

## Order CHARADRIIFORMES

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

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

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

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

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

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

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## 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 *Stiltia 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.

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## 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. albostrata* 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*, *albostrata*, *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. albigitta*); 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).

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*Sterna fuscata* Sooty Tern

COLOUR PLATE FACING PAGE 673

*Sterna fuscata* Linnaeus, 1766, *Syst. Nat.*, ed. 12 (1): 228 — Santo Domingo.Specific name from Latin *fuscatus*, dark (from *fuscare*, to darken).

OTHER ENGLISH NAMES Wideawake, Wideawake Tern, Egg-Bird, Whale Bird.

**POLYTYPIC** Subspecies *serrata* Wagler, 1830, breeds from w. and n. Aust. through s. Pacific, E to Easter I.; subspecies *nubilosa* Sparrman, 1788, breeds Red Sea, Persian Gulf and Indian Ocean, E to Greater Sunda Is (including Cocos-Keeling Is), Philippines and Ryu Kyu Is; subspecies *keradeci* (Mathews, 1916) breeds Kermadec Is. Four other extralimital subspecies: nominate *fuscata* breeds Caribbean and Atlantic; subspecies *oahuensis* Bloxham, 1826, breeds tropical n. Pacific, from Marcus I. to Christmas I.; subspecies *crissalis* (Lawrence, 1871 [1872]) breeds Pacific coast of Central America, S to Galapagos; subspecies *luctuosa* Philippi & Landbeck, 1866, breeds on islands off Chilean coast.

**FIELD IDENTIFICATION** Length 33–36 cm; wingspan 82–94; weight 170–285 g. Medium-sized tropical tern, with slender but rather heavy bill (slightly shorter than length of head); long pointed wings, with tip of longest tertial reaching to third or fourth primary on folded wing; deeply forked tail, with, in adult, elongate rectrices forming tail-streamers; and slender and rather long legs. Slightly larger than Bridled Tern *Sterna anaethetus* and larger than noddies *Anous*. Adult, strikingly black and white; juvenile, mostly dark brown. Sexes similar. Slight seasonal variation. Juvenile distinctive. Immatures separable.

**Adult breeding** Forehead and fore-supercilium, white, tapering to point above middle of eye. Crown, nape, hindneck, sides of head to just below and behind eye, and upper ear-coverts, black, forming neat cap; black loreal stripe extends from bill and joins black cap at eye, separating white forehead from white underparts. Rest of head and neck, white. Upperparts, upperwing-coverts and tail, grey-black, slightly paler on mantle, and contrasting with black cap, and with white sides to tail; outer rectrices, elongated, forming long tail-streamers. When plumage worn, may have narrow white collar between dark cap and mantle. Upperwing: remiges, black, contrasting slightly with grey-black coverts, and with narrow white leading-edge from body to just past carpal. Throat to breast, white; rest of underbody, pale grey, slightly darker on belly, lower flanks and undertail-coverts. Underwing: lining, white, with faint grey suffusion; remiges, dark grey, with paler silvery-grey bases. Bill, grey-black. Iris, dark brown. Legs and feet, black. **Adult non-breeding** Differs from adult breeding by: white streaks through black cap and hindcrown; more often has white hindneck-collar; mantle, scaled with light grey; lesser upperwing-coverts have faint grey fringes; tail-streamers, shorter and concolorous with rest of tail. **Juvenile** Dark brown, with white or buff spots above. Head, dark brown, darkest on cap and ear-coverts and slightly paler, light grey-brown on forehead, lores and throat; in very fresh plumage, cap faintly barred whitish buff. Mantle and scapulars, dark brown, with thin white, buff or cinnamon bars, spots or blotches and dark-brown barring; with wear, pale markings much reduced, leaving only a few pale spots. Back, rump and uppertail-coverts, dark brown with white, cream or light-brown barring. Tail, dark brown, with broad buff to white fringes, which are quickly lost with wear. Upperwing, dark brown, with white,

buff or cinnamon barring to coverts and indistinct white leading-edge to innerwing. Underparts, mostly grey-brown, with faint cream bars on sides of breast in fresh plumage; vent, white or off-white, speckled with light grey-brown; and undertail-coverts, light grey-brown to grey, with broad whitish-buff or light-brown streaks or bars. On some, lower belly white. Underwing: lining, white or pale grey, mottled light grey-brown; remiges, dark-grey with silvery sheen. Bill, shorter than in immatures or adults; at first, grey-black with dark-yellow or red tinge at base. Legs, black with red tinge. Rapidly darken to adult coloration. **First immature non-breeding** Very similar to juvenile, differing by: forehead, lores, and cheeks, mottled black-brown and grey; eye-patch, ear-coverts and nape, dark brown, often with brown extending along sides of neck to sides of upper chest; chin, throat and lower neck, pale grey, contrasting with dark-brown band on upper breast; underparts below breast-band, mottled brownish grey and white; vent, white. **Second immature non-breeding** Like first immature non-breeding, still with dark breast-band, but chin, throat and belly below breast-band, paler. **Older immatures** Like adult non-breeding but some distinguished by pale fringes to black feathers of upperparts and dark blotches to feathers of forehead and underparts.

**Similar species** Can be confused with **Bridled Tern**, which is: slightly smaller and more slender, with finer bill and slightly longer legs; in **ADULT PLUMAGES**, also differs by: (1) Pattern of head, with white restricted to narrow band on lower forehead (not whole forehead) and white supercilium extending well past eye (not ending above eye); black loreal stripe broader; (2) mantle, paler and grey, contrasting more with black cap (though, in bright light, Sooty Tern can show more contrast than usual); (3) underparts and underwing, darker and greyer, though, when worn, may appear paler below; and (4) best distinguished by underwing: underwing appears mostly white, with grey leading-edge to outer primary and broad dark-grey trailing-edge; bases of primaries, off-white, and extend well onto primaries, grading to grey at tips (on Sooty, underwing appears darker: primaries mostly dark grey, with only slightly paler silvery-grey bases; though, in strong light, bases can appear much paler, approaching pattern of Bridled Tern). **JUVENILE** Bridled typically much paler and distinctive, though darker birds close to coloration of Sooty Tern; Bridled usually have at least a hint of paler supercilium and throat; white belly



and contrasting grey sides to breast; and blackish bars and only slightly contrasting paler-grey fringes to feathers of upperparts and upperwing-coverts. Juvenile Sooty Tern could also be confused with noddies *Anous*, which are also mostly dark but differ by: smaller; lack pale spots above; do not have pale vent; usually have contrasting white caps; and, in close view, have white crescent below eye and white spot above eye; in flight, noddies have either wedge-shaped or rounded tails; some juvenile Common Noddies *A. stolidus* have dark caps, but always distinguished by wedge-shaped tail, with shallow notch in centre, and flight behaviour like that of Wedge-tailed Shearwater *Puffinus pacificus* (Sooty more aerial and more like typical tern). Black *A. minutus* and Lesser *A. tenuirostris* Noddies much smaller; Black always has contrasting white cap; Lesser usually much paler grey over body.

Gregarious; feed in mixed flocks, usually well out to sea, and only occasionally close to shore. Most often seen breeding on sandy tropical cays. In S, only likely to be seen from shore after bad storms. Apparently spend much time in flight at sea, rarely landing. Flight powerful, with strong deep wing-beats, and usually fly more directly than most *Sterna*; aerobatic, when wheeling, soaring, diving to surface of water and feeding from surface. On land, stance rather horizontal, with head held high. Walk well, but in a scurrying manner. Diagnostic call often interpreted as *wide-awake* or *ker-wacki-wack*; heard most often at colonies; alarm calls vary, including *krarrk* and extended *kreeaa*; only occasionally call at sea.

**HABITAT** Offshore and pelagic zones of tropical waters; almost never inshore unless forced there by bad weather (Noske 1974; Storr 1980, 1984a; Wood 1991; Brandis *et al.* 1992; HASB). During breeding season, frequent vegetated coral cays and offshore islands and stacks. Forage at sea, in offshore or pelagic zones (Noske 1974; Serventy & Whittell 1976; Langham 1986; Dunlop *et al.* 1988; Hulsman & Smith 1988), taking food from just below surface of water, occasionally diving through crests of waves (Hutton 1991; HASB). Rarely forage round islands: observed feeding in waters in lee of atoll (Gibson-Hill 1949); on Lord Howe I., occasionally feed aerially over canopy of forest during summer (Hutton 1991). During breeding season, roost or loaf at breeding colonies, on beaches of coral cays (Noske 1974; King *et al.* 1983c); on Kermadec Is, roost or loaf on bare rocky ledges and cliff-tops (Edgar *et al.* 1965) and on bare ground of thermal silica flats (G.A. Taylor). Rarely, loaf on water (HASB); just before sunset one seen sitting on buoy, 80 km S of Kermadec Is (G.A. Taylor).

