

entered as variables, 34% of this variability is then explained. We are forced to reject the hypothesis that the availability of food is the major determinant of clutch size in these populations. Certainly some factor is missing from this analysis on which much of the variation in clutch size is dependent. From inspection of figure 1, this factor seems to be associated with the axis termed island effect, and therefore with the population size and its isolation. Cody (op. cit.) associated low clutch sizes of islands at temperate latitudes with the combined effects of (a) increased year-to-year survival of the adult population and, only partially in consequence of this, and (b) the decreased survival of offspring to reproductive age. The necessary life table information to test this hypothesis is lacking for the island Wrens.

SUMMARY

Clutch size is reduced in the endemic populations of Wrens of the northeastern Atlantic islands, perhaps in

response to reduced food supply of the islands. Yet a plot of territory size against food density in three insular and two mainland populations of Wrens is close to rectangular hyperbolic, indicating that the Wrens compensate for reduced densities of food by increasing territory size. The relation is even closer to that stated when the effects of various numbers of competitors are removed. The product territory size \times food density is a measure of the availability of food, and accounts for only 20% of the variation in clutch size among populations. Latitude and body size of Wrens increase this figure to only 34%, leaving major factor(s) of island clutch size undetermined.

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AREAL VERSUS LINEAL TERRITORIES IN THE WREN, *TROGLODYTES TROGLODYTES*

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In summer 1970 we studied the relation between territory size and its food value in insular and mainland populations of the Wren (*Troglodytes troglodytes*)¹ in the British Isles (Cody and Cody, *Condor* 74:473). In one of these populations, *T. t. zetlandicus* of the Shetland Islands, we found that pairs included in defended territories dry-stone walls, as well as more usual foraging habitat such as bushes, stream banks, and cliff faces. In particular, we found Wrens to be common on Mousa, an island off the east coast of Mainland Shetland, where the only available foraging habitat is either dry-stone wall or the faces of sea cliffs. Only one of the six Wrens whose territories we plotted there was limited to cliff face (M_1 of Cody and Cody, loc. cit.); the others fed partially or completely in stonework and were not mentioned in our other paper.

Our data on the Wrens of Mousa are particularly apt for demonstrating the relative value to Wrens of two quite different sorts of feeding habitat, quasi-planar cliff face and stone walls in a linear configuration. The stone walls of Mousa are in various degrees of disrepair, so we converted the walls to an area measure, length \times (variable) height; thickness is roughly constant at around 2.5 ft. In this way we can also include in the measure of territory size the walls of ruined buildings. Thus the six territories of Wrens are scored in two components, area of cliff face and area of dry-stone wall. These are plotted in figure 1.

¹ = Winter Wren of N.A.

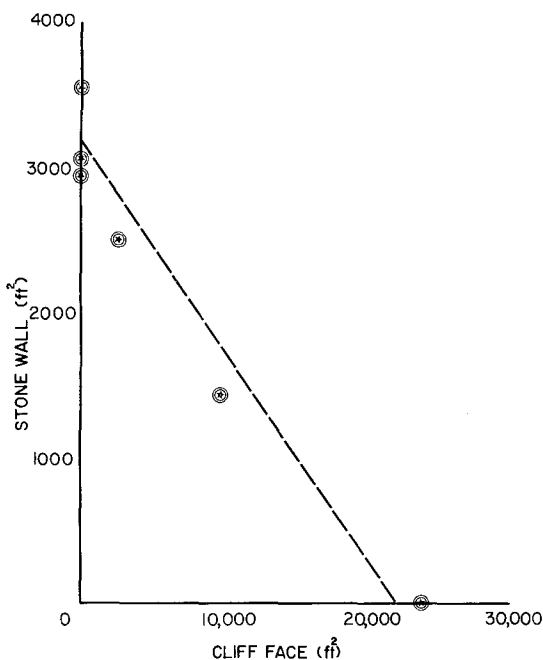


FIGURE 1. Two components of territory size in Wrens on Mousa, area of stone wall and area of cliff face, are shown to be complementary to each other. The six pairs of Wrens whose territories are plotted and which are mentioned in the text are, from lower right to upper left, M_1 , M_2 , M_7 , M_3 , M_4 , and M_6 .

As can be seen from the figure, the territory area of dry-stone wall and that of cliff face complement each other in a precise way, in such a way that area not available in one habitat type is made up from the other. More interesting is the discovery that dry-stone wall is worth much more to the Wren per unit area, apparently, than is cliff face, about 12 times more. We believe the reason for this is that the walls present a much greater area over which the Wrens can forage than do the more planar cliff faces. The walls are constructed sufficiently loosely that the birds forage within them with much freedom; a Wren

might remain out of sight in the wall interior for some minutes, to emerge perhaps a hundred feet further along. Thus a more accurate measure of the value of this habitat to the Wrens is not the profile area of the wall but the surface area of the rocks from which it is made. From the shape of these rocks, which are flattened but somewhat rounded rectanguloid solids, we calculate that such rocks would have to be two to three deep in the walls in order to increase by a factor of 12 the profile area of the wall. This approximate figure concurs well with our observations; the walls had rocks showing faces to one or the other side of the wall, and occasionally rocks which were not exposed to the outside at all.

