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DESERTION AND ABNORMAL DEVELOPMENT IN A COLONY OF SOOTY TERNS *STERNA FUSCATA* INFESTED BY VIRUS-INFECTED TICKS

There have been several instances reported of mass desertion at tern colonies. Marples & Marples (1934) suspected that food shortage caused birds of a Sandwich Tern *Sterna sandvicensis* colony to desert, and Austin, Robertson & Woolfenden (1972) suggested that a mass failure of Sooty Terns *S. fuscata* in the Dry Tortugas in 1969 might have been caused by frequent sonic booms over the colony. Marshall (1942) described the night desertion of Common Terns *S. hirundo*, and their return to incubate during the day, but was unable to suggest a cause.

During a study of the biology of Sooty Terns on Bird Island, Seychelles (55° 12' E, 3° 43' S) (Feare 1973), no abnormal behaviour was noticed in the 1972 season, nor in most of the colony in 1973. Egg losses away from the colony edge averaged about 25%, and territories from which eggs were lost were quickly re-occupied by other pairs of birds (Feare in prep.). Of 264 chicks whose histories from hatching to death or flying were followed, none was deserted shortly after hatching. However, in a part of the colony mass desertion of well-incubated and hatching eggs, and of newly hatched chicks, was observed in 1973. In this season peak laying occurred between 8 and 17 June, and on 14 July an area (c. 25 m²) of eggs, some of them broken and all without attendant adults, was noticed in a shallow valley at the northern end of the colony. The broken eggs had been predated by Turnstones *Arenaria interpres* and rats *Rattus rattus*, but the presence of intact but cold eggs in this area suggested that predation was not the factor causing desertion. After 14 July the area of desertion spread rapidly, and by 5 August 5000 pairs were estimated to have deserted their well-incubated eggs or newly hatched chicks (Plate 1).

During daytime there was no indication of what was causing the adults to desert; but on a visit to the affected area at night on 18 July, it was noted that adults were more restless around the deserted area than elsewhere in the colony, and that the ground was covered with argasid ticks (subsequently identified by Drs H. Hoogstraal and M. N. Kaiser as *Ornithodoros capensis*). The legs of observers standing in this area quickly became covered with ticks, whereas in the main part of the colony, where no desertions had occurred, no ticks were found either on the ground or on observers. All bites sustained by people visiting the colony at night, except for one on the upper back, were around the pubic hair, and they left a severe itch which lasted for several days. Collections of ticks during this period consisted almost entirely of nymphs.

In 1972 none of the people working in the colony was aware of the presence of ticks, despite many hours spent sitting in the colony handling chicks, but in 1973 by 22 August

