Breeding adaptations of the Damara Tern *Sterna balaenarum*

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ABSTRACT

The breeding of the Damara Tern *Sterna balaenarum* near Swakopmund, South West Africa, is described. Loose aggregations of nesting birds occur on gravel plains about one kilometre inland from the sea. At any one locality the nests were well spaced. Clutch size was one. The parent birds were relatively unaggressive towards human intruders. These features are discussed in relation to the possible selection pressures involved in their evolution. The implications that these adaptations have for the conservation of the species are discussed. It is stressed that the area reported on in this paper represents the only currently known regular breeding area of the species. Like other terns, the Damara Tern may be susceptible to disturbance when breeding. The area north of Swakopmund is a popular resort for tourists during December—January, when the tern breeding season is at a peak. It is suggested that efforts be made to assess the extent and effect, if any, of human disturbance at the breeding sites. If necessary, other breeding areas, where more rigid protection can be enforced, should be located. Finally, it is noted that a survey needs to be undertaken to assess what changes, if any, are occurring in the population status of this little known species, endemic to southern Africa.

1 INTRODUCTION

The Damara Tern *Sterna balaenarum* is a small tern confined, during the breeding season (November—April), to the coastal waters of southern Africa from Cabinda (5 10S, 12 10E), south to Cape Agulhas (34 25S, 20 05E) (Bannermann, 1953; Liversidge, 1959) and eastwards as far as Cape Vacca (34 20S, 21 55E) (pers. obs.). Biological productivity along the south west African coast is high, due to the influence of the cold, nutrient-rich Benguela current (Cushing, 1971). Outside the breeding season, Damara Terns have been recorded regularly from Lagos (6 20N, 3 20E) in the Gulf of Guinea (Elgood, Fry & Dowsett, 1973).

Almost nothing is known of the species' biology. Ecologically, the Damara Tern appears to belong to the little tern complex, which includes the Least *Sterna albifrons*, Yellow billed *S. superciliaris*, Fairy *S. nereis* and Peruvian *S. lorata* terns (see Moynihan, 1959; Schnell, 1970 a, b, for details of tern systematics, and Ashmole, 1971, for a summary of the feeding ecology of the group). Like most of these species the Damara Tern is essentially an inshore feeder which usually frequents sheltered bays, estuaries and lagoons (McLachlan & Liversidge, 1970). It is said to feed on small fish and crustaceans (Mackworth-Praed & Grant, 1962; Watson, 1966). The past and present population status of the species is not known. Andersson (1872) found Damara Terns breeding at Walvis Bay (22 40S, 14 30E) where he described them as being common. Our unpublished data suggest that the situation is no different today; Walvis Bay and nearby coast are the only areas where these terns can be observed reg-

ularly. Moreover the coastal region north of Swakopmund (22 33S, 14 35E) is the only area where Damara Terns currently are known to breed in any numbers. There are historical records of this tern breeding near Cape Town (33 55S, 18 22E) (Gill, 1945; Vincent 1946), though these colonies apparently are now extinct. Recent observations suggest that small numbers of Damara Terns may breed at a few widely scattered localities along the southern Cape coast, but the size of the population is not known.

In a recent compilation of the rare and vulnerable birds of South Africa (Siegfried, Frost, Cooper & Kemp, in press) the Damara Tern was considered to be one of twenty species in need of immediate investigation. In part, this concern was prompted by the apparent uncommonness of the species away from the Walvis Bay—Swakopmund area. The species is rarely seen now in the southern portion of its breeding range, an area where considerable coastal development has taken place. In both Europe and North America, populations of the ecologically similar Least Tern have declined markedly in recent years, the major reasons appearing to be the displacement of breeding colonies through coastal development and the disturbance caused by increased public access to formerly isolated beaches (Norman & Saunders, 1969; Cramp, Bourne & Saunders, 1974; Wilbur, 1974). Similar factors may be affecting Damara Terns in southern Africa.

This paper describes some features of the species' breeding biology and discusses the probable selection pressures involved in their evolution. Finally, the implications of these features for the conservation of the Damara Tern are discussed. There is a paucity of basic biological data on this species and it is hoped that this paper will generate some interest and further research.

