

CONTRIBUTION TO THE STUDY OF THE PETRELS OF THE GENUS PTERODROMA IN THE ARCHIPELAGO OF MADEIRA

By P.A.Zino * and F.Zino **

With 1 plate, 3 figures and 6 tables

CONTENTS

| | <i>Pages</i> |
|---|--------------|
| INTRODUCTION | 142 |
| HISTORICAL ASPECT | 142 |
| Records published by Schmitz | 143 |
| Miscellaneous data | 145 |
| Summary of birds collected and their present whereabouts | 147 |
| Rediscovery of the Madeira Pterodroma | 148 |
| Recent visits to the breeding sites | 149 |
| BIOLOGICAL AND TAXONOMICAL ASPECT | 152 |
| Breeding sites | 152 |
| Nests and population estimates | 153 |
| Data on breeding periods | 156 |
| Lists of egg sizes, dates of collection and stage of incubation | 157 |
| Comparison of Bugio and Madeira Pterodromas ... | 158 |
| <i>Weight of birds</i> | 158 |
| <i>Egg weight to bird weight</i> | 158 |
| <i>Measurements of birds</i> | 159 |
| <i>Method of measuring bill</i> | 159 |
| <i>Bill measurements</i> | 160 |
| <i>Vocalization</i> | 161 |
| <i>Plumage</i> | 161 |
| <i>Recognition at sea</i> | 163 |
| CONCLUSION | 163 |
| ACKNOWLEDGEMENTS | 164 |
| REFERENCES | 165 |

* Rua Dr. Pita 5, 9000 Funchal, Madeira, Portugal.

** Rua Dr. Pita 7, 9000 Funchal, Madeira, Portugal.

RESUMO. No presente trabalho é relatada a história das observações das aves do género *Pterodroma*, feitas na Ilha da Madeira e no Bugio (Ilhas Desertas) e que levaram à descoberta da ave da Madeira a qual se julgava, até recentemente, extinta. Ambas as aves são comparadas quanto ao peso, comprimento, medidas do bico, vocalização e período de nidificação. Confirmando a sugestão feita por W.R.P. Bourne, conclui-se que estas duas aves, cujos locais de nidificação distam apenas 30 milhas um do outro, pertencem a duas espécies distintas: *Pterodroma feae* no Bugio e *P. madeira* na Madeira.

INTRODUCTION

Ever since the Gadfly Petrels of the genus *Pterodroma* were first discovered in the Archipelago of Madeira, they have been considered rare birds. Interest in these seabirds has fluctuated considerably over the years but lately renewed attention has been focused on the different characteristics of those birds which breed on Bugio, one of the Deserta Islands, and those which breed on the island of Madeira proper.

Much of what has been written on the Madeira *Pterodroma* was published many years ago and the papers are consequently out of print and difficult to obtain. Moreover, a large part of these older observations are in languages other than the universally understood English and consequently are not read by many of those studying these birds.

In view of their rarity and the difficulties encountered when attempting to study them, especially the often complete inaccessibility of the breeding sites, we propose to give a short history of all the birds and eggs of this genus known to have been taken in the archipelago and how they were first proved to breed on Bugio and then on Madeira itself; how the Madeira bird, for many years considered to be the same species as the Bugio bird, and recently thought to be extinct, was rediscovered in 1969, and how in 1983 it was suggested that it and that of Bugio be considered two distinct species, *Pterodroma feae* for the one breeding on Bugio and *P. madeira* for the one breeding in Madeira (Bourne 1983). We hope that with the evidence here presented we can help prove conclusively that this is in fact so. We describe the principal morphological differences in the 2 species and how their cries also differ.

HISTORICAL ASPECT

The first known record of *Pterodroma* in the Madeira archipelago was that of the 2 birds obtained by Frere in 1853 from his correspondent on the island of Madeira and which Dalgleish (1891) referred to as *Oestrelata mollis*. Both birds are in the Cambridge museum. However, in the British Museum (National History) in Tring there is one specimen of *Pterodroma feae* with the skin number 1852.1.31.1 indicating that the bird was obtained in 1852. The measurements of its bill, wing, tarsus and tail

fit in with those of the Bugio bird. Apart from the fact that it is a Deserta bird no other data are available either on the label or in the registry.

The next record was the bird obtained by Dalgleish in July 1889 from Ilheu da Cal, Porto Santo, followed by 2 more which he mentioned as 1 from Deserta Grande in the spring of 1890 and another in 1891.

Although Schmitz came to Madeira in 1874, his interest in birds only developed several years later. He started publishing ornithological papers in 1893, but he had been active in the field some years earlier, for Hartwig (1891) mentions that from 1889 to 1891 Schmitz sent him about 200 skins and many clutches of eggs. It is probable that all 3 birds mentioned by Dalgleish had also passed through Schmitz's hands although Schmitz himself does not mention them.

In a letter to Hartwig dated 21 July 1891 Schmitz wrote: "Yesterday (20 July) I was brought 2 specimens of *Oestrelata mollis* taken from a hole in the rocks of Deserta Grande. Can this bird possibly be a breeding bird? To-day, 21 July, I received yet another 2 specimens of *Oestrelata mollis*, also from Deserta Grande. Strange that a bird so rare should be brought to me in such numbers." He adds: "Perhaps this bird should be accepted as appearing more often than one was inclined to think, for, due to its habits, it is not easy to observe." (Hartwig 1891 *Ornis* 7: 187-188)

Records published by Schmitz

1894 *Ornith. Monatsb.* 2:195 (14 October 1894)

"*Oestrelata mollis* appears to be a breeding bird of Madeira. Two people who have worked many times on the Desertas and to whom I showed *Puffinus anglorum* and *O. mollis*, assure me that *O. mollis* breeds on the Desertas, specifically on Bugio, and that as proof they would bring me young birds from this year's expedition.* They did not bring any birds but said that although they had handled some, they had to leave them behind. One of the party fell and died instantly, completely smashed up. They brought 2 eggs, apparently *Oestrelata* eggs. One was broken and empty. It appeared to be an abandoned egg. The other was very developed; the almost fully developed embryo showed a really short and broad bill with very closely situated nasal apertures which applies only to *O. mollis*." These eggs were the first ever found, but Schmitz was not fully satisfied with them and wanted further definite proof of breeding in the form of downy young.

1896 *Ornith. Jahrb.* 7:199

13 October 1895. "From the island of Bugio (Desertas) I received another *Oestrelata mollis*."

* Probably referring to the annual slaughter of *Calonectris diomedea borealis*, then known as *Puffinus kuhli*, on the Deserta Islands, which took place every year at this time.

Schmitz was away from Madeira from July to October 1897 and again for 4 years from 1898 to 1902. During this period no specimens were recorded but the year following his return the first specimens of *Pterodroma* were found in Madeira.

