

Order CHARADRIIFORMES

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

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

Thinororidae	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 (Thinororidae, 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).¹

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

¹ 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.¹ 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.

¹ 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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Anous minutus Boie, 1844, *Isis*, col. 188 — New Holland = Raine Island (*apud* Mathews).

The specific name is directly from Latin *minutus*, little, small (from *minuere*, to make smaller), in comparison with Common Noddy *Anous stolidus*.

OTHER ENGLISH NAMES White-capped Noddy, Lesser Noddy, Hawaiian Noddy, Titerack.

POLYTYPIC Nominate *minutus* breeds from Tuamotu to Samoa, New Caledonia, New Guinea, Kermadec, Norfolk and Lord Howe Is and Aust. Subspecies breeding Ashmore Reef, e. Indian Ocean, not known. Extralimitally, subspecies *worcesteri* (McGregor, 1911) breeds islands off Philippines, Sumatra and possibly Maldives; subspecies *marcusi* (Bryan, 1903) breeds Marcus and Wake Is and throughout Micronesia to Caroline I.; subspecies *melanogenys* Gray, 1846, breeds Hawaiian Is; subspecies *diamesus* (Heller & Snodgrass, 1901) breeds off w. Central America, on Clipperton Is and Cocos Is; subspecies *americanus* (Mathews, 1912) breeds Caribbean; subspecies *atlanticus* (Mathews, 1912) breeds Atlantic Ocean, from St Pauls Rocks to St Helena and Ascension I.

FIELD IDENTIFICATION Length 35–40 cm; wingspan 65–72 cm; weight 110 g. Medium-sized slender sooty-black tern with: long straight slender bill, about one-third longer than length of head; long narrow wings; and medium-length tail, with shallow fork when closed but somewhat wedge-shaped (with shallow central notch) when spread, and falling level with tips of folded primaries at rest. Smaller and slimmer than Common Noddy *Anous stolidus*, with much longer, slimmer and straighter bill. Slightly larger but very similar in shape to Lesser Noddy *Anous tenuirostris*. General appearance similar to other noddies but plumage blacker and more uniform above

and below, with bolder and more contrasting white cap and paler greyish centre to uppertail. Sexes alike. No seasonal variation. Juvenile distinct. First immature separable.

Adult Forehead and crown, white, forming conspicuous pale cap, grading evenly into pale blue-grey or silvery nape. Rest of head and neck, brown-black, with contrasting black loreal patch in front of eye, sharply demarcated from white forehead in usually straight (though sometimes curved) line between eye and bill; and small white patch above and narrow white arc below eye, giving spectacled appearance; when plumage fresh, have faint grey bloom on hindneck and sides of neck. Rest of upperparts, uniform brown-black, except centre of tail, which is contrastingly paler and greyer (and conspicuous on bird seen from above and behind in strong light). Underbody and underwing-coverts, brown-black; coverts contrast with slightly paler, glossy and reflective remiges to give subtle two-tone pattern to underwing in good light or when close. Plumage slightly browner with wear but retain blackish tone. Bill, black. Iris, black-brown. Legs and feet, dull red-brown to yellow-brown; webs, dull orange or dull pink, sometimes dark brown. **Juvenile** Similar to adult, differing by: Forehead, crown and nape, white, forming more sharply demarcated and more extensive white cap; brown-black hindneck lacks grey or silvery tones of adult. Upperparts, brown-black, with varying pale edges to feathers: some have faint, paler, grey or brown scaling on mantle, scapulars and innerwing-coverts when plumage fresh; in others, pale scaling barely apparent,

Plate 46

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

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

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

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

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

even when close. Tail, less deeply forked; brown-black, with less distinct grey centre, appearing only slightly paler than upperparts and not contrasting as much as in adult; when fresh, central rectrices have obvious pale-grey fringes. Underparts slightly paler and browner than in adult, with faint, paler grey or brown scaling on breast when plumage fresh and pale-grey or brown tips to undertail-coverts. Bare parts similar to adult but bill shorter; legs and feet duller, brown-black in some. **First immature non-breeding** Pattern of head and white cap like that of juvenile. Mantle and underparts like those of adult; rest of upperparts and upperwing like juvenile but without pale scaling. Tail-fork and bill-length as in adult.

Similar species Sooty-black plumage, with conspicuous white cap, and tail with shallow fork or gentle wedge-shape, distinguishes Black Noddy from all seabirds except **Common** and **Lesser Noddies** (q.v.). Could also be confused with juvenile **Sooty Tern** (q.v.); and small all-dark jaegers *Stercorarius* (see comments under Lesser Noddy).

Gregarious; usually seen in flocks, sometimes in hundreds when feeding, in tropical and warmer subtropical waters. In some parts of non-breeding range, forage close inshore off ocean beaches; also roost on offshore rock stacks. Feed and roost with other terns, especially Common Noddies; join feeding flocks of other seabirds, such as terns and shearwaters. Trotting gait similar to that of Common Noddy. In light winds, flight direct and low to water, with continuous shallow wing-beats, with slightly more emphasis on downstroke; in stronger winds, flight low and direct but with some side-slipping, and slightly faster and more powerful wing-beats. Flight slightly faster, more buoyant and fluttering than in Common Noddy. Flight silhouette somewhat front-heavy, with projection in front of wings about two-thirds of that behind wings, which, with medium-length tail, gives compact appearance; silhouette very different from that of Common Noddy, wings appearing slightly shorter, broader, and often slightly straighter. When closed, tail has straight or gently convex sides, shallow fork at tip and pointed corners; when spread, looks broad, with narrow base, curved sides, and somewhat wedge-shaped tip, with ragged corners and shallow central notch. When feeding, often congregate in dense flocks over surfacing shoals of fish; feed by hovering just above surface before plunging feet first, then lifting off with fluttering wing-beats, or dipping to surface to snatch prey with bill. Loaf in flocks on beaches and coral cays; in some areas, roost on buoys, posts, roof-tops and other structures; often settle on small boats or flotsam. Also settle on water, floating buoyantly like small gull, showing shaggy rear-end. Voice, harsh staccato rattle; abrupt *kerr*; and crackling *kik kirrik*.

HABITAT Wooded tropical or subtropical islands and surrounding seas; either on seaward side of nearshore reefs or farther out to sea.

Mostly breed in tall (often broad-leaved) trees, usually in sheltered situations, such as in middle of island or in protected gullies. Vegetation varies from dense forest to exposed marginal scrub, though vegetation that is too dense or too exposed usually avoided (Hindwood *et al.* 1963; Bingham 1977; Tarburton 1981; Barnes & Hill 1989). Preferred plant species varies with sites. On most islands of Capricorn Grp, prefer *Pisonia*; use *Ficus* sometimes, avoid *Casuarina* (MacGillivray 1926; Shipway 1969; Braithwaite 1973; Jahnke 1975; Barnes & Hill 1989; Buttmer & Astheimer 1990); on North-West I., prefer *Ficus* (Hulsman *et al.* 1984); on Lady Elliot I., mainly in *Casuarina* (Walker 1989); on Lord Howe I., only nest in

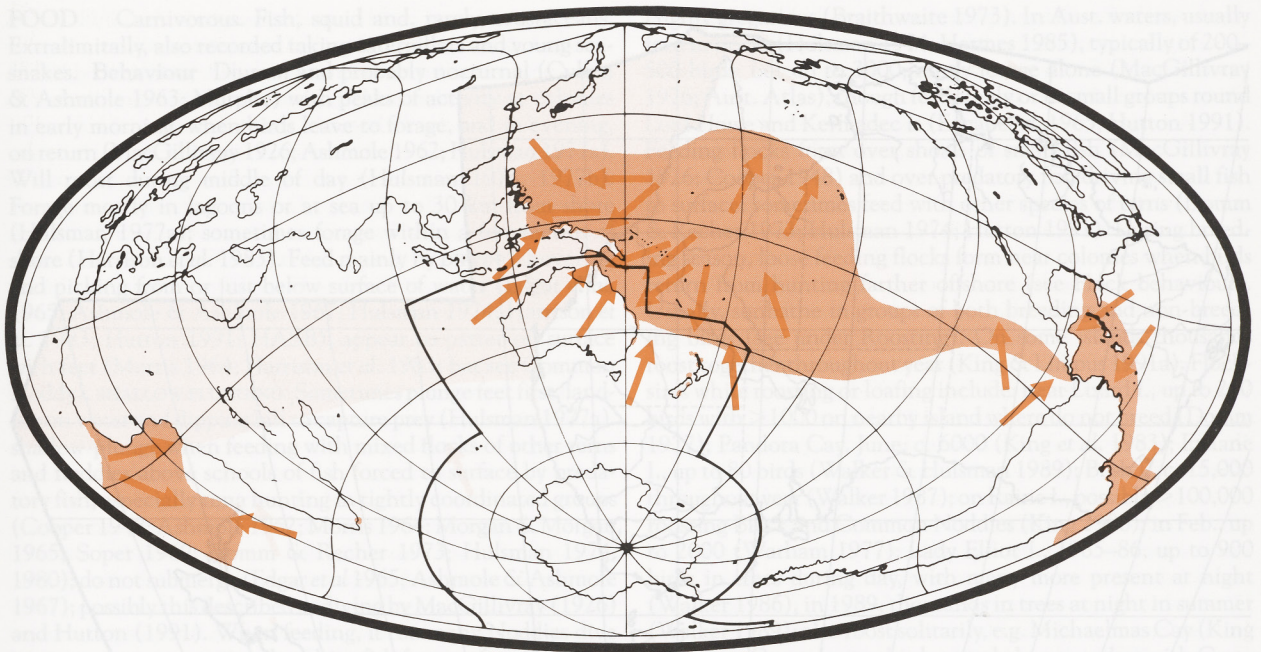
Melaleuca (Hutton 1991); on Norfolk I., use Norfolk Island Pines *Araucaria heterophylla* and White Oak *Lagunaria patersonii* (Wakelin 1968; Tarburton 1981; Schodde *et al.* 1983; Hermes 1985); on Kermadec Is, often in *Pisonia*, Pohutukawa *Metrosideros excelsa* and Ngaio *Myoporum laetum* (Edgar *et al.* 1965; Soper 1969; Merton 1970; Morrison 1979). Rarely nest in *Pandanus* (Braithwaite 1973; Jahnke 1975; Barnes & Hill 1989). May nest in shrubs, including *Messerschmidia*, *Manilkara* and *Sesbania*, usually when no trees available (Hindwood *et al.* 1963; Noske 1974; King *et al.* 1985, 1989; Stokes & Hinchey 1990). On Bird I., nest in mangroves (King & Limpus 1985). Rarely, especially at sites without trees, nest on ground, on edges of cliffs, on rock ledges and in caves (Wakelin 1968; Merton 1970; Morrison 1979). Numbers on Norfolk I. thought to have declined after clearance of forest (Schodde *et al.* 1983).

