ID FORUM

Identification of Christmas Island, Great and Lesser Frigatebirds

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Introduction

Frigatebirds rate amongst the most artful and graceful of all flying creatures. With room to stretch their wings, these large tropical seabirds are masters of flight. Whether speeding and accelerating, gliding, soaring, manoeuvring, hovering, or just playing, they are nothing short of spectacular. Their feeding strategies are dramatic, including piratical chasing and harrying of other seabirds, aerial pursuit-catching of flying fish, and hovering to pick up shoaling bait fish. And their courtship displays, with clusters of males inflating their giant red gular sacs, vibrating their bills and wings at females flying overhead, are truly something to behold. They are spectacular birds to watch, no matter what they are doing. I hope that this article will help to widen appreciation and enjoyment of frigatebirds, and improve the documentation of their occurrence around the Orient.

Frigatebirds present a notorious problem for field identification, a situation described by Harrison (1983) as "perhaps the most difficult challenge of any seabird group". This problem is nowhere more acute than in the Oriental Region, where three species occur: Christmas Island Frigatebird *Fregata andrewsi*, Great Frigatebird *F. minor* and Lesser Frigatebird *F. ariel*. As a result of identification difficulties, the status and distribution of frigatebirds remains a little confused in many parts of the region. Although the species are all rather similar, and each has many plumages, the identification problems stem more from inadequate information than from indistinguishable plumages.

This article attempts to set out characters that, given reasonable viewing conditions, will allow the field identification of the three Asian species of frigatebird, and facilitate their ageing and sexing. Existing characters are refined and new characters are presented, while remaining knowledge-gaps in these areas are highlighted. Features thought to be of limited assistance are largely ignored rather than discredited. Colour photographs illustrate 20 of the 24 plumages recognised here, as well as variation in some of these. New information is based on field and photographic studies made between 1997 and 2004 at breeding stations in the Indian Ocean and the Coral Sea, and shipboard and coastal observations in the seas of northern Australia, Papua New Guinea and the Sunda Shelf.

Background

The family Fregatidae contains five very similar species of frigatebirds, all in the genus *Fregata*. The Oriental Region is the only region where three species are regularly recorded together (Christmas Island, Great and Lesser). Apart from these three species, the Magnificent Frigatebird *F. magnificens* occurs mostly along the tropical and subtropical coasts of the Americas, in the eastern Pacific and western Atlantic, while the Ascension Frigatebird *F. aquila* is largely restricted to the central Atlantic. These two species are not considered further here, but Magnificent has been thoroughly compared with Great by Howell (1994).

Frigatebirds are mostly tropical and marginally subtropical seabirds. With their large size, long angular wings, and long, deeply forked tails, they are easily recognised as frigatebirds. But identification to species is a great challenge, thanks to the similarity between the species and the large number of different plumages within each species. Plumages are mostly black and white (with the notable exception of the tawny or rufous heads of immature birds), and the pattern of the underparts is always most helpful in making identifications. The bare parts of the face are often colourful, including the spectacular, bright red, inflatable gular pouches of adult males; bill and orbital ring colours can sometimes assist with an identification.

Detailed accounts of the identification of frigatebirds are relatively few. Nelson's review of the biology of the family (Nelson 1976) included one of the earliest attempts to describe all the plumages of the group, but his account was not intended to solve the field identification issues. The first comprehensive identification account of any substance was that of Harrison (1983). Although a major turning point, minor inaccuracies and omissions in Harrison's treatment have also introduced a share of confusion. In all fairness, Harrison made the greatest advance, while acknowledging that there was still much to be learned, but his model of plumage succession can now be improved upon. Howell (1994) provided a masterful comparison of Great and Magnificent Frigatebirds, but unfortunately it is of limited application in the Oriental Region. Howell's model of plumage succession is comparable to the one presented here. Recent handbook accounts (del

Hoyo *et al.* 1992, Enticott *et al.* 1997, Marchant *et al.* 1990, Metz *et al.* 2002), have added very little new information, and in some instances have misreported the facts and introduced greater confusion. As a consequence of insufficient information and space limitations, the flurry of modern regional field guides in Asia and Australasia have had only limited success in addressing this challenging group, although many regional guides now treat adult plumages with competence. Most recently, Chalmers (2002) reviewed in detail the field characters of juvenile plumages of the three Oriental species. This was a significant advance, addressing perhaps the biggest problem remaining in frigatebird identification, but it only dealt with three of the 24 plumages seen in the three species.

Rather than build from previous works, this article will attempt to document the plumage sequences of frigatebirds as I have come to understand them from my own studies. In 1997 and 1998, breeding surveys and photographic studies were undertaken at the Herald Cays in the Coral Sea, where Great and Lesser both breed. From 2002 to 2004 regular visits to Christmas Island in the Indian Ocean facilitated a complete survey of nesting Christmas Island Frigatebird and partial surveys of nesting Great Frigatebird. Numerous shipboard and coastal observations, and brief visits to other colonies in northern Australia, Papua New Guinea and the Sunda Shelf have provided additional opportunities to test and refine identification criteria. About 1,000 photographs of my own document almost every plumage, and I have had the opportunity to examine almost as many photographs again from colleagues in many parts of the world, to whom I am most grateful.

Distribution and status

Frigatebirds are recorded with varying regularity from all coastlines of the Oriental Region, particularly within the tropics. However, there are only a handful of breeding stations actually within the Orient. Many of the records must therefore be of birds originating from breeding stations outside the region, in the tropical Indian and Pacific Oceans. Frigatebirds are now known to disperse long distances from their colonies (Sibley *et al.* 1967, Metz *et al.* 2002, Weimerskirch *et al.* 2003) and make regular use of non-breeding roost sites far from their natal islands (Wells 1999).

The distributions of the three Oriental species are summarised below, but a full review of their status in each country is beyond the scope of this paper.