1905 Ornith. Jahrb. 16:220

18 July 1903. "From the mountains between S. Antonio and Curral I received 4 live *Oestrelata feae* (Salv.). There were 2 males and 2 females. Ten months later it was discovered that they bred there. I obtained the first and only egg of this species, which was heavily brooded, on 14 October 1894 from Bugio, the southernmost of the Deserta Islands, which indicates a very long breeding period, or then 2 distinct breeding periods." Schmitz here refers to the birds as *Oestrelata feae* and still believes the birds from Madeira to be the same as those from Bugio. However, when on 14 May 1904, he discovered that fresh eggs had been found in that same site in Madeira, he began to suspect that the Bugio and Madeira birds had different breeding seasons.

1905 Zeitsch. für Oologie u. Ornith. 14:1-2

Ten months after receiving the 4 live specimens, Antonio Fernandes, who had found the birds, when referring to the exploit, casually told Schmitz: "In 6 holes we also found an egg but we threw them against the cliff; they were no good for eating, anyhow."

1906 Ornith. Jahrb. 17:25

17 September 1905. "This very moment I have tangible proof that *Oestrelata feae* (Salv.) is a breeding bird of the island of Madeira itself: A beautiful, fully developed chick and an abandoned and unfertilized egg from Poio do Louro, from where I have already received several adult birds." Schmitz notices that the size of this egg, 52.5mm x 40.5mm, is definitely smaller than that of the Bugio egg which was 59mm x 42mm and adds: "Since the hatching period is in the second half of July, we can hardly expect another egg this year. The breeding place lies over 1000m a.s.l., accessible only with the use of ropes."

1906 Ornith. Jahrb. 17:199-204

He here describes how on 11 June 1906 a boy brought him a basket containing 4 live birds and one fresh, undamaged egg. Another had been broken. The previous day the boy had found one bird in each hole, but in only 2 had he found an egg. On 15 June Schmitz set out for the breeding site which was over 1400m a.s.l. and which he reached only after considerable difficulty.

"I found myself 15m immediately above the spot and I laid myself down on the ground so that I could look over the edge and watch everything in safety. My boy quickly wrapped a 15m long rope around himself with the knot to his breast, reached a slightly lower level where the rope was firmly held by the strongest of the other men, and then was slowly let out as the boy slipped down holding the rope with his hands, his feet

searching for any small protruding rock in order to lighten his weight. In a moment he was on the ledge which formed a long right-angled triangle."

No further egg or bird was found. In each nest the boy found several dried grasses and mountain plants which Schmitz lists.

1910 Ornith. Jahrb. 21:106

No more birds or eggs were found before Schmitz left Madeira for good in 1908, but in 1910 he reported from Jerusalem that 2 more young birds had been taken from Curral das Freiras * on 14 July 1909.

Miscellaneous data

Jesse Metcalf 1927 "Wandering among forgotten Isles"

On 23 September 1926, Metcalf, who was collecting for the American Museum of Natural History, took 4 adult *Pterodroma* and 2 tiny chicks at Bugio. One of these chicks, a day or two out of the shell, was about to be despatched to become a museum specimen, when Metcalf cupped it in her hands and placed it near her face. To her astonishment it felt the moisture on her lips and pecked them and then at her tongue. She decided to chew some raw fish in her mouth and mix this with her saliva. The chick immediately started to eat this and for several weeks it was fed from the lips and in this manner managed to survive remarkably well. Later it was fed from the fingers and cod liver oil was added to its diet.

From Madeira Metcalf took this chick to the Canary Islands and from there to Dieppe, then to Paris and London and finally to New York where she arrived on 7 December, a journey of over 9000 miles. It soon began to shed its down and the tail and wing feathers began to develop remarkably well and its bite became strong. On 13 January 1927 Metcalf left the bird in the care of a friend. Five days later it died. Its label in the American Museum of Natural History, which P.A.Z. had the privilege

* The Portuguese name for both the Bugio and the Madeira *Pterodroma* is "freira", but Curral das Freiras did not obtain its name from the bird, nor did the bird obtain its name from the locality near which it was found. Freira is also "nun" in Portuguese and the meaning of Curral das Freiras is "The nuns' fold". It is thus depicted in a 1850 lithograph of the locality by Frank Dillon.

João Gonçalves Câmara, the son of the discoverer of Madeira, had two daughters who both became nuns. When in the 15th century they entered the Santa Clara Convent in Funchal, their father presented the convent with an extensive and rich agricultural property in the mountains, which became known as Curral das Freiras. When in later years pirates attacked the island, the nuns took refuge in this their hidden mountain retreat.

Schmitz (1896) stated that the birds collected from near the Desertas in August 1895 were known by the fishermen as "Freiras". At this time the Madeira bird had not yet been found, so this name could not have been obtained from the locality near which it was later found breeding.

of seeing, reads: "Artificially fed and reared by Mrs. Jesse Metcalf who had fed it raw fish and cod liver oil from her lips. Robert Cushman Murphy thinks it is the only petrel ever reared in captivity. It died in New York January 18 1927." We might add Metcalf's comments: "Primarily he owed his survival to the weakness in every feminine heart for anything that is fluffy and helpless and produces an appealing sound." For anyone who has heard the sound of a disturbed *Pterodroma* chick, as we have, our own comments are that there may well have been a slight misprint in the penultimate word.

Three specimens from Bugio in the British Museum (Natural History) are dated 5 September 1932. One was presented by R.M. Lockley in 1939. Another was presented in 1934 by Mrs. F.G. Bird and another by her son Edward Bird in 1953. All 3 had originally come from the Seminary Museum in Funchal but no details are known of how they were obtained.

On 5 October 1940 a young bird with down was found near the Governor's Palace on the sea front of Funchal.

On 6 October 1951 another young bird, also with down, was found on the outskirts of Funchal in the Ribeira de Santa Luzia. Both these specimens, now in the Funchal Museum, were undoubtedly young birds which had left their nests in the mountains of Madeira in an unsuccessful attempt to reach the sea at fledging time and were probably attracted and confused by the lights of Funchal. Although their breeding site is not known for sure, it would appear that in both cases these birds had come from nests west of the Pico do Areeiro — Pico Ruivo ridge, for they would thus have been able to glide or fly down to the level of Funchal without having to climb higher than their nesting site. Had their nests been sited east of that ridge, they would have been unable to reach the Funchal area, where they were found, without first having to climb considerably higher after leaving their nests. While no observations have been made of these birds at fledging time, it would seem probable that, as in the case of *Calonectris diomedea borealis* on the Salvage Islands, which we have had occasion to observe over a period of years, when the young leave their nests, they glide straight down to the sea. We have observed that the breeding sites of *Pterodroma feae* on Bugio and of *Puffinus puffinus* on Madeira are also so situated that the young, when they leave their nests, can reach the sea in a continuous glide or downward flight without the need to climb to a higher level.

In 1964 G.E. Maul, curator of the Funchal Museum, asked the whale lookouts on Bugio to try and obtain specimens of *Pterodroma*. Within a very short time they brought him 8 specimens. Maul was surprised at the ease with which these birds were obtained and had difficulty in convincing the lookouts that no more specimens were needed. At approximately the same time Knecht also obtained 2 specimens and also 1 egg which was presented to the museum.

Summary of birds collected and their present whereabouts (Tabs. 1A & B).

