

## Order CHARADRIIFORMES

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

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

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

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

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

Because the Order comprises so many species and adaptations are so diverse, few characters shared by all species; those that are shared are mostly anatomical features of the skull, e.g. most or all have schizorhinal nostrils, schizognathous palates, well-developed vomer, lachrymals fused with ectethemoid and pre-frontal bones, well-developed supra-orbital grooves; see Olson & Steadman (1981) for more information on osteological characters. Wings usually have 11 primaries, with p10 longest and p11 minute; 15–24 secondaries; diastataxic except in *Scolopax minor*, as far as is known. Usually 12 tail-feathers. Necks usually rather long with 15–16 cervical vertebrae. Oil-gland bilobed and tufted. Syrinx, tracheo-bronchial; two carotids (type A-1 of Glenny 1955); caeca present. Legs usually rather long; hind toe small or lacking in most but all toes greatly elongated in Jacaniidae. Feathers with small thin afterfeathers. Normally two moults annually: complete post-

breeding and partial pre-breeding; some jacanas and alcids have flightless periods when moulting remiges. Young, downy, usually with intricate cryptic patterns on upperparts of three chief types: pebbly, spotted and striped, matching characters of habitat (Fjeldså 1976, 1977): precocial, nidifugous usually, self-feeding or not depending greatly on parents.

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

#### REFERENCES

- Christian, P.D., et al. 1992. *Aust. J. Zool.* 40: 291–302.
- Fjeldså, J. 1976. *Vidensk. Medd. dansk. Natur. Foren.* 139: 179–243.
- 1977. *Guide to the Young of European Precocial Birds*. Scarv Nature Productions, Tisvildeleje.
- Glenny, F.H. 1955. *Proc. US natn. Mus.* 103 (3346): 525–621.
- Jehl, J.L., Jr. 1968. *Mem. San Diego Soc. nat. Hist.* 3.
- Mayr, E., & D. Amadon. 1951. *Am. Mus. Novit.* 1496.
- Mickevich, M.F., & L.R. Parenti. 1980. *Syst. Zool.* 29: 108–113.
- Olson, S.L., & A. Feduccia. 1981. *Smithson. Contrib. Zool.* 323: 1–24.
- , & D.W. Steadman. 1981. *Smithson. Contrib. Zool.* 337: 1–25.
- Sibley, C.G., & J.E. Ahlquist. 1990. *Phylogeny and Classification of Birds of the World*. Yale Univ. Press, New Haven.
- , & B.L. Monroe. 1990. *Distribution and Taxonomy of the Birds of the World*. Yale Univ. Press; New Haven.
- , et al. 1988. *Auk* 105: 409–423.
- Strauch, J.G., Jr. 1978. *Trans. zool. Soc. Lond.* 34: 263–345.

## Family LARIDAE skuas, jaegers, gulls and terns

A large assemblage of small to very large charadriiform seabirds. We recognize four subfamilies within the Laridae following Mayr & Amadon (1951), AOU (1983).<sup>1</sup>

**Stercorariinae** Skuas and jaegers; about six species; cosmopolitan.

**Larinae** Gulls; c. 47 species; cosmopolitan.

**Sterninae** Terns; c. 42 species; cosmopolitan.

**Rynchopinae** Skimmers; three extralimital species, pan-tropical.

Taxonomic rank given to above groups varies greatly. Considered four families within suborder Lari (e.g. Campbell & Lack 1985; BWP), or four tribes within subfamily Larinae (e.g. Sibley *et al.* 1988; Sibley & Ahlquist 1990; Sibley & Monroe 1990). Others have divided Lari into three families (Stercorariidae, Laridae and Rynchopidae) with gulls and terns usually considered subfamilies within Laridae (e.g. Wetmore 1960; Judin 1965; Hackett 1989; Peters). Moynihan (1959) divided the group into two subfamilies, Stercorariinae, containing the skuas, and Larinae, containing gulls, terns and skimmers in three tribes. Study of skeletal and external morphology of suborder 'Lari' (our Laridae) was mostly unable to cluster gulls and terns satisfactorily and found group surprisingly uniform (Schnell 1970a,b). Despite lack of agreement on taxonomic ranking of above groups, monophyly of Laridae is not in doubt. Studies of biochemistry (Christian *et al.* 1992), DNA–DNA hybridization (Sibley & Ahlquist 1990), downy young (Fjeldså 1977) and skeletal morphology (Strauch 1978; Mickevich & Parenti 1980; Chu 1995) generally agree in finding close relation with Glareolidae (pratincoles) and Dromadidae (Crab Plover *Dromas ardeola*). DNA–DNA hybridization suggests Alcidae (auks) also closely related (Sibley & Ahlquist 1990), though this contradicted by studies of skeletal morphology (e.g. Strauch 1978; Chu 1995).

Body-form varies greatly, from small and slender in some gulls and terns, to robust and thickset in skuas, jaegers, some gulls and a few terns. Differences in size between sexes slight; males usually larger but females larger than males in Stercorariinae. Wings usually long, narrow and pointed, but broader and more rounded in some; 11 primaries; p10 longest, p11 minute; 17–24 secondaries. Tail has 12 rectrices; shape varies: in Stercorariinae, central rectrices project beyond rest of tail and greatly elongated in adult breeding plumages of *Stercorarius*; in most Sterninae and Rynchopinae, outer rectrices elongated and tail forked; in Larinae, usually square. Bill, varies, though usually rather short and stout, with prominent gonydeal angle; rather fine in some Larinae and Sterninae; tip pointed in Sterninae, decurved in strong hook in Stercorariinae. Bill highly modified for unique foraging methods in Rynchopinae (Zusi 1962). Lack cere, except in Stercorariinae. Nostrils schizorhinal and perforate, with no median septum. Legs, short and stout; attached near centre of body; tibiae partly bare; tarsi, short and typically scutellate in front. Four toes; hindtoe, short, raised, sometimes rudimentary or absent; front toes, fully webbed (webs somewhat incised in some). Claws, moderately long, strong, laterally compressed. Caeca ranges from large (Stercorariinae) to poorly developed (Rynchopinae, Sterninae). Supra-orbital salt-glands well developed.

Plumages mainly browns, black, white and greys. Colours of bare parts often striking and often showing marked variation with both season and age. Adults moult twice annually: (1) a post-breeding (pre-basic) moult to non-breeding plumage, which is complete (with apparent exception of *Larus sabini*); and (2) a pre-breeding (pre-alternate) moult to breeding plumage, which is almost always partial (but see *Larus pipixcan* and *L. sabini*); some terns also undergo one or two pre-supplemental moults of inner primaries. Primaries moult outwards.

Hatch in natal down, which is replaced by juvenile plumage; downy young precocial but more dependent on

<sup>1</sup> This treatment differs from the arrangement presented in the introduction to the Charadriiformes in Volume 2 of HANZAB (p. 648), where these four subfamilies were listed as families. Recent major studies in avian classification (particularly by Sibley and co-workers) and the publication of a revised species list of Aust. birds (Christidis & Boles 1994) since the preparation and publication of Volume 2, have brought much rearrangement. In this and subsequent volumes of HANZAB, taxonomy, nomenclature and arrangements of species follow Christidis & Boles (1994) (though they do not present subfamilial taxonomy). Their sequence of families of Charadriiformes occurring in HANZAB region is: Pedionomidae, Scolopacidae, Rostratulidae, Jacanidae, Chionidae, Burhinidae, Haematopodidae, Recurvirostridae, Charadriidae, Glareolidae and

Laridae. However, work on Volume 2 was too advanced to follow their sequence and taxonomy fully. The Scolopacidae are out of place in the arrangement of subfamilies in Volumes 2 and 3; other families follow the order of Christidis & Boles (1994).

### Plate 23

Oriental Pratincole *Glareola maldivarum* (page 366)

1 Adult breeding; 2 Adult non-breeding; 3 Juvenile;  
4, 5 Adult

Australian Pratincole *Siltia isabella* (page 373)

6 Adult; 7 Downy young; 8 Juvenile;  
9 First immature non-breeding;  
10, 11 Adult

parental feeding than other Charadriiformes. Post-juvenile (first pre-basic) moult complete or partial, varying within and between families; moults of subadults complicated and vary between subfamilies (see subfamily accounts). Generally slow to mature, attaining adult plumage when 2–4 years old and first breeding at 2–4 years (smaller gulls and terns) to 4–9 years (many skuas and larger gulls and terns); some may breed in first year (e.g. *Sterna albifrons*).

Inhabit wide range of marine and freshwater habitats from Tropics to polar regions; many species strongly migratory, especially those breeding at high latitudes, e.g. South Polar Skua *Catharacta maccormicki* and Arctic Tern *Sterna paradisaea*, which migrate between polar regions. Most nest in terrestrial colonies near water (see subfamily accounts); some species highly pelagic in non-breeding season. Use wide range of foraging methods (see subfamilies; for discussion of feeding methods, see General Introduction).

See subfamily accounts for summaries of social organization and breeding.

## REFERENCES

- AOU. 1983. *Check-list of North American Birds*. Am. Orn. Union, Lawrence, Kansas.
- Campbell, B., & E. Lack. 1985. *A Dictionary of Birds*. Poyser, Calton, England.
- Christian, P.D., et al. 1992. *Aust. J. Zool.* 40: 225–33.
- Christidis, L., & W.E. Boles. 1994. *RAOU Monogr.* 2.
- Chu, P.C. 1995. *Condor* 97: 174–96.
- Fjeldså, J. 1977. *Guide to the Young of European Precocial Birds*. Skarv Nature Pubs, Strandgården, Tisvildileje.
- Hackett, S.J. 1989. *Condor* 91: 73–90.
- Judin, K.A. 1965. *Fauna USSR, Aves. Ser. 1, 2*, ns 91. Acad. Sci., Moscow & Leningrad.
- Mayr, E., & D. Amadon. 1951. *Am. Mus. Novit.* 1496.
- Mickevich, M.F., & L.R. Parenti. 1980. *Syst. Zool.* 29: 108–13.
- Moynihan, M. 1959. *Am. Mus. Novit.* 1928.
- Schnell, G.D. 1970a. *Syst. Zool.* 19: 35–57.
- 1970b. *Syst. Zool.* 19: 264–302.
- Sibley, C.G., & J.E. Ahlquist. 1990. *Phylogeny and Classification of Birds*. Yale University Press, New Haven.
- , & B.L. Monroe Jr. 1990. *Distribution and Taxonomy of Birds of the World*. Yale University Press, New Haven.
- , et al. 1988. *Auk* 105: 409–23.
- Strauch Jr, J.G. 1978. *Trans. zool. Soc. Lond.* 34: 263–345.
- Wetmore, A. 1960. *Smithson. Misc. Coll.* 139 (II): 1–37.
- Zusi, R.L. 1962. *Publ. Nuttall orn. Club* 3.

## Subfamily STERNINAE terns and noddies

Cosmopolitan group of seabirds, with narrow pointed wings and long pointed bills, ranging in size from Little *Sterna albifrons* (20–28 cm) to Caspian Terns *Sterna caspia* (up to 55 cm). Mostly smaller, slimmer and longer-tailed than gulls (Larinae) and more aerial. About 42 species in six genera.

GENUS	NUMBER OF SPECIES
<i>Sterna</i>	Sea terns (including commic terns); c. 32 species; 17 in HANZAB region (15 breeding, 2 non-breeding migrants; 1 species not acceptably recorded)
<i>Chlidonias</i>	Marsh terns; 3 species; all recorded HANZAB region (1 breeding, 1 non-breeding, 1 accidental)
<i>Phaetusa</i>	Monotypic; Large-billed Tern <i>P. simplex</i> ; extralimital in South America; often combined in <i>Sterna</i>
<i>Anous</i>	Dark noddies; 3 species; all breed HANZAB region
<i>Procelsterna</i>	1 (possibly 2) species; Grey Ternlet <i>P. albivitta</i> breeds HANZAB region (second taxa extralimital)
<i>Gygis</i>	Monotypic; White Tern <i>G. alba</i> ; breed HANZAB region
<i>Larosterna</i>	Monotypic; Inca Tern <i>L. inca</i> ; extralimital in South America

Studies of osteology (Strauch 1978; Mickevich & Parenti 1980; Chu 1995), behaviour (Moynihan 1959), DNA–DNA hybridization (Sibley & Ahlquist 1990) and allozymes (Christian *et al.* 1992) have generally suggested that terns more closely related to gulls than to other Laridae; monophyly of the Sterninae appears not to be in doubt, and sometimes considered a full family (e.g. BWP).

