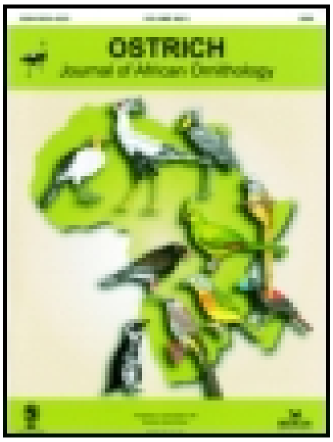

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DISTRIBUTION AND BREEDING OF THE ROCK PRATINCOLE ON THE UPPER AND MIDDLE ZAMBEZI RIVER

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SUMMARY

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The Rock Pratincole *Glareola nuchalis* was studied on the Upper and Middle Zambezi from May to November 1986 and from April to December 1987. Altogether 1938 Rock Pratincoles were counted; their distribution was closely associated with the availability of breeding habitat. The first birds were seen in mid-August and the species was still present in December. They nested in loose colonies on midstream rocks separated from the shore by flowing water. Sixty-four clutches (mean clutch size 1,8 eggs) were found and 44 eggs measured (mean size 29,2 × 21,5 mm). The eggs were usually laid on bare rock less than 1 m above the surface of the water and were sometimes in shade. Both sexes incubated and the frequency of nest relief was greatest during the hottest times of the day. The responses of incubating birds to overheating were bill-opening, panting, dorsal-feather erection, holding the wrists away from the body, and belly-soaking. Non-incubating birds drank often and did not seek shade. After hatching the young sought refuge in rock overhangs and crevices. The important breeding sites in the study area were identified and possible effects of future hydro-electric schemes are discussed.

INTRODUCTION

The Rock Pratincole *Glareola nuchalis* is an endemic resident and intra-African migrant. The species is found in rocky areas of rivers and lakes, where it is locally abundant, from Sierra Leone to southwestern Chad, Zaire and western Kenya southward to east-central Angola, extreme northwestern Botswana, Zimbabwe and western Mozambique; also southeastern Tanzania, western Ethiopia and northeastern Sudan (Brosset 1986).

Studies of the breeding biology of the Rock Pratincole in west Africa have been done (Brossett 1979; Cheke 1980). Less is known about it in its southern range. Breeding is reported from August to December (Benson *et al.* 1971; Irwin 1981). Penry (1979) noted breeding activities at Greystone, Zambia on the Kafue river and found eggs laid in January. Britton (1970) reported a clutch of 2 eggs on sand in Zambia's Northwest Province. Some notes on breeding behaviour are given by Chapin (1939) and Vincent (1945).

METHODS

From May to November 1986 and April to December 1987 we surveyed the Zambezi river from the source in northwestern Zambia to the Luangwa-Zambezi confluence which lies just upstream of Cabora Bassa, Mozambique, except for the stretch of river in Angola. See Coppinger *et al.* (1988) for further details.

The location and habitat of each Rock Pratincole sighting was noted. Accurate counts were not possible at three inaccessible sites, where estimates were made: Victoria Falls (50 birds), Katambora rapids (50 birds) and Deka rapids (40 birds). The birds were counted while slow-boating a section of the river. Where the Zambezi was narrow, one traverse of that portion was sufficient. As the river widened, we counted in all areas by boating twice over that region, but where the river was very wide, we noted that the river had not fully been covered. There are numerous rapids for about 90 km downstream of the Victoria Falls and a commercially operated raft trip provided the only river access. The nature of the journey limited our activities to counting Rock Pratincoles.

Likely breeding areas were investigated for nest sites. At breeding colonies the birds' behaviour was studied and photographs taken. Above Victoria Falls, at Mpala Jena fishing camp, 12 nesting pairs were monitored from 10–24 November 1987. Two incubating pairs were observed for a total of 90,75 hours. The following temperatures were recorded using a thermometer: ambient temperature (Ta), permanently shaded rock temperature (Ts), unshaded rock temperature with thermometer shaded during the measurement (Tr), and unshaded rock temperature with thermometer unshaded (Tu). During measurements of rock temperatures the thermometer bulb was kept 3 mm above the rock surface by the thermometer's wooden casing. It was not possible to record Ta, Ts, Tr and Tu at the same time. Ta was found unreliable owing to the poor air-flow through the hide. Ts and Tr represent the temperature tolerated by Rock Pratincoles incubating in the shade and the sun respectively, while Tu was regarded as a crude approximation of the total heat load.

We distinguished the following heat-load conditions. Grade 0 was Ts < 35 °C, Tu < 45 °C and the incubating bird fully in shade. Grades 1 to 3 involved three factors, namely the incubating bird unshaded, Ts > 35 °C and Tu > 45 °C. The heat load was grade 1 if one factor was present, grade 2 if two factors, and grade 3 if all three factors were present. The responses to heat stress were: bill open with exposure of the buccal mucosa, panting, wrists held slightly away from the body, dorsal-feather erection, crouching over the eggs so that the eggs were partially visible, and belly-soaking. The occurrence of these responses was calculated as a percentage for each heat-load grade.

We graded the habitat as follows:

Grade 0 — No breeding habitat noted
Grade 1 — Breeding habit noted 1–3 times and/or total breeding habitat length less than 1 km
Grade 2 — Breeding habitat noted 4 or more times and/or total breeding habitat length 1 km or more.

