

Order PELECANIFORMES

Medium-sized to very large aquatic birds of marine and inland waters. Worldwide distribution. Six families all breeding in our region. Feed mainly on aquatic animals including fish, arthropods and molluscs. Take-off from water aided by hopping or kicking with both feet together, in synchrony with wing-beat. Totipalmate (four toes connected by three webs). Hind toe rather long and turned inwards. Claws of feet curved and strong to aid in clambering up cliffs and trees. Body-down evenly distributed on both pterygiae and apteria. Contour-feathers without after shaft, except slightly developed in Fregatidae. Pair of oil glands rather large and external opening tufted. Upper mandible has complex rhamphotheca of three or four plates. Pair of salt-glands or nasal glands recessed into underside of frontal bone (not upper side as in other saltwater birds) (Schmidt-Nielson 1959; Siegel-Causey 1990). Salt-glands drain via ducts under rhamphotheca at tip of upper mandible. Moist throat-lining used for evaporative cooling aided by rapid gular-flutter of hyoid bones. Tongue rudimentary, but somewhat larger in Phaethontidae. Throat, oesophagus and stomach united in a distensible gullet. Undigested food remains are regurgitated. Only fluids pass pyloric sphincter.

Sexually dimorphic plumage only in Anhingidae and Fregatidae. Selection of nest-site and initiation of pair-formation by male, but in Pelecanidae female first leads several males in a male-selection (or persistence) chase as in ducks. Nest built by female with material brought to nest-site mainly by male. Copulation normally on nest-site. Both sexes take turns guarding nest-site, incubating eggs, and brooding and feeding chicks. Eggs unicoloured with chalky finish except for Phaethontidae. Webbed feet used to warm eggs. Chicks hatch naked (except in Phaethontidae) and blind. Later fully covered with down for several weeks. Newly hatched chicks take fluid food from tip of parental bill. Older chicks take partly digested food from parental gullet, except in Phaethontidae, in which parent inserts bill into gullet of chick. Chicks become independent usually within a few weeks after fledging and at fledging in gannets *Sula* spp. At nesting colonies severe loss of eggs and chicks may result from human disturbance, parents being forced off nests, so that eggs and chicks become cold or overheat or are taken by predators.

Anatomical and behavioural similarities suggest close phylogenetic affinities between Pelecaniformes and Ciconiiformes, which could perhaps be united. Cottam (1957) found skeletal characters that suggest that the Shoe-billed Stork *Balaeniceps rex*, only member of the African family Balaenicipitidae, ought to be in Pelecaniformes rather than Ciconiiformes. Linnaeus (1758) included all pelecaniform birds known to him, except those in *Phaethon*, in the genus *Pelecanus*, from which Brisson (1760) removed the genera *Sula*, *Anhinga*, *Phalacrocorax* and *Fregata*. Subsequently these genera became the bases of six families in the order Pelecaniformes, formerly known as the Steganopodes. Over the last 200 years there has been debate about whether *Phaethon* and even *Fregata* ought to be included, and whether *Anhinga* ought to be in the same family as *Phalacrocorax*. There is ample behavioural (van Tets 1965), osteological and palaeontological (Olson 1985) evidence to demonstrate that there are six distinct extant families in the Pelecaniformes.

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Family **PHAETHONTIDAE** tropicbirds

Medium-sized, highly aerial seabirds. Three species in one genus *Phaethon*, so similar and closely related that they may be regarded as a superspecies. Body elongate; neck short; wings long and narrow, with 11 primaries (p10 longest, p11 minute); secondaries diastataxic; tail with 12–14 feathers, central pair elongated into streamers; bill, powerful and decurved with serrated edges but not hooked at tip; nostrils, well-developed slits; no bare gular skin; very short tarsus, totalpalmate toes; claws not with comb. Crouching stance; shuffling gait and unable to walk easily. Oil-gland, feathered. Sexes, similar. Plumage, white with black markings on head and upperparts. Golden and pink-washed plumages of some species have been taken as reason for separating into subspecies but probably best regarded as morphs because they occur in different proportions in different colonies.

Distributed throughout Tropics and Subtropics. Essentially pelagic and can be seen far from land; rarely wander outside tropical and subtropical waters but occasionally blown far inland during storms. Usually do not fly low over water; flight sustained with strong wing-beats, equally efficient in calms or in winds. Mostly feed by plunge-diving for fish and squids, from fairly high but not entering water deeply. Attracted by ships but usually do not follow them persistently. Mostly solitary at sea or in pairs; loosely gregarious at breeding stations. Nest in loose groups where terrain is suitable; indulge in communal display flights at colonies. Pair-bond monogamous, often long-term in successful pairs, which are more likely to reunite than those that fail. Pairs may maintain contact at sea unlike most other seabirds. Defend nest-site territories and re-use same site from year to year. Probably roost on water when not breeding. No specialized visual displays ashore, being almost unable to walk and because nest-sites not convenient or suitable for displays. Calls also seem unspecialized, mostly given on wing near colony and at sea and sometimes from nest-site.

Breeding season often prolonged; individuals may lay at intervals of 9–12 months. Nests are scrapes without any or much material; usually in cavities under rocks or bushes. Eggs vary in shape and colour, fawn to rich purple-brown and quite unlike those of other Pelecaniformes. Clutch-size, one. Replacement laying after loss. Incubation by both sexes in spells lasting from 3 to 16 days. Single median brood-patch. Incubation period, 40–46 days. Young, semi-altricial, nidicolous, downy at hatching. Cared for and fed by both parents by regurgitation. In *P. rubricauda*, at least, adult inserts bill into gullet of chick and disgorges, unlike any other Pelecaniformes. Nestling period, 65–90 days, varying greatly according to food supply. Independent of parents at fledging and no period of desertion before fledging.

Phaethon lepturus White-tailed Tropicbird

COLOUR PLATE FACING PAGE 949

Phaeton [sic] *lepturus* Daudin, 1802, in Buffon, *Hist. nat. (éd Didot) Quadr.*, 14: 319 — Mauritius.

The specific name is compounded of the Greek λεπτός (fine, slender, delicate) and οὐρά (rear, tail).

OTHER ENGLISH NAMES Golden or White-tailed Bos'nbird, Yellow-billed Tropicbird, Longtail, Marlin-spike.

MONOTYPIC Brisson (1760) first described white morph as *Lepturus candidus* and golden morph as *L. fulvus*.