Christmas Island Frigatebird breeds only on Christmas Island in the eastern Indian Ocean, about 360 km south of Java Head. The population is about 2,000 pairs, plus perhaps 1,000 to 2,000 immature birds. Despite being the rarest frigatebird in the world, it is recorded in Indo-Malaysian seas with regularity. The main foraging areas are on the Sunda Shelf, including the Java, Natuna, southern South China and eastern Andaman Seas. Westwards, vagrants have been reported from the Indian subcontinent and even Africa. They are very rare east of Java with only a few records from the Lesser Sundas and New Guinea, and one from Darwin in Australia. Non-breeding birds make regular use of roost islands off western Thailand, eastern Peninsular Malaysia and north-eastern Sabah, at least (Wells 1999), which explains the many sightings in the Sunda Region (see map in BirdLife International 2001).

Great Frigatebird is a widespread breeder in the tropical Indian and Pacific Oceans. Breeding stations in the Oriental Region include Christmas Island (several thousand pairs), the Xisha Archipelago (Paracel Is) in the South China Sea, and a handful of islands in the Banda Sea. It is likely that visitors also originate from the Cocos-Keeling Islands in the eastern Indian Ocean, Aldabra and other islands in the western Indian Ocean, the Coral Sea off the east coast of Australia, and numerous islands in the mid-Pacific (Feare 1984, Dickinson *et al.* 1991, de Korte *et al.* 1994, Wells 1999). Perhaps surprisingly, they seem to be the least common of the three species in the Oriental Region, and only rarely make use of roost islands in South-East Asia (Wells 1999). However, they are more widely recorded than Christmas Island away from the Sunda Shelf.

Lesser Frigatebird is also a widespread tropical breeder, mostly in the Indian and Pacific Oceans.

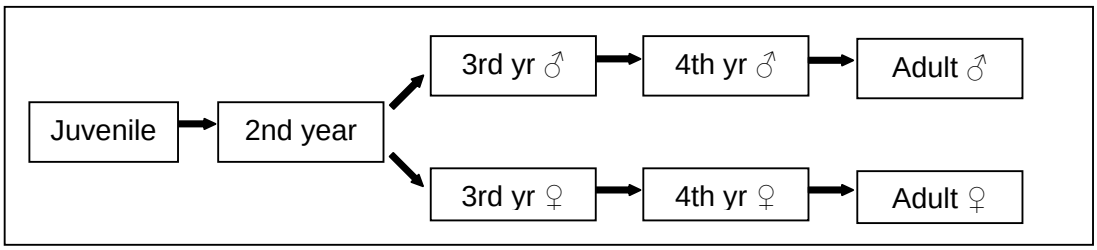

Fig. 1. Model of plumage sequence and terminology for frigatebirds in the Oriental Region

Plate 1

Plate 2

Plate 3

Plate 4

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Plate 1. Adult male and female Great Frigatebird *Fregata minor*. On the male, note the very faint alar bar. On the female, note the diagnostic pale throat, moderately prominent alar bar, and blue orbital ring (latter diagnostic of South Pacific populations). Herald Cays, Coral Sea, June 1997.

Plate 2. Adult male Christmas Island Frigatebird *Fregata andrewsi*. Note the egg-shaped white belly-patch. Only a small proportion of adult males show white axillary spots like this. Note the reddish gular skin and black bill. Christmas Island, Indian Ocean, February 2002.

Plate 3. Adult male Great Frigatebird *Fregata minor*. This is the only frigatebird plumage in the Oriental Region with no white on the underparts. Adult males of all species have inflatable red gular pouches. Christmas Island, Indian Ocean, February 2002.

Plate 4. Adult male Lesser Frigatebird *Fregata ariel*. Note the bold white axillary spurs and otherwise all black underparts. Herald Cays, Coral Sea, September 1998.

Plate 5

Plate 6

Plate 7

Plate 8

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Plate 5. Third-year male Christmas Island Frigatebird *Fregata andrewsi*. This individual has a clearly defined white belly-patch typical of older males. Note the female-like hood and remnants of axillary spurs and breast-tabs, but the breast is on the way to being entirely black. The dark grey bill and red gular skin are already visible, aiding the elimination of females (compare with Plate 16). Christmas Island, Indian Ocean, February 2002.

Plate 6. Fourth-year male Great Frigatebird *Fregata minor*. The mottled white saddle on the breast is reminiscent of female Great (see Plates12 and 17), but the throat is dark. There are no axillary spurs. More advanced individuals show heavier mottling on the breast. Herald Cays, Coral Sea, June 1997.

Plate 7. Fourth-year male Lesser Frigatebird *Fregata ariel*. Note the extensively white flanks and slight mottling on the breast (compare with Plates 4 and 8). Herald Cays, Coral Sea, June 1997.

Plate 8. Third-year male Lesser Frigatebird *Fregata ariel*. Note the extensively white flanks and upper breast, with black mottling spreading on the rest of the underparts. There is an evident hood, and although it is tawny, not black, it shows the shape of an adult female Lesser. The axillary spurs are atypically small on this individual. Compare with Plate 7. Christmas Island, Indian Ocean, February 2002.

In the Oriental Region there are only a few breeding sites, probably on Christmas Island, possibly in eastern Indonesia and the Xisha Archipelago, and possibly formerly in the Malacca Strait (de Korte *et al.* 1994, Wells 1999). Visitors probably originate from the Cocos-Keeling Islands in the eastern Indian Ocean, Aldabra and other islands in the western Indian Ocean, the Maldives, the Coral Sea off the east coast of Australia, and numerous islands in the mid-Pacific (Sibley *et al.* 1967, Feare 1984, de Korte *et al.* 1994, Wells 1999). This is apparently the most common species at mixed roost islands around the Malay Peninsula and Borneo (Wells 1999), and the most widely recorded species in the Oriental Region.

Identification

Moult, ageing and sexing

Accurate ageing of frigatebirds is an essential step in the identification process that cannot be omitted. For instance, juveniles of one species look more like juveniles of other species than like adults of their own species, and adult females are more like females of other species than they are like males or juveniles of their own species. Therefore, it is necessary to age and sex each bird in the process of narrowing down the contenders. Fortunately, as described below, the three species show parallel patterns of progression from the first or juvenile plumage to the fifth or adult plumage, even though the moults that introduce these plumages (or age-classes) are poorly understood.

