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CYCLE OF COLOUR CHANGES IN CATTLE EGRETS *Ardeola ibis (coromandus)* IN AUSTRALIA DETERMINED FROM FIELD OBSERVATIONS OF MARKED BIRDS

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Colour changes in nestlings and the timing and nature of changes in colour which take place in adults before, during and after the nesting season, as determined from field observations of marked birds, are described for the Cattle Egret *Ardeola ibis coromandus* at two Australian breeding colonies. Nestlings have a yellow beak at hatching, which changes to yellow-tipped grey or black by about ten days and by fledging at about 45 days, to diffuse yellow and grey. By time of independence the beak has changed to yellow, but some retain the grey or black for up to two months after fledging. All birds two years of age or older attained full orange-coloured breeding plumage and during courting gained magenta face colour. First-year birds of each sex included some with typical full orange-coloured breeding plumage (22%), some with varying degrees of pale colouration (29%), some with complete but pale colouration (9%), while others remained white (40%). First-year birds of each pattern gained magenta courting colour on the face, attempted to attract a mate, or mated and successfully reared young. Wide variation occurred in the dates of onset and time for completion for both pre-breeding and post-breeding moults. Significant variation was found in the timing of onset of magenta facial colours and return to normal non-breeding yellow.

INTRODUCTION

There is no Australian study comprehensively describing the colour changes during the life cycle of the Asian race of the Cattle Egret *Ardeola ibis coromandus,* which has become widespread in eastern Australia since it first began breeding in 1954. Hindwood *et al.* (1969) provided some information on colour of adults and young, while McKilligan (1985) described the onset of colour with age of first year birds returning to the breeding colony. Maddock (1989) further extended the information in McKilligan (1985) with a study of tagged birds. This paper describes the results of intensive study of the Cattle Egret life cycle carried out at two Hunter Valley breeding colonies (Shortland and Seaham) between the 1981–82 and 1992–93 breeding seasons and updates the information published in Maddock (1989).

STUDY AREA

The study was conducted in the Lower Hunter region of New South Wales. A breeding colony of egrets, which included Cattle Egrets, became established at Shortland (32°53′S, 151°42′E), an outer suburb of Newcastle, in the 1981–82 breeding season and the birds have returned each season since. The Seaham colony, established in the 1978–79 season (Gilligan 1979) is situated in a corner of the Seaham Swamp Nature reserve (32°30′S, 151°44′E) on the Williams River, just over 30 km north of Shortland. The flood plains

near the junctions of the lower Hunter, Williams and Paterson Rivers provide foraging areas for Cattle Egrets from the colonies during the breeding season and for both local and migrating birds during winter.

METHODS

More than a thousand nestling Cattle Egrets were examined in the hand during banding since 1983–84. Nine hundred and eighty-two which have had patagial tags attached were observed in the nest several times each week from time of banding to fledging. Observations were maintained in the field near the colony after fledging until the birds disappeared either through death or by migration.

The Shortland colony was visited almost daily in each of the breeding seasons between 1981–82 and 1985–86 and once to twice per week in the breeding seasons between 1986–87 and 1990–91. Seaham was visited about once per week during 1985–86 and usually twice daily from 1986–87 to 1992–93. Observations at Shortland were carried out from an observation platform in the centre of the colony, from a tower at the edge of the colony and from vantage points at water level within the colony. At Seaham the observations were made from the roadside and a path adjacent to the colony at 5 to 10 metres distance from nests.

Since 1986, twice daily traverses, usually five days per week, were made along a 20 km stretch of road between Glenoak and Raymond Terrace, in the Williams Valley, and periodically through Cattle Egret foraging areas in the lower Hunter-Paterson flood plains. To the order of 240 000 sightings of unmarked birds were made each year. It was not possible to determine how many of these were the same individuals because of the waves of migrating birds arriving in and leaving the Hunter.

During each winter from 1986 onwards, flocks using winter roosts were regulary monitored at Seaham and Shortland, and from 1987 at Richardsons Swamp, 8 km south of Seaham.