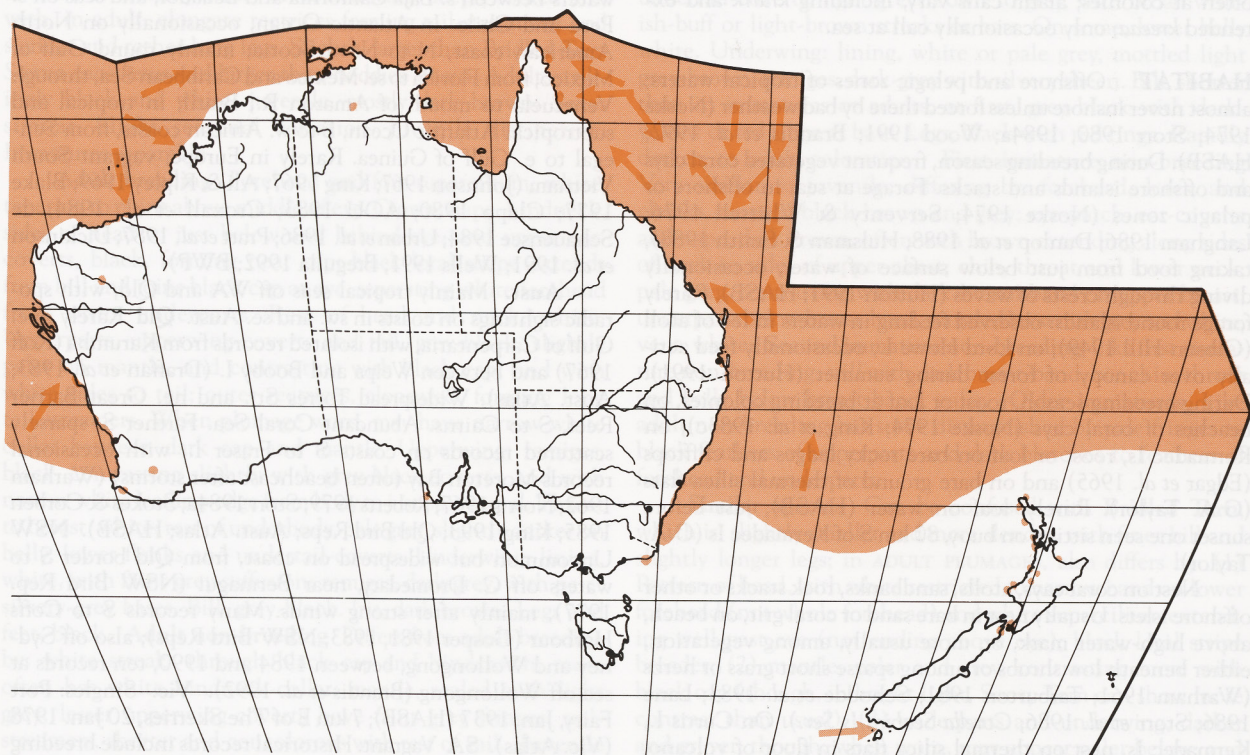
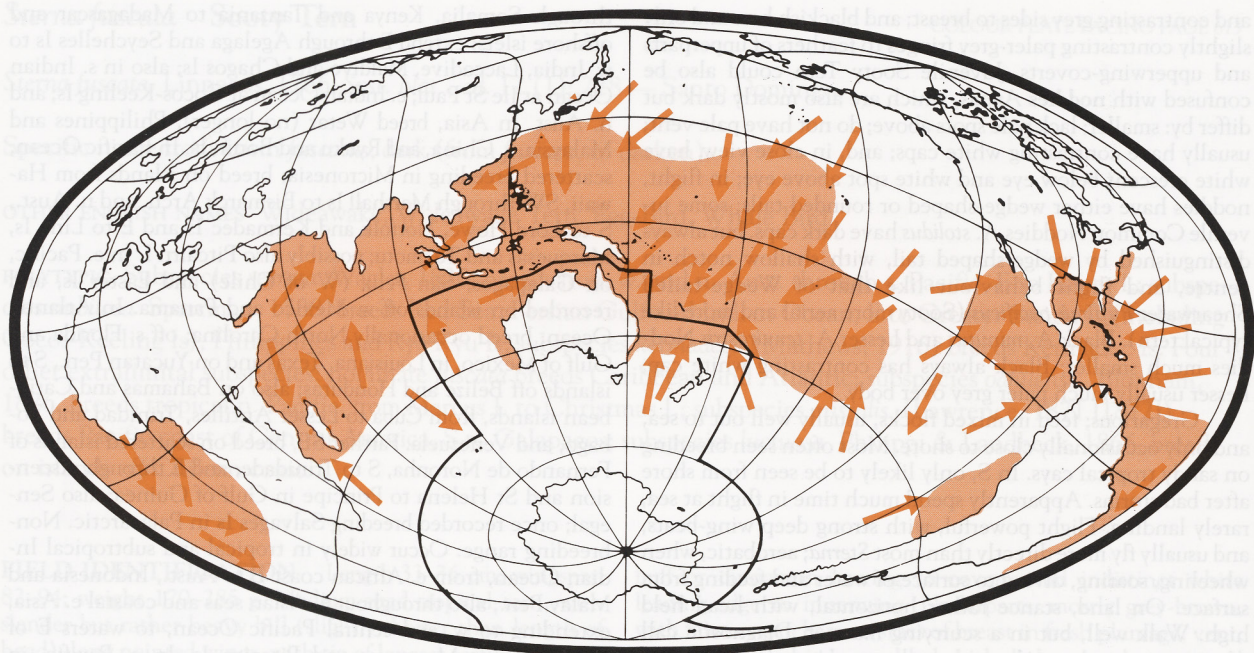
Nest on coral cays, atolls, sandbanks, rock stacks or other offshore islets. Usually nest in bare sand or coral grit, on beach, above high-water mark, or, more usually, among vegetation, either beneath low shrubs or among sparse short grass or herbs (Warham 1961; Tarburton 1981; Schodde *et al.* 1983; Lane 1986; Storr *et al.* 1986; *Corella Seabird Is Ser.*). On Curtis I., Kermadec Is, nest on thermal silica flats in floor of volcano, where ground warm or hot (G.A. Taylor). Prefer open vegetation with areas of exposed sand, rather than denser vegetation (Hindwood *et al.* 1963; Edgar *et al.* 1965). On stacks, especially round Norfolk and Lord Howe Is, nest on ledges or terraces of cliffs, with or without vegetation; avoid sheer cliff-faces (McKean 1963; Wakelin 1968; Brown 1979; Tarburton 1981).

**DISTRIBUTION AND POPULATION** Breed tropical and subtropical regions of Indian, Pacific and Atlantic Oceans. In w. Indian Ocean, at scattered sites from Arabian Pen., S

through Somalia, Kenya and Tanzania to Madagascar and offshore islets; extend E through Agelaga and Seychelles Is to w. India, Laccadive, Maldives and Chagos Is; also in s. Indian Ocean at Ile St Paul; e. Indian Ocean at Cocos-Keeling Is; and n. Aust. In Asia, breed Wetar (no longer), Philippines and Malaysia, s. China, and Ryuku and Bonin Is. In Pacific Ocean, scattered breeding in Micronesia; breed on islands from Hawaii, SW through Marshall Is to Bismarck Arch. and n. Aust., S to Lord Howe, Norfolk and Kermadec Is and E to Line Is, Marquesas and Tuamotu; possibly also Pitcairn I. In e. Pacific, on Galapagos, San Felix (W of Chile) and Easter Is, and recorded on islands off w. Mexico and Panama. In Atlantic Ocean, breed occasionally North Carolina; off s. Florida and Gulf of Mexico, in Louisiana, Texas and on Yucatan Pen., S to islands off Belize and Honduras; also on Bahamas and Caribbean islands, from Cuba to Lesser Antilles, Trinidad and Tobago, and Venezuela. Farther SE, breed on scattered islands of Fernando de Noronha, S to Trinidad, and E through Ascension and St Helena to Principe in Gulf of Guinea; also Senegal; once recorded breeding Salvages Is in Palaeartic. Non-breeding range: Occur widely in tropical and subtropical Indian Ocean, from e. African coast E to Aust., Indonesia and Malay Pen.; also throughout e. Asian seas and coastal e. Asia, extending to w. and central Pacific Ocean, to waters E of Hawaii, Line, Marquesas and Pitcairn Is. In e. Pacific, in waters between s. Baja California and Ecuador, and seas off s. Peru and Chile. In Atlantic Ocean, occasionally on North American coast, N to Nova Scotia; mainly round Gulf of Mexico, from Florida to se. Mexico and Caribbean Sea, through Venezuela to mouth of Amazon R., Brazil; in tropical and subtropical Atlantic Ocean, E to w. African coasts, from Senegal to e. Gulf of Guinea. Rarely in Europe; vagrant South Vietnam (Johnson 1967; King 1967; Ali & Ripley 1969; Blake 1977; Clapp 1980; AOU 1983; Croxall *et al.* 1984; de Schauensee 1984; Urban *et al.* 1986; Pratt *et al.* 1987; Dickinson *et al.* 1991; Wells 1991; Bregulla 1992; BWP).

**Aust.** Mainly tropical seas off WA and Qld, with sporadic sightings on coasts in sw. and se. Aust. **Qld** Rarely in e. Gulf of Carpentaria, with isolated records from Karumba (Roff 1967) and between Weipa and Booby I. (Draffan *et al.* 1983; Aust. Atlas). Widespread Torres Str. and ne. Great Barrier Reef, S to Cairns. Abundant Coral Sea. Farther S, sparsely scattered records on coasts S to Fraser I., with occasional records Moreton Bay (often beachcast after storms) (Warham 1962; Norris 1967; Roberts 1979; Storr 1984a; Stokes & Corben 1985; King 1993; Qld Bird Reps; Aust. Atlas; HASB). **NSW** Uncommon but widespread on coast, from Qld border S to waters off C. Dromedary, near Bermagui (NSW Bird Rep. 1977), mainly after strong winds. Many records S to Coffs Harbour (Gosper 1981, 1983; NSW Bird Reps); also off Sydney and Wollongong; between 1984 and 1990, ten records at sea off Wollongong (Brandis *et al.* 1992). **Vic.** Singles: Port Fairy, Jan. 1937 (HASB); 7 km E of The Skerries, 20 Jan. 1978 (Vic. Atlas). **SA** Vagrant. Historical records include breeding on Kingscote Spit, Kangaroo I., Oct. 1884 (Parker 1980); single among Crested Terns *S. bergii*, Baudin Rocks, 26 Nov. 1906 (Campbell 1907); single, specimen, Brighton, 28 Mar. 1937 (Sutton 1937); single, Christmas Cove, near Penneshaw, Kangaroo I., late Mar. to early Apr. 1937 (Rix 1938). More recently, singles recorded Brothers I., Coffin Bay, Eyre Pen., 22 Dec. 1972, 8 Dec. 1974, 20 Dec. 1975, 1 Dec. 1976, Dec. 1978 (Gill 1973; SA Bird Reps 1974, 1975, 1976, 1977–81). **WA** In SW, occasional records Swan R. district and elsewhere S to Manjimup; sometimes inland after gales, e.g. Moulyinning





(Serventy 1948; Storr & Johnstone 1988). Regularly recorded from Fisherman Is and round Houtman Abrolhos N to North West C. (where breed). Scarce n. Pilbara; widespread at sea off w. and n. Kimberley Div., especially round Ashmore Reef, though rare on coasts (Storr 1980, 1984b; Dunlop *et al.* 1988; Johnstone *et al.* in press; Aust. Atlas). Single recorded inland at Paraburdoo, 25 Feb. 1975, after Cyclone Trixie passed along nw. coast (Storr 1984b). NT Rare round Darwin (e.g. Lendon 1966; McKean & Gray 1973; Storr 1977; H.A.F. Thompson &

D.K. Goodfellow); no records Aust. Atlas. Single recovered Edith R., about 230 km SE of Darwin, 13 Jan. 1974 (ABBBS 1975). Many records off e. Arnhem Land to n. Gulf of Carpentaria (Blaber & Milton 1994; Aust. Atlas). Lavery (1964) reported the species from Sir Edward Pellew Is but subsequent surveys have recorded only Bridled Terns (McKean & Gray 1973; Schodde 1976), though Sooty Terns recorded at sea to the E (Aust. Atlas).

NZ Uncommon visitor; most reports beachcast birds.



**NI** From 1964 to 1993, all 38 beachcast birds recorded in NZ Beach Patrol Scheme from NI: 23 in Auckland West; three in Taranaki; nine in Wellington West; and three in Auckland East. Mostly recorded after storms and rough weather. Other records: mainly w. coast, from Tom Bowling Bay (Edgar *et al.* 1971) S to Wellington Harbour (CSN 22); single recovered Tauranga, Bay of Plenty, Feb. 1936 after storm (Edgar 1978; Oliver). **SI** Four, Tory Channel–Queen Charlotte Sound, 27 Feb. 1968 (CSN 22); single (dead), Waikawa, 18 Feb. 1979 (CSN 26); single (dead), Centre I., Foveaux Str., Sept. 1986 (Cooper 1991).