Number of genera recognized varies. Moynihan (1959) recognized only three: *Sterna* (including *Chlidonias* and *Phaetusa*), *Larosterna*, and *Anous* (including *Procelsterna* and *Gygis*). Others have recognized as many as ten (e.g. Peters) or 12 (e.g. Wolters 1975) genera. Gull-billed Tern *S. nilotica* often placed in monotypic genus *Gelochelidon*; large terns with erectile crests (e.g. *S. bergii*, *S. bengalensis*) sometimes placed in *Thalasseus*; Caspian Tern *S. caspia* sometimes placed in monotypic genus *Hydroprogne*, or in *Thalasseus*. *Anous*, *Procelsterna* and *Gygis* sometimes treated as tribe Anousini (noddies). Our arrangement follows Christidis & Boles (1994) and Sibley & Monroe (1990), except that Black-fronted Tern *S. albostrigata* placed in *Sterna* rather than *Chlidonias* (following Mees 1977; Lalas & Heather 1980; NZCL; see that account). Monophyly of genus *Sterna* as recognized here has been challenged by electrophoretic study of Hackett (1989).

Body-form gull-like, but slimmer and more elongate than gulls except in largest species. Males usually slightly larger than females, especially in length and depth of bill. Necks short. Wings, long and pointed, narrower than in gulls; when wing folded, primaries project well beyond tertials (tips of 5–6 outer primaries usually exposed) and often beyond tip of tail. About 18–24 secondaries; ulnar part of wing shorter than in gulls. Flight musculature differs from gulls by lack of expansor secundarium (except in *Anous*). Tail, long in most species, with 12 rectrices: most have deeply forked tail, with t6 often elongated as tail-streamer; *Chlidonias* has short tail, only shallowly forked; tail of noddies forked, but with t3 or t4 longest in *Anous* and t5 longest in *Procelsterna* and *Gygis*. Bill, straight, with simple rhamphotheca and no cere; slender and rather long in most species, heavier in larger species, especially *Phaetusa*, short and thick in *S. nilotica*; tip pointed, not hooked. Legs, short or very short; tarsi rather weak; scutellate. Three front toes fully webbed, though webs deeply incised in *Chlidonias*; hindtoe reduced or vestigial, raised. Swim less readily than gulls, and have less well developed oil-gland (vestigial in *S. fuscata*). Supra-orbital salt-glands well developed. Down occurs on both pterygiae and apteria.

Sexes similar in plumage. Adult *Sterna* and *Phaetusa* usually uniform light grey above and white or pale grey below (with evanescent pink flush in some species), usually with contrasting black markings on head (often in form of cap) and tip of wing; some browner above (e.g. *S. fuscata*, *S. anaethetus*). *Chlidonias*, *Larosterna* and *Anous* mostly dark grey, dark brown or black above and below; *Procelsterna*, uniform ash-grey; *Gygis*, all white. Irides normally dark brown. Bill, legs and feet of most, yellow, orange, red or black. *Phaetusa*, *Chlidonias* and most *Sterna* show seasonal change in plumage: in non-breeding plumage, black caps reduced or flecked with white, many develop dark cubital bars, fork of tail usually less deep (and tail often slightly darker), underparts of grey-bellied species become paler, and bill and feet often become darker; *Chlidonias* also develop paler upperparts. No seasonal change in appearance of noddies. Adults typically have two moults per cycle: a complete post-breeding (pre-basic) moult to non-breeding plumage; and a partial pre-breeding (pre-alternate) moult to breeding plumage (which involves at least head, neck and some of body, and often all of body, tail and varying number of inner primaries). Primaries moult outwards. Moult of remiges, especially primaries, protracted in most; post-breeding (pre-basic) moult of primaries continues long after moult of body finished, and often overlaps with start of pre-breeding (pre-alternate) moult. Species moulting inner primaries in pre-breeding (pre-alternate) moult can thus have two concurrently active waves of moult in primaries. In some species (e.g. *S. albifrons* and some *Chlidonias*) there is often a third wave, as innermost primaries replaced a third time in a pre-supplemental moult. In two small pale tropical species (*Gygis alba* and *Sterna*

*sumatrana*), primaries replaced in staffelmauser, which is interrupted only when breeding; pre-alternate moults possibly lost in these species. Breeding and moult seldom overlap, except for some pre-basic moult of feathers of head when raising chicks (usually in larger or migratory species); in migratory species, most or all moult of remiges occurs in non-breeding areas and post-breeding moult (if started) is suspended during migration. In several species of oceanic terns nesting in Tropics, annual cycles last for less than 1 year, with duration between breeding events possibly dependent on time needed to complete moult (e.g. Ashmole 1962, 1963, 1968).

Downy young, precocial or semi-precocial; semi-nidifugous in most; nidicolous in *Gygis*, *Anous*. Natal down, ramose and woolly in most species, but long, straight, silky and very soft in *Chlidonias* (perhaps an adaptation to rather wet nesting sites). In some *Sterna* (e.g. *S. dougallii*), terminal barbs of down cling together to cause spiny appearance, especially on upperparts; down also very short in some (e.g. *S. albifrons*, *S. nereis*). Ground-colour of down ranges from white to grey or buff (rich orange-buff in *Chlidonias*), though dark, like adults, in some *Anous*. Dark markings on upperparts complex and diffuse: *Chlidonias* have bold black blotches; others varyingly streaked or speckled dark brown or black above, without distinct pattern except for three radiating lines on crown in many. Some species virtually unmarked above (e.g. *S. caspia*, *S. nilotica*). Some variation in colour and patterning of down (especially ground-colour) appears to be geographical (e.g. down of tropical populations of *S. dougallii* usually paler than in temperate populations) but also much individual variation, and siblings from the same clutch often look totally different (see Fjeldså 1977 for more information on downy young). Juvenile plumages typically differ from non-breeding adults in having buff or blackish tips or bars on much of upperparts and upperwing; tail generally darker than in adult, often with dark subterminal markings; many species have much individual variation in upperparts, and darkness of ground-colour and width of dark barring usually correlated. Juvenile plumages rather unusual in *S. virgata*, *S. vittata* and *S. fuscata*; see species accounts for details. In *Anous*, *Gygis* and *Procelsterna*, juvenile plumage similar to adult.

Sequence of moults from juvenile to adult plumage, complex. When recognizable traces of juvenile plumage have been lost, distinction of immatures from adults depends mainly on moult and wear of primaries. However, this of little use for ageing species in which timing of breeding and moulting vary (a frequent occurrence in Tropics) and subadult moults of such species (including all noddies) poorly known. Following generalizations based on species of *Sterna* and *Chlidonias* with regular cycles. **POST-JUVENILE (FIRST PRE-BASIC) MOULT** usually complete, with head and body finished several months before last outer primaries; in some species, birds can arrest moult when a few very worn outer primaries remain. In several species of medium-sized *Sterna* from s. hemisphere (*striata*, *albobristata*, *vittata* and *virgata*), post-juvenile moult appears to be partial, moulting almost no remiges or rectrices (though interpretation complicated because, unlike most juvenile terns, first post-breeding [second pre-basic] moult of head and body coincides with first moult of primaries, much as in typical gulls [D.J. James]); these species (and possibly *S. hirundinacea*) have several other unusual features in common, including heavily marked juvenile plumages, little sexual dimorphism in length of wing, and only one moult of primaries and (apparently) rectrices per cycle. They may represent a radiation from a single s. hemisphere ancestor (D.J. James). Whether first pre-basic moult partial or complete, most terns superficially resemble adult non-breeding when 3–7 months old, except for retained juvenile remiges (which are still moulting). When 9–12 months old, at least some perform partial **FIRST PRE-BREEDING (FIRST PRE-ALTERNATE) MOULT**, often starting before post-juvenile moult finished; some attain traces of breeding plumage (especially on crown and cubital bar) but in most there is probably no change in appearance. Resultant first immature non-breeding (first alternate) plumage superficially like adult non-breeding and, in species with regular cycles, held when adults in full breeding plumage.<sup>1</sup> When c. 1 year old, complete **FIRST IMMATURE POST-BREEDING (SECOND PRE-BASIC) MOULT** brings on plumage almost identical to adult non-breeding; this retained for much of second year, so most immatures retain non-breeding appearance from c. 5 months to c. 21 months old. Partial **SECOND PRE-BREEDING (SECOND PRE-ALTERNATE) MOULT** near end of second year is first moult to bring on extensive breeding plumage. In many species, second immature breeding plumage may differ from adult breeding in having a few non-breeding-like feathers in crown, cubital bar, tail or underparts; however, reliability of these ageing characters undermined in some species by similar variation in very small number of adults. Subsequent moults, as adults.

Mostly marine, inshore; some frequent both littoral and freshwater habitats; some markedly pelagic. Carnivorous; some only or mainly take fish (e.g. Black-naped Tern *S. sumatrana*, White-fronted Tern *S. striata*); other HANZAB species take mixture of fish, molluscs, crustaceans and insects; some freshwater species also take small vertebrates, such as mice or frogs (e.g. Whiskered Tern *C. hybridus* and Gull-billed Tern *S. nilotica*). Mostly diurnal but some nocturnal or crepuscular. Forage singly, in small groups or in mixed species feeding flocks, usually with other terns or seabirds, such as shearwaters. Feed mainly by surface plunging, occasionally shallow plunging; and by dipping (contact and non-contact). Also feed by hawking for insects over land and water; gleaning food while walking on ground or in shallow water; and kleptoparasitism.

<sup>1</sup> In Arctic Terns, the first alternate plumage was once mistaken as a separate species and named *Sterna portlandica* (Ridgway 1874), and the second alternate plumage was mistaken as another, *Sterna pikei* (Lawrence 1853). These taxonomic treatments have long since been discarded, but the terms 'portlandica plumage' and 'pikei plumage' still confusingly and incorrectly used for homologous plumages in many terns.

Highly gregarious when feeding, roosting and breeding, and will mob predators at colonies. Monogamous, with pair-bonds tending to persist from year to year. Birds may breed as early as 1 year old, but usually not till 3–4 and even older. Can live for many years. Normally breed in colonies, which can number up to tens of thousands. Nesting densities vary with species and habitat, and in large colonies of some *Sterna*, distances between nests can be a body-length. Nesting territories used for courtship and pair-formation, courtship feeding, copulation, and nesting. Fidelity to nesting site between years high in some species, though other species move between colonies or shift site of colonies altogether (Campbell & Lack 1985). At colonies, social flights, called MASS FLIGHTS, DREADS, PANICS, or UPFLIGHTS, common. In these displays, some or all members of a colony take flight and fly round in dense flock. Many authors use the terms interchangeably. Others distinguish between Mass Flights and Dreads: In Dreads, birds take off and fly low over colony for some distance without calling, then fly upwards calling loudly; Dreads an escape response but may also be used to help synchronize breeding. In Mass Flights, all birds take off and fly upwards, calling loudly from outset; Mass Flights most common before laying and are used to help synchronize breeding cycles of individuals; resurgence of Mass Flights occurs when chicks being fed, mostly by non-breeding birds visiting colony, at least some of which are preparing to breed in the next breeding season (K. Hulsman). The distinction is often not clear in published descriptions of flock behaviour. Vocal at breeding colonies; calls raucous.