Feed from or just below surface of water; often well out to sea, between 15 and 30 km from shore (Soper 1969; Merton 1970; Domm & Recher 1973; Hulsman 1977a; Hulsman & Smith 1988; Smith & Ogilvie 1989). May also feed in deep water along reef-edge (Domm & Recher 1973), or water off cliffs, islets or stacks; sometimes with Grey Ternlets *Procelsterna cerulea* (Hutton 1991). Recorded dipping into foam in surf near rocky reef (Sawyer 1974).

Mostly roost or loaf on vegetated islands, usually in tall trees, especially *Pisonia* (Braithwaite 1973; Hulsman 1977b; Walker 1986; Smith & Ogilvie 1989; Walker & Hulsman 1989); occasionally in shrubs (Hulsman 1977b; Morrison 1979; King *et al.* 1985). Once recorded in mangrove forest (mainly *Rhizophora*) on Bird I., Qld (King & Limpus 1985). Sometimes on ground, either on sandy beaches or spits (Braithwaite 1973; Noske 1974; Hulsman 1977b; King 1985), or on rocks and boulders (Wakelin 1968; Soper 1969; Merton 1970). Recorded sheltering from cyclonic winds on tree-branches (Langham 1986).

DISTRIBUTION AND POPULATION Breed mainly in central and sw. Pacific Ocean; breeding populations sparsely scattered elsewhere in tropical and subtropical Atlantic Ocean, Caribbean Sea, e. Pacific, Philippines and Indonesia. In Atlantic Ocean, breed Pagalu and Principe Is in Gulf of Guinea; also scattered on islands from St Helena and Ascension, NW to Fernando de Noronha and St Paul Rocks. In Caribbean, on islands off Venezuela and Belize. In e. Pacific, on Cocos I. (off Costa Rica) and Clipperton I. In central and w. Pacific Ocean, breed from Gambier I., E to Kermadec, Norfolk and Lord Howe Is and e. Aust., and N to Palau, Yap and Marcus Is and Hawaii. Also breed Tubataha Reef in Philippines and in Indonesia; breed Ashmore Reef in Indian Ocean. During non-breeding period, mostly in seas round breeding islands; widespread central and sw. Pacific Ocean, S to coasts of Aust. and NZ; also recorded w. African coast, from s. Ghana to Senegal. Vagrants se. Aust., Gulf of Mexico, and off Honduras; said to have reached Sri Lanka (AOU 1983; de Korte 1984; Garnett 1984; Williams 1984; Coates 1985; Urban *et al.* 1986; White & Bruce 1986; Pratt *et al.* 1987; Dickinson *et al.* 1991).

Aust. Mostly off ne. and e. coasts of Qld; rarely, coastal NSW. **WA** Ashmore Reef (Stokes & Hinchey 1990), though further study of this population needed. **NT** Single, at sea off Wessel Is, Nov. 1980 (Aust. Atlas; H.A.F. Thompson & D.K. Goodfellow). **Qld** Widespread in seas from Torres Str. S to 17°S; also widespread s. Great Barrier Reef and Capricorn-Bunker Grps S to Lady Elliot I.; regularly to n. Fraser I.; occasionally round North Stradbroke I. (Barry & Vernon 1976; Ingram 1976; Draffan *et al.* 1983; Sutton 1990; *Corella*



Seabird Is Ser.; Qld Bird Reps; Aust. Atlas). NSW Rare visitor (singles unless stated). Long Reef, 8 Feb. 1969 (Hindwood 1970; Sawyer 1974); specimen, 10 km off Terrigal, 15 Mar. 1969 (Hindwood 1970); Forster, 3 Apr. 1972 (NSW Bird Rep. 1972); Muttonbird I. NR, Coffs Harbour, 30 May 1977 (NSW Bird Rep. 1977); Toronto, 20 Mar. 1978 (NSW Bird Rep. 1978); Nambucca Heads, 30 Nov.–23 Dec. 1980 (NSW Bird Rep. 1980; Aust. Atlas); Ballina: 24 Jan. 1982, 18–19 Feb. 1984, 1 Mar. 1984, 15 and 17 Feb. 1985 (NSW Bird Reps 1982, 1984, 1985); Woody Head, 7 Feb. 1982 (NSW Bird Rep. 1982); C. Byron: 6 Mar. 1982, 12 May 1983, three, 26 July 1987 (NSW Bird Reps 1982, 1983, 1987); beachcast, Brunswick Heads, 5 May 1983 (NSW Bird Rep. 1983); beachcast, Red Rock, 22 Oct. 1986 (NSW Bird Rep. 1986); two, Broken Head, 23 July 1987 (NSW Bird Rep. 1987); Station Ck, Yuraygir NP, 13 Dec. 1990 (NSW Bird Rep. 1990). Vic. Single, Airey's Inlet, 26–27 Dec. 1991 (R. Drummond).

NZ Rare visitor; mostly after strong or cyclonic winds (singles unless stated). NI South Kaipara Head, 10 Oct. 1953 (Sibson 1955); specimen, near Woodhill, Kaipara, 5 Aug. 1964 (Sibson 1965); Spirits Bay, 10 Jan. 1965 (MacDonald 1965); Whangarei Heads, 13 Feb. 1965 (Robb & Robb 1965); specimen, Houhara Harbour, Mar. 1975 (CSN 22); beachcast, Muriwai Beach, Jan. 1986 (Powlesland 1989); beachcast, Karikari Bay, 27 Jan. 1986 (Dowding 1987; Powlesland 1989); Three Kings Is, 13–14 May 1989 (CSN 37); beachcast, between Maunganui Bluff and Pouto, near Dargaville, Oct. 1989, Nov. 1989 (Powlesland *et al.* 1992); Rangaunu Harbour, 2 Sept. 1990 (Guest 1991). SI Farewell Spit, 27 Jan. 1961 (Bell *et al.* 1961); two, 8 km NE of mouth of Waipara R., 3 May 1975 (CSN 22); Taiieri R. Mouth, 3 Apr. 1977 (Westerskov 1977).

Lord Howe I. First recorded Feb. 1909, c. 50 birds (Basset Hull 1909); three published records between 1950 and 1963 (McKean & Hindwood 1965); several records in 1970s, up to 30 birds at a time (NSW Bird Reps). Breeding suspected long before confirmation in 1989 (Hutton 1991).

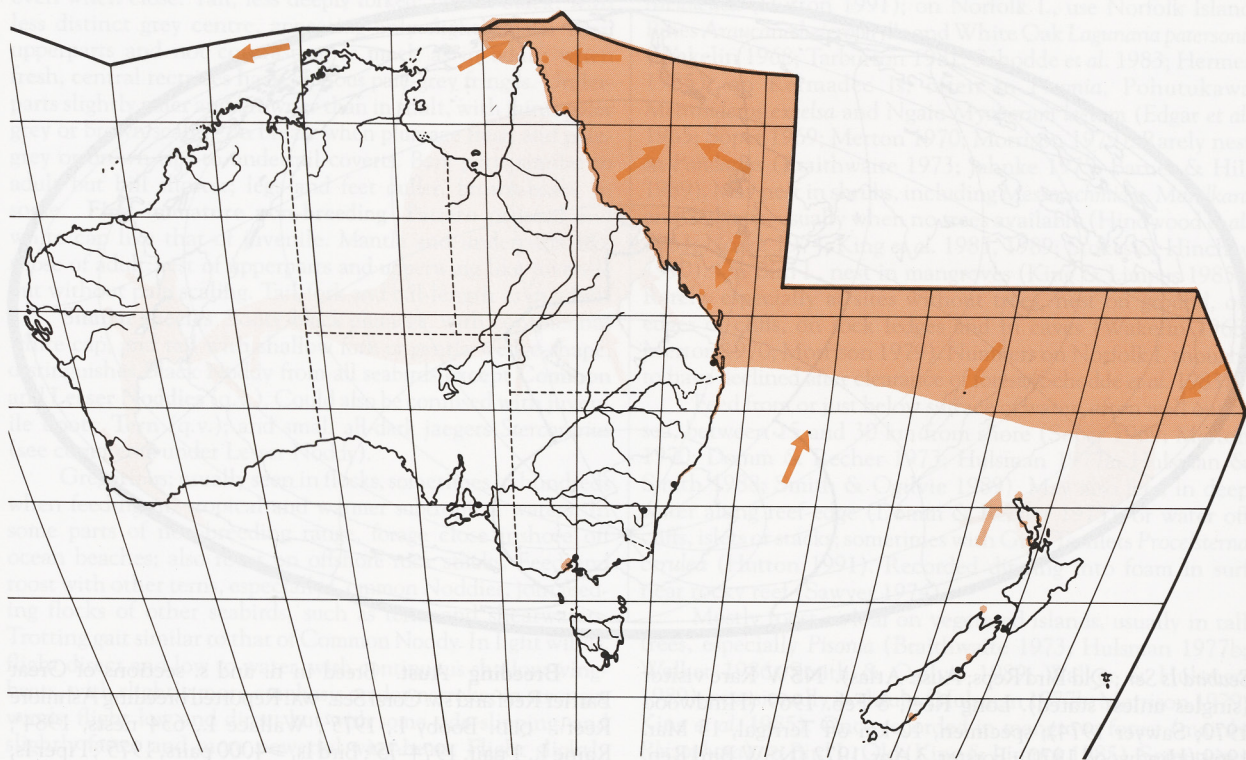
Norfolk I. Breeding resident.