Observations were recorded in and near the breeding colonies of a total of 161 birds marked with patagial tags which returned for nesting. Of these, one was observed on each of five consecutive seasons, 10 for four seasons, 23 for three seasons and 54 for two. Tagged birds from the two colonies and tagged visitors passing through the area on their outward autumn and return spring migration were also observed. More than 5 000 sightings, consisting of from less than ten to more than 400 observations of individual birds were made.

Behaviour and colouration of birds were recorded from observations made using 10×50 binoculars and 30×–90× telescope. Detailed records of the transitions from pre-breeding winter colour throughout the breeding cycle to completion of post-breeding moult were recorded for the tagged birds.

RESULTS

Nestling to Fledging

Newly-hatched nestlings have a yellow beak (n = 10). By the time the young can be seen above the edge of the nest at about one week after hatching, the beak has changed to grey or black with a yellow tip (n = 73). As they approach fledging, which takes about 45 days, the grey or black becomes diffuse in colour as the adult yellow spreads from the tip (n > 1 000) and during the same period, the crown of the head attains a buff coloured patch (Maddock 1988). However, the black or grey coloured bill may be retained for up to a month after fledging (n > 1 000). Two birds with juvenile black beak have been recorded at migration destinations in March and April.

Winter (Non-breeding) Colour: Adult Birds

All tagged first-year birds, once they became independent and lost the dark beak colouring, were indistinguishable from adult birds and no distinguishing features were discovered in wintering flocks (n = 108). Body plumage is all white except for a pale buff crown and the beak and facial skin (lores) are yellow. The buff crown was visible on all birds seen clearly at the winter roosts and on birds foraging in pastures during winter (n > 1 000).

The tarsus and upper surface of the toes are a grey-black colour with the tibia grey. However, when observed in the field, particularly in back lighting, the whole of the legs appear grey-black.

Acquisition of Breeding Colour

Maddock (1989) classified first-year Cattle Egrets, identified by patagial tags, into four colour groups:

white (no signs of colour except for a buff patch on the crown of the head);

pale (touches or distinct patches of pale buff colouration on neck, shoulders and breast);

full-pale (a full coverage of breeding colour on neck, shoulders and breast, which was a distinctly paler buff than the colour of older birds);

full-coloured (head, shoulders and breast carried a full coverage of strong orange colour).

First-year birds returning to the colonies since that study fitted the same colour descriptions (Table 1). Both sexes, identified by their courting behaviour and copulation, were identified in all four colour categories and all combinations nested and successfully raising young at both colonies. Seasonal variation in the colour categories is shown in Table 1.

Stages of Colour Change

The stages of transition to breeding colour identifiable under field conditions are:

1. the start of pre-breeding moult, identified by loss of feathers are from the neck, giving a scraggy appearance and ultimately bare skin;
2. the new neck plumage, before the feathers begin to break from the sheath, resembles stiff, very pale-coloured buff straws;
3. when the plumage resumes a smooth appearance, the colour is at first a pale buff, much the same colour as is retained by pale and full-pale first-year birds throughout the rest of the season;
4. the colour deepens to the typical strong orange for older birds and for full-coloured first-year birds;
5. the facial skin begins to acquire a pinkish tinge and finally attains a strong magenta hue, the beak becomes a strong magenta red, with a yellow tip, and strong magenta can be seen inside when the beak is agape at about the time the full strength of colour is achieved;
6. the legs may begin to acquire a reddish colour, but some birds pass through the courting cycle without colour change to the legs;
7. the skin of the head and neck becomes a bright cobalt blue at the magenta stage, observed when the bird raises the neck feathers during courting behaviour while facing away from the observer;
8. the magenta acquires a rich purplish-red flush and the iris becomes a rich red during the height of display and pair-bond formation;
9. after the bond is established, the eye quickly returns to yellow and the facial skin and beak begin to fade to pinkish (commencement of fading has been observed over a period as short as 20 minutes in five cases);
10. face and beak have returned to the normal colour by the time egg laying is advanced and incubation commenced;
11. leg-colour, if acquired, fades to a brownish-yellow during early incubation and eventually reverts to grey-black during chick raising.