**Lord Howe I., Norfolk I., Kermadec Is** Breeding visitor.

**Christmas I.** Single, specimen, undated (Stokes *et al.* 1987).

**Cocos-Keeling Is** Breeding visitor (Stokes *et al.* 1984).

**Breeding Qld** Islands in Torres Str. and cays in n. Great Barrier Reef; only two breeding records from s. Great Barrier Reef (King 1993). Bramble Cay, 20,000 pairs, 1979 (Elvish & Walker 1991); islet near Darnley I. (HASB); Murray I. Sandbank (King 1993); MacLennan Cay, 1000 nests, 1980 (King *et al.* 1983a); Pandora Cay, up to 1200 nests, 1982 (King *et al.* 1983b); Raine I., up to 600 birds, 1985 (King 1986); Sandbank No. 8, between 1000 and >10,000 nests (King *et al.* 1983c); Sandbank No. 7 (King 1993); Davie Cay, >5000 nests (King & Buckley 1985a); Tydeman Cay, 50 nests, 1981 (King & Buckley 1985b); Stapleton I., up to 5000 birds, 1980 (King 1985a); Combe I., large colony (King *et al.* 1985); Low Isles (Kikkawa 1976); Michaelmas Cay, >10,000 pairs, 1982 (King 1985b); Upolu Bay (HASB); Bell Cay, three unfledged young (Walker & Jones 1986b); One Tree I., one pair, 1974–75 (Hulsman 1979). Also widespread on cays in Coral Sea: Willis Is (Mid or Bird Isl.); Coringa Grp (Chilcott I.; South West Isl.); Herald Cay (South West Cay); Lihou Reef (No. 1 Cay; No. 8 Cay; Turtle Isl.); Mellish Reef (Herald's Beacon Isl.); Diamond Is (West, East, and South East Isl.); Marion Reef (Paget Cay); Kenn Reef (Observatory Cay; South West Projection Cay); Wreck Reef (Bird Isl.); Cato I. (HASB). Possibly breed Frigate Cay (Walker & Jones 1986a). **SA** Historical record from Kangaroo I., Oct. 1884 (Parker 1980). **WA** Ashmore Reef (incl. East Isl.), 10,000–50,000 pairs, 1983–88 (Fuller *et al.* 1994; Aust. Atlas); Lacedpede Is (East and Middle Is) (Storr 1980); Bedout I., not recorded since 1901 (Fuller *et al.* 1994); Houtman Abrolhos, 260,320 pairs: Easter Grp (Alexander I., c. 50,000 pairs; Kern I., 2000–3000 pairs; Leo I., c. 20 pairs; Little North I., c. 200 pairs; Morley I.; Stokes I., 1000–1500 pairs; Suomi I., 3000–5000 pairs; White I., 5000–6000 pairs; Wooded I., c. 500 pairs [Johnstone 1992; Fuller *et al.* 1994]); Pelsaert Grp (Pelsaert I., 246,000 nests, 1991; Jon Jim Isl. [Storr *et al.* 1986; Fuller & Burbidge 1992; Fuller *et al.* 1994]). Possibly breed Serventy and Campbell Is (Storr *et al.* 1986).

**Lord Howe I.** Up to 1,000,000 breeding pairs (Fullagar *et al.* 1974); breed on main island and off-lying islets, including Admiralty Isl., Muttonbird I., Ball's Pyramid (>1000 pairs; Brown 1979) and Roach Isl. (McKean & Hindwood 1965; Hutton 1991).

**Norfolk I.** Nest on nearby islets: Philip I., 40,000–70,000 pairs; Nepean I., several hundred pairs; Bird Rock and other adjacent stacks (Tarburton 1981). Possibly also on mainland (Wakelin 1968).

**Cocos-Keeling Is** North Keeling I., 30–40 nests, 1983 (Stokes *et al.* 1984).

**Kermadec Is** Raoul I., in 1966–67 two colonies, with c. 40,000 pairs in each; in 1993, colony just a few thousand pairs

(C.R. Vietch); Curtis I., 5500 pairs; Macauley I., 10,000 pairs; Herald Isl., including North Meyer Isl., c. 2000 breeding birds; South Meyer Isl., >4000 birds; Dayrell Isl., c. 3000 birds (Merton 1970; Taylor 1979; Tennyson & Taylor 1989; Tennyson *et al.* 1989).

**Populations** Estimates of colony sizes given above; no other estimates. Colony at Denham Bay, Raoul I., Kermadec Is, being destroyed by predation of adults, chicks and eggs by feral cats, Brown Rats *Rattus norvegicus* and Kiore *R. exulans*; in 1966–67, >20% of eggs in this colony eaten by rats (Edgar *et al.* 1965; Merton 1970; Taylor 1979). On Macauley I., Kermadec Is, after removal of goats in 1970, colony increased from small numbers in 1966–70 to 10,000 pairs in 1988; Brown Rats and Kiore still eat eggs (B.D. Bell; G.A. Taylor). Human predation of eggs widespread. On Norfolk I., eggs legally collected (Hermes 1985; Hermes *et al.* 1986) from 1 Oct. to 30 Nov. (Wakelin 1968). In 1908, between 10,000 and 15,000 eggs harvested several times a week from Nepean I., off Norfolk I. (Bassett Hull 1909) and numbers thought to have declined greatly, with only several hundred pairs now breeding there (Tarburton 1981). On Lord Howe I., collecting of eggs stopped by early 1980s (Hutton 1991). Wholesale egg-gathering on Rat I. blamed for desertion of colony in 1938 (Storr *et al.* 1986). Eggs also collected on North Keeling I., where formerly plentiful (Gibson-Hill 1950; Stokes *et al.* 1984). Human predation also occurs on Bramble Cay, Torres Str. (Druffan *et al.* 1983; Walker 1988). On Lord Howe I., after removal of pigs from Scab Pt in 1979, numbers of Terns nesting have increased (Hutton 1991).

**MOVEMENTS** Vary; dispersive to migratory; strongly pelagic outside breeding season. Movements in HANZAB area poorly known; complex and varied breeding cycles means origins of birds seen away from breeding grounds impossible to interpret without band recoveries. Six subspecies, three occurring and breeding in HANZAB region: (1) subspecies *nubilosa* breeds Red Sea, Persian Gulf and Indian Ocean E to Greater Sunda Is (including Cocos-Keeling Is), Philippines and Ryu Kyu Is. Arabian Sea and Seychelle Is birds apparently move to non-breeding areas S of Equator, with one young bird recovered Aust.; Cocos-Keeling population apparently move elsewhere outside breeding period; (2) subspecies *serrata* breeds w. and n. Aust., through s. Pacific, E to Easter I.; non-breeding range not known. Aust. birds move away from most colonies outside breeding season, and at least some move long distances; Aust. birds recorded extraliminally from mid-Pacific and Philippines; possibly occur in small numbers in Wallacea; (3) subspecies *kermadeci* breeds Kermadec Is, moving from breeding areas to unknown non-breeding areas (Gibson-Hill 1950; Robertson 1969; Clancey 1977; White & Bruce 1986; see BWP; see Banding).

Unusual numbers recorded in some areas after bad weather, and wrecks of Terns sometimes occur. Gales in Nov. 1946 followed by records in WA up to 100 km inland; single recorded over 250 km from coast in Pilbara, WA, after cyclone. Some s. records and some mainland records from Aust. and NZ during or after storms (Goddard & Hindwood 1951; Sefton 1958; Gibson & Sefton 1962; Lane 1967; Robertson 1972; McKean & Gray 1973; Noske 1974; Habraken 1982; Gosper 1983; Storr 1984b; NSW Bird Rep. 1989, 1991; Qld Bird Rep. 1990; Aust. Atlas). Exhausted bird recorded landing on ship (Druffan *et al.* 1983); ship-assisted movement also recorded (Jenkins 1962).

**Departure** **SUBSPECIES NUBILOSA:** Populations breeding



Seychelle Is recorded in non-breeding areas (5–20°S) from Oct. Young disperse widely, with banded first-year bird last seen Seychelle Is on 29 Sept. 1973, recovered 8800 km E at Darwin, c. 3.5 months later (ABBBS 1975; Feare 1976; see Banding). In 1941, most had left Cocos-Keeling Is, Feb. and early Mar. (Gibson-Hill 1950). **SUBSPECIES SERRATA:** (1) In Tasman Sea, regularly move away from breeding areas. On Lord Howe I., adults and young leave Feb. and Mar., sometimes as late as first week Apr. (Hindwood 1940; North). On Norfolk I., 1979–85, left Apr. in most years, with laggards present till late May (Hermes 1985; Hermes *et al.* 1986). Banding indicates juveniles move considerable distances within a few months of leaving colony and that at least some adults move thousands of kilometres from natal colonies (see Banding). Adults and young recorded in NSW waters well S of breeding range (Aust. Atlas); recorded off Wollongong, NSW, till Mar. (Brandis *et al.* 1992). (2) On islands of Great Barrier Reef patterns of movements vary. Appear to leave some islands; in 1921 left Willis I. in Dec. (Davis 1923b), though recorded as numerous in late Dec. (Hogan 1925). Breeding failure or disturbance sometimes results in departure from breeding areas, e.g. left Bramble Cay in early Jan. after eggs raided late Nov. (Elvish & Walker 1991). Adults possibly accompany juveniles away from breeding grounds; an adult recorded with juvenile 850 km ENE from nearest breeding colony (Wood 1991). (3) Off w. Aust., common Houtman Abrolhos till early May (Storr *et al.* 1986), though some leave earlier (Serventy & Whittell 1976). Recorded S of breeding grounds on w. coast, though possibly birds forced S by storms in summer and autumn; all SA records are from summer and possibly also storm-driven from WA (Serventy & Whittell 1976; Storr & Johnstone 1988; Johnstone *et al.* in press; HASB). **SUBSPECIES KERMADECI:** On Kermadec Is, said to be present till end Dec. or mid-Jan. (Cheeseman 1890); more recent records indicate later departure. In 1908, adults began to leave Raoul I., mid-Mar., with all young gone by end Apr.; breeding grounds usually almost deserted by end Apr. (Iredale 1910; Sorensen 1964; Falla *et al.* 1981).

**Non-breeding** Range not known, small parties observed far from land (Hindwood 1964; Hermes 1985). **SUBSPECIES NUBILOSA:** Mostly absent from Cocos-Keeling outside breeding season, though small numbers sometimes recorded North Keeling I. (Gibson-Hill 1950; Stokes *et al.* 1984). **SUBSPECIES SERRATA:** Mostly absent from colonies during non-breeding season. Absence from breeding localities varies from several weeks to several months. Recorded on some breeding islands outside breeding season occasionally (e.g. Lord Howe I., McKean & Hindwood 1965; Fullagar *et al.* 1974) or regularly (e.g. Raine I., King 1986); numbers occurring can vary greatly (e.g. King *et al.* 1983c). At Willis I., Great Barrier Reef, birds absent during daylight in Dec.–Feb. (non-breeding), though in some seasons said to roost on and hover over island at night during this period (Hogan 1925). **SUBSPECIES KERMADECI:** Absent. Not recorded Raoul I. from mid-May till end July or Aug. (Iredale 1910; Oliver). Non-breeding areas not known, though Terns, possibly this subspecies, recorded NZ in summer, autumn and winter, particularly after n. winds (see Distribution).

**Return** In HANZAB region, arrive at breeding islands at night and, at first, only visit at night (Warham 1961); later, also in daylight (e.g. Elvish & Walker 1991). **SUBSPECIES NUBILOSA:** Present non-breeding areas in Indian Ocean till May (Feare 1976). In 1941, near Cocos-Keeling Is, from mid-Sept. (Gibson-Hill 1950). **SUBSPECIES SERRATA:** Recorded cir-

cling above colonies weeks before nesting begins (e.g. Reithmüller 1931). In Tasman Sea: Arrive Lord Howe I., late July or Aug. (Hindwood 1940). On Norfolk I., 1979–85, heard over island at night from late Aug.; descend on nesting islands and occasionally land during daylight from mid-Sept. (Hermes *et al.* 1986). Up to hundreds of birds per day recorded early Oct. 1985 on voyage in n. Tasman Sea (D.W. Eades). In Great Barrier Reef: recorded flying over Raine I., Feb. (nesting recorded from Apr.) (Warham 1977); on One Tree I., arrive at night in late Aug. or early Sept. (some breed in summer) (Hulsman 1979); on Willis I., arrive Feb. or Mar., at least in years when laying recorded (beginning Apr.); seen on island in daylight by Mar. (Davis 1923a,b; Hogan 1925). Off w. Aust., common Houtman Abrolhos, from late Aug. (Storr *et al.* 1986). **SUBSPECIES KERMADECI:** Arrive Raoul I., Aug. (Sorensen 1964); in 1908, began to arrive and roost at night in Aug.; first seen near island in daylight in Sept.; circled above island through Oct.; first settled on island during daylight late Oct.; eggs Nov. (Iredale 1910). On Curtis I., thousands of birds ashore by day in mid-Oct., with laying beginning by this time (G.A. Taylor).