RESULTS

A total of 1 938 Rock Pratincoles was counted. Fifteen (0,8 %) birds, of which ten were in one group, were seen on bare river sand. The remaining Rock Pratincoles were on bare rock or flying above rocky terrain. In all cases the birds were in the immediate vicinity of the river. Fig. 1 illustrates the distribution of the species and the availability of suitable breeding habitat per 10-km length (TKL) of the study area. 1 818 (93,8 %) of the Rock Pratincoles occurred in 260 km (16,8 %) of the river's length, namely Sioma Falls (10 km), the region between Katambora and Deka rapids (190 km), Kariba Gorge (30 km) and the stretch including the Chewore-Zambezi confluence and Mupata Gorge (30 km).

The birds were most often seen on rock-island complexes situated amid a strongly flowing current, especially near rapids. Excluding those rock complexes where eggs were located, of 47 sightings in 1987, 41 (87,2 %) were of birds on mid-stream rocks and six (12,8 %) of birds resting on rock complexes connected to the river's side-banks. Thirty-six (76,6 %) of the rock complexes were 30 m or less in length and 34 (72,3 %) 10 m or less in width. The maximum height of the rock above water level was 0,5 m or less in 40 cases (85 %). Below Victoria Falls in the Batoka Gorge the rock islands were taller but we did not record their height.

Movements

We counted 300 Rock Pratincoles in October and November 1986 in the vicinity of Kandahar camp about 15 km upstream of the Victoria Falls. However, from 11–24 April 1987, the same area was thoroughly investigated (both near to and away from the river) and no birds were seen, but by October 1987 they were again present.

In 1986 we first saw Rock Pratincoles on 9 August on the Middle Zambezi, and in 1987 on 12 August in Zambia's northwestern Province. Two sightings (12 and 20 August 1987) were about 20 km from the nearest suitable breeding habitat and the birds were resting on sandbars, probably *en route* to breeding grounds. It appears the species is migratory on the Upper and Middle Zambezi (Irwin 1980), unlike the situation in Gabon (Brosset 1979). On 28 August 1987 two Rock Pratincoles were observed at the Lunguebungu-Zambezi confluence on rocks that were submerged ten days previously. As the birds were not noted before, we suggest they were recent arrivals and still establishing territories. Similarly in August 1986 near Kariba Gorge, territories did not seem fully established because two pairs competed for the same rock. However by mid-September nesting areas seemed well established.

General behaviour

Maintenance activities

Rock Pratincoles were most active at dawn and dusk, feeding on the wing usually 15–50 m above the ground. When not feeding they spent much of their time resting, either standing or sitting. Habitual resting spots were often used.

The birds scratched their heads directly like all other glareolids. Other comfort movements noted were jaw-stretching (yawning), one-sided-wing-and-leg-stretch, preening and body-shake with the wings retained in the pectoral feather pockets. As the ambient temperature rose, birds exposed the

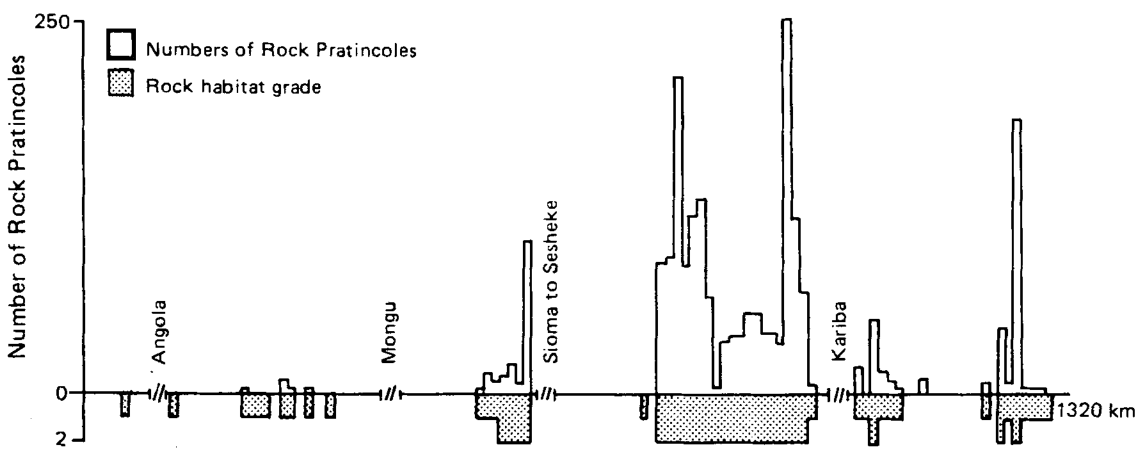

FIGURE 1

Graph showing numbers of Rock Pratincoles and availability of breeding habitat per TKL of the study area.

buccal mucosa and drank frequently. They did not seek shade.

Of the 219 group sizes recorded, 184 were groups of ten birds or fewer; 88 groups consisted of two birds (Table 1). The largest breeding colony was 52 birds on one rocky island in Mupata Gorge and the largest group was 126 birds on a small rocky area which was not suitable for breeding. Birds established territories on the rocks in loose colonies. In most cases, even in larger colonies, they appeared to associate in pairs.

Other species were tolerated at nesting colonies. A Whitebacked Night Heron *Gorsachius leuconotus* incubated three eggs in a pratincole colony of 25 birds. Two Water Dikkop *Burhinus vermiculatus* parents successfully hatched two young in a nest 9 m from nesting Rock Pratincoles. Wattled Plovers *Vanellus senegallus* and Whitecrowned Plovers *V. albiceps* nested in suitable pratincole habitat and not far from their colonies. Reed Cormorant *Phalacrocorax africanus*, Greenbacked Heron *Butorides striatus*, Greenshank *Tringa nebularia*, Pied Kingfisher *Ceryle rudis*, Wiretailed Swallow *Hirundo smithii* and African Pied Wagtail *Motacilla aguimp* came to within 2 m of Rock Pratincole eggs or young without any response from the parents being noted. Once a Hobby Falcon *Falco subbuteo* drank for 3 min 25 m from a Rock Pratincole nest. The incubating parent looked directly at the falcon, kept its bill closed and stayed absolutely still. By assuming this position the white collar and red gape were hidden. When the falcon flew off the pratincole turned its head to follow the raptor's progress.

