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Order **PASSERIFORMES**

The largest and most diverse order of birds, commonly called passerines or perching birds, and comprising some 5712 species in 45 families (based on Sibley & Monroe 1990; Sibley & Ahlquist 1990), and well over half the world's known bird species. In the HANZAB region, Passeriformes represented by some 382 species in 39 families. Tiny to large: smallest passerine is Pygmy Tit *Psaltria exilis* of Java, with a total length *c.* 8 cm; largest is Greenland Raven *Corvus corax principalis*, with a total length *c.* 64 cm and weighing up to 1.7 kg. Superb Lyrebird *Menura novaehollandiae* of e. Aust. probably second largest in Order, with a total length (in adult male) of *c.* 103 cm, including tail of *c.* 70 cm, and weight up to *c.* 1.1 kg. Cosmopolitan except Antarctica and some oceanic islands; and occupying all terrestrial habitats.

Overall, Passeriformes are characterized by (based on Raikow 1982; Sibley & Ahlquist 1990; and DAB [=Schodde & Mason 1999]): Palate aegithongnathous (except Conopophagidae [gnateaters]). Intestinal caeca rudimentary. Single left carotid artery (except paired in *Pseudocalyptomena* and possibly other broadbills [Eurylaimidae]). Aftershaft reduced or absent. Neck short, with 14 cervical vertebrae in most, but 15 in Eurylaimidae (broadbills); atlas perforated; metasternum usually two-notched (rarely four-notched). Bicep slip absent. Expansor secundariorum often present (Berger 1956; Raikow 1982; *contra* Beddard 1898; Ridgeway 1901). Pelvic muscles AXY (AX in *Dicrurus* [drongos]). Ambiens absent. Iliofemoralis externus usually absent, but present in some groups as 'developmental anomaly' (Raikow 1982). Tensor propatagialis brevis tendon present. Hypocleideum present (except Menuridae [lyrebirds]). Wings eutaxic. Usually ten primaries, but p10 often reduced or absent; 11 primaries in Menuridae (lyrebirds), most Eurylaimidae (broadbills), most Furnariidae (ovenbirds), and some Passeri (oscines [see below]). Usually nine secondaries (ten in Menuridae [lyrebirds]). Usually 12 rectrices, but from six (*Stipiturus* [Maluridae]) to 16 (Menuridae). Lesser primary and secondary coverts usually reduced or absent (Zeidler 1966; Morlion 1985; Winkler & Jenni 1996), but a few well-developed lesser primary coverts are present in Superb Lyrebird (Morlion 1985). Uropygial preen glands naked. No basipterygoid process. Nasal glands minute. Foot anisodactyl. Hallux incumbent, large and directed backwards; toes 2, 3 and 4 directed forward; digital formula 2–3–4–5. Deep plantar tendons usually of type VII (lacking vinculum), but often type I in Eurylaimidae (broadbills). Spermatozoa bundled with coiled head and large acrosome.

The DNA–DNA hybridization studies of Sibley & Ahlquist (1985a, 1990) revealed much about the relationships within the Passeriformes and resulted in fundamental changes to the higher level taxonomy of passerines, not least to the taxonomy of the Australo-Papuan oscine passerines. Importantly, these studies showed that many elements of the Australo-Papuan avifauna (e.g. the A'asian wrens [Maluridae], robins [Petroicidae], babblers [Pomatostomidae], and so on), represent an endemic radiation of forms that bear an external resemblance to Eurasian families. Many of the findings of DNA–DNA hybridization studies regarding the Australo-Papuan oscines have since been broadly corroborated by studies using protein allozymes (e.g. Christidis 1991; Christidis & Schodde 1991) and microcomplement fixation (e.g. Baverstock *et al.* 1991, 1992), though there are also many points that remain uncertain and many familial relationships within the Passeriformes are unresolved (Christidis & Boles 1994). (For discussion of historical taxonomic arrangements preceding results of DNA–DNA hybridization studies, see BWP, and Sibley & Ahlquist [1985a,b, 1990]).

The Passeriformes divide into two main groups:

SUBORDER TYRANNI (SUBOSCINES): The distribution of the suboscines is centred in the American and Afro-asian Tropics, with a massive radiation in South America (Sibley & Ahlquist 1990; DAB). Suboscines characterized by mesomyodian syrinx, with or without a single pair of intrinsic syringeal muscles (van Tyne & Berger 1976; Campbell & Lack 1985; DAB). Suborder sometimes named Oligomyodi (e.g. Sibley & Ahlquist 1985a,b), Deutero-Oscines (e.g. Morony *et al.* 1975; Voous 1977), or Clamatores (Campbell & Lack 1985). Poorly represented in the HANZAB region: only TYRANNIDAE (tyrant-flycatchers), with two species, both accidental to South Georgia; ACANTHISITTIDAE (NZ wrens), with four species (one extinct) in three genera, endemic to NZ; and PITTIDAE (pittas), with four species in one genus in HANZAB region (three breeding, one accidental). Tyranni formerly included the Menuridae and Atrichornithidae (e.g. Wetmore 1960; Storer 1971), though subsequently shown that these two families should be included in Passeri (e.g. Sibley 1974; Sibley & Ahlquist 1985, 1990).

SUBORDER PASSERI (OSCINES OR SONGBIRDS): Cosmopolitan in distribution. Within the HANZAB region there are 36 families of Passeri. The Australo-Papuan Passeri can be subdivided into several supra-familial groups, but those recognized differ between authors (for further information, see Sibley & Ahlquist 1985, 1990; DAB). Oscines are characterized by acromyodian syrinx, with three or four pairs of intrinsic syringeal muscles (van Tyne & Berger 1976; Campbell & Lack 1985; Sibley& Ahlquist 1990; DAB).

Suborder Passeri comprises the major element of the Aust. and NZ passerine avifauna. The families recorded in the HANZAB region, and the representatives in the region, are (following Christidis & Boles [1994] for Aust., with additional species for wider region added as appropriate):

MENURIDAE (lyrebirds): two species in one genus; endemic to Aust.;
ATRICHORNITHIDAE (scrub-birds): two species in one genus; endemic to Aust.;
CLIMACTERIDAE (A'asian treecreepers): six species in two genera breeding in Aust.;
MALURIDAE (Australopapuan fairy-wrens, emu-wrens and grasswrens): 22 breeding species in three genera in Aust.;
MELIPHAGIDAE (honeyeaters and Aust. chats): 76 species in 26 genera in Aust. and NZ, all breeding;
PARDALOTIDAE (pardalotes, scrubwrens, thornbills and allies): 51 species (one extinct) in 15 genera in HANZAB region, all breeding;
PETROICIDAE (A'asian robins): 23 species in eight genera in HANZAB region, all breeding;
ORTHONYCHIDAE (logrunners): two breeding species in one genus in Aust.;
POMATOSTOMIDAE (A'asian babblers): four breeding species in single genus in Aust.;
CINCLOSOMATIDAE (whipbirds, wedgebills, quail-thrushes and jewel-babblers): eight breeding species in two genera in Aust.;
NEOSITTIDAE (sitellas): single species breeding in Aust.;
PACHYCEPHALIDAE (whistlers, shrike-thrushes and allies): 17 species in seven genera in HANZAB region, all breeding;
DICRURIDAE (monarchs, flycatchers, fantails and drongos): 19 species in seven genera in HANZAB region, all breeding;
CAMPEPHAGIDAE (cuckoo-shrikes, trillers and minivets): eight species (one extinct) in two genera in HANZAB region, all breeding;
ORIOLIDAE (Old World orioles and figbirds): three species in two genera in Aust., all breeding;
ARTAMIDAE (woodswallows, butcherbirds and currawongs): 14 species in four genera in HANZAB region, all breeding;
PARADISAEIDAE (birds of paradise): five breeding species in two genera in Aust.;
CORVIDAE (crows and jays): six breeding species in single genus in Aust. and NZ, including one introduced to NZ;
CORCORACIDAE (Aust. mudnesters): two species in two monospecific genera, endemic to Aust.;
CALLAEIDAE (NZ wattlebirds): three species (one extinct) in three monospecific genera, endemic to NZ;
LANIIDAE (shrikes): two species in HANZAB region, one accidental to Prince Edward Is, the other accidental to Christmas I.;
PTILONORHYNCHIDAE (bowerbirds): ten species in seven genera in Aust. (nine species) and NZ (one species), all breeding; Piopio of NZ probably extinct (Heather & Robertson 1997);
ALAUDIDAE (larks): two breeding species in HANZAB region (including one successfully introduced to Aust. and NZ);
MOTACILLIDAE (wagtails and pipits): eight species in two genera in HANZAB region, only two breeding (one on South Georgia), the rest non-breeding visitors or accidentals;
PRUNELLIDAE (accentors): one species successfully introduced to NZ;
PASSERIDAE (Old World sparrows and A'asian finches): 22 species in nine genera (including four successful introductions) in HANZAB region, all breeding;
FRINGILLIDAE (Old World finches): seven species in four genera in HANZAB region, all introduced except one naturally occurring vagrant to South Georgia;
EMBERIZIDAE (buntings, cardinals, tanagers and allies): two successfully introduced species, occurring NZ and Lord Howe I.;
NECTARINIIDAE (sunbirds and spiderhunters): single breeding species in Aust.;
DICAEIDAE (flowerpeckers): single breeding species in Aust.;
HIRUNDINIDAE (swallows and martins): eight species in four genera in HANZAB region, including four breeding species in Aust. and NZ, one non-breeding visitor and three accidentals;
PYCNONOTIDAE (bulbuls): one successfully introduced species in Aust.;
SYLVIIDAE (Old World warblers): 13 species in eight genera in HANZAB region, including ten breeding species (one extinct) in Aust. and NZ, and three accidental to region;
ZOSTEROPIDAE (white-eyes): seven species (one extinct) in single genus in HANZAB region, all breeding;
MUSCICAPIDAE (Old World flycatchers, thrushes and chats): eight species in six genera in HANZAB region, including five breeding species (two introduced), and four accidentals (including one on Prince Edward Is);
STURNIDAE (starlings and mynas): five species in four genera, four breeding in HANZAB region (including two species successfully introduced, and one species now extinct), and one accidental.

The Aust. oscines fall into two distinct clusters, each with at least three major supra-familial lineages (DAB): One cluster is the Passerida, comprising the Muscicapoidea (including true thrushes and allies), Sylvioidea (true warblers and babblers, and swallows, and others), and Passeroidea (including larks, pipits, sunbirds, flowerpeckers and all finches and their allies). The other cluster is the Corvida, which is centred on the Australo-Papuan region (though its origins are not certain) and which also comprises three main lineages: Menuroidea (lyrebirds, scrub-birds, treecreepers and bowerbirds), Meliphagoidea (A'asian wrens, pardalotes, acanthizid warblers, and honeyeaters), and Corvoidea (A'asian robins, logrunners, A'asian babblers, whipbirds and quail-thrushes, sitellas, whistlers, fantails and monarchs, birds of paradise, butcherbirds and woodswallows, cuckoo-shrikes, Old World orioles, crows and mudnesters).

Throughout this volume, arrangement of families follows that of Christidis & Boles (1994) except that the Meliphagidae precedes the Pardalotidae. This change was made to ensure the Meliphagidae were dealt with in a single volume, rather than split between volumes, and because the switch meant no change to the positioning of Meliphagidae relative to the Pardalotidae (including Acanthizidae), one another's closest relatives, and because there is little overriding evidence of the exact taxonomic positioning of all families within the Meliphagoidea; Sibley & Monroe (1990) also placed the Meliphagidae between the Maluridae and Pardalotidae. However, DAB points out that based on structure of humeral fossa, positioning of Meliphagidae between the Maluridae and Pardalotidae is not correct.

DAB, however, varies from the familial arrangement of Christidis & Boles (1994) in several ways. The main differences are: (1) recognition of Pardalotidae and Acanthizidae as separate families (combined in Pardalotidae in Christidis & Boles); (2) minor rearrangement of the sequence of the families Paradisaeidae–Artamidae–Campephagidae–Oriolidae between the Dicruridae and Corvidae (cf. Dicruridae–Campephagidae–Oriolidae–Artamidae–Paradisaeidae–Corvidae in Christidis & Boles); (3) and use of the more traditional muscicapoid (flycatcher) – sylvioid (warbler) – passeroid (finch) sequence of Sibley *et al.* (1988), Sibley & Ahlquist (1990) and Sibley & Monroe (1990) and much contemporary literature of n. hemisphere, with families in the sequence Muscicapidae–Sturnidae–Hirundinidae–Pycnonotidae–Zosteropidae–Sylviidae–Alaudidae–Dicaeidae–Nectariniidae–Passeridae–Motacillidae–Estrildidae–Fringillidae and noting recognition of the Estrildidae as a separate family (cf. the reversed sequence of Christidis & Boles, as given above, and which submerges the Estrildidae within the Passeridae). For discussion of the reasons for these changes, see DAB (and discussion under these families in future volumes of *HANZAB*).

Arrangement of genera and species within families also follows Christidis & Boles (1994), which was in turn largely based on Schodde (1975) unless there were specific reasons for change. Lastly, with few exceptions, which are discussed in individual species accounts, taxomony of subspecies follows DAB.

Passerines are extremely diverse in body form and plumage, and vary greatly in rates of maturation. Some attain adult plumage within months or weeks of fledging; others can take up to 9 years to attain adult plumage (e.g. Superb Lyrebird). Degree of sexual dimorphism also varies greatly: some monomorphic, others vary in either size, plumage or both. Common pattern of annual moult is a single complete post-breeding (pre-basic) moult, but some groups (e.g. Maluridae) or species (e.g. Banded Honeyeater *Certhionyx pectoralis*) also undergo a partial pre-breeding (pre-alternate) moult annually. Moult of primaries usually outward. Secondaries moult from innermost and outermost toward s5. Moult of tail usually centrifugal (outward from centre). Young altricial, nidicolous and dependent on adults for food; usually hatch with sparse to very sparse covering of down, mainly on dorsum; Menuridae (lyrebirds) have heavy natal down. Juvenile plumage usually duller than adult, and in many sexually dimorphic species, often similar to that of adult female.

There are few common features of food, feeding behaviour, social organization and behaviour, voice or breeding in such a large and diverse group of birds.

Volant; extinct Stephens Island Wren *Traversia lyalli* probably the only flightless passerine (Millener 1988). Movements vary greatly: some species long-distance migrants (e.g. Barn Swallow *Hirundo rustica*, Nightingale *Luscinia megarhynchos* and many Old World warblers, such as *Acrocephalus* and *Locustella*, breed in temperate Palaearctic and migrate to Africa or Indian subcontinent [BWP]; Acadian Flycatcher *Empidonax virescens* breeds North America and migrates to South America [Ridgely & Tudor 1994]), others sedentary in small territories (e.g. Cactus Wren *Campylorhynchus brunneicapillus* of sw. USA and Mexico [Ricklefs 1975; Ehrlich *et al.* 1988]). In HANZAB region, movements also vary widely: e.g. Yellow-faced Honeyeater *Lichenostomus chrysops* regular annual migrant in parts of e. Aust.; Rifleman *Acanthisitta chloris* of NZ sedentary in small territories. In Aust., movements often poorly known and unstudied; many species often said to be nomadic, with such claims often based on no or very poor knowledge of actual movements and based only on apparently irregular occurrence in an area (see General Introduction [Movements] for fuller discussion of this point).

Arboreal or terrestrial or both; some strictly arboreal (e.g. Hirundinidae), others strictly terrestrial (e.g. Menuridae, Pittidae); most combine both arboreal and terrestrial foraging to varying degrees, but usually with one predominating. Feed on almost all known food, from plant material to vertebrate animals, but most show some specialization for certain food, such as feeding on nectar (Nectariniidae), seeds (Passeridae), fruit (Zosteropidae), small vertebrates (Artamidae) and, commonly, insects (e.g. Maluridae, Pardalotidae, Petroicidae and others). Mostly feed by gleaning and probing, including probing flowers for nectar; and other substrates for invertebrates; also feed by sallying, including various sallying techniques (sally-hovering, sally-striking and sally-pouncing), each suited for one group of prey, particularly moving animals.

In passerines, parental care in both sexes is well developed. However, a few species are parasitic, e.g. cowbirds *Molothrus* (Campbell & Lack 1985). Young are dependent on parents for food. Young beg by gaping, typically exposing brightly coloured inside of mouth, often with contrasting pale or dark spots; in non-passerines, bright gape present only in hoopoes (Upupidae), mousebirds (Coliiformes) and cuckoos (Cuculiformes) (BWP). See Boles & Longmore (1985) for descriptions of colours and markings inside the mouths of some Aust. passerines.

Anting is a highly specialized behaviour: ants are held in the bill and applied to the plumage, usually to the underside of the wing-tip (direct or active anting, or ant-application), or ants are allowed access to the plumage (indirect or passive anting, or ant-exposure), or both, e.g. anting recorded in Regent Honeyeaters *Xanthomyza phrygia* in HANZAB region, with bird then seen eating ant. Thought to be unique to Passeriformes (e.g. Simmons 1966; Campbell & Lack 1985; BWP). Suggested this may be comfort behaviour related to maintenance of feathers, by perhaps reducing ectoparasite load, removing stale or excess lipids, or adding supplementary essential oils (Campbell & Lack 1985); some secretions of ants are antibiotic, inhibiting growth of both fungi and bacteria, and the secondary acquisition of these antibiotic secretions would be an important advantage of anting (Ehrlick et al. 1986).

Other behavioural characters include head-scratching indirectly (or over the wing) in most families, with the foot brought up above the lowered wing. Head oiled indirectly, as seen in most taxa, but passerines also oil head by head-scratching, in which bird oils the bill directly, then transfers the oil first to one foot by scratching the bill, and then to the head by scratching the head with foot. To oil the undersurface of the wings, use bill or bill and head together, extending one wing at a time sideways and forward, carpus uppermost, and often alternating rapidly from one wing to the other. The stretching of one wing as a comfort movement seems common to all birds, but in passerines it is often accompanied by sideways fanning of tail. After both wings are stretched, passerines often give a two-leg stretch as they straighten the tarsal joints and lift the body. Heat is dissipated by gaping and panting (not by gular-fluttering, so far as known) (Campbell & Lack 1985; BWP). Bathing widespread, mainly by standing in shallow water, but some groups jump into and out of water repeatedly, or flight- or plunge-bathe, while others bathe only or mainly in rain or among wet foliage; for further details of bathing, see Campbell & Lack (1985). Passerines do not flap wings in the manner of non-passerines to dry, but perform various shaking movements, as well as preening (Campbell & Lack 1985). Dusting confined to only a few groups, but sunning, both for gaining heat (sun-basking) and other purposes (sun-exposure), is widepread, and of two distinct types: (1) lateral posture, in which sunning bird squats or sits down, usually on ground, and leans to one side exposing the flank or the 'sun-wing', which has been lowered and partly unfolded, and the fanned tail, which has been brought round to the same side; and (2) spread-eagle posture, in which bird squats or lies flat with both wings open and tail fanned (details in Campbell & Lack 1985; Simmons 1986).

There is a high incidence of co-operative breeding in Aust. and NZ, and it is especially common and well-studied in the Maluridae but is more widely recorded, including within the Acanthisittidae, Meliphagidae, Petroicidae, Pomatostomidae and Corcoracidae (see Dow 1978, 1980; Brown 1987; Ford 1989; Rowley & Russell 1997).

In vocal abilities, species of Passeriformes are more accomplished than those of any other order, but songs may be simple or highly complex, and repertoires small or large. Mimicry of calls of other species is practised by many species; c. 15% of Australian passerine species have been reported to mimic (Marshall 1950). The Superb Lyrebird and the Tui *Prosthemadera novaeseelandiae* have been classed among the best seven of the world's songsters (Hartshorne 1973). Oscines, or songbirds, have specialized forebrain song nuclei, and, through auditory feedback, learn their songs from those of adults, in much the same way as human young learn their spoken language from adults. In contrast, the songs of suboscines are relatively simple (like the non-learned call-notes of songbirds), repertoires are small, geographical variation is minimal, and development of song appears to take place without any imitative or feedback process. Some oscine species use vocal learning to generate large song repertoires and may vary them geographically, even locally. Other oscine species forgo these possibilities and have song repertoires more like those of suboscines; how the learning process maintains stereotypy of song over the range of such species is a mystery (Kroodsma 1996).

Apart from the five families discussed hereunder, syringeal structure of passeriform species of our area is similar, there being four pairs of intrinsic muscles. Pittidae have no intrinsic muscles (Ames 1971); calls are mostly loud strong whistles (Pizzey 1980). Acanthisittidae also have no intrinsic muscles, but the presence of a well-developed drum (fusion of posterior tracheal elements) suggests they may have once been present; vocal repertoire is not great (Ames 1971). Menuridae and Atrichornithidae have similar syringeal structures, with three pairs of intrinsic muscles; songs are highly developed, and there can be much mimicry (Ames 1971). Climacteridae, with four pairs of intrinsic muscles, exhibit gross asymmetry of the extrinsic muscles, unusual directions of muscle fibre in the intrinsic muscles, and an exceptionally robust sternotracheal muscle (Ames 1987); calls are brisk, sharp and piping (Pizzey 1980).

Extended tracheae are found in the genus *Manucodia* (Paradisaeidae), the calls of which are deep, loud or far-carrying (Frith 1994). In the only species occurring in our area, the Trumpet Manucode *M. keraudrenii*, the trachea forms a flat coil between the skin and the pectoral muscles, sometimes extending over the abdominal muscles as well, and may be up to 828 mm in length, compared with body-length, from bill to pygostyle, of c. 150 mm (Ames 1971; Clench 1978).

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Family **HIRUNDINIDAE** swallows and martins

A fairly large family of familiar and morphologically similar small to medium-sized insectivorous passerines, adapted to aerial feeding, with distinctive slender bodies, short necks, long pointed wings, short broad bills, small weak feet and, often, deeply forked tails. The family comprises 83–89 species in 14–20 genera, and is cosmopolitan in distribution other than polar regions and many oceanic islands, occurring throughout Europe, most of Asia, including the Indian subcontinent, Africa, A'asia, islands of the sw. Pacific Ocean, and N., central and S. America (Turner & Rose 1989; Sibley & Monroe 1990; Monroe & Sibley 1993; Turner 2004; Sheldon *et al.* 2005). Nine, and possibly ten, species in four genera recorded in HANZAB region. Some early authors associated swifts (Apodidae) and swallows (see Sibley & Ahlquist [1990] and *HANZAB* 4 for discussion). Sharpe (1885) first termed the family Hirundinidae, and this has been maintained since. Opinion concerning nearest relatives varies. Sharpe (1885) thought Old World flycatchers (Muscicapidae) to be nearest relatives. Several authors (Stresemann 1927–34; Mayr & Amadon 1951; Bock 1962; Voous 1977; Peters) place swallows immediately after larks (Alaudidae) at the beginning of the oscine sequence. Berndt & Meise (1953) placed Hirundinidae between white-eyes (Zosteropidae) and waxwings (Bombycillidae). Beecher (1953) suggested affinities with Old World flycatchers and true thrushes (Muscicapidae) and starlings (Sturnidae) based on jaw musculature. Sibley (1970) suggested affinities with sylviid warblers (Sylviidae) and Muscicapidae based on electrophoresis of egg-white proteins. Wolters (1975–82) placed them after starlings at the end of the passerine sequence. DNA–DNA hybridization studies (Sibley & Ahlquist 1982, 1990) indicate swallows and martins are a distinctive group with no particularly close relatives. They are, however, part of the superfamily Sylvioidea, a major lineage of oscine passerines that includes the true warblers, Old World babblers, white-eyes, nuthatches, tits and bulbuls among others. Sibley & Ahlquist (1982) indicate that swallows and martins shared a common ancestor with sylviid warblers and Old World babblers, the divergence occurring *c*. 50 million years ago. More recent analyses based on nuclear DNA-sequences (Barker *et al.* 2004) supports Hirundinidae being part of the sylvioid lineage of songbirds.

The following two subfamilies are recognized by most authors (Turner & Rose 1989; Sibley & Monroe 1990; Monroe & Sibley 1993; Turner 2004; Sheldon *et al.* 2005): **PSEUDOCHELIDONINAE** (river-martins): Two species in single genus *Pseudochelidon*: African River-Martin *P. eurystomina* of Zaire; and White-eyed River-Martin *P. sirintarae* of Thailand; and **HIRUNDININAE** (typical swallows): Comprising 81–87 species in 13–19 genera, with cosmopolitan distribution. Nine species in four genera accepted for HANZAB region, seven of which, in two genera (*Hirundo, Delichon*), recorded in Aust. Pacific Swallow *Hirundo tahitica* possibly also occurs in Aust., but no formally accepted records of the species as yet (Christidis & Boles 1994; BARC). Red-rumped Swallow combined here with *Hirundo*, but often considered as *Cecropis*. Tree *H. nigricans* and Fairy *H. ariel* Martins also combined here with *Hirundo*, but often considered as *Petrochelidon* (see below for discussion).

Taxonomic relationships between genera within typical swallows (Hirundininae) were first clarified by Mayr & Bond (1943) who defined the following ten groups, based mainly on construction of nests and patterns of plumage (with number of species currently recognized following Turner [2004]): (1) **PHEDINA** (one species in w.-central Africa, and one in Madagascar and on Mascarene Is); (2) **SAND MARTINS** *Riparia* (five species, four with Afro-Asian distribution and one also in Americas); (3) **MUD-NESTING SWALLOWS**, comprising barn swallows *Hirundo* (14 species, cosmopolitan), crag martins *Ptyonoprogne* (three species, distributed in Africa and Eurasia), red-rumped swallows *Cecropsis* (seven species, distributed in Africa and Eurasia, one species reaching Australo-Papuan Region), cliff swallows *Petrochelidon* (11 species, distributed through much of Africa, the Americas, India, e. Lesser Sundas and Australo-Papuan region), and house martins *Delichon* (three species, with Afro-Asian distribution, one species reaching HANZAB region); (4) **WHITE-BACKED SWALLOW** *Cheramoeca leucosternus* (endemic to Aust.); (5) **GREY-RUMPED SWALLOW** *Pseudhirundo griseopyga* (endemic to Africa); (6) **AFRICAN SAW-WINGS** *Psalidoprocne* (five species, Africa); (7) **ROUGH-WINGED SWALLOWS** comprising *Stelgidopteryx* (two species in Americas), *Alopochelidon* (one species in S. America) and *Neochelidon* (one species in S. America); (8) **ATTICORA GROUP**, of the Americas, comprising *Notiochelidon* (four species in central and S. America, including Blue-and-white Swallow *N. cyanoleuca* which sometimes placed in monotypic genus *Pygochelidon*), *Haplochelidon* (one species, S. America) and *Atticora* (two species, S. America); (9) **TREE SWALLOWS** *Tachycineta* (nine species, the Americas); and (10) **AMERICAN MARTINS** *Progne* (nine species, the Americas). These genera and groupings are largely supported by molecular analyses, but the New World rough-winged swallows and Neotropical *atticora* group form a monophyletic cluster, with *Tachycineta* probably forming a sister-group to these (Sheldon *et al.* 2005). Several authors (Turner & Rose 1989; Sibley & Monroe 1990; Christidis & Boles 1994) do not recognize *Cecropis* or *Petrochelidon*, instead combining these with *Hirundo*; we follow their treatment here, but accept that the rigorous DNA-sequencing studies of Sheldon *et al.* (2005) provide empirical evidence for accepting *Cecropis* and *Petrochelidon*. Several other authors also accept latter two genera (Mayr & Bond 1953; Sheldon & Winkler 1993; Dickinson & Decker 2001; Turner 2004;

DAB). Basal relict lineages include White-backed Swallow, Grey-rumped Swallow and river martins, with disjunct distributions in Africa and Aust. (Sheldon *et al.* 2005).

Size varies from small (e.g. Fairy Martin: total length 11–12 cm, weight 9–14 g; and White-thighed Swallow *Neochelidon tibialis*: total length 12 cm, weight 10 g) to medium-sized (e.g. Purple Martin *Progne subis*: total length *c.* 19 cm, weight 48–64 g; and Mosque Swallow *Hirundo senegalensis*, total length *c.* 24 cm, weight 38–54 g). In HANZAB region, smallest is Fairy Martin and largest is migrant Barn Swallow *Hirundo rustica* (total length *c.* 18 cm, weight 16–24 g) or Red-rumped Swallow (total length 16–17 cm, weight *c.* 33 g). Species in the family share the following morphological characteristics (summarized from Beecher 1953; Bock 1962; Warner 1972; Moreno 1986; Turner & Rose 1989; Turner 2004; BWP; DAB): Body slender. Neck short. Wings long and pointed at tips. Ten primaries, with outermost (p10) vestigial; p9 often longest; two genera, *Stelgidopteryx* and *Psalidoprocne*, unique in having series of fine serrations (barbules) along outer edge of outer primaries. Nine secondaries, including three tertials. Tail varies from short and rather square or slightly notched at tip (e.g. cliff swallows, including Fairy and Tree Martins) to rather short with obvious fork or deep notch at tip (e.g. *Progne* and *Riparia* martins) or long and deeply forked, with elongated outermost rectrices (e.g. most *Hirundo* swallows); one species, White-eyed River Martin, is unique in having highly elongated central rectrices. Bill short, broad and flattened; tomia notched near tip. Nares usually operculate, but semi-operculate in house martins (*Delichon*) and red-rumped swallows (*Cecropis* [here considered *Hirundo*]), and non-operculate in cliff swallows; nostrils usually lateral slits, but sunken rounded apertures in cliff swallows (including Tree and Fairy Martins). Gape broad. Rictal bristles present, but usually vestigial. Loral feathering directed forward to act as lens shade for eyes; act under muscular control. Tongue broad, tapering to short, bifid tip. Legs and feet short; foot musculature rather weakly developed; front toes nearly united at base. Tarsus sharply ridged at rear (acutiplantar); tarsal scaling laminiplantar. Tarsi and toes usually naked, but partly or nearly fully feathered in some species (e.g. house martins). Claws rather strong. Jaw musculature distinctive, with enlarged protrators allowing bill to be opened widely. Syrinx unique among passerines, having complete bronchial rings (except in subfamily Pseudochelidoninae which have large syrinx with half bronchial rings and large internal membrane running length of bronchial tubes). Humerus short with single pneumatic fossa at head and vestigial second tricipital fossa. Maxillo-palatine processes pin-like. Double ectethmoid foramina. Aust. species have multiple orbital perforations at front of cranium. Temporal fossae narrow.

Following summarized from Turner & Rose (1989) and Turner (2004). Upperparts typically glossy, blackish, dark bluish or dark greenish, and underbody pale, often with dark streaking; some species (e.g. rough-winged swallows, crag martins) have much duller, brownish plumage, while others (e.g. some African saw-wings) have uniformly blackish plumage. Many species (e.g. red-rumped swallows, Tree and Fairy Martins) have contrasting colour to rump–uppertail-coverts or forehead or both. Many species have white markings, such as patches or spots, on rectrices. A few species (e.g. White-backed Swallow) have distinctive pattern to head and upperbody. Bare parts typically blackish or grey in adults. Sexes usually alike in plumage, but in some species (e.g. *Progne* martins) female duller; adult male *Hirundo* have longer, more deeply forked tails than adult females. Nestlings mostly naked at hatching, with a few patches of down; denser down develops after *c.* 1 week. Nestlings lack markings of mouth or tongue. Fledge in juvenile plumage, which is usually duller and less glossy than that of adults, and usually also have shorter, less deeply forked tails (particularly in *Hirundo*). Nestlings and juveniles of most species have swollen yellow gapes. Usually undergo a complete post-juvenile (first pre-basic) moult to adult (definitive basic) plumage, but a few species (e.g. Tree Swallow *Tachycineta bicolor*) acquire a distinct, brownish first immature (first basic) plumage in this moult. Adults usually undergo one complete post-breeding (pre-basic) moult annually, with no change in appearance; in migratory species (e.g. Barn Swallow), moult usually starts on wintering grounds, but sometimes (e.g. Collared Sand Martin *Riparia riparia*) starts on breeding grounds and is then suspended till arrival on wintering grounds. A few species (e.g. Asian House Martin *Delichon dasypus*) also undergo a partial pre-breeding (pre-alternate) moult, involving mainly feathers of head and body, and resulting in breeding plumage that usually appears little or no different from non-breeding plumage; sometimes pre-breeding and post-breeding moults overlap. Primaries moult outward, starting at p1; moult usually slow. Moult of secondaries inward; moult of tertials starts with central feather. Moult of tail centrifugal, usually starting during early stage of, or about halfway through, moult of primaries. Moult of body usually starts at about same time as moult of primaries.

Habitat usually includes open areas suitable for aerial foraging for insects. Generally found over open or sparsely wooded areas, and often near or over water (e.g. Pale Martin *Riparia diluta*), though sometimes inhabit open areas well away from water (e.g. Red-rumped Swallow in its wintering ranges in Africa and India). Often use open modified habitats, such as farmland (e.g. Grey-rumped Swallow), roadsides, airstrips and sewage ponds (e.g. Red-throated Swallow *Hirundo rufigula*). Also commonly over grassland, savanna and at edges of woodlands or forests (e.g. saw-wings *Psalidoprocne*). Often near settlement including residential areas, though densely built-up areas often avoided. Densely wooded habitats mostly avoided, but some species occur over forests (e.g. Pacific Swallow and Asian House Martin). Roost and nest in sand, dirt or gravel banks (e.g. Collared Sand Martin), crags, cliffs and caves, or artificial structures, such as culverts, bridges and buildings (e.g. Eurasian Crag Martin *Pytonoprogne rupestris*). Found from sea level to *c.* 4000 m asl. In Aust. and NZ, mostly over open habitats, including farmland, airfields, grasslands, coastal areas, and wide range of wetlands; less often in or over mangroves and open woodland; some species associated with more heavily treed dry and wet eucalypt forests and rainforest, often at edges or clearings such as those created by logging (e.g. Tree Martin and Welcome Swallow *Hirundo neoxena*). Also common round settlements and cities (Heinzel *et al.* 1977; King *et al.* 1978; AOU 1998; Coates 1990; Keith *et al.* 1992; Ridgely & Tudor 1994; Orn. Soc. Japan 2000; Robson 2000, 2002; Turner 2004; BWP; see species accounts).