**Breeding** Pattern varies greatly. **SUBSPECIES SERRATA:** Breed annually on some islands of Great Barrier Reef (see King 1993) and in Tasman Sea (e.g. Norfolk I., King *et al.* 1992). In some areas breeding irregular, occurring in some years but not in others (e.g. at Raine I., King 1986). Size of colonies can vary between years (e.g. Sandbank No. 8, Pelsaert I.; King *et al.* 1983c; Fuller & Burbidge 1992). In some areas, breed in different colonies within an area (e.g. round Oyster Cay, n. Qld; Alexander 1926). At other colonies, breeding aseasonal and population breeds more than once in a year (e.g. Michaelmas Cay) with periodicity of breeding and peaks in numbers breeding affected by cyclones (King *et al.* 1992). In some areas breed throughout year (e.g. at Michaelmas Cay; King 1985b). **SUBSPECIES KERMADECI:** Recorded moving away from colonies to sea during bad weather, returning after weather improves (Iredale 1910). Recorded as far as 400 km SW of Macauley I., during breeding period (R.P. Scofield; G.A. Taylor; A.J.D. Tennyson).

**Banding** Birds banded Lord Howe I. recovered e. Aust., as far N as C. York Pen. (c. 2800 km NNW) and in Philippines (c. 5800 km NW) (see Recoveries below), and said to have been sighted in mid-Pacific (Hutton 1991); three nestlings banded Lord Howe I. recovered 640–780 km W on e. coast Aust., within 4 months of banding (Lane 1967; see Recoveries). Extraliminally, high fidelity to natal colony (Robertson 1969). Some recoveries of subspecies *serrata* also suggest high fidelity to natal site, e.g. nestling banded near Lord Howe I. recovered near banding place nearly 11 years later (ABBBS 1974). Age of first breeding not determined for HANZAB area; 6-year-old (nestling banded Lord Howe I., Nov. 1962, recovered off C. York Pen., 21 Nov. 1968 [Draffan *et al.* 1983]) recovered away from natal breeding colony in month when breeding occurred there. For notes on navigational ability, see Watson (1910). Over 3000 chicks banded on Kermadec Is, none recovered elsewhere (Merton 1970). Said to be three recoveries of subspecies *oahuensis* from Aust. (Clapp 1980) but not confirmed in ABBBS.

#### Recoveries

31S159E	11	P	U	51	5900	316	ABBBS
31S159E	11	P	U	192	2847	317	ABBBS
31S159E	11	P	U	1	791	311	ABBBS
31S159E	11	P	U	1	709	309	ABBBS
31S159E	11	P	U	3	663	257	ABBBS



**FOOD** Carnivorous. Cephalopods, hydrozoans, crustaceans and fish. **Behaviour** Diurnal and nocturnal. Nocturnal foraging suggested by presence of vertically migratory species in diet (McKean & Hindwood 1965; Mörzer Bruyns & Voous 1965; Hutton 1991) and because birds heard flying at night (Gould 1974). Pelagic, rarely feeding within sight of land (Ashmole 1963a). Believed to be obligate commensal foragers with large migratory tuna (Scombridae) during non-breeding season (e.g. Ashmole & Ashmole 1967; Gould 1974; Ainley *et al.* 1986; Au & Pitman 1986; Flint 1991); tuna drive prey to surface, which then taken by birds (N.G. Cheshire); appear to be entirely reliant on smaller species of tuna feeding near islands in breeding season to ensure breeding success (Flint 1991). Most observations at sea of single birds, though greatest biomass in large flocks (Gould 1974). Mostly feed by **DIPPING**: gleaning food from or just below surface of water; comprised 91% of observations in Pacific Ocean (Ashmole & Ashmole 1967; Gould 1974; Ainley & Boekelheide 1983; Hutton 1991; HASB); may use feet to help prevent submersion (not analogous to pattering of storm-petrels Hydrobatidae) (Ashmole & Ashmole 1967). Some records of **PLUNGING** in mixed flocks of boobies *Sula* and noddies *Anous* (Dorward 1962; Ashmole 1963a; Ashmole & Ashmole 1967; Gould 1974; Harrison *et al.* 1983), though rarely immerse fully because plumage becomes waterlogged when wet (Johnston 1979; Harrison *et al.* 1983). **AERIAL PURSUIT**: in Pacific Ocean, 9% of observations were of aerial pursuit (Ainley & Boekelheide 1983); may also catch some fish as they leap from water (Watson & Lashley 1915). **HAWKING**: On Lord Howe I., recorded hawking for cicadas over forest in summer (Hutton 1991). In Hawaiian Is, mean length of prey 69 mm (Brown 1975); on Christmas I. (Pac.) 85% of fish and most squid, 2–8 cm long (Ashmole & Ashmole 1967). Size of prey taken related to width of gape (Hulsman 1981). Estimated maximum foraging radius, calculated using time away from nest, is 290 km for brooding birds and 522 km for birds feeding older chicks (Flint 1991). Most studies of diet from breeding grounds and combine regurgitations of adults and young.

**Adult** No detailed studies in HANZAB region. On Lord Howe I. (regurgitations; McKean & Hindwood 1965): Molluscs: cephalopods 70% no.; Crustaceans: shrimps: Sergestidae: *Sergestes*; Fish: Exocoetidae *Cypselurus*; Atherinidae *Hypoatherina*; Myctophidae; Mugilidae *Mugil*. **Other records** Cnidarians: hydrozoans: Velellidae: *Velella* (R.P. Scofield); Molluscs: cephalopods: Spirulidae: *Spirula* (Oliver; Hutton 1991); squid (Alexander 1926; Hutton 1991; Oliver); Crustaceans: crabs (Cleland 1911); Insects: Hemiptera: Cicadidae; Fish. Plastic (Hutton 1991).

**Extraliminally** Detailed studies on Christmas I. (Pac.) (Ashmole & Ashmole 1967), nw. Hawaiian Is (Harrison *et al.* 1983) and Ascension I. (Ashmole 1963a). Major food items were: molluscs 39.9% no. on Christmas I. (Pac.), 32.6% no. on nw. Hawaiian Is; crustaceans 0.1, 2.6; fish 60, 64.8. Other extralimital records in Watson (1908), Watson & Lashley (1915), Ridley & Percy (1958), Mörzer Bruyns & Voous (1965) and Murphy.

**Young** See above. At colonies, aerial feeding of fledged young reported (Feare 1976). Proportions of major food items vary markedly from site to site.

**Intake** No studies in HANZAB region. Extraliminally: on Tern I., Hawaiian Is, mean weight of food-load (weight of regurgitations of incubating adults that had recently returned from sea) 14.7 g (10.5; 94), which is 8% average adult weight (Flint 1991); on nw. Hawaiian Is, mean volume of

regurgitations, 10.4 ml, containing average 4.5 items, with mean length 48 mm (1–120) (Harrison *et al.* 1983). On Christmas I. (Pac.), mean volume of three largest regurgitations 48 ml, which is 28% average adult weight (Ashmole & Ashmole 1967). Field Metabolic Rate calculated to be 5.8 kJ/h while sitting and 17.2 kJ/h while flying (Flint & Nagy 1984).

**SOCIAL ORGANIZATION** Little known in HANZAB region; better known extraliminally (e.g. Ashmole 1963a; Harrington 1974). Gregarious, though sometimes seen singly (e.g. Gibson-Hill 1950; Johnstone & Hooper 1973; NSW Bird Rep. 1973, 1975; North). On arrival at breeding grounds, first visit only at night; only later seen during day, up to several weeks after arrival. Then, during late afternoon, large flocks fly over breeding sites 90–120 m above ground; flights continue day after day till flocks begin to land in or near potential nesting area; nesting may not begin for another month (e.g. Iredale 1910; Davis 1923a; Hogan 1925; Reithmüller 1931; Hermes *et al.* 1986; Hutton 1991; HASB). On Curtis I., begin roosting at nesting site only 2–4 days before laying (G.A. Taylor & A.J.D. Tennyson). On Willis I., on one moonlit night before breeding, dense masses of birds covered large areas of sand and many more flew overhead (Hogan 1925). Other records of flock-sizes (gathering or roosting on land, usually not yet breeding): 1000+, MacLennan Cay (King *et al.* 1983a); 1000s, Sandbank No. 8 (King *et al.* 1983c); 300–400, Kermadec Is (Edgar *et al.* 1965); 20,000–30,000 breeding or roosting, Pelsaert I. (Serventy 1943a). During breeding season on Lord Howe I., scattered groups of 4–5 (sometimes single birds) seen flying throughout day near breeding colonies (North); flocks of about six birds in June–July (McKean & Hindwood 1965). Off NSW, generally seen in groups of 2–6+ (Brandis *et al.* 1992; NSW Bird Rep. 1974); off nw. Aust., flock of 10+ seen (Pocklington 1967). At sea, congregate in small to large flocks to feed (Alexander 1926; Noske 1974; HASB). Often feed offshore with other seabirds (Noske 1974; Stahl & Bartle 1991); extraliminally, usually feed in mixed species flocks in association with tuna (see Food). Sometimes roost with other species of terns (Officer 1976; Habraken 1982).

**Bonds** Monogamous (Urban *et al.* 1986). Age of first breeding in HANZAB region, unknown; for extralimital observations see Harrington (1974). **Parental care** Both parents incubate (Lawry 1926; HASB); said that only female feeds young (Lawry 1926) but this seems unlikely. Young can form large crèches and move round colony and nearby beaches (HASB). During day young can pack together in shady areas (Hogan 1925). On Michaelmas Cay, hundreds of immatures observed in groups on beach, while adults rested on inner, vegetated parts of cay (Noske 1974). Parents feed young for some time after fledging (Hutton 1991). Young said to stay in colony till up to 70 days old (NZRD). Adults and juveniles observed together at sea, which suggests that adults care for young after young have left colony (Wood 1991); observations include: two adults flying with juvenile (Gosper 1983); an adult and juvenile together (Wood 1991); and groups of adults and juveniles, almost always twos, with young bird following adult closely, both calling back and forth using calls typical of adult and chick trying to locate one another at colony (Ainley *et al.* 1986).