FIELD IDENTIFICATION Length 70–90 cm (includes central rectrices up to 45 cm long); wingspan 90–95 cm; weight c. 300 g. Distinctive, medium-sized, elegant, mainly white seabird with black diagonal bar on inner upperwing, black-based outer primaries, long white central tail-feathers and yellow bill. Smallest tropicbird, of slender proportions with long angular wings, in size appearing only a little larger than Silver Gull *Larus novaehollandiae* and much smaller than Red-tailed Tropicbird *P. rubricauda*. Dimorphic; white morph few at Christmas I. (Ind.); golden morph rare elsewhere (van Tets & van Tets 1967). Sexes similar and usually indistinguishable. Juveniles, immatures separable.

DESCRIPTION ADULT. Head, white with tapering black facial marking from lores through eye to ear-coverts. Rest of upperparts mainly white, with brilliantly contrasting black upperwing markings on basal three-quarters of outer primaries and thick black diagonal stripe from carpal to tertials. Tail, very pointed and mainly white; central pair of rectrices very elongated into flexible points, white with black shafts; one or both elongations liable to be broken short or missing. Below white, with very varying flush of orange, pink or reddish. Underwing, white or flushed like body; in flight against strong light, black upperwing markings seen shadowed through translucent wings. Many birds from ne. Indian Ocean populations (and some elsewhere) have flush extending over upperparts and whole bird appears golden rather than white. Bill pointed, usually yellow but orange, reddish or greyish in some. Iris, dark brown. Legs, greenish white; feet, black, bluish-grey or yellowish. **JUVENILE, IMMATURE.** Nape, hindneck, mantle, back and rump barred with black; inner upperwing heavily barred black forming triangular patch along leading-edge, tapering back to body; markings on outer primaries similar to adult. Tail, white tipped with black spots; no long tail-feathers though central rectrices may project slightly. Underparts and underwing, white except for faint spots along flanks and lateral tail-coverts; against strong light, upperwing markings can be seen. Bill usually dull yellowish with black tip. Rest of bare parts as adult. No information on transition to adult plumage.

SIMILAR SPECIES Greatest risk of confusion in our region with **Red-tailed Tropicbird**; White-tailed much smaller, with more slender pointed wings; adult distinguished by bold black markings on upperwings (visible at some distance), yellow or, sometimes, orange bill (never red) and conspicuous white tail-streamers (though difficult to see at distance); from below, against strong light, black upperwing markings visible through translucent wings; more graceful and buoyant in flight. Juvenile and immature of both species closely similar; White-tailed much smaller, with black outer-primary patch (as in adults) more extensive than Red-tailed, tail longer with slight projection of central rectrices even in

young birds and bill usually yellowish with black tip (blackish or dark with red or blue base in Red-tailed); barring on upperparts finer in White-tailed. Extralimital Red-billed Tropicbird of Indian Ocean has not occurred in our region (see Harrison 1985, 1987 for details). Easily distinguished from large terns Sternidae, which have different shape and flight, grey upperwings, black cap and forked tails. **White Tern** *Gygis alba* all white, much smaller with forked tail.

Oceanic, near land only when breeding; usually solitary at sea. Fly high and powerfully with fast tern-like wing-beats. Follow ships and boats, hovering over rigging before attempting to perch (Harrison 1985). Plunge-dive for fish; rest and swim on surface with tail raised. Very awkward on land, shuffling along on breast and pushing with wings. Apparently silent at sea, but noisy at breeding grounds, with chattering and screaming calls in aerial displays.

HABITAT Marine, in tropical waters, sea surface-temperature <22 °C (Ainley & Boekelheide 1983), of Indian, Pacific and Atlantic Oceans. Marine habitat preferences poorly known; on Christmas I. (Ind.), feed over warm waters of low salinity close to island, but may wander up to 1000 km from it (Pocklington 1979; Dunlop *et al.* 1988b; Stokes 1988). In Aust. waters, probably pelagic; rarely found inshore or beachcast.

Breed on tropical islands and atolls, at high or low elevations. Catholic taste in nest-site enables use of many habitats, from closed-canopy rainforest to bare sandy ground, to rugged rocky terrain in cliffs and quarries (Gibson-Hill 1950; Stokes *et al.* 1984; Stokes 1988).

Clearing of about one-third of plateau rainforest for mining on Christmas I. (Ind.) has reduced breeding habitat; but some nesting on limestone pinnacles in quarries formed by mining; one nest found in pipe in cantilever for loading phosphate (Stokes 1988).

DISTRIBUTION AND POPULATION Pantropical, throughout central and w. Pacific, s. tropical Indian and Atlantic Oceans, and Caribbean Sea. Straggler to S. Africa, during summer (Brooke & Sinclair 1978; Batchelor 1979; Ryan & Rose 1989); to w. coast of N. America (Hetrick & McCaskie 1965) and to Arizona (AOU CL). Regular visitor to Aust. in small numbers; straggler to NZ.

In Indian Ocean, uncommon in NW, mostly S of Equator, extending to 20–25°S N of Madagascar (Bailey 1966, 1968); in E and NE recorded S of Java and in Banda Sea (Cadée 1985), mostly known in waters of S. Equatorial Current and concentrations round Christmas I., even as far as 350–1300 km SE of Island and off nw. Aust. (Dunlop *et al.* 1988a; Pocklington 1967). In e. Aust. waters may be fairly regular in Coral

Sea (HASB) but only one bird recorded in 51 h of observation, 15–26 May, near Swain Reef (Stokes & Corben 1985). In sw. Pacific, regular at Fiji and between Fiji and NZ to 21°19'S (Jenkins 1973; Lovegrove 1978). Between 20°S and 30°N in Pacific, to 5°S off nw. S. America (Pitman 1986).

AUST. Regular but rare visitor to Coral Sea and e. waters. **Qld:** eight records during 1977–81 (Aust. Atlas). Recorded from e. Torres Str. (Draffan *et al.* 1983) to N. Stradbroke I. (Qld Bird Rep. 1985). Six recovered N. Stradbroke I. (Roberts 1979). **NSW:** mostly dead and dying birds recorded from Ballina S to Bateman's Bay (Morris *et al.* 1981; NSW Bird Reps 1982, 1984). Few except in 1978 wreck. Several inland records (Morris 1979). **Vic:** only recorded singly from Gippsland: Lakes Entrance: Mar. 1978 (Wheeler 1978), Jan. 1986 (Mitchell 1986); Ram Head, Croajingalong NP, Apr. 1983 (Vic. Bird Rep. 1983). **WA:** ten, between Montebello Is and Adele I., July 1965 (Pocklington 1967); single, 465 km NE of Dampier, Dec. 1966; single, Torbay, Dec. 1977 (Nicholls & Spence 1978). Wreck occurred Mar. 1978 in se. Aust. following easterly gales; birds found along e. coasts of NSW and Vic., and in inland NSW at Tamworth, Warrumbungle NP, Widden Valley and Griffith (Morris 1979).