Frigatebirds apparently have one moult per cycle (or year), in which all the feathers are replaced once, and there are no partial moults. However, it is a so-called wave moult (or Staffelmauser), which is protracted, not necessarily tightly synchronised to season or between individuals, often progresses in an irregular and asymmetrical manner, and may be punctuated by periodic interruptions. Consequently, there is a slow and gradual progression from one plumage to the next, which can make ageing difficult. Nevertheless, at breeding stations, five age-classes can be recognised at any one time. These age-classes appear to represent adults and four cohorts of pre-adult birds. They probably coincide with year-classes, although there is little corroborative evidence (e.g. from ringing studies) to confirm this. In addition, the last three age-classes in the sequence are sexually dimorphic. This gives a total of eight distinguishable post-fledging plumages for each species: juvenile, second-year, male and female third-year, male and female fourth-year, and male and female adult plumages. These plumage sequences are summarised in Fig. 1. Herein, plumages are deemed to have passed from age-class to the next when the moult between them has passed its midway point.

Despite this seemingly complicated situation, ageing is a relatively straightforward process. A simple system, using only the gross head and ventral patterns, can be applied for ageing all three species. In general terms, juveniles of both sexes have tawny-coloured heads (which bleach rapidly), broad blackish breast-bands, and clean white bellies. Second-year birds lose the breast-band gradually from the centre outwards (often showing blackish tabs or blotches on the sides of the breast) to show extensively white underparts and a pale head. They cannot be sexed in most cases. In the third year, males and females begin to differ in plumage, when a hint of the incipient adult plumage can be discerned. Areas of the head and ventral surfaces that are white in juveniles and black in adults become increasingly flecked and mottled with black. At this stage, females are typically white, mottled with black on the head and belly while the breast remains cleanly white. Meanwhile, males start to show black mottling on the head and belly, but also on the breast. This replacement of white with black continues gradually, and fourth-years show an adult-like plumage of their respective sex except for tell-tale signs of immaturity such as white mottling on the head and underparts. By this stage, adult bare part colours are evident, including the red inflatable gular pouches of males. Adults have cleanly demarcated black and white areas on the underparts, usually without mottling. Adult males are mostly black, although some species have small white areas on the underparts. Adult females are more extensively white below (Plate 1).

Size

All species show so-called reverse sexual dimorphism, females being noticeably larger than males. This is most pronounced in Christmas Island and least pronounced in Lesser. The largest species in the region is Christmas Island. Great averages substantially smaller than Christmas Island but shows considerable geographical variation in size, and there is some overlap between the smallest male Christmas Island and largest female Great. Lesser is considerably smaller than Great and is dwarfed by Christmas Island. Because of the sexual dimorphism, male Great is a little larger than female Lesser, while female Great dwarfs male Lesser.

Datasets of measurements of frigatebirds are remarkably few and mostly involve quite small sample sizes. Some recent reviews of measurements have erroneously implied that Christmas Island and Great are similar in size. In

Table 1. Mean measurements of frigatebirds from various localities

Note that all measurements are means only. Measurement techniques vary slightly between sources. Wingspan data have been omitted because available samples are not representative. All measurements are in millimetres.

Measure	Christmas Island		Great		Lesser		Location	Reference
	male	female	male	female	male	female		
Length	907	999	863	932			Christmas I., IO	Gibson-Hill 1947
Wing	610	650	565	587			Christmas I., IO	Gibson-Hill 1947
Wing	616	648	563	587			Christmas I., IO	Nelson 1976
Wing			608	610	538	553	Aldabra I.	Nelson 1976
Wing			582	607	536	547	Cocos-Keeling Is	Gibson-Hill 1950
Wing			582	607	534	547	Coral Sea	Nelson 1976
Wing			589	606			French Frigate Shoals	Metz et al. 2002
Wing			555	577			Christmas I., PO	Metz et al. 2002
Culmen	111	132	96	113			Christmas I., IO	Nelson 1976
Culmen			104	117	80	87	Aldabra I.	Nelson 1976
Culmen			102	116	82	89	Cocos-Keeling Is.	Gibson-Hill 1950
Culmen			102	116	83	88	Coral Sea	Nelson 1976

Table 1, mean measurements of total length, wing cord and exposed culmen are compared for different species, populations and sexes. These data are not definitive, but they do demonstrate significant mean differences between the species.

In the field, size differences are not likely to be safely judged on lone individuals, especially at distance. However, in mixed flocks the size differences can be readily apparent and of great help. Comparative bill length can be quite helpful, particularly on perched birds. Christmas Island has a much longer bill than Great, which in turn has a longer bill than Lesser. However, within species, females have longer bills than males, so there is overlap in the ranges of different species.

Plumage characters

The plumages of frigatebirds are mostly black (to dark brown) and white, or nearly all black, with the exception that juveniles can have tawny head feathers. The most useful features for identification of frigatebirds are the plumage patterns of the ventral surfaces and head. Features to make note of on all birds include:

The shape of any white patch(es) on the underparts. Note in detail the shape, location and extent of all white plumage on the ventral surface, and how it relates to black on the underparts. Bear in mind that the underbody is not flat but curved. This presents two problems: (1) patterns can appear to differ according to the angle from which they are viewed; and (2) the patterns tend to be comprehended and described as flat projections rather than the curved projections that they actually are (similar to mapping the land masses of a globe on flat paper).

The presence or absence of white spurs in the axillary region. These are white wedge-shaped marks protruding from the body onto the underwing. They are present in Lesser in all plumages, Christmas Island in all plumages but not all individuals, and Great only in a proportion of juveniles. If present it is important to note the shape of the spurs (triangular or parallel-sided); their location on the underwing (near the centre or towards the leading edge); the direction they run in (perpendicular to the body or angling forward); and whether or not they are isolated from white areas on the underbody.

