

A SURVEY OF THE DISTRIBUTION, DENSITY AND HABITAT PREFERENCES OF THE LONG-TOED PIGEON.

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With 2 figures, 3 tables and 2 appendices

ABSTRACT: The purpose of the study was to obtain information on the distribution, population density and habitat preferences of the Long-toed Pigeon. Eight weeks were spent on Madeira surveying laurel forest and associated habitats mainly in the north of the island. Pigeons and a number of habitat variables were recorded using a simple line-transect method. The Long-toed Pigeon was most common in Ribeira do Inferno, Ribeira da Janela and Ribeira Grande. Supplementary evidence suggests that the Fajã da Nogueira and Lamaceiros/Ribeiro Frio areas are also important. The association of pigeons with laurel forest was confirmed and a particular association with low-level forest was highlighted. Two recommendations arising from the work are, firstly, that special consideration should be given to the preservation of the forest in Ribeira da Janela and secondly, that the survey should be repeated in the future years to monitor long-term changes in distribution and density.

RESUMO: ESTUDO DA DISTRIBUIÇÃO, DENSIDADE E PREFERÊNCIA DE HABITAT DO POMBO TROCAZ. O objectivo deste estudo era obter informação sobre a distribuição, densidade populacional e preferências de habitat do Pombo Trocaz. Foram gastas 8 semanas a observar a Laurisilva e habitats associados, principalmente no Norte da ilha. Foram registados os pombos e um certo número de variáveis de habitat usando o método do transecto linear simples. O Pombo Trocaz revelou-se mais comum na Ribeira da Janela, Ribeira do Inferno e Ribeira Grande. Evidências suplementares sugerem que as áreas da Fajã da Nogueira e os Lamaceiros / Ribeiro Frio são também importantes. A associação dos Pombos Trocazes à Laurisilva foi confirmada e uma associação particular com a floresta de baixa altitude é evidenciada. Do presente trabalho nascem duas recomendações: particular atenção deve ser dada à protecção da Laurisilva na Ribeira da Janela e levantamentos deste tipo devem ser repetidos em anos futuros a fim de detectar alterações de distribuição e densidade.

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INTRODUCTION

The Long-toed Pigeon, *Columba trocaz* (HEINEKEN, 1829), is endemic to Madeira and is restricted almost entirely to areas of native laurel forest in the north of the island (ZINO & ZINO, 1986). The species is endangered (COLLAR & STUART, 1985) and there is comparatively little information concerning its biology, behaviour and ecology. The population was estimated to be *ca.* 1000 birds (ZINO & ZINO, 1986) and with the continued hunting pressure (up to 500 birds shot or poisoned in 1985, (ZINO & ZINO, 1986)) there is obvious concern about the continued survival of the species.

In the summer of 1986 a team from Manchester, England visited Madeira to gather information on the ecology and status of the Long-toed Pigeon. Presented in this paper are the most important results of this work. A complete account was published by the International Council for Bird Preservation in their study report series (JONES *et al.*, 1989).

The objectives of our study were 1) to collect data on the relative densities of pigeons in different parts of the island and to identify 'good' areas for this species; 2) to provide information on the habitat requirements of the species and 3) to provide a baseline of data on pigeon density and distribution with which future comparisons can be made.

METHODS

A total of eight weeks was spent on Madeira from 20th July to 14th September 1986. Survey work was undertaken from four different locations: Lamaceiros near Portela; Fonte de Bispo; Ribeiro Frio and Encumeada. Two weeks were spent at each location and we stayed in houses owned by the Forestry Service.

Data were collected by walking and censusing through areas of laurel forest and other habitats. Whilst walking we used a line-transect method to record Long-toed Pigeons. This involved walking continuously and recording all contacts with pigeons regardless of how far away the birds were. Although we walked continuously whilst censusing, the recording was split into five-minute periods. At the beginning of each five-minute period a number of habitat variables were assessed. The dominant habitat types were recorded on a scale from 0 to 4. A 0 denoted the absence of a habitat type and a 4 denoted its maximum occurrence. These habitat types were; laurel forest, tree heather, pine, eucalyptus, agriculture, housing and pasture. Height of the canopy was also assessed on a scale of 1 (below 1m.) to 5 (above 15m.).