NZ. Vagrant. Only recorded NI. Singles, beachcast: skeletal remains, near Whakatane, Jan. 1973 (Brown 1973); near Okato, Feb. 1979 (Medway & Medway 1979); Dargaville, Feb. 1979 (Gordon 1979); Muriwai, June 1979 (Thomas 1979); Ninety Mile Beach, Mar. 1983, May 1983 (Powlesland 1985); Omamari Beach, Apr. 1983 (Powlesland 1985); Auckland East, Dec. 1985 (Powlesland 1987); Waikuku Beach, Jan. 1986 (Powlesland 1989); Great Exhibition Bay, Jan. 1986 (Powlesland *op. cit.*). Recoveries where age known (Jan. 1973, Feb., June 1979) were immatures or juveniles.

BREEDING Only Christmas I. (Ind.), Cocos-Keeling Is and three islets of Ashmore Reef in our region. Also breed on NZ territory of Niue I., sw. Pacific Ocean (Kinsky & Yaldwyn 1981).

Christmas I.: 1967, >1000 pairs (Feare 1984); 1984, c. 600 pairs (Woehler 1984); >6000 pairs (Dunlop 1988). Early

estimates probably too low because secretive nesting habit, rugged terrain and dense vegetation.

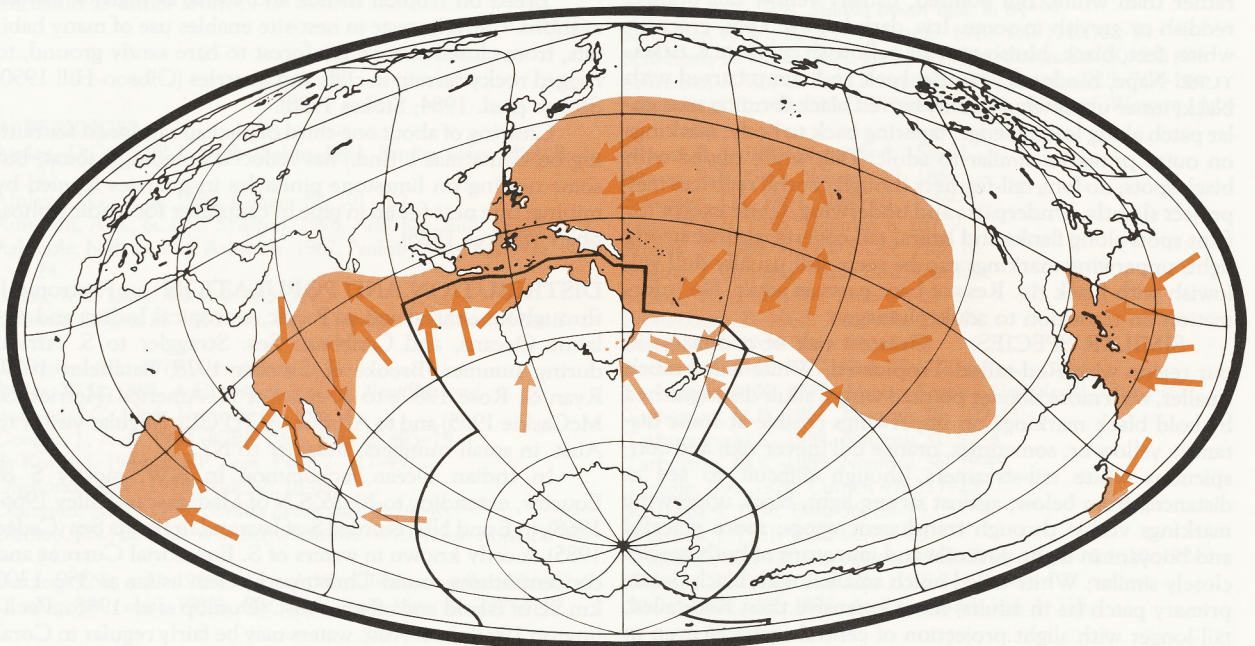
Cocos-Keeling Is: Jan. 1982, 40–50 pairs (Stokes *et al.* 1984)

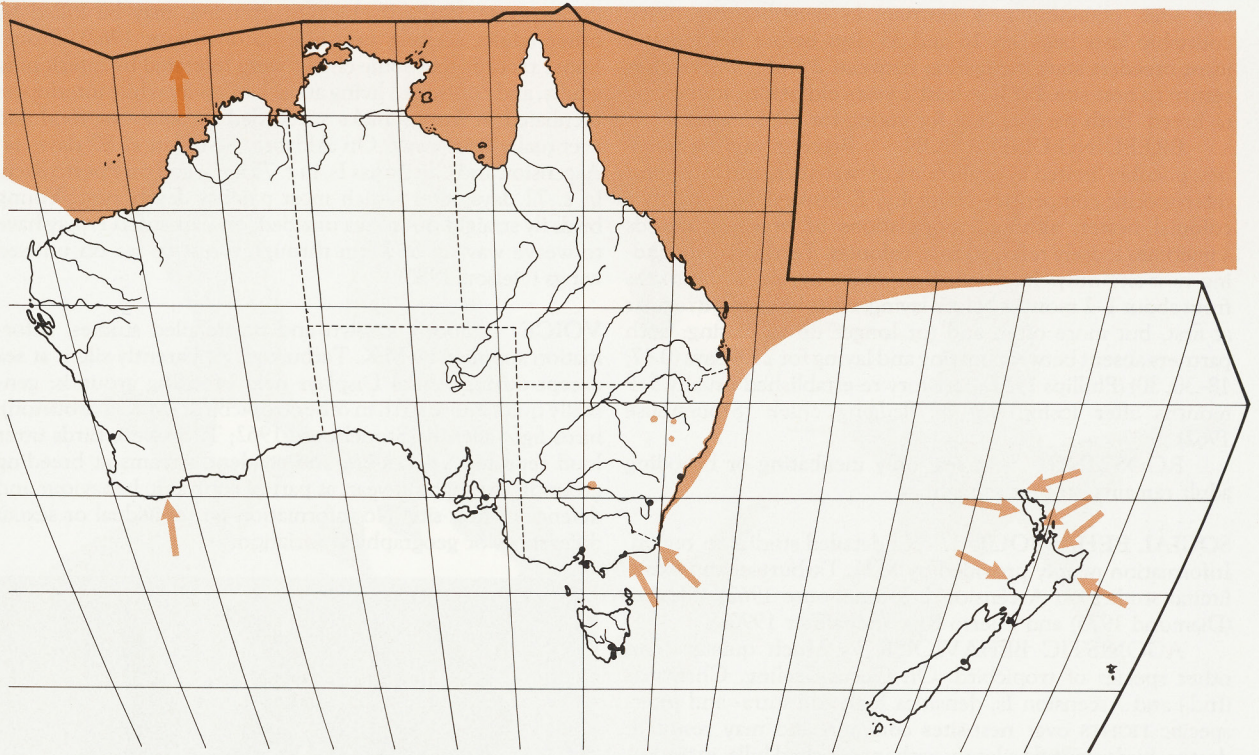
Ashmore Reef: 1983–89, <10 pairs p.a. (ANPWS).