Whether there is a dark breast-band. If there is a pale head and white breast separated by a black breast-band, then the bird is a juvenile, and the shape of the belly-patch and axillary spurs is diagnostic. Note the shape of the white belly-patch (round to oval, triangular with the base formed by the breast-band and the peak pointing to the rear, or diamond-shaped). If there are axillary spurs, note whether they extend from near the front or the middle of the belly-patch.

The colour and pattern of the head. The head provides the first clues for ageing and sexing frigatebirds and is sometimes diagnostic of species. Juveniles and second-years have tawny, bleached buff or white heads. Adults have black heads (except for the paler throat of female Great). Third- and fourth-year birds have mottled black-and-pale heads. Note whether the bird has a black hood and, if it does, note its shape, particularly on the throat. Look for white hind-collars.

Plate 9

Plate 10

Plate 11

Plate 12

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Plate 9. Adult female Christmas Island Frigatebird *Fregata andrewsi*. Note the vertical demarcation between the black hood and the white underparts, the black breast-tabs, white axillary spurs and white belly. Christmas Island, Indian Ocean, February 2002.

Plate 10. Adult female Christmas Island Frigatebird *Fregata andrewsi*. Note the prominent alar bar and the location of the axillary spur close to the leading edge of the underwing. Christmas Island, Indian Ocean, February 2002.

Plate 11. Adult female Christmas Island Frigatebird *Fregata andrewsi*. Note the white collar (incomplete in this case), prominent alar bars and pink bill. Compare with Plates 1 and 13. Christmas Island, Indian Ocean, February 2002.

Plate 12. Adult female Great Frigatebird *Fregata minor*. Note how the pale throat and lack of a bold white hind-collar produce a diagonal demarcation between black and white on the side of the head. The broadly rounded, saddle-shaped white breast and flanks and broadly rounded black belly-point are diagnostic of Great. The dirty wash on the white breast is typical of many adult female Great and is not an indication of immaturity (compare with Plate 17). Christmas Island, Indian Ocean, September 2002.

Plate 13

Plate 14

Plate 15

Plate 16

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Plate 13. Adult female Great Frigatebird *Fregata minor*. Note the light brown hind-collar, and moderately prominent, narrow, brownish alar bars. Christmas Island, Indian Ocean, May 2002.

Plate 14. Adult female Lesser Frigatebird *Fregata ariel*. Note the white axillary spurs and all-black hood including throat. The black belly-point and absence of black breast-tabs distinguish this bird from adult female Christmas. Herald Cays, Coral Sea, June 1997.

Plate 15. Fourth-year female Christmas Island Frigatebird *Fregata andrewsi*. Note the adult-like dark throat, white belly and axillary spurs, black breast-tabs (compare with Plate 14) and pink bill. The white mottling on the throat is the last trace of immaturity. Christmas Island, Indian Ocean, February 2002.

Plate 16. Third-year female Christmas Island Frigatebird *Fregata andrewsi*. Note the pink bill, indicative of older females. The white axillary spurs and hind-collar, and the black breast-tabs, though messy, are strongly evident, indicating this is a female (compare with Plate 5). The breast-tabs and white belly separate from similar stages of Lesser (compare with Plate 19). Christmas Island, Indian Ocean, February 2002.

Whether there is any mottled plumage. The presence of mottled black-and-white plumage on the head and underbody is usually a sign of immaturity. Document the extent of any mottling. Also note whether the demarcation between black and white on the underparts and head is crisp or blurred.

The prominence of the alar bars. Most frigatebirds have a pale alar bar of varying prominence on the upperwing, formed by broad pale edges to some of the upperwing-coverts. The alar bar runs diagonally inwards and backwards across the secondary coverts from the leading edge just inside the carpal, and peters out well before reaching the trailing edge and base of the wing. In general the alar bar is more prominent in juveniles than in adults of a given species, more prominent in females than in males of a given age and species, and more prominent in Christmas Island than in Great or Lesser. Alar bars may be slightly diminished by wear, but they also vary between individuals of the same species, sex and age. They are especially useful in identifying perched juveniles.

Colours of bare parts

Adult and subadult female frigatebirds have either pink or blue-grey bills and either red or blue orbital rings. The combination of these colours can be diagnostic of subspecies as well as species, although they are only visible at close ranges. For males and juveniles, the colours of bare parts provide little assistance for field identification. Harrison (1983) suggested that foot colour is useful, but this is rarely visible in the field and rarely has diagnostic value, especially for juveniles.

Adult males

Adult males of all three species are mostly black or blackish, but the pattern of the underside is always diagnostic.

Christmas Island (Plate 2) always has an egg-shaped white patch on the belly, with the larger end facing the breast. The patch appears to vary in shape slightly depending upon the angle of view, looking more elliptical when viewed from behind and more semi-circular (with the straight edge towards the breast) when viewed from in front. In favourable conditions this patch is readily visible at hundreds of metres. Christmas Island is the only species of frigatebird in which the adult males show any white on the belly, making this one of the easiest plumages to recognise in the entire genus. A small percentage of Christmas Island show an irregular white spot in the (subhumeral) coverts of the underwing close to the body and the leading edge (isolated from the white belly-patch) or a hint of axillary spurs off the widest part of their belly-patch. Lesser (Plate 4) is always entirely black on the underside except for white axillary spurs. These spurs are quite small and distinctly triangular. The peak of the triangle points directly out along the wing. The spurs are located roughly midway between the leading and trailing edge of the wing. Great (Plate 3) is almost entirely blackish below, except for thin and subtle pale barring or scalloping on the axillaries which is only evident at close range. This never looks like a white spur.

The upper surfaces of all three are mostly black, with a metallic gloss on the mantle and scapulars. This is greenish on Christmas Island and Great (though a little stronger on Christmas Island) and varies from greenish to purplish on Lesser. Gloss is only visible at close range and unreliable for identification. Christmas Island always shows a moderately prominent pale alar bar. Great usually has a faint to moderate alar bar (Plate 1), although it is said to be lacking in Greats from Aldabra Island (Diamond 1975), and this might also be true of other Indian Ocean populations. In Lesser the alar bar varies from moderate to absent, between and possibly within populations.