In *Sterna* and allied genera, displays usually elaborate and similar between species. Aerial flights and some ground displays persist after laying. In GROUND DISPLAYS, which often involve more than two birds, birds drop wings, raise tails and stretch necks upwards. Aerial displays occur in and round colonies. In HIGH FLIGHTS, several birds ascend rapidly to 100 m or more, with some birds displaying as they descend. Zigzagging flights common and especially spectacular in Crested Tern, even after nesting has finished (Gibson 1956). A male carrying a fish will execute noisy LOW FLIGHT through colony, which often stimulates others to join in. FISH-OFFERING CEREMONIES involve one bird flying round, calling loudly, usually with fish held crosswise in bill; usually, another joins it, flying in front of first. Fish not transferred on wing, but may be passed on ground, accompanied by strutting.

Noddies (*Anous*, *Procelsterna* and *Gygis*) have different displays to sea terns. Similarities include ground displays before and during incubation, which involve birds dropping wings so that tips on or close to ground. In courtship display at nest-site, male bobs head slightly and caresses head and neck of female with bill; male courtship-feeds female, and birds call and touch bills. In aggressive territorial displays, male raises feathers of crown slightly, gives rattling call, then thrusts stiffened neck forward and bows. In all displays, orange tongue, pale crown and markings round eyes prominent (Woodward 1972).

Within Sterninae, both sexes share nest duties. Chicks semi-precocial and, if undisturbed, semi-nidifugous (most species) or nidicolous (*Anous*, *Gygis*); older chicks occasionally form crèches in some *Sterna*. Food given in bill (most species) or by regurgitation (e.g. *S. fuscata*, *Anous*). Parental feeding continues after fledging, sometimes for several months and, sometimes, after dispersal from colonies (Campbell & Lack 1985; BWP).

Breeding seasonal, though some tropical terns, notably Bridled *S. anaethetus* and Sooty *S. fuscata* Terns, breed at sub-annual intervals depending on local conditions; at some sites, breeding of population may be continuous (King & Buckley 1985; King *et al.* 1992; BWP). Usually breed in colonies on offshore islands or on headlands; also on or round terrestrial wetlands or in coastal habitats, such as sand dunes, beaches and on islands and sandspits in estuaries; some species nest on cliffs (e.g. Grey Ternlet *P. albivitta*); Black-fronted Terns nest in shingle beds in streams; Whiskered Terns in vegetation in freshwater swamps; occasionally nest on man-made structures, such as jetties and wrecked ships (HASB; Aust. NRS). Will nest with other species of terns. Ground-nesting birds make unlined or poorly lined scrape in sand or gravel, sometimes under vegetation or in crevice of rock; most noddies nest in trees and bushes, and build bulky nests out of plant material, though many Common Noddies *A. stolidus* nest on ground; Whiskered Terns build mounds or platforms of vegetation; White Terns make no nest, laying egg on bare branch or leaf of a tree (Fjeldså 1977; HASB; Aust. NRS). Ground-colour of eggs varies from cream or stone-grey to greenish stone, buff or light brown, with markings of black or dark brown, occasionally dark purple (HASB). Clutch-size, 1–3; most species breeding temperate zones average two eggs per clutch, most in tropical areas only one. Incubation period ranges from 19 to 36 days; species that lay 2–3 eggs per clutch incubate for shorter periods, mostly between 19 and 23 days, while those that usually lay one egg incubate for longer, from 28 to 36 days. Both sexes incubate. Adults defecate away from nest. Both sexes feed young, mostly bill to bill or by dropping item beside chick, though noddies, *Procelsterna* and some tropical *Sterna* fed by regurgitation. Young of ground-nesting species leave nest within 1 week of hatching but may remain near nest for a few more days; usually seek shelter in nearby cover, though some species form crèches (Hulsman 1977; HASB); young of tree-nesting species usually remain in nest till able to fly (but see *Gygis alba*). Most species dependent on parents for food for up to 4 months after fledging. Age of first breeding, usually 3–4 years, some species at 2 years (BWP).

#### REFERENCES

- Ashmole, N.P. 1962. *Ibis* 103b: 235–73.  
 — 1963. *Postilla* 76.  
 — 1968. *Condor* 70: 35–55.

- Campbell, B., & E. Lack. 1984. *A Dictionary of Birds*. Poyser, Calton, England.  
 Christian, P.D., *et al.* 1992. *Aust. J. Zool.* 40: 291–302.  
 Christidis, L., & W.E. Boles. 1994. *RAOU Monogr.* 2.

576 Sterninae

- Chu, P.C. 1995. *Condor* 97: 174–96.
- Fjeldså, J. 1977. *Guide to the Young of European Precocial Birds*. Skarv Nature Publs, Strandgården, Tisvildileje.
- Gibson, J.D. 1956. *Emu* 56: 131–2.
- Hackett, S.J. 1989. *Condor* 91: 73–90.
- Hulsman, K. 1977. *Emu* 77: 49–60.
- King, B.R., & R.C. Buckley. 1985. *Corella* 10: 73–7.
- , et al. 1992. *Emu* 93: 1–10.
- Lalas, C., & B.D. Heather. 1980. *Notornis* 27: 45–68.
- Lawrence, G.N. 1853. *Ann. Lyceum Nat. Hist. New York* 6: 1–4.
- Mees, G.F. 1977. *Zool. Verh.* 157: 1–64.
- Mickevich, M.F., & L.R. Parenti. 1980. *Syst. Zool.* 29: 108–13.
- Moynihan, M. 1959. *Am. Mus. Novit.* 1927.
- Ridgway, R. 1874. *Am. Nat.* 8: 433.
- Sibley, C.G., & J.E. Ahlquist. 1990. *Phylogeny and Classification of Birds*. Yale University Press, New Haven.
- , & B.L. Monroe Jr. 1990. *Distribution and Taxonomy of Birds of the World*. Yale University Press, New Haven.
- Strauch, J.G. Jr. 1978. *Trans. zool. Soc. Lond.* 34: 263–345.
- Wolters, H.E. 1975. *Die Vogelarten der Erde. 1*. Hamburg.
- Woodward, P.W. 1972. *Atoll Res. Bull.* 164: 1–318.



*Sterna alba* Sparrman, 1786, *Mus. Carlson.*, fasc. 1(11) — East Indies, Cape of Good Hope and islands of the Pacific Ocean = Ascension Island, South Atlantic Ocean (*apud* Mathews, 1912, *Birds Aust.* 441).

In Dionysius (*De Avibus*, ii. 16) γύγης is a type of seabird. The specific name is Latin for white.

**OTHER ENGLISH NAMES** Fairy Tern, Common, Little, Atlantic or Cocos Fairy-Tern, White Noddy, Love Tern, Lover Tern, Pacific Tern, White Bird.

**POLYTYPIC** Subspecies *candida* (Gmelin, 1789) breeds tropical Indian Ocean, including Cocos-Keeling Is, and much of tropical Pacific Ocean, including Norfolk, Lord Howe and Kermadec Is. Extralimitally: Nominat *alba* breeds Atlantic Ocean; subspecies *microrhyncha* Saunders, 1876, breeds Marquesas Is, and possibly Kiribati (Phoenix and Line Is); subspecies *leucopes* Holyoak & Thibault, 1976, breeds Pitcairn Grp.

**FIELD IDENTIFICATION** Length 28–33 cm; wingspan 66–78 cm; weight 110 g. Medium-sized tern, with delicate appearance, large rounded head, rather deeply based and slightly upturned bill, short legs, long slender wings and long tail with shallow fork. Between Black-naped *Sterna sumatrana* and Roseate *Sterna dougallii* Terns in size, though closer to latter. Adult wholly white, unique among terns. Sexes alike. No seasonal variation. Juvenile distinctive.

**Description** **Adult** White except for dark shafts of primaries and rectrices, and narrow black eye-ring and patch in front of eye, which combine with large black eye to give endearing big-eyed appearance. From below, tail and most of wing translucent. Bill, mostly black with varying blue-black base. Legs and feet, slate-blue to violet, with buff webs. **Juvenile** Differs from adult by: faint smudges of ginger on lores, crown, nape, hindneck, behind eye, on centre of throat and breast, and on thighs (soon lost with wear). Saddle, tertials and secondary coverts delicately marked with varying ginger scaling and with faint cubital bar; reduced with wear and fading. Rectrices sometimes narrowly edged or tipped ginger. Bill, black.

**Similar species** None. All ages easily distinguished by plumage, distinctive big-headed jizz, big-eyed look, strongly translucent wings and tail, and buoyant graceful flight. All other Terns have some black on head, except for Grey Ternlet *Procelsterna cerulea*, which may look white at distance or in bright light but appears smaller headed and lacks translucent wings and tail; plumage greyish, with contrast between remiges and rest of underwing.

Pelagic tern of tropical and warm subtropical seas; seen singly or in small groups at nesting islands or fishing in surrounding waters; usually seen singly or in pairs farther out to sea. Readily associate with noddies when fishing but otherwise seldom seen with other terns or noddies. On nesting islands often perch in trees. Nest in trees but build no nest, balancing single egg on branch. Tame and inquisitive; often hover directly above people. Flight, airy and fluttering, or sometimes swift and darting, with deep, slow and effortless wing-beats; wings appear broad and often rounded at tips, which, with large rounded head and big dark eye, impart distinctive chunky jizz while remaining buoyant and graceful. Tail forked but can appear square-tipped when fully spread. Mostly feed by dipping; hover and flutter low to water and swoop down to pick prey from surface of water; rarely surface-plunge. At nest-site, utter harsh raspy laugh *grich grich grich*....

**HABITAT** Isolated tropical islands, in nearshore waters within a few kilometres of shore, and often in lagoons or over reefs; in sheltered wooded valleys during breeding season. Occasionally recorded in pelagic zone, especially off Aust. mainland (e.g. Wollongong, Wood 1991). Usually only recorded on mainland in exhausted state. Highly pelagic away from breeding islands.

Usually breed in tall open forests, up to c. 700 m from coast, in valleys or other sheltered locations (Crowfoot 1885; Sorensen 1964; Smithers & Disney 1969; Schodde *et al.* 1983; Stokes *et al.* 1984). On Kermadec Is, also breed in coastal areas (Merton 1970 *cf.* Sorensen 1964); on Cocos-Keeling Is, also

observed breeding near edge of island in 'less-thickly wooded' areas (Gibson-Hill 1950). Nest on horizontal branches or leaves of trees. Preferred species vary from island to island: on Lord Howe I., usually in Norfolk Island Pines *Araucaria heterophylla* or Sallywood *Acacia* (Hutton 1991); on Norfolk I., Norfolk Island Pines or White Oak *Lagunaria patersonii* (Crowfoot 1885; Basset Hull 1909; Wakelin 1968; De Ravin 1975; Tarburton 1981); on Cocos-Keeling Is, Cocos Ironwood *Cordia subcordata*, Kayu Sireh *Argusia argentea* and Coconut Palms *Cocos nucifera* (Gibson-Hill 1949a, 1950; Stokes *et al.* 1984); on Kermadec Is, on Pohutukawa *Metrosideros kermadecensis* (Bell 1912; Sorensen 1964; Merton 1970). Also use many other trees (Crowfoot 1885; Basset Hull 1909; Gibson-Hill 1950; Disney & Smithers 1972; Hutton 1991).