2 OBSERVATIONS

Observations were made during early December 1974 at a number of small breeding aggregations of Damara Terns located on inland gravel plains north of Swakopmund, at the western edge of the Namib Desert. The plains are situated about one km from the sea. The lichens *Parmelia* and *Teloschistes* and the halophytic bush *Arthraerura* are the only plant life occurring on these plains.

The terns typically nested in small, loose aggregations. Thirteen breeding pairs were recorded at five different localities. A further five birds appeared to be incubating at these localities but the nests were not checked. At two localities single nests only were recorded, while at the other localities the birds nested in aggregations of seven, five and four pairs, respectively. Time spent by us in the vicinity of these aggregations was kept short, in order to minimise disturbance. Consequently, no attempt was made to find nests peripheral to these aggregations, so that the figures for colony size may be slightly underestimated. The nests at any one locality were widely dispersed, the estimated distance between neighbouring nests varying from 100 to 150 m. The nests were simple unlined scrapes usually situated in fine gravel (although one nest was found in an area of large (fist-sized) boulders).

Clutch size was invariably one. Eleven nests contained single eggs while two newly-hatched chicks were located at different sites. The chicks were not in nest scrapes, but were found crouching motionless in the gravel (Plate 1). One parent bird was in attendance at each clutch and brood. The eggs were pale fawn, sparsely covered with dark brown freckles and faint purple blotches. The chicks were white beneath and pale fawn above. The upperparts were covered with small black speckles. Newly hatched chicks of this species have never previously been described (Mackworth-Praed & Grant, 1962). In general pattern they are very similar to, though paler than, Least Tern chicks. Both the eggs and the chicks matched perfectly the background colour of lichen-covered gravel (Plate 1).

When approached, incubating birds left their nests early. However, unlike other little terns, Damara Terns do not appear to be particularly aggressive towards intruders at the nests. Although the birds flew overhead, and called loudly, they did not mob or harass intruders. Birds with chicks vocalised more persistently than those birds with eggs. Furthermore, only those birds with nests in the immediate vicinity of the observer flew overhead. Other birds, nesting farther away, did not exhibit alarm until their nests were approached. These reactions to disturbance contrast markedly with those of most other tern species, in which mobbing is a well developed anti-predator strategy (Cullen, 1960).

The aggregations of breeding terns observed by us were all located close to the coastal road from Swakopmund to Cape Cross. The terns ignored motor traffic passing along this road. Moreover, those terns that we disturbed, returned readily to their nests, usually within two minutes of our departure from the vicinity. However, this readiness to resume incubation may indicate that the eggs were near hatching, rather than that the birds were tolerant of disturbance *per se*. On returning to a nest, the bird, instead of alighting on the nest, would land a few yards away, pause, then walk over to the egg. Similar behaviour has been noted for the Peruvian Tern, another species that nests on desert plains away from the sea (Murphy, 1936). Possibly the behaviour is associated with nest location in a relatively featureless environment.

3 DISCUSSION

Several features of the breeding biology of the Damara Tern merit discussion: the scattered distribution of small colonies along the coast; the apparent tendency to nest on inland gravel plains, away from the sea; the spacing of nests within the colony; the absence of an aggressive, anti-predator, mobbing response; and the one egg clutch. Because