A: Birds from the Deserta Islands (one from Porto Santo)

| Year | Date | No. Collector | Provenance | Present whereabouts/ref. |
|------|------------|------------------------------|-----------------------------|--|
| 1853 | ? | 2 Frere | Near Madeira | Cambridge Museum |
| 1889 | July | 1 Dalgleish | Ilheu da Cal Porto Santo | Royal Museum of Scotland |
| 1890 | 18 June | 1 Schmitz | "Deserta Grande" | Funchal Museum |
| 1891 | ? | 1 ? | ? | "In possession of C.J. Cos- sart". (Dalgleish 1891) |
| 1891 | 20 July | 2 Schmitz | "Deserta Grande" | Museum für Naturkunde, Berlin |
| 1891 | 21 July | 2 Schmitz | "Deserta Grande" | Hartwig 1891 Orn. 7:187 |
| 1891 | 6 August | 1 Schmitz | Desertas | Manchester Museum |
| 1892 | 12 Sept. | 1 Schmitz | Desertas | Alexander Koenig Museum Bonn |
| 1895 | 12 August | 2 Schmitz | Desertas | 1 American Museum of Na- tural History |
| 1895 | 27 Sept. | 3 Schmitz | Desertas | 1 British Museum |
| 1895 | 13 October | 1 Schmitz | Bugio | Schmitz 1896 O.J. 7:199 |
| 1926 | 23 Sept. | 4 ad. 2 chicks Metcalf | Bugio | All in American Museum of Natural History |
| 1932 | 5 Sept. | 3 ? | Desertas | All in British Museum |
| 1964 | 10 July | 8 Maul | Bugio | 7 Funchal Museum 1 Museu do Mar, Cascais |
| 1964 | 21 August | 2 Knecht | Bugio | 1 Funchal Museum |
| 1967 | 13 July | 3 Jouanin & Roux | Bugio | All in Museum National d'Histoire Naturelle Paris |
| 1967 | 1 August | 1 Skeleton Jouanin & Roux | Bugio | Museum National d'Histoi- re Naturelle, Paris |
| 1985 | 21 January | 1 Skeleton Zino | Bugio | Funchal Museum |

B: *Birds from Madeira*

| Year | Date | No. Collector | Provenance | Present whereabouts/ref. |
|------|-----------|-----------------|-------------------------|--|
| 1903 | 18 July | 4 Schmitz | Santo Antonio | 1 American Museum of Natural History |
| 1905 | 17 Sept. | 1 chick Schmitz | Curral das Freiras | Schmitz 1906 O.J. 17:25 |
| 1906 | 10 June | 4 Schmitz | Santo Antonio | 2 American Museum of N. H. 2 British Museum |
| 1909 | 14 July | 2 Silveira | Curral das Freiras | 1 Funchal Museum |
| 1940 | 5 October | 1 Maul | Funchal | Funchal Museum |
| 1951 | 6 October | 1 Maul | Funchal | Funchal Museum |
| 1969 | 16 June | 3 | Curral das Freiras area | 2 Museum National d'Hist. Naturelle |
| 1986 | 10 Sept. | 1 chick Zino | Curral das Freiras area | Funchal Museum |

Rediscovery of the Madeira *Pterodroma*

In 1967 and 1968 Jouanin, Roux and P.A.Z. visited Bugio on several occasions. During this period 3 specimens and 2 eggs were taken and tape recordings were made of the cries of the adult birds as they flew round their nests. P.A.Z. then reasoned that if the Madeira *Pterodroma* still existed, its cry would probably be very similar to that of the Bugio bird. If someone in Madeira could be found who would recognize these uniquely strange and eery cries when they heard the tape recordings of the Bugio bird, this person would then be able to indicate where the cries were heard and consequently the area where the birds nested.

A shepherd from the village of Curral das Freiras was chosen as the most likely person to be able to help. When the tape recording was played he immediately recognized the call, so from that moment we were sure that the Madeira *Pterodroma* still existed. Lucas, the shepherd in question, went on to say that the only place where he had heard these calls was high in the mountains above Curral das Freiras, approximately in the area as described by Schmitz in 1906.

On 17 May 1969 a search party led by Lucas was organized to cover the area he had described and strict instructions were given to all four men that if nests were found, on no account was any bird to be disturbed or any egg taken. The search was not conclusive for the men found several nest burrows, apparently fresh, but no eggs or birds were present. The

ledges where they were found could only be reached by rope and were thus similar in this aspect to those which had been described by Schmitz.

On 15 June 1969, upon our return from the Salvage Islands, we were informed that a visiting ornithologist had organized the same men as had searched the mountains in May and that the same area was going to be searched again the following day. On 16 June we were informed by phone that the birds had been found. We hurried to the spot where to our horror we found that the men had collected from a single breeding site 8 live birds and 6 eggs. We tried to persuade the ornithologist to return all birds and eggs and it was finally agreed that 2 birds and 2 eggs would be kept, the rest would be returned to their nests.

We set off with the men and when the spot where the birds had been found was reached, we looked down a cliff which fell away to a depth of several hundred metres. A ledge about 60m perpendicularly below was pointed out as the breeding site. As the men prepared to lower one of their companions down the cliff on a rope, it started to rain. The rain increased and the men were very weary, so the operation was called off. The six birds were released and the eggs handed to the ornithologist with a request that one be handed to the Funchal Museum and one to us.

From the length of the rope used to reach this ledge it was evident that this spot was not the same as visited by Schmitz in 1906. Schmitz's man had been lowered 15 metres while here 60m of rope had been needed.

The same evening it was discovered that another man had found a *Pterodroma* and egg the previous day. The length of the rope used to reach this smaller ledge was 15m and it could well have been the site described by Schmitz. It was about 250m distant from the first site.

Recent visits to the breeding sites

In Madeira. On 28 June 1977 the same men who had reached the breeding site in 1969 returned to the ledge and brought up 2 birds, taken from 2 nests each containing an egg. After being photographed and weighed they were released. A few other fresh and used burrows were found but no exact count was made.

In 1981 Le Grand reported finding another breeding site of the Madeira *Pterodroma* in approximately the same area which he calculated held about 20 nests. He reached this site alone and without the use of ropes and was able to observe 7 birds on their egg in shallow burrows without disturbing them. (Le Grand in litt. 1984).

Le Grand also reported hearing the cries of this bird at other localities in Madeira several kilometres distant from the known breeding area. In 1985 F.Z. together with friends who also know the mountains of Madeira well, spent several nights in the various areas indicated by Le Grand but were unable to hear any cries. Renewed efforts are needed to localize these and establish whether there are any nests in the areas.



Plate I.—*Pterodroma madeira*. Picture taken at night near nesting site, 17th June 1986.
Phot. T.R. Maul.

In 1985 the smaller known breeding site was visited on 15 May and 20 June. Twelve empty burrows were found and also many rat droppings. Rat poison was later put down and on 14 August it had all been eaten. There were no birds.