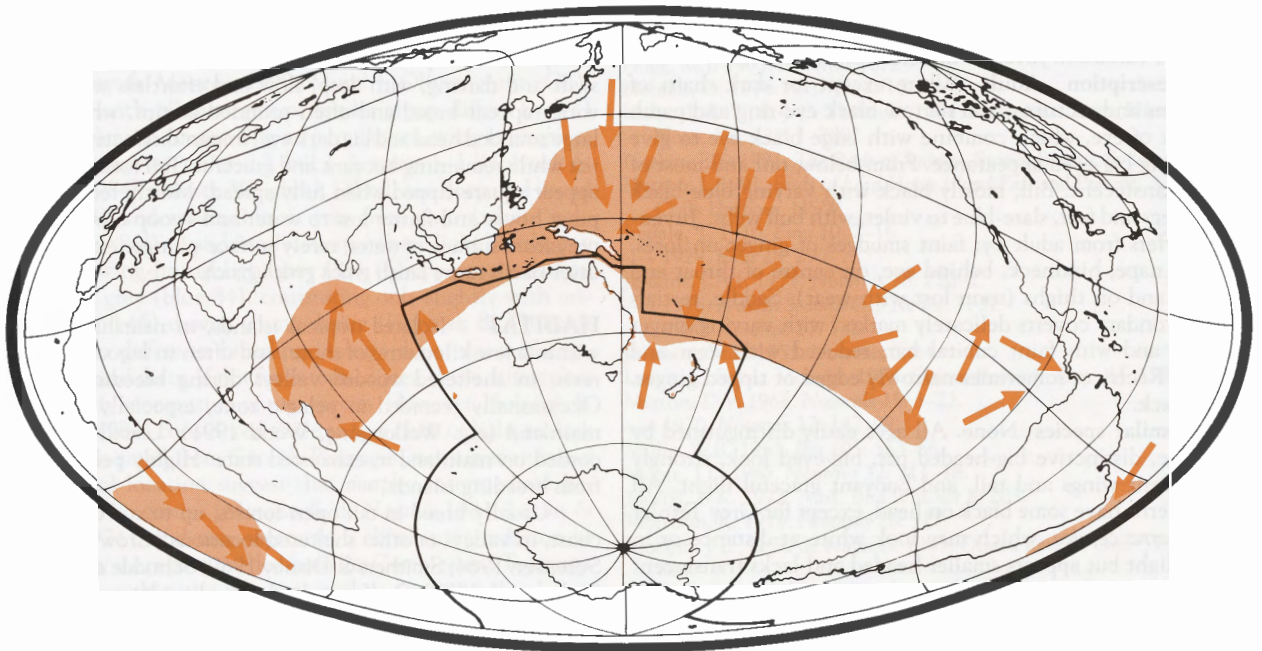
Forage from surface of water; in lagoons, close to atolls, or outside reefs; in pelagic zone away from breeding islands (Bell 1912; Gibson-Hill 1950; Thompson & Hackman 1968; Greensmith 1973; Child 1982; Stokes *et al.* 1987; Hutton 1991); feed in open sea off Christmas I. (Stokes *et al.* 1987). At night, roost in exposed positions in trees, including Norfolk Island Pines (McKean & Hindwood 1965; Hutton 1991). Chicks, blown from nests, will roost on ground, tree-stumps and fence posts (Moore 1985).

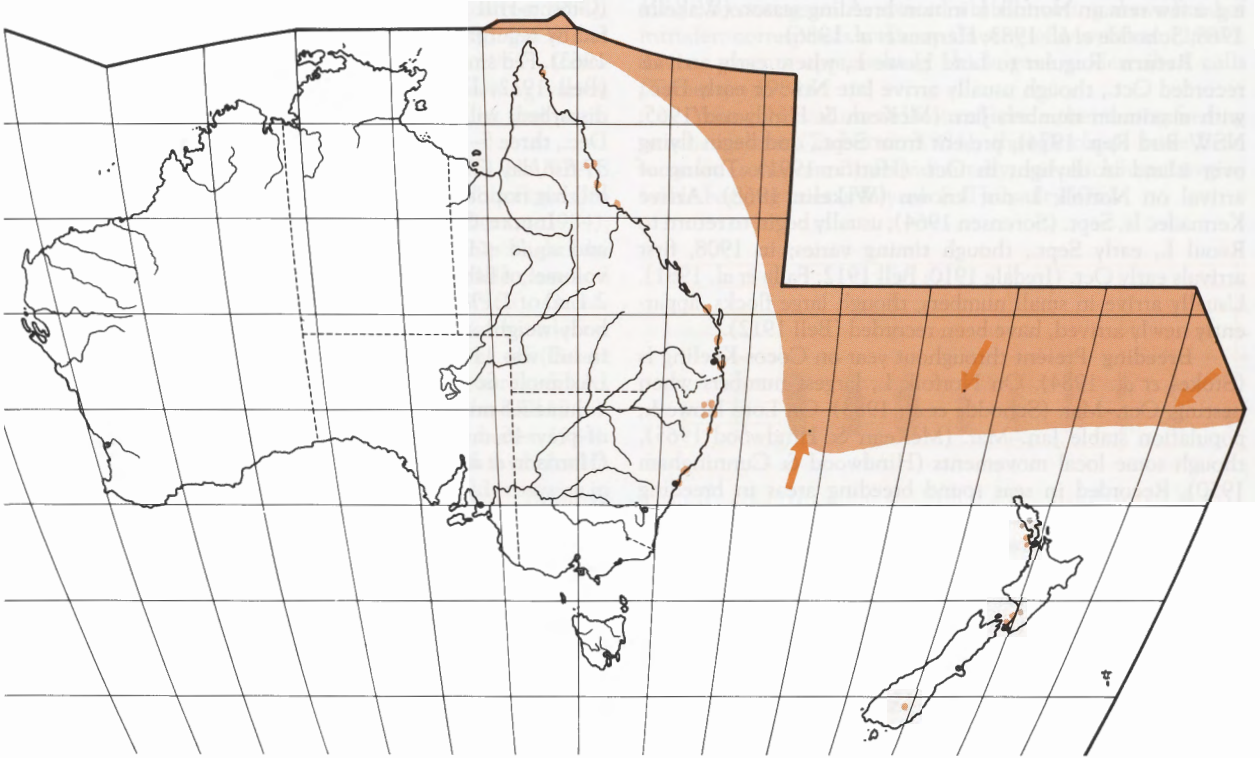
**DISTRIBUTION AND POPULATION** Breeding widespread in Pacific and w. Indian Oceans, with populations in Atlantic Ocean. In w. and central Atlantic, breed at a few scattered islands, from Fernando de Noronha, S to Trinidad, and E to Ascension and St Helena. In Indian Ocean, widespread in w. and central regions, from Seychelles, W to Aldabra Is, S to Mascarenes and E to Chagos and Maldive Is; also on Cocos-Keeling Is. In Pacific Ocean, breeding widespread, mostly in sw. and central Pacific: from Hawaiian Is, SW to Micronesia and through outlying n. atolls of PNG, Tuvalu, Tokelau, Fiji, Tonga to Polynesia, Marquesas Is and Pitcairn I.; also Kiribati. In e. Pacific, sparsely scattered on islands from Clipperton and Cocos Is, S through Galapagos Is to Sala-y-Gomez and Easter I. In Tasman Sea, breed Lord Howe, Norfolk and Kermadec Is. During non-breeding season, usually near breeding islands, but common visitor to Solomon Is, Vanuatu and New Caledo-

nia; occasionally e. Aust. and NZ. Vagrants recorded n. Madagascar, Christmas I., s. coast of China, Revillagigado I. (off Mexico) and Bermuda (AOU 1983; de Schauensee 1984; Feare 1984; Garnett 1984; Williams 1984; Coates 1986; Pratt *et al.* 1987; Langrand 1990; Bregulla 1992).

**Aust.** Occasional visitor to e. coast (all records singles unless stated). **Qld** Specimen, The Spit, Mooloolaba, Apr. 1973 (Peddie 1981); specimen, Meeandah, 30 Apr. 1973 (Vernon 1973); off Pt Lookout, North Stradbroke I., 20 May 1973 (Greensmith 1973); Salamander Reef, Cleveland, 8 June 1973 (Griffin 1976); specimen, Mission Beach, 21 Apr. 1974 (Cooper *et al.* 1977); specimen, Ingham, 4 Feb. 1976 (Griffin 1976); specimen, Torquay, 10 May 1976 (Barry & Vernon 1976); specimen, Hervey Bay, 13 May 1976 (Barry & Vernon 1976); specimen, Lower Tully, Mar. 1979 (Peddie 1981); specimen, Maryborough, 9 Jan. 1981 (Peddie 1981); beachcast, near Currumbin, Mar. 1983 (Qld Bird Rep. 1983); Pt Lookout, 5 June 1983 (Qld Bird Rep. 1983); Maryborough, 26 Apr. 1989 (Qld Bird Rep. 1989); six, Chilli Beach, Iron Ra., 16 Sept. 1990 (Qld Bird Rep. 1990). **NSW** Many records round Ballina, off Sydney Heads and off Wollongong (Brandis *et al.* 1992; Wood 1991; NSW Bird Reps; Aust. Seabird Atlas). Other records: Grafton, June 1951 (A.R. McGill); specimen, Port Kembla, 12 June 1967 (Gibson & Sefton 1971); specimen, Taree, 4 Mar. 1976 (Cooper *et al.* 1977); beachcast, Windang, 24 Apr. 1978 (NSW Bird Rep. 1978); off C. Solander, 6 July 1981 (NSW Bird Rep. 1981); specimen, Macleans Ridge, near Lismore, 1982 (NSW Bird Rep. 1982); Dorrigo, 21 Feb. 1985 (NSW Bird Rep. 1985). Two observed w. Tasman Sea, 140 km offshore between Port Stephens and Bateman's Bay, 22 Dec. 1984 (NSW Bird Rep. 1984); HASB also list two records at sea.

**NZ** Vagrant; all singles. Records up to 1986 from Powlesland (1989) unless stated. **NI** Waipu, 1883; beachcast, Bethell's Beach, Te Henga, 22 May 1960 (Sibson 1961); Pakotai, May 1964; Palmerston North, June 1972 (CSN 25); beachcast, Otaki Beach, May 1986; beachcast, Te Horo Beach, Apr. 1988 (Powlesland & Pickard 1992); beachcast, Muriwai Beach, 6 May 1990 (Guest 1991); beachcast, between Tikinui and Maunganui Bluff, near Dargaville, July 1990 (Powlesland





*et al.* 1993). **SI** Single, Ettrick, Mar. 1945.

**Lord Howe I.** Breeding visitor. First recorded Jan. 1943, when 4–5 observed; c. 50 birds recorded 3 years later, though numbers subsequently fluctuated (Hindwood & Cunningham 1950).

**Norfolk I.** Breeding resident (Hermes *et al.* 1986). Said to be less common than it had been (Turner *et al.* 1968) but other authors have not noted declines.

**Kermadec Is** Breeding visitor (Sorensen 1964; Merton 1970).

**Christmas I.** Single, 10 Jan. 1985 (Stokes *et al.* 1987).

**Cocos-Keeling Is** Breeding resident (Gibson-Hill 1950).

**Breeding** **LORD HOWE I.:** First recorded breeding 1967–68 (Disney & Smithers 1972). Between 1972 and 1977, 10 breeding pairs (Fullagar *et al.* 1974; Cooper *et al.* 1977); by 1990, between 60 and 100 pairs nested annually (Hutton 1991). **NORFOLK I.:** Between 2000 and 2500 pairs (van Tets & Fullagar 1984; Hermes *et al.* 1986); no nests recorded on Nepean or Philip Is (Tarburton 1981). **COCOS-KEELING IS:** On North Keeling I., <2000 birds; also nest on West I. (Stokes *et al.* 1984); recorded breeding on Horsburgh and Direction Is in 1940–41 (Gibson-Hill 1949a,b) but not since (Stokes *et al.* 1984). **KERMADEC IS:** Fewer than 1000 breeding pairs on Raoul I. (Robertson & Bell 1984).

**Populations** See above (Breeding) for HANZAB region.

Eaten by feral cats on Norfolk and Raoul Is (Merton 1970; Klapste 1981; Tarburton 1981). On Norfolk I., Black Ants, introduced from NZ during World War II, are major cause of mortality among young birds (Wakelin 1968). Colonization of Lord Howe I. hindered by predation by introduced Masked Owls *Tyto novaehollandiae* (Disney & Smithers 1972; Fullagar *et al.* 1974; Cooper *et al.* 1977).