On each of the transects there was a minimum of two people. If there were more observers, the number specifically watching for pigeons was restricted to two. The

personnel were changed for different transects, so that very few were covered by the same group of people. An effort was made to ensure that each transect was conducted at the same walking pace, and that the pace did not vary during a transect. Within the constraints of time and personnel available, an attempt was made to repeat as many transects as possible. The habitat variables were not recorded on the repeats of the transects.

We attempted to visit and carry out transects in all the areas of Madeira where there had been previous sightings of pigeons (except when the record was a very old one from an area which has since lost its native vegetation). We also censused other areas which we thought might be suitable for pigeons. The precise locations of our transects were dictated by the topography of the island. The river valleys are steep-sided and there are often sharp ridges between adjacent valley systems. Because there are very few paths through these areas, we either followed the man-made water channels (levadas) through the mountains or walked along the river beds.

RESULTS

TRANSECT RESULTS

We undertook 25 separate transects, 11 of which were repeated at least once. The approximate locations of all the transects are shown in Figure 1. A detailed description of the location of each transect is given in Appendix 1. Specific details of the date, time and length of each transect are shown in Appendix 2. It is hoped that the information given in the figures, and appendices and the notes associated with the appendices, will enable the transects to be repeated in a comparable way in the future.

The transects covered a total distance of 171 km., of which 62 km. were repeats of transects. These figures were summed from those provided for each transect in Appendix 2 and they are likely to be underestimates. We measured the lengths of the transects from a 1:50,000 map which does not show all the twists and turns of the paths and riverbeds.

It can be seen from the map in Figure 1 that most of our effort was concentrated on the north side of the island where the laurel forest is most abundant. We were anxious to carry out some censuses on the south side of the island and five transects (13, 14, 22, 23 and 24 in Appendix 1) were conducted partly or wholly on the south side. We recorded for a total of 721 five-minute periods, 92 of which were on repeated transects. The numbers of pigeons recorded on each transect are shown in Table 1. These data are presented in a variety of ways; under the heading 'all counts' is given the mean and standard deviation of the number of pigeons re-