On 8 June 1985 4 freshly dug burrows were found in the larger breeding site but no birds. On 20 June 3 more burrows were found. All were empty. There were many rat droppings. On 30 August all rat poison had been eaten and again there were no birds; one broken, mud-encrusted egg was found which had been eaten by rats. From the foregoing it would appear that no birds fledged in the known sites in 1985 but it is possible that birds bred in other inaccessible ledges in this area.

On 10 September 1986 this site was again visited. Nine burrows showing signs of being occupied were found. The nesting chambers of seven of these were reached without disturbing the burrow. Six of these were empty and one contained a dead chick which showed signs that it had been killed by rats, for most of its head and neck had been eaten and it was covered in maggots. We reckon that it had been dead 2 to 4 days. Its weight was 175g and we calculate it would have fledged in about another three to four weeks.

All the plastic bags containing rat poison which had been placed there earlier were empty and had been taken inside the burrows. In view of the presence of rats the remaining 2 burrows were opened and they too proved to be empty.

On Bugio. In 1981 Le Grand ringed 10 *Pterodroma* and took one egg. On 25 August 1985 we visited the southern plateau where many calls were heard and many birds were seen at night. No work could be carried out due to heavy rain but one bird was weighed, measured and ringed.

On 8 November 1985 we again visited the southern plateau, this time by helicopter from H.M.S. Endurance. Of several occupied burrows, one was opened which contained a single adult *Pterodroma* with neither egg nor chick. On the same day a 15 minute visit was made to the rough, narrow strip of soil and rock on the northern crest of Bugio which had never been visited by any ornithologist and it was not known whether *Pterodroma* nested here. It is impossible to reach the northern half of Bugio from the southern half and the existence of this flattish strip of soil was known only from the map. The site proved to be larger than expected and in this short visit 5 burrows were found with every sign that they were occupied by *Pterodroma*, for smudges of white droppings, some tinted with green, were found just outside the entrances. However, considering the area containing soil the number of nests was very disappointing.

Although it is impossible to reach northern Bugio from the southern half of the island, we found that fishermen had been there, for we found many Cory's Shearwater wings. The fishermen climb up and down these cliffs like goats and it is probable that they reached this spot by landing on the northeastern extremity of Bugio, the place used for landing by the old

shearwater hunters. This spot was pointed out to us in 1967 by Ornelas, who many years ago used to lease the shearwater hunting rights on the Deserta Islands and who later accompanied us on several of our trips to Bugio.

On 24 July 1986 we reached Bugio by helicopter from H.M.S. Brave where, during a short stay, we found 2 birds without an egg in one nest and 45 possible burrows were counted on a part of the southern plateau.

After many unsuccessful attempts to reach Bugio by sea and spend a night ashore, we finally spent the night of 4/5 October on the southern plateau in ideal weather conditions. There was no moon and *Pterodroma* started calling at 20.00 hours and continued until 23.30 hours after which no more calls were heard. Seven birds were measured, weighed and ringed. A further 83 possibly occupied burrows were counted bringing the total for the plateau and immediate surroundings to 128. One bird was brought down in the morning to be photographed. We looked around to see if any Herring Gulls were present; none were seen so the bird was then released. Immediately a Herring Gull dived down from the cliffs above and attacked the *Pterodroma* which managed to escape only with the greatest of difficulty for there was no wind and it was consequently at a great disadvantage.

BIOLOGICAL AND TAXONOMICAL ASPECT

Breeding sites

On Porto Santo. Dalgleish (1890) reported a *Pterodroma* being taken on Ilheu de Baixo at Porto Santo in July 1889. This specimen is in the Scottish Museum and from its measurements it is undoubtedly a Bugio bird, *Pterodroma feae*. No further specimen has ever been obtained from the Porto Santo Islands. Recent investigations by Jouanin, Roux and ourselves have shown that there is no trace of this bird on any of the islands of the Porto Santo group nor is there any indication that they have bred there in recent times.

On the Desertas islands. Dalgleish (1891), Hartwig (1891) and Schmitz (1894) report specimens being taken at Deserta Grande, but Schmitz (1894) later refers to *Pterodroma* as "breeding on the Desertas, specifically on Bugio" and in 1905 (*Zeitschrift für Ool. u. Ornith.* 14:1-2) he writes: "Up to the present the only breeding site of *Oestrelata feae* was on the Deserta Island of Bugio, an island of most difficult access and hardly ever visited."

We believe that the early *Pterodroma* which were reported as having been taken on Deserta Grande were all, in fact, taken on Bugio. It is highly probable that all Deserta specimens collected between 1889 and 1906 passed through the hands of Schmitz who never collected any of these birds himself but obtained them from fishermen who frequented the waters surrounding the Deserta Islands. Local fishermen are not always precise in the information they give and are likely to attach no importance to exactly where specimens are obtained, so misunderstandings can easily arise. Even

now, if a fisherman states he has been to the Desertas, most people would understand that he has been to Deserta Grande, for it is this island which, seen from Funchal, stretches a long distance across the horizon.

Over the years we have spent a total of more than 50 nights anchored close to the cliffs of Deserta Grande, several of which close to the southern tip, but have never heard a single *Pterodroma* call. On the other hand, on 2 nights anchored close to Bugio, while one of us was on the plateau above, their cries were heard faintly in the distance from above.

On 20 September 1986 we spent the night on the summit and close to the southernmost tip of Deserta Grande. While for most of the night there was moonlight, during which time these *Pterodroma* would not normally call, none were seen. However, there was a period of approximately one and one half hours of darkness before the moon rose during which no *Pterodroma* calls were heard. In several areas where there was thick soil covered in grass and *Mesembryanthemum* no sign of any burrows was found. An occasional rabbit warren was seen without any sign of being occupied by *Pterodroma*.

While we cannot completely rule out the possibility of *Pterodroma* nesting on the inaccessible southern tip of Deserta Grande, it is our opinion that they do not breed there nor on any other part of Deserta Grande.

In Madeira. In the island of Madeira proper, as has already been stated, the only 2 confirmed breeding sites are situated among the highest mountain peaks of the island and they can only be reached with the use of ropes. The exact location of the site reported by Le Grand which was reached alone and without the use of ropes is, at the time of writing, still unknown to us.

As a result of several night visits to the nesting area in 1985 and 1986, we now believe that nests may exist very close to the larger breeding site on a nearly perpendicular, slightly convex cliff up above, which then drops to a river bed about 300m below. Here there are no ledges but, instead, a few isolated pockets in the rocks which appear to contain earth. Exploration of this cliff is a difficult undertaking which we hope to attempt in the near future.

Nests and population estimates

On Bugio. Our searches for *Pterodroma* on Bugio have been concentrated mostly on and around the southern plateau where there is a thick layer of earth covered with grass and *Mesembryanthemum*. In 1968 its length was calculated to be about 375m (Jouanin et al. 1969) and its width varied considerably from about 10 to 30m. This site was reached by climbing up cliffs which rise straight out of the sea to a height of 345m and then scrambling along the crest to the plateau. Recently, the treacherous climb from sea level to the plateau has become even more dangerous due to heavy rains dislodging earth and rocks. However, the plateau itself appears to be much the same today as it was in 1969.