A defending bird gave the full alarm-call while flying or walking up to an intruder during intraspecific defence of a territory. A head-down threatening run directed at an intruding bird was observed, also an aerial swoop by an intruder which brought it close to an incubating pratincole. A persistent intruder considerably disrupted the nest-relief routine of an incubating pair at Mpala Jena (see below). Head-bobbing was an anxiety reaction. No distraction display was seen.

Vocalizations

The commonest adult vocalization was given in flight or when alarmed or challenged by an intruder. We transcribed it as "Kwip, Kwip Kwip Kwipeerree" (compare Maclean 1985). A contact call was regularly used at nest relief. It was a single "Kwip" rapidly repeated 3–8 times to form a string of notes and was not as high-pitched as the alarm call. A close-contact call, a very soft *chuck chuck* was heard twice at nest relief.

Breeding behaviour

During November 1987 a loose colony was investigated for two weeks near Mpala Jena Camp, about 30 km upstream of the Victoria Falls. Upstream, the nearest group of Rock Pratincoles was about 5 km from the colony under study, and downstream, 700 m separated the colony from the next group of birds. Within an area of 1 100 × 900 m we counted 42 pratincoles and 12 nests. Eleven nests fell within a circle of radius 350 m and all were encompassed by a circle of radius 450 m.

TABLE 1
DISTRIBUTION OF GROUP SIZE OF ROCK PRATINCOLES, EXCLUDING BIRDS COUNTED DURING THE RAFTING TRIP

No. of birds per group	No. of sightings	% total sightings
1	23	10,6
2	88	40,3
3–5	33	15,2
6–10	40	18,3
11–15	12	5,5
16–20	7	3,2
21–25	6	2,3
26–50	7	3,2
51–100	2	0,9
101–200	1	0,5
Total	219	100

Nest and eggs

In 1986 eggs were first noted on 25 October at Katambora rapids, and thereafter we systematically searched other likely areas. However once young were seen on 10 November we stopped this activity so as not to disturb them. By this date 33 clutches had been discovered.

In 1987 we did not find any young because none of the clutches we were monitoring hatched before our departure from their area. Thirty-one clutches were found: 9 October (three clutches), 29–30 October (16 clutches) and 10–22 November (12 clutches), a span of 46 days. The incubation period is 20 days (Brosset 1986). Interestingly the "October clutches" were situated downstream and the "November clutches" upstream of the Victoria Falls.

A total of 64 clutches and 120 eggs was found, 56 (87,5 %) clutches of two eggs and eight (12,5 %) of one egg (clutch mean 1,88). Measurements of 44 eggs were 27,6–31,4 × 20,2–22,8 (29,2 × 21,5 mm). The egg colour varied considerably as described by Brosset (1986). The eggs blended well with the background rock colour.

Nests were all situated on rocky islands isolated from the banks by flowing water. The rocks varied in geological type and no variety seemed preferred. Nest details were recorded from 61 clutches. The vertical distance from the river to the top of the rock complex was 1 m or less in 69,3 % and the vertical distance from water to nest was 0,5 m or less in 83,6 % of the sites. One clutch was lapped by water and likely to be submerged by the rising river.

Twenty-two (36 %) of the clutches were located on rock ledges, 19 (31,1 %) under a rock overhang or in the recesses of a hole, 16 (26,3 %) in slight rock hollows and four (6,6 %) on flat exposed rock. Twenty-three (37,7 %) were fully exposed to the sun, 25 (41,0 %) shaded almost continuously and 13 (21,3 %) were shaded for part of the day. Shade was provided by adjacent vegetation (three clutches), rock overhangs (15 clutches), ledges (19 clutches) and a rock hollow (one clutch). There was no evidence of nest construction. Forty-one (67,2 %) clutches lay on bare rock, 18 (29,5 %) on a thin layer of sand which was largely undisturbed and probably incidental, one on rock debris and one on a dried mud layer.

We found more than one clutch on 11 of the rock complexes. There were two clutches on eight (72,7 %) occasions and three clutches on three (27,3 %) occasions. The average distance between clutches situated on the same complex was 9,2 m. Thus twenty-five (41 %) of 61 clutches were on rocks harbouring more than one nest.

In 1987 we found 21 rock complexes containing nests. Eleven (52,4 %) of them supported two Rock Pratincoles, seven (33,3 %) had 3–10 birds and three (14,3 %) had 11–16 birds.

Incubation

We abandoned attempts to study incubation in 1986 as the birds did not accept a hide. However, in 1987 we managed to monitor nest R for 40,5 hours and nest T for 50,25 hours at Mpala Jena.

Nest R was observed from a hide or a boat 11 m and 25 m from the nest respectively. A single egg was noted on 10 November and a second on 13 November. We watched the incubating pair for five consecutive days (11–15 November), thereafter visiting daily. The nest was situated in a 10-m × 15-m rocky outcrop, 60 m from the nearest bank and separated from the bank by other small islands. The deep mainstream Zambezi flowed 15 m to the north of the rock complex. Sand deposits supported grasses and some small bushes that covered about 50 % of the island's area. Nest R was on a small south-facing ledge on the southern edge of the island and 0,8 m above the water. The rock complex's maximum height was 1,5 m. The eggs lay on bare rock and were shaded from about 08h30–17h00.