Numbers on Christmas I. have declined since settlement as habitat cleared for mining. Eggs and nestlings taken by cats and rats (Stokes 1988). At Niue I., adults and chicks taken by islanders (Kinsky & Yaldwyn 1981).

MOVEMENTS Pattern of movements away from breeding site not known but both adults and juveniles appear to disperse widely. Nesting interval about 9 months (Stonehouse 1962; Diamond 1975; Prys-Jones & Peet 1980) but no seasonal peak (Nelson 1972; Prys-Jones & Peet 1980; Kinsky & Yaldwyn 1981; Stokes 1988). Most records from s. Aust. (Morris 1979; Aust. Atlas), NZ (Medway & Medway 1979; Gordon 1979) and s. Africa (Batchelor 1979) during summer; Morris (1979) suggests immatures move S after fledging. Wrecks sometimes occur after cyclones, which may blow birds hundreds of kilometres inland (Morris 1979).

FOOD Chiefly fish and cephalopods, proportions varying with locality. **BEHAVIOUR.** Most food apparently captured by deep-plunging vertically into water from up to 20 m with wings half-folded. Often hover before descending in a spiral (Murphy). Also swoop rapidly without touching surface, possibly flight-feeding on flying fish (Stonehouse 1962). Of three observations, two deep-plunges, one pursuit-plunge (Ainley & Boekelheide 1983). Usually feed alone or in pairs (Bailey 1968; T. Stokes). Feeding almost always during day; at Aldabra and Puerto Rico, most chicks fed 08:00–11:00 (Diamond 1975; Schaffner 1990); at Christmas I. (Ind.), said to return to island, 14:00–15:00, after feeding at sea (Gibson-Hill 1947a) but morning return more likely correct (T. Stokes). Probably feed closer to nesting island than Red-tailed Tropicbird: food regurgitated as bolus to chicks; lacks mucus, which may retard digestion during travelling time (Diamond 1975). Often feed





in association with Black-winged Petrel *Pterodroma nigripennis*, Red-footed Booby *Sula sula*, White Tern, Black Noddy *Anous tenuirostris*, Common Noddy *A. stolidus* (Ainley & Boekelheide 1983).

BREEDING At Christmas I. (Ind.) and Cocos-Keeling Is, fish, particularly immature *Exocoetus volitans* and *Cypselurus bahiensis*, more important in diet than cephalopods (12 adults) though young chicks fed cephalopods almost exclusively with percentage of fish increasing with age of chick (Gibson-Hill 1947a).

Detailed extralimital analyses summarized Table 1. On Aldabra (27 adults, 9 chicks; Diamond 1975) cephalopods all Ommastrephidae 1–12 cm; fish incl. Gonorynchidae <0.1% wt., 13.4% no., 5.6% freq., *Exocoetus volitans* 7.8, 2.5, 5.6, 5–25 cm, *Cheilopogon furcatus* 2.5, 0.8, 2.8, 5–10, *Oxyporhamphus micropterus* 3.9, 0.8, 2.8, 5–10, other Hemiramphidae <0.1, 0.8, 2.8, Coryphaenidae <0.1, 0.8, 2.8, Gempylidae <0.1, 6.7, 16.7, Scombridae <0.1, 2.8, 0.8. Proportion by weight of cephalopods increased during wet season (Nov.–Mar. 90.7%) compared to dry (Apr.–Oct. 46.1%).

At Seychelles (Ind., 43 regurgitations; Diamond 1983) fish were *Paraxocoetus brachypterus* 1.3% wt., 2.1% no., 8–10 cm, *Cheilopogon furcatus* 3.7, 6.3, 4–12 cm, C. sp. 6.2, 6.4, 8–12 cm, unident. Exocoetidae 40.6, 27.8, 4–18 cm, Hemiramphidae 1.9, 2.1, 16–18 cm, Belonidae 4.8, 4.2, 14–16 cm, *Decapterus maroadsi* 21.6, 8.5, 10–16 cm, Blennidae 8.9, 2.1, 16–18 cm, Balistidae 0.01, 2.1, 2–4 cm.

At Ascension I., chicks fed mostly fish, particularly *Exocoetus volitans* and *Oxyporhamphus micropterus*; *Ophiobienius steindachneri*, *Holocentrus ascensionis* and the cephalopod *Hyaloteuthis pelagica* also recorded (Stonehouse 1962). Young chicks were fed partly digested fish and cephalopods; older chicks fed only flying fish. At Bermuda, chicks fed gastropods (pteropods) and other soft-bodied marine animals up to 15 days, then mainly cephalopods to 30 days (Gross 1912).

Adults seen taking flying fish off Niue and cephalopods regurgitated at nests (Kinsky & Yaldwyn 1981).

Table 1. Diet of White-tailed Tropicbird.

	% wt.		% no.		% freq.
	1	2	1	2	1
FISH	15.2	89.0	42.0	72.3	63.9
Exocoetidae	14.2	51.8	19.2	42.6	
CEPHALOPODS	84.8	11.0	58.0	27.7	72.2

(1) Aldabra (Diamond 1975). (2) Seychelles (Diamond 1983).