Many highly migratory. Extralimitally, range from sedentary or resident (e.g. Nepal House Martin *Delichon nipalensis*), predominantly resident with altitudinal movements (e.g. Eurasian Crag Martin, Black Saw-wing *Psalidoprocne pristoptera*), partly migratory (e.g. Blue-and-white Swallow) to total long-distance migrants (e.g. Barn Swallow). Several species more sedentary at lower latitudes, and migratory at higher latitudes (e.g. Red-breasted Swallow *Hirundo semirufa*, Lesser Striped Swallow *H. abyssinica*, Grey-breasted Martin *Progne chalybea*). This trend reflected across family as a whole, with tropical or subtropical breeding species more likely to be sedentary or resident (e.g. Congo Sand Martin *Riparia congica*) though many of these make local seasonal movements (e.g. Brazza's Martin *Phedina brazzae*), and most others, especially Holarctic breeding species, making at least some movement away from higher latitudes during winter (e.g. Collared Sand Martin and Northern House Martin *Delichon urbicum*). In HANZAB region, breeding species resident (White-backed Swallow) to partly migratory, with strong N–S pattern of movements (e.g. Tree Martin); Barn Swallow a regular non-breeding visitor to n. Aust. and vagrant elsewhere, mainly Sept.–Apr. (de Schauensee 1970, 1984; AOU 1998; Keith *et al.* 1992; Robson 2000; Griffioen & Clarke 2002; Turner 2004; BWP; see species accounts).

Aerial insectivores. Diet consists almost entirely of flying insects, but other invertebrates (e.g. spiders, small crustaceans) eaten occasionally, and a few species also take fruit or seeds in autumn–winter when insects scarce; other matter, such as gravel, shell fragments and pieces of fish bone, are also ingested. Most prey taken in flight by screening or sallying; usually involves pursuit of aerial prey, but items may also be snatched from surface of water or other substrates. When chasing aerial prey, use one of two general methods: (1) for agile prey, flight is rapid and involves much banking and turning; (2) for less manouvreable prey, which often occur in swarms, flight punctuated by gliding and fluttering. Also forage occasionally by sally-hovering; and sometimes seen hovering or fluttering in vegetation to flush insects. Despite preference for aerial feeding, food sometimes gleaned on ground or while perched, usually in adverse weather (when few insects in flight) or when non-aerial prey abundant. Foraging heights vary between species according to location of preferred prey items, but all species tend to feed at low levels in poor weather, when insects are scarce at higher altitudes (see above). Opportunistic; readily attend sites that attract insects or provide rich sources of prey (e.g. frequent fires, and associate with livestock or tractors ploughing fields to take advantage of flushed insects). Forage selectively: usually seek largest prey available, though all species take some smaller prey, and some (e.g. Northern House Martin, Red-throated Swallow *Hirundo rufigula*, Cliff Swallow *Hirundo pyrrhonota*) specialize on small prey; and generally avoid stinging insects. Many species forage singly or in pairs during breeding season; otherwise, forage in flocks that can be quite large at sites where food abundant. Drink regularly, by dipping bill into water while flying low over surface of creeks, lakes, rivers or the like (Keith *et al.* 1992; Turner 2004; BWP; see species accounts).

During breeding season, most species usually seen singly, in pairs, or in small flocks, but some gregarious when breeding (e.g. Collared Sand Martin *Riparia riparia*). When not breeding, most are gregarious, with some species occasionally gathering in large flocks of hundreds of thousands, especially near roosting sites (see below). Nearly all socially monogamous, but extra-pair copulation common. Some Tree Swallows occasionally polygynous. In most species, pair-bonds usually last only for duration of breeding season. Incubation by both sexes in some species, but only by female in others. Both sexes feed nestlings and fledgelings. Many species defend only nest and its immediate vicinity, but some species highly territorial and defend large all-purpose territories (e.g. Mangrove Swallow *Tachycineta albilinea*). Many nest solitarily, but some colonial. In colonial species, colonies vary greatly in size from just a few individuals, up to colonies of thousands (e.g. Cliff Swallow). Some colonial species build nests so close as to be in contact with those of neighbours (e.g. Streak-throated Swallow *Hirundo fluvicola*). Many species roost communally, but at start of breeding season, pair often roost at nest-site, and when nest active, female often roosts in nest. Flocks of some species perform spectacular aerial manoeuvres when flying to and from communal roosts, and sometimes large communal roosts consist of more than one species. Swallows and martins spend much time maintaining plumage. Often perch and preen after foraging in early morning and late evening, and often scratch both while perched and in flight. Scratch head indirectly. Usually bathe by skimming over water and briefly hitting surface to splash themselves, but occasionally wade into shallow water. Often also sunbathe. At start of breeding season, males usually choose a nest-site which they defend from other males. Threat displays often include calling and sometimes ruffling of feathers of head or vibrating of wings. Also lunge at or chase intruders, sometimes resulting in fights. Fights between males can be rather violent, with combatants beating each other with wings, pecking each other, pulling out feathers or grappling with feet. Once paired, both members of pair aggressively defend nest-site. In order to attract female, male usually sings in front of chosen nest-site, and in some species, male also performs visual displays, e.g. male Purple Martins fly up, circle over site and then dive back down and enter hollow. In some other species (e.g. Cliff Swallow), courtship behaviour almost lacking apart from singing, and the pair do little more than tolerate each other at the nest-site. Pair-formation usually occurs at nest-site when female accepts a site that has been chosen and defended by a male. Copulation often occurs in or near nest, and is sometimes preceded by a short invitation display (Keith *et al.* 1992; Taylor 2004; BWP).

Song usually consists of a series of twittering or grating notes. Also utter variety of other calls, including alarm calls, contact calls, aggressive calls, submissive calls, copulation calls and begging calls. Often also produce non-vocal sounds, such as bill-snapping and fluttering or swishing sounds made by wings (Keith *et al.* 1992; Taylor 2004; BWP).

Socially monogamous, but extra-pair copulation common; rarely polygynous. Most species nest solitarily or in loose groups, but some are colonial, and colonies of some species (e.g. Cliff Swallow) may contain thousands of pairs (see above). **SEASON:** In temperate regions, breed mainly in late spring and summer, though season sometimes longer, e.g. Welcome Swallow recorded breeding throughout year in parts of Aust. Season shorter at higher latitudes (where laying may not begin till early summer), but can extend throughout year in tropics and subtropics; sometimes with peaks during rains. Breeding can also follow rains in arid regions. Breeding potential of some species may be limited by lack of mud for nests, particularly during extended dry periods or drought. **SITE:** Species that nest in pre-existing holes, or in burrows that they excavate themselves, use sites such as tree-hollows, termitaria, crevices in cliffs and caves, burrows in banks and cuttings, holes in artificial structures, and nest-boxes. Others build mud nests (see below), attached to trees, riverbanks, cliffs and caves, and a multitude of artificial structures, including bridges, culverts, wells, dams, mine shafts and exteriors and interiors of buildings. Use of unusual sites, generally artificial, is not uncommon in some species. Nests usually placed some distance above ground or often above water, and mud nests often built just beneath overhead cover. Nest-sites, especially mud nests, commonly re-used. Some species, such as Purple Martin, may usurp nests of other hirundines. **NEST, MATERIALS:** Nesting burrows comprise an entrance-tunnel, sometimes >1 m long, with an enlarged nest-chamber at the end. Mud nests vary in form, from open cups or half-cups to retort- or bottle-shaped structures with entrance spouts. Structure of mud nests often varies according to nest-site, e.g. nests of Welcome Swallow cup-shaped on horizontal surfaces, and usually half-cup if fixed to vertical surface or built in angle; when nesting in crevices, some species (e.g. South African Swallow *Hirundo spilodera*) simply add mud to reduce diameter of entrance to nest and to create tunnel. Most mud-nesting species build nests from pellets of pure mud, but some mix mud with grass, rootlets or other material. Both nesting burrows and mud nests have bowl-shaped lining, most commonly of grass, rootlets, leaves, twigs, hair and feathers. Nesting materials (including mud) sometimes stolen from nests of conspecifics. Both sexes build, which can take several days or several weeks. **EGGS:** Varyingly oval or subelliptical, usually smooth and somewhat glossy. Typically white and unmarked, though in some mud-nesting species, eggs spotted and blotched with reddish, brownish, grey or purple markings, usually concentrated at large end. Size of eggs does not vary substantially between smaller species (e.g. Blue-and-white Swallow, 17.2 × 12.5 mm, 1.4 g) and larger ones (e.g. Purple Martin, 24.3 × 17.4 mm, 4.1g). **CLUTCH-SIZE:** In tropics, usually two or three. In temperate regions, typical range 3–6, and in many species, clutch-size usually 4–5; clutches of 1–2 or 7–8 recorded occasionally, but may result from disruption of laying or egg-dumping. Clutch-size declines as breeding season progresses; and, in widely distributed species, tends to be smaller at lower latitudes. **LAYING:** Eggs laid early in morning, usually on successive days. Some species (e.g. Purple Martin, Cliff Swallow) engage in egg-dumping. Some species (e.g. Cliff Swallow) usually rear one brood per season, while others (e.g. Barn Swallow) often rear two, or sometimes three; multiple broods occur most commonly in lower latitudes. **INCUBATION:** By both sexes or, in some species, by female only. Begins with last or penultimate egg when by female only, and usually before penultimate egg when by both sexes. Incubation period in most species 14–18 days, but ranges from 10 to 21 days. **YOUNG:** Hatch over 1, 2 or sometimes 3 days. Nestlings usually fed by both parents, often almost equally; in cases of polygyny, one brood occasionally fed by female parent only. Helpers may also feed young in some species (e.g. Barn and Welcome Swallows). Nestlings usually brooded by both parents. Adults remove or swallow faecal sacs for *c.* 1 week after hatching. **FLEDGING TO INDEPENDENCE:** Fledging period usually 3–4 weeks. Fledging usually synchronous, with entire brood usually fledging on same day or within 24 h (and sometimes much less), but broods occasionally leave over >1 day. Young return to nest often during day, and roost in nest at night, for several days, and sometimes several weeks, after fledging. Both sexes feed fledgelings. Young dependent on adults for 1–4 weeks after fledging. **SUCCESS:** Causes of breeding failure include extreme or adverse weather, and depredation of nests by a variety of avian, reptilian, mammalian and even invertebrate predators. Nests also susceptible to infestation by a wide variety of blood-sucking and other parasites, which can reduce breeding success (Keith *et al.* 1992; Turner 2004; BWP; see species accounts).

Seven species considered globally threatened. White-eyed River Martin of Thailand, discovered only in 1968, is critically endangered, mainly as a result of loss and degradation of habitat at their unknown breeding sites and wintering grounds, exacerbated by hunting and trapping at roosting sites. Six other species considered vulnerable: Bahama Swallow *Tachycineta cyaneoviridis* (Bahamas), Golden Swallow *T. euchrysea* (Jamaica, Haiti, Dominican Republic), Galápagos Martin *Progne modesta* (Galápagos), Peruvian Martin *P. murphyi* (Peru, Chile), Blue Swallow *Hirundo atrocaerulea* (e. Africa), and White-tailed Swallow *H. megaensis* (Ethiopia) (Stattersfield & Capper 2000; BirdLife International Species Factsheets, available at http://www.birdlife.org/datazone/species/index.html [accessed Sept. 2005]).

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Hirundo neoxena Welcome Swallow

COLOUR PLATE FACING PAGES 1529, 1560

Hirundo neoxena Gould, 1842, *Birds Aust.* pt. 9: pl. 13 and text in vol. 2 — the whole of the southern portions of Australia ... Van Diemen's Land = Tasmania.

Gould (1842) confirmed the Welcome Swallow had been so called 'from the circumstance of its appearance throughout the whole of the southern portion of Australia being hailed as a welcome indication of the approach of spring and its arrival there associated with precisely the same ideas as those popularly entertained respecting our own pretty swallow in Europe' (Greek **νεο**, welcome, and **ξένος**, a guest).

OTHER ENGLISH NAMES Swallow or Australian, Australian Welcome, House or Pacific Swallow.

POLYTYPIC Nominate *neoxena*, se. Aust., Tas. and islands in Bass Str., W to head of Great Aust. Bight and N to s. L. Eyre and n. Murray–Darling R. Drainage Basins, and along e. coast to Rockingham Bay, Qld, Lord Howe and Norfolk Is, and NI, SI and Stewart I., NZ, straggler to Kermadec and Chatham Is, wintering throughout e. Aust. N to C. York Pen. and Torres Str. islands; *carteri* (Mathews, 1912), sw. Aust., N to North West C., WA, NE to upper reaches of Murchison R. Drainage Basin, WA, and E to round head of Great Aust. Bight, wintering N through all Pilbara, WA, to sw. Great Sandy Desert.

FIELD IDENTIFICATION Length 16 cm (14–16); wingspan 28 cm (26–31); weight 15 g (9–20). Familiar and common swallow with rounded head, small bill and wide gape, short neck, slim body, long, broad, pointed wings and deeply forked tail. Sexes similar, but female has slightly shorter tail-streamers with slightly smaller white spots. Juveniles separable (see below); moult into adult plumage. Slight seasonal variation, due to wear of feathers; birds in fresh plumage have bright glossy sheen to upperparts and bright-rufous throat. Little geographical variation (see Plumages). **Adult male** Forehead and forecrown, rufous, forming broad, oval, reddish forehead-patch, appearing red in bright light; hindcrown and nape, blue-black, sharply demarcated from forecrown. Lores, black, merging with hindcrown, and extending past eye, through upper ear-coverts to upper sides of neck, forming black eye-stripe; lower ear-coverts and lower sides of neck, rufous. Hindneck, and rest of upperbody, glossy blue-black, concolorous with nape. Uppertail mostly glossy blue-black, with series of white spots, hidden when tail closed (see undertail for full description of spotting); outer tail-feathers, attenuated *c.* two-thirds along feather, forming narrow and elongated tail-streamers. Upperwing, black, glossy blue-black on marginal and median secondary coverts, brownish black on rest. Chin and throat, rufous, forming large rufous throat-patch, concolorous with lower ear-coverts, and extending onto upper breast; appears reddish in bright light, wearing to paler rufous. Some birds have narrow, crescent-like black band at sides of breast separating rufous of upper breast from light brownish-grey lower breast; very rarely, this band extends towards centre of breast and forms complete, but very narrow, black breast-band bordering lower edge of rufous upper breast; a few birds lack any black at sides of breast but have diffuse small black patch in centre of upper breast. Lower breast, centre of belly and flanks, light brownish-grey on flanks and lower breast, often grading to off-white on centre of belly. Undertail-coverts, grey with black chevron-shaped subterminal markings and white fringes to feathers. Undertail, dark grey with series of white spots or patches on inner webs of each feather, aligning to form white V-shaped bar two-thirds down tail; spots or patches increase in size outward, usually roughly oval on t2–t4, and varying on t5–t6, but markings usually elongated along central part of inner web, just short of where feather attenuates into streamer; t6 has largest white patch, either diagonal patch from shaft across to inner edge or white stripe along inner edge; close views of undertail needed to assess size and shape of white markings. Underwing-coverts, light grey with slight rufous suffusion, diffusely mottled darker on outer edge of primary coverts; remiges, dark grey, forming distinct broad dark trailing edge to wing. Bill, black; iris, blackish brown; orbital ring, black; legs, black. **Adult female** Very similar to male and difficult to distinguish in field; tail-streamers average shorter than male, and white patches on outermost rectrices tend smaller, but these differences best seen when alongside male. Birds in moult and young males with slightly shorter outer rectrices further complicate distinguishing sexes. **Juvenile** Similar to adult, but generally duller. Distinguished from adult by: lack of distinct oval forehead-patch, with rufous much less extensive and confined to base of forehead, forming diffuse supercilium that extends to just behind eye (not extending onto upper forehead or forecrown); coloration duller rufous, appearing less solid, and often mottled black on upper edge. Top of head, neck and upperbody, brownish black, with slight bluish gloss; wears to paler dark-brown, lacking gloss. Tail much shorter than adult with much shallower fork, less than half that in adult; outer tail-feathers much less attenuated, forming short, blunt extensions (*c.* 1 cm long) to outer feathers (not streamers). Upperwing as adult, but brownish black, wearing to dark brown; less glossy blue-black on marginal and median secondary coverts (gloss lost with wear); tertials have small, neat, whitish or cream spots or fringes at tips; tips lost with wear, and worn juveniles have uniform upperwing. Underparts as adult, but throat-patch paler rufous or dull brown, wearing to pale brown or pale buff, and undertail-coverts, grey with pale-grey fringing, appearing lightly mottled, and lack black chevrons of adult, though those in transition between moults can have adult patterning on coverts. Undertail as adult, but white markings on inner webs much smaller, especially on outermost tail-feathers, where markings vary from oval spots that reach inner edge, narrow white inner edges, or combination of white edges and spots, which occasionally join; these all *c.* one-third from tip of feather, just basal to emarginated portion. Underwing as adult. Bare parts as adult, but recently fledged juveniles have yellow gapes.

Similar species Most readily confused with **Barn Swallow** *Hirundo rustica* (q.v.). Also easily confused with **Pacific Swallow** *H. tahitica*, which has not been definitely recorded in HANZAB region; extremely difficult to distinguish in the field; for details of distinguishing features, see Recognition, below. Also possibly confused with **Red-rumped Swallow** *H. daurica* (q.v.). Readily distinguished from **Tree** *H. nigricans* and **Fairy** *H. ariel* **Martins** by: long forked tail (martins have much shorter tail without streamers) and upperparts wholly dark (martins have pale rumps); for more detail of differences from martins, see those accounts. Swiftlets and swifts (*Apodidae*) superficially similar, but have longer, narrower wings which are very stiff and not as flexible as in Swallows, and swifts tend not to make such sharp turns and weaves as Swallows and have powerful, fast flight with shallow flicking wing-beats (more fluttering in swallow). Welcome Swallow slightly larger than **White-rumped Swiftlet** *Aerodromus spodiopygius*, with shorter, blunter wings and longer, deeply forked tail. All HANZAB swifts and swiftlets have mostly blackish plumage, apart from white or pale markings on one or more of: chin, throat, rump or undertail-coverts (some all dark); all swifts and swiftlets have slightly notched to rather squarish tails, except **Fork-tailed Swift** *Apus pacificus* which has deeply forked, graduated tail, but lacks highly elongated outermost rectrices (swallow has deeply forked tail with elongated t6).

Gregarious; sometimes occur singly or in twos, but more often in flocks, usually up to 30 but sometimes much larger, especially just before departure on seasonal movement or when congregating to roost. Often mix with other aerial insectivores, especially martins, and sometimes with White-backed Swallow *Cheramoeca leucosternus*, woodswallows *Artamus* or swifts. Flight quick, graceful and extremely agile, with rapid fluttering and sharp turns, swooping up and down to catch insects, sweeping low over ground, or flying to great heights, especially in humid weather; when moving long distances, fly strongly and directly with constant wing-beats; often hover above perches before landing. Usually perch on wires, fences, bare branches and twigs, and sometimes cling to cliff-faces or buildings; occasionally perch on ground, but usually on elevated perches, such as clods of soil. Shuffle over ground, usually with wings flapping and sometimes with tail sticking up at 45°. Build distinctive mud-nest. Utter twittering or chattering Song, monosyllabic Contact Call, sharp, high-pitched Alarm Call, and various other vocalizations (see Voice).

HABITAT Mostly occur above various open habitats, such as grasslands (including modified grassy habitats such as farmland), heathlands, shrublands, woodlands and open forest; seldom occur in dense habitats, such as moist forest or rainforest, except in clearings; common in settled areas. Often occur in such habitats near wetlands (see below). Occur from coasts to arid inland areas (e.g. Dove 1933; Brandle 1998), and from sea-level, up to >1500 m asl (e.g. Brown 1949; Jenkins 1969; Davey 2002a).

Often occur in airspace above grasslands or sedgelands, including tussock grasslands and subalpine moors (Finlayson 1938; Coleman 1943; Ridpath & Moreau 1966; Smith 1977; Marchant & Fullagar 1983; Morris 1986; Baxter & Paton 1998; Brandle 1998; Davey 2002b), sometimes with a few sparsely scattered trees (McEvey 1965; Clarke 1967); also over other open grassy areas, such as airfields, golf courses and playing fields (Hollay 1971; Johnson & Hooper 1973; Fleming 1976; Smithers 1977; Brock 1978; Ratkowsky 1993; Freeman 1994); and farmland, including pasture and crops (Mellor 1924a,b; Cameron 1932; Ridpath & Moreau 1966; Keast 1975; Morris 1975; Gibson 1977; Smithers 1977; Marchant & Fullagar 1983; Craig 1984; Loyn 1985; Semmens 1993; Heather & Robertson 2000; Hewish 2004). Also occur round reed beds, where forage overhead or roost (McEvey 1965; Bishop & Bishop 1985; Brown *et al.* 1990; Schokman 1990); alpine herbfields (Longmore 1973); and, in Tas., in buttongrass plains (Ridpath & Moreau 1966; Tas. Bird Rep. 6). Occur above low shrublands, including those dominated by chenopods such as *Sarcocornia*, saltbush *Atriplex*, bluebush *Maireana*, *Bassia* or *Sclerostegia*, occasionally with scattered taller shrubs or trees (Watson 1955; Hyett & Gottsch 1963; Ford & Sedgwick 1967; McEvey & Middleton 1968; Klau 1988; Schokman 1990; Baxter & Paton 1998; Brandle 1998; Hewish *et al.* 1999); taller shrublands, dominated by acacias such as Sandhill Wattle *Acacia ligulata* or sometimes mixed with hopbush *Dodonaea* (Brandle 1998). Also shrubby heathlands, dominated in coastal areas by banksias, tea-trees and casuarinas (Cooper 1974; Preston 1983; Morris 1986; Hewish 1999, 2000); in semi-arid inland areas, dominated by banksias (Gell 1977); and at high elevations in Tas., dominated by shrubs such as tea-trees, beard-heath *Leucopogon*, heath *Epacris*, *Olearia* and Creepy Monotoca *Monotoca empetrifolia* (Ridpath & Moreau 1966; Hingston 1994); or coastal scrub dominated by Coastal Tea-tree and Moonah *Melaleuca lanceolata* (Hyett & Gottsch 1963; Horrocks & Brown 1993), e.g. on Moturoa Is, NI, NZ, recorded in coastal scrub resulting from regeneration after fire, comprising grasses, rushes, flax *Phormium*, *Cortaderia*, Bracken and *Cordyline* with scattered Mingimingi *Leucopogon fasciculatus*, *Cassinia* and Variable Groundsel *Senecio lautus* (Adams 1971). In coastal areas, sometimes occur round mangroves (Hindwood 1935; Edgar 1966; Smith & Johnstone 1985). Also often recorded in or above open woodland, or remnant or partly cleared woodland (e.g. Marchant & Fullagar 1983; Jones 1986; Saunders & Ingram 1995); often dominated by various eucalypts, ranging from subalpine Snow Gum woodlands to mallee woodlands or River Red Gums or Black Box along watercourses in semi-arid or arid regions (e.g. Sedgwick 1964; McEvey 1965; McEvey & Middleton 1968; Jones 1986; Osborne & Green 1992; Mawson & Massam 1995; Er 1997; Er *et al.* 1996, 1998; Brandle 1998; Leavesley & Tidemann 2001; McDonald 2001; Watson 2002); also acacia woodland, especially in arid and semi-arid areas, dominated by species such as Brigalow, Gidgee, Myall, Mulga, and Dead Finish (Ford & Sedgwick 1967; Howard 1983; Leach & Watson 1994; Leach 1995; Brandle 1998); or various other woodlands, dominated by banksias (Wheeler & Calver 1996), paperbarks, such as Moonah (Wheeler & Calver 1996), casuarinas (Baxter & Paton 1998) or cypress-pines (Gell 1977); or mixed assemblages, such as woodland of Yellow Box, Gum-topped Box *Eucalyptus moluccana*, cypress-pine *Callitris* and Buloke (McEvey 1965); White Box, Cypress Pine *Callitris glauca* and Manna Gum (Emison & Porter 1978); or River Red Gum, Yellow Gum, Drooping Sheoak and Slender Cypress-pine (Clarke 1967). Less often occur over forests, usually open dry sclerophyll forests dominated by various eucalypts, or occasionally mixed with other trees, such as cypress-pines or casuarinas (e.g. Gepp & Fyfe 1975; Jones 1981; Ratkowsky 1983; Nichols & Nichols 1984; Smith 1984, 1985; Jones 1986; Gosper 1992; Cale 1994; Leishman 1994); and forests regenerating after logging (Wilson 1982; CSN 48). Seldom recorded round wet sclerophyll forests dominated by various tall eucalypts with dense midstorey of trees or dense shrubby understorey, sometimes with rainforest elements (e.g. Ratkowsky & Ratkowsky 1977; Ambrose 1982; Smith 1984, 1985; Ratkowsky 1986; Gosper 1992; Cale 1994). At high elevations in Tas., recorded above stunted subalpine forest, some dominated by endemic conifers (Ridpath & Moreau 1966). Also occur round pine plantations, including young plantations, with open grassy areas or dense layer of shrubs, ferns, grasses and herbs (Friend 1982). Very occasionally recorded above rainforest, or in clearings within (Marchant & Fullagar 1983), e.g. tall subtropical rainforest dominated by Black Booyong, Purple Cherry and Yellow Carabeen with irregular canopy (Gosper 1992) or warm-temperate rainforest dominated by Lilly Pilly (Smith 1984, 1985). Often occur round settlements, either in parks, gardens, lawns and streets in cities (Morgan 1914a; Sutton 1928b; Geary 1932; Whitlock 1939; Brock 1978; Harris 1980; Jones 1981; Mason 1985; Guest & Guest 1987, 1993; Woodall 1995; Moverley 1998; CSN 32), rural towns, or isolated buildings in remote or sparsely settled areas (e.g. Arnold 1927; Le Souëf 1928; Warham 1955; Beruldsen 1969; Clayton 1970; Reed 1976; Costello 1981; Johnstone *et al.* 2000; Storr 21, 26, 27).

When recorded in or above aforementioned habitats, often associated with nearby wetlands, permanent or ephemeral, fresh or salt, natural or artificial, including watercourses, lakes, swamps, coastal lagoons, estuaries, bores and springs, reservoirs, and ponds in sewage farms, saltworks and the like; vegetation round such wetlands varies from grass and rushes, low ground-cover and weeds, low shrubs, including saltmarsh, to larger shrubs and scattered trees (e.g. Watson 1955; Hall 1960; Mack 1961; Storr 1965; Turbott 1965; Pierce 1980; Badman 1979; Howard 1983; Marchant & Fullagar 1983; Klapste & Klapste 1985; Owen & Sell 1985; Leach & Hines 1987; Schokman 1990; Carter *et al.* 1995; Beauchamp & Parrish 1999; Ashton 2001; Cox 2001; Stewart & Gynther 2003; Tas. Bird Rep. 9; CSN; see above). Commonly in River Red Gum forest subject to regular inundation, especially when flooded, mainly next to open areas within the forest (Loyn *et al.* 2002). Also often occur round beaches, over intertidal zone, including sandy beaches and mudflats, especially with clumps of beachcast seaweed, and adjacent sand-dunes with low vegetation such as Marram Grass *Ammophila arenaria*, Hairy Spinifex *Spinifex hirsutus*, Beach Daisy *Arctotheca populifolia* and Sea Rocket *Cakile maritima* (Dove 1933; Whitlock 1939; Brown 1949; Johnson & Hooper 1973; Abbott 1976; Hornsby 1978; Howard 1983; Morris *et al.* 1990; Hewish *et al.* 1999; CSN 19 Suppl.); also often occur over water, round rafts of floating seaweed, round breaking waves, including flying along barrel of breaking wave (Jenkins 1969; Storr 28; CSN 34; J.M. Peter), or farther out to sea, up to several kilometres offshore (Morgan 1916b; White 1916; Sutton 1931a; Amiet 1964).

DISTRIBUTION AND POPULATION Endemic to A'asia. Widespread in Aust. and NZ; vagrant to New Guinea (Finch 1980, 1984; Coates 1990).

Aust. Widespread, though mostly S of 20°S. **Qld** Widespread in most regions, but occur at scattered sites in W and N. Occur on several islands in Torres Str. (Draffan *et al.* 1983; Lansley 1997; Carter 1999), and recorded at scattered sites in coastal and subcoastal areas of C. York Pen. (but apparently not farther inland) S to Kowanyama and Princess Charlotte Bay (Aust. Atlas 1, 2). Widespread E of line from Port Stewart and Silver Plains Stn, SSW to Cuddapan Stn in Diamantina R.–Cooper Ck Drainage Basin (Bruce 1979; Aust. Atlas 1, 2; Storr 19). Farther W, recorded at scattered sites, mainly W of 140°E, from Birdsville N to Mt Isa, and very occasionally in North-Western Region, at a few sites from Camooweal N to near Doomadgee and E to near Normanton (Horton 1975; Schrader 1981; Aust. Atlas 1, 2; Storr 19). **NSW, Vic., Tas.** Widespread. **SA** Widespread in most regions (Aust. Atlas 1, 2) except e. Great Victoria Desert, where generally absent (Close & Jaensch 1984; Aust. Atlas 1, 2; SA Bird Rep. 1976); though widespread in L. Eyre Drainage Basin, more scattered than in areas farther S (Badman 1979, 1989; Black & Badman 1986; Aust. Atlas 1, 2). **WA** Widespread S of 20°S; vagrant farther N. Widespread in Eucla Div. and South-East Interior Region, S of 30°S. Also widespread farther W, in area W of 122°E and S of 20°S (Johnstone *et al.* 2000; Aust. Atlas 1, 2; Storr 21, 26, 27, 28, 35). Very occasionally recorded at a few scattered sites in Kimberley Div., e.g. Broome (though historical account stated that the species was common in early 20th century; Crossman 1910), Derby and Mt Anderson in SW, Wyndham, Kununurra and L. Argyle in NE, and Fitzroy Crossing and Halls Ck in S (Collins 1995; Boyle 1999; Anon. 2003; Hall; Storr 11; Aust. Atlas 1, 2), and farther S in Great Sandy Desert, mostly along Canning Stock Route; recorded less often in Gibson and Great Victoria Deserts (Aust. Atlas 1, 2; Storr 26). **NT** Very occasionally recorded at a few sites in Top End, e.g. round Darwin at Leanyer Swamp and Palmerston, in Kakadu NP at Yellow Waters and Jabiru, and farther S at Ngukurr (McCrie 1999a,b; Goodfellow 2001; Aust. Atlas 1, 2). Farther S, recorded at scattered sites between Anthony Lagoon, in Barkly Tableland, and Elkedra Stn; and more widespread S of 22°S, in area S of line from near Docker R., through Hann Ra. and Harts Ra., to Andado Stn (Tucker 1970; Parker 1971; Wilson 1974; Aust. Atlas 1, 2; Storr 7).

NZ Widespread. **NI** Recorded in all districts, mainly in lowlands. NORTHLAND, AUCKLAND, S. AUCKLAND, BAY OF PLENTY, VOLCANIC PLATEAU, TARANAKI AND WAIKATO: Widespread from C. Reinga S to line from Torere in Bay of Plenty, through L. Rotoaira in Volcanic Plateau, to lower reaches of Waitotara R. in s. Taranaki, though scattered in Taranaki and Volcanic Plateau Districts. Also occur on numerous islands, from Three Kings Is S to Ponui I., and E to Mercury Grp (Munro 1969, 1973; Edgar 1971; Lovegrove 1978; Innes *et al.* 1982; Riddell & Taylor 1984; Robertson *et al.* 1993; NZ Atlas; CSN). EAST COAST: Occur at scattered sites, mostly in coastal areas, S of Maungakaka, NW of East C., with most records from round Gisborne and Wairoa, but also very occasionally recorded farther inland, e.g. L. Tiniroto (NZ Atlas; CSN). HAWKES BAY: Generally widespread, especially S of Esk R. (NZ Atlas; CSN). WAIRARAPA:

Widespread in Ruamahanga R. Drainage Basin, N to near Eketahuna (Dennison 1974; NZ Atlas; CSN). WELLINGTON: Mainly restricted to lowlands (NZ Atlas; CSN). MANAWATU: Widespread (NZ Atlas; CSN). WANGANUI: Widespread in lowlands (NZ Atlas; CSN). SI NELSON: Widespread (NZ Atlas; CSN). MARLBOROUGH: Occur in most coastal and subcoastal areas, but generally absent inland (NZ Atlas; CSN). CANTERBURY: Widespread, mostly near coast and on Canterbury Plains, though also occasionally recorded in high country, e.g. headwaters of Waimakariri R., L. Sarah, L. Coleridge, L. Tekapo and L. Ohau (NZ Atlas; CSN). OTAGO: Occur at scattered sites, mostly near coasts, mainly S to Taieri Beach, but nevertheless recorded farther S at scattered sites S to Papatowai; very occasionally recorded much farther inland, e.g. Naseby, near Alexandra and Pigeon I. in L. Wakatipu (Child 1982; NZ Atlas; CSN). SOUTHLAND: Recorded at scattered sites, mainly in coastal areas, from Otara W to mouth of Waiau R., with most records round Invercargill, but also occur farther inland, e.g. Gore, Mataura, Otahuti, at several sites between Lumsden and Te Anau, and along Mararoa R., and occasionally also occur deeper into Fiordland, such as at Supper Cove, Deep Cove, Dark R. and Milford Sound. Also occur on Stewart I. and associated islets (NZ Atlas; CSN). WEST COAST: Occur at scattered sites between Awarua Pt and Turnbull R., but, farther N, widespread N of Cook R. (Child 1986; NZ Atlas; CSN).

Lord Howe I. First confirmed record in 1913, when specimen collected (Hindwood 1940b), though reported on several earlier occasions (Hutton 1991); rare or occasional visitor in small numbers till early 1970s (e.g. Le Souëf 1924; Hindwood & Cunningham 1950; McKean & Hindwood 1965). Said to have colonized island in mid-1973, when breeding first recorded (NSW Bird Rep. 1973); recorded over large areas of island by 1974 (NSW Bird Rep. 1974) and large numbers present in 1977 (Smithers 1977). Now well established and numerous (Hutton 1991; McAllan *et al.* 2004).