Nest T was on a narrow 50-m × 15-m rock island that jutted from the southern Zambezi bank outwards into a mainstream area of minor turbulence. The island was a maximum height of 0,7 m and about 5 % covered by grass. The nest was 0,2 m above the water and on a bare east-facing rock ledge about 3 m from a shallow pool of flowing water. The eggs were shaded by the ledge from about 12h20 onwards.

We were able to distinguish the parents by differences in the pattern of the white collar (parents P1 and P2 at nest R, R1 and R2 at nest T). Both members of a pair incubated. P1 and P2 incubated an average of 59,8 min before nest relief (only undisturbed periods of incubation considered), P1 sitting an average of 40 min and P2 79,5 min. R1 and R2 averaged 34,4 min, R1 32,4 min and R2 36,6 min (Fig. 2). The longer average incubation at nest R may have been because of the better shade conditions. The differences in incubation times between P1 and P2 were not seen in R1 and R2 and might be just individual variations in behaviour. The frequency of nest relief varied during the day directly with rock and ambient temperatures. Fig. 3 shows Ts and Tu taken from the hide at nest R on different days. The numbers of undisturbed incubation periods for different times of day are in Table 2 and most nest reliefs took place during the hottest hours. No difference in frequency was noted between the two pairs.

We noted that the responses to heat stress differed between the incubating and non-incubating birds. However, the hide position at nest R was

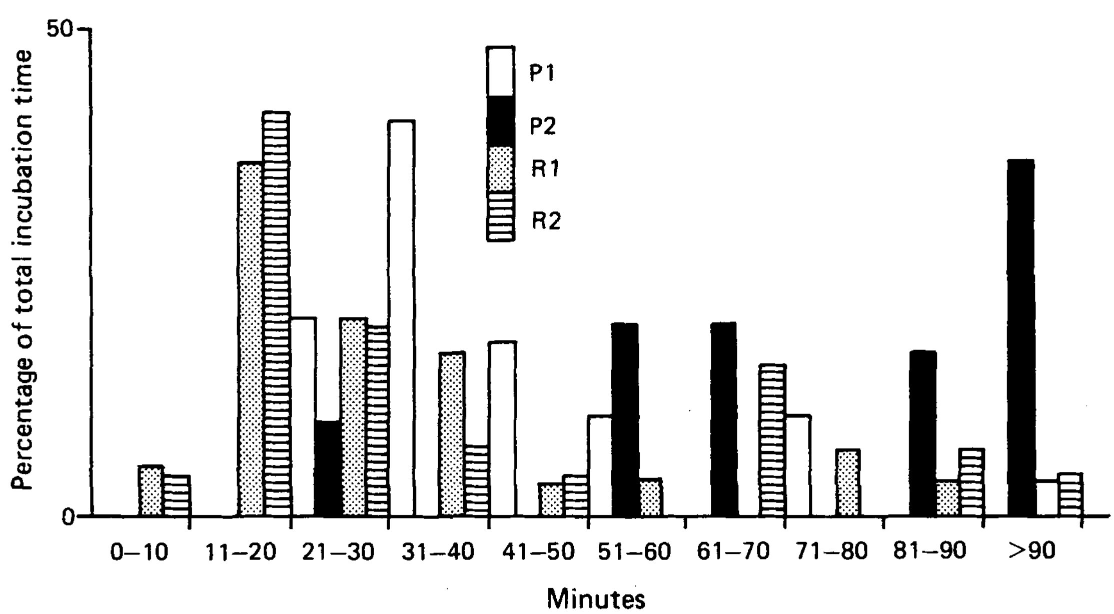

FIGURE 2

Histogram of uninterrupted periods of incubation by P1 and P2 at nest R, and R1 and R2 at nest T, Mpala Jena colony.

TABLE 2
NUMBER OF UNINTERRUPTED PERIODS OF INCUBATION AT NESTS R AND T DURING VARIOUS PERIODS OF THE DAY

Time	Nest R		Nest T	
	No of periods	% total	No of periods	% total
06h00–10h00	0	0	12	21,1
Periods spanning 10h00	2	9,5	2	3,5
10h01–14h00	10	47,7	30	52,6
Periods spanning 14h00	2	9,5	2	3,5
14h01–18h00	7	33,3	11	19,3
Total	21	100	57	100

inadequate for studying these differences so the hide was relocated at nest T. Fig. 4 relates those responses to a graded heat load. Bill-opening was the earliest response and initiated before 08h00 on all five days of observation. The bill was frequently closed momentarily and the buccal mucosa gleamed moist on re-opening, only to dull as moisture evaporated. Copious bubbles of saliva were seen in hot weather. The wrists were held away from the body as heat load increased, but showed little change thereafter, suggesting that other factors such as comfort and egg concealment may be relevant. Panting frequency was difficult to count accurately, but was of the order of 5–8 times per second. When conditions were cool the breathing rate was 30–60 per min. In very hot conditions the bird's whole body shook during panting and this we termed "coarse panting" as opposed to the less vigorous "fine panting" when shaking was not apparent. The early and rapid increase in the incidence of panting as heat load increased suggests that it is a major method of heat dissipation for the Rock Pratincole. Feather erection of the crown, mantle, nape, and back commenced after panting and the incidence rose sharply, as did the incidence of belly-soaking, once high heat loads were present. Rock Pratincoles exposed their legs by squatting on six (15 %) occasions during 57 periods of incubation. The eggs were then partially visible.