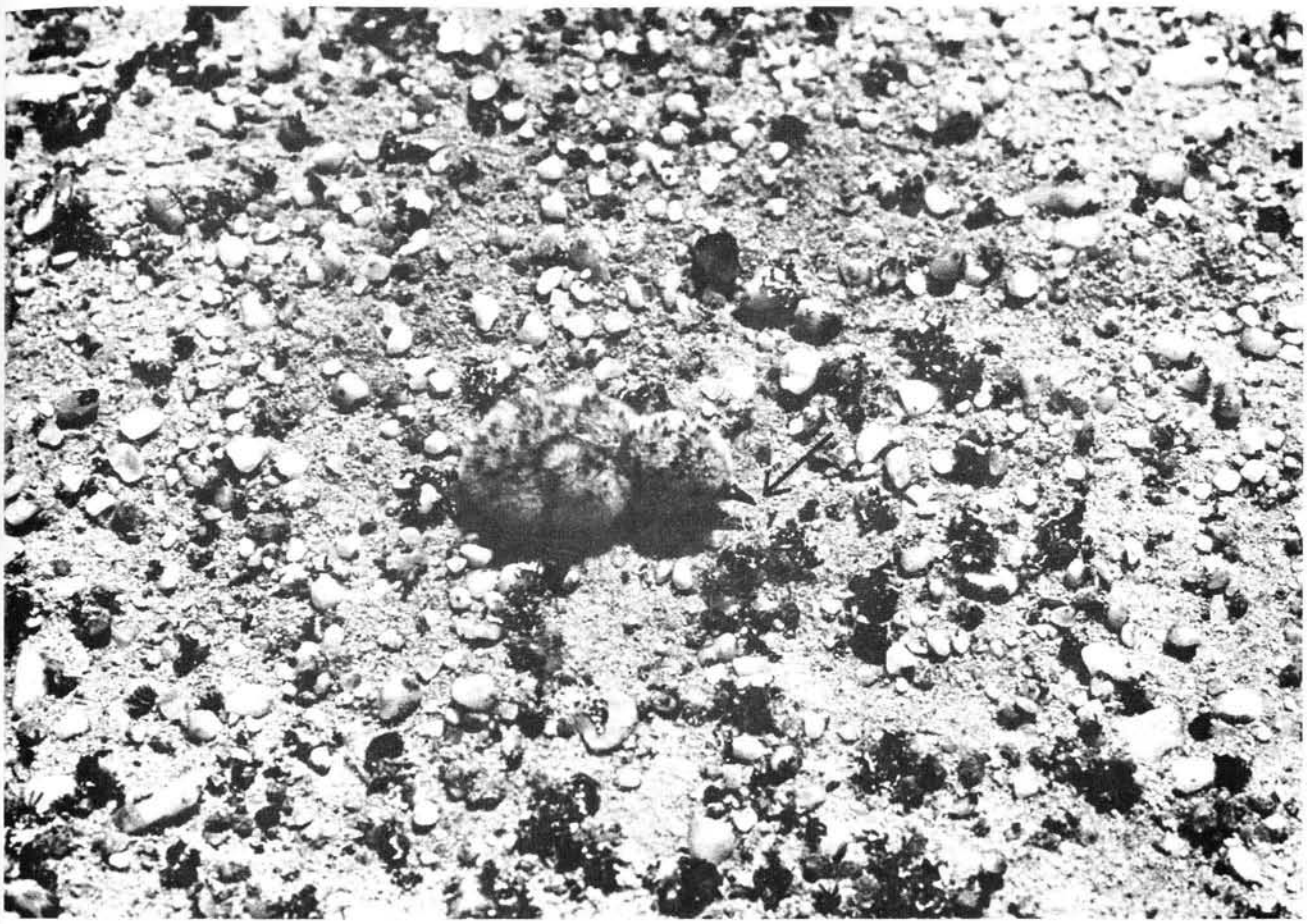

Plate 1. Newly hatched Damara Tern chick. Note egg tooth (arrowed) and absence of nest scrape. The lichens on the gravel are *Parmelia*.

of the paucity of information about this species, the following discussion incorporates considerable speculation. The only other tern known to breed in a similar environment is the Peruvian Tern (Murphy, 1936; Johnston, 1966). Its biology is as poorly known as that of the Damara Tern, so that a comparison between the two is not possible at this stage. However, it is hoped that the ideas advanced will stimulate further observations.

The Damara Tern is an inshore feeder (McLachlan & Liversidge, 1970). The scattered distribution of small aggregations of breeding birds along the coast is considered to be primarily an adaptation to enable Damara Terns to breed close to their inshore food supplies, as has been suggested by Lack (1968) for the Least Tern. If all available feeding areas are to be utilised, colonies must be widespread. Consequently, the birds cannot be very selective about the location of these colonies, without affecting the area over which it remains economical to forage for food for the young. However, these sites tend to be accessible to mammalian predators. By contrast, offshore feeding tern species can afford to select less accessible breeding sites without significantly increasing the distance that they fly to feed, for they forage some distance from land in any case. Thus, offshore feeding terns tend to nest in larger and more discrete colonies (Lack, 1968).