Norfolk I. First recorded in Mar. 1969 (Disney & Smithers 1972). Occasionally recorded in small numbers till 1978, when 50+ recorded in July, and good numbers still present in Sept. (Moore 1981, 1985); subsequently recorded in small numbers (usually <20, but occasionally up to 40) (Hermes *et al.* 1986; Anon. 1996, 1999; Moore 1999; K.L. Evans). Also occur on Philip I. (Hermes *et al.* 1986).

Macquarie I. Vagrant; <10 records, but no details (Anon. 1987); at least one recorded Jan. 1976 (Green 1989).

Kermadec Is Widespread (Tennyson & Taylor 1989) with most records on Raoul I. (Veitch *et al.* 2004). RAOUL I.: Single, Sept. 1972 (Veitch *et al.* 2004); several records in 1973, with 3–6 in Mar., and 'later ten after a small hurricane', 11 in May and 13 on 1 July (Veitch *et al.* 2004; CSN 20); single, 13 Oct. 1974 (Veitch *et al.* 2004); numerous records, Jun.– Nov. 1977, with 23, 7 Aug. (CSN 26); eight, *c.* 16 Mar. 1978 (Craig 1984); single specimen collected, 25 Apr. 1983 (Veitch *et al.* 2004); eight, Mar. 1984, when considered to have been firmly established (Craig 1984); 'moderate numbers' recorded early Oct. 1993, but not present over summer, and numbers increased again Mar. 1994, with up to 20 birds present (Veitch *et al.* 2004). OTHER ISLANDS: Also recorded on Macauley I. (at least two), Sept. 1988; on Curtis I., two on 15 Sept. 1988 and ten (including three dead birds), Oct.–Nov. 1989 (Veitch *et al.* 2004); and three SW of L'Esperance Rock, 16 Mar. 1984 (Craig 1984).

Chatham Is First recorded in 1970 (Hollay 1971). Most records from Chatham I., where now considered common (Freeman 1994; Nilsson *et al.* 1994; CSN), though most records are of small numbers (Freeman 1994; CSN). Only occasionally recorded on outlying islets: recorded on Pitt I. in Dec. 1970, Apr. 1993 and Dec. 1997 (Hollay 1971; Freeman 1994; Tennyson 1998), and on Rangatira in Feb. 1993 (Nilsson *et al.* 1994).

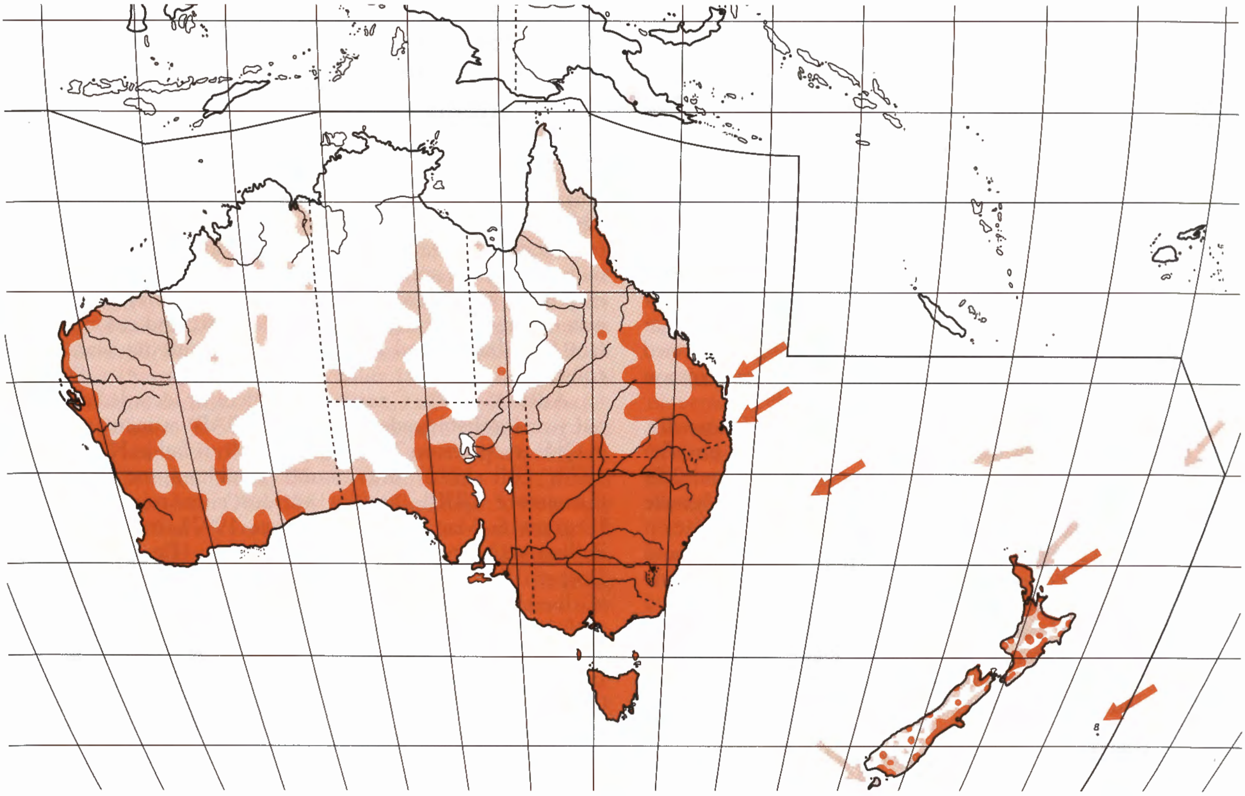
Snares Is Vagrant; all records from North East I. Two, June 1981; single, 18 Nov.–3 Dec. 1982; 12 mummified corpses, 12 Nov. 1985; single on 12 and 15 Oct. 1986; several, Apr.–May 1998; in Apr. and May 1999, numbers increased from two on 14 Apr. to ≥19 on 7 May; 35 on 9 Apr. 2000, and at least five still present on 5 May (Miskelly *et al.* 2001).

Auckland Is Vagrant; all records from Enderby I. Single, Port Ross, 1943 (Bailey & Sorensen 1962; Oliver); *c.* 20, early Apr. 1983 (Claridge 1983); six, 11 Apr. 1983 (Claridge 1983). Unconfirmed report of six in late Jan. 1982 (Claridge 1983).

Campbell I. Unconfirmed report, Perseverance Harbour, 1946 (Bailey & Sorensen 1962).

Breeding AUST.: Widespread in most areas except n. and central Aust. In Qld, recorded in Atherton Region (Wet Tropics), from near Cairns S to Townsville, and inland to Atherton; recorded at a few sites in Central-eastern Region, mainly from round Bowen S to Eungella, though recorded inland to Clermont; more widespread in South-eastern Region, extending W to Salvator Rosa NP and Mitchell in e. South-central Region; and very occasionally recorded in South-western Region, e.g. at Eulo Bore, Currawinya NP and Birdsville. Widespread throughout NSW, Vic. and Tas. In SA, widespread S of 30°S; farther N, not recorded W of 134°E, and recorded at a few scattered sites in L. Eyre Drainage Basin, so that most records N of 30°S are from William Ck and Coward Springs W to line joining Arckaringa Stn and Coober Pedy. In WA, recorded at scattered sites on and S of Nullarbor Plain, extending W in coastal areas and subcoastal areas to C. Le Grande NP, but more widespread still farther W, in area W of 122°E, and N to 27°S; farther N, recorded at coastal and subcoastal sites N to Barrow I. (Aust. Atlas 1, 2; NRS). NZ: Published records from many sites throughout NI and SI (CSN) indicate that breeding probably occurs throughout most of range in lowlands. First recorded breeding on NI at Awanui, Northland, in Oct. 1958 (Michie 1959a), and on SI at L. Ellesmere, Canterbury, in Nov. 1961 (Turbott 1965). Formerly considered to breed no farther S than L. Wainono in s. Canterbury (Pierce 1980), but despite absence from many sites in S of range during breeding season (CSN; see Movements), some birds evidently remain to breed, as nests recorded at several sites S of 45°S, especially round Otago Pen. and in s. Southland between Waituna Lagoon and L. George, and inland to Otahuti and Te Anau; and few published records in West Coast, at Arawata R., Karangarua R. and Buller R. (Child 1986; Morrison 1987; CSN). OUTLYING ISLANDS: First recorded breeding on Lord Howe I. in 1973 (NSW Bird Rep. 1973). Not recorded breeding on Norfolk I. (Hermes *et al.* 1986), though has possibly occurred more recently; 'young birds' recorded in 1969 (Disney & Smithers 1972), and bird seen carrying mud in 1978 (Moore 1981). Recorded breeding on Chatham Is since *c.* 1976 (Heather & Robertson 2000). Breeding not recorded on Kermadec Is (Veitch *et al.* 2004).

Change in range, populations Aust. Range said not to have increased greatly (Aust. Atlas 1), but nevertheless thought to have expanded into some formerly forested areas, e.g. McPherson Ras (Marshall 1935) and some inland areas, e.g., inland Qld, Mid-Eastern Interior and South-Eastern Interior Regions of WA, since those areas were settled (Carnaby 1933; Davies 1977; Storr 19, 22, 26); colonized area traversed by Trans-Continental Railway between 1921 and 1931 (Storr 26); and first recorded in Top End in 1970s (Aust. Atlas 1). Range may also have expanded in sw. Kimberley Div., where claimed to have been first recorded at Broome in 1991 (Collins 1995; cf. Crossman 1910), but regularly recorded in small numbers since then (Collins 1995). Population round Mt Mary Plains, SA, said to have increased after settlement in early 20th century (Boehm 1957), though said to have subsequently declined after abandonment of many homesteads in the area, combined with reduction in number of horses (and resulting reduction of horse manure in which insects breed) (Boehm 1961). Became established on Houtman Abrolhos, WA, in 1945, only after huts were erected there (Storr 24). Population round Roxby Downs, SA, increased after establishment of town in 1986 (Read 1999). **NZ** Range in NZ expanded spectacularly since early 1960s. Suggested that colonization occurred after Swallows crossed Tasman Sea naturally (Edgar 1966), as there are many records of the species at sea off NZ (e.g. Jenkins 1978; Lovegrove 1978; Syms 1978; Latham 1981a; Craig 1984; CSN 24), though possibly ship-assisted (Gregory 1978). Some early records of Tree Martins (q.v.) were possibly misidentified Welcome Swallows (Edgar 1966). NI: **1950s** First recorded in Northland in 1958, round Awanui in Oct. and also at Waiomio, near Kawakawa (Shanks 1960), though there were unconfirmed reports, also from Northland, round Awanui and Herekino, in 1920s (Michie 1959a). By 1959, there was 'a fair sprinkling of Welcome Swallows in Northland', with breeding recorded at three or four sites (Michie 1959b); in Mar. of same year, also recorded at Matata in Bay of Plenty (Hall 1960). **1960s** By 1960s, recorded at many sites in Northland, with numbers increasing (Findlay 1960; Shanks 1960; Skegg 1962); e.g. round Kaikohe, first recorded in 1959, a flock of 11 recorded in Feb. 1960, and one of 100 in Feb. 1962 (Ross 1960, 1962). Though mostly confined to Northland by mid-1960s, with records at scattered sites from C. Reinga S to Kaipara Harbour (Flux & Wilson 1965; McKenzie 1965; Edgar 1966; Wagener 1966), there had been several records from various sites farther S by 1962, e.g. at Matata in Bay of Plenty in Mar. 1959 (see above), near Himatangi in Manawatu in Feb.–Mar. 1961 (Edgar 1966), Waitakere Ras near Auckland in Mar. 1961 (Edgar 1966) and near Waipukurau in Hawkes Bay in Nov. 1962 (Hankins 1963); and by 1964, there were records from Auckland, Miranda and mouth of Waikato R., and farther S, in Hawkes Bay at Bay View and L. Hatuma, near Waipukurau, in Wairarapa between Featherston and L. Wairarapa, and in Taranaki at mouth of Waiongana R. (Edgar 1966). Dramatic increase in populations recorded in late 1960s and early 1970s: rapid expansion of range recorded round Hokianga in 1966–67 (Cowan 1968); already well established at various scattered sites scattered round Whangarei by 1968, but in 1969 appeared at many new localities in area, bred in following year and common in 1971 (Munro 1973); widespread throughout Northland by 1971 (Edgar 1971). General increases in numbers reported in Wairarapa and Manawatu in 1969–70 (CSN 19 Suppl.). **1970s** By 1970, recorded at several sites in Bay of Plenty, between Kaituna and Tarawera Rs, and first record in Volcanic Plateau at L. Okareka in Mar. (Broun & Broun 1970). Widespread from Waikanae N to Wanganui by 1972 (CSN 19). By 1973, spreading well into Auckland and already established farther S round Gisborne (CSN 20). By 1974, widespread in S. Auckland and n. Waikato, though only scattered records in intervening area; scattered records in Bay of Plenty from Bowentown E to Omarumutu; Volcanic Plateau, mainly round lakes round Rotorua, but also farther S round upper–middle reaches of Waikato R. and L. Rotoaira; and in East Coast at a few sites between Ruatoria and Gisborne, but mostly round Wairoa; more widespread in Hawkes Bay from Waikari R. S to Porangahau, but mainly between Napier and Waipawa; widespread in w. Wairarapa (where considered a recent arrival at Eketahuna in 1974 [Dennison 1974]), but sparsely scattered in Wellington; widespread in w. and n. Manawatu, and recorded at a few scattered sites in Wanganui and Taranaki (NZ Atlas). A 'spectacular and phenomenal' increase in numbers recorded round Auckland in 1973–74 (CSN 21). Parts of Wairarapa were colonized only slowly: not recorded in Hutt R. Valley till 1972 (Anon. 1972; CSN 19), and not at W. Hutt till Nov. 1978 (Gibb 2000). Widespread throughout most lowlands by 1978 (NZ Atlas; CSN 26), with numbers increasing round Gisborne in early 1980s (CSN 31). Range continues to expand into high country of Volcanic Plateau (Heather & Robertson 2000). Occurrence on offshore islands generally



reflected timing of expansion into adjacent areas of mainland: first recorded on Noises Is in early 1960s (Edgar 1966; Cunningham & Moors 1985), Cavalli Is in 1969 (Millener 1980) and Great Barrier I. in Jan. 1972 (CSN 20; q.v. Bell 1976), though apparently not recorded on expedition there a few weeks later (Reed 1972). SI: **1950s** First records were of two birds, both specimens, taken on Stewart I. in Sept. 1953 (Sansom 1954), though unconfirmed report of two at Nugget Pt in Otago in 1940s (Edgar 1966); subsequently recorded at Farewell Spit in Nov. 1955 (Heather 1956) and Smiths Bridge, near Blenheim, in July 1957 (Edgar 1966; Tunnicliffe 1968). **1960s** Expansion of range much slower than on NI, with a few records at widely scattered sites in early 1960s, with no regular pattern of distribution: recorded breeding at L. Ellesmere, Canterbury, in Nov. 1961 (Turbott 1965); and recorded on Stephens I., Marlborough, a month later (Edgar 1966; Tunnicliffe 1968); and at Jackson Bay, s. West Coast, in Aug. 1962 (Edgar 1966; Tunnicliffe 1968). Intermittently recorded at Otatara, near Invercargill, Nov. 1963–Mar. 1964 (Henderson 1964), though possibly a misidentified Tree Martin (Edgar 1966); also recorded on Brothers Is in Cook Str. in Nov. 1964 (Wright 1964), and between Haast and Fox Glacier, West Coast, in Nov. 1965 (Tunnicliffe 1968). Established at L. Ellesmere by 1964–65, having bred there for 4 years (Edgar 1966), and at Farewell Spit by mid-1960s, with breeding first recorded in 1967 (Wagener 1966; Tunnicliffe 1968). In 1966–8, recorded at several sites between Blenheim and Kaikoura, Marlborough (Tunnicliffe 1968). Established in all districts except West Coast by 1968, and continued to spread, with most records round Farewell Spit, C. Campbell and L. Ellesmere (Tunnicliffe 1968). **1970s** First recorded at Te Anau in June 1971 (CSN 19). Considered widespread in Southland by 1972 (CSN 20), though few NZ Atlas records. By 1974, recorded at scattered sites in Nelson and Marlborough, from Farewell Spit to Flaxborne R. near Ward; in Canterbury, at scattered sites from near Amberley S to Waitaki R., with most records round L. Ellesmere; few records farther S, e.g. at scattered sites in Otago between Dunedin and Clutha R., and at sparsely scattered sites in Southland, inland to Lumsden and Te Anau; and scattered sites in West Coast, N of Cook R. (NZ Atlas; CSN 19 Suppl., 21). Range in s. Canterbury still expanding in mid-1970s (Sagar 1976). Widespread throughout most lowland areas, including West Coast, by *c.* 1978 (NZ Atlas; CSN 26, 27). **1980s** Range expanded to include some areas of high country in inland Canterbury and Otago: absent from mountains of inland Canterbury before 1980, with spread of range possibly occurring along rivers, e.g. McKenzie Basin thought to have been colonized via Waitaki R. in 1980s (CSN 36); first recorded in central Otago at Kyeburn R. in Oct. 1981 (Child 1982; CSN 30); bred at L. Sarah in 1984–85 (CSN 33); and recorded at L. Emily and L. Clearwater in 1989 (CSN 37); range continued to expand in highlands in 1990s, though remain uncommon (Heather & Robertson 2000; CSN 39, 42, 48, 49).

Populations RECORDED DENSITIES: AUST.: At Townsville, ne. Qld, mean 0.2 birds/ha in wet season 1980, 0.26 birds/ha in dry season 1980, 0.1 birds/ha in wet season 1997 and 0.04 birds/ha in dry season 1997 (Jones 1983; Jones & Wieneke 2000); 0.075 birds/ha, near Tallegalla, Qld (Leach & Watson 1994); <0.01–0.23 birds/ha, Cooloola NP, se. Qld (McFarland 1988); 0.12 birds/ha, Archerfield Airport, near Brisbane (Woodall 1999); 0.05 birds/ha, near Armidale, NSW (Ford *et al.* 1985); 0.1 birds/ha, Hawkesbury R., NSW (Keast 1985); 0.9 birds/ha, near Eden, NSW (Kavanagh *et al.* 1985); 0.09–0.5 birds/ha, near Moyston, Vic. (Kennedy 2003); 0.25–0.88 birds/ha, near Woodsdale, Tas. (Taylor *et al.* 1997); 1.19–2.19 birds/ha, Eyre Bird Observatory, WA (Davies 1982); 0.39 birds/ha, Barrow I., WA (Sedgwick 1978). NZ: Between Palmerston N and Foxton (32.5 km), recorded at densities of 0–0.34 birds/km (n=56 trips) (Gill 1977). **5-MINUTE COUNTS:** 0.06 birds/count (n=120 counts), Red Mercury I. (Robertson *et al.* 1993); 0.33 birds/count (0.91; 333 counts), Kaitoke Wetland, Great Barrier I. (Anderson & Ogden 2003).

THREATS AND HUMAN INTERACTIONS Numbers and range have increased since European settlement: benefited from creation of open areas by clearing forests; from provision of artificial water-points in arid and semi-arid areas; and from provision of artificial nest-sites, such as buildings and culverts (Carnaby 1933; Boehm 1957; Davies 1977; Wilson 1982; Johnstone *et al.* 2000; Storr 19). In patches of forest in Gippsland, Vic., surrounded by cleared areas, mainly recorded over paddocks and edges of small grazed patches: 39 recorded in 100 counts in patches of forest up to 5 ha (i.e. small areas of forest surrounded by much cleared land), one in 6–10 ha, three in 11–22 ha, three in 26–57 ha, 11 in 94–144 ha and five in 973–1771 ha (Loyn 1985). Near Bathurst, NSW, recorded in open areas where forest regenerating, and none in either advanced or relatively undisturbed forest (Fisher 2001). Roosting birds or young in nest occasionally killed by Black Rats or Stoats, and roosting birds or newly fledged ones sometimes killed by Cats (Edgar 1966; Park 1981b; Tarburton 1993). Occasionally killed by vehicles on roads (ABBBS 1986; Brown *et al.* 1986; Lepschi 1992). Very occasionally killed by colliding with windows (Park 1981a; cf. Edgar 1966). Nests sometimes removed or otherwise interfered with by people (see Breeding: Success); in suburban Perth, a man died from fungal meningitis transmitted by inhaling the fungus *Cryptococcus neoformans* in fine particles of Swallow nest-material or faeces while removing nest (Coyle 1994). First fledgelings recorded in NZ were shot by 'an irresponsible youth ... with an air-rifle' (Michie 1959b).

MOVEMENTS Partial migrant, with resident populations seasonally augmented by visitors, in spring–summer in S and autumn–winter farther N (Morris *et al.* 1981; Aust. Atlas 1; see below). Broad-scale analysis of bird atlas and count data from e. Aust. found strong evidence for seasonal N–S pattern of movement, moving N in autumn and S in spring, in 'Mid Line North' pattern (see Griffioen & Clarke 2002). Partial migrant in e. Aust. (Morris *et al.* 1981; Storr 19; ACT Atlas; see below), possibly with increase in proportion of migrants to residents with increasing latitude (see below). Most of Tas. population leaves for mainland Mar.–Apr. and returns Aug.–Sept. (Aust. Atlas 1; see below). Populations in WA and SA apparently less mobile, and often considered resident (see below). Patterns in NZ less obvious; apparently non-migratory in NI, and seasonal movements recorded on SI, but cryptic in nature (see below). Able to cross large tracts of water, as regularly migrate across Bass Str., and colonized NZ (see Distribution and Population), and outlying islands also colonized.

Aust. E. AUST.: Considered resident or recorded throughout year (probably sedentary of *HANZAB*) at many sites, e.g. in Qld, on Atherton Tableland and at Innisfail in NE (Bravery 1970; Gill 1970) and round Rockhampton farther S (Longmore 1978), and at various sites round Brisbane (Durrant & Mac Rae 1994; Noyce 1997), in ne. NSW at Ballina and upper reaches of Macleay R. (De Warren 1928; Gosper 1983), in Hunter, Sydney and Illawarra Regions (Gilbert 1935; Morris 1975; Smith & Chafer 1987; Chafer *et al.* 1999), round Cobar in w. NSW (Schmidt 1978), and in ne. Vic. (Shanks 1949; Rowley 1961; Bedggood 1972; Roberts 1975), E. Gippsland (Bedggood 1970, 1980) and Geelong (Belcher 1914). In many areas, however, partial migrant, with local populations seasonally supplemented by visitors from elsewhere; timing of such expansions is dictated by location, e.g. populations increase in winter between Townsville and

Daintree, ne. Qld (Hopkins 1948; Wieneke 1988; Nielsen 1996) and Maryborough and Cooloola NP, farther S (Roberts & Ingram 1976; Jones 1981), and in sw. NSW (Hobbs 1961); and small wintering populations augmented in summer at Murphys Ck, near Toowoomba, se. Qld (Lord 1956), Sydney (Hoskin 1991) (though banding records suggest that birds present in winter may replace breeding population rather than augmenting it; Lane 1968), round Geelong and Ballarat, Vic. (Russell 1921; Thomas & Wheeler 1983; King & Cameron 1997; Hewish *et al.* 1999; Baverstock & McCarthy 2000), and, in Tas., at Launceston and Hobart (Littler 1903c; Sharland & Crane 1922; Green 1989). At other sites, populations swelled twice a year, usually in autumn and spring, presumably reflecting presence of birds on passage (see below). SA: Resident or present throughout year at most sites, from Fleurieu Pen. N to Moolawatana Stn–L. Frome and Roxby Downs, and Mannum W to Cook on Nullarbor Plain (Morgan 1916c; McGilp 1923, 1930; Symon 1946; Leiblich 1971; Cox 1973; D.C. Paton & J.B. Paton 1980; Ashton 1985; P.W. Taylor 1987; Klau 1988; Read *et al.* 2000). Some evidence of movement, though, as most numerous in spring and summer in Belair Recreation Park, Mt Lofty Ras (Baxter 1980) and on Kangaroo I. (Baxter 1989), and suggested that least numerous round Adelaide in winter (Morgan 1916a); and mainly autumn–winter visitor to Parra Wirra CP, Mt Lofty Ras (Ford & Paton 1976). WA: Usually considered resident, as recorded throughout year at many sites, such as Nullarbor Plain (Brooker *et al.* 1979), and especially in South West Div. (e.g. Alexander 1921; Carter 1924; Jenkins 1931; Whitlock 1939; Sedgwick 1940a,b, 1988; Serventy 1948; Ford 1965; Storr 1965; Serventy 1970; Abbott 1980; Stranger 1993; Mawson & Massam 1995), and also on islands farther N, e.g. Houtman Abrolhos and Barrow I. (Storr 1966; Sedgwick 1978; Storr 24). Some seasonal movements evident, however, in areas where present throughout year: influx noted in Eucla Div. in autumn–winter, e.g. Eyre Bird Observatory in winter (Dymond 1988; Storr 27), but also claimed that numbers on Nullarbor Plain decline in winter (McColl 1929); farther W, numbers fluctuate seasonally round Perth, populations generally increasing in spring–summer and decreasing in winter (Masters & Milhinch 1974; Brown & Brown 1983; Shannon 1984; Biddiscombe 1985; Brown *et al.* 1990). Farther N, 'some' remain throughout year at North West C. (Carter 1903).

Departure QLD: Leave Murphys Ck, near Toowoomba, Apr.–May. (Lord 1956). NSW–ACT: Leave South Coast and adjacent S. Highlands, including ACT and upper reaches of Murrumbidgee R., in late Apr. to May (Lamm & Calaby 1950; Frith 1969; Whiter 1989, 1994; Gregory-Smith 1991), though depart areas >1000 m asl in Apr. (ACT Atlas). Depart Orange after May (Heron 1973); Sydney in late summer or early autumn (Hoskin 1991); and in N. Tableland, depart sites round Inverell, Walcha and in upper reaches of Macleay R. in Apr.–May (Norton 1922; De Warren 1928; Baldwin 1975). VIC.: Numbers declined sharply at Laverton, W of Melbourne, in Apr. (Watson 1955), and mostly depart Ballarat in late autumn (Thomas & Wheeler 1983). TAS: Depart Hobart, Apr. (McClymont 1902a; Sharland & Crane 1922), and Campania, Feb.–Mar. (Park 1981a; Tas. Bird Reps 3, 4); mostly depart Lakes Country in mid-Mar., with a few remaining till early Apr. (Fletcher 1909b; Tas. Bird Rep. 8); and Devonport, on n. coast, mostly late Mar. to early Apr. (Dove 1919, 1922, 1926, 1927, 1928, 1937), though very occasionally leave earlier, in early Mar. (Lawrence 1945), and some remain till late Apr. (Dove 1912, 1924, 1931). In NW, leave Albatross I., Apr. (Brothers & Davis 1985).

Passage QLD: Recorded on n. passage Mar.–May, and s. passage July–Oct. (Storr 19). NSW–ACT: Recorded on s. passage in Illawarra Region in second half of Aug. (Gibson 1977); and n. passage through South Coast Region in late Apr. (Whiter 1989, 1994). In ACT, peaks in numbers detected Apr.–May, representing birds on n. passage, and Aug.–Sept., representing s. passage (Lenz 1981, 1982; Taylor & Davey 1985; Taylor *et al.* 1987; COG 1990; Veerman 2003). VIC.: Recorded on n. passage Mar.–May (Thomas 1968). At Wilsons Prom., n. passage recorded Apr.–June and s. passage Sept.–Nov. (Cooper 1974, 1975; Garnett *et al.* 1991); at Lerderdurg Gorge, near Bacchus Marsh, n. movements recorded late Mar. to early Apr., and s. passage mid- to late Aug. (Hewish 1999); and near Ararat, n. passage mid-Dec. to mid-Mar. and s. passage mid-Aug. to mid-Nov. (Semmens 1993). TAS.: In SE, n. passage recorded on 1 Apr. at Kingston (McClymont 1902a). In w. Bass Str., King I. used as staging point on n. passage Feb.–Apr., mostly by early Apr. (Templeton 1976); s. passage recorded Albatross I. early Sept. (Brothers & Davis 1985). In e. Bass Str., flocks on Swan, Flinders and Deal Is, early to mid-Mar. (Newman *et al.* 1984; Field & Field 1989; Garnett *et al.* 1991). SA: Recorded on passage Parra Wirra CP, Mt Lofty Ras, late Feb. to Mar. (Clarke 1967). WA: Possible s. passage of small flocks at Bunbury in spring (Whitlock 1939).

Non-breeding Non-breeding visitor to inland and n. Aust. (see Distribution and Population). QLD: Winter visitor to islands in Torres Str. (Draffan *et al.* 1983), e. C. York Pen. and Atherton Region (Wet Tropics), S to Mossman (Nielsen 1996; Storr 19) and round Richmond, where present mid- to late Apr. till Sept. (Berney 1903, 1904). NT: Scarce winter visitor to Top End (Goodfellow 2001), and farther S, Apr.–Aug. (Storr 7). N. WA: Winter visitor to parts of e. Pilbara, ne. North-East Interior and s. Kimberley Div. (Storr 1981; Storr 11, 16). S. WA: Present Gooseberry Hill, suburban Perth, Feb.–Sept. (Brooker 2001).

Return E. AUST.: Most return in late winter and early spring. QLD: Return to Murphys Ck, near Toowoomba, early spring (Lord 1956). NSW–ACT: Return Orange, Aug. (Heron 1973) and Araluen, Sept. (Gregory-Smith 1991); and in ACT, return Aug. (Lamm & Calaby 1950; Frith 1969; I. Taylor 1987b; ACT Atlas). VIC.: Return Tawonga, Aug. (Wilson 1903), Wangaratta, late Sept. (Cheney 1915). TAS: Arrive n. coast in late Aug., e.g. Launceston, 26 Aug. (Littler 1903c), La Trobe, 26 Aug. (Fletcher 1902) and Devonport, 26 Aug.–8 Sept. (e.g. Dove 1903, 1918, 1935; Lawrence 1945); Wilmot, mostly mid-Aug. to mid-Sept., though once early July (Fletcher 1902); Break O'Day Valley, near St Marys, in NE, mostly early Sept., but occasionally late Aug. (Napier 1969); Lake Country early Sept. (Tas. Bird Rep. 8); and in SE, arrive Antill Ponds 30 Aug. (Fletcher 1902), Campania late Aug. to early Sept. (Park 1981a; Tas. Bird Reps 2, 3, 4), Hobart late Aug. to mid-Sept. (McClymont 1902a; Sharland & Crane 1922; Thomas 1966; Fielding 1977), and Tasman Pen. late Sept. (McClymont 1902a,b; Le Souëf 1907).

NZ Patterns of movements poorly understood; probably resident or sedentary on NI and undertake more extensive movements on SI. NI: Described as resident or recorded throughout year in Northland (Edgar 1966), including round Whangarei (Beauchamp & Parrish 1999); and in W. Hutt Hills, near Wellington (Gibb 2000). Some movements reported, though, e.g. departed Kaikohe, Northland, 12 Mar. (Ross 1962), and sometimes seen well out to sea off Northland in autumn and early winter (Jenkins 1978; Lovegrove 1978; CSN 24), when suggested to be moving to Norfolk I. (Heather & Robertson 2000; see below). At Bay of Plenty, local movements autumn–winter to concentrations of food in estuaries, swamps and herds of cattle (P.C.M. Latham). SI: Though occur throughout year in West Coast, between Greymouth and Westport (CSN 35, 36; see below), movements recorded in various areas, but seasonal pattern poorly understood. Partial migrant in some areas (Heather & Robertson 2000): small breeding population at L. Wainono, s. Canterbury, supplemented in late Feb., with extra birds remaining till mid-Sept. (Pierce 1980; CSN 24). Flocks recorded on s. passage in Otago in autumn, e.g. at Oamaru in Mar. and Dunedin in May (CSN 24), and farther S, at Papatowai, in Southland, Mar.–May (CSN 36; see also below). Also recorded moving N through Christchurch in Apr. (CSN 37) and, in West Coast, n. passage observed at C. Foulwind, near Westport, in May (CSN 35), and seen flying N from Farewell Spit in late autumn (Heather & Robertson 2000). In Southland, occur as winter visitor, arriving in autumn and remaining till Aug., with none present in summer (CSN 22, 23, 25).

Norfolk I. Recorded in all months except Jan., but most records Mar.–Oct. (Moore 1981, 1985, 1999; Hermes 1985; Hermes *et al.* 1986).

Regular local movements Resident population near Brisbane undertakes daily movements in winter, flying W in morning and E in evening (Dawson *et al.* 1991). In Northland, apparently make local movements in winter (Edgar 1966).

Nature of passage AUST.: Gather in large flocks before departure (e.g. Le Souëf & Macpherson 1920; Carter 1924; Leach 1928; Gilbert 1935; Galbraith 1945; Watson 1955; Sharland 1958; Bedggood 1970; Brown & Brown 1991; Hoskin 1991; Vic. Bird Reps 1982, 1985). Migrate in flocks, usually of 25–300 (Sharland 1958; Bell 1961; Hobbs 1961; Thomas 1966; Field & Field 1989; Garnett *et al.* 1991; Semmens 1993; Aust. Atlas 1; Tas. Bird Rep. 13), though also sometimes singly or in twos (McClymont 1902a; Dove 1903). Birds on migration may stream past all day, possibly continuing at night (Templeton 1976). Near Ararat, Vic., flight-paths usually follow tree-lined creeks or roads between mountain ranges (Semmens 1993); and on Flinders I., Tas., moved along e. coast then out to sea (Newman *et al.* 1984). Over land, recorded moving low, mainly just above height of trees, but at heights varying from just above ground up to *c.* 300 m above ground; when flying into headwind, often pause to forage, rest or shelter (McClymont 1902a; Templeton 1976; Semmens 1993). When on migration, adverse winds may cause numbers to build up (Templeton 1976; Semmens 1993). Become restless when departing, small groups within large flocks taking off and circling, then resettling, with pattern intensifying till whole flock erupts into air, circles and leaves (Semmens 1993). Sometimes migrate with Fairy and Tree Martins (Dawson *et al.* 1991; Semmens 1993; ACT Atlas). NZ: Large numbers seen on n. passage Christchurch, passing at rate of >100 birds/h in early Apr. (CSN 37); and numbers on s. passage over Papatowai, Southland, peaked at 365 birds/h, 19 Apr. (CSN 36).