TABLE 1

Colours of returning year 1 birds 1985/86–1992/93.

	Full Colour	Full Pale	Pale	White	Total
85/86	1	0	0	3	4
86/87	4	3	8	8	23
87/88	8	0	13	2	23
88/89	9	2	11	10	32
89/90	9	2	8	16	35
90/91	2	5	3	9	19
91/92	2	2	4	17	25
Totals	35	14	47	65	161
Percentage	22	9	29	40	100

It has not been possible to determine the duration of the cobalt blue skin colour, because the displays which reveal the colour cease soon after the pair bond is established. No bird has been observed with cobalt skin after the magenta phase has been completed.

All tagged birds which returned for the second, third, fourth and fifth years acquired a full coverage of strong orange breeding colour. The colour which emerges after the scraggy neck phase is at first a pale buff and the deep orange takes about two weeks after the complete coverage of colour is observable in the field. Three tagged birds, in which the complete transition was observed, took 9, 13 and 15 days respectively.

Variation in Schedule of Colour Change

Table 2 summarises the dates of beginning of changes recorded each season from 1988–89 to 1992–93.

Wide variation occurred amongst individuals in the timing of the stages of colour change. In 1987, along the Williams Valley transect from Glenoak, the first signs of neck moult, identified by scraggy neck feathers and first signs of colour on the neck, were observed on 19 August. One bird in 1 000 was noted to have achieved full colour on 25 August, with others in neck moult. By 23 September, the onset of breeding colour for those

achieving colour was well advanced. In 1988, the first signs were in July (16th at Seaham and 25th at the Shortland evening roost) and in 1989 on 7 July. In 1991 the first signs of colour were recorded at Morpeth, on 9 August and the first magenta was seen near Maitland on 16 October (N. Foster, pers. comm.).

In 1988, nesting began at Seaham on 5 October and by 14 October, 16 nests were established. At evening roost time on 14th, 36 of 110 birds loafing in mid swamp were white birds only just beginning the obvious neck and head moult. Birds in full colour but lacking courting colours on the soft parts and birds in full colour and courting flush were included in the remainder. On 23 October 13 of 130 loafing birds were still in early moult stages.

In the 1989–90 season, two white birds were recorded with scraggy neck on 17 November, when several hundred nests were already well established in the colony after nesting commenced before the end of October.

The Magenta Courting Phase

Wide individual variation occurs in the date of acquisition of magenta, with first year birds in general being much later than older birds (Table 3). Of 24 marked egrets for which changes could be followed, five of 14 birds which were two years or older first acquired magenta in October, the other nine in November. Of the 10 one-year old birds, four gained magenta in November, the remainder in December. Fifty first-year birds, which acquired magenta, nested during the period of the study, 23 successfully. Some first-year (for example four in 1992–93) pass through the breeding season without changing and do not attempt to nest.

Variation also occurs in the length of time magenta is held. Most returning birds have already gained magenta before they arrive at the colony and consequently the length of time preceding arrival cannot be determined. The mean time for 42 of these birds which were followed until the magenta was lost, was 15 days, (range 2–38, SD 9). Of four birds for which complete records were obtained from time of pre-nesting moult, the times held were 9, 18–20, 24 and 27 days.

During the peak display period just prior to a pair bond being established, the magenta undergoes a flush to a rich and glossy state. Once the pair bond is established, the red iris changes rapidly to yellow (sometimes visible in a few hours), and the magenta fades to pink, which progressively weakens until the bill and face are completely yellow again. The mean number of days for 21 cases in which this fading was completely recorded was three days (range 0–9, SD 2). In the zero case the fading was completed before the end of the first day.

Fading of Magenta After Bond Formation

The timing of the fading phase was the same for both members of a pair in the majority of pairs studied but ten pairs of 59 which were observed at least to commencement of fading were identified in which the changes were not synchronized. The difference in timing between one member and its mate in reverting to yellow colour, was one day for three pairs, two days for four, three days for two, four days for one pair and nine days for one.