An alternative explanation, that the walls supported a greater density of insect food per actual surface area exposed to scrutiny by the Wrens, can be ruled out. We counted insects caught per 24-hr period on linoleum grease-covered plaques and found that we caught 1.60 0.25 inch insects/plaque/day in the walls and 1.55 on the cliffs. Thirty-four plaques were used over 2 days, = 68 plaque/days of trapping effort. Only one other factor affects the amount of food available to the Wrens in the two habitats, and that is the presence of competing species. No other bird species used the walls as foraging sites, and one other species, the Rock Pipit *Anthus petrosus*, used the cliffs. We therefore calculated an index of similarity between

the Wren and the pipit, which takes into account feeding behavior, habitat preferences, and bill morphology. This index came to 0.301, where a value of 0 denotes complete separation and a value of 1 denotes complete overlap in feeding ecology. The observed territory size of Wren M₁ is therefore scaled down from 38,400 ft² to 23,900 ft² in the way described in detail in our longer paper (see p. 473). Likewise, the cliff-face component of Wrens M₂ and M₇ is reduced because of its lessened value in the presence of the Rock Pipit. M₆ is the only Wren whose territory is located exclusively in ruined buildings. These are constructed much more solidly than the walls, with much reduced interstitial space and hence reduced surface area for foraging Wrens. This territory is therefore worth less per unit wall area than this measure indicates, and its recorded value is somewhat inflated.

We conclude from this brief study that each Wren secures and defends a territory which varies in size (a measure of foraging area), habitat quality (a measure of insect productivity), and in the numbers and types of competitors (an adjustment to the measure of available food) but which, rather dramatically, varies little in overall food value.

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ROOSTING AGGREGATIONS OF BUSHTITS IN RESPONSE TO COLD TEMPERATURES

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On 9 January 1969, I discovered the roosting location of a flock of 29 Common Bushtits (*Psaltriparus minimus*) in a hawthorn tree (*Crataegus douglasii*) on the University of Washington campus. Thereafter, roosting was observed regularly until the spring break-up of the flock, which occurred in the third week of February. Under normal conditions the birds arrived in the hawthorn almost simultaneously, and immediately began to roost; there was minimum shifting of position after arrival. The result was an evenly spaced group with no two birds being closer than 2 inches from each other. If two birds landed closer together than this, there followed a concentric ripple of shifting until the "correct" spacing was achieved.

On the evening of 21 January, I saw what appeared to be a thick branch in the roost tree. This "branch" was actually a row of 25 bushtits packed tightly together along their perch. Four other individuals were roosting singly nearby.

Table 1 shows the records of roosting behavior with respect to temperature. There was a period of 10 days in January when the average temperature in Seattle was at least 10°F below normal. During this period, the bushtits roosted nightly in a row, each bird in close contact with its neighbors.

The night of 1 February was the first for over 2 weeks when the temperature did not descend below freezing. At 17:45, the bushtits were observed packed

TABLE 1. Roosting behavior of the Common Bushtit with respect to temperature.

Date	Temperature			Departure from normal	Roosting behavior
	Max.	Min.	Avg.		
Jan. 9	41	35	38	-1	even
10	43	35	39	0	even
11	39	34	37	-2	even
12	39	29	34	-5	even
13	39	32	36	-2	even
14	40	33	37	-1	d.n.o. ^a
15	39	33	36	-2	even
16	37	33	35	-3	even
17	35	30	33	-5	even
18	35	28	32	-6	d.n.o.
19	37	31	34	-4	even
20	36	25	31	-7	d.n.o.
21	31	25	28	-10	clumped
22	29	23	26	-12	clumped
23	29	17	23	-15	clumped
24	30	18	24	-14	clumped
25	30	25	28	-10	clumped
26	27	23	25	-14	clumped
27	27	21	24	-15	d.n.o.
28	22	15	19	-20	d.n.o.
29	27	19	23	-16	d.n.o.
30	30	22	26	-13	d.n.o.
31	40	28	34	-5	clumped
Feb. 1	39	35	37	-2	clumped
2	42	35	39	0	even

^a d.n.o. = did not observe.

tightly together. The next night the whole flock was seen evenly dispersed in the roost tree, with individual distance restored. The temperature did not fall below freezing again that spring, nor was clumping seen again.