When perched, Christmas Island shows a slight shaggy rear crest formed by lanceolate crown feathers. The other species lack this feature. Bills and orbital rings of all species are black to dark grey.

Adult females

Females have a dark upper surface (except for alar bars), an all or mostly black head, and a white breast. The pattern of the under surface is always diagnostic.

Christmas Island (Plates 9–11) and Lesser (Plate 14) both have an all-black head. The black throat of both has a peak in the centre that points back towards the breast. On both species there is a clean white collar across the back of the neck, separating the black head and mantle. The lower neck and breast are also white, which makes for a clean, vertical line of demarcation (on flying birds) between the black head and the white breast and hind-collar. Thus, both Christmas Island and Lesser appear completely hooded. Occasionally the hind-collar is narrowly incomplete on Christmas Island, but the vertically demarcated hood is always apparent. Conversely, Great (Plates 1, 13 and 14) has a greyish or mottled throat and lacks a clean hind-collar. On flying birds there is an obvious diagonal line of demarcation between the black top of the head and the paler underside. The demarcation line (on flying birds) runs diagonally backwards and up from the chin to the upper side of the neck. When they are overhead, the black throats of Christmas Island and Lesser versus the paler, vaguely defined and sullied throat of Great are quite easily discerned.

Christmas Island and Lesser are best separated on the belly pattern. Lesser has a white breast and black belly. The black belly extends forward as a rounded point, leaving the rear flanks white. On Christmas Island the breast and belly are both white, with only the undertail-coverts and vent black (behind the legs). In the demarcation between black and white, the white is convex on Christmas Island, concave on Lesser. Both Christmas Island and Lesser always show axillary spurs. On Lesser, the spurs originate from a broad base on the flanks, and are partly behind the forwardmost point of the black belly. They are triangular and point out straight along the wing, close to its midline. On Christmas Island the spurs are larger, more parallel-edged and squarer-ended. They originate from a narrower base on the sides of the breast, just forward of the centre line of the wing, but angle forwards and outwards to terminate near the leading edge. On Christmas Island there is also a broad black tab on the side of the breast, outlined by the spur and the white side of the neck. This tab angles back and inwards. Occasionally the spur of Christmas Island is reduced to a series of ragged spots or a single white spot on the inner underwing-coverts, isolated from the white underbody. Lesser never shows a pattern like this. Great has a black belly pattern similar to Lesser, but the black belly is more widely rounded at its anterior point, and the white flanks are much more rounded, extending in a saddle shape around the belly-point. The white on the flanks, though broad, appears more confined than it does on Lesser, because there are no axillary spurs. Conversely, on Lesser the spurs combine with the flanks to form a much larger and less confined white shape that the belly-patch points into. The upper breast of Great is often smudged with grey and rufous, which is not a sign of immaturity. Some Lesser may show a little tawny wash on the breast, but this is not typical.

The upperparts of all three are largely blackish, with some greenish gloss on the mantle and scapulars, although less than males show. Again, it is more prominent in Christmas Island than the others. Christmas Island (Plate 11) and Lesser both show a white hind-collar (occasionally narrowly incomplete in Christmas Island). Great tends to show a slightly paler brown mantle with no gloss (Plate 13), visible only in close views. Christmas Island occasionally shows an isolated white spot on the inner upperwing-coverts (usually just one feather), forward (inside) of the alar bar, which is presumably diagnostic. All three species always show alar bars. On Christmas Island, these are very prominent, relatively broad and whitish. On Great they are moderately prominent, relatively narrower and brownish. Lesser has alar bars that are more prominent than Great's but less prominent than Christmas Island's.

On perched birds the grey throat of Great (Plate 1) is readily apparent and diagnostic. The black hoods of Christmas Island and Lesser are similar, but the very long bill of Christmas Island dwarfs that of Lesser. The black belly of Lesser or white belly of Christmas Island will not always be evident on perched birds. Female Christmas Island has a shaggy rear crest like the male Christmas Island, and unlike any plumage of the other two species. Female Christmas Island also has bright orange gular skin that is often visible in flight and on perched birds. At the nest, this is sometimes inflated into a pouch about the size of a tennis ball, a feature unique amongst female frigatebirds.

Female Christmas Island has a bright pink bill and red orbital ring throughout the year. The bare parts of Great differ significantly across the range: in the western Indian Ocean, South China Sea and Cocos-Keeling Islands the bill is pink (brighter in the breeding season) and the orbital ring is red; at Christmas Island the bill is blue-grey and the orbital ring red; in the South Pacific both the bill and the orbital ring are blue-grey; and in the North Pacific the bill can be either pink or blue-grey, but the orbital ring is always red. Most populations of Lesser are dimorphic in bill colour (either pink or blue-grey) with red orbital rings, but it is reported that some have blue-grey orbital rings on Aldabra Island (Diamond 1975).

Juveniles (first-year birds)

Juveniles have a complete or nearly complete dark breast-band, a white belly, and a pale head (tawny when fresh, fading to white). They cannot be sexed on present knowledge. The breast-band is partly black with varying amounts of rufous or dark chestnut feathers towards the centre on the anterior edge, but usually appears all black in flight. The shape of the white belly-patch below the breast-band, and any axillary spurs joined to it, are diagnostic in combination. However, care must be taken when assessing the shape of the belly-patch, as it can appear slightly different if viewed from front-on versus the side or rear. The breast-band appears to be of limited assistance in identification.

The white belly-patch of Lesser (Plate 30) is roughly triangular with a rounded, narrow peak pointing rearwards and almost straight base bordering the black breast-band. The axillary spurs originate from the two anterior basal corners of the triangle, which places them in line with the front of the belly-patch. The spurs originate from the front corners of the triangle. As with adults, the spurs originate at the midline of the wing, but they are narrower, more parallel-edged, and angled

Plate 17

Plate 18

Plate 19

Plate 20

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Plate 21

Plate 23

Plate 22

Plate 24

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Plate 17. Fourth-year female Great Frigatebird *Fregata minor*. Unlike adult female Great (see Plate 12), the white mottling on the black belly indicates this individual is not quite mature. Christmas Island, Indian Ocean, February 2002.