**Breeding dispersion** Colonies conspicuous, with nests densely packed (Dunlop & Jenkins 1992). Sometimes nest with other seabirds (see Breeding). Sizes of colonies can vary from year to year (Fuller & Burbidge 1992; Fuller *et al.* 1994), and can be very large (see Distribution). In crowded colonies,



nests often c. 50 cm apart (rim to rim) (HASB). On Pelsaert I., WA, c. 233,000 nests in 16.18 ha in one year and c. 246,000 nests in 17.08 ha in another (Fuller & Burbidge 1992; Fuller *et al.* 1994); nests densely packed, with barely pecking distance between most birds (Lane 1986); nests often <1 m apart (Garstone 1978). On Willis I., 131 nests in 83.5 m<sup>2</sup> (Serventy 1959); six birds or more to every 0.8 m<sup>2</sup> within colony (Reithmüller 1931); lay 'within a few inches' of each other (Lawry 1926). On Lord Howe I. and Admiralty Isl. said that nests often so close together that one has to proceed with caution to avoid treading on contents (Basset-Hull 1909; Hindwood 1940; Hutton 1991; North); average 0.6 to 0.9 m apart, though many much closer (North). Breeding colony made up of a number of flocks that arrive at different times (Serventy 1959). Within large colonies, compact assemblages, each of several hundred birds, appeared to behave as distinct breeding groups (Hindwood *et al.* 1963); Davis (1923a) mentioned that Terns settled in companies of c. 100 when nesting. **Territories** On Roach Isl., Lord Howe I., territory size estimated c. 0.8 m<sup>2</sup> (Hindwood 1940).

**Roosting** Some feeding occurs at night (see Food). Large flocks recorded roosting night and day (see above). At breeding islands, birds often continuously flying and calling overhead from late afternoon till shortly before dawn (e.g. MacGillivray 1917; Davis 1923a; Hogan 1925; Lawry 1926; Serventy 1959; Warham 1961; Serventy & Whittell 1976; Elvish & Walker 1991; G.A. Taylor & A.J.D. Tennyson); before nesting, birds may not land (MacGillivray 1917) or may roost in large numbers (Iredale 1910; Davis 1923a; Hogan 1925) then fly away just before sunrise (Iredale 1910); non-incubating adult said to fly nearly all night, with pair calling to each other. As nesting nears, flocks seen landing on beaches during day (Lawry 1926). Said that most birds left for fishing grounds c. 06:00 (Serventy 1959). Later in season, Hogan (1925) saw flocks, which included almost fledged young, resting during day. Believed to sleep on wing and rarely to land on water (Urban *et al.* 1986; HASB); unable to rest on water for more than a few hours without becoming waterlogged (Hindwood 1940). Young shelter from sun under bushes, tufts of grass, or any shade, and a number can pack close together when doing so (Hogan 1925).

**SOCIAL BEHAVIOUR** Little known in HANZAB region; better known extraliminally (e.g. Ashmole 1963a; Dinsore 1972; Feare 1976; Harrington 1974). **Flock behaviour** Few details in HANZAB region (see Social Organization). On Curtis I., Kermadec Is, laying in sub-colonies highly synchronized (G.A. Taylor & A.J.D. Tennyson). Extraliminally, synchronous laying facilitated by mass display behaviour, often at pre-breeding clubs away from nesting areas (Ashmole 1963a). **Comfort behaviour** Commonly seen scratching head with feet, ruffling plumage and pecking at toes while in flight (Warham 1956).

**Agonistic behaviour** Use threat calls against trespassing conspecifics (Warham 1956). Select nest-site with much squabbling (Davis 1923a; Lane 1986), see below. On Kermadec Is, nesting adults said to kill wandering chicks (Merton 1970). **Alarm** Become agitated when disturbed, even in absence of eggs or fledgelings (Hindwood *et al.* 1963).

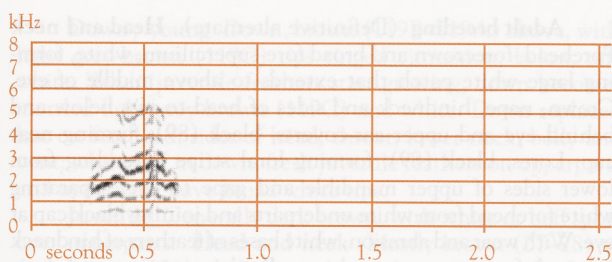
**Sexual behaviour** Breeding cycle not always annual. Observations only from breeding sites. Courtship behaviour includes two birds performing conspicuous high-speed synchronized zigzag flights over colony, interspersed with slow wing-beats; during display, birds call (Warham 1956, 1961;

Hutton 1991; HASB); rise on air currents in nuptial flights, chasing one another rapidly at times (Tarr 1949). On Pelsaert I. in Aug., 500 birds in display flights over island; on Easter Grp, Houtman Abrolhos, in early Oct., up to 100 birds seen in high circular display flights (Storr *et al.* 1986). On Curtis I., Kermadec Is, mid-Oct., birds noisy and displaying in early morning, quiet round noon and early afternoon, with increasing numbers calling and displaying in flight by 15:00 and, by sunset, 400–500 birds in swirling display flight; flying continued after dark (G.A. Taylor & A.J.D. Tennyson). On ground at colony often seen to PARADE: one bird circles, with small steps; both drop wings, arch necks, and turn heads slightly away from partner, presenting napes to each other and give Parade Call; usually performed at change-over, but also seen before laying (Warham 1956; HASB). Courtship behaviour at nest-site said to involve Parading and pair fencing with their bills (Hutton 1991). BOWING also common; raise wings in sharp V over back and thrust head horizontally forward (HASB). **Greeting** Pair may use a greeting call (Warham 1956; see Voice). Non-incubating bird in flight may call to incubating bird through night (Lawry 1926).

**Relations within family groups** Appear to select nest-sites quickly; pairs of birds seen trying to land on bushes where other birds already perched; one of pair dropped to sand to select site, then other followed and sat nearby; occurred with much squabbling with others (Lane 1986). Young fed by regurgitation (Lawry 1926; Reithmüller 1931). Adult may repeatedly bring pieces of fish to end of its bill then swallow again, while chick chirps and attempts to get morsel (Reithmüller 1931). When feeding young, Common Noddies *Anous stolidus* may try to steal food. Female brings salt water to young, mainly during heat of day (Lawry 1926). **Anti-predator responses of young** Chicks shelter under rocks or among tussocks of grass (Hindwood 1940); run in panic (Hindwood *et al.* 1963). **Parental anti-predator strategies** Said to leave nests easily (Tarr 1949). When White-breasted Sea Eagle *Haliaeetus leucogaster* flew over colony, every bird flew off bushes and called (Sandland 1937). If person intrudes: call (Alexander 1926; Sandland 1937; Hindwood *et al.* 1963; Lane 1986); panic and scramble through vegetation before flying off nests (Warham 1956; Lane 1986) and can injure or kill themselves doing so (Tarr 1949); while trying to escape, can fly into people walking in colony (Lawry 1926); some fly off nests and hover overhead, calling, others remain brooding (Basset Hull 1909; Hindwood 1940; Warham 1956; North; Campbell); hovering birds may strike hats of observers (Campbell) and snap mandibles (Basset Hull 1909). Some brooding birds can be caught by hand (Basset Hull 1909; North).

**VOICE** Well known. Noisy (Cheeseman 1890; Gould), especially after dark (Iredale 1910; MacGillivray 1917; Hindwood 1940; Warham 1957; Serventy & Whittell 1976; Elvish & Walker 1991). Noise of colony incessant, and audible 800 m away (Davis 1923a). Non-incubating member of pair said to fly most of night, with calls passing continually between it and incubating bird (Lawry 1926). Large numbers called while hovering, from late afternoon till shortly before dawn, every night for 6 months, except during 4 days of gales (Hogan 1925). On Lord Howe I., return July, when can be heard calling at night, before being seen by day (Hutton 1991). When colony disturbed by person, birds call while scrambling through vegetation before taking off (Lane 1986), and call overhead (Alexander 1926; Hutton 1991). **NON-VOCAL SOUNDS:** Snap mandibles when hovering over intruder





A R. Swaby; Michaelmas Cay, Qld, June 1971; P39

(Basset Hull 1909).

**Adult WIDEAWAKE CALL:** rendered as *haydlaylo*, but rather varying (Warham 1956) (see sonagram A); accent on first and last syllables; not unlike 'wideawake' spoken in a squeaky voice (Oliver), hence alternative common name. Given in flight (Warham 1961; Campbell). **DEEP GROWL:** *wruk*; used when neighbour encroaches on territory; sometimes shortened to a bark (Warham 1956). Probably the croak of Iredale (1914). **DRAWN-OUT GROWL:** *scra-are*; heard from nesting birds as person walks past (Warham 1956); described as prolonged guttural scream (Campbell). **WEK CALL:** Powerful and explosive *wek, wek, wek*; perhaps greeting call (Warham 1956). **PARADE CALL:** Give quiet *wuk, wuk, wuk* during Parade (see Social Behaviour) (Warham 1956). **HARSH SCREAM:** Scolding *scurr* (Warham 1961); given in flight (Hindwood 1940; Warham 1961; Hindwood *et al.* 1963). Squeaking notes of anger from birds overhead (distinguished from Wideawake Calls of birds in flight higher up) when person intrudes into colony (Campbell), may correspond to this call. **Other calls** When handled, utter incessant *ka-ka-ka* (North) or *go-ak*, with accent on second syllable (Oliver); may correspond to one of the above calls.

**Young** Chicks expecting to be fed give *chirps* (Reithmüller 1931). At sea, adults and juveniles communicate using calls typical of adult and chick trying to locate each other at colony (Ainley *et al.* 1986).

**BREEDING** Well known extralimally (e.g. Ashmole 1963a; Harrington 1974), less so in Aust. Information from Willis I., n. Qld (e.g. Hogan 1925; Lawry 1926; Serventy 1959) and Abrolhos Is, WA (e.g. Sandland 1937; Lane 1986). Breed in small to large colonies.

**Season** Protracted; groups within a colony may begin laying at different times (HASB; G.A. Taylor). **N. QLD:** Appear to have two seasons, in spring and autumn; spring laying: Sept.; young, Oct. and Nov.; leave colony, mid-Dec.; autumn laying, early Apr. to July; fledge, Oct. (Davis 1923a; Hogan 1925; Alexander 1926; Lawry 1926; Serventy 1959). On Michaelmas Cay, some breeding in progress in almost every month of year (King *et al.* 1992); length of time between peaks of breeding: excluding cyclone-affected seasons, 8.6 months (8–9; 5); including cyclone-affected seasons, 9.5 months (8–14; 6). **WA:** Houtman Abrolhos: Eggs and young, early Nov. and Jan. (Sandland 1937; Serventy 1943b; Lane 1986; Storr *et al.* 1986). **LORD HOWE I.:** Laying, mid-Sept. to at least mid-Nov.; young leave late Mar. to early Apr. (Hindwood 1940; North). **NORFOLK I.:** Arrive, late Aug.; laying protracted because eggs harvested, early Oct. to late Nov., with latest eggs in late Jan.; hatching, mid-Nov. to late Mar., mostly in Jan.; fledging, from late Jan. (Hermes *et al.* 1986); eggs, early Dec. (Aust. NRS). **KERMADEC IS:** Laying, mid-Oct. to mid-Dec. or later; hatching, early and mid-Jan.; fledge, Feb.–Mar. (Iredale

1910; Merton 1970; Taylor 1979; G.A. Taylor). Most birds lay c. 1 week after selecting site (Reithmüller 1931). **COCKEELING IS:** Laying, Nov. and Dec. (Gibson-Hill 1949); eggs, Jan. (Stokes *et al.* 1984). Formerly bred SA, with eggs in Oct. (Parker 1980).