Return to Magenta After Nest Failure

After nest failure, some birds return to a further stage of magenta and magenta flush on the face, as a prelude to re-mating for a further nesting, but not all are successful in obtaining a second mate. Fourteen tagged birds of 110 nesting attempts commenced a second nest, of which five were successful in raising chicks at the second attempt. The mean time between failure of the first nest and return to magenta was nine days (3–21, SD=6).

Another tagged male with an unmarked mate, which raised three chicks to fledging, was seen feeding the young on 10 January 1989. On 11 January, the male had acquired new magenta and it renested about 3–5 metres from its original nest. The mate for the second nest also passed through the magenta phase but it is not known whether this female was the same mate as for the first nest. The new nest was abandoned after 23 days.

Another tagged male went through the magenta process for a second nest after nest failure and renested on the same site. This nest again failed and the bird was seen one day later attending a mate on a third nest nearby, without

TABLE 2

Timing of first record of events 1988–89 to 1992–93.

Week: (AFTER WEEK 1 JULY)	1	5	10	15	20	25	30	35	40	45	50
1988–89	2	1	4	3 4	5	5 6	6 8	8	7	9	
1989–90	2	1		3 4	5	5 6	6 8	8 7		9	
1990–91		1 2	3	4	5	5	6	6	7		
1991–92		2		3 4	5	5	6	8 7	7 9		
1992–93		2		4	5	5	6	8	7	9	

1: First report of colour in a bird.
2: First birds observed with scraggy heads/necks.
3: First magenta beak observed.
4: Nesting commenced.
5: Chicks became obvious.
6: First bird observed at beginning of post breeding moult.
7: Nesting finished: last fledged chick departed.
8: Return to white: first marked bird recorded.
9: Last colour: last report of isolated adult in colour.

TABLE 3

Dates of first acquisition of magenta.

Age Tag	OCTOBER 3 6 11 16 21 26 31	NOVEMBER 1 5 10 15 20 25 30	DECEMBER 1 5 10 15
1988–89			
2 104	Y M		
1 151			Y M
1 178	p - - - - - - - - - - - - -	- - - Y - - - - - M	
1990–91			
3 104	Y M		
2 192	Y M		
2 208	Y M		
2 221	Y	M	
2 240	Y	M	
1 254			Y M
1 314		Y	M
1 324		Y	M
1 327		Y	M
1991–92			
*5 102	Y	M	
4 104	Y M		
3 230	Y	M	
3 249	Y	M	
2 286		Y M	
1 367			Y M
1 409			Y M
1 496			Y M
1992–93			
†4 230		M	
†4 249		M	
†3 286		M	
1 513		Y	M
1 499			Y M
1 564		Y	M

Y: seen in field with yellow face and bill; M: first seen in magenta; p: moult seen; *: Shortland bird; †: These birds were not seen prior to November in yellow-billed phase, but are included because they were observed in previous years.

going through the magenta phase. It is suspected that the third mating represents a case of bigyny, where the third bond had been established earlier, parallel to the second attempt. The regular nest attendance was transferred to third mate after failure of the second nest. Fujioka (1986) reported two cases of bigyny in Cattle Egrets in Japan.

Four birds were recorded during the course of the study returning to magenta after nest failure but failing to find a second mate. In all cases of second magenta, the fading phase was similar to that in the first episode of magenta.

Post-breeding Change

Post-breeding moult of some birds feeding young has been observed before the young are fledged. In 1992–93 one bird moulted while feeding chicks in the first week in January at the same time as two pairs in courting magenta were commencing nesting. Three birds in an advanced state of moult were feeding young in late February. Similar observations have been recorded in previous seasons. One tagged male with a second nest after failure of the first had started the moult while feeding young in mid February. This was the 75th day after the second pair pond was formed and the male had virtually completed moult after a further five days. Another female, renesting after a successful brood, was seen in post-breeding moult after 16 days of incubation. She was completely white seven days later and the nest was abandoned.