In contrast to the Least Tern, which nests on shingle and shell beaches just above the high tide mark (Norman & Saunders, 1969), the Damara Tern nests on inland gravel plains, away from the sea. This increases the distance that the birds must fly to the feeding grounds, in apparent contradiction of the arguments outlined in the preceding paragraph.

However, along this particular coast, beaches are probably unsuitable for the establishment of successful breeding colonies. Firstly, the beaches consist largely of sand, a smooth and homogeneously coloured substrate that offers little potential for concealment. Secondly, the dunes are steeply undulating and relatively bare of vegetation. This indicates instability, presumably due to the strong onshore prevailing winds. Consequently, one might expect considerable drift and therefore an unstable nest site. Thirdly, the strand zone, above the high tide mark, attracts a number of scavenging animals. Black backed Jackals *Canis mesomelas*, and a number of other predators, occur regularly along the coast, apparently feeding largely on washed up carcasses (pers. obs.). Proximity to areas patrolled by these predators would make colonial or aggregated nesting hazardous. Furthermore, the conformation of the dune system limits the horizon of nesting birds. This makes the early detection of predators difficult. It is suggested that, as a consequence, Damara Terns

have established colonies inland in the Namib Desert. This is not meant to imply that Damara Terns necessarily always nest away from the sea and never nest in sand dunes. In fact, where there are suitable sites (e.g. shingle or pebble beaches) Damara Terns could be expected to nest on the beach. Furthermore, Vincent (1946) found Damara Terns nesting in extensive sand dune systems north of Cape Town. However in this case there were broad slack areas between the dunes in which shingle and other debris accumulated. These were the preferred nesting areas.

In the Namib Desert, inland breeding sites are advantageous because the overall visibility is better, and nesting birds, their eggs and chicks, can be more effectively concealed. However, while the density of predators on these plains may be lower than along the shore, any aggregation of birds nesting in close proximity to one another would be both conspicuous and accessible to predators. This would negate any advantage gained by nesting inland. By nesting in loose aggregations, with considerable distances between neighbouring nests, breeding terns should be less conspicuous and thus less vulnerable to predation.

Most tern species exhibit anti-predator mobbing. Species in which mobbing is weakly developed, such as the Sandwich Tern *Sterna sandvicensis*, generally nest in areas inaccessible to predators or nest in association with more aggressive species such as the Black headed Gull *Larus ridibundus* (Cullen, 1960). Therefore, it is surprising that the Damara Tern does not exhibit mobbing, particularly as we consider predation to be important in determining nest site selection and breeding dispersion. The related Least and Fairy Terns are very aggressive towards intruders (Cullen, 1960; Serventy, Serventy & Warham, 1971). It could be argued that a combination of small body size, small aggregations of breeding birds, and the wide dispersion of nests militates against effective mobbing. There would seem to be little advantage in mobbing a predator that was not in the immediate vicinity of the nest. However, this does not seem to be the whole answer as the Peruvian Tern, which nests in similar situations, is aggressive towards intruders (Murphy, 1936). Possibly, nesting dispersion in this species is different. Furthermore, it should be noted that we have only recorded the response of Damara Terns to human intruders; their response to other potential predators may be different.

The Damara Tern is further anomalous in laying only one egg. We have been unable to verify statements that this species may lay two eggs (McLachlan & Liversidge, 1970). All the records available to us indicate a one egg clutch, though the occasional two egg clutch can not be ruled out. All other temperate-zone, inshore-feeding terns lay two, or occasionally three, eggs (Table 1). In terns generally, single egg clutches are associated with either pelagic foraging, or, in tropical species that feed close to the nest site, with a sparse food supply. In addition, single egg clutches are correlated with a relatively large egg, and a long incubation and fledging period (Lack, 1968). Obviously, such features can only evolve in environments where predation is an insignificant factor. Where the risk of predation is high, these phases have been shortened. In most terns, both parents feed the young, at least from about three days onwards (Witherby, Jourdain, Ticehurst & Tucker, 1941). Growth rates are consequently rapid. Moreover, most young terns fledge relatively prematurely, and there is an extension of parental care away from the colony (Lack, 1968).