INTAKE Mean feeding intervals at Aldabra and Puerto Rico, 1.5 days (Diamond 1975; Schaffner 1990); however highly bimodal in Puerto Rico, with many short and long intervals but few near average value. Feeding interval increases with age of chick (Murphy). On Ascension I., size of meal increased from 30–50 g near hatching to 40–70 g at fledging (Stonehouse 1962). However, in Puerto Rico, size of meal unrelated to age of chick, sex of parent delivering food, or length of non-feeding intervals before and after feed (Schaffner 1990).

SOCIAL ORGANIZATION No detailed studies in region. Based on information provided by M.K. Tarburton and extralimital studies on Ascension I. (Stonehouse 1962) and Aldabra Atoll (Diamond 1975). Solitary or in pairs at sea. Near breeding grounds, form loose groups of <10 birds when performing Aerial Display. Adults can be seen any time of year as breeding occurs any time of year.

BONDS. Monogamous. On Ascension I., show strong attachment to traditional nest-sites though small number de-

sert sites, obtaining new partners in neighbouring nests; courtship lasts between 16 and 35 days before nesting and most breeders start incubating between 2 and 5 weeks after return to nest-site. Birds at least 2 years old before attempting to breed. Both parents care for young for 10–12 weeks.

BREEDING DISPERSION Breed in varying densities, possibly limited by availability of nest-sites, and intra- and inter-specific competition (Murphy; T. Stokes). Not strictly a colonial nester, although populations of breeding islands sometimes loosely referred to as colonies. Territorial, defending nest-site only. In Seychelles, adults appear at nest-sites from about 1–2 months before laying; visits brief and irregular at first, but more often and for longer up to mating; both partners absent between mating and laying for 21.4 days (0.47; 18–30; 30) (Phillips 1987); territory re-established usually 5–9 months after losing egg or fledging chick (Stonehouse 1962).

ROOSTING At sea; only incubating or brooding adult remains on nest at night.

SOCIAL BEHAVIOUR No detailed studies in region. Information mainly provided by M.K. Tarburton and extralimital studies on Ascension I. (Stonehouse 1962), Aldabra (Diamond 1975) and Puerto Rico (Schaffner 1990).

AGONISTIC BEHAVIOUR Much quieter than other species of tropicbird. On Cocos-Keeling, Christmas (Ind.) and Ascension Is, densities high and intra- and inter-specific **FIGHTS** over nest-sites common and may result in deaths; birds struggle silently with interlocked bills; intruders attacked if alighting within reach of incubating bird; unattended chicks unable to defend themselves and may be killed by adults seeking nest-sites.

SEXUAL BEHAVIOUR **COURTING** takes place at nest-site and in air (Stonehouse 1962). Above breeding grounds, groups of up to ten birds execute **AERIAL DISPLAYS**, calling *kek-kek-kek* and flying in wide circles at heights of up to 100 m with drooping tails and streamers trailing in arcs; this often attracts other birds including those on nests; display similar to Red-tailed Tropicbird but close gliding descent of birds much less frequent (Stonehouse 1962; Diamond 1975; Nelson 1980). Pairs may leave group and perform descending glide, or zig-zag, one closely above other, upper birds with downbent wings and other with wings raised, perhaps for several hundred metres; on Christmas I., zig-zag above, and sometimes within, rainforest (Nelson 1980). Flight usually ends with one bird flying close by or to nest-cavity, where joined by one or more others; often two or three cavities occupied simultaneously by groups of birds; Aerial Displays possibly help synchronize breeding (Stonehouse 1962). **COPULATION** occurs on nest (Stonehouse 1962); during copulation, tail of mounting bird depressed to left or right of female's tail; in copulations observed by Stonehouse both birds flew to sea immediately afterwards.

RELATIONS WITHIN FAMILY GROUP Both parents incubate; incubation shifts on Ascension I., 3–4 days; slightly longer on Aldabra; male takes first full shift and somewhat greater share than female and incubating birds occasionally leave nest to feed. Parents brood chick for only a few days, then leave it unattended, returning to feed it until it is ready to fledge. On Aldabra and Puerto Rico, mean feeding intervals 1.5 days. Chick fed almost exclusively during daylight (Schaffner 1990). Chicks beg for food with guttural chirps and take food directly from parent's crop; begging calls persist at low intensity after feeding while parent on nest

(Stonehouse 1962). If chick unattended, may be killed by other adults seeking nest-hole (Stonehouse 1962). Stonehouse records that some chicks were tolerated by interloping adults, and continued living at back of cavity while interlopers incubated in front; chicks succeeded in obtaining food and eventually flew away. On Aldabra, fledge in c. 80 days; on Ascension and Christmas Is, in c. 75 days; and on Puerto Rico, in c. 72 days; after which most parents desert nest. Young birds fly straight out to sea unaided; on Christmas I. may have to weave way up to 3 km through forest to sea on untried wings (Nelson 1980).

VOICE Poorly known and no detailed studies. Information supplied by M.K. Tarburton. Apparently silent at sea except during Aerial Displays near breeding grounds; generally quiet, more so than other tropicbirds (M.K. Tarburton); birds fight silently (Stonehouse 1962; T. Stokes). Birds utter loud repeated *kek-kek-kek* and strident screams at breeding grounds, throughout year, as part of courtship behaviour and defence of nest-site. No information on individual or sexual differences or geographical variation.