**MOVEMENTS** Unknown, though outside breeding season apparently disperse to pelagic waters, generally near breeding islands (AOU 1983; Harrison 1983). Populations either resi-

dent and breeding year-round (e.g. Seychelles) or breed seasonally and move away from breeding islands in non-breeding periods (e.g. Norfolk I.). In tropical Pacific Ocean, common within c. 80 km of breeding islands and less abundant farther out to sea (King 1967). One subspecies in HANZAB region: subspecies *candida* breeds throughout Indian Ocean, including Cocos-Keeling Is, and through much of Pacific Ocean, including Norfolk, Lord Howe and Kermadec Is. In Indian Ocean, generally breed throughout year and considered resident, though records of White Terns away from breeding islands: off Sumatra, Bay of Bengal and, possibly, Madagascar. On Lord Howe, Norfolk and Kermadec Is, breed seasonally and move away from breeding islands to unknown non-breeding areas; recorded NZ and e. coast Aust. and present in New Guinea waters all year, probably reaching ne. Wallacea (Gibson-Hill 1950; Bayliss-Smith 1972; Penny 1974; Ripley 1982; Harrison 1983; Harrison *et al.* 1984; Stokes *et al.* 1984; Beehler *et al.* 1986; White & Bruce 1986; van Marle & Voous 1988; Langrand 1990; HASB). Some mainland records associated with strong winds or heavy rain, e.g. one recovered 30 km inland on e. Qld coast after days of strong e. winds (Griffin 1976; Peddie 1981; Lane 1986; NSW Bird Reps 1987, 1989; Aust. CL).

**Departure** On Norfolk I., fledge Mar. and Apr. (Hermes *et al.* 1986); last chicks fledge Mar. (Schodde *et al.* 1983). On Lord Howe I., numbers decrease after Mar. till all have left by July or Aug. (McKean & Hindwood 1965); present till June, dispersing when winter gales begin (Hutton 1991). On Kermadec Is, leave Raoul I. by end Apr., though seen as late as May (Oliver); young leave in Mar. and Apr. (Bell 1912).

**Non-breeding** Range unknown. Away from breeding grounds, occasionally recorded e. Aust. (all seasons) (Cooper *et al.* 1977); recorded NZ coastal waters between Mar. and June (see Distribution). During non-breeding period, also recorded at sea, e.g. two recorded May 1981 in w. Coral Sea (Stokes & Corben 1985). Some remain near breeding areas,

e.g. a few remain Norfolk I. in non-breeding season (Wakelin 1968; Schodde *et al.* 1983; Hermes *et al.* 1986).

**Return** Regular to Lord Howe I., where early arrivals recorded Oct., though usually arrive late Nov. or early Dec., with maximum numbers Jan. (McKean & Hindwood 1965; NSW Bird Rep. 1974); present from Sept., and begin flying over island in daylight in Oct. (Hutton 1991). Timing of arrival on Norfolk I. not known (Wakelin 1968). Arrive Kermadec Is, Sept. (Sorensen 1964); usually begin to return to Raoul I., early Sept., though timing varies; in 1908, first arrivals early Oct. (Iredale 1910; Bell 1912; Falla *et al.* 1981). Usually arrive in small numbers, though large flocks, apparently newly arrived, have been recorded (Bell 1912).

**Breeding** Present throughout year on Cocos-Keeling Is (Stokes *et al.* 1984). On Norfolk I., largest numbers when nesting, Oct.–Mar. (Schodde *et al.* 1983). On Lord Howe I., population stable Jan.–Mar. (McKean & Hindwood 1965), though some local movements (Hindwood & Cunningham 1950). Recorded in seas round breeding areas in breeding period; occasionally recorded between Dec. and June off Wollongong, NSW (Brandis *et al.* 1992; NSW Bird Rep. 1989); record between Lord Howe I. and Aust. Dec. (Gibson 1960). At least some immatures seen away from breeding areas, e.g. one seen Christmas I. (Stokes *et al.* 1987).

**FOOD** Carnivorous. Fish and squid; less often, crustaceans and insects. **Behaviour** Diurnal, leaving at dawn and returning to colony before dark (15 min after sunset) (Dorward 1963; Tarburton 1984). Diet includes species of fish and squid that only move to surface at night, which suggests dawn and dusk feeding important (Ashmole & Ashmole 1967). Feeding mostly solitary or at edges of mixed-species flocks (Ashmole & Ashmole 1967). Forage both inshore and offshore (Harrison *et al.* 1983). On Cocos-Keeling Is and Seychelles Grp, often feed inshore, in lagoons, and not seen >46 km from land (Gibson-Hill 1950; Feare 1981); on Ascension I., rarely forage close to land (Dorward 1963). Mainly forage by **DIPPING**: picking items from surface or just below surface of water (Dorward 1963; Harrison *et al.* 1983); in one study, 100% observations (Ainley & Boekelheide 1984); often hover before dipping (Gibson-Hill 1949b). Also take fish that jump clear of water when chased by predatory fish (Bell 1912; Gibson-Hill 1949b; Dorward 1963; Murphy). Rarely, feed by **SURFACE-PLUNGING** (Dorward 1963; Harrison 1983). On Lord Howe I., **HAWK** for cicadas over forest, eating only abdomen and discarding head, thorax and wings (Hindwood & Cunningham 1950).

**Adult** No detailed studies in HANZAB region. Mainly records of items brought to chicks. Molluscs: squid (Hutton 1991); Crustaceans: crabs (Gibson-Hill 1949b); Insects: Orthoptera: Cicadidae (Hindwood & Cunningham 1950); Fish (Bell 1912), 5–10 cm (Wakelin 1968; Tarburton 1984), <2 cm (Hutton 1991); Engraulididae: *Stolophorus* (Gibson-Hill 1949b).

Extraterritorially, detailed studies on Christmas I. (Pac.) (Ashmole & Ashmole 1967) and on nw. Hawaiian Is (Harrison *et al.* 1983); in both studies main items were molluscs, 47.7% no. on Christmas I., 7.7% no. on Hawaiian Is; crustaceans tr., 2.5; and fish 52.22, 82.1. See also Fisher (1906), Baker (1951), Brandt (1962), Stonehouse (1962), Dorward (1963) and Murphy for other extralimital records.

**Young** See adult. Adults carry up to five fish in bill at a time, neatly arranged crossways in bill. Pass fish to chicks head first. At first, chick said to be fed semi-liquid matter by regurgitation and not fed solid matter till second or third week

(Gibson-Hill 1949b). However also suggested that chicks not fed by regurgitation but merely fed very small fish (Dorward 1963). Fed smaller fish at first; later, fed fish up to 20 cm long (Bell 1912; Dorward 1963; Ali & Ripley 1969). If adults disturbed, will swallow fish themselves (Wakelin 1968). In Dec., three 5–15-day-old chicks fed c. 8–10 times/day and 24–37 fish/day (Tarburton 1984). Chicks catch and kill flies with bill but not observed to eat them (Bell 1912).

**Intake** On Christmas I. (Pac.), take fish <1–16 cm long and squid <1–8 cm long (most 2–4 cm); mean individual volume: of fish, 1.2 ml or 1.2% of adult body-weight; of squid, 2.1 ml or 2.1% of body-weight; largest squid 8.5 ml or 8.4% of body-weight; average volume of three largest samples carried in bill was 11.3 ml and of three largest regurgitations, 19 ml (Ashmole & Ashmole 1967). On nw. Hawaiian Is, average volume 3.8 ml, containing average 2.6 items per sample; length of prey 46 mm (12–200; 319) with most items 30–80 mm (Harrison *et al.* 1983).

**SOCIAL ORGANIZATION** Poorly known. Not sociable (Bell 1912). Seen singly or in twos at sea (Gibson 1960; Brandis *et al.* 1992). On Kermadec Is, usually arrive in small flocks at start of breeding season, though large flocks sometimes seen (Bell 1912); arrive Lord Howe I. in groups of 2–6 (Hutton 1991). On Norfolk I. during breeding season, commonly flew in threes (Wakelin 1968).

**Bonds** Monogamous extraliminally (e.g. Ashmole 1968). On Norfolk I. pairing begins in Aug. (Hermes *et al.* 1986); on Lord Howe I., courting seen Feb. (McKean & Hindwood 1965); on North Keeling I., many seen displaying Jan. while some on eggs (Stokes *et al.* 1984). **Parental care** Sexes sometimes share preparation of nest-site (Bell 1912; see Nest, Materials). Both sexes incubate (Basset Hull 1909; Gibson-Hill 1950; *contra* Bell 1912, who suggested only male incubates) and care for young (Hutton 1991). Young forage at sea with parents as soon as fully feathered (Bell 1912).

**Breeding dispersion** On Kermadec Is, breed in small colonies or as single pairs; two or three birds may be seen close together but on different branches (Bell 1912). On Norfolk I., not colonial (Crowfoot 1885; Basset Hull 1909; North; Campbell); nesting trees (usually with one pair per tree) usually widely scattered with often c. 400 m between nests; a few cases of birds in neighbouring trees and, in one large tree, two eggs were found and three other birds appeared to be sitting (Basset Hull 1909); usually 2–3 nest-trees in same valley but up to 11 in one locality (Crowfoot 1885). On Norfolk I., return to same tree each year (Crowfoot 1885; North). Extraliminally, colonial nesting recorded (e.g. Dorward 1963). **Home-range** On Cocos-Keeling Is, birds resident year-round and forage mainly in lagoons or close to atolls; occasionally on open sea a few kilometres from shore; said to range up to c. 40 km from main atoll (see Gibson-Hill 1950).

**Roosting** On breeding islands, roost at night in trees where eventually nest (Bell 1912; Hutton 1991). After arrival, fly over island during daylight; later, both breeding and non-breeding birds roost in trees during daylight (Hutton 1991); some perch on future nesting trees during heat of day; very active morning and evening (Bell 1912). Young blown from nesting trees found resting on ground, tree-stumps and fence-posts (Moore 1985); when young first feed at sea, always return to nesting tree at night (Bell 1912). Sleep with head behind or under wing; do not defecate on roost (Tarburton 1984).

**SOCIAL BEHAVIOUR** Poorly known. Some observations

on Kermadec (Bell 1912) and Norfolk Is (Tarburton 1984). Extralimitally, studied on Ascension I. (Dorward 1963) and Midway and Easter Is, Pacific Ocean (Moynihan 1962). **Comfort behaviour** Time nesting birds spend preening varies; preen breast, axillaries, secondaries, wing-coverts and primaries (Tarburton 1984).

**Agonistic behaviour** No information for HANZAB region. **Sexual behaviour** On Norfolk I., courtship flights, to heights of 400–500 m, common in Dec. (Tarburton 1984); Hermes (1985) also refers to graceful courtship flights by breeding pairs. Known as Lover Tern as they cuddle close and appear to whisper in each other's ears (Wakelin 1968). **Greeting** At change-over, male circles, calling and, as he settles on limb balancing with raised wings, female moves off (Basset Hull 1909). Said to leave nest by dropping backwards off tree, reducing chances of knocking egg with feet (Gibson-Hill 1948). **Allopreening** Once seen in one pair at sunrise (Tarburton 1984).

