population**). Often associate with White-throated Needletails, and occasionally also with swiftlets, swallows, martins and woodswallows, and solitary birds can be found in flocks of other species; also observed flying with White-winged Black Terns *Chlidonias leucopterus* (Lindgren 1957) and, possibly on passage, with Spangled Drongos *Dicrurus bracteatus* and Black-faced Cuckoo-shrikes *Coracina novaehollandiae* (Noonan *et al.* 1963); also see **Food**. Seen to mob potential predators, such as Nankeen Kestrels *Falco cenchroides* (Simpson 1961). Seen over almost any type of country and, though less often, also over ocean. Rarely reported roosting or perched in HANZAB region (see **Habitat**). Apparent aerial chases of two and three birds recorded, with one chasing another erratically through flock (e.g. Wheeler 1952; Simpson 1973). Like White-throated Needletail, appearance of flocks often precede or accompany thunderstorms or weather fronts; often seen feeding at dusk. Flight-silhouette distinctive, with very long narrow scythe-shaped wings that taper to finely pointed tips, and deeply forked tail, which, when closed, can appear as long slender spike. Flight more buoyant and slower than that of White-throated Needletail, with erratic flutters and turns when feeding. Calls include long high-pitched squeak *dzee dzee* or *skree-ee-ee*; also twittering and buzzing notes.

HABITAT Almost exclusively aerial; from <1 m to 'considerable heights', and at least 300 m (Sanders 1938; Boehm 1962; Carter 1969; Talbot & Talbot 1989; Dawson *et al.* 1991) and probably much higher. In Aust., mostly over inland plains but sometimes above foothills or in coastal areas (Sullivan 1931; Gilbert 1935; Storr 19; Vic. Atlas). Often occur over cliffs and beaches (Sutton 1927; Crompton 1928); also over islands; and sometimes seen well out to sea (Rix 1938; Serventy 1951; Cleland 1970; McKean 1980; McLean 1996). Also occur over

settled areas, including towns, urban areas and cities (Robinson 1973; Longmore 1978). Mostly over dry or open habitats, including: riparian woodland and tea-tree swamps (Parsons 1933; Gibson & Cole 1988); low scrub, heathland or saltmarsh (Sutton 1927; Mayo 1933; Watson 1955; Kitchener *et al.* 1975); treeless grassland and sandplains covered with spinifex (Klapste 1977; Gibson 1986; Gibson & Cole 1988); open farmland (Campbell 1935; Boehm 1939a; Bravery 1971); and inland and coastal sand-dunes (Reilly *et al.* 1975; Johnstone 1983; Gibson & Cole 1988). Sometimes above rainforest, wet sclerophyll forest or open forest (MacGillivray 1914; Campbell 1920; Blackburn 1970; Woinarski 1993) or plantations of pines (Templeton 1992). In NZ, most records from around cliffs; also reported over coastal sand-dunes, valleys and hilly pasture (Gibb & Dunnet 1969; Hudson 1973; CSN).

Feed aerially. Forage up to hundreds of metres above ground, but also <1 m above open areas or over water (Rogers 1928; Boehm 1944, 1962; Cleland 1955; Watson 1955). Often in areas of updraughts, especially cliffs (Cleland 1928; Eckert 1971; Reilly *et al.* 1975; SA Bird Rep. 1968-69). Sometimes feed aerially among tree-tops in open forest (Boehm 1939b; Carter 1969; Bravery 1971); once between palm trees in parkland (Tarr 1950). Also forage through smoke of bushfires (Hood 1941; McCulloch 1966; McGarvie & Templeton 1974); and sometimes among duststorms, or clouds of dust associated with mining activities (Cleland 1965; Haselgrove 1975). Once seen hawking over paddock being mown (Bravery 1971).

Probably roost aerially (Wheeler 1954a; Carter 1969), but occasionally observed to land (*contra* Rowley 1974; Pescott 1983; Aust. RD). Once recorded roosting in trees, using bare exposed branch emergent above foliage (Newell 1930). Once said to have roosted among reeds and rushes (White 1928), though these possibly misidentified Tree Martins *Hirundo nigricans* (M.K. Tarburton). Published references to terrestrial roosting probably over-emphasize such occurrences. Sometimes loaf in air, by allowing strong winds to support them (Boehm 1939b) or, possibly, in uncontrolled dives (Carter 1969). Rare records of loafing elsewhere include Swifts briefly

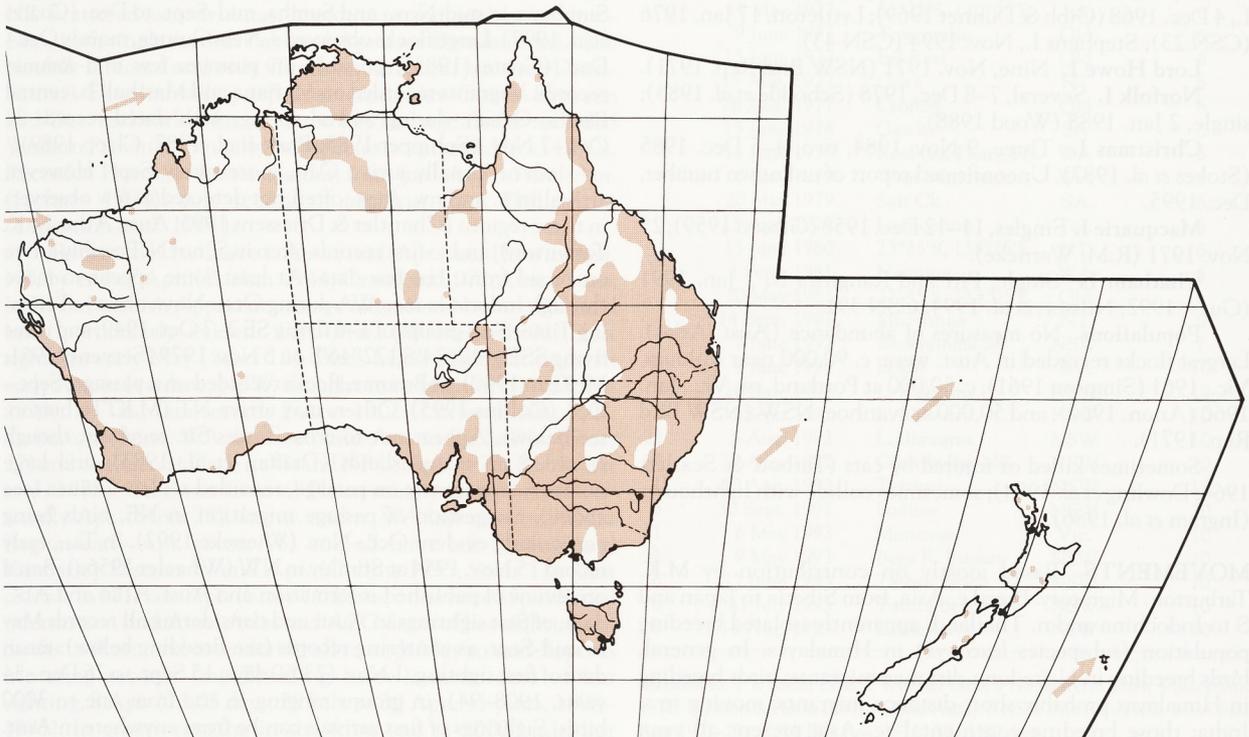


resting on ground (Campbell) and alighting on wire netting of tennis court (Wheeler 1959). Once seen attempting to land on wall of lighthouse (Scarff 1990).

DISTRIBUTION AND POPULATION Breed in Asia, from s. Siberia around Altai Mts, N to near Arctic Circle, E to Sea of Okhotsk, Kamchatka, e. China, Korean Pen., Japan and Taiwan, and S to Himalayas, e. Burma, nw. Thailand and central Vietnam; possibly also in n. Philippines. In non-breeding season, widespread from ne. India, E through Malay Pen. to Indochina and Philippines, and S to Indonesia, New Guinea, Aust. and NZ (Ali & Ripley 1970; Gore & Won 1971; de Schauensee 1984; Flint *et al.* 1984; Coates 1985; White & Bruce 1986; van Marle & Voous 1988; Sibley & Monroe 1990; Dickinson *et al.* 1991; Lekagul & Round 1991). Regular in small numbers in Seychelles (Feare 1979). Vagrant w. and n. Pacific Ocean, on Marshall and Mariana Is in Micronesia, and Aleutian and Pribilof Is (Kessel & Gibson 1978; Gibson 1981; AOU 1983; Schipper 1985; Pratt *et al.* 1987; Clapp 1989). Also vagrant to w. Europe (Parker 1990; Gantlett 1993; BWP).