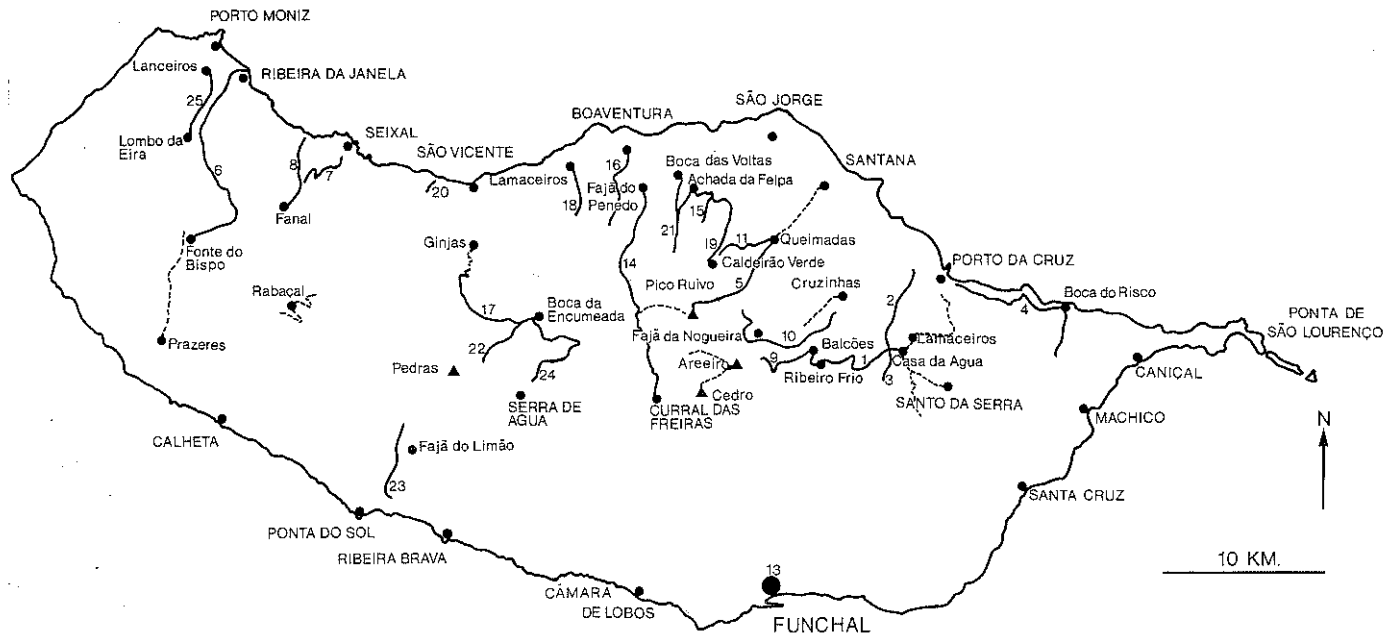


Fig. 1 - Map showing the transects on the island of Madeira. The solid lines represent transects. The dotted lines show walks undertaken whilst we were engaged in other work but were still watching for pigeons. The number adjacent to each solid line is the transect number in Appendices 1 and 2. The solid dots represent towns or other places referred to in Appendices 1 and 2; the solid triangles represent mountain peaks.

corded per five-minute period. These figures do not necessarily reflect the relative densities of pigeons in different areas. On some transects much more time was spent walking through suitable pigeon habitat. A more direct comparison of the density of pigeons within suitable areas is shown under the heading 'zeros omitted'. Recorded here, for each transect, is the mean and standard deviation of the number of pigeons seen or heard in five-minute counts which recorded at least one pigeon. In this case "c" in the table indicates the number of five-minute periods in which pigeons were recorded. The last column in Table 1, 'max. n' represents the maximum possible number of pigeons seen on each transect. When some of the transects

TABLE 1. - TRANSECT RESULTS

transect number	n	c	all count		zeros omitted			max. n
			\bar{x}	S.D.	c	\bar{x}	S.D.	
1.	6	34	0.17	0.58	4	1.50	1.00	22
2.	4	19	0.21	0.53	3	1.33	0.58	4
3.	1	12	0.08	0.29	1	1.00	0.00	1
4.	0	29	0.00	0.00	0	0.00	0.00	0
5.	0	18	0.00	0.00	0	0.00	0.00	0
6.	140	82	1.65	2.80	38	3.55	3.19	148
7.	5	18	0.28	0.67	3	1.67	0.58	5
8.	0	45	0.00	0.00	0	0.00	0.00	0
9.	3	26	0.12	0.43	2	1.50	0.17	3
10.	2	29	0.07	0.26	2	1.00	0.00	2
11.	2	21	0.09	0.29	2	1.00	0.00	2
12.	-	-	-	-	-	-	-	-
13.	0	5	0.00	0.00	0	0.00	0.00	0
14.	4	80	0.05	0.22	4	1.00	0.00	4
15.	5	11	0.46	0.69	4	1.25	0.25	5
16.	4	18	0.22	0.55	3	1.33	0.58	5
17.	2	32	0.06	0.35	1	2.00	0.00	2
18.	2	18	0.11	0.32	2	1.00	0.00	2
19.	27	26	1.04	1.56	11	2.46	1.51	27
20.	12	6	2.00	3.03	4	3.00	3.37	1
21.	8	29	0.28	0.59	6	1.33	0.52	12
22.	0	10	0.00	0.00	0	0.00	0.00	0
23.	2	18	0.17	0.38	3	1.00	0.00	3
24.	2	26	0.08	0.27	2	1.00	0.00	2
25.	9	16	0.56	1.26	3	3.00	1.00	9
Totals	241	629	0.38	1.28	98	2.41	2.39	262

n = number of pigeons on initial transect. c = number of five-minute periods. \bar{x} = mean number of pigeons. S.D. = standard deviation. max. n = highest number of pigeons seen on either initial or repeat transects. Under "zeros omitted" are included only the five-minute periods where at least one pigeon was seen.

were repeated, more pigeons were seen than on the initial census. When the figure for 'max. n' is the same as that under 'n', either the transect was not repeated or fewer pigeons were seen on the repeat transect.

The highest numbers and densities of Long-toed Pigeons were recorded on

transects in Ribeira do Inferno (Transect 20), Ribeira da Janela (Transects 6 and 25) and Ribeira Grande (Transect 19). Another area which had a high density of pigeons was the area between Lamaceiros and Ribeiro Frio (Transect 1). This was not initially apparent in the results until we looked at the 'max. n' for Transect 1 in Table 1. Many more pigeons were seen on a repeat of Transect 1 (12 in one flock) than on the initial census. An adjacent area, Fajã da Nogueira/Ribeira da Ametade, also produced low numbers on the census (Transect 10) but from results of all-day watches at this site, we know that there was a high density of pigeons here.