Incubation and fledging periods for the Damara Tern are unknown, but the egg is similar in size to those of ecologically equivalent species (Table 1). Furthermore, the masses of two incubated eggs were 7,8 g and 9,5 g respectively (Kinahan pers. comm.), which is similar to the mass of the Least Tern egg (Lack, 1968). As the breeding range of the Damara Tern falls within a region of high biological productivity (Cushing, 1971), it is unlikely that the low clutch size is related to a poor food supply *per se*. We suggest that clutch size in this species is largely the consequence of selection for maximum growth rate of the young, as a result of the exposed nest site and the risk of predation.

Table 1. Mensural and other data for five ecologically similar species of tern.

	Feeding habitat	Breeding habitat	Breeding dispersion [a]	Mean wing length (mm)	Mean culmen length (mm)	Mean egg size (mm)	Usual clutch size	Mobbing behaviour	References
Least *S. albifrons*	inshore	beach shingle	C	172	30,0	33,0 x 23,9	2–3	yes	Witherby *et. al.*, 1944
Fairy *S. nereis*	inshore	small nearshore islands	C	183	32,7	34,7 x 25,2	2–3	yes	Serventy *et al.*, 1971
Yellowbilled *S. superciliaris*	rivers and coastal lagoons	river sand banks	S-SC	184	33,1	30,5 x 23,6	2–3	yes	Escalante, 1970. Jonson, 1966
Peruvian *S. lorata*	inshore	desert plains	C-SC	181	31,0	31,4 x 23,9	2	yes	Johnson, 1966; Murphy, 1936
Damara *S. balaenarum*	inshore	desert plains	SC	167	30,0	32,9 x 23,9	1	no	McLachlan and Liversidge, 1970; pers. obs.

a Breeding dispersion – C colonial – SC semi-colonial – S solitary

The growth rates of young birds are related to the rate at which the parent birds supply food, the quality of the food, and to the number of young in the brood. The rate at which parent birds supply food is a function of the distance that the birds forage from the nest site, the size of the food items and their availability. Furthermore, Pearson (1968) has shown that the amount of time required by small seabirds to obtain food for their young increases rapidly with decreasing body size of the birds. Thus the Common *Sterna hirundo* and Arctic *S. paradisaea* terns (both more than twice the size of the Damara Tern) are at almost the minimum size at which it remains economical to feed the young on small fish. This is confirmed by the reduced growth rates of tern chicks in broods larger than one (Pearson, *op. cit.*), suggesting that the parent birds were unable to forage at a rate sufficient to maintain maximum growth rates in the larger broods. However, both the Common and Arctic Terns feed some distance from the nest site. Smaller, inshore-feeding terns, because of the proximity of their food supplies, may be able to continue supplying food sufficiently frequently to rear two young at, or near, maximum growth rate. In fact this is so. The Least Tern supplies food to its chicks at nearly double the rate of the larger Arctic Tern (Borodulina, 1960).

However, two factors may militate against this happening in the Damara Tern. Firstly, the species breeds inland. Secondly, there are few sheltered bays and estuaries along the South West African coast. The immediate onshore waters are often turbulent and murky. One of us (P.F.) has observed Damara Terns, in breeding plumage, over five km from land during the breeding season. This suggests that breeding birds may have to forage further from shore than do other inshore-feeding terns (but not necessarily as far offshore as large tern species). Both these factors tend to increase the distance over which food must be collected, which will, in turn, affect the feeding rate. Therefore, in order to rear chicks at maximum growth rate, birds laying one egg clutches appear to have been selected for, as they would be vulnerable to predation for a shorter period. A time-energy budget is needed to test this idea.

It is not known if the Damara Tern is single or multiple-brooded. Eggs have been recorded in all months from November to February (Table 2). This may indicate either a prolonged breeding season, with a considerable spread in the breeding activity of individuals; multiple-breeding by individuals; or, renesting after an initial failure resulting from predation or disturbance. In this latter respect, a single egg clutch might be advantageous. If the probability of predation on eggs or chicks is high, it may be better to commit only a proportion of the available productivity energy to any particular breeding attempt. A small clutch can be replaced more rapidly than a larger clutch. Moreover the problem of low clutch size (and therefore a low reproductive rate) could be overcome by multiple brooding. Obviously, these considerations, if they apply in the Damara Tern, are not mutually exclusive from those outlined earlier. In fact they appear consistent with the hypothesis that predation has been a major force in the evolution of this species' breeding strategy.