Aust. Widespread non-breeding visitor. Reported more frequently in closely settled areas, such as se. Qld, coastal NSW, s. Vic., where more observers, and this may distort picture of true distribution and abundance (Aust. Atlas; Vic. Atlas). **Qld** Scattered records in Gulf Country, from Mt Isa and near Camooweal, N to Karumba in se. Gulf of Carpentaria. A few records on C. York Pen., including at Edward R. and Weipa in W, at C. York, and Iron Ra. in E (Horton 1975; Kikkawa 1975; Garnett & Bredl 1985; Beruldsen 1990; Aust. Atlas). Recorded over many islands in Torres Str. (Draffan *et al.* 1983). Elsewhere in North-Eastern Region, many records E of Great Divide from near Cooktown S to Townsville; also widespread but scattered in coastal areas from 20°S, S to Brisbane and in much of s. South-Eastern Region. More widespread W of Great Divide, W of line joining Chinchilla and Hughenden, W to between

Richmond and Winton, Longreach, Gowan Ra., Maraila NP and Dirranbandi; rarely farther W, to Windorah and Thargomindah (Roberts 1979; Ford *et al.* 1980; Storr 19; Aust. Atlas; Qld Bird Reps). More numerous Aust. Atlas records in S probably result of observer bias. **NSW** Recorded in all regions. Many records E of Great Divide; few over Great Divide; widespread but scattered farther W, to line joining Bourke and Dareton. Few records farther W, including sites SW of Milparinka, Bulloo R. Overflow and Thurloo Downs HS (Morris *et al.* 1981; Cooper & McAllan 1995; Aust. Atlas; NSW Bird Reps). **Vic.** Widespread but sparsely scattered in all regions (Vic. Atlas; Vic. Bird Reps). **Tas.** Several records from islands in Bass Str., especially King I., where recorded in 1961 (30–40), Feb. 1967 (500), Mar. 1969 (many), Feb. 1971 (10–100+) and Jan. 1973 (200) (Green & McGarvie 1971; McGarvie & Templeton 1974; Tas. Bird Rep. 1); also on C. Barren I., Furneaux Grp, Dec. 1981 (Aust. Atlas). Few mainland records from before 1970s, mostly in N, from Stanley E to Cullenswood and Break O'Day Valley (Legge 1904; Littler 1903, 1910a,b; Anderson 1939; Wheeler 1956a; Napier 1969). Since 1970s, published records include: single, Horton R., 30 Jan. 1978 (Aust. Atlas; Tas. Bird Rep. 8); >20, Riverside, 26 Feb. 1980 (Bird 1981); many, between Blackburn Ck and Cluny, 7 Mar. 1980 (Aust. Atlas); 3–4, Maria I., 11 Dec. 1980 (Bird 1981; Aust. Atlas); single, Rosebery, 27 Mar. 1981 (Aust. Atlas; Tas. Bird Rep. 11); 60, Waddamana, 29 Mar. 1981 (Aust. Atlas; Tas. Bird Rep. 11); 20, Oakwood Hill, 12 Mar. 1982 (Tas. Bird Rep. 12); 2–3, Henty Bridge, 4 Jan. 1988 (Talbot & Talbot 1989). **SA** Widespread from Vic. border W to Spencer Gulf, and in coastal parts of Eyre Pen. as far W as Franklin Is, off Streaky Bay; occur N to 32°S in Lower North Region (Eckert 1971, 1974; Stove 1994; Aust. Atlas; SA Bird Reps). Few recent published records beyond these bounds, such as in Flinders Ras and L. Eyre Drainage Basin from Billa Kallina Stn, L. Eyre S and Marree, N to Moorapepe and E to Innamincka and Moomba (Badman



1989; Aust. Atlas; SA Bird Rep. 1977–81). **WA** Sparsely scattered records along s. coast, from near Eyre Bird Observatory, W to Denmark. Widespread in coastal and subcoastal areas between Augusta and Carnarvon, including some nearshore and offshore islands, and scattered along coast from sw. Pilbara to n. and e. Kimberley, near Wyndham. Sparsely scattered inland records, especially in Wheatbelt; from L. Annean and Wittenoom in n. and nw. Gascoyne Region, N through much of Pilbara Region; and s. and e. Kimberley Div. Also recorded in Timor Sea, both at sea and around islands such as Ashmore Reef. Isolated records at Neale Junction in Great Victoria Desert and on Nullarbor Plain (Serventy 1951; Reilly *et al.* 1975; Burbidge *et al.* 1976; Fletcher 1980; McKean 1980; Dymond 1988; Saunders & Ingram 1995; Aust. Atlas; Storr 26, 27). **NT** Widespread but scattered in Top End, including some offshore islands, mostly S to Victoria R. Downs, and scattered records farther S to Attack Ck, N of Tennant Ck. Farther S, isolated records in Tanami Desert, Avon Downs in s. Barkly Tableland; also in far S, from Hay R. in n. Simpson Desert W to near Alice Springs (Haselgrove 1975; Boekel 1980; Gibson 1986; Gibson & Cole 1988; Storr 7; Aust. Atlas; H.A.F. Thompson & D.K. Goodfellow).

NZ Rare visitor; widespread but scattered records (Heather *et al.* 1997). **NI** Scattered records from s. Ninety Mile Beach S to Manawatu. Records, singles unless stated, include: four, including specimen, White Cliffs, Dec. 1884 (Stidolph 1927; Oliver); L. Taupo <1955 (Oliver); four, C. Kidnappers, 19 Nov. 1967 (CSN 19 [Suppl.]); Kaipara Flats, early Sept. 1972 (Hudson 1973); Foxton Beach, 14 June 1975 (CSN 22); probable, Waipapakauri, 11 Oct. 1975 (CSN 23); Whau Valley, 29 Aug. 1977 (CSN 24); two, Napier, 2 July 1983 (CSN 32); Warawara Forest, 7 Apr. 1994 (CSN 42). **SI** Few scattered records, all singles, include: Karamea, 15 Dec. 1952 (CSN 5); specimen, Manakiaua R., 31 May 1957 (Turbott & Scarlett 1964); specimen, Waianiwa, 20 Nov. 1960 (Turbott & Scarlett 1964); Greymouth, 11 Feb. 1961 (CSN 19 [Suppl.]); probable, Motunau I., 4 Dec. 1968 (Gibb & Dunnet 1969); Lyttleton, 17 Jan. 1976 (CSN 23); Stephens I., Nov. 1994 (CSN 43).

Lord Howe I. Nine, Nov. 1971 (NSW Bird Rep. 1971).

Norfolk I. Several, 7–8 Dec. 1978 (Schodde *et al.* 1983); single, 2 Jan. 1988 (Wood 1988).

Christmas I. Three, 9 Nov. 1984; two, 4–5 Dec. 1985 (Stokes *et al.* 1987). Unconfirmed report of unknown number, Dec. 1995.

Macquarie I. Singles, 11–12 Dec. 1958 (Gibson 1959); 25 Nov. 1971 (R.M. Warneke).

Chatham Is Single, Pitt and Rangitira Is, 2 Jan. 1991 (Guest 1992; Nilsson *et al.* 1994; CSN 39).

Populations No measures of abundance (Aust. Atlas). Largest flocks recorded in Aust. were: c. 90,000 near Mildura, Vic., 1961 (Simpson 1961); c. 50,000 at Portland, sw. Vic., Jan. 1960 (Anon. 1960); and 50,000 at Ivanhoe, NSW (NSW Bird Rep. 1971).

Sometimes killed or injured by cats (Turbott & Scarlett 1964; Dowling *et al.* 1994); sometimes collide with lighthouses (Ingram *et al.* 1986).