Plate 18. Third-year female Great Frigatebird *Fregata minor*. The black belly, mottled with white, and the extensive sullying on the whitish flanks indicate immaturity. The first signs of black feathers replacing buff feathers are indicative of a bird in transition from second to third year. The rounded whitish flanks wrapping around the black belly-point in a broad saddle shape is typical of female plumages of Great from the third year on. Christmas Island, Indian Ocean, February 2002.

Plate 19. Fourth-year female Lesser Frigatebird *Fregata ariel*. Note how the broad bases to the triangular axillary spurs originate off the flanks, and create a much larger area of white on the sides of the underbody, compared with female Great (compare with Plates 12, 17 and 18). Note the diagnostic black ring around the neck at the base of the hood. The black belly-point is fully developed, eliminating female Christmas. Herald Cays, Coral Sea, June 1997.

Plate 20. Second-year Christmas Island Frigatebird *Fregata andrewsi*. In the early part of their second year, some Christmas Island lack axillary spurs, but typically show broad black breast-tabs, angling forwards toward the centre of the breast. Note the patches of fresh buff feathers on the head, typical of all species moulting from juvenile to second-year plumage. Christmas Island, Indian Ocean, February 2002.

Plate 21. Second-year presumed Great Frigatebird *Fregata minor*. The combination of buff head and no dark breast-band is diagnostic of second-year plumages. In the absence of axillary spurs and breast-tabs, second-year Christmas Island and Great are extremely difficult to separate on present knowledge. The presence of black mottling on the belly (outlining an incipient black belly-point), and the consequent rounded rear edge to the white flanks almost certainly identify this bird as a Great. Compare the flank pattern with Plate 20. Christmas Island, Indian Ocean, February 2002.

Plate 22. Fresh juvenile Christmas Island Frigatebird *Fregata andrewsi*. Note that the narrow, parallel-edged axillary spurs angle slightly forwards from near the front of the white belly-patch. Christmas Island, Indian Ocean, September 2002.

Plate 23. Fresh juvenile Christmas Island Frigatebird *Fregata andrewsi*. Note the absence of axillary spurs, a feature of a small proportion of juvenile Christmas Island. The angular, rather than rounded, front and squarish sides of the white belly-patch eliminate juvenile Great Frigatebird *F. minor* (compare Plate 27). Christmas Island, Indian Ocean, September 2002.

Plate 24. Worn juvenile Christmas Island Frigatebird *Fregata andrewsi*. Note the broad and whitish alar bars. Christmas Island, Indian Ocean, February 2002.

slightly forward. Great have an elliptical to egg-shaped belly-patch with the narrower end towards the rear (Plate 27). Most importantly, the front edge of the patch is distinctly rounded. Care should be taken with side views, when the rear of the patch can look narrower and more pointed than it does when it is overhead (and thus more like Lesser). About a third of juvenile Greats have small axillary spurs, but these always come off the widest part of the patch, distinctly behind both the front edge of the belly-patch and breast-band (Plate 28). When spurs are present, they are near the midline of the wing and point directly out. Most often they are blunt-ended, but rarely they are pointed or have an 'island' off the end of a 'peninsula'. They rarely, if ever, extend onto the underside of the wing, although it can be difficult to judge where they end. Most Christmas Island show prominent axillary spurs, which are long, narrow and parallel-sided, noticeably closer to the leading edge than the trailing edge of the wing, and angled distinctly forwards (Plate 22). Often the spurs are mottled with black and sometimes they are ragged, broken up or represented only by an isolated spot on the inner underwing-coverts (the subhumerals). Rarely, Christmas Island lacks axillary spurs (Plate 23), and such birds are very difficult to distinguish from Great. In the absence of spurs, the belly pattern of Christmas Island tends to be almost hexagonal in shape, with rather squarish sides and a slightly angular front edge. The white patch of Great is evenly rounded at the front, so the rear margin of the breast-band is concave. Conversely, on Christmas Island, the white patch tends to narrow in a way that makes the rear edge of the breast-band look like two convex arcs meeting at a shallow angle in the centre of the breast. These differences are subtle, but usually combine to provide quite different overall patterns, although they are difficult to describe and subject to misinterpretation if assessed from other than directly below. On both species the white belly extends back to about the base of the legs, and the feet tend to obscure the boundary between black and white. In both species, the black may extend slightly forward of the feet or the white may extend slightly behind the feet. On average, the white extends slightly further rearwards on Christmas Island, but the variation and overlap render this an unreliable field character.

On the upperparts, juveniles are blackish-brown and lack the metallic gloss of adults. The alar bars are conspicuous on all three species. Christmas Island always has extremely prominent alar bars that often look dazzlingly white (Plates 24–25). Great and Lesser have quite prominent alar bars but they tend to be buffy and not as white as those of Christmas Island (Plate 29). Considerable variability within species in the prominence of the bar, perhaps related to sexual differences, makes it a difficult feature to judge without experience. Some Christmas Island have a small spot of pure white feathers on the inner upperwing-coverts, inside the alar bar, which is diagnostic.

Bill, orbital ring and foot colours vary from very pale blue to very pale pink. Owing to the poorly known influences of geographical variation, it is not possible to define any consistent differences between species at this time.

When perched, the extremely long bill of Christmas Island is often, but not always, very obvious (Plates 25–26). However, all frigatebirds have long bills and this is another feature difficult to judge in isolation.

Second-year birds

Second-year birds may be the hardest age group to identify on present knowledge, and more information is needed about this age-class in all species. Generally, they are quite similar to juveniles of their respective species, but they gradually lose the dark juvenile breast-band. During the first moult, the breast-band gradually retreats from the centre outwards, and in intermediate stages many birds show incomplete dark tabs on the sides of the breast, while others show scattered blotches of black and faded buff. The tawny feathers of the head are renewed at least once, but this is gradual. Before the last head feathers have been replaced the first ones have already bleached, so they never regain the bright tawny, almost orange, head that fresh juveniles display. Apparently all species can temporarily show a poorly defined buff throat, extending as a pointed bib towards the upper breast. Meanwhile, few other changes take place and the features which best separate species and sexes are not well developed.

