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The Calls of Male and Female Madeiran Storm-Petrels (*Oceanodroma castro*)

PAUL C. JAMES¹ AND HUGH A. ROBERTSON²

Edward Grey Institute, Zoology Department, South Parks Road, Oxford OX1 3PS, U.K.

Attention has been forced recently on the phenomenon of sex-specific calls in the nocturnal Procellariiformes (Brooke 1978, Ristow and Wink 1980, Simons 1981, James 1984a, James and Robertson 1985). It has been suggested that such sexual dimorphism in voice constitutes an adaptation for sexual advertisement in low light levels (Brooke 1978). However, for most of these species, little is known regarding such potential differences. With this in mind, we conducted research on the calls of male and female Madeiran Storm-Petrels (*Oceanodroma castro*) on Great Salvage Island (30°09'N, 15°52'W) in the northeastern subtropical Atlantic from 30 June to 11 July 1983.

At the time of our visit, egg-laying was in progress, so it was possible to sex birds by cloacal inspection (Serventy 1956). Nesting birds were located at night from their vocal activity and removed from their burrows for sexing and banding. The nests were visited later, again at night, and the same incubating birds (15 males and 7 females) stimulated to call using the playback of this species' Burrow Call (Cramp and Simmons 1977) on a Sony M9 microcassette recorder.

Their vocal responses were recorded using a Uher 4000 Report IC tape recorder, and spectrograms were produced on a Kay 6061-B Sound Sona-Graph using the wide-band filter.

Both males and females produced three call types in response to playback (Fig. 1). Two of these, the Flight Call and Burrow Call (Cramp and Simmons 1977), were sexually dimorphic, and the third, here called the High Call, was not. The Flight Call consists of an irregular repetition of short notes. The general form, timing, and emphasis of notes is similar in the calls of both sexes, but in all males investigated these notes were markedly clearer, producing a more melodious call. In females, by comparison, the notes were more harsh. This difference was such that we could easily assign all Flight Calls heard at the colony, whether given in flight or in burrows, to one sex or the other. As this was possible, we decided to investigate the sex ratio of these calls heard in flight. For three nights, 9-11 July, male and female Flight Calls were counted for a 5-min period at the same time and site. The results were 81, 83, and 86 male calls and 71, 73, and 78 female calls heard. The totals (250 male and 222 female calls) were not significantly different from parity ($\chi^2 = 1.66$, $df = 1$). This contrasts strongly with similar flight call counts conducted on Manx Shearwaters (*Puffinus puffinus*; Brooke 1978, James 1985), where female calls significantly outnumbered male calls, and Cory's Shearwaters (*Calonectris diomedea*, James 1984b), where the opposite was

¹ Present address: Department of Veterinary Anatomy, University of Saskatchewan, Saskatoon, Saskatchewan S7N 0W0, Canada.

² Present address: Ecology Division, DSIR, Private Bag, Lower Hutt, New Zealand.

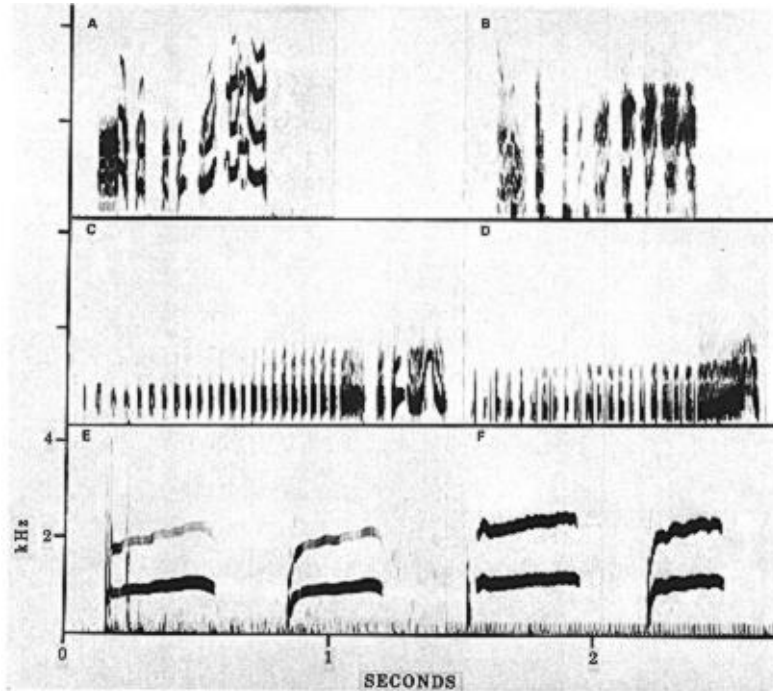


Fig. 1. Typical Madeiran Storm-Petrel call types: male (A) and female (B) Flight Calls, male (C) and female (D) Burrow Calls, and male (E) and female (F) High Calls.

true. Whether these differences represent true species-specific differences in behavior remains to be resolved by more extensive research.