Pterodroma nesting burrows are found in the earth both on the plateau and along its edges where in places there is a 1m thickness of earth. The entrances of the burrows vary in size as do their depths. Some are about 10cm in diameter, others about 13cm. (Jouanin et al. 1969). Some are not more than 1m long but the majority are much longer and not straight and some of these may well be rabbit burrows which have been taken over by the birds. Burrows are built nearly horizontally, the nest chamber being 30 to 60cm below the surface and, exceptionally, much more, which makes us believe that in these cases they were certainly originally rabbit burrows.

The nesting chambers themselves are about 13cm in height and 20cm across and they are kept clean and free of droppings. Nesting material is sparse, sometimes consisting of a little dried grass and/or *Mesembryanthemum* and occasionally one or two feathers.

On 5 October 1968 the number of occupied nests on and around the plateau was calculated at 35, possibly 50. (Jouanin et al. 1969), On 4 October 1969 Jouanin and we searched the area carefully and counted 108 probable nests on and around the plateau. At that time we had thought that *Pterodroma* nested almost exclusively in the area of this plateau but we later found 2 nests at about 200m a.s.l., each containing a bird and egg, under rocks in what were originally *Calonectris diomedea borealis* nests, for there were large piles of small stones leading up to the entrances. A nest with bird and egg was also found on the eastern side of the island among rocks 80m a.s.l. It is, therefore, apparent that *Pterodroma* nests not only in the burrows which they dig where they find sufficient soil and vegetation, but also in rocky parts of Bugio where there is no soil, and even occupy the abandoned nests of *Calonectris d.b.*

On the crest of the northern part of Bugio there exists a long, narrow, rough strip of soil with almost no vegetation. It is over 500m long and varies in height from 363m to 384m a.s.l. and its surface is uneven. Nearly all the earth, not being held by grass or *Mesembryanthemum*, is subject to strong erosion by rain and wind, of which there is ample evidence. The lack of vegetation to hold the earth is probably the reason why so few nests were found here, the five nests which were found being in 2 of the 3 spots where there was a little vegetation.

While lack of vegetation and consequent soil erosion may restrict the places where *Pterodroma* choose to nest, goats and rabbits do not interfere with successful breeding once the birds have occupied their burrows. However, constantly cropping the little grass which grows on the island, nearly all of which is on the southern plateau, they tend to destroy the grass and thus increase erosion.

The greatest danger to the birds is the fishermen who every year comb those parts of the island which they can reach and take every living seabird, especially *Calonectris diomedea borealis*, the young of which reach their fattest condition in the first half of October, (Personal observations

on Selvagem Grande). However, in October the *Pterodroma* chicks are so small that the fishermen probably ignore them. Furthermore, at that time, most *Pterodroma* chicks would be alone in the nest during the day, and since most of the burrows are long and deep, the fishermen would probably not go to the trouble of opening them just to extract a small chick. Unfortunately, most fishermen do not wait until October to take the *Calonectris* young, and in August and September raid the island for the adult birds. It is at this time that the adults of *Pterodroma* are at their greatest risk, for any which are found are undoubtedly taken.

Now that it has been established that *Pterodroma* nest on the northern part of Bugio, the possible breeding area has been considerably enlarged, but since most of Bugio cannot normally be reached by man, one cannot make anything like a correct assessment of the number of birds nesting there. 128 possibly used burrows were counted on and around the southern plateau in 1986 but we have found that of the total number of possibly used burrows, less than half are actually occupied in the same season. We, therefore, estimate that the maximum number of used burrows on and around the southern plateau in 1986 was about 50. On the night of 4/5 October birds were heard calling on the eastern and western faces of Bugio, indicating that there were probably more nests there. If we add the nests of the northern plateau and those which probably nest in the rocks below, we estimate that there is a breeding colony in the neighbourhood of 150 birds.

In Madeira. While Bugio is difficult to climb, once on the southern plateau, where most of the nests are found, one can move around freely and without any danger while searching for the burrows. In Madeira, however, this is not the case, for the 2 known breeding sites can only be reached with the use of ropes and searching for burrows in these mountain ledges is extremely dangerous. An estimate of the breeding population of the Madeira *Pterodroma* can only be made from the number of used burrows found on these ledges and by calculating the number of birds heard calling in the breeding area at night.

We know that there were only 9 breeding pairs on our 2 ledges in 1986 with no known breeding success either in 1985 or 1986. Even if other nests are found in this area, which is possible, since many birds were heard calling earlier in the season, we believe that the number will be small. We estimate that the breeding population of this bird in the area under observation is less than 30 pairs and we believe that unless birds breed in greater numbers in other unknown areas, which is unlikely, then the Madeira *Pterodroma* must be considered the most endangered seabird species in Europe, with but little chance of survival unless the menace from rats can be brought under control. As this paper goes to press we understand that the ICBP and the RSPB together with the Commission of the European Community are elaborating a plan in conjunction with the Funchal Museum

and the Parque Natural da Madeira, to try and save *Pterodroma madeira* from extinction.

Data on breeding periods

No further information has been obtained on the biology of the Bugio *Pterodroma* since Jouanin, Roux and Zino published their paper in 1969. From the data available at the time, it was suggested that laying commences at the earliest on 18 to 21 July, is probably at its height at the beginning of August and could continue until about 19 to 21 August. Based on the incubation period of 51 to 54 days and fledging period of 90 to 100 days of *P. cahow*, the Bugio fledglings would leave their nests between 13 December and 23 January. On 21 January 1986 we spent a night on Bugio and found no sign of any *Pterodroma*. These dates are mentioned here so that comparisons can be made with the Madeira *Pterodroma* on which we also have little information.

Whereas the incubation and fledging periods of *P. cahow* were used to assess the approximate fledging dates of the Bugio *Pterodroma*, these same periods cannot be used for the Madeira *Pterodroma*. Imber (1985) states that the period from hatching to departure in the genera of Procellariids is mainly dependent on body mass. Whereas the weight of the Bugio bird (275-355g) (Tab. 4) falls in the same category as that of *P. cahow* (270-330g), the Madeira bird (175-231g) weighs ca. 50% less than the Bugio bird and consequently the fledging period should be considerably less than that of *P. cahow*. Since Pycroft's Petrel, with a weight of ca. 150g, rears its young in ca. 80 days (Imber 1985) we would suggest that the fledging period of the Madeira *Pterodroma* could be ca. 85 days.

Of the 7 eggs taken in Madeira on 16 June 1969 we know (personal comm.) that:

- 1 was very slightly brooded
- 2 were slightly brooded
- 1 was brooded over 15 days

Eggs had, therefore, been laid from about 31 May to about 12 June. We also know that Schmitz found a fresh, undamaged egg on 10 June. (Schmitz 1906).