Kermadec Is Non-breeding visitor to Raoul I.; breed Meyer Isl. and s. islands.

Breeding Aust. Breed in n. and s. sections of Great Barrier Reef and sw. Coral Sea. wa: Reported breeding Ashmore Reef¹. QLD: Booby I., 1975²; Wallace I., 634 nests, 1984³; Raine I., 1 pair, 1974–75⁴; Bird Is, ≥ 4000 pairs, 1975⁵; Piper Is, 1000+ birds, 1984⁶; Quoin I., 800 nests¹¹; Chapman I., >3000 nests, 1984⁷; Lady Musgrave I.¹³; Sherrard I., >500 nests, 1987¹⁰; Combe I., 1 nest, 1984¹²; Michaelmas Cay, 1–2 pairs attempted breeding, 1972^{3,14}; Magdelaine Is (South East Cay)^{13,15}; Coringa Grp (Chilcott I., South West Isl.)^{13,15}; Herald Grp (North East Cay)^{13,15}; Diamond Is (West, Mid, East, South West Isl.)^{13,15}; Tryon I., historical and probably false breeding record^{16,17}; North West I., 91,000 pairs¹⁸; Wilson I., 5 pairs, 1990²⁰; Heron I., $40,718 \pm 3214$ pairs, 1985²²; Erskine I., 4 nests (possibly practice nests), 1984¹⁹; One Tree I.²³; Masthead I., 75,000–85,000 pairs, 1972²⁴, though figure over estimate¹⁸; Hoskyn I.⁶; Fairfax Is: East Cay, 2100 pairs, 1990; West Cay, >2100 pairs, 1990²¹. **Lord Howe I.** Confirmed in 1989, when 36 pairs nested²⁵. **Norfolk I.** 1000s of birds in five colonies; also 1000–10,000 pairs breed in scattered groups on Philip I.^{26,27,28}. Possibly breed on islets N of Norfolk I.²⁷. **Kermadec Is** On North and South Meyer Isl. (c. 1000 pairs), Macauley I. and L'Esperance Rock^{29,30,31,32,33}.

REFERENCES: ¹ Stokes & Hinchey 1990; ² Garnett *et al.* 1988; ³ King 1985; ⁴ King 1986; ⁵ King 1991; ⁶ King 1993; ⁷ King & Limpus 1985; ⁸ King & Limpus 1989; ⁹ King & Limpus 1991a; ¹⁰ King & Limpus 1991b; ¹¹ King & Buckley 1985; ¹² King *et al.* 1985; ¹³ HASB; ¹⁴ Noske 1974; ¹⁵ Hindwood *et al.* 1963; ¹⁶ MacGillivray 1928; ¹⁷ Hulsman *et al.* 1993; ¹⁸ K. Hulsman; ¹⁹ Walker & Hulsman 1989; ²⁰ Walker & Hulsman 1993; ²¹ Walker *et al.* 1993; ²² Barnes & Hill 1989; ²³ Hulsman 1979; ²⁴ Jahnke 1977; ²⁵ Hutton 1991; ²⁶ Moore 1985; ²⁷ Hermes *et al.* 1986; ²⁸ P.J. Fullagar; ²⁹ Edgar *et al.* 1965; ³⁰ Soper 1969; ³¹ Merton 1970; ³² Morrison 1979; ³³ Tennyson & Taylor 1989.

Populations No estimates other than colony sizes (see above). On Heron I., Capricorn Grp, number of breeding pairs has increased: in 1910, 53 nests; in 1965, 8500 pairs; in 1978, 13,000–28,000 pairs; estimates of breeding pairs in 1980s: 29,349 in 1982–83; 36,855 in 1983–84; $40,718 \pm 3214$ breeding pairs in 1985 (Shipway 1969; Kikkawa 1970; Ogdin 1979; Hulsman 1983, 1984; Barnes & Hill 1989).



On Norfolk I., during breeding season, boys known to knock down flying birds with sticks for use as bait (Wakelin 1968). On Kermadec Is, sometimes eaten by cats (Merton 1970). Occasionally collide with lighthouses (Stokes 1983).

MOVEMENTS Considered sedentary in Aust., most populations remaining on breeding islands throughout year, though regularly move away from some islands when not breeding, and some long-distance movements recorded. Movements of Kermadec Is populations not known. Extraliminally, some populations considered dispersive or migratory (Diamond 1978; Coates 1985). Appear to be more sedentary than other noddies. One subspecies, nominate *minutus*, in HANZAB region; breeds from Tuamotu to New Guinea, Samoa, New Caledonia, Aust. and Kermadec Is; recorded as far W as Flores Sea. Band-recoveries suggest at least some movements between island groups in Pacific Ocean (birds banded Fiji recovered 1400–2900 km away in Solomon Is) (Medway & Wells 1976; Harrison 1983; van Halewyn & Norton 1984; Coates 1985; White & Bruce 1986; Tarburton 1987; van Marle & Voous 1988; Dickinson *et al.* 1991; HASB; Aust. Atlas). Rest of account refers to nominate *minutus*. Exhausted birds sometimes land on boats (HASB).

Non-breeding Range not known. Remain on many breeding islands throughout year, e.g. Heron I. (Barnes & Hill 1989). On some islands, lower numbers recorded in non-breeding season, e.g. few present Fairfax Is in winter (Walker *et al.* 1993). Recorded away from breeding areas: roost on islands where breeding does not appear to occur, e.g. Tryon I., Great Barrier Reef (Hulsman *et al.* 1993), and even regarded as regular or common visitor to some islands where breeding not recorded, e.g. Lizard I., Bushy I. (Domm 1977; Walker 1987). On some islands where little breeding, large populations recorded throughout year, e.g. Raine I. (King 1986). On some

non-breeding islands, highest numbers recorded during windy weather, e.g. Lizard I. (Domm 1977). Some also recorded considerable distances from breeding islands, e.g. coastal NSW, 725 km from nearest potential breeding island (Hindwood 1970; Hutton 1991). On mainland Aust., seasonal trends in records in some areas, e.g. most sightings North Stradbroke I., Dec.–May (Smyth & Corben 1984); in other areas no apparent seasonality, e.g. recorded all seasons in NSW (NSW Bird Reps). Records from NZ mainland often associated with poor weather (Robb & Robb 1965; Westerskov 1977). Claim that Kermadec Is population move elsewhere outside breeding season (Cheeseman 1890) needs confirmation.

Return Poorly known; on Fairfax Is, main population returns to breed Aug.–Sept. (Walker *et al.* 1993).

Breeding Breed seasonally on some islands, throughout year on others, e.g. Quoin I., Wallace I. (King & Buckley 1985; King & Limpus 1989); possibly breed irregularly on some islands, e.g. Booby I. (Garnett *et al.* 1988). In Capricornia Section of Great Barrier Reef, 1983–84, most foraged within 6 km of colonies; on Masthead I. foraged up to 30 km from nearest nesting colony (Hulsman 1977b, 1984).

Dispersal of young Poorly known; possibly move long distances and rapidly. Bird banded as juvenile on Heron I. sighted c. 980 km away when no older than 21 weeks (Ogilvie & Humphery-Smith 1989). Suggested that at least part of non-breeding population in n. Great Barrier Reef are young from breeding populations in s. Great Barrier Reef or Coral Sea (King 1993).

Banding Longest recorded movement within HANZAB region, c. 980 km (Ogilvie & Humphery-Smith 1989). Bird banded Heron I., recaptured near banding site over 6 years later (ABBBS 1986). Though fidelity to natal colony not known (Ogilvie & Humphery-Smith 1989), birds banded as nestlings recovered at banding site over 9 years later (ABBBS 1992).