Banding Of 15,176 banded in Aust., 1953–June 2003, 826 recoveries (5.4%), of 484 birds. Of these, 817 (98.9%) were <10 km from banding place; seven (0.8%) 10–49 km; one (0.1%) 50–99 km; and one (0.1%) >100 km (ABBBS; but see below). Long-distance recovery: Near Mudgee, NSW, to Eyre Bird Observatory, WA (2206 km, 264°, 8 months, Apr., +1) (ABBBS). Long-term banding study near Manjimup, WA; of 1250 banded 1974–91, 90 (7.2%) retrapped, most presumably at or near banding sites, but one long-distance recovery of dead bird recorded at Brookton, WA, 235 km NNE, 33 months after banding; of 760 banded 1974–88, 505 were nestlings banded from 275 nests; of 176 banded by mist-netting 1 Jan.–29 Apr. 1988, 63 (36%) adults and 113 (64%) juveniles; of all recoveries, no known parents and young trapped together (Brown & Brown 1983, 1989, 1991; Brown *et al.* 1990). LONGEVITY: Adult banded at Eyre Bird Observatory, WA, 2 September 1982, recaptured >11 years 6 months later (ABBBS).

FOOD Invertebrates, mainly insects, including flies, beetles, wasps, ants and moths. **Behaviour** Forage aerially, taking prey at various heights by sallying or screening, and less often by gleaning from ground or foliage. Forage singly, in twos or flocks, and often forage with other aerial-feeding birds, especially Tree Martins (see below). DETAILED STUDIES: Near Armidale, ne. NSW, 1981–82 and 1984 (Ford *et al.* 1986). FORAGING ASSOCIATIONS: Often forage in flocks, but also singly and in twos (MacGillivray 1931; Lawrence 1945; Michie 1959b; Amiet 1964; Edgar 1966; Hornsby 1978; Claridge 1983; Baxter & Paton 1998; CSN 30). Foraging flocks vary from small, up to c. 12 birds (Gilbert 1939; Brown 1949; Sedgwick 1964; Brock 1978; Craig 1984), mid-sized, of up to 60 (Ford 1909; Morgan 1916a; Boehm 1954; Edgar 1966; Templeton 1976; Brown *et al.* 1990; Semmens 1993; Tas. Bird Rep. 9; CSN 30, 39), and very occasionally much larger flocks of 100–500, usually round rich sources of food, such as swarms of insects (Mellor 1922a, 1924a,b; Watson 1955; Storr 1965; Ross 1980, 1984; Owen & Sell 1985; Baxter 1989; Henle 1989; Hewish 2000, 2004; CSN; P.C.M. Latham); once, congregation of 3000+ seen feeding over L. Rotorua, NI (CSN 42). Occasionally, hundreds seen foraging while descending to roost-site (Bishop & Bishop 1985; CSN 32). Often forage with Tree Martins (Mellor 1924a,b; Mollison & Green 1962; Simpson 1964; Semmens 1993; Darnell & Darnell 1995; P.C.M. Latham), Fairy Martins and White-backed Swallows (Le Souëf 1918; Lord 1939); or other aerial-foraging birds, such as Dusky Woodswallows *Artamus sordidus* (Ford 1909), White-throated Needletails *Hirundapus caudacutus* (Bedggood 1965), and occasionally Whiskered Terns *Chlidonias hybridus* (Whitlock 1926), White-winged Black Terns *C. leucopterus* (Sibson 1982), Rainbow Bee-eaters *Merops ornatus* (Ford 1909) or Grey Fantails *Rhipidura fuliginosa* (CSN 39). Once, at Womboin, NSW, present in large mixed-species feeding flock, circling above flock containing 18 species of insectivores; see Cook (2002) for details of composition of flock. Also recorded feeding on swarm of flying ants with Restless Flycatchers *Myiagra inquieta*, Willie Wagtails *Rhipidura leucophrys* and Fairy Martins (Le Souëf 1918). Observed feeding on beach at Mandurah, WA, with six other species (Jenkins 1969, which see for details of other species). On Rangitaiki Plains, NZ, seen foraging with large numbers of Silver Gulls *Larus novaehollandiae*, as well as Black-winged Stilts *Himantopus himantopus*, Common Starlings *Sturnus vulgaris* and Cattle Egrets *Ardea ibis* (Latham 1981b). Once fed co-operatively with Magpie-larks *Grallina cyanoleuca* and Common Starlings on playing field, walking *c.* 50 cm behind them, then flitting into air to snatch insects thus disturbed (Brock 1978). Sometimes also forage in association with livestock, sallying for insects disturbed by them (Boehm 1954; Ross 1980; CSN 26, 33, 36); sometimes follow people walking through grass (Whitlock 1939; J.M. Peter). Also recorded foraging above seal colony (Nilsson *et al.* 1994). Sometimes follow the plough (Boehm 1957). FORAGING HEIGHTS: Forage at various heights, but usually either in and above canopy, or close to ground (Keast 1975; Cunningham & Moors 1985; see below). Near Armidale, ne. NSW, of 62 records of foraging: 21.3% at 1–2 m above ground, 11.5% 3–5 m, 13.1% 6–9 m, 4.9% 10–14 m and 49.2% 15+ m. On Rottnest I., WA, of 52 observations of foraging, May–July (means of combined monthly data): none on ground, 54% up to 1.5 m, 15% 1.5–3.0 m, 31% 3.0–4.5 m, <0.1% >4.5 m (Wheeler & Calver 1996). At ten sites in ACT, mostly foraged at >10 m (Er 1997; Er *et al.* 1998); and at Weddin Mt, NSW, mostly >15 m (Turner 1992). Sometimes recorded foraging at great heights, e.g. up to 60 m (Simpson 1964) or ≥120 m (Mollison & Green 1962). Also often forage near ground, at times skimming <1 m above grass, shrubs or surface of water (Mellor 1907, 1924a; Morgan 1916a; Dove 1917; Watson 1955; Hornsby 1978; Hobbs 1980; Park 1981b; CSN 34, 39). Very occasionally recorded feeding on ground (see Foraging sites). FORAGING SITES: Most prey taken in air. In various detailed studies, all prey taken from air: near Armidale, ne. NSW (n=62); round e. suburban Melbourne (n=24) (Green 1984);

at Rottnest I., WA (n=52) (Wheeler & Calver 1996); at Culeenup I., WA (n=35) (Keast 1975); and in W. Hutt Hills, NI (n unknown) (Gibb 2000). Sometimes take insects from foliage of trees, grass and other vegetation (Edgar 1966; Lepschi 1986); and observed perching on seed-heads of *Senecio*, removing unknown items (Smithers 1977). Very occasionally feed from ground, such as paddocks, roads, sandy beaches and clods of soil (McGilp 1930; White 1943; Boehm 1957; Edgar 1966; Hornsby 1978), and once alighted briefly among manure in garden to take newly hatched flies (Beck 1924). Seldom take insects from surface of water in lakes and ponds (Turbott 1965; Edgar 1966). Often forage in sheltered areas, e.g. in lee of rocks, levees, hedges, trees and dunes, islands, buildings or grassy paddocks (Cleland 1932; Watson 1955; Semmens 1993; CSN 19 Suppl., 39, 48; P.C.M. Latham); and in areas which attract many insects or their larvae, e.g. stables, cowsheds and piggeries, rubbish tips, silage outflows, sewage ponds and sediment ponds, or clumps of beachcast seaweed (Mellor 1930; Whitlock 1939; Shanks 1960; Edgar 1966; Jenkins 1969; Hobbs 1986; Beauchamp & Parrish 1999; Storr 28; CSN 19 Suppl., 39); also round fires, hunting in smoke for insects disturbed by fire, or caught in updraught (Barker 1939; Edgar 1962, 1966; Simpson 1964); or at clifftops (Mitchell *et al.* 1996; CSN 31; J.M. Peter), also possibly where insects caught in updraught. Once recorded foraging at night, taking moths attracted to lights (Hobbs 1966). Sometimes flutter round windows, flyscreen doors, walls, eaves and roofs of buildings to catch insects (Dove 1905; Barrett 1922; Mellor 1930; Serventy 1958; Edgar 1966; Tarburton 1993). Forage in airspace above many different open habitats, including water of terrestrial wetlands and sea (see Habitat). FORAGING METHODS: Forage almost entirely by screening or sallying (probably mostly referring to screening of *HANZAB*) (e.g. McClymont 1902a; Mellor 1907, 1924a; Ford 1909; Morgan 1916a; Campbell & Barnard 1917; Barrett 1920; Whitlock 1926; MacGillivray 1931; Cleland 1932; Geary 1932; Barker 1939; Sedgwick 1940b; Hindwood 1948; Boehm 1954; Hall 1960; Edgar 1962; Mollison & Green 1962; Simpson 1964; Fleming 1976; Templeton 1976; Ross 1980; Bishop & Bishop 1985; Cunningham & Moors 1985; Ford *et al.* 1986; Semmens 1993; Nilsson *et al.* 1994; Wheeler & Calver 1996; CSN 26, 32, 37, 39, 41; see below). Near Armidale, ne. NSW, of 62 foraging records, all by screening; on Rottnest I., WA, of 52 observations of foraging, all by sallying (probably screening; Wheeler & Calver 1996); in sclerophyll forest in ne. Tas., of 21 observations of foraging, all by sallying (probably screening; Cale 1994). Sometimes forage by flying low into strong wind, snapping insects, then rising and turning back, then repeating process (Hornsby 1978; Hewish 2000). Forage in swarms of insects by making fast, level passes through swarm, close to ground (CSN 39). Very occasionally forage by gleaning. Recorded gleaning ants from ground (McGilp 1930), invertebrates from beachcast seaweed (Whitlock 1939), insects from glass of window, while clinging to sash bar of window (Dove 1905) and material from seed-heads (Smithers 1977); also recorded taking insects from foliage by hover-gleaning (Lepschi 1986). FORAGING TIMES: Though forage throughout daylight hours, apparently mostly in morning, usually 08:00–11:00 (Cleland 1932; Barker 1939; Brock 1978; Klapste & Klapste 1985; CSN 39, 48) and late in afternoon or evening (Templeton 1976; Bishop & Bishop 1985; Hewish 2002b; CSN 30, 32), e.g. 19:15–19:30 (Ford 1909), or for 20 min before sunset (Coleman 1943). DRINKING: Sometimes drink in flight, skimming low over water (Edgar 1966; Blyth 1997); drink at pools, creeks, soaks, troughs and tanks (Storr 1965; Edgar 1966; D.C. Paton & P.A. Paton 1980).

No detailed studies—**Aust. Animals** CRUSTACEANS: Amphipoda: sand-hoppers[26]. SPRINGTAILS: Collembola: Sminthuridae: *Sminthurus viridus*[14]. INSECTS[1,4,10,11,12,13,14,17,20,22,24,25,26,28,32,35,36,37,38,40,42,43,44,45,47,49,51,52,53,55]: Coleoptera[10,27,40,54,55,57]: Anthicidae[41,57]; Carabidae[41,57]: *Clivina*[41,57]; *Notagonum submetallicum*[41,57]; Chrysomelidae[41,57]; Curculionidae[40,41,57]: *Aphela helopoides*[17]; Dytiscidae[41]; Hydrophilidae[41]: *Berosus australiae*[41,57]; Scarabaeidae: Aphodiinae[41]; Staphylinidae[46]; Diptera[2,3,5,6,7,8,18,19,24,26,27, 29,31,40,41]: gnats[4,5,6,7]; Bombyliidae[46]; Calliphoridae[30]; Chironomidae[34,56]; Coelopidae[36,56]; Culicidae[26,54,57]; Dolichopodidae[40,57]; Muscoidae[57]: Muscidae[17]: *Musca domestica*[50,54]; Syrphidae[57]: *Syrphus viridoceps*[57]; Tabanidae[41,57]; Tephritidae[57]; Tipulidae[46]; Hemiptera[46]: Corixidae[57]; Lygaeidae[41,57]; Reduviidae[40]; Hymenoptera[27,38,40,46]: Braconidae[40]; Formicidae[17,20,40,41,55,57]: alates[9,16,39,40]; *Camponotus* alates[33]; *Iridomyrmex*[41,57]; *I. purpureus*[41,57]; *Pheidole*[41,57]; *Rhytidopon-era*[41,57]; Ibaliidae: *Ibalia leucospoides*[48]; Siricidae: *Sirex noctilio*[48]; Lepidoptera[40]: moths[24]; Orthoptera: grasshoppers[21]; Plecoptera[57]; Trichoptera[46]. **Other matter** Glass[38].

REFERENCES: [1] McClymont 1902a; [2] Dove 1905; [3] Mattingley 1907; Mellor [4] 1907, [5] 1922a, [6] 1924a, [7] 1924b, [8] 1930; [9] Ford 1909; [10] Cleland 1911; Morgan [11] 1914a, [12] 1916a, [13] 1916b; White [14] 1916, [15] 1943; [16] Le Souëf 1918; [17] Lea 1923; [18] Beck 1924; [19] Chisholm 1924; McGilp [20] 1930, [21] 1935; [22] Geary 1932; [23] Simpson 1933; [24] Woodroffe 1938; [25] Barker 1939; [26] Whitlock 1939; [27] McKeown 1944; Boehm [28] 1954, [29] 1957; [30] Serventy 1958; [31] Warham 1960; [32] Mollison & Green 1962; [33] Bedggood 1965; [34] Storr 1965; [35] Green 1967; [36] Jenkins 1969; [37] Lavery 1969; Rose [38] 1973, [39] 1974, [40] 1999; [41] Vestjens 1977; [42] Brock 1978; [43] Harris 1980; [44] Hobbs 1980; [45] Ross 1980; [46] Park 1981b; [47] Wooller & Calver 1981; [48] Madden 1982; [49] Klapste & Klapste 1985; [50] Hobbs 1986; Lepschi [51] 1986, [52] 1992; [53] Semmens 1993; [54] Cleland; [55] Hall; [56] Storr 28; [57] FAB.

No detailed studies—**NZ Animals** INSECTS[1,3,6,7,8]: Coleoptera[3]; Diptera[3]: Chironomidae[2,3,4,5,8]; Lepidoptera: butterflies[3].

REFERENCES: [1] Michie 1959b; [2] Turbott 1965; [3] Edgar 1966; [4] Hollay 1971; [5] Beauchamp & Parrish 1999; CSN [6] 36, [7] 37, [8] 39.

Young Fed by both parents (see Breeding), and occasionally by helpers (see Social Organization: Co-operative breeding). Nestlings fed as soon as hatched (Tarburton 1993; NRS), though sometimes not for first 2 days (Salter 1960). In NZ, nestlings fed at short intervals in morning and evening; intervals between feeds increase in middle of day; at one nest, not fed for up to 2 h in morning and up to 3 h later in day (Edgar 1966). Near Masterton, NI, young nestlings fed at intervals up to 1 h, decreasing to *c.* 30 min nearer to fledging; intervals varied much after fledging, but usually shorter in twilight (Crouchley & Crouchley 1979). A nest with three 4-day-old nestlings and one 3-day-old nestling was visited 430 times, 05:37–20:45 (a visit every 2.1 min); 61% of feeding visits were by male (Tarburton 1993). At one nest, during peak of feeding in second week, when helpers present, rates of feeding visits included six in 5 min, 32 in 30 min and 56 in 60 min (Salter 1960). At another nest, 10-day-old young fed 36 times in 1 h (Marchant & Fullagar 1983). At Salt Ck, SA, nestlings first fed at 05:30, and fed every 2.5 min (Sutton 1933). At Heytesbury, Vic., a nest with five nestlings visited every 3 min; of 20 visits in 1 h, ten made by each parent (Hall 1900). Nestlings fed from daylight till dark (Mellor 1930), and sometimes fed after sunset (Tarburton 1993) or, very occasionally, at night (Littler 1904): at Burronga, NSW, nestlings fed mostly at night, food largely comprising moths taken from round lights (Hobbs 1966). Fledgelings fed by parents for 2 weeks (Salter 1960; Crouchley & Crouchley 1979); fed in flight (Hall 1900, 1924; McClymont 1905; Hall 1924; Salter 1960; Edgar 1966; Ross 1983; Rowe & Rowe 1996; Woolley 1996; CSN 44; NRS), on ground (McClymont 1905), while perched (Crouchley & Crouchley 1979; Rowe & Rowe 1996) or in nest (NRS); when fed in flight, adult and young bird both fluttered up, face to face, with bills touching, transferring food (Hewish 2003). One pair, with nest in well, fed chick that had fallen from nest and was perched on leg of goanna clinging to wall of well (Scott 1962). In captivity, nestlings recorded feeding siblings (Nicholls 1962).

No detailed studies. (All records from Aust. except Cowan [1971], which from NZ.) **Plants** Wood fragment[7]. MONOCOTYLEDONS: Poaceae: grass[7]. **Animals** MOLLUSCS: Piece of shell[7]. INSECTS[5,6,7]: Coleoptera[7]: Carabidae[5]; Cerambycidae[5]; Diptera[1,3]: gnats[3]; Culicidae[3]; Tipulidae[5]; Hemiptera: Cicadidae[2]; Hymenoptera[7]; Lepidoptera: moths[4]. SPIDERS[7]. **Other matter** Ball of down and hair[7].

REFERENCES: [1] Beck 1924; [2] Chisholm 1924; [3] Mellor 1930; [4] Hobbs 1966; [5] Cowan 1971; [6] Ross 1983; [7] Rose 1999.

SOCIAL ORGANIZATION Reasonably well known. Studies include: breeding biology of colour-banded birds (25 adults, 213 nestlings) at Campania, s. Tas., 1971–76 (Park 1981a,b); breeding biology at Ivanhoe, w. NSW, 1973–74 (Schrader 1976); breeding biology at various sites in se. Aust., especially Murwillumbah, NSW, 1989–91, and in NZ, round Longburn, Manawatu, 1985–88, with extra information from NRS and various museums (Tarburton 1993); roosting and pair-bonds of 230 banded birds near Manjimup, sw. WA, 1977–88, including intensive study of five colour-banded males and seven colour-banded females, 1986–88 (Brown *et al.* 1990). Also, detailed observations of general habits and breeding, Northland, 1958–65 (Edgar 1966); of pair breeding over one season at Black Rock, Vic. (Salter 1960); and of captive population in Taronga Zoo, Sydney, 1986 (Disney 1988). GREGARIOUSNESS: *AUST.*: Sometimes recorded singly and in twos (presumably pairs), and often in flocks of up to 30 (Boehm 1957; Bell 1961; Sharland 1958; Bravery 1970; Gepp & Fife 1975; Longmore 1978; Passmore 1982; Nichols & Nichols 1984; Cale 1992; Britton & Britton 2000; Storr 16, 22, 26, 27, 28, 35), and occasionally in larger flocks of 100–350 (Lashmar 1946; Hopkins 1948; Lavery & Hopkins 1963; Bedggood 1973, 1980; Hirth 1976; Gosper 1981; Thomas & Wheeler 1983; Saunders & de Rebeira 1993; Serventy & Whittell; Storr 28, 35). In autumn and winter, form large flocks comprising up to 2000 birds, in preparation for migration, and migrate in flocks of 30–300, though also arrive on breeding grounds in pairs (see Movements: Nature of passage). For size of foraging flocks, see Food. *NZ*: Occur in flocks of 10–50 (Ross 1962; Edgar 1966; Munro 1969; Sagar 1976; CSN 19 Suppl., 20, 36), up to 100 (Ross 1962; Edgar 1966; CSN 19 Suppl., 20, 26), or occasionally up to 250 (CSN 22, 24, 30). Mostly occur in flocks Apr.–Sept. (CSN 19 Suppl., 23), though flocks may form as early as late Dec. to Jan., comprising up to 200 adults and young (Ross 1962; Edgar 1966; Andrew 1967; CSN 22). Sometimes occur in mixed flocks with other swallows (Collins 1995), especially Tree Martins (Mellor 1931; Parker 1971; Masters & Milhinch 1974; Nevill 1984; Dawson *et al.* 1991; Saunders & de Rebeira 1993; Semmens 1993; Darnell & Darnell 1995; Tas. Bird Rep. 14), Fairy Martins (Carter 1924; Watson 1955; Gibson 1986) and sometimes White-backed Swallows (Souter 1928; Jeffery 1955; Parker 1971).

Bonds Apparently monogamous; nest in pairs (Morgan 1916a; Park 1981a). Bonds may be seasonal (Park 1981a) or maintained throughout year (Saunders & de Rebeira 1993). At Campania, Tas., often change partners each year, and one female had three different partners in three successive breeding seasons; longest pair-bond lasted for three seasons. If both partners returned to breeding grounds they usually stayed together as a breeding pair. Sometimes change partners during season, usually due to one bird disappearing. One male changed partners during season: started with new female, then reunited with mate from previous breeding season, but when she disappeared, he paired with a third female, with whom he also paired in following year (Park 1981a). Pairs near Manjimup, sw. WA, changed partners in successive breeding seasons (Brown *et al.* 1990). AGE OF FIRST BREEDING: One male, banded as a nestling, paired with a female in following season, breeding when 8 months old (Park 1981a). One 14-month-old bird had a brood-patch, and probably bred at 1 year old (Brown & Brown 1989). **Co-operative breeding** A few records of helpers attending nest (NRS). At Black Rock, Vic., when nestlings 5 days old, up to six extra birds attended nest, feeding young and removing faecal sacs, and sometimes sat in a row near nest, waiting to bring food, leaving immediately after attending nestling. When nestlings 16 days old, parents drove helpers from nest; helpers allowed to feed fledgelings (Salter 1960). **Parental care** Both parents feed nestlings and fledgelings (see Breeding), and remove eggshells and faecal sacs, carrying them away from nest, though at one nest mostly by male (Edgar 1966; Tarburton 1993; see Breeding: Young). **Dispersal of young** Fledgelings remain round nest-site till independent, then, when able to fly strongly, disperse (Edgar 1966; Crouchley & Crouchley 1979; Marchant & Fullagar 1983; Saunders & de Rebeira 1993; Green 1995; North; NRS), though some form small flocks that remain in area while second or third brood attended (Edgar 1966). Disperse over wide area (Brown & Brown 1989), progressively and radially from natal area to find new nesting sites at increasing distances (Edgar 1966). One fledgeling, 36 days old, was trapped 2 km from natal site (Brown & Brown 1989). Only one of 213 banded nestlings returned to breed in natal area (Park 1981a).

Breeding dispersion Nest both singly and colonially; mostly singly (White 1952; Brown & Brown 1989, 1991; Aust. Atlas 1; NRS). In NZ, apparently nest singly more often than in Aust. (Edgar 1966; Tarburton 1993). Near Manjimup, WA, only three sites contained more than one pair, and none held more than three pairs; single nests were more likely to be successful than nests in colonies; when nests near each other, usually out of view, or breeding cycles were staggered (Brown & Brown 1991). Degree of colonial nesting may be overstated, as birds sometimes build more than one nest (Tarburton 1993; NRS), e.g. seven nests once built by one pair (Anderson 1940), and nests from previous seasons often remain, with new nests built nearby (Sutton 1929, 1931b; McGill & Lane 1955; Marchant & Fullagar 1983; Tarburton 1993). In Aust., colonies usually comprise up to 45 active nests (Marchant & Fullagar 1983; Burbidge 1985; Saunders & de Rebeira 1993; Tarburton 1993; Aust. Atlas 1; Tas. Bird Rep. 7; NRS), though 500 birds nested in deserted farmhouse near Moonta, SA (Aust. Atlas 1). In NZ, colonies comprise up to five active nests (Edgar 1966): at Longburn, NI, each of 27 sites had a single pair, but up to seven nests (Tarburton 1993); at Hokianga, 143 of 146 sites (97.9%) occupied by single pairs, one site with two pairs, and two sites with three pairs (Cowan 1968); of 240 nests at 200 sites in Northland, 169 (84.5%) contained one nest, 25 (12.5%) had two nests, three (1.5%) had three nests and three (1.5%) had four nests (Edgar 1966); at Whangarei, NI, no bridge surveyed had more than one active nest, but *c.* 50% had 2–6 nests (Munro 1973). DISTANCE FROM NEIGHBOURING NESTS: *AUST.*: 3.18 m (4.45; 1.00–14.00; 16); *NZ*: 2.24 m (1.35; 1.00–6.00; 29) (Tarburton 1993). Once, two nests *c.* 45 cm apart, but only one nest successful (Ross 1960); active nests usually ≥1 m apart (Brown & Brown 1991; NRS). At Rotamah I., Vic., nests occasionally <20 cm apart on opposite sides of beam (A.H. Burbidge). Once, one apparently laid eggs in two nests built *c.* 20 cm apart (Roberts 1940b). Nests sometimes near nests of other species, as close as 3 m, including Fairy Martins (Conole 1981; NRS). **Territories** Though often nest colonially, defend area round nest; area defended varies with nest-site (Park 1981b; Disney 1988; Brown *et al.* 1990; Brown & Brown 1991). One pair sat 4–6 m from nest and called loudly when other Swallows flew nearby (Park 1981b).

Roosting ADULTS: Roost at night. Often roost in vegetation, especially reed beds (Morgan 1916a; Coleman 1943; Brown & Brown 1983, 1989, 1991; Thomas & Wheeler 1983; Bishop & Bishop 1985; Brown *et al.* 1990; CSN 32, 33, 34); also in trees, including hollows (Dove 1923; CSN 21, 32), caves (De Warren 1928; Lindgren 1956; Saunders & de Rebeira 1993; North), rock-faces, e.g. cliffs or in crevices (Cale 1992; Miskelly *et al.* 2001; North), active and old nests (Ross 1960; Storr 1965; Cooper 1975; Brown *et al.* 1990; Brown & Brown 1991; Saunders & de Rebeira 1993; CSN 25, 32, 37), on fences, overhead wires or clotheslines (Saunders & de Rebeira 1993; CSN 21), under shelter of bridges, roofs, eaves, verandas and the like (Barrett 1916; Stephen 1916; Ford 1922; Brookes 1968; Gosper 1981; Congreve & Congreve 1985; Brown *et al.* 1990; Ashton *et al.* 1996; CSN 42), on ledges on buildings (Gilbert 1935; North; NRS), under jetties or bridges (Gosper 1981; Burbidge 1985; CSN 21), on ground (Hopkins 1948) or down wells (McGilp 1925). During breeding season, including while nest still being built, roost at nest, one in nest, the other next to it on nest-rim, on an old nest or on a nearby perch, e.g. 60 cm away (McGilp 1930; Schrader 1976; Wood 1973; Park 1981b; Tarburton 1993; NRS). One pair did not roost in nest till first egg laid; another pair roosted on nest when only half-built (Park 1981b). After breeding season, pair may continue to roost in nest, which relined before roosting in winter, with one inside and one next to nest, but during cold weather, both roost in nest (Salter 1960; Cooper 1975; Brown & Brown 1983; NRS). On cold nights, sometimes both adults roost in nest (Park 1981b). Some pairs continue to roost side by side at nest-site after nest has fallen (Saunders & de Rebeira 1993; NRS). During non-breeding season, often roost communally, sometimes in groups of >500 (Stephen 1916; Ford 1922; Dove 1923; Thomas & Wheeler 1983; Brown & Brown 1989, 1991; Brown *et al.* 1990; Saunders & de Rebeira 1993; North; Serventy & Whittell; CSN 21, 32, 33), e.g. *c.* 1000–3300 (Brookes 1968; Gosper 1981; Bishop & Bishop 1985). Large groups may perch side by side, spaced out at 'peck distance' apart (Ford 1922; Congreve & Congreve 1985; North); one group perched in rows regularly spaced, one line facing E and another facing W, so that no droppings fell on lower birds (Coleman 1943). Occasionally roost in flocks with Tree Martins (Saunders & de Rebeira 1993). On frosty nights, birds roosting under corrugated iron would sometimes have feathers stuck fast; either freed themselves, losing feathers in the process (Anon. 1930), or waited till ice melted (White 1910). Once, pair roosting in culvert appeared to have become torpid: they were unresponsive to torchlight, and had feathers fluffed and bills tucked in (Brown *et al.* 1990). Flocks usually arrive at roost-sites round dusk, though timing depends on weather, with a few arriving later, in twilight; and leave at first light, though sometimes much later in winter (Barrett 1916; Stephen 1916; Ford 1922; Coleman 1943; Salter 1960; Brookes 1968; Ashton *et al.* 1996; North; NRS). Flocks may fly round roost-site, feeding, before going to roost, or perch in groups nearby before going to roost simultaneously (Coleman 1943; Bishop & Bishop 1985; Brown & Brown 1989; North; CSN 32). YOUNG: Sometimes recorded roosting in nest with nestlings; once one roosted with nestlings while other roosted outside nest, nearby (Wood 1973). Fledgelings return to nest to roost for up to 5 weeks after fledging (McGilp 1930; Salter 1960; Wood 1973; Schrader 1976; NRS), though sometimes roost for first few nights huddled together near nest (NRS). After independence, cease roosting in nest, and may instead huddle together near nest-site (Salter 1960; Schrader 1976; NRS). Adults seldom roost in nest with fledgelings (NRS), but occasionally do so (Salter 1960; Wood 1973; CSN 32); usually roost nearby instead, returning to nest in morning to collect fledgelings (Salter 1960; Wood 1973; Morrison 1987; NRS); once, both adults plus two juveniles roosted in nest with three eggs (Park 1981b). Once, smallest fledgeling of brood was enticed back into nest by parents, where it roosted alone (NRS). Adults may roost with offspring during winter (Schrader 1976; CSN 21). LOAFING: Loaf during day, often in large numbers perched in rows, on overhead wires (Carter 1924; Edgar 1966; Templeton 1976; Nevill 1984; Brown *et al.* 1990; Semmens 1993), aerials (Sutton 1930b), wire fences (Mellor 1931; Edgar 1962, 1966; Smithers 1977; Semmens 1993; Hewish 1999; CSN 48), clotheslines (CSN 29), among foliage of shrubs or trees or other vegetation (Semmens 1993; Hewish 1999), stumps, logs and the like (Sibson 1960; Edgar 1962, 1966), roofs (Edgar 1966), and occasionally on ground, including muddy edge of lake (Mellor 1931; Sedgwick 1940b; Sibson 1960; Edgar 1962; Twaits 1998). Fledgelings shelter in nest during heat of day (McGilp 1930; NRS); and during inclement weather, pair shelter in nest, sometimes with fledgelings (Salter 1960), and often shelter on beams under bridges or on the lee side of buildings (Ford 1922; Templeton 1976; North).

SOCIAL BEHAVIOUR Well known. For details of studies and detailed observations, see Social Organization. Commonly occur near human settlement (see Habitat), and nests are therefore accessible and easily examined (Mellor 1930; ACT Atlas). Often allow close approach (Anon. 1907; Sullivan 1927; Findlay 1960; Edgar 1966; Campbell). At one nest-site in railway station, adults repeatedly flew in and out of building by fluttering in front of electronic sensor that controlled door (McKnight & McKnight 1991). **Flock behaviour** Flocks call constantly while foraging (Edgar 1966). Two birds, one adult and apparently an immature, sometimes flew together in playful chases (Sibson 1960). **Maintenance behaviour** Often preen while perched (Broadbent 1910). Often sun themselves, for up to 1 h at a time, either on ground or perched above (Dennison 1974; Fleming 1976; Lenz 1981; Park 1981b; Nevill 1984; Klapste & Klapste 1985; CSN 23, 24, 31); sunning recorded in pair with young (CSN 31), in small groups (Dennison 1974; Klapste & Klapste 1985), and a group of 12 on frosty morning (CSN 23); once up to *c.* 290 seen sunning on edge of road (Klapste & Klapste 1985). Lie on side at right angles to sun, spreading tail-feathers, extending and partly raising one wing, raising contour-feathers, opening bill and closing nictitating membranes (Dennison 1974; Park 1981b; Klapste & Klapste 1985). After 1–2 min, may fly to perch and preen (Park 1981b). Once seen dust-bathing, lying on belly and shuffling in dust for a few seconds, then stood up, shook itself and flew off (Klapste & Klapste 1985). Occasionally recorded bathing (Fletcher 1909a; Hood 1941; Schrader 1976); once, after bathing in hot weather, returned to nest and perched over nestlings (Schrader 1976). During hot weather, nestlings gape and pant (Schrader 1976; NRS). During inclement weather, huddle together with feathers fluffed out (North).