Belly-soaking has not previously been described for Rock Pratincoles. Twenty-one belly-soaking episodes were noted and the underparts of the bird relieving at the nest were seen to be wet on a further 12 occasions. Belly-soaking occurred just before nest relief, except on two occasions when disturbances diverted the bird from going to the nest. A bird often returned to the same area in order to belly-soak and sometimes left a resting place near the water's edge and walked to another location by the water to commence belly-soaking. The activity occurred in shallow water, in still pools or in flowing water. The belly-soaking manoeuvre consisted of a standing bird suddenly dropping down into a squatting position, thus wetting its belly in water, and then immediately standing erect again. The body was held in the same position relative to the horizontal throughout the manoeuvre. The act was extremely quick and it appeared as though the bird's legs had momentarily given way and then instantly recovered (Fig. 5). We termed the belly-soaking manoeuvre a "drop-sit". Usually a bird executed a number of drop-sits and then walked away from the water. This we called a "bout" of belly-wetting. The bird often returned to water and drop-sat some more, thus commencing another bout. An episode was defined as all the belly-soaking activity by one bird before relief at the nest. We observed 301 drop-sits during 21 epi-

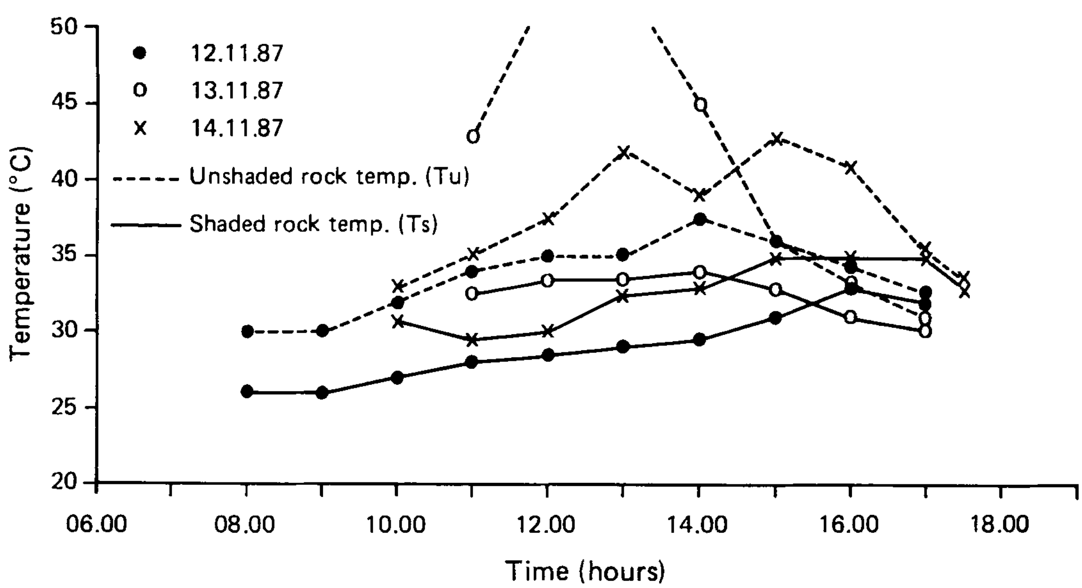

FIGURE 3

Graph showing shade rock temperatures (Ts) and unshaded rock temperatures (Tu) for nest R at various times of the day.

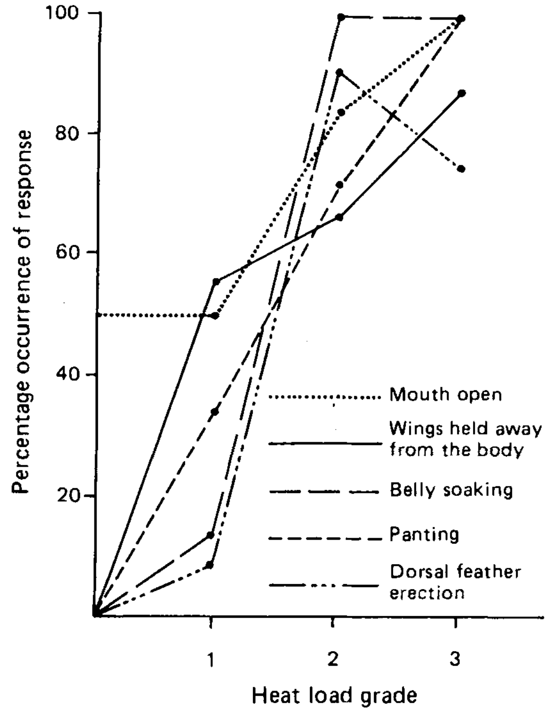

FIGURE 4

Graph of the responses to a graded heat load by incubating Rock Pratincoles.

sodes, bouts ranging from 1–5 per episode. One or two were most common. The frequency was: one bout (37,5 %), two bouts (37,5%) three bouts (18,8 %) and five bouts (6,2 %). The average number of drop-sits per bout was 5,1 and per episode was 15,1. The depth of water during a belly-soaking bout was tarsometatarso-phalangeal joint (65,8 %), tarsometatarsal joint (23,7 %), and mid-thigh (10,5 %). On 14 occasions the birds drop-sat on dry land (but near water) and those ineffectual drop-sits usually heralded the onset of another bout of drop-sitting.

The bird often drank while standing in water during a belly-soaking episode. This occurred in two ways. If standing the bird tilted its head down and its tail up, thus stooping down to drink. The relative position of the body to the horizontal changed (Fig. 5). Sometimes a bird sipped water during a drop-sit. The two manoeuvres remained distinct, the body tilting for drinking and retaining the "standing angle" for belly-soaking. Either of the manoeuvres might occur first. The total number of sips during 21 belly-soaking episodes was 153 with an average of 3,4 sips per bout and 8,5 per episode. The drop-sit : sip ratio was 1,97 : 1. R1 belly-soaked for ten episodes and R2 for 11.