The sexual difference in the Burrow Call can be seen in its terminal flourish (Fig. 1). Again, while the overall structure of the call is similar in both sexes, the last few notes of males have a clearer quality than those of females. The difference was apparent in all such calls heard at the colony. The High Calls of both sexes were very similar, and no differences could be detected either by ear or by visual inspection of spectrograms.

Most of the storm-petrels exhibit aerial calling at their colonies. Among those in which sexual differences in Flight Calls have been examined, one exhibits an audible difference (Madeiran Storm-Petrel) and two do not [Fork-tailed Storm-Petrel (*O. furcata*, Simons 1981) and British Storm-Petrel (*Hydrobates pelagicus*, James 1984a)], although the term Flight Call applied to the latter species is something of a misnomer as the species rarely calls in flight.

Ainley (1980) proposed a new subspecies of Leach's Storm-Petrel (*O. leucorhoa*) based on mensural characters. He also indicated that two subspecies, including the new one, had differing vocal characters as well. While the Flight Calls of the two Guadalupe subspecies apparently differed in the tempo, inflec-

tions, and number of notes from the other subspecies, it is now likely that Ainley's spectrogram of the call from *O. l. cheimomnestes* was of a female call and that from *O. l. socorroensis* (as well as calls from other populations) was of a male call, assuming, of course, that the raspiness of notes in *O. leucorhoa* differs sexually as in the Madeiran Storm-Petrel (see Palmer 1962). It should be noted that a typographical error occurs in Ainley's Fig. 4: E is the call of the summer population and D is the call of the winter population (Ainley pers. comm.).

In another recent study of petrels where vocalizations were considered, Jehl (1982) compared the calls of Manx Shearwater subspecies, but did not take account of the sexual dimorphism in voice already demonstrated in this species (Brooke 1978). In conclusion, we suggest that caution be exercised when using the calls of these species for taxonomic purposes unless the sexes of calling birds are known.

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Spruce Grouse in Habitat Patches in the Adirondack Mountains: Dispersal vs. Rarity

ROBERT S. FRITZ

Department of Biology, Vassar College, Poughkeepsie, New York 12601 USA

The contribution of habitat isolation and species dispersal to species occupancy of habitat patches is an important, unresolved issue in the debate over the sizes and configurations of wildlife reserves. Random sampling of rare species could also account for absences of species from habitat patches, but few quantitative data are available to test between these alternatives.

Haila and Järvinen (1983) and Järvinen and Haila (1984) have applied a stochastic sampling model to census data of northern European birds on an island. Their results support the hypothesis that, for most species, observed occupation of an island is similar to occupation of similar-sized patches from a mainland habitat. Here, I apply this model to data from Fritz (1979, 1981). The alternative hypothesis tested was: Can the absence of Spruce Grouse (*Dendragapus canadensis*) from small habitat patches be attributed to rarity? In other words, would Spruce Grouse be expected to be absent from similar-sized areas in large, contiguous forest blocks?

I reported (Fritz 1979, 1981) that 7 patches that previously had supported Spruce Grouse populations or were of sufficient size to support them were unoccupied in 1977. I concluded that dispersal was insufficient to lead to recolonization of the unoccupied patches. Further censuses of these patches conducted from 1978 to 1980 showed that none were recolonized and that 7 more populations had become extinct. Data from 4 yr will provide a test of the hypothesis that rarity and not dispersal may be

responsible for the absence of Spruce Grouse from these patches.

I used the Poisson model of Haila and Järvinen (1983), employing a mean density representative of a contiguous habitat. Of the 7 populations for which Spruce Grouse density was known (Fritz 1981), 4 eventually became extinct, while 2 other patches were too small to be considered equivalent to a large, contiguous habitat. Only 1 site, Grasse River, is large enough to be considered representative of a contiguous habitat as required by the model. The mean density of Spruce Grouse at that site for 3 yr was 4.3 pairs/km².

During 1977 and 1978, none of the patch sizes differed in observed occupancy more than expected by the Poisson model (Table 1). In 1978, 3 previously occupied patches became extinct. Three more populations went extinct in 1979, and 1 in 1980. Analysis of the last 2 yr shows that for the 50-ha patch size, observed occupancy was significantly less than expected from the model ($P < 0.025$). Dispersal had not led to recolonization of any of the unoccupied patches. Expected values (Table 1) were derived by assuming that only a single year's census data were available. However, when a series of censuses are used, the expected fraction of patches occupied must be adjusted as described in Haila and Järvinen (1983). When this was done, the agreement between observed and expected occupancy based on the model is even poorer ($\chi^2 = 6.486$, $P < 0.01$) for 50-ha patches.

Observed and expected occupancy for patches of