**Site** On islands, on level beaches, sandy ridges, sometimes on rock shelves, stacks; in open or in grassy areas, under grass tussock or bushes; in sand or shingle (Iredale 1910; Hogan 1925; Sandland 1937; Serventy 1943b, 1959; Tarr 1949; Merton 1970; Fuller *et al.* 1994); on Norfolk I., on cliffs and outlying rocks (North); on Curtis I., Kermadec Is, on thermal silica flats in floor of volcano, where ground warm or hot (G.A. Taylor). Site abandoned after eggs taken (North). Breed with other species: Lesser Crested Terns *Sterna bengalensis* (Cornwall 1903); Common Noddies; Black-winged *Pterodroma nigripennis* and White-necked *P. cervicalis* Petrels and Wedge-tailed Shearwaters (which have burrows under Tern colony) (Lane 1986; G.A. Taylor); small numbers of Masked Boobies *Sula dactylatra* (North); one pair nested among Crested Terns in SA (Parker 1980).

**Nest, Materials** Depression or scrape in sand or grass; usually unlined, sometimes with debris scratched round it or a few twigs added; in grassy areas, press grass down to make hollow, and no material used (Alexander 1926; Reithmüller 1931; Hindwood 1940; Serventy 1959; North).

**Eggs** Oval or elongate oval, with many abnormally elongate or very pointed; close-grained, mostly lustreless or with slight gloss; ground-colour varies: white, pink, reddish white, pale buff, stone, dull yellowish-stone to creamy buff, light red, rich creamy-red and salmon-red; markings also vary: minute freckles, spots, irregular blotches and large clouded patches of dark red, rich chestnut, purplish red, purplish black, purplish grey, chocolate-brown and reddish black, intermingled with underlying markings of fainter hues, but mainly purple, violet and inky grey, some being uniformly distributed over shell, others predominating on one, usually larger, end, and may consist of zones, caps or a few large confluent patches; rarely, eggs found covered with scratches, wavy streaks or fine linear markings; markings sometimes appear blurred, or beneath shell; white eggs unmarked (Hindwood 1940; Serventy 1959; North). **MEASUREMENTS:** Aust.: 53.6 (2.21; 50.7–56.6; 8) x 36.4 (0.88; 35.2–37.7) (Serventy 1959); 52.0 (5.85; 34.0–63.2; 35) x 35.5 (3.26; 24.6–41.9) (North). Kermadec Is: 54.1 (1.98; 49.9–56.8; 12) x 36.9 (1.09; 35.3–38.3) (A.J.D. Tennyson). **WEIGHT:** Kermadec Is: eggs 1–3 days old: 40.2 (2.48; 35.0–43.0; 12) (A.J.D. Tennyson).

**Clutch-size** Usually one, occasionally two; some two-egg clutches probably arise when stray eggs roll into nest (Alexander 1926; Lawry 1926; Serventy 1959; North); 10,000 nests of C/1 in a colony at Michaelmas Cay; on Norfolk I., C/1 x 559, C/2 x 2 (Aust. NRS); on Macauley I., C/1 x 322, C/2 x 1 (G.A. Taylor & A.J.D. Tennyson).

**Laying** Varies: synchronous within colony; occurs as wave through colony as it expands (Lane 1986); may be synchronized within groups or sub-colonies in colony (Lawry 1926; HASB); on Curtis I., highly synchronized within sub-colonies: one egg on 29 Oct. and 270 eggs 2 days later (G.A. Taylor & A.J.D. Tennyson). Laying may occur 1 day after selecting site (Lane 1986); up to 1 month after arriving at site (HASB). Re-lay after loss of eggs, up to twice, usually 2 weeks later (HASB); extralimally, 8–28 days after loss (n=22 eggs) (Ashmole 1963a). When nesting with Lesser Crested Terns, occasionally take possession of each other's eggs (Cornwall 1903).



**Incubation** By both sexes (Lawry 1926). Birds incubating two-egg clutches sit on one egg and put wing over second; change order of eggs every day (Lawry 1926). On hot days, do not sit on eggs but stand over them (Reithmüller 1931). **INCUBATION PERIOD:** On Curtis I., incubation period at least 28 days; one egg had star fracture 26 days after laying (G.A. Taylor & A.J.D. Tennyson); extraliminally, 28.5–30 days, occasionally longer (Ashmole 1963a).

**Young** Precocial, semi-nidifugous. Move about when 2–3 days old; start flapping wings at 1 week old (Lawry 1926; Reithmüller 1931). Feathered after 30 days (Witherby *et al.* 1941). **Growth** No information for A'asia; extralimital data in Ashmole (1963a). **Parental care, Role of sexes** Young can form crèches (HASB). Said that only female feeds young (Lawry 1926) but this seems unlikely. Young susceptible to exposure during rain, because adults leave colony and fly out to sea (Iredale 1910); young shelter from sun under bushes or tufts of grass, or any shade (Hogan 1925).

**Fledging to maturity** **FLEDGING PERIOD:** Young said to 'fly freely' within 4 weeks of hatching, then leave island (Lawry 1926); extraliminally, c. 8 weeks, but varies with rate of development (Ridley & Percy 1958; Ashmole 1963a). Leave island, apparently with at least one adult, soon after fledging (Lawry 1926; Ashmole 1963a; Harrington 1974). Can breed when 4 years old; most begin breeding from 5 years (Harrington 1974).

**Success** On Kermadec Is, feral cats, Brown Rats and Kiore eat eggs and young; chicks sometimes die of starvation; adults will kill stray chicks. Kiore seen to chew eggs at night, while adult Terns were sitting; push up behind Tern, then chew out end of egg and eat contents. Of 5537 marked eggs, 1578 (28.5%) hatched; 336 chicks had died by late Jan.; total mortality 77.5%. Of 3959 eggs that failed to hatch, 170 eaten by rats, 988 deserted because rats interfered, and rest lost to natural causes. Of 1512 chicks banded when 1–3 days old, 432 (28.9%) recovered dead; of 1500 chicks banded when  $\leq 17$  days old, 113 (7.5%) recovered dead (Edgar *et al.* 1965; Merton 1970; Taylor 1979; G.A. Taylor). On Curtis I., Kermadec Is, many eggs laid on hot floor of volcano were cooked and eventually abandoned (G.A. Taylor). Fledging success on Michaelmas Cay, 11.3% to 47.5% (King *et al.* 1992). In Aust., eggs eaten by King's Skinks *Egernia kingii*, land crabs, Buff-banded Rails *Gallirallus philippensis*, and Silver Gulls; at one colony all eggs (hundreds) gone within 5 days of laying (Hogan 1925; Tarr 1949); eggs deserted during rainstorms (Iredale 1910; Alexander 1926); some eggs lost by being pressed into grass (Serventy 1959); Green Turtles *Chelonia mydas* can destroy nests (HASB).

**PLUMAGES** Prepared by K. Bartram. Extraliminally, finish post-natal moult to distinctive juvenile plumage when c. 8 weeks old (Ashmole 1963b). Timing of moults dependent on timing of breeding, which differs between Tropics and Subtropics. Undergo complete post-juvenile moult to first immature non-breeding plumage, which is attained 6–9 months after fledging. Subsequent plumages poorly understood. Full adult plumage attained when between 3 and 6 years old (Harrington 1974). Adults moult twice each cycle (though cycles are not 1-year long in all populations); extent of each moult varies geographically and usually depends on frequency of breeding. Undergo a complete post-breeding (pre-basic) moult and a partial pre-breeding (pre-alternate) moult each cycle, with only slight change in appearance. Sexes similar. Slight geographical variation in size and coloration of underparts. Subspecies *serrata* described below.

**Adult breeding** (Definitive alternate). **Head and neck** Forehead, forecrown and broad fore-supercilium, white, forming large white patch that extends to above middle of eye. Crown, nape, hindneck and sides of head to just below and behind eye and upper ear-coverts, black (89), forming neat cap. Lores, black (89), forming loreal stripe extending from lower sides of upper mandible and gape to eye, separating white forehead from white underparts and joining black cap at eye. With wear and abrasion, white bases of feathers of hindneck exposed, forming narrow white collar between cap and mantle. Rest of head and neck, white, curving up behind cap on lower mid-neck. **Upperparts** Dark grey (82–83) when fresh, becoming grey-black (82) to dark grey-brown (82–19) with wear; always slightly paler than black cap. **Underparts** Breast, white, with slight pale-grey tone on belly and mid-flanks. Thighs, lower flanks and undertail-coverts, pale grey (86). Axillaries, white, with pale-grey suffusion. Small wedge-shaped patch of grey-black (82) extends from upperparts, between legs and undertail-coverts. **Uppertail** T1–t5 (including shafts), mostly grey-black (82), as upperparts. Outer rectrices (t6), elongated, forming long tail-streamers: outer webs, white; inner webs range from white or white with grey (84–85) subterminal smudge, to dark grey (82–83) over most of distal half; shaft of t6, white. **Undertail** Slightly paler than uppertail; tail-streamers usually white on outer web, sometimes with very pale grey wash near tip; inner webs vary, from white with light-grey (86) wash near tip, to grey (84–85) with white base. Shafts, cream. **Upperwing** Typically, coverts and remiges, grey-black (82) and concolorous with upperparts, though coverts often worn and slightly browner (brownish 21–82). In fresh plumage, outer web of secondaries and p1–p9 have silvery sheen; become grey-black (82) with wear. Inner webs of primaries have varying, paler brownish-grey (brownish 85 to brownish 84) wedge through centre and slightly darker grey (83) stripe on inner edge; wedges paler towards base of feathers. Secondaries have concealed white bases. Shafts of remiges, dark grey (83), except on p10, dark cream (dark 92). Marginal secondary coverts, white, forming narrow white leading-edge. Marginal primary coverts have white outer edges, forming indistinct broken white line extending c. 3 cm past carpal joint. **Underwing** Coverts, mostly white, with faint whitish-grey suffusion; greater primary coverts, pale grey (86) and edges to outer webs of marginal primary coverts, grey-black (83). Remiges, dark grey (83) with: white to pale-grey (86) bases to secondaries; paler, silvery-grey (85) wedge through centre of inner web of primaries; pale-grey (86) to dark-grey (83) outer web to p9 and p8; and white outer web to p10. Shafts of outer five or so primaries, pale cream (81–92), grading to pearl-grey (81) on rest of remiges.

**Adult non-breeding** (Definitive basic). Varies according to frequency of breeding (see Moults). In those tropical populations that have a breeding cycle lasting less than 1 year, birds acquire little non-breeding plumage, moulting only a few feathers; in populations that breed once annually, birds have more obvious changes in plumage. Differ from breeding by: cap, grey-black, with brown tinge (brownish 82); feathers of crown have white edges, creating black-and-white mottling and striations from above eye to hindcrown; feathers of hindneck have white or faint-grey tips, which wear quickly to produce obvious white collar; feathers of mantle, fringed light grey (86), giving scaly appearance; some lesser upperwing-coverts have faint-grey fringes; tail-streamers, grey-black (82–83), concolorous with rest of tail, and with only base of inner web paler than rest of tail; shafts of t6, grey-black (82).



**Downy young** Down, brown (119B–119A) above, with light grey-brown (119C) tips tinged cinnamon; below, off-white. When juvenile feathers start growing, down becomes mottled light grey-brown (119C) and white. Down replaced last on forehead, sides of head, throat, lower neck, belly and vent; while still in down, fresh juvenile feathers on upperparts and upperwing have broad white tips.