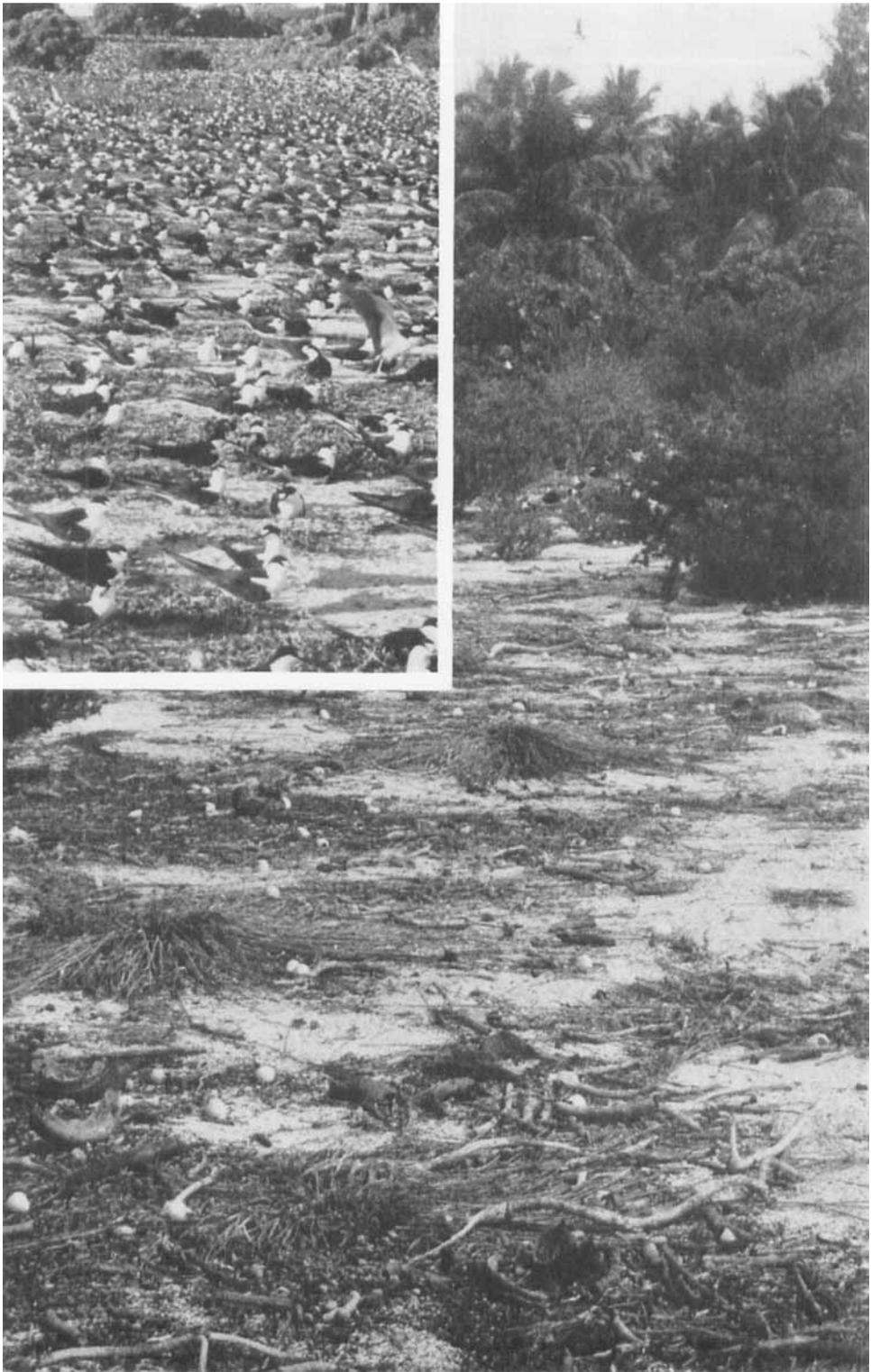


PLATE 1. The area of the Bird Island Sooty Tern colony which was infested with *Ornithodoros capensis*, showing large numbers of deserted eggs. The bushes are *Suriana maritima*, and the dry sedge *Cyperus pachyrhiza*. *Inset*: For comparison, a similar area during the incubation period, unaffected by desertion.

workers were occasionally bitten while sitting in the main part of the colony, and ticks appeared to be present at a low density throughout the colony. In early October, when birds were leaving the colony, no ticks were apparent above ground, and people in the colony received no further bites. However, adult ticks were found under boxes, logs and coconuts in the colony, especially where the underlying soil retained some moisture.

The soil and vegetation in the deserted area were typical of several areas around the periphery of the colony. The dominant plants were *Suriana maritima* and *Cyperus pachyrhiza*. A litter overlying sand consisted mainly of decaying leaves of *S. maritima*. During the daytime ticks were found in this litter, and also on chicks.

Of 59 chicks examined for adult and nymphal ticks (but not for larvae) between 19 July and 7 August, 28 had a total of 70 ticks on them distributed as follows: feet, 63; face, 6; belly, 1. Of the 28 infested chicks, 19 carried only one tick at the time of examination; the maximum number found on any one chick was 15. On 22 July and 7 August, 40 chicks in the affected area were given numbered rings; their survival up to the first appearance of scapular feathers (10–15 days, during which most chick mortality was concentrated) is shown in Table 1. Significantly more infested chicks died or were presumed to have died (being weak when last seen) than chicks which had had no signs of ticks on them ($\chi^2 = 4.03$, $P < 0.05$).

The most likely causes of chick death were starvation following desertion by their parents, or a tick-borne infection. Of the 15 ringed chicks which were eventually found dead, ten had been weighed on the day prior to death, and of these seven were underweight for their age (compared with the weights of healthy chicks from a study area in the main part of the colony). Thus these chicks could have been dying from starvation, but the recent finding (Converse *et al.* in press) that the ticks were carrying Soldado virus (Jonkers *et al.* 1973) suggests that death may have been hastened by the virus, since infected ticks transferred to chicks of domestic fowl transmitted the virus and caused the death of the chicks (Converse *et al.* in press).

TABLE 1

The survival to the first appearance of scapular feathers of 40 Sooty Tern chicks ringed on 22 July and 7 August, 1973, in the tick-infested part of the Bird Island colony

	Chicks with no ticks	Chicks with tick-bite scars on feet	Chicks with ticks
Survived	7	2	4
Found dead	3	5	7
Weak when last seen, presumed dead	1	0	5
Fate unknown	5	1	0

Soldado virus has previously been isolated from *O. capensis*-group ticks in Trinidad (Jonkers *et al.* 1973), Ethiopia and Wales, and also from *O. capensis* collected in nest of Masked Booby *Sula dactylatra* on Desneufs Island, Amirantes, in 1974 (Converse *et al.* in press). The wide distribution of the virus suggests that birds may be involved in its spread (Hoogstraal 1972).