MOVEMENTS Based mostly on contribution by M.K. Tarburton. Migratory. Breed e. Asia, from Siberia to Japan and S to Indochina and n. Thailand; apparently isolated breeding population (subspecies *leuconyx*) in Himalayas. In general, birds breeding in N are long-distance migrants; birds breeding in Himalayas probably short-distance migrants, moving to s. India; those breeding continental se. Asia present all year,

though some spend boreal winter Malay Pen. (Gore & Won 1971; Chantler & Driessens 1995; BWP). Nominate *pacificus* migrates S for boreal winter, wintering Thailand, probably Malay Pen., Indonesia, New Guinea, Melanesia, Aust., and occasionally NZ; some reach India and small numbers, apparently on passage, regular in Seychelles; vagrant to central Pacific Ocean (see Medway & Wells 1976; Coates 1985; Schipper 1985; Pratt *et al.* 1987; Clapp 1989; Lekagul & Round 1991) and Britain (BWP; NZCL). Route between breeding and non-breeding areas not properly known. Movements in HANZAB region (where only *pacificus* recorded), poorly known. Usually arrive Aust. in Oct.–Nov., and leave Apr. (see below). Small numbers occasionally winter in Aust. or NZ, but migration normally complete (Aust. Atlas). In Aust., very mobile, covering great distances; movements described as nomadic (Strahan; M.K. Tarburton).

Departure Leave breeding grounds in Siberia, Aug. to mid-Sept. (Dement'ev & Gladkov 1951). Pass through Korea, late Aug. (Gore & Won 1971); and Malay Pen., mid-Sept. to mid-Nov. (Medway & Wells 1976). Pass through Philippines, where recorded late July and Nov.–Dec. (Dickinson *et al.* 1991). Pass through Greater Sundas, e.g. in Sumatra in Aug. (four records), Oct. (three) and Nov. (one) (van Marle & Voous 1988); on Borneo, noted mid- to late Oct. at Kuching and e. Kalimantan (Smythies 1981); in Java and Bali, considerable passage E from Java in austral spring (Ash 1984; Coates *et al.* 1997). In Sulawesi and nearby islands, recorded Aug.–Oct. (White & Bruce 1986; Coates *et al.* 1997). In Moluccas, birds, possibly on s. passage, recorded on Halmahera, late Sept.; Ambon in late Aug.; and Kasiruta in Nov. (Coates *et al.* 1997); once over Buru, 29 Nov. and 1 Dec. (Jepson 1993). Lesser Sundas apparently important migration route through Indonesia: flocks recorded Flores, Sept.–Nov., and, less commonly, in Aug. and Dec. to mid-Apr. (Coates *et al.* 1997); in w. Timor, recorded Sept., and small numbers often seen in passage over broad front, 8 Oct.–5 Nov. 1993 (Holmes 1994); also noted Sumbawa in mid-Nov., and Sumba, mid-Sept. to Dec. (Coates *et al.* 1997). Large flocks observed s. New Guinea, mainly Oct.–Dec. (Coates 1985), possibly on passage; few mid-summer records. Vagrants recorded on Mariana and Marshall Is, central Pacific Ocean, during austral spring, with dated records 22 Oct.–7 Nov. (Schipper 1985; Pratt *et al.* 1987; Clapp 1989).

AUST.: Usually arrive Oct., more rarely Sept. However, arrival in n. and nw. Aust. often not detected as few observers in these regions (Chantler & Driessens 1995; Aust. Atlas; M.K. Tarburton), and so first records often in S, not N. Possibly arrive on broad front, but few data. At least some appear to move through Indonesia into WA during Oct.–Nov.; observed crossing Timor Sea: groups of 1–6 flying SE 2–7 Oct. 1949, and three flying SSE at 12°24'S 122°46'E on 8 Nov. 1979 (Serventy 1951; McKean 1980); at Broome, flocks recorded on s. passage, Sept.–Oct. (Collins 1995). Others may arrive NT (M.K. Tarburton; see below). Appear not to cross Torres Str. regularly, though recorded on many islands (Draffan *et al.* 1983), and large numbers, apparently on passage, recorded s. New Guinea (see above). Suggestion of passage migration in NE, birds being particularly evident Oct.–Nov. (Wieneke 1992). In Tas., early record 15 Nov. 1954 at Stanley in NW (Wheeler 1956a). Based on review of published information and Aust. Atlas and ABC data, of first sightings in Aust. and considering all records May to mid-Sept. as wintering records (see Breeding below): mean date of first sighting, 1 Nov. (23.60 days; 15 Sept. to 26 Dec.; 34 years, 1908–94), in groups ranging in size from one to 3000 birds. Sightings of first arrivals can be from anywhere in Aust.

Proportion of first sightings in each state: Qld, 28.6% (of 34 years); NSW, 22.9%; Vic., 5.7%; Tas., 2.9%; SA, 14.3%; WA, 14.3%; NT, 5.7%; Christmas I., 2.9%; Macquarie I., 2.9% (Cleland 1928, 1938; Campbell 1935; Serventy 1951; Wheeler 1954a, 1956a,b, 1958, 1959b, 1960, 1969; Wheeler *et al.* 1961; Bouchier & Noonan 1962; Noonan *et al.* 1963, 1964; Noonan & Wheeler 1965; Gill 1970; Cooper 1986, 1991; Niland 1986; Stokes *et al.* 1987; Dymond 1988; Aust. Atlas; NSW Bird Reps 1993, 1994; SA Bird Reps 1970–71, 1972–73, 1975, 1977–81; ABC data; R.M. Warneke). NZ: Rare visitor, with earliest record early Sept. 1972; most records Nov.–Dec. (see Distribution). On Christmas, Lord Howe, Macquarie Is, all records Nov. and Dec.; one of two Norfolk I. records, Dec. (see Distribution).

Non-breeding Aust. In s. Aust. no significant difference apparent in arrival times in different regions (Aust. Atlas). Said to move much during non-breeding period (Aust. Atlas; ACT Atlas; M.K. Tarburton). Large flocks often precede or follow low-pressure systems crossing Aust., searching for food (Boehm 1939b; M.K. Tarburton). However, emphasis on association with hot thundery weather of low-pressure systems (e.g. Storr 11, 16, 28) may be exaggerated, especially as birds call more often, and so more noticeable, during thunderstorms (M.K. Tarburton). Published regional occurrence (see also Departure and Return): QLD: Oct. to early May (Storr 19). NSW: Oct.–Apr. (Morris *et al.* 1981). ACT: Flocks three or four times per year in Dec.–Mar. (ACT Atlas). VIC.: Most common in years when late-summer subtropical cyclone centres move much farther S than usual. Reports most frequent Dec.–Apr., in N of State (Vic. Atlas). TAS.: Mostly Feb.–Mar. (Green 1989). SA: Oct.–May, most common Dec.–Mar. (SA Bird Reps). WA: At Broome, maximum numbers in Feb. (Collins 1995). In Kimberley Div., present late Sept. to late Apr; in Pilbara Region and Eucla Div., Nov. to early Apr.; in Gascoyne Region, summer; in SE Interior, once on 12 Mar. Round Perth, recorded late Dec.–Apr., mostly Mar. (Storr 11, 16, 21, 22, 26, 27, 28). NT: Mid-Oct. to late Apr., though said largely to leave Top End in Jan.–Feb. (Crawford 1972; Storr 7). NZ Scattered records in non-breeding period, with most Nov.–Dec., with single records Feb. and Apr. (see Distribution). One Norfolk I. record and only Chatham Is record, Jan. (see Distribution). Extralimitally, *pacificus* recorded New Guinea between mid-Oct. and early Mar. (Coates 1985); large flocks recorded Western Province annually (subspecies not stated; Hicks 1990). Recorded Flores, in Lesser Sundas, from mid-Aug. to mid-Apr. (Holmes 1994). July record of *pacificus* from Philippines (Dickinson *et al.* 1991).