Table 2. Recorded breeding for Damara Terns from Swakopmund.

Date	Number of pairs with			Observer
	Eggs	Young	Fledglings	
4 Dec	11	2	0	this study
18-19 Dec	2	4	0	Clinning; NRC's
5 Jan	2	1	1	Kinahan; pers. comm.
3 Feb	1	0	0	Clinning; NRC's
22 Feb	1	0	0	Patten; NRC's

4 CONSERVATION

In general, the conservation of terns poses considerable problems, largely because of their vulnerability to disturbance during the breeding season. The major adverse influences on their numbers have been the disruption and displacement of breeding sites through coastal development and public recreation. Bays and lagoons are dredged, reclaimed, or polluted by industrial development while estuaries are favoured by the developers of coastal townships and marinas. Furthermore, with the advent of off-road vehicles, formerly isolated beaches have become accessible to the general public. These and other factors have been implicated in the decline of several tern species (Norman & Saunders, 1969; Cramp *et al.*, 1974; Bourne & Smith, 1974; Wilbur, 1974). Similar alterations of coastal areas are taking place in southern Africa (Rand, 1971), and may be having, or be expected to have, a similar adverse effect on breeding Damara Terns.

The status of the Damara Tern in South Africa is poorly known. The species used to breed near Cape Town 40—50 years ago (Gill 1945; Vincent 1946) but these sites apparently are no longer occupied. Industrial and urban development may have been a contributing factor in the desertion of these sites. Currently, small numbers of Damara Terns may breed at scattered localities along the southern Cape coast, but breeding has only been confirmed so far at one of these sites. This coast is very popular with holiday makers during the summer months, and disturbance is likely to be high.

The only known localities where this species breeds regularly lie along the coast north of Swakopmund. This area is extremely popular with tourists, particularly during the holiday period mid-December to mid-January. This coincides with the middle of the Damara Tern's breeding season. The incidence of off-road traffic is high, as witnessed by the number of wheel tracks seen between the coastal road and the sea (Plate 2). It is not known to what extent this potential disturbance affects breeding