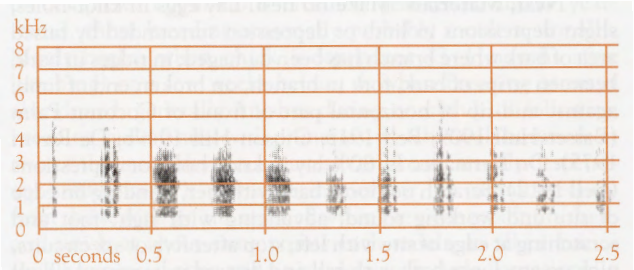
**Relations within family groups** Chicks fed whole fish (but see Food). Parent returns with a few fish held crosswise in bill, and either circles before landing or flies straight to chick; occasionally calls on approach and young responds by standing alert with gaping bill. Chick watches approaching parent, then moves to parent with head lowered and bill upturned in **BEGGING POSTURE**; take and swallow fish one at a time. Fish that are too large are rejected by young; fish dropped onto branch are retrieved by parent but fish dropped onto ground are seldom retrieved. Chicks not heard to call when feeding or when alone (Wakelin 1968; Tarburton 1984), though extralimitally this not always so (Holyoak & Thibault 1976). After feeding, chick commonly begs and jabs with bill, which seemed on several occasions to hasten departure of parent to sea (Tarburton 1984). Time between feeding visits for three young 5–15 days old was 7–92 min (Tarburton 1984; see Breeding: Young). Parents will brood young while still holding fish in bills. At c. 1 month old, though still covered in down, chicks able to flutter for short distances, and sometimes found on ground. Able to climb trees: one climbed 3 m up a tree; this feat took c. 0.5 h and required much effort and resting; the chick dug bill in and levered itself up tree by bending neck and using its feet, at the same time spreading wings and tail against bark to stop it from slipping backwards; this action was repeated again and again as chick moved in spiral round tree; feathers of wing and tail were very frayed (Wakelin 1968). **Anti-predator responses of young** When approached, young lie on branch, with necks stretched out. If handled, cling tenaciously to branch (Bell 1912). On Lord Howe I., Pied Currawongs *Strepera graculina crissalis* threaten chicks when parents absent (Hutton 1991). **Parental anti-predator strategies** Eggs never left unattended (Gibson-Hill 1949b). One parent attends chicks constantly for 7–10 days (Bell 1912). In response to people: sitting bird can sometimes be handled (Crowfoot 1885; North); when approached, bird on egg may leave carefully: raises and gently flutters wings and tiptoes sideways off egg (Basset Hull 1909); rises slowly to feet, rocking body slightly from side to side. Often hover close over intruder, making clicking sounds, but never seem belligerent (Basset Hull 1909; Wakelin 1968).

**VOICE** Virtually no information from HANZAB region. Extralimitally, five calls described by Moynihan (1962) and another by Dorward (1963). No calls (by parent or chicks) associated with feeding (Dorward 1963).

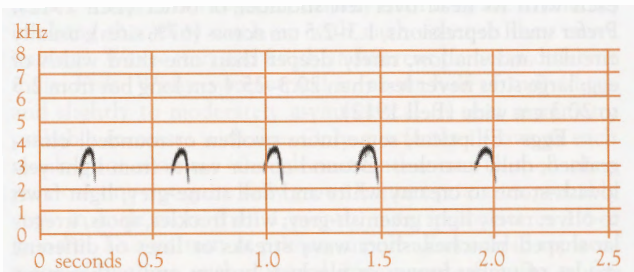
In HANZAB region, only call described a repeated guttural *heech*, *heech* (Basset Hull 1909) or clicking sound (Wakelin

1968); see sonagram A; uttered while hovering above head of intruder; corresponds to Buzzy Cawing of Moynihan (1962). Twice, parents approaching chick gave undescribed calls (Tarburton 1984).

**Young** No calls heard from chicks, either during feeding or when alone (Tarburton 1984); though *cheeps* have been recorded (sonagram B). Extralimitally, one chick heard to give feeble begging cries (Holyoak & Thibault 1976).



A E. Slater; Lord Howe I., Feb. 1988; priv. 123



B R. Swaby; Norfolk I., Dec. 1978; P39

**BREEDING** Not well known. Some information from Norfolk I. (Basset Hull 1909) and Kermadec Is (Bell 1912); four records in Aust. NRS to Aug. 1993. Nest in trees on volcanic islands, in pairs or small colonies or groups of 2–3 pairs (Bell 1912); widely scattered rather than in colonies (Basset Hull 1909).

**Season** On Lord Howe I.: laying begins late Oct., sometimes continues till Apr. (Hutton 1991); downy young and fledgelings in early Mar. (Aust. NRS). On Norfolk I.: laying from mid-Oct., last egg found late Feb. (Basset Hull 1909); laying from early Sept.; hatching from mid-Oct., many chicks in Dec. and Jan.; fledge, Mar. and Apr. (Hermes *et al.* 1986). On Cocos-Keeling Is: possibly all year, with peak May–July (and possibly a second peak Sept.–Nov.); single egg seen Mar. and 2-week-old chick beginning of May (Gibson-Hill 1949b); eggs, Jan., early July and late Nov. (Stokes *et al.* 1984). On Kermadec Is: laying begins mid-Oct. or early Nov., sometimes from late Nov. to late Dec., though fresh eggs also found till early Jan.; hatching, early Nov. to late Jan.; young leave Mar. and early Apr., with some still present in early May (Bell 1912; Sorensen 1964; Merton 1970; Oliver).

**Site** On trunk or limbs of trees, often as high in tree as possible (Basset Hull 1909; Bell 1912; Sorensen 1964; Wakelin 1968; De Ravin 1975; Stokes *et al.* 1984; Hutton 1991; see Habitat). On Kermadec Is, 75% pairs lay near tops of long, thin leaning trees, especially over steep hillsides or deep gullies and exposed to wind (Bell 1912), *contra* Basset Hull (1909), who said Terns generally select trees sheltered from prevailing winds. Eggs laid on bare stem or branch, rarely less than 10–13 cm wide, occasionally only 7.6 or 5.7 cm wide, usually horizon-

tal, sometimes at angles of 30° or 40°; wherever flat space or nook exists where egg will not roll off and rainwater will not collect (Bell 1912). **MEASUREMENTS:** Height of nest: on Cocos-Keeling Is, usually 3–8 m (Gibson-Hill 1949b); on Norfolk I.: usually 9.1–18.3 m, rarely less than 6.1 m (Basset Hull 1909); on Kermadec Is: two nests, 13.7, 15.2 m (Bell 1912; Merton 1970). Return to same spot season after season, but not known if same pairs (North).

**Nest, Materials** Make no nest. Lay eggs in knot-holes, slight depressions in limb or depression surrounded by raised area of bark where branch has been damaged; in ridges in bark, between strips of bark, fork in branch, on broken end of limb; against mid-rib of horizontal part of frond of Coconut Palm (Basset Hull 1909; Bell 1912; Gibson-Hill 1949b; De Ravin 1975). On Kermadec Is, 80% lay in knot-holes or depressions (Bell 1912). Scratch out loose bark with feet, standing on edge of site and working round, advancing with right foot and scratching at edge of site with left; stop after five or six circuits, pick up any loose bark with bill and discard it; repeated till all loose bark cleared. Occasionally, both adults work together, each with its head over left shoulder of other (Bell 1912). Prefer small depressions, 1.3–2.5 cm across (67% sites); usually circular and shallow, rarely deeper than one-third width of egg; large sites never less than 20.3–25.4 cm long but from 2.5 to 20.3 cm wide (Bell 1912).

**Eggs** Elliptical, some more swollen or rounded; close-grained, dull, lustreless. Ground-colour varies from light yellowish-stone to creamy white and dull stone-grey; light fawn to olive; rarely light greenish-grey; with freckles, spots, irregular-shaped blotches, short wavy streaks or lines of different shades of umber-brown or blackish brown; and with similar underlying markings of inky grey; some consist entirely of freckles, dots and small spots of blackish brown, often with underlying spots of inky grey; or a zone of confluent markings on one end; others have a network of wavy streaks and large blotches of umber-brown and brownish black, or boldly but sparingly blotched with olive-brown and various shades of ashy grey, latter appearing as if beneath surface; markings on a few very faint, only slightly darker shade of ground-colour, or partly obscured by large underlying patches of ashy grey (Gibson-Hill 1949b; Wakelin 1968; Hutton 1991; North). Colour said to resemble branch, e.g. light-coloured eggs on light branches, and dark-coloured eggs, without exception, on dark branches (Bell 1912). **MEASUREMENTS:** Cocos-Keeling Is: 42.6 (40–44.5; 15) x 32.3 (30–34) (Gibson-Hill 1949b). Norfolk I.: 43.2 (1.49; 40.9–45.7; 10) x 33.0 (0.60; 31.8–33.8) (North). Six specimens selected for greatest variation: 44.1 (3.01; 40.1–48.3; 6) x 32.3 (1.33; 30.5–34.0) (Basset Hull 1909). Kermadec Is: 44.5 x 32.5, 42.5 x 34, 41.5 x 30.5 (Oliver).

**Clutch-size** One (Bell 1912; Gibson-Hill 1949b; Wakelin 1968; North).

**Laying** Replacement egg laid if first is lost or chick eaten (Hutton 1991); re-lay some weeks after loss (Basset Hull 1909), in same spot (North).

**Incubation** By both sexes (Basset Hull 1909) *contra* Bell (1912), who says male probably does all incubating. Sitting adult sits behind egg, not above it, almost enveloping egg with long feathers of breast, depressing forked tail onto branch to secure hold, and with bill pointing into wind (Basset Hull 1909; Bell 1912; Gibson-Hill 1949b). When incubating bird leaves, it usually falls away backwards rather than springing up (Gibson-Hill 1949b). When returning to incubate, adult moves close to egg, fluffs out feathers, covers egg and settles upon it, returning feathers to their normal position and rocking from

side to side as though to work tips of feathers under eggs (Bell 1912). **INCUBATION PERIOD:** c. 28 days (Hutton 1991); 35–36 days (Hermes *et al.* 1986); two eggs: 30–31 days, 31–32 days (Gibson-Hill 1949b).

**Young** Precocial, semi-nidifugous. Hatch in varyingly coloured down (see Plumages). Feathers first appear along middle of dorsal tract and on scapulars at c. 8 days and visible through down 3–5 days later; remiges and rectrices appear soon after; by c. 35 days, down only obvious on forehead, neck, flanks, belly and rump and a little on wing-coverts; by 47–50 days only traces of down remain (Gibson-Hill 1949b). **Parental care, Role of sexes** Downy young brooded (Basset Hull 1909). One parent attends chick constantly for first 7–10 days (Bell 1912). Both parents feed young (Hutton 1991); young take fish from parent's bill, one at a time (Basset Hull 1909; but see Food). Young 5–15 days old fed throughout day; one chick received 12 feeding visits, lasting 20 min (1–109) with 3.1 fish (1–6) delivered on each of eight trips, equalling an estimated 37 fish/day; chick left alone for periods of 44 min (21–92); a second chick fed twice between sunrise and noon, one visit lasting 180 min, with 7 min period between visits; a third chick visited nine or ten times, fed 24–27 fish, with feeding parent staying for 0.5–15 min periods, and leaving chick alone for 10–20 min periods (Tarburton 1984). At 1 month old, young that come to ground able to climb up trees (Wakelin 1968).

Growth of one chick (Gibson-Hill 1949b) in Table 1.

Table 1

AGE (DAYS)	1	4	10	16	19	25	31	34	40	43
Length	79	95	120	165	184	215	230	239	260	274
Gape	20	24	29	34	37	39	41	42	43	43
Culmen	12	14	18	22	24	26.5	28	29	31	31
Wing (Flat)	17.5	20	30	54	80	109	122	130	149	160
Longest rectrix	–	–	1	24	34	44	50	53	64	73

**Fledging to maturity** Young able to flutter about when 1 month old (Wakelin 1968). **FLEDGING PERIOD:** 60–75 days (Hutton 1991); most begin to fly when 47–50 days old, but some when 40 days old (Gibson-Hill 1949b). Can fly when still largely covered in down; forage with parents as soon as fully feathered, returning to nest at night (Bell 1912).

**Success** Large young taken by feral cats and Nankeen Kestrels *Falco cenchroides* (Tarburton 1984); on Lord Howe I., many young taken by Masked Owls, with greatest mortality early in season (Hutton 1991); many young die when blown from nests during high winds (Wakelin 1968); young that fall to ground often killed and eaten (De Ravin 1975); also attacked by Black Ants (Wakelin 1968); much mortality of chicks caused by cold summer storms, with heavy rain and 2–3 days of fog and drizzle (Hermes *et al.* 1986).