Return Said to leave s. Aust., mid-Apr., and Darwin area, NT, by end of Apr. (Boehm 1944; Crawford 1972; Aust. Atlas; M.K. Tarburton). Apparent passage migration N in ne. Qld, and birds particularly evident Feb.–Mar. (Wieneke 1992); last sightings early May (Storr 19). Birds heard calling at night in early Apr. at Ivanhoe, NSW, thought to be migrating N (Hobbs 1990). In Tas., late record, 2 Apr. 1902 (Littler 1910a; M.K. Tarburton). In se. WA, last seen mid-Apr. in Eucla Div. (Storr 27) and one seen at Cape Le Grand NP 18 Apr. 1972 (Kitchener *et al.* 1975). On Swan Coastal Plain, usually seen Mar., occasionally Apr. (Storr 28). In nw. and n. WA last seen in Pilbara Region early Apr. (Storr 16) and all have left Broome and Kimberley District by end Apr. (Collins 1995; Storr 11). Last records in NT, late Apr. (Storr 7). Based on review of published information and Aust. Atlas and ABC data, of last sightings of Swifts in Aust. and considering all records May to mid-Sept. as wintering records (see Breeding below): mean date of last sighting, 8 Apr. (13.05 days; 28 Feb. to 30 Apr.; 41 years, 1898–1995), in groups ranging in size from one to 3000 birds; last

sightings in each state: Qld, 24.4% (of 41 years); NSW, 12.2%; Vic., 19.5%; Tas., 4.9%; SA, 17.1%; WA, 19.5%; NT, 2.4% (Berney 1904; Littler 1910a,b; MacGillivray 1914; Cleland 1928; Bridgewater 1934; Lord 1936; Boehm 1944; Lord 1948; Lamm & White 1950; Wheeler 1952, 1954a, 1956b, 1957, 1958, 1959a,b, 1969; Storr & Dunnett 1955; Wheeler *et al.* 1961; Bouchier & Noonan 1962; Noonan *et al.* 1963, 1964, 1966; Robinson 1973; Dell & Johnstone 1977; Jones 1982; Cooper 1986; Dymond 1988; Aust. Atlas; SA Bird Reps 1970–71, 1972–73, 1977–81; ABC data).

Extralimitally, passage migrant in Java and Wallacea (see White & Bruce 1986; Coates *et al.* 1997). Recorded on passage over s. coast of Timor, 6 Mar. 1994; estimated rate of 57 birds/min for at least 30 min, on a front c. 3 km wide (Holmes 1994). Thousands also seen over w. Timor, 12 Mar. 1985 (Andrew 1986). On passage Malay Pen. from late Feb. to late May (subspecies not specified; Medway & Wells 1976). *Pacificus* migrate through se. China (de Schauensee 1984); pass through Hong Kong (subspecies not mentioned) with large flocks between early Feb. and mid-May (Chalmers 1986). One record of n. migration through Korea, mid-Apr. 1969 (Gore & Won

Table 1. Records of probable wintering Fork-tailed Swifts in Aust. (prepared by M.K. Tarburton).

NUMBER	DATE	LOCATION	STATE	REFERENCES
1	11 May 1957	Mystic Park	Vic.	1
50	12 Aug. 1959	W. Grafton	NSW	2
	12 Aug. 1959	Fine Flower	NSW	2
	4 June 1964	L. Collelal	WA	3
1	4 June 1964	Perth	WA	3
50	19 July 1969	Iron Ra.	Qld	4
1	13 June 1973	Normanville	SA	8
1	3 May 1976	Sandy Ck CP	SA	5,9
	14 May 1977	33°35'S, 140°05'E	SA	6
	9 June 1977	Townsville	Qld	6
	15 June 1977	Eel Reef	Qld	6
	15 Aug. 1977	Gove	NT	6
	26 Aug. 1977	Croftby	Qld	6
	15 June 1978	Gawler	SA	6
	15 June 1978	Roebuck Plains HS	WA	6
	7 May 1979	W of Mandurah	WA	6
	20 May 1979	Salt Ck	SA	6
	23 Aug. 1979	Launceston	Tas.	6
	15 June 1980	23°25'S, 135°25'E	NT	6
	2 Sept. 1981	Nannine	WA	6
	20 May 1981	27°55'S, 153°05'E	Qld	6
	14 Sept. 1981	Mt Finnis	NT	6
1	7 June 1992	Backgamma SF	NSW	7
6	9 June 1990	Bokal	WA	10
3	20 June 1991	L. Illawarra	NSW	10
2	26 Sept. 1991	L. Illawarra	NSW	10
21	5 Aug. 1992	L. Illawarra	NSW	10
14	29 Aug. 1992	Crowdy Bay NP	NSW	10
1	30 Aug. 1992	Terrigal	NSW	10
3	30 Sept. 1992	Ludlow	NSW	10
1	6 May 1993	Montrose	Vic.	10
32	9 May 1993	Bega R. Estuary	NSW	10
6	17 June 1993	Tathra Beach	NSW	10
6	27 July 1993	Tathra Beach	NSW	10
8	15 Aug. 1993	L. Illawarra	NSW	10

REFERENCES: 1 Wheeler 1958; 2 Wheeler 1960; 3 Noonan *et al.* 1964; 4 Blackburn 1970; 5 Paton & Paton 1980; 6 Aust. Atlas; 7 NSW Bird Rep. 1992; 8 SA Bird Rep. 1972–73; 9 SA Bird Rep. 1976; 10 ABC data.

1971). Most return to breeding grounds in May (Dement'ev & Gladkov 1951).

Breeding A few winter in HANZAB region. Aust. records from May to mid-Sept. summarized in Table 1; these assumed to be wintering birds (M.K. Tarburton) but some may be early arrivals or late departures. In NZ, a few records May–Aug. (see Distribution).

Banding No information. None banded in Aust. or NZ.

FOOD Account prepared by M.K. Tarburton. Not well known in HANZAB region. Insectivorous, taking a wide variety of insects and spiders. **Behaviour** Aerial. Forage from within 1 m to several hundred metres above ground (see Habitat). Said to search along edges of low-pressure systems, that both lift food and assist flight (Boehm 1939b); low-flying Swifts said to be precursors of unsettled weather, possibly because insect prey fly at lower altitude when air is humid and air density low (Cameron 1952). Feeding flight characterized by much circling, particularly through prey-rich sites (M.K. Tarburton). Mostly forage in groups of ten to hundreds (Cleland 1928; Hood 1941; Tarr 1950; Carter 1969; Eckert 1971; McGarvie & Templeton 1974; Reilly *et al.* 1975), sometimes in flocks of thousands (Wheeler 1960). Feed in mixed flocks with other aerial foragers; of 69 feeding flocks recorded in literature, 80% in company with White-throated Needletails, 11% with Tree Martins, 6% with Welcome Swallows *Hirundo neoxena* and 3% with Dollarbirds *Eurystomus orientalis*. Said to be attracted to bushfires or rising smoke (Hood 1941), e.g. seen feeding with White-throated Needletails in smoke of bushfires near Melbourne on 11 Mar. 1965 (McCulloch 1966). Once seen drinking from a series of broad, shallow rainwater puddles between large *Nitroaria* bushes at L. Victoria, NSW (Simpson 1973). Bill small: exposed culmen 7.0 mm (0.9; 58); gape as wide as head (16–17 mm); pre- and supra-orbital ridges help protect large recessed eyes from collisions with prey (M.K. Tarburton).

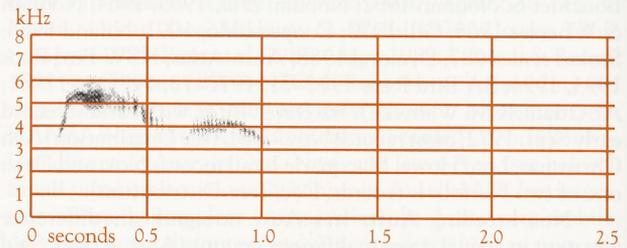
No detailed studies. **Animals** INSECTS: Coleoptera⁵: Cerambycidae^{3,5}; Curculionidae^{3,5}; Diptera: Chironomidae^{3,5}; Hemiptera: Cicadellidae⁵; Hymenoptera: unident. small bees and wasps^{3,5}; Apidae: *Apis mellifera*^{3,5,6}; Brachionidae^{3,5}; Formicidae⁵; Isoptera: unident. termites^{1,3,4}; Lepidoptera: moth³. (REFERENCES: ¹MacGillivray 1918; ²Mathews; ³Cleland 1928; ⁴Boehm 1939b; ⁵Lea & Gray; ⁶M.K. Tarburton.)

For extralimital details, see Litvinenko (1972), Tso-Hsin (1964) and Zhaoqin & Benxiang (1987).