On five transects, numbers 4, 5, 8, 13, and 22, no pigeons were recorded. There was little or no Laurel forest along these routes. The exception was transect 5 from Pico Ruivo, via Achada do Teixeira to Queimadas. This transect passed through areas which contained some laurel forest, but heavy rain stopped us censusing in the areas which would have been most suitable for pigeons.

There are several areas of the island which, for various reasons, we were not able to census thoroughly. These areas include: the area around Serra de Água near Encumeada; the upper reaches of the Ribeira da Ponta do Sol (we lost the path half-way up Transect 23) and the upper reaches of Chão da Ribeira (we could not find a path that went right through the valley). The lower part of Chão da Ribeira was censused on Transect 7. We know from published reports that the Long-toed Pigeon inhabits all of these three areas.

There are also a number of other areas which we could not visit and which, even though there were no previous records for these areas, still look suitable for pigeons. Transect 20, along Ribeira do Inferno came to a halt when our way was blocked by a waterfall. The upper reaches of this valley are likely to contain pigeons and may be accessible from Bica da Cana, via Pico Ruivo do Paul. The valley of the Ribeira Seca (see description for Transect 10) is covered with laurel forest and looks ideal for pigeons. We were prevented from walking up this valley by a waterfall. In the extreme west of Madeira the valley of the Ribeira da Cruz looks suitable, while the same may be said for several valleys overlooking the north coast. These include Ribeira de João Delgado, Ribeira dos Caimbos or Água d'Alto, and Ribeiro da Fajã do Ribeirão.

COMPARISONS OF INITIAL AND REPEATED TRANSECTS

There are many factors which might produce variability in the numbers of pigeons observed along the transects. The extent to which they might conspire to affect the validity of the results may be investigated by comparing the initial and repeated counts along the same transect. This information is given in Table 2 for eight transects. The mean number of pigeons per five-minute count is given for the initial and repeat census of each transect. The transects have also been ranked

TABLE 2. - COMPARISON OF THE DENSITIES OF PIGEONS RECORDED ON INITIAL AND REPEAT TRANSECTS

transect	initial census			repeat census		
	pigeons seen	\bar{x}	rank	pigeons seen	\bar{x}	rank
1	6	0.17	3	22	0.65	3
3	1	0.08	4	0	0	6
6*	51	2.32	1	59	2.68	1
14	4	0.05	7	2	0.03	5
17	2	0.06	6	2	0.06	4
19*	11	1.00	2	22	2.00	2
22	0	0	8	0	0	6
24	2	0.08	4	0	0	6

* indicates that only part of the census was repeated and in these cases the figures for the initial census represent only those parts that were subsequently repeated. \bar{x} =mean number of pigeons recorded per five minute line count. Using Kendall's concordance test, there is no significant difference between the two ranked orders ($w=0.959$, probability that there is a difference <0.001).

in order of decreasing 'pigeon means' for the initial and the repeat censuses. If our census results are a true reflection of the pigeon populations in different areas then we might expect there to be little difference in the ranked orders. In other words, the transect which produces the highest mean count should also produce the highest when all the transects are repeated. The rank order of repeated transects was much the same as that for the original ones. Using a statistical test of concordance (KENDALL, 1948), the orders were not significantly different ($w=0.959$; probability that they were different <0.001). Transects which changed their order, namely 3 and 6, were ones on which very few pigeons were observed. These data suggest that the differences in densities of pigeons recorded on different transects are likely to be meaningful ones.