FOOD Carnivorous. Fish, squid and, rarely, crustaceans. Extraliminally, also recorded taking caterpillars and young sea-snakes. **Behaviour** Diurnal and probably nocturnal (Cullen & Ashmole 1963; Murphy) with peaks of activity at colonies in early morning, when birds leave to forage, and in evening, on return (MacGillivray 1926; Ashmole 1962; Hulsman 1977a). Will roost during middle of day (Hulsman 1974, 1977b). Forage mostly in lagoons or at sea up to 30 km from shore (Hulsman 1977a); sometimes forage within a few metres of shore (Harrison *et al.* 1983). Feed mainly by DIPPING, hovering and picking from or just below surface of water (Edgar *et al.* 1965; Ashmole & Ashmole 1967; Hulsman 1974; Harrison *et al.* 1983; Hutton 1991; HASB); appear to patten on surface with feet (Morris 1964; Harrison *et al.* 1983; but see Common Noddy). SHALLOW PLUNGING: Sometimes plunge feet first, landing on water and dipping bill to capture prey (Hulsman 1977a). shallow-plunge when feeding with mixed flocks of other terns and noddies above schools of fish forced to surface by predatory fish, especially tuna hunting in tightly coordinated groups (Cooper 1948; Ashmole 1962; Morris 1964; Morgan & Morgan 1965; Soper 1969; Domm & Recher 1973; Hulsman 1974, 1980); do not submerge (Edgar *et al.* 1965; Ashmole & Ashmole 1967); possibly this described as diving by MacGillivray (1926) and Hutton (1991). When feeding, if too many Noddies dive into water at any one time they drive fish from surface (Hulsman 1980). Recorded taking fish from shallow pools (Ashmole 1962) and as they jump clear of water (Murphy). Rarely have food stolen by other birds. Skim water with bill to drink (Braithwaite 1973; Hulsman 1974, 1975).

Adults No detailed studies in HANZAB region. Plankton; Molluscs: gastropods³; cephalopods⁵; Crustaceans⁸; Fish^{2,8,9}; Atherinidae^{1,9}; *Hypoatherina uisila*⁵, *Praneus capricornensis*⁵; Blenniidae⁵; Clupeidae: *Spratelloides delicatus*⁴, *S. japonicum*², *Sardenella jussieu*⁴; Engraulidae⁴; *Engraulis australis*^{5,6,7}. (REFERENCES: ¹ MacGillivray 1926; ² Cooper 1948; ³ Soper 1969; ⁴ Domm & Recher 1973; ⁵ Hulsman 1977a, ⁶ 1978, ⁷ 1980; ⁸ Hutton 1991; ⁹ Smith 1993). Grit, pebbles and feathers (Soper 1969).

Extraliminally, detailed studies on Christmas I. (Pac.) (110 regurgitations, 2004 items; Ashmole & Ashmole 1967) and on nw. Hawaiian Is (494 regurgitations, 6224 items from 390 adults and 104 chicks; Harrison *et al.* 1983). On Christmas I. (Pac.): squid 3.5% no., crustaceans 1.0, fish 95.5; on nw. Hawaiian Is, molluscs 6.8% vol., 2.7% no., crustaceans 0.6%, 1.5%, insects tr., tr., fish 82.6%, 95.8%. Some other extralimital observations in Ashmole (1962), Morgan & Morgan (1965) and Tarburton (1978).

Young Fed by regurgitation. At first, fed every 4 h; intervals become increasingly longer over time (Soper 1969). Adults make 2–4 trips/day to feed chicks (Hulsman 1980). Fed whole or nearly whole fish (Hulsman 1980; Congdon 1990), though on Kermadec Is, said to be given thin oily liquid for first 3 days and, later, a thick salmon-coloured paste (Soper 1969).

Intake In Capricorn Grp, one regurgitation contained 50 atherinid fish, 25–38 mm long (MacGillivray 1926). In Fiji, chick regurgitated eight young sea-snakes *Laticauda* 90–150 mm long (Tarburton 1978). On Christmas I. (Pac.), average volume of three largest regurgitations was 17.2 ml or 19% of body-weight (Ashmole & Ashmole 1967). On nw. Hawaiian Is, average volume of regurgitate, 5 ml, containing average 12.6 prey items, 34 mm long (5–167; 1038), most were 20–50 mm long (Harrison *et al.* 1983).

SOCIAL ORGANIZATION Some aspects well known.

Highly gregarious (Braithwaite 1973). In Aust. waters, usually feed in flocks (Hulsman 1974; Hermes 1985), typically of 200–500 birds, but up to 3000; rarely forage alone (MacGillivray 1926; Aust. Atlas), though feed singly or in small groups round Lord Howe and Kermadec Is (Edgar *et al.* 1965; Hutton 1991). Feeding flocks form over shoals of small fish (MacGillivray 1926; Cooper 1948) and over predatory fish driving small fish to surface; sometimes feed with other species of terns (Domm & Recher 1973; Hulsman 1974; Hutton 1991). During breeding season, loose feeding flocks form near colonies when birds return from hunting farther offshore (see Flock behaviour). Usually, sunbathe in groups of both breeding and non-breeding birds (see under Roosting). On some islands thousands roost together throughout year (King & Limpus 1991a). Flock-sizes while roosting or loafing include: near Lizard I., up to 200 birds with >1000 on nearby island where do not breed (Domm 1977); Pandora Cay, June, c. 6000 (King *et al.* 1983); Erslane I., up to 80 birds (Walker & Hulsman 1989); Bush I., c. 15,000 throughout year (Walker 1987); on Raine I., possibly >100,000 roosting Black and Common Noddies (King 1986); in Feb., up to 2000 (Warham 1977); Lady Elliot I., 1985–86, up to 900 birds in trees during day, with many more present at night (Walker 1986), in 1989, thousands in trees at night in summer (Walker 1989); also roost solitarily, e.g. Michaelmas Cay (King 1985); on Green I., two birds rested close together with Common Noddies (Noske 1974). Occasionally rest during day with other species of terns (Hulsman 1977b). Non-breeding birds observed in breeding colonies, especially at night (e.g. Braithwaite 1973; Walker 1986).

Bonds Monogamous. No details on length of pair-bond, though possibly related to permanence of nest-site (Fisk 1977). **Parental care** Both sexes assist with building nest (North); male appears to collect material, female to build nest (Fisk 1977). Both sexes incubate and feed young (e.g. Gilbert 1926; MacGillivray 1926; Braithwaite 1973; Fisk 1977). Fledged young return to nests late in day and are fed by adults (HASB); said to be dependent on parents for food long after fledged (Pringle 1987; Hutton 1991). Extraliminally, much post-fledging care can occur at nest (Cullen & Ashmole 1963).

Breeding dispersion Colonial. Often in large colonies (tens of thousands), though colonies sometimes smaller (tens) (see Distribution); on some islands, nest singly or only a few pairs nest, sometimes with other noddies (e.g. Wakelin 1968; Noske 1974). On Heron I., in one 5 m tall *Ficus* tree with 12 nests, mean distance to closest nest, 50 cm, but as close as 12.7 cm and one as far as 14 m (Braithwaite 1973); nests as little as 0.6 m apart (Bingham 1977); 143 occupied nests in one tree (Gilbert 1926; MacGillivray 1926); sometimes six or more on one bough (Campbell); sometimes crowded, with over 80 nests in one small tree, but more often scattered (North). Studies of densities on islands with large colonies by various authors (e.g. Barnes & Hill 1989; Dale *et al.* 1984; Hulsman *et al.* 1984), e.g. on Masthead I., taller trees contained more nests than smaller trees and highest nesting densities found in *Ficus opposita* and *Celtis paniculata* (Hulsman *et al.* 1984). **Territories** Defend nest-site (Hulsman *et al.* 1984). Territory sometimes as small as c. 0.09 m² (Gilbert 1926). Defend c. 30 cm in front of bird and c. 10 cm in other directions (Braithwaite 1973); area defended rarely greater than pecking distance (Fisk 1977). Nest-site used for courtship (Fisk 1977). **Home-range** Many forage inshore, though also forage at sea up to 6 km and, occasionally, up to 30 km, from colonies (Campbell & White 1910; Domm & Recher 1973; Hulsman 1977b). When first leave colony in morning, forage over shallow water for

some time before flying offshore; on Heron I., Noddies formed loose feeding flocks over reefs after they returned from feeding at sea (Fisk 1977), though also said to return directly to colony (MacGillivray 1926).

Roosting Communal and usually nocturnal. Roost in trees; on breeding and non-breeding islands (e.g. Domm 1977; see Habitat); some islands have large nocturnal roosting populations throughout year. On Heron I., no evidence that birds hunted at night and little nocturnal movement, though established pairs courted at night (Fisk 1977). Arrive at and leave islands in flocks (Campbell & White 1910). On One Tree I. (non-breeding island), attendance correlated with time of day and not with tidal cycle; most birds left early morning, some returning 08:00–09:00; maximum number on island during daylight between 14:00 and 15:00 (hottest part of day); after 15:00, again left island, returning at dusk (Hulsman 1977b). Pattern on Heron I. (breeding island) similar, at least when birds not feeding young. Elsewhere, return to colony just before dark and leave early morning, e.g. 04:30–05:00 (Gilbert 1926; MacGillivray 1926; Hutton 1991; HASB); also said to arrive after dark and leave before light, but, if weather overcast and windy, occasionally return mid-afternoon (Walker 1987). During day, rest on water in rafts (Hulsman 1977b), or roost or loaf on land (e.g. MacGillivray 1928; Domm & Recher 1973; Hulsman 1977b; King 1985), e.g. during breeding season, many in flocks of 25–50 on beach (Gilbert 1926). Large numbers congregate on breeding islands before laying, where observed throughout day (Campbell & White 1910); Braithwaite 1973; Domm & Recher 1973; Walker 1986). On Heron I. in non-breeding season, few stay on island during day if sea calm (Kikkawa 1970). **Sunning** Often seen; studied on Heron I. by Cannon (1979). Use variety of non-nesting sites for sunning, resting, and preening; prefer sandy areas with temperatures as high as 51°C. Mostly sun with others, average group-size 12 birds (up to 50); mean distance between heads of neighbouring birds, 30.2 cm (12.2; 8–84; 305) but varies with time of day; solitary birds sometimes seen. Upon landing in sunning group, bird often Nods or Foot-looks; while sunning, occasionally Nods, Foot-looks or Head-shakes (see Social Behaviour). **SUNNING POSTURE**: similar to that described and illustrated by Cullen & Ashmole (1963): bird stands side on to sun and extends one wing and fans one side of tail, as in stretching movement, with extended wing usually lying on spread tail, though occasionally wing fully opened and rested on ground or perch; at times, both wings may be partly extended; almost always pant. Posture may be held for several minutes; bird then changes wings or preens. Right and left wings sunned equally often. During mid-summer, sunbathe for average of 3 min (from a few seconds to >11 min) between 08:00 and 16:00, though varies with time of day. During sunning periods, birds sunbathe for only c. 85% of time; rest of time spent in non-sunning behaviour, such as perching and preening. Braithwaite (1973) reported sunning for much longer periods, up to 20 min, by much smaller sunning groups. Sunning also noted by Hulsman (1977b) and HASB. Soper (1969) recorded sexual behaviour in sunning groups. Possible benefits of sunning discussed by Cannon (1979). Also see Comfort behaviour below.