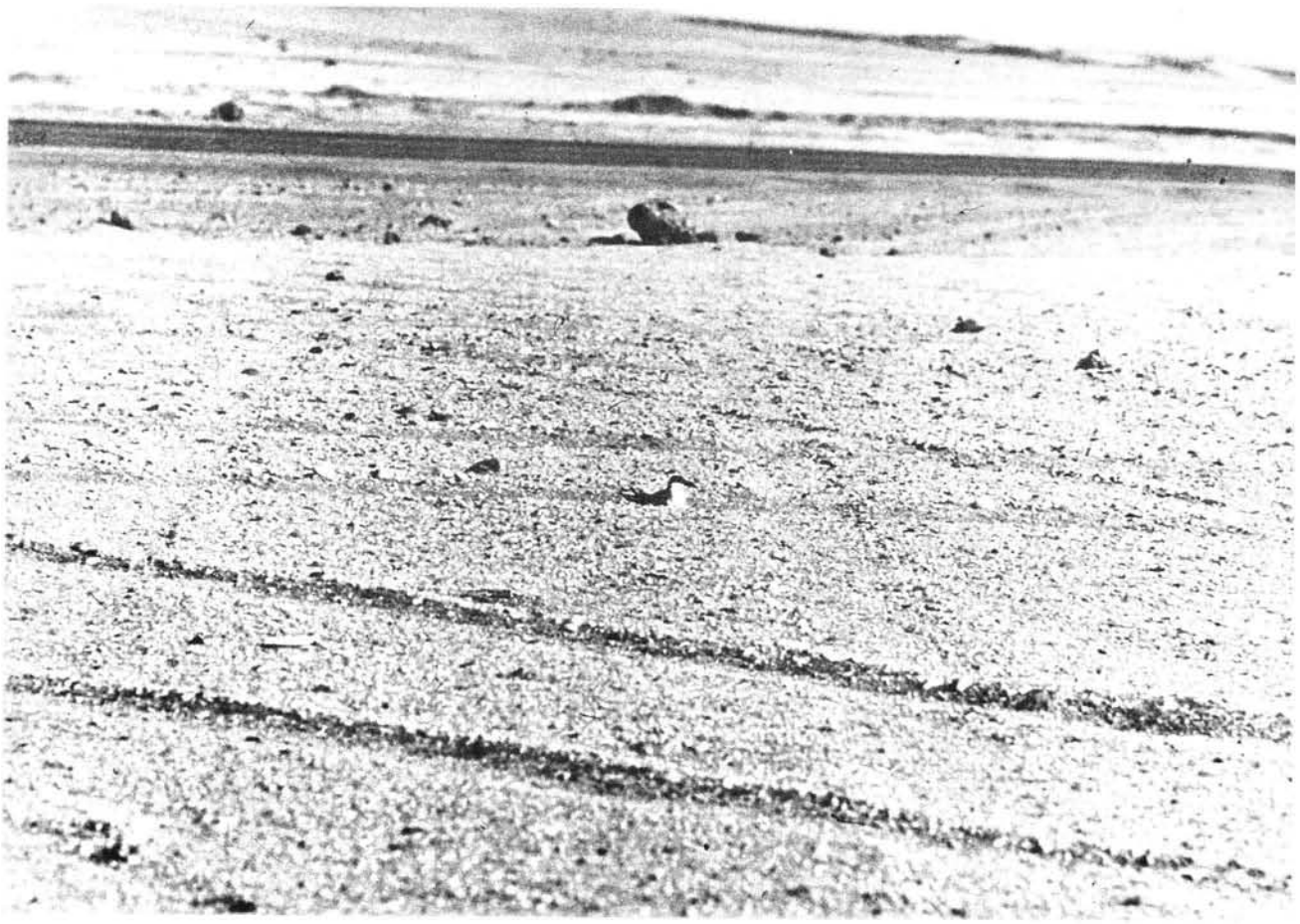

Plate 2. Typical open Damara Tern nesting habitat near the coastal road from Swakopmund to Cape Cross. Note the large number of wheel tracks in the gravel.

success. Birds breeding as late as February may be repeat breeders who lost or deserted their nests earlier in the season as a result of disturbance.

All terns are protected by nature conservation ordinance in both South and South West Africa. Protection is also afforded through the Sea Birds and Seals Protection Act, 1973, which covers the offshore islands and the territorial waters of South Africa. However, these legislative provisions only deal with the birds themselves and do not necessarily protect the birds against loss of vital habitat or unwitting disturbance while breeding. In short, the continued coexistence of viable populations of different organisms is not assured simply by granting statutory protection. Species that are rare and vulnerable to disturbance must receive more direct protection. In the Damara Tern this could prove to be a complex issue.

The conservation problems posed by the Damara Tern are fourfold. Firstly, their overall population size appears to be low. This is suggested by the paucity of observations on the species. It appears to be generally true that inshore-feeding seabirds have small populations. This may be related to the restricted amount of habitat available for exploitation, compared to that available for offshore-feeding species (Ashmole, 1971).

Secondly, the Damara Tern has a small clutch size and therefore a limited capacity for rapid increase in numbers. Consequently, it becomes imperative to afford strict protection to breeding aggregations of this species. Thirdly, the breeding colonies are small and spread over a wide area. This makes it difficult to incorporate a sizeable population within a protected area. Finally, the pressure of predation appears to have been important in determining colony site selection and breeding dispersion. Thus there has been strong selection for an isolated breeding site that is relatively safe from disturbance. In this respect, the general tendency in terns to desert readily any site where disturbance increases, must be seen as a necessity for species nesting in situations where isolation and safety from predators is of a tenuous nature. Thus areas set aside as reserves may be deserted, unless steps are taken to keep disturbance to a minimum. Clearly, a flexible approach is needed when protecting tern colony sites.

In view of the fact that Damara Terns are currently known to breed regularly in only one area in southern Africa and that this area is accessible to, and heavily utilised by the public, efforts should be made to:

i assess the effect of human disturbance on the breeding birds;

ii locate other breeding areas where more rigid protection can be applied;

iii determine what changes, if any, are occurring in the population status of the species, and the factors effecting such changes.

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