As Great (Plate 21) lose the breast-band those 30% or so that had axillary spurs as juveniles quickly lose them, never to be regained. Thus any frigatebird with a pale head and axillary spurs, but without a complete breast-band, is not a Great. The lower belly becomes a little mottled with black, showing a sketchy outline of a black belly-point reminiscent of adult female Great. Lesser tends to lose the breast-band more rapidly and tends not to show lingering tabs on the side of the breast. The axillary spurs remain as prominent triangles. The head often shows a peppery pattern hinting at the hood of adult females, and a black belly-point reminiscent of adult females becomes apparent. Christmas Island (Plate 20) loses the breast-band most gradually, and almost always retains prominent, very broad black tabs on the side of

the breast. Many seem to lose their axillary spurs temporarily, making separation from Great extremely difficult. However, they never develop any hint of a black belly-point.

The alar bars of Christmas Island remain more prominent on average than on the other two.

Female Greats from populations with red orbital rings can show a pale red orbital ring at this age, and it is unlikely that any change would be evident in Greats from populations where females have blue orbital rings. It is likely that Lesser do the same, but Christmas Island apparently do not show any red in the orbital ring until the third year.

Third- and fourth-year males

With the second moult, young frigatebirds start showing a hint of the pattern of adults, by gaining more black feathering on the head and underparts. As a rule, a mottled shadow of the adult female plumage can be discerned, but males develop black plumage in places where females remain white. By the fourth year, young males closely resemble their respective adult plumages, and the distinguishing features of adults are well established. Telltale signs of immaturity persist in the form of white mottling on the head or underparts. Many birds breed in subadult plumage, and it may be that it lingers for more than one year. Alar bars are like adults'. Gular pouches are formed and inflatable, but tend to be a little smaller and less vividly coloured than those of adults. Bills and orbital rings are black or grey like adult males', except that Christmas Island have red orbital rings like their adult females. Both these age-classes are seen comparatively rarely, so while the sequences described below may be typical, it is not yet certain how much variation occurs.

In third-year Christmas Island (Plate 5), the head becomes mottled with black (in a pattern like the hood of adult females), the white belly sharply defined, and the breast lightly mottled with black. Clear black tabs (without any mottling) on the sides of the breast become sandwiched between heavy black mottling on the remnants of the axillary spur and the formerly white sides of neck. At this point they are most easily sexed from female Christmas Island of the same age by a dark rather than pink bill, and the already red gular skin. By the fourth year, they differ from adult males only by sparse white mottling on the black breast.

In their third year, male Great appear similar to adult female Great, with an evident outline of adult female plumage. However, white mottling persists on the head and belly-point, and black mottling begins to sully the breast and flanks. The throat becomes much darker than on females of any age. As the belly-point broadens the mottled flank-patches narrow. By their fourth year, Great are all dark like adult males except for a mostly black lower breast (and sometimes flanks), distinctly mottled with white or grey (Plate 6).

Third-year Lesser (Plate 7) initially resemble adult female Lesser, but the belly-point is broader and less neatly defined than a female's, and black mottling sullies the mostly white breast. The axillary spurs remain obvious and large. They have a dark hood but it is not sharply defined. White mottling may be present on the head and the black belly-point. Black gradually encroaches outwards from the centre of the belly and forwards from the breast to the head. By their fourth year they resemble adult males with only a little white mottling on the upper breast and, occasionally, white mottling on the flanks at the base of the spurs.

Third- and fourth-year females

Like males, third-year females develop the outline of the plumage patterns seen in adults, but remain mottled in places where they will eventually be uniformly black. Unlike third-year males, they show virtually no black mottling outside the places where adult females are black, and tend to have a sharper demarcation between black and white on the underparts. By their fourth year they resemble adult females but for traces of mottling. In the third year, faded versions of adult bare-part colours are evident, and by the fourth year these are nearly as bright as adults. In populations where bills are pink and/or orbital rings are red the development of adult coloration is more apparent than in populations where they are blue-grey.

Third-year Christmas Island (Plate 16) show a white belly, a patchy black and white breast and a mostly black head. Black tabs on the side of the breast are usually ragged, and sandwiched between the lightly mottled axillary spur and the side of neck. Often, the top of the head is paler, forming a 'skullcap'. The bill is already obviously pink, a useful character for separating them from third-year male Christmas Island. By the fourth year they resemble adult females, but with some white flecking on the head and some remnant black blotching around the edges of the breast-tabs (Plate 15).

Third-year Great (Plate 16) show a white to pale buff top of the head, with sparse black flecking, and a broad black belly-point with some white mottling. An adult female-like pattern of white breast and flanks surrounding the belly-point is fully developed, but usually there is a little black mottling on the flanks. The breast is messily washed with dirty buff. Unlike males, the demarcation of the belly-point is clear, and black mottling is not prominent on the upper breast. By

M. J. CARTER

Plate 25

D. J. JAMES

Plate 26

D. J. JAMES

Plate 27

D. J. JAMES

Plate 28

D. J. JAMES

Plate 29

F. KRISTO, COURTESY ENVIRONMENT AUSTRALIA

Plate 30

Plate 25. Worn juvenile Christmas Island Frigatebird *Fregata andrewsi*. Note the relatively long bill and the broad white fringes to the upperwing-coverts forming an extremely prominent whitish alar bar (compare with Plate 29). The mantle is brownish and lacks extensive gloss. Christmas Island, Indian Ocean, March 2002.

Plate 26. Worn juvenile Christmas Island Frigatebird *Fregata andrewsi*. Note the long axillary spur, the relatively long bill, and the new (second-year) buff feathers on the upper breast. Christmas Island, Indian Ocean, May 2002.