Based on an incubation period of 51-54 days and a fledging period of ca. 85 days, these 4 eggs would have hatched between 21 July and 5 August and the young fledged between 14 and 29 October. However, we also know that 2 downy young were found in Funchal on their way to the sea on 5.10.40 and 6.10.51. If we apply the same estimated incubation and fledging periods to these birds we find that their two eggs were laid between about 19 and 23 May and hatched ca. 12 or 13 July. From this evidence we, therefore, suggest that the laying period of the Madeira *Pterodroma* commences about 19 May and could continue until about 12

June. This would mean that there is a difference of about two months in the laying periods of the Bugio and Madeira *Pterodroma*, birds which feed in the same waters and whose nesting sites are only about 30 miles apart.

Lists of egg sizes, dates of collection and stage of incubation (see Tabs. 2A & B and 3A & B).

Whereas Schmitz had obtained *Pterodroma* specimens both from Bugio and Madeira, he was not so successful in collecting their eggs. The 2 collected by him from Bugio on 14 October 1894, one of which was found

Tab. 2A & B.—Eggs from Bugio:

A: Length and width.

| | | |
|-----------------|-----------------------|------------------------|
| 59.0mm x 42.0mm | Schmitz 14.10.1894 | Very developed embryo. |
| 57.5 x 44.0 | Knecht 21.8.1964 | Heavily incubated |
| 58.6 x 43.9 | Jouanin et al. 1.8.67 | Fresh |
| 57.4 x 44.6 | » » | » |
| 59.9 x 41.8 | Roux 5.10.68 | Found broken and empty |

B: Minimums, maximums and average.

| | |
|----------------------|-------------------|
| Min. and Max. length | 57.4mm 59.9mm |
| Min. and Max. width | 41.8mm 44.6mm |
| Average | 43.26mm x 58.48mm |

Tab. 3A & B.—Eggs from Madeira.

A: Length and width.

| | | |
|-----------------|-----------------|-------------------------|
| 52.5mm x 40.5mm | Schmitz 17.9.05 | Addled |
| 55.5 x 41.2 | Schmitz 10.6.06 | Fresh |
| 54.6 x 40.5 | 16.6.69 | Very slightly incubated |
| 54.0 x 41.75 | » | 7-10 days incubation |
| 51.25 x 40.2 | » | » » » |
| 54.1 x 40.15 | » | Over 2 weeks incubation |
| 55.8 x 40.0 | » | No information |

B: Minimums, maximums and average.

| | |
|----------------------|-------------------|
| Min. and Max. length | 51.25mm 55.8mm |
| Min. and Max. width | 40.0mm 41.75mm |
| Average | 40.61mm x 53.96mm |

broken and empty, were the first and only such eggs that he or anyone else had ever obtained from the Deserta Islands. There was to be an interval of 70 years before the next was found on 21 August 1964 by Knecht.

Schmitz managed to collect only 3 eggs of the Madeira *Pterodroma*, the last of which on 10 June 1906. One of these was found broken and abandoned. The next eggs were found, after an interval of 63 years, on 16 June 1969. One of these 7 eggs was presented to the Funchal Museum. Both this egg and that from Bugio have disappeared mysteriously from the collection and theft is suspected.

The above samples show that the egg of the Madeira bird is smaller both in length and width than that of the Bugio bird and that the eggs of both birds, at least from this small sample, can be distinguished from a single specimen, there being no overlap in either of the 2 parameters.

Comparison of Bugio and Madeira *Pterodromas*

The average weight of 17 Bugio birds is 311.47g while that of 8 Madeira birds is 203.85g (Tab. 4). This small sample shows that the Bugio bird is on average 52.79% heavier than the Madeira bird. The difference is manifest when the birds are held in the hand. We recently handled a Madeira bird and four days later handled 2 Bugio birds. A large difference in weight was immediately apparent, visually most noticeable in the size of the head and bill. The Bugio bird is also more powerful and has considerably greater strength in the bill.

Tab. 4 (weight of birds).

| | Number of birds | Min. | Max. | Average | s. d. |
|--------------------|-----------------|------|------|---------|--------|
| Birds from Bugio | 17 | 275g | 355g | 311.47g | ±20.59 |
| Birds from Madeira | 8 | 175g | 231g | 203.85g | ±22.65 |

Egg weight to bird weight. Jouanin et al. (1969) found that the weight of 2 Bugio eggs, 59g and 60g, represented respectively 17.8% and 18.1% of the average weight of 5 adult birds. The percentage values of the

same 2 eggs now related to the average weight of 17 adult birds has changed to 18.94% and 19.25%.

The weights of 2 Madeira eggs are 45g and 49.8g., representing respectively 22.07% and 24.43% of the average weight of 8 adult birds.

Measurements of birds

(Tabs. 5A & B)

A: Of birds from Bugio.

| | Number of birds measured | Min. | Max. | Average | s. d. |
|--------------|--------------------------|--------|-------|----------|-------|
| Wing length | 40 | 258mm | 282mm | 267.82mm | ±5.98 |
| Tarsus | 32 | 32mm | 41mm | 35.76mm | ±2.33 |
| Middle Toe | 25 | 41.9mm | 50mm | 46.35mm | ±1.73 |
| Tail | 29 | 106mm | 155mm | 110.29mm | ±2.81 |
| Total length | 14 | 330mm | 360mm | 353.21mm | ±8.19 |

B: Of birds from Madeira.

| | Number of birds measured | Min. | Max. | Average | s. d. |
|--------------|--------------------------|---------|-------|----------|-------|
| Wing length | 13 | 241mm | 254mm | 246.78mm | ±4.11 |
| Tarsus | 12 | 29.5mm | 38mm | 32.85mm | ±2.85 |
| Middle Toe | 2 | 41.5mm | 43mm | 42.5mm | |
| Tail | 7 | 100.5mm | 108mm | 104.6mm | ±3.33 |
| Total length | 5 | 320mm | 333mm | 326.2mm | ±4.66 |

The above measurements show that the Bugio bird is on average undoubtedly larger in all respects than the Madeira bird but only in weight and wing size is there no overlap. The overlap in total length is also minimal. However, each individual can easily be identified as a Bugio or Madeira bird without recourse to any measurements by looking at its bill alone. (see fig. 1).

Method of measuring bill (fig. 2). The comparative measurements of the bill of both birds are given in Tabs. 5A & B. We have measured the maximum height (2) perpendicularly down from the same spot as the length of the bill is measured: At A. We find this a more accurate measurement than at 4. The surface of the bill at F and G is round, hard and slippery. With

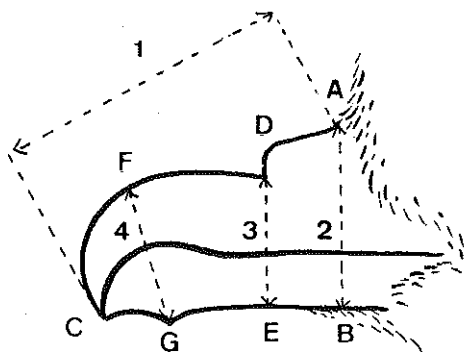


Fig. 1. — Measurements used.

a live, struggling bird this measurement is difficult to make accurately. It is easier to keep the bill closed, holding it together at 4 and measuring 2. In museum specimens the bill is often slightly open, making accurate measurements at 4 impossible. By measuring maximum height at 2 there is far less room for error in both museum and live specimens.