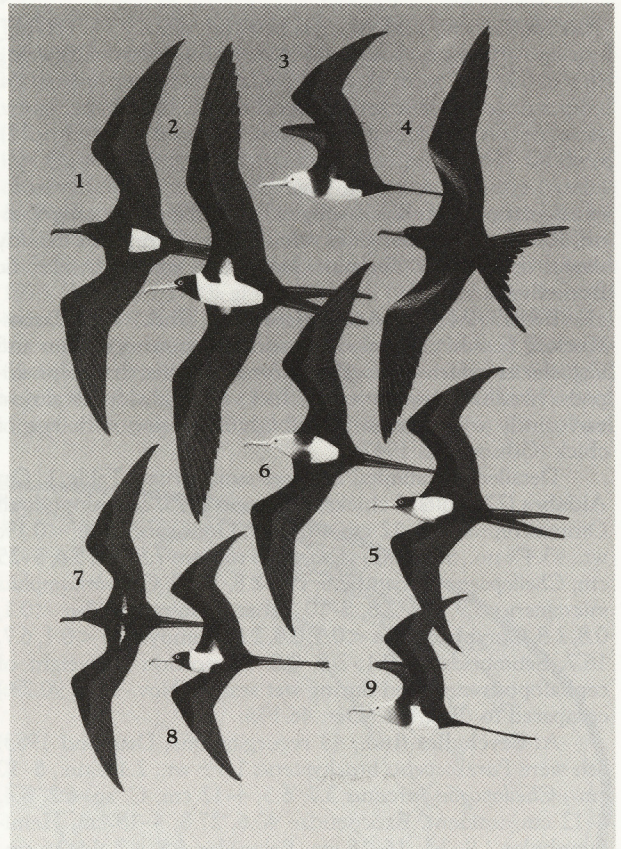


Plate 67

Christmas Frigatebird *Fregata andreusi*

1. Adult male
2. Adult female
3. Juvenile

Least Frigatebird *Fregata ariel*

7. Adult male
8. Adult female
9. Juvenile

Great Frigatebird *Fregata minor*

4. Adult male
5. Adult female
6. Juvenile

ADULT Guttural *chucks* exchanged between bird on nest and other in flight (T. Stokes) and in response to begging chicks; also give guttural *clicks* in response to begging chicks (Stonehouse 1962). In flight, as part of Aerial Display, utter high-pitched chattering *ch-ch-ch-ch* or *kie-ya-ya-ya*; probably equivalent to *kek-kek-kek* (Nelson 1980), and *keek-keek-keek* call described for male displaying to model gliders (Hetrick & McCaskie 1965); also utters *crit-aark*, more highly pitched and less raucous than in Red-tailed Tropicbird (Cook Is; M.K. Tarburton) and harsh high-pitched squawk or scream. High-pitched scream given when approached on nest and when handled. Said to utter rattling ticking *t-t-t-t-t . . .* in flight.

YOUNG Beg persistently before, during and after being fed, for as long as parent remains at nest (Stonehouse 1962); begging call described as series of guttural chirps (Murphy).

BREEDING No Aust. studies. Based on studies at Ascension (Stonehouse 1962) and Aldabra (Diamond 1975). Breeds in simple pairs on oceanic islands.



Plate 68

Red-tailed Tropicbird *Phaethon rubricauda*

1. Adult
2. Juvenile
3. Downy young
4. Adult
5. Juvenile

White-tailed Tropicbird *Phaethon lepturus*

6. Adult, white morph
7. Adult, golden morph
8. Juvenile, white morph
9. Adult, white morph
10. Juvenile, white morph

SEASON Laying in all months without preference on Christmas I. (Ind.) (Dunlop 1988; T. Stokes; *contra* Gibson-Hill 1947b); laying throughout year on Cocos-Keeling (T. Stokes), Ascension and Aldabra Is, with perhaps slight peaks of laying at 9 month intervals at Ascension (Stonehouse 1962) and slight peaks Dec.-Feb. and Apr.-May at Aldabra (Diamond 1975).

SITE On ground under bushes and grass, overhanging rocks; generally in smaller cavities than Red-tailed Tropicbird; also generally better sheltered, hidden (Diamond 1975) but with easy access (Stonehouse 1962). Competition for sites with other *Phaethon* spp at Ascension, Galapagos (Harris 1969) and Aldabra. In Fiji use hollow branches of trees (Tarburton 1978), as also at Christmas I. (Ind.) where known 8-15 m high (Gibson-Hill 1947b; Stokes 1988). Considerable fidelity to site.

NEST, MATERIALS Nil, except what may occur adventitiously round scrape or hollow.

EGG Ovoid; unglossed, mat surface for c. 6 days, becoming polished (Stonehouse 1962); whitish, pale fawn to rich purple-brown ground-colour with reddish-purple blotches; colour tends to wear off round equator of egg so that ends are often darker than middle (Stonehouse 1962).

MEASUREMENTS:

Ascension I.: 54 (2.2; 46.4-62.2) x 38 (1.2; 33.9-41.3);

Cocos-Keeling Is: 53x37, 53x39;

Christmas I. (Ind.): 48-53.5 x 37-40 (n=6; Gibson-Hill 1947b, 1950);

Fiji: 50x36, 54x40 (Tarburton 1978).

CLUTCH-SIZE One.

LAYING At any time of day. Replacement laying exceptional at intervals of 27-79 days (n=38). Successful breeders re-nest at c. 38 week interval (35-47) (Stonehouse 1962).

INCUBATION By both sexes in alternate shifts, male often starting, sometimes within 2 h of laying. Shifts <3-4 days at Ascension, 3-6+ days at Aldabra; males take somewhat larger share than females (Stonehouse 1962; Diamond 1975). Pipping of egg to emergence of chick 48 h approx. Eggshells pushed out of nest or trampled. **INCUBATION PERIOD:** at Ascension 40-42 days (Stonehouse 1962); Gross (1912) gave 28 days at Bermuda, which must be in error.

YOUNG Altricial, nidicolous. Hatched usually blind (perhaps for 2-3 days) with long silky white to fawn-grey or blue-grey down. At Ascension, attended by both parents for 75% of time for first 5 days, decreasing to 3% for chicks 51-60 days old and then increasing slightly to fledging (Stonehouse 1962). At Aldabra similar decrease from 90% of time in first week to 24% in weeks 3-4 and then virtually no attendance (Diamond 1975). Fed by both parents by incomplete regurgitation; mean feeding interval 1.5 days at Aldabra and Puerto Rico; adult staying with young for 1-2 h at each feed at Ascension, but usually <3 min on Puerto Rico. Chick defecates in and round nest-scraps. **NESTLING PERIOD.** Gross (1912) reported c. 62 days at Bermuda, which seems exceptionally short. At Ascension, a few young left before 70 days old, most 70-85 (Stonehouse 1962); Puerto Rico, 72 days (70-77); Aldabra, estimated at 80 days (Diamond 1975); Christmas I. (Ind.), 75 days (one nest; T. Stokes).

GROWTH Weight at hatching av. 30 g, increasing to mean max. 400 g when 51-60 days old, decreasing to 330 g at fledging. Tips of scapulars appear at 11-15 days, secondaries at 16-20 days, primaries at 21-25 days, rectrices at 26-30 days;

down clearing at 41–50 days, traces only left 61–70 days (Gross 1912; Stonehouse 1962).