**PLUMAGES** Prepared by R.P. Scofield and D.J. James. Medium-sized tern maturing in 1 year. Fledge in juvenile plumage when 7–11 weeks old (Dorward 1963; Ashmole 1968; see Breeding). Undergo probably complete post-juvenile moult to definitive plumage. Thereafter, complete wave-moult (staffelmauser) renews basic plumage once per cycle. Sexes similar. No seasonal variation. Four subspecies; *candida*, described below, occurs HANZAB region.

**Adult** (First and subsequent basic). Pure white except for: (1) narrow black-brown (119) eye-ring, broadest in recess in front of eye; (2) dark primary-shafts: on inner primaries,

brown (c123) grading to white at base; on p8–p9, brown (c33); on p10, black-brown (119) fading to dark brown (22) with wear; (3) shafts of all rectrices usually black-brown (119) to dark brown (22); shafts of t5–t6 sometimes white or brown. Underdown and plumulaceous bases, grey (84) to sooty-grey (c82) on marginal and lesser upperwing-coverts, round pygostyle, and sometimes on crown and back.

**Downy young** Based on skins from Lord Howe and Norfolk Is (ANWC), and published description from Raoul I., Kermadec Is (Bell 1912; Oliver). Brownish-grey (79); exceptionally dark grey (c83), light grey (c85) or almost white; vent, off-white. Bases to most down, white. Some have black-brown (119) or dark-brown (119A) patch on crown, and two parallel, dark-brown (119A) stripes from nape to mantle. Down gradually fades with age (Bell 1912). Claimed that variation in darkness of down (and eggs) related to darkness of branch chosen as nest-site (Bell 1912).

Outside HANZAB region, downy young vary greatly (Berger 1981; photos in Bailey 1956, Pringle 1987): (1) off-white, with pearl-grey (81) wash on throat; (2) white, with one or two black-brown (119) streaks (or spots) on crown; or (3) pink-buff (121D) to buff (124) with small black-brown (119) patches or bars on hindcrown, two black-brown (119) spots on ear-coverts, a black-brown (119) post-ocular line and dark-brown (119A) neck and breast. Not clear whether these forms are distinct morphs or whether they form part of a continuum.

**Juvenile** Based on single skin from Samoa (AIM), photos (Harrison 1987; unpubl.: D.W. Eades) and field observations (D.W. Eades); see also Gibson-Hill (1949b). Mostly white, with fine ginger-brown wash to tips of many feathers, which is rapidly lost with wear. In fresh plumage, differs from adult by: **Head and neck** Narrow, diffuse, orange-buff (c118) to ginger-brown (c123B) or light-brown (239) edges to feathers of forehead, lores, crown, nape, rear ear-coverts and throat; tips broadest (most prominent) on crown and ear-coverts. **Upperparts** Mantle, back and scapulars, white, with broad, unevenly washed, light-brown (239) to ginger-brown (123B) tips; markings more prominent than those on head and underparts. Back, rump and uppertail-coverts mostly white, with faint tinge of light brown (27–239) at tips of feathers producing softly mottled appearance. **Tail** White, with dark shafts like adult, but speckled with light brown (239) to ginger-brown (123B) distally on inner four rectrices (distal half of t1, distal quarter of t2–t3, narrow tip of t4). **Upperwing** Coverts and tertials, as scapulars; tips of primary coverts less bold than those of secondary coverts. Inner five primaries have faint, light-brown (c239) wash at tips.

**BARE PARTS** Based on published descriptions (Berger 1981; Oliver), field observations (D.W. Eades) and photos (Harrison 1987; Pringle 1987; Hutton 1991; unpubl.: D.W. Eades). **Adult** Bill, black, with blue-black (c90) to dark-blue (74) base of varying extent. Iris, blue-black (c90) to black (89). Legs, light violet (170C); toes, blue (69); webs, buff (124) to orange-buff (118); claws, black-brown (119). **Downy young** Bill, blue-black (c90) becoming black (89) at tip; also described as dark grey (Oliver). Iris, black (89) to blue-black (c90). Legs and toes, blue-black (c90); webs, dull pink (5) or buff (124). Claws, black (89) with pale tips. **Juvenile** Bill, matt-black. Iris, legs and feet, similar to adult.

**MOULTS** Complex and poorly known because few data from non-breeding birds away from colonies. Based on studies of subspecies *candida* at Christmas I., central equatorial Pacific

Ocean (Ashmole 1968), and of subspecies *alba* on Ascension I., tropical Atlantic Ocean (Dorward 1963); supplemented by examination of c. 35 skins (AM, NMNZ). Ashmole (1968) discussed hypotheses on the functional significance, evolution and physiological control of the unusual pattern of moult of this species. **Adult post-breeding** (Pre-basic). No data from HANZAB region. Complete. Moult undertaken almost entirely at sea, between breeding episodes, and takes 5.5–7 months to complete. Populations breeding year-round moult year-round, those breeding seasonally probably moult seasonally. Moult begins when chick independent (3–4 months after hatching) or a few weeks before, or when breeding attempt abandoned; generally finishes during courtship of following breeding cycle. Starts with primaries, which moult outwards in two or three simultaneous waves (continual, serially descendant staffelmauser); waves begin more or less simultaneously from the several points reached when previous moult finished, and finish at about same points each moult, so all primaries usually replaced once and no more in each cycle (occasionally one or two feathers replaced twice in a moult-episode). Successive waves closer together distally than they are in middle, implying that they catch up with each other as they move outward. Waves start and finish at different points in different individuals. Wings symmetrical in about half of individuals and slightly to moderately asymmetrical in rest; asymmetry probably increases with age. Only one feather grows at each moult-front at a time (though next feather may be shed when previous one not quite fully grown); inner primaries probably grow in little more than 1 month, outer primaries in 1.5–2 months. This pattern of primary-moult allows rapid replacement of feathers, with minimal impairment of ability to fly. Moult of secondaries usually centripetal, usually involving more than one wave of moult in each direction; usually all replaced, though occasionally retain one or two feathers. Moult of tail asymmetrical and apparently irregular; mainly moulted during period when primaries moulting. However, growing rectrices occasionally found at any stage of breeding cycle; normally all rectrices replaced at least once, but no evidence if some replaced more than once per cycle. Begin moult of body after chick hatches. No data on possible differences between males and females. **Post-juvenile** (First pre-basic). No data. Probably complete. Apparently begins after leaving colonies.

**MEASUREMENTS** T1 = length of t1; T5 = length of t5 (= Tail). (1–2) Pulo Luar, Cocos-Keeling Grp; Tarsus not as HANZAB method (Gibson-Hill 1950): (1) Adults; (2) Juveniles still retaining some down. (3–5) Adults, skins: (3) Lord Howe I. (ANWC); (4) Norfolk I. (AM, ANWC); (5) Kermadec Is (CM, NMNZ).

	MALE	FEMALE	
WING	(1) 236.6 (4.96; 225–241; 10)	235.8 (3.39; 232–241; 6)	ns
	(2) 165.3 (34.95; 126–208; 4)	179	
	(3) 245	252	
	(4) 245, 257	240, 252, 260	
	(5) 247.5 (8.18; 241–258; 4)	247.8 (6.21; 240–255; 6)	ns
T1	(3) 74	72	
	(4) 75, 74	73	
	(5) 74, 75, 75	75, 75	
T5	(1) 108.6 (5.87; 100–120; 10)	106.7 (6.16; 98–117; 6)	ns
	(2) 71.5 (18.83; 48–90; 4)	83	
	(3) 108	120, 123	
	(4) 108, 121	114, 119	
	(5) 117 (2.45; 114–120; 4)	112, 113, 114	

BILL	(1)	40.8 (1.68; 37–43.5; 10)	40.0 (0.82; 39–41; 6)	ns	
	(2)	30.0 (2.00; 28–32; 4)	29		
	(3)	44.5	42.3, 44.4		
	(4)	38.0, 42.0	40.0, 45.9		
	(5)	42.1, 42.7,	42.9 (1.56; 41.3–44.7; 4)		
BILL D	(3)	10.3	10.6		
	(4)	11.0, 11.2	–		
	(5)	9.8, 10.4, 12.4	10.4, 10.7		
	TARSUS	(1)	17.3 (0.56; 16.5–18; 10)	16.4 (1.24; 14–18; 6)	ns
		(2)	17.0 (0.79; 16–18; 4)	18	
(3)		15.2	14.8		
(4)		16.1, 15.9	11.5, 13.0		
(5)		13.1 (0.29; 12.9–13.5; 4)	13.0 (0.47; 12.4–13.5; 4)	ns	
TOE C	(3)	27.6	27.0		
	(4)	26.7, 27.2	–		
TOE	(5)	20.2, 20.2, 20.5	20.0, 20.5, 21.2		

No evidence of sexual dimorphism in size. Juveniles significantly smaller ( $P < 0.01$ ) than adults except in Toe C (but flight-feathers probably not completely grown).

(6) Pulo Luar, Cocos-Keeling Grp (Gibson-Hill 1950); (7) Norfolk I.; (8) Kermadec Is (Baker 1951; Holyoak & Thibault 1976).

#### UNSEXED

WING	(6)	236.3 (4.47; 225–241; 16)
	(7)	250 (242–257; 16)
	(8)	252 (243–256; 18)
T5	(6)	107.9 (6.05; 98–120; 16)
	(7)	113 (105–124; 16)
	(8)	115 (109–121; 18)
BILL	(6)	40.5 (1.46; 37–43.5; 16)
	(7)	42 (41–44; 16)
	(8)	43 (39–46; 18)
BILL D	(7)	8.6 (8.1–9.4; 16)
	(8)	8.6 (8.2–9.5; 18)
TARSUS	(6)	16.9 (0.97; 14–18; 16)

Measurements of extralimital populations in Baker (1951), Holyoak & Thibault (1976), Kinsky & Yaldwyn (1981), Lacan & Mougouin (1974), Ridgway (1919) and Murphy.

**WEIGHTS** Lord Howe I.: adult male 142, adult female 135 (ANWC). Norfolk I.: adult male 130; immature male 85; immature female 59 (ANWC); small downy young (17 Dec.) c. 57. Extraliminally: Niue I.: adult males 115, 116; females 110 (4.82; 102–115; 5) (Kinsky & Yaldwyn 1981). Tuamotu and Gambier Grps: males 112 (100–120; 6); females 110 (90–130; 9) (Lacan & Mougouin 1974). Guam and Rota Is, Micronesia: adult males 110 (97–124; 11), females 108 (100–116; 6) (Baker 1951). More weights in Dorward (1963).

Weights of seven chicks 8–40 days old and weighing between 42 and 120 g, fluctuated by a mean 10.3 g within a day; variation related to times of feeding (Dorward 1963).

**STRUCTURE** Wing, long, narrow and pointed. Eleven primaries: p10 longest, p9 3–10 mm shorter, p8 13–23, p7 31–42, p6 49–65, p5 70–82, p4 91–102, p3 103–122, p2 120–138, p1 142–149; p11 minute; at rest p1 projects beyond tail by 10–15 mm. Seventeen secondaries, including four tertials; longest tertials reach tip of p6 or p7 on folded wing. Tail, long and forked; 12 rectrices; t5 longest, t6 29–36 mm shorter, t4 8–17, t3 25–33, t2 32–42, t1 33–44. Bill, stout, slightly longer than head; slightly upcurved, with angle increasing at gonys; upper mandible c. 1 mm longer than lower and slightly decurved

near tip. Tibia fully feathered, with some feathers extending to tibio-tarsal joint; tarsus extremely short and slender, with reticulate scaling. Toes, long, with long downcurved claws; front toes fully webbed; webs have concave edges and cancellate scaling. Outer toe 86–94% of middle, inner 64–71%, hind 33–40%, raised.