**Juvenile** Generally dark brown, with white or buff spots over upperparts. **Head and neck** Mostly brown (27–28) to dark brown (121), darkest on cap and ear-coverts; forehead, lores and throat often slightly paler than cap, light grey-brown (27); in fresh plumage, have faint whitish-buff barring on cap. **Upperparts** Upper mantle, dark brown (121) with thin white, cream (92), buff (124) or light-brown (39) fringes to feathers. Feathers of lower mantle and scapulars, mainly dark brown (119A) with light grey-brown (27) bases, darker brown (121) subterminal bands, and broad white (sometimes buff-white or cream [92]) fringes; fringes abrade rapidly, and older juveniles show only a few white or buff-white spots (rarely none). Back, rump and uppertail-coverts, dark brown (121) with white, cream (92) or light-brown (39) tips to feathers, giving narrowly barred appearance. **Underparts** Mostly light grey-brown (27) with darker brown (28) tips to feathers; in very fresh plumage, feathers have faint cream (92) bars. Axillaries vary from light grey-brown (grey 119D) faintly spotted with white, to brown (28). Feathers of thighs, brown, with white fringes. Vent, white (sometimes dirty white) speckled with light grey-brown (119D). On some, lower belly and vent, white. Undertail-coverts, light grey-brown (brown 86) to grey (84–85) with broad whitish-buff or light-brown (223C) fringes. **Uppertail** Dark brown (219) with paler brown (119B) base and broad light grey-brown (119C–119D), light-brown (39) or white fringes; fringes lost with wear; shafts, dark brown (219). **Undertail** Brownish-grey (79) with silvery sheen; shafts, light grey-brown (119D). **Upperwing** Coverts patterned and coloured like upperparts except subterminal part of feathers slightly darker brown (119). Marginal secondary coverts, brown, with white edges on outer web, forming indistinct white leading-edge. Remiges, dark brown (119) with bluish-silver sheen when fresh and slightly paler brown (119A) wedge through centre of inner web; when fresh, remiges have thin dull-white fringes that become broader towards innerwing, and are very broad on tertials. **Underwing** Coverts, mottled, light grey-brown (119C–199D) or grey (85–86) with paler brownish-grey (brownish 86) or grey-white fringes. Primaries, grey (87) with silvery sheen and paler grey (85) wedge through centre of inner webs. Most of outer web of p10, light grey (86) except for grey (87) outer edge; rest of primaries have grey (87) outer webs. Secondaries, light grey (85–86) with grey-white bases and fringes. Shafts of remiges, cream (whitish 92).

**First immature non-breeding** (First basic). No Aust. specimens available; description based on BWP. Very similar to juvenile. Forehead, lores, and cheeks, mottled black-brown and grey. Eye-patch, ear-coverts and nape, dark brown, often extending along sides of neck to sides of upper chest. Chin, throat and lower neck, pale grey, contrasting with dark-brown band on upper breast. Underparts below breast-band, mottled brownish-grey and white; vent, white.

**Second immature non-breeding** (Second basic). No specimens available; based on BWP. Like first immature non-breeding (retains dark breast-band), but chin, throat and belly below breast-band, paler.

**Subsequent immature plumages** No specimens available; based on Harrington (1974). Nothing known of transi-

tion from second non-breeding to third year. Age of attainment of full adult plumage varies. Immatures, presumably 3–5 years old, resemble adult non-breeding except for pale edges to black feathers of upperparts, and dark edges to feathers of forehead and underparts; 30% of 3-year-olds ( $n=227$ ), 11% of 4-year-olds ( $n=830$ ), and 5% of 5-year-olds ( $n=105$ ) showed dark speckling on underparts (Harrington 1974).

**BARE PARTS** From museum labels and photos (Pringle 1987; unpubl: D.W. Eades; G.A. Taylor; A.J.D. Tennyson). **Adult** Bill, glossy grey-black (82). Iris, dark brown. Legs and feet, black. **Downy young** When very young: bill, yellow or dark red, with black tip; becomes darker with age, brownish yellow or blackish red to dull black, with dull-yellow to red tinge to base of lower mandible. Legs, yellow-brown or dark pink, with dark grey claws; darken through dark brown to dull-black with red tinge. **Juvenile** At time of fledging, like adult except base of upper mandible has dark yellow or red tinge. Legs, black, with red tinge. Bill and legs rapidly darken to adult coloration.

**MOULTS** Based on 175 skins (ANWC, HLW, MV, SAM, WAM, QM), Ashmole (1963b) and BWP. Poorly known despite major studies by Ashmole (1963b) and BWP; information from Penguin I., sw. WA, in Dunlop & Jenkins (1992). Timing and extent of pre-breeding moults strongly affected by great variation in timing and duration of breeding cycle. Some populations have a 12-month cycle (referred to below as annual breeders); others have shorter cycles of only 9–10 months or 6 months (referred to below as short-cycle adults). Moulting and breeding are mutually exclusive and, as length of nesting season roughly similar in all populations, time available for moult varies. Almost all moult occurs at sea, so identification of breeding locality and season of moulting birds is seldom possible.

**ANNUAL BREEDERS: Adult post-breeding** (Pre-basic). Complete. Primaries outwards. No specimens collected at breeding colonies were in moult. Failed breeders sometimes moult up to half of inner primaries before leaving colony (BWP). After departure, successful breeders begin moult with p1, together with feathers of face, crown, mantle or tail. When PMS c. 25, head, neck, underparts, some scapulars, tertials, and tail mainly fresh. Moult of primaries finished c. 7.5 months after starting; at this time, head, body, tail and wing-coverts fresh. Tail moulted in sequence t6–t1–t2–t5–t3–t4; occasionally moult t1 before t6; then proceed, without a break, into adult pre-breeding moult of tail (see below). **Adult pre-breeding** (Pre-alternate). Partial. Begins immediately after post-breeding moult finished. Moult head, body, part or all of tail and some upperwing-coverts. In some populations, inner primaries also apparently moulted; Ashmole (1963b) noted that in many birds from Bedout I., WA, and Phoenix and Line Is, central Pacific Ocean, varying number of inner primaries were contrastingly fresher than outer primaries; this rare in other populations (e.g. not observed in any of the specimens examined in this study) and not necessarily an indication of immaturity (BWP; *contra* Ashmole 1963b). Moult of tail continues from post-breeding moult in sequence t6–t1–t2–t5; sometimes moult t3–t4. **MOULTS OF SHORT-CYCLE ADULTS:** Develop less non-breeding plumage than annual breeders; post and pre-breeding moults run into one another, so identification of separate pre-basic and pre-alternate moults problematical on present knowledge. Begin moult at same time as those that breed annually and moult primaries at same rate.



Many replace head, neck, part of mantle, scapulars, then remaining old breeding (alternate) feathers directly replaced by fresh breeding (alternate) plumage. Fewer rectrices (often only t6 and t1, sometimes also t2 and t5 are replaced twice each cycle). Birds breeding twice in year apparently attain hardly any non-breeding body-plumage and only replace rectrices once per cycle; some nesting birds have non-breeding tail-streamers (Ashmole 1963a). They may also suspend primary-moult, usually with inner 7–9 (sometimes five) primaries new, moult continuing when breeding finished, sometimes restarting at p1. Above indicates that at least some biannual breeders still go through pre-breeding moult, but it is interrupted by breeding. **Post-juvenile** (First pre-basic). Complete. Like adult, timing of moult varies with timing of breeding. Poorly known, because juveniles leave colonies straight after fledging. One bird from Lord Howe I., Feb., had PMS of 9, and had started moulting feathers of cap; other juveniles at same time had not started moult. Probably start moult a few months after leaving nest, with head and body, followed by primaries (based on bird collected from NSW in Feb. which was moulting body, but not primaries). When PMS c. 25, head and body in full-first basic plumage; then moult tail and tertials. **Second pre-breeding** (Second pre-alternate). Probably begins 12 months after fledging; p1 dropped before previous set of primaries completed. **Subsequent moults** No information.

**MEASUREMENTS** (1–4) Aust., adults, skins; T6 = length of t6 from base to tip (only taken for birds in breeding plumage); T1 = length of t1 from base to tip; Bill D(N) = depth of bill at basal edge of nostril; Bill D(G) = maximum depth of bill at gonys (AM, ANWC, HLW, MV, QM, SAM, WAM): (1) WA; (2) N. Aust., not including WA, se. Qld and NSW; (3) SE. Qld and NSW (probably includes birds from Lord Howe, Norfolk and Kermadec Is as well as from Tropics); (4) Lord Howe, Norfolk and Kermadec Is. (5) Kermadec Is, adults, live; sexed by cloacal examination; Bill W = width of bill from tomiom to tomiom, at junction of culmen with feathering; Bill D(B) = depth of bill at base (A.J.D. Tennyson).

	MALES	FEMALES	
WING	(1) 287.7 (5.85; 282–296; 7) (2) 298.3 (9.84; 286–315; 11) (3) 299.8 (7.80; 293–311; 4) (4) 303.9 (5.79; 290–315; 29) (5) 311.7 (4.79; 301–321; 19)	280, 285, 290 290 (7.29; 279–298; 6) 295.5 (7.42; 286–304; 4) 298.4 (3.71; 282–311; 17) 307.4 (4.97; 295–315; 15)	ns ns *
T6	(1) 181, 203 (2) 181 (3) 178 (4) 195.7 (13.06; 176–218; 9) (5) 201.9 (9.58; 187–222; 19)	173 179 158 196, 201, 201 201.5 (7.63; 189–217; 15)	ns ns *
T1	(1) 78.4 (1.92; 75–81; 8) (2) 80.0 (3.00; 76–86; 11) (3) 77.5 (2.07; 75–81; 6) (4) 80.5 (3.15; 74–87; 31) (5) 81.7 (3.31; 74.3–87.8; 19)	76.9 (4.14; 72–85; 7) 76.7 (2.87; 73–81; 7) 77.8 (3.27; 74–83; 5) 80.0 (3.71; 72–88; 18) 80.9 (1.78; 78–83.2; 15)	ns * ns ns ns
BILL	(1) 42.7 (1.76; 40.6–45.8; 8) (2) 41.5 (1.86; 38.0–43.9; 9) (3) 43.9 (1.03; 42.2–44.7; 5) (4) 43.5 (2.10; 40.3–47.3; 31) (5) 44.8 (1.46; 43.1–48.4; 19)	40.4 (1.8; 37.3–42.3; 8) 41 (1.25; 39.2–42.9; 7) 41.4 (0.62; 40.3–41.8; 5) 42.0 (1.70; 39.4–46.1; 18) 43.7 (1.78; 40.3–46.5; 15)	ns ns ** * ns
BILL D(B)	(5) 11.5 (0.44; 10.7–12.2; 12)	10.8 (0.52; 10.0–11.5; 10)	**
BILL D(N)	(1) 9.0 (0.31; 8.4–9.3; 6) (2) 9.0 (0.65; 7.7–9.8; 9)	9.2 (0.27; 8.8–9.6; 7) 9.2 (0.27; 8.8–9.6; 7)	ns ns