Agonistic behaviour At start of breeding season, agonistic behaviour occurred when competing for nest-sites (Brown & Brown 1991). **Threat displays** Nest-sites defended vigorously against conspecifics, calling at and chasing any Swallows near nest or nest-site (Salter 1960; Park 1981b; Disney 1988; Brown *et al.* 1990; NRS). **Attack and fighting** Territorial defence sometimes involves fighting and interference at nests. Once eggs were removed from nest and broken, and lining pulled up by competing birds (NRS). Fighting while building nest resulted in one adult being found dead, partly buried in mud wall of nest (Campbell). When bird attempted to roost near nest, resident pair drove it away, and once, male and intruder grappled and fell to ground, locked together, with male pecking intruder violently (Salter 1960). Once, male attacked a third bird that regularly approached nest, but this bird later mated with female when original male died; new male attacked young in nest, especially the smallest, which he sat on and viciously pecked its head; it later died (Park 1981a). Adults occasionally attack young from nearby nests (Park 1981a; Brown & Brown 1991; Tarburton 1993). **Escape behaviour** When stooped at by Australian Hobby *Falco longipennis*, one evaded capture with a fast spiralling dive while giving Alarm Call (Debus *et al.* 1991). **Alarm** Give Alarm Call when intruder near nest, when mobbing potential predator or when being chased by one (Edgar 1966; Debus *et al.* 1991; Rose 2001). A Hobby that caught an adult in mid-air was mobbed by many other Swallows (Rose 2001); another that was perched on fence post was dived at by a pair till it flew away (Storr 1947). Also mob other species, especially when nesting (NRS), including Brown Goshawk *Accipiter fasciatus* (J.M. Peter), owls (Jurisevic & Sanderson 1994), Grey Butcherbird *Cracticus torquatus* (Hewish 2004; J.M. Peter) and a Stoat (CSN 45). **Interactions with other species** Attack other species that use favoured perch, including a Buff-breasted Sandpiper *Tryngites subruficollis* (Smith 1962) and a Sacred Kingfisher *Todiramphus sanctus* (CSN 22), and a Common Sandpiper *Actitis hypoleucos* that trespassed onto feeding territory (Smith 1964). Sometimes also aggressive towards other species (Shaw 1991; CSN 23, 45), diving at or chasing shags (CSN 26), a Wrybill *Anarhynchus frontalis* (CSN 39), Black-fronted Dotterels *Charadrius melanops* (CSN 37), a Whiskered Tern (Brown & Habraken 1979), a White-winged Black Tern (CSN 28, 35), Swamp Harriers *Circus approximans* (Hedley 1983), and New Zealand Falcons *Falco novaeseelandiae* (Shaw 1991; CSN 45). When nesting, aggressive towards other species near nest or fledgelings, such as Striated Heron *Butorides striatus*, Swamp Harrier, New Zealand Falcon, Nankeen Kestrel *Falco cenchroides*, Sacred Kingfisher, Laughing Kookaburra *Dacelo novaeguineae*, Noisy Miner *Manorina melanocephala*, Pied Currawong *Strepera graculina* and House Sparrow *Passer domesticus* (Turbott 1965; Park 1981b; Anon. 1989; CSN 23, 32; NRS). A pair swept back and forth through flock of honeyeaters at feeding dish 5 m from nest (Salter 1960); and a Rufous Whistler *Pachycephala rufiventris*, which became agitated and attacked its reflection in window, was swooped at by Swallows from nearby nest, calling and flying back and forth, just skimming its head (Salter 1958). Once, pair aggressive towards nesting Dusky Robins *Melanodryas vittata*, flying back and forth in front of sitting bird, often snapping their bills, at which sitting bird left nest to chase them, and they even landed on nest; nestlings subsequently disappeared and Robins deserted nest, which Swallows then usurped (Fletcher 1904).

Sexual behaviour Pair-formation After death of mate, presumed male abandoned nest with nestlings and perched nearby, calling persistently; a female roosted near him that night, and they subsequently paired and successfully bred (Park 1981a). Once, a female paired with a male that harassed her previous mate before he died; new male appeared to take over territory, but did not attend brood from previous partner, and attacked one of the fledgelings and apparently killed it (Park 1981a). When new pair is formed, male appears to try to persuade new female to accept nest by flying together near nest. Female will often accept nest or nest-site, but a new male would not usually do so when pairing with a widowed female (Brown & Brown 1991; NRS). During nest-construction, pair often perch on wire together and sing (Salter 1960). **Courtship displays** Apparent aerial courtship displays described, though none seen culminating in copulation. Pairs perform high-level chasing flights round nesting territory, either with male following female or birds following each other in wide circles; or at lower levels, slow, almost hovering flights are accompanied by much tail-fanning by one or both birds (Edgar 1966; Tarburton 1993). Members of pair perch together, quietly twittering; only male said to Sing during courtship (Disney 1988). Sometimes squat, occasionally extending wings, and move towards each other, curtsey and touch bills in reciprocal feeding movements, though no food exchanged (Roberts 1945; Edgar 1966); one pair then flew round, possibly inspecting nest-site, then returned to perch and continued displaying (Roberts 1945). One chasing wind-blown feather doubtfully interpreted as part of courtship activity (Edgar 1966). Said to be triggered by warm weather (Hobbs 1966). **Courtship feeding** Sometimes incubating bird fed on nest by partner (Fletcher 1904; McGilp 1930; Wood 1973), but not always (Park 1981b; Tarburton 1993); sometimes bird leaves nest to be fed, having been called by mate (Fletcher 1904; Schrader 1976). Once, sitting bird fed, thought to be on day of hatching (Disney 1988). Female may perch with open bill while male flies round, before perching beside or hovering in front of her; food then offered (Edgar 1966). **Pair-bond maintenance** Pairs often perch together and chatter to each other, including when building nest (Edgar 1966; Park 1981b). Possible mate-guarding may occur: male often sits near nest when female laying eggs and during incubation, and also accompanies her when flying to or from nest, or following her in display flights 3 days before eggs hatched (Park 1981b; Tarburton 1993). **Copulation** Seldom seen. Male briefly alights on female (Disney 1988). Occurs near nest (Park 1981b) or away from it (Tarburton 1993). Observed during nest-construction in both wild and captivity (Disney 1988; NRS), and during laying (Park 1981b).

Relations within family group Brooding usually by female (see Breeding). Female sometimes waited till male arrived at nest before they left together to feed, and male also often accompanied female when she returned to nest (Tarburton 1993). Adults roost on nest with nestlings (NRS). Both adults feed young (see Breeding). Three-day-old nestlings only begged after parent called; by 6 days, raised their heads without vocal stimulus (Mellor 1930; Schrader 1976; Park 1981b; Tarburton 1993); some push themselves forward to receive food, then retreat when satisfied, allowing others to be fed (NRS). Once, when both parents arrived at nest together with food, and nestlings did not beg, ate food themselves (Tarburton 1993). At one nest, female continued to feed nestlings when her mate died; another nest abandoned after female died (Park 1981a). After feeding, parents remove faecal sacs (see Breeding), often stimulating nestlings first by nudging them near cloaca (Edgar 1966; Park 1981b; Tarburton 1993; NRS). During hot weather, nestlings may put their heads over edge of nest (NRS). At one nest, nestlings fell from

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Plate 43 (N. Day)

Yellow-bellied Sunbird *Nectarinia jugularis* (page 1464)
SUBSPECIES *FRENATA*: **1** Adult male; **2** Adult female;
3 Immature male; **4, 5** Adult male

Mistletoebird *Dicaeum hirundinaceum* (page 1476)
6 Adult male; **7** Adult female; **8** Juvenile; **9** Immature male; **10** Adult male; **11** Adult female

Red-capped Flowerpecker *Diceaum geelvinkianum* (page 1491)
SUBSPECIES *ALBOPUNCTATUM*: **12** Adult male;
13 Adult female; **14** Juvenile;
15, 16 Adult male

nest repeatedly and were replaced by observer; later, when nestlings climbed onto nest-rim, adults fluttered against them, forcing them back into nest (Anon. 1912). Adults said to encourage nestlings to fledge (NRS), by giving same call as when they arrive with food (Park 1981b) or by pushing young out of nest (Mattingley 1907; Salter 1960); also said to stop feeding young, with female preventing male from feeding them, to entice them out with food (Salter 1960). When fledging, family group twitters (Edgar 1966; Salter 1960) and parents fly to and from nest before and after young fledge (Salter 1960). On day of fledging, parents appeared to call in other adults to fly round nest calling, apparently to entice nestlings out. When young left nest, they flew low, accompanied by adults; later in day, after all had fledged but returned to nest, five adults flew round again but parents sent them away (NRS). Parents apocryphally claimed to teach young to fly by carrying them from nest, each holding a wing-tip (Hobbs 1966). Once, fledgeling roosted in nest with incubating female, sometimes sitting on eggs during day while female absent; remained till 5 days after eggs hatched, when attacked by female, driven away, and not seen again (Salter 1960). Fledgelings often roost in nest (see Social Organization [Roosting] and Breeding [Fledging to independence]), but parents may discourage fledgelings from roosting in nest after *c*. 4 weeks (though some stay for up to 5 weeks; see Breeding); then roost nearby in huddled group for up to 8 weeks after fledging (Schrader 1976; Dedman *et al.* 1998). A week after fledging, pair seen trying to draw young away from nest (NRS). Both parents feed fledgelings (see Food, Breeding). Brood remains together for up to 12 days after fledging, and some fledgelings associate with parents for up to 42 days after fledging (NRS). Adults move young away from nest-site when independent, and then they disperse (see Social Organization: Dispersal of young). Chased away if second clutch laid (Mattingley 1907); once, female started second clutch while male attended fledgeling, but when eggs hatched, fledgeling chased away (Salter 1960); at another second clutch, female tried to keep rest of family away from nest (NRS). However, fledgelings also seen round nest with second brood of nestlings, 46 days after fledging (NRS). After independence, young still remained together, occasionally joining parents near nest at dawn (Salter 1960). **Anti-predator response of young** Nestlings, usually *c*. 16 days old, sometimes flush from nest prematurely when approached (Edgar 1966; Park 1981b; NRS); some return to nest (NRS), but others may remain on ground, where fed by parents (NRS). Nestlings crouched in nest when agitated Rufous Whistler nearby (Salter 1958). On day of fledging, young returned to nest when Pied Currawong appeared, possibly in response to calling and actions of adults (NRS). **Parental anti-predator strategies** Some sit tight on nest with eggs or new nestlings (NRS), one allowing itself to be stroked (Campbell); others leave nest at approach of observer, returning only when person leaves (Hankins 1963; NRS); one pair would not approach nest when person nearby (NRS). May desert nest or eject nestlings due to human interference, such as examining nest (Disney 1988). At one nest, male guarded nestlings when female left to forage, so that young guarded by at least one parent for ≥80% of time (Tarburton 1993). Nesting birds aggressive to intruders, including conspecifics, people and others, giving Alarm Call and swooping closely till they leave (Salter 1960; Hobbs 1966; Park 1981b; Anon. 1989; Brown *et al.* 1990; CSN 26; NRS; see Agonistic behaviour); and strongly defend fledgelings (Dedman *et al.* 1998). One or both parents may attack intruder, and others from nearby may join in (Salter 1960; Turbott 1965; NRS). When fledgelings harassed by miners *Manorina*, parents herded them away to be fed (NRS). Once, when fledgeling taken by Nankeen Kestrel, parents did not attempt any defence (Butler 1975).

Plate 44 (K. Franklin)

White-backed Swallow *Cheramoeca leucosternus* (page 1499)
1 Adult; **2** Juvenile

Barn Swallow *Hirundo rustica* (page 1508)
SUBSPECIES *GUTTURALIS*: **3** Adult male; **4** Juvenile

Welcome Swallow *Hirundo neoxena* (page 1517)
NOMINATE *NEOXENA*: **5** Adult male (fresh plumage);
6 Adult male (worn plumage); **7** Juvenile

Red-rumped Swallow *Hirundo daurica* (page 1549)
SUBSPECIES *JAPONICA*: **8** Adult male; **9** Juvenile

Tree Martin *Hirundo nigricans* (page 1553)
10 Adult; **11** Juvenile

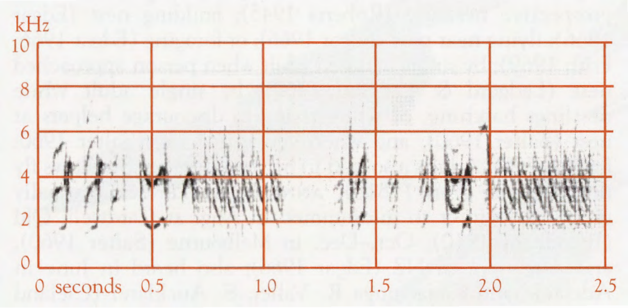
Fairy Martin *Hirundo ariel* (page 1568)
12 Adult; **13** Juvenile

Asian House Martin *Delichon dasypus* (page 1583)
NOMINATE *DASYPUS*: **14** Adult

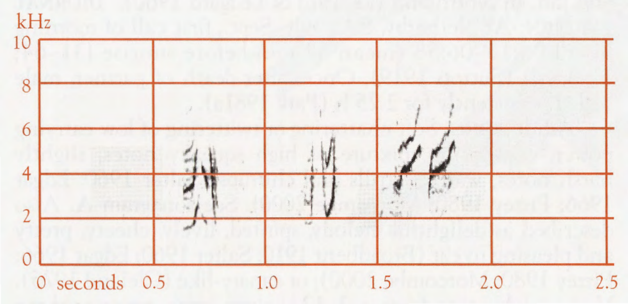
VOICE Not well known, with most information from incidental observations. Single study, in NZ (Edgar 1966), which attempted to describe range of vocalizations. Sonagram of Alarm Call in Jurisevic & Sanderson (1994). Vocalizations often described as twittering or chattering (e.g. Crompton 1919; Ledgard & Ledgard 1960; Salter 1960; Edgar 1966; Fleming 1976), which probably encompass Song, rapidly repeated Contact Call and possibly other calls (see below). Twittering and chattering given in various situations: by both adults of pair while perched together near nest (Crompton 1919; Park 1981b); prospecting for nest-site (Roberts 1945; Edgar 1966; Fleming 1976); chasing other Swallows from prospective nest-site (Roberts 1945); building nest (Edgar 1966); flying near nest (Edgar 1966); or foraging (Edgar 1966; Frith 1969); by single agitated adult when person approached nest (Ledgard & Ledgard 1960); by single adult while nestlings hatching, or while trying to discourage helpers at nest (Salter 1960); and when young fledging (Salter 1960; Edgar 1966). Adults also said to be vocal if other Swallows fly near nest-site (Park 1981b). ANNUAL PATTERN: Song usually given late winter to midsummer: in Aug. at Cardwell, Qld (Broadbent 1910), Oct.–Dec. in Melbourne (Salter 1960), and Aug.–Jan. in NZ (Edgar 1966); also heard in June in Adelaide and Kauaeranga R. Valley, S. Auckland (Cleland 1925; CSN 44). Chattering or twittering heard in late Sept. in Sydney (Roberts 1945), Mar. in Melbourne (Fleming 1976) and Jan. in Northland (Ledgard & Ledgard 1960). DIURNAL PATTERN: At Netherby, SA., July–Sept., first call of morning heard 06:13–06:58 (mean 52 min before sunrise [31–64; 29 days]) (Sutton 1919). Once, after death of partner, male called persistently for 2.25 h (Park 1981a).

Adult SONG: Soft chattering or twittering of low carrying power, comprising mixture of high squeaky notes, slightly harsh notes, warbles, trills and chirrups (Salter 1960; Edgar 1966; Pizzey 1980; Morcombe 2000). See sonagram **A**. Also described as delightful melody, spirited, lively, cheery, pretty and pleasing to ear (Broadbent 1910; Salter 1960; Edgar 1966; Pizzey 1980; Morcombe 2000); or canary-like (Cleland 1925). Varies in duration from *c*. 3–12 s; given once, twice or three times, or continued in series for up to 1 min (Edgar 1966).

Usually given from perch, but sometimes while flying (Fletcher 1903; Edgar 1966; Morcombe 2000); sometimes given while preening (Broadbent 1910). In captivity, only males sang during courtship (Disney 1988). Given in various situations (see above). Said to include lots of *zees*, similar to European Goldfinch *Carduelis carduelis* (CSN 44). CONTACT CALLS: Short, single *twit* or *tswit* usually uttered in flight, but sometimes given from perch. Audible as twitter when frequently and rapidly repeated (Edgar 1966). An occasional, single, squeaky, harsh, *tzeck* or *tchek* (Morcombe 2000), single *chep* (Pizzey 1980), and constant twittering chatter while flying (Frith 1969) probably all describe this call. Sonagram **B** shows three calls which may be Contact Calls (intervals between calls are artificial). Apparently most often used to maintain contact between fast-flying individuals (Edgar 1966; Frith 1969); more strident version used aggressively (Frith 1969). ALARM CALL: Sharp *tswee* or sometimes *sweert*; occasionally disyllabic *tit-swee* with emphasis on second syllable (Edgar 1966); sharp whistled *tseip-tseeeip* (Morcombe 2000); or high-pitched, puny *seeet* (Pizzey 1980); also described as 'chatter' (Jurisevic & Sanderson 1994). Louder than Contact Call (Edgar 1966). Structure of Call noisy, with mean peak frequency 6.9 kHz (3.4; 4 individuals and 45 pulses); mean minimum frequency 2.7 kHz (2.0; 4 individuals and 45 pulses); mean frequency range 4.2 kHz (4.7; 4 individual and 45 pulses); and mean duration 0.059 s (0.2; 4 individual and 45 pulses) (Jurisevic & Sanderson 1994). Given by parents when intruder near nest (Edgar 1966), and by one being chased by Australian Hobby (Debus *et al.* 1991). Noise made by pair when Common Starling raided nest and ate eggs (North), and loud chattering given by pair when Rufous Whistler was near nest (Salter 1958) probably both this call. **Other calls** One female gave constant cry, resembling a drawling *jim* while incubating; possibly a begging call (Fletcher 1904). At one nest, parents sometimes called *twit twit twit* to get 3-day-old nestlings to beg (Tarburton 1993); at another nest, short call given by adults when landing at nest with food, and when enticing fledgelings from nest (Park 1981b), probably same call. Also a rising *seep seep seep* (Pizzey 1980) and strident whistle (Aust. RD).



A F.W. van Gessel; Newcastle, NSW, June 1983; P48



B F.W. van Gessel; Newcastle, NSW, June 1983; P48

Young Nestlings first make audible begging calls at 5–6 days, when become very vocal (Park 1981b); and call with outstretched necks when parents approach (Schrader 1976). Nestlings squeaked shrilly while exercising wings in preparation for fledging (Salter 1960).

BREEDING Well known from detailed studies at Ivanhoe, w. NSW, Dec. 1972–Jan. 1975 (Schrader 1976); various sites in se. Aust., especially at Murwillumbah, NSW, 1989–91, and round Longburn, Manawatu, 1985–88, with extra information from NRS and various museums (Tarburton 1993); at Campania, s. Tas., 1971–72 to 1975–76 (Park 1981b); near Manjimup, WA, 1974–75 to 1988–89 (Brown & Brown 1991); and in Northland, NI, 1958–65 (Edgar 1966); also, analysis of 1169 Aust. NRS cards to 1976 (Marchant & Fullagar 1983); and of 525 NZ NRS cards, 1962–96 (Evans *et al.* 2003). Data for season, clutch-size and success, and breakdown of natural and artificial nest-sites in Aust. obtained from 3649 NRS records to Sept. 2004; samples of NRS data were used for other aspects of breeding; data from Park (1981b) and Brown & Brown (1991) submitted to NRS, and included in analysis. Nest either solitarily or colonially. For data on captive birds, see Disney (1988).

Season Aust. Eggs recorded all months, mainly Aug.–Dec. (see below). Of 2593 clutches in NRS from throughout range: five (0.2%) in mid-July, 20 (0.8%) in late July, 56 (2.2%) in early Aug., 79 (3.0%) in mid-Aug., 155 (6.0%) in late Aug., 212 (8.2%) in early Sept., 257 (9.9%) in mid-Sept., 256 (9.9%) in late Sept., 294 (11.3%) in early Oct., 196 (7.6%) in mid-Oct., 233 (9.0%) in late Oct., 199 (7.7%) in early Nov., 198 (7.6%) in mid-Nov., 142 (5.5%) in late Nov., 103 (4.0%) in early Dec., 66 (2.5%) in mid-Dec., 50 (1.9%) in late Dec., 17 (0.7%) in early Jan., nine (0.3%) in mid-Jan., five (0.2%) in late Jan., three (0.1%) in early Feb., two (<0.1%) in mid-Feb., none in late Feb. or early Mar., two (<0.1%) in mid-Mar., five (0.2%) in late Mar., three (0.1%) in early Apr., seven (0.3%) in mid-Apr., ten (0.4%) in late Apr., six (0.2%) in early May, two (<0.1%) in mid-May, and one (<0.1%) in early June. At various sites in se. Aust., eggs recorded in all months, but mostly late Aug. to mid-Nov., with peak in early Oct. (Tarburton 1993). Sometimes determined by climatic conditions; follow rainfall in arid areas (Schrader 1976; Beruldsen 1980; Storr 21), and may extend into autumn with above-average temperatures (Hall 1900; Bedggood 1980; Tarburton 1993). QLD: Eggs, July–Apr., though breeding recorded all months (see below). *N. QLD*: Eggs, July–Apr. (Lavery *et al.* 1968; Gill 1970; Schulz 1998; NRS); of 14 clutches in NRS: three (21.4%) in Aug., one (7.1%) in Sept., four (28.6%) in Oct., four (28.6%) in Nov., and two (14.3%) in Dec. Nestlings, Aug.–Dec. and Apr. (Bell 1961; NRS [n=20 broods]). Unspecified breeding, including fledgelings, June–Jan. and Apr. (Hopkins 1948; Tarr 1948; Aust. Atlas 1, 2; NRS); throughout most of year on Atherton Tableland (Bravery 1970). *S. QLD*: Eggs, mid-Aug. to late Nov., and late Mar. (NRS); of 37 clutches in NRS: eight (21.6%) in Aug., 14 (37.8%) in Sept., seven (18.9%) in Oct., seven (18.9%) in Nov., and one (2.7%) in Mar. Nestlings, late Aug. to early Dec. and Apr.–June (Wheeler 1959; NRS [n=64 broods]). Unspecified breeding, including fledgelings, all months except Mar. and June (Agnew 1921; Lord 1937; Aust. Atlas 1, 2; NRS). NSW–ACT: Eggs recorded in all months (Hindwood 1940a; Hobbs 1966; MacLean 1976; Morris *et al.* 1981; Tarburton 1993; Campbell; North; ACT Atlas; NRS); of 970 clutches in NRS: five (0.5%) in mid-July, 15 (1.5%) in late July, 50 (5.2%) in early Aug., 50 (5.2%) in mid-Aug., 85 (8.8%) in late Aug., 81 (8.4%) in early Sept., 101 (10.4%) in mid-Sept., 106 (10.9%) in late Sept., 123 (12.7%) in early Oct., 58 (6.0%) in mid-Oct., 72 (7.4%) in late Oct., 64 (6.6%) in early Nov., 51 (5.3%) in mid-Nov., 39 (4.0%) in late Nov., 20 (2.1%) in early Dec., 11 (1.1%) in mid-Dec., eight (0.8%) in late Dec., none in Jan., one (0.1%) in mid-Feb., two (0.2%) in mid-Mar., four (0.4%) in late Mar., three (0.3%) in early Apr., five (0.5%) in mid-Apr., ten (1.0%) in late Apr., five (0.5%) in early May and one (0.1%) in mid-May. Nestlings, late July to mid-Jan. and mid-Mar. to early June (Elliott 1936; Lane 1962; Hobbs 1966; Tarburton 1993; North; ACT Atlas; NRS [n=885 broods]). Unspecified breeding, including fledgelings, all months (Hobbs 1961; Baldwin 1975; Morris 1975; Schrader 1976; Gibson 1977; Gosper 1981; Ross 1983; I. Taylor 1987a; Leishman 1994; North; Aust. Atlas 1, 2; NRS). VIC.: Eggs, early Aug. to early Jan. and Mar. (Hall 1900; Salter 1960; Storer 1962; Wood 1973; NRS); of 516 clutches in NRS: three (0.6%) in early Aug., 12 (2.3%) in mid-Aug., 23 (4.5%) in late Aug., 54 (10.5%) in early Sept., 46 (8.9%) in mid-Sept., 67 (13.0%) in late Sept., 76 (14.7%) in early Oct., 50 (9.7%) in mid-Oct., 51 (9.9%) in late Oct., 38 (7.4%) in early Nov., 43 (8.3%) in mid-Nov., 25 (4.8%) in late Nov., 16 (3.1%) in early Dec., eight (1.6%) in mid-Dec., three (0.6%) in late Dec. and one (0.2%) in early Jan. Nestlings, June–mid-Jan., and once in Apr. (Hall 1900; Salter 1960; Campbell; NRS [n=480 broods]). Unspecified breeding, including fledgelings, all months (Hall 1900; Salter 1960; Storer 1962; Bedggood 1970, 1973, 1980; Tarburton 1993; Aust. Atlas 1, 2; Vic. Atlas; NRS). TAS.: Eggs, mid-Sept. to mid-Feb. (Thomas 1966, 1969; Park 1981a,b; Tas. Bird Reps 3, 4; NRS); of 295 clutches in NRS: three (1.0%) in mid-Sept., seven (2.4%) in late Sept., 36 (12.2%) in early Oct., 21 (7.1%) in mid-Oct., 34 (11.5%) in late Oct., 32 (10.8%) in early Nov., 16 (5.4%) in mid-Nov., 21 (7.1%) in late Nov., 24 (8.1%) in early Dec., 34 (11.5%) in mid-Dec., 34 (11.5%) in late Dec., 16 (5.4%) in early Jan., eight (2.7%) in mid-Jan., five (1.7%) in late Jan., three (1.0%) in early Feb. and one (0.3%) in mid-Feb. Nestlings, mid-Sept. to early Mar., and once in late June (Fletcher 1906; Tas. Bird Rep. 5, 11, 30; NRS [n=272 broods]). Unspecified breeding, including fledgelings, June–Mar. (Dove 1902; McClymont 1905; Littler 1910; Campbell 1938; Wilson 1950; Thomas 1966; Templeton 1976; Aust. Atlas 1, 2; Tas. Bird Rep. 7; NRS). SA: Eggs, late July to mid-Jan. and Apr.–May (Mellor 1921; Souter 1928; Sutton 1928a, 1930a, 1931a,b; Brummitt 1937; Lashmar 1937, 1942; Woodroffe 1938; Stirling *et al.* 1970; NRS); of 96 clutches in NRS: one (1.0%) in July, nine (9.4%) in Aug., 27 (28.1%) in Sept., 35 (36.5%) in Oct., 15 (15.6%) in Nov., five (5.2%) in Dec., none Jan.–Mar., two (2.1%) in Apr. and two (2.1%) in May. Nestlings, Aug.–Jan. and May–June (Morgan 1916a; Mellor 1921; Sutton 1930a, 1933; Lashmar 1937; Woodroffe 1938; Ashton 1986; NRS [n=120 broods]). Unspecified breeding, including fledgelings, all months (Beck 1921; McGilp 1921, 1923; Mellor 1921, 1923, 1927; Boehm 1928; Woodroffe 1938; Ashton 1986; Tarburton 1993; Paton & Pedler 1999; Aust. Atlas 1, 2; NRS). WA: All details refer to endemic subspecies *carteri*. *N. WA*: Eggs, Apr., June, and Aug.–Sept. (Carter 1903; Butler 1975; NRS [n=2]). Nestlings, June and Aug.–Oct. (Butler 1975; Sedgwick 1978; NRS [n=7 broods]). Unspecified breeding, including fledgelings, Mar.–Apr. and July–Oct. (Robinson 1934; Butler 1975; Sedgwick 1978; Storr 16; Aust. Atlas 1, 2; NRS). *S. WA*: Eggs, late July to late Feb. (Carter 1924; Serventy 1952, 1958; Sedgwick 1953; Ford 1965; Storr 1965; NRS); of 664 clutches in NRS: four (0.6%) in late July, one (0.2%) in early Aug., nine (1.4%) in mid-Aug., 37 (5.6%) in late Aug., 58 (8.7%) in early Sept., 91 (13.7%) in mid-Sept., 69 (10.4%) in late Sept., 50 (7.5%) in early Oct., 50 (7.5%) in mid-Oct., 56 (8.4%) in late Oct., 53 (8.0%) in early Nov., 80 (12.0%) in mid-Nov., 51 (7.7%) in late Nov., 39 (5.9%) in early Dec., 11 (1.7%) in mid-Dec., four (0.6%) in late Dec., and one (0.2%) in mid-Jan. Of 268 clutches near Manjimup (estimated from graph): four (1.5%) in mid-Aug., 27 (10.1%) in late Aug., 45 (16.8%) in early Sept., 33 (12.3%) in mid-Sept., eight (3.0%) in late Sept., 16 (6.0%) in early Oct., 16 (6.0%) in mid-Oct., 21 (7.8%) in late Oct., 48 (17.9%) in early Nov., 26 (9.7%) in mid-Nov., 13 (4.9%) in late Nov. and 11 (4.1%) in early Dec. (Brown & Brown 1991). Nestlings, mid-Aug. to mid-Jan., and once in May (Tarr 1949; Sedgwick 1955; Serventy 1958; Scott 1962; Ford 1965; Storr 1965; NRS [n=632 broods]). Unspecified breeding, including fledgelings, all months (Milligan 1903; Carter 1924; Jenkins 1931; Sedgwick 1940b; Robinson 1955, 1956; Ford & Stone 1957; Scott 1962; Ford 1965; Brown *et al.* 1990; Storr 21, 24, 26, 27, 28; Aust. Atlas 1, 2; NRS). NT: No records. **NZ** Eggs, Aug.–Feb. or Mar. (Falla *et al.* 1981; Tarburton 1993; Heather & Robertson 2000; see below). From NZ NRS, mean date of laying first egg 23 Nov. (Evans *et al.* 2003). Trends, based on mathematical modelling, include: laying has become progressively earlier since 1962; eggs laid earlier in E than in W; and season may be influenced by altitude, laying much later at higher altitudes (see Evans *et al.* 2003 for details). Old nest-sites occupied up to 6 weeks earlier than new ones (Edgar 1966). Breeding sometimes delayed in dry weather (Edgar 1966). NI: Eggs, Aug.–late Feb. (Michie 1959a; Graham 1960; Ross 1960; Shanks 1960; Skegg 1962; Hankins 1963; Flux & Wilson 1965; McKenzie 1965; Edgar 1966; Lovegrove 1970; CSN 22). In Bay of Islands district, of 132 clutches: nine (6.8%) in Aug., 26 (19.7%) in Sept., 29 (22.0%) in Oct., 34 (25.8%) in Nov., 29 (22.0%) in Dec., four (3.0%) in Jan. and one (0.8%) in Feb.; three peaks of laying recorded, in early Sept., late Oct. and late Dec., representing first, second and third clutches of season, though a few second clutches were laid late Aug. and Sept. after first clutches lost, and third clutches laid Nov.–Jan. (Edgar 1966). Nestlings, Aug.–Oct. and Dec.–Jan. (Michie 1959a; Ross 1960; Hankins 1963; Lovegrove 1970; Drake 1985; CSN 22, 28, 29). Unspecified breeding Aug. and Oct.–Feb. (Michie 1959a; Findlay 1960; Ledgard & Ledgard 1960; Ross 1960; Lovegrove 1970; CSN). SI: Eggs, Sept.–Mar. (Turbott 1965; Tunnicliffe 1968; Child 1986; CSN 19 Suppl., 20, 32, 43). Nestlings, Nov.–Feb. (Turbott 1965; Norris 1968; Tunnicliffe 1968; Morrison 1987). Unspecified breeding, including fledgelings, Sept. and Dec.–Feb. (Turbott 1965; Norris 1968; Tunnicliffe 1968; Morrison 1987; CSN). OUTLYING ISLANDS: *NORFOLK I.*: No confirmed breeding records (Schodde *et al.* 1983; Hermes *et al.* 1986), though seen carrying mud in Sept. (Moore 1981), and 'young birds' recorded Mar. (Disney & Smithers 1972). *LORD HOWE I.*: Unspecified breeding Apr., Aug., Oct. and Dec. (NSW Bird Reps 1973, 1977; Aust. Atlas 2).