VOICE Not well known. Account based on information supplied by M.K. Tarburton. Calls audible in flight, even when birds flying high and barely visible, or no longer visible with binoculars, and can draw attention to birds that would otherwise be overlooked (Gilbert 1935; Lord 1943, 1948; Hobbs 1961, 1990; Simpson 1973; Mathews). Screaming calls once heard in early Apr. at 03:00 (Hobbs 1990). Call more during thunderstorms (M.K. Tarburton). **NON-VOCAL SOUNDS**: Swish of wings audible if bird flying low, and described as hissing *chuff-chuff-chuff* (Campbell 1920; Boehm 1944; Campbell). Some sounds reported as calls, e.g. whistle calls of Mathews and monotonic *tat-tat-tat-tat* of Gilbert (1935) much more likely to be noise of wings (Boehm 1944; M.K. Tarburton).

Adult **CALLS IN FLIGHT**: Various described as: long *skree-ee-ee* (Bridgewater 1934); shrill sound like simultaneous whistle and buzz with slight downward inflection (Simpson 1973); thin drawn-out, insect-like *zwee* (Storr & Dunnet 1955); high-pitched twittering and wheezy screeching (Boehm 1939b; Mathews); shrill scream *sree* (Hobbs 1961, 1990); faint silvery

twitter (Campbell); continual harsh churring (sonagram A); and sharp twitter (D.A. Stewart). Birds gave screeches when Brown Goshawk *Accipiter fasciatus* approached flock (Wheeler 1952). **CALL AT ROOST**: Flock roosting in large eucalypt tree uttered constant twittering till it was quite dark (Campbell).



A D.A. Stewart; Byron Bay, NSW, Dec. 1992; M24-9

PLUMAGES Prepared by D.I. Rogers. Nominate *pacificus* (described below) fledges and migrates S in juvenile plumage. Partial post-juvenile (first pre-basic) moult to immature plumage occurs in non-breeding areas during first austral summer; most birds migrate N at end of first austral summer in immature plumage, which is very similar to adult plumage except for retained juvenile remiges. Adult plumage attained with complete first post-breeding (second pre-basic) moult in second austral summer.

Adult (Second and subsequent basic). **HEAD AND NECK**: Top of head, sides of neck and most of face, dark brown (121) with narrow white fringes to feathers (broadest on crown and sides of neck) that are lost with wear and gone by time of arrival in HANZAB region in Oct.; bases of feathers, grey-brown (119A–119B), and bases can be partly exposed on nape and sides of head. Feathers immediately in front of eye, short and bristly, black-brown (119), forming small, darker, velvet-textured patch. Chin and throat, white, forming patch that is not sharply demarcated from dark plumage and is often smudged darker by partly exposed concealed grey-brown (c119A–c119B) bases to feathers; in many, chin and throat finely streaked by dark-brown (121) shafts to feathers. **UPPERPARTS**: Mainly black-brown (119); feathers grade to dark brown (121–119A) at bases, which are increasingly exposed with wear; feathers have narrow white fringes at tip when fresh, causing faintly scalloped effect. Neat white band, very straight and 15–20 mm wide, runs across lower rump; band finely streaked by dark brown (121) or black-brown (119) shafts to feathers and can have a faint pale grey-brown (ne) tinge. **UNDERPARTS**: Look dark brown to black-brown, boldly scalloped white except when very worn. Feathers mostly dark greyish-brown (121) grading into black-brown (119) subterminal bands 1–4 mm wide, and with boldly contrasting white tips c. 2 mm wide; tips can dwindle to 0.5 mm wide when plumage very worn, but none examined had wholly lost white tips; with wear, dark grey-brown (c119B–c121) bases more exposed than when plumage fresh. Rear-flanks, white or off-white (ne), finely streaked dark brown (21) or black-brown (119) like rump; white of rear-flanks runs into band on rump. **TAIL**: Black-brown (119). **UPPERWING**: Black-brown (119), gradually and patchily fading to dark brown (c121) with wear (never becomes wholly dark brown). Lesser and median coverts have very narrow white fringes when fresh (like upperparts); tertials and inner secondaries have slightly broader and cleaner white fringes at tips, traces of which can remain till plumage quite worn. **UNDERWING**: Marginal, lesser and median coverts as underparts: dark brown (121) to black-brown (119), scalloped by white fringes at tips

of feathers; these white fringes stay 1–2 mm broad even when plumage very worn. Greater coverts and remiges, dark glossy grey (82–83) with varying white tips to greater coverts; tips mainly narrow, <1 mm wide, but up to 2 mm wide on some greater primary coverts. Bases of remiges and greater coverts tend to be a little glossier and paler than tips, so tips of greater primary coverts can look subtly darker than surrounding feathers (effect is less striking than in White-throated Needletail).

Juvenile Very similar to adult but usually separable by wear of feathers (see Ageing). BWP states that white band on rump and white patch on chin and throat often broader than in adults and that juveniles have less noticeable dark shaft-streaks; this consistent with the little Aust. material available, though overlap between juveniles and adults occurs. BWP reported that t5 differed in shape between juveniles and adults: distal inner web straight or slightly convex in juveniles, concave or with a slight notch in adults. This difference not apparent in Aust. material, in which shape of t5 of adults and juveniles is as that given for juveniles in BWP; illustration of t5 of adult in Vaurie (1959) also consistent with Aust. material rather than with BWP.

Immatures (First basic). Only separable from adult by wear of feathers (see Ageing).

BARE PARTS From museum labels (ANWC, HLW, MV, QM, SAM). **Adult, Juvenile** Bill, black (–). Mouth, pale pink (–) to purplish pink (–). Iris, black-brown (–). Feet usually black (–), sometimes with a purplish tinge; soles described as purplish flesh by BWP. Claws, black (–).

MOULTS Based on BWP and Aust. skins of 44 adults and 13 younger birds (AM, ANWC, HLW, MV, QM, SAM). **Adult post-breeding** (Definitive pre-basic; first such moult is probably second pre-basic). Complete; primaries outward. Some may start moult of body while still on breeding grounds, as birds staging in Indonesia (and one from Japan) in Sept.–Oct. had yet to start moult of primaries and tail but had replaced c. 30% of feathers of upperparts and c. 60% of underparts. A few birds arrive in Indonesia having suspended moult after replacing 3–4 primaries. Moult of primaries then starts or resumes in Indonesia: PMS 4 (0–10; 11) in first half of Oct.; 7 (0–20; 10) in second half of Oct.; 16 (6–23; 6) in first half of Nov.; few birds remain in Indonesia thereafter, having resumed s. migration. Molt finished in Aust. non-breeding grounds; not known if moult of primaries suspended briefly while migrating between Indonesia and Aust. If moult is suspended it must resume immediately on arrival in Aust., as all Aust. specimens collected spring and early summer showed active moult of primaries (one or two feathers growing concurrently) and body. PMS probably 20–30 on arrival in Aust.; active moult continues through summer and is usually finished Feb.–Mar.: PMS 29 (n=1) in first half Nov.; 27.8 (25–36; 4) in first half Dec.; 37 (35–38; 4) in Jan. By Feb., four of 12 had finished moult and others had mean PMS of 47.1 (43–49; 8). Most birds finish moult in Mar. (moult finished in two of five specimens examined and PMS 49 in the remaining three); one examined was still moulting p10 in Apr. A few specimens excluded from above summary had advanced moult of primaries (two with PMS 49 in late Dec., one with PMS 49 in early Jan.) and may have been failed breeders or pre-breeders. Much of body-moult finished on arrival in Aust. (though one collected early Nov. had done no moult); moult continues through summer and is finished by some in late Dec. to Jan., when PMS 38–49; in others, traces of moult of body can linger till Mar., after moult

of primaries finished. Moult of tail usually centripetal but some show some variation from this sequence, e.g. by starting moult at t4 rather than t5, or by skipping moult of t4 or t2 and then replacing them outside usual centripetal sequence. Most moult of tail occurs late Dec. to Feb. (latest birds finish mid-Mar.), starting when PMS 30–38; many finish moult of tail before p10 fully grown, but others still have as many as four old rectrices by time moult of primaries finished. **Post-juvenile** (First pre-basic). Partial, involving all feathers of body, all of tail, lesser upperwing-coverts and a few tertials. A few start moult of body from late Nov., but others, and possibly most, still in full juvenile plumage by time they arrive in Aust. in Nov.–Dec. Both specimens examined Jan.–Feb. had active moult of body and one had begun moult of tail. By late Mar., moult of only available specimen was finished (except for retained juvenile primaries and secondaries); birds in this condition have also been collected in May–Aug. of second calendar year (BWP). **Subsequent moults of subadults** Probably perform a complete second pre-basic moult in second austral summer, in which all remaining juvenile remiges replaced. Possible that this moult occurs slightly earlier than in successfully breeding adults (as described for White-throated Needletail), but confirmation needed.