HABITAT PREFERENCES

Spearman rank correlation coefficients were calculated to relate the habitat variables to the number of pigeons seen in each five-minute period. The results are shown in Table 3. Correlation coefficients were also calculated between altitude

TABLE 3. - SPEARMAN RANK CORRELATIONS OF NUMBER OF LONG-TOED PIGEONS WITH HABITAT AND PHYSICAL VARIABLES.

correlation with -	r_s	n	P
height of canopy	0.193	689	<0.001
amount of laurel	0.260	689	<0.001
amount of heather	-0.060	689	0.115
amount of pine	-0.142	689	<0.001
amount of eucalyptus	-0.090	689	0.018
amount of agriculture	-0.134	689	<0.001
amount of pasture	-0.057	689	0.132
amount of housing	-0.084	689	0.027
altitude	-0.299	600	<0.001
gradient	0.364	600	<0.001

r_s = Spearman rank correlation coefficient, n = number of five minute counts, P = probability that there is no correlation between pigeon numbers and each variable.

and gradient, and pigeon numbers. The approximate altitude of each five-minute section of each transect was assessed by reference to the 1:50,000 scale map of Madeira. The gradient was calculated from the map by counting the number of contours within appropriate 10mm sections either side of the path walked. Only the results from the initial, not repeat, transects were used for these correlations.

When interpreting the results of the correlations it must be remembered that the different variables are likely to be very highly correlated amongst themselves. For instance, one variable may be correlated with the occurrence of pigeons, not because it is itself important but because it is correlated with another variable which is important in delimiting pigeon distribution. The results in this instance are fairly clear. The variables which are positively correlated with the occurrence of pigeons all appear to be related to the distribution of laurel forest. The variable 'amount of laurel' is obviously important, as is 'height of canopy'. Taken together they suggest that pigeons prefer areas with a complete cover of large laurel trees. The amount of heather, pine, eucalyptus etc. are all negatively related, probably because the presence of these habitats reflects a lack of laurel forest. The high

correlation with gradient may simply indicate that agriculture and forestry are not practical in the steepest valleys and that these valleys are likely to have undisturbed laurel forest. On the other hand, there may be something about the steep valleys which the pigeons particularly 'like'.

The negative correlation with altitude is interesting. It is usually thought that this species is confined to laurel, which in turn is restricted to the upper reaches of valleys. CRAMP (1985) refer to the pigeon as present "in the high forest zone". The concentration of laurel in higher areas is no doubt because of the use of the lower parts of the valleys for housing and agriculture. When valleys are not settled in this way, as in the cases of Ribeira da Janela (Transect 6) and Ribeira do Inferno (Transect 20), pigeons may be recorded right down to the coast (this has also been reported by ZINO & ZINO, 1986). More than this, the correlation suggests that low lying areas may actually be preferred.

The relationships between laurel, altitude and pigeon density are explored in more detail in Figure 2. Two variables, 'number of pigeons' and 'laurel cover', both

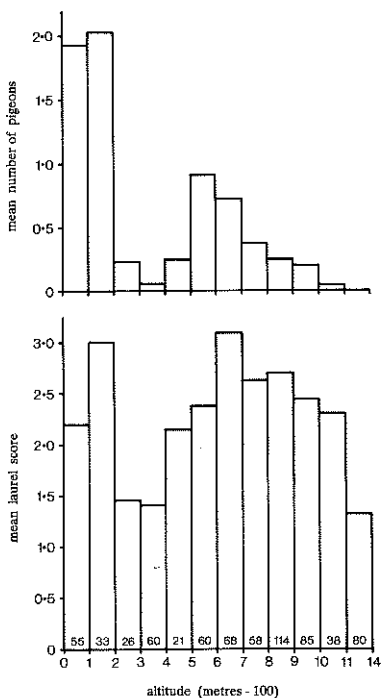


Fig. 2 - Histograms showing the effect of the altitude on the occurrence of Long-toed Pigeons and laurel forest. Pigeon occurrence is represented by the mean number seen per five-minute line count. Laurel is represented by the mean laurel score recorded for each five-minute count. The numbers inside the histograms represent the number of observations at each altitude.

calculated as the mean per five-minute count, are plotted against altitude. The distribution of the laurel shows two peaks, a low level and a higher level peak, with a sharp dip between. This dip may indicate where the laurel forest has been removed and replaced by agriculture and forestry. Although the same 'gap' in distribution is seen when pigeon numbers are plotted against altitude, there is still a marked difference between the histograms. The lower peak of pigeon numbers is relatively much more important than the higher peak. This indicates a preference of pigeons for laurel forest at low altitudes. There is no correlation between altitude and height of canopy within laurel forest areas ($r_s = 0.058$, $n = 466$, $P = 0.211$) so the preference for low altitude forest is probably not due to some factor such as height (and therefore age) of the trees.