Site Usually attached to vertical surface, though sometimes horizontal or sloping, beneath and close to overhead cover (Mellor 1930; Flux & Wilson 1965; Edgar 1966; Munro 1969, 1973; Beruldsen 1980; Park 1981b; Marchant & Fullagar 1983; Tarburton 1993; Heather & Robertson 2000; NRS). In Aust., sometimes nest on horizontal supports, but seldom do so in NZ (Tarburton 1993). Often placed near or over water (e.g. Skegg 1962; Edgar 1966; Brown & Brown 1991; Tarburton 1993; NRS). **Aust.** Since spread of European settlement, often in artificial sites round human habitation (Mellor 1930; Hyem 1936; Morris 1975; Gibson 1977; Jones 1981; Campbell; North; NRS). Of 3536 sites in NRS, 3296 (93.2%) in or on artificial structures, and 240 (6.8%) in natural sites. Of another 1240 nests throughout se. Aust., 144 (11.6%) in natural sites (Tarburton 1993); and near Manjimup, of 349 nests, 17 (4.9%) in natural sites. ARTIFICIAL SITES: Mostly placed on or in buildings (e.g. Littler 1903a,b; McGilp 1923, 1931; Mellor 1923, 1930; Sutton 1933; Lashmar 1942; Serventy 1958; Gill 1970; Pinner & Bird 1974; Lenz 1980, 1981; Henle 1989; Brown & Brown 1991; Campbell; North; NRS); of 1240 nests in se. Aust., 674 (54.4%) were on or in buildings (Tarburton 1993). Though usually placed on first or ground floor, one was placed five storeys up (Marchant & Fullagar 1983). Nests typically placed beneath overhangs such as verandas, eaves, awnings or roofs (e.g. Dove 1902, 1918; Littler 1904; McGilp 1930; Favaloro 1931; Hood 1935; Woodroffe 1938; Tarr 1948; Bell 1961; Hobbs 1966; Tayson 1981; Ross 1983; Klau 1988; Webb 1990; Campbell; NRS). Usually not exposed to direct sunlight (Ambrose & Congreve 1985). Of 487 nests on buildings, recorded in NRS to 1976: 304 (62.4%) were inside or underneath, and 183 (37.6%) on outer walls and verandas (Marchant & Fullagar 1983). Usually attached to beams, rafters or walls of buildings (e.g. Littler 1904; Mattingley 1907; Parsons 1921; Sutton 1927b; Pearse 1933; Lashmar 1937; Anderson 1940; Watson 1955; Wood 1973; Marchant & Fullagar 1983; Brown & Brown 1991; Campbell; NRS); at Campania, most nests in shed were on sloping girders, always on darkest side. Often built on top of supports (Ambrose & Congreve 1985). On external walls, often placed on protuberances, such as telephone or meter boxes (Marchant & Fullagar 1983; Brown & Brown 1991; NRS), door frames (Mellor 1922b; Dove 1929; Salter 1960; Ormay 2001; Tas. Bird Rep. 5; NRS), window frames or sills (Dove 1902; Barrett 1922; NRS), light fittings (Wheeler 1959; Brown & Brown 1991; North; NRS) or ventilators (Sedgwick 1978). Often nest under bridges (e.g. McGilp 1920; Parsons 1928; Hood 1935; Sedgwick 1940b; Mollison 1974; Lenz 1980, 1981; Gosper 1981; Marchant & Fullagar 1983; Paton & Pedler 1999; Campbell; North; NRS); of 1240 nests in se. Aust., 343 (27.7%) were under bridges (Tarburton 1993). Usually attached to bearers or horizontal cross-beams beneath bridge decking, and occasionally anchored to protruding bolts or nutheads (Brown & Brown *et al.* 1991; NRS). Sometimes nest in culverts, both circular and box-shaped (Beruldsen 1980; Gosper 1981; Jones 1981; Marchant & Fullagar 1983; Brown & Brown 1991; North; NRS); nests in circular culverts usually attached between side and ceiling of pipe (Brown & Brown 1991; NRS), and those in box culverts attached to wall, close to ceiling (NRS). Two nests in newly built culvert were placed over rough surface at joins between concrete sections (NRS). Other concrete structures used include control structure at outlet gates of lake (Wilson 1950), ammunition tunnels (Storr 1965) and old bunkers (Tas. Bird Rep. 7). Sometimes nest below ground in mine shafts (mostly disused, occasionally active) or wells (Morgan 1914b; McGilp 1923, 1925, 1930; Pearse 1931; Hood 1935, 1936; Scott 1962; Clayton 1970; BFNC 1976; Klapste 1977; Marchant & Fullagar 1983; Campbell; North; NRS), where placed on ledges or in gaps in timber lining (Carter 1903; McGilp 1925, 1930). Sometimes nest in water tanks or boilers, sometimes underground, or on tank-stands (Morgan *et al.* 1926; Pearse 1931; Brummitt 1937; Lashmar 1937; Roberts 1942; Watson 1955; Lord 1956; Lane 1962; Schrader 1976, 1981; NRS); of 29 nests recorded in tanks from NRS to 1976, 17 (58.6%) were underground (Marchant & Fullagar 1983). At Ivanhoe, most nests in underground tank were built on side of wooden beams; two were on top of beams, and one on steel support. Sometimes placed under jetties, piers or wharves (Hall 1900; Milligan 1902; Littler 1910; Nicholls 1962; Marchant & Fullagar 1983; Campbell; Storr 24; NRS). Occasionally use nest-boxes (Brown & Brown 1991; Dedman *et al.* 1998; Hewish 2002a,b, 2003; NRS) and once inside a large tin which was placed onto end of stick (Sutton 1931a). Nests sometimes built on boats, coaches, and once in iron framework beneath railway carriage (Carter 1903; Shepherd 1912; Crompton 1919; Roberts 1940a,b, 1957; Francis 1944; Rix 1945; Sedgwick 1949; Bell 1957; Wheeler 1959; Marchant & Fullagar 1983; Campbell; North; NRS); sometimes these vessels and vehicles are mobile, and Swallows recorded accompanying boats which house nests (White 1915; Chenery & Morgan 1920; Bell 1957; Roberts 1957; Marchant & Fullagar 1983), e.g. for 56 km (Carter 1903), or >200 km between Stansbury and Port Lincoln, SA, for 36 h (Crompton 1919), though sometimes birds just wait till boat returns (Wheeler 1959), and one boat was followed for several kilometres out to sea before it was abandoned (Roberts 1957); train with nest said to have been met by pair at various points along route (Shepherd 1912). Another pair built a nest in horse-drawn coach when it arrived each day (Campbell). Sometimes nest on stationary objects with moving parts: one was on a wool press that moved up and down constantly (Campbell); another was on door of public telephone box, and split in half each time door was opened (J.M Peter; J.R. Starks). Sometimes nest in unusual sites, e.g. kennels (Hall 1900; North), inside tent (Hyem 1936), on hanging objects, including buckets, hats, clothing, bags and picture-frames (Carter 1903; D'Ombrain 1906; Crompton 1919; Selby 1930; Anon. 1933; Roberts 1940a; Campbell; North), curtains (North), and once on sheepskin hanging on rack (Anon. 1938), and on bill of dead Wedge-tailed Eagle *Aquila audax* hanging in outhouse (White 1918). NATURAL SITES: Mostly placed on rock-faces or trees. Of 240 natural sites recorded in NRS: 184 (76.7%) were in caves, cliffs or under rock overhangs; 37 (15.4%) in dead trees; and 19 (7.9%) in live trees. Usually attached to wall (or, very occasionally, stalagmite) in cave, hollow in cliff-face, beneath overhanging rock or down a blow-hole (e.g. Milligan 1902; Morgan 1906, 1915; McGilp 1923, 1930; McColl 1929; Warham 1955; Lindgren 1956; Ford & Sedgwick 1967; Reilly *et al.* 1975; Marchant & Fullagar 1983; Campbell; North; NRS); once said to have nested behind waterfall (Barnard 1926). One placed among roots growing from bank (NRS). Also attach nest to inside of hollows in branches and trunks of large trees or stumps, often burnt out (Fletcher 1924; Lansell 1933; Hood 1935; Elliott 1936; Hindwood 1940a; Boehm 1957; Beruldsen 1980; Gates 1996; Campbell; North; NRS), or attached to underside of leaning trunk (Attiwill 1948; Hobbs 1961; Storr 28). Nest-plants usually eucalypts (Hall 1900; Morgan 1906; Barrett 1916; Dove 1917; Mellor 1930; Elliott 1936; Hobbs 1961); all 25 records of nest-plant in NRS were in eucalypts, including 18 (72.0%) in red gums. At The Steppes, Tas., birds favoured trees with openings facing N or E (Fletcher 1924). NESTS OF OTHER BIRDS: Occasionally use nests of Fairy Martin; one pair usurped half-built nest (Ashton 1986; Tarburton 1991; Schulz 1998; Hewish 1999; NRS). One pair reared young in nest of Dusky Robin *Melanodryas vittata* (Fletcher 1906); and another in unrefurbished nest of Willie Wagtail (Thomas & Wheeler 1983). ANALYSIS OF NRS: Of 963 sites recorded in NRS to 1976: 487 (50.6%) on buildings, 241 (25.0%) on bridges, 104 (10.8%) in caves or cliffs, 57 (5.9%) in culverts, 29 (3.0%) in water tanks, 16 (1.7%) in hollow trees, 15 (1.6%) under jetties, loading ramps or tank-stands, seven (0.7%) in mine shafts or tunnels, five (0.5%) on boats, one (0.1%) in wrecked car and one (0.1%) in trailer (Marchant & Fullagar 1983). From sample of 500 sites after 1976: 284 (56.8%) on buildings, 84 (16.8%) under bridges, 47 (9.4%) in culverts, 22 (4.4%) in caves, crevices in cliffs and rock overhangs, 17 (3.4%) in nest-boxes, 14 (2.8%) in water tanks, nine (1.8%) in trees or stumps, seven (1.4%) under jetties, four (0.8%) on boats, four (0.8%) under boardwalks, three (0.6%) in metal canisters fixed to stumps, one (0.2%) in meter box, one (0.2%) in fire hose box, one (0.2%) in concrete bunker, one (0.2%) on pump platform and one (0.2%) 0.3 m below ground in mine shaft (NRS). **NZ** Mainly use artificial sites, such as bridges and culverts; natural sites seldom used (Edgar 1966; Cowan 1968; Tarburton 1993; Heather & Robertson 2000): of 107 sites recorded at Whangarei and Longburn, NI, all were artificial (Munro 1973; Tarburton 1993). Claimed that natural sites used increasingly as population expands (Cowan 1971). ARTIFICIAL SITES: Most placed under bridges, in culverts (box-shaped or round) (e.g. Michie 1959b; Findlay 1960; Graham 1960; Shanks 1960; Skegg 1962; Edgar 1966; Cowan 1968, 1971; Tunnicliffe 1968; Munro 1969; Lovegrove 1970; Morrison 1987; Ashton 2000; CSN). At Whangarei, NI, of 80 nest-sites, 55 (68.8%) were beneath bridges, and five (6.3%) in culverts (Munro 1973); and of 27 nest-sites at Longburn, NI, 20 (74.1%) were under culverts or bridges (Tarburton 1993). Claimed that *c.* 95% of nests fixed to bridges or culverts (Edgar 1966). Appear to favour bridges that offer clear access, though increased demand for nest-sites has led to use of sites with lesser access (Skegg 1962; Edgar 1966), e.g. culverts blocked at one end with floodgates (Edgar 1966; Norris 1968). Under bridges, usually attached to vertical, sometimes horizontal or sloping, beams, girders or buttresses (Michie 1959a; Hankins 1963; Flux & Wilson 1965; Edgar 1966; Munro 1969, 1973), and sometimes attached to protuberances, such as bolts (Edgar 1966; Munro 1969, 1973); concrete bridges without beams and with smooth vertical walls not favoured (Edgar 1966). Near Whangarei, NI, of 85 nests under bridges: 40 (47.1%) were attached to concrete girders, 30 (35.3%) to steel girders and 15 (17.6%) to wooden girders; 59 (69.4%) were attached to vertical surfaces, 17 (20.0%) on horizontal or sloping surfaces, five (5.9%) partly supported by lower lip of steel girders and four (4.7%) attached to bolts (Munro 1973). In culverts, sometimes attached to objects protruding from wall, such as protruding stone or roots (Edgar 1966; Cowan 1968); one attached to pendulous Kikuyu *Pennisetum* grass hanging over entrance (Cowan 1971). One nest built on concrete extension at end of culvert, rather than inside it (Munro 1969). Sometimes on buildings, usually attached to rafter, beam or wall beneath roof or eaves (Shanks 1960; Edgar 1966; Cowan 1968, 1971; Scarlett 1968; Munro 1969; Drake 1985; Child 1986; CSN): at Whangarei, NI, of 80 nest-sites, 15 (18.8%) were on buildings (Munro 1973); and at Longburn, NI, of 27 nest-sites, four (14.8%) were on buildings (Tarburton 1993). Occasionally use protuberances from walls of buildings, including meter boxes and a wall-mounted telephone (CSN 26, 29, 36), a letterbox (CSN 19), and light-fittings (CSN 19); and one attached to old sack hanging in shed (Cowan 1971). Occasionally nest in water tanks, or on tank-stands (Edgar 1966; Tunnicliffe 1968; Cowan 1971; Heather & Robertson 2000; CSN 19, 19 Suppl.); round Longburn, NI, of 27 sites, three (11.1%) were in tanks or wells (Tarburton 1993). Also recorded on concrete walls of reservoirs or dams (Edgar 1966; Tunnicliffe 1968), on inner wall of concrete water-gauge (Turbott 1965), and old gun emplacements (Edgar 1966; CSN 32). Occasionally nest beneath jetties and wharves (Michie 1959a; Edgar 1966; Cowan 1971; Heather & Robertson 2000; CSN 19 Suppl., 29); also in boats, including under pontoon of hydrofoil (Edgar 1966; Tunnicliffe 1968; Cowan 1971; Heather & Robertson 2000; CSN 19 Suppl., 21, 25). At Whangarei, NI, of 80 nest-sites, two (2.5%) were on wharves, one (1.3%) on boat and one (1.3%) on operational drag-line excavator, which parents followed as drag-line moved (Munro 1973). Also recorded in vehicles (Edgar 1966; CSN 19). Once in nest-box (CSN 26). NATURAL SITES: Seldom used (Edgar 1966; Tarburton 1993), and few published records. Mostly in shallow caves, or hollows or overhangs of cliffs or banks (Edgar 1966; Andrew 1967; Cowan 1968, 1971; Heather & Robertson 2000; CSN 22, 24, 32, 43). One nest attached to rotten wood in hollow Totara *Podocarpus totara*; another was beneath log in small depression (Lovegrove 1970); another was among roots of macrocarpa (CSN 48). FIDELITY TO SITE: Often re-use old nests or sites in successive seasons, and for multiple attempts within a season (e.g. Dove 1902; Wilson 1928; Selby 1930; Michie 1959a,b; Turbott 1965; Schrader 1976; Marchant & Fullagar 1983; Brown & Brown 1991; Tarburton 1993; Heather & Robertson 2000; North; NRS; CSN). Nest sometimes rebuilt on same site as old or fallen nest, or within a few centimetres (Edgar 1966; Cowan 1968; Schrader 1976; Brown & Brown 1991; NRS); at Ivanhoe, five nests built on same spot in one season. One pair removed old nest, then built a new one (North); also build on top of existing nests (Watson 1955; Edgar 1966; Cowan 1968; Munro 1969; Lenz 1981; North). Some sites are used for many years (Hall 1900; Morgan 1906; Edgar 1966; North; NRS). At Campania, of 262 eggs, 139 (53.1%) were laid in refurbished nests; though pairs often changed nest-site, farthest moved was 15 m (Park 1981b). One pair had three nests in roof of building; when young fledged from one nest, adults moved to another (Mattingley 1907). Once, fledged young said to have nested near natal nest (NRS). Though old nests favoured, few remain till following season (Edgar 1966; Cowan 1968; Tarburton 1993). At Ivanhoe, nests on vertical surfaces seldom lasted for more than two clutches; two nests on horizontal supports were still intact after 3 years. ASSOCIATIONS: In Aust., occasionally found among colonies of Fairy Martins under bridges or culverts (Conole 1981; NRS). SELECTION OF SITE: Near Manjimup, nest-site changed if male of pair disappeared, suggesting old site unacceptable to new male; if female disappeared, new female accepted old nest or nest-site (Brown & Brown 1991). One pair spent 17 days inspecting possible sites, remaining at each for a few days (Edgar 1966). Old sites are re-used 'with little ado' (Edgar 1966). MEASUREMENTS (m): Based on data from Tarburton 1993 (see below): nests in Aust. significantly higher above ground or water, and significantly farther from overhead cover than nests in NZ, but no significant difference in distance from opening or distance from neighbouring nest (Tarburton 1993). Culverts used for nesting: round culverts, 0.46 diameter; box culverts, 20.0 × 10.0 (Cowan 1968; Munro 1969, 1973; Marchant & Fullagar 1983; Brown & Brown 1991; NRS). AUST.: Height of nest above ground or water, 2.4 (1.56; 0.0–25.7; 3165) (NRS). Height of nest above ground, 2.71 (1.19; 0.7–4.0; 14); height of nest above water, 3.4 (3.36; 0.8–8.0; 39); depth below ceiling, 0.94 (0.65; 0.02–0.60; 53); distance from opening, 3.10 (1.74; 0.30–8.50; 53) (Tarburton 1993). *ARTIFICIAL SITES*: Height of nest, 2.5 (1.51; 0.0–25.7; 2955) (NRS). Height above ground, 2.6 (0.3–7.6; 540); height above water, 1.7 (0.3–12.0; 154); depth below cover, 0.14 (0.03–0.66; 138) (Marchant & Fullagar 1983). Depth below ground in wells and mine shafts, 11.24 (7.69; 3.5–23.8; 5) (McGilp 1923, 1925, 1930; Clayton 1970; Klapste 1977; North). *NATURAL SITES*: Height of nest above ground or water, 2.1 (2.13; 0.3–21.0; 207) (NRS). Height of nest above ground, 1.9 (1.0–4.3; 91); depth below cover, 0.19 (0.07–0.50; 19) (Marchant & Fullagar 1983). Depth below ground, 2.4 m (Ford & Sedgwick 1967). NZ: Height of nest above ground or water, 0.5–13.5 (Michie 1959a; Ross 1960; Skegg 1962; Edgar 1966; Andrew 1967; Norris 1968; Lovegrove 1970; Evans *et al.* 2003; CSN 24). Height above ground, 1.74 (0.40; 0.90–2.60; 49); height above water, 1.50 (0.47; 0.85–2.40; 23) (Tarburton 1993). One nest recorded on upper half of 0.46 culvert that was half filled with water at high tide (Munro 1973); another was a few centimetres above water, and another in culvert with 0.30 between water and ceiling (Munro 1969). Depth below ceiling, 0.15 (0.26; 0.04–1.20; 39) (Tarburton 1993); 0.05 (0.04–0.08; 11) (Skegg 1962); 0.04–0.08 (Edgar 1966; Norris 1968); usually 0.15 (Heather & Robertson 2000). Distance from opening, 3.20 (1.87; 0.40–8.00; 62) (Tarburton 1993).

Nest, Materials Size and shape vary with type of attachment: usually cup shaped on horizontal support; and half-cup or other if on vertical surface or built into angle (McGilp 1930; Edgar 1966; Schrader 1976; North; NRS). One, suspended from wire, was tubular and built on 45° angle, with nest-cavity at one end (Munro 1973). Nests on horizontal supports said to be smaller, easier to build and much more durable than unsupported nests (Edgar 1966). Suggested that nests on smooth surfaces have greater depth of area of attachment than those on rough surfaces (Skegg 1962), but security of attachment to smooth surfaces is increased by larger total area of attachment, rather than increased depth alone (Edgar 1966). Nests usually made from pellets of mud or clay mixed with dry (or occasionally green) grass, hair or rootlets, and occasionally with twigs, bark, fragments of wood or small stones. Some nests contain little or no mud, usually due to local scarcity (Bryant 1931; NRS); occasionally use sand or sandy mud instead of mud with clay component, giving nests a fragile appearance (Bryant 1931; Turbott 1965; Cowan 1971). At Bool Lagoon, SA, mud was not used, despite being abundant (Attiwill 1948); where mud unavailable, usually built of grass, rootlets or plant fibre with some lining (Attiwill 1948; Marchant & Fullagar 1983; Hooper & Wells 1989; NRS). One nest, suspended from wire hook, had grass stems looped through hook and cemented into mud (Munro 1973); another included long grass cuttings that hung down, giving nest a shaggy appearance (Marchant & Fullagar 1983). Lining comprises two layers: (1) base of mostly dry (or, seldom, green) grass, hair, fur or wool, feathers or rootlets, and sometimes pieces of fern or dry leaves; and (2) upper layer of feathers of various colours, occasionally fur or hair (McGilp 1930; Skegg 1962; Edgar 1966; Andrew 1967; Cowan 1968, 1971; Schrader 1976; Beruldsen 1980; Park 1981b; Marchant & Fullagar 1983; Tarburton 1993; Heather & Robertson 2000; Campbell; North; NRS); one nest was lined only with a few pieces of straw (Cowan 1968), another only with feathers (Tarburton 1993), and another with leaves of eucalypt (White 1908). Lining comprises 30–67 feathers, up to 10 cm long; in nest with 67 feathers, underlining had 31, and upper layer 36 (Edgar 1966; Cowan 1968; NRS); one pair, nesting in plastic container, simply lined container with feathers (NRS). Feathers taken from many different species, especially Domestic Fowl *Gallus gallus* or ducks, such as Australian Shelduck *Tadorna tadornoides*, Australian Wood Duck *Chenonetta jubata* and Mallard *Anas platyrhynchos* (Shanks 1960; Skegg 1962; Edgar 1966; Cowan 1968; Norris 1968; Tarburton 1993; CSN 22; NRS); and hair or fur of lining taken from various species, including Horse, Cow, possum, Rabbit, Cat and Dog (Hall 1900; Edgar 1966; Cowan 1968; Schrader 1976; Park 1981b; North; NRS). One nest contained sticks 200 mm long and 4 mm thick (Marchant & Fullagar 1983). Sometimes incorporate seaweed and other aquatic vegetation, such as water-weed, into cup or lining (Edgar 1966; Marchant & Fullagar 1983; Campbell; NRS); one partly complete nest was reinforced with leaves, fruit of *Lemna* and Tall Fescue *Festuca arundinacea*, a clover *Trifolium* seed and filamentous algae (Turbott 1965); string, spider web and moss also recorded in nests (NRS). Dead Swallows sometimes incorporated into structure of nest (Fletcher 1906; Luttrell 1918; Wilson 1928; Drake 1985; Campbell). Aberrant materials sometimes used in lining include: tissue paper, cotton, plant down, jute, hessian, coir fibres, wood-shavings, shells and nylon fishing line (Schrader 1976; Park 1981b; Marchant & Fullagar 1983). BUILDING: Both sexes build nest, collecting material, building cup and lining it (McGilp 1930; Woodroffe 1938; Michie 1959a; Storr 1965; Edgar 1966; Schrader 1976; Crouchley & Crouchley 1979; Park 1981b; Marchant & Fullagar 1983; Brown & Brown 1991; Tarburton 1993; Heather & Robertson 2000; North; NRS). Mud usually collected from edge of wetlands (Ashby 1929; Bell 1957; Michie 1959a; Turbott 1965; Park 1981b; NRS), though may be gathered from any available source (Sutton 1928b; Wolstenholme 1929; Storr 1965; Job 1969; Gibb 2000; NRS). One pair, with nest on ferry, collected mud from both banks of river (Bell 1957). Mud sometimes taken from several different sources (Anon. 1938; Edgar 1966), e.g. some nests comprise pellets of different-coloured clays, forming discrete patches on some, while others have different-coloured layers, or different-coloured pellets mixed throughout (Edgar 1966). Feathers for lining often collected from nearby farmyards (Skegg 1962); one pair gathered them from gull colony (CSN 22). Once pulled coconut fibre from mats to bind mud (White 1924). Material often collected nearby (Park 1981b), but sometimes carried up to 800 m (Marchant & Fullagar 1983; Campbell). Mud scooped up in bill, and it and other material carried in bill (Pearse 1931; Michie 1959a; Schrader 1976; Park 1981b). Material collected while standing on ground, or sometimes by swooping down to scoop mud in bill without alighting (Michie 1959a; Edgar 1966). Pellets carried singly (McGilp 1930). Often both sexes collect material and return to nest together (Park 1981b). Sometimes plant fibre or hair is gathered in bill before mud collected; use feet to push fibres into soft mud, either at nest-site or at site of collection, then mud and grass patted into shape with bill (Woodroffe 1938; Shanks 1960; Park 1981b). Male appears to start nest, calling to female, apparently inviting her to join him (Park 1981b). A few days after two birds began roosting together, male approached female, presenting her with small pellets of mud and grass, while calling, then flew to nest-site and back to female, till she accompanied him to nest-site; mud then deposited and nest started. Male continued to present pellets to female, but after she left for a few days, he continued to build; when female returned, both worked steadily to finish nest (Salter 1960). On horizontal supports, perch inside nest and position pellets to form outline of nest before adding mud to nest-wall (Park 1981b). On vertical surfaces, a small mud bracket is attached to wall and left to harden, forming base of nest (Shanks 1960; Edgar 1966); mud then added to top and sides of bracket till it forms a shallow U-shape, which is then built outward and upward to form a shallow bowl; supporting surface remains exposed and forms rear wall of nest (Edgar 1966). Once mud structure complete, cup is lined (McGilp 1930; Edgar 1966); sometimes lining shaped by bird sitting in nest and turning repeatedly (McGilp 1930; NRS). Feathers are added last; in some nests, lining sparse; in others, lining so thick it projects over nest-rim and obscures eggs (Edgar 1966; Cowan 1968); one female surrounded herself with wall of feathers, and had to push head through to see out of nest (Park 1981b). Depth of lining varies between nests (Park 1981b) and across season, compressing as season progresses (Edgar 1966; Cowan 1968). Feathers usually laid loosely, but in one nest, pressed into tight pad (Edgar 1966). Many discarded feathers may be found beneath some nests, but none near others (Edgar 1966). Nests built mostly in morning, but also in afternoon (Park 1981b). Building time varies much, depending on weather, availability of material or distance from nest to supply of mud (Littler 1910; Schrader 1976; Park 1981b; Tarburton 1993; NRS). In Aust., one built and lined in 6 days (Marchant & Fullagar 1983); another built in 5 days, and lined 3 days later (Campbell); 12–15 days (McGilp 1930; North); 6–24 days (Park 1981b); one pair built cup over 2 weeks, and spent another 2 weeks lining it (Woodroffe 1938); c. 5 weeks (Shepherd 1912); >6 weeks (Salter 1960). At Ivanhoe, NSW, cup usually finished in 5–8 days, and lining in 2–4 days, but one nest, built in Apr., was not lined till Aug. (Schrader 1976). In NZ, first unsupported nests of season usually built in 9–12 days, with cup completed in 4–6 days; sometimes pause between completion of cup and addition of lining. Replacement nests built more quickly, usually in c. 6 days, spending 4 days on cup and 2 days on lining (Edgar 1966). Occasionally feathers added after laying or incubation started (Ford 1965; Edgar 1966; Park 1981b; Tarburton 1993; NRS). Nests damaged during incubation or fledging periods are sometimes repaired (Edgar 1966). At Black Rock, Vic., female brought fresh material when returning each night to roost;

sometimes mud was brought to repair nest (Salter 1960). Partly built nests are sometimes abandoned (Hall 1900; Roberts 1940b); one pair used only one of seven nests built, abandoning five when 25% complete (Anderson 1940). Old nests are refurbished before being re-used (Luttrell 1918; Souter 1928; Wilson 1928; Dove 1934; Thomas 1966, 1969; Wood 1973; Schrader 1976; Park 1981a,b; Brown & Brown 1991; Tarburton 1993; NRS). Nests used annually usually have *c.* 2.5 cm of mud added each year (Hall 1900); one nest had 2.5 cm added for second attempt of season (Salter 1960). Regular addition of material can cause nests to become quite tall, in some cases more than 30 cm taller than original foundation (Hall 1900; NRS), and repaired nests usually taller than new ones (Schrader 1976). At one nest, repairs took >7 days (Hall 1900). Nests sometimes re-used without being repaired, but are relined between clutches (Mellor 1930; Salter 1960; Storr 1965; Schrader 1976; Crouchley & Crouchley 1979; Tarburton 1993; Edgar 1996); new lining placed on top of old (Hall 1900), or occasionally on top of deserted clutch (Park 1981b; Brown & Brown 1991; Tarburton 1993; NRS); relining of one nest took ⩾15 days (NRS). One pair built up old nest over body of dead nestling (Wilson 1928). Old material sometimes cleaned out (NRS); once, lining found below nest was replaced by observer, but female removed lining and dropped it *c.* 10 m from nest, and added new lining next day (Salter 1960). One pair repaired small section of rim of nest of Fairy Martin that had lost its neck, then thickly lined nest (Ashton 1986). Occasionally repair old nests of Dusky Robin; one pair spent almost 2 weeks repairing and relining one nest (Fletcher 1904, 1906). MEASUREMENTS (cm): AUST.: External diameter, external vertical depth, internal diameter, internal vertical depth: 10.2–12.7, 7.6–8.9, 6.4, 2.5 (Campbell; North). In sample from NRS, external width 12.0–18.0, external horizontal depth 7.0–10.0, and internal vertical depth 3.0 (Marchant & Fullagar 1983). Two nests, built up over several seasons, had external vertical depths of 10.0 and 18.0 (NRS). NZ: External width, external horizontal depth, external vertical depth, internal vertical depth: 9.33 (9.7; 8.0–11.7; 34), 7.64 (6.4; 6.5–8.8; 34), 3.82 (8.6; 2.0–5.5; 34), – (unknown whether on vertical or horizontal surfaces, or both; Tarburton 1993). On vertical surfaces: 8.0 (6.0–12.0; 11), 13.0 (11.0–14.5; 11), 8.0 (7.0–11.0; 11), 3.0–5.0 (but usually 3.0–3.5) (Skegg 1962); 15.67 (45.37; 11.5–20.5; 3), 8.83 (2.89; 8.5–9.0; 3), 8.67 (7.64; 8.0–9.5; 3), 3.73 (6.43; 3.0–4.2; 3) (Edgar 1966); 16.8, 9.5, 9.0, 3.8 (n=1) (Cowan 1968). One nest said to be *c.* 13 long, possibly equals external width (Norris 1968). One on horizontal surface had horizontal depth of 9.0 and vertical depth of 5.5 (Edgar 1966). In most nests, egg-chamber roughly circular and *c.* 6–8 wide (Edgar 1966). WEIGHT (g): AUST.: No information. NZ: 264.6 (86.61; 170.1–340.2; 3) (Edgar 1966); 340.2 (n=1) (Cowan 1968).

Eggs Short oval, oval, long or tapered oval; eggs of different shapes sometimes occur in a single clutch. Finely textured, smooth, and range from glossy to almost lustreless (Edgar 1966; Beruldsen 1980; Campbell; North). Usually shades of white, e.g. dull white, warm white or cream; some pale pink, or have pinkish tinge when fresh (Littler 1910; Woodroffe 1938; Michie 1959a; Skegg 1962; Edgar 1966; Beruldsen 1980; Falla *et al.* 1981; Heather & Robertson 2000; Campbell; North). Spotted, freckled or blotched umber, red, brown, rusty-brown, slate or purplish brown, with a few underlying spots of light grey, bluish grey, inky grey or lavender; markings vary in size and density, and usually concentrated round large end, forming well-defined zone on some (Woodroffe 1938; Michie 1959a; Skegg 1962; Edgar 1966; Beruldsen 1980; Falla *et al.* 1981; Heather & Robertson 2000; Campbell; North; NRS). MEASUREMENTS: AUST. 18.4 × 13.6 (n=65) (Schönwetter 1966); 18.7 (0.58; 17.8–19.6; 9) × 14.2 (0.68; 13.2–15.2) (Campbell; North); 19.0 × 13.0 (Beruldsen 1980). *QLD*: No information. *NSW*: 18.7 (0.31; 18.3–19.1; 5) × 13.1 (0.29; 12.7–13.5) (North). *VIC.*: 18.2 (1.10; 16.0–19.5; 9) × 13.1 (0.27; 12.5–13.4) (NRS). *TAS.*: 18.0 (16.0–19.4; 28) × 13.2 (12.1–14.0) (Park 1981b); 18.2 (0.54; 17.8–19.0; 4) × 13.2 (0.24; 13.0–13.5) (Littler 1910). *SA*, *WA*: No information. NZ 18.0 × 13.0 (Heather & Robertson 2000). *NI*: 18.2 (0.90; 16.4–21.0; 142) × 13.2 (0.47; 11.9–14.6) (Tarburton 1993); 17.8 (0.88; 16.0–19.2; 14) × 13.3 (0.48; 12.5–14.0) (Edgar 1966); 17.3 (0.58; 17.0–18.0; 3) × 12.3 (0.29; 12.0–12.5) (Skegg 1962); 17.5 × 14.0 (n=2) (Michie 1959a); 22.0 × 12.5 (n=1) (Cowan 1968). Eggs from Northland, NI (Edgar 1966) significantly shorter than eggs from Longburn, NI, but no significant difference in width; and eggs from Longburn were shorter and narrower than eggs from Aust. (Tarburton 1993). No correlation between size of eggs and laying order (Tarburton 1993). *SI*: No information. WEIGHT (g): *AUST.*: 1.75 (n=65) (Schönwetter 1966). *NZ*: 1.59 (0.19; 1.14–2.07; 133) (Tarburton 1993); 1.6 (Heather & Robertson 2000). Eggs from Longburn, NI, were lighter than eggs from Aust. No correlation between mass of eggs and laying order (Tarburton 1993).

Clutch-size In Aust., three to five, usually four (Stone 1912; McGilp 1923, 1930; Newell 1927; Mellor 1930; Beruldsen 1980; Gosper 1981; Campbell; North); occasionally clutches of one, two or six recorded (Wilson 1912; Hyem 1936; Salter 1960; Beruldsen 1980; Burbidge 1985; see below). In NZ, three to five (Falla *et al.* 1981); usually four, but ranging from two to seven (Heather & Robertson 2000). **Aust.** 3.71 (0.77; 941): C/1 × 4, C/2 × 50, C/3 × 278, C/4 × 499, C/5 × 105, C/6 × 5 (NRS). Mean clutch-size of nominate *neoxena* significantly larger than that of subspecies *carteri* (Tarburton 1993). NOMINATE *NEOXENA*: 3.91 (0.72; 697): C/1 × 2, C/2 × 26, C/3 × 121, C/4 × 438, C/5 × 105, C/6 × 5 (NRS); 3.74 (0.89; 489): C/1 × 10, C/2 × 29, C/3 × 119, C/4 × 258, C/5 × 66, C/6 × 7 (Tarburton 1993). *QLD*: 3.45 (0.93; 11): C/1 × 1, C/3 × 3, C/4 × 7 (NRS); 3.8 (0.45; 5): C/3 × 1, C/4 × 4 (Storr 19). *NSW*: 3.94 (0.70; 406): C/1 × 1, C/2 × 13, C/3 × 66, C/4 × 259, C/5 × 65, C/6 × 2 (NRS); 4.13 (0.81; 46): C/2 × 3, C/3 × 3, C/4 × 25, C/5 × 15 (Schrader 1976). *VIC.*: 3.99 (0.78; 166): C/2 × 7, C/3 × 27, C/4 × 96, C/5 × 33, C/6 × 3 (NRS). *TAS.*: 3.75 (0.68; 80): C/2 × 5, C/3 × 16, C/4 × 53, C/5 × 6 (NRS); 3.97 (0.70; 67): C/2 × 2, C/3 × 11, C/4 × 41, C/5 × 13 (Park 1981b). *SA*: 3.71 (0.58; 34): C/2 × 1, C/3 × 9, C/4 × 23, C/5 × 1 (NRS). *WA*: All data refer to subspecies *carteri*. S. *WA*: 3.14 (0.60; 243): C/1 × 2, C/2 × 24, C/3 × 156, C/4 × 61 (NRS); 3.21 (0.56; 169): C/2 × 12, C/3 × 110, C/4 × 47 (Tarburton 1993). In Eucla Div., 3.00 (0.71; 9): C/2 × 2, C/3 × 5, C/4 × 2 (Storr 27). Near Manjimup, 3.20 (0.60; 296): C/1 × 2, C/2 × 24, C/3 × 184, C/4 × 86 (Brown & Brown 1991). On Swan Coastal Plain, 3.42 (0.65; 24): C/2 × 2, C/3 × 10, C/4 × 12 (Storr 28). On Houtman Abrolhos, C/3 × 3 (Storr 24). In Gascoyne Region, 3.3 (0.73; 20): C/2 × 3, C/3 × 8, C/4 × 9 (Storr 21). N. *WA*: In Pilbara Region, 3.50 (0.55; 6): C/3 × 3, C/4 × 3 (Storr 16); C/3 × 1 (NRS); Barrow I., C/4 × 3 (Butler 1975). **NZ** 4.41 (0.64; 27): C/3 × 1, C/4 × 15, C/5 × 10, C/6 × 1 (Tarburton 1993); 4.04 (0.86; 293), excluding clutches of 8–10, which assumed to reflect egg-dumping (Evans *et al.* 2003). *NI*: 4.08 (0.77; 132): C/2 × 1, C/3 × 31, C/4 × 57, C/5 × 43 (Edgar 1966); 4.2 (3–5; 10) (Crouchley & Crouchley 1979). Mean clutch-size at Longburn, NI, significantly larger than those in e. and w. Aust. (Tarburton 1993). No latitudinal variation in clutch-size detected in NZ (Evans *et al.* 2003), but clutch-size apparently declined temporally as population density increased (Heather & Robertson 2000; see Evans *et al.* 2003 for further details). In Aust. and NZ, clutch-size peaks in middle of laying period (Edgar 1966; Schrader 1976; Brown & Brown 1991; Evans *et al.* 2003). At Ivanhoe, NSW, most clutches of four recorded during first attempts, most clutches of five during second attempts; in third and fourth attempts, most were C/4, and one was C/3 in single fifth attempt. At Rotamah I. in 1981, mean clutch-size of first clutches, 4.09 (n=34), and of known second or replacement clutches, mean 4.63 (n=16); clutch-size peaked in middle of breeding season; mean monthly clutch-sizes: Sept. 4.09 (n=34), Oct. 4.47 (n=15), Nov. 4.07 (n=15) (A.H. Burbidge). Near Manjimup, mean clutch-size of first clutches, 3.12 (0.59; 170): C/1 × 2, C/2 × 14, C/3 × 115, C/4 × 39; in second clutches (including three third clutches, replacements for failed second clutches), 3.29 (0.61; 126): C/2 × 10, C/3 × 69, C/4 × 47. Number of C/4 varied between seasons, with fewer laid during poor weather, especially in first clutches (Brown & Brown 1991). In NZ, clutch-size varies by up to one egg over course of season (Evans *et al.* 2003). In Bay of Islands district, NI, monthly mean clutch-size: Aug., 3.56 (0.53; 9): C/3 × 4, C/4 × 5; Sept., 4.31 (0.68; 26): C/3 × 3, C/4 × 12, C/5 × 11; Oct., 4.34 (0.77; 29): C/3 × 5, C/4 × 9, C/5 × 15; Nov., 4.00 (0.78; 34): C/2 × 1, C/3 × 7, C/4 × 17, C/5 × 9; Dec., 3.93 (0.80; 29): C/3 × 10, C/4 × 11, C/5 × 8; Jan., 3.75 (0.5; 4): C/3 × 1, C/4 × 3; and Feb., C/3 × 1. Total of 22 five-egg clutches could be assigned to a breeding attempt: five (22.7%) were first clutches of season, 13 (59.1%) second clutches, and four (18.2%) third clutches. For six pairs which laid two clutches in season: mean size of first clutch, 4.00 (n=24 eggs); second clutch, 4.50 (n=27 eggs). For six pairs which laid three clutches in season: mean size of first clutch, 3.33 (n=20 eggs); second clutch, 4.83 (n=29 eggs); third clutch, 3.33 (n=20 eggs) (Edgar 1966, which see for details of clutch-size sequence for pairs that suffered clutch- or brood-reduction and failures). Near Masterton, NI, clutch-size sequence of one pair over three seasons: five, four and four eggs; four, five and three; four, five and four (Crouchley & Crouchley 1979). Clutches of up to ten recorded occasionally (Evans *et al.* 2003), but probably laid by two females, or represent a fresh clutch laid in a deserted nest (Heather & Robertson 2000).