Plate 27. Juvenile Great Frigatebird *Fregata minor*. This bird shows the most typical pattern of an egg-shaped white belly-patch and no axillary spurs (compare with Plate 23 and Plate 28). The breast-band is composed of both black and tawny feathers, but it will usually appear black in the field. Christmas Island, Indian Ocean, February 2002.

Plate 28. Juvenile Great Frigatebird *Fregata minor*. This individual shows "'well developed "axillary spurs. Note that they originate from well behind the front of the belly-patch, and do not extend onto the underwing. The breast-band appears entirely black, although it is partly tawny. Compare with Plate 22 and Plate 27. Herald Cays, Coral Sea, June 1997.

Plate 29. Worn juvenile Great Frigatebird *Fregata minor*. Note the relatively short bill, and narrower and browner alar bars compared with Christmas Island (Plate 25). Although this bird is more worn than the one in Plate 25, wear only accounts for a little of the difference between their alar bars. This is probably a male. Christmas Island, Indian Ocean, September 2002.

Plate 30. Juvenile Lesser Frigatebird *Fregata ariel*. Note the prominent axillary spurs originating from the front corners of an almost triangular white belly-patch (the belly-patch appears more triangular when viewed from directly below). Compare with Plate 28. Herald Cays, Coral Sea, February 1993.

Table 2. Summary of important identification characters of frigatebirds

Sex and age	Christmas Island Frigatebird	Great Frigatebird	Lesser Frigatebird
Male, adult and 4th year. Black head and upperparts. Some spp have clean white marks on underparts. Large red inflatable gular sacs when breeding	Belly with oval white patch. Axillary spurs in some. Alar bars moderately prominent. Crest shaggy (when perched). 4th year has white mottling on throat/ breast.	Underparts all dark. No axillary spurs. Alar bars slight to absent. Crest absent. 4th year has white mottling on breast.	Underparts black, except: Axillary spurs white. Alar bars slight to absent. Crest absent. 4th year has white mottling on breast.
Male, 3rd year. Underparts resemble adult female of respective species, but white mottling where females black, black mottling where females white. Bills, blackish.	Belly extensively white. Axillary spurs mottled. Breast tabs evident, mottled. Orbital ring red.	Belly with black point. Axillary spurs absent. Breast tabs absent. Orbital ring dark.	Belly with black point. Axillary spurs clear. Breast tabs absent. Orbital ring dark.
2nd year. Buff or white head. Mostly white underparts. Breast band absent or remnant.	Breast tabs black. Belly white, without outline of black belly point. Axillary spurs present (parallel-sided, angled slightly forwards) or absent. Alar bars prominent, whitish. Bill very long.	Breast tabs absent. Belly with mottled outline of black belly point. Axillary spurs absent. Alar bars moderate, buff. Bill moderately long.	Breast tabs absent. Belly with mottled black point. Axillary spurs present (triangular, angled outwards. Alar bars moderate, buff. Bill shorter.
Juvenile. Buff or white heads. Mostly white underparts. Breast band dark, prominent.	White belly patch hexagonal. Axillary spurs usually present (parallel-sided, angled slightly forwards), rarely absent. Spurs originate behind line of breast band. Alar bars very prominent, whitish. Bill very long.	White belly patch elliptical. Axillary spurs present in 30 % (short, angled outwards). Spurs originate well behind line of breast band. Alar bars moderate, buff. Bill moderately long.	White belly patch triangular. Axillary spurs present (parallel-sided, or triangular, angled outwards). Spurs originate near line of breast band. Alar bars moderate, buff. Bill shorter.
Female, 3rd year. Underparts resemble adult female of respective species, but white mottling where females black. Lack black mottling where females white and 3rd year males mottled.	Throat black.Lower belly white. Axillary spurs mottled. Breast tabs evident, mottled. Bill bright pink.	Throat pale, sullied. Lower belly with mottled black point. Axillary spurs absent. Breast tabs absent. Bill pale.	Black ring round neck. Lower belly with mottled black point. Axillary spurs prominent, triangular. Breast tabs absent. Bill pale.
Female, adult and 4th year. Mostly dark upperparts and heads. Extensively white underparts. Brightly coloured bills and orbital rings.	Throat black. Hind-collar white, distinct. Demarcation of hood vertical. Belly white. Axillary spurs, white, parallel-sided, angled forwards. Breast tabs black. Alar bars broad, whitish. Crest shaggy (when perched). Pink bill. 4th year has white mottling on head.	Throat pale, sullied. Hind-collar brown, indistinct. Demarcation of hood diagonal. Belly with black point. Axillary spurs absent. Breast tabs absent. Alar bars narrow, brown. Crest absent. Pink or blue bill. 4th year has white mottling on head.	Throat black. Hind-collar white, distinct. Demarcation of hood vertical. Belly with black point. Axillary spurs, white, triangular, angled outwards. Breast tabs absent. Alar bars moderate, whitish. Crest absent. Pink or blue bill. 4th year has white mottling on head.

the fourth year they are very similar to adult females except for pale mottling on the head, and more dirty buff on the breast (Plate 17). There are no axillary spurs in either age-class.

Third-year Lesser resemble adult female Lesser, but with a distinctly pale head. A diagnostic black ring develops around the neck forming the lower margin of the incipient black hood, and black feathering slowly progresses forward, replacing the faded buff of the head. The black belly-patch is completely formed, but usually shows some white mottling. Black gradually encroaches forwards from the neck onto the head. By the fourth year they resemble adult female but for traces of white mottling on the head (Plate 19).

Conclusion

Table 2 summarises the plumage characters discussed in the text. When viewing conditions are reasonable, these characters should allow the identification of most individuals. However, some juveniles and second-year birds will remain difficult to identify until more information becomes available. Unfortunately, some of the characters require subtle assessments, and often this will be difficult without experience. Frigatebirds are often detected at great distances, when identification may remain frustratingly elusive. In such circumstances, it is far nobler to be conservative than to risk a misidentification and cloud the distribution literature with errors.

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