MEASUREMENTS Nominate *pacificus*: (1–2) Aust., skins; Tail = length of tail from base of t1 to tip of t5; Fork = distance between tips of t1 and t5 (AM, ANWC, HLW, MV, SAM): (1) Adults; (2) Juveniles (including birds in post-juvenile moult of body).

	MALES	FEMALES	
WING	(1) 180.8 (6.06; 169–191; 23) (2) 179.2 (4.17; 174–185; 6)	176.3 (5.81; 169–188; 12) 169	* ns
TAIL	(1) 79.3 (3.29; 71–86; 22) (2) 77.6 (5.37; 70–85; 5)	78.0 (4.34; 69–85; 13) 72	ns
FORK	(1) 34.3 (4.79; 25–49; 22) (2) 32.5 (5.00; 26–38; 4)	33.7 (4.23; 27–41; 13) –	ns
BILL	(1) 6.81 (0.456; 6.0–7.7; 23) (2) 6.68 (0.366; 6.3–7.3; 6)	6.66 (0.34; 6.3–7.4; 13) –	ns
BILL S	(1) 12.4 (1.35; 10.3–14.8; 21) (2) 12.6 (0.85; 11.9–14.0; 5)	12.2 (1.43; 9.3–14.5; 11) –	ns
TARSUS	(1) 11.2 (0.84; 9.9–13.2; 23) (2) 11.1 (1.05; 9.3–11.8; 5)	11.3 (0.75; 10.0–13.0; 13) 12.6	ns

Measurements from e. Siberia and Indonesia (BWP) very similar to above data. In both datasets, length of wing of adult females significantly shorter than in adult males. Aust. samples showed no differences in size related to age, but few young birds measured; BWP reported that average Wing of juvenile 4 mm shorter than in adult, Tail 9 mm shorter, and Fork 6 mm shorter.

WEIGHTS Aust. adults, from museum labels (AM, ANWC, MV, SAM).

	MALES	FEMALES
NOV.–FEB.	26, 29, 36	33.8 (4.99; 27–39; 4)
MAR.	–	39
APR.	36	–

Too few data to assess whether differences in weight related to age or sex occur. Possibly some seasonal variation: e.g. adults from Nov.–Feb., including unsexed birds, 29.6 (5.50; 26–35; 9); all lighter than two adult weights available from Mar. and Apr. (data above). These heavy autumn weights, and a

juvenile male, with much subcutaneous fat, in Mar. weighing 40.9 (the only subadult weight available), possibly associated with pre-migratory gain in weight; confirmation needed, as analogy with Aust. weights of White-throated Needletail (q.v.) suggests that these samples may include some atypically light birds. The few weights available from Palaearctic also appear heavier than those of birds in Aust. summer: e.g. in Mongolia in early June, males 48.1 (5.87; 38–54; 7) (BWP).

STRUCTURE Wing long and narrow, tapering to very pointed tip. Eleven primaries: p9 longest; p10 1–6 mm shorter, p8 8–14, p7 28–38, p6 47–59, p5 66–82, p4 82–91, p3 97–106, p2 107–118, p1 117–131. Primaries very narrow, curved toward body; taper to narrow rounded tips but lack emarginations. BWP implies that p11 is absent, but there is in fact a remicle very similar to that reported in House Swift by Naik (1965); it is very short, narrow and pointed, minute, and concealed by median and greater primary underwing-coverts. Nine secondaries, including three tertials; unlike *Hirundapus*, s1 is similar in length and shape to adjacent secondaries. Tail deeply forked; ten rectrices; t5 longest, t4 c. 4 mm shorter, t3 c. 13, t2 c. 27, t5 c. 36; for further information on depth of fork, see Measurements. Bill very flat (2.5 mm deep at base of exposed culmen) and broad at base, with only small tip (<50%) projecting beyond feathers of forehead; neatly triangular in dorsal view, with width of c. 13 mm at base of gape and of c. 6 mm at level of feathering of forehead. Tip of upper mandible strong and curved; nostrils large and oval, face upward, and are set just beside narrow ridge on culmen. Face exposed, extending back almost to underside of eye; no rictal bristles. Tarsus short, strong, feathered in front. Toes short and strong; 'hind' toe directed to form innermost; can direct all toes forward when clinging to vertical surface but probably often grip with two inner toes opposite two outer toes, as has been reported for other apparently pamproductyl swifts by Collins (1983). Middle toe without claw, 6.4 (5.6–6.8; 7). Claws strong and curved; 6–7.5 mm long on middle toe, 5.5–7.3 mm on outer and inner toes, c. 4 mm long on hindtoe. Innermost (hind) toe with claw, c. 69% of length of middle toe with claw; inner toe c. 83%; outer toe, c. 80%.

AGEING Plumages of juveniles and adults very similar but timing of moult differs consistently, so that ageing possible if wear of feathers examined carefully. On arrival in HANZAB region (Oct.–Nov.), most adults have performed much moult of body and show patchwork of fresh and worn plumage; juveniles are uniformly and slightly worn. This difference more marked by end Dec., when body of adults predominantly or wholly fresh, and that of juveniles more worn (with white fringes to feathers of underparts reduced). Juveniles perform most moult of body to first basic plumage in Jan.–Feb., when adults have few or no retained old body-feathers. Thereafter, body-plumage of immatures slightly fresher than that of adults, but difference subtle and difficult to detect. Moult of primaries also an invaluable guide to ageing: all adults in HANZAB region show active moult of primaries in Oct.–Dec. (till Feb. in most birds), while young birds retain juvenile wing throughout first austral summer. From Feb. to Sept. of second calendar year, retained juvenile primaries of immatures are older than those of adults and should be distinctly more worn but this difficult to assess without comparative material on hand, as primaries of *Apus* swifts do not show wear readily.

RECOGNITION Confusion possible with aberrant, partly

albino, extralimital *Apus* (Chantler & Driessens 1995), but bold scalloping of underparts in all plumages, in combination with large size and deeply forked tail, always diagnostic.

GEOGRAPHICAL VARIATION Reasonably distinct; four subspecies, differing in size, darkness of ground-colour of plumage, amount of ventral scalloping, and size of pale patches of chin and rump. Following summary based mainly on Vaurie (1959) and BWP; other useful reviews include Deignan (1956), Lack (1956, 1958), Mees (1973) and Chantler & Driessens (1995).

Nominate *pacificus*, the only subspecies confirmed from HANZAB region, is largest (see Measurements), with largest, clearest white patches on throat and band on rump; ground-colour of head and nape slightly paler than upperparts. BWP reported slight geographical variation within *pacificus*: birds from W of breeding range tend to be slightly blacker than those in China and Japan (though complete overlap occurs). Measurements of *pacificus* from N and W of breeding range very similar in size to those from Aust., while small samples from China and Japan suggested these birds might be slightly larger, e.g. Wing 187 (182–192; 5).

Subspecies *kanoi* of s. China has blacker ground-colour than *pacificus*, with crown and mantle concolorous or nearly so; white patch on chin is smaller, more strongly suffused grey and with more obvious dark shaft-streaks; white band on rump averages c. 5 mm narrower and tends to be more streaked than in *pacificus*; and pale fringes at tips of feathers of body usually less conspicuous and can be minute or absent on upperparts. *Pacificus* and *kanoi* are similar in size: Wing of *kanoi*, 181.6 (3.72; 176–188; 10) in males, 177.6 (4.97; 173–185; 6) in females (Vaurie 1959). Subspecies *leuconyx* of outer Himalayas has similar plumage to *kanoi* but is much smaller, with Wing 160.8 (4.91; 155–171; 9) (Vaurie 1959). Subspecies *cooki* of se. Asia, is darker and more glossy than other subspecies, with white feather-fringes fainter or absent; white patches of throat and rump have numerous and distinct dusky shaft-streaks; and p10 is similar in length to p9 or slightly longer (in other subspecies, p9 is much the longest primary). Subspecies *cooki* intermediate in size, with Wing 175.8 (3.90; 170–180; 5) (Vaurie 1959).