Laying Usually begins a few days after lining added to nest, though at one nest first egg laid 5 days before lining added (Tarburton 1993; NRS); another nest completed in Aug., but eggs not laid till Oct. (Storer 1962). For first clutches, interval between completion of nest and laying usually 3–6 days, sometimes 7–10 days, and once 17 days; for second and subsequent clutches, laying begins as soon as lining is complete, usually 1–3 days, sometimes 4–6 days (Edgar 1966). Eggs usually laid at *c.* 24 h intervals (Hyem 1936; Woodroffe 1938; Edgar 1966; Cowan 1968; Schrader 1976; Crouchley & Crouchley 1979; Park 1981b; North; NRS), though sometimes laid at 2-day intervals (Wood 1973; NRS), and at one nest second egg apparently laid 4 days after first (NRS); and, once, three eggs laid within 48 h (Hall 1900), and two within 22 h (NRS). One observer claimed eggs laid on alternate days (Shanks 1960). Eggs usually laid early in morning (McGilp 1930; Edgar 1966; Heather & Robertson 2000). Of 11 records where time of laying of single eggs calculated to ≤2 h, all were laid 04:35–08:30 (NRS). At Campania, in Nov. and Dec., all eggs laid 05:26–06:45 (Park 1981b); at Hokianga, NI, eggs laid: 05:20–06:03, 06:30–07:40, 06:14–08:30, and 06:15–08:00 (Cowan 1968); and at Longburn, NI, all laid before 06:30 (Tarburton 1993). At Campania, interval between laying of first eggs of successive clutches, where first clutch successful, 56 days (47–63; 18); and at Adelaide, SA, eggs laid 3–4 weeks after previous ones hatched (Mellor 1921). Second clutch laid 1–4 weeks after previous brood fledged (Wilson 1928; Edgar 1966; Crouchley & Crouchley 1979; Ashton 1986; Brown & Brown 1991). Re-nest after loss of nest, clutch or brood (Mellor 1930; Beruldsen 1980): in Aust., up to five broods reared in a season (Hall 1900; Cheney 1915; Beck 1924, 1929; Fletcher 1924; McGilp 1925; Howe 1928; Mellor 1930; Marshall 1935; Hopkins 1948; Beruldsen 1980; Tarburton 1993; NRS); and in NZ, up to three per season (Findlay 1960; Edgar 1966; Crouchley & Crouchley 1979; Falla *et al.* 1981; Tarburton 1993; Ashton 2000; Heather & Robertson 2000; CSN 25, 26, 32). Near Manjimup, of 296 completed clutches: 170 (57%) were first clutches, 123 (42%) second clutches, and three (1%) third clutches. Some second clutches were laid after failure of first, but all third clutches were replacements for failed second clutches (Brown & Brown 1991). At Longburn, NI, three clutches usually laid only if earlier clutch lost; of 86 pairs, 48 (55.8%) produced three clutches, 28 (32.6%) two clutches and ten (11.6%) one clutch per season; of the 48 pairs that laid three clutches, only six (12.5%) raised three broods (Tarburton 1993). Once, new eggs in nest 9 days after first clutch disappeared (Hall 1900).

Incubation Usually by female (Park 1981b; Brown & Brown 1991; Tarburton 1993; Heather & Robertson 2000; NRS), though once claimed that both sexes incubate (McGilp 1930), and males very occasionally sit on eggs for a few seconds (Tarburton 1993). At one nest, fledgeling from earlier brood sometimes sat on eggs when female absent (Salter 1960). Incubation usually begins when clutch complete (Hall 1900; Edgar 1966; Wood 1973; Schrader 1976; Crouchley & Crouchley 1979; Brown & Brown 1991; NRS), but sometimes before clutch finished (Edgar 1966; Park 1981b; NRS). Eggs usually hatch either on same day, or in ≤48 h (Woodroffe 1938; Salter 1960; Edgar 1966; Brown & Brown 1991; Tarburton 1993; Heather & Robertson 2000; NRS). At Campania, usually hatched early morning; in three clutches, all eggs hatched within 4 h of each other, and in two others, one egg hatched 24 h later (Park 1981b). At Longburn, NI, of 12 clutches, three (25.0%) hatched on same day, eight (66.7%) hatched over 2 days, and one (8.3%) over 3 days. At one nest, 3 days before hatching, observed for 12.1 h, female incubated for 8.33 h, with mean stint of incubation 8.1 min (1–30; n=62 stints), and foraged for 3.75 h, of mean length of 3.7 min (0.25–22.00; n=61) with intervals between incubation longer in afternoon (Tarburton 1993). At one nest, adults attended for 10–15 min at a time, with infrequent periods of inattentiveness (Turbott 1965; Edgar 1966). Eggs may be left uncovered for longer in hot weather (Schrader 1976; NRS). At Campania, females left nest more often in cool conditions. Sometimes incubating bird fed by mate, usually away from nest (McGilp 1930; Wood 1973; Schrader 1976), but not always fed (Park 1981b). INCUBATION PERIOD: Mostly 15–19 days, but 13–22 days recorded (see below; n= number of eggs unless stated). AUST. 14 days (North). From completion of clutch to hatching, 16.4 days (1.46; 13–21; 114) (NRS). From laying of last egg to hatching of last egg, 16.0 days (1.5; 13–19; 20 clutches) (Tarburton 1993). From laying to hatching for individual eggs, 17.4 days (1.43; 13–22; 85) (NRS); 15.9 days (1.1; 13–19; 35) (Tarburton 1993). QLD: No information. NSW: From completion of clutch to hatching, 16.7 days (1.82; 13–21; 59) (NRS); 14.0 days (n=4 eggs) (Hobbs 1971). From laying to hatching, 18.0 days (1.59; 13–22; 41) (NRS). Usually 16–18 days, but for one clutch, 19±1 days (Schrader 1976); 15 days (Hyem 1936). VIC.: From completion of clutch to hatching, 15.6 days (0.53; 15–16; 9) (NRS); 15.4 days (0.53; 15–16; 9) (Hall 1900); 15–16 days (n=5) (Salter 1960); 19.0 days (n=4) (Wood 1973). From laying to hatching, 17.0 days (1.51; 15–20; 8) (NRS); 17.0 days (1.31; 15–19; 8) (Hall 1900); 20.8 days (1.71; 19–23; 4) (Wood 1973). TAS.: 15.6 days (14–18; 48 clutches) (Park 1981b). From completion of clutch to hatching, 15.9 days (0.47; 15–17; 14); from laying to hatching, 17.0 days (1.08; 15–19; 13) (NRS). SA: From completion of clutch to hatching, 17.0 days (0.82; 16–18; 4) (Woodroffe 1938); 16 days (n=1) (NRS). From laying to hatching, 18.5 days (0.58; 18–19; 4) (Woodroffe 1938); 16 days (n=1) (NRS). Otherwise, 13–14 days (McGilp 1930). WA: From completion of clutch to hatching, 16.1 days (0.81; 15–18; 31); from laying to hatching, 16.9 days (0.89; 16–19; 23) (NRS). Said to be *c.* 16 days early in season, and 15 or sometimes 14 days late in season, depending on weather (Brown & Brown 1991). *NZ* 17 days (15–19) (Heather & Robertson 2000); *c.* 15 days (Falla *et al.* 1981). NI: From laying of last egg to hatching of last egg, 16.7 days (1.1; 16–19; 9 clutches) (Tarburton 1993); *c.* 15 days (Edgar 1966). From completion of clutch to hatching, 17.0 (n=6) (Cowan 1968). From laying to hatching, 16.1 days (1.1; 15–18; 31) (Tarburton 1993); 18.0 (1.15; 17–19; 4) (Cowan 1968). Otherwise, 15–16 days (Crouchley & Crouchley 1979). SI: No information. No significant difference in incubation period between Aust. and NZ (Tarburton 1993). At Campania, mean daily temperatures did not affect incubation period. Infertile eggs sometimes incubated for long periods, once for ≥33 days (NRS) and another for 28 days (Ross 1960); one clutch incubated for 24 days before being deserted (Schrader 1976). Unhatched eggs may be removed from nest during fledging period, but some remain in nest (Edgar 1966; Tarburton 1993; NRS). Infertile eggs usually removed before subsequent clutches laid (Edgar 1966; Tarburton 1993), but deserted clutches sometimes left in nest during subsequent attempts, with fresh eggs laid on top of deserted ones (Edgar 1966; Brown & Brown 1991; NRS).

Young Altricial, nidicolous. Hatch blind, either naked (Edgar 1966, Marchant & Fullagar 1983; NRS) or with a little down (Hall 1900; Park 1981b; Tarburton 1993; NRS). At Longburn, three newly hatched nestlings had neosoptile feathers on crown, shoulder and rump, and two had feathers on back (Tarburton 1993). Eyes begin to open at 3–4 days, and completely open by 5–6 days (Edgar 1966; Park 1981b; NRS), though, on some, still closed at 7–9 days (Hall 1900; NRS). Feather-tracts visible at 3–4 days; pins of primaries and secondaries emerge at 4–6 days; contour-feathers emerge by 5–6 days (at Campania) or *c.* 8 days (at Longburn); chest and abdominal tracts in quill at 8 days; pins of primaries, secondaries and tail-feathers burst at 9–12 days (10.1 days [0.8; 9–12; 25]), and feathers well developed by 12–13 days (Hall 1900; Wood 1973; Park 1981b; Tarburton 1993; NRS). When pins of primaries and secondaries burst, usually 5–10 feathers appeared, though sometimes only one erupted, and sometimes all primaries and secondaries appeared at once and, twice, rectrices appeared on same day (Tarburton 1993). By 16 days, able to break fall to ground if flushed from nest (Park 1981b). Feathers of body develop later; feathers of rump burst after other body-feathers, *c.* 14 days; at 15 days, still had scattered tufts of down; some feathers on head erupted at 17 days, and feathers on forehead at 18–20 days old. By this stage, most or all down shed, and nestlings capable of flight (Park 1981b; Tarburton 1993; North; NRS), though also claimed that newly fledged young retain much down, especially on head and shoulders (McGilp 1930). When young fledge, rectrices shorter than those of adults (McGilp 1930; NRS). GROWTH: At Longburn, young fed immediately after hatching; often gained weight within 1 h. Mean weight of nestlings at hatching 1.6 g (0.2; 1.0–1.8; 16), equal to mean weight of fresh eggs at same location (see Eggs), indicating some were fed before weighing. Mean weight peaked at >17 g at 15 days (Tarburton 1993). Similar pattern observed at Campania, where maximum weight-gain in 24 h was 3.5 g (Park 1981b). If deprived of food, nestlings maintain wing-growth at normal rate while losing body-fat (Ashton 2000). At Longburn, mean wing-length increased from *c.* 7 mm on day after hatching to *c.* 90 mm at 22 days; and weight-gain and wing-growth showed little difference between broods of different sizes (Tarburton 1993). Wing-length of 15-day-old nestlings 61 mm (North). PARENTAL CARE: *FEEDING*: Fed by both parents (Woodroffe 1938; Salter 1960; Storr 1965; Edgar 1966; Wood 1973; Crouchley & Crouchley 1979; Park 1981b; Marchant & Fullagar 1983; Morrison 1987; Tarburton 1993; Heather & Robertson 2000; North; NRS). Sometimes fed by helpers (see Social Organization: Co-operative breeding). Usually one nestling fed per visit, but once two were fed (Park 1981b). Nestlings unattended for long periods, e.g. 6 h, if adults do not follow nests on boats (Wheeler 1959); one pair met boat in morning with food, some distance from shore, if it had been absent overnight (Roberts 1940a). *BROODING*: Usually by female (Salter 1960; Tarburton 1993; Heather & Robertson 2000), though at one nest, both adults roosted together in nest with young, and at another, both adults covered nestlings on a cold morning (NRS). At one nest, on third day of brooding, female brooded nestlings for 7 h 48 min of total 15 h 8 min observation; mean bout 2.94 min (0.5–12; 159). Male did not feed female, but guarded nestlings while female foraged; female left nest on arrival of male on 151 of 169 occasions. Nestlings were guarded by one or other parent for ≥80% of observation time (Tarburton 1993). At one nest, female always brooded young after feeding them (Salter 1960). At Ivanhoe, adults seen diving into water, then perching over nestlings on hot days (Schrader 1976). *NEST-SANITATION*: Both adults remove eggshells from nests (Edgar 1966; NRS); and remove faecal sacs, but as nestlings grow they void over nest-rim, where droppings accumulate (Edgar 1966; Schrader 1976; Park 1981b). At Campania, faecal sacs dropped *c.* 30–50 m from nest, but not removed after *c.* 6–8 days; females sometimes swallowed sacs of 2–3-day-old nestlings. At Longburn, of 25 faecal sacs removed by adults in >15 h, 23 (92.0%) were removed by male, who caught sacs as they emerged and dropped them 8–25 m from nest. Once, parent collected sac, but disposed of by other bird (Disney 1988). Dead nestlings are removed from nest; adults carry them in bill and drop them elsewhere (Woodroffe 1938; NRS). Once, female ejected two live nestlings that had been removed then replaced by person (NRS).

Fledging to independence FLEDGING PERIOD: 12–30 days, but usually 17–23 days (see below; n= number of nestlings except where stated). Said to be significantly shorter at Longburn, NI, than in Aust. (Tarburton 1993). At Campania, s. Tas., brood-size said to have no effect on duration of fledging period (Park 1981b). *AUST.* From hatching to day first recorded out of nest, 21.1 days (1.70; 17–23; 38) (NRS); from hatching of last nestling to day last nestling not in nest, 18.9 days (1.8; 16–22; 12) (Tarburton 1993). Otherwise, 18–20 days (North). QLD: At least 20 days (NRS [n=1 brood]). NSW: 21.7 days (0.88; 20–23; 15) (NRS); 16 days (n=4) (Schrader 1976); 19 days (n=1 brood) (Hyem 1936). VIC.: 20.0 days (2.17; 17–22; 12) (NRS); 26.1 days (3.69; 23–30; 9) (Hall 1900); 18 days (n=4) (Wood 1973); 20–21 days (n=2 broods), though one nestling, only member of brood, left nest at 12 days (Salter 1960). TAS.: 20.6 days (18–23; 33 broods) (Park 1981b); 20 days (n=1) (NRS). SA: 17.3 days (0.58; 17–18; 3) (Woodroffe 1938); 18–21 days (n=2) (NRS); 16–18 days (McGilp 1930). WA: 22.0 days (0.93; 21–23; 8) (NRS); *c.* 20 days (Brown & Brown 1991). *NZ* 21 days (18–23) (Heather & Robertson 2000); 17–22 days (Falla *et al.* 1981). NI: From hatching of last nestling to day last nestling not in nest, 21.5 days (1.4; 20–23; 6) (Tarburton 1993). From hatching to day first recorded out of nest, 20.5 days (0.55; 20–21; 6) (Cowan 1968). Otherwise, 18–23 days, but usually 20–21 (Edgar 1966). SI: No information. Most records of young fledging are in morning (Cowan 1968; NRS), or occasionally round midday (Edgar 1966; NRS). One brood seen leaving nest in evening, but may have fledged earlier (Edgar 1966). All nestlings of brood usually fledge on same day, or within 24 h of one another, though interval can be much shorter, e.g. all fledging at same time (Edgar 1966; Cowan 1968; NRS), over 30–60 min, or all on same morning (NRS). Nestlings preen, spread and flap wings, especially from 15–18 days old, when close to fledging (Salter 1960; Edgar 1966; NRS), and may cling to edge of nest, with tail outward, exercising their wings (Salter 1960; NRS). May perch on edge of nest before fledging (Edgar 1966; NRS). Newly fledged young usually capable of short, unsteady flights only; one fledgeling made first flight of 18.3 m (Salter 1960; Turbott 1965; Cowan 1968; Butler 1975; NRS). Young occasionally fledge before they can fly (Edgar 1966; NRS); some exit nests on horizontal supports by walking (Edgar 1966). Some fledgelings capable of strong flight, flying considerable distances upon leaving (Hall 1900; Edgar 1966; NRS). Once, two fledgelings first flew 8 days after leaving nest (NRS). New fledgelings take short flights at first, round nest-area (Edgar 1966; Marchant & Fullagar 1983; NRS). Sometimes one of a brood may not fledge, or quickly returns to nest after fledging (Wood 1973; NRS), and sometimes all fledgelings return to nest (NRS). Fledgelings often return to nest in late afternoon (Park 1981b), and roost in or near nest, and also shelter in nest during inclement weather (Woodroffe 1938; Michie 1959a; Salter 1960; Storer 1962; Turbott 1965; Cowan 1968; Wood 1973; Schrader 1976; Crouchley & Crouchley 1979; Morrison 1987; Heather & Robertson 2000; NRS). Continue to roost in nest for between a few days and up to *c*. 5 weeks (Hall 1900; McGilp 1930; Salter 1960; Edgar 1966; Schrader 1976; Park 1981b; NRS); at Black Rock, Vic., one fledgeling continued roosting in nest after female re-laid, and was driven off by female when 53 days old (Salter 1960). At Ivanhoe, fledgelings roosted *c*. 120 cm from nest for up to 8 weeks, having been discouraged from roosting in nest by adults. Both parents feed fledgelings, even if re-nesting has begun (Sutton 1927a; Edgar 1966; Crouchley & Crouchley 1979; Heather & Robertson 2000; NRS). Fledge-lings fed by both parents for *c*. 3–4 weeks (Salter 1960; Crouchley & Crouchley 1979; Saunders & de Rebeira 1993; Green 1995; Heather & Robertson 2000; NRS); near Masterton, NI, young fed for 2 weeks after fledging (Crouchley & Crouchley 1979); at Black Rock, Vic., fed for 10 days after fledging (Salter 1960). Fledgelings sometimes fed in flight (see Food). At one nest, male fed fledgeling while female repaired nest for second breeding attempt (Salter 1960). At a nest at Black Rock, Vic., helpers assisted resident pair to feed fledgelings (Salter 1960; see also Young). Hand-reared fledgelings sometimes feed nest-mates (Nicholls 1962).

Success Aust. For 396 nests where clutch-size, number hatched and number fledged known: of 1414 eggs, 1020 (72.1%) hatched, and 828 (58.6%) fledged, equal to 2.09 fledgelings per nest. Of 396 nests, 251 (63.4%) fledged at least one young; of these, mean clutch-size 3.58; and mean number fledged, 3.30. For 260 nests where clutch-size and number hatched known, but number fledged unknown: of 969 eggs, 933 (96.3%) hatched; of 1769 nests where outcome known, 1227 (69.4%) successfully fledged at least one young, and 542 (30.6%) failed. At 228 nests where outcome unknown, young considered capable of leaving when last seen (NRS). From 403 clutches: of 1446 eggs, 1009 (69.8%) fledged, equal to 2.50 fledgelings per clutch (Tarburton 1993). *E. AUST*.: From 266 clutches: of 1005 eggs, 685 (68.2%) fledged, equal to 2.58 fledgelings per clutch (Tarburton 1993). QLD: For three nests in which clutch-size, number hatched and fledging known, of ten eggs, seven (70.0%) hatched and seven (70.0%) fledged. At another nest, four eggs laid and all hatched, but outcome unknown. Of 42 nests where only outcome known: 30 (71.4%) successfully fledged at least one young, and 12 (29.6%) failed (NRS). NSW: For 141 nests where clutch-size, number hatched and number fledged known: of 548 eggs, 402 (73.4%) hatched and 294 (53.6%) fledged, equal to 2.09 fledgelings per nest. Of 141 nests, 80 (56.7%) fledged at least one young; of these, mean clutch-size 4.11, and mean number fledged 3.68. Another 33 nests were successful, but number fledged was unknown; of 130 eggs in these nests, 128 (98.5%) hatched. For 92 nests where clutch-size and number hatched known, but outcome unknown: of 358 eggs, 340 (95.0%) hatched; of 504 nests where only outcome known, 348 (69.0%) successfully fledged at least one young, and 156 (30.0%) failed (NRS). At Ivanhoe, from 46 clutches: of 190 eggs, 120 (63.2%) hatched and 74 (38.9%) fledged, equal to 1.61 fledgelings per clutch. VIC.: For 61 nests where clutch-size, number hatched and number fledged known: of 236 eggs, 131 (55.5%) hatched, and 115 (48.7%) fledged, equal to 1.89 fledgelings per nest. Of 61 nests, 33 (54.1%) fledged at least one young; of these, mean clutch-size 3.88, and mean number fledged 3.48. Another ten nests were successful, but number fledged was unknown; of 43 eggs in these nests, 42 (97.7%) hatched. For 34 nests where clutch-size and number hatched known, but outcome unknown: of 132 eggs, 129 (97.7%) hatched; of 239 nests where only outcome known, 158 (66.1%) successfully fledged at least one young, and 81 (33.9%) failed (NRS). TAS.: For 38 nests where clutch-size, number hatched and number fledged known: of 139 eggs, 97 (69.8%) hatched, 77 (55.4%) fledged, equal to 2.03 fledgelings per nest. Of 38 nests, 23 (60.5%) fledged at least one young; of these, mean clutch-size 3.65, and mean number fledged 3.35. Another four nests successful, but number fledged unknown; of 15 eggs in these nests, 14 (93.3%) hatched. For 17 nests where clutch-size and number hatched known, but outcome unknown: of 61 eggs, 60 (98.4%) hatched; of 115 nests where only outcome known, 66 (57.4%) successfully fledged at least one young, and 49 (42.6%) failed (NRS). At Campania, of 266 eggs, 158 (59.4%) fledged (seasons combined); success varied much between seasons (27.4%–89.8%). SA: For 18 nests where clutch-size, number hatched and number fledged known: of 66 eggs, 65 (98.5%) hatched, and 57 (86.4%) fledged, equal to 3.17 fledgelings per nest. Of 18 nests, 17 (94.4%) fledged at least one young; of these, mean clutch-size 3.65, and mean number of young fledged 3.35. At one nest, of three eggs, two hatched; though successful, unknown number fledged. At another nest, of four eggs, all hatched, but outcome unknown. Of 76 nests where only outcome known, 60 (78.9%) successfully fledged at least one young and 16 (21.1%) failed (NRS). WA: For 136 nests where clutch-size, number hatched and number fledged known: of 419 eggs, 322 (76.8%) hatched, and 282 (67.3%) fledged, equal to 2.07 fledgelings per nest. Of 136 nests, 97 (71.3%) fledged at least one young; of these, mean clutch-size 3.11, and mean number of young fledged 2.91. Another 15 nests were successful, but number fledged unknown; of 54 eggs in these nests, all hatched. For 51 nests where clutch-size and number hatched known, but outcome unknown: of 161 eggs, 152 (94.4%) hatched; of 333 nests where only outcome known, 250 (75.1%) successfully fledged at least one young, and 83 (24.9%) failed (NRS). From 137 clutches: of 441 eggs, 324 (73.5%) fledged, equal to 2.36 fledgelings per clutch (Tarburton 1993). For 305 nests near Manjimup: of 969 eggs, 768 (79.3%) hatched, 730 (75.3%) fledged, equal to 2.39 fledgelings per nest. NT: No breeding recorded. **NZ** NI: In Northland, from 72 clutches: of 284 eggs laid, 153 (53.9%) hatched, 136 (47.9%) fledged, equal to 1.89 fledgelings per clutch (Edgar 1966). At Longburn, from 25 clutches: of 108 eggs, 51 (47.2%) fledged, equal to 2.04 fledgelings per clutch (Tarburton 1993). At Masterton, one pair over four seasons laid 42 eggs, 30 (71.4%) of which hatched and fledged (Crouchley & Crouchley 1979). On Heretaunga Plains, Hawkes Bay, >90% of nestlings survived to fledging (Ashton 2000). SI: No information. SUCCESS VS CLUTCH-SIZE: Success varies with clutch-size (see below); comparison between regions shows that all clutch-sizes in WA produced more fledgelings than corresponding clutch-sizes elsewhere, and that, though less productive than those in WA, clutches in e. Aust. more productive than those at Longburn, NI (see below). In e. Aust.: C/1: of seven eggs, two (28.6%) fledged, equal to 0.29 fledgelings per clutch; C/2: of 22 eggs, four (18.2%) fledged, equal to 0.36 fledgelings per clutch; C/3: of 246 eggs, 154 (62.6%) fledged, equal to 1.88 fledgelings per clutch; C/4: of 532 eggs, 366 (68.8%) fledged, equal to 2.75 fledgelings per clutch; C/5: of 175 eggs, 140 (80.0%) fledged, equal to 4.00 fledgelings per clutch; and C/6: of 30 eggs, 21 (70.0%) fledged, equal to 4.20 fledgelings per clutch (Tarburton 1993). At Ivanhoe: C/2: of six eggs, two (33.3%) hatched, and two (33.3%) fledged, equal to 0.67 fledgelings per clutch; C/3: of nine eggs, three (33.3%) hatched, and three (33.3%) fledged, equal to 1.00 fledgelings per clutch; C/4: of 100 eggs, 65 (65.0%) hatched, and 35 (35.0%) fledged, equal to 1.40 fledgelings per clutch; C/5: of 75 eggs, 50 (66.7%) hatched, and 34 (45.3%) fledged, equal to 2.27 fledgelings per clutch. At Campania, C/3 most successful. In WA: C/2: of 22 eggs, 10 (45.5%) fledged, equal to 0.91 fledgelings per clutch; C/3: of 255 eggs, 177 (69.4%) fledged, equal to 2.08 fledgelings per clutch; C/4: of 164 eggs, 137 (83.5%) fledged, equal to 3.34 fledgelings per clutch (Tarburton 1993). Near Manjimup: C/1: of two eggs, two (100.0%) hatched, and one (50.0%) fledged, equal to 0.50 fledgelings per clutch; C/2: of 56 eggs, 29 (51.8%) hatched, and 29 (51.8%) fledged, equal to 1.04 fledgelings per clutch; C/3: of 567 eggs, 459 (81.0%) hatched, and 426 (75.1%) fledged, equal to 2.25 fledgelings per clutch; C/4: of 344 eggs, 278 (80.8%) hatched, and 274 (79.7%) fledged, equal to 3.19 fledgelings per nest-clutch. In NZ, probability of at least one egg or young being lost is lowest for intermediate clutch-sizes (C/4 and C/5), i.e. smaller and larger clutches more likely to suffer at least partial losses. Overall probability of successfully fledging at least one young increased with increased clutch-size (see Evans *et al.* 2003 for details). In Northland: C/3: of 33 eggs, 25 (75.8%) hatched, and 25 (75.8%) fledged, equal to 2.27 fledgelings per clutch; C/4: of 120 eggs, 95 (79.2%) hatched, and 88 (73.3%) fledged, equal to 2.93 fledgelings per clutch; C/5: of 90 eggs, 69 (76.7%) hatched, and 66 (73.3%) fledged, equal to 3.67 fledgelings per clutch. At Longburn: C/3: of three eggs, one (33.3%) fledged, equal to 1.00 fledgelings per clutch; C/4: of 64 eggs, 20 (31.3%), equal to 1.25 fledgelings per clutch; C/5: of 35 eggs, 25 (71.4%) fledged, equal to 3.57 fledgelings per clutch; C/6: of six eggs, five (83.3%) fledged, equal to 5.00 fledgelings per clutch. **SUCCESS VS NUMBER OF CLUTCHES IN SEASON:** Success varies throughout season, or between breeding attempts: rates of success highest in middle of season (see below). At Ivanhoe, success greatest for second clutches of season: for first clutches, of 81 eggs, 58 (71.6%) hatched, and 32 (39.5%) fledged; for second clutches, of 64 eggs, 47 (73.4%) hatched, and 33 (51.6%) fledged; for third clutches, of 34 eggs, 15 (44.1%) hatched, and nine (26.5%) fledged; for fourth clutches, of eight eggs, none hatched; and for fifth clutches, of three eggs, none hatched. At Campania, rates of fledging were: 51.6% of eggs in first clutches, 76.9% of eggs in second clutches, and 50.0% of eggs in third clutches. Near Manjimup, for first clutches (n=95; seasons combined): of 296 eggs, 242 (81.8%) hatched, and 226 (76.4%) fledged, equal to 2.38 fledgelings per clutch; for second (n=69) and third clutches (n=3): of 224 eggs, 165 (73.7%) hatched, and 165 (73.7%) fledged, equal to 2.29 fledgelings per nest; third clutches were replacements for failed second clutches. In Northland, for first clutches (n=25): of 96 eggs, 51 (53.1%) hatched, and 45 (46.9%) fledged, equal to 1.80 fledgelings per clutch; for second clutches (n=25): of 108 eggs, 68 (63.0%) hatched, and 60 (55.6%) fledged, equal to 2.40 fledgelings per clutch; for third clutches (n=18): of 66 eggs, 34 (51.5%) hatched, and 31 (47.0%) fledged, equal to 1.72 fledgelings per clutch; for fourth clutches (n=2): of eight eggs, none hatched; for fifth clutches (n=2): of six eggs, none hatched (Edgar 1966). **SUCCESS VS PROXIMITY TO OTHER NESTS:** Proximity of other nests can affect success. Near Manjimup, solitary nests were more successful than those in small colonies. For 224 nests in sites occupied by single pair: of 719 eggs, 587 (81.6%) hatched, and 559 (77.7%) fledged, equal to 2.50 fledgelings per nest; for 81 nests in sites occupied by 2–4 pairs: of 250 eggs, 181 (72.4%) hatched, and 171 (68.4%) fledged, equal to 2.11 fledgelings per nest. **OTHER TRENDS IN RATES OF SUCCESS:** Near Manjimup, pairs nesting in nest-boxes more successful than those in other sites (Brown & Brown 1991). In NZ, mathematical modelling revealed other trends: (1) Probability of successfully rearing at least one young increased significantly between 1962 and 1995; (2) probability of total or part failure decreased with increased nest-height; and (3) probability of both total or part failure and success varied with altitude (see Evans *et al.* 2003 for details). **CAUSES OF FAILURE:** Most nest-failures occurred during incubation period. *AUST.*: In e. Aust., of 1101 failed nests: 1026 (93.2%) failed during incubation, 43 (3.9%) during fledging period, 21 (1.9%) during building and 11 (1.0%) at unknown stage (Tarburton 1993). Near Manjimup, reduced hatching success at sites with multiple pairs was due mostly to disappearance of eggs: 14% of eggs in shared sites disappeared, but only 2% lost in exclusive sites. *NZ*: In Northland, of 29 failed attempts: 15 (51.7%) nests fell or were knocked down, seven (24.1%) had eggs disappear, five (17.2%) failed to hatch (eggs infertile or deserted), and two (6.9%) had nestlings disappear. At Longburn, of 12 failed nests: six (50.0%) failed during incubation, three (25.0%) during building and three (25.0%) during fledging. At L. Ellesmere, SI, success said to be limited by choice of site, e.g. on Kaitorete Spit, failure rate was high because of fluctuating water-levels in tanks used for nesting (Tunnicliffe 1968). *EGGS*: At Ivanhoe, of 19 nests in which eggs did not hatch: eight (42.1%) were deserted (including four deserted during cold snap), five (26.3%) had eggs disappear, two (10.5%) had contents of eggs eaten, two (10.5%) collapsed and two (10.5%) were damaged and had lining removed; of 175 eggs in four- and five-egg clutches, six (3.4%) were infertile. In Northland, of 131 eggs lost: 62 (47.3%) deserted or failed to hatch (especially those laid after mid-Jan.), 42 (32.1%) lost when nest fell or was knocked down, and 27 (20.6%) preyed upon. Once, nest failed after incubating female was injured (Brown & Brown 1991). *YOUNG*: At Ivanhoe, nestlings in three nests died after flooding by heavy rain, and four nestlings drowned when nests collapsed; ten fledgelings drowned in tank. Young removed from two nests by children. In Northland, of 17 nestlings lost: seven (41.2%) by predation, one (5.9%) after nest fell, and nine (52.9%) by other unstated causes. At Longburn, young that fledged prematurely drowned. Some nestlings starve to death after becoming trapped in nest-lining (Edgar 1966; Cowan 1971; Tarburton 1993); once, brood failed when female was killed and male did not feed young (Park 1981a). *ADVERSE WEATHER*: Nests sometimes deserted after cold, wet and windy weather, and sometimes flooded during heavy rain (Hankins 1963; Edgar 1966; Munro 1969; Schrader 1976; NRS). Heavy rain at Ivanhoe in 1974 caused mean number of young fledged to decline from 4.6 fledgelings/site in 1973 to 2.1 fledgelings/site, possibly due to reduction in time spent feeding. At Rotamah I. in 1981, *c.* 20 of 25 nests with eggs under jetties were washed away by waves caused by storms (A.H. Burbidge). Hot weather also caused several broods to die (Park 1981b; NRS), and dried out eggs in one nest (NRS). *INTERFERENCE AND OTHER DESTRUCTION OF NESTS*: Often removed or vandalized by people (Edwards 1925; Cohn 1928; Michie 1959a; Turbott 1965; Edgar 1966; Tarburton 1993; Coyle 1994; NRS). One nest was destroyed by Common Mynas *Acridotheres tristis* (CSN 22); and House Sparrows sometimes interfere with nests, removing lining (Edgar 1966; Webb 1990; North). One nest torn down by Dogs (NRS). For details of interference at nest in a captive colony, see Disney (1988).