SUCCESS At Ascension: 821 eggs laid, 395 (48.1%) hatched, 249 (82.2%) chicks fledged for total success 30.3% (Stonehouse 1962). At Aldabra, average for two seasons 47.5% (50.0–46.1). Losses at both localities probably largely from interference by other tropicbirds; heat-stress at Aldabra; possibly some starvation after loss of parents, attacks by frigatebirds, storm-petrels (*Oceanodroma castro*) at Ascension. On Christmas I. (Ind.), nestlings taken by cats and goshawks; nests robbed by rats; formerly, nests destroyed when trees cleared for mining (Stokes 1988).

PLUMAGES Age of first breeding unknown.

ADULT White morph. **HEAD AND NECK.** Crown and nape, glossy white; concealed bases of feathers, grey-black (82); outline of base visible through somewhat transparent feathers. Moderately broad inclined U-shaped, grey-black (82) line of feathers, extends from ear-coverts, through eye, to distal lores; at distal lores, line extends downwards to gape. Rest of head and neck, glossy white. At throat, basal half of rachis, grey-black (82). **UPPERPARTS.** Mantle, glossy white; rachis on upper mantle, basally grey-black (82) for quarter length of feather, rest white. Back, glossy white; basal fifth of rachis on back, grey-black (82). Rump and upper tail-coverts, glossy white with basal quarter of feather grey-black (82); a pair of small white spots, one on each web, near base of rump-feathers. Smaller, uppermost scapulars, glossy white, tipped grey-black (82) for quarter length of feather; rachis, grey-black (82). Larger, subscapulars, glossy white, broadly tipped grey-black (82) for three-quarters of length. **TAIL,** white; each t1 forms a streamer; rachis, grey-black (82), with distal quarter, white. **UPPERWING.** Primaries, glossy white; outer webs of p10–7, grey-black (82), tipped white; inner webs have narrow grey-black (82) margin along inner web, rest of inner web, white. Rachis of p10 broad and grey-black (82). Secondaries, white; tertials, grey-black (82) with basal inner web white and tipped white. Rest of coverts, including alula, glossy white, except innermost greater coverts and median coverts, grey-black (82), extending from humeral joint along three-quarters length of radius-ulna towards carpal joint and tapering; when wing spread, contrasting grey-black (82) forms slight diagonal bar; concealed bases of median coverts, white. **UNDERPARTS,** glossy white; feathers on upper breast have basal quarter of rachis, grey-black (82). Long lowermost flank-feathers, white with broad grey-black (82) shaft-streaks. Most under tail-coverts and all axillaries, white; lateral under tail-coverts, grey-black (82), tipped white. **UNDERWING.** Entirely glossy white; outer web of p10 narrow.

Golden morph. Plumage similar to white morph, but extensively suffused bright orange-buff (118); apparently suffusion less intense on skins after death (Gibson-Hill 1950), and same applies to other colour suffusions in extralimital subspecies (Palmer 1962).

DOWNY YOUNG At Ascension f.: down, long silky, varying from fawn-grey to blue grey; eyes closed at hatching and may remain closed for 2–3 days (Stonehouse 1962). At Christmas I. (Ind.), covered in long fine down; white (Gibson-Hill 1947b) except round oil-gland, where black (T. Stokes).

JUVENILE White morph. **HEAD AND NECK.** Forehead, glossy white. Crown, glossy white with black-brown (119) spot at base and subterminal crescent-shaped black-brown (119) narrow bar; black-brown (119) bar often exposed.

Moderately broad line of black-brown (119) feathers extends from ear-coverts, through eye, to front of lores; at distal lores, line extends downwards to gape, forming incomplete inclined U-shape. Rest of head and neck, glossy white, except feathers of nape and hindneck similar to those of crown, but broad bar and spot at base extended to half length of feather. **UPPERPARTS.** Mantle-feathers, glossy white with subterminal black-brown (119) spot at middle of feather, with subterminal black-brown (119) crescent-shaped bar near tip; rachis, white. Back and rump similar, but lack spot at middle of feather, and have basal black-brown (119) shaft-streak. Crescent-shaped bars on upperparts give scaled appearance. Upper tail-coverts, white with three broad black-brown (119) bars. Smaller scapulars, white with up to three irregularly shaped black-brown (119) crescent-shaped bars on webs. Longer scapulars, white with two subterminal crescent-shaped bars mainly on outer webs; rachis, white with grey-black (82) streak at middle of feather. **TAIL.** Outer rectrices, white with a few subterminal black-brown (119) spots on inner web. Rachis, grey-black (82) basally for half length of feather, rest white. Other rectrices, except streamers, white, tipped black-brown (119). Both t1, short, white, with black-brown (119) shaft-streak; rachis, grey-black (82); no long streamers. **UPPERWING.** Primaries, white with narrow black-brown (119) shaft-streaks, broadening from p10–7. Rest of primaries, white with grey-black (82) rachis for three-quarters length, distal quarter white. Secondaries, white with basal rachis, grey-black (82). Tertials, white with irregular narrow to broad black-brown (119) subterminal shaft-streaks. Tertial coverts similar to smaller scapulars. Greater primary coverts and most of greater coverts, white; innermost greater coverts have black-brown (119) shaft-streaks. Rest of coverts, glossy white with single subterminal crescent-shaped black-brown (119) bars on feathers. **UNDERPARTS,** mostly white, including axillaries. Flank-feathers with broad black-brown (121) shaft-streaks shaped like pea-pod; lateral under tail-coverts similar but with irregular pea-pod shapes. **UNDERWING,** white. Golden morph similar in plumage patterns to white morph; glossy white with no trace of orange-buff (118) colouring; unknown at what age this colouring achieved. A fledgeling described by T. Stokes differed in having black outer edges to p8–p10, black spot on outer web of p7 and wholly white rachis on secondaries.

BARE PARTS Based on photos in Lindsey (1986), except where stated.

ADULT White morph. Iris, dark brown (219). Bill, buff (124) or straw-yellow (57) basally, merging to buff (124) to orange-buff (118); grey-black (82) round nostril; apparently colour of bill varies; red and black claimed (HASB). Leg and proximal third of toes, white, tinged blue, rest black. Golden morph. Iris, dark brown. Eyelids, black. Bill, yellowish grey, almost grey at base with dark-grey line through nostril. Legs and feet, jet-black, except for inner toe and small patch in inner web, very light blue-grey, almost white (Gibson-Hill 1950). Photos in Lindsey (1986) show bill buff (124) basally, merging to orange buff (118).

