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CORY'S SHEARWATER BURROWS AS HABITATS FOR INVERTEBRATES ON SELVAGEM GRANDE

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With 5 tables

ABSTRACT. Cory's shearwater nests appear to be important habitats for invertebrate species, over half of those found in nests were not recorded elsewhere on the island. The major factor affecting invertebrate distribution in occupied burrows appears to be nest size, while in unoccupied ones degree of wetness is more important.

Invertebrate species arrays were found to be different in nests at different sites, on different substrates and in different burrow types. For occupied nests there were no differences in the mean numbers of species or individuals when adjusted for nest size. However, the means for occupied nests were higher than those of unoccupied nests. More species were found in those nests situated on sandy soils and in more sheltered burrows.

RESUMO. Os ninhos de Cagarra são habitats importantes de espécies de invertebrados, mais de metade das quais não foram encontradas noutros locais da ilha à excepção de nos ninhos. O maior factor condicionante da distribuição dos invertebrados nos ninhos ocupados parece ser o seu tamanho, enquanto que nos desocupados este factor parece ser o grau de humidade.

A proporção dos indivíduos de cada espécie e o número de espécies de invertebrados diferem consoante a localização dos ninhos, os tipos de substracto e os tipos de covas. Para os ninhos ocupados não existem diferenças nas médias das espécies ou dos indivíduos, quando corrigidas de acordo com a dimensão dos ninhos. Contudo, as médias nos ninhos ocupados são maiores do que nos desocupados. Mais espécies foram nos ninhos situados em terreno arenoso e nas covas mais abrigadas.

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INTRODUCTION

During the summer of 1984 an expedition from Manchester University visited Selvagen Grande, a small (2km^2) volcanic island lying 290km south of Madeira and 175km north of Tenerife.

The island is bounded by steep cliffs rising to a plateau 80-154m above sea level. The vegetation is sparse and low growing and the ground is stony. It is one of the largest breeding sites of Cory's shearwater *(Calonectris diomedea).* The majority of the birds nest on the cliffs in caves, crevices or under ledges. However, almost any suitable nest site is used; at the base of walls, in old rabbit burrows, under stones, in dense vegetation and in man-made shelters. The latter are slabs of stone placed in triangular arrangements. These, and gaps delibrately left or made at the base of walls, date from the era, previous to protection, when the birds were semi farmed (Hartog *et al.,* 1984). The nests tend to be little more than piles of sticks, feathers and bone, compressed by the weight of the occupant and often «cemented» together with excreta and decaying food, the latter presumably dropped during regurgitation by the adult.

The presence of a large number of nests provides potential habitats for a variety of animals, especially on an island which otherwise appears so barren. Other workers who have examined the fauna of birds nests have often concentrated on the Siphonaptera present, rather than the total fauna (Thompson 1937, Ash 1952, Raes 1969, Everleigh & Threlfall 1976).

This paper is a preliminary ecological study examining the differences in nest fauna with respect to site, nest material and other conditions, and highlights another reason for continuing the current conservation of Cory's shearwaters. A faunistic paper is planned later.

METHODS

Three areas were surveyed: comprising nests on the cliffs around Enseada das Cagarras, the plateau and at the base of walls. One hundred nests occupied by chicks were sampled at each site and each was scored for nest size on a scale from 1 (very little nest material present) to 5 (massive nest — large amount of material present). The nests were also scored for moisture content again on a scale from 1 (nest bone dry to 5 (all of nest very wet). Samples, comprising approximately 50 per cent of each nest, were taken and weighed, the type of material noted, and the inhabitants collected. For each nest details of burrow type (cave, under stone, ledge, etc.) and substrate type (sand, stones or rock) were noted. At the cliff site one hundred nests without occupants were also examined. Although chicks in occupied nests occasionally needed to be slightly displaced during sampling, neither this treatment nor the removal

of some of their nest material adversely affected them. In all cases chicks were still alive and well in the same burrows several days later.

RESULTS

From the 400 nests sampled 723 individuals of 20 invertebrate species were found. It can be seen from table 1 that the occupied nests on the cliff site had more individuals and species than any other site, and that the unoccupied nests had the lowest numbers of both species and individuals.

A significant difference was found between the arrays of invertebrates from occupied nests in different sites ($G=127$, $df=22$, $p<0.0001$) but there was no difference between occupied and unoccupied nests at the cliff site ($G=18$, $df=11$, $p=0.08$).