SOCIAL BEHAVIOUR Detailed extralimital study on Ascension I. (Cullen & Ashmole 1963) with some additional information from Midway Grp (Moynihan 1962). Poorly known in HANZAB region: some information from study on Heron I., Qld by Fisk (1977) and some in Braithwaite (1973). Fisk

(1977) mentions a number of displays performed by birds on Heron I. (see below) and makes some comparisons with displays observed on Ascension I. by Cullen & Ashmole (1963), but only partly describes displays and the circumstances in which they are used. Because the differences in behaviour between Heron I. and Ascension I. are not at all clear, the following does not present the extralimital observations of Cullen & Ashmole (1963), which see for full descriptions. Form and function of behaviour on Ascension I. and Heron I. populations similar, though additional behaviours said to be recorded on Heron I. (Feeding Flock Display and Head-breast Posture) (Fisk 1977). Tame (Campbell), confiding (Wakelin 1968; Noske 1974), not shy (Basset Hull 1909); nesting birds so tame can be caught by hand (HASB). Also said to be shy when first approached (North) and not so tame when incubating (North). **Flock behaviour** Mild Dreads occur when roosting (HASB). Fisk (1977) described **FEEDING FLOCK DISPLAY**: on return to colony in afternoon, birds formed loose feeding flocks over reefs; birds flew in normal feeding pattern low over water, calling constantly, till they reached leading edge of flock, then rose and glided to rear of flock and repeated low flight; may involve many unpaired birds because fewer birds take part as season progresses. **Comfort behaviour** Gregarious sunning behaviour common (see Roosting). Incubating birds exposed to sun will adjust posture, gape or pant, and may leave nests briefly. Birds incubating in full sun gradually raise scapulars, then gape, then either drop wings or pant for short time; will leave nest briefly to wet feathers of belly. Birds on shaded nests tend to sit more tightly on eggs than those in exposed nests (Buttemer & Astheimer 1990; see Breeding).

Displays At colonies, many displays given in both agonistic and sexual circumstances. Following Cullen & Ashmole (1963), interactions observed when a bird approaches another classified as either **HOSTILE**, with one bird driving other away; or **'MEETING'**, where both birds relax or fly off in display flight (Cullen & Ashmole 1963); some interactions not readily classified as either. **NODDING**: As one bird approaches another, or after approach, one normally Nods and other usually responds. Often performed in same circumstances described below under Head-shake. **NOD-PARP**: Like Nodding but bird gives Parp Call as head raised; usually occurs after a vigorous bout of Nodding between birds and precedes Bridling. **FOOT-LOOK**: Bird looks down and away from other bird; usually elicits similar response from other bird; occurs in most interactions. Similar to that described on Ascension I. **HEAD-SHAKE**: Often performed by bird on nest when another lands nearby but does not approach or display; during nest-building, sometimes given by bird at nest waiting for mate to return with nesting material. Often associated with Foot-looking. **BRIDLING**: Occurs in two forms: (1) **BRIDLE-RATTLE**, where display accompanied by rattling sound; and (2) **BRIDLE-CLICK**, which is silent or accompanied by click as bill closed; both similar to that described on Ascension I. On Heron I., Bridle-click always precedes Bridle-rattle when there is gradual build-up of intensity. **GAPING**: Said to differ from that described on Ascension I. but no details given. **LANDING GAPE**: Gape upon landing, whether another bird present or not; very common. Aggressive or sexual behaviour rare in loafing areas (Cannon 1979).

Agonistic behaviour On Heron I., intraspecific aggression said not to be as common as reported on Ascension I. (Braithwaite 1973; Fisk 1977), though Braithwaite (1973) considered it still common. Distance defended round individuals and nests rarely greater than pecking distance (Fisk

1977). When both parents away, older chicks defend nests against intruding adults (see Anti-predator responses of young). Nesting birds will steal nesting material from one another (MacGillivray 1926). **Territorial advertising** Bridling appears to advertise ownership of territory (also used in courtship; see below); seen only a few times in Hostile situations (Fisk 1977). **Threat** On Ascension I., Nodding used as a short-range hostile display. On Heron I., Nod-Parp, seen in aggressive circumstances and can precede further hostile behaviour. Established pairs, when approached by another bird, sometimes turn to each other, Nod until Nod-Parp given, then one of pair turns to intruder and gives a hostile display (Fisk 1977). **CHIN-UP WITH RATTLE** (see Cullen & Ashmole 1963): on Heron I., an aggressive display. Hostile form of Gaping (see Cullen & Ashmole 1963) rarely seen on Heron I. **Fighting** Occurs occasionally, usually when two pairs claim same nesting site (Fisk 1977). **Alarm** When approached by observers before laying, birds fly off calling (Campbell & White 1910). During breeding season, loafing birds take off and fly overhead (Gilbert 1926). See Parental anti-predator strategies.

Sexual behaviour Established pairs court on territories at night (Fisk 1977). **Courtship, Pair-formation** From Fisk (1977) unless stated. Feeding Flock Display (see above) may be social phase of courtship. Pair-formation includes birds performing PAIRED FLIGHTS similar to those described on Ascension I. Paired Flights usually develop from Feeding Flock Display and lead to ground displays; can also occur after birds have been courting on ground, one bird simply taking off and other following, or one bird repeatedly flying out and in front of other. Once loosely paired, male Bridles to attract female. Bridling may attract other females and, if a number of females approaches male, he may attack all indiscriminately. On ground, members of potential pair usually approach each other with Nodding or some other introductory display; pair avoids aggression by Foot-looking and approaching slowly. Sometimes perform Nod-Parp during courtship. Often build a series of nests during courtship; this behaviour important in formation and maintenance of pair-bond. Said to give HEAD-BREAST POSTURE (not recorded Ascension I. and not described by Fisk [1977]) when passing nesting material, and to display between delivery of each piece. Each courtship nest usually close to previous ones. Both members of pair appear to select nest-site by placing nesting material at site; do not usually perform courtship behaviours while building egg-nest. Occupy nest continually for some time before laying, one bird sitting while other feeds. Maintenance of pair-bond appears to involve Nodding, allopreening and courtship feeding. MacGillivray (1926) also described courtship: male sidled along branch to female while bobbing head and calling; male then caressed head, neck and bill of female with bill; female made rattling call while bobbing head with bill wide open, and male then fed female. **Courtship feeding** Female begs with head and neck kept low and bill pointing upwards (HASB); male regurgitates and female takes fish by putting bill across his gape (MacGillivray 1926; Soper 1969). Head-breast Posture (undescribed) also said to be used by pair during courtship feeding (Fisk 1977). Courtship feeding common during courtship and at nest, particularly at change-over during incubation (MacGillivray 1926; Braithwaite 1973; Fisk 1977). **Greeting** In 'Meeting' interactions, Bridling often followed by Nod-Parp (Frith 1977). At change-over during incubation, may Nod, allopreen and courtship-feed; after hatching, change-over direct and without ceremony (Gilbert 1926; MacGillivray 1926; Braithwaite 1973). Calls possibly used to recognize mate:

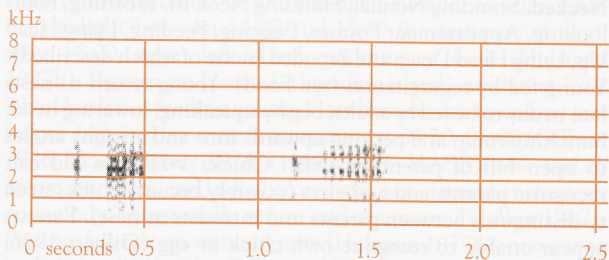
in established pairs, incoming bird normally calls before landing and, in response, resident Bridles immediately and few or no introductory displays given (Fisk 1977). **Allopreening** Probably used in maintenance of pair-bond; occurs during change-over; non-sitting bird also seen to preen sitting bird (Gilbert 1926). **Copulation** Said to take place mostly at night or just before dawn and seldom seen during day (Fisk 1977). Seen to occur at nest-site (Soper 1969). Recorded in association with courtship feeding (MacGillivray 1926).