DOWNY YOUNG Christmas I. birds described in Gibson-Hill (1947b): iris, dark brown, almost black; bill and facial skin, off-black; legs, pinkish, with webs and distal two-thirds of toes, off-black.

JUVENILE White morph. Iris, dark-brown. Bill, light grey with black tip and black streak at nostril. Legs and

base of toes, greyish pink; rest of toes and webs, black (Kinsky & Yaldwyn 1981).

MOULTS At Christmas I., breeding occurs in all months (Dunlop 1988; Stokes 1988), *contra* Gibson-Hill (1947b), who stated that most birds lay June–Oct.; thus timing of moult varies. Similarly, breeding season likely to be protracted in Pacific Ocean (Kinsky & Yaldwyn 1981).

ADULT Primaries moult outwards in staffelmauser. Duration and onset of moult-series undescribed. Moult of adults suspended during breeding in Pacific Ocean (Kinsky & Yaldwyn 1981) as in Red-tailed Tropicbird *P. rubricauda* (*q.v.*). Tail-moult, except moult of streamers, occurs at same time as wing-moult, but usually later than moult of primaries and may not be completed before all primaries moulted. Streamers moult alternately during breeding (Kinsky & Yaldwyn 1981; Chasen 1933; T. Stokes).

POST-JUVENILE Undescribed. For full details of moult in *ascensionis* see Stonehouse (1962).

MEASUREMENTS (1) Cocos-Keeling Is, adults; BILL (G) = bill length from gape, TAIL (S) = tail including streamers (Gibson-Hill 1950).

MALES

WING (1) 276.3 (2.92; 273–281; 6)
 TAIL (S) (1) 413.0 (52.08; 355–501; 7)
 BILL (1) 49.4 (1.04; 48–51; 7)
 BILL (G) (1) 72.3 (2.57; 67–76; 7)
 TARSUS (1) 23.5 (0.72; 23–25; 7)

(2) Ne. Aust., adults, skins; TAIL = tail without streamers, TAIL (S) = tail including streamers (MV, WAM, SAM, ANWC). (3) Niue I., sw. Pacific Ocean; TAIL (S) = tail including streamers (Kinsky & Yaldwyn 1981). (4) Cicobia and Vatu-i-Ra, Fiji, live; WING = maximum chord, TAIL = tail without streamers, TAIL (S) = tail including streamers (Tarburton 1978).

MALES

WING (2) 277.3 (4.10; 272–282; 3)
 (3) 263.8 (3.58; 260–270; 5)
 TAIL (2) 107.6 (15.79; 96–130; 3)
 TAIL (S) (2) 362.6 (46.6; 318–427; 3)
 (3) 386.5 (39.62; 346–455.5; 5)
 BILL (2) 50.0 (0.75; 49.5–51.1; 3)
 (3) 47.4 (2.57; 45–50.7; 5)
 TARSUS (2) 21.3 (1.76; 19–23.3; 3)
 (3) 21.4 (0.58; 20.8–22.4; 5)

FEMALES

263.0
 269.0 (1.77; 267.5–271.5; 3)
 91.0
 440.5 (10.55; 426.5–452; 3) *
 43.5
 46.3 (0.65; 45.5–47.1; 3)
 22.5
 20.3 (0.16; 20.1–20.5; 3) *

UNSEXED

WING (4) 259, 266
 TAIL (4) 103
 TAIL (S) (4) 288
 BILL (4) 45, 51
 TARSUS (4) 21

(5) Christmas I. (Ind.), adults, live; WING = maximum chord, BILL D measured at nares (T. Stokes).

UNSEXED

WING (5) 276 (12; 265–290; 4)
 BILL (5) 48.6 (0.89; 47.2–49.6; 7)
 BILL D (5) 16.35 (0.08; 16.2–16.4; 6)
 THL (5) 99.0 (2.2; 95.2–102.9; 9)

Additional measurements in Chasen (1933).

WEIGHTS At Christmas I. (Ind.): label data from adult skins at AM, WAM, Nov., June: males 295.0 (54.00; 220–345; 3); female 220.0. Unsexed adults, live, all months: 330 (43; 230–410) (T. Stokes). Voous (1964) gives weight of adult male, Apr., 310 g; unsexed adult, June, 350 g.

Cocos-Keeling Is, unsexed adults, live, Mar.: 321 (29; 280–365; 6).

Niue I., NZ: males 262.4 (16.40; 230–275; 5); females 305.0 (21.21; 290–335; 3); females heavier ($P < 0.05$). No data on seasonal changes.

STRUCTURE Wing, long and pointed. Eleven primaries: p10 longest, p9 2–4 mm shorter, p8 9–19, p7 31–39, p6 51–57, p5 73–81, p4 94–100, p3 117–131, p2 142–145, p1 162–175, p11 minute. No emarginations. Fourteen secondaries, including four of tertial form. Tail, wedge-shaped, with long central pair of streamers; 12 rectrices, t1 (streamer), longest; t6, 241–377 mm shorter; where t2 longest, t6 39–61 mm shorter. Streamers often worn when breeding or lost in moult. Inter-ramal space, feathered. Bill, deep at base, slightly compressed, decurved and pointed; backward serrations on cutting edges. Nostril, elongate-oval in shape, situated near base of upper mandible. Tarsus, short. Feet, totipalmate. Claws, narrow and strongly curved. Outer and middle toes about equal in length, inner c. 85%, hind c. 37%.

RECOGNITION Confusion possible between juveniles of White-tailed and Red-tailed Tropicbirds *P. rubricauda*; juvenile Red-tailed Tropicbirds larger; see discussion in Gibson-Hill (1947b) and Plumage texts.

GEOGRAPHICAL VARIATION Tropical N. Atlantic birds have greatest extent of black on primaries; w. Indian Ocean birds larger, w. Pacific birds smaller (Palmer 1962).

RMO

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Volume 1 (Part B), Plate 68

Red-tailed Tropicbird *Phaethon rubricauda*

1. Adult
2. Juvenile
3. Downy young
4. Adult
5. Juvenile

White-tailed Tropicbird *Phaethon lepturus*

6. Adult, white morph
7. Adult, golden morph
8. Juvenile, white morph
9. Adult, white morph
10. Juvenile, white morph

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