Dark-backed Swift *Apus aticaudatus* once considered conspecific with Fork-tailed Swift, but Vaurie (1959) showed that they should be separated; Brooke (1970) regarded the two as a superspecies and considered Common Swift *Apus apus* and Plain Swift *Apus unicolor* to be part of the same species-group.

REFERENCES

- Ali, S., & S.D. Ripley. 1970. *Handbook of the Birds of India and Pakistan*. 4. OUP, Bombay.
- Anderson, B. 1939. *Emu* 39: 67.
- Andrew, P. 1986. *Kukila* 2: 92–5.
- Anon. 1960. *Bird Obs.* 348: 3–5.
- AOU. 1983. *Check-list of North American Birds*. Am. Orn. Union, Lawrence, Kansas.
- Ash, J.S. 1984. *Bull. Br. Orn. Club* 104(1): 24–35.
- Badman, F.J. 1989. *The Birds of Middle and Lower Cooper Creek in South Australia*. Nat. Cons. Soc. S. Aust., Adelaide.
- Berney, F.L. 1904. *Emu* 4: 43–7.
- Beruldsen, G. 1990. *Aust. Bird Watcher* 13: 209–17.
- Bird, C.L. 1981. *Tas. Bird Rep.* 10: 22–4.
- Blackburn, A. 1970. *Emu* 70: 90.
- Boehm, E.F. 1934. *S. Aust. Orn.* 12: 154–60.
- 1939a. *S. Aust. Orn.* 15: 38–46.
- 1939b. *S. Aust. Orn.* 15: 54–8.
- 1944. *S. Aust. Orn.* 17: 21.
- 1962. *Emu* 61: 281–2.
- Boeckel, C. 1980. *Aust. Bird Watcher* 8: 171–93.

- Bouchier, M., & D. Noonan. 1962. *Bird Obs.* 371: 2–4.
- Bravery, J.A. 1971. *Emu* 71: 182.
- Bridgewater, A.E. 1934. *Emu* 34: 97–9.
- Brooke, R.K. 1970. *Durban Mus. Novit.* 9: 13–24.
- Brooker, M.G., et al. 1995. *West. Aust. Nat.* 20: 169–84.
- Burbidge, A.A., et al. 1976. *Wildl. Res. Bull. West. Aust.* 5: 3–16.
- Cameron, A.C. 1952. *Emu* 52: 86–8.
- Campbell, A.G. 1935. *Emu* 34: 312–14.
- Campbell, A.J. 1920. *Emu* 20: 49–66.
- Carter, M.J. 1969. *Aust. Bird Watcher* 3: 168–71.
- Chalmers, M.L. 1986. *Annotated Checklist of the Birds of Hong Kong*. Hong Kong Bird Watching Soc., Hong Kong.
- Chantler, P., & G. Driessens. 1995. *Swifts*. Pica Press, Robertsbridge, England.
- Clapp, R.B. 1989. *Elepaio* 49(1): 1–2.
- Cleland, J.B. 1928. *S. Aust. Orn.* 9: 205–13.
- 1938. *S. Aust. Orn.* 14: 172–3.
- 1955. *S. Aust. Orn.* 21: 54.
- 1965. *S. Aust. Orn.* 65: 144–8.
- 1970. *S. Aust. Orn.* 25: 125, 142.
- Coates, B.J. 1985. *The Birds of Papua New Guinea*. I. Dove Pubs, Alderley, Qld.
- , et al. 1997. *A Guide to the Birds of Wallacea*. Dove Pubs, Alderley, Qld.
- Collins, C.T. 1983. *Auk* 100: 735–7.
- Collins, P. 1995. *The Birds of Broome*. Broome Bird Observatory, Broome, WA.
- Congreve, P. 1983. *West. Aust. Bird Notes* 25: 5.
- Cooper, R.M. 1986. *Aust. Birds* 23: 68–95.
- 1991. *Aust. Birds* 24: 49–72.
- , & I.A.W. McAllan. 1995. *The Birds of Western New South Wales: A Preliminary Atlas*. NSW Bird Atlasers, Albury, NSW.
- Crawford, D.N. 1972. *Emu* 72: 131–48.
- Crompton, A. 1928. *S. Aust. Orn.* 9: 206–7.
- Dawson, P., et al. 1991. *Sunbird* 21: 93–111.
- de Schauensee, R.M. 1984. *The Birds of China*. OUP, Oxford.
- Deignan, H.G. 1956. *Bull. Raffles Mus.* 27: 147–9.
- Dell, J. 1978. *Rec. West. Aust. Mus. Suppl.* 7: 55–68.
- , & R.E. Johnstone. 1977. *Rec. West. Aust. Mus. Suppl.* 4: 37–77.
- , & D.J. McGauran. 1981. *Rec. West. Aust. Mus. Suppl.* 13: 67–93.
- Dement'ev, G.P., & N.A. Gladkov (Eds) 1951. *Birds of the Soviet Union*. I. Israel Prog. Scient. Transl. Jerusalem (1966).
- Dickinson, E.C., et al. 1991. *BOU Checklist* 12.
- Dowling, B., et al. 1994. *Tech. Rep. Arthur Rylah Inst. Environ. Res.* 134.
- Draffan, R.D.W., et al. 1983. *Emu* 83: 207–34.
- Dymond, N. 1988. *RAOU Rep.* 38: 13–66.
- Eckert, J. 1971. *Emu* 71: 61–4.
- 1974. *S. Aust. Orn.* 26: 138–41.
- Feare, C.J. 1979. *Bull. Br. Orn. Club* 99: 75–7.
- Fletcher, T. 1980. *Aust. Bird Watcher* 8: 220–31.
- Flint, V.E., et al. 1984. *A Field Guide to Birds of the USSR*. Princeton Univ. Press, Princeton.
- Ford, J., et al. 1980. *Sunbird* 11: 58–70.
- Gantlett, S.J. 1993. *Birding World* 6(5): 190–1.
- Garnett, S., & R. Bredl. 1985. *Sunbird* 15: 6–23.
- Gibb, J.A., & G.M. Dunnet. 1969. *Notornis* 16: 204–5.
- Gibson, D.B., & J.R. Cole. 1988. *Tech. Rep. Cons. Comm. North. Terr.* 40.
- Gibson, D.D. 1981. *Condor* 83: 65–77.
- Gibson, D.F. 1986. *Tech. Rep. Cons. Comm. North. Terr.* 30.
- Gibson, J.D. 1959. *Emu* 59: 64.
- Gilbert, P.A. 1935. *Emu* 35: 17–27.
- Gill, H.B. 1970. *Emu* 70: 105–16.
- Gore, M.E.J., & P.-O. Won. 1971. *The Birds of Korea*. R. Asiatic Soc., Seoul.
- Green, M. 1995. *West. Aust. Nat.* 20: 51–2.
- Green, R.H. 1989. *Birds of Tasmania*. Potoroo, Launceston, Tas.
- , & A.M. McGarvie. 1971. *Rec. Queen Vict. Mus.* 40: 1–39.
- Guest, R. 1992. *Notornis* 39: 319–21.
- Haselgrove, P. 1975. *Sunbird* 6: 32–41.
- Heather, B.D., et al. 1997. *The Field Guide to the Birds of New Zealand*. OUP, Oxford.
- Hicks, R.K. 1990. *Muruk* 4: 91–105.
- Hobbs, J.N. 1961. *Emu* 61: 21–55.
- 1990. *Bird Obs.* 69: 47.
- Holmes, D.A. 1994. *Kukila* 7: 69–71.
- Hood, J.B. 1941. *S. Aust. Orn.* 15: 125–7.
- Horton, W. 1975. *Sunbird* 6: 49–69.
- Hudson, F.P. 1973. *Notornis* 20: 168.
- Ingram, G.J., et al. 1986. *Sunbird* 16: 12–24.
- Jepson, P. 1993. *Kukila* 6: 85–109.
- Johnstone, R.E. 1983. *Wildl. Res. Bull. West. Aust.* 11: 54–69.
- Jones, W.G. 1982. *Tas. Bird Rep.* 11: 30–43.
- Kessell, B., & D.D. Gibson. 1978. *Studies Avian Biol.* 1: 1–100.
- Kikkawa, J. 1975. *Sunbird* 6: 43–7.
- Kitchener, D.J., et al. 1975. *Rec. West. Aust. Mus. Suppl.* 1.
- Klapste, J. 1977. *Aust. Bird Watcher* 7: 65–6.
- Lack, D. 1956. *Ibis* 98: 34–62.
- 1958. *J. Bombay Nat. Hist. Soc.* 55: 160–1.
- Lamm, D.W., & D. White. 1950. *Emu* 49: 199–204.
- Legge, W.V. 1904. *Emu* 3: 179–81.
- Lekagul, B., & P.D. Round. 1991. *A Guide to the Birds of Thailand*. Saha Karn Bhaet, Bangkok.
- Lindgren, E. 1957. *West. Aust. Nat.* 5: 124.
- Littler, F.M. 1903. *Emu* 2: 171–2.
- 1910a. *A Handbook of the Birds of Tasmania and its Dependencies*. Author, Launceston.
- 1910b. *Emu* 10: 50–1.
- Litvinenko, N.M. 1972. *Ornithologiya* 10: 361–2.
- Longmore, N.W. 1978. *Sunbird* 9: 25–53.
- Lord, E.A.R. 1936. *Emu* 35: 216–18.
- 1943. *Emu* 43: 18–23.
- 1948. *Emu* 48: 166.
- MacGillivray, W. 1914. *Emu* 13: 132–86.
- 1918. *Emu* 17: 180–212.
- Mayo, L.M. 1933. *Emu* 32: 300–1.
- McCulloch, E.M. 1966. *Emu* 65: 290.
- McGarvie, A.M., & M.T. Templeton. 1974. *Emu* 74: 91–6.
- McKean, J.L. 1980. *North. Terr. Nat.* 1(3): 8–13.
- McLean, J.A. 1996. *Sunbird* 26: 66–75.
- Medway, Lord, & D.R. Wells. 1976. *The Birds of the Malay Peninsula*. 5. Witherby, London.
- Mees, G.F. 1973. *Zool. Mededlingen* 46: 197–205.
- Morris, A.K., et al. 1981. *Handlist of Birds in New South Wales*. NSW Field Orn. Club, Sydney.
- Morse, R.A., & M. Laigo. 1969. *Philippine Entomol.* 1: 138–43.
- Naik, R.M. 1965. *Pavo* 3: 89–95.
- Napier, J.R. 1969. *Aust. Bird Watcher* 3: 179–92.
- Newell, H.H. 1930. *Emu* 29: 277.
- Niland, D.C. 1986. *Sunbird* 16: 49–67.
- Nilsson, R.J., et al. 1994. *Notornis* 41 (Suppl.): 109–25.
- Noonan, D., & W.R. Wheeler. 1965. *Bird Obs.* 408: 5–8.
- , et al. 1963. *Bird Obs.* 383: 6–8.
- , et al. 1964. *Bird Obs.* 396: 5–8.
- Parker, M. 1990. *Br. Birds* 83: 43–6.
- Parsons, F.E. 1933. *S. Aust. Orn.* 12: 82–5.
- Paton, D.C., & J.B. Paton. 1980. *S. Aust. Orn.* 28: 120–6.
- Pescott, T. 1983. *Birds of Geelong*. Neptune, Geelong, Vic.
- Pratt, H.D., et al. 1987. *A Field Guide to the Birds of Hawaii and the Tropical Pacific*. Princeton Univ. Press, Princeton.
- Reilly, P.N., et al. 1975. *Emu* 75: 73–6.
- Rix, C.E. 1938. *S. Aust. Orn.* 14: 172–3.
- Roberts, G.J. 1979. *The Birds of South-East Queensland*. Qld Cons. Council, Brisbane.
- Robinson, R.D. 1973. *S. Aust. Orn.* 26: 133–4.
- Rogers, J.P. 1928. *S. Aust. Orn.* 9: 212–13.
- Rowley, I. 1974. *Bird Life*. Collins, Sydney.
- Sanders, S. 1938. *S. Aust. Orn.* 14: 173.
- Saunders, D., & J. Ingram. 1995. *Birds of Southwestern Australia*. Surrey Beatty, Sydney.
- Scarff, A. 1990. *West. Aust. Bird Notes* 54: 7.
- Schipper, W.L. 1985. *Elepaio* 46(4): 27–32.
- Schodde, R., et al. 1983. *Aust. Natn. Parks Wildl. Serv. Spec. Publ.* 8.
- Serventy, D.L. 1951. *Emu* 51: 134.
- Sibley, C.G., & B.L. Monroe. 1990. *Distribution and Taxonomy of Birds of the World*. Yale Univ. Press, New Haven.
- Simpson, K.N.G. 1961. *Bird Obs.* 358: 2–3.
- 1973. *Mem. Natn. Mus. Vict.* 34: 42–51, 253–73.
- Smythies, B.E. 1981. *The Birds of Borneo*. Sabah Soc. & Malay. Nat. Soc., Kuala Lumpur.
- Stidolph, R.H.D. 1927. *Emu* 26: 212–19.