During times of anxiety the birds performed many drop-sits. For example, 47 drop-sits when the hide flapped noisily in a strong wind and 30 during the presence of a Rock Pratincole intruder. This suggests some degree of displacement activity in these two instances.

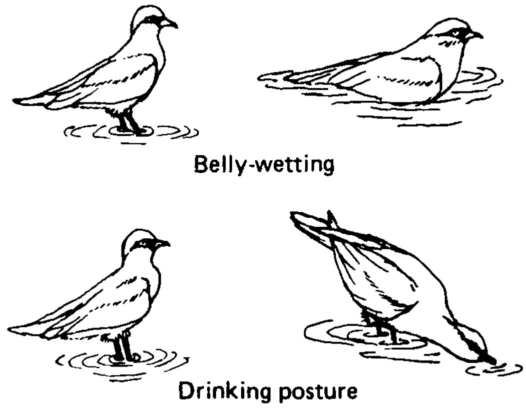

FIGURE 5

Belly-soaking and drinking postures.

We saw the wet belly feathers enveloping the eggs and several times noted a wet sheen on the eggs at the subsequent nest relief. This suggests that belly-soaking in the Rock Pratincole serves as an egg-cooling mechanism. Other factors support this contention. Belly-soaking was seen only just before incubation and not after relief from incubation when the parent might be expected to be maximally heat-stressed. Birds relieved from nest duties went to water, standing in it and drinking, thus cooling off. Sometimes their underparts became incidentally wet but the birds did not immediately return to incubate.

Off-duty pratincoles relieved heat stress by standing in water, drinking, exposing the buccal mucosa and occasionally by "fine panting". Feather erection, "coarse panting" and holding the wrists slightly away from the body were not seen. The birds made no effort to seek shade.

The usual course of events during incubation was as follows: In the early mornings the parents were mostly within 40 m of the nest but not incubating. As the day progressed, if the weather was cool, the nest was left unoccupied for periods of up to 96 min. Usually, however, the sky was cloudless, the ambient and rock temperatures rose rapidly, and one parent would settle on the eggs with its mate standing nearby. Orientation of the incubating pratincole was determined by contour of the rock and not by wind direction.

Nest relief seemed to be initiated by the non-incubating bird which called "Kwip Kwip Kwip" several times. Usually the mate did not answer but walked off the nest and then flew or walked to the water's edge. The relieving bird approached the nest directly (walking or flying) and walked the final metre or so to the nest. Most times it immediately started incubation, adjusting the position of the eggs with its bill. Sometimes the sitting bird waited until its mate arrived. There was no greeting ritual or vocalization when they were together. The relieving bird thrice had to shove the sitting mate gently with its head to get it to leave, then took over without further ado.

Sometimes a bird changed position while incubating. This might be a slight shift or a 180° turn. It occasionally called "Kwip" softly 3–4 times while repositioning. Usually the sitting bird remained alert but if the weather was mild, it periodically nodded off into apparent sleep. At nest R the incubating pratincole often pecked with a closed bill at the ground (rock patchily with sand). It sometimes picked up an object, usually stone debris, in its bill and tried to crush it before discarding the article. The bird also side-threw small objects and once tugged with its beak at a grass stalk. This ritualized behaviour was exhibited when the bird approached the nest or during a change of position or on leaving the nest after relief. It was not seen at nest T. Once the incubating bird walked off the nest to a pool, drank and belly-soaked, and returned to the vacant nest.

On 20 November Rock Pratincole R1 landed silently 2 m from the nest, holding a flying termite in its bill. R2 left the nest and approached R1 which turned away and ate the insect. R2 flew off and R1 took over incubation. The nest was vacated some time between 17h30 and 18h30 hours on all days of observation. The sun set at approximately 18h20. We made no night observations.

The off-duty bird either rested near the nest or by water, preening and drinking and occasionally calling.

Other Rock Pratincoles intruding onto the nest-T rock complex caused disruption of the orderly incubation routine. On 24 November one intruder was persistent. Initially the off-duty partner flew and stood close to the intruder. Both birds alarm-called. The intruder remained near the nest and later gave a head-down threatening display. At one stage the incubating partner left the nest. By the end of the day the intruder and the off-duty mate were standing together, apparently without any confrontation. Flying Rock Pratincoles sometimes called *en masse* while passing above the nest territory. They were often ignored by the incubating pair but occasionally joined (after alarm-calling) by the off-duty bird. Once the incubating bird vacated the nest in response to constant alarm-calling from six Rock Pratincoles flying overhead.

The young

In 1986 at Katambora Rapids seven nests were intermittently visited from 25 October to 19 November. At one nest on 27 October, there was a villager's fishing net within 1 m of the nest site. The eggs had presumably been taken. The parents had abandoned the rock and it was not used again for breeding during the study period. Although Rock Pratincole chicks are very difficult to detect, we were confident there were no young at another nest. Of the clutches followed up, three (50 %) definitely hatched.

Near Sansimba Camp, Upper Zambezi, five young were found in 1986: on 10 November two chicks, estimated 2–3 days old, and on 11 November one newly hatched chick known to be less than 16 h old. At Katambora one fledgling on 19 November was able to fly 3–10 m but preferred to hide in water under rock ledges. Emergent feathers on the tail, wings and back were spotted light brown. This mottling coalesced on the immature to form a brown breast. The immature lacked the adults' white collar. Downy young often "froze" on rock when endangered and were superbly camouflaged. They hid in rock cracks and overhangs and swam (even at 2–3 days of age) to escape. Their alarm call was a weak "keep keep".