	(3) 9.3 (0.35; 8.6–9.5; 6)	8.5 (0.27; 8.1–8.8; 5)	**
	(4) 9.8 (0.38; 9.0–10.8; 32)	9.2 (0.47; 8.3–9.8; 18)	**
BILL D(G)	(1) 7.5, 7.8, 8.0	7.5 (0.25; 7.2–7.8; 5)	
	(2) 7.9 (0.56; 6.7–8.5; 10)	7.7 (0.35; 7.1–8.2; 7)	ns
	(3) 8.3 (0.37; 7.9–8.9; 6)	7.4 (0.27; 7.0–7.7; 5)	**
	(4) 8.5 (0.38; 7.8–9.1; 32)	7.8 (0.31; 7.4–8.4; 18)	**
BILL W	(5) 11.2 (0.58; 10.3–12.1; 12)	10.9 (0.60; 10.2–12.1; 10)	ns
TARSUS	(1) 23.0 (0.85; 22.0–24.3; 8)	22.8 (0.62; 21.8–23.7; 7)	ns
	(2) 23.9 (0.90; 22.2–25.4; 11)	23.5 (0.71; 22.5–24.5; 6)	ns
	(3) 23.9 (0.55; 23.1–24.7; 5)	23.1 (0.87; 22.1–24.3; 5)	ns
	(4) 24.3 (0.9; 21.7–25.8; 32)	23.7 (0.89; 22.0–26.0; 18)	*
	(5) 24.8 (0.86; 23.2–26.2; 19)	24.6 (1.12; 22.7–26.5; 15)	ns
TOE C	(1) 28.7 (1.64; 25.0–31.8; 19)	28.2 (1.16; 25.8–30.0; 15)	ns
	(2) 27.8 (1.29; 25.3–29.6; 10)	28.3 (1.20; 26.3–29.5; 5)	ns
	(3) 28.7 (0.87; 27.3–29.6; 6)	27.3 (0.81; 26.1–28.1; 5)	*
	(4) 27.8 (1.07; 25.1–29.6; 31)	27.5 (0.99; 26–29.6; 18)	ns

Males from Lord Howe, Norfolk and Kermadec Is have significantly deeper and longer bills than males from tropical Aust.; females not significantly different; both sexes have significantly longer wings. Males from WA have significantly shorter wings than other Aust. populations. In non-breeding plumage, t6 and tail-fork c. 30 mm shorter than in adult breeding (BWP).

(6–7) Adults (AM, ANWC, MV, QM, SAM): (6) Tropical Aust., excluding WA; (7) Lord Howe I.

#### UNSEXED AND SEXES COMBINED

WING	(6) 296.7 (8.83; 279–315; 23) (7) 301.7 (6.9; 282–315; 62)
T6	(6) 179, 181, 194 (7) 191.9 (12.19; 171–218; 16)
T1	(6) 78.5 (2.58; 73–83; 22) (7) 79.8 (3.39; 72–88; 68)
BILL	(6) 41.3 (1.52; 38.8–43.9; 22) (7) 42.8 (1.87; 39.4–46.9; 68)
BILL D(N)	(6) 9.1 (0.41; 8.3–9.8; 18) (7) 9.5 (0.50; 8.3–10.8; 69)
BILL D(G)	(6) 7.9 (0.41; 6.9–8.5; 21) (7) 8.2 (0.42; 7.4–9.1; 69)
TARSUS	(6) 23.8 (1.88; 22.2–25.4; 22) (7) 24.0 (0.99; 21.4–26.0; 70)
TOE C	(6) 27.6 (1.14; 25.3–29.6; 18) (7) 27.7 (1.21; 24.7–30.6; 69)

Birds from Lord Howe I. have significantly longer wing and culmen, and deeper bill.

(8) Aust., juveniles (AM, ANWC, MV, QM).

#### UNSEXED AND SEXES COMBINED

WING	(8) 280.9 (15.07; 230–302; 37)
T6	(8) 119.2 (6.67; 103–131; 29)
T1	(8) 77.0 (4.13; 67–84; 36)
BILL	(8) 32.8 (2.18; 28.5–38.3; 36)
BILL D(N)	(8) 7.8 (0.63; 6.4–9.7; 36)
BILL D(G)	(8) 6.7 (0.40; 5.9–7.6; 34)
TARSUS	(8) 23.1 (0.82; 21.2–24.6; 36)
TOE C	(8) 27.3 (1.36; 23.6–30.0; 34)

Juveniles have significantly shorter and finer bills than adults; bill-length does not overlap; wing also shorter. Length of t1 like adult, but t6 (and, therefore, depth of tail-fork) significantly shorter. Tarsus and middle toe about fully grown at fledging.



**WEIGHTS** (1) Aust., adults, skins; sex from museum labels (AM, MV, QM, WAM). (2) Kermadec Is, live; sexed by cloacal examination (A.J.D. Tennyson).

	MALES	FEMALES	
(1)	155.6 (33.66; 107–217; 13)	157.9 (34.51; 117–200; 6)	ns
(2)	239.1 (29.95; 183–285; 19)	249.3 (30.26; 187–280; 15)	ns

Differences between Aust. and Kermadec samples partly because Aust. specimens include beachcast birds, which often die of disease or starvation, which reduces weight. However, heaviest Kermadec birds heavier than heaviest Aust. birds known to have been collected from colonies.

Aust., juveniles, sexes combined (AM, ANWC, QM): 107.2 (16.24; 75–145; 12), including specimens collected at colonies and beachcast birds.

**STRUCTURE** Wings, long and pointed. Eleven primaries: p10 longest, p9 0–11 mm shorter, p8 16–30, p7 41–52, p6 61–79, p5 86–109, p4 111–130, p3 134–160, p2 154–180, p1 166–198; p11 pointed, c. 40 mm long, concealed by greater primary coverts; no emarginations. Eighteen secondaries, including about six tertials; little difference between innermost secondaries and outermost tertials. Longest tertials reach to p3 or p4 on folded wing. Three humerals, half length of longest tertial. Twelve rectrices; in adults, tail deeply forked with t6 elongated, forming tail-streamers (see Measurements): t1 shortest, t2 2–10 mm longer, t3 10–18, t4 24–37, t5 46–60, t6 100–132. In juveniles, tail forked but t6 not elongated: t1 shortest, t2 3–5 mm longer, t3 8–14, t4 18–25, t5 26–37, t6 38–52. Bill from above, broad at base and laterally compressed at tip; in profile, straight, with sharply pointed and decurved tip; gonys, slightly angled; cutting edges of mandibles, finely serrated; bill similar in shape to, but slightly heavier than, bill of most *Sterna* of same size, including Bridled Tern. Bill, slightly shorter than length of head. Oil-gland, vestigial (and so lacks water-proof plumage) (BWP). Tarsus, short and slender, but rather long for a tern; scutellate. Toes quite long for *Sterna*; deeply incised webs between front toes; outer toe c. 87% of middle toe, inner c. 64%, hind 26%.

**GEOGRAPHICAL VARIATION** Slight, involving coloration of underparts and measurements. Number of subspecies accepted varies, and status of all needs examination. Subspecies *serrata* (described above) often lumped with Indian Ocean *nubilosa*. Indian Ocean birds similar; differ by paler underparts (though grey tips to feathers on underparts of *serrata* lost with wear and underparts may then be as pale as those of *nubilosa*). Other Pacific Ocean subspecies (*crissalis*, *oahuensis*, and *luctuosa*) all similar to Aust. and Indian Ocean subspecies and further work needed to ascertain status. Subspecies *kermadeci* also recorded from HANZAB region and supposed to breed Kermadec Is. However, type-specimen of *kermadeci* described from Sydney (Mathews 1916). Males on Kermadec, Lord Howe and Norfolk Is, similar to male *serrata*, but generally slightly larger (see Measurements) with thicker bill. Nominative *fuscata* of Atlantic Ocean differs from all other subspecies by mostly white underparts, underwing-coverts and tail-coverts, with only slightly grey tinge on flanks and belly in fresh plumage (see BWP).

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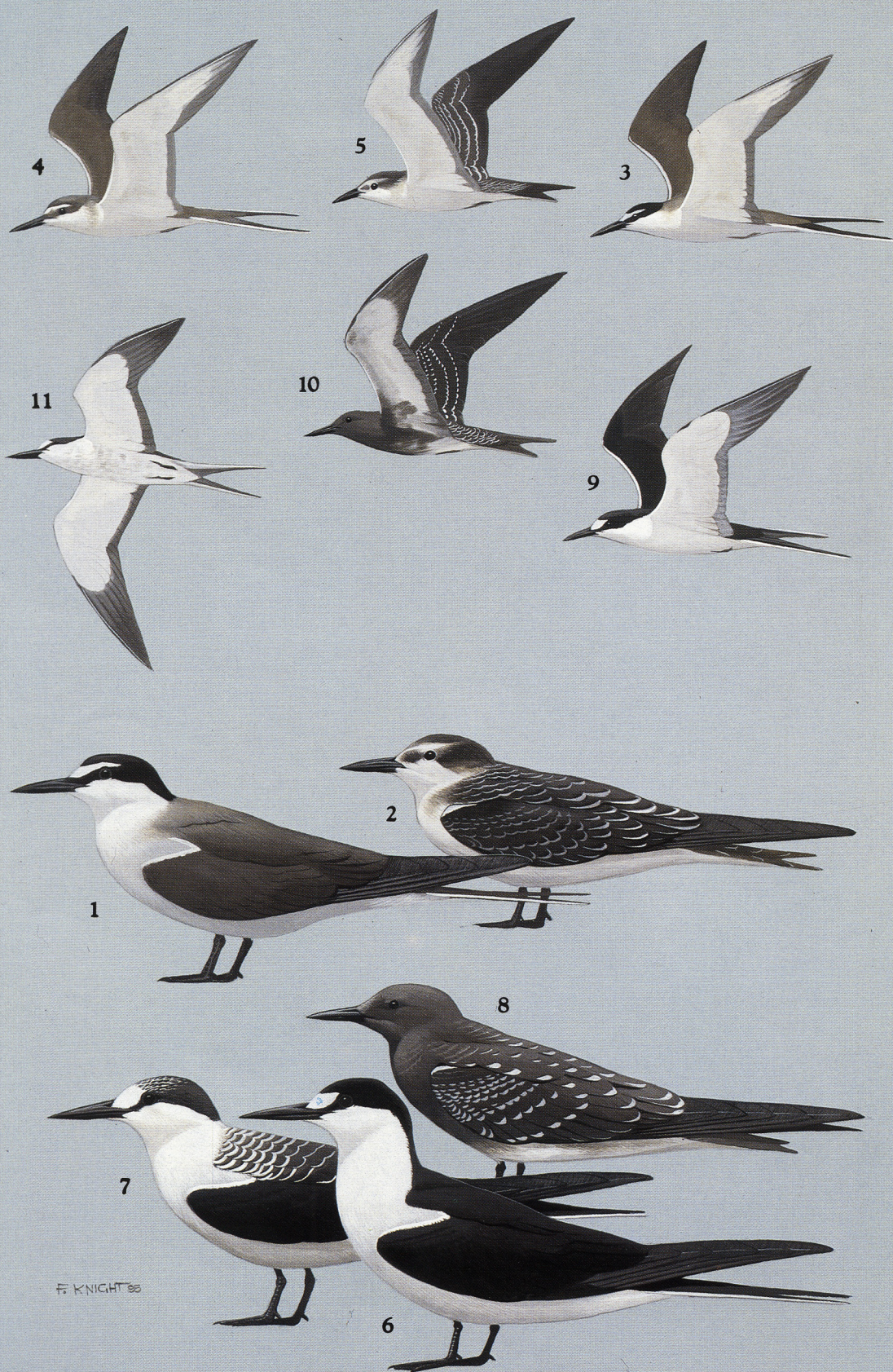
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Bridled Tern *Sterna anaethetus* (page 738)

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

Sooty Tern *Sterna fuscata* (page 752)

6 Adult breeding; 7 Adult non-breeding; 8 Juvenile; 9 Adult breeding; 10 Juvenile; 11 Older immature