With the exception of the comparison between wall and plateau nests, all sites have significantly different mean numbers of individuals per

Table 1. — Distribution of invertebrate groups at different nesting sites.

Group	Cliff (O)	Plateau	Walls	Cliff (U)
Woodlice	—	1	—	—
Ticks	17	18	33	2
Mites	60	93	32	3
Pseudoscorpions	14	3	4	1
Spiders	2	6	13	—
Silverfish	—	—	—	2
Fleas	158	41	65	26
Ants	46	22	20	4
Fly larvae	12	—	1	2
Fly pupae	3	—	7	—
Fly adults	2	—	—	2
Beetle larvae	3	1	1	—
Other larvae	1	—	2	—
Number of species	15	10	13	9
Number of individuals	318	185	178	42

(O) = occupied
(U) = unoccupied

nest (Table 2). All means were compared using t-tests with variances not assumed to be equal (Sokal & Rohlf, 1969).

This situation is altered with means corrected for the weight of the nest material (Table 2b). Here all the occupied sites have similar numbers of individuals per gram of nest material, and all have significantly higher means than those found in unoccupied nests.

Table 2a. — Comparisons of mean numbers of individuals per nest.

Site	Number of individuals	Number of nests	$\bar{x}$/ nest	SD	Weight of nests (g)	$\bar{x}$/g of nests	SD
Cliff (O)	318	100	3.18	5.29	5377	0.0657	0.118
Plateau	185	100	1.88	3.58	3937	0.0836	0.229
Wall	179	100	1.79	2.84	4955	0.0426	0.086
Cliff (U)	42	100	0.42	1.21	1208	0.0157	0.078

Plateau	2.035(*)		
Walls	2.316(*)	0.197	
Cliff (U)	5.088(**)	3.862(**)	4.444(**)
Sites	Cliff (O)	Plateau	Walls

Cells contain t' values, (*)=$p<0.05$, (**)=$p<0.01$

Table 2b. — Comparisons of mean numbers of individuals per gram of nest material.

Plateau	0.696		
Walls	1.579	1.676	
Cliff (U)	3.531(**)	2.808(**)	2.309(**)
Sites	Cliff (O)	Plateau	Walls

The mean numbers of species per nest shows a similar trend to that of the mean numbers of individuals (Table 3). With the exception of the wall and occupied cliff site comparisons, all the sites have significantly different mean numbers of species.

Table 3a. — Comparisons of the mean numbers of species per nest.

Site	Number of species	Number of nests	$\bar{x}$/ nest	SD	Weight of nests (g)	$\bar{x}$/g nest	SD
Cliff (O)	15	100	1.18	1.234	5377	0.0257	0.0384
Plateau	10	100	0.66	0.832	3937	0.0248	0.0457
Walls	13	100	0.95	0.857	4955	0.0221	0.0264
Cliff (U)	9	100	0.23	0.510	1208	0.0070	0.0203

Plateau	3.495(**)		
Walls	1.531	2.429(*)	
Cliff (U)	7.116(**)	4.409(**)	7.220(**)
Sites	Cliff (O)	Plateau	Walls

Table 3b. — Comparisons of the mean numbers of species per gram of nest material.

Plateau	0.157		
Walls	0.750	0.483	
Cliff (U)	4.319(**)	3.560(**)	4.583(**)
Sites	Cliff (O)	Plateau	Walls

As found previously with mean numbers of individuals there is no significant difference between the mean numbers of species per gram of nest material for the occupied sites. However, the unoccupied site has a significantly lower mean than any occupied site (Table 3b).

The differences between areas are, therefore, differences in species type and array, rather than in numbers of species or individuals. The species array is affected by two factors: —

Burrow type: —

At the occupied cliff site significant differences were found between the species arrays in nests in caves, crevices and under ledges ($G=65.07$, $df=12$, $p<0.001$).

Substrate: —

Also at the occupied cliff site there were significantly different species arrays between nests on rock, stones and sand ($G=58,13$, $df=12$,

$p<0.001$). At the plateau and wall sites similar differences were found between nests on sand or stones (plateau site $G=25.46$, $df=6$, $p<0.005$ and wall site $G=38.66$, $df=7$, $p<0.005$).

Taking all the areas together more species were found on sandy soils than on stones or rock ($F=9.015$, $p=0.0001$). This was also true for nests in cave or crevice burrows, or at the base of walls compared to those under ledges, in rabbit burrows or under man-made shelters ($F=5.447$, $p=0.0011$). The numbers of individuals appears to be unaffected by the substrate or burrow type.