Relations within family groups Congdon (1991) recognized five categories of postures of adults tending young: Standing Normal, Foot-looking, Preening, Feeding or Brooding; also observed 11 distinct postures of chicks: Standing Long Necked, Standing Normal, Standing Neck In, Preening, Foot-looking, Appeasement Posture, Begging, Feeding, Lying Head Up, Lying Head Down and Brooded (none of which described). Young fed by regurgitation (see Food). Young return to nests late in day to be fed by adults; beg by squeaking, lowering head, hunching rump and pecking upwards into and at right angles to open bill of parent (HASB). Chicks >28 days old can recognize parents and nest-sites (possibly because chicks need to distinguish between parents and intruders at nest). Parents appear unable to recognize own chick or egg (Gilbert 1926; Braithwaite 1973; Congdon 1991), though chicks >28 days old that have fallen from nest have been attended by adults on ground, with recognition possibly by call (Congdon 1991); others have found adults ignore chicks that fall to ground (e.g. Braithwaite 1973; Langham 1986). Adults will raise to fledging a second chick introduced to nest but, after 28 days, aggressive interactions between the two chicks common and one often forced from nest onto nearby branches (Congdon 1990). **Anti-predator responses of young** When both parents away, chick defends nest against intruding adults; chick may be badly pecked or ejected from nest if it responds passively to intruders (Congdon 1991). **Parental anti-predator strategies** For first few days after hatching, chick attended constantly by one parent (Braithwaite 1973); on Kermadec Is, one chick was brooded continuously for first 3 days, then, for next 3 weeks, one parent squatted nearby and guarded chick (Soper 1969). On Heron I., Noddies respond to Eastern Reef Egrets *Egretta sacra* (which eat eggs and young) with vigorous alarm calls. Said to attack White-breasted Sea-Eagles *Haliaeetus leucogaster* fearlessly (Gilbert 1926) but also said to remain silent and not give Alarm Calls (Braithwaite 1973). Said not to be easily disturbed from nests, allowing observers to pass quite close before flying off (Campbell & White 1910; North) or, when within reach, sidling along branch and calling (Basset Hull 1909). Circle and call overhead *en masse* if disturbed after dark (North).

VOICE Only anecdotal information in HANZAB area. Elsewhere, many calls and associated displays described by Cullen & Ashmole (1963). Colonies noisy: continual chattering at large colonies; at night, rattling calls likened to frogs in swamp (Wakelin 1968; North). When threatened, birds circle above people, screaming and chattering; after disturbance at colony, calls of birds in flight said to be audible >1.5 km from shore (Gilbert 1926); give alarm calls in response to Eastern Reef Egret, but not to White-bellied Sea-Eagle (Braithwaite 1973). Birds in feeding flock call constantly (Fisk 1977). Bird at nest appears to recognize mate from its call before it lands (Fisk 1977). Adults and chicks can recognize each other before chick leaves nest; means of recognition thought to be vocal (Congdon 1991). **NON-VOCAL SOUNDS:** Distinct click of

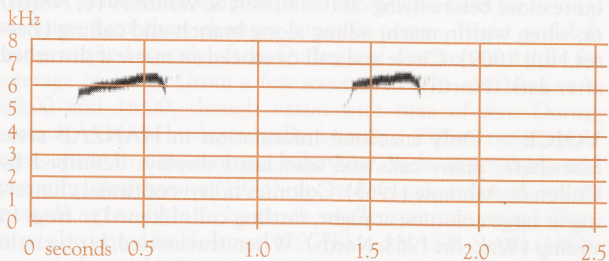
closing bill may accompany Bridling (Bridle-click) (Fisk 1977); great flapping of wings when birds fly off after being disturbed (Campbell & White 1910).

Adult More than one of the following descriptions may refer to the same call. **RATTLE**: Harsh and staccato rattle, likened to noise of loosely running cogwheels (Gilbert 1926); sonagram A shows two rattles, each similar to the *kik-krrrrr* described by Cullen & Ashmole (1963). Used in alarm (HASB). Given with Bridling (Bridle-rattle) and Chin-up With Rattle (Fisk 1977). **SCREECHING**: Deep screeching. Given in alarm by perched pairs of courting birds, when disturbed by person (Campbell & White 1910). **KERR**: Sharp *kerr*; used during Dreads (HASB). **CRACKLING CALL**: sustained *krikrikrik*.



A C. & L. Weismann; Heron I., Qld, Sept, 1957; P39, P105

Normal flight call, and often used when perched; used during mild clashes at roosts, starting slowly, speeding up, and ending slowly (HASB). Loud harsh crackling *kriii-yaah* given in flight by vagrant in NZ (Westerskov 1977). **TITERACK**: Querulous cry uttered when leaving nest to sidle along branch when person too close; on Norfolk I., Titerack vernacular name for Black Noddy (Basset Hull 1909). **PARP CALL**: Given with Nodding (Nod-Parp); display and call normally only given once, but may be repeated (Fisk 1977). **CROAKING**: Deep croaking given during courtship, when perched side by side, with calling alternating between one bird and the other; described as frog-like, or sometimes like stridulations of insects (Campbell & White 1910; Gilbert 1926; MacGillivray 1926). **PURRING**: Constant purring accompanies nocturnal courtship (Fisk 1977). **PRE-COPULATORY CALLS**: Male utters *kedrutt*, *kedrutt*, *kedrutt urrutt*, *urrutt* when sidling along branch towards female; female gives rattling and guttural call in response to Pre-Copulatory Call of male (MacGillivray 1926; HASB). **CHUCKLE**: Uttered by male before change-over during incubation (Gilbert 1926).



B C. & L. Weismann; Heron I., Qld, Sept, 1957; P39

Young Chicks 1–2 days old utter sweet but subdued *swee-oo swee-oo* (Gilbert 1926); see sonagram B. Chicks swapped to other nests gave *chirping* calls when parents seen at original nest (Congdon 1991). Juveniles supplicate with sibilant squeaking *see-ew*, much more piercing than that of Lesser Noddy (HASB).

BREEDING Fairly well known. Studied on Heron I. (Braithwaite 1973; Barnes & Hill 1989; Buttemer & Astheimer 1990; Congdon 1990), and on Masthead I. (Dale *et al.* 1984; Hulsman *et al.* 1984). Seven records in Aust. NRS up to Oct. 1993. Usually colonial.

Season Capricorn Grp: protracted; eggs, Oct.–Mar., peak in Nov. and Dec.; building, incubating and young recorded late Nov. to mid-Dec. (Campbell & White 1910; MacGillivray 1926; Kikkawa 1970; Aust. NRS). Norfolk I.: Oct.–Mar.; eggs, Nov. and Dec. (Basset Hull 1909; Tarburton 1981; Schodde *et al.* 1983); building starts Oct.; first eggs, early Dec., with peak laying over by end Jan.; young, Jan. to mid-Apr. (Hermes *et al.* 1986); eggs in mid-Feb. (Aust. NRS). Kermadec Is: eggs, Oct. to late Jan. (Sorensen 1964; Edgar *et al.* 1965; Merton 1970). Ashmore Reef: nesting, Mar.–Sept.; peak laying, June–July (Stokes & Hinchey 1990).

Site Nest on trees or shrubs; on horizontal or near horizontal limbs or forks, in sheltered locations, in areas with little or no undergrowth (Campbell & White 1910; MacGillivray 1926, 1928; Braithwaite 1973; Barnes & Hill 1989). On Masthead I., prefer shaded sites (Campbell & White 1910); on Kermadec Is, in sunny places, mainly on nw. slopes (Merton 1970); on Heron I., shelter from sun appears unimportant, sites ranging from fully shaded to sites exposed to sun for most of day (Braithwaite 1973; Buttemer & Astheimer 1990). On Heron I., 75% nests in *Pisonia*; also nested in *Ficus*, *Celtis*, *Cordia*, *Argusia*, *Pandanus*, *Casuarina* and other plants (Barnes & Hill 1989). On Masthead I., most nests (49.4%) in *Pisonia* forest 6–8 m tall (Dale *et al.* 1984; Hulsman *et al.* 1984). For further details of vegetation and nesting preferences on Masthead I., see Dale *et al.* (1984) and Hulsman *et al.* (1984). On Lady Elliot I., most nests in *Casuarina*, which cover almost half of island (Walker 1989). On Norfolk I., nests built in White Oaks and Norfolk Island Pines (Tarburton 1981). On Kermadec Is, in Pohutukawa and Ngaio scrub (Edgar *et al.* 1965); on Ashmore Reef in *Sesbania cannibina* bushes (Stokes & Hinchey 1990). On Masthead I. average number nests per tree from 0.3±1.5 in *Pandanus* to 6.0±10.5 in *Celtis*; on Heron I., average from 1.5±1.7 in *Casuarina* to 25.9±6.2 in large *Pisonia* trees (Barnes & Hill 1989); on Heron I., number of nests in *Pisonia*, *Ficus* and *Celtis* generally increase with height of tree (Hulsman *et al.* 1984); up to 143 nests per tree on North West I. (MacGillivray 1926). Height above ground: on Heron I.: 5.3 (1.2–10; 207) (Braithwaite 1973); on North West I.: 0.9–9.1 m, mostly between 6.3 and 7.8 m (MacGillivray 1926). One pair at Norfolk I. nested on cliff, in site exposed to sun but sheltered from wind (Wakelin 1968). Both sexes appear to select site by placing material at chosen site (Fisk 1977); choose site after several inspections (MacGillivray 1926). Nest among Common Noddies on Ashmore Reef (Stokes & Hinchey 1990).