Tabs. 6A & B (*Bill measurements*).

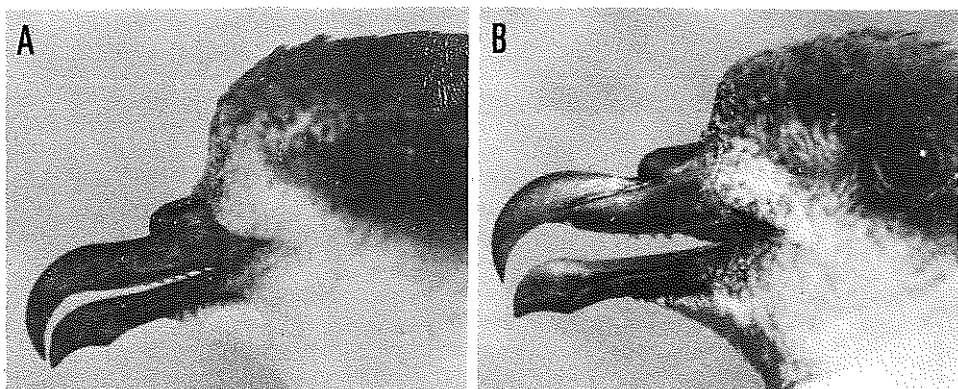
A: Bugio birds.

| | Number of birds measured | Min. | Max. | Average | s. d. |
|-------------|--------------------------|-------|--------|---------|------------|
| Length | 39 | 27mm | 31mm | 29.06mm | ± 1.01 |
| Max. height | 39 | 13mm | 16.2mm | 14.65mm | ± 0.78 |
| Min. height | 37 | 9.5mm | 12mm | 10.70mm | ± 0.64 |

B: Madeira birds.

| | Number of birds measured | Min. | Max. | Average | s. d. |
|-------------|--------------------------|--------|--------|---------|------------|
| Length | 16 | 22mm | 26mm | 25.00mm | ± 1.07 |
| Max. height | 16 | 10.5mm | 12mm | 11.19mm | ± 0.52 |
| Min. height | 14 | 6.85mm | 8.45mm | 7.7mm | ± 0.54 |

Since there are no overlaps in any of the 3 parameters, a single Bugio or Madeira bird can be distinguished by the size of its bill.



Figs. 2A & B.—Profiles of head, A: *Pterodroma madeira*; B: *P. feae*. Showing difference in relative bill size.

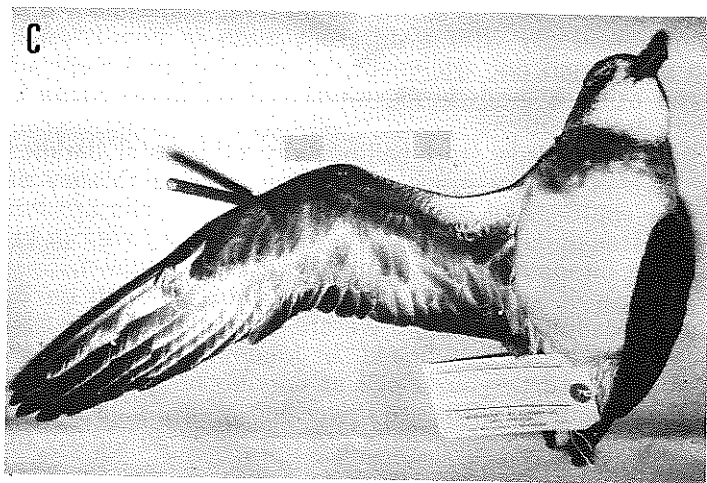
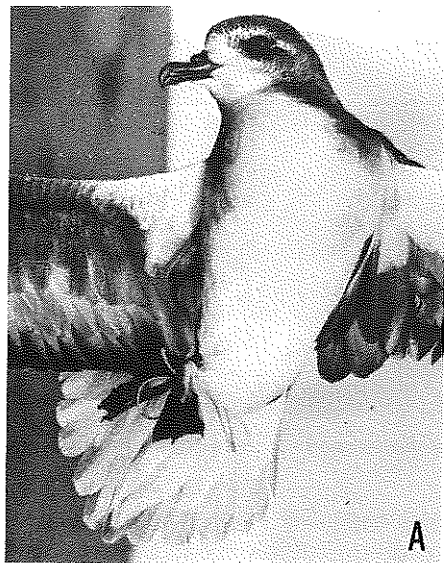
Vocalization. The calls of the Bugio and Madeira *Pterodroma* are different and easily distinguishable from any of the other Procellariidae which nest in the Madeira Archipelago (Jouanin et al. 1969). That of the Bugio bird is a long, mournful wail, occasionally ending in a kind of hiccup. Sometimes a sharper ululating cry is also heard (Jouanin et al. 1969).

The cry of the Madeira bird is similar but somewhat sharper and not quite so mournful as that of the Bugio bird. Sometimes a strange and completely different cry with a different pitch is heard, resembling the whimpering of a small dog. However, in the analyses' made of the sonographs of the cries of both birds, no significant differences were found between their vocalizations.

On Bugio the birds start calling only after total darkness but will not call if there is a clear moon. When the moon sets they start calling again until the approach of dawn. In Madeira their calls are heard half an hour or more after darkness has set in and continue, even in bright moonlight, in varying intensity, while there is no sign of dawn.

The volume of sound and number of birds calling on Bugio is far greater than in Madeira. On Bugio we are alongside the nest burrows and the birds call just above our heads. In Madeira the breeding area is at about 1650m a.s.l. and the birds call at varying heights among the mountain peaks. Since here the birds are fewer and we are placed a considerable distance from their nests, their calls are not heard so clearly or so loudly.

Plumage. We have been unable to find any constant distinguishing feature in the plumage of either bird. Both birds have white underparts including the chin, cheek, throat, breast and belly. The general appearance of the underparts of the tail is also white but mixed with a light shade of grey. However the ventral surface of the wing, including the primaries, secondaries and under-wing coverts, are grey with a little smudging of white in



Figs. 3A-C.— Three species of *Pterodroma*. A: *P. madeira*; B: *P. feae*, photos. P.A.Z.; C: *P. mollis* from Antipodes Island, New Zealand, phot. John Warham. Note dark collar only on *P. mollis*.

the middle of the wing. This amount of white varies. The tail is wedge shaped.

All upperparts of both birds, including the dorsal surface of the wing, are dark grey, but the upper surface of the tail, including the tail-coverts, is a very pale grey. The dark grey of the crown extends to below the eye where the grey is a still darker shade. The area between the black bill and the forehead is occasionally white but is mostly a mixture of grey and white. In some birds, immediately above the eye there is a whitish eyestripe, not sharply outlined, varying in intensity, extending a short distance back and very faintly forward. In other birds this feature is hardly noticeable, in others non-existent. The sides of the breast have a varying amount of light grey but in none of the live birds we have handled or in any of the museum specimens we have examined have we found anything remotely approaching a complete breast band such as is present in most *P. mollis* from New Zealand (see fig. 4A-C).