Sublethal effects of Soldado virus on the avian hosts of the ticks are unknown, but various kinds of abnormal development of Sooty Tern chicks were observed on Bird Island in 1972 and 1973. In 1972 one chick was found with primaries missing, three were

found with curved upper mandibles, and one with a third foot at the top of the tarsus. It is not known what proportion of the total population these birds represent.

In 1973, out of 198 chicks that I had ringed at hatching, nine (4.5%) lost feathers, as a result of which at least one died (Table 2). Up to shedding, the feathers of these chicks appeared to be growing normally, and there were no other apparent abnormalities. Feather shedding was restricted to remiges and rectrices, and after the loss of the first set new feather sheaths soon appeared. Most of the birds involved were late-hatched chicks. In addition to birds which shed feathers, two ringed chicks (1.0%) lost their ability to coordinate and balance, and appeared to be having fits. A chick hatched on 10 July was found in this condition on 27 August, and it died on 30 August, and one hatched on 12 July was found unable to stand on 20 July and it died on 22 July.

Abnormal feather development, rather than feather shedding, was seen in White Tern *Gygis alba* and Black Noddy *Anous tenuirostris* chicks on Cousin and Aride Islands, Seychelles, in 1972 and 1973. Abnormal development, mainly feather loss, has also been recorded from tern colonies on the east coast of the U.S.A. (Hays & Risebrough 1972, Gochfeld 1971, 1975), but at incidences lower than that recorded on Bird

TABLE 2

Feather-loss in ringed Sooty Tern chicks in 1973. The median date of hatching was 10 July

Date hatched	Date feathers shed	Feathers lost	New sheaths first seen
7 July	27 Aug.	Primaries 6 and 7	5 Sep.
10 July	24 Aug.	All remiges and rectrices	Primaries 27 Aug. Rectrices 8 Sep.
12 July	9 Sep.	Rectrices	21 Sep.
25 July	7 Oct.	Secondaries	?
27 July	24 Sep.	Primaries and rectrices	Primaries 27 Sep.
	30 Sep.	Primaries again	Primaries 9 Oct.
27 July	15 Sep.	Inner primaries	21 Sep.
28 July	24 Sep.	Inner primaries	3 Oct.
28 July	21 Sep.	Inner primaries	6 Oct. (died 17 Oct.)
30 July	24 Sep.	Inner primaries	30 Sep.

Island in 1973. In America, pollutants have been suspected as causative agents. So far, no Seychelles seabirds have been examined for pollutant content, but the alternative possibility that abnormalities such as feather loss may be induced by a virus warrants further research.

Should Soldado virus affect man, as does the closely related Zirqa virus (Hoogstraal *et al.* 1970, Varma 1973), egg collectors (Feare 1973) and other people working in seabird colonies in the Seychelles may be at risk.

The Bird Island Sooty Tern colony was visited again from 9 to 12 July 1974. The 1974 breeding season was unusually late and no chicks were present at the time of the visit, but egg-laying was well advanced. Although terns were incubating all round the area which had been deserted in 1973, no eggs had been laid within this area. During the day large numbers of ticks were found under and within rotting wood and among the roots of *Cyperus pachyrhiza* in this area, while at night ticks were crawling all over the ground. Footprints in the sand showed that terns had settled in this area earlier in the season, but none had dug scrapes. Elsewhere in the colony ticks were found at a much lower density under decaying coconut leaves or buried in the sand around the edges of scrapes.

The desertion of eggs and chicks by adult Sooty Terns in 1973, and the failure to re-occupy this deserted area in 1974, appears to have been due to the heavy infestation of *O. capensis* ticks in that part of the colony, either due to the birds contracting a virus infection or perhaps simply due to irritation following tick bites.

The unexplained night desertion of Common Terns observed by Marshall (1942) followed a pattern similar to that observed on Bird Island, and ticks may be implicated there. Similarly, Evans (1970) noted that Puffin *Fratercula arctica* burrows in south-west Ireland were heavily infested with ticks and mites following a sharp decline in the breeding colonies of auks in that area.

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LACK OF A 'DESERTION PERIOD' IN THE NESTLING LIFE OF THE PUFFIN *FRATERCULA ARCTICA*

Lockley (1934) described how the young Puffin *Fratercula arctica* was deserted by its parents when it was about 40 days old, but remained in the burrow and completed its growth on fat reserves for a further 7-10 days before fledging at night. Although based on only three young, this fitted well with his (1930) findings that the Manx Shearwater