DISCUSSION

One of the main aims of this study was to provide a baseline of data on the density and distribution of Long-toed Pigeons. This aim was largely achieved. Recording along transects has provided data from various habitats over a wide area of Madeira. There are perhaps two uses for these data. One is to enable comparisons to be made with future surveys. For this reason simple and easily-repeatable techniques were used and suggestions about repeating the transects are given later. The second use is to compare the transect results from different areas and decide which are the best areas for pigeons. According to our results the best areas are obviously those in which we recorded the highest pigeon densities. This does not mean that there are not other areas which are equally good or even better for pigeons. In short, we can definitely say that some areas are good for pigeons but not that these are the only good areas.

There are a number of areas which seem to be particularly important - Ribeira da Janela, Ribeira Grande and Ribeira do Inferno produced the highest densities of pigeons on the transect counts. Information from other observations suggests that Fajá da Nogueira and the forest between Ribeiro Frio and Lamaceiros are also important.

Ribeira da Janela deserves the highest conservation status. This valley has a large area of unbroken laurel forest which extends almost from the sea to the plateau of the Paul da Serra. There is little agriculture and no housing in the valley itself and there seems to be no need for roads or other developments. The only access into the valley is either up the river bed itself or along one of the levadas. There are some large stands of very old *Ocotea foetens* and *Laurus azorica* in the valley and there seems to have been very little disturbance of the forest. The Ribeira da Janela area must represent one of the most 'natural' and therefore important forest habitats left in Europe.

Another of our aims was to gather information on the habitat preferences of the Long-toed Pigeon. It has already been established that this species is largely confined to laurel forest (BANNERMAN & BANNERMAN, 1965). We have been able to confirm this

preference and also point out that low altitude laurel forest may be particularly important to pigeons. There are at least two possible explanations for this apparent preference for low-level forest. One reason might be that the species make-up of the laurel forest changes with altitude and the species that pigeons prefer are more often found at low altitude. We do not have enough information on the changes in vegetation with altitude and the pigeon's diet to suggest how the two factors might interact to determine the species' range. A second reason is that the trees might have longer growing seasons and might produce more fruit at lower altitudes. The preference for laurel at low altitudes may of course be only temporary, if fruiting of the laurel trees is dependant upon weather, and the weather changes with altitude, trees at different altitudes may fruit at slightly different times. This might lead to pigeons exploiting laurel forest at different altitudes at different times of the year.

RECOMMENDATIONS FOR FURTHER WORK

The most important aspect of this study is probably that it can be easily repeated in the future. This will allow an assessment of any changes in the abundance and distribution of Long-toed Pigeons on Madeira. Future workers should replicate our methods as closely as possible and follow the routes described. Extension of the survey to new areas would also be very useful.

If one is primarily interested in highlighting changes in population density of the pigeons, it is perhaps not necessary to repeat all the transects. Repetition of a representative sample would probably provide an estimate of how the population is changing. This sample would have to include transects from different altitudes, different regions of the island, areas where we recorded low densities of pigeons and areas where we recorded high densities. Bearing these criteria in mind a minimum sample should perhaps include Transects 1, 6, 14, 17, 19, 20 and 23.

The distribution and abundance of pigeons may well change throughout the year. Repetition of transects at different times of year should greatly increase our knowledge concerning the use of different areas of laurel at different times of year. Ideally this sort of information would be best obtained from monitoring the movements of individually-marked birds. Wing-tagging or radio-tracking would be the best techniques (assuming that the birds could be caught!). The data obtained from such a monitoring scheme would tell us the areas of laurel forest needed to support certain densities of pigeons, the home range sizes of individual birds and the use of different areas of laurel forest at different times of year.