Recognition at sea. In flight the contrast of their dark grey upperparts with their white underside is a distinguishing feature of both birds, as they soar up and swoop down, showing, alternately, their dorsal and ventral surfaces. However, despite the considerable difference in size between the Bugio and Madeira bird, we have found it impossible to distinguish one from the other at sea.

During the breeding season they can be seen in fair numbers between Madeira and the Deserta Islands especially if there is a stiff breeze. During the approximately 3 hour trip between Funchal and Bugio we have seen as many as 17 *Pterodromas*, but sometimes, and especially when there is no wind, none are seen. They are seldom seen within 2 miles of the coast but at sunset we have seen an occasional bird flying in the passage between Bugio and Deserta Grande.

Between Porto Santo and Madeira fewer are seen, but between Ponta de São Lourenço and Santa Cruz birds are often observed. It is here that they are to be found most regularly and in greatest numbers. One might be led to believe that, since this area is so close to Madeira and 18-20 miles distant from Bugio, they are Madeira birds, but since they cannot be distinguished at sea this cannot be proved.

CONCLUSION

The Bugio *Pterodroma* has recently been known as *P. mollis deserta* Mathews and the Madeira one as *P. m. madeira* Mathews; both known locally as Freira and both considered different races of *P. mollis*. Mathews also considered the Cape Verde Island bird, *P. m. feae*, a third race of *P. mollis* but Bourne 1957, Jouanin et al. 1969, and Cramp & Simmons 1977, all considered *P. m. deserta* as inseparable from *P. feae*.

Bourne 1983 advocated that the two birds under discussion be treated binomially as distinct species, the Madeira bird as *P. madeira* and the Bugio bird, together with the Cape Verde Island bird, as *P. feae*.

Both Jouanin and we have been of the same opinion for a number of years and in 1976 P.A.Z. wrote to Warren B. King suggesting that the Madeira and Bugio birds were in fact different species. We hope that with the data presented here any possible doubt which may have existed will be now removed and that what was advocated by Bourne will be generally accepted.

While we believe that all *P. feae* specimens referred to in this paper and listed as being taken on Deserta Grande were actually taken on Bugio, and while we also believe that *P. feae* does not nest on Deserta Grande and has not done so in recent times, Harald Pieper, who is making a study of the fossil bird bones of the Madeira Archipelago, has found the bones of *P. feae* on Deserta Grande, Madeira and Porto Santo. He has no fossil bones from Bugio. He has also found *P. madeira* bones on Madeira and Porto Santo. Among the small sample of fossil bones from the Salvage Islands he has found no trace of *Pterodroma* (In litt).

ACKNOWLEDGEMENTS

Our thanks are due to many people, chief among whom is Jerry Maul, previous curator of the Museu Municipal do Funchal, for his encouragement and continued help in writing this paper. He has read the drafts and has offered many invaluable suggestions for improvement. Our thanks are also due to several friends who accompanied us on our visits to the breeding sites of the Madeira *Pterodroma* and to Bugio. Without the help of Henrique Costa Neves, Manuel Biscoito, present curator of the Funchal Museum, and Donato Caires, we would never have reached the ledges on which the Madeira bird breeds. Timothy Maul, Ted Gerrard, and Elizabeth Zino (patient and long suffering wife of F.Z.) also helped in these expeditions. We are also most grateful to the Portuguese Navy and to the Royal Navy for their help in our studies of the Bugio bird. Helicopter trips from H.M.S. Endurance, H.M.S. Naiad and H.M.S. Brave, and the resulting discovery of the northern plateau were of special importance. Our thanks too go to Adam Blandy and João Borges for helping with transport and to Jorge de Castro for photographic work. Recordings of the cries of both birds were analysed by Paul Gailly of the Service de Ethologie of Liège University, for which we are indeed grateful.

We also wish to thank Graham Cowles of the British Museum (Natural History), the Royal Museum of Scotland, the Cambridge Museum, the American Museum of Natural History, the Alexander Koenig Museum in Bonn, and the Museum für Naturkunde in Berlin and also Christian Jouanin, Francis Roux and B. Zonfrillo for supplying us with details and measurements of specimens, W.R.P. Bourne for advice and Harald Pieper for pertinent information and Cecilia Zino for a drawing.

We are also most grateful to ICBP for supplying us with the climbing equipment necessary for these expeditions and to Sun Tours of Witney for transporting it to Madeira.

REFERENCES

- Bourne, W.R.P.:
 1983. The Soft-plumaged Petrel, the Gon-gon and the Freira, *Pterodroma mollis*, *P. feae*, and *P. madeira*. *Bull. Brit. Orn. Club* 103:52-58.
- Collar, N.J. & Stuart, S.N.:
 1985. Gon-gon, *Pterodroma feae* (Salvadori 1900), Freira, *Pterodroma madeira* Mathews 1934 in Threatened birds of Africa and related islands: The ICBP/IUCN Red Data Book, Part 1, 3rd edition 39-46, 52-58.
- Cramp, S. & Simmons, K.E.L.:
 1977. The birds of the western Palearctic. Vol. 1. Oxford University Press: pp. 129-132.
- Dalgleish, J.J.:
 1890. Notes on the petrels of Madeira and adjoining seas. *Proc. Roy. Phys. Soc. Edinburgh* 11:27-30.
 1891. Letter *Ibis* (6) 2:386.
- Hartwig, W.:
 1891. Die Vögel der Madeira Insel-Gruppe. *Ornis* 7:151-188.
- Imber, M.J.:
 1985. Origins, phylogeny and taxonomy of the gadfly petrels *Pterodroma* spp. *Ibis* 127:197-229.
- Jouanin, C., Roux, F. & Zino, A.:
 1969. Visites aux lieux de nidification de *Pterodroma mollis* "deserta". *Oiseau* 39: 161-175.
- Mathews, G.M.:
 1934. Remarks on the races of *Pterodroma mollis*. *Bull. Brit. Orn. Club* 54:161, 178-179.
- Metcalf, J.:
 1927. Wandering among forgotten Isles. J.H. Sears & Co. New York.
- Schmitz, E.:
 1894. *Orn. Monatsb.* 2:195.
 1896. *Orn. Jahrb.* 7:199.
 1905. *Orn. Jahrb.* 16:220.
 1905. *Zeitsch. für Oologie u. Ornithol.* 14:1-2.
 1906. *Orn. Jahrb.* 17:25, 199-204.
 1910. *Orn. Jahrb.* 21:106.
- Warham, J. & Bell, B.D.:
 1979. The birds of Antipodes Island, New Zealand. *Notornis* 26:127-169.

Corrections

- Page 145, footnote, first line from top: Instead of "Portuguesa" read "Portuguese".
- Page 152, line 15 from top: Instead of "arount" read "around".
- Page 159, line 6 from bottom: Instead of "fig. 1." read "figs. 2A & B".
 line 5 " " " of "fig. 2." " "fig. 1."
 line 4 " " " of "Tabs. 5A & B" read "Tabs. 6A & B".
- Page 163, line 15 from top: Instead of "figs. 4A-C" read "figs. 3A-C".