Spearman rank correlation coefficients were used to identify those factors having the greatest influence on the presence of invertebrate groups and these are listed in table 4. In the majority of cases where a factor influences the presence of a species, or group of species, in sites with occupied nests, the amount of nest material present (measured either as weight or size) appears to have a major effect.

The amount of nest material present appears to be dependent on the substrate; more material being present on sandy than on stony or rocky ground (Table 5). These differences may reflect the types and amounts of suitable material available on different substrates, rather than on choice by the birds.

In unoccupied burrows, dampness of the nest material is a critical factor (Table 4) and occupied nests were found to be significantly wetter than unoccupied ones ($F=64.07$, $p<0.0001$).

DISCUSSION

The barren aspect of Selvagem Grande is such that small pockets of shelter, such as stones, bushes and birds' nests are useful habitats for invertebrates. This is reflected by the relationship some species have with the amount of nest material present. Obviously in those nests where chicks are present the moisture content will be high in comparison with the situation outside and with unoccupied nests. In unoccupied nests moisture appears to be a limiting factor for a number of invertebrates and increasing wetness is associated with an increase in their abundance. Moisture also seems to be of some importance in plateau nests. These are usually more open and, therefore, have less protection from water loss than do nests on cliffs or in walls.

During a seperate study, invertebrates were sampled by means of a transect of 64 $1m^2$ quadrates across the island. A total of 3004 individuals from 42 species were recorded. In the present study 723 individuals from 20 species were found. Of these, only 8 were found elsewhere on the island (i.e. on the transect), two of these, a woodlouse and a silverfish were found once and twice respectively in the nests, and one, a species of flea, was found only once on the transect. It may be said, therefore, that such nests are important habitats for a number of invertebrates. Whilst unoccupied nests are of some value, it is likely that

Table 4. — Factors affecting the distribution of invertebrates in nests at different sites.

No significant relationships were found for woodlice, mites, silverfish or larvae other than beetle or fly larvae.

Animals	Cliff (O) Factor	r s	p	Plateau Factor	r s	p	Walls Factor	r s	p	Cliff (U) Factor	r s	p
Ticks		NSR		C	0.230	0.022		NSR		C	0.301	0.003
Pseudoscorpions		NSR		C	0.269	0.008		NSR		C	0.447	0.001
Spiders		NSR		B	0.287	0.005	A	0.237	0.018	—	—	—
Fleas	A	0.217	0.031	C	—0.219	0.030	A	0.249	0.013	C	0.247	0.014
Ants	A	0.244	0.015		NSR			NSR			NSR	
Fly larvae	A	0.296	0.003	—	—	—		NSR		D	—0.390	0.001
Fly pupae	A	0.233	0.020	—	—	—		NSR		—	—	—
Fly adults		NSR		—	—	—	—	—	—	A	—0.205	0.041
Beetle larvae	A	0.214	0.036		NSR			NSR		—	—	—
No. of species	A	0.417	0.001		NSR		A	0.280	0.005	C	0.249	0.013
No. of individuals	A	0.380	0.001		NSR		A	0.230	0.022	C	0.260	0.009

NSR = no significant relationships

p = 0.001 indicates probabilities less than or equal to 0.001

Factors: —

A = weight of nest

B = size of nest

C = wetness of nest

D = distance from nearest nest

these will become more barren as time progresses and the nest material dries out. The unoccupied nests used during this study all showed signs of having been occupied during the breeding season. The nests are commonly occupied during March or April and the eggs laid during May (Hartog *et al.* 1984). The chicks fledge in October and the nests are probably visited during the winter, which is the wet season. Any nest used for successful breeding is, therefore, likely to remain relatively moist, so providing an important resource for a variety of invertebrates.

Table 5. — Comparisons of nest sizes on different substrates

	Nest volume (0-5)				Nest weight (g)			
Substrate	$\bar{x}$	SD	F	p	$\bar{x}$	SD	F	p
Rock	2.26	0.87			49.47	28.74		
Stones	2.30	0.93	3.54	0.03	46.47	28.84	5.97	0.003
Sand	2.60	1.09			58.27	29.56		

These results are important from a conservation point of view. The exploitation and eventual persecution of Cory's shearwaters on this island (documented by Hartog *et al,* 1984) resulted in wardens being employed to guard the island all the year round. Any management effecting Cory's shearwaters is also likely to affect the invertebrates inhabiting their nests and it is assumed, therefore, that the recent wardening of the island has helped to maintain invertebrate populations as well as avian ones.

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