**GEOGRAPHICAL VARIATION** Holyoak & Thibault (1976) recognized four subspecies: nominate *alba* in Atlantic Ocean; subspecies *candida* throughout Indian and most of Pacific Oceans; subspecies *microrhyncha* on Marquesas Is and, according to Pratt *et al.* (1987), Kiribati; and subspecies *leucopes* on some islands of Pitcairn Grp. Subspecies *candida* and *microrhyncha* said to hybridize or intergrade on some smaller islands of Marquesas (Holyoak & Thibault 1976) and Kiribati (Pratt *et al.* 1987). In arrangement of Holyoak & Thibault (1976), subspecies *candida* is only one in HANZAB region. Other treatments (e.g. Baker 1951; Peters; Aust. CL; NZCL) have recognized several more subspecies in Pacific, including *royana*, Mathews, 1912, breeding Kermadec, Norfolk and Lord Howe Is. However, Holyoak & Thibault (1976) and Kinsky & Yaldwyn (1981) showed that size (upon which subspecific distinction based) varies in irregular cline, increasing from N to S in Pacific Ocean. They also suggested that size of bill may vary with intensity of competition for nest-sites (Holyoak & Thibault 1976).

Genus *Gygis* usually regarded as monotypic. However, several authors have treated *microrhyncha* as separate species (Mathews; Pratt *et al.* 1987; Sibley & Monroe 1990, 1993) despite its integration with *candida*.

#### REFERENCES

- Ainley, D.G., & R.J. Boekelheide. 1984. *Studies avian Biol.* 8: 2–23.  
 Ali, S., & S.D. Ripley. 1969. *Handbook of the Birds of India and Pakistan*. 3. OUP, Bombay.  
 AOU. 1983. *Check-list of North American Birds*. Am. Orn. Union, Lawrence, Kansas.  
 Ashmole, N.P. 1968. *Condor* 70: 35–55.  
 —, & M.J. Ashmole. 1967. *Bull. Yale Peabody Mus. nat. Hist.* 24: 1–131.  
 Bailey, A.M. 1956. *Denver Mus. nat. Hist. Mus. Pictorial* 12.  
 Baker, R.H. 1951. *The Avifauna of Micronesia, Its Origin, Evolution, and Distribution*. Univ. Kansas Publ., Mus. Nat. Hist. 3 (1).  
 Barry, D.H., & D.P. Vernon. 1976. *Sunbird* 7: 107–11.  
 Basset Hull, A.F. 1909. *Proc. Linn. Soc. NSW* 34: 636–93.  
 Bayliss-Smith, T.P. 1972. *Bull. Br. Orn. Club* 92: 1–10.  
 Beehler, B.M., *et al.* 1986. *Birds of New Guinea*. Princeton Univ. Press, Princeton, New Jersey.  
 Bell, R.S. 1912. *Emu* 12: 26–30.  
 Berger, A.J. 1981. *Hawaiian Birdlife*. Univ. Press Hawaii, Honolulu.  
 Brandis, C.C.P., *et al.* 1992. *Aust. Bird Watcher* 14: 165–79.  
 Brandt, J.H. 1962. *Condor* 64: 416–37.  
 Bregulla, H.L. 1992. *Birds of Vanuatu*. Nelson, Shropshire, England.  
 Child, P. 1982. *Notornis* 29: 31–6.  
 Coates, B.J. 1986. *The Birds of Papua New Guinea. 1*. Dove Pubs, Alderley, Qld.

#### Plate 47

Barbary Dove *Streptopelia 'risoria'* (page 864)  
 1 Adult; 2 Juvenile; 3, 4 Adult

Rock Dove *Columba livia* (page 838)  
 5 Adult, ancestral type; 6 Adult, dark variant; 7 Juvenile;  
 8, 9 Adult, ancestral type



- Cooper, W.T., et al. 1977. *Aust. Bird Watcher* 7: 11–12.
- Crowfoot, M.W. 1885. *Ibis* 3: 263–70.
- De Ravin, J.A. 1975. *Aust. Bird Watcher* 6: 4–10.
- de Schauensee, R.M. 1984. *The Birds of China*. OUP, Oxford.
- Disney, H.J. de S., & C.N. Smithers. 1972. *Aust. Zool.* 17: 1–11.
- Dorward, D.F. 1963. *Ibis* 103b: 365–78.
- Falla, R.A., et al. 1981. *The New Guide to the Birds of New Zealand*. Collins, Auckland.
- Feare, C.J. 1981. *Ostrich* 52: 179–85.
- 1984. *ICBP Tech. Publ.* 2: 457–71.
- Fisher, W.K. 1906. *US Fish Comm. Bull.* 23: 767–807.
- Fullagar, P.J., et al. 1974. Pp 55–72 (Appendix F) In: Recher & Clark 1974.
- Garnett, M.C. 1984. *ICBP Tech. Publ.* 2: 547–58.
- Gibson, J.D. 1960. *Emu* 60: 11–19.
- , & A.R. Sefton. 1971. *Aust. Bird Watcher* 4: 16–18.
- Gibson-Hill, C.A. 1948. *J. Malay. Branch Roy. Asiatic Soc.* 21: 68–103.
- 1949a. *Ibis* 91: 221–43.
- 1949b. *J. Bombay Nat. Hist. Soc.* 48: 214–35.
- 1950. *Bull. Raffles Mus.* 22: 212–70.
- Greensmith, A. 1973. *Sunbird* 4: 55–6.
- Griffin, A.C.M. 1976. *Sunbird* 7: 49–50.
- Guest, R. 1991. *Notornis* 38: 240–4.
- Harrison, C.S., et al. 1983. *Wildl. Monogr.* 85: 1–71.
- , et al. 1984. *ICBP Tech. Publ.* 2: 513–26.
- Harrison, P. 1983. *Seabirds: An Identification Guide*. Croom Helm, Sydney.
- 1987. *Seabirds of the World: A Photographic Guide*. Christopher Helm, Lond.
- Hermes, N. 1985. *Birds of Norfolk Island*. Wonderland Publs, Norfolk I.
- , et al. 1986. *Notornis* 33: 141–9.
- Hindwood, K.A., & J.M. Cunningham. 1950. *Emu* 50: 23–35.
- Holyoak, D.T., & J.-C. Thibault. 1976. *Alauda* 44: 457–73.
- Hutton, I. 1991. *Birds of Lord Howe Island Past and Present*. Author, Coffs Harbour, NSW.
- Iredale, T. 1910. *Emu* 10: 2–16.
- King, W.B. 1967. *Seabirds of the Tropical Pacific Ocean*. Smithsonian Inst., Washington, D.C.
- Kinsky, F.C., & J. Yaldwyn. 1981. *Nat. Mus. NZ Misc. Ser.* 2.
- Klapste, J. 1981. *Aust. Bird Watcher* 9: 35–40.
- Lacan, F., & J.L. Mougín. 1974. *Oiseau Rev. fr. Om.* 44: 191–280.
- Lane, S.G. 1986. *Aust. Birds* 20: 94–5.
- Langrand, O. 1990. *Guide to the Birds of Madagascar*. Yale Univ. Press, New Haven, USA.
- McKean, J.L., & K.A. Hindwood. 1965. *Emu* 64: 79–97.
- Merton, D.V. 1968. *Notornis* 15: 3–22.
- 1970. *Notornis* 17: 147–99.
- Moore, J.L. 1985. *Notornis* 32: 311–18.
- Moynihan, M. 1962. *Behaviour Suppl.* 8.
- Peddie, H. 1981. *Aust. Bird Watcher* 9: 100–1.
- Penny, M. 1974. *The Birds of the Seychelles*. Collins, Lond.
- Powlesland, R.G. 1989. *Notornis* 36: 125–40.
- , & C.R. Pickard. 1992. *Notornis* 39: 27–46.
- , et al. 1993. *Notornis* 40: 27–43.
- Pratt, H.D., et al. 1987. *A Field Guide to the Birds of Hawaii and the Tropical Pacific*. Princeton Univ. Press, Princeton, New Jersey.
- Pringle, J.D. 1987. *The Shorebirds of Australia*. Angus & Robertson, Sydney.
- Recher, H.F., & S.S. Clark. (Eds) 1974. *Environmental Survey of Lord Howe Island. A Report to the Lord Howe Island Board*. Aust. Mus., Sydney.
- Ridgway, R. 1919. *Bull. US Natn. Mus.* 50(8): 1–852.
- Ripley, S.D. 1982. *A Synopsis of the Birds of India and Pakistan Together with those of Nepal, Bhutan, Bangladesh and Sri Lanka*. Second edn; Bombay Nat. Hist. Soc., Bombay.
- Robertson, C.J.R., & B.D. Bell. 1984. *ICBP Tech. Publ.* 2: 573–86.
- Schodde, R., et al. 1983. *Aust. Natn. Parks Wildl. Serv. Spec. Publ.* 8.
- Sibley, C.G., & B.L. Monroe. 1990. *Distribution and Taxonomy of the Birds of the World*. Yale Univ. Press, New Haven.
- , — 1993. *A Supplement to the Distribution and Taxonomy of the Birds of the World*. Yale Univ. Press, New Haven.
- Sibson, R.B. 1961. *Notornis* 9: 137.
- Smithers, C.N., & H.J. de S. Disney. 1969. *Aust. Zool.* 15: 127–40.
- Sorensen, J.H. 1964. *Notornis* 11: 69–81.
- Stokes, T., & C. Corben. 1985. *Corella* 85: 25–9.
- , et al. 1984. *Emu* 84: 23–8.
- , et al. 1987. *Aust. Bird Watcher* 12: 1–7.
- Stonehouse, B. 1962. *Ibis* 103b: 107–23.
- Tarburton, M.K. 1981. *Notornis* 28: 209–11.
- 1984. *Notornis* 31: 86–9.
- Thompson, M.C., & C.D. Hackman. 1968. *Notornis* 15: 109–17.
- Turner, J.S., et al. 1968. *Aust. Cons. Found. Spec. Publ.* 1.
- van Marle, J.G., & K.H. Voous. 1988. *BOU Checklist* 10.
- van Tets, G.F., & P.J. Fullagar. 1984. *ICBP Tech. Publ.* 2: 559–71.
- Vernon, D.P. 1973. *Sunbird* 4: 38–40.
- Wakelin, H. 1968. *Notornis* 15: 156–76.
- White, C.M.N., & M.D. Bruce. 1986. *BOU Checklist* 7.
- Williams, A.J. 1984. *ICBP Tech. Publ.* 2: 393–401.
- Wood, K.A. 1991. *Corella* 15: 93–102.

**Sponsors: A Bedford, Mr I & Mrs M Endersby, Mr D & Mrs N McDonald**



Nicolas Day  
1926

**Volume 3, Plate 45**

Common Noddy *Anous stolidus* (page 789)

1 Adult; 2 Downy young; 3 Juvenile, darkest (= typical) birds; 4 Juvenile, palest birds

Black Noddy *Anous minutus* (page 801)

5 Adult; 6 Downy young; 7 Juvenile

Lesser Noddy *Anous tenuirostris* (page 812)

8 Adult, typical bird; 9 Adult, with atypical head-pattern; 10 Downy young; 11 Juvenile, pale-capped bird, worn plumage; 12 Juvenile, dark-capped bird, fresh plumage

Grey Ternlet *Procelsterna cerulea* (page 818)

13 Adult; 14 Downy young; 15 Juvenile

White Tern *Gygis alba* (page 825)

16 Adult; 17 Downy young; 18 Juvenile



Nicolas Day  
1995

Volume 3, Plate 46

Common Noddy *Anous stolidus* (page 789)  
1, 2 Adult; 3 Juvenile, darkest (= typical) birds

Black Noddy *Anous minutus* (page 801)  
4, 5 Adult; 6 Juvenile

Lesser Noddy *Anous tenuirostris* (page 812)  
7, 8 Adult, typical bird

Grey Ternlet *Procelsterna cerulea* (page 818)  
9, 10 Adult

White Tern *Gygis alba* (page 825)  
11, 12 Adult; 13 Juvenile