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APPENDIX 1. LOCATION OF TRANSECTS

transect number/description	co-ordinates		altitude (m)	
			start(mid.)	end
1 Casa da Água dos Lamaceiros to EN103 road at Ribeiro Frio	32° 44' 07" N 32° 45' 59" N	16° 50' 36" W to 16° 50' 24" W	800	825
2 Rocha dos Pingos to São Roque do Faial	32° 44' 20" N 32° 45' 59" N	16° 50' 48" W to 16° 50' 24" W	800	225
3 Rocha dos Pingos towards Lombo do José Nunes	32° 44' 20" N 32° 43' 36" N	16° 50' 48" W to 16° 51' 06" W	800	1178
4 EN101-3 road above Machico via Boca do Risco to Porto da Cruz	32° 44' 17" N 32° 45' 34" N	16° 46' 13" W to 16° 48' 30" W	125 (350)	125
5 Pico Ruivo via Achada do Teixeira towards Queimadas	32° 45' 18" N 32° 45' 45" N 32° 46' 28" N	16° 56' 20" W via 16° 54' 58" W to 16° 54' 28" W	1862(1592)	900
6 Fonte do Bispo to Ribeira da Janela, then along river to coast	32° 47' 19" N 32° 51' 02" N	17° 10' 32" W to 17° 09' 02" W	1225	0
7 Fanal via Chão da Ribeira to Seixal	32° 48' 32" N 32° 48' 54" N	17° 07' 24" W to 17° 06' 34" W	1100	325
8 Fanal to just above EN101 road near Ribeira da Pedra Branca	32° 48' 50" N 32° 49' 30" N	17° 07' 30" W to 17° 07' 23" W	1175	200
9 Ribeiro Frio to Balcões, then along levada to Ribeira das Lages	32° 43' 56" N 32° 44' 06" N	16° 53' 00" W to 16° 54' 24" W	825	900
10 Head of Ribeira Seca through Fajã da Nogueira to EN103 road	32° 45' 09" N 32° 45' 05" N	16° 54' 52" W to 16° 52' 34" W	1050	425
11 Casa das Queimadas towards Caldeirão Verde	32° 46' 48" N 32° 46' 33" N	16° 54' 04" W to 16° 55' 48" W	900	950
12 Point counts around Ribeiro Frio	32° 43' 56" N	16° 53' 00" W	825	825
13 Park at end of Avenida do Infante, above marina, Funchal	32° 38' 25" N 32° 38' 25" N	16° 54' 46" W to 16° 54' 46" W	25	25

14 Curral das Freiras via Pico das Torrinhãs to Fajã do Penedo	32° 43' 00" N 32° 45' 05" N 32° 48' 04" N	16° 57' 44" W via 16° 58' 22" W to 16° 57' 25" W	550(1425) 225	
15 Levada above Ribeira do São Jorge to Ribeiro Bonito	32° 48' 13" N 32° 47' 27" N	16° 56' 16" W to 16° 56' 10" W	625	750
16 Along Ribeira dos Moinhos above Boaventura	32° 48' 50" N 32° 47' 21" N	16° 58' 12" W to 16° 58' 52" W	300	975
17 Boca da Encumeada via Rocha do Folhadal to path to Ginjas	32° 45' 02" N 32° 45' 25" N 32° 46' 15" N	17° 00' 56" W via 17° 02' 45" W to 17° 02' 40" W	975 (925)	725
18 Along Ribeira da Camisa, above Lamaceiros, west of Boaventura	32° 48' 34" N 32° 47' 43" N	16° 59' 51" W to 16° 59' 37" W	300	800
19 Ribeiro Bonito via Ribeira Grande to below Caldeirão Verde	32° 47' 52" N 32° 45' 31" N	16° 55' 59" W to 16° 55' 56" W	650	600
20 Along Ribeira do Inferno, west of São Vicente	32° 48' 23" N 32° 48' 12" N	17° 03' 46" W to 17° 03' 56" W	25	25
21 Achada da Felpa towards Pico Canário, then to Boca das Voltas	32° 47' 53" N 32° 47' 02" N 32° 48' 22" N	16° 56' 34" W via 16° 56' 56" W to 16° 56' 52" W	850(1250)	750
22 Boca da Encumeada to head of Ribeira da Fajã das Éguas	32° 45' 03" N 32° 44' 20" N	17° 01' 13" W to 17° 02' 12" W	1175	1375
23 Levada above Ribeira da Ponta do Sol	32° 41' 03" N 32° 42' 41" N	17° 05' 12" W to 17° 04' 52" W	350	375
24 Boca da Encumeada via Casa das Voltas towards Serra de Água	32° 45' 00" N 32° 44' 12" N 32° 43' 45" N	17° 00' 58" W via 17° 00' 00" W to 17° 01' 02" W	950 (975)	575
25 Lanceiros along middle slopes above Ribeira da Janela to Lomba da Eira	32° 50' 45" N 32° 49' 38" N	17° 09' 48" W to 17° 10' 32" W	500	550

NOTES. Place names, co-ordinates and altitudes were taken from the 1:50.000 map of Madeira published by the Instituto Geográfico e Cadastral. If there was an obvious landmark in the middle of a transect, its co-ordinates and altitude are given. The 'Lamaceiros' in Transect 19 is not the 'Lamaceiros' referred to in earlier transects. Several place names on Madeira occur more than once.