- Stokes, T., *et al.* 1987. *Aust. Bird Watcher* 12: 1-7.
- Storr, G.M., & G.M. Dunnet. 1955. *West. Aust. Nat.* 5: 22-3.
- Stove, K. (Ed.) 1994. *S. Aust. Orn.* 31: 195-265.
- Sullivan, C. 1931. *Emu* 31: 124-35.
- Sutton, J. 1927. *S. Aust. Orn.* 9: 93-6.
- Talbot, J., & V. Talbot. 1989. *Tas. Bird Rep.* 18: 30-1.
- Tarr, H.E. 1950. *Emu* 49: 271.
- Templeton, M.T. 1992. *Sunbird* 22: 87-110.
- Thomas, D.A.G. 1947. *S. Aust. Orn.* 18: 55-60.
- Tso-Hsin, C. 1964. *China's Economic Fauna: Birds*. Science Publ. Soc., Peking.
- Turbott, E.G., & R.J. Scarlett. 1964. *Notornis* 11: 107-9.
- van Marle, J.G., & K.H. Voous. 1988. *BOU Checklist* 10.
- Vaurie, C. 1959. *Am. Mus. Novit.* 1971.
- Watson, I.M. 1955. *Emu* 55: 224-48.
- Wheeler, W.R. 1952. *Bird Obs.* 249: 2-3.
- 1954a. *Bird Obs.* 274: 3-4.
- 1954b. *Bird Obs.* 275: 3-4.
- 1956a. *Bird Obs.* 291: 3-4.
- 1956b. *Bird Obs.* 297: 3-4.
- 1957. *Bird Obs.* 309: 5-6.
- 1958. *Bird Obs.* 322: 2-4.
- 1959a. *Emu* 59: 229-49.
- 1959b. *Bird Obs.* 334: 2-5.
- 1960. *Bird Obs.* 348: 3-5.
- 1969. *Bird Obs.* 456: 6-8.
- , *et al.* 1961. *Bird Obs.* 359: 2-3.
- White, C.M.N., & M.D. Bruce. 1986. *BOU Checklist* 7.
- White, S.A. 1928. *S. Aust. Orn.* 9: 210-11.
- Wieneke, J. 1992. *Where to Find Birds in North East Queensland*. Author, Townsville, Qld.
- Woinarski, J.C.Z. 1993. *Emu* 93: 100-20.
- Wood, S. 1988. *Norfolk Nature Notes* 4: 241.
- Zhaoqin, C., & Z. Benxiang. 1987. *Acta Zool. Sin.* 33: 180-6.



Volume 4, Plate 48

White-throated Needletail *Hirundapus caudacutus* (page 1070)
1-4 Adult; 5 Juvenile

Fork-tailed Swift *Apus pacificus* (page 1081)
6-9 Adult; 10 Juvenile

House Swift *Apus affinis* (page 1090)
11-13 Adult