The fate of the pratincoles at Mpala Jena island (12 clutches, 23 eggs) was followed from 10–24 November 1987. The eggs were monitored for a range of 2–15 days (average 7,7 days). Eight (34,8 %) eggs of average minimum age 5,25 days disappeared. At one nest (c/2) we found one broken egg with yolk inside; presumably the clutch fell victim to a predator. The parents were nearby and alarm-called when we approached. Most of the night of 21 November the wind gusted strongly and about 15 mm of rain fell over 3 h in the early morning. That afternoon three clutches, each of two eggs, had vanished. We did not find any young or egg remnants. The parents were all at their nest sites and became agitated at our presence.

DISCUSSION

The migrations of the Rock Pratincole in its southern range are unclear. In our study area the records were fully summarized by Benson & Irwin (1965). Penry (1979) reviews the movements in Zambia and finds no clear pattern. He noted birds arrive at their southernmost Zambian breeding areas (Katambora, Livingstone, Gwembe Valley and Katima Mulilo) in July and August, 2–3 months before their arrival on the Kafue, Kabompo and East and West Lunga rivers. We confirmed August sightings for the Middle Zambezi, and also found the species further north upstream of the Kabompo-Zambezi confluence in mid-August. Pratincoles were not seen north of the confluence during May to mid-June in regions where breeding was recorded (Chavuma Falls, Mwinilunga). Our sightings support the view that the species arrives from the north in July and August.

The accuracy of our Rock Pratincole count is subject to the assumption that the number of birds missed or being recounted was small. Birds arrive on the Zambezi in July and depart by late February (Benson & Irwin 1965; Irwin 1981), so it was only from May to July that we were likely to have missed birds. The pratincoles' breeding-habitat requirements enabled us to assess a region's potential for supporting the species and thus to eliminate certain areas visited during those three months. Our count contains three estimates which, if 50 % inaccurate, give an error of 70 birds. In the field we tried to minimize errors by causing as little disturbance as possible. The territorial nature of the species considerably reduced the likelihood of birds flying far from their nesting area. In most cases birds disturbed by us remained within sight. Rafting the gorges below Victoria Falls was hectic and only downstream travel was possible. Our count over the 105-km stretch could

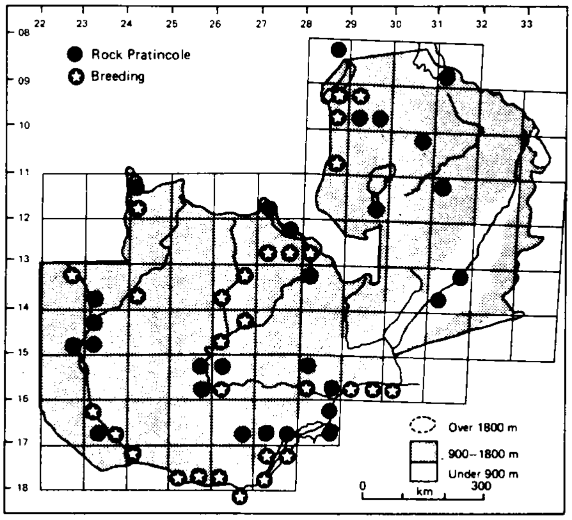

FIGURE 6

Distribution of the Rock Pratincole on the Upper and Middle Zambezi.

TABLE 3
NUMBERS OF ROCK PRATINCOLES ON THE UPPER AND MIDDLE ZAMBEZI. * ESTIMATES (SEE TEXT)

Area	Number	River length (km)
Source to Angola-Zambia border	33+	80
Angola	?	280
Chavuma to Lukulu	12	180
Lukulu to Senanga	1	250
Senanga to Sioma	153	70
Sioma to Katima Mulilo	100*	120
Katima Mulilo to Kazangula	10*	120
Kazangula to Victoria Falls	742	70
Victoria Falls to Kariba Lake	706	160
Kariba Lake	0	250
Kariba Wall to Mozambique border	324	250
Total	2 081	1 830

be significantly less than the actual population.

Irwin (1981) suggested there may be fewer than 1 000 Rock Pratincoles in Zimbabwe. Pollard (1982) estimated 1 020 for the area Kazangula to Deka river mouth. We counted 1 276 birds in this area and it seems the numbers of this particular population have remained fairly stable over six years. We have estimated the population for the Upper and Middle Zambezi (Table 3) and Fig. 6 illustrates their distribution. The Zambezi section from Senanga to Sioma averaged 0,83 Rock Pratincoles per kilometre (excluding Sioma Falls) and this figure was used to estimate the populations in the stretch from Sioma to Katima Mulilo and also the portion of the Zambezi in Mwinilunga that we considered likely to support the species. Mpalela Island lies upstream of Kazangula and is a recorded breeding area, although we did not see Rock Pratincoles there during our visit in May.

Irwin (1981) states that in Zimbabwe "the Rock Pratincole has never been a common species and is now seriously threatened by dam building". The species formerly occurred in the Kariba Basin (Donnelly & Donnelly 1983) but we did not see it there and Irwin (1981) considers it scarce. Two further dams are proposed on the Zambezi (Du Toit 1982). The Mupata Gorge dam will flood the section of the river in which 237 birds (73 % of the Middle Zambezi total) were counted. The second dam is envisaged at Batoka Gorge and will flood breeding sites below Victoria Falls where 103 birds (5,9 % of the Upper Zambezi total) were seen. The altered flow below the dam may also affect their breeding. Likewise the proposed diversion of the Zambezi from Kasane to the Witwatersrand could be a problem by changing downstream flow. If these schemes are effected where would the birds breed? It was our impression that most potential breeding sites are occupied on the Zambezi below Kariba, but not above and below Victoria Falls and the latter area could better accommodate an influx of birds. Conservation of the high-density breeding regions is essential as 93,8 % of the Rock Pratincoles counted were seen in only 16,8 % of the study area.