These two cases were the fastest post-breeding changes recorded. The interval between the onset of moult being recognized in the field and the apparent completion, indicated by complete white colour and smooth feathering, ranged from five days to between 28 and 40 (n=11).

DISCUSSION

The description of the patterns of colour change during the life cycle of the Cattle Egret has been developed by a synthesis of observations of thousands of unmarked birds and almost a thousand tagged birds over the period of the study. The study provides a picture only of those aspects of the moulting process and colour changes which can be obtained from field observations. A more comprehensive picture would require capture and examination of birds in the hand at various stages of the cycle. Despite the large number of tagged birds, complete observations of single individuals have been very difficult to obtain.

Less than one per cent of birds remain in the immediate natal area during the winter, migrating as far as Tasmania and New Zealand to the south and to northern New South Wales (Maddock and Geering 1993) and most commence the pre-breeding changes in the wintering areas or during the return migration, arriving at the colony already in breeding colour, and in the case of the older birds, in magenta. Only three birds remained in the main study area for long enough to obtain continuous observations over an extended period of time, one for more than four years, but even then there were gaps in recording the cycle of changes.

Time Scale for Breeding Season Changes

Reports from Project Egret Watch observers in Queensland, New South Wales, Victoria and Tasmania, and published reports by Chalmers (1972) and Heather (1982), linked with the Hunter Valley observations indicate that pre-breeding moult to acquire breeding colour usually begins in August to September. Chalmers (1972) indicated that almost all Cattle Egrets wintering in the Gippsland area of Victoria developed 'nuptial plumage' by early September. Birds attaining strong colour in north-western Tasmania depart earlier than than those which do not (S. Plowright, pers. comm.).

About 50 per cent of birds wintering in New Zealand acquire colour before their departure (Heather 1982). However, although marked birds from Australian colonies have been seen in New Zealand over a number of years, none have been seen back in Australia (Maddock 1990; Maddock and Geering 1993).

A feature of the change process is its variability within and between seasons and between individuals. The earliest onset of breeding colouration in both 1988 and 1989, when nesting commenced some weeks earlier than usual, occurred in the Hunter Valley in July. In other seasons, the first signs have not been noted till August. Birds have been recorded just beginning to change colour in October and November.

Comparison with African Cattle Egret
Ardeola ibis ibis

Blaker (1969) referred to the colour change of the beak and lores to magenta for the African race as occurring about 10–20 days before egg laying, with fading occurring one to three days before mate acquisition was observed. In this study, magenta acquisition was on a similar time scale, but no sign of fading was observed before a pair bond was established, except for birds which failed to attract a mate.

Lancaster (1970) did not record the time involved for colour changes of the soft parts in his study of the African race in South America, but stated that these colour changes probably showed for about two weeks, 'perhaps less', and that individual birds vary considerably in the time required for transformation. Lancaster (1970) also referred to the rapidity with which fading of the facial colours can occur. He estimated that the minimum time involved for the iris to change to yellow was two days, with three days for the bill, five to six days for the lores and six days for the tarsus, a similar time-scale to that for the Hunter Valley birds.

Lancaster (1970) also reported wide variation in colour change schedules between members of a pair. In the majority of pairs studied in this project, the pattern followed by both members of a pair was the same. Asynchronous fading of magenta to pink was recognized in 10 of 59 pairs, seven of which varied by two days or less.

Blaker (1968) and Siegfried (1971) make no reference to changes in skin colour, but Lancaster (1970) stated that birds in his study acquired cobalt blue on the skin of the head and neck. He did not give any time scale. Observation of the blue colour was difficult and intermittent in this study and it was not possible to determine a time scale except that the only birds observed with the colour were in magenta and displaying.

Siegfried (1971) reported that juvenile birds have immature white plumage for about five months after hatching, before gaining buff colour on the crown. In this study, the buff crown was clearly recognizable in young birds before fledging and strengthened before mid-winter. The emergence of specialized buff plumes at about 10 months, towards the start of the first breeding season, reported by Siegfried, is of similar order as for one Seaham bird which acquired pale colour in its first year. However, no plume development was recognized in any first year bird which remained white.

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