Nest, Materials Well-built platform, with shallow depression in centre; of *Pisonia* leaves, seaweed, grass, rootlets, twigs, feathers, also polythene and hair ribbon (Campbell & White 1910; Bingham 1977; Hulsman *et al.* 1984; Aust. NRS). Pull out rootlets exposed by turtles at night; if straw or bits of string scattered, birds quickly retrieve every piece (MacGillivray 1928). Search ground for faded *Pisonia* leaves; make foundation by folding leaves over a limb, where arranged with bill and trampled down with feet; leaves stuck together by being mixed with seaweed or sticky seeding heads of *Pisonia*, and occasionally consolidated with grass; whole mass built up and cemented into a solid mass with excrement (MacGillivray 1926). Male gathers material and female builds (Aust. NRS).

Nests have approach paths, with returning birds always approaching nest from same direction (Braithwaite 1973). Compete for *Pisonia* leaves when they flutter to ground; material may be stolen from other nests (MacGillivray 1926). Re-use old nests (Braithwaite 1973); all nests in an area gone by next season (Wakelin 1968). Often build several (up to three) courtship nests before egg-nest (Fisk 1977). **MEASUREMENTS** (cm): diameter, 12.7–15.2 (MacGillivray 1926), 17.8–22.9 (Campbell & White 1910); depth, 15.2–20.3; depth of cavity, 3.8 (MacGillivray 1926).

Eggs Typically oval, some varying from short to elongate oval; close-grained, dull, lustreless; ground-colour varies from almost pure white to faint creamy-, reddish- or buff-white, sparingly distributed with irregular spots and blotches of purple and purplish grey, intermingled with faint underlying markings of dull bluish-grey, predominating and often confined to thicker end. Some have penumbral markings, or blurred longitudinal streaks, purplish red in centre and grading to paler dark purplish-red at sides or overlying darker underlying markings of purplish grey. Some have a zone of intermingled, very short fine wavy streaks, or lines and spots of purplish red or purplish grey on thicker end, intermingled with similar wavy markings of faint bluish-grey, and with rest of shell almost devoid of markings (North). On Norfolk I.: elongate or stout oval; white, cream or warm pink, more or less spotted or blotched deep reddish and chocolate-brown, with purple suffusion, scattered over whole shell or forming a cap at larger end; a few eggs white, almost devoid of markings (Basset Hull 1909). **MEASUREMENTS**: (most eggs picked to show variation in size): 45.2 (1.96; 42.4–49.5) x 32.2 (0.80; 30.7–33.3) (North); Norfolk I.: 44.9 (2.12; 41.4–47.2; 6) x 31.5 (0.97; 30.5–33.0) (Basset Hull 1909); Kermadec Is: 44.8 (2.12; 40.0–47.2; 13) x 31.1 (0.97; 29.8–33.0) (A.J.D. Tennyson). **WEIGHT**: Kermadec Is: 20.7 (2.39; 16.0–24.0; 13) (A.J.D. Tennyson).

Clutch-size One (Campbell & White 1910; MacGillivray 1926; Aust. NRS).

Laying Protracted in Capricorn Grp and on Kermadec Is (MacGillivray 1926; Merton 1970); on Masthead I., laying began rapidly, from no eggs on 8 Oct., one egg on 11 Oct., to 84 eggs on 13 Oct. (Campbell & White 1910).

Incubation By both sexes. Change-over can take place at any time of day (MacGillivray 1926); for six 1-h watches during day at 30 nests: incubating birds remained on nest for over 12 h (Braithwaite 1973); stints may last for up to 24 h (Buttner & Astheimer 1990). Birds nesting in unshaded sites on Heron I. repeatedly left nest, flew 50–200 m offshore, then, after drinking, dived, breaking surface of water with feet, and rubbed feet into feathers of breast to soak them; returned to nest with wetted belly feathers, which cool eggs; egg left unattended for average 56 s (45.3; 15–255; 79); incubation resumed straight away or after first covering egg with a wet foot (Buttner & Astheimer 1990). Egg-shells found on ground after hatching (MacGillivray 1926). Incubation period on Kermadec Is: 36 days (Soper 1969).

Young Semi-precocial. Probably remain in nest till fledging. No information on development. **Growth** From growth-curve in Langham (1983): weight (g): at hatching, 17; at 10 days, 63; 20 days, 95; 30 days, 104; reach asymptotic weight of 117 g (102% adult weight) at 31.5 days (though text says 29 days); from Congdon (1984): asymptotic weight, 126 g; reach 95% asymptotic weight 12–20 days before fledging. For details of growth and survival of chicks in artificially enlarged broods with simulated synchronous and asynchronous hatching, see Congdon (1990). **Parental care, Role of sexes** Constantly

attended for first few days; change-overs during brooding probably at intervals of less than 2 h; shade young (Braithwaite 1973). Both sexes feed young; chicks fed at change-over (Braithwaite 1973).

Fledging to maturity No information.

Success Hatching success, 46.2% (Langham 1983); for 11 chicks, four (36%) fledged; five died before and two during a cyclone (Braithwaite 1973; Langham 1986). Eastern Reef Egrets eat young (Braithwaite 1973); fledgelings can become entangled in sticky *Pisonia* fruits and die (Ogden 1979). Mortality of young (% adult population) on Heron I. after cyclones: in 1980, 1.13% and 2.1% for two plots; in 1992, 0.6% for each of two plots; may be slightly higher as some dying chicks may have been taken by Eastern Reef Egrets (Ogden 1993).

PLUMAGES Prepared by K. Bartram. Timing of moults related to timing of breeding. Extraliminally, finish post-natal moult to juvenile plumage when c. 40 days old (Petit *et al.* 1984). Juveniles undergo complete post-juvenile (first pre-basic) moult to first immature non-breeding (first pre-basic) plumage. Subsequent moults and plumages, poorly understood; not known when adult plumage attained. Adults undergo two moults annually: a complete and protracted post-breeding moult and a partial pre-breeding moult, with no seasonal change in appearance. Sexes similar. Geographical variation slight. Nominate *minutus* breeds HANZAB region; described below.

Adult (Definitive basic and alternate). **Head and neck** Forehead and forecrown to just behind level of eye, white, grading to whitish-grey (whitish 86) on rear-crown and nape, and to pale blue-grey (pale 78–85) on rear of nape; forms pale cap. Hidden bases to feathers of cap, light grey (86). Upper ear-coverts, grey (84–83). Lores, malar area, lower ear-coverts, chin and throat, grey-black (82) with thin black line between lores and pale cap; have large patch in front of eye, usually slightly blacker than rest of lores and lower face, though sometimes concolorous. Partly white rims to eyelids form small white spot above anterior half of eye and white crescent below eye. Sides of neck and lower neck, dark grey (83). **Upperparts** Dark grey (83) with olive tinge to mantle, back and scapulars; longest uppertail-coverts contrastingly paler, grey (84). **Underparts** Dark brown (221), slightly darker than upperparts. Undertail-coverts, dark grey (83). **Tail** Grey (84) above, with outer rectrices slightly darker than rest; shafts, dark red-brown (dark 221A) with cream (92) bases. Below, blackish-brown (82–221) with glossy sheen; shafts, cream (c92). **Upperwing** Secondary coverts, dark brown (221). Remiges and primary coverts, blackish-brown with olive tinge (olive 82–221). Very little contrast between coverts and remiges. Shafts of secondaries and inner primaries, black; shafts of outer primaries, black basally and dark red-brown (dark 221A) on distal half. **Underwing** Most coverts, dark grey (82–83). Greater coverts and remiges, slightly paler, grey with silvery sheen (83). Shafts of remiges, buff (124), becoming duller and less well defined on secondaries.

Downy young Down, dark brown (119A–219) with distinct white cap, extending to rear of nape; hidden bases of down of cap, dark brown (119A–219).

Juvenile Similar to adult, differing mainly by more distinct white cap and dark-brown body. **Head and neck** Forehead, crown and nape, white, forming neat cap sharply cut off from dark hindneck, and with thin faint brownish-white barring on rear of crown (quickly lost with wear) grading to slightly broader dark-brown (121) barring on nape; hidden

bases to feathers of cap, dark brown (119A–219). Hindneck, dark brown (121) to dark olive-brown (olive 221) without bluish-grey tones of adult. Lores, black. Rest of head and neck, blackish brown (121–82) with faint pale-grey (86) fringes to feathers of neck and ear-coverts when plumage fresh. **Upperparts, Upperwing** Dark brown (121–221). In fresh plumage, have slightly paler grey fringes to feathers of mantle and slightly paler olive-brown (dark 28) fringes to feathers of rest of upperparts. **Underparts** Dark brown (121–221), slightly darker than upperparts, but paler and browner than in adult. Undertail-coverts have pale-grey tips. In fresh plumage, feathers of breast have faint grey-brown fringes. **Tail** Dark brown (pale 221) or brownish-grey (brownish 83–84), slightly paler than upperparts but not contrasting as much as in adult. In fresh plumage, t1 has pale-grey (86) fringes and other rectrices have faint pale fringes. **Underwing** Coverts, dark grey (83) with light-grey (86) fringes.

First immature non-breeding (First basic). Intermediate between adult and juvenile. Cap, as in juvenile, white and sharply cut off from hindneck; hidden bases to feathers, brownish grey (brownish 85). Mantle and underparts, like adult. Rest of upperparts and upperwing, like juvenile but without pale fringes.