APPENDIX 2. - DETAILS OF TRANSECT

transect number	date	length (km)	start time	finish time	walking time (mins)	repeat dates
1	25.7	5.7	1050	1127	35	27.7, 20.8
	27.7		1110	1416	140	
2	25.7	3.7	1134	1356	65	2.8
3	1.8	2.3	1100	1207	35	
4	1.8	6.9	1110	1420	145	12.8, 2.9
5	3.8	5.7	1200	1511	90	
6	12.8	10.3	1135	1421	110	12.8, 2.9
	13.8		1124	1855	300	
7	15.8	2.3	1715	1908	90	19.8
8	15.8	2.3	1533	1718	90	
9	17.8	4.0	1433	1600	45	19.8
	19.8		1133	1357	85	
10	22.8	6.3	1130	1510	145	27.8
11	22.8	4.0	1230	1455	110	
12	24.8		1501	1610	-	28.8
13	27.8		1030	1055	20	
14	26.8	12.8	1355	1950	195	27.8
	27.8		0900	1405	205	
15	29.8	3.4	1335	1537	55	1.9
16	31.8	4.0	1109	1341	90	
17	31.8	6.6	1200	1700	160	1.9
18	31.8	2.3	1210	1500	90	
19	31.8	4.3	1450	1600	55	1.9
	1.9		1405	1558	75	
20	2.9	0.6	1040	1125	30	3.9
21	1.9	4.9	1115	1748	75	
	2.9		1033	1231	70	3.9
22	3.9	4.0	1300	1430	50	
23	3.9	3.7	1234	1455	90	5.9
24	5.9	5.1	1200	1625	130	
25	6.9	3.4	1435	1625	80	5.9

GENERAL NOTES FOR APPENDIX 2.

The scales are explained in the methods section. The length of all the walks were measured directly from a 1:50,000 map of Madeira. The map does not show the routes travelled in detail so all lengths are likely to be underestimates. Some transects were completed over two days walking.

SPECIFIC NOTES. **Transect 1:** Lamaceiros to Rocha dos Pingos on 25.7, repeat of this and extension to Ribeiro Frio on 27.7. **Transect 6:** Part of this transect, from the mouth of the river to a point approximately 3 km up Ribeira da Janela was walked on 12.8. This part of the walk was repeated on 13.8 but from the other direction as part of a walk from Fonte do Bispo, down into the bed of Ribeira da Janela then along to the coast. The whole route was repeated on 2.9. Walking from Fonte do Bispo the route signposted "Galhano" was taken. **Transects 7 and 8:** Directions for these obscure paths were obtained from the forestry house at Fanal. **Transect 9:** The first part of this transect, on 17.8, was from Ribeiro Frio, along the levada to a point about 500m past the turn off to the Balcões viewpoint. On the 19.9 this walk was extended along the levada and then down into Ribeira das Lages. A waterfall prevented a continuation into Fajã da Nogueira. **Transect 11:** During most of this transect, the recorders were walking in sunlight but viewing the forest through a layer of cloud below. **Transect 12:** This 'transect' consisted of three point counts around the Ribeiro Frio area. **Transect 14:** The first part of this transect, on 26.8, was between Curral das Freiras and the Torrinhãs pass. On the next day, 27.8, the transect was continued to Fajã do Penedo on the EN 101 road. The walk was repeated, according to the same pattern, by other observers, on 27.8 and 28.8. **Transect 17:** A total of 2.3 km. of this walk was through tunnels. **Transect 19:** The first part of this transect was from Ribeiro Bonito to Ribeira Grande on 31.8. This was extended to a point below Caldeirão Verde on 1.9. **Transect 21:** The first part of this transect was from Achada da Felpa to Pico Canário on 1.9. The second part, from Pico Canário to Boca das Voltas, took place on 2.9. Much of the time on both days was spent wandering around in circles looking for paths.