A far smaller human threat comes from the human inhabitants of the Zambezi. We have cited one clutch possibly destroyed by fishermen and have seen local children sweeping in rock crevices for Rock Pratincoles young. However, human habitation is sparse along the Zambezi in the breeding areas.

The specialized breeding habitat of the Rock Pratincole successfully eliminates competition from many species although we recorded three other species nesting in a similar environment. Non-swimming predators are excluded and avian predation of the young is low, probably because of their excellent camouflage and inaccessible hiding places. However, the low midstream rocks are exposed to the elements and vulnerable to fluctuations in river level. Successful breeding depends on river dynamics and usually requires a departure from the breeding site during times of flooding.

Rock Pratincoles are apparently not obligatory colonial breeders but rather adapt to the available rock distribution. Thus in various parts of the Zambezi we found large numbers on a single rock complex, loose colonies on stretches of scattered rocks over 4–6 km, and a few pairs many kilometres from neighbours. Breeding territories within a colony appeared smaller than the 100 m cited (Brosset 1986). In Gabon the mean clutch is 1,56 (72 clutches) (Brosset 1986) whereas the mean was 1,88 (64 clutches) in our study. The mean egg size (29,2 × 21,5; n = 44) is similar to measurement given by Brosset (29,0 × 21,6; n = 13). Allowing for an incubation period of 20 days and a 40–45-day fledging period, all the eggs were laid in October or November. Breeding records show an October peak in Zimbabwe and September in Zambia.

African rivers seasonally flood, thus regulating the timing of Rock Pratincole breeding by submerging the nest sites at certain times of the year. After studying a colony in Gabon for 9 years, Brosset (1979) suggested the visual stimulus of the reappearance of rocks in the river provided the cue for birds to start laying. However, Cheke (1980) found breeding commenced in Togo after the rains had arrived, when the rivers were rising. Similarly Penry (1979) in Zambia noted pratincoles breeding when river levels were rising. Near the Victoria Falls we found clutches laid in October and November, when the Zambezi was low. At the Victoria Falls the Zambezi generally starts rising in late November, reaching a maximum in April–May (C. Nugent *in litt.*). In November 1986 eggs were still present when the river started to rise, but in 1987 levels remained low until early December. Upstream of the Victoria Falls the Zambezi is 2 km wide and fairly shallow whereas in the gorges downstream of the falls it is only 10–50 m wide and much deeper. Consequently any variation in river volume results in a far greater change in water level below the Victoria Falls than upstream of it. If Brosset's postulate regarding the onset of laying is correct, nesting should occur earlier in the downstream gorges. Our observations confirmed this.

Downstream of the Kariba Dam the seasonal fluctuations since 1981, when the floodgates were last opened, have been minimal. Even at Mana Pools which is downstream of the Kafue–Zambezi confluence, the variation in water level is estimated to be only 30–50 cm (C. Nugent *in litt.*). This suggests the choice of breeding sites for Rock Pratincoles in the lower Middle Zambezi has remained constant since 1981 and that river rises are less of a hazard for these birds.

Our study stresses the need for water during the breeding season. The species drinks often throughout the day, besides feeding on insects, a rich water source. It can thus afford to use water freely for loss by evaporation and this must account in large measure for its ability to tolerate heat. The very wide gape and consequently large surface area in the buccal cavity where evaporative cooling can occur must be important. Rock Pratincoles did not often use their legs as centres of heat loss during incubation. Belly-soaking in the charadriiformes was reviewed by Maclean (1975) and has been noted in *Glareola lactea* and perhaps *G. pratincola*. In India, where the habit is most widespread, charadriiformes that belly-soak are mostly spring to summer breeders and have eggs or young when air temperatures are relatively low. However, *G. nuchalis* has its breeding cycle intrinsically linked to fluctuations in river level and, in its southern range, incubates during the hottest months. We also observed White-fronted Plover *Charadrius marginatus*, White-crowned Plover *Vanellus albiceps* and African Skimmer *Rynchops flavirostris* belly-soaking during the hot Zambezi breeding season in September to December.

The genera *Glareola* and *Stiltia* have adopted the refuge-system (Maclean 1976) which must cut down the need for evaporative cooling, not only because the refuge has a cool, shady micro-climate but also because the chicks are inactive during the heat of the day. However, for *G. nuchalis* independence from surface water is not necessary as it is always close by.

The refuge affords good protection as predation of the young is rare (Brosset 1986). Our study suggests a significant loss of eggs through predation, flooding and exposure to the elements.

A phenomenon common to some species of *Glareola* is the complete, or nearly complete, absence of adults from the nesting colony at certain times of the day. *G. nuchalis* was seen near the nest for the whole day, although, if the temperatures were sufficiently cool, it does not necessarily incubate. At twilight feeding times the colony's adults are mostly airborne.

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NOTICE

20th INTERNATIONAL ORNITHOLOGICAL CONGRESS 1990

Final Notice

The 20th International Ornithological Congress will take place in Christchurch, New Zealand, on 2–9 December 1990. The Congress programme will include 7 plenary lectures, 48 symposia, contributed papers (spoken and poster), workshops, round-table discussions and films. There will be a mid-Congress excursion day. Longer tours are planned to interesting ornithological sites in New Zealand before and after the Congress, including the post Congress cruises to sub-antarctic islands.

The Second and Final Circular of the Congress will be available from 1 October 1989 and will include the registration papers and forms for submitting papers. In late 1990 New Zealand will also host the 20th World Conference of the International Council for Bird Preservation in Hamilton on 21–27 November 1990 and a Pacific Festival of Nature Films in Dunedin on 27 November–1 December 1990. Requests for this Final Circular, which includes information on the above events, should be sent to:

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