BARE PARTS From photos (Coates 1985; Pringle 1987; unpubl.; NPIAW; D.W. Eades; G.A. Taylor; A.J.D. Tennyson). **Adult, Juvenile** Bill, glossy black; inside of mouth, flesh-pink; tongue, yellow. Iris, black-brown. Legs and feet: tarsus, dull red-brown (dull 132–132A or dull 140) to almost yellow-brown, usually slightly darker at front; webs, dull rufous (dull 41) or dull pink (6–5), sometimes dark brown (129); tops of toes, darker than webs; claws, vary from slightly darker than rest of feet to glossy grey-black (82). Legs and feet incorrectly described as black by most authors. **Downy young** Like adult, but tarsus, darker, and toes, black.

MOULTS Studied on Ascension I., Atlantic Ocean, by Ashmole (1962), on which much of account based. The little Aust. data available is similar to extralimital observations. **Adult post-breeding** (Definitive pre-basic). Complete. Moulting usually starts after breeding, unsuccessful breeders usually starting moulting earlier; in HANZAB region none recorded in moulting during breeding period. Primaries outwards. Moulting of primaries protracted, taking c. 10 months to complete. On Ascension I., most birds had either completed or nearly completed moulting of primaries when nesting started; in n. Qld, specimens had fresh primaries in late winter, before breeding started (see Breeding). On Ascension I., moulting of secondaries begins when about half of primaries replaced, and usually finishes about same time as moulting of primaries, occasionally before and sometimes well after; begins with tertials (s14–s18) and usual sequence: s18–s17–s16–s15–s14–s13–s12–s11–s10–s9–s8–s7–s6–s5–s4–s3–s2–s1 (Ashmole 1962); inner secondaries grow faster than tertials. Replace greater, median, smaller lesser and marginal secondary coverts before moulting larger and central lesser secondary coverts; moulting of coverts finished when PMS 30–40. Moulting of tail, asymmetrical; seems almost continuous, with many birds collected in nesting areas moulting tail but not primaries. Moulting of body begins when primary-moulting advanced and is finished before breeding starts. No details on sequence of moulting of body; birds with PMS of 30–40 had almost completed moulting of body apart from a few feathers of breast and mantle. Probably moulting feathers of crown and nape continuously. **Adult pre-breeding** (Pre-alternate). Partial. Probably involves tail (which probably moults continuously)

and, possibly, some feathers of body; almost certainly moulting feathers of forehead, crown and nape, which can be in pin at height of breeding. **Post-juvenile** (First pre-basic). Complete. Begins with feathers of cap, nape and mantle, then rest of body. No information on moulting of primaries in Aust. On Ascension I., one bird 8 months old had just begun moulting of primaries, moulting of secondaries had not started, t1 was growing, and much of body was in active moulting; at 10 months old, moulting had progressed slightly, and t2 was moulting, but secondaries still not replaced.

MEASUREMENTS (1) Aust., adults, skins; T1 = length of t1 from base to tip; T4–T1 = difference between length of t4 (= Tail) and T1; Bill D(N) = depth of bill at basal end of nostril; Bill D(G) = depth of bill at gonys (AM, ANWC, MV, QM, SAM).

	MALES	FEMALES	
WING	(1) 226.5 (5.76; 218–233; 10)	221.2 (6.63; 212–231; 9)	ns
TAIL	(1) 120.1 (3.90; 112–125; 10)	115.3 (4.50; 109–123; 10)	*
T1	(1) 103.3 (6.25; 91–111; 11)	100.1 (4.33; 94–109; 10)	ns
T4–T1	(1) 14.9 (2.47; 10–19; 10)	15.0 (1.58; 12–17; 9)	ns
BILL	(1) 44.1 (1.92; 41.5–46.5; 9)	41.3 (2.00; 38.6–44.2; 10)	**
BILL D(N)	(1) 7.00 (0.23; 6.6–7.4; 10)	6.80 (0.22; 6.4–7.1; 10)	ns
BILL D(G)	(1) 6.40 (0.17; 6.1–6.6; 8)	6.00 (0.31; 5.5–6.3; 9)	**
TARSUS	(1) 21.7 (0.84; 20.5–23; 12)	21.2 (0.65; 20.6–22.7; 10)	ns
TOE C	(1) 34.6 (1.27; 33.1–36.3; 11)	33.9 (1.26; 31.2–35.5; 9)	ns

(2–4) Sexes combined and unsexed birds; Bill W = width of bill at base; other measurements as above: (2) Aust., skins; (3) Lord Howe, Norfolk and Kermadec Is, skins; (4) Kermadec Is, live (A.J.D. Tennyson).

	ADULTS	JUVENILES
WING	(2) 222.6 (6.19; 212–233; 23) (3) 227.5 (6.02; 219–234; 6) (4) 230.6 (4.12; 225–238; 10)	219.3 (5.50; 212–225; 6) – –
TAIL	(2) 118.0 (4.45; 109–125; 24) (3) 120.5 (3.11; 117–124; 4) (4) 118.6 (4.60; 109–126; 10)	109.8 (2.23; 107–113; 6) – –
T1	(2) 102.1 (5.16; 91–111; 25) (3) 104.4 (3.44; 101–109; 5)	98.0 (3.74; 93–103; 5) –
T4–T1	(2) 15.1 (2.14; 10–19; 23) (3) 15.3 (1.26; 14–17; 4)	11.6 (2.07; 9–14; 5) –
BILL	(2) 42.8 (2.26; 38.6–46.5; 24) (3) 43.6 (2.47; 40.6–46.2; 6) (4) 43.7 (2.07; 40.8–47.5; 10)	34.9 (2.04; 31.4–37.1; 6) – –
BILL D	(4) 8.20 (0.34; 7.4–8.7; 10)	–
BILL D(N)	(2) 6.90 (0.25; 6.4–7.5; 25) (3) 7.10 (0.32; 6.5–7.4; 7)	6.40 (0.30; 6.0–6.9; 6) –
BILL D(G)	(2) 6.20 (0.34; 5.5–6.9; 22) (3) 6.30 (0.32; 5.6–6.5; 7)	5.90 (0.16; 5.7–6.1; 5) –
BILL W	(4) 8.10 (0.53; 7.4–9.2; 10)	–
TARSUS	(2) 21.5 (0.86; 20.5–23.7; 27) (3) 21.6 (0.58; 20.7–22.5; 6) (4) 22.0 (0.75; 21.2–23.5; 10)	21.1 (0.90; 19.5–22.3; 6) – –
TOE C	(2) 34.5 (1.36; 31.2–36.8; 24) (3) 33.5 (0.93; 32.5–35.1; 6) (4) 34.0 (1.14; 32.4–35.8; 10)	34.0 (2.01; 30.2–35.4; 6) – –

Juveniles have shorter bills than adults; depth of bill, length of tail and depth of tail-fork (T4–T1) shorter than in adult. Wing, legs and feet of juveniles fully grown by time of fledging. A first-year bird from Aust. had Wing of 225, Tail

112, T1 97, T4–T1 15, Bill 40.4, Bill D(N) 6.3, Bill D(G) 5.9, Tarsus 21.5 and Toe C of 34.8.

WEIGHTS Few data from HANZAB region. On Heron I., two males, 93 and 95 g; four females, 90, 97, 99, and 104 g. Juveniles: two females, 60 g (Norfolk I.) and 85 g (Herald C.); unknown sex, 55 g (Currumbin). Kermadec Is, live, unsexed: 109.7 (10.52; 95–127; 10) (A.J.D. Tennyson).

STRUCTURE Wings, long, broad and pointed. Eleven primaries: p10 longest, p9 1–6 mm shorter, p8 11–21, p7 27–38, p6 46–57, p5 63–75, p4 73–92, p3 91–108, p2 103–123, p1 115–134; p11, small, c. 30 mm long, pointed; no emarginations. Eighteen secondaries, including five tertials (though tertials poorly defined); tips of longest tertials reach to p3 or p4 on folded wing. Three well-developed humerals, as long as smallest tertials. Tail, slightly wedged-shaped, with deep notch in centre; 12 rectrices: t4 longest, t1 12–17 mm shorter, t2 5–12, t3 1–6, t5 3–10, t6 21–35. Bill, very long and slender; about one-third longer than length of head; straight for basal two-thirds; distal third decurved, with well defined gony. Tarsus, short and thin; scutellate, squared at front. Toes, long, connected by slightly incised webs; outer toe c. 89% of middle, inner 74%, hind 20%.

GEOGRAPHICAL VARIATION Poorly known. Seven subspecies have been described (Peters), differing in coloration of cap and darkness of rest of plumage; also in size (Heller & Snodgrass 1901; Hachisuka 1932; Mathews). Only nominate *minutus* recorded HANZAB region. Birds photographed at Ashmore Reef, off nw. Aust. (Stokes & Hinchey 1990) appear typical of Aust. A. *minutus* but subspecies not known.

Within HANZAB region, specimens from Kermadec and Norfolk Is larger than tropical Aust. populations, particularly in length of wing (see Measurements). Lord Howe I. population probably similar to those from Kermadec and Norfolk Is.

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1926

Volume 3, Plate 45

Common Noddy *Anous stolidus* (page 789)

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

Black Noddy *Anous minutus* (page 801)

5 Adult; 6 Downy young; 7 Juvenile

Lesser Noddy *Anous tenuirostris* (page 812)

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

Grey Ternlet *Procelsterna cerulea* (page 818)

13 Adult; 14 Downy young; 15 Juvenile

White Tern *Gygis alba* (page 825)

16 Adult; 17 Downy young; 18 Juvenile



Volume 3, Plate 46

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

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

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

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

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