Nests, especially those on vertical surfaces, sometimes collapse (Edgar 1966; Tunnicliffe 1968; Schrader 1976; NRS), and those beneath bridges sometimes collapse from vibration of traffic (Edgar 1966; NRS); nests made of sandy mud especially prone to collapse (Cowan 1971). At Ivanhoe, main causes of nest collapse were family groups roosting in nest, and wet weather. Strong wind occasionally dislodges nests (NRS). *DESERTION*: Sites often abandoned after human interference (Edgar 1966). Near Manjimup, nest in pump-house was abandoned when new motor installed. Also deserted after adverse weather (see above). *USURPATION OF NESTS*: House Sparrows sometimes appropriate nests (q.v.). *PREDATION*: Eggs or young or both sometimes taken by: rats (Edgar 1966; NRS; A.H. Burbidge); Cats (Park 1981b; NRS); Common Starlings (North); Brown Falcons *Falco berigora* (NRS); Nankeen Kestrels (Butler 1975); Pied Currawongs (Ormay 2001; NRS); House Sparrows (Edgar 1966); and Brown Tree Snakes *Boiga irregularis* (NRS). Others suspected of predation of eggs or young include: Stoats (Tarburton 1993); Foxes (said to take sitting birds from nests in trees below 1.8–2.4 m; Hall 1900); Grey Shrike-thrushes (Ormay 2001); Common Blackbirds *Turdus merula* (Tarburton 1993); Southern Boobooks *Ninox novaeseelandiae* (Tarburton 1993); and Grey Butcherbirds (Park 1981a,b; Hooper & Wells 1989; NRS). Adult Swallows occasionally attack young from nearby nests (see Social Behaviour).

PLUMAGES Prepared by J.S. Matthew. Hatch either naked or with a little down (see Breeding: Young). Fledge in juvenile plumage. Complete post-juvenile moult to adult (first basic) plumage. Thereafter, complete post-breeding (pre-basic) moult each cycle produces successive adult non-breeding (basic) plumages with no change in appearance. Sexes differ slightly. Two subspecies; nominate *neoxena* described below based on examination of skins of 15 adult males, seven adult females, five juvenile males and two juvenile females (HLW, MV).

Adult male (Definitive basic). **HEAD AND NECK:** Forehead and forecrown, dark rufous-brown (dark 240) with concealed greyish (ne) bases to feathers. Hindcrown, nape, hindneck and upper sides of neck, glossy blue-black (glossy 90), sharply demarcated from rufous-brown forecrown; blue-black of upper sides of neck extends as narrow arc onto sides of lower throat. Lores and eye-ring, black (89) or black-brown (119). Upper ear-coverts and narrow line of feathers below eye, dark brown (121), combining with lores and eye-ring to form narrow blackish-brown (c119) eye-stripe which merges at rear with blue-black upper sides of neck. Lower ear-coverts, lower sides of neck, malar area, chin and throat, rufous-brown (340, c240), slightly paler than forehead and forecrown; feathers have concealed greyish (ne) bases. Several fine, short (*c*. 2 mm) black (89) bristles protrude from above lores and above gape. **UPPERPARTS:** Entire upperparts, glossy blue-black (glossy 90); feathers of mantle and hindneck have concealed greyish-white (ne) band across centre. All feathers have concealed grey (87) bases. **UNDERPARTS:** Upper breast, rufous-brown (c240, 340), as throat; some birds have one or two small, diffuse blackish (c89) patches on centre of upper breast, formed by blackish tips to one or more feathers. Lower breast, flanks, axillaries and thighs, grey-brown (c91), grading to off-white (ne) on centre of lower breast; some birds have narrow, diffuse black-brown (119) line at sides of breast, separating rufous-brown of upper breast from light grey-brown of lower breast, but this line very rarely extends across centre of breast (as in most Barn Swallows *Hirundo rustica*). Belly and vent, off-white (ne) or creamy white (ne). Undertail-coverts, light grey-brown (119D) with dark-brown (121) shafts and broad white tips; longest undertail-coverts have black-brown (119) subterminal band or chevron near tip, appearing as series of black-brown bands or chevrons at base of undertail. **UPPERTAIL:** Rectrices, blackish brown (119) with faint greenish-blue (c164) gloss on outer webs and towards tips, and with very narrow off-white (ne) outer edges. T2–t6 have narrow white inner edges and prominent white panel (or sometimes spot on t2–t4) about one-third feather length from tip, panels or spots becoming larger towards outertail and usually merging with inner edges, but separated from inner edges in some birds; white panel to t5 and t6 usually extends diagonally from inner edge at base to shaft distally; mean length of white panel (measured diagonally from base to tip) on inner web of t6, 15.8 mm (2.28; 13–20; 10); see Figure 1 for variation in markings on t6. Tail deeply forked, more so than in females (see Sexing and Measurements, below); t6 very elongated, forming distinct streamers. **UNDERTAIL:** Rectrices, dark brown (121); markings as uppertail and white markings to inner webs combine to form inverted V across distal third of tail, visible when tail spread or folded. **UPPERWING:** Marginal and median secondary coverts, dark brown (121) with glossy blue-black (glossy 90) tips; outer few coverts (along leading edge of wing) have narrow off-white (ne) fringes at tips. Greater secondary coverts, dark brown (121) with faint glossy blue (ne) tinge to outer webs; inner two coverts (usually concealed by overlying scapulars) have pale-grey (86) inner webs and buff (124) or off-white (ne) fringes at tips. Marginal primary coverts, brown (28) or light grey-brown (119C). Median and greater primary coverts, and alula, dark brown (121). Tertials, dark brown (121) with glossy blue (ne) tinge and narrow cream (92) or off-white (ne) tips, much narrower on outer tertial, which quickly wear away to leave small notch at tips. Secondaries and primaries, dark brown (121) with faint glossy greenish-blue (c64) tinge to outer webs and concealed diffuse pale-greyish (c86) inner edges; on secondaries, inner edges merge with narrow white fringes at tips, which lost with wear. **UNDERWING:** Wing-coverts, light brownish-grey (c80); most coverts with diffuse buff (124) or rufous-brown (c38) tips or fringes; greater primary coverts have narrow dark-brown (119A) fringes at tips. Remiges, brownish grey (c79) with indistinct narrow white fringes at tips of secondaries when fresh.

Adult female (Definitive basic). Similar to adult male, from which differs by following features of tail: (1) tail shorter and less deeply forked than adult male (see Measurements); (2) t4–t6 broader and less acute at tips than in adult male, especially on t5 and t6 (see Fig. 1 in Recognition, below); and (3) on typical female, white panels or spots to inner webs of rectrices tend smaller, not reaching shaft (see Fig. 1 in Recognition); mean length of white panel on inner web of t6, 9.7 (3.57; 4–16; 10); in a few birds pattern of white on t6 as for typical juvenile (see below); a few birds have white panel on outer rectrices approaching size and shape of those in adult male. See also Disney (1991: Fig. 1) for differences between sexes in structure and markings of tail.

Nestlings Photos of nestlings (Strahan 1) show fine pale-grey (86) down on crown. Acquire pale down soon after hatching (Marchant & Fullagar 1983); also said to hatch with a little down (Tarburton 1993).

Juvenile Sexes alike. Rather similar to adult, from which differs by: **HEAD AND NECK:** Lower forehead, light brown (39) or rufous-brown (38); with wear becomes paler, greyish white (ne) as pale bases to feathers exposed. Upper forehead, black-brown (119) or dark brown (121), some birds with light-brown (39) scalloping or wash formed by light-brown fringes to feathers. Crown, nape, hindneck and upper sides of neck, dark brown (121) or black-brown (119) with varying glossy blue-black (glossy 90) tinge which always duller and less distinct than in adult. Narrow line of rufous-brown (38) feathers extends from sides of lower forehead to above eye, forming narrow fore-supercilium. Eye-stripe slightly paler dark brown (c121) than in adult; lower ear-coverts, dark brown (121) with light-brown (39) tips. Lower sides of neck, malar area, chin and throat, light rufous-brown (pale 38) or light brown (c39), paler than in adult. UPPERPARTS: Entire upperparts, black-brown (119) or dark brown (121) with glossy blue-black (glossy 90) wash over mantle, scapulars and back; gloss distinct in some and indistinct in others, but always duller and less distinct than in adult. Uppertail-coverts and feathers of rump have narrow light-brown (223D) fringes to tips when fresh. UNDERPARTS: Similar to adult, but breast paler rufous-brown (pale 38). Undertail-coverts, light grey-brown (119C) or light brownish-grey (c80) with white or buff (124) fringes; lack dark subterminal markings of adults. Feathers of underparts more loosely textured than in adult. TAIL: Similar to typical adult female, but less deeply forked (see Measurements and Fig. 1 in Recognition) and tip to t6 slightly broader; white on inner web of t6 tends more diffuse and confined to small patch on inner edge, but in some birds no different in extent and shape compared with typical adult females; white markings to inner webs of rectrices do not reach shafts, unlike most adult males. UPPERWING: Marginal and median secondary coverts, dark brown (121) with faint bluish-black (c90) gloss near tips. Greater secondary coverts and tertials, similar to adult but with less distinct gloss; tertials have narrow light-brown (39) or buff (c124) tips when fresh (cf. whitish in adults). UNDERWING: As adult.

Aberrant plumage Skin (HLW) of juvenile male has: mostly greyish-white (ne) plumage of body with slightly darker (light brownish-grey [c80]) upperparts and top of head; pale rufous-brown (pale 38) lower forehead, malar area, chin and throat; pale orange-rufous (pale 132D) wash on breast and flanks and at tips of tertials and greater secondary coverts. Another skin (HLW), of adult male, has distinct off-white (ne) subterminal bands to all remiges, greater coverts, feathers of alula and rectrices, forming distinct pale barring across wing and tail; this skin otherwise as adult male.

BARE PARTS Based on photos (P. Rogers [1995] **In**: *Bird Obs.* 752: 1; Watts 1999; unpubl.: M.J. Carter; G.S. Chapman; R. Drummond), and standard sources; data from museum labels (MV), live birds captured in Vic. and Tas. (Rogers *et al.* 1986), and other information as cited. **Adult** Bill and gape, black (89). Palate, yellowish pink (ne); also described as yellow (Hall). Iris, black-brown (119); also dark brown or red-brown (Hall). Orbital ring, black (89). Legs and feet, black (89) or grey-black (82). **Nestlings** Bill, gape, pale yellow (157), swollen. Palate, orange (17). Egg-tooth described as white (Park 1981b). Bare skin, pink (3); also described as pink (Park 1981b). **Juvenile** Bill, dark grey (c83) with pale-yellow (157) base to lower mandible; also brown with flesh base to lower mandible (MV) or dark grey (Rogers *et al.* 1986). Gape, pale yellow (157), swollen; also fawn (Rogers *et al.* 1986), yellowish or flesh (MV). Iris, black-brown (119); also dark brown (MV); skin (HLW) with aberrant plumage (see above) had iris described as pale blue. Orbital ring, dark grey (c83). Legs and feet, dark brown (c22), scales demarcated with white.

MOULTS Based on examination of skins of 20 adult and nine juvenile nominate; six adult and one juvenile *carteri* (HLW, MV, SAM), and other information as cited. **Adult post-breeding** (Second and subsequent pre-basic). Complete. Primaries moult outward, starting at p1. Usually one or two primaries grow at once, but sometimes as many as three. Little information on timing in e. Aust. Rogers *et al.* (1986) recorded active moult from Jan.–Apr. in Vic. From skins: active moult of primaries recorded from: Jan. (1 of 1; PMS 23), and Apr. (2 of 2; PMS 44, 47); one in Mar., two in May, one in June and two in July had all primaries new or only slightly worn; all 11 from Aug.–Dec. had all primaries worn. One from central SA in June showed no active moult (Hall). More detailed information on timing of moult of primaries comes from birds captured in sw. WA, Jan.–Apr. 1988 (Brown & Brown 1989): they captured 65 adults and plotted primary-moult scores against date of capture, and estimated moult of primaries started about mid-Nov. and finished May; based on six birds initially captured with PMS 5–25, and recaptured in same moult-cycle with PMS 35–40, individual duration of moult of primaries estimated at *c.* 132 days. Secondaries moult inward, starting on average when PMS 17; moult of secondaries apparently finished before moult of primaries (Brown & Brown 1989). Moult of tertials starts at about same time as moult of primaries, and in sequence s8–s9–s7 (Brown & Brown 1989). Moult of tail starts when PMS 18–25; usual sequence t1–t2–t3–t4–t6–t5 or t1–t2–t3–t5–t6–t4 (Brown & Brown 1989). Timing of moult of body much as primaries. **Post-juvenile** (First pre-basic). Complete. Acquire adult plumage in this moult, and first-year birds indistinguishable from adults from late autumn onward. Primaries moult outward, starting at p1. From e. Aust. skins, active moult of primaries recorded from: Dec. (1 of 5; PMS 5) and Jan. (2 of 3; PMS 29, 33); one in Oct., and rest from Dec.–Jan., not yet started moult of primaries. Disney (1991) stated that post-juvenile moult starts at *c.* 3 months old, and nearly finished (most juvenile feathers of head still present) at *c.* 5 months old. In sw. WA, juveniles start moult of primaries *c.* 2 weeks later than adults and finish in June or July; individual duration of moult of primaries *c.* 150 days, based on recaptures of three individuals within same moult-cycle; thought that juveniles from second brood moult more quickly than those from first brood. Sequence of replacement of secondaries, tertials and rectrices as for adult (Brown & Brown 1989).

MEASUREMENTS NOMINATE *NEOXENA*: (1–2) Qld, NSW, Vic., Tas. and SA, skins (HLW, MV, SAM): (1) Adults; (2) Juveniles. Tail-fork measured as length between tips of t1 and t6 on closed tail.

		MALES	FEMALES	
WING	(1)	113.7 (2.18; 110–117; 19)	112.3 (3.00; 106–116; 13)	ns
	(2)	109.0 (4.85; 101–114; 5)	105.7 (7.02; 91–111; 7)	ns
TAIL	(1)	77.9 (4.84; 65–83; 17)	71.2 (4.55; 64–79; 14)	**
	(2)	60.5 (6.71; 54–71; 5)	61.2 (6.76; 50–70; 7)	ns
TAIL-FORK	(1)	35.2 (3.68; 29–42; 15)	27.4 (4.45; 17–36; 13)	**
	(2)	18.0 (6.79; 10–25; 4)	19.7 (5.02; 14–27; 5)	ns
BILL S	(1)	10.8 (0.69; 9.3–12.4; 19)	10.5 (0.97; 9.0–12.1; 14)	ns
	(2)	10.7 (0.65; 10.0–11.6; 5)	10.1 (0.80; 9.2–11.2; 7)	ns
TARSUS	(1)	10.4 (1.54; 8.6–13.3; 15)	11.0 (1.45; 9.3–12.7; 12)	ns
	(2)	11.1 (1.49; 9.4–13.3; 5)	11.9 (0.66; 11.2–12.7; 4)	ns

NOMINATE *NEOXENA*: (3) Vic. and Tas., live adults, unsexed (Rogers *et al.* 1986).

		UNSEXED
WING	(3)	(102–119; 59)
THL	(3)	(26.4–28.8; 47)
TAIL-FORK	(3)	(17–39; 26)

SUBSPECIES *CARTERI*: (4–5) WA, skins (HLW, MV, WAM): (4) Adults; (5) Juveniles. WAM skins measured by R. Schodde & I.J. Mason.

		MALES	FEMALES
WING	(4)	112.3 (2.52; 109–116; 6)	111, 117
	(5)	107	–
TAIL	(4)	76.0 (1.17; 74–77; 5)	62, 76
	(5)	62	–
TAIL-FORK	(4)	34	31
	(5)	16	–
BILL S	(4)	11.1, 11.5, 12.1	12.3
	(5)	9.6	–
TARSUS	(4)	10.1	9.4
	(5)	10.6	–

SUBSPECIES CARTERI: (6) WA, unsexed, adults, skins (WAM) (Johnstone & Storr 2004).

		UNSEXED
WING	(6)	113.3 (108–120; 15)
TAIL	(6)	65.1 (55–82; 15
BILL S	(6)	12.3 (9–14; 15)
TARSUS	(6)	12.6 (11–15; 15)

WEIGHTS NOMINATE *NEOXENA*: (1–2) NSW, Vic., from museum labels (MV): (1) Adults; (2) Juveniles.

	MALES	FEMALES
(1)	15.0 (3.49; 9.2–20.0; 6)	12.0
(2)	13.5	–

NOMINATE *NEOXENA*: (3) Vic., Tas., live adults (Rogers *et al.* 1986). (4) Rotamah I., Vic., live adults (A.H. Burbidge).

	UNSEXED
(3)	(12.5–17.3; 19)
(4)	14.7 (0.90; 13.2–16.0; 11)

Juvenile male (MV) subspecies *carteri* from sw. WA weighed 13 g. Johnstone & Storr (2004) gave weight of *carteri* as 10–20 g.

STRUCTURE Wing long and very pointed at tip. Ten primaries: p9 longest; p10 vestigial, p8 1–2.5 mm shorter than p9, p7 9–10, p6 18–19, p5 25–27, p4 33–39, p3 38–43, p2 45–50, p1 52–56. Primaries not emarginated. Nine secondaries including three tertials; tips of longest tertials fall shorter than tips of secondaries on folded wing; secondaries have distinct notch in centre of tips. Tail long with deep fork in adult males; tends shorter with shallower fork in adult females, and much shorter with shallow fork in juveniles (see Measurements and Sexing); 12 rectrices; t6 longest, very elongated, forming streamers in adult male; t5 14–24 mm shorter than t6 in adult males (12–18 in females), t4 20–30 (17–22 in females), t3 25–37 (21–24), t2 26–39 (22–29); see Measurements and Recognition for difference between t1 and t6. Bill short, rather wide at base and flattened, pointed at tip. Tarsus short and slender, toes long in comparison; scaling laminiplantar with ridged plantar surface. Tibia fully feathered. Middle toe with claw 14.7 (0.50; 14.1–15.2; 6); outer toe 69–83% of middle, inner 66–77%, hindtoe 59–69%.

AGEING Juvenile distinguished by plumage and bare parts (q.v.). Once post-juvenile moult finished, by late autumn or early winter, first-year birds indistinguishable from adult.

SEXING Similar in plumage. At least some, possibly most, adult females distinguishable from adult males on tail structure and markings. In nominate *neoxena*, combination of following criteria useful for sexing adults: (1) Tail (length of t6) tends shorter in females: 65–83 for males, 64–79 for females; 9 of 17 male skins had Tail >79 mm and all 14 females had Tail ≤79 mm; (2) Tail-fork tends shallower in females: 29–42 for males, 17–36 for females; seven of 15 males had Tail-Fork >36 mm and all 13 females had Tail-Fork ≤36 mm; ten of 13 females had Tail-Fork <29 mm and all males had Tail-Fork ≥29 mm; (3) white panel on inner webs of outer rectrices tends smaller in females; diagonal length (from basal point at inner edge to distal point near shaft) of white panel on outermost rectrix (t6) 4–16 and usually not reaching shaft in females; *c.* 10% of females lack white panel and instead have narrow white inner edge to t6; 13–20 and often reach shaft in males; see Figure 1 in Recognition for pattern of white markings on males and females; and (4) t6 tends slightly broader near tip in females, slightly narrower in males, but considerable overlap between sexes. Disney (1991) also established following sexing criteria for adult nominate: (1) length of t6 usually ≥80 mm in adult males, ≤80 mm in adult females; (2) distance between tips of t5 and t6 ≥17 mm (usually >20 mm) in adult males, ≤16 mm (usually 12–14 mm) in adult females; and (3) t5 and t6 usually broader at tips in adult females, narrower in adult males. Brown & Brown (1989) used length of t6 as sexing criterion for adults in sw. WA (subspecies *carteri*): birds with Tail >76 mm being males, those with Tail <73 mm being females; sexing based on presence or absence of incubation patch on breeding birds.

RECOGNITION For separation from Barn Swallow *Hirundo rustica gutturalis*, see that account. Most likely to be confused with Pacific Swallow *H. tahitica*, which not confirmed for HANZAB region, but could possibly occur on n. Aust. coast or offshore islands. Subspecies of Pacific Swallow most likely to occur in HANZAB region are: subspecies *javanica* from Sumatra, Java and their offshore islands (most likely to occur on Christmas I.); subspecies *frontalis* from Moluccas and Lesser Sundas, E to w. New Guinea (most likely in nw. Aust.); and recently described subspecies *albescens* (DAB) from se. and e. mainland New Guinea (most likely in Torres Str. and ne. Qld). Pacific Swallows from Bismarck Arch., E to sw. Pacific Ocean, are subspecies *subfusca* and nominate *tahitica* (Mayr & Diamond 2002; Peters); these are very different from subspecies *albescens*, *frontalis* and *javanica*, and are larger, lack white markings to rectrices, and have dark grey-brown lower underbody and extensively black undertail-coverts (n=4 skins from Bougainville and New Britain; this study). Table 1 summarizes measurements of Pacific Swallow from se. New Guinea.

Table 1. *H. TAHITICA ALBESCENS*: (1–2) SE. PNG, skins (AM, ANWC, MV): (1) Adults; (2) Juvenile.

		MALES	FEMALES
WING	(1)	108.8 (1.30; 107–110; 5)	105, 109
	(2)	96	–
TAIL	(1)	50.6 (2.07; 47–52; 5)	47, 50
	(2)	46	–
TAIL-FORK	(1)	10.9 (0.86; 9–12; 5)	9, 11
	(2)	4	–
BILL S	(1)	11.1 (0.90; 10.1–12.4; 5)	10.0, 10.3
	(2)	10.3	–
TARSUS	(1)	10.3 (0.36; 9.8–10.8; 5)	10.4
	(2)	10.3	–

In addition to above skins, two unsexed juvenile skins (QM 07726, 020068) from se. PNG have following measurements: Wing 102, 103; Tail 41, 45; Tail-Fork 6, 6; Bill S 10.1, 11.4; Tarsus 10.9, 10.9. Adult Pacific Swallows weigh 14.3 g (1.28; 13.5–15.0; 6; sexes combined) (data from ANWC).

Following criteria for separation of Pacific Swallow (subspecies *albescens*) from Welcome Swallow based on skins (see above) and useful for in-the-hand identification; those characters useful in the field discussed below; these criteria best used in combination for reliable separation of species. Correct ageing of birds essential for identification (see Plumages and Ageing); criteria for ageing of Pacific Swallow much as for Welcome. Confusion most likely between adult Pacific and Welcome Swallow nearing finish of post-juvenile moult (with most of body-feathers replaced but short juvenile outer rectrices not yet replaced); any birds with active moult of outer rectrices potentially difficult to identify. **Adults** Welcome Swallow differs from Pacific by: (1) slightly larger size: mean Wing (sexes combined) 113.1 (106–117; 32) for nominate Welcome compared with 108.3 (105–110; 7) in Pacific; (2) much longer

Tail (length of t6): 65–83 in male (cf. 47–52 in male Pacific); 64–79 in female (cf. 47 and 50 in female Pacific); (3) much deeper Tail-Fork: 17–42 (cf. 9–12 in Pacific); (4) distance between tips of t5 and t6, 12–24 (cf. 3–5 in Pacific); (5) outer rectrix (t6) much more attenuate with gradual emargination along *c.* distal third of feather (cf. much less attenuate with emargination to inner web confined to *c.* distal tenth [5–7 mm] of feather in Pacific); (6) tip of t6 blunter (cf. more acute in Pacific); (7) white markings to inner webs of rectrices usually much larger (see Fig. 1 below; see Plumages above for details): maximum length of white marking on t6 6–20 mm (cf. 4–11 mm in Pacific); both female and 2 of 5 male Pacific have small white spot on inner web of t6, not reaching shaft or edge of feather (cf. Welcome, which have white panel extending diagonally from inner edge and often reaching shaft, especially in males; never small white spot to t6); other three male Pacific have narrow white panel extending from inner edge to shaft, not unlike adult male Welcome, but marking squarer (less diagonal) and smaller in Pacific; (8) usually concealed band across centre of feathers of hindneck and mantle, greyish white (ne), some birds almost whitish (ne), 1–2 mm long (cf. pure white and 2–5 mm long in Pacific); this difference can be difficult to assess on individual bird and best seen in direct comparison of species; (9) underparts unmarked (cf. centre of lower breast, flanks and belly have fine dark-brown striations in Pacific, formed by shafts of feathers); and (10) longest (distal) undertail-coverts tend slightly duller and slightly more diffuse (cf. slightly blacker and more sharply defined subterminal markings in Pacific), but overlap in colour and markings of undertail-coverts between the species is almost complete. **Juveniles** Differ by: (1) T6 longer: 50–71 mm (cf. 41–46 in three skins of Pacific examined here); (2) Tail-Fork deeper: 10–27 mm (cf. *c.* 6 mm in Pacific); (3) inner web of t6 has broader white inner edge, often merging with white patch which, in some birds, similar to adult female in size and shape (cf. squarer adult-like panel or small isolated spot near tip in Pacific; see Fig. 1); (4) distal third or so of inner web emarginated, less prominent than in adult but still obvious (cf. no, or only slightest, emargination to inner web of t6 in Pacific); (5) t6 narrower and more acute (cf. broader and more rounded at tip in Pacific), opposite situation for adults; (6) lack striations on lower underbelly (cf. fine dark-brown striations on lower underbody in Pacific, as adult); (7) greyish-white band across centre of feathers of hindneck and mantle (white in Pacific); (8) undertail-coverts lack subterminal markings (undertail-coverts mostly grey-brown with broad off-white (ne) fringe at tips and with small blackish (c89) subterminal marking in Pacific). IN THE FIELD: Differences in size probably only useful when two species can be directly compared (e.g. perched alongside each other); otherwise, shape of tail and outer rectrices, shape of white markings on t6, and presence or absence of dark striations on lower underbody useful for distinguishing adults; observer must be particularly cautious with birds undergoing moult of tail as this likely to occur in either species during summer–autumn; shape of outer rectrices, pattern of undertail-coverts and presence or absence of dark striations on lower underbody useful for distinguishing juveniles. Criteria for separation of Pacific Swallow subspecies *frontalis* from Welcome Swallow probably much as for *albescens*, based on examination of one skin (HLW) from Tepa Babar I., Lesser Sundas; this skin closely resembles *albescens*.

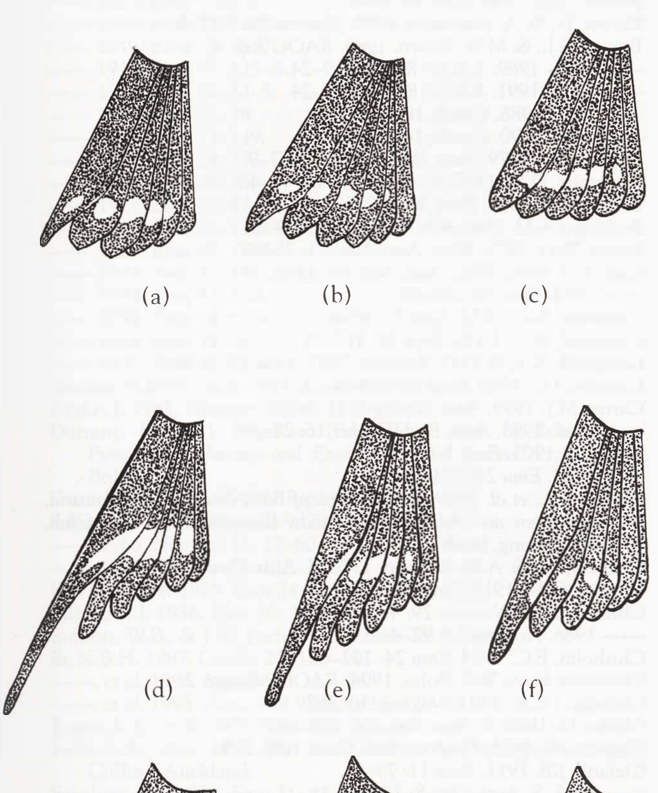


Figure 1 Right side of undertail (t1–t6) of *H. tahitica albescens*: (a) Adult male; (b) Adult female; and (c) Juvenile; *H. neoxena*: (d) Adult male; (e) Adult female; and (f) Juvenile; *H. rustica gutturalis*: (g) Adult male; (h) Adult female; and (i) Juvenile (t4–t6 only)

GEOGRAPHICAL VARIATION Not fully resolved. Sometimes considered as subspecies of Pacific Swallow *H. tahitica neoxena* (Peters). Here, we follow most recent authors (Turner & Rose 1989; Sibley & Monroe 1990; Christidis & Boles 1994; DAB) in considering *neoxena* as a full species. Two subspecies recognized in most recent study (DAB); nominate *neoxena* breeding in s. central and se. Aust. (including Tas.) and wintering as far N as n. Qld and central Aust.; and subspecies *carteri* breeding in s. and sw. WA (N to sw. Pilbara) and wintering as far N as n. Pilbara and s. Kimberley. Populations from n. Qld (from Rockhampton N to Torres Str.) sometimes considered as subspecies *parsoni* (White 1936; Peters), but DAB states no difference in measurements or plumage of n. Qld birds from those in se. Aust. Examination of adult skins from WA (n=8; this study) reveals no difference in measurements, plumage-colour or markings from e. Aust. adult skins (n=32). However, DAB states that WA birds have shorter Tail (for males: 70–77 cf. 73–83 in e. Aust.; for females: 62–67 cf. 65–74 in e. Aust.) with slightly broader outermost rectrices, and longer Bill (exposed culmen: 6.7–7.6 [sexes combined] cf. 6.5–7.3 in e. Aust.); DAB mentions possibility that age-bias may account for shorter tails of WA skins. Comparison of measurements (see above) of skins from e. Aust. (this study) with those from WA (Johnstone & Storr 2004) suggests WA birds have shorter Tail and longer Bill as stated in DAB, but insufficient data for statistical comparison. Skins in WAM not available for present study, and more data needed to compare e. and w. populations. Insufficient material from Tas. to determine if populations have differentiated there (DAB).

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Sponsors: P Park, D Prest

Volume 7 (Part B), Plate 44

White-backed Swallow *Cheramoeca leucosternus* (page 1499)
1 Adult; **2** Juvenile

Barn Swallow *Hirundo rustica* (page 1508)
SUBSPECIES *GUTTURALIS:* **3** Adult male; **4** Juvenile

Welcome Swallow *Hirundo neoxena* (page 1517)
NOMINATE *NEOXENA:* **5** Adult male (fresh plumage); **6** Adult male (worn plumage); **7** Juvenile

Red-rumped Swallow *Hirundo daurica* (page 1549)
SUBSPECIES *JAPONICA:* **8** Adult male; **9** Juvenile

Tree Martin *Hirundo nigricans* (page 1553)
10 Adult; **11** Juvenile

Fairy Martin *Hirundo ariel* (page 1568)
12 Adult; **13** Juvenile

Asian House Martin *Delichon dasypus* (page 1583)
NOMINATE *DASYPUS:* **14** Adult

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White-backed Swallow *Cheramoeca leucosternus* (page 1499)
1, 2 Adult

Barn Swallow *Hirundo rustica* (page 1508)
SUBSPECIES *GUTTURALIS:* **3, 4** Adult male

Welcome Swallow *Hirundo neoxena* (page 1517)
NOMINATE *NEOXENA:* **5, 6** Adult male

Red-rumped Swallow *Hirundo daurica* (page 1549)
SUBSPECIES *JAPONICA:* **7, 8** Adult male

Tree Martin *Hirundo nigricans* (page 1553)
9, 10 Adult

Fairy Martin *Hirundo ariel* (page 1568)
11, 12 Adult

Asian House Martin *Delichon dasypus* (page 1583)
NOMINATE *DASYPUS:* **13, 14** Adult

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