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Sexual dimorphism in the voice of the Greater Shearwater.—Typically active at their colonies after dark, burrowing petrels may use calls to convey information given by visual signals in other diurnal seabirds. Recent studies of these calls have revealed that there is sexual dimorphism in some species (e.g., Little Shearwater [*Puffinus assimilis*], James and Robertson 1985a), and the call provides an immediate label of the bird's sex. In other species (e.g., White-chinned Petrel [*Procellaria aequinoctialis*], Brooke 1986), the sexes share two calls, one for sexual advertisement and another probably serving to discourage intrusion into the breeding burrow. Various intermediate vocal systems have also been described. For example in the British Storm-Petrel (*Hydrobates pelagicus*), the two sexes share a call, but in addition the male utters a sex-specific call (James 1984). However, the factors which dispose species to adopt a specific vocal system are not yet clear. The Manx Shearwater (*P. puffinus*) (Brooke 1978a) and the Little Shearwater (James and Robertson 1985a) have a marked sexual dimorphism in their calls. In both species the male call has a ringing quality lacking in the female, and sonograms of these calls are also distinct (Brooke 1978a, James and Robertson 1985a) so that human subjects, asked to assign a particular sonogram to the male or to the female group, may be 100% successful (Brooke 1978a). The closely related Cory's Shearwater (*Calonectris diomedea*) has an equally distinct sexual call dimorphism (Wink et al. 1982). The present note reports on dimorphism of the calls of Greater Shearwaters (*Puffinus gravis*).

Study area and methods.—The study was carried out in 1986 on Gough Island (40°21′S, 9°53′W) and Nightingale Island (37°24′S, 12°28′W), 420 km to the NNW, in the South Atlantic. The study period included the first two weeks of November, during the laying

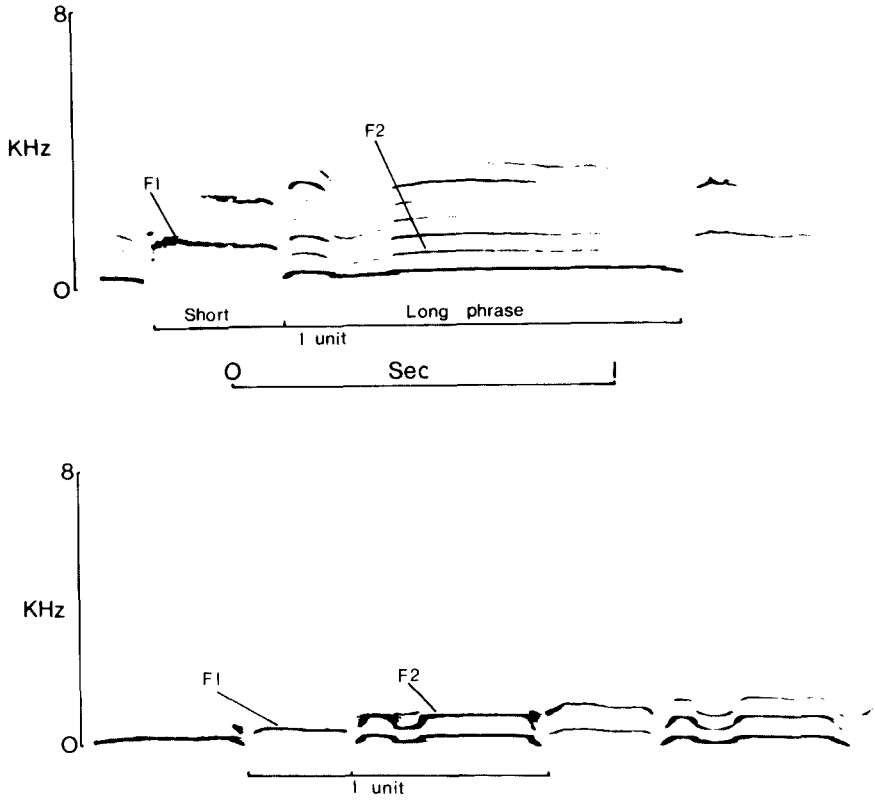

FIG. 1. Sonograms of the call of a male (upper) and female (lower) Greater Shearwater. The long and short phrases contained in each repeated unit are shown. The relative frequencies of F1 and F2 provide one means of distinguishing the calls of the two sexes (see text).

period on Gough, and late November/early December during early incubation (Rowan 1952, pers. obs.) on Nightingale. Thus most, but not all, calls recorded on Gough were of males undertaking the first long incubation stint and similarly, playback tests were there directed at males. Conversely, on Nightingale, where I worked some three weeks after the peak of laying, females were incubating and provided most data. However, there were no significant differences in calls or in responsiveness to playback between islands, and henceforth the data are pooled.

Most birds handled in study burrows could be sexed by cloacal inspection (Serventy 1956). The calls of 12 males and 10 females were recorded on a Uher Report 1C tape recorder at 19 cm/s using a Uher microphone. All birds were incubating alone at dusk or at night when recorded. They were stimulated to call by playing a call of a Greater Shearwater of the same sex as themselves, either from the Uher or from a Sanyo M1170 dictaphone. Calls were analysed on a Kay 6061-B sound spectrograph using a narrow band filter.

TABLE 1

THE FREQUENCY OF RESPONSE OF INCUBATING GREATER SHEARWATERS TO THE PLAYBACK OF CALLS. NOTE: PLAYBACKS TO BIRDS OF THE OPPOSITE SEX DID NOT INCLUDE ANY PLAYBACKS TO MATES

Sex of incubating bird	Call heard	No. of occasions bird	
		Responded	Did not respond
Male	Male	13	8
Male	Female	0	22
Female	Male	0	13
Female	Female	15	8

The recorded calls were played back at night at 39 burrows, 20 on Gough and 19 on Nightingale, to birds of known sex incubating alone. No bird experienced more than one playback per night, and no recording was played to a particular adult more than twice. In each test, the recording, usually lasting about 20 s, was played through once only, and I noted whether or not the incubating bird called in reply. No attempt was made to measure other possible responses, such as movement along the burrow towards the source of the sound.

Results.—Greater Shearwater calls usually consist of two principal phrases combined into a repeated call unit, and they are best described as vigorous unmelodious cries that crescendo in duetting pairs and during agonistic encounters. Though given mostly from the ground, calls were also uttered by flying birds. Calls began around 1600 GMT, reached a maximum as darkness fell (2000–2100), and then diminished in the next two hours. Birds in rafts approximately one km offshore from Nightingale also called.

Compared to Manx and Little shearwaters, the calls of male and female Greater Shearwaters were less distinct, both as sonograms (Fig. 1) and in the field. When five colleagues were given the 22 sonograms, one per bird, and asked to separate them into two groups, without it being specified how many should be assigned to each group, only two people (those with most experience of reading sonograms) achieved a satisfactory separation, with less than five birds placed in the "wrong" group.

In females (10/10) the fundamental frequency (F1; Fig. 1) of the shorter inspiratory phrase is lower than the frequency (F2) of the first harmonic of the longer expiratory phrase. The reverse is true in most males (9/12). The mean (±1 SE) length of male units was 1.02 ± 0.045 s ($N = 12$), and of female units 0.76 ± 0.045 s ($N = 10$), a highly significant difference ($t = 4.01$, 20 df, $P < 0.001$). In fact calls with unit length greater than 0.85 s are very likely male (11 male and two female), whereas calls of shorter unit length are very probably female (eight female and one male).

Five of the recordings obtained were of birds (two males and three females) whose calls crescendoed during recording. From each crescendo, three sonograms were made. The sonograms revealed (by definition) changes in volume and also changes in the detailed frequency structure of each phrase. However, variation in unit length between individuals remained greater than that within individuals (one-way analysis of variance, $F_{4,10} = 46.5$, $P < 0.001$).

Differences in frequency structure and unit length provide a potentially powerful means of discriminating the calls of male and female Greater Shearwaters. No birds were misclassified by both criteria. Males normally responded when played a male call but were silent

on hearing a female call (Table 1: $\chi^2 = 16.7$, 1 df, $P < 0.001$). Conversely females responded to female calls but were silent on hearing male calls (Table 1: $\chi^2 = 12.0$, 1 df, $P < 0.001$).

This study did not systematically investigate mate recognition of calls, known from other petrels (Brooke 1978a, 1986). However, on the two occasions a male's call was played to his mate (two different pairs involved), there was one response, whereas females never ($N = 13$: Table 1) responded to the calls of strange males.

Discussion.—The results of the playback experiments demonstrate that Greater Shearwaters can discriminate male and female calls. Such discrimination is potentially useful in mate selection (James 1985). Calling in response to the playback of the call of a bird of similar sex may occur because a bird's ownership of a burrow is more significantly threatened by the entry of another bird of its own sex (Brooke 1978a). The call may therefore serve a "keep-out" function. Although it may generally not pay a shearwater to change mates (Brooke 1978b), it is arguably less important to keep out birds of the opposite sex; hence the lack of response in playback tests to calls of the opposite sex (Table 1).

Among petrels, sexual dimorphism in call may be related to whether or not the species calls in the air (James and Robertson 1985b, Brooke 1986). If correct, this relationship is supported by the Greater Shearwater results. This species has sexual call dimorphism, as evidenced by the statistical analysis and playback tests. However the extent of sexual dimorphism is manifestly less than in Manx and Little shearwaters (Brooke 1978a, James and Robertson 1985a). At colonies Greater Shearwaters seem to call less in the air than do Manx Shearwaters (pers. obs.), but critical data are not available. A detailed knowledge of the amount of time spent flying over the colony and the calling rates of flying and grounded birds of known status would be necessary to test whether or not the Manx Shearwater engages in more aerial calling than does the Greater Shearwater.

Another factor which may reduce the intensity of selection for strong sexual call dimorphism in the Greater Shearwater is this species' crepuscular habits (Rowan 1952, pers. obs.). On land, it lacks the strictly nocturnal habits of certain other petrels (e.g., Leach's Storm Petrel [*Oceanodroma leucorhoa*], Watanuki 1986), possibly because it is sufficiently large to be relatively secure from predation by Great Skuas (*Catharacta antarctica*). Consequently, some display takes place in light sufficient to allow visual signalling.

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House Sparrow and Chipping Sparrow feed the same fledgling Brown-headed Cowbird.— On 10 June 1986, on the campus of the University of Western Ontario, London, Ontario, I saw a Chipping Sparrow (*Spizella passerina*) and a female House Sparrow (*Passer domesticus*) successively feed a fledgling Brown-headed Cowbird (*Molothrus ater*). A Chipping Sparrow fed the cowbird, which I judged to be about a week out of a nest, at 09:07 EDT. Immediately after the Chipping Sparrow left, a female House Sparrow, carrying millet, appeared and fed the cowbird. At 09:15 a Chipping Sparrow, and at 09:16 a female House Sparrow, fed the cowbird. The House Sparrow flew to the roof of a nearby building where there were Potter traps baited with millet. She returned to feed millet to the cowbird at 09:22 and later, at 09:28, a Chipping Sparrow fed a caterpillar to the cowbird.

Seven days later, within 15 m of the site of the preceding event, I saw a Chipping Sparrow feed an almost fully grown cowbird five times between 10:30 and 10:35. From its size, the cowbird could have been the one observed on 10 June. I saw no House Sparrow upon this occasion.

The nest-parent of the cowbird was unknown, but it is likely that a Chipping Sparrow had reared the cowbird. Chipping Sparrows commonly nest nearby and are heavily parasitized (Scott, D. M., unpubl. data) by cowbirds. My students and I have more than 60 records of Chipping Sparrows feeding or attending fledgling cowbirds on the campus. Although House Sparrows nest on the campus in small colonies, I previously had never seen a House Sparrow feeding a cowbird.

This incident emphasizes the uncertainty of recording a species as a host solely upon the basis of an individual feeding a young cowbird (Klein and Rosenberg 1986). In the present case, one of the possible foster-parents, the Chipping Sparrow, is a common host (Friedmann 1963), and the observation about the Chipping Sparrow is not remarkable. However, the House Sparrow has only once been reported as rearing a nestling Brown-headed Cowbird (Mearns 1881, Friedmann 1963). I